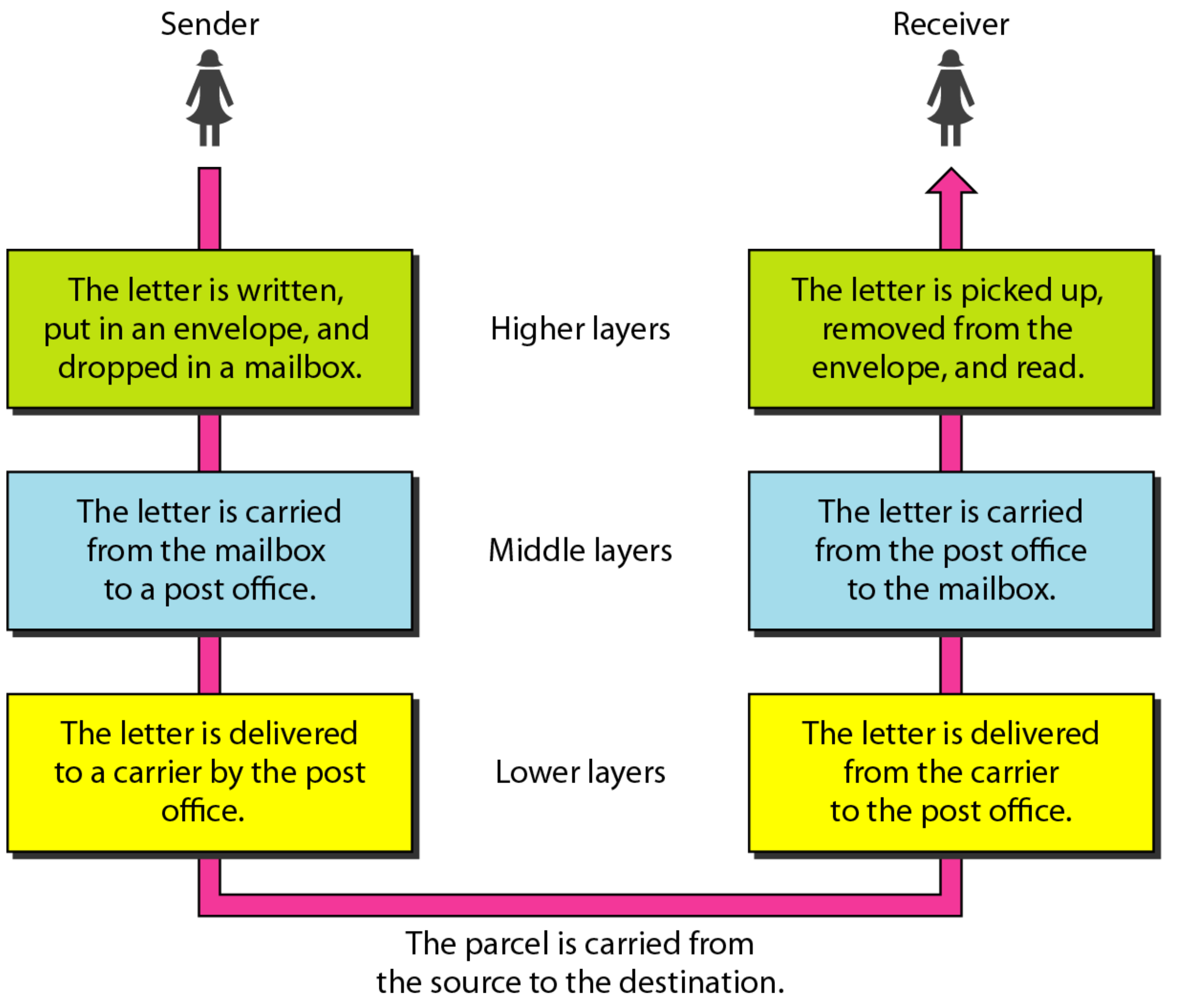
# Lecture 2

# 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.***

## Tasks involved in sending a letter



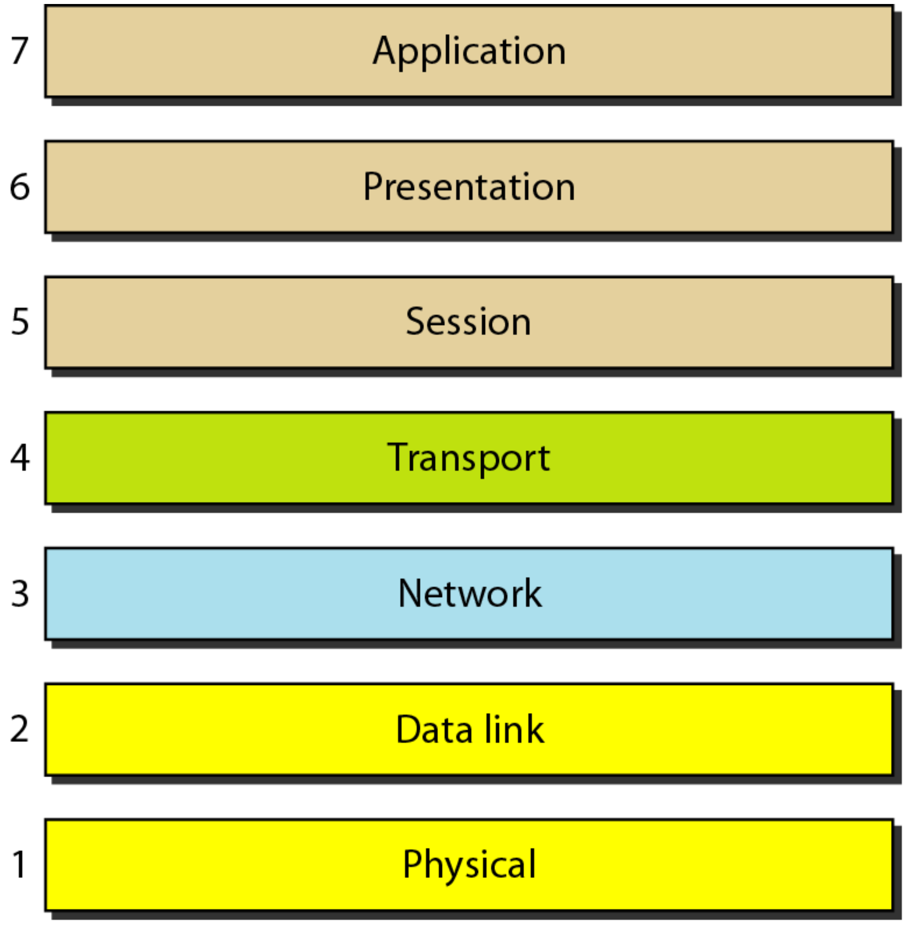
# 2-2 THE OSI MODEL

***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.***

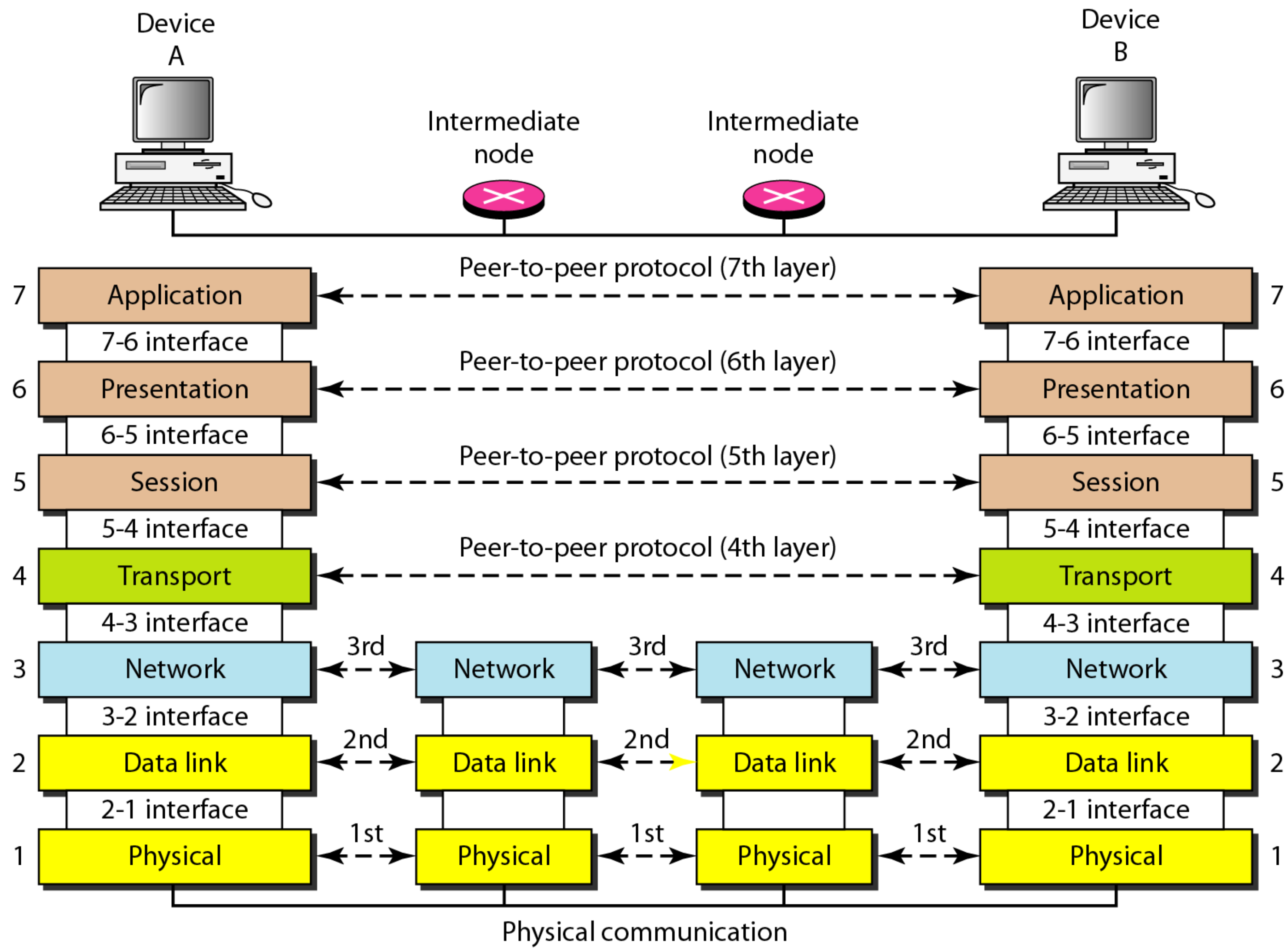
***Note***

**ISO is the organization.**
**OSI is the model.**

## *Seven layers of the OSI model*



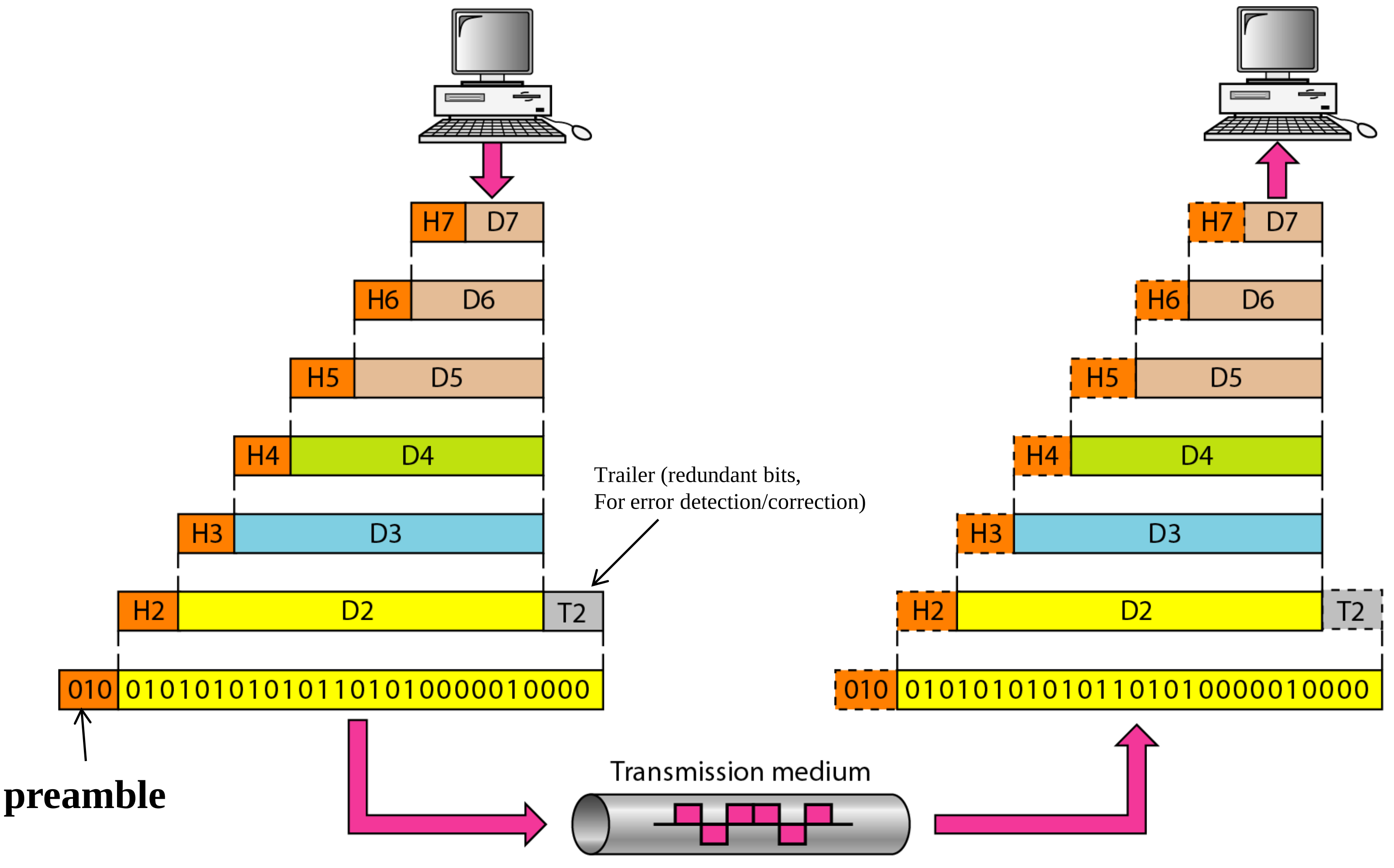
## *The interaction between layers in the OSI model*






**Each interface defines the service provided by the lower layer**

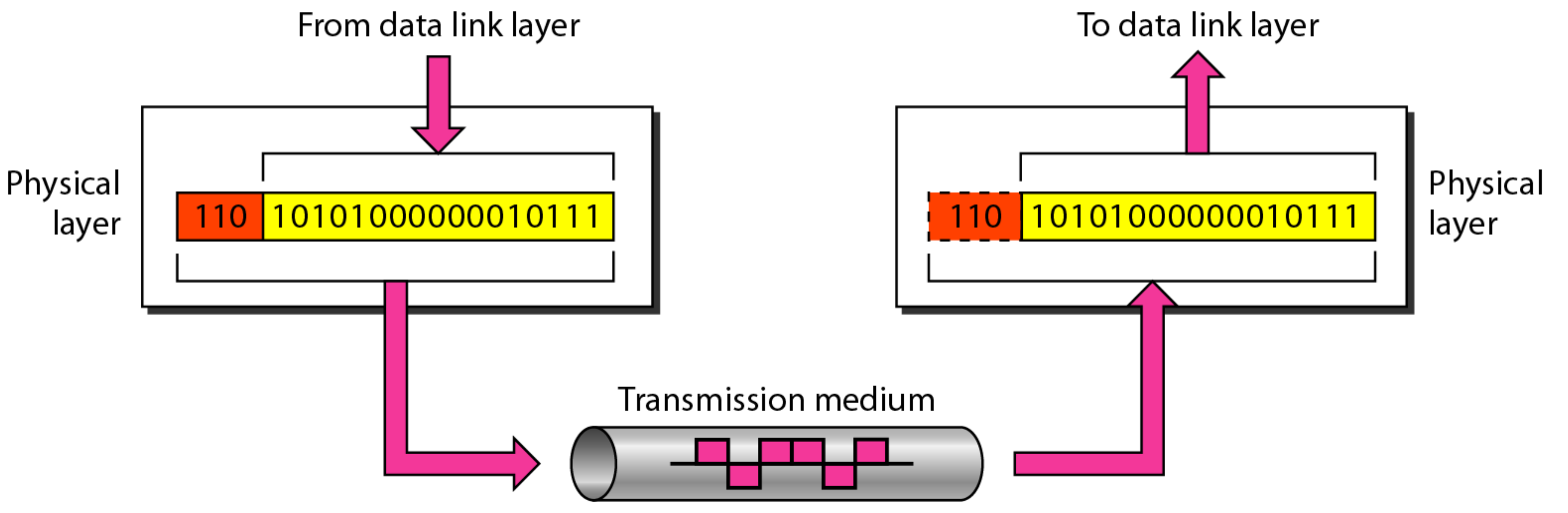
# *An exchange using the OSI model*



# 2-3 LAYERS IN THE OSI MODEL

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

## *Physical layer*

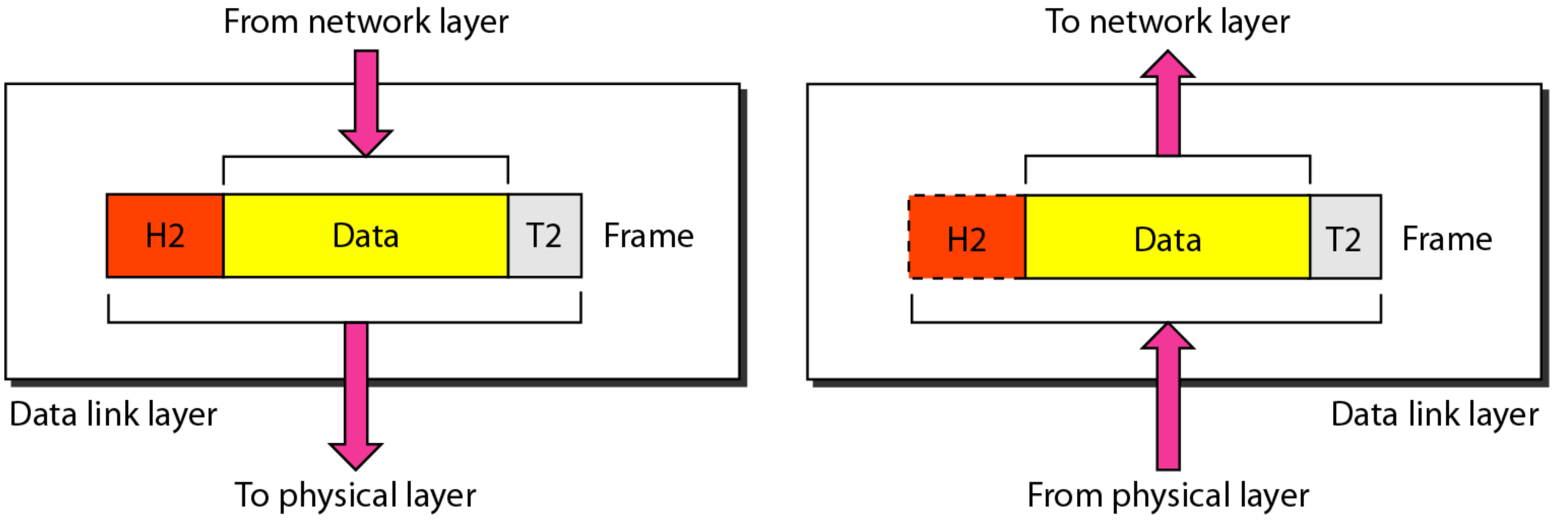


***Note***

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

**Physical characteristics of medium**
**Data rate**
**Bit synchronization**
**Transmission mode (simplex, half-duplex, or full duplex)**

# *Data link layer*



**The data link layer is responsible for moving frames from one hop (node) to the next.**
**It transforms the physical layer, a raw transmission facility, to a reliable link. It makes the physical layer appear error-free to the upper layer (network)**

**Framing (the focus of Lecture 6 “Ethernet”)**

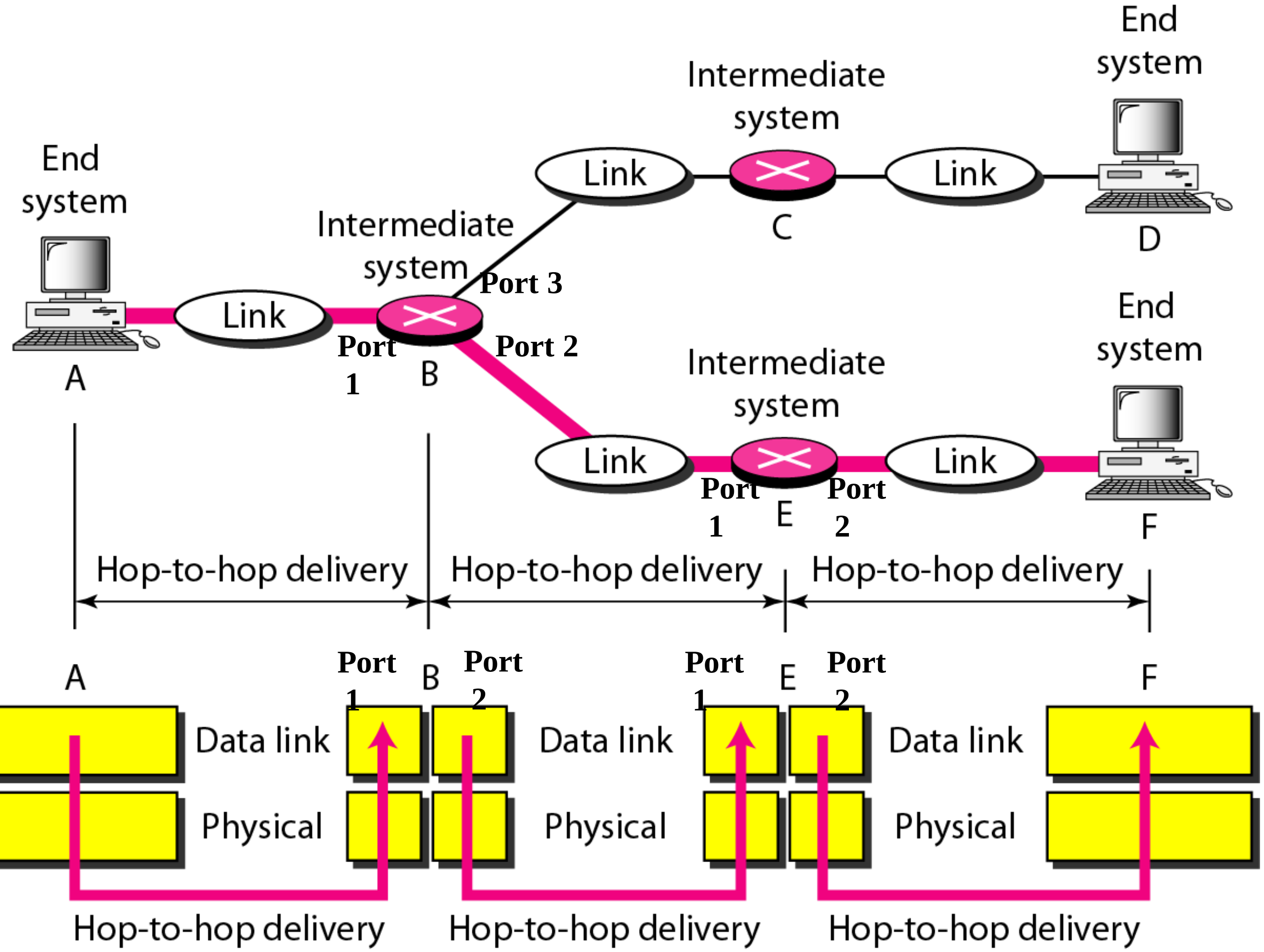
**Physical addressing: through the header**

**Flow control: if the receiver is slow, flow control can avoid overwhelming the receiver (the focus of Lecture 4 “Data link control”)**

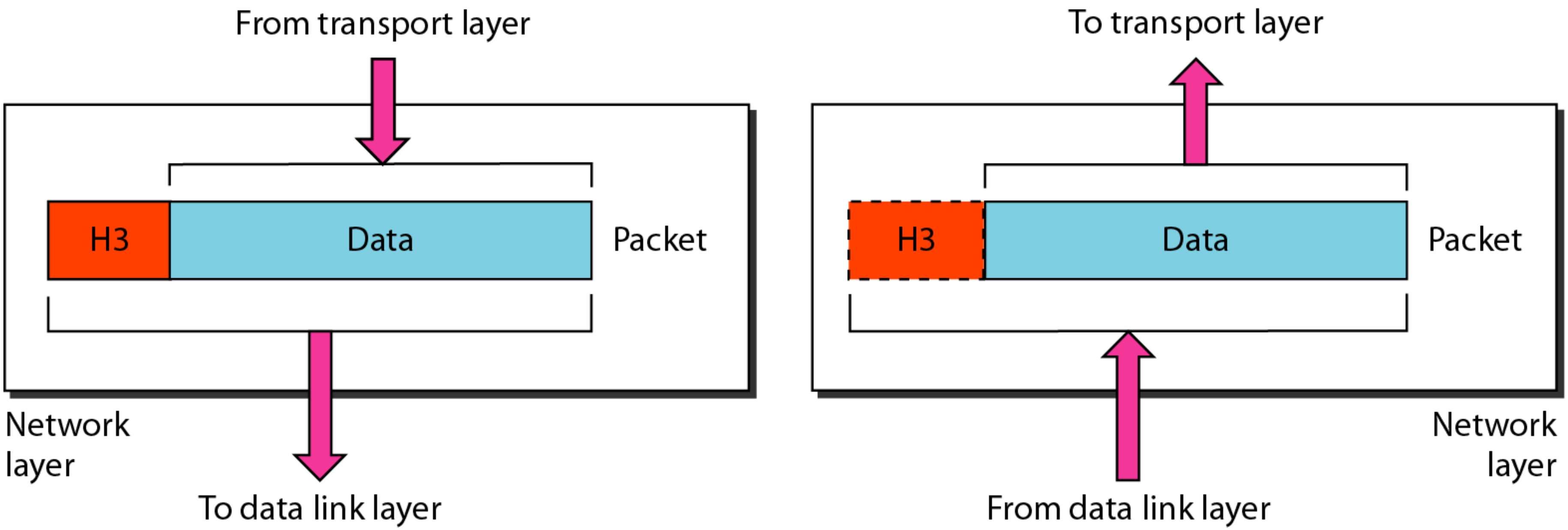
**Error control: through the trailer (the focus of our Lecture 3 “Error detection and correction” and Lecture 4 “Data link control”)**

**Medium access control (MAC): when there are more devices, MAC determines which device can access the medium at one moment (the focus of Lecture 5 “Multiple access” and Lecture 7 “WLAN”)**

## *Hop-to-hop delivery*



## *Network layer*

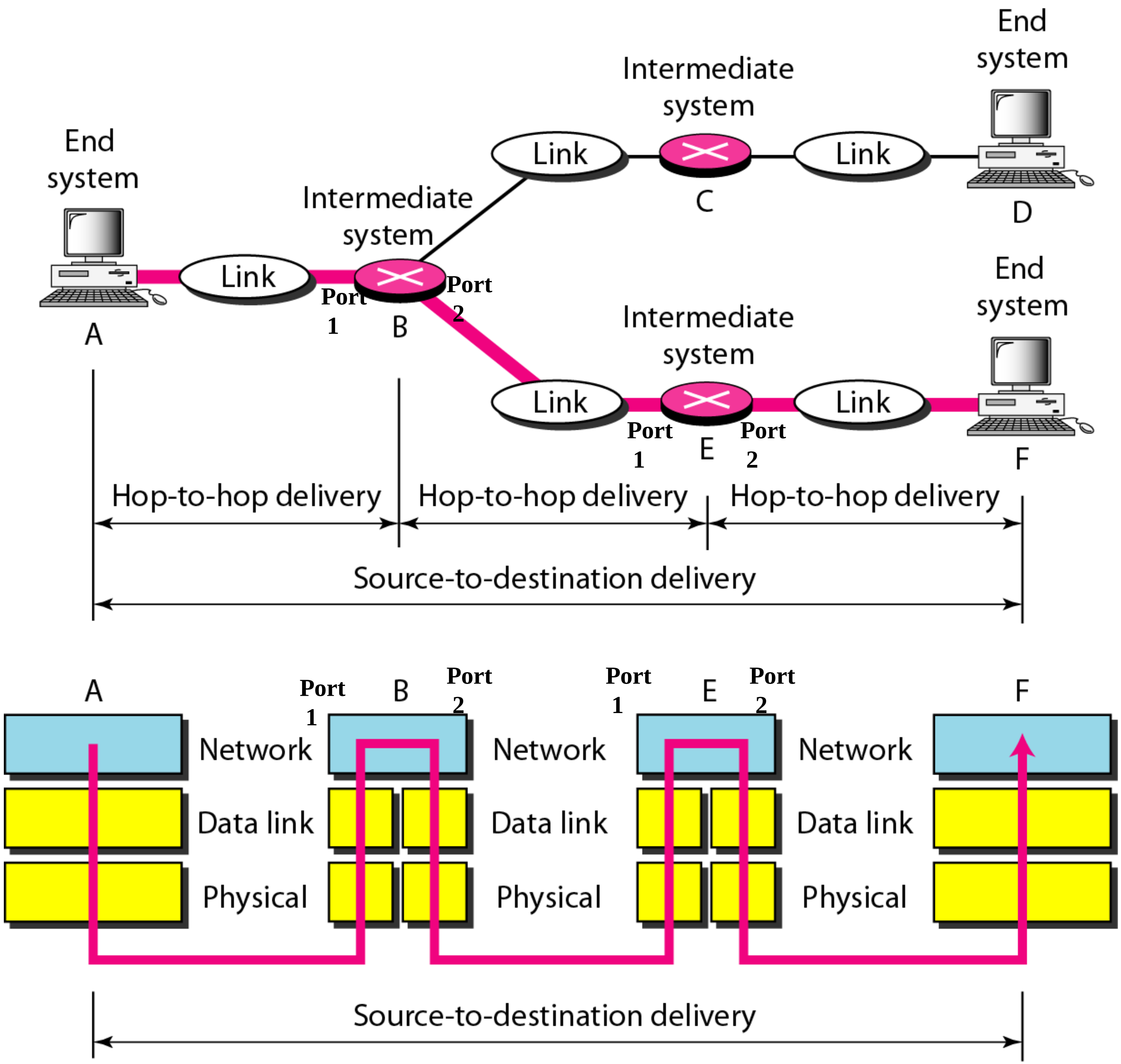


*Note*

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

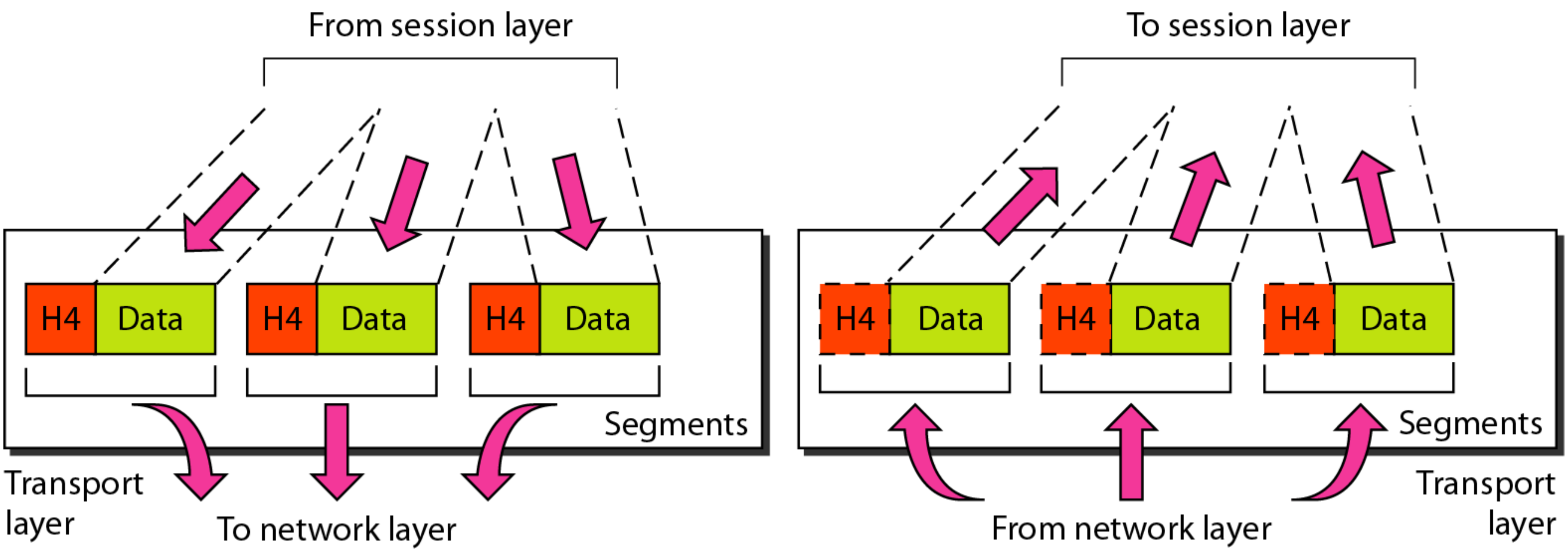
**IP addressing: define connection to the network, through the header (the focus of Lecture 9 “addressing” and Lecture 10 “Internet protocol and address mapping”)**

**Routing (the focus of Lecture 8 “Packet switched networks”)**



End system
Intermediate system
End system
Link
Link
C
D
Intermediate system
Link
Port 1
B
Port 2
A
End system
Intermediate system
Link
Link
Port 1
E
Port 2
F
Hop-to-hop delivery
Hop-to-hop delivery
Hop-to-hop delivery
Source-to-destination delivery
A
Port 1
B
Port 2
Port 1
E
Port 2
F
Network
Network
Network
Data link
Data link
Data link
Physical
Physical
Physical
Source-to-destination delivery

## *Transport layer*



***Note***

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

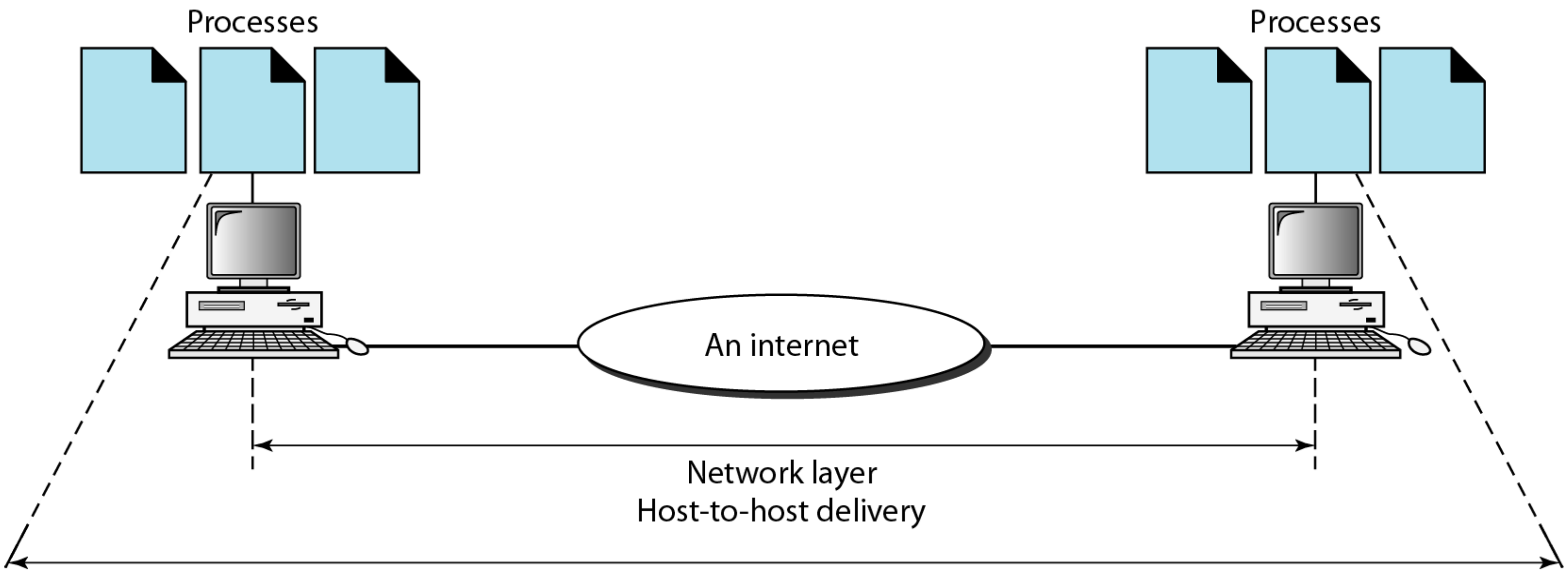
**Service-point addressing: through the header, distinguish a process from another within a device**

**Segmentation and reassembly: through the header a message is divided into transmittable segments, each with a sequence number**

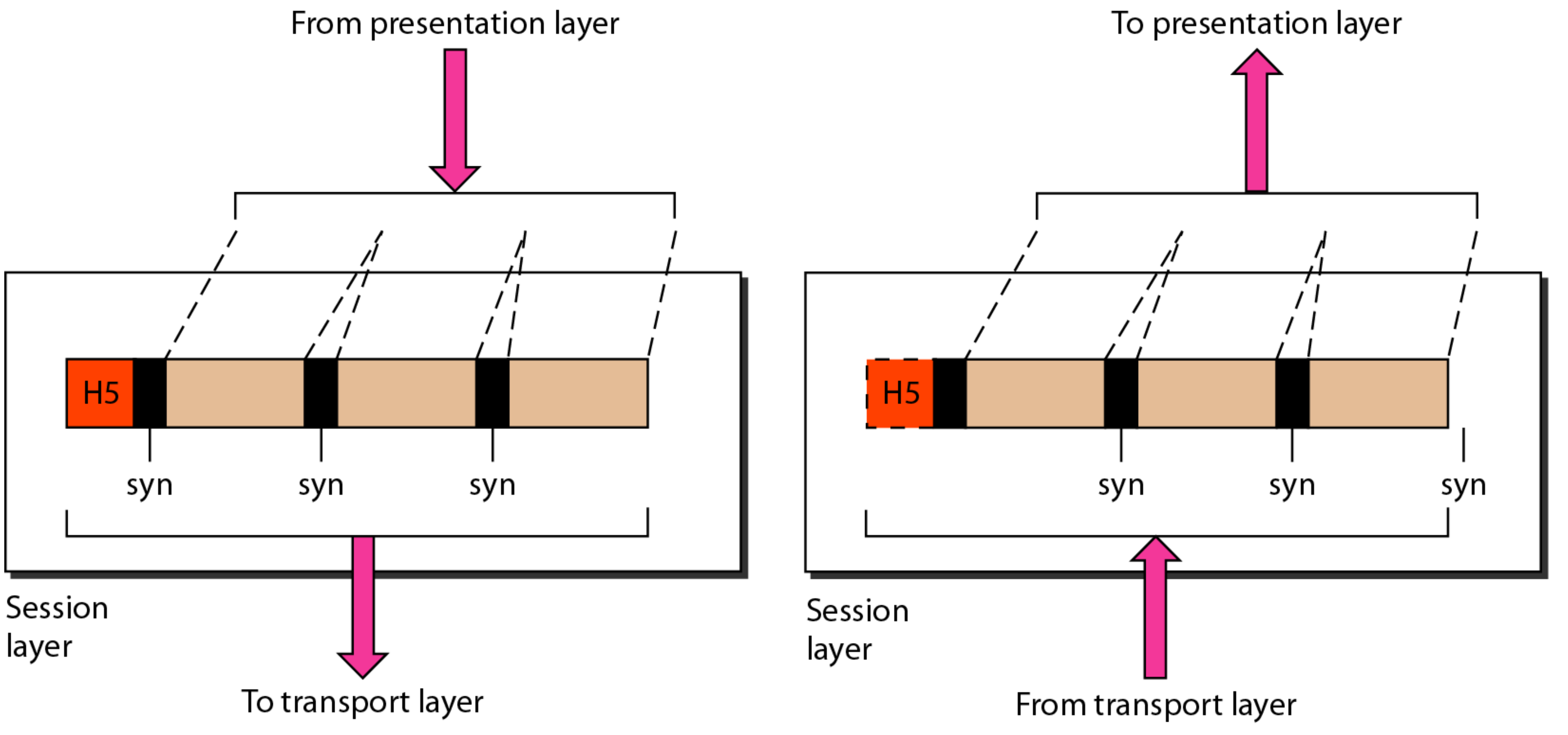
**Flow control: end-to-end flow control (vs. flow control in Layer 2 across a single link)**

**Error control: by retransmission**

## *Reliable process-to-process delivery of a message*



# *Session layer*



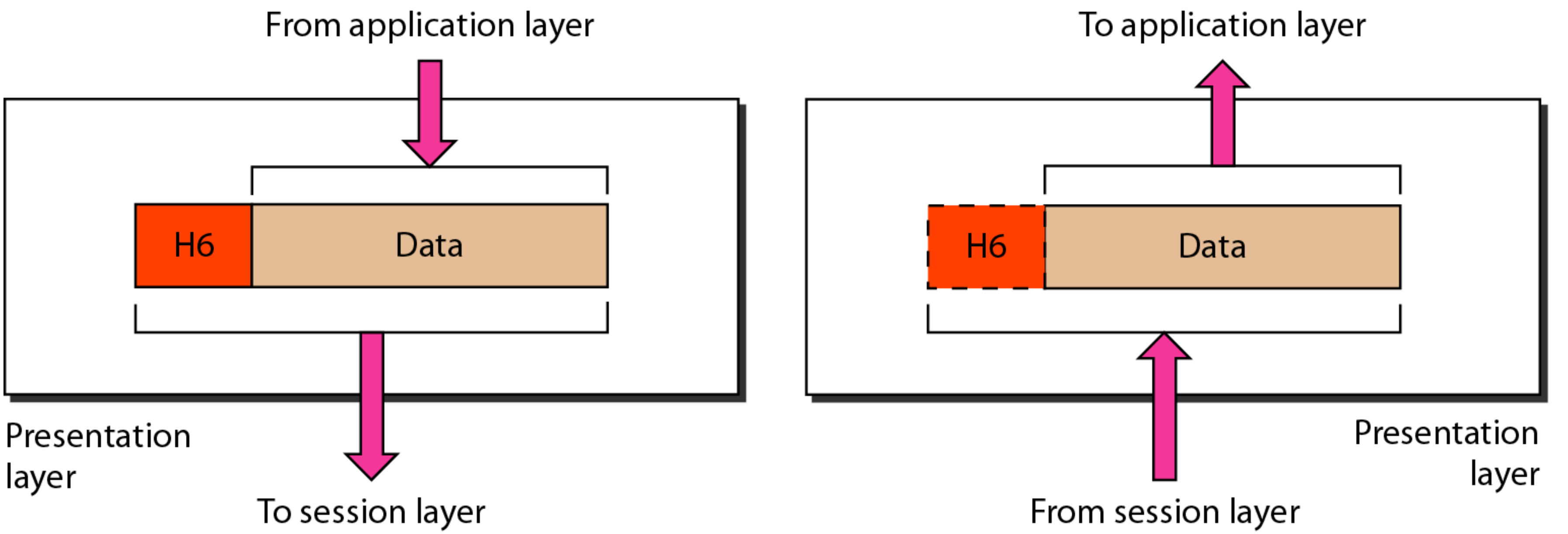
*Note*

**The session layer is responsible for dialog control and synchronization.**

**Dialog control: allow two systems to enter into a dialog. allow half-duplex or full-duplex communication between two processes**

**Checkpoints or synchronization points: e.g., insert checkpoints after every 50 pages for a 1000-page files.**

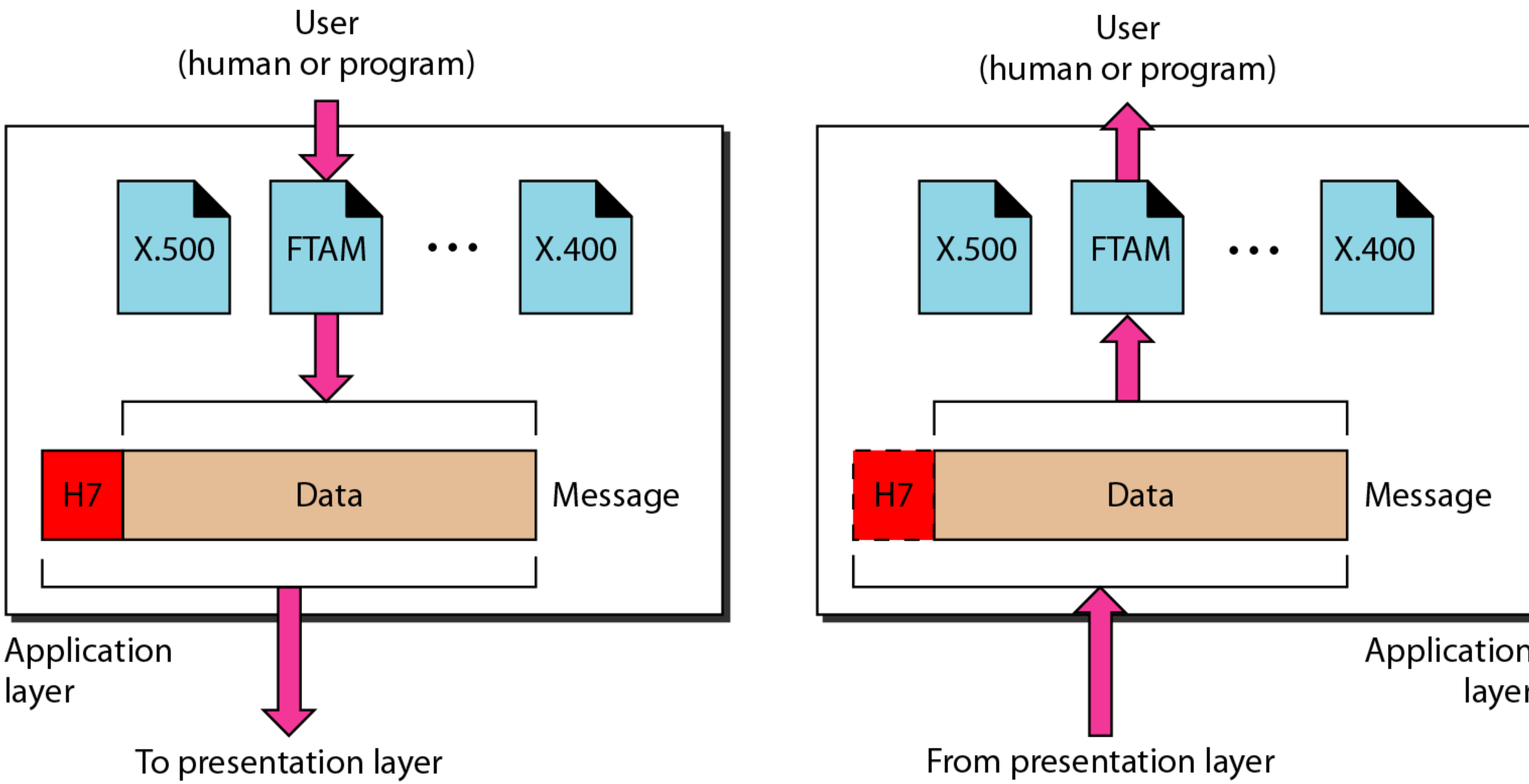
## *Presentation layer*



***Note***

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

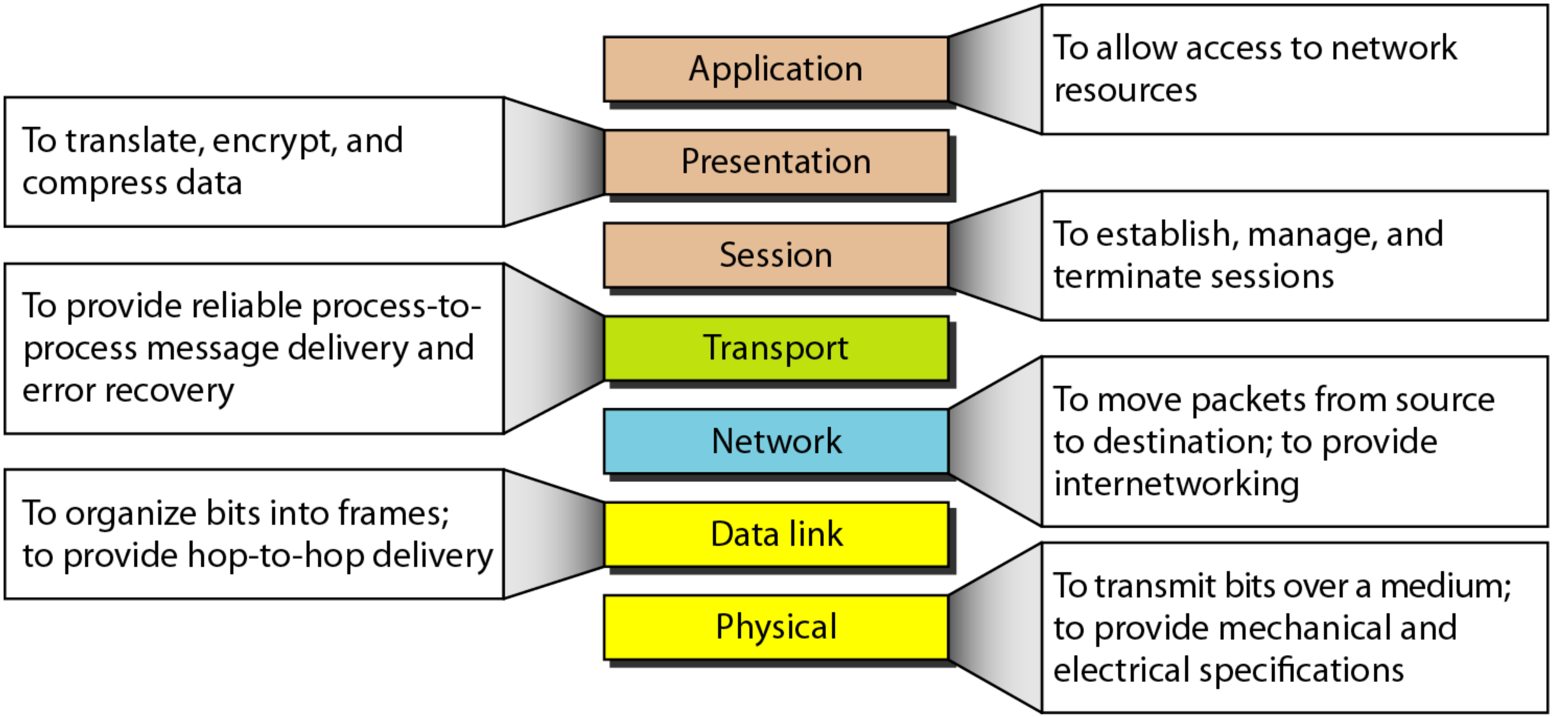
# *Application layer*



***Note***

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

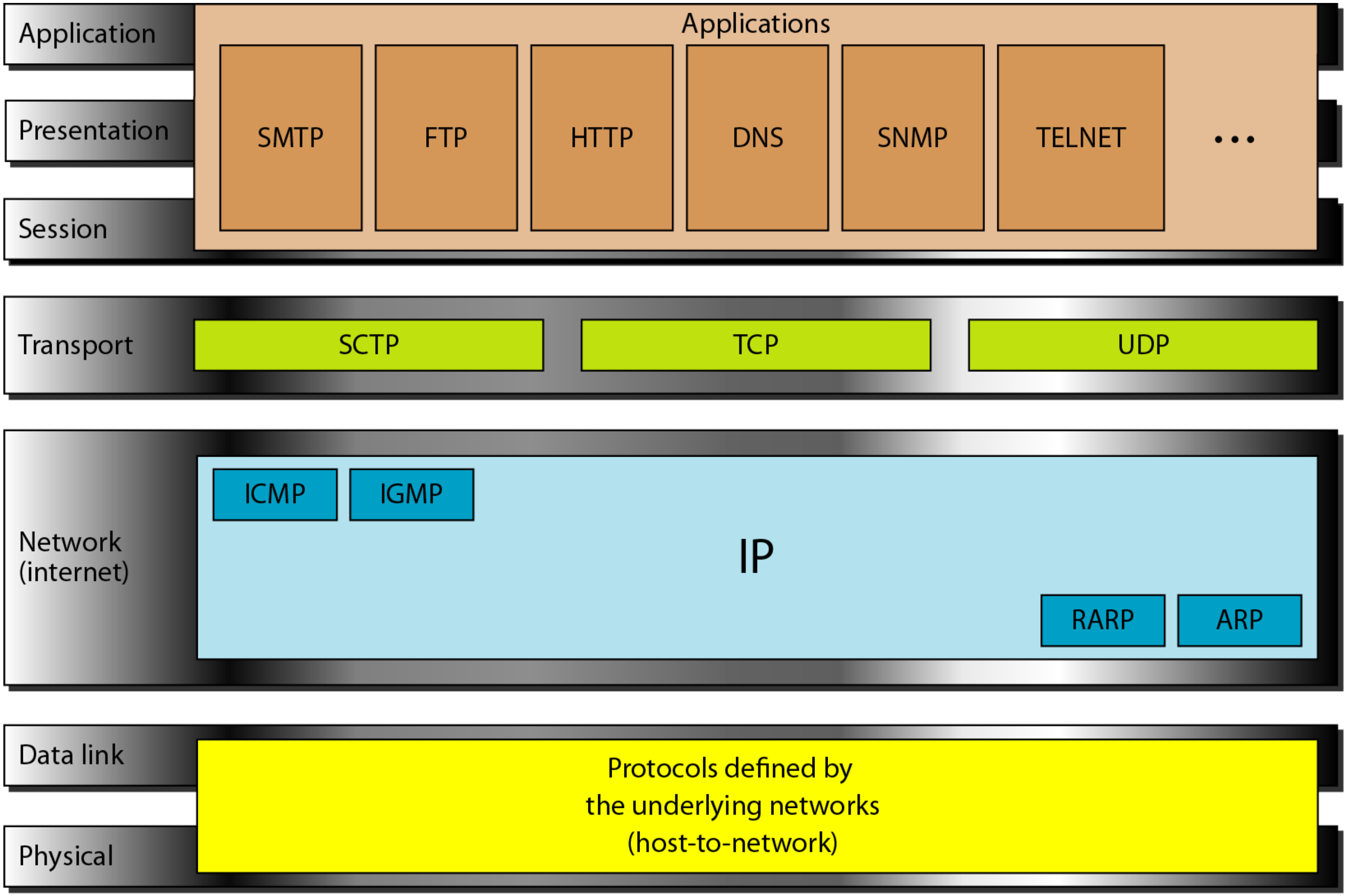
## *Summary of layers*



# 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.***

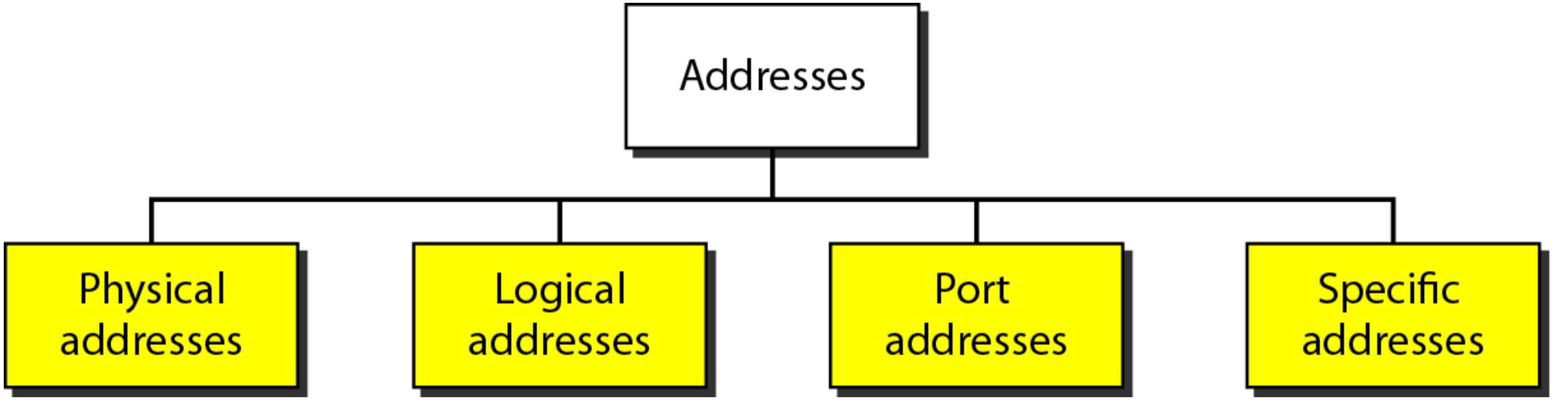
# TCP/IP and OSI model



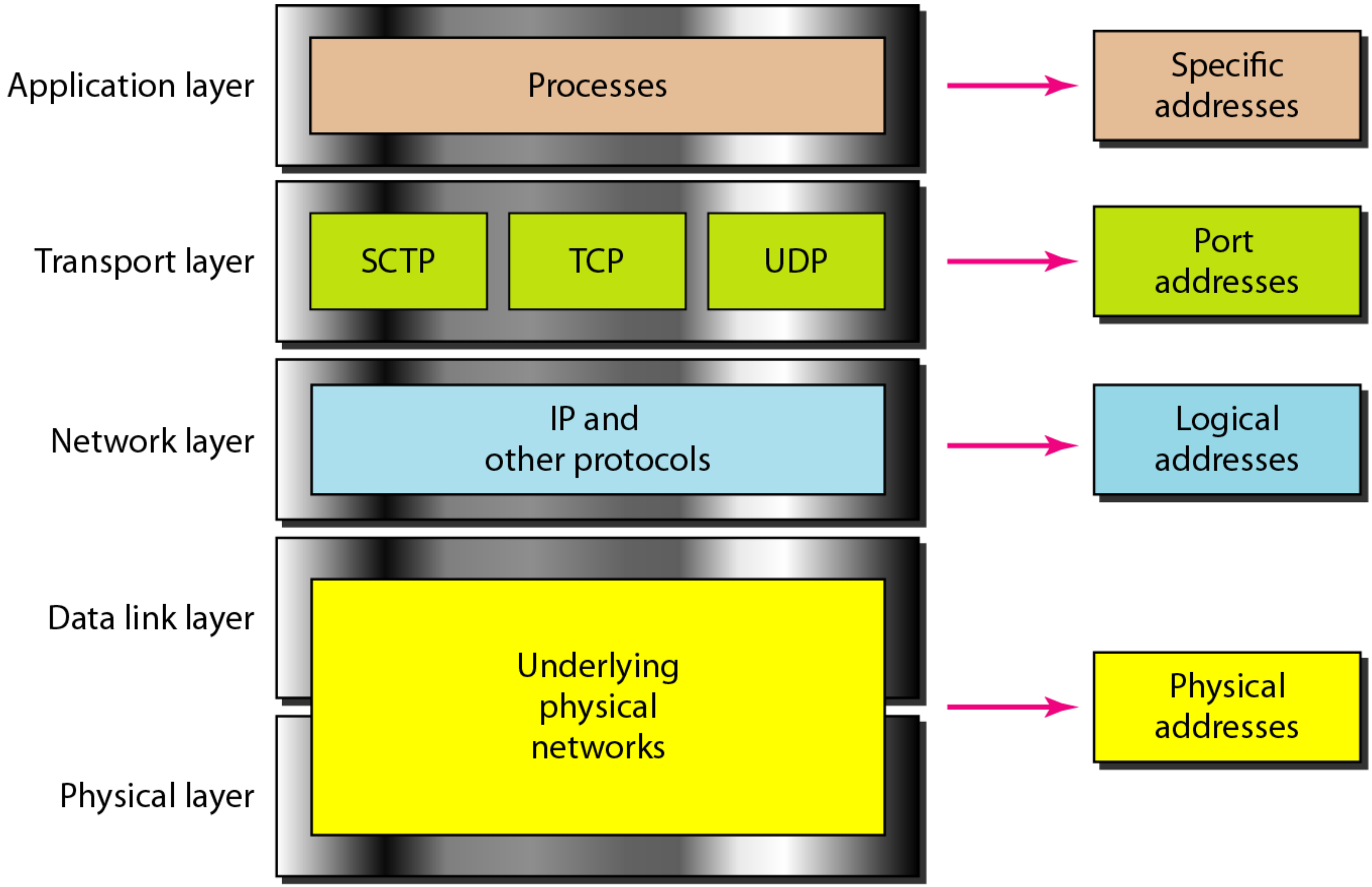
# 2-5 ADDRESSING

***Four levels of addresses are used in an internet employing the TCP/IP protocols: physical, logical, port, and specific.***

# *Addresses in TCP/IP*



## *Relationship of layers and addresses in TCP/IP*

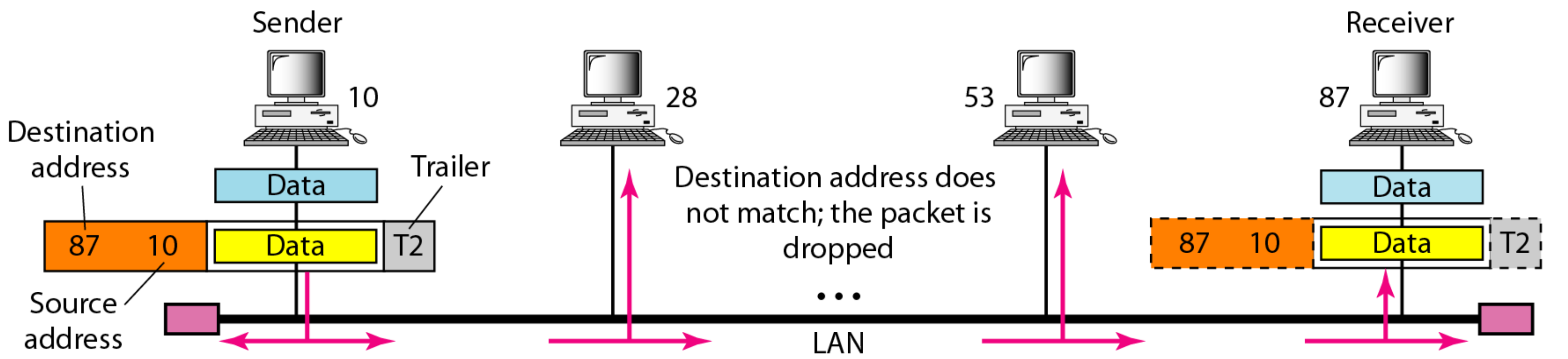


# *Example 2.1 – Physical addresses*

***Physical address: address of a node as defined by its LAN or WAN standards.***

***In next figure 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.***

# *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.**

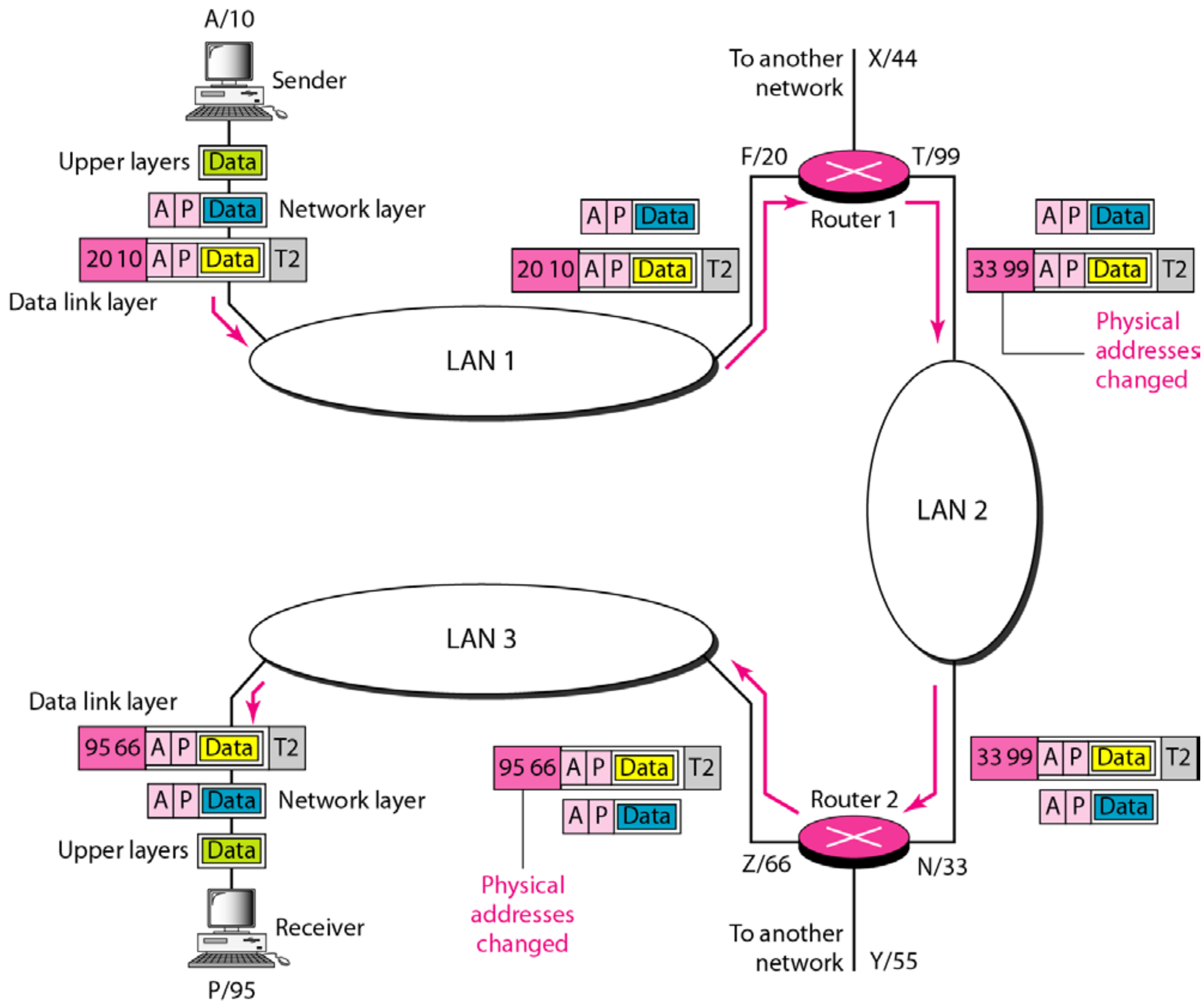
# *Example 2.3 – logic addresses*

***Different networks have different physical address formats.→ not adequate for universal communications.***

***A logic address in the Internet is currently a 32-bit address to uniquely define a host connected to the internet (in IPv4). (128 bits in IPv6)***

***Next figure 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.***

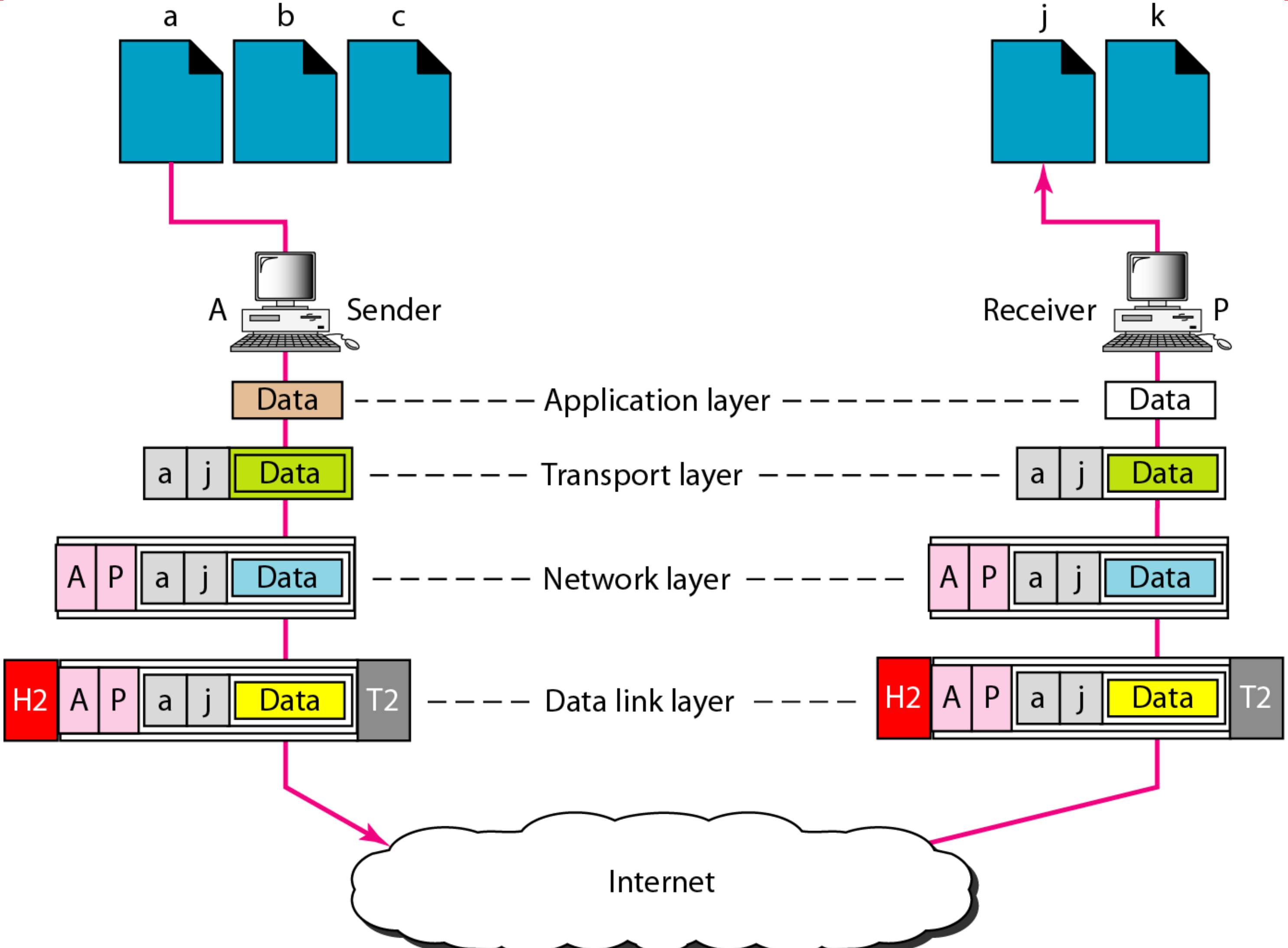
# *IP addresses*



# *Example 2.4 – port addresses*

***Next figure 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.***

## *Port addresses*



# *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.**

***Note***

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

**If you move and connect your computer to a new network of the same type, your logic address changes, while your physical address keeps the same.**

# *Specific addresses*

***User-friendly addresses, such as email address and Universal Resource Locator (URL) (for example, www.ualberta.ca). → get changed to the corresponding port and logic addresses by the sending computer.***

**How to get port address & IP address of the final destination, and MAC address for the next-hop neighbor:**

1. **Port address of the final destination: well-known port address, for example, HTTP uses port address 80 for server.**
2. **IP address of final destination: translated from specific address by DNS (Domain Name System)**
3. **MAC address of next-hop neighbor: Based on IP address of final destination, the routing algorithm will tell IP address of next hop; the station then sends an inquiry over the link to ask who has the IP address.**