

DATA COMMUNICATION CONCEPTS

CHAPTER 1

INTRODUCTION TO DATA COMMUNICATIONS

1.0 OBJECTIVES

- At the end of this chapter, you should be able to:
 1. Define data communications and list down its components.
 2. Explain the model of data communications systems.
 3. Network criteria: Performance, reliability, security.
 4. Line configurations and transmission mode.
 5. Explain the various network topologies.
 6. Explain the various network types: LAN, MAN, WAN

1.1 PURPOSE OF DATA COMMUNICATION

- **Data:** refers to facts, concepts and instructions presented in whatever form is agreed upon by the parties creating and using the data.
- In the context of computer information systems, data are represented by binary information units (or bits) in form of 0s and 1s.
- **Data Communication :** the exchange of data (0 and 1) between two devices via some form of transmission medium (wire cable).
- **Data format:**
 - Text, voice, pictures/images, graphics, video.

- The effectiveness of a data communication system depends on **FOUR** fundamental characteristics:

1. **Delivery:**

- The system must deliver data to the correct destination.
- Data must be received by the intended device or user and only by that device or user.

2. **Accuracy:**

- The system must deliver data accurately.
- Data that have been altered in transmission and left uncorrected are unusable.

3. **Timeliness:**

- The system must deliver data in a timely manner.
- Data delivered late are useless.

4. Jitter :

Jitter refers to the variation in the packet arrival time. It is the uneven delay in the delivery of audio or video packets. For example, let us assume that video packets are sent every 30-ms. If some of the packets arrive with 30-ms delay and others with 40-ms delay, an uneven quality in the video is the result.

1.2 COMPONENTS OF DATA COMMUNICATION

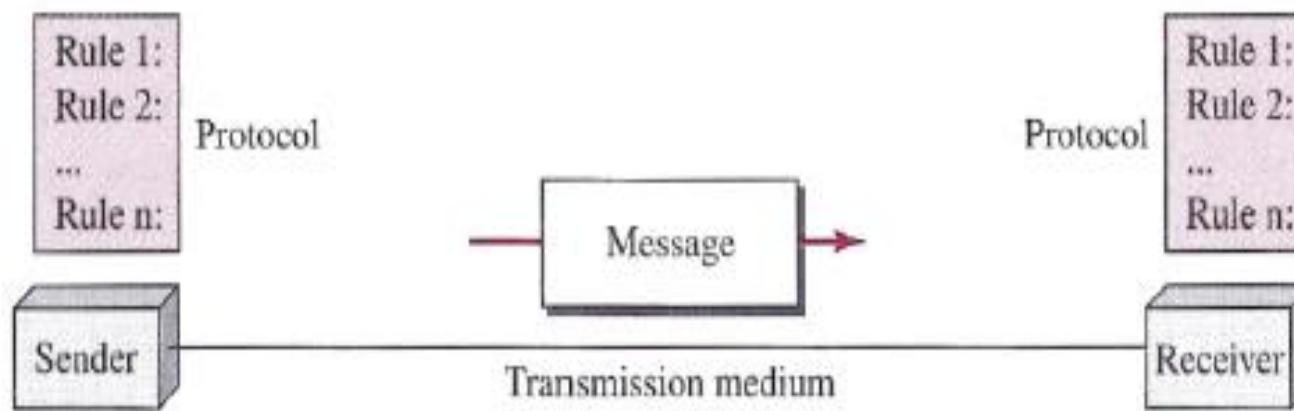


Figure 1.1 : Components of DCS

- 5 components of data communication:
 - i. ***Sender:***
 - The device that sends the data message (computer, workstation, handset, video camera).

ii. ***Receiver:***

- The devices that receive the message (computer, workstation, handset, video camera).

iii. ***Medium:***

- The physical path by which message travels from sender to receiver (twisted pair, coaxial cable, fiber-optic cable, laser or radio waves).

iv. ***Message:***

- Information (data) to be communicated (text, picture, number, sound).

v. ***Protocol:***

- A set of rules that governs data communication. It can be said as a representative agreement between communication devices.

1.3 NETWORK CRITERIA

- To be considered effective and efficient, a network must meet a number of criteria. The most important of these criteria are performances, reliability ad security.

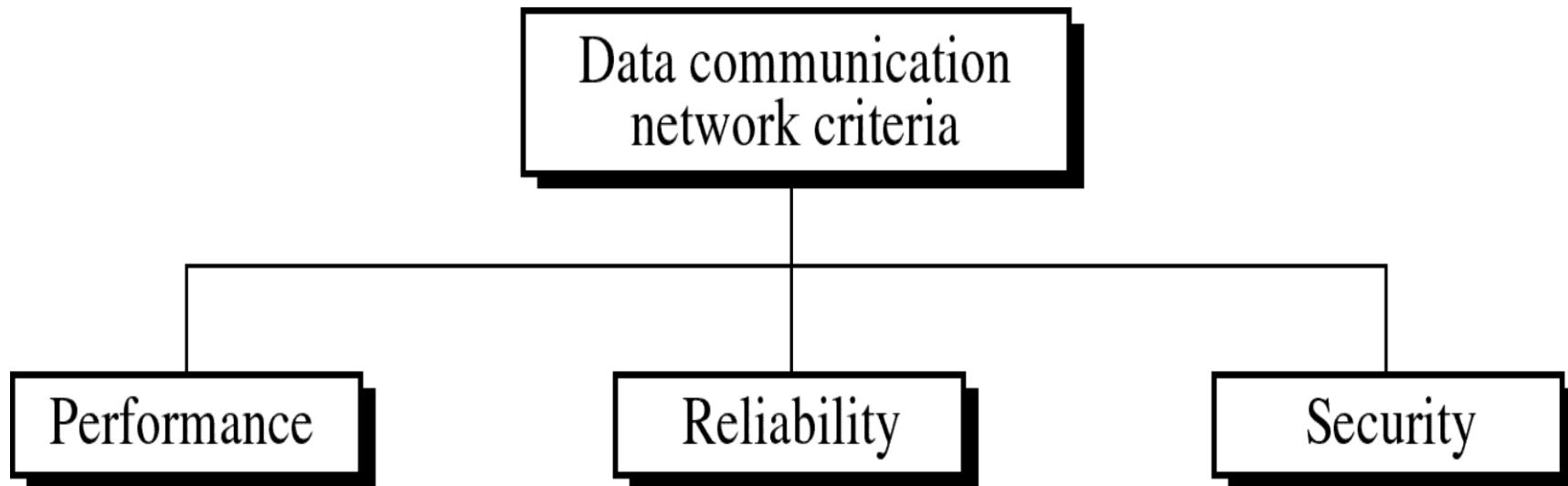


Figure 1.2 : Data Communication Network Criteria

1.3.1 PERFORMANCE

- Can be measured in many ways including **transit time** and **response time**.
- **Transit time** : the amount of time required for a message to travel from one device to another.
- **Response time** : the elapsed time between an inquiry and a response.
- The **performance** of network depends on:
 - i. **Number of users**
 - A large number of concurrent users can slow response time in a network.

ii. ***Type of transmission medium***

- The medium defines the speed at which data can travel through a connection (data rate).

iii. ***Hardware***

- Types of hardware included in a network affect both the speed and capacity of transmission.

iv. ***Software***

- The software used to process data at the sender, receiver and intermediate nodes also affects network performance.

Performance is often evaluated by two networking metrics:
throughput and delay.

1.3.2 RELIABILITY

- Can be measured by frequency of failure, the time it takes a link to recover from a failure and the network's robustness in a catastrophe.
 - i. ***Frequency of failure***
 - A network that fails often however is of little value to a user.
 - ii. ***Recovery time of a network after a failure***
 - How long does it takes to restore service?
 - iii. **Network's robustness in a catastrophe (*disaster*) .**
 - Network must be protect from fire, earthquake or theft.

1.3.3 SECURITY

- Protecting data from unauthorized access and viruses.

- i. ***Unauthorized access***

- Sensitive data must be protected from unauthorized access.

- ii. ***Viruses***

- A good network is protected from viruses by hardware and software designed specifically for that purpose.

- iii. ***damage and development***

And implementing policies and procedures for recovery from breaches and data losses.

1.4.1 TYPES OF STANDARDS

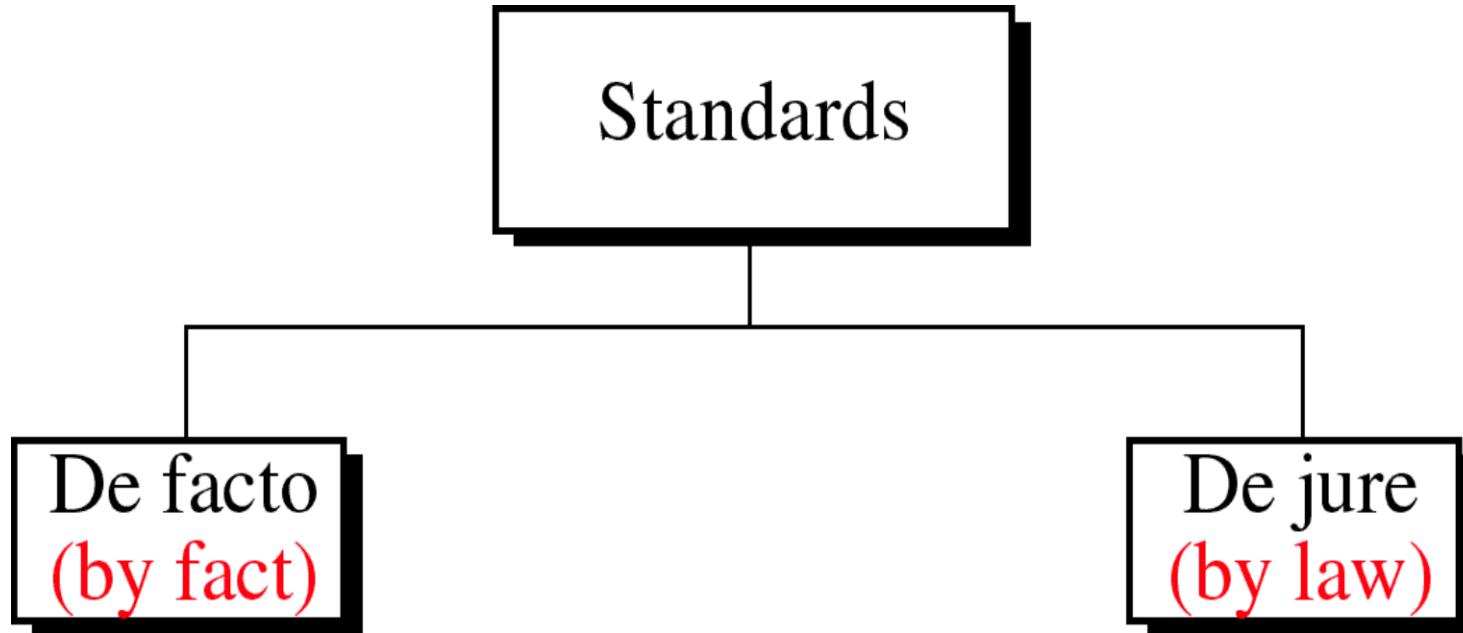


Figure 1.3:Types of Standards

■ 2 categories of data communication standards:

i. ***De jure standard (by law)***

- standard that have been legislated by an officially recognized body.

ii. ***De facto standard (by fact)***

- standard that have not been approved by an organized body but have been adopted as standards through widespread use.

1.5 LINE CHARACTERISTICS

- Lines characteristic defines the attachment of communication devices to a link.
- A ***link*** is the physical communication pathway that transfers data from device to another.
- There are **TWO** line characteristic or line configurations; point-to-point and multi-drop point.

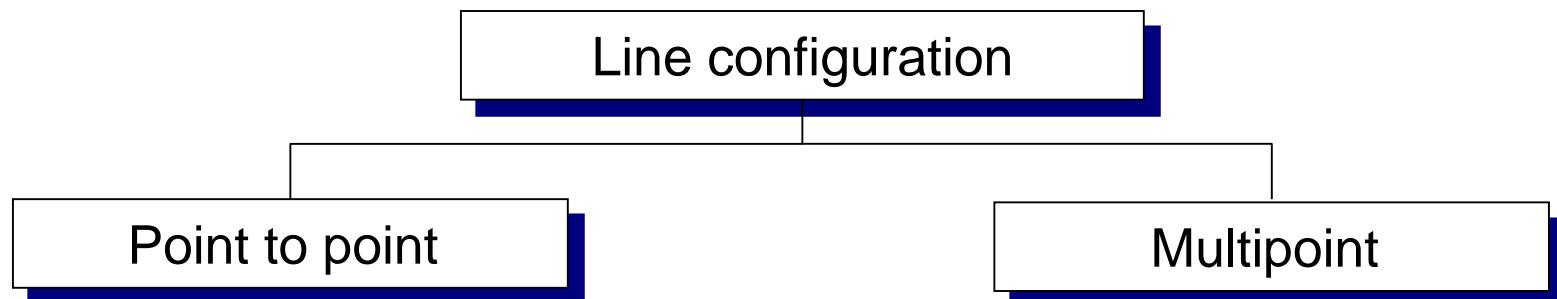
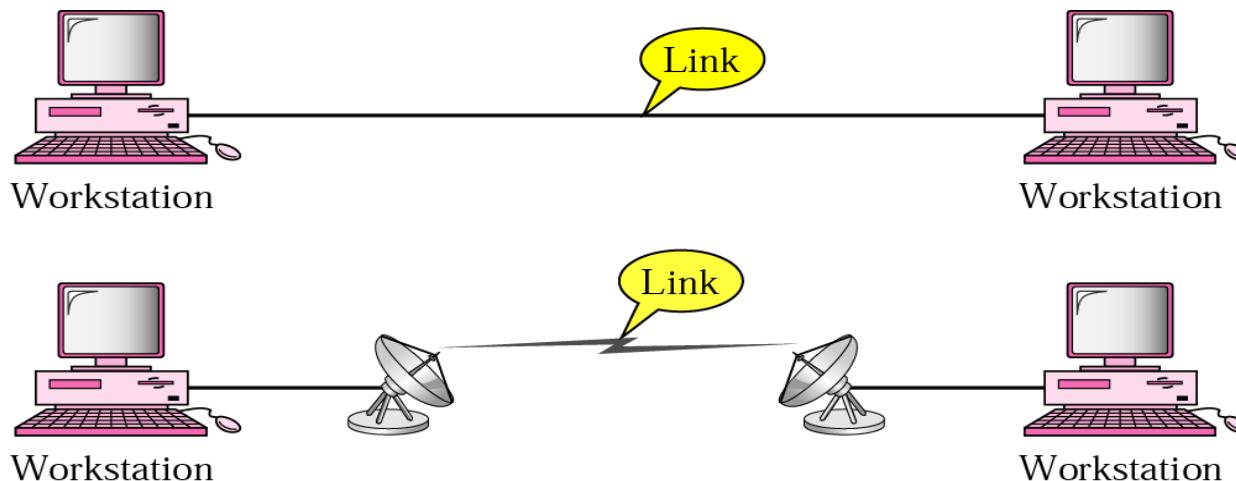


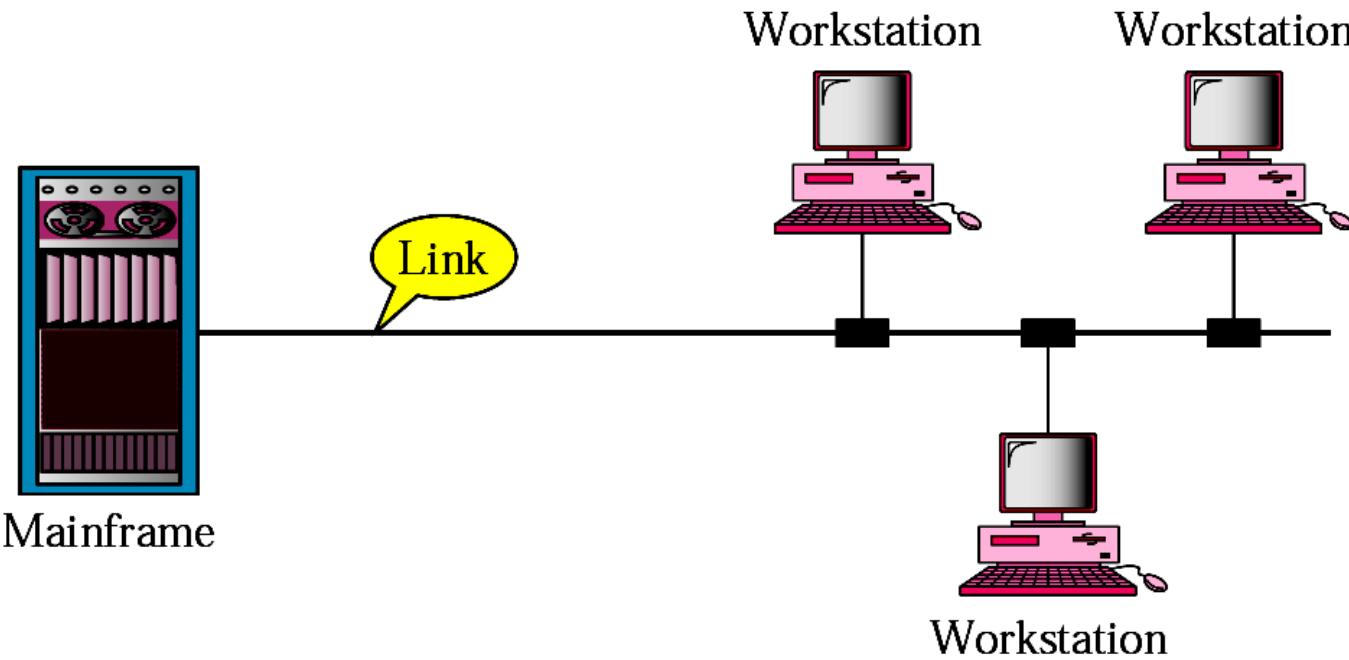
Figure 1.4 : Categories of Line Configuration

1.5.1 POINT-TO-POINT LINE CONFIGURATION



- ***Definition:*** A dedicated transmission link between two devices.
- Point-to-point line configuration provides a dedicated link between two devices.
- ***E.g.:*** When you change television channels by infrared remote control, you are establishing a point-to-point line configuration between remote control and television.

1.5.2 MULTI-DROP POINT LINE CONFIGURATION



- ***Definition:*** A line configuration in which three or more devices share a common transmission line.
- More than two specific devices share a single link.
- Capacity of channel is shared.

1.6 NETWORK TOPOLOGIES

- **Definition:** Topology refers to the structure of a network including physical arrangement of devices.
- There are five basic topologies possible: mesh, star, tree, bus and ring (additional topology: hybrid).

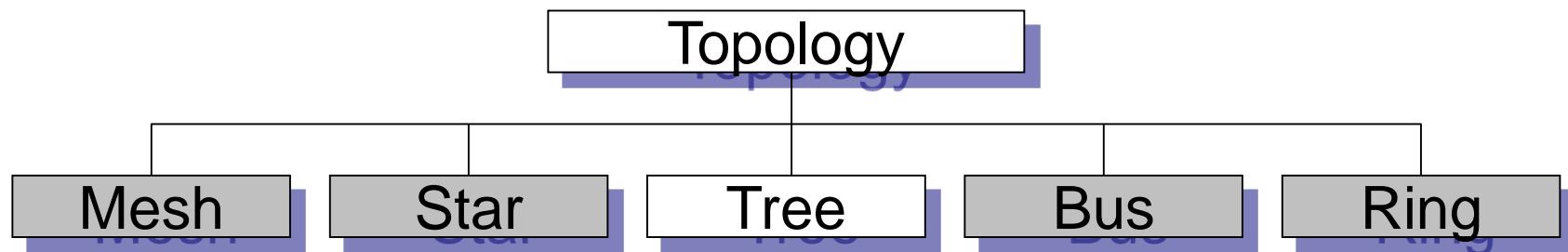
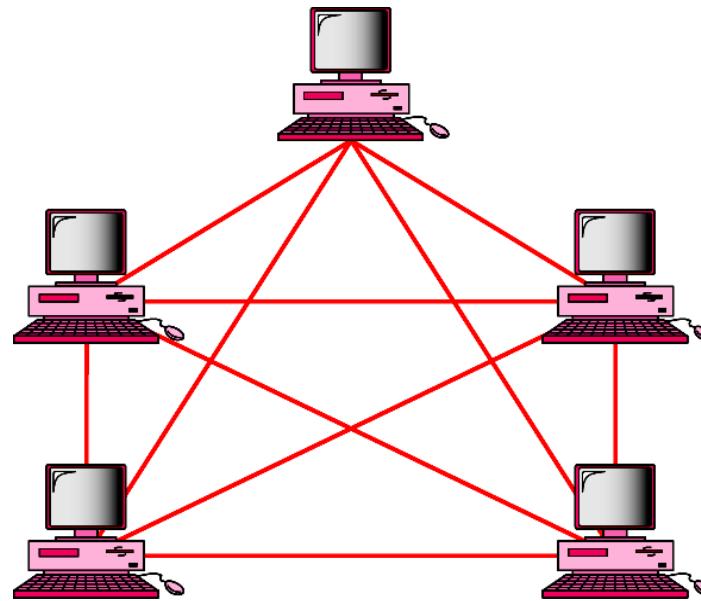


Figure 1.5 : Categories of Topology

1.6.1 MESH TOPOLOGY



- ***Definition:*** A network topology in which each device has a dedicated point-to-point link to every other device.
- Number of links = $n(n - 1)/2$ (n : number of devices)
- Number of ports = $n - 1$ (n : number of devices)

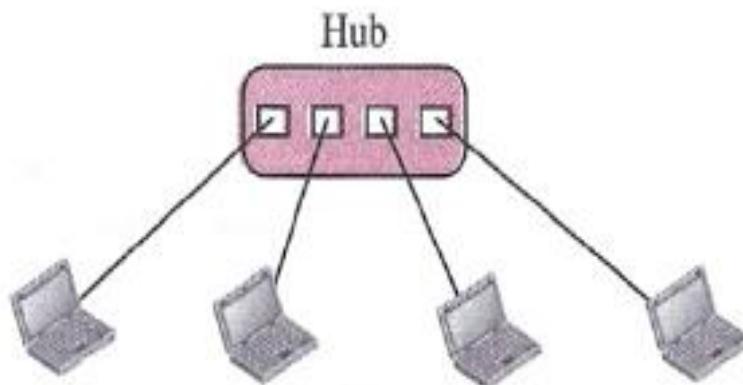
- **Advantages:**

- ***Eliminate traffic problem:*** The use of dedicated links guarantees that each connection can carry its data load.
- ***Robust:*** If one link becomes unusable, it does not incapacitate the entire system.
- ***Privacy and security:*** Physical boundaries prevent other users from gaining access to message.

- **Disadvantages:**

- ***Difficult in installation and reconfiguration:*** every device must be connected to every other device.
- Expensive hardware.

1.6.2 STAR TOPOLOGY



- ***Definition:*** A network topology in which all stations are attached to a central device (hub).
- Devices are not linked to each other.
- Star topology does not allow traffic between devices.

- ***Advantages:***

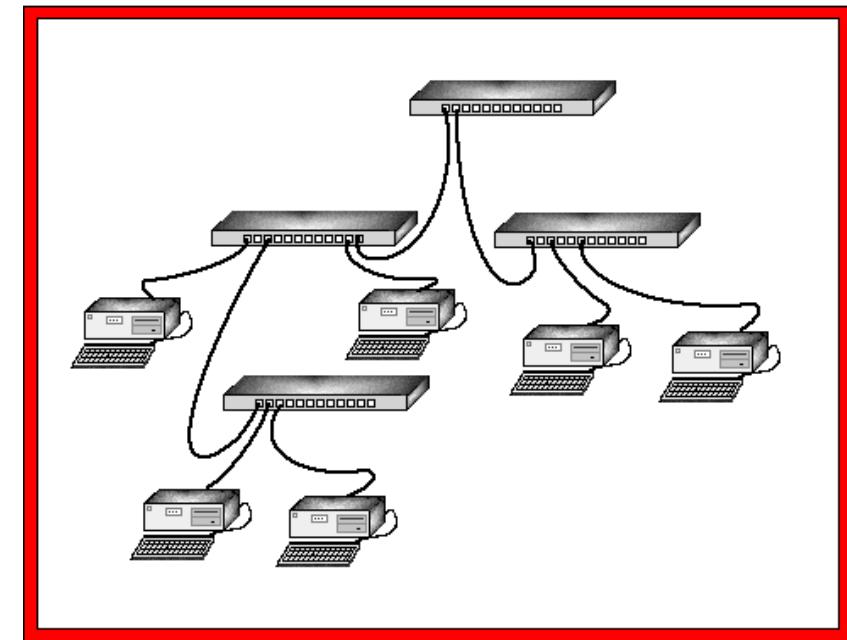
- Easy fault identification and isolation.
- Easy to install and reconfigure.
- Robustness

- ***Disadvantages:***

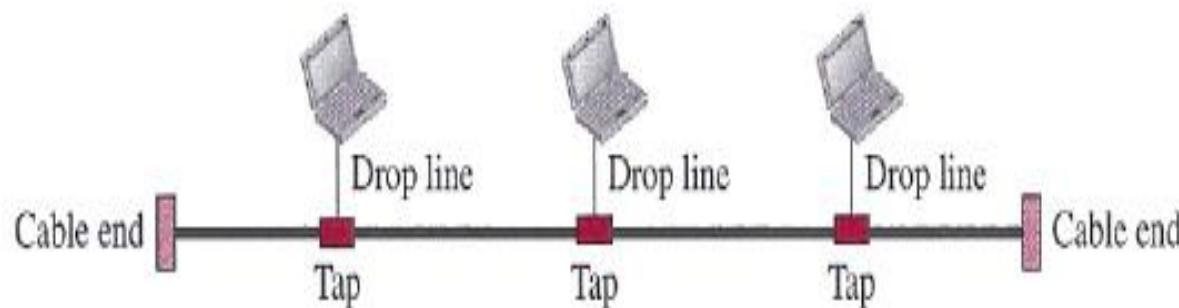
- Each node must be linked to a central hub. More cabling is required.

1.6.3 TREE TOPOLOGY

- ***Definition:*** A network topology in which stations are attached to a hierarchy of hubs.
- It is an extension of star topology with more than one level.
- ***Advantages:***
 - Allow more devices to be attached to a single central hub.
 - Allow network to isolate and prioritize communications from different computers.



1.6.4 BUS TOPOLOGY



- ***Definition:*** A network topology in which all computers are attached to a shared medium (often a single cable).

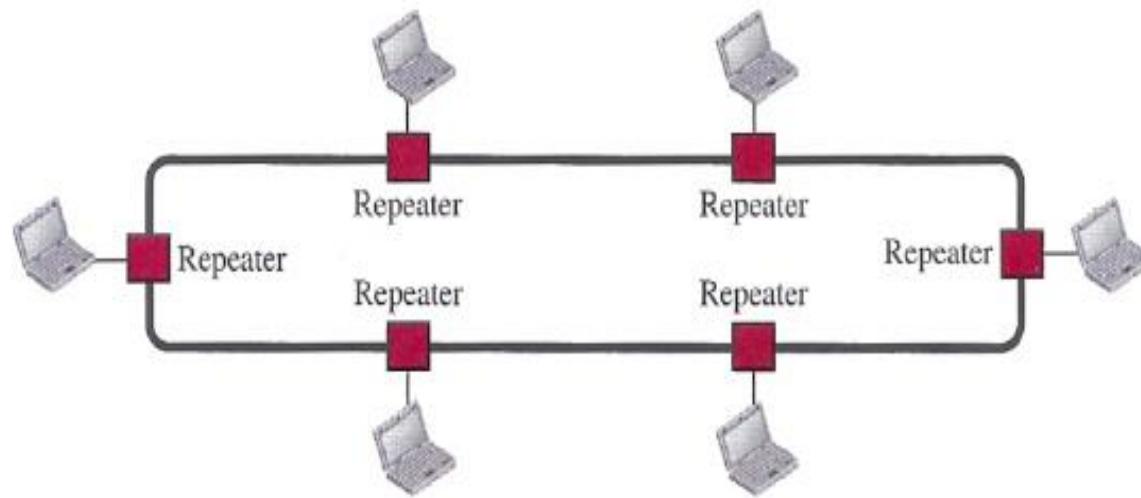
- ***Advantages:***

- Ease of installation.
 - Use less cabling.

- ***Disadvantages:***

- *Difficult reconfiguration and fault isolation* – difficult to add new devices.
 - A fault or break in the bus cable stops all transmission.

1.6.5 RING TOPOLOGY



- ***Definition:*** A network topology in which the devices are connected in a ring.
- Each device on the ring receives the data unit from the previous device, regenerates it and forwards it to the next device.

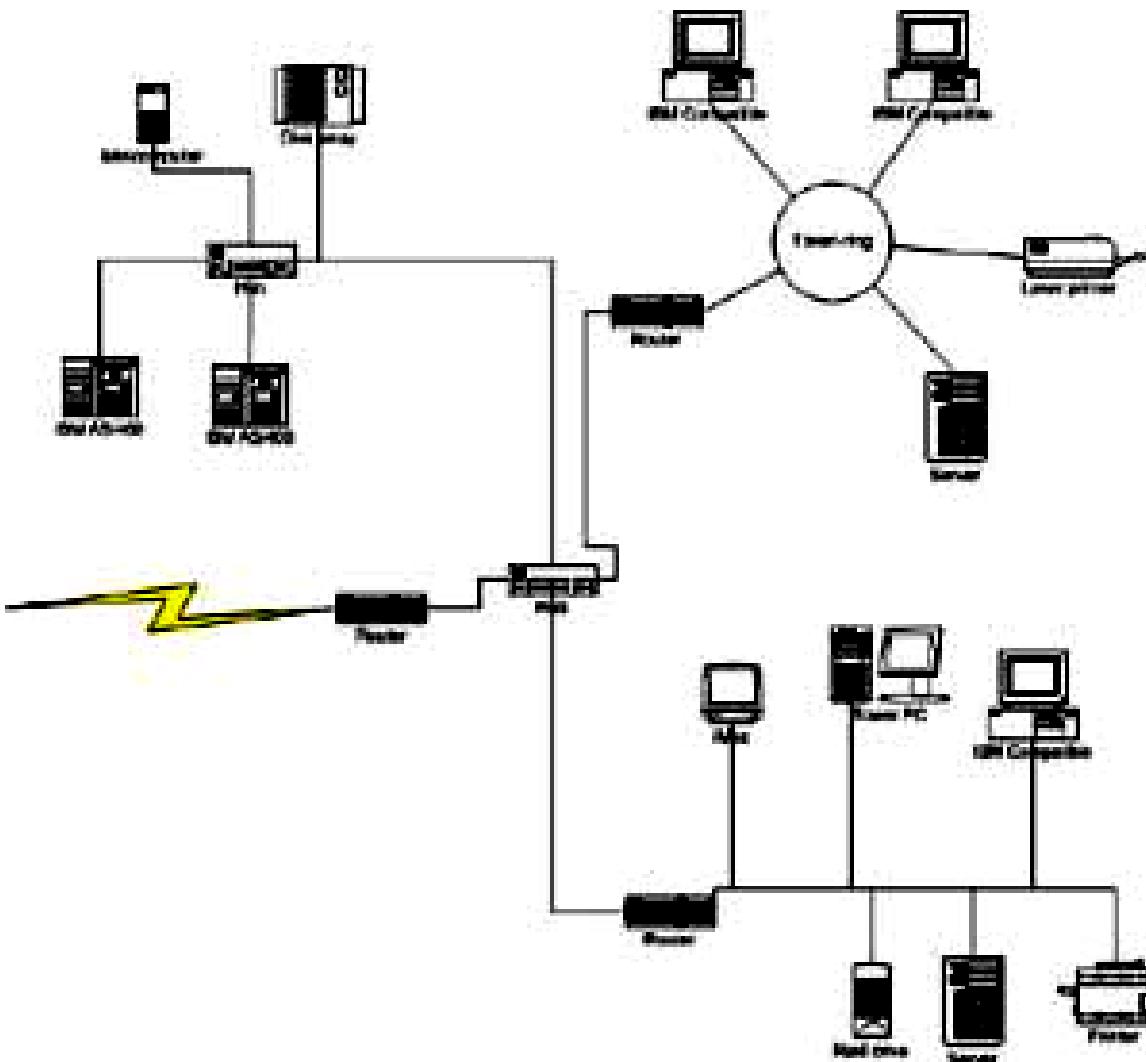
- ***Advantages:***

- Easy to install and reconfigure.
- Easy fault identification and isolation.

- ***Disadvantages:***

- Unidirectional traffic.
- A break in the ring can disable the entire network.

1.6.6 HYBRID TOPOLOGY



- ***Definition:*** A network topology which is composed of more than one basic topology.

1.7 TRANSMISSION MODE

- ***Definition:*** Transmission mode refers to the direction of information flow between two devices.
- There are three types of transmission modes: simplex, half duplex and full duplex.

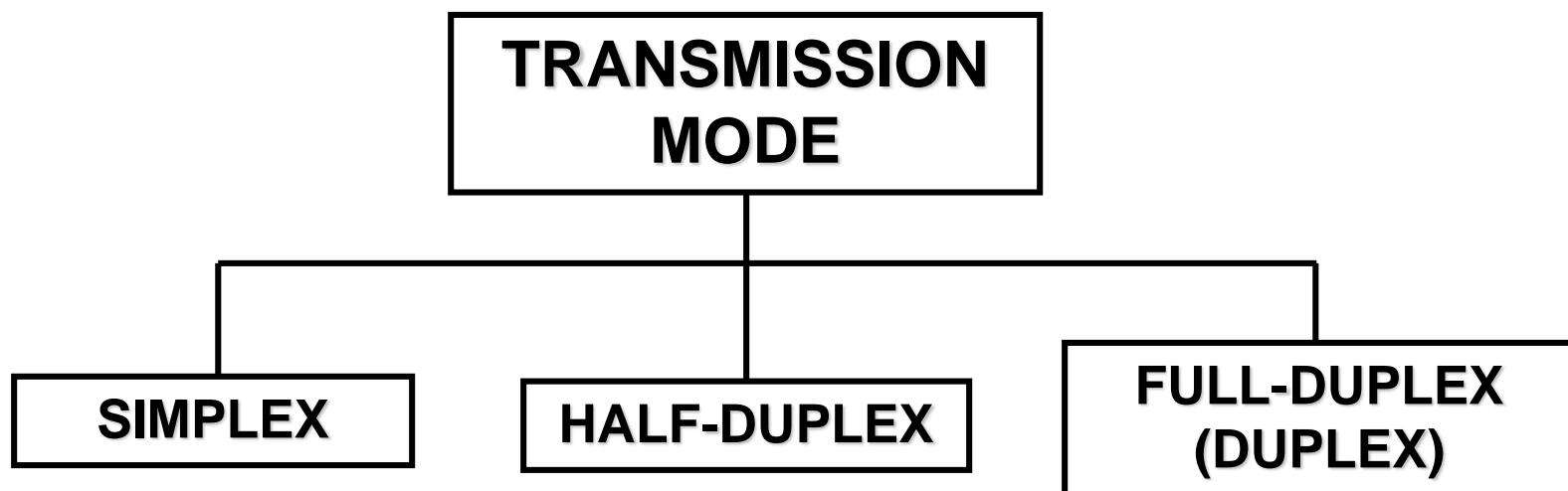
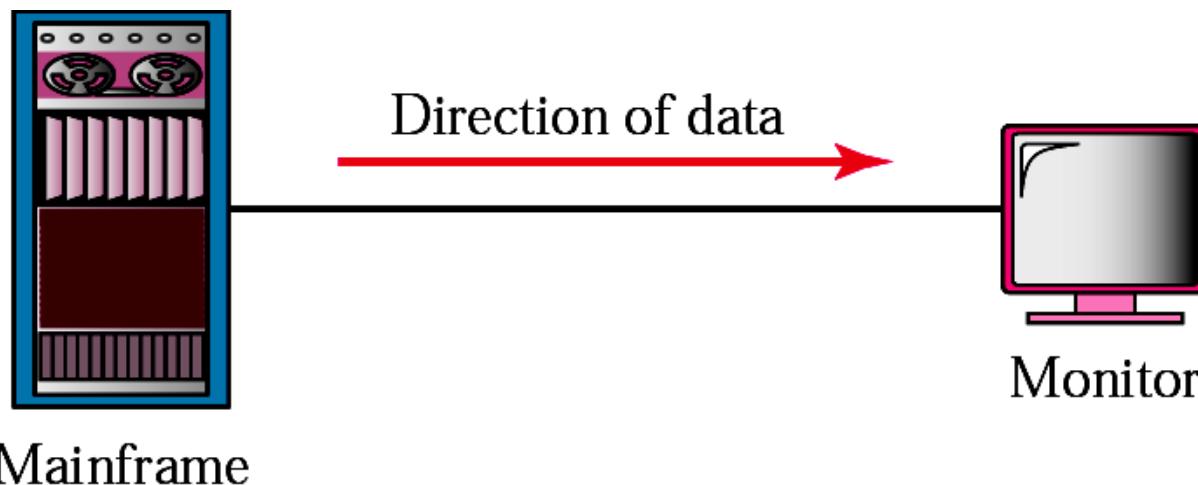


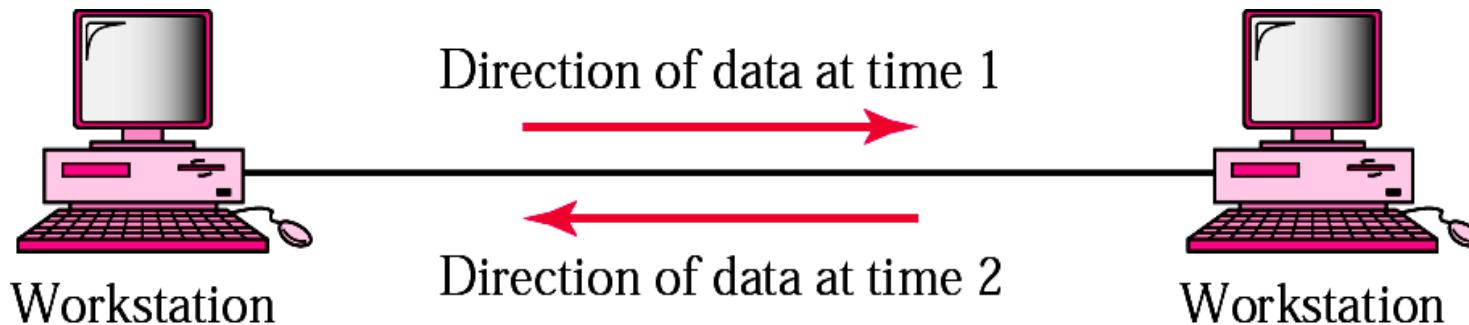
Figure 1.6 : Categories of Transmission Mode

1.7.1 SIMPLEX



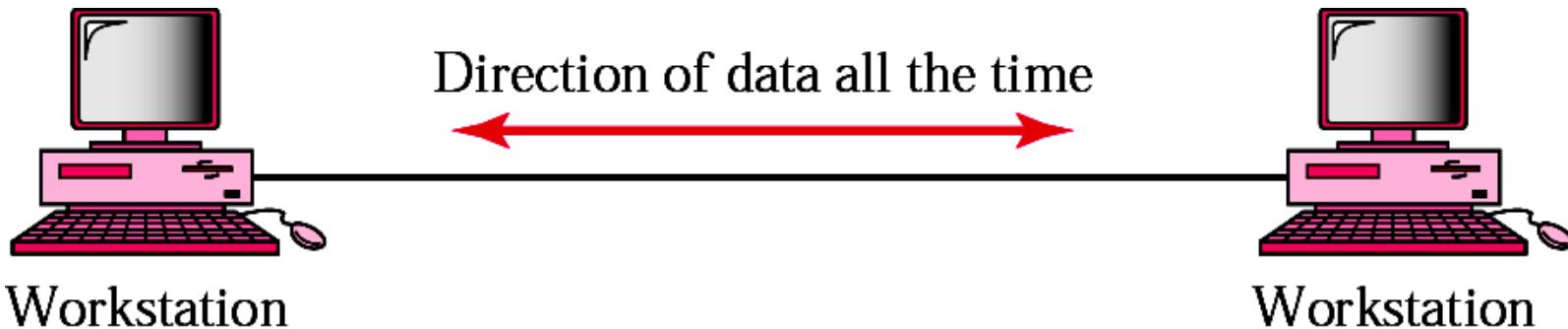
- ***Definition:*** A transmission mode in which communication is one way.
- Unidirectional as on a one-way street.
- Only one of the two stations on a link can transmit; the other can only receive.
- *E.g.:* keyboards and traditional monitors

1.7.2 HALF-DUPLEX



- ***Definition:*** A transmission mode in which communication can be two way but not at the same time.
- Each station can both transmit and receive, but not at the same time.
- When one device is sending, the other can only receive and vice versa.
- *E.g.: walkie-talkies and CB radios*

1.7.3 FULL-DUPLEX (DUPLEX)



- ***Definition:*** A transmission mode in which communication can be two way simultaneously.
- Both stations can transmit and receive simultaneously.
- Like a two-way street with traffic flowing in both directions at the same time.

1.8 NETWORK TYPES: LAN, MAN, WAN

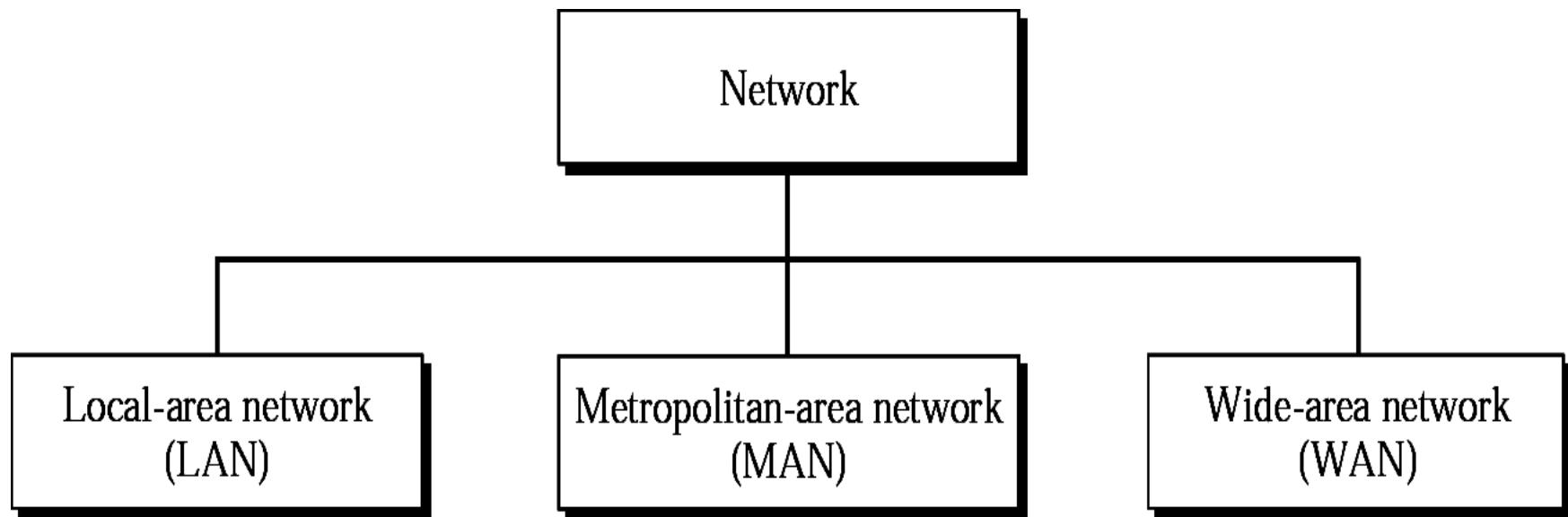
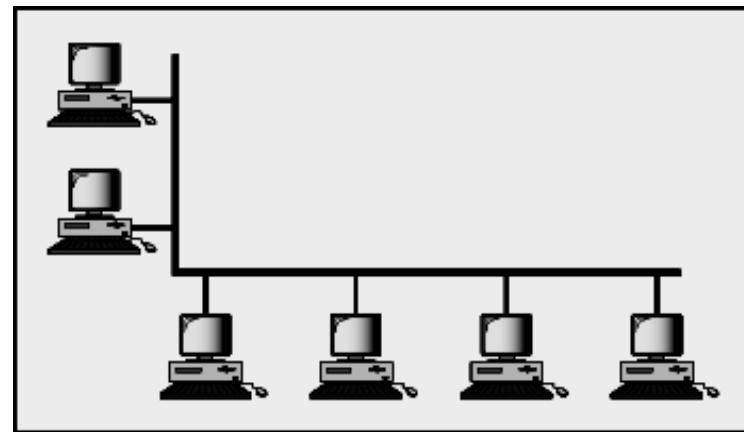


Figure 1.7:Network Types

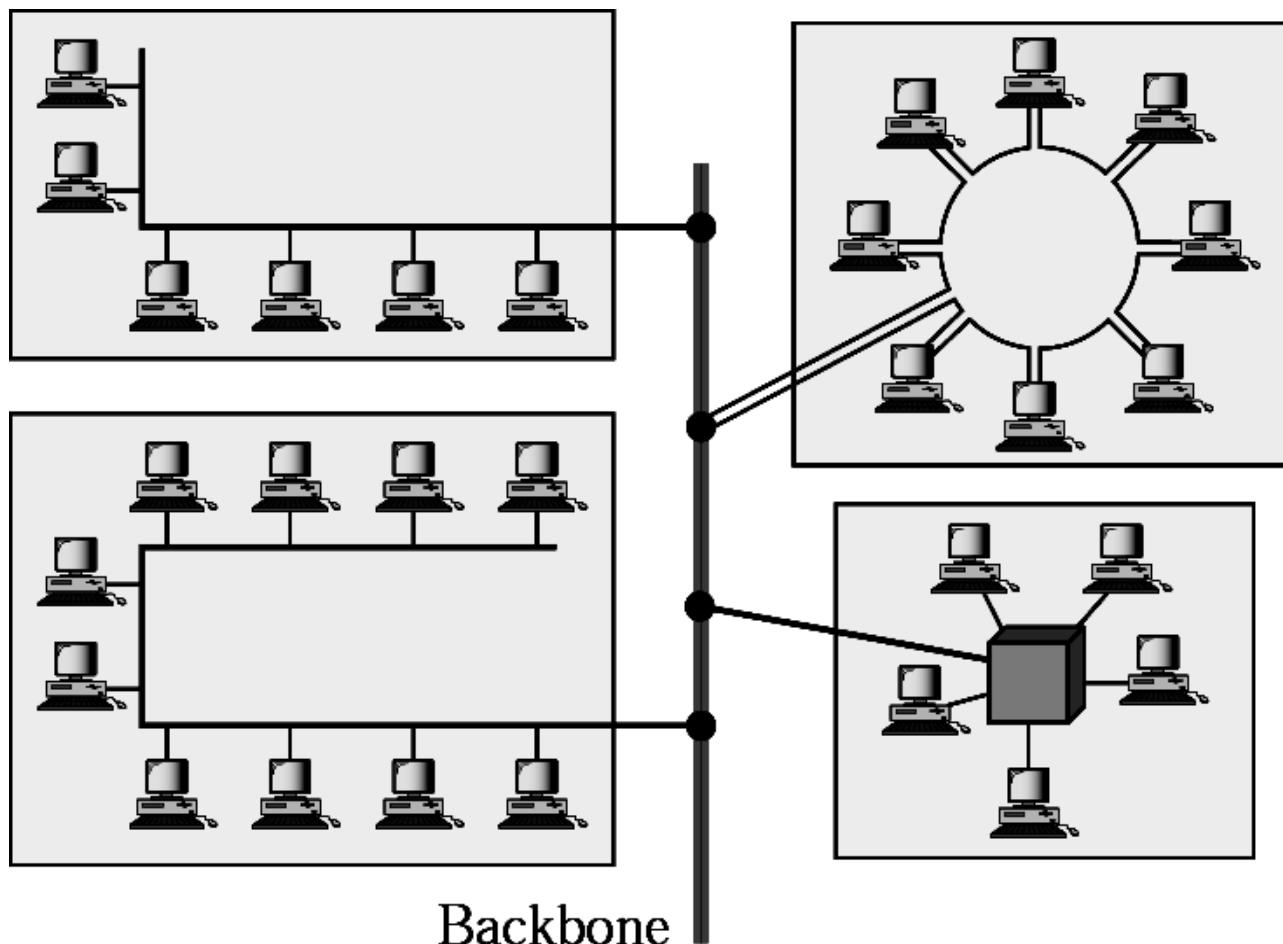
1.8.1 LOCAL AREA NETWORK (LAN)

- ***Definition*** : LAN is a network connecting devices in a relatively small area such as building.
- LAN size is limited to a few kilometers.
- LAN are distinguished from others type of networks by its transmission media and topology.
- In general, a given LAN will use only one type of transmission medium.
- The most common topologies are bus, ring and star.



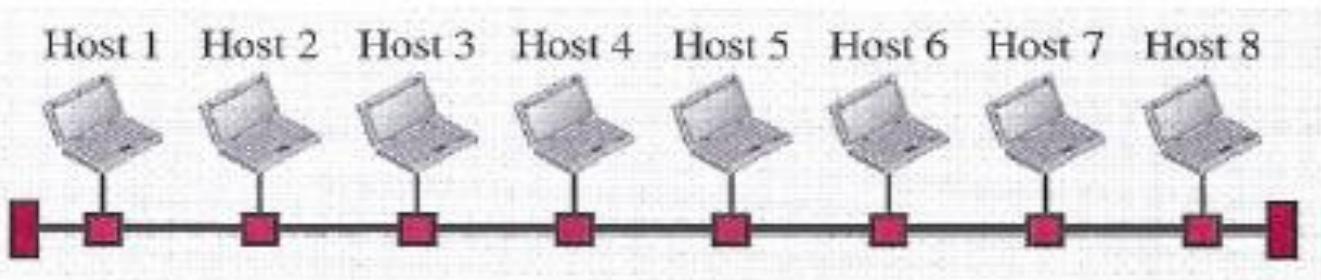
a. Single-building LAN

Figure 1.8(a) : Local Area Network (LAN)



b. Multiple-building LAN

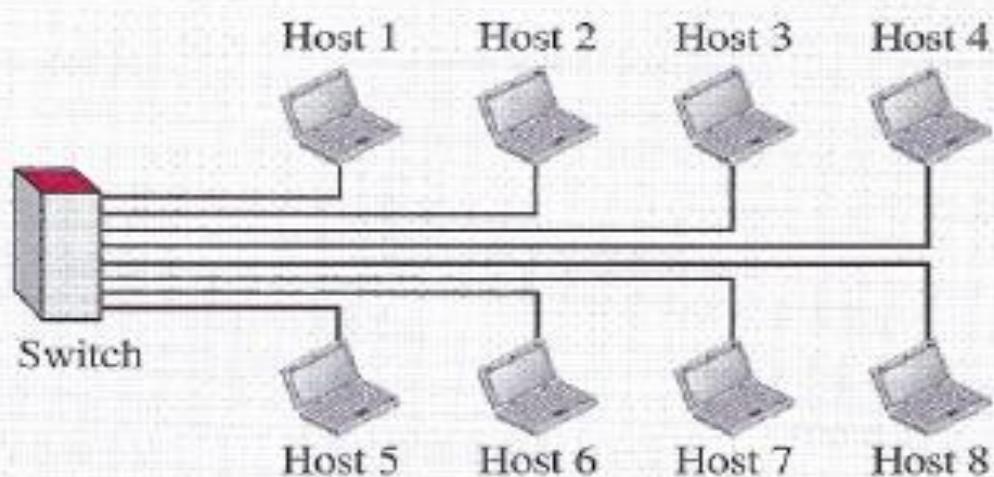
Figure 1.8(b) : Local Area Network (LAN)



a. LAN with a common cable (past)

Legend

- A host (of any type)
- A switch
- A cable tap
- A cable end
- The common cable
- A connection



b. LAN with a switch (today)

1.8.2 WIDE AREA NETWORK (WAN)

- ***Definition*** : A network connecting devices within very large areas such as states, countries and the world.
- Dedicated transoceanic cabling or satellite uplinks may be used to connect this type of network.
- Complicated.

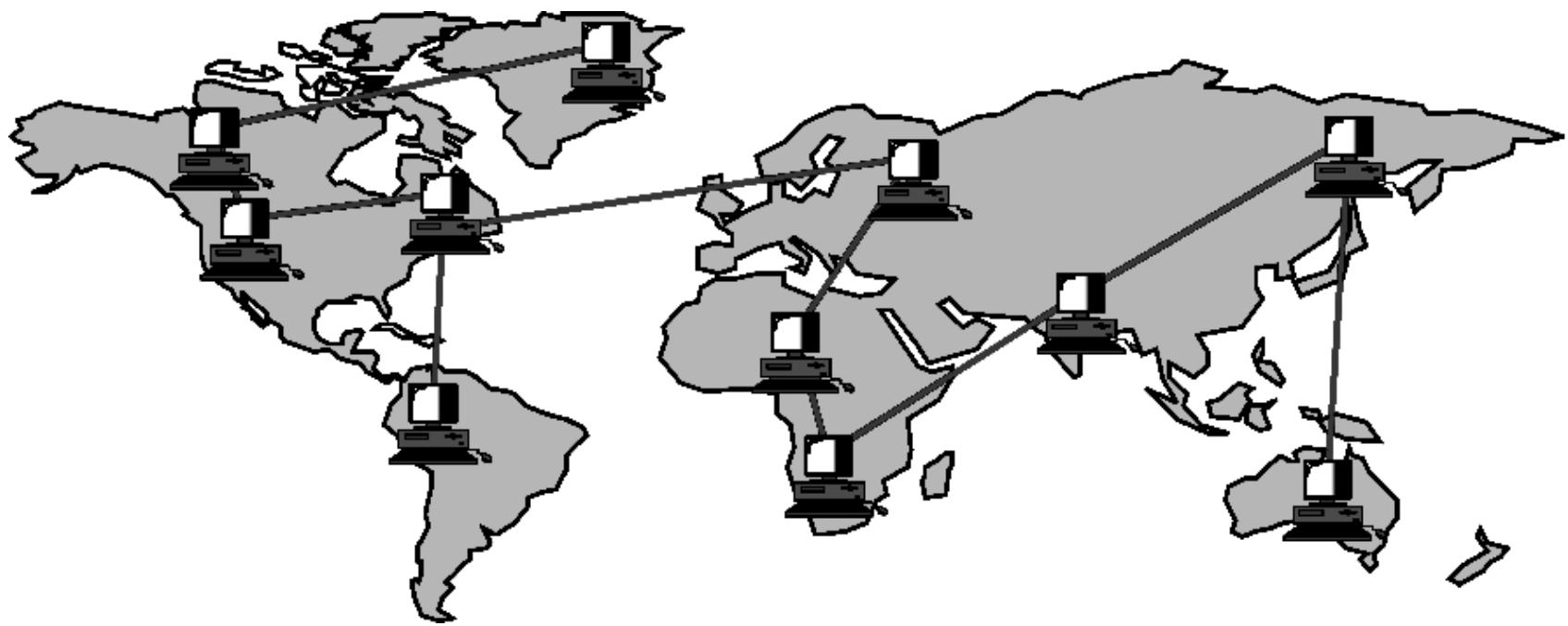


Figure 1.10 : Wide Area Network (WAN)

TYPES OF WAN

A **point-to-point WAN** is a network that connects two communicating devices through a transmission media (cable or air).

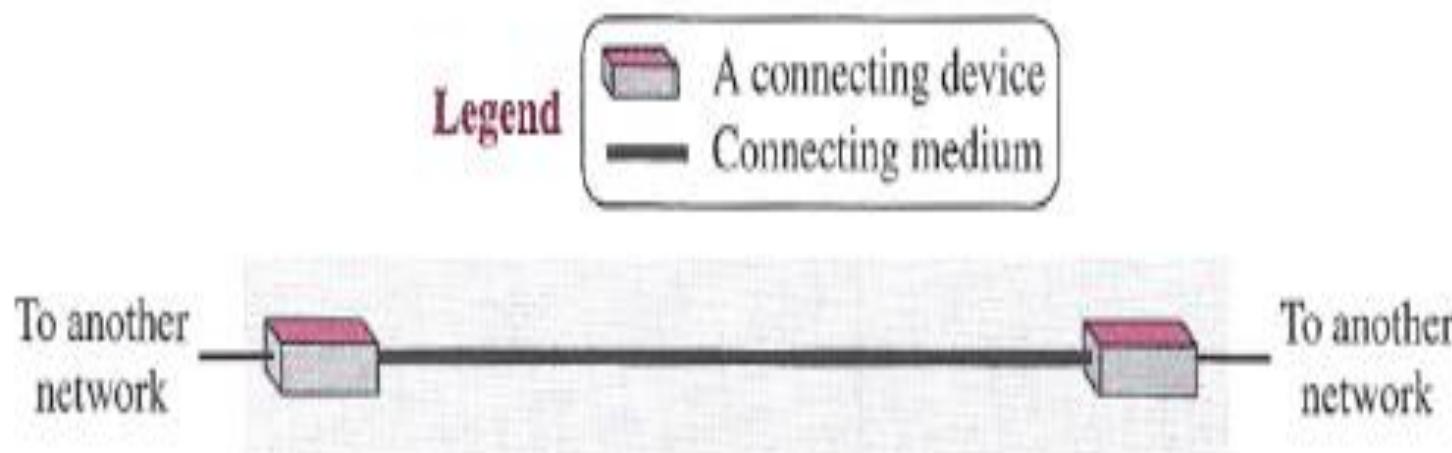


Figure 1.9 shows an example of a point-to-point WAN.

TYPES OF WAN

Switched WAN

a network with more than two ends.
is used in the backbone of global communication today.
a combination of several point-to-point WANs that are connected by switches.

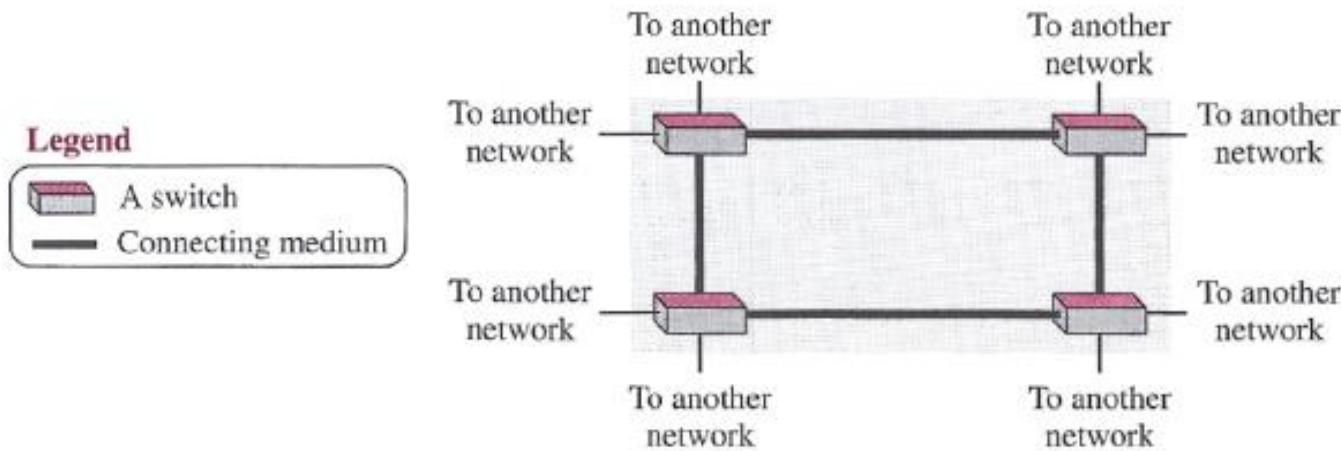
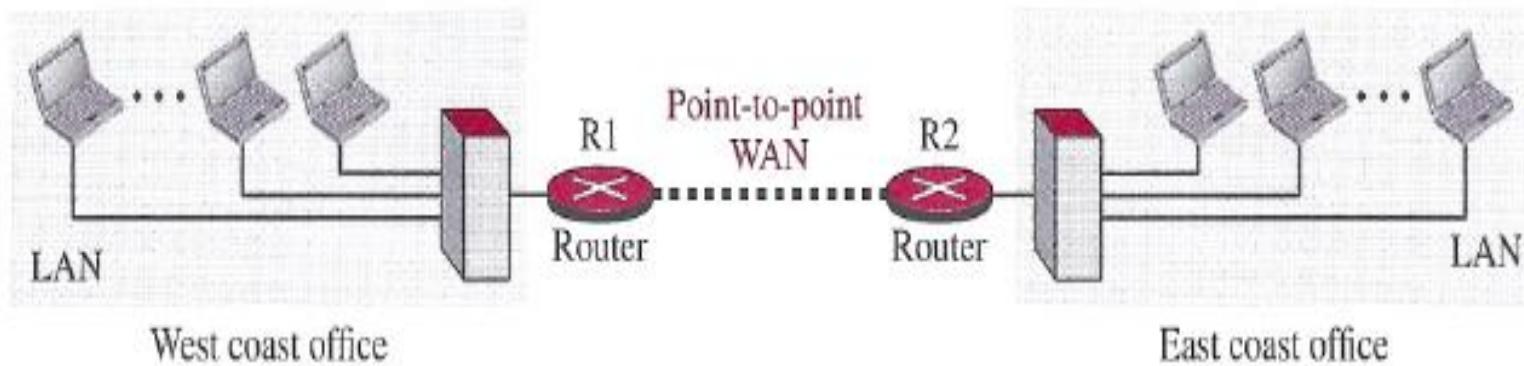


Figure 1.10 shows an example of a switched WAN.

LAN	WAN
limited in size: spanning an office, a building, or a campus;	has a wider geographical span, spanning a town, a state, a country
interconnects hosts	interconnects connecting devices such as switches, routers, or modems
normally privately owned by the organization that uses it	normally created and run by communication companies and leased by an organization that uses it

Internetwork

very rare to see a LAN or a WAN in isolation
they are connected to one another –
internetwork/internet.



1.10 EXERCISES

SECTION A: (TRUE/FALSE)

1. A LAN is a data communication system covering an area the size of a town or city. (TRUE/FALSE)
2. Networks are judged by their performance, reliability and compatibility. (TRUE/FALSE)
3. Full duplex is transmission mode in which communication can be two way but not at the same time.(TRUE/FALSE)
4. In a point-to-point line configuration, three or more devices share a link. (TRUE/FALSE)