

- Computer Networks
- Al-Mustansiryah University
- Elec. Eng. Department College of Engineering  
Fourth Year Class

# Chapter 2

## Network Models

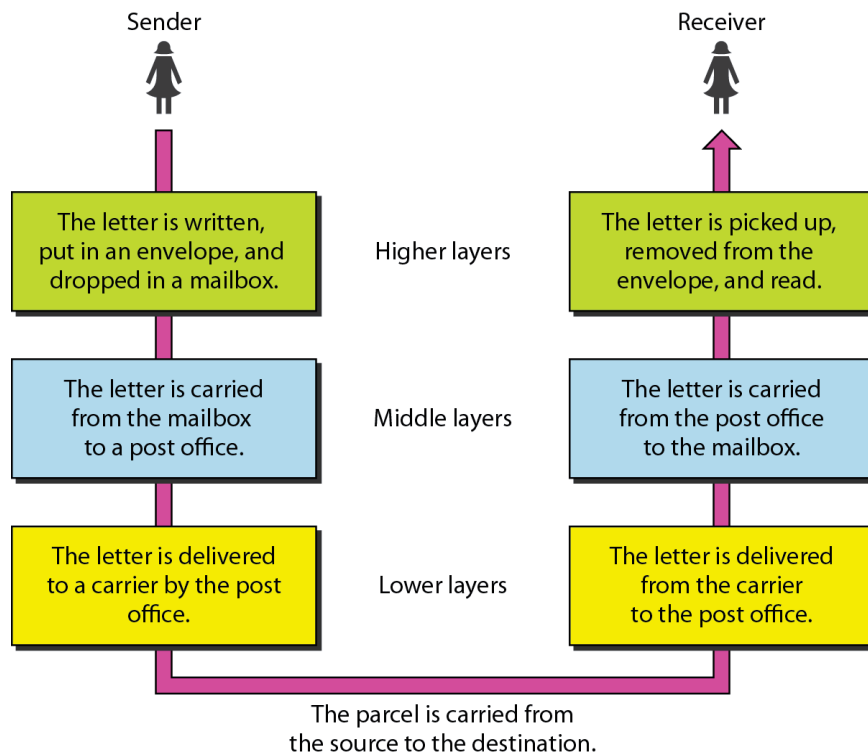
### 2.1

#### 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.

### 2.2

**Figure 2.1** Tasks involved in sending a letter



## 2.3

### 2-2 THE OSI MODEL

The International Standards Organization (ISO) is a multinational body dedicated to worldwide agreement. An ISO standard that covers international standards all aspects of network communications is the Open Systems Interconnection (OSI) model. It was first introduced in the late 1970s.

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

## 2.4

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## Why do we need the OSI Model?

- ❑ To address the problem of networks increasing in size and in number, the International Organization for Standardization (ISO) researched many network schemes and recognized that there was a need to create a network model
- ❑ This would help network builders implement networks that could communicate and work together

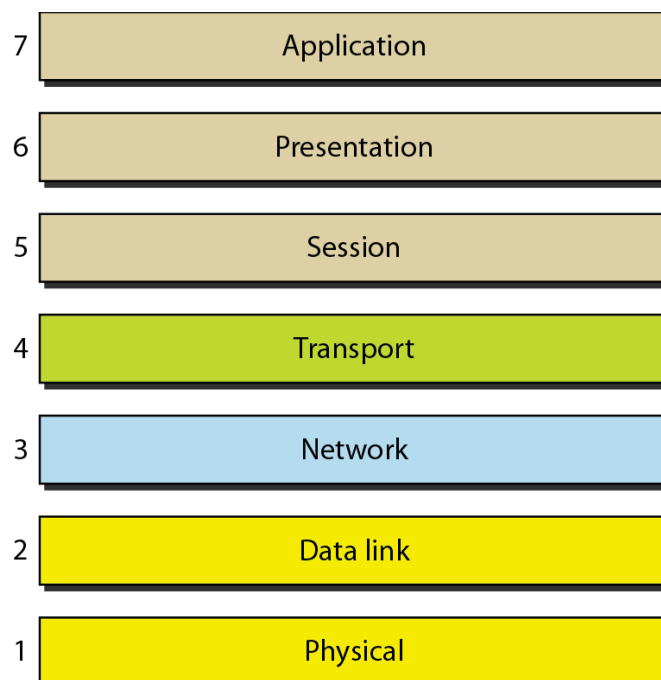
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### 2.5

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**Figure 2.2** *Seven layers of the OSI model*

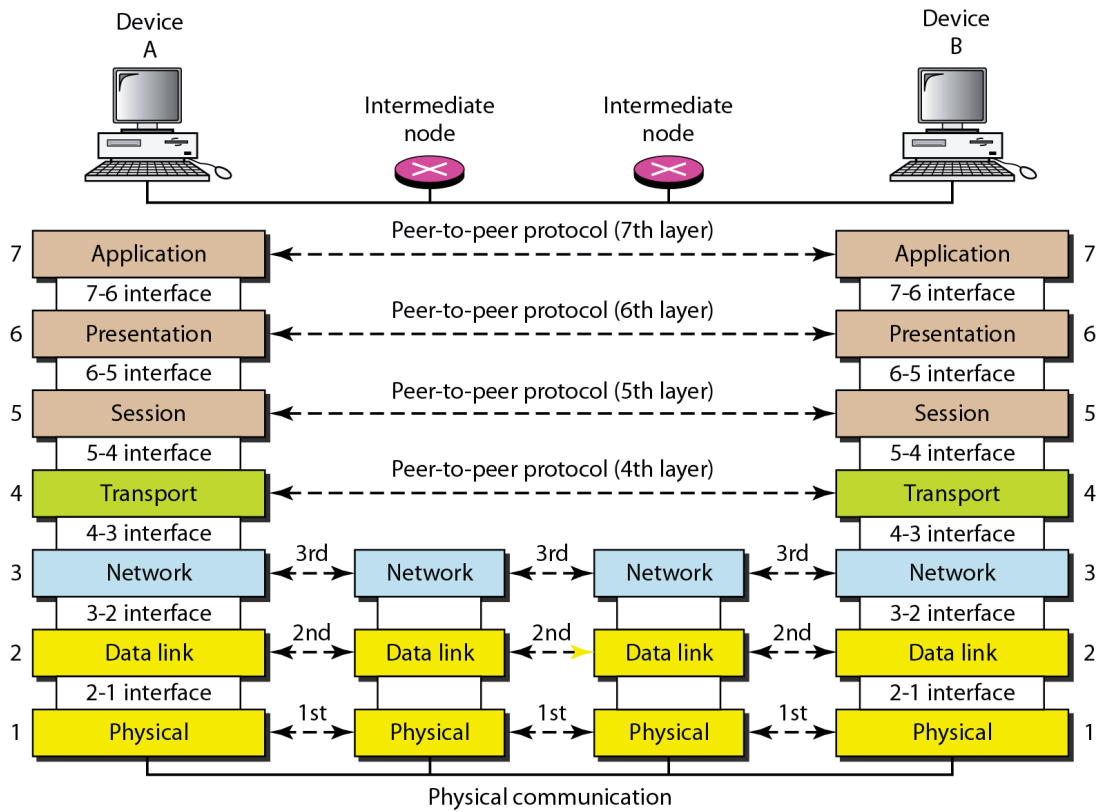
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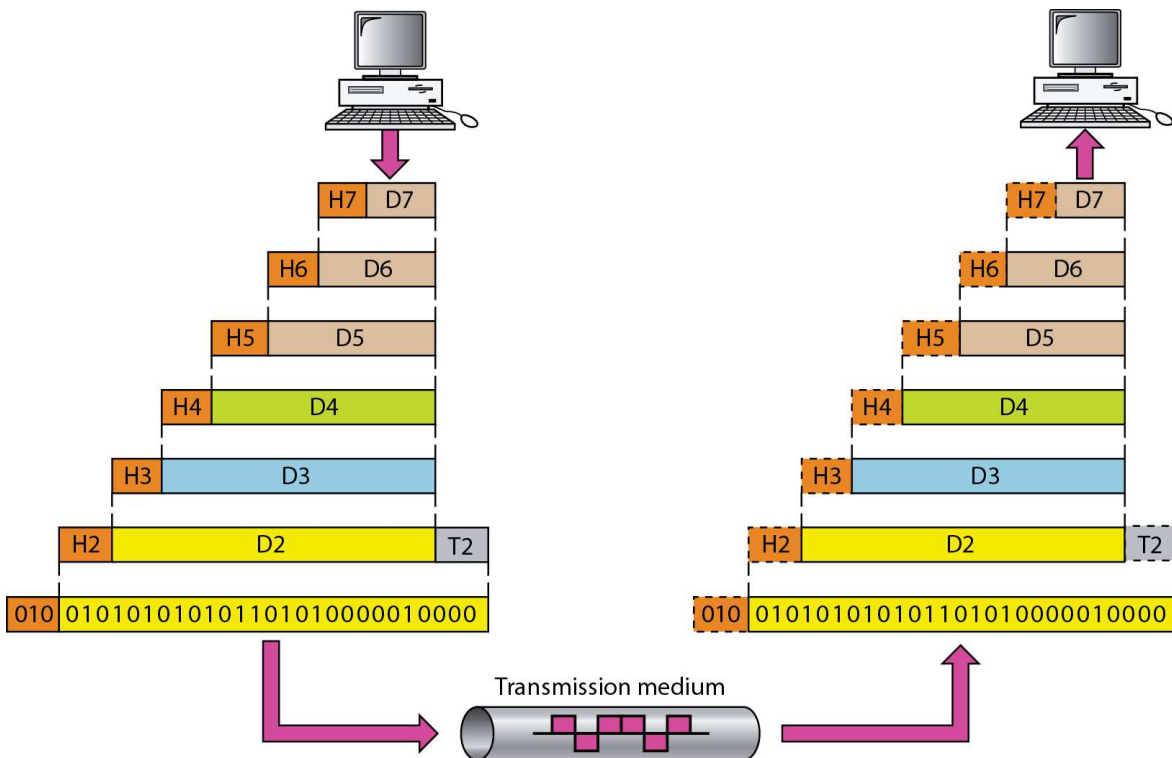
### 2.6

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



2.7

**Figure 2.4** *An exchange using the OSI model*



2.8

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## Peer-to-Peer Processes

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- At the higher layers, communication must move down through the layers on device A, over to device B.
- Each layer in the sending device adds its own information to the message it receives from the layer just above it and passes the whole package to the layer just below it.
- At the receiving machine, the message is unwrapped layer by layer, with each process receiving and removing the data meant for it.
- For example, layer 2 removes the data meant for it, then passes the rest to layer 3. Layer 3 then removes the data meant for it and passes the rest to layer 4, and so on
- Each interface defines the information and services a layer must provide for the layer above it.

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## 2.9

### 2-3 LAYERS IN THE OSI MODEL

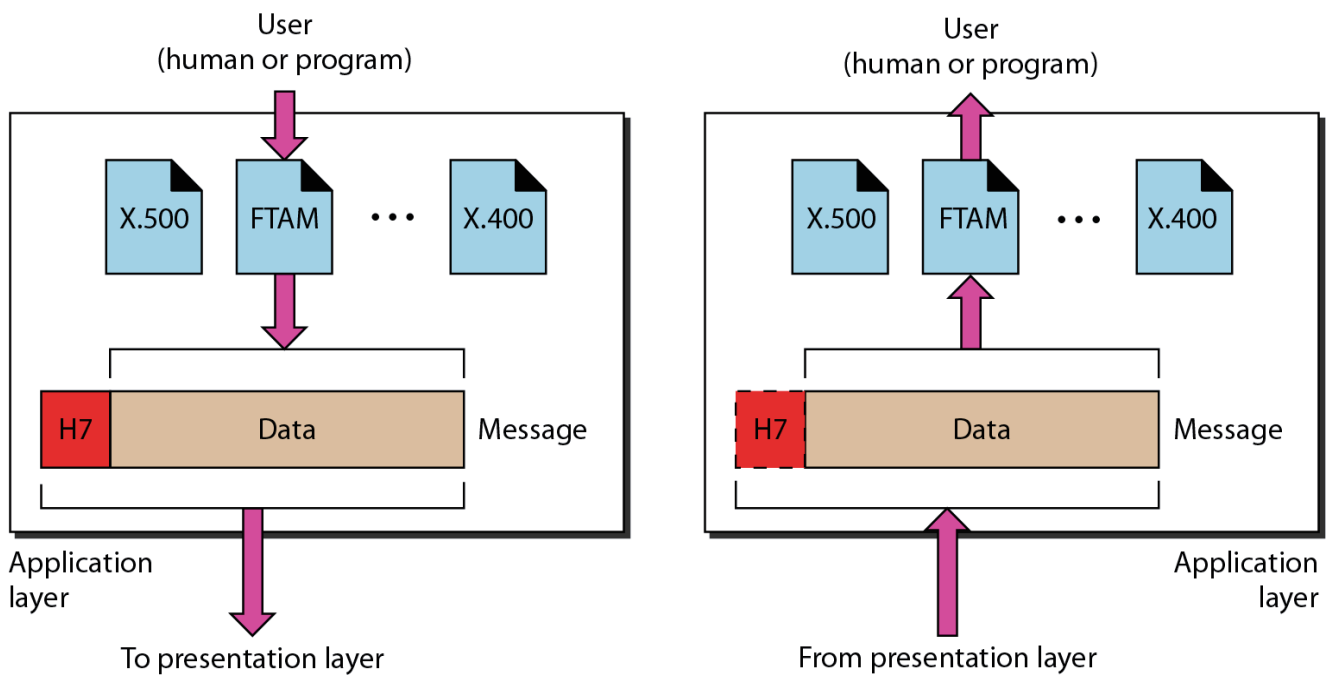
**In this section we briefly describe the functions of each layer in the OSI model.**

#### **OSI Layers:**

**Application Layer**  
**Presentation Layer**  
**Session Layer**  
**Transport Layer**  
**Network Layer**  
**Data Link Layer**  
**Physical Layer**

## 2.10

**Figure 2.14** *Application layer*



## 2.11

*Note*

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

Examples:

- Email
- Web browsers
- **PDU - User Data**

**The application layer is also concerned with the following**

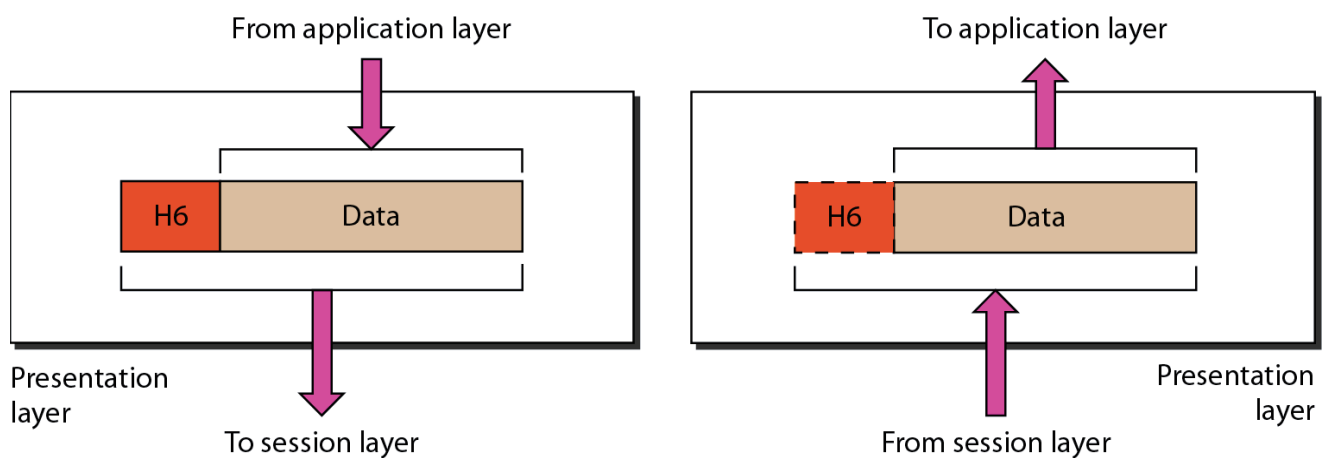
- 1) Network virtual terminal.
- 2) File transfer.
- 3) Mail services.
- 4) Directory services.

## 2.12

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**Figure 2.13** *Presentation layer*

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## 2.13



**Note**

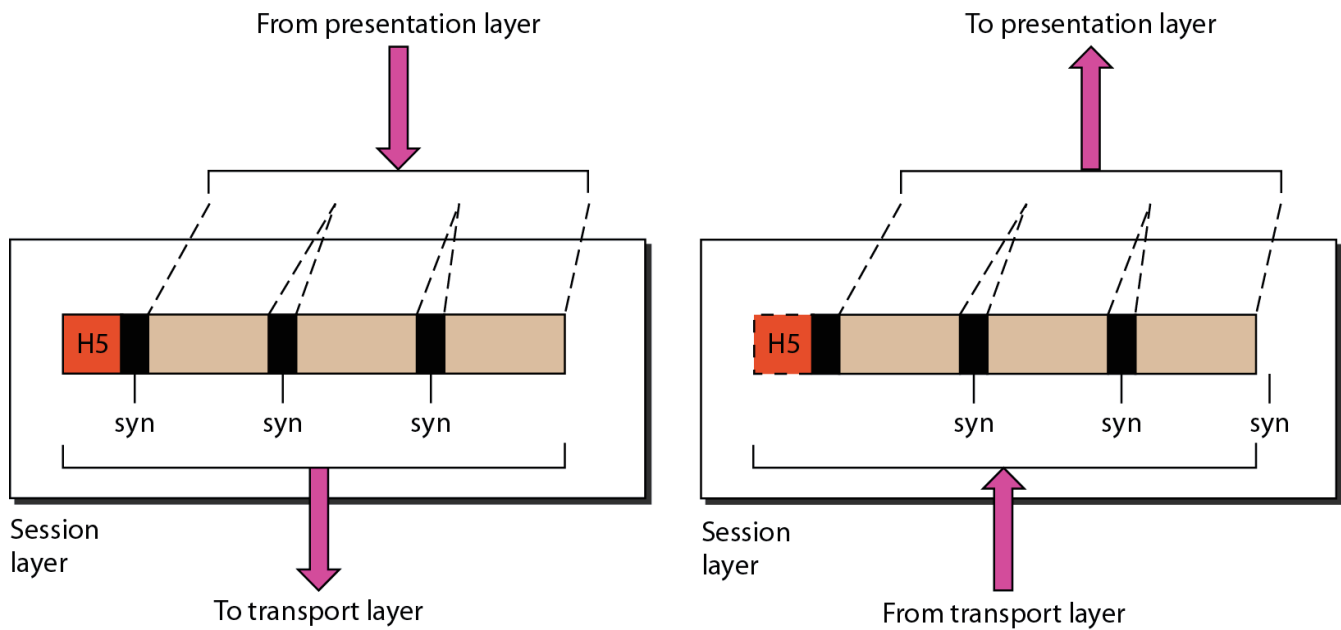
- The presentation layer is responsible for translation, compression, Code Formatting and encryption.
  - PDU - Formatted Data
- 

**The Presentation layer is also concerned with the following**

- 1) Translation.
- 2) Encryption.
- 3) Compression.

## 2.14

**Figure 2.12** *Session layer*



**2.15**

**Note**

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

**-PDU - Formatted Data**

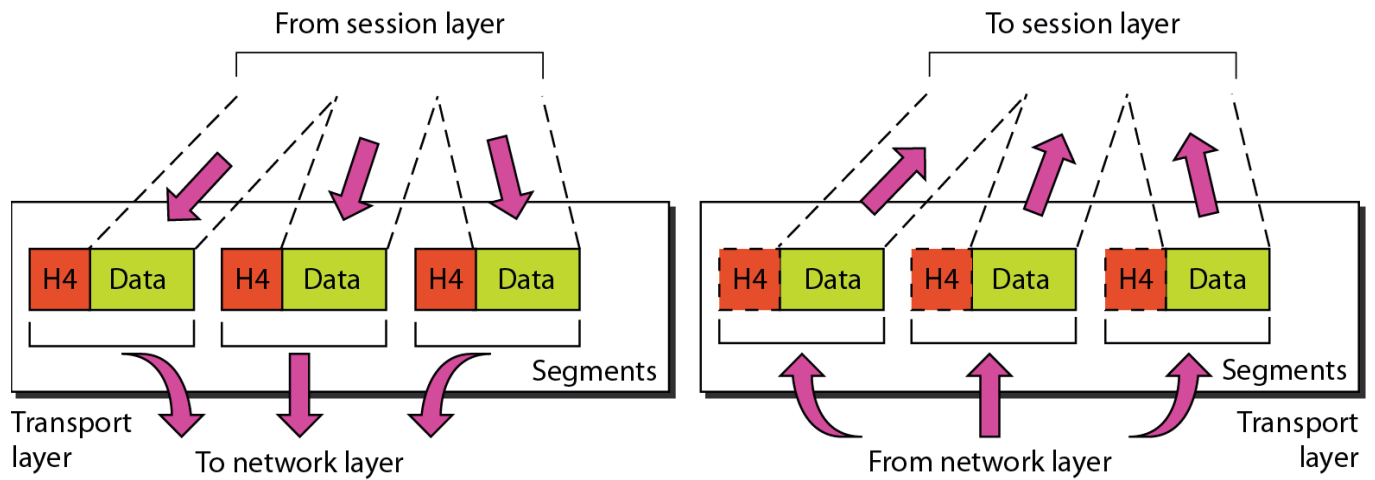
The Session layer is also concerned with the following

- 1) Dialog control.
- 2) Synchronization.

**2.16**



**Figure 2.10** *Transport layer*



## 2.17

### *Note*

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

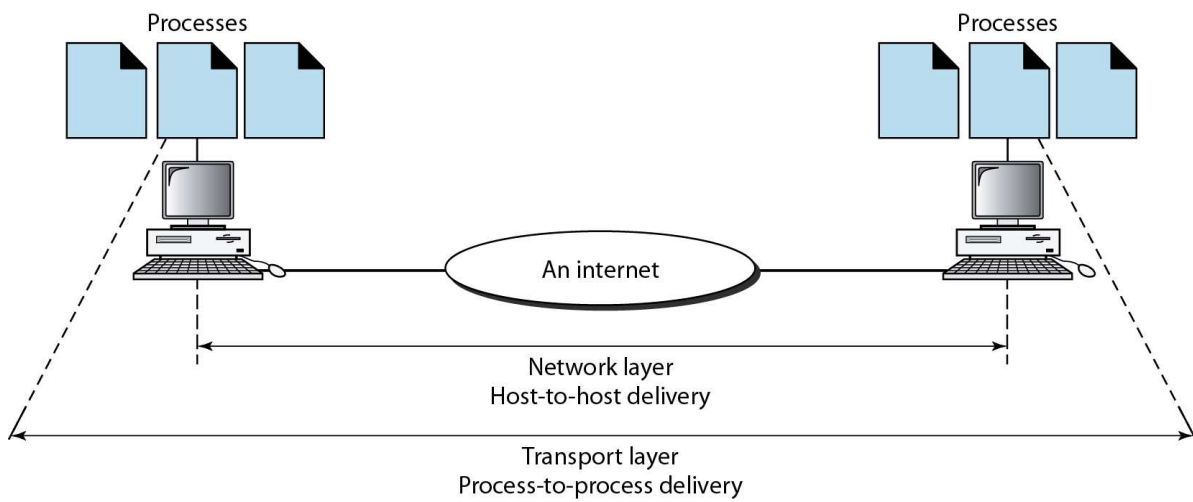
**-PDU - Segments**

**The Transport layer is also concerned with the following**

- 1) Service-point addressing.**
- 2) Segmentation and reassembly.**
- 3) Connection control.**
- 4) Flow control.**
- 5) Error control.**

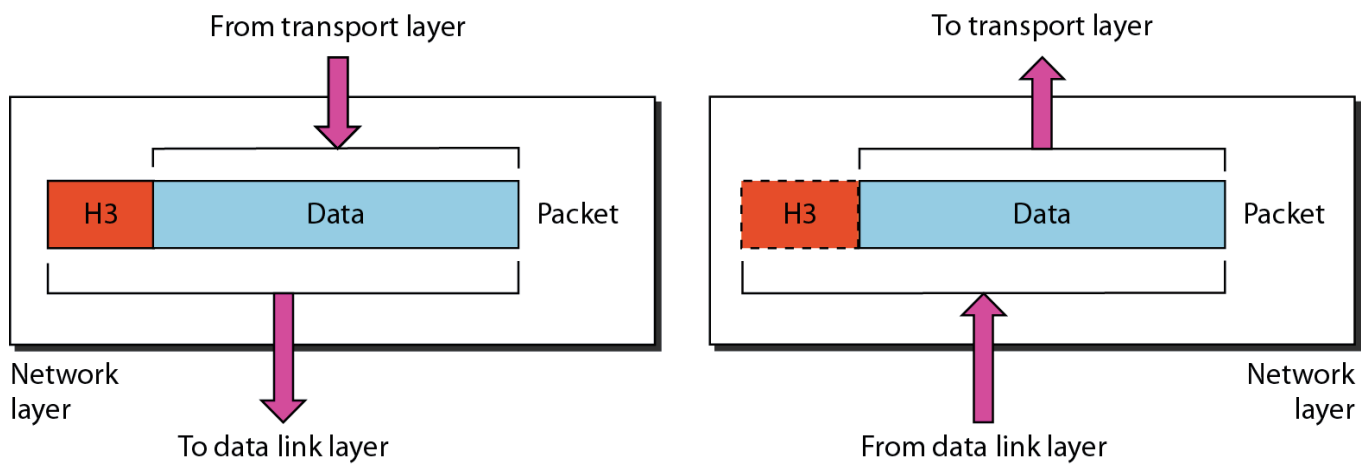
## 2.18

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



2.19

**Figure 2.8** *Network layer*



2.20

## Note

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

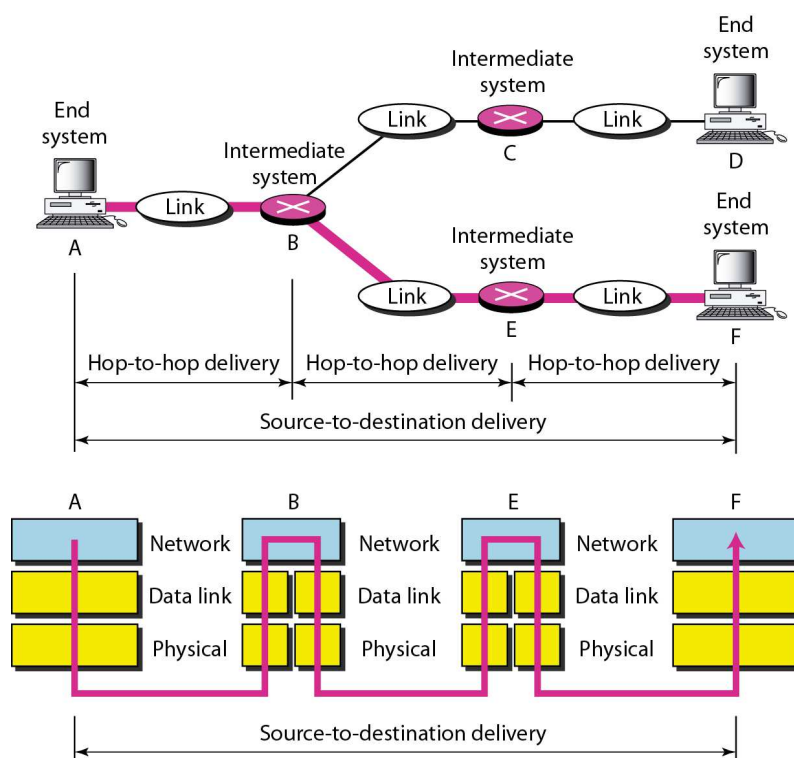
-PDU – Packets

The Network layer is also concerned with the following

- 1) Logical addressing.
- 2) Routing.

## 2.21

Figure 2.9 Source-to-destination delivery

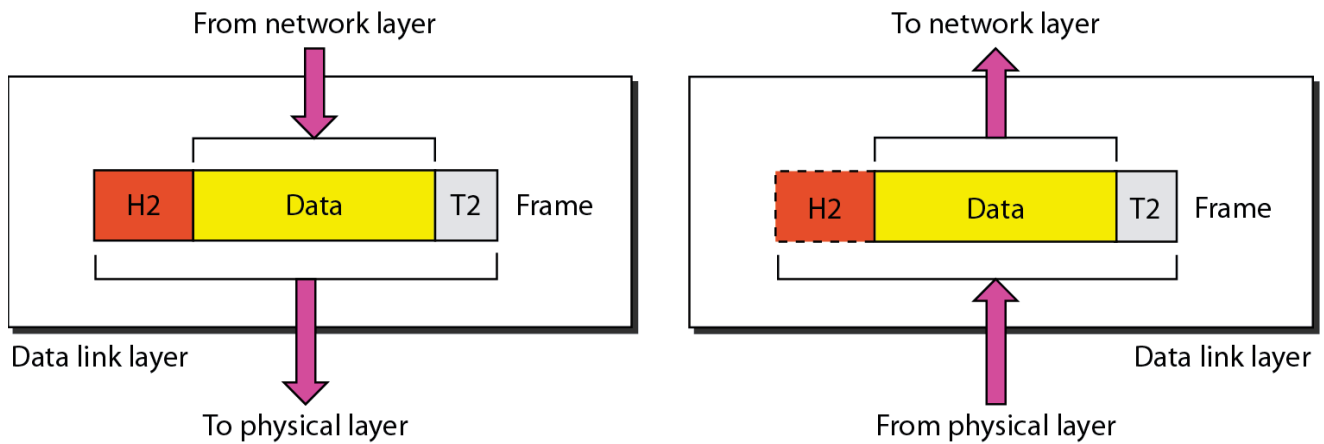


## 2.22

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**Figure 2.6** *Data link layer*

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## 2.23



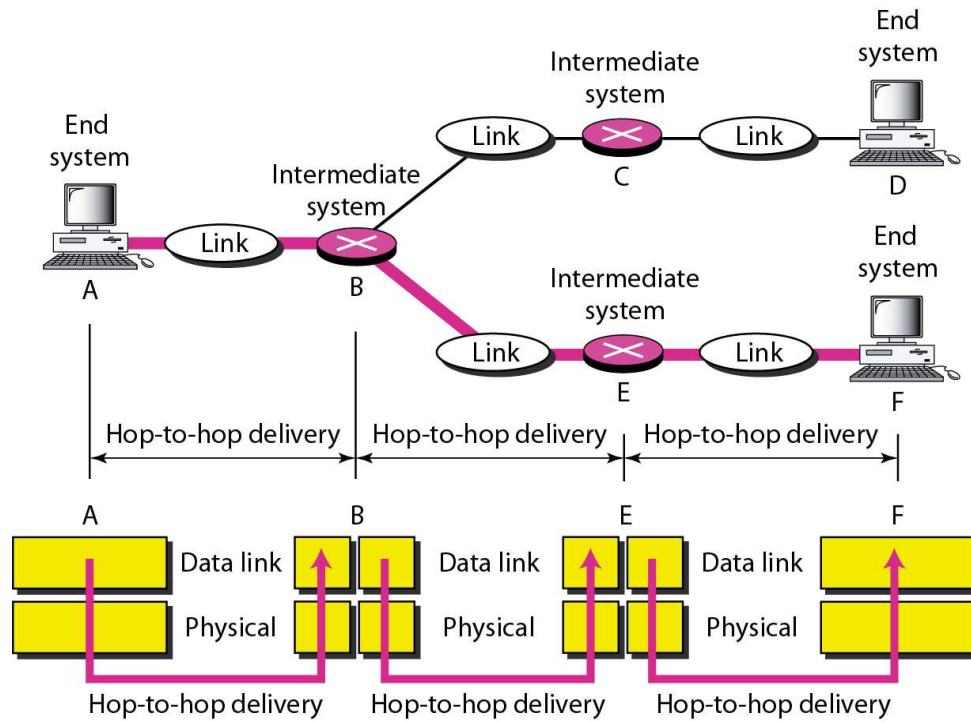
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- The data link layer is responsible for moving frames from one hop (node) to the next.
  - PDU - Frames
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**The data link layer is also concerned with the following**

- 1) Framing.
- 2) Physical addressing.
- 3) Flow control.
- 4) Error control.
- 5) Access control.

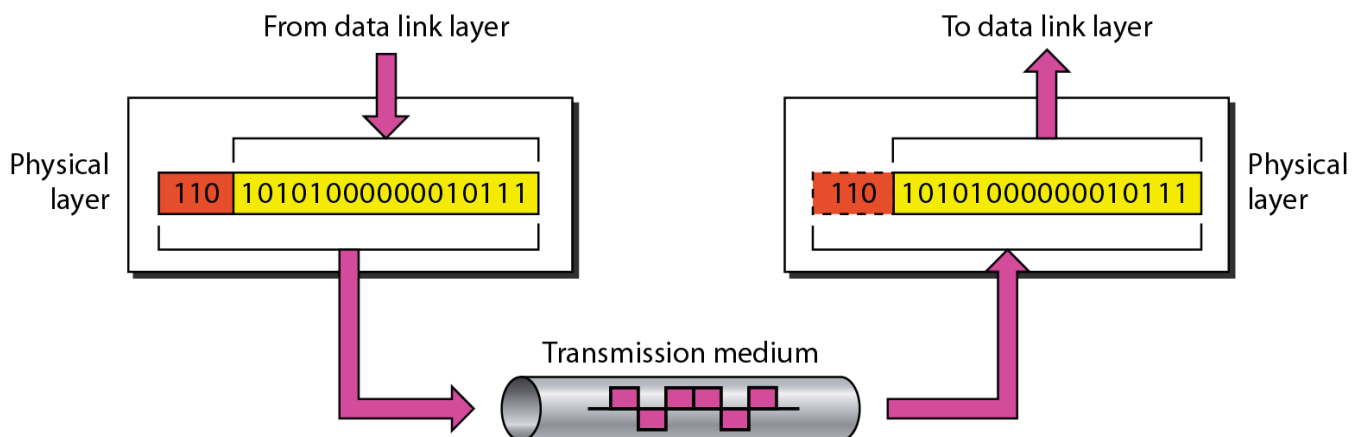
## 2.24

**Figure 2.7** *Hop-to-hop delivery*



**2.25**

**Figure 2.5** *Physical layer*



**2.26**

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

-PDU - Bits

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### The physical layer is also concerned with the following

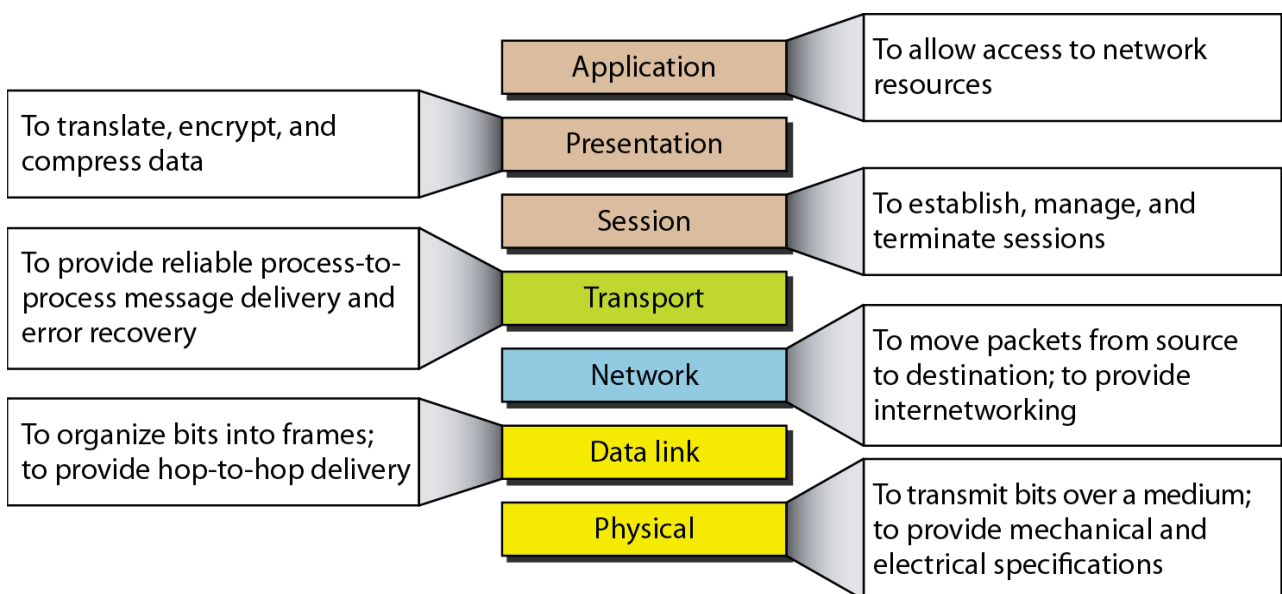
- 1) Physical characteristics of interfaces and medium.
- 2) Representation of bits.
- 3) Data rate.
- 4) Synchronization of bits.
- 5) Line configuration.
- 6) Physical topology.
- 7) Transmission mode.

## 2.27

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**Figure 2.15** *Summary of layers*

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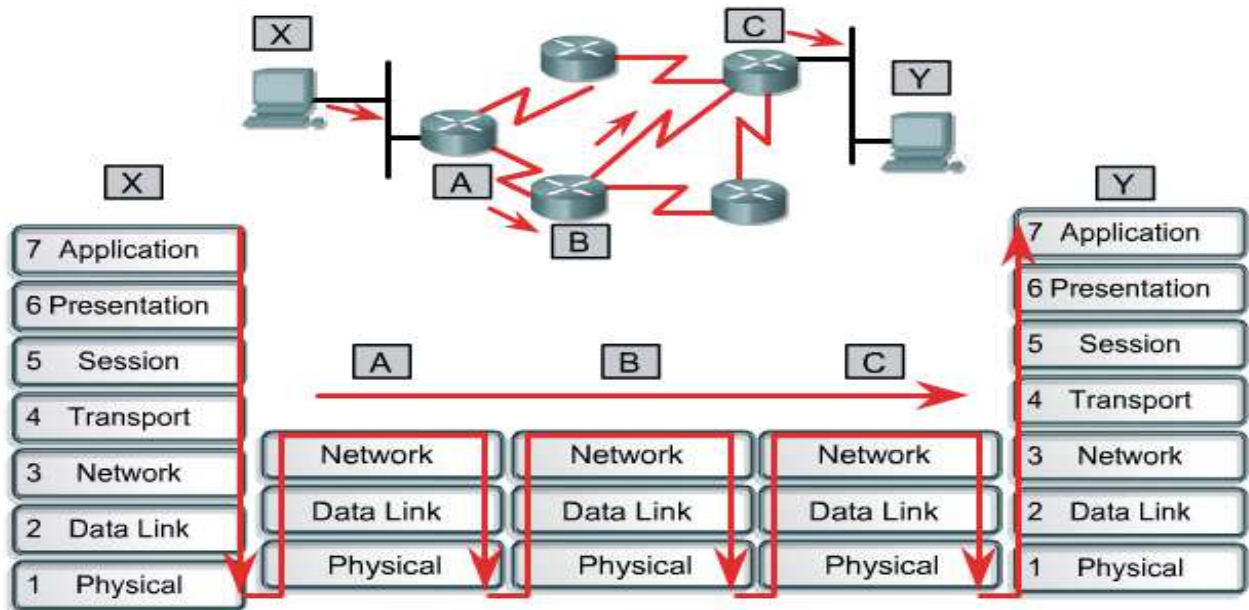


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## 2.28

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# Data Flow Through a Network



Data flow in a network focuses on layers one, two and three of the OSI model. This is after being transmitted by the sending host and before arriving at the receiving host.

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## 2.29

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### Data Flow and Encapsulation

Data flow occurs when two devices are connected in a network with some kind of shared transmission medium.

- 1) An application running on the source device creates some kind of data. This happens at the Application layer.
- 2) The application needs to add encryption to that data. This will be done at the Presentation layer.
- 3) At the Session layer it appends the Session ID.
- 4) The Transport layer breaks the data into blocks of data which we call **Segments**. Every Segment also gets the Port number to identify which upper layer application needs to receive the data on the destination device
- 5) The Network layer takes the Segment, and appends the source and destination IP address. At that point the Segment becomes a **Packet**.
- 6) At Data Link layer the source and destination MAC address and the CRC is added. At this point we have a **Frame**.
- 7) The Frame then is sent to the physical device where it is translated into some kind of a signal (often call it **Bits**)

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## 2.30

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## Decapsulation at the Destination Device

- 1) The destination device receives series of bits and interprets them as a Frame.
- 2) It removes MAC addresses and the CRC, and passes the data up to the Network layer.
- 3) IP addresses are removed and the Packet is forwarded up to the Transport layer .
- 4) The Port number is looked at and the Segment gets forwarded up the to the appropriate application specified by the Port number.
- 5) The Session ID is used.
- 6) Encryption will be removed.
- 7) The data in its original form is presented to the application that needs to interpret it.

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2.31

## 2-4 TCP/IP PROTOCOL SUITE

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**

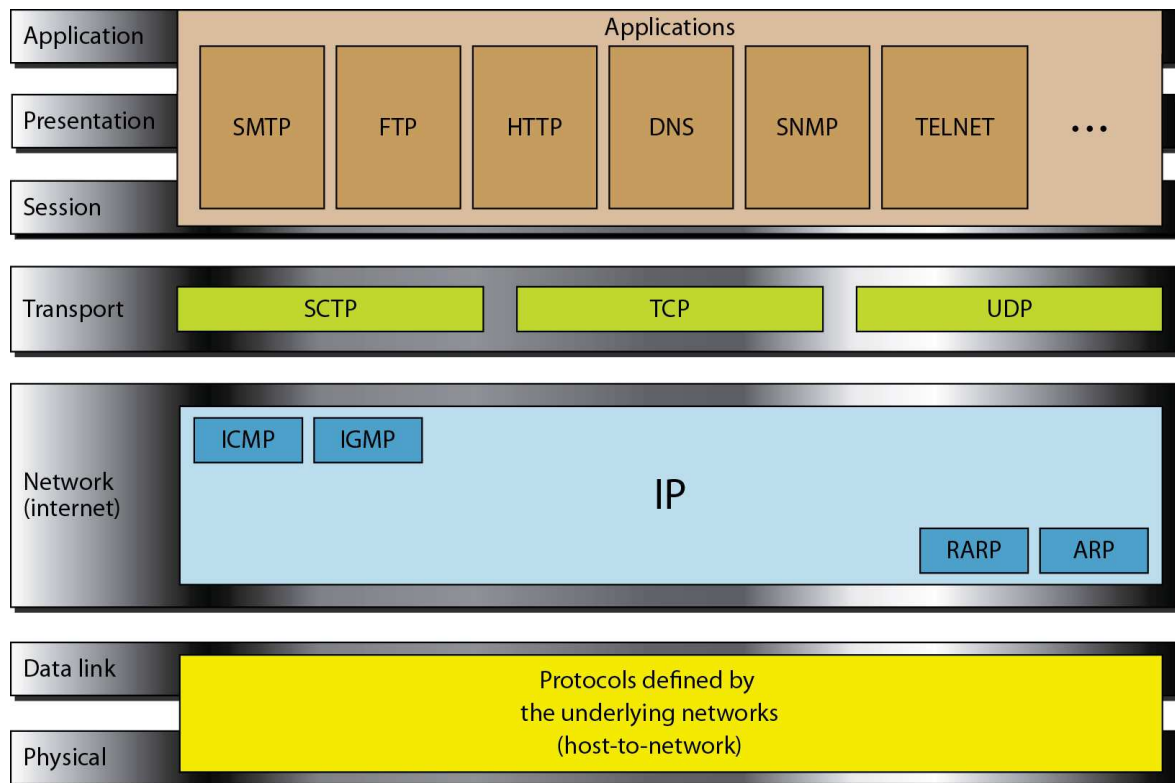
**Transport Layer**

**Application Layer**

2.32



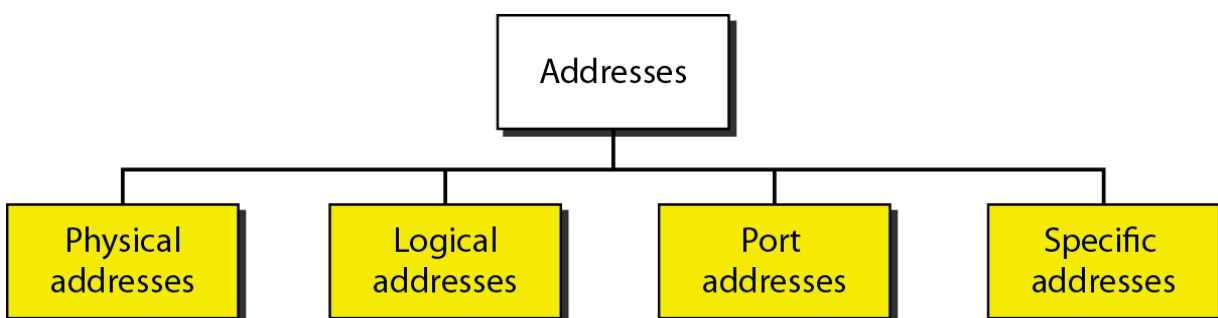
**Figure 2.16** *TCP/IP and OSI model*



2.33

## 2-5 ADDRESSING

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

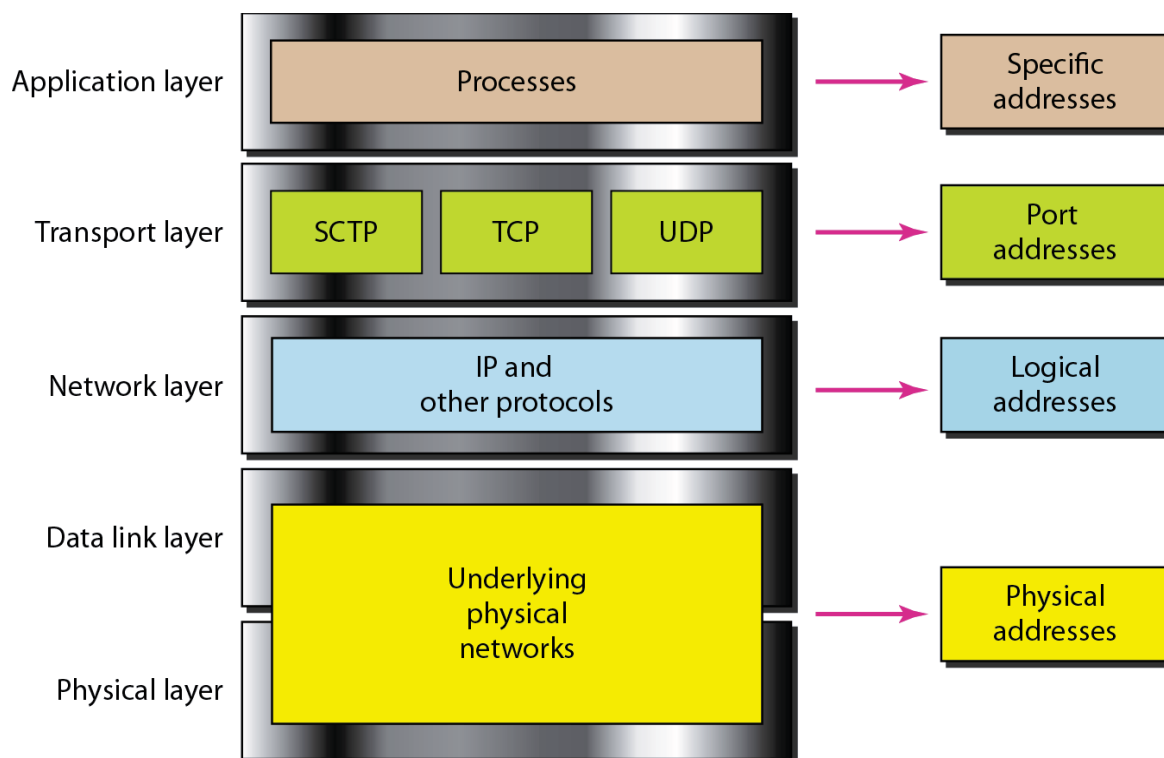


2.34

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

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## 2.35

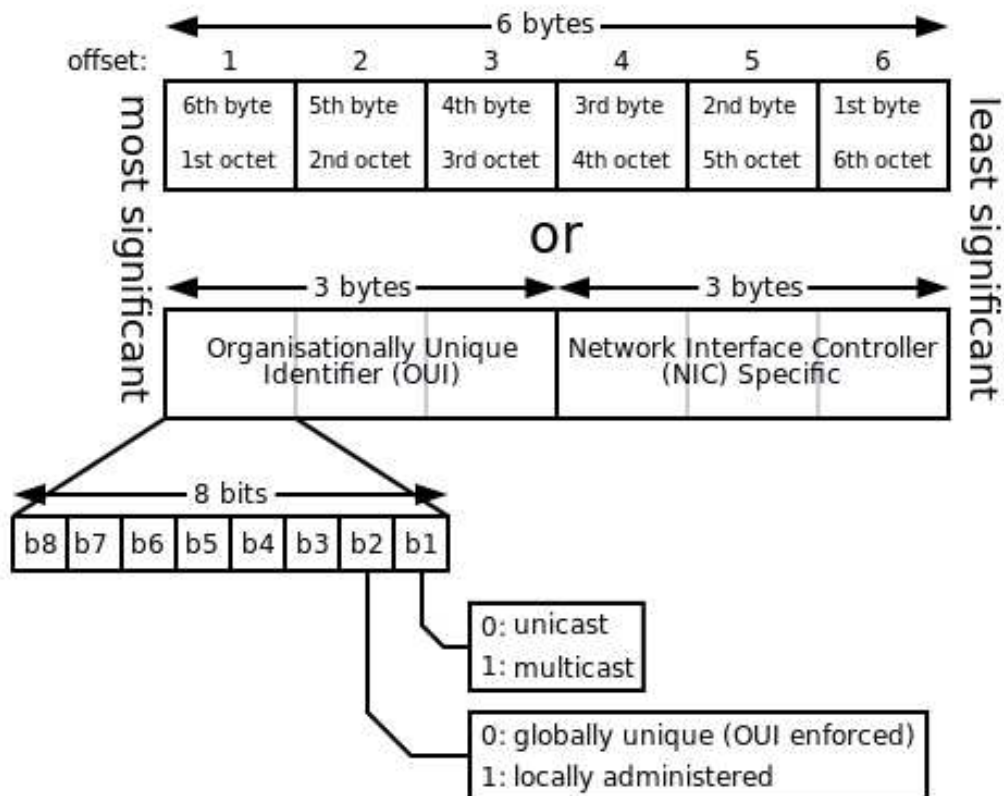
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### Physical address (MAC address):

- The physical address is the physical hardware device.
- This is specified by the manufacture company of the card.
- A hardware address that uniquely identifies each node of a network.
- The MAC layer interfaces directly with the network medium.

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## 2.36



## 2.37

### Physical address (MAC address):

An example of a MAC-48 address would be

"00-08-74-4C-7F-1D". If you cross-reference the first three octets with IEEE's OUI assignments, you can see that this MAC address came from **Dell Computer Corp.** The last three octets represent the serial number assigned to the adapter by the manufacturer

## 2.38

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## Logical address (IP):

- An IP address of the system is called logical address.
- This address is used by network layer to identify a particular network (source to destination) among the networks.
- This address can be changed by changing the host position on the network. So it is called logical address.

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### 2.39

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## Port Address:

- There are many application running on the computer.
- Each application run with a port no.(logically) on the computer.

## Specific Address:

- User-friendly addresses
- Examples include the e-mail address (for example, forouzan@fhda.edu) defines the recipient of an e-mail

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### 2.40

## 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.

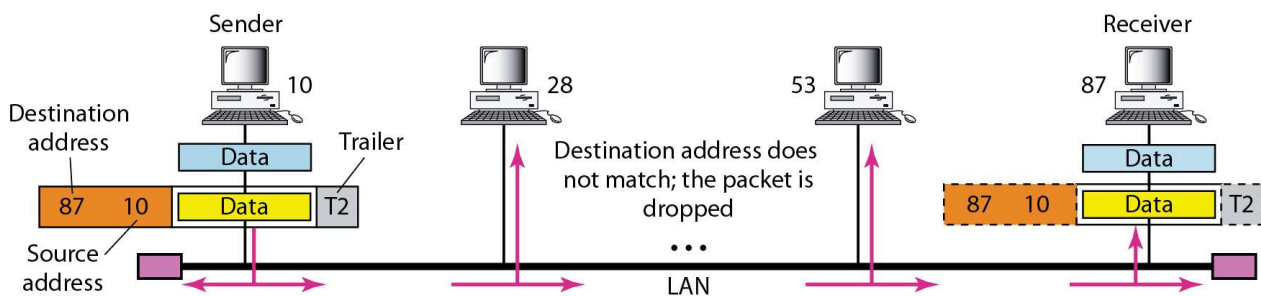


Figure 2.19 Physical addresses

2.41

## 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.**

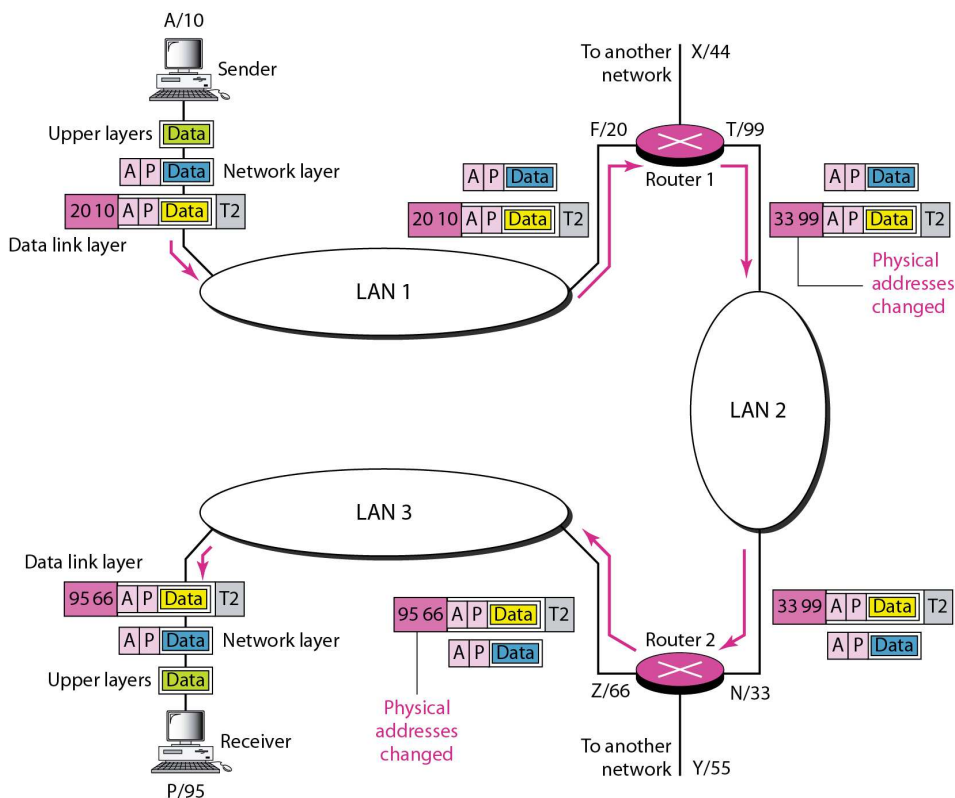
2.42

## 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.

2.43

Figure 2.20 IP addresses



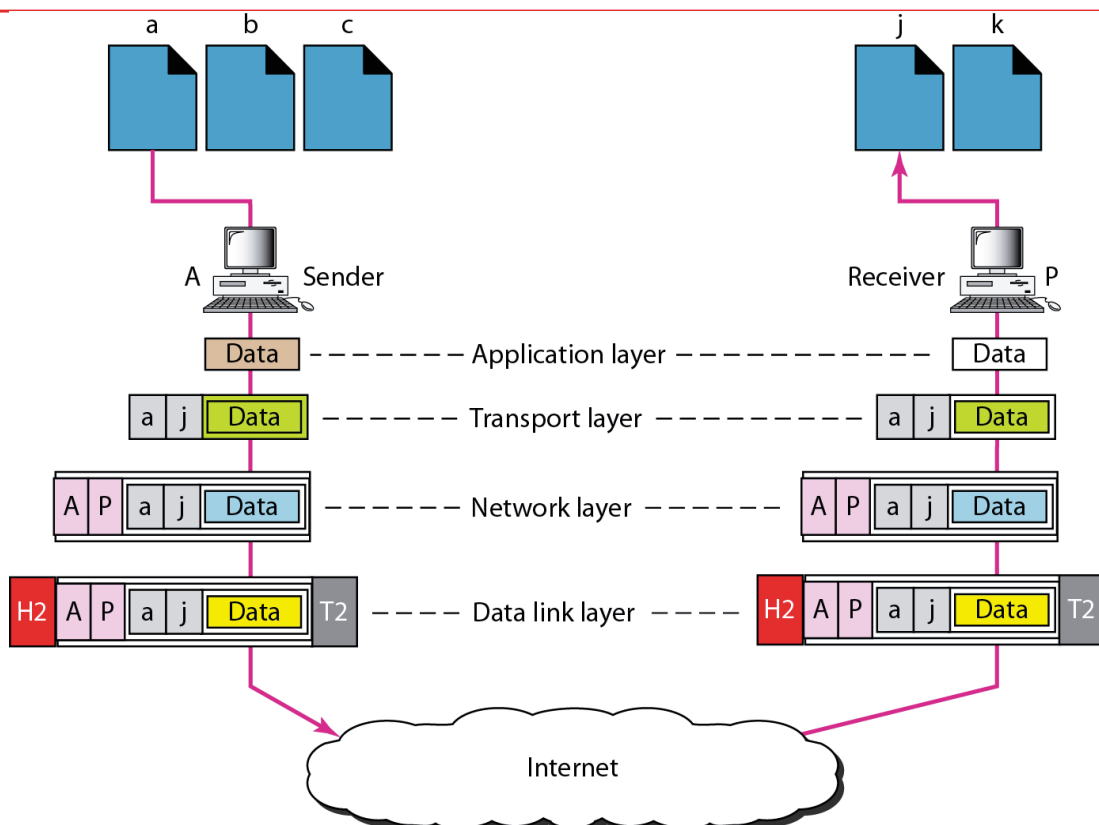
2.44

## 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.

2.45

Figure 2.21 Port addresses



2.46



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***Note***

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

2.47



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***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.**

2.48