Network Models

The OSI Model

- Open Systems Interconnection (OSI).
- Developed by the International Organization for Standardization (ISO).
- Model for understanding and developing computer-to-computer communication architecture that is flexible, robust and interoperable.
- It is not a protocol.
- Developed in the 1980s.
- Divides network architecture into seven layers.

OSI cont.

- Each layer performs a subset of the required communication functions

- Each layer relies on the next lower layer to perform more primitive functions

- Each layer provides services to the next higher layer

- Changes in one layer should not require changes in other layers

- Layer 1,2,3 are the network support layer, deals with the physical aspects of moving data from one device to another.

- Layer 5,6,7 are the user support layer, allow the interoperability among unrelated software.

- Layer 4 ensures that what the lower layer have transmitted is in a form that the upper layers can use.

OSI layer

- Application layer

- Presentation layer

- Session layer

- Transport layer

- Network layer

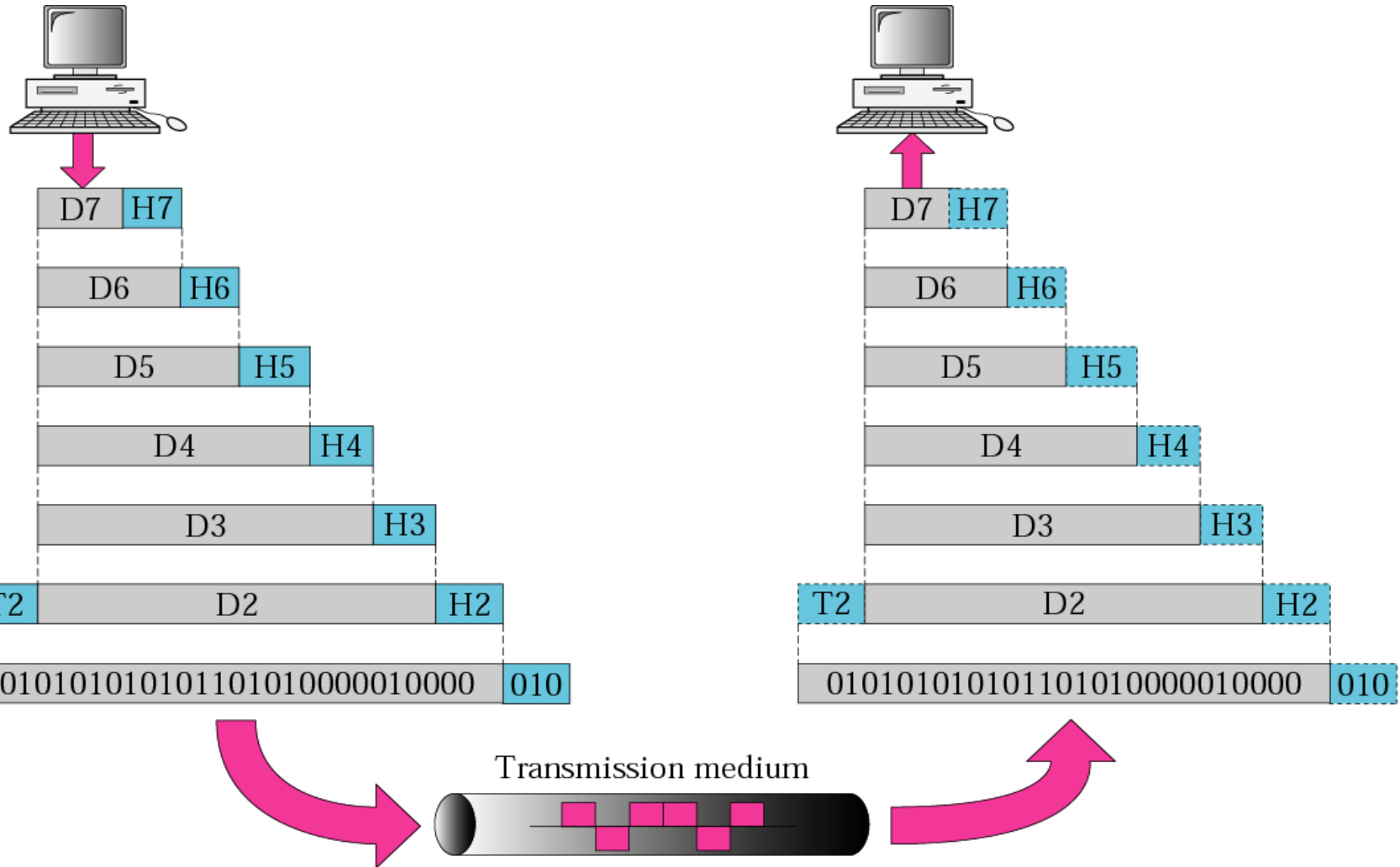- Data Link layer
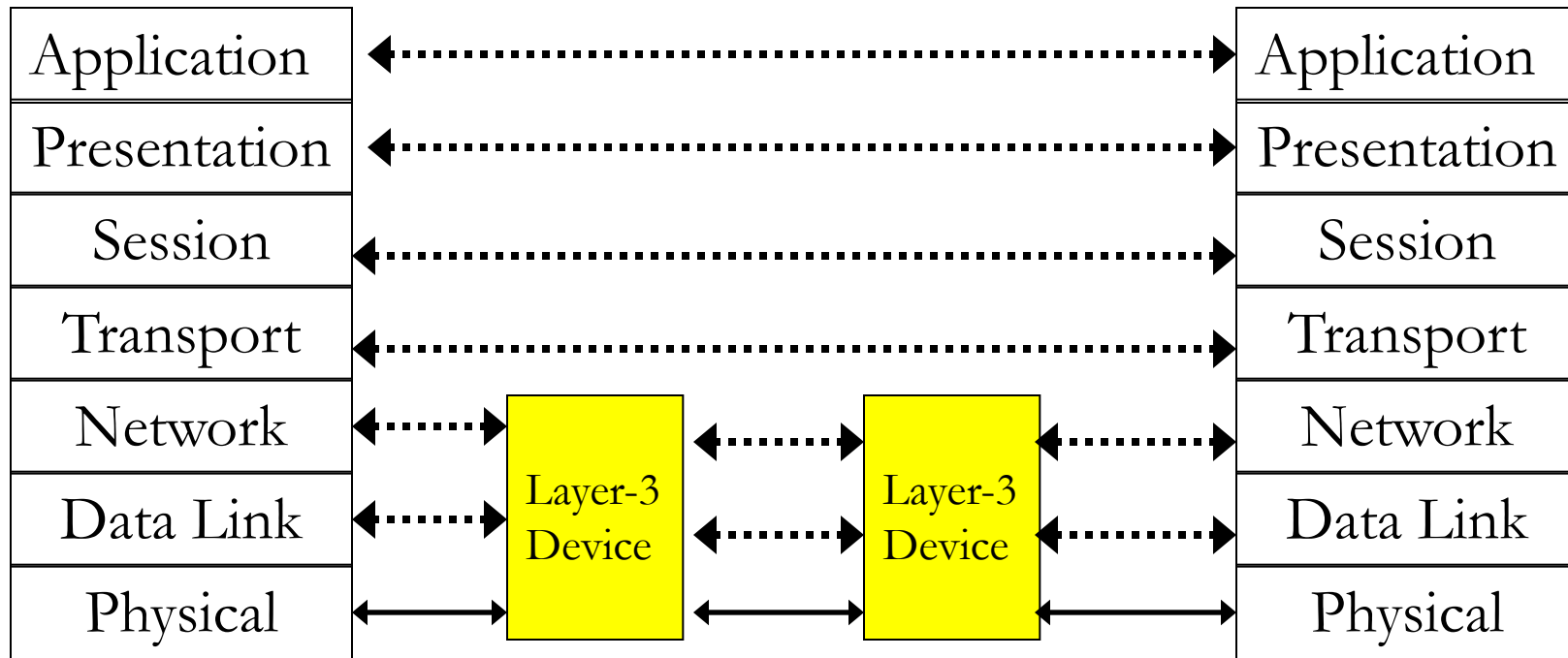
- Physical layer

OSI layer
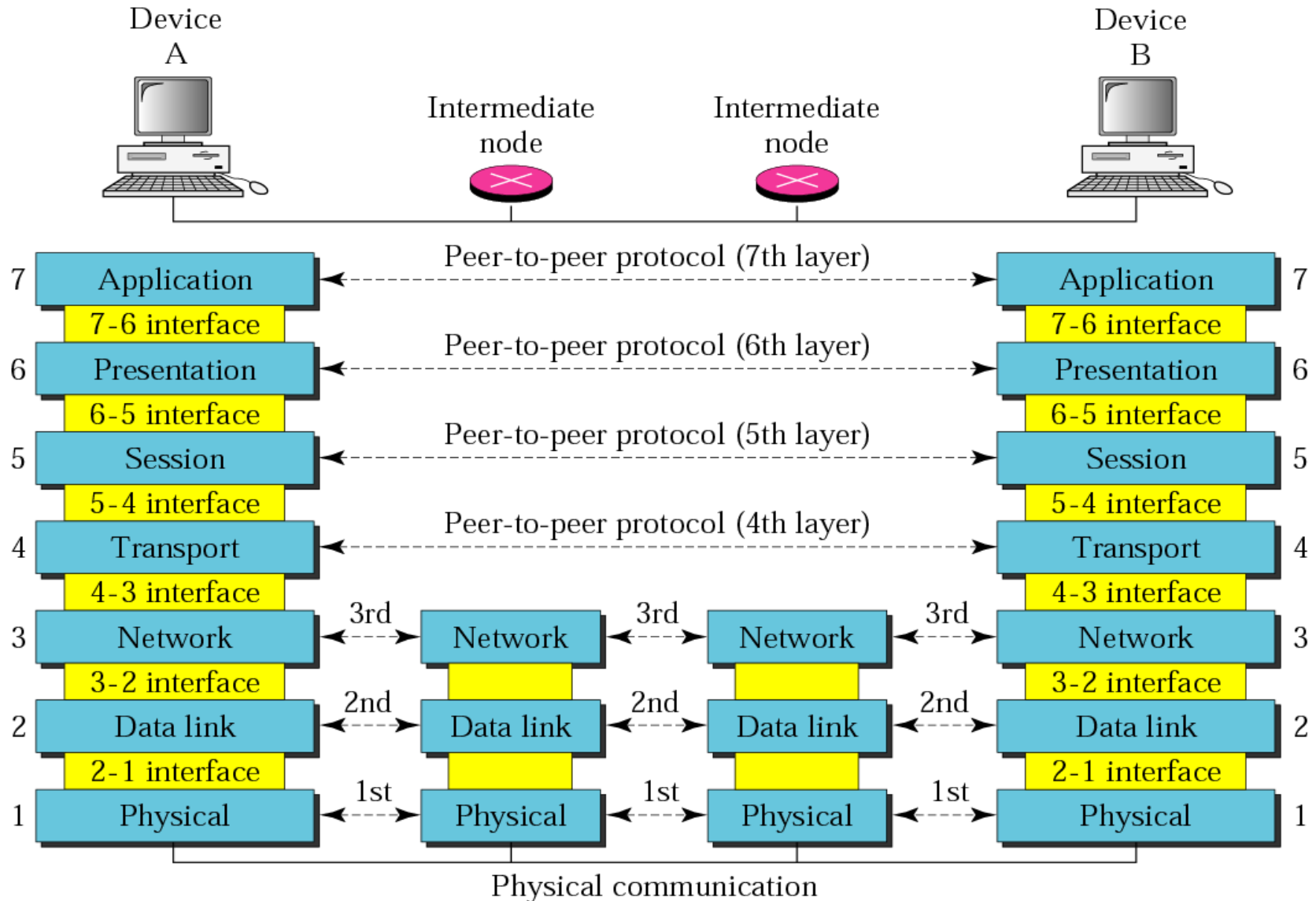
Protocol Data Units (PDU)

- At each layer, protocols are used to communicate
- Control information is added to user data at each layer
- For example, the transport layer may fragment user data
- Each fragment has a transport header added
  - Destination Address
  - Sequence number
  - Error detection code
- This creates a *transport protocol data unit (TPDU)*

An exchange using the OSI model

Transmission medium

Layer 1,2,3

| Application		Application
Presentation		Presentation
Session		Session
Transport		Transport
Network	Layer-3 Device	Layer-3 Device	Network
Data Link			Data Link
Physical			Physical

Layer 2 and 3 addressing schemes needed and layer 1 addressing scheme is not needed

Layer 1: Physical Layer

- Responsible of:
  - Transmitting individual bits from one to the next.
  - Physical characteristics of interface and media.
  - Representation of bits: a stream of bit(0s,1s),
  - Data rate.
  - Synchronize of bits
  - Line configuration
 - Physical topology
 - Transmission mode

Physical Layer cont.
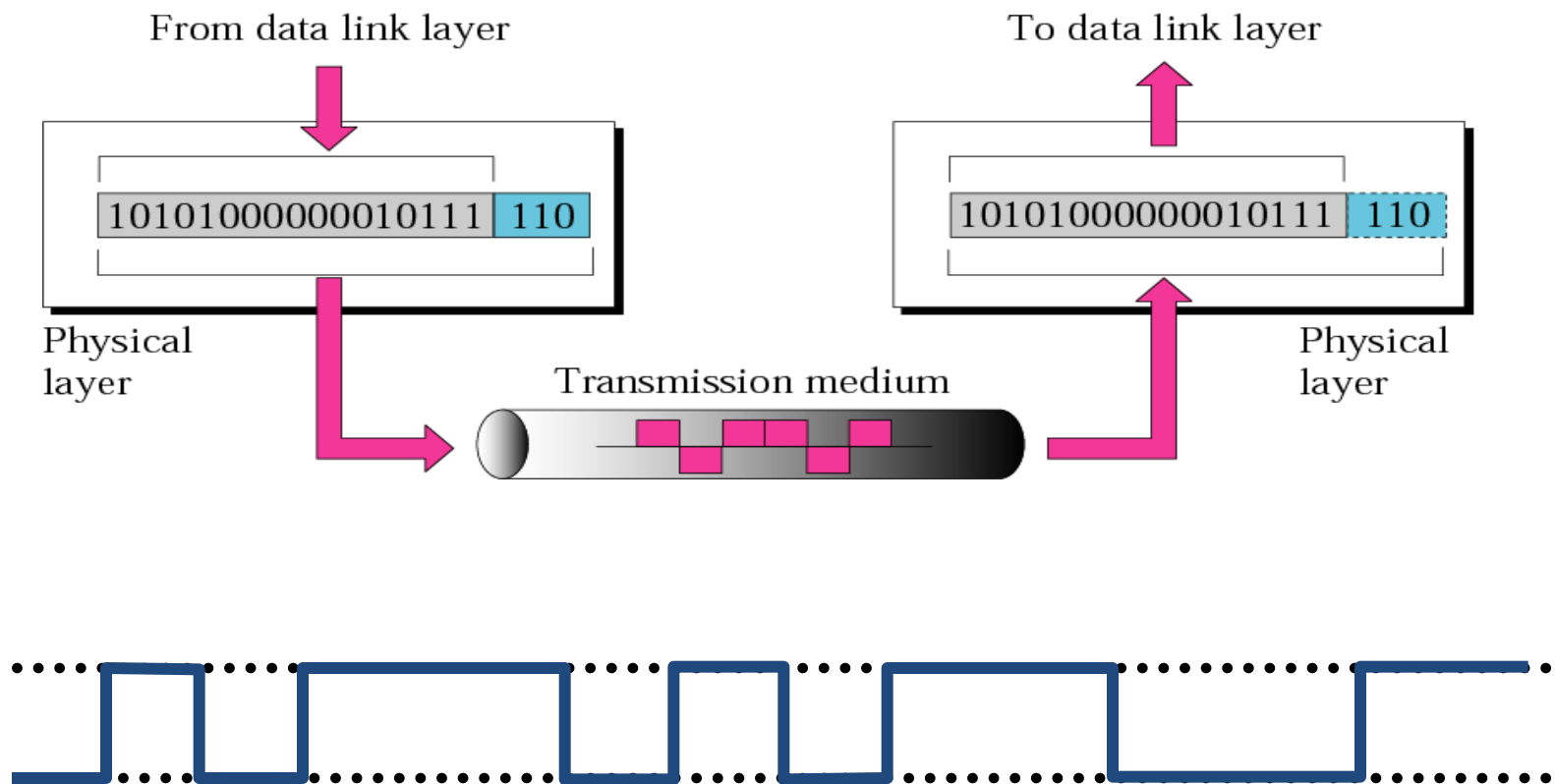
Layer 2: Data Link layer

- Responsible of:
  - Moving frames from one hop (node) to the next.
  - Framing: divided the stream of bits received from the network layer manageable data units called frames.
  - Physical address (MAC address).
  - Flow control.
  - Error control: added trailer to the end of frame.
  - Access control.
 - Hop to hop delivery

# Data Link layer cont.
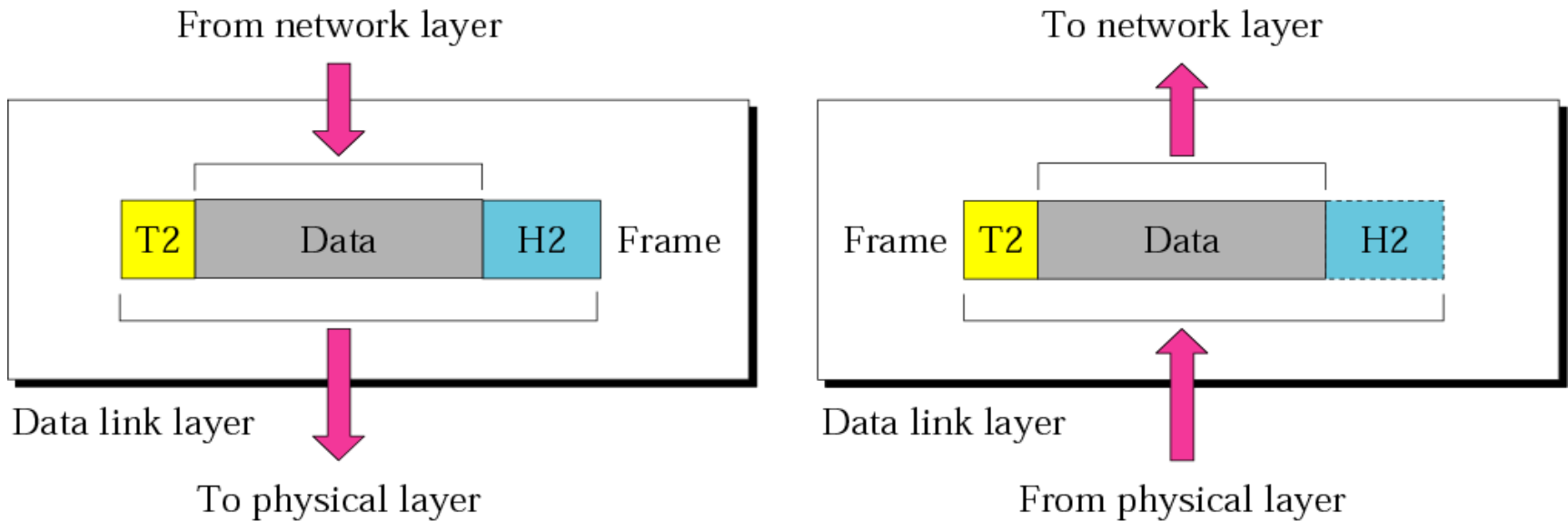
Hop-to-Hop delivery
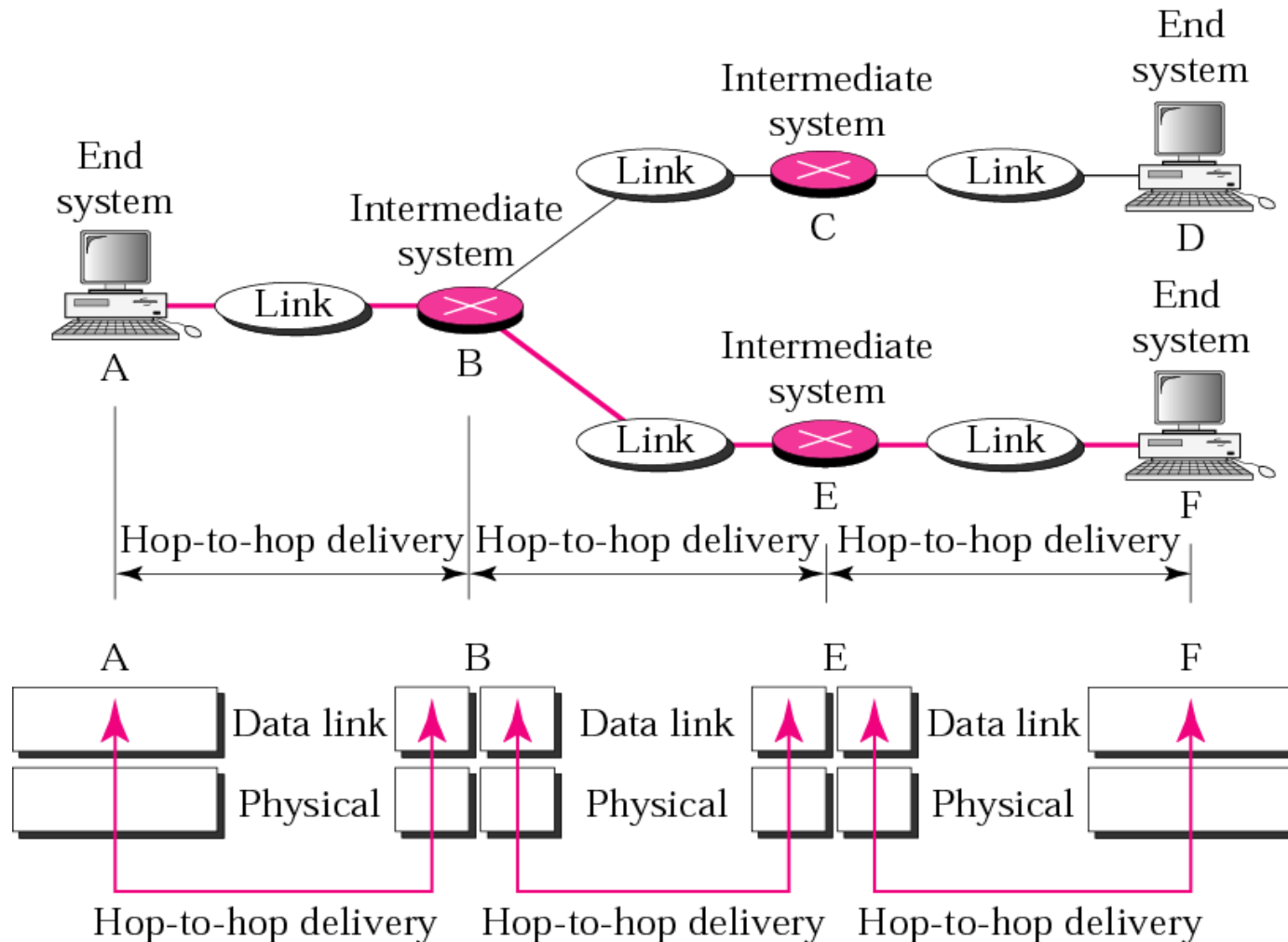
Layer 3: Network Layer

- The network layer is responsible:

  - The delivery of individual packets from the original source to the final destination .

  - Logical addressing: if the packet passes the network boundary we need another addressing system to help (source to destination) connection.

  - Routing : route or switch the packet to final destination.

  - Source-to-destination delivery (End-to-End).

Network Layer cont.
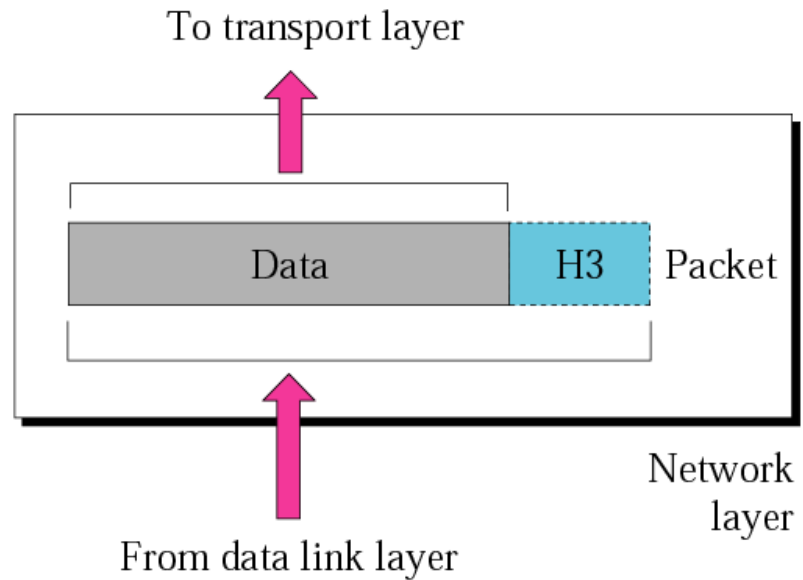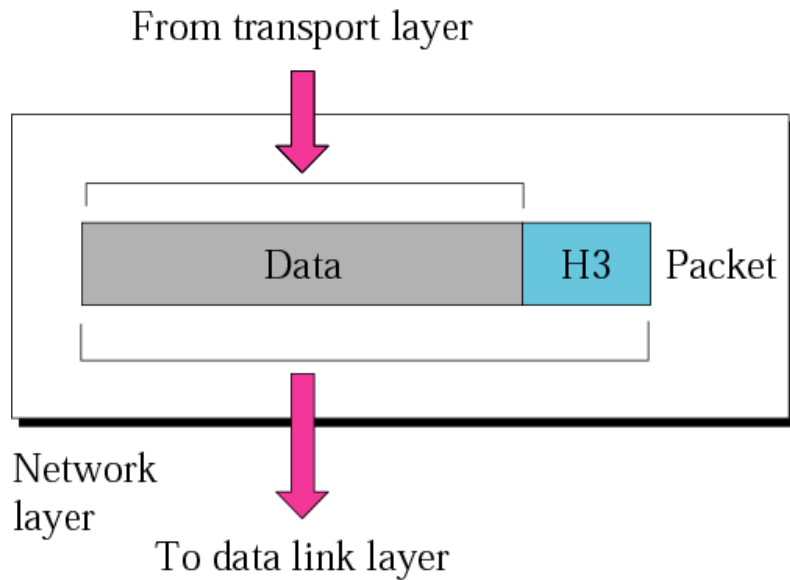
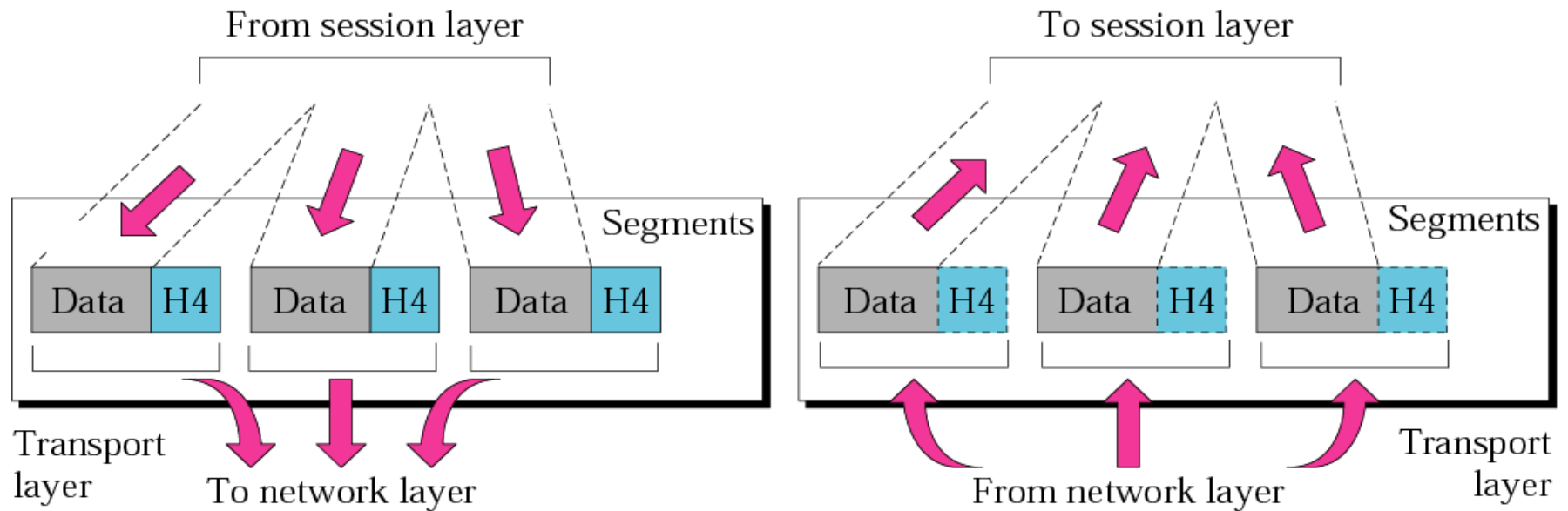# Source-to-Destination delivery
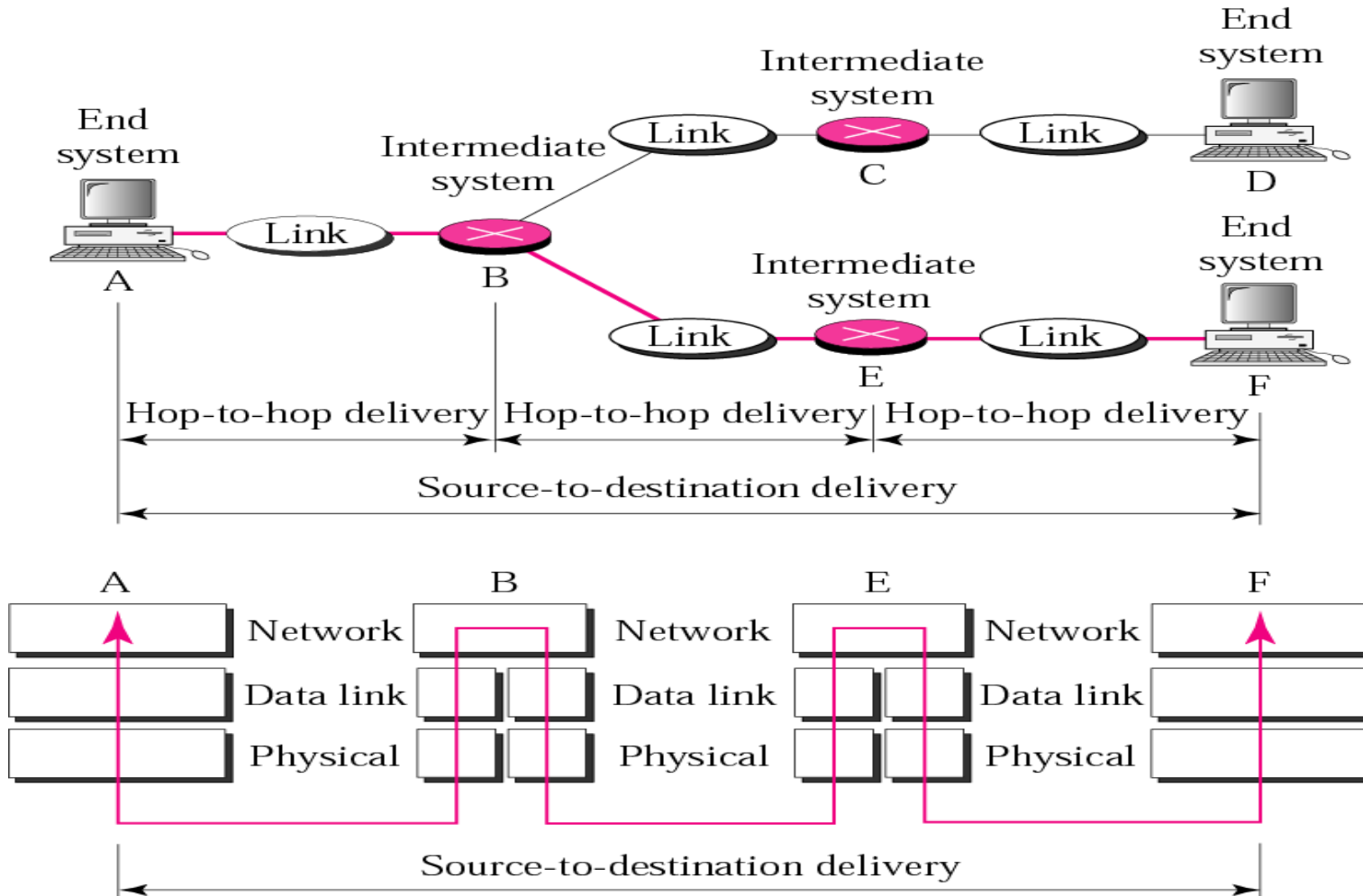
Layer 4: Transport Layer

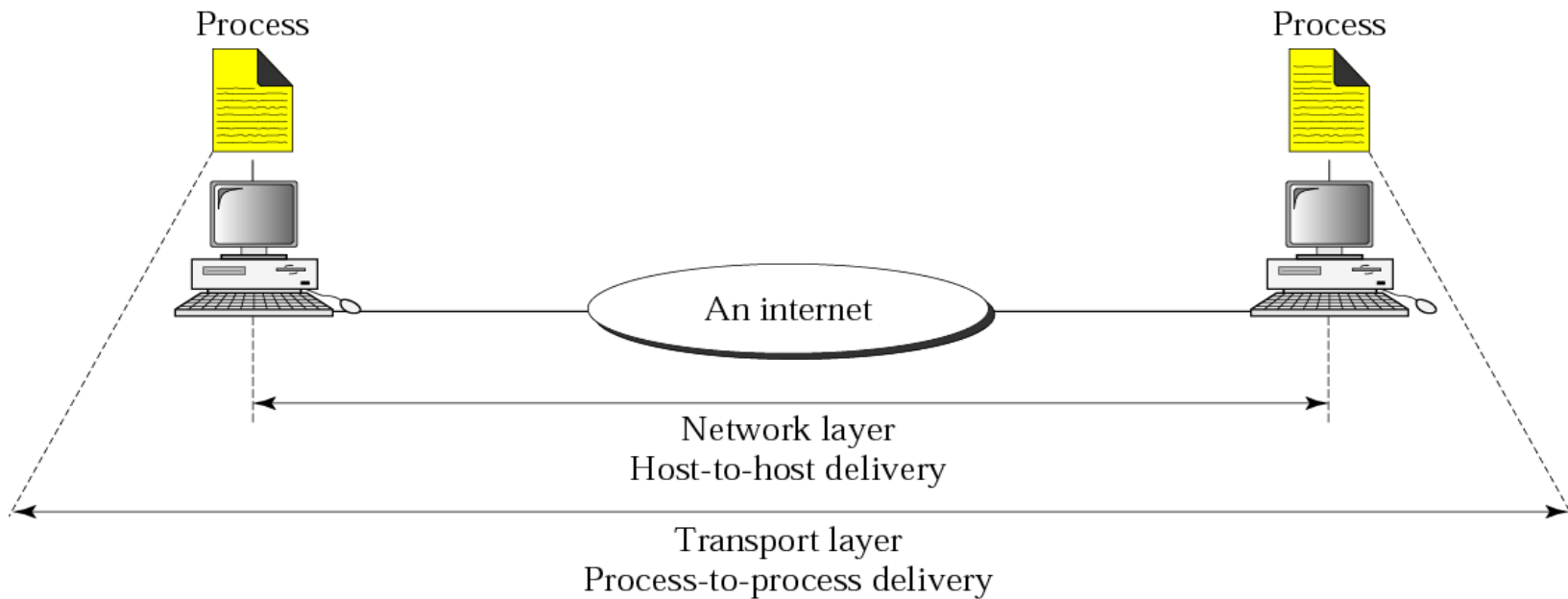- The transport layer is responsible for:
  - **Service point or Port addressing**
  - **Segmentation and reassembly** : a message is divided into transmittable segments each segment containing a sequence no.
  - **Connection Control**: connection oriented or connectionless.
  - **Flow control**
  - **Error control**

Transport Layer cont.

Reliable process-to-process delivery of a message

Layer 5: Session Layer

- Dialog control: design to establish, maintain, and synchronize the interaction between communicating systems.

- Synchronization: it allows a process to add checkpoints or synchronization points to a data stream.

Session Layer cont.
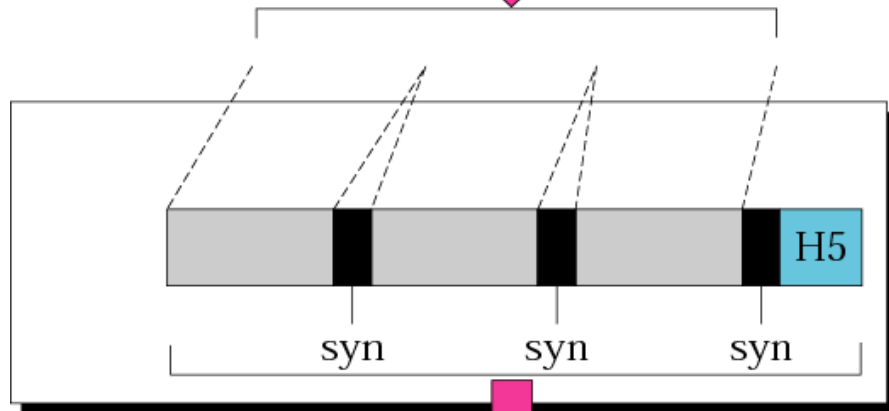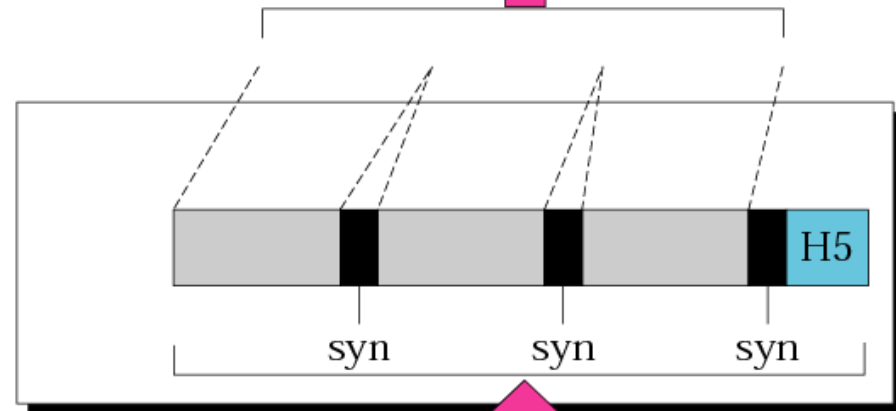
Layer 6 :Presentation Layer

- Design to the handle the syntax and semantic of the information exchanged between 2 systems.

- And design for data translation, encryption, decryption, and compression.

Presentation Layer cont.
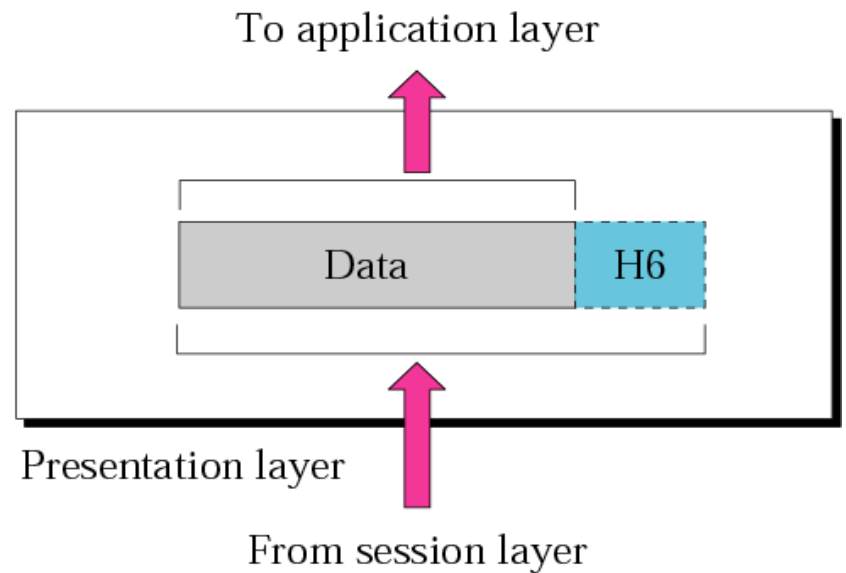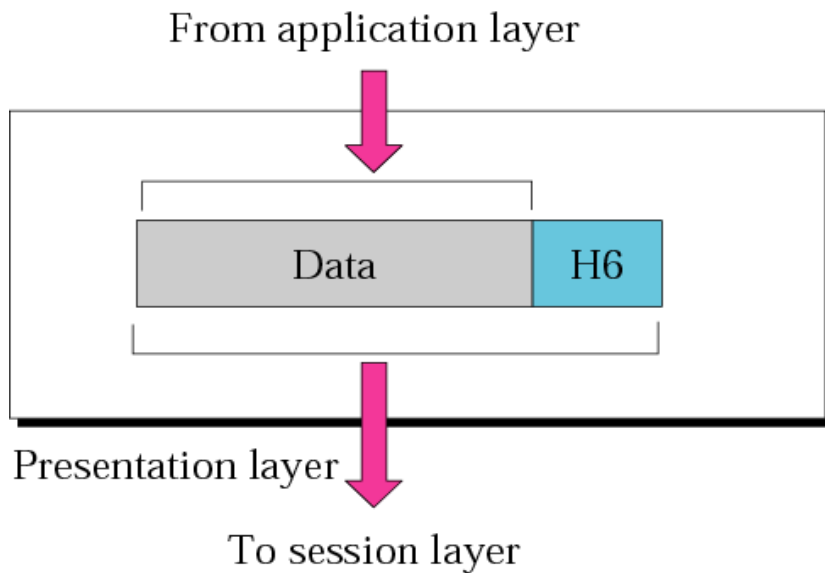
Layer 7: Application Layer

- The application layer is responsible for providing services to the user.
- Mail services
- File transfer, access and management
- Remote log-in or network virtual terminal
- Accessing the World Wide Web
- Directory service

Application Layer cont.

Summary

	Application	To allow access to network resources
To translate, encrypt, and compress data	Presentation	
	Session	To establish, manage, and terminate sessions
To provide reliable process-to-process message delivery and error recovery	Transport	
	Network	To move packets from source to destination; to provide internetworking
To organize bits into frames; to provide hop-to-hop delivery	Data link	
	Physical	To transmit bits over a medium; to provide mechanical and electrical specifications

Application   data stream

Presentation   data stream   → data

Session   data stream

Transport

| data | data | data | → Segments

Network

| Network header | data | → packets

Data link

| Frame H | Network H | data | From trailer | → Frames

Physical   1110111 0111 011111101   → Bits

TCP/IP Protocol Suite

- **The <u>TCP/IP protocol suite</u> is a hierarchical protocol , made of five layers:**
  - **Physical layer**
  - **Data link layer**
  - **Network layer**
  - **Transport layer**
  - **Application layer.**

Some Protocols in TCP/IP Suite
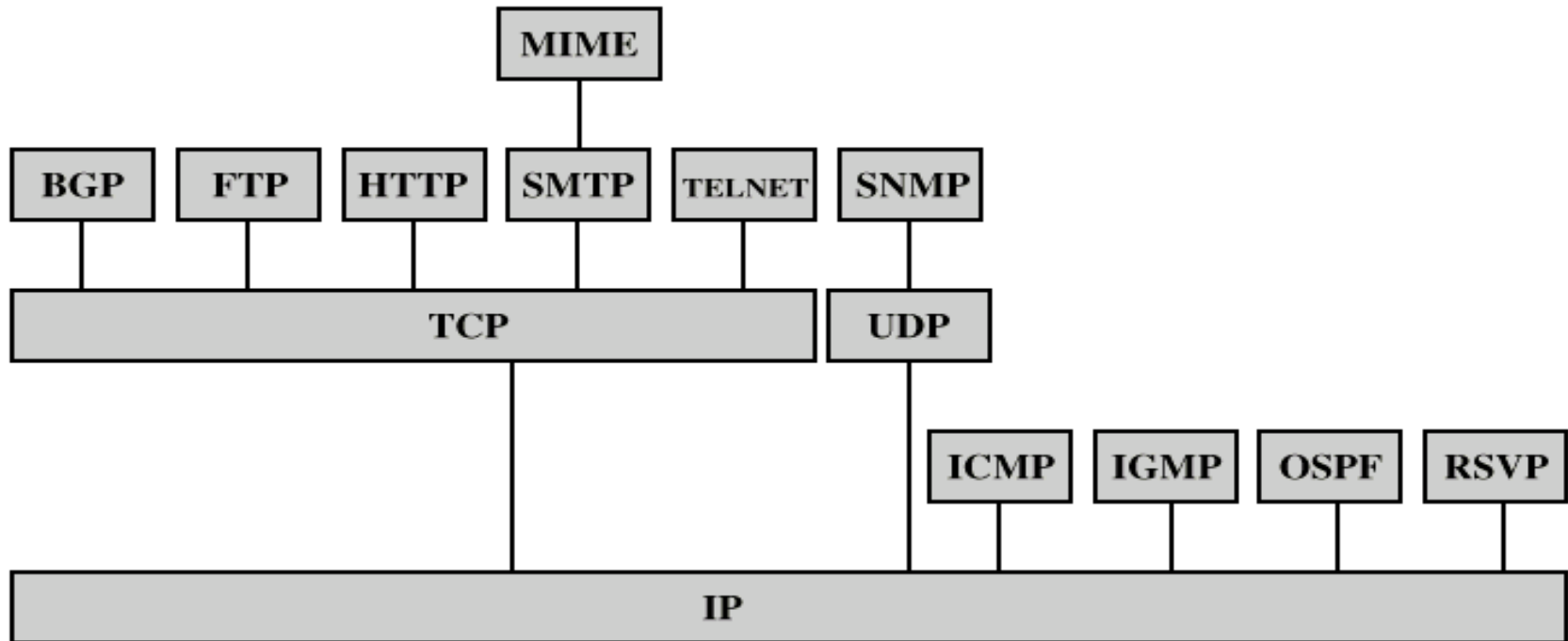
BGP =	Border Gateway Protocol	OSPF = Open Shortest Path First
FTP =	File Transfer Protocol	RSVP = Resource ReSerVation Protocol
HTTP =	Hypertext Transfer Protocol	SMTP = Simple Mail Transfer Protocol
ICMP =	Internet Control Message Protocol	SNMP = Simple Network Management Protocol
IGMP =	Internet Group Management Protocol	TCP = Transmission Control Protocol
IP =	Internet Protocol	UDP = User Datagram Protocol
MIME =	Multi-Purpose Internet Mail Extension	

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

	Applications						
Application							
Presentation	SMTP	FTP	HTTP	DNS	SNMP	TELNET	. . .
Session							

Transport	SCTP	TCP	UDP

Network (internet)	ICMP IGMP IP RARP ARP

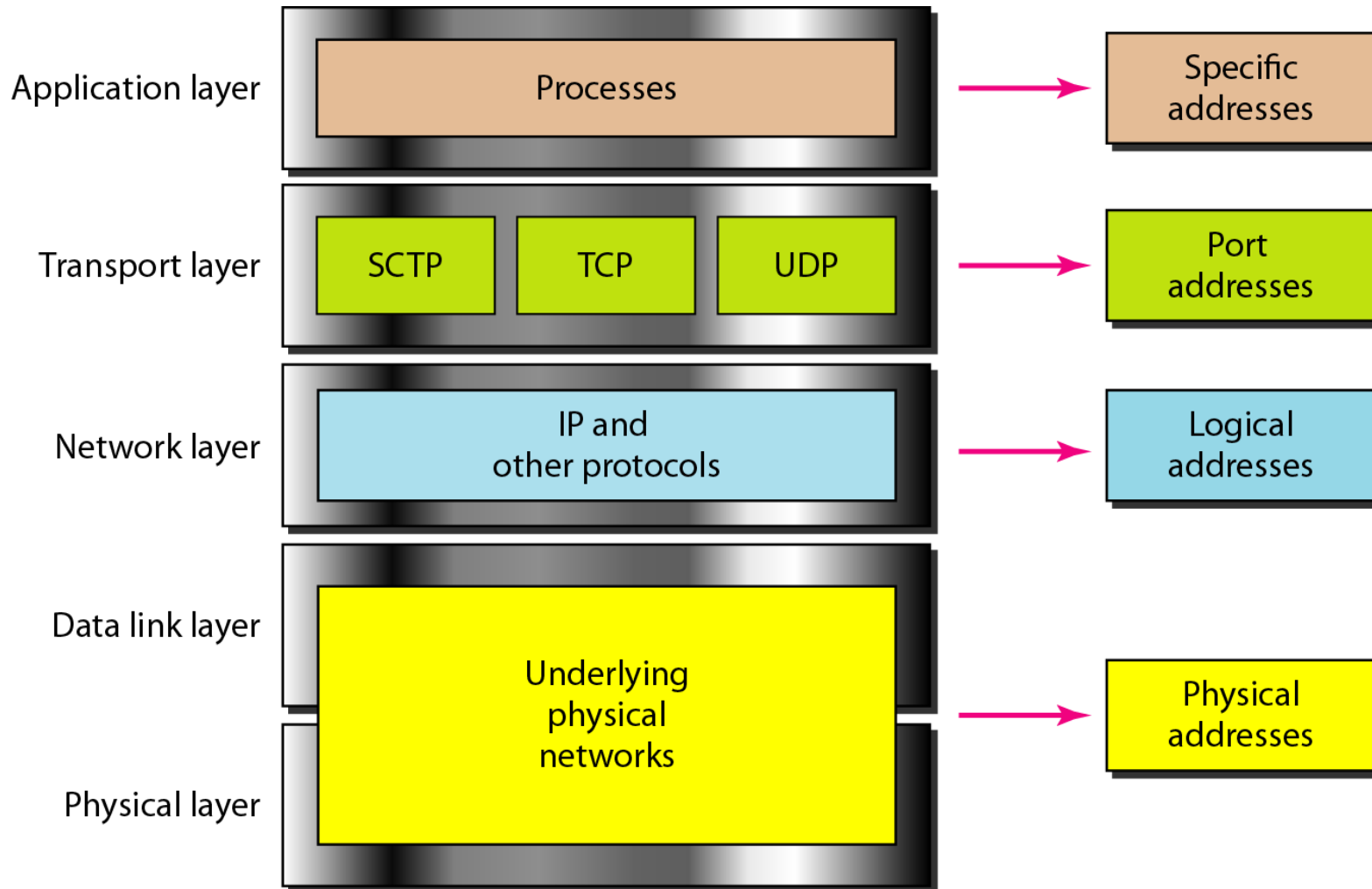|	
Data link	Protocols defined by the underlying networks (host-to-network)
Physical	
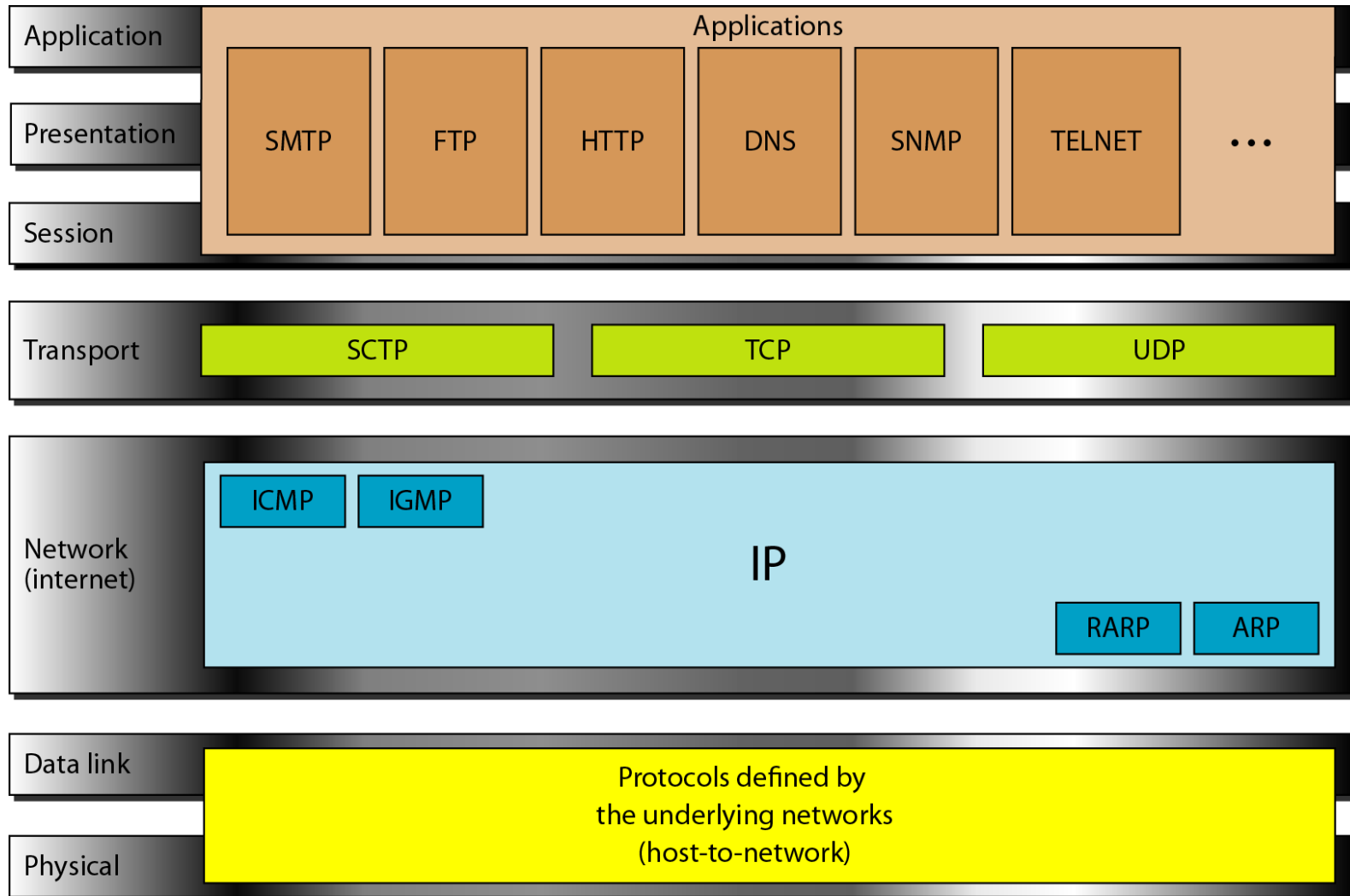
ADDRESSING

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

Relationship of layers and addresses in TCP/IP

SCTP: Stream Control Transmission Protocol
TCP: Transmission Control Protocol
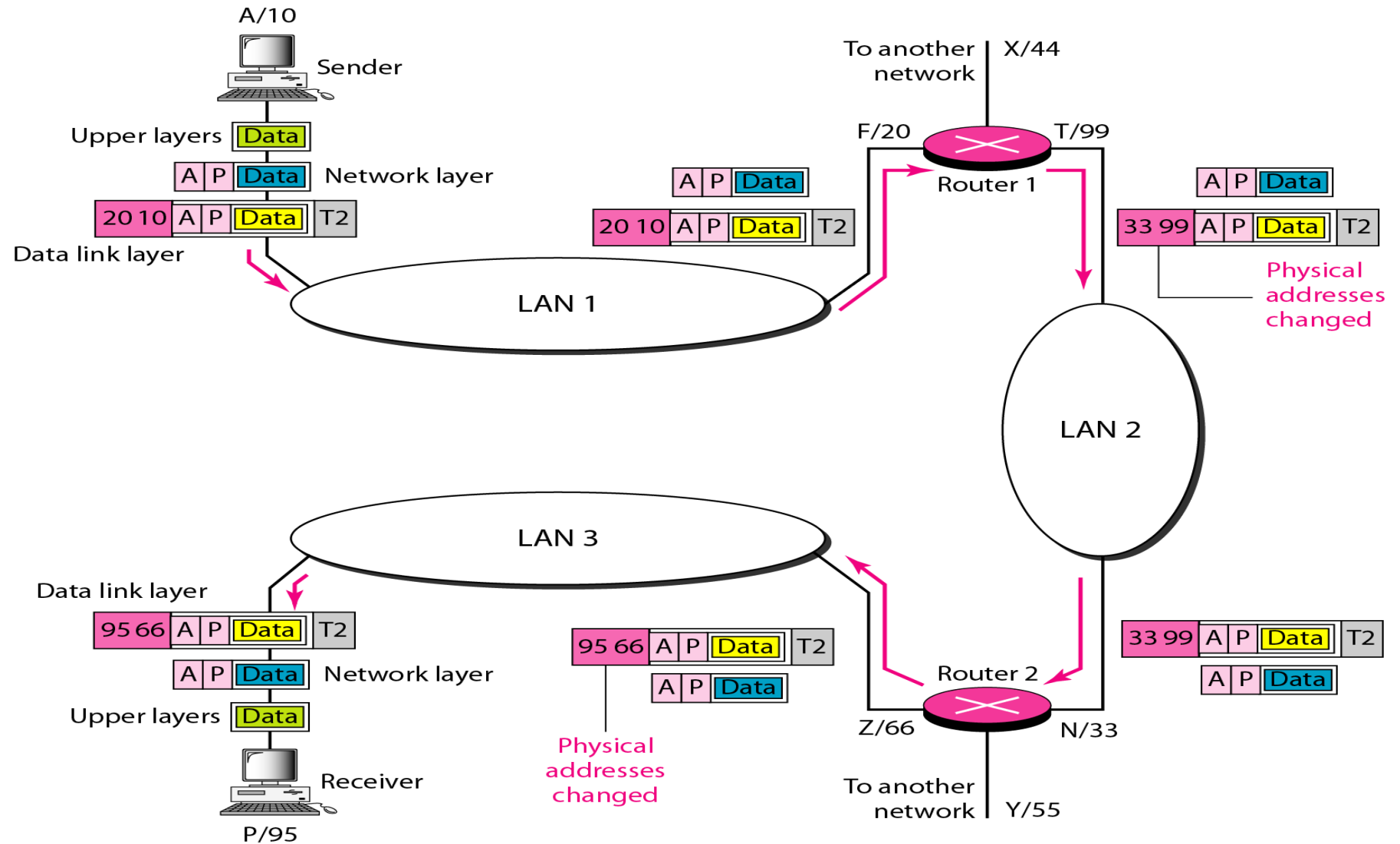UDP: User Datagram Protocol

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.
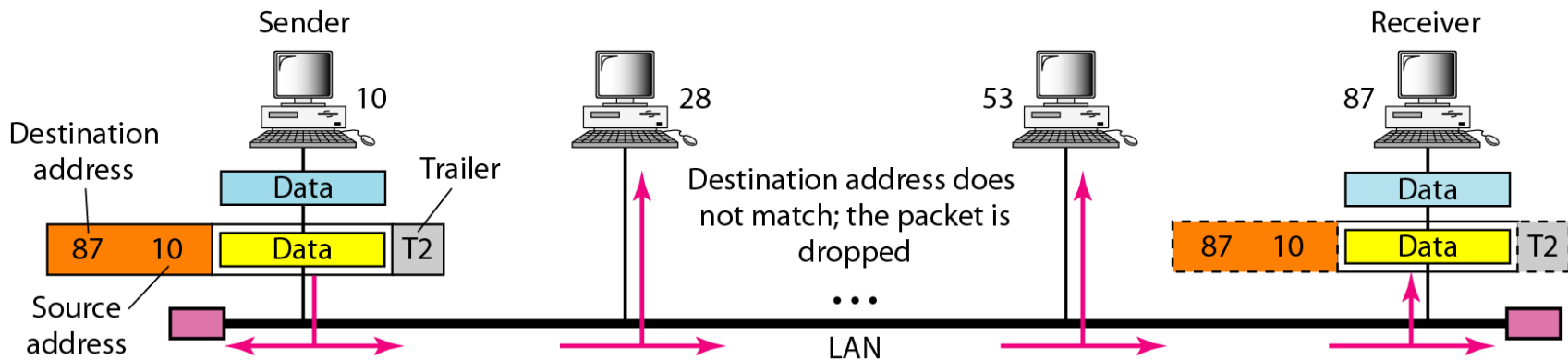
Example 2.3

- 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*

A/10

Sender

Upper layers **Data**

A P **Data** Network layer

20 10 A P **Data** T2

Data link layer

LAN 1

A P **Data**

20 10 A P **Data** T2

To another
network   X/44

F/20   T/99

Router 1

A P **Data**

33 99 A P **Data** T2

Physical
addresses
changed

LAN 2

Data link layer

95 66 A P **Data** T2

A P **Data** Network layer

Upper layers **Data**

Receiver

P/95

LAN 3

95 66 A P **Data** T2

A P **Data**

Physical
addresses
changed

Router 2

Z/66   N/33

To another
network   Y/55

33 99 A P **Data** T2

A P **Data**

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
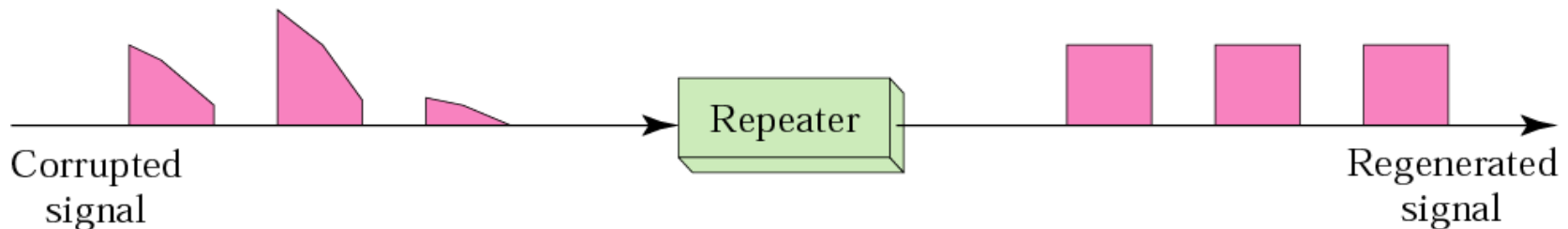
Figure 2.21 *Port addresses*
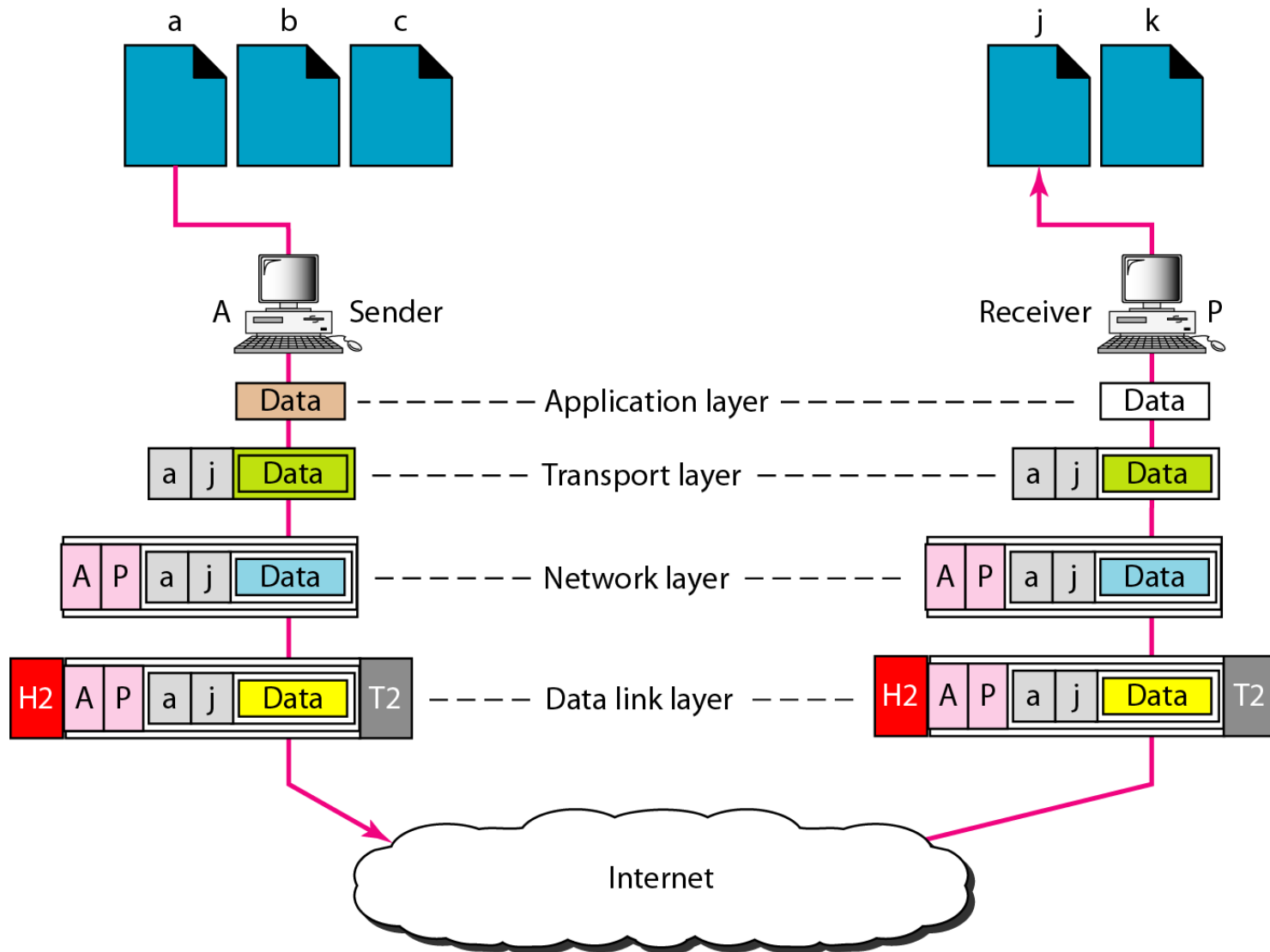
Network Devices

- Modem: a device that modulates a digital signal onto analog signal for transmission over telephone lines.

- Repeater: Re-generates the signal again.

Regenerated signal — Repeater — Corrupted signal
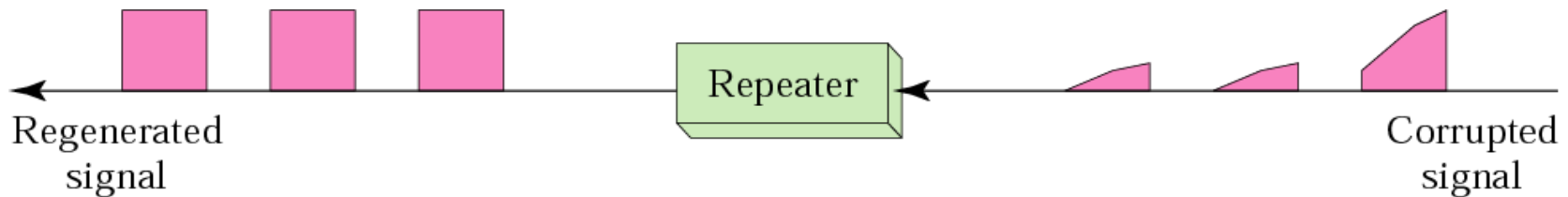
a. Right-to-left transmission.

Corrupted signal — Repeater — Regenerated signal

b. Left-to-right transmission.

DEVICES :

1. **Hub**, a distributor that has a lot of ports which connected to computers.

2. **Switches**, like a hub but it transmit packets to it destination

3. **Bridge**, it is used to connect two similar LANs.

4. **Routers**, choose the best path to transmit the packet.

5. **Gateway**, it is use to connect two deferent LANs and connect different application protocols.

6. **Repeaters**, repeats signals that travels via long distance

Network devices With Layer

Layers	Network Devices
Application Layer	Application gateway
Transport Layer	Transport gateway
Network Layer	Router and gateway
Data link layer	Bridge and Switch
Physical Layer	Repeater, Hub and Modem.