



Chapter 1

Introduction

1-1 DATA COMMUNICATIONS

*The term **telecommunication** means communication at a distance. The word **data** refers to information presented in whatever form is agreed upon by the parties creating and using the data. **Data communications** are the exchange of data between two devices via some form of transmission medium such as a wire cable.*

The effectiveness of data communication system depends on four fundamental characteristics

Delivery, accuracy, timeliness, jitter

Topics discussed in this section:

Components

Data Representation

Data Flow

Figure 1.1 *Five components of data communication*

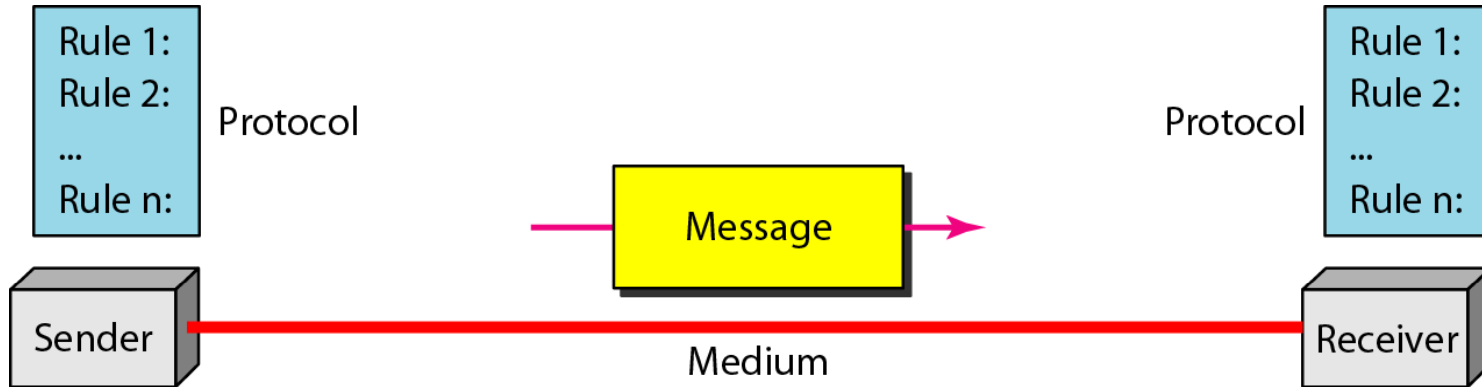
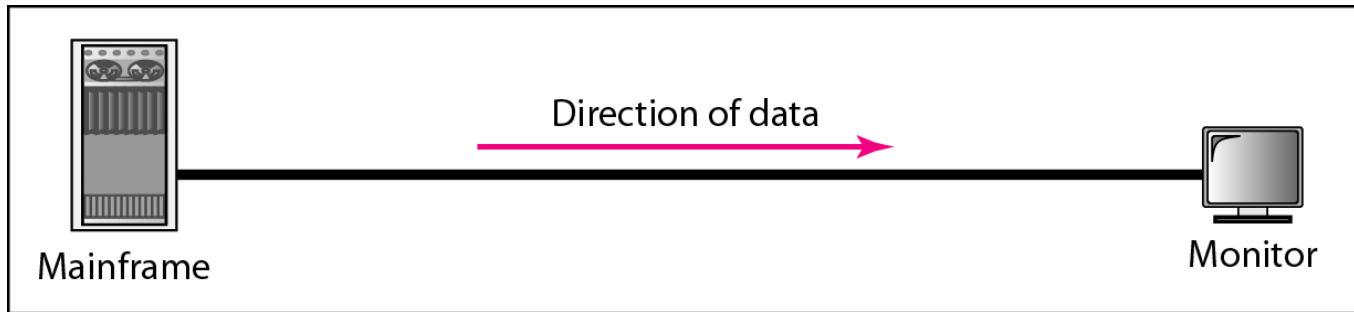
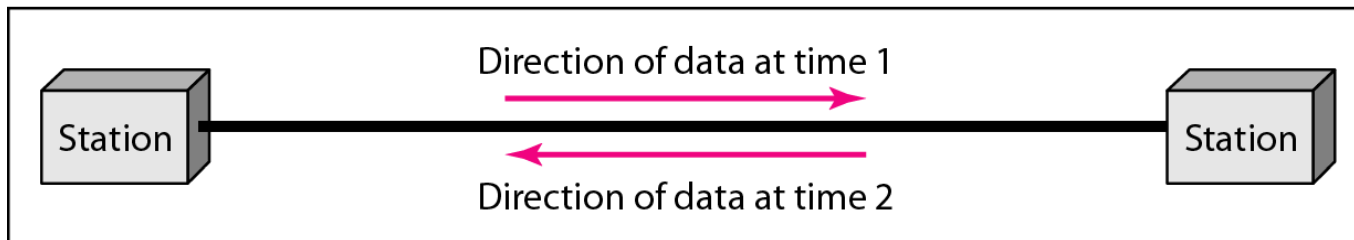


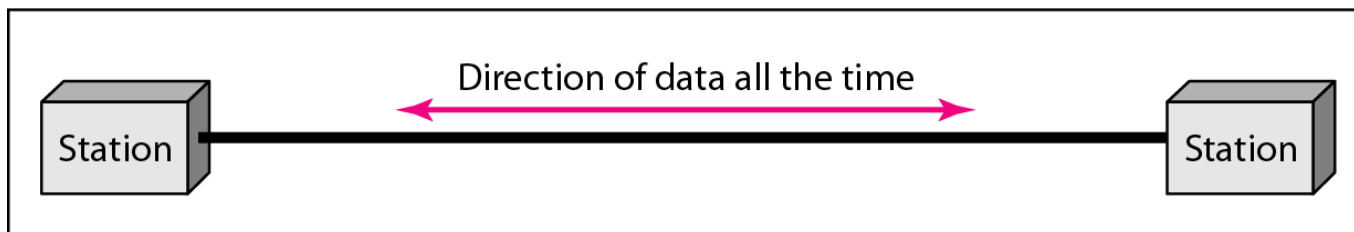
Figure 1.2 *Data flow (simplex, half-duplex, and full-duplex)*



a. Simplex



b. Half-duplex



c. Full-duplex

1-2 NETWORKS

*A **network** is a set of devices (often referred to as **nodes**) connected by communication **links**. A node can be a computer, printer, or any other device capable of sending and/or receiving data generated by other nodes on the network.*

Topics discussed in this section:

Distributed Processing

Network Criteria

Physical Structures

Network Models

Categories of Networks

Interconnection of Networks: Internetwork

■ Network criteria

Performance

Transit time – amount of time required for a message to travel from one device to another

Response time – the time elapsed between an inquiry and a response

Throughput and delay

The increase in throughput (sending more data) may result in increase of delay because of traffic congestion

Reliability

measured using frequency of failure

Security

protecting data from unauthorized access and damage and recovery

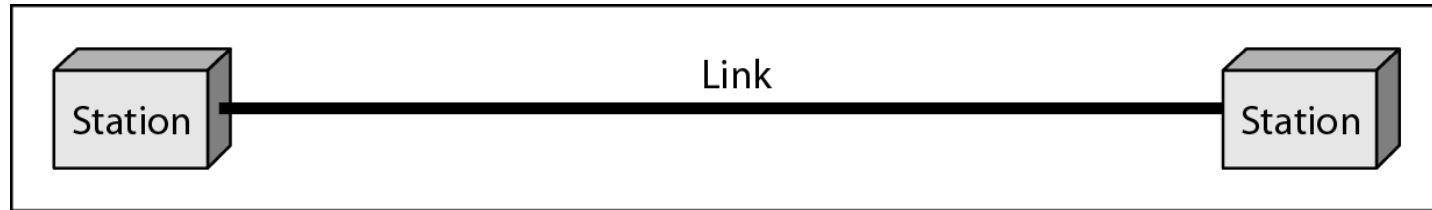
Physical structures

- A network is two or more devices connected through links
- A link is a communication path way that transfers data from one device to another

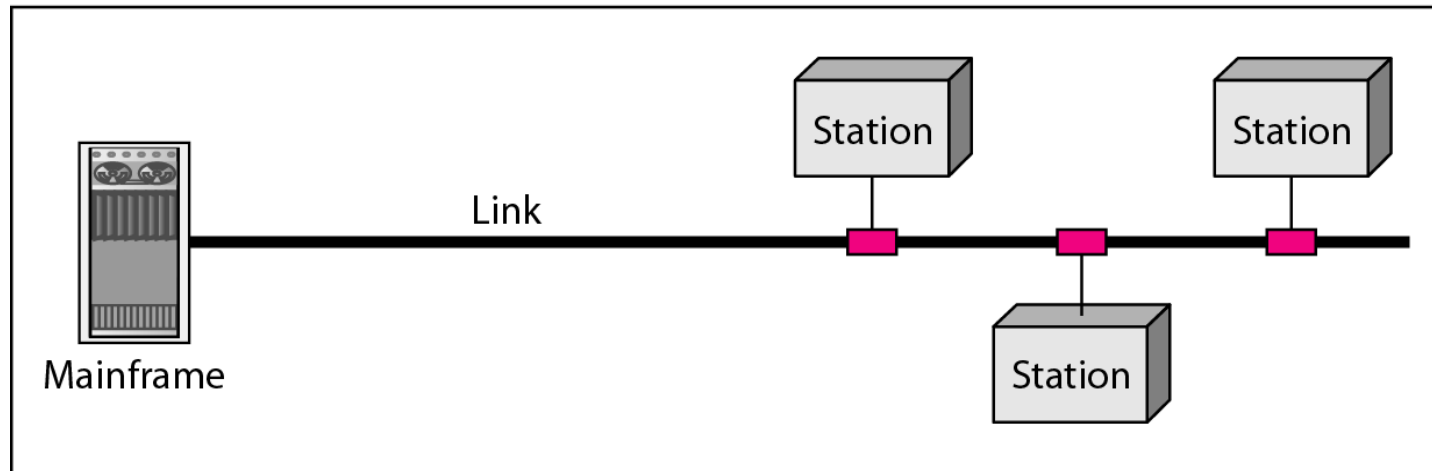
Types of connection

- **Point-to-point** – dedicated link between two devices. Entire capacity of the link is reserved for transmission between the devices. Eg. Infrared remote control in television
- **Multi point** - more than two devices share a single link. Capacity of the channel is shared either spatially(simultaneously) or temporally (time shared connection)

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



a. Point-to-point



b. Multipoint

Physical topology

- it refers to the way in which a network is laid out physically.
- Two or more links form a topology
- topology of a network is the geometric representation of the relationship of all the links and linking devices(nodes) to one another.

Four basic topologies

mesh, star, bus, and ring

Mesh

- every device has a dedicated point-to-point link to every other device. Link carries traffic only between the two devices it connects.
- $n(n-1)$ physical links
- in duplex mode $n(n-1)/2$ links

Advantages of mesh

- Eliminates traffic problem using dedicated links
- Robust
- Privacy or security
- Easy fault identification and fault isolation

Disadvantages of mesh

- Amount of cabling and the number of I/O PORTS required
- Eg. Backbone connecting the main computers of a hybrid network as in the connection of telephone regional offices

Figure 1.4 *Categories of topology*

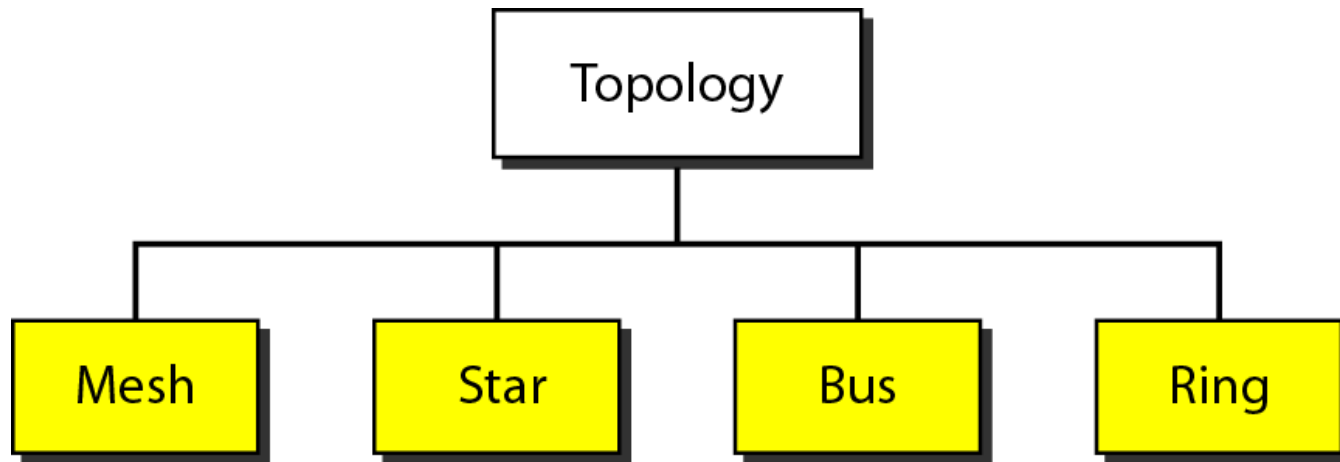


Figure 1.5 *A fully connected mesh topology (five devices)*

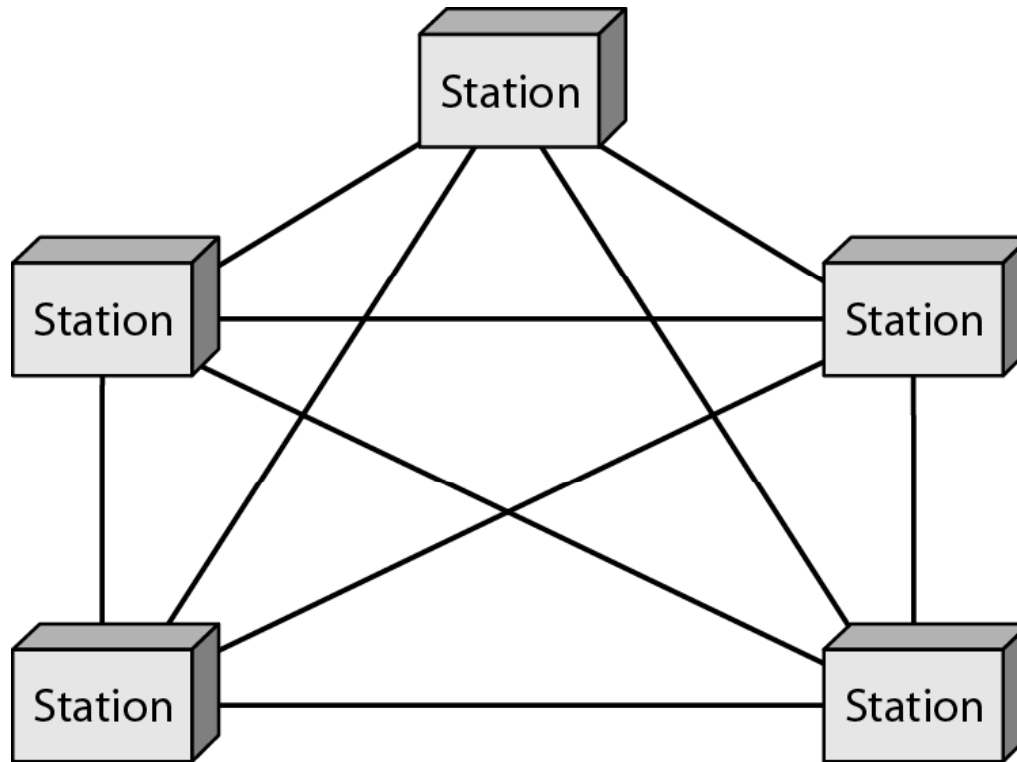
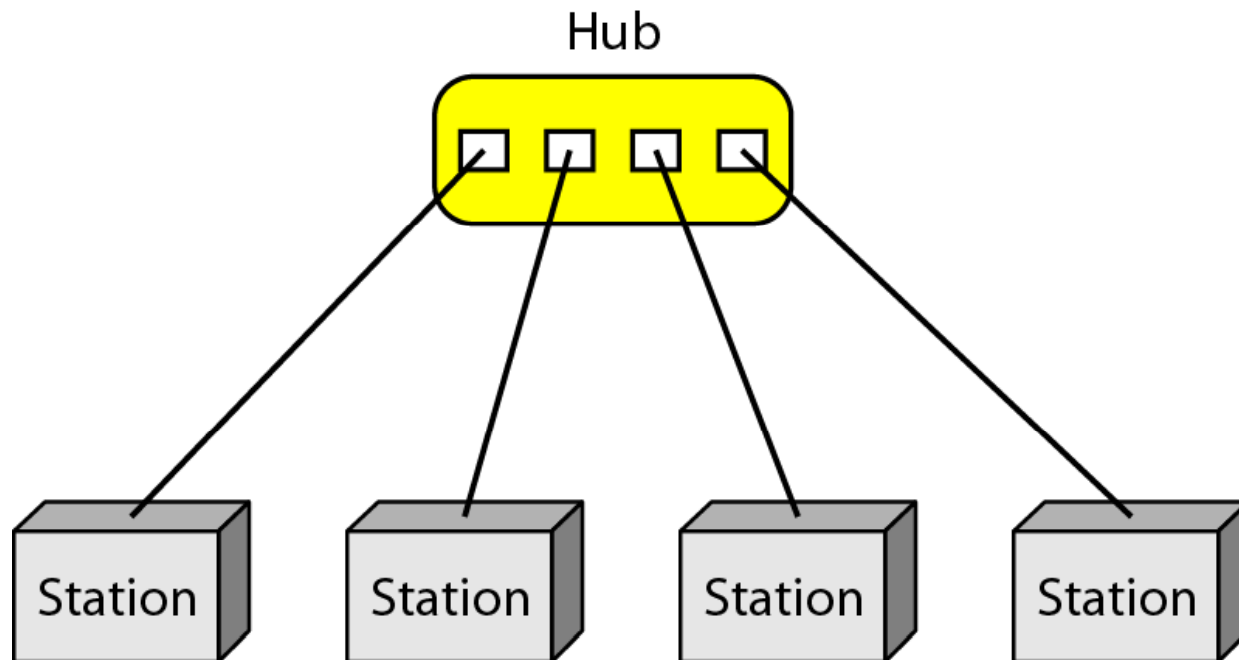


Figure 1.6 *A star topology connecting four stations*



Star topology

- Each device has a dedicated point-to-point link only to a central controller called a **hub**
- No direct traffic between devices
- The controller acts as an exchange

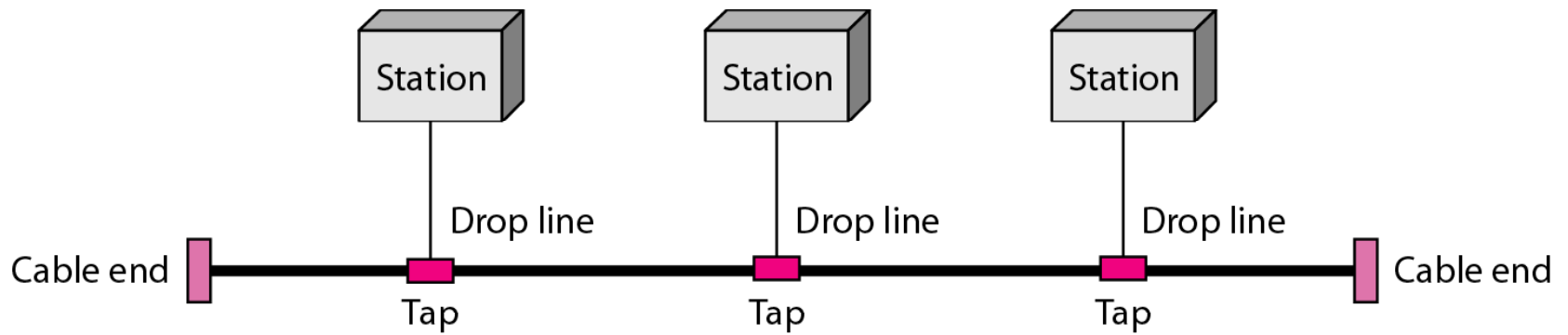
Advantages of star

- Less expensive
- Each device needs only one link and one I/O port to connect to any number of devices. So easy to install and reconfigure
- Less cabling
- Robustness
- Fault identification fault isolation

Disadvantages of star

- Dependency of whole topology on one single point the hub
- More cabling compared to ring or bus

Figure 1.7 *A bus topology connecting three stations*



Bus topology

- it is multipoint, one cable acts as backbone to link all the devices in a network
- Nodes are connected to the bus cable by drop lines and taps(connectors)

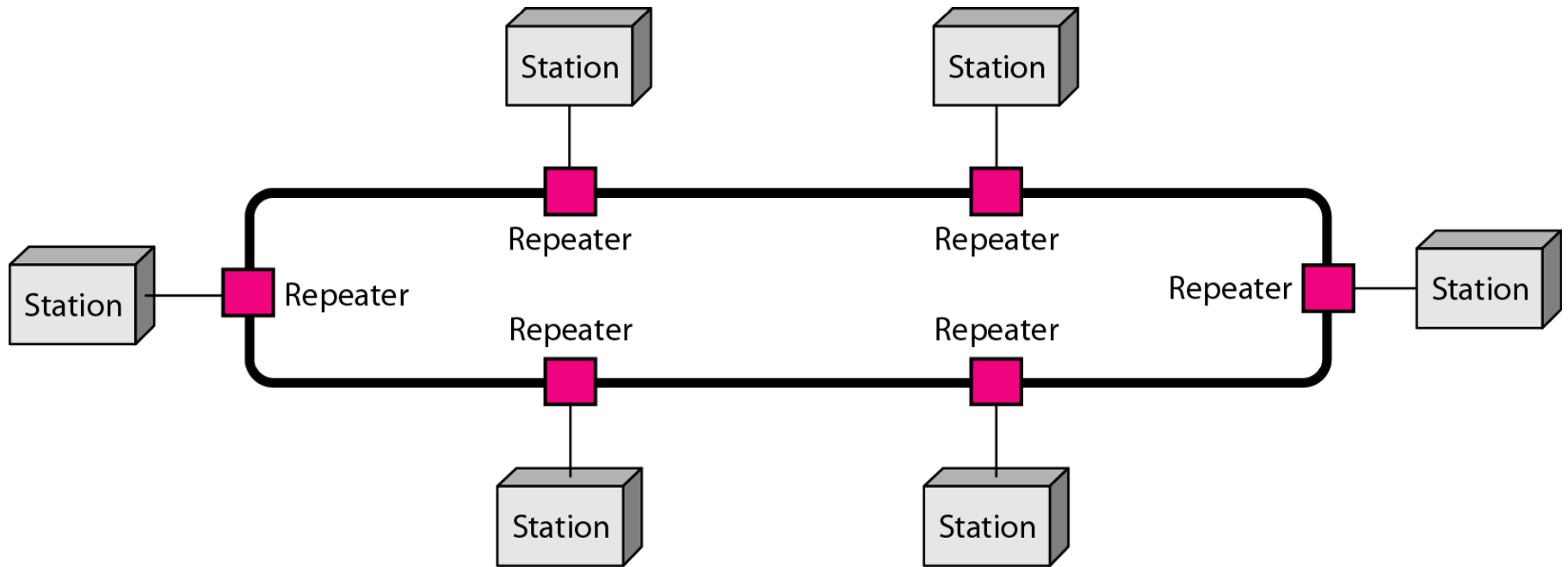
Advantages

- Ease of installation
- Less cabling than mesh and star topologies

Disadvantages

- Difficult reconnection and fault isolation
- Fault or break in the bus cable stops all transmission

Figure 1.8 *A ring topology connecting six stations*



Ring topology

- Each device has a dedicated point to point connection with only two devices on either side of it.
- A signal is passed in one direction from device to device until it reaches its destination.
- Each device incorporates a repeater

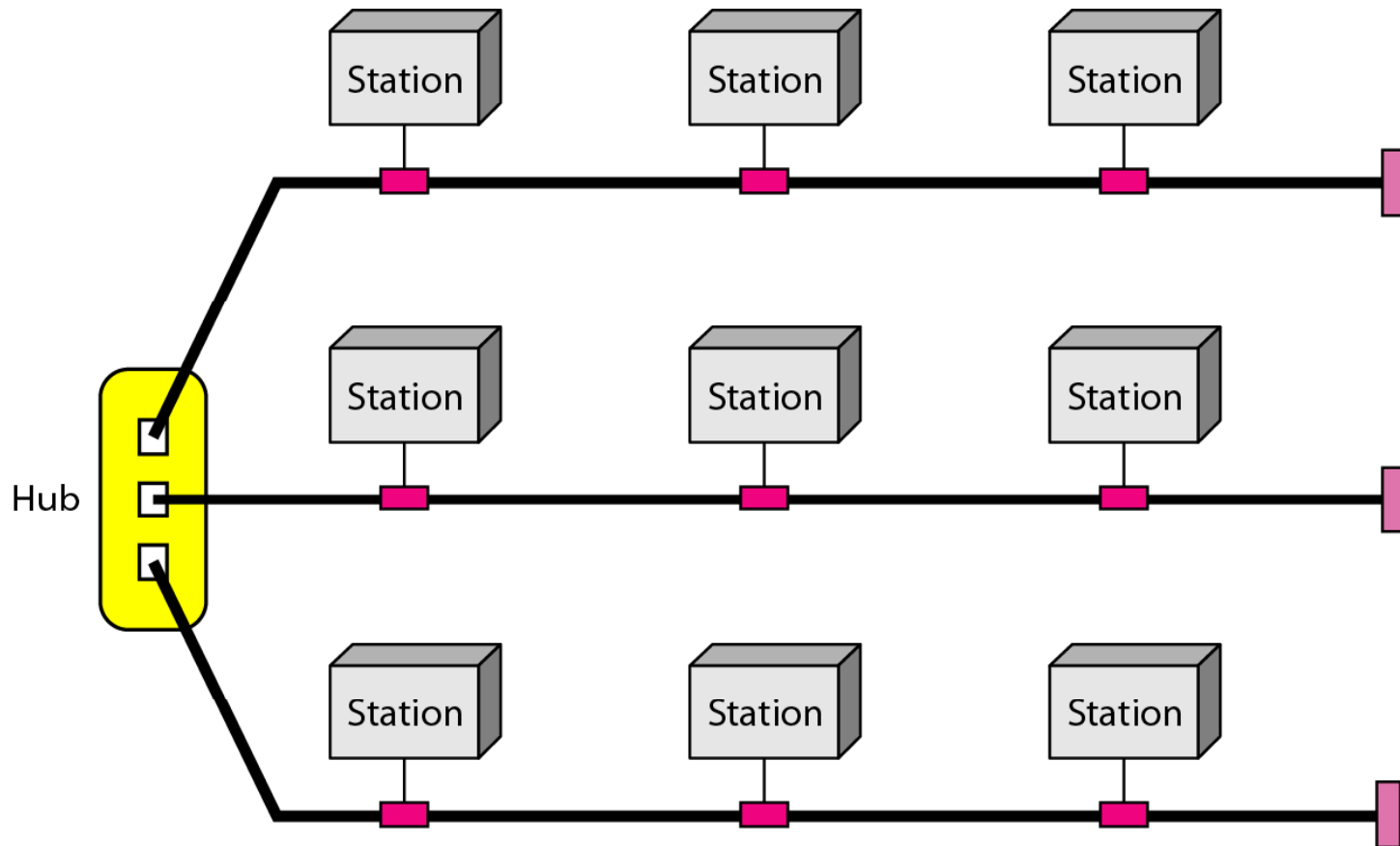
Advantages

- Easy to install and reconfigure.
- Fault isolation is simplified

Disadvantages

- Unidirectional traffic- a break in the ring can disable entire network

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



Network models

- Standards are needed so that the heterogeneous networks can communicate with one another
- Two standards are OSI (Open Systems Interconnection)model (7 layered network) and Internet model (5 layered network).

Two categories of networks according to size

- 1) LAN (Local Area Network)
- 2) WAN (Wide Area Network)

LAN

- Privately owned and links the devices in a single office, building, or campus
- LAN size is limited to a few kilometers
- Sharing of resources(like h/w, s/w or data) by personal computers
- One server computer with large capacity disk drive and others act as clients.
- Size of the LAN is determined by licensing restrictions on the number of users per copy of s/w stored in the server.

- The most common LAN topologies are star, ring, bus.
- Speed are 100 mbps or 1000 mbps.

Wide Area Network(WAN)

- Provides long distance transmission data, image, audio and video over large geographic areas (country, continent or the whole world)
- WAN can be backbones that connect the Internet (**switched WAN**) or as simple as a dial up connection that connects the home computer to Internet (**Point-to-point WAN**)
- Switched WAN connects the end systems, which usually comprises a router that connect to other LAN or WAN. E.g. X.25 and ATM are switched WANs.
- Point-to-point WAN is a line leased from a telephone or cable TV provider that connects a computer or a small LAN to an Internet Service Provider

MAN (metropolitan area network)

- Size between a LAN and a WAN (inside a town or city)
- e.g high speed DSL line , cable TV network

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

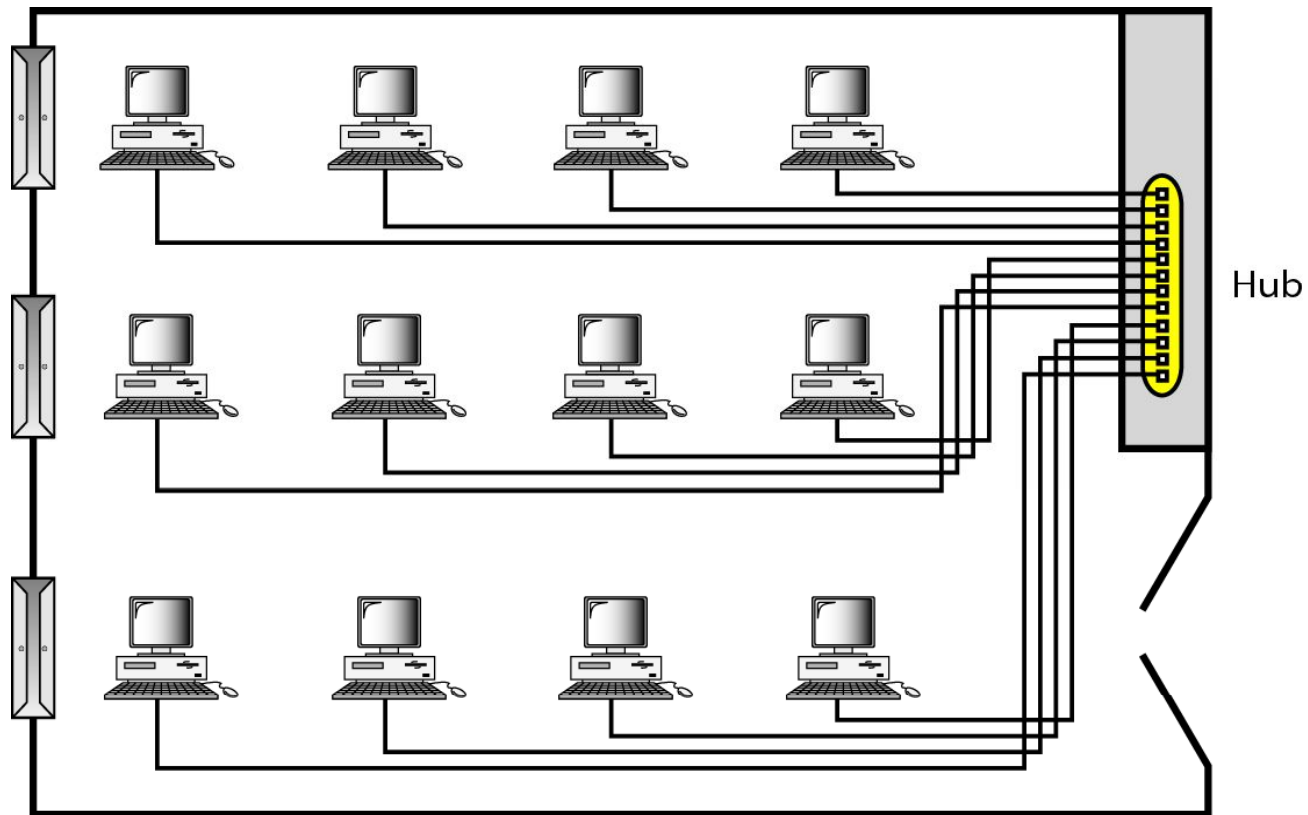
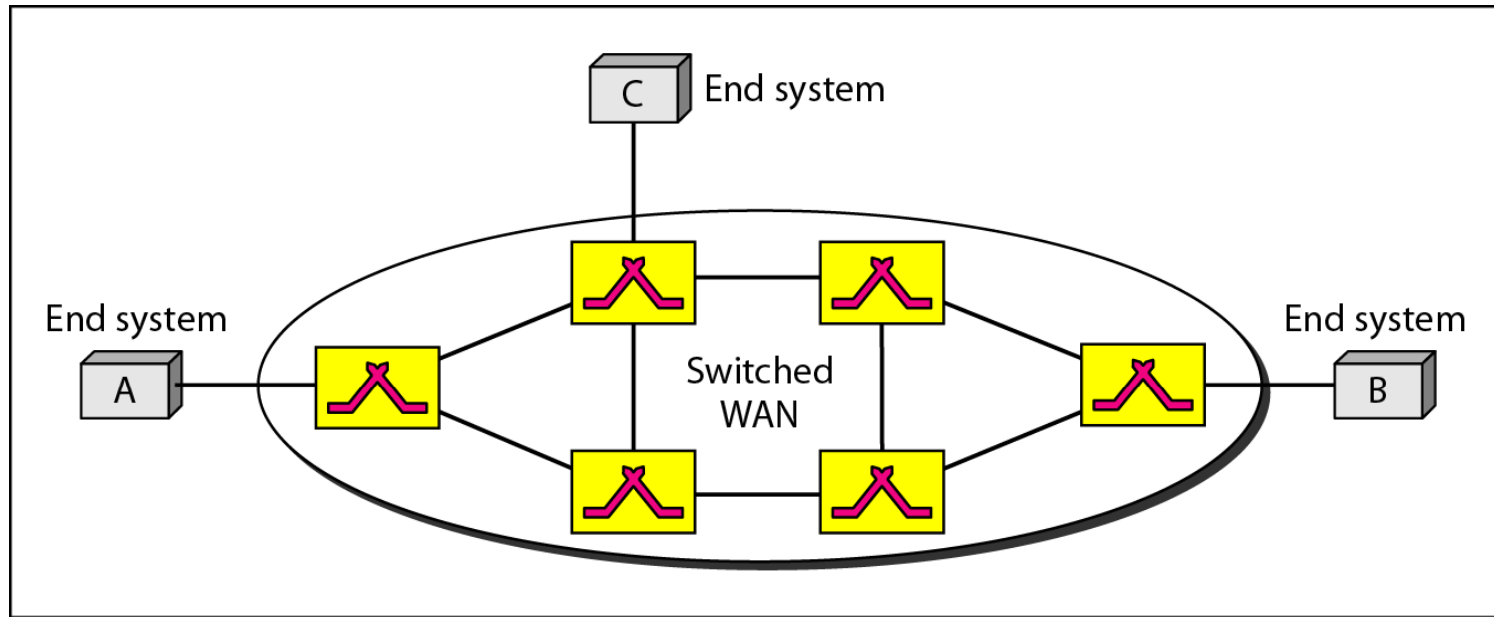
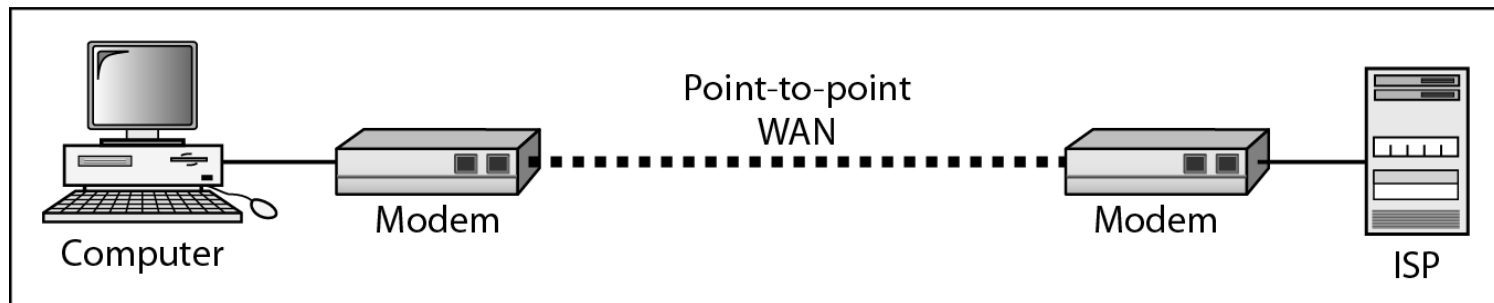


Figure 1.11 *WANs: a switched WAN and a point-to-point WAN*



a. Switched WAN

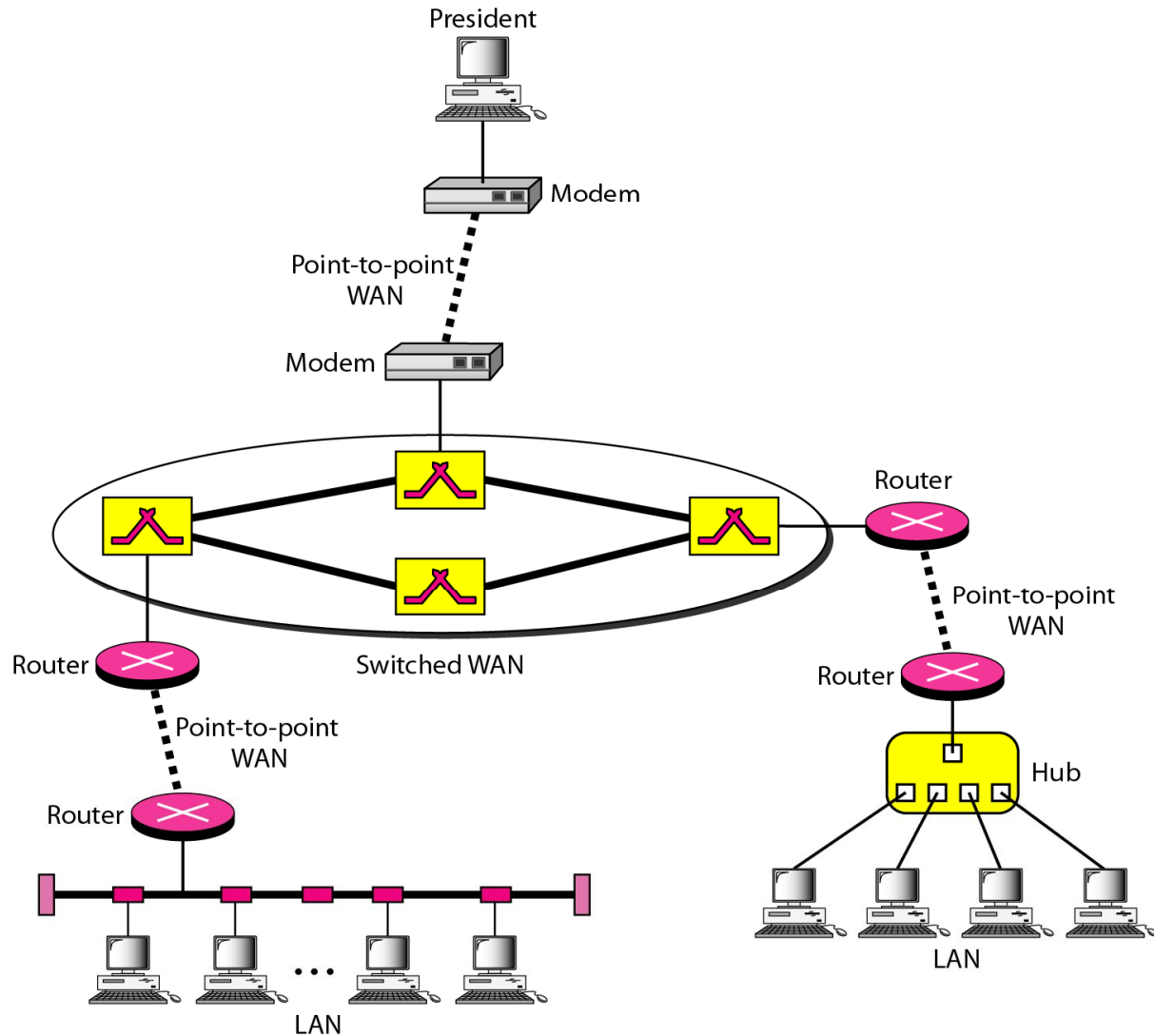


b. Point-to-point WAN

internetwork or internet

- When two or more networks are connected, they become internetwork or internet.
- Eg. An organization that has two offices, one on the east coast (star topology LAN) and the other on the west coast (bus topology LAN). President of the company lives in the middle and needs to have control over the company.
- A switched WAN operated by service provider such as a telecom company is used as a backbone to connect these three entities.
- Three point-to-point WANs (high speed DSL line offered by a telephone company) are used to connect the LANs to the switched WAN.

Figure 1.12 *A heterogeneous network made of four WANs and two LANs
(Internetwork or internet)*



1-3 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.*

Topics discussed in this section:

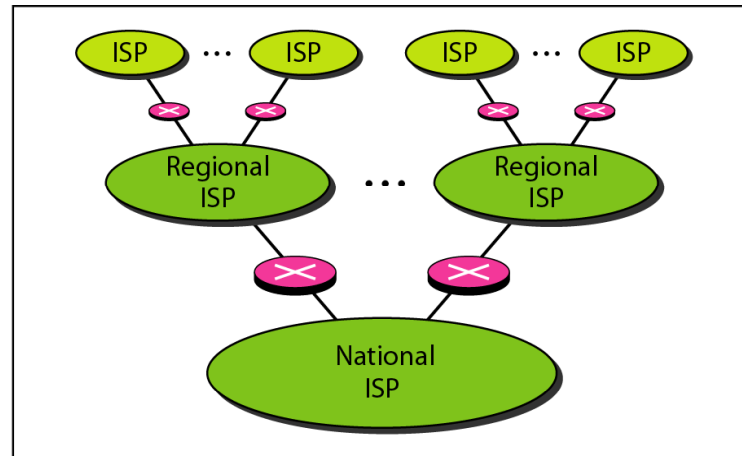
A Brief History

The Internet Today (ISPs)

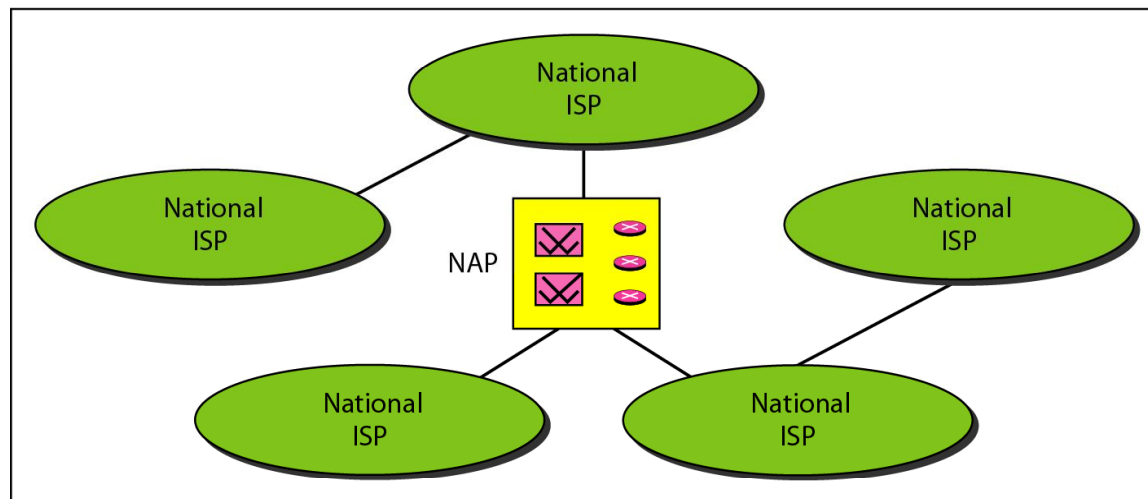
■ The Internet Today (ISPs)

- International internet service provider that connect nations together
- national internet service provider are backbone networks
- Backbone networks are connected by switching stations called **network access points (NAPs)**
- Some national ISP networks are connected to one another by private switching stations called peering points
- Regional ISP are smaller ISPs connected to national ISPs
- Local ISPs provide direct service to the end users E.g company or university that provide Internet services

Figure 1.13 *Hierarchical organization of the Internet*



a. Structure of a national ISP



b. Interconnection of national ISPs

1-4 PROTOCOLS AND STANDARDS

*In this section, we define two widely used terms: **protocols** and **standards**. First, we define protocol, which is synonymous with rule. Then we discuss standards, which are agreed-upon rules.*

Topics discussed in this section:

Protocols

Standards

Standards Organizations

Internet Standards

Protocol

- Protocol is a set of rules that govern data communications
- Protocol defines what is communicated, how it is communicated and when it is communicated

Key elements of a protocol

Syntax

- It refers to the format of data
- A simple protocol might expect
 - the first 8 bits to be the address of the sender,
 - the second 8 bits to be the address of the receiver and
 - the rest of the bits to be the message itself

Semantics

- It refers to meaning of each section of bits. How is particular pattern to be interpreted and what action to be taken
- For eg. Does an address identify the route to be taken or the final destination of the message

Timing

When data should be sent and how fast they can be sent

Standards

Standards are essential in creating and maintaining an open and competitive market for equipment manufacturers and in guaranteeing national and international interoperability of data and telecommunications technology and processes.

Two categories of data communications standards

- 1) Defecto – By convention
- 2) Dejure – By law

Standards organizations

Standards are developed through the cooperation of the following.

Standards creation committee

- 1) International organization for standardization (ISO)
- 2) ANSI
- 3) IEEE
- 4) Electronics Industries Association (EIA)

Forums

Forums are made up of representatives from interested corporations.

Regulatory agencies

*Communication technology is subject to regulation by Govt agencies such as **Federal Communications Commission (FCC)***