ECE 487: Data Communications Networks
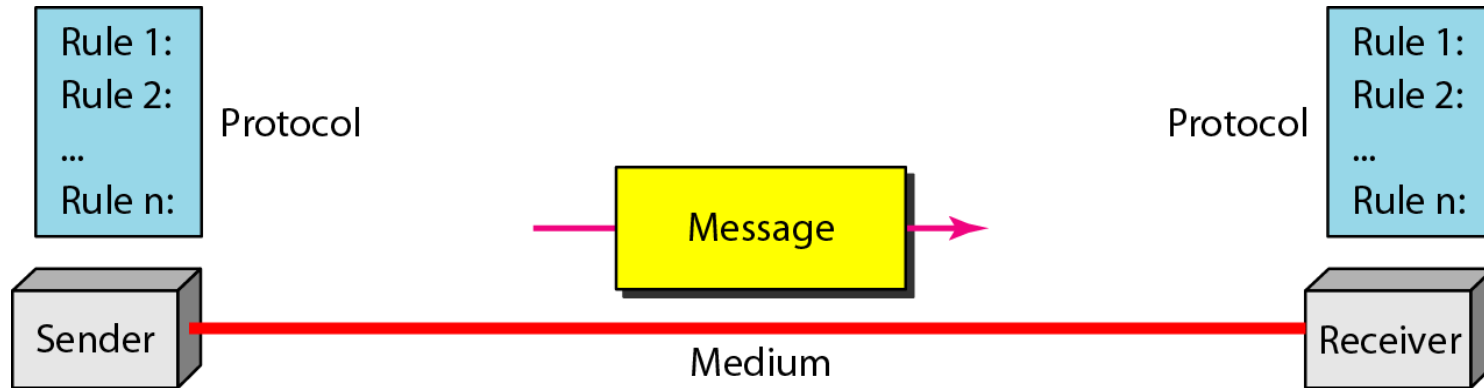
Lecture 1: Introduction

**(Chapter 1 of "Data Communications and Networking"
[B. A. Forouzan], 5th Edition)**
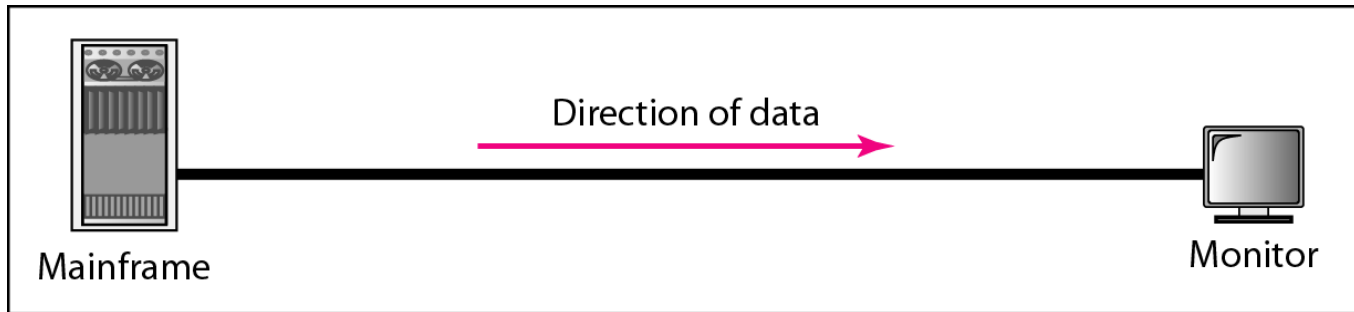
1-1 DATA COMMUNICATIONS

The term telecommunication means communication at a distance. The word data refers to information presented in whatever form 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.

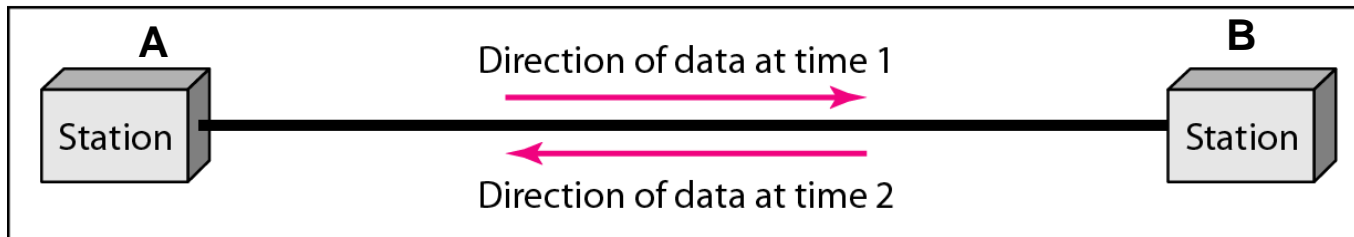# *Five components of data communication*
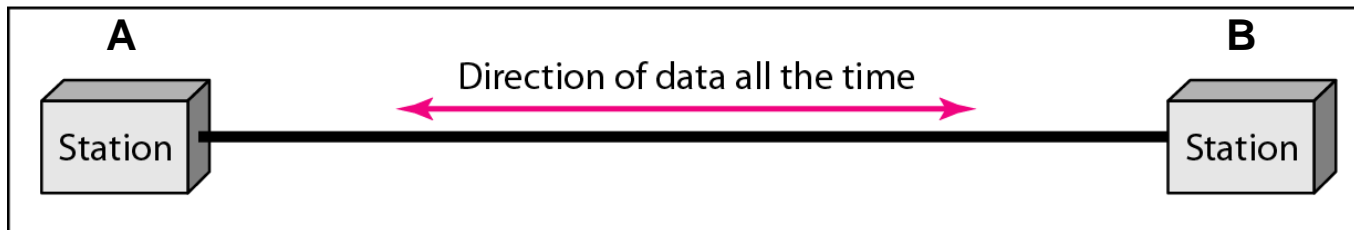
Data flow (simplex, half-duplex, and full-duplex)

Direction of data

Mainframe   **Monitor**

a. Simplex

A   **B**

Station   Direction of data at time 1   Station   **Walkie-talkies**

Direction of data at time 2

b. Half-duplex

A   **B**

Station   Direction of data all the time   Station
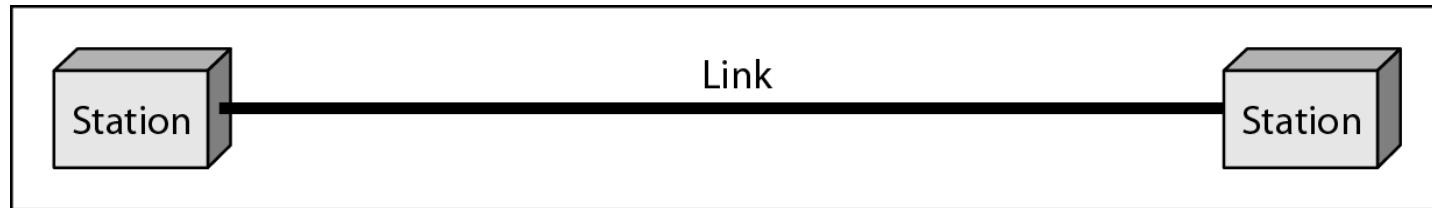
c. Full-duplex

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*

  - *A link can be copper wire, fiber optics, radio, microwaves, etc.*
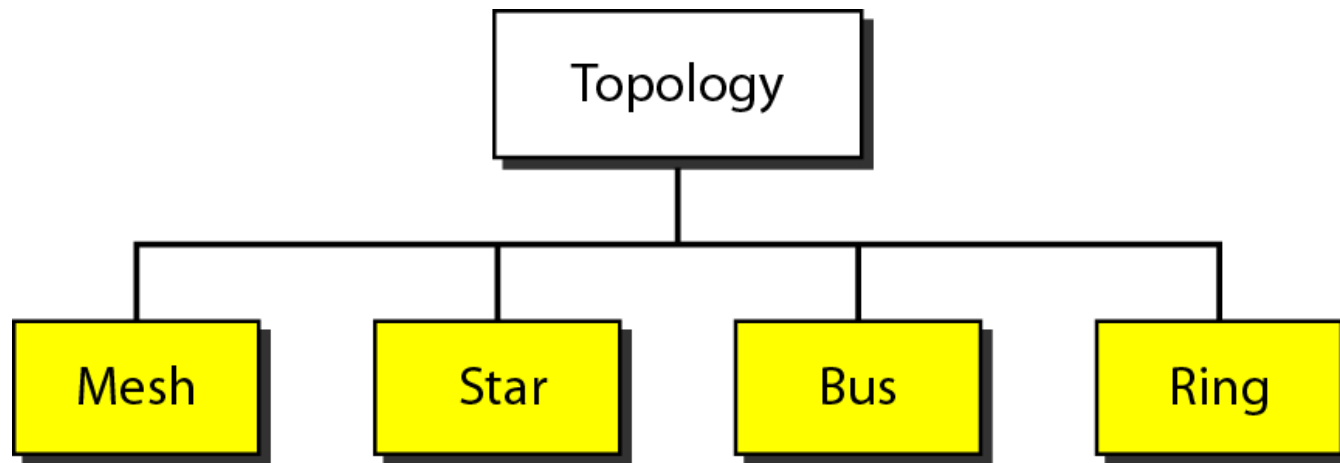
Types of connections: point-to-point and multipoint
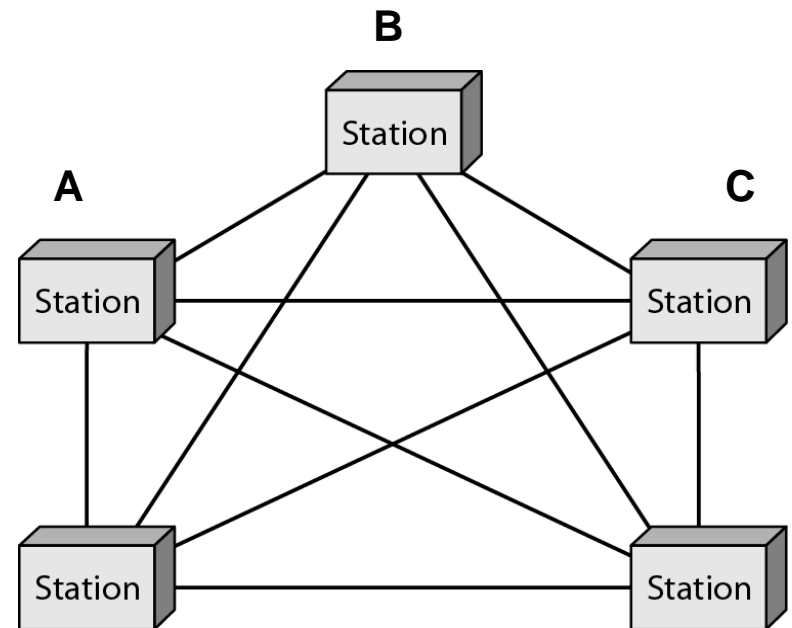

a. Point-to-point
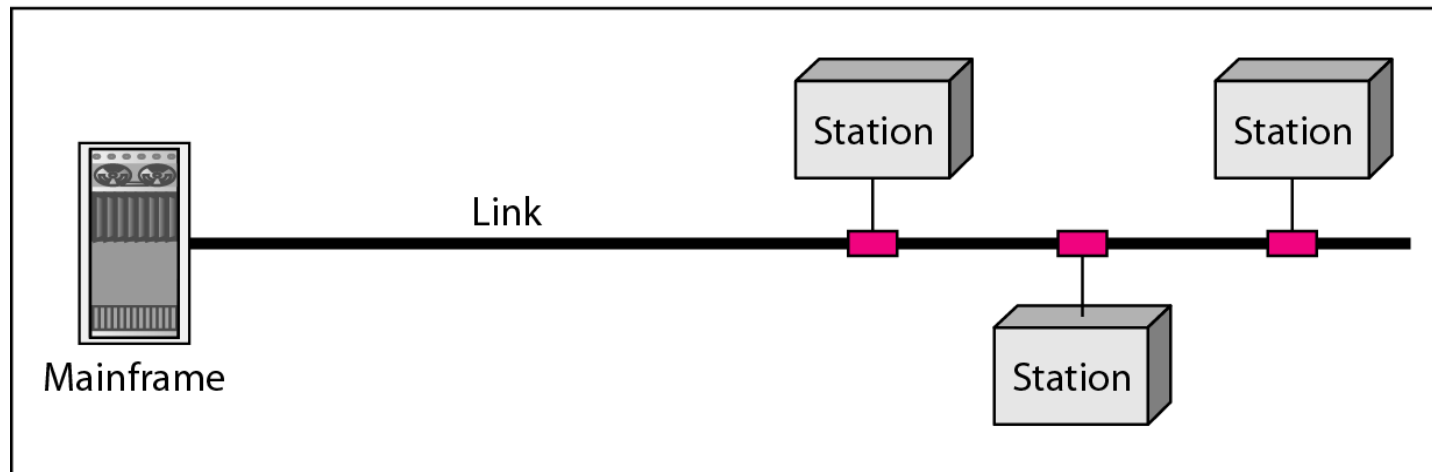
b. Multipoint

# *Categories of topology*

Mesh Topology

- **A dedicated point-to-point link for every device pair**

- **Advantages**
  - Robust
  - Privacy
  - Easy to identify faults

- **Disadvantages:**
  - Hardware (cabling, I/O ports)

- **Application examples:**
  - Backbone connecting

Star topology

- **A dedicated point-to-point link for each device to a central controller**

- **No direction link between two devices**

- **Advantages**
    - Less expensive than mesh topology
    - Privacy, easy to identify faults

- **Disadvantages:**
    - If the hub goes down …

- **Application examples:**
    - Local area networks (LANs)

Hub/router/switch

Station   Station   Station   Station

A   **B**   **C**   **D**
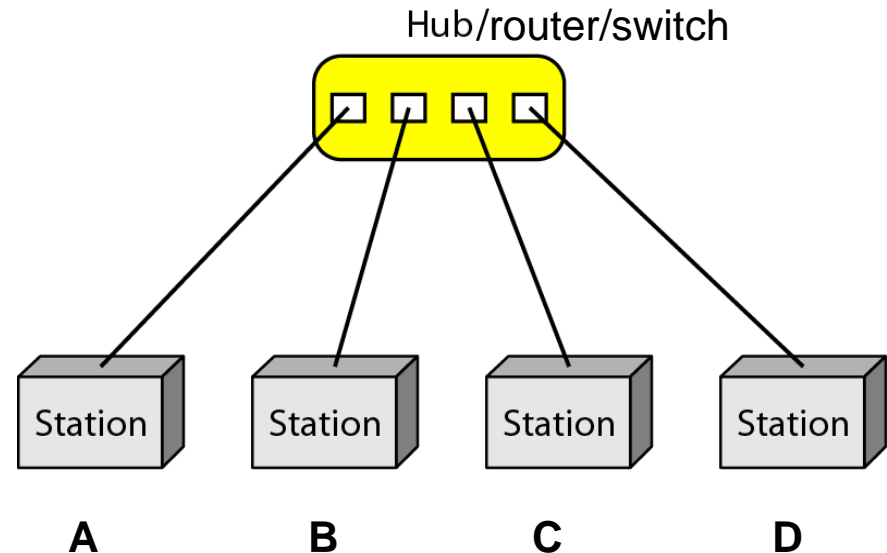
1.9 If a hub is used, we do not have privacy, since for a hub, signal received at one port is just repeated at all other ports. If switch/router is used, we have privacy, since switch/route sends signal received at a port to only the target port.
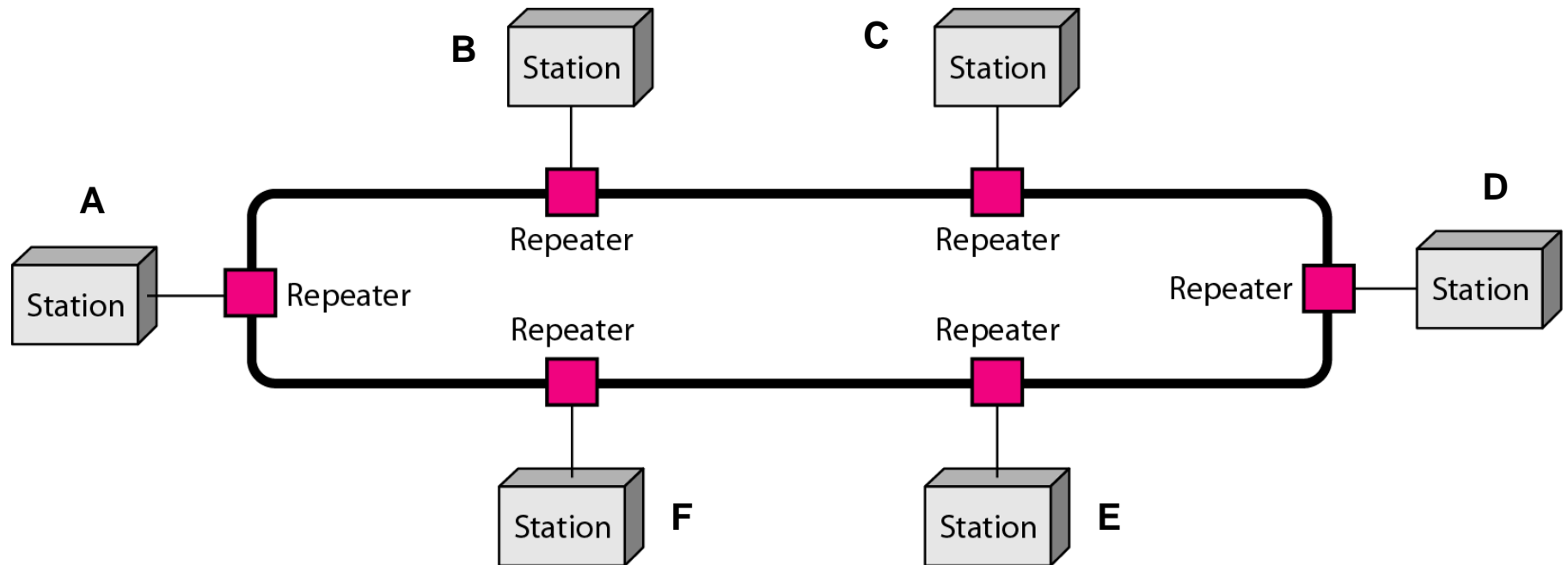
Bus topology
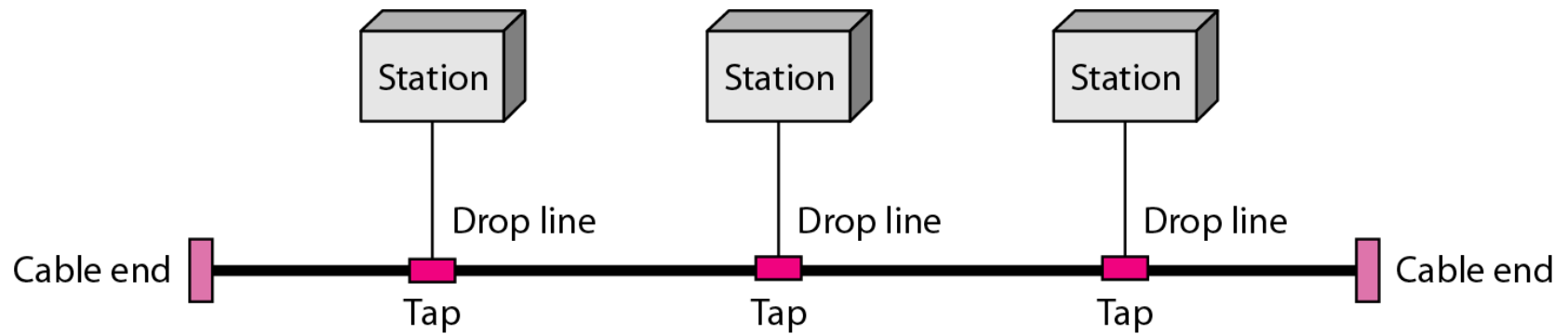
Bus topology (cont'd)

- **Nodes connected to the bus cable by drop lines and taps**

- **Signal becomes weaker as it travels further →Limit on # of taps and on distance between taps**

- **Advantages**

  - Easy to implement

- **Disadvantages:**

  - Difficult reconnection and difficult fault isolation.

  - Signal reflection causes quality degradation → Hard to add new nodes

  - A fault in the bus cable stops all transmissions, even between devices on the same side of the problem

- **Application examples:**

  - Local area networks (LANs)

Ring topology

Ring topology (cont'd)

- **Each device connected to only its immediate neighbors**

- **A signal is circulating in one direction, until its destination**

- **Advantages**

  - Easy to implement

  - Easy to reconfigure (adding or deleting affects only two connections)

  - Fault isolation

- **Disadvantages:**

  - Unidirectional traffic → any break disables the entire network

- **Application examples:**

  - Local area networks (LANs)

# A hybrid topology: a star backbone with three bus networks
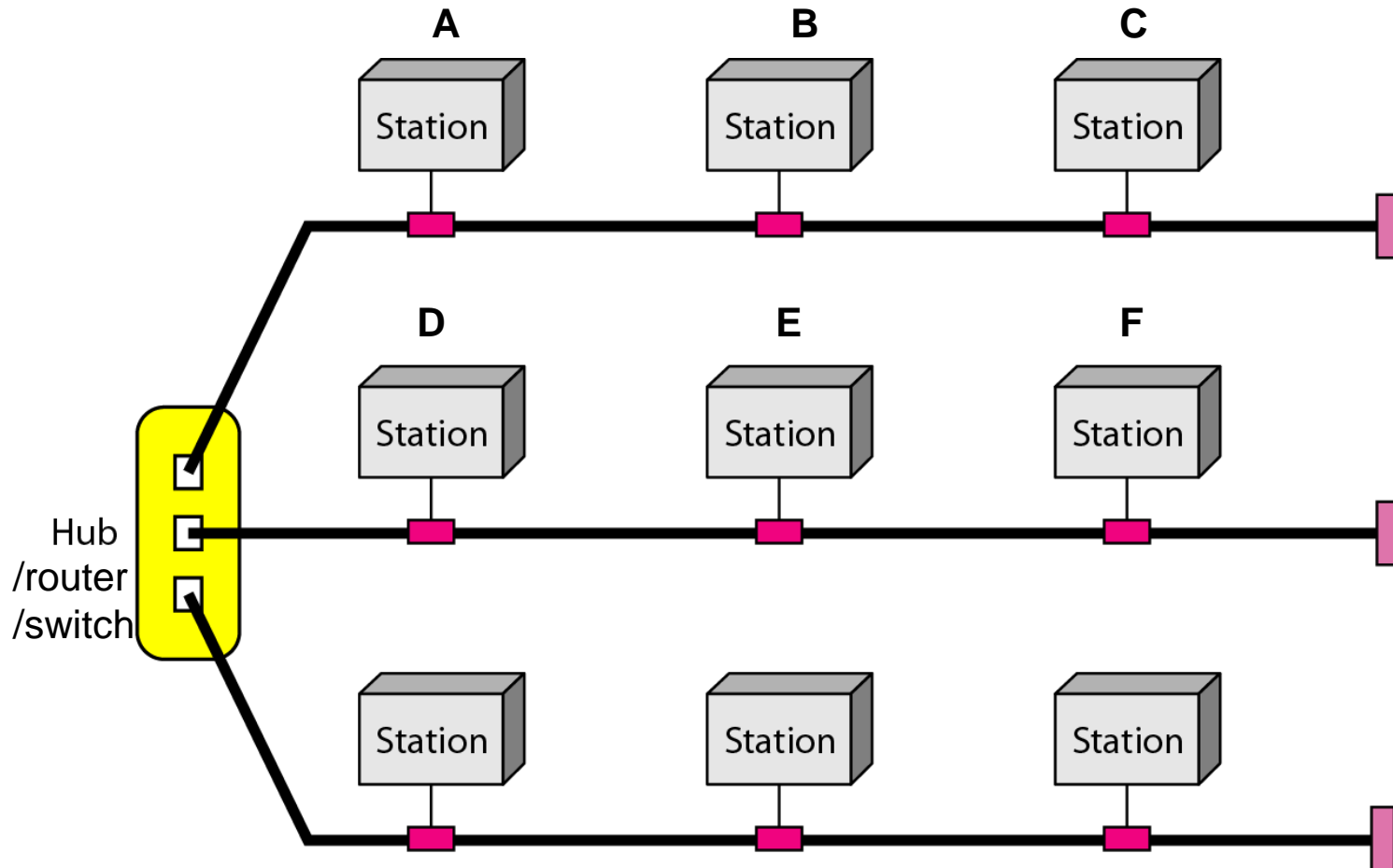
What happens if one station sends to its neighbour?

Categories of networks

- **Local area network (LAN)**

  - For resource sharing in a local area (office, campus, etc.)

  - A few kilometers

  - One type of transmission medium for a given LAN

  - 4Mbps (early LAN) → more than 1Gbps

  - Common topologies: bus, ring, star

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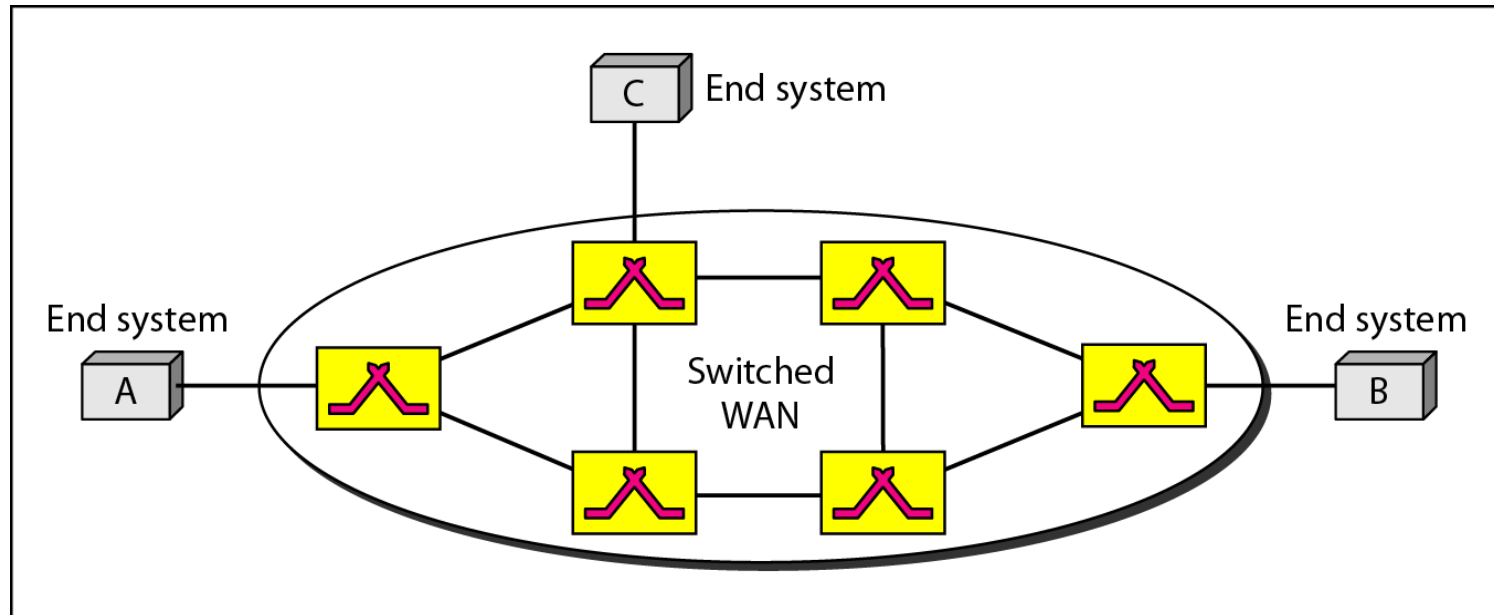

Hub/router/switch
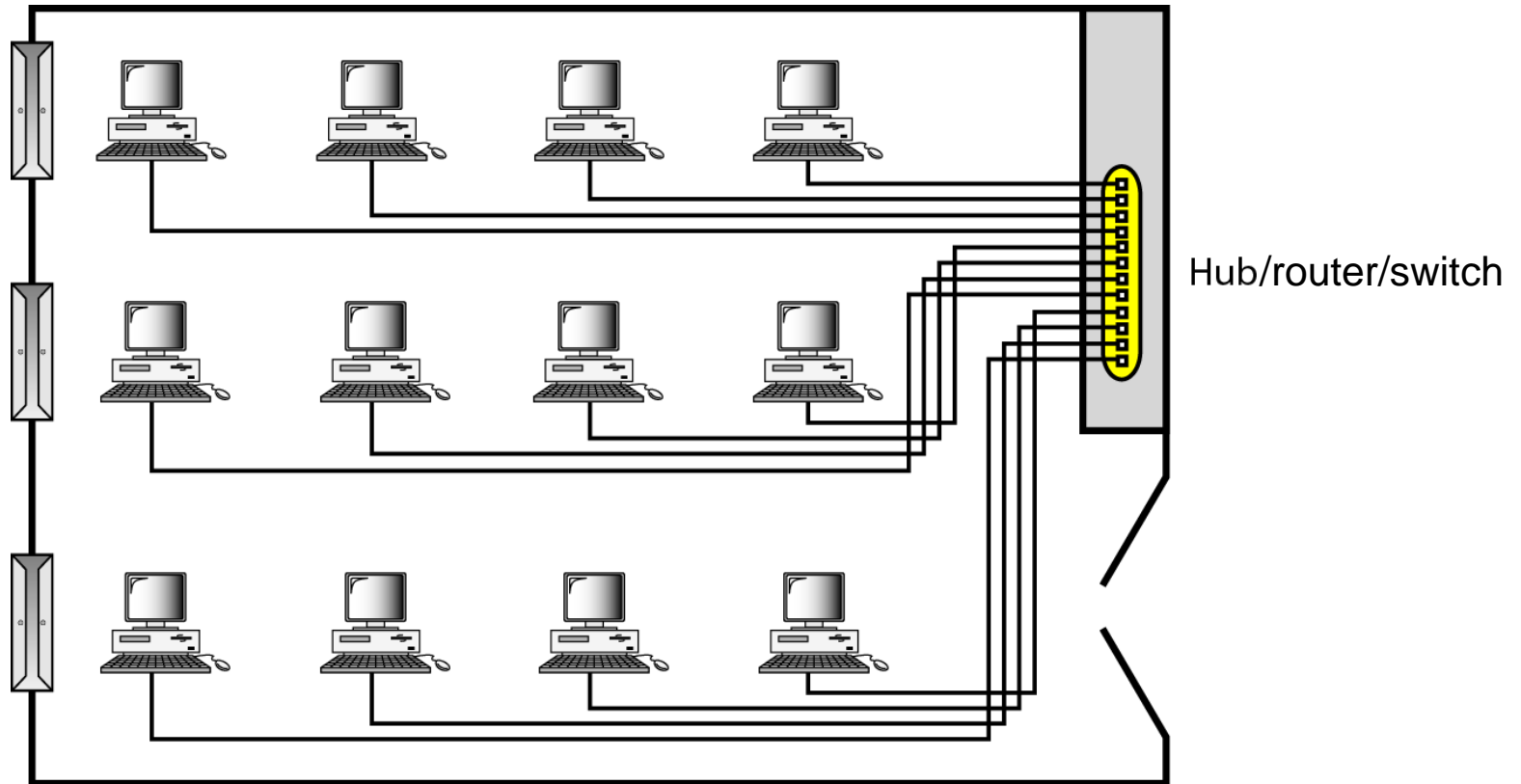
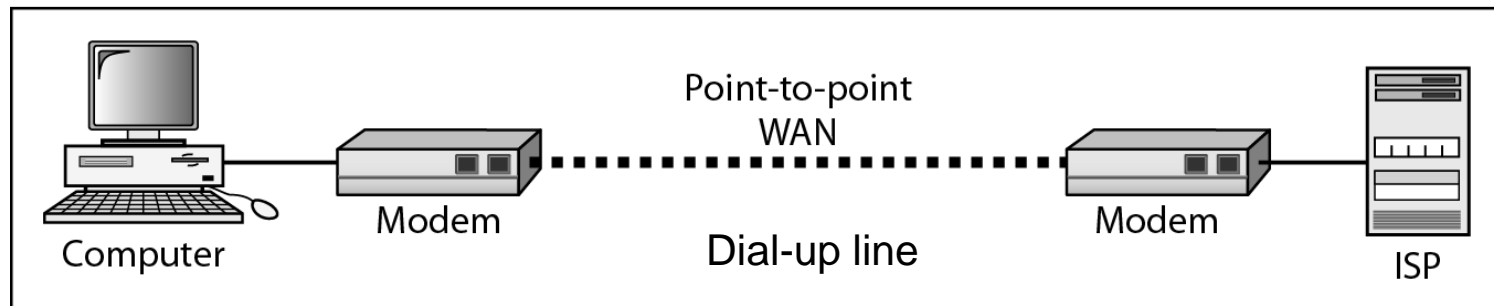# *Categories of networks (continued)*

- **Wide area network (WAN)**

    - Long-distance transmission of information: a country, a continent, or the world

    - As complex as the Internet backbones (switched WAN); or as simple as a dial-up line connecting a home computer to the Internet (point-to-point WAN)

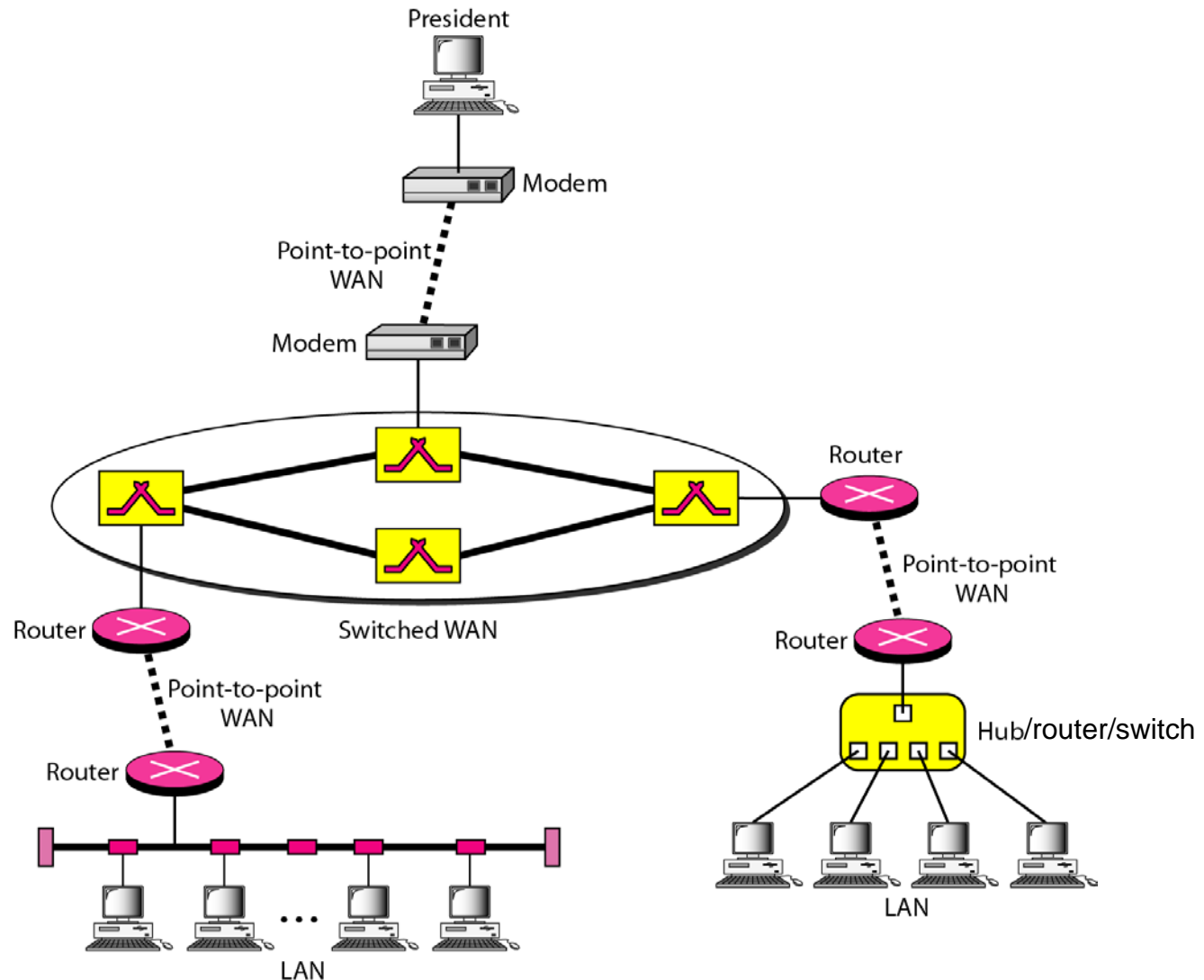# WANs: a switched WAN and a point-to-point WAN

a. Switched WAN

b. Point-to-point WAN

Modem: for conversion between computer digital data and analog data signal suitable for transmission over telephone lines

Interconnection of networks

A heterogeneous network made of four WANs and two LANs

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.*

The Internet is made up of many wide- and local-area networks joined by connecting devices and switching stations.

1-4   PROTOCOLS AND STANDARDS

- **Protocol: a set of rules govern data communications**

- **Standard: protocol widely recognized**

  - Standard organizations: International Organization for Standardization (ISO), American National Standards Institute (ANSI), institute of Electrical and Electronics Engineers (IEEE), etc.

  - Regulatory agencies: e.g., Federal Communications Commission (FCC), to protect the public interest by regulating radio, television, and wire/cable communications.
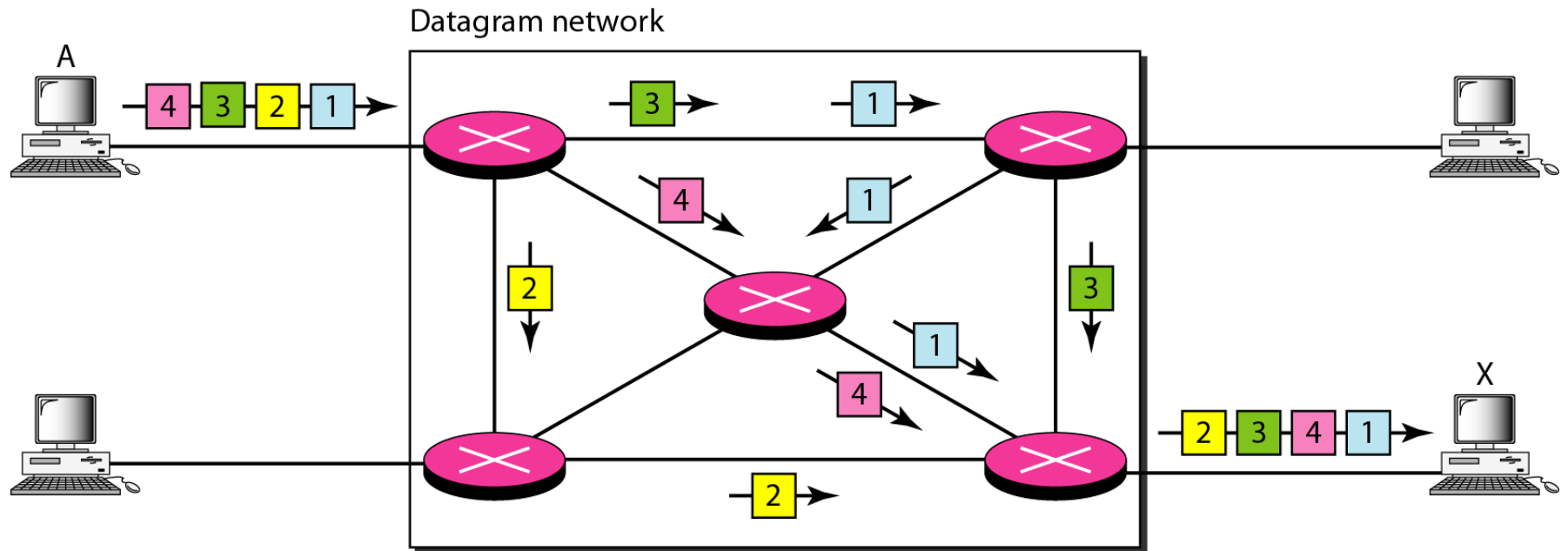
1-5 CIRCUIT SWITCHING vs. PACKET SWITCHING

- Circuit switching: a circuit is set up between two terminals for the duration of the conversation. Resources (bandwidth, time slot, etc) are reserved among the circuit, which are used by the two terminals exclusively. The circuit is released when the call terminates. Example: telephone network.

- Packet switching: packets can follow different paths to the destination. The resources in the network can be shared by many connections. Example: Internet.

1.22

	Circuit switching	Packet switching
Dedicated path	Yes	No
Bandwidth available	Fixed	Dynamic
Potential waste	Yes	No
Store and forward	No	Yes
Call setup	Yes	No need
congestion	At setup time	On every packet
Charge	Per minute	Per packet
Same route/all packets	Yes	No

Packet switching

Datagram network

- Telephone network: designed for voice conversation (very likely with constant rate). Less suited to data (e.g., email, ftp, web browsing, etc) and other nonconversational transmissions. Nonvoice transmissions tend to be bursty, i.e., data come in spurts with idle gaps between them.

- Internet: suited to data transmission. It provides best-effort services, with no guarantee on the delays or even the loss rate of the transmissions. The network is not reliable and offers no security.
  - Self-organizing: the packets find their way to their destination even a link or a router breaks down.

- Technology
  - Information transmission capacity
  - Signal processing technology
  - Digital computer technology
  - ...
- Regulation
- Market
- Standards