



**Department of Distance Education**  
**Punjabi University, Patiala**

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***Lesson No.***

- 1.1 : Computers : hardware, input, output and storage devices.  
software : system software and application software
- 1.2 : Information and Communication Technology (ICT) : Concept and  
Impact on Society
- 1.3 : ICT : Application in Libraries
- 1.4 : Library Automation : Need, Purpose and Application
- 1.5 : Information Retrieval : Search Engines, Boolean Operators
- 1.6 : Computer Networks : Concept, Classification of Computer Network  
on the basis of size (LAN, MAN and WAN) and Topologies and  
Advantages of networks

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**COMPUTERS : HARDWARE, INPUT, OUTPUT AND STROAGE DEVICES.  
SOFTWARE : SYSTEM SOFTWARE AND APPLICATION SOFTWARE**

- 1.1 Introduction
- 1.2 What is a Computer ?
- 1.3 Definition of Computer.
- 1.4 Components of Computer.
- 1.5 Salient features of Computer.
- 1.6 Hardware
  - 1.6.1 Input Device
  - 1.6.2 Output Device
  - 1.6.3 Storage Device
- 1.7 Software
  - 1.7.1 System Software
  - 1.7.2 Application Software
- 1.8 Summary.
- 1.9 Keywords.
- 1.10 Self check exercise.
- 1.11 Suggested Redings.

**1.1 Introduction**

The computer is not just a calculator that works automatically but also sophisticated electronic equipment for manipulating words and numbers. To many people, the word computer suggests “computation”, and that word means “math”, which scares some people. Computers are not calculators, although you can use a computer as a calculator. In the simplest definition, a computer is an electronic device—a machine that can manipulate data. Many of these manipulations have nothing to do with math. Computers are devices, which can compute at a very high speed. There are many kinds of computers in the world today but their basic functions are mostly the same. Computers have made a lot of impact on our everyday life. Computers are used by writers, television producers, musicians, poets, and in every walk of life be it homes,

schools, colleges, offices, industries, hospitals, banks, railways etc. They are presently used, among other applications, to :

- Design buildings, bridges and machines.
- Assist in Railways reservations.
- Minimize material cost through inventory control.
- Prepare examination results.
- As teaching aids.
- Systematically store and retrieve data quickly on crimes and criminals.
- Play games like chess and video games.

### **1.2 What is a Computer ?**

A computer is “an electronic device that processes given data to derive the required and useful information”. The computer performs the following functions like :

**INPUT :** It accepts data and instructions from the user by means of an input device, such as a keyboard.

**PROCESSING :** It performs a number of arithmetic and logical operations as per instructions given.

**OUTPUT :** It presents the required information or output to the user on a device, such as a printer or a monitor that shows the end results of processing operations.

**STORAGE :** It stores the results of processing operations for future use.

So we can say “a computer is an electronic device which can receive inputs (data) as raw material and processes it according to the program instructions to produce the output in a useful form”.

### **1.3 Definition of Computer**

A computer can be defined as a fast and accurate electronic system for data management designed to accept and store input data, and process them under the direction of a program (set of instructions) stored in the computer itself, for producing the desired outputs.

### **1.4 Components of Computer**

- **Central Processing Unit :-** The CPU or microprocessor is a device which can receive the information in bits, process it and transform it into a meaningful output. The CPU comprises of control unit, memory unit and Arithmetic logic unit. The CPU is the brain of any computer system.

- **Arithmetic logic Unit :-** The arithmetic logic unit of a computer system is the place where the actual execution of instruction takes place during the processing operation. To be more precise, all calculations are performed and all comparisons are made in the ALU.

- **Control Unit :-** How does the input device know that it is time for it to feed data into the storage unit ? How does the ALU know what should be done with the data once they are received ? and how is it that any the final results are sent to the output device and not the intermediate results ? All this is possible because of the control unit of the computer system. By selecting interpreting and seeing to the execution of the program instruction, the control unit is able to maintain order and direct the operation of the entire system.

- **Memory Unit :-** All the data and results are stored in memory unit. The memory unit comprises of million of cells each capable of storing a unit of information. These electromagnetic cells are also referred as storage locations or addresses.

### 1.5 Salient Features of Computers

Computers are becoming popular day by day because of their characteristics. The major characteristics that make the computer such a powerful machine can be enumerated as speed, storage, accuracy, ability to operate automatically, diligence, scientific approach and versatility etc. These are briefly explained below :

#### 1.5.1 Speed

The way we can measure the speed of a car travelling in terms of Km/hour, the speed of a computer too can be measured. The speed of a computer is much more than what man can possibly record or calculate normally. The computer's speed at performing a single operation can be measured in terms of :

1. Milliseconds—A thousandth of a second or  $10^{-3}$
2. Microseconds—A millionth of a second or  $10^{-6}$
3. Nanoseconds—A thousand millionth of a second or  $10^{-9}$
4. Pico seconds—A million millionth of a second or  $10^{-12}$

A computer is a very fast and accurate device. Most instructions are carried out in less than a millionth of a second. It can process thousands of instructions within a few seconds for which a human being can take several days or months. Computers make calculations at a very high speed. A powerful computer is capable of executing about 3 million calculations per second. The unit of measurement of a computer's speed is MIPS which means Millions of instruction per second.

#### 1.5.2 Storage and Retrieval of Information

One of the major failings in man is his inability to remember and 'store' large volumes of information in his brain. The computer is capable of overriding this deficiency as it can store

- (a) Large volumes of information being processed simultaneously within its own temporary memory and

- (b) Larger volumes of data to be maintained more permanently  
o n  
secondary media such as—floppy disks, magnetic disks and  
tapes, punched cards, microfilms etc.

The storage capacity of any media or item can be measured in terms of certain units e.g. a 1 litre bottle or a 5 kg pack or a 1500 cubic litre water tank etc. The storage capacity of a computer is measured in terms of Bytes, Kilobytes, Megabytes and Gigabytes. Computers can store vast amounts of information on magnetic media, such as magnetic tapes and magnetic disks. For instance the entire Encyclopedia Britannica can be stored in half of the compact disk. Equally important is the fact that information held on such media can be shifted through and accessed within a few milliseconds.

### **1.5.3 Accuracy**

Computer's accuracy is consistently high. In spite of its high speed of processing errors seldom occur. The amount of research that has gone into developing the computer to function optimally has created a device that operates at near 100% accuracy. Errors can occur in computerized system also but most of them occur due to human mistakes rather than technical problems in the computer.

### **1.5.4 Automatic**

As stated earlier, the computer is a device, which performs much more than a calculator, which is capable of doing lot of arithmetic operations and need a human operator to press the necessary keys for any operation to be performed. A computer is quite capable of functioning automatically, thus the ability to accept and store a sequence of instructions. Such a sequence of instructions is called a program and must be written in the language of the computer. The program instructions will be processed in the sequence automatically.

### **1.5.5 Diligence**

The computer is a machine that does not feel tired and distracted. Computer is free from problems like exhaustion, lack of concentration, confusion, etc. It can perform even to an extent of more than 10 million calculations; it does each and every calculation operating at exactly the same level of speed and accuracy even if it has to carry out the most lengthy and complex operations.

### **1.5.6 Scientific Approach**

The entire approach to solving problems is highly scientific, objective and sequentially carried out, leaving no room for emotional and subjective evaluations made by man, which are sources of potential errors and unjustified

results.

### **1.5.7 Versatility**

The computers are used widely in so many areas of man's daily life. This is ample evidence of its versatility that it can carry out processes ranging from simple mathematical calculations to highly complex and logical evaluations. Computers can perform almost any task, provided the task can be reduced to a series of logical steps.

### **1.5.8 Reliability**

Computers are designed in such a way that their individual components have very high life and degree of reliability. The output generated by the computer is very reliable, but it is reliable only when the data, which is passing as input to the computer and the program, which gives instructions, are correct and reliable.

### **1.5.9 Intangible benefits**

Computers give many intangible benefits like flexibility, ability to accommodate changes and expansion, competitive advantage, better services can be provided, people may be served in jiffy without much hassle etc.

### **1.5.10 No emotional, ego and psychological problems**

As computers are machines they do not come with any emotional, ego and psychological problems, which are otherwise destructive in nature. We may not neglect this front because above all, these are the things, which are the major causes of problems arising in an environment.

### **1.5.11 No Intelligence**

A computer can perform the information processing and reasoning only on the basis of the intelligence provided by human beings in terms of programs developed but it cannot make decisions on its own.

A computer may thus be thought of as a servant who would carry out instructions obediently at a very high speed and without exhibiting any emotions. Thus with above characteristics computers do have a strong point to enter every sphere of life.

## **1.6 Hardware**

Hardware is the term given to the machines itself and to the various individual pieces of equipments. It refers to the physical devices of a computer system. Thus, the input, storage, processing, control and output devices are hardware.

### **Input, Output and Storage Devices**

The links between man and computer are through the input, output and storage devices. These act as the interface between the I & O devices and the CPU. While the Input device transmits the input as a series of electrical pulses to the computer, the output device retranslates the electrical pulse into a High

Level Language readable by man.

The communication link established between man and the computer is through the Input Device. It 'reads' the INPUT, that the user has prepared and wish to give to the computer, and translates it into a series of electrical pulses for the machine to understand. Just as one can understand and sense things through sight, smell, sound and touch, the computer, too is able to accept INPUT from different kinds of INPUT DEVICES. Over the years these have also undergone changes and modifications.

### **1.6.1 Input Devices**

#### **Punched Card Reader**

J. Jacquard had initiated the system of punched cards, through his loom. H. Hollerith further developed it as a significant means to input data & instructions into the computer (- based on the Hollerith code.). This input unit was used by Charles Babbage, the "Father of Computers". Punched cards are the most primitive form of communication and are used very sparingly today.

The punched card contains 80 columns, containing 12 punching positions in each column. The information is punched as holes into these cards in a series of unique codes. These cards are then sequentially arranged into a series of 'pack' ready to be input to the computer. For this purpose we require an input device called as CARD READER—which is a device for reading packs of cards 'electro-mechanically with speed of about 300-1600 cards per minute and transcribing the pattern of holes punched, into a series of electrical pulses which the computer, can interpret. About 200 characters per minute could be read by this input device.

Today, the typically modern card-readers can operate at speeds of over 1000 cards per minute resulting in a maximum transmission of about 80,000 characters per minute into the computer.

Punched card has the following advantages :

1. It is relatively cheaper.
2. Both user as well as machine can read data.

#### **Limitations :**

1. The volume of cards which are very huge are difficult to maintain and control.
2. As the card devices are essentially composed of many mechanical parts, these devices are subject to frequent breakdowns.
3. Speed of processing data on card by card reader and punched cards is low.

4. They are not reusable.

### **Paper Tape Reader**

Another input device that also deals with paper media is the PAPER TAPE READER. This device reads the unique combination of holes punched into a paper tape in much the same way as the card reader. Only here the information is stored on a roll of paper tape, instead of a pack of cards. As the paper tape is cheaper than punched cards it gained wide usage for data communication, recording and requisition. The typical reading speed of a modern paper tape reader is about 1,000 characters per second but can go up to over 2000 CPS.

### **Mark and Character Recognition**

Mark and character recognition involves 3 types of recognition viz. OPTICAL MARK SENSE Reading, MAGNETIC INK Reading and the OPTICAL CHARACTER Reading.

The OPTICAL MARK SENSE READER is an input device that reads the presence or absence of a mark made with a pencil. The card or the form is divided into boxes or ovals, in which a mark is made either by pen or pencil. A character is represented by marking a correct combination of boxes in any column. Usually these cards are printed for special purposes, so that, marking at specific purposes signify number, yes or no etc. This technique is now-a-days popular in various competitive examinations, where the examinees have to mark their answers on preprinted answer sheets using pencil, which is then read by an OMR, so that the evaluation becomes easier and accurate. The reading mechanism goes over the media on which the data is present and reads it as a series of absence or presence of marks, made by the graphite deposits of a pencil. These readers are capable of operating at a speed of 10,000 A4 documents per hour. It is widely used in a number of spheres and the most common application is perhaps the checking of answer sheets with multiple-choice answers.

With the success of the mark sense readers, a further research was done into character recognition readers. This proved highly successful and resulted in the development of the OPTICAL CHARACTER READER. OCR permits direct reading of any printed character. A photoelectric device that determines the outline and shape reads each character on an OCR document. This shape is then compared with a sample set that is already within the device. The identification of the characters is generated in electronic codes to the computer. OCRs recognize characters printed in a special format. Use of OCR saves a lot of time that would otherwise be spent in data transcription. It increases data accuracy and timeliness of information produced.

The early OCR devices would only read a single 'font' (type-style), but now they are able to 'read' typewriter and computer printed documents. They, however, cannot be used to read handwriting since every person's handwriting has variations to it.

Some of the typical OCR fonts being used are the OCR-A, OCR-B, ECMA-II, PICA-72. OCR devices are able to read about 2400 characters per second. They are used in connection with billing in western countries e.g. electricity bills, gas bills, etc. Examples are American National Standards OCR, European OCR.

Finally we arrive at MAGNETIC INK CHARACTER RECOGNITION devices, also called MICR readers. The method employed in this is the documents with characters marked in ink are passed through a magnetic field where the ink-coded characters magnetize the reader's head due to magnetic ink. These are then read and recognized on the basis of the strength of current according to the size of the magnetized area in a specific pattern. MICR devices operate at a speed of reading 2400 characters per second and find wide application in banking systems and establishments. One can see these characters on cheques. Banks, to process the large volumes of cheques generally use MICR. The information coded on the cheque is printed with special ink that contains magnetized particles of iron oxide. The characters are read or recognized by the reader based on patterns on magnetization of particles in the ink. Magnetic ink characters are also human readable. It eliminates the document encoding process. Applications besides banking include utility bills, customer payment coupons, etc.

This way of input has several advantages :

1. In spite of rough handling, one can read the information with a very high degree of accuracy.
2. The information processing is faster.

The major limitation of MICR is that it can recognise only 10 digits and 4 special characters, we cannot use alphabetic characters.

### **Bar Codes**

Data can also be recorded in the form of Bar Codes i.e. Vertical lines with varying widths alternating with spaces. These bars are read by bar code reader or optical reader and converted into electrical pulses. The pattern of bar is unique and standardized, which gets converted into specific information. Bar code readers read price and inventory codes printed on products that are frequently purchased, such as goods in supermarkets. These codes are specific codes of which the UPC (Universal Product Code) and EAN (European Article Number) are common. They are used in manufacturing and distribution, in

warehouses, retail stores, bank teller windows, and business offices.

### **Keyboard**

Most computer systems use an input device that is attached with the computer or a terminal and looks quite like a typewriter. This device that consists of keys marked with characters on them is referred to as a KEYBOARD. Some of the keys have two characters marked on them, one above the other— which are known as upper case and lower case characters, respectively. The numbers usually appear on the topmost row with other upper shelf symbols. Every key and key combination passes a unique signal to the computer. It is generally used for typing text-based information. During typing, the keys get displayed on the VDU so that the user can see what he is typing.

Key boards usually contain the following keys :

1. Numeric keys, which are arranged as a pad as same as calculator, which are used for inputting numeric values.
2. Character keys, which are used for inputting characters.
3. Function keys, which are preprogrammed for specific operations. These can also be programmed by the user so as to work in a way he desires.
4. Special keys : Which are usually used for cursor controls, special symbols, and other specific purposes.

Cursor-control keys, the ones with arrows, move the cursor on the VDU. Other special keys delete and insert characters from text, scroll the screen, clear the screen, and so on.

Keyboards are used to input data and program, where the depression of a key sends the corresponding electronic code to the computer. They cannot be used to input large volumes of data since they are slow and tedious i.e. at the rate of human typing. These keyboards are an integral part of computer terminals.

### **Mouse**

A mouse is a pointing device that rolls on a small rubber ball and has two or three buttons on the top. This input device is used specially for Graphic User Interfaces (GUI). This is used as a pointing device. The user rolls on a smooth surface, the cursor movement on the screen is controlled by mouse. The movement of the ball is sensed by two sensors and resolved into horizontal and vertical components. The movement of the mouse controls the movement of cursor on the screen. Clicking of the mouse button while the cursor or pointer points to the option to be selected does selection of menu option. One can point to any place on screen, make selections, and click an option etc., so that input is provided to computer.

**Light pen**

Light pen is used to select a menu option displayed on the screen. It is used in application areas like designing and engineering etc. We usually see, during election analysis, that the anchors of the show, draw lines or markings on the computer screen which we can see, and as well during cricket matches we see the various points, field is pointed or shown using free hand lines. This is done using a light pen. It is a type of pointing device that is used to choose a displayed menu option on screen for a program. It functions on the concept of photocell placed in a small tube. As the tip of the pen is moved over the screen surface, it will detect the light coming from a limited field of view. This light from the screen activates photocell, and electric response is transmitted to the process which identifies menu option that has triggered photocell.

**Joystick**

It is one of the popular input devices used for playing games on computers. It provides fast, controlled movement on the screen and allows movement of objects around the screen easily. The position and speed with which the joystick is moved is controlled by a lever that is attached to a solid base. Different shapes of joysticks are available now-a-days.

**Track Ball**

This is similar to joystick, the difference is that track ball uses hard sphere instead of handle for cursor control. This hard ball can be rotated by hand in any direction. The sphere's speed and direction of rotation is translated into digital signals, which control the cursor.

**Touch Screen**

These input devices are very user friendly, which accept the input by mere clicking/pressing with a finger or any other object. These are similar to video display units, which are having the same appearance, the difference being they take input directly. Touch screen takes input as when a finger or object comes in contact with the screen, the light beam is broken, and the location of breaking of light beam is recorded, which acts as inputs.

**Magnetic Strips**

These are thin bands of magnetically encoded data. These are usually on credit cards. The data stored on these strips can be anything, but usually they include special codes, which are used for accessing accounts. These strips are usually pasted on the card, and this card is swiped in a card reader which reads the data stored on the strips. The data cannot be seen and read by mere looking at the card, it is usually secret.

**Scanner**

These scanners look and work somewhat like a photocopier. One needs to simply lay an image or page of text face down on the flatbed scanner and then issue a command to scan the page.

The page stays stationary and mechanism inside the flat bed scanner moves over the image to scan it. The scanned image is then transferred to the system and saved. A scanner allows you to scan documents, pictures, or graphics and view them on the computer. You can also use software to edit the items you scan. To scan text, optical character recognition (OCR) software is needed.

**Voice Input/Recognition Devices**

Another form of inputting data is by the voice-input system, which is one of the latest developments. The human need for easy and faster way of input is giving rise to a very friendly input systems, which take input using human voice, i.e. when one speaks it takes the input. These devices convert human speech into electric signals that a computer can recognize. The device has a microphone through which spoken words are input to the computer. Within the computer there is a pre-stored vocabulary of about 100 to 200 words in the form of typical 'sound-patterns'. The voice-input word is then compared with and recognized with the vocabulary stored inside. These devices are used in those areas of application where one may not be free to use the keyboard e.g. in laboratories, quality control or even by disabled people. The great limitation is the vocabulary and modulation, which will surely be overcome and we can get voice response systems. Most of the voice recognition systems are speaker dependent. For example, talk writer.

**1.6.2 Output devices**

So far, we have dealt with how data and instructions can be generated as INPUT and is retrieved by us via the OUTPUT DEVICE. Like the former, there are many kinds of output devices.

**Hard Copy Devices**

Hard copy means that the output is in directly usable form, that is, in printed or plotted form. Hard copy devices produce a permanent record on media such as paper or microfilm. They are very slow in operation as compared to soft copy devices because these often involve mechanical movement. Following hard copy devices are very popular :

- Card and Tape Punch (now outdated)
- Printers
- Plotters
- Photographic output

**Card and Tape Punch**

These punching devices are output devices which look like the corresponding readers but in this case, the read units are replaced by punch units for punching holes. Speed of card punches are about 5 cards per second, and that of paper tape punchers are up to 300 characters per second.

**Printers**

Printed output are extremely popular as man immediately understand them. There are various kinds of printers as output devices viz. :

- Character Printers—which print a character at a time.
- Line Printers—which print a full line at a time.
- Page Printers—which print a full page at a time.

The above are examples of what are termed as IMPACT PRINTERS. In impact printer, a character is printed on the paper through physical contact between the print head and paper. Either the needle or a character is stuck on the paper through the ribbon. This creates a lot of noise when these printers work. NON-IMPACT printers are those in which printing is done without the 'contact' e.g. Laser Printing, Thermal Printing etc.

A further classification of printers can be done on the basis of the TYPE OF CHARACTERS used viz. Dot Matrix printers and Shaped character printers.

Printers are also classified on the basis of the quality of output and speed, where letter quality printing is best seen in electronic typewriters used for correspondence purposes. Printers of low speeds are the character printers like the DOT Matrix Printers, Daisy-Wheel Printers, Thermal Printers. Medium Speed printers are like the line printers that can be drum, chain or band based. High-speed printers are page printers like the Optical Laser printer and Electrostatic printers.

Let us now analyse the more commonly used printers one by one.

**Impact Printers**

These are those type of printers which have direct mechanical contact between the head of the printer and paper.

**Character Printers**

Character printers form one letter at a time on the paper. Typically, they do this in one of two ways.

**Dot Matrix**

The dot-matrix printer is a widely used inexpensive printer capable of operating at speeds of 30 to 200 characters per second. Each character in this print type is a collection of dots in a rectangular matrix. Thus the name dot matrix has come to these printers. The printing head of these printers contain vertical array of pins, which fires the selected pins against carbon ribbon or

inked surface, while the head moves across the paper to form a pattern of dots representing characters. In these type of printers individual characters are formed by needles which hit against the ribbon selectively forming patterns of dots. These printers are versatile as their character set can be changed so that different styles and graphic symbols can be printed. The print quality of dot matrix printers is inferior. These printers can print characters in draft quality, standard quality as well near letter quality.

Non-impact printers such as ink-jet, thermal and electrostatic units also use the dot-matrix technique. It comes in two print head specifications, 9 pins and 24 pins.

Examples are EPSON EX 1000, EPSON LQ 1050, CITIZEN MSP 55, GODREJ, etc.

### **Daisy Wheel**

This printer is a solid font type character printer. The quality of print of this printer is good. Daisy wheel printer is named as such because the print head resembles a daisy flower, with the printing arms appearing like the petals of the flower. The daisy wheel printer uses shaped characters at a speed of about 40 characters per second. The print head is a 60 mm diameter, spoke rimmed wheel in which each spoke contains a single character at the end of the spoke. Printing is performed by the rotation of the wheel to the appropriate spoke at the print-location. It is a bi-directional printer, i.e. the head of the printer prints while moving in forward direction as well as in backward direction. Daisy wheel printer is a letter quality printer because it produces solid characters unlike broken characters formed by a dot matrix printer. The font (i.e. style of character) is of fixed type for a Daisy Wheel printer. This printer is relatively expensive, produces high quality printing but is still slow in printing.

### **Line Printers**

Line printers are also impact printers using shaped characters. These can be barrel/drum printers or chain/band printers. These printers print a complete line at a time. The drums, chains or bands have letters marked on them and rotate at a uniform speed. The paper passes between the drum, chain or band and a row of hammers strike the character image through a carbon ribbon, as the required characters pass the print positions. Line Printers are capable of operating at speeds of 300 to 1200 lines per minute and each line contains about 132-136 print positions. Line printers sacrifice quality of print for speed.

### **Page Printers**

Optical laser printer and electrostatic printers have facilitated the

printing of matter, a complete page at a time. These are high-speed printers capable of operating at speeds of 30-250 pages per minute, but due to their extremely high costs, are not very popular. Laser printers use character type made of dots, but the dots are so closely placed that they look like shaped characters.

### **Non-Impact Printers**

These are those types of printers where there is no direct mechanical contact between the head of the printer and paper. There is no impact or hitting of needles, so non-impact printers don't make any noise while printing. They come in many varieties :

- Thermal Printer
- Laser Printer
- Ink Jet Printer
- Electrostatic Printer

### **Thermal Printer**

Thermal printers, the slowest of the non-impacts, form characters by burning them on specially treated paper. In a thermal printer pressing an array of electrically heated needles against heat sensitive paper forms the characters. Such papers have a special heat sensitive coating that becomes dark when a spot is heated. Character is printed with a matrix of dots that are heated by the needles.

This printer's basic disadvantages are that it uses special type of paper. It isn't possible to produce multiple copies simultaneously with this type of printer. A special type of paper is used with this printer, that is costly. This has reduced the popularity of thermal printers. Operating at about thirty characters per second, they are sometimes built into microcomputers, especially portable and lap sized versions.

### **Laser Printer**

When cost is not the criteria, and the quality is important, then the most suitable printer is a laser printer. Laser printer works on the concept of using laser beams to create an image on a photosensitive surface. Initially the desired output image is written on a copier drum with a laser beam that operates under the control of the computer. These type of printers use laser beams which charge the drum negatively, to which black toner powder which is positively charged is stucked. The toner is permanently fused on paper with heat and/or pressure by rolling the drum over the blank paper. Laser printers are quiet and produce very high quality of output. They are capable of printing 4-30 pages per minute.

**Ink Jet Printer**

Ink Jet printer uses dot matrix approach to print text and graphics. This is an expensive but faster printing device. Nozzles in the print head produce tiny ink droplets. This printer uses a mechanism where it sprays ink from tiny nozzles through an electric field that arranges charged particles ink into characters. The paper absorbs the ink and it dries instantaneously. It has a speed of 40-300 cps (character per second) with software controls on size and style of characters. These printers support colour printing and are very quiet and noiseless in operation. The print quality of such printers is very near letter-quality. These types of printers are very reliable.

**Electrostatic printer**

An electrostatic printer moves a continuous sheet of paper over the print in pins that put small electric charges on the paper. The paper then passes through a toner solution. Particles of ink adhere to the charged areas of the paper. When the paper is heated, the particles melt, thus producing the characters. Some electrostatic printers print upto 5,000 lines per minute. Such printers use dot-matrix approach for printing. The print head contains a vertical array (i.e. a vertical column) of pins. Such printers can also produce graphics. Electrographic printers can be quite fast. A Honeywell model, for example prints upto 18,000 lines (about 300 pages) per minute.

**Plotters**

Plotters are printers of a special kind in which there is an ink pen (or many ink pens in the case of coloured plotters) that moves up, down and across. The graphics and drawings produced by plotters are uniform and precise and of very high quality. Plotters are output devices that are used to produce precise and good quality graphics and drawings under computer control. Plotters are used widely in scientific and engineering fields, complex engineering drawing and for drawing of maps that require high degree of accuracy and have to be used for CAD purposes (Computer Aided Design).

**Photographic Output**

It is in the form of a high-resolution image on the photographic film. It is capable of storing large quantities of data in readable character form in a relatively small space e.g. microfilm.

**Micro Film**

The computer output Microfilm device is very expensive and specially made for extensive computer users. Information stored on magnetic tapes is made into miniature images on the microfilm. The information is displayed as characters on the VDU, and by using photographic methods, it is recorded on to a film, usually, a 16-35 mm roll film. Drawings, picture and narrative text,

on a full display (equivalent to a page of line punch output), is recorded as a single frame. A special reader of printer can be used to view the processed film. The speed of recording is 25-50 times faster than the average line printers. Its density is very high. it is used to store data for future viewing.

### **Soft Copy Devices**

Soft copy is magnetic/audible form that cannot be used directly. These devices do not produce a permanent record. Following soft copy devices are very popular :

- Visual Display Unit (VDU)
- Liquid Crystal Display (LCD) used in laptop computers
- Audio Response Unit (ARU)

### **Visual Display Unit**

Where temporary and quick retrieval of information is needed Visual Display Units is the best output terminal that can be used. It is the most commonly used output device. The VDU uses a cathode ray tube to display information. The screen enables the user to check the accuracy of both the INPUT and the OUTPUT. The characters are generated from a 'dot matrix' where a selected pattern of dots is illuminated to form a character. The input errors can be corrected instantly—without wasting anytime. A specialized and expensive form of VDU is the graphics VDU which is able to display graphics. VDUs can be the ordinary black and white variety or the coloured variety.

There are many types of VDU based on different characteristics :

1. Text and Graphics
2. Monochrome and Coloured.

**1. Text and Graphics :** Certain VDUs are capable of displaying a character set such as that provided by the ASCII code. The output of a computer is best presented in graphical form. For that a graphical monitor is required which has a high degree of resolution and the screen is divided into rows and columns of dots called pixels.

**2. Monochrome and Colour Monitor :** Monitors capable of displaying only a single colour image are called monochrome monitors. It has only one electron gun. Colour monitor is capable of displaying upto 17 million colors using combinations of basic colours. It has different colours. Generally two types of coloured monitors are used :

RGB (RED, GREEN, BLUE)

CMYK (CYAN, MAGNETA, YELLOW and 'K' FOR BLACK)

RGB colour monitor has three electron guns and the screen is coated with three types of phosphors : Red, Green and Blue.

### **Liquid Crystal Display**

This is like the display in digital watches and calculators where Liquid

Crystal Display (LCD) is used. Here there is a flat panel and does not have a picture tube. It works on the principle that when high voltage is applied, the crystals line up in such a way that it blocks the light passing through them and in absence of light is seen as the characters on the screens. These panels are a lot better than CRTs as they do not flicker and cause strain to the eyes.

### **Audio Response Unit**

Transient information, or any information that need to be conveyed on once, could be utilised in such a manner that the OUTPUT can be retrieved by an AUDIO RESPONSE UNIT. Here, the messages have to be composed and transmitted in coded form over telephone lines through a Voice-input system or by using a keyboard for INPUT. The response is assembled from pre-recorded words and phrases after the input is analysed, and the response is delivered clearly and more slowly than human verbal replies. ARU permits computers to talk to people. It works in the following manner. All the sounds needed to process the possible inquiries are provided on a storage medium. Each sound is given a code. When enquiries are received, the processor follows a set of rules to create a reply message in a coded form. This coded message is then transmitted to an audio-response device. The sounds are assembled in proper sequence.

A common example of an ARU is the way messages and train schedules are narrated on railway stations having automatic enquiry system.

### **1.6.3 Storage Devices**

The primary stroage memory cannot hold data or instructions once the computer is switched off. Therefore, a computer requires more stable (non-volatile) type of memory so that it can store all the data (files) and instructions (software programs) even after the computer is turned off. This kind of memory is known as *secondary memory* or *auxiliary memory* or *peripheral storage* or *secondary storage*. As opposed to primary storage, which the Central Processing Unit (CPU) uses for processing data and instructions, secondary storage is used to store data and programs when they are not being processed. Secondary storage includes devices like hard disks, floppies, CD-ROMs, and magnetic tapes. These devices have a larger (and more permanent) storage capacity and they are less expensive as compared to primary storage devices, but they are slow in comparison.

#### **Magnetic Tape**

It is oldest type of secondary storage device. Magnetic tape mechanism is similar to the commonly used audio tape recorders. It is a plastic tape with magnetic coating. The data is stored in the form of tiny segments of magnetised and de-magnetised portion on the surface of material. Magnetised portion of

the surface refers to the bit value '1' where as demagnetised portion refers to the bit value '0'. Tapes come in a number of forms, including ½-inch wide tape wound on a reel, ¼-inch wide tape in data cartridges and cassettes, and tapes that look like ordinary music cassettes but are designed to store data instead of music.

The major differences between magnetic tape units are the speed at which the tape is moved past the read/write head and the density of the recorded information. The amount of data or the number of binary digits that can be stored on a linear inch of tape is known as the tape's recording *density*.

Magnetic tapes are very durable and can be erased as well as reused. These tapes are the least expensive and reliable storage medium for organising archives and taking backup. However, magnetic tapes are not suitable for data files that need to be revised or updated often because it stores data in a sequential manner. Being sequential access devices means that the user must advance or rewind the tape to the position where the requested data starts. Tapes are also slow due to the nature of the media. While data transfer can be increased by increasing the speed of the tape, this can lead to two problems. One, the heads are more likely to miswrite due to not having enough time to align the polarities of the magnetic particles, or may misread due to the tape not being under the head long enough. The other problem has to do with the durability of the tape media itself - the faster the tape is started, pulled, and stopped, the more it will stretch. If the tape stretches too much, then it will render it unusable for data storage, and data loss may result. The tape now has a limited role because disk has proved to be a superior storage medium.

**Advantages:**

- (1) Data-entry to CPU *from* magnetic tape is 100 times faster than the card readers.
- (2) Magnetic tape is used for input, output and very large amount of data storage.
- (3) Magnetic tape cassettes are easily transportable.
- (4) Magnetic tapes are available in varying densities.
- (5) Magnetic tapes hold high data recording density, resulting in low cost per bit of storage.

**Disadvantages:**

- (1) Loading and unloading of tape require much time.
- (2) Handling of the tape must be done carefully. Tapes should be kept in dust free environment and away from corrosive gases or chemicals.
- (3) Effect of magnetism and heat may damage the tapes.

- (4) It is necessary to check the accuracy of data is stored on the tape.
- (5) They are not flexible when file updating requires record insertion and deletion.

### **Magnetic Disk**

Magnetic disks are the most widely used and popular storage medium for direct access secondary storage. They offer high storage capacity, reliability, and have the capability to access the stored data directly. A magnetic disk comprises a thin piece of plastic/metal circular plate/platter, which is coated with magnetic oxide layer. Data is represented as magnetised spots on a disk. A magnetised spot represents as 1 (bit) and the absence of a magnetised spot represents a 0 (bit). To read the data, the magnetised data on the disk is converted into electrical impulses, which is transferred to the processor. Writing data onto the disk is accomplished by converting the electrical impulses from the processor into magnetic spots on the disk. The data in a magnetic disk can be erased and reused virtually infinitely. The disk is designed to reside in a protective case or cartridge to shield it from the dust and other external interference.

The surface of a disk is divided into imaginary *tracks* and *sectors*. Tracks are concentric circles where the data is stored. *Disk sectors* refer to the number of fixed- size areas that can be accessed by one of the disk drive's read/write heads, in one rotation of the disk, without the head having to change its position. An intersection of a track and a disk sector is known as *track sector*. Generally, a disk has eight or more disk sectors per track. However, different types of magnetic disk may have different number of tracks. Modern day disks are marked (tracks and sectors) on both surfaces, hence they are also known as *double-sided* disks.

In order to make the disk usable, first it must be *formatted* to create tracks and sectors. The formatting of a magnetic disk refers to the assignment of addresses to the different areas in the disk. Without formatting, there would be no way to store data into the disk. If a sector is corrupted after formatting, it will be marked as damaged, and the data saved on it will not be readable.

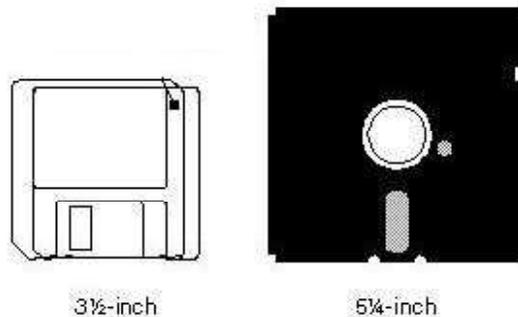
Frequently, multiple disks are maintained and used together to create a large disk storage *system*. Typically, *two, three, or more* platters are stacked on top of each (*disk pack*) other with a common spindle, which turns the whole assembly. There is a gap between the platters, making room for magnetic read/write head. There is a read/write head for each side of each platter, mounted on arms, which can move them towards the central spindle or towards the edge. This concept of stacking the disk is known as *cylinder*.

### Types of Magnetic Disk

Broadly, magnetic disks can be classified into three types: *floppy disk*, *hard drive* and *zip disk*.

#### Floppy Disk

It is the most popular secondary storage device used to transfer the files *from one PC to another Pc*. Floppy disk is made of plastic material. It is coated with magnetic oxide. It is normally covered with a plastic or cardboard sleeve *for protection*. A hole at the center is provided *for mounting disk drive hub*, and an another small hole *for index mark sensing*. The data is stored along concentric circles called tracks. A notch at the right side of the disk is used to protect floppy *form* writing over it. There are two standard sizes, 5½ inch and 8 inch. Now 8-inch floppy is outdated. A more recent development is 3½ inch. The capacity of floppy disk is varied (e.g. 360 KB, 1.2 MB, 2 MB, 1.44 MB etc.)



**Figure: Floppy disks**

The floppy disk is slipped into the drive mechanism for read/write operation. The mechanism holds the envelope and the flexible disk are rotated inside the envelope by the drive mechanism. The read/write head is in contact with a slit for operation. The head is moved radically. i.e. track to track. The floppy disk is a low cost device. Floppies have a speed limitation of about 360-RPM. A low-density floppy disk has 40 tracks, 9 sector per track and 515 bytes per sector. Floppy disks are used for data preparation, small business applications and word processing systems.

#### Hard Disk:

The **hard** disk, also called the **hard** drive or fixed disk, is the primary storage unit the computer. A hard disk consists of a stack of disk platters that are made up of aluminum alloy glass substrate coated with a magnetic material

and protective layers. The hard drive's speed is discussed in terms of access time (the speed at which the hard drive finds data), which is measured in milliseconds. The average drives have an access time of 9 to 14 ms. The lower the access time, the faster the hard drive. The capacity, or amount of information that a hard drive can store, is measured in bytes. Hard disk plays a significant role in the following important aspects of a computer system:

- **Performance:** The hard disk plays a very important role in overall system performance. The speeds at which the computer boots up and programs load are directly related to the hard disk speed. The hard disk's performance is also critical when multitasking is exercised.
- **Storage Capacity:** A bigger hard disk lets one store more software and data into it, thereby permitting the user to store large software related to complex processes such as graphics and multimedia.
- **Software Support:** Nowadays almost all software needs large storage space and faster hard disks to load them efficiently. Usually, older hard disks can barely hold the operating system and few uncomplicated software that does not require much space.
- **Reliability:** One way to assess the importance of any hardware component is to consider how much damage is caused in case it fails. By this standard, the hard disk is considered the successful storage component by a long way. A good quality hard disk, combined with smart maintenance and backup habits, can help ensure that the nightmare of data loss doesn't become part of daily life.

### **Zip disk**

Zip disk is a removable storage device and it has a capacity to store 100-250 MB of data. Zip disk's drive unit is measured at 18 x 13 x 4 cm and weighs about half kilogram. It has rubber feet to stabilise the unit in either vertical or horizontal position. The substrate for the disk is made up of plastic material on which magnetic oxide particles are coated. There are two indicator lights, green for power, and amber for disk access. It has an eject button, but no ON/OFF switch. It comes complete with drive, connection cable, power supply, operating software, and a starter 100 MB disk. After installation, you can transfer files to and from the zip drive as if you are accessing hard disk or floppy drive.

The zip disk is similar in diameter to that of the 3½-inch floppy diskette. However, one should keep in mind that although they may look similar to floppy disks, but a zip drive cannot read or write floppy disks and similarly a floppy drive cannot read/write data onto a zip disk. Either the zip drive can be built into the computer or it can be connected to the computer via a parallel or SCSI

cable. There are different versions of zip disks and drives available in the market. These versions can hold 100, 250, and 110 MB of data. As a zip disk can hold as much as 70 times of information as compared to a floppy disk, it can be used to store heavy graphics, music or presentation files.

#### **Advantages of Magnetic Disks**

- Magnetic disks follow direct access mode for reading and writing onto the data files, thereby making an ideal device for accessing frequently accessed data.
- Magnetic disks are easily moveable from one place to another because of their small size and lightweight.
- The data transfer rate of disks is much higher than magnetic tapes.
- Due to their low cost and high data recording densities, the cost per bit in magnetic disks is minimum.
- The storage capacity of these disks is virtually unlimited as numbers of such disks can be added to store data.
- Magnetic disks are less prone to the corruption of data as they can withstand the temperature and humidity change in a much better way as compared to magnetic tapes.

#### **Disadvantages of Magnetic Disks**

- Magnetic disks must be stored in a dust-free environment in order to protect them from crashing down.
- The cost of Magnetic disks storage is more costly than the cost of magnetic tapes.
- Magnetic disks are less secure than magnetic tapes.

#### **4.5 Optical Disk**

As compared to magnetic tape and magnetic disk, optical disk is a relatively new secondary storage medium. During the last few years, it has proved to be a promising random access medium for high capacity secondary storage, because it can store extremely large amounts of data in a limited space.

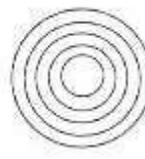
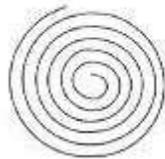
An optical-disk storage system consists of a rotating disk, which is coated with a thin metal or some other material that is highly reflective. Laser beam technology is used for recording/reading of data on the disk. Due to the use of laser beam technology, optical disks are also known as *laser disks* or *optical laser disks*.

Unlike magnetic disks, which have several concentric tracks, an optical disk has one long track, which starts at the outer edge and spirals inward to the center. This spiral track is ideal for reading large blocks of sequential data, such as music. However, it makes for slower random access time than the

concentric tracks used by magnetic disks, whose sectors can be located faster, because they are always found on a given track at a fixed -distance from the center.

(a) Track pattern on an optical disk

(b) Track pattern on a magnetic disk



Difference in track patterns on optical and magnetic disks.

Like a track on a magnetic disk, the track of an optical disk is split up into sectors, but with optical disks, each sector has the same length, regardless of whether it is located near the disk's center or away from the center. This type of data organization allows data to be packed at maximum density over the entire disk. However, it also requires a more complicated drive mechanism, because the rotation speed of the disk must vary inversely with the radius; the drive must slow down the disk's rotation speed to read sectors towards the outside of the disk, and speed it up to read sectors towards the center of the disk.

The cost-per-bit of storage is very low for optical disks, because of their low cost and enormous storage density. They come in various sizes, ranging from 12-inch to 4.7-inch diameter. The most popular one is of 5.25 inch diameter, whose capacity is around 650 Megabytes. This storage capacity is equivalent to about 2,50,000 pages of printed text.

### **Types of Optical Disks**

All optical disks are round platters. They come in different sizes and capacities. The two most popular types of optical disks in use are CD-ROM and WORM disks.

- **CD-ROM:** CD-ROM stands for Compact Disk-Read-Only Memory. It is a spin-off of music CD technology, and works much like the music CDs used in music systems. In fact, if you have a soundboard and speakers connected to your computer, you can play music CDs with your computer.

The CD-ROM disk is a shiny, silver color metal disk of 5½ inch (12 cm) diameter. It has a storage capacity of about 650 Megabytes. It is so called, because of its enormous storage capacity on a compact-size disk, and because it is a read-only storage medium. That is, these disks come

pre-recorded, and the information stored on them cannot be altered.

- **WORM Disk:** WORM stands for *write-once, read-many*. WORM disks allow the users to create their own CD-ROM disks by using a CD-recordable (CD-R) drive, which can be attached to a computer as a regular peripheral device. WORM disks, which look like standard CD-ROM disks, are purchased blank and encoded using a CD-R drive. The information recorded on a WORM disk by a CD-R drive can be read by any ordinary CD-ROM drive. As the name implies, data can be written only once on a WORM disk, but can be read many times. That is, as with a CD-ROM disk, once data has been etched on to the surface of a WORM disk, it becomes permanent, which can be read, but never altered.

**Advantages:**

1. The cost-per-bit of storage for optical disks is very low, because of their low cost and enormous storage density.
2. The use of a single spiral track makes optical disks an ideal storage medium for reading large blocks of sequential data, such as music.
3. Optical disk drives are more reliable storage medium than magnetic tapes or magnetic disks.
4. Optical disks have a data storage life in excess of 30 years.
5. Since data once stored on an optical disk becomes permanent, the danger of stored data getting inadvertently erased/overwritten is not there with optical disks.
6. Due to their compact size and light weight, optical disks are easy to handle, store, and port from one place to another.
7. Music CDs can be played on a computer having a CD-ROM drive along with a sound board and speakers. This allows computer systems to be also used as music systems, whenever desired.

**Limitations:**

1. It is a read-only (permanent) storage medium. Data once recorded, cannot be erased, and hence, the optical disks cannot be reused.
2. It is not easy to copy an optical disk, as it is to a floppy disk. One needs to have software and hardware for writing disks.
3. The data access speed for optical disks is slower than magnetic disks.
4. Optical disks require a more complicated drive mechanism than magnetic disks.

## Uses of Optical Disks

Optical disks are typically used for one or more of the following purposes:

1. For distributing large amounts of data at low cost. For example, a complete encyclopedia, dictionary, world atlas, dictionary of quotations, biographies of great people, information about all educational institutions of a particular type in a country, etc. are often distributed on CD-ROM disks.
2. For distribution of electronic version of conference proceedings, journals, magazines, books, product catalogs, etc.
3. For distribution of new or upgraded versions of software products by software vendors.
4. For storage and distribution of a wide variety of multimedia applications, such as video games.
5. For archiving of data, which are not used frequently, but which may be used once in a while.
6. WORM disks are often used by end-user companies to make permanent storage of their own proprietary information. For example, many banks use them for making a permanent record of their daily transactions.

## Magneto-Optical Disk

As implied by the name, these drives use a hybrid of magnetic and optical technologies, employing Laser to read data on the disk, while additionally needing magnetic field to write data. A magneto-optical disk drive is so designed that an inserted disk will be exposed to a magnet on the label side and to the light (laser beam) on the opposite side. The disks, which come in 3½-inch and 5½-inch formats, have a special alloy layer that has the property of reflecting laser light at slightly different angles depending on which way it is magnetised, and data can be stored on it as north and south magnetic spots, just like on a hard disk.

Magneto-optical drives use a laser to target and heat specific regions of magnetic particles. This accurate technique enables magneto-optical media to pack in a lot more information than other magnetic devices. Once heated, the magnetic particles can easily have their direction changed by a magnetic field generated by the read/write head. Information is read using a less powerful laser, making use of the *Kerr effect*, where the polarity of the reflected light is altered depending on the orientation of the magnetic particles. Where the laser/magnetic head has not touched the disk, the spot represents a '0', and the spots where the disk has been heated up and magnetically written will be seen as data '1'. However, this is a 'two-pass' process, which, coupled with ill

tendency for magneto-optical heads to be heavy, resulted in early implementations being relatively slow. Nevertheless, magneto-optical disks can offer very high capacity and cheap media as well as top archival properties, often being rated with an average life of 30 years, which is far longer than any magnetic media.

### **Mass Storage Devices**

In order to get vast amount of storage capacity of several bytes (trillions and more) in a computer system, a different kind of storage system is used. In such type of system, multiple units of similar kinds of storage media are associated together to form a chain of mass storage devices. These storage media may include multiple magnetic tape reels or cartridges, multiple arrays of magnetic disks or multiple CD-ROMs as a secondary storage device.

Broadly speaking, we can categorise mass storage devices into three types:

- **Redundant Array of Inexpensive Disks (RAID):** The basic idea of RAID is to combine multiple hard disks into an array of disk drives to obtain high performance, large capacity, and reliability that exceeds that of a single large drive. These arrays of drives appear to the host computer as a single logical drive.
- **Automated Tape Library:** An automated tape library comprises numerous set magnetic tapes along with their drives and controllers mounted in a single unit. The unit comprises one or more tape drives to perform read/write operations on the tapes in the tape library. In the multiple tape drive environment, these tapes can be simultaneously read or write, thus, resulting in the speedy rate of data transfer. Multiple drives lead to the reliability of the storage unit because if one of the drives fails, then the unit can continue to operate with other tape drives. These tape libraries, can store up to several terabytes of data.
- **CD-ROM Jukebox:** A CD-ROM jukebox comprises numerous set of CD-ROM disks along with their drives and controllers mounted in a single unit. The unit comprises one or more CD-ROM drives to perform read/write operations on the CD-ROM in the jukebox. In the multiply CD-ROM drive environment, these CD-ROMs can be simultaneously read or write, thus resulting in the speedy rate of data transfer. Multiple drives lead to the reliability of the storage unit because if one of the drives fails, then the unit can continue to operate with other CD-ROM drives. These jukeboxes can store up to several terabytes of data.

### **Benefits of Secondary Storage**

Modern computing systems consist of four hardware components: *central processing unit, memory, secondary storage, and input-output devices* that interact with end users. The input device is used for providing data to the computer. The CPU processes this data and provides the output via the output device. The secondary storage is used to store the data and instructions permanently. These data (files) and instructions (software programs) are then loaded in primary memory (RAM) so that the computer can process the data efficiently. Once the output is presented by the computer, if the user wants to, it is stored on the secondary storage.

Imagine how many filing-cabinet drawers would be required to hold the millions of files of, say, tax records kept by a big corporation. The record storage rooms would have to be enormous. Computers, in contrast, permit storage on a tape or disk in extremely compressed form. Storage capacity is unquestionably one of the most valuable assets of the computer. Secondary storage is the storage space where one can store software and data on a semi-permanent basis. It is necessary because primary storage can be used only temporarily. The user probably will like to store the data that he derives from processing; that is why secondary storage is needed. Furthermore, main memory is limited in size, whereas secondary storage media can store as much data as necessary.

#### **The benefits of secondary storage can be summarised as follows:**

- **Non-Volatility:** By nature, a secondary storage device is non-volatile, that is, it does not lose its contents even when its power is cut off. Hence, such devices do not require a continuous supply of electricity as the primary memory does.
- **Capacity:** Secondary storage devices are used by organisations so that they can store large volumes of data (equivalent of a room full of data on paper) in sets of disks that take up less space than a breadbox. A simple diskette holds the equivalent of 500 printed pages, or 1 book. An optical disk can hold the equivalent of approximately 500 books.
- **Reliability:** Data in secondary storage is safe because secondary storage is physically reliable. Sometimes, however, disks may fail, but the overall reliability of secondary storage is excellent. Moreover, it is more difficult to tamper or illegally access the data on secondary storage as compared to data stored in traditional file cabinets.
- **Convenience:** With the help of a computer, authorised people can locate and access data quickly.
- **Cost:** It is less expensive to store data on a tape or disk (the principal means of secondary storage) than to buy and house filing cabinets. Data

that is reliable and safe is less expensive to maintain than data subject to errors. Nevertheless, the greatest savings can be found in the speed and convenience of filing and retrieving data.

- **Reusability:** The data remains in the secondary storage as long as it is not overwritten or deleted by the user. When the data is placed in the RAM, the computer actually makes a copy of that data in the memory. The user can change the data as per requirement, and in case he wants to revert to the original copy, he can simply close the data file, as long as he has not saved the modified work. In that case, CPU will replace the original copy with the modified copy.
- **Portability:** Modern day storage devices like CD-ROMs and floppy disks are so small that they can be easily ported from one computer to another. In addition, since most of the storage devices are standardised, they can be used with almost every computer irrespective of their construct.

## 1.7 Software

The term software refers to the set of computer programs. To be precise, software means a collection of programs, whose objective is to enhance the capabilities of the machine.

### 1.7.1 System Software

System software is a term for the programs that handle the running of your computer's hardware. System software is a type of program that acts like a driver in a bus. This software controls all processing activities and ensures that the resources of the computer are used efficiently. It sets the rules for how the hardware and software work together. This is that software which is used for developing or running a computer system. It contributes to the control and improved performance of the computer system. MS DOS, UNIX and Microsoft Windows are examples of system software or operating system software. This software provides a wide variety of services and functions which makes the computer useful.

System software basically serves major purposes like :

- Used by the computer to do a task.
- It controls the execution of programs on the computer.
- It controls the internal function of the computer.
- It controls other devices connected to the CPU.

System software can be categorized as :

1. Operating systems (control programs)
2. Language Processors or Translators (Assemblers, Compilers, Interpreters)
3. Device Drivers (system testing tools)
4. Utility Programs etc.

Thus we can describe system software as a package which consists of various programs required for the functioning of the computer itself. It is also needed for translation, loading, controlling and running of the programs.

### **Operating systems :**

In between the hardware and the applications lies the operating system. The operating system is a program that conducts the communication between the various pieces of hardware like the video card, sound card, printer, the motherboard and the applications.

- The operating system is usually located on a disk.
- Can be on the hard disk drive, a floppy disk, or CD-ROM disk.
- Must be loaded into RAM before it can be used.
- Used by the computer's hardware to work with its parts.
- Tells the computer how to :
  - \* display information on the screen.
  - \* use a printer.
  - \* store information on a secondary storage device.
- The system software's that control peripherals are called drivers.
- Does basic tasks, like printing a document or saving a file.
- The operating system starts (launches) the application software so that it can be used.

### **Language Processors :**

#### **(a) Translators :**

A digital computer accepts digits and characters as input from an input device like keyboard; however this input is not understandable by the computer. To make the computer understand it, the input has to be converted into machine language. The software which does this and increases the productivity of the programmer is called Translator.

Translators are divided into three categories.

- (i) Compilers
- (ii) Interpreters
- (iii) Assembler

**(i) Compilers :** A compiler is software that will accept the total program code as input and then convert it into machine code. Compilers are the translators which translate high level language programs into machine code which is executed afterwards. For every language usually there is

a compiler which interprets and converts the program in that language into machine understandable code. Some of the important ones are COBOL, PASCAL, FORTRAN, Turbo C, etc.

- (ii) **Interpreters** : Interpreter also does the same task of converting the program code into machine code like compiler which takes the complete program as input, but interpreter takes the program code line by line and converts it into machine code. When coming to operational efficiency, compiler is more efficient than an interpreter. Most high level languages are compiler-based languages where as BASIC language is interpreter based.
- (iii) **Assembler** : An assembly language program cannot be directly executed by the computer. It also works the same way as compiler and interpreter but here, the input programs are in assembly language. The output is in machine language. The input to assembler program is an assembly language program known as source program and the output of assembler is a machine language program known as object program.

#### **Device Drivers :**

These are special programs which enhance the capability of operating systems, so that it can support many input/output devices. Device Drivers are special type of software created by peripheral device manufacturers to provide the facility to the computer to communicate with the peripheral device, e.g., printer drivers, mouse drivers, etc. These softwares are to be installed so that they are activated to work on the given operating system. Drivers convert the data supplied by the computer according to the device setting and then transfer to the device to work over it.

#### **Utilities :**

These utilities are those software programs which are provided by the manufacturer of hardware to perform some specific tasks on your computer. Examples of some of these tasks are file organizations.

Utilities allow you to

- Specific purpose application software used to help a computer work better or to avoid problems.
- Some utility programs are built into the operating system.
- Scandisk in the Windows operating system.
- Disk formatting software

Examples of utility programs

1. Anti-virus software
2. Disk maintenance software
3. File management programs
4. Security software

### **1.7.2 Application Software**

Application software programs work with the operating system to help you use your computer to do specific types of work such as specific inventory control reports, financial accounting, linear programming, or medical accounting tasks, payroll, examinations, human resources management etc. These software packages vary with the degree of sophistication, extent of coverage, and complexity. These applications must be user friendly, so that one can work by following easy and specific instructions, which are to be provided by the software.

It is subdivided into two broad categories depending upon the source of development as well as the users :

- Standard or Pre written Application Software
- Customized or User written Application Software

#### **Standard or Pre written Application Software**

These are generalized set of programs used to deal with a particular application. These are developed by group of people or an individual to be used by others to solve common problems faced by many users. These are usually sold in the market at specific prices, which act as the source of revenue for the developers of these software. They are user friendly and are helpful for general activities of an organisation or an individual, where one does not have time or knowledge to write their own programs, but can use these software for their use. It saves programming effort and expense on the part of the user and the user gets well tested and tried programs. Examples include MS-Office, WordStar, Lotus Smart Suite, Tally, Adobe PageMaker, Adobe Photoshop, etc. One major class of standard application packages is ERP (Enterprise Resource Planning) packages like SAP, Oracle, etc. Some common tasks done by those application software

- Planning
- Writing
- Record keeping
- Calculating
- Communicating
- Drawing
- Painting

What can be done with general purpose application software is only limited by the imagination of the user.

The various types are :

- (i) Word processing software
- (ii) Electronic spread sheets
- (iii) Database management software
- (iv) Report generator

(v) Communication software

**(i) Word Processing Softwares**

These are that software, which helps in creating documents, manipulating, formatting and printing of the text in documents e.g. WordStar, Microsoft Word etc. are some of the available word processing software.

**(ii) Electronic Spreadsheets**

Electronic spreadsheets are like sheets of paper with rows and columns. In these data can be entered as numbers, characters, formulae and all other types of data which has to be entered in the form of a table. Electronic spreadsheets have significant advantages over paper. Some of the advantages are :

- (a) These are flexible and changes can be made easily.
- (b) Various in built functions can be used.
- (c) Calculations can be carried out automatically.
- (d) On updating data recalculating is done automatically.
- (e) Columns and rows can be resized.
- (f) Data can be easily inserted and deleted.

Examples of spreadsheet software are Lotus 1-2-3, Microsoft-Excel, etc.

**(iii) Database Management Software**

Data can be organised in a collection of logically related tables called a database. The most commonly used database in our day-to-day life are Dictionary, where words are arranged alphabetically alongwith their meaning and the telephone directory, where the telephone numbers alongwith the name and address are arranged in alphabetical order. The data has to be managed so that the retrieval of information is effective and easy. Managing data involves creating deleting, updating, adding, modifying data in databases. Database Management Software or System (DBMS) is a software package that allows a user to perform above functions. Some of the DBMS packages commonly used by people for personal computing are dBASE, FOXPRO, Microsoft Access, Oracle etc.

**(iv) Report Generator**

Timely reports of various activities are always needed in day-to-day operations to help in decision making. If these reports are made manually it is a very difficult task, therefore some software are used to help a user to design a report, with ease and within time. Some of the commonly available report generating software are Oracle reports, Crystal reports etc.

**(v) Communication Software**

Communication is required for all operations. Effective communication i.e. sending and receiving data plays a key role in the smooth running of any organisation or day-to-day life. There can be an electronic data transfer between two different computers in a network using communication lines, satellites

etc. The concept of E-Mail, i.e., electronic mail has become the order of the day, where one can communicate with anyone throughout the world by sending a mail electronically.

### **Customized or User written Application Software**

These are programs written by the user programmer in order to perform specific jobs for the user. They are written in a variety of programming languages depending on the task at hand. Normally these are sets of programs used in conjunction with one another, e.g., Payroll System, Customized Accounting Packages for a company, etc.

So major difference between System Software and Application Software is :

<b>System Software</b>	<b>Application Software</b>
This includes the operating system (Windows 98, for example) and all other programs that allow the computer to function.	This includes programs that are used by the computer operator such as word processors (Microsoft Word, for example), games, spreadsheets, etc.

### **1.8 Summary**

Computers are versatile machines and are found to be used in various application areas like science & technology, commerce & industry, education & research, medicine, law, transport & Communication, home, entertainment, etc. A computer can perform both arithmetical as well as logical operations. The major characteristics of computer are speed, storage, accuracy, automatic, diligence, and versatility etc.

The peripheral devices of a computer; referred to as I/O devices, provide an efficient mode of communication between the central system and the outside environment. A computer serves no purpose without the ability to receive information from an outside source and transmit back the results in a meaningful form. The most familiar means of entering information into a computer is through the keyboard, mouse, punched card readers, tapes and disks, etc. The output can be in any form i.e. typed, printed, sketched, visible nonviable, audio, video etc. Similarly a number of output devices are available on which the computer system can give its processing results like printer, computer screen (VDU), plotter, disks, etc.

*Secondary memory* refers to the memory, which can store all the data (files) and instructions (software programs) even after the computer is turned off. It includes devices like hard disk, floppy disk, CD-ROM, and tape drives. *Secondary*

*storage* comes with many benefits, that is, non-volatility, capacity, reliability, convenience, cost, reusability, and portability.

Hardware needs software or programs, to work. Software is of two types: system software and application software. Programs designed to act as interface between the hardware and application programs are called system software. System software coordinates and controls the computer hardware. Application software is designed to do a specific task or solve a specific problem. Application software includes special-purpose and general-purpose programs.

### **1.9 Keywords**

Input, processing, Output, Vacuum tubes, Transistors, Integrated circuits. Input devices, output devices, hard copy devices, VDU, LCD, soft copy devices, printers, plotters. Hardware, Software, System Software, Operating Systems, Translators, Compilers, Assembler, Interpreters, Device drivers, Utilities.

### **1.10 Self check exercise**

- Q1 :- What are the major characteristics of the computer that make it such a powerful device ?
- Q. 2: Define an Input device and list names of various Input devices you know of.
- Q. 3: What are various kinds of printers ? Classify them and give five suitable examples.
- Q. 4: Define and distinguish between Application Software and System Software.
- Q. 5 : What is the importance of System Software for a Computer System ?

### **1.11 Suggested readings**

- “Computer Fundamental” By P.K. Sinha,  
BPB Publications, New Delhi
- “Information Technology” By P.S.G. Kumar,  
BR Publishing Corporation, New Delhi

**INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT):**  
**CONCEPT AND IMPACT ON SOCIETY**

- 1. Introduction**
- 2. Advantages of ICT**
- 3. Disadvantages of ICT**
- 4. Impact of ICT on Society**

**1. Introduction**

There is widespread research interest in information and communication technologies (ICTs). ICTs are crucially important for sustainable development in developing countries, for the past two decades most developed countries have witnessed significant changes that can be traced to ICTs. These multi-dimensional changes have been observed in almost all aspects of life: economics, education, communication, and travel. In a technology-driven society, getting information quickly is important for both sender and receiver. ICTs have made it possible to quickly find and distribute information.

The technological changes that have influenced our lives in recent years, information technology (IT) has had the greatest impact. This will continue at least until the end of the first half of the century, when other major technological breakthroughs in the area of new materials, biotechnology, or energy, may provide entirely new ways of living.

An information society is one that makes the best possible use of ICTs. We support this view by describing it as a society in which the quality of life, as well as prospects for social change and economic development, depends increasingly upon information and its exploitation. In such a society, living standards, patterns of work and leisure, the education system and marketplace are all influenced by advances in information and knowledge. This is evidenced by an increasing array of information-intensive products and services.

The information society is a way for human capacity to be expanded, built up, nourished, and liberated by giving people access to tools and technologies, with the education and training to use them effectively. There is a unique opportunity to connect and assist those living in the poorest and most isolated regions of the world. Informatization of society is a major hurdle that most

nations, especially developing countries, are encountering. The information society or information age is a phenomenon that began after 1950, which brings challenges as we seek to integrate and expand the universe of print and multimedia sources. The two terms are often used to describe a cybernetic society in which there is a great dependence on the use of computers and data transmission linkages to generate and transmit information.

In the past few decades there has been a revolution in computing and communications, and all indications are that technological progress and use of information technology will continue at a rapid pace. Accompanying and supporting the dramatic increases in the power and use of new information technologies has been the declining cost of communications as a result of both technological improvements and increased competition. According to Moore's law the processing power of microchips is doubling every 18 months. These advances present many significant opportunities but also pose major challenges. Today, innovations in information technology are having wide-ranging effects across numerous domains of society and policy makers are acting on issues involving economic productivity, intellectual property rights, privacy protection and affordability of and access to information. Choices made now will have long-lasting consequences and attention must be paid to their social and economic impacts.

One of the most significant outcomes of the progress of information technology is probably electronic commerce over the Internet, a new way of conducting business. Though only a few years old, it may radically alter economic activities and the social environment. Already, it affects such large sectors as communications, finance and retail trade and might expand to areas such as education and health services. It implies the seamless application of information and communication technology along the entire value chain of a business that is conducted electronically.

### **ICTs for Informing Citizens**

One of the identified agents through which the world will constantly experience change is technology. In the business of trying to make information available in the right form to the right user both at the personal and organizational levels, and at the right time, the bid to cope with great flood of information has led to the need for a more sophisticated way of handling information faster and better.

Information technology is "the use of manmade tools for the collection, generation, communication, recording, re-management and exploitation of information. It includes those applications and commodities, by which information is transferred, recorded, edited, stored, manipulated or

disseminated". The information technology is a revolution which has penetrated almost all fields of human activity, thus transforming economic and social life.

ICTs have been the basis for human existence from time immemorial and this has driven man to continuously seek ways to improve the processing of information and communicating such information to one another irrespective of distance and on a real-time basis. Surviving in the information age depends on access to national and global information networks. ICTs are the bedrock for the survival and development of any nation in a rapidly changing global environment, and it challenges us to devise initiatives to address a host of issues such as reliable infrastructure, skilled human resources, open government, and other essential issues of capacity building.

At the heart of technology lie two main or branches of technology: computing and telecommunication. The technologies covered are the computer system, Internet/electronic mail (e-mail), mobile phone, and fax machine.

### **Computers**

Computers were originally used by scientists for calculating numbers, and have gradually become useful in offices and industries. In recent times, simplified models that can be used by almost everybody have become common in schools and homes for accomplishing many varied tasks and applications.

The uses that computers are now commonly put to: writing letters, and reports, printing books, newspapers, and magazines, drawing pictures and diagrams, doing statistics, mathematics and handling financial records, controlling traffic lights, flying aeroplanes, making and playing music and video, sending messages anywhere in the world.

### **Internet**

The Internet is a global collection of many types of computers and computer networks that are linked together. It is increasingly becoming the solution to much information, problems, information exchange, and marketing. The Internet is a mixture of many services with the two most commonly used being electronic mail (e-mail for short) and the World Wide Web (www). It plays a significant role in education, health, political processes, agriculture, economy, businesses and newsgroups, with Internet connectivity; one can do business all over the world without physical contact with the buyer or the need for a business intermediary.

### **E-mail**

Electronic mail (e-mail) is the exchange of text messages and computer files transmitted via communications networks such as the Internet. Fapohunda

sees the e-mail system as the equivalent of postal mailing services, with the biggest difference being the time and cost involved. And not only written data, but all sorts of information in the form of video, audio, or photographs, can be sent via e-mail. Oketunji describes e-mail as an increasingly popular method of communication, especially in the workplace.

### **Mobile Phones**

Bittner defines mobile phones as a telephone system that can move or be moved easily and quickly from place to place. Mobile phones were once the tool of rich and busy executives who could afford both the luxury. Mobile phones are now the ICT that is reshaping and revolutionizing the communications globally. Its impact on the economic activities of nations, businesses, and small entrepreneurs is phenomenal. According to Marcelle the availability of this new technology has been reshaping the material basis of the society as well as bringing about a profound restructuring of economic, political and cultural relations among states.

According to Tiemo, the importance of information cannot be overemphasized. People need information to plan and carry out their decisions. More than 90 percent of Africa's population could greatly benefit from information on better choice of food, safe water and basic nutrition, child care, family planning, immunization, prevention and control of endemic diseases. The combination of modern communication devices could play significant roles in the collection and dissemination of global information. Oji-Okoro supported this view by stating that mobile telephony usage by individuals enables them to communicate with loved ones, clients and business associates. For large businesses, it is a means of providing a service that leads to an increase in profits. For governments, revenues are gained through taxes and duties. As a tool for sustainable livelihoods, mobile telephones provide employment for many who could have been idle.

### **Fax machine**

Telefacsimile systems permit the transaction of images (photos, printed images, maps, drawings) and their reproduction on paper at a remote receiver. Facsimile (fax) is not a new service; however, advances in digital imaging technology and microelectronics have caused a sharp drop in prices with a significant increase in capacities. "Long distance copying" might be an appropriate nickname for this telecommunication process. Any document, whether it is handwritten, contains pictures, diagrams, graphs, charts or typed text can be transmitted at a great speed for relatively low cost. The fax system is widely available; most organizations have at least one fax machine.

## **2. Advantages of ICT**

ICTs stand for information and communication technologies and are defined, for the purposes, as a “diverse set of technological tools and resources used to communicate, and to create, disseminate, store, and manage information.” These technologies include computers, the Internet, broad casting technologies (radio and television), and telephony.

### **The Effectiveness of ICTs in Education**

ICTs are a potentially powerful tool for extending educational opportunities, both formal and non-formal, to previously underserved constituencies—scattered and rural populations, groups traditionally excluded from education due to cultural or social reasons such as ethnic minorities, girls and women, persons with disabilities, and the elderly, as well as all others who for reasons of cost or because of time constraints are unable to enroll on campus.

- ***Anytime, anywhere.*** One defining feature of ICTs is their ability to transcend time and space. ICTs make possible asynchronous learning, or learning characterized by a time lag between the delivery of instruction and its reception by learners. Online course materials, for example, may be accessed 24 hours a day, 7 days a week. ICT-based educational delivery (e.g., educational programming broadcast over radio or television) also dispenses with the need for all learners and the instructor to be in one physical location. Additionally, certain types of ICTs, such as teleconferencing technologies, enable instruction to be received simultaneously by multiple, geographically dispersed learners (i.e., synchronous learning).

- ***Access to remote learning resources.*** Teachers and learners no longer have to rely solely on printed books and other materials in physical media housed in libraries (and available in limited quantities) for their educational needs. With the Internet and the World Wide Web, a wealth of learning materials in almost every subject and in a variety of media can now be accessed from anywhere at anytime of the day and by an unlimited number of people. This is particularly significant for many schools in developing countries, and even some in developed countries, that have limited and outdated library resources. ICTs also facilitate access to resource persons, mentors, experts, researchers, professionals, business leaders, and peers—all over the world.

### ***ICTs help prepare individuals for the workplace.***

One of the most commonly cited reasons for using ICTs in the classroom has been to better prepare the current generation of students for a workplace where ICTs, particularly computers, the Internet and related technologies, are becoming more and more ubiquitous. Technological literacy, or the ability to use

ICTs effectively and efficiently, is thus seen as representing a competitive edge in an increasingly globalizing job market.

### **Benefits/Advantages of ICT in Education**

Here are some of the benefits which ICT brings to education according to recent research findings.

#### **General benefits**

- Greater efficiency throughout the school.
- Communication channels are increased through email, discussion groups and chat rooms
- Regular use of ICT across different curriculum subjects can have a beneficial motivational influence on students' learning.

#### **Benefits for teachers**

- ICT facilitates sharing of resources, expertise and advice
- Greater flexibility in when and where tasks are carried out
- Gains in ICT literacy skills, confidence and enthusiasm.
- Easier planning and preparation of lessons and designing materials
- Access to up-to-date pupil and school data, any time and anywhere.
- Enhancement of professional image projected to colleagues.
- Students are generally more 'on task' and express more positive feelings when they use computers than when they are given other tasks to do.
- Computer use during lessons motivated students to continue using learning outside school hours.

#### **Benefits for students**

- Higher quality lessons through greater collaboration between teachers in planning and preparing resources.
- More focused teaching, tailored to students' strengths and weaknesses, through better analysis of attainment data.
- Improved pastoral care and behavior management through better tracking of students
- Gains in understanding and analytical skills, including improvements in reading Comprehension.
- Development of writing skills (including spelling, grammar, punctuation, editing and re-drafting), also fluency, originality and elaboration.
- Encouragement of independent and active learning, and self-responsibility for learning.
- Flexibility of 'anytime, anywhere' access.
- Development of higher level learning styles.

- Students who used educational technology in school felt more successful in school, were more motivated to learn and have increased self-confidence and self-esteem.
- Students found learning in a technology-enhanced setting more stimulating and student-centred than in a traditional classroom.
- Broadband technology supports the reliable and uninterrupted downloading of web-hosted educational multimedia resources
- Opportunities to address their work to an external audience
- Opportunities to collaborate on assignments with people outside or inside school

### **Benefits for parents**

- Easier communication with teachers
- Higher quality student reports – more legible, more detailed, better presented
- Greater access to more accurate attendance and attainment information
- Increased involvement in education for parents and, in some cases, improved self-esteem
- Increased knowledge of children's learning and capabilities, owing to increase in learning activity being situated in the home
- Parents are more likely to be engaged in the school community
- You will see that ICT can have a positive impact across a very wide range of aspects of school life.

### **ICT and Raising Standards**

Recent research also points to ICT as a significant contributory factor in the raising of standards of achievement in schools.

- Schools judged by the school inspectors to have very good ICT resources achieved better results than schools with poor ICT.
  - Schools that made good use of ICT within a subject tended to have better achievement in that subject than other schools.
  - Socio-economic circumstances and prior performance of pupils were not found to be critical.
  - Secondary schools with very good ICT resources achieved, on average, better results in English, Mathematics and Science than those with poor ICT resources.
- A range of research indicates the potential of ICT to support improvements in aspects of literacy, numeracy and science.
- Improved writing skills: grammar, presentation, spelling, word recognition and volume of work.
  - Age-gains in mental calculations and enhanced number skills, for example the use of decimals.

- Better data handling skills and increased ability to read, interpret and sketch graphs Improvements in conceptual understanding of Mathematics (particularly problem solving) and Science (particularly through use of simulations)

### **The use of ICTs helps improve the quality of education**

ICTs can enhance the quality of education in several ways: by increasing learner motivation and engagement by facilitating the acquisition of basic skills, and by enhancing teacher training. ICTs are also transformational tools which, when used appropriately, can promote the shift to a learner-centered environment.

**Motivating to learn.** ICTs such as videos, television and multimedia computer software that combine text, sound, and colorful, moving images can be used to provide challenging and authentic content that will engage the student in the learning process. Interactive radio likewise makes use of sound effects, songs, dramatizations, comic skits, and other performance conventions to compel the students to listen and become involved in the lessons being delivered. More so than any other type of ICT, networked computers with Internet connectivity can increase learner motivation as it combines the media richness and interactivity of other ICTs with the opportunity to connect with real people and to participate in real world events.

**Facilitating the acquisition of basic skills.** The transmission of basic skills and concepts that are the foundation of higher order thinking skills and creativity can be facilitated by ICTs through drill and practice. Educational television programs such as Sesame Street use repetition and reinforcement to teach the alphabet, numbers, colors, shapes and other basic concepts. Most of the early uses of computers were for computer-based learning (also called computer-assisted instruction) that focused on mastery of skills and content through repetition and reinforcement.

**Enhancing teacher training.** ICTs have also been used to improve access to and the quality of teacher training. For example, At Indira Gandhi National Open University, satellite-based one-way video- and two-way audio-conferencing was held in 1996, supplemented by print-materials and recorded video, to train 910 primary school teachers and facilitators from 20 district training institutes in Karnataka State. The teachers interacted with remote lecturers by telephone and fax

### **Examples of ICT-based activities**

What kinds of classroom activities are suited to the use of ICT? The following is a brief guide to some of the most common uses of ICT in teaching and learning.

#### **Finding out**

Students can use ICT to find out information and to gain new knowledge in several ways. They may find information on the Internet or by using an ICT-based encyclopedia such as Microsoft Encarta. They may find information by extracting it from a document prepared by the teacher and made available to them via ICT, such as document created using Microsoft Word or a Microsoft PowerPoint slideshow. They may find out information by communicating with people elsewhere using email, such as students in a different school or even in a different country.

### **Processing knowledge**

Students can use ICT as part of a creative process where they have to consider more carefully the information which they have about a given subject. They may need to carry out calculations (eg. by using Microsoft Excel), or to check grammar and spelling in a piece of writing (perhaps using Microsoft Word), or they may need to re-sequence a series of events (for example by re-ordering a series of Microsoft PowerPoint slides).

### **Sharing knowledge**

Students can use ICT to present their work in a highly professional format. They can create documents and slideshows to demonstrate what they have learned, and then share this with other students, with their teacher and even via email with people all around the world.

### **Computers and the Internet use for teaching and learning**

There are three general approaches to the instructional use of computers and the Internet, namely:

- 1) Learning about computers and the Internet, in which technological literacy is the end goal;
- 2) Learning with computers and the Internet, in which the technology facilitates learning across the curriculum; and
- 3) Learning through computers and the Internet, integrating technological skills development with curriculum applications.

### ***Learn about computers and the Internet***

Learning about computers and the Internet focuses on developing technological literacy. It typically includes:

- Fundamentals: basic terms, concepts and operations
- Use of the keyboard and mouse
- Use of productivity tools such as word processing, spreadsheets, data base and graphics programs
- Use of research and collaboration tools such as search engines and email

- Basic skills in using programming and authoring applications such as Logo or HyperStudio
- Developing an awareness of the social impact of technological change.

### ***Learning with computers and the Internet***

Learning with the technology means focusing on how the technology can be the means to learning ends across the curriculum. It includes:

- Presentation, demonstration, and the manipulation of data using productivity tools
- Use of curriculum-specific applications types such as educational games, drill and practice, simulations, tutorials, virtual laboratories, visualizations and graphical representations of abstract concepts, musical composition, and expert systems
- Use of information and resources on CD-ROM or online such as encyclopedia, interactive maps and atlases, electronic journals and other references.
- Technological literacy is required for learning with technologies to be possible, implying a two-step process in which students learn about the technologies before they can actually use them to learn.

### ***Learning through computers and the Internet mean***

Learning through computers and the Internet combines learning about them with learning with them. It involves learning the technological skills “just-in-time” or when the learner needs to learn them as he or she engages in a curriculum-related activity.

### ***Computers and the Internet used in distance education***

Many higher educational institutions offering distance education courses have started to leverage the Internet to improve their programme’s reach and quality.

### **3. Disadvantages of ICT**

One of the major barriers for the cause of ICT not reaching its full potential in the foundation stage is teacher’s attitude. According to Hara, within the early years education attitudes towards ICT can vary considerably. Some see it as a potential tool to aid learning whereas others seem to disagree with the use of technology in early year settings. Blatchford and Whitebread, suggests that the use of ICT in the foundation stage is “unhealthy and hinders learning”. Other early years educators who are opposed to offering ICT experiences within the educational settings take a less extreme view than this and suggest that ICT is fine, but there are other more vital experiences that young children will benefit from. In theory some people may have the opinion that the teachers who had not

experienced ICT throughout their learning tend to have a negative attitude towards it, as they may lack the training in that area of the curriculum.

Another important drawback to using ICT in schools is the fact that computers are expensive. According to the IT learning exchange, in most schools ICT will be the single largest curriculum budget cost. This may be seen as a good thing but on the other hand there will be little money left over for other significant costs.

#### **4. Impact of ICT on Society**

**ICT** refers to the devices used to communicate between computers. Information communication technology (**ICT**) has greatly impacted and enhanced global socialization and interactions. In fact information technology has taken over nearly every aspect of our daily lives from commerce (buying and selling) to leisure and even culture. Today, mobile phones, desktop computers, hand held devices, emails and the use of Internet has become a central part of our culture and society. These technologies play a vital role in our day to day operations. **ICT** has made global social and cultural interaction very easy. We now live in an interdependent global society, where people can interact and communicate swiftly and efficiently. News and information can now be transmitted in minutes. Individuals can easily stay in contact with members of their families who reside in other countries or make new friends across the world. **ICT** made a major contribution towards the elimination of language barriers - people speaking different languages can connect and socialize or trade in real time via the Internet. This is made possible with the use of language translators. Examples of information and communication technology (**ICT**) tools used for these purposes are emails, instant messaging (IM), Chat rooms and social networking websites, such as Facebook and Twitter, Skype, iPhones, cellular phones and similar applications.

There are many advantages of the new **ICT** technology:

**Processing** of data is much faster on a computer.

**Example** : Calculating an annual budget on a spreadsheet is instantaneous, doing the calculations by hand would take some time.

**Repetitive** processing can be better done using computerised machinery.

**Example** : Humans get tired, lose concentration and generally fed up if they have to repeat the same task over and over again. Robotic machinery will perform the same task repeatedly with consistent quality and never need a break, or software programs can be written to process all the records in a database.

**Searching** for data is much faster.

**Example** : Finding a patient's record in a doctor's surgery can be done in seconds on a computerised database system, whereas it would take a receptionist some minutes to locate a folder in a paper filing system.

**Data storage capacity** is almost limitless in a computer system.

**Example** : Large quantities of data can be stored on hard discs or media such as CDs or DVDs instead of needing enormous quantities of paper and many large filing cabinets. Eg. In a national driving licence database.

**Data communications** are fast and accurate. Data transmitted over a network will arrive at its destination anywhere in the world in just a few seconds.

**Example** : A computer user can place an order for an item on an Internet website and it will be received immediately - posting an order in the mail would take a day or two to arrive.

**Data can be output** on a computer in a variety of different formats.

**Example** : Annual sales figures for a retail business can be printed as a spreadsheet, displayed as a graph, or as a multimedia presentation involving text, sound, graphics and animations.

In as much as the advantages of IT are numerous, it is important to mention some of its major disadvantages to the society.

A significant disadvantage is that older generations find it difficult to catch up with the ever changing and numerous technologies available today. Fear of change, resistance to change and inability to catch up with rapid technology evolution are areas to note.

The issue of digital divide cannot be ignored. In the world today, there are people in the society who are not in the position to take advantage of available technology. This may be due to poverty or geographical location. For example, access to technology can be said to be limited in many developing countries and these may result in lesser opportunities for economical and social development.

**ICT: Application in Libraries**

- 1. Objectives**
- 2. Introduction**
- 3. ICT: Concept and meaning**
- 4. Components of ICT in libraries**
- 5. Reproduction Technology**
- 6. Concept of ICT in Libraries: A Gradual Development**
- 7. Why is ICT Needed in Libraries?**
- 8. Functions and Benefits of ICT Based Library System**
- 9. ICT Based User Services**
- 10. Impact of ICT on Libraries and Librarians**
- 11. New Skills and Knowledge Required For Information Professionals**
- 12. Major Problems and Recommendations**
- 13. Conclusion**

**1. Objectives**

- to explore various components of ICT used in libraries
- to trace the advancement of ICT in libraries;
- to compare old and new technologies;
- to identify the reasons for introducing ICT in Libraries;
- to explain the functions, impacts and challenges of ICT based library services

**2. Introduction**

Information and Communication Technology (ICT) is a comprehensive concept and parallel concept with Information Technology (IT), that denotes not only a single unit of technology but an assemble of technologies like telecommunication equipments, data processing equipments, semi conductors, consumer electronics, etc. The concept has brought a phenomenal change in the information collection, preservation and dissemination scene of the world. For the profession of librarianship, this turn of the events is a blessing in disguise.

The emergence of IT is one of the wonderful gifts of modern science and technology which has brought tremendous changes in Library and Information Science. Application of IT to Library and information work has revolutionized the traditional concept of Libraries from a 'store house of books to an intellectual information center' connoting the concept of electronic Library. It has opened up a new chapter in Library communication and facilitated global access to information

crossing the geographical limitations. Using ICT, libraries are also playing an important role in facilitating access to global information and knowledge resources.

### **3. ICT: Concept and meaning**

ICT incorporates a range of technologies used to support communication and information. ICT includes both networks and applications. Networks include fixed, wireless and satellite telecommunications, broadcasting networks. Well-known applications are the Internet, database management systems and multimedia tools. By implication, a holistic understanding of ICT necessarily includes consideration of telecommunications policies, information policies and human resource development policies

Information and Communication Technology (ICT) is a diverse set of technological tools and resources used to communicate and to create, disseminate, store and manage information. The ICT sector is a heterogeneous collection of industry and service activities including information technology equipment and service, telecommunication equipments and services, media and broadcast, Internet service provision, libraries, commercial information providers, network based information services and related professional specialized services. We can also say that ICTs are those technologies that enable the handling of information and facilitate different forms of communication. These include capturing technologies (eg. camcorders), storage technologies (e.g CD-ROMs), processing technologies (e.g. application software), communication technologies (e.g. Local Area Network) and display technologies (e.g. computer monitors). So, we can define ICT as '***the use and application of computers, telecommunications and microelectronics in the acquisition, storage, retrieval, transfer and dissemination of information***'.

### **4. Components of ICT in libraries**

The ICT came about as a result of the digital convergence of computer technologies, telecommunication technologies and other media communication technologies.

We can categorize the components of Information Technology (IT), which frequently used in library and information center are as follows:

- Computer Technology
- Communication Technology
- Reprographic, micrographic and printing technology.

**Now a brief account of these Information and Communication Technologies is discussed below:**

**Computer technologies:** The dramatic development in the information transmission process in every field of human endeavor has been made by the widespread use of computer technology that can further be divided into following categories:

**Workstations:** These are expensive and powerful computers used mainly by engineers and scientists for sophisticated purposes. These include following:

**Mainframe computers:** Mainframe computers are fast, large capacity computers, after the super computer, occupies a specially wired, air-conditioned room and capable of great processing speeds and data storage.

**Super computers:** Super computers are high-capacity computers that are the fastest calculating device ever invented. They are used where complex numerical calculations are required.

**Mini computers:** Mini computers are refrigerator-size machine that are essentially scale-down mainframes. Minicomputers are becoming more important as servers in networks.

**Personal Computer (PCs):** These are desktop, floor-standing or portable computers that can run easy-to-use programmes such as word processing or spreadsheets.

**Microchip technology:** A microchip is a tiny piece of silicon that contains thousands of micro-miniature electronic circuit components, mainly transistors. The microprocessor of microcomputer, which process data, is made from microchips.

**Artificial Intelligence (AI):** AI is a group of related technologies that attempts to develop machines to emulate human like qualities, such as learning, reasoning, communicating, seeing and hearing.

**Software technology:** Software consists of the step-by-step instructions that tell the computer what to do. Many software packages for various applications in the field of library and information services and management are commercially available. Some of the important library packages available are:

**Cds/isis (computerized documentation system/integrated set of information system):** This public domain package of library software developed by UNESCO is a menu driven generalized information storage and retrieval system designed especially for computerized management of structured database. The windows version of CDS/ISIS is called WINISIS.

**In magic:** In this study, the major functions include cataloguing, acquisitions, circulations, serials, on-line catalogue, retrieval, etc.

**Book:** This software system which supports all the major library functions including circulation control, acquisition, serial control, etc. This software is in COBOL language.

**Winisis:** This study is for use in creating, maintaining and searching library and information databases. It supports text and index searches, controlled indexing terms.

**Libsys:** It is the most comprehensive library software. It supports almost all activities relating to acquisition, cataloguing, circulation, serials and articles alert

**CD-ROM technology:** CD-ROM is an acronym that stands for Compact Disc Read

Only Memory. It is an optical disc of 120 mm diameter and a hole of 15 mm at the center with thickness 1.2 mm. Data is recorded in digital form using laser beam. CD-ROM is used to hold prerecorded text, graphics and sound.

**Communication technologies:** Communication or telecommunication technologies are used to transmit information in the form of signals between remote locations, using electrical or electromagnetic media as carriers of signals. Communication technologies comprise the following:

**Audio technology:** The outmoded AM (Amplitude Modulated) radio receivers are being replaced by the modern FM (Frequency Modulated) receivers. The recent development is the production of Compact Discs (CDs). Audio technology can be used in libraries and information centres for a wide variety of purposes such as storytelling to children, imparting education, knowledge, recreation, etc.

**Audio-visual technology:** AV technologies are those by which things can be understood by listening as well as seeing. AV technologies include the following:

**Motion picture:** It can be used in library as one of the instruments of mass media communication. It is the dynamic source of information, education and recreation.

**TV:** Television is one of the traditional and old information and communication technologies which was dominated by major of station in its formative period.

**CATV (Cable Television) system:** It is a wired communication system of high capacity that flows from a central source through a major distribution cable to neighborhood lines and finally to the line into the house.

**Videodisc:** Videodiscs can be used to disseminate computer programmes, digital databases, educational video programmes and a range of electronic publications.

**Videotext:** Videotext is a newer technology, but as in the on-line information retrieval, the information is stored in computer files and accessed through a telecommunication link.

**Teletext:** Teletext is a one-way service to a large number of simultaneous users, where parts of information from a central database are broadcast as part of the regular television signal.

**Telephone:** The telephone is one of the longest established methods of electronic information transfer especially to transfer the voice which can be a strong means of disseminating information and keeping of what is being happened concerned organization and outside as well.

**Cell phone or mobile phone:** Mobile telephones are based on the cellular radio technology. Mobile phone provides the facility to dial connections anywhere in the world. As the user of mobile telephone moves from cell to cell the radiotelephone link switches from one central transmitter/receiver to a second while the call continues, uninterrupted.

**Fax (facsimile transmission):** It is a method of converting an image into electronic signals that can be transmitted over a communication link and converted back into an image at the receiving end.

**E-mail:** E-mail is a system of exchanging message in electronic format. It is the most used tool on the Internet. It has brought a revolutionary changes in communication because any type of information such as personal notes, letter, documents, publication, computer program, even pictures and sound can be sent to or received from anywhere of the world within a fraction of a second at a very cheap rate through electronic signals called SMTP (Simple Mail Transfer Protocol).

**Voice Mail:** Voice mail acts like a telephone machine that digitizes the incomings voice message and store for retrieval later. It is an alternative system of e-mail.

**Teleconference:** Teleconference is a meeting among people remote from one to another who are linked by a communication device such as a telephone, television or computer. There are following five types of teleconference: Audio teleconference, Video teleconference, Computer teleconference or Computer conference, Document conference and Personal videoconference.

**Satellite technology:** Satellites are in fact formed of microwave transmission in that satellites, which are positioned in space approximately 22,300 miles above the earth, represent relay stations for earth round communication.

**Internet:** Technically the Internet is a junction of a number of hardware and software resources or equipments to construct the infrastructure and to perform multiple functions. It is treated as a virtual library where world's information resources are gathered for the use of the clientele. It has broken down the distance barrier in communication. It has greatly influenced the practice of librarianship. Access to information through Internet has changed the total scenario of librarianship.

**Network technology:** The important function of network is to interconnect computers and other communication devices so that data can be transferred from one location to another instantly. Generally computer network is of following three types:

**LAN (Local Area Network):** LAN is a communication network that covers limited geographic area such as campus, or building.

**MAN (Metropolitan Area Network):** MAN is a communication network that covers the whole big city.

**WAN (Wide Area Network):** WAN is a communication network that covers wide geographic area such as a country, or state.

## **5. Reproduction Technology**

**Reprographic technology:** The term reprographic is used to identify that field of information processing which concerns with technologies and equipments for the

reproduction of documents.

**Micrographic technology:** Micrographic is that field of information technology which concerns making use of microforms. Microform is a generic term for all information carriers which use microfilm or similar optical media (including study) for the high-density recording and storage of optically encoded information in the form of micro images of printed document, bit patterns or holograms.

**Printing technology:** A printer is a device that converts computer output in to printed images. There are a number of different kinds of printers used in library such as Dot Matrix Printers, Laser printer, InkJet printer, Thermal printer, etc.

### 6. Concept of ICT in Libraries: A Gradual Development

Library and information centers entered into information and communication technology era in 1960s

Table 1: The devices and systems available to manipulate the resources of information

Operations	Information technology Device/System
Capture	Remote resource sensing satellite Radar system Electronic camera
Transportation	VCR system, Video disks Coaxial cable, Optical fiber cable Microwave link, Communication satellite Satellite phone, Cellular mobile radio, Laser beams Facsimile transceivers, Video phone Electronic teleprinter, Modem, Multiplexer
Storage	Memory chips Hard disk/Magnetic tape/Drum/Floppy disk Holography Laser emulsion, Microfilm
Processing	Integrated circuits, Microprocessors Computer Software/Peripheral equipments.
Retrieval	High definition television Teletext/Videotext, Pay Television system Online database.

Table 2: Comparison between old and new technologies

Functions	Old technologies	New technologies
Text entry, editing and composing	Typing, Type setting	Electronic word, Processing
Replication	Printing	OCR scan Computer terminal, Display, Print, Videodisc mfg.
Storage	Shelving Cataloguing	Digital mass store, videodisc
Searching, selecting, retrieving	Catalogue search, browsing	Computer database software
Communication	Mail, freight, Personal travel	Computer network, Teletext, CATV, satellites, videodisc

With the availability of general purpose computers for performing traditional library activities. Some of the significant developments regarding ICT in libraries during that period are as follows:

- The MEDLARS (Medical Literature Analysis and Retrieval System) project to mechanize the handling medical literature at the national library of medicine, USA;
- The pioneering work on serial control by the Southern Illinois University of California at San Diego.
- Initiation of project MARC (Machine Readable Cataloguing) by the Library of Congress to provide a format for cataloguing.

The next era of ICT based library began in the late 1960s to a great extent with the success of INTREX and the MARC projects. During this online, real time interactive computer systems were introduced in the library and information field. In 1967 both OCLC and BALLOTS became operative. In the early 1970s, Online Systems were in operation in several libraries, for example, Bell Telephone Laboratories, Eastern Illinois University etc.

### 7. Why is ICT Needed in Libraries?

Various factors have contributed to bring about change from traditional to ICT based library operations. Basically ICT is needed in libraries for the following two main reasons:

**In terms of various problems faced by the traditional Library systems:** The manual performances of library functions were getting difficult because of the following main reasons:

- The size of recorded information is ever growing whereas space available at the disposal of each library is limited. No library can think of getting additional space every year, although the collection will grow continuously;
- Due to knowledge explosion, the society is faced with multifaceted and

multidimensional information to such an extent that not only its storage has created challenge, but the organization of this bulk of information has also become unwieldy;

- Library operations, due to potential growth of information, could take many hours to perform manually;
- Due to information explosion, all sorts of housekeeping jobs and information works can be performed by manually with less effective and less accuracy.

**In terms of various facilities provided by computers and related technologies:**

The advantages of using computers and other telecommunication media/devices in managing libraries are manifold. Some of the advantages are as follows:

**Speed:** A computer can carry out an instruction in less than a millionth of a second. Searching of information, compilation of bibliographies, and preparation of current awareness bulletins, indexing and sorting can be processed by a computer in a few hours.

**Storage:** Human brain can store pieces of information to some limitation whereas computers can store voluminous data.

**Accuracy:** Computers can perform functions very accurately.

**Reliability:** Computers and all related technologies have long life if maintained properly. The data gathered in it are reliable.

**Repetitiveness:** A computer can be used repetitively to process information.

**Compactness:** The present day computers are laptop/palmtop, which do not occupy more space.

**8. Functions and Benefits of ICT Based Library System**

Traditionally, computers in libraries have been used and in most cases are still being used to automate the following functions:

- Acquisition and budget
- Cataloguing and short loans
- Circulation
- Serial control (Periodicals)
- Provision of access to online catalogue.

Since the 1950s, use of ICT in libraries has basically gone through four stages, *corresponding to the major reasons for automating:*

- *Improving the efficiency of internal operations*
- *Improving access to local library resources*
- *Providing access to resources outside the library*
- *Interoperability of information systems.*

ICT is used in various fields of library activities. Some of the areas where new technologies can perfectly be used are as follows:

**Acquisition:**

- Accession list
- Order file/report

**Serials management**

- Serials check-in/out and claiming
- Union/holding list

**Cataloguing/ classification**

- Catalogue card/label production
- Retrospective conversion
- On-line catalogue

**Circulation**

- Issuing
- Inter library loan
- Reservations
- Over dues

**Audio-visual management**

- Accounting/budgeting

**Management**

- Word processing/ mailing
- Scheduling/ planning
- Statistics/report

**Information storage/retrieval**

- Database construction
- Online database searching
- Down loading/uploading
- Indexing and abstracting

**Reference Information Services**

- Bibliographic listings
- Library instructions
- Public access/computer literacy.

**9. ICT Based User Services**

Some library users are adopting electronic habits, making increasing use of the new ICT including computers, the Internet, the Web, Intranet, Extranet and other technologies. As a result; library users are placing new demands on their libraries. They require access to the latest information, updated information resources and access to ICT facilities that they could use in their work.

Use of ICT in libraries enhances user's satisfaction. It provides numerous benefits to library users. Some of the benefits are:

- provide speedy and easy access to information
- provides remote access to users
- provides round the clock access to users
- provides access to unlimited information from different sources
- provides information flexibility to be used by any individual according to his/her requirements
- provides increased flexibility
- facilitates the reformatting and combining of data from different sources.

Libraries are also providing various ICT -based services to their users, including the following:

- Provision of Web access to OPACs
- Electronic document delivery
- Networked information resources
- Delivery of information to user's desktops
- Online instructions
- Online readers advisory services

**Web access to OPACs:** Libraries are providing access to Web-based Online Public Access Catalogue (OPAC) interfaces. This is making it easier for OPAC users to learn and use these resources since they only have to learn how to use one universal access client, the Web browser.

**Electronic document delivery:** Libraries are implementing ICT -based interlibrary lending system using electronic networks to deliver copies of journal articles and other documents in digital format [mainly in Portable Document Format (PDF)] to library users desktops.

**Networked information resources:** Libraries are providing their users with access to networked information resources, i.e. databases, electronic scholarly journals, encyclopedias, public government information, etc, provided by various publishers or suppliers.

**Information delivery to users:** Library and information users are now getting access to electronic information resources from the computer desktops in the computer laboratories, Internet cafes, offices and even at home. This is resulting in librarians and other information specialists investigating and implementing systems that can deliver customized information to user's desktop computer environment, irrespective of their geographical location.

**Online instructions:** Libraries are also implementing online based bibliographic or library use programmes. These include online tutorials on searching online resources and virtual tours of library collections.

**Online readers advisory services:** Libraries are implementing Web-based versions of reader's advisory services and reference services. These include services such as

informing users via the Web about new acquisitions, providing reviews and recommendations, providing facilities for readers to interact with the reference staff (Virtual Reference Desks), etc.

### **10. Impact of ICT on Libraries and Librarians**

Computer has brought in a new impact to the library and information usage. In libraries, information technology has assisted library professionals to provide value added quality information service and give more remote access to the internationally available information resources. Today's highly sophisticated information technology to facilitate the storage of huge amounts of data or information in a very compact space. Information technologies promise fast retrieval of stored information and revolutionize our concept of the functions of a traditional library and a modern information center. Recently technological developments have dramatically changed the mode of library operations and services.

Modern ICT is impacting on various aspects of libraries and the information profession. Advancements in ICT and the wide spread use of ICT is resulting in digital information sources and digital media replacing and becoming the dominant form of information storage and retrieval.

The term library no longer refers only to physical buildings located in a specific geographic location but also to electronic or digital or virtual libraries that can be accessed from anywhere. Library collections consist not only of physical information resources such as books, periodicals, videos, films and many more, stored in physical library buildings, but also include digital resources. Access to digital information resources is not restricted to specified hours and days of the week at one physical library building. The proliferation of digital information available over the Internet, intranets and extranets is resulting into libraries and information centers losing their former place as the focus of the information environment in many organisations. Libraries are becoming one of the many information systems available to information end-users.

### **11. New Skills and Knowledge Required For Information Professionals**

Information sources and services being provided by libraries to their users need to adapt to the electronic information environment being experienced by most information end-users. In addition to the traditional library and information management skills, librarians now need to possess additional skills and expertise, more so in the use of modern information and communication technologies, automated information service, electronic publishing, digital information management and knowledge management. New informational professional should acquire technological systems thinking, commitment to continuous improvement of skills, techniques and strategies and sensitivity to network environment.

In modern ICT based library services, the information professionals handle

various types of activities in relation to the use of computers and other new information technologies. Some of these are: handling and developing information storage and retrieval systems of specialized/local data and materials, managing different types of housekeeping operations, carrying out on-line searches for information users using modern equipment, exchanging local databases and sharing of resources through networking.

For the modern information services, technically qualified personnel will be required to provide access to databases and databanks and to work in the exploitation of the resources of libraries. In a study less system, the information personnel, who are familiar with the resources available in machine-readable form and with vocabularies, query languages, indexing and search strategies will be needed to exploit these resources most effectively and efficiently.

## **12. Major Problems and Recommendations**

Today the world of ICT-based libraries is still in its infancy. A number of problems contribute to this situation.

### **1. Administrative barriers**

This problem is much more acute in public university libraries than private university libraries and special libraries. Administrators, policy makers, and government executives are not fully aware of the importance of ICT. Moreover, library administrators have failed to make its importance clear. Lack of knowledge of technological developments has created a significant barrier to the installation or development of ICT facilities in libraries.

### **2. Lack of skilled manpower**

Library professionals do not have adequate knowledge regarding computer applications and automation.

### **3. Lack of financial support**

Inadequate financial support has made possibility of ICT application in libraries more complex.

### **4. Lack of infrastructure**

Inadequate physical facilities hamper the growth of ICT. Telecommunications infrastructure and an uninterrupted power supply are crucial needs for Libraries.

### **5. Lack of ICT resources**

ICT means more than the use of computers. Less attention has been paid to other communication and related technologies. Some libraries have no Internet connection. Most have a manual circulation operation. They have no barcode readers for use in automated circulation. Most libraries are using microcomputers only with no server in most of the libraries.

**6. Absence of local resources**

50% of the libraries in the survey use the CDS/ISIS developed by UNESCO. Most have no system administrator or other means of developing other software.

**7. Psychological Barriers**

The reluctance of library personnel to accept new technologies hinders the development of ICT-based libraries.

**8. Lack of E-Resources Selection Policy**

The lack of a comprehensive collection development policy for e-resources means that the collections of e-resources in surveyed libraries are not significant.

**9. Lack of shared initiatives****10. Lack of ICT Training Programs****11. Lack of long-term planning****Recommendations or action plans to help overcome the barriers to ICT-based library systems:**

1. Well-trained and skilled personnel are essential ingredients for implementing ICT in libraries. Steps should be taken to develop properly trained and competent people for this purpose.
2. Libraries need funds to initiate the implementation of ICT. The government can play a vital role by allotting sufficient funds for purchasing and maintaining ICT in libraries.
3. The government's administrative complexity should be reduced to help create awareness of the importance of ICT in libraries.
4. The government should make library and information services a part of national development initiatives, efforts, and plans.
5. Libraries need a suitable location with sufficient space for collections and services. To this end, government must create an information infrastructure for the country.
6. The libraries should develop a centralized database, linked with other international networks, that includes all documents and sources of information available in the country, in order to support scientific research and to provide decision-makers easy access to information.
7. Libraries need strong support from their parent organizations and the government. This can be achieved only if there is such awareness regarding ICT.
8. Networking is one of the most effective ways of serving users' needs comprehensively. Networked access to databases would help get newly-published information to library users.
9. Professional organizations such as the Library Associations and library administrators should organize short-term training programmes for library professionals in computer applications in library and information services, online

information retrieval, data processing, electronic publishing, and also software such as Microsoft Office, CDS/ISIS, etc.

10. A comprehensive collection development policy for e-resources should be maintained by the libraries in the study, in order to follow a set of standard practices for acquisition and management of electronic information resources. There should be specific budget for new resources and the renewal of existing resources.

### **13. Conclusion**

Today computer and related technologies has brought revolutionary changes in the whole world of information. Perhaps, this is the most exciting period in the history of human race when world's most population is shifting from 'techno-illiterate' to 'techno-literate'. The society is undergoing a kind of transformation with the passing of each day; we find that 'Information and Communication Technology (ICT) has affected almost every sector of our life, bringing a change in the case of people's think, interaction, etc. This revolutionary change is also true in the case of libraries and information centers. Libraries and information centers can hardly function today without computers and information technologies. In the modern world the library and information professions have been changed and adopted itself to the developments of Information and Communication Technology. These technologies have acquired the do-or-die prominence; those who go with the advances will survive and others will become obsolete. A well-equipped library with the facilities of modern information infrastructures and technologies could satisfy the maximum demand of the present technology conscious users.

**LIBRARY AUTOMATION : NEED, PURPOSE  
AND APPLICATION**

**STRUCTURE**

- 4.1 Objective
- 4.2 Introduction
- 4.3 Prequisites for understanding library automation
- 4.4 Need of Library automation
- 4.5 Factors for library automation
- 4.6 Advantages of library automation
- 4.7 Objectives of a library automation programme
- 4.8 Application of automation in libraries.
  - 4.8.1 Housekeeping operations
    - 4.8.1.1 Acquisition
    - 4.8.1.2 Periodicals Management
    - 4.8.1.3 Cataloguing
    - 4.8.1.4 Circulation
  - 4.8.2 Information retrieval
  - 4.8.3 Content analysis
  - 4.8.4 Management information and reporting
- 4.9 Summary
- 4.10 Self-check exercise
- 4.11 References and further reading

**4.1 Objective**

The objective of this lesson is to introduce the students to the basic concept of library automation, its need and purpose, and to identify areas/ functions/operations where automation activities in libraries can be applied.

**4.2 Introduction**

In common usage, library automation refers to the use of computers and other machines in various operations of the library. As with other new technologies, computer technology in the later half of the 20<sup>th</sup> century and later, the communication technologies have been adopted by libraries and information centres for improving the efficiency and effectiveness of their services. Beginning from Machine Readable Cataloging (MARC) project of the Library of Congress (the national library of the United States) in 1460s for cataloguing, and later the use of computer technology in various activities and operations in libraries all

over the world, three open many other areas and opportunities for libraries by possibility of offering improved as well as new services to their users. Such alternative terms were (and sometimes even presently are) also being used to describe library automation as : computerization of libraries, computerized library systems, modernization of libraries, IT in libraries etc. 'Library automation' and 'library automation and networking' are now standard terms in professional literature of library & information science. In these chapters, the discussion is largely on automation aspect in libraries though a large number of libraries worldwide (as well as in India) are either already networked or are moving towards networking.

#### **4.3 Prerequisites for understanding Library automation :**

An understanding of some of the following topics is necessary to understand the concept of library automation.

- Computers in general and their historic perspective
- Computer generations
- Types of computers and their classification
- Functional parts of a computer
- Working of a computer
- Computer hardware and software
- Operating systems and computer languages
- Many of these topics are covered in enough detail in the preceding chapters.

#### **4.4 Need of Library Automation :**

The invention and increasing use of computers in various fields of human activity is witness to the fact that the computer is considered to be essential component for the all round development. Computer's entry in almost all the fields of human endeavour is due to its great qualities, viz, the splendid speed to act in nano second, the superb capabilities to do unmanageable and impossible looking things, the unlimited capacity to store ocean of information on to tiny storage mediums, immense capability to perform repeatative jobs without fatigue, the radical power to sort, arrange, retrieve and disseminate information almost instantaneously etc. The computer was invented because it was needed, and it will remain as it is needed. Day by day it is becoming more and more indispensable for the society and has swayed all fields of human activities. Its use in the library is the need of the day and its application will certainly increase the use and utility of libraries.

#### **4.5 Factors for library automation :**

Besides tremendous growth of information, technological and other factors now require libraries to use modern information and communication technologies for improving their services. These factors are outlined below in the proper context :

- a. Exponential growth in information. Information explosion is another term used to describe the phenomenon of a large quantity of information being produced in the form of various documents. Not only printed documents, today much of information is being produced in non-print documents and on the networks.
- b. Increase in number of users. Barring public libraries which have been neglected by the state and hence in decline in many parts of India, library users have increased in number. Not only that, information requirements of users have also grown and diversified.
- c. Static or declining library budgets. Marginal increase in library budgets in currency terms in real terms sometimes comes out to be less budgetary support for libraries than previous times. Library budgets have not grown at the rate the prices of documents have grown.

#### **4.6 Advantages of Library Automation :**

The library automation has the following advantages :

1. Larger data can be handled with ease and accuracy
2. Operate at great speed and promptness
3. Labour saving
4. High rate and better quality in performance
5. Cost effective
6. Ease in functioning
7. Avoids/eliminates duplication of work
8. Greater manipulation possible

#### **4.7 Objectives of Library Automation :**

In the light of these developments, a library needs to chalk out a programme for efficient and effective management of its services through the use of ICTs. Though library automation programmes started out in many libraries in India as ad-hoc developments which were regularized later, efficiency and effectiveness in library services can be brought out by detailing the objectives of a 'library automation programme.' These objectives can be :

- Identifying areas/functions within a library whose efficiency and effectiveness is to be improved
- Providing new services
- Relieving professional staff of the routine and repetitive tasks
- Improving cost-efficiency in library operations identified above. When discussing cost-efficiency, this must not be understood that by using ICTs, the resulting costs of the operations/services would be necessarily less than those before the use of ICTs.

Here, it must be emphasized that library automation in itself for a 'traditional library' is quite an expensive affair, it not only involves one time

expenditure on computer parts (hardware), but besides that many other costs such as on software, data entry, data storage, maintenance, upgradation, etc.

#### **4.8 Application of Automation in libraries**

Before moving further, let us now identify areas/functions/operations/services where automation, or the use of computers and other related technologies and technology products can be applied. Such areas/functions/operations services can be categorized in many ways but one useful categorization in Indian context is as follows :

- a. For housekeeping operations
- b. For information retrieval
- c. For content analysis
- d. For management information and reporting in each of the three areas above and in general.

Another categorization listing ‘Basic functions of a library management system’ is provided by Rowley (1948, pp. 314-15). This categorization is similar to the one mentioned above but functions are given in much detail and deals with networking aspects also, is reproduced below :

“Basic functions of a library management system.”

##### **Ordering and Acquisitions**

- Ordering
- Receipting
- Claiming
- Fund accounting
- Enquiries (about the status of orders)
- Reports and statistics (about orders)

##### **Cataloguing**

- Data Entry
- Authority control
- Downloading (of records from other databases)

OPAC and other catalogue forms

- Online access
- Public Access Interface
- Other Catalogue forms
- Internet access
- Access from remote users over the Internet

##### **Circulation Control**

- Setting parameters (to reflect loan policies, opening times, etc.)
- Issue
- Return
- Renewal

- Fines
- Reservations
- Short-term loans
- Borrower file maintenance
- Enquiries (concerning borrower or the status of items)
- Notices
- Reports and statistics (about the utilization of stock)

#### **Serials Control**

- Ordering (placing and renewing subscriptions)
- Receipting (of individual issues)
- Claiming
- Binding (control of items in binding)
- Fund accounting
- Cataloguing (of new titles)
- Circulation control (if items are issued or circulated)
- Inquiries (related to serials)
- Reports and statistics

#### **Management Information**

- Various reports and statistics
- Tools and analysis of statistical information

#### **Inter library loans**

- (Similar to circulation control but usually with fewer options)
- Entry
- Issue
- Return
- Fines
- Borrower file maintenance
- Enquiries
- Reports and statistics

#### **Community information**

- Data Entry
- Online access
- Public Access interface

However, in the following pages the details would be discussed in terms of the first categorization, particularly of the housekeeping operations and a little of management information.

**4.8.1 Housekeeping operations :** Traditional libraries are generally involved in many functions which are done in the background rather than dealing directly with the public. These are termed as housekeeping operations described below, though one of them, circulation, deals extensively with the users and is not a background job but a

front office area that provides one of the most heavily used services in many libraries. The application areas for housekeeping are as follows :

- Acquisition
- Periodicals management
- Cataloguing
- Circulation

**4.8.1.1 Library automation in acquisition :** Acquisition is one of the first jobs in a library. Large and medium sized libraries have such sections as book selection section, book selection and acquisition section, or sometimes only acquisition section or in some modern libraries are being termed as collection development section. By whatever name such a section/unit within a library is designated, the functions are generally, apart from book selection, acquiring books and other materials (other, than periodical publications). This involves preparing records of books on order, purchase orders, correspondence with book suppliers and publishers, advance payments, checking for duplication, receiving books ordered, etc.

These functions can be categorized into two broad categories as administrative and managerial ones, and routine and clerical ones. All these activities and functions require generation of and recording of new information for the library. Recording of it in a traditional library consumes a lot of time particularly when such tasks are done repetitively- for example, bibliographic details of books are entered several times at the time of order reminders, etc. Computers are assigned to such tasks to achieve the following :

- Speedy processing of book orders and receipts
- Speedy accessioning
- Better administration over budgetary resources
- Saving of time in searching records on paper
- Reliving of time of professionals for important and urgent professional tasks.

**4.8.1.2 Library automation in Periodicals Management :** Most of the libraries acquire newspapers, magazines, and/or journals besides other periodical publications as serials, conference proceedings of learned societies etc. The term serials control is also used to describe this larger function of establishing policies, procedures and operations for the management of the acquisition and display of periodicals in a library. There are various problems associated with periodical publications which are not encountered while acquiring books. Hence the acquisition function of periodicals is generally with periodicals section in a library and not the acquisition section. Some of these problems are :

- Delays in publishing
- Change of title and/or sponsoring body and/or frequency and/or volume numbers

- Combined issues of periodicals.
- Additional and special materials, such as, supplements, special issues.
- Additional issues, indexes etc.
- Loss/misplacement of issues in transit

Users' inquiries about the periodicals can be broadly categorized as follows :

- About a particular periodicals title-inquiries such as whether subscribed presently, before, ever, if yes, which years, rate of annual subscription, etc.
- About periodicals based on subject approach
- About specific issues or special and additional materials

The functions of a periodical section in a library that can be automated are therefore as follows :

- Placing orders for new titles,
- Monitoring expiry of subscriptions and sending renewal/standing orders.
- Registration of issues arrived in a library
- Sending reminders for overdue issues
- Preparing lists of periodicals subject wise, vendor wise, according to local parameters such as academic department/unit wise for academic libraries
- Maintain records related to payments and other expenditures by fund
- Preparation of routing slips for journal issues
- Preparation of lists of periodicals to be bound
- Updating of holding list

**4.8.1.3 Library automation in cataloguing :** Cataloguing is one of the most important behind the doors function in libraries intended to create tools (catalogues) that are to be used if not every time, but most of the times by most of the users. Effective users of such tools help in utilization of a library's resources and services. Computers were initially introduced in libraries for cataloguing purposes, e.g. MARC project. Its present uses have been extensively listed by Rowley under two headings of (a) Cataloguing, and (b) OPAC and other catalogue forms. These have been reproduced above. The basic use of computers in cataloguing is for reducing the data-entry effort. Once bibliographic details of document are fit into the system, the data can be used for generating catalogue cards, as well as getting output in given electronic forms, e.g. the Online Public Access Catalogue (OPAC). In many cases libraries in their initial stages have only electronic catalogues without those available online.

Production of book catalogues of new arrivals is also possible. Book cards and spine labels can also be produced using the same data that was entered at an earlier stage in technical or circulation or acquisition sections.

**4.8.1.4 Library automation in circulation :** Libraries control circulation by keeping records in order to achieve optimum availability, and therefore use, of its reading

materials. These records pertain to the following :

- Materials ready available for loan and where located within a library
- What items are on loan, to whom, and when are likely to be next available
- Items on loan user wise, subject wise, or by other categories according to local variation
- Materials overdue and related overdue charges, if any.

Besides these, automated circulation systems in libraries perform functions to meet the following requirements :

- Preparation of overdue and recall notices for lent out items
- Facilitation of renewals
- Collection of issue statistics
- Identification and trapping of reserved books upon their return
- Helping in calculation and collection of overdue charges
- Notification of over borrowing and other borrower details
- Becoming reliable substitutes for manual records

In a large multi site library, refinements of these basic functions of issue, return, overdue charges and reservations include the following, according to Rowley (1448, p.322):

- Multi-site provision, with each site having its own-stock, borrowers and associated circulation parameters
- Definition of loan periods
- Location definition of patron records
- Recalls or hold on items, editions, and titles
- Printing of check-in receipts
- A variety of categories of stock and borrowers, each with its own library-defined circulation parameters
- Fine payment, accompanied by a record of the details of payment, such as date, workstation and operator, supplemented by printed receipts.

Besides these housekeeping operations, which when become automated no longer remain only housekeeping one but are active in provision of service. In fact the division of activities into two watertight compartments of 'technical services' and 'user services' in case of traditional libraries does not hold good in case of automated libraries. Users come to or contact the library to get information stored in books and documents. Automated systems help the library staff and the users in saving of their time in organizing and finding information. The context of the five laws of library science given by Ranganathan, particularly the fourth law, i.e., 'Save the time of reader' becomes clear. When automated libraries effectively help each and every user in finding the required documents through OPAC/electronic catalogue, users immediately come to know as to which items are available on which shelf for loan and are issued through an automated

circulation system. Those not available on shelf are reserved and previously loaned ones are renewed. Those not acquired by library are then recommended by user through an automated system or are got through an interlibrary loan, request for which can be made again through automated system. In libraries other than public libraries, where users belong to a particular organization, e.g., a school, college, university, or a research centre, for many the activities described above, users need not come to the library. Many activities can be performed on the computers in their departments or at their desk through a local area network (LAN) within their campus where library databases including catalogue are available via LAN.

**4.8.2 Information retrieval :** We use this category for retrieving information stored in electronic form which are called 'information services' or computerized information services', but essentially these are uses of computer technology for providing current awareness (CAS) and selective dissemination of information (SDI) services. These are discussed in the next chapter.

**4.8.3 Content Analysis :** In this category computers are not used for routine clerical, repetitive and administrative tasks but for the intellectual tasks of indexing and abstracting. Since these tasks require considerable man hours and are not fully amenable to automation, the role of computers is to help the abstractor or indexer in the mental process is limited. However, in a few libraries computers are being extensively used for this purpose successfully.

**4.8.4 Management information and reporting :** Automated libraries are as complex if not more, as the traditional libraries as far as their management is concerned. Library managers need information in a timely manner to make decisions. Besides, library managers need to report on general and specific functions and activities carried out in their libraries to the library authorities. For this purpose whatever functions in a library are automated, a report generation function is generally added in the software in which a few general formats for reports can be specified. These reports are of immense value to top and middle level library managers, as well as to operational level staff in taking policy decisions and in providing services.

For example, status regarding availability of financial resources according to various funds and academic departments in a university library during middle of financial year is extremely useful in book selection and acquisition for the rest of the year. In manual systems, collection of such information requires considerable time, whereas in automated system, this information can be generated within very less time. provided provisions for this are incorporated in the software. Libraries generally start, from housekeeping operations in the beginning of their automation programs and later add management information function for each of the functional subdivisions in housekeeping. However,

majority of the integrated softwares for library management that are available commercially presently do have such modules for report generation (as well as for statistics of various transactions) on many such parameters as the one described above. Details of such would be discussed while discussing library softwares in next chapters.

**4.9 Summary :** This chapter discuss to need and importance of mini computer related technologies in libraries. Further is identifies factors and objectives for library automation programme and then identifies various areas in detant for automation of a library.

**4.10 Self Check Exercise :**

- (1) Explain briefly the need for automation of a library?
- (2) Identify in areas cataloguing function for automation?
- (3) List the objectives of the automation programme of a library?

**4.11 References and further reading :**

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**INFORMATION RETRIEVAL: SEARCH ENGINES AND BOOLEAN OPERATORS**

Conventional Information Retrieval (IR) has the specified goal of retrieving relevant information to what user wants, while minimizing the amount of irrelevant information retrieved.

The description of what information is of interest is often referred to as 'user's profile' a rudimentary kind of user model of 'user's interest'. One such popular method is to provide a set of terms to describe their subject interests. Even with a clear idea of what factors are important for predicting information interest there is no guarantee that these factors can be identified easily.

Information Retrieval Models are primarily focused on the comparison process. The three major alternatives for comparison are Boolean, Vector Space and Probabilities retrievals. The first of these is based on 'exact match' principles and other two on the concept of 'best match'.

The first model is the core of discussion of this lesson with reference to retrieval of information.

**Objective**

After the study of the material you will be able to :

- (i) Identify the critical factors involved in the information retrieval process;
- (ii) Know the problems concerning the expression of information needs by the users; and
- (iii) Acquire experience in the development of models for information retrieval process.

**Structure**

- 5.1. Introduction
- 5.2. Meaning of I. R.
- 5.3. Definitions of I.R.
- 5.4. Components of I.R.
  - 5.4.1 Database
  - 5.4.2 Information base
  - 5.4.3 Retrieval Techniques
- 5.5 Search Engines
- 5.6. Boolean Search Model
  - 5.6.1. Boolean Query formulation

### 5.6.2. Limitation of Boolean searching

- 5.6. Conclusion
- 5.7. Self-Check Exercise
- 5.8. References and Further Readings
- 5.9. Answers to the Self-Check Exercise

## 5.1. Introduction

The basic issues of Information Retrieval (IR) process is an attempt to identify a structure of knowledge and its components that exhibit flexibility for inquirer's understanding and assimilation. Information is a human resource which when assimilated by the society become knowledge. Such knowledge is a resource with ability to consolidate the valuable results of human thinking and civilization through different time. It is totality of understanding nature and its features and improved quality of human society. Because of this reason and due to human curiosity there is a continuous cultivation of human mind for increasing knowledge.

The human mind is physiological and psychological the same since the first homospian was born. But the growth of knowledge has been increasing in volume, variety dimensions and directions. The vast store of knowledge has been organized by human society in an external memory in the form of variety of source and we have to retrieve pertinent source from this vast sea to bridge a gap in knowledge by way of information retrieval.

## 5.2. Meaning of IR

Information Retrieval (IR) is a process of selecting information from a store or database. It primarily helps a person who needs to get some information in his activities problem solving decision-making production service, etc.

## 5.3. Definitions of I.R

It was Calvin Mooers who coined the phrase 'Information Retrieval' in 1950. He was much concerned with the crux of problem of recognition of pertinent need of users and to supply matching document as expeditiously as possible. He describe it as "searching and retrieval of information" from storage according to specification by subject. Dictionary meaning of the word retrieval is "to get back something lost or mislaid."

'Retrieval' in the context of Library science which mean to discover and bring the documents in whrch scientific information is embedded. Therefore, Shera defined it as "the process of locating and selecting data relevant to given requirement."

According to Vickery, "retrieval is essentially concerned with the structure and operation of devices to select documentary information from a store or *collection of* documentary information in response to search questions."

In the field of library computerization for retrieval following are the

milestones:

Work based on IBM-701 at U.S. Naval Ordnance Test Station in 1954.

Medical Literature Analysis and Retrieval System (MEDLARS) in 1964.

Online reference retrieval system DIALOG

Another important Landmark in the area of information's retrieval system during the period 1959-70 was the work of Luhn. In 1961 he used computers to produce Keyword-in-Context (KWIC).

#### **5.4. Components of IR**

In the modern computer-based information retrieval services, we have three basic components-database; the information seeker; and the repertoire of techniques, models and processes which attempt to bridge the gap between searcher and the data base.

##### **5.4.1. Database**

It is designed to take-in information and information sources acquired for the specific purpose of serving users.

A database has a logical and physical organization. It is an arrangement based on user's approach. Today there are several softwares, which can organise information. According to international standard some are CDS/ ISIS, MINISIS, TULIPS, LIBSYS, ORACLE, BRAS and BASES etc.

The physical storage of information can be made on Magnetic Disks, Drums, Floppies, Optical Media, CD-ROM, WROM and many other materials.

##### **5.4.2 Information Base (Seeker of Information)**

Information Storage and Retrieval System locate and present information to the users, based on the query presented by the seeker to the system. This query may indicate precisely the characteristics of information to be retrieved, or it may express as approximation of information need, indicating merely an initial guess as to the characteristics of the information to be retrieved. Information Storage and Retrieval System must be able to receive different kinds of queries and answers in different ways retrieving individual facts or groups of potentially relevant terms.

###### **5.4.2.1. Structured Query Language (SQL)**

Some information storage and retrieval systems are limited to finding those facts or documents containing characteristics specified by query. Such information storage and retrieval systems are often referred to as database systems or database as Structured Query Language (SQL) or forms variant of it recognised by the system under consideration.

###### **5.4.3. Retrieval Techniques**

The organization of information and the development of various techniques to retrieve information has been a major area of research and with the development in computer technology, interest in this area has been renewed through greater

emphasis on the computerized information retrieval systems.

The required techniques can be broadly categorized into exact match and partial match techniques and the latter can be divided into individual or network techniques and these can be further broken down to accommodate specific technique, such as, cluster, probabilistic, vector space and so on.

The technique most widely used is the *exact match retrieval*. It is implemented as Boolean, full text or string searching.

### **5.5 Search Engine:**

A web search engine is an interactive tool to help people locate information available in the WWW. Web search engines are actually databases that contain reference to thousand of resources.

There are many search engines available on the web. A search engine is an interface between the user and the underlying database. The interface presents the user with a place to type in a search string, which may be a word, phrase, date or some other criterion, and a way to submit the request.

The search engine runs the search string against the database, returns a list of resources that match the criteria and display the results of the user.

#### **How search engine works:**

Most web search engines use automated tools and programs to gather resources. These tools often referred to as worms, spiders, crawlers and robots, search thousand of information world wide, collect information and store information in the database.

When they find new and updated pages, they copy this information back home to be included in an updated version of the index at the search engine site. The spider will also follow any new links which it finds and repeat the process until it can not find any more new pages, at which point it will retrace its step and follow a new route.

This has a number of implications as far as the searcher is concerned. Given the size of the World Wide Web, this is a full-time job, and even the fastest computers have trouble keeping up with the flood of new pages onto the web. This has been overcome to a certain extent in that website authors can contact search engines to inform them of new or updated pages which should be included in the indexes.

A search engine cannot possibly contain every piece of information that is on the WWW; therefore, search engine will not include very available web resource. In addition, because search engine collects resources differently, the same query can be typed into several search engines is likely to produce differently results.

#### **Types of Search Engines:**

There are basically five types of search engines available to you:

##### **1. Free-text search engine**

Free text search engines are very easy to describe. You can simply search for any single keyword, a number of words or in some cases a phrase. You are not limited

in any way as to your choice—you may wish to search for the name of a company, a line of poetry, a number, a person's name, a foreign language term, just about anything.

This approach has both advantages and disadvantages, as you would expect. Free-text search engines are very useful if you know exactly what you are looking for, or if you are looking for a concept which can be defined in a small number of words. They are less useful if you want a broad overview of a subject, or are searching in an area that you don't know very well and consequently have no idea as to the best terms to use.

### **2. Index or directory based search engines**

These search engines take a rather different approach to providing you with information on the sites that you might wish to visit. Their emphasis is on classifying information under a series of major subject headings, and then subdividing these into a tree structure of more specific headings and sites are listed as appropriate in this directory structure. If this approach sounds familiar, that is, because it is as anyone who as ever used a library classification scheme will know. The advantage of this approach is obvious as the headings and subheadings can be used to guide the users through the vast amount of information.

### **3. Multi or Meta search engines**

The next type of search engine is not really a search engine at all, since a multi-search engine does not actually search anything itself. Instead it takes your query and passes it on to a selected group of search engines. Once the results start coming in from these individual search engines, a multi-search engine displays the result on the screen. The more advanced engine will collate the results, removing duplicate and put them in some sort of sensible order.

Multi-search engines are useful if you want to try and obtain a comprehensive listing of websites that cover a particular subject. Individual search engines may well not be fully comprehensive, and one may index sites that another has missed and vice-versa.

### **3. Natural language search engines**

This is a very small category with only very few engines; the most popular is probably Ask Jeeves at <http://www.aj.com>. Search engines in this category will take your search terms and will attempt to map them to other terms as well, so a search for 'tax revenue' will look also for financial, business and economic information.

They can be very useful if you are having real problems finding information; for example, was able to find a list of gases that are partially soluble in water by asking the question 'which gases are partially soluble in water?' I doubt that I would have been able to find that information as quickly or as easily using any other search engine.

#### **4. Resource or Site-specific search engines**

The final category of search engine is perhaps the largest, but paradoxically the least used, probably as a result of their diversity. A resource specific engine may well have been created simply to search one particular resource, such as the Bible, a dictionary or an encyclopedia. There is very little which can be said about these search engines, since they are all very different to look at and to use.

One type of resource-specific search engine which is worth mentioning here is little detail is what is generally referred to as 'people finder' or 'people searcher'. These engines will, as the name implies, find people on the internet. You obviously need to know a little bit about the person you are looking for, such as their name, where they come from and any other information you have available. A people searcher will then attempt to locate individuals in its database that match the information you have provided and will list them for you, thus allowing you to contact them. Usually, the Email address is given, but in some cases you can also discover their geographical address and even phone number.

##### **List of Some useful Search Engines:**

###### **1. Alta Vista**

Alta Vista was created in 1995 by digital equipment corporation, and was originally designed to index the entire internet. It is a very fast, up-to-date search service of the entire full-text of web pages and articles. It searches for exact phrases, word(s), Boolean operators (and/or, not, near); URL's addresses, page titles and related links. To ensure the most current database contents, Alta Vista uses a web spider program to routinely search every web page. Pages that do not change often are checked for updates less frequently than pages that changes often.

Alta Vista is a search engine; it helps users to find great deal of information on the Internet. Individuals can search for what they need by typing in the keyword or words they are looking for information about.

###### **2. Yahoo**

Yahoo is a fine search engine. Yahoo offers its visitors a wide range of services that are organized by categories. Some examples of categories that can be searched include Business and Economy, News and Media, Health, Government and Science just to name a few. Yahoo also offers links to Email, messenger, jobs, and even shopping. The user also has the option of choosing an advanced search or a search of the most popular sites. The page is arranged in a very colorful and easily maneuverable setup. The site is published by Yahoo Inc. and was copyrighted by this company in 2003.

Its homepage contains links to entertainment, shopping, current news, sports, weather, music and more. There is also a directory enabling users to search for information by categories. "Yahoo" is a site that provides a plethora of services. It is best known for its search engine; however, you can access a multitude of other things, with their main categories being Shop, Find, Connect, Organize, Fun, and Info. The

layout of the site is cluttered, yet not hard to use. There are many links for search categories, services, products, news, and more, however, all the links of the like kinds are grouped together, making the site easy to navigate.

### **3. Google**

“Google” is the premier search tool on the Internet. “Google” allow visitors to select a category and search for results based on a word or phrase entered. Categories include the Web, Images, Groups, Directory and News.

Google is a search engine; it helps users to find great deal of information on the Internet. Individuals can search for what they need by typing in the keyword or words they are looking for information about. The search can also be made more specific if users decide to do an advanced search. This would allow them to pick certain words that the source they are searching for must contain and other words it must omit.

Google is one of the most complete search engines on the Internet today. When the site is first accessed, the page is very plain, the main part being a text box with a flashing cursor. After entering a search expression, Google returns a list of hyperlinks to relative Web pages. Each hyperlink is accompanied by the URL of that page. Links at the bottom of each page take you to pages on company information, advertising information, search solutions, and services and tools.

### **4. Lycos**

It is a popular search engine on the internet. Lycos is the largest catalogue, which include 90% of the entire web. It’s “spiders” are constantly scanning the internet, automatically keeping tracks of new documents that appear, as well as changes and deletions to documents that already exist. Lycos provides the fastest possible search with the widest retrieval of information on the net. Currently, it catalogues three kinds of files: HTTP, Gopher and FTP files. The search can be performed by keyword(s) or simple Boolean (and/or), with options of loose or strong match and the number of displayed hits. The summary-information of each page helps to focus the search. “Point communications” owned by Lycos, offers a list of most popular web’s sites, with review and ratings.

### **5. Ask Jeeves**

“Ask Jeeves” is a search engine on the Internet. By entering a question, word, or phrase and clicking on the search button, users can receive results that most closely match their entry. The home page includes this search bar, as well as links to news and shopping. In addition, there are buttons at the bottom of the page for Interesting Queries, Breaking News, Browse by Subject, and AJ Kids. There is also an option to add the search feature of “Ask Jeeves” to the toolbar of your browser, which provides convenient searching without the hassle of first going to the homepage of the website. This site is designed to provide convenient searches, news, and shopping. Its primary audience includes Internet users everywhere. The site is published by Ask Jeeves, Inc. and was copyrighted by this company in 2003.

## 6. Infoseek

Infoseek is another popular search engine. It allows users choose the best search mode depending on the level of search assistance they require. Two Info seek search engines are offered as part of Info seek service : general and advanced. General offers comprehensive query results. It is especially good if you have a general idea of what you are seeking, but you do not have specific details. Advanced (search options link) is intended for experienced searchers who know what they want and how they get it quickly. One way to narrow your search to places other than web pages with Info seek is by using its drop-down menu.

As with most search engines, the returns that most closely match your search results are cited first. To narrow your search even further, Infoseek offers you the choice of searching only within the results. Like many search engines, Infoseek return your results in terms of the percentage of its accuracy, with the highest likely return results first.

## 7. Excite

The first concept based navigational tool, which searches web pages and the past two weeks of Usenet postings. Search by a keyword or concept (in plain English). Excite finds not only sites and articles in response to a keyword, but also relevant pages connected by a concept. In addition to Netsearch, Excite's Netreviews provides a catalogue of reviewed sites organized by subject, and current news from Reuters.

## 8. Web Crawler

It has fast and simple search of indexed web pages. Also provides a list of most popular web sites and information on web statistics. The search is by a keyword, string of words, or, and, not, any. It searches the entire net everyday. Also, you can browse through category.

### 5.6. Boolean search model

George Boole (1815-1864) devised a system of symbolic logic in which he used three operators, viz. +, x and - to combine statements in symbolic form. John Venn later expressed Boolean logic relationships through what are known as Venn diagrams. The three operators of Boolean logic are the *logical sum* (+), *logical product* (x) and *logical difference* (-). Information retrieval systems allow the users to express their queries by using these operators.

*Logical product* or *AND logic* allows the searcher to specify the coincidence of two or more concepts. For example, in order to ask for information on 'computers and information retrieval' the user may formulate the search statement as

(COMPUTERS) AND INFORMATION RETRIEVAL.

*Logical sum* or *OR logic* allows the searcher to specify alternatives among search terms '(or concepts). For example, with the *query* statement.

(COMPUTERS) OR INFORMATION RETRIEVAL

the searcher indicates that items on either of these two topics, or both, will serve the purpose.

*Logical difference* or *NOT logic* provides facilities to exclude items from a set. For example, with the search statement

(INFORMATION RETRIEVAL AND NOT (DBMS))

the user narrows his subject, in this case specifying that he or she does not require information on DBMS.

These three operators may be combined in one search statement, e.g.

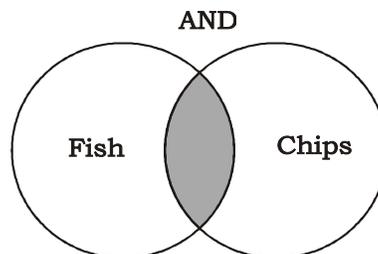
(INFORMATION RETRIEVAL OR INFORMATION SCIENCE) AND (ONLINE OR COMPUTERS) AND (DEVELOPING COUNTRIES OR THIRD WORLD) AND NOT (DBMS)

However, when the operators are combined, the resulting search statement can become quite complex. Venn diagrams can be helpful in demonstrating Boolean logical relationships. There are several ways of discussing and representing set operations and basic Boolean logic.

#### **5.6.1. Boolean query formulation**

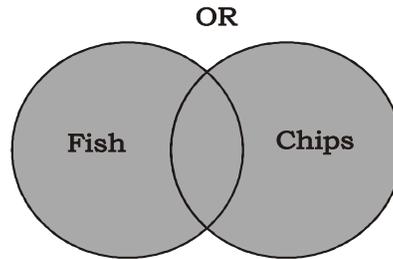
A text retrieval system should provide for query formulation by using the Boolean AND, OR and NOT operators, and also provide nested Boolean searching. Boolean search facilities allow a user to combine search terms in a given search prescription, with certain conditions imposed. These conditions specify whether more than one search term should simultaneously be present in the desired records, whether anyone of some chosen words should be present, or whether one or more terms should be present while another term should not be present in the desired records, and so on. Nested Boolean search facilities allow more complex conditions to be imposed along with the search terms. The following search statements permitted in BRS/ Search software illustrate the use of Boolean operators.

FISH AND CHIPS



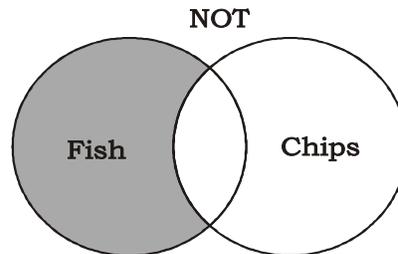
will retrieve all records with the search terms FISH and CHIPS occurring in the same record;

FISH OR CHIPS



will retrieve all those records where either of the search terms occur;

FISH NOT CHIPS



will retrieve all those records where the search term FISH occurs and at the same time the term CHIPS does not occur;

FISH XOR CHIPS

will retrieve all those records where either of the search terms occur but not both.

Text retrieval software may use different conventions for denoting the different Boolean operators. For example, in *STATUS*,

FISH + CHIPS ?

is equivalent to the 'FISH AND CHIPS' of the previous example, and

FISH, CHIPS ?

is equivalent to 'FISH or CHIPS'. The following is an example of a nested Boolean search expression allowed in Micro-CDS /ISIS:

LIBRARY \* (NETWORK + TELECOMMUNICATION)

which will retrieve all those records where the terms LIBRARY and NETWORK occur, and also those records where the terms LIBRARY and TELECOMMUNICATION occur.

All text retrieval systems, including online search services like DIALOG, and CD-ROM databases like LISA Plus, provide Boolean search facilities. Let us try to understand how a Boolean search takes place from a file organization

point of view:

- \* For Boolean OR queries, the system first finds hits for each search term and then matches the output sets to find out those records that contain both or either of the search terms.
- \* For Boolean AND queries, the system produces one set for each term is produced and then the results are matched to find out those record numbers that are common in each set.
- \* For Boolean NOT queries, a set(s) is produced with the search term(s) and another for the NOT term(s), and then the items which appear in the former set but not in the NOT set are retrieved.

However, as a number of sets are to be produced by the retrieval system, complex Boolean search expressions comprising a number of search terms combined with appropriate Boolean operators, may be quite time-consuming.

### **5.6.2. Limitations of Boolean searching**

Although Boolean searching has been used by almost all the information retrieval systems for quite some time, it has certain limitations. The first relates to the formulation of search statements. It has been noted that users are not able to formulate an exact search statement by the combination of AND, OR and NOT operators, especially when several query terms are involved. In such cases either the search statement becomes too narrow or too broad. Boolean searching, therefore, often calls for a trained intermediary.

The second limitation relates to the number of retrieved items. It has been noted that users cannot predict a priori exactly how many items are to be retrieved to satisfy a given query. If the search statement is broad, the number of retrieved items may sometimes be several hundreds and thus it may be quite difficult to find out the exact information required. On the other hand, a given search may retrieve very few items, if the search statement is too narrow, in which case the user may miss some relevant items.

The third limitation of Boolean searching is that it identifies an item as relevant by finding out whether a given query term is present or not in a given record in the database. Thus, all retrieved items are considered to be of equal importance, however, a given concept may be discussed in different documents with differing emphasis or weight there is no mechanism available in Boolean searching to determine this. In other words, the retrieved items cannot be ranked in decreasing order of relevance, for example.

It is therefore necessary to pay more attention to the provision of facilities that would enable the end-user to search in a more effective manner. Two different methods have been suggested for this purpose. The first is called *best-match searching*, also known as *nearest neighbor* or *ranked output searching*. These systems are designed to

produce ranked output through the application of statistical techniques. There are also other systems that use Boolean searches but with the help of front-end systems or interfaces, provide guidances to the users in conducting the search in an effective manner. These systems allow the user to put the query in natural language, and are, therefore, called natural language interfaces.

### 5.7. Conclusion

Information Retrieval Process (IRP) presents the relationship between user and a document as independent variables. The psychological characteristics of user have implications in information retrieval processes and practices. The subjective as well as the interpretive nature of relevance poses a serious problem in the evaluation of efficiency of information retrieval process. It might be quoted that cognitive modeling flexible search responses and qualitative representation would add value to information retrieval.

The application of Boolean factor to information retrieval systems, however, is not standard. There are differences in the processing order in which statements are combined. Some systems set the priority as NOT, AND, OR, whereas in other systems AND may take precedence over OR. It is extremely important that the correct Boolean search logic be used since the processing priority allocated to each Boolean operator will dictate the way in which the computer program will construe a search specification. For example, A AND B OR C AND D is capable of several interpretations. If the processing order is AND followed by OR, the processing will be [A AND B] OR [C AND D], but if the processing order is OR followed by AND, the processing order will be A AND [B OR C] AND D.

### 5.8. Self Check Exercise

Q. 1. How will you define Information Retrieval Process?

Q. 2. Enumerate the different limitations of Boolean searching.

*Note:* Check your answers with the answers given at the end of the lesson.

### 5.9. References and Further Readings

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### 5.10. Answers to Self-Check Exercise

**Q.1. Given the definitions of IR by different authors.**

**Q.2. Explain the Limitations of Boolean searching.**

**COMPUTER NETWORKS : CONCEPT, CLASSIFICATION OF COMPUTER  
NETWORK ON THE BASIS OF SIZE (LAN, MAN AND WAN) AND TOPOLOGIES  
AND ADVANTAGES OF NETWORKS**

**Structure of the Lesson**

- 6.1 Introduction**
- 6.2 Concept and Classification of Computer Networks**
- 6.3 Local Area Network**
  - 6.3.1 LAN Topology
  - 6.3.2 LAN Access Method
  - 6.3.3 LAN Hardware
  - 6.3.4 LAN Software/Operating Systems
- 6.4 Wide Area Network**
  - 6.4.1 Communication Switching Techniques
  - 6.4.2 WAN Devices/Hardware
  - 6.4.3 Types of Wide Area Networks
- 6.5 Metropolitan Area Network (MAN)**
- 6.6 Topologies**
- 6.7 Advantages of Networks**
- 6.8 Self check Exercise**
- 6.9 Suggested Readings**

**OBJECTIVES :** This lesson will make the learner familiar with the various network types.

**6.1 INTRODUCTION**

Today, Computer networks form the backbone of most enterprises big or small around the world. Computer networks allow people remote to the computer to access the information available to that computer. Computer networks are being used to provide resource sharing between systems separated from a few feet to thousands of kilometers. This technology is leading many corporations to take advantages of the reduced price and increased performance in the workplace. In this lesson we will discuss networking and how it plays an important role in information exchange. Impact of networking be it LAN or WAN and data communication has been felt across the globe, in various sectors such as education, medicine, transport, etc. This trend of information sharing in most

sophisticated manner has completely revolutionised the concept of communication. It brings with it increased access to people in different fields.

## **6.2 CONCEPT AND CLASSIFICATION OF COMPUTER NETWORKS**

Communication using computer has brought a revolution in the world of Information Technology, particularly in the field of personal computer. We have always heard of networking or the term network. A network is a way or means of transmitting or receiving (exchange) information from one or more sources.

As an example, car salesmen, after years in the business, have developed a network of associates. When the car salesman need to locate a car to make a sale, the car salesman calls out to his network to retrieve information on the location of the car. Employment agents also develop a network". Their customers become their networks. Employment agents will frequently keep in touch with their clientele for possible openings or to locate a candidate for an opening. Without the capability of networking, these two people would have a difficult time. It is the same in computing. Networks provide the means for locating and transporting information.

In computing networks, the origin of the information request utilises the services of a network to locate and return the information. This is done with addresses. In the two previous examples of the car salesman and the employment agent, a telephone number can be considered the address of their associate or client. Addresses in computer networking are used in the same manner. These addresses identify the network resource. There are two popular architectures for networking-hierarchical and peer.

Peer networking does not need pre-defined network addressing. Instead, each resource on the network is seen as a peer. Each network resource is a peer to the other network resources. When a new network resource joins the network it introduces itself and notifies its peer of any other network resources that it knows about - peer networks are open and share network information.

The entire computer network can be classified into three board categories.

- (a) LAN (Local Area Network)
- (b) WAN (Wide Area Network)
- (c) MAN (Metropolitan Area Network)

## **6.3 LOCAL AREA NETWORK (LAN)**

As number of systems grows within an organisation, a need is felt for sharing expensive resource and exchanging data and information between systems. This need of information exchange and resource sharing within an organisation has resulted in development of Local Area Network or LAN.

A LAN is a data communication network, which connects many computers or workstations (computers terminal, printer etc. and permits exchange of data and information among them, within a localised area, typically confined to a building, or a

cluster of buildings. The distance between two communication points connected on the same LAN channels, is usually upto 02-05 kms.

LANs are not rigidly defined but tend to share most of all of the following characteristics :

- (a) All the connected devices in the network share the transmission media.
- (b) Each device connected in the network can either operate standalone or in the network.
- (c) Area covered is small.
- (d) Data transfer rates are high, usually 1 Mbps-100. (Million of bits per second)

### **6.3.1 LAN Topology**

A network topology refers to the physical layout of the network in which all the devices are connected. This includes all the hardware that makes up the network. The points of connection to the network by the stations are called Nodes or link stations. There are several types of topographical design and strategies used to implement LAN. The majority of these are based on three types of topologies :

Star Topology

Bus Topology

Ring Topology

### **6.3.2 LAN Access Method**

A discipline must be imposed on devices connected to the network to ensure a controlled access to the media. Access methods are the means or ways by which stations actually gain the use of the common channel to transmit messages. The right to transmit is an issue only in broadcast where workstations share a single channel.

Many techniques have been proposed, but two of these are commonly used.

- (i) Carrier-Sense Multiple Access with Collision Detection (CSMA/CD)
- (ii) Token passing

### **CSMA/CD**

CSMA/CD access method is used with bus networks. The bus operates in a Multiple Access (MA) mode. A node is allowed to transmit on the bus, if it senses that the medium is free (carrier sense). Occasionally two or more nodes may simultaneously sense that the medium is free and begin to transmit. This creates a collision, as the contents of transmitted information frames will collide resulting in corruption of the information frame. This collision is detected (collision detect) by the transmitting node. The two (or more) nodes involved then wait for a further short random time interval before trying to retransmit a frame once again.

**Token Passing**

Another way of controlling access to a shared medium is by the use of a control (permission) token. The control token is passed from one node to another according to a defined set of rules understood and adhered to by all nodes. A node may transmit a frame when it is in possession of the token and after it had transmitted the frame, it passes the token to the next device in a predetermined sequence.

In token passing, a logical ring to all nodes connected to the physical medium is first established and a single token is generated; the control token passes from one node to another traversing the logical ring. The token keeps on circulating the logical ring until it is received by a node waiting to send an information frame. After receipt of the token, waiting station transmits the waiting frames on the physical medium after which it passes the control token to the next node in the logical ring.

For token passing, the physical medium need not be a ring topology; it can be used to control access to a bus network also.

**6.3.3 LAN Hardware**

As we have seen so far, to realise a LAN process, several functions are to be performed. These are so specialised in nature that they require hardware specially built for such purpose. Here we will discuss briefly the basic hardware components of LAN, these are :

**(a) Transmission Channel**

The transmission channel may be simplex, half duplex or full duplex.

**(b) Network Interface Units (NIU)**

Network interface units connect each device in the LAN network to shared transmission device. It contains the rules or logic to access the LAN. NIU is also used to implement LAN protocols and for device attachments. Its function depends on the type of topology used in LAN. In microcomputers, NIU may be installed as an add-on card.

**(c) Servers**

One of the major benefits of implementation of LAN is sharing expensive resources such as storage devices, printer etc. This is achieved through providing servers on the LAN. It is a dedicated computer, which control one or more resources. This contains both hardware and software interface for LAN. Three major categories of servers used in LANs are :

- (i) File Server
- (ii) Printer Server
- (iii) Modem Server

In a networking file server is used to share storage space for files, Besides providing storage space for files in a LAN environment, it is used for taking periodical backup, and also to provide gateway to other servers within and between LANs. Similarly printer server is used to handle printing works of all workstation connected in the network In LAN environment also modem is required to get connected to other network or simply to use a telephone. A modem server is used to share few telephone lines and modems by all connected workstations in a network.

#### **6.3.4 LAN Software/Operating System**

As the name suggests, LAN Operating System is required to operate on the LAN system, manage the tremendous work load with a number of various types of server attached to it. It has basically two aspect (i) Server software (ii) workstation software. As in case of other multi-user operating systems, LAN operating system also facilitates the sharing of expensive resources such as printer, storage space etc. among all LAN users provides security for data and permits connection to other networks. There are various types of LAN operating system for example Novel Netware. WINDOWS NT, etc.

#### **6.4 WIDE AREA NETWORK**

As the name suggests, WAN spread across countries and continents, satellites being one of the transmission media. A Wide Area Network or WAN, is a network that links separate geographical locations. A WAN can be a public system such as the Public Switched Telephone Network (the PSTN) or one of the various packet switched services provided by the public telecommunication authorities. WANs can also use most other types of circuit including satellite networks, ISDN, Value Added Networks (VANs/VADs).

The network can be a private system made up from a network of circuits leased form the local Telephone Company or set up using public systems as virtual private networks. A Virtual Private Network is one which operates in the same way as a private network but which uses public switched services for the transmission of information.

The main distinguishing feature between a WAN and LAN is that, the LAN is under the complete control of the owner, whereas the WAN needs the involvement of another authority like the Telephone Company. LANs are also able to handle very high data transfer at low cost because of the limited area covered. LANs have a lower error rate than WANS.

##### **6.4.1 Communication Switching Techniques**

In WAN, two computing devices are not directly connected. A network of switching nodes provides a transfer path between the two devices. The process of transferring data blocks from one node to another is called data switching. There are three switching techniques commonly employed, and these are :

**Circuit Switching**

In circuit switching there is a dedicated communication path between the sending and receiving devices. The dedicated path is a connected sequence of links between switching nodes. A conventional telephone network, where a dedicated path is set between the caller and the called party for the duration of a telephone call is an example of circuit switching.

Communication viz. circuit switching involves three steps : Circuit establishment; data transfer; and circuit termination.

Circuit switching is mainly used for voice telephone network, but is not all that effective for data communication networks, as channel capacities are not fully utilised, as data communication equipments do not generate data continuously.

**Message Switching**

Message switching is an alternative switching technique, where it is not necessary to establish a dedicated path between the sending and receiving devices. In Message Switching, the sending device appends the destination address to the message and passes it to the network; the message is then passed through the network from one node to another till it reaches the intended destination. Each switching node receives a message, stores it briefly and then transmits it to the next node. Examples of a message are electronic mails, computer files, telegrams and transaction queries and responses. A complete exchange may consist of several messages. The basic disadvantage of message switching is the variable delay at intermediate switching nodes.

**Packet Switching**

Packet Switching combines the advantages of message and circuit switching. Packet Switching is functionally similar to message switching, in which data is transmitted in block, stored by the first switching node it meets in the network and is forwarded to the next and subsequent downstream nodes until it reaches the destination. The length of data block is limited in a packet switching network. Typical maximum length of packets is between 128 bytes to 4096 bytes. There are two approaches to packet switching.

- \* Datagram
- \* Virtual circuit

In datagram approach, each packet is treated independently and may follow a different path through the network. Packets may be re-ordered, dropped or delivered in wrong sequence. The communication protocols provide the error recovery and sequencing of packets at the receiving device.

In virtual circuit approach, a fixed logical path, through the network from the sender to the receiver is established before any packets are sent. This path remains unchanged for duration of the session. This is quite like circuit switching, but no

resources are reserved along the path. Packets are buffered at intermediate nodes awaiting transmission.

#### **6.4.2 WAN Devices/Hardware**

The switching techniques utilise the routing technology for data transfer. Routing is responsible for searching a path between two computing devices that wish to communicate and for forwarding the data packets on this path. Devices such as bridges, router and gateways provide this routing function.

While discussing the WAN devices we referred to X.25; what is it? X.25 is a set of recommendation by International Telegraph and Telephone Consultative Committee for packet switched network. You can refer to further readings for more details.

#### **6.4.3 Types of Wide Area Networks**

The essential purpose of Wide Area Networks, regardless of the size or technology used, is to link separate locations in order to move data around. A WAN allows these locations to access shared computer resources and provides the essential infrastructure for developing widespread distributed computing systems. We will now discuss the different types of WAN, which are commonly used.

##### **Public Networks**

Public Networks are those networks which are installed and run by the telecommunication authorities and are made available to any organisation or individual who subscribe it. Examples include Public Switched Telephone Networks (PSTN), Public Switched Data Networks (PSDN), Value Added Services (VANs/VADs) and the Integrated Services Digital Networks (ISDN). We would be discussing the main features of these services.

##### **Public Switched Telephone Network (PSTN)**

The features of the PSTN are its low speed, the analog nature of transmission, a restricted bandwidth and its widespread availability. As PSTN is designed for telephones, modems are required when it is used for data communication.

The PSTN is most useful in wide area data communication systems as an adjunct to other mechanisms. It is seldom advisable to use PSTN as the sole communications medium for building a network system. Costs are high, as data connections last for a considerable time. Also, the links set up are unreliable and can terminate without warning.

PSTN connections are usually easy to obtain at short notice, and are widely available and cover almost every location where people live and work. PSTN is most useful for occasional user or as backup to private circuits. It is also used for facsimile (FAX) machines.

##### **Public Switched Data Networks (PSDN)**

The term PSDN covers a number of technologies, although currently it is limited to Public Packet Switched Networks available to the public. The main features

of all PSDNs are their high level of reliability and the high quality of the connections provided. They can support both low and high speeds at appropriate costs.

Like the PSTN, a PSDN is very useful and adjunct to a private network for backup and occasional access purposes. It can also be used to link computer systems and networks of one organisation to several other organisations. PSDN is very popular for connecting public and private mail systems to implement electronic mail services with other companies.

#### **Value Added Services (VANs/VADs)**

In Value Added Services, the provider of such services must process, store and manipulate the data that is carried on the network, that is, add value to it. The technique can be used in specific types of business in which it is advantageous to be able to share information with other companies in the same line.

Electronic Data Interchange (EDI) is one area for Value Added Services in which two trading partners exchange trading documents such as purchase orders, invoices, transportation etc. using electronic means. In India, Videsh Sanchar Nigam Ltd. is a service provider.

#### **Integrated Services Digital Network (ISDN)**

The ISDN is a networking concept providing for the integration of voice, video and data services using digital transmission media and combining both circuit and packet switching techniques. The motivating force behind ISDN is that telephone networks around the world have been making a move towards utilising digital transmission facilities for many years.

Users in shops or small offices can use their digital connection to Telephone Company for transmitting both voice and data over the same twisted pair cable which connects their telephone. As information from the telephone/PC/ Stereo/TV/PABX are all seen as bit streams by the networks switch, they can be switched and transported by the same network.

#### **Private Networks**

The basic technique used in all forms of private WAN is to use private (or more usually leased) circuits to link the locations to be served by the network. Between these fixed points the owner of the network has complete freedom to use the circuits in any way they want. They can use the circuits to carry large quantities of data or for high speed transmissions.

#### **6.5 Metropolitan Area Networks (MANs)**

A Metropolitan Area Network (MAN) is one of a number of types of networks. A MAN is a relatively new class of network. There are three important features which discriminate MANs from LANs or WANs.

The network size falls intermediate between LANs and WANs. A MAN typically covers an area of between 5 and 50km diameter. Many MANs cover an area the size of a city, although in some cases MANs may be as small as a group of buildings or as large as the city.

A MAN is not generally owned by a single organisation. The MAN, its communications links and equipment are generally owned by either a consortium of users or by a single network provider who sells the service to the users. This level of service provided to each user must therefore be negotiated with the MAN operator, and some performance guarantees are normally specified.

A MAN often acts as a high speed network to allow sharing of regional resources (similar to a large LAN). It is also frequently used to provide a shared connection to other networks using a link to a WAN.

A typical use of MANs to provide shared access to a wide area network.

Some technologies used for this purpose are ATM (**Asynchronous Transfer Mode**), FDDI (**fiber-distributed data interface**) and SMDS (**Switched Multimegabit Data Service**). These older technologies are in the process of being displaced by Ethernet-based MANs (e.g. Metro Ethernet) in most areas. MAN links between LANs have been built without cables using either microwave, radio, or infra-red, free-space optical communication links.

DQDB, Distributed Queue Dual Bus, is the Metropolitan Area Network standard for data communication. It specified in the IEEE 802.6 standard. Using DQDB, networks can be up to 30 miles long and operate at speeds of 34 to 155 Mbit/s.

## **6.6 Topologies**

### **6.6.1 Network Topologies**

The term topology refers to the way a network is laid out, either physically or logically. A topology can be considered as the network's shape. It is the geometric representation of the relationship of all the links. There are five basic topologies: Bus, Ring, Star, Tree, and Mesh.

### **6.6.2 Bus Topology**

Bus topology uses a common bus or backbone (a single cable) to connect all devices with terminators at both ends. The backbone acts as a shared communication medium and each node (file server, workstations, and peripherals) is attached to it with an interface connector. Whenever a message is to be transmitted on the network, it is passed back and forth along the cable, past the stations (computers) and between the two terminators, from one end of the network to the other. As the message passes each station, the station checks the message's destination address. If the address in the message matches the station's address, the station receives the message. If the addresses do not match, the bus carries the message to the next station, and so on. Figure 16.4 illustrates how devices such as file servers, workstations, and printers are connected to the linear cable or the backbone.

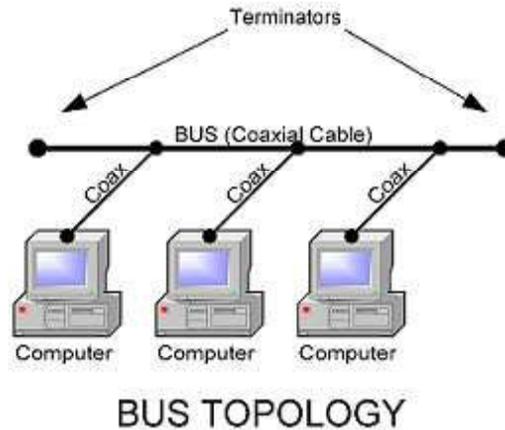


Figure 6.6.2

### Advantages of Bus Topology

- Connecting a computer or peripheral to a linear bus is easy.
- This topology requires least amount of cabling to connect the computers and, therefore, less expensive than other cabling arrangement.
- It is easy to extend a bus since two cables can be joined into one longer cable with a connector.

### Disadvantages of Bus Topology

- Entire network shuts down if there is a failure in the backbone.
- Heavy traffic can slow down a bus because computers on such networks do not coordinate with each other to reserve time to transmit.

### 6.6.3 Ring Topology

In ring topology, computers are placed on a Circle of cable without any terminated ends since there are no unconnected ends. Every node has exactly two neighbours for communication purposes. All messages travel through a ring in the same direction (clockwise or counterclockwise) until it reaches its destination. Each node in the ring incorporates a repeater. When a node receives a signal intended for another device, its repeater regenerates the bits and passes them along the wire.

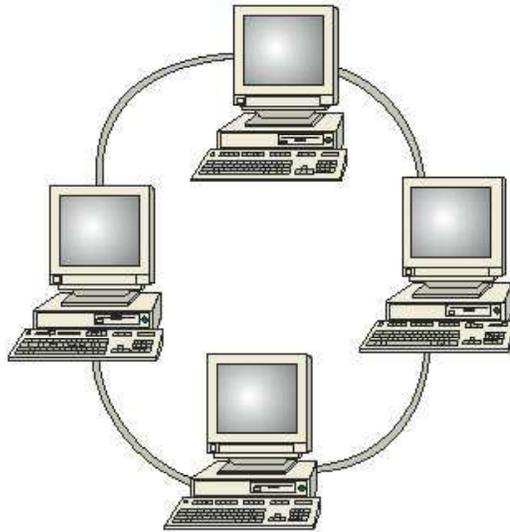


Figure 6.6.3 Ring Topology

#### **Advantage of Ring Topology**

- Ring topology is easy to install and reconfigure.
- Every computer is given equal access to the ring. Hence, no single computer can monopolise the network.

#### **Disadvantages of Ring Topology**

- Failure in any cable or node breaks the loop and can take down the entire network.
- Maximum ring length and number of nodes are limited.

#### **6.6.4 Star Topology**

In star topology, devices are not directly linked to each other but they are connected via a centralised network component known as hub or concentrator. The hub acts as a central controller and if a node wants to send data to another node, it boosts up the message and sends the message to the intended node. This topology commonly uses twisted pair cable, however, coaxial cable or fiber optic cable can also be used.

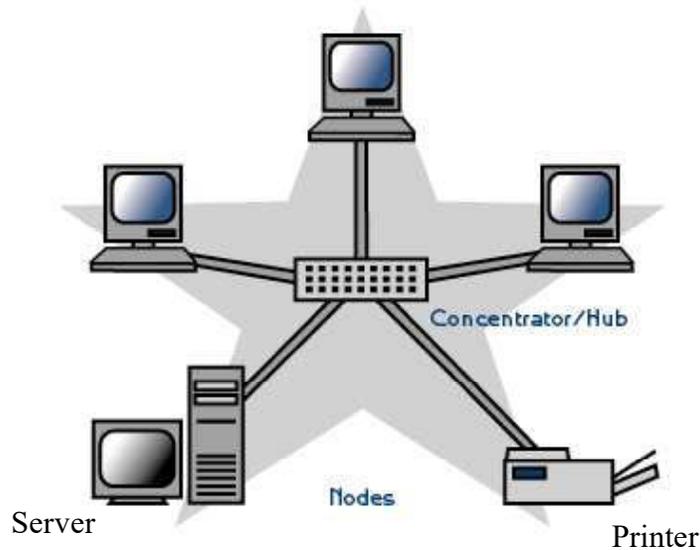


Figure 6.6.4 Star Topology

**Advantages of Star Topology**

- Star topology is easy to install and wire.
- The network is not disrupted even if a node fails or is removed from the network.
- Fault detection and removal of faulty parts is easier in star topology.

**Disadvantages of Star Topology**

- It requires a longer length of cable.
- If the hub fails, nodes attached to it are disabled.
- The cost of the hub makes the network expensive as compared to bus and ring topology.

**6.6.5 Tree Topology**

A tree topology combines characteristics of linear bus and star topologies. It consists of groups of star-configured workstations connected to a bus backbone cable. Not every node plugs directly to the central hub. The majority of nodes connect to a secondary hub that in turn is connected to the central hub. Each secondary hub in this topology functions as the originating point of a branch to which other nodes connect.

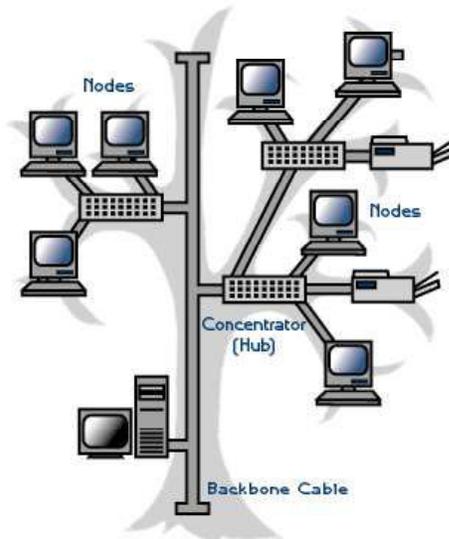


Figure 6.6.5 Tree Topology

#### Advantages of Tree Topology

- The distance to which a signal can travel increases as the signal passes through a chain of hubs.
- Tree topology allows isolating and prioritising communications from different nodes.
- Tree topology allows for easy expansion of an existing network, which enable organisations to configure a network to meet their needs.

#### Disadvantages of Tree Topology

- If the backbone line breaks, the entire segment goes down.
- It is more difficult to configure and wire than other topologies.

#### 16.2.5 Mesh Topology

In a mesh topology, every node has a dedicated point-to-point link to every other node. Messages sent on a mesh network can take any of several possible paths from source to destination. A fully connected mesh network has  $n(n-1)/2$  physical links to link  $n$  devices. For example, if an organisation has 5 nodes and wants to implement a mesh topology,  $5(5-1)/2$ , that is, 10 links are required. In addition, to accommodate that many links, every device on the network must have  $n-1$  communication (input/output) ports.

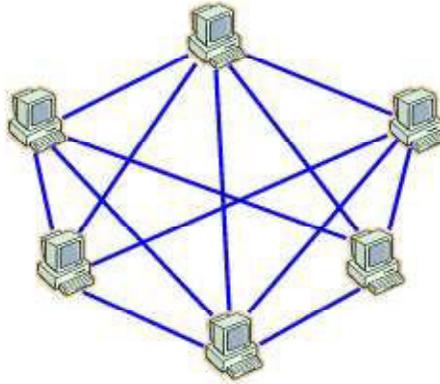


Figure 16.8 Mesh Topology

### Advantages of Mesh Topology

- The use of large number of links eliminates network congestion.
- If one link becomes unusable, it does not disable the entire system.

### Disadvantages of Mesh Topology

- The amount of required cabling is very large.
- As every node is connected to the other, installation and reconfiguration is very difficult.
- The amount of hardware required in this type of topology can make it expensive to implement.

## 6.7 Advantages of Networks

**Speed:** Sharing and transferring files within Networks are very rapid. Thus saving time, while maintaining the integrity of the file.

**Cost:** Individually licensed copies of many popular software programs can be costly. Networkable versions are available at considerable savings. Shared programs, on a network allows for easier upgrading of the program on one single file server, instead of upgrading individual workstations.

**Security:** Sensitive files and programs on a network are passwords protected (established for specific directories to restrict access to authorized users) or designated as “copy inhibit,” so that you do not have to worry about illegal copying of programs.

**Centralized Software Management:** Software can be loaded on one computer (the file server) eliminating that need to spend time and energy installing updates and tracking files on independent computers throughout the building.

**Resource Sharing:** Resources such as, printers, fax machines and modems can be shared.

**Electronic Mail:** E-mail aids in personal and professional communication. Electronic mail on a LAN can enable staff to communicate within the building having tot to leave their desk.

**Flexible Access:** Access their files from computers throughout the firm.

**Workgroup Computing:** Workgroup software (such as Microsoft BackOffice) allows many users to work on a document or project concurrently.

### **6.8 SELF CHECK EXERCISE**

- Q.1 Write a detailed note on LAN.
- Q.2 List down the various types of WAN.

### **6.9 SUGGESTED READINGS**

1. Andrew S Tanenbaum, "Computer Networks."
2. ED Titel, "Computer Networking."
3. William Stallings, "Data Communications."