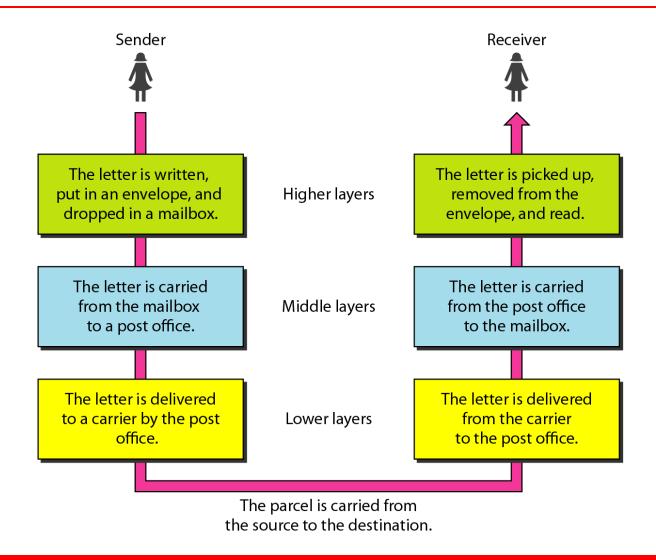# Chapter 2

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

Sender

Receiver

The letter is written, put in an envelope, and dropped in a mailbox.

Higher layers

The letter is picked up, removed from the envelope, and read.

The letter is carried from the mailbox to a post office.

Middle layers

The letter is carried from the post office to the mailbox.

The letter is delivered to a carrier by the post office.

Lower layers

The letter is delivered from the carrier to the post office.

The parcel is carried from the source to the destination.

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

2.4

Note

ISO is the organization.
OSI is the model.

Figure 2.2 *Seven layers of the OSI model*

#	Layer	Description
7	Application	**Variety of protocols used by users**
6	Presentation	**Syntax and semantics / abstract data structures**
5	Session	**Dialog control/ token management (preventing critical operation)/ synchronization/ checkpointing for recovery**
4	Transport	**Reliable service (error-free point-to-point)/ true end-to-end service**
3	Network	**subnet/packet routing: static/ dynamic/ bottlenecks in a subnet (congesting control)/quality of service**
2	Data link	**Data frames/Ack/errors/flow control/ control access to shared channel**
1	Physical	**Bits/timings/pins/electrical signals**

Figure 2.3 *The interaction between layers in the OSI model*
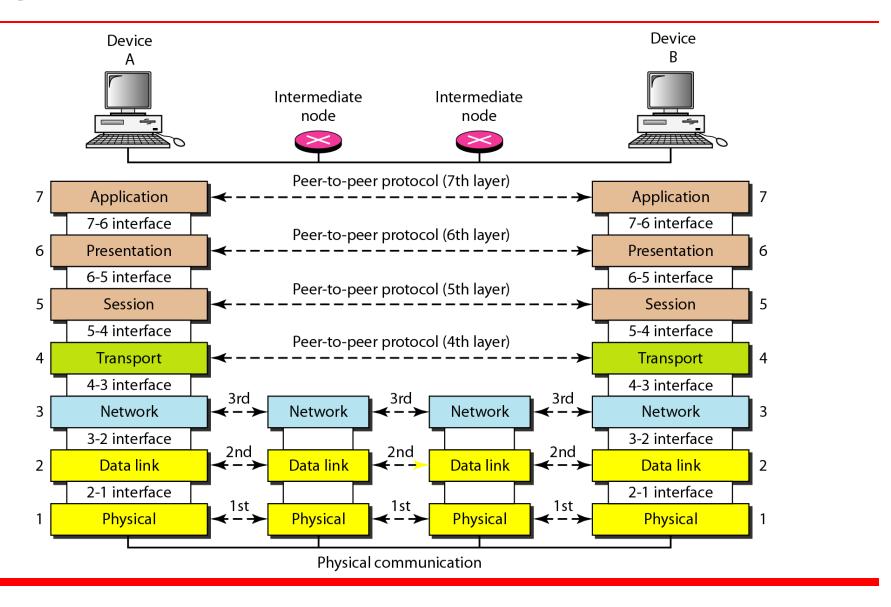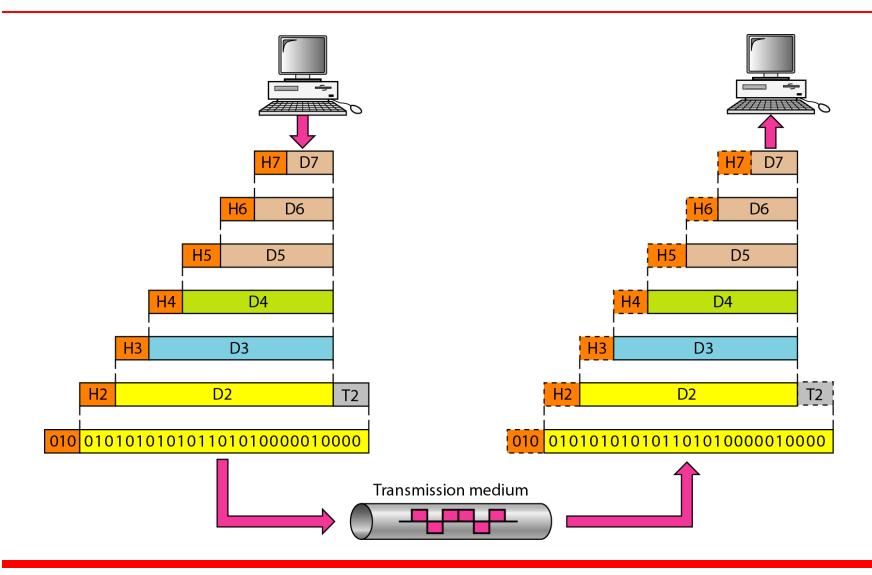
Figure 2.4 *An exchange using the OSI model*

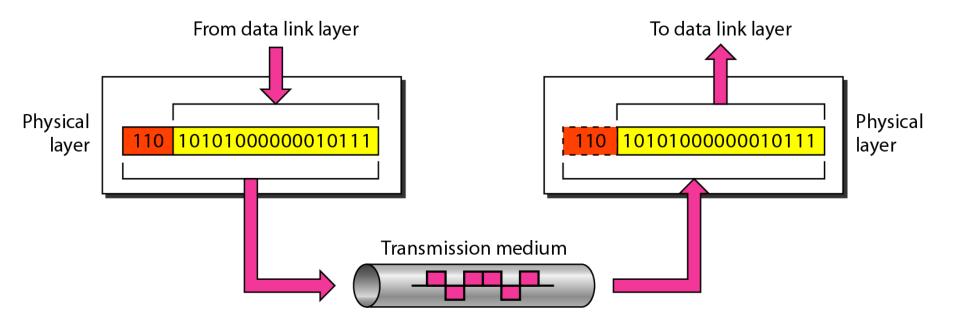# 2-3   LAYERS IN THE OSI MODEL

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*
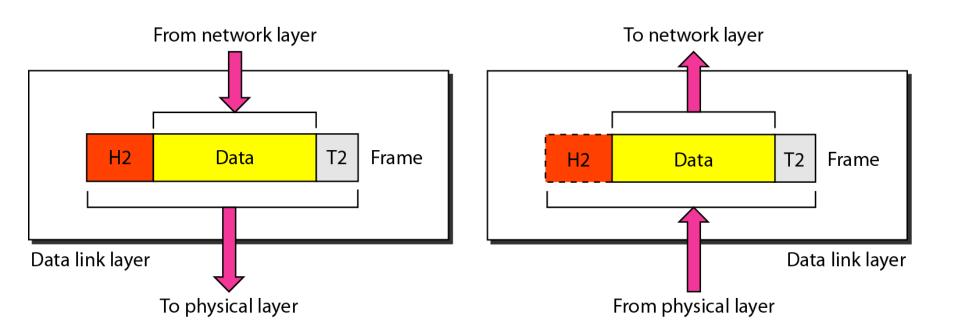
Bits/timings/pins/electrical signals

Note

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

Figure 2.6 *Data link layer*

Data frames/Ack/errors/flow control/ control access to shared channel

Note

The data link layer is responsible for moving
frames from one hop (node) to the next.
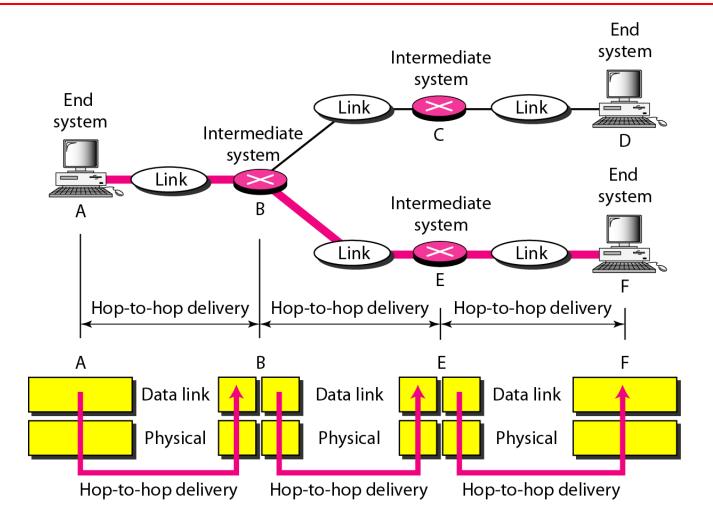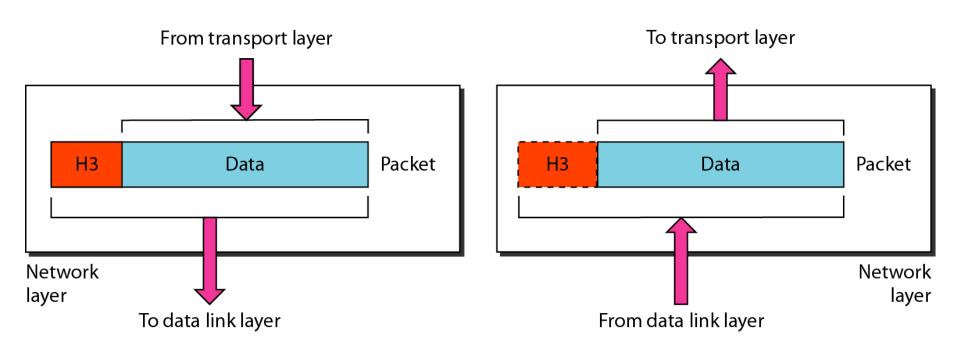
Figure 2.7 *Hop-to-hop delivery*

Figure 2.8 *Network layer*

subnet/packet routing: static/ dynamic/ bottlenecks in a subnet (congesting control)/quality of service

Note

The network layer is responsible for the
delivery of individual packets from
the source host to the destination host.
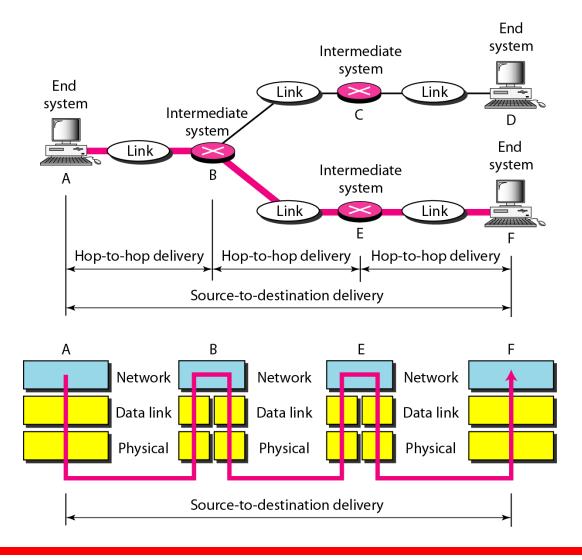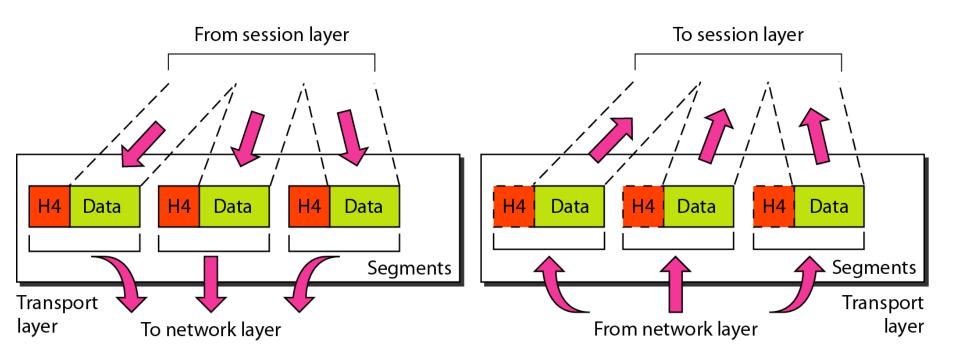
Figure 2.9 *Source-to-destination delivery*

Figure 2.10 *Transport layer*

Reliable service (error-free point-to-point)/ true end-to-end service

Note

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

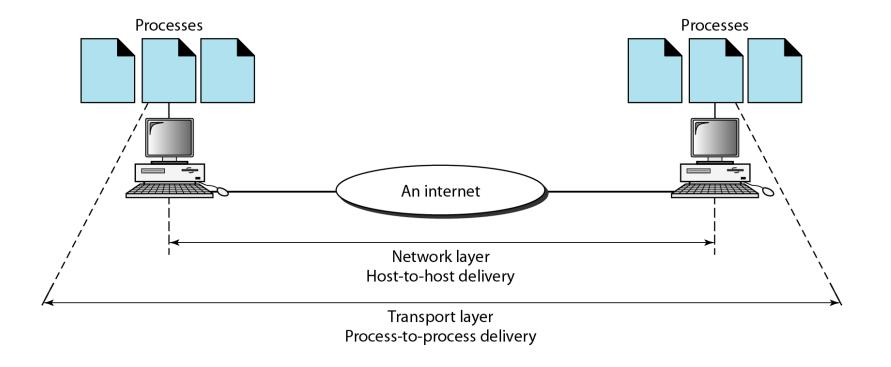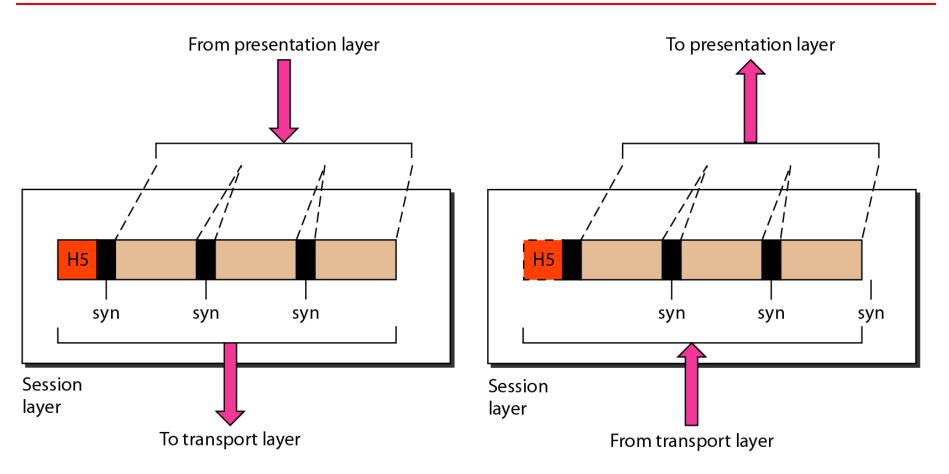# Figure 2.11 *Reliable process-to-process delivery of a message*

2.20

Figure 2.12 *Session layer*

From presentation layer

To presentation layer

H5   syn   syn   syn

H5   syn   syn   syn

Session layer

Session layer
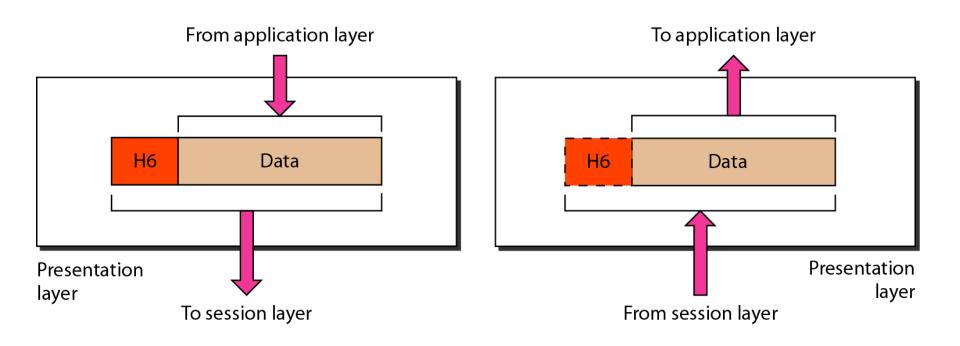
To transport layer

From transport layer

Dialog control/ token management (preventing critical operation)/ synchronization/ checkpointing for recovery

Note

The session layer is responsible for dialog
control and synchronization.
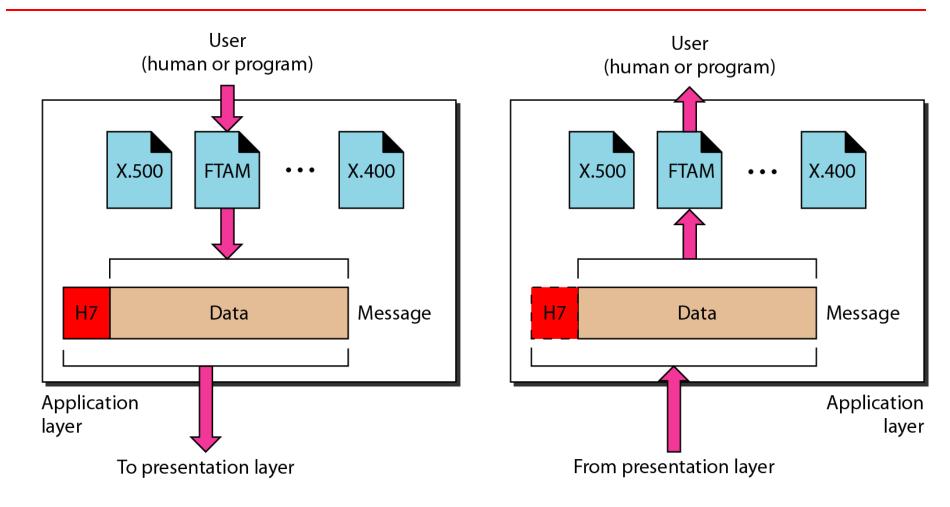
Figure 2.13 *Presentation layer*

Syntax and semantics / abstract data structures/ encryption/compression

Note

The presentation layer is responsible for translation, compression, and encryption.
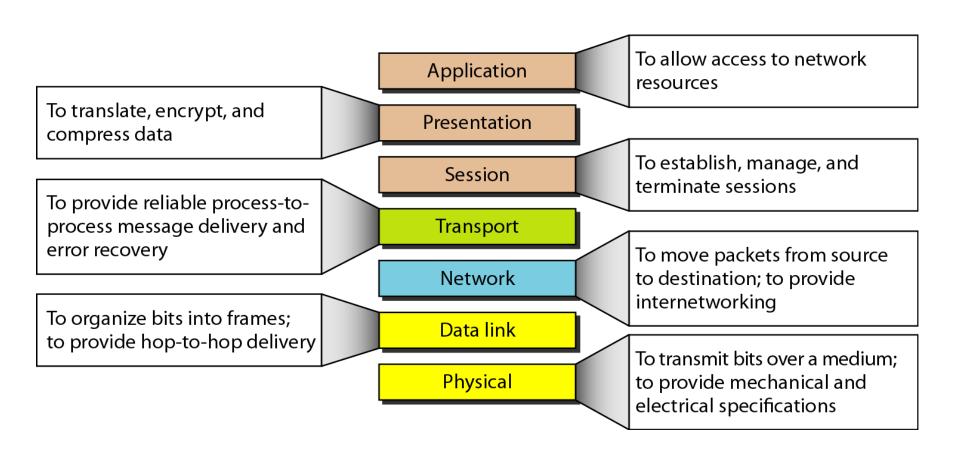
Figure 2.14 *Application layer*

X500: electronic directory services; X.400: Message Handling System; FTAM: File Transfer Access and Management

Note

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

Figure 2.15 *Summary of layers*

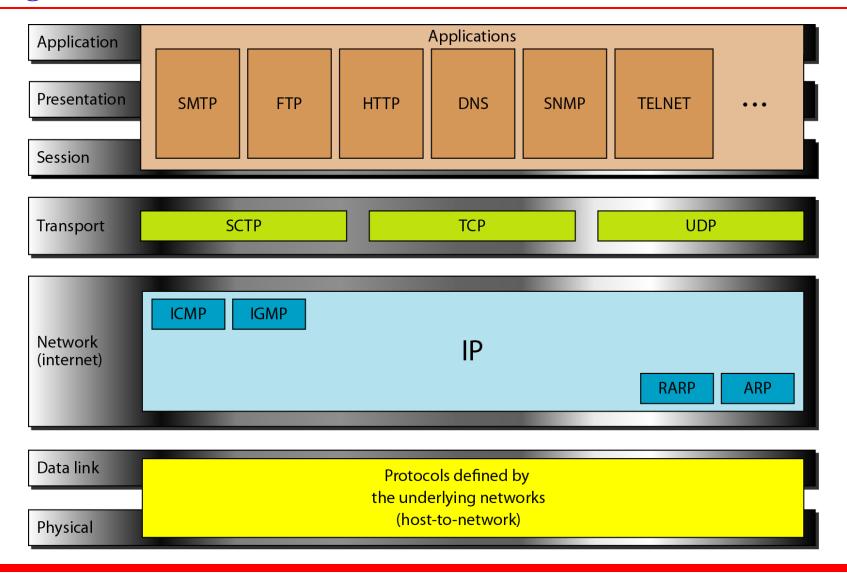|	Layer	
	Application	To allow access to network resources
To translate, encrypt, and compress data	Presentation	
	Session	To establish, manage, and terminate sessions
To provide reliable process-to-process message delivery and error recovery	Transport	
	Network	To move packets from source to destination; 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

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.*

2.28

Figure 2.16 *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 / Physical: Protocols defined by the underlying networks (host-to-network)

2-4   TCP/IP PROTOCOL SUITE

- *TCP/IP* is a **hierarchical protocol** made up of interactive modules, each upper-level protocol is supported by one or more lower-level protocols.
- **Application:**
  equivalent to the combined session, presentation, and application layers in the OSI model. Provide many application protocols.
- **Transport:**
  represented by protocols TCP, UDP and SCTP (Stream Control Transmission Protocol) for some new applications (voice over the Internet). Best features of UPD and TCP

2-4   TCP/IP PROTOCOL SUITE

Internet / Network Layer:
- supports the Internetworking Protocol (IP).
- IP uses four supporting protocols:
    - ARP (determine MAC address with IP address)
    - RARP (determine IP address with MAC address)
    - ICMP (send notification, e.g. Ping message)
    - IGMP (multicast address)
- **Host-to-network (physical, data link):**
    - At the physical and data link layers, TCP/IP does not define any specific protocol.
    - It supports all the standard and proprietary protocols.
    - A network in a TCP/IP internetwork can be a LAN or a WAN

2-5 ADDRESSING

Four levels of addresses are used in an internet employing the TCP/IP protocols:

1) **Physical Addresses**
2) **Logical Addresses**
3) **Port Addresses**
4) **Specific Addresses**

Figure 2.17 *Addresses in TCP/IP*

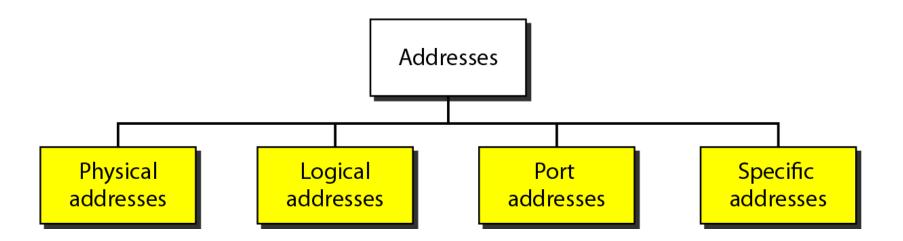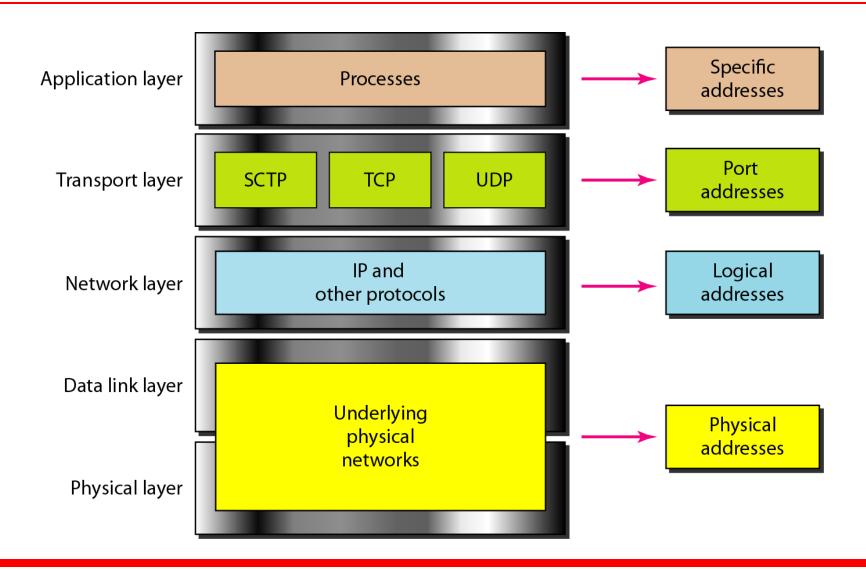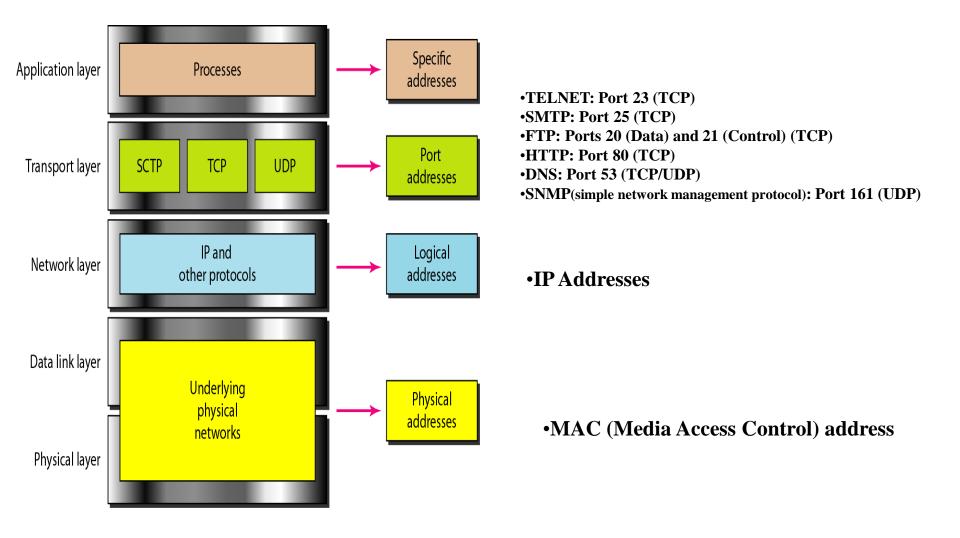# Figure 2.18 *Relationship of layers and addresses in TCP/IP*

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

•**TELNET: Port 23 (TCP)**
•**SMTP: Port 25 (TCP)**
•**FTP: Ports 20 (Data) and 21 (Control) (TCP)**
•**HTTP: Port 80 (TCP)**
•**DNS: Port 53 (TCP/UDP)**
•**SNMP**(simple network management protocol)**: Port 161 (UDP)**

•**IP Addresses**

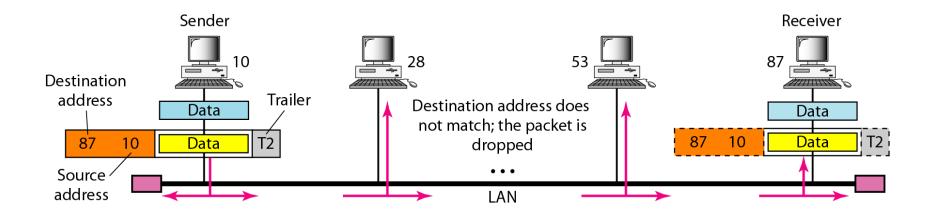•**MAC (Media Access Control) address**

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*

Sender

10

Destination
address

Trailer

Destination address does
not match; the packet is
dropped

Receiver

87

| 87 | 10 |

| Data |

T2

28

53

| 87 | 10 |

| Data |

T2

Source
address

LAN

2.37

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

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.

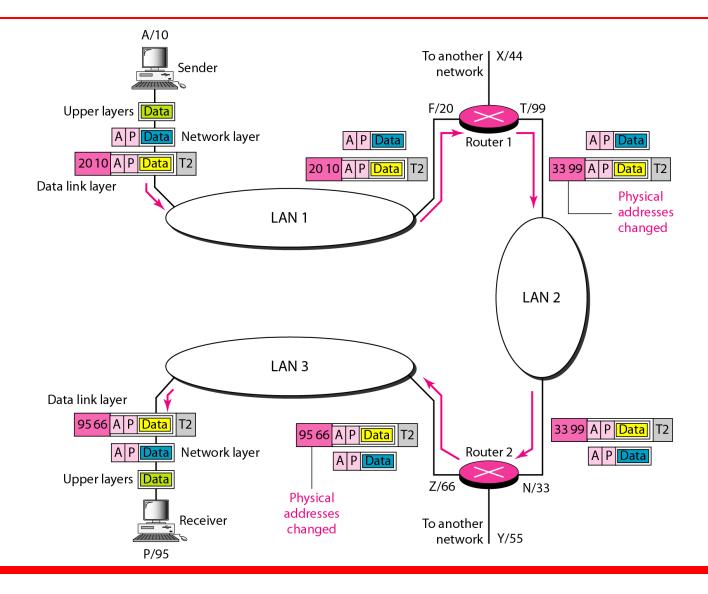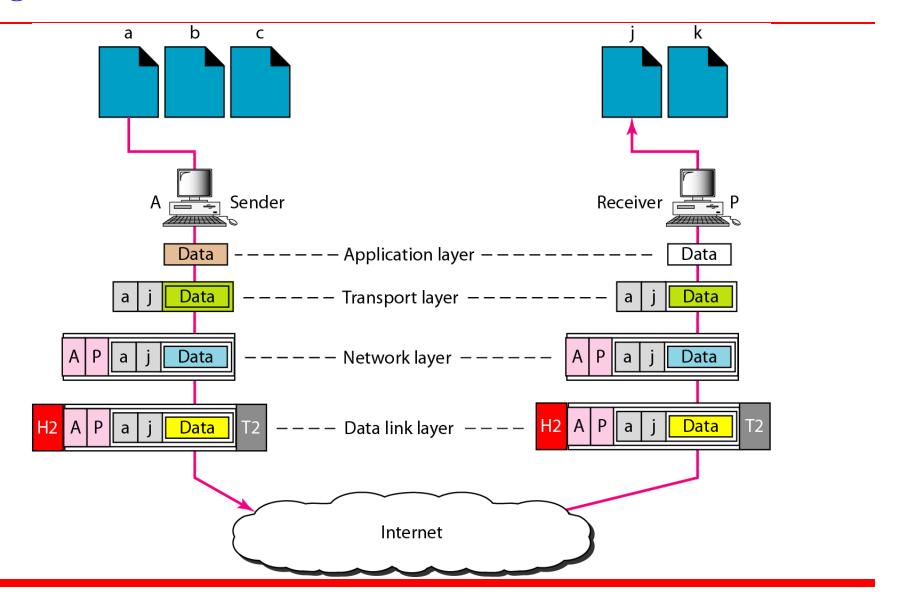# Figure 2.20 *IP addresses*

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

A port address is a 16-bit address represented by one decimal number can range from **0 to 65535.**

> **753**
>
> **A 16-bit port address represented as one single number.**