UNIT 2 ELEMENTS OF DATA COMMUNICATION

Structure

2.0 OBJECTIVES

After reading this Unit, you will be able to:

- define data communication;
- list various international organisation for defining standards;
- identify the Hardware and Software associated with data communication;
- list the features of various communication channels/media; and
- understand basic terminology/concepts used in data communication.

2.1 INTRODUCTION

More than 80 percent of the personal computers used in business and education are connected to a network or the Internet. The chances are good that you will have to interact with a network soon if you don't already. This Unit helps you understand computer networks in several ways. It helps to scratch the **intellectual itch** you might have about where the data resides and what goes on inside the cable, equipment, and software. If you understand the basic structure and operation of a network, you can be more efficient in your job.

We tend to think that data communication using networks is something new. Although the art and science of connecting computers via network cable are fairly new, as a matter of fact, the essential concepts used in computer networks are relatively old i.e., as early as nineteenth century old. The data communication owes its existence to three Victorian-era inventions: the telegraph, telephone, and

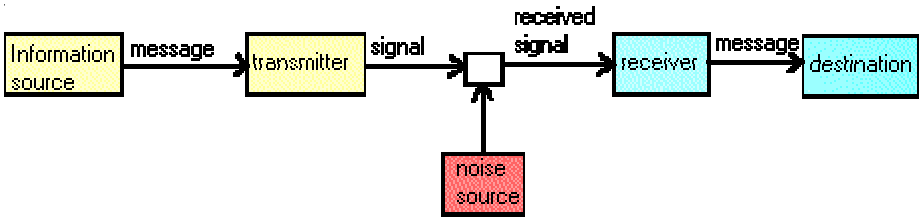
teletypewriter. Let us learn more about data communication in the following section.

2.2 DATA COMMUNICATION - AN OVERVIEW

In technological terms **"Communications"** is a general word for the transmission of signals between two or more points. When these signals constitute computer data, we refer to **"data communications"**. **"Telecommunications"** pertains to transmissions over a distance in one of two forms: (1) **electronic transmission** (via electrons) occurs through physical media such as wires and (2) **electromagnetic wave** transmission (via laser, radio, television, microwave, etc.) requires no media (thus information can be sent through space). **Networking** is the linking of computers (not necessarily over large distances) so they can communicate, sharing hardware and software, thus uniting processing power. The goal of **distributed computing** is the optimum spread of computing resources among users; obviously, telecommunications and networking are critical features of such systems. The combination of large **databases, communications, and distributed computing** is having a dramatic impact on all areas of **human interaction**; it will have a profound effect on **education and learning.**

To understand the data communication, you have to familiarise yourself with some of the basic terminology/concepts used. Without going into a greater detail, let us list them below with a brief explanation.

- **Generic model of communications**: All communications, including data communications, can be represented by the generic model proposed by Claude Shannon and Warren Weaver. Their model is represented diagrammatically as shown below:



The Shannon-Weaver Model (1947) proposes that all communica-tion must include six elements:

- **a source**: the source originates or initiates the communication. the source might be a person or a computer

- **an encoder:** the message is encoded by changing its format into one that can be transmitted. In a modern communications system, a message is typically encoded into an electronic signal that can be sent over telephone lines or broadcast by radiowaves or microwaves.

  - **a message:** is the information that source wants to communicate to the receiver. The message might be a document, a picture, or sounds, or numeric data.

  - **a channel** : The encoded message travels by means of a channel or communications link. A communications link might include telephone wiring, fibre optic cable, microwave, or satellites.

- **a decoder:** the message is decoded at the end of the transmission. Decoding usually means reversing the coding process that took place before the message was sent.

- **a receiver:** is the destination for the message. The receiver can be a person or a computer.

These six elements are shown graphically in the model. Another element normally discussed along with the above elements is the "**noise". Noise** such as electrical interference, sometimes disrupts the transmission. The message can become garbled unless the communications system has the capability to check for errors and correct them. When you watch a television, while it is raining and there is a strong wind outside sometimes you notice that the pictures are flickering on the screen. It is due to electromagnetic interference.

- **Telecommunication network:** It is a particular arrangement of **resources** including:

  - **computer hardware** (host computers, servers, workstations, peripheral devices, etc.)

  - **communication hardware** (modems, codecs, transmitters, receivers, repeaters, and switching devices) (See section 2.5)

  - communication **media** (telephone lines, cables, etc.) (See section 2.6), and

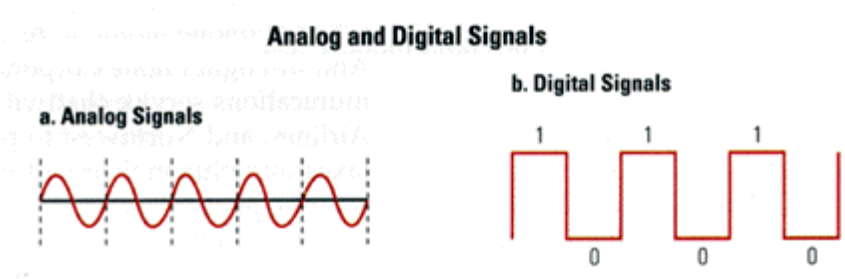
  - communication **software** that co-ordinates the network components. (See section 2.7)

- **Transmission Signals:** Data is transmitted over communication channels in either analogue or digital form.

  - An **analog signal** is a continuous wave pattern that varies in frequency or amplitude to convey data/information. Most "real-world" data has an analog format, e.g. voice transmission over the telephone. This type of signal was not deigned to convey the digital information that are present in computer system.

  - A **digital signal** is a pattern of discrete high or low amplitude pulses. Such signals can carry digital data without modification (i.e. there is no need for a modulation).

The following figures show the analogue and digital signals.



- **Carrier signal:** It is a base analog signal for transporting data over a communication channel. The actual data is superimposed on the carrier

signal by modulating (altering) this carrier signal. There are several forms of modulation, but the most basic include the following:

- **Amplitude Modulation (AM):** This technique changes the amplitude of the analogue (sine) wave. In the earliest modems, digital signals were converted to analogue by transmitting a large amplitude sine wave for a "1" and zero amplitude for a "0". This is also used to send analog data (for tape, radio, television, telephone) using analog signal. The main advantage of this technique is that it is easy to produce such signals and also to detect them. This technique has **two major disadvantages**. The first is that the speed of the changing amplitude is limited by the bandwidth of the line. The second is that the small amplitude changes suffer from unreliable detection. Telephone lines limit amplitude changes to some 3000 changes per second. The disadvantages of amplitude modulation causes this technique no longer to be used by modems, however, it is used in conjunction with other techniques.

- **Frequency Modulation (FM):** In this technique the frequency of the carrier signal is changed according to the data. The transmitter sends different frequencies for a "1" than for a "0". The disadvantages of this technique are that again (as it was with amplitude modulation) the rate of frequency changes is limited by the bandwidth of the line, and that distortion caused by the lines makes the detection even harder than amplitude modulation. Today this technique is used in low rate asynchronous modems up to 1200 baud only.

- **Phase Modulation (PM):** In this modulation method a sine wave is transmitted and the phase of the sine carries the digital data. For a "0", a 0 degrees phase sine wave is transmitted (PHI = 0). For a "1", a 180 degrees sine wave is transmitted (PHI = 180). This technique, in order to detect the phase of each symbol, requires phase synchronisation between the receiver's and transmitter's phase. This complicates the receiver's design but does not suffer the disadvantages of AM and FM.

- **Transmission channels:** The direction in which data can flow over a transmission path is determined by the properties of both the transmitting and receiving devices. There are three basic options available. They are:

  - **A simplex channel** transmits/receives data in only one direction**.**

  - **A half-duplex channel** can transmit/receive in either direction, but only one way at a time**.**

  - **A full-duplex channel** allows data to be transmitted/received in both directions simultaneously**.**

- **Transmission parameters:** There are two transmission parameters. They are

  - **The transmission speed** is the amount of data transmitted per unit time, e.g. bits per second, **bps** (the most commonly used unit), or characters per second, **cps** (don't confuse with cycles per sec.). This is also called channel capacity.

  - **The bandwidth,** or range of frequencies that can be used with a particular channel, is a measure of the data transmission capacity. Standard telephone lines are "voiceband channels" that have a bandwidth of 3 kilohertz (3000 cycles per second) which is somewhat larger than the range of

frequencies of a typical human voice; when used to transmit binary data it can transmit up to about 33 Kbps (kilobits per second) via modems. ISDN, cable, and fibre optics have increasingly higher bandwidth (see section 3.6 below). The higher the bandwidth, more the channel capacity. For example fibre optics cable provides more bandwidth than coaxial cable, therefore the channel capacity of fibre optics will be higher than coaxial cable.

Self Check Exercise

1) What do you mean by data communication? List the elements of a general communication model.

2) Identify and discuss the three basic types of data transmission channels.

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

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

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2.3 MODES OF DATA TRANSMISSION

The most commonly used medium for data transmission, both nationally and internationally, is the telephone system. If the data is transmitted using wires, like the existing telephone lines or any other privately installed wires, we refer the transmission as wired communication. On the other hand, wireless communication is another mode through which data could be transmitted. Let us learn more about wired communication and wireless communication.

2.3.1 Wired Communication

Wired communication requires that the transmitter and receiver be physically connected. There are two basic types of wires, based on the kind of signal they are designed to transmit analogue or digital signals.

- **Analogue lines**, e.g. “plane old telephone service” (“**POTS”**) which carry analogue signals via electrons. To transmit data, the digital data must be superimposed, by a modem, on the telephone’s analogue carrier signal.

- **Digital Lines** carry digital signals and thus avoid the analogue/digital conversions necessary for digital transmission over POTS. They are sometimes referred to as **last-mile technologies** because they are used only for connections from a telephone switching station to a home or office, not between switching stations. Digital lines allow the phone company to provide a **much wider bandwidth** than POTS for transmitting data. Also the signal can be separated so that **telephone conversations and computer data can be transmitted simultaneously on the same line.** Digital lines offer more than a bandwidth advantage over POTS in that they can transmit

voice, text, and video as well as computer data. On the other hand**,** current disadvantage is that all implementations have a **limited maximum distance** to the telephone office (< 20,000 ft.). There are currently **two types of digital lines:**

a) **ISDN** (Integrated Services Digital Network) is a **circuit-switched**, **dial-up** service for transmitting digital data via a single wire or fibre optics cable. This transmission is completely digital. Each ISDN line provides two 64 Kbps channels (called B channels) that operate independently of one another. Each of these B channels can be used for voice or data, and each channel can have its own phone number. A third 16 Kbps D channel carries dialing, ringing, and caller ID information for the other two channels.

b) **Digital Subscriber Lines (DSL),** an improvement on ISDN, is also a technology for transmitting high-bandwidth, totally digital data over POTS between end-users and telephone companies. Unlike ISDN, DSL is a **dedicated point-to-point technology** that provides a much higher bandwidth (a practical maximum of over **6 Mbps** for current technologies and up to 52 Mbps in the future). Without doubt, DSL technologies **will compete with** cable modems for the future last-mile technology; the jury is out. The current implementation of this technology is called **ASDL** (form assymetric DSL) whose download bandwidth is much higher than its upload bandwidth.

Self Check Exercise

3) What is ISDN? Explain how it works.

Note: i) Write your answer in the space provided below.

ii) Compare your answer with the one given at the end of this Unit.

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2.3.2 Wireless Communication

As the name itself suggests, wireless communication uses no wires (i.e., no physical link) for data communication. **Wireless communication** uses **microwaves** (electromagnetic waves with frequencies between Radio/TV and light) or **radio waves** to provide high-capacity transmission (over 3 million bps) over line-of-eight channels.

a) **Terrestrial** communications involve transmission via **repeater stations** which form a series of direct line-of-sight links from source to receiver.

b) **Satellite** communication involves satellites in **geosynchronous orbit,** which receive data transmitted on an **uplink**, amplify that signal, and transmit to a receiver station on a **downlink.**

c) **Cellular** communications is a form of short-wave wireless technology that is currently used mostly with cellular telephones, The user connects to a

nearby transmitter. The land area covered by the transmitter is called its "cell". As the user travels between adjacent cells, the cellular telephone is automatically passed on to the next local cell transmitter.

d) **Bluetooth** is a relatively new technology designed to provide widely available, wireless communication between independent devices, particularly portable devices like notebook computers, PDAs, cell phones, etc. Each device will be equipped with a microchip transceiver that transmits and receives in a previously unused frequency band of **2.45 GHz** that is available globally (with some variation of bandwidth in different countries). In addition to data, up to three voice channels are available. **Each device will have a unique 48-bit address** from the IEEE 802 standard. The IEEE standards define several access mechanisms for local Area Networks. Connections are one-to-one. The **maximum range is 10 meters**. Data can be exchanged at a rate of 1 megabits per second (up to 2 Mbps in the second generation of the technology). A frequency hop scheme allows devices to communicate even in areas with a great deal of electromagnetic interference. Built-in encryption and verification is provided. There are ambitious plans to develop "personal area networks" (PANs) based on Bluetooth that network the various microprocessor based devices belonging to an individual in the near future.

2.4 CHARACTER TRANSMISSION

There are two types of character transmission techniques. They are serial transmission and parallel transmission.

A) **Serial** transmission sends one bit at a time over a single wire. Telephone lines use serial transmission for digital data, thus modems are connected to the computer via a serial port.

   a) A **serial port** is a socket on a computer used to connect the serial interface to a serial line or bus.

   b) A **serial interface** is a data channel that transfers digital data serially; it is typically implemented as a card that plug into an expansion slot on a computer motherboard. Serial interfaces have multiple lines, but only one is used for data (two must be used for full duplex communication).

   c) An external **serial bus** carries serial data to any device connected to it, e.g. Ethernet.

B) **Parallel** transmission communicates bits simultaneously over multiple lines; typically the total consists of one or more bytes at a time. In a manner similar to serial hardware, a **parallel port** connects a **parallel interface** to an external **parallel bus**.

   a) Computers are typically connected to **printers and external disk drives** via parallel interfaces, ports, and buses (which are analogous to their serial counterparts).

   b) **SCSI** (pronounced "scuzzy"), which stands for Small Computer System Interface, is an example of an external parallel bus; standard SCSI has an 8-bit path and fast SCSI has a 16-bit path.

2.5 COMMUNICATION HARDWARE

As you have seen so far, to realise a data communication process, several functions are to be performed. These are so specialised in nature that they require hardware specially built for such purposes. To cite a simple example, let us consider an organisation having two three branches geographically distributed over say 1000 km wants to exchange information digitally using computers. Their data can be exchanged digitally over telephone lines. But, telephone lines can carry only analogue signals only. So we need a device which can convert digital data into analogue form so as to enable the data to be transmitted over telephone lines. Of course, at the receiving end, these analogue signals have to be converted back in to the digital signals so that computer can handle it. Like this a variety of hardware are required. We shall consider only the important ones here. More details about hardware are available in subsequent units of this course.

2.5.1 Modem

The need to communicate between distant computers led to the use of the existing phone network for data transmission. Most phone lines were designed to transmit analogue information - voices, while the computers and their devices work in digital form - pulses. So, in order to use an analogue medium, a converter between the two systems is needed. This converter is the MODEM, which performs MODulation and DEModulation of transmitted data. It accepts serial binary pulses from a device, modulates some property (amplitude, frequency, or phase) of an analogue signal in order to send the signal in an analogue medium, and performs the opposite process, enabling the analogue information to arrive as digital pulses at the computer or device on the other side of connection. The basic modulation techniques such as frequency, amplitude and phase modulations were discussed in section 2.2.

Modems, in the beginning, were used mainly to communicate between **DATA TERMINALS** and a **HOST COMPUTER**. Later, the use of modems was extended to communicate between **END COMPUTERS**. This required more speed and the data rates increased from 300 bps in early days to 56 kbps today. Today, transmission involves data compression techniques, which increase the rates, error detection and error correction for more reliability.

In order to enable modems of various types and different manufacture to communicate, interface standards were developed by some standard organisations

Today’s modems are used for different functions. They act as textual and voice mail systems, facsimiles, and are connected or integrated into cellular phones and in notebook computers enabling sending data from anywhere. The future might lead to new applications. Further dramatic speed increases will require digital phone technology such as ISDN and fibre optic lines.

New applications might be implemented such as simultaneous voice and data. Videophones are an example of this.

2.5.2 Multiplexers

Multiplexing is the process of combining the transmission, character by character, from several devices into a single data stream that can be transmitted over a single communication channel. A multiplexer (MUX) is a device, which interleaves multiple communications, so that they can share a single communications channel. It is also used at the receiving end to separate the transmissions and send them

back in their original order for processing. A multiplexer allows the communication channels to transmit much more data, at any one time, than what a single device can send. Multiplexers are more efficient and less expensive. The two common multiplexing techniques are FDM and TDM. FDM (Frequency Division Multiplexing) which separates signals by modulating the data onto different carrier frequencies, and TDM (Time-Division Multiplexing) which separates signals by interleaving the bits of different signals. There is one more method of multiplexing technique that you may find in some of the books. It is STDM (Statistical Time Division Multiplexing). Conventional TDM systems waste bandwidth if many of the time slots are left unused. STDM solves this problem by dynamically allocating time slots to active devices on a first-come, first-served or priority basis. STDM can be safely used at high speeds to provide very efficient use of the lines even in highly sensitive applications where data loss or corruption is unacceptable. Television or radio broadcast is an example of both FDM and TDM. Each television broadcast is done at different frequency range and also there are different time slots for each programme.

2.5.3 Concentrators

As the name implies, the concentrators help in connecting more devices (or terminals) to a computer so that the communication channel can handle all at once. Once the concentrators are used, individual communication lines between the terminals and the computer are no longer required. The concentrator works based on the following simple principle. It collects all the data to be passed in one direction (say from terminal to the computer), tags it to identify the source and then puts it out on one of the serial lines. Obviously, the concentrator should have its counterpart as an integral part of the computer. This part (may be in hardware and software but typically in firmware) will separate out the data to its original form and feed it to the computer for further processing. At this point, the data looks similar to the one received from the local terminals that are connected via dedicated cables.

2.5.4 Front-end Processor

When the number of communication channels and types of communication are more, it becomes necessary to supplement the Central Processing Unit by a separate hardware and software unit dedicated for the communications job. Such systems are known as Front-end Processors (FEP). Usually these are small processors specially programmed to carry out dedicated jobs. Essentially, the computer delegates all the communication responsibilities to a FEP.

2.6 COMMUNICATION MEDIA

Communication media is the channel through which data is transmitted from one place to the other. In effect, media are “data highways’, carrying signals from sending stations to receiving station along predefined routes. The communication media can broadly be categorised into the following three groups:

- Electronic Cables transmit data, via electrons, through copper wires.
- Fibre Optics Cables transmit data, via light, through glass wires
- Microwaves transmit data through aerial route.

Which one of the above medium has to be used? As an answer to this question, we shall look into some of the selection consideration. Important selection considerations include resistance to crosstalk (electric currents between pairs of

wires in the same cable), resistance to outside electrical fields caused by power lines, motors, relays, radio transmitters, and other devices; and ease of installation. If a cable resists internal and external electrical noise, network designers can use longer cables and faster signalling between nodes. Because fibre optic cables signal with pulses of light, they have total immunity from electrical noise. Fibre optic cables carry signals faster and farther than any other type of cable. Cables with outside shields of copper braid or foil, such as coaxial and shielded twisted pair, offer good resistance to electrical noise. But because they are thicker, they are difficult to pull through wiring conduits and walls. The thin unshielded twisted pair wire is easier to install, but it offers less resistance to electrical noise. Thin fibre optic cable doesn't fill conduits, but installers need special training and equipment to attach connectors, so the costs for fibre optic cable are high. As a final consideration, remember that the out jackets of cables used inside air plenums and between floors must have special fire-resistant jackets to resist the spread of fire and the creation of toxic gas when exposed to flame. Cabling is important in establishing a network. Study the options and carefully specify your needs. Let us learn more about the cables in the following section.

2.6.1 Electronic Cables

Electronic cables are the most popular and widely used medium to transmit data. The reasons for their popularity are that they are less expensive, easy to use and extensive networks in some cases (like the telephone lines) are already available. A disadvantage of this medium is that they are susceptible to electrical interference and thus making it less reliable. Another disadvantage is that the data has to be transmitted only in analogue form. This calls for a converter like a modem and thus slows down the transmission speed. Let us study in brief the various electronic cables that are in vogue today.

- **Telephone lines**: It is the most widely used medium. The advantage in using this medium is that a well-established network is available already.

- **Leased Lines**: A leased line is a telephone line that is dedicated only for the purpose of communication between two computers. The line is not shared with any other users and is traffic free all the times for data communication between the computers. A leased line is similar to a telephone connection that is always open. Both computers are always listening for a signal to start the communication.

- **Twisted Pair Cables:** It is the typical telephone cable. The wires are twisted around each other to minimise interference from other twisted pairs bundled in a cable. There are two types of twisted pair cables. They are Unshielded Twisted Pair (UTP) wire and Shielded Twisted Pair (STP) wire.

    - Unshielded Twisted Pair (UTP) wire: This cable typically combines four pairs of wires inside the same out jacket. Each pair is twisted with a different number of twists per inch. The twisting cancels out electrical noise from adjacent pairs and from other devices in the building such as motors, relays, and transformers. Although unshielded twisted pair externally resembles common telephone wire, telephone wire lacks the twisting and other electrical characteristics needed to carry data. UTP cables are graded according to categories that describe the quality of the components and the installation techniques. Category 3 and Category 5 UTP are commonly used in computer networking. Category 5 denotes the highest quality. UTP cables are popular because they are least expensive, fast enough, and easy to install. The disadvantages are that they are susceptible to electrical and other interference. All copper wire

suffer from rapid attenuation (i.e., inability to carry signals to a greater distance) when used as a communication medium. UTP is no exception. As a result, these cables have a range of hundreds of meters only.

- Shielded Twisted Pair (STP) wire: This cable uses a woven copper braid, a foil wrap between and around the wire pairs, and internal twisting of the pairs to provide a high degree of protection from outside electric currents. The combination creates a thick cable that rapidly fills the space in building wiring ducts. STP is more difficult to install than UTP. STP also suffers from attenuation at a rate similar to UTP.

- **Co-axial cables:** It is more expensive than twisted pairs but is stronger and provides more interference protection, i.e. it inhibits "crosstalk". The cable has a solid central conductor surrounded by insulating material and then by a cylindrical shield woven from fine wires. The shield is usually connected to electrical ground to reduce electrical interference. This cable gets its name from the two conductors that share the same centre axis; they are coaxial. Coaxial cable typically has a bandwidth of 100 megahertz or 10 Mbps. Ethernet is a standard coaxial cable LAN technology. The typical current bandwidth is 10 Mbps, but the new "Fast Ethernet" has a bandwidth of 100 Mbps and "Gigabit Ethernet" is coming. There are different ratings knows as RS ratings of coaxial cables existing which denote a unique set of physical specification including the wire gauge of the inner conductor the thickness and types of inner insulator etc. the following are a few of the common ones : RG-8 : used in thick Ethernet; RG-9 : used in thick Ethernet; RG-11 : used in thick Ethernet; RG-58 : used in thick Ethernet; RG – 59 used in TV.

- **Cable television (CATV)**: These cables are coaxial cables that have a high capacity bandwidth. They were designed to carry the huge signals that analogue TV requires to deliver full-colour, full-motion, stereo-sound broadcasts. Currently, transmission is simplex, i.e. there is no signal from your TV back to the cable company (Pay-per-View utilises your phone lines for feedback to the cable company). However to use CATV for data communication (e.g. to connect to the Internet), full duplex communication is necessary. To facilitate this a cable modem (also called a cable adapter) will be used. These are relatively new devices and will probably have many different implementations. In fact, cable modems can be part modem, part tuner, part encryption/decryption device, part bridge, part router, part NIC card, part SNMP agent, and part Ethernet hub.

Self Check Exercise

4) What are the advantages and disadvantages of STP and UTP cables?

Note: i) Write your answer in the space provided below.

ii) Compare your answer with the one given at the end of this Unit.

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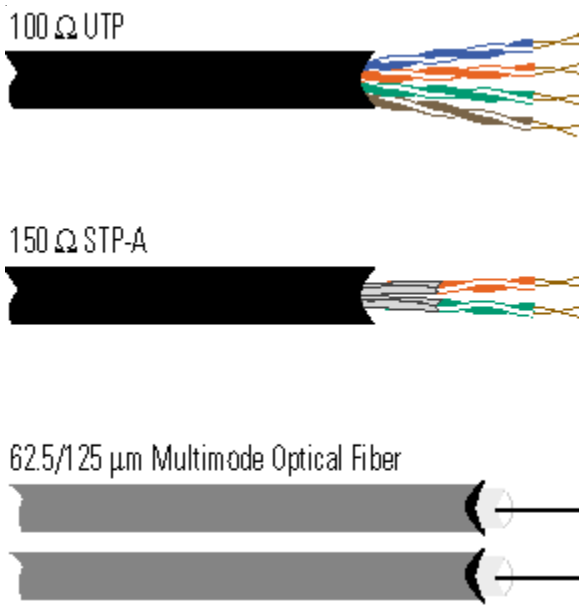
2.6.2 Fiber Optic Cables

Fibre optics cables transmit data via concentrated bursts of laser beams, which are carried through bundles of hair-thin glass fibres. They have advantages over electronic cables in **transmission speed** as well as **volume.** This technology promises to revolutionise telecommunication applications, which has used electronic cables. Because they are free of interference and the light pulses travel for miles without losing appreciable strength (i.e., very less attenuation rate), fibre-optic cables can carry data at high signalling speeds over long distances. They also **minimise interference** (because electrical and magnetic fields do not affect light) and **inhibit wire-tapping**, two critical problems with electronic cable communications.



2.6.3 Microwave

Microwave is also a type of analogue communication medium. Microwave signals are transmitted through the atmosphere rather than through wire cables, similar to the way radio and television broadcasting signals are transmitted. Microwave signals must be transmitted in a straight line, they do not bend around corners or around the curve of the earth. Transmitter stations redirect and boost the signals.

The data may be beamed to a communication satellite that acts as a reflector by accepting signals from one point on earth and returning the same signals to some other point on earth. Compared to wired cables or fibre optics cables, microwave has a much lower error rate, making it more reliable. Also, because there are no physical links between the sending and receiving systems communication links can be made over large distances and rough terrain. The only disadvantage is the high cost of ground stations and requirement of satellites to support a microwave network.

Self Check Exercise

5) Collect the information from reference books about bandwidth of various media discussed above?

Note: i) Write your answer in the space provided below.

ii) Compare your answer with the one given at the end of this unit.

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2.7 COMMUNICATION SOFTWARE

Communication software controls a computer's access to system resources and stored data. Communication software set up a communication link between two computers and assist in the transmitting of data. Data communication software performs a number of jobs. A communications **program** manages the transmission of data, in its most basic form, between a computer and another computer or network; it is not needed for data transfers between a computer and its peripheral devices, which is governed by device drivers (although these could be classified as communications software). In PCs it manages transmission to and from the computer's serial port. In multi-user systems minicomputer and mainframe computer networks) the communications programs are called "access methods", "network control programs", and "TP monitors". A **communications application** performs a specific communications **service** or, in the case of Browsers (often improperly called "Web browsers") several communications services. These include:

a) communication services, e.g. e-mail, news groups, mailing lists, and chat.

b) resource access, e.g. file transfer (downloading or uploading) and remote logon.

c) information retrieval , e.g. Web browsing, searching, etc.

There are a few other types of specific purpose communication software. **Terminal Emulation** is the ability of a microcomputer to assume the characteristics of a certain type of mini or mainframe terminal; this is accomplished by software. **Data-encryption** techniques may be used to scramble data for greater transmission security.

2.8 COMMUNICATION PROTOCOLS

Communications protocols are standards that govern the communications between computing devices. Communications protocols are sets of hardware and software standards (rules and procedures) that govern the communications (transmission of data) between two or more computer devices. Two different computer systems can communicate only if they use the same communications protocol. They govern:

a) how the communications link is established (including intermediate connections),

b) how data is transmitted, and

c) how errors are detected and corrected

Examples of few standard protocols are TCP, IP, FTP, HTTP etc.

In network context, a **protocol is a standard,** established by a computer standards group, that facilitates the exchange of data between two computers. Examples of such standards group are:

a) **ANSI** (American National Standards Institute) which sets standards for programming languages like C/C++ and for a wide range of technical areas, from electrical specifications to communications protocols, e.g. FDDI, the set of protocols for sending data over fiber optic cables.

b) **ISO** (International standards group) which maintains the **OSI** model of communications

c) Although **no standards organisation actually controls the Internet**, two federations promote and supervise Internet protocols:

   i) The **Internet Society**, founded in 1992, is an international non-profit organisation that acts as a "guide and conscience" for the Internet development. The evolution of TCP/IP (Transmission Control Protocol / Internet Protocol) is overseen by the **Internet Engineering Task Force (IETF)** which is part of the **Internet Architecture Board (IAB).** Other IAB activities include the Internet Research Task Force (IRTF), which works on network technology; the Internet Assigned Numbers Authority, which assigns IP addresses; and the Internet Registry, which manages the Domain Name System. The Internet Society is based on Reston, Virginia and maintains a Web site at http://www.isoc.org.

   ii) The **World Wide Web Consortium (W3C)** is an industry consortium which, in its own words "seeks to promote standards for the evolution of the Web and interoperability between WWW products by producing **specifications and reference software**. Although industrial members fund W3C, it is **vendor-neutral**, and its **products are freely available** to all. The Consortium is **international**; jointly hosted by the **MIT Laboratory for Computer Science** in the United States and in Europe by **INRIA** who provide both local support and performing core development. The W3C was initially established in collaboration with CERN, where the Web originated, and with support from DARPA and the European Commission." Organizations may apply for membership to the Consortium; individual membership isn't offered. The W3C has taken over what was formerly called the CERN httpd or Web server. The Web site maintained by W3C Web site is http://www.w3.org.

In the more abstract context of information technology, **a communication protocol is the special set of communication rules** that both **end points** of a communications link must use in order for transmissions to occur. There are protocols between communicating applications within the same computer or between separate computers on a network. Protocols exist at **several levels** in a telecommunication connection. There are, currently, three basic categories of protocols:

a) **Basic protocols** specify whether communication is synchronous or asynchronous, govern error detection and correction ("parity"), etc.

b) **Modem protocols:** On PCs communications programs offer a variety of protocols (e.g. Kermit, Xmodem, Ymodem, Zmodem, etc.) that facilitate transfer of files via modem and SLIP and PPP which facilitate modem connections to the Internet.

c) **Network protocols:**

i) **WAN protocols** govern communications of complex distributed systems involving disparate architectures, operating systems, and applications, e.g. TCP/IP (Transmission Control Protocol/Internet Protocol), the protocol of the Internet. Note that there is often much overlap of LAN and WAN protocols, e.g. TCP/IP is used in Intranets (corporate networks) as well as the Internet; on the other hand, Ethernet is not applicable to WANs.

ii) **LAN protocols** are simpler than WAN protocols because they do not involve different kinds of networks and thus do not have to govern complex gateways or routers; On LANs, data link protocols such as Ethernet, Token Ring, and FDDI provide the access method to the Internet. Each of these protocols have been defined by IEEE and ANSI standards.

OSI (**Open Systems Interconnection**) is a **reference model for relating the common services of a telecommunications system**. It was defined by the CCITT (the international telecommunications standards-making body). Although to date no network architecture implements the OSI model, **it is the standard reference** for discussing network design and comparing different network architectures. It is commonly used as a guideline when new products are designed.

2.9 SUMMARY

You have learnt basic concepts/terminology used in data communication. “Communications” is a general word for the transmission of signals between two or more points. “Data communications” refers to computer data. The concepts of analogue and digital signals were explained and their implication on the type and modes of data transmission was brought out. You learnt the essential elements in data communications under the sections: Lines for data transmission, Character transmission, Communication Hardware, Communication Media, Communication Software, and Communication protocols. This Unit provides you the confidence and basic knowledge required to understand various network related components discussed elsewhere in this programme.

2.10 ANSWERS TO SELF CHECK EXERCISES

1) **“Communications”** is a general word for the transmission of signals between two or more points. **“Data communications”** refers to computer data. Following are the six elements that are normally considered in a communication model

- **a source**: the source originates or initiates the communication
- **an encoder:** the message is encoded by changing its format into one that can be transmitted.
- **a message:** is the information that source wants to communicate to the receiver..
- **a channel** : The encoded message travels by means of a channel or communications link.
- **a decoder:** the message is decoded at the end of the transmission.
- **a receiver:** is the destination for the message.

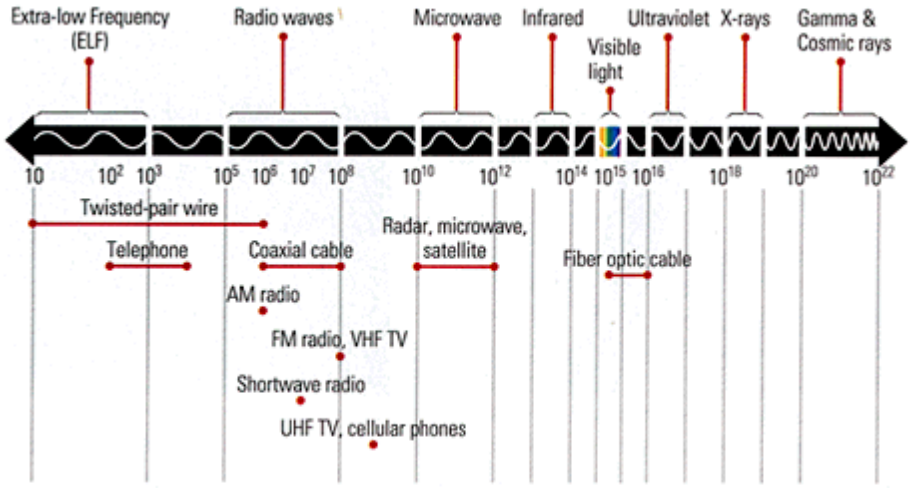
2) Transmission channels include simplex, half-duplex, and full duplex. In the simplex channel, data can be transmitted in one direction only. In a half-duplex channel data can be transmitted back and forth between two stations, but only in one direction at a time. A full-duplex channel allows data to be transmitted and/or received simultaneously.

3) ISDN stands for Integrated Services Digital Network. It is an all-digital telephone service that provides reliable voice and data communications using the same wiring as the existing telephone network. ISDN provides two 64 Kbps connections (B channels) that can be combined into one 128,000 bps connection. Each of the two 64 Kbps channels operates independently of the other, and each channel can be used for voice or data communication. Phones attached to ISDN lines can place and receive calls to conventional analogue phones, and most ISDN lines have two phone numbers, one for each of the two channels. A third 16 Kbps D channel carries dialling, ringing, and caller ID information for the other two channels. In some areas , the D channel can also be used for low-speed, full-time data communication using a service called Always On/Dynamic ISDN, or AODI.

4) The advantages and disadvantages of STP and UTP are summarised in the following table:

Characteristics	UTP	STP
Speed and throughput	Fast enough	Fast enough
Average cost per node	Least expensive	Inexpensive
Media Connector Size	Small	Medium
Maximum cable length (because of attenuation)	Short	Medium
Resistance to outside interference	Low	Moderate

5) The following figure provides the information about the bandwidth of various media that are used for data communication.



Communications Channels

2.11 KEYWORDS

Analogue signal : It is a continuous wave pattern that varies in frequency or amplitude to convey data/ information. Most "real-world" data has an analogue format, e.g. voice transmission over the telephone.

Bandwidth : Refers to the relative range of frequencies, that is, the difference between the highest and lowest frequencies transmitted. For example, the bandwidth of a TV channel is 6 MHz

Carrier Signals : A continuous frequency capable of being modulated or impressed with second (information carrying) signal

Coaxial cable : An electro-magnetic transmission medium consisting of a center conductor and an outer concentric conductor.

Data Communications : The transmission and reception of computer data, often including such operations as coding, decoding and validation.

Digital signal : It is a pattern of discrete high or low amplitude pulses. Such signals can carry digital data without modification (i.e. there is no need for a modulation).

Fibre Optics : A technology for transmitting their formation via light waves moving through a fine filament. Signals are encoded by varying some characteristics of the light waves generated by low powered laser. Output is sent through light conducting fibre to a receiving device that encodes the signal.

ISDN : ISDN (Integrated Services Digital Network) is a circuit-switched, dial-up service for transmitting digital data via a single wire or fibre optics cable.

Modem : Modem is a device that transmits digital data over an analogue channel by modulating the analogue carrier signal.

Multiplexing : Multiplexing is the process of combining the transmission, character by character, from several devices into a single data stream that can be transmitted over a single communication channel.

Networking : It is the linking of computers (not necessarily over large distances) so they can communicate, sharing hardware and software, thus uniting processing power.

Protocols : In the context of data communication, a protocol is the special set of communication rules that both

end points of a communications link must use in order for transmissions to occur.

Twisted pair cables : It is the typical telephone cable. The wires are twisted around each other to minimise interference from other twisted pairs bundled in a cable.

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