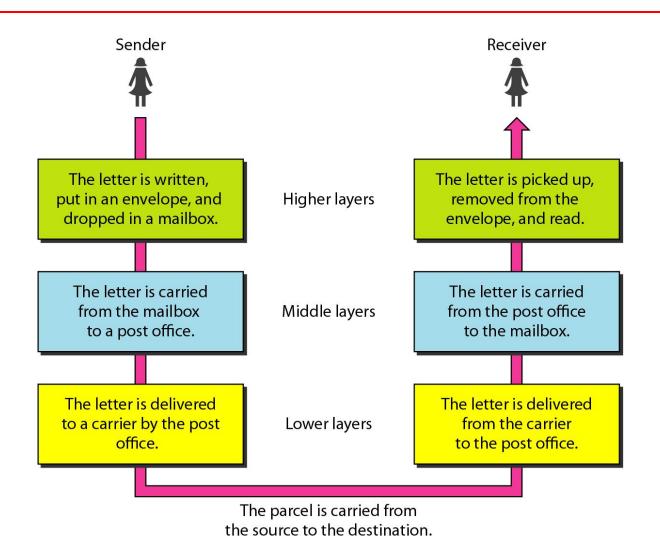
Unit IV Reference Model

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



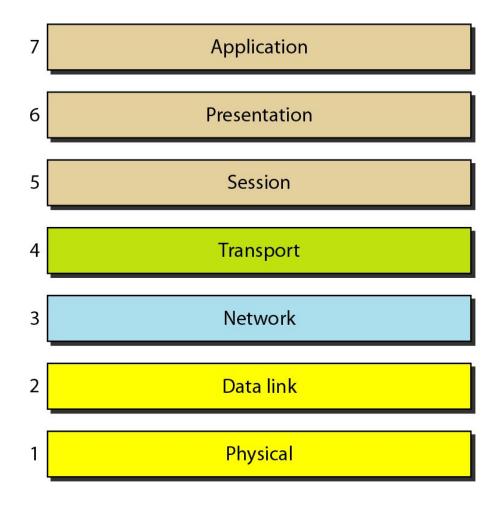
THE OSI MODEL

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.



ISO is the organization. OSI is the model.

Seven layers of the OSI model



The interaction between layers in the OSI model

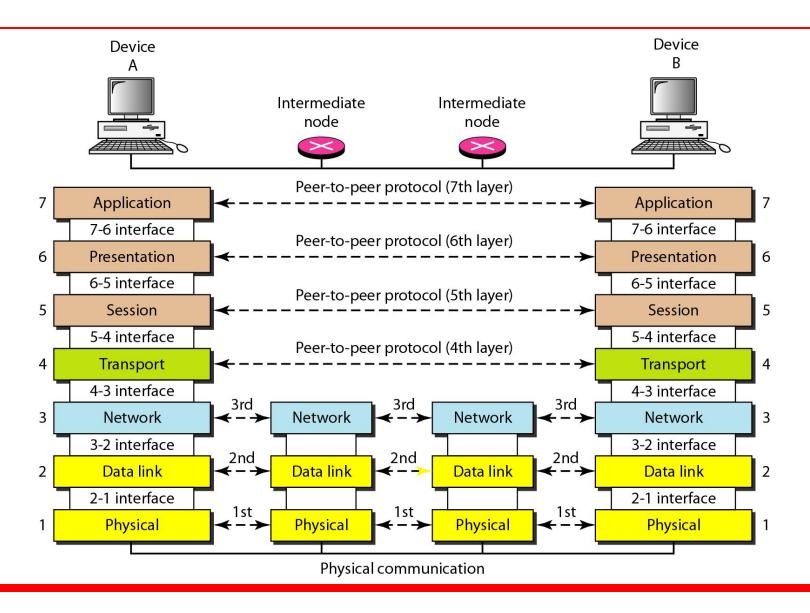
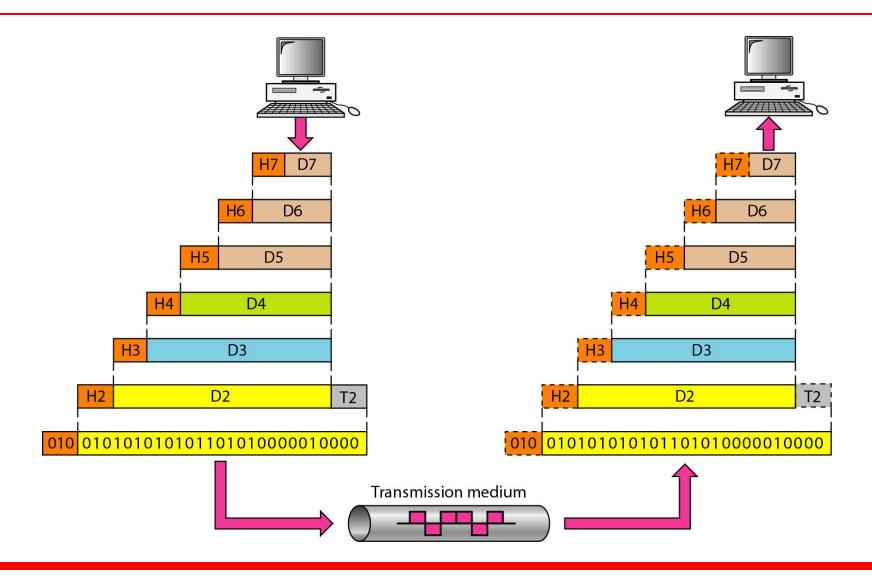


Figure 2.4 An exchange using the OSI model



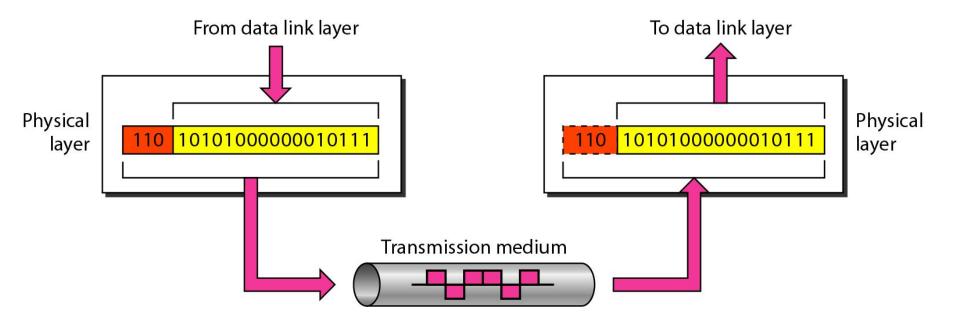
2-3 LAYERS IN THE OSI MODEL

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

Topics discussed in this section:

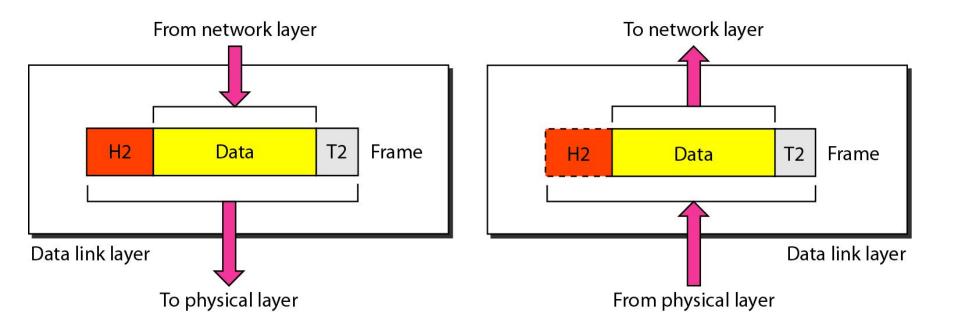
Physical Layer
Data Link Layer
Network Layer
Transport Layer
Session Layer
Presentation Layer
Application Layer

Figure 2.5 Physical layer



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

Figure 2.6 Data link layer



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

Figure 2.7 Hop-to-hop delivery

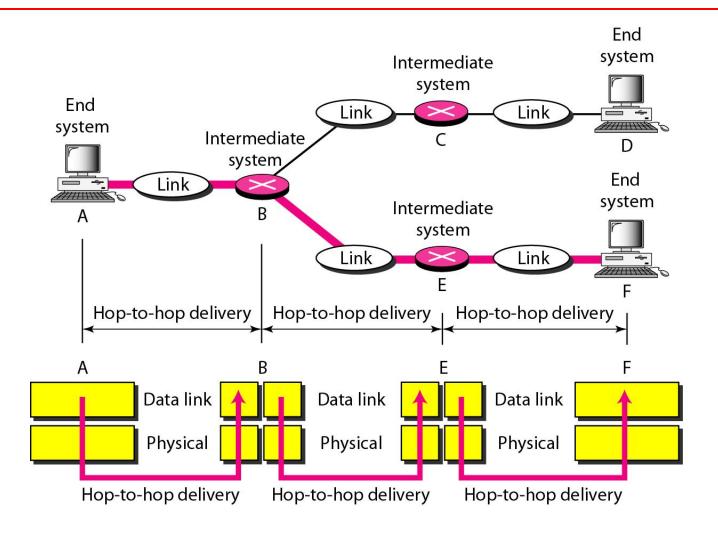
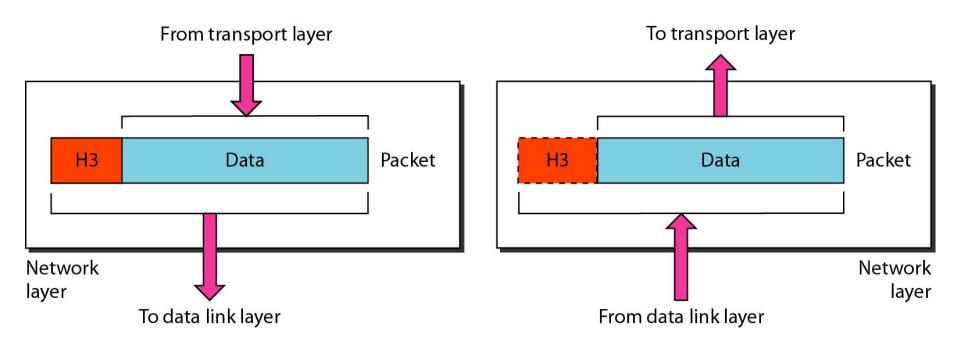


Figure 2.8 Network layer



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

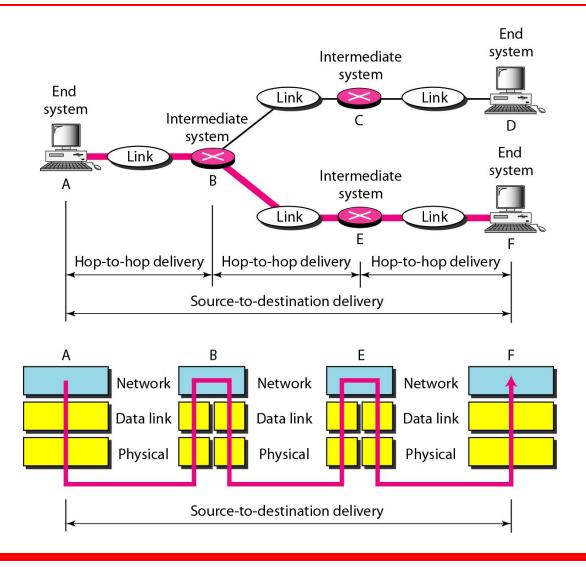
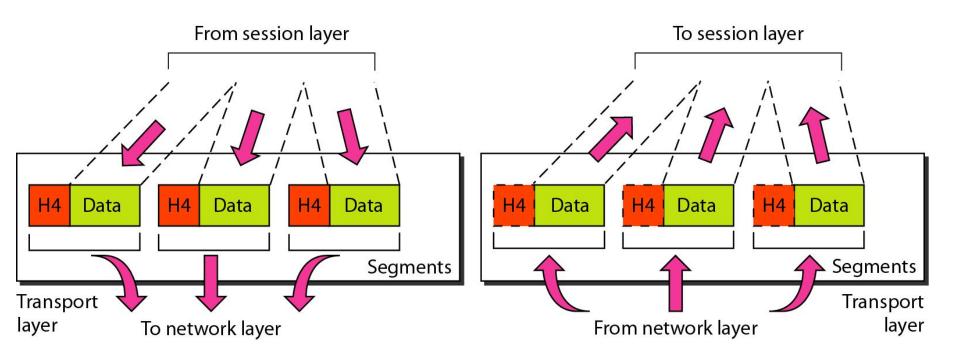


Figure 2.10 Transport layer



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

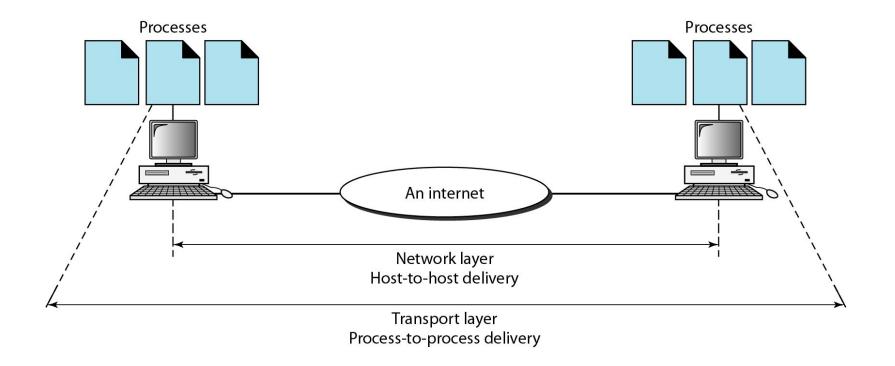
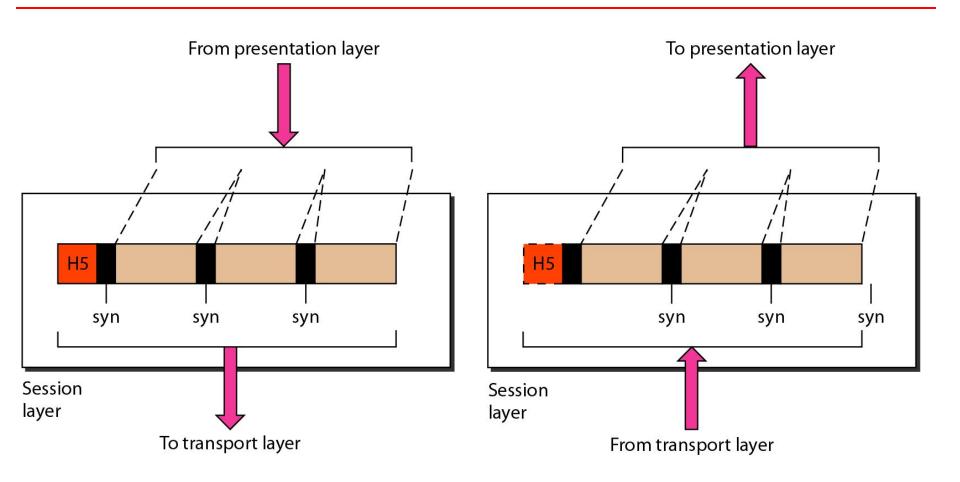
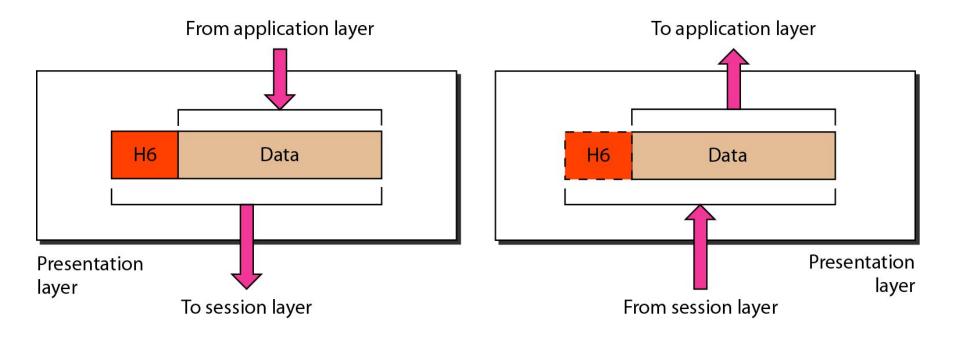


Figure 2.12 Session layer



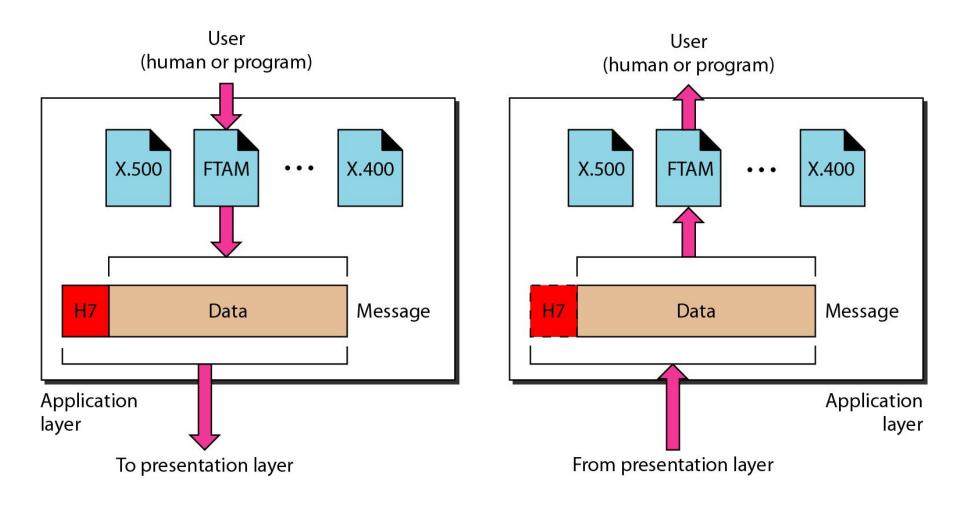
The session layer is responsible for dialog control and synchronization.

Figure 2.13 Presentation layer



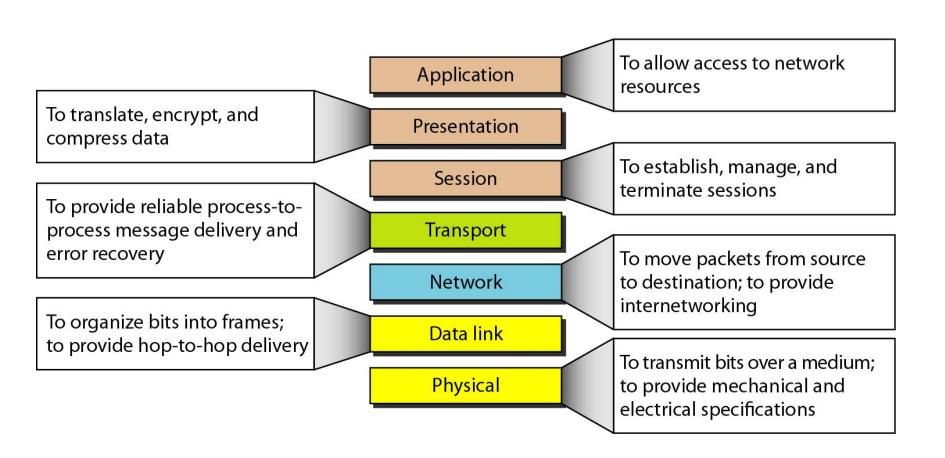
The presentation layer is responsible for translation, compression, and encryption.

Figure 2.14 Application layer



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

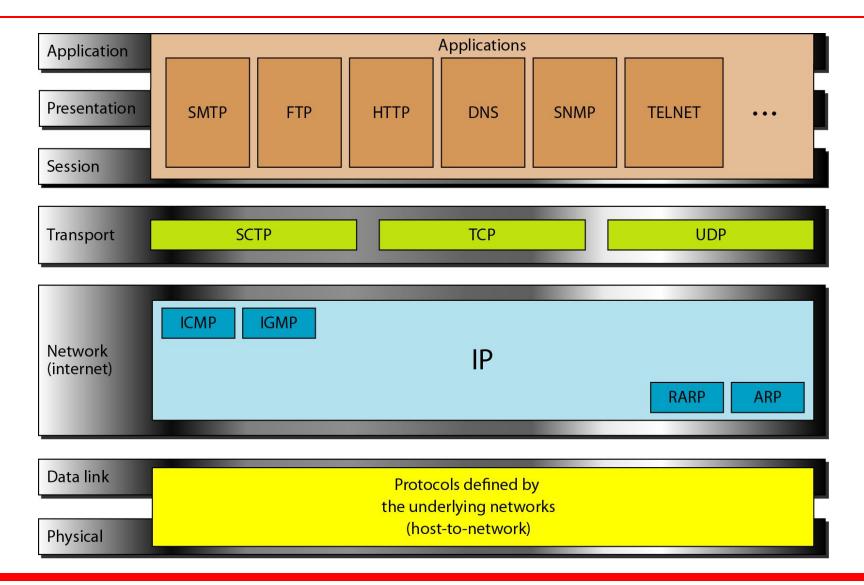
Figure 2.15 Summary of layers



TCP/IP PROTOCOL SUITE

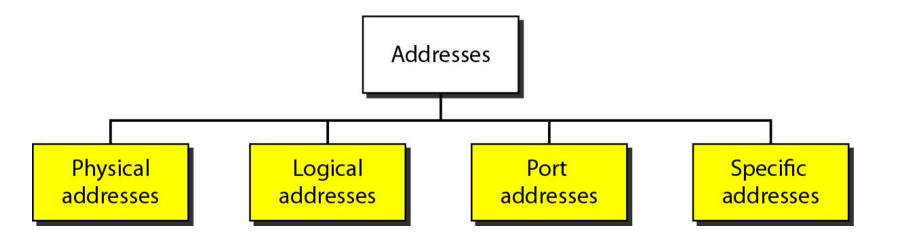
The layers in the TCP/IP protocol suite do not exactly match those in the OSI model. The original TCP/IP protocol suite was defined as having four layers: host-to-network, internet, transport, and application. However, when TCP/IP is compared to OSI, we can say that the TCP/IP protocol suite is made of five layers: physical, data link, network, transport, and application.

Figure 2.16 TCP/IP and OSI model



ADDRESSING in TCP/IP

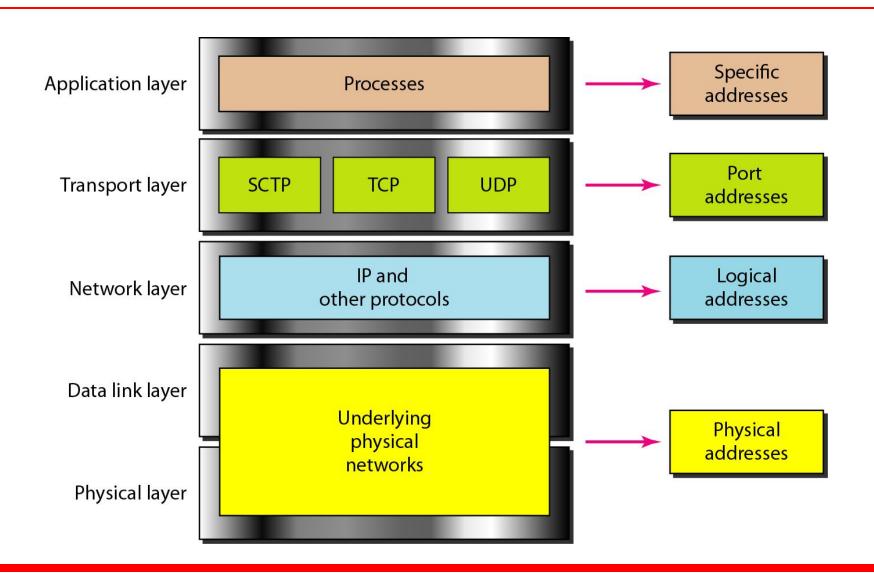
Four levels of addresses are used in an internet employing the TCP/IP protocols: physical, logical, port, and specific.



Physical Addresses

The physical address, also known as the link address, is the address of a node as defined by its LAN or WAN. It is included in the frame used by the data link layer. It is the lowest-level address.

Relationship of layers and addresses in TCP/IP



Logical Addresses

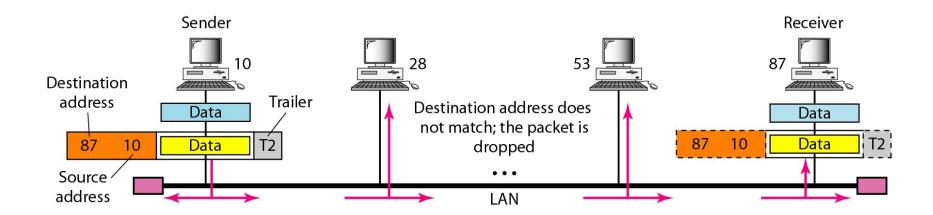
Logical addresses are necessary for universal communications that are independent of underlying physical networks. Physical addresses are not adequate in an internetwork environment where different networks can have different address formats. A universal addressing system is needed in which each host can be identified uniquely, regardless of the underlying physical network.

The logical addresses are designed for this purpose. A logical address in the Internet is currently a 32-bit address that can uniquely define a host connected to the Internet. No two publicly addressed and visible hosts on the Internet can have the same IP 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



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:

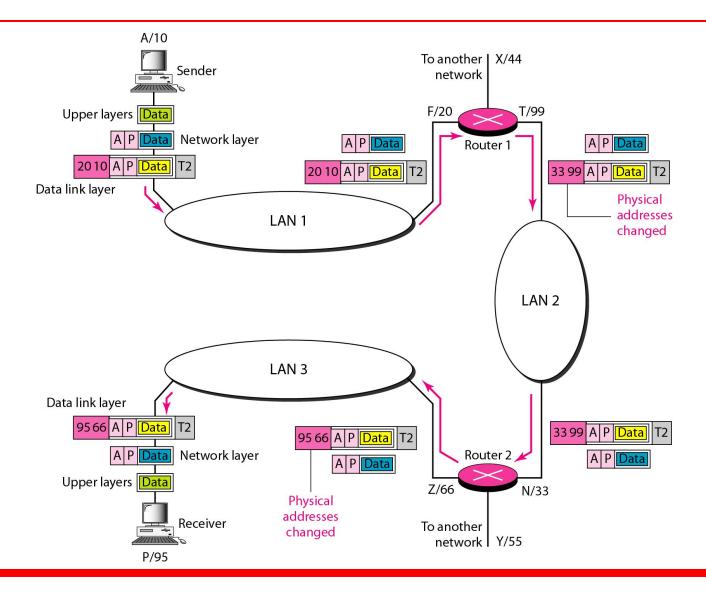
07:01:02:01:2C:4B

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

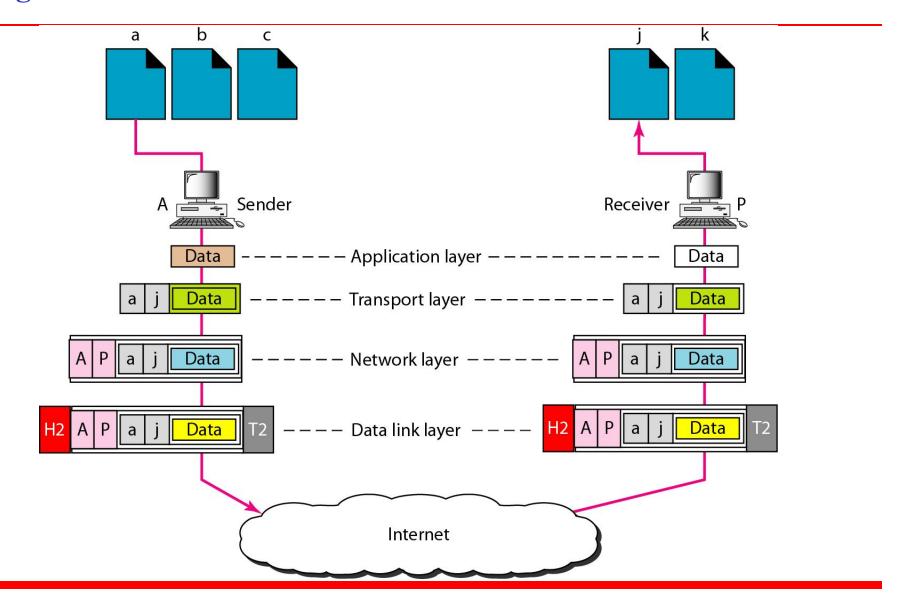
Figure 2.21 shows two computers communicating via the Internet. The sending computer is running three processes at this time with port addresses a, b, and c. The receiving computer is running two processes at this time with port addresses j and k. Process a in the sending computer needs to communicate with process i 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

The IP address and the physical address are necessary for a quantity of data to travel from a source to the destination host. However, arrival at the destination host is not the final objective of data communications on the Internet. A system that sends data from one computer to another is not complete. Today, computers are devices that can run multiple processes at the same time. The end objective of Internet communication is a process communicating with another process. For example, computer A can communicate with computer C by using TELNET. At the same time, computer A communicates with computer B by using the File Transfer Protocol (FTP). For these processes to receive data simultaneously, we need a method to label the different processes.

In other words, they need addresses. In the TCP IP architecture, the label assigned to a process is called a port address. A port address in TCP IP is 16 bits in length.

Figure 2.21 Port addresses



Note

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

Specific Addresses

Some applications have user-friendly addresses that are designed for that specific address. Examples include the e-mail address (for example, forouzan@fhda.edu) and the Universal Resource Locator (URL) (for example, www.mhhe.com). The first defines the recipient of an e-mail; the second is used to find a document on the World Wide Web .These addresses, however, get changed to the corresponding port and logical addresses by the sending computer.

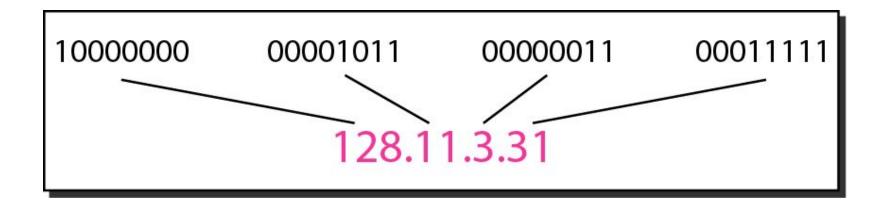
Network Layer: Logical Addressing

IPv4 ADDRESSES

An IPv4 address is a 32-bit address that uniquely and universally defines the connection of a device (for example, a computer or a router) to the Internet.

- □An IPv4 address is 32 bits long.
- **The IPv4 addresses are unique and universal.**
- \Box The address space of IPv4 is 2^{32} or 4,294,967,296.

Dotted-decimal notation and binary notation for an IPv4 address



Change the following IPv4 addresses from binary notation to dotted-decimal notation.

- a. 10000001 00001011 00001011 11101111
- **b.** 11000001 10000011 00011011 11111111

Solution

We replace each group of 8 bits with its equivalent decimal number and add dots for separation.

- a. 129.11.11.239
- **b.** 193.131.27.255

Change the following IPv4 addresses from dotted-decimal notation to binary notation.

- a. 111.56.45.78
- **b.** 221.34.7.82

Solution

We replace each decimal number with its binary equivalent.

- a. 01101111 00111000 00101101 01001110
- **b.** 11011101 00100010 00000111 01010010

Find the error, if any, in the following IPv4 addresses.

- a. 111.56.045.78
- **b.** 221.34.7.8.20
- c. 75.45.301.14
- **d.** 11100010.23.14.67

Solution

- a. There must be no leading zero (045).
- b. There can be no more than four numbers.
- c. Each number needs to be less than or equal to 255.
- d. A mixture of binary notation and dotted-decimal notation is not allowed.

Note

In classful addressing, the address space is divided into five classes: A, B, C, D, and E.

Finding the classes in binary and dotted-decimal notation

	First byte	Second byte	Third byte	Fourth byte
Class A	0			
Class B	10			
Class C	110			
Class D	1110			
Class E	1111			

a. Binary notation

	First byte	Second byte	Third byte	Fourth byte
Class A	0–127			
Class B	128–191			
Class C	192–223			
Class D	224–239			
Class E	240–255			

b. Dotted-decimal notation

Find the class of each address.

- **a.** <u>0</u>0000001 00001011 00001011 11101111
- **b.** <u>110</u>000001 100000011 00011011 111111111
- *c.* <u>14</u>.23.120.8
- **d. 252**.5.15.111

Solution

- a. The first bit is 0. This is a class A address.
- b. The first 2 bits are 1; the third bit is 0. This is a class C address.
- c. The first byte is 14; the class is A.
- d. The first byte is 252; the class is E.

Table 1 Number of blocks and block size in classful IPv4 addressing

Class	Number of Blocks	Block Size	Application
A	128	16,777,216	Unicast
В	16,384	65,536	Unicast
С	2,097,152	256	Unicast
D	1	268,435,456	Multicast
Е	1	268,435,456	Reserved

Table 2 Default masks for classful addressing

Class	Binary	Dotted-Decimal	CIDR
A	1111111 00000000 00000000 00000000	255 .0.0.0	/8
В	1111111 11111111 00000000 00000000	255.255. 0.0	/16
С	1111111 11111111 11111111 00000000	255.255.255.0	/24

Figure 19.3 shows a block of addresses, in both binary and dotted-decimal notation, granted to a small business that needs 16 addresses.

We can see that the restrictions are applied to this block. The addresses are contiguous. The number of addresses is a power of 2 ($16 = 2^4$), and the first address is divisible by 16. The first address, when converted to a decimal number, is 3,440,387,360, which when divided by 16 results in 215,024,210.

Figure 19.3 A block of 16 addresses granted to a small organization

