

# 2

## BASICS OF DATA COMMUNICATION AND COMPUTER NETWORKING

### 2.1 INTRODUCTION

Computers are used to generate information. Generated information is not useful in itself. The information must be delivered to the right person at the right time. Often information must be transmitted from one location to another. This process is called data communication. Here, we will be concerned with the hardware, software and procedures used in data communication.

Office automation is based on communication; the transfer of information. Advances in communication technology, combined with rapidly evolving computer technology, have made possible much of the progress in the field. Electronic communication consists of telecommunication and data communications. Telecommunication refers to the use of telephone, telegraph, and radio or television facility to transmit information, either directly or via computer. Data communication means the transfer of data or information between computers devices.

### 2.2 OBJECTIVES

After going through this lesson, you would be able to:

- learn the basic elements of data communication system.
  - describe communication protocols and data transmission modes.
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- explain the use of computer network.
- describe different components of computer network
- identify different types of network

## 2.3 DATA COMMUNICATION

Data communication is the active process of transporting data from one point to another. Networks are communication system designed to convey information from a point of origin to a point of destination. Note that they are communication system, not computer system. The operative word is communication, the transfer of information from one device to another.

Networks come in two flavors – **local** as in local area network, which cover a small area and have a finite, relatively small, number of users and **global** or long-haul, which cover long distance and have an unlimited number of users. Telephone networks are long network. It refers to the transmission of the digital signals over a communication channel between the transmitter and receiver computers. Communication is possible only with wired and wireless connectivity of the computers with each other.

The effectiveness of a data communication system depends on three fundamental characteristics:

- **Delivery:** The system must deliver data to the correct destination. Data must be received by the intended device or user and only by that device or user.
- **Accuracy:** The system must deliver data accurately. Data that have been altered in transmission and left uncorrected are unusable.
- **Timeliness:** The system must deliver data in a timely manner. Data delivered late are useless. In the case of video, audio and voice data, timely delivery means delivering data as they are produced, in the same order that they are produced, and without significant delay. This kind of delivery is called real-time transmission.

### 2.3.1 Data Communication Component

The following are the basic components for working of a communication system. (see fig. 2.1)

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1. Transmitter
2. Receiver
3. Medium
4. Message
5. Protocol

The transmitter sends the message and the receiver receives the message. The medium is the channel over which the message is sent and the protocol is the set of rules that guides how the data is transmitted from encoding to decoding. The message of course is central to all the components. The message is the data that is being communicated.

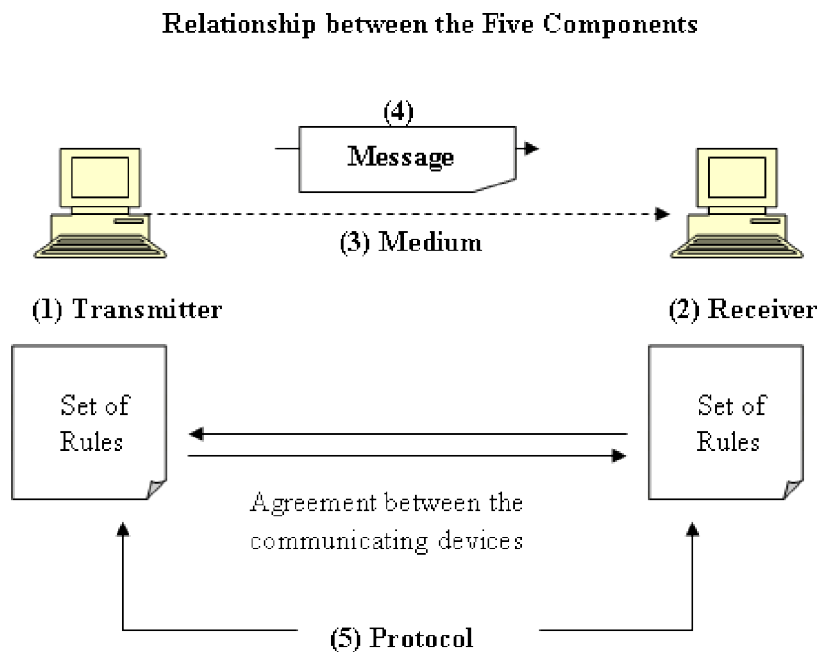


Fig 2.1 : Data Communication Components

**Transmitter:** The transmitter is the device that sends the message. It can be a computer, workstation, telephone handset, video camera, and so on.

**Receiver:** The receiver is the device that receives the message. It can be a computer, workstation, telephone handset, television, and so on.

**Medium:** The transmission medium is the physical path by which a message travels from sender to receiver. It can consist of twisted pair wire, coaxial cable, fiber-optic cable, laser or radio waves (terrestrial or satellite microwave).

**Message:** The message is the transmission (data) to be communicated. It can consist of text, number, pictures, sound, or video or any combination of these.

**Protocol:** A protocol is a set of rules that governs data communication. It represents an agreement between the communicating devices. Without a protocol, two devices may be connected but not communicating, just as a person speaking German cannot be understood by a person who speaks only Japanese.

## 2.4 COMMUNICATION MEDIA

Following are the major communication devices which are frequently used:

- **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. Using these wire pairs data transmission speed is normally 9600 bits per second in a distance of 100 metre.
  - **Twisted pair:** Twisted pair wire is the most widely used medium for telecommunication. Twisted-pair cabling consist of copper wires that are twisted into pairs. Ordinary telephone wires consist of two insulated copper wires twisted into pairs. Computer networking cabling (wired Ethernet as defined by IEEE 802.3) consists of 4 pairs of copper cabling that can be utilized for both voice and data transmission. The use of two wires twisted together helps to reduce crosstalk and electromagnetic induction. The transmission speed ranges from 2 million bits per second to 10 billion bits per second. Twisted pair cabling comes in two forms which are Unshielded Twisted Pair (UTP) and Shielded twisted-pair (STP) which are manufactured in different increments for various scenario.
  - **Coaxial cable:** Coaxial cable is widely used for cable television systems, office buildings, and other work-sites for local area networks. The cables consist of copper or aluminum wire wrapped with insulating layer typically of
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a flexible material with a high dielectric constant, all of which are surrounded by a conductive layer. The layers of insulation help minimize interference and distortion. Transmission speed range from 200 million to more than 500 million bits per second.

- **Optical fiber:** Optical fiber cable consists of one or more filaments of glass fiber wrapped in protective layers that carries data by means of pulses of light. It transmits light which can travel over extended distances. Fiber-optic cables are not affected by electromagnetic radiation. Transmission speed may reach trillions of bits per second. The transmission speed of fiber optics is hundreds of times faster than for coaxial cables and thousands of times faster than a twisted-pair wire. This capacity may be further increased by the use of colored light, i.e., light of multiple wavelengths. Instead of carrying one message in a stream of monochromatic light impulses, this technology can carry multiple signals in a single fiber.

### **Wireless technologies**

- **Terrestrial microwave:** Terrestrial microwaves use Earth-based transmitter and receiver. The equipment looks similar to satellite dishes. Terrestrial microwaves use low-gigahertz range, which limits all communications to line-of-sight. Path between relay stations spaced approx, 48 km (30 mi) apart. Microwave antennas are usually placed on top of buildings, towers, hills, and mountain peaks.
- **Communications satellites:** The satellites use microwave radio signals as their telecommunications medium which are not deflected by the Earth's atmosphere. The satellites are stationed in space, typically 35,400 km (22,000 mi) (for geosynchronous satellites) above the equator. These Earth-orbiting systems are capable of receiving and relaying voice, data, and TV signals.

## **2.5 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

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information in such a system 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:

- Narrowband handles low data volumes. Data transmission rates are from 45 to 300 baud. The low-speed devices might use narrow band communications.
- 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.
- 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.

## **2.6 MODEM**

A modem (modulator-demodulator) is a device that modulates an analog carrier signal to encode digital information, and also demodulates such a carrier signal to decode the transmitted information. The goal is to produce a signal that can be transmitted easily and decoded to reproduce the original digital data. Modems can be used over any means of transmitting analog signals, from light emitting diodes to radio.

A modem modulates outgoing digital signals from a computer or other digital device to analog signals for a conventional copper twisted pair telephone line and demodulates the incoming analog signal and converts it to a digital signal for the digital device.

In recent years, the 2400 bits per second modem that could carry e-mail has become obsolete. 14.4 Kbps and 28.8 Kbps modems were temporary landing places on the way to the much higher bandwidth devices and carriers of tomorrow. From early

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1998, most new personal computers came with 56 Kbps modems. By comparison, using a digital Integrated Services Digital Network adapter instead of a conventional modem, the same telephone wire can now carry up to 128 Kbps. With Digital Subscriber Line (DSL) systems, now being deployed in a number of communities, bandwidth on twisted-pair can be in the megabit range.

### **2.6.1 Types of Modems**

- Landline Modems
- Wireless Modems
- LAN Modems

#### **A. Landline Modems:**

Landline modems are modems which connect to the public switched telephone network (PSTN). To connect to PSTN, these modems have a jack known as RJ-11, or regular phone jack. A telephone cable with a RJ-11 plug connects the modem to the nearest phone jack, which also conforms to the RH-11 standard. Landline modems can be further classified into the followings types:

- 1. Internal modems:** This device is a circuit board that plugs into one of the expansion slots of the computer. Internal modems usually are cheaper than external modems, but when problems occur, fixing and troubleshooting the modem can sometimes prove to be quite difficult. The telephone line plugs into the modem port in the back of the computer. Most internal modems come installed in the computer you buy. Internal modems are more directly integrated into the computer system and, therefore, do not need any special attention. Internal modems are activated when you run a communications program and are turned off when you exit the program. This convenience is especially useful for novice users.

Internal modems usually cost less than external modems, but the price difference is usually small. The major disadvantage with internal modems is their location: inside the computer. When you want to replace an internal modem you have to go inside the computer case to make the switch.

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2. **External modems:** This device is attached to the back of the computer by way of a cable that plugs into the modem port. It is usually less expensive and very portable. It can be used with other computers very easily by unplugging it and plugging it into another computer. This is the simplest type of modem to install because you don't have to open the computer. External modems have their own power supply and connect with a cable to a computer's serial port. The telephone line plugs into a socket on the rear panel of the modem.

Because external modems have their own power supply, you can turn off the modem to break an online connection quickly without powering down the computer. Another advantage over an internal modem is that an external modem's separate power supply does not drain any power from the computer. You also can monitor your modem's connection activity by watching the status lights.

3. **Voice/data/fax modems:** This device can be hooked up to your telephone and used to send information to your computer. Your computer can also send information to a fax machine. Most computer modems are modems with faxing capabilities.
4. **PC Card modem:** These modems, designed for portable computers, are the size of a credit card and fit into the PC Card slot on notebook and handheld computers. These modems are removed when the modem is not needed. Except for their size, PC Card modems are like a combination of external and internal modems. These devices are plugged directly into an external slot in the portable computer, so no cable is required other than the telephone line connection. The cards are powered by the computer, which is fine unless the computer is battery-operated. Running a PC Card modem while the portable computer is operating on battery power drastically decreases the life of your batteries.

#### **B. Wireless Modems:**

Wireless modems are radio transmitters/receivers installed into mobile computing devices (i.e. devices that are used while you are moving such as mobile phones, laptops etc.)

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Using wireless modems, one can connect to a network while being mobile. Unlike landline modems, wireless modems do not plug into an RJ-11 jack.

### **C. LAN Modems:**

LAN modems allow shared remote access to LAN (Local Area Network) resources. LAN modem comes fully preconfigured for single particular network architecture such as Ethernet or Token Ring and/or particular network software such as IPX, NetBIOS, NetBEUI etc.

## **2.6.2 Working of Modem**

Modems convert analog data transmitted over phone lines into digital data so that computers can read; they also convert digital data into analog data so it can be transmitted. This process involves modulating and demodulating the computer's digital signals into analog signals that travel over the telephone lines. In other words, the modem translates computer data into the language used by telephones and then reverses the process to translate the responding data back into computer language.

## **2.7 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 communicating 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.

### **2.7.1 Characteristics of a Computer Network**

The primary purpose of a computer network is to share resources:

- You can play a CD music from one computer while sitting on another computer
  - You may have a computer that doesn't have a DVD or BluRay (BD) player. In this case, you can place a movie disc (DVD or BD) on the computer that has the player, and then view the movie on a computer that lacks the player
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- You may have a computer with a CD/DVD/BD writer or a backup system but the other computer doesn't have it. In this case, you can burn discs or make backups on a computer that has one of these but using data from a computer that doesn't have a disc writer or a backup system
- You can connect a printer (or a scanner, or a fax machine) to one computer and let other computers of the network print (or scan, or fax) to that printer (or scanner, or fax machine)
- You can place a disc with pictures on one computer and let other computers access those pictures
- You can create files and store them in one computer, then access those files from the other computer(s) connected to it

### **2.7.2 Concept of Networking:**

A computer network, often simply referred to as a network, is a collection of hardware components and computers interconnected by communication channels that allow sharing of resources and information. Networks may be classified according to a wide variety of characteristics such as the medium used to transport the data, communications protocol used, scale, topology, and organizational scope. The rules and data formats for exchanging information in a computer network are defined by communications protocols.

### **2.7.3 Properties of Network**

#### **1. Facilitate communications:**

Using a network, people can communicate efficiently and easily via email, instant messaging, chat rooms, telephone, video telephone calls, and video conferencing.

#### **2. Permit sharing of files, data, and other types of information**

In a network environment, authorized users may access data and information stored on other computers on the network. The capability of providing access to data and information on shared storage devices is an important feature of many networks.

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### 3. Share network and computing resources

In a networked environment, each computer on a network may access and use resources provided by devices on the network, such as printing a document on a shared network printer. Distributed computing uses computing resources across a network to accomplish tasks.

#### 2.8 BENEFITS OF NETWORK

- **File sharing:** Network file sharing between computers gives you more flexibility than using floppy drives or Zip drives. Not only can you share photos, music files, and documents, you can also use a home network to save copies of all of your important data on a different computer. Backups are one of the most critical yet overlooked tasks in home networking.
  - **Printer / peripheral sharing:** Once a home network is in place, it's then easy to set up all of the computers to share a single printer. No longer will you need to bounce from one system or another just to print out an email message. Other computer peripherals can be shared similarly such as network scanners, Web cams, and CD burners.
  - **Internet connection sharing:** Using a home network, multiple family members can access the Internet simultaneously without having to pay an ISP for multiple accounts. You will notice the Internet connection slows down when several people share it, but broadband Internet can handle the extra load with little trouble.
  - **Multi-player games:** Many popular home computer games support LAN mode where friends and family can play together, if they have their computers networked.
  - **Internet telephone service:** Voice over IP (VoIP) services allows you to make and receive phone calls through your home network across the Internet.
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- **Home entertainment:** Newer home entertainment products such as digital video recorders (DVRs) and video game consoles now support either wired or wireless home networking. Having these products integrated into your network enables online Internet gaming, video sharing and other advanced features.

## 2.9 TYPES OF NETWORK

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

- Local Area Network
- Wide Area Network
- Metropolitan Area Network

### 2.9.1 Local Area Network (LAN):

A local area network (LAN) supplies networking capability to a group of computers in close proximity to each other such as in an office building, a school, or a home. A LAN is useful for sharing resources like files, printers, games or other applications. A LAN in turn often connects to other LANs, and to the Internet or other WAN.

Most local area networks are built with relatively inexpensive hardware such as Ethernet cables, network adapters, and hubs. Wireless LAN and other more advanced LAN hardware options also exist. 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. Most LANs (as shown in Fig. 2.2) 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 chat sessions. There are many different types of LANs-token-ring networks, Ethernets, and ARCnets being the most common for PCs.

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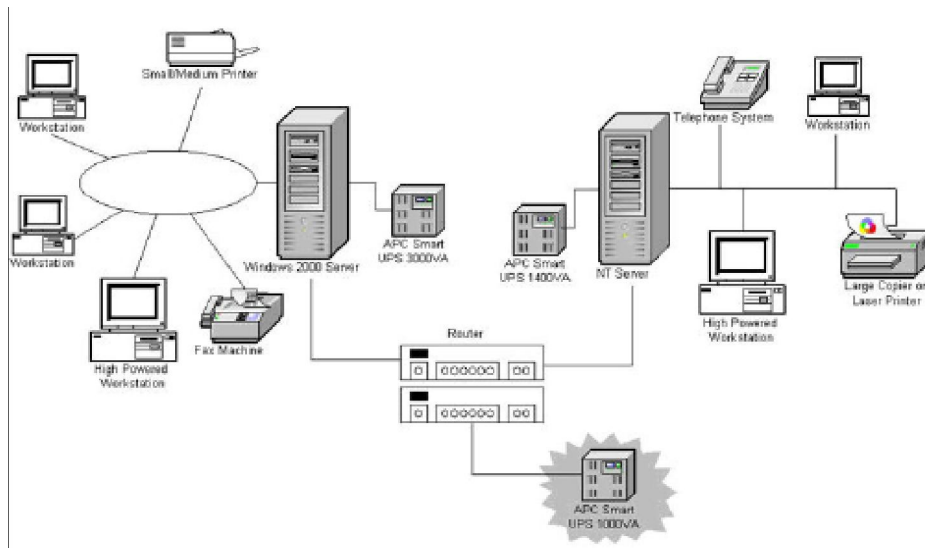


Fig. 2.2 LAN

## 2.9.2 Wide Area Networks (WANs)

The term Wide Area Network (WAN) usually refers to a network which covers a large geographical area, and use communications circuits to connect the intermediate nodes. A major factor impacting WAN design and performance is a requirement that they lease communications circuits from telephone companies or other communications carriers. Transmission rates are typically 2 Mbps, 34 Mbps, 45 Mbps, 155 Mbps, 625 Mbps (or sometimes considerably more).

## 2.9.3 Metropolitan Area Network (MAN)

A Metropolitan Area Network (MAN) is one of a number of types of networks (see also LAN and WAN). A MAN is a relatively new class of network, it serves a role similar to an ISP, but for corporate users with large LANs.

## 2.10 IMPORTANT TERMS USED IN NETWORKING

### 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 digitized 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 a communication network.

### **Hub**

A hub is typically the least expensive, least intelligent, and least complicated. Its job is very simple: anything that comes in one port is sent out to the others. Every computer connected to the hub "sees" everything that every other computer on the hub sees. The hub itself is blissfully ignorant of the data being transmitted. For years, simple hubs have been quick and easy ways to connect computers in small networks.

### **Switch**

A switch does essentially what a hub does but more efficiently. By paying attention to the traffic that comes across it, it can "learn" where particular addresses are. For example, if it sees traffic from machine A coming in on port 2, it now knows that machine A is connected to that port and that traffic to machine A needs to only be sent to that port and not any of the others. The net result of using a switch over a hub is that most of the network traffic only goes where it needs to rather than to every port. On busy networks this can make the network significantly faster.

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## **Router**

A router is the smartest and most complicated of the bunch. Routers come in all shapes and sizes from the small four-port broadband routers that are very popular right now to the large industrial strength devices that drive the internet itself. A simple way to think of a router is as a computer that can be programmed to understand, possibly manipulate, and route the data its being asked to handle. For example, broadband routers include the ability to "hide" computers behind a type of firewall which involves slightly modifying the packets of network traffic as they traverse the device. All routers include some kind of user interface for configuring how the router will treat traffic. The really large routers include the equivalent of a full-blown programming language to describe how they should operate as well as the ability to communicate with other routers to describe or determine the best way to get network traffic from point A to point B.

## **Network Repeater**

A repeater connects two segments of your network cable. It retimes and regenerates the signals to proper amplitudes and sends them to the other segments. When talking about, ethernet topology, you are probably talking about using a hub as a repeater. Repeaters require a small amount of time to regenerate the signal. This can cause a propagation delay which can affect network communication when there are several repeaters in a row. Many network architectures limit the number of repeaters that can be used in a row. Repeaters work only at the physical layer of the OSI network model.

## **Bridge**

A bridge reads the outermost section of data on the data packet, to tell where the message is going. It reduces the traffic on other network segments, since it does not send all packets. Bridges can be programmed to reject packets from particular networks. Bridging occurs at the data link layer of the OSI model, which means the bridge cannot read IP addresses, but only the outermost hardware address of the packet. In our case the bridge can read the ethernet data which gives the hardware address of the destination address, not the IP address. Bridges forward all broadcast messages. Only a special bridge called a translation bridge will allow two networks of different

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architectures to be connected. Bridges do not normally allow connection of networks with different architectures. The hardware address is also called the MAC (media access control) address. To determine the network segment a MAC address belongs to, bridges use one of the following:

- **Transparent Bridging:** They build a table of addresses (bridging table) as they receive packets. If the address is not in the bridging table, the packet is forwarded to all segments other than the one it came from. This type of bridge is used on ethernet networks.
- **Source route bridging:** The source computer provides path information inside the packet. This is used on Token Ring networks

### **Router**

There is a device called a router which will function similar to a bridge for network transport protocols that are not routable, and will function as a router for routable protocols. It functions at the network and data link layers of the OSI network model.

### **Gateway**

A gateway can translate information between different network data formats or network architectures. It can translate TCP/IP to AppleTalk so computers supporting TCP/IP can communicate with Apple brand computers. Most gateways operate at the application layer, but can operate at the network or session layer of the OSI model. Gateways will start at the lower level and strip information until it gets to the required level and repackage the information and work its way back toward the hardware layer of the OSI model.

## **2.11 TELECONFERENCING**

The term teleconferencing refers to electronic meetings that involve people who are at physically different sites. Telecommunication technology system allows meeting participants to interact with one another without travelling to the same location. Three different types of teleconferencing exist: audio teleconferencing, video teleconferencing and computer conferencing.

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### **2.11.1 Audio Conferencing**

Audio conferencing is the use of voice communication equipments to establish an audio link between geographically dispersed persons, one that allows them to conduct a conference. The conference call was the first form of audio conferencing and is still in use. Some firms install more elaborate systems consisting of private, high-quality audio communications circuits that can be activated with the flip of a switch.

Audio conferencing does not require a computer. It only requires a two-way audio communications facility.

Audio conferencing is best suited for firms that are spread over a wide area. However, since it is a form of synchronous communication that requires all participants to be present at the same time, it is difficult to schedule conferences when time zones are far apart.

### **2.11.2 Video Conferencing:**

Video conferencing is the use of television equipment to link geographically dispersed conference participants. The equipment provides both sound and picture. Like audio conferencing, video conferencing also does not necessarily require a computer.

With video conferencing, participants can see and hear each other. Generally, participants gather in relatively expensive, specially equipped rooms that can handle the complexities of simultaneous video and audio transmission.

There are three possible video conferencing configurations.

**One-Way Video and Audio:** Video and audio signals are sent from a single transmitting site to one or more receiving sites. This is a good way for a project leader to disseminate information to team members at remote locations.

**One-Way Video and Two-Way Audio:** People at the receiving sites can talk to people at the transmitting site, while everyone views the same video images.

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**Two-Way Video and Audio:** The video and audio communications between all sites are two-way. Although this is the most effective of the electronically aided conferencing approaches, it can be the most expensive as well.

### 2.11.3 Computer Conferencing

A third form of electronic conferencing is computer conferencing. There is a fine line between this system and E-mail. Both use the same software and hardware. Two factors determine this application, who uses the system, and the subject matter.

E-mail is available to any one who has access to the network and that includes practically everyone in the office. Also, the E-mail system can be used for any purpose. Computer conferencing, on the other hand, is the use of a networked computer that allows particular task. Computer conferencing is more disciplined form of E-mail.

Unlike an audio conference, a computer conference group can consist of large number of participants. One of the largest computer conferences was formed within IBM to include anyone who had an interest in the IBM PC. Its members exceeded 40,000, and there were over 4,000 separate topic areas.

Computer conferencing differs from audio and video conferencing because it can be used within a single geographic site. A person can use computer conferencing to communicate with someone in the office next door.

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### INTEXT QUESTION 2.1

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1. State TRUE or FALSE
    - (a) The basic components for working of a communication system are transmitter, medium, receiver, message and protocol.
    - (b) The technique by which a digital signal is converted to analog form is known as modulation.
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## **2.12 WHAT YOU HAVE LEARNT**

In this lesson you learnt about the importance and modes of data communication through computers. Computers can communicate with one another through computer networking. There are mainly two types of computer network: LAN and WAN. We discussed about various types of modems used for data communications such as land line modems, wireless modems and LAN modems. At the end we discussed about various types of teleconferencing.

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## **2.13 TERMINAL QUESTIONS**

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1. What is computer network? What are its main objectives?
2. Explain in brief different communication media?

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## **2.14 ANSWER TO INTEXT QUESTIONS**

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### **Intext Question 2.1**

1. (a) True (b) True
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