



Computer Networks

School of Computer Engineering
KIIT Bhubaneswar

Syllabus

UNIT I

Data Communications:

Data Transmission, Multiplexing, Data Encoding Techniques, Introduction to computer networks, Network, Topologies, Reference Models: ISO/OSI Model and TCP/IP Model.

UNIT II

Physical Layer:

Transmission Media, Analog signals, Digital Signals, Data Link Layer, Error Detection and Correction, Parity, LRC, CRC, Hamming Code, Flow Control and Error Control, Stop and wait, ARQ, Sliding window – IEEE, Ethernet.

UNIT III

Network Layer:

Packet Switching and Circuit Switching, IP addressing methods, Subnetting, Super netting, Routing Protocols: IP, ARP, RARP, DHCP, Routing Algorithms: Distance Vector Routing, Link State Routing.

UNIT IV

Transport Layer:

Transport Services, UDP, TCP, Congestion Control, Quality of Services (QOS).

UNIT V

Application Layer:

Domain Name Space (DNS), Electronic Mail, HTTP, WWW.

Course Outcome

Upon completion of this course, the students will be able to:

- CO1: Use different models for study of computer networks
- CO2: Identify the components required to build different types of networks
- CO3: Choose the required functionality at each layer for given application
- CO4: Identify solution for each functionality at each layer
- CO5: Trace the flow of information from one node to another node in the network
- CO6: Build networking solutions using the concepts of world wide web and electronic mail technologies

Text Book

- Data Communications and Networking with TCP/IP Protocol Suite, 6th Edition, Behrouz A. Forouzan (ISBN: 9789355320940)

Reference Book :

1. W. Stallings, "Data and Computer Communication", Tenth Edition, Pearson Education, 2018.
2. Larry L. Peterson, Bruce S. Davie, "Computer Networks: A Systems Approach", Sixth Edition, Morgan Kaufmann Publishers, 2011.
3. Nader. F. Mir, "Computer and Communication Networks", First Edition, Pearson Publisher 2007

Scheme of Evaluation

Full marks for the Computer Networks theory is 100, which is divided into the following components.

- ☐ Internal Assessment (30 Marks)
- ☐ Mid Semester (20 Marks)
- ☐ End Semester (50 Marks)

1-1 DATA

TELECOMMUNICATIONS

- **Telecommunication** means communication at a distance.

Data:

- **Data** refers to facts/information presented in whatever form is agreed upon by the parties creating and using the data.

Data Communication:

- **Data communications** are the exchange of data between two devices via some form of transmission medium such as a wire cable. It depends on four characteristics:

1. Delivery
2. Accuracy
3. Timeliness
4. Jitter

Components of Data Communication

- Sender
- Receiver
- Message
- Communication medium
- Protocols(set of rules used for data communication in a network)

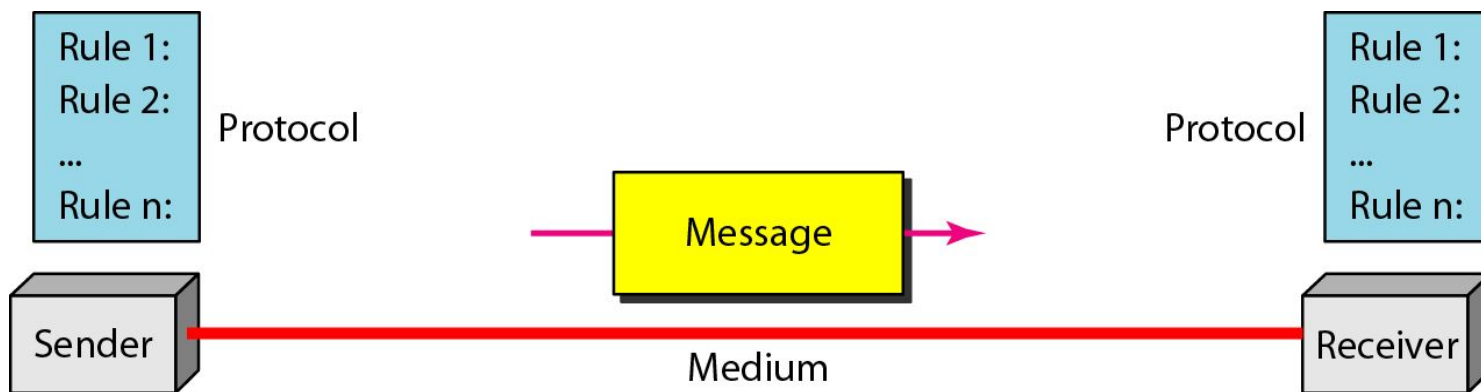


Figure 1.1 *Five components of data communication*

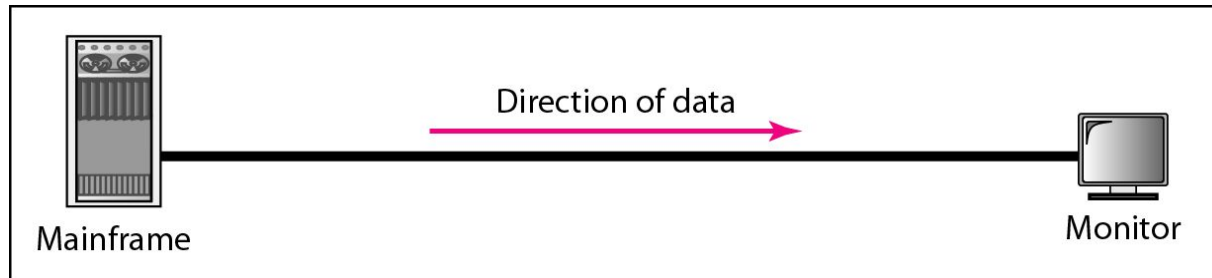
Data Representation

- Text: Bit patterns (sequence of 0 and 1).
ASCII code used
- Numbers: Represented in bit patterns
- Images: Represented in bit patterns
- Audio: Sound or music (Continuous signal)
- Video: Picture of movie (Combination of continuous and discrete entity)

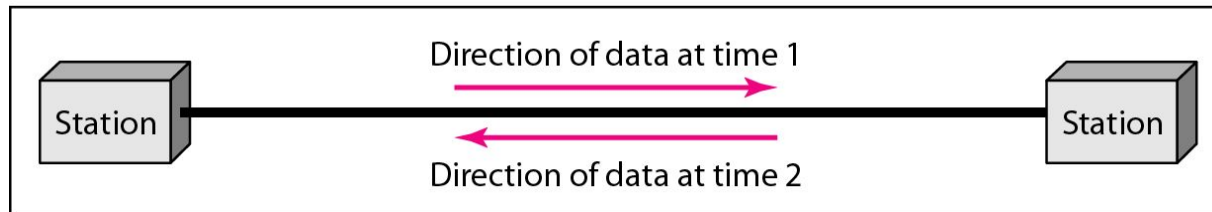
Data flow

(Transfer of data/information)

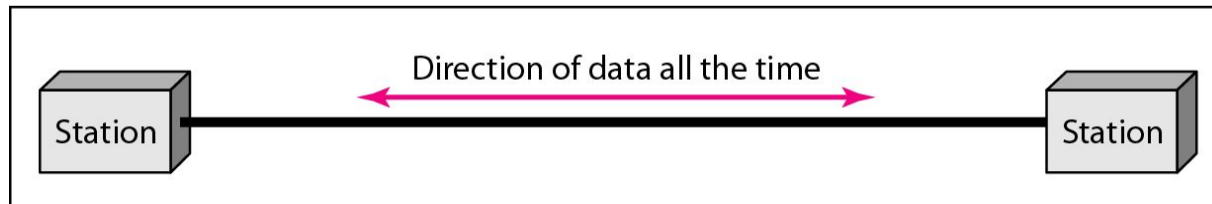
Communication between two devices can be simplex, half-duplex, and duplex



a. Simplex



b. Half-duplex



c. Full-duplex

NETWORK

- ✓ A network is the interconnection of a set of devices capable of communication.
- ✓ A device can be a host such as a large computer, desktop, laptop, workstation, cellular phone, or security system.
- ✓ A device can also be a connecting device such as a router a switch, a modem that changes the form of data, and so on.

□ Each device in the network has a unique address.

Example: 142.250.182.174

www.google.com

Network Criteria

- Performance
 - ✓ Transit time
 - ✓ Response time
 - ✓ Throughput
 - ✓ Delay
- Reliability: Frequency of failure and time to recover from it
- Security :Authentication, Authorization and Integrity

Distributed Processing

- Task divided among multiple computers
Example: Peer to peer system

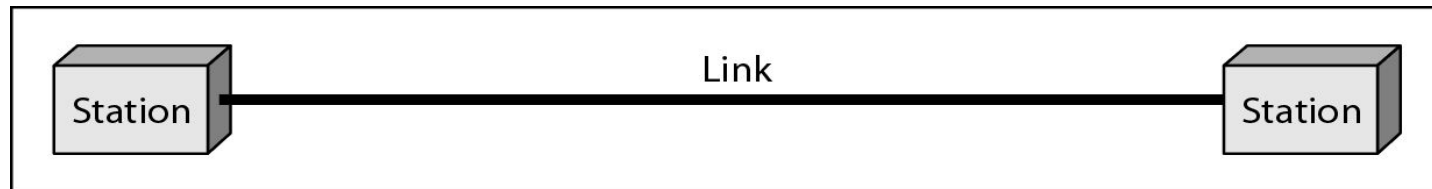
Physical Structure of Network

- **Types of Connection**

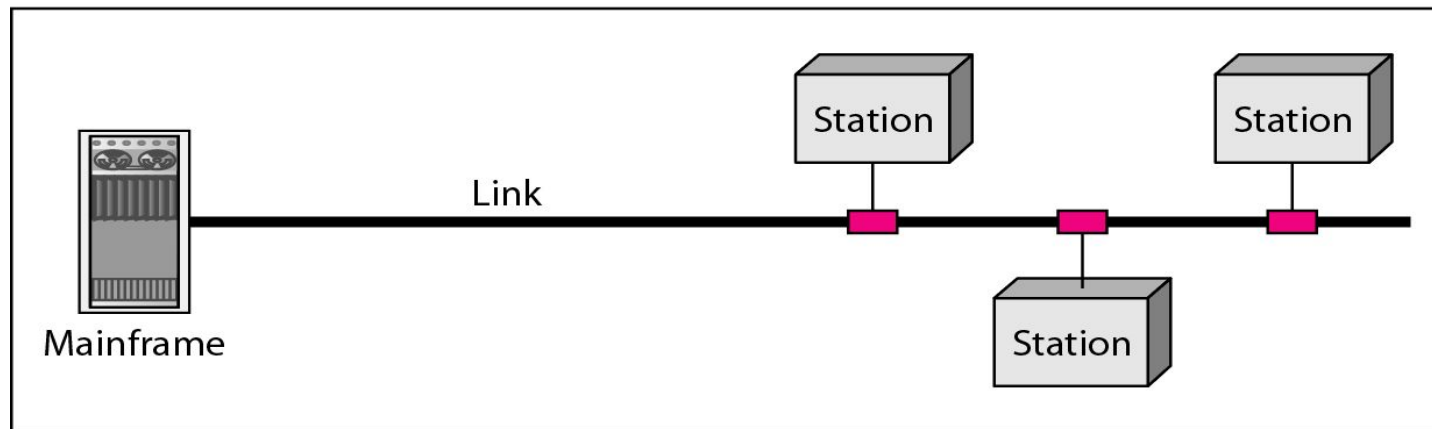
- **Point to Point:** Link shared dedicatedly between two devices.
- **Multipoint:** Link shared among multiple devices.

Figure 1.3 *Types of connections: point-to-point and multipoint*

In a network two or more devices connected through links. A link is a communications pathway that transfers data from one device to another. There are two possible types of connections: point-to-point and multipoint



a. Point-to-point



b. Multipoint

Topology

- Topology defines the arrangement/structure of the network comprising of nodes/devices.
- Defines how all the components are interconnected to each other
- The topology of a network is the geometric representation of the relationship of all the links and linking devices (usually called nodes) to one another

Types

- Physical topology: Defines how nodes are actually interconnected with wires and cables
- Logical topology: How they appear.

Figure 1.4 *Categories of topology*

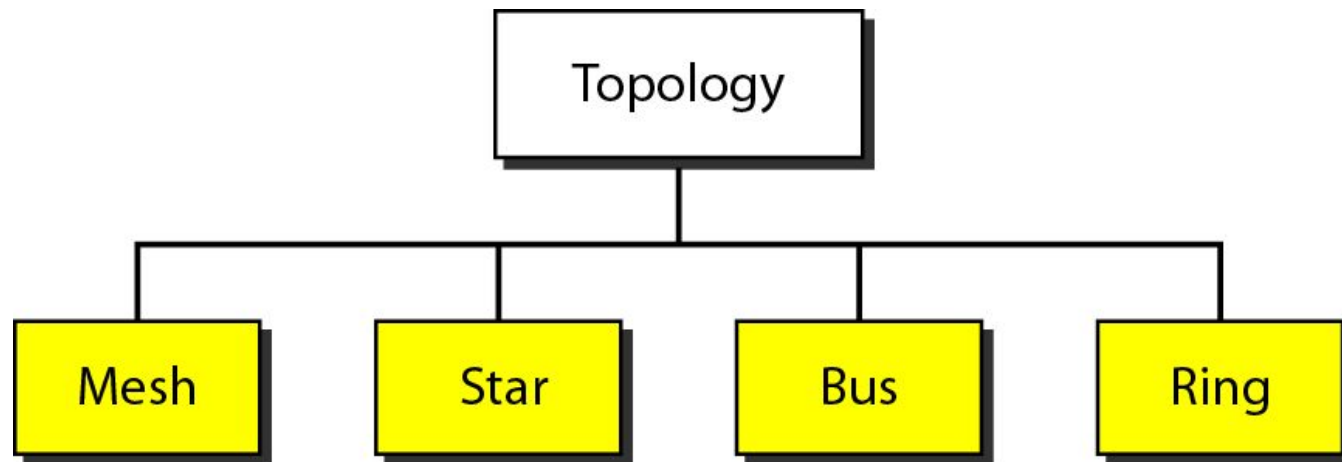
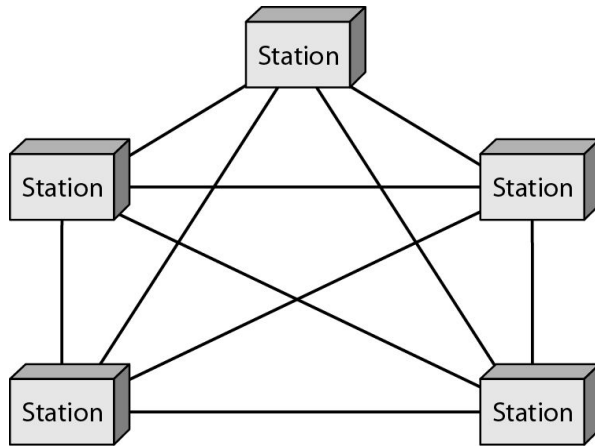


Figure 1.5 *A fully connected mesh topology (five devices)*



- ✓ In a mesh topology, every device is connected to another device via a particular channel.
- ✓ Total number of dedicated links required to connect N devices in a mesh topology is NC_2 i.e. $N(N-1)/2$.

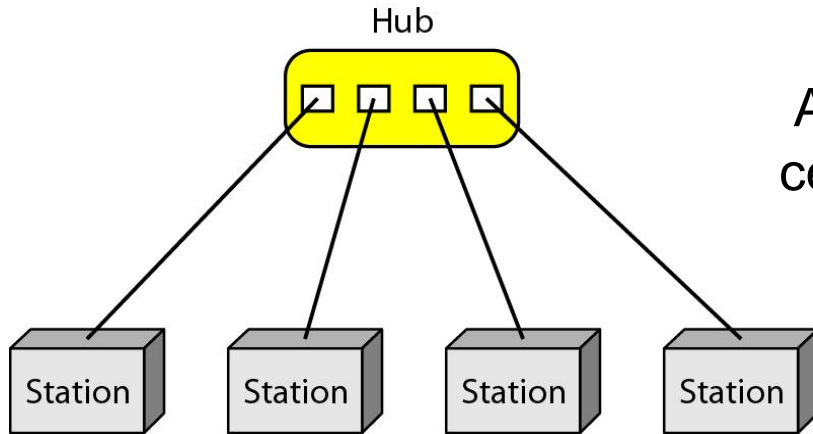
Advantages of this topology

- ✓ It is robust.
- ✓ The **fault is diagnosed easily**. Data is **reliable** because data is transferred among the devices through dedicated channels or links.
- ✓ Provides **security and privacy**.

Disadvantages this topology

- ✓ Installation and configuration are difficult.
- ✓ The **cost of cables is high** as bulk wiring is required, hence suitable for less number of devices.
- ✓ The **cost of maintenance is high**.

Figure 1.6 *A star topology connecting four stations*



All the devices are connected to a central hub

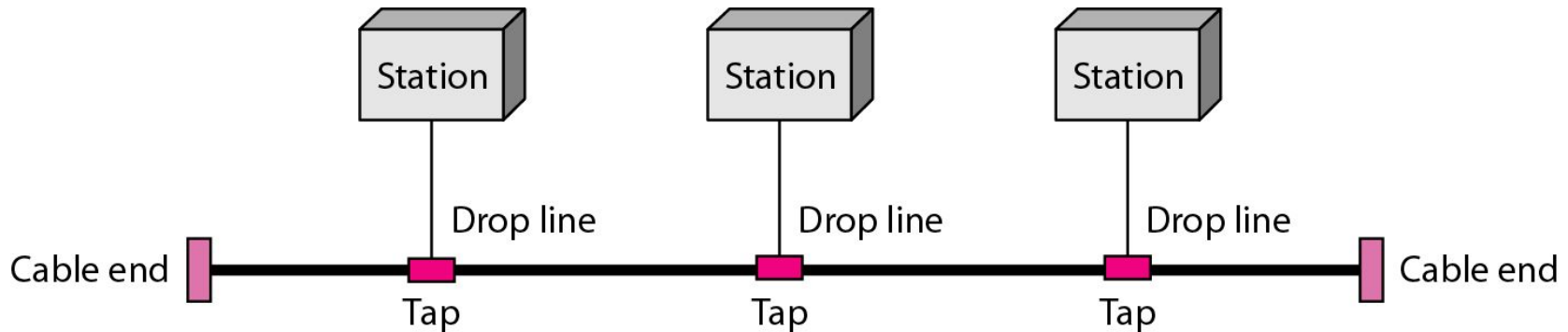
Advantages

- ✓ If N devices are connected to each other in a star topology, then the number of cables required to connect them is N .
- ✓ It is easy to set up.
- ✓ Each device requires only 1 port i.e. to connect to the hub, therefore the total number of ports required is N .

Disadvantages

- ✓ If the hub on which the whole topology relies fails, the whole system will crash down.
- ✓ The cost of installation is high.
- ✓ Performance is based on the hub.

Figure 1.7 *A bus topology connecting three stations*



The nodes/stations are connected to the shared backbone channel via drop lines

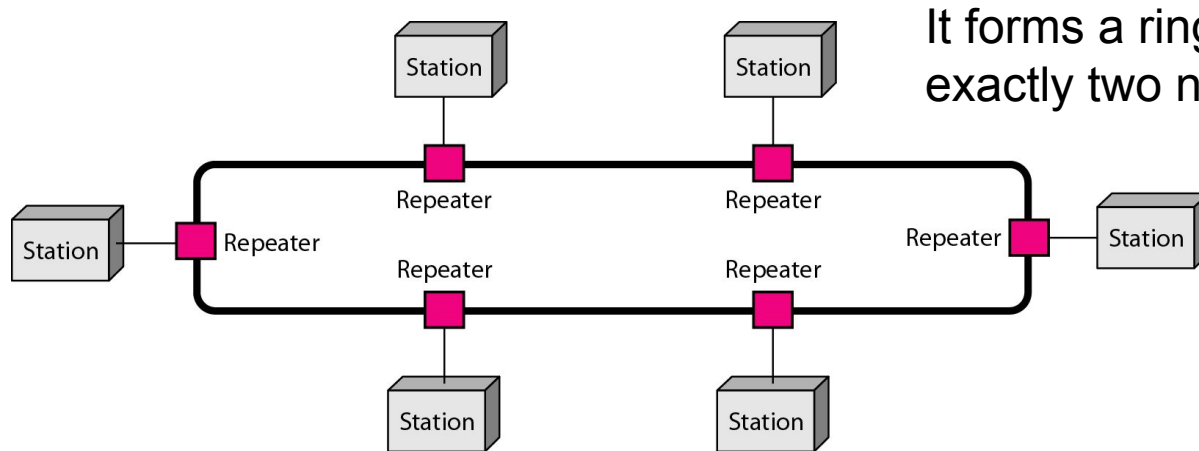
Advantages:

- ✓ If N devices are connected, then the number of cables required to connect them is 1, which is known as backbone cable, and N drop lines are required.
- ✓ The cost is less as compared to other topologies,
- ✓ It is used to build small networks.

Disadvantages:

- ✓ If the common cable fails, then the whole system will crash down.
- ✓ If the network traffic is heavy, it increases collisions in the network.
- ✓ Security is very low.

Figure 1.8 *A ring topology connecting six stations*



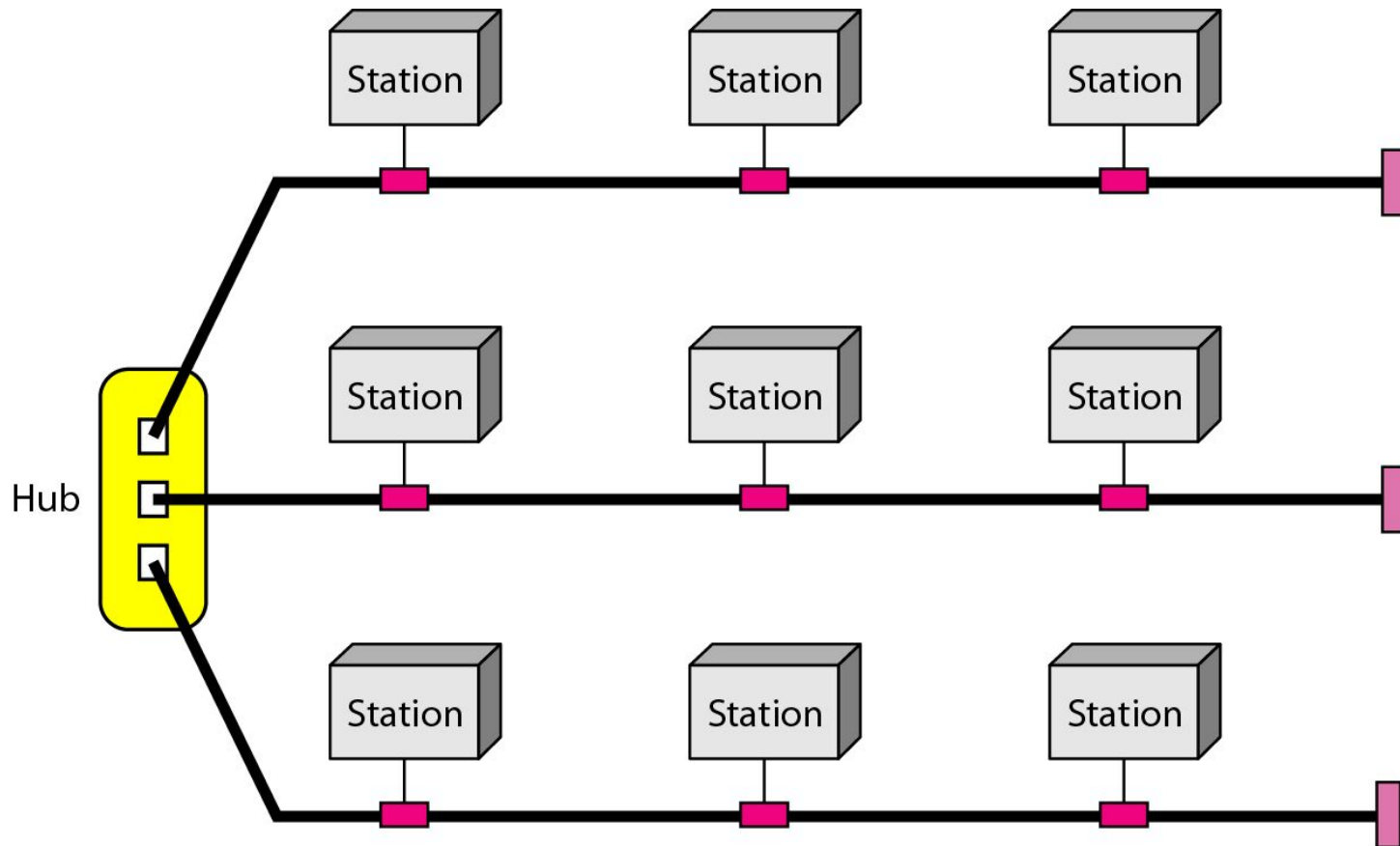
Advantages

- ✓ The possibility of collision is minimum in this type of topology.
- ✓ Cheap to install and expand.

Disadvantages

- ✓ Troubleshooting is difficult in this topology.
- ✓ The addition of stations in between or removal of stations can disturb the whole topology.
- ✓ Less secure.

Figure 1.9 *A hybrid topology: a star backbone with three bus networks*



Network Models

Network model describes the architecture, components, and design used to establish communication between the source and destination systems.

Types of Network Models

- OSI(Open Systems Interconnection): Seven Layers
- Internet Model(TCP/IP): Five Layers

Categories of Networks

- PAN(Personal Area Network)
- LAN(Local Area Network)
- MAN(Metropolitan Network)
- WAN(Wide Area Network)

Categories of Networks

- **PAN(Personal Area Network):**

- Smallest network which is very personal to a user.
- 1-10m range
- This may include Bluetooth enabled devices or infra-red enabled devices.
- PAN may include wireless computer keyboard and mouse, Bluetooth enabled headphones, wireless printers and TV remotes.

- **LAN(Local Area Network):**

- A LAN is a data communication system within a building, plant, or campus, or between nearby buildings.
- 10m-1km range
- LAN uses either Ethernet or Token-ring technology.
- Ethernet is most widely employed LAN technology and uses Star topology, while Token-ring is rarely seen.
- LAN can be wired, wireless, or in both forms at once.

- **MAN(Metropolitan Network):**

- A MAN is a data communication system covering an area the size of a town or city.
- 10-100km
- It can be in the form of Ethernet ,Token-ring, ATM, or Fiber Distributed Data Interface (FDDI).

- **WAN(Wide Area Network):**

- A WAN is a data communication system spanning states, countries, or the whole world.
- Types of WAN: Point to Point WAN and Switched WAN

Types of WAN

- Switched WAN: Uses router and switches to connect two or more networks(LAN,MAN,WAN) and end systems
- Point to Point WAN: Uses leased line from telephone line or cable TV provider that connects home computer or small LAN to ISP

Figure 1.10 *An isolated LAN connecting 12 computers to a hub in a closet*

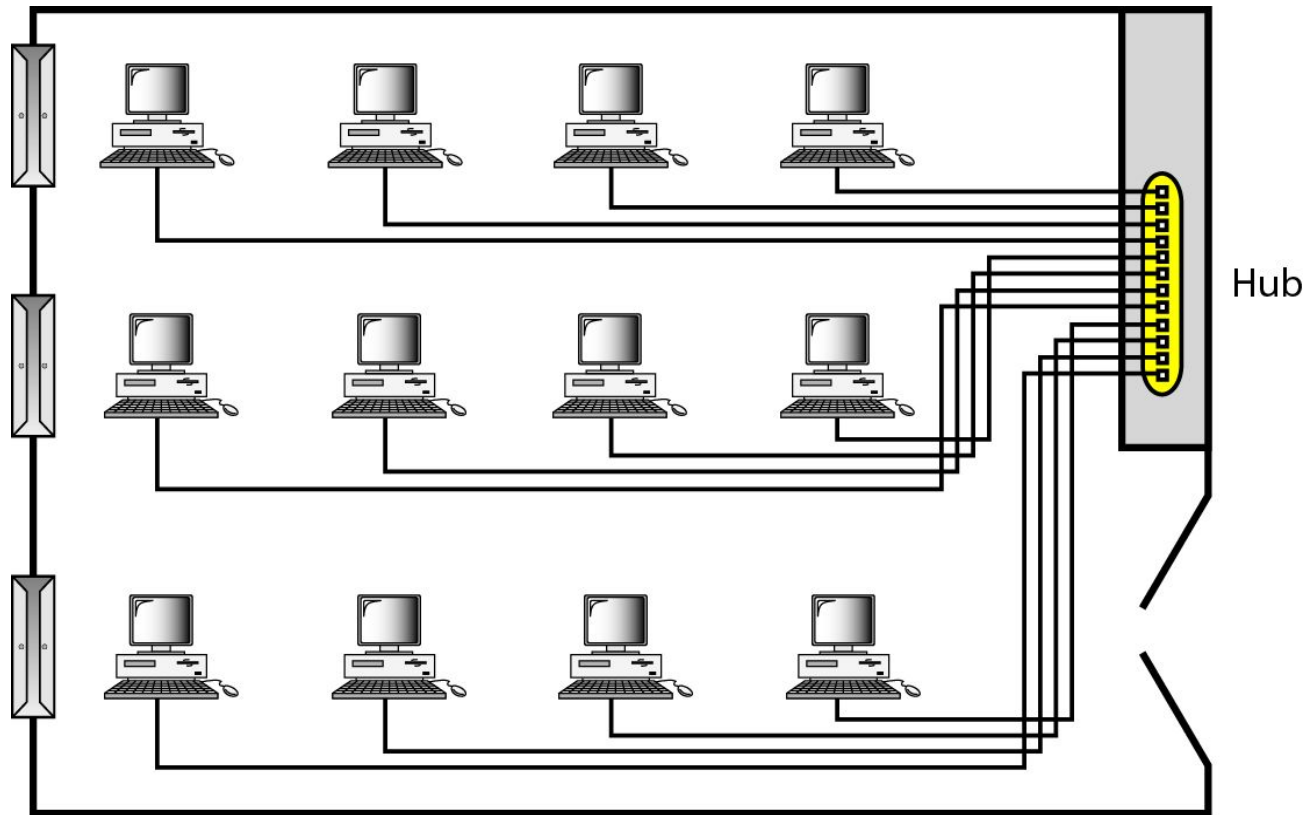
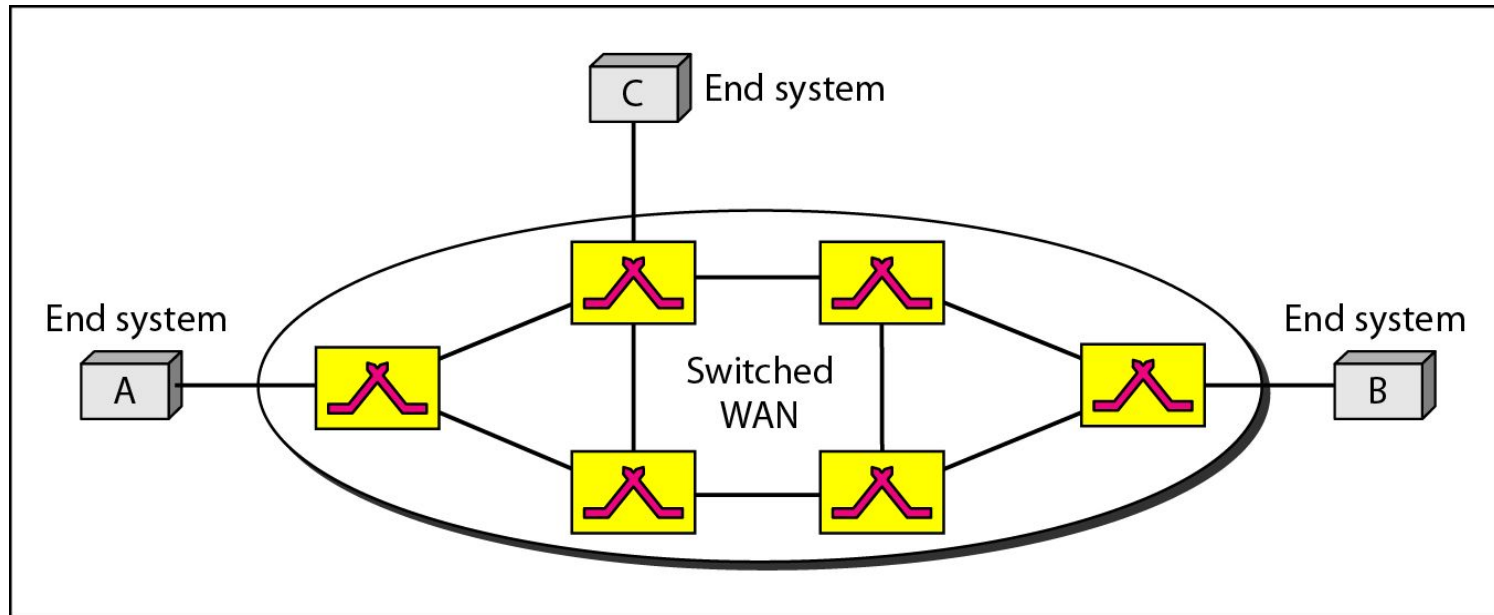
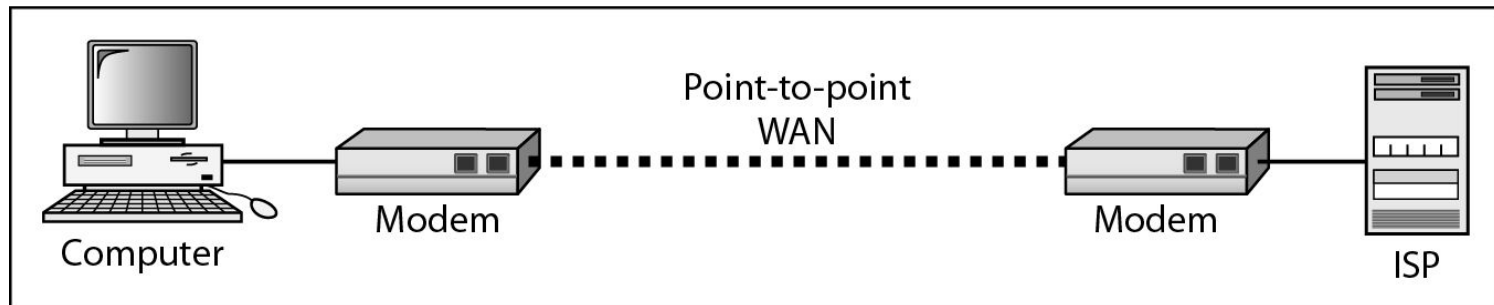


Figure 1.11 *WANs: a switched WAN and a point-to-point WAN*

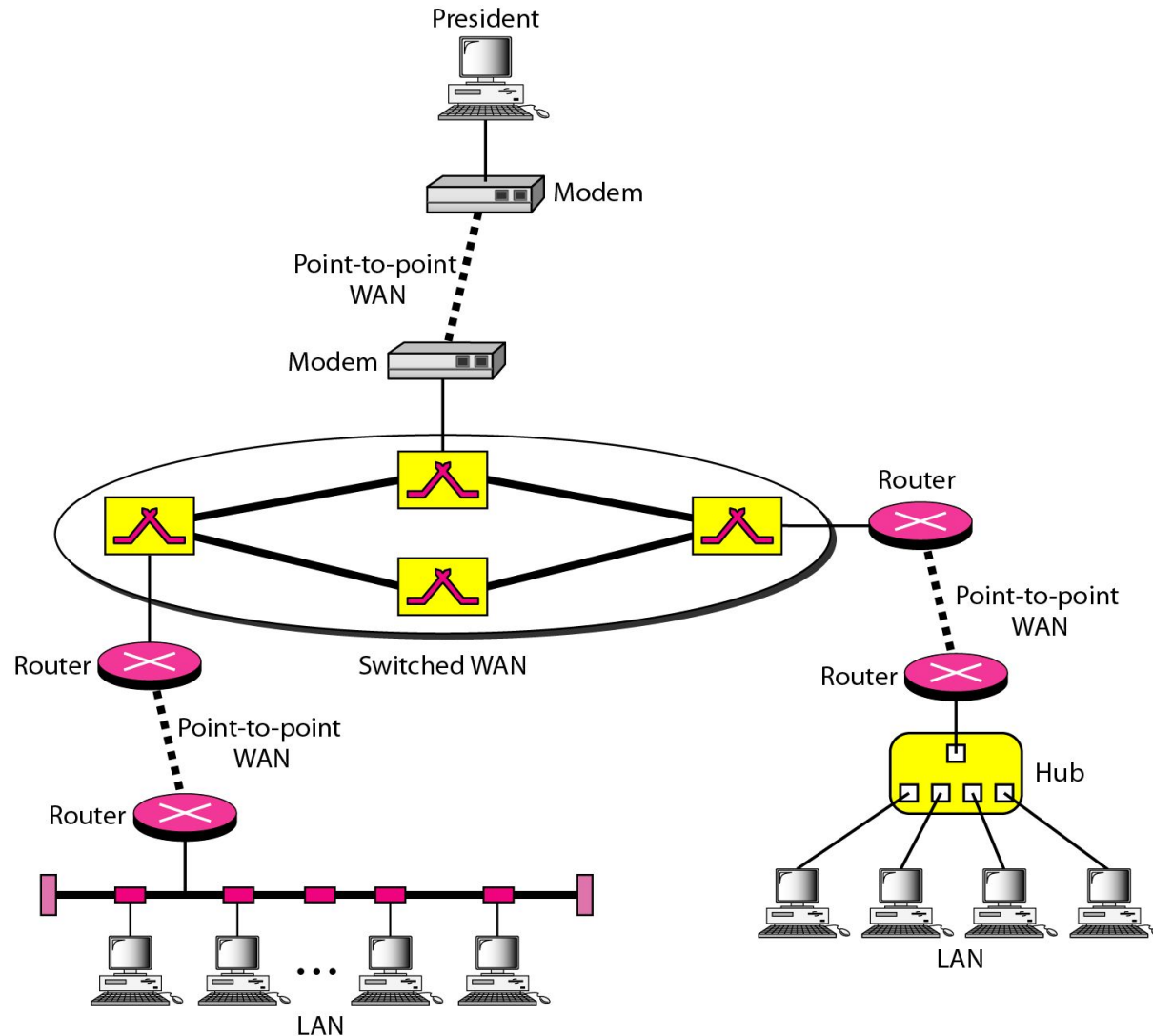


a. Switched WAN



b. Point-to-point WAN

Figure 1.12 *A heterogeneous network made of four WANs and two LANs*



1-3 THE INTERNET

- An internet is a network of networks.
The Internet is a collection of many separate networks.
- TCP/IP is the protocol suite for the Internet.
- The Internet has revolutionized many aspects of our daily lives.
- It has affected the way we do business as well as the way we spend our leisure time.
- The Internet is a communication system that has brought a wealth of information to our fingertips and organized it for our use.

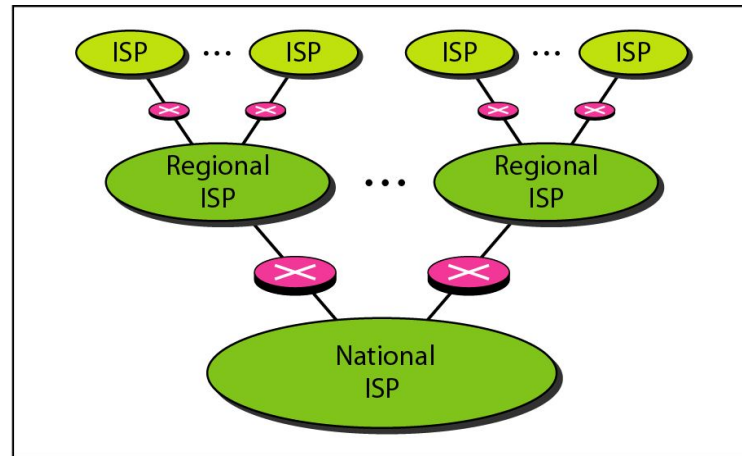
Internet service providers (ISPs)

Organization that provides using the Internet and Internet services .

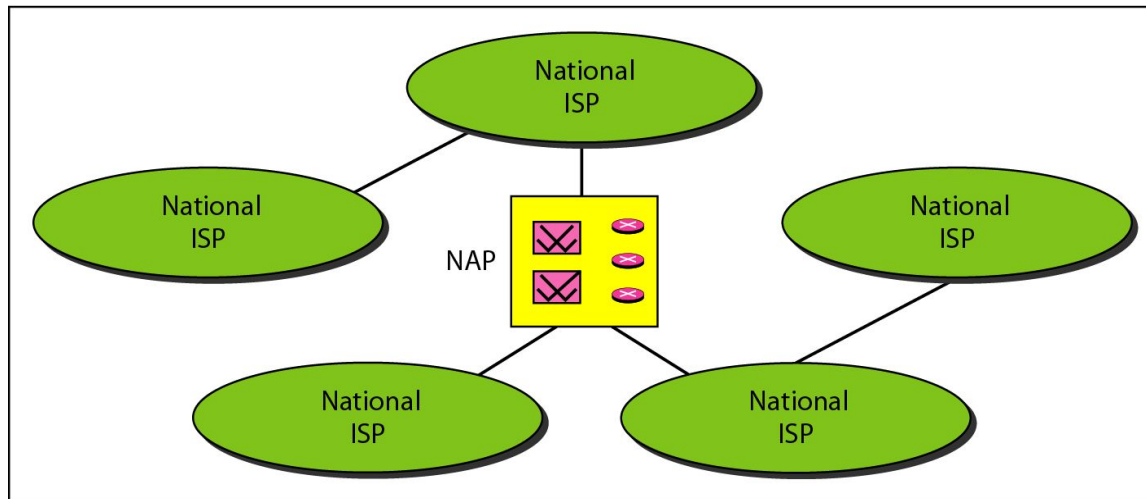
Types

- Local (ISPs)
- Regional (ISPs)
- National (ISPs)
- International (ISPs)

Figure 1.13 *Hierarchical organization of the Internet*



a. Structure of a national ISP



b. Interconnection of national ISPs

Protocol

- A protocol is a set of rules that governs data communication; the key elements of a protocol are syntax, semantics, and timing.

Examples

http,tcp,ftp

Standards

- Standards are necessary to ensure that products from different manufacturers can work together as expected.
- Defacto: By Fact
- Dejure: By Law

Standards Organizations

- The ISO, ITU-T, ANSI, IEEE, and EIA are some of the organizations involved in standards creation.
- Regulatory Agencies: Govt agencies such as FCC(Federal Communications Commision) in US

Internet Standards

- Internet Draft(Working Documents)
- RFC(Request For Comment): A number assigned to the draft and made available for stake holders.