CCE 313 Computer Networks
CCE 314 Computer Networks Sessional

Prof. Dr. Md. Samsuzzaman

Sarna Majumder, Associate Professor

1-1 A BRIEF HISTORY

A network is a group of connected, communicating devices such as computers and printers. An *internet* is two or more networks that can communicate with each other. The most notable internet is called the *internet*, composed of hundreds of thousands of interconnected networks. Private individuals as well as various organizations such as government agencies, schools, research facilities, corporations, and libraries in more than 100 countries use the Internet.

Internet Evolution

- ✓ARPANET
- ✓Birth of the Internet
- ✓TCP/IP
- ✓MILNET
- ✓CSNET
- ✓NSFNET
- ✓ANSNET
- ✓The Internet Today
- ✓World Wide Web
- ✓Growth of the Internet

Topics Discussed in the Section

✓Protocols

✓Standards

Standards are developed through the cooperation of standards creation committees, forums, and government regulatory agencies.

RFCs can be found at http://www.rfc-editor.org.

A Request for Comments (RFC) is a formal document from the Internet Engineering Task Force (IETF) that is the result of committee drafting and subsequent review by interested parties. Some RFCs are informational in nature. Of those that are intended to become Internet standards, the final version of the RFC becomes the standard and no further comments or changes are permitted. Change can occur, however, through subsequent RFCs that supersede or elaborate on all or parts of previous RFCs.

1-5 INTERNET ADMINISTRATION

The Internet, with its roots primarily in the research domain, has evolved and gained a broader user base with significant commercial activity. Various groups that coordinate Internet issues have guided this growth and development.

- ✓Internet Society (ISOC)
- ✓Internet Architecture Board (IAB)
- ✓Internet Research Task Force (IRTF)
- ✓Internet Assigned Number Authority (IANA)
- ✓Internet Corporation for Names and Numbers (ICANN)
- ✓Network Information Center (NIC)

2-4 ADDRESSING

Four levels of addresses are used in an internet employing the TCP/IP protocols: physical address, logical address, port address, and application-specific address. Each address is related to a one layer in the TCP/IP architecture, as shown in Figure 2.15.

- ✓ Physical Addresses
- ✓ Logical Addresses
- ✓ Port Addresses
- ✓ Application-Specific Addresses

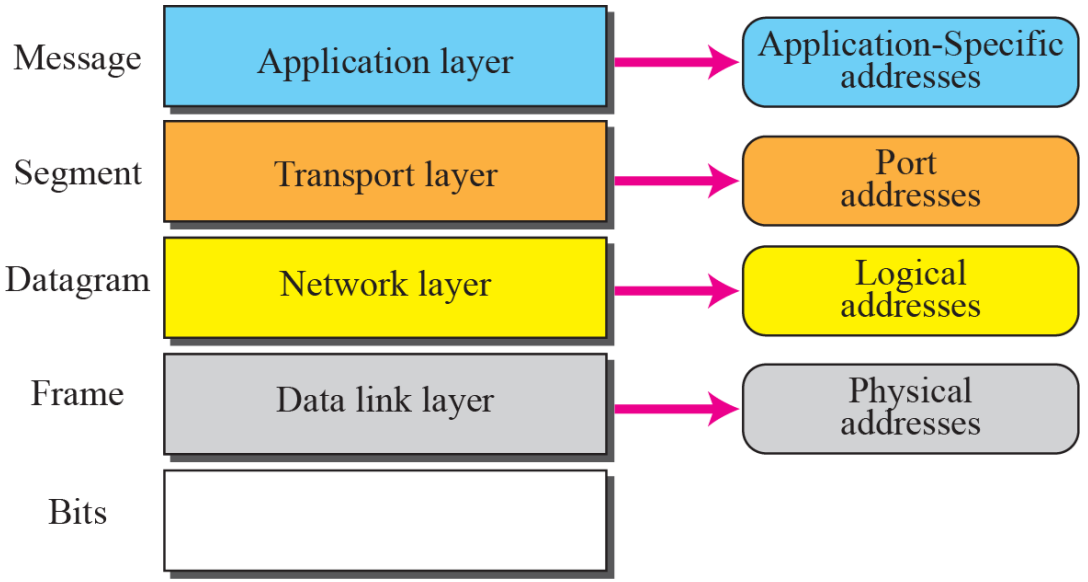
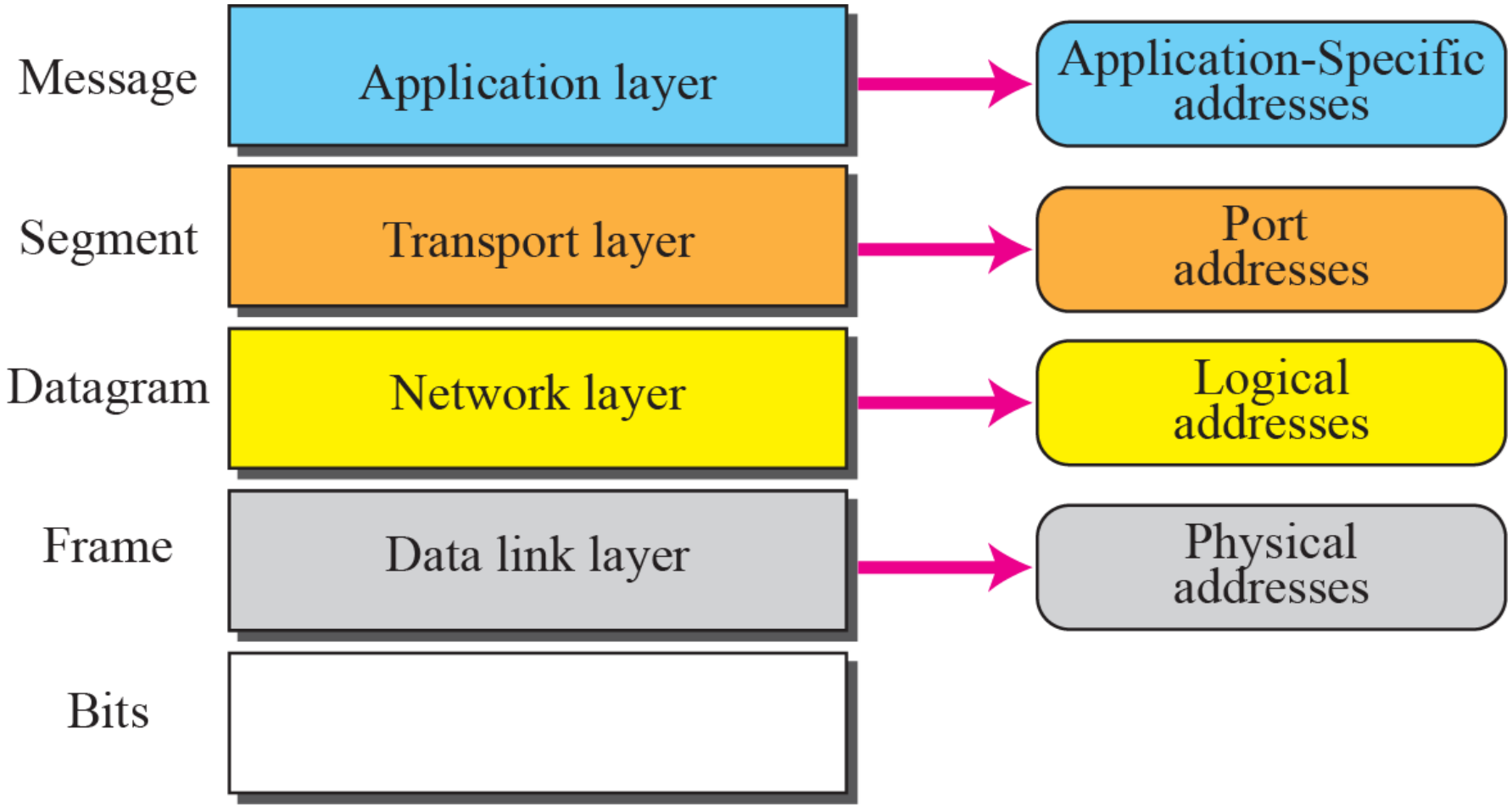


Figure 2.15 *Addresses in the TCP/IP protocol suite*



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

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

Example 2.4

As we will see in Chapter 3, 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 2.7

As we will see in future chapters, a port address is a 16-bit address represented by one decimal number as shown.

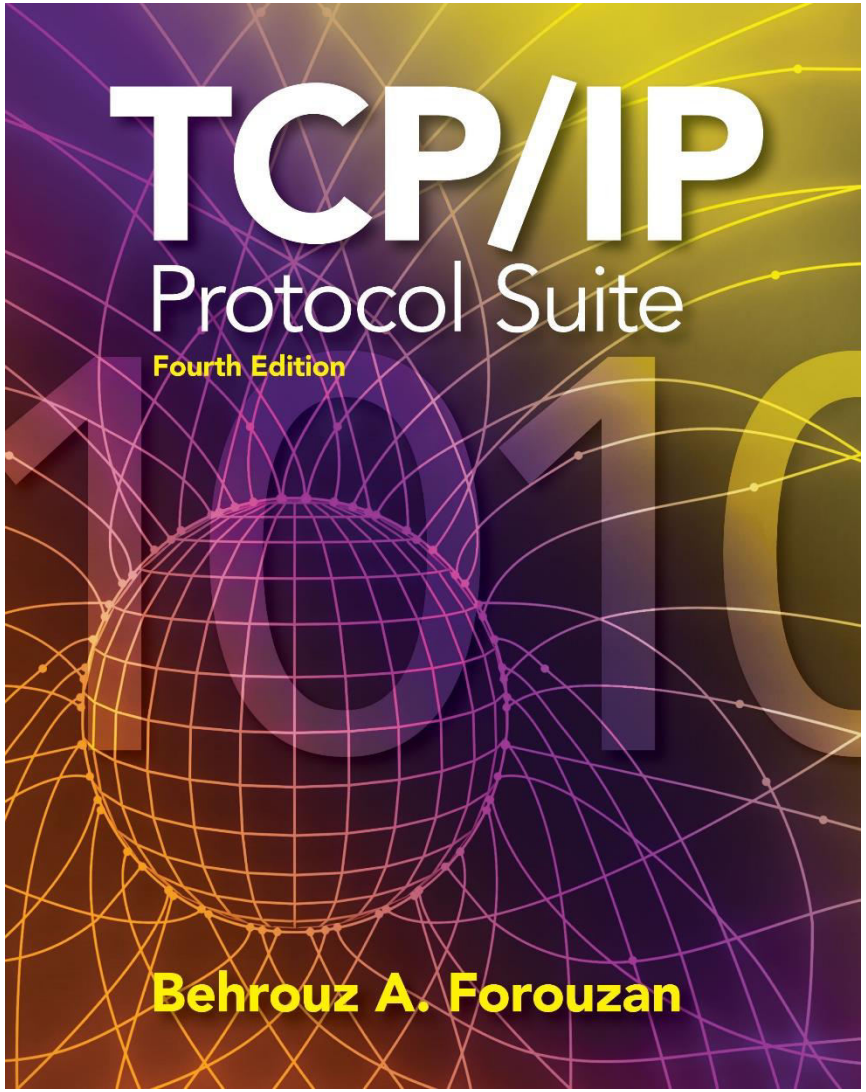
753

A 16-bit port address represented as one single number

A port number can range from 0-65535, but port numbers between 0-1023 are termed as well known ports because most of the popular services are under these range only such as 21 for FTP,80 for HTTP, 443 for HTTPS, 23 for TELNET and 22 for SSH

Chapter 3

Underlying Technology



3-1 WIRED LOCAL AREA NETWORKS

A local area network (LAN) is a computer network that is designed for a limited geographic area such as a building or a campus. Although a LAN can be used as an isolated network to connect computers in an organization for the sole purpose of sharing resources, most LANs today are also linked to a wide area network (WAN) or the Internet.

The LAN market has seen several technologies such as Ethernet, token ring, token bus, FDDI, and ATM LAN, but Ethernet is by far the dominant technology.

Figure 3.1 *IEEE standard for LANs*

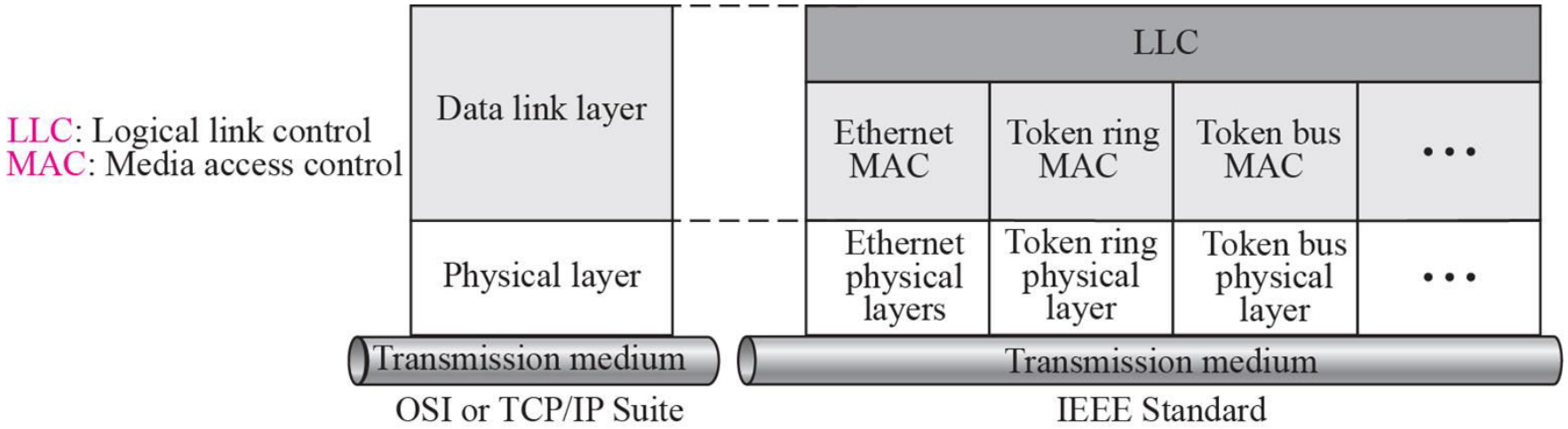


Figure 3.2 *Ethernet Frame*

Preamble: 56 bits of alternating 1s and 0s.

SFD: Start frame delimiter, flag (10101011)

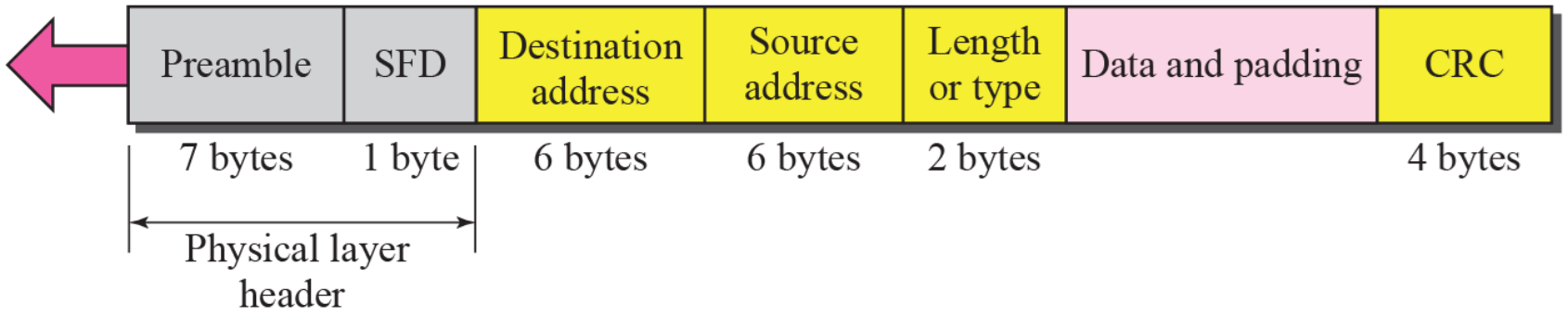


Figure 3.3 *Maximum and minimum lengths*

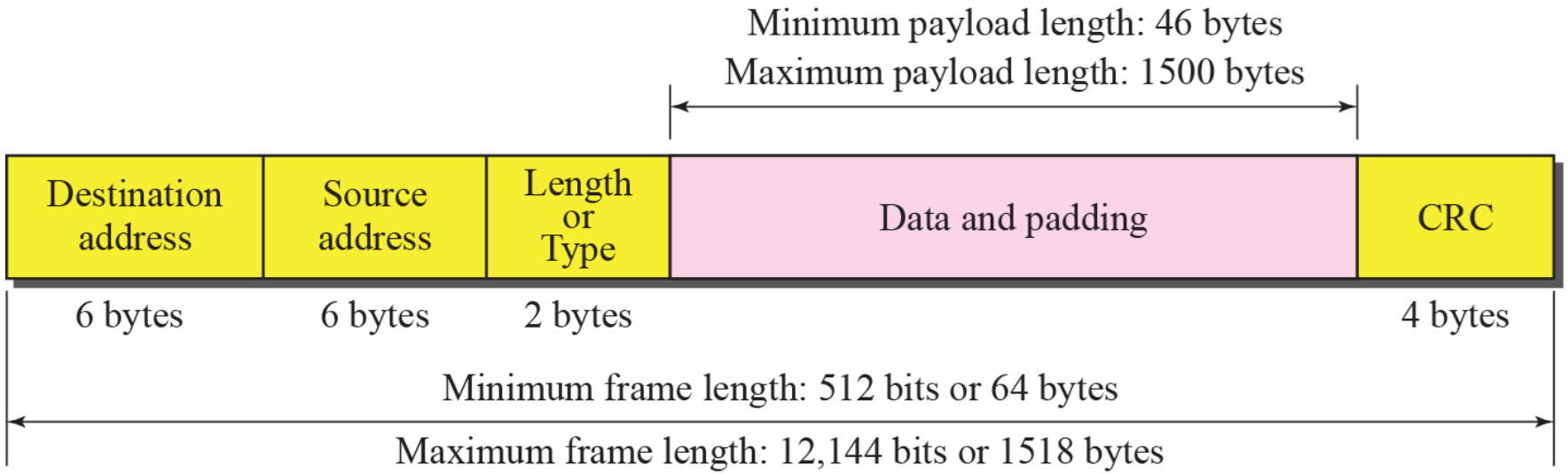


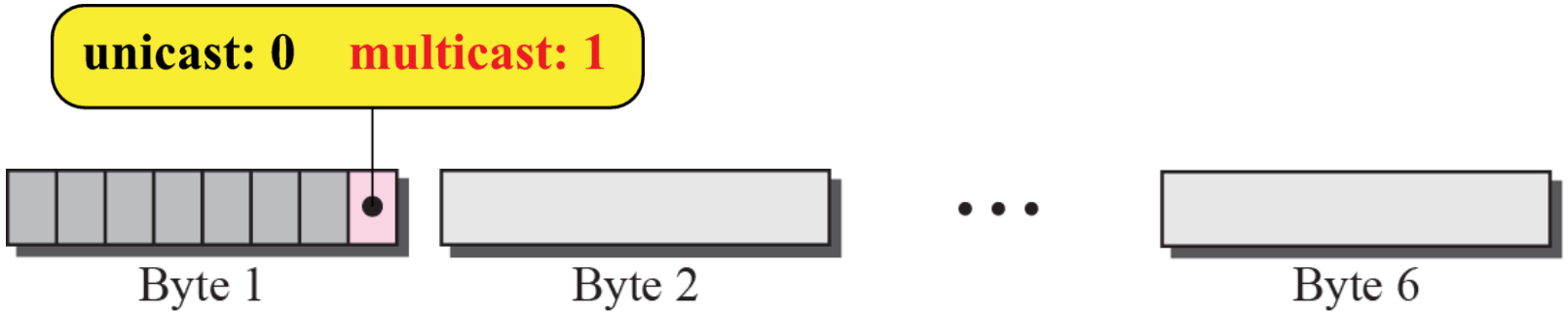
Figure 3.4 *Ethernet address in hexadecimal notation*

d: Hexadecimal digit

$$d_1d_2 : d_3d_4 : d_5d_6 : d_7d_8 : d_9d_{10} : d_{11}d_{12}$$

6 bytes = 12 hexadecimal digits = 48 bits

Figure 3.5 *Unicast and multicast addresses*



The broadcast destination address is a special case of the multicast address in which all bits are 1s.

The least significant bit of the first byte defines the type of address.
If the bit is 0, the address is unicast; otherwise, it is multicast.

Example 3.1

Define the type of the following destination addresses:

a. 4A:30:10:21:10:1A 1010

b. 47:20:1B:2E:08:EE 0100 0111

c. FF:FF:FF:FF:FF:FF

Solution

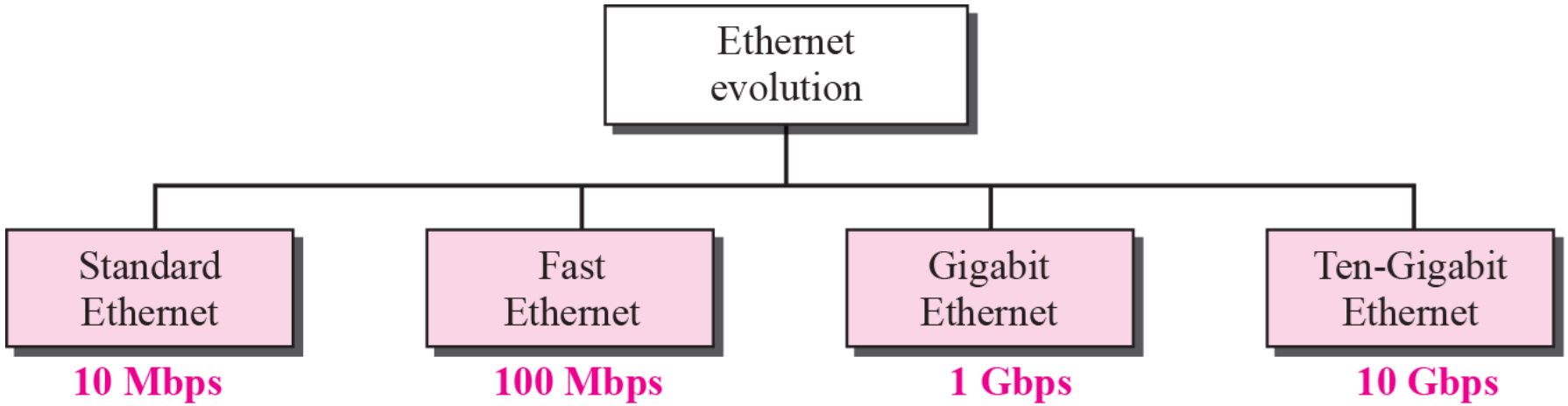
To find the type of the address, we need to look at the second hexadecimal digit from the left. If it is even, the address is unicast. If it is odd, the address is multicast. If all digits are F's, the address is broadcast. Therefore, we have the following:

a. This is a unicast address because A in binary is 1010 (even).

b. This is a multicast address because 7 in binary is 0111 (odd).

c. This is a broadcast address because all digits are F's.

Figure 3.6 *Ethernet evolution through four generations*

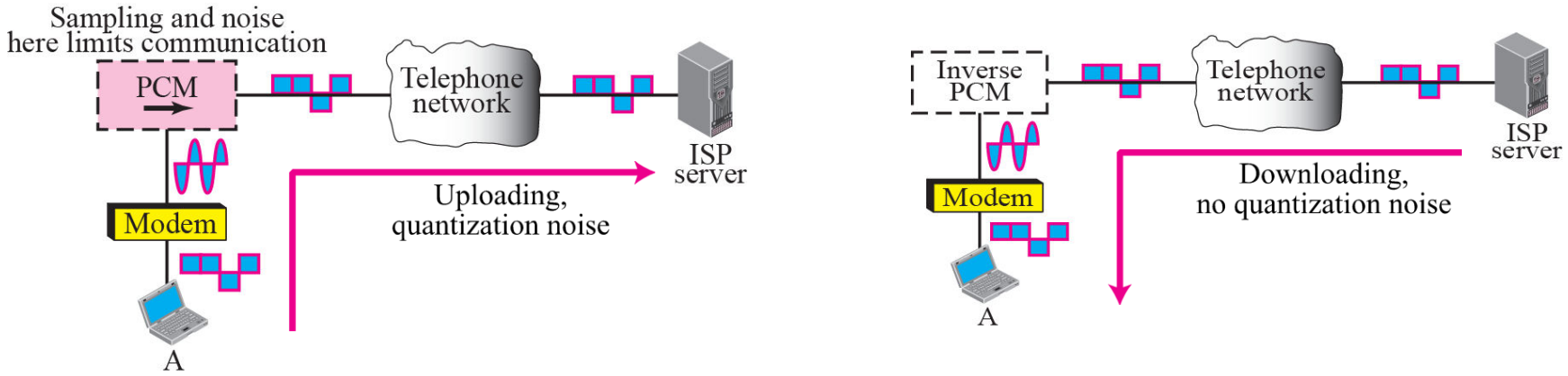


3-3 POINT-TO-POINT WANS

A second type of network we encounter in the Internet is the point-to-point wide area network. A point-to-point WAN connects two remote devices using a line available from a public network such as a telephone network. We discuss traditional modem technology, DSL line, cable modem, T-lines, and SONET.

- ✓56K Modems
- ✓DSL Technology
- ✓Cable Modem
- ✓T Lines
- ✓ SONET
- ✓PPP
- ✓PPPoE (Point-to-Point Protocol over Ethernet)

Figure 3.26 *56K modem*



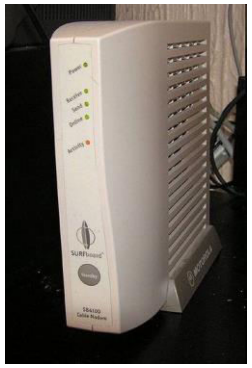
DSL

- Digital Subscriber Line (DSL)
- Can transmit very high data rates on phone wire using special equipment at the phone company allowing higher frequency signals

- DSL Access Multiplexer (DSLAM)
- 100 kbps - 100 Mbps

Cable

- Cable companies have a very-high speed medium (for video transmission)
- Phone wire = 4kHz for voice
  Video Cable = 500 MHz for video
  One TV Channel = 6 MHz
- 30 Mbps down/1 Mbps up
- Fiber in the main line + Coax in tributaries
  ⇒ Hybrid Fiber Coax (HFC)



Cable Modem

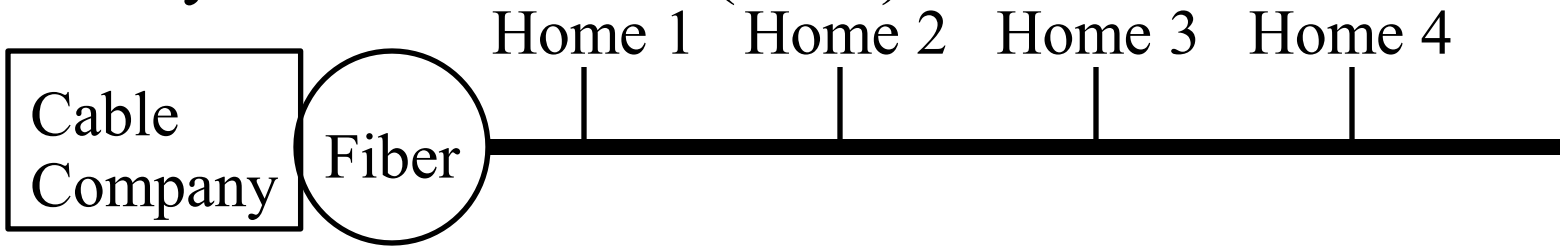
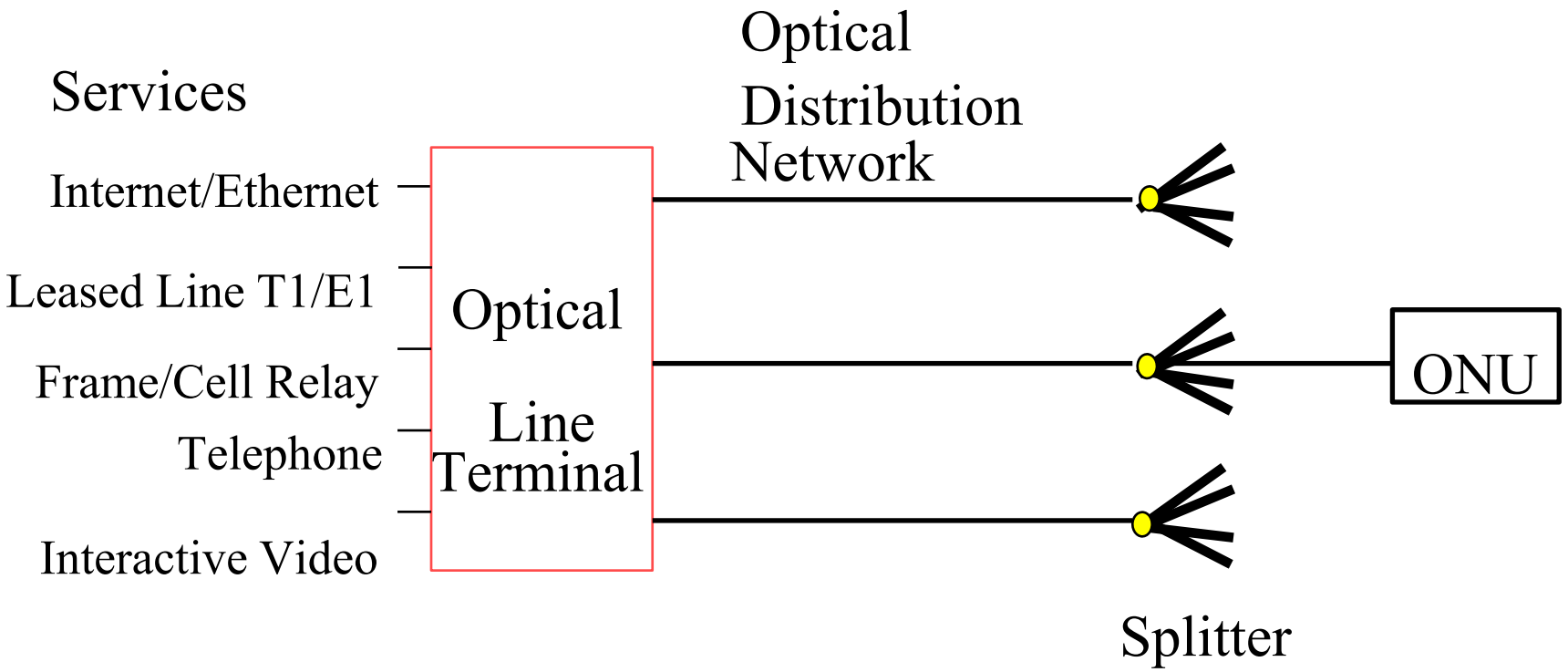


Table 3.8 *T line rates*

Line	*Rate (Mbps)*
T-1	1.544
T-3	44.736

Fiber-To-The-Home (FTTH)



- 100+ Mbps per home. Multiple services.
- No electronic components in the distribution system
  ⇒ Passive ⇒ Reliable
- Passive Optical Network (PON)

3-4 SWITCHED WANS

The backbone networks in the Internet can be switched WANs. A switched WAN is a wide area network that covers a large area (a state or a country) and provides access at several points to the users. Inside the network, there is a mesh of point-to-point networks that connects switches. The switches, multiple port connectors, allow the connection of several inputs and outputs.

Switched WAN technology differs from LAN technology in many ways.

3-5 CONNECTING DEVICES

LANs or WANs do not normally operate in isolation. They are connected to one another or to the Internet. To connect LANs and WANs together we use connecting devices. Connecting devices can operate in different layers of the Internet model. We discuss three kinds of connecting devices: repeaters (or hubs), bridges (or two-layer switches), and routers (or three-layer switches).

Figure 3.40 *Connecting devices*

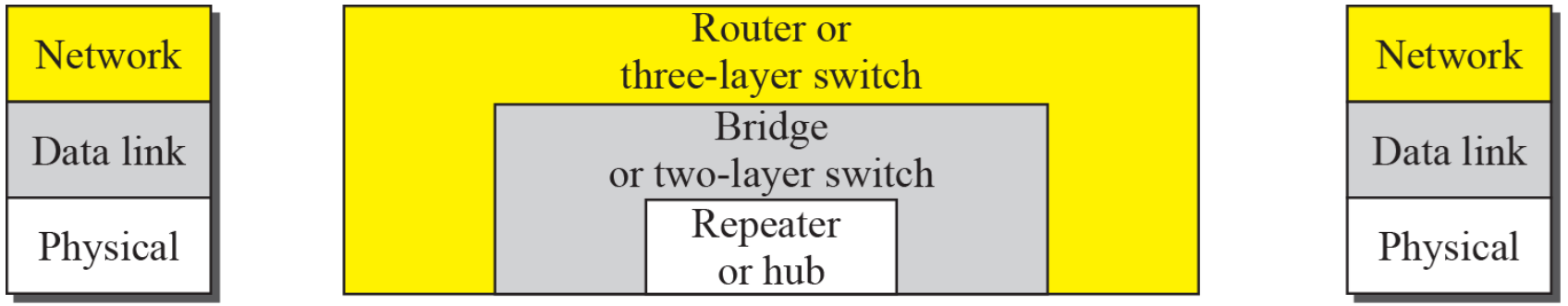
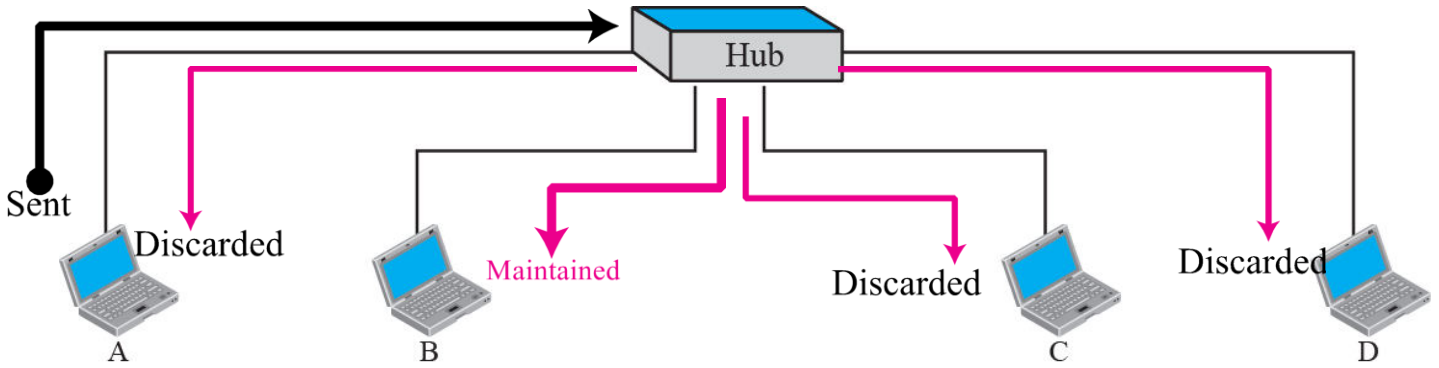


Figure 3.41 *Repeater or hub*

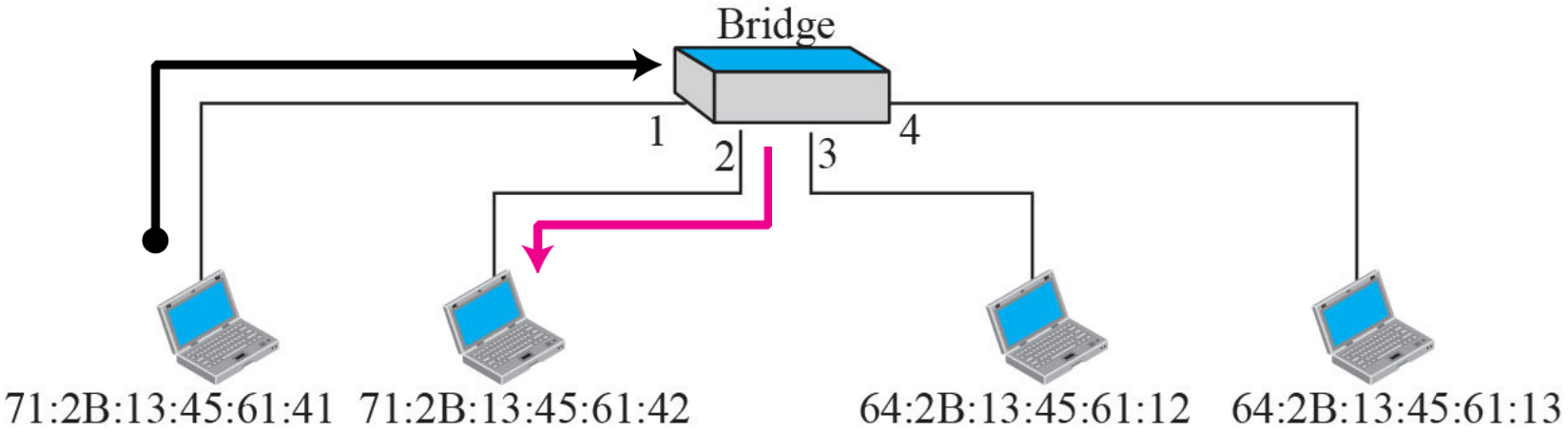


A repeater forwards every bit; it has no filtering capability.

Figure 3.42 *Bridge*

Bridge table

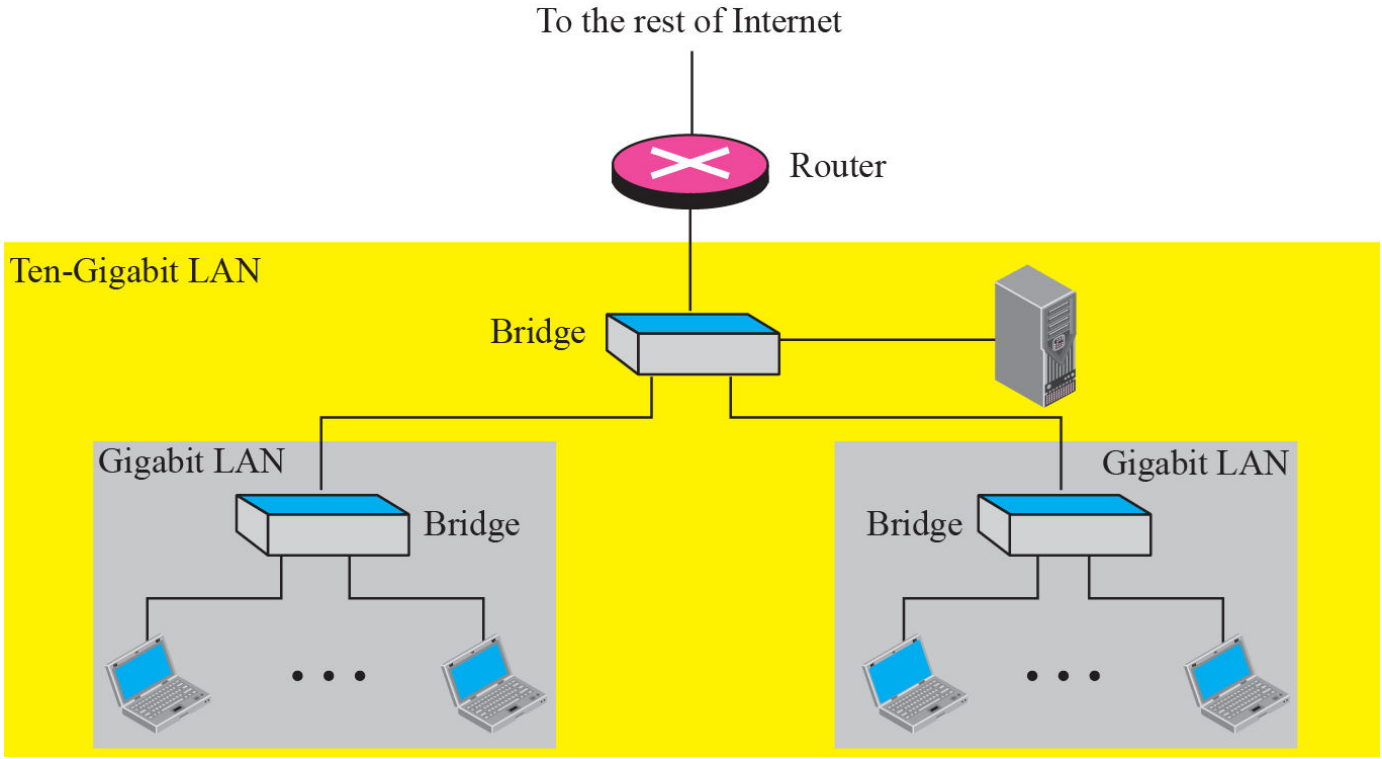
Address	Port
71:2B:13:45:61:41	1
71:2B:13:45:61:42	2
64:2B:13:45:61:12	3
64:2B:13:45:61:13	4



A bridge does not change the physical (MAC) addresses in a frame.

A bridge has a table used in filtering decisions.

Figure 3.44 *Routing example*



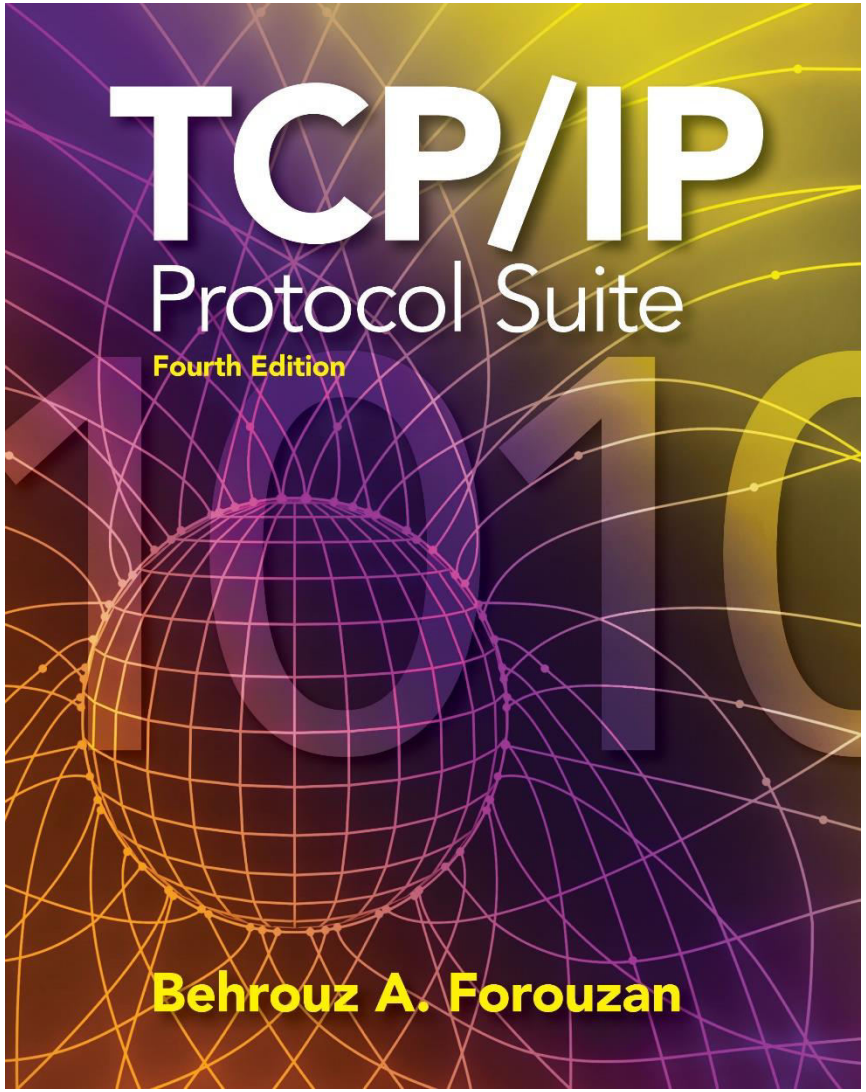
A router is a three-layer (physical, data link, and network) device.

A repeater or a bridge connects segments of a LAN.
A router connects independent LANs or WANs to create an internetwork (internet).

A router changes the physical addresses in a packet.

Chapter 4

Introduction to Network Layer



4-1 INTRODUCTION

At the conceptual level, we can think of the global Internet as a black box network that connects millions (if not billions) of computers in the world together. At this level, we are only concerned that a message from the application layer in one computer reaches the application layer in another computer.

Figure 4.1 *Internet as a block box*

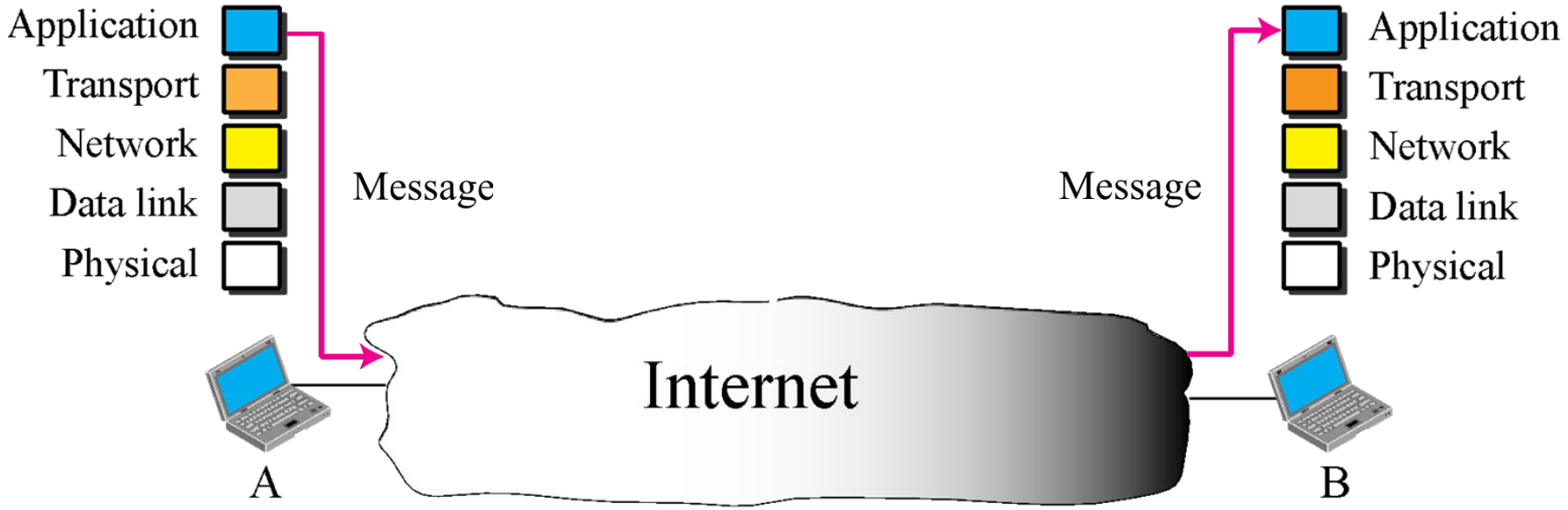
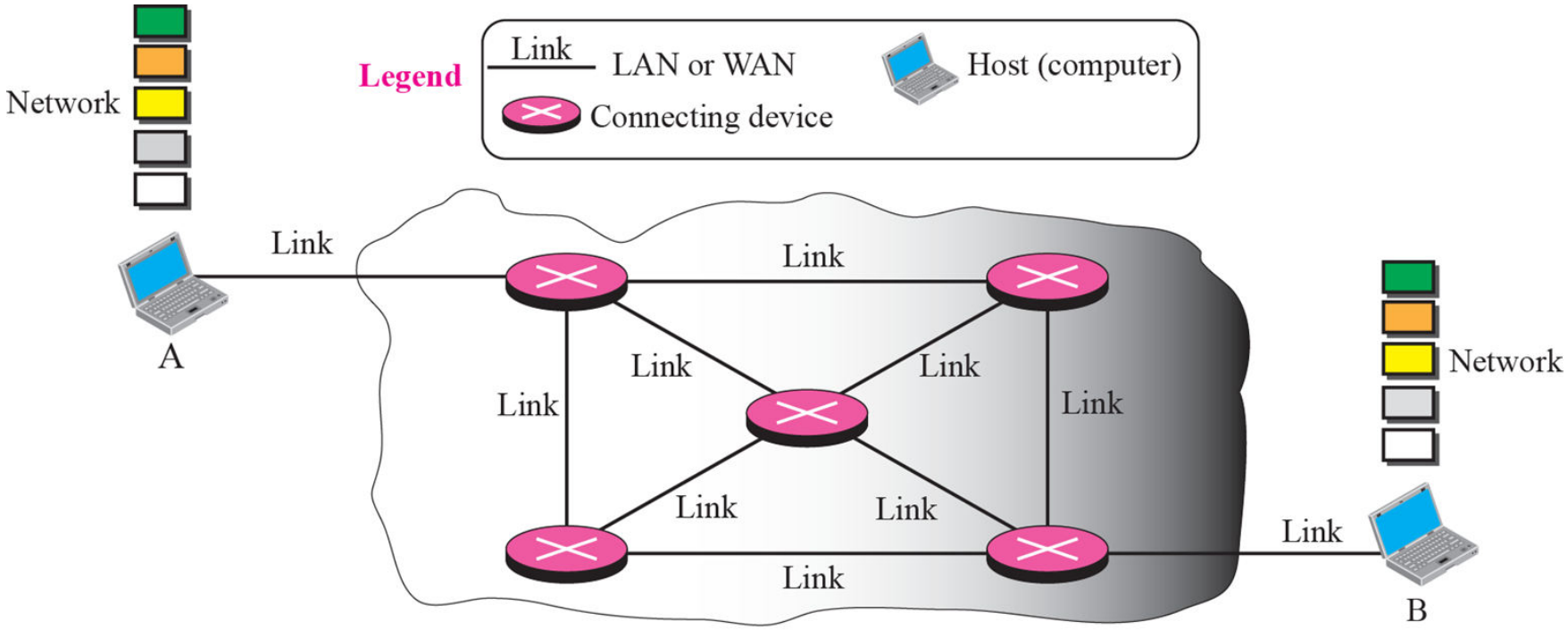


Figure 4.2 *Internet as a combination of LANs and WANs connected together*



An internet as a combination of links and connecting devices

4-2 SWITCHING

From the previous discussion, it is clear that the passage of a message from a source to a destination involves many decisions. When a message reaches a connecting device, a decision needs to be made to select one of the output ports through which the packet needs to be send out. In other words, the connecting device acts as a switch that connects one port to another port.

✓ Circuit Switching

In circuit switching, the whole message is sent from the source to the destination without being divided into packets.

✓ Packet Switching

In packet switching, the message is first divided into manageable packets at the source before being transmitted.
The packets are assembled at the destination.

Example 4.1

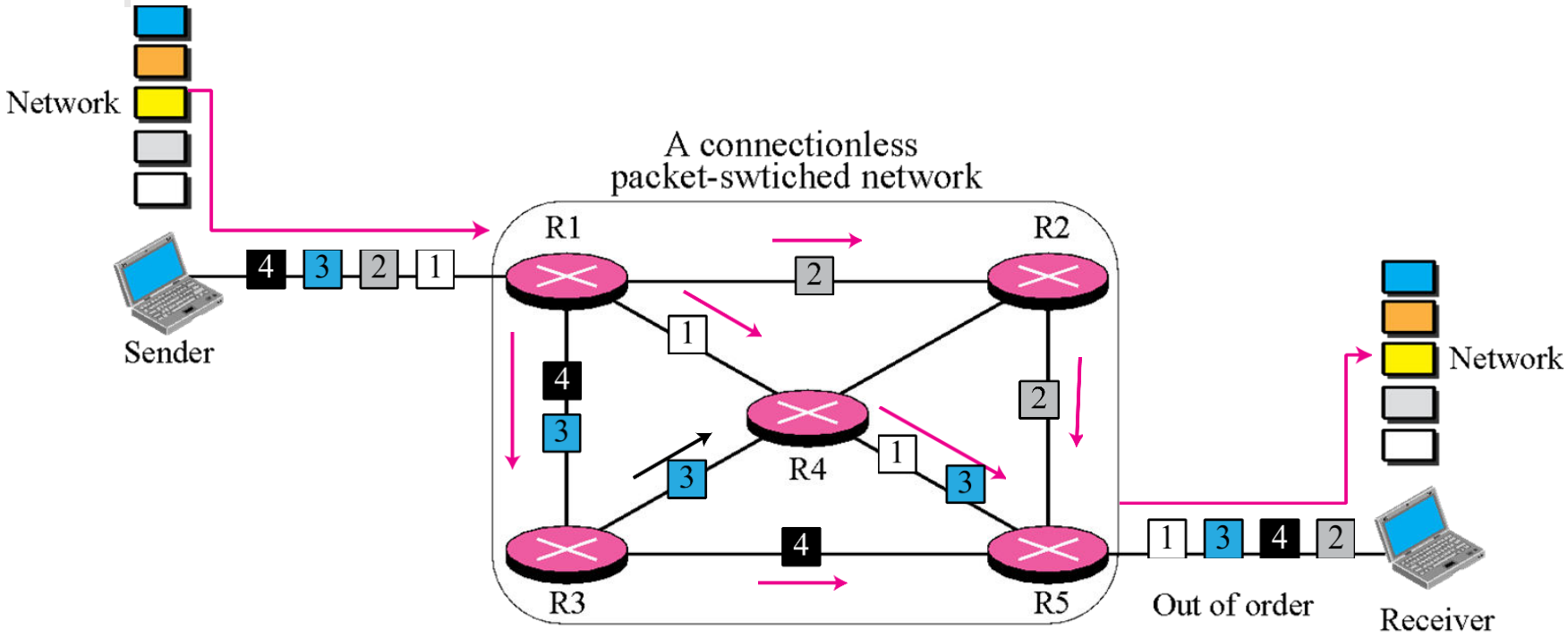
A good example of a circuit-switched network is the early telephone systems in which the path was established between a caller and a callee when the telephone number of the callee was dialed by the caller. When the callee responded to the call, the circuit was established. The voice message could now flow between the two parties, in both directions, while all of the connecting devices maintained the circuit. When the caller or callee hung up, the circuit was disconnected. The telephone network is not totally a circuit-switched network today.

4-3 PACKET SWITHING

The network layer is designed as a packet-switched network. This means that the packet at the source is divided into manageable packets, normally called datagrams. Individual datagrams are then transferred from the source to the destination. The received datagrams are assembled at the destination before recreating the original message. The packet-switched network layer of the Internet was originally designed as a connectionless service, but recently there is a tendency to change this to a connection-oriented service.

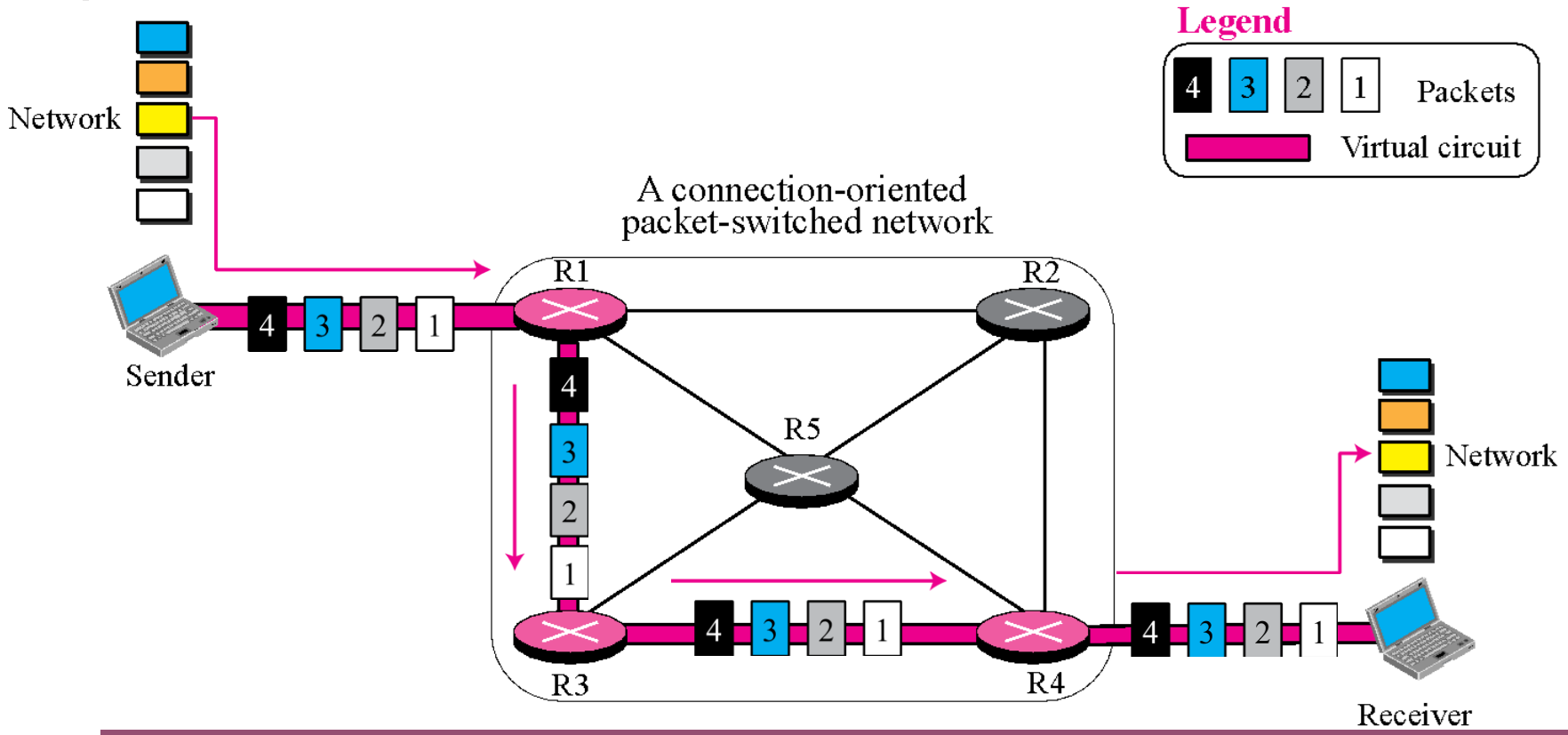
- ✓ Connectionless Service
- ✓ Connection-Oriented Service

Figure 4.3 *A connectionless packet-switched network*



In a connectionless packet-switched network, the forwarding decision is based on the destination address of the packet.

Figure 4.6 *A connection-oriented packet switched network*



In a connection-oriented packet switched network, the forwarding decision is based on the label of the packet.

Figure 4.12 *An imaginary part of the Internet*