Chapter 2

Network Models

- The main responsibility of computer network is to enable two processes, which are not in same computer, to communicate.

- So in computer networks, we are providing both H/W and S/W functionalities to these processes.

- There are nearly around 70+ such functions. Some are mandatory and some are optional functionality.

- Hence, we need to think about, how to implement them, where to implement them. What are the sets of functionalities which are closely related to each other. What are the sets of functionalities which are not closely related to each other.

- So depending upon all these functionalities and their grouping, we have some reference models.
  - ISO/OSI Reference Model
  - TCP/IP Reference Model
  - ATM
  - X.25
  - IEEE (LAN Technologies)

The ISO/OSI Model

- ISO/OSI – International Standard Organization/ Open System Inter-connection.
- Now when we have so many functions to implement, it is better to put all the closely related functions and form their group.
- So that it is easy for us to implement them.

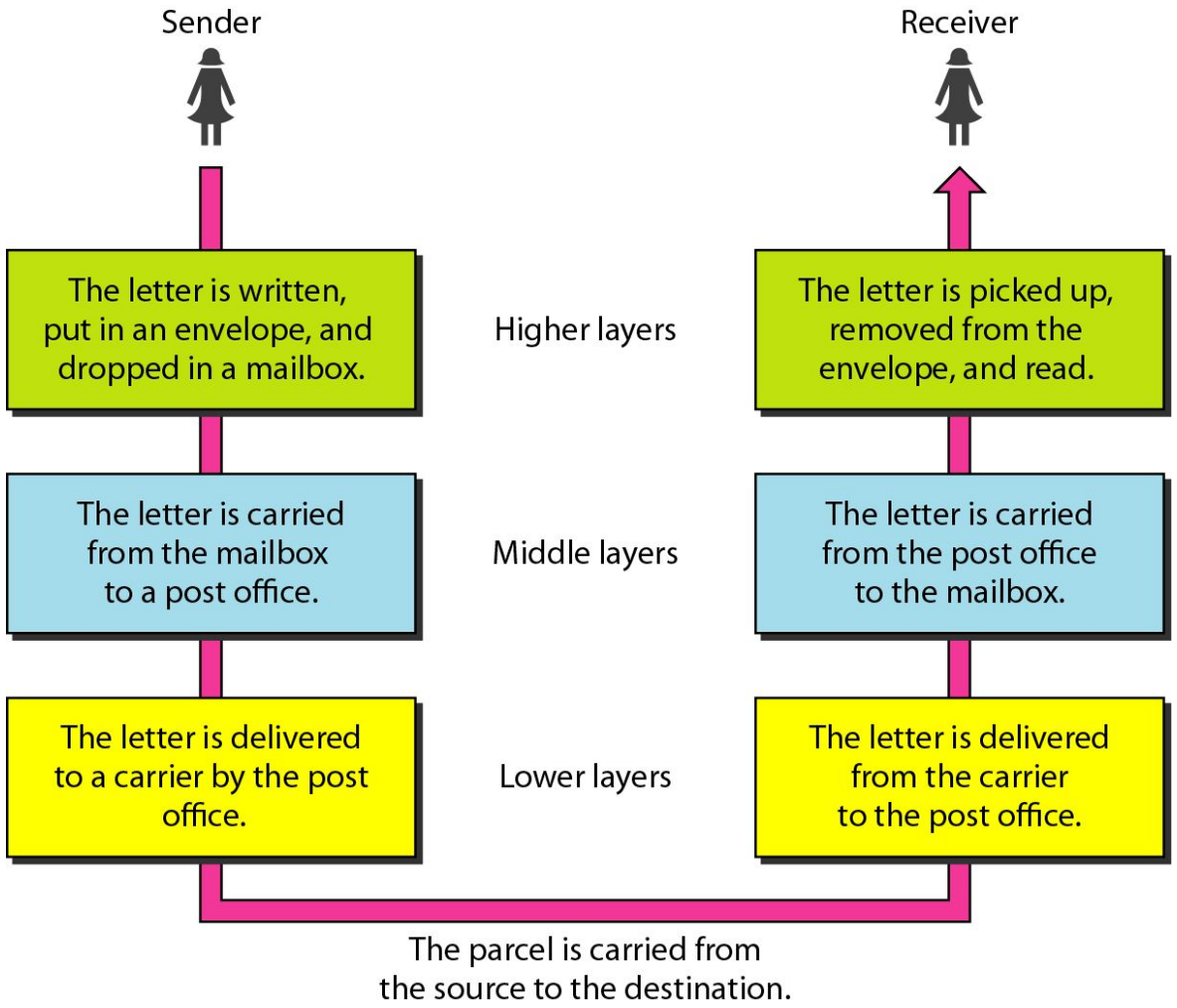
2-1 LAYERED TASKS

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.

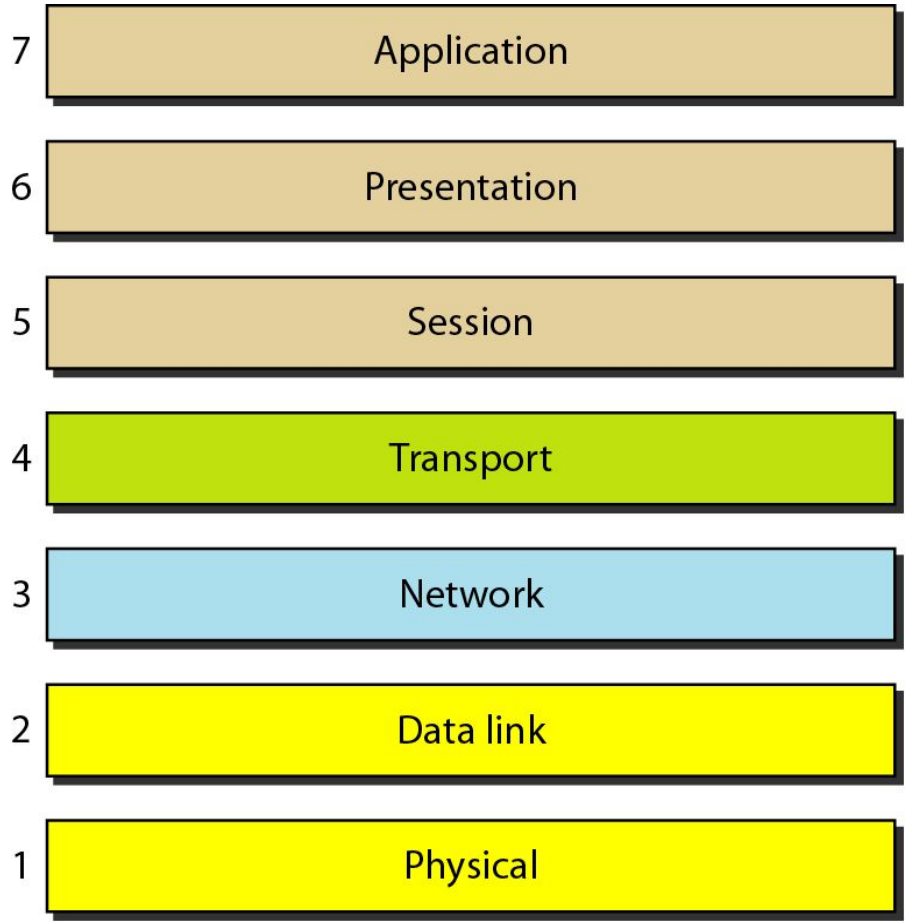
Topics discussed in this section:

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*



Advantages of classifying into layers:

-- Divide & Conquer Technique

-- Encapsulation

-- Abstraction

-- Testing

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

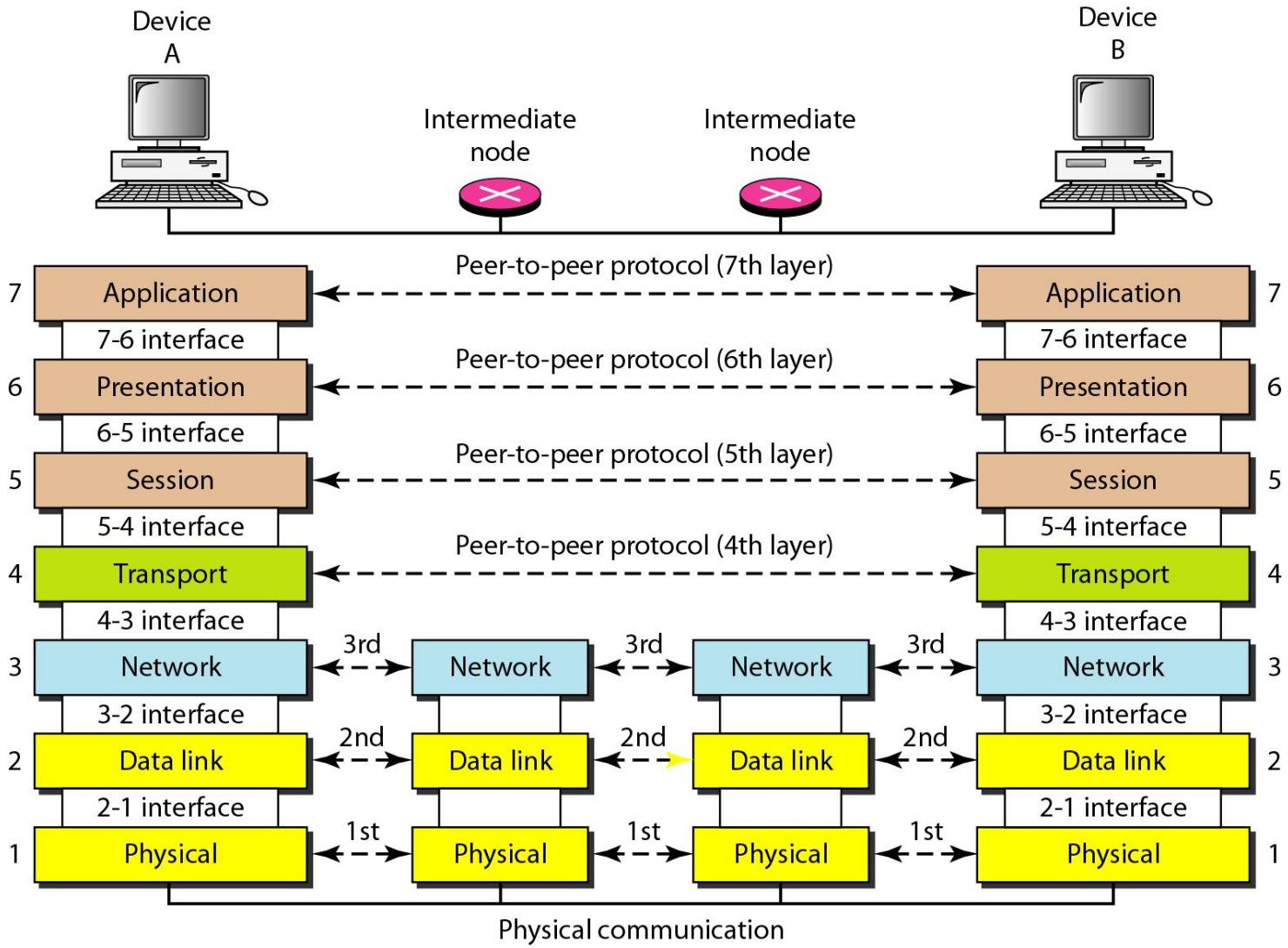
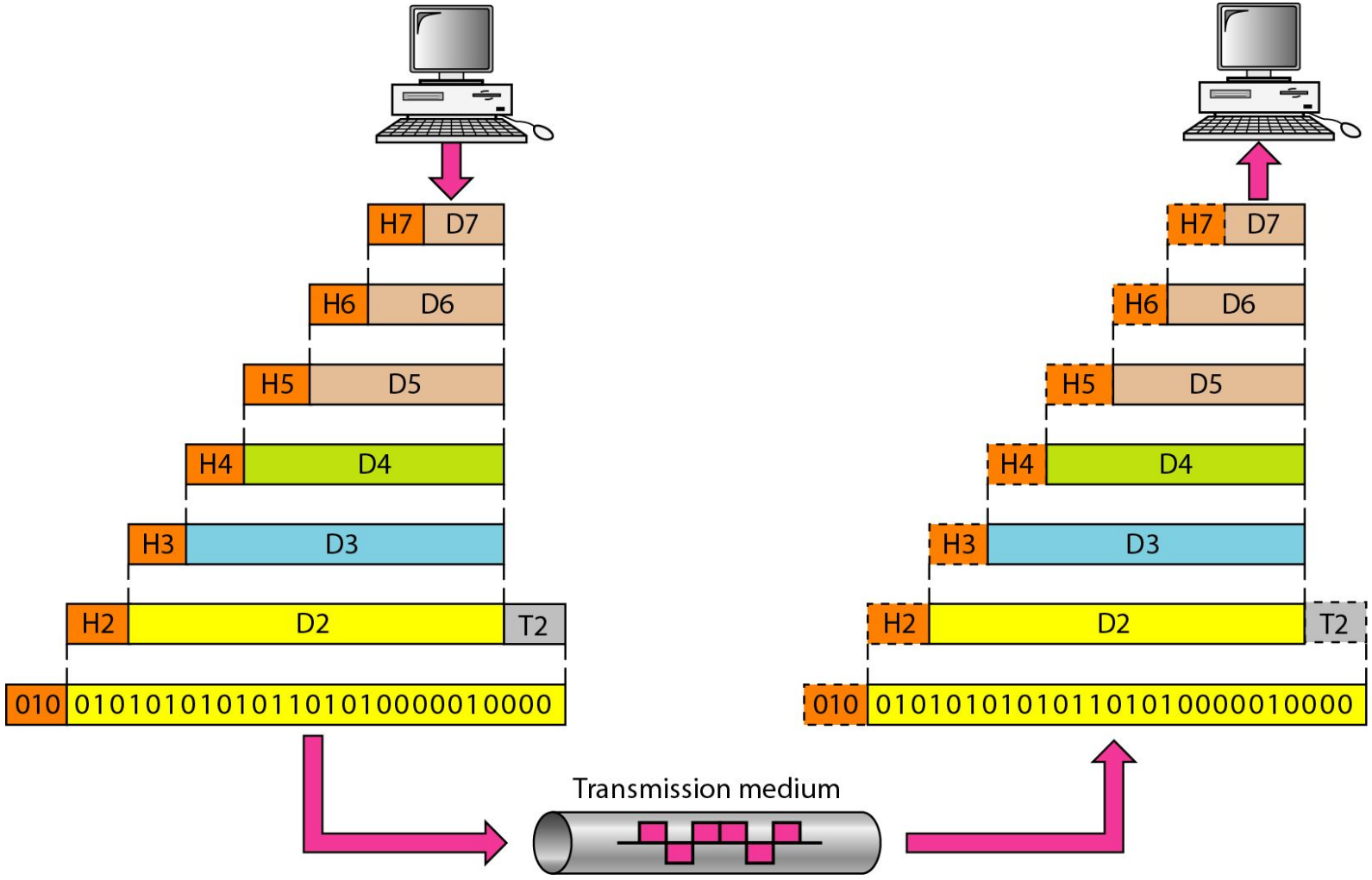


Figure 2.4 *An exchange using the OSI model*



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

Functions of Physical Layer (Layer-1)

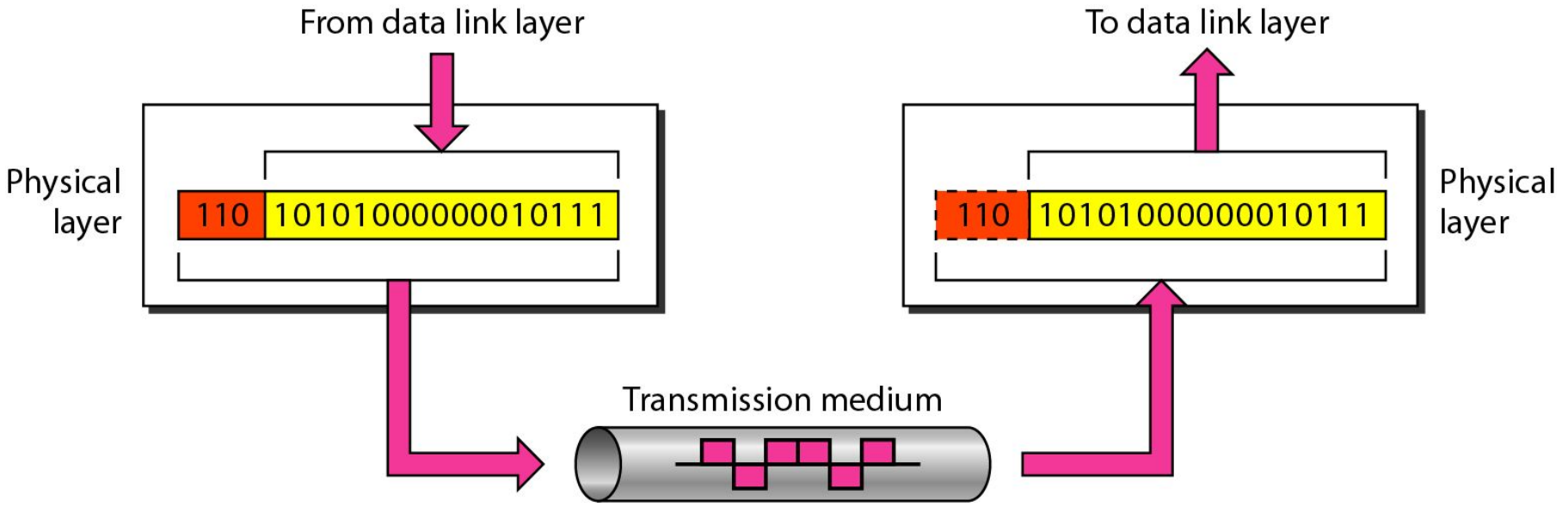
- The physical layer coordinates the functions required to carry a bit stream over a physical medium.
- Physical Layer deals with
  - Electrical characteristics
  - Mechanical characteristics
  - Functional characteristics
  - Procedural characteristics

  of a physical link.
- If physical link is of type copper – That means if you are sending your message over copper wire, then message has to be converted into electrical signal. Or if it is of type optical fibre, then the message has to be converted into light. Or if available link is wireless then the message has to be converted into electromagnetic waves.
- So depending on what is the type of link is available; the signals are converted accordingly.

- Functional & Procedural characteristics means: which type of transmission modes we can use.
- Physical Layer also deals with Network topologies:- logically how devices are connected.
- Physical Layer also deals with encoding and representation of bits:- given 1’s and 0’s data, how are you going to convert them into waves or electrical signal and send them.

  - We have two ways to encode the bits:
    - Manchester Encoding
    - Differential Manchester Encoding

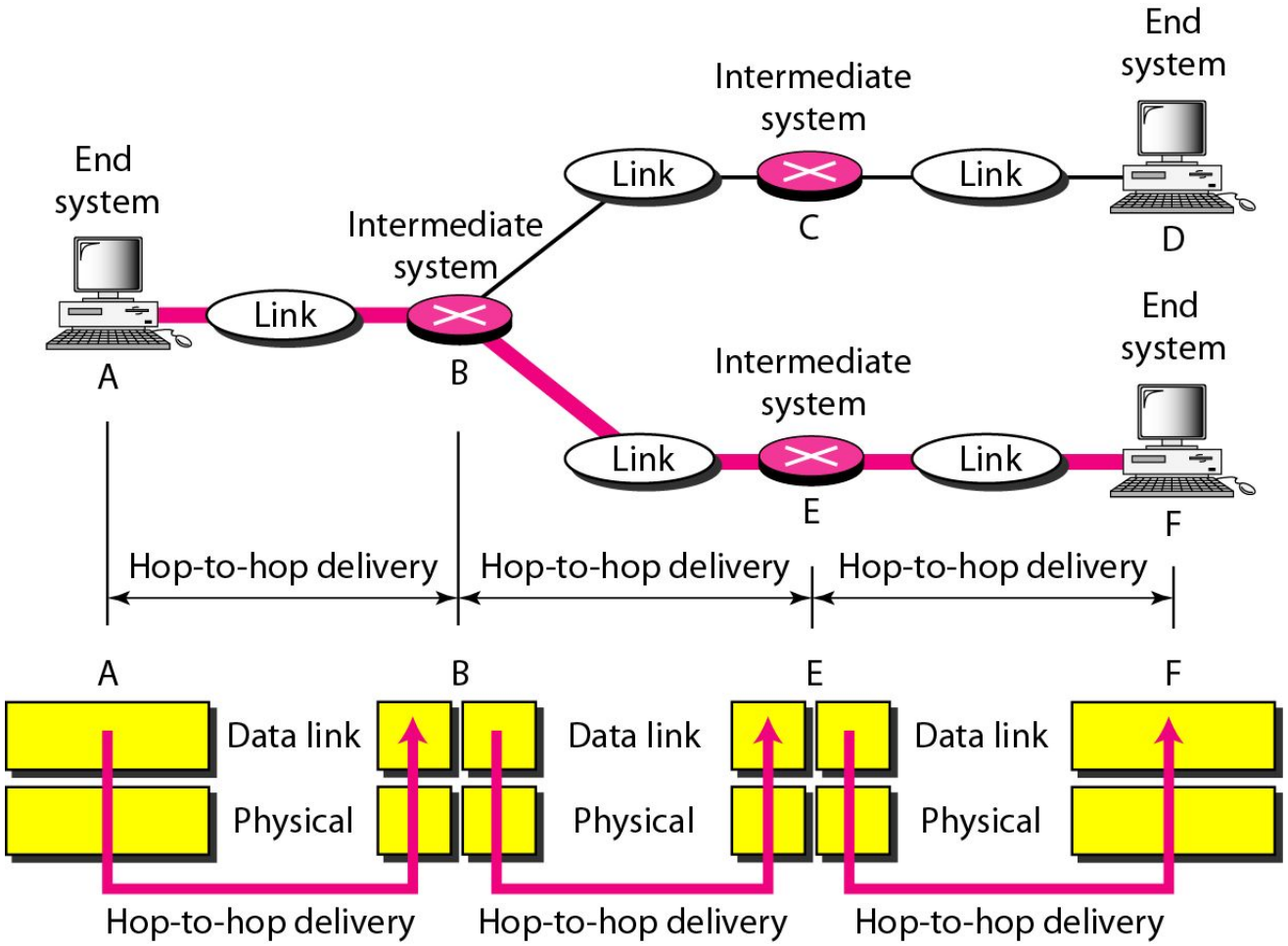
Figure 2.5 *Physical layer*



Functions of Data Link Layer (DLL) (Layer-2)

- The data link layer is responsible for moving frames from one hop (node) to the next.
- The responsibilities of the data link layer include the following:
  - Framing
  - Physical addressing
  - Flow control
  - Error control
  - Access control

Figure 2.7 *Hop-to-hop delivery*



Functions of Network Layer (Layer-3)

- The network layer is responsible for the source-to-destination delivery of a packet, across multiple networks. (Host-to-host communication)
- However, the data link layer oversees the delivery of the packet between two systems on the same network.
- The responsibilities of the network layer includes the following:
  - Logical Addressing
  - Routing/Switching
  - Fragmentation

Figure 2.8 *Network layer*

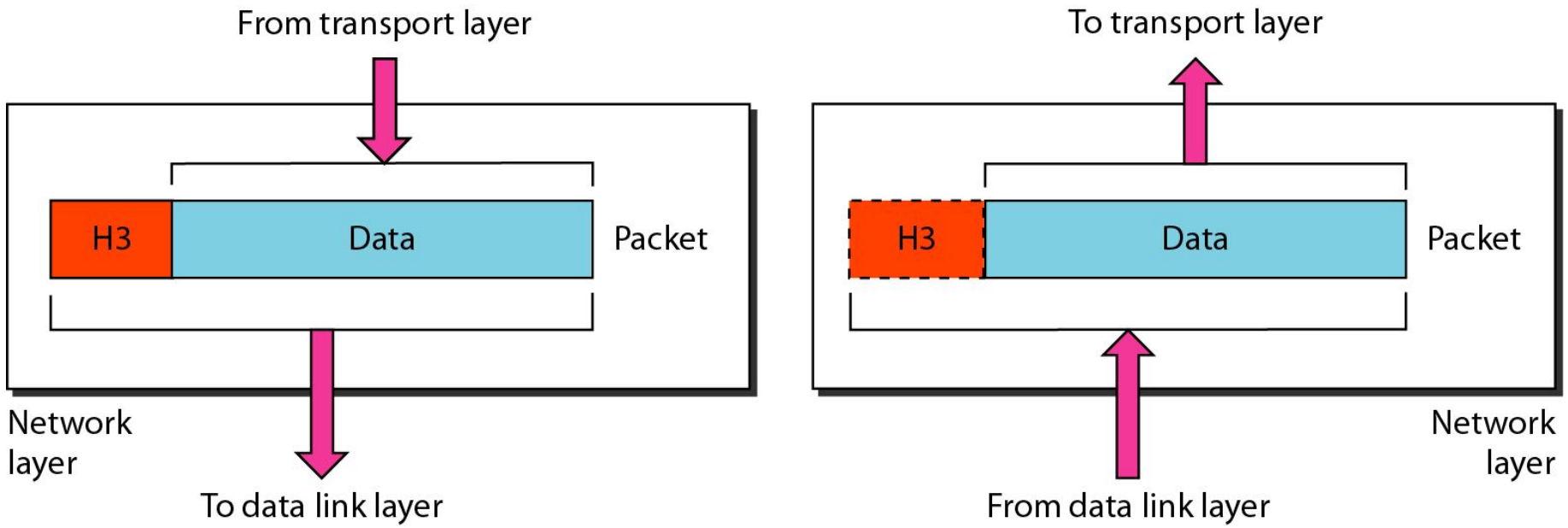
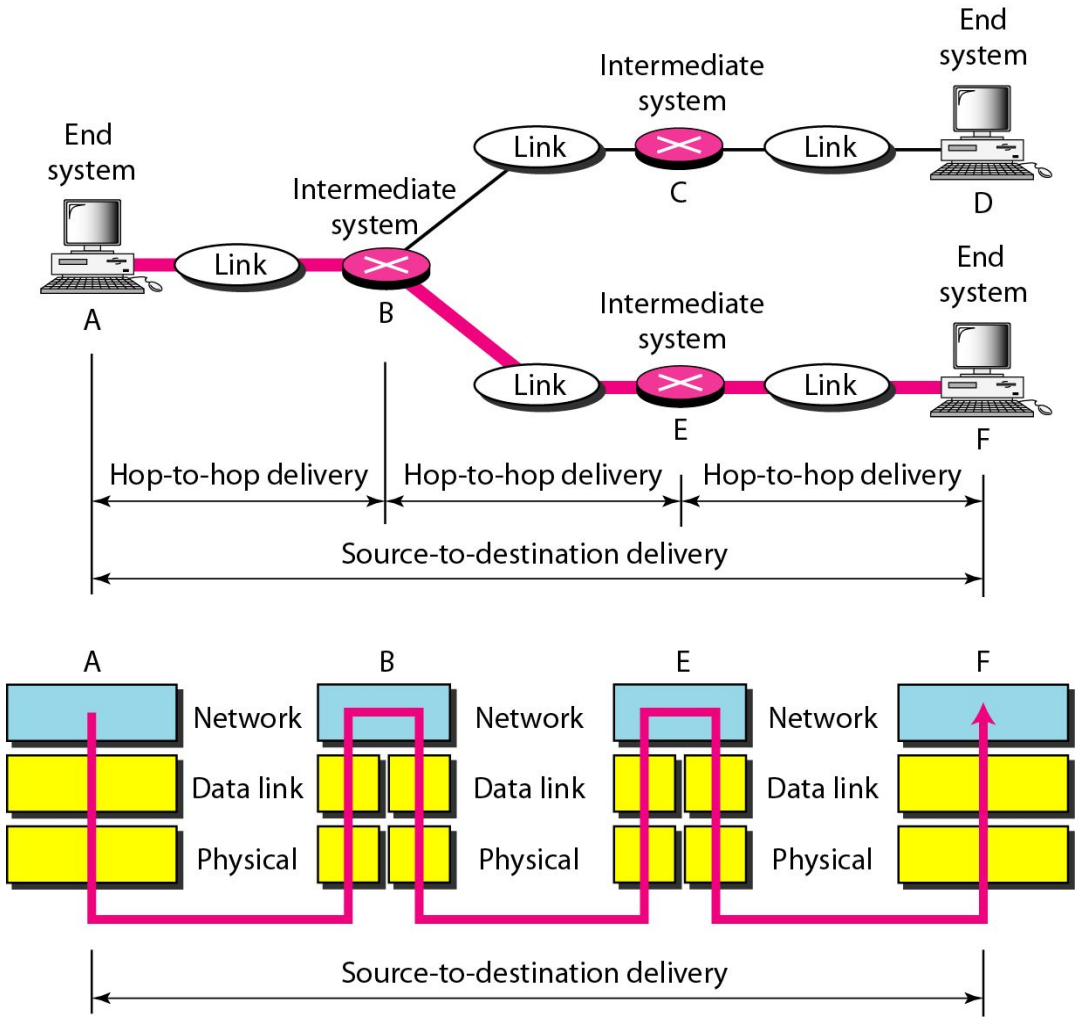


Figure 2.9 *Source-to-destination delivery*



Functions of Transport Layer (Layer-4)

- The transport layer is responsible for process-to-process delivery of the entire message.
- Whereas the network layer oversees source-to-destination delivery of individual packets, it does not recognize any relationship between those packets.
- Network layer treats each packet as independent entity.
- The transport layer, on the other hand, ensures that the whole message arrives intact and in order.
- The responsibilities of the transport layer includes the following:
  - Service-point addressing
  - Segmentation and Reassembly
  - Error and Flow control

Figure 2.10 *Transport layer*

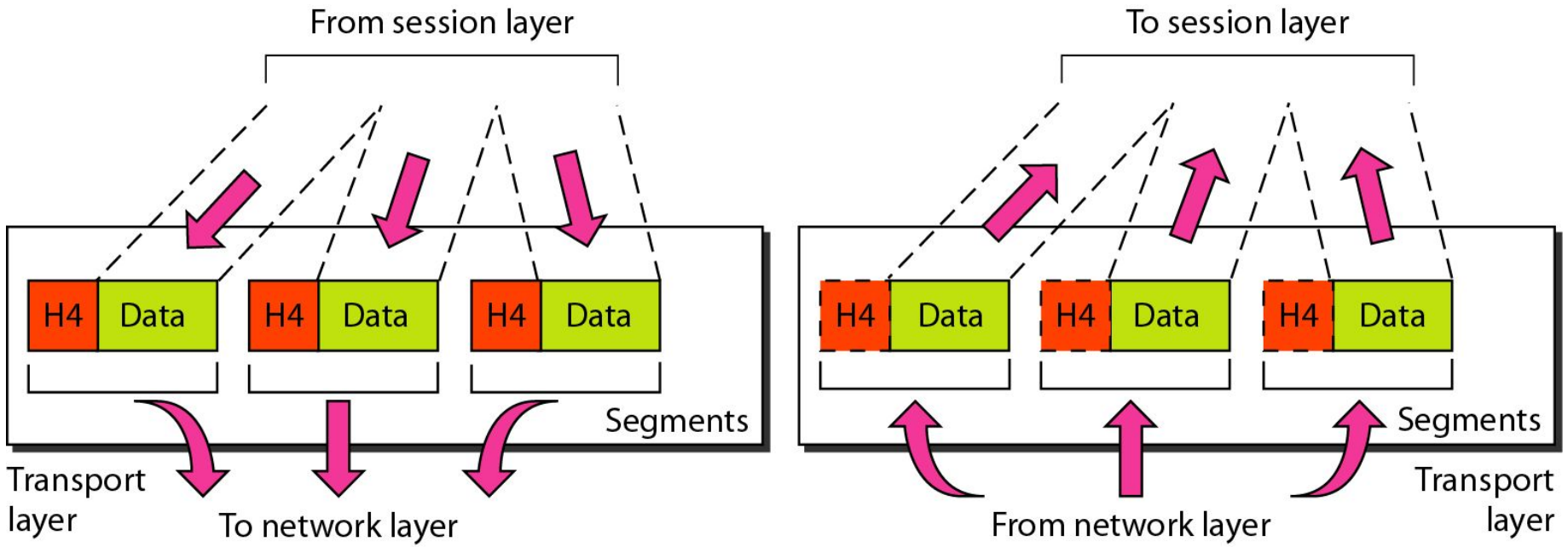
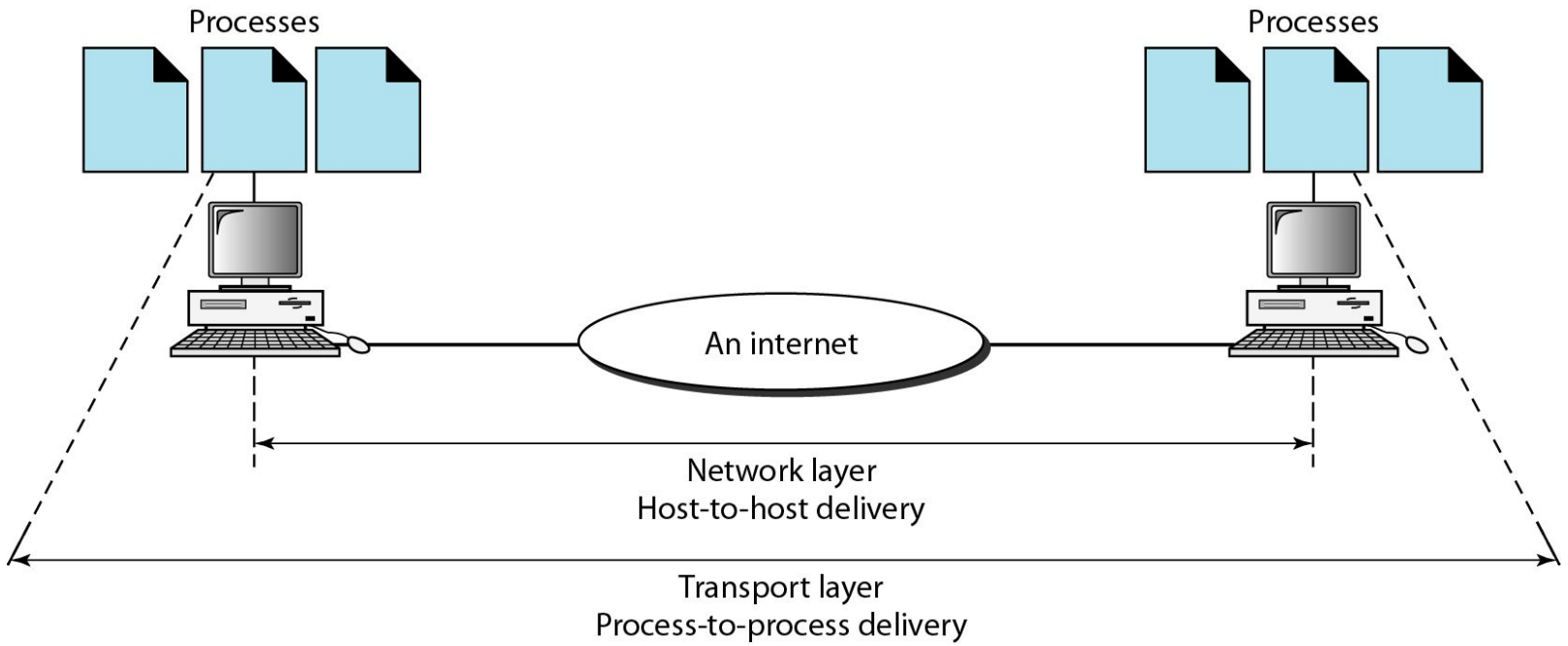


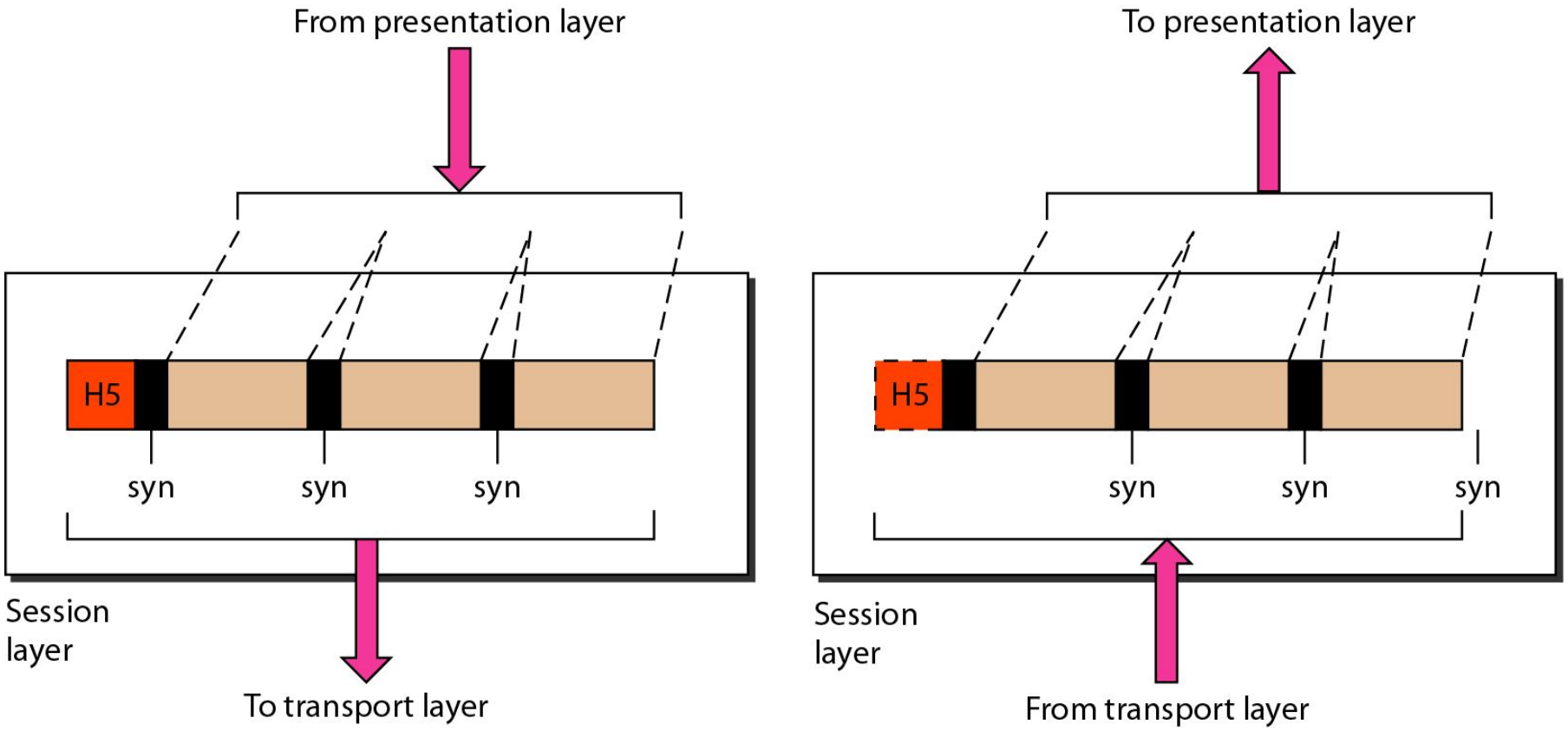
Figure 2.11 *Reliable process-to-process delivery of a message*



Functions of Session Layer (Layer-5)

- The session layer is the network dialog controller.
- It establishes, maintains, and synchronizes the interaction among communicating systems.
- The responsibilities of the session layer includes the following:
  - Dialog control
  - Synchronization

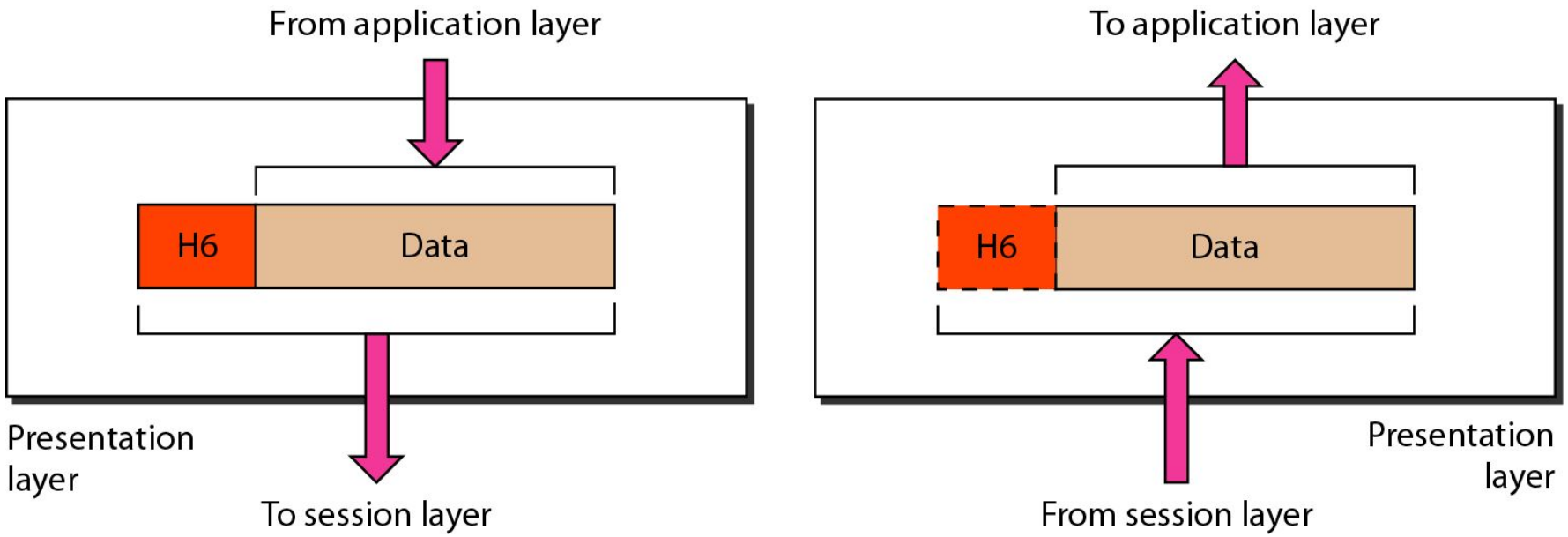
Figure 2.12 *Session layer*



Note

The session layer is responsible for dialog control and synchronization.

Figure 2.13 *Presentation layer*



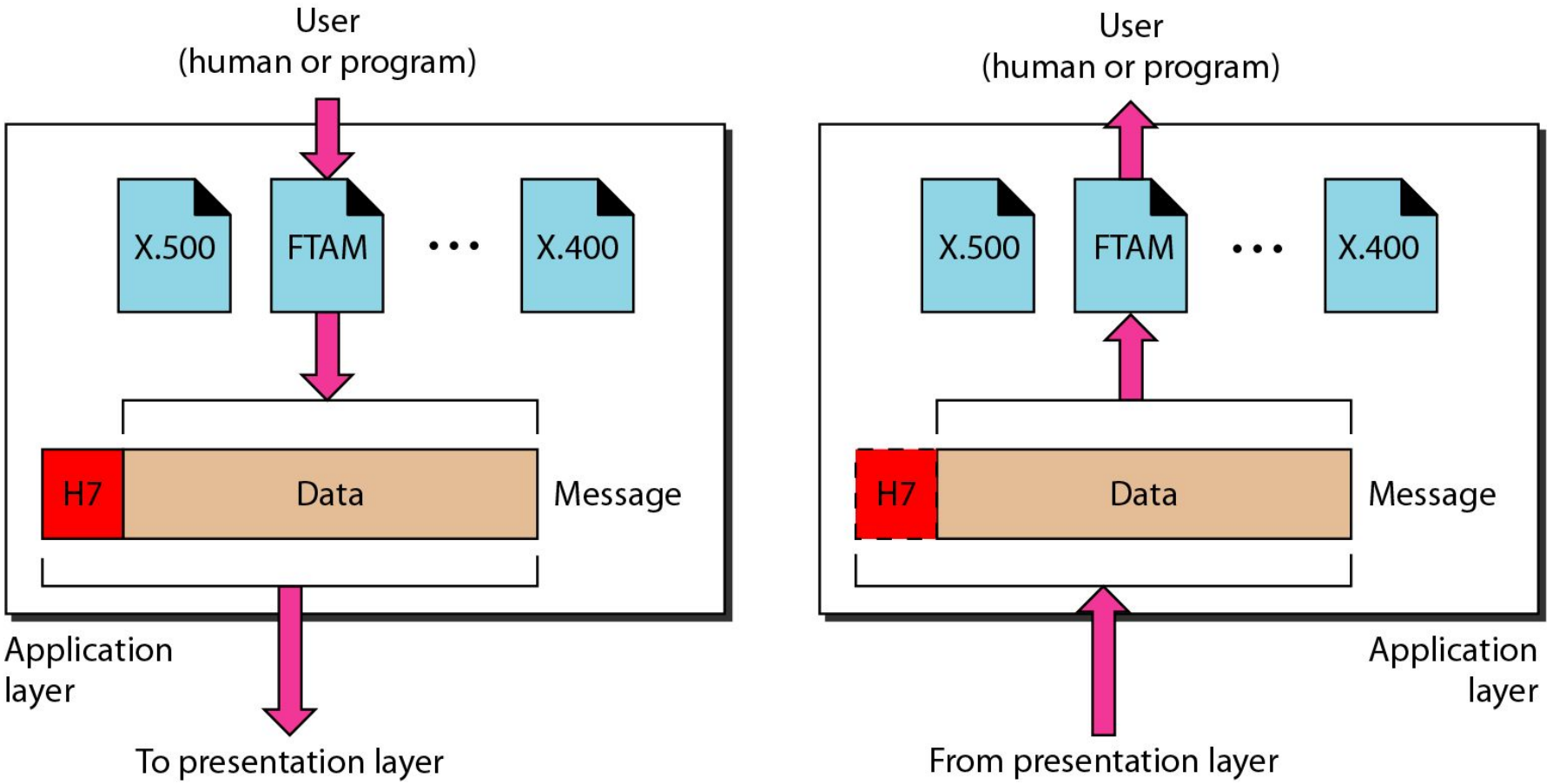
Functions of Presentation Layer (Layer-6)

- The presentation layer is concerned with the syntax and semantics of the information exchanged between two systems.
- The responsibilities of the presentation layer includes the following:
  - Translation
  - Encryption
  - Decryption
  - Compression

Note

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

Figure 2.14 *Application layer*



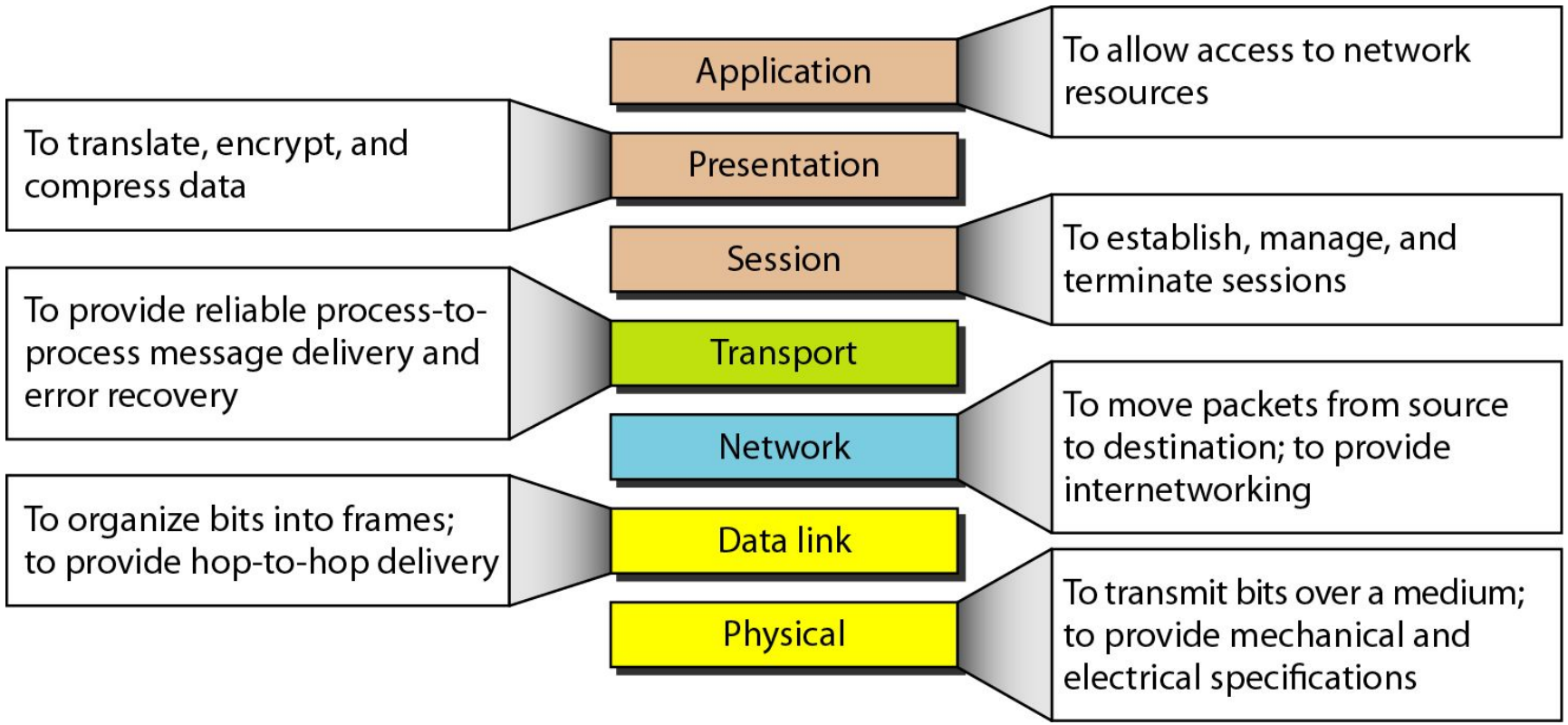
Functions of Application Layer (Layer-7)

- The application layer enables the user, whether human or software, to access the network.
- It provides user interfaces and support for services such as electronic mail, remote file access and transfer.

Note

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

Figure 2.15 *Summary of layers*



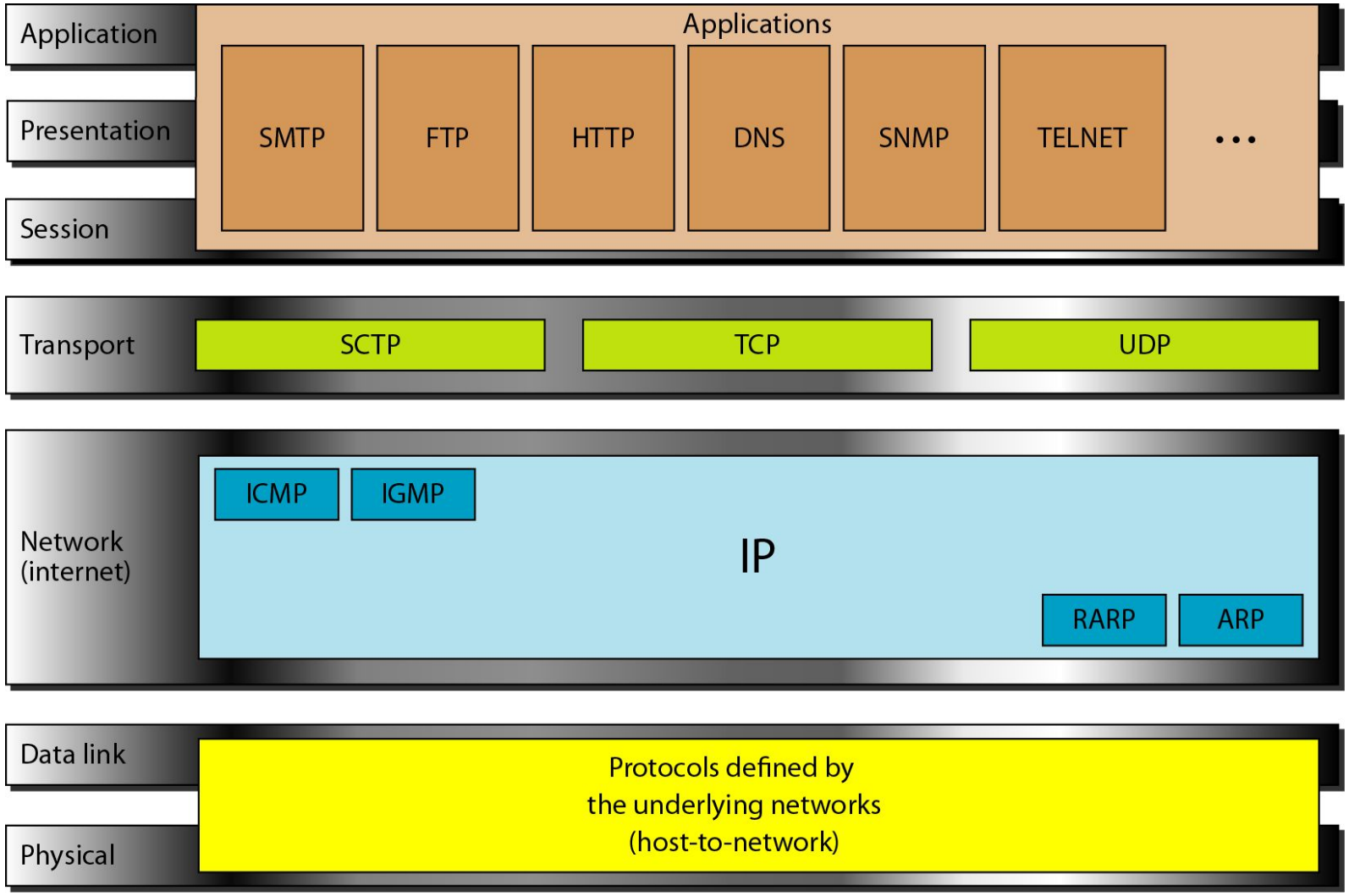
2-4 TCP/IP PROTOCOL SUITE

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*

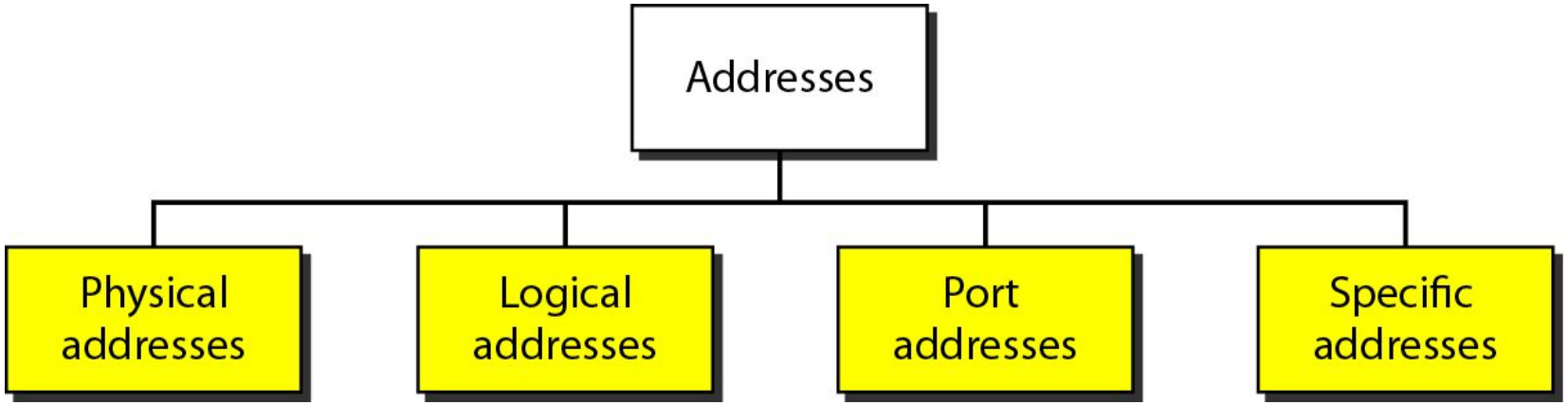
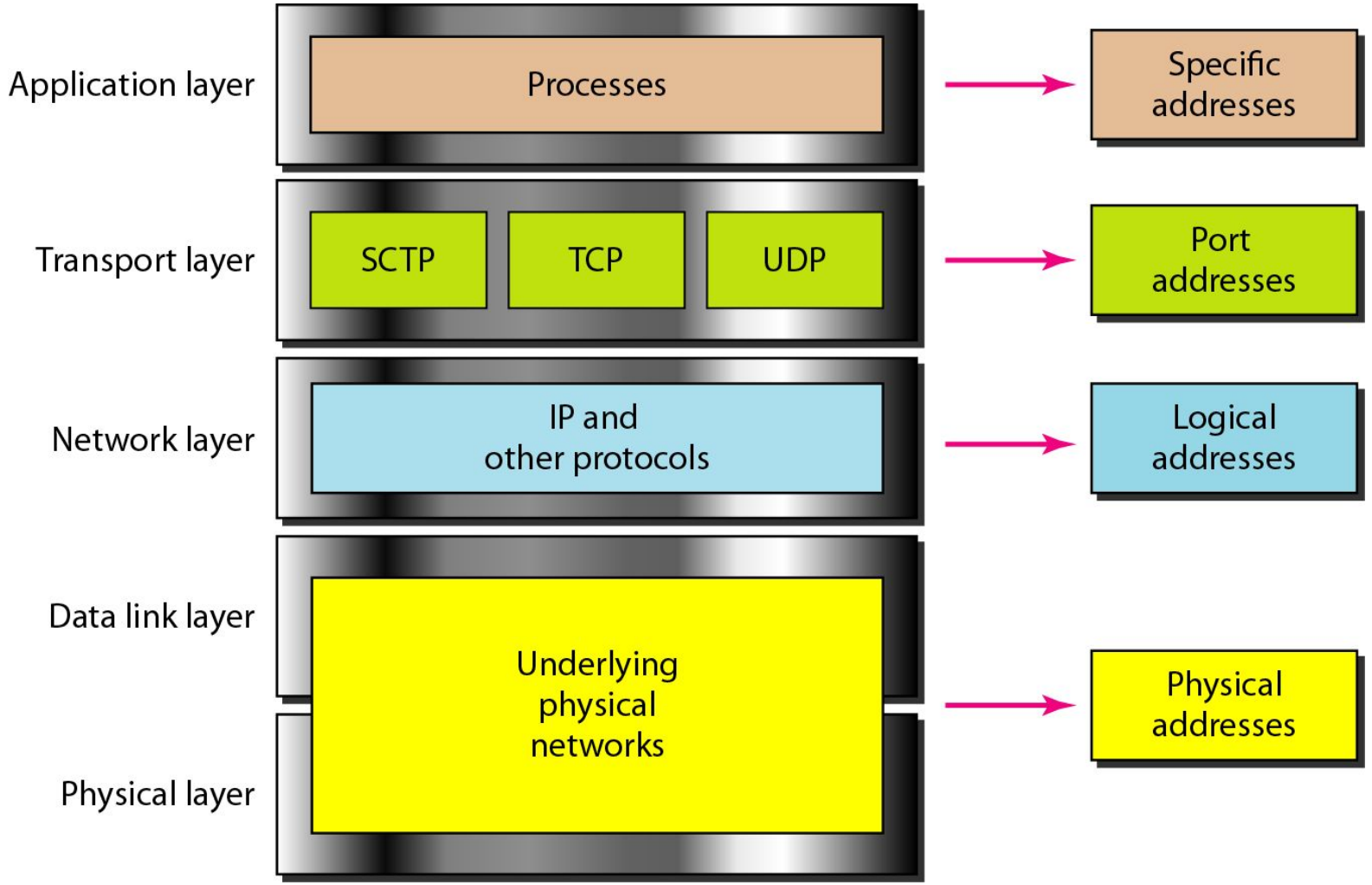


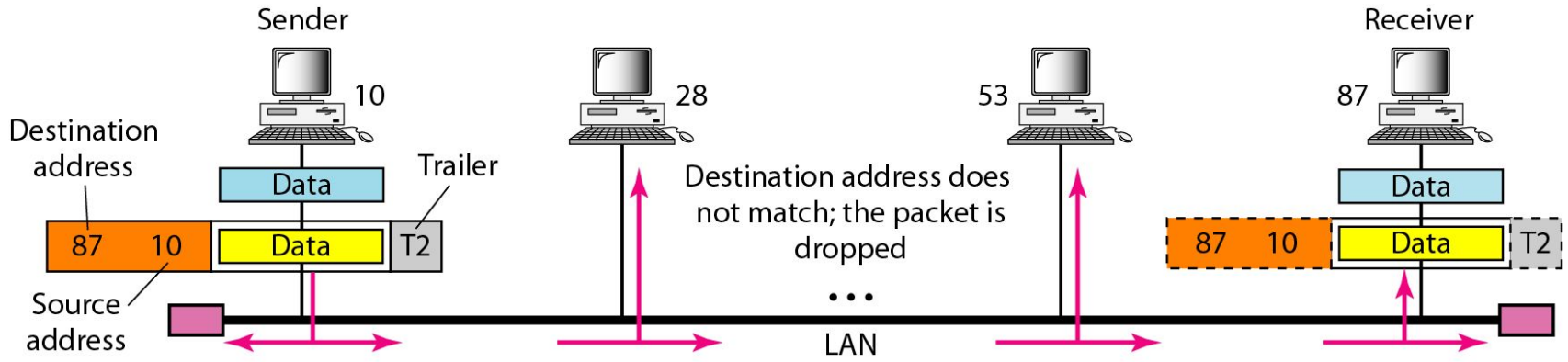
Figure 2.18 *Relationship of layers and addresses in TCP/IP*



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:

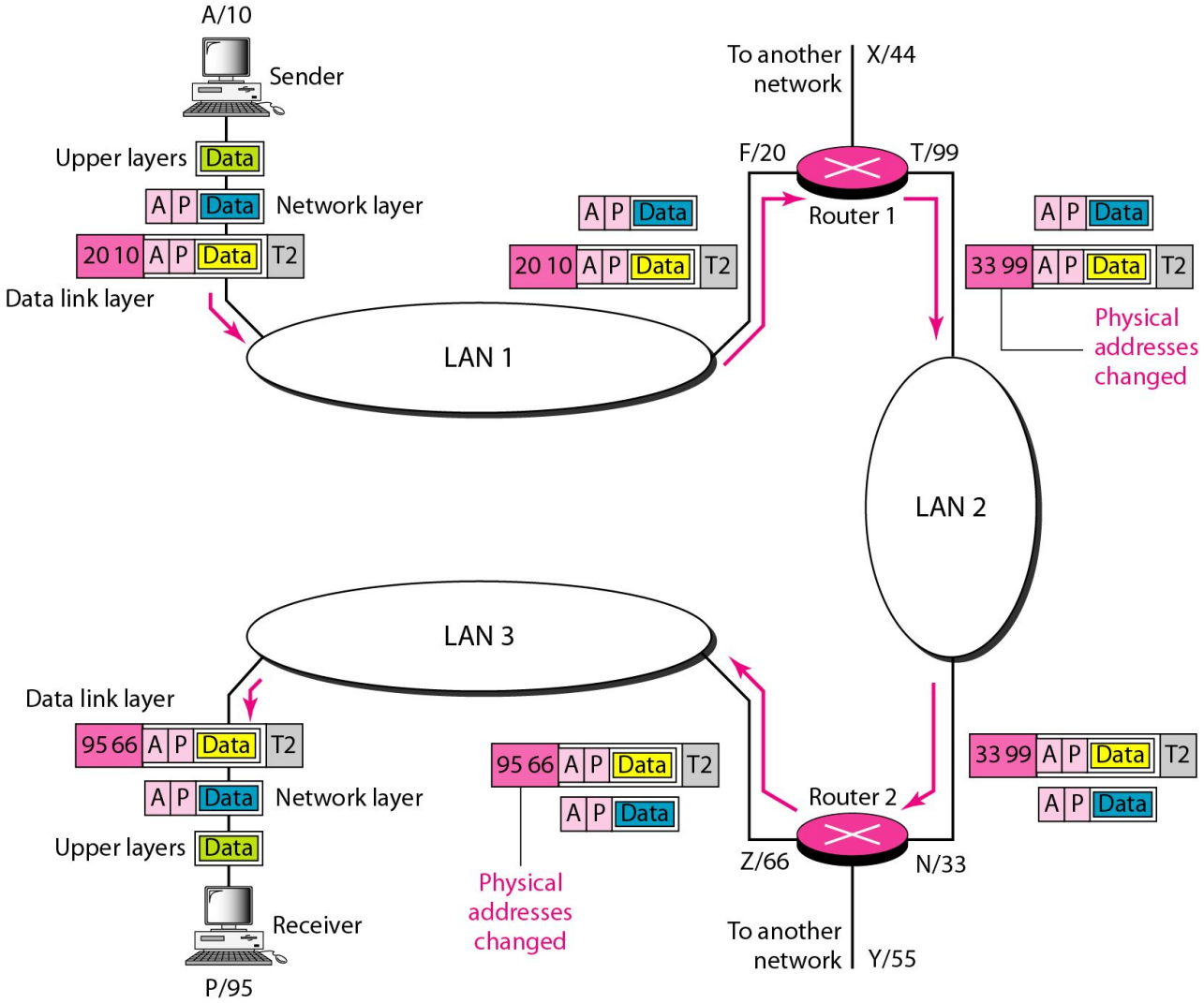
07:01:02:01:2C:4B

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.

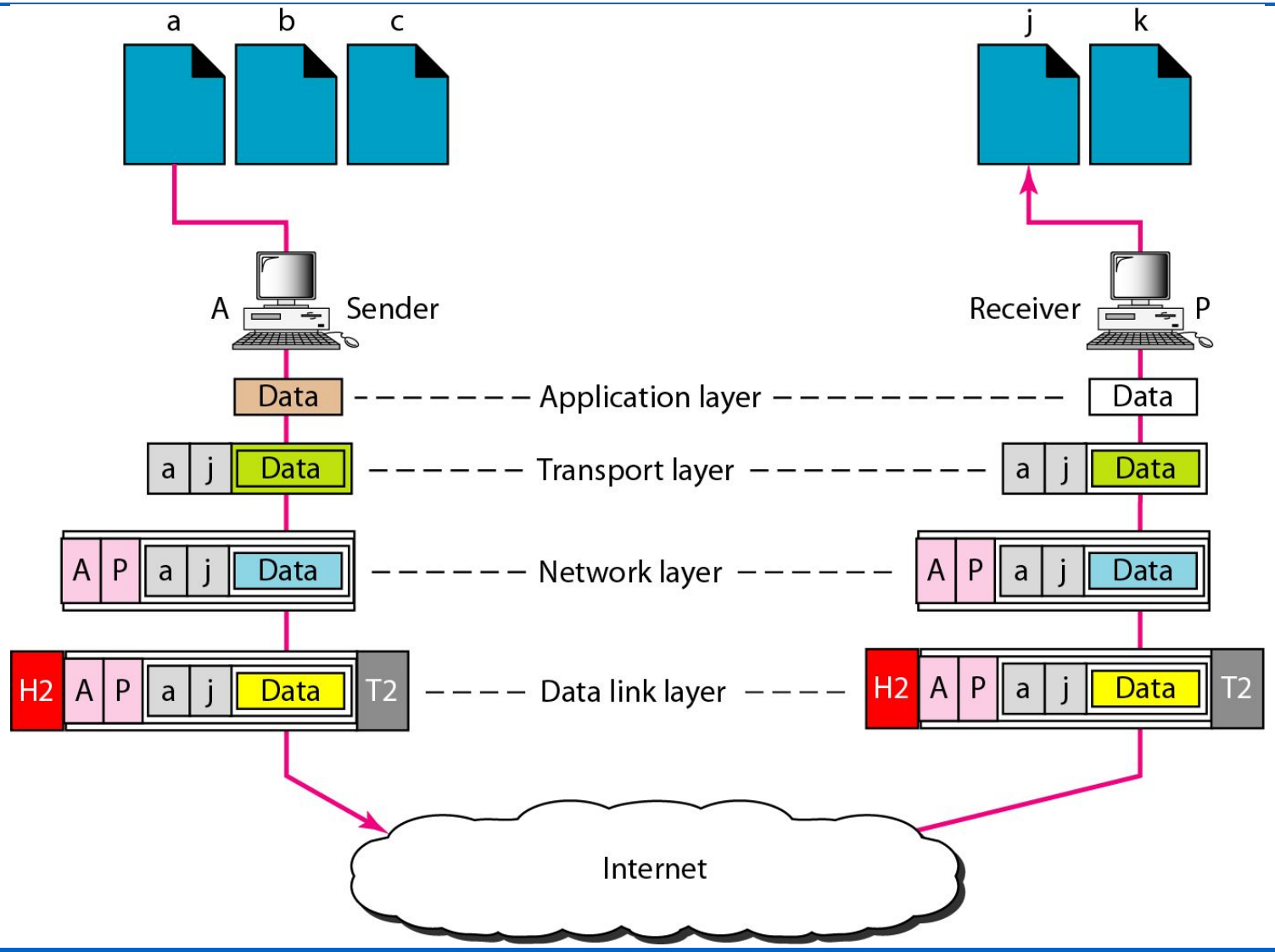
Figure 2.20 *IP addresses*



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.