

Unit 1: Chapter 1

Introduction to Computer Networks

[1] Data Communication and Networking : B. A. Forouzan, 4th Edition,
TMH, 2007.

Chapter 1: 1.1, 1.2

Data Communication

- It refers to **exchange to data between two devices** via some form of transmission medium.
- For data communication to occur, the **communicating devices must be a part of communication system** made up of a combination of hardware and software.

Topics discussed in this section:

Components

Data Representation

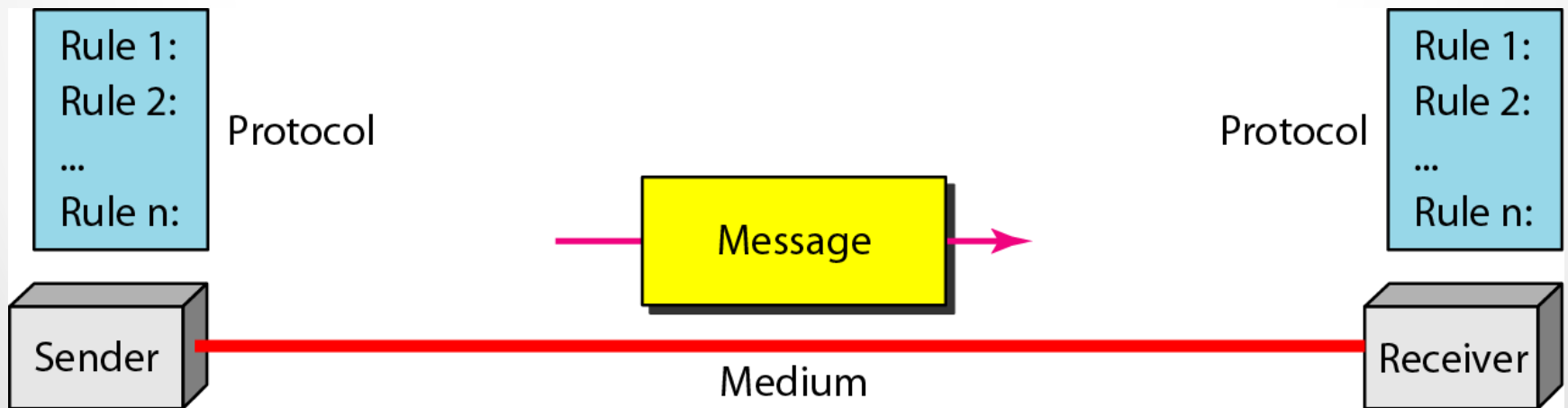
Data Flow

Characteristics of Effective Data Communication

- **Delivery:** Data must be delivered to the correct destination.
- **Accuracy:** System must deliver the data accurately. Data that have been altered in transmission and left uncorrected are unusable.
- **Timeliness:** Data must be delivered timely.
- **Jitter:** It refers to the variation in the packet arrival time. It is the uneven delay in the delivery of audio or video packets.

Components of a Data Communication System

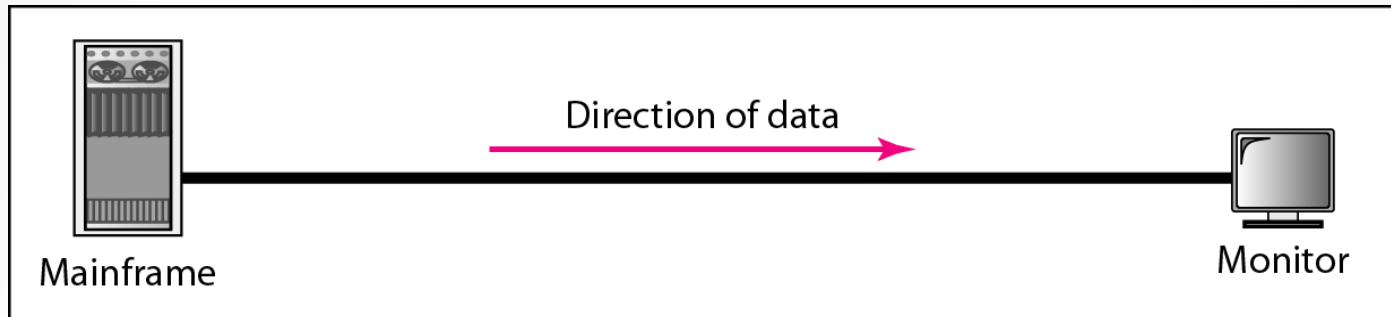
- Message
- Sender
- Receiver
- Transmission Medium
- Protocol



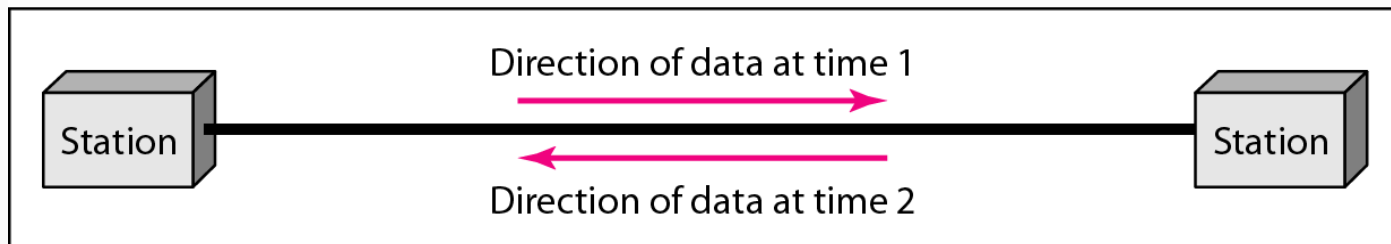
Data Representation

- Text
- Numbers
- Images
- Audio
- Video

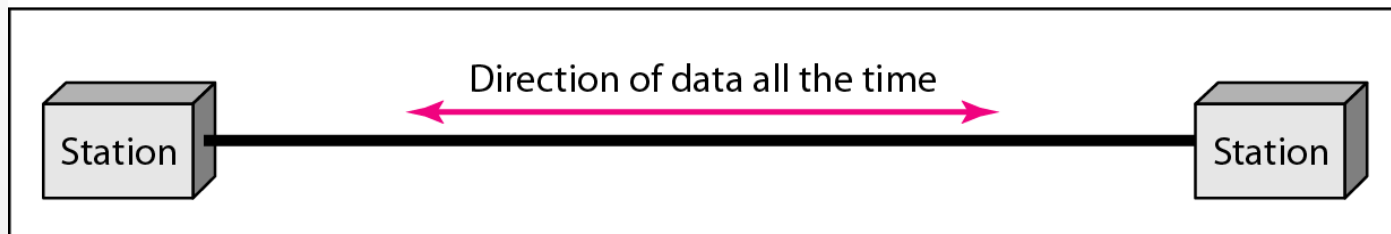
Data Flow



a. Simplex



b. Half-duplex



c. Full-duplex

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

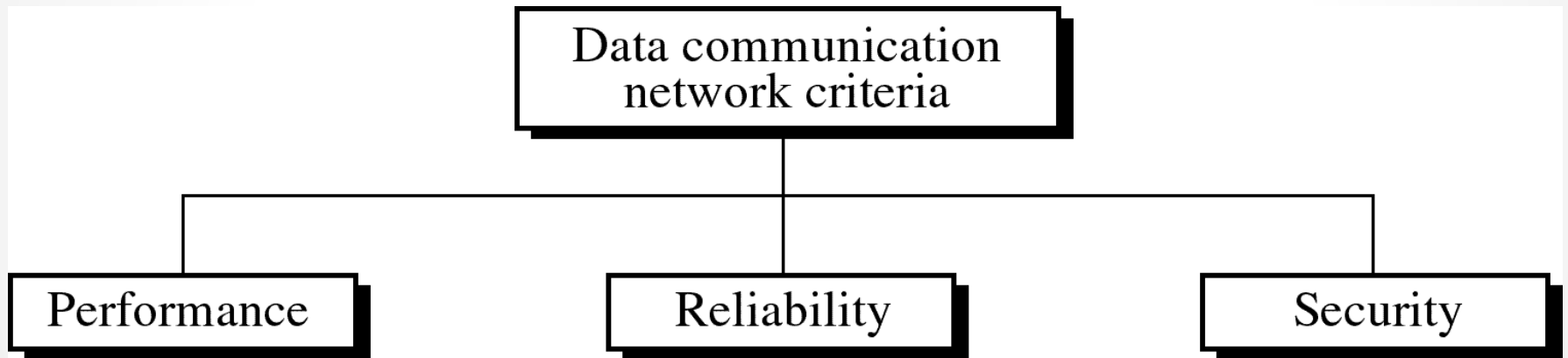
Interconnection of Networks: Internetwork

Distributed Processing

- Distributed processing is a setup in which multiple individual central processing units (CPU) work on the same programs, functions or systems to provide more capability for a computer or other device.

Network Criteria

- A network must be able to meet a certain number of criteria.



Physical Structures

Before discussing networks, we need to define some **network attributes**.

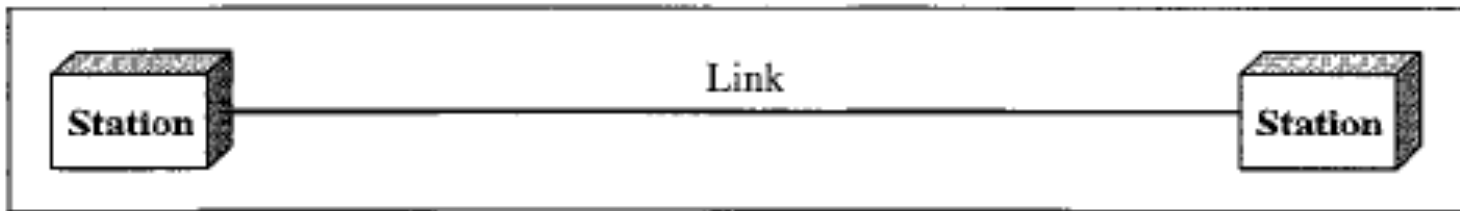
- Types of Connection
- Physical Topology

Types of Connection

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

Point to Point connection

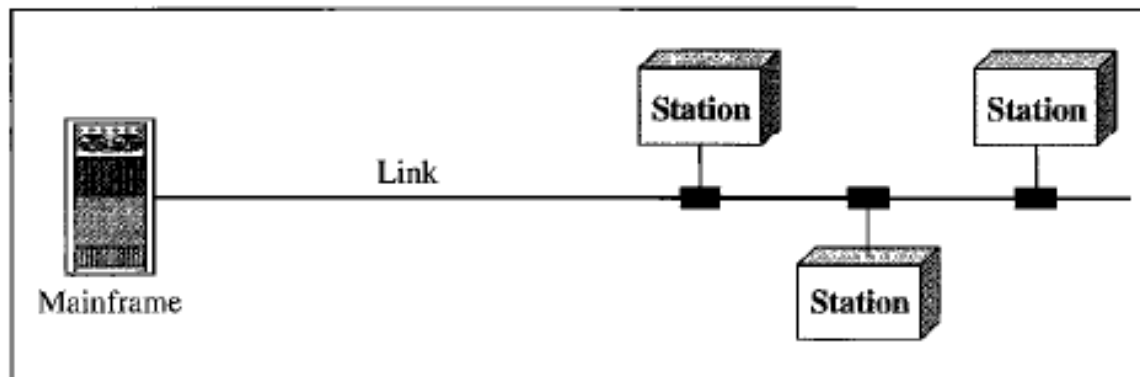
- It provides a dedicated link between two devices.
- The entire capacity of the link is reserved for transmission between those two devices.



a. Point-to-point

Multipoint Connection

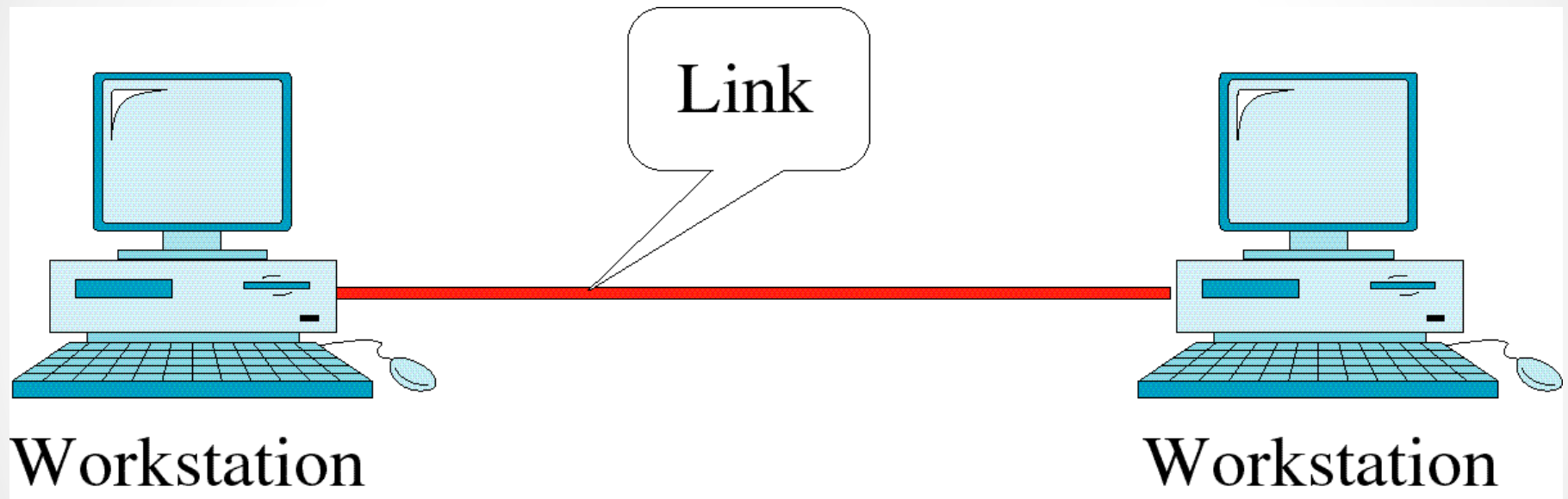
- A multipoint (also called multidrop) connection is the one in which more than two devices share a specific link.
- The capacity of the channel is shared, either spatially or temporarily.
- If several devices can use the same link simultaneously, it is a spatially shared connection.
- If users must take turns, it is a timeshared connection.



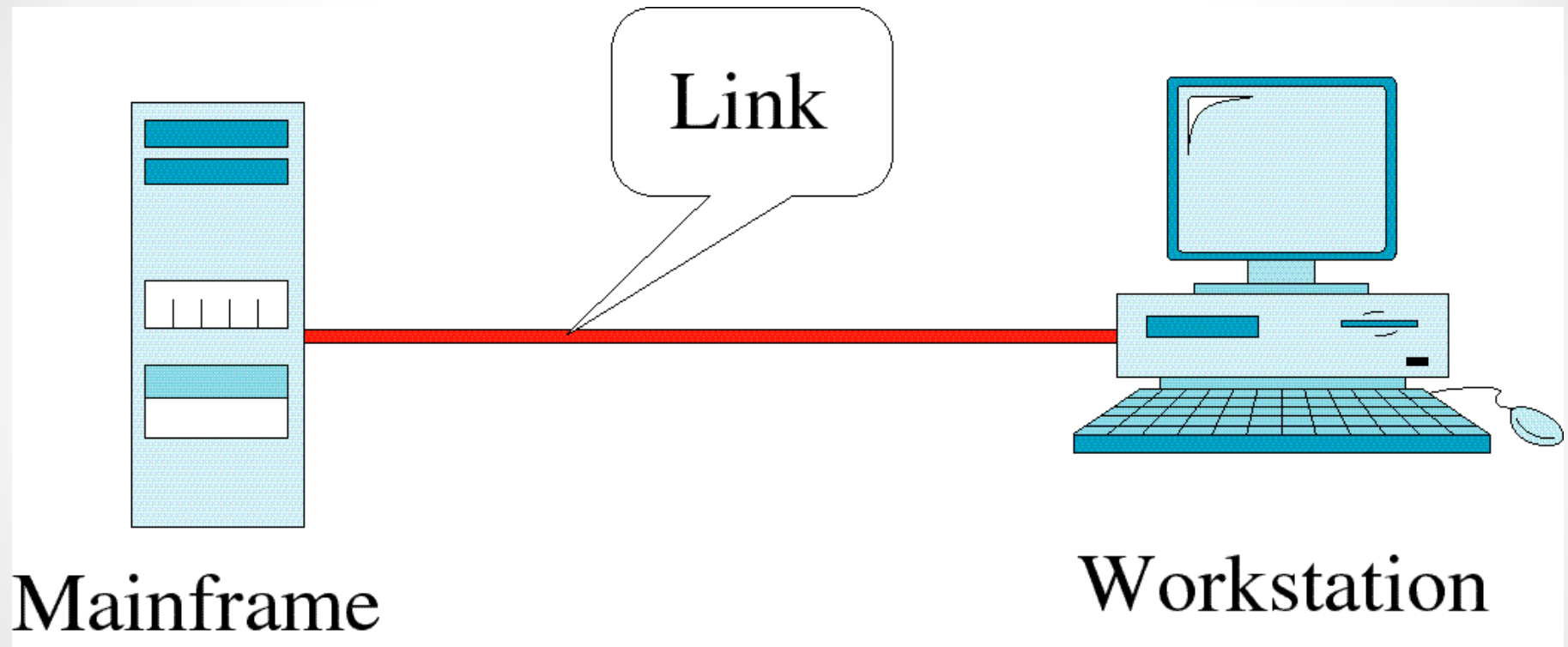
b. Multipoint

Figure 2-2

Point-to-Point Line Configuration



Point-to-Point Line Configuration

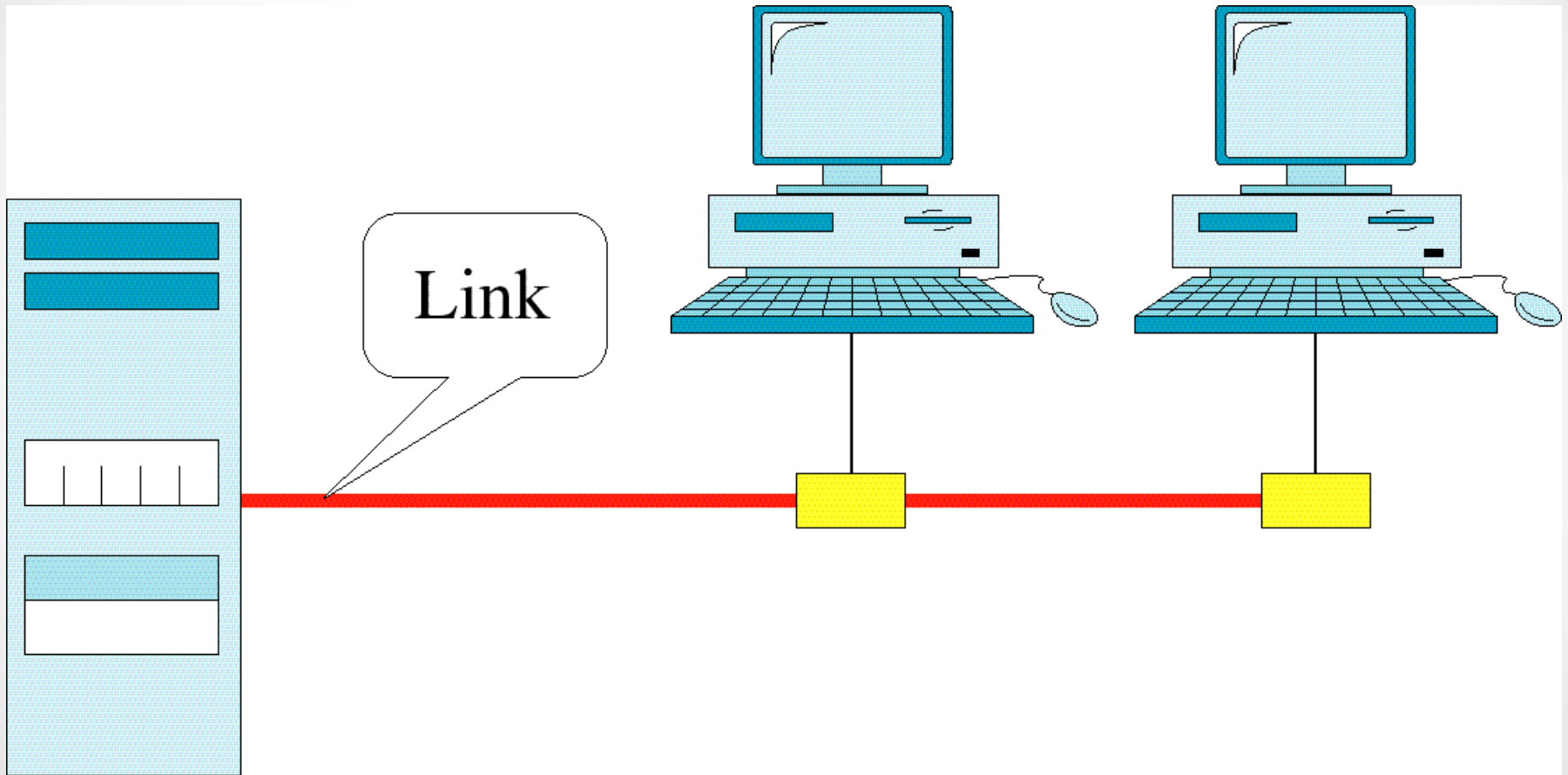


Point-to-Point Line Configuration



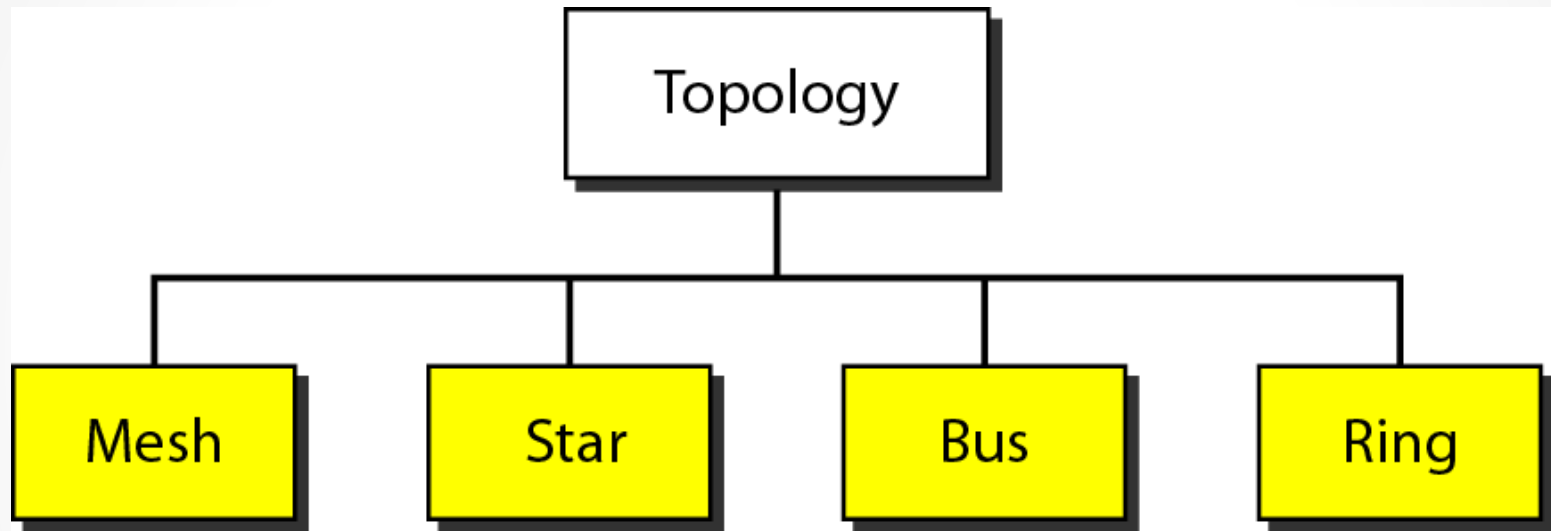
Figure 2-3

Multipoint Line Configuration



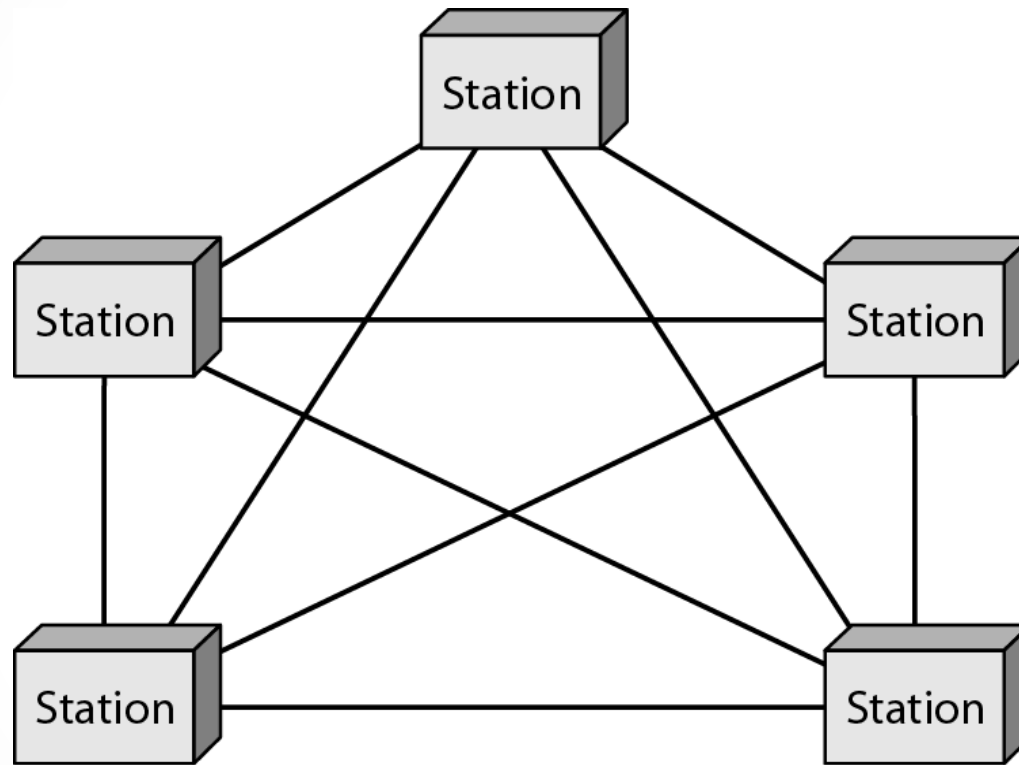
Physical Topology

- It refers to the way in which a network is laid out physically.
- Two or more devices connect to a link, two or more links form a topology.
- The topology of a network is the geometric representation of the relationship of all the links and the linking devices (usually called nodes) to one another.



Mesh Topology

- In Mesh Topology, every device has a dedicated point-to-point link to every other device.
- The term dedicated means that the link carries traffic only between two devices it connects.
- For a mesh network of n nodes, we have $n(n-1)/2$ duplex-mode links.



*A fully connected mesh topology (five devices) with $(5*4)/2$ links*

Advantages

- Use of Dedicated links guarantees that each connection can carry its own data load, thus eliminating the traffic problems that can occur when links must be shared by multiple devices.
- It is robust, i.e. if one link becomes unusable, it does not incapacitate the entire system.
- Because of dedicated links, it offers privacy or security.
- Point-to-point links make fault identification and fault isolation easy.

Disadvantages

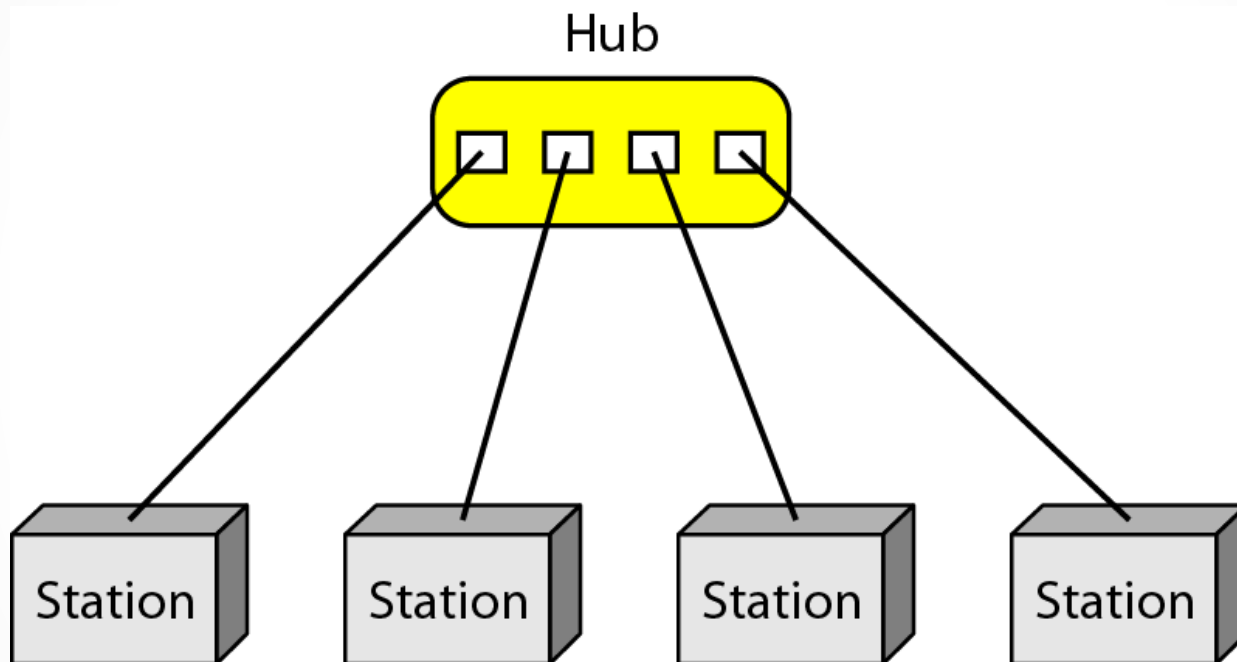
- Too much cabling and too many number of I/O ports are required.
- Because of point-to-point links, installation and reconnection are difficult.
- Hardware required to connect each link can be expensive.

Star Topology

- In star topology, each device has a dedicated point-to-point link only to central controller, usually called hub.
- Devices are not directly connected to each other.
- Hub acts as an exchange, if one device wants to send data to another, it sends data to the hub, which then relays the data to another connected device.

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A star topology connecting four stations

Advantages

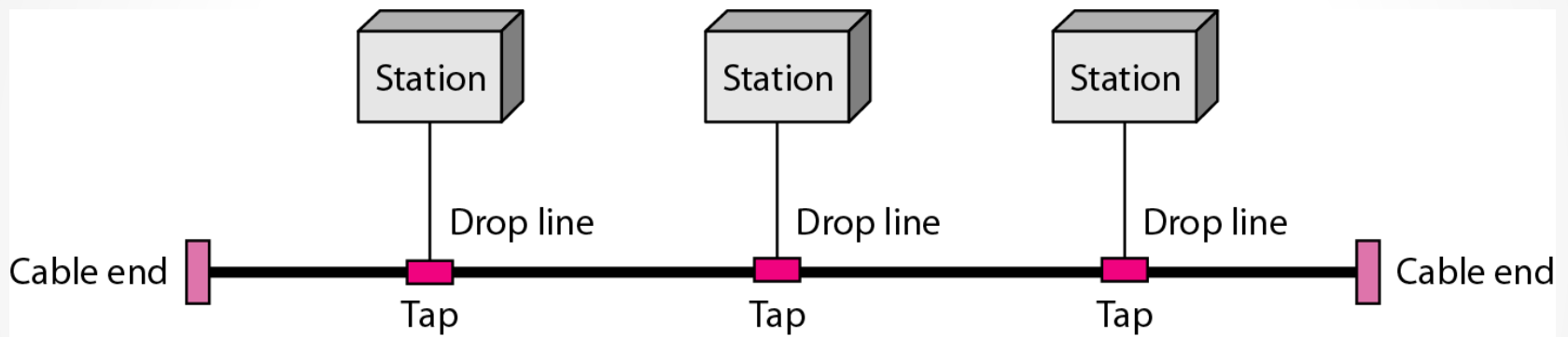
- Less expensive than Mesh Topology.
- Easy to install and reconfigure since each device needs only one link and one I/O port to connect it to any number of devices.
- It is robust; i.e. if one link fails, only that link is affected. All other links remain active.
- Easy fault identification and fault isolation.
- As long as hub is working, it can be used to monitor link problems and bypass defective links.

Disadvantages

- Dependency of the whole topology on a single point, the HUB. If hub goes down, the whole system is dead.
- Although a star requires far less cabling than a mesh, each node must be linked to a central hub. For this reason, often more cabling is required in a star than in some other topologies (such as ring or bus).

Bus Topology

- Mesh and Star topology had point-to-point links; whereas Bus Topology has multi-point links.
- One long cable acts as a backbone to link all the devices in a network.
- Nodes are connected to the bus cable by drop lines and taps.
- A drop line is a connection running between the device and the main cable.
- A tap is a connector that either splices into the main cable or punctures the sheathing of a cable to create a contact with the metallic core.



A bus topology connecting three stations

Advantages

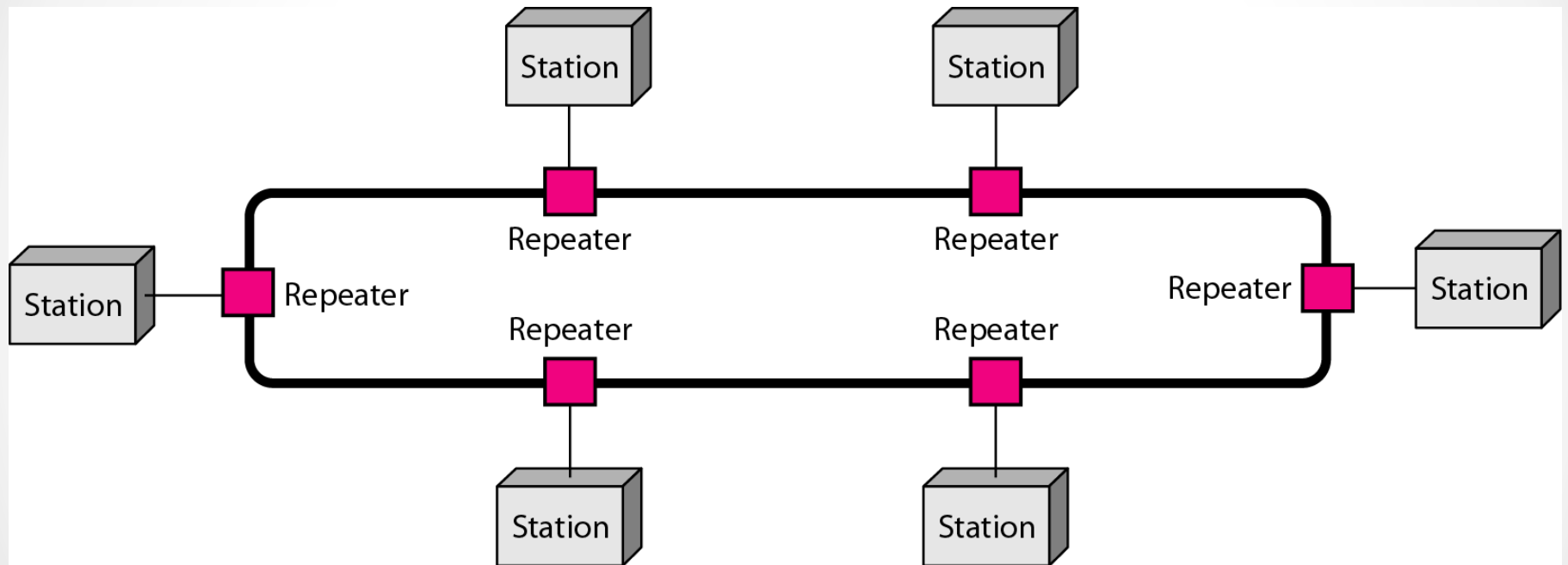
- Easy installation
- Backbone can be laid along the most efficient path, then connected to the nodes by drop lines of various lengths. In this way, a bus requires less cabling than mesh or star topology.

Disadvantages

- Difficult reconnection and fault isolation.
- A bus is usually designed to be optimally efficient at installation. It can therefore be difficult to add new devices.
- Signal reflection at the taps can cause degradation in quality.
- A fault or a break in the bus cable stops all transmission, even between devices on the same side of the problem.

Ring Topology

- In a Ring Topology, each device has a dedicated point-to-point connection with only two devices on either side of it.
- A signal is passed along the ring in one direction, from device to device, until it reaches its destination.
- Each device in the ring incorporates a repeater.
- When a device receives a signal intended for another device, its repeater regenerates the bits and passes them along.



A ring topology connecting six stations

Advantages

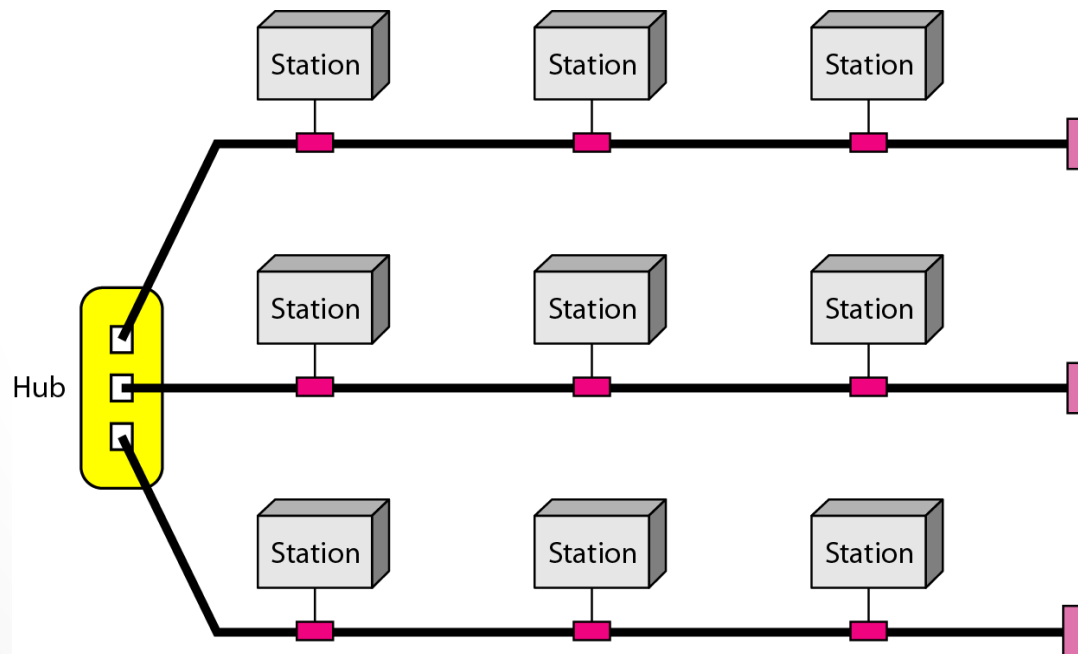
- A ring is relatively easy to install and reconfigure.
- Each device is linked to only its immediate neighbours. To add/delete a device, it requires only changing two neighbours.
- Simplified fault isolation.

Disadvantages

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

Hybrid Topology

- A network can be hybrid.
- For example, we can have a main star topology with each branch connecting several stations in a bus topology.



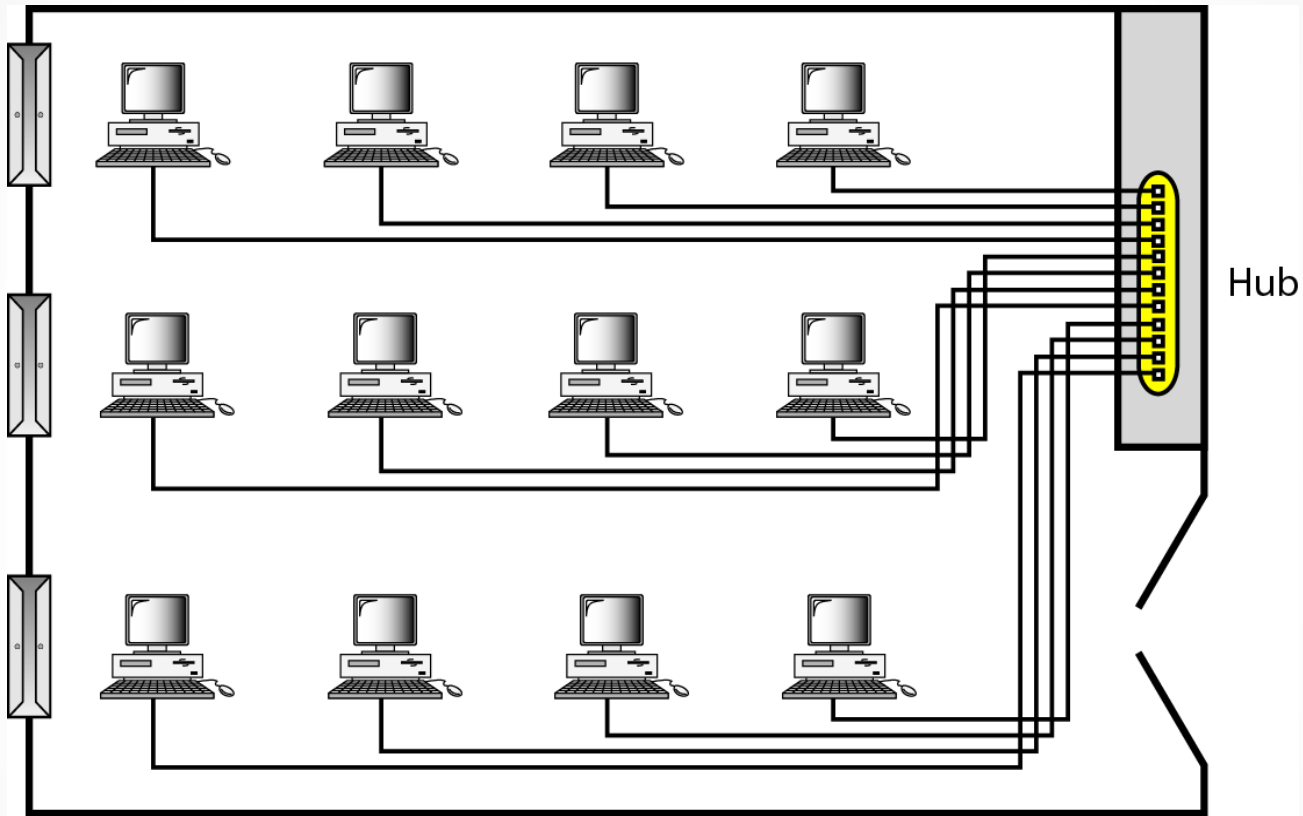
A hybrid topology: a star backbone with three bus networks

Categories of Networks

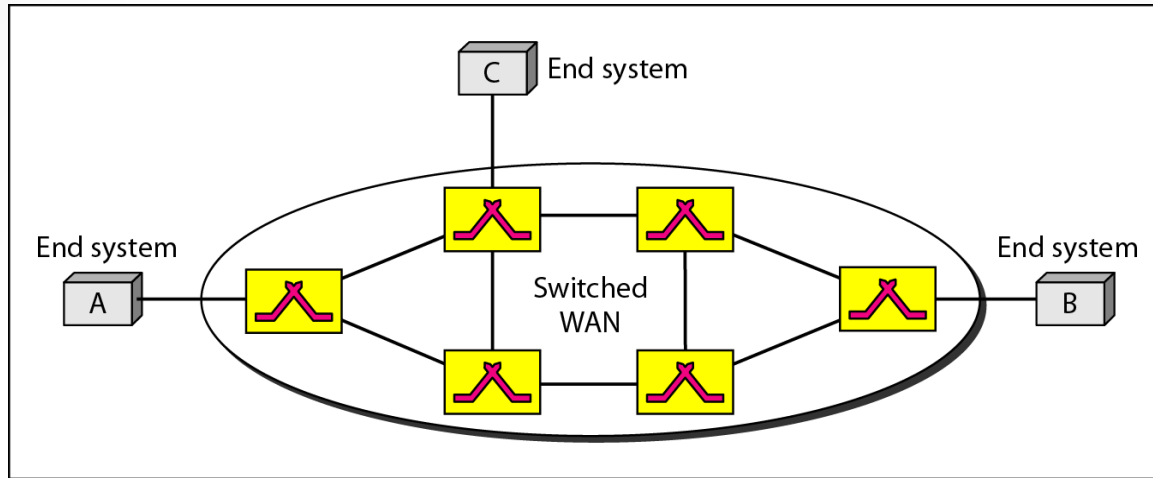
Local area
network
(LAN)

Metropolitan area
network
(MAN)

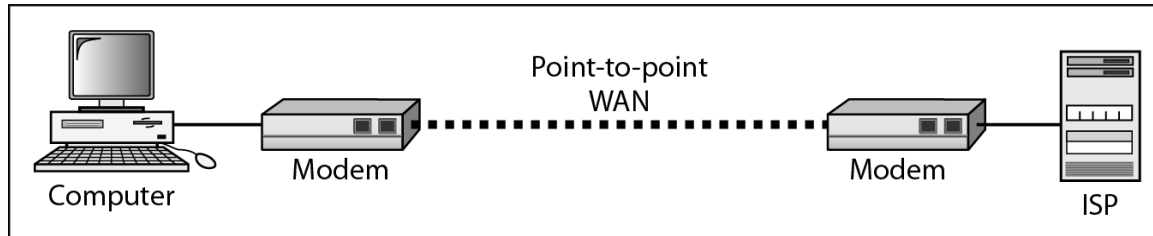
Wide area
network
(WAN)



An isolated LAN connecting 12 computers to a hub in a closet

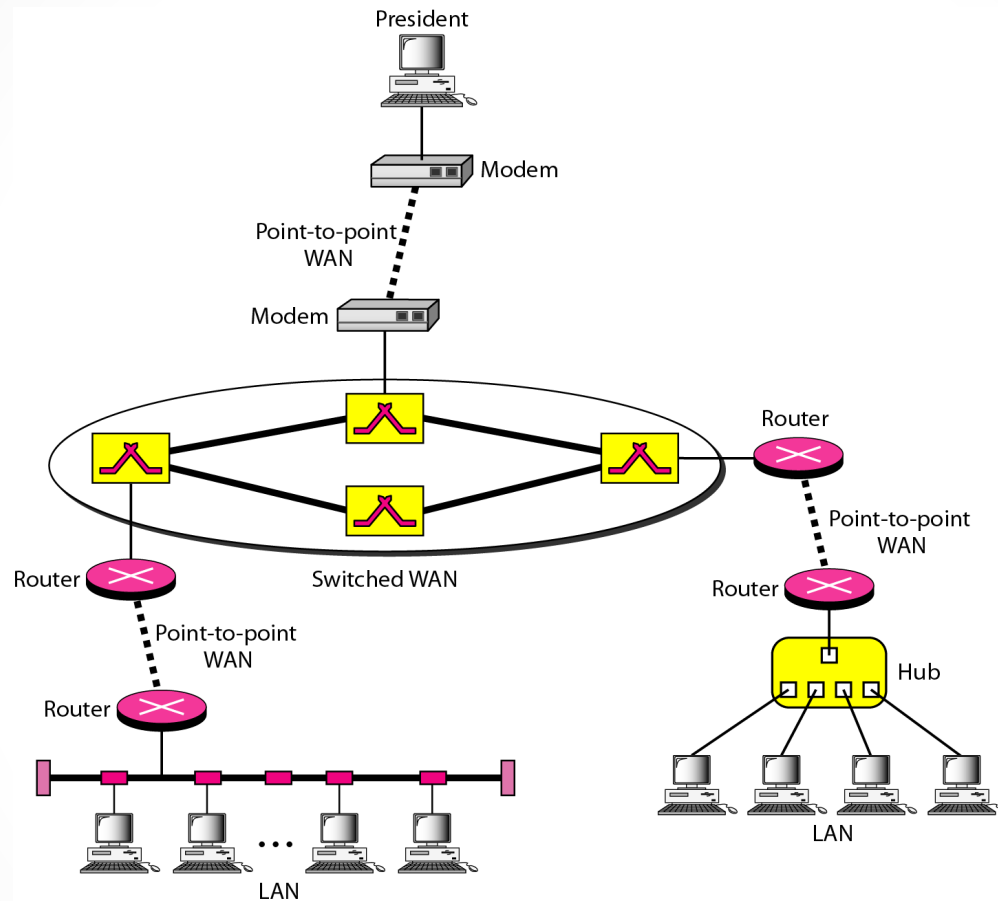


a. Switched WAN



b. Point-to-point WAN

WANs: a switched WAN and a point-to-point WAN



A heterogeneous network made of four WANs and two LANs