Data Communication and Networking

Understanding network architecture, design, and management

Dr. Brahampal Singh

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Dedicated to

My beloved parents:

Shri Tejpal Singh *and* ***Smt. Kamlesh Devi***

and

My wife ***Sunita Tanwar****,*
my twin daughters ***Anshika Tanwar****,* ***Vanshika Tanwar***
and my son ***Tanishk Tanwar***

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Preface

Computer network is a core subject for undergraduate students in **Computer Science Engineering (CSE), Electronics and Communication Engineering (ECE),** and information stream etc. This book is primarily intended to serve as a textbook in accordance with the syllabus of computer networks offered by various universities in India and abroad.

In this book, a significant effort has been made to find simple ways to develop theoretical aspects of computer networks. A strong emphasis has been given on numerical examples. Neat and clear diagrams have been used for explanation.

This book covers many different aspects of computer networks, the importance of computer networks and related technology. This book also introduces the importance of computer networks in the real-time industry. It shows how the data and network is important for the industries. This book solves the basic understanding of computer networks in the network and data world so that computer networks' basic concepts get refreshed. This book also gives information about the usefulness of computer networks in technology.

It takes a practical approach for computer network learners. It covers few real-time industry examples as well. It will cover information such as computer networks basically used for information and data sharing. It is used in different domains for networking purposes.

This book is divided into **13 chapters**. The chapters cover computer network basics and advanced topics so learners can become more interested in computer network tools. The details are listed below:

Chapter 1: Basic Concepts- This chapter will cover what is topology, transmission modes, categories of networks, OSI model layers, digital transmission or transmission media in wireless communication. How topology, transmission modes, categories of networks, OSI model layers, digital transmission, or transmission media work in wireless communication. This chapter will give an introduction and basic idea of topology, transmission modes, and categories of networks, OSI model layers, digital transmission, or transmission media.

Chapter 2: Telephony- This chapter will cover multiplexing and its types in detail, different switching techniques besides line discipline, flow control, and error control to explain the process of data link control protocols, and synchronous and asynchronous protocols.

Chapter 3: Integrated Services Digital Network- This chapter will cover an introduction to ISDN, its services, Historical outline, subscriber access, ISDN Layers, and broadband ISDN Layers. These are all part of ISDN and play a very important role in a Network. In this chapter, we shall cover ISDN and its services, subscriber access in details, and ISDN Layers and broadband ISDN in a network.

Chapter 4: Networking Devices- This chapter will cover information such as brief introduction of network devices, their services, functions, uses as well as utility for the network. Network devices play a very important role in Network for communication and data transmission.

Chapter 5: Network Layer- This chapter will cover the network layer for wired and wireless communication and how it aids data transmission. It will introduce the network layer, design issues, network addressing, routing concepts, routing methods, distance vector protocol, and link state routing.

Chapter 6: Transport Layer and Upper Layers in OSI Model - This chapter will cover information such as addressing, routing, functions, connection management, and design challenges for the transport layer, session layer, presentation layer, and application layer in this chapter.

Chapter 7: Foundation- This chapter will cover network, encoding, links, frame error detection and correction, reliable transmission, Ethernet, and MAC in network & wireless communication.

Chapter 8: Internetworking- This chapter will give an introduction to basic internetworking, switching, bridging, and routing. Internetworking, switching, bridging, and routing play a very important role in network and communication.

Chapter 9: Advanced Internetworking- This chapter introduces advanced internetworking, the global internet, Multicast, MPLS, and Routing among mobile devices, which play a very important role in the Network and communication.

Chapter 10: End-to-End Protocols- This chapter explains an introduction to Simple demultiplexure, Reliable Byte Stream (TCP), RPC, and RTP, which play a very important role in network and communication.

Chapter 11: Congestion Control and Resource Allocation- This chapter provides an overview of resource allocation, congestion control, queuing disciplines, TCP congestion control avoidance strategies, and quality of service, which are crucial to network and communication.

Chapter 12: Multimedia Networking - This chapter will introduce multimedia networking, multimedia networking applications, RTSP, SIP, and H.323.

Chapter 13: Network Security- This chapter explains network security, cryptographic building blocks, symmetric key encryption, public key encryption authentication protocols, PGP, TLS, SSL, Firewall, and intrusion detection will all be introduced in this chapter.

The author hopes that the book will fulfill the need of readers and welcomes any suggestions towards the improvement of the book. The good suggestions for improvement will be thankfully acknowledged and will be incorporated in the next edition of this book.

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Chapter 1
Basic Concepts

Introduction

In this chapter, we will cover how we can use topology, transmission modes, categories of network, OSI model layers, digital transmission, or transmission media in wireless communication. How topology, transmission modes, categories of network, OSI model layers, digital transmission, or transmission media work in wireless communication.

These are all part of telephony and play a very important role in mobile computing and wireless communications.

Structure

In this chapter, we will go through the following topics:

- Introducing data communication
- Distributing processing
- Line configuration
- Topology
- Transmission modes
- Categories of computer network
- Open System Interconnection model layers

- Network layer
- TCP/IP model layers and their functions
- Comparison of models
- Digital transmission
- Transmission media

Objectives

This chapter seeks to provide a fundamental overview of topology, transmission modes, categories of network, OSI model layers, digital transmission or transmission media. In order to explain topology, transmission modes, categories of network, OSI model layers, digital transmission, or transmission media, we will also go into detail about how to use topology, transmission modes, categories of network, OSI model layers, digital transmission, or transmission media. We shall start with topology, transmission modes, categories of network, OSI model layers, and digital transmission or transmission media. We shall conclude the chapter with some model questions as well as objective questions.

Introducing data communication

When we communicate, we are sharing information that can be local or remote, this is known as data communication between individuals. Local communication usually occurs face to face, while isolated communication occurs over distance. There are five components of the data communications system, which are depicted in *Figure 1.1*:

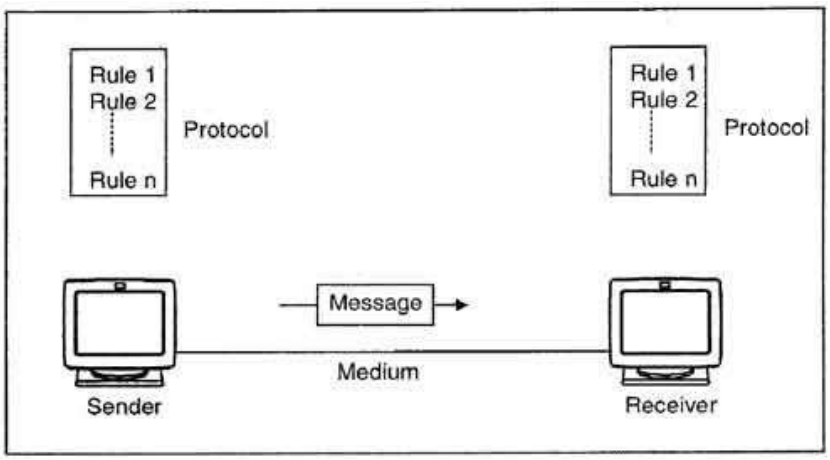

***Figure 1.1**: Components of the data communication*

- **Message**: Text, numbers, photos, audio, and video are the main types of data or information that is conveyed as information in a message.

- **Sender**: The sender functions as a tool for transmitting the data message. A computer, workstation, phone, video camera, and other devices may fall under this category.
- **Receiver**: The receiver serves as a tool for acquiring the message. This could be a computer, workstation, phone, TV, or other device.
- **Transmission medium**: The actual physical media used to transmit messages from sender to receiver is known as the **transmission channel**. Twisted-pair wire, coaxial cable, fiber-optic cable, and radio waves are examples of transmission media.
- **Protocol**: A collection of guidelines known as a protocol plays a crucial part in data transfers, between the communicating devices. Without a protocol, communication between two connected devices is impossible, like how someone speaking Japanese cannot understand someone speaking French.

Distributed processing

Distributed processing is a term used to indicate to a variety of computer systems that use more than one computer (or **processor**) to run an application. This includes parallel processing in which a single computer uses more than one CPU or processor for executing programs.

Mainly distributed processing refers to **local area networks** (**LANs**) which are designed so that a single program can run simultaneously at various sites.

Most of the networks use distributed processing, in which a task is divided among multiple computers. Instead of one single large machine being responsible for all aspects of the process, separate computers (usually a personal computer or workstation) handle a subset.

Line configuration

Line setup describes how two or more communication devices are linked to a physical communication pathway that is a link. The configuration of a line can also be used as a connection. The physical communication pathway that transports data from one device to another is referred to as a link. Two devices must be connected to the same link at the same time for a healthy conversation.

There are two possible line configurations available which are as follows:

- Point-to-point
- Multiple points

Point-to-point

It connects the two ends of a physical piece of wire or cable to provide a dedicated link between two devices. Infrared remote controls and television remote controls are a couple of examples.

For transmission between such two devices, the channel's full capacity is used. A physical length of wire or cable is typically used in point-to-point line configurations, but other options, such as microwave or satellite links, are also available. The point-to-point network topology is one of the most common and simple network topologies. It is also the most straightforward technique to establish and comprehend. To understand point-to-point network topology, imagine two phones arranged end to end, refer to the following figure:

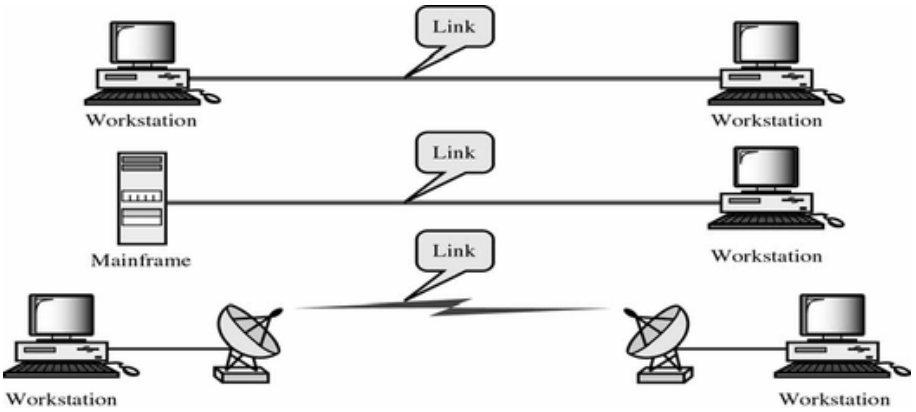

Figure 1.2: Point-to-point

Multipoint configuration

This configuration, which enables one or more devices to share a single link capacity of the channel, is called as **multipoint configuration**. It is also known as a **multidrop line setup**.

The link is shared by more than two devices, which means the channel's capacity is now shared. In a multipoint line configuration with shared capacity, there are two options:

- **Spatial sharing configuration**: Spatially shared line configuration is another name for a link that can be shared by multiple devices at once.
- **Temporal (Time) sharing configurations**: When users must access the link sequentially, a configuration known as a **temporarily shared** or **time-shared line** is employed.

Refer to *Figure 1.3*, the multipoint configuration has been explained:

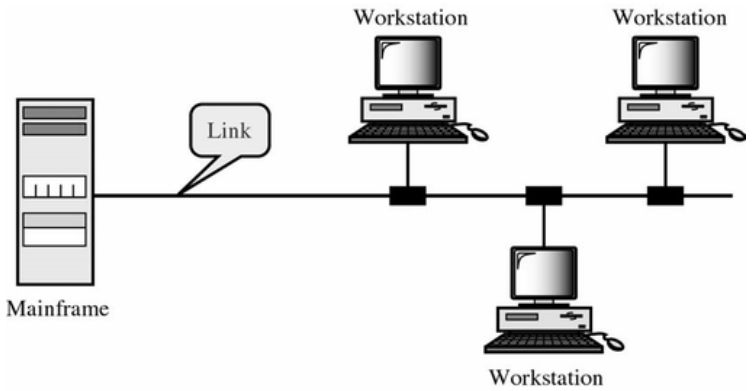

***Figure 1.3**: Multipoint configuration*

Topology

How computer systems or network hardware are connected to exchange resources and information is described by a **network topology**. Topologies can be used to define the network's physical and logical aspects. The logical and physical topologies of a network may be the same or different.

Point-to-point topology

In this network, a single cable links two back-to-back hosts (computers, switches, routers, or servers). Frequently, the receiving end of one host is linked to the sending end of another, refer to the following *Figure 1.4*:

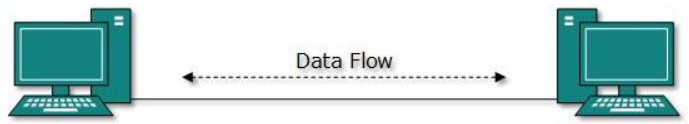

***Figure 1.4**: Point-to-point topology*

If the hosts or nodes are logically connected point-to-point, many intermediary devices may be required. The end hosts, however, perceive one another as though they are directly connected and are not aware of the underlying network.

Bus topology

In this bus architecture, every device uses the same cable or communication line for communication. Each device is connected to this common line. The bus topology may cause issues when numerous hosts are sending data simultaneously. To remedy the problem, the bus architecture either employs CSMA/CD technology or identifies one host

as the **bus master**. It is a simple networking technology in which the failure of one device does not affect the others. However, if the shared communication channel fails, all other devices will fail as well. Please refer to the following figure:

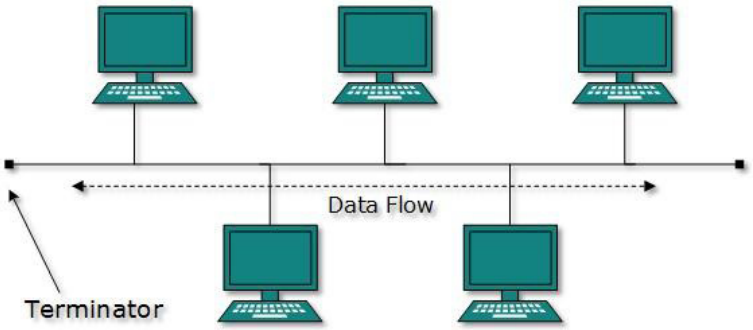

***Figure 1.5**: Bus topology*

A line terminator is present at both ends of this shared channel. The data is delivered in only one way, and the terminator removes it from the line when it reaches the complete or extreme end.

Advantages of bus topology

The following are the advantages of bus topology:

- **Cheap cable**: This topology is cheap. In a bus architecture, nodes connect to the cable directly as opposed to through a hub. With this architecture, installation costs are low. Coaxial or twisted pair cables are excellent for moderate data rates since they are frequently used in bus-based networks with data rates of up to 10 Mbps limit.
- **Common technology**: The bus topology is a reliable and well-known technology since installation and troubleshooting procedures are well-known and hardware components are easily accessible.
- **Limited failure**: In this scenario, a node failure has no impact on the other nodes of the network.

Disadvantages of the bus topology

The following are the disadvantages of bus topology:

- **Large no of cables**: Although the bus architecture is basic, it nevertheless necessitates a significant amount of wiring.
- **Difficult troubleshooting**: In this case, specialist test equipment is required to identify cable issues and flaws. If a fault or error occurs in the cable, it will disrupt or disrupt communication between all nodes.