Chapter 1

Introduction

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.
- Communication Systems are the combination of hardware (physical equipments) and software (programs)

Data Communications (Conti…)

- The effectiveness of a communication system depends on four fundamental characteristics:

  - Delivery
  - Accuracy
  - Timeliness
  - Jitter

1.3

Components of Communication Systems

- A Communication System has five basic components:

  - Message
  - Sender
  - Receiver
  - Transmission Medium
  - Protocol

1.4

Components of Communication Systems (Conti...
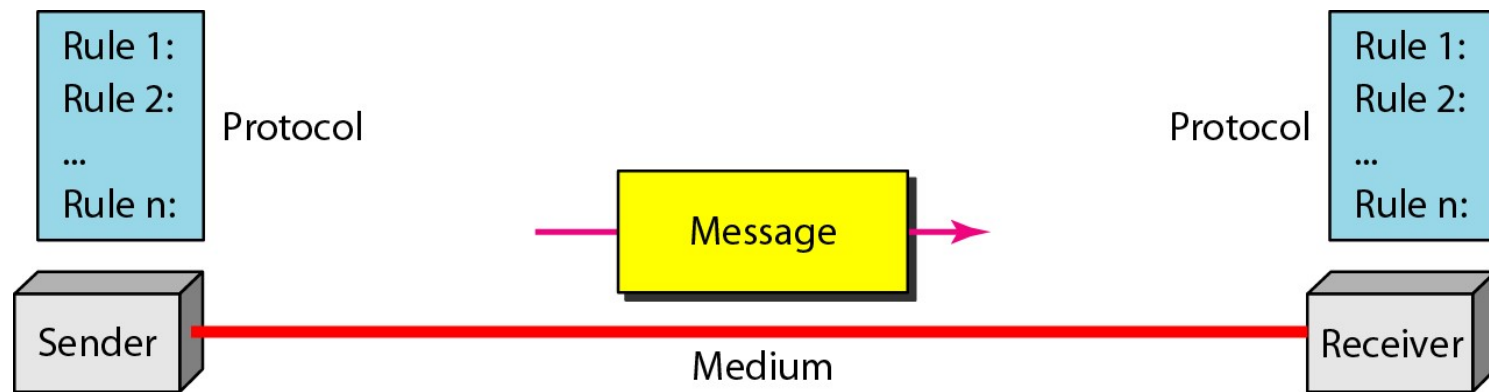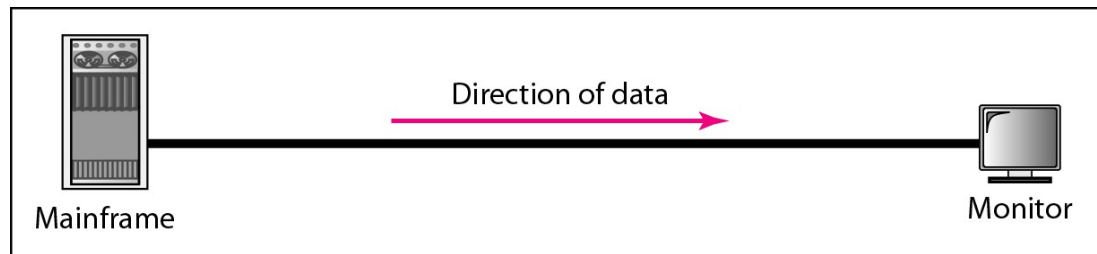
Figure 1.1 *Components of a data communication system*
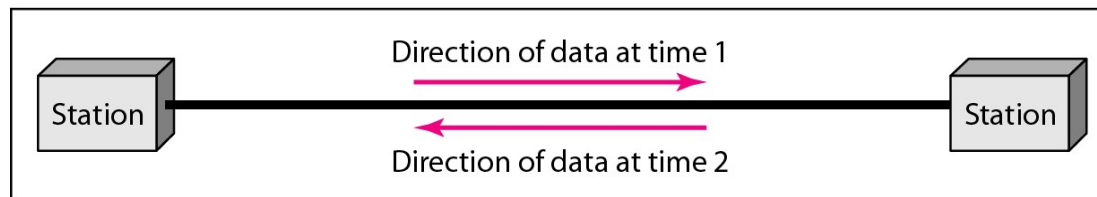
Data Representation

- Information (Data) today comes in different forms, such as:

  - Text

  - Numbers
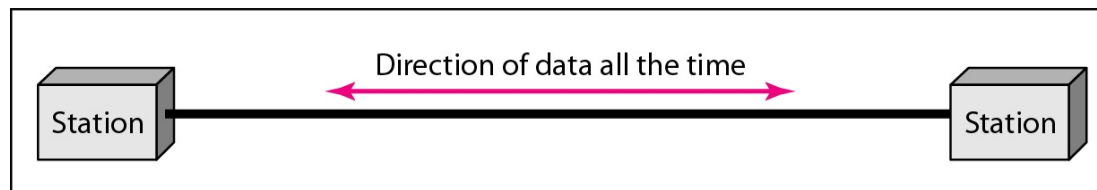
  - Images

  - Audio

  - Video

Data Flow

- Communication between two devices can be simplex, half-duplex, or full-duplex:

a. Simplex

b. Half-duplex

c. Full-duplex

Figure 1.2 *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.

- Most networks use distributed processing, in which a task is divided among multiple computers.

1.8

Network Criteria

A network must be able to meet a certain number of criteria. The most important of these are:

- **Performance**
  - Depends on number of users, type of transmission medium, capabilities of the connected devices and efficiency of the software
  - Measured in terms of Delay and Throughput
    - Both of these are contradictory
- **Reliability**
  - Accurate Delivery
  - Rate of failure

1.9

Network Criteria (Conti…)

- **Reliability (Conti…)**
  - Time required to recover a link
  - Measured in terms of availability/robustness
- **Security**
  - Data protection against corruption/loss of data due to:
    - Errors
    - Malicious users

1.10

Physical Structures

- **Type of Connection**
  - **Point to Point** - single transmitter and receiver
    - Dedicated link between two devices
    - Wired (cable) or wireless (microwave and satellite)
  - **Multipoint** - multiple recipients of single transmission
    - Shared medium (link)
    - Spatially Shared – Several devices use the link simultaneously
    - Timeshared – Users must take turns

1.11

Physical Structures (Conti…)

- **Physical Topology**

  - Connection of devices

    - Two or more devices connect to a link, two or more links form a topology

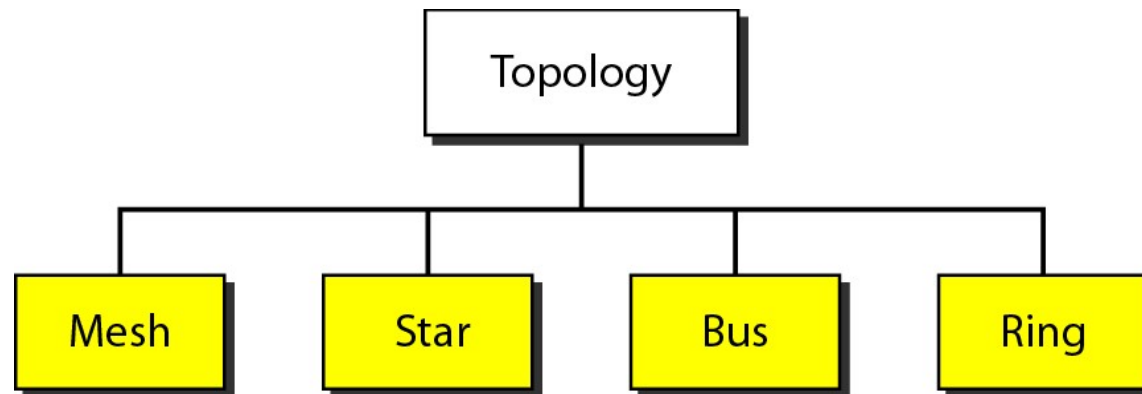 - Type of transmission - unicast, multicast, broadcast

Figure 1.4 *Categories of topology*

1.12

Mesh Topology

- Every device has a dedicated point-to-point link to every other device

- For 'n' nodes n(n-1)/2 full-duplex links are required

- Advantages:

  - No traffic problems due to dedicated links, robustness, privacy or security, and fault identification & isolation

- Disadvantages:

  - The main disadvantage is the number of cables and I/O ports
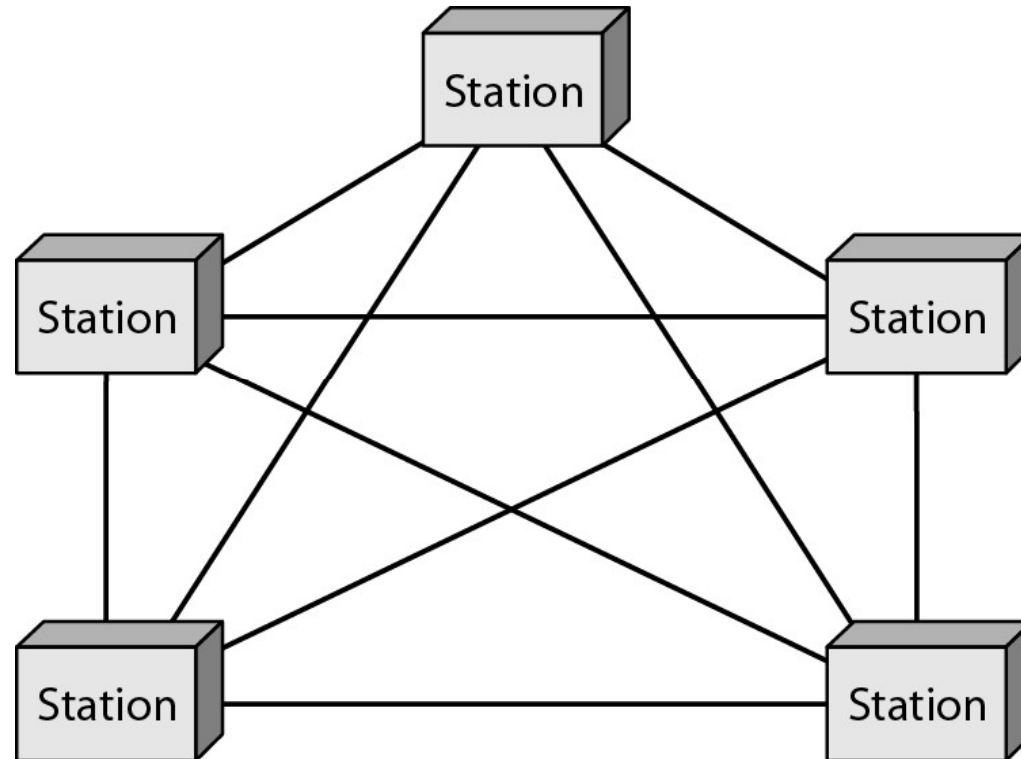
Mesh Topology (Conti…)

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

Star Topology

- Each device has a dedicated point-to-point link to a central controller, known as hub.

- Nodes are not directly connected but connected through hub.

- Advantages:

  - Less expensive, each device requires only one link and one I/O port, less cabling, robustness, and fault identification & isolation

- Disadvantages:

  - The main disadvantage is its dependency on a single point
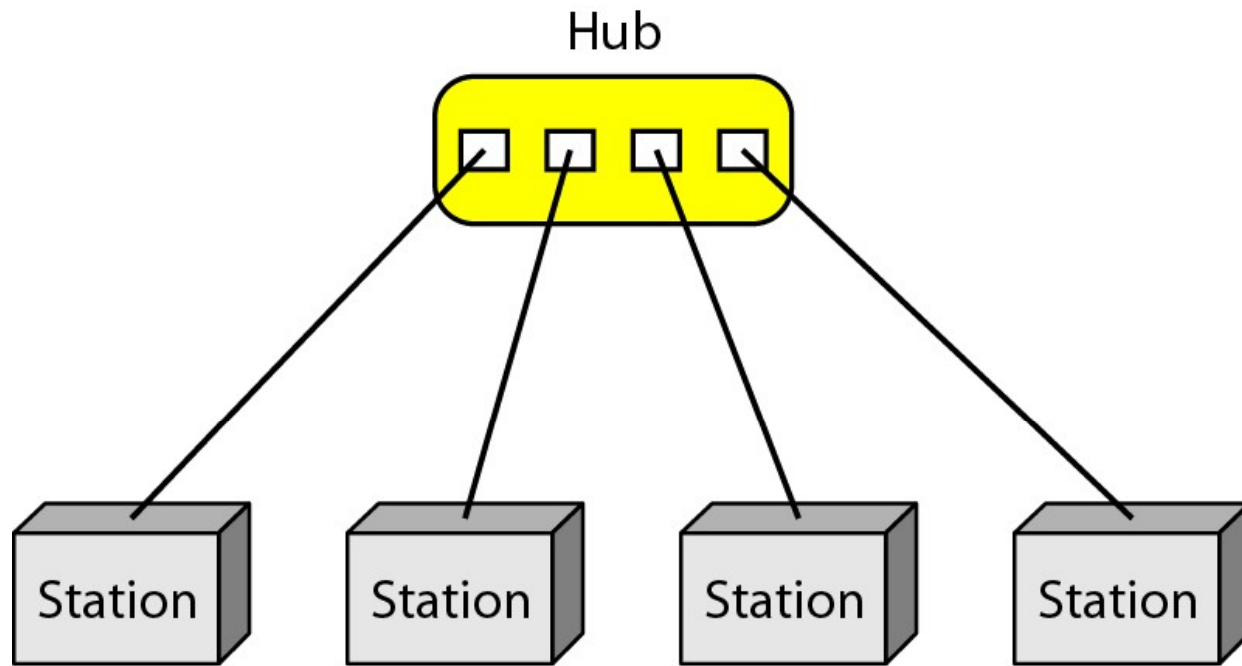
1.15

Star Topology (Conti…)

Figure 1.6 *A star topology connecting four stations*

Bus Topology

- Unlike Mesh and Star topologies, Bus topology is multi-point
- Only one cable (bus cable) acts as backbone to link all devices
- Nodes are connected to bus cable through drop line and taps.
  - Drop line is the connection between the device and bus cable
  - Tap is the connector
- Advantages:
  - Easy installation, and less cabling
- Disadvantages:
  - Difficult reconnections, and fault isolation
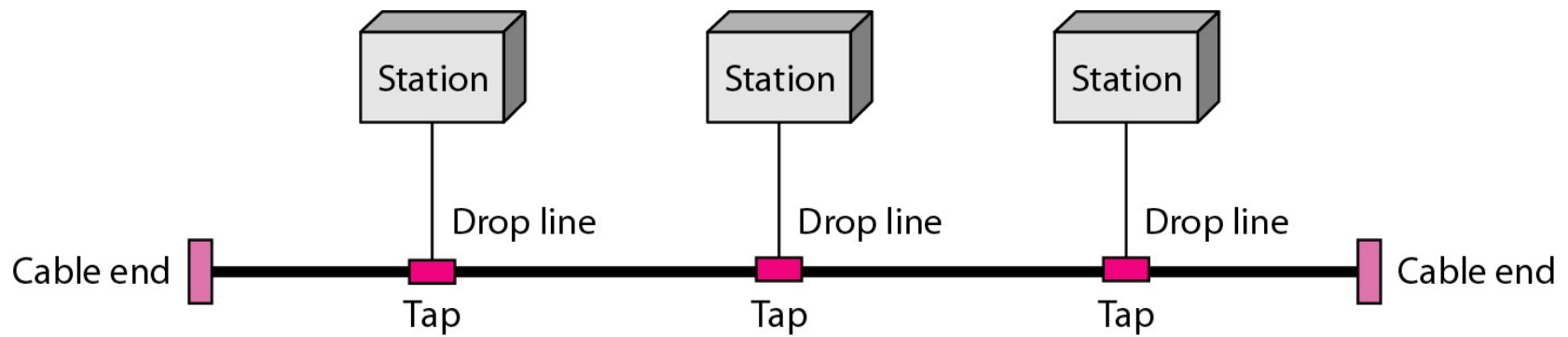
Bus Topology (Conti…)

Figure 1.7 *A bus topology connecting three stations*

Ring Topology

- Each device has dedicated point-to-point link with only devices on either sides

- The message travels along the ring in one direction

- Each node has repeater to regenerate the message

- Advantages:

  - Easy installation & reconfiguration, and fault isolation

- Disadvantages:

  - Unidirectional traffic, and dependency on ring
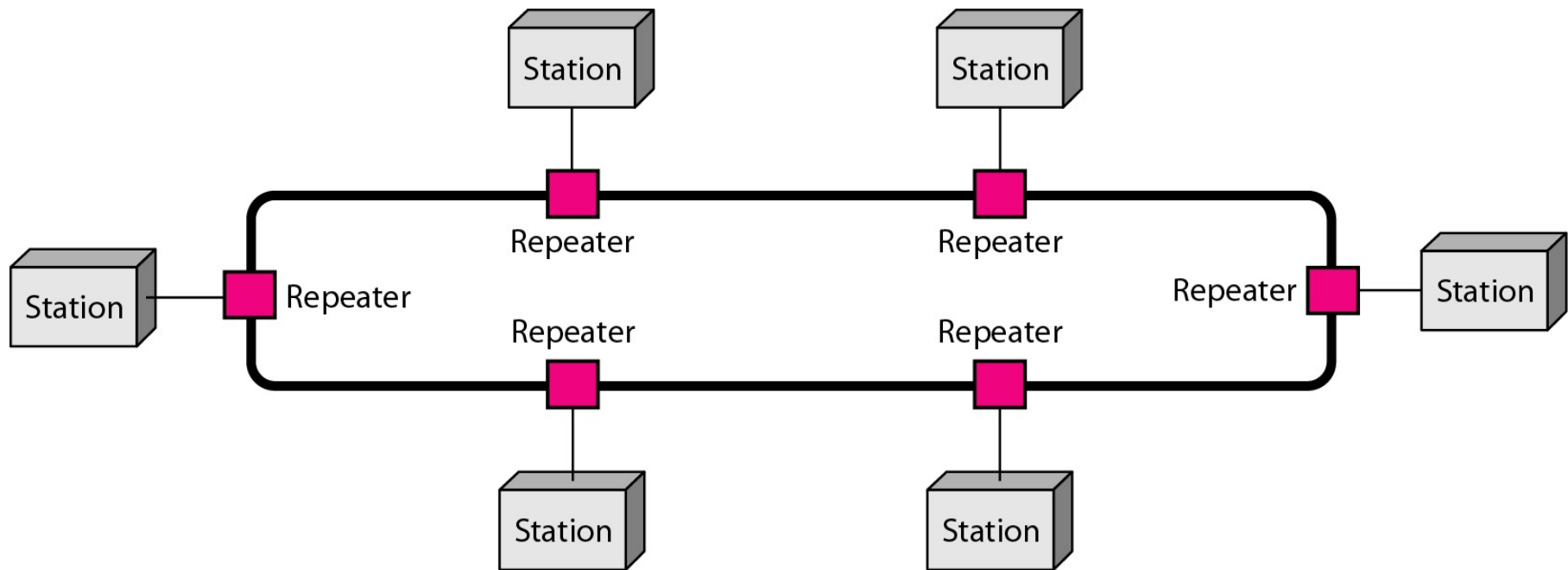
1.19

Ring Topology (Conti…)

Figure 1.8 *A ring topology connecting six stations*

Hybrid Topology

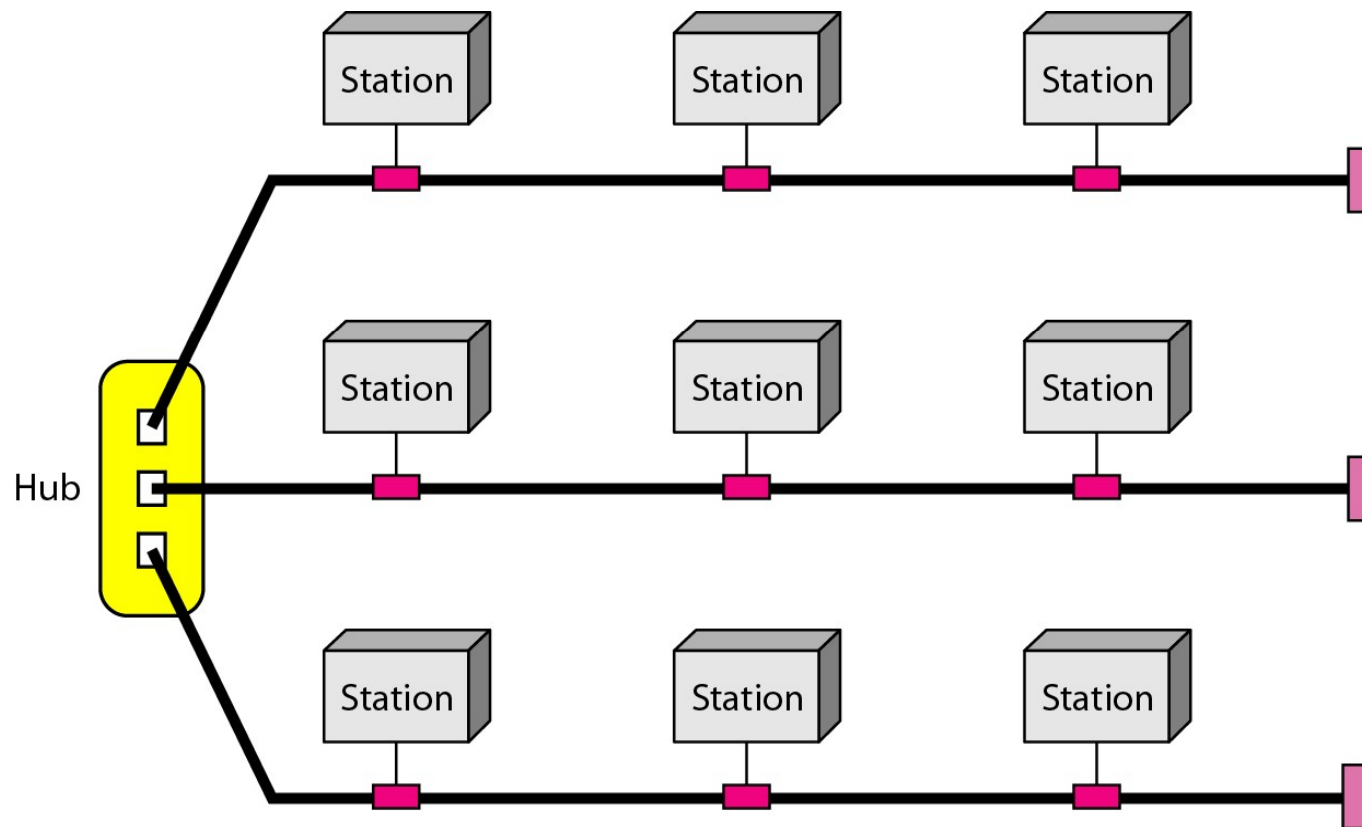- The network topology can hybrid

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

Types 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

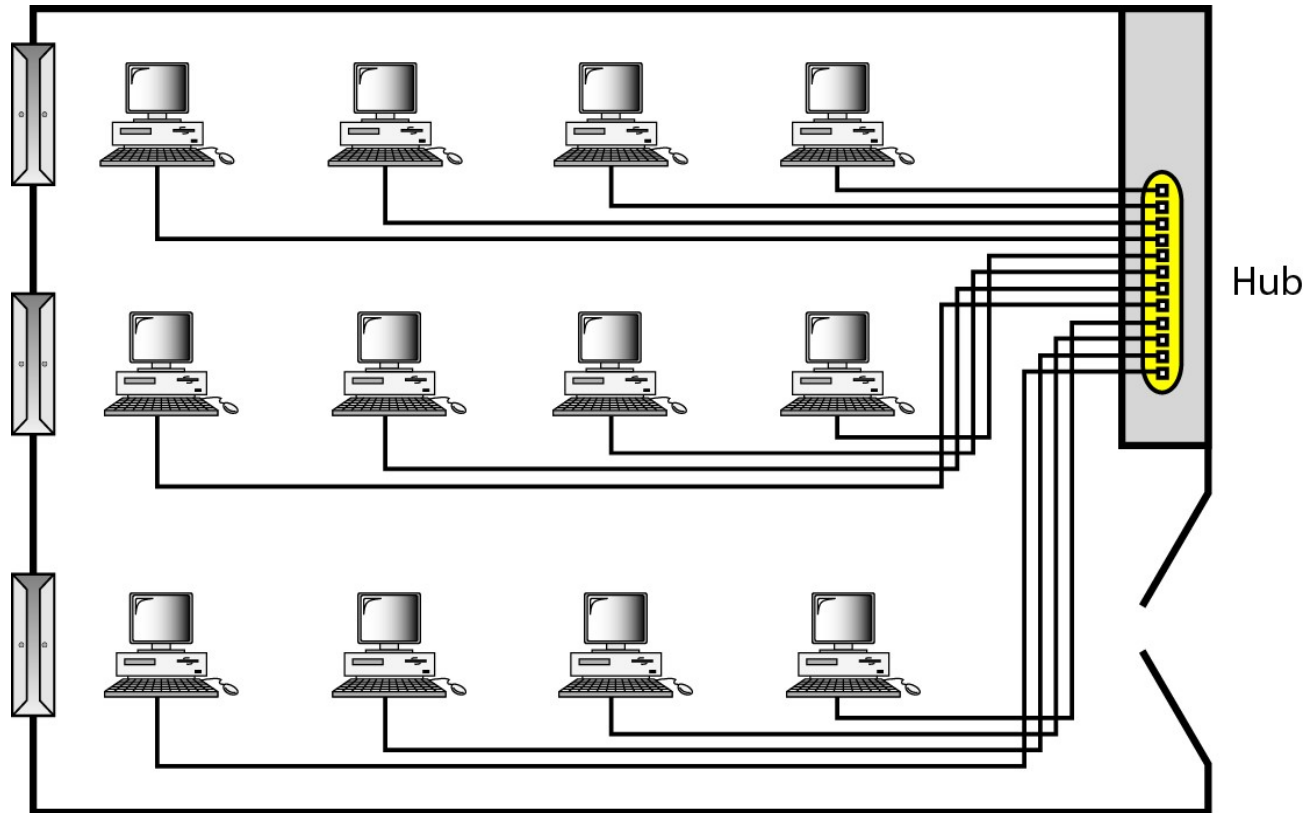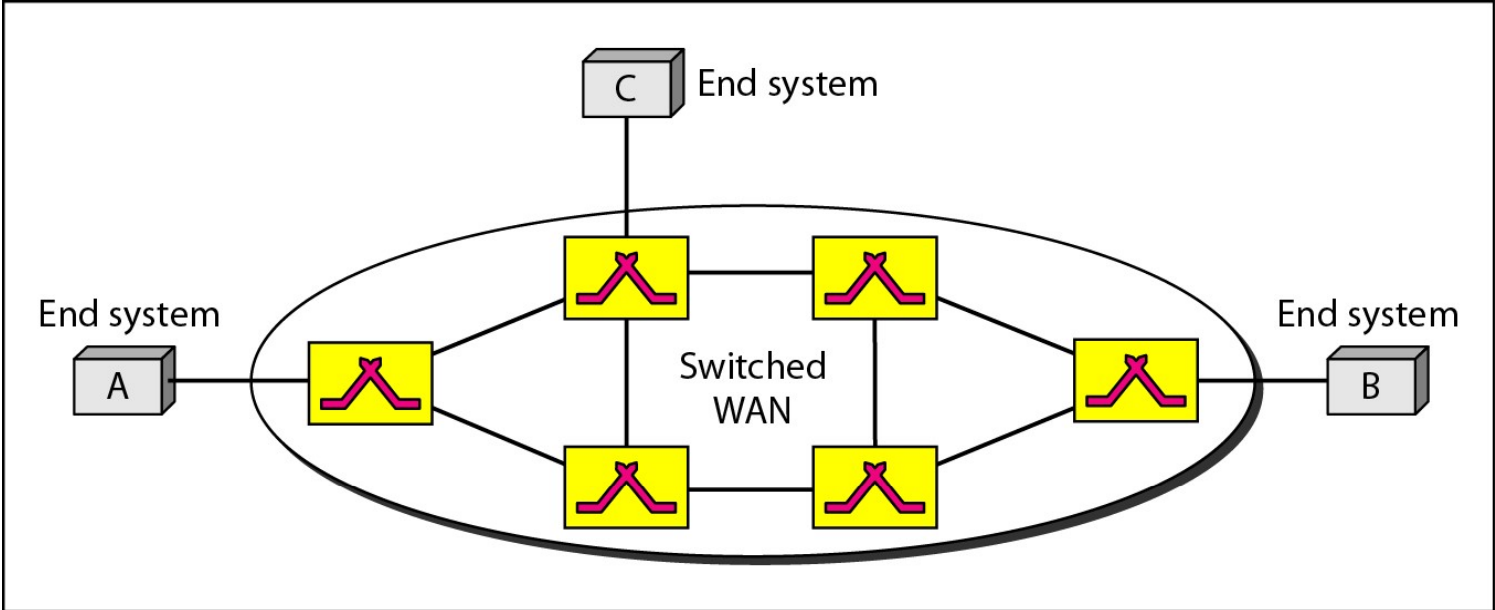Figure 1.10 *An isolated LAN connecting 12 computers to a hub in a closet*
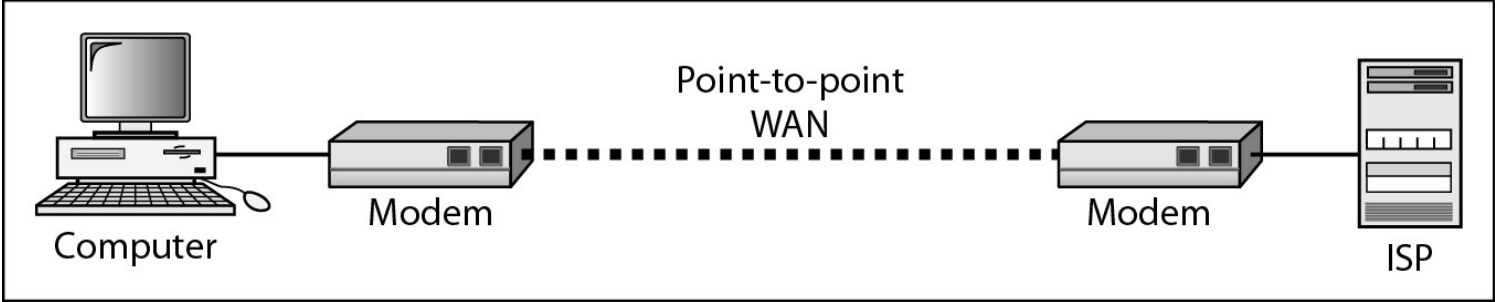
1.23

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

a. Switched WAN

b. Point-to-point WAN

1.24

Internetwork

- Isolated LANs/WANs are very rare nowadays; they are connected to one another.

- When two or more networks are connected, they make an internetwork or internet.

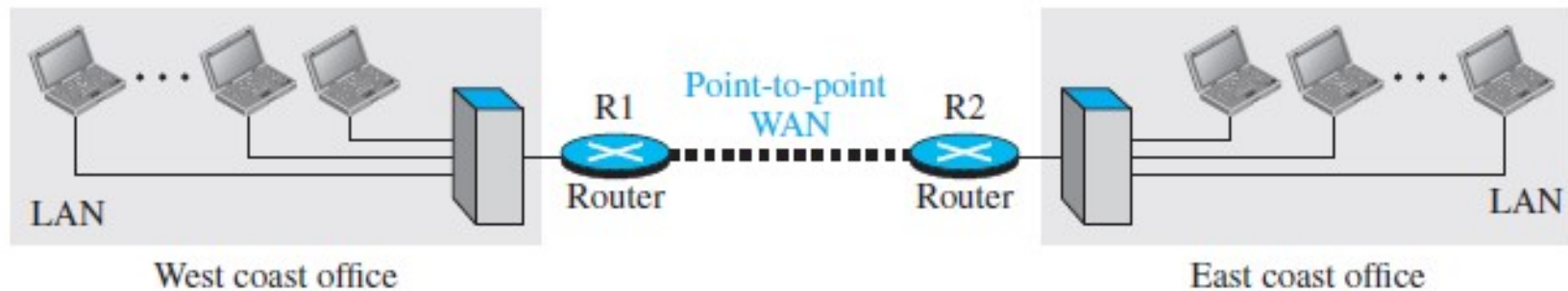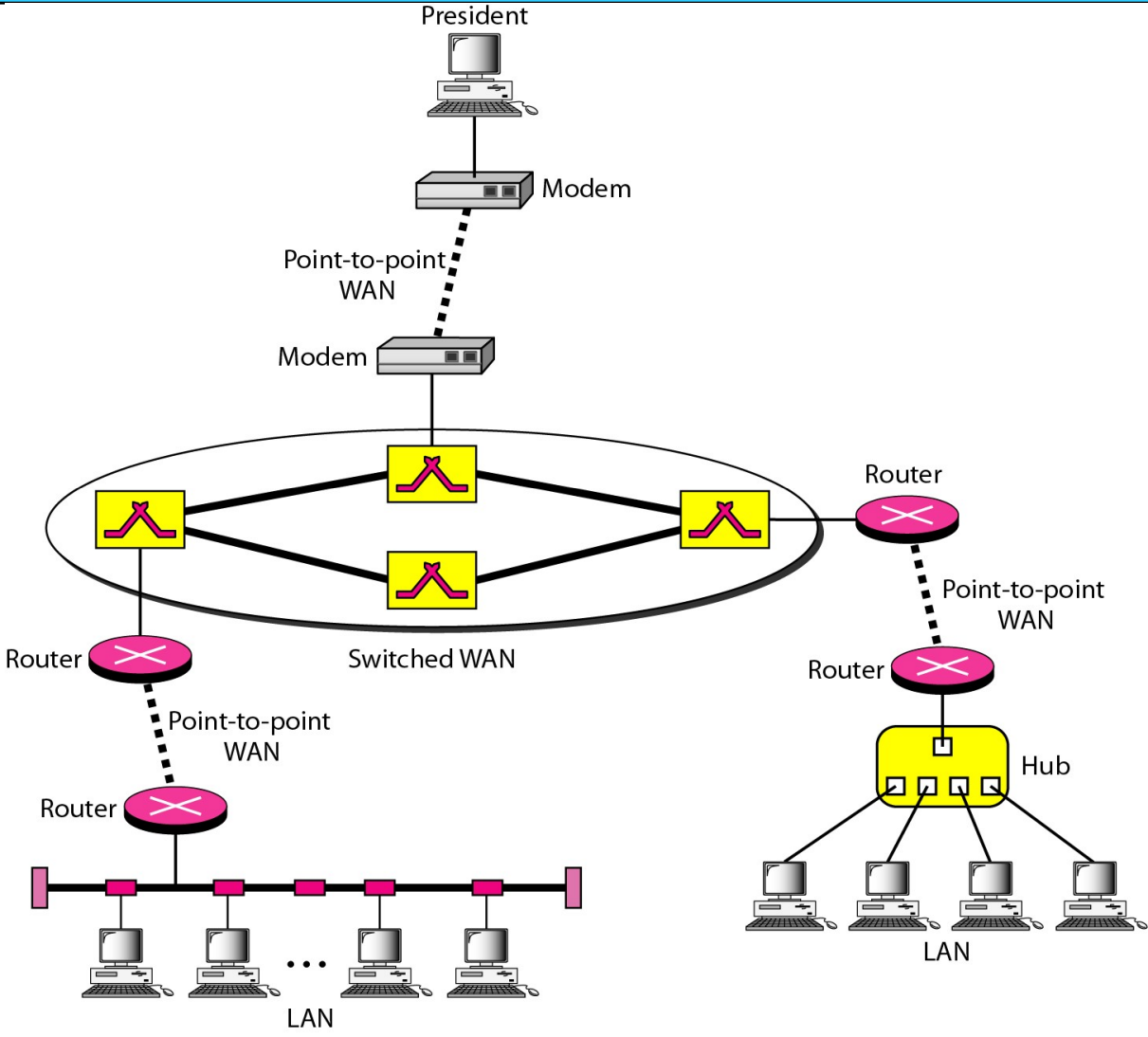Figure 1.11 An internetwork made of two LANs and one point-to-point WAN

Figure 1.12 *A heterogeneous network made of four WANs and two LANs*

1.26

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.

- Made-up of many Wide and Local Area Networks joined by connecting devices and switching stations

- Today most end users use the services of Internet Service Providers

1.27

The Internet (Conti…)

Internet Service Provider (ISP)

- International Internet Service Provider

- National Internet Service Provider

    - Network Access Point (NAP) – Complex switching stations

    - Peering Points – Private switching stations

- Regional Internet Service Provider

- Local Internet Service Provider

1.28

Figure 1.15 *The Internet Today*

1.29
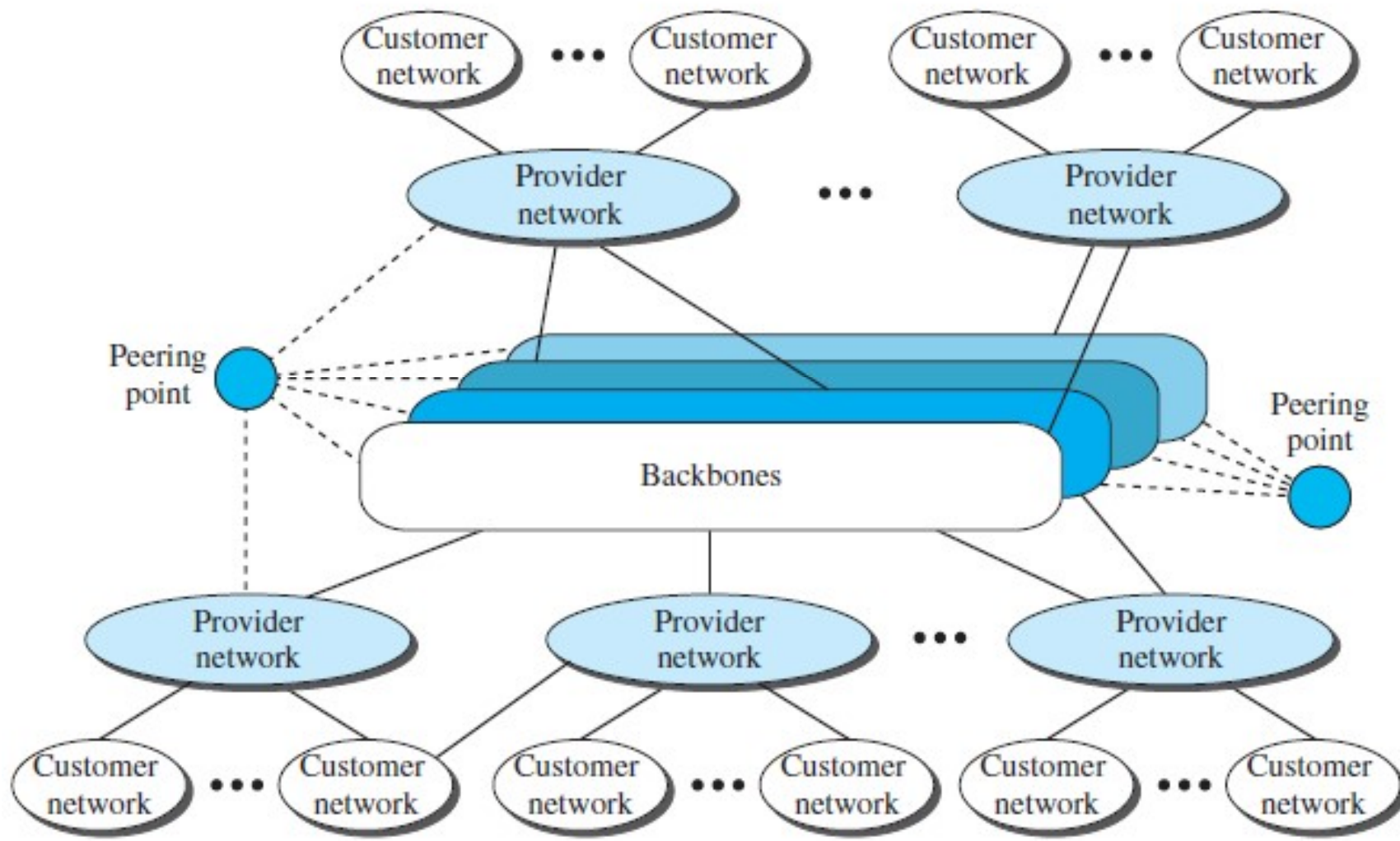
Protocols

- 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:

- Syntax

  - Structure or format of the data or the order in which the data is presented

  - Indicates how to read the bits - field delineation

Protocols (Conti…)

- ## 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.

Standards

- Standards are agreed-upon rules
- Guarantee the national and international interoperability of technology and processes
- Provide guidelines for manufacturers
- Standards creation committees
  - International Organization for Standardization (ISO)
  - International Telecommunication Union-Telecommunication Standards Sector (ITU-T)
  - American National Standards Institute (ANSI)
  - Institute of Electrical and Electronics Engineers (IEEE)
  - Electronic Industries Association (EIA)
  - And Many more