Fundamentals of Networking and Web Technology

SEMESTER I

MASTER OF COMPUTER APPLICATION /

MASTER OF SCIENCE IN INFORMATION TECHNOLOGY

BLOCK - 1

KRISHNA KANTA HANDIQUI STATE OPEN UNIVERSITY

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COURSE INTRODUCTION

This course is basically designed for the learners who are begineers in the field of computer networks. This is age of digital technology. In this age it is very important to know about digital communication. Data transmission, speed of transmission, medium of transmission and techniques of transmission are very much essential to understand. Through this course it is aimed to introduce the learners about the basic knowledge of communication technology. The different layers of communication technology have been explained in details.

There are two blocks in this course.

Block 1 deals with the basic concept of networking devices and communication principles. After going through this block learners will be comfortable to learn Block 2.

Block 2 concentrates on basic principles of Internet and Web Technology. At the end of this block learners will be acquainted with basic idea of Internet, Webpage design and its standards.

Each unit of these blocks includes some along-side boxes to help you know some of the difficult, unseen terms. Some “EXERCISES” have been included to help you apply your own thoughts. You may find some boxes marked with: “LET US KNOW”. These boxes will provide you with some interesting and relevant additional information. Again, you will get “CHECK YOUR PROGRESS” questions. These have been designed to self-check your progress of study. It will be helpful for you if you solve the problems put in these boxes immediately after you go through the sections of the units and then match your answers with “ANSWERS TO CHECK YOUR PROGRESS” given at the end of each unit.

BLOCK INTRODUCTION

Block 1 of ‘‘Fundamentals of Networking and Web Technology’’ discuss the basic concept of computer network. Unit I deals with the basic concept of computer network including types of networks, transmission methods etc. Unit 2 introduces data communication models like serial and parallel communication, simplex and duplex communication.The basic of network devices like Network Interface Card, Modem, Repeater, Bridges, Hub, Switch, Router are discussed in Unit 3. Introduction to network topology like Bur, Ring, Mesh, tree are discussed in Unit 4. Unit 5 discusses the data transmission techniques like asynchronous and synchronous transmission. The concept of network models mainly ISO-OSI and TCP/IP are discussed in Unit 6. Unit 7 discusses the details of Transmission media mainly duided and unguided.

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Fundamentals of Networking and Web Technology

DETAILED SYLLABUS

BLOCK-1
Semester I

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UNIT 1: Introduction to Computer Network [8 marks] 7-20

Goals of Computer Network, Broadcast and Point-to-Point Networks, Connection-Oriented and Connection-Less Services, Types of Network, Local Area Network, LAN Transmission Methods, Peer-to-Peer LAN & Server Based LAN, Metropolitan Area Network, Wide Area Network

UNIT 2: Data Communication Modes [8 marks] 21-32

Data Communication, Types of Communication, Modes of Communication

UNIT 3: Network Devices[5 marks] 33-42

Network Interface Card (NIC), Modem, Repeater, Bridges and Gateways, Hub, Switch, Router

UNIT 4: Network Topology [5 marks] 43-52

Network Topology, Bus Topology, Ring Topology, Star Topology, Mesh Topology, Tree Topology

UNIT 5: Data Transmission [8 marks] 53-63

Parallel Transmission, Serial Transmission, Asynchronous Transmission, Synchronous Transmission, Switching Techniques, Circuit Switching, Message Switching, Packet Switching

UNIT 6: Network Models [8 marks] 64-79

Design Issues of Layers, Protocol Hierarchy, ISO-OSI Reference Model : Functions of Layers, Important Terminologies, Connection-Oriented and Connectionless Service, TCP/IP Reference Model, Comparison of ISO-OSI & TCP /IP Model

UNIT 7: Transmission Media [8 marks] 80-100

Transmission Medium, Guided Media: Coaxial Cable, Twisted Pair Cable, Fiber Optics Cable , Unguided Media: Radio Waves, Infrared, Microwave, Satellite, Wireless LANs (IEEE 802.11)

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UNIT 1 : INTRODUCTION TO COMPUTER NETWORK

UNIT STRUCTURE

1.1 Learning Objectives

1.2 Introduction

1.3 Goals of Computer Network

1.4 Broadcast and Point-to-Point Networks

1.5 Connection-Oriented and Connection-Less Services

1.6 Types of Network

- 1.6.1 Local Area Network
  - 1.6.1.1 LAN Transmission Methods
  - 1.6.1.2 Peer-to-Peer LAN & Server Based LAN
- 1.6.2 Metropolitan Area Network
- 1.6.3 Wide Area Network

1.7 Let Us Sum Up

1.8 Further Reading

1.9 Answers to Check Your Progress

1.10 Model Questions

1.1 LEARNING OBJECTIVES

After going through this unit, you will be able to :

- define the goals of computer network
- learn about broadcast and point-to-point networks
- describe connection-less and connection-oriented services
- describe the types of computer network
- differentiate server-based and peer-to-peer LANs

1.2 INTRODUCTION

A computer network is a collection of several computers and terminals that shares information across wireless or wired technology. The

main goal of a network system is the transfer and exchange of data between the computers and terminals.

In this unit, we will begin our discussion with the goals of computer network. We will introduce various concepts associated with computer network such as the concept of broadcast and point-to-point network, connection-less and connection oriented services, various internetrking devices etc. We will further discuss the various types of network together with the concept of network topology. At the end, we will briefly discuss the different transmission types and communication modes followed by various switching techniques.

Before discussing the technical issues in detail, it is worth devoting some time to pointing out why people are interested in computer networks and what they can be used for.

1.3 GOALS OF COMPUTER NETWORKS

Before the advent of computer networks, papers and diskettes were the only means to share information. Now a days, computer networks which comprise a number of computers as well as other devices like printers, scanners etc. are widely used to share resources in a more efficient and faster way.

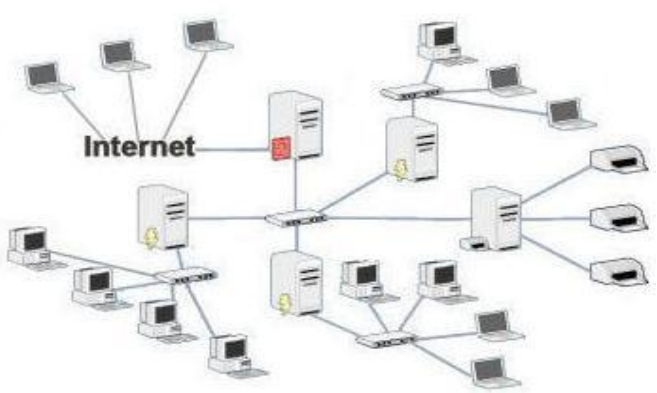


Fig. 1.1 : A typical computer network

In a network, whether big or small, all the devices are interconnected to transmit and receive data from one another. These connections are usually made not only by copper wires; instead, fiber optics, microwaves, infrared,

and communication satellites are also used for efficient communication. The main goals of these networks can be summarized as follows :

- **Resource Sharing :** Using computer networks, it is possible to share programs, data and other resources among several users on the network. The sharing of resources is independent of the physical location of the user and the resource. Files on a particular user's computer can be shared on the network or files can be placed on a file server which provides a central location for all files needed by the users on the network. Users can also share devices such as printers, CD-ROM drives, and hard drives etc. It also makes upgrading an application easier because the upgrade only has to be performed only on the server itself. Thus, we do not need seperate resource for each computer.
- **High Reliablity :** A second goal is to provide high reliability by having alternative sources of supply. For example, all files could be replicatied on two or three machines; so if one of them is unavailable, the other copies could be available.
- **Cost Reduction :** Resource sharing automatically reduces cost and hence money can be saved. For example, let us there are ten users and each user requires a printer. If they could have been working individually, then ten printers would have to be purchased. If these ten users are allowed to work in a network, then only two or three printers would be sufficient.
- **Communication Medium :** Computer networks provide a powerful communication medium among the people who are in a geographically same or different location. A file that was updated or modified on a network, can be seen by the other users on the network immediately. Thus, it becomes easy for two or more peoples living far apart to work on a same project by dividing it using a network. They can write programs, can discuss or can even change or modify some data using a network while they are far off. Otherwise, they will have to wait for several days for

communication through letters or some other media. Thus, it makes speedy co-operations and enhances human to human communication.

1.4 BROADCAST AND POINT-TO-POINT NETWORK

On the basis of *transmission technology*, computer networks can be divided into two categories: *broadcast* and *point-to-point*.

- ***Broadcast networks*** have a single communication channel which is shared by all the machines on the network. Here, messages are broken into *packets* which are then broadcast to all machines in the channel. A packet sent by any machine is received by all the machines but only that machine processes the packet for which it is intended. An address field (destination address), within the packet specifies for whom it is intended. Upon receiving a packet, a machine checks the address field. If the packet is intended for itself, it processes the packet; if it is intended for some other machine, it is just ignored. However, in broadcast networks, we have the problem of deciding who uses the channel, if there is competition for it. For this, *medium access control* (MAC) is used to determine who goes next.

  As an analogy, let us imagine a scenario where a teacher is taking the attendance in a particular class. He/she will call every roll number in the classroom, all will listen but only the respective student will respond. Broadcast implies "*sending a signal where multiple parties may hear a single sender*".

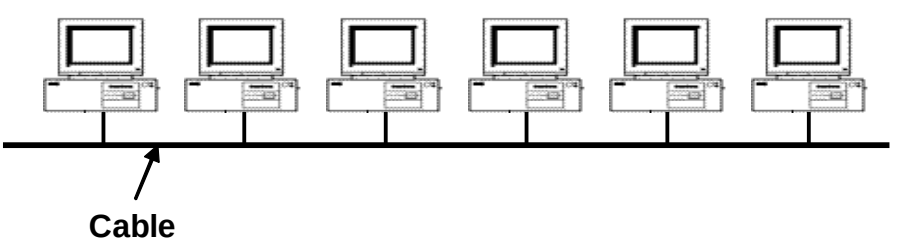


Fig. 1.2 : A Broadcast Network

- Again, let us imagine a scenario that a teacher is taking the attendance in an examination hall. He/she will go to each member of the room and will take the attendance individually. Here, only one person listen and he only responds to the call. ***Point-to-point network*** is a method of communication where one "point" (person or device or entity) speaks to another entity. Point-to-point network consists of many connections between individual pairs of machines. Packet, on this type of network, may have to visit one or more intermediate machines to reach from the source to the destination. Often multiple routes of different lengths are possible in point-to-point networks. Therefore, routing algorithms are required to determine the best routes out of multiple available routes.

1.5 CONNECTION-ORIENTED AND CONNECTION-LESS SERVICES

On the basis of *acknowledgement sent by the receiver*, there are two distinct techniques used in data communications to transfer data. These

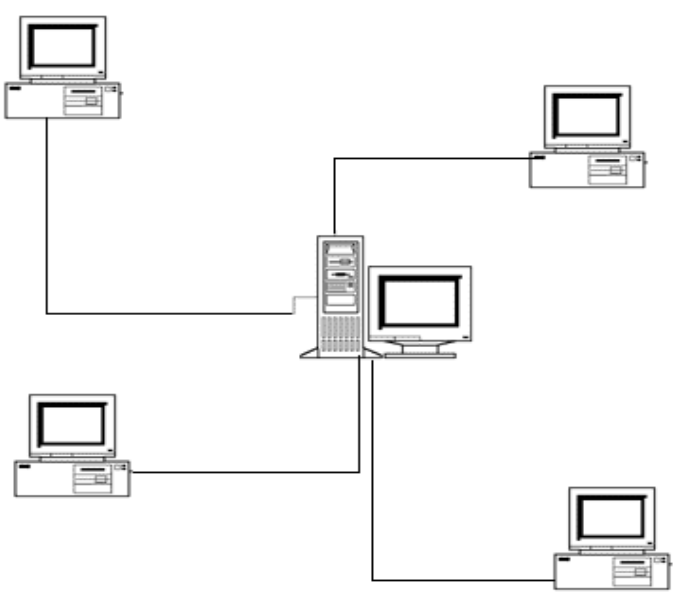


Fig. 1.3 : Point-to-Point Network

are: *connection-oriented* and *connection-less services*. Each service can be characterized by a quality of service. In general, a reliable service is implemented by having the receiver acknowledge the receipt of each message; so the sender is sure that it has arrived.

- ***Connection-oriented service*** is modelled after the telephone system. For making a call to someone, first we have to pick up the phone and dial the number. After the connection is established, we talk, and then hang up.

  Connection-oriented service requires a connection to be established before any data can be sent. It sets up virtual links between the end systems through a network. After the connection is established, the data is transferred. As soon as the transmission is completed, the service user releases the connection. This procedure requires a specific acknowledgement for the information whether the connection is established or not. This method is often called a "reliable" network service. In some cases, when the connection is established, the sender, receiver, and subnet conduct a negotiation about the parameters to be used such as maximum message size, quality of service required, and other issues. Typically, one side makes a proposal and the other side can accept it, reject it, or make a proposal as an alternative to the earlier proposal.

- The analogy of sending letters and postcards best explains the ***connection-less service.*** Each message (letter) carries a full destination address, and each one is routed through the system independent of all the others. Normally, when two messages are sent to the same destination, the first one sent will be the first one to arrive. But it is also possible that the first one sent can be delayed so that the second one arrives first. In a connection-less service, there is no initial end-to-end setup for a session; each packet is independently routed to its destination. The sender simply starts sending packets (called datagrams)

to the destination. This service does not have the reliability of the connection-oriented method, but it is useful for periodic burst transfers. Neither system must maintain state information for the systems that they send transmission to or receive transmission from.

1.6 TYPES OF NETWORK

Whenever we have a set of computers or networking devices to be connected, we make the connections, depending on the physical layout and our requirements. On the basis of geographical area covered, computer networks can be classified under the following three categories:

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

1.6.1 Local Area Network

A ***local area network*** or **LAN**, is a high-speed data network that covers a relatively small geographic area such as a building, a laboratory, or a school. It typically connects workstations, personal computers, printers, servers, and other devices. LANs offer computer users many advantages, including shared access to devices and applications, file exchange between connected users, and communication between users via electronic mail and other applications. LANs differ in the way the computers are connected (i.e., their topology), how information moves around the network (i.e., their transmission technology) and their size.

IEEE (Institute of Electrical and Electronic Engineers) is a US publishing and standards organization responsible for many LAN standards such as the 802 series. *IEEE 802.3,* popular called *Ethernet,* is the most popular LAN, usually operating at 10 Mbps to 10 Gbps and is present in most large organizations and offices. In a typical LAN configuration, one computer is designated as the *server*.

It stores all of the software that controls the network as well as the software that can be shared by the computers attached to the network. Computers connected to the server are called *workstations*. Two most commonly used LAN implementations are depicted below:

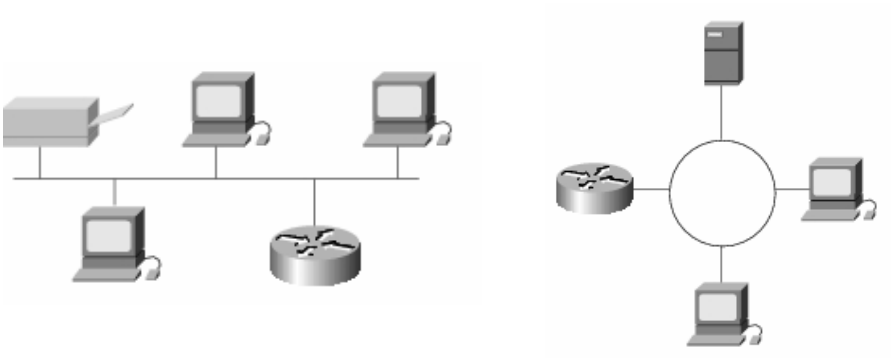


Fig.1.14 : (a) Ethernet or IEEE 802.3 (b) Token Ring or IEEE 802.5

LAN protocols function at the lowest two layers, i.e., the *physical* and the *data link layer* of the OSI reference model. We will discuss the layer concept of ISO-OSI reference model in the next unit which is “Network models”.

1.6.1.1 LAN Transmission Methods

LAN data transmissions fall into three classifications: *unicast*, *multicast*, and *broadcast*. In each type of transmission, a single packet is sent to one or more nodes.

- ***Unicast :*** Unicast is a one-to-one transmission method in which the network carries a message to one receiver, such as from a server to a LAN workstation. In a unicast environment, even though multiple users might ask for the same information from the same server at the same time, such as a video clip, duplicate data streams are sent. Unicast sends separate data streams to each computer requesting the data, thereby flooding the network with traffic.
- ***Multicast :*** Multicast is a one-to-many transmission method

in which the network carries a message to multiple receivers at the same time. Multicast is similar to broadcasting, except that multicasting means sending to a specific group, whereas broadcasting implies sending to everybody, whether they want the traffic or not. When sending large amounts of data, multicast saves considerable network bandwidth because the bulk of the data is sent only once. The data travels from its source through major backbones and is then multiplied, or distributed out, at switching points closer to the end users. This is more efficient than a unicast system, in which the data is copied and forwarded to each recipient.

- ***Broadcast :*** Concept of broadcast is already discussed in previous section. *Broadcast* is a one-to-all transmission method in which the network carries a packet to all devices at the same time, but a particular machice for which the packet is intended accepts it.

1.6.1.2 Peer-to-Peer LAN & Server Based LAN

On a LAN, we expect to share files, programs, or printers, all without being particularly aware of where the physical resources we are using are actually located. LANs providing these types of services are typically set up either as "*peer-to-peer*" or "*client-server*" LANs, or perhaps as a combination of the two.

- **Peer-to-Peer LAN**

  All the machines on a peer-to-peer LAN are equal. Provided that the file's owners give permission, a file on machine A can be accessed from machine B, and vice versa. Peer-to-peer LANs do not require any one machine to be a dedicated, high-performance server; service by a peer-to-peer LAN is often cheaper for this reason. Peer-to-peer LANs work well when only a small number of machines are connected to it. But as the size of the LAN grows, peer-to-peer services can

become quite disorganized. To serve all its peers, each machine on the LAN must be powerful enough and for this reason its cost increases. For larger LANs, the dedicated client-server LAN architecture becomes more cost effective.

Advantages :

Less initial expense – No need for a dedicated server.

Setup – An existing operating system (such as Windows XP) of the machine may only need to be reconfigured for peer-to-peer operations.

Disadvantages :

Decentralized – No central repository for files and applications.

Security – Does not provide the security available on a client/server.

- **Client-Server LAN**

A client-server LAN consists of one or more server machines on which shared files and programs reside and many client machines where people do their task. The LAN server machines usually have higher configuration and are fast because they must serve many users, while the client machines need only to be fast enough for one person to use at a time. Shared printers are either attached directly to a server, or to a print server (a specialized computer attached to the network), or to a personal computer on network that acts as a print server.

Advantages :

Centralized – In case of client-server architecture, resources and data security are controlled through the server.

Scalability – Any or all elements can be replaced individually as needs increase.

Flexibility – New technology can be easily integrated into system.

Accessibility – Server can be accessed remotely and across

multiple platforms.

Disadvantages :

Expense – Requires initial investment in dedicated server.

Maintenance – Large networks will require a staff to ensure efficient operation.

Dependence – When server goes down, operations will cease across the network.

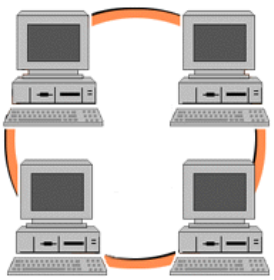


Fig.1.15 : Peer-to-Peer

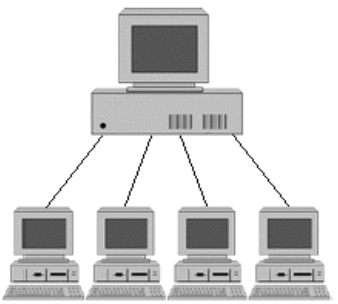


Fig. 1.16 : Client-Server

1.6.2 Metropolitan Area Network

A ***metropolitan area network,*** or **MAN**, is basically a bigger version of a LAN and normally uses similar technology. It might cover a group of nearby corporate offices or a city and might be either private or public.

A MAN often provides efficient connections as it has high-speed transmission capabilities which uses some types of telecomminication components to handle long-distance transmission. One very common example of MAN is the cable television network. Another important example is the high-speed wireless Internet access, which has been standardized as *IEEE 802.16.*

1.6.3 Wide Area Network

A ***wide area network*** or **WAN** is a computer network covering multiple distance areas, which may spread across the entire world. WANs often connect multiple smaller networks, such as local area networks (LANs) or metropolitan area networks (MANs).

Typically, a WAN consists of a number of interconnected switching nodes. A transmission from any one device is routed through these internal nodes to the specified destination device. These nodes are not concerned with the content of the data; rather, their purpose is to provide a switching facility that will move the data from node to node until they reach their destination. Traditionally, WANs have been implemented using either *circuit switching* or *packet switching* technologies. More recently, frame relay and *ATM* (*Asynchronous Transfer Mode*) networks have assumed major roles. Frame relay provides higher data rates, lowar costs, efficient handling of bursty data transmission in less expenditure. ATM offers more bandwidth to end users at less cost.

The ***Internet*** is the best known example of a WAN. Some segments of the Internet are also WANs in themselves. The Internet is a system of linked networks that are worldwide in scope and facilitate data communication services such as *remote login*, *file transfer*, *e-mail*, the *World Wide Web* etc. With the rise in demand for connectivity, the Internet has become a communications highway for millions of users. The Internet was initially restricted to military and academic institutions, but now it is a full-fledged conduit for any and all forms of information and commerce. Internet websites now provide personal, educational, political and economic resources to every corner of the planet.



CHECK YOUR PROGRESS

Q.1. What are the three LAN transmission methods?

Q.2. What are the basic difference between point-to-point and Broadcast network?



1.7 LET US SUM UP

This unit provides the basic concept of computer networking. **Networking** is the linking of computers (not necessarily over large distances) so they can communicate, sharing hardware and software, thus uniting processing power. Various concepts such as connection-oriented and connection-less services, broadcast and point-point networks etc. are also presented in this unit. We are also acquainted with the different types of computer networks with their relative advantages and disadvantages.



1.8 FURTHER READING

- *"Computer Netwotks",* Andrew S. Tanenbaum, Prentice Hall India.
- *"Data and Computer Communications",* William Stallings, Pearson Prentice Hall.



1.9 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : Unicast, Malticast, Broadcast.

Ans. to Q. No. 2 : Broadcast networks have a single communication channel which is shared by all the machines on the network. Broadcast implies sending a signal where multiple parties may hear a single sender. Point-to-point network is a method of communication where one 'point' (person or device or entity) speaks or communicates to another entity.



1.10 MODEL QUESTIONS

Q.1. Define computer network. What are the goals of computer networks?

Q.2. What is the difference between connection oriented and connection less services?

Q.3. Distinguish between peer-to-peer LAN and client-server LAN.

Q.4. Differentiate between broadcast and point-to-point network.

Q.5. Mention the advantages and disadvantages of Peer-to-Peer LAN.

Q.6. What is Ethernet?

Q.7. Discuss briefly about WAN and MAN.

****

UNIT 2 : DATA COMMUNICATION MODES

UNIT STRUCTURE

2.1 Learning Objectives

2.2 Introduction

2.3 Data Communication

2.4 Types of Communication

2.5 Modes of Communication

2.6 Let Us Sum Up

2.7 Further Reading

2.8 Answers to Check Your Progress

2.9 Model Questions

2.1 LEARNING OBJECTIVES

After going through this unit, you will be able to :

- define data communication models
- describe the different types of modes of data communication
- describe the modes of transmission

2.2 INTRODUCTION

In the previous unit you have been introduced to the concept of data communication. Signals and different types of signals like analog and digital have been covered in the previous unit. Introductory definitions of many important concepts of data communication have also been covered in the earlier unit.

In this unit you will be introduced to different data communication modes. We will also learn about the types of communication - parallel and serial communication. Synchronous and asynchronous types of communication have also been covered in this unit. In addition to these the different communication modes - simplex, half-duplex and full duplex will also be introduced in this unit.

Once you are familiar with these basic modes of data communication, you will be introduced with digital transmission fundamental concepts like modulation and multiplexing in the next unit.

2.3 DATA COMMUNICATION

Data communication means sending data or information from a source to a receiver. This data or information can be anything. This information can be a simple data file, or an audio file or video file. Data communication has become an essential part of our lives. Transferring of data from one computer to another computer is an example of data communication.

Communication usually has three important parts - a source, a destination and a communication channel. Let us look at these three components:

- Source: This is where the data originates. Generally, it is a computer but it can be any electronic device like a mobile phone, an audio recorder etc.
- Destination: This is where the data is absorbed. It can be a computer system or a television set.
- Communication Channel: This is the entity which is used to send data or signals from a source to a destination. This can be an optical fiber or a wireless medium. There are provisions of data being lost in the communication channel.
    - **Resource Sharing :** Using computer networks, it is possible to share programs, data and other resources among several users on the network. The sharing of resources is independent of the physical location of the user and the resource. Files on a particular user's computer can be shared on the network or files can be placed on a file server which provides a central location for all files needed by the users on the network. Users can also share devices such as printers, CD-ROM drives, and hard drives etc. It also makes upgrading an application easier because the

upgrade only has to be performed only on the server itself. Thus, we don't need seperate resource for each computer.

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- **Cost Reduction :** Resource sharing automatically reduces cost and hence money can be saved. For example, let us suppose, there are ten users and each user requires a printer. If they could have been working indivually, then ten printers would have to be purchased. If these ten users are allowed to work in a network, then only two or three printers would be sufficient.
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Figure 2.1: A simplified communication system

A simplified communication system can be seen in figure 2.1. The data or signal is send from the source to the destination using the communication channel. Let us now look at what could be the different types of communication.

2.4 TYPES OF COMMINICATION

The sender sends data to the receiver through a communication channel. The data sent could be sent using one communication unit or many units. Depending on these differences, communication can be broadly divided into two types: serial communication and parallel communication. The communication can be synchronized using a clock or some other mechanisms. Depending on these, the serial communication is again subdivided into two major categories: synchronous communication and asynchronous communication.

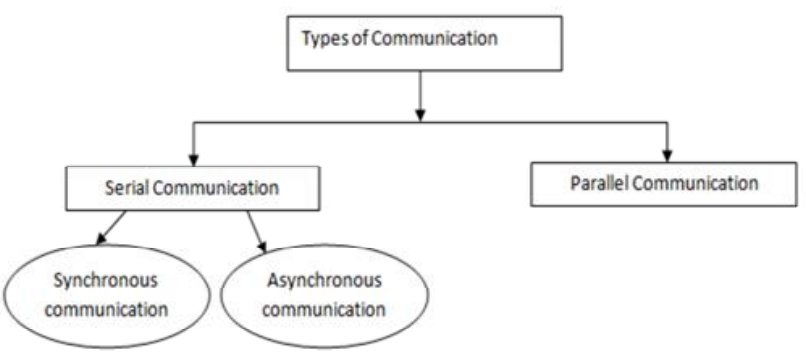


Figure 2.2: Types of Communication

Figure 2.2 shows the different types of communication. Let us now try to understand the definitions and concept of serial and parallel communications.

Serial communication is the sequential transmission of data using a single communication unit like a single copper wire or an optical fiber. In the digital domain, the data is represented as bits and can be sent over using a single electrical wire sequentially.

Parallel communication is the concurrent transmission of data using many communication units for transmission of data. In the digital

domain, multiple data bits are sent simultaneously using multiple electrical wires.

In serial communication, since there is only one communication unit so less data is sent in one transmission. Whereas in parallel communication more data can be sent since we can use multiple communication units for one transmission.

To find the suitability between serial and parallel transmission, let us take an example. Suppose we have a parallel connection with 4 wires and a serial connection with 1 wire. It would seem to us that the parallel connection could send more data than serial communication and faster than serial communication. But less data means the error in data transfer will be less as compared to parallel communication. This means that the error rates are higher in parallel communication corresponding to the increase in data.

Serial communication is preferred for sending data over longer distances due to less data error. It also has low cost and is more easy to use than parallel communication. Also this communication can be used when high data rates are not needed. Examples of serial communication are USB (Universal Serial Bus), Ethernet, Bluetooth among many. Parallel communication is used for faster data transfer since they use multiple wires and can transmit data on all the wires simultaneously. Examples of parallel communication are IDE hard disk connectors among many.

Serial communication can be again broadly divided into two categories: *Synchronous* and *Asynchronous* communication.

- **Synchronous communication:** In this mode of communication, the data bits are sent over a single communication unit, using a clock to synchronize the timing between the sending and the receiving communication devices.

  The clocks of both the sender and receiver are required to be at synch with each other in this communication. The sending and receiving time for data is already known to both parties and using

this protocol the data are being transferred. The disadvantage of synchronous communication is that eventually the clocks may get out of synch and may have to be resynchronized from time to time.

- **Asynchronous communication:** In this mode of communication, the data bits are sent over a single communication unit, and start and stop bits are used before and after the data to signify the starting and ending of the data sent.

  The data will be sandwitched between the start and stop bit in this communication. Since this communication does not use clocks, which is why it is necessary to use other means to signal the starting and ending of data to the receiver. For this purpose, the start bit is used to signal the beginning of data and the stop bit is used to signal the ending of data. For example, if the data to be sent is '0010', then it can be sent using a start bit '1' and an end bit 0' and would look like this : **'1**00101**'**. The start and stop bit are shown in bold here.



CHECK YOUR PROGRESS

Q1. Define serial and parallel communication.

Q2. Describe the difference between asynchronous and synchronous communication.

2.5 MODES OF COMMUNICATION

The manner in which information flow between two communication devices is known as the communication or transmission mode. The communication modes deal with the way traffic flows from one computer to another. In simple terms, it is the way or direction in which the flow of information takes place. This can be in any one direction or in both the directions between two systems. Depending on these differences the communication modes are basically divided into three groups. These are *simplex* and *duplex*. Further duplex communication can be *half-duplex* and full duplex.

Let us discuss these modes in detail now:

- **Simplex:** In this type of communication mode the data can travel through in only one direction. In other words, we can say that the communication is unidirectional.

In simplex mode of communication, a device can either receive or transmit information but cannot do both. For example, a television set can only receive information from the satellite channels but not transfer any information in return.

Let us take another example to understand this concept better. Suppose we need to write a paper on Indian Freedom Movement. One of the most common ways now-a-days is to collect the information from internet. For that we may use a computer and enter the information we need to search through the keyboard. The keyboard is only used to send the information to the computer but it cannot receive any information in return from the computer. This has been illustrated in the Figure 2.3.

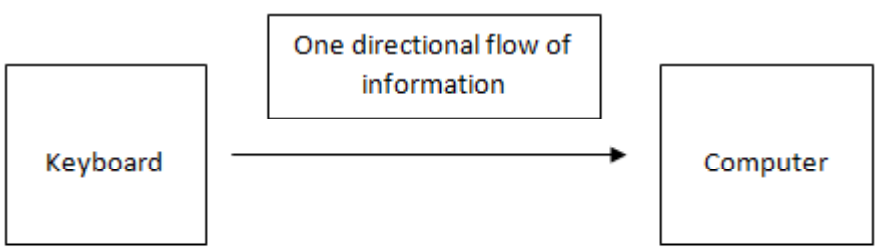


Figure 2.3 Example of Simplex communication

- **Half-Duplex:** In this type of communication mode the data can travel through in both directions but in only one direction at a time. In other words, we can say that this mode supports bidirectional transmission but can perform only one-directional transmission at a time.

In half-duplex mode of communication, a device can both receive and transmit information but cannot do both at the same time. That is, it can either receive or transmit at a particular instant of time. For example, a computer system cannot send information to another computer system while it is receiving information from that computer system. After the information has been received the computer system can now start to send

information to the other computer system.

Let us take another example to understand this concept better. We may have seen many police personnel talking in their walkie-talkie. The police officers can listen to information or send some information through their walkie-talkie. But the act of both listening and speaking at the same time using the walkie-talkie cannot be done. This is why we mostly see them either holding it against their ear or in front of their mouth while communicating with their officers and saying the word "over" when they have finished delivering the information. This has been illustrated in the figure below.

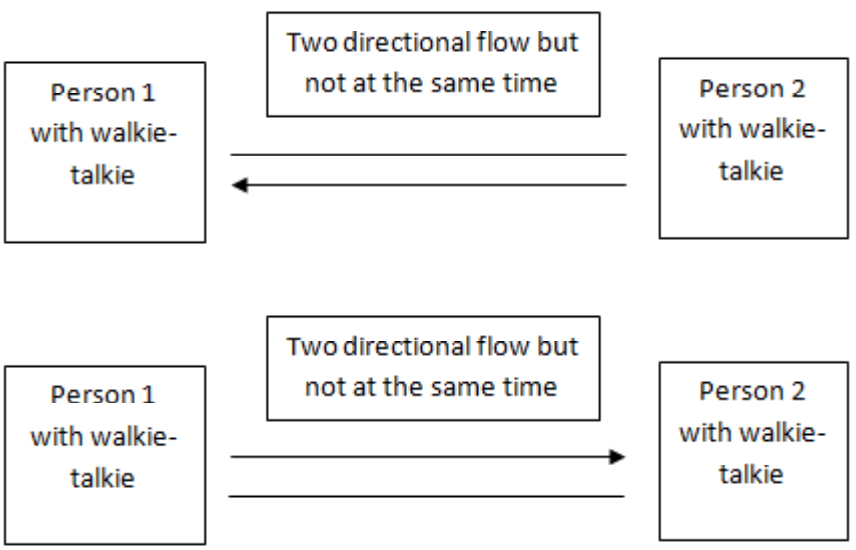


Figure 2.4 Example of half-duplex communication

- **Full-Duplex:** In this type of transmission mode the data can travel through in both directions at a time. In other words, we can say that this mode supports bidirectional communication and can perform communication in both directions at the same time.

In full-duplex mode of communication, a device can both receive and transmit information at the same time. It means that the device can receive information while sending some other information. For example, on a local area network that has full-duplex transmission, one computer system can transmit information while it is receiving data from another computer system which is also receiving information.

Let us take another example to understand this concept better. We

have used the telephone for communication many times. We can both talk and listen using the telephone at the same time. Even though it may be difficult for us to hear and speak at the same time, but it is possible to use it in full-duplex transmission mode. This has been illustrated in the Figure 2.5.

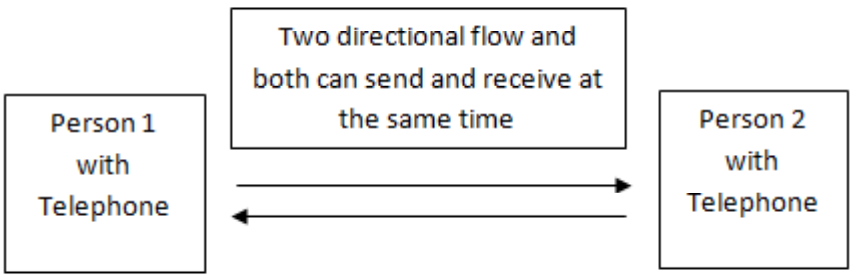


Figure 2.5: Example of full-duplex communication

The simplex communication is a one directional communication. The half-duplex is bi-directional but only one way communication at a time and full-duplex is bi-directional communication at all times. The concept of simplex, half-duplex and full-duplex communication can be illustrated further using the figure 2.6.

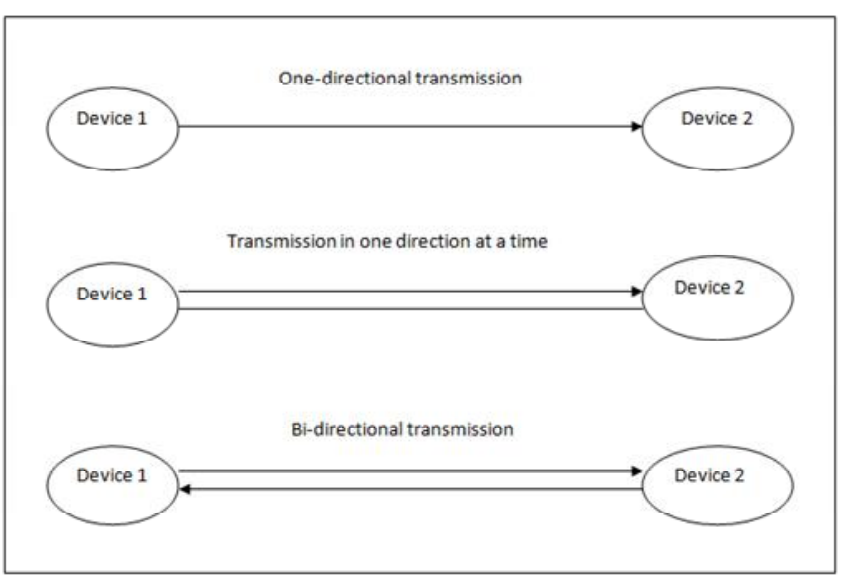


Figure 2.6: Simplex, half-duplex and full-duplex communication



CHECK YOUR PROGRESS

Q3. Define communication modes.

Q4. Describe the different types of communication modes.



2.6 LET US SUM UP

- Data communication means sending data or information from a source to a receiver.

  Communication usually has three important parts - a source, a destination and a communication channel.
- Serial communication is the sequential transmission of data using a single communication unit like a single copper wire or an optical fiber. In the digital domain, the data is represented as bits and can be sent over using a single electrical wire sequentially.
- Parallel communication is the concurrent transmission of data using many communication units for transmission of data. In the digital domain, multiple data bits are sent simultaneously using multiple electrical wires.
- In synchronous communication, the data bits are sent over a single communication unit, using a clock to make it happen at the same time concurrently. The timing between the sending and receiving devices are the controlling factors common to both ends. synchronize the timing between the sending and the receiving communication devices.
- In asynchronous communication, the data bits are sent over a single communication unit, and start and stop bits are used before and after the data to signify the starting and ending of the data sent.
- There are two broad types of communication modes. They are: simplex and duplex, Duplex modes may be half-duplex and full-duplex.

- In simplex communication mode, the data travel through in only one direction.
- In half-duplex communication mode, the data travel through in both directions but in only one direction at a time.
- In full-duplex communication mode, the data travel through in both directions at a time.



2.7 FURTHER READING

- "Computer Networks", Andrew S. Tanenbaum, Prentice Hall India.
- "Data and Computer Communications", William Stallings, Pearson Prentice Hall.



2.8 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1: Data communication means sending data or information from a source to a receiver. This data or information can be anything. It can be a data file, or audio or video files. Communication usually has three important parts - a source, a destination and a communication channel.

Ans. to Q. No. 2: Depending on whether data sent could be sent using one communication unit or many units, communication can be broadly divided into two types: serial communication and parallel communication. The communication can be synchronized using a clock or some other mechanisms. Depending on these, the serial communication is again subdivided into two major categories: synchronous communication and asynchronous communication.

Ans. to Q. No. 3: The direction of flow of information between two communication devices is known as communication or transmission mode. The communication modes deal with the way traffic flows from one computer to another. In simple terms, it is the way or direction in which the flow of information takes place. This can be in any one direction or in both

the directions between two systems. Depending on these differences the communication modes are basically divided into two groups. They are: simplex and duplex. Duplex communication is further subdivided into half-duplex and full-duplex.

Ans. to Q. No. 4: There are two types of communication modes. They are: simplex and duplex. Duplex communication takes place in half and full-duplex. In simplex communication mode the data can travel through in only one direction. In other words, the communication is unidirectional. In half-duplex communication mode data can travel through in both directions but in only one direction at a time. In other words, we can say that this mode supports bidirectional communication but can perform only one-directional communication at a time. In full-duplex communication mode the data can travel through in both directions at all time. In other words, we can say that is mode supports bidirectional communication and can perform communication in both directions at the same time.



2.9 MODEL QUESTIONS

Q1. What do you understand by data communication? Explain in detail.

Q2. What are the different types of communication?

Q3. Give the different modes of communication.

Q4. What are the basic differences between half-duplex and full-duplex modes of communication?

Q5. Give some applications where half-duplex communication is used.

Q6. Give some applications where full-duplex communication is used.

Q7. Give some applications where simplex communication is used.

****

UNIT 3 : NETWORK DEVICES

UNIT STRUCTURE

3.1 Learning Objectives

3.2 Introduction

3.3 Network Interface Card (NIC)

3.4 Modem

3.5 Repeater

3.6 Bridges and Gateways

3.7 Hub

3.8 Switch

3.9 Router

3.10 Let Us Sum Up

3.11 Further Reading

3.12 Answers to Check Your Progress

3.13 Model Questions

3.1 LEARNING OBJECTIVES

After going through this unit, you will be able to :

- learn about different network devices and their characteristics
- differentiate bridges and gateways
- learn the functions of hub, switch and router.

3.2 INTRODUCTION

The internetworking devices are the vital tools for communication. Here, we will gain some information about the various hardware that is used to maintain connections between the network.

3.3 NETWORK INTERFACE CARD (NIC)

A ***network interface card***, also known as a ***network adapter***, is avery important hardware which is responsible for connecting a particular computer to a network. The NIC mediates between the computer(and its

user) and the network. Usually, an NIC consists of a printed circuit board containing different electronic components. It possesses a ROM chip that contains a unique number, known as the Media Access Controll (MAC) address. The MAC address identifies the device uniquely on the LAN. It also contains DMA (Direct Memory Access) circuit that allows the NIC to transmit or receive bits from memory without the involvement of the CPU. A NIC contains connector which provides plug-in facility to the network cable. It exists on the Data Link Layer of the ISO-OSI reference model. NIC handles all the details of packet transmission and reception.



Figure 3.1 : A Network Interface Card

3.4 MODEM

A modem (***mo***dulation-***dem***odulation) is a communication device that converts binary electrical signals into analog signals for transmission over telephone lines and converts these signals back into binary form at the receiving end. Conversion to analog form is called *modulation;* and the reverse process is known as *demodulation.*

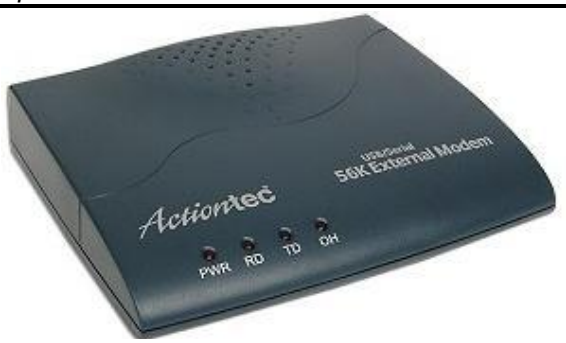


Figure 3.2 : A Modem

At the transmitting end, a bits stream arrives at the modem from computer's serial port. These bits are converted into analog form (modulation) using a predefined modulation technique. This analog signal is transmitted along telephone lines. At the receiving end, the analog signal is converted back to digital form(demodulation). The resulting serial stream is sent on to the computer at the receiving end.

3.5 REPEATER

Signals can only travel so far through media before they weaken and become garbled. This weakening of signals is called *attennuation*. Repeaters are used to regenerate the analog as well as the digital signals which are distorted by transmission loss. These are Layer 1(Physical layer) internetworking devices used to combat attenuation. Repeaters take in weakened signals, clean them up, regenerates them, and send them on their way along the network. By using repeaters, the distance over which a network can operate is extended.

For example, 10Base-T (a wiring standard) is allowed to run 100 meters. One repeater can double this distance to 200 meters, as depicted in Figure 3.3

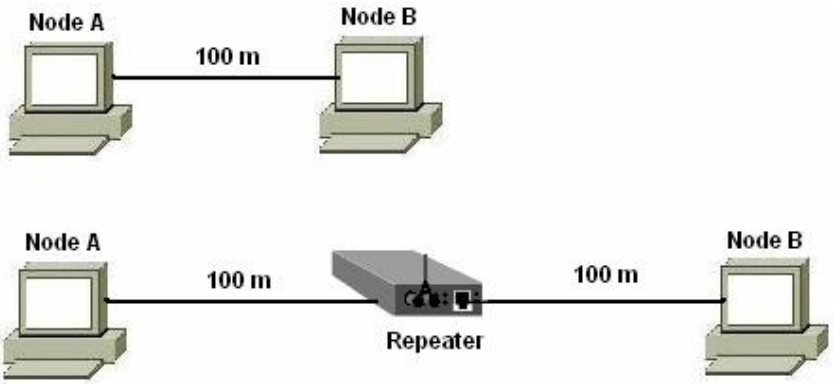


Figure 3.3 : A repeater extending network without attenuation

3.6 BRIDGES AND GATEWAYS

As the size of local area networks grew, the management of the networks became more difficult. Controlling traffic flow, maintaining fault monitoring, and adding and deleting stations from the system required more and more sophisticated system management. An alternate method to handling larger networks is to divide them into smaller networks that are interconnected using hardware/software systems called *bridges* and *gateways*.

Bridges are mainly used to connect multiple LANs which operate in the Data Link Layer to construct a larger LAN. The type of data transferred between the LANs must have the same format. A bridge can regenerate a signal it receives like a repeater. The basic function of a bridge is to transfer the frames from one LAN to another LAN. Bridge also has the capacity of frame filtering. It examines the header of each incoming frame and based on this information bridge decides whether to discard or forward this frame. Bridge stores the MAC address of received frame, keeps record on which port it has received, and which address belongs to which computer on the LAN.



Figure 3.4 : A typical bridge

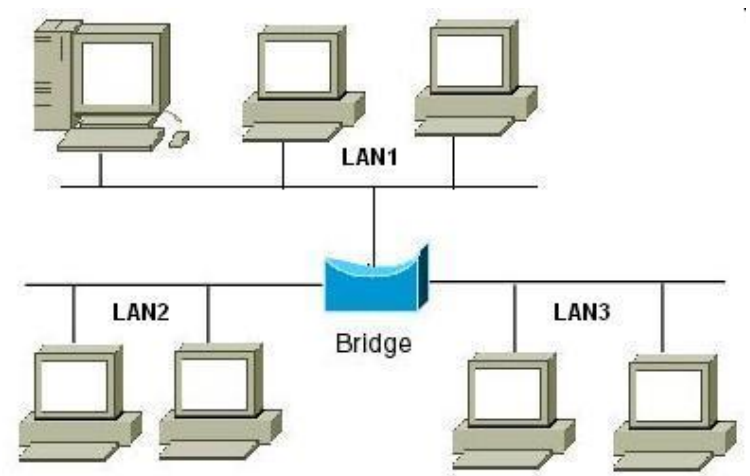


Figure 3.4 : A bridge connecting 3 LANs

Gateways are similar in functions to bridges in that they connect more than one networks. The main difference between bridges and gateways is that the latter can interconnect networks with differing message formats. A bridge does not perform any protocol translation in transferring packets between networks. whereas gateway takes an application message, reads it and interprets it. Hence, it can be used as a connecting device between two inter networks that use different model of references. One of them may use OSI model whereas the other uses TCP/IP model. A gateway is capable of receiving a frame coming from one model, makes necessary conversions and sends it to the other system of model. Thus, gateway relays packets among networks that have different protocols (e.g., between a LAN and a WAN). A gateway can provide security also.

3.7 HUB

Hubs are Physical layer(Layer 1) devices. Data that comes in one port is sent out to all other ports, except for the port it came in on. Hub does not read data passing through it and does not know the source and destination points. It simply receives the data packets, amplifes the electrical signal and then retransmit data packets on the network. Hubs usually accomodate four or eight nodes, and many hubs include connectors for linking to other hubs. A hub connects nodes that have a common network architecture.

The types of hubs that exist in the network are: *Passive hub* and *active hub*. *Passive hub* receives data packet and retransmits them on the network without amplifying the electrical signal. A multiport repeater is called an *active hub*. They receives the data packets, amplify them and retransmit on the network. For amplification they need the electrical signal.



Figure 3.5 : A hub

3.8 SWITCH

Switches are the core devices in today's modern LANs. A network ***switch*** is a hardware device that is used to connect computers that require high bandwidth and is also used to connect hubs to form large network. Switches are more expensive but provide better performance to hubs. Unlike hubs, network switches are capable of inspecting data packets as they are received, determining the source and destination device of each packet, and forwarding them appropriately. By delivering messages only to the connected device intended, a network switch conserves network bandwidth and offers generally better performance than a hub.



Figure 3.6 : A Switch

Two types of switches exist, which are :

Layer- 2 switches : These types of switches are based on the bridging technology. They establish connection between the ports based on the MAC address stored in the address table.

Layer-3 switches : These types of switches are based on the routing technology and are responsible for seting up connection between the ports based on the network address.

3.9 ROUTER

A router is the primary device responsible for connecting multiple networks together. The function of a router is to provide a path from a node on one network to a node on another network. The two networks may be separated by several intervening networks and possibly, by many miles. The purpose of a router is to forward data packets between networks. It examine incoming packets, chooses the best path for them through the network, and then switches them to the proper outgoing port. Routers are normally used to connect LANs and WANs in the Internet. It performs routing of packets based on their logical addresses. It has a routing table to take decision about the routes of packets. The table is constructed and updated dynamically by following some routing algorithm. Routers work at Layer 3, the Network Layer. In the Fig.1.9(b), routers connect nodes on different networks.



Figure 3.7(a) : Some images of Cisco routers

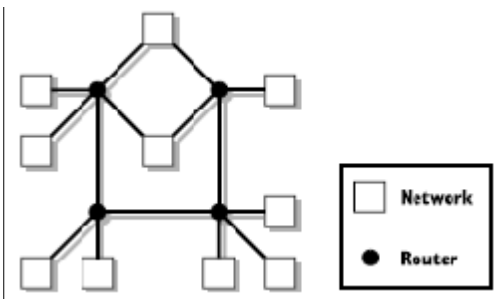


Figure 3.7 (b) : Networks connected with routers



CHECK YOUR PROGRESS

Q.1. State True or False :

i) Conversion of analog signals to digital form is called modulation; and the reverse process is known as demodulation.

ii) A hub connects nodes that have a common network architecture.

iii) Routers operates at physical layer.

iv) Broadcast networks share a single communication channel.



LET US KNOW

The terms DTE and DCE are very common in the field of networking. ***DTE*** stands for ***data terminal equipment*** and ***DCE*** stands for ***data -communication equipment***. **DTE** is an end instrument that converts user information into signals or reconverts received signals. It is used to describe the end user machine, which is usually a computer or terminal. The function of communication network is to interconnect DTEs so that they can share resources, exchange data, provide backup for each other, and allow users to perform their work from any location. The DCE is used to connect the DTEs into the communications line or channel. It also contains a portion of an application process but the primary function of the DCE remains to provide an interface to the DTE with the communication network.



3.10 LET US SUM UP

- Network devices are physical components used to connect with the computers.
- NIC is responsibile for connecting a particular computer to a network.
- A modem is responsible for converting analog signal to digital form and vice-versa.
- Repeater is responsible for regenerating analog as well as the digital signals which are destroyed by transtrvission loss.
- Buidges are mainly used to connect multiple LANS.
- Gateways are responsible for interconnecting networks with different missage format.
- Hubs are used to connect nodes that have a common network architecture.

- Switches are very efficient network device. Unlike hus, switches are more expensive but provide better performance to hub.
- A router is the primary device responsible for connecting multiple network together.



3.11 FURTHER READING

- "Computer Netwotks", Andrew S. Tanenbaum, Prentice Hall India.
- "Data and Computer Communications", William Stallings, Pearson Prentice Hall.



3.12 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : i) False, ii) True, iii) True, iv) True



3.13 MODEL QUESTIONS

Q.1. What are the different types of networking devices?

Q.2. List the relative advantages and disadvantages of hub and switch.

Q.3. Mention the role of router in a network.

Q.4. Mention the main differences between bridges and gateways.

Q.5. What is Media Access Controll (MAC) adress?

Q.6. In which layer Repeater works? What is the role of a repeater in a computer network?

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UNIT 4 : NETWORK TOPOLOGY

UNIT STRUCTURE

4.1 Learning Objectives

4.2 Introduction

4.3 Network Topology

4.4 Bus Topology

4.5 Ring Topology

4.6 Star Topology

4.7 Mesh Topology

4.8 Tree Topology

4.9 Let Us Sum Up

4.10 Further Reading

4.11 Answers to Check Your Progress

4.12 Model Questions

4.1 LEARNING OBJECTIVES

After going through this unit, you will be able to :

- learn about various kinds of network topologies
- describe the topology structure

4.2 INTRODUCTION

In the previous unit we have learnt various internetworking devices with their uses. In this unit we will discuss how computers and other devices are connected in a network for the purpose of communication.

4.3 NETWORK TOPOLOGY

In computer networking, ***topology*** refers to the layout of connected devices. Network topologies can be *physical* or *logical*. ***Physical topology*** means the physical design of a network including the devices, location and cable installation. It defines how the systems are physically connected.

Several physical topologies are in use for networks today. Some of the common topologies include the *bus*, *ring*, *star*, *tree* and *mesh*. More complex networks can be built as *hybrids* of two or more of the above basic topologies. The ***logical topology*** defines how the systems communicate across the physical topologies. The two most common types of logical topologies are ***broadcast*** and ***token passing***.

When we decide which topology we should choose for our network, then there are few basic points that we need to take care of. The factors that decide which topology we should choose are:

- ***Cost*** : Cost is a factor that plays an important role for the decision of topology. If we want to create a network for 4 to 5 computers, we should not expense very much in network.
- ***Scalability***: What is the size of the network that we need to make and is it possible in that kind of topology
- ***Bandwidth capacity****:* The required speed of the network that can be taken care of by any particular topology.
- ***Ease of installation***: It is easy to install the network using selected topology.

4.4 BUS TOPOLOGY

A network of bus topology consists of a long single cable to which all the computers and other devices are connected. Any node attached to the bus can send signals down the cable to all the nodes of the network; that means, a bus is a broadcast medium. When more than one node start sending data through the bus, they mix with each other and the sent data becomes a garbage. This is called *collision.* To avoid collision there must be some agreement between the nodes so that when one computer starts to send data, others refrain themselves from sending data. To ensure correct data communication, both ends of the cable are terminated by a special device called end terminator.



Figure 4.1(a) : A Bus Topology

Ethernet bus topologies are relatively easy to install and do not require much cabling compared to the alternatives. 10Base-2 (Thin) and 10Base-5 (Thick) both were popular Ethernet cabling options for bus topologies. Some advantages and disadvantages of the bus topology are listed below:

Advantages :

- Bus topology is inexpensive in installation
- It requires less cable than other topologies
- Good for smaller networks not requiring higher speed.
- Easy to add systems to network.

Disadvantage :

- Out-of-date technology. Bus topology was used in the early days of networking because it was inexpensive to use and relatively easy to set up.
- If the backbone cable fails, the entire network effectively becomes unusable.
- Unmanageable in a large network. If more than a few dozen computers are added to a network bus, performance problems are likely to occur.
- Difficult to troubleshoot.

4.5 RING TOPOLOGY

In ring topology the computers are connected between each other in a way that forms a close loop. In practice, a cable connects the first computer to the second computer, another cable connect

the second computer to the third and so on until the last computer is connected back to the first to complete the loop. It should be noted that the topology may not physically look like a circle. The ring means the computers are connected with each other in a logical ring. The interconnecting cables may take any shape in practice. All messages travel through a ring in the same direction (either “clockwise” or “counterclockwise”).

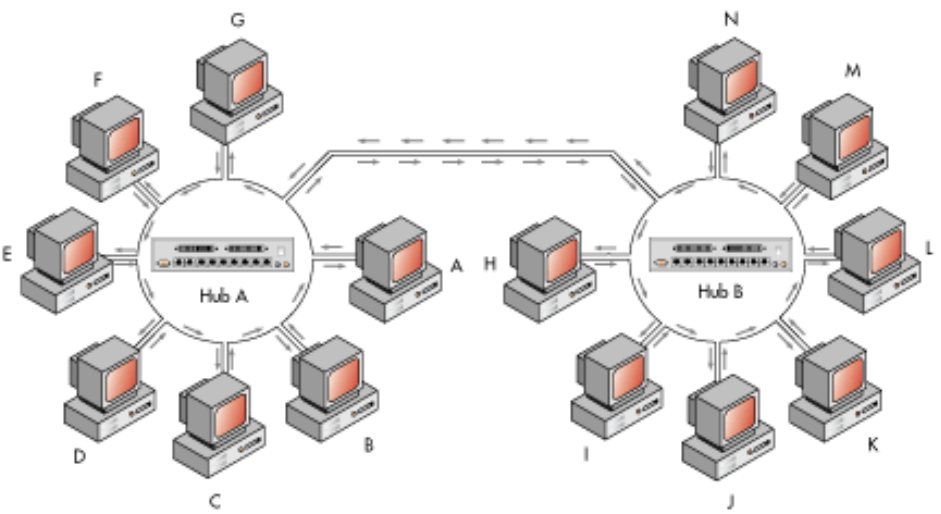


Figure 4.2 : A Dual Ring Topology

In ring topology the communicating computers must follow some agreement between them to avoid collision as it is also a broadcast network. The main difference between the bus and ring is that the ring topology does not require termination. Because the systems are connected all together in a loop, there are no beginning and end point as there is with the bus topology. A failure in any cable or device breaks the loop and can take down the entire network.

Two major network types that use the ring topology are :

i) *Fiber Distributed Data Interface* (FDDI) where a large, high speed networks use fiber optic cables in a physical ring topology.

ii) *Token-Ring networks* that use logical ring topology.

Advantages :

- No collision of data as data travel in one direction only.
- Easier to fault find. If any point gets broken we can trace that easily.

- No terminator required.

Disadvantages :

- Ring topology requires more cable than bus topology
- A break in ring will take the whole network down.
- Addition or removal of any node can affect the entire network.

4.6 STAR TOPOLOGY

In the *star* topology, all computers and other network devices connect to a central device(controller) called a ***hub*** as depicted in the Figure.4.3. Each connected device requires a single cable to be connected to the hub. A hub normally accepts data from a sending computer and delivers it to the computer for which the data is addressed. Hence, a star network is not a broadcast network, rather a point-to-point network. Using a separate cable to connect to the hub allows the network to be expanded without disruption to the network. Because each computer uses a separate cable to connect to the hub, the failure of a network connection affects only the single machine concerned. The other computers can continue to function normally.

Fast Ethernet (100Base-TX & 100Base-FX) in a star topology is the most commonly used LAN today. *10Base-T Ethernet* and *1000Base-TX Gigabit Ethernet* also use star topology.

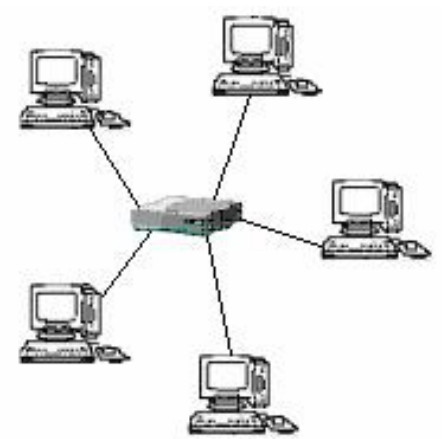


Figure 4.3 : A Star Topology

Adavntages :

- Star networks are easily expanded without disruption to the network.
- Easy to add/remove devices to/from network
- One break does not bring the whole network down. Cable failure affects only a single user.
- Easy to troubleshoot and isolate problems.
- Widely used centralized management

Disadvantages :

- Costs are usually higher than with bus or ring networks.
- Requires more cable than most of the other topologies.
- If the hub fails, any device connected to it will not be able to access the network.

In the following table, various networks with their cable types, topologies are shown:

Table 4.1 : Network cable types and topologies

Network Type	Standard	Cable Type	Topology
Ethernet	10Base-2	Thin(RG-58)	Bus
Ethernet	10Base-5	Thick(RG-59)coaxial	Bus
Ethernet	10Base-T	CAT3 or CAT5 UTP	Star
Fast Ethernet	100Base-TX	CAT5 UTP	Star
Gibabit Ethernet	1000BaseTX	CAT5, 5e or UTP	Star
Token Ring	all	UTP or STP	Logical Ring

4.6 MESH TOPOLOGY

The mesh topology incorporates a unique network design in which each computer on the network connects to every other, creating a point-to-point connection between every device on the network. A mesh topology is used when there can be absolutely no break in communications; for example, the control systems of a

nuclear power plant. The purpose of the mesh topology is to provide a high level of redundancy. If a network cable, computers or other components fail, the data always has an alternative path to get to its destination.

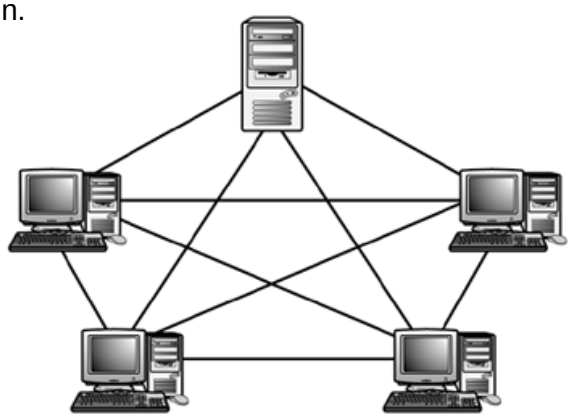


Figure 4.4 : A Mesh Topology

A fully connected mesh network has n(n-1)/2 cables to link 'n' devices. Therefore, every device on the network must have 'n-1' input/output (I/O) ports. For example, in the Figure 4.4, we have five systems that require 10 cables to create a mesh network. This topology is mainly used in environments where high availability outweighs the costs associated with this amount of interconnection. We can see in the figure that the wiring for a mesh network can be very complicated. Further, troubleshooting a failed cable can be tricky. Because of this, the mesh topology is rarely used.

Advantages :

- Provides alternative paths between devices in the network.
- The network can be expanded without disruption to current users.

Disadvantages :

- It is expensive as because a large amount of cabling are required.
- Routing network traffic can be difficult because of all the different possible paths between nodes.
- It is very expensive to wire up.

There are also partial-mesh networks where some of the nodes are connected to all the others, but others are only connected to nodes with which they exchange the most of the data.

4.7 TREE TOPOLOGY

A tree topology combines the characteristics of bus and star topologies. It consists of groups of star-configured workstations connected to a linear bus backbone cable (Figure 4.5). This bus/ star hybrid approach supports future expandability of the network much better than a bus (limited in the number of devices due to the broadcast traffic it generates) or a star (limited by the number of hub connection points) alone.

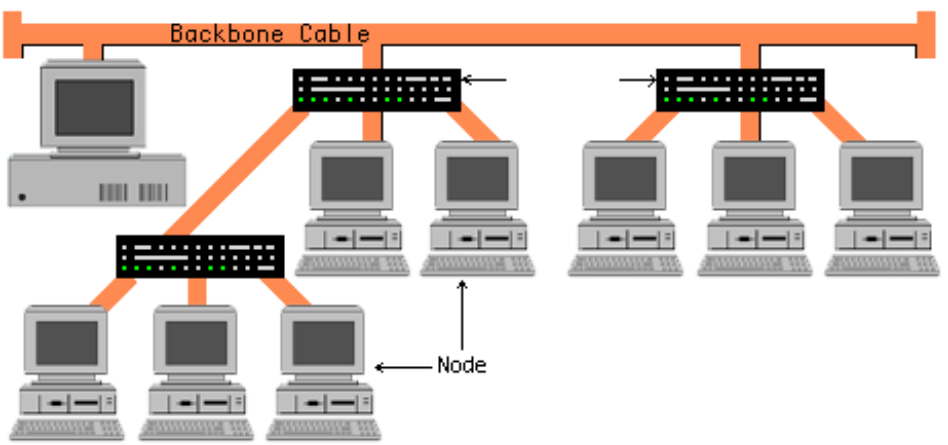


Fig. 4.5 : A Tree Topology

Advantages of Tree Topology :

- The network is easy to extend by just adding another branch.
- Fault isolation is relatively easy.

Disadvantages of Tree Topology :

- If the backbone cable breaks, the entire network goes down.
- More difficult to configure and wire than other topologies.
- If any hub goes down, all branches of that hub go down.



CHECK YOUR PROGRESS

Q.1. Choose the correct answer:

i) A network topology consists of a long single cable to is

known as.

a) Star topology

b) Bus topology

c) Mesh topology

d) None of the above

ii) In which topology if the backbone cable breaks, the entire network goes down.

a) Star topology

b) Bus topology

c) Mesh topology

d) Tree topology

iii) In which topology all computers and other network devices connect to a central device(controller) called a *hub*.

a) Star topology

b) Bus topology

c) Mesh topology

d) Tree topology



4.8 LET US SUM UP

- Topology of a network refers to the way in which the network's computers and other devices that need to communicate are linked together.
- There are different types of netwrok physical topology such as Bus Ring, Star, Mess, Tree etc. In this unit we have discussed different network topologies with their merits and demerits.



4.9 FURTHER READING

- *"Computer Netwotks",* Andrew S. Tanenbaum, Prentice Hall India.
- *"Data and Computer Communications",* William Stallings, Pearson Prentice Hall.



4.10 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : i) Bus, ii) Tree, iii) Star



4.11 MODEL QUESTIONS

Q.1. Define network topologies. What are the goals of networks topologies?

Q.2. What is the difference between bus topology and star topology?

Q.3. What are the different types of topologies used in computer network?

Q.4. What are the advantages and disadvantages of star topology?

Q.5. List the relative advantages and disadvantages of bus and ring topologies.

****

UNIT 5 : DATA TRANSMISSION

UNIT STRUCTURE

5.1 Learning Objectives

5.2 Introduction

5.3 Parallel Transmission

5.4 Serial Transmission

5.5 Asynchronous Transmission

5.6 Synchronous Transmission

5.7 Switching Techniques

- 5.7.1 Circuit Switching
- 5.7.2 Message Switching
- 5.7.3 Packet Switching

5.8 Let Us Sum Up

5.9 Further Reading

5.10 Answers to Check Your Progress

5.11 Model Questions

5.1 LEARNING OBJECTIVES

After going through this unit, you will be able to :

- define the goals of data transmission
- learn about serial and parallel transmission
- describe synchronous and Aschronous transmission
- learn about different switching techniques

5.2 INTRODUCTION

Digital transmission is the sending of information over a physical communications media in the form of digital signals. Analog signals must therefore be digitised first before being transmitted. However, as digital information cannot be sent directly in the form of 0s and 1s, it must be encoded in the form of a signal with two states, for example:

- two voltage levels with respect to earth

- the difference in voltage between two wires
- the presence/absence of current in a wire
- the presence/absence of light

Digital data transmission can occur in two basic modes:***parallel*** and ***serial.*** Data within a computer system is transmitted via parallel mode on buses with the width of the parallel bus matched to the word size of the computer system. Data between computer systems is usually transmitted in bit serial mode. Consequently, it is necessary to make a parallel-to-serial conversion at a computer interface when sending data from a computer system into a network and a serial-to-parallel conversion at a computer interface when receiving information from a network. The type of transmission mode used may also depend upon the distance and the required data rate. Now we will discuss about parallel and serial transmission.

5.3 PARALLEL TRANSMISSION

Parallel transmission communicates bits simultaneously over multiple lines(wires, frequency channels); typically, the total consists of one or more bytes at a time. Parallel devices have a wider data bus than serial devices and can therefore transfer data in words of one or more bytes at a time. As a result, there is a speedup in parallel transmission bit rate over serial transmission bit rate. The timing for parallel transmission is provided by a constant clocking signal sent over a separate wire within the parallel cable; thus parallel transmission is considered synchronous. Computers are typically connected to printers and external disk drives via parallel interfaces, ports, and buses.

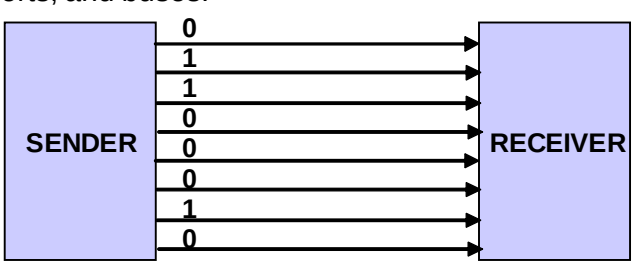


Figure 5.1 : (a) Parallel Transmission; The eight bits are sent through eight wires at a time

5.4 SERIAL TRANSMISSION

Serial transmission sends one bit at a time over a single transmission line. The cost of communication hardware is considerably reduced since only a single wire or channel is required for the serial bit transmission which also slows the speed of transmission. Telephone lines use serial transmission for digital data. Thus, modems are connected to the computer via a serial port. A ***serial port*** is a socket on a computer used for connecting the serial interface to a serial line or bus. A ***serial interface*** is a data channel that transfers digital data serially; it is typically implemented as a cord that plugs into an expansion slot on a computer motherboard. Serial interfaces have multiple lines, but only one is used for data. An external ***serial bus*** carries serial data to any device connected to it, e.g., Ethernet. Serial transmission can be either *synchronous* or *asynchronous*.

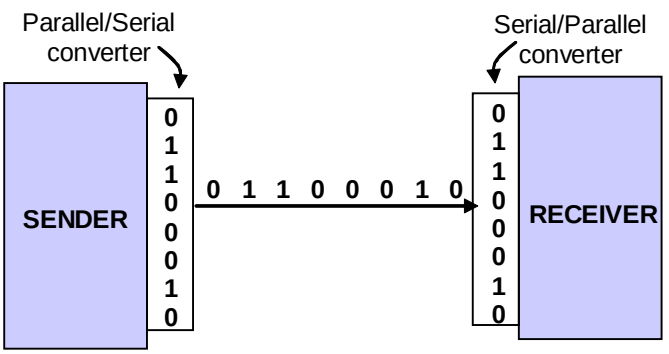


Figure 5.1 : (b) Serial Transmission;
The eight bits are sent one after another through a single wire

Serial transmission technology is increasingly used for the transmission of digital data. A large number of up-to-date communication networks apply serial transmission. The numerous applications include computer networks for office communications, building and manufacturing automation, and finally, Internet. The transmission of a stream of bits from one device to another accross a transmission media involves a great deal of cooperation and agreement between the two sides (sender and receiver). One of the most fundamental requirements is ***synchronization***. The receiver must know the rate at which bits are being received so that it can sample

the medium at appropriate intervals to determine the value of each received bit. For achieving the desired synchronization, there are two approaches. ***Synchronous*** and ***asynchronous transmissions*** are two different methods of transmission synchronization.

5.5 ASYNCHRONOUS TRANSMISSION

Communication is called *asynchronous* if the transmitter and the receiver do not need to synchronise before each transmission. A sender can wait arbitrarily long between transmissions and the receiver must be ready to receive data when it arrives. Most PC serial devices such as mouse, keyboards and modems are asynchronous.

As the name implies, asynchronous communication is performed between two or more devices which operate on independent clocks. Thus, there is no guarantee that when Point A begins transmitting, Point B will begin receiving, or that Point B will continue to sample at the rate Point A transmits. In asynchronous transmission, data are transmitted one character at a time, where each character is five to eight bits in length. Timing or synchronization must only be maintained within each character; the receiver has the opportunity to resynchronize at the beginning of each new character. The following Figure 5.2 depicts what happens when transmission clocks differ significantly. In Figure 5.2(a), we see that, the receiver samples at mid point of each bit of the incoming data. In Figure 5.2(b), the receiver clock is too slow; causing bit 4 to be skipped and as a result, the data is corrupted.To combat this type of timing problem, asynchronous communication requires additional bits to be added around actual data in order to maintain signal integrity. The bits of the character are transmitted beginning with the least significant bit.

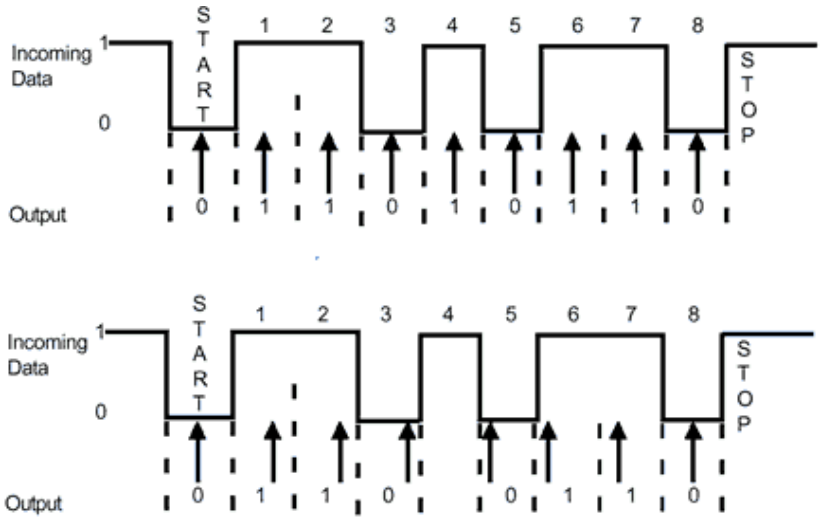


Figure 5.2 : Asynchronous Data Sampling

Asynchronously transmitted data is preceded with a ***start bit*** which indicates to the receiver that a character is about to begin. The end of a character is followed by a ***stop bit***, which tells the receiver that the character has come to an end, that it should begin looking for the next start bit, and that any bits it receives before getting the start bit should be ignored. To avoid confusion with other bits, the start bit is twice the size of any other bit in the transmission. To ensure data integrity, a ***parity bit*** is often added between the last bit of data and the stop bit. The parity bit is set by the transmitter so that the total number of ones in the character, including the parity bit, is even (even parity) or odd (odd parity), depending on the convention being used. The receiver uses this bit for error detection. The parity bit makes sure that the data to be received is composed of the same number of bits in the same order in which they were sent.

5.6 SYNCHRONOUS TRANSMISSION

The term synchronous is used to describe a data transfer method in which a continuous stream of data signals is accompanied by timing signals (generated by an electronic clock) to ensure that the transmitter and the receiver are synchronized with one another.

These types of connections are used when large amounts of data must be transferred very quickly from one location to the other. The speed of the synchronous connection is attained by transferring data in large blocks instead of individual characters. A block of bits is transmitted in a steady stream without start and stop bits. Data or information is moved from one place to another at instants in time that are measured against the clock signal being used. This signal usually comprises of one or more high frequency rectangular shaped waveforms, generated by special purpose clock circuitry. These pulsed waveforms are connected to all the devices that operate synchronously, allowing them to start and stop operations with respect to the clock waveform.

Typical examples of synchronous signals include the transfer and retrieval of address information within a computer via the use of an *address bus*. For example, when a processor places an address on the address bus, it will hold it there for a specific period of time. Within this interval, a particular device inside the computer will identify itself as the one being addressed and will acknowledge the commencement of an operation related to that address.

In synchronous transmission, each block begins with a preamble bit pattern and generally ends with a postamble bit pattern. In addition, there are some other bits that convey control information. The data with the preamble, postamble, and control information are termed as a ***frame***. A general frame format for synchronous transmission is shown in Figure 5.3. Typically, the frame starts with a preamble called a flag, which is 8 bits long.

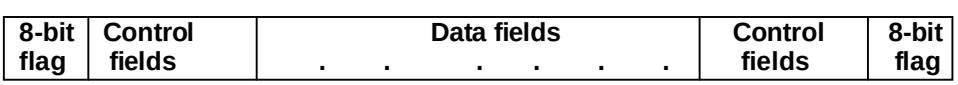


Figure 5.3 : Synchronous Frame Format

The same flag is used as a postamble. The receiver looks for the occurence of the flag pattern to signal the start of a frame. This is followed by some number of control fields, then a data field, more control fields, and finally the flag is repeated.

5.7 SWITCHING TECHNIQUES

When we have multiple work stations, a problem of connecting them for one to one communication arises. One solution for this problem is to establish point to point connections between each individual pair of stations. To interconnect ***n*** stations, ***n(n-1)/2*** individual connections are needed. For instance, to connect 10 components, a total of individual 45 connections are required; for 100 components, 4950 connections are required. The requirement increases drastically as the number of stations to be interconnected increase, and for a large number of stations, it is almost impossible to maintain individual connections. A well known solution for such type of problems is, ***switching***. Let us think, how things would be if we could only use our telephone to talk to just one other person! So there are requirements for switching systems to route our calls around the world. The switches can be placed on the transmission path so that the stations do not need to be interconnected directly. In this section, we will briefly discuss the various switching techniques which are in use currently.

In general, there are three methods of switching techniques. These are: ***circuit switching***, ***message switching*** and ***packet switching***.

5.7.1 Circuit Switching

Circuit switching is the transmission technology that has been used since the first communication networks in the nineteenth century. The basic idea of circuit switching is to set up a dedicated logical path between two users or machines, prior to the commencement of data communication. In circuit switching, a caller must first establish a connection to a callee before any communication. During the connection establishment, resources are allocated between the caller and the callee. The most common application of circuit switching is *telephone* network. Circuit switching mechanism is divided into three phases: *circuit establishment*, *data transfer* and *circuit disconnect.*

Characteristics of Circuit Switching :

- An end to end dedicated path is needed.
- Connection path must be established before the beginning of data transmission.
- Channel capacity must be reserved between each pair of nodes whether that capacity is utilized or not.
- The technology is developed to handle voice data because of its key requirement that there should be no delay in the transmission and a constant signal transmission rate must be maintained.

Advantages of Circuit Switching :

- It is well suited for real time communication purposes.
- The service provided by circuit switching is guaranteed since the channel remains dedicated to users throughout the communication session.

Disadvantages of Circuit Switching :

- Any unused ***bandwidth*** over the allocated circuit is wasted.
- Line may be idle most of the time.
- Both sender and the receiver must function with the same speed. This limits the utility of the network in interconnecting a variety of host computers and terminals.

5.7.2 Message Switching

Message switching refers to a switching technique involving transmission of messages from node to node through a network. In this technique, the source computer sends data or the message to the switching office first, which stores the data in its buffer. It then looks for a free link to another switching office and then sends the data to this office. This process is continued until the data are delivered to the destination computers. Owing to its working principle,

it is also known as *store and forward*. That is, store first (in switching office), forward later, one jump at a time.

Advantages of Message Switching :

- No waiting of the setup of path- As soon as a user has data to send, he/she may transmit it over the channel.
- The channel can be fully utilized.
- Priority of messages can be implemented.
- Broadcasting can be done very easily to all the nodes in a network.

Disadvantages of Message Switching :

- Not suitable for real time transmission
- In message switching, message size is not fixed. For very large message, the nodes are required to have large buffers, which may not be practically implemented due to economical and technical constraints.
- Since there is no size limitation of the message, long messages can keep the channel blocked for a long period of time.

5.7.3 Packet Switching

Packet switching is very similar to message switching. The main difference is that the length of the units of data that may be presented to the network is limited in a packet-switched network.

With message switching, there is no limit on block size.In contrast, packet switching places a tight upper limit on block size. A fixed size of packet which can be transmitted across the network is specified. Another point of its difference from message switching is that data packets are stored on the disk in message switching whereas in packet switching, all the packets of fixed size are stored in main memory. This improves the performance as the access time (time taken to access a data packet) is reduced and thus the throughput (measure of performance) of the network is improved.

There are two approaches to implement packet switching. These are : the datagram approach and the virtual circuit approach.



CHECK YOUR PROGRESS

Q.1. Fill in the blanks:

i) Telephone lines use _____ transmission for digital data.

(ii) A start bit and a stop bit is required in case of _____ transmission.

(iii) The three phasses of circuit switching are _____, _____ and _____.

(iv) For real time transmission _____ switching is suitable.

Q.2. What is a switched network?



5.8 LET US SUM UP

- Digital data transmission can occur in two basic modes:***parallel*** and ***serial.***
- ***synchronization means*** the receiver must know the rate at which bits are being received so that it can sample the medium at appropriate intervals to determine the value of each received bit.
- *Parallel transmission* communicates bits simultaneously over multiple lines
- ***Synchronous*** and ***asynchronous transmissions*** are two different methods of transmission synchronization.



5.9 FURTHER READING

- *"Computer Netwotks",* Andrew S. Tanenbaum, Prentice Hall India.
- *"Data and Computer Communications",* William Stallings, Pearson Prentice Hall.



5.10 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : (i) serial

(ii) asynchronous

(iii) circuit establishment data transfer, circuit disconnect.

(iv) circuit switching

Ans. to Q. No. 2 : A switched network consists of a series of interlinked nodes, called switches. Switches are devices capable of creating temporary connections between two or more devices linked to the switch. In a switched network, some of these nodes are connected to the end systems (computers or telephones, for example). others are used only for routing.



5.11 MODEL QUESTIONS

Q.1. Define the term digital transmission?

Q.2. What is the difference between serial and parallel transmission?

Q.3. List the relative advantages and disadvantages of serial transmission.

Q.4. Explain the concept of message switching.

Q.5. Discuss the advantages and disadvantages of message switching techniques.

Q.6. Why switching is required?

Q.7. What are the characteristics of circuit switching?

Q.8. What is packet switching?

****

UNIT 6 : NETWORK MODELS

UNIT STRUCTURE

6.1 Learning Objectives

6.2 Introduction

6.3 Design Issues of Layers

6.4 Protocol Hierarchy

6.5 ISO-OSI Reference Model : Functions of Layers

6.6 Important Terminologies

6.7 Connection-Oriented and Connectionless Service

6.8 TCP/IP Reference Model.

6.9 Comparison of ISO-OSI & TCP /IP Model

6.10 Let Us Sum Up

6.11 Further Reading

6.12 Answers to Check Your Progress

6.13 Model Questions

6.1 LEARNING OBJECTIVES

After going through this unit, you will be able to :

- describe design issues of network architecture
- describe functions of various network layers
- define various network terminologies
- distinguish between connection-oriented and connection-less service
- compare between OSI and TCP/IP model

6.2 INTRODUCTION

The computer network and its structure can be best understood by studying its underlying communication software and the related hardware. Historically, first computer networks were designed to work on hardware which proved to be fatal afterwards. It leads to inflexibility to the computer

networks. The later development of computer networks were based primarily on highly structured software implemented on ever changing hardware. The communication software in a computer network is a much thought out software which is organized as layered software. The internal structure of the layered software is discussed in this unit.

6.3 DESIGN ISSUES OF LAYER

Before proceeding to learn the layered structure of network software and the various aspects of computer network, we should be acquainted with different design issues of ***layer***.

- To interchange data between two processes running on two computers there must be some addressing technique for the communication correctly.
- The communication may be unidirectional (simplex communication) or in both directions alternately one after another (half-duplex communication) or bidirectional (full-duplex communication).
- Error control is also an important issue because physical communication channels are not perfect, rather, they are error prone. Now both communicating parties must agree on which error detecting and correcting code is to be used. The receiver should also let the sender know which message is received correctly and which is not.
- During transfer, messages are often divided into pieces and all the pieces may not be transferred in proper order. This loss of sequencing has to be taken care of by the protocol concerned.
- There must be provision to refrain a fast sender from swamping a slow receiver.
- The layer concern may decide to use the same connection for several unrelated conversations by the multiplexing and de-multiplexing techniques.
- When there are many paths between the sender and the receiver,

a decision must be taken as to which route is to be taken. The decision may be static or dynamic.

6.4 PROTOCOL HIERARCHY

From the design issues discussed above it is apparent that the computer network design is a complex job. To reduce the complexity of design, most of the computer networks are organized as a stack of layers, one above another, taking the service offered by the layer below. In this structure, a lower layer gives certain services to the layer just above it; at the same time it shields the details of the implementation of those services from the upper layer.

In the layered organization, a particular layer on one machine talks with a peer layer on another machine. During the conversation, they follow some rules and conventions. These rules and conventions are collectively known as **protocol**. Here we have used the term **peer** which means entities comprising the corresponding layer on different machines. So, it is the peers that talk using their own protocol.

In Fig 6.1 a five layer network is shown. Here we can see dotted arrow between peers and solid arrow between any two adjacent layers. Dotted arrow indicates that layer *n* on one machine communicates with

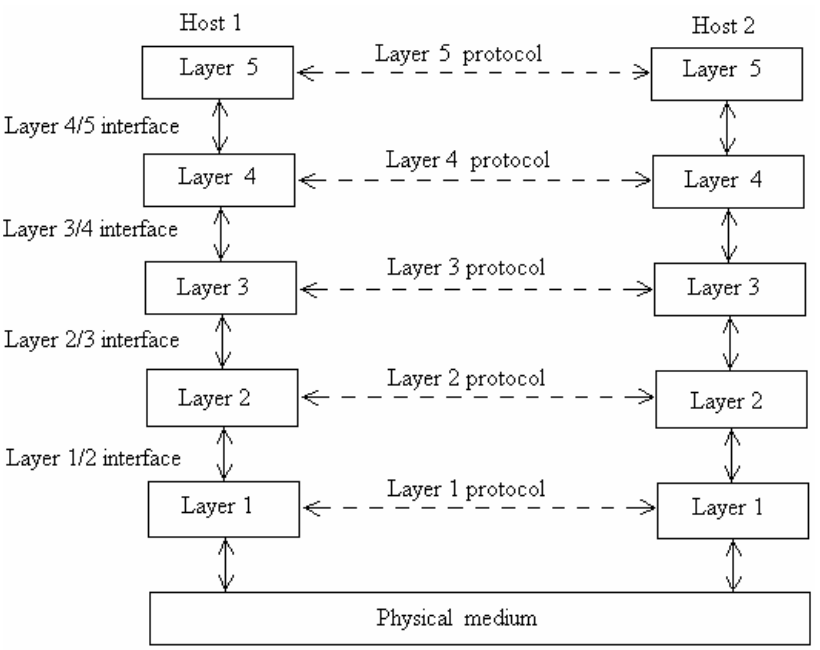


Fig. 6.1 Layers, protocols and interfaces

layer *n* on the other machine. During communication they follow their protocol.

Every layer communicates with the peer layer on the other machine. But all these communications are virtual since no data really moves through these dotted lines; rather data moves through solid arrow lines. In the process of communication, each layer hands over their data to the layer immediately below it. In this way, data moves downward until the lowest layer, below which lies the physical medium through which the the actual communication takes place. This is the picture in the sending machine. The picture is just opposite in the receiving machine where data moves upward after it enters the computer from the physical medium.

In the Fig 6.1 each layer gets **service** from the layer just below it. A layer performs some primitive operations to give the service required by the immediate upper layer. The transaction between two adjacent layers takes place as per a predefined guideline where each layer performs a specific collection of functions. So, there exists an **interface** between each pair of adjacent layer through which they exchange data and information and in the process, the upper layer gets service from the lower layer. As long as the interface is unchanged, one can change the underlying hardware at any time without affecting the network operations. As for example, underground copper cables are gradually replaced by fiber optic cables but it is not hampering the operations of the existing network because the interfaces between the layers remain unchanged.

The layers and their protocols are collectively known as network **architecture**. In network architecture each layer has its own protocol. The protocols used by all the layers of a network system is called **protocol stack**. Stack means something arranged one above another, like stack of bricks or something similar. In a layered network architecture, layers are arranged from bottom to top, one upon another, hence their respective protocols also lie one upon another. That's why the name protocol stacks. In the same sense, *protocol hierarchy* indicates that the protocol of any layer is hierarchically above the protocol of the layer immediately below it.

6.5 ISO-OSI REFERENCE MODEL

The OSI reference model is shown in Fig 6.2. The International Standard Organization (ISO) developed a proposal for a network model and the resulting model is known as ISO – OSI reference model. This model has seven layers and the layers are :

i) Physical layer
ii) Data link layer
iii) Network layer
iv) Transport layer
v) Session layer
vi) Presentation layer
vii) Application layer

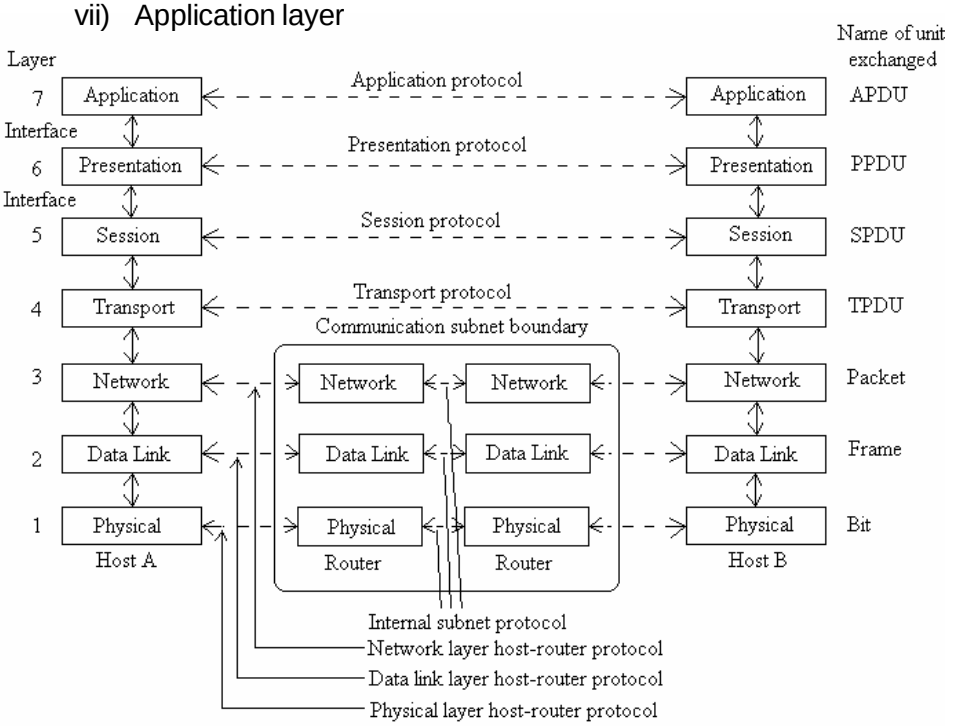


Fig. 6.2 : Layers, protocols and interfaces

(i) The Physical Layer : The physical layer is responsible for transmitting raw bits over the communication channel. This layer is to ensure how to send a 1 bit from the sending computer as 1 bit to the receiving computer; not as 0 bit. The physical layer also deals with the issues of how many bits per second will be transmitted, what level of voltage will be used to represent 1 and

0, whether transmission will be unidirectional or bidirectional, how the initial connection be established and terminated at the end, how many pins of network the connector has and which pin is for what etc etc. Hence, the design issues of the physical layer is mostly mechanical, electrical and procedure oriented.

(ii) The Data Link Layer : The data link layer use the raw transmission facility and transforms it to an apparently error-free facility to be used by the network layer. This layer breaks the input data into frames by inserting appropriate frame boundary, transmits the frames sequentially and processes the acknowledgment sent back by the receiving computer. If a frame is completely destroyed by noise burst, it is the duty of data link layer to retransmit it from the source machine. Data link layer also ensures that a fast sender is not allowed to swamp a slow receiver by sending data at a higher rate than it can be handled by the receiver. This is called ***flow control***. In a broadcast network it is the duty of MAC (Medium Access Control) sub-layer of data link layer to decide who will access the transmission medium at a particular time.

(iii) The Network Layer : The network layer controls the operation of the subnet. The layer is to determine how packets are routed from source to destination. The routing may be static or dynamic depending on traffic load and availability of channel.

Too many packets may cause congestion (traffic-jam) and control of such congestion is also a duty of the network layer.

The subnet operation requires cost; hence, some accounting function is also there being built into the network layer. When a packet crosses national boundary some other aspects of accounting has to be dealt with by network layer.

Packets have to travel in between heterogeneous network running on different platforms using different network protocol and the network layer is also responsible to resolve all the problems arising out of such situations.

(iv) The Transport Layer : The transport layer is to accept the data from the session layer, breaks it into smaller units if necessary, hands over these to the network layer and ensures that the pieces all delivered correctly to the receiver. The above duties must be done efficiently and in such a way that it will not affect the upper layer in case there is any change in the hardware.

Normally, the transport layer creates individual connection for each session. If high throughput is required, the transport layer may establish multiple network connections, dividing the data among individual connections, thereby improving the throughput. To reduce cost the transport layer may also multiplex several transport connections onto the network connection. However, multiple connections or multiplexing must not be seen by the session layer.

The transport layer also determines the type of service given to the user of the network. Error free point-to-point connection is the most popular transport layer service where messages or bytes are delivered in order in which they were sent. The transport layer also performs flow control.

(v) The Session Layer : This layer offers facility to different users on different computers to establish session between them. A session allows an user to remotely log into a distant machine and transfer file between the two machines. Session layer perform token management to provide unidirectional communication. It also provides a service called synchronization.

(vi) The Presentation Layer : This layer performs data presentation job by following syntax and semantics rules. Before presenting data to the user, it transforms data into their acceptable form.

(vii) The Application Layer : This layer is the nearest layer to all the network users. It offers variety of protocols that are commonly needed. It helps to transfer file. Different file systems have different meanings in different machines with different data formats etc. When files are transferred from one machine to

another with different file systems, the application layer takes the necessary steps to resolve the abnormalities.



CHECK YOUR PROGRESS

Q.1. What are *service* and interface?

.....

.....

Q.2. What do you mean by network architecture?

.....

.....

Q.3. How many layers are there in ISO-OSI model?

.....

Q.4. What are the prime duties of Data Link Layer?

.....

6.6 IMPORTANT TERMINOLOGIES

When we study the subject of computer network, we encounter many terminologies associated with the subject. Already we have come across a few terminologies such as **peer, interface, protocol, service** etc. Some others are briefly described below:

- **Entity :** The active components in each layer is called an entities. Entity can be a software process or hardware like an intelligent input/output device etc.
- **Peer Entity:** Entities in the same layer running on different machines are called peer entities.
- **Service provider and Service user:** In layered architecture, layer *n* provides a service which is used by layer *n+1*. Here layer *n* is service provider and layer *n+1* is service user.
- **SAP (Service Access Points):** A layer *n* offers services to layer *n+1* at a place which is called service access point. Each SAP has a unique address for identification.

6.7 CONNECTION-ORIENTED AND CONNECTIONLESS SERVICE

A layer can offer two different types of services to the layer immediately above it – connection-oriented and connectionless service.

In ***connection-oriented*** service, the service user atfirst establishes a connection atfirst, communicates over the connection and at last release the connection. It is similar to a telephone system.

In ***connectionless*** service, no connection is established beforehand. Instead, like in a postal system, every massage carries its full destination address and each is routed independently to its destination. If a big message is broken into pieces and sent to the same destination, then in connectionless service sometimes it may happen that the first piece may arrive at the destination after the later pieces. That means at the receiving end the order of delivery may not be same as the order of transmission. In connection-oriented service this never happens.

6.8 TCP/IP REFERENCE MODEL

TCP/IP reference model was developed much earlier than the OSI reference model. It was evolved from the US Department of Defense's (DoD) research network- The ARPANET. Eventually the ARPANET connected many universities and other government organizations. During the process of interconnecting all these through the existing telephone lines, satellite link and radio, the protocol used for the ARPANET had trouble and therefore, a new architecture was needed to overcome that. The model has four layers, namely :

1. The Host-to-Network Layer.
2. The Internet Layer.
3. The transport Layer.
4. The Application Layer.

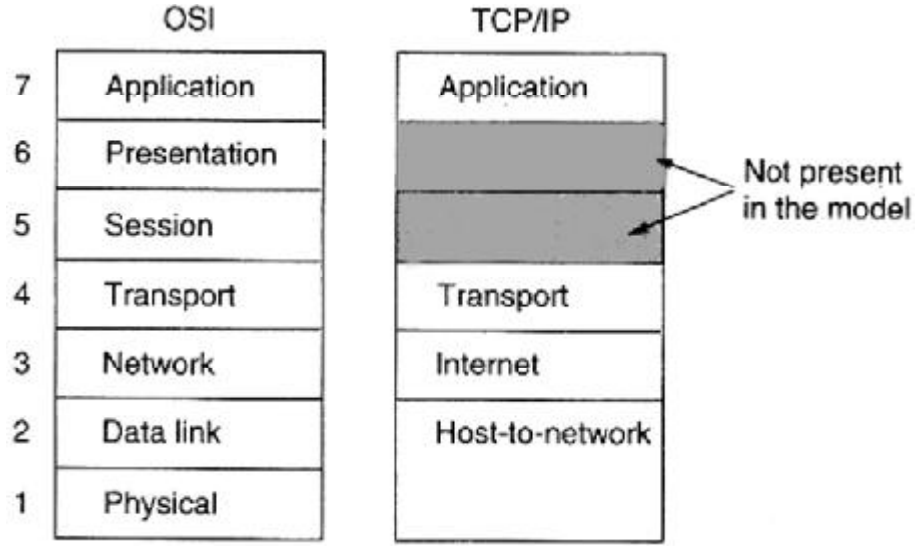


Fig. 6.3 : The TCP/IP reference model

1. **The Host-to-Network Layer :** In TCP/IP reference model the bottom layer is not defined clearly. Yet we can consider that whatever is there below the internet layer is the bottom layer in the TCP/IP model. In the model, the host has to be connected to the network using some protocol so that it can send IP packets over it.
2. **The Internet Layer :** The DoD planned to set up their inter-network in such a way that it had to survive even if a particular link failed in a probable war. So, this requirement led to connectionless packet-switching network instead of a connection-oriented circuit-switching network. The internet layer is designed to fulfil the goal of the architecture in such a way that it becomes the linchpin of the whole architecture. The job of this layer is to pump the packets from the host machine into any network and to help the packets to go to the destination independently. In this style of communication, packets may arrive in a different order than they were sent. This layer has its own protocol called **IP (Internet Protocol)** and a specified packet format. Packets routing as well as congestion avoidance are the major issues in this layer. This layer is similar to the network layer in OSI reference model.

3. **The Transport Layer :** The layer immediately above the internet layer is called the transport layer. This layer communicates with the peer layer on the other machine. It has two protocols namely **TCP and UDP.**

   (i)TCP: TCP is a reliable connection-oriented protocol that ensures delivery of byte stream from source machine to destination machine. This layer breaks the byte stream received from the upper layer into messages and passes them to the internet layer. At the receiving machine, these messages are reassembled by the TCP which passes them to the upper layer. Flow control is also another job of this layer to restrict a fast sender from swamping a slow receiver.

   (ii) UDP: UDP is another protocol used by this layer which offers an unreliable, connectionless service. Here, unlike TCP, sequencing and flow control is not done. When prompt delivery is more important than accurate delivery, UDP is used. It is also widely used in one time client-server type communication. Email, video or sound transmissions are some of these applications.

4. **The Application Layer :** In OSI model, there are session and presentation layers above the transport layer. In TCP/IP model these two layers are absent. So, on top of the transport layer, the application layer is present in TCP/IP reference model. All the high level protocols are present here. TELNET, FTP, SMTP are some of the early inclusions. Later, other protocols such as DNS, NNTP, HTTP are added to this layer.

6.9 COMPARISON OF ISO-OSI & TCP /IP REFERENCE MODEL

There is not much difference between the OSI and TCP/IP reference model. In both, the concept of independent stack of protocols is used. The functions of the layers are also more or less same. In both models, starting from bottom up to the transport layer, the function of the layers is to provide

end-to-end network independent transport service for communicating processes. The layers above the transport layer are application oriented.

On the other hand, there are some differences between the two models. In OSI reference model, three concepts are distinct. These are -

1. Services,
2. Interfaces,
3. Protocols.

The *Service* tells what a particular layer serves the layer just above it, not how these services are accessed by the above layer or how these are provided by the layer. The *Interface* tells how the above layer accesses the services provided by the layer just below it. It also does not say how these are provided. The *Protocols* used between peer layers are the set of rules agreed upon by both the layers to get the job done. Protocols can be changed without affecting the software in the higher layers.

In TCP/IP model, there is no such distinction between *Services, Interface and Protocol*. Therefore, in TCP/IP reference model the protocols are not so hidden as in the OSI reference model. As the technology advances, protocol between a peer layer can be replaced easily in OSI model than in TCP/IP model.

In OSI model, the layered structure was thought out before the protocols were invented. The designers were new in the network technology and hence in some layer a sub-layer has to be provided later to accommodate some new mode of communication. For example, in data link layer, the MAC sub-layer was introduced later when broadcast communication came to deal with channel allocation issues. On the other hand, in TCP/IP model, the protocols came first and then the model. So there was no problem of fitting the protocols into the model.

The two models also differ in their number of layers; In OSI model there are seven layers whethas TCP/IP model has four layers. Both have (inter)network, transport and application layers in common but the other layers are not the same.

In OSI model, network layer supports both *connection-oriented* and

connectionless communication and the transport layer supports only *connection-oriented* communication. On the contrary, in TCP/IP model the network layer supports only *connectionless* communication but the transport layer supports both the modes i.e. *connectionless* and *connection-oriented* communication.



CHECK YOUR PROGRESS

Q.5. What are the two services that can be offered by a layer to the layer above it?

.....

Q.6. How many layers are there in TCP/IP reference model?

.....

Q.7. Which model of network architecture was developed earlier – OSI or TCP/IP?

.....

Q.8. Which two layers of OSI model are absent in TCP/IP model?

.....



6.10 LET US SUM UP

- There must be some addressing technique for smooth communication between two computers.
- Simplex communication means one directional communication.
- In half-duplex communication, communication is bidirectional alternatively; not at the same time.
- Full-duplex communication means bidirectional communication at all time.
- Most of the computer networks are organized as a stack of layers, one above another, taking the service offered by the layer below.
- Protocol means a set of rules followed by two peers during communication.

- Entity: The active components in each layer are called entities. Entity can be a software process or hardware like an intelligent input/output device etc.
- Peer Entity: Entities in the same layer running on different machines are called peer entities.
- Service provider and Service user: In layered architecture, layer *n* provides a service which is used by layer *n+1*. Here layer *n* is service provider and layer *n+1* is service user.
- SAP (Service Access Points): A layer *n* offers services to layer *n+1* at a place which is called service access points. Each SAP has a unique address for identification.
- The layers and their protocols are collectively known as network architecture.
- OSI model is a seven layer network architecture.
- A layer can offer two different types of services to the layer immediately above it – connection-oriented and connectionless service.
- In TCP/IP model of network architecture, there are four layers.
- Most of the computer networks are based on TCP/IP model.



6.11 FURTHER READINGS

- Tanenbaum, Andrew, *Computer Networks*, PHI.
- Forouzan Behrouz A., *Tata Mcgraw Hill*.
- Norton Peter, *Complete Guide to Networking*.
- Comer, E. Douglas, Narayanan, M. S., *Computer Networks and Internets with Internet Applications*, Pearson Education.



6.12 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : A layer performs some primitive operations to fulfill the requirement of the layer immediately above it. This responsibility of the lower layer is called service.

On the other hand interface is the junction between two adjacent layers across which the lower layer provides the services to the layer above it.

Ans. to Q. No. 2 : The layers and their protocols are collectively known as network **architecture**.

Ans. to Q. No. 3 : Seven layers.

Ans. to Q. No. 4 : Framing, flow control , error control, and access control.

Ans. to Q. No. 5 : Connection-oriented service and connection-less service.

Ans. to Q. No. 6 : Four layers.

Ans. to Q. No. 7 : TCP/IP reference model was developed earlier than OSI model.

Ans. to Q. No. 8 : Session layer and presentation layer.



6.13 MODEL QUESTIONS

Q.1. What are the design issues of layered architecture of a computer network?

Q.2. What is the principal difference between connection-less and connection-oriented communication ?

Q.3. Describe ISO-OSI reference model of computer network.

Q.4. Define : peer entity, protocol, protocol stack, SAP.

Q.5. Which of the OSI layers handles each of the following:

a) Breaking the transmitted bit stream into frames.

b) Determining the route through which subnet is to be used.

Q.6. Describe the functions of various layers of the TCP/IP model.

Q.7. What are the responsibilities of the network layer in the TCP/IP model?

Q.8. What are the responsibilities of the transport layer in the TCP/IP model ?

Q.9. How do the layers of the TCP/IP model correlate to the layers of the OSI model ?

Q.10. Match the following to one or more layers of the OSI model:

a. Flow control

b. Route determination

c. Provides access for the end user

d. Interface to the transmission media.

****

UNIT 7 : TRANSMISSION MEDIA

UNIT STRUCTURE

7.1 Learning Objectives

7.2 Introduction

7.3 Transmission Medium

7.4 Guided Media

- 7.4.1 Coaxial Cable
- 7.4.2 Twisted Pair Cable
- 7.4.3 Fiber Optics Cable

7.5 Unguided Media

- 7.5.1 Radio Waves
- 7.5.2 Infrared
- 7.5.3 Microwave
- 7.5.4 Satellite

7.6 Wireless LANs (IEEE 802.11)

7.7 Let Us Sum Up

7.8 Further Reading

7.9 Answers to Check Your Progress

7.10 Model Questions

7.1 LEARNING OBJECTIVES

After going through this unit, you will be able to :

- learn about different classes of transmission media
- describe the twisted pair, coaxial and fiber optics cables
- elaborate the radio waves, infrared, microwaves
- learn the concept of Wireless LANs

7.2 INTRODUCTION

So far, you must have been acquainted with the basic terminology of computer networks, concept of layers as well as ISO-OSI and TCP/IP

model. In this unit, we will concentrate on the transmission media and its various types.

7.3 TRANSMISSION MEDIUM

Transmission medium is the physical path that carries data from transmitter to receiver. The signals are transmitted from one device to another device in the form of electromagnetic energy with the help of transmission medium. The transmission medium can be divided into two classes : **Guided** (wired) media and **unguided** (wireless) media. Guided media includes twisted pair cables, coaxial cables and fiber optics cables. For guided media, the electromagnetic waves travel along a solid medium, such as different types of cables. For unguided media, the medium is wireless and occurs through air, space or water.

7.4 GUIDED MEDIA

Guided transmission media uses a cabling system that guides the data signals along a specific path. The data signals are bounded by the cabling system. Guided media is also known as bound media. “Cabling” is meant in a generic sense and is not meant to be interpreted as copper wire cabling only. The followings are the basic guided media used in networking :

- Coaxial Cable
- Twisted-pair cable
- Fiber optic cable

7.4.1 Coaxial Cable

The first version of Ethernet was based on coaxial cable. The original form of Ethernet 10Base-5 used a thick coaxial cable (called thick coax) that was not directly connected to the computer’s NIC (Network Interface Card). An attachment unit Interface (AUI) ran from a DB15 connector on the back side of the NIC to the thick coax. A “vampire tap” was inserted into the thick coax to which the AUI is connected.

Another version of coaxial cables are there which are thinner in size and hence its name is thin coaxial cable (called thin coax). 10Base-2 Ethernet cards are connected to this type of cable by a BNC (Bayonet-Neill-Concilman) –T connector on the rear side.

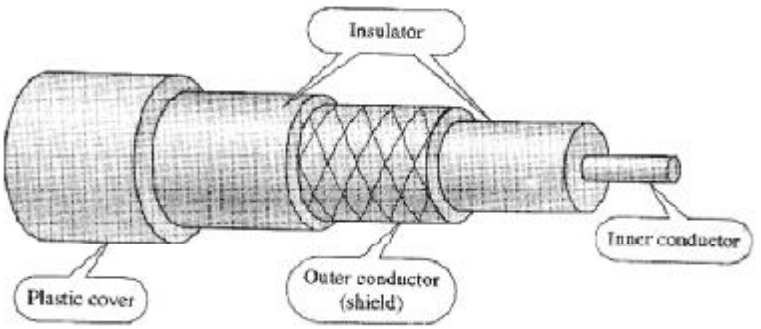


Fig. 7.1 : Construction of a coaxial cable

The physical construction of a coaxial cable can be seen in the Fig 7.2. We can see that the cable has a central core made of solid or stranded copper which carries the signals. Upon the central conductor there is an insulating layer upon which a braided wire mesh is provided as a shield to protect the cable from external noise. Upon this shield another insulating sheath is there enclosing which a plastic cover is provided to complete the construction of the cable.

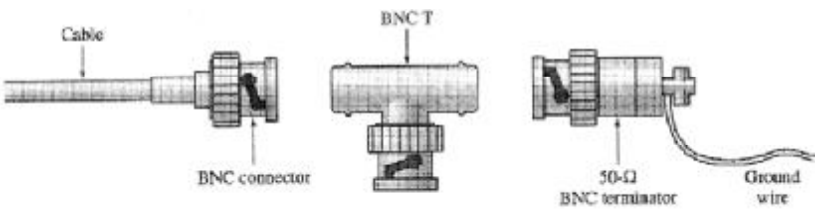


Fig. 7.2 : BNC and BNC-T Connector

Thick and Thin coax differs in size and cable impedance. Coaxial cables are categorized by their Radio Government (**RG**) ratings. Each RG number denotes a set of physical specifications uniquely.

Category	Impedance	Use
RG – 59	75 Ω	Cable TV
RG - 58	75 Ω	Thin Ethernet
RG - 11	50 Ω	Thick Ethernet

Table 7.1 : Categories of Coaxial Cables

Applications :

Coaxial cable was extensively used in analog telephone networks to carry 10,000 voice signals at a time. Later these cables were used in digital telephone networks which could carry digital data up to 600 Mbps. But coaxial cables are almost replaced today by fiber optic cables.

Cable TV networks are still running on coaxial cables in our country. However, in some advanced countries these are replaced by fiber optic cables.

Another most common application of coaxial cable is in traditional Ethernet LAN, which are also gradually replaced by twisted-pair cables.

Advantages :

- **Strong construction :** Constructional features make a coaxial cable strong in structure.
- **Good immunity to noise :** Coaxial cables have good immunity to external noise.
- **Good LAN length :** LAN implemented by using coaxial cables are of moderate length; it is around 500 meter for thick coax and 200 meter for thin coax.

Disadvantages :

- **Heavy weight :** Coaxial cables are heavy in weight. Therefore coaxial cables need strong support.
- **Unreliable tap :** When thick coax is connected by vampire tap, it provides an unreliable connection because with slight shaking the connection becomes loose.
- **High cost of installation :** Due to heavy weight laying of coaxial cables causes high labour cost.

7.4.2 Twisted Pair Cable

Twisted-pair cable is just what its name implies; insulated wires housed within a protective casing with a specified number of twist

per foot of distance. Twisting of wires reduces the effect of electromagnetic interference which may be generated from nearby electric motors, fluorescent tube lights etc. Shielded twisted-pair (STP) cables are provided with shielding and additional insulation over the cluster of wires to protect it from outside noise. Unshielded twisted-pair (UTP) cables are mostly used in small office or home LANs which are less costly. Fig 7.3 shows UTP and STP cable.

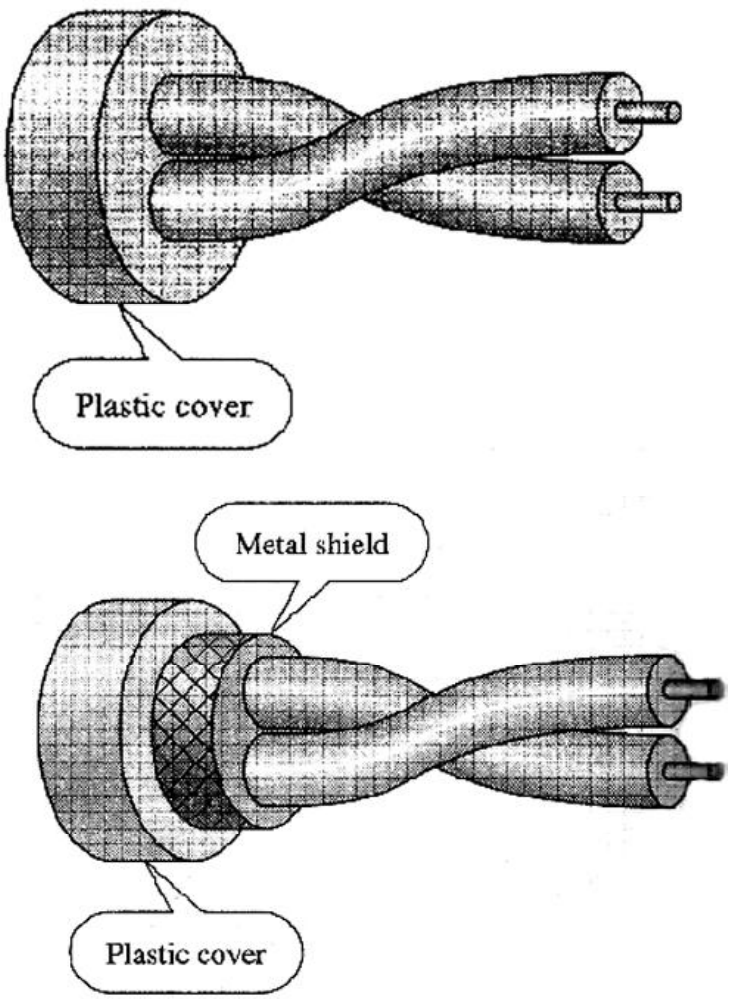


Fig. 7.3 : Twisted pair cable

The unshielded twisted-pairs are classified by The Electronic Industries Association (EIA) into seven categories. The categories are determined by cable quality. 1 is the lowest and 7 is the highest in quality. Table 7.2 shows the different categories of UTP cables.

Cate-gory	Specification	Data Rate (Mbps)	Use
1	Unshielded twisted-pair used in telephone	< 0.1	Telephone
2	Unshielded twisted-pair originally used in T-lines	2	T-1 lines
3	Improved CAT-2 used in LAN	10	LANs
4	Improved CAT-3 used in Token-Ring Networks	20	LANs
5	CAT-5 Cable wire with a jacket and outside sheath	100	LANs
5e	Extension of CAT-5, can minimize cross-talk & interference	125	LANs
6	CAT-6 cable with other matched components	200	LANs
7	Shielded screen twisted-pair (SSTP)	600	LANs

Table 7.2 : Categories of UTP cables

The most common UTP connector is RJ 45 (Registered Jack 45) which can be inserted in one way only.

Applications :

- Twisted-pair cables are extensively used in telephone lines as voice and data channels. The lines connecting subscribers to the telephone exchange are unshielded twisted-pair cables.
- People use twisted-pair cables to connect DSL lines for high speed Internet Connection.
- LAN such as 10Base-T and 100Base-T uses twisted-pair cables.

Advantages :

- **Low cost :** The cost of twisted-pair is not so high.
- **Light weight** : Twisted-pair cables are lighter in weight. Hence it does not require heavy support.
- **Easy installation & maintenance:** The technology of twisted-pair cable laying is a job of almost any person. Connecting the RJ45 connector to the cable is called crimping and it requires a few hours of practice.
- **Cheaper equipment:** Crimping tools and other tools necessary for twisted-pair cable preparation are cheap. Hence these are easy to purchase.

Disadvantages :

- **Susceptible to cross talk:** Twisted-pair cables are not totally immune to cross talk.
- **Distance limitation :** The maximum length of LAN using twisted-pair cable is short, in comparison to optical fiber.

7.4.3 Fiber Optics Cable

Fiber optic cable is a communication medium made of glass or plastic that can transmit signals in the form of light. In optics there is a principle which states that when a beam of light travels from denser medium to rarer medium then it deviates away from the normal drawn at the point of incidence at the junction of the two media. It can be seen from the Fig 7.4.

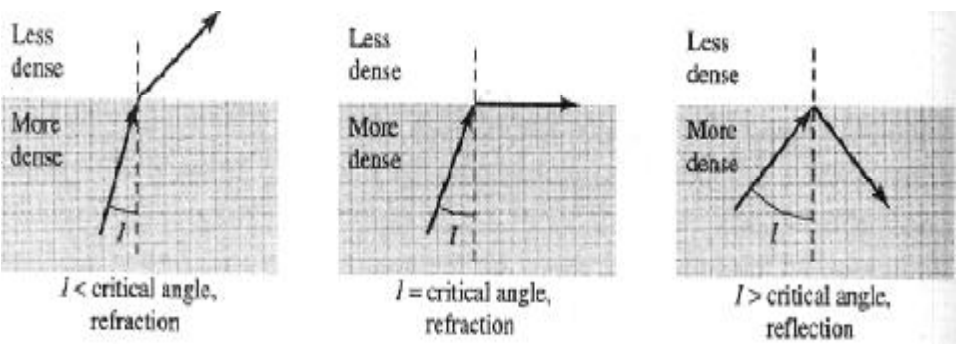


Fig. 7.4 : Bending of Light Ray

If the angle of incidence is such that the angle of refraction is 90^0 then the angle of incidence is called **critical angle**. Now if the angle of incidence is greater than critical angle then the refracted ray would re-enter into the denser medium. This phenomenon is called **total internal reflection.**

In optical fiber light signals travel by following the principle of total internal reflection. In an optical fiber, a glass or plastic **core** is surrounded by a **cladding** of less dense glass or plastic. This difference in density facilitates total internal reflection for a light signal that travels through the cable. Fig 3.5 shows the propagation of light through an optical fiber.

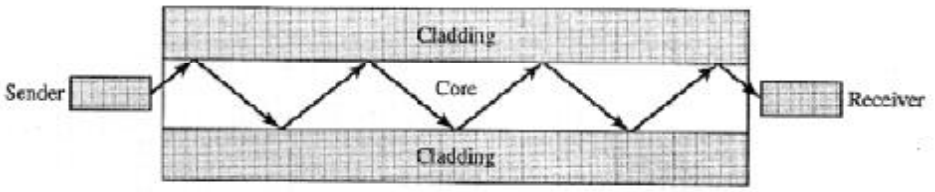


Fig. 7.5 : Light propagation through optical fiber

Current technology provides two modes of light propagation through an optical fiber. These two modes are: **mono mode** and **multi mode.** Further, fiber optic cable has two varieties: **step index** and **graded index**.

In step index fiber, core and cladding has a definite boundary. In graded index fiber, density of the fiber gradually decreases from inner core to the outer boundary.

In ***mono mode***, step index fiber is used. Mono mode fibers are of the order of 8 – 10 microns in diameter. Mono mode fibers are costly and they can transmit light signal to a longer distance than multi mode fiber. A highly focused beam of light is injected into the fiber at an incident angle close to the horizontal line. Its density is also much lower so that the critical angle is almost equal to 90^0. Therefore, the reflected beam also propagates in almost horizontal line. The delay is minimum here.

Multi mode operation can transmit multiple beams of light signal at a time. These fibers are thicker in diameter than the mono mode fiber, of the order of 50 microns. These are cheaper but can transmit signal to a shorter distance. In multi mode both step index and graded index cables are used.

Fiber optic cables are connected to NIC by three types of connectors: **Subscriber channel (SC) connector, Straight-tip (ST) connector** and **MT-RJ connector.**

Applications : Fiber optic cable is now extensively used as a communication medium for backbone networks due to its low cost wide bandwidth. Its data transfer rate now arrived at 1600 Gbps. Some cable TV companies use a combination of optical fiber and coaxial cable. Here optical fiber provides the backbone network and

the coaxial cable gives service connection to the users. 100Base-FX (Fast Ethernet) and 1000Base-X (Gigabit Ethernet) LAN uses optical fiber cable.

Advantages and Disadvantages of Optical Fiber :

Advantages : Fiber optic cables have several advantages over the metallic cables such as coaxial cable and twisted-pair.

- **Higher bandwidth :** Fiber optic cable can provide very high bandwidth and, therefore, high, data rate than the coaxial and twisted-pair cable.
- **Less attenuation :** It offers less attenuation than metallic cables. Hence, signal can travel up to 50 Km without repeater in a fiber optic cable.
- **Immunity to electromagnetic interference :** Electromagnetic noise cannot affect a light signal traveling through a fiber optic cable.
- **Resistance to corrosion :** Fiber optic cables are not affected by corrosive substances.
- **Light weight :** These are much lighter in weight than metallic cables.
- **Greater immunity to tapping :** Light signals are more difficult to tap than an electrical signal. Hence, the signal passing through a fiber optic cable has greater immunity to tapping.

Disadvantages : Despite many advantages, fiber optic cable has some disadvantages also. These are:

- **Difficult to instal and maintain :** Since fiber optic cable is a new technology, so skills personal for installation and maintenance of the fiber optic cable are not easy to find.
- **Unidirectional signal propagation :** Light propagation is unidirectional. So, if we require bidirectional communication, we need two fiber cables.
- **Cost :** The fiber optic cables and the interfaces are more expensive till date in comparison to other types of cables.



CHECK YOUR PROGRESS

Q.1. What are the different types of cables used in LAN?

.....

.....

Q.2. How can a thick coax be connected to the AUI?

.....

Q.3. What is the impedance of a coaxial cable used in cable TV?

.....

Q.4. What is the maximum data rate of SSTP cable?

.....

Q.5. Why is twisting done in twisted-pair cables?

.....

.....

Q.6. On what principle does light travels in fiber optic cable?

.....

7.5 UNGUIDED MEDIA

In wireless transmission, the data signals travel without any guides media. The data signals are not bound to a cabling media and are therefore often called unbound media. The transmission and reception are achieved by means of an antenna. In two way communication, the same antenna can be used for both transmission and reception.

For wireless communication, signals can travel from source to destination in several ways. They are - ***ground propagation, sky propagation*** and ***line-of-sight propogation***.

Radio waves travel through the lowest portion of the atmosphere. These low frequency signal (which is about 2 MHz) emanate in all directions from the transmitting antenna and follow the curvature of the planet. The distance depends on the amount of power in the signal. This type of propagation is called **ground propagation**.

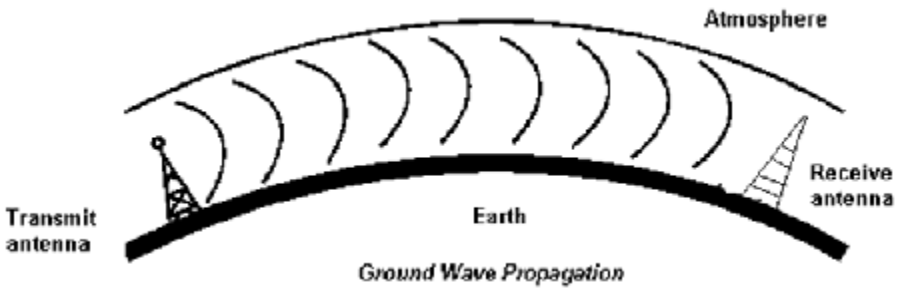


Fig. 7.7 : Ground wave propagation (below 2 MHz)

Higher frequency radio waves (2 to 30 MHz) propagate upward into the layer of the atmosphere where particles exist as ions (ionosphere). This type of transmission allows greater distances with lower power output and is called as **sky propagation**.

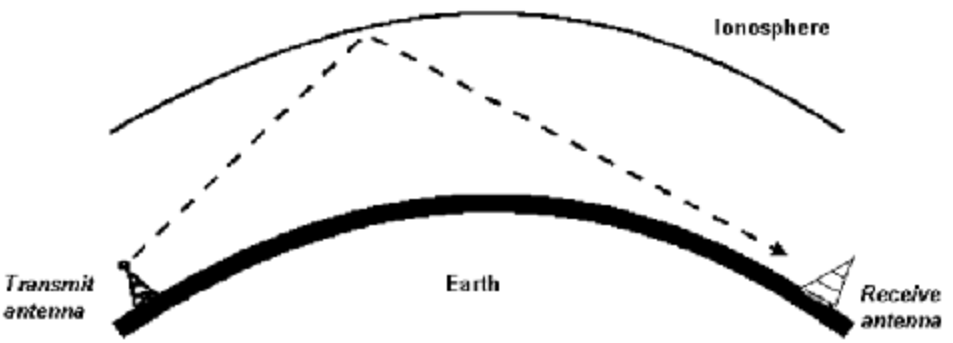


Fig. 7.8 : Sky wave propagation (2 to 30 MHz)

When very high frequency signals are transmitted in straight lines directly from antenna to antenna, it is called **line-of-sight propagation**. Antennas must be directional, facing each other, and either tall enough or close enough together not to be affected by the curvature of the earth.

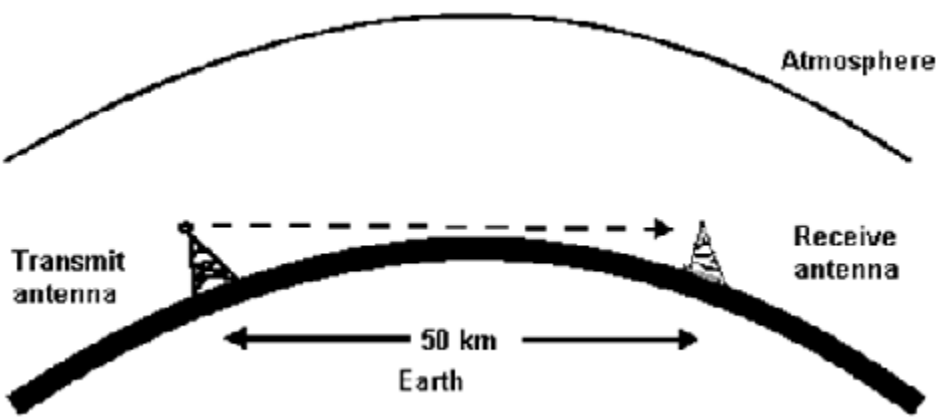


Fig. 7.8 Line-of-sight propagation (above 30 MHz)

7.5.1 Radio Waves

The radio waves are omnidirectional while the microwaves are directional. Radio waves are used for one sender and multiple receivers i.e. for multicasting property. Because of this multicast communication, it is used by radio, television, cordless phones and pagers. Radio wave is a general term to encompass frequencies in the range 3 KHz to 1 GHz. The microwaves range in frequencies between 1 to 300 GHz. Broadcast radio term may be informally used for the FM radio and VHF television and number of data networking applications.

As the radio waves are omnidirectional, they do not require dish-shaped antennas with precise alignment. Radio waves used omnidirectional antennas that send the signals in all directions. We can have different types of antennas based on wavelength and strength. Radio waves can penetrate walls. It can be considered an advantage. For example, AM radio can receive signals inside the building. It has the disadvantage that radio wave band is relatively narrow and if we subdivide it farther, it becomes narrower resulting in lower data rate for digital communications. Another problem with the radio waves is the multipath interference. Reflection from different sources can create multiple paths between antennas which is evident when TV reception displays multiple images. But because of longer wavelength, radio waves suffer less attenuation.

7.5.2 Infrared

Infrared signals are used for short range communication. It has the frequency range from 300 GHz to 400 THz. It has wavelength from 1 mm to 770 mm. Infrared communications is achieved by using the transmitters / receivers(transceivers) that modulate infrared light. Transceivers must be within the line of sight of each other directly or via reflection.

One disadvantage of infrared is that it does not penetrate walls. We cannot use infrared outside a building because the sun's rays contain infrared waves which can interfere with the communication.

When we use infrared remote control, we do not interfere with the use of the remote by our neighbours. It can be used for digital data transmission with high data rate.

As no licensing is required, there is no freuency distribution issue in case of infrared. The association that has setup standards for communication is called Infrared Data Association (IrDA). IrDA port is used to communicate a wireless keyboard to communicate with PC.

7.5.3 Microwaves

Microwaves use line of sight propogation. Microwaves frequency ranges from 1 to 300 GHz. Microwaves are used in cellular phones, satellite networks and Wireless LANs. Microwaves are unidirectional. It is useful in unicasting i.e. one to one communication. To travel longer distances, the antennas must be taller. There should not be any obstacle in between . Usually mountain tops are the preferred positions for the antennas to avoid obstacles. Microwaves can travel for one direction at a time. For two way communication two frequencies need to be allocated.At both ends a transceiver for operating two different frequencies. Repeaters are used along with antennas to regenerate the signal. Microwave is inexpensive and it allows you to communicate from anywhere.

Microwave is commonly used for both voice and television transmission.

There are two types of antennas used for microwave communications: (1) the parabolic dish and (2) the horn.

The parabolic dish is 3 m in diameter and its shape is like a parabola. It focuses a narrow beam to achieve line of sight transmission. The parabolic dish acts as a funnel, catching wide

range of waves and directing to a common point.

In horn antenna, the outgoing transmission is broadcast up a stem and deflected outward in a series of narrow parallel beams by the curved head. The scooped shape of the horn collects the received transmissions and deflected down into the stem.



Fig. 7.9 : Microwave Antenna

Typical Digital Microwave Performance

7.5.4 Satellite

A communication satellite is, in fact, a microwave relay station. It is used to link two or more ground based microwave transmitter/ receivers, known as earth stations, or ground stations. The satellite receives transmissions on one frequency band (uplink), amplifies or repeat the signal, and transmit it on another frequency (downlink). A single orbiting satellite will operate on a number of frequency bands, called **transponder channels,** or simply **transponders**.

Thus, the satellites are transponders (units that receive on one frequency and retransmit on another) that are set in geostationary orbits directly over the equator. These geostationary orbits are 36,000 km from the Earth's surface. At this point, the gravitational pull of the Earth and the centrifugal force of Earth's rotation are balanced and thus cancel out each other. Centrifugal force is the rotational force placed on the satellite that wants to fling it out into space. The following figure shows a general way of communication through the satellite.

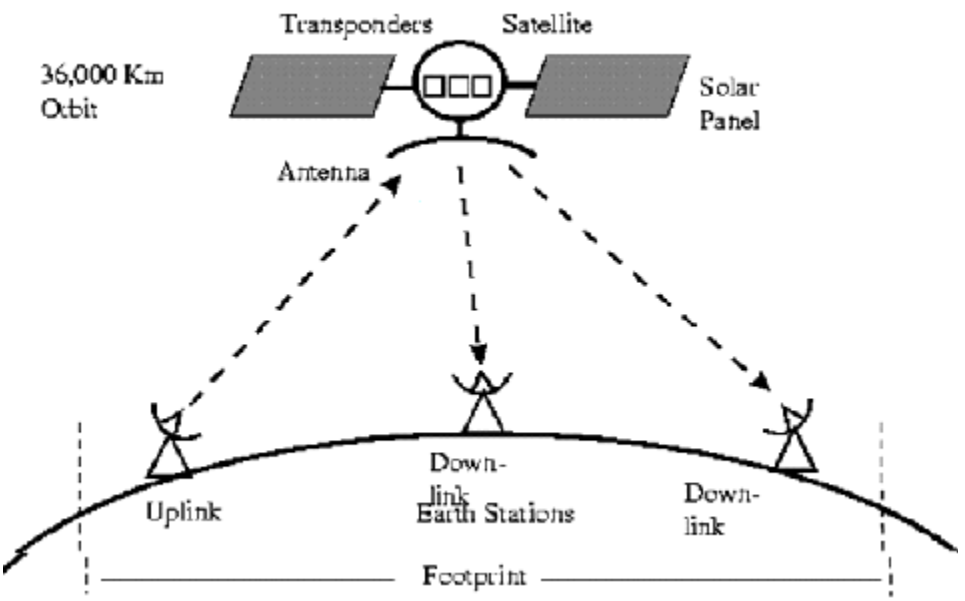


Fig. 7.10 : Satellite Communication

7.4 WIRELESS LANS (IEEE 802.11)

Now-a-days Wireless LAN becomes one of the fastest growing technologies and everyone likes to connect without using cables. One can find wireless LAN in office building, colleges and public areas. At home, a wireless LAN can be used by connecting roaming devices to Internet.

Wireless LANs are generally catogorized according to the transmission techniques. There are two types of categories:

Infrared (IR) LANs : As the infrared technology can not penetrate walls, an individual cell of an IR LAN is limited to a single room.

Spread spectrum LANs : The technology that uses this type LANs is spread spectrum transmission technologies. They operate in the ISM(industrial,scientific and medical) microwave bands in most of the cases. They operate in these bands so that there will be no licensing issue from Federal Communications Commission (FCC).

IEEE 802.11 : IEEE formed a new specification IEEE 802.11, specially for the development of wireless LANs, MAC protocol and physical medium specification. The following lines define the terminologies used in the IEEE 802.11 standard.

IEEE 802.11 terminology :

Access Point(AP) : Any entity that has station functionality and provides access to the distribution system via wireless medium for associated stations.

Basic service set (BSS) : A set of stations controlled by a single coordination function.

Coordination function : The logical function that determines when a station operating within a BSS is permitted to transmit and may be able to receive PDUs

Distribution System DS : A system used to interconnect a set of BSSs and integrated LANs to create an ESS.

Extended service set : A set of one or more interconnected BSSs and integrated LANs that appear as a single BSS to the LLC layer at any station associated with one of these BSSs.



CHECK YOUR PROGRESS

Q.7. What is transmission media?

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Q.8. What are the three types of guided media?

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Q.9. Write two advantages and disadvantages of fiber optics cable.

.....

.....

Q.10. Name the three ways for wireless data to be propagated.

.....

.....



7.7 LET US SUM UP

- Transmission media can be classified two main categories: guided media and unguided media.
- Guided media uses physical cable for data transmission, whereas in case of unguided media, air is the main transmission medium.
- The three main types of guided media are twisted pair cable, coaxial cable and fiber optics cable.
- Fiber optics cable is the latest, best and most expensive.
- Unguided media can be classified as radio waves, microwaves and infrared waves.
- Wireless data are transmitted through ground propagation, sky propagation and line-of-sight propogation.
- Radio waves are omnidirectional.

- Microwaves are unidirectional; propagation is line-of-sight.
- Infrared waves are used for short-range communication such as between a PC and a peripheral device.
- IEEE 802.11 standard defines for Wireless LANs.



7.8 FURTHER READINGS

- Data and Computer Communications by William Stallings, Pearson Education.
- Data Communications and networking by Behrouz A. Forouzan, Tata McGrawHill.



7.9 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : The different types of cables used in LANs are : Coaxial cables, shielded and unshielded twisted-pair cables and fiber optic cables.

Ans. to Q. No. 2 : A “vampire tap” is inserted into the thick coax to which the AUI is connected.

Ans. to Q. No. 3 : 75 Ω

Ans. to Q. No. 4 : 600 Mbps

Ans. to Q. No. 5 : Twisting of wires reduces the effect of electromagnetic interference which may be generated from nearby electric motors, fluorescent tube lights etc.

Ans. to Q. No. 6 : In optical fiber light signals travel by following the principle of total internal reflection.

Ans. to Q. No. 7 : Transmission media are the physical infrastructure components that carry data from one computer to another computer. They are the basis of data communication.

Ans. to Q. No. 8 : Guided media can be subdivided into three main categories.

1)Twisted Pair, (2) Coaxial cable and (3) Fiber Optics.

Ans. to Q. No. 9 : The two advantages of fiber optics cable are :
(i) Huge bandwidth, (ii) Resistance to noise.
The two disadvantages of fiber optics cable are :
(i) Cost, (ii) Maintenance overhead

Ans. to Q. No. 10 : Wireless data are transmitted through ground propagation, sky propagation and line-of-sight propagation.



7.10 MODEL QUESTIONS

Q.1. How does guided media differ from unguided media.

Q.2. Write about a use of each class of guided media.

Q.3. What are the three major classes of guided media.

Q.4. Name the advantages of optical fiber over twisted pair and coaxial cable.

Q.5. Name the three ways for wireless data to be propagated.

Q.6. Write what you know about radio waves and microwaves.

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