Introduction to Computer Networks

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.

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Data communications are the exchange of data between two devices *via* some form of transmission medium such as a wire cable.

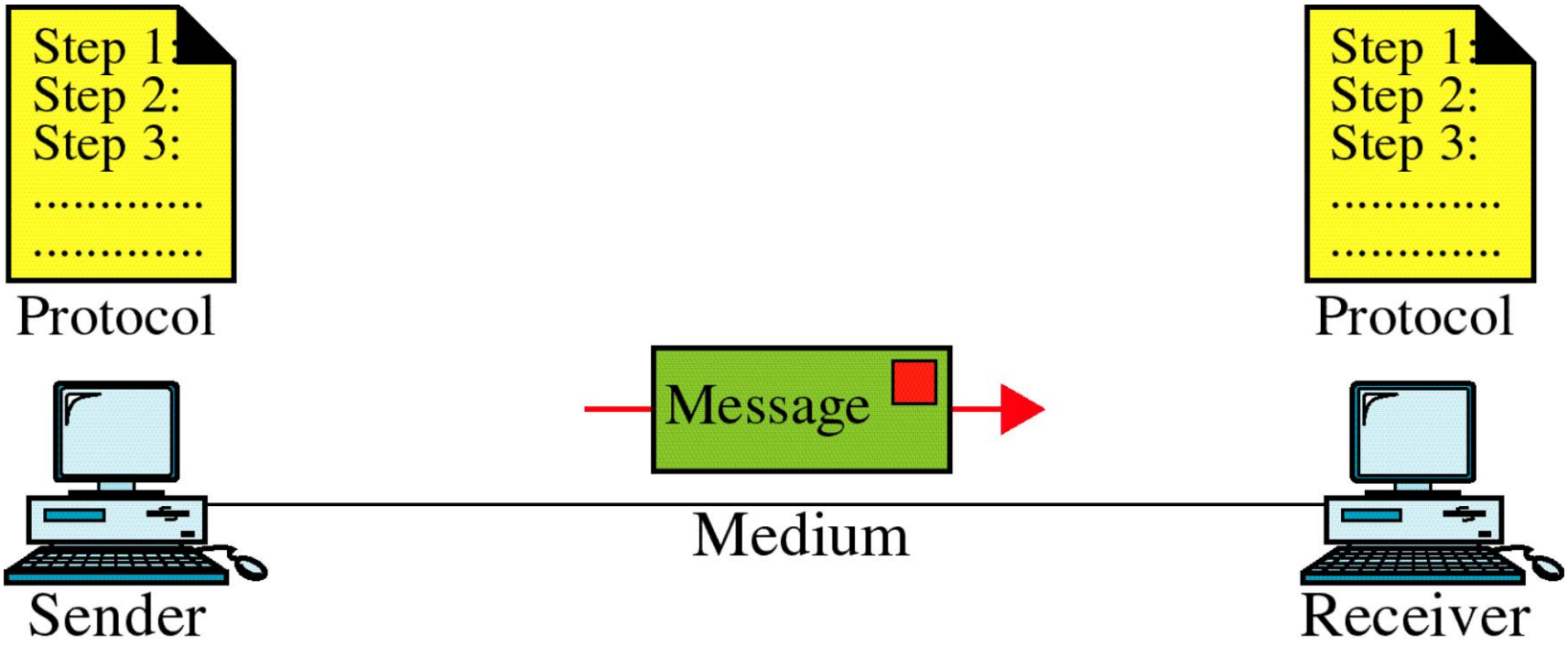
For data communications to occur, the communicating devices must be part of a communication system made up of a combination of hardware (physical equipment) and software (programs)

The effectiveness of a data communications system depends on four fundamental characteristics: delivery, accuracy, timeliness, and jitter.

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

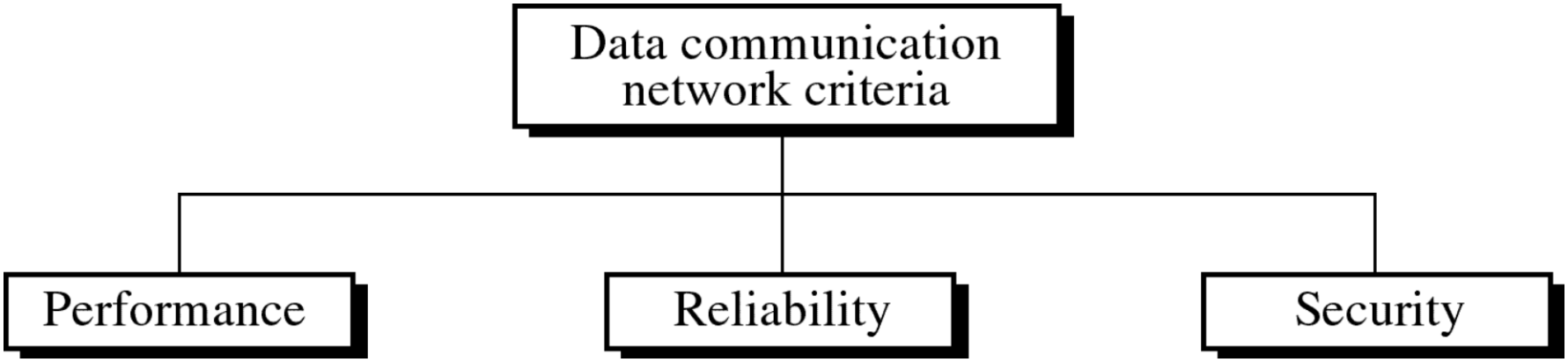
- **Timeliness:** The system must deliver data in a timely manner. Data delivered late are useless. In the case of video and audio, timely delivery means delivering data as they are produced, in the same order that they are produced, and without significant delay. This kind of delivery is called real-time transmission.
- **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 3D ms. If some of the packets arrive with 3D-ms delay and others with 4D-ms delay, an uneven quality in the video is the result.

Data Communication System Components



- **Message:** The message is the information (data) to be communicated. Popular forms of information include text, numbers, pictures, audio, and video.
- **Sender**: The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera, and so on.
- **Receiver:** The receiver is the device that receives the message. It can be a computer, workstation, telephone handset, television, and so on.

- **Transmission medium**: The transmission medium is the physical path by which a message travels from sender to receiver. Some examples of transmission media include twisted-pair wire, coaxial cable, fiber-optic cable, and radio waves.
- **Protocol:** A protocol is a set of rules that govern data communications. It represents an agreement between the communicating devices. Without a protocol, two devices may be connected but not communicating, just as a person speaking French cannot be understood by a person who speaks only Japanese.


Data communication network criteria
Performance
Reliability
Security

1. Performance: Performance can be measured in many ways, including transit time and response time.

- Transit time is the amount of time required for a message to travel from one device to another.
- Response time is the elapsed time between an inquiry and a response.

The performance of a network depends on a number of factors, including the **number of users**, the **type of transmission medium**, the **capabilities of the connected hardware**, and the **efficiency of the software**.

Performance is often evaluated by two networking metrics:

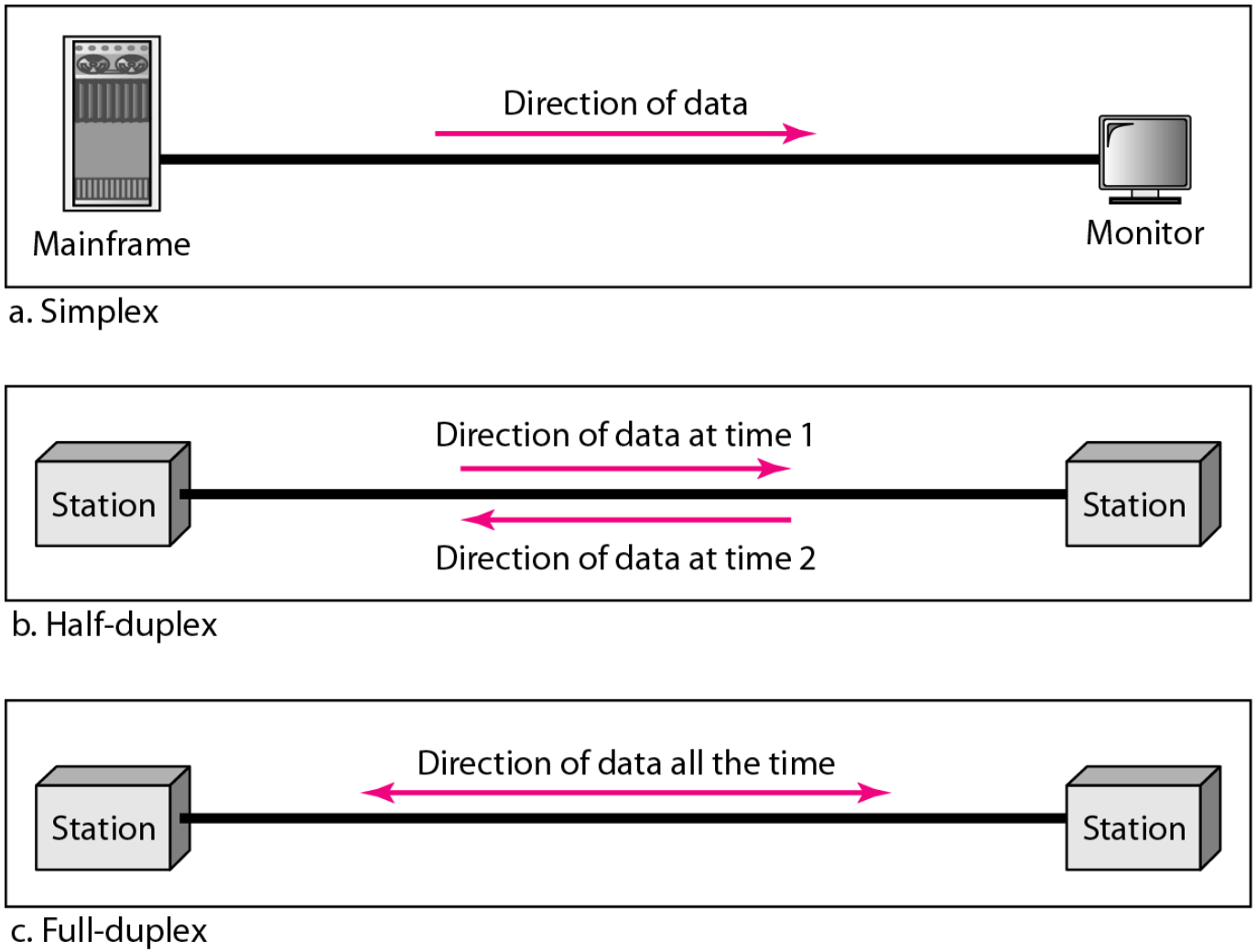
- Throughput
- Delay

We often need more throughput and less delay. However, these two criteria are often contradictory. If we try to send more data to the network, we may increase throughput but we increase the delay because of traffic congestion in the network

2. Reliability: In addition to accuracy of delivery, network reliability is measured by the frequency of failure, the time it takes a link to recover from a failure, and the network's robustness in a catastrophe.

3. Security: Network security issues include protecting data from unauthorized access, protecting data from damage and development, and implementing policies and procedures for recovery

Data flow (simplex, half-duplex, and 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. A link can be a cable, air, optical fiber, or any medium which can transport a signal carrying information.

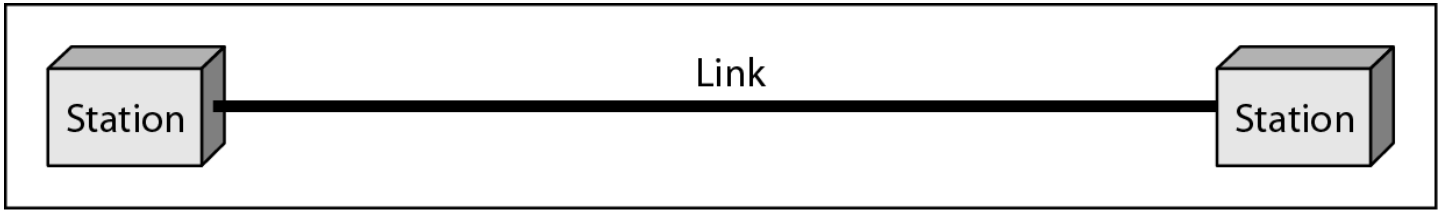
Network Criteria

- **Performance**
  - **Depends on Network Elements**
  - **Measured in terms of Delay and Throughput**
- **Reliability**
  - **Failure rate of network components**
  - **Measured in terms of availability/robustness**
- **Security**
  - **Data protection against corruption/loss of data due to:**
    - **Errors**
    - **Malicious users**

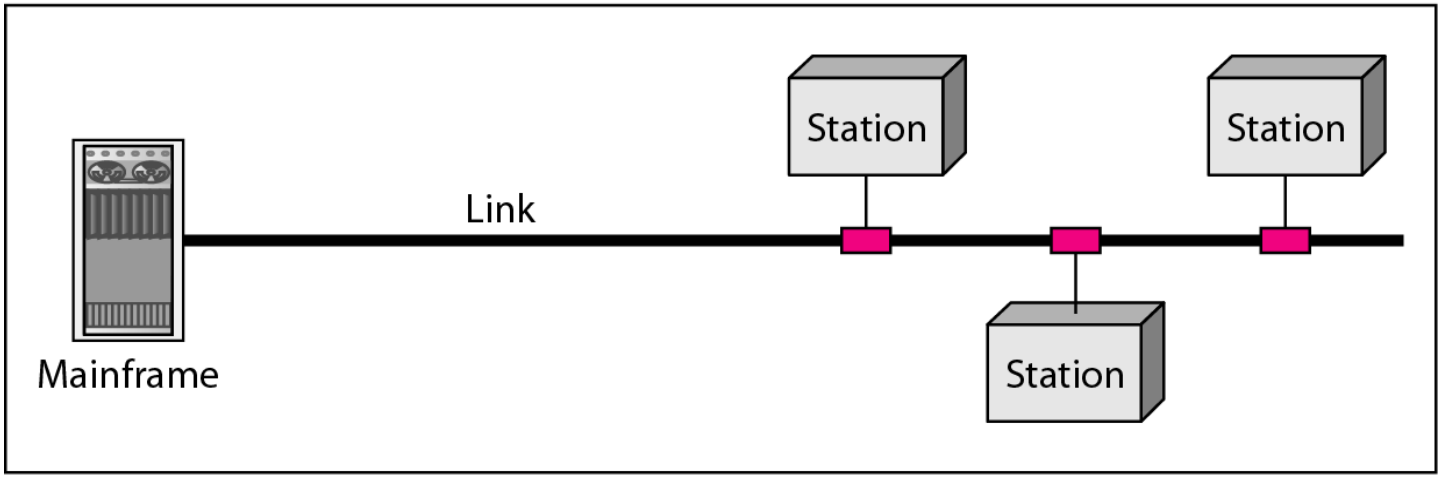
Physical Structures

- **Type of Connection**
  - **Point to Point - single transmitter and receiver**
  - **Multipoint - multiple recipients of single transmission**
- **Physical Topology**
  - **Connection of devices**
  - **Type of transmission - unicast, mulitcast, broadcast**

Types of connections: point-to-point and multipoint

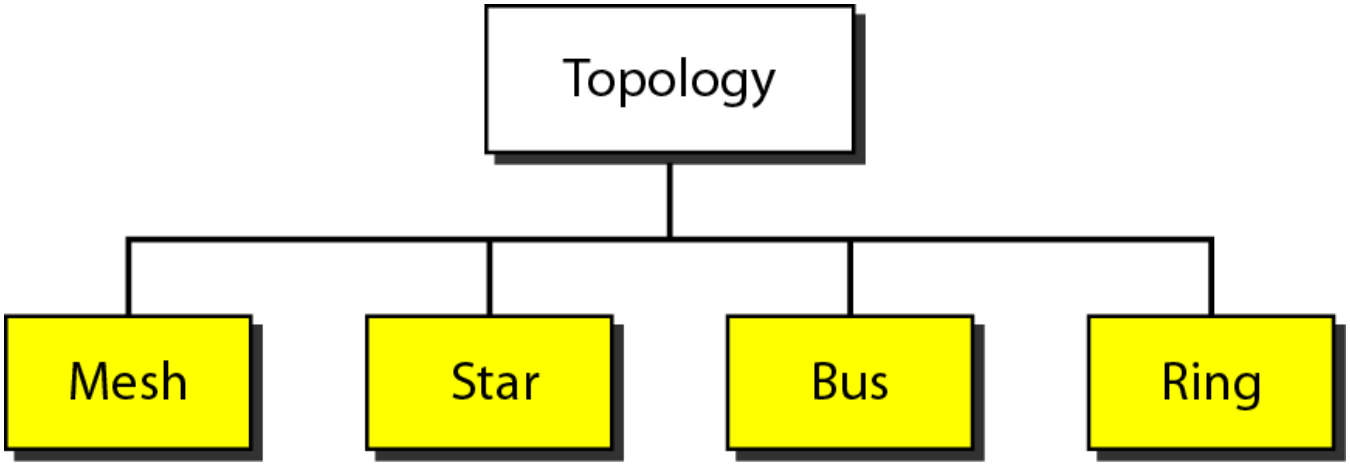


a. Point-to-point

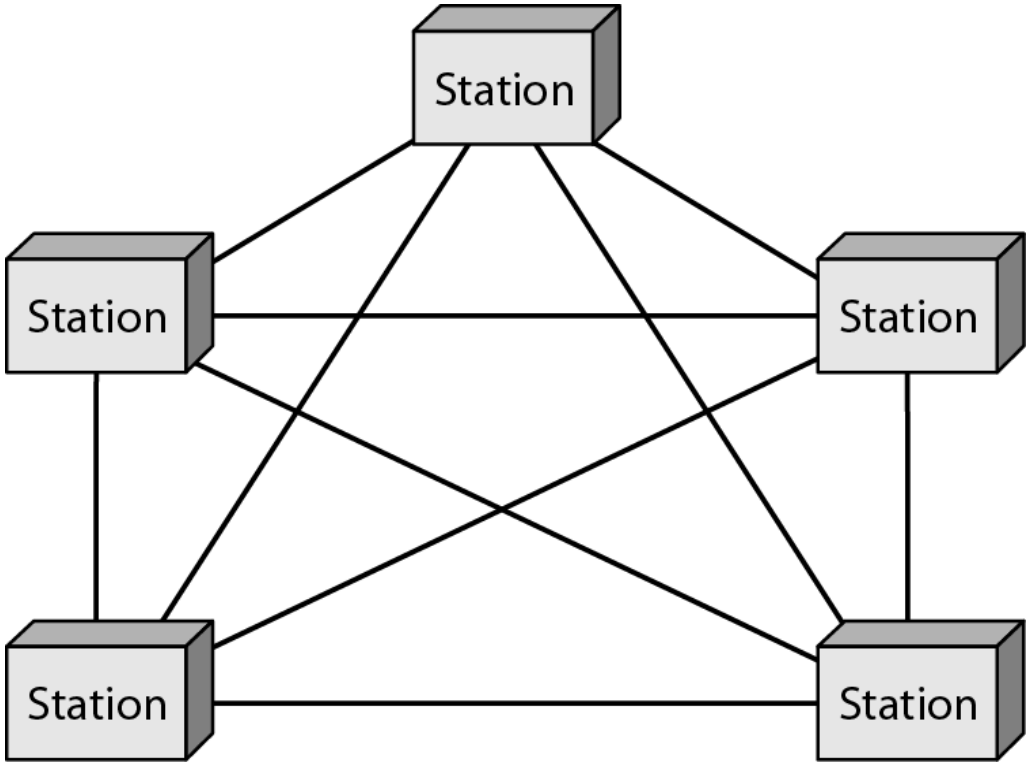


b. Multipoint

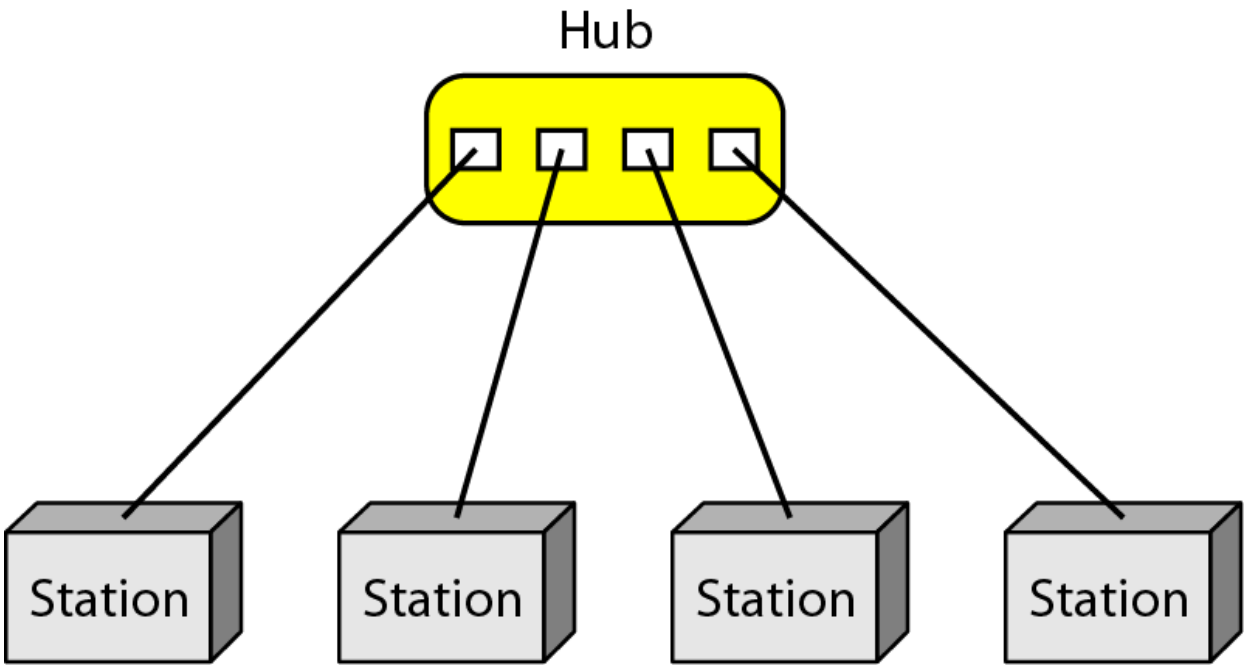
Categories of topology



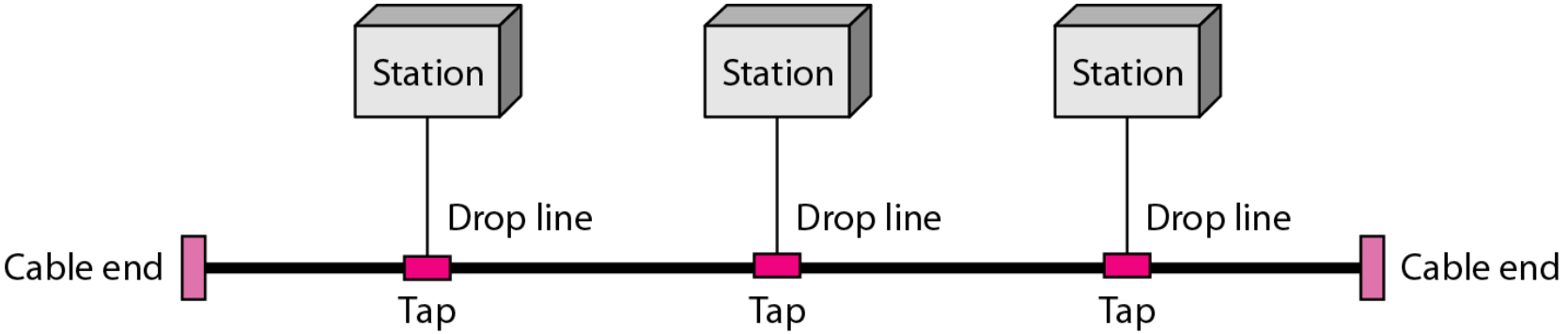
A fully connected mesh topology (five devices)



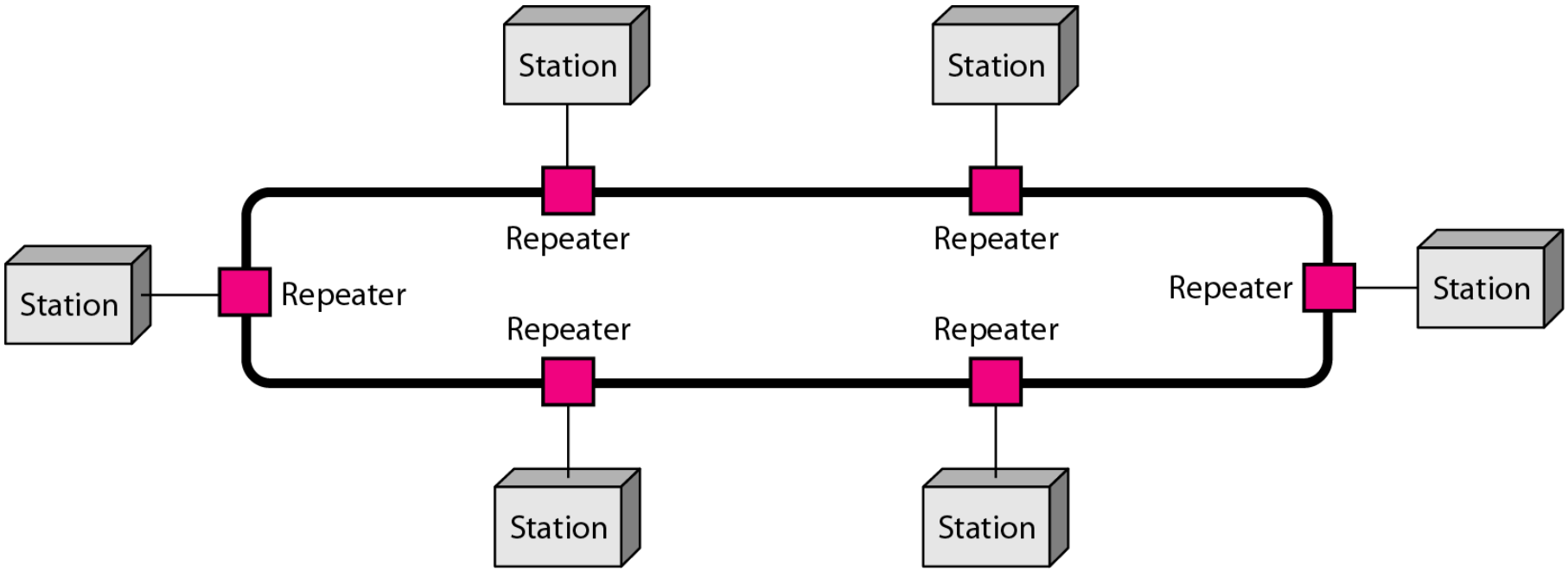
A star topology connecting four stations



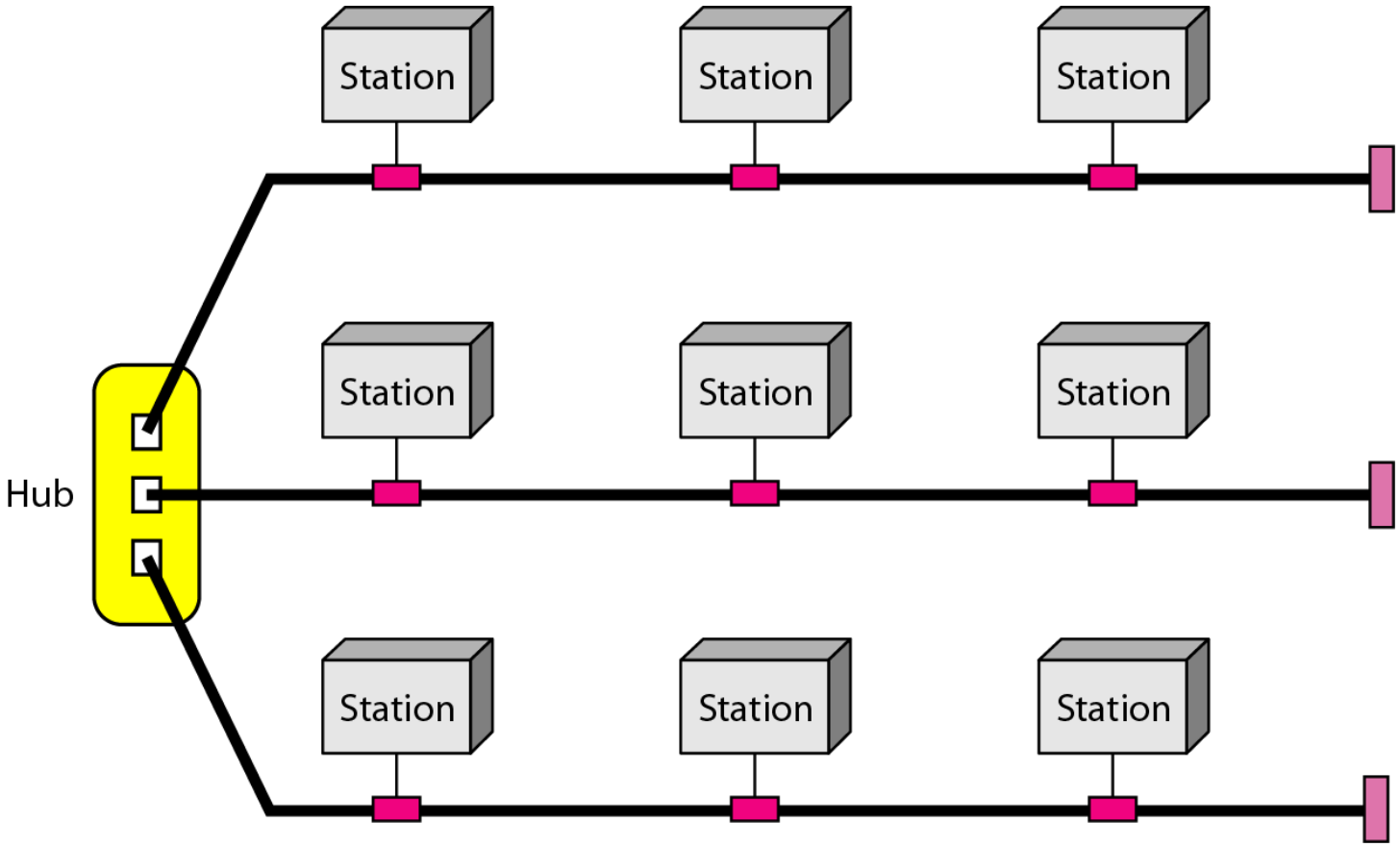
A bus topology connecting three stations



A ring topology connecting six stations



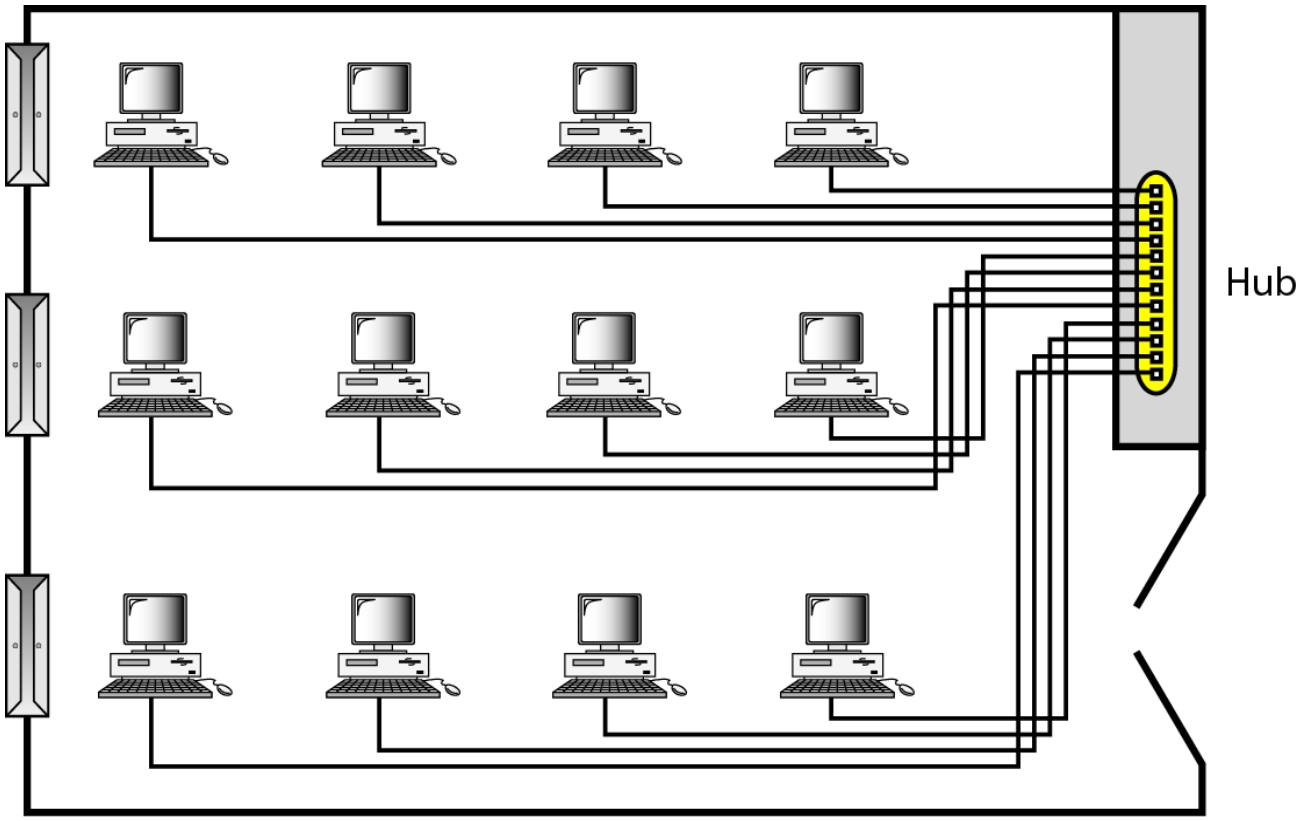
A hybrid topology: a star backbone with three bus networks



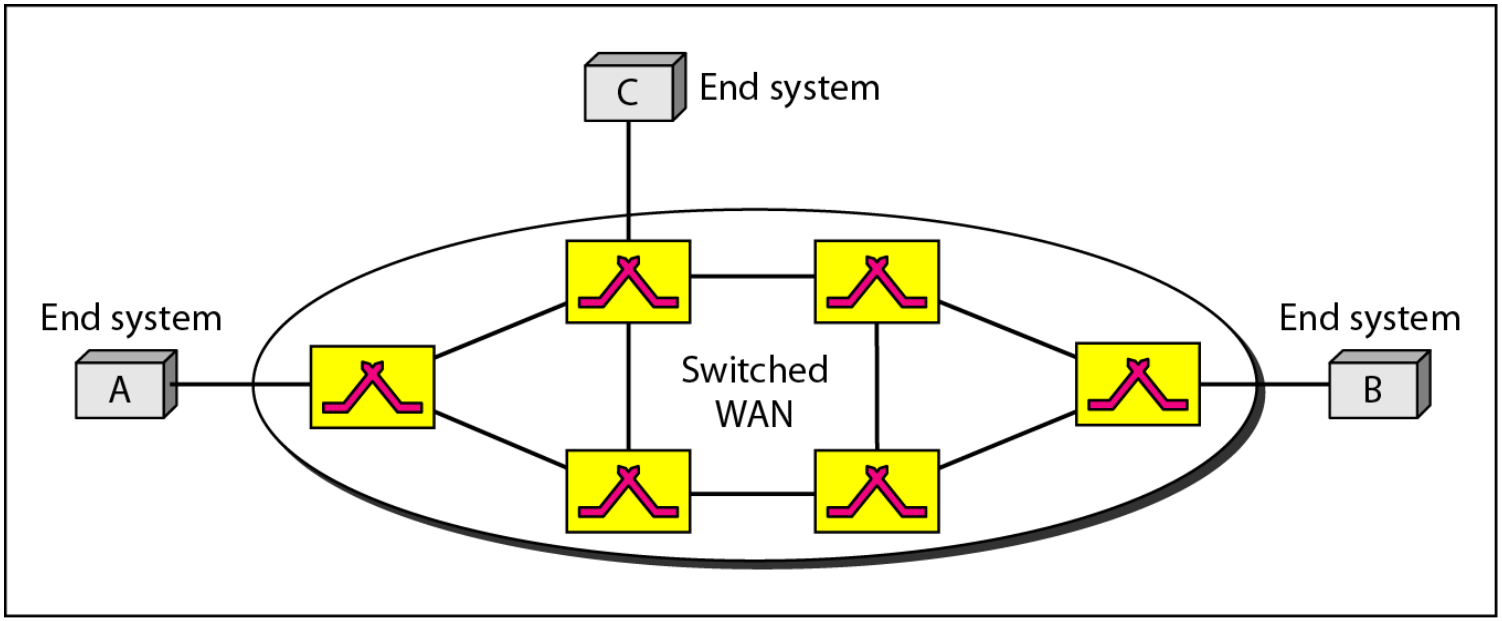
Categories of Networks

- Local Area Networks (LANs)
  - Short distances
  - Designed to provide local interconnectivity
- Wide Area Networks (WANs)
  - Long distances
  - Provide connectivity over large areas
- Metropolitan Area Networks (MANs)
  - Provide connectivity over areas such as a city, a campus

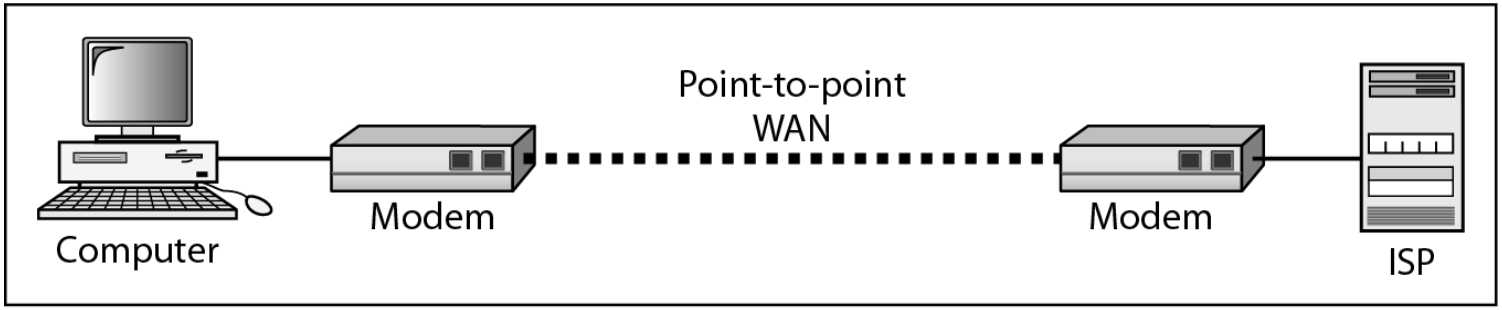
An isolated LAN connecting 12 computers to a hub in a closet



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

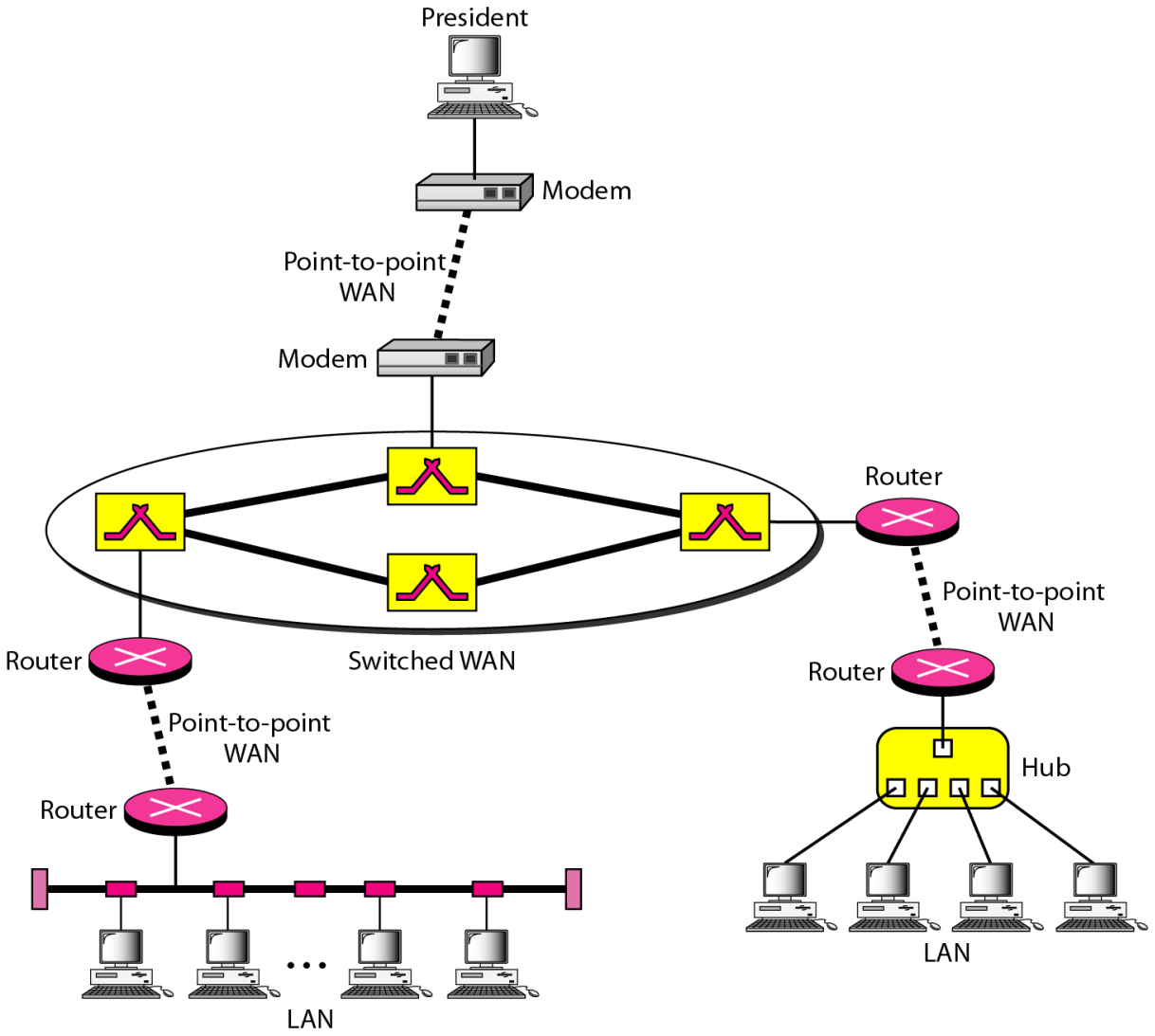


a. Switched WAN



b. Point-to-point WAN

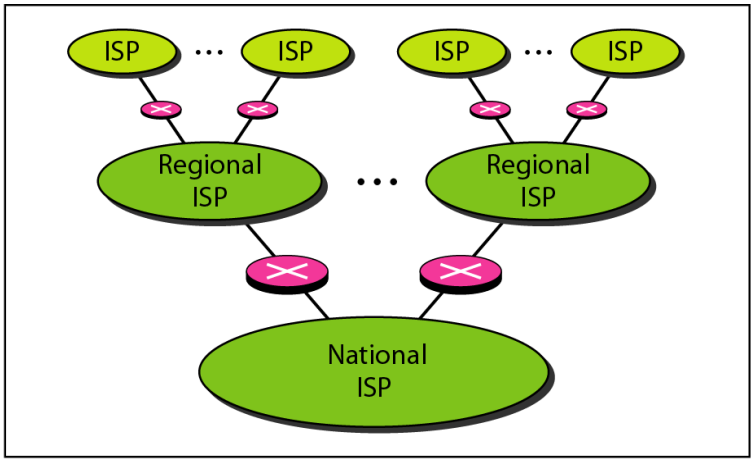
A heterogeneous network made of four WANs and two LANs



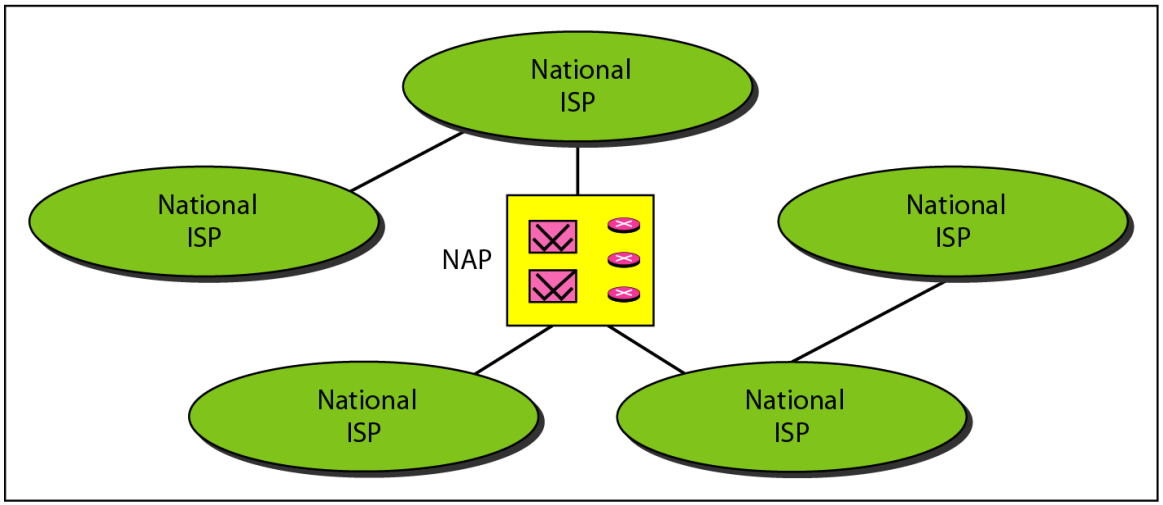
THE INTERNET

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.

Hierarchical organization of the Internet



a. Structure of a national ISP



b. Interconnection of national ISPs

PROTOCOLS

A protocol is synonymous with rule. It consists of a set of rules that govern data communications. It determines what is communicated, how it is communicated and when it is communicated. The key elements of a protocol are syntax, semantics and timing

Topics discussed in this section:

- **Syntax**
- **Semantics**
- **Timing**

Elements of a Protocol

- **Syntax**
  - **Structure or format of the data**
  - **Indicates how to read the bits - field delineation**
- **Semantics**
  - **Interprets the meaning of the bits**
  - **Knows which fields define what action**
- **Timing**
  - **When data should be sent and what**
  - **Speed at which data should be sent or speed at which it is being received.**

Thank
You