Data Communications and Networking Fourth Edition

Forouzan

Chapter 2

Network Models

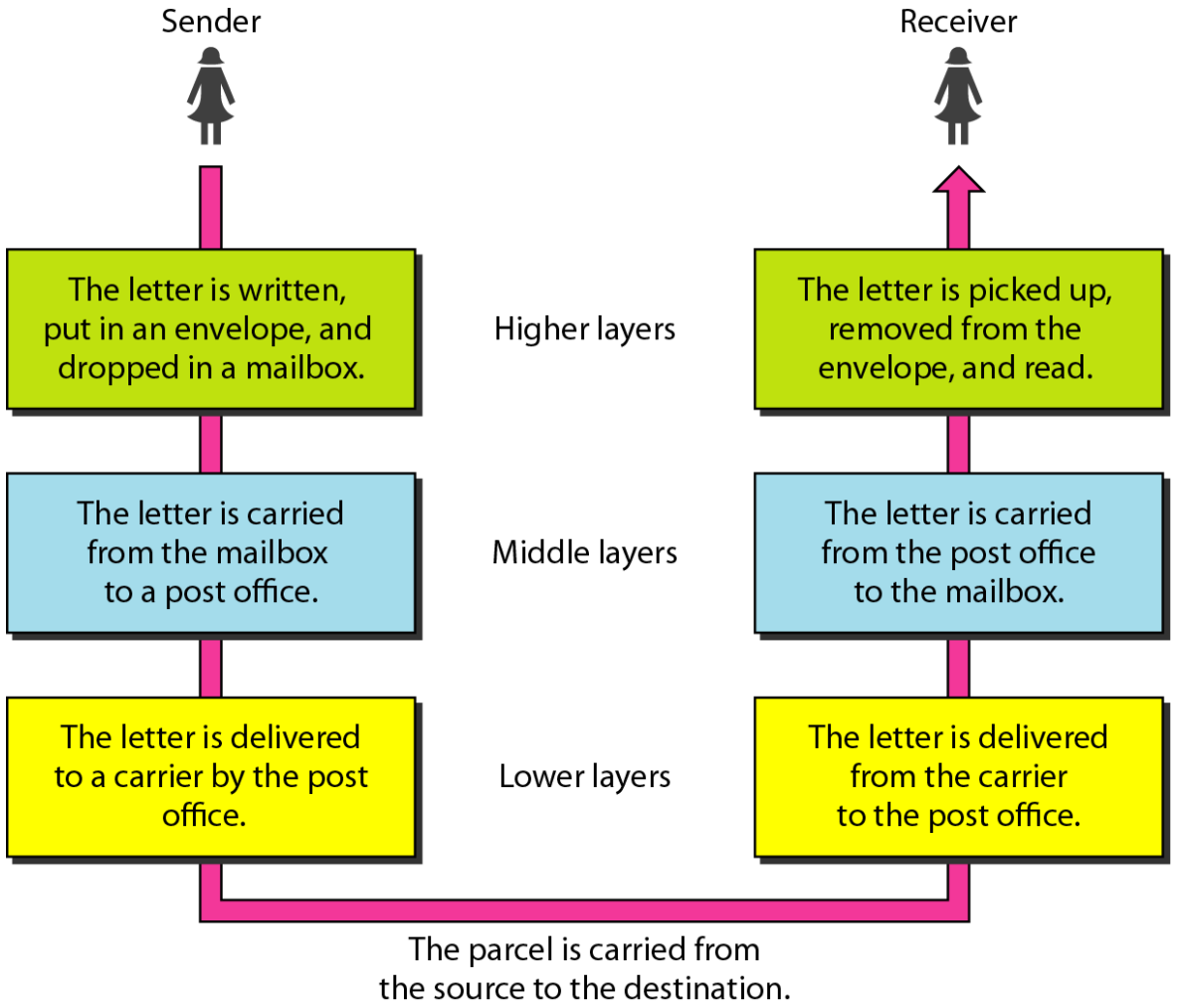
2-1 LAYERED TASKS

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

- ISO stands for **International organization of Standardization**.

- This is called a model for **Open System Interconnection** (OSI) and is commonly known as OSI model.

- The ISO-OSI model is a seven layer (7 Layer)architecture developed in 1984

- To reduce the design complexity, most of the networks are organized as a series of **layers or levels, each one build upon one below it.**

- The basic idea of a layered architecture is *to divide the design into small pieces.*

- Each layer adds to the services provided by the lower layers in such a way that the highest layer is provided has a full set of services.

- The basic elements of a layered model are
  - services
  - protocols
  - and interfaces.

- A **service** is a set of actions that a layer offers to another (higher) layer.
- A **Protocol** is a set of rules that a layer uses to exchange information.
- A **Interface** is communication between the layers.

Note

ISO is the organization.
OSI is the model.

Figure 2.2 *Seven layers of the OSI model*

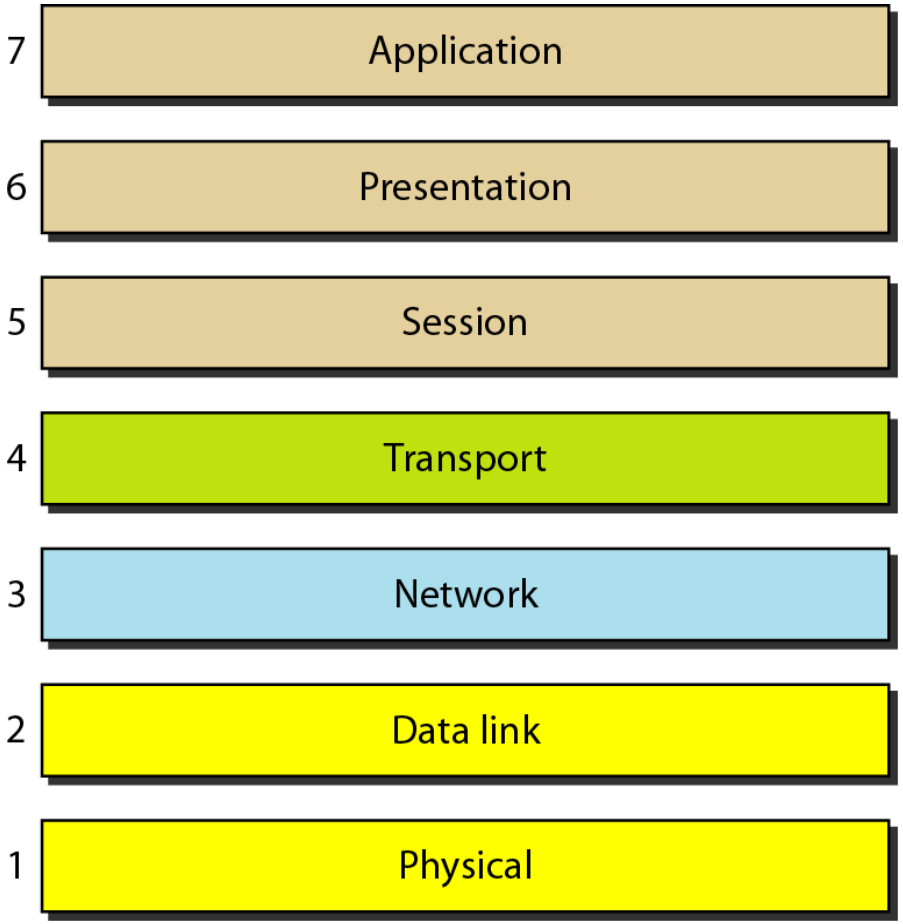


Figure 2.3 *The interaction between layers in the OSI model*

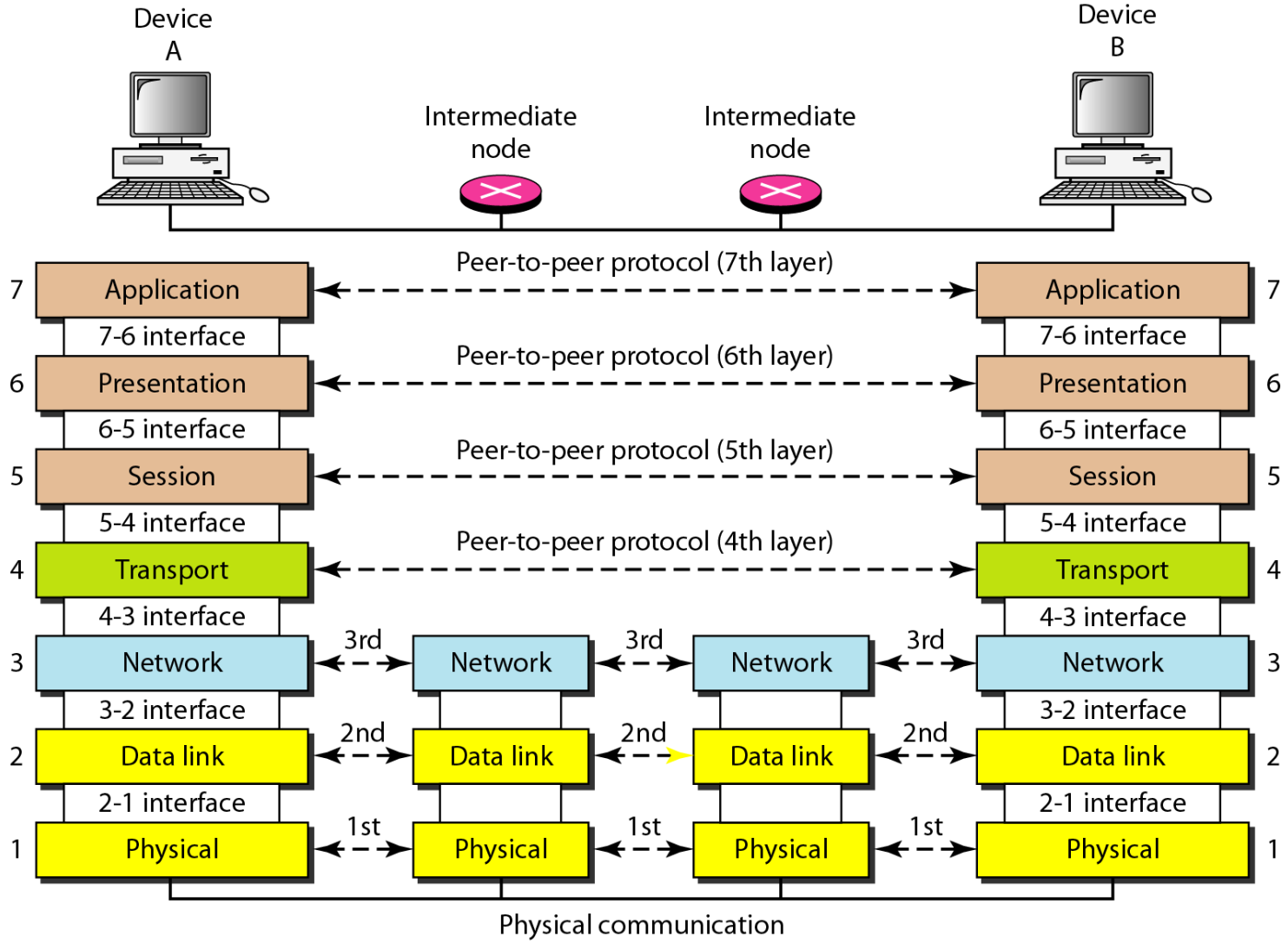
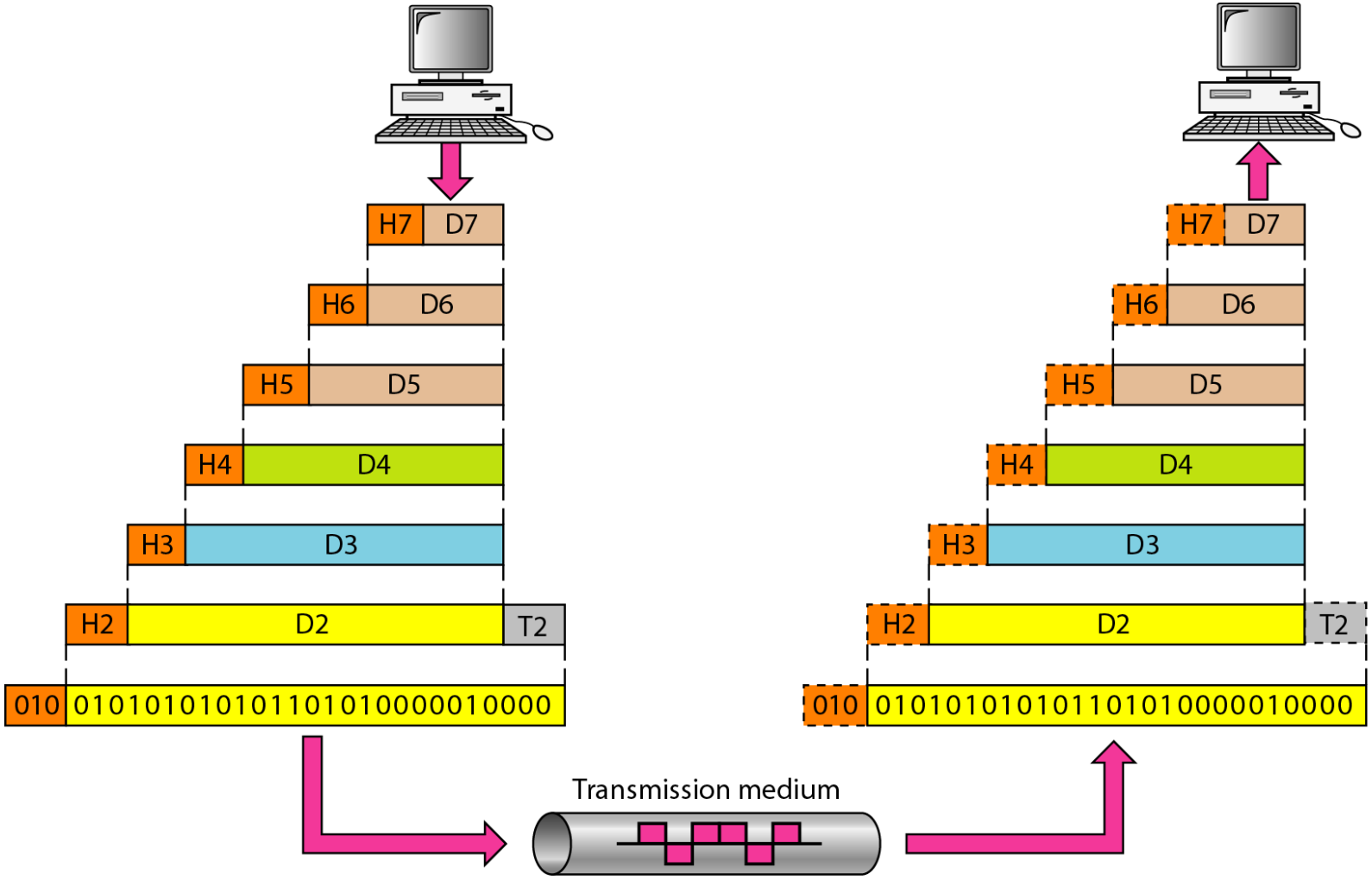


Figure 2.4 *An exchange using the OSI model*



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

Physical Layer:Layer 1

- Physical layer is the lowest layer of all. It is responsible for sending bits from one computer to another. This layer is not concerned with the meaning of the bits and deals with the physical connection to the network and with transmission.

- This layer defines electrical and physical details represented as 0 or a 1

Functions of Physical Layer:

- **Representation of Bits:** Data in this layer consists of stream of bits.

- **Data Rate:** This layer defines the rate of transmission which is the number of bits per second.

- **Synchronization:** It deals with the synchronization of the transmitter and receiver.

- **Interface:** The physical layer defines the transmission interface between **devices** and **transmission medium**.

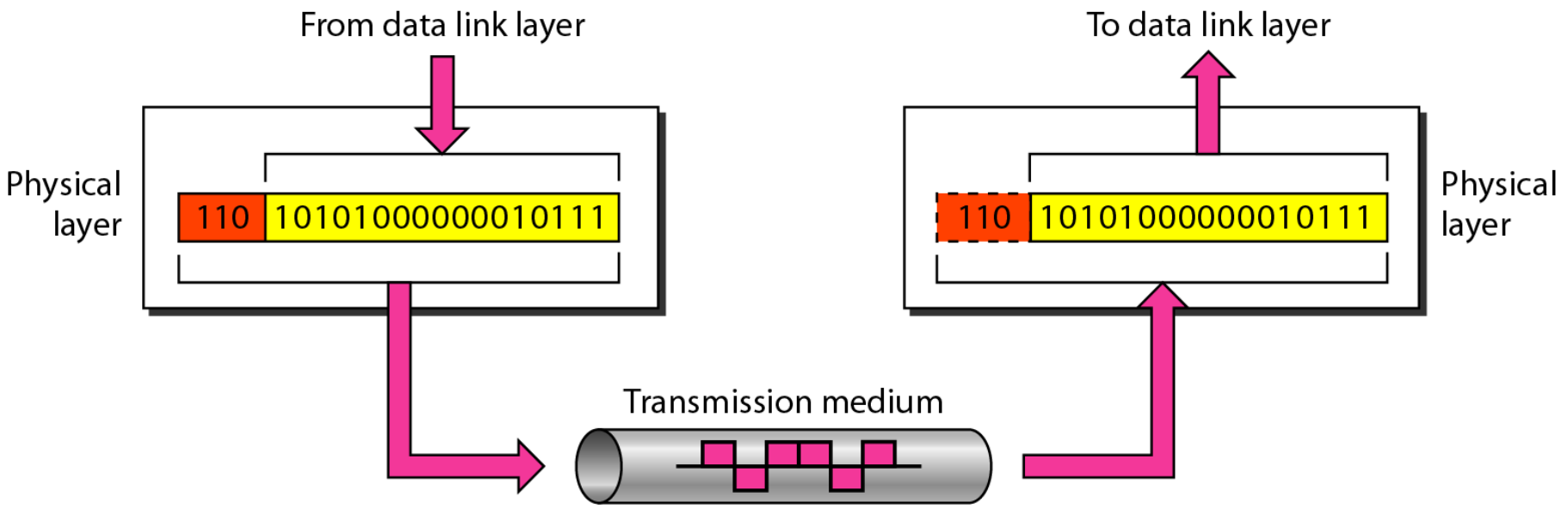
- **Line Configuration:** This layer connects devices with the medium: **Point to Point** configuration and **Multipoint** configuration.

- **Topologies:** Devices must be connected using the following topologies: **Mesh, Star, Ring and Bus.**

- **Transmission Modes:** Physical Layer defines the direction of transmission between two devices: **Simplex, Half Duplex, Full Duplex.**

- Deals with **baseband and broadband transmission.**

Figure 2.5 *Physical layer*



Note

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

Data Layer:Layer 2:

- Data link layer is most reliable node to node delivery of data. It forms frames from the packets that are received **from network layer** and gives it **to physical layer.**

- Error controlling is easily done. Error detection bits are used by the data link layer. It also corrects the errors.

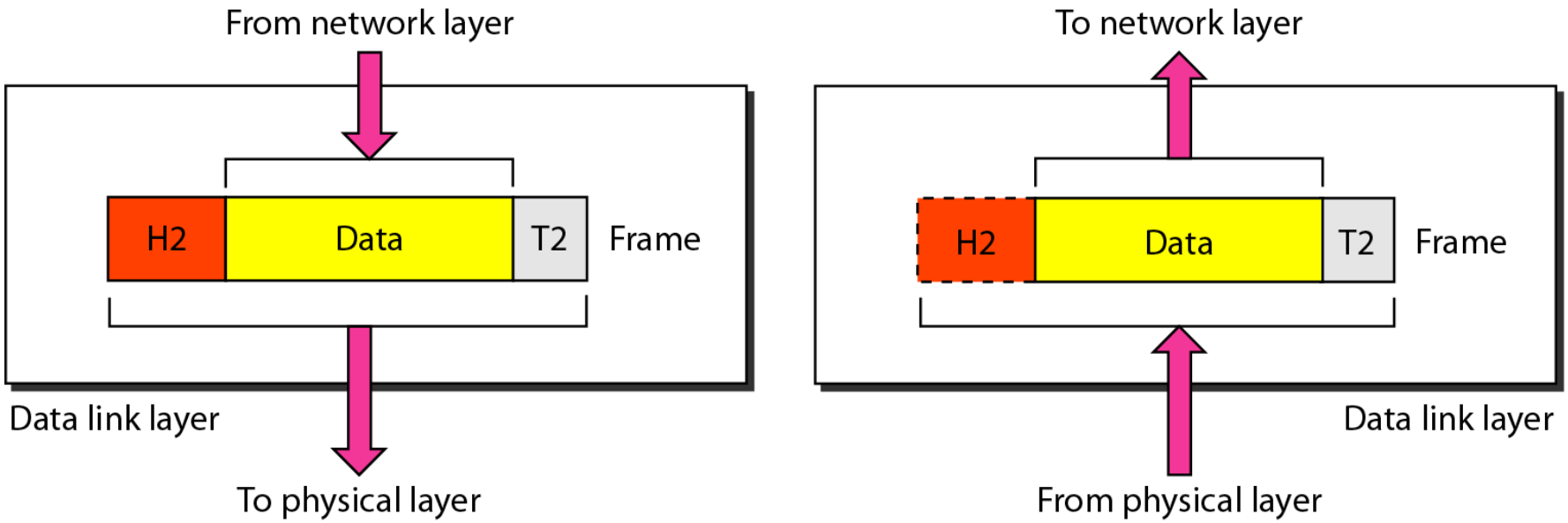
FUNCTIONS OF DATA LINK LAYER:

- **Framing:** Frames are the streams of bits received from the network layer into manageable data units.
- **Physical Addressing:** The Data Link layer adds a header to the frame in order to define physical address of the sender or receiver of the frame, if the frames are to be distributed to different systems on the network.

- **Flow Control:** A flow control mechanism to avoid a fast transmitter from running a slow receiver by buffering the extra bit is provided by flow control. This prevents traffic jam at the receiver side.
- **Error Control:** Error control is achieved by adding a trailer at the end of the frame. Duplication of frames are also prevented by using this mechanism

- **Access Control:** Protocols of this layer determine which of the devices has control over the link at any given time.

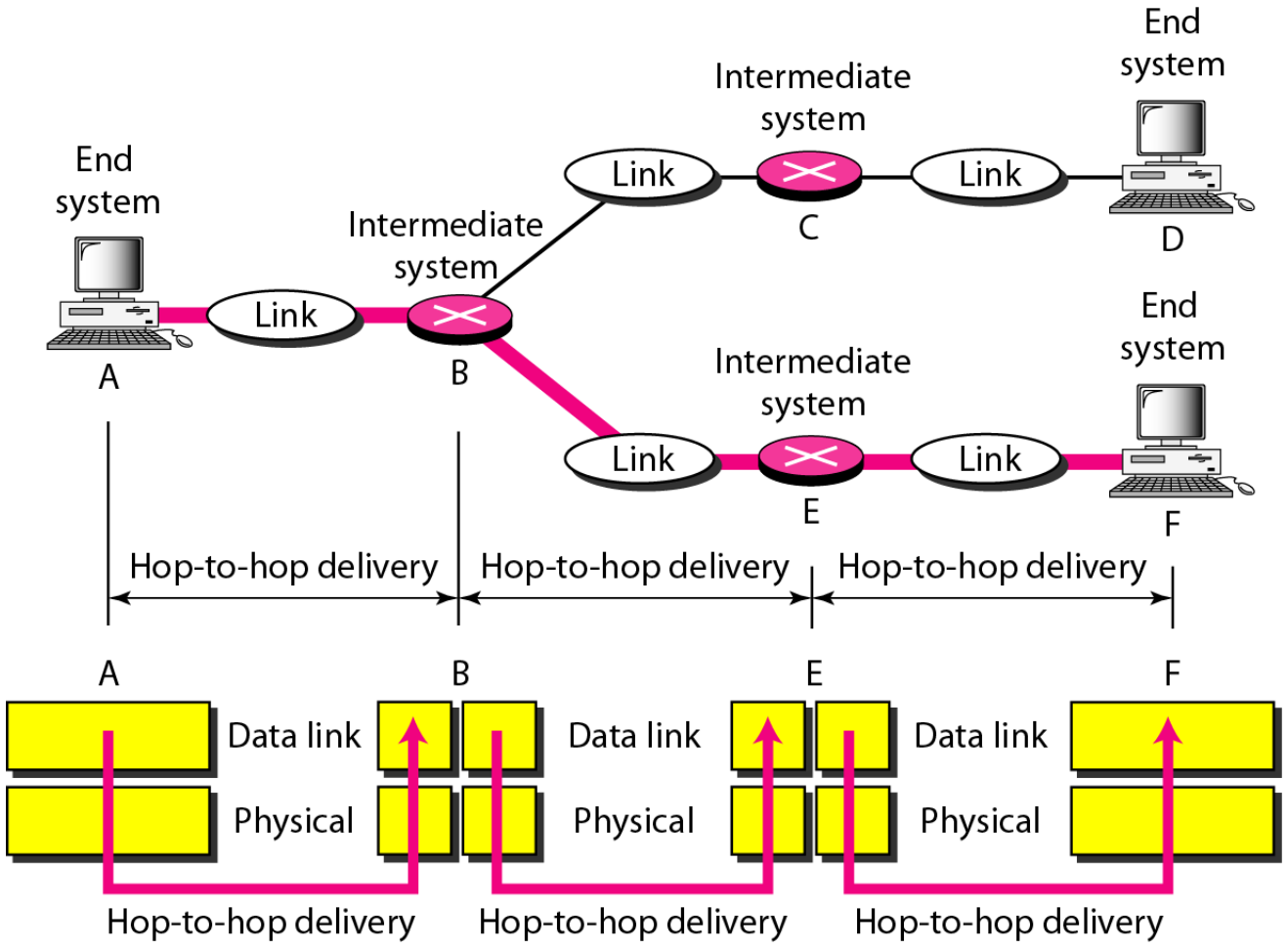
Figure 2.6 *Data link layer*



Note

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

Figure 2.7 *Hop-to-hop delivery*



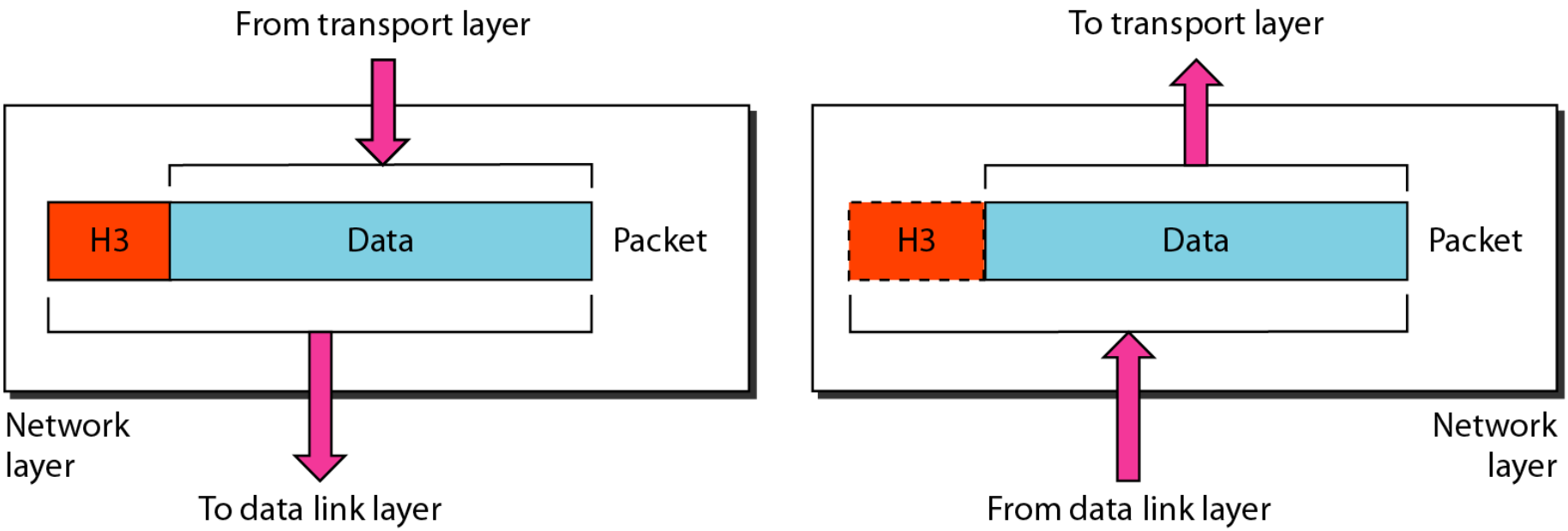
Layer 3: The Network Layer :

- It routes the signal through different channels from one node to other.
- It acts as a network controller. It manages the Subnet traffic.It decides by which route data should take.
- It divides the outgoing messages into **packets.**

Functions of Network Layer:Layer 3

- It translates logical network address into physical address.
- Routers and gateways operate in the network layer. Mechanism is provided by Network Layer for routing the packets to final destination.
- Connection services are provided.
- Breaks larger packets into small packets.

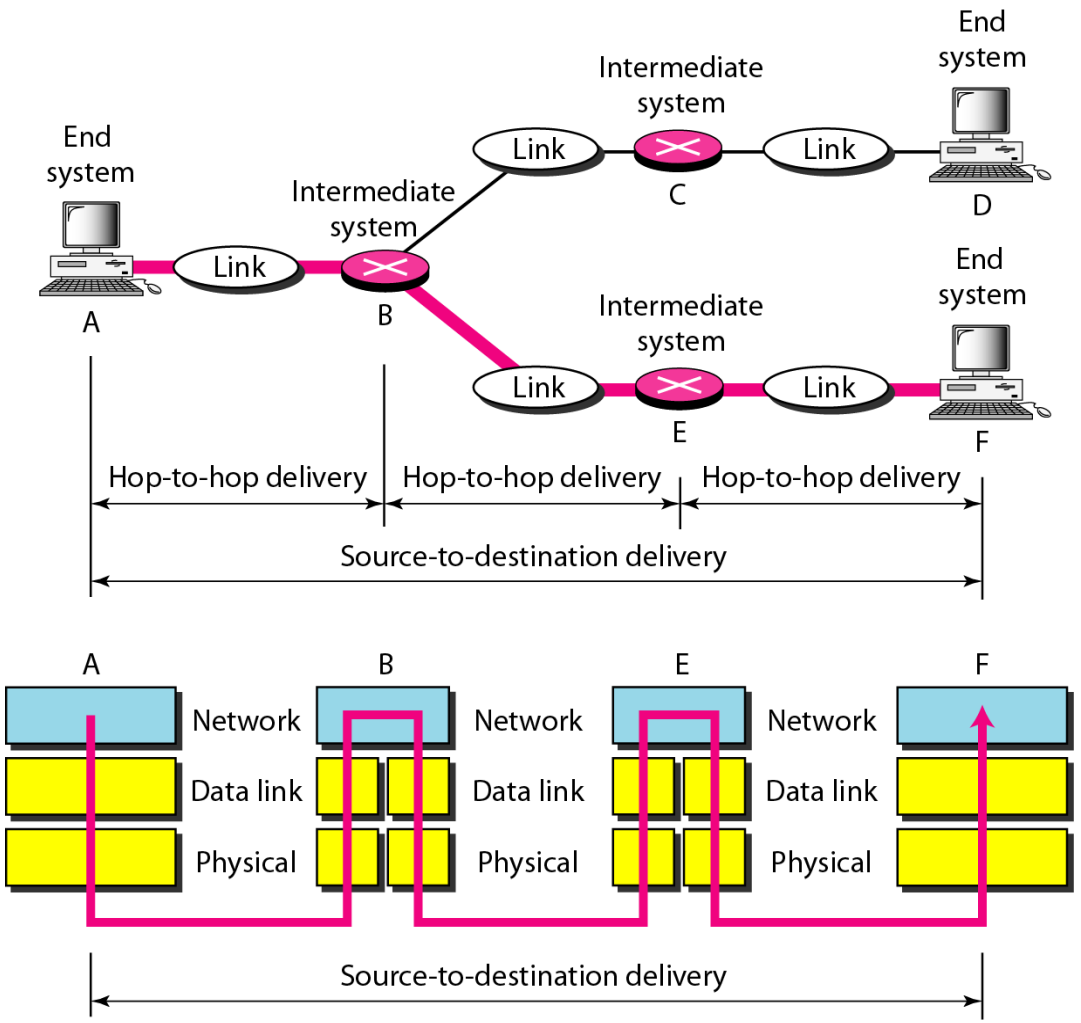
Figure 2.8 *Network layer*



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*



Layer 4:Transport Layer

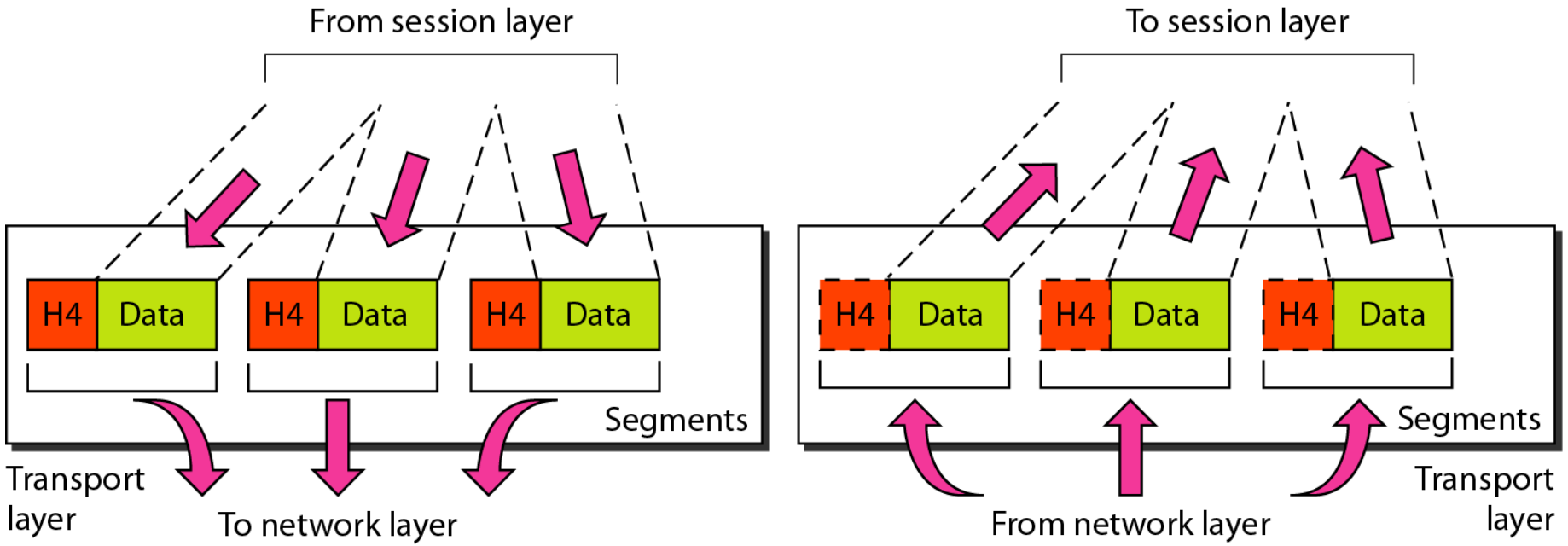
- It decides if data transmission should be on parallel path or single path.
- It receives messages from the Session layer above it, convert the message into smaller units and passes it on to the Network layer.
- Transport layer breaks the message (data) into small **units** so that they are handled more efficiently by the network layer.

Function of Transport Layer:Layer 4

- **Service Point Addressing :** Transport Layer header includes service point address which is port address.
- **Segmentation and Reassembling :** A message is divided into segments; each segment contains sequence number, which enables this layer in reassembling the message.

- **Flow Control :** In this layer, flow control is performed end to end.
- **Error Control :** Error Control is performed end to end in this layer to ensure that the complete message arrives at the receiving transport layer without any error. Error Correction is done through retransmission.

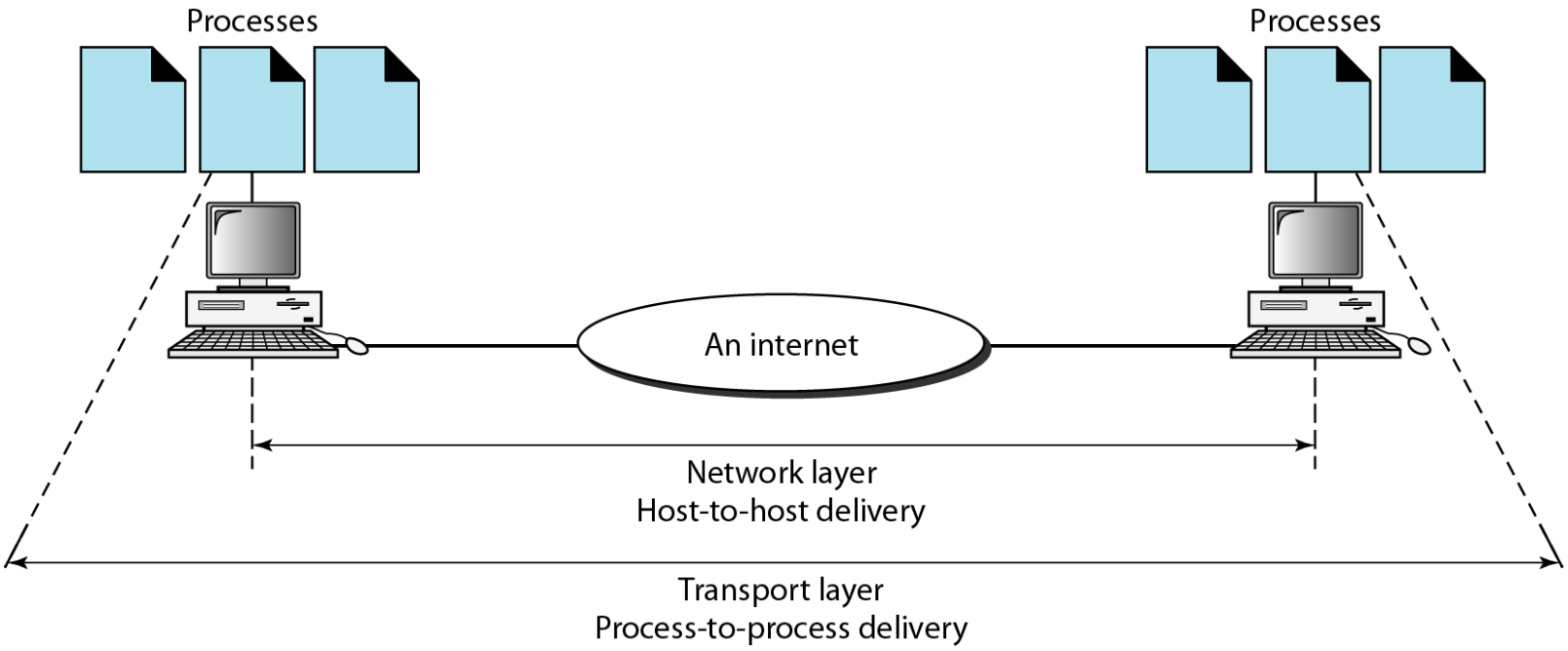
Figure 2.10 *Transport layer*



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*



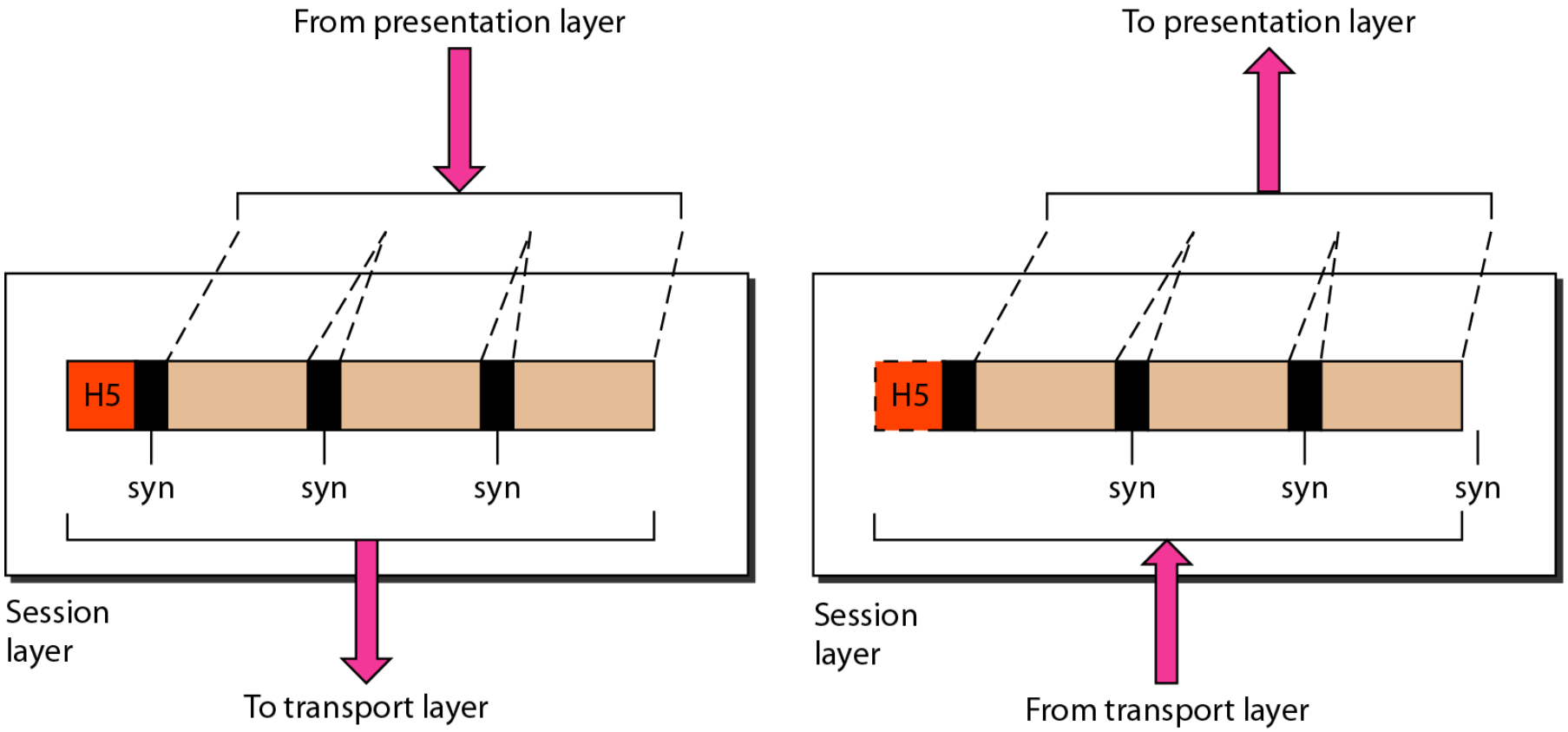
Layer 5: The Session Layer :

- Session layer manages and synchronize the conversation between two different applications.
- Transfer of data from source to destination session layer streams of data are marked and are resynchronized properly, so that the ends of the messages are not cut and data loss is avoided.

Functions of Session Layer:Layer 5

- **Dialog Control :** This layer allows two systems to start communication with each other in half-duplex or full-duplex.
- **Synchronization :** This layer allows a process to add checkpoints which are considered as synchronization points into stream of data.

Figure 2.12 *Session layer*



Note

The session layer is responsible for dialog control and synchronization.

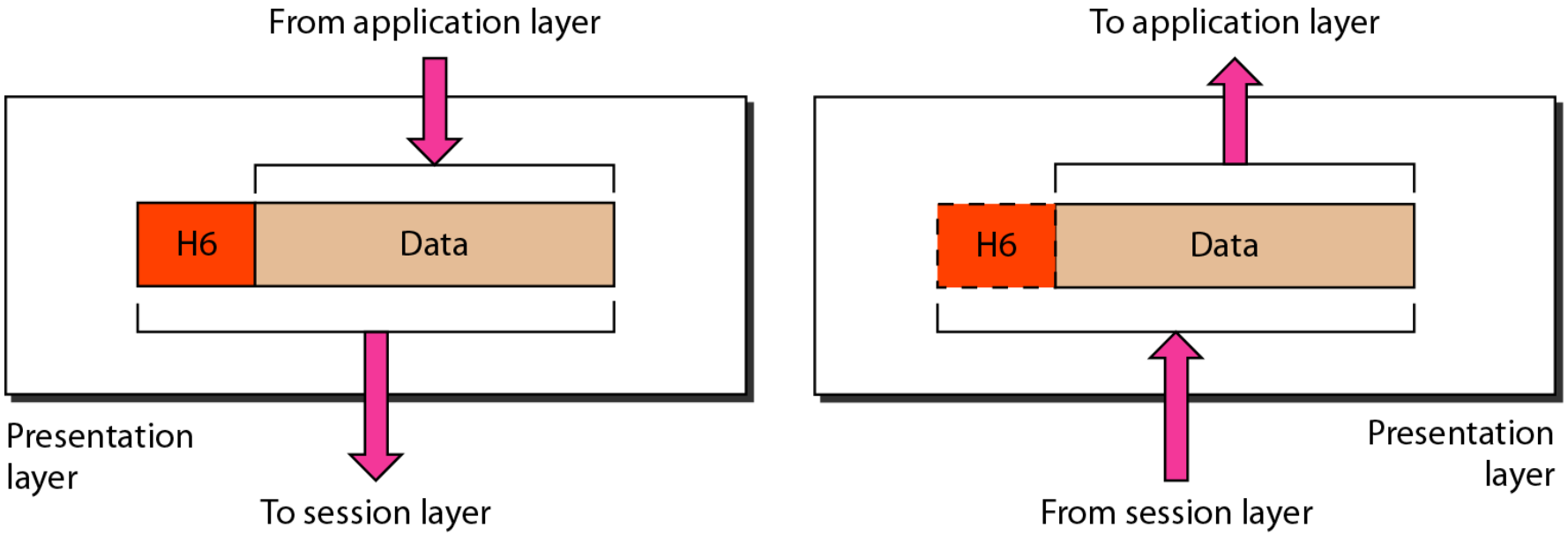
Layer 6: The Presentation Layer :

- The primary goal of this layer is to take care of the syntax and semantics of the information exchanged between two communicating systems.
- Presentation layer takes care that the data is sent in such a way that the receiver will understand the information (data) and will be able to use the data.

Functions of Presentation Layer:Layer 6

- **Translation :** Before being transmitted, information in the form of characters and numbers should be changed to bit streams.
- **Encryption :** It carries out encryption at the transmitter and decryption at the receiver.
- **Compression :** It carries out data compression to reduce the bandwidth of the data to be transmitted. It is important in transmitting multimedia such as audio, video, text etc.

Figure 2.13 *Presentation layer*



Note

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

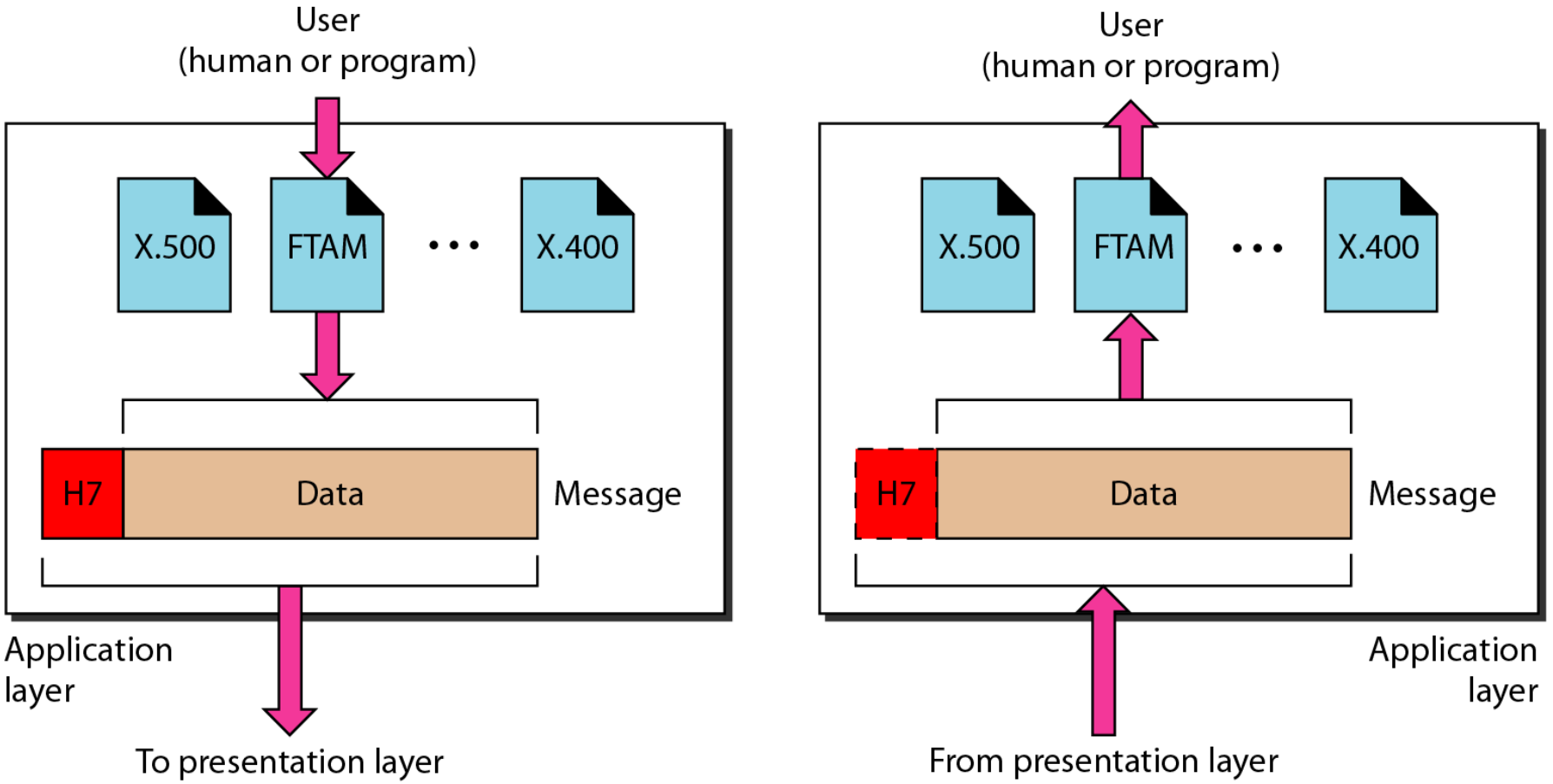
Layer 7: Application Layer :

- It is the topmost layer.
- Transferring of files disturbing the results to the user is also done in this layer. Mail services, directory services, network resource etc are services provided by application layer.
- This layer mainly holds application programs to act upon the received and to be sent data.

Functions of Application Layer:Layer 7

- **Mail Services :** This layer provides the basis for E-mail forwarding and storage.
- **Directory Services :** This layer provides access for global information about various services.
- **File Transfer, Access and Management (FTAM) :** It is a standard mechanism to access files and manages it.

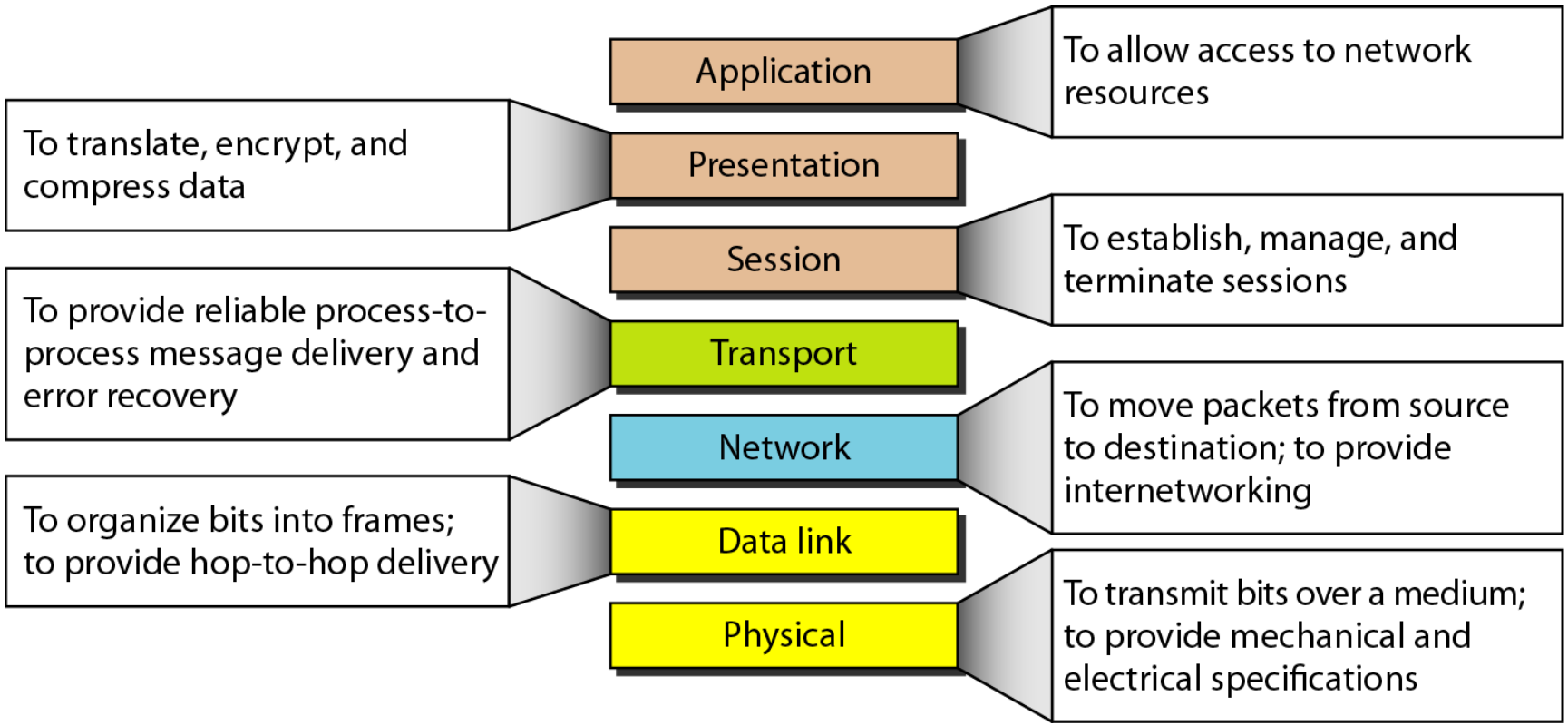
Figure 2.14 *Application layer*



Note

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

Figure 2.15 *Summary of layers*



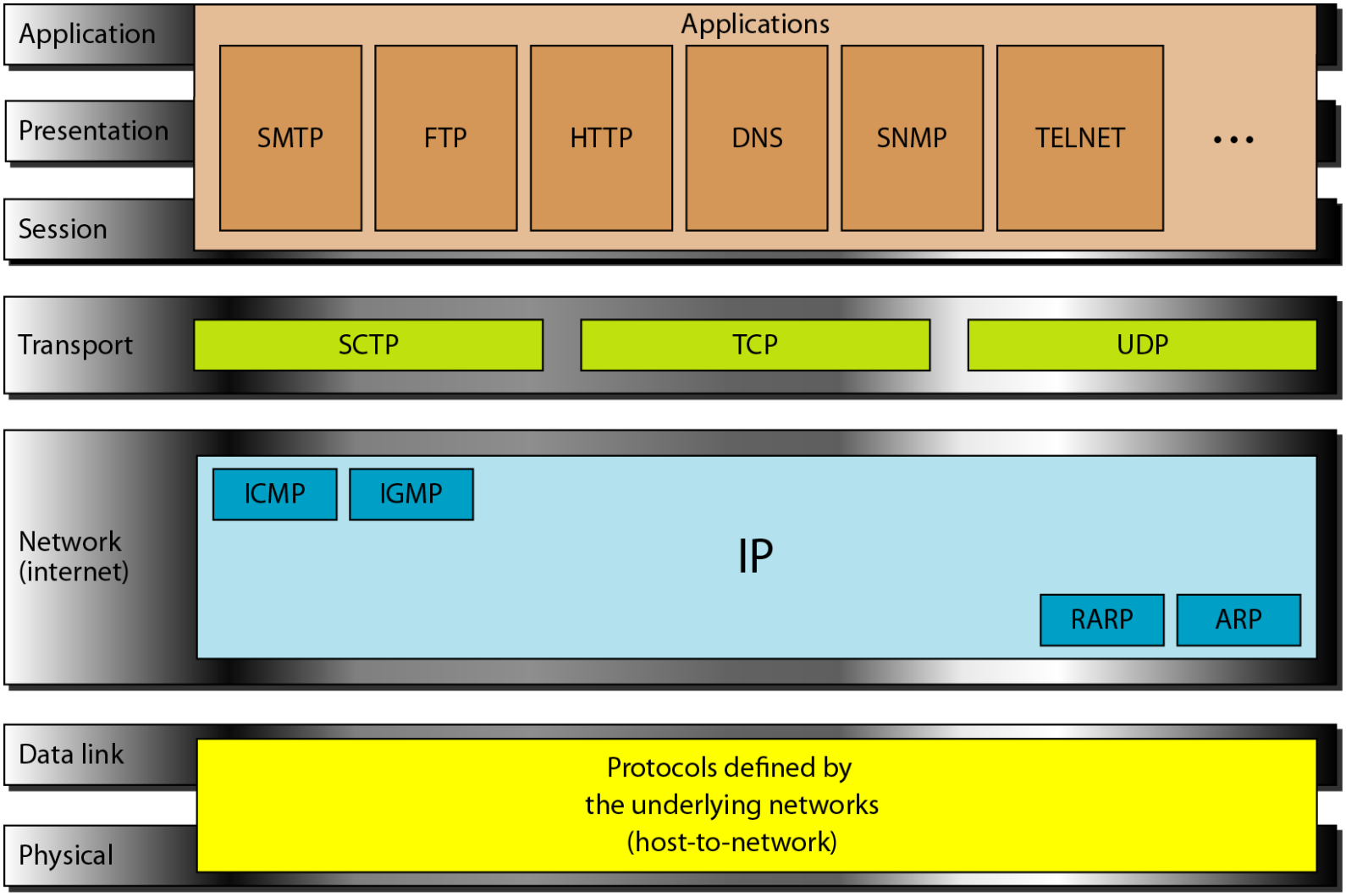
2-4 TCP/IP PROTOCOL SUITE

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*

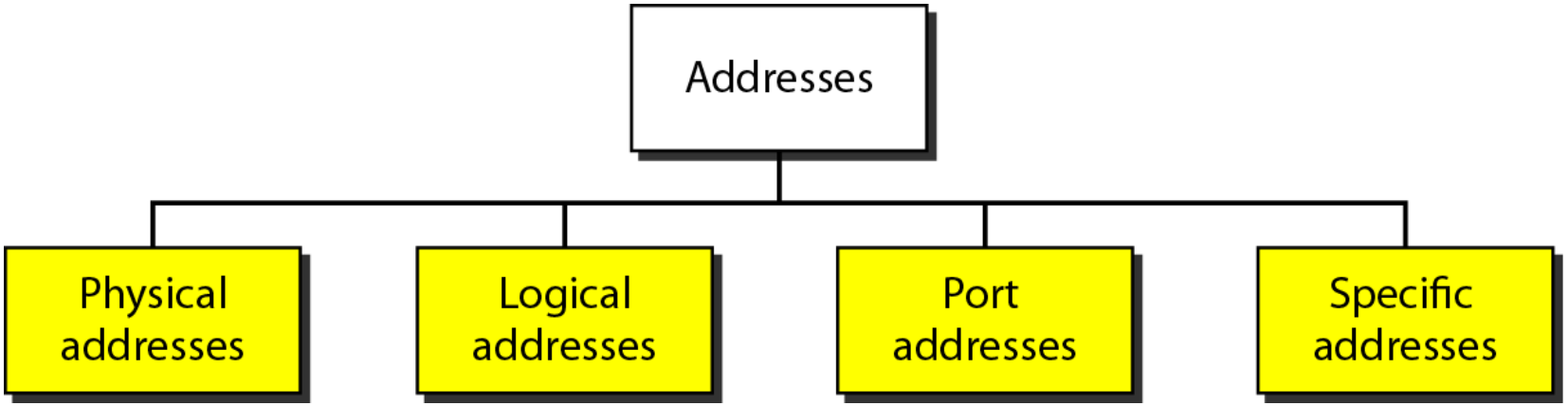


Figure 2.18 *Relationship of layers and addresses in TCP/IP*

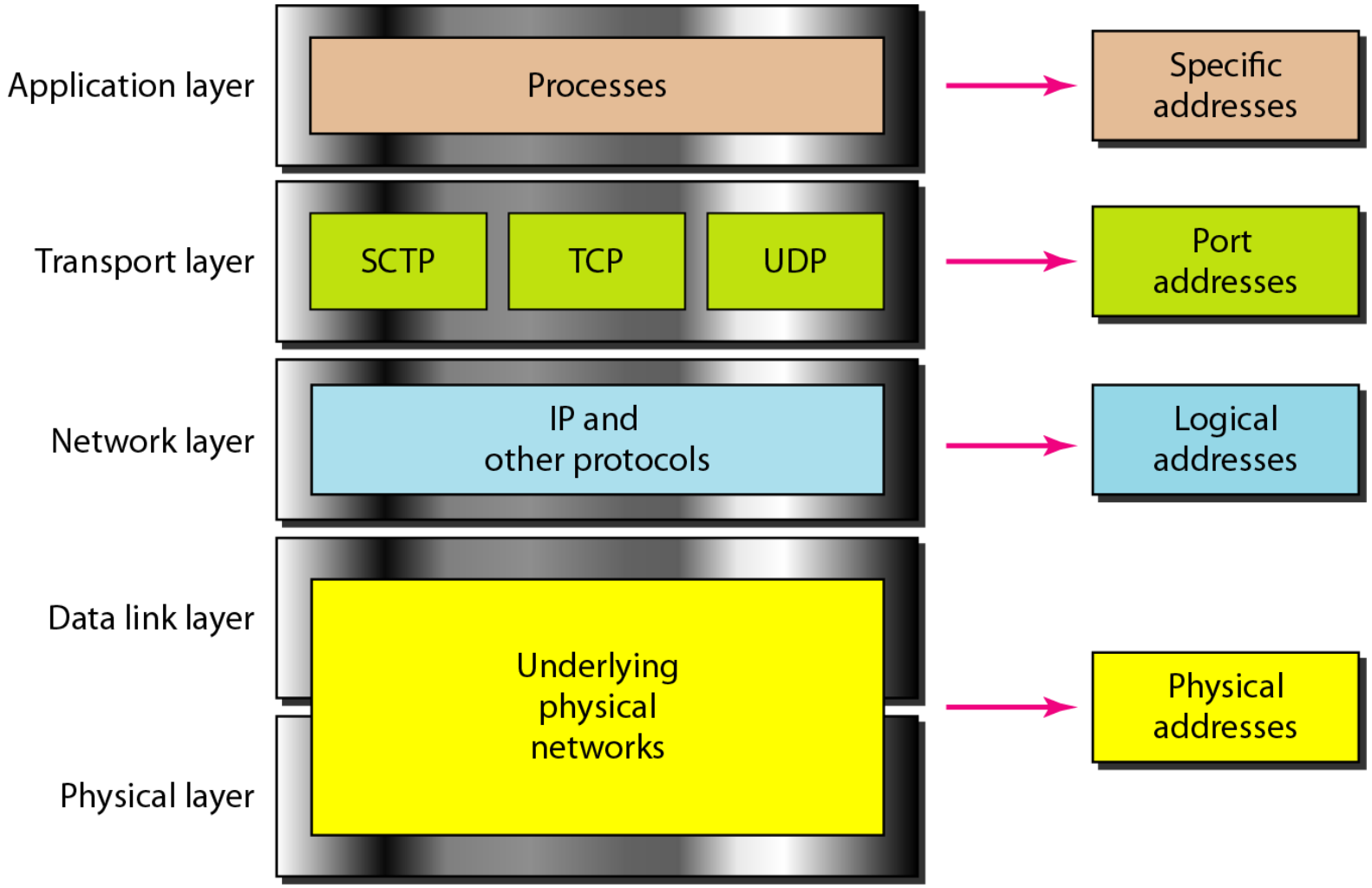


Figure 2.19 *Physical addresses*

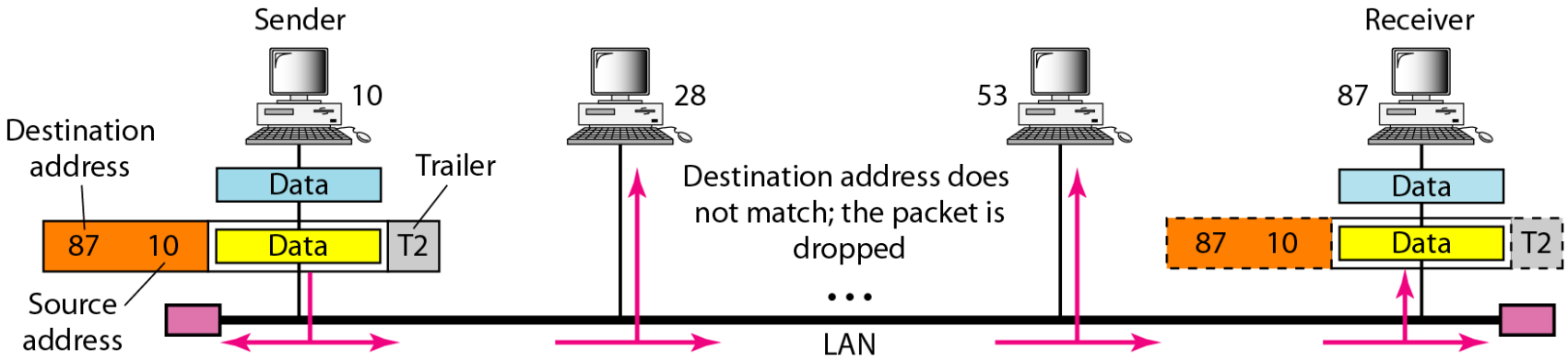


Figure 2.20 *IP addresses*

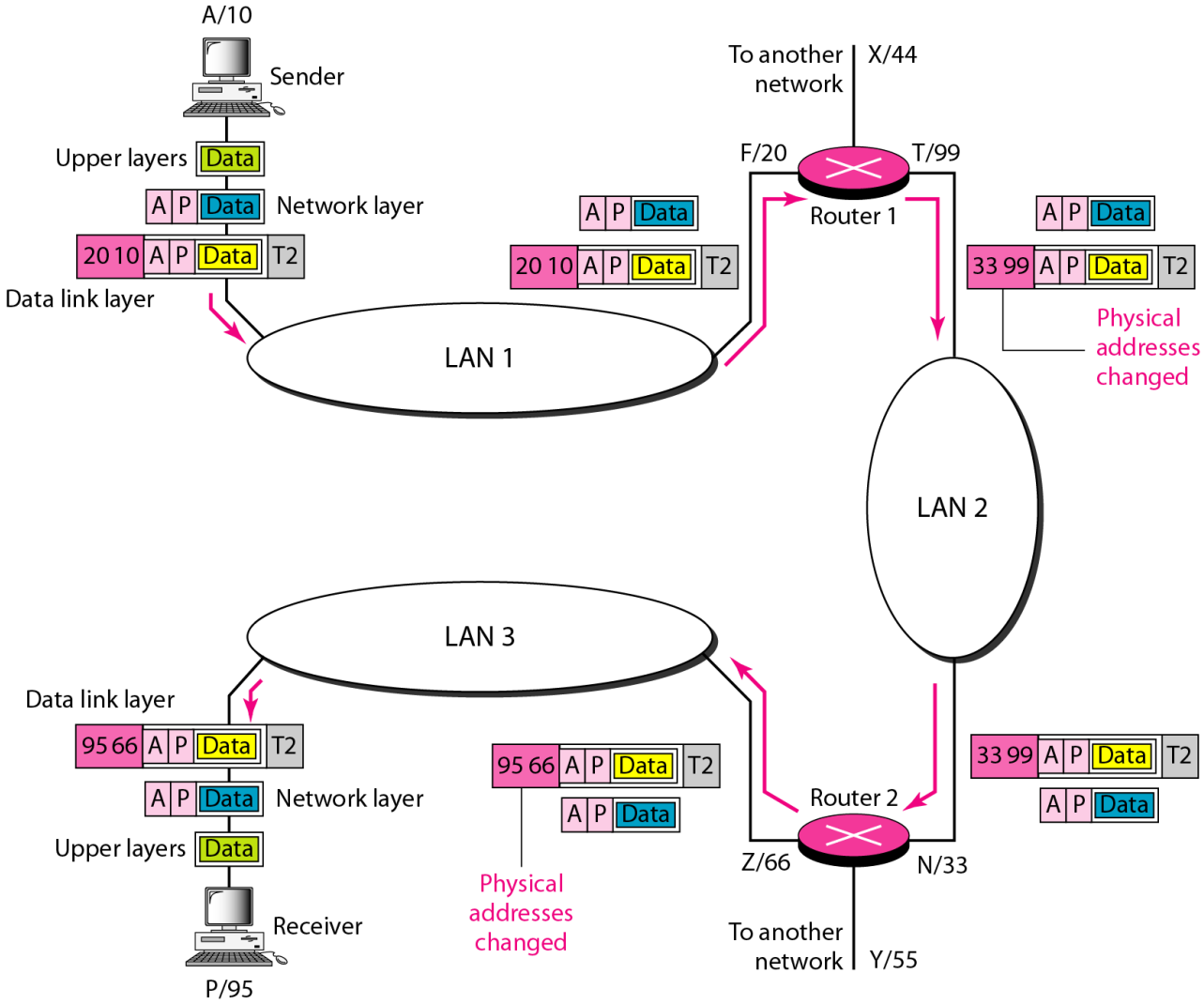
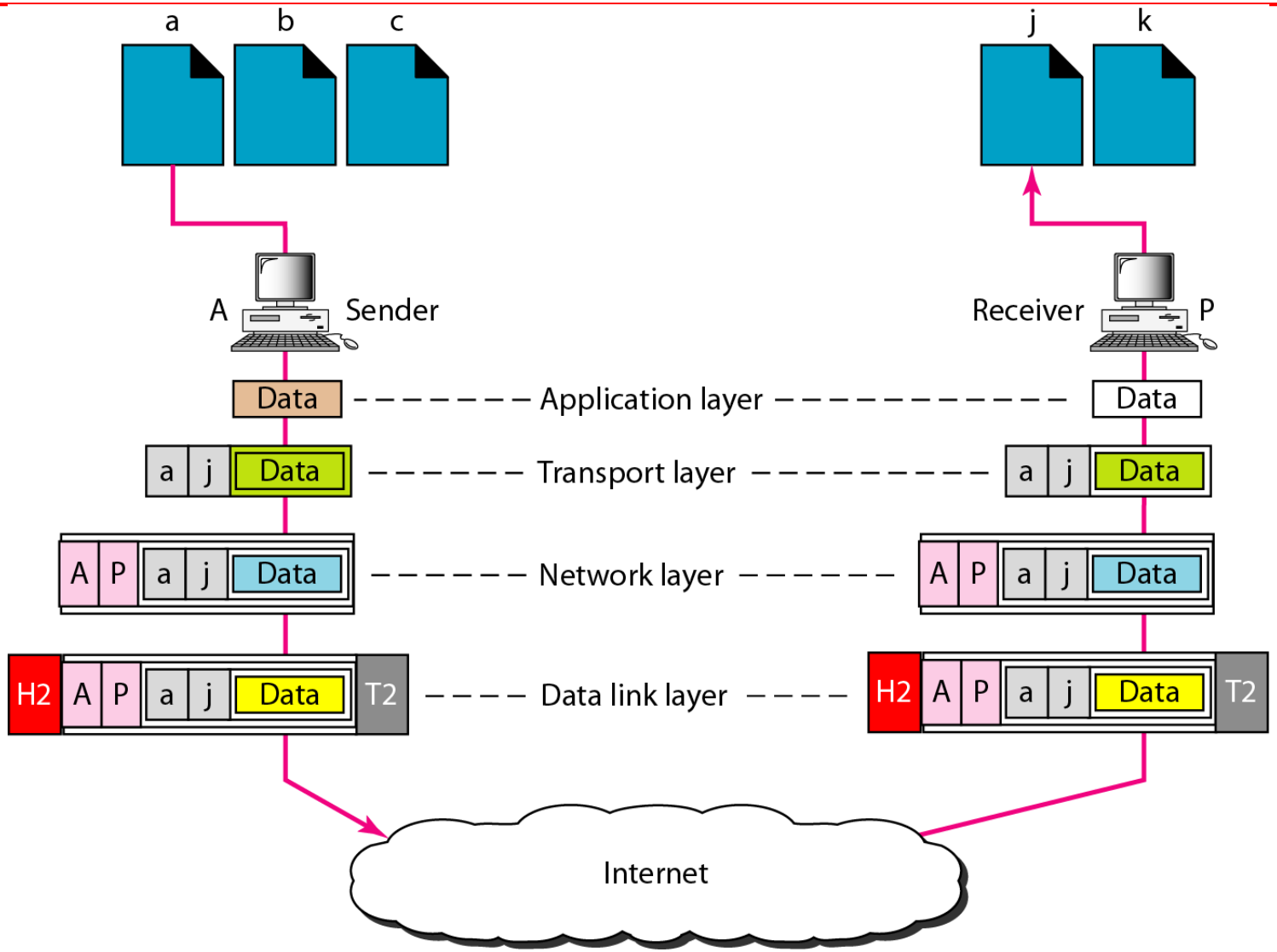


Figure 2.21 *Port addresses*



Note

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

Note

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