Chapter 2

Network Models

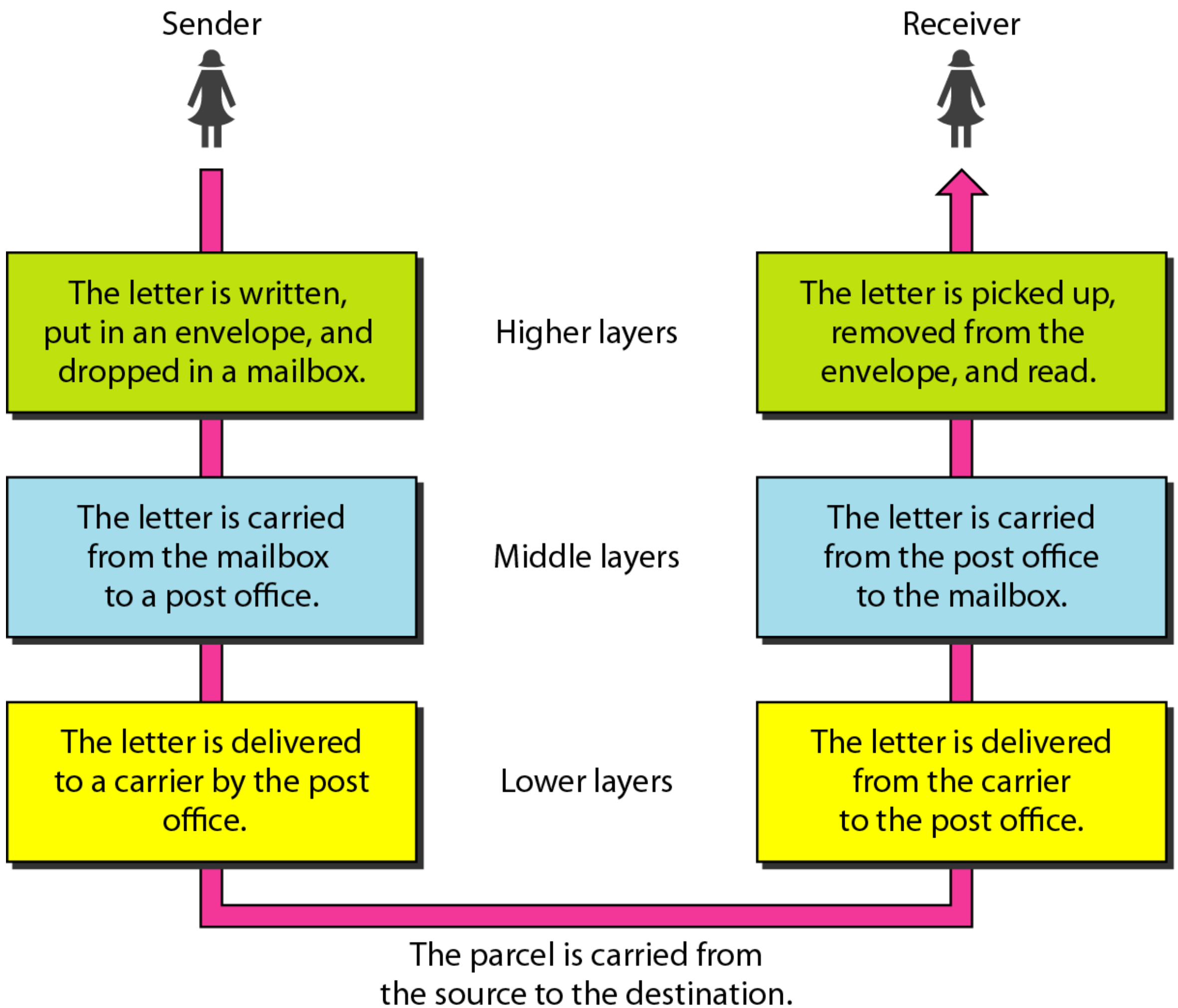
2-1 LAYERED TASKS

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

An open system is a set of protocols that allows any two different systems to communicate regardless of their underlying architecture.

Note

ISO is the organization.
OSI is the model (not a protocol) for understanding and designing a network architecture that is flexible, robust, and interoperable.

Figure 2.2 *Seven layers of the OSI model*

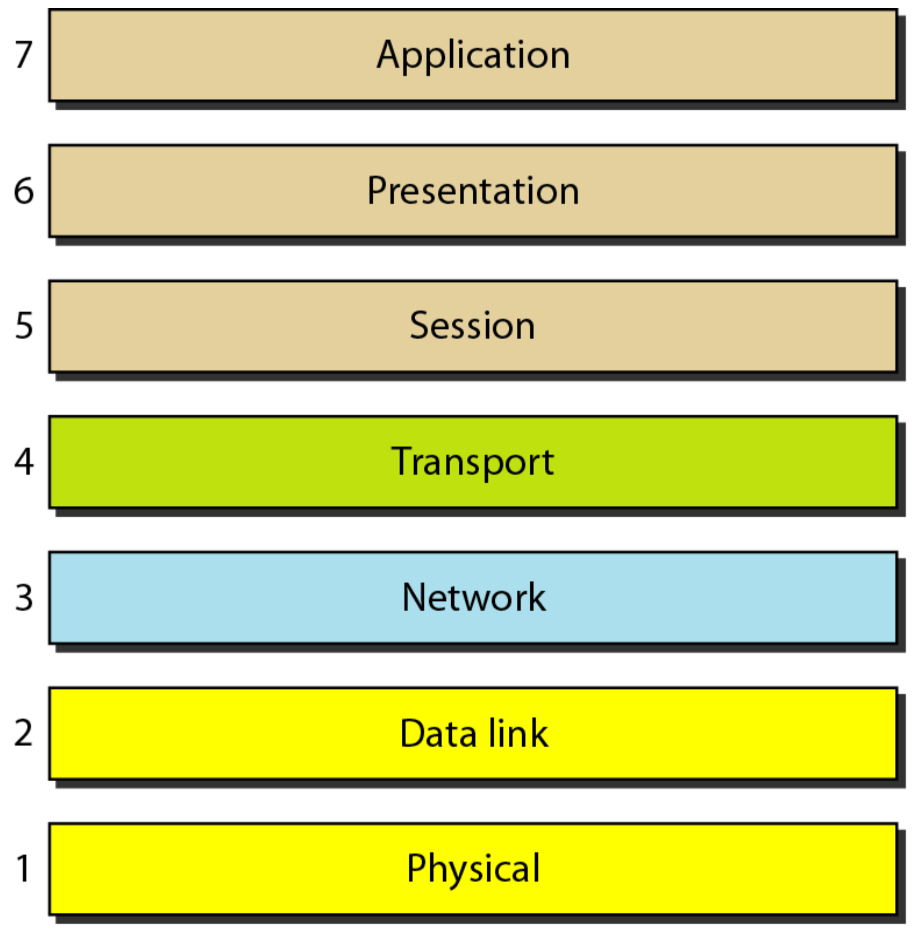


Figure 2.3 *The interaction between layers in the OSI model*

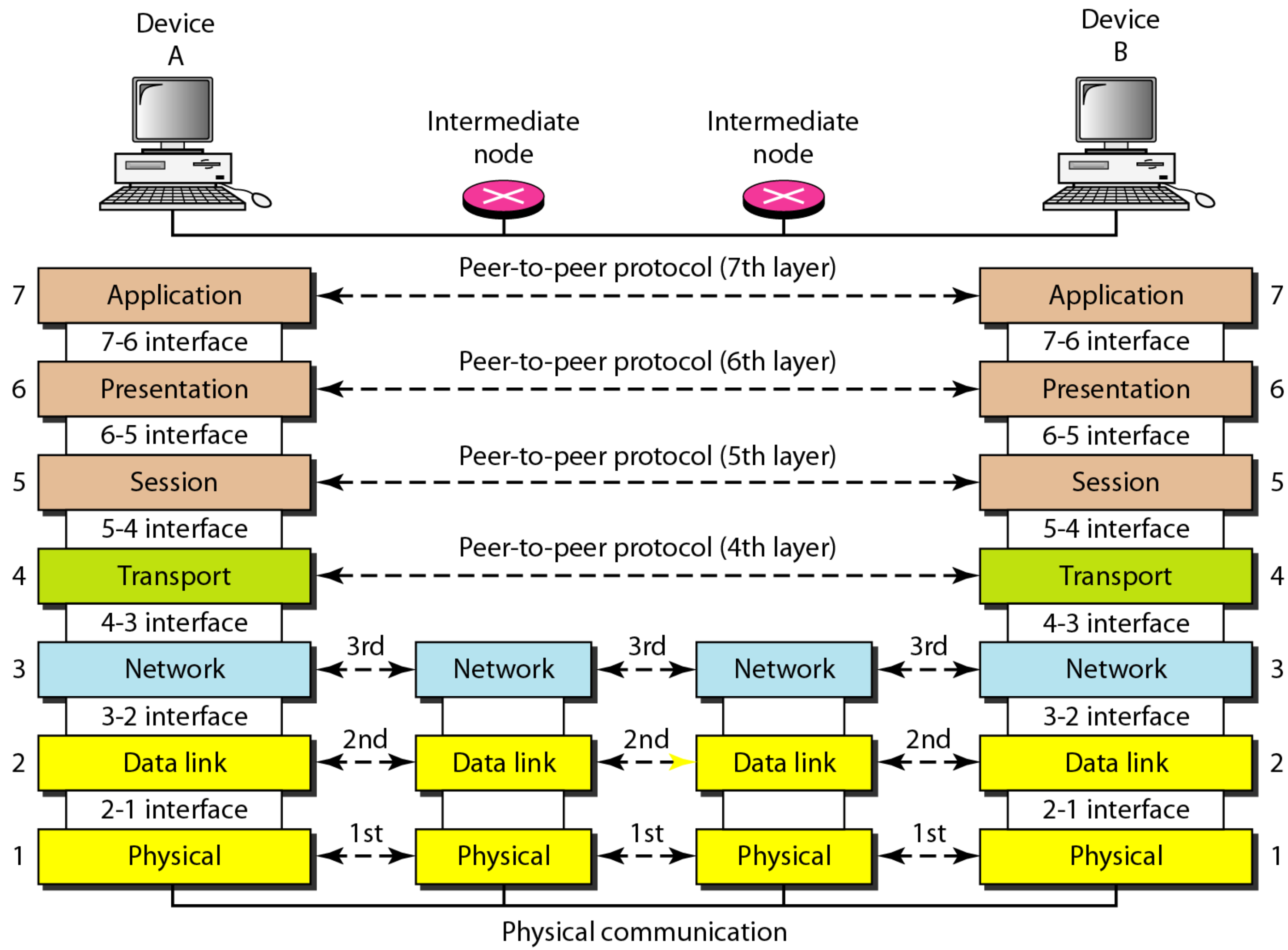
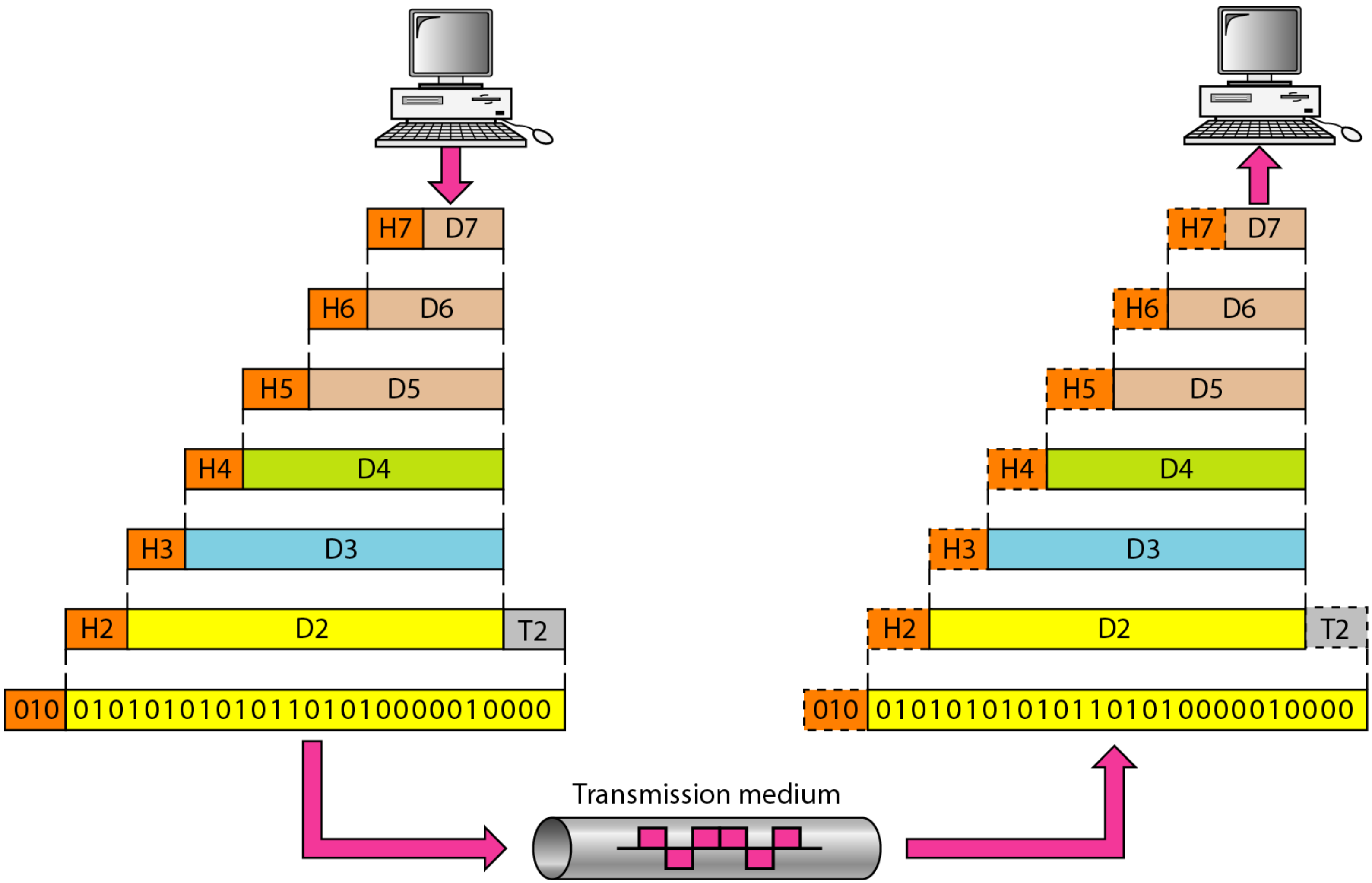


Figure 2.4 *An exchange using the OSI model*



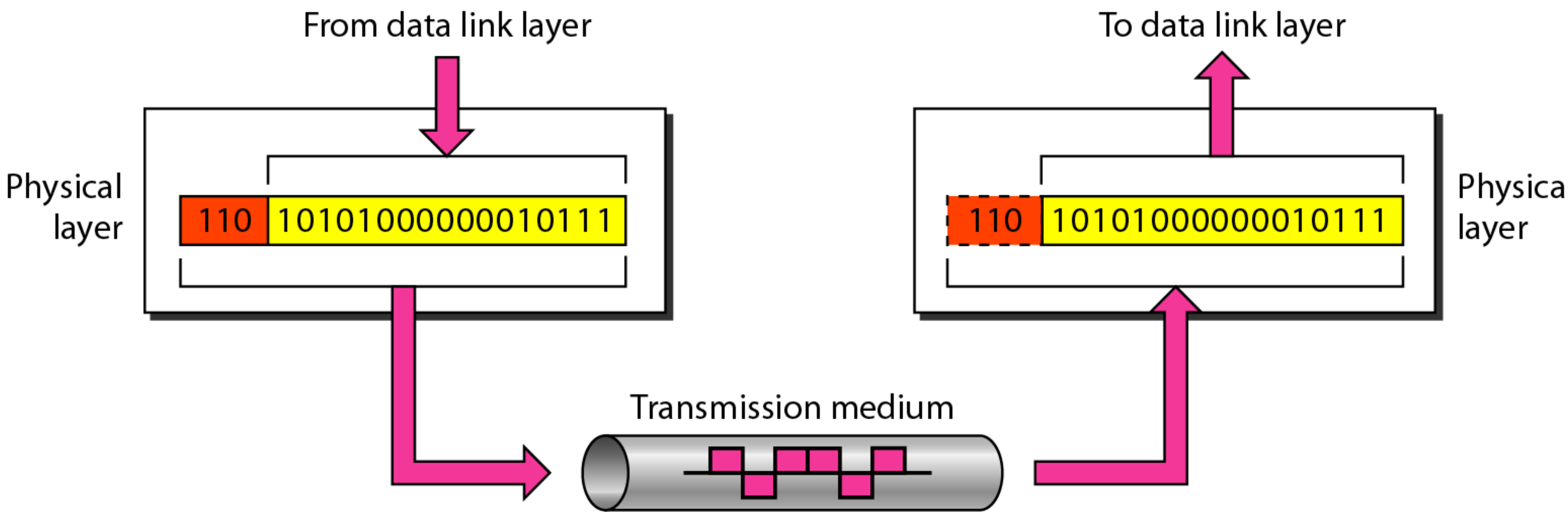
2-3 LAYERS IN THE OSI MODEL

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*



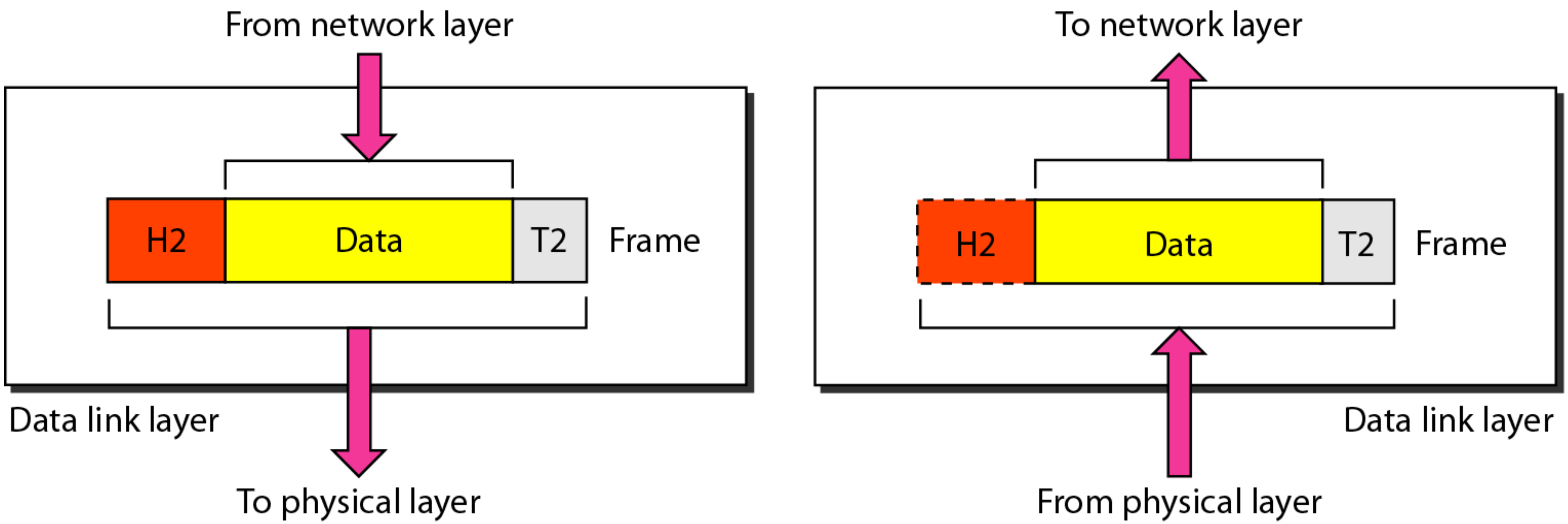
Note

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

Also concern

- Physical characteristics of interfaces and medium
- Representation of bits
- Data rate
- Synchronization of bits
- Line configurations
- Physical topology
- Transmission mode

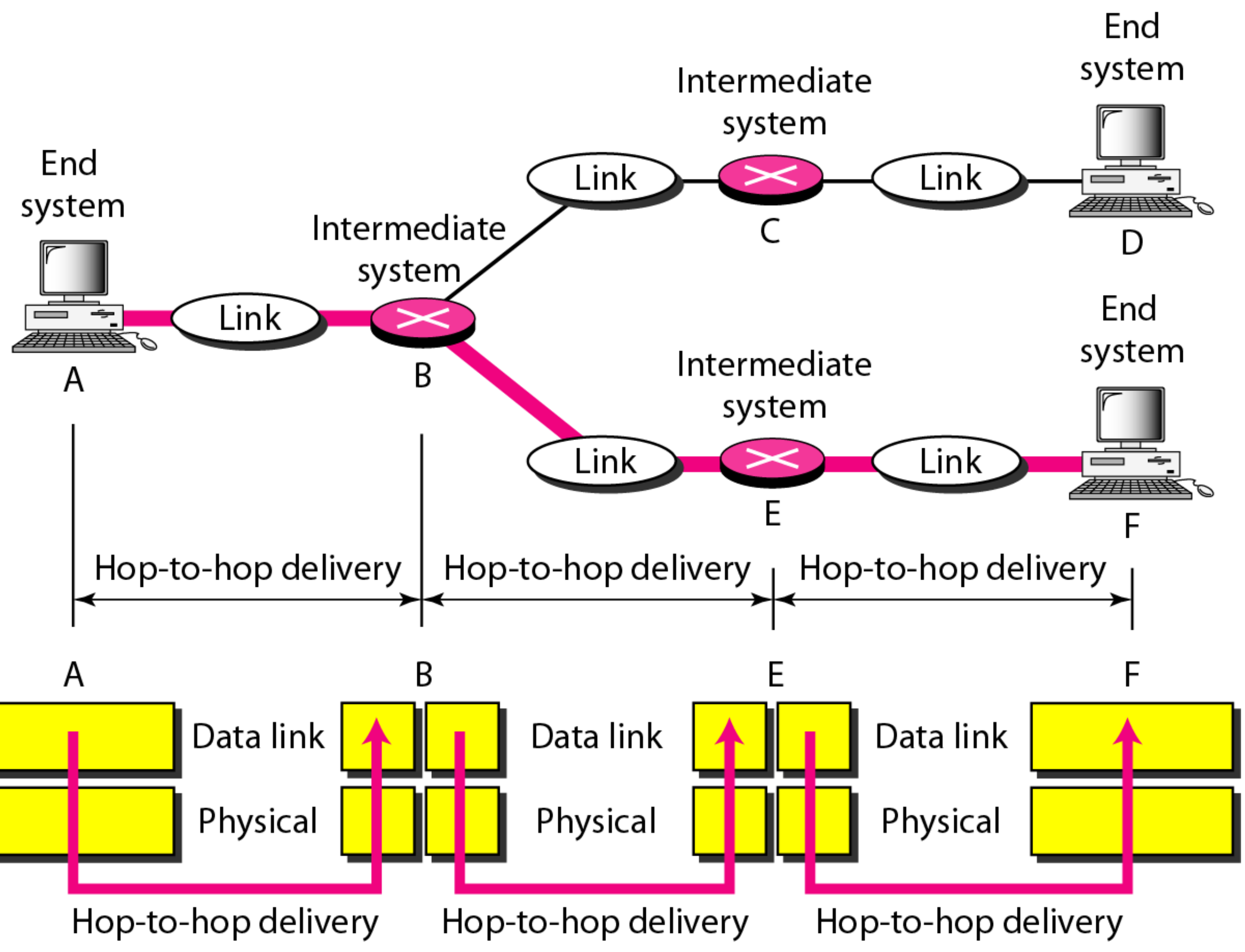
Figure 2.6 *Data link layer*



Note

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

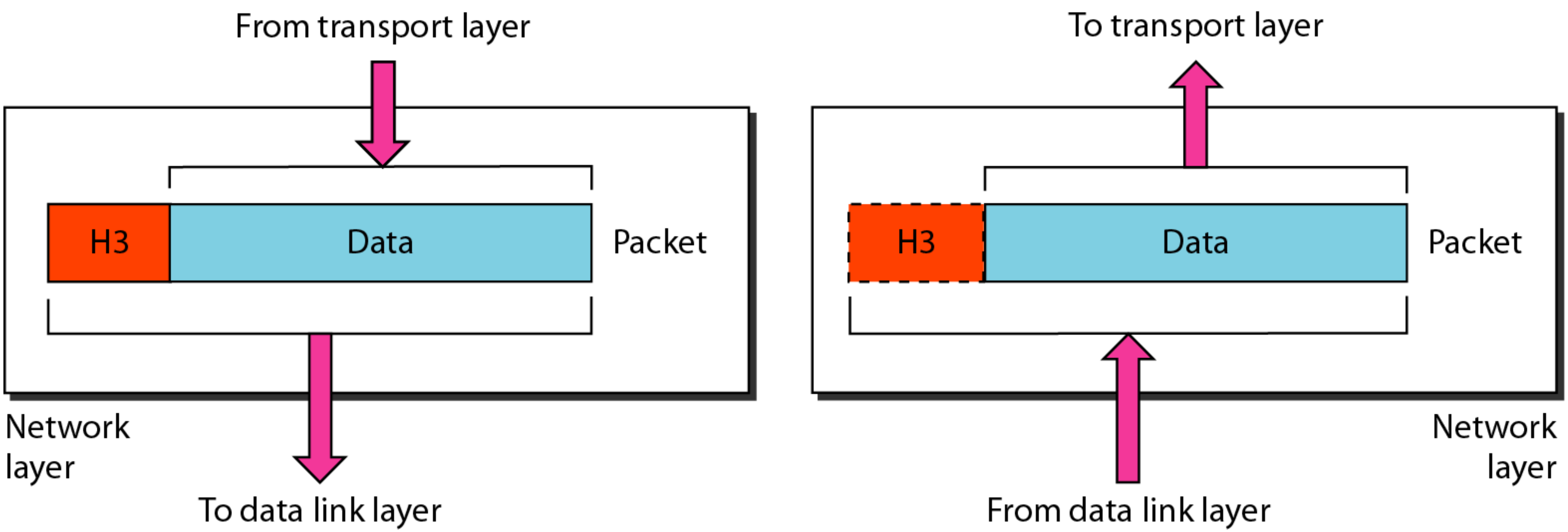
Figure 2.7 *Hop-to-hop delivery*



Other responsibilities

- Framing
- Physical addressing
- Flow control
- Error control
- Access control

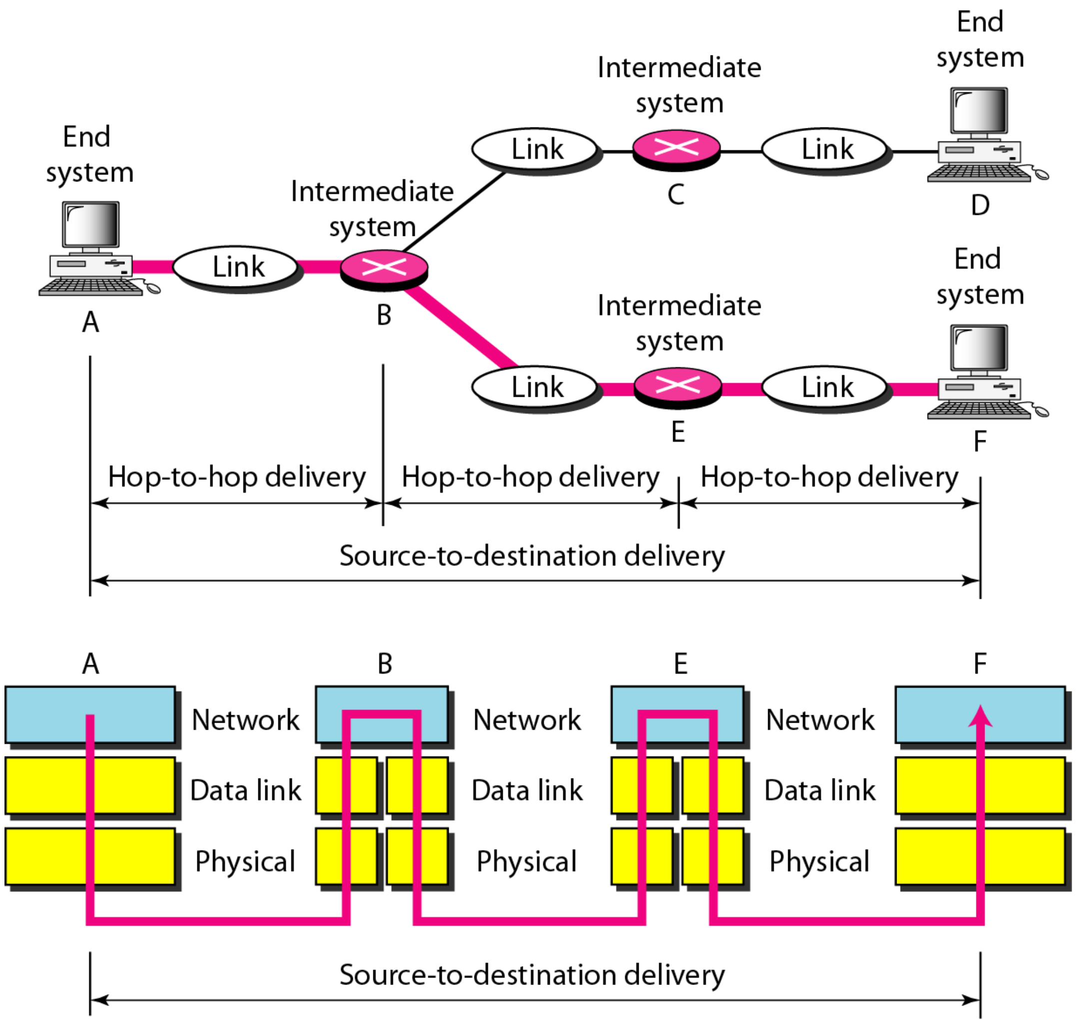
Figure 2.8 *Network layer*



Note

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

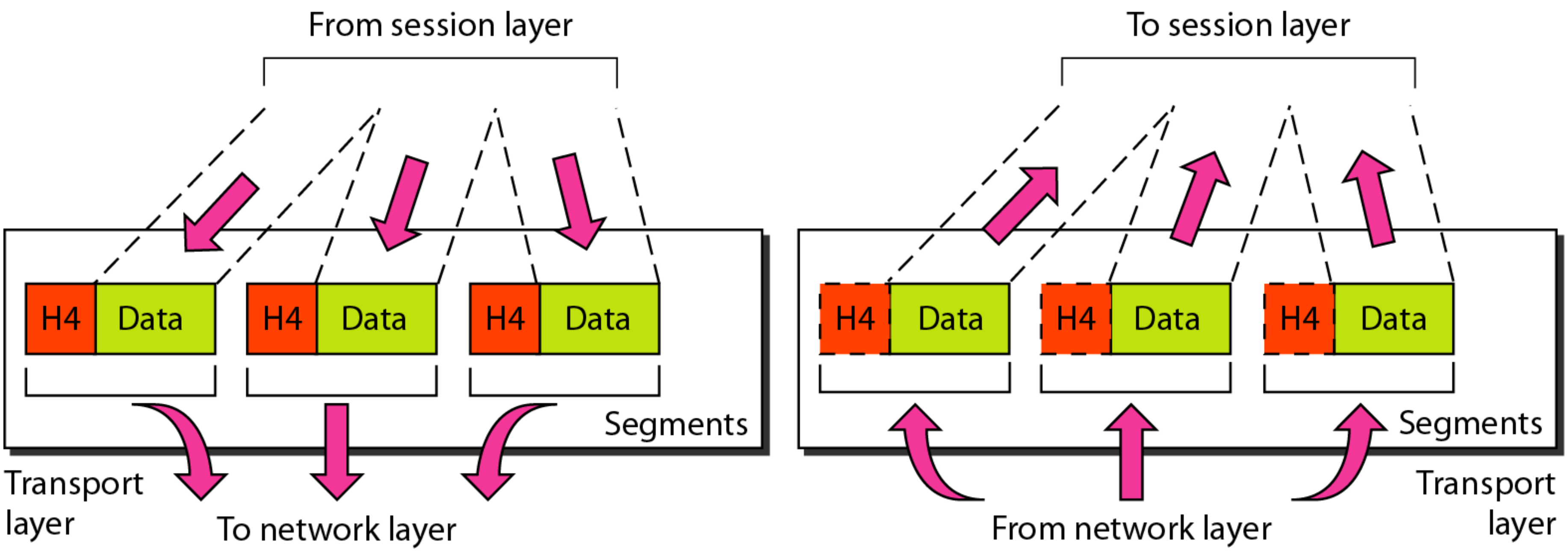
Figure 2.9 *Source-to-destination delivery*



Other responsibilities

- Logical addressing
- Routing

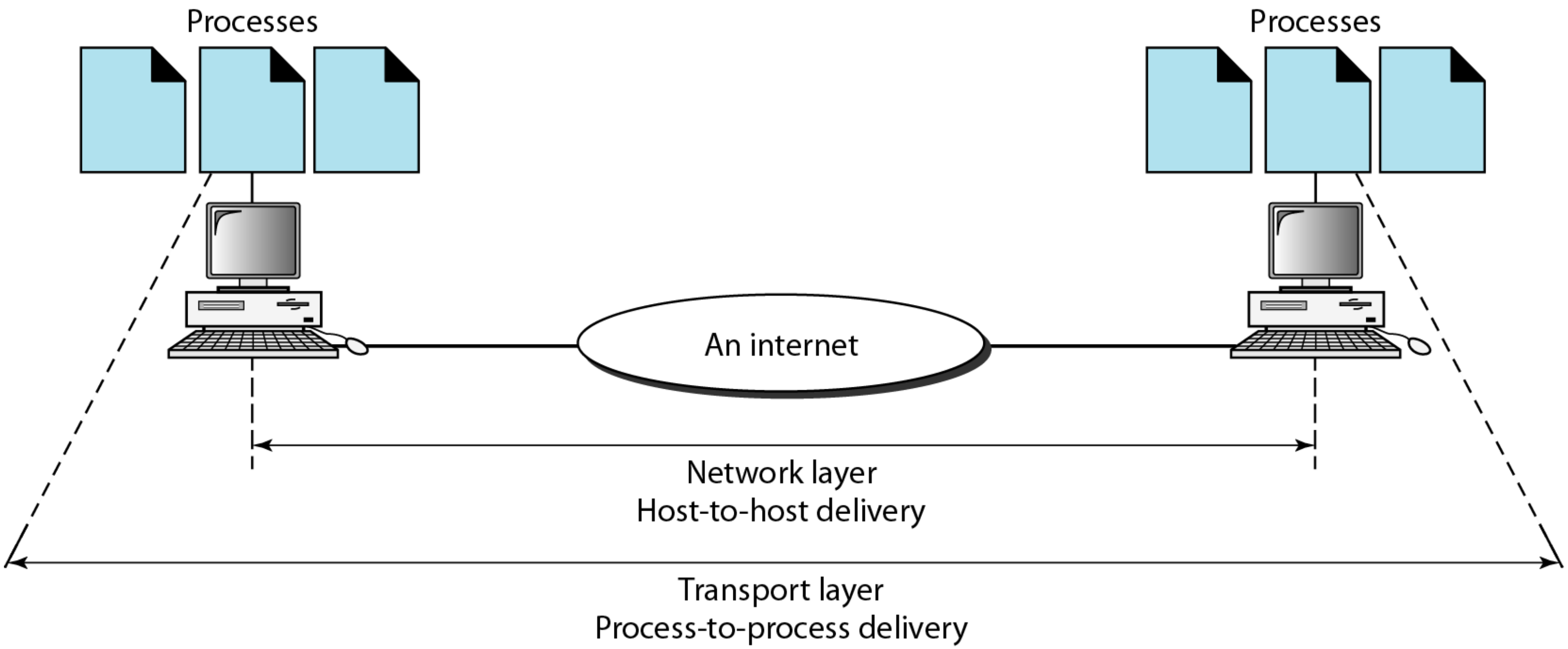
Figure 2.10 *Transport layer*



Note

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

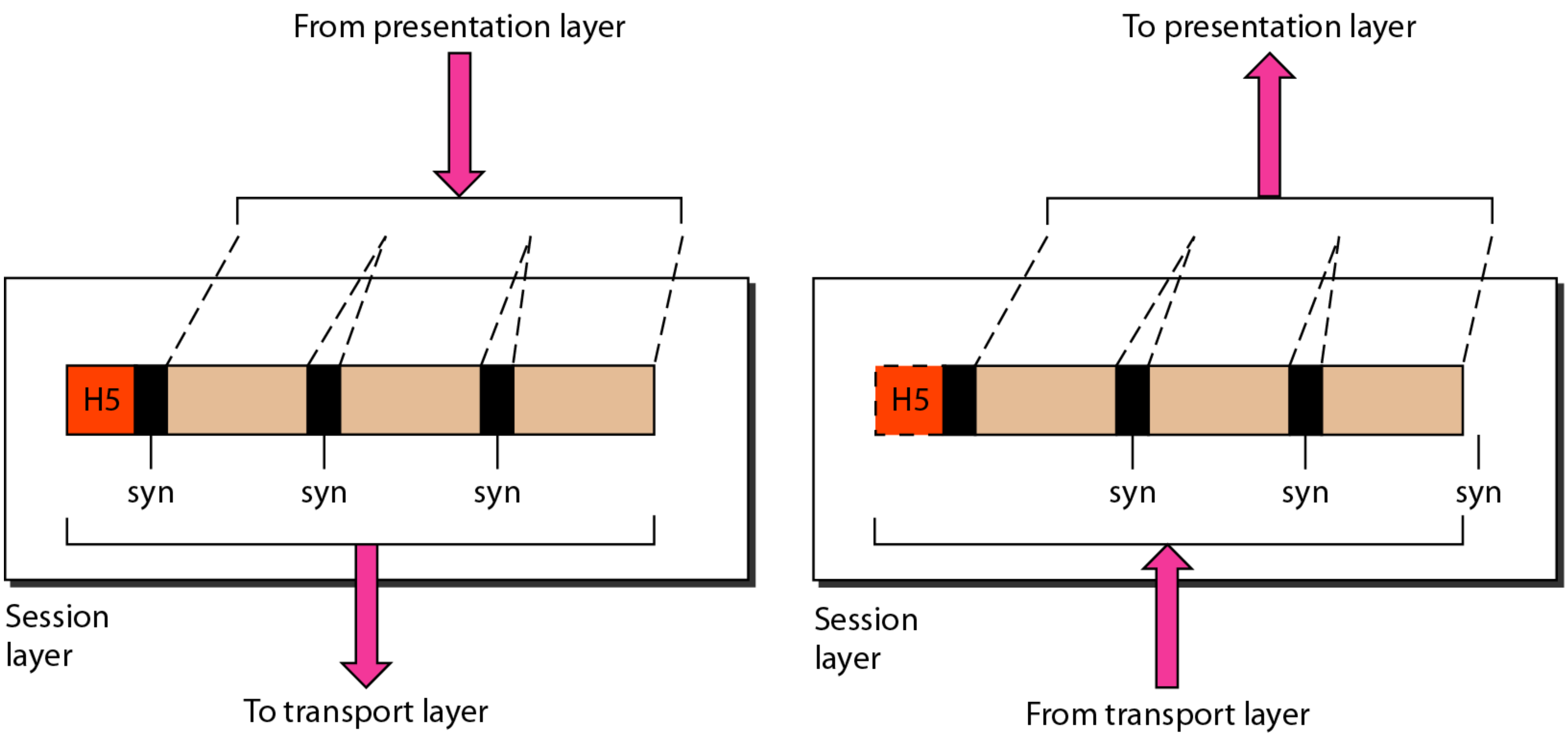
Figure 2.11 *Reliable process-to-process delivery of a message*



Other responsibilities

- Service-point addressing (or port address)
- Segmentation and reassembly
- Connection control
- Flow control
- Error control

Figure 2.12 *Session layer*



Note

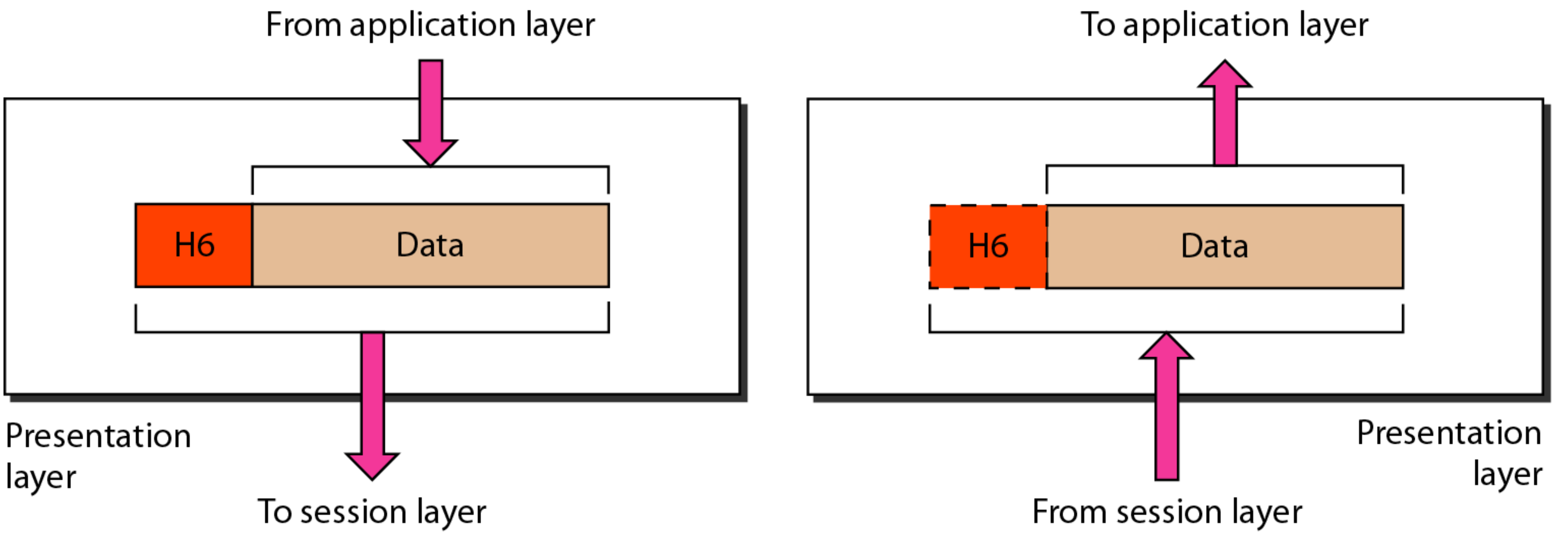
The session layer is responsible for dialog control and synchronization.

Establishes, manages, and terminates sessions between two communicating hosts.

Specific responsibilities

- Dialog control
  - It allows the communication between two processes to take place in either half-duplex or full-duplex mode
- Synchronization
  - Allows a process to add checkpoints or synchronization points

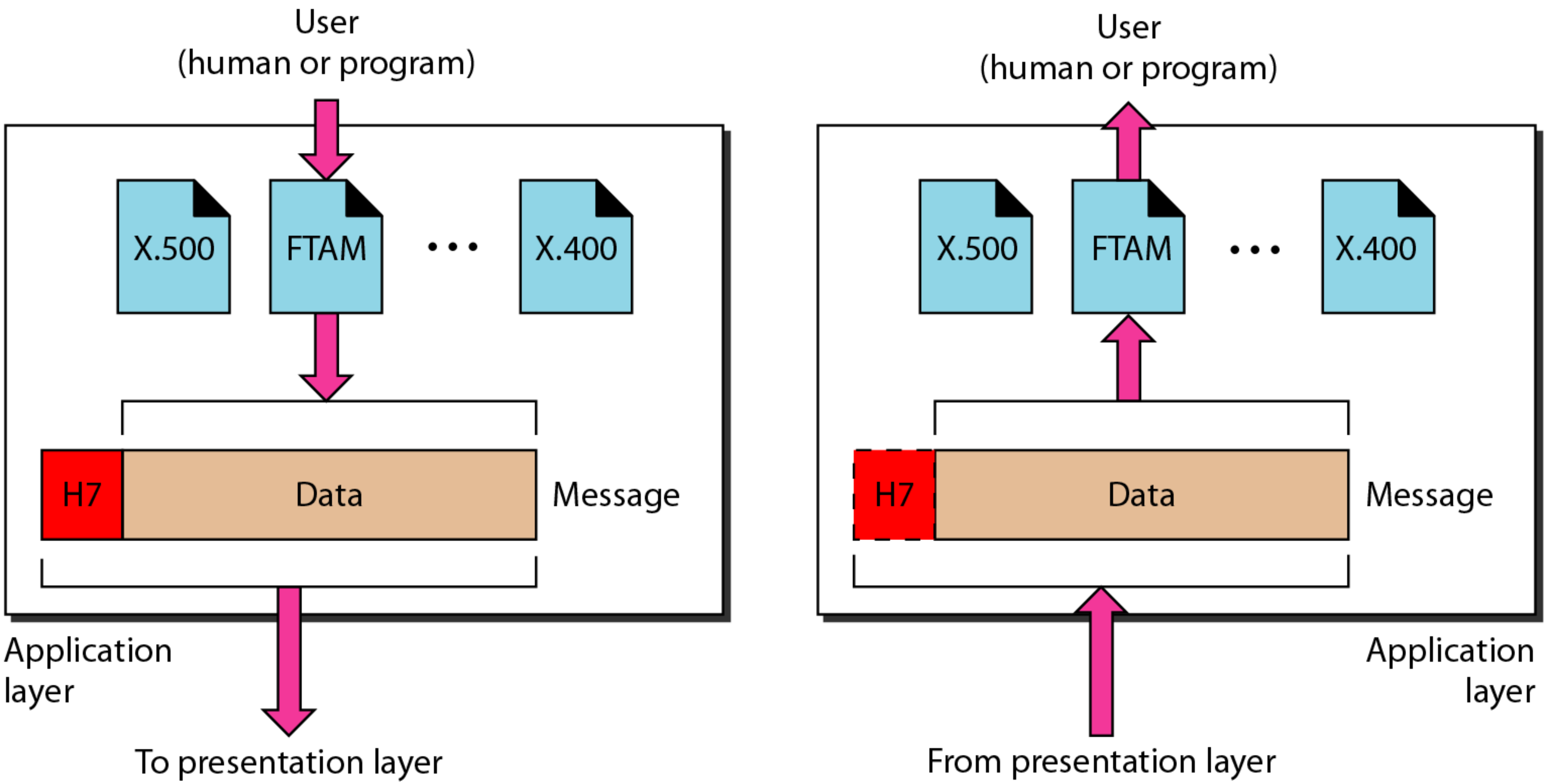
Figure 2.13 *Presentation layer*



Note

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

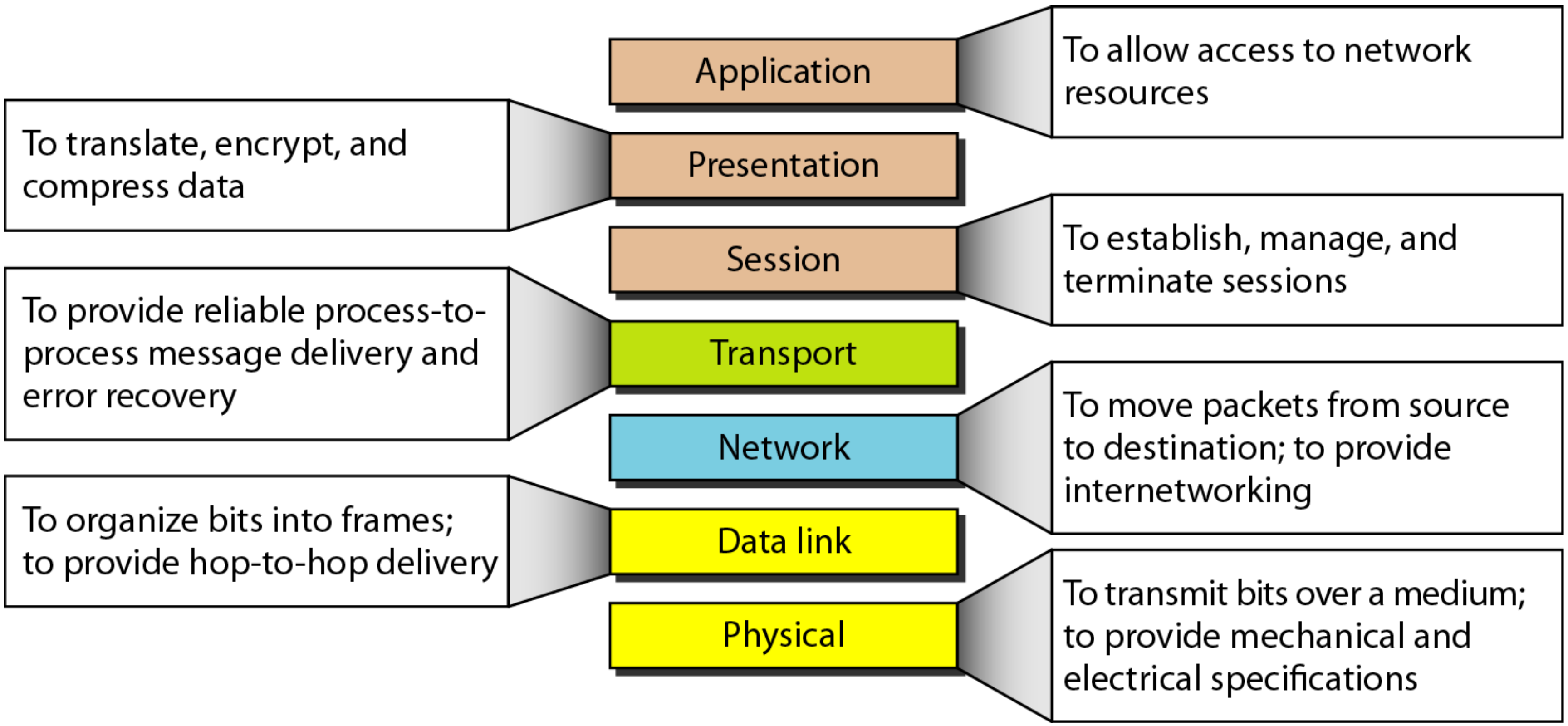
Figure 2.14 *Application layer*



Note

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

Figure 2.15 *Summary of layers*



Each of the layers have Protocol Data Unit (PDU)

- Physical: *Bits*
- Data link: *Frames*
- Network: *IP/IPX (Internetwork Packet Exchange)*
- Transport: *Segments*
- Session: *Formatted Data*
- Presentation: *Formatted Data*
- Application: *User Data*

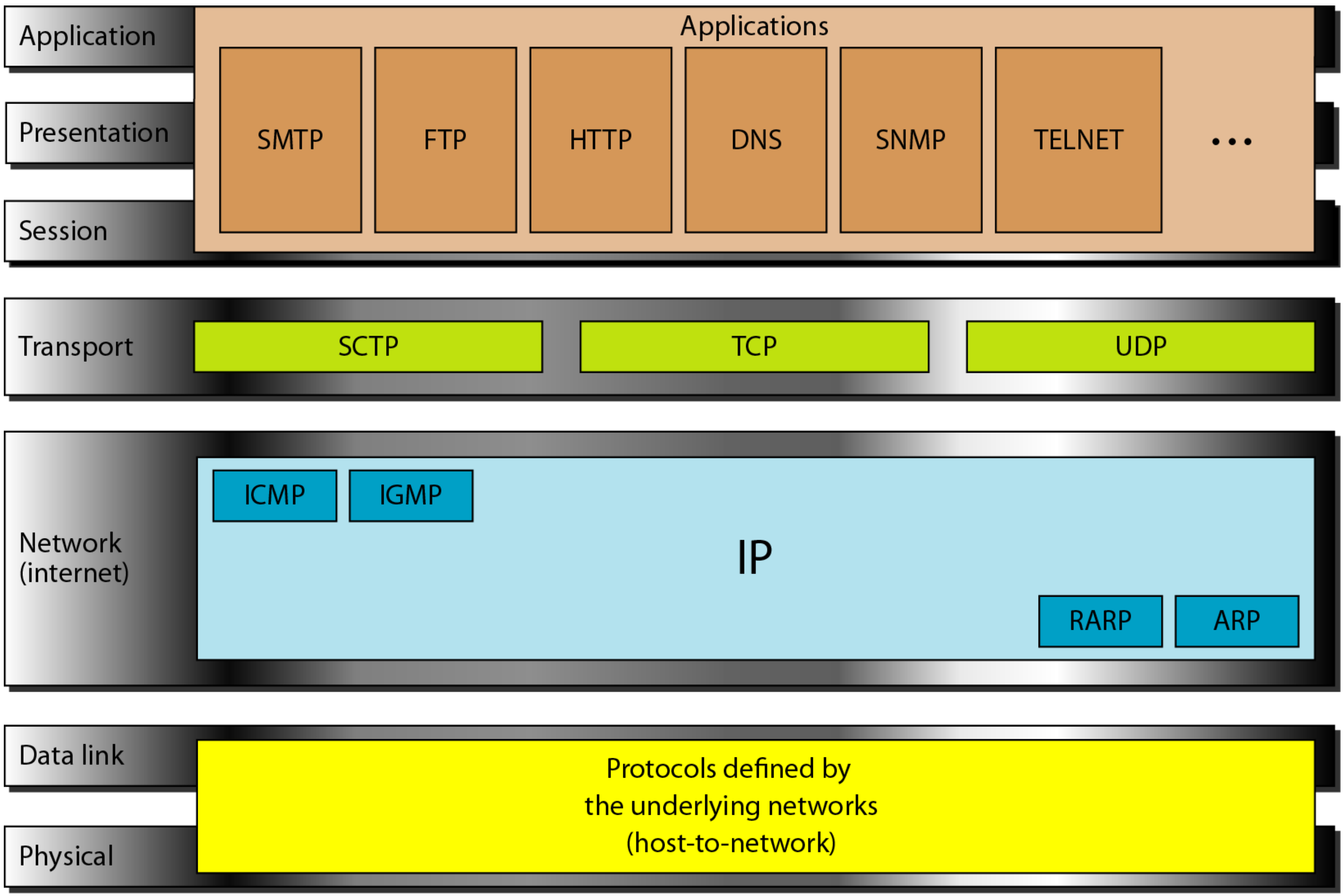
2-4 TCP/IP PROTOCOL SUITE

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

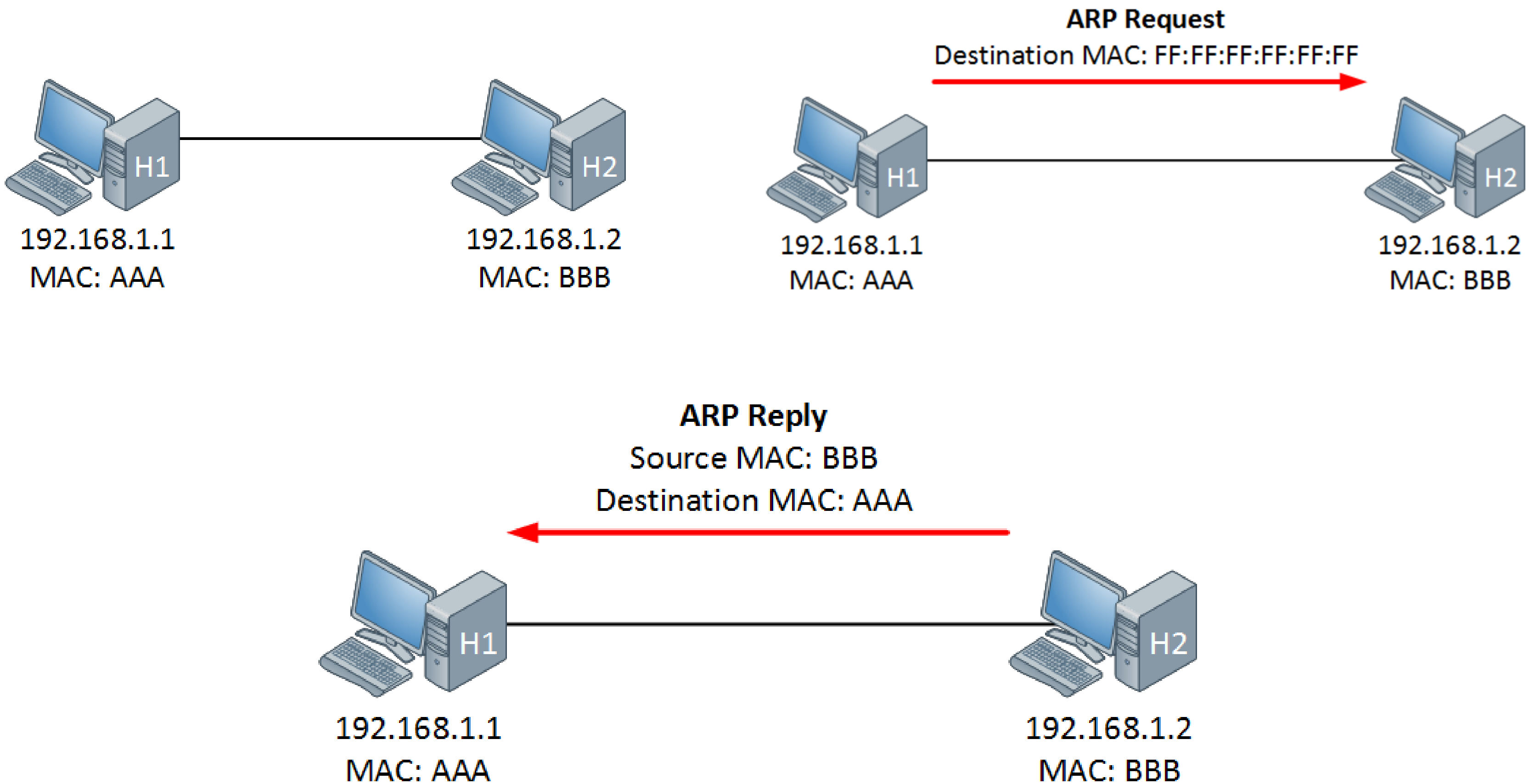
Figure 2.16 *TCP/IP and OSI model*



TCP/IP Hierarchical Protocol

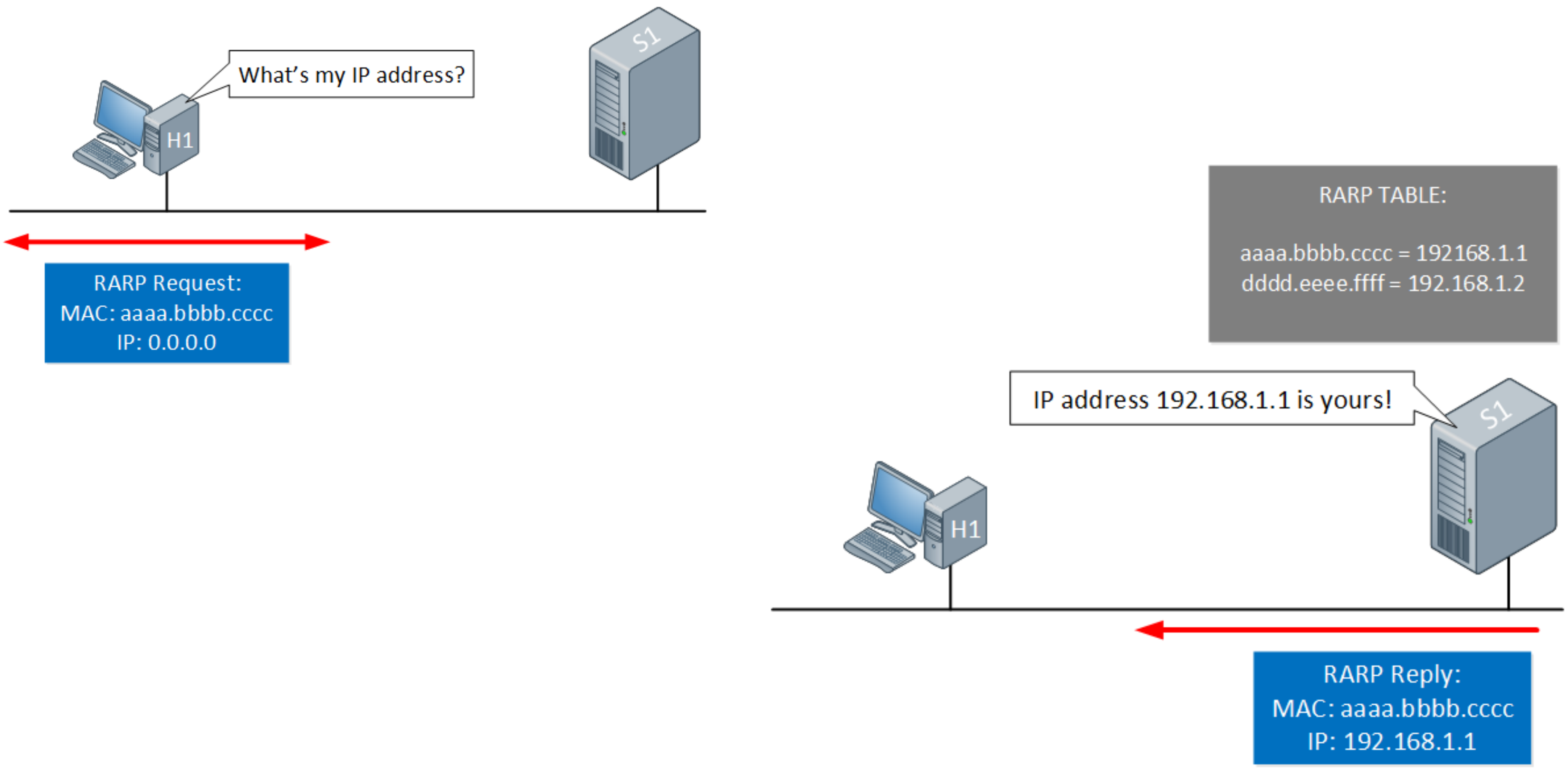
- Made up interactive modules, each of which provides a specific functionality
- Modules are not necessarily interdependent
- Hierarchical means that each upper-level protocol is supported by one or more lower-level protocols

ARP

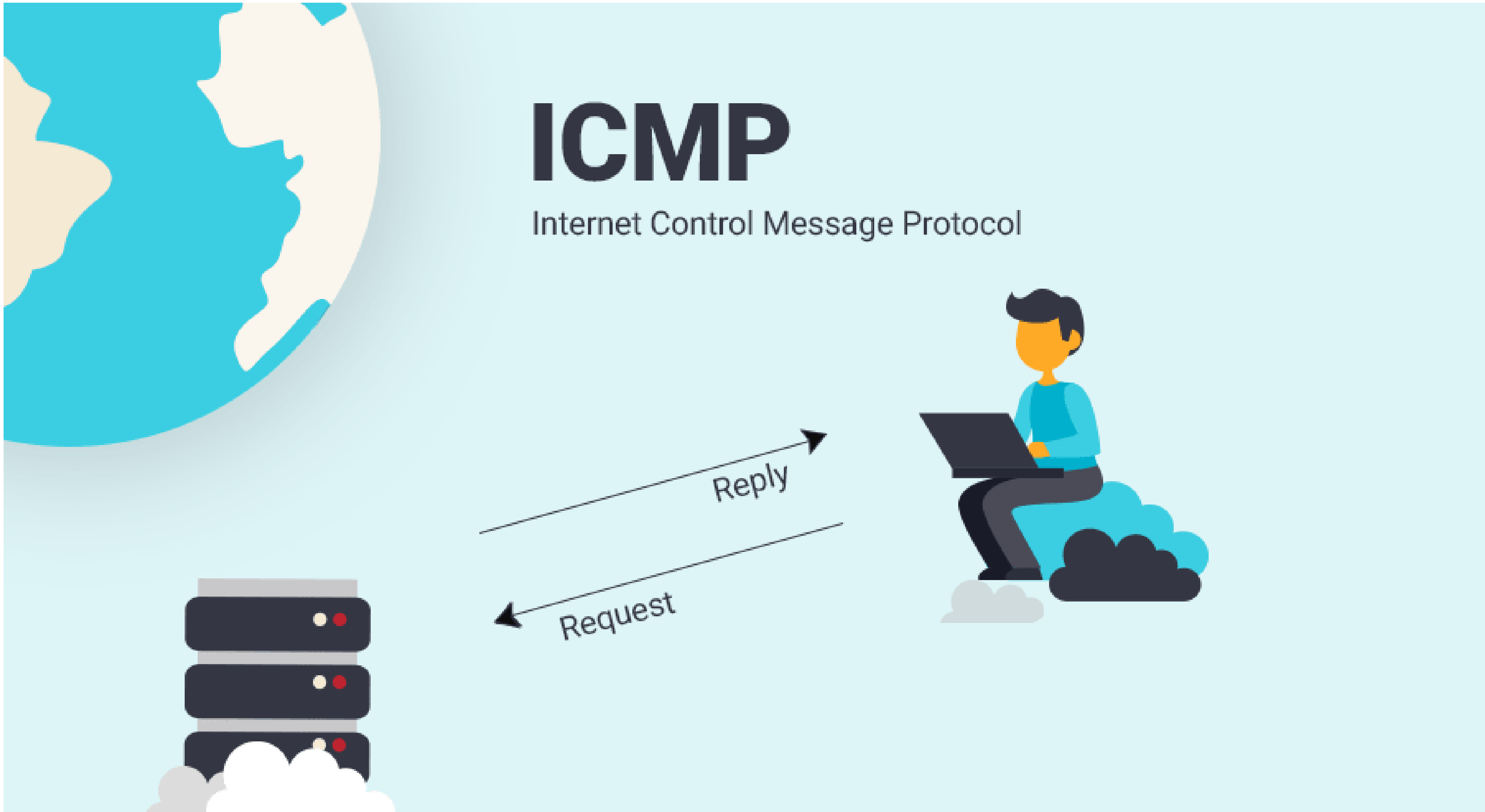

H1
192.168.1.1
MAC: AAA
H2
192.168.1.2
MAC: BBB
ARP Request
Destination MAC: FF:FF:FF:FF:FF:FF
H1
192.168.1.1
MAC: AAA
H2
192.168.1.2
MAC: BBB
ARP Reply
Source MAC: BBB
Destination MAC: AAA
H1
192.168.1.1
MAC: AAA
H2
192.168.1.2
MAC: BBB

RARP

- It has been replaced by BOOTP (Bootstrap Protocol) and later by DHCP



ICMP sends query and error reporting messages



IGMP

- "Used by hosts and gateways to send notification of datagram problems back to the sender" same as ICMP
- Used to facilitate the simultaneous transmission of a message to a group of recipients

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*

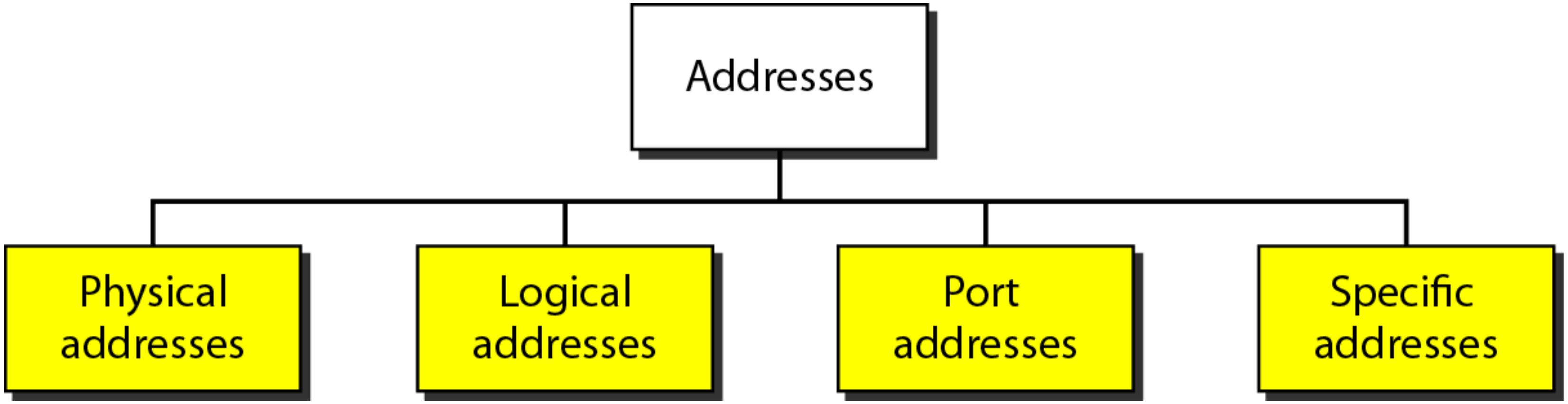
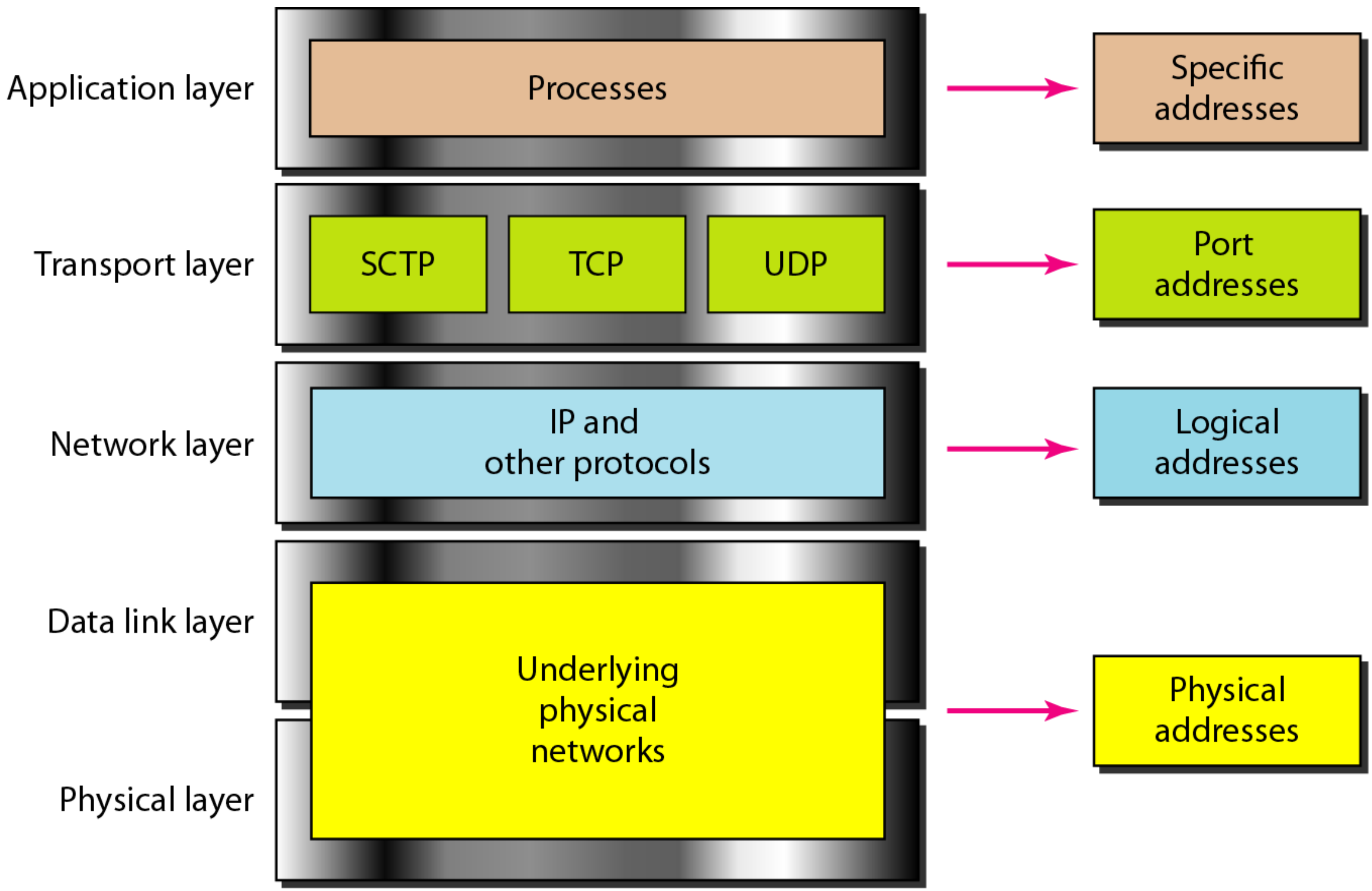


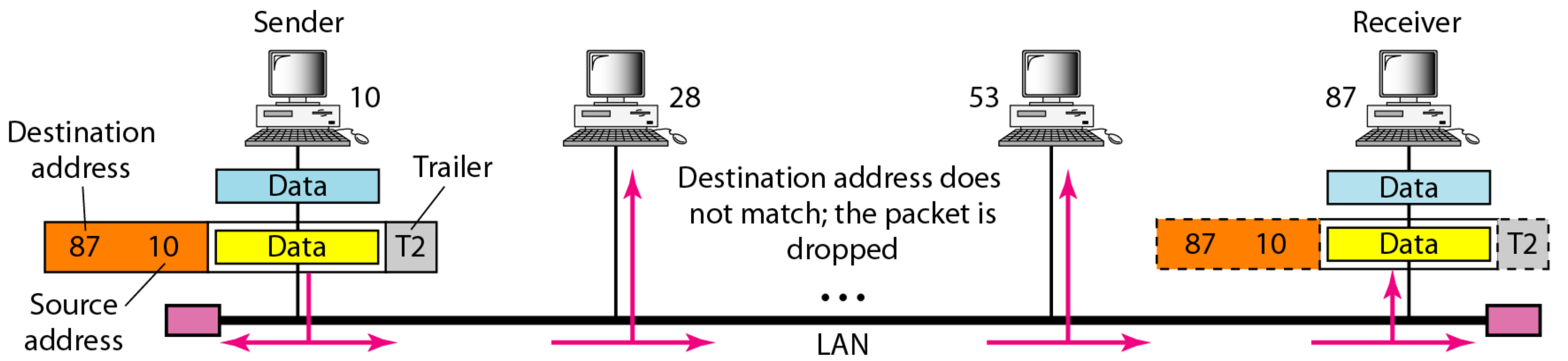
Figure 2.18 *Relationship of layers and addresses in TCP/IP*



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:

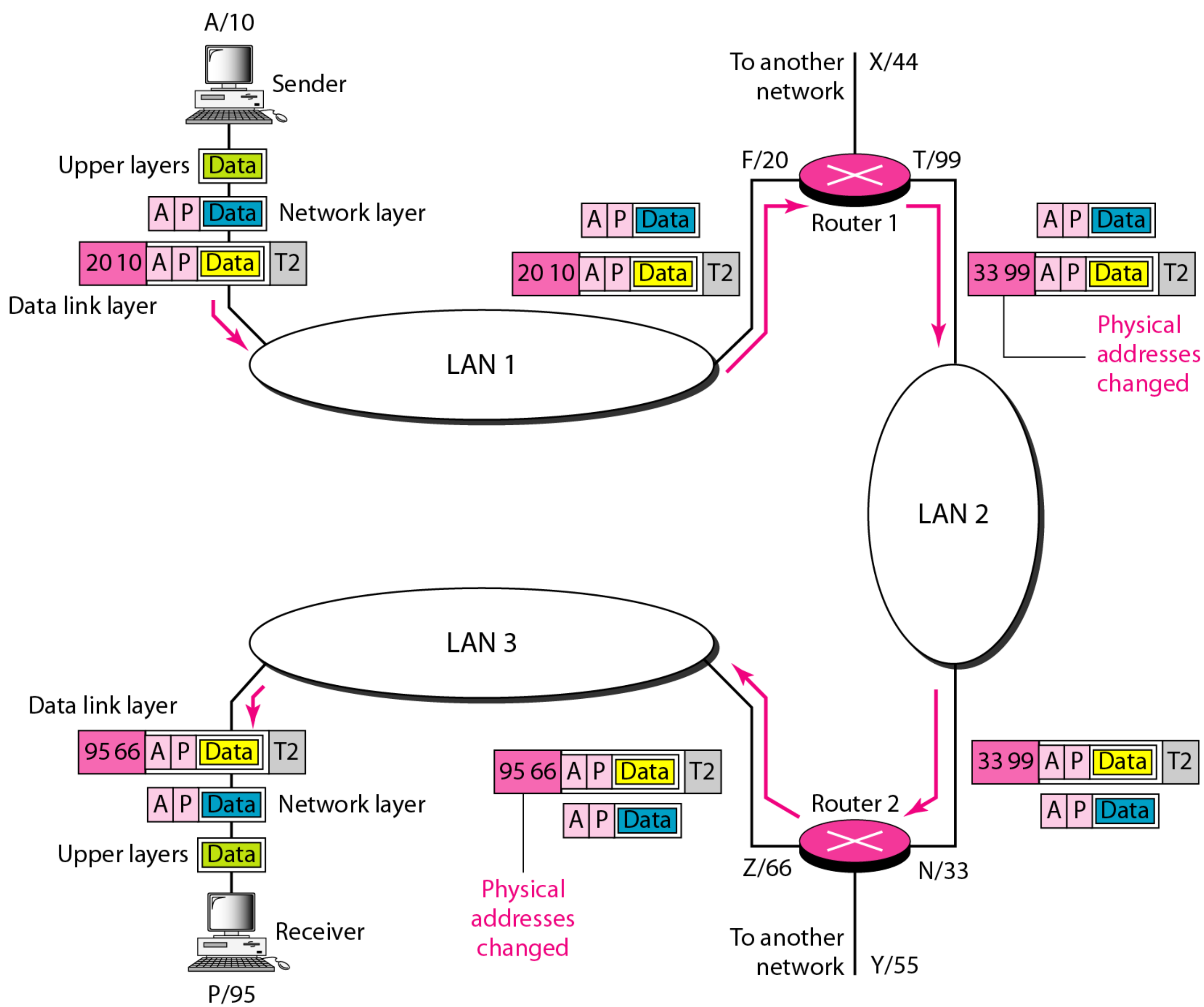
07:01:02:01:2C:4B

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.

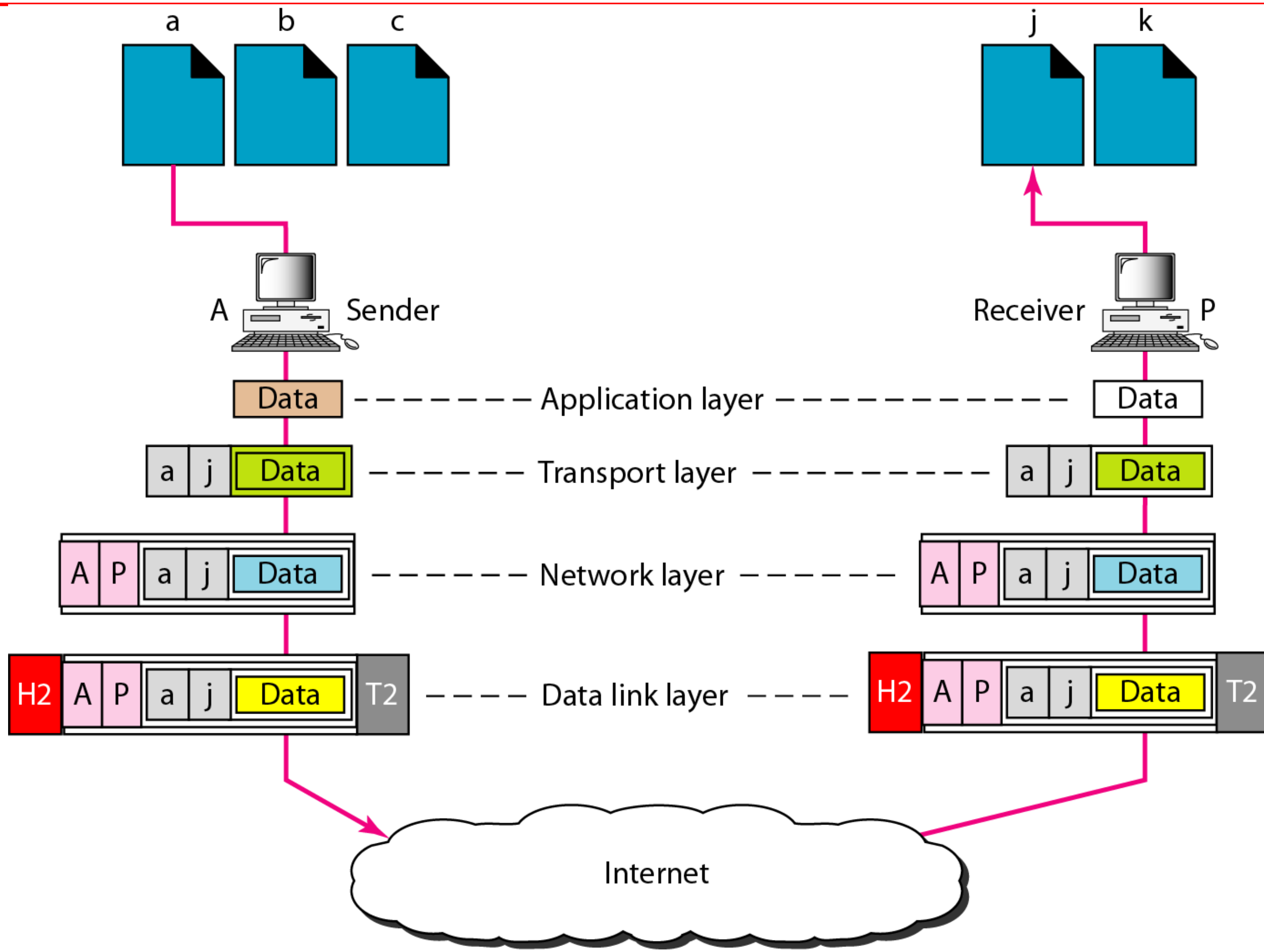
Figure 2.20 *IP addresses*



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.

Note

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

Specific Addresses

- Examples mainly consist of the email address (example@gmail.com) and the Universal Resource Locator (URL) (for eg, www.mail.gmail.com)

- However, this address gets changed according to the required logical and port addresses sent from the sender computer.