Chapter 1: Types of Computer

Computer: Definition

A computer is a machine that can be programmed to manipulate symbols. Its principal characteristics are:

- It responds to a specific set of instructions in a well-defined manner.
- It can execute a prerecorded list of instructions (a program).
- It can quickly store and retrieve large amounts of data.

1.1 Operation: Analog and Digital

Analog Computer

An analog computer (spelt analogue in British English) is a form of computer that uses *continuous* physical phenomena such as electrical, mechanical, or hydraulic quantities to model the problem being solved

Digital Computer

A computer that performs calculations and logical operations with quantities represented as digits, usually in the binary number system
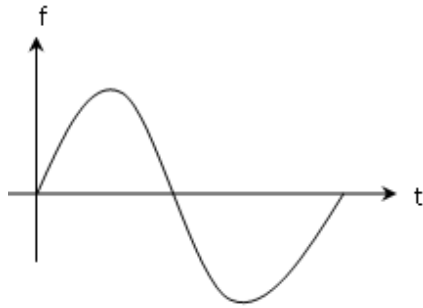
Hybrid Computer (Analog + Digital)

A combination of computers those are capable of inputting and outputting in both digital and analog signals. A hybrid computer system setup offers a cost effective method of performing complex simulations.

Analog Computer	Digital Computer	Hybrid computer
Analog computer operates on continuous data like temperature, pressure, speed, voltage, etc.	Digital computer operates on discontinuous or discrete data (0 and 1).	Hybrid computer is the combination of analog and digital computer. It can operate on both continuous and discontinuous data.
It operates by measuring and comparing.	It operates by counting and calculation.	It can convert analog data to digital and vice versa.

It has low accuracy.	It has higher accuracy.	In a hybrid computer, analog component is used for measuring and comparing, and digital component is used for controlling.
It usually contains either no any or limited storage capacity.	It usually contains larger storage capacity.	Its storage capacity varies from the application area.
It is special purpose computer.	It is a general purpose computer.	It is a special purpose computer.
It cannot be reprogrammed.	It can be reprogrammed.	
It can be operated only by skilled manpower.	It can be operated by general users.	It can be operated only by skilled manpower.
Devices like thermometer, speedometer, pressure gauge, voltmeter, etc. are the examples of analog devices.	Devices like digital watch, digital speedometer, etc. are the examples of digital devices.	
'Presley' is an example of analog computer.	IBM desktop PC, Dell laptop, Acer notebook are the examples of digital computers.	Super computers are usually hybrid computer.

* The wave form of analog computer is

* The wave form of digital computer is

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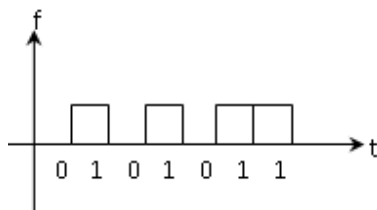
* Major application areas of hybrid computers are

- Weather forecasting
- Automated industry control
- Automated vehicles
- Rocket launching system
- Diagnosis in hospital

1.2 Uses: General Purpose and Specific Purpose

Computers differ based on their data processing abilities. They are classified according to purpose, data handling and functionality.

According to purpose, computers are either general purpose or specific purpose. General purpose computers are designed to perform a range of tasks.

They have the ability to store numerous programs, but lack in speed and efficiency. Specific purpose computers are designed to handle a specific problem or to perform a specific task. A set of instructions is built into the machine.

General Purpose Computers: General-purpose computers are designed to solve a large variety of problems. That is they can be given different programmes to solve different types of problems. General-purpose computers can process business data as readily as they process

complex mathematical formulas. General-purpose computers can store large amount of data and the programmes necessary to process them. Because general-purpose computers are so versatile, most businesses today use them. Most digital computers are general computers and it is mainly such computers that are used in business and commercial data processing.

Special Purpose Computers: Special purpose computers are designed to solve a specific problems; the computer programmer for solving the problem is built right into the computer. Special purpose computers have many features of general-purpose computers but are designed to handle specific problems and are not applied to other computerized activities. For example, special purpose computers may be designed to process only numeric data or to completely control automated manufacturing processes. Moat analogue computers are special purpose computers.

Special purpose computers are often used as training simulators. A simulator is a computer-controlled device for training people under simulated, or artificially created, conditions. The computer creates test conditions the trainee must respond t. it then records and evaluates he responses, providing these results to both trainee and supervisor.

1.3 Capacity: Mainframe, Mini, Personal and Super computer

Computers can be generally classified by size and power (Capacity) as follows:

- Personal computer: A small, single-user computer based on a microprocessor.
- Workstation: A powerful, single-user computer. A workstation is like a personal computer, but it has a more powerful microprocessor and, in general, a higher-quality monitor.
- Minicomputer: A multi-user computer capable of supporting up to hundreds of users simultaneously.
- Mainframe: A powerful multi-user computer capable of supporting many hundreds or thousands of users simultaneously.
- Supercomputer: An extremely fast computer that can perform hundreds of millions of instructions per second.

Supercomputer and Mainframe

Supercomputer is a broad term for one of the fastest computers currently available. Supercomputers are very expensive and are employed for specialized applications that require immense amounts of mathematical calculations (number crunching). For example, weather forecasting requires a supercomputer. Other uses of supercomputers scientific simulations, (animated) graphics, fluid dynamic calculations, nuclear energy research, electronic design, and analysis of geological data (e.g. in petrochemical prospecting). Perhaps the best known supercomputer manufacturer is Cray Research.

Mainframe was a term originally referring to the cabinet containing the central processor unit or "main frame" of a room-filling Stone Age batch machine. After the emergence of smaller "minicomputer" designs in the early 1970s, the traditional big iron machines were described as "mainframe computers" and eventually just as mainframes. Nowadays a Mainframe is a very large and expensive computer capable of supporting hundreds, or even thousands, of users simultaneously. The chief difference between a supercomputer and a mainframe is that a supercomputer channels all its power into executing a few programs as fast as possible, whereas a mainframe uses its power to execute many programs concurrently. In some ways, mainframes are more powerful than supercomputers because they support more simultaneous programs. But supercomputers can execute a single program faster than a mainframe. The distinction between small mainframes and minicomputers is vague, depending really on how the manufacturer wants to market its machines.

Minicomputer

It is a midsize computer. In the past decade, the distinction between large minicomputers and small mainframes has blurred, however, as has the distinction between small minicomputers and workstations. But in general, a minicomputer is a multiprocessing system capable of supporting from up to 200 users simultaneously.

Workstation

It is a type of computer used for engineering applications (CAD/CAM), desktop publishing, software development, and other types of applications that require a moderate amount of computing power and relatively high quality graphics capabilities. Workstations generally come

with a large, high-resolution graphics screen, at large amount of RAM, built-in network support, and a graphical user interface. Most workstations also have a mass storage device such as a disk drive, but a special type of workstation, called a diskless workstation, comes without a disk drive. The most common operating systems for workstations are UNIX and Windows NT. Like personal computers, most workstations are single-user computers. However, workstations are typically linked together to form a local-area network, although they can also be used as stand-alone systems.

Personal computer:

It can be defined as a small, relatively inexpensive computer designed for an individual user. In price, personal computers range anywhere from a few hundred pounds to over five thousand pounds. All are based on the microprocessor technology that enables manufacturers to put an entire CPU on one chip. Businesses use personal computers for word processing, accounting, desktop publishing, and for running spreadsheet and database management applications. At home, the most popular use for personal computers is for playing games and recently for surfing the Internet.

Personal computers first appeared in the late 1970s. One of the first and most popular personal computers was the Apple II, introduced in 1977 by Apple Computer. During the late 1970s and early 1980s, new models and competing operating systems seemed to appear daily. Then, in 1981, IBM entered the fray with its first personal computer, known as the IBM PC. The IBM PC quickly became the personal computer of choice, and most other personal computer manufacturers fell by the wayside. P.C. is short for personal computer or IBM PC. One of the few companies to survive IBM's onslaught was Apple Computer, which remains a major player in the personal computer marketplace. Other companies adjusted to IBM's dominance by building IBM clones, computers that were internally almost the same as the IBM PC, but that cost less. Because IBM clones used the same microprocessors as IBM PCs, they were capable of running the same software. Over the years, IBM has lost much of its influence in directing the evolution of PCs. Therefore after the release of the first PC by IBM the term PC increasingly came to mean IBM or IBM-compatible personal computers, to the exclusion of other types of personal computers, such as Macintoshes. In recent years, the term PC has become more and

more difficult to pin down. In general, though, it applies to any personal computer based on an Intel microprocessor, or on an Intel-compatible microprocessor. For nearly every other component, including the operating system, there are several options, all of which fall under the rubric of PC

Today, the world of personal computers is basically divided between Apple Macintoshes and PCs. The principal characteristics of personal computers are that they are single-user systems and are based on microprocessors. However, although personal computers are designed as single-user systems, it is common to link them together to form a network. In terms of power, there is great variety. At the high end, the distinction between personal computers and workstations has faded. High-end models of the Macintosh and PC offer the same computing power and graphics capability as low-end workstations by Sun Microsystems, Hewlett-Packard, and DEC.

III, Personal Computer Types

Actual personal computers can be generally classified by size and chassis / case. The chassis or case is the metal frame that serves as the structural support for electronic components. Every computer system requires at least one chassis to house the circuit boards and wiring. The chassis also contains slots for expansion boards. If you want to insert more boards than there are slots, you will need an expansion chassis, which provides additional slots. There are two basic flavors of chassis designs–desktop models and tower models–but there are many variations on these two basic types. Then come the portable computers that are computers small enough to carry. Portable computers include notebook and subnotebook computers, hand-held computers, palmtops, and PDAs.

Desktop model

A computer designed to fit comfortably on top of a desk, typically with the monitor sitting on top of the computer. Desktop model computers are broad and low, whereas tower model computers are narrow and tall. Because of their shape, desktop model computers are generally limited to three internal mass storage devices. Desktop models designed to be very small are sometimes referred to as **slimline models**.

Notebook computer

An extremely light weight personal computer. Notebook computers typically weigh less than 6 pounds and are small enough to fit easily in a briefcase. Aside from size, the principal difference between a notebook computer and a personal computer is the display screen. Notebook computers use a variety of techniques, known as flat-panel technologies, to produce a lightweight and non-bulky display screen. The quality of notebook display screens varies considerably. In terms of computing power, modern notebook computers are nearly equivalent to personal computers. They have the same CPUs, memory capacity, and disk drives. However, all this power in a small package is expensive. Notebook computers cost about twice as much as equivalent regular-sized computers. Notebook computers come with battery packs that enable you to run them without plugging them in. However, the batteries need to be recharged every few hours.

Laptop computer

A small, portable computer -- small enough that it can sit on your lap. Nowadays, laptop computers are more frequently called notebook computers.

Subnotebook computer

A portable computer that is slightly lighter and smaller than a full-sized notebook computer. Typically, subnotebook computers have a smaller keyboard and screen, but are otherwise equivalent to notebook computers.

Hand-held computer

A portable computer that is small enough to be held in one's hand. Although extremely convenient to carry, handheld computers have not replaced notebook computers because of their small keyboards and screens. The most popular hand-held computers are those that are specifically designed to provide PIM (personal information manager) functions, such as a calendar and address book. Some manufacturers are trying to solve the small keyboard problem by replacing the keyboard with an electronic pen. However, these pen-based devices rely on

handwriting recognition technologies, which are still in their infancy. Hand-held computers are also called PDAs, palmtops and pocket computers.

Palmtop

A small computer that literally fits in your palm. Compared to full-size computers, palmtops are severely limited, but they are practical for certain functions such as phone books and calendars. Palmtops that use a pen rather than a keyboard for input are often called hand-held computers or PDAs. Because of their small size, most palmtop computers do not include disk drives. However, many contain PCMCIA slots in which you can insert disk drives, modems, memory, and other devices. Palmtops are also called PDAs, hand-held computers and pocket computers.

PDA

PDA stands for Personal Digital Assistant, a handheld device that combines computing, telephone/fax, and networking features. A typical PDA can function as a cellular phone, fax sender, and personal organizer. Unlike portable computers, most PDAs are pen-based, using a stylus rather than a keyboard for input. This means that they also incorporate handwriting recognition features. Some PDAs can also react to voice input by using voice recognition technologies. The field of PDA was pioneered by Apple Computer, which introduced the Newton MessagePad in 1993. Shortly thereafter, several other manufacturers offered similar products. To date, PDAs have had only modest success in the marketplace, due to their high price tags and limited applications. However, many experts believe that PDAs will eventually become common gadgets.

PDAs are also called palmtops, hand-held computers and pocket computers.

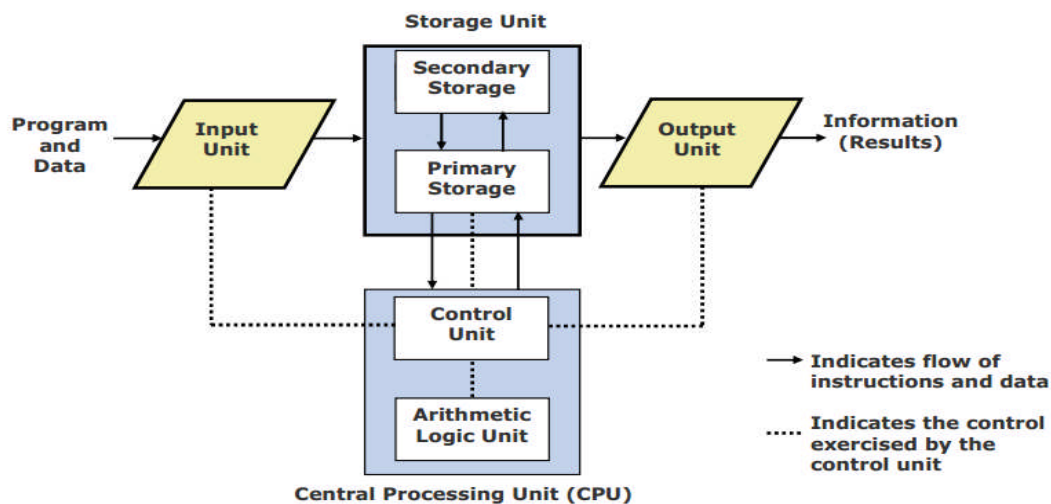# Chapter 2: Basic Architecture

2.1 Building blocks of PC

Figure: Building block of PC

2.2 CPU (Central Processing Unit)

➢ CPU consists of the following features:

  o CPU is considered as the brain of the computer.

  o CPU performs all types of data processing operations.

  o It stores data, intermediate results and instructions (program).

  o It controls the operation of all parts of computer.

  o CPU itself has following three components.

    ▪ Memory or Storage Unit

    ▪ Control Unit

    ▪ ALU(Arithmetic Logic Unit)
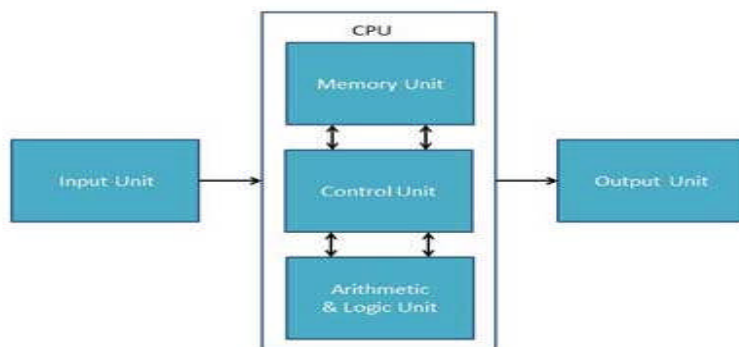
Memory or Storage Unit

> This unit can store instructions, data and intermediate results. This unit supplies information to the other units of the computer when needed. It is also known as internal storage unit or main memory or primary storage or Random access memory (RAM).

> Its size affects speed, power and capability.

> Primary memory and secondary memory are two types of memories in the computer.

> Functions of memory unit are:
> o It stores all the data and the instructions required for processing.
> o It stores intermediate results of processing.
> o It stores final results of processing before these results are released to an output device.
> o All inputs and outputs are transmitted through main memory.

Control Unit

> This unit controls the operations of all parts of computer but does not carry out any actual data processing operations.

> Functions of this unit are:
> o It is responsible for controlling the transfer of data and instructions among other units of a computer.
> o It manages and coordinates all the units of the computer.
> o It obtains the instructions from the memory, interprets them, and directs the operation of the computer.
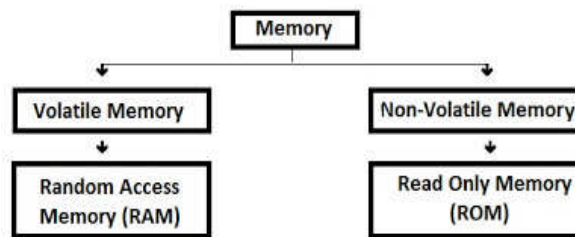
- o It communicates with Input/ Output devices for transfer of data or results from storage.
- o It does not process or store data.

ALU (Arithmetic Logic Unit)

➢ This unit consists of two subsections namely
1. Arithmetic section
2. Logic Section
1. Arithmetic Section
➢ Function of arithmetic section is to perform arithmetic operations like addition, subtraction, multiplication and division. All complex operations are done by making repetitive use of above operations.
2. Logic Section
➢ Function of logic section is to perform logic operations such as comparing, selecting, matching and merging of data.

2.3 RAM, DRAM, SRAM, ROM, EPROM

➢ Memory is an essential element of a computer. Without its memory, a computer is of hardly any use. Memory plays an important role in saving and retrieving data. The performance of the computer system depends upon the size of the memory.
➢ A memory is just like a human brain. It is used to store data and instructions. Computer memory is the storage space in computer where data is to be processed and instructions required for processing are stored. The memory is divided into large number of small parts called cells. Each location or cell has a unique address which varies from zero to memory size minus one. For example if computer has 64k words, then this memory unit has 64 * 1024=65536 memory locations. The address of these locations varies from 0 to 65535.
➢ Memory is of following types:

1. Primary Memory / Volatile Memory.

2. Secondary Memory / Non Volatile Memory.

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        ┌──────────┐
        │  Memory  │
        └────┬─────┘
    ┌────────┴────────┐
    ▼                 ▼
┌──────────────┐  ┌──────────────────┐
│Volatile Memory│  │Non-Volatile Memory│
└──────┬───────┘  └────────┬─────────┘
       ▼                   ▼
┌──────────────┐  ┌──────────────────┐
│Random Access │  │ Read Only Memory │
│Memory (RAM)  │  │     (ROM)        │
└──────────────┘  └──────────────────┘
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1. Primary Memory / Volatile Memory:

   ➢ Primary Memory is internal memory of the computer.

   ➢ RAM AND ROM both form part of primary memory.

   ➢ The primary memory provides main working space to the computer.

   ➢ Primary memory holds only those data and instructions on which computer is currently working. It has limited capacity and data is lost when power is switched off. It is generally made up of semiconductor device. These memories are not as fast as registers. The data and instruction required to be processed reside in main memory.

   ➢ Characteristics of Main Memory

      o These are semiconductor memories

      o It is known as main memory.

      o Usually volatile memory.

      o Data is lost in case power is switched off.

      o It is working memory of the computer.

      o Faster than secondary memories.

   ➢ A computer cannot run without primary memory

   ➢ It is divided into two subcategories RAM and ROM.

   Random Access Memory (RAM):

   ➢ The primary storage is referred to as random access memory (RAM) because it is possible to randomly select and use any location of the memory directly

store and retrieve data. It takes same time to any address of the memory as the first address. It is also called read/write memory. The storage of data and instructions inside the primary storage is temporary. It disappears from RAM as soon as the power to the computer is switched off. The memories, which lose their content on failure of power supply, are known as volatile memories. So now we can say that RAM is volatile memory.

➢ RAM (Random Access Memory) is the internal memory of the CPU for storing data, program and program result. It is read/write memory which stores data until the machine is working. As soon as the machine is switched off, data is erased.

➢ Access time in RAM is independent of the address that is, each storage location inside the memory is as easy to reach as other locations and takes the same amount of time. Data in the RAM can be accessed randomly but it is very expensive.

➢ RAM is volatile, i.e. data stored in it is lost when we switch off the computer or if there is a power failure. Hence a backup uninterruptible power system(UPS) is often used with computers. RAM is small, both in terms of its physical size and in the amount of data it can hold.

➢ RAM is of two types
   1. Static RAM (SRAM)
   2. Dynamic RAM (DRAM)

1. **Static RAM (SRAM)**
➢ The word static indicates that the memory retains its contents as long as power is being supplied. However, data is lost when the power gets down due to volatile nature. SRAM

chips use a matrix of 6-transistors and no capacitors. Transistors do not require power to prevent leakage, so SRAM need not have to be refreshed on a regular basis.

➢ Because of the extra space in the matrix, SRAM uses more chips than DRAM for the same amount of storage space, thus making the manufacturing costs higher. So SRAM is used as cache memory and has very fast access.

➢ Characteristic of the Static RAM

   o It has long life

   o There is no need to refresh

   o Faster

   o Used as cache memory

   o Large size

   o Expensive

   o High power consumption

2. Dynamic RAM (DRAM)

➢ DRAM, unlike SRAM, must be continually refreshed in order to maintain the data. This is done by placing the memory on a refresh circuit that rewrites the data several hundred times per second. DRAM is used for most system memory because it is cheap and small.

➢ All DRAMs are made up of memory cells which are composed of one capacitor and one transistor.

➢ Characteristics of the Dynamic RAM

   o It has short data lifetime

   o Need to be refreshed continuously

   o Slower as compared to SRAM

   o Used as RAM

   o Lesser in size

   o Less expensive

   o Less power consumption

Read Only Memory (ROM)

➢ There is another memory in computer, which is called Read Only Memory (ROM). Again it is the ICs inside the PC that form the ROM. The storage of program and data in

the ROM is permanent. The ROM stores some standard processing programs supplied by the manufacturers to operate the personal computer. The ROM can only be read by the CPU but it cannot be changed.

➢ The basic input/output program is stored in the ROM that examines and initializes various equipment attached to the PC, when the power switch is ON. The memories, which do not lose their content on failure of power supply, are known as non-volatile memories. ROM is non-volatile memory.

➢ This type of memory is also known as external memory or non-volatile. It is slower than main memory. These are used for storing data/Information permanently. CPU directly does not access these memories instead they are accessed via input-output routines. Contents of secondary memories are first transferred to main memory, and then CPU can access it. For example : disk, CD-ROM, DVD etc.

➢ Characteristic of Secondary Memory
   o These are magnetic and optical memories
   o It is known as backup memory.
   o It is non-volatile memory.
   o Data is permanently stored even if power is switched off.
   o It is used for storage of data in a computer.
   o Computer may run without secondary memory.
   o Slower than primary memories.

➢ ROM stands for Read Only Memory. The memory from which we can only read but cannot write on it. This type of memory is non-volatile. The information is stored permanently in such memories during manufacture. A ROM, stores such instructions that are required to start a computer. This operation is referred to as bootstrap. ROM chips are not only used in the computer but also in other electronic items like washing machine and microwave oven.
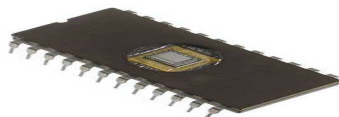
Advantages of ROM

- The advantages of ROM are as follows:
  - Non-volatile in nature
  - These cannot be accidentally changed
  - Cheaper than RAMs
  - Easy to test
  - More reliable than RAMs
  - These are static and do not require refreshing
  - Its contents are always known and can be verified

Following are the various types of ROM

1. **MROM (Masked ROM)**
- The very first ROMs were hard-wired devices that contained a pre-programmed set of data or instructions. These kinds of ROMs are known as masked ROMs which are inexpensive.

2. **PROM (Programmable Read only Memory)**
- PROM is read-only memory that can be modified only once by a user. The user buys a blank PROM and enters the desired contents using a PROM program. Inside the PROM chip there are small fuses which are burnt open during programming. It can be programmed only once and is not erasable.
- There is another type of primary memory in computer, which is called Programmable Read Only Memory (PROM). You know that it is not possible to modify or erase programs stored in ROM, but it is possible for you to store your program in PROM chip. Once the programmers' are written it cannot be changed and remain intact even if power is switched off. Therefore programs or instructions written in PROM or ROM cannot be erased or changed.

3. **EPROM (Erasable and Programmable Read Only Memory)**
- The EPROM can be erased by exposing it to ultra-violet light for duration of up to 40 minutes. Usually, an EPROM eraser achieves this function. During programming, an electrical charge is trapped in an insulated gate region. The charge is retained for more than ten years because the charge has no leakage path. For erasing this charge, ultra-

violet light is passed through a quartz crystal window (lid). This exposure to ultra-violet light dissipates the charge. During normal use the quartz lid is sealed with a sticker.

➤ This stands for Erasable Programmable Read Only Memory, which overcome the problem of PROM & ROM. EPROM chip can be programmed time and again by erasing the information stored earlier in it. Information stored in EPROM exposing the chip for some time ultraviolet light and it erases chip is reprogrammed using a special programming facility. When the EPROM is in use information can only be read.

4. **EEPROM(Electrically Erasable and Programmable Read Only Memory)**

➤ The EEPROM is programmed and erased electrically. It can be erased and reprogrammed about ten thousand times. Both erasing and programming take about 4 to 10 ms (milli second). In EEPROM, any location can be selectively erased and programmed. EEPROMs can be erased one byte at a time, rather than erasing the entire chip. Hence, the process of re-programming is flexible but slow.

Cache Memory:

➤ The speed of CPU is extremely high compared to the access time of main memory. Therefore the performance of CPU decreases due to the slow speed of main memory. To decrease the mismatch in operating speed, a small memory chip is attached between CPU and Main memory whose access time is very close to the processing speed of CPU. It is called CACHE memory. CACHE memories are accessed much faster than conventional RAM. It is used to store programs or data currently being executed or temporary data frequently used by the CPU. So each memory makes main memory to be faster and larger than it really is. It is also very expensive to have bigger size of cache memory and its size is normally kept small.

➤ Cache memory is a very high speed semiconductor memory which can speed up CPU. It acts as a buffer between the CPU and main memory. It is used to hold those parts of data and program which are most frequently used by CPU. The parts of data and programs are transferred from disk to cache memory by operating system, from where CPU can access them.

➤ Advantages
  o The advantages of cache memory are as follows:

- o Cache memory is faster than main memory.
- o It consumes less access time as compared to main memory.
- o It stores the program that can be executed within a short period of time.
- o It stores data for temporary use.
➢ Disadvantages
- o The disadvantages of cache memory are as follows:
- o Cache memory has limited capacity.
- o It is very expensive.

Registers:

➢ The CPU processes data and instructions with high speed; there is also movement of data between various units of computer. It is necessary to transfer the processed data with high speed. So the computer uses a number of special memory units called registers. They are not part of the main memory but they store data or information temporarily and pass it on as directed by the control unit.

3. Secondary Memory / Non-Volatile Memory:

➢ Secondary memory is external and permanent in nature. The secondary memory is concerned with magnetic memory. Secondary memory can be stored on storage media like floppy disks, magnetic disks, magnetic tapes, This memory can also be stored optically on Optical disks - CD-ROM. The following terms comes under secondary memory of a computer are discussed below:

Magnetic Tape:

Magnetic tapes are used for large computers like mainframe computers where large volume of data is stored for a longer time. In PC also you can use tapes in the form of cassettes. The cost of storing data in tapes is inexpensive. Tapes consist of magnetic materials that store data permanently. It can be 12.5 mm to 25 mm wide plastic film-type and 500 meter to 1200 meter long which is coated with magnetic material. The deck is connected to the central processor and information is fed into or read from the tape through the processor. It's similar to cassette tape recorder.

Magnetic Disk:

You might have seen the gramophone record, which is circular like a disk and coated with magnetic material. Magnetic disks used in computer are made on the same principle. It rotates with very high speed inside the computer drive. Data is stored on both the surface of the disk. Magnetic disks are most popular for direct access storage device. Each disk consists of a number of invisible concentric circles called tracks. Information is recorded on tracks of a disk surface in the form of tiny magnetic spots. The presence of a magnetic spot represents one bit and its absence represents zero bit. The information stored in a disk can be read many times without affecting the stored data. So the reading operation is non-destructive. But if you want to write a new data, then the existing data is erased from the disk and new data is recorded. Example Floppy Disk.

Optical Disk:

With every new application and software there is greater demand for memory capacity. It is the necessity to store large volume of data that has led to the development of optical disk storage medium. Optical disks can be divided into the following categories:

- Compact Disk/ Read Only Memory (CD-ROM)
- Write Once, Read Many (WORM)
- Erasable Optical Disk

2.4 Input / Output

➢ The term I/O is used to describe any program, operation or device that transfers data to or from a computer and to or from a peripheral device. Every transfer is an output from one device and an input into another. Devices such as keyboards and mouses are input-only devices while devices such as printers are output-only. A writable CD-ROM is both an input and an output device.

➢ In computing, **input/output** or **I/O** (or informally, **io** or **IO**) is the communication between an information processing system(such as a computer) and the outside world, possibly a human or another information processing system. Inputs are the signals or data received by the system and outputs are the signals or data sent from it. The term can also be used as part of an action; to "perform I/O" is to perform an input or output operation.

I/O devices are used by a human (or other system) to communicate with a computer. For instance, a keyboard or mouse is an input device for a computer, while monitors and printers are output devices. Devices for communication between computers, such as modems and network cards, typically perform both input and output operations.

➢ Note that the designation of a device as either input or output depends on perspective. Mice and keyboards take physical movements that the human user outputs and convert them into input signals that a computer can understand; the output from these devices is the computer's input. Similarly, printers and monitors take signals that a computer outputs as input, and they convert these signals into a representation that human users can understand. From the human user's perspective, the process of reading or seeing these representations is receiving input; this type of interaction between computers and humans is studied in the field of human–computer interaction.

➢ In computer architecture, the combination of the CPU and main memory, to which the CPU can read or write directly using individual instructions, is considered the brain of a computer. Any transfer of information to or from the CPU/memory combo, for example by reading data from a disk drive, is considered I/O. The CPU and its supporting circuitry may provide memory-mapped I/O that is used in low-level computer programming, such as in the implementation of device drivers, or may provide access to I/O channels. An I/O algorithm is one designed to exploit locality and perform efficiently when exchanging data with a secondary storage device, such as a disk drive.

Different types of Input Device

1. Keyboard

➢ Keyboard is the most common and very popular input device which helps in inputting data to the computer. The layout of the keyboard is like that of traditional typewriter, although there are some additional keys provided for performing additional functions.

➢ Keyboards are of two sizes 84 keys or 101/102 keys, but now keyboards with 104 keys or 108 keys are also available for Windows and Internet.

➢ The keys on the keyboard are as follows:

Sr.No	Keys	Description
1	Typing Keys	These keys include the letter keys (A-Z) and digit keys (0-9) which generally give same layout as that of typewriters.
2	Numeric Keypad	It is used to enter numeric data or cursor movement. Generally, it consists of a set of 17 keys that are laid out in the same configuration used by most adding machines and calculators.
3	Function Keys	The twelve function keys are present on the keyboard which are arranged in a row at the top of the keyboard. Each function key has unique meaning and is used for some specific purpose.
4	Control keys	These keys provide cursor and screen control. It includes four directional arrow keys. Control keys also include Home, End, Insert, Delete, Page Up, Page Down, Control(Ctrl), Alternate(Alt), Escape(Esc).
5	Special Purpose Keys	Keyboard also contains some special purpose keys such as Enter, Shift, Caps Lock, Num Lock, Space bar, Tab, and Print Screen.

2. Mouse

➢ Mouse is most popular pointing device. It is a very famous cursor-control device having a small palm size box with a round ball at its base which senses the movement of mouse and sends corresponding signals to CPU when the mouse buttons are pressed.

➢ Generally it has two buttons called left and right button and a wheel is present between the buttons. Mouse can be used to control the position of cursor on screen, but it cannot be used to enter text into the computer.

➢ Advantages
   o Easy to use
   o Not very expensive
   o Moves the cursor faster than the arrow keys of keyboard.

3. Joystick

➢ Joystick is also a pointing device which is used to move cursor position on a monitor screen. It is a stick having a spherical ball at its both lower and upper ends. The lower spherical ball moves in a socket. The joystick can be moved in all four directions.

➢ The function of joystick is similar to that of a mouse. It is mainly used in Computer Aided Designing (CAD) and playing computer games.

4. Light Pen

➢ Light pen is a pointing device which is similar to a pen. It is used to select a displayed menu item or draw pictures on the monitor screen. It consists of a photocell and an optical system placed in a small tube. When the tip of a light pen is moved over the monitor screen and pen button is pressed, its photocell sensing element detects the screen location and sends the corresponding signal to the CPU.

5. Track Ball

➢ Track ball is an input device that is mostly used in notebook or laptop computer, instead of a mouse. This is a ball which is half inserted and by moving fingers on ball, pointer can be moved. Since the whole device is not moved, a track ball requires less space than a mouse. A track ball comes in various shapes like a ball, a button and a square.

6. Scanner

➢ Scanner is an input device which works more like a photocopy machine. It is used when some information is available on a paper and it is to be transferred to the hard disc of the computer for further manipulation. Scanner captures images from the source which are then converted into the digital form that can be stored on the disc. These images can be edited before they are printed.

7. Digitizer

➢ Digitizer is an input device which converts analog information into digital form. Digitizer can convert a signal from the television or camera into a series of numbers that could be stored in a computer. They can be used by the computer to create a picture of whatever the camera had been pointed at. Digitizer is also known as Tablet or Graphics Tablet

because it converts graphics and pictorial data into binary inputs. A graphic tablet as digitizer is used for doing fine works of drawing and image manipulation applications.

8. Microphone

➤ Microphone is an input device to input sound that is then stored in digital form. The microphone is used for various applications like adding sound to a multimedia presentation or for mixing music.

9. Magnetic Ink Card Reader (MICR)

➤ MICR input device is generally used in banks because of a large number of cheques to be processed every day. The bank's code number and cheque number are printed on the cheques with a special type of ink that contains particles of magnetic material that are machine readable. This reading process is called Magnetic Ink Character Recognition (MICR). The main advantages of MICR are that it is fast and less error prone.

10. Optical Character Reader (OCR)

➤ OCR is an input device used to read a printed text. OCR scans text optically character by character, converts them into a machine readable code and stores the text on the system memory.

11. Bar Code Readers

➢ Bar Code Reader is a device used for reading bar coded data (data in form of light and dark lines). Bar coded data is generally used in labelling goods, numbering the books etc. It may be a hand held scanner or may be embedded in a stationary scanner. Bar Code Reader scans a bar code image, converts it into an alphanumeric value which is then fed to the computer to which bar code reader is connected.

12. Optical Mark Reader(OMR)

OMR is a special type of optical scanner used to recognize the type of mark made by pen or pencil. It is used where one out of a few alternatives is to be selected and marked. It is specially used for checking the answer sheets of examinations having multiple choice questions.

Output Device

Following are few of the important output devices which are used in a computer.

1. Monitors

➢ Monitors, commonly called as Visual Display Unit (VDU), are the main output device of a computer. It forms images from tiny dots, called pixels that are arranged in a rectangular form. The sharpness of the image depends upon the number of pixels.

- ➤ There are two kinds of viewing screen used for monitors.
    - o Cathode-Ray Tube (CRT)
    - o Flat- Panel Display

Cathode-Ray Tube (CRT) Monitor

- ➤ The CRT display is made up of small picture elements called pixels. The smaller the pixels, the better the image clarity, or resolution. It takes more than one illuminated pixel to form whole character, such as the letter 'e' in the word help.
- ➤ A finite number of characters can be displayed on a screen at once. The screen can be divided into a series of character boxes - fixed location on the screen where a standard character can be placed. Most screens are capable of displaying 80 characters of data horizontally and 25 lines vertically.
- ➤ There are some disadvantages of CRT:
    - o Large in Size
    - o High power consumption

Flat-Panel Display Monitor

- ➤ The flat-panel display refers to a class of video devices that have reduced volume, weight and power requirement in comparison to the CRT. You can hang them on walls or wear them on your wrists. Current uses of flat-panel displays include calculators, video games, monitors, laptop computer, graphics display.
- ➤ The flat-panel display is divided into two categories:
    - o Emissive Displays - The emissive displays are devices that convert electrical energy into light. Example are plasma panel and LED(Light-Emitting Diodes).

o Non-Emissive Displays - The Non-emissive displays use optical effects to convert sunlight or light from some other source into graphics patterns. Example is LCD (Liquid-Crystal Device)

2. Printers

➤ Printer is an output device, which is used to print information on paper.

➤ There are two types of printers:

  o Impact Printers

  o Non-Impact Printers

Impact Printers

➤ The impact printers print the characters by striking them on the ribbon which is then pressed on the paper.

➤ Characteristics of Impact Printers are the following:

  o Very low consumable costs

  o Very noisy

  o Useful for bulk printing due to low cost

  o There is physical contact with the paper to produce an image

  o These printers are of two types

   ▪ Character printers

   ▪ Line printers

Character Printers

➤ Character printers are the printers which print one character at a time.

➤ These are further divided into two types:

  o Dot Matrix Printer(DMP)

  o Daisy Wheel

Dot Matrix Printer

➢ In the market one of the most popular printers is Dot Matrix Printer. These printers are popular because of their ease of printing and economical price. Each character printed is in form of pattern of dots and head consists of a Matrix of Pins of size (5*7, 7*9, 9*7 or 9*9) which come out to form a character that is why it is called Dot Matrix Printer.

➢ Advantages
  o Inexpensive
  o Widely Used
  o Other language characters can be printed

➢ Disadvantages
  o Slow Speed
  o Poor Quality

Daisy Wheel

➢ Head is lying on a wheel and pins corresponding to characters are like petals of Daisy (flower name) that is why it is called Daisy Wheel Printer. These printers are generally used for word-processing in offices which require a few letters to be sent here and there with very nice quality.

➢ Advantages
  o More reliable than DMP
  o Better quality
  o The fonts of character can be easily changed

➢ Disadvantages
  o Slower than DMP
  o Noisy

o More expensive than DMP

Line Printers

➤ Line printers are the printers which print one line at a time.

➤ These are of further two types
   o Drum Printer
   o Chain Printer

Drum Printer

➤ This printer is like a drum in shape so it is called drum printer. The surface of drum is divided into number of tracks. Total tracks are equal to size of paper i.e. for a paper width of 132 characters, drum will have 132 tracks. A character set is embossed on track. The different character sets available in the market are 48 character set, 64 and 96 characters set. One rotation of drum prints one line. Drum printers are fast in speed and can print 300 to 2000 lines per minute.

➤ Advantages
   o Very high speed

➤ Disadvantages
   o Very expensive
   o Characters fonts cannot be changed

Chain Printer

➢ In this printer, chain of character sets is used so it is called Chain Printer. A standard character set may have 48, 64, or 96 characters.

➢ Advantages
  o Character fonts can easily be changed.
  o Different languages can be used with the same printer.

➢ Disadvantages
  o Noisy

Non-impact Printers

➢ Non-impact printers print the characters without using ribbon. These printers print a complete page at a time so they are also called as Page Printers.

➢ These printers are of two types
  o Laser Printers
  o Inkjet Printers

➢ Characteristics of Non-impact Printers
  o Faster than impact printers.
  o They are not noisy.
  o High quality.
  o Support many fonts and different character size.

Laser Printers

➢ These are non-impact page printers. They use laser lights to produce the dots needed to form the characters to be printed on a page.

➢ Advantages
  o Very high speed
  o Very high quality output
  o Give good graphics quality
  o Support many fonts and different character size

➢ Disadvantages
  O Expensive.

o Cannot be used to produce multiple copies of a document in a single printing.

Inkjet Printers

➢ Inkjet printers are non-impact character printers based on a relatively new technology. They print characters by spraying small drops of ink onto paper. Inkjet printers produce high quality output with presentable features.

➢ They make less noise because no hammering is done and these have many styles of printing modes available. Colour printing is also possible. Some models of Inkjet printers can produce multiple copies of printing also.

➢ Advantages
  o High quality printing
  o More reliable

➢ Disadvantages
  O Expensive as cost per page is high
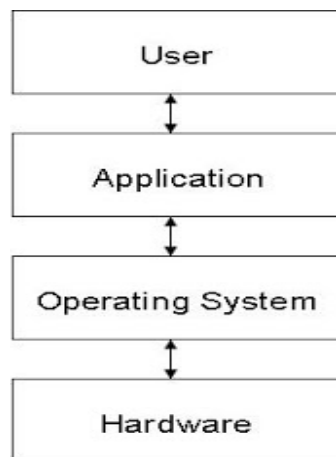 O Slow as compared to laser printer

Chapter 3: Operating System

Definition of Operating System:

An **operating system** (**OS**) is software that manages the computer hardware, and provides common services for execution of various application software. For hardware functions such as input and output and memory allocation, the operating system acts as an intermediary between application programs and the computer hardware.

An operating system (sometimes abbreviated as "OS") is the program that, after being initially loaded into the computer by a boot program, manages all the other programs in a computer.

```
┌─────────────────────┐
│        User         │
└─────────────────────┘
           ↕
┌─────────────────────┐
│     Application      │
└─────────────────────┘
           ↕
┌─────────────────────┐
│  Operating System   │
└─────────────────────┘
           ↕
┌─────────────────────┐
│      Hardware       │
└─────────────────────┘
```

Objectives of Operating System:

1. **Convenience**: makes computer user friendly.
2. **Efficiency**: allows computer to use resources efficiently.
3. **Ability to evolve**: constructed in a way to permit effective development, testing and introduction of new functions without interfering with service.

Functions of Operating System:

1. **Resource Management:** The resource management function of an OS allocates computer resources such as CPU time, main memory, secondary storage, and input and output devices for use.

2. **Process Management:** The operating system is responsible for the following activities in connection with process management:

        i. Creating and deleting both user and system processes.

        ii. Suspending and resuming processes.

        iii. Providing mechanisms for process synchronization.

        iv. Providing mechanisms for process communication.

        v. Providing mechanisms for deadlock handling.

3. **Memory Management:** The operating system is responsible for the following activities in connection with memory management:

    I. Keeping track of which parts of memory are currently being used and by whom.

    II. Deciding which processes and data to move into and out of memory.

    III. Allocating and de allocating memory space as needed.

4. **Storage Management:**

  i. **File – System Management:** The operating system is responsible for the following activities in connection with the file management:

- ➢ Creating and deleting files
- ➢ Creating and deleting directories to organize files.
- ➢ Supporting primitives for manipulating files and directories.
- ➢ Mapping files onto secondary storage.
- ➢ Backing up files on stable (nonvolatile) storage media.

  ii. **Mass – Storage Management:** The operating system is responsible for the following activities in connection with disk management:

- ➢ Free-space Management
- ➢ Storage Allocation
- ➢ Disk Scheduling.

4. **Device Management:** One of the purposes of operating system is to hide the peculiarities of specific hardware devices from the user.

5. **Data Management:** The data management functions of an OS govern the input and output of the data and their location, storage, and retrieval.

6. **Job Management:** The job management function of an OS prepares, schedules, controls, and monitors jobs submitted for execution to ensure the most efficient processing. A job is a collection of one or more related programs and their data.

7. **Standard means of communication between user and computer:**
   - The OS establishes a standard means of communication between users and their computer systems. It does this by providing a user interface and a standard set of commands that control the hardware.
   - In a multitasking operating system where multiple programs can be running at the same time, the operating system determines which applications should run in what order and how much time should be allowed for each application before giving another application a turn.
   - It manages the sharing of internal memory among multiple applications.
   - It handles input and output to and from attached hardware devices, such as hard disks, printers, and dial-up ports.
   - It sends messages to each application or interactive user (or to a system operator) about the status of operation and any errors that may have occurred.
   - It can offload the management of what are called batch jobs (for example, printing) so that the initiating application is freed from this work.
   - On computers that can provide parallel processing, an operating system can manage how to divide the program so that it runs on more than one processor at a time.
   - Operating systems perform basic tasks, such as recognizing input from the keyboard, sending output to the display screen, keeping track of files and directories on the disk, and controlling peripheral devices such as disk drives and printers.
   - The operating system is also responsible for *security*, ensuring that unauthorized users do not access the system.

Types of Operating System:

Serial Processing:
   - The Serial Processing Operating Systems are those which Performs all the instructions into a **Sequence Manner** or the Instructions those are given by the user will be **executed by using the FIFO Manner** means First in First Out. All the Instructions those are

Entered First in the System will be Executed First and the Instructions those are Entered Later Will be Executed Later.

➢ **For Running the Instructions the Program Counter is used which is used for Executing all the Instructions**. In this the Program Counter will determines which instruction is going to Execute and the which instruction will be Execute after this. Mainly the **Punch Cards** are used for this. In this all the Jobs **are firstly Prepared and Stored on the Card** and after that card will be entered in the System and after that all the Instructions will be executed one by One. But the **Main Problem is that a user doesn't interact with the System** while he is working on the System, means the user can't be able to enter the data for Execution.

Batch Operating System:

➢ Batch operating system is the operating system which analyzes your input and groups them into batches i.e. data in each batch is of similar characteristics. And then it performs operation on each individual batch. The Batch Processing is **same as the Serial Processing Technique.** But in the Batch Processing **Similar Types of jobs are Firstly Prepared** and they are Stored on the Card and that card will be Submit to the System for the Processing. The System then Perform all the Operations on the Instructions one by one. And a **user can't be Able to specify any input**. And Operating System wills increments his Program Counter for Executing the Next Instruction.

➢ The **Main Problem is that the Jobs those are prepared for Execution must be the Same Type** and if a job requires for any type of Input then this will not be Possible for the user. Time will be wasted for Preparing the Batch. The Batch Contains the Jobs and all those jobs will be executed without the user Intervention. And **Operating System will use the LOAD and RUN Operation**. **This will first LOAD the Job from the Card and after that he will execute the instructions** By using the RUN Command.

➢ The Speed of the Processing the Job will be Depend on the Jobs and the Results those are produced by the System in difference of Time which is used for giving or submit the Job and the Time which is used for Displaying the Results on the Screen.

Real-time OS:

- A real-time operating system is a multitasking operating system that aims at executing real-time applications. Real-time operating systems often use specialized scheduling algorithms so that they can achieve a deterministic nature of behavior.

- The main object of real-time operating systems is their quick and predictable response to events. They either have an event-driven or a time-sharing design. An event-driven system switches between tasks based on their priorities while time-sharing operating systems switch tasks based on clock interrupts.

  a. **Hard real-time system:** It has the most stringent requirements, guaranteeing that real-time tasks be completed within their deadlines. Safety-critical systems are typically hard real-time systems.

  b. **Soft real-time system:** It is less restrictive, simply providing that a critical real-time task will receive priority over other tasks and that it will retain that priority until it completes. Many commercial operating systems – as well as Linux – provide soft real-time support.

Multi-user vs. Single-user:

- **A multi-user operating system** allows multiple users to access a computer system concurrently. Time-sharing system can be classified as multi-user systems as they enable a multiple user access to a computer through the sharing of time.

- **Single-user operating systems**, as opposed to a multi-user operating system, are usable by a single user at a time. Being able to have multiple accounts on a Windows operating system does not make it a multiuser system. Rather, only the network administrator is the real user.

- As we know that in the Batch Processing System there are multiple jobs Execute by the System. The System first prepare a batch and after that he will Execute all the jobs those are Stored into the Batch. But the Main Problem is that if a process or job requires an Input and Output Operation, then it is not possible and second there will be the wastage of the Time **when we are preparing the batch and the CPU will remain idle at that Time.**

- But With the help of **Multi programming we can Execute Multiple Programs on the System at a Time** and in the Multi-programming the CPU will never get idle, because with

the help of Multi-Programming we can Execute Many Programs on the System and When we are Working with the Program then we can also Submit the Second or Another Program for Running and the CPU will then Execute the Second Program after the completion of the First Program. And in this we can also specify our Input means a user can also interact with the System.

➢ The Multi-programming Operating Systems never use any cards because the Process is entered on the Spot by the user. But the **Operating System also uses the Process of Allocation and De-allocation of the Memory** Means he will provide the Memory Space to all the Running and all the Waiting Processes. There must be the Proper Management of all the Running Jobs.

Multi-tasking vs. Single-tasking:

➢ When a single program is allowed to run at a time, the system is grouped under a single-tasking system, while in case the operating system allows the execution of multiple tasks at one time, it is classified as a multi-tasking operating system.

➢ Multi-tasking can be of two types namely, pre-emptive or co-operative. In **pre-emptive multitasking**, the operating system slices the CPU time and dedicates one slot to each of the programs. **Cooperative multitasking** is achieved by relying on each process to give time to the other processes in a defined manner.

Single-processor vs. Multi-processor Systems:

➢ On a **single-processor** system, there is one main CPU capable of executing a general-purpose instruction set, including instructions from user processes.

➢ A **multiprocessing** operating system allows a program to run on more than one central processing unit (CPU) at a time. This can come in very handy in some work environments, at schools, and even for some home-computing situations.

   a. **Asymmetric multiprocessing:** In this each processor is assigned a specific task. A master processor controls the system; the other processors either look to the master for instruction or have predefined tasks. This scheme defines a master-slave

relationship. The master processor schedules and allocates work to the slave processors.

b. Symmetric **multiprocessing (SMP):** In this each processor performs all tasks within the operating system. SMP means that all processors are peers; no master-slave relationship exists between processors.

Distributed:

➤ A distributed operating system manages a group of independent computers and makes them appear to be a single computer. The development of networked computers that could be linked and communicate with each other, gave rise to distributed computing.

➤ Distributed computations are carried out on more than one machine. When computers in a group work in cooperation, they make a distributed system. Distributed Means Data is Stored and Processed on Multiple Locations. When a Data is stored on to the Multiple Computers, those are placed in Different Locations. Distributed means In the Network, Network Collections of Computers are connected with Each other.

➤ Then if we want to Take Some Data from other Computer, Then we use the Distributed Processing System. And we can also Insert and Remove the Data from out Location to another Location. In this Data is shared between many users. And we can also Access all the Input and Output Devices are also accessed by Multiple Users.

Embedded:

➤ Embedded operating systems are designed to be used in embedded computer systems. They are designed to operate on small machines like PDAs with less autonomy. They are able to operate with a limited number of resources. They are very compact and extremely efficient by design. Windows CE and Mini x3 are some examples of embedded operating systems.

Windows:

- Microsoft's Windows OS has owned the lion's share of the market in PCs for a long time now, but with the rise of mobile operating systems, it has lost favor to the Linux-based Android and Apple's iOS operating systems.
- The biggest advantage of Windows is that it provides ready-made solutions that can be implemented by just about anyone who's ever used a computer.
- Microsoft Office is also 100% compatible with any file or document produced in the office space in America.
- In fact, MS Office isn't compatible with other software and systems; so much as other software and systems strive to be compatible with Office!
- Finally, software services are in large supply when it comes to Windows. From Microsoft's official services, to Maryland software support, to Microsoft certification training for individuals, **there is no lack of software support for Windows**.
- The only other major disadvantage of using Windows in the workplace is that over 95% of all viruses and malicious software are written for the Windows OS. This means you have to double-down all security measures if you're using Microsoft software across the board.

Pros:

- Everything works on Windows. Well, almost everything. Still, when it comes to compatibility, neither Mac nor Linux can boast better records.
- Finding support for problems in Windows is very easy. That said, Mac and Linux aren't far behind, but simply by the volume of users it has, there is much more help available for Windows.
- Features and functionality is another segment that Windows has been known for. The other two are catching up very fast though.
- More than 80% of the desktop computers in the world run some sort of Windows operating system.
- You won't have any trouble finding hardware and drivers.
- You won't have any problems finding support.
- Most widely supported operating system for games.

- Large shareware and freeware application library.

Cons:

- Being the most popular OS, it is also the most attacked. Hence, there are many viruses and other forms of malware for Windows.
- Windows OS eats a lot of your system's resources and makes it slow. In fact, Windows Vista and Windows 7 can easily be called the slowest of them all.
- It's proprietary and so comes at a cost.
- The most prone operating system for spyware and virus applications.
- You are going to need support.
- General instability due to the sheer number of possible configurations.
- Poor security.
- Limited access to the library of free open source software.

Mac Os:
- Macintosh OS is actually older than Windows.
- In fact, Apple's platform was the first ever successful graphical-based operating system and it was released a year before Windows.
- Using the Mac operating system has its own advantages and disadvantages. For one thing, Mac OS is the only commercial operating system that is custom-made to work with Apple's hardware. This gives it a level of efficiency, power, and stability, which is most important for the workplace.
- Mac OS X is still the operating system of choice for graphic artists, designers and most others who work with visual and audio media. It also synchronizes user information well across multiple Apple devices, such as the iPhone and iPad, making it easily usable in a mobile office environment.
- Apple has its own set of disadvantages, too. The biggest one is price: Apple computers simply cost much more than your average PC. This is offset somewhat by those computers' durability, and the fact that they take a long time to go out of date.

Pros:

➤ Mac does not get viruses. This is one of the biggest USPs of the platform. Because of its lesser market share, there aren't many viruses for Apple's Mac OS.

➤ To run a Mac, you must have a Mac too. Being compatible only with Apple's devices, this OS always runs smoothly as the devices are made for the OS.

➤ On the presentation department, Apple has always been ahead of Windows. Mac always comes with a style quotient attached to them.

➤ Easier to use for the non technical.

➤ Content creation is its strength.

➤ More secure than Windows due to its UNIX base

➤ More stable than Windows due to Apple's tighter control over the configuration options and its UNIX base.

➤ Almost no spyware or virus applications.

➤ More powerful than Windows due to its UNIX base.

➤ You have almost complete access to the enormous library of free open source applications.

Cons:

➤ If you thought Windows was expensive, then Mac isn't the one for you. It is even more expensive than Windows.

➤ The second point in the pros section is also a con for the Mac. You have to buy an Apple computer to run the Mac. These computers are expensive.

➤ Mac has never been known for its gaming compatibility, even though the computers are immensely powerful. Moreover, many other programs do not run on the Mac PC.

➤ More expensive upfront than other choices. Some would say this is offset by less maintenance required over the life of the system.

➤ Less support. You have to go to Apple for all your hardware problems.

➤ Less hardware choices than Windows. For your average user this isn't much of a problem. All the common hardware types will work.

➤ More complex than Windows due to its UNIX base. This really isn't a major con because OSX does a great job of hiding this complexity from the end user.

Linux:

➢ It is an operating system assembled under the model of open source software development and mostly used for server purpose.

➢ It supports a dozen of programming languages like C, C++,JAVA, PHP and many more..

➢ Distributions such as Linux Mint and the increasingly popular Ubuntu were designed especially to be easy and non-threatening for the average user.

➢ Implementing Linux on an enterprise level can add up to huge savings: the operating system and almost all of its available software (including the Microsoft-compatible Libre Office) are 100% free.

➢ Most versions of Linux are also easy to update and install. Operating from a single computer, the right Maryland software support personnel can implement and update dozens of computers over a single network in a matter of minutes. Linux software is also highly customizable–something that software services can make use of to make a network more secure.

➢ Its biggest disadvantage is that its end-users and office workers are often scared of it at first. This is usually easily overcome with a morning of orientation and an afternoon's worth of experience with the system. Perhaps more difficult is getting other managers or board members to approve the change.

Pros:

➢ Linux is free and that is its biggest USP. You have to pay nothing. You can download a copy of your favorites Linux site and then even build your own using this one.

➢ Linux is just the kernel, not the OS. Being proprietary OS, Windows and Macs come about once a year or not even that. Linux, on the other hand, has a variety of options available. You can go from Ubuntu to Fedora to Debian to Arch Linux. If you're interested in hacking, then Kali Linux is at your disposal.

➢ An interesting thing about Linux is that it is almost immune to viruses.

➢ Runs on just about any hardware. It is a misnomer that Linux lacks the driver support of Windows and OSX. Linux actually has the broadest driver support of any system. What is true, is that the latest and greatest hardware doesn't come to Linux first if the manufacture choose not write Linux drivers.

- If you want to change anything in Linux you can. The only limiting factor is your desire to figure out how.
- Way more secure than Windows XP.
- Everything is free. Although please donate a little something to your favorite projects.
- If you choose to, you can always be on the cutting edge of computer science. All the new ideas in development on college campuses across the world are tried on Linux first and then the best of those filters down to Apple and Windows but, what's best is subjective so Linux leaves you with a choice, while Apple and Windows limit you.
- Full access to the free open source library of software. Great full featured, compatible, and free replacements for your proprietary software.
- Linux management, for example patch management, is much easier. Typical one command or wizard has to be invoked in order to update everything vs. Windows where you have to get OS patches from Microsoft and third party patches from each individual vendor.

Cons:

- Linux is somewhat more complicated than Mac or Windows. You can't always go click on the mouse to unlock its full potential.
- Linux also has a compatibility issues, but that is strictly because of its market share. There are open source alternatives to almost all programs though.
- While many have started selling Linux-based computers, the number of vendors is still low. You will most often have to buy a Windows PC and then download Linux onto it. The OS is free though, so there's no added cost.
- When it comes to choosing your operating system, you must focus on what your usage is. A gamer will always prefer a Windows PC, simply because all games are compatible with it. On the other hand, a sound engineer or a video editor will prefer to work with Mac for its superior support in that segment. Linux users are open source proponents and they like the flexibility of the OS. Often, Linux users are more serious computer users than other and know about coding etc.
- The latest and greatest hardware is typically slower to reach Linux.

- The sheer number of options can be daunting to a non-technical user. Although, like OSX, the distribution you select will determine the level of complexity presented or hidden from the end user.
- Limited vendor support.

MS DOS

- Disk Operating System (specifically) and disk operating system (generically), most often abbreviated as DOS, refers to an operating system software, used in most computers, which provides the abstraction and management of secondary storage devices and the information on them (e.g., file systems for organizing files of all sorts).
- Such software is referred to as a disk operating system since the storage devices it manages are made of rotating platters (such as hard disks or floppy disks).
- DOS is the medium through which the user and external devices attached to the system communicate.
- DOS translates the command issued by the user in the format that is comprehensible by the computer and instructs the computer to function accordingly. It also translates the result and any error message in the format for the user to understand.
- Short for **Microsoft Disk operating system**, **MS-DOS** is a non-graphical command line operating system derived from 86-DOS that was created for IBM compatible computers. MS-DOS originally written by Tim Paterson and introduced by Microsoft in August 1981 and was last updated in 1994when MS-DOS 6.22 was released. MS-DOS allows the user to navigate, open, and otherwise manipulate files on their computer from a command line instead of a GUI like Windows.

Advantages:

- DOS is very lightweight and it allows direct access to most hardware.
- It does not have the overhead of a multitasking operating system.

Disadvantages:

- It is 16-bit and limited to 640k of RAM (this can be overcome with a DOS extender)
- It runs in real mode, so a buggy or malicious program can cause corruption.
- It's a Single User OS (One User can Work at a time)
- It's a Single Tasking OS (One application can run at a time)
- It does not supports Graphics
- It does not supports Networking
- We can only make 2GB of Maximum partition as it supports only FAT 16

UNIX

- UNIX is older than all the other PC OS and in many ways it served as a model for them.
- UNIX was developed by Bell Labs in 1970's.
- It was widely used as a teaching and research tool by programmers and computer scientists.
- From the beginning, UNIX was an incredibly powerful and flexible operating system that could run on a single computer or on a network.
- It provides multitasking, which makes efficient use of computer's resources especially when meeting the document of many users.
- UNIX supports multiprocessing system- a pc with more than one CPU working at a time
- UNIX is not friendly because of its command-line interface and cryptic instruction and the fact that it requires many commands to do a simple task.
- Most popular OS especially among organization that manages large database shared by hundreds or thousands users.

Chapter 4: Programming language and Compiler

4.1 Introductions to programming language

- ➢ Computer program is a set of instructions that, when executed, causes the computer to behave in a predetermined manner.
- ➢ Computers generally don't understand natural languages like English or Nepali unless it is instructed. The languages, which are used to instruct the computer to perform certain tasks, are called computer programming languages.
- ➢ There are many programming languages like C, C++, Pascal, BASIC, FORTRAN, COBOL, LISP, etc.

Types or Levels of Programming Languages

- ➢ Programming languages are categorized in the following:

I. First Generation Programming Language: Machine Language

- ➢ Machine language has the least possible level at which we can program a computer in its own native machine code, consisting of strings of 1's and 0's, and are stored as binary numbers.
- ➢ The main advantage of machine language is that they execute faster than high-level language.
- ➢ However, machine languages are more difficult to write.

II. Second Generation Programming Language: Assembly Language

- ➢ Assembly language is categorized as the second generation programming language.
- ➢ It is a symbolic representation (called mnemonics) of machine code.

➢ Assembly program is closer to plain english words, hence a bit more easier to read and write the program as compared with machine language but the computer can't understand them directly.

➢ The assembly-language program must be translated into machine code by a separate program called an assembler.

III. Third Generation Programming Language (3GL): High Level Language

➢ It is a refinement of second generation programming language (2GL).

➢ 3GL was introduced to make the language more programmers friendly.

➢ High level languages falls somewhere between assembly language and natural languages.

➢ It includes languages like FORTRAN, COBOL, BASIC, C, C++.

➢ The programming language that bridges the gap between traditional machines/ assembly language and conventional high level language is called middle level language.

➢ C language on one hand supports assembly language and we can access memory directly using pointer, on the other hand C supports high level language features. However C is categorized into high level language, it is easy to create machine code using C. Hence, C is sometimes also called middle level language.

IV. Fourth Generation Programming Language (4GL): Very High Level Language

➢ The higher the generation of language means the more efficient, faster and user friendly programming language.

➢ The features of 4GL are:

      a. It is a non-procedural programming language i.e. queries language.

      b. Code comprising of English like sentences.

      c. Program is portable and easily expandable.

      d. 4GL code enhances the productivity of the programmers as they have to type fewer lines of code.

➢ A typical example of 4GL is the query language that allows user to extract data from database, data warehouse and big data.

V. Fifth Generation Programming Language (5GL): Future Language

- Fifth generation languages are based on Artificial Intelligence. It solves the problem using constraints given to the program.
- 5GLs are considered to be the wave of the future and predicted to replace all other languages for system development.
- However, it is a highest level of programming language that meets the visual programming requirements.
- Examples of 5GL are Prolog, OPS5 and Mercury.
- 3GL, 4GL and 5GL are in overall categorized into High Level Languages.
- From the programmers point of view, using high level language is time saving.
- It is designed to reduce programmer's effort.
- High level languages are simply classified into following two categories:

  - Procedure Oriented (Function oriented) Programming

  - Object Oriented Programming

- One or more related blocks of statements that perform some complete function are grouped together into a program module is simply called a Procedure.
- Procedure is just a mini program that performs specific task.
- The languages that are used to write such procedures to perform the task defined are called procedure oriented languages.
- Object-oriented programming (OOP) is a programming language model organized around objects rather than "actions" and data rather than logic. C++ and JAVA are the examples of Object Oriented programming language.

4.2 Assembler, Interpreter and Compiler

Assembler:

- A computer will not understand any program written in a language, other than its machine language.

- The programs written in other languages must be translated into the machine language. Such translation is performed with the help of software.
- A program which translates an assembly language program into a machine language program is called an **assembler**.
- If an assembler which runs on a computer and produces the machine codes for the same computer then it is called **self assembler** or resident assembler. If an assembler that runs on a computer and produces the machine codes for other computer then it is called **Cross Assembler.**
- Assemblers are further divided into two types: One Pass Assembler and Two Pass Assembler. One pass assembler is the assembler which assigns the memory addresses to the variables and translates the source code into machine code in the first pass simultaneously. A Two Pass Assembler is the assembler which reads the source code twice. In the first pass, it reads all the variables and assigns them memory addresses. In the second pass, it reads the source code and translates the code into object code.
- The translated program is called as object program.
- Assembler checks each instruction for its correctness and generates diagnostic messages, if there are mistakes in the program.
- Various steps of assembling are:
    1. Input source program in Assembly Language through an input device.
    2. Use Assembler to produce object program in machine language.
    3. Execute the program.

Compiler:

- It is a program which translates a high level language program into a machine language program.
- A compiler is more intelligent than an assembler. It checks all kinds of limits, ranges, errors etc. But its program run time is more and occupies a larger part of the memory.
- It has slow speed. Because a compiler goes through the entire program and then translates the entire program into machine codes. If a compiler runs on a computer and produces the machine codes for the same computer then it is known as a **self compiler** or

resident compiler. On the other hand, if a compiler runs on a computer and produces the machine codes for other computer then it is known as a **cross compiler.**

➢ The process of transferring source program into object code is a lengthy and complex process as compared to assembling.

➢ Compliers have diagnostic capabilities and prompt the programmer with appropriate error message while compiling a HLL program.

➢ The corrections are to be incorporated in the program, whenever needed, and the program has to be recompiled. The process is repeated until the program is mistake free and translated to an object code.

➢ Thus the job of a complier includes the following:

1. To translate HLL source program to machine code.
2. To trace variables in the program.
3. To include linkage for subroutines.
4. To allocate memory for storage of program and variables.
5. To generate error messages, if there are errors in the program.

Interpreter:

➢ An interpreter is a program which translates statements of a program into machine code. It translates only one statement of the program at a time.

➢ It reads only one statement of program, translates it and executes it. Then it reads the next statement of the program again translates it and executes it. In this way it proceeds further till all the statements are translated and executed. On the other hand, a compiler goes through the entire program and then translates the entire program into machine codes.

➢ A compiler is 5 to 25 times faster than an interpreter.

➢ By the compiler, the machine codes are saved permanently for future reference. On the other hand, the machine codes produced by interpreter are not saved. An interpreter is a small program as compared to compiler. It occupies less memory space, so it can be used in a smaller system which has limited memory space.

➢ In compiler, the program is translated completely and directly executable version is generated. Whereas interpreter translates each instruction, executes it and then the next instruction is translated and this goes on until end of the program.

➢ In this case, object code is not stored and reused. Every time the program is executed, the interpreter translates each instruction freshly. It also has program diagnostic capabilities.

➢ However, it has some disadvantages as below:

1. Instructions repeated in program must be translated each time they are executed.

2. Because the source program is translated fresh every time it is used, it is slow process or execution takes more time. Approx. 20 times slower than complier.

Linker:

➢ In high level languages, some built in header files or libraries are stored. These libraries are predefined and these contain basic functions which are essential for executing the program. These functions are linked to the libraries by a program called **Linker**.

➢ If linker does not find a library of a function then it informs to compiler and then compiler generates an error. The compiler automatically invokes the linker as the last step in compiling a program.

➢ Not built in libraries, it also links the user defined functions to the user defined libraries. Usually a longer program is divided into smaller subprograms called modules. And these modules must be combined to execute the program. The process of combining the modules is done by the linker.

Loader:

➢ Loader is a program that loads machine codes of a program into the system memory.

➢ In Computing, a **loader** is the part of an Operating System that is responsible for loading programs. It is one of the essential stages in the process of starting a program. Because it places programs into memory and prepares them for execution.

➢ Loading a program involves reading the contents of executable file into memory. Once loading is complete, the operating system starts the program by passing control to the loaded program code. All operating systems that support program loading have loaders. In many operating systems the loader is permanently resident in memory.

4.2   Program Design, Programming Tools

Program Design

➢ The activity of progressing from a specification of some required program to a description of the program itself.

➢ Most phase models of the software life cycle recognize program design as one of the phases.

➢ The input to this phase is a specification of what the program is required to do.

➢ During the phase the design decisions are made as to how the program will meet these requirements, and the output of the phase is a description of the program in some form that provides a suitable basis for subsequent implementation.

➢ Frequently the design phase is divided into two sub phases, one of coarse *architectural design* and one of *detailed design*.

➢ The architectural design produces a description of the program at a gross level; it is normally given in terms of the major components of the program and their interrelationships, the main algorithms that these components employ, and the major data structures.

➢ The detailed design then refines the architectural design to the stage where actual implementation can begin.

➢ There are two design approaches: top-down approach and bottom up approach

1. Top-down approach:
➢ In this an overview of the system is first formulated, specifying but not detailing any first-level subsystems.

➢ Each subsystem is then refined in yet greater detail, sometimes in many additional subsystem levels, until the entire specification is reduced to base elements.

- Tactical, limited coverage
- Delayed return on investment
- Lower impact to overall organization
- Higher deployment costs

Advantage

- Your organization realizes a focused use of resources from the individual managed application.
- The first implementation becomes a showcase for the identity management solution.
- When the phases are completed for the managed application, you have implemented a deeper, more mature implementation of the identity management solution.
- Operation and maintenance resources are not initially impacted as severely as with the bottom-up approach.

Disadvantage

- The solution provides limited coverage in the first phases.
- A minimal percentage of user accounts are managed in the first phases.
- You might have to develop custom adapters at an early stage.
- The support and overall business will not realize the benefit of the solution as rapidly.
- The implementation cost is likely to be higher.

2. Bottom-up approach:
- In this approach the individual base elements of the system are first specified in great detail.
- These elements are then linked together to form larger subsystems, which then in turn are linked, sometimes in many levels, until a complete top-level system is formed.
- High deployment coverage in early phases
- Earlier return on investment
- High visibility of organizational changes

➢ Higher impact to organization

Advantage

➢ User and business awareness of the product. Benefits are realized in the early phases.
➢ You can replace many manual processes with early automation.
➢ You can implement password management for a large number of users.
➢ You do not have to develop custom adapters in the early phases.
➢ Your organization broadens identity management skills and understanding during the first phase.
➢ Tivoli Identity Manager is introduced to your business with less intrusion to your operations

Disadvantage

➢ The organizational structure you establish might have to be changed in a later roll-out phase.
➢ Because of the immediate changes to repository owners and the user population, the roll-out will have a higher impact earlier and require greater cooperation.
➢ This strategy is driven by the existing infrastructure instead of the business processes.
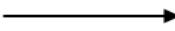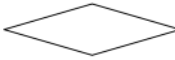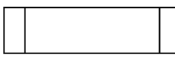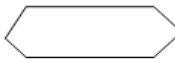
Programming Tool

➢ A programming tool may be any software program or utility that aids software developers or programmers in creating, editing, debugging, maintaining and/or performing any programming or development-specific task.
➢ A programming tool is also known as a software development tool.
➢ There are various programming tools that help us to write a system program. They are
   1. Flowchart
   2. Algorithm
   3. Pseudo codes
   4. Decision tables
1. Flowchart

- Flowchart is the graphical representation of an algorithm using standard symbols. In other words, flowchart is a pictorial representation of an algorithm that uses boxes of different shapes and connecting lines/arrows to denote different types of instructions.
- Advantages of Flowcharts
  - Communication: Flowcharts are a better way of communications.
  - Effective Analysis: Flowcharts provide a clear overview of the entire problem and its algorithm for solution.
  - Proper Documentation: The flowchart provides a permanent recording of program logic. It documents the steps followed in an algorithm.
  - Efficient Coding: Flowcharts show all major parts of a program. A programmer can code the programming instructions in a computer language more easily with a comprehensive flowchart as a guide.
  - Easy in debugging and program maintenance: Flowcharts help in the debugging process and maintenance of operating program.
- Limitations of Using Flowcharts
  - Complex Logic: A flowchart becomes complex and clumsy when the program logic is quite complicated.
  - Difficulty in alteration and modifications: If alterations are required; the flowchart may need to be redrawn completely.

Flowchart Symbols

→—————	Arrow	Used to connect flowchar symbols and the direction indicate the flow of logic
▭	Start/Stop/End (Terminal)	Used to represent the beginning and end of task
▭	Rectangle	Used for arithmetic and data manipulation operations. The instructins are written inside the symbol.
▱	Input/Output	Used for input (reading data) and output (displaying data). the data to be read and displayed are written inside the symbol.
◇	Decision	Used for decision making and brancing operations that has two alternatives (true or false, yes or no)
○	Connectors	Used to connect different flow lines and remote parts of the flowcharts on the same page
▭	Function Call	Used whenever you call the function from main or other user defined functions. Function name is written inside the box.
⬡	For Loop	Used to Indicate For Loop

Table 1.1 Symbols used for flowchart

2. Algorithm

- Refers to the logic.
- It is step by step description how to arrive at the solution to the problem.
- Algorithm is defined as sequence of instruction that when executed in the specified sequence the desired results are obtained.
- The set of rules that define how a particular problem can be solved infinite number of steps is known as algorithm.
- A good algorithm helps us to create a good program.
- A sequential solution of any program that written in human language, called algorithm.
- Algorithm is first step of the solution process, after the analysis of problem, programmer writes the algorithm of that problem.

- Example of Algorithms:

Q. Write a algorithm to find out number is odd or even?

Ans.

step 1 : start

step 2 : input number

step 3 : rem=number mod 2

step 4 : if rem=0 then

       print "number even"

       else

            print "number odd"

       endif

step 5 : stop

3. Pseudo code
- ➢ Pseudo code is one of the tools that can be used to write a preliminary plan that can be developed into a computer program.
- ➢ Pseudo code is a generic way of describing an algorithm without use of any specific programming language syntax.
- ➢ It is, as the name suggests, pseudo code —it cannot be executed on a real computer, but it models and resembles real programming code, and is written at roughly the same level of detail.

4. Decision tables

- ➢ Decision tables are used to model complicated programming logic.
- ➢ They can make it easy to see that all possible combinations of conditions have been considered; when conditions are missed, it is easy to see this.
- ➢ **Decision tables** are a precise yet compact way to model complex rule sets and their corresponding actions.

- Decision tables, like flowcharts and if-then-else and switch-case statements, associate conditions with actions to perform, but in many cases do so in a more elegant way
- Table representing complete set of conditional expressions where expressions are mutually exclusive in a predefined area
- Consists of three parts
    - Condition rows (stubs)
        - Lists condition relevant to decision
    - Action rows (stubs)
        - Actions that result from a given set of conditions
    - Rules
        - Specify which actions are to be followed for a given set of conditions

Condition Stub:	Condition entry:				
Is the student male?	Y	N			
Is the student taking at least 12 hours?	Y		N		
Is the student at least 77 inches tall?	Y			N	
Does the student weigh at least 180 pounds?	Y				N
Action Stub:	Action Entry:				
List the student's name and address	X				
Reject the student		X	X	X	X

4.4   Program Structure, Programming Algorithm

Every C program consists one or more modules called function. One of the function must be called main( ).A function is a sub-routine that may include one or more statements designed to perform a specific task. A C program may contain one or more sections shown in figure
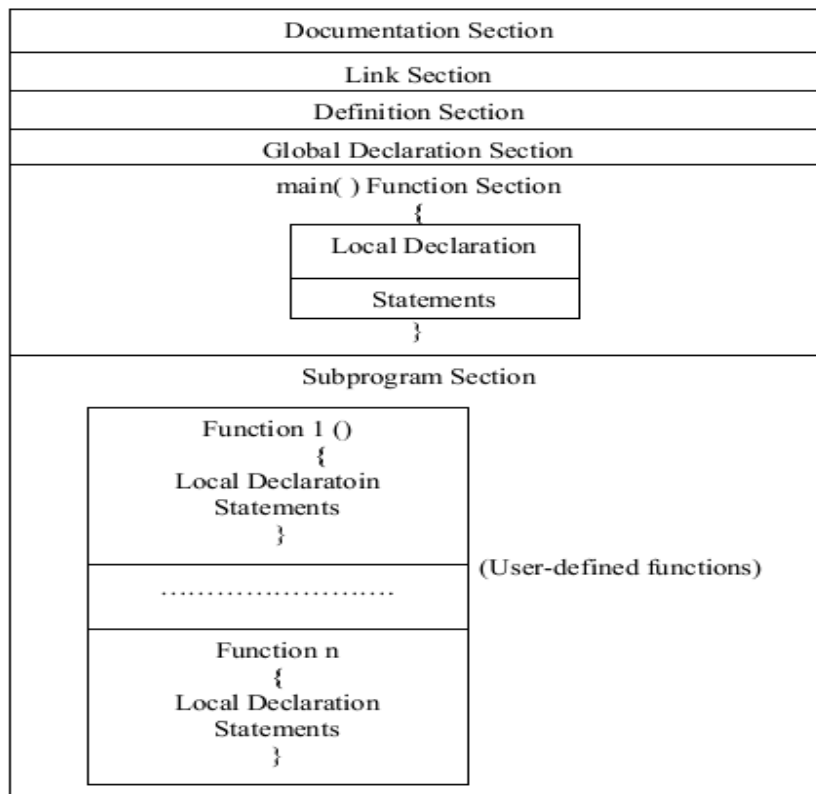
Documentation Section
Link Section
Definition Section
Global Declaration Section

main( ) Function Section {

Local Declaration
Statements

}

Subprogram Section

Function 1 ()
{
Local Declaratoin
Statements
}

....

Function n
{
Local Declaration
Statements
}

(User-defined functions)

Figure: Program Structure

The documentation section consists of a set of comment lines giving the name of the program, the author and other details which the programmer would like to use later. The link section provides instructions to the compiler to link function from the system library. The definition defines all the symbolic constants. There are some variables that are used in more than one function. Such variables are called global variables and are declared in global declaration section that is outside of all the function. Every C program must have one main ( ) function section. This section consists two parts: declaration part and executable part. The declaration part declares all the variables used in the executable part. These two parts must appear between the opening and the closing braces. The program execution begins at the opening braces and ends at the closing brace. The closing brace of the main ( ) function section is the logical end of the program. All the statements in the declaration and executable parts end with a semicolon. The subprogram section contains all the user-defined functions that are called in the main ( ) function. User-defined functions are generally placed immediately after the main ( ) function, although they may appear

in any order. All section, except the main ( ) function section may be absent when they are not required.

4.5   Program Specification

➢   A programmer is usually given a specification of what the propsed program is required to do. Then the programmer must design and implement the program so as to meet its specification.

➢   There are several methods that help in developing the proper specification for program design and implementation.

Documentation		Problem Analysis
Debugging & Testing		Algorithm Development
Compilation& Execution		Flowcharting
	Program Coding	
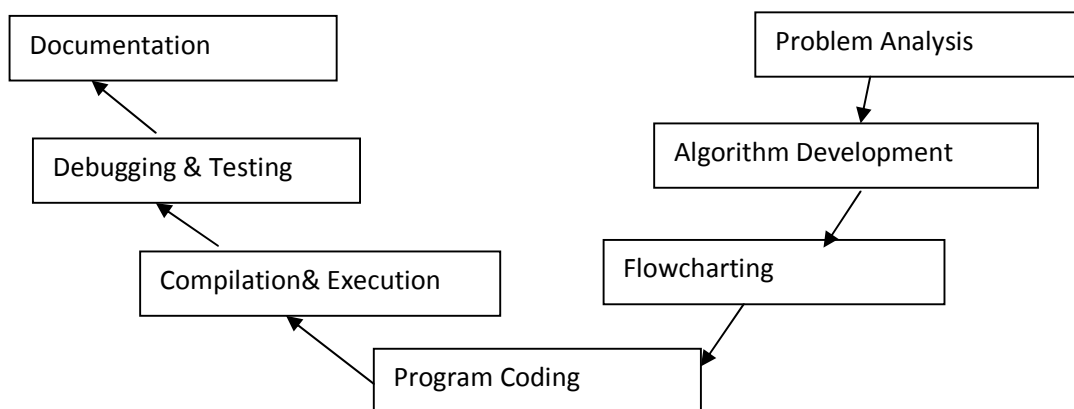
Fig: Steps in problem solving by a computer

1) **Problem Analysis:**

Before solving a problem, it should be analyzed well. It is impossible to solve a problem by using computer without clear understanding & identification of the problem. Thus, problem analysis contains different activities like determining input/output, software and hardware requirement, time constraints, different types of users, accuracy etc.

2) **Algorithm Development:**

Algorithm is step by step description of the method to solve a problem. In other words, it can be defined as a sequence of instructions designed in such a way that if the instructions are executed in the specified sequence, the desired result is obtained.

Example: write an algorithm to solve the problem which tests a number for even or odd.

Step1: Start

Step2: Read a number.

Step3: Divide the number by 2 and check the remainder.

Step4: If the remainder in step 3 is zero,

Display the number as even otherwise as odd.

Step5: Stop.

3) **Flowchart:**

Flowchart is the graphical representation of the algorithm using standard symbols. In other words, flowchart is a pictorial representation an algorithm that uses boxes of different shapes to denote different types of instruction. The actual instructions are written within these boxes using clear statement. The boxes are connected by solid lines having arrow marks to indicate the flow of operation.
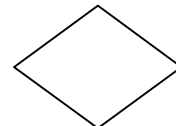
Flowchart Symbols

1) Start or End
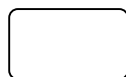
2) Input or Output

3) Processing

4) Decision

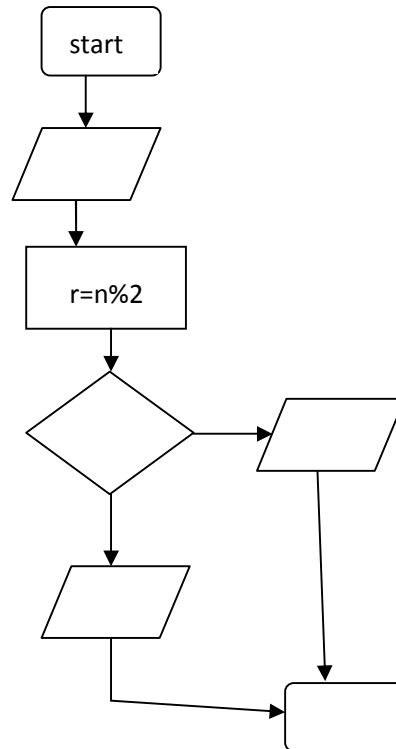5) Flow lines

6) Continuation

Example of flow chart: Draw flowchart to solve the problem which tests the number for even   or   odd.

4) Coding:

This is the process of transforming the program logic design into a computer language format. This stage translates the program design into computer instructions. These instructions are the actual program or software product. It can be said that coding is the act of transforming operations in each box of the flowchart in terms of the statement of the programming.

5) Compilation and Execution:

The process of changing high level language into machine level language is known as compilation. It is done by a compiler. Once the compilation is completed then the program is linked, loaded and finally executed. The original high level language is called the source program and the resulting machine language program is called object program.

6) Debugging & Testing:

Debugging is the discovery and correction of programming errors. Even after taking full care in program design, some errors may remain in the program because the designer might have never thought about a particular case. These errors are detected only when we start executing the program in a computer. Such types of program errors are called BUGS and process of removing these BUGS is knows as debugging.

Testing is the validation of the program. Testing ensures that program performs correctly the required tasks. The program testing and debugging are closely related.

7) Program Documentation:

Documentation of program helps to those who use, maintain and extend the program in future. Properly documented program is useful and efficient in debugging, testing, maintenance and redesign process. A properly documented program can easily be used again when needed and an undocumented program usually requires much extra work. Among the techniques commonly found in documentation are flowcharts, comments, memory maps, and parameter & definition list.

Chapter 5: Software Application

- ➢ Application software allows you (the user) to complete specific tasks like typing a report, keeping track of inventory, or planning a budget.

- ➢ An application program is the type of program that you use once the operating system has been loaded.

- ➢ Application software is computer software designed to help the user to perform singular or multiple related specific tasks.

- ➢ Examples include word-processing programs, spreadsheets and databases enterprise software, accounting software, office suites, graphics software, and media players.

- ➢ Application software is contrasted with system software and middleware, which manage and integrate a computer's capabilities, but typically there is no direct application of them in the performance of tasks that benefit the user.

- ➢ We have seen that the application software tells the computer how to accomplish specific tasks such as word processing or creating drawings for the user.

- ➢ Some of the categories of application software include:
  - o Word Processing Software
  - o Spreadsheets
  - o Database Management Software
  - o Presentation Programs
  - o Graphics Programs
  - o Multimedia Authoring Applications
  - o Entertainment and Education software
  - o Web design tools and Web browsers

Application Software

- ➢ **Word processing applications**
  - o Microsoft Word
  - o Lotus Word Pro
  - o WordPerfect

- ➢ **Spreadsheets**
  - o Microsoft Excel
  - o Lotus 123
- ➢ **Database**

  - o Microsoft Access
  - o Lotus Approach

Word Processing

- ➢ The text processing Software or Word Processing is one of the most significant application packages of Windows.
- ➢ The Word processing software is used for creating documents. Drafts, letters, reports, essays, write-ups etc. can be created by means of word processing software.
- ➢ However, the most common place word processing package used today is Microsoft Word.
- ➢ Microsoft Word is Microsoft's word processing software.
- ➢ It was first released in 1983 bearing the name Multi-Tool Word for Xenix systems.
- ➢ It is a component of the Microsoft Office system; however, it is also sold as a standalone product and included in Microsoft Works Suite.
- ➢ Beginning with the 2003 version, the branding was revised to emphasize Word's identity as a component within the Office suite.
- ➢ Microsoft began calling it Microsoft Office Word instead of merely Microsoft Word.
- ➢ The latest releases are Word 2007 for Windows and Word 2008 for Mac OS X.
- ➢ Once again, the 2010 version appears to be branded as Microsoft Word, once again.
- ➢ The contemporary versions are Microsoft Word 2010 for Windows and 2008 for Mac.
- ➢ The significant features of MS Word are as follows:

1. It is an easy and simple package for a general user.
2. The features such as paragraph, font, symbols, spell check, table, drawing, bullets and numbering, page numbering provided by this package enable a user to develop a document in an error free format.
3. The text file generated by MS Word is .doc. This file can be used in other applications such as MS Excel, MS Visual Studio 6.0, MS Visual Studio.net, Web browser, pdf format etc.

➢ The key to successful use of a word processor is to make full use of the automation it provides. It will lay out your text in neatly justified paragraphs; split your work into pages and number them; align the columns in a table.

➢ The supplied styles give a professional appearance to your document, and also allow the word processor to generate a table of contents by selecting all text that you have declared to be a heading.

➢ These features significantly reduce the time needed to change a document around, perhaps by deleting or adding new text, or perhaps to use a different printer or a different font. These tasks require the adjustment of paragraphs, page numbering, table of contents, and so on.
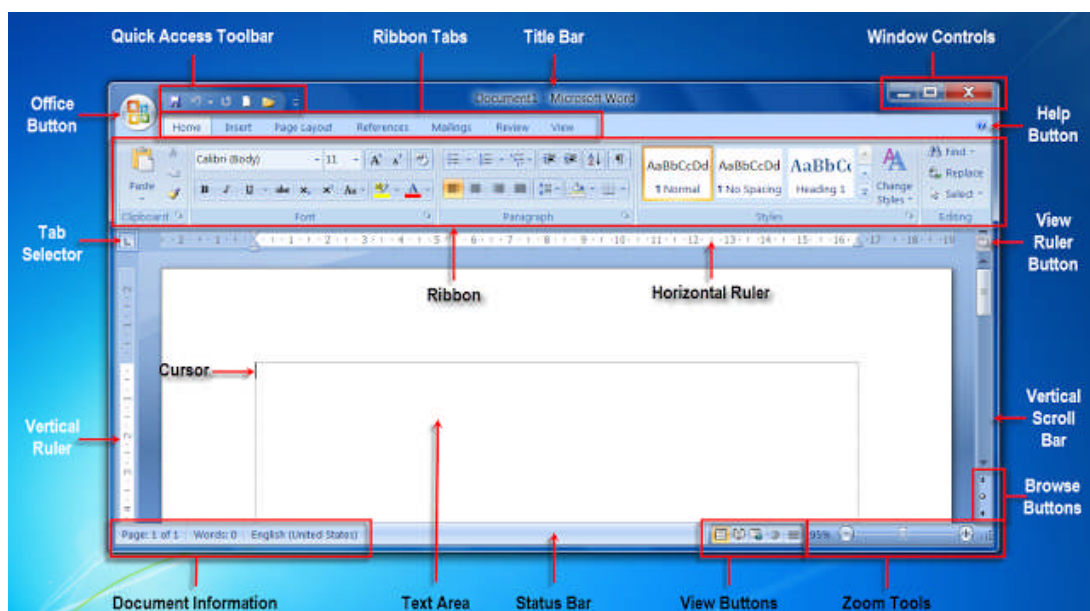

Figure: interface of Microsoft word

Title Bar

The title bar shows the name of the document on screen. When a new document is started, Word 2007 gives it a generic name like 'Document 1' and this is displayed on the title bar. When you save the document with a name, the generic name on the title bar is replaced by the given name.

Quick Access Toolbar

Located in the top left corner of the Word 2007 window, the Quick Access Toolbar contains some of the most frequently used commands like Save, Undo, Redo. You can add more commands to the Quick Access Toolbar as per your need. This toolbar helps you to perform Word tasks speedily by providing one-click access to oft used commands.

Window Controls

These are a set of three buttons in the top right corner of the program window.
- The right button,displaying an x, is the Close button . On clicking, this button closes the current document but not the Word programme.
- The left button is the Minimize button which minimizes the program window to the taskbar.
- The middle button, sporting a rectangle, is the Maximize button, which, on clicking, maximizes the Word 2007 window and the button image changes to a pair of rectangles. Another click restores the program window to its previous size and the button image to a single rectangle.

Ribbon

You can think of the Ribbon as a collection of seven horizontal tabbed toolbars arranged on top of each other. These toolbars are accessed through their tabs. The toolbars have command buttons, menus and input boxes arranged in groups. Some groups have dialog launchers (represented by a downward pointing arrow) which, when clicked, display a dialog box related to

that group.

At any given time, only one tabbed toolbar is visible. When Word is launched, the Home tab is current and the toolbar attached to it is at the top, enabling you to invoke its commands by clicking them. When any other tab is clicked, its toolbar comes to the top and you can use the commands stored on it.

You may minimize the ribbon by clicking the 'Customize Quick Access Toolbar' button located to the right of the 'Quick access Toolbar' and choosing 'Minimize the Ribbon' from the drop-down menu. The Ribbon can also be minimized by double clicking the active tab; clicking any tab of the minimized Ribbon will redisplay it once again.

Office Button

Clicking 'Office' button reveals a drop-down menu showing commands for file operations. These commands are described below in brief.

- **New**: When you click this button, the 'New Document' window comes up displaying three panes. The first pane shows a list of templates types, the second pane shows the templates available for the template type selected in the first pane and the third pane shows a preview of the template selected in second pane. You can start a new document based on a template selected from amongst these. By default, the blank document template is chosen. Clicking the Create button starts a new document based on the selected template. Notice that Word 2007 offers a wide variety of templates from the Microsoft Office Online.

- **Open**: Starts the Open dialog where you can navigate to your documents folder, select an existing (i.e. previously saved) document and open it in Word window.

- **Save**: Clicking Save button saves the current document if it has been given a name and saved earlier, otherwise it launches the Save As dialog.

- **Save As**: Opens the Save As dialog. Here you can assign a name to a new document and save it. You may also rename a document saved earlier and save it with the new name.

- **Print**: This command is used for printing the current document.

- Prepare: Clicking this button opens a menu which provides inormation regarding the current document and has commands for preparing it for distribution.

- **Send**: You may use this command to email a document or to fax it via internet.

- **Publish**: This command allows you to create a blog post and publish it.

- **Close**: You can close the current document using this button. However, the Word 2007 program keeps running.

- **Word Options**: Opens the Word Options Dialog where you can chose your preferred settings for display, proofing, saving, language, etc. It also provides facility for customizing the Ribbon and the Quick access Toolbar.

- **Exit Word**: Clicking this option closes the Word 2007 programme together with all open documents.

Help Button

Located below the Window Controls in the top right corner of Word window, this button brings up the Word Help window.

Rulers

The horizontal ruler is used to set tabs and indent text. You may use the vertical ruler to set vertical location of text in the document. If the rulers are not visible, click the View Ruler button immediately below the Ribbon on the extreme right.

The rulers show measurements in inches or centimetres, depending on the units of measure specified in Word Options.

Tab Selector

Repeated clicking of the Tab Selector shows five tab markers and two indent markers. By choosing the desired tab or indent marker and clicking on the horizontal ruler, you can set tabs or indent text.

Status Bar

On the left hand side, the status bar displays document information such as the current page number and total number of pages, word count, language, proofing error notification, etc. You can customize the information display by right clicking the status bar and and making selections out of the context menu that pops up.

View Buttons

These buttons allow you to use five different document views:

- **Print Layout View**: This view shows the document as it will look when it is printed.

- **Full Screen Reading View**: This view shows the document on full screen to make reading your document more comfortable.

- **Web Layout View**: Web Layout view enables you to see your document as it would appear in a browser such as Firefox or Internet Explorer.

- **Outline View**: Outline view displays the document in outline form in which headings could be displayed without the text. When you move a heading, the accompanying text will move with it.

- **Draft View**: This is the most frequently used view for editing your document.

Zoom Tools

The Zoom slider lets you zoom out or zoom in the current document. The zoom range is from 10% to 500%. The current zoom level is displayed on the taskbar immediately left of the slider. Clicking the zoom level opens the Zoom dialog where you can specify the desired zoom level.

Vertical & Horizontal Scroll Bars

The vertical scroll bar is located at the extreme right of the Word 2007 window while the horizontal scroll bar is at the bottom of the window just above the status bar. Vertical scroll bar

is always visible while the horizontal scroll bar appears only when the document width exceeds the screen width.

The scroll bars let you scroll the document up-down vertically or left-right horizontally. To scroll, you need to click and drag the scroll box showing three vertical/horizontal lines. The document moves in a direction opposite to the movement of the scroll box.

Text Area

Framed between the rulers and the scroll bars is a large area looking like a blank sheet of paper. This is the text area where you type the text of the document. You will see a blinking vertical line in the top left corner. This is the Cursor. The typed characters appear at its location. As a character appears at its location, the cursor moves to its immediate right.

Mouse Pointer

In Word, you use the mouse to choose commands, move around in the document, select and move text, etc. As you move the mouse pointer across the screen, it takes different shapes. It is a right pointing arrow within the left margin of the text area and an I-beam in the rest of the text area. Outside the text area, it takes the shape of a left pointing arrow.

The mouse is used to perform following actions :
- Point: Positioning the mouse pointer on an item.
- Single click: Clicking the left mouse button once.
- Double click: Clicking the left mouse button twice in quick succession.
- Triple click: Clicking the left mouse button thrice in quick succession.
- Right click: Clicking the right mouse button once.
- Drag & Drop: Pointing to an item, pressing and holding the left mouse button while moving the pointer to a new location and releasing the mouse button.

Spreadsheets

➢ Spreadsheet is a computer application that simulates a paper worksheet.

➢ It displays multiple cells that together formulate a grid consisting of rows and columns, each cell containing either alphanumeric text or numeric values.

➢ A spreadsheet cell may alternatively contain a formula that defines how the contents of that cell are to be calculated from the contents of any other cell (or combination of cells) each time any cell is updated.

➢ Spreadsheets are frequently used for financial information as they robotically enable the re-calculation of the total sheet, after a modification to a single cell is made.

➢ Lotus 1-2-3 was the most popular spreadsheet in use when DOS was the dominant operating system.

➢ Excel is now considered to have the largest market share on the Windows and Macintosh platforms

Microsoft Excel

➢ Microsoft had been developing Excel on the Macintosh platform for several years, eventually converting it into a powerful system.

➢ A port of Excel to Windows 2.0 resulted in a fully functional Windows spreadsheet.

➢ The highly robust Windows 3.x platforms of the early 1990s made it possible for Excel to take a significant amount of market share from Lotus.

➢ By the time Lotus responded with serviceable Windows products, Microsoft had started compiling their Office suite.

➢ Starting in the mid 1990s and continuing through to the present, Microsoft Excel has dominated the commercial electronic spreadsheet market.

- The first spreadsheet, Visicalc, was designed in 1978 and ran on the Apple II microcomputer. This one application converted the Apple II from being a hobbyist's machine into a tool for business.

- The key concepts in the spreadsheet are the cell, the cell address, and the formula.

- A spreadsheet stores data, usually numbers, in a table split into columns (A, B, C ...) and rows (1, 2, 3 ...).

- A row and a column intersect in a cell, which has an address such as B3. This is simpler in a database where field names (column headings) must be defined before any data can be entered.

- A cell can hold any data item, be it a number, text or formula. Again, this differs from a database where the type of data stored in a field is pre-determined when the database is set up.

- When a formula is entered in a cell, the formula itself is remembered, but what is displayed, the cell's contents, is the value of the formula.

- An example of a formula is = 1 + 3 + 6. The equals sign distinguishes formulas from ordinary text. The value of this formula is 10 and that is what will be displayed.

- More interesting, and useful, is to make a formula depend on the contents of another cell. This is done using the cell address, such as B3, as a variable. The formula = B2 + B3 + B4 will calculate and display the sum of cells B2, B3 and B4. This can also and more conveniently be calculated using functions that are built in to the spreadsheet program = SUM(B2:B4)

- Here the function is SUM, and it is acting on the range of cells B2 to B4, that is to say B2, B3 and B4. Ranges allow functions such as SUM to act on any rectangle; for example AVERAGE (B2:D5) calculates the mean of the 12 cells in columns B, C, D and rows 2, 3, 4 or 5. For better readability of formulas, it is possible to give a mnemonic name to a range, and enter a formula such as = SUM(marks)

- There are many other built-in functions for calculating statistical and financial values. They are listed in the on-line help. It is also possible to define your own functions in the built-in macro programming language. In the case of Microsoft Excel this is a variant of Basic.

- The spreadsheet is more powerful than an ordinary calculator in two ways. Firstly it allows you to replicate formulas, so you do not have to type them repeatedly. Secondly it automatically recalculates formulas when any cells that they depend on are changed. This automatic recalculation is powerful yet simple. With automatic recalculation it is trivial to redo complex predictions for a range of assumptions.

- Charting, or business graphics, adds much to the power of a spreadsheet. This is now a standard part of any spreadsheet program. One or more columns or rows of data can be displayed in line graphs, histograms (bar charts), pie charts or scatter graphs. It is important to use the appropriate type of graph according to the message you hope to convey.

- A typical use of spreadsheets is in analysis of financial data. There are dangers in making such calculations using so flexible a package: the spreadsheet performs little or no checking. Surveys have suggested that more than half the spreadsheets used by businesses had errors in them. The wrong figures had been entered, or the formulas had been typed wrongly, or were calculating over the wrong range of addresses. For serious business use, it is probably better to use a specialist accounts package which incorporates better checking, and comes already programmed with many calculations, avoiding the risk of entering a formula wrongly.

- Recently the word processor, spreadsheet and database package have started to converge. Modern spreadsheet packages can be used to store simple (single file) databases, and provide sorting and simple querying. They also support text formatting features, such as choice of font, more often associated with word processors.

- Similarly calculation functions can now be found in both database and word processor packages. For the novice user this may not be a good thing as it may lead to them being offered more choices than they can easily deal with.

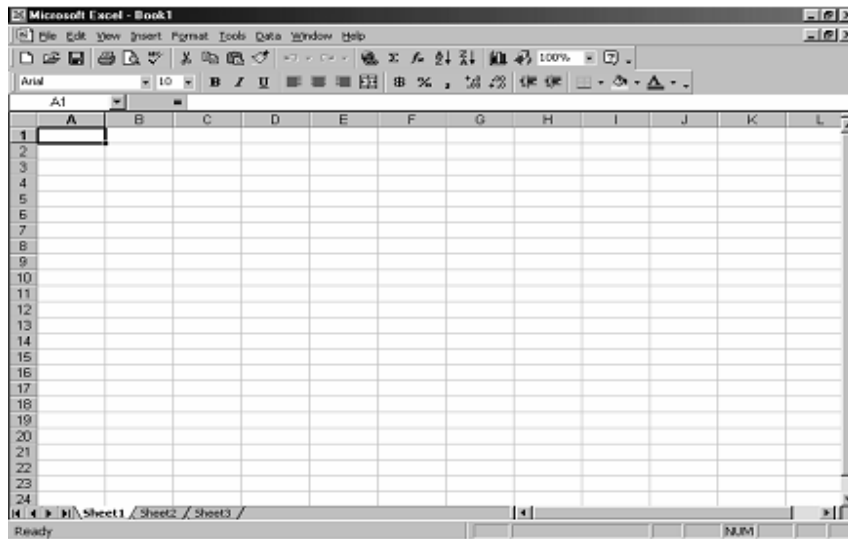- The Excel window is shown below:

Figure: Interface of Microsoft spreadsheet

Title Bar: Displays the application name, file name and various window controls, such as minimize button, maximize button and close button.
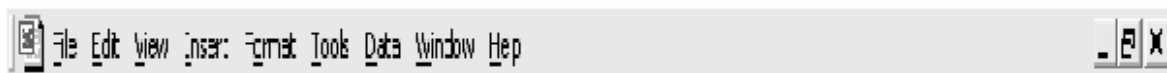

 a. Minimize button: This is used for altering a window/sheet into a button. The screen is minimized and appears in the form of a button on the taskbar.

b. Maximize button: This is used for magnifying a window/sheet subsequent to its minimization and restoration.

c. Close button: This is used to close a window/sheet.

Menu Bar: Different options for selection

File: Use this option to create a new file, open an existing file and save a file. Other options are printing, print preview, setting up of print area, closing the worksheet, exiting Excel etc.

Edit: This helps in copying, cutting and deleting a range of text, pasting text that is copied or cut from another location, clearing the contents of cells, finding the particular text in the worksheet, etc.

View: This helps in enabling and disabling certain tools in the Excel worksheet

Insert: This can be used to insert cells, rows and columns in the work sheet.

Format: This helps in formatting the row/ column to increase/decrease height, width etc.

Tools: This helps the spell check and protection of worksheets/ workbooks by setting a password for accessing it and customizing it according to one's specification etc.

Data: This is used to sort (ascending/descending), filter the list, to obtain the subtotal etc.

Window: This is used to hide/unhide the workbook, to create a new window, to split the pane etc.

Help: This can be used to get any help about Excel.

Standard tool bar: Displayed by default, allows giving common commands like saving the file, opening a file, printing etc.

New: This is used to create a new workbook.

Open: This is used to open an existing file.

Save: This is used to save the file.

Print: This is used to take a printout of the file.

Preview: This is used to preview the document before the actual printing.

Spell check: This is used to check the spelling and grammatical errors in the file.

Cut: This is used to move a selected block from one location to another.

Copy: This is used to copy a selected block from one location to another.

Paste: This is used to place the selected block during the copy or cut operation at a certain location.

Undo: This is used to retain any modifications made to a file.

Redo: This is used to reverse the last undo action performed on the file.

Auto Sum Button: This is used to add the numbers on a particular range.

Paste function Button: This is used to perform different operations on a selected set of numbers, such as calculating the average or finding the minimum or maximum of set of numbers etc.

Sort Ascending: This is used to arrange a set of numbers in ascending (increasing) order. **Sort Descending:** This is used to arrange a set of numbers in descending (decreasing) order.

Chart Wizard Button: This is used in creating chart graphs for a set of numbers.

Drawing: This is used to add the drawing tool bar just above the status bar of the window.

Zoom: This is used to change the size of the work sheet or to display the selected block in greater size.

Formatting toolbar: Allows the user to give commands related to formatting cells and cell contents such as Bold, Underline, Font Style, Font Size, Color etc.

Font: This helps in changing the style of the text typed in the work sheets. One can select a required font from the available font list and change the style of the text inside the selected block.

Font Size: This helps in changing the size of the text. One can select a required size for the font from the available list and change the size of the text inside the selected block. **Bold:** This helps in making the selected look bolder/ darker than the other text

Italic: This helps to make the text in the selected block look tilted or slanted.

Underline: This helps in underlining the selected text.

Align Left: This helps in left justifying the contents of cell in the selected block.

Centre: This helps in centre justifying the contents of the cell inside the selected block.

Align Right: This helps in right justifying the contents of the cell inside the selected block.

Name box– Displays the address of the current cell.

Formula Bar– Displays the cell content.

> ➢ The above figure shows the address of the active cell and the contents of active cell.
> ➢ In the above example C1 is the address of the cell and 'sales' is content of that cell.

Current Cell: Current cell is the active cell

Row Headers: There are 65636 rows (lines) numbered as 1, 2, 3 … 65536. The number of the first row is 1 and that of the last row is 65636. To go to a cell in last row, press End and Down arrow keys and to return to a cell in the first row, press End and up arrow key.

Column Headers: There are 256 columns numbered as A, B, C, Z, AA, and AB… AZ, BA, BB, IV. The first column is designated as 'A' and the last column as 'IV'. To go to a cell in last column header, press End and Right arrow keys. To return to the cell in the first column, press End and Left Arrow keys.

Scroll Bars: Used to scroll through different parts of the current sheet.

Sheet Tabs: Display the sheet names. Each worksheet is named as Sheet1, Sheet2 and Sheet3.

Status Bar: Displays various modes such as Ready or Edit mode on the left side. The status of Num lock, Caps lock and Scroll lock keys on the keyboard is on the right side.

➢ The status bar is located at the bottom of the Microsoft Excel Window. It displays ready or Edit on the left hand side and NUM on the right hand side.

Ready: This indicates that the workbook is ready to accept data from the user.

Edit: This indicates the workbook is in edit mode i.e. the contents of the cell are being modified or a new content is being placed in the cell.

NUM: This is located on the right hand side of the status bar and represents the status of Num Lock indicator on the keyboard. If Num Lock is enabled on the keyboard, NUM appears and if Num Lock is disabled, NUM disappears from the Status Bar.

5.3 Database

➢ A *database* is a collection of information stored in an organized form in a computer.

➢ A *database program* is a software tool for organizing storage and retrieval of that information.

➢ Many of the terms that describe the computer come from the file cabinet terminology of the office.

➢ For databases, the term *file* means a data file that is a part of a database.

➢ A *record* is the information relating to one person, item or event.

➢ Each discreet chunk of information in a record is called a *field*.

➢ There are different types of fields. *Field types* include a *text fields* that contain text, a *numeric fields* which contain only numbers and *date fields* which contain only dates. Other field types can include other types of data including graphics, photos, sounds or even videos. Computed fields contain formulas similar to spreadsheets.

➢ Most database programs have more than one way that data can be viewed. For example, *form views* show one record at a time and *list views* which show several records at a time.

➢ Any file or collection of files containing information can be described as a database

- For example, suppose you have a file of names and addresses, and you want to look up a certain person whose last name is Lane. Using text searching you will also find every address such as Lover's Lane, and other surnames such as DeLaney.
- To avoid such problems it is usual to keep serious amounts of data in a structured format, in which the file is split into clearly separate records, and moreover to split the information in each record into clearly separate fields. Then one address can be kept per record, and the address can be split into separate fields such as first name, last name, house name or number, street name, town, and postcode.
- Another advantage of this structure is that the information can easily be sorted by, say, postcode, and then re-sorted by last name. Thus the structure facilitates accurate information retrieval and efficient information processing.
- Each file holds a two dimensional table, the rows being the records, and the columns being the fields. This is called a relational database. Other arrangements are hierarchical, as in the directories and subdirectory structure of files on a computer disk; or network as in the network of links in a hypertext system.

Why databases?

- Databases make it easy to store large quantities of information. The larger the mass of information, the bigger the benefit of using a database.
- Databases make it easy to retrieve information quickly and flexibly.
- Databases make it easy to organize and reorganize information. You can quickly switch between schemes.
- Databases make it easy to print and distribute information in a variety of ways.

File Manager vs. Database Management System (DBMS)

- A file manager is a program that allows users to work on one file at a time. A true DBMS is a program or a system of programs that can manipulate data in a large collection of files cross-referencing as needed.
- A file manager is sufficient for mailing lists and other common data management applications

- For large, complex jobs a DBMS is needed.
- With a DBMS there is no need to store redundant information in multiple files.
- With a DBMS databases that are related are linked using *key fields*. These are fields that are shared by all files that use data from each other.
- Since the files in databases that have DBMSs relate to each other, they are commonly called *relational databases*.

Relational database definitions

- The common definition is that relational databases are databases that allow files to be related to each other so that changes in one file are reflected in other files automatically, those that have DBMSs.
- There is a more specific technical definition with the structure of a relational database based on a specific mathematical model that combines data in tables.
- Almost all databases that have DBMSs meet both definitions of a relational database.

Advantage

- Reduced data redundancy
- Reduced updating errors and increased consistency
- Greater data integrity and independence from applications programs
- Improved data access to users through use of host and query languages
- Improved data security
- Reduced data entry, storage, and retrieval costs
- Facilitated development of new applications program

Disadvantage

- Database systems are complex, difficult, and time-consuming to design
- Substantial hardware and software start-up costs
- Damage to database affects virtually all applications programs
- Extensive conversion costs in moving form a file-based system to a database system
- Initial training required for all programmers and users

- A **database management system (DBMS)** is a software package designed to define, manipulate, retrieve and manage data in a database. A DBMS generally manipulates the data itself, the data format, field names, record structure and file structure. It also defines rules to validate and manipulate this data. A DBMS relieves users of framing programs for data maintenance. Fourth-generation query languages, such as SQL, are used along with the DBMS package to interact with a database.

- A database management system (DBMS) is a collection of programs that enables you to store, modify, and extract information from a database. There are many different types of DBMSs, ranging from small systems that run on personal computers to huge systems that run on mainframes.

- The following are examples of database applications:
  - computerized library systems
  - automated teller machines
  - flight reservation systems
  - computerized parts inventory systems

5.4 Graphics

- **Graphics** (from Greek γραφικός *graphikos*, 'something written' e.g. autograph) are visual images or designs on some surface, such as a wall, canvas, screen, paper, or stone to inform, illustrate, or entertain.

- In contemporary usage it includes: pictorial representation of data, as in computer-aided design and manufacture, in typesetting and the graphic arts.

- Images that are generated by a computer are called computer graphics.

- Examples: photographs, drawings, LineArt, graphs, diagrams, typography, numbers, symbols, geometric designs,maps, engineering drawings, or other images.

- Graphics often combine text, illustration, and colours.

- Graphic design may consist of the deliberate selection, creation, or arrangement of typography alone, as in a brochure, flyer, poster, web site, or book without any other element. Clarity or effective communication may be the objective, association with other cultural elements may be sought, or merely, the creation of a distinctive style.

- Graphics can be functional or artistic. The latter can be a recorded version, such as a photograph, or an interpretation by a scientist to highlight essential features, or an artist, in which case the distinction with imaginary graphics may become blurred.

- **Graphic design** is the methodology of visual communication, and problem-solving through the use of type, space and image. The field is considered a subset of visual communication and communication design, but sometimes the term "graphic design" is used interchangeably with these due to overlapping skills involved.

- Graphic designers use various methods to create and combine words, symbols, and images to create a visual representation of ideas and messages.

- A graphic designer may use a combination of typography, visual arts and page layout techniques to produce a final result. Graphic design often refers to both the process (designing) by which the communication is created and the products (designs) which are generated.

- Common uses of graphic design include identity (logos and branding), publications (magazines, newspapers and books), print advertisements, posters, billboards, website graphics and elements, signs and product packaging.

- For example, a product package might include a logo or other artwork, organized text and pure design elements such as images, shapes and colour which unify the piece. Composition is one of the most important features of graphic design, especially when using pre-existing materials or diverse elements.

Graphics Software

- *Paint Programs:* work with bitmapped images which can have jagged lines and are hard to scale, but good for subtle coloring.

- *Draw Programs:* work with vectors and curves described mathematically which scale well and can be drawn smoothly.
- *Business Graphics:* The facilities provided by eg spreadsheet programs to produce charts from numbers.
- *Scientific Graphics:* Like business graphics but supporting the kind of graphs scientists like to use.
- *Presentation Graphics:* Programs to produce computerized slide shows or OHPs.

5.4 Customized Package

- **Custom software** (also known as **bespoke software** or **tailor-made software**) is software that is specially developed for some specific organization or other user. As such, it can be contrasted with the use of software packages developed for the mass, such as commercial off-the-shelf (COTS) software, or existing free software.
- Since custom software is developed for a single customer it can accommodate that customer's particular preferences and expectations.
- Custom software may be designed in stage by stage processes, allowing all nuances and possible hidden dangers to be taken into account, including issues which were not mentioned in the specifications. Especially the first phase in the software development process may involve many departments, including marketing, engineering, research and development and general management.
- Large companies commonly use custom software for critical functions, including content management, inventory management, customer management, human resource management, or otherwise to fill the gaps present in the existing software packages. Often such software is legacy software, developed before COTS software packages offering the required functionality became available.
- Custom software development is often considered expensive compared to off-the-shelf solutions or products. This can be true if one is speaking of typical challenges and typical solutions.
- However, it is not always true; custom software development by a reputable supplier is often a matter of building a house upon a solid foundation and, if managed properly, it is

possible to do this quickly and to a high standard. In many cases, COTS software requires customization to correctly support the buyer's operations. The cost and delay of COTS customization frequently adds up to the expense of developing custom software.

➢ Additionally, COTS comes with high upfront license costs frequently running into millions of dollars. Thus only the big corporations are able to absorb such high costs upfront. Additionally, the big software houses having COTS products revamp their product very frequently. Thus a particular implementation needs to be upgraded for compatibility every 2–4 years. Given the cost of customization, such upgrades also turn out to be expensive as a dedicated product release cycle will have to be earmarked for it.

➢ The decision to build a custom software or go for a COTS implementation would usually reside on one or more of the following:

   o Finances - Cost and Benefit: The upfront license cost for COTS products mean that a thorough cost-benefit analysis of the business case needs to be done.

   o Time to market: COTS products usually have a lesser time to market.

   o Size of implementation: COTS comes with standardization of business processes and reporting. For a global and national player, these bring in gains in cost savings, efficiency and productivity.

Chapter 6: Computer Peripherial

6.1 Printer and Ploter

➢ A **printer** is an electromechanical device which converts the text and graphical documents from electronic form to the physical form.

➢ Generally they are the external peripheral devices which are connected with the computers or laptops through a cable or wirelessly to receive input data and print them on the papers.

➢ A wide range of printers are available with a variety of features ranging from printing black and white text documents to high quality colored graphic images.

➢ Quality of printers is identified by its features like color quality, speed of printing, resolution etc.

➢ Modern printers come with multipurpose functions i.e. they are combination of printer, scanner, photocopier, fax, etc. To serve different needs there are variety of printers available that works on different types of technologies.
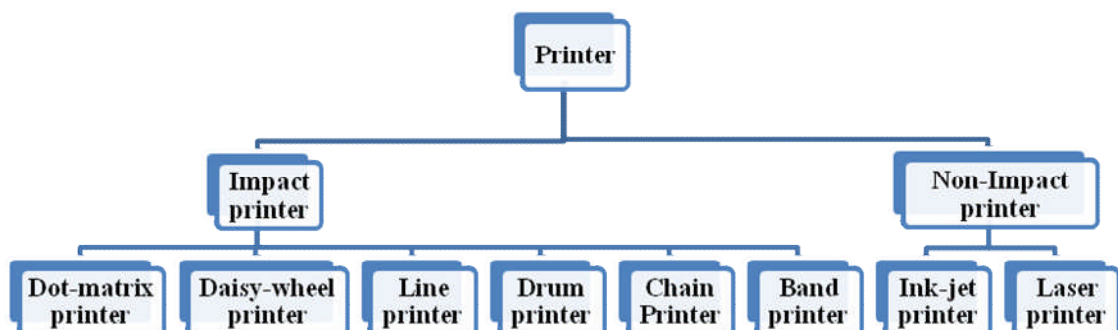
There are two types of printers.

Impact printers

➢ It usually forms the print image by pressing an inked ribbon against the paper using a hammer or pins. Following are some examples of impact printers.

Dot-Matrix Printers

➢ The dot-matrix printer uses print heads containing from 9 to 24 pins. These pins produce patterns of dots on the paper to form the individual characters.

➢ The 24 pin dot-matrix printer produces more dots than a 9 pin dot-matrix printer, which results in much better quality and clearer characters.

➢ The general rule is: the more pins, the clearer the letters on the paper. The pins strike the ribbon individually as the print mechanism moves across the entire print line in both directions, i-e, from left to right, then right to left, and so on.

➢ The user can produce a color output with a dot-matrix printer (the user will change the black ribbon with a ribbon that has color stripes).

➢ Dot-matrix printers are inexpensive and typically print at speeds of 100-600 characters per second.

➢ It is a popular computer printer that prints text and graphics on the paper by using tiny dots to form the desired shapes. It uses an array of metal pins known as print head to strike an inked printer ribbon and produce dots on the paper. These combinations of dots form the desired shape on the paper.

➢ Generally they print with a speed of 50 to 500 characters per second as per the quality of the printing is desired. The quality of print is determined by the number of pins used (varying from 9 to 24).

➢ The key component in the dot matrix printer is the 'print head' which is about one inch long and contains a number of tiny pins aligned in a column varying from 9 to 24. The

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print head is driven by several hammers which force each pin to make contact with the paper at the certain time. These hammers are pulled by small electromagnet (also called solenoids) which is energized at a specific time depending on the character to be printed. The timings of the signals sent to the solenoids are programmed in the printer for each character.

Advantages

➢ The Dot matrix printers are cheap and easily available in the market.
➢ They can make carbon copies of the print out unlike non-impact printers.
➢ The printing costs are the lowest as compared to other printers.
➢ The printout fades gradually rather than coming to a halt suddenly. We get plenty of time to change the ribbon before crisis emerges.
➢ They use paper continuously unlike other printers that require frequent change of paper.
➢ The maintenance cost is low as compared to other printers.
➢ They tolerate dirty and hot conditions as are found in industrial environments.

Disadvantages

➢ The output is not high resolution.
➢ Color printout is limited and the print speed is also lesser as compared to non-impact printers.
➢ Therefore, the quality of print out in general is not very good. This affects the scanner readability of the print out.
➢ The printer creates great deal of noise while the pins strike the ribbon to the paper.
➢ The pins get bended easily destroying the print head.
➢ The single sheet of paper has to wound and aligned by hand which is time-consuming and hectic. This also makes it prone to jamming frequently. Although paper jamming can happen with any printer, fixing it here is not an easy task.
➢ The density of barcodes is low and may fail to match user's standards.

Nowadays, dot matrix printers are found in devices such as ATM's, cash registers, and POS terminals in shopping outlets.

Daisy-wheel printers

➢ In order to get the quality of type found on typewriters, a daisy-wheel impact printer can be used.

➢ It is called daisy-wheel printer because the print mechanism looks like a daisy; at the end of each "Petal" is a fully formed character which produces solid-line print. A hammer strikes a "petal" containing a character against the ribbon, and the character prints on the paper.

➢ Its speed is slow typically 25-55 characters per second.

➢ Daisy wheel printers print only characters and symbols and cannot print graphics. They are generally slow with a printing speed of about 10 to 75 characters per second.

➢ By 1980 daisy wheel printers were the dominant printers for quality printing but since the prices of laser and inkjet printers have declined and quality of dot matrix printers has been improved, the daisy wheel printers are now obsolete.

Working of daisy wheel printers

➢ Is very similar to typewriters.

➢ A circular printing element (known as daisy wheel, shown in the below image) is the heart of these printers that contains all text, numeric characters and symbols mould on each petal on the circumference of the circle.

➢ The printing element rotates rapidly with the help of a servo motor and pauses to allow the printing hammer to strike the character against the paper.
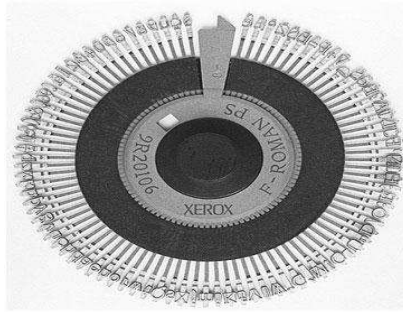
Advantage

- Low maintenance
- Low costs
- Can create carbon copies
- Can use fan-fold paper and heavy paper grades
- Better print quality than a dot-matrix printer

Disadvantages

- Noisy printing
- No graphics
- Limited number of characters/types
- The character set is changed by replacing the daisy wheel

Line printers

- In business where enormous amount of material are printed, the character-at-a-time printers are too slow; therefore, these users need line-at-a-time printers.
- Line printers, or line-at-a-time printers, use special mechanism that can print a whole line at once; they can typically print the range of 1,200 to 6,000 lines per minute.
- Drum, chain, and band printers are line-at-a-time printers.

Drum printer

- A drum printer consists of a solid, cylindrical drum that has raised characters in bands on its surface.
- The number of print positions across the drum equals the number available on the page.

➢ This number typically ranges from 80-132 print positions.

➢ The drum rotates at a rapid speed.

➢ For each possible print position there is a print hammer located behind the paper. These hammers strike the paper, along the ink ribbon, against the proper character on the drum as it passes. One revolution of the drum is required to print each line. This means that all characters on the line are not printed at exactly the same time, but the time required to print the entire line is fast enough to call them line printers.

➢ Typical speeds of drum printers are in the range of 300 to 2000 lines per minute.

Chain printers

➢ A chain printer uses a chain of print characters wrapped around two pulleys.

➢ Like the drum printer, there is one hammer for each print position. Circuitry inside the printer detects when the correct character appears at the desired print location on the page. The hammer then strikes the page, pressing the paper against a ribbon and the character located at the desired print position. An impression of the character is left on the page. The chain keeps rotating until all the required print positions on the line have filled. Then the page moves up to print the next line. Speeds of chain printers range from 400 to 2500 characters per minute.

Band printers

➢ A band printer operates similar to chain printer except it uses a band instead of a chain and has fewer hammers.

➢ Band printer has a steel band divided into five sections of 48 characters each.

➢ The hammers on a band printer are mounted on a cartridge that moves across the paper to the appropriate positions. Characters are rotated into place and struck by the hammers. Font styles can easily be changed by replacing a band or chain.

Non-impact printers

- Non-impact printers do not use a striking device to produce characters on the paper; and because these printers do not hammer against the paper they are much quieter.
- Following are some non-impacted printers.

Ink-jet printers

- Ink-jet printers work in the same fashion as dot-matrix printers in the form images or characters with little dots. However, the dots are formed by tiny droplets of ink.
- Ink-jet printers form characters on paper by spraying ink from tiny nozzles through an electrical field that arranges the charged ink particles into characters at the rate of approximately 250 characters per second. The ink is absorbed into the paper and dries instantly. Various colors of ink can also be used.
- One or more nozzles in the print head emit a steady stream of ink drops. Droplets of ink are electrically charged after leaving the nozzle. The droplets are then guided to the paper by electrically charged deflecting plates [one plate has positive charge (upper plate) and the other has negative charge (lover plate)]. A nozzle for black ink may be all that's needed to print text, but full-color printing is also possible with the addition of needed to print text, but full-color printing is also possible with the addition three extra nozzles for the cyan, magenta, and yellow primary colors. If a droplet isn't needed for the character or image being formed, it is recycled back to its input nozzle.
- Several manufacturers produce color ink-jet printer. Some of these printers come with all their color inks in a cartridge; if you want to replace on color, you must replace all the colors. Other color ink-jet printers allow you to replace ink individually. These printers are a better choice if user uses one color more than other colors. These printers produce less noise and print in better quality with greater speed.
- Inkjet printers are most popular printers for home and small scale offices as they have a reasonable cost and a good quality of printing as well.
- A typical inkjet printer can print with a resolution of more than 300 dpi and some good quality inkjet printers are able to produce full colored hard copies at 600 dpi.

PROS:

➢ Great for photos and image-heavy documents.

➢ Inkjet printers do a better job of blending smooth colors than laser printers.

➢ Inkjet printers have a low start-up cost. Printers are less expensive than laser printers and inkjet ink cartridges are cheaper than toner cartridges.

➢ Inkjets can print onto many types of paper, including glossy photo paper, textured stationery and even some fabrics.

➢ Almost no warm-up time is needed before printing.

➢ Inkjet cartridges can be refilled and reused, cutting down on waste and saving money

➢ Inkjet printers tend to be smaller, lighter and easier to maintain than laser printers.

CONS:

➢ Inkjet ink is more expensive than champagne.

➢ Inkjet ink is water-based, so prints are susceptible to water damage and fading.

➢ Ink cartridges need frequent cleaning. Although printers perform this maintenance automatically, it wastes lots of ink.

➢ Inkjet printers are getting faster, but are still very slow compared to laser printing. High volumes are a challenge with inkjets.

➢ Some inkjet printers will produce gray, fuzzy text if printing on plain office paper.

➢ Inkjet printers for home use have low-capacity paper trays of around 50-100 sheets. Output trays are nearly nonexistent. This might be a problem if you print a lot.

Laser printers

- A laser printer works like a photocopy machine.
- Laser printers produce images on paper by directing a laser beam at a mirror which bounces the beam onto a drum. The drum has a special coating on it to which toner (an ink powder) sticks. Using patterns of small dots, a laser beam conveys information from the computer to a positively charged drum to become neutralized.
- From all those areas of drum which become neutralized, the toner detaches. As the paper rolls by the drum, the toner is transferred to the paper printing the letters or other graphics on the paper. A hot roller bonds the toner to the paper.
- Laser printers use buffers that store an entire page at a time. When a whole page is loaded, it will be printed. The speed of laser printers is high and they print quietly without producing much noise.
- Many home-use laser printers can print eight pages per minute, but faster and print approximately 21,000 lines per minute, or 437 pages per minute if each page contains 48 lines.
- When high speed laser printers were introduced they were expensive.
- Developments in the last few years have provided relatively low-cost laser printers for use in small businesses.

Advantages of Laser Printer

- The main advantage of Laser printer is its speed & efficiency at which it prints high-quality quality graphics & text.
- Laser printers produce high-quality output as compared to other printers.
- Laser printer is quite and does not produce disturbing sounds.
- They are also capable to produce color prints.
- Laser printers can print faster than inkjet printers. It won't matter much if you print a few pages at a time, but high volume users will notice a huge difference.
- Laser printers produce perfect sharp black text. If your print jobs are mostly text with occasional graphics, laser is the way to go. Laser printers also handle small fonts and fine lines far better than inkjet.

- Laser printers are better prepared to handle high-volume print jobs.
- Price-by-price comparisons favor laser printers over inkjet printers for documents that aren't graphically complex. Although they're more expensive, laser toner cartridges print more sheets relative to their cost than inkjet cartridges and are less wasteful

Disadvantages of Laser Printer

- The main disadvantage of Laser printer is its cost; they are relatively costly as compared to other printers.
- The maintenance, repair & servicing charges are also high of these printers.
- Laser printers emit small amount of ozone and are hazardous to health and the atmosphere.
- Although laser printers work faster, they take time to warm-up.
- Although toner is cheaper in the long run, upfront costs for laser printing are more.
- Toner leaks are a nightmare.
- Laser printers can't handle a variety of paper or printing materials like inkjets. Anything heat-sensitive cannot be run through them.
- Home laser printers can handle simple graphics, but smooth photographs are a challenge. If you want to print photos, go for inkjet.
- There are some compact laser printers on the market, but in general, laser printers are bigger and heavier than their inkjet counterparts.

Plotter

- The **plotter** is a computer printer for printing vector graphics.
- In the past, plotters were used in applications such as computer-aided design, though they have generally been replaced with wide-format conventional printers.
- A plotter gives a hard copy of the output.
- It draws pictures on paper using a pen.
- Plotters are used to print designs of ships and machines, plans for buildings and so on.

- A plotter is a printer that interprets commands from a computer to make line drawings on paper with one or more automated pens.
- Unlike a regular printer , the plotter can draw continuous point-to-point lines directly from vector graphics files or commands.
- There are a number of different types of plotters: a *drum plotter* draws on paper wrapped around a drum which turns to produce one direction of the plot, while the pens move to provide the other direction; a *flatbed plotter* draws on paper placed on a flat surface; and an *electrostatic plotter* draws on negatively charged paper with positively charged toner.
- Plotters were the first type of printer that could print with color and render graphics and full-size engineering drawings.
- Plotters are much more expensive than printers.
- They are most frequently used for CAE (computer-aided engineering) applications, such as CAD (computer-aided design) and CAM (computer-aided manufacturing).

Pros:

- Since the story is already planned out, you don't have to think about what will happen next. You can simply refer to your outline and write the scene.
- It'll be easier for you to spot plot holes or underdeveloped characters before you get lost in the story.
- You can ensure the characters' GMCs (goals, motivations, and conflicts) are clear throughout
- Because you know what will happen next, you'll have less of a chance of experiencing writer's block.
- If you go as far as creating a character sheet, you should be able to keep your characters consistent. For example, a character that has blue eyes on page three shouldn't have green

eyes on page twenty. You'll have all the character details in front of you and won't have to rely on your memory.

➢ You can use the outline to help you create your synopsis, if you need one.

➢ You shouldn't find yourself writing scenes and chapters only to delete them later, because they no longer fit with the story. You'll before you write the novel what will and won't fit.

➢ Because you have an outline, you won't lose sight of the original story. You'll stay on track and not go somewhere unrelated to the story itself.

Cons:

➢ You may spend too much time plotting the story, when you could've been writing it.

➢ You might research something to death, maybe even becoming an expert on the subject, only to decide you won't include it in the novel.

➢ You may get distracted by all the research.

➢ You may enjoy thinking about and plotting your story more than actually writing it. (Meaning: You may lose the passion for the story because you already know how it'll turn out.)

➢ You may feel like you have to stick to the outline, when it really shouldn't be set in stone.

➢ You might lose the love for writing and creating, because the story has already been envisioned to a certain extent.

6.2 Scanner,Digital Camera and Digitizer

Scanner

➢ A scanner is a device that captures images from photographic prints, posters, magazine pages, and similar sources for computer editing and display.

➢ Scanners usually attach to your personal computer with a Small Computer System Interface (SCSI).

➢ Very high resolution scanners are used for scanning for high-resolution printing, but lower resolution scanners are adequate for capturing images for computer display.

➢ Scanners usually come with software, such as Adobe's Photoshop product, that lets you resize and otherwise modify a captured image.

➢ Some major manufacturers of scanners include: Epson, Hewlett-Packard, Microtek, and Relisys.

Scanner Types

➢ There are three major types of scanners in common use today: flatbed, film and drum.
➢ They have differing uses, strengths and weaknesses.

Flatbed Scanners

➢ The most common scanners are flatbed scanners.
➢ These are a type of reflective scanner that commonly sits flat on a desk.
➢ Flatbed scanners are adapting at scanning pieces of paper, objects, photo prints, and other opaque items.
➢ The most common desktop scanners resemble copy machines, in that the item being scanned rests on a glass plate while the scanning head moves underneath it.
➢ These flatbed scanners are versatile because they can scan flat originals of various sizes, and they can even scan small three-dimensional objects.
➢ Using a flatbed scanner is relatively simple. First you open the cover and set your subject on the glass surface, and close the cover. Usually you can then run the scanner software, tell the scanner what resolution to use for the scan and possibly set a few other simple preferences. The scanner will then begin scanning your subject. After the scan is complete, you can remove the subject from the surface.
➢ Some scanning software comes with simple editing tools, or you can edit your image by yourself.
➢ Most flatbed scanners require a transparency adapter with a separate light source in order to scan slides, x-rays, and other transparent originals.
➢ Flatbed scanners can be very inexpensive, even with a transparency adapter. Flatbed scanners with good film scanning capabilities are more expensive, however.

Film Scanners

- Film scanners are specialized transmissive scanners made to scan film strips and mounted slides (negatives and positives).
- Film scanners have optics and electronics specifically catered to scanning film. Because of this specialization, film scanners achieve better results when scanning film than flatbed scanners.
- Some film scanners include feeder attachments that can make doing many scans easier and faster. Having an automatic feeder is very helpful for more extensive scanning work, such as a large slide collection.
- Only a few models of film scanners have this capability, and it is generally a fairly expensive optional attachment.
- Film scanners are relatively easy to operate.
- Film scanners are moderately priced, from $400-$1500 (with a few high end models going up to perhaps $20,000).

Drum Scanners

- Before the advent of desktop scanning, most images were loaded into computers through drum scanners.
- Drum scanners work differently than the other two types of scanners.
- Flatbed and film scanners rely on light from a source hitting a microchip called a CCD (Charged-Coupled Device). The drum scanner, instead of a CCD, has a photo multiplier tube which is a type of vacuum tube that is highly sensitive to light. A beam of light, which can be focused quite small, is then moved across the image and the photo multiplier tube picks up the reflection.
- Drum scanners can generally scan any type of film.
- Technicians there would carefully mount originals on a glass cylinder, which would then be rotated at high speeds around a sensor located in the center.
- Drum scanners are large, very expensive (up to $100,000), and very difficult to use.
- However, due to the extremely sensitive photo multiplier tube, you can obtain images that are higher quality than images from a CCD scanner. Therefore, applications requiring extremely high quality utilize a drum scanner.

Digital Camera

- A camera that stores images digitally rather than recording them on film.
- Once a picture has been taken, it can be downloaded to a computer system, and then manipulated with a graphics program and printed.
- Unlike film photographs, which have an almost infinite resolution, digital photos are limited by the amount of memory in the camera, the optical resolution of the digitizing mechanism, and, finally, by the resolution of the final output device.
- Even the best digital cameras connected to the best printers cannot produce film-quality photos.
- However, if the final output device is a laser printer, it doesn't really matter whether you take a real photo and then scan it, or take a digital photo. In both cases, the image must eventually be reduced to the resolution of the printer.
- The big advantage of digital cameras is that making photos is both inexpensive and fast because there is no film processing.
- Interestingly, one of the biggest boosters of digital photography is Kodak, the largest producer of film. Kodak developed the Kodak Photo CD format, which has become the de facto standard for storing digital photographs.
- Most digital cameras use CCDs to capture images, though some of the newer less expensive cameras use CMOS chips instead.
- Many current models are also able to capture sound or video, in addition to still images.
- Capture is usually accomplished by use of a photo sensor, using a charged coupled device (CCD).
- Images may also be archived on a photographic compact disc or external hard disk.
- Most digital cameras have a LCD for viewing both images in the viewfinder and those in the camera's memory.
- Kodak, Canon, Sony, Nikon, Olympus and several other companies make digital cameras.

Type of digital camera

- There are different types of digital camera.
- They are a compact camera, a super zoom camera, DSLR camera.

Compact camera

- Compact cameras are intended to be portable (pocketable) and are particularly suitable for casual "snapshot" that are perfectly capable of taking pictures without any extra bells and whistles
- Most budgets compacts offer lenses with a 3x optical zoom, which will ordinarily stretch from around 35-105mm. This is a capable range for everyday photography, although some cameras push the boundaries a little further to offer particularly wide or long focal lengths.
- The number of megapixels such cameras have, as they all have enough. In fact, more megapixels can be detrimental to image quality, (particularly when shooting in low light) and these images take up more space on your memory card. Unless you have a specific reason for needing more megapixels, bear in mind that less is often more.

Superzoom bridge cameras

- Bridge cameras physically resemble DSLRs, and are sometimes called DSLR-shape or DSLR-like.
- They provide some similar features but, like compacts, they use a fixed lens and a small sensor.
- Most use live preview to frame the image. Their usual autofocus is by the same contrast-detect mechanism as compacts, but many bridge cameras have a manual focus mode and some have a separate focus ring for greater control.
- In bright sun, the quality difference between a good compact camera and a digital SLR is minimal but bridge cameras are more portable, cost less and have greater zoom ability.

Thus a bridge camera may better suit outdoor daytime activities, except when seeking professional-quality photos.

➢ Superzoom cameras combine the flexibility of a wide focal range with a small format body.

➢ Many offer manual control over exposure (such as with an aperture or shutter priority option), and some allow you to manually focus too, meaning the photographer can take many decisions into their own hands.

➢ One crucial aspect of a superzoom camera is its image stabilization system. When shooting at longer focal lengths a camera has to work harder to keep the image stable, which makes a lens or sensor based image stabilization system vital.

➢ Some cameras only offer sensitivity-based image stabilization systems which work by increasing the camera's ISO – this is something best avoided if one of the alternative two solutions are available.

➢ Another popular feature on such models is an articulated LCD screen. These pull away from the body and allow you to shoot at awkward angles to the subject, such as at ground level. They may also help when shooting in bright conditions, as they can be adjusted to the angle with the least glare.

DSLR (Digital single-lens reflex cameras)

➢ DSLR cameras offer the best image quality and more options than the other cameras featured here, although because of these factors they are also more expensive.

➢ Their larger sensors are able to produce better images in low-light conditions than with other cameras and with a wider dynamic range too.

- Furthermore, they are designed to work with a range of high-quality lenses, meaning the photographer may choose one that's been developed specifically to suit their requirements.
- Digital single-lens reflex cameras (DSLR) use a reflex mirror that can reflect the light and also can swivel from one position to another position and back to initial position.
- By default, the reflex mirror is set 45 degree from horizontal, blocks the light to the sensor and reflects light from the lens to penta-mirror/prism at the DSLR camera and after some reflections arrives at the viewfinder. The reflex mirror is pulled out horizontally below the penta-mirror/prism when shutter release is fully pressed, so the viewfinder will be dark and the light/image can directly strike the sensor at the time of exposure (speed setting).

Digitizer

- An input device that enables you to enter drawings and sketches into a computer.
- A digitizing tablet consists of an electronic tablet and a cursor or pen. A cursor (also called a puck) is similar to a mouse, except that it has a window with cross hairs for pinpoint placement, and it can have as many as 16 buttons. A pen (also called a stylus) looks like a simple ballpoint pen but uses an electronic head instead of ink. The tablet contains electronics that enable it to detect movement of the cursor or pen and translate the movements into digital signals that it sends to the computer.
- For digitizing tablets, each point on the tablet represents a point on the display screen in a fixed manner. This differs from mice, in which all movement is relative to the current cursor position. The static nature of digitizing tablets makes them particularly effective for tracing drawings. Most modern digitizing tablets also support a mouse emulation mode, in which the pen or cursor acts like a mouse.

- Digitizing tablets are also called digitizers, graphics tablets, touch tablets, or simply tablets.
- A digitizer tablet (also known as a digitizer or graphics tablet) is a tool used to convert hand-drawn images into a format suitable for computer processing.
- Images are usually drawn onto a flat surface with a stylus and then appear on a computer monitor or screen.
- Digitizer tablets can also be used as an input device, receiving information represented in drawings and sending output to a CAD (computer aided design) application and PC-based software like AutoCAD.
- Digitizers are often used along with takeoff software because they can quickly measure, transfer and store quantities seen on a blueprint. Additional benefits are found in features such as a dimension list, which can be saved and used for a future estimate.
- Digitizer tablets are compatible with most digitizer software programs that have a 32-bit Win TAB driver.

6.3 Sound System

- Audio is sound within the acoustic range available to humans.
- An audio frequency (AF) is an electrical alternating current within the 20 to 20,000 hertz (cycles per second) range that can be used to produce acoustic sound.
- In computers, audio is the sound system that comes with or can be added to a computer. An audio card contains a special built-in processor and memory for processing audio files and sending them to *speakers* in the computer.
- An audio file is a record of captured sound that can be played back. Sound is a sequence of naturally analog signals that are converted to digital signals by the audio card, using a microchip called an analog-to-digital converter (ADC). When sound is played, the digital signals are sent to the speakers where they are converted back to analog signals that generate varied sound.
- Audio files are usually compressed for storage or faster transmission. Audio files can be sent in short stand-alone segments - for example, as files in the Wave file format. In order for users to receive sound in real-time for a multimedia effect, listening to music, or in

order to take part in an audio or video conference, sound must be delivered as streaming sound.

➢ More advanced audio cards support wavetable, or pre captured tables of sound.

➢ The most popular audio file format today is MP3 (MPEG-1 Audio Layer-3).

6.4 Storage Device: magnetic disk, optical, Zip drive

➢ Disk is a round plate on which data can be encoded. There are two basic types of disks: *magnetic disks* and *optical disks*.

Magnetic Disk

➢ On magnetic disks, data is encoded as microscopic magnetized *needles* on the disk's surface.

➢ You can record and erase data on a magnetic disk any number of times, just as you can with a cassette tape.

➢ The basic approach to magnetic data storage, however, is very similar for the different types of media. A read-write head moves very close to the magnetic surface - the distance is often no more than tens of nanometers. The head is able to detect and modify the magnetization of the material. The magnetic surface is divided into very small regions, each of which has a mostly uniform magnetization. As the head moves relative to the surface, the changes in magnetization from region to region are detected and recorded as zeros and ones. Different technologies vary in how the head moves relative to the surface of the media and how the regions on the media are organized, but the basic principle is the same.

➢ Magnetic disks are coated with a magnetic material such as iron oxide. There are two types: hard disks made of rigid aluminum or glass, and removable diskettes made of flexible plastic.

➢ Magnetic disks are platters coated with iron oxide, like tape and drums. An arm with a tiny wire coil, the read/write (R/W) head, moves radially over the disk, which is divided into concentric tracks composed of small arcs, or sectors, of data.

- Magnetic disks are flat circular plates of metal or plastic, coated on both sides with iron oxide. Input signals, which may be audio, video, or data, are recorded on the surface of a disk as magnetic patterns or spots in spiral tracks by a recording head while the disk is rotated by a drive unit

- The machine that spins a disk is called a disk drive. Within each disk drive is one or more *heads* (often called *read/write heads*) that actually read and write data.

- Accessing data from a disk is not as fast as accessing data from main memory, but disks are much cheaper.

- And unlike RAM, disks hold on to data even when the computer is turned off.

- Consequently, disks are the storage medium of choice for most types of data. Another storage medium is magnetic tape. But tapes are used only for backup and archiving because they are *sequential-access* devices (to access data in the middle of a tape, the tape drive must pass through all the preceding data).

- A new disk, called a *blank disk,* has no data on it. Before you can store data on a blank disk, however, you must *format* it.

Type of magnetic Disk

Hard Disk

- Hard drives consist of stacks of non-removable **platters** coated with magnetic materials – each with its own read/write head as shown in the photo.

- Hard disk drives are built into desktops and laptops.

- The **capacity of a hard disk is measured in gigabytes**. It holds much more data than a CD-ROM. The capacity of a CD-ROM is measured in megabytes. To find the capacity of the latest hard drive you should look in the latest computer magazines or search the internet.

- Hard disk drives use random/direct access to locate data stored on the disk.

Advantages of Hard disks

1. Large storage capacity.
2. They read and write data very quickly.
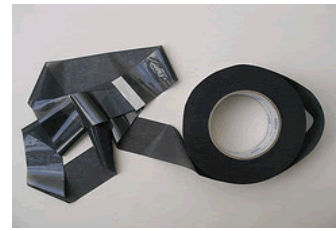3. They can hold large quantities of data.

Floppy Disk

➤ Floppy disks are disks of plastic coated in magnetic material and enclosed in a hard plastic case. The read/write area is covered by a sliding metal flap.

➤ Although, they used to be very common, as they were a convenient way of transporting files from one computer to another, they not much used anymore.

➤ Floppy disks are written to and read from, through the use of separate **floppy disk drives**.

➤ Floppy disks are **less popular** than they have been because :-
  o They are **easily damaged.**

  o Have a **limited storage capacity** in that they can only hold 1.44MB. Photos, text documents etc have become too large.

Magnetic Tape

- Made of a long plastic strip coated with magnetic material, tape is mostly used for making backups. It can store lots of data, but this data is **slower to access**, because of having to wind through to the information you need slows down he access time. This makes it **impractical for use as main storage**
- **One great advantage of magnetic tape is its cheapness.**
    - Magnetic tape uses **sequential or serial access** to locate data stored on the tape.

Optical Disk

- In computing and optical disc recording technologies, an **optical disc** (**OD**) is a flat, usually circular disc which encodes binary data (bits) in the form of pits (binary value of 0 or off, due to lack of reflection when read) and lands (binary value of 1 or on, due to a reflection when read) on a special material (often aluminium) on one of its flat surfaces.
- Optical discs are usually between 7.6 and 30 cm (3 to 12 in) in diameter, with 12 cm (4.75 in) being the most common size. A typical disc is about 1.2 mm (0.05 in) thick, while the track pitch (distance from the center of one track to the center of the next) is typically 1.6 µm.
- An optical disc is designed to support one of three recording types: read-only (e.g.: CD and CD-ROM), recordable (write-once, e.g. CD-R), or re-recordable (rewritable, e.g. CD-RW). Write-once optical discs commonly have an organic dye recording layer between the substrate and the reflective layer. Rewritable discs typically contain an alloy recording layer composed of a phase change material, most often AgInSbTe, an alloy of silver, indium, antimony, and tellurium

- Optical disks record data by burning microscopic holes in the surface of the disk with a laser. To read the disk, another laser beam shines on the disk and detects the holes by changes in the reflection pattern.
- Optical disks come in three basic forms:

- o **CD-ROM :** Most optical disks are read-only. When you purchase them, they are already filled with data. You can read the data from a CD-ROM, but you cannot modify, delete, or write new data.
- o **WORM :** Stands for *write-once, read-many*. WORM disks can be written on once and then read any number of times; however, you need a special WORM disk drive to write data onto a WORM disk.
- o **Erasable optical (EO):** EO disks can be read to, written to, and erased just like magnetic disks.

Advantages

- ➢ They are non- volatile which means that the memory can be retained even when the power is turned off
- ➢ Durability - With proper care, optical media can last a long time, depending on what kind of optical media you choose.
- ➢ Great for archiving - Several forms of optical media are write-once read-many, which means that when data is written to them, they cannot be reused. This is excellent for archiving because data is preserved permanently with no possibility of being overwritten.
- ➢ Transportability - Optical media are widely used on other platforms, including the PC. For example, data written on a DVD-RAM can be read on a PC or any other system with an optical device and the same file system.
- ➢ Random access - Optical media provide the capability to pinpoint a particular piece of data stored on it, independent of the other data on the volume or the order in which that data was stored on the volume.

Disadvantages

- ➢ WORM discs are permanent
- ➢ Optical discs require special drives to read/write.
- ➢ Optical storage does not provide enough data storage in comparison to other storage technologies
- ➢ Optical storage is expensive per GB/TB in comparison to other technologies including disruptive formats that offer convenience over cost.
- ➢ Optical storage rewritable formats suffer from compatibility issues between drives.

- Consumer based formats like CD-R and DVD-R, BD-R do not have a formal method of grading quality of discs. There are no standards for longevity tests.

Zip Drive

- The **Zip drive** is a medium-capacity removable floppy disk storage system that was introduced by Iomega in late 1994.
- A Zip drive is a small, portable disk drive used primarily for backing up and archiving personal computer files.
- Originally, Zip disks launched with capacities of 100 MB, but later versions increased this to first 250 MB and then 750 MB.
- A Zip drive system consists of a disk drive with a slot for a Zip disk and the Zip disk itself, also referred to as a Zip cartridge.
- A Zip disk is about the same size as a 3 ½ inch floppy, but much thicker. The plastic casing is also much stronger. The actual disk itself relies on magnetic storage, much like hard disks and floppy disks.

- There are two types of Zip disk drives: internal and external. An internal drive is installed inside the actual computer case, similar to how an optical drive (CD/DVD) is installed. The drive is directly connected to the motherboard of the computer, and the drive itself cannot easily be removed. An external drive has its own separate casing and connects to the computer using a separate connector cable

Chapter 7: Computer network

What is a Computer Network?

➢ A computer network is a system in which multiple computers are connected to each other to share information and resources.

Characteristics of a computer network

➢ Share Resources from one computer to another
➢ Create files and store them in one computer, access those files from the other computer(s) connected over the network
➢ Connect a printer, scanner, or a fax machine to one computer within the network and let other computers of the network use the machines available over network.
➢ Following is the list of hardware's required to setup a computer network.
   o Network Cables
   o Distributors
   o Routers
   o Internal Network Cards
   o External Network Cards

Network Cables

➢ Network cables are used to connect computers.
➢ The most commonly used cable is Category 5 cable RJ-45.

Distributors

➢ A computer can be connected to another one via a serial port but if we need to connect many computers to produce a network, this serial connection will not work.

➢ The solution is to use a central body to which other computers, printers, scanners etc. can be connected and then this body will manage or distribute network traffic.

Router

➢ A router is a type of device which acts as the central point among computers and other devices that are part of a network.

➢ A router is equipped with holes called ports and computers and other devices are connected to a router using network cables.

➢ Now-a-days router comes in wireless modes using which computers can be connected without any physical cable.

Network Card

- Network card is a necessary component of a computer without which a computer cannot be connected over a network.
- It is also known as network adapter or Network Interface Card (NIC). Most branded computers have network card pre-installed.
- Network cards are of two types: Internal and External Network Cards.
    a. **Internal Network Cards**
    - Motherboard has a slot for internal network card where it is to be inserted. Internal network cards are of two types in which first type uses Peripheral Component Interconnect (PCI) connection while the second type uses Industry Standard Architecture (ISA). Network cables are required to provide network access.

   b. **External Network Cards**
   - External network cards come in two flavors: Wireless and USB based.
   - Wireless network card need to be inserted into the motherboard but no network cable is required to connect to network.
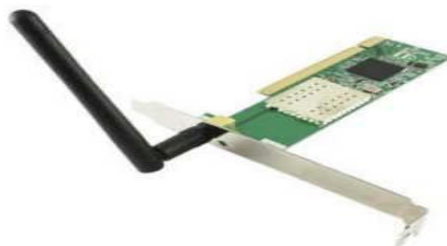
   - USB card are easy to use and connect via USB port. Computers automatically detect USB card and can install the drivers required to support the USB network card automatically.

7.1 Peer-to-peer and Dedicated Server types

Peer-to-peer

➤ Peer-to-peer (P2P) is a decentralized communications model in which each party has the same capabilities and either party can initiate a communication session.

➤ Unlike the client/server model, in which the client makes a service request and the server fulfills the request, the P2P network model allows each node to function as both a client and server.

➤ **Peer-to-peer** (**P2P**) computing or networking is a distributed application architecture that partitions tasks or workloads between peers. Peers make a portion of their resources, such as processing power, disk storage or network bandwidth, directly available to other network participants, without the need for central coordination by servers or stable hosts.

➤ Peers are equally privileged, equipotent participants in the application. They are said to form a peer-to-peer network of nodes.
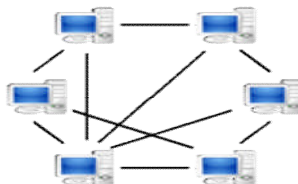
➤ In its simplest form, a peer-to-peer (P2P) network is created when two or more PCs are connected and share resources without going through a separate server computer.

➤ A P2P network can be an ad hoc connection—a couple of computers connected via a Universal Serial Bus to transfer files.

➤ A P2P network also can be a permanent infrastructure that links half-dozen computers in a small office over copper wires. Or a P2P network can be a network on a much grander

scale in which special protocols and applications set up direct relationships among users over the Internet.

➢ The initial use of P2P networks in business followed the deployment in the early 1980s of free-standing PCs.

➢ **Peer to peer** is an approach to computer networking where all computers share equivalent responsibility for processing data

Characteristics of a Peer Network

➢ Peer to peer networking is common on small local area networks (LANs) , particularly home networks. Both wired and wireless home networks can be configured as peer to peer environments.

➢ Computers in a peer to peer network run the same networking protocols and software.

➢ Peer networks are also often situated physically near to each other, typically in homes, small businesses or schools. Some peer networks, however, utilize the Internet and are geographically dispersed worldwide.

Advantages of Peer-to-peer networking

1) It is easy to install and so is the configuration of computers on this network, Easy and simple to set up only requiring a hub or a switch to connect all computers together.

2) All the resources and contents are shared by all the peers.

3) P2P is more reliable as central dependency is eliminated. Failure of one peer doesn't affect the functioning of other peers. If one computer fails to work all the other computers connected to it still continue to work.

4) There is no need for full-time System Administrator. Every user is the administrator of his machine. User can control their shared resources.

5) The over-all cost of building and maintaining this type of network is comparatively very less.

6) Computers in peer to peer *workgroups* to allow sharing of files , printers and other resources across all of the devices.

7) Peer networks allow data to be shared easily in both directions, whether for downloads to your computer or uploads from your computer.

Disadvantages (drawbacks) of Peer to peer architecture

1) In this network, the whole system is decentralized thus it is difficult to administer. That is one person cannot determine the whole accessibility setting of whole network.

2) Security in this system is very less viruses, spywares, trojans, etc malwares can easily transmitted over this P-2-P architecture.

3) Data recovery or backup is very difficult. Each computer should have its own back-up system

4) Lot of movies, music and other copyrighted files are transferred using this type of file transfer. P2P is the technology used in torrents.

Dedicated server

➢ The term **"dedicated server"** can also mean a single computer within a network that is reserved for a specific purpose.

➢ For example, within a network, you could have a computer dedicated to printer resources; another computer dedicated to Internet connections, another computer serving as a firewall, etc. These computers would all be dedicated servers, as the whole computer is allocated for a specific task within the network.

➢ A *dedicated server* is a single computer in a network reserved for serving the needs of the network. For example, some networks require that one computer be set aside to manage communications between all the other computers.

➢ A dedicated server could also be a computer that manages printer resources. Note, however, that not all servers are dedicated. In some networks, it is possible for a computer to act as a server and perform other functions as well.

- There are many different types of dedicated servers available for those who need to have storage and server availability for personal and professional purposes.

- One of the most common types of dedicated server is one that is used for web hosting, often utilized for hosting a particular website or Internet service.

- There are also servers utilized for hosting online personal computer (PC) games, which may be optional and established by players of a game or mandatory for online games.

- Some dedicated servers can be used for security purposes, such as hosting data utilized by a company or organization and which is not intended for public access.

- Dedicated servers are computers designed to store and maintain various programs and data for access by other computer users who connect to the server as clients.

- One of the most common uses for such servers is to host a website, usually one that is publicly accessible. This type of server maintains the data necessary for a website, and other users connect as clients to the server to access the website. While these dedicated servers are often protected by security software, especially when sensitive information is stored on them, they are largely meant for public access.

- Some dedicated servers are established for use in PC gaming, especially for online games or those games with a major multiplayer component. Multiplayer gaming can often utilize such servers, and some games have servers that are rented and maintained by players for personal use among small groups, or gaming clans.

- Other games have servers established and run by the company that makes the PC game, which may be used by players.

- Private dedicated servers can also be utilized by companies and organizations for remote storage of important data. Such servers are often used to store data, and then employees are able to connect to these servers to access the data. Security protocols are typically utilized with these types of servers to maintain their privacy and security. Such security measures can be especially important for dedicated servers that store personal information, such as medical records or financial information, or servers used to store company transactions and proprietary information considered a trade secret.

Different type of network in computer system

- Networking is required to make accessible communication between computers possible by a network connection. Networking allows for many possibilities, such as accessing the internet, file sharing, file transferring, networks attacks and system communication

LAN:

- A **local area network** (**LAN**) is a computer network that interconnects computers within a limited area such as a home, school, computer laboratory, or office building, using network media.
- Due to its small size, it is possible for one person to administrate a Local Area Network. Local Area Networks are viable to quick change.
- Most LANs are confined to a single building or group of buildings; however, one LAN can be connected to other LANs over any distance via telephone lines and radio waves.
- A group of computers that share a common connection and are usually in a small area or even in the same building.
- For example an office or home network. They are usually connected by Ethernet cables and have high speed connections. If it was a wireless setup it would be called a WLAN, which would have a lower connection speed.
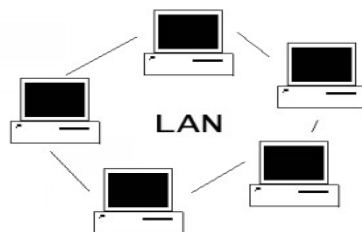
Advantages of LAN

- Files can be stored on a central computer (the file server) allowing data to be shared throughout an organization.
- Files can be backed up more easily when they are all on a central fileserver rather than when they are scattered across a number of independent workstations.
- Networks also allow security to be established, ensuring that the network users may only have access to certain files and applications.
- Software and resources can be centrally managed.

- Network versions of software often allow for their speedy installation on workstations from the file server.
- Expensive devices such as laser printers or scanners can be shared.
- Users can access their files from any workstation

Disadvantages of LAN

- Power - a good LAN is required to be on all the times.
- Security - each computer and device become another point of entry for undesirables.
- Upkeep - when things go wrong or the software gets updated.
- Frustration if having a problem setting up.
- A lot of times a network shares one Internet connection - if all computers running at once, can reduce speed for each.
- Area covered is limited.

MAN

- **MAN** (metropolitan area network) is a larger network that connects computer users in a particular geographic area or region.
- For example a large university may have a network so large that it may be classified as a MAN.
- The MAN network usually exists to provide connectivity to local ISPs, cable tv, or large corporations. It is far larger than a LAN and smaller than a WAN. Also large cities like London and Sydney, Australia have metropolitan area networks.

Advantages of MAN

- The biggest advantage of MANs is the bandwidth (potential speed) of the connecting links.
- This means that resources (such as databases and files) shared on the network can be accessed extremely quickly.
- Some installations allow multiple users to share the same high-speed Internet connection, thereby sharing the cost of the service and securing a better quality of service through collective bargaining and economies of scale.

Disadvantages of MANs

➢ The key disadvantage of MANs is the cost of the cutting-edge technology employed. Also, this equipment generally has to be installed for the first time, as the copper traditionally used for the phone network is generally considered to be too slow to be annexed for this purpose.

➢ The cost is what inhibits the geographical reach of MANs, which is also another drawback.

WAN

➢ **WAN** (wide area network) is the largest network and can interconnect networks throughout the world and is not restricted to a geographical location.

➢ The Internet is an example of a worldwide public WAN.

➢ Most WANs exist to connect LANs that are not in the same geographical area.

➢ This technology is high speed and very expensive to setup.

➢ A **wide area network** (**WAN**) is a network that covers a broad area (i.e., any telecommunications network that links across metropolitan, regional, national or international boundaries) using leased telecommunication lines.

➢ Business and government entities utilize WANs to relay data among employees, clients, buyers, and suppliers from various geographical locations.

➢ In essence, this mode of telecommunication allows a business to effectively carry out its daily function regardless of location.

➢ The Internet can be considered a WAN as well, and is used by businesses, governments, organizations, and individuals for almost any purpose imaginable
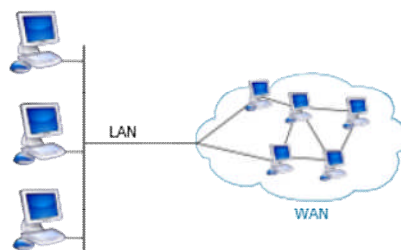
Advantages

- WAN can connect the computer to a wider area geographically, for example connecting Florida, United States with the world.
- WAN network seeks to connect schools in Florida with other places in the world as an example of Tokyo in just a few minutes, without the need to provide a large sum of money for a pay phone.

Disadvantages

- WAN network is more complicated and complex.

7.2 Network Topology

- Network topologies describe the ways in which the elements of a network are connected. They describe the physical and logical arrangement of network nodes.
- In communication networks, a topology is a usually schematic description of the arrangement of a network, including its nodes and connecting lines.
- In computer networking, *topology* refers to the layout of connected devices.
- **Network topology** is the arrangement of the various elements (links, nodes, etc.) of a computer network.
- Essentially, it is the topological structure of a network and may be depicted physically or logically. *Physical topology* is the placement of the various components of a network, including device location and cable installation, while *logical topology* illustrates how data flows within a network, regardless of its physical design. Distances between nodes, physical interconnections, transmission rates, or signal types may differ between two networks, yet their topologies may be identical.
- An example is a local area network (LAN): Any given node in the LAN has one or more physical links to other devices in the network; graphically mapping these links results in a geometric shape that can be used to describe the physical topology of the network. Conversely, mapping the data flow between the components determines the logical topology of the network.

Different types of topology

➢ There are different types of topology. They are: bus topology, star topology, ring topology and mesh topology.

Bus topology

➢ Bus Topology is the simplest of network topologies.
➢ In this type of topology, all the nodes (computers as well as servers) are connected to the single cable (called bus), by the help of interface connectors. This central cable is the backbone of the network and is known as Bus (thus the name). Every workstation communicates with the other device through this Bus.
➢ A signal from the source is broadcasted and it travels to all workstations connected to bus cable. Although the message is broadcasted but only the intended recipient, whose MAC address or IP address matches, accepts it. If the MAC /IP address of machine doesn't match with the intended address, machine discards the signal.
➢ A terminator is added at ends of the central cable, to prevent bouncing of signals. A barrel connector can be used to extend it. A basic diagram of a bus topology with its advantages and disadvantages of Bus Network Topology.
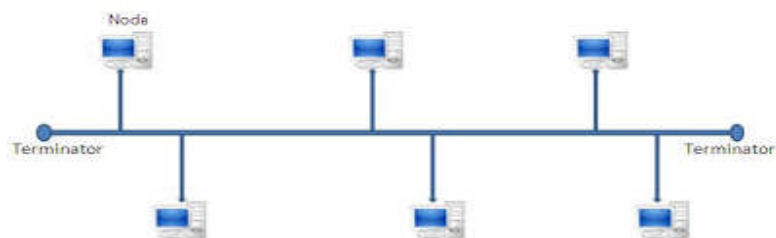
Bus topology diagram

Advantages (benefits) of Linear Bus Topology

1) It is easy to set-up and extend bus network.
2) Cable length required for this topology is the least compared to other networks.
3) Bus topology costs very less.
4) Linear Bus network is mostly used in small networks.
5) Good for LAN.

Disadvantages (Drawbacks) of Linear Bus Topology

1) There is a limit on central cable length and number of nodes that can be connected.
2) Dependency on central cable in this topology has its disadvantages. If the main cable encounters   some problem, whole network breaks down.
3) Proper termination is required to dump signals. Use of terminators is must.
4) It is difficult to detect and troubleshoot fault at individual station.
5) Maintenance costs can get higher with time.
6) Efficiency of Bus network reduces, as the number of devices connected to it increases.
7) It is not suitable for networks with heavy traffic.
8) Security is very low because all the computers receive the sent signal from the source.

Star topology

➢ In Star topology, all the components of network are connected to the central device called "hub" which may be a hub, a router or a switch. Unlike *Bus topology* where nodes were connected to central cable, here all the workstations are connected to central device with a point-to-point connection. So it can be said that every computer is indirectly connected to every other node by the help of "hub".

➢ All the data on the star topology passes through the central device before reaching the intended destination.

➢ Hub acts as a junction to connect different nodes present in Star Network, and at the same time it manages and controls whole of the network.

➢ Depending on which central device is used, "hub" can act as repeater or signal booster. Central device can also communicate with other hubs of different network. Unshielded Twisted Pair (UTP) Ethernet cable is used to connect workstations to central node.

Star Topology Diagram

Advantages of Star Topology

1) As compared to Bus topology it gives far much better performance, signals don't necessarily get transmitted to all the workstations. A sent signal reaches the intended destination after passing through no more than 3-4 devices and 2-3 links. Performance of the network is dependent on the capacity of central hub.

2) Easy to connect new nodes or devices. In star topology new nodes can be added easily without affecting rest of the network. Similarly components can also be removed easily.

3) Centralized management. It helps in monitoring the network.

4) Failure of one node or link doesn't affect the rest of network. At the same time it's easy to detect the failure and troubleshoot it.

Disadvantages of Star Topology

1) Too much dependency on central device has its own drawbacks. If it fails whole network goes down.

2) The use of hub, a router or a switch as central device increases the overall cost of the network.

3) Performance and as well number of nodes which can be added in such topology is depended on capacity of central device.

Ring Topology

➢ In Ring Topology, all the nodes are connected to each-other in such a way that they make a closed loop. Each workstation is connected to two other components on either side, and it communicates with these two adjacent neighbors. Data travels around the network, in one direction. Sending and receiving of data takes place by the help of TOKEN.

➢ *Token Passing*: Token contains a piece of information which along with data is sent by the source computer. This token then passes to next node, which checks if the signal is

intended to it. If yes, it receives it and passes the empty to into the network, otherwise passes token along with the data to next node. This process continues until the signal reaches its intended destination. The nodes with token are the ones only allowed to send data. Other nodes have to wait for an empty token to reach them. This network is usually found in offices, schools and small buildings.
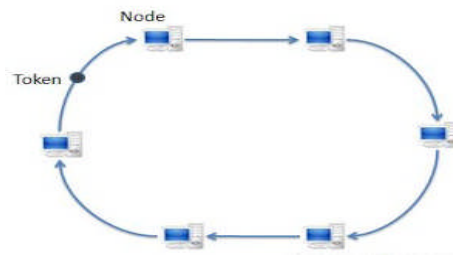
Ring Topology & token

Advantages of Ring Topology

1) This type of network topology is very organized. Each node gets to send the data when it receives an   empty token. This helps to reduces chances of collision. Also in ring topology all the traffic flows in only one direction at very high speed.

2) Even when the load on the network increases, its performance is better than that of Bus topology.

3) There is no need for network server to control the connectivity between workstations.

4) Additional components do not affect the performance of network.

5) Each computer has equal access to resources.

Disadvantages of Ring Topology

1) Each packet of data must pass through all the computers between source and destination. This makes it slower than Star topology.

2) If one workstation or port goes down, the entire network gets affected.

3) Network is highly dependent on the wire which connects different components.

4) MAU's and network cards are expensive as compared to Ethernet cards and hubs.

Mesh Topology

➤ In a mesh network topology, each of the network node, computer and other devices, are interconnected with one another. Every node not only sends its own signals but also relays data from other nodes. In fact a true mesh topology is the one where every node is connected to every other node in the network.

➤ This type of topology is very expensive as there are many redundant connections, thus it is not mostly used in computer networks. It is commonly used in wireless networks. Flooding or routing technique is used in mesh topology.

Types of Mesh Network topologies:-

1) Full Mesh Topology:-

➤ In this, like a true mesh, each component is connected to every other component. Even after considering the redundancy factor and cost of this network, its main advantage is that the network traffic can be redirected to other nodes if one of the nodes goes down. Full mesh topology is used only for backbone networks.

2) Partial Mesh Topology:-

➤ This is far more practical as compared to full mesh topology. Here, some of the systems are connected in similar fashion as in mesh topology while rests of the systems are only connected to 1 or 2 devices. It can be said that in partial mesh, the workstations are 'indirectly' connected to other devices. This one is less costly and also reduces redundancy.
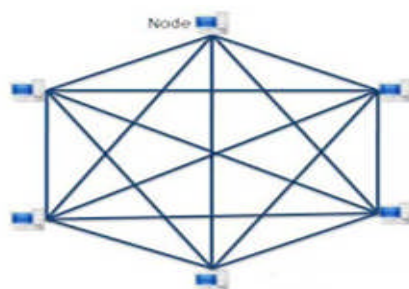
Mesh Topology Diagram

Advantages of Mesh topology

1) Data can be transmitted from different devices simultaneously. This topology can withstand high traffic.

2) Even if one of the components fails there is always an alternative present. So data transfer doesn't get affected.

3) Expansion and modification in topology can be done without disrupting other nodes.

Disadvantages of Mesh topology

1) There are high chances of redundancy in many of the network connections.

2) Overall cost of this network is way too high as compared to other network topologies.

3) Set-up and maintenance of this topology is very difficult. Even administration of the network is tough.

7.3 Network Cabling

➢ Cable is the medium through which information usually moves from one network device to another.

➢ There are several types of cable which are commonly used with LANs. In some cases, a network will utilize only one type of cable, other networks will use a variety of cable types. The type of cable chosen for a network is related to the network's topology, protocol, and size.

➢ Understanding the characteristics of different types of cable and how they relate to other aspects of a network is necessary for the development of a successful network.

➢ There are various types of network cabling

Twisted-pair cabling

➢ *Twisted pair* cabling is a form of wiring in which pairs of wires (the forward and return conductors of a single circuit) are twisted together for the purposes of canceling out electromagnetic interference (EMI) from other wire pairs and from external sources. This type of cable is used for home and corporate Ethernet networks.

➢ A type of cable that consists of two independently insulated wires twisted around one another. The use of two wires twisted together helps to reduce crosstalk and

electromagnetic induction. While twisted-pair cable is used by older telephone networks and is the least expensive type of local-area network (LAN) cable, most networks contain some twisted-pair cabling at some point along the network. Other types of cables used for LANs include coaxial cables and fiber optic cables.


Twisted Pair - Side View
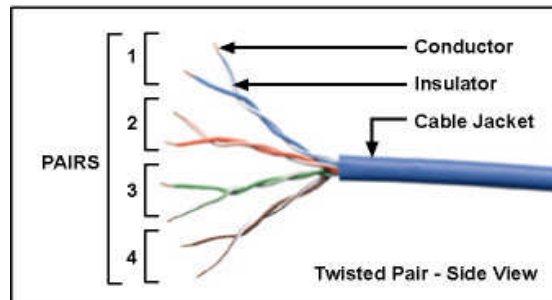
Pros:

➢ Although a twisted pair consists of figure of a wires but the best thing is its not that much bulky in size, and for this reason it could easily be train in walls.

➢ Though its consists of multiple pairs, still the cable remains flexible for easy installation.

➢ Since its not bulky in size, so it could be string in a same wiring duct which gives pleasant outlook.

➢ Apart from the above mentioned benefits, it is less expensive if compared to other types of cables being used in LAN.

Cons:

➢ How strongly twisted pair fights back with external sources is all depend on twisting rate, if the pairs are twisted frequently in size, result would be far good, else, vice versa.

➢ Twisted pair cables are also used in video applications for most of the time, but it could lead the streaming to poor quality because twisting of pairing are vary from each other, so packets may delivered out of sequence at the other end.

➢ No doubt, twisted pair cable is a powerful and effective cable to adopt for a computer networking if it is implemented in a better way, and this could be done if one make advice with the *IT Consultants* expertise for the reason specialists knows hidden pin points a lay man could hardly notice.

- There are two types of twisted pair cables: shielded, unshielded.
- **Unshielded twisted pair (UTP)** is the most popular and is generally the best option for school networks.
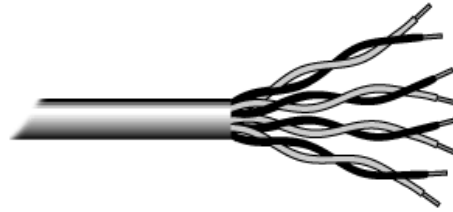
Unshielded twisted pair

The key characteristics of UTP (unshielded twisted pair)

- Transmission rate of 10-100 Mbps
- Maximum cable segment of 100 meters
- Most susceptible to electrical interference or 'crosstalk' (although shielding may lessen the impact)
- Less expensive than coax or fiber-optic. In some cases, preinstalled telephone wire may be used in the network (if it is of sufficient grade).
- Very flexible and easy to work with
- Wire type is 22-26AWG
- Uses an RJ-45 connector
- Ethernet designation is 10baseT
- The following categories of unshielded twisted pair (UTP) cable were established by the EIA/TIA (EIA/TIA 568 is the standard developed by the Electronic Industries Association/Telecommunications Industry Association applies to all UTP that works with networks.) to support the networks indicated:
  - Category 1 - Traditional telephone cable; supports voice only, not data
  - Category 2 - Data transmissions up to 4 Mbps (but not token ring)
  - Category 3 - 10 Mbps Ethernet
  - Category 4 - 16 Mbps token-ring
  - Category 5 - 100 Mbps; supports ATM

Shielded twisted pair

➢ STP cables have a conducting shield made of metallic foil encasing the twisted wire pairs, which blocks out electromagnetic interference, allowing it to carry data at a faster rate of speed.

➢ The characteristics of shielded twisted pair (STP)

    ○ Shielded twisted pair (STP) is similar to UTP except it contains a copper braid jacket to 'shield' the wires from electrical interference.

    ○ It can support transmissions over greater distances than UTP.

Coaxial Cable

➢ Coaxial cables are a type of cable that is used by cable TV and that is common for data communications.

➢ Taking a a round cross-section of the cable, one would find a single center solid wire symmetrically surrounded by a braided or foil conductor. Between the center wire and foil is an insulating dielectric. This dielectric has a large affect on the fundamental characteristics of the cable

➢ Data is transmitted through the center wire, while the outer braided layer serves as a line to ground. Both of these conductors are parallel and share the same axis. This is why the wire is called coaxial!
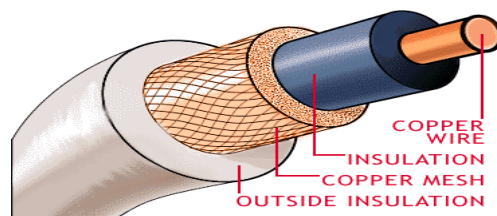
➢ The characteristics of coaxial cable

    ○ Transmission rate of about 10 Mbps

    ○ Maximum cable length of 185 meters for Thinnet, 500 meters for Thicknet

- o Good resistance to electrical interference
- o Less expensive than fiber-optics but more expensive than twisted pair.
- o Flexible and easy to work with (Thinnet)
- o Wire type is 20 AWG for Thinnet (R-58) and 12 AWG for Thicknet.
- o Ethernet designation is 10base2 (Thinnet) or 10base5 (Thicknet, also referred to 'standard Ethernet').
- ➢ The different types of coaxial cable
  - o RG-58 A/U – Thinnet, stranded wire core, 50 ohms
  - o RG-58 /U – Thinnet, solid wire core, 50 ohms
  - o RG-59 – Thicknet, cable television, broadband
  - o RG-62 – ArcNet, 75 ohms

PROS:

- ➢ Flexible and easy to install;
- ➢ Relatively good resistance to electronic interference;
- ➢ Electronic support components are relatively inexpensive
- ➢ They are incompatible with some electronics, making them impractical compared to coax cables.
- ➢ Coaxial has the capability to protect televisions from interference, which helps provide the best quality of pictures along with static prevention

CON:

- ➢ Short cable length;
- ➢ More expensive than UTP;
- ➢ Unsecure;
- ➢ Hard to change configuration;
- ➢ Thinnet generally not good for use between buildings
- ➢ Many consider them bulky, and there is no way to make them smaller.
- ➢ In addition, they are often available in only one length, making it necessary to purchase more cable than needed.

➤ Installation of coax cables can be difficult because consumers must screw them onto their receiving electronic equipment and ensure that the screw tracking of the coax matches the receiving unit.

10Base5

➤ The popularity of Ethernet began in 1980 with 10BASE5, or what is better known as coaxial cable.

➤ *10Base5* is nearly identical to **10Base2,** except that it uses a different type of cabling and media connector.

➤ 10Base5 is known as Thicknet because it uses the RG-8 coaxial cable. It requires an external transceiver to attach to the network interface card on each device. The transceiver is a device that translates the workstation's digital signal to a baseband cabling format. Thinnet and UTP network interface cards have built-in transceivers. Only 10Base5 Thicknet network interfaces use external transceivers.

➤ In the 10Base5 configuration, the NIC attaches to the external transceiver using an AUI connector. The transceiver then clamps into the Thicknet cabling, which is why it is usually called a vampire tap. 10Base5 can also use BNC connectors.

➤ For 10Base5, the following rules apply:
   o First the 5-4-3 rule applies to Thicknet just as it did to Thinnet. In addition, the minimum cable distance between each transceiver is 2.5 meters. The maximum network segment length is 500 meters, which is where 10Base5 gets the "5" in its name. The entire set of five segments cannot exceed 2,500 meters. You can have 100 devices on a 10Base5 network segment.

10Base2

➤ **10Base2,** also called ThinNet, is one of the two Ethernet specifications that use coaxial cable. (One of the best ways to remember that *10Base2* is ThinNet, and 2 is smaller than 10Base5, which is ThickNet.) One of the most important issues to remember in an Ethernet coax wiring scheme is the *5-4-3 rule,*

5-4-3 rule: which states that you can have up to five cable segments, connected by four repeaters, with no more than three of these segments being mixing segments.

- In the days of coaxial cable networks, this meant that you could have up to three mixing segments of 500 or 185 meters each (for 10Base5 and 10Base2, respectively) populated with multiple computers and connected by two repeaters. You could also add two additional repeaters to extend the network with another two cable segments of 500 or 185 meters each, as long as these were link segments connected directly to the next repeater in line, with no intervening computers,

- A 10Base2 network could therefore span up to 925 meters and a 10Base5 network up to 2,500 meters which states that there can only be 5 segments in a series and 4 repeaters between these 5 segments, although only 3 of the segments can be populated with devices.

- 10Base2 uses BNC connectors and is implemented as both a physical and logical bus topology using RG-58 cabling.

- The minimum distance for cables between workstations must be at least a half-meter.

- Drop cables should not be used to connect a BNC connector to the network interface card (NIC) because this will cause signaling problems unless the NIC is terminated.

- 10Base2 Thinnet segments cannot be longer than 185 meters, although it is often exaggerated to 200 meters, and you can't put more than 30 devices on each populated segment. The entire cabling scheme, including all five segments, can't be longer than 925 meters.

Optical Fiber

- An **optical fiber** (or **optical fiber**) is a flexible, transparent fiber made of extruded glass (silica) or plastic, slightly thicker than a human hair.

- A **fiber optic cable** is a network cable that contains strands of glass fibers inside an insulated casing. These cables are designed for long distance and very high bandwidth (gigabit speed) network communications.

- Fiber optic cables carry communication signals using pulses of light. While expensive, these cables are increasingly being used instead of traditional copper cables, because fiber offers more capacity and is less susceptible to electrical interference.

- An **optical fiber cable** is a cable containing one or more optical fibers that are used to carry light.

- The optical fiber elements are typically individually coated with plastic layers and contained in a protective tube suitable for the environment where the cable will be deployed.
- Different types of cable are used for different applications, for example long distance telecommunication, or providing a high-speed data connection between different parts of a building.
- Optical fibers are long, thin strands of very pure glass. They have the diameter of around that of a human hair.
- They are arranged in bundles called optical cables and used to transmit light signals over long distances.
- Optical fibers are commonly used in telecommunication systems, as well as in illumination, sensors, and imaging optics.
- Optical fibers are made up of three components:
    - Core - Thin glass centre of the fiber where the light travels
    - Cladding - Outer optical material surrounding the core that reflects the light back into the core.
    - Buffer coating - Plastic coating that protects the fiber from damage and moisture.

This is shown in the diagram below.
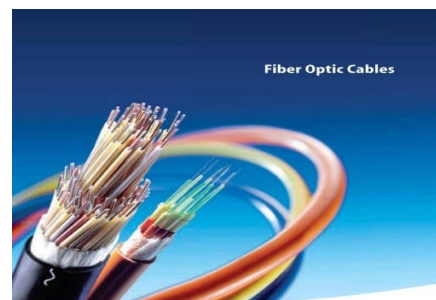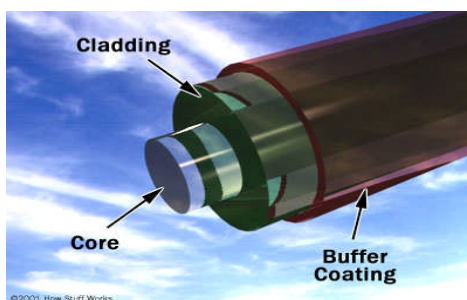
Types of fiber-optic cables

- Optical fibers carry light signals down them in what are called **modes**. That sounds technical but it just means different ways of traveling: a mode is simply the path that a light beam follows down the fiber. One mode is to go straight down the middle of the fiber. Another is to bounce down the fiber at a shallow angle. Other modes involve bouncing down the fiber at other angles, more or less steep.

Single-mode fiber

Multi-mode fiber
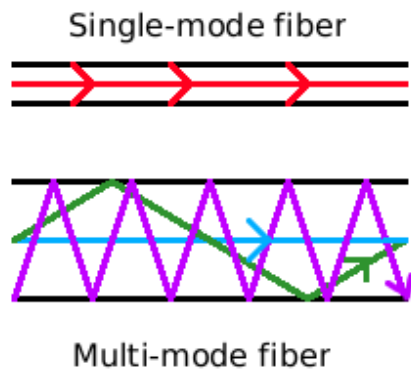
➢ The simplest type of optical fiber is called **single-mode**. It has a very thin core about 5-10 microns (millionths of a meter) in diameter. In a single-mode fiber, all signals travel straight down the middle without bouncing off the edges (red line in diagram). Cable TV, Internet, and telephone signals are generally carried by single-mode fibers, wrapped together into a huge bundle. Cables like this can send information over 100 km (60 miles).

➢ Another type of fiber-optic cable is called **multi-mode**. Each optical fiber in a multi-mode cable is about 10 times bigger than one in a single-mode cable. This means light beams can travel through the core by following a variety of different paths (purple, green, and blue lines)—in other words, in multiple different modes. Multi-mode cables can send information only over relatively short distances and are used (among other things) to link computer networks together.

How fiber-optics works

➢ Light travels down a fiber-optic cable by bouncing repeatedly off the walls. Each tiny **photon** (particle of light) bounces down the pipe like a bobsleigh going down an ice run. A beam of light, traveling in a clear glass pipe, simply to leak out of the edges. But if light hits glass at a really shallow angle (less than 42 degrees), it reflects back in again—as though the glass were really a mirror. This phenomenon is called total internal reflection. It's one of the things that keep light inside the pipe.

➢ The other thing that keeps light in the pipe is the structure of the cable, which is made up of two separate parts.

➢ The main part of the cable—in the middle—is called the **core** and that's the bit the light travels through. Wrapped around the outside of the core is another layer of glass called

the **cladding**. The cladding's job is to keep the light signals inside the core. It can do this because it is made of a different type of glass to the core. (More technically, the cladding has a lower refractive index than the core. This causes total internal reflection that stops the light escaping and keeps it bouncing down the core.)
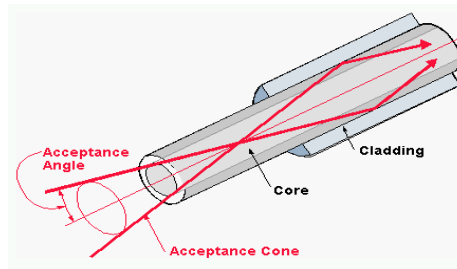
The advantages of optical fibers are:

➢ Less expensive - Several miles of optical cable can be made cheaper than equivalent lengths of copper wire.

➢ Higher carrying capacity - Because optical fibers are thinner than copper wires, more fibers can be bundled into a given-diameter cable than copper wires. This allows more phone lines to go over the same cable or more channels to come through the cable into your cable TV box.

➢ Less signal degradation - The loss of signal in optical fiber is less than in copper wire.

➢ Light signals - Unlike electrical signals in copper wires, light signals from one fiber do not interfere with those of other fibers in the same cable. This means clearer phone conversations or TV reception.

➢ Digital signals - Optical fibers are ideally suited for carrying digital information, which is especially useful in computer networks.

➢ Non-flammable - Because no electricity is passed through optical fibers, there is no fire hazard.

➢ Lightweight and thin - An optical cable weighs less than a comparable copper wire cable. Optical fibers can be drawn to smaller diameters than copper wire. Fiber-optic cables take up less space in the ground.

The disadvantages of optical fibers are:

- Price - Even though the raw material for making optical fibers, sand, is abundant and cheap, optical fibers are still more expensive per meter than copper. Although, one fiber can carry many more signals than a single copper cable and the large transmission distances mean that fewer expensive repeaters are required.
- Fragility - Optical fibers are more fragile than electrical wires.
- Affected by chemicals - The glass can be affected by various chemicals including hydrogen gas (a problem in underwater cables.)
- Opaqueness - Despite extensive military use it is known that most fibers become opaque when exposed to radiation.
- Requires special skills - Optical fibers cannot be joined together as a easily as copper cable and requires additional training of personnel and expensive precision splicing and measurement equipment.

Uses for optical fibers are:

- Communication - Telephone transmission method uses fiber-optic cables. Optical fibers transmit energy in the form of light pulses. The technology is similar to that of the coaxial cable, except that the optical fibers can handle tens of thousands of conversations simultaneously.
- Medical uses - Optical fibers are well suited for medical use. They can be made in extremely thin, flexible strands for insertion into the blood vessels, lungs, and other hollow parts of the body. Optical fibers are used in a number of instruments that enable doctors to view internal body parts without having to perform surgery.
- Simple uses - The simplest application of optical fibers is the transmission of light to locations otherwise hard to reach. Also, bundles of several thousand very thin fibers assembled precisely side by side and optically polished at their ends, can be used to transmit images.

ADVANTAGES	
Bandwidth - Fiber optic cables have a much greater bandwidth than metal cables. The	**Cost** - Cables are expensive to install but last longer than copper cables.

amount of information that can be transmitted per unit time of fiber over other transmission media is its most significant advantage.

Low Power Loss - An optical fiber offers low power loss. This allows for longer transmission distances. In comparison to copper; in a network, the longest recommended copper distance is 100m while with fiber, it is 2000m.

Interference - Fiber optic cables are immune to electromagnetic interference. It can also be run in electrically noisy environments without concern as electrical noise will not affect fiber.

Size - In comparison to copper, a fiber optic cable has nearly 4.5 times as much capacity as the wire cable has and a cross sectional area that is 30 times less.

Weight - Fiber optic cables are much thinner and lighter than metal wires. They also occupy less space with cables of the same information capacity. Lighter weight makes fiber easier to install.

Safety - Since the fiber is a dielectric, it does not present a spark hazard.

Security - Optical fibers are difficult to tap. As they do not radiate electromagnetic energy, emissions cannot be intercepted. As physically tapping the fiber takes great skill to do undetected, fiber is the most secure medium available for carrying sensitive data.

Flexibility - An optical fiber has greater tensile

Transmission - transmission on optical fiber requires repeating at distance intervals.

Fragile - Fibers can be broken or have transmission loses when wrapped around curves of only a few centimetres radius. However by encasing fibers in a plastic sheath, it is difficult to bend the cable into a small enough radius to break the fiber.

Protection - Optical fibers require more protection around the cable compared to copper.

strength than copper or steel fibers of the same diameter. It is flexible, bends easily and resists most corrosive elements that attack copper cable.

Cost - The raw materials for glass are plentiful, unlike copper. This means glass can be made more cheaply than copper.

10BaseT

➢ 10BASE-T, one of several physical media specified in the IEEE (Institute of Electrical and Electronics Engineers) 802.3 standard for Ethernet local area networks (LANs), is ordinary telephone twisted pair wire.

➢ 10BASE-T supports Ethernet's 10 Mbps transmission speed. In addition to 10BASE-T, 10 megabit Ethernet can be implemented with these media types:

   o 10BASE-2 (Thinwire coaxial cable with a maximum segment length of 185 meters)

   o 10BASE-5 (Thickwire coaxial cable with a maximum segment length of 500 meters)

   o 10BASE-F (optical fiber cable)

   o 10BASE-36 (broadband coaxial cable carrying multiple baseband channels for a maximum length of 3,600 meters)

➢ The "10" in the media type designation refers to the transmission speed of 10 Mbps. The "BASE" refers to baseband signaling, which means that only Ethernet signals are carried on the medium. The "T" represents twisted-pair; the "F" represents fiber optic cable; and the "2", "5", and "36" refer to the coaxial cable segment length (the 185 meter length has been rounded up to "2" for 200).

➢ Cables in the 10Base-T system connect with RJ-45 connectors. A star topology is common with 12 or more computers connected directly to a hub or concentrator.

- The 10Base-T system operates at 10 Mbps and uses baseband transmission methods.
- One of the most common types of Ethernet in use today is **10BaseT.** This particular implementation uses four-pair UTP wiring (Cat3 or higher, but most commonly you will see Cat5) using RJ-45 connectors. Each cable is connected from each network device to a central hub in a physical star topology. Within the hub, the signals are repeated and forwarded to all other nodes on the network because it is a logical bus topology. Older network interface cards are configured with jumpers to set addresses and interrupts.
- Today's network interfaces cards can be managed through a diagnostic program, or automatically configure themselves through plug and play technology. There is a limit of 1024 devices on an Ethernet segment, plus you can have a maximum of 1024 network segments. A UTP cable has a maximum distance of 100 meters, which is equivalent to 328 feet.

100Base-T

- *100Base-T* is an *Ethernet* wiring standard for LANs (local area networks) that supports data transfer rates up to 100Mbps (100 megabits per second) over unshielded twisted pair copper wire cable or optical fiber cable.
- Ethernet is by far the most commonly used LAN architecture as a result of its high speeds, robustness (i.e., high reliability), low cost and adaptability to new technologies.
- 100Base-T is based on the older 10Base-T Ethernet standard, which supports transfer rates of 10Mbps. Because it is ten times faster than its predecessor, it is often referred to as *fast Ethernet*.
- The network segment length for a 100BASE-T cable is limited to 100 meters, as with 10Base-T and *gigabit Ethernet* (which supports a speed of one billion bits per second). Likewise, it also uses the CSMA/CD (carrier sense multiple access/collision detection) LAN access method to avoid collision..
- There are versions of 100Base-T for three different cabling schemes:
    - 100Base-TX for two pairs of high-quality twisted pair wires, One pair receives signals while the other sends them.

- 100Base-T4 for four pairs of normal-quality twisted pair wires , One pair receives and one pair sends signals. The two remaining pairs are reserved and used as required.
- 100Base-FX for multimode optical fiber cables. The two strands are used to transmit and receive signals; one sends and the other receives to provide full-duplex communication.

➢ 100Base-T is the most widely used Ethernet standard, and the vast majority of common implementations or installations of 100Base-T are 100Base-TX.
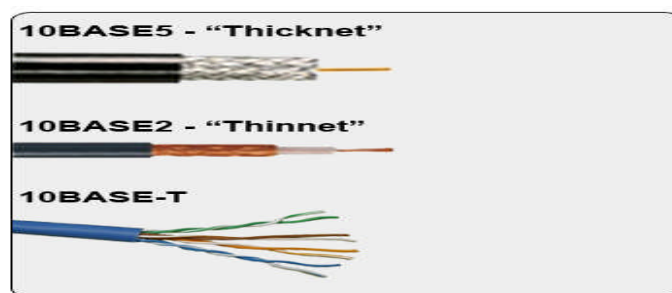
Hub

➢ Hub is a device for connecting multiple Ethernet together and making them act as a single network segment.

➢ A common connection point for devices in a network.

➢ Hubs are commonly used to connect segments of a LAN.

➢ Hubs do not read any of the data passing through them and are not aware of their source or destination. Hub simply receives incoming packets, possibly amplifies the electrical signal and broadcast these packet out to all device on the network including the one that originally sent the packet

➢ A hub contains multiple ports. When a packet arrives at one port, it is copied to the other ports so that all segments of the LAN can see all packets.

➢ Hubs were the common network infrastructure devices used for Local Area Network (LAN) connectivity but network switches are rapidly replacing hubs.

➢ Hubs function as the central connection point for Local Area Network (LAN).

➢ Hubs are designed to work with twisted pair cabling and normally use RJ45 jack to connect the devices. Network devices (Servers, Workstations, Printers, Scanners etc) are

attached to the hub by individual network cables. Hubs usually come in different shapes and different numbers of ports.

➢ When a hub receives a packet of data (an Ethernet frame) at one of its ports from a network device, it transmits (repeats) the packet to all of its ports to all of the other network devices. If two network devices on the same network try to send packets at the same time a collision is said to occur.

➢ Hubs are considered to operate at Physical Layer (Layer 1) of OSI model. An 8 port hub is shown below.

What Hubs Do

➢ Hubs and switches serve as a central connection for all of your network equipment and handles a data type known as frames. Frames carry your data. When a frame is received, it is amplified and then transmitted on to the port of the destination PC.

➢ In a hub, a frame is passed along or "broadcast" to every one of its ports. It doesn't matter that the frame is only destined for one port. The hub has no way of distinguishing which port a frame should be sent to. Passing it along to every port ensures that it will reach its intended destination. This places a lot of traffic on the network and can lead to poor network response times.

Pros: Cheap, easy to monitor

Cons: Delays as all the ports are used for every transmission. Not good on large networks.

Terminator

➢ A device attached to the end-points of a bus network or daisy-chain.

➢ The purpose of the terminator is to absorb signals so that they do not reflect back down the line.

➢ Ethernet networks require a terminator at both ends of the bus.

➢ Terminator prevent signal, reflection which can produce interference that cause signal loss.

- Most communication systems such as networks and computer buses require some form of termination at the ends of the data path, although this is often provided internally by the devices at the ends of the data path.

How Terminator Works

- In a bus-based system, a single wire or series of wire segments connects network components in a chain formation. If the ends of the cable are not terminated, a signal placed on the wire by one component will bounce back and forth between the ends of the cable, hogging the cable and preventing other components from signaling. Terminators eliminate this signal bounce by absorbing the signal after each component has seen it once, allowing other components to place their signals on the cable.

7.4 Modem, Repeaters, Bridges, Routers, Radio Link

Modem

- A **modem** (**mo**dulator-**dem**odulator) is a device that modulates signals to encode digital information and demodulates signals to decode the transmitted information. The goal is to produce a signal that can be transmitted easily and decoded to reproduce the original digital data.
- A modem is a device or program that enables a computer to transmit data over, for example, telephone or cable lines. Computer information is stored digitally, whereas information transmitted over telephone lines is transmitted in the form of analog waves.
- Modems can be used with any means of transmitting analog signals, from light emitting diodes to radio.
- A common type of modem is one that turns the digital data of a computer into modulated electrical signal for transmission over telephone lines and demodulated by another modem at the receiver side to recover the digital data.
- The Modem is a hardware device that enables a computer to send and receive information over telephone lines by converting the digital data used by your computer into an analog signal used on phone lines and then converting it back once received on the other end.

- Modems are referred to as an **asynchronous device**, meaning that the device transmits data in an intermittent stream of small packets. Once received, the receiving system then takes the data in the packets and reassembles it into a form the computer can use.
- There are also modems that come as an expansion board that you can insert into a vacant expansion slot. These are sometimes called *onboard* or *internal modems*.

Types of computer modems

- Modem that can be used in computers as:
1. **Internal modem** that connects to a PCI slot inside a newer desktop computer or ISA slot on an older computer. The Internal Modem shown at the beginning of this document is an example of a PCI modem.
2. **External modem** is located within a box and is hooked up externally to the computer, usually the Serial Ports or USB port.
3. **Removable modem** that is used with older laptops PCMCIA slot and is removed when you need the PCMCIA slot for another device, but are not planning on using the modem.

Repeater
- A network device used to regenerate or replicate a signal.
- Repeaters are used in transmission systems to regenerate analog or digital signals distorted by transmission loss. Analog repeaters frequently can only amplify the signal while digital repeaters can reconstruct a signal to near its original quality.
- In a data network, a repeater can relay messages between sub networks that use different protocols or cable types. Hubs can operate as repeaters by relaying messages to all connected computers. A repeater cannot do the intelligent routing performed by bridges and routers.
- In digital communication systems, a repeater is a device that receives a digital signal on an electromagnetic or optical transmission medium and regenerates the signal along the next leg of the medium.

- In electromagnetic media, repeaters overcome the attenuation caused by free-space electromagnetic-field divergence or cable loss. A series of repeaters make possible the extension of a signal over a distance.

- In telecommunications, a **repeater** is an electronic device that receives a signal and retransmits it at a higher level or higher power, or onto the other side of an obstruction, so that the signal can cover longer distances. It is a generic term that refers to several different types of devices; a *telephone repeater* is an amplifier in a telephone line, an *optical repeater* is an optoelectronic circuit that amplifies the light beam in a optical fiber cable; and a *radio repeater* is a radio receiver and transmitter that retransmits a radio signal.

Advantages

- Makes it easy to expand a network over a large distance.
- Connection between various type of media [e.g optical fiber, coaxial] is possible

Disadvantage

- Traffic cannot be filtered to ease congestion
- A repeater cannot work across multiple network architecture

Bridges

- A bridge is a type of computer network device that provides interconnection with other bridge networks that use the same protocol.
- Bridge devices work at the data link layer of the Open System Interconnect (OSI) model, connecting two different networks together and providing communication between them.
- Bridges are similar to repeaters and hubs in that they broadcast data to every node. However, bridges maintain the media access control (MAC) address table as soon as they discover new segments, so subsequent transmissions are sent to only to the desired recipient.
- Bridges are also known as Layer 2 switches.
- A bridge uses a database to ascertain where to pass, transmit or discard the data frame.

    o If the frame received by the bridge is meant for a segment that resides on the same host network, it will pass the frame to that node and the receiving bridge will then discard it.

o If the bridge receives a frame whose node MAC address is of the connected network, it will forward the frame toward it.

Router

➢ A **router** is a networking device that forwards data packets between computer networks.

➢ A router is connected to two or more data lines from different networks. When a data packet comes in one of the lines, the router reads the address information in the packet to determine its ultimate destination. Then, using information in its routing table or routing policy, it directs the packet to the next network on its journey. This creates an overlay internetwork.

➢ Routers perform the "traffic directing" functions on the Internet. A data packet is typically forwarded from one router to another through the networks that constitute the internet work until it reaches its destination node.

➢ In packet-switched networks such as the Internet, a router is a device or, in some cases, software in a computer, that determines the next network point to which a packet should be forwarded toward its destination.

➢ The router is connected to at least two networks and decides which way to send each information packet based on its current understanding of the state of the networks it is connected to. A router is located at any gateway (where one network meets another), including each point-of-presence on the Internet. A router is often included as part of a network switch.

➢ A router may create or maintain a table of the available routes and their conditions and use this information along with distance and cost algorithms to determine the best route for a given packet. Typically, a packet may travel through a number of network points with routers before arriving at its destination.

Pros:

➢ Data can be transferred between different networks; you can use both LAN and WAN connectivity.

➢ The router has many different connections, which connect to lots of architecture and media for the internet and internal use within an organization.

- It is useful for sending data across because it determines the best route and paths to get to the right data to the target node.
- Router has domain, which brings less collisions.

Cons:
- Cost more than hub/switch.
- It has a high bandwidth for when interconnected with multiple buildings or when doing an update.
- The router will have a bigger latency when there are more packets to be filtered.

Radio link
- Radio link is a two-way communication system (usually microwave); part of a more extensive telecommunication network
- Radio link can be of two types
  - One to many broadcast network commonly used for public information
  - Two-way radio commonly used for public safety and public services such as fire etc.

7.5 Networking Operating System
- Unlike **operating systems**, such as Windows that are designed for single users to control one computer, **network operating systems** (NOS) coordinate the activities of multiple computers across a network. The network operating system acts as a director to keep the network running smoothly.
- **Network operating system** refers to software that implements an operating system of some kind that is oriented to computer networking.
- For example, one that runs on a server and enables the server to manage data, users, groups, security, applications, and other networking functions. The network operating system is designed to allow shared file and printer access among multiple computers in a network, typically a local area network (LAN), a private network or to other networks.
- A network operating system provides printer sharing, common file system and database sharing, application sharing, and the ability to manage a network name directory, security, and other housekeeping aspects of a network.

- The term *network operating system* is generally reserved for software that enhances a basic operating system by adding networking features. Novell Netware, Artisoft's LANtastic, Microsoft Windows Server, and Windows NT are examples of a NOS.
- NOS must be able to handle typical network duties such as the following:

  - Providing access to remote printers, managing which users are using which printers when, managing how print jobs are queued, and recognizing when devices aren't available to the network
  - Enabling and managing access to files on remote systems, and determining who can access what—and who can't
  - Granting access to remote applications and resources, such as the Internet, and making those resources seem like local resources to the user (the network is ideally transparent to the user)
  - Providing routing services, including support for major networking protocols, so that the operating system knows what data to send where
  - Monitoring the system and security, so as to provide proper security against viruses, hackers, and data corruption.
  - Providing basic network administration utilities (such as SNMP, or Simple Network Management Protocol), enabling an administrator to perform tasks involving managing network resources and users.

NetWare

- **NetWare** is a computer network operating system developed by Novell, Inc. It initially used cooperative multitasking to run various services on a personal computer
- Novell developed with NetWare a network operating system that no complex and over weighted GUI needs for use on servers.
- Novell provides simple but powerful text-based menus on the command line for the configuration since the first NetWare release.
- The administration of resources like printers, files and users is possible with a client and a graphical window system and granted administrator rights.
- Netware evolved from a very simple concept: file sharing instead of disk sharing.
- Netware is the first network operating system that supports the multiple platforms.

- Netware was the choice of network administration because of its ease of use, performance, flexibility, interoperability and scalability.
- Since NetWare 6 no more clients is necessary for this, the configuration can be done completely on the server.
- NetWare needs only low hardware requirements and has memory protection. It protects single processes from each other and is very stable through this in operation. Virtual memory is used reliably.
- This operating system is used for all sorts of fields of application. Use as a directory service, Internet server, Intranet server, file server or also application server is part of it.
- The first release of NetWare was 1983 for the operating system DOS.
- In 2005 the current version of the network operating system Open Enterprise Server was published in different variants. Either with NetWare 6.5 kernel or Linux kernel of the Suse Enterprise 9 server, no matter which variant is used the same services are available.
- However in the last decade, netware has lost approximately 80% of its previous market share to more popular NOS such as windows server 2003, UNIX and Linux.

LANtastic

- **LANtastic** is a peer-to-peer local area network (LAN) operating system for DOS, Microsoft Windows and OS/2.
- LANtastic supports Ethernet, ARCNET and Token Ring adapters as well as its original twisted-pair adapter at 2 Mbit/s.
- Its multi-platform support allows a LANtastic client station to access any combination of Windows or DOS operating systems, and its interconnectivity allows sharing of files, printers, CD-ROMs and applications throughout an enterprise.
- LANtastic was especially popular before Windows 95 arrived with built-in networking and was nearly as popular as the market leader Novell at the time.
- LANtastic was originally developed by Artisoft Inc. in Tucson, Arizona.
- The LANtastic system allows the user to choose whether to dedicate a server or to run the server on a user's workstation.
- It is designed for small and home office networks. It can be easily set up and will allow the sharing of printers, hard drives, and CD-ROM drives. Offices can exchange files between computers and pool network software applications and communicate via e-mail.

Security is provided down to subdirectory level for full-access, read-only access, or no access.

➢ LANtastic is the simplest DOS Networking software available.

LAN manager

➢ LAN Manager is a network operating system originally co-developed by IBM and Microsoft.

➢ It supported the Server Message Block (SMB) protocol and, at the time of its deployment, it allowed for a very robust mode of communication within an local area network (LAN).

➢ It has since been replaced by other modes of communication within an LAN.

7.6 Introduction to Client-Server model

➢ Client-server architecture (client/server) is a network architecture in which each computer or process on the network is either a *client* or a *server*.

➢ Servers are powerful computers or processes dedicated to managing disk drives (*file servers*), printers (*print servers*), or network traffic (*network servers*).

➢ Clients are PCs or workstations on which users run applications. Clients rely on servers for resources, such as files, devices, and even processing power.

➢ In this case, the client establishes a connection to the server over a local area network (LAN) or wide-area network (WAN), such as the Internet. Once the server has fulfilled the client's request, the connection is terminated.

➢ The **client–server model** of computing is a distributed application structure that partitions tasks or workloads between the providers of a resource or service, called servers, and service requesters, called clients.

➢ Often clients and servers communicate over a computer network on separate hardware, but both client and server may reside in the same system. A server host runs one or more server programs which share their resources with clients. A client does not share any of its resources, but requests a server's content or service function. Clients therefore initiate communication sessions with servers which await incoming requests.

➢ Examples of computer applications that use the client–server model are Email,network printing, and the World Wide Web.