Chapter-2

Network Models

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Network Models

Two network models

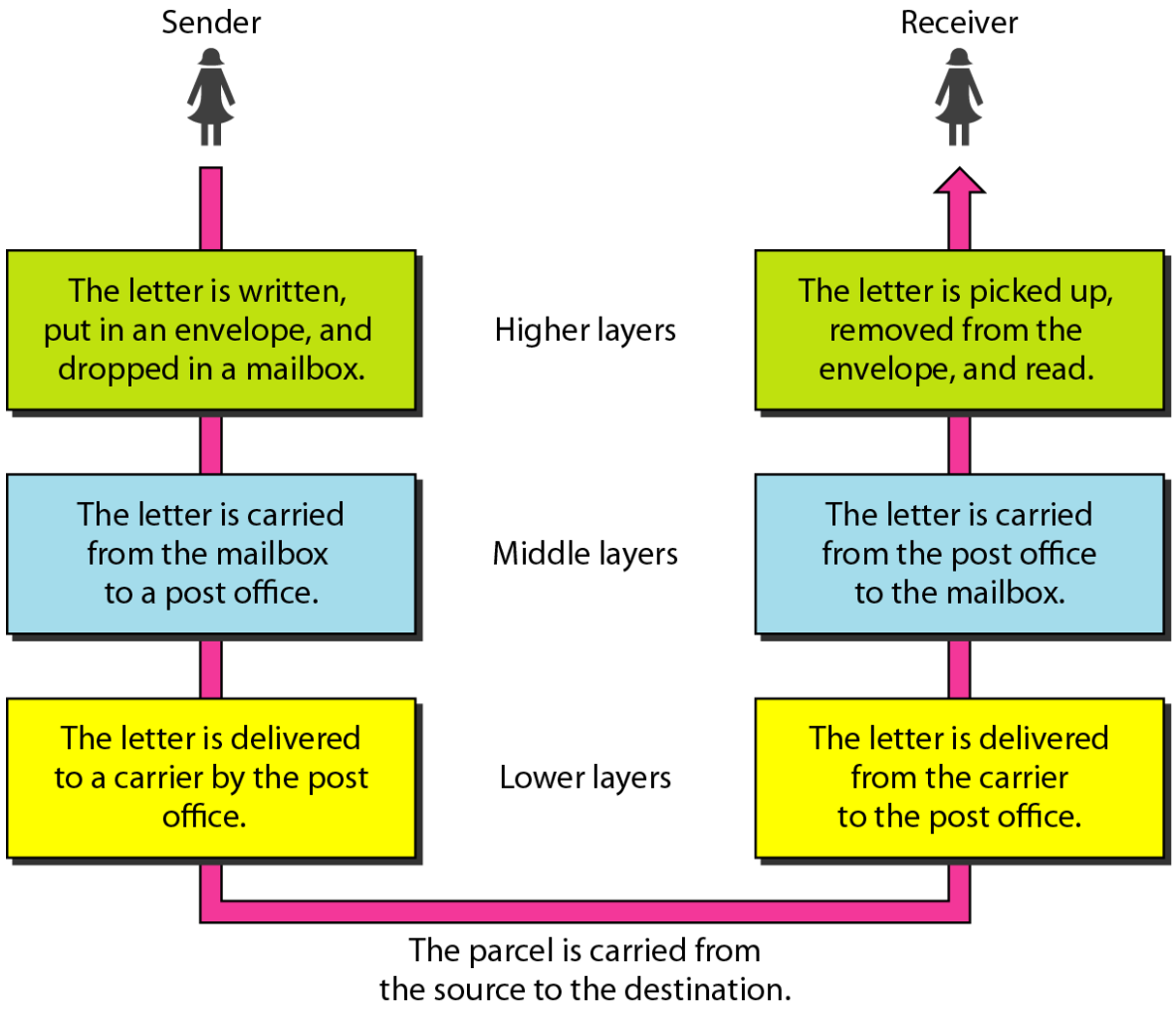
1. OSI(Open System Interconnection) model
2. TCP/IP Model

Both models use layered task approach

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.***

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.

The purpose of OSI model is to show how to facilitate communication between different systems without requring changes to the logic of underlying hardware and software.

Note

ISO is the organization.
OSI is the model.

Open systems

- In open systems, set of protocols allow any two different systems to communicate regardless of their underlying architecture

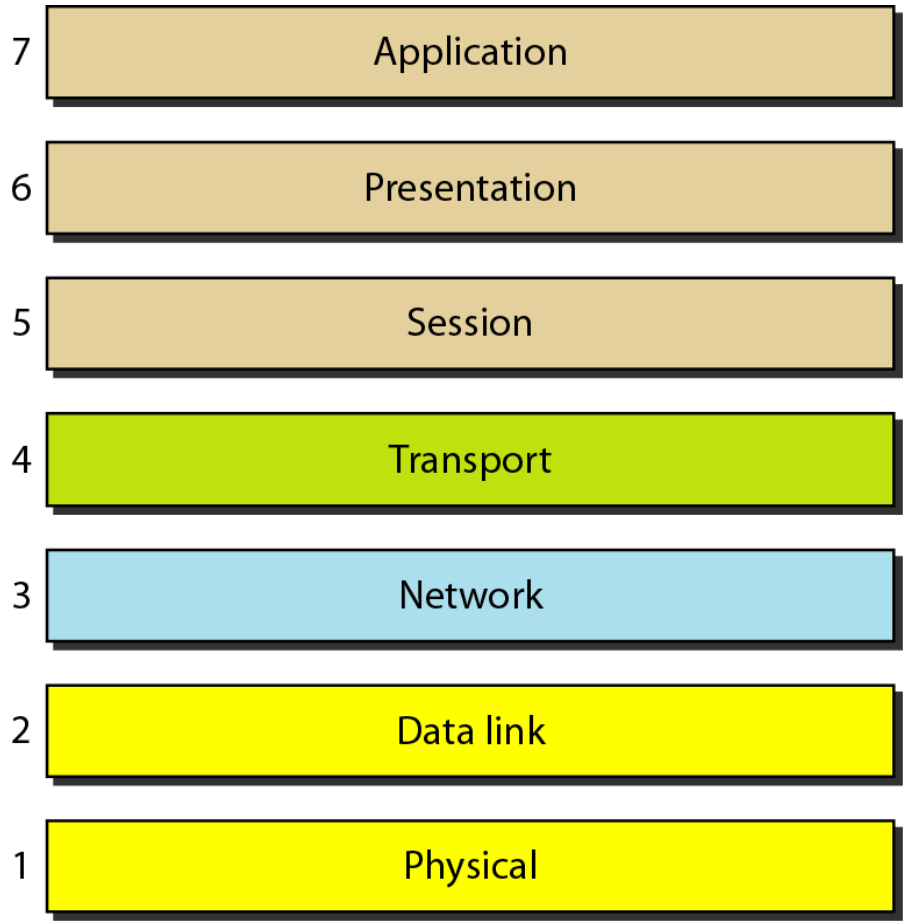
Layered Architecture is used:

•To reduce design complexity computer networks are organized as stack of layers or levels.

•Each layer get service from the layer below it.

•The OSI model is divided in to seven layers.

Figure 2.2 *Seven layers of the OSI model*

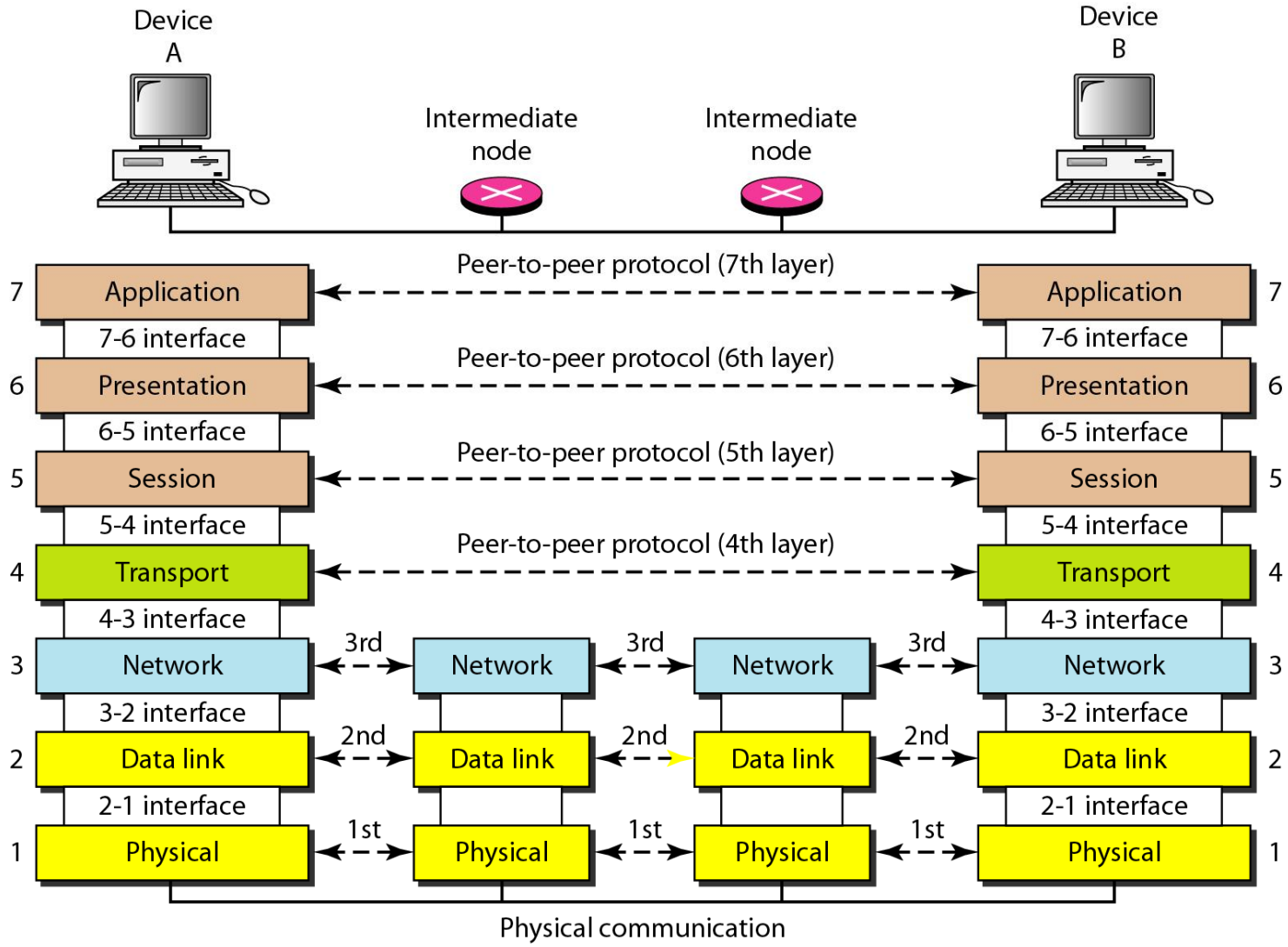


Why layering is necessary

- To reduce design complexity
- To provide well-defined interfaces between adjacent layers ie a change in one layer that does not affect the change in other layers.
- Allows structured development of network software.

(Note: A set of layers and protocols is called a network architecture)

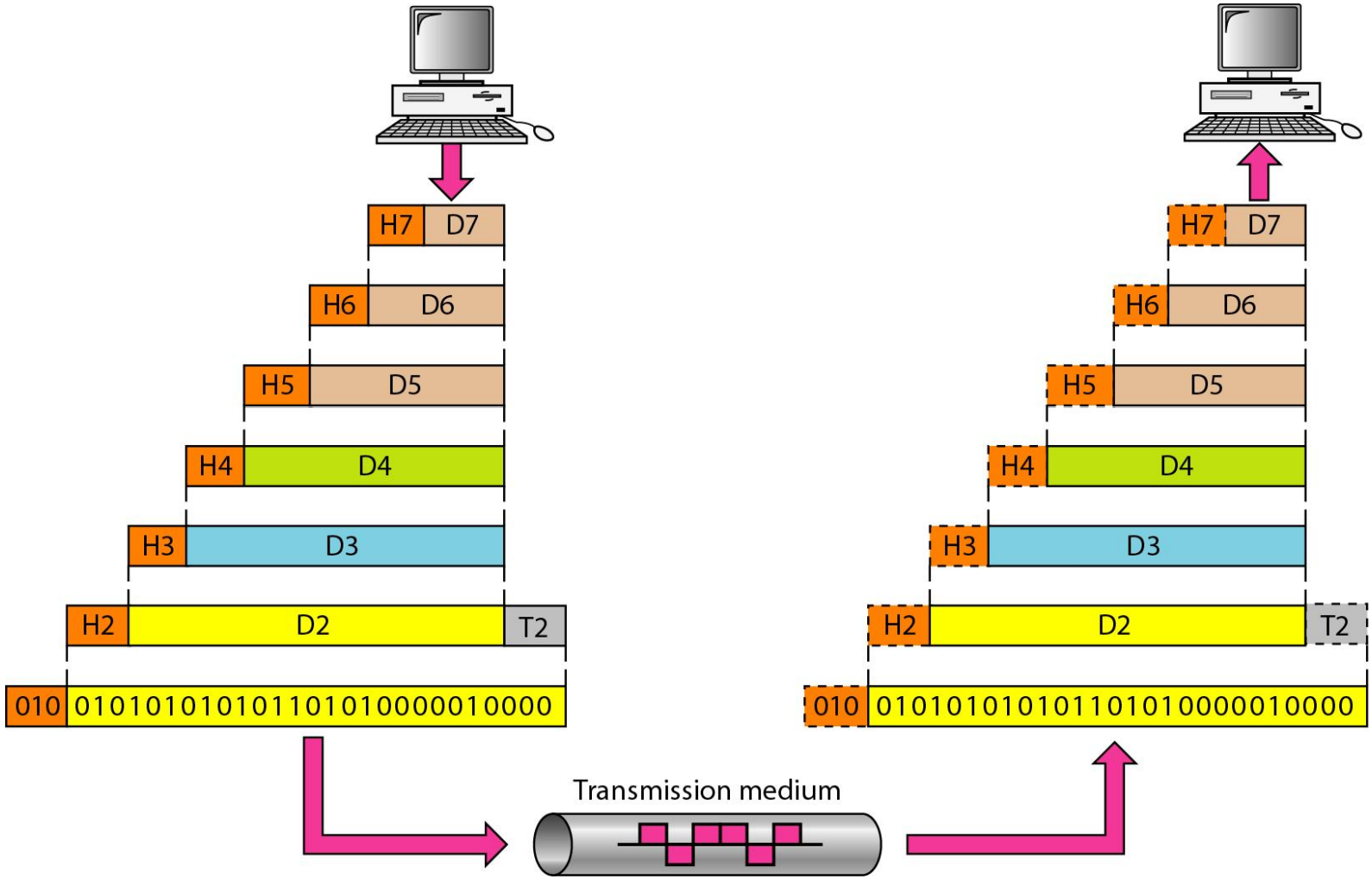
The interaction between layers in the OSI model



Peer-to-Peer Processes

- The processes on each machine that communicate at a given layer are called peer-to- peer processes.

Figure 2.4 *An exchange using the OSI model*



Encapsulation

- A packet(header,data and trailer) at level n is encapsulated in level n-1.

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- The data portion of a packet at level n-1 carries the whole packet (data,header,and trailer) from level n

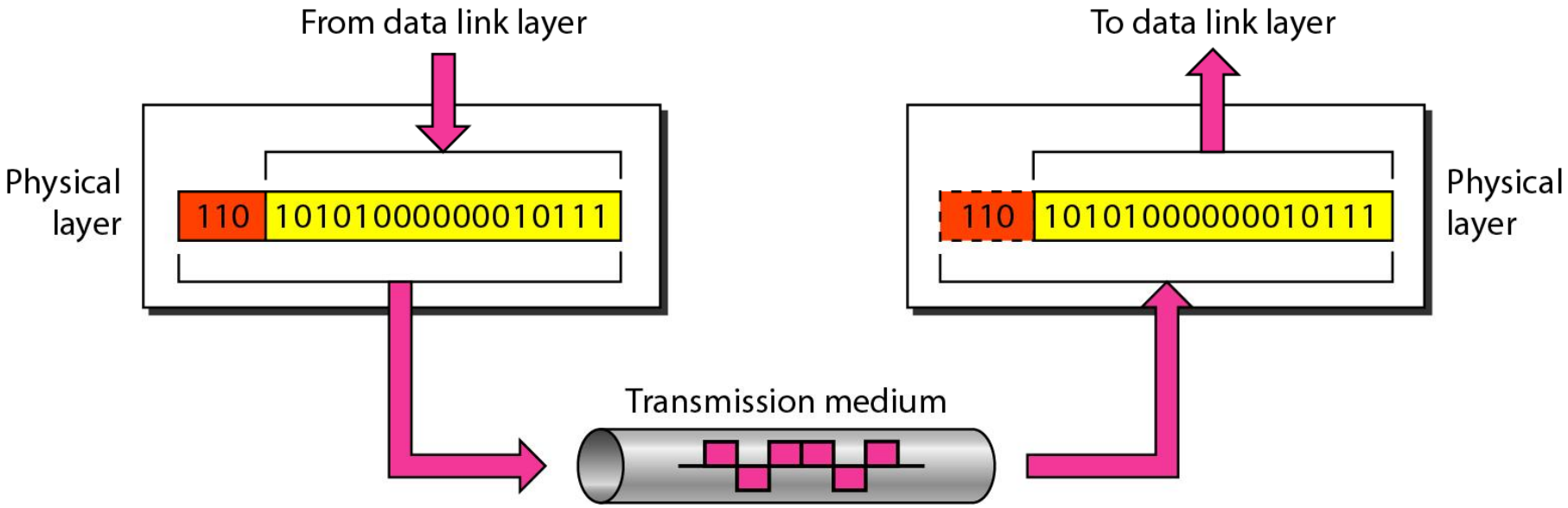
LAYERS IN THE OSI MODEL

7 layers of OSI Model

1.Physical Layer
2.Data Link Layer
3.Network Layer
4.Transport Layer
5.Session Layer
6.Presentation Layer
7.Application Layer

Figure 2.5 *Physical layer*

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

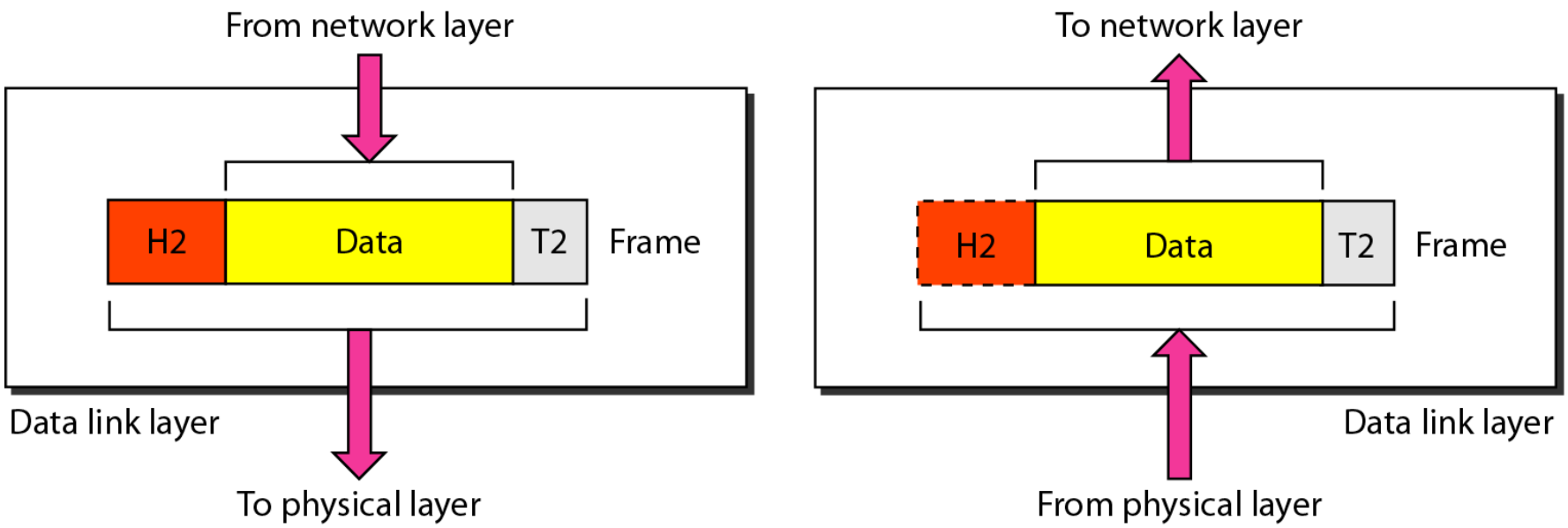


Functions of physical layer

- Define Physical characteristics of the interface between devices and transmission medium.
- Representation of bits: bits are converted in to electrical or optical signals.
- Data rate/Transmission rate: The no of bits sent each second and how long it lasts.
- Syncronization of bits:Sender and the receiver clocks must be syncronized.
- Line configuration:point to point or multipoint.
- Physical topology:star,bus ring,mesh etc.
- Transmission modes:full-duplex,half-duplex etc.

Figure 2.6 *Data link layer*

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



Functions of data link layer

- Framing:The data link layer divides the stream of bits received from the network layer in to manageable data units called as frames.
- Physical addressing: MAC address
- Flow control: Controls the flow of data between sender and receiver
- Error control: Controls the error in data during transmission in the link.
- Congestion control: Controls network traffic.
- Access control: When two or more devices are connected to the same link then data link layer protocols determine which device has the control over the link at a given time

Sub layers of Data link layer

1. Logical Link Control(LLC)
2. Media Access Control(MAC)

Functions

LLC:

- Acts as an interface between the media access control (MAC) **sublayer** and the network layer.
- Link control: Managing error control and flow control
- Multiplexing

MAC:

- Physical addressing
- Multiple access

Figure 2.7 *Hop-to-hop delivery*

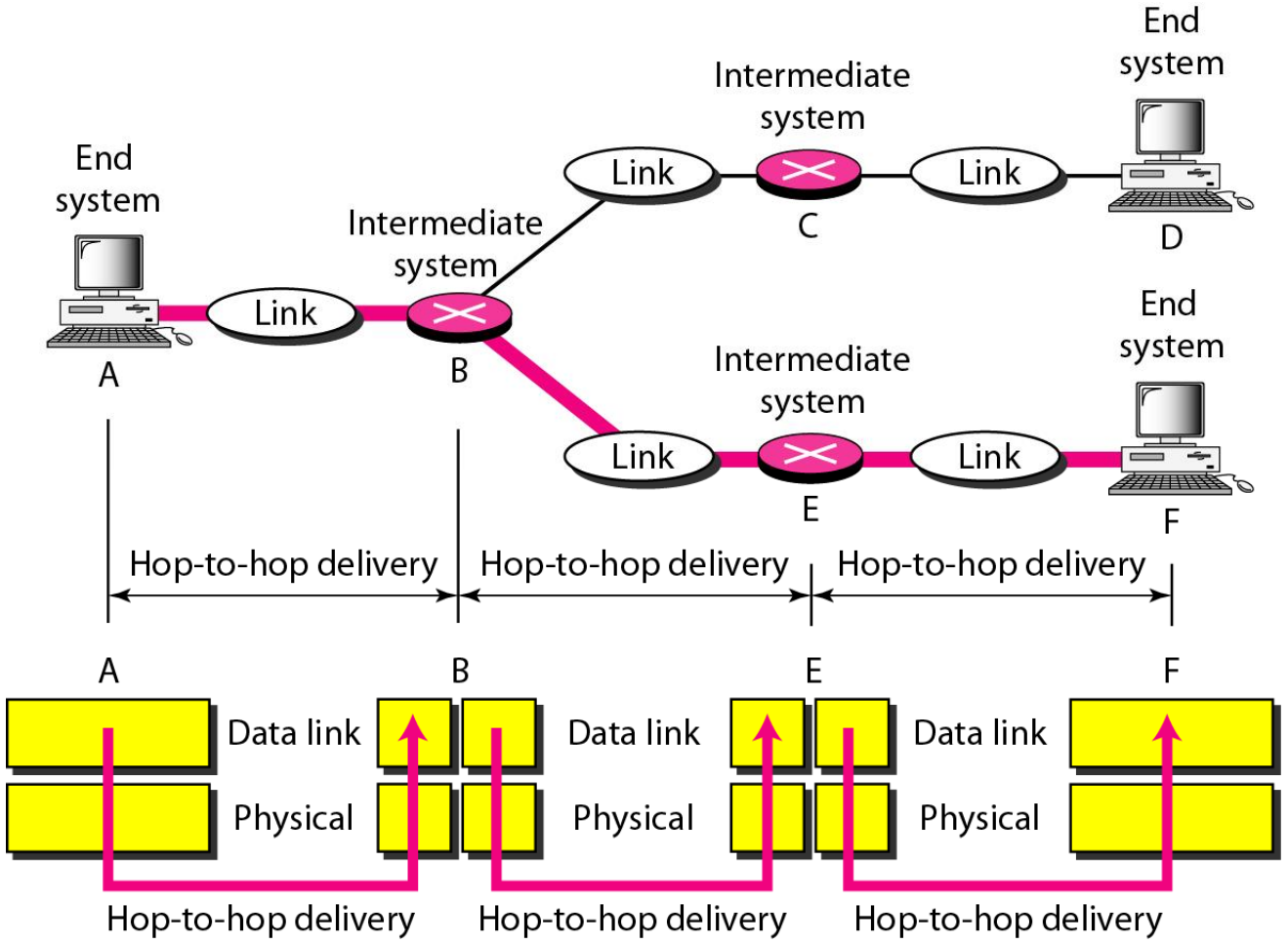
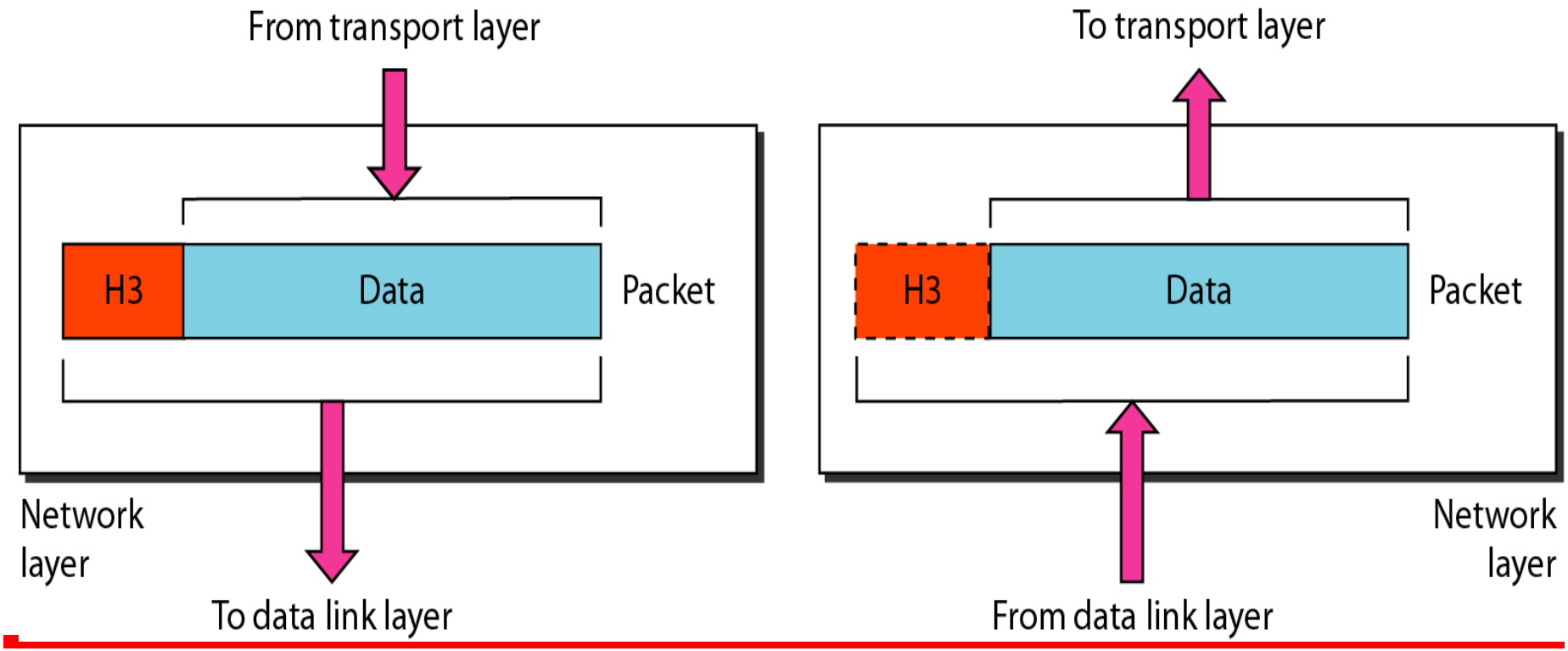


Figure 2.8 *Network layer*

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



Functions of Network layer

- Logical addressing: IP address
- Routing: Routes the packets from source to destination using routing algorithm.

Figure 2.9 *Source-to-destination delivery*

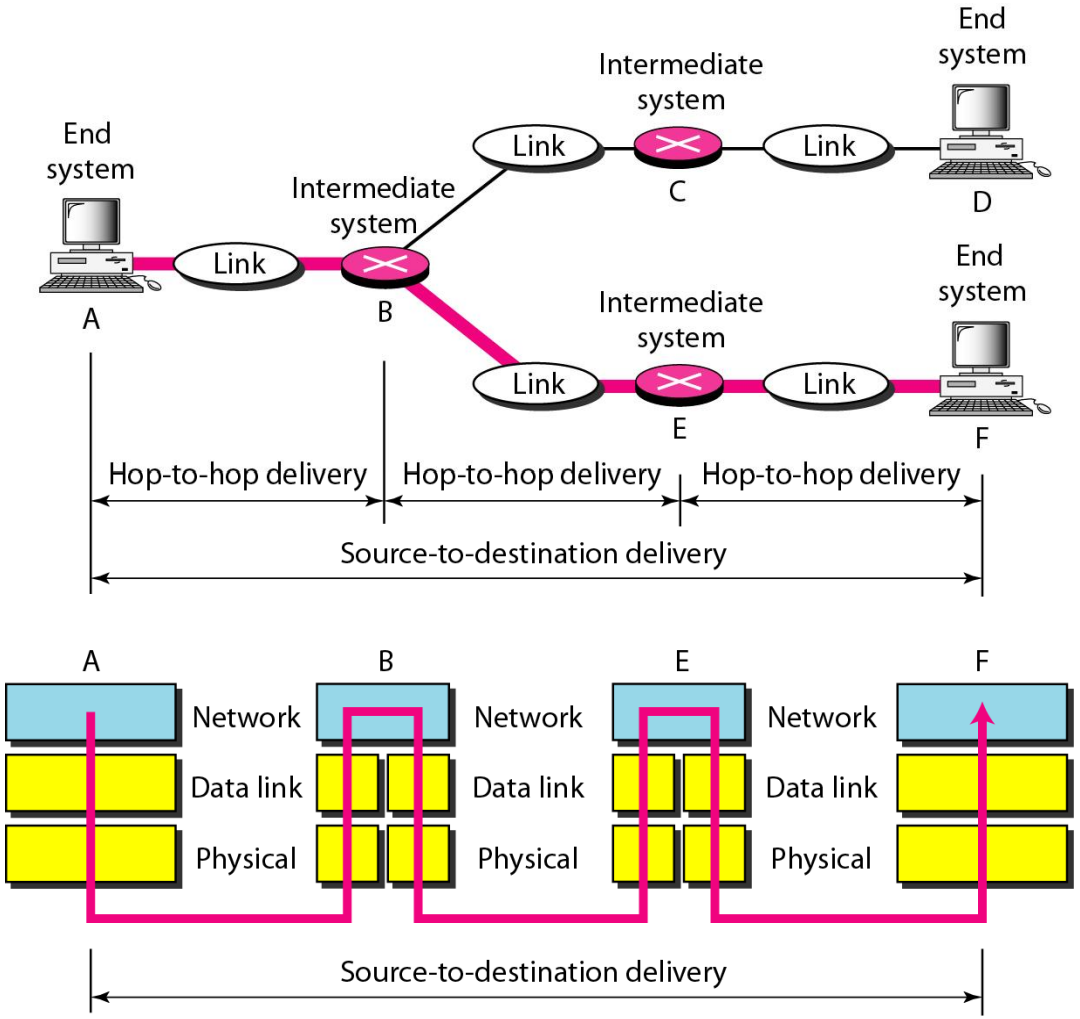
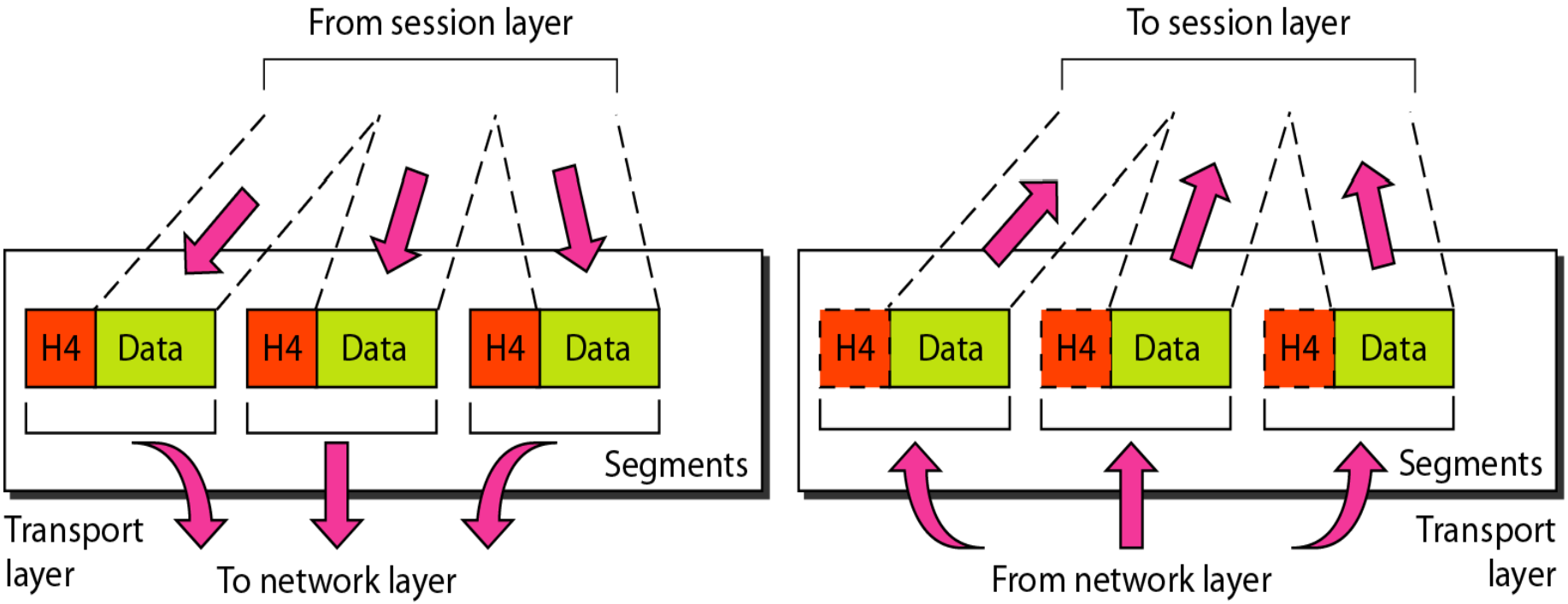


Figure 2.10 *Transport layer*

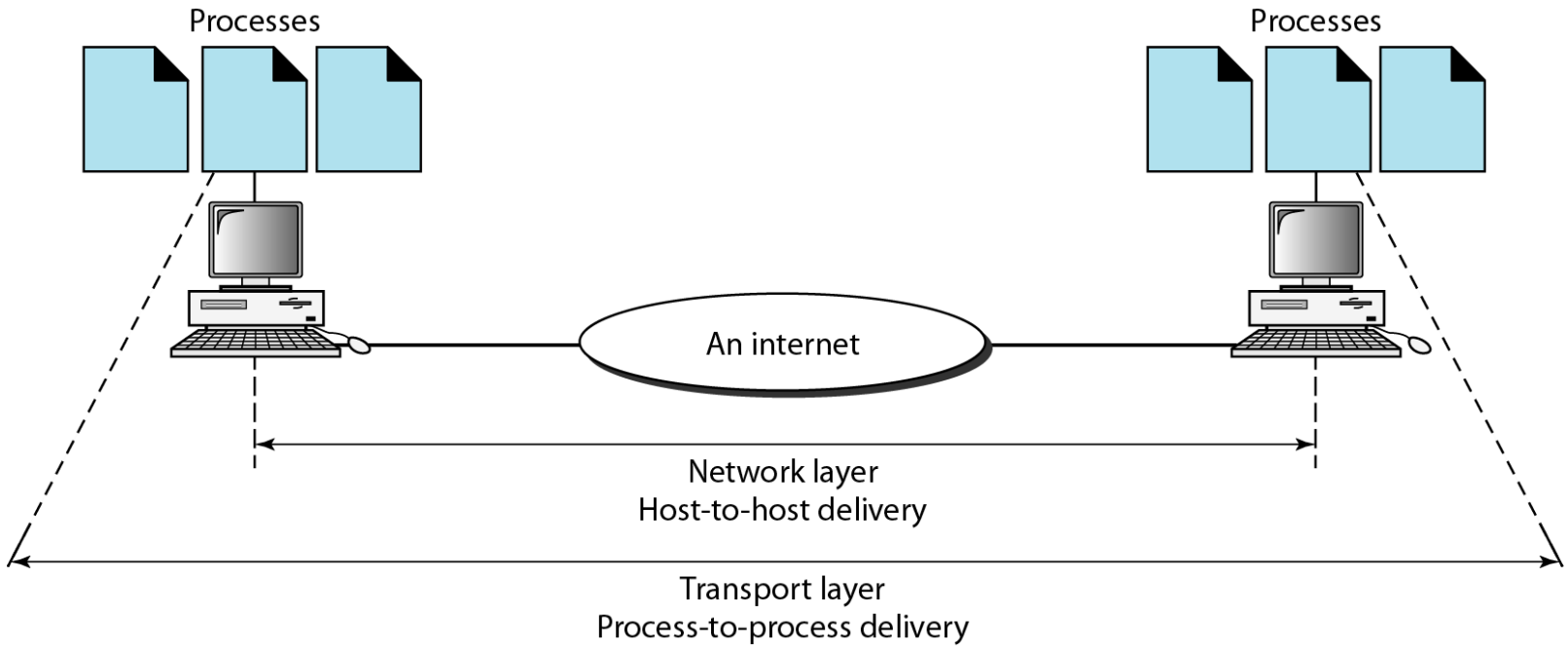
The transport layer is responsible for the delivery of a message(segments) from one process to another.



Functions

- Service point addressing: process to process communication is done using port addressing
- Segmentation and reassembly:message is divided in to segments with a sequence number and reassembled after received at destination.
- Connection control:Transport layer is either connection less or connection oriented.
- Flow control:end to end flow control is performed rather than on a single link.
- Error control:Transport layer performs process to process error control rather than on a single link.The sending transport layer makes sure that the entire message arrives at the receiving transport layer without error.Error correction is usulay done by retransmission.

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



Connection oriented vs connection less

Connection oriented

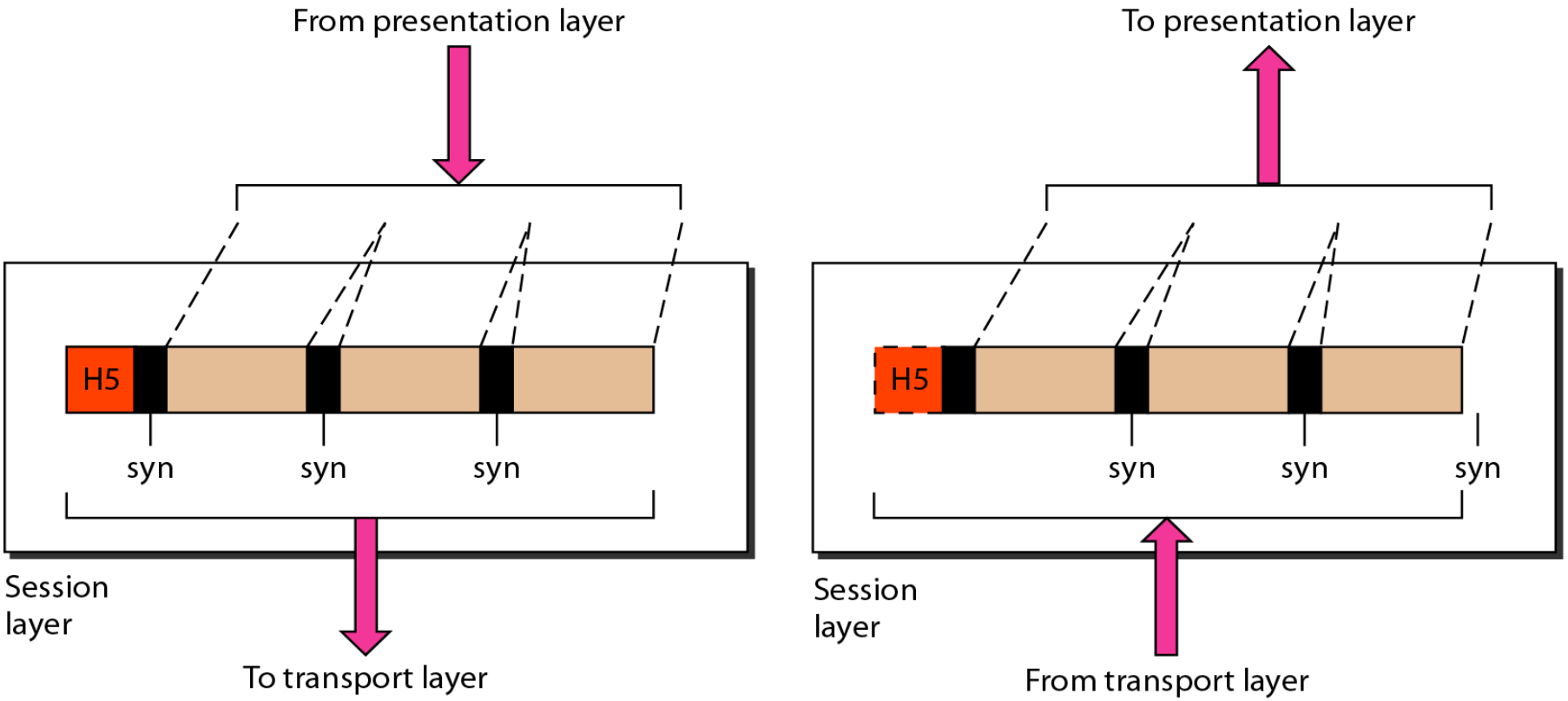
- Before any data transmission takes place a dedicated path needs to be established between the source and destination.

Connection less

- No need to establish a path before any data transmission takes place between the source and destination.
- The source simply puts the data on to the network and expects that the data to be reached to the destination properly.

Figure 2.12 *Session layer*

The session layer is responsible for dialog control and synchronization.

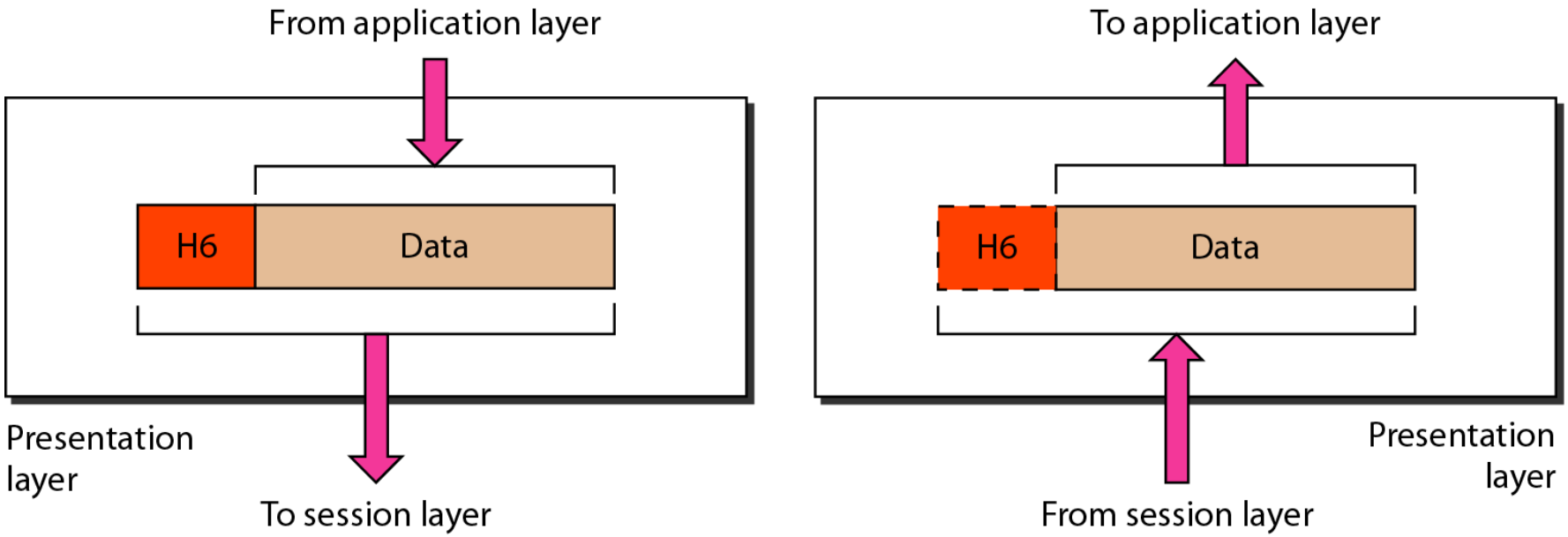


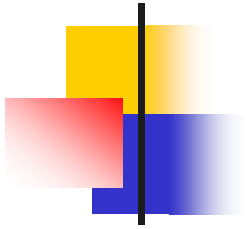
Functions

- Dialog Control:session Layer allows two systems to enter in to a dialog.It allows the communication between two processes to take place either in half duplex or full duplex mode.
- Syncronization:The session layer allows processes to add checkpoints or syncronization points to a stream of data in order to minimize the data loss.

Figure 2.13 *Presentation layer*

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



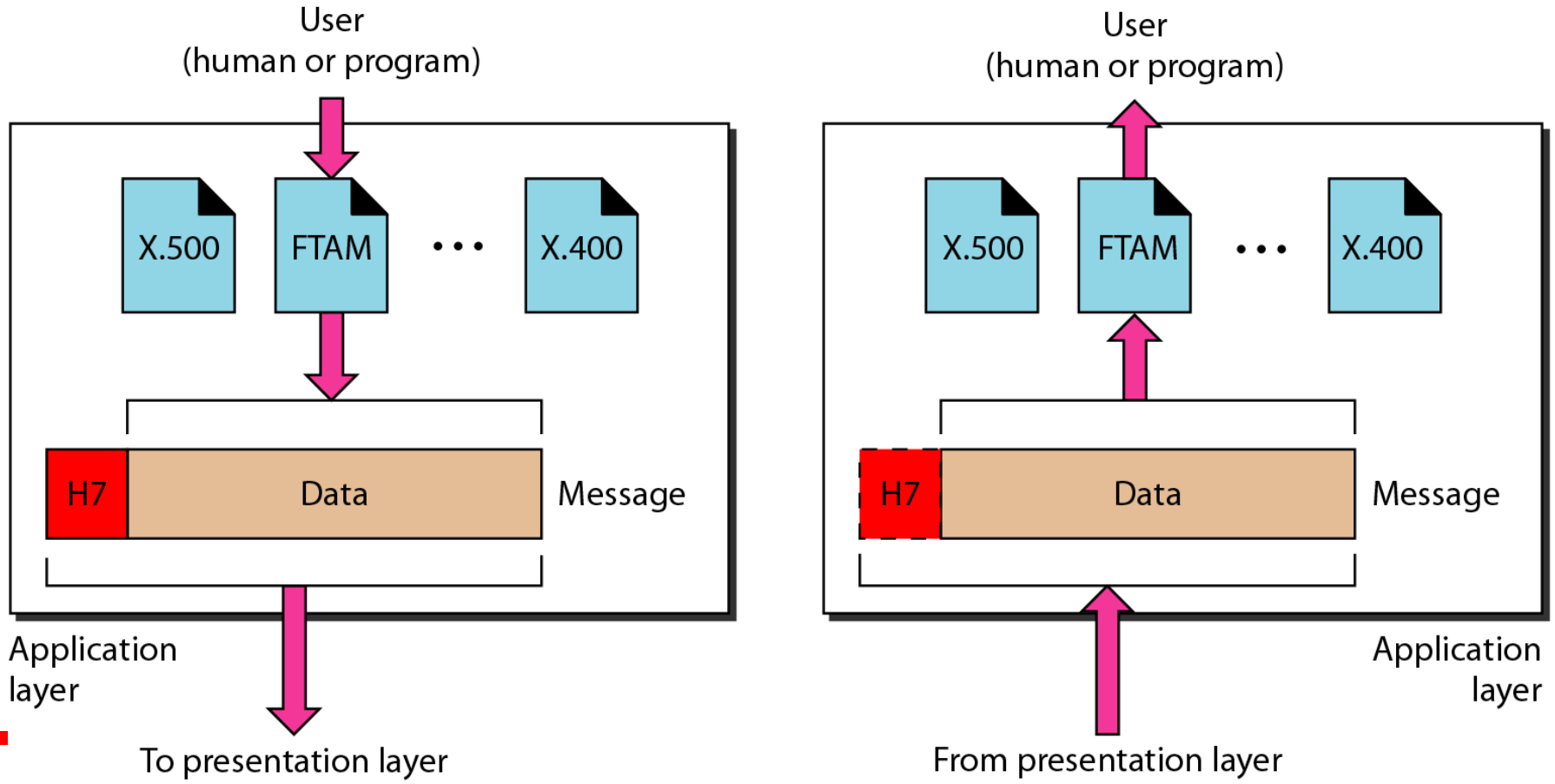


Functions

- Translation: Different computers use different encoding systems, the presentation layer is responsible for interoperability between these different encoding methods. At sender side it changes the information from its sender dependent format to in to a common format and at the receiving side it changes the common format in to receiver dependent format.
- Encryption: Message is converted in to some secrete code in order to achieve privacy.
- Compression: Data compression reduces the no of bits contained in the information.

Figure 2.14 *Application layer*

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



Functions

- Network virtual terminal: It is a software version of a physical terminal and it allows a user to log on to a remote host. To do so the application creates a software emulation of a terminal at the remote host.
- File transfer ,access and management: This allows a user to access files in a remote host, to retrieve files and manage files at remote host.
- Mail services: Provides the basis for email forwarding and storage.
- Directory services: Provides distributed database sources and access for global information about various objects and services

Devices used in each layer

- **Physical layer** : Hubs, Repeaters, Cables, Fibers.
- **Data-link layer**: Bridges, Modems, Network cards, layer-2 switches.
- **Network layer**: Routers, Brouters, layer-3 switches.
- **Transport layer**: Gateways, Firewalls.
- **Session layer**: Gateways, Firewalls
- **Presentation layer** : Gateways, Firewalls
- **Application layer**: Gateways, Firewalls

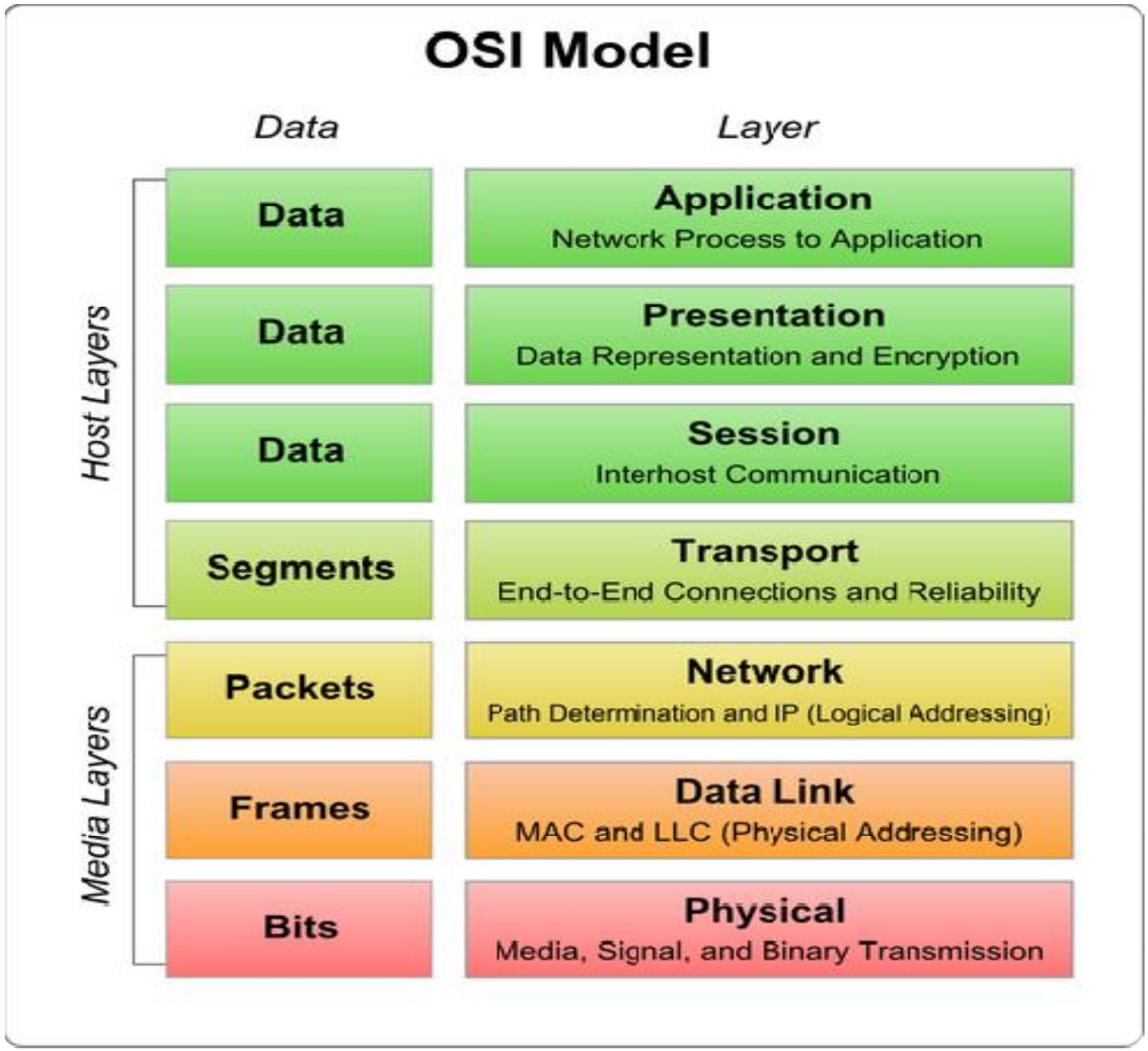
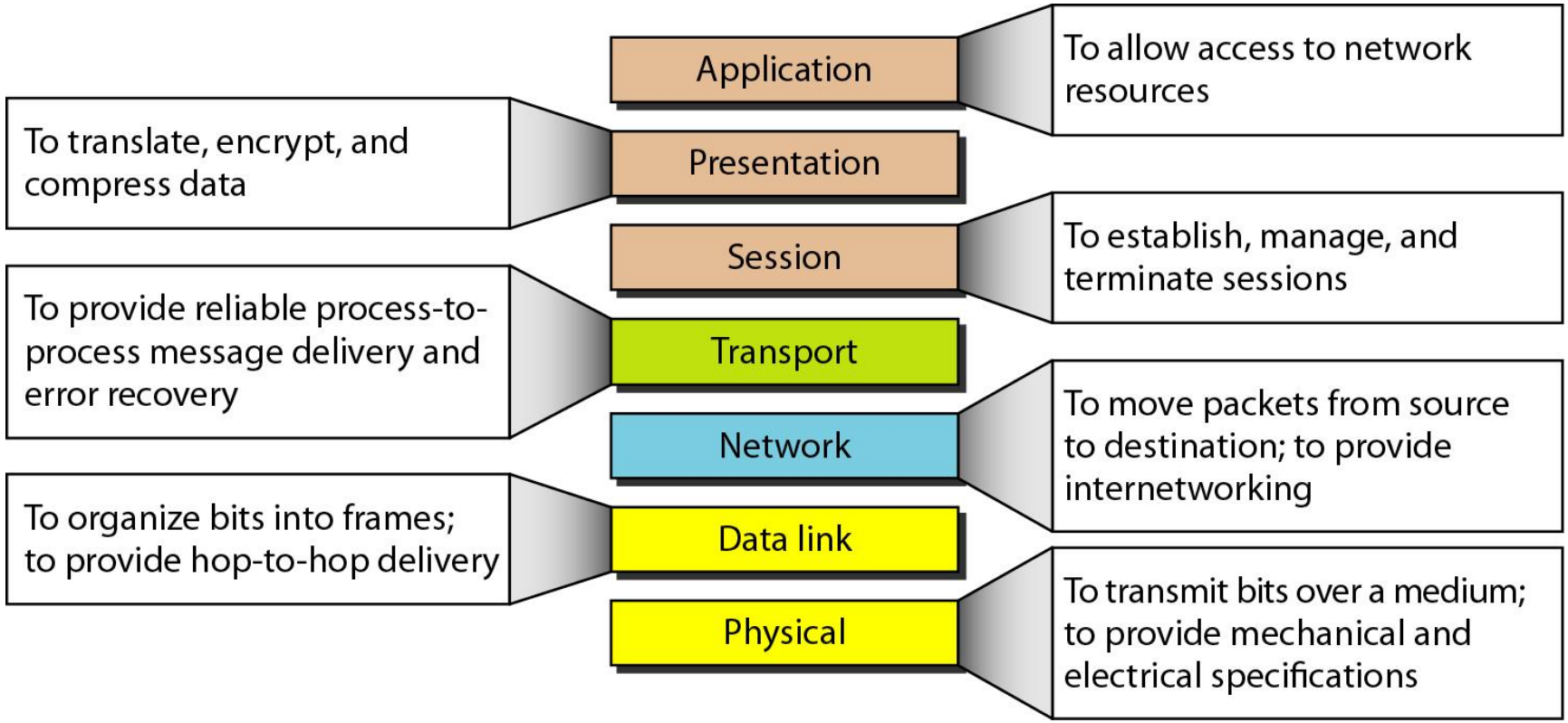

OSI Model
Data
Layer
Host Layers
Media Layers
Data
Application
Network Process to Application
Data
Presentation
Data Representation and Encryption
Data
Session
Interhost Communication
Segments
Transport
End-to-End Connections and Reliability
Packets
Network
Path Determination and IP (Logical Addressing)
Frames
Data Link
MAC and LLC (Physical Addressing)
Bits
Physical
Media, Signal, and Binary Transmission

Figure 2.15 *Summary of layers*



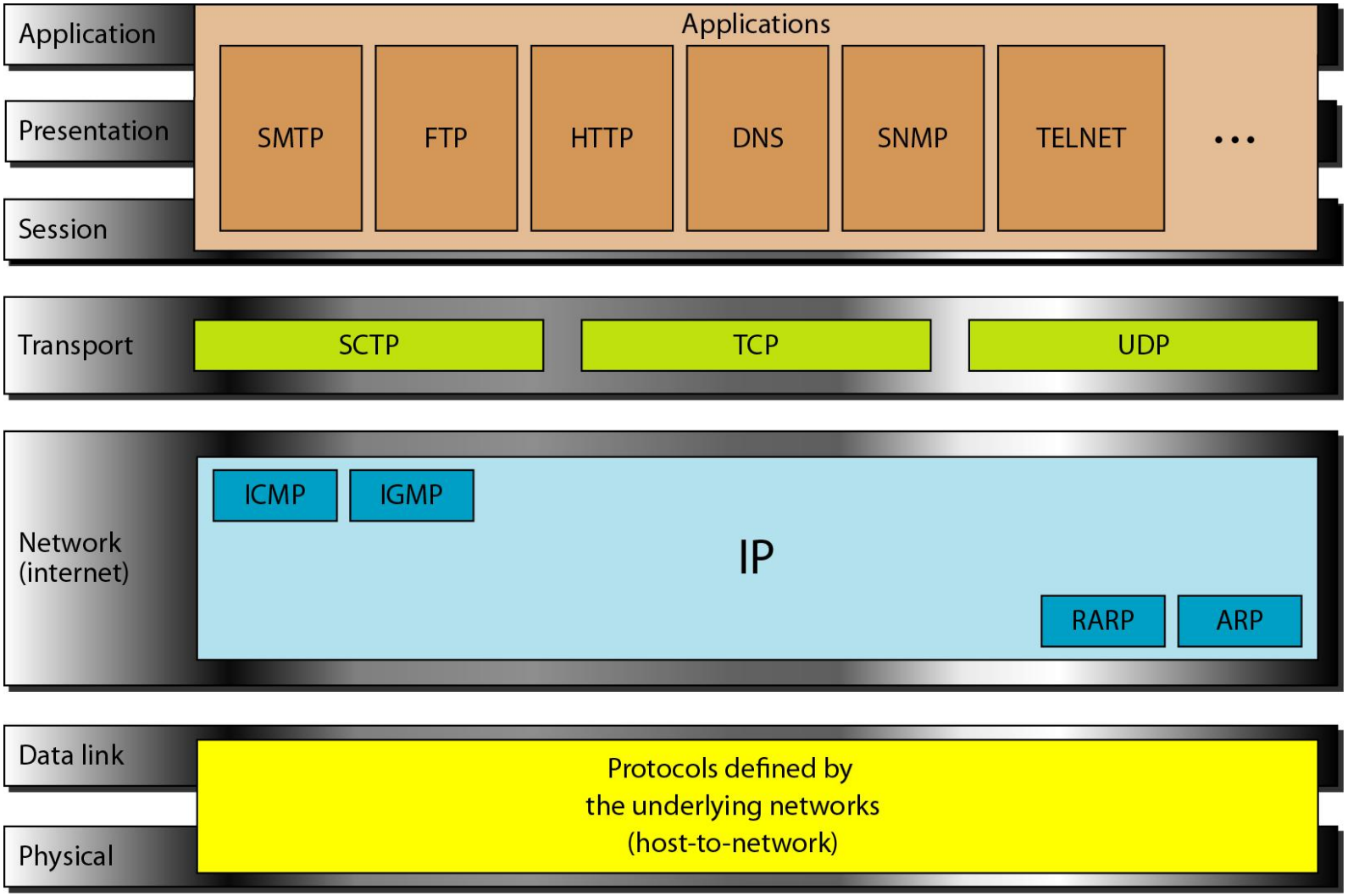
2-4 TCP/IP PROTOCOL SUITE

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.

Layers of TCP/IP Model:

1. **Physical**
2. **Data Link Layer**
3. **Network Layer**
4. **Transport Layer**
5. **Application Layer**

Figure 2.16 *TCP/IP and OSI model*



Protocols of TCP/IP layers

- **Physical layer protocols:**

1. Telephone network modems- V.92
2. 802.11
3. Wi-Fi

- **Datalink layer protocols**

1. Point-to-Point Protocol(PPP)
2. IEEE 802.11 wireless LAN
3. Token ring
4. Fiber Distributed Data Interface (FDDI)

- **Network Layer Protocols**

1. Internet protocol(IP)
2. Internet Control Message Protocol (ICMP)
3. Internet Group Multicast Protocol(IGMP)
4. Address Resolution Protocol (ARP)
5. Reverse Address Resolution Protocol (RARP)

- Transport layer protocols

1. Transmission Control Protocol (TCP)
2. User Datagram Protocol (UDP)
3. Stream Control Transmission Protocol (SCTP)

- Application layer protocols

1. File transfer protocol (FTP)
2. Simple Mail Transfer Protocol (SMTP)
3. Hypertext Transfer Protocol (http)
4. Domain Name System (DNS)
5. telnet

Some important protocols of Network Layer

- Internet protocol IP

  It is unreliable and connection less protocol.It transports data in packets called datagrams, each of which is transported separately.

- Address Resolution Protocol ARP

  Used to find physical address from logical address.

- Reverse Address Resolution Protocol RARP

  Used to find logical address from physical address

- Internet control Message Message Protocol ICMP

  Allows the host to send notification of datagram problems back to the sender.

- Internet Group Message Protocol IGMP

  Used to facilitate the simultaneous transmission of a message to a group of recipients.

Some Important protocols of Transport layer

- **User Datagram Protocol UDP**

- It is a process to process protocol that adds only port addresses, checksum, error control and length information to the data from upper layer.

- **Transmission control protocol TCP**

- It is a connection oriented protocol. A connection must be established between both ends of transmission before either can transmit data.
- At the sending end TCP divides a stream of data into smaller units called segments with a sequence number.
- At the receiving end TCP collects each datagram as it comes and reorders the transmission based on sequence number.

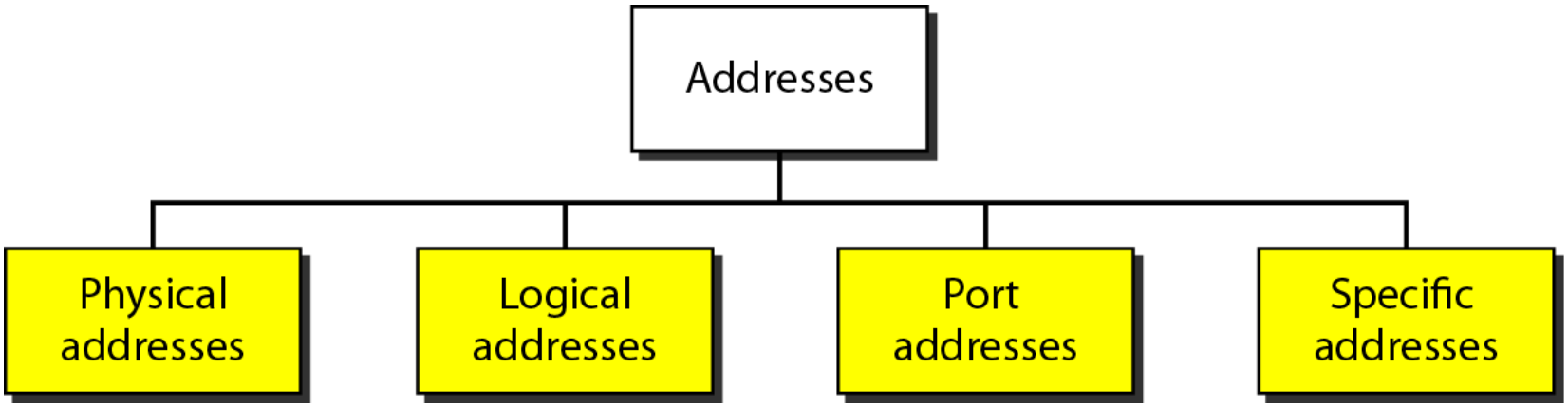
2-5 ADDRESSING

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*



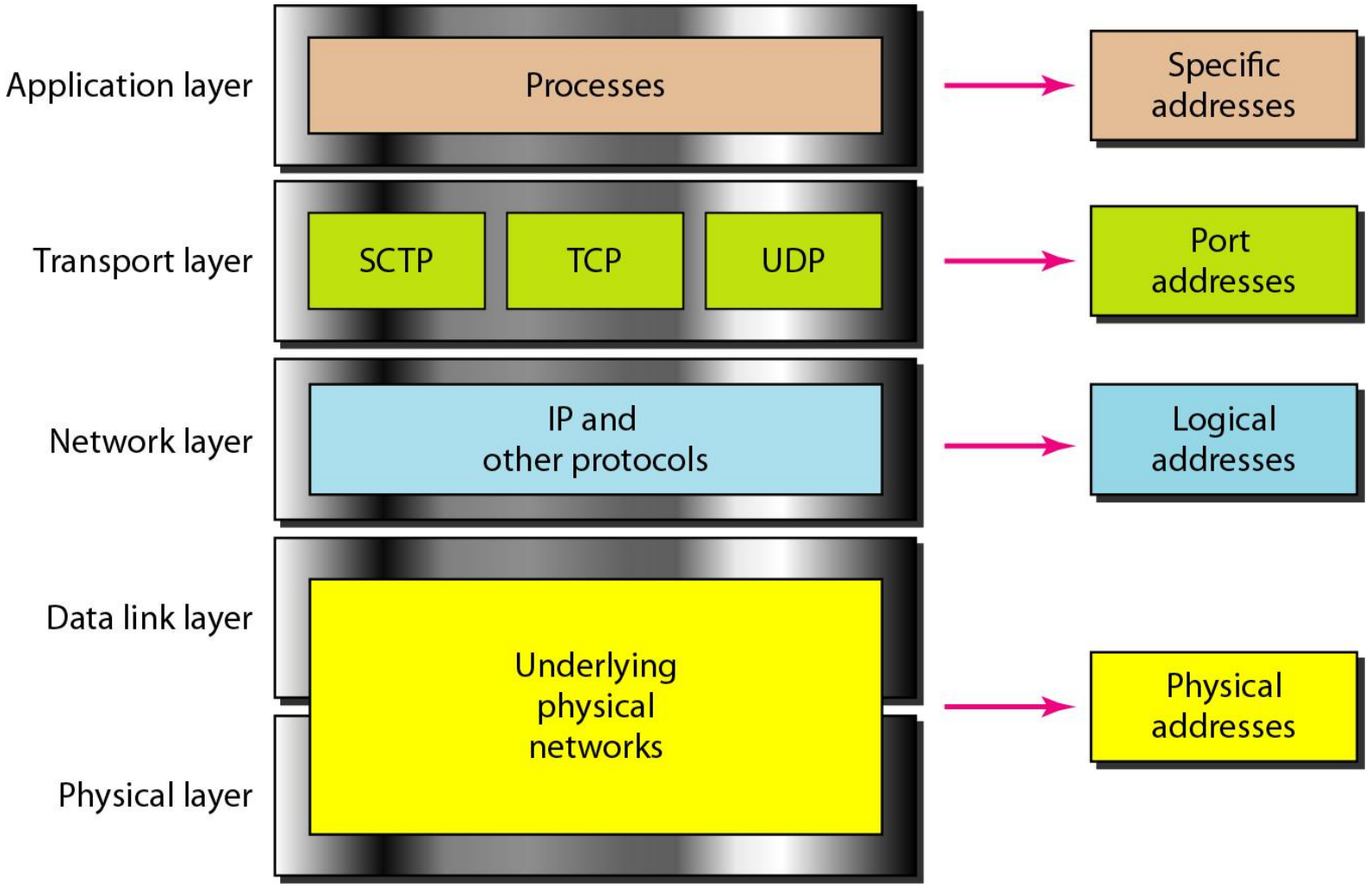
Addresses in TCP/IP

- Physical address
  - It is the actual address of the device, generally a number printed on the network interface card also known as MAC address.
- Logical Address
  - Different networks have different physical addressing format. so a universal addressing scheme system needed in which each host can be identified uniquely regardless of the underlying physical network.
  - A 32 bit IP address is the logical address.
- Port address
  - The end objective of internet communication is a process communicating with another process.The level assigned to a process is called a port address.A port address in TCP/IP is 16 bit in length.
- Specific address

This is the specific address of the application such as url , email-id.

Eg www.google.com, asifkhan.iiit@gmail.com etc

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



Example of Physical Address scenario

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.

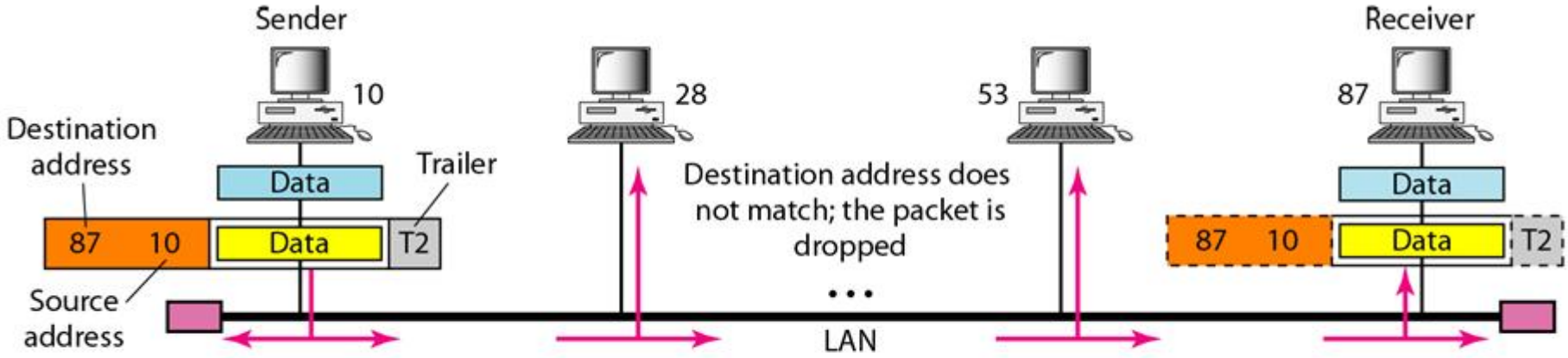
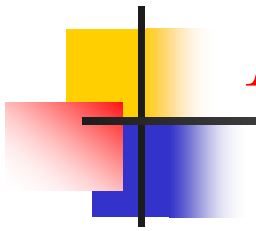


Figure 2.19 *Physical addresses*



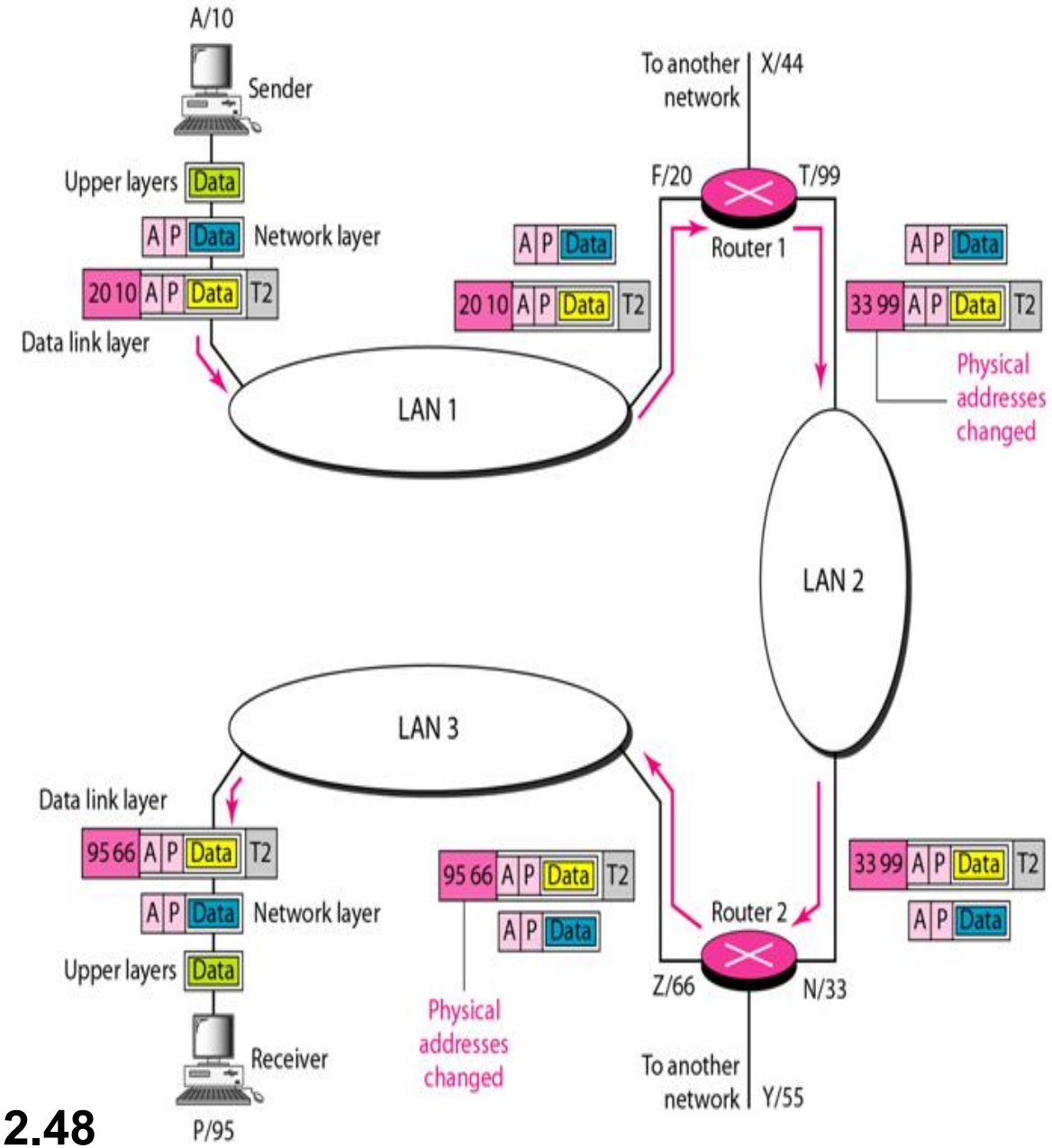
Physical Address format

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 scenario of Physical and Logical Address



- ✓ *Figure shows a part of an internet with two routers connecting three LANs.*
- ✓ *Each device 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.*

Port addresses

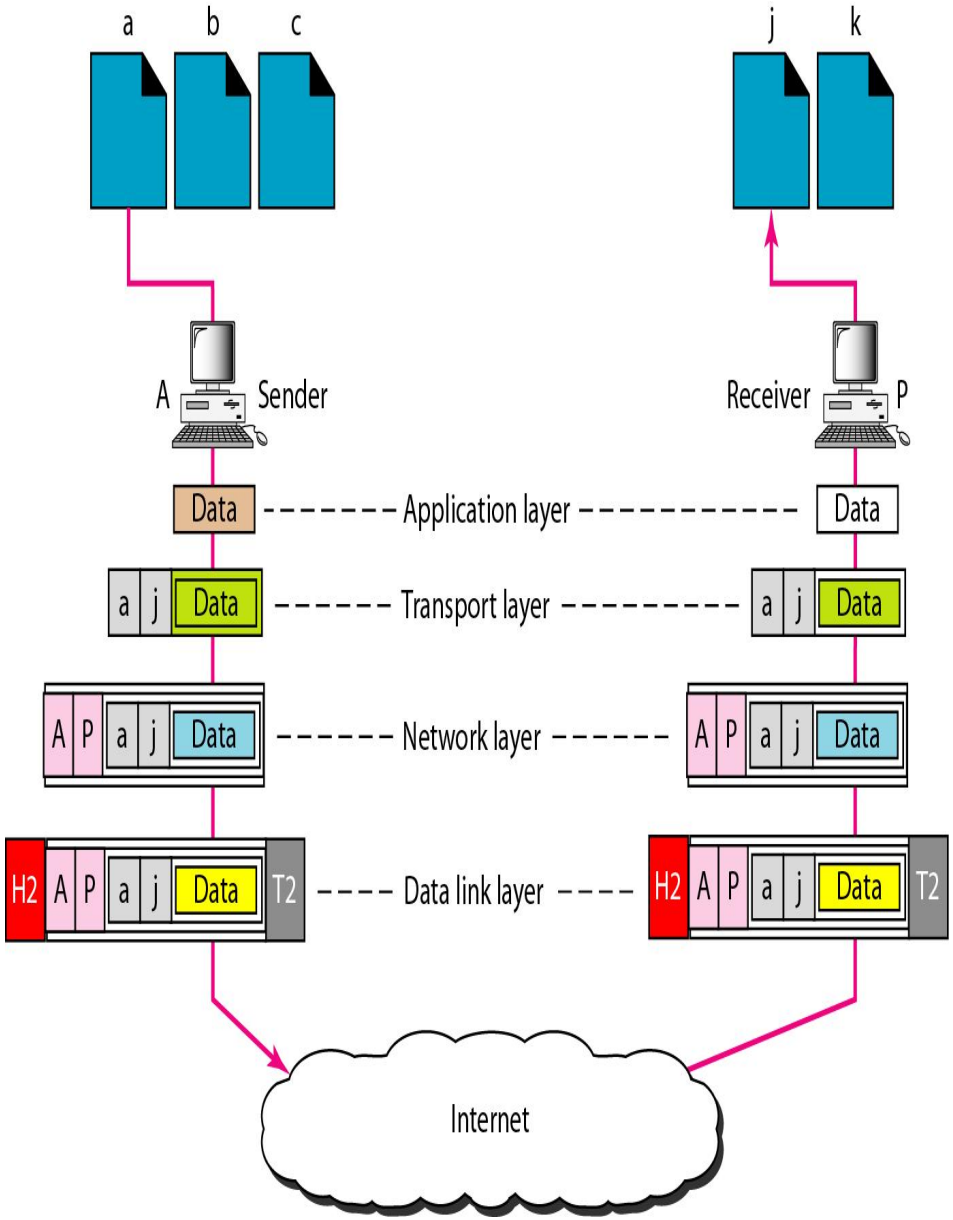


Figure 2.21

✓*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.*

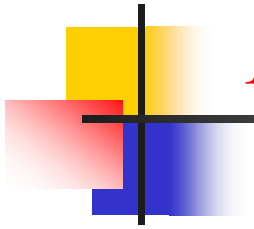
✓*The receiving computer is running two processes at this time with port addresses j and k.*

✓*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.*

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.