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.*
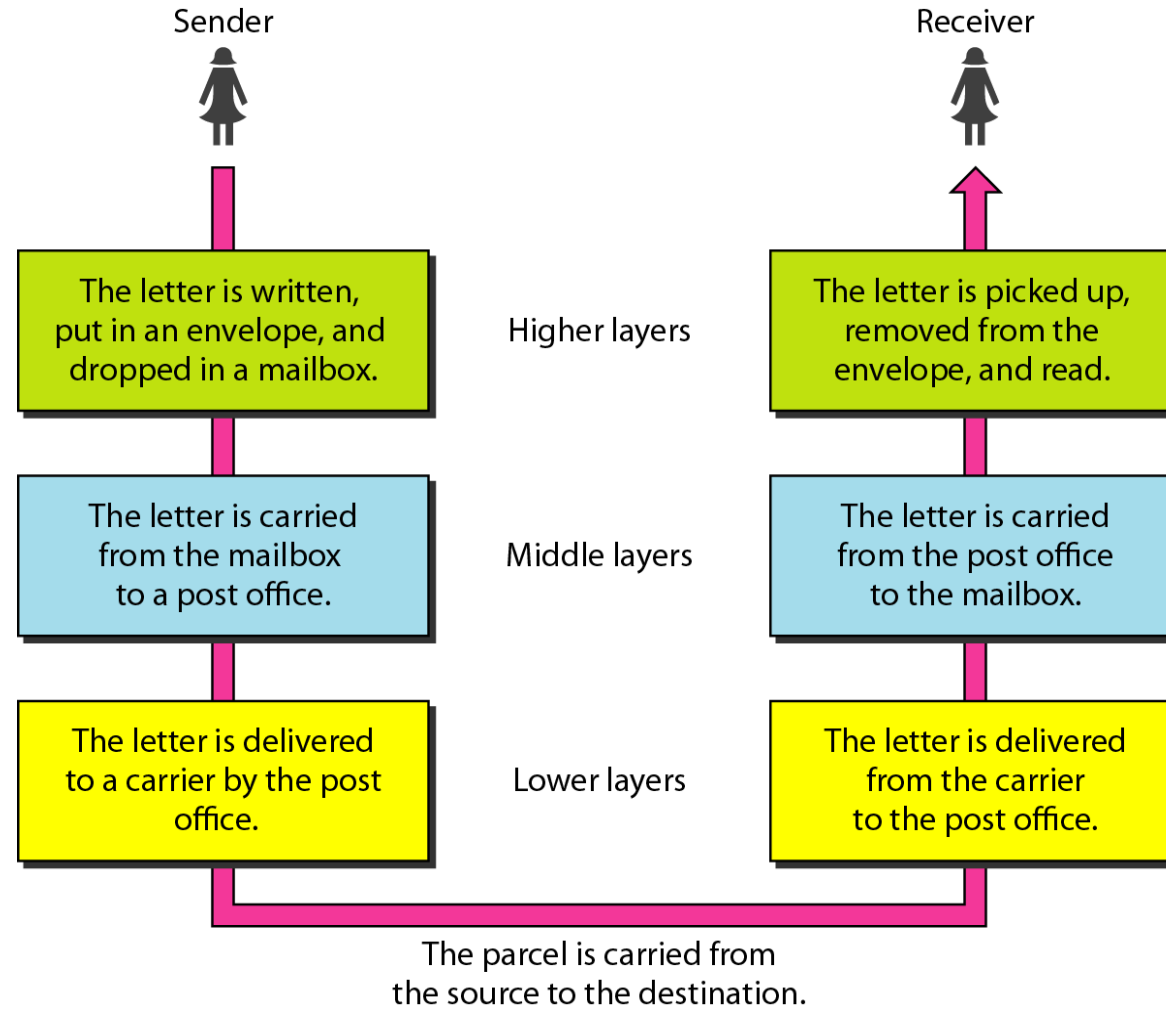
Topics discussed in this section:

Sender, Receiver, and Carrier
Hierarchy
Services

2.2

Figure 2.1 Tasks involved in sending a letter

Sender   Receiver

| The letter is written, put in an envelope, and dropped in a mailbox. | Higher layers | The letter is picked up, removed from the envelope, and read. |

| The letter is carried from the mailbox to a post office. | Middle layers | The letter is carried from the post office to the mailbox. |

| The letter is delivered to a carrier by the post office. | Lower layers | The letter is delivered from the carrier to the post office. |

The parcel is carried from
the source to the destination.

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, interfaces
Headers & Trailer
Encapsulation

2.4

Note

ISO is the organization.
OSI is the model.

Organization of the layers

3 Subgroups
- **Physical, Data Link, Network** (network support layers)
- **Transport**
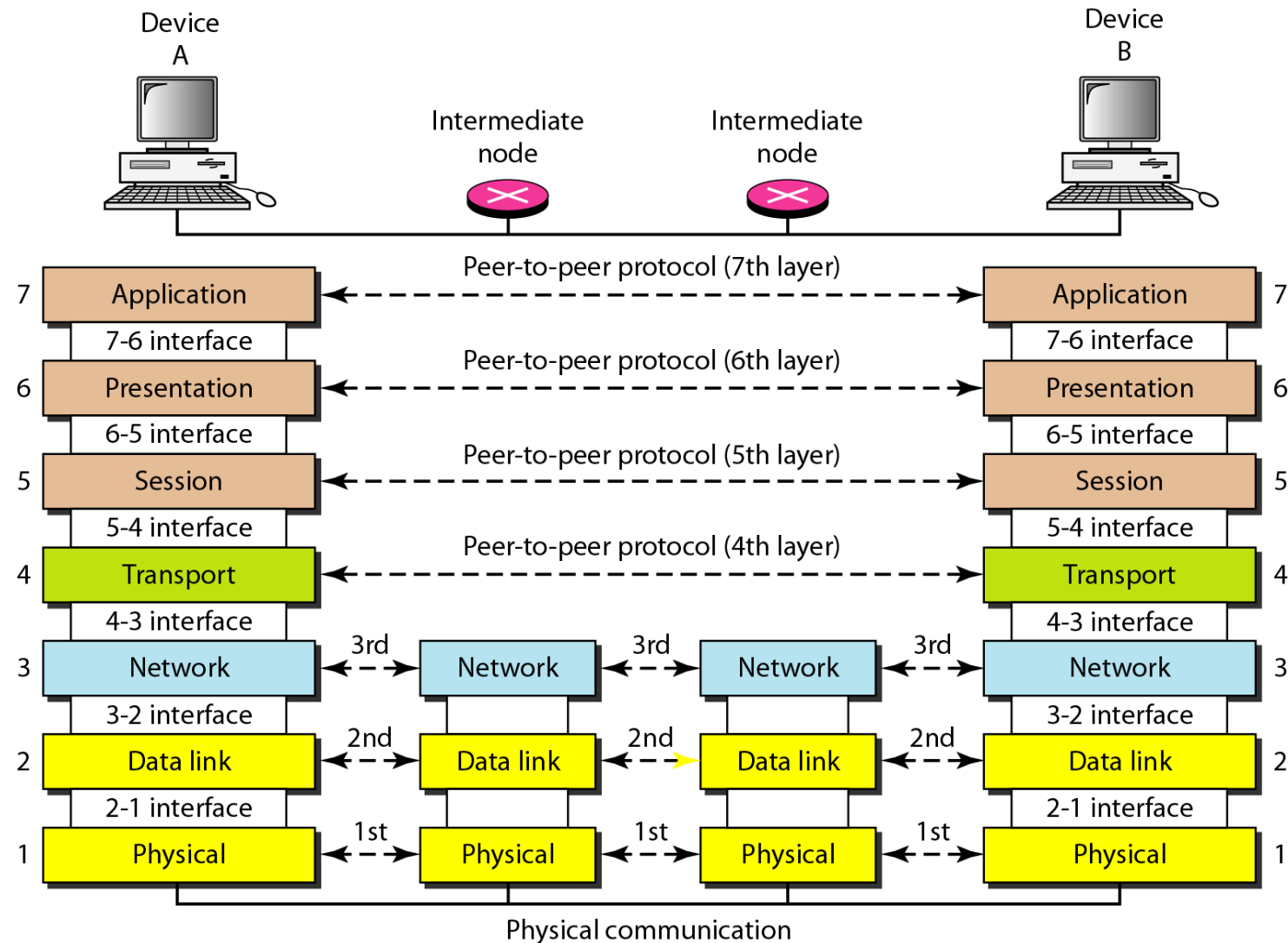- **Session, Presentation, Application** (user support layers)

Figure 2.2 *Seven layers of the OSI model*

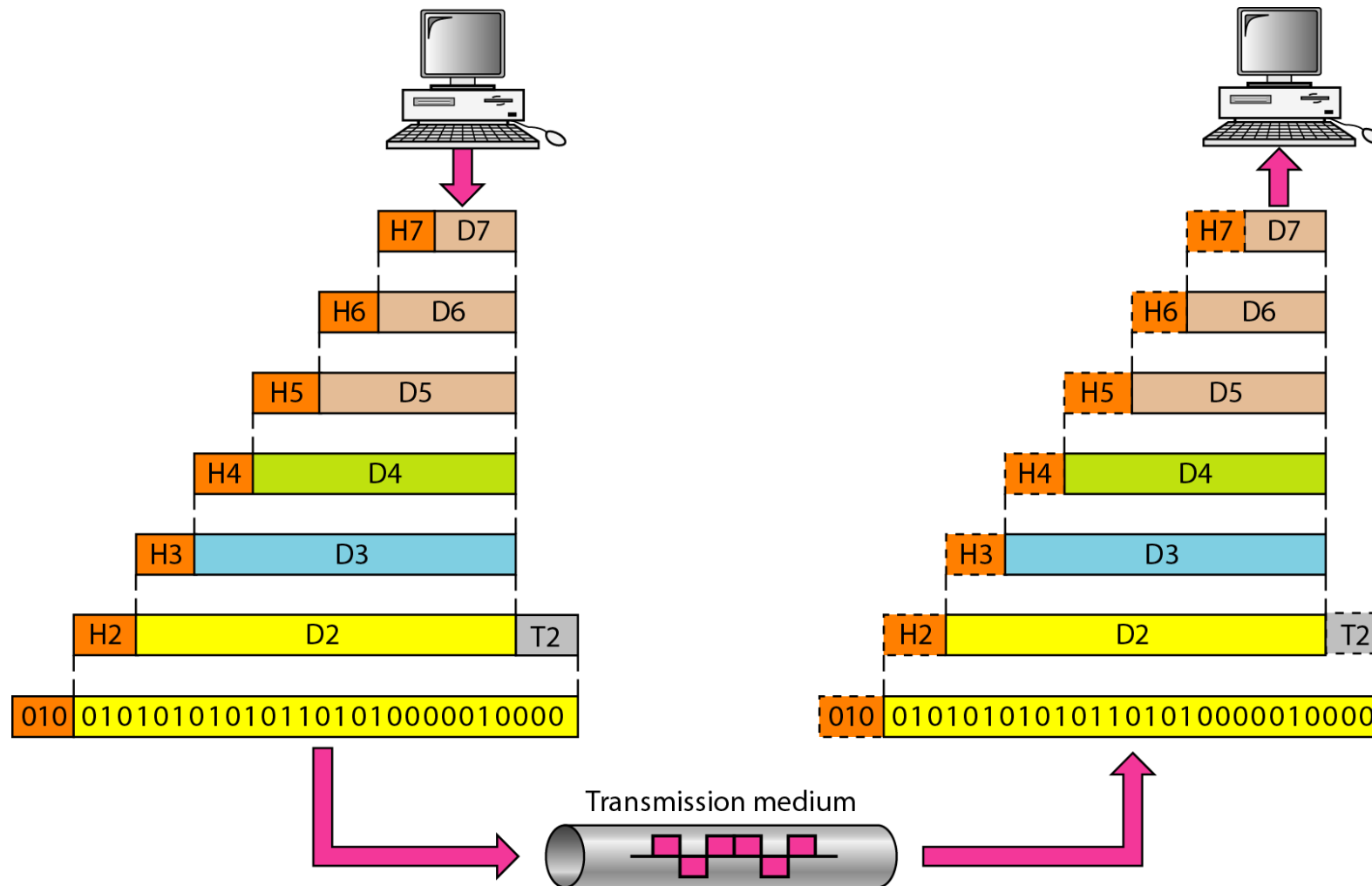|	
7	Application
6	Presentation
5	Session
4	Transport
3	Network
2	Data link
1	Physical
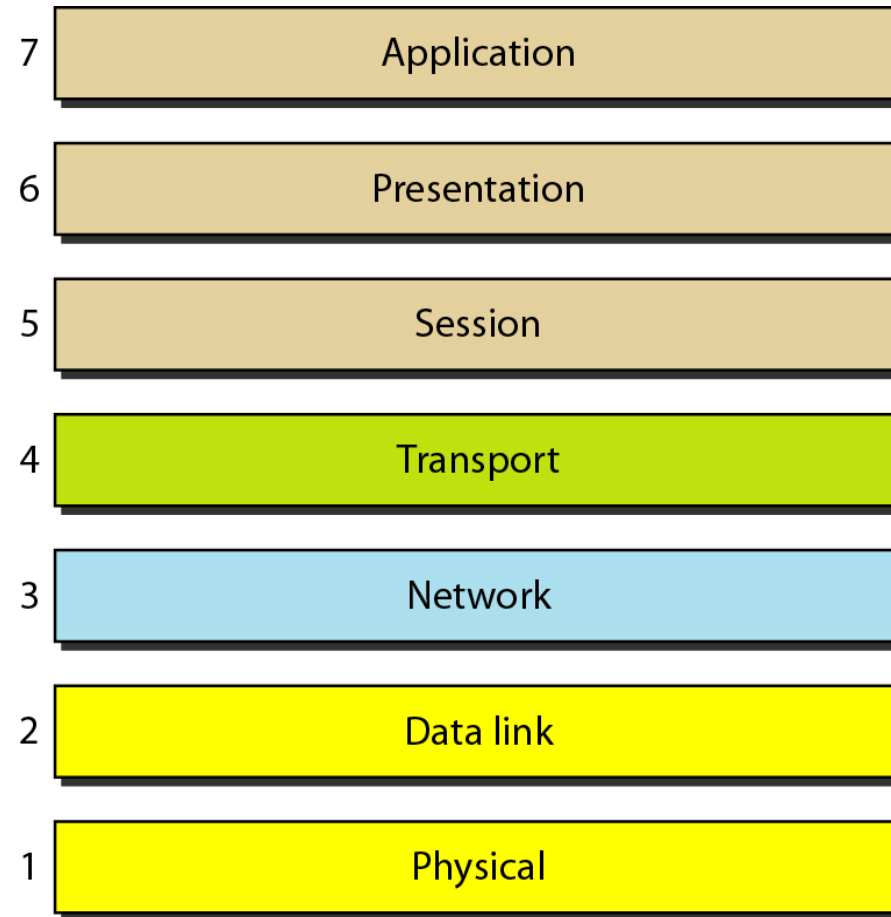
Figure 2.3 The interaction between layers in the OSI model

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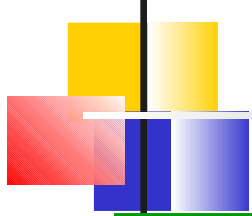Data Link Layer
Network Layer
Transport Layer
Session Layer
Presentation Layer
Application Layer

Figure 2.5 *Physical layer*
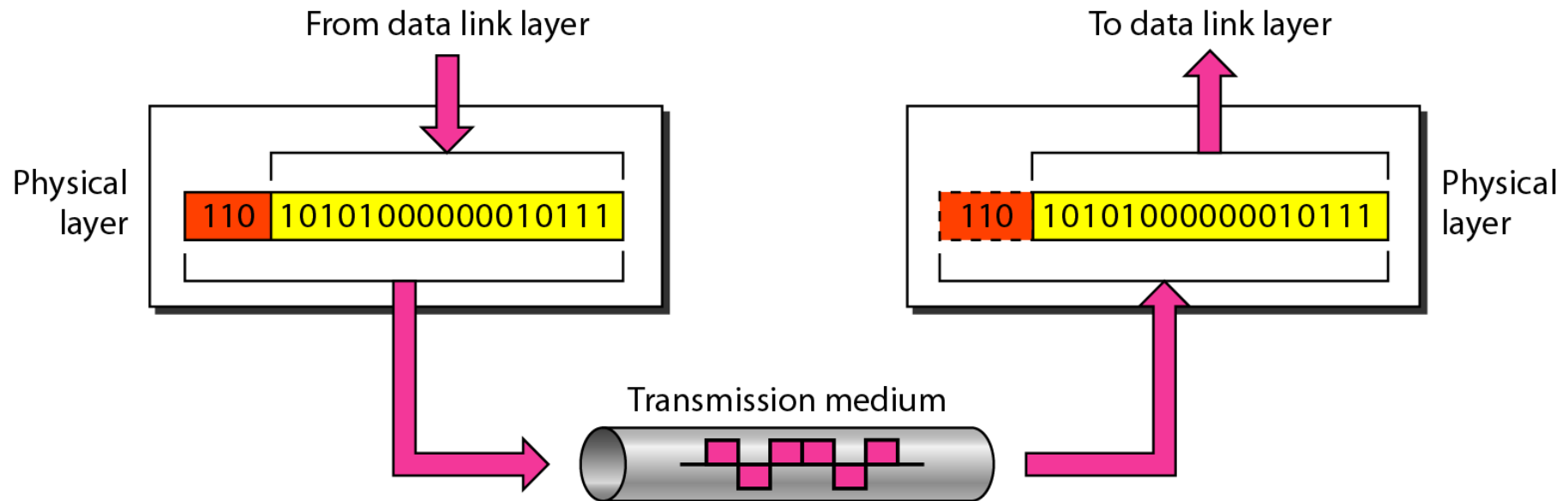
The physical layer is responsible for movements of individual bits from one hop (node) to the next.

Physical layer concerns with:

- **Physical Characteristics of interfaces and medium**
- **Representation of bits (type of encoding)**
- **Synchronization of bits**
- **Line configuration (P2P/Multipoint)**
- **Physical Topology**
- **Transmission mode**

Figure 2.6 *Data link layer*
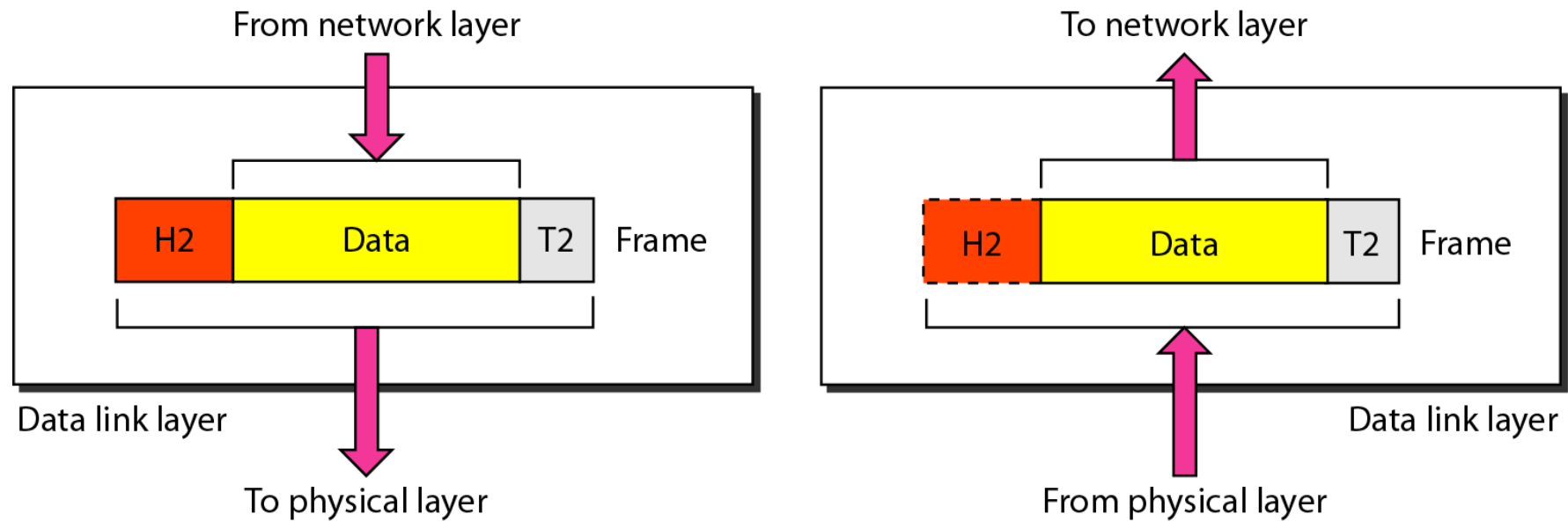
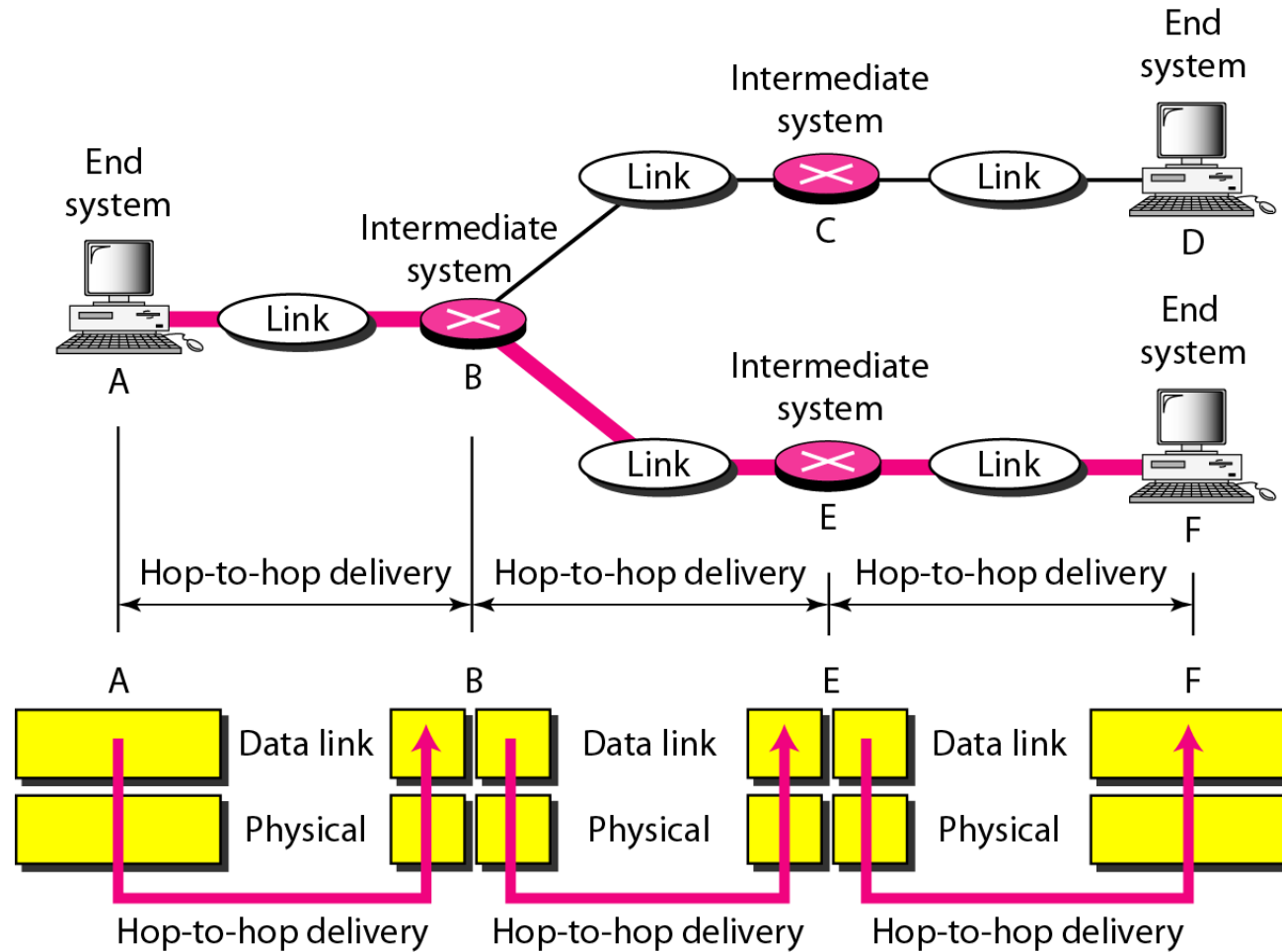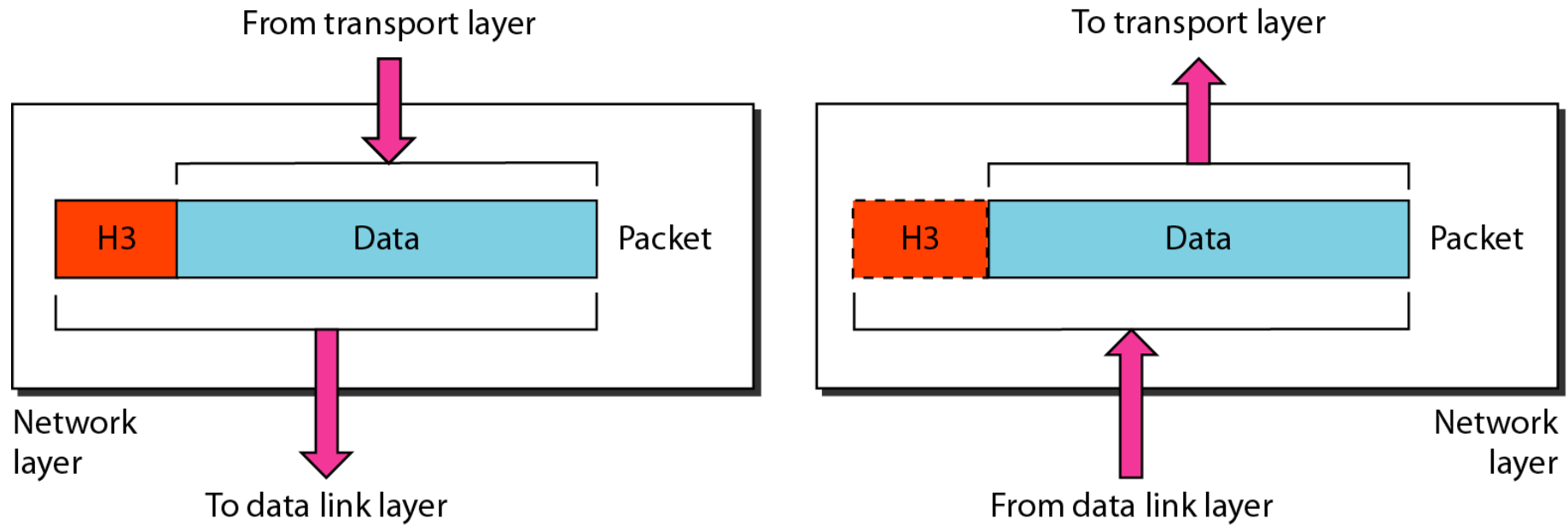**The data link layer is responsible for moving frames from one hop (node) to the next.**

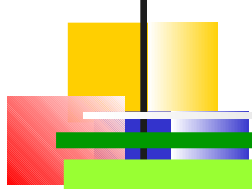## *Responsibilities of Data Link Layer*

- **Framing (manageable data units)**
- **Physical Addressing (MAC address)**
- **Flow control**
- **Error control (detect, retransmit, duplication)**
- **Access Control**

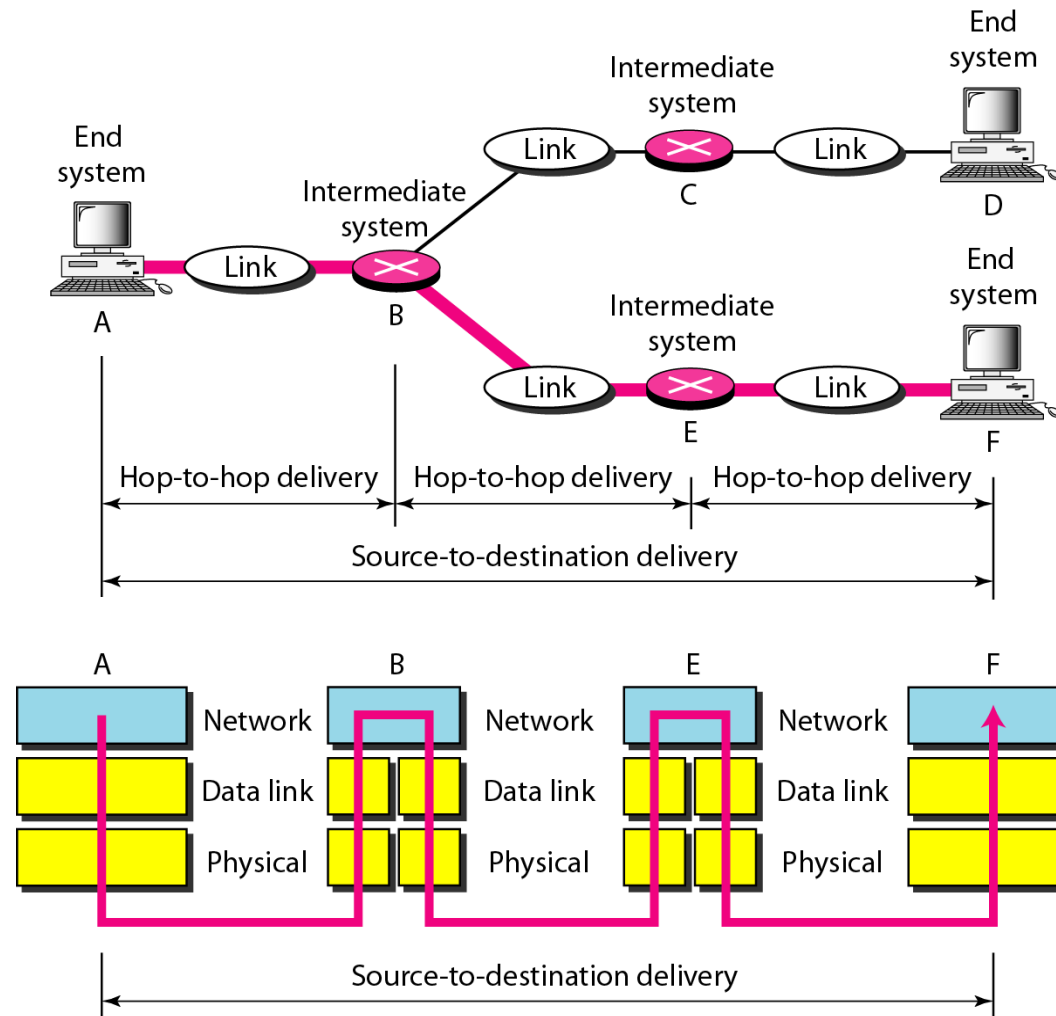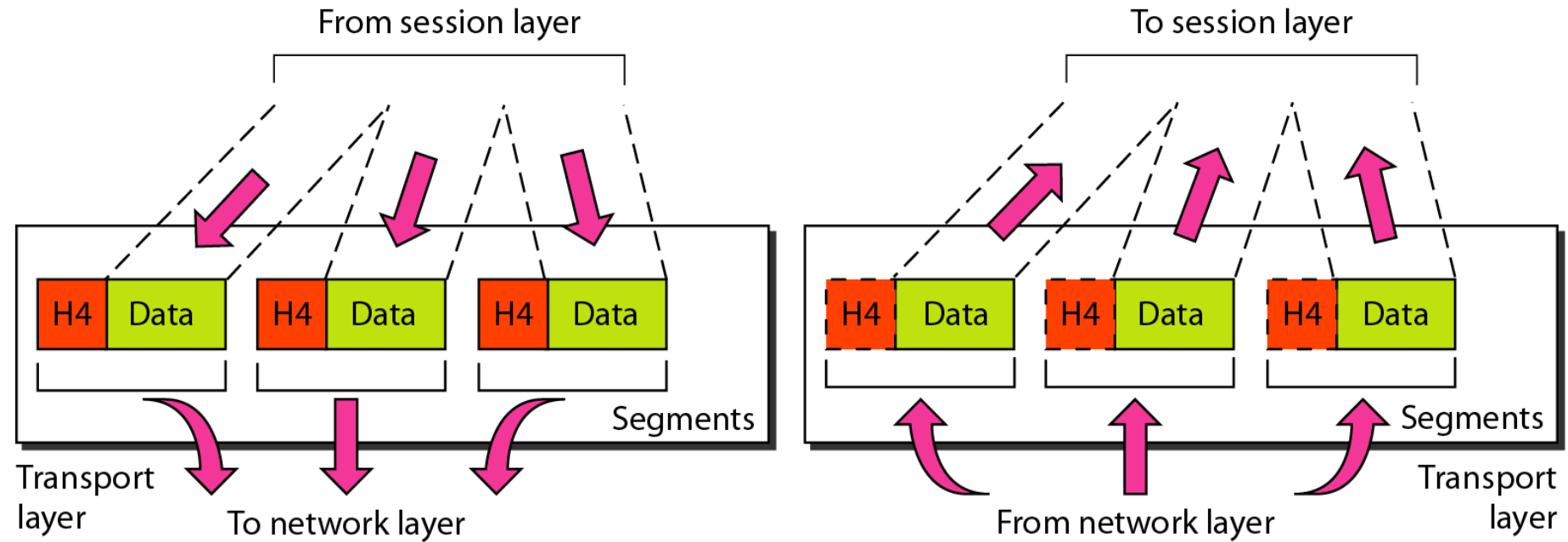# Figure 2.7 Hop-to-hop delivery

Figure 2.8 *Network layer*

**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*

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

Responsibilities of Transport Layer

- **Port address (service point addressing)**
- **Segmentation and reassembly (Sequence No.)**
- **Connectionless & Connection oriented services**
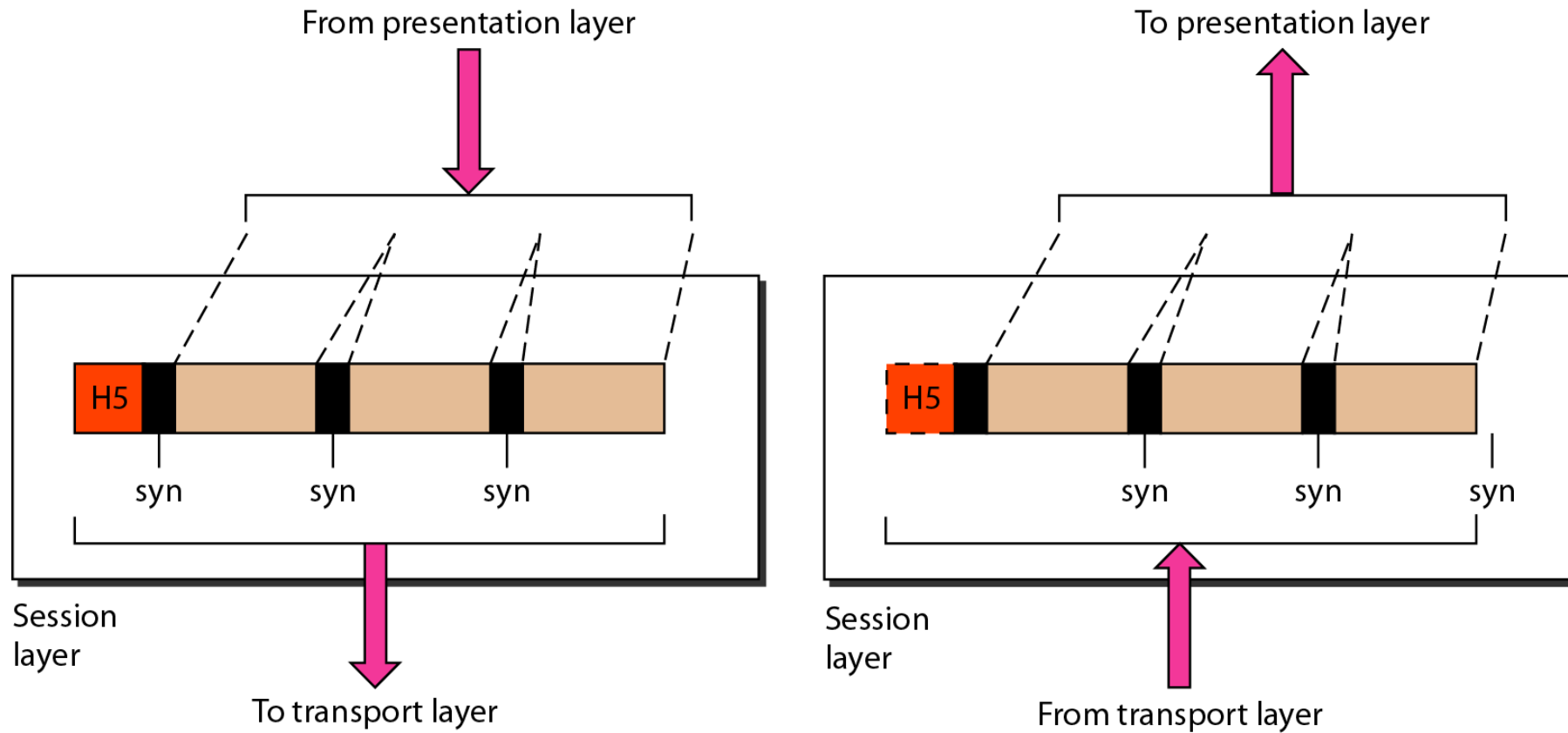- **Error Control (retransmission)**
- **Flow Control**

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

Processes

Processes

An internet

Network layer
Host-to-host delivery

Transport layer
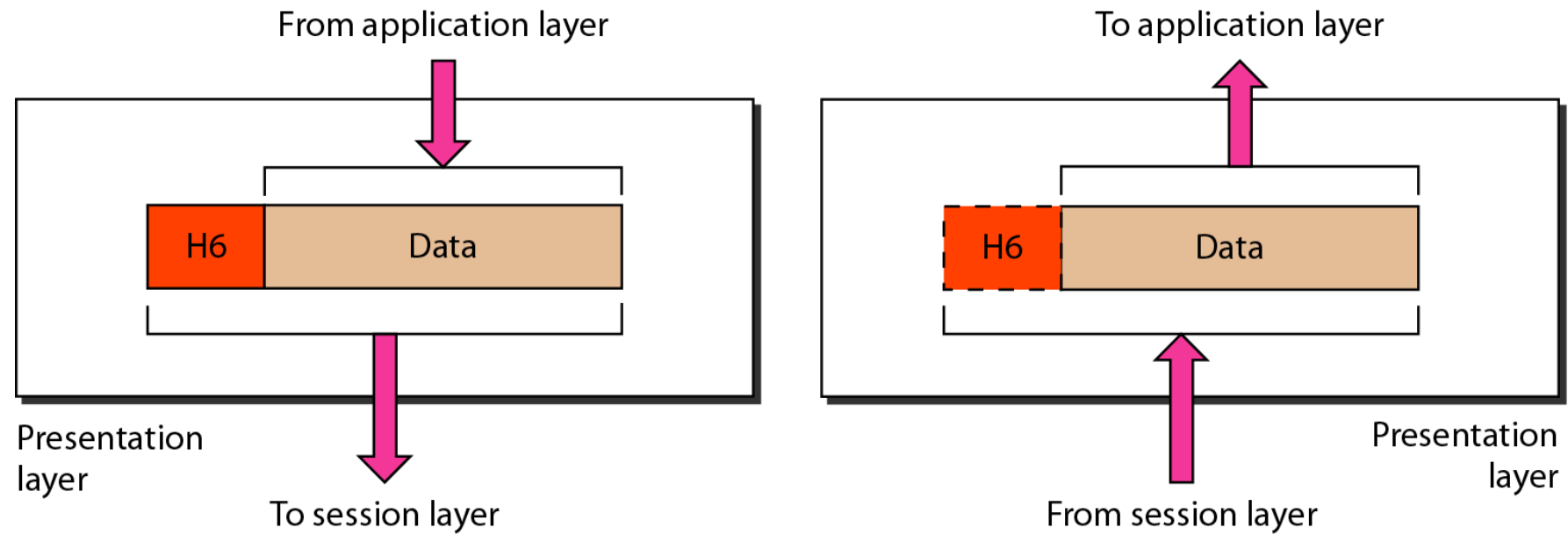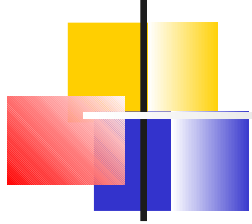Process-to-process delivery
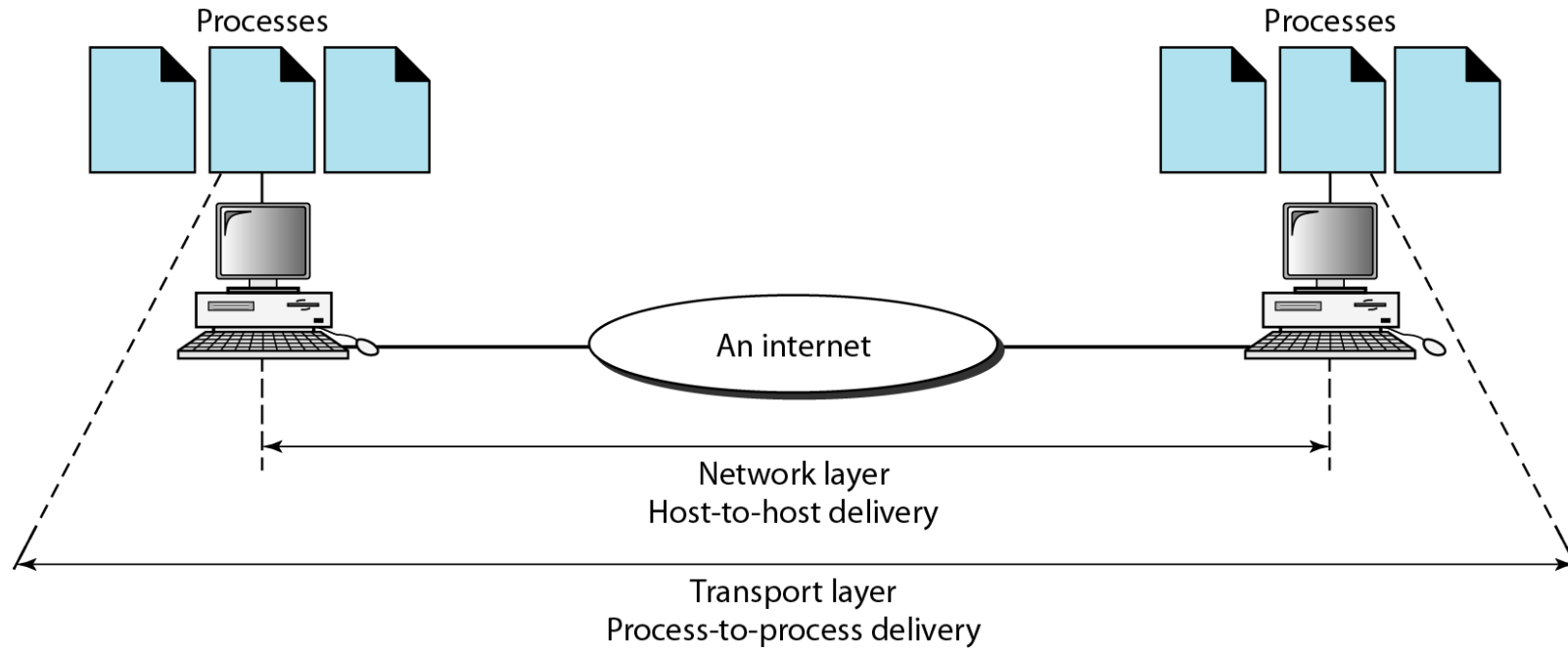
Figure 2.12 *Session layer*

The session layer is responsible for dialog control and synchronization.

Responsibilities of Session Layer

- **Dialog control (full duplex or half duplex)**
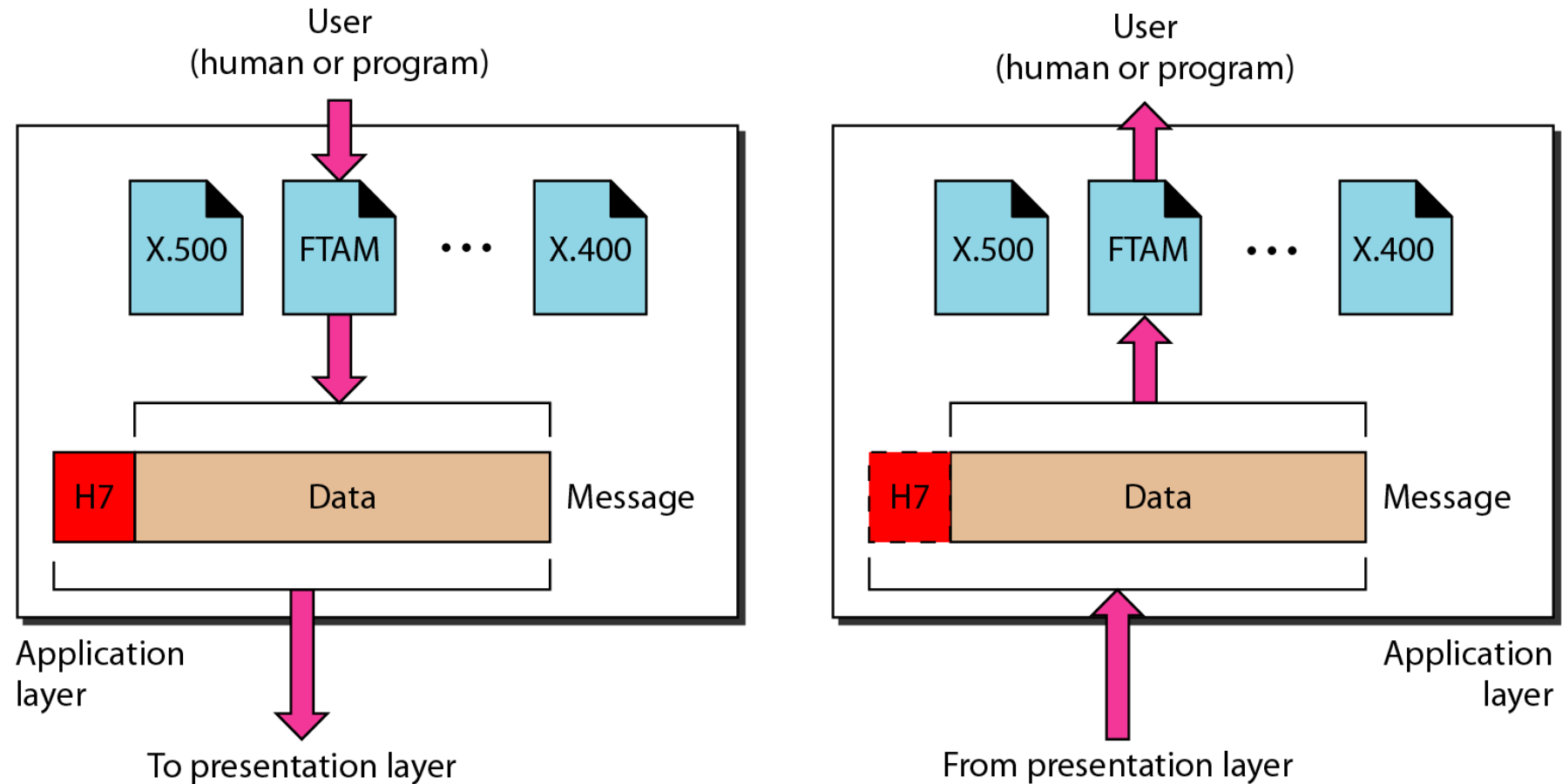- **Synchronization (check points)**

Figure 2.13 *Presentation layer*

Note

The presentation layer is responsible for translation, compression, and encryption.
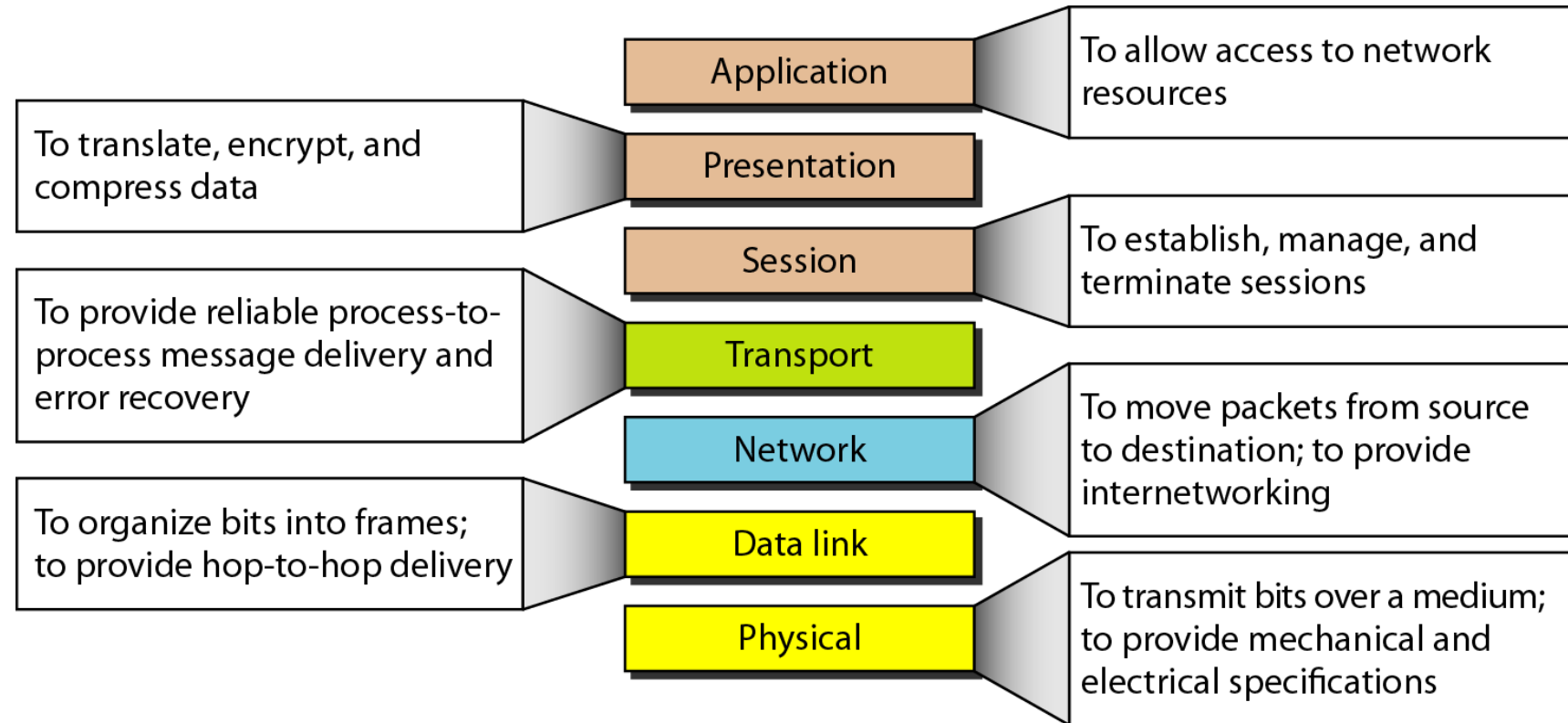
Figure 2.14 *Application layer*

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

Services at Application Layer

- **Network virtual terminal**
- **File transfer, access, and management**
- **Mail Services**
- **Directory services.**

2.26

Figure 2.15 *Summary of layers*

To translate, encrypt, and compress data

| Application | To allow access to network resources |

| Presentation |

| Session | To establish, manage, and terminate sessions |

To provide reliable process-to-process message delivery and error recovery

| Transport |

| Network | To move packets from source to destination; to provide internetworking |

To organize bits into frames; to provide hop-to-hop delivery

| Data link |

| Physical | To transmit bits over a medium; to provide mechanical and electrical specifications |

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.
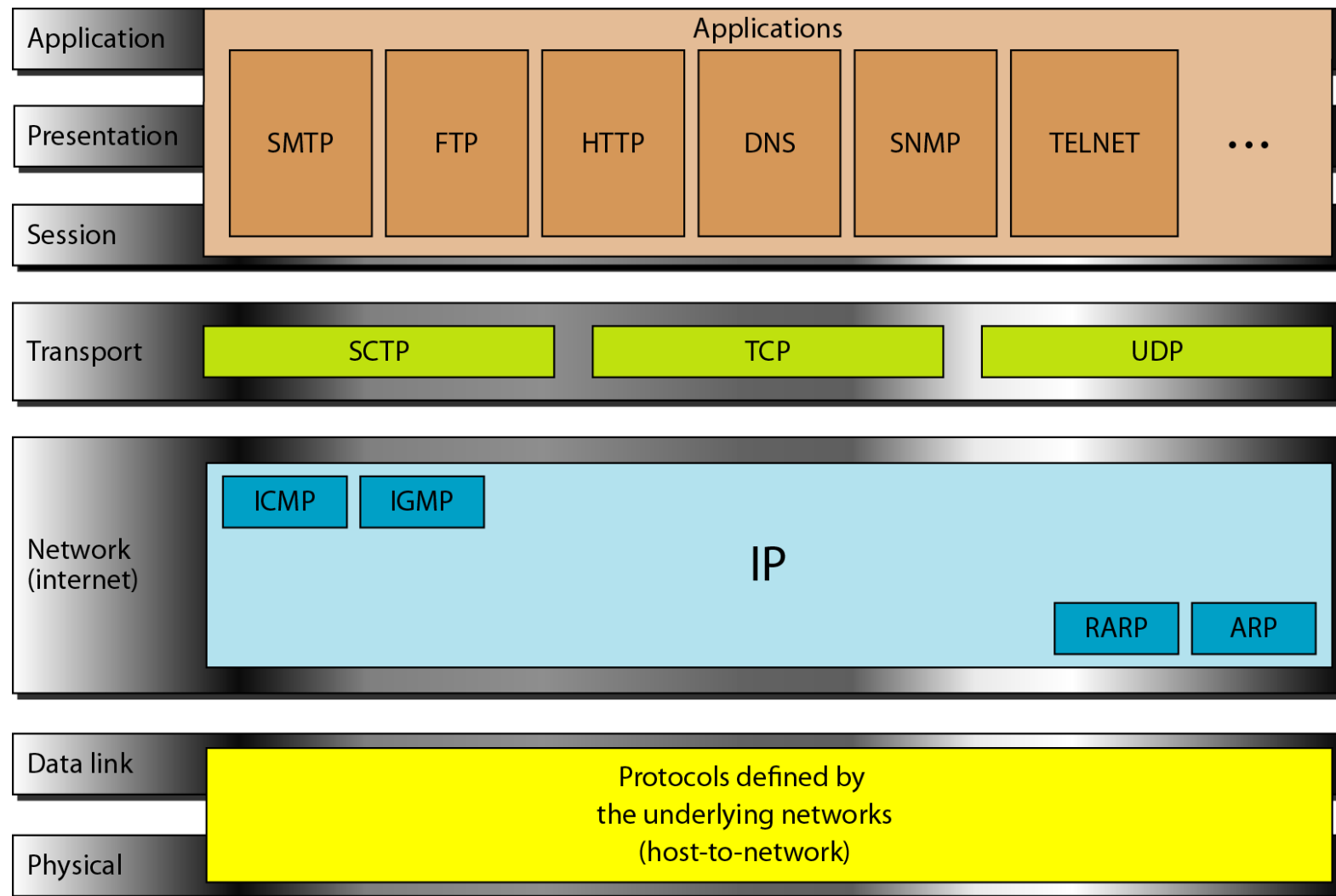
Topics discussed in this section:

Physical and Data Link Layers
Network Layer
Transport Layer
Application Layer

Figure 2.16   *TCP/IP and OSI model*

Application	**Applications**	
Presentation	SMTP FTP HTTP DNS SNMP TELNET • • •	
Session		

| Transport | SCTP | TCP | UDP |

Network (internet)

ICMP   IGMP

IP

RARP   ARP

| Data link | Protocols defined by the underlying networks (host-to-network) |
| Physical | |

2.29

Network Layer Protocols

Internetworking Protocol (IP)

- **Unreliable & Connectionless—best effort delivery (no error checking)**
- **Datagrams**
- **Different routes, no sequencing**

Network Layer Protocols

Address Resolution Protocol (ARP)

- **Association of logical address with physical**

Reverse Address Resolution Protocol (RARP)

- **Used to discover IP address**
- **First time connection / diskless booting**

ICMP

- **Notification of datagram problems by gateways or hosts**
- **Query and error message**

IGMP

Transport Layer Protocols

UDP

- **Connectionless**
- **Adds port addresses, checksum and length information**

TCP

- **Connection Oriented**
- **Segments**
- **Acknowledgment**

SCTP

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
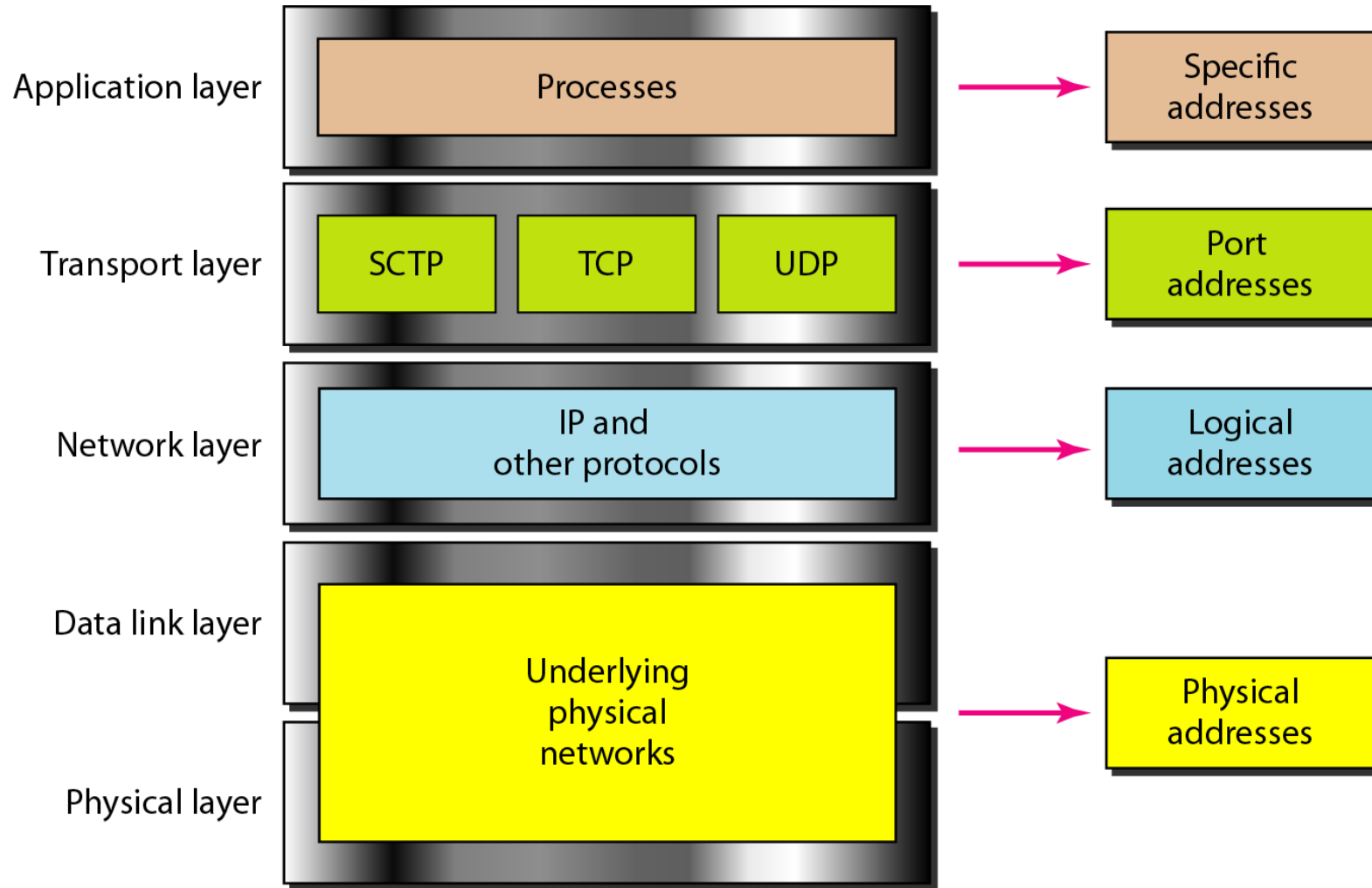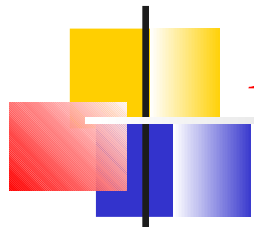Logical Addresses
Port Addresses
Specific Addresses

Figure 2.17 *Addresses in TCP/IP*
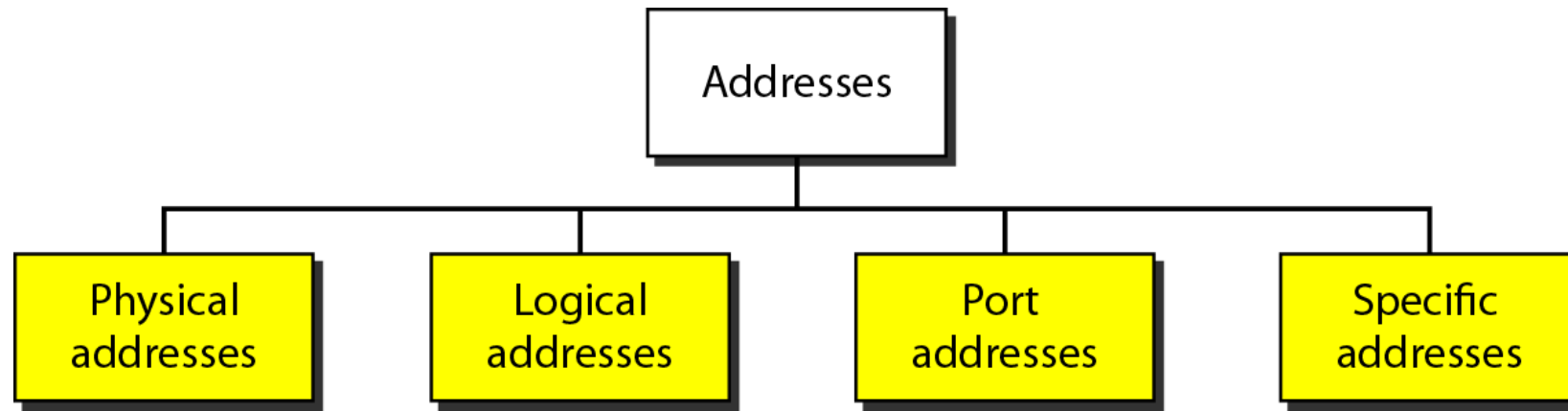
# Figure 2.18 *Relationship of layers and addresses in TCP/IP*

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.
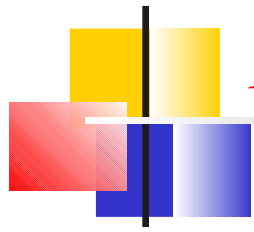
Figure 2.19 *Physical addresses*
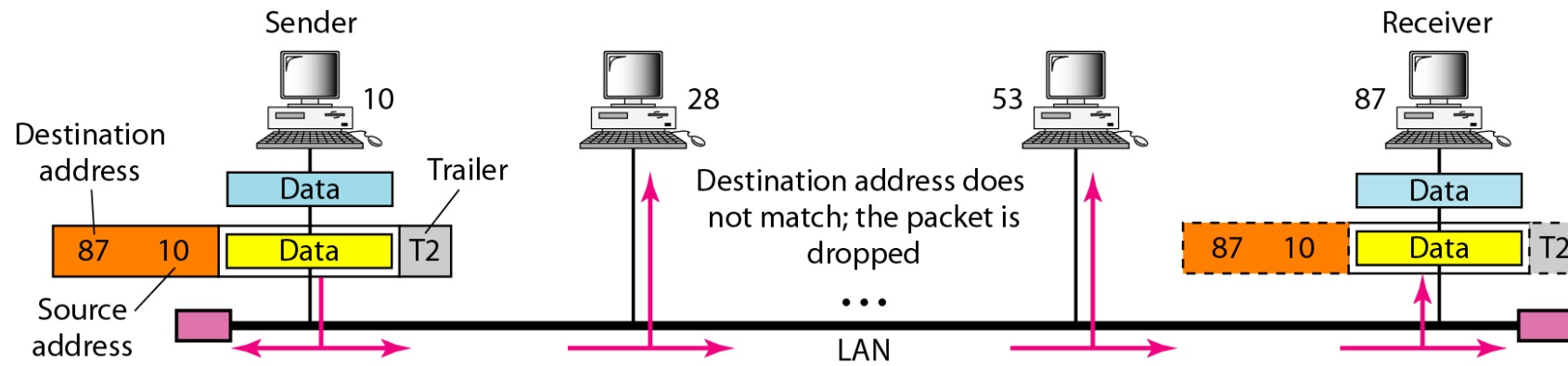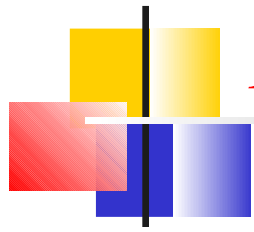
Example 2.2

As we will see in Chapter 13, 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
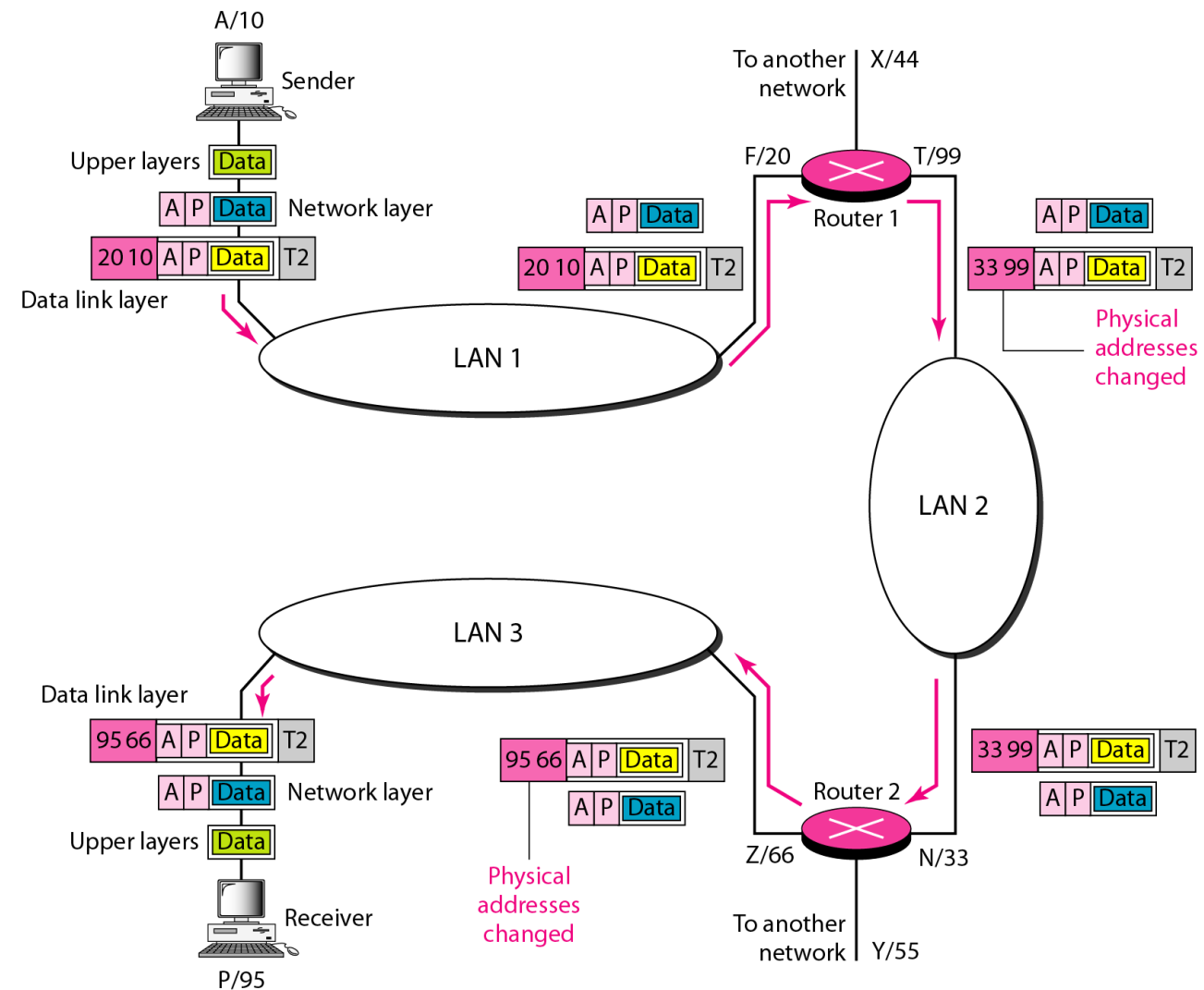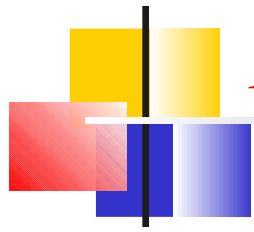
Example 2.4

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.
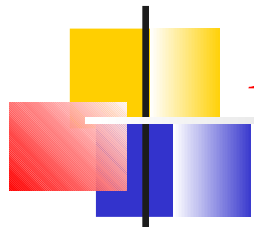
Figure 2.21 *Port addresses*
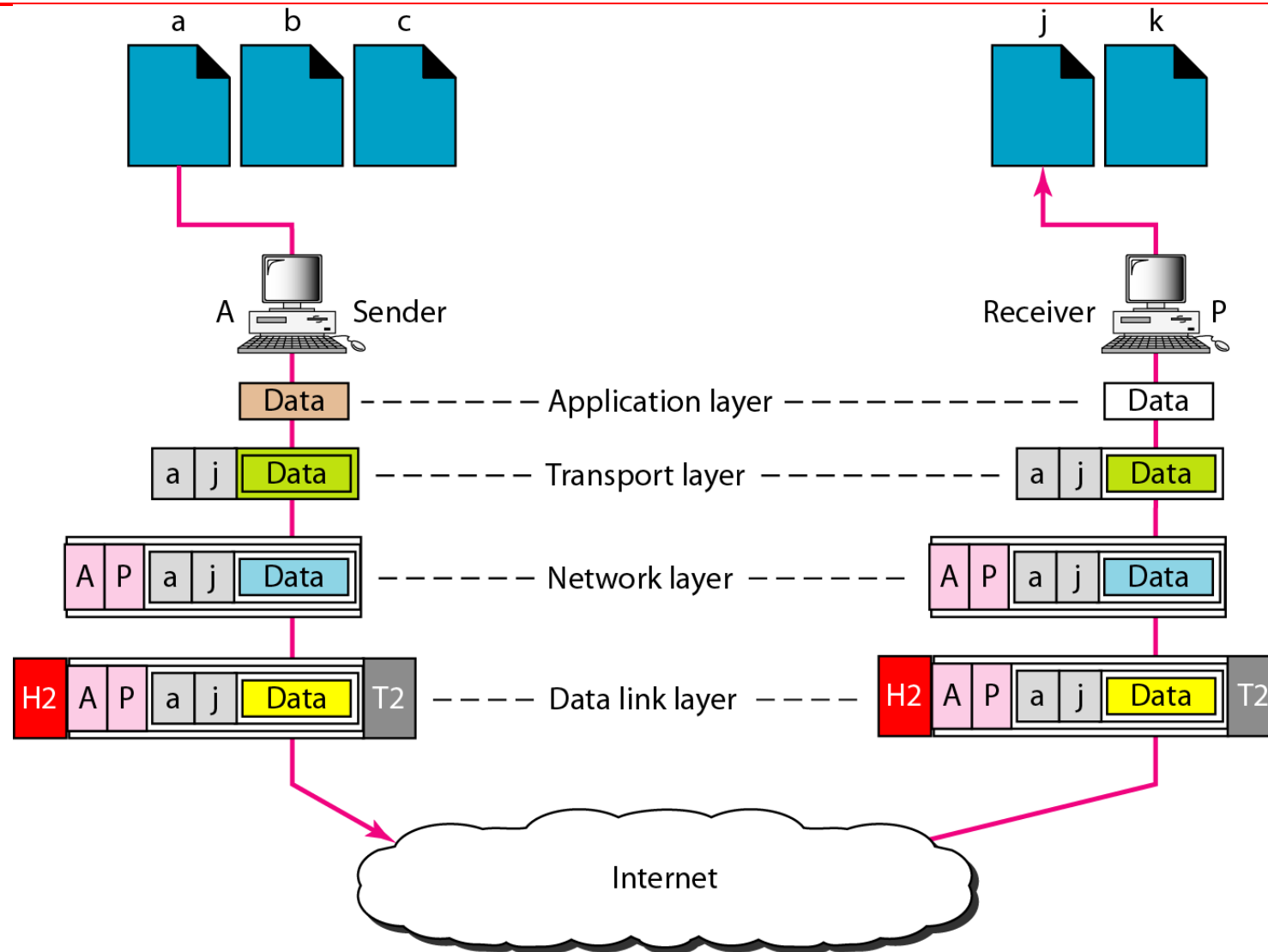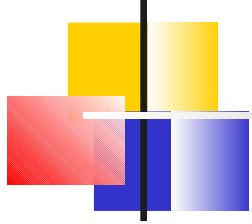
Note

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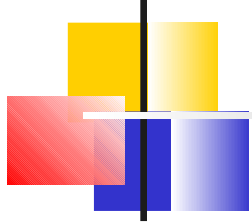but the logical addresses usually remain the same.

Example 2.5

As we will see in Chapter 23, 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.**

**The physical addresses change from hop to hop,
but the logical and port addresses usually remain the same.**