2.0 INTRODUCTION

Information Technology (IT) has ushered in a variety of media that can help library and information managers in efficient and effective acquisition, organisation and dissemination of information. It has already been mentioned the computer technology and communication technology as two components of the information technology. Tremendous developments are taking place in both of these day by day.

The computer hardware and software are changing so fast. From a historical perspective it is quite amazing how much progress has been made in the computer industry in such a short period of time. Telecommunication is also changing very rapidly. There is a very fast development in the data transmission devices. The development of telecommunication has a great deal of kinship with that of computer science. In fact, much of the equipment is common to both fields. Telephone, television, telefax and terminals are just a few examples of engineering technology where improvements and developments are shared by both telecommunication and computing.

This chapter provides a global view on the development of information technology, and those aspects of it that are most significant for library operations are surveyed. The chapter has been divided into three sections. Section I provides an introduction to computer hardware and software. It has been completely updated to reflect recent developments in information
processing equipment and programme. Section II discusses developments in telecommunication technologies including general aspects of data transmission, data transmission channels, and networking technology. Section III surveys the technologies that are related to both above fields, such as computer network, CD-ROM, Video Text, Electronic Mail, Teleconferencing and other electronic devices.

2.1 COMPUTER

A computer is an electronic device designed to perform arithmetic operations. It can also perform several non-arithmetic operations on the alphabetic or numeric data used. These operations are performed at very high speeds, with a high level of accuracy. The machine is able to control volumenous information with the high speed which is not possible by any human being.

A computer system consists of three major groups of components:

(a) hardware or equipment;

(b) software or the programmes that cause the equipment to perform specific operations; and

(c) data or the information that the hardware and software process, store, retrieve, or otherwise manipulate (Saffady, 1994, p. 3).

2.1.1 Hardware Aspects

The term hardware refers to the physical components of a computing system which can be seen and handled. In the early days the term hardware
was used to denote mechanical devices such as analytical engine devised in 1833 to perform calculating automatically using punched cards. In the 1940s the first electronic computer i.e. ENIAC, came into being. The equipment is known as hardware.

From hardware viewpoint a computer system consist of several hundred thousand to several million electronic components. For a simplified description a computer hardware components are generally divided into two broad groups:

i) The computer itself. It is also called the central processor, the central processing unit (CPU).

ii) The peripheral (input/output) devices.

2.1.1.1 Basic Computer Configuration

Any computer system can be said to encompass four activities: capture data at source i.e. record data; prepare data in a form acceptable to a computer; perform processing requirements; communicate results of processing. The basic organisation of the computer for completing these four activities is shown in Figure 2.1. The computer can be treated as a system, consisting of various sub-systems, integrated with each other to achieve a common objective. As illustrated in the Figure 2.1 (adopted from Agarwal and Dhanajay, 1993, p.8) the functional components of a computer are:

i) Input Devices

ii) Central Processing Unit (CPU)

iii) Output Devices
2.1.1.1.1 Central Processing Unit (CPU)

The CPU which is the main unit of the computer, as described in Figure 2.1, it consists of three main sections.

1. Control Unit
2. Arithmetic Logical Unit (ALU)
3. Storage Unit

1. **Control Unit**

   This is the central nervous system of the computer. It controls, maintains order and directs the operations of the entire system. The programme instructions are stored in the main memory before execution. During execution they are transferred one by one to the control unit for
execution. Here, the instructions are interpreted and appropriate action for its execution is taken.

2. **Arithmetic Logical Unit (ALU)**

   The ALU is the area where calculations and comparisons (decisions) are made. Once the data from the input device is fed into primary storage, it is transferred to the ALU, as and when required. The entire processing takes place here. Data moves back and forth from the primary storage area to the ALU, using the working storage area (of the primary storage section) until the processing is over. The results of processing are released to the output storage area where they are held until release.

   The ALU contains one or more storage locations called registers. The registers provide temporary storage for one or both of the operands that take part in the arithmetic or logical operations. Generally, the result is also produced in a register.

3. **Storage Unit**:

   The primary storage section is the main memory of the computer and is logically divided into the following four areas.

   i) **Input Storage Area**: The area in which input data is held until it is ready to be processed.

   ii) **Working Storage Area**: The area that holds the data being processed and the intermediate results.

   iii) **Output Storage Area**: This is where finished results (output) are held until released to the output devices.
iv) **Programme Storage Area:** While the above three areas are data related storage areas, the programme storage area holds the processing instructions.

It should be noted that these four storage areas are not created through physical boundaries in the primary storage section. They may vary from application to application.

The memory contains a large number of storage cells, each of which can hold only one bit of information. The term **bit** is an abbreviation of binary digit. The bit can be either 0 or 1 and any type of data can be represented as a sequence of bits. A single bit of information is rarely handled separately. Instead, the memory is organized in such a way that a group of bits can be stored into or retrieved from the memory in a single operation. Such a group of bits is called a **word**. The number of bits that forms a word is fixed and is called **word length**. The word length, though fixed for a specific computer, varies from computer to computer. The word length generally varies from 8 bits to 64 bits.

The number of words that may be stored in a computer's memory vary from computer to computer. The memory size is often specified in terms of K words where K stands for the number 1024. Thus a 32 K memory indicates a word capacity of 32,768 words (i.e. 32x1024). Since the word length may differ from one computer to another, the memory size is often quoted in terms of **kilobytes** (KB). A byte is a group of 8 bits. Thus in a case where the word length is 16 bits and the memory is of 32 K, the memory size is often stand to be 64 KB (Agarwal & Dhananjay, 1993, pp. 9-11; Xavier,
The memory of the computer is of two types:

i) Read Only Memory (ROM)

ii) Random Access Memory (RAM)

**Read Only Memory (ROM).** This type of memory is permanently loaded by the manufacturer and cannot be changed or erased by the user. As their name implies, the contents of ROM circuits can be read. The several forms of ROM circuits are variously described as programmable read-only memory (PROM), erasable programmable read-only memory (EPROM), and electrically alterable read-only memory (EAROM). While these names suggest recordability, their contents can only be altered by special mechanisms that are typically unavailable to computer users.

**Random Access Memory (RAM).** This type of main memory circuit is blank when purchased. Under this type of memory, programmes are stored only as long as the power is ON. It is a read/write memory, i.e. information may be written on to, or read from it. Since the contents of this kind of memory are lost when it is powered OFF, secondary storage devices are used to permanently store programmes/data. (Xavier, 1998, pp. 132-133).

### 2.1.1.2 Input Devices

The input devices consist of one or more physical devices through which data or programmes can be read into the computer. Each input device requires the data to be recorded on a specific medium. From amongst the available input peripherals, two types of equipment are commonly identified as being widely used. These are: keyboard - oriented devices and optical recognition equipment. The keyboard oriented devices feature a
typewriter-like keyboard on which the data are typed character by character. On the other hand optical recognition also called electronic scanning uses reflected light to determine the content of material. The common input devices are: floppy drive, keyboard, magnetic disk drive, magnetic type drive, etc.

2.1.1.3 Output Devices

Similar to the input devices, the output devices are instruments of communication between the user and the computer system. These devices are used to output results from the CPU. The most common output device is a printer, which prints the result on paper. Other output devices are: magnetic tape drive, magnetic disk drive, floppy disk drive, plotter, visual display unit (VDU) etc.

Since many of these devices can be used both for input and output, they are generally referred to as input/output devices or more frequently as I/O devices. As computer systems have developed crossing their generations, input and output devices have improved and developed a lot in parallel. Figure 2.2 projects input/output devices.
2.1.1.2 Classification of Computers

Depending upon physical size, processing power, the type of peripherals, intended application and price, computers are generally categorized as follows:

i) Mainframe computers

ii) Minicomputers

iii) Microcomputers

Mainframe

At the low end of this product group, there are small mainframe computers with word lengths of 32 bits or more. Their processing speeds are typically measured in microsecond (millionths of a second). On the other end of the mainframe computer groups are so-called 'supercomputers'. Very powerful, special-purpose machine designed for scientific or other
research applications requiring the very fast execution of a high volume of complex calculations. Their word size is 64 bits; their processing speed are measured in fractions of a nanosecond (a billionth of a second). They provide main memory capacity for millions of characters.

Between these two extremes, most mainframe computers are properly identified as medium designed to perform the most commonly encountered scientific and data processing tasks. Medium-scale computers access 64 bits words, offer several hundred megabytes of main memory, and their operating speed is measured in nanosecond. They can support several hundred online terminals as well as high-capacity auxiliary storage devices.

**Minicomputers**

Improvements in the manufacturing of integrated circuit made such smaller devices to be termed “minicomputers” because of their smaller physical dimension when compared to mainframes. They are also available in a wide range of sizes and speeds. “Super-minis” are more powerful. These are 32 bits word length machines, the processing speed is measured in microseconds or even nanoseconds. Their main memory capacities approach gigabyte levels.

Minicomputers are often incorporated in the turn-key systems developed for library applications. They are sometimes used to control all the input from, and output to, terminals linked to a mainframe computers.

**Microcomputers**

Microcomputers are systems based on the use of microprocessor.
A microprocessor is a programmable large-scale integrated circuit chip containing all the elements required to process binary data. In simpler terms, a microcomputer performs all arithmetic and logical functions of a computer. Quite often microcomputers are also called personal computers (PCs).

The first microcomputers were based on microprocessors with a word length of 8 bits. More recent microcomputers are based on microprocessors with a word length of 16 bits and 32 bits thus providing faster processing speeds and increased storage facilities.

The next generation of chips 64 bit processor is underway and will bring even more power to the desk top. These developments are reflected in the emergence of a new computer called Personal Workstation (PW).

Portable microcomputers - variously categorized as ‘lap top’, ‘note book’, or ‘palm top’ systems - provide self-contained data processing capabilities outside of traditional work environments. The simplest personal computers incorporate a microprocessor, random access memory circuits and a keyboard in a single unit designed to be attached to a television monitor (Xavier, 1998, pp. 19-22).

The microcomputer world is indeed in a state of permanent evolution and progress. While in the past library automation was restricted by the high costs of mainframes and minicomputers, today microcomputers have brought tremendous computing power at affordable prices. Availability of microcomputers and turnkey systems etc. have further increased libraries desire to have their own computer systems.

As Saffady (1994, p.9) stated, types of computers can be categorized
by memory size, word length, and intended application as follow:

<table>
<thead>
<tr>
<th>Type of Computer</th>
<th>Main Memory</th>
<th>Word Size</th>
<th>Typical Installation pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large-Scale</td>
<td>16MB to 512MB+</td>
<td>64 bits or 32bits</td>
<td>Centralized in large library, government agency, corporation, or other organisation; shared by many departments.</td>
</tr>
<tr>
<td>Minicomputer</td>
<td>2MB to 64 MB+</td>
<td>32 bits or 16 bits</td>
<td>Centralized in medium size, library, government agency corporation, or other organisation; decentralized at division or department level in larger organisations; sometimes dedicated to specific applications, such as circulation control.</td>
</tr>
<tr>
<td>Microcomputer</td>
<td>64K to 16 MB+</td>
<td>32 bits, 16 bits or 8 bits</td>
<td>Decentralized at office or desk level in organisations of all types, and sizes, may serve as sole computer in very small libraries and other organisations; sometimes dedicated to specific applications, such as circulation control.</td>
</tr>
</tbody>
</table>

2.1.2 Software

For a computer to work and provide solutions, certain programmes are required to drive the hardware. The hardware is of no use by itself.

Software is the general term used to describe the type of programmes, or lists of instructions which are needed to enable the computer system to carry out the necessary processing. In other word, software is nothing but a

2.1.2.1 Type of Software

There are basically two types of software:

i) System Software

ii) Application Software.

I. System Software

The system software consists of standard programmes which enable a computer to function and control its own operation. The system software comprises of:

a) Operating Systems

b) Translator of Programming Languages (compilers and interpreter)

c) Utility Programmes

A) Operating Systems (OS) The operating system is a software that controls the entire operation of the computer system. Some of the examples of operating systems used today are MS-DOS, Windows, UNIX, VMS, MVS, etc.

B) Translator of Programming Languages (Compilers & interpreter)

Compilers translate the complete programme, written in a high-level language called a "Source language" into the equivalent machine level programme before the programme is actually executed by the computer.
An interpreter, on the other hand, translates each instruction separately as the computer needs it in order to process a given task. However, interpreters execute programmes more slowly than those executed by compilers.

Instructions are given to the computer with the help of computer languages. These languages can be classified as follows:

a) **Machine language**

b) **Assembly language**

c) **High-level languages.**

a) **Machine Language**. Computers use the binary system. All data or instructions ultimately have to be converted into a combination of binary digits 0’s and 1’s. Each computer system has its own machine language.

b) **Assembly Language**. This language was designed to facilitate writing programmes. In this method mnemonic codes are used by the programmer rather than binary digits.

c) **High-level Language**. A high-level language is designed to be user-friendly. A higher level language is closer to natural language. Many high-level languages enable programmers to write instructions using a combination of words in English and in mathematical notations. Some examples are COBOL, BASIC, FORTRAN, C etc.

C. **Utility Programmes**

During computer processing, there are some tasks which are repeated again and again. Instead of the user writing programmes for
performing these tasks, utility routines are written and provided by the hardware vendors. Some examples are: sorting routines, copying files, etc.

II Applications Software

Applications software denotes those computer programmes that are developed for specific applications like material systems, billing and despatch, financial accounting, etc. These programmes are custom designed to suit the existing systems and procedures in the organisation. For some standard applications, it is possible to procure a standard software package. Predesigned application softwares are becoming more and more popular as in the time and effort involved in designing a new software is generally very high (Xavier, 1998, pp. 151-169; Agarwal & Dhananjay, 1993, pp. 22-24).

2.1.2.2 Pre-written Software Packages and Turnkey Systems

For computer applications with relatively straightforward requirements, pre-written software packages are invariably more economical than custom-developed programmes, besides they offer the significant advantage of faster implementation. As the name implies, a pre-written software package is a programme or group of programmes that is marketed as a finished product.

To further simplify implementation, some software developers offer complete “turnkey systems” that consist of pre-selected combinations of hardware and software designed to automate specific operations. The vendor of turnkey systems supply the hardware and complete packaged software and is responsible for dealing with any problems in the system.
The turnkey designation suggests that a customer need only add the data particular to a given application, turn the key, and begin immediately realizing the benefits of automation without the involvement of programmers or other data processing professionals.

In the turnkey system the library staff could make the desired changes on the assumption that they possessed the necessary experience and qualifications. The most common complexes of turnkey systems at present are minicomputer based integrated library systems. They perform almost all housekeeping jobs as an integrated unit (Saffady, 1994 pp. 88-89; Riaz, 1991).

2.2 TELECOMMUNICATION TECHNOLOGY

2.2.1 General Aspects of Telecommunication

Telecommunication is the communication of signals over a long distance. It refers to any communication of information in verbal, written, coded, or pictorial form by electric means, whether by wire or by radio waves. Over the last 150 years, telecommunication has come to mean long-distance communication by electrical means, beginning with the telegraph in 1837. Nearly 40 years later the telephone made it possible to communicate by voice over a relatively long distance. Shortly after the beginning of the twentieth century, wireless telegraphy made transoceanic communication a reality. Two decades later radio stations were sending signals through the atmosphere. After World War II, television became widespread, and the emergence of space-age technology gave rise to communication satellites.
that made it possible to transmit television, telephone and telegraph signals around the world almost instantaneously.

Every telecommunication system has a terminal such as a telephone, fax, computer or radio transmitter. In some cases, as with the telephone, the interaction is two-way. In others, such as radio and television, the communication is one-way, from sender to receiver.

Telecommunication is made possible by network with switching systems, relay stations, and satellites that carry personal telephone calls around the globe. The great expansion of communication in the late twentieth century was made possible by the digital signals used in computers. With digital coding there is less distortion. Much more information can be sent per unit time, and data from voice, image, and graphics are easily integrated.

With high-definition television, which uses digital signals, television can be readily coupled with computers. The union of television and computers, together with fiber optics, will vastly enhance telecommunications and make it possible for television to become a truly interactive form of communication leading to the information superhighway (Gardner and Shortelle, 1997). However, there is a very fast development in the traffic devices. Non voice traffic, namely, datagraphics through fax, E-mail, and file-transfer etc. are growing very fast than voice traffic, namely, telephone, telex etc.

2.2.2 Data Transmission Channels

Telecommunication media transmit information in two ways: ‘analog’ and ‘digital’. Analog transmission constitutes a jumble of frequencies which
are in a continuous range (sound waves). Digital transmission occurs in a stream of bits. The bits are binary digits which form a digital code. Not only number, letters, and special symbols can be converted into binary code, but sound, visuals and voice can also be converted. In fact any type of information can be transmitted in either analog or digital form.

Communication lines are essential element of computer communication systems. The selection of a communication service to provide a specific bandwidth depends on the volume and speed requirements of the system. Data transmission channels, which carry data from one location to another, are classified as a narrow band, and ‘wide band’.

Narrow band line is a communication line similar to the common voice-grade line, but it operates on a lower frequency. It is appropriate for terminal-to-terminal interaction.

Wide band channel is a channel wider in bandwidth than a voice-grade channel. These channels which support faster speed are normally required for bulk transmission of large quantities of information between computers. A wide band communication system can accommodate broadcast and other services (Sippl, 1985). ‘Coaxial cables’, ‘microwave’ circuits and communication ‘satellites’ are commonly used to provide the broadband channels. These channels are discribed as follows:

**Microwave Transmission**

Microwave transmission is transmission of voice, television, or data signals by means of highly directional, high-frequency radio waves. The
microwave signals are electromagnetic waves in the super-high frequency portion of the radio frequency spectrum ([above 890 megahertz (MHz)]). Their wavelengths are sufficiently short to exhibit some of the properties of light. Microwaves are used in point-to-point communication because they are concentrated into a beam easily. In addition to the microwave transmission used by the communication common carrier, many privately owned microwave systems are in service.

**Satellite Communication**

In a satellite communication, the data is beamed to the satellite station that acts as reflector by accepting signals from one point on earth and returning the same signals to another point on earth. The satellite repeater receives radio transmissions for each earth station, amplifies the message and retransmits it. The message is picked up from the satellite by earth stations, which are often dish aerials.

**Cables**

A cable is a physical path which is used to send and receive signals. A cable that transmits only one signal is called a baseband cable. This term is often abbreviated to BAND. Some cables can handle simultaneous transmission of different signals by sending them at different frequencies. These cables are called broadband cables. The most commonly used cable types now a days are:

1. **Coaxial**

   Coaxial cable is the most common type on networking cable. It consists of an inner wire surrounded by a layer of insulating material, a
conducting layer of woven wire, another layer of insulation and a plastic covering. Coaxial cable is much used due to its wider band width, interface resistance, high conductivity and longer distance coverage.

2. **Twisted-Pair**

Twisted-pair cable uses one or more pairs of two twisted copper wires to transmit signals. It is commonly used in telecommunication. Twisted pairs are two colour-coded, insulated copper wires that are twisted around each other. A twisted pair cable consists of one or more twisted pairs in a common jacket.

Unshielded Twisted-Pair (UTP) cable consists of a number of twisted pairs with a simple plastic casing. UTP cable is available in different categories by quality grade-category 1 through 5. Each category refers to quality and characteristics. Category 5 supports Fast Ethernet, more insulation, more twise per foot, and data rate of 100 mbps and higher with compatible equipment (Tyagi and Anwer, 2000).

3. **Fibre-Optic**

Fibre-optics brought about a revolution, as a wide band communication channel. This type of cable consists of thin glass or plastic filament, about as wide as a human hair, protected by thick plastic padding and an external plastic sheath. Fibre-optic cable uses, a pulse of laser light instead of an electronic frequency to transmit a signal. Fibre optic links can support very fast transmission speeds (Suman & Lal, 1998).
2.2.3 Telecommunications Networks

Broadly defined, a telecommunication network is a combination of equipments transmission facilities, and in some cases, software that supports the communication of information-bearing signals from one location to another. The most familiar telecommunication network, the Public Switch Telephone Network (PSTN), was originally designed for the transmission of voice messages, although it is also used to transmit computer-processible information. Other telecommunication networks are Public Data Network (PDN), Satellite Data Networks (SDN), and Integrated Service Digital Network (ISDN).

Presently many countries have set up dedicated PDN for data transfer, which work on a packet switched mode, where in a physical line can be used more efficiently by multiplexing message packets from a number of sources. Expansion of packet-switching networks has also let to fall in the changes of inland and international calls with continuous improvement in quality and range of facilities. A packet-switched network employs dynamic allocation that moves messages from sender to receiver by way of intermediate nodes. Data is broken up into small units of data called packets. Each packet contains an address which tells the communication hardware where the packet should be sent. At the destination, the receiving computer reassembles the packets and if any are missing, the computer requests a retransmission (Krishnan and Sanjay, 2000). Satellite networks are broadcast networks where a message is transmitted by one station and heard by all other stations.
ISDN is a system of digital phone connections which has been available for over a decade. The system allows data to be transmitted simultaneously across the world, using end-to-end digital connectivity. The ISDN is a world wide public telecommunication network that delivers a wide variety of services. These kind of supernetworks provide universal, accessible, flexible information services. The services that are used extensively over ISDN are mainly two types: Textual form, and Pictorial form. Textual form includes Electronic mail, Teletext, Videotext, Viewdata etc., where the flow of information is a dialogue or distribution/retrieval. In pictorial form, the services include fascimile, teleconferencing and moving pictures etc.

These fast developing changes in networking technologies will heavily influence computer specifications because of excessively used on-line networks, which have become quite common today (Abdulrashid, 1997; Ramesh et. al. 1996).

2.3 Related Technologies

There are a variety of other technological developments in the telecommunication and computer area which are of potential relevance to libraries and information centers. These technologies are discussed in this section.

2.3.1 Computer Network

A computer network is a specialized form of telecommunication network. It consists of various combinations of computers, terminals and
related equipment connected by data communication facilities.

In computer network terminology, hardware components are called ‘nodes’ and communication facilities are called ‘links’. The specific types and combinations of nodes encountered in a given computer network will vary with the networks topology or structure. Computer networks also vary in their geographic spans, and the type of communication facilities they use.

Computer networks are often categorized by their geographic spans as follows:

i) Local Area Network (LAN)

ii) Wide Area Network (WAN)

I) Local Area Network (LAN)

A local area network connects computers and related devices located within a narrowly circumscribed geographic area, such as a college campus, a school, an office building, or a library. A local area network is a data communication network for independent devices capable of autonomous operation. LAN nodes may be computers or autonomous noncomputer devices, such as facsimile machines. Printers, disk drives, and other nonautonomous peripheral devices are not themselves considered nodes, although they may operate as LAN devices attached to nodes. In many local area network installations, designated nodes function as servers which provide particular resources to other network nodes.

Local area networks typically utilize telephone wires, sometimes described as ‘twisted-pair wiring’ or coaxial cable as communication links.
Also fiber optic links can be utilized. As an alternative to conventional cabling, some local area networks use microwave, infrared, or spread-spectrum radio technology to transmit signals between nodes over the air (Sharma, Sarita, 1996).

II) Wide Area Network (WAN)

A wide area network links geographically distant computers and related equipment. WANs may utilize a combination of leased telephone lines, fiber optics, terrestrial microwave, satellite microwave and other high-speed linkages that permit long-distance communication. Perhaps the best-known example of a publicly accessible wide area computer network is the Internet. It is actually a collection of networks that interconnect computers in universities, government agencies, scientific laboratories, corporations and other organisations (Suman & Lal, 1998).

2.3.1.1 Network Topology

In a network computers are connected to each other. The way in which the connections are made is called the topology of the network. It refers the locations of the computers and how the cable is run between them. It is important to select the right topology for how the network will be used. Star, ring and bus are three most common topologies.

Star

Star wiring brings all the cables together at some central box. Each machine will have only one cable (containing either two or four wires) leading to a central box of some sort. This is the preferred topology for trouble shooting and newer networks.
Ring

With a ring topology, each station has two cables, one going in and the other going out. The last machine in the line up connects back to the first to form a ring. All the stations are effectively in series. One advantage is that each station acts as an amplifier; no separate amplifier is needed except for abnormally long cable runs. A ring is a very difficult configuration which either connects or removes a station. Since each station is needed to complete the ring, either each station will have to be always turned on or the two ring ends will have to be "jumpered" when a station is turned off or removed.

Bus

A bus topology uses one long central cable. The computers are connected to this cable at tap points. The two ends of the main cable simply end in a terminating resistor. A physical bus can be somewhat difficult to troubleshoot because each connection point is at a different physical location, often in the ceiling or inside a wall. Any failure in the central bus cable will often disconnect half, if not all, of the users.

2.3.1.2 Network Protocol

A protocol is a set of rules that governs the communications between computers on a network. These rules include guidelines that regulate the following characteristics of a network: access method, allowed physical topologies, types of cabling, and speed of data transfer. Protocols can be broadly divided into hardware and software categories. Hardware protocol define how hardware devices operate and work together. Programmes
communicate with each other via software protocols. The most common protocols are: Ethernet, Local Talk, Token Ring, FDDI, ATM (Tyagi, OM P., 2000)

2.3.1.3 Hardware Components of a Network

Networking hardware includes all computers, peripherals, interface cards and other equipment needed to perform data processing and communications within the network. For successful transmission as well as receipt of data via network it is necessary to have the following hardwares.

Bridge

A bridge consists of a computer with two or more network interface cards connecting two different types of networks. For example, one interface card might connect to an Ethernet System, while a second card connects to a Token Ring system. These two systems speak two entirely different data languages that is recognised by the other.

Gateway

A gateway is used when simply transferring data between networks is not enough. Some network systems (in particular mainframe or minicomputers - based systems) require specific instructions on how data is to be managed once it is received onto the network. A gateway is also required when connecting two or more networks that are running on top of different Operating Systems (OS).

Network Interface Card

It is the key component of the network workstation. Its chief purpose
is to send data out onto the network and receive data sent to the workstation in which it resides. Each network card is manufactured with a unique, permanent electronics address. The licensing system allows the manufacturer to encode a unique address on the card. This licensing system ensures that no address is ever duplicated.

**Terminals**

A terminal is a device that allows users to transmit data to, and receive data from a computer or other information-processing machines. Terminals designed for interactive applications can be categorized in a number of ways. With respect to their electronic circuitry, terminals can be categorized as dumb, smart, or intelligent. Dumb terminals derive all of their information-processing capabilities from the computer with which they are communicating. Smart terminals are essentially enhanced versions of nonprogrammable dumb terminals. Intelligent terminals are actually programmable microcomputer that can also function as terminals.

**Modem**

The public telephone network has been routinely employed for data transmission for several decades. But it was originally designed to transmit the continuously varying analog signals characteristic of the human voice. The discrete, digitally coded signals generated by online terminals and other computing devices must consequently be converted to analog form prior to transmission and reconverted to digital form following reception. This conversion process, which is termed “modulation and demodulation”, is performed by modem. A modem is an electronic device that converts digital
signals to and from the analog form required for transmission over telephone lines. In terminal-to-computer communication over analog telephone lines, both devices must be equipped with modems.

Transmission Media

Cable is the medium through which information usually moves from one network device to another. There are several types of cables which are commonly used with LANs. In some cases, a network will utilize only one type of cable and other networks will use a variety of cable types. The type of cable chosen for a network is related to the network’s topology, protocol, and size. The following three types of cables are generally used in LAN to connect the computers: twisted pair cable, coaxial cable, and fiber optic cable. Some LANs are wireless. Wireless LANs use infrared or radiowave transmission.

Hubs

Hubs are used to interconnect the terminals and servers. All the networks (Except those using coaxial cable) requires a central location to bring media segments together. These central locations are called hubs. A hub organizes the cable and relays signals to the media segments. A hub can be either passive or active. The passive hub is a simple device that only accept connections. The active hub is a complicated electrical components that monitor and control the flow of information to various network locations.

Server

It is powerful computer which runs special software to act as a file server and it is completely enclosed logical structure which is secure against...
accidental or malicious abuse as it can be accessed only through Network Operating System (NOS). (Suman and Lal, 1998; Saffady, 1994, Dhiman, 2000).

2.3.2 Internet

Internet is a worldwide communication system which links together thousands of computers. In fact it is a network of thousands of networks which communicate among themselves using a single set of software which are generally known as protocols. In Internet environment such protocols are termed as TCP/IP (Transmission Control Protocol/Internet Protocol). When a number of computers use these protocols they are said to be internet worked. The TCP/IP protocols can also be used on local area networks without actually being connected to internet (such networks are termed intranets). However, if they are connected, they can have access to all other computers and databases situated worldwide and use their resources. The computers which are part of the internet are called hosts (Singh, 1997).

The internet, intranet and extranet are revolutionary in increasing effectiveness and knowledge of the use of information. Internet is a worldwide information net used for searches, communication and E-mail. Intranet is a company's internal information net based on Internet technology. Extranet is a two-way net allowing customers and partners access to company’s intranet (Kauria, 1998).

Approximately half of the networks of Internet are commercial and one third are associated with educational and research institutions. The number of people using internet has grown to over 100 million and to 45
million host computers in nearly 200 countries. By the end of 2000 AD, the number of Internet connections will grow to at least 300 million (Naidu, et. al., 1998).

2.3.2.1 Internet Services

Various services offered by internet range from basic E-mail services to high facility hypertext viewing. The popular offering by Internet include: E-mail, mailing list, Usenet/Newsgroups, World Wide Web, Gopher, Archie, Veronica, WAIS, FTP, Telenet, etc. Basically these fall into four categories, namely E-mail applications, user groups applications, publishing applications and browsers to retrieve information of interest.

E-Mail

E-mail is the most extensively used service on the Internet. Through gateway, it is possible to communicate with the Internet from other networks. This service permits the electronic transmission of messages between computers as long as there are networks connecting them. Internet mail makes mail delivery more reliable. One can also make requests for database searches through electronic mail and have the results mailed back.

Usenet / Newsgroup

Usenet is the Bulletin Board Service (BBS) of Internet. Electronic BBSs are very effective ways to share information. The messages in Usenet are organized into thousands of topical groups or “Newsgroups” which cover specific areas of interest. Usenet is read and contributed to, on a daily basis, by millions of people.
Telnet

Telnet allows an Internet user to login to remote host from the local host. Once connected and logged into the remote host, the user can enter data, run programmes, or do any other operation just as if he were logged in directly to the remote host.

FTP

File Transfer Protocol (FTP) is used for copying files from remote host to a user’s host and vice versa, even if each computer has a different operating system and file storage formats. Many systems connected to the internet have file libraries, or archives and libraries of documents accessible to the public.

Archie

Archie is a collection of servers used for searching files at several different anonymous FTP sites. A huge shared database is used for pooling information by archies servers which is updated from time to time. A keyword is given for the search.

Gopher

Gopher is a menu driven utility that allows its user to search for the information in various information libraries or servers around the world. It is different from Archie which only lets user know when the information is found whereas Gopher actually gets the information and puts it on the screen.
Veronica

Very-Easy, Rodent-oriented, Net wide Index to Computer Archives (Veronica) is a programme that can be accessed through Gopher. A keyword is entered for Veronica to search for files, Veronica then searches and gets all the files matching the keyword and stores them on a temporary Gopher menu that user can browse through.

WWW

World Wide Web (WWW) is based on Hypertext. In Gopher menus are linked together and for searching files or documents one has to give a keyword whereas in www documents can be linked together. One can read a document and from that document he can go to a new document by just pointing the keywords in the original document and can form the new document to another new document and so on.

Web Browsers (Mosaic)

The software that make the web work is called a web browser. The most popular browser is Mosaic. Mosaic translates HTML (Hypertext Markup Language) files into attractive, readable on-screen documents, making the web seem more like a traditional easy-to-navigate online service. It requires a native TCP/IP connection and hence users with shell accounts will not be able to use it. Cello, Win web, Netscape are some of the other popular web browsers available for Windows and Lynx is a non-graphical web interface.
WAIS

The Wide Area Information System (WAIS) is a full text indexing software that is used to index large text files, documents and periodicals. When a word is typed in, WAIS searches internet libraries. It returns a master index providing links to all the sites related to the request. The index is weighted, identifying which links are most closely related to the topic (Reddy and Rajan, 1997; Kumar, T.S. 1999).

2.3.3 Compact Disc

Compact disc is the generic designation for a group of read-only optical disc formats based on specifications developed jointly by Sony and Philips. Philips produced the first CD in 1985 and since then a number of agencies have started producing CDs. The most encountered type of compact disc is a rigid plastic platter that measures 12 centimeters (4.75 inches) in diameter. A nine centimeter version is also available. The various compact disc formats are typically categorized by the type of data they contain. The best-known formats are intended for music and/or video recording. They include Compact Disc Digital Audio (CD-DA), Compact Disc - Video (CD-V), and Compact Disc - Interactive (CD-I). Digital Video Disks (DV-Ds) the double-layer high-density CDs with storage capacity of 7.4 GB to 10 GB are expected soon. They will have the added advantage of running audio and video apart from text. In the near future CD-Recordable will be available. They will be useful in CD-publishing, online storage of text, audio and video and archival backups.

Compact Disc-Read Only Memory (CD-ROM) is the compact disc
format for computer processible information and widely accepted optical media. A 4.75 inch CD-ROM can store approximately 680 MB (Megabytes). It is likely to be increased ten times within the next few years. Read-Only Memory means that the data is permanently stored or coded on the disc and it cannot be added to, erased, rewritten or altered. The data is recorded in digital form using laser beams. The recorded information is read by special designed drives which typically operate a microcomputer peripherals. (Sharma, 1996; Ramesh, 1996; Meera, 1998).

Initially CD-ROM was distributed on a single workstation configuration which was too expensive for the small institutes and information centres. The cost and sharing of information led to the introduction of multi user and multi disk CD-ROM systems, which are more economical for most of the organisations, especially where the same data or databases are required for several users.

2.3.4 Multimedia Technology

Multimedia (MM) means digitising information from a number of resources, text, graphics, images, video, audio and recording it on a computer system where it can be manipulated and recombined. Multimedia is a collection of multisensory presentation technologies combined through a common user interface into an information delivery system. Multimedia has become possible because many previously separate pieces of hardware -such as phone, television and computer- are moving toward the use of a single technology called digital. The multimedia denotes the evolving phenomenon that includes interactive use of multiple digitised media in all
aspects of computing. Multimedia enables the addition of ‘real world’ to any application on a personal computer to improve the effectiveness of the communication of information or the transfer of knowledge by providing their desired information for what it is needed, where it is needed and how it is needed. Multimedia products include various types of databases, network publishing and portable systems. The driving technologies for a successful multimedia markets are CD-ROM, digital audio tape, multimedia telephones and fiber optics, (Rao & Muralidhar, 1997; Singh et al, 1998).

2.3.5 Videotext

Videotext systems deliver information to specially modified television receivers. In videotext technology a number of innovative approaches involving various combination of transmission technologies like telephone cable, TV cable, satellite, optical fibers have been recommended for videotext delivery. Through this system the users can get hard copy by using home facsimile or printing devices.

Videotext systems have been divided into two categories - Teletext and Viewdata - which are differentiated by the information dissemination methodology they employ.

Teletext systems, sometimes called “broadcast videotext” utilize an otherwise unused portion of conventional television signals to transmit digitally coded information over the air or through cable services. Teletext information is usually formatted as a ‘magazine’ composed of a predetermined number of pages or frames that are continuously broadcast on a recirculating basis. Teletext subscribers are equipped with specially
modified television receivers. After consulting a table-of-contents frame, the subscriber selects a desired information frame and enters its number into a keypad that operates with a television receiver equipped with a teletext decoder. The indicated frame is captured by the decoder as it is rebroadcast and is stored in the decoder’s internal memory, from which it is displayed on the television screen.

Viewdata systems transmit information stored in computer databases through a telephone line and display them on a television screen or computer terminals. The simplest terminal is a television receiver equipped with a viewdata decoder, typewriter-like keyboard, and modem. Viewdata systems resemble conventional timesharing computer services, although the information they offer is a distinctively packaged combination of text and graphics. Compared to viewdata technology, teletext systems are simpler, both conceptually and technically. They require no special telecommunications or computer facilities, but their interactive facilities are limited to the selection of desired pages from a recirculating collection of frames. With viewdata systems, the use of telephone lines permits interactive communication, but teletext system is usually one way, not allowing any feedback from the user. Viewdata systems can address a broader range of information processing applications than their teletext counterparts.

The major videotext systems in the world are Prestel (UK), Prodigy (US), Teletel (France), Captain (Japan), Teledom (Canada), Videotel (Italy), Video tex (Sweden), Videtel (the Netherlands) and so on. Libraries constitute a major category of users of this service (Vijayakumar, 1997; Ramesh et al, 1996, Saffady, 1994 pp. 177-180).
2.3.6 Teleconferencing

Teleconferencing is a generic term that denotes the combined use of telecommunications and electronic technologies as an alternative to in-person meetings. In fact it is a sort of network capability that uses the telephone as a medium for voice transmission, the television for video, and the computer for data transmission service. Data terminal are connected together via the telephone network.

Videoconferencing is a form of teleconferencing. Videoconferencing systems utilize video and audio technology to conduct interactive meetings between geographically separated groups of people.

Another form of teleconferencing is audioconferencing, which was the familiar conference telephone call to establish a voice link between three or more people.

Computer teleconferencing is another variant form of teleconferencing which can be used by hundreds of people at diverse geographical locations through terminals. In the simplest computer conferencing configurations, one participant sends a message to multiple recipients for comments. Individual responses are appended to the original message and can be reviewed by other participants. These, in turn, may provoke responses which are themselves made available for review and comment. The result is a computer - sorted dialogue that can be reviewed, in whole or in part, by all authorized persons (Vijayakumar, 1997; Saffady, 1994 pp. 183-186).

2.3.7 Audiotex

This is also known as voice service. It is a form of electronic news
delivery service. As it is practiced in USA, a computer system allows callers
to dial a phone number and obtain information from a prerecorded menu of
options. The items available through this service include news, weather,
stock market rates, sports results, and the like. In 1993 roughly one-third of
the newspapers in America had some form of audiotex system in operation
(Vijayakumar, 1997).

2.3.8 Electronic Mail

The term “Electronic Mail” or simply E-mail has different connotations.
However, its main characteristic can be said to be the transmission of material
from place to place or person to person, using electronic methods of
capturing, transmitting and delivering information. In the broadest sense, voice
communications by telephone can be considered a form of electronic mail
and message system, but the scope of this group of automated products is
usually limited to those systems that transmit text and graphics generated by
handwriting, typewriters, word processing programmes, or any of the several
special terminals. The term covers telex, teletex, facsimile and computer-
based electronic mail services.

Computer-based electronic mail systems are actually software
packages designed to operate on timeshared mainframes or minicomputers,
or an microcomputers linked in local area networks. Most computer-based
electronic services have a central controlling computer. This computer, at
the centre of the system, has been programmed to divide a part of its memory
into compartments, known as "mailboxes", which can be allocated to individual
users. The system software keeps track of the individual mailboxes and will
“post” messages to the appropriate address. Communication facilities enable users to call in to the system in order to read messages and to send mail (Glausiusz & yates - mercer, 1990; saffady 1994 pp. 170).

2.3.9 Facsimile

Facsimile, also known as telefacsimile or simply fax, is the oldest of the image-oriented message transmission technologies. In a facsimile system an encoded image of document is transmitted electronically from one location to another, where it is reconstructed as a paper copy. In most cases the transmission medium is an ordinary, voice-grade telephone line to which a facsimile machine is connected by means of modem, although facsimile signals can also be transmitted by terrestrial microwave carriers, satellites, coaxial cable, or other communication facilities.

Fax machines are categorized into four standard groups. Group I and Group II standards applied to analog facsimile equipment, which is now obsolete. Group III facsimile devices, which employ digital encoding, have dominated the technology since the 1980s. The Group IV facsimile standard likewise employs digital encoding and image compression but is intended for high-volume transmission of documents over leased rather than switched telephone lines. Depending on the type of fax machine and communication channel it takes from a few second to a few minutes per page to deliver facsimile documents.

Considerable recent attention has been given to the relationship between facsimile and computer technologies. Fax modems can convert computer-processible information to a form suitable for facsimile
transmission, thereby eliminating the need to print them as paper documents for scanning. For terminal-to-computer communication, most fax modems can also operate as conventional data modems (Gardner and Shortelle, 1997).

2.3.10 Hypertext

Another novel trend is the concept of hypertext, i.e. a non-linear, non-sequential text. The hypertext system allows the user to look for information, such as words or sentences, in one electronic document to related information in another document and the creating trails through associated materials.

In hypertext, the linking of information and the setting up of pathways through a large information store is enhanced by harnessing the powers of computers to their implementation. Two commercial hypertext applications available in the market are: (a) Apple computer’s Hyper Card; and (b) Owl international’s guide for the IBM PC and Macintosh. The service provides for the deposit and continual revision of linked electronic documents and simultaneous access to a large collection of documents. Moreover, this has paved the way to opening of texts for comments and verification by readers. The computer can help track these comments (Varalakshmi, 1992).

2.3.11 Desk Top Publishing (DTP)

The developments in the computer industry brought in major changes in printing industry also. DTP has emerged in the last few years as the latest application of the microcomputers. It has changed the concept of publishing, and brought on the desk top high quality and low-cost printing. The arrival of DTPs facilitate in-house publishing in libraries. The computers with the aid
of software packages like Venture or Page Maker can make writing, editing,
graphic design, illustrations, typography, type setting and printing operations.
The personal computers, combined with advanced laser imaging technology,
are capable of producing prepress production system. A terminal, word
processor and page make up software, mouse, scanner and printer are the
basic elements of desk top publishing system. The faster growing
applications of DTP, in libraries, are to produce printed brochures,
newsletters, facts sheets, annual reports, training manuals etc. (Natarjan,
1993; Wright, 1995).