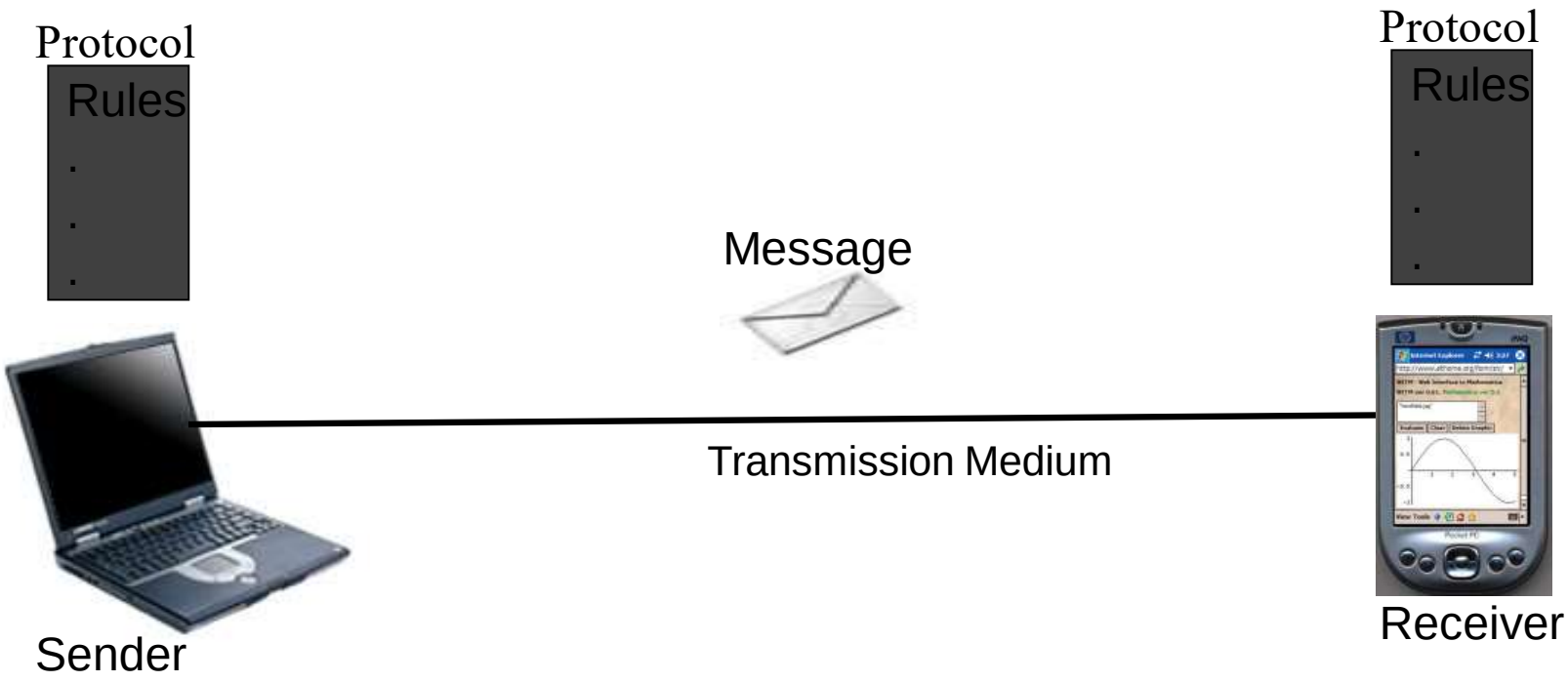
Lecture 1

Introduction to Data Communication

Data Communication

- Data Communications are the exchange of data between two devices via some form of transmission.



Components of Data Communication

1. **Message:** data.
2. **Sender:** The device that send the message.
3. **Receiver:** The device that receive the message.
4. **Transmission Medium:** The physical path between sender and receiver, the message travel.
5. **Protocol:** Protocol is a set of rules that governs data communication. It represents an agreement between the communicating devices. Without a protocol, two devices may be connected but not communicating.

Data Communication Characteristics

1. **Delivery:** The system must deliver data to the correct destination.
2. **Accuracy:**
   - Data delivered accurately.
   - Altered data which left uncorrected are unusable.
3. **Timelines:**

   The system must deliver data in timely manner without delay (real-time).

Data Flow in Communication

- Simplex: one direction only.

Remote Control

TV

- Always one side sender and another side receiver.

Data Flow in Communication

- Half-Duplex: two-way alternate.

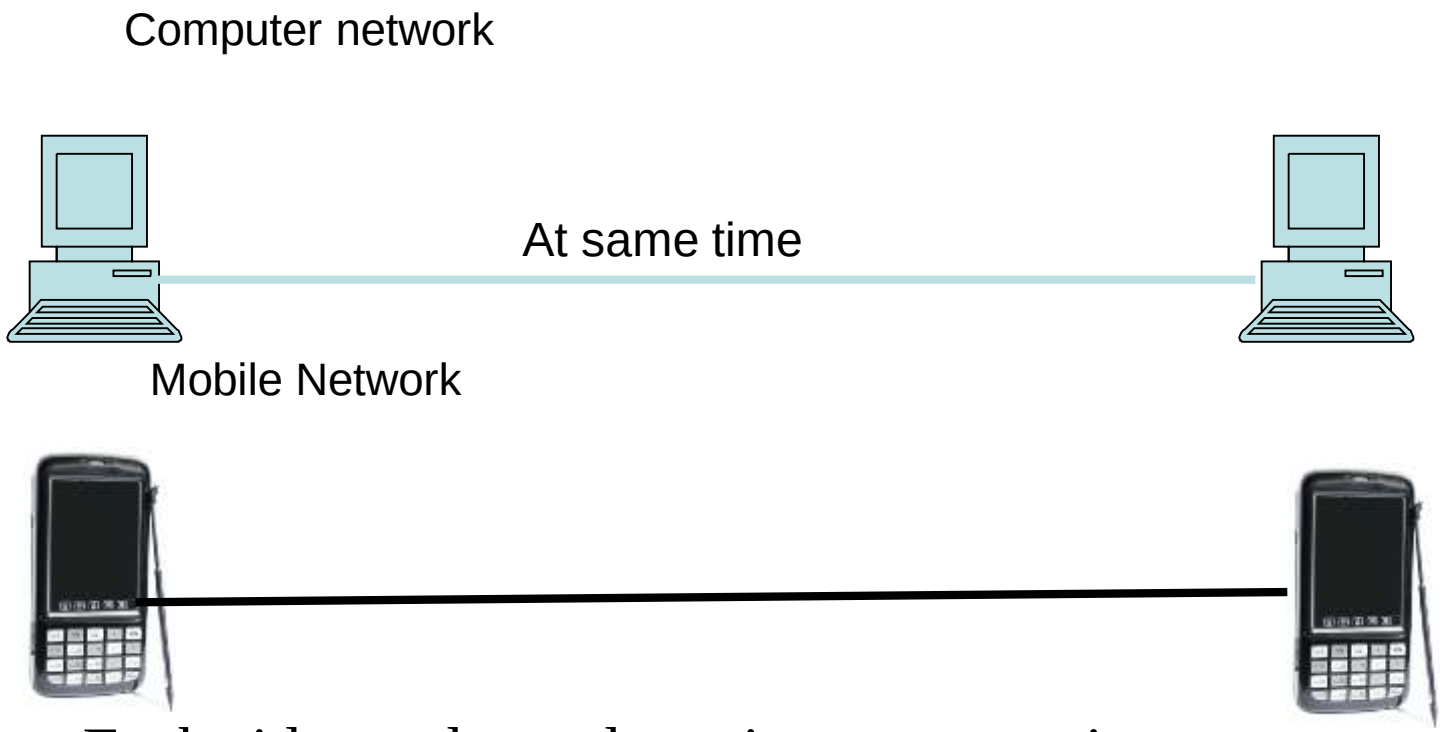
Walki-Talki

In different time

- Each side maybe sender or receiver but not a same time.

Data Flow in Communication cont.

- Duplex: two-way concurrent.



- Each side sender and receiver at same time.

Network

- A Network is a set of node connect together by communication link to sharing of resources and to transmit information.

- Node: Computer, Printer, Scanner, Software , PDA, etc.
- Information: text, voice, picture, etc.

Network Services

- Sharing (file, printer, application).
- Internet browsing.
- Fax Service.
- Telephony.
- Conferencing.
- Database.
- Backup.
- Etc……..

Network Components

- Transmission media (wired, wireless).
- Network Operating System (NOS).
- Network Interface Card (NIC).
- Network Hardware:-
  1. Hubs.
  2. Switches.
  3. Routers.
  4. Gateways.
  5. Access Point.
  6. Repeaters.

Network Classification

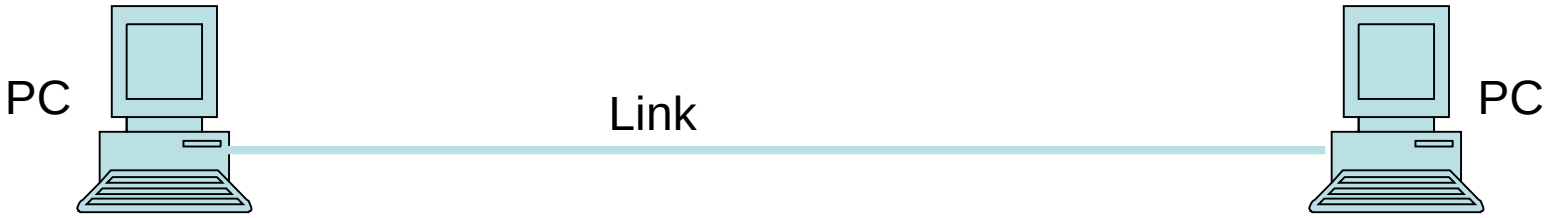
- Upon the transmission medium (type of connection):-

1. Point-to-point:

2. Multipoint:

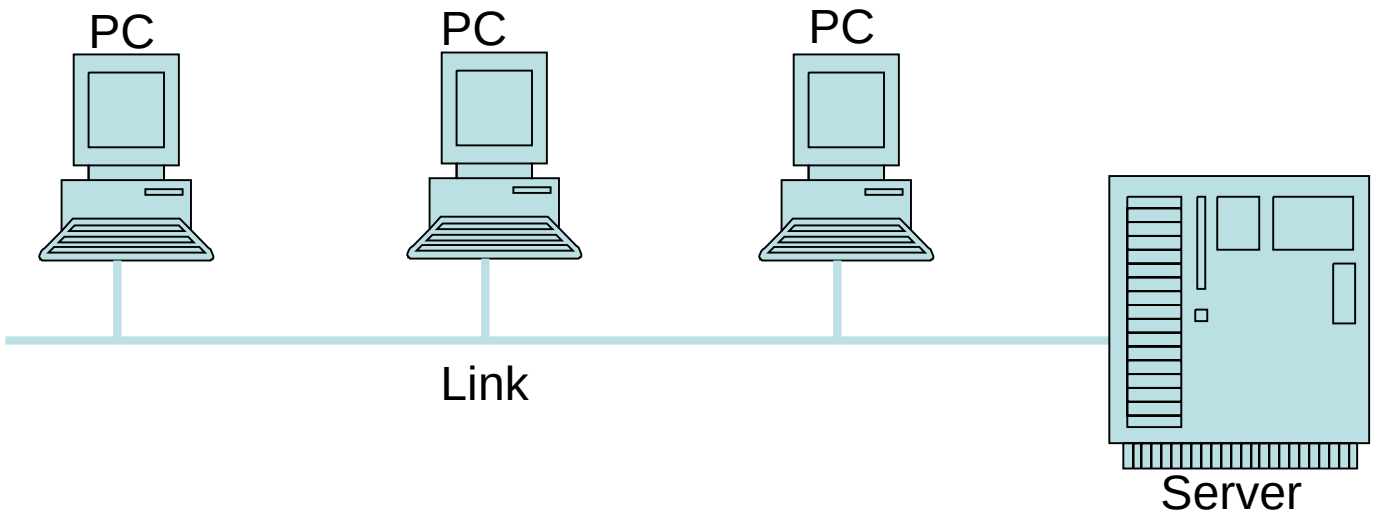
Point-to-Point

- A pair of nodes connected together via dedicated link.



Multipoint

- Number of node connected and share a single link.



Network Classification

Upon the scale (size):-

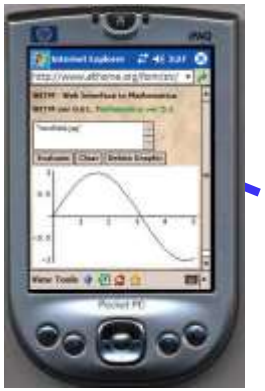
1. PAN (Personal Area Network).
2. LAN (Local Area Network).
3. CAN (Campus Area Network).
4. MAN (Metropolitan Area Network).
5. WAN (Wide Area Network).

PAN (Personal Area Network)

- PAN is a short-distance network design to individual user (person).
- PAN may be contain:- printer, mobile, computer, wireless printers , PDA, etc.
- components of PAN connected together via Bluetooth , USB cable ,IrDA (infrared), etc.

PAN cont.

Wireless Printer



Bluetooth

USB Cable

IrDA

Scanner

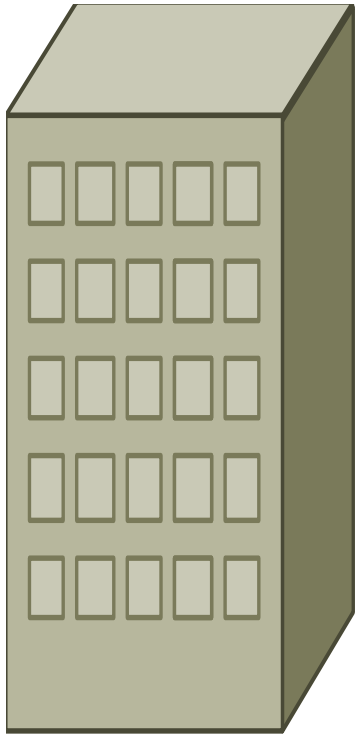
PDA

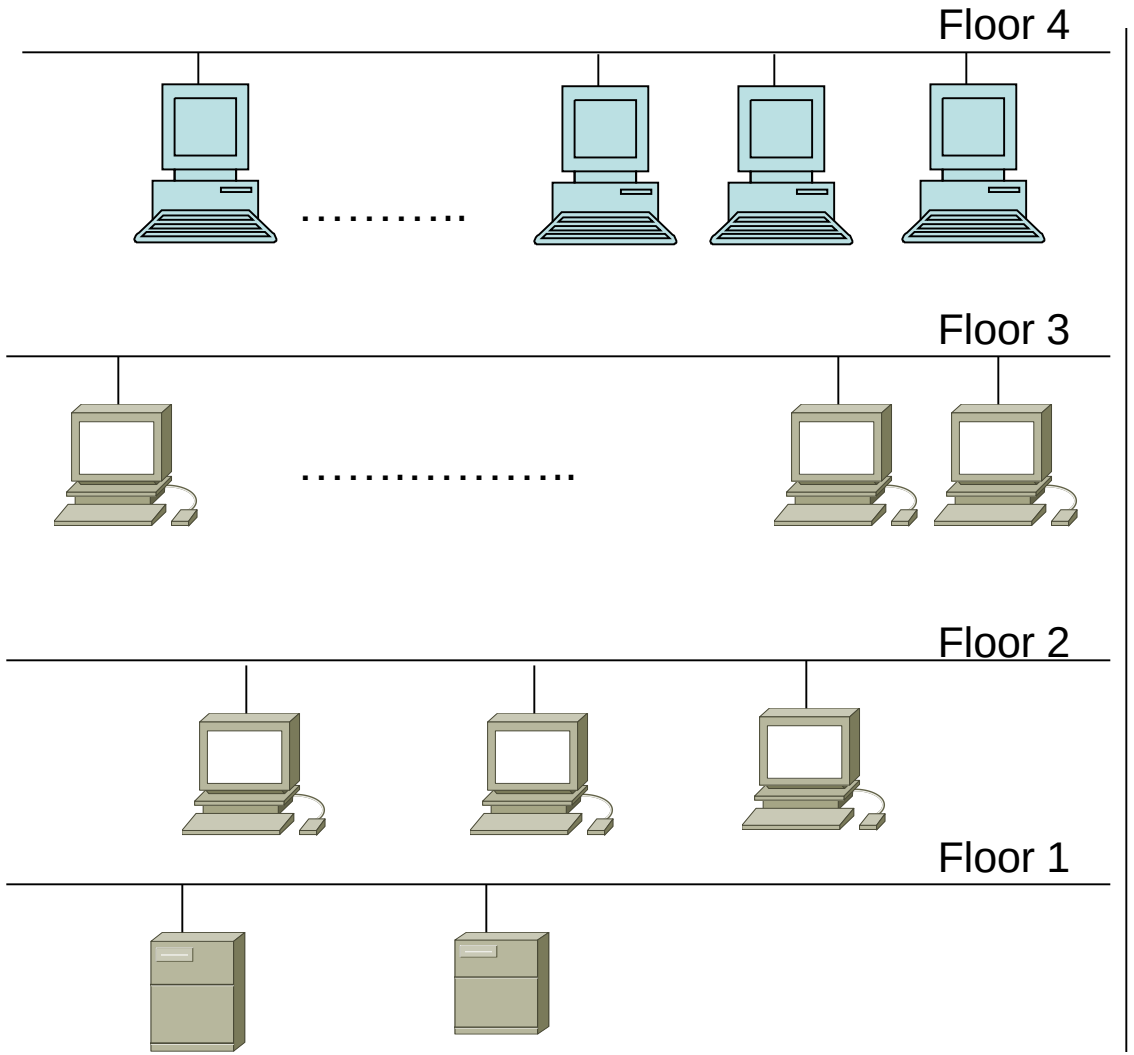
LAN (Local Area Network)

- A LAN is a group of node connected together in a small specific area.

- LAN may be contain workstations, computers, scanner, printers, servers, etc.

LAN cont.



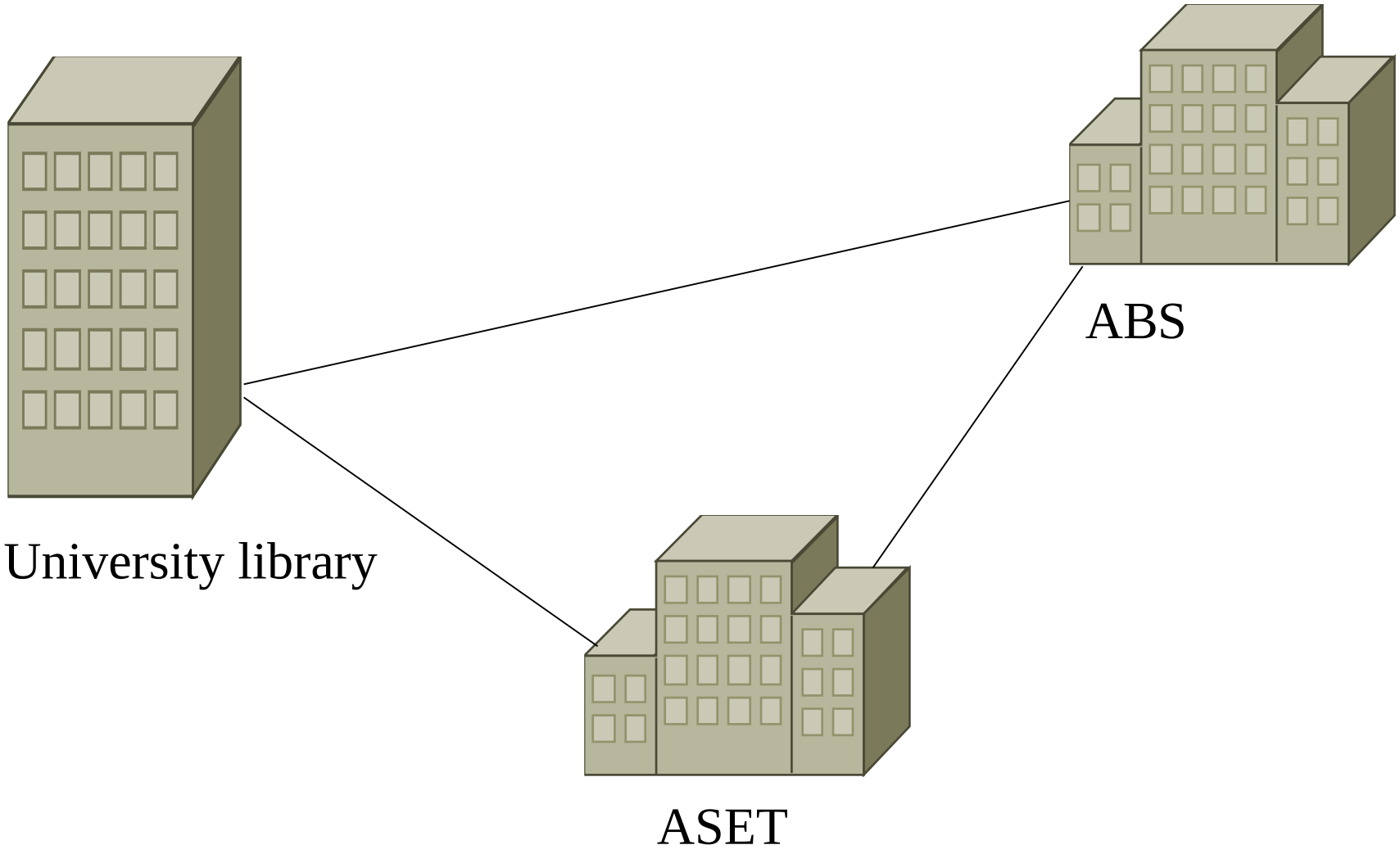


CAN (Campus Area Network)

- A CAN is a group of interconnection LAN within limited geographical area.

- A CAN using in school campus, military base, university campus ,etc.

CAN cont.

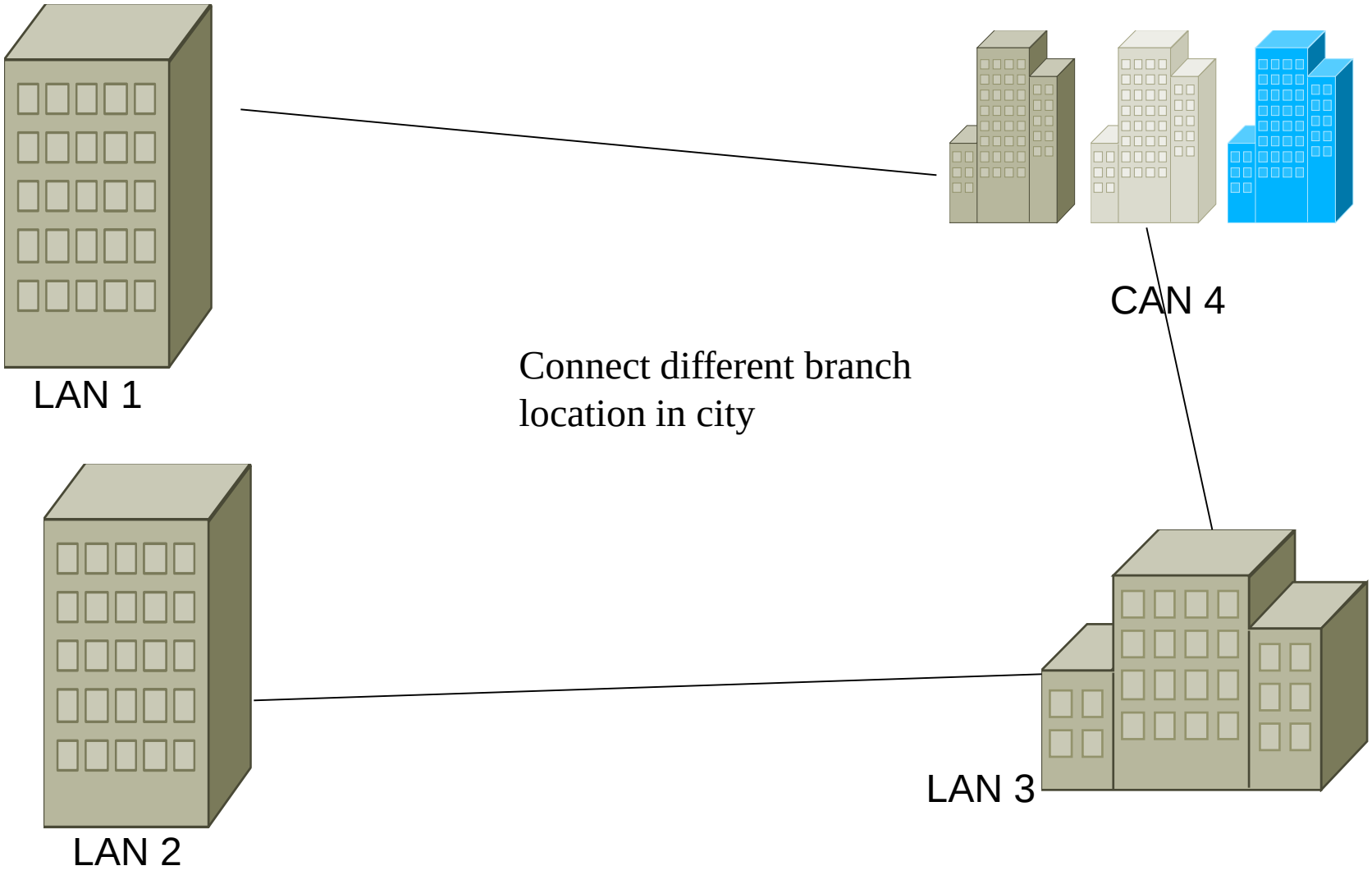


MAN (Metropolitan Area Network)

- A MAN is a large computer network uses to connect between LAN in different location (cities).

- A MAN is a group of node connect together over city.

MAN cont.


LAN 1
CAN 4
Connect different branch location in city
LAN 2
LAN 3

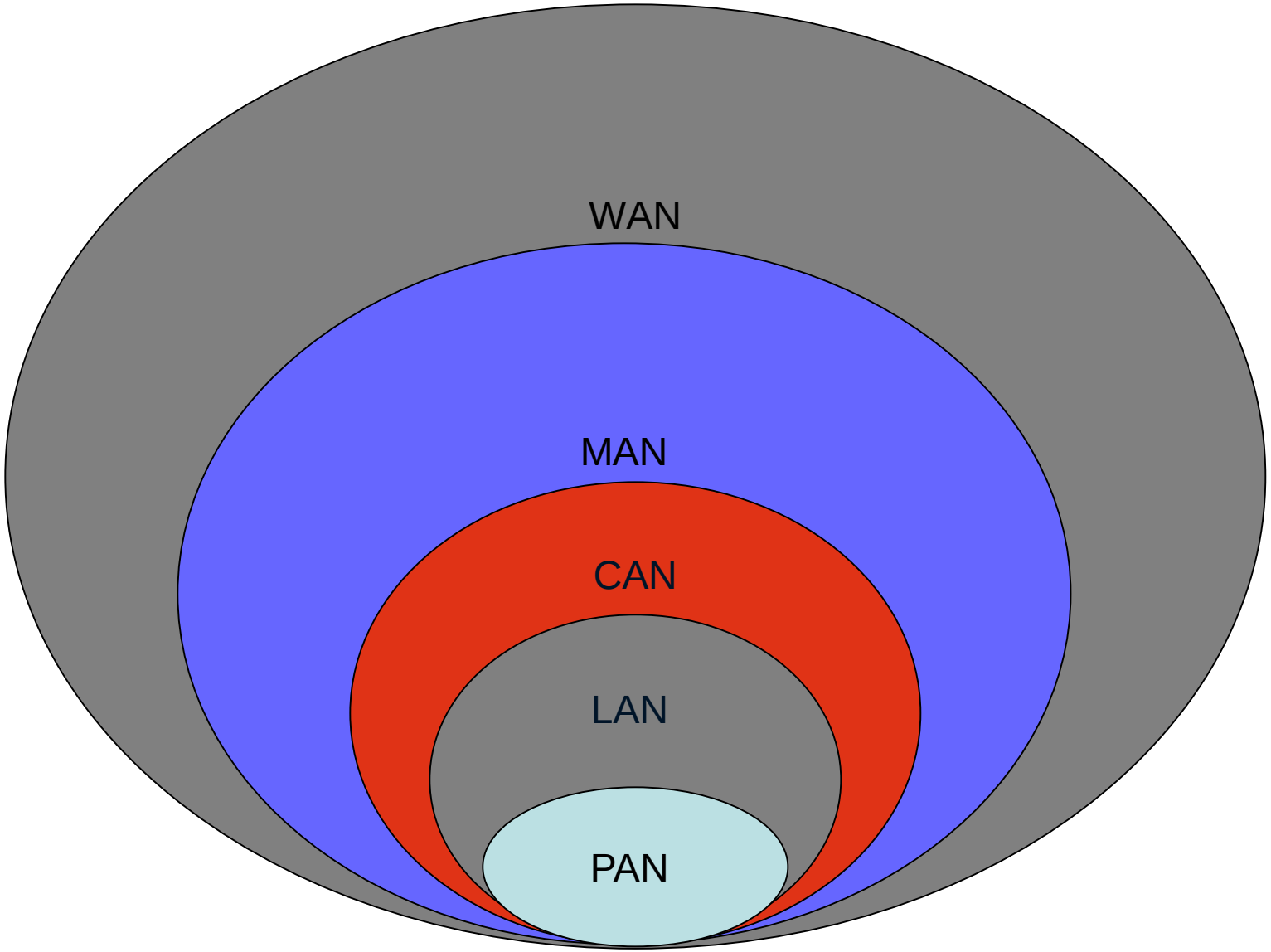
WAN (Wide Area Network)

- A WAN is a computer network that covers large geographical area.

- WANs are used to connect types of networks together.

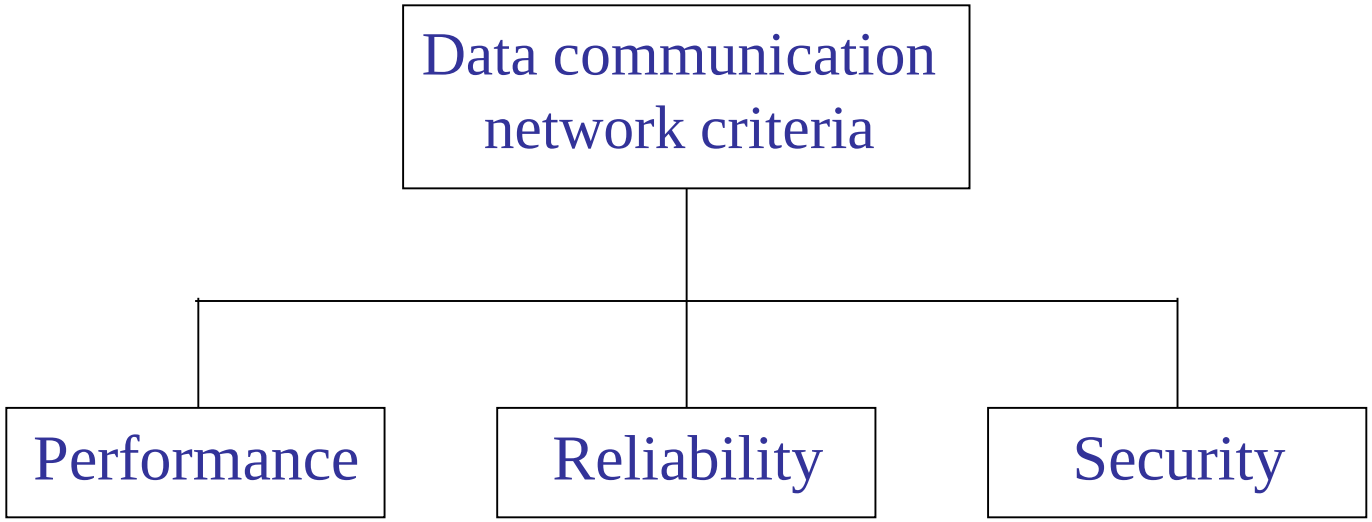
WAN cont.

ASET



Network Criteria

- A network must be able to meet a certain number of criteria.
- The most important of these are Performance, Reliability, and Security.



Network Criteria

Performance:

- The performance of network depends on a number of factors:
  - Number of users
  - Type of transmission medium
  - Hardware
  - Software.
- The performance is evaluate by two networking metric : Throughput and Delay.

Network Criteria

Reliability:

The network reliability is measured by the frequency of failure, (the time it takes a link to recover from of failure).

In addition to accuracy of delivery, network reliability is measured by

1. Frequency of failure

2. Recovery time of a network after a failure

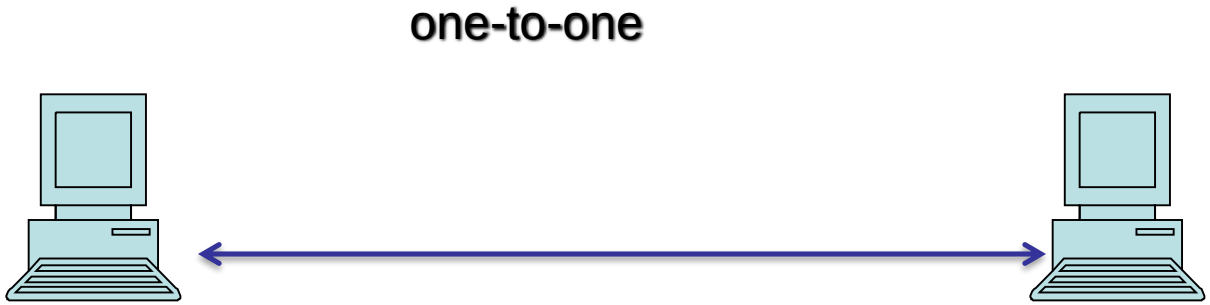
Network Criteria cont.

- **Security:**

  Network security include protecting data from unauthorized access, protecting data from damage, and write policies and implementing it for security issues.

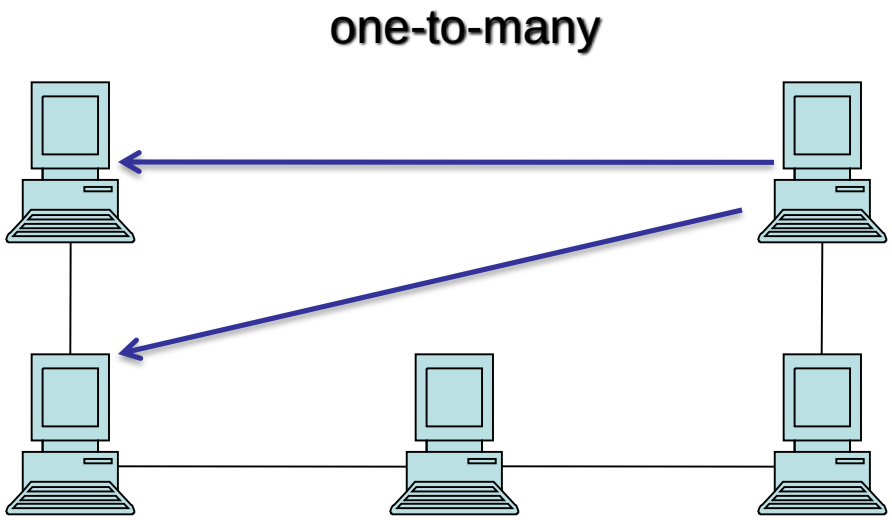
Network Modes

- Unicast Mode : Single source send to single node.



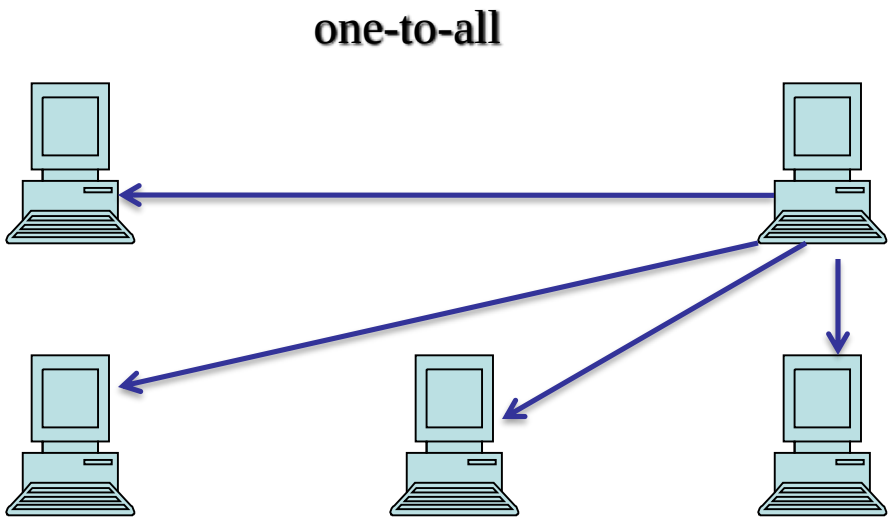
Network Modes cont.

- Multicast Mode : Single source send to specific nodes (group) that are connected to same Network.



Network Modes cont.

- Broadcast Mode : Single source send to all others node that are connected to same Network

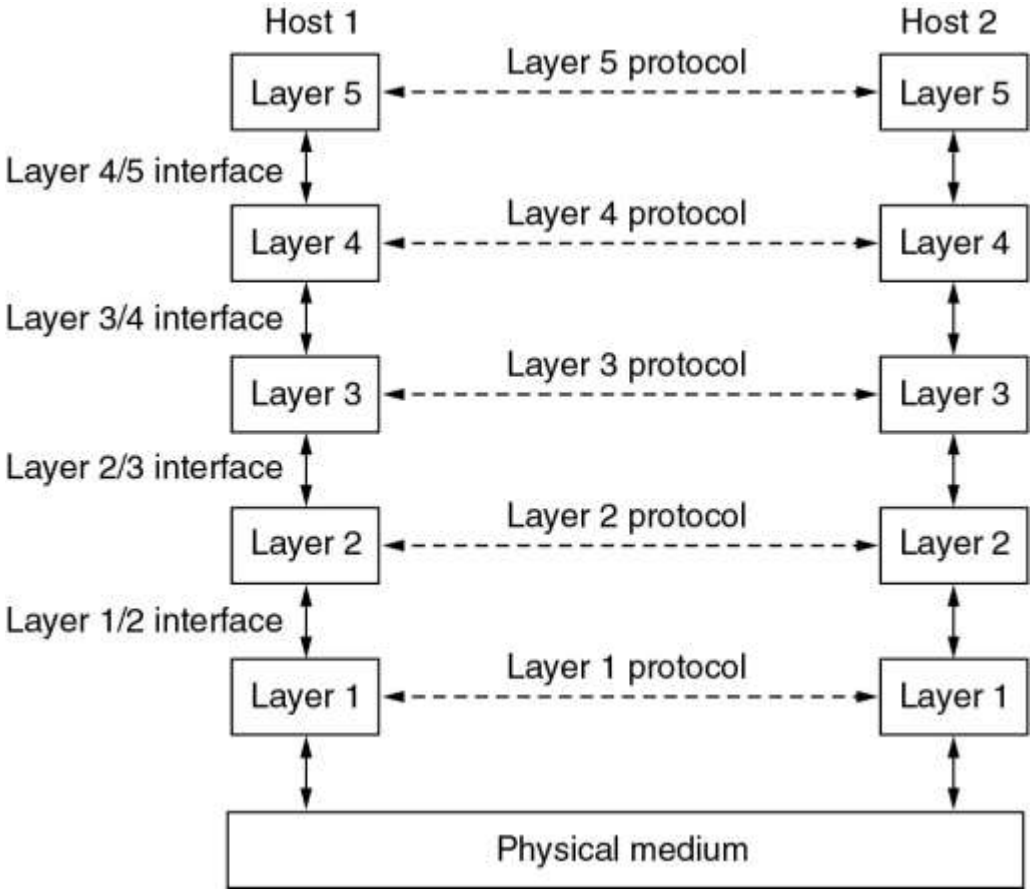


Network Software

- Protocol Hierarchies
- Design Issues for the Layers
- Connection-Oriented and Connectionless Services
- Service Primitives
- The Relationship of Services to Protocols

Network Software

Protocol Hierarchies



- Layers, protocols, and interfaces.

Design Issues for the Layers

- Addressing
- Error Control
- Flow Control
- Multiplexing
- Routing

Reference Models

- The OSI Reference Model
- The TCP/IP Reference Model
- A Comparison of OSI and TCP/IP
- A Critique of the OSI Model and Protocols
- A Critique of the TCP/IP Reference Model

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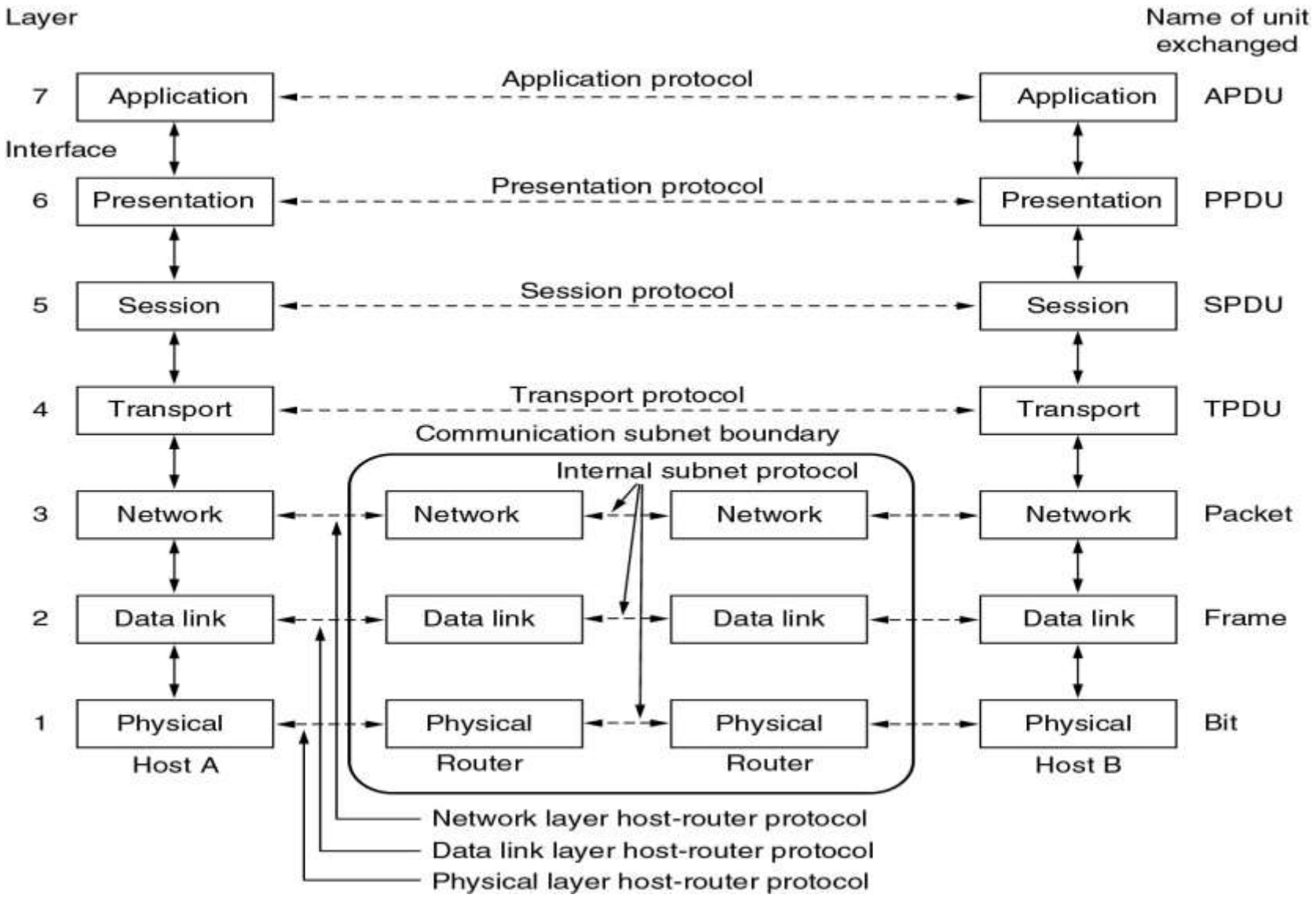
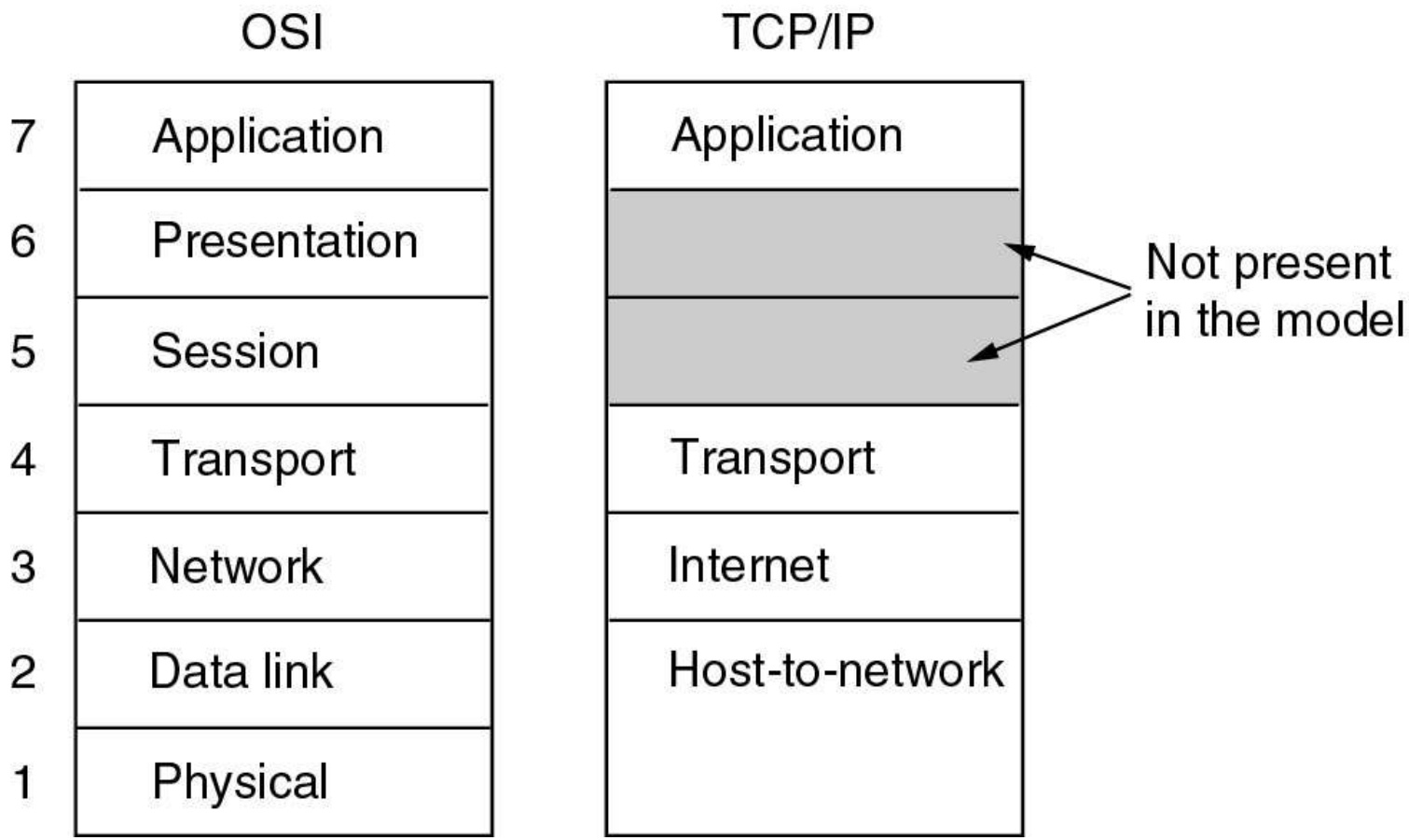
OSI Reference Models

ASET



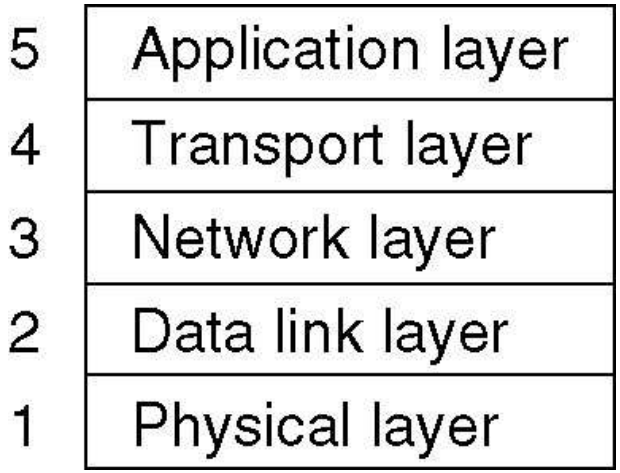
Reference Models (2)

- The TCP/IP reference model.



Hybrid Model

- The hybrid reference model .



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Chapter 1

Introduction

1-1 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.

Topics discussed in this section:

- **Components of a data communications system**
- **Data Flow**

Figure 1.1 *Components of a data communication system*

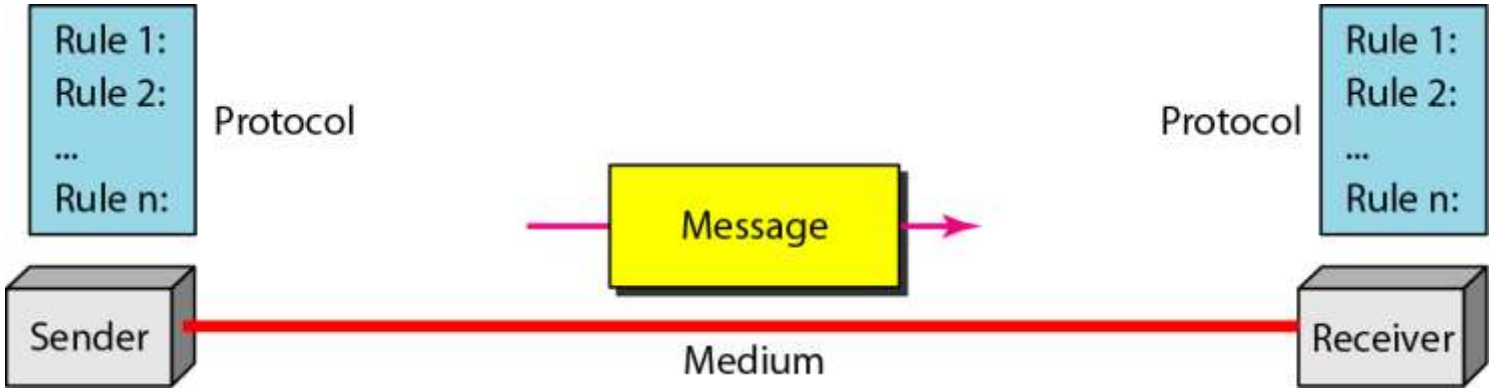
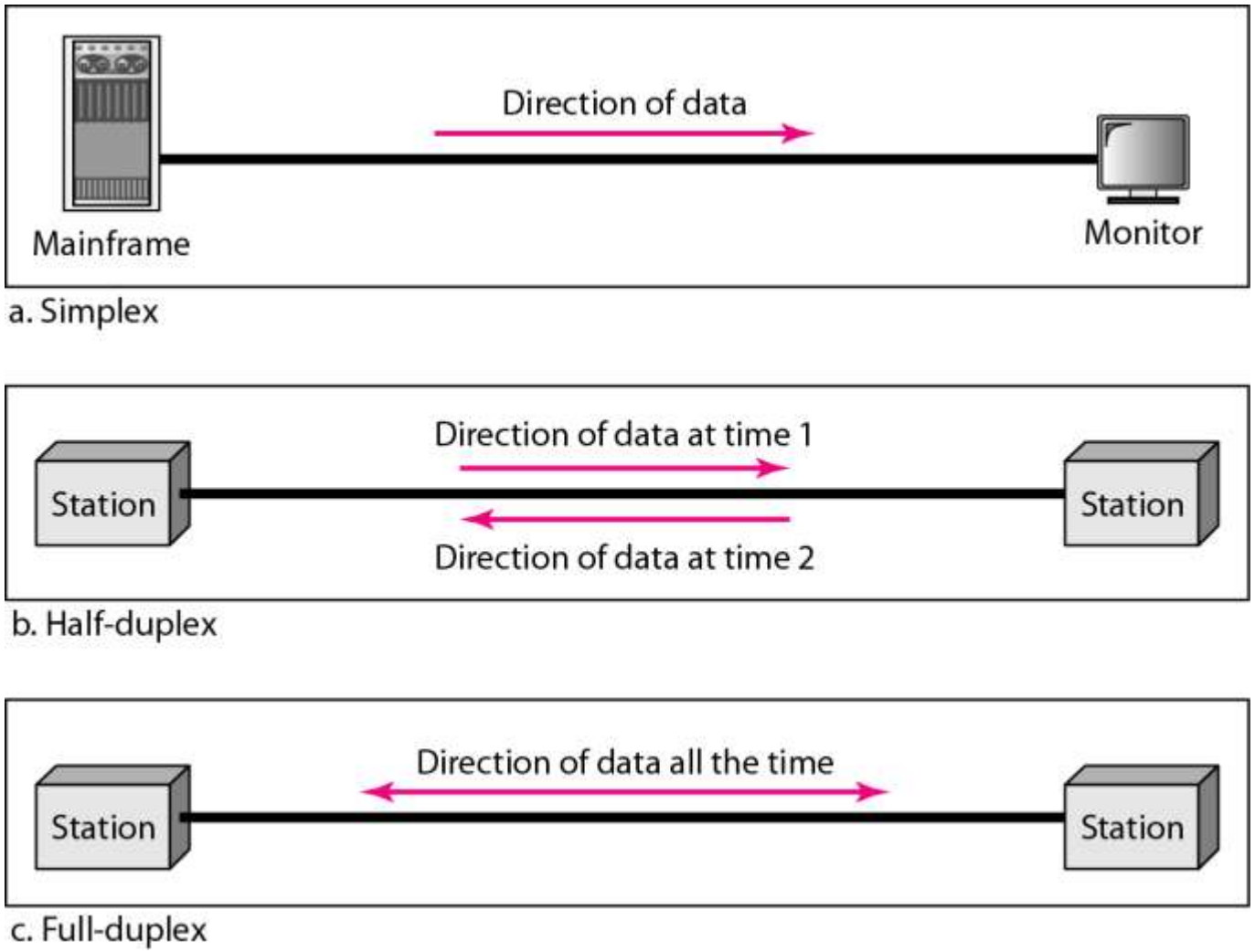


Figure 1.2 *Data flow (simplex, half-duplex, and full-duplex)*



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 a cable, air, optical fiber, or any medium which can transport a signal carrying information.

Topics discussed in this section:

- **Network Criteria**
- **Physical Structures**
- **Categories of Networks**

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

Figure 1.3 *Types of connections: point-to-point and multipoint*

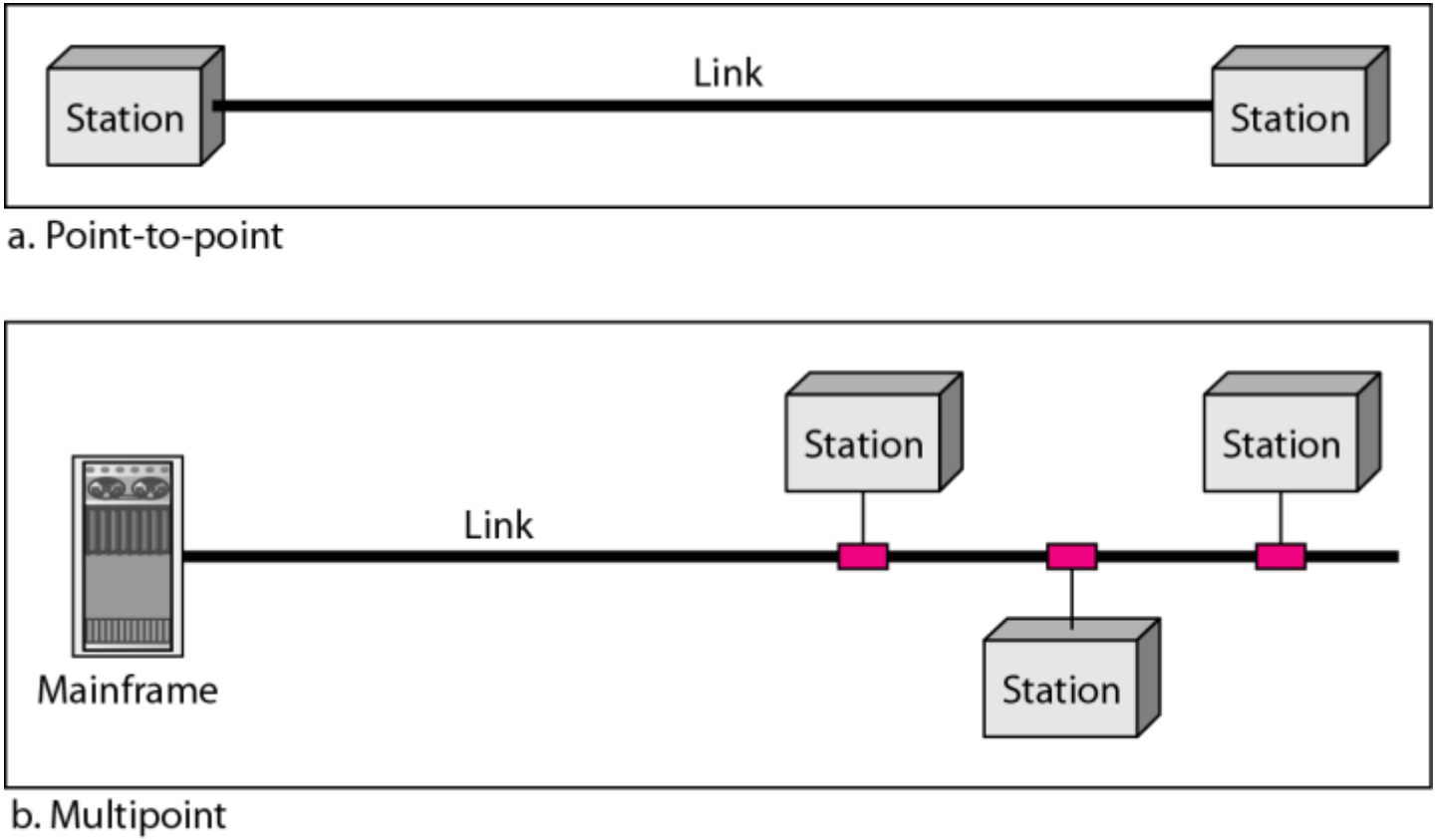


Figure 1.4 *Categories of topology*

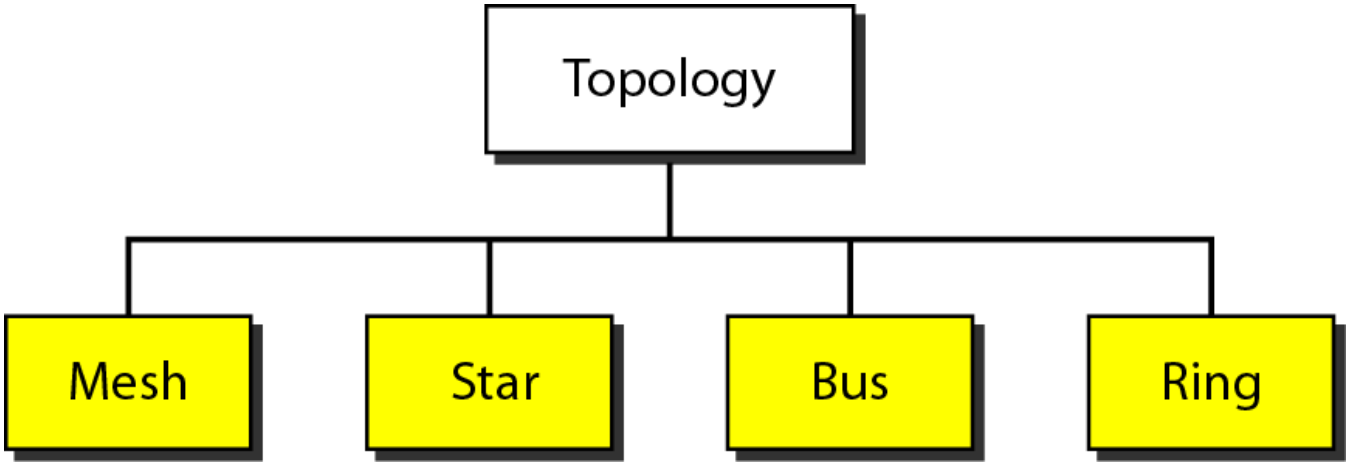


Figure 1.5 *A fully connected mesh topology (five devices)*

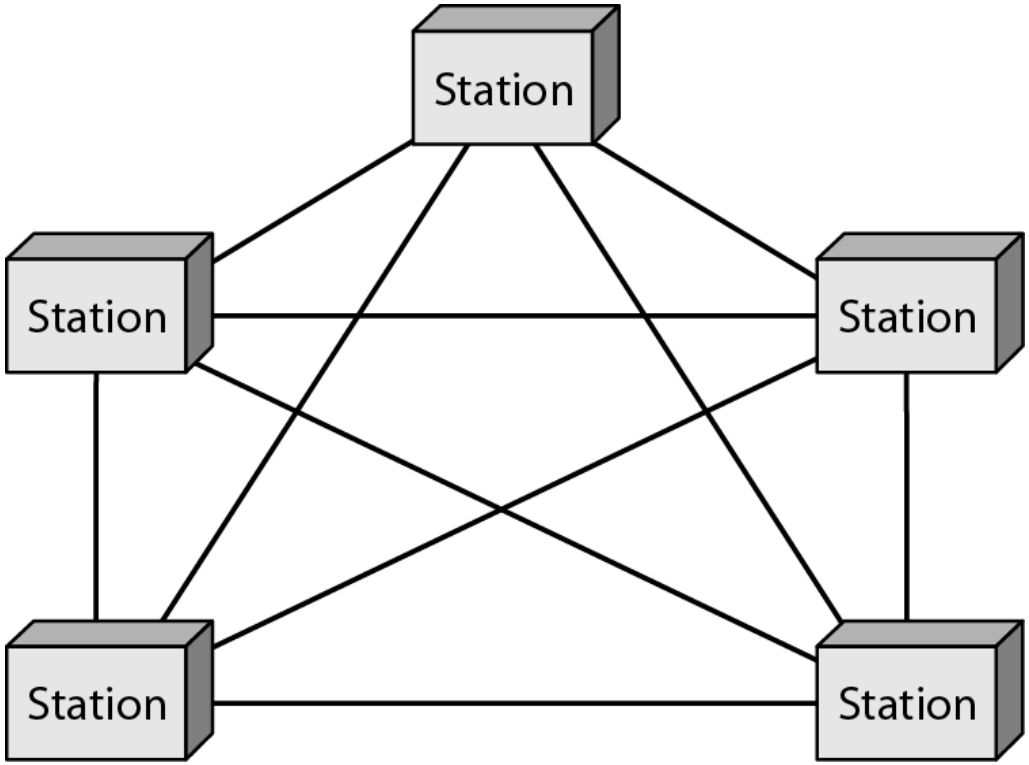


Figure 1.6 *A star topology connecting four stations*

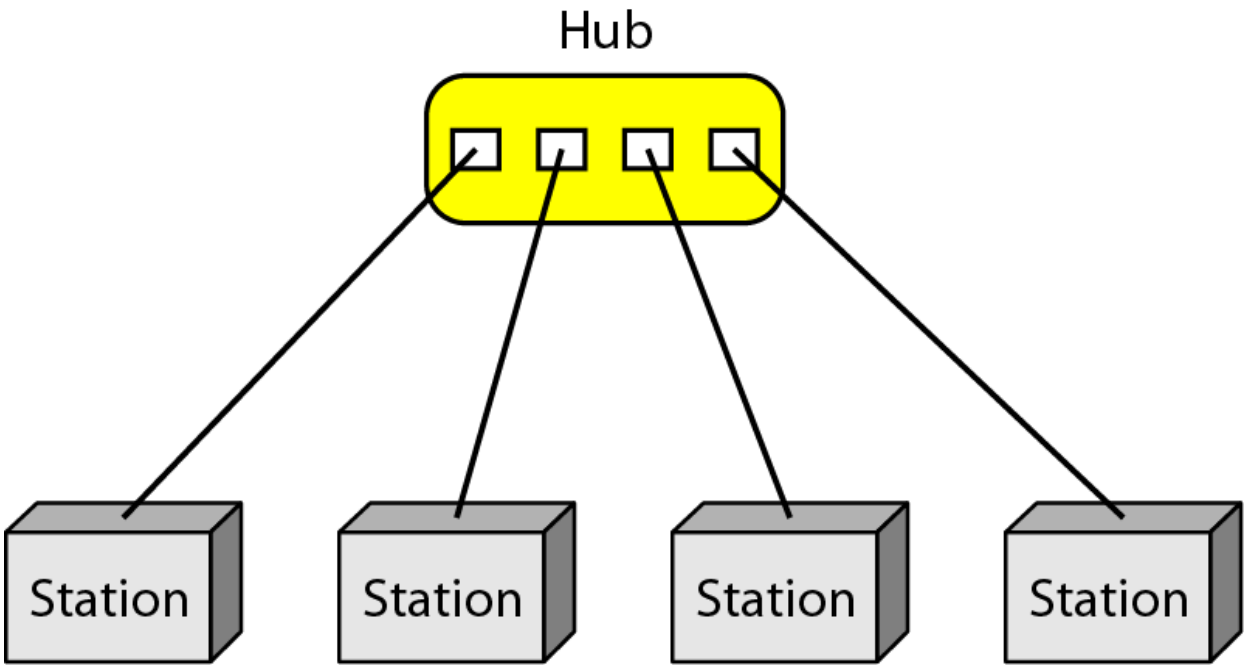


Figure 1.7 *A bus topology connecting three stations*

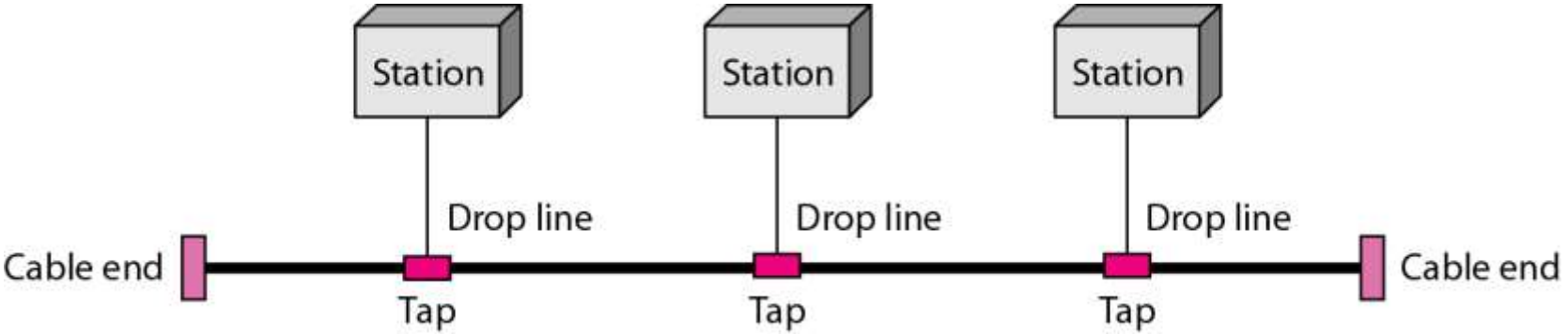


Figure 1.8 *A ring topology connecting six stations*

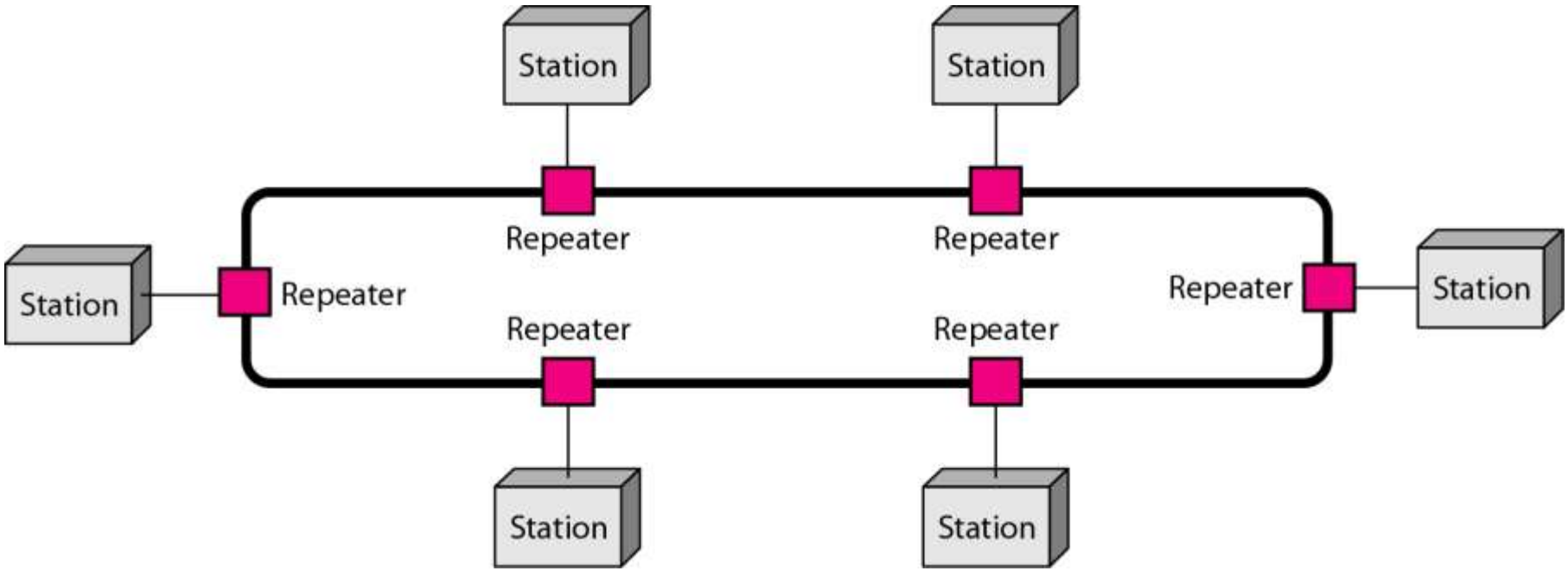
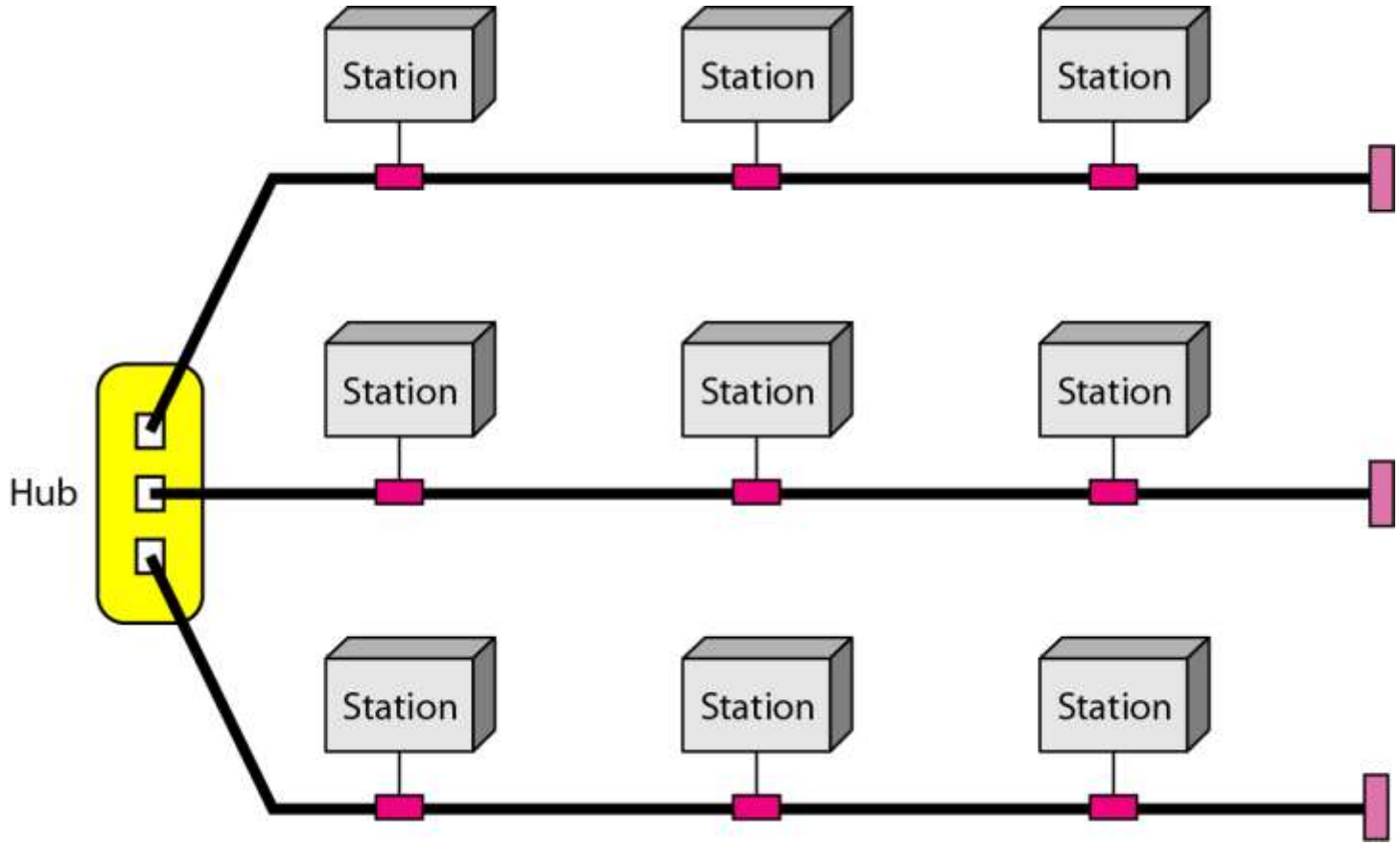


Figure 1.9 *A hybrid topology: a star backbone with three bus networks*



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

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

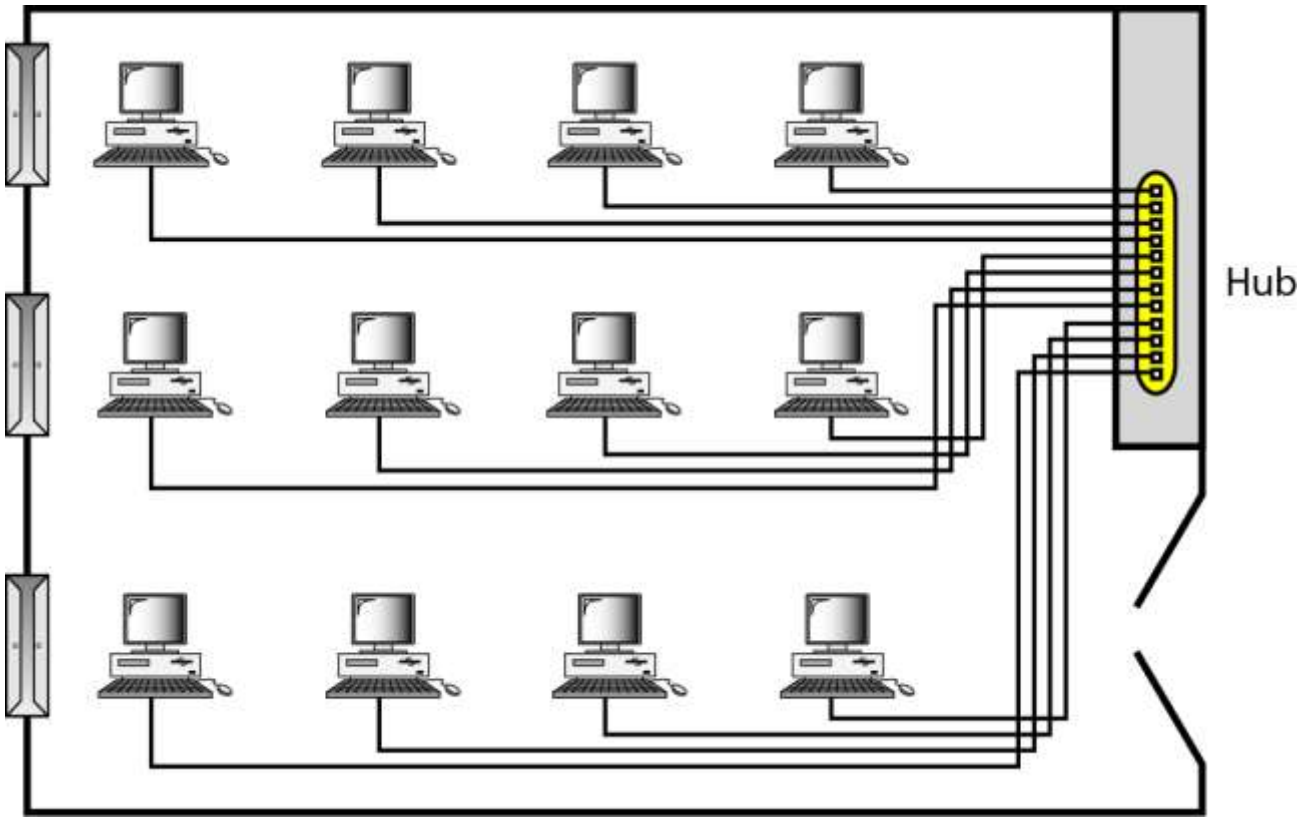
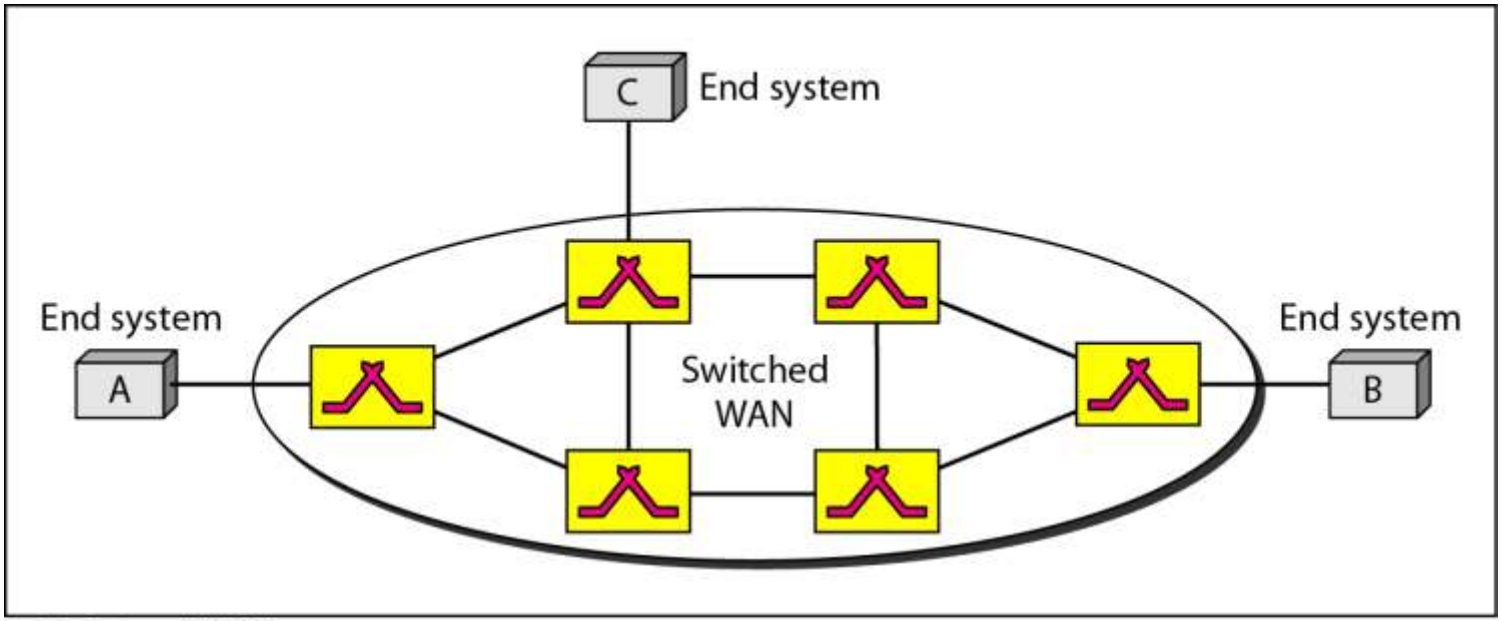
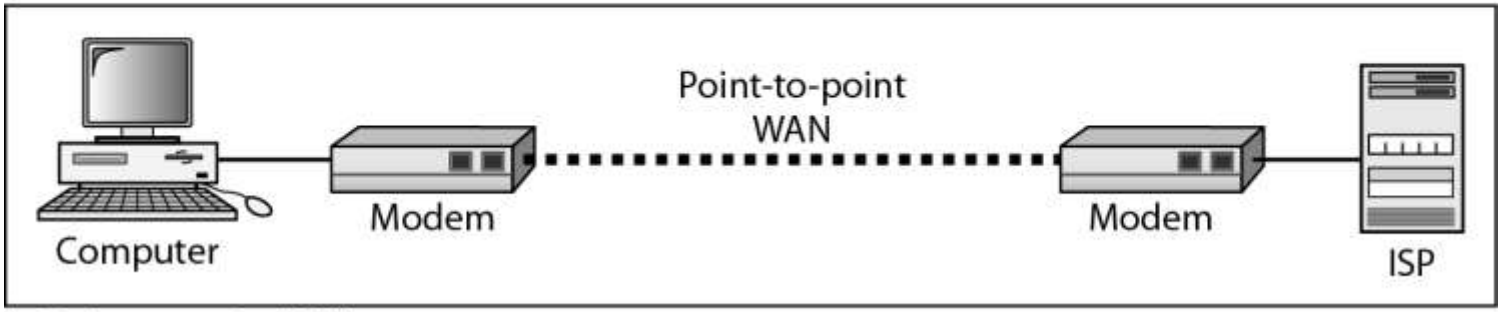


Figure 1.11 *WANs: a switched WAN and a point-to-point WAN*

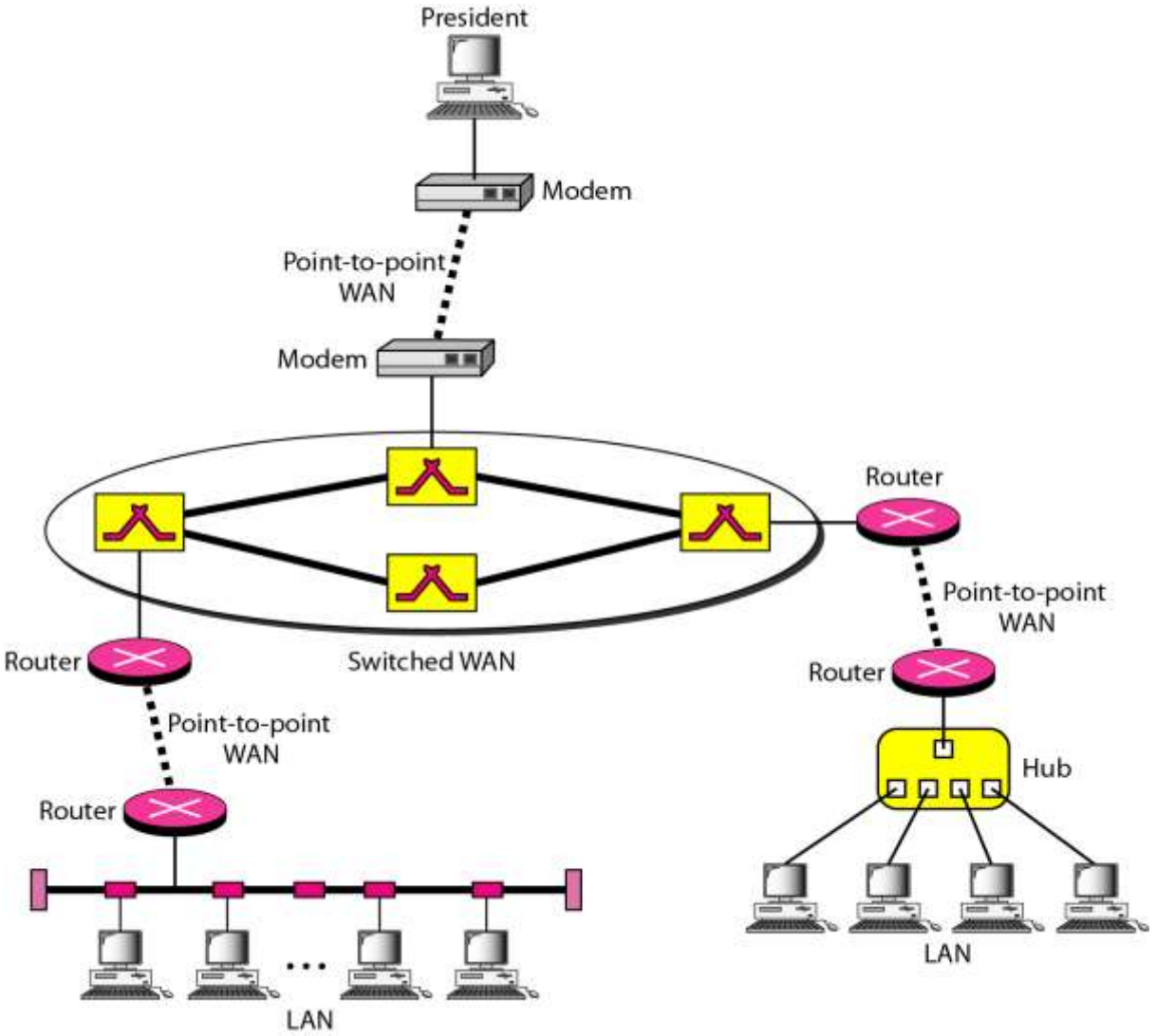


a. Switched WAN



b. Point-to-point WAN

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



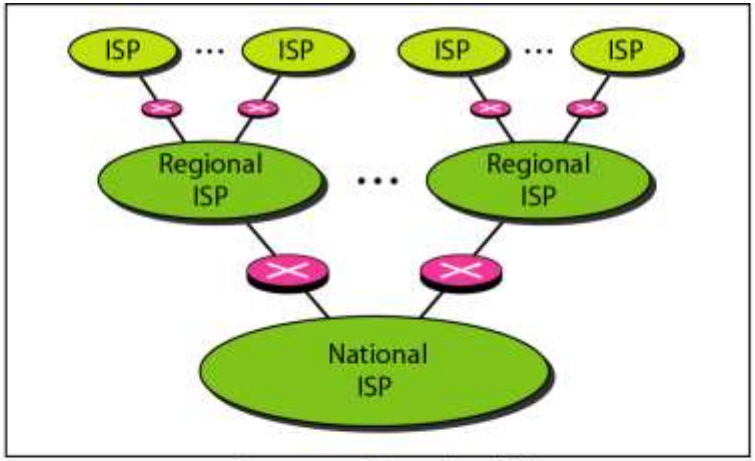
1-3 THE INTERNET

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.

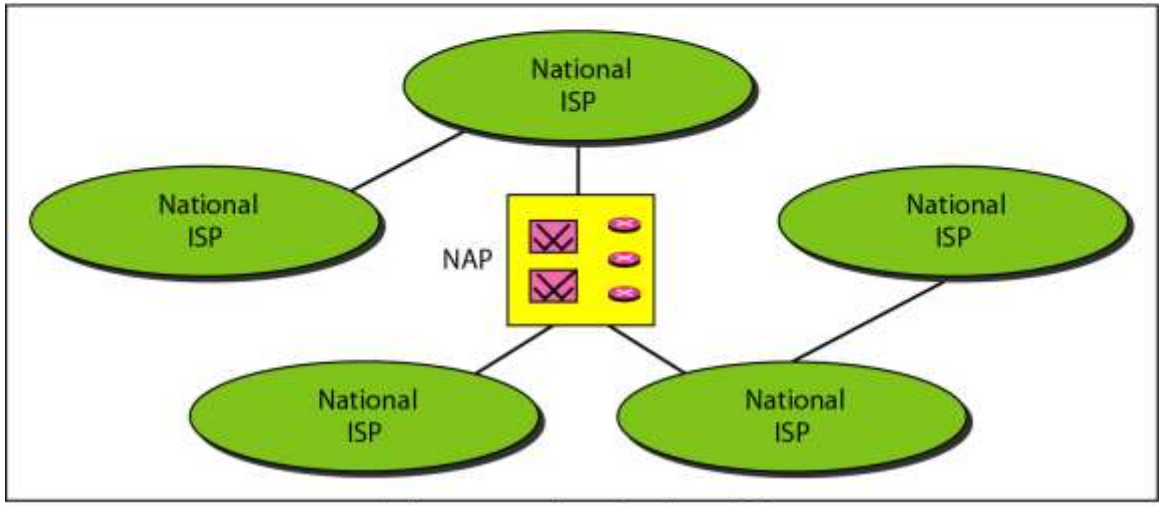
Topics discussed in this section:

Organization of the Internet
Internet Service Providers (ISPs)

Figure 1.13 *Hierarchical organization of the Internet*



a. Structure of a national ISP



b. Interconnection of national ISPs

1-4 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.

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Chapter 2

Network Models

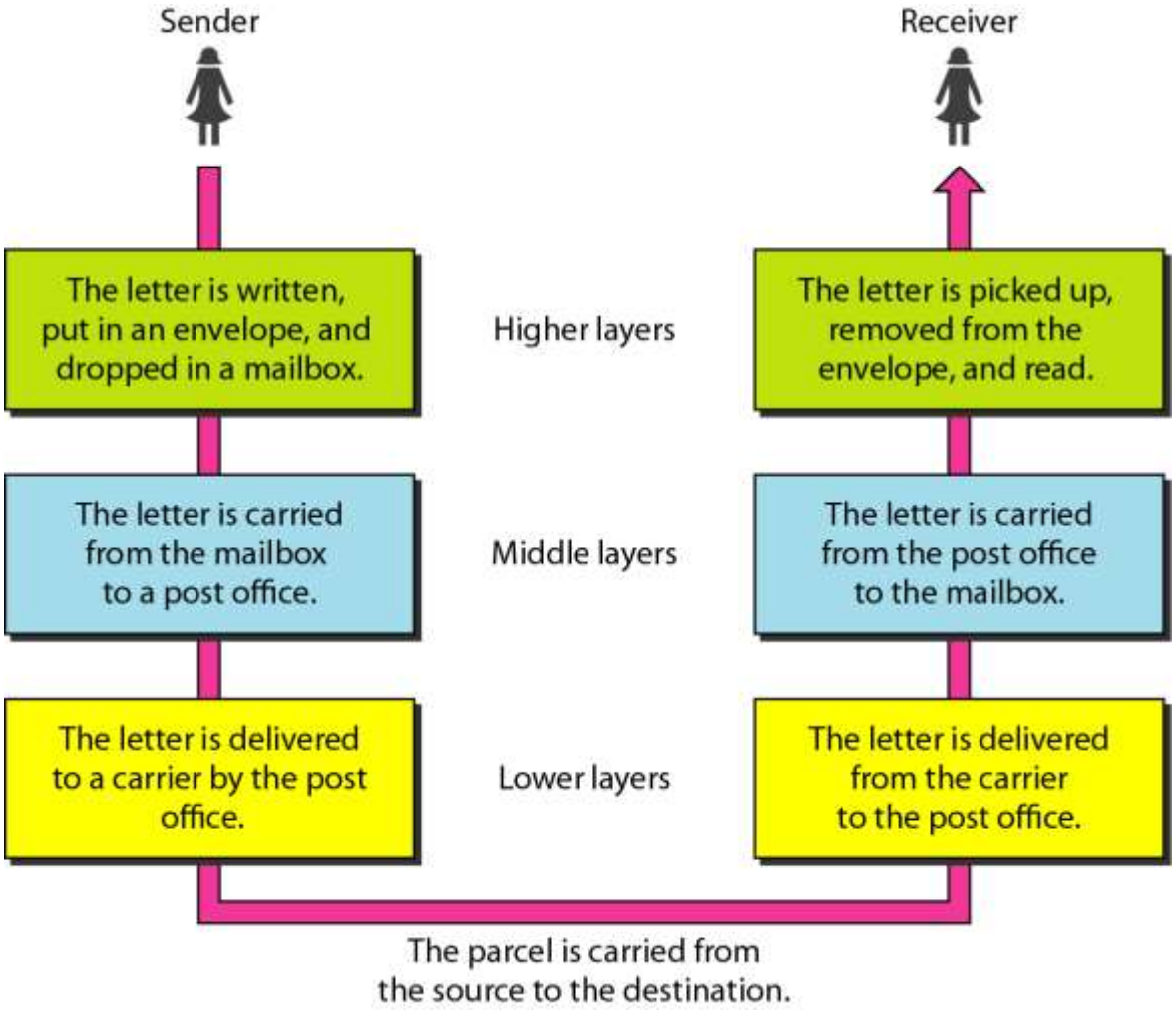
2-1 LAYERED TASKS

We use the concept of layers in our daily life. As an example, let us consider two friends who communicate through postal mail. The process of sending a letter to a friend would be complex if there were no services available from the post office.

Topics discussed in this section:

Sender, Receiver, and Carrier
Hierarchy

Figure 2.1 Tasks involved in sending a letter



2-2 THE OSI MODEL

Established in 1947, the International Standards Organization (ISO) is a multinational body dedicated to worldwide agreement on international standards. An ISO standard that covers all aspects of network communications is the Open Systems Interconnection (OSI) model. It was first introduced in the late 1970s.

Topics discussed in this section:

Layered Architecture
Peer-to-Peer Processes
Encapsulation

Note

ISO is the organization.
OSI is the model.

Figure 2.2 *Seven layers of the OSI model*

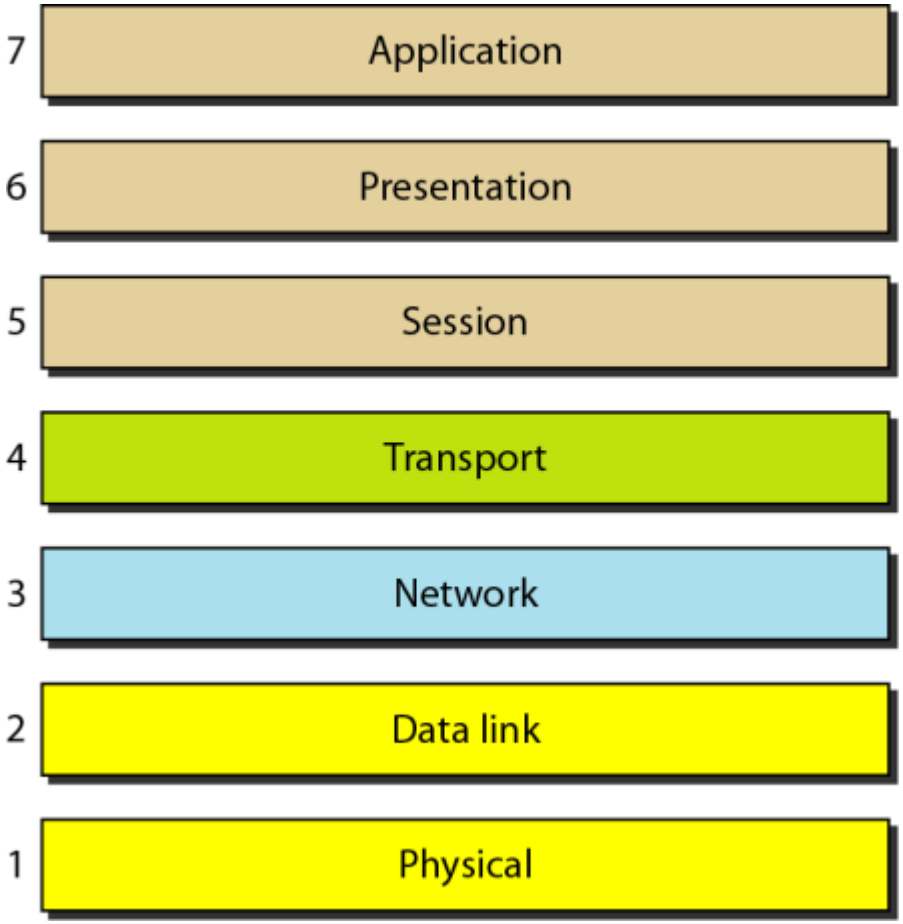


Figure 2.3 *The interaction between layers in the OSI model*

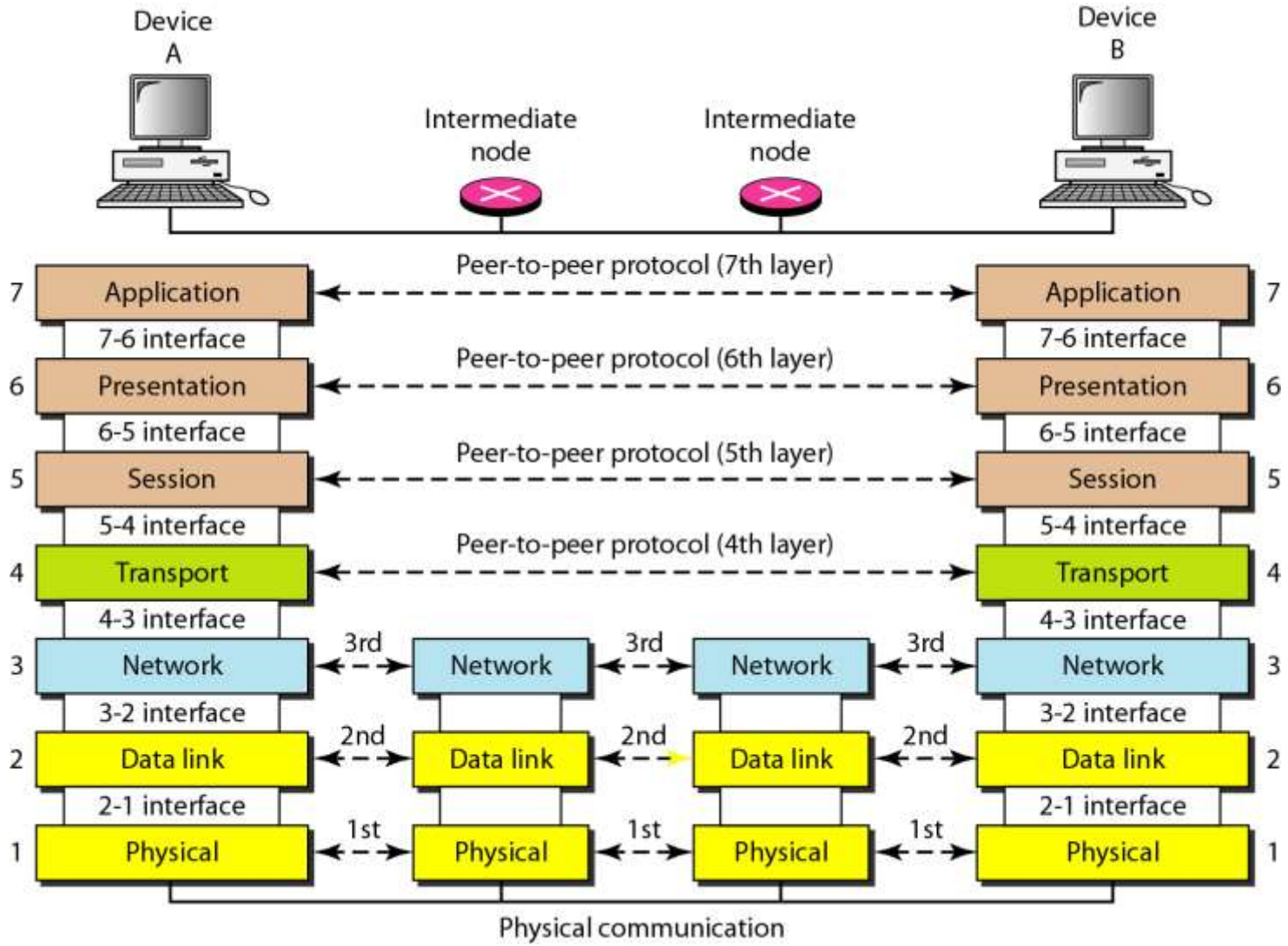
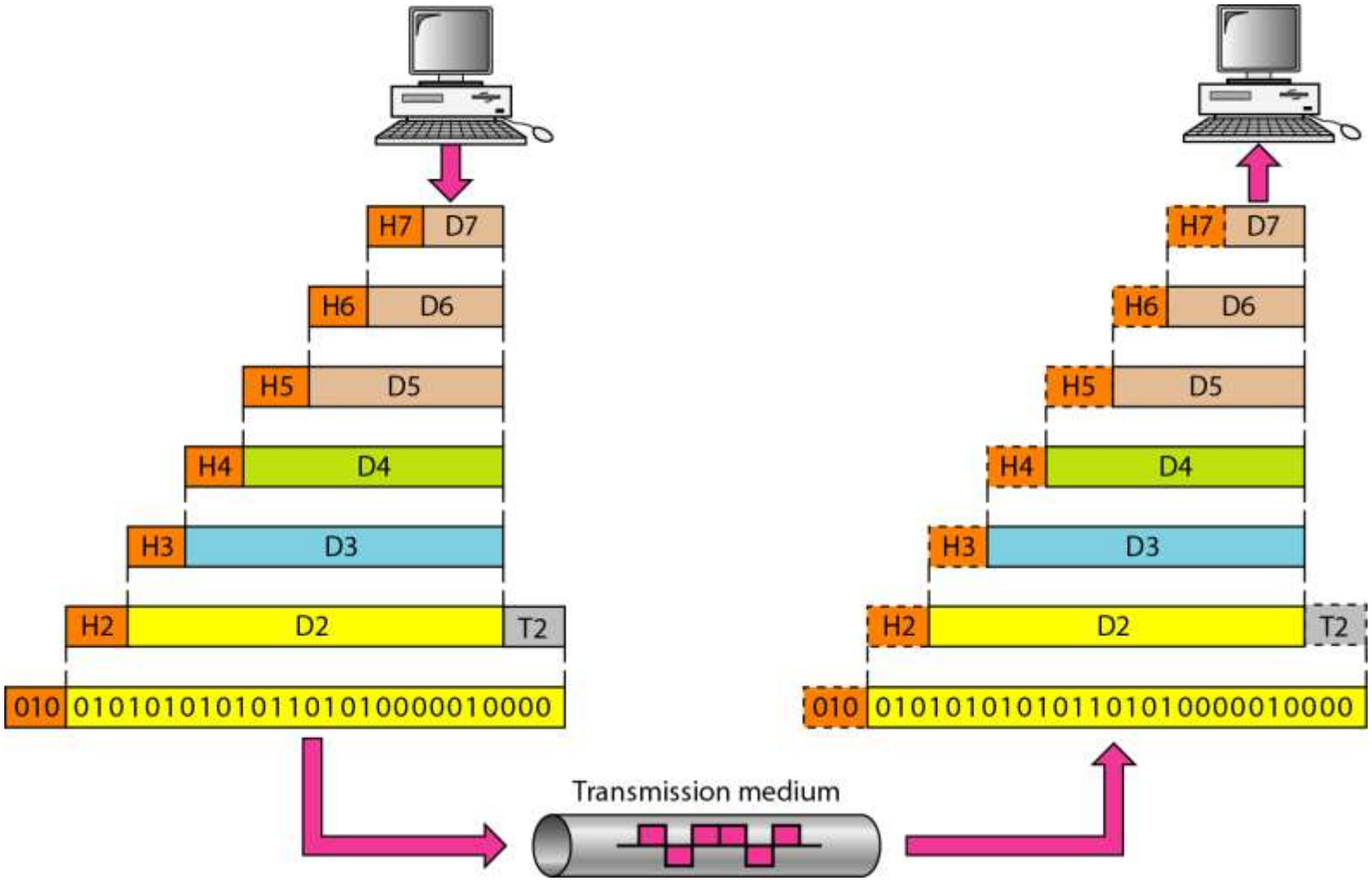


Figure 2.4 *An exchange using the OSI model*



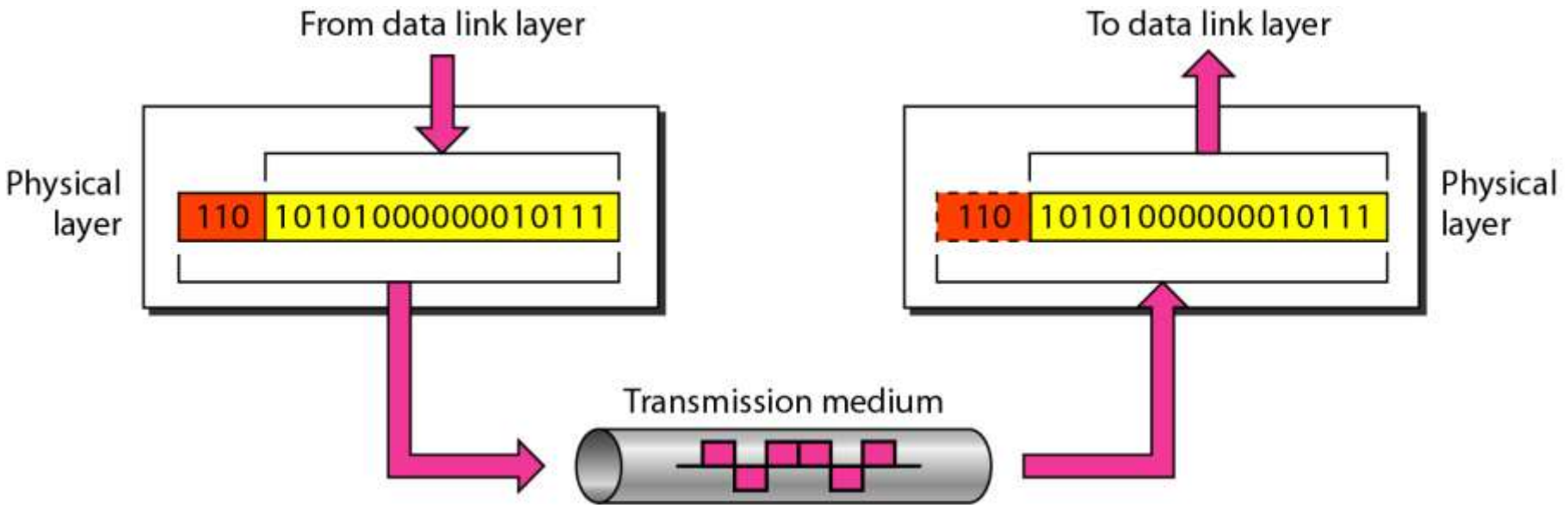
2-3 LAYERS IN THE OSI MODEL

In this section we briefly describe the functions of each layer in the OSI model.

Topics discussed in this section:

Physical Layer
Data Link Layer
Network Layer
Transport Layer
Session Layer
Presentation Layer
Application Layer

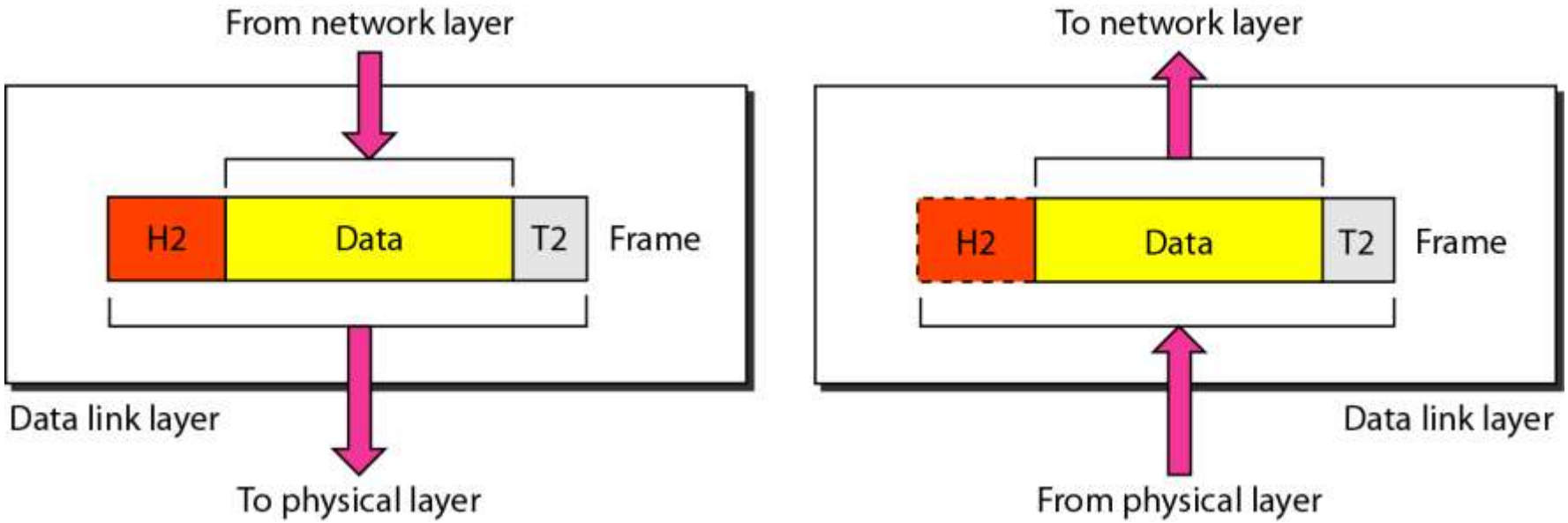
Figure 2.5 *Physical layer*



Note

The physical layer is responsible for movements of individual bits from one hop (node) to the next.

Figure 2.6 *Data link layer*



Note

The data link layer is responsible for moving frames from one hop (node) to the next.

Figure 2.7 *Hop-to-hop delivery*

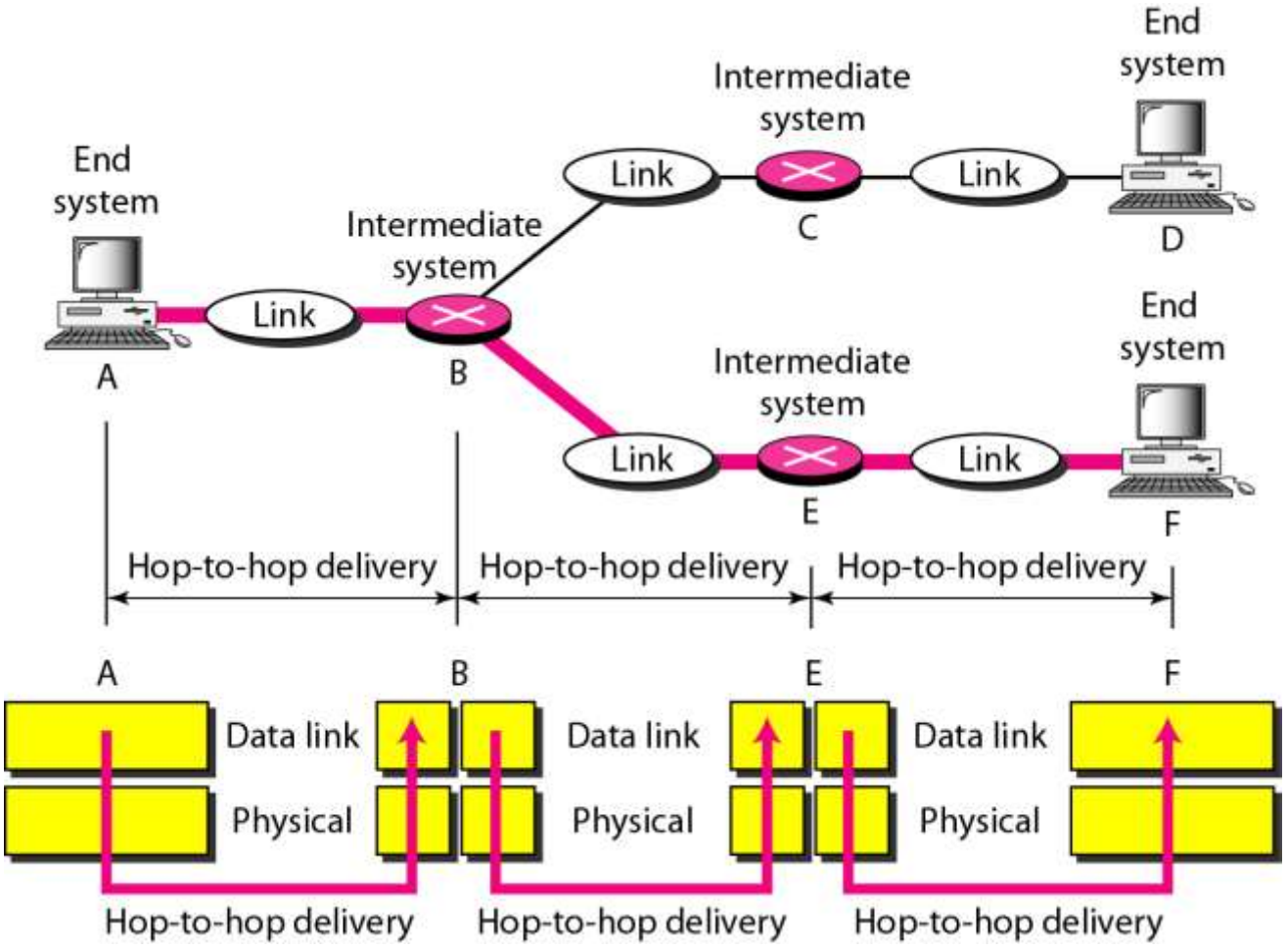
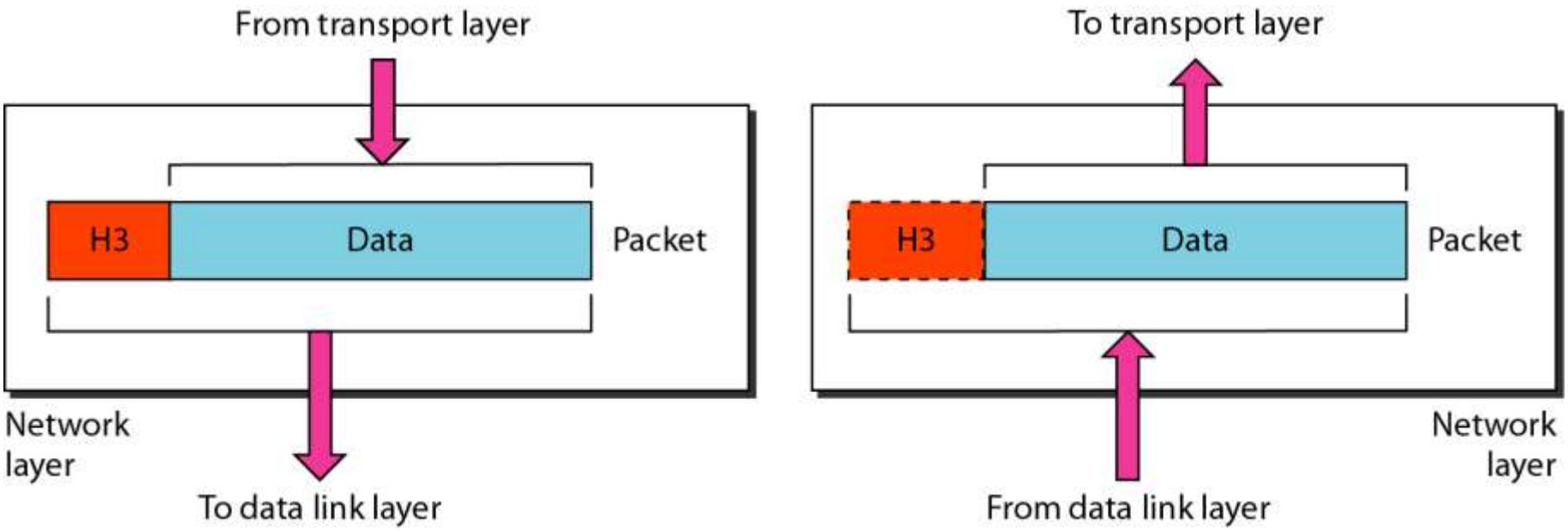


Figure 2.8 *Network layer*



Note

The network layer is responsible for the delivery of individual packets from the source host to the destination host.

Figure 2.9 *Source-to-destination delivery*

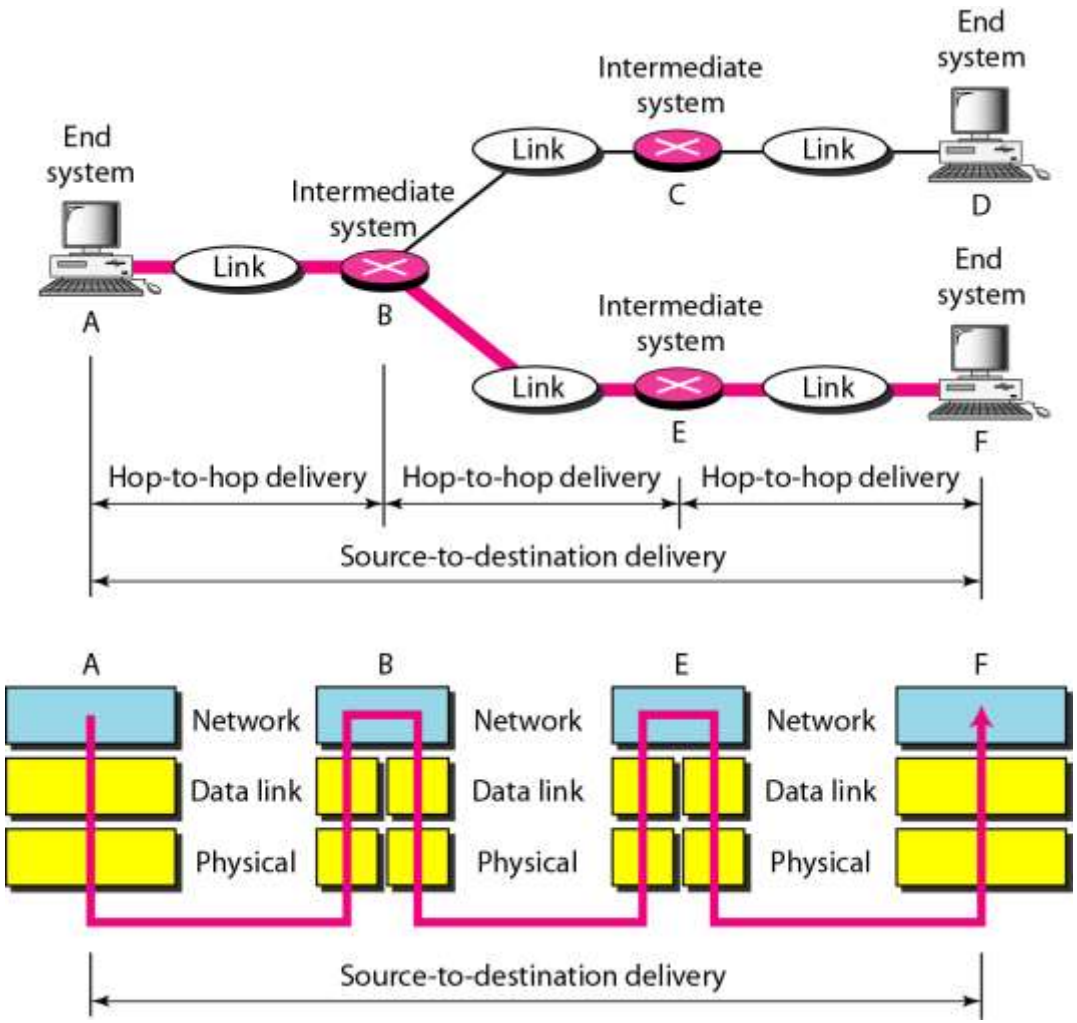
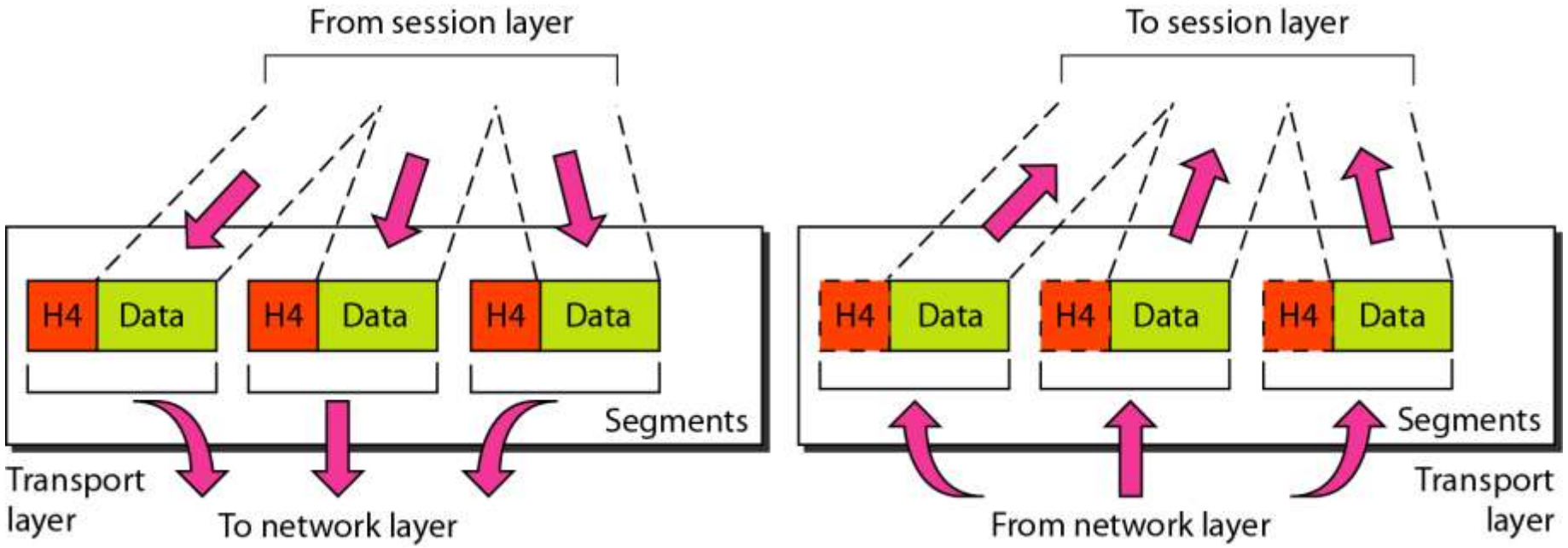


Figure 2.10 *Transport layer*



Note

The transport layer is responsible for the delivery of a message from one process to another.

Figure 2.11 *Reliable process-to-process delivery of a message*

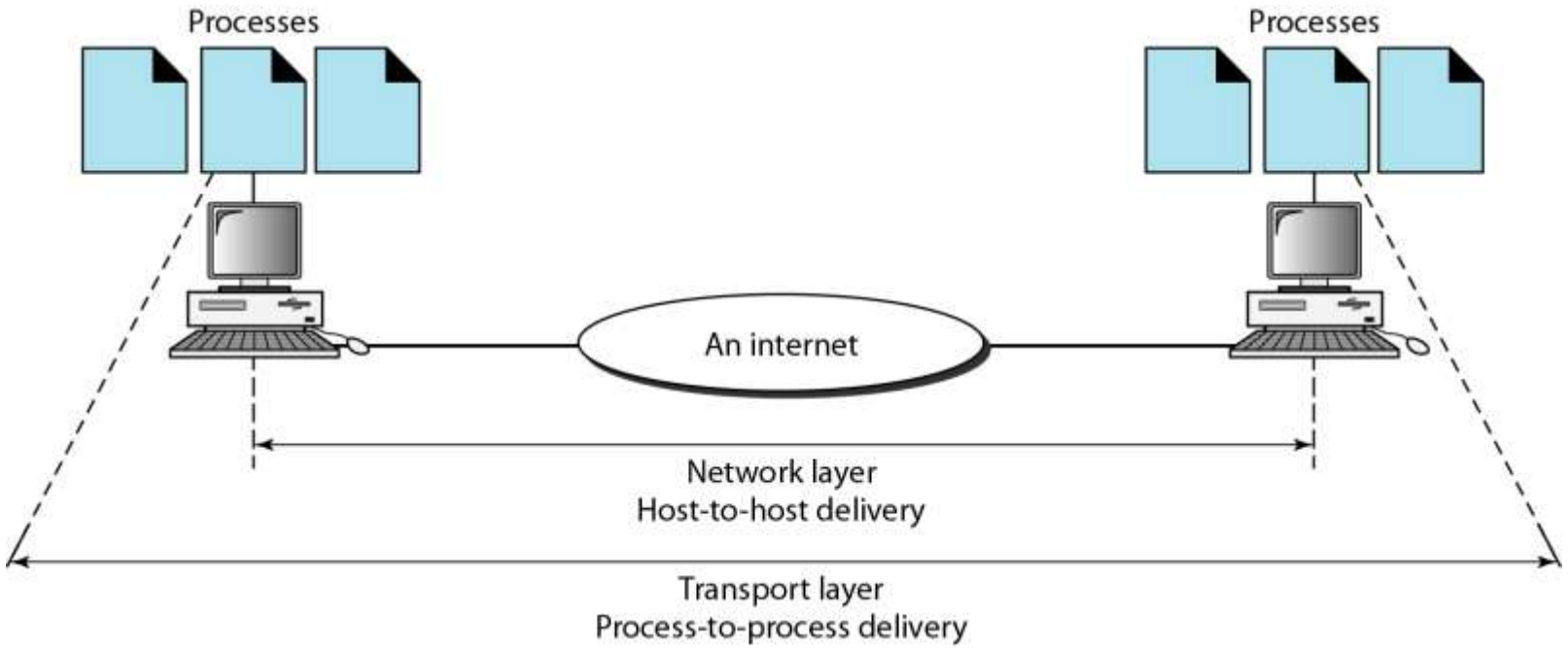
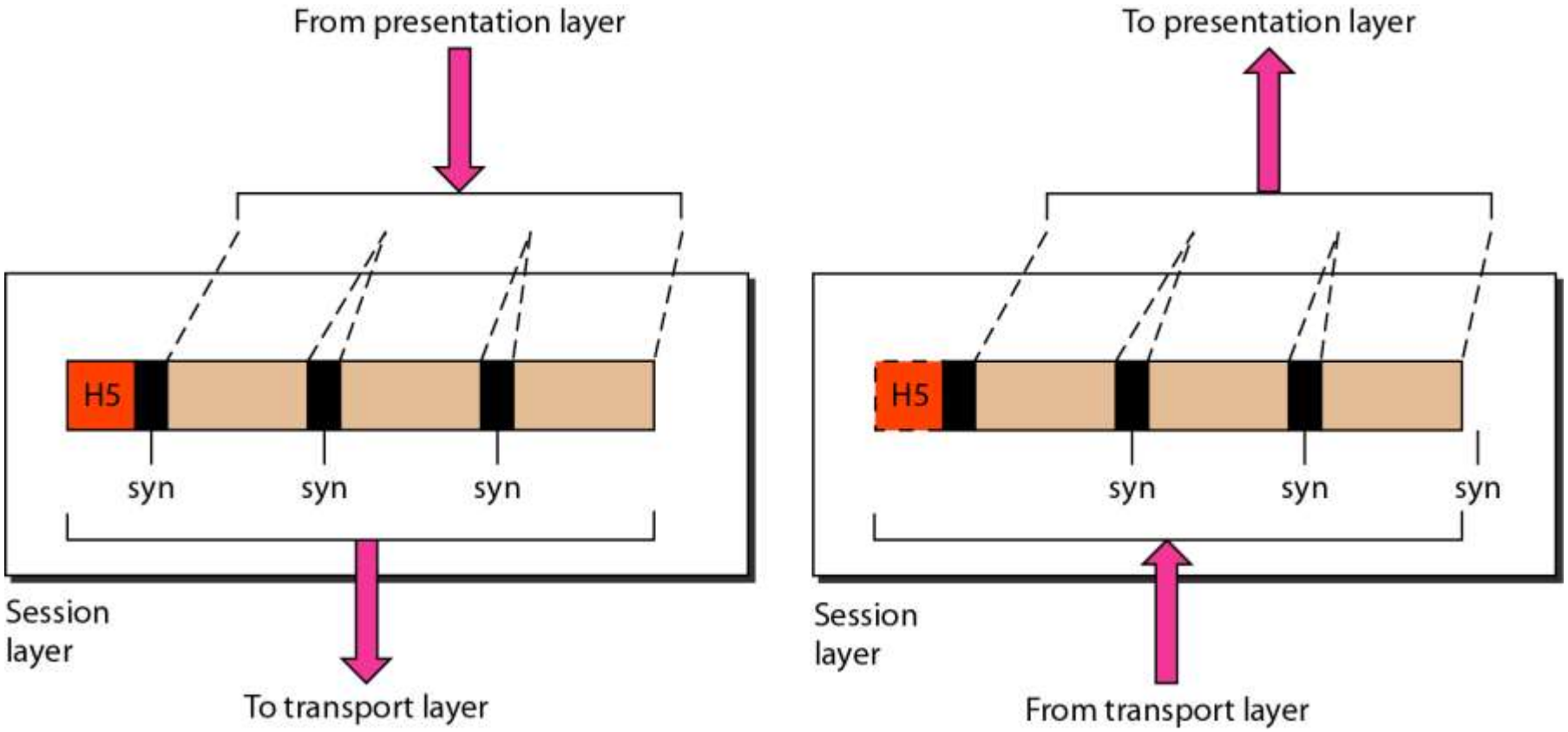


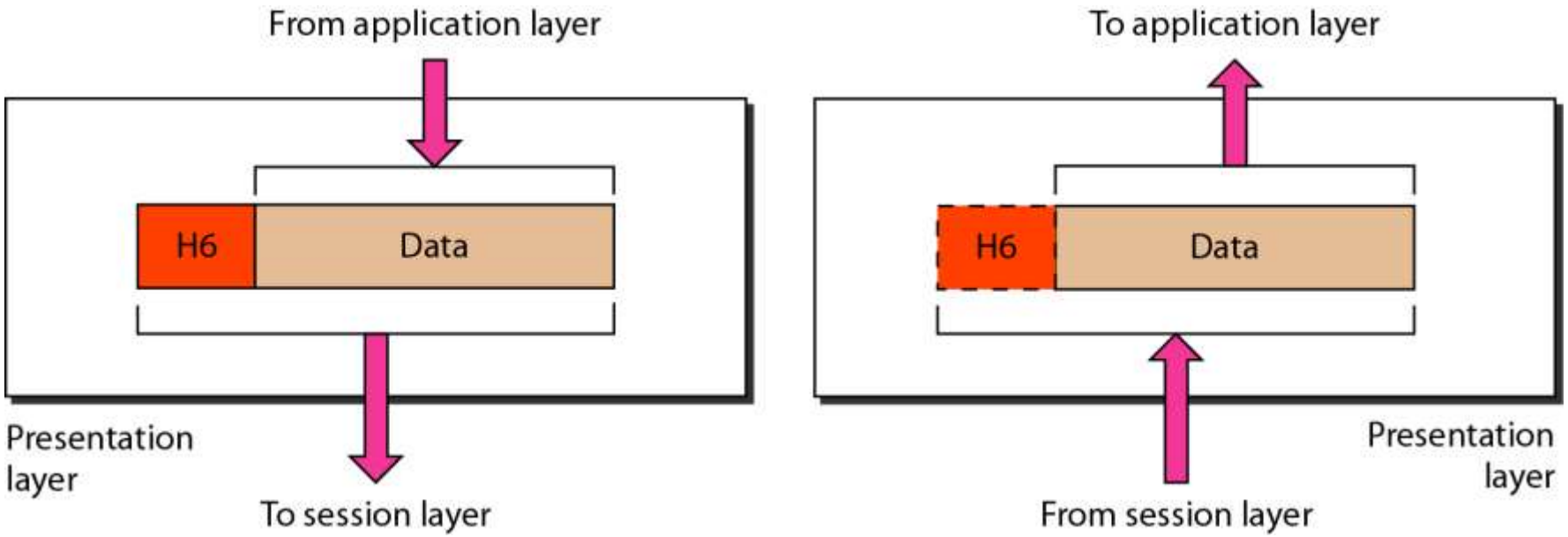
Figure 2.12 *Session layer*



Note

The session layer is responsible for dialog control and synchronization.

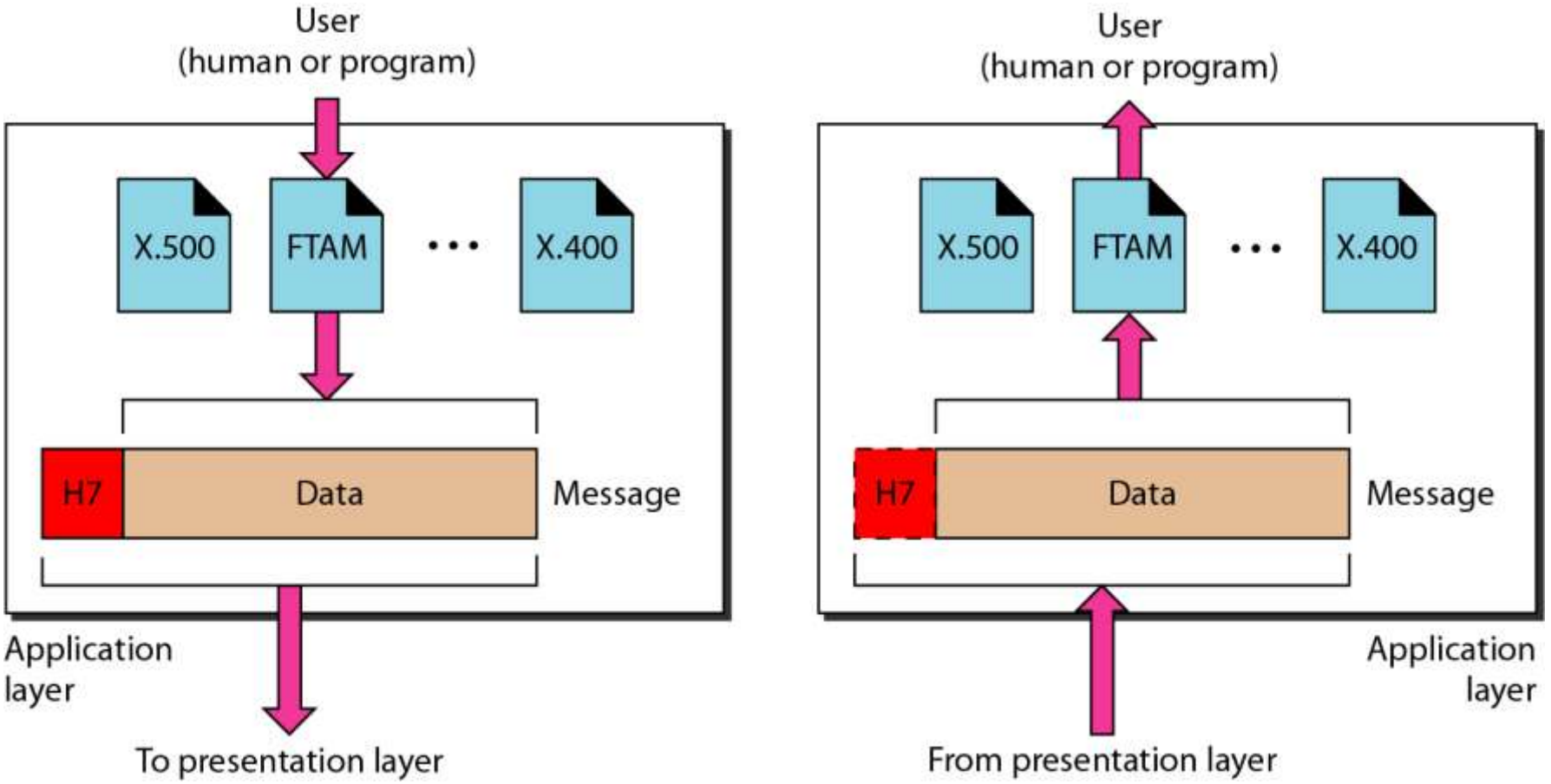
Figure 2.13 *Presentation layer*



Note

The presentation layer is responsible for translation, compression, and encryption.

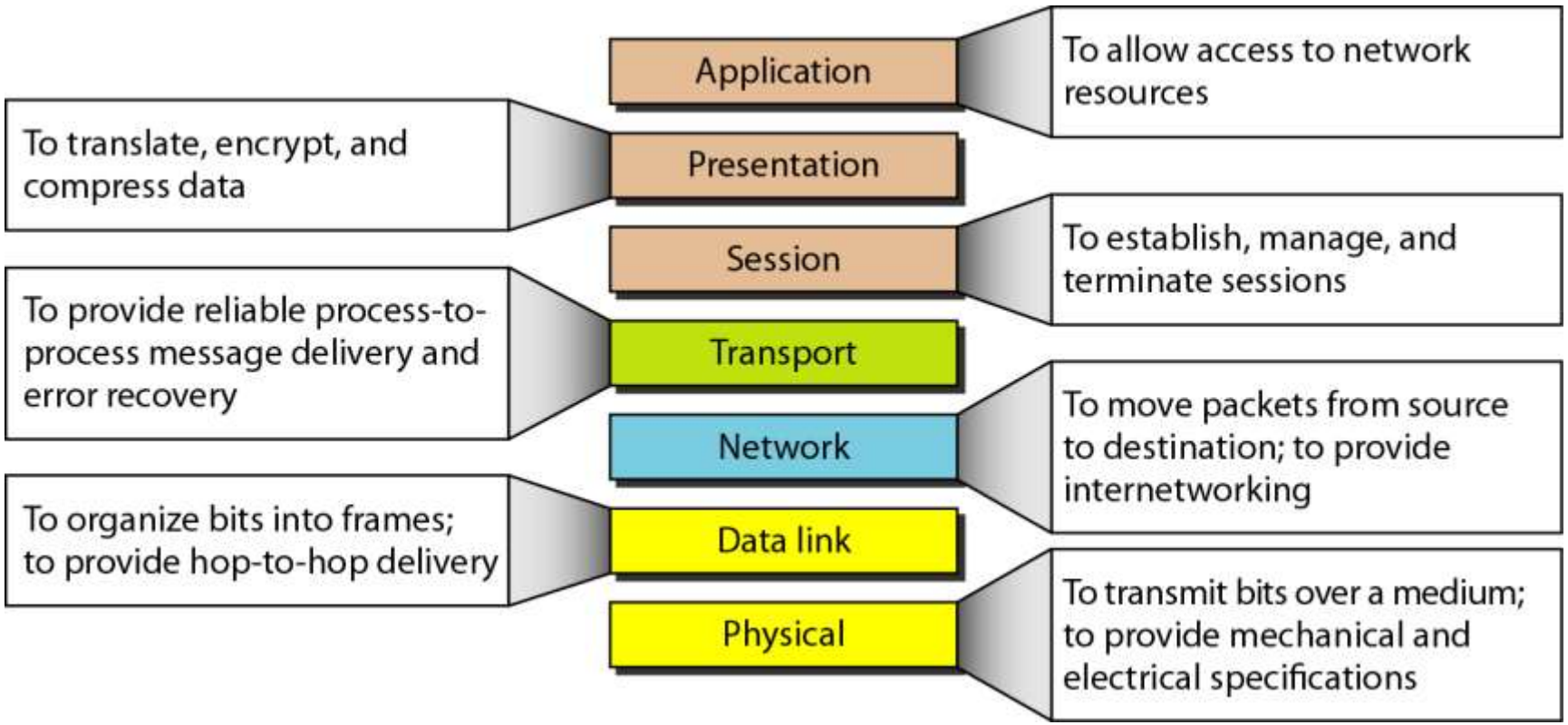
Figure 2.14 *Application layer*



Note

The application layer is responsible for providing services to the user.

Figure 2.15 *Summary of layers*



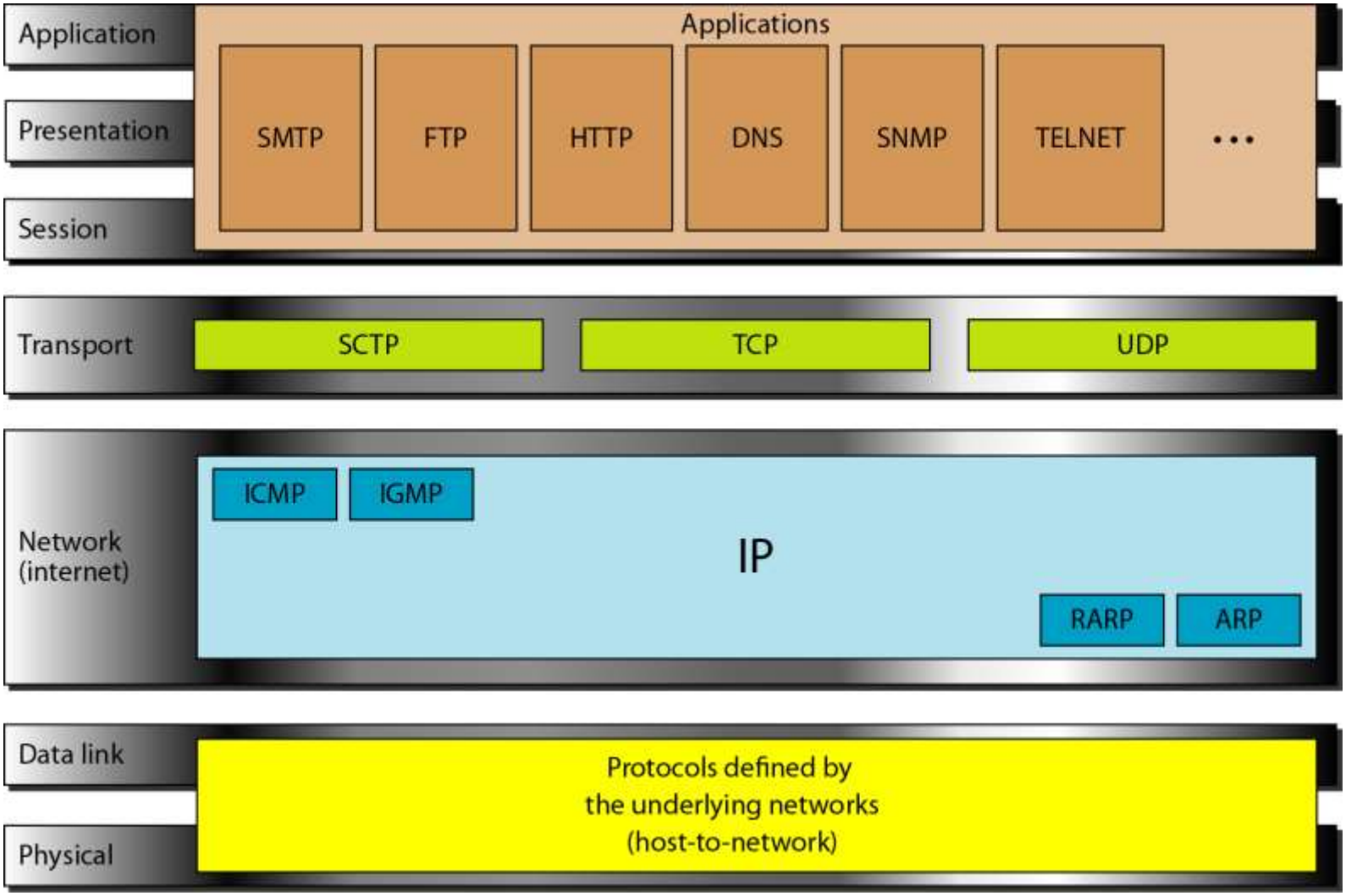
2-4 TCP/IP PROTOCOL SUITE

The layers in the TCP/IP protocol suite do not exactly match those in the OSI model. The original TCP/IP protocol suite was defined as having four layers: host-to-network, internet, transport, and application. However, when TCP/IP is compared to OSI, we can say that the TCP/IP protocol suite is made of five layers: physical, data link, network, transport, and application.

Topics discussed in this section:

Physical and Data Link Layers
Network Layer
Transport Layer
Application Layer

Figure 2.16 *TCP/IP and OSI model*



2-5 ADDRESSING

Four levels of addresses are used in an internet employing the TCP/IP protocols: physical, logical, port, and specific.

Topics discussed in this section:

Physical Addresses
Logical Addresses
Port Addresses
Specific Addresses

Figure 2.17 *Addresses in TCP/IP*

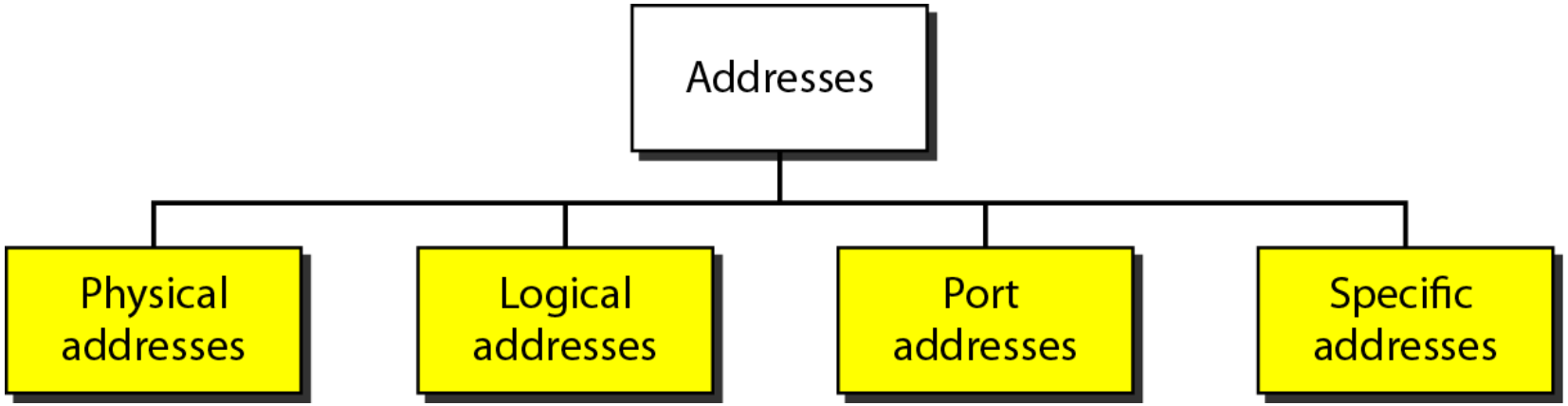
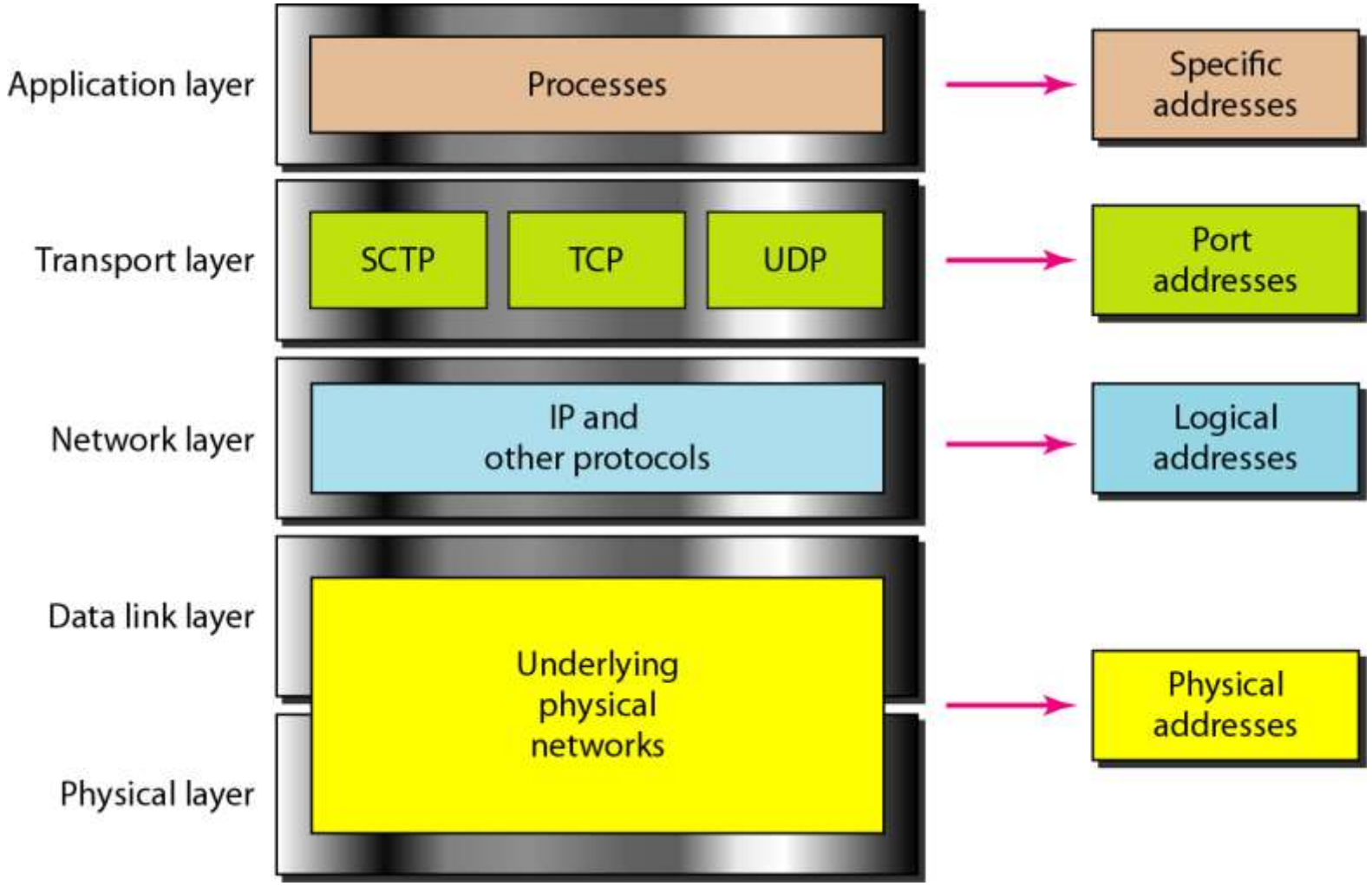


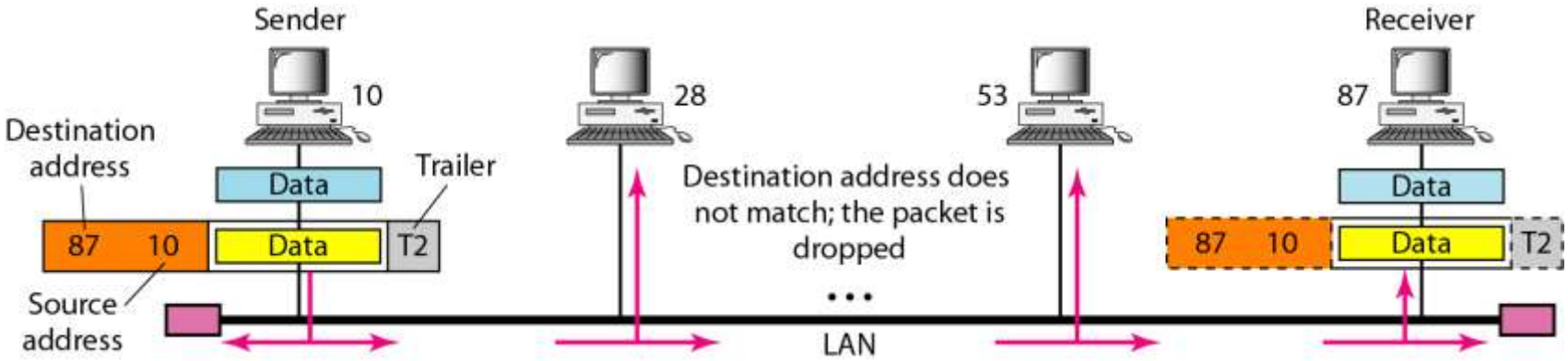
Figure 2.18 *Relationship of layers and addresses in TCP/IP*



Example 2.1

In Figure 2.19 a node with physical address 10 sends a frame to a node with physical address 87. The two nodes are connected by a link (bus topology LAN). As the figure shows, the computer with physical address 10 is the sender, and the computer with physical address 87 is the receiver.

Figure 2.19 *Physical addresses*



Example 2.2

Most local-area networks use a 48-bit (6-byte) physical address written as 12 hexadecimal digits; every byte (2 hexadecimal digits) is separated by a colon, as shown below:

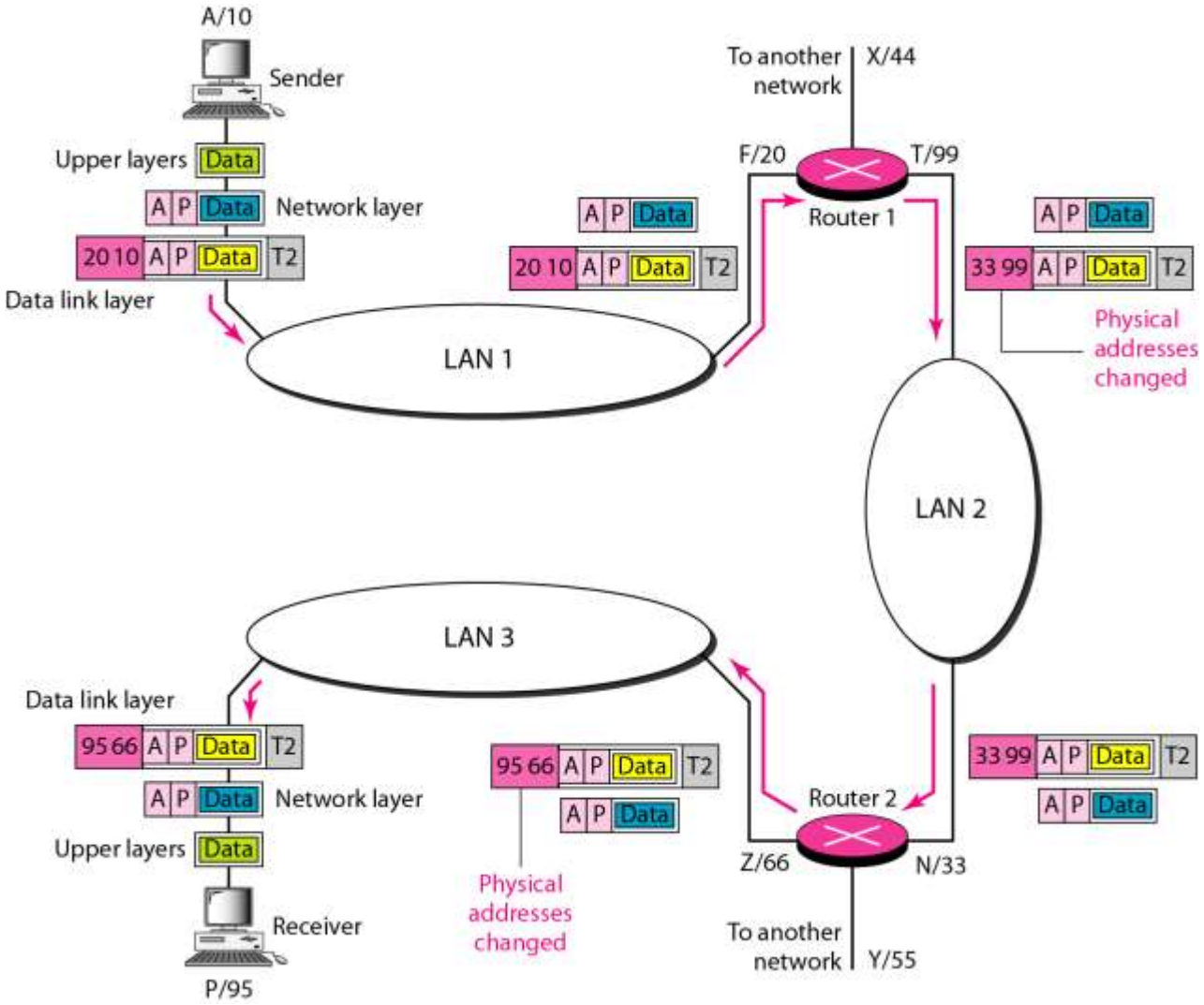
07:01:02:01:2C:4B

A 6-byte (12 hexadecimal digits) physical address.

Example 2.3

Figure 2.20 shows a part of an internet with two routers connecting three LANs. Each device (computer or router) has a pair of addresses (logical and physical) for each connection. In this case, each computer is connected to only one link and therefore has only one pair of addresses. Each router, however, is connected to three networks (only two are shown in the figure). So each router has three pairs of addresses, one for each connection.

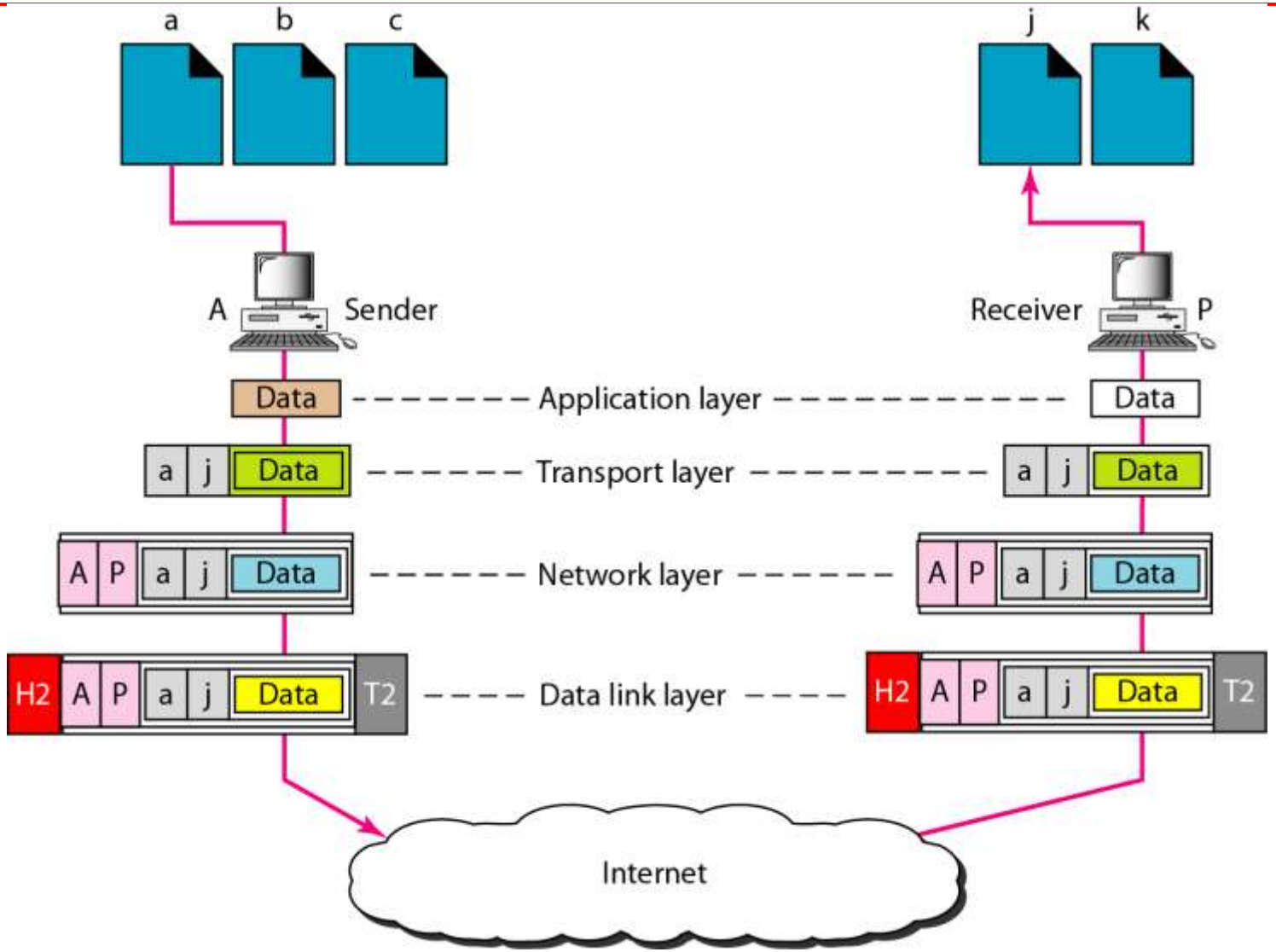
Figure 2.20 *IP addresses*



Example 2.4

Figure 2.21 shows two computers communicating via the Internet. The sending computer is running three processes at this time with port addresses a, b, and c. The receiving computer is running two processes at this time with port addresses j and k. Process a in the sending computer needs to communicate with process j in the receiving computer. Note that although physical addresses change from hop to hop, logical and port addresses remain the same from the source to destination.

Figure 2.21 *Port addresses*



Note

The physical addresses will change from hop to hop, but the logical addresses usually remain the same.

Example 2.5

A port address is a 16-bit address represented by one decimal number as shown.

753

A 16-bit port address represented as one single number.