UNIT 3 TELECOMMUNICATIONS : BASICS

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3.0 OBJECTIVES

After reading this Unit, you will be able to:

- understand what telecommunications is all about and the features and characteristics it involves;
- explain the basic, concepts and terminologies in telecommunications;
- discuss the ways and methods as to how information is transmitted;
- identify the specific telecommunications technologies and their current or potential applications in library and information activities;
- examine information developments which are a direct result of the recent advances in telecommunications; and
- acquire knowledge relating to some important standards that are helpful in the transmission process.

3.1 INTRODUCTION

Telecommunications is an important area of Information Technology. The rapid developments in telecommunications over the past twenty years have been an essential component in the growth of computer-based library and information systems and services.

It would not have been possible to realise and implement systems and services like Videotex, Teletext, CATV, Electronic directory, Electronic mail, teleconferencing, document preparation and transfer, database handling, VANS/LANS, etc. without the aid of telecommunications. Also, the comparatively cheap and easy way by which large collections of bibliographic data on a variety of computer systems throughout the world can be passed on to or accessed from a terminal in a library or information centre would not have been, possible but for the rapid developments in telecommunications.

Since all these aspects have become part of computer-based library and information systems and services, it is necessary that an information professional should have a basic knowledge of recent innovations in telecommunications which involve the use of novel transmission media, increased computer control of networks and specific provision for data communications. All these provide' faster, cheaper, and more reliable transmission of large amounts of data over both short and long distances. The integration of electronic mail services means that they can all be accessed from one terminal, either through the use of specific hardware such as telex or fax boards, or via 'protocol conversions. Similar type of integration is being seen with online search services also. This Unit is intended to provide telecommunications basics with the objective of imparting elementary knowledge of the subject to the participants of BLIS Programme. The Unit is intended to be a primer in this regard.

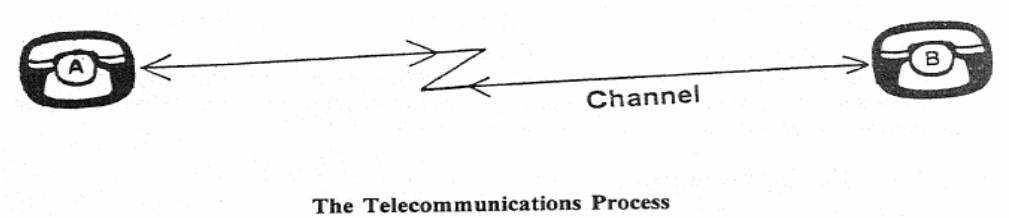
3.2 BASIC CONCEPTS AND TERMINOLOGY

In order to understand specific telecommunications technologies and their current or potential applications, in libraries and information services, we need to understand basic concepts and terminology in telecommunications. It is assumed that the participants of BLIS programme of IGNOU have no prior knowledge of the subject. Hence, some of the elementary concepts and terminology are discussed in this section to provide them the necessary backdrop.

3.2.1 Telecommunications; Definitions

`Data communications', `Communications technology', `Computer telecommunications', Compunications', `Telecomputing', etc., are just some of the terms we come across in our 'current literature on the subject. Most of these terms are used to describe a process, that of transmitting a message from one point to another by electronic means, and the devices used to achieve this process. The process is well known and we engage in this process daily as we speak to one another. We call this the communications process. Therefore, "Telecommunications may be defined as the transmission of representations of information between remote locations by electronic means. This information may be in the form of Voice, Video, or data generated by, a computer". (Kenney, 1981)

When we use the telephone to talk with each other, we engage in a telecommunications process. We use the telephone instrument (which might be characterised as a terminal) to enter our message (data) for transmission to another point; at the destination, another terminal is used to receive our message and return one if needed. The two terminals are connected by an electronic communications channel 'or link, which serves to carry the message from point A to point B and back again. A telecommunication process, thus consists of data to be transmitted (our messages), devices called terminals to send and receive messages, and a communications channel (see the fig.).



The Telecommunications Process

In ease many messages are being sent and received at any one time between many different points; switching mechanisms are needed to ensure that all messages arrive as quickly as possible, without bottle necks encountered along the way. For an easy understanding of this concept, we can compare this message traffic to city traffic, flowing in many directions and controlled by traffic lights which allow only a certain number of vehicles to move in a given direction at any one time. Telephone messages are similar to vehicles; both have definite

points of origin and destination and we can think of the system of traffic lights as switching mechanisms, to permit vehicles to move as quickly as possible to their destination. We speak of traffic networks, and similarly, we speak of telecommunications networks.

"A telecommunications network, at its simplest, may be regarded as comprising a transmission network, an arrangement of transmission paths and switching centres through which signals are conveyed by a physical transmission medium. Information coming from a source, or to a receiver, is converted via a terminal into signals appropriate to the characteristics of the particular network". (Bawden and Blakeman). For example, in the standard voice telephone network system, the changes in air pressure at the microphone are represented by a corresponding variation in electrical voltage. This is an example of an analogue signal. In contrast, computer systems generate digital signals, which are represented as one of two discrete states, namely on or off (1 or 0). Other sections of this Unit will be devoted for a brief description and discussion of the process of data transmission, communication channels, transmission media, switching mechanisms, terminals and networks - all of which form the basic components of telecommunications.

Self Check Exercise

l) Explain briefly the concept of "telecommunications"

2) Describe the functional components of a telecommunication network.

Note: i) Write your answer in the space given below

ii) Check your answer with the answers given at the end of this Unit.

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3.3 DATA TRANSMISSION

When we talk on the telephone we generally transmit a message to someone else. The message is made up of words that we speak into the telephone instrument. The human voice causes sound to be formed into words; these sounds are transmitted in the form of acoustical wave patterns into the telephone instrument where they are translated into electronic wave patterns. These wave patterns are transmitted over a channel to their destination where they are converted back into sound waves received by the human ear. It may be mentioned that all electronic transmission takes place by means of wave patterns. There are two major patterns. They are analog and digital.

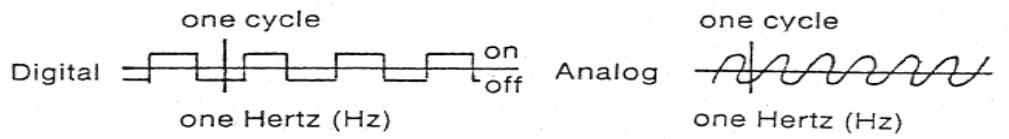
3.3.1 Analog Transmission

In analog transmission, there is a continuous up and down pattern. For example, one wave constitutes one cycle, which is measured in the unit called Hertz (cycle per second), the terms cycle and hertz may be used inter-changeably. Thus, it is customary to describe channels as transmitting a certain number of cycles per second (cps).

3.3.2 Digital Transmission

In digital transmission, wave patterns are translated into discrete bits and are separated by intervals. Bits (contraction for binary digits) are the smallest unit of information in data processing. They may be compared to a light-bulb, which is either on or off. When the bulb is on, information is being transmitted; when it is off, there is a blank or interval. In the figure, the upper line of the rectangular wave form represents the bits. The lower line denotes the interval between bits. At this juncture, it must be noted that all electronic transmission

can occur in either the analog or the digital mode. The telephone network, originally intended to carry only the human voice, operates mostly in the analog mode, although all-digital transmission is now available as well. Digital transmission has the advantage of being entirely compatible with computer and terminal originated messages, which also operate in digital mode, and of having the capability of transmitting messages more accurately than the analog mode.



Transmission Modes

3.3.3 Frequency and Bandwidth

Let us try to understand a little about how information is transmitted. The information may be in the form of sound (human voice, music) or it may be visual (printed page, microfilm, video picture) or it may be digital data. Whatever may be the form, it must be converted to electrical signals (electromagnetic waves) before it can be transmitted over a given medium. Such signals very often cannot be sent over a channel as they are, but must be modulated in some way to fit them into the carrying medium. The frequencies of the electromagnetic waves are normally radio frequendies which range from low frequencies capable of carrying only small amounts of information to millimeter waves, which can carry very large amounts. Above the radio frequencies lies light frequency, which can be modulated to carry even larger amounts of information. In other words, the amount of information that can be sent over a given channel in a given time is dependent on the bandwidth. The bandwidth available increases with increasing carrier frequency. Thus, generally speaking the wider the bandwidth, the larger the amount of information which can be carried and the faster its speed. Therefore, we can provide a definition to the concept of frequency as under.

Frequency is the rate at which a wave or cycle alternates between high and low (analog mode) or on and off (digital mode). For example, the lowest buz notes reproduced on a good stereo set may emanate a wave pattern as slow as 30 times (cycles) per second, while very high notes cause wave patterns to alternate as often as 20,000 times per second.

One cycle per second is called a Hertz (HZ). The enclosed table shows some frequencies for telephone and other electronic transmission media.

Electronic Transmission Frequencies

Media	
Sub-voice	30-300 Hz (Hertz)
Voice	300-3000 Hz
High Fidelity Equipment	3-30 KHz (Kilohertz)
Radio Broadcasting	30-3000 KHz
Television Broadcasting	3-30 MHz (megahertz).
VHF Television	30-300MHz
UHF Television	300-3000MHz
Satellite Communication	3-30 GHz(gigahertz)
Microwave communication	30-300 GHz
Lasers, fiber optics	300 GHz Tern hertz Range

Bandwidth

Bandwidth is the second concept important for transmission. This concept can be explained with the help of the traffic network mentioned earlier. If there is a two-way street, consisting of two single lanes, one in each direction, only one line of vehicles can travel in each direction. On a superhighway, however, there may be three or four lanes in each direction; cars may travel along these lanes, in parallel, each at its own rate of speed. We have a wider

`band' of highway which can accommodate more cars traveling in the same direction at the same time. In the same way, the width of the electronic path determines how many cycles or bits can travel along this given path at any given time; the more bandwidth is available, the more bits may be transmitted, and the better the quality of transmission. In a simple telephone conversation, we use a bandwidth of about 3000 bits per second or 3 KHz . Television needs more bandwidth to accommodate audio and visual signals, and uses approximately 4,500,000 Hz or 4.5 MHz.

Frequencies and bandwidth occur from low to very high along a continuous range of frequencies called the spectrum. To keep transmission from interfering with one another, each type (voice, radio, television, satellites, etc.) is allocated a bandwidth in this spectrum. Allocation is determined for any nation by its communications commission and internationally by the International Telecommunications Union (ITU) to avoid competition for the same bandwidths by different carriers and countries.

When bandwidths are allocated°, sufficient extra space is provided between frequencies to prevent electronic interference in so far as possible. This safety precaution might not always work, when we hear or see overlap among radio broadcasts or television programs.

3.3.4 Message Quality and Quantity

Quality of transmission is a very important .consideration in telecommunication. Voice communication can use a narrow bandwidth, which means the reproduction of sound is not of high fidelity because the human ear is adaptable and can discern words even if not entirely faithfully reproduced. The same is not true for the transmission of music, where we expect high quality sound; for television broadcasting, where our picture must be sharp and the quality of colour high; and especially for data transmission, where inaccurate bit transmission can result in garbled and worthless messages.

There are many techniques, besides providing more bandwidth than actually needed, to improve transmission quality and reduce the noise. One such technique is multiplexing. Multiplexing is of two types: Frequency Division Multiplexing, (FDM) and Time Division Multiplexing (TDM). Frequency Division Multiplexing is used to split a channel into several discrete narrower ones for simultaneous but separated transmission. On the other hand, time division multiplexing uses a common channel for several messages but at intermittent times; each signal taking turns on the same channel. In other words, multiplexing is a technique that is often used to interleave data so that they can be carried more efficiently in the same bandwidth. It is similar to concentrating but replaces many lines with one transmission path of .greater capacity. It must be remembered that multiplexing is a sharing technique only. There is no increase in the total information than can be transmitted.

Self Check Exercise

3) Explain the concept of frequency and bandwidth.

4) write short on message quality and quantity in telecommunication.

Note: i) Write your answer in the space given below

ii) Check your answer with the answers given at the end of this Unit.

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3.4 COMMUNICATION CHANNELS

A wire pair connecting two telephones is the simplest circuit, allowing communication in both directions. Other channels include coaxial cables, optical fibres, satellites, a light beam, microwaves, and others. Whatever the physical medium over or through which message travels, transmission may take place in a number of different modes. They are : Simplex, Half-duplex and Full-duplex.

Simplex In this type of channel, the message travels in only one direction, that is from point A to point B but not back again.

Half-Duplex Transmission can take place in either direction, but not at the same time. In other words, message can be transmitted either from A to B or by B to A one at a time.

Full-Duplex In this type of arrangement messages can be transmitted and received over the same channel at the same time.

Many librarians and information scientists are familiar with the latter two types because database search terminals must be set to transmit full or half duplex in order to communicate with database vendors' computers.

3.4.1 Synchronous and Asynchronous Transmission

Another method of setting of terminals denotes synchronous or asynchronous transmission. Many terminals can only communicate in one or the other mode. Asynchronous transmission is also known as "start-stop" transmission. This means that every transmitted character (or group of characters) is defined by a special character at the beginning and end denoting `beginning' and 'end' of that character.. Thus, the receiving terminal does not have to operate "in phase" with each other and transmission is interpreted or decoded at the receiving terminal exactly as it was encoded by the sender In other words, in synchronous communication data is sent from one machine to another in a continuous stream, the sending and receiving equipment must be in step with each other throughout the transmission. This type of transmission is used for high speed data transmission, generally between two mainframes.

Asynchronous form of communication is used by most information systems attached to the public telephone network.

3.4.2 Moderns

As it was explained earlier, communications channels can operate in either the Analog or digital mode. However, a given circuit can operate only in one mode not both of them at the same time. Thus, there is need for translating from one to the other of the two modes. All voice communication occurs in the analog mode; yet, when we use voice-grade channels to transmit data we need to communicate with the receiving or sending computer in the digital mode.

Modems are devices which function as "translators", changing the digital signals coming out of the terminal to analog so that it can travel along a voice-grade channel. At the receiving end, there is another modem, retranslating the analog signal into the digital signal the computer can accept Modem stands, for modulation-demodulation. Some modems are built into the terminal, while others are separate devices interposed between the terminal and the telephone line;

Modems come in a variety of forms. They are : acoustic coupler, stand-alone modems, and internal modems. Modems are sometimes referred to as V22, V32, etc. The V numbers are series of standards defined by Consultative Committee for International Telegraphy and Telephones (CCITT), some of which are summerised below:

V2I	300bps	full-duplex	asynchronous
V22	1200bps	full-duplex	asynchronous
V22 bis	2400bps	full-duplex	asynchronous
V23	200/75bps	full-duplex	asynchronous
V26	2400.1bps	full-duplex	asynchronous
V27ter	4800bps	full-duplex	asynchronous
V29	9600bps	full-duplex	asynchronous
V32	9600bps	full-duplex	asynchronous
V2142	Recent standard including error		correction protocols

Self Check Exercise

5) Explain the difference between Simplex , Half – Duplex and Full- Duplex modes of transmission .

6) What is the difference between synchronous and asynchronous transmission

7) What is meant by the acronym modem? Explain its use in transmission process.

Note: i) Write your answer in the space given below

ii) Check your answer with the answers given at the end of this Unit.

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3.5 TRANSMISSION MEDIA.

When we speak of transmission media, we usually mean a mix of physical lines ranging from wire pairs to cable, and over the air transmission media, such as microwave and satellites.

The transmission media used in telecommunications networks vary both physically and in their carrying capacity. The "commonly used performance measurement of a telecommunications link is its **bandwidth**. This gives an indication of the range of frequencies which can be transmitted by these channels. The greater the bandwidth, the greater the rate at which data can be transmitted.

The channels or media can be grouped into two main divisions, i.e., line and' free space. In the line group, we have two metallic media, twisted pairs and coaxial cables and one optical medium - glass or optical fibres. In the free space category, we have radio propagation which includes broadcast (e.g., TV) and point to point (e.g., microwave signals). Let us discuss these in a greater detail.

3.5.1 Twisted Pairs

Twisted pairs are familiar to all of us as the copper wire telephone lines. These are of low frequency, and support a limited bandwidth (one voice channel) but can also be used for data communication at the lower speeds of 300bps. For higher speed or rates of data transfer,

4-wire leased lines may be used. The problems associated with this kind of transmission are: noise on the line, parity errors and so on. Twisted pairs are used for conventional voice telephone and telex services.

3.5.2 Coaxial Cables

Another metallic transmission medium which offers a large bandwidth, is the coaxial cable. Such cables consist of an outer protective shell made of copper tube, less than one inch in diameter, which actually carries messages. There are two types of coaxial cables- the base band and the broad band. Base band cables use digital transmission and are suitable for fairly short distances. These have a data rate of about 50 Mb/s in half-duplex mode. Broad band coaxial cable on the other hand, is more familiar as CATV and is suitable for long distance (up to 15 KM) transmission. It can support data rates of over 100 Mb/s. Coaxial cables, with their better electrical properties, can transmit at much higher frequencies and support wider bandwidth than the twisted pairs. They are suitable, therefore, for high quality bulk transmission of data at high speeds as well as text, picture and voice. For example, one such cable can support the equivalent of up to 10800 telephone (voice) channels.

3.5.3 Optical Fibres

Coaxial cables have limitations such as broadband transmission medium which can be overcome by the use of optical fibres. Optical fibres carry light waves (representing electrical impales) by the principle of internal reflection. These fibres carry signals in the form of light, and hence can carry large volumes of data at high speed, and are resistant to interference. Thus, they are `clearer' lines with less noise. Though they were expensive when first introduced, but nowadays costs hive fallen to such a level that they are being used by some organisations for their local area networks.

3.5.4 Microwave Transmission

Using space as transmission medium, microwave emanates from an origination point on earth, such as telephone exchange, where many individual messages have been concentrated. Because the microwave beam travels in a straight line, it is advantageous to place microwave towers on hills or mountains to minimise interference from land mass. Usually, towers are placed between 25 to 30 miles apart to remain in sight of each other (`line-of-sight'). Microwave transmission can carry 600 to 1800 voice channels. Advantages of microwave transmission include lower cost than coaxial cable, where right-of-way must be obtained and higher costs are incurred when the physical cable is laid over long distances. As with other systems that transmit through free space the signals are subject to fading caused by absorption and scattering from moisture and precipitation in the air. In other words, atmospheric interference is greater and rain can cause severe transmission problems.

The great advantage is that the microwave transmission is a broad band facility able to carry several thousand channels. It is suitable for bulk transmission data over long distances.

3.5.5 Satellite Transmission

Satellites use microwave frequencies and techniques. Satellites used for message transmission (as opposed to those, which travel around the earth on strategic and meteorological missions) remain in constant position in relation to a fixed location on earth; they are said to be in a geostationaty orbit. This position allows the satellite to of data over a long distance.
Used extensively for general telecommunications, as well as for television, satellites were originally contemplated only for long distance transworld links but are now increasingly employed for high speed; high volume transfer for example document delivery, electronic publishing. In some countries like India, satellites are used instead of underground cables because of the high cost of installing the latter.

3.5.6 Choice of Medium

All the transmission channels discussed in the foregoing paragraphs can be used as point to point connections or as broadcast systems. Transmitting information electronically or photonically is considered in two aspects - telecommunications and broadcasting. The former is a direct interchange of information within limited groups of talkers and listeners (which may be terminals of computers as well as people). Thus, there is a certain amount of interaction. Broadcasting is the mass distribution of information to large markets with one `speaker' and many "listeners' and no real interaction.

Because of the increasing linking up of the two forms with computers, the traditional distinction is being blurred and now you get systems like electronic mail, which can either he broadcast of telecommunication and cable TV broadcasting systems which carry telecommunications. And any given transmission circuit could be made up of a mixture of terrestial microwaves, cable and satellite links. Thus, a given service could be transmitted over more than one of channel. For example, a television program can be broadcast let us say normally - as you get it at home via satellite or via broadband coaxial cable using radio frequency.

The decision on which medium to use is determined by factors such as the distance involved, the area to be covered and the type of information to be sent. For example, terrestial microwave radio transmission requires line-of-sight communication and for long distances repeaters must be added. If the medium has to accommodate video or high speed data then a broad bandwidth such as is provided by satellite and coaxial, fibre optical cables will be required.

3.6 SWITCHING MECHANISMS

Switching mechanisms are techniques devised to send messages in many dinections at once and to ensure that these messages are received with a minimum of delay. In other words, if a bottleneck or queue occurs in message traffic, bypasses or alternate paths to the destination are provided by taking recourse to switching mechanisms.

If traffic between two exchanges is too heavy, an alternate path is chosen. These exchanges perform the switching function for the telephone system. Switching is carried out by computers in most cases. Computers also serve to concentrate (collect) messages for transmission over higher capacity lines. The lines used in the telephone network are wires, coaxial cables, microwave and satellite links.

The different techniques relating to switching mechanisms are discussed below.

3.6.1 Circuit Switching

Many switching techniques are in use. One of them is line or circuit switching in which a communications path is actually established before the message is accepted for transmission. For voice communication circuit switching is the norm where by a path through connected circuits is established. While this method is suited to telephone traffic, it is not so, economical or efficient for data which is transmitted at different bit rates and in varying amounts.

3.6.2 Message Switching

This is a different technique associated with switching. According to this method, the system accepts all messages, stores them in a computer, and transmits them as and when channels become available,

3.6.3 Packet Switching

This is one of recent techniques of switching. Packet switching was originally developed for use by ARPA network by the Defence Department of US. According to this method, each message is broken into packets of approsimately 1000 bits each. Each packet carries information about its origin and destination Packets are stored and forwarded by means of computers in a steady stream, but not in any order. Specially designed computers sort out

the packets at each node in the transmission network and retransmit them along the best path to their destination, where they are put in the right sequence for decoding. Because of the standard size of packets, transmission is highly efficient and less prone to error. As a result, economies are effected which benefit the end user. -Packet switching is the technology used in value-added networks like Tymnet and Telenet, which provide libraries with connections to many database search services.

The advantages of packet switching include transmission economies because of shared utilization, high quality, error reduced service, and the facilities for speed changing and procedures conversion thus allowing communication between different types of terminals and the interconnection of networks.

Self Check Exercise

8) Discuss briefly the different types of transmission media.

9) Explain the meaning of the term 'Switching Mechanism' and mention the advantages of 'packet switching'.

Note: i) Write your answer in the space given below

ii) Check your answer with the answers given at the end of this Unit.

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3.7 NETWORKING AND TELECOMMUNICATIONS

Computers can now communicate with each other and with a range of peripheral devices, over distances with increasing speed and reliability. Technological advances in worldwide communications have ushered in a new era not only of computing power but also of access to information services at _least in those countries which have been able to develop extensive and reliable telephone networks. The transmission over telephone network, not only of voice, but more recently also of text and illustration through telefacsimile, laid the foundations for this age in which communication is taken for granted in developed countries. Predictions made earlier, that rapid growth in computer networking would be the emphasis of the ¸1990s seem to be borne out in the developments of networks at local, regional, national and global levels. Some of the developments are discussed in the following paragraphs.

3.7.1 Networks

There are different interpretations for the term °nets% The Oxford English Dictionary states that `a network is an interconnected chain or system of immaterial things". On the other hand, the National Commission on Libraries and Information Science (NCLIS) USA defines network as: "Two or more libraries and/or other organisations engaged in a common pattern of information exchange, through communications, for some functional purpose. A network usually consists of a formal arrangement whereby materials, information and services provided by a variety of types of libraries and/or other organisations are made available to all potential users. Libraries may be in different jurisdictions but agree to serve one another on the same basis as each services its own constituents. Computers and telecommunications may be among the tools used for facilitating communications among them". (ALA Year Book, 1976, p. 248).

UNISIST II working document defines Information Network as : "A set of interrelated information systems associated with communications facilities, which are operating though more or less formal agreements and institutional arrangement in order to jointly implement information handling operation with a view to pooling their resources and to offer better services to user. They generally follow identical or compatible procedures." (UNISIST II).

3.7.2 Types of Networking

There are three types of networking, which may be said to have considerable impact on library and information services. They are: communication networks, computer networks and information networks. Although as information professionals, we are to understand the functioning of each of these types, in the context of this Unit, we shall limit our discussion mainly to communication networks.

Communication Networks

Communication networks are made up of transmission lines, concentrators, switching mechanisms and non-data processing components. Due to increased competition in the communication industry, new and specialised common carriers and value-added networks with data processing equipment, is also linked to communication networks.

The current technological trend setter in communications is "packet switching technology". The greatest advantage of packet switched networks is in applications where the distance involved is great. Information services involve relatively large quantities of data for full bibliographic or full text retrieval, and therefore, the distance advantage applies more clearly to these applications. Depending upon the area of administrative jurisdiction, networks fall into three categories: Local Area Networks (LANs), Metropolitan Area Networks and Wide Area Networks (WANs).

Local Area Networks (LANs)

A Local Area Network connects a large number of different types of equipment, including computer terminals, fax, telex, CD ROM players, etc., on a single site. The majority of LANs use packet switching technology and offer very high transmission speeds - up to one hundred times faster than those available on public networks at present. Most of these are baseband that is they carry only digital computer data, but broadband LANs can carry video and voice signals as well as data. The topology of LANs can vary greatly (i.e., linear, star, ring) affecting efficiency, reliability and costs.

Metropolitan Area Networks

These type of networks generally cover specific metropolitan area and provide to them all the services.

Wide Area Networks (WANs)

Wide Area Networks (WANs) are private networks linking equipment at several different sites and have much in common -with conventional large scale data networks.

In configuring a network to communicate information the focus is on minimising costs while maintaining the desired performance (or minimum desired quality) standards depend on the nature of the information to be sent. In the case of voice, quality is measured by word intelligibility or articulation index. For video, the Television Allocations Study Organisation has adopted the TASO grades ranging from excellent to poor that specify the degree of subjective acceptability of the picture displayed to viewing audiences. For both voice and video, the corresponding quantified measure of quality, signal-to-noise ratio, is used as a technical design parameter. For digital information, say from one computer to the other the quality of the transmission is expressed as the number of bit `errors', a appearing as '0' or vice versa, that occur as a fraction of the total number of bits sent.

Along with performance requirements, it is necessary to choose the channel bandwidth for analog transmission. The transmission speed of digital signals is also referred to as data rate or bit rate. These factors partly determine coat. Therefore, depending on whether the

transmission is from one point to another, one point to several, or several points to a central point, a network is designed. The simplest `network' might involve just two stations (point to point) linked for example, to transfer data from one computer to another, or it might be a complicated system where several stations are connected to a local node, several local nodes connected to a central node, and so on in hierarchical fashion.

Developments in network technology include the increasing use of computers to control switching and information flow, most significant is the modernisation of the public network so that voice and data can be carried over a single network. This type of single network is referred to as an Integrated Services Digital Network (ISDN).

3.7.3 Open Systems Interconnection (OS1)

As there are many different protocols for LANs and WANs, communication between two different systems can be difficult. The International Standards Organisation (ISO) has attempted with some success to solve the problem by the introduction of Open 'Systems Interconnection (OSI). OSI defines a set of procedures and standards grouped into seven layers, for the exchange of information between terminals and computers.

In theory all systems which conform to OSI specifications should be able to interconnect, but the definitions are vague in certain areas and incompatibilities do arise. To overcome this, some countries have developed their own more detailed standards.

Anyone involved in the purchase of equipment which is to be linked to a network should find out whether there are any industry specific GOSIPS (Government OSI Profiles) to which they must conform.

3.8 TELECOMMUNICATIONS STANDARDS AND PROTOCOLS

Standards .are very important in the telecommunications area if data is to be transmitted successfully between different equipment manufactured by different firms. ,

3.8.1 Standards

They are defined internationally by the CCITT (Consultative Committee for International Telegraphy and Telephones), but to deal with the rapidly changing telecommunications needs of the EEC, the European Telecommunications Standards Institute (ETSI) has been set up. The ETSI is responsible for defining standards for services and equipment specially for the networks of the EEC member countries. Examples of standards are the X.25 standard for packet switched networks, the RS 232 interface, and the V series for modems. In addition to these official standards, there are a number of de facto standards such as, the MNP error correction protocols for modems, which have been developed independently by manufacturers and became widely used.

In order to ensure that equipment that is to be connected to the public network is safe and does not interfere with the normal operation of the network, it must be approved by the appropriate regulatory body.

Equipment that has been approved carries sticker with a green circle and the word `approved' on it.

3.8.2 Protocols

The two major components relating to a WAN are the Protocol and the Media. The media are the actual path ways that the protocol travels on. The network protocol defines the format in. which data are sent through the media.

Protocols are rules governing the initiation and *maintenance of data flows. These are implemented in different ways for different types of equipment and networks. Information professionals are most likely to encounter these when setting up their sat-ware and hardware

for online searching. In such situations, all should deal with such parameters as:

- bit rate
- parity
- stop bits
- flow control
- echoplex
- duplex

Besides the above, other important parameters are word length used, and whether transmission is synchronous or asynchronous. The significance of these parameters is summarised below

Line bit rate is measured in bits per second (bps) and also referred to as baud rate. The speed at which data can be transmitted is determined by the service being accessed, and the quality and characteristics of the telecommunications link.

Parity: The parity bit is a rudimentary form of error checking which can be employed when a word length of 7 bits is in use. The full range of values is: odd, even, ignore; mark (always set to 1); none (word length of bits in use).

If odd parity is selected the computer assigns a value to the parity bit so that the numbers of `1' bits in each character is odd, for even parity, the parity is set so that the number of bits is even.

Stop bits: These are a means of keeping the transmitting and receiving computers in step with one another. Normally one stop bit is used.

Flow Control: When data is flowing into a computer at a rate greater than that at which it can be printed, displayed or stored to disk, the connection between the transmitting and receiving computers may be severed. This is avoided by using X-ON X-OFF. If the receive buffer is nearly full, the computer sends an X-OFF signal to the transmitting system to tell it to temporarily suspend transmission. When the receive buffer has emptied, an X-ON signal is sent and the transmission is resumed. X-OFF and X-ON can be sent from keyboard by pressing control/s and control/q respectively.

Echoplex: Echo ON/OFF is sometimes referred to as echoplex. In other words, the characters are displayed on the screen either as they are typed in or after being echoed back by the remote computer.

Duplex: Data flows in both directions at the same time are referred to as duplex mode.

Word Length: This defines the number of bits that make up a character, (i.e.,) 7 or 8 bits. The most common codes are ASCII (American Standard Code for Information Interchange) and EBCDIC, Telex uses the Band of code which has a word length of 5 bits, thus limiting the number of characters that can be generated.

Synchronous Communication

In synchronous communication, data is sent from one machine to another in a continuous stream. The sending and receiving computers must be in step with each other through out the transmission. Synchronous transmission is used for high speed data transmission, generally between two mainframes.

Asynchronous Transmission

In asynchronous mode of transmission data is sent character by character. This form of communication is used by most information systems attached to the public telephone network.

Self Check Exercise

10) Describe the different types of networks.

11) Briefly explain the significance of 'protocols' and 'standards' in the functioning of networks.

Note: i) Write your answer in the space given below

ii) Check your answer with the answers given at the end of this Unit.

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3.9 SUMMARY

In this Unit, an attempt has been made to explain to you the basic terminology and concepts in telecommunications. The main emphasis, however, has been particularly on data transmission, communication links, switching mechanisnis, terminals and networks.

The focus has been on basic concepts and simple explanations as far as possible, with examples easily understood by persons not acquainted with telecommunications. Information professionals- must remain abreast of new technological advances as they become practical and affordable to ensure that their telecommunications needs are met by the best possible combinations of telecommunications processes and devices at the lowest cost possible. Knowledge relating to technological advances will 'make you a better equipped information professional. In this Unit, networks and networking has been given come what detailed _treatment. The Unit furnishes Self Check Exercises and Key Words, These features are expected to enable you to grasp the basic concepts easily and comprehend the subject better.

3.10 ANSWERS TO SELF CHECK EXERCISES

1) Telecommunications is an important area of Information Technology. The developments in telecommunications over the past two decades have paved the way to the growth of computer-based library and information systems and services.

Data Communications', `Communications Technology', `Computer Telecommunications' `Compunications', `Telecomputing', etc., are just some of the terms used to describe a process, that of transmitting a message from one point to another by electronic means, and the devices used to achieve this process. The process is well known and we engage

in this process daily as we speak to one another. We call this the communications process. Therefore, telecommunications is the transmission of representations of information between remote locations by electronic means. This information may be in the form of voice, video, or data generated by a computer.

2) A simple telecommunications network consists of the following functional components: i) a transmission network, ii) an arrangement of transmission paths, iii) switching centres through which signals are conveyed by a physical medium. For example, information coming from a source, or to a receiver is converted via a terminal into signals appropriate to the characteristics of the particular network. For instance, in the standard voice telephone network system, the changes in air pressure at the micropone are represented by a corresponding variation in electrical voltage. This is an example of analogue signal. In contrast, computer systems generate digital signals, which are represented as one of two discrete states, namely, on or off (1, or 0).

3) Frequency and bandwidth are two basic components which enable us to understand how information is transmitted. The information which may in the form of sound (human voice) or may be visual (printed page, video picture) must be converted to electric signals (electromagnetic waves) before it can be transmitted over a given medium.

   Frequency is the rate at which a wave or cycle alternates between high and low (analog mode) or on and off (digital mode). For example, the lowest buz notes reproduced on a good stereo set may estimate a wave pattern as slow as 30 times (cycles) per second, while very high notes cause wave patterns to alternate as often as 20,000 times per second. One cycle per second is called a Hertz (Hz).

   Bandwidth is another important concept for transmission. This concept can be understood easily if we take the analogy of traffic network. For example, if there is a two way street, consisting two single lanes,.one in each direction, only one line of vehicles can travel in each direction. On a superhighway, however, there may be three or four lanes in each direction; cars may travel along these lanes, in parallel, each at its own rate of speed. Similarly, if we have a wider band highway which can accommodate more cars travelling in the same direction at the same 'time. In the same way, the width of an electronic path determines 'how many cycles or bits can travel along this given path' at any given time. Therefore, the more bandwidth is available, the more bits may be transmitted, and the better will be the quality of transmission. Frequency and bandwidth occur from low to very high along a range of frequencies, called the spectrum. To keep transmission from interfering with one another, each type (voice, radio, television, satellites, etc.) is allocated a bandwidth in this spectrum.

4) Quality of transmission is very important consideration in telecommunication.. 'Voice communication can use a marrow bandwidth, which means that the reproduction of sound is not of high fidelity because, the human ear is adaptable and can discern words even if not entirely faithfully reproduced. The same is' not true, for the transmission of music, where we expect high quality sound, for television broadcasting where our picture must be sharp and the quality of colour high, this is specially so in data transmission, where inaccurate bit transmission can result in worthless messages and poor quality transmission.

   Better quality transmission can be achieved by different techniques besides providing more bandwidth. One such technique is multiplexing. Multiplexing is of two types: frequency division multiplexing (FDM) and time division multiplexing. FDM is used to split a channel into several discrete narrower ones for simultaneous but, separate transmission. On the other hand, TDM uses a common channel for several messages but at intermittent times. Multiplexing is a sharing technique used to improve the quality of transmission.

5) Simplex, Half duplex and Full-duplex are the different modes in which transmission takes place whenever message travels over or through a physical medium.

   In simplex channel, the message travels in only one direction. That is to say if A and B are two points involved in transmission process, the message travels from A to B and not back again.

   On the other hand in half-duplex mode, transmission can take place in either direction (i.e., A to B and B to A) but one at a time.

In case of full-duplex mode the transmission as well as reception of messages can take place between A and B at the same time. Librarians require the latter two types namely half-duplex and full-duplex modes because database search terminals must be set either in half-duplex or in full-duplex mode in order to communicate with database vendors' computers.

6) Terminals can be set to transmit in two ways: synchronous mode and asynchronous mode. Many terminals can communicate in one or the other of these modes.

   Asynchronous transmission is also known as start-stop transmission. This means that every transmitted character (or group of characters) is defined by a special character at the beginning and end denoting beginning and end of transmission. Thus, the receiving terminal does not have to operate in phase with each other and transmission Is interpreted or decoded at the receiving terminal exactly as it was encoded by the sender. In synchronous communication data is sent from one machine to another in a continuous stream, the sending and receiving equipment must be in step, to each other throughout the transmission. This type of transmission is used for high speed data transmission, generally between two mainframe computers. On the other hand asynchronous form of communication is used by most information systems attached to public telephone network,

7) Communications channels can operate in analog or digital mode. It may be stated that a given circuit can operate only in one of the modes and not in both of them at the same time. Therefore, there is a need for translating from one to the other of these modes.

   'Modems' are devices which function as translators, changing the digital signals coming out of the terminal to analog so that these signals could travel along a voice grade channel. At the receiving end there is another modem which retranslates the analog signals into digital signals which the computer can accept. Modem stands for modulation and demodulation. Modems are available in variety of forms. They are: acoustic coupler, stand alone modems and internal modems. They are appropriately used in different situations.

8) By transmission media, we usually mean a mix of physical lines ranging from wire pairs to cable, and over the air transmission media, such as microwave and satellites.

   The transmission media used in telecommunications networks vary both physically and in their carrying capacity. The commonly used performance measurement of a telecommunications link is its bandwidth. This gives an indication of the range of frequencies which can be transmitted 15y the channel.

   The channels or media can be grouped into two main divisions: line and free space. In the line group we have two metallic media namely twisted pairs and coaxial cables and one optical medium, i.e. glass or 'optical fibres. In the free space category, we have radio propagation which includes broadcast(e.g., TV) and point to point (e.g.,microwave signals)

9) Switching mechanisms-are techniques devised to send messages in many directions at the same time and to ensure that these messages are received with a minimum delay. In other words, if a bottleneck or queue occurs in message traffic, then bypasses or alternate paths to the destination are provided taking recourse to switching mechanism. There are: i) circuit switching, ii) message switching, and Hi) packet-switching. Of these three, packet switching is one of the recent techniques. This was originally developed for use by ARPA network. The advantages of packet switching include transmission economies because of shared utilization, high quality transmission, error reduced service, and the facilities for speed changing and procedures conversion, thereby allowing communication between different types of terminals and the interconnection of networks.

10) Computers can now communicate with each other and with a range of peripheral devices, over distances with great speed and reliability. Technological- advances in worldwide communications have ushered in a new era of computing power and access to information services and have been able to develop extensive and reliable telephone networks. The transmission over telephone networks of voice, text and illustrations through facsimile laid the foundations for the development of networks at local, regional, national and global levels.

Communication networks are made up of transmission lines, concentrators, switching mechanisms and non-data processing components. Due to increased competition in the communication industry, new and specialised common carriers and value-added networks with data processing equipment, is also linked to communication networks.

A local area network (LAN) connects a large number of different types of equipment, including computer terminals, fax, telex on a single site. Most of these are baseband that is to say that they carry only digital computer data. LANs can also carry video and voice signals. The topology of LANs can vary greatly (i.e., linear, star and ring) affecting efficiency, reliability and costs.

Wide area networks (WANs) are private networks linking equipment at several different sites. The simplest network might involve just two stations (point to point) linked to transfer data from one computer to another or it might be a complicated system where several stations are connected to a local node, several local nodes connected t') a central node and so on.

11) The two significant components relating to a WAN are protocol and the media. The media are the actual pathways that the protocol travels on. The network protocol defines the format in which data are sent through the media. Protocols are rules governing the initiation and maintenance of data flows. These are implemented in different ways in different types of equipment and -networks. Information professionals are most likely to encounter these when setting up their software and handware for online searching. In such situations they should deal with the following parameters.

i) bit mate
ii) parity
iii) stop bits
iv) flow control, etc.

Standards are very important in telecommunications area if data is to be transmitted successfully between different equipment manufactured by different firms. Standards are defined by the CCITT (Consultative Committee for International Telegraphy and Telephones). Examples of standards are the X.25 standard for packet switched networks, the RS 232 interface, and the V series for modems.

3.11 KEY WORDS

Acoustic Coupler — A device with two cups into which the telephone handset is placed. It is not expensive but susceptible to interference from noisy surroundings.

Amplitude Modulation (AM): — It is the process of changing the Wave form's height and depth.

Analog Mode — It is one of the modes of electronic transmission. In analog transmission, there is a continuous up and down pattern, one wave constitutes one cycle, which is measured in Hertz (cycles per second).

Asynchronous — This is one of be modes of transmission. In asynchronous transmission, data is sent character by character

Bandwidth — It is the width of the electronic path which determines how many cycles or bits can travel along the path at any given point of time. In other words, the more band width is available, the more bits may be transmitted, and the better the quality of transmission.

Digital Mode — In digital transmission, wave patterns are translated into discrete bits and are separated by intervals. Bits. a contraction for `binary digits' are the smallest unit of information in data processing

Frequency	It is the rate at which a wave or cycle alternates between high and low (analog mode) or `ON" and "OFF" (digital mode).
Frequency Division Multiplexing	It is a technique used to improve transmission quality and reduce `noise'. It is used to split a channel into several discrete narrower ones for simultaneous but separated transmission
Frequency Modulation (FM)	Spaces the frequency of the waves in a certain pattern to transmit information.
Full-Duplex	Messages can be transmitted and received over the same channel at the same time (i.e., simultaneously).
Half-duplex	Transmission can take place in either direction, but not at the same time.
IPSS :	PSS links into the International Packet Switch Stream so that data can be transmitted internationally
ISDN(Integrated Services Digital Network) :	It is modernisation of the public network so that voice and data can be carried over a single network
Internal Modems	These fit inside the computer, but difficult to monitor
LAN (Local Area Network) :	Which connects a large number of different types of equipment including computer terminals, fax, telex, CD-ROM players, etc., on a single site. They use packet switching technology and offer very high transmission speeds
Line Bit Rate :	This is also referred to as baud rate and is measured by bits per second (bps). In other words, it refers to transmission speed.
Modem :	An acronym standing for modulator and demodulator. Modems are essential for linking computers via telecommunication lines and are available in a variety of forms
Multiplexing :	It is one of the techniques to improve transmission quality and reduce `noise'.
Multi Stream :	Most user of PSS access their local mode via PSTN which can introduce noise and interference into the transmission. Multi stream offers error protection over this link..
PDN(Packet Data Network):	A generic term used to describe data services such as PSS, Multistream, etc. The term is used by British Telecom.
PSS(Packet Switch Stream):	These are lines dedicated to computer use, and are cheaper to use than the ordinary telephone network.
PSTN(Public switched Telephone Network) :	The conventional voice telephone network.
Bit Parity :	The bit a rudimentary form of error checking which can be employed when a word length of 7 bits is in use. If odd parity is selected, the computer assigns a value to the parity bit so that the number of '1' bits is even.

Simplex : In this case the message travels in only one direction, from point A to point B, but not back again

Stand Alone Modems : These are most commonly used devices. They vary in sophistication from basic single speed, manual dial to high speed intelligent auto dial models which can be programmed to carry out the dialing sequence and log on. procedure automatically

Stop Bits : These are a means of keeping the transmitting and receiving computers in step with one another. Normally one stop bit - is used.

Synchronous : In synchronous mode of communication data is sent from' one machine to another in a continuous stream. The sending and receiving computers must be in step with each other throughout transmission

Time Division Multiplexing : It. is a technique which uses a common channel for several messages but at intermittent times, each signal taking turns on the same channel

Word Length : This defines the number of bits that make up a character. The commonly used codes are ASCII and EBCDIC. Telex uses Band of code which has a word length of 5 bits only.

3.12 REFERENCES AND FURTHER READING

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