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Data Communication and Networking

5.1 Introduction

Today computer is available in many offices and homes and therefore there is a need to share data and programs among various computers. With the advancement of data communication facilities the communication between computers has increased and thus it has extended the power of computer beyond the computer room. Now a user sitting at one place can communicate with computers of any remote site through communication channel. The aim of this lesson is to introduce you the various aspects of computer network.

5.2 Objectives

After going through this lesson, you will be in a position to

- learn the basic elements of data communication system
 - describe communication protocols and data transmission modes
 - explain the use of computer network
 - describe different components of computer network
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- identify different types of network
- understand what is internet and e-mail and its uses in modern communication
- appreciate the use of satellite communication

5.3 Data Communication

We all are acquainted with some sorts of communication in our day to day life. For communication of information and messages we use telephone and postal communication systems. Similarly data and information from one computer system can be transmitted to other systems across geographical areas. Thus data transmission is the movement of information using some standard methods. These methods include electrical signals carried along a conductor, optical signals along an optical fibers and electromagnetic areas.

Suppose a manager has to write several letters to various clients. First he has to use his PC and Word Processing package to prepare the letter, if the PC is connected to all the client's PC through networking, he can send the letters to all the clients within minutes. Thus irrespective of geographical areas, if PCs are connected through communication channel, the data and information, computer files and any other programs can be transmitted to other computer systems within seconds. The modern form of communication like e-mail and Internet is possible only because of computer networking.

Basic Elements of a Communication System

The following are the basic requirements for working of a communication system.

1. The sender (source) who creates the message to be transmitted
2. A medium that carries the message
3. The receiver (sink) who receives the message

In data communication four basic terms are frequently used. They are:

Data : A collection of facts in raw forms that become information after processing.

Signals : Electric or electromagnetic encoding of data.

Signaling : Propagation of signals across a communication medium.

Transmission : Communication of data achieved by the processing of signals.

5.4 Communication Protocols

You may be wondering how computers send and receive data across communication links. The answer is data communication software. It is this software that enables us to communicate with other systems. The data communication software instructs computer systems and devices as to how exactly data is to be transferred from one place to another. The procedure of data transformation in the form of software is commonly known as protocol.

The data transmission software or protocols perform the following functions for the efficient and error free transmission of data.

1. **Data sequencing** : A long message to be transmitted is broken into smaller packets of fixed size for error free data transmission.
2. **Data Routing** : It is the process of finding the most efficient route between source and destination before sending the data.
3. **Flow control** : All machines are not equally efficient in terms of speed. Hence the flow control regulates the process of sending data between fast sender and slow receiver.
4. **Error Control** : Error detecting and recovering is the one of the main functions of communication software. It ensures that data are transmitted without any error.

5.5 Data Transmission Modes

There are three ways for transmitting data from one point to another as shown in Fig. 5.1

1. **Simplex** : In simplex mode the communication can take place in one direction. The receiver receives the signal from the transmitting device. In this mode the flow of information is Uni-directional. Hence it is rarely used for data communication.
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2. **Half-duplex** : In half-duplex mode the communication channel is used in both directions, but only in one direction at a time. Thus a half-duplex line can alternately send and receive data.
3. **Full-duplex** : In full duplex the communication channel is used in both directions at the same time. Use of full-duplex line improves the efficiency as the line turnaround time required in half-duplex arrangement is eliminated. Example of this mode of transmission is the telephone line.

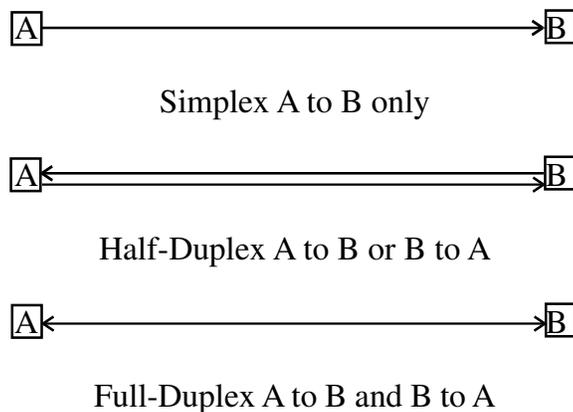


Fig 5.1 Simplex, Half-Duplex and Full-Duplex.

5.5.1 Digital and Analog Transmission

Data is transmitted from one point to another point by means of electrical signals that may be in digital and analog form. So one should know the fundamental difference between analog and digital signals. In analog signal the transmission power varies over a continuous range with respect to sound, light and radio waves. On the other hand, a digital signal may assume only discrete set of values within a given range. (see fig. 5.2 and 5.3) Examples are computer and computer related equipment. Analog signal is measured in Volts and its frequency is in Hertz (Hz). A digital signal is a sequence of voltage represented in binary form. When digital data are to be sent over an analog form the digital signal must be converted to analog form. So the technique by which a digital signal is converted to analog form is known as modulation. And the reverse process, that is the conversion

of analog signal to its digital form, is known as demodulation. The device, which converts digital signal into analog, and the reverse, is known as modem.

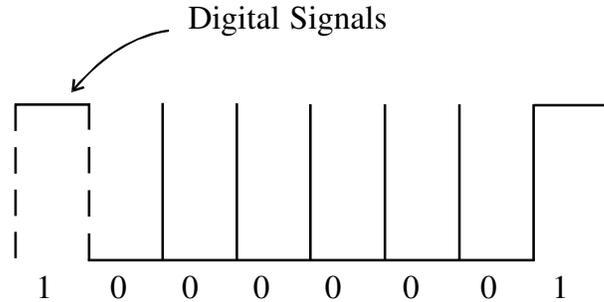


Fig. 5.2 Analog Signal

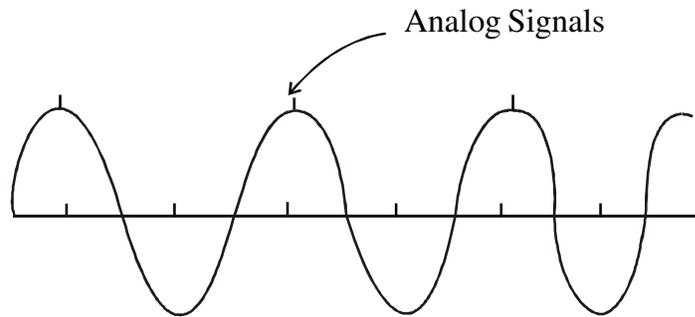


Fig. 5.3 Digital Signal

5.5.2 Asynchronous and Synchronous Transmission

Data transmission through a medium can be either asynchronous or synchronous. In asynchronous transmission data is transmitted character by character as you go on typing on a keyboard. Hence there is irregular gaps between characters. However, it is cheaper to implement, as you do not have to save the data before sending. On the other hand, in the synchronous mode, the saved data is transmitted block by block. Each block can contain many characters. Synchronous transmission is well suited for remote communication between a computer and related devices like card reader and printers.

5.6 Types of Communication Services

A term used to describe the data-handling capacity of a communication service is bandwidth. Bandwidth is the range of frequencies that is available for the transmission of data. A narrow range of frequencies in a communication system is analogous to a garden hose with a small diameter. The flow of information in such a system its data rate is restricted, just as is the flow of water in the narrow hose. Wider bandwidths permit more rapid information flow. The communication data transfer rate is measured in a unit called baud. Baud is identical to bits per second. Therefore, a rate of 300 baud is 300 bits per second.

Communication companies such as American Telephone and Telegraph (AT&T) and Western Union are called common carriers, and they provide three general classes of service for both voice and data communication:

1. Narrowband handles low data volumes. Data transmission rates are from 45 to 300 baud. The low-speed devices might use narrow band communications.
2. Voiceband handles moderate data transmission volumes between 300 and 9600 baud. They are used for applications ranging from operating a CRT to running a line printer. Their major application is for telephone voice communication hence, the term voiceband.
3. Broadband handles very large volumes of data. These systems provide data transmission rates of 1 million baud or more. High-speed data analysis and satellite communications are examples of broadband communication systems.

5.7 Communication Media

Following are the major communication devices which are frequently used :

1. **Wire Pairs** : Wire pairs are commonly used in local telephone communication and for short distance digital data communication. They are usually made up of copper and the pair of wires is twisted together. Data transmission speed is normally 9600 bits per second in a distance of 100 meter.
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2. **Coaxial Cables** : Coaxial cable is groups of specially wrapped and insulated wires that are able to transfer data at higher rate. They consist of a central copper wire surrounded by an insulation over which copper mesh is placed. They are used for long distance telephone lines and local area network for their noise immunity and faster data transfer.
3. **Microwave** : Microwave system uses very high frequency radio signals to transmit data through space. The transmitter and receiver of a microwave system should be in line-of-sight because the radio signal cannot bend. With microwave very long distance transmission is not possible. In order to overcome the problems of line of sight and power amplification of weak signal, repeaters are used at intervals of 25 to 30 kilometers between the transmitting and receiving end.
4. **Communication Satellite** : The problem of line-sight and repeaters are overcome by using satellites which are the most widely used data transmission media in modern days. A communication satellite is a microwave relay station placed in outer space. INSAT-1 B is such a satellite that can be accessible from anywhere in India. In satellite communication, microwave signal is transmitted from a transmitter on earth to the satellite at space. The satellite amplifies the weak signal and transmits it back to the receiver. The main advantage of satellite communication is that it is a single microwave relay station visible from any point of a very large area. In microwave the data transmission rate is 16 giga bits per second. They are mostly used to link big metropolitan cities.

Intext Questions 5.1

1. What is communication protocol?
 2. What is the difference between asynchronous and synchronous transmission?
 3. Write True or False for the following statement
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- (a) The basic requirements for working of a communication system are sender, medium and receiver.
 - (b) Electric or Electromagnetic encoding of data is called Transmission.
 - (c) In full duplex the communication channel issued in both directions at the same time.
 - (d) Analog signal is measured in Volts and its frequency is in Hertz
 - (e) The technique by which a digital signal is converted to analog form is known as modulation.
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5.8 Computer Network

A computer network is interconnection of various computer systems located at different places. In computer network two or more computers are linked together with a medium and data communication devices for the purpose of communication data and sharing resources. The computer that provides resources to other computers on a network is known as server. In the network the individual computers, which access shared network resources, are known as nodes.

5.9 Types of Networks

There are many different types of networks. However, from an end user's point of view there are two basic types:

- **Local-Area Networks (LANs)**

The computers are geographically close together (that is, in the same building).

- **Wide-Area Networks (WANs)**

The computers are farther apart and are connected by telephone lines or radio waves.

In addition to these types, the following characteristics are also used to categorize different types of networks.

- **Topology**

The geometric arrangement of a computer system. Common topologies include bus, star, and ring.

- **Protocol**

The protocol defines a common set of rules and signals that computers on the network use to communicate. One of the most popular protocols for LANs is called Ethernet. Another popular LAN protocol for PCs is the IBM token-ring network.

- **Architecture**

Networks can be broadly classified as using either peer-to-peer or client/server architecture.

Computers on a network are sometimes called nodes. Computers and devices that allocate resources for a network are called servers.

- **Local Area Network (LAN)**

LAN is a computer network that spans a relatively small area. Most LANs are confined to a single building or group of buildings. However, one LAN can be connected to other LANS over any distance via telephone lines and radio waves. A system of LANs connected in this way is called a wide-area network (WAN).

Most LANs as shown in Fig. 5.4 connect workstations and personal computers. Each node (individual computer) in a LAN has its own CPU with which it executes programs, but it is also able to access data and devices anywhere on the LAN. This means that many users can share expensive devices, such as laser printers, as well as data. Users can also use the LAN to communicate with each other, by sending e-mail or engaging in chart sessions.

There are many different types of LANs-token-ring networks, Ethernets, and ARCnets being the most common for PCs.

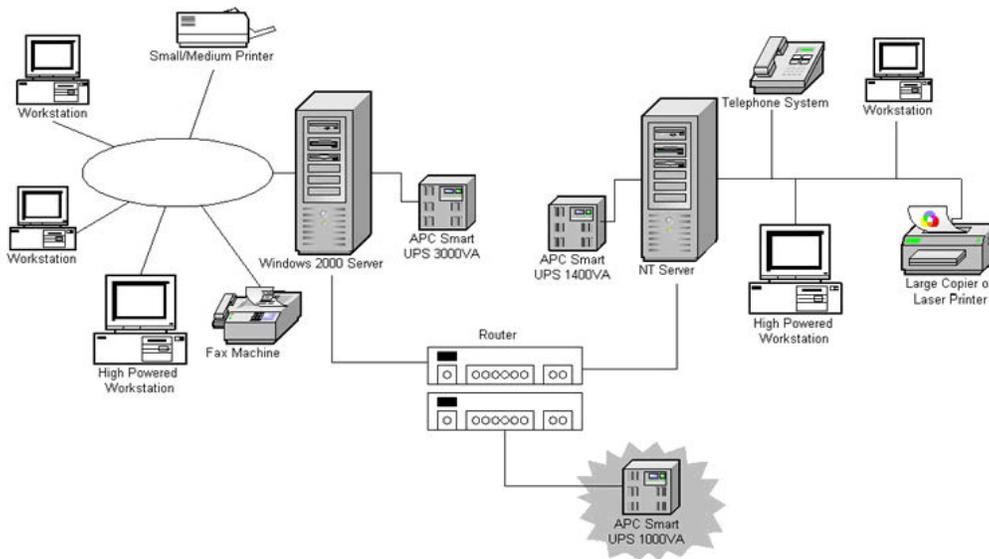


Fig. 5.4 Local Area Network

LANs are capable of transmitting data at very fast rates, much faster than data can be transmitted over a telephone line; but the distance are limited, and there is also a limit on the number of computers that can be attached to a single LAN.

Wide Area Network (WAN)

A WAN is a computer network that spans a relatively large geographical area. Typically, A WAN consists of two or more local-area networks (LANs).

Computers connected to a wide-area network are often connected through public networks, such as the telephone system. They can also be connected through leased lines or satellites. The largest WAN in existence is the Internet.

A typical WAN set up is shown in Fig. 5.5

Fig. 5.5 Wide Area Network

Network Topologies

As we have seen earlier, topology is the geometric arrangement of the computers in a network. Common topologies include star, ring and bus.

Star Network

The star network as shown in Fig 5.6 is frequently used to connect one or more small computers or peripheral devices to a large host computer or CPU. Many organizations use the star network or a variation of it in a time-sharing system, in which several users are able to share a central processor.

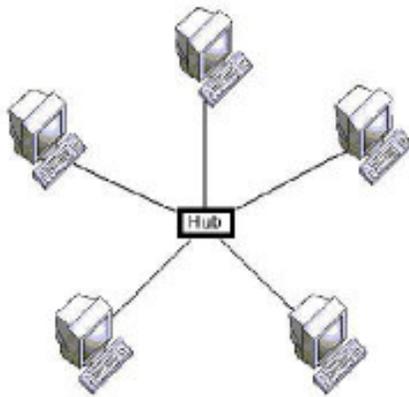


Fig. 5.6 Star Topology

In a time-sharing setup, each terminal receives a fixed amount of the CPU's time, called a time slice. If you are sitting at a terminal and cannot complete your task during the time slice, the computer will come back to you to allow you to do so. Actually, because the CPU operates so much faster than terminals, you will probably not even notice that the CPU is away.

By establishing time-sharing, many people in a large organization can use a centralized computing facility. Time-sharing can also be purchased from an outside service, which is an economical way to operate for a small company that cannot afford its own large computer.

Star network is frequently used in a LAN to connect several microcomputers to a central unit that works as a communications controller. If the user of one microcomputer wants to send a document or message to a user at another computer, the message is routed through the central communications controller. Another common use of the star network is the feasibility of connecting several microcomputers to a mainframe computer that allows access to an organization's database.

Access and control of star network typically is maintained by a polling system. Polling means that the central computer, or communications controller "polls" or asks each device in the network if it has a message to send and then allows each in turn to transmit data.

Ring Network

The ring network (see Fig. 5.7) is a Local Area Network (LAN) whose topology

is a ring - can be as simple as a circle or point-to-point connections of computers at dispersed locations, with no central host computer or communications controller. That is, all of the nodes are connected in a closed loop. Messages travel around the ring, with each node reading those messages addressed to it. One of the advantages of ring networks is that they can span larger distance than other types of networks, such as bus networks, because each node regenerates messages as they pass through it.

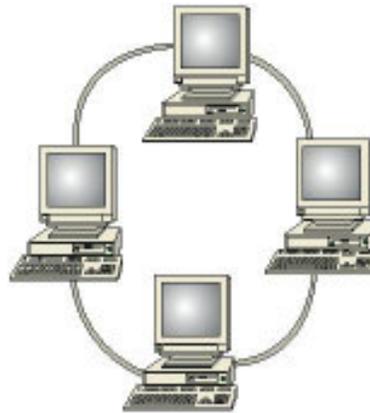


Fig. 5.7 Ring Topology

Access and control of ring networks are typically maintained by a "token-passing" system. IBM's Token-Ring network is thought by some observers to be a watershed event comparable to the development of the IBM PCV itself, because the Token-Ring network is designed to link all types of computers together, including not only personal computers but also possible mini computers and mainframes.

A Token-Ring network as shown in Fig. 5.7 resembles a merry-go-round. To deliver a message, you would hand over your addressed note to a rider (the token) on the merry-go-round, who would drop it off at the appropriate place.

Bus Network

Bus networks (see Fig. 5.8) are similar to ring network that the ends are not connected. All communications are carried on a common cable or bus and are available to each device on the network.

Access and control of bus networks are typically maintained by a method called contention, whereby if a line is unused, a terminal or device can transmit its message at will, but if two or more terminals initiate messages simultaneously, they must stop and transmit again at different intervals.

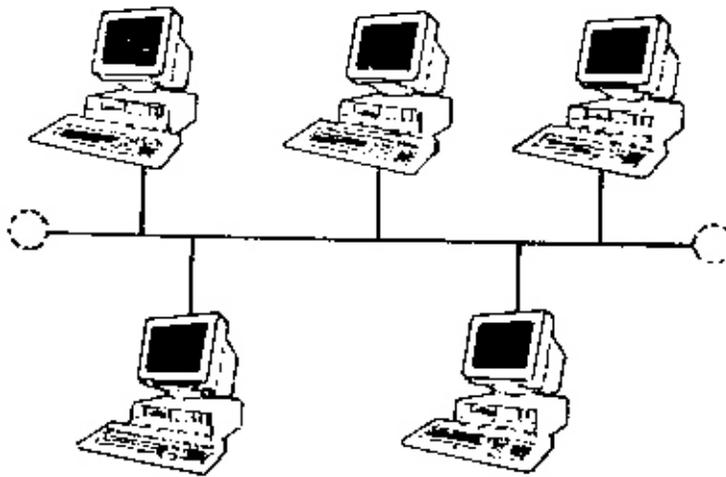


Fig. 5.8 Bus Network

5.10 Network Protocols

A protocol is an agreed-upon format for transmitting data between two devices. The protocol determines the following :

- The type of error checking to be used.
- Data compression method, if any
- How the sending device will indicate that it has finished sending a message
- How the receiving device will indicate that it has received a message

There are a variety of standard protocols from which programmers can choose. Each has its own particular advantages and disadvantages; for example, some are simpler than the others, some are more reliable, and some are faster.

From a user's point of view, the only interesting aspect about protocols is that your computer or device must support the right ones if you want to communicate with other computers. The protocol can be implemented either in hardware or in software. Some of the popular protocols are TCP/IP, HTTP, FTP, SMTP, POP, Token-Ring, Ethernet, Xmodem, Kermit, MNP, etc.

5.11 Network Architecture

The term architecture can refer to either hardware or software, or a combination of hardware and software. The architecture of a system always defines its broad outlines, and may define precise mechanisms as well.

An open architecture allows the system to be connected easily to devices and programs made by other manufacturers. Open architectures use off-the-shelf components and conform to approved standards. A system with a closed architecture, on the other hand, is one whose design is proprietary, making it difficult to connect the system to other systems. As we have seen before, network architectures can be broadly classified as using either peer-to-peer or client/server architecture.

Peer-to-peer Architecture

This is a type of network in which each workstation has equivalent capabilities and responsibilities. This differs from client/server architecture, in which some workstations are dedicated to serving the others. Peer-to-peer networks are generally simpler and less expensive, but they usually do not offer the same performance under heavy loads.

Client/Server Architecture

This is a network architecture in which each computer or process on the network is either a client or a server. Servers are powerful computers or processors dedicated to managing disk drives (file servers), printers (print servers), or network traffic (network servers). Clients are less powerful PCs workstations on which users run applications. Clients rely on servers for resources, such as files, devices, and even processing power.

Intext Questions 5.2

1. Distinguish between LAN and WAN.
 2. What are the different types of network topology?
 3. Write True (T) or False (F) for the following statements :
 - (a) Networks used to interconnect computers in a single room, within a building or buildings on one site are called Wide Area network (WAN).
 - (b) The term Wide Area Network (WAN) is used to describe a computer network spanning a regional, national or global area.
 - (c) The speed of data transmission is much higher in WAN than in LAN.
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5.12 Important terms used in Networking

(a) Internet

The newest type of network to be used within an organisation is an internet or internet web. Such networks enable computers (or network) of any type to communicate easily. The hardware and software needs are the same as for the internet, specifically TCP/IP, server and browser software used for the World Wide Web. Because most organisations have a need for more dynamic ways to link people and information, the internet market is expanding day by day. Moreover, there is no need to adjust the network when a new user joins in. With the help of Internet, all computers of an organisation can work as stand-alone systems, connected to a mainframe, or part of a LAN or WAN.

(b) E-Mail

E-mail stands for electronic mail. This is one of the most widely used features of Internet. Mails are regularly used today where without the help of postage stamp we can transfer mails anywhere in the world. With electronic mail the service is similar. But here data is transmitted through Internet and therefore within minutes the message reaches the destination may it be anywhere in the

world. Therefore the mailing system through e-mail is excessively fast and is being used widely for mail transfer.

(c) Voice Messaging

It is a new communication approach which is similar to electronic mail except that it is audio message rather than text messages that are processed. A sender speaks into a telephone rather than typing, giving the name of the recipient and the message. That sender's voice signal is then digitised and stored. The system can then either deliver the message at a specified time in future or it can be retrieved from a database by the recipient. The message is reconverted back into its analog format when it is delivered or retrieved so that the recipient hears it as the original sender's voice on a telephone. Voice messaging requires a computer with an ability to store the audio messages in digital form and then convert them back in an audio form upon verification. Each user has a voice mailbox in secondary storage and special equipment converts the audio message to and from the digital form. The main advantage of voice mail over electronic mail is that the sender does not have to type. Voice mail also makes it easy to include people in the firm's environment in an communication network.

(d) E-Commerce

Electronic commerce or e-commerce as it is popularly known refers to the paperless exchange of business information using Electronic Data Interchange, Electronic mail, Electronic Bulletin Boards, Electronic Fund Transfer and other network based technologies. Electronic Commerce (EC) not only automates manual process and paper transactions, but it also helps organisations to move into a fully electronic environment and change the way they usually operate. Few organisations have recently started conducting EC over Internet, the network of networks. Internet has also helped EC to boost up because it is a low cost alternative to the proprietary networks. EC standards are however under development. Electronic Data Interchange (EDI) is still the dominant part of EC.

Information Technology has transformed the way people work. Electronic Commerce (EC) has unearthed yet another revolution which is changing the way business houses buy and sell products and services. EC is associated with buying

and selling of products and services over computer communication networks. EC transfers information electronically from computer to computer in autonomous way. EC has, in fact, transformed the way organisations operate.

(e) Electronic Data Interchange (EDI)

EDI is the computer-to-computer exchange of business documents in a standard format. These formats look much like standard forms and are highly structured.

(f) Teleconferencing

It refers to electronic meetings that involve people who are at physically different sites. Telecommunication technology allows participants to interact with one another without travelling to the same location.

5.13 What you have Learnt

In this lesson you learnt about the importance and modes of communication through computers. Computers can communicate with one another through computer networking. There are two types of computer network: LAN and WAN. We discussed about the physical arrangements of computer and peripherals in network topology. There are three types of network topology: star topology, bus topology and ring topology. At the end we discussed about Internet and e-mail.

5.14 Terminal Questions

1. What is computer network? What are its main objectives?
 2. Distinguish between analog and digital transmission of data.
 3. Explain in brief different communication media.
 4. What is the difference between simplex and full-duplex transmission?
 5. Explain network architecture briefly.
 6. Define teleconferencing.
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5.15 Feedback to In-Text Questions

In-text Questions 5.1

1. The data communication software instructs computer systems and devices as to how exactly data is to be transferred from one place to another. The procedure of data transformation in the form of software is commonly called protocol.
2. In asynchronous transmission data is transmitted character by character as you go on typing on a keyboard. On the other hand, in the synchronous mode, the saved data is transmitted block by block.
3. (a) True (b) False (c) True (d) True (e) True

In-Text Questions 5.2

1. LAN is restricted to limited geographical area whereas WAN covers long distance. In LAN the computer terminals and peripheral devices are connected with wires and cables whereas in WAN communication is done through telephone lines and satellite links. The speed of data transmission is much higher in LAN than in WAN.
 2. There are three major types of network topology. They are star topology, bus topology and ring topology.
 3. (a) False (b) True (c) False
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