Data Communications and Networking Fourth Edition

Forouzan

Chapter 2

Network Models

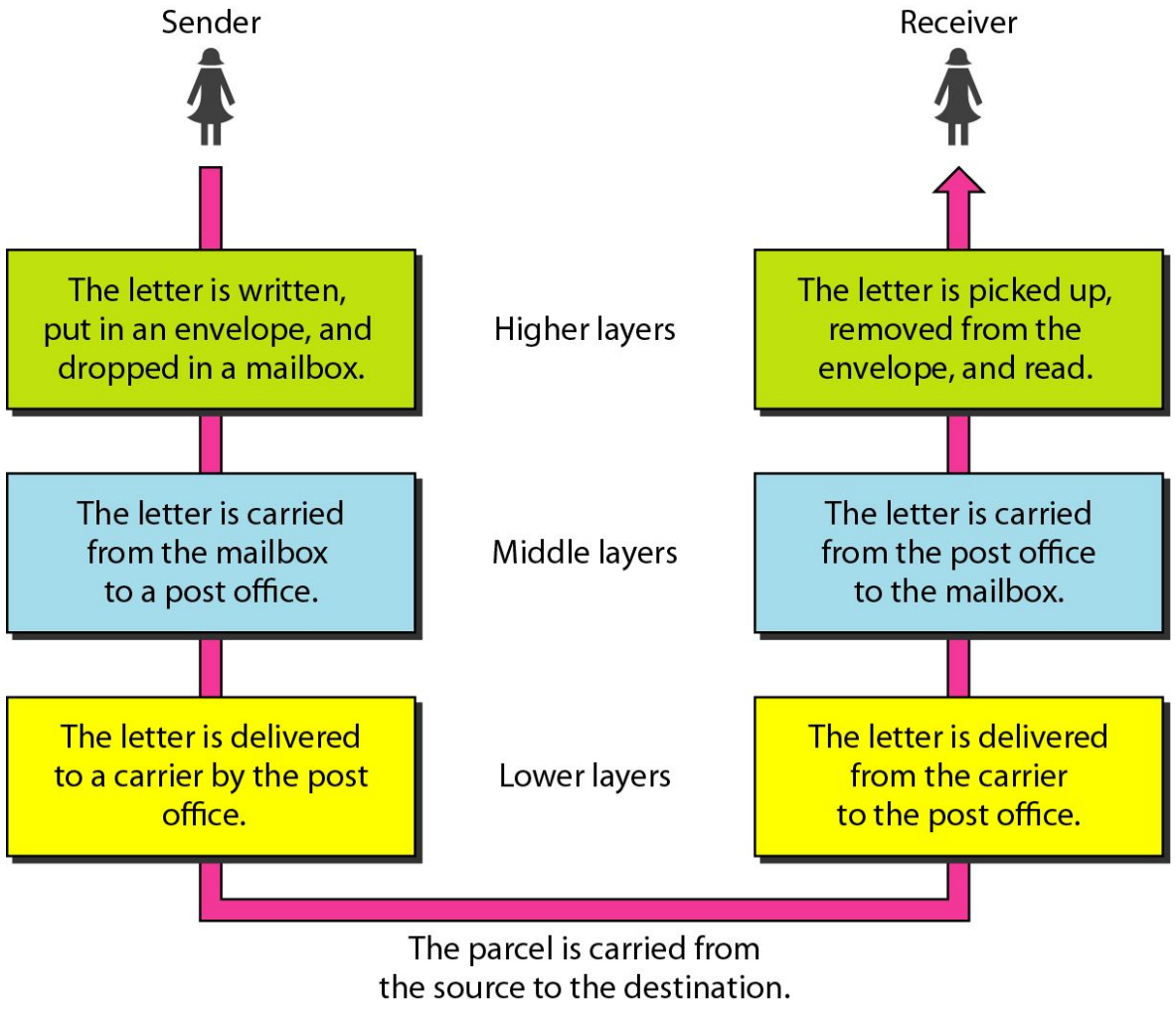
2-1 LAYERED TASKS

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

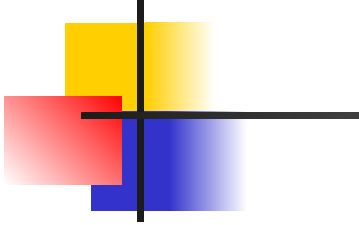


2-2 THE OSI MODEL

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*

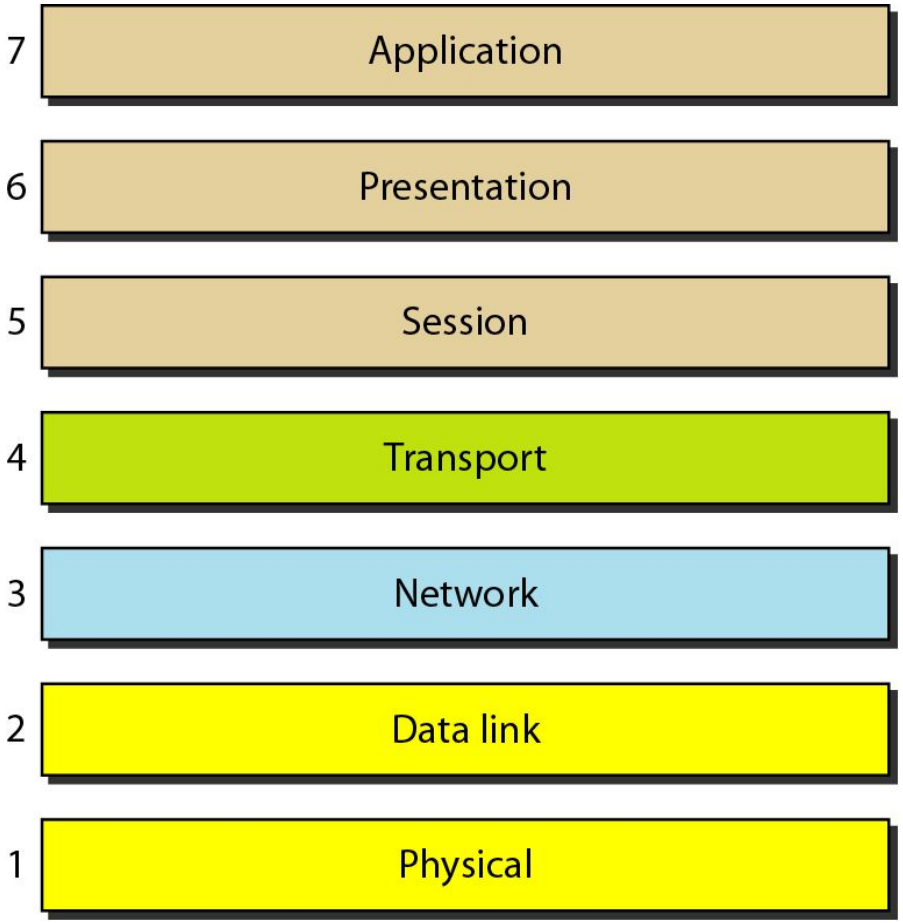


Figure 2.3 *The interaction between layers in the OSI model*

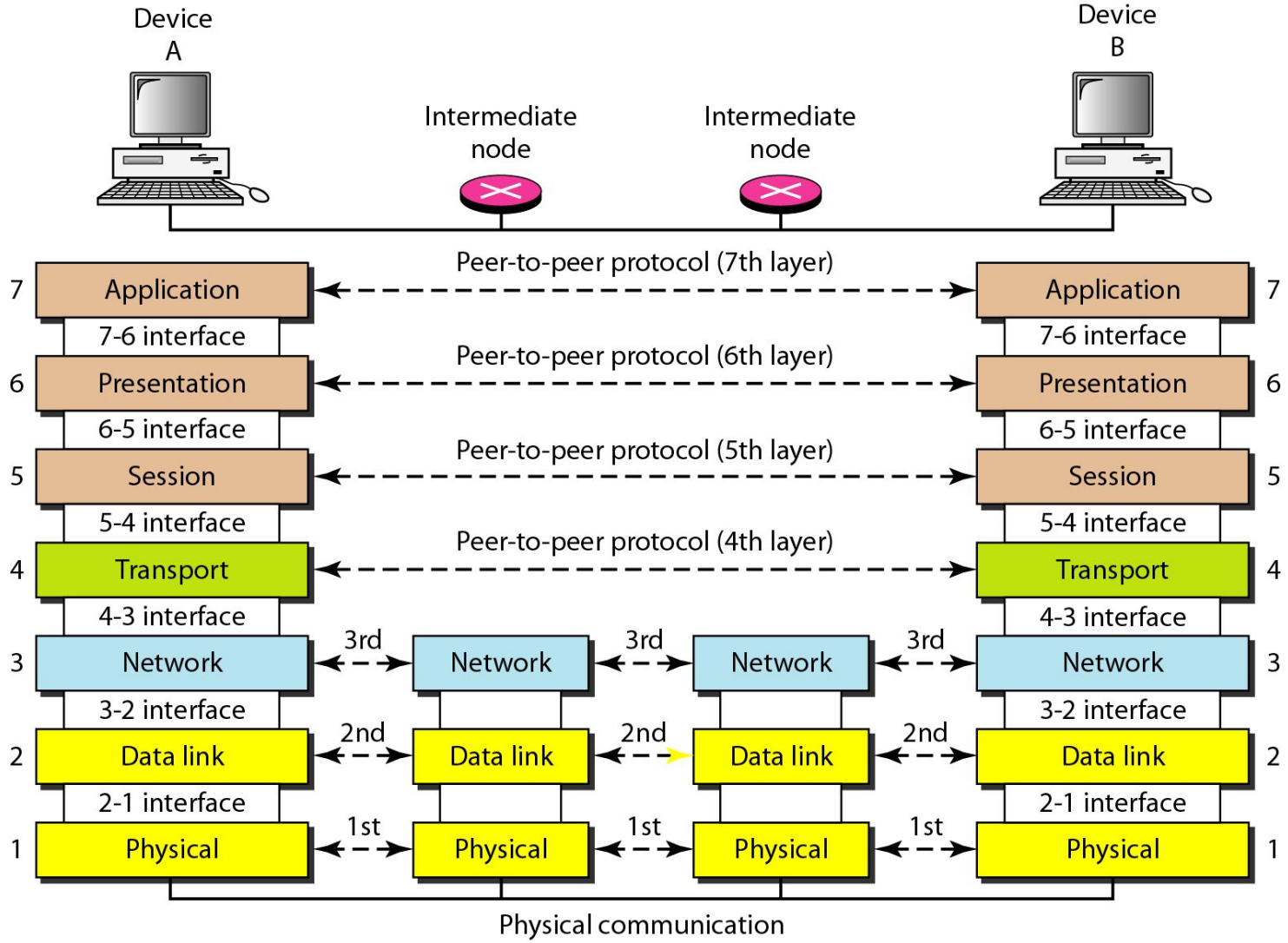
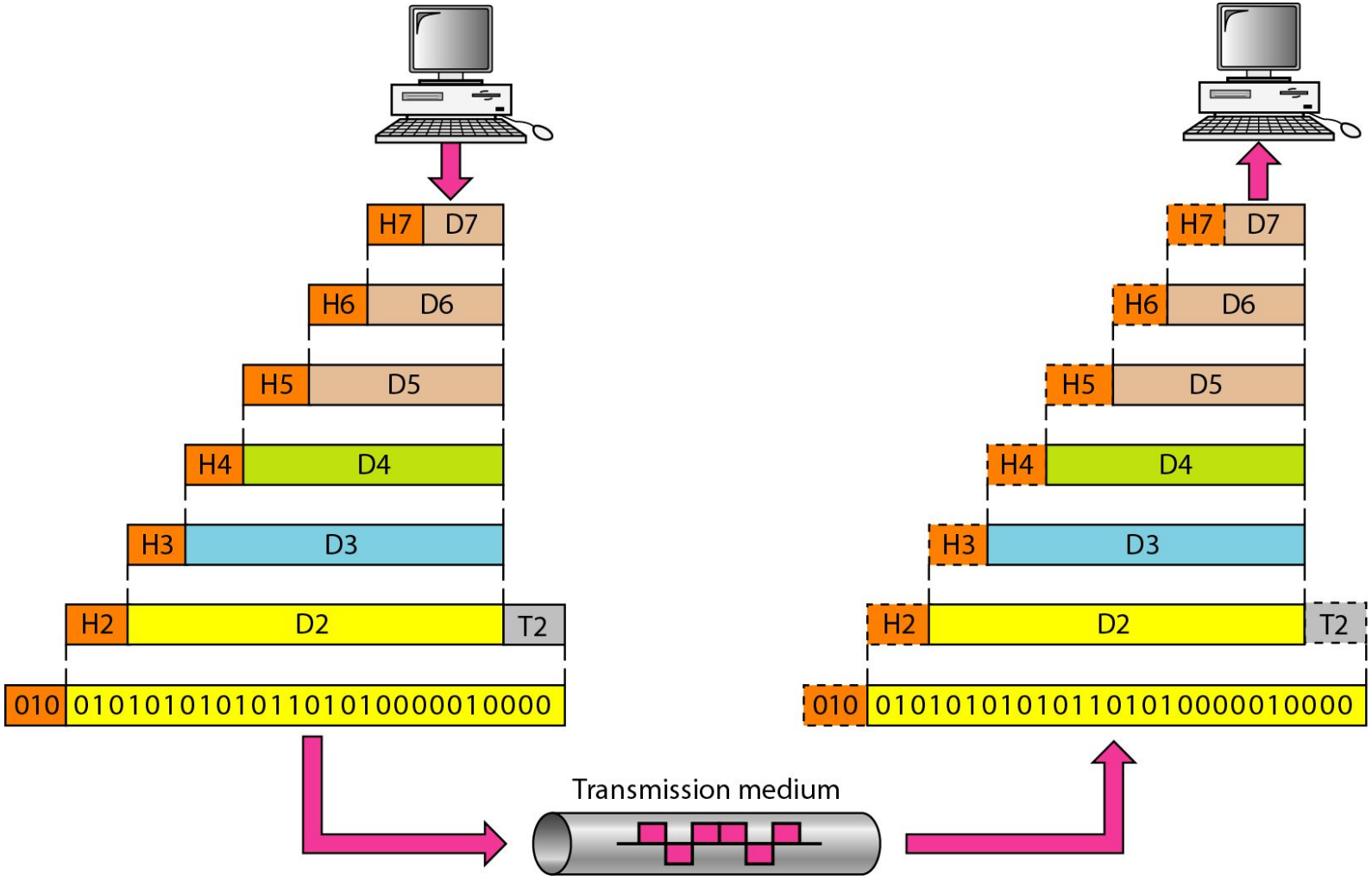


Figure 2.4 *An exchange using the OSI model*



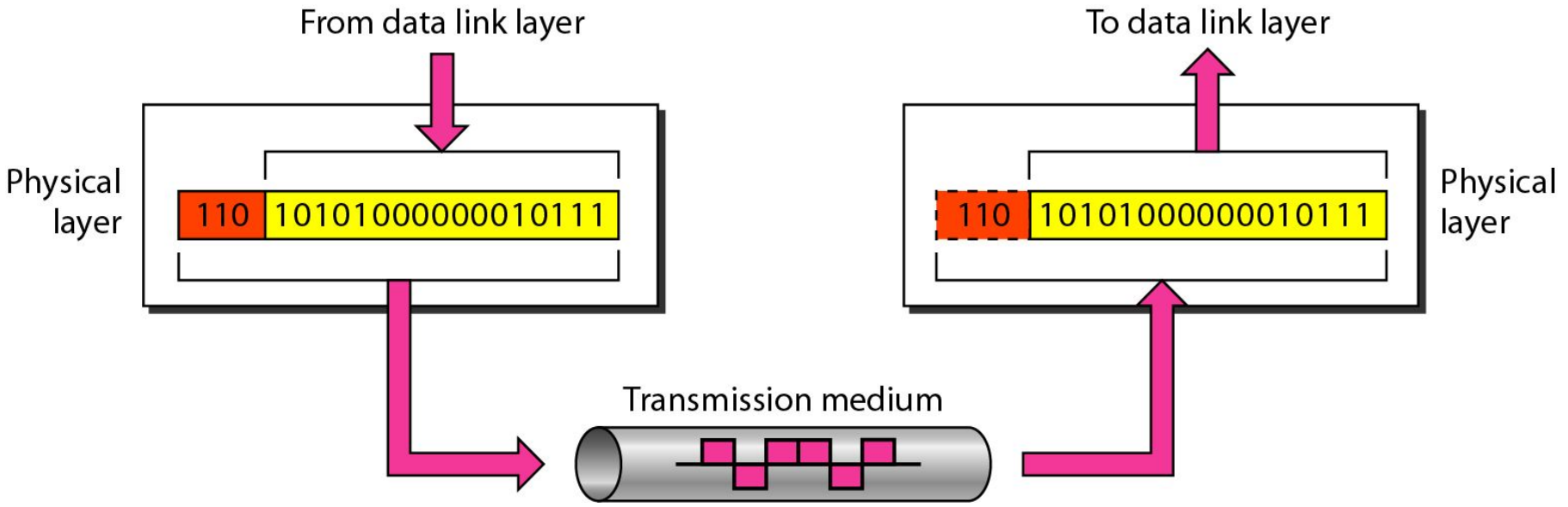
2-3 LAYERS IN THE OSI MODEL

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

Topics discussed in this section:

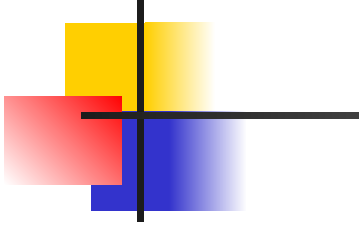
Physical Layer
Data Link Layer
Network Layer
Transport Layer
Session Layer
Presentation Layer
Application Layer

Figure 2.5 *Physical layer*



Functions of Physical Layer:

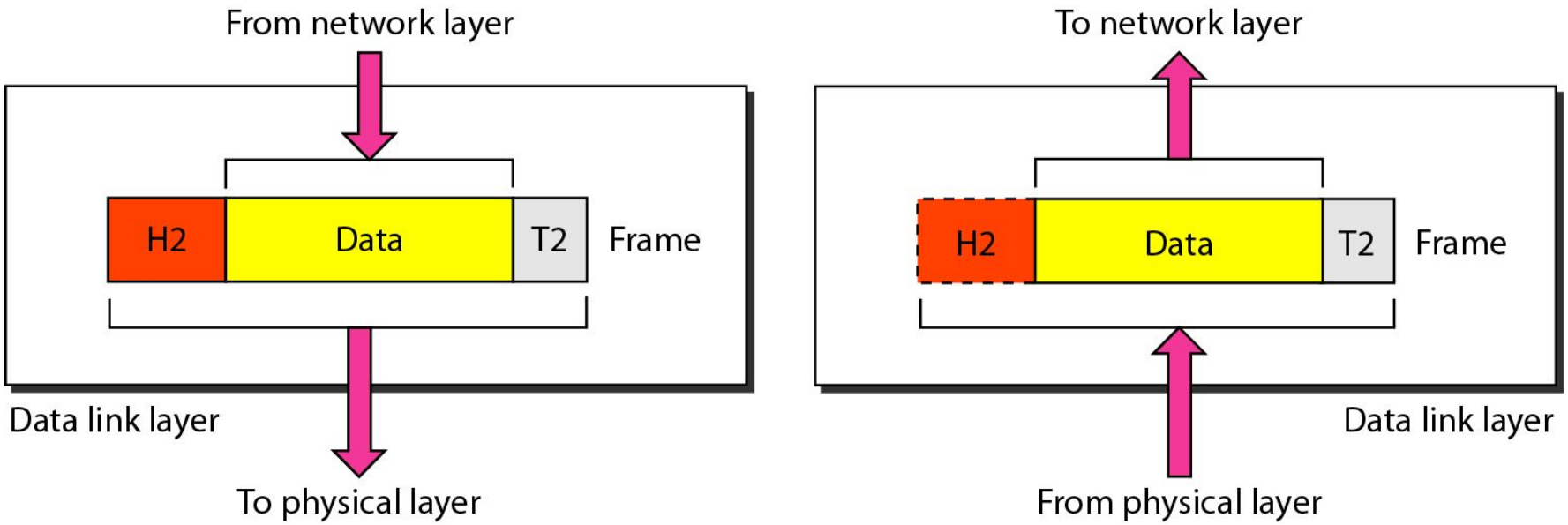
- Convert bits to signals
- Bit synchronization
- Manage physical connection
- Bit rate control
- Line configuration
- Physical topology
- Transmission mode
- Multiplexing
- Switching



Note

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

Figure 2.6 *Data link layer*



Functions of Data Link Layer of OSI Model

- It frames the data in a way that is meaningful to the receiver using special bit patterns.
- It adds physical addresses of both sender and receiver in every frame.
- This layer controls error by detecting and retransmitting frames.
- It controls the flow by calculating the amount of data before receiving it.
- It determines the extent of control devices have in a given time.
- Network Interface Card handles this layer using devices like switch & bridge.

Note

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

Figure 2.7 *Hop-to-hop delivery*

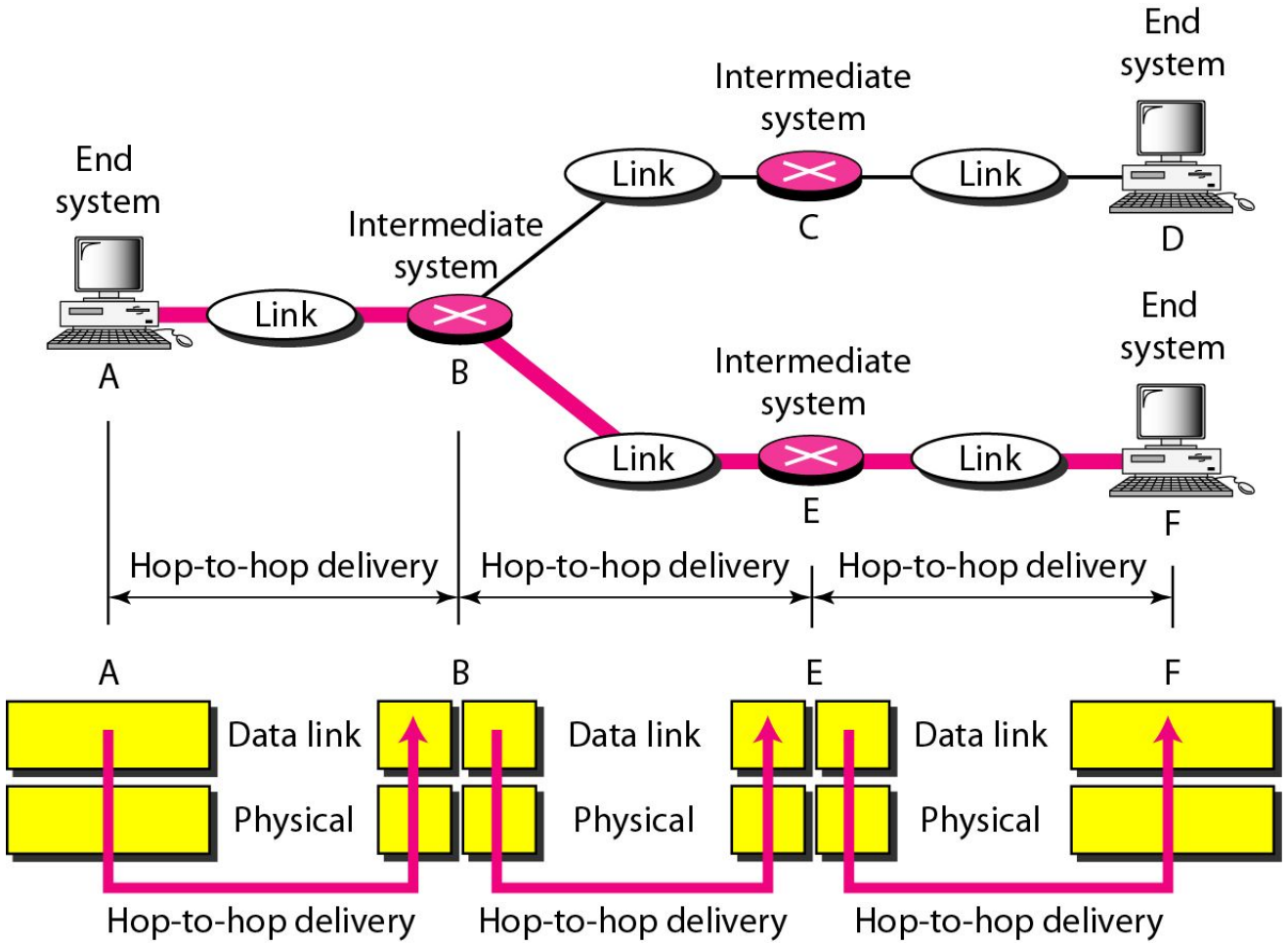
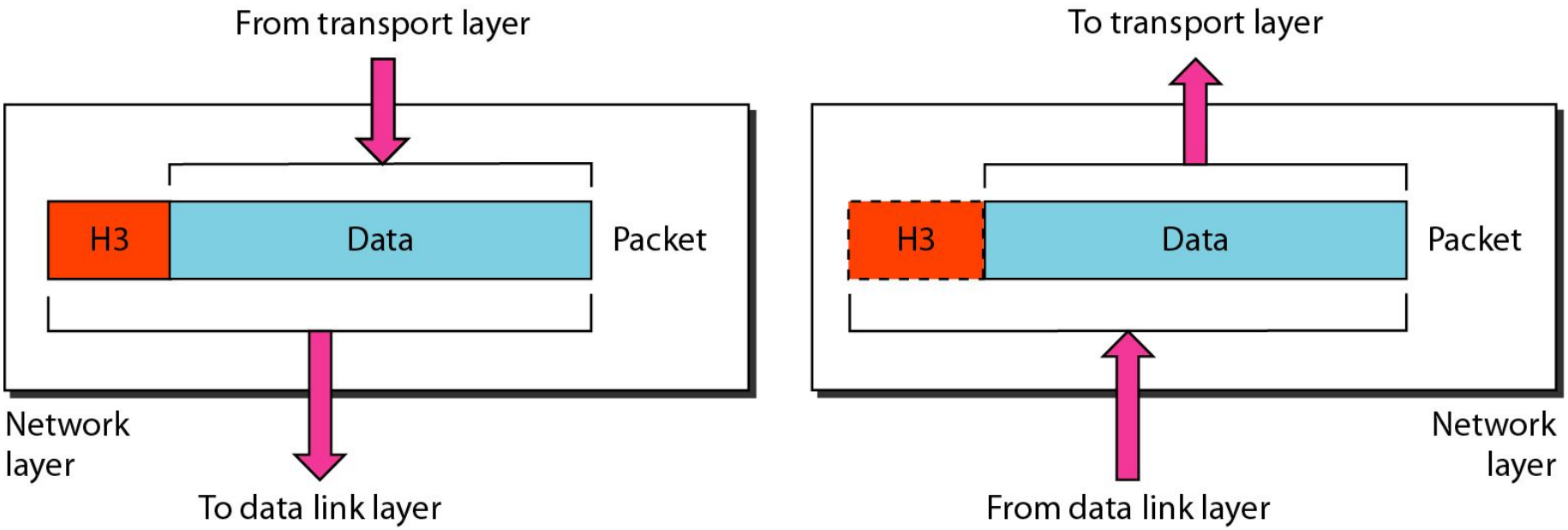


Figure 2.8 *Network layer*



Functions of Network Layer of OSI Model

- It formulates a connection between different devices in a layer.
- It decides the ideal route for information transfer from source to destination. This process is known as routing.
- This layer follows an addressing scheme to find the correct IP address universally.
- It breaks information into packets using internet protocol.

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*

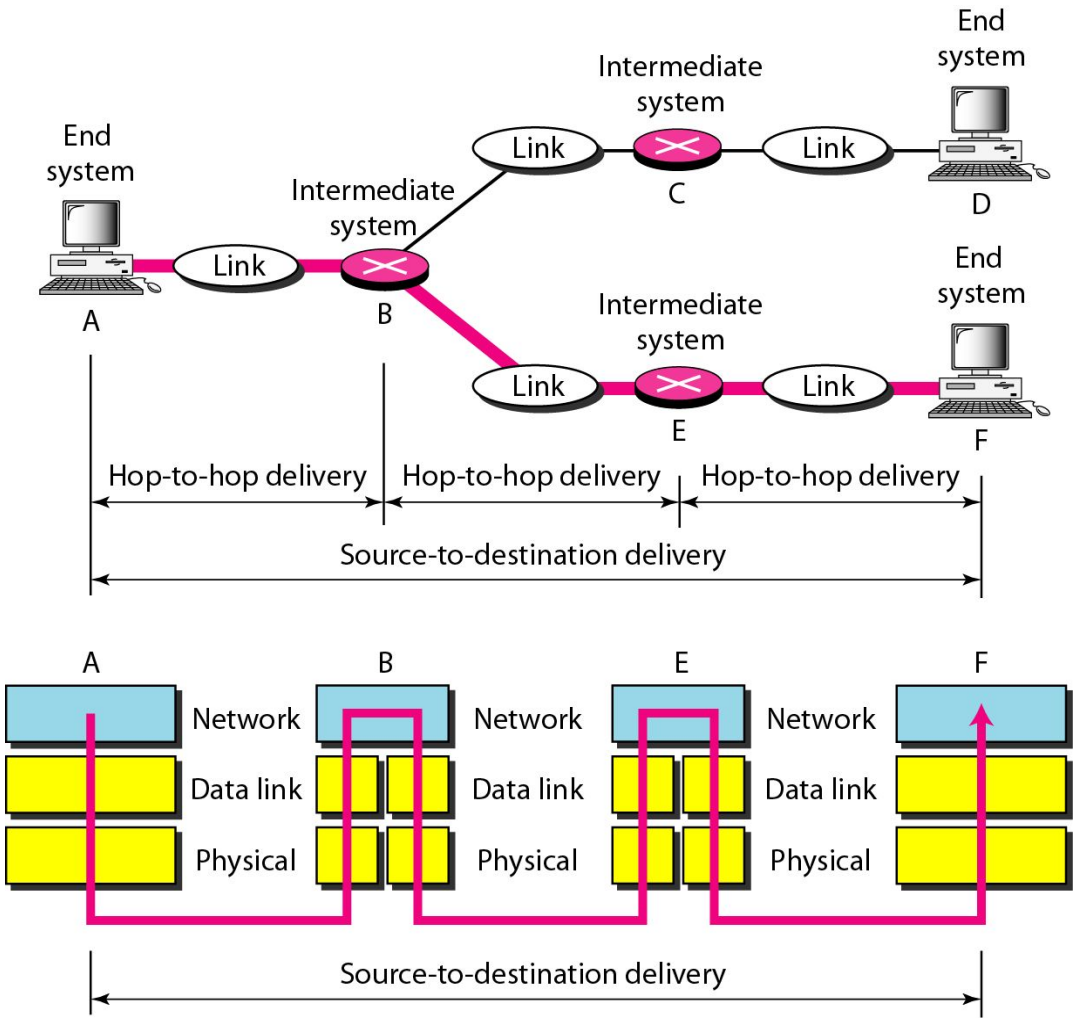
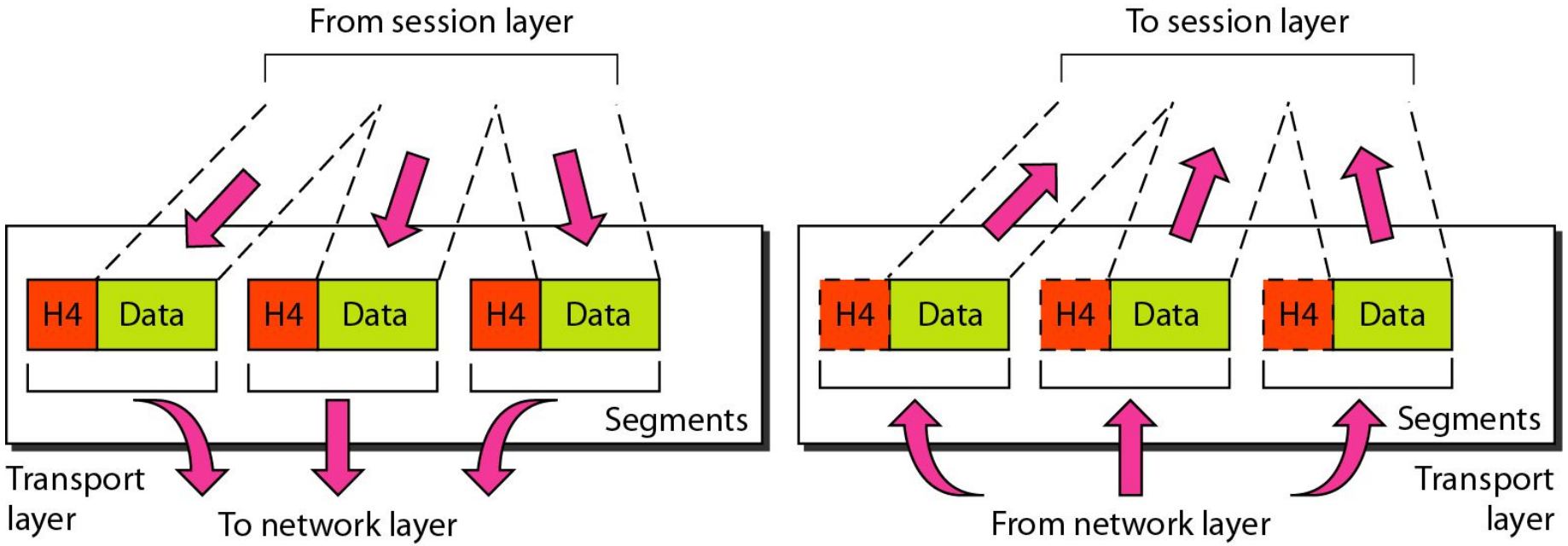


Figure 2.10 *Transport layer*



Functions of Transport Layer of OSI Model

- It accepts data and breaks into smaller units while sending. And it reassembles the data while receiving.
- It follows a service point address to deliver the message to the correct process.
- This layer provides connection-oriented service by establishing a connection, transferring data, and terminating the process. It is secure as the sender receives an acknowledgment of data delivery.
- It also provides connectionless service by using data transfer. The receiver doesn't get an acknowledged receipt but the process is faster.

Gateway v/s Router

Differences	Router	Gateway
Function	To ensure that data packets are switched to the right address with the best route	To connect two networks of different protocols as a translator
Networks	It routes the data packets via similar networks	It connects two dissimilar networks
Support Dynamic Routing	Yes	No
OSI Layer	Work on layer 3 and layer 4	Work on layer 5
Additional Features	wireless networking, static routing, NAT, DHCP server, etc	network access control, protocol conversion, etc
Hosted On	dedicated appliance (router hardware)	dedicated/virtual appliance or physical server

Note

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

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

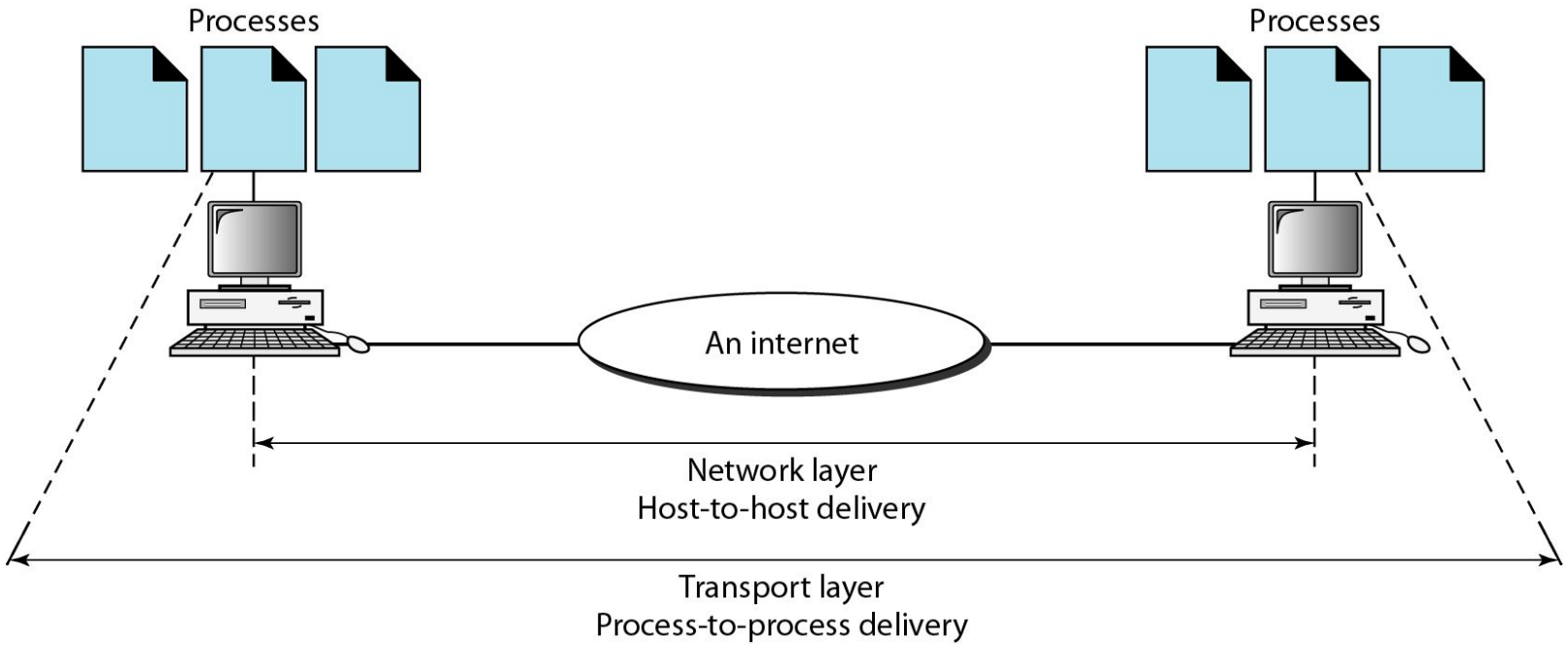
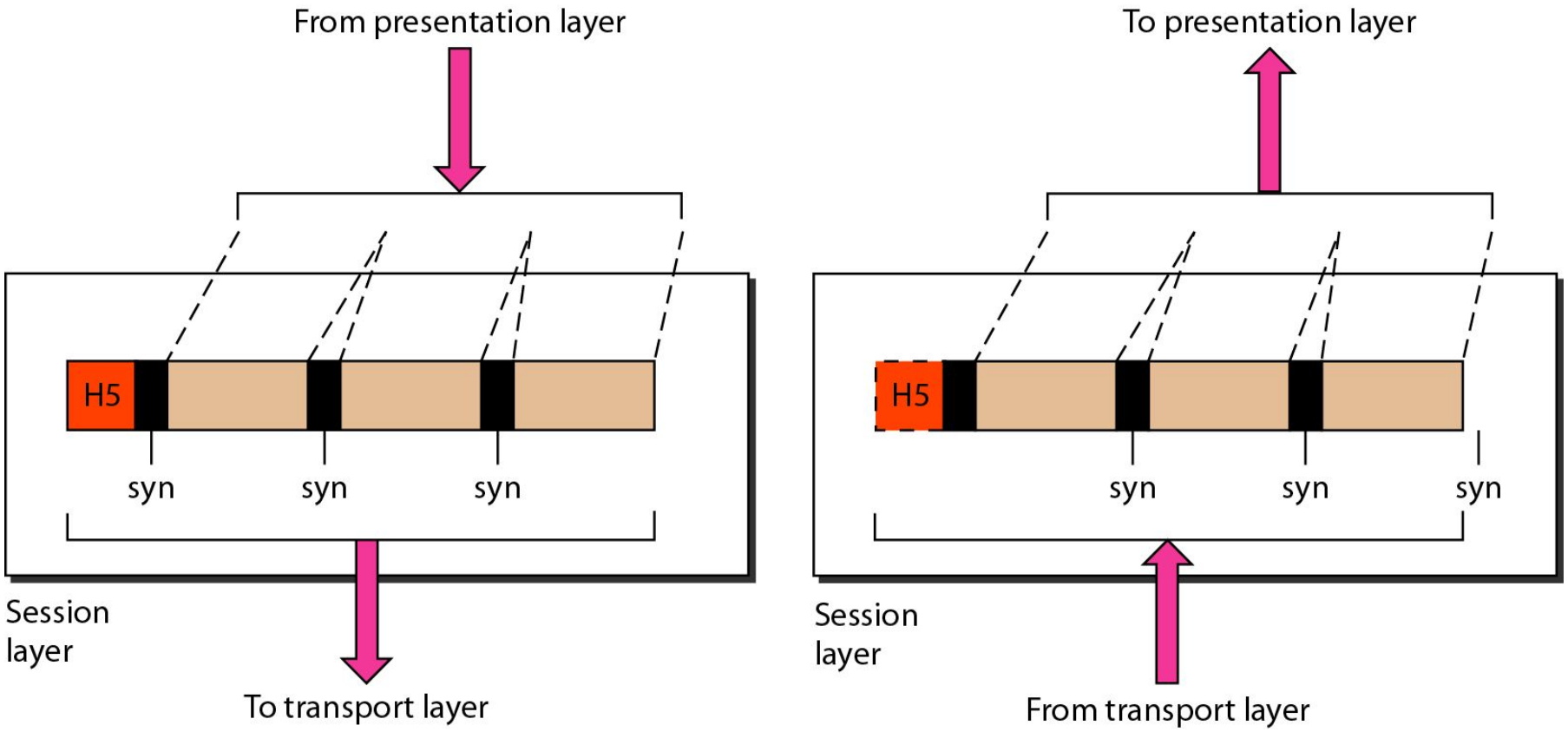


Figure 2.12 *Session layer*



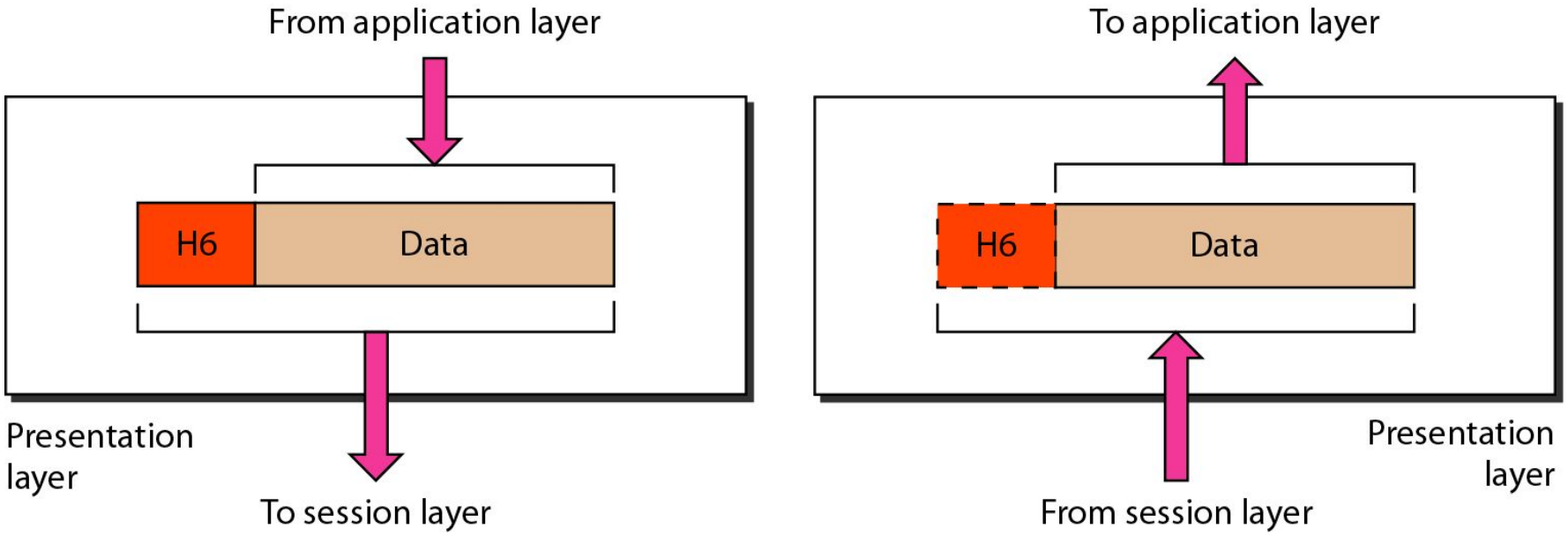
Functions of Session Layer:

- Establishment, maintaining and ending a session:
  - Sends SYN packet – establish request
  - Receives ACK & SYN- established
  - To end – Sender sends ACK
- Dialog Control: The session layer allows two systems to enter into a dialog.
- Synchronization: Allows a process to add checkpoints to a stream of data.

Note

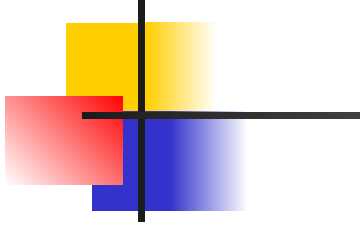
The session layer is responsible for dialog control and synchronization.

Figure 2.13 *Presentation layer*



Functions of Presentation Layer:

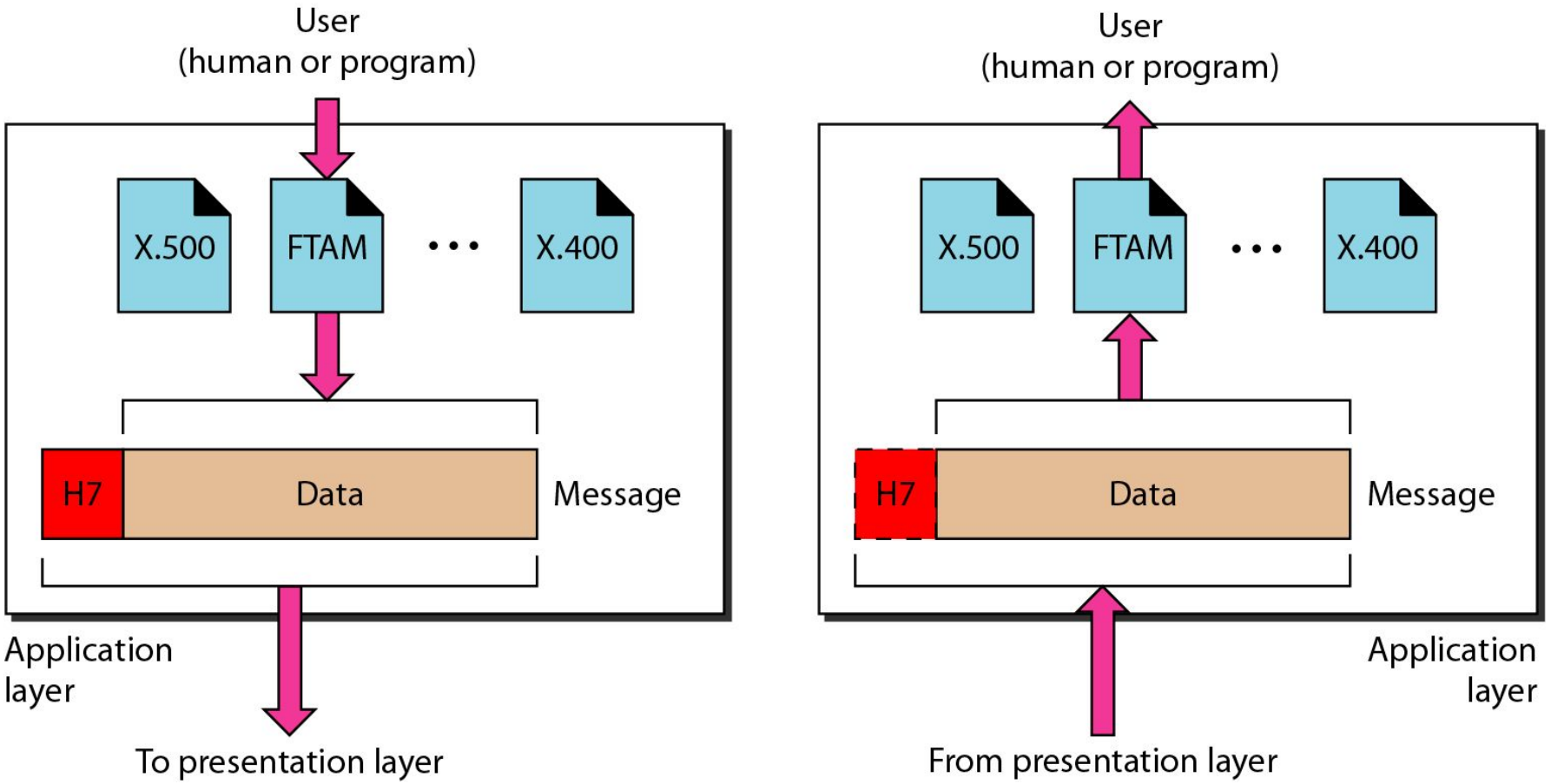
- Data Translation: Encoding and Decoding
  Sender to Common format on Sending side
  Common to Receiving format on Receiver side
- Data Encryption: For security and privacy purpose.
- Data Compression: Data compression reduces the number of bits contained in the information.



Note

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

Figure 2.14 *Application layer*



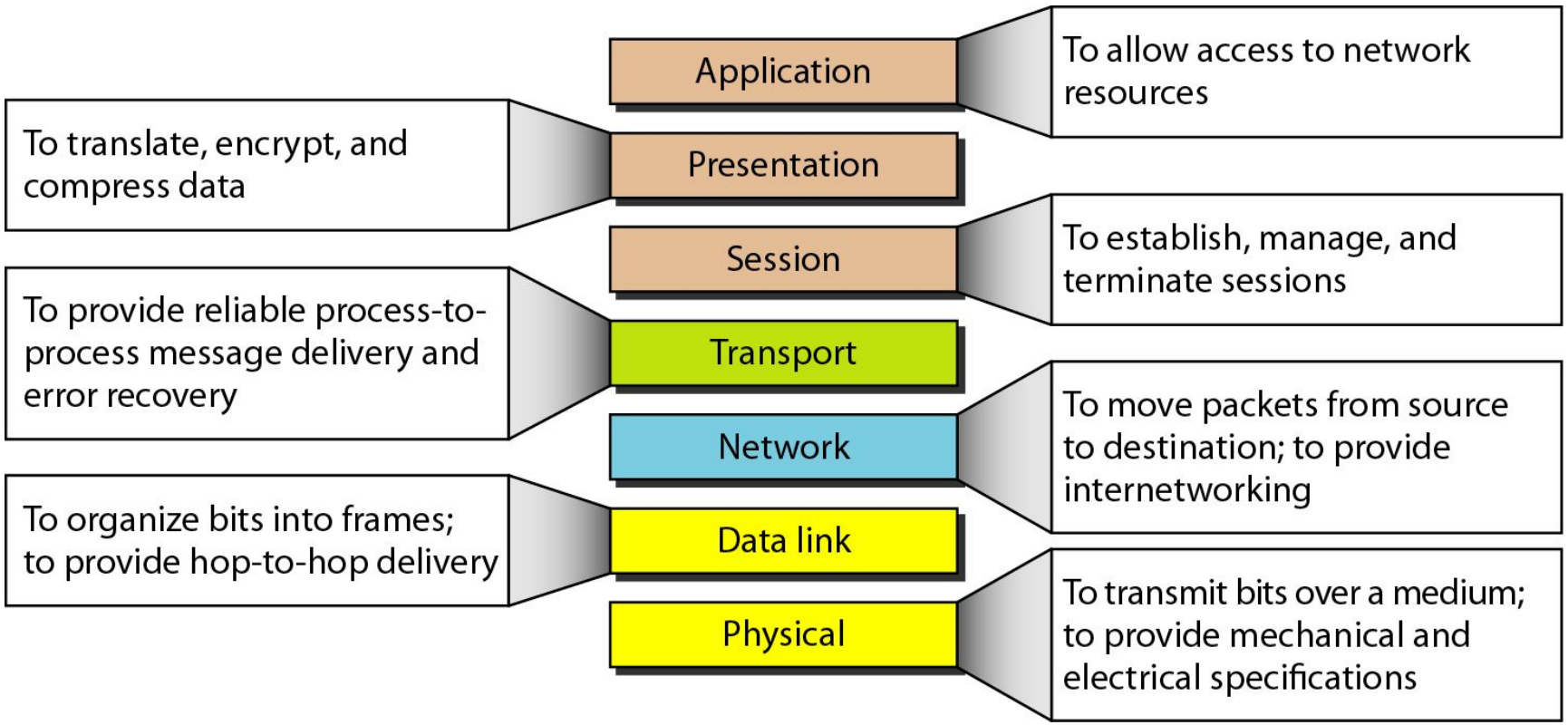
Functions of Application Layer:

- Network Virtual terminal: It allows a user to log on to a remote host.
- File Transfer Access, and Management: This application allows a user to access files in a remote host.
- Mail Services: This application provides various e-mail services.
- Directory Services: This application provides the distributed database sources and access for global information about various objects and services.

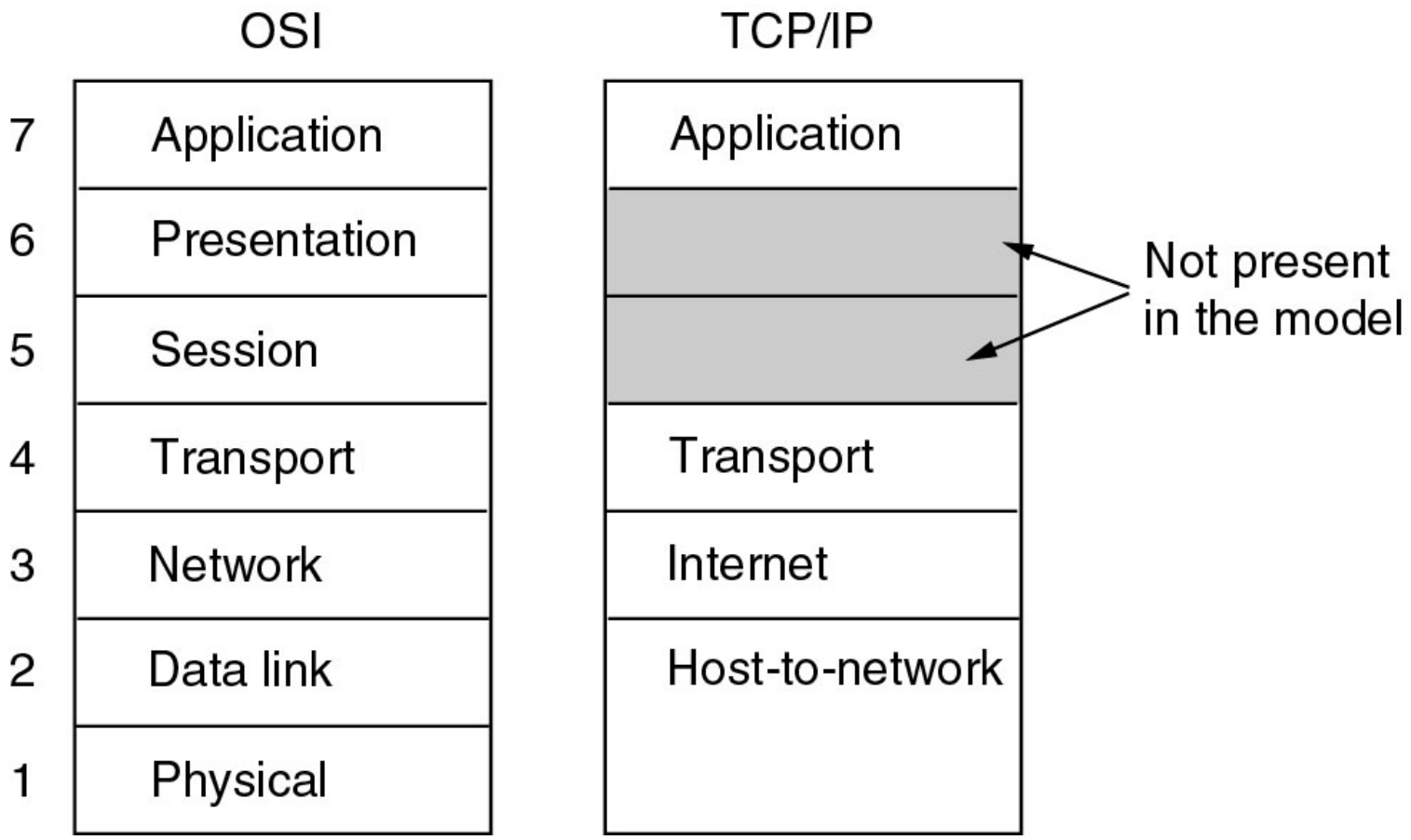
Note

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

Figure 2.15 *Summary of layers*



The TCP/IP Reference Model



- The TCP/IP reference model.

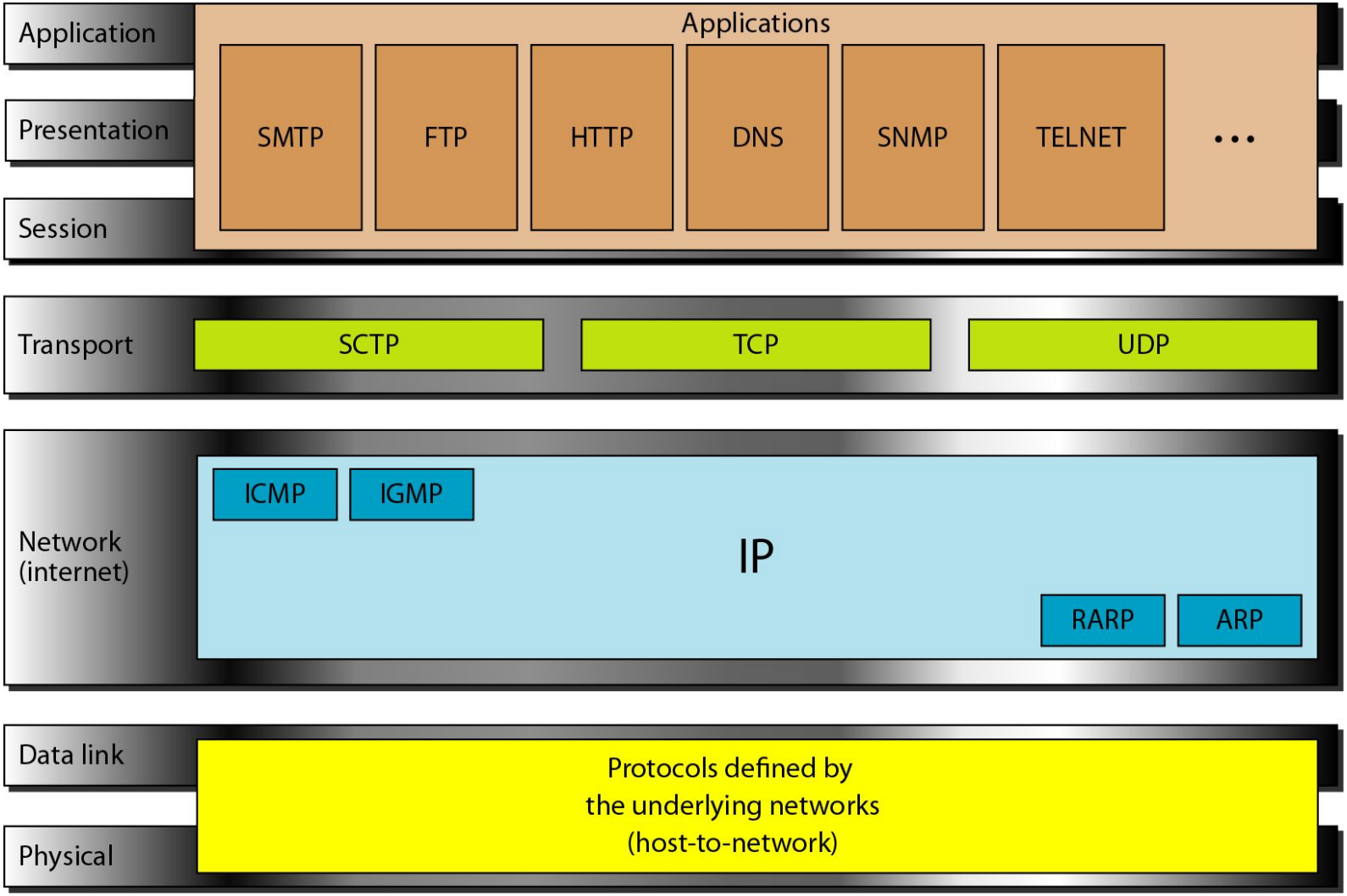
2-4 TCP/IP PROTOCOL SUITE

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*

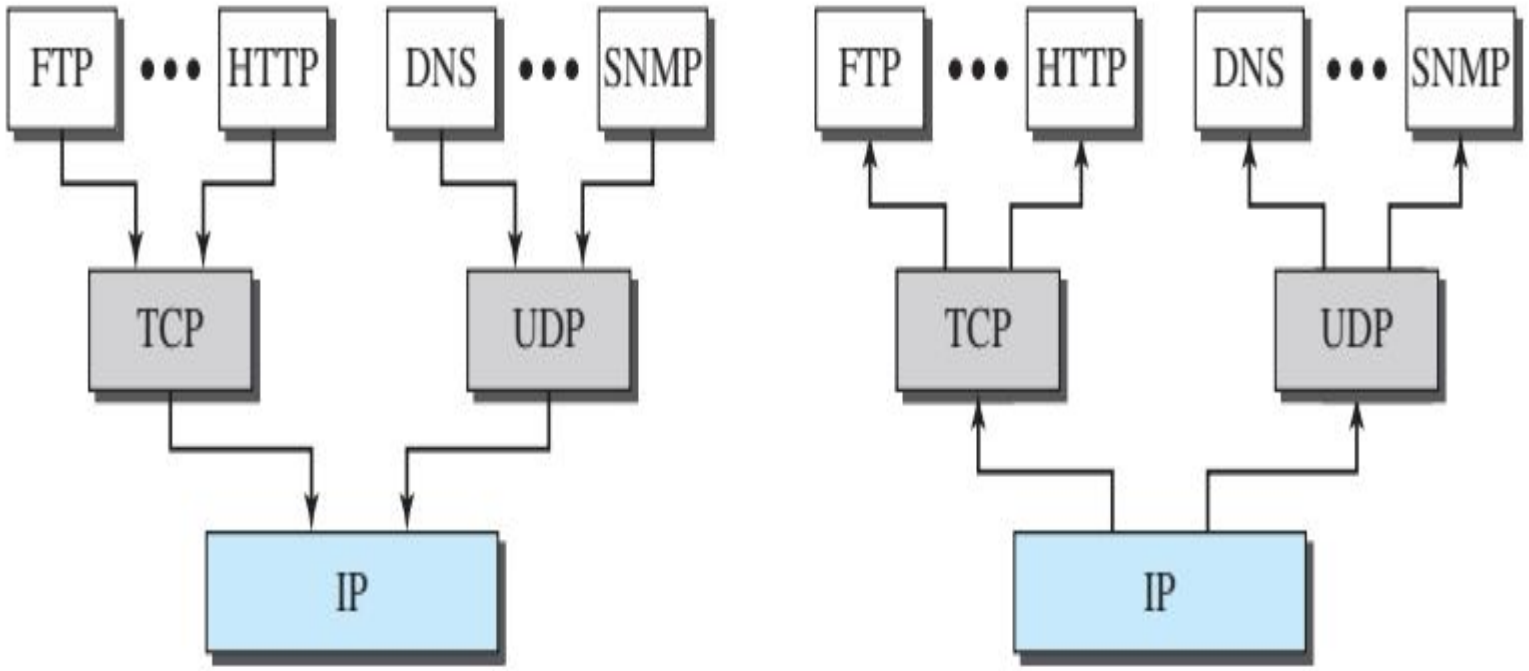


Full Forms: *TCP/IP and OSI model*

- SMTP – Simple Mail Transfer Protocol
- FTP – File Transfer Protocol
- HTTP – Hyper Text Transfer Protocol
- DNS – Domain Name Server
- SNMP – Simple Network Management Protocol
- SCTP - Stream Control Transmission Protocol
- TCP – Transmission Control Protocol
- UDP – User Datagram Protocol
- ARP - Address Resolution Protocol
- RARP - Reverse Address Resolution Protocol
- ICMP - Internet Control Message Protocol
- IGMP - Internet Group Management Protocol
- IP – Internet Protocol

Multiplexing and Demultiplexing

Figure 2.10 *Multiplexing and demultiplexing*



a. Multiplexing at source

b. Demultiplexing at destination

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*

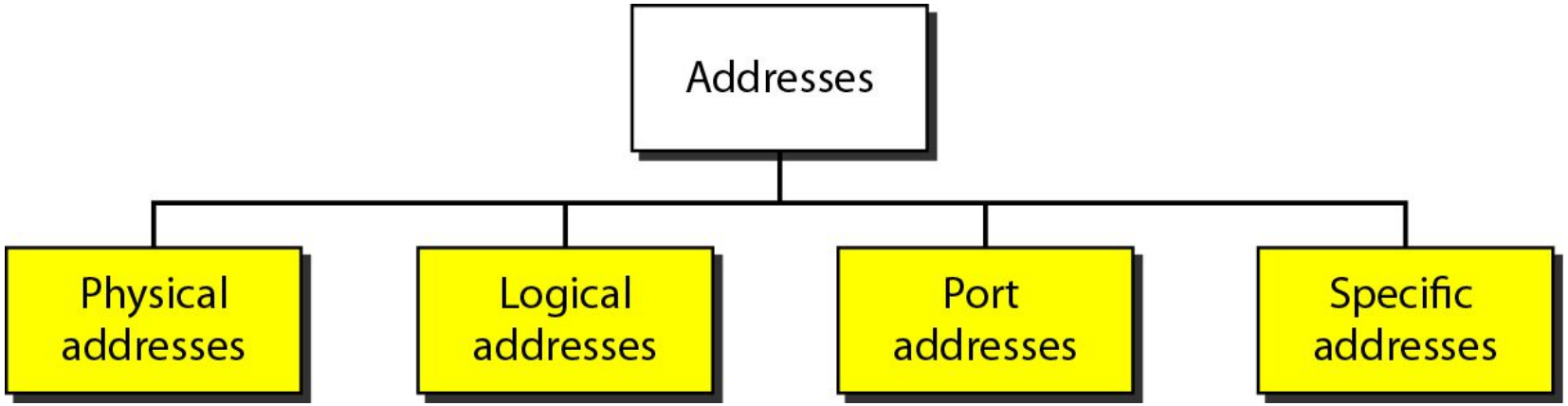
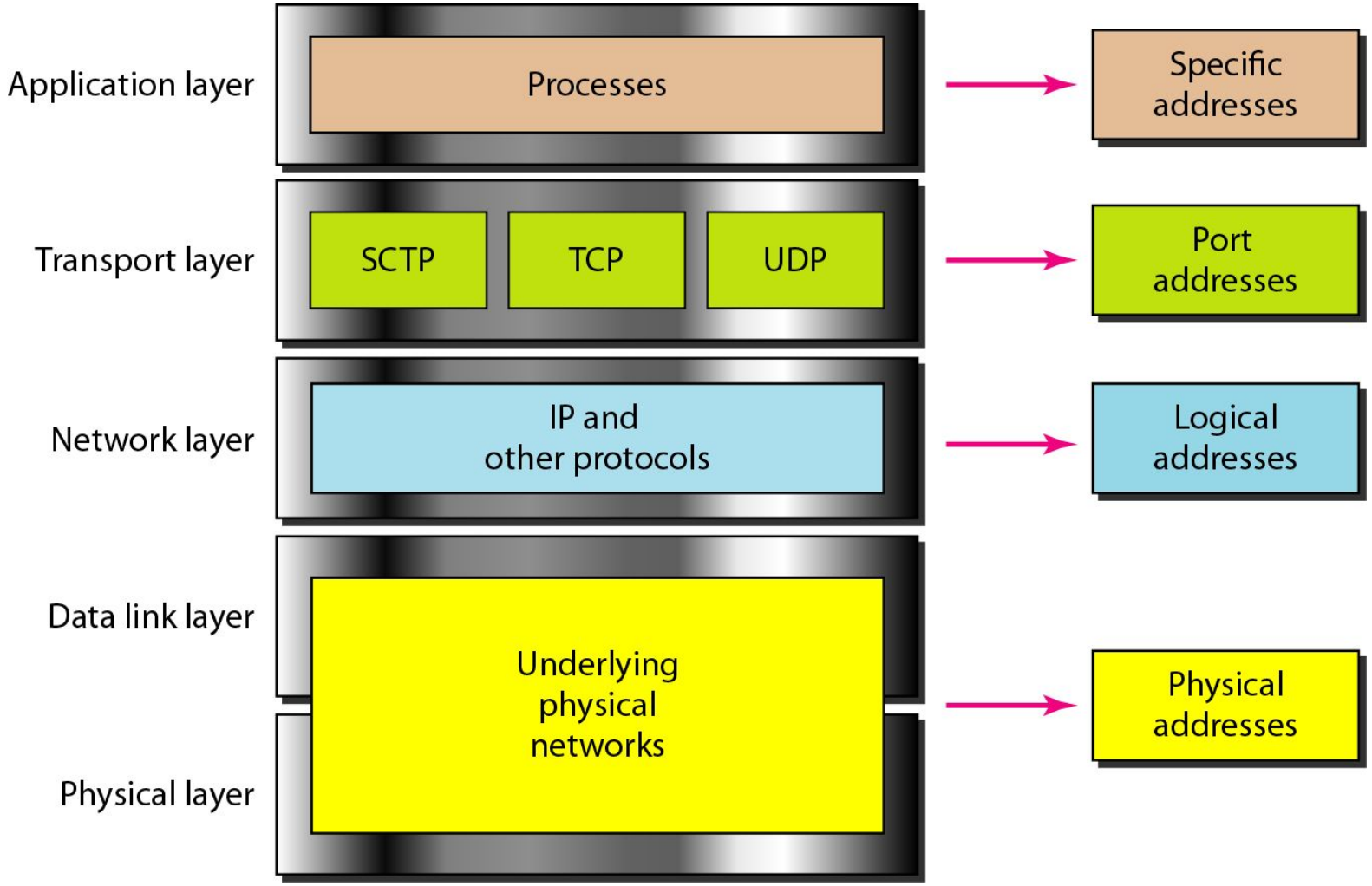


Figure 2.18 *Relationship of layers and addresses in TCP/IP*



OSI v/s TCP-IP

OSI Model	TCP/IP Model
It is developed by ISO (International Standard Organization)	It is developed by ARPANET (Advanced Research Project Agency Network).
OSI model provides a clear distinction between interfaces, services, and protocols.	TCP/IP doesn't have any clear distinguishing points between services, interfaces, and protocols.
OSI refers to Open Systems Interconnection.	TCP refers to Transmission Control Protocol.
OSI uses the network layer to define routing standards and protocols.	TCP/IP uses only the Internet layer.
OSI follows a vertical approach.	TCP/IP follows a horizontal approach.
OSI layers have seven layers.	TCP/IP has four layers.
In the OSI model, the transport layer is only connection-oriented.	A layer of the TCP/IP model is both connection-oriented and connectionless.
In the OSI model, the data link layer and physical are separate layers.	In TCP, physical and data link are both combined as a single host-to-network layer.
Session and presentation layers are a part of the OSI model.	There is no session and presentation layer in the TCP model.
It is defined after the advent of the Internet.	It is defined before the advent of the internet.

TCP/IP v/s OSI

- 4 Layers
- Did not clearly distinguish between service, interface and protocol.
- Protocols in TCP/IP model are not hidden and tough to replace if technology changes.

- 7 Layers
- Distinction between these three concepts are explicit.
- Protocols in the OSI model are better hidden than in the TCP/IP model and can be replaced relatively easily as the technology changes.

- The protocols came first, and the model was really just a description of the existing protocols.
- Designers have much experience with the subject and have clear idea of which functionality to put in which layer.

- The model was not biased toward one particular set of protocols, a fact that made it quite general.
- Designers did not have much experience with the subject and did not have a good idea of which functionality to put in which layer.