IEEE 802 Standards and LAN Technologies

13-1 IEEE STANDARDS

In 1985, the Computer Society of the IEEE started a project, called Project 802, to set standards to enable intercommunication among equipment from a variety of manufacturers. Project 802 is a way of specifying functions of the physical layer and the data link layer of major LAN protocols.

Topics discussed in this section:

Data Link Layer
Physical Layer

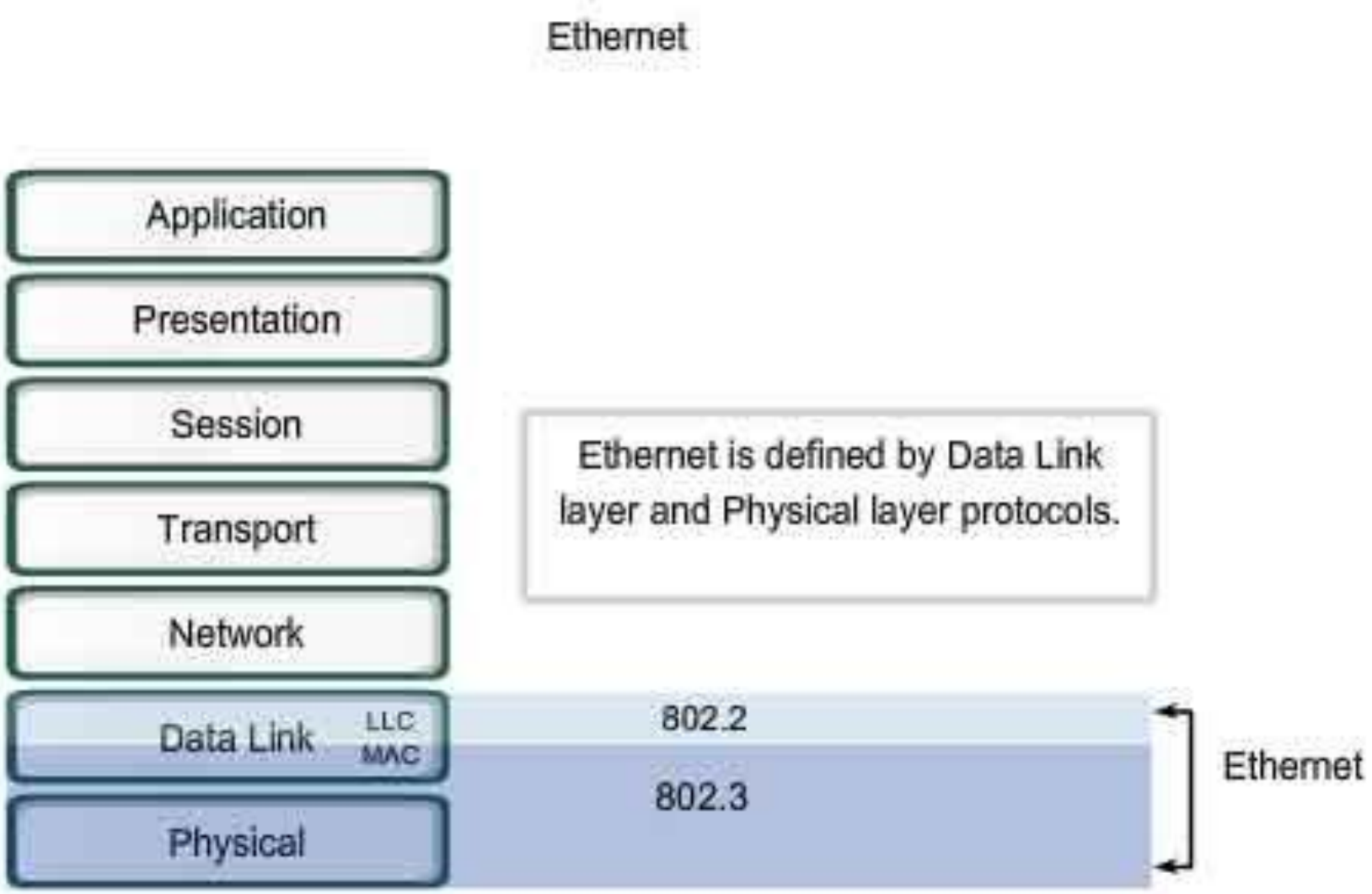
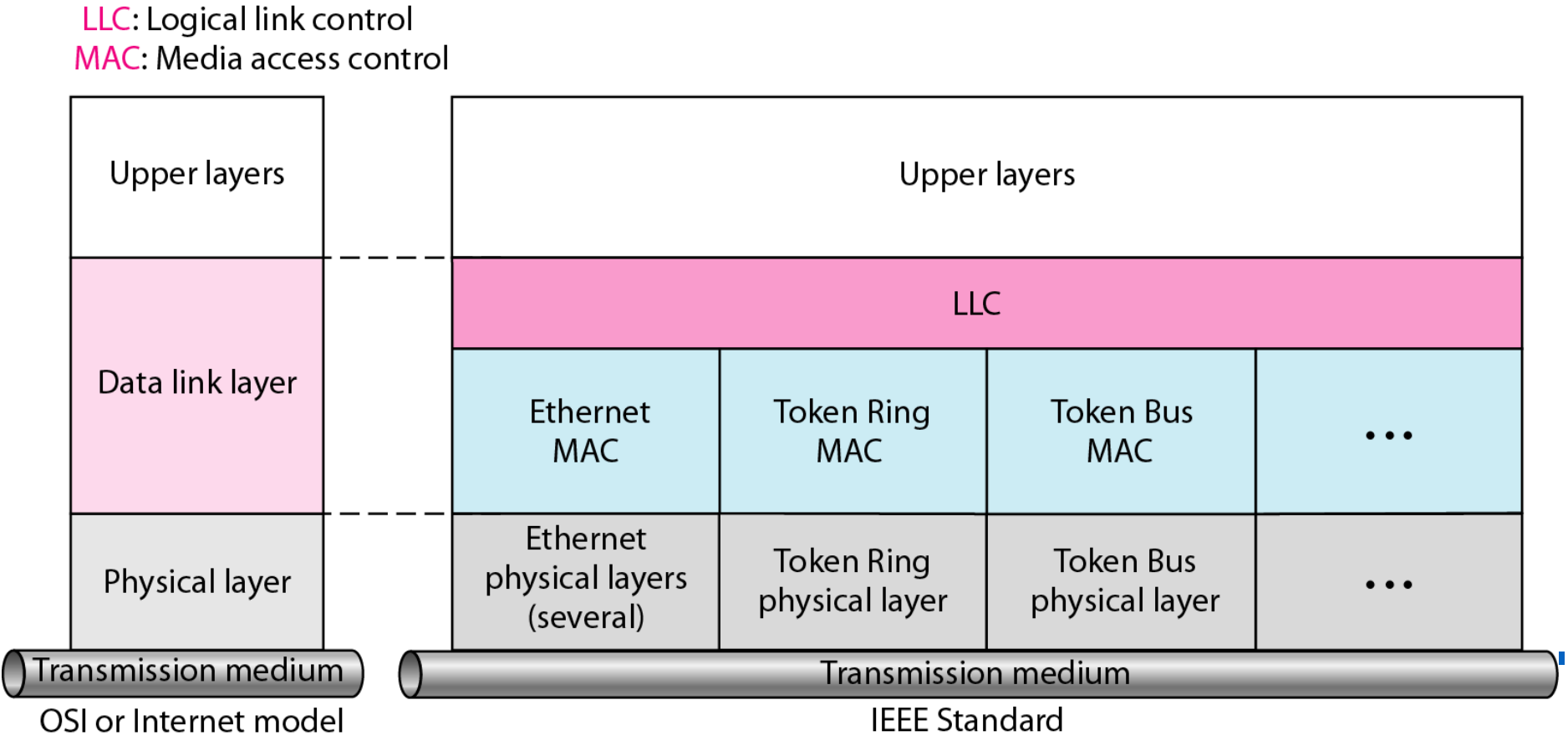

Ethernet
Application
Presentation
Session
Transport
Network
Data Link
LLC
MAC
Physical
Ethernet is defined by Data Link layer and Physical layer protocols.
802.2
802.3
Ethernet

Figure 13.1 *IEEE standard for LANs*

LLC: defines flow control, error control and part of framing duties
MAC: define specific access method for each LAN



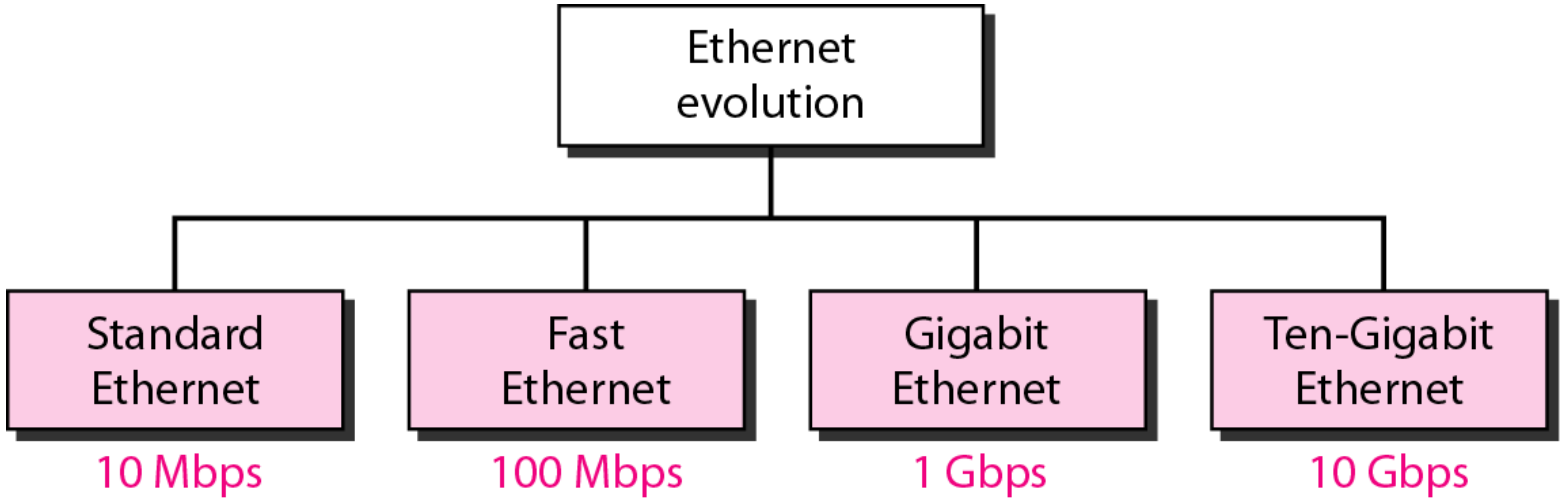
13-2 STANDARD ETHERNET

The original Ethernet was created in 1976 at Xerox's Palo Alto Research Center (PARC). Since then, it has gone through four generations. We briefly discuss the Standard (or traditional) Ethernet in this section.

Topics discussed in this section:

MAC Sublayer
Physical Layer

Figure 13.3 *Ethernet evolution through four generations*



Traditional Ethernet

Traditional Ethernet was designed to operate at 10 Mbps. It uses 1 persistent CSMA/CD. The media are shared between all stations.

MAC Sublayer

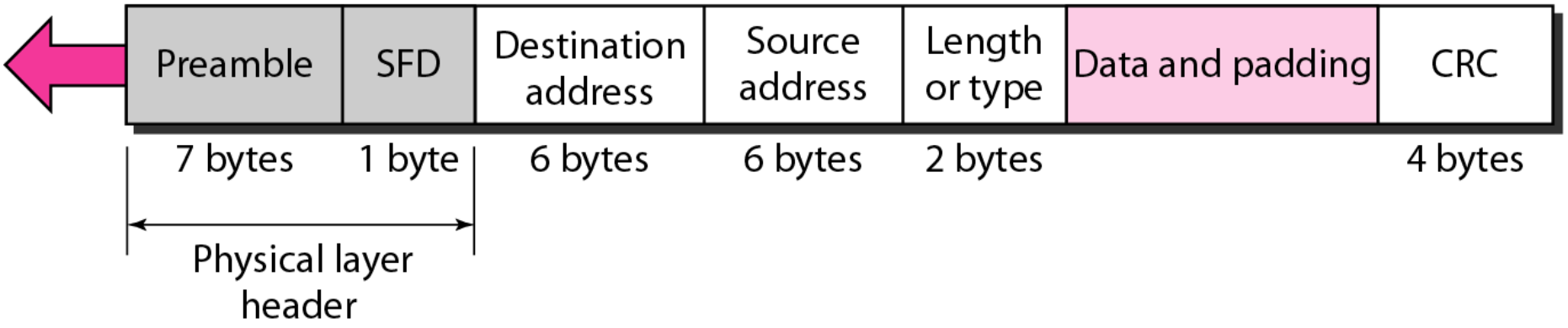
It governs the operation of the access method. It also frames the data received from the upper layer and passes them to the PLS sublayer for encoding.

Frame

Frame Contains seven fields as shown below.

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

SFD: Start frame delimiter, flag (10101011)



Traditional Ethernet MAC Sublayer Frame

Preamble: The first field of the 802.3 frame contains 7 bytes of alternating 0s and 1s that alert the receiving system to the coming frame and enable it to synchronize its input timing.

Start Frame Delimiter (SFD): This field (1 byte: 10101011) signals the beginning of the frame. This is the last chance for synchronization.

Destination and Source address (DA and SA): These are six byte field.

Length/Type: If value < 1518, its a length field and shows the length of the data field. If value > 1536, it defines the type of PDU packet. that is encapsulated in the frame.

Data and CRC: Minimum length of data field can be 46 bytes and a maximum of 1500 bytes. CRC contains the error detection information.

Why do we require minimum length of data field to be 46?

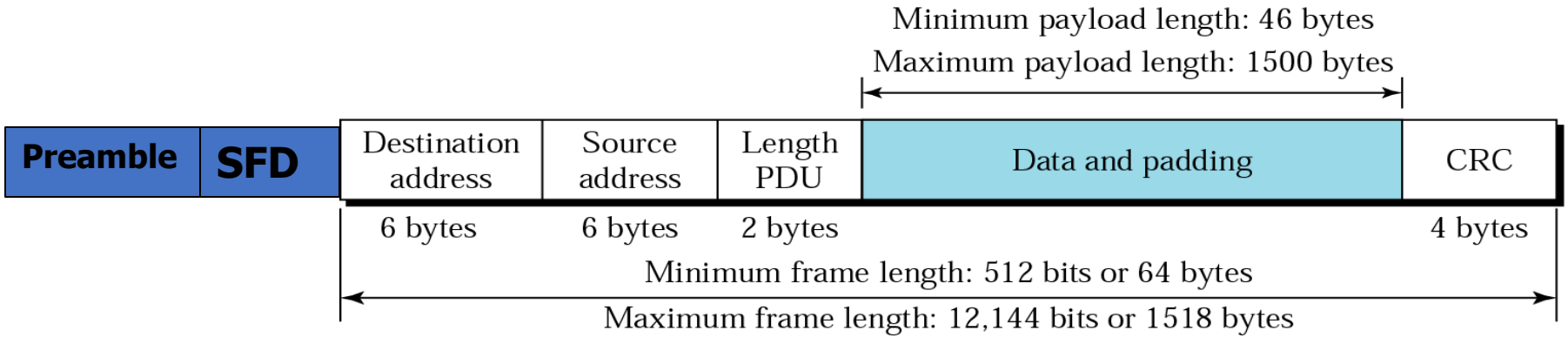


Figure 13.4 Ethernet Frame format: *802.3 MAC frame*

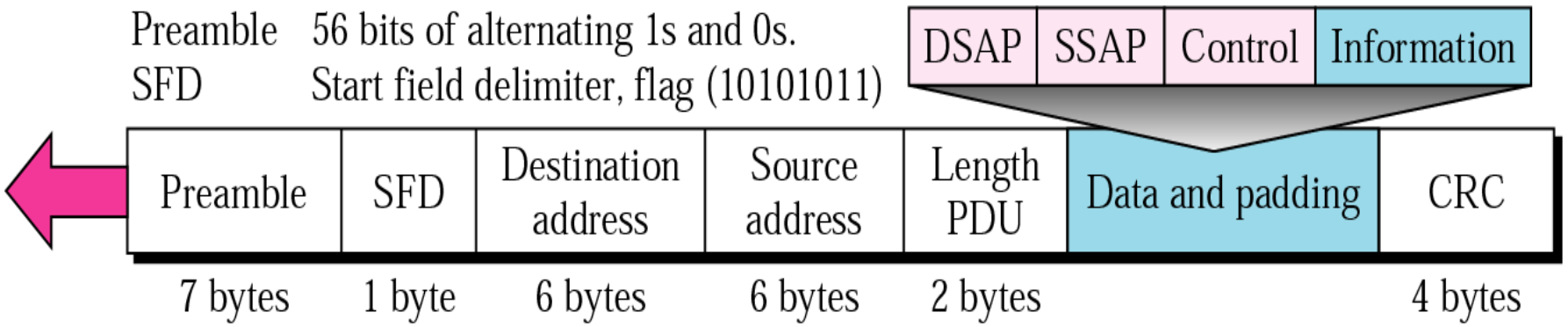
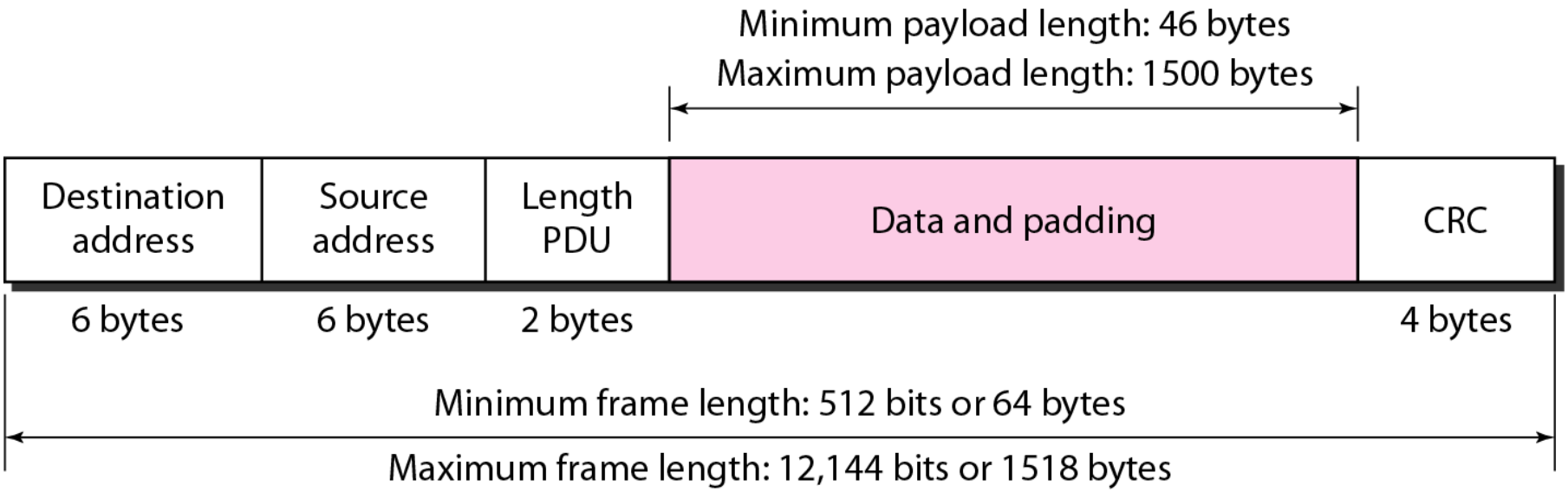


Figure 13.5 *Minimum and maximum lengths*



Note

Frame length:

Minimum: 64 bytes (512 bits)

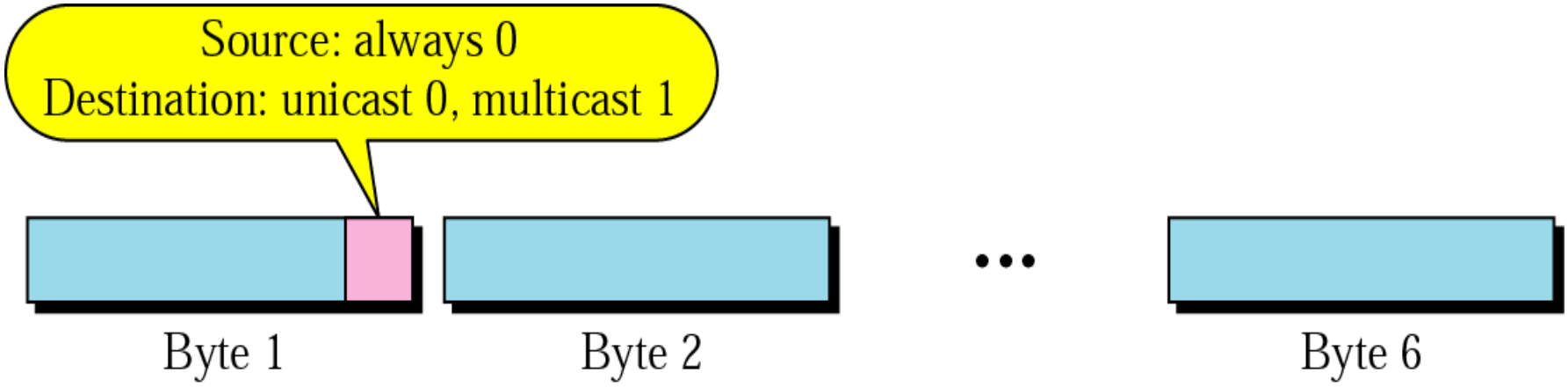
Maximum: 1518 bytes (12,144 bits)

Traditional Ethernet MAC Sublayer Addressing

Each station on an Ethernet network has its own network interface card (NIC). The Ethernet address is 6 bytes.

06-01-02-01-2C-4B

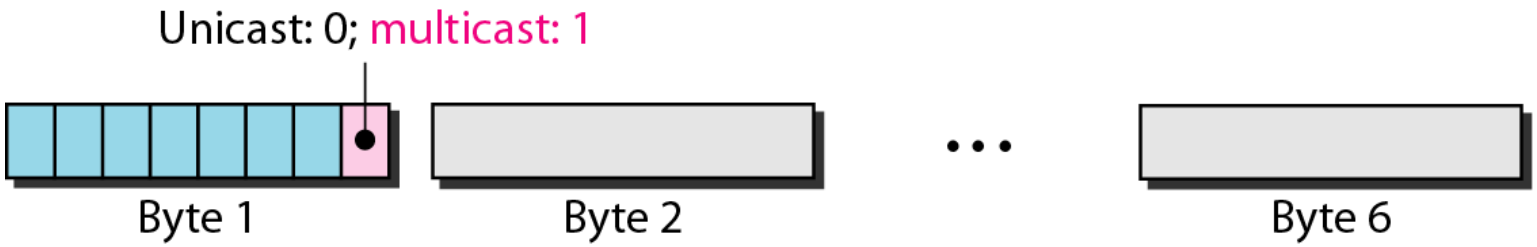
A source address is always unicast address – the frame comes from only one station. The destination address can be unicast, multicast, or broadcast.



The broadcast address is represented by 48 1s.

Figure 13.6 *Example of an Ethernet address in hexadecimal notation*

Figure 13.7 *Unicast and multicast addresses*



Note

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.

Note

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

Example 13.1

Define the type of the following destination addresses:

a. 4A:30:10:21:10:1A *b. 47:20:1B:2E:08:EE*

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.

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

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

Example 13.2

Show how the address 47:20:1B:2E:08:EE is sent out on line.

Solution

The address is sent left-to-right, byte by byte; for each byte, it is sent right-to-left, bit by bit, as shown below:

Figure 13.8 *Categories of Standard Ethernet*

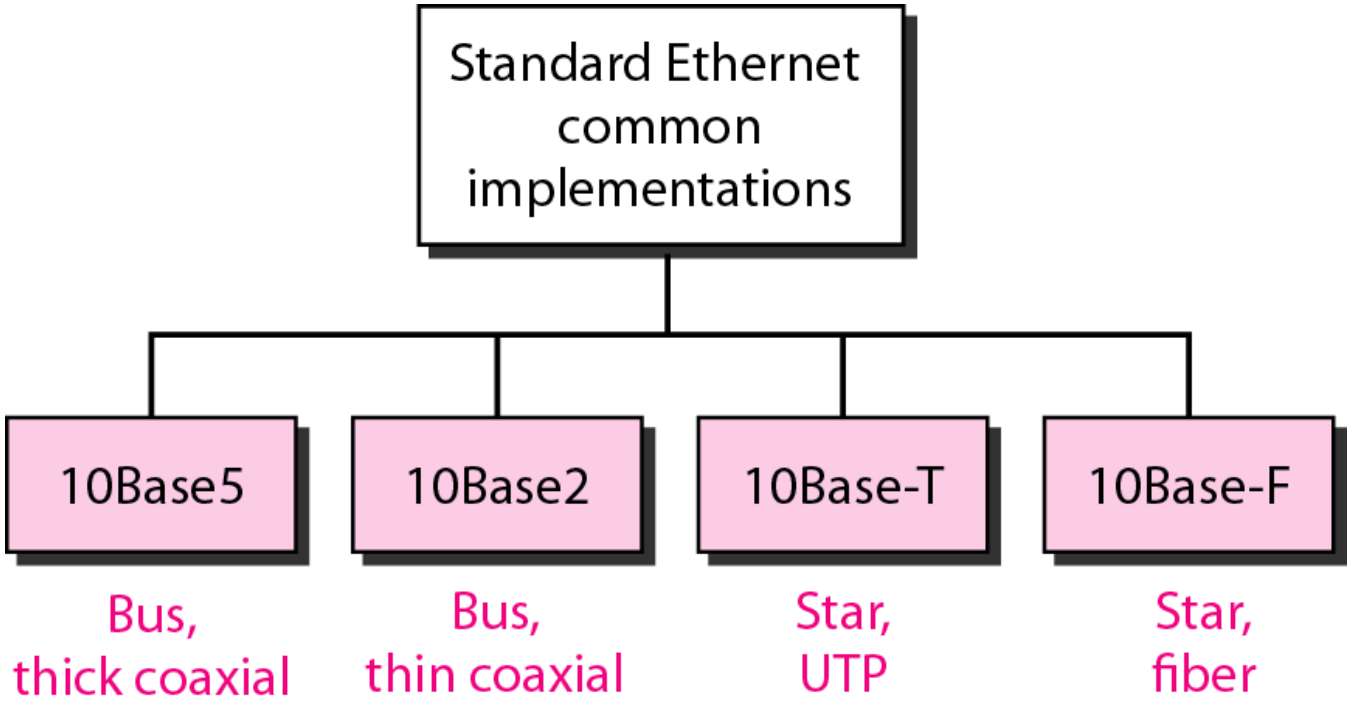


Figure 13.9 ***Encoding in a Standard Ethernet implementation***

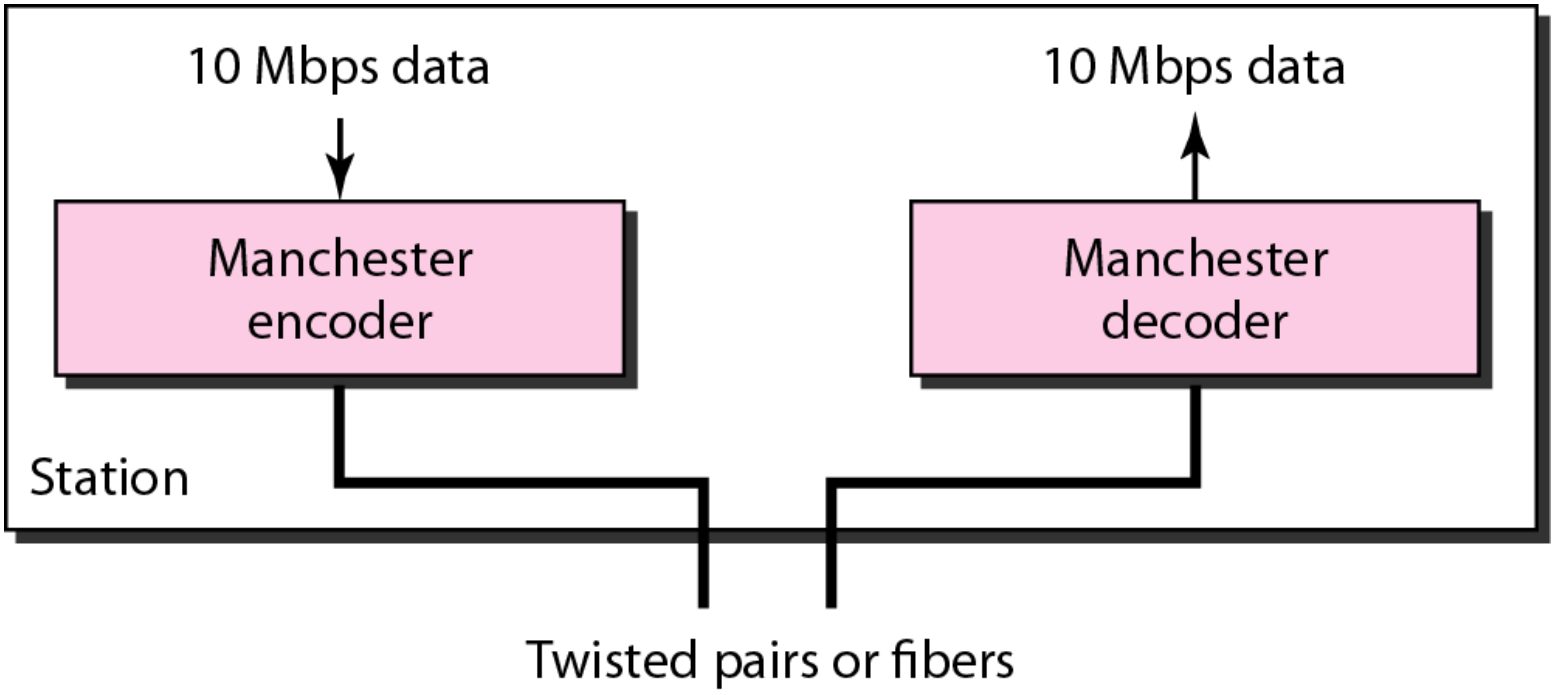


Figure 13.10 *10Base5 implementation*

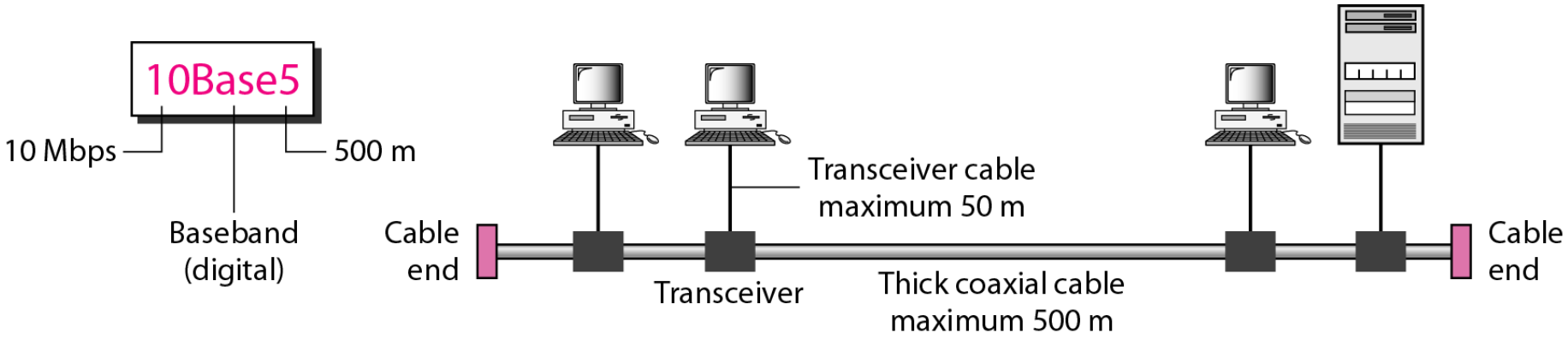


Figure 13.11 *10Base2 implementation*

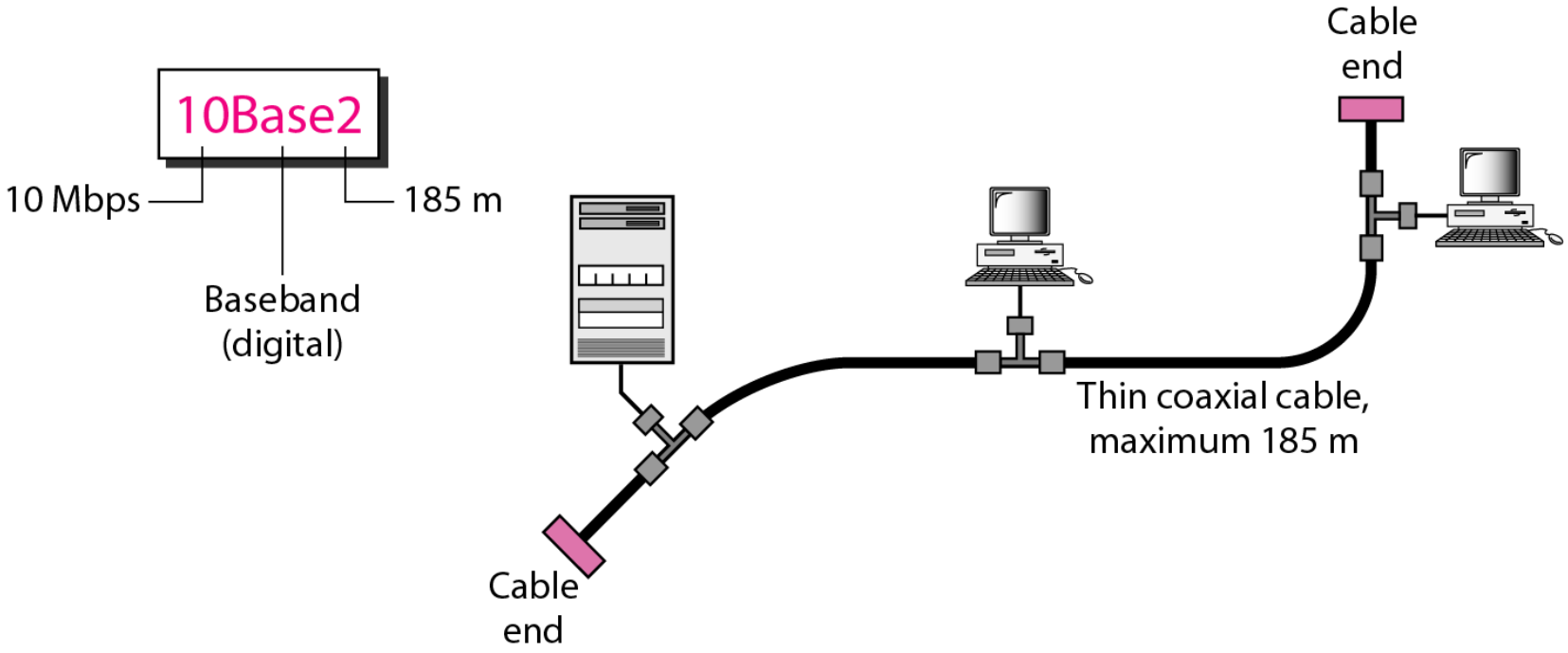


Figure 13.12 *10Base-T implementation*

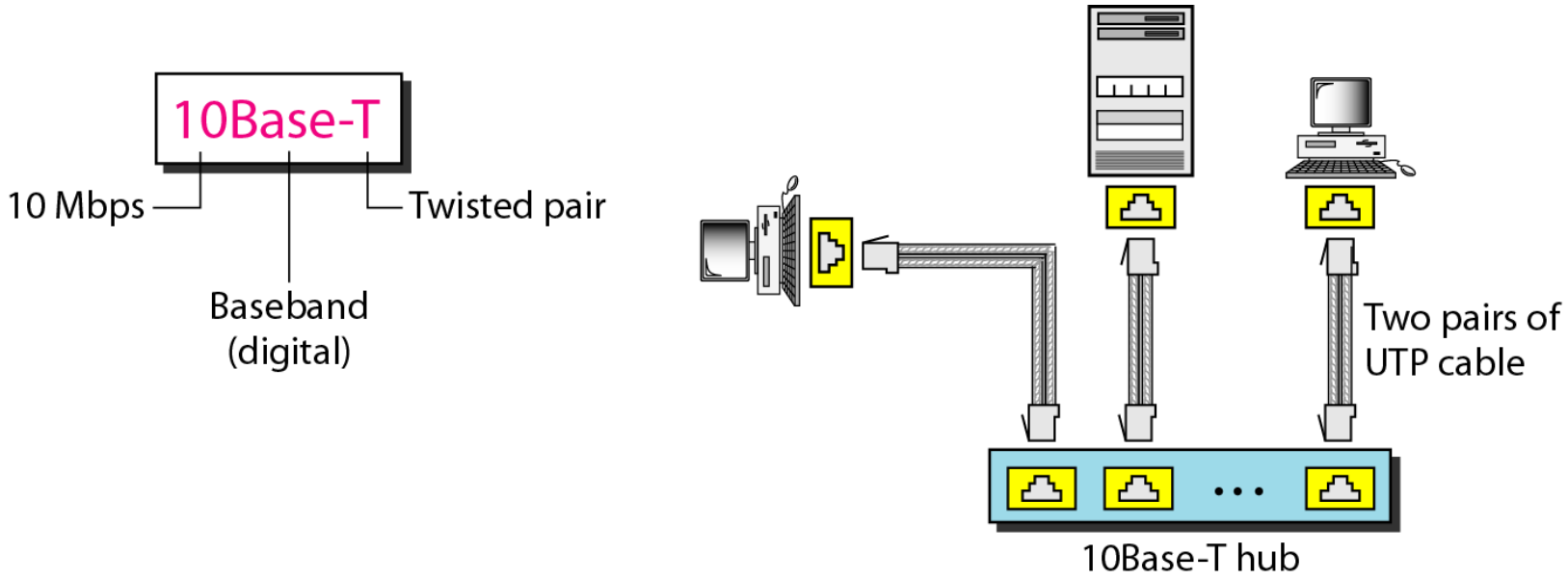


Figure 13.13 *10Base-F implementation*

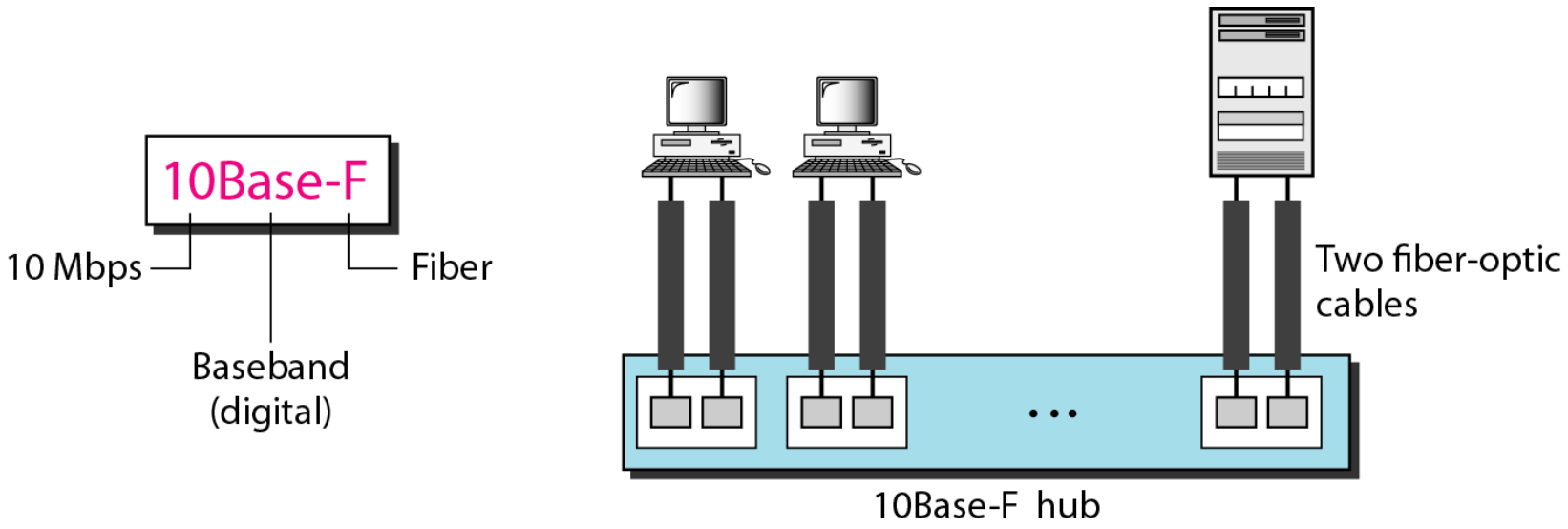


Table 13.1 *Summary of Standard Ethernet implementations*

Characteristics	*10Base5*	*10Base2*	*10Base-T*	*10Base-F*
Media	Thick coaxial cable	Thin coaxial cable	2 UTP	2 Fiber
Maximum length	500 m	185 m	100 m	2000 m
Line encoding	Manchester	Manchester	Manchester	Manchester

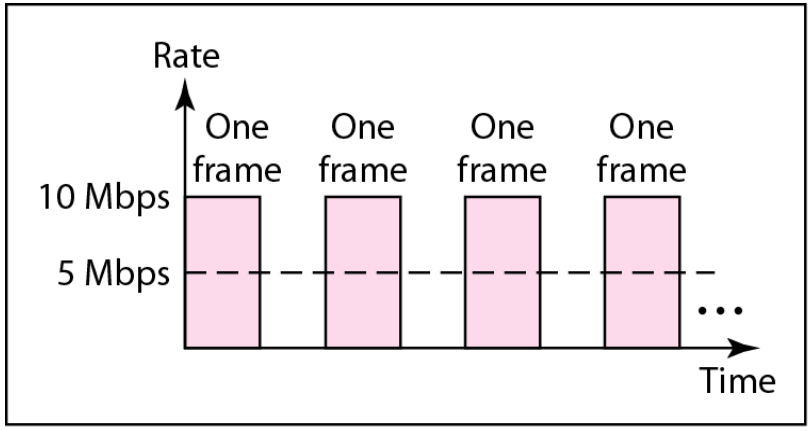
13-3 CHANGES IN THE STANDARD

The 10-Mbps Standard Ethernet has gone through several changes before moving to the higher data rates. These changes actually opened the road to the evolution of the Ethernet to become compatible with other high-data-rate LANs.

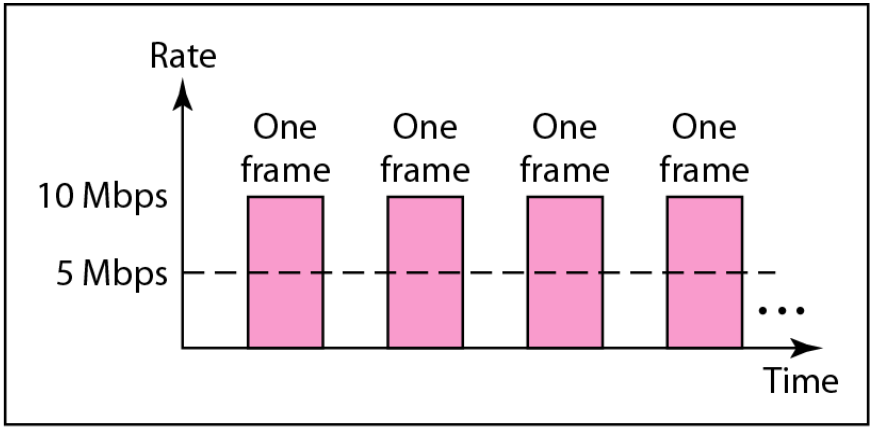
Topics discussed in this section:

Bridged Ethernet
Switched Ethernet
Full-Duplex Ethernet

Figure 13.14 *Sharing bandwidth*



a. First station



b. Second station

Traditional Ethernet Bridged Ethernet

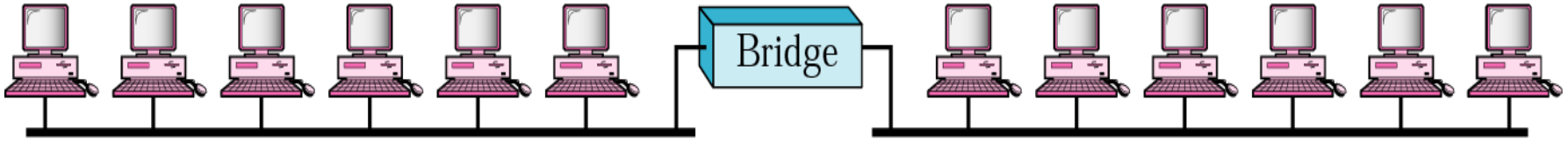
Bridges have two effects on LANs :

 # They raise the bandwidth.

 # They separate collision domains.

Raising The Bandwidth

a. Without bridging

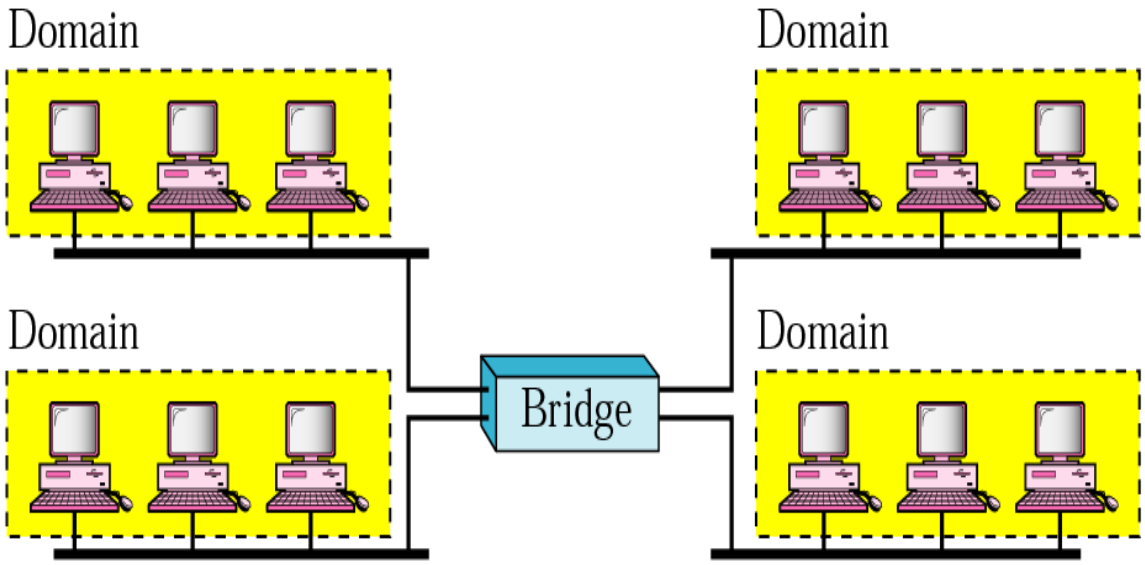


b. With bridging

Traditional Ethernet Bridged Ethernet

Separating Collision Domains

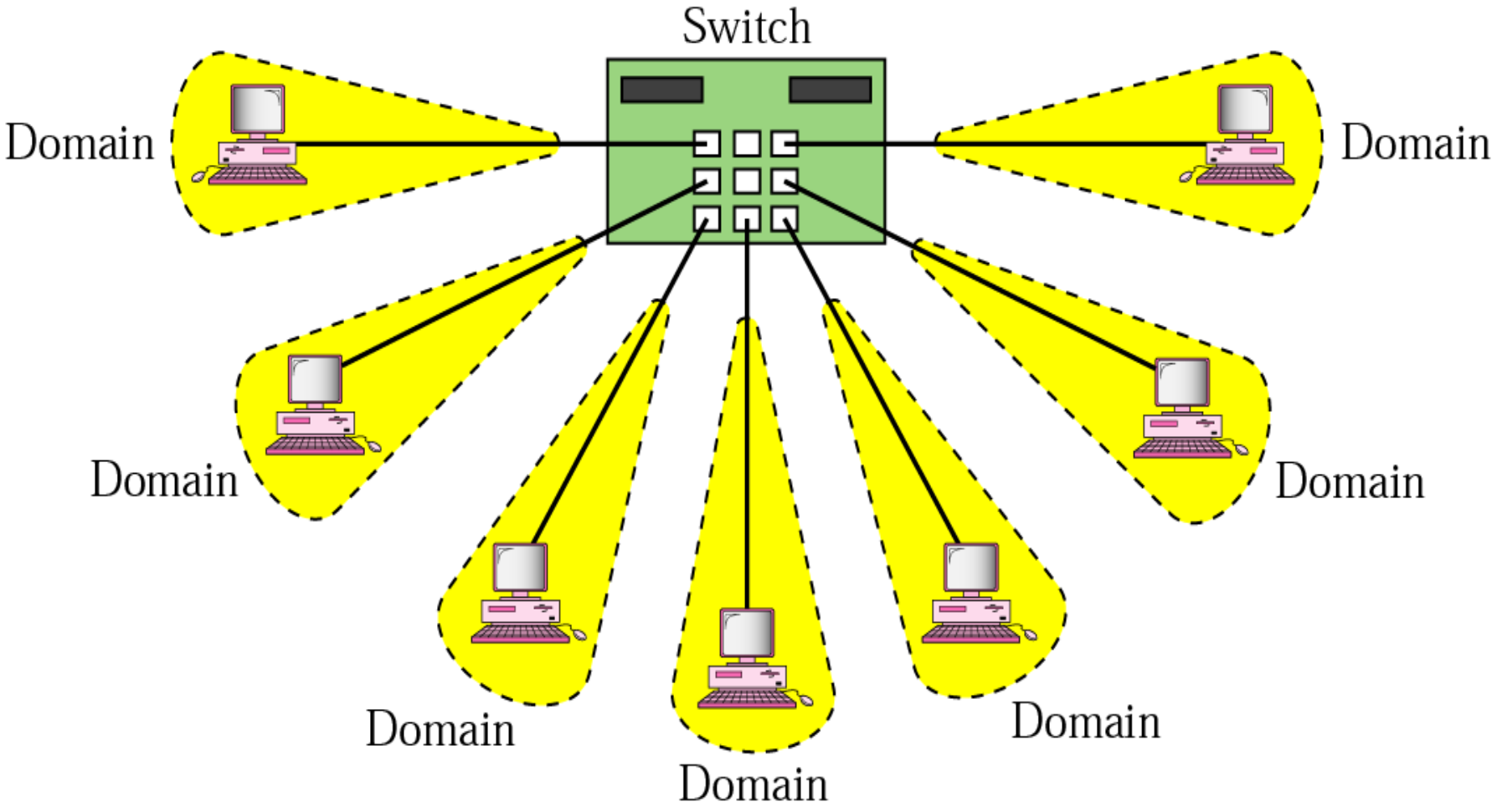
a. Without bridging



b. With bridging

Traditional Ethernet Switched Ethernet

A layer 2 switch is an N-port bridge with additional sophistication that allows faster handling of the packets.

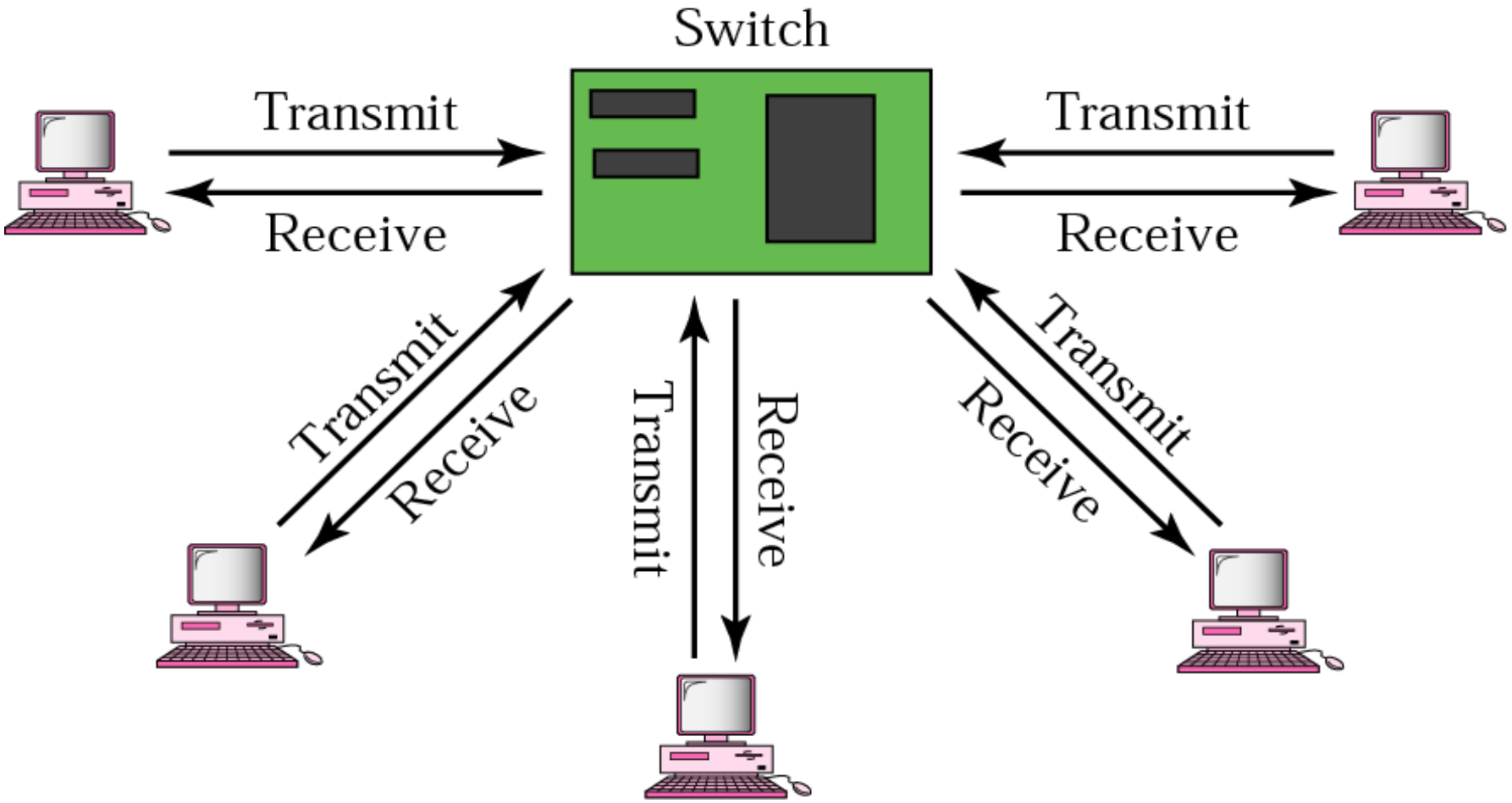


Traditional Ethernet

Full-Duplex Ethernet

 # The configuration uses two links: one to transmit and one to receive.

 # No need for CSMA/CD.



13-4 FAST ETHERNET

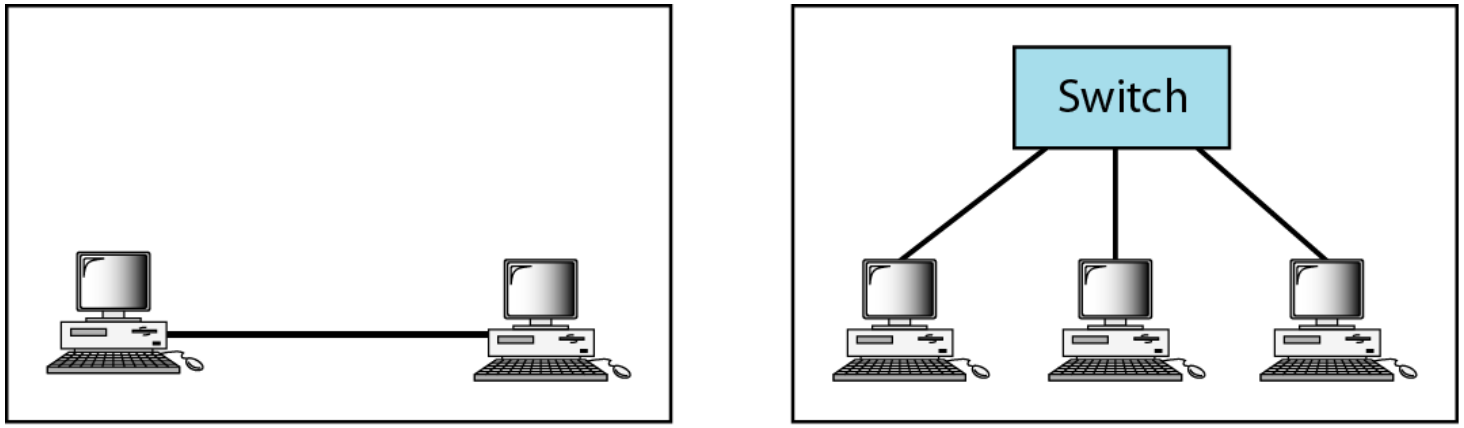
Fast Ethernet was designed to compete with LAN protocols such as FDDI or Fiber Channel. IEEE created Fast Ethernet under the name 802.3u. Fast Ethernet is backward-compatible with Standard Ethernet, but it can transmit data 10 times faster at a rate of 100 Mbps.

Topics discussed in this section:

MAC Sublayer

Physical Layer

Figure 13.19 *Fast Ethernet topology*



a. Point-to-point

b. Star

Figure 13.20 *Fast Ethernet implementations*

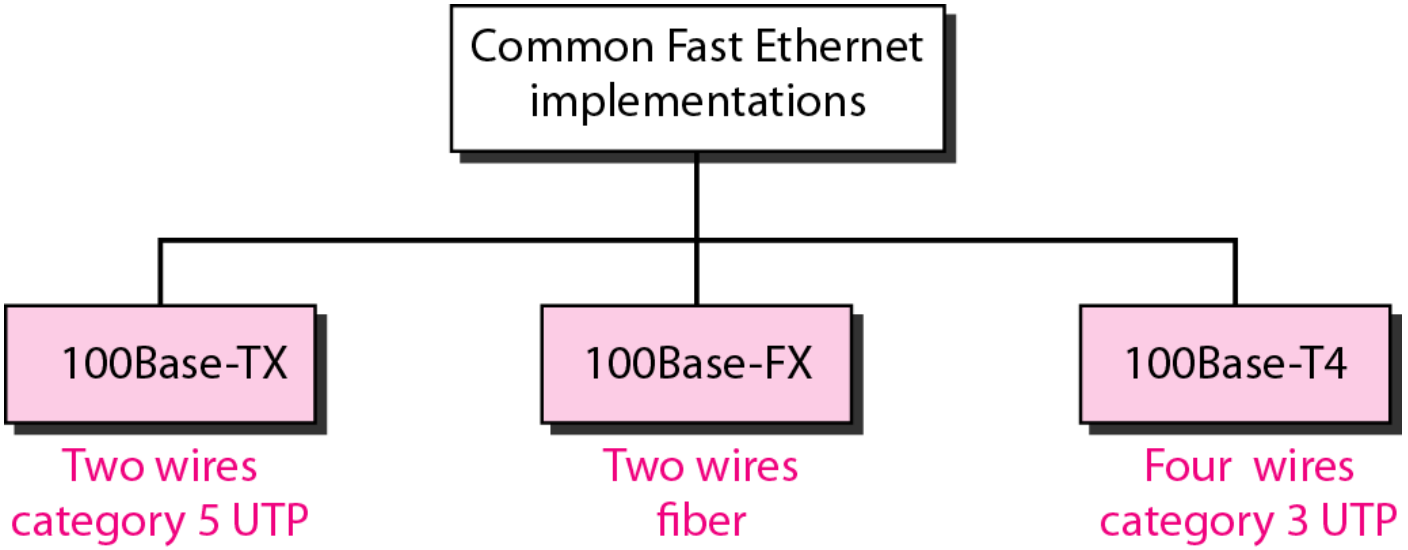


Table 13.2 *Summary of Fast Ethernet implementations*

Characteristics	*100Base-TX*	*100Base-FX*	*100Base-T4*
Media	Cat 5 UTP or STP	Fiber	Cat 4 UTP
Number of wires	2	2	4
Maximum length	100 m	100 m	100 m
Block encoding	4B/5B	4B/5B	
Line encoding	MLT-3	NRZ-I	8B/6T

13-5 GIGABIT ETHERNET

The need for an even higher data rate resulted in the design of the Gigabit Ethernet protocol (1000 Mbps). The IEEE committee calls the standard 802.3z.

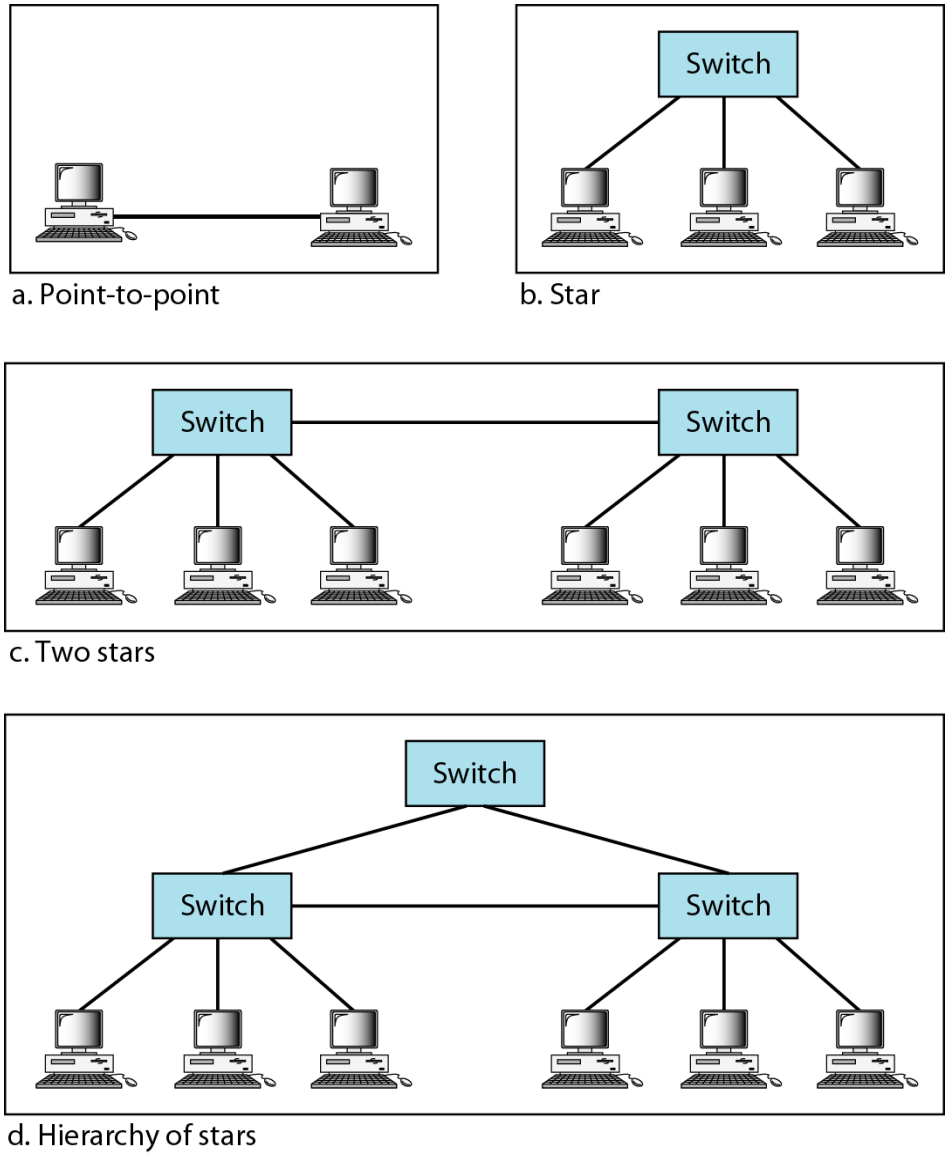
Topics discussed in this section:

MAC Sublayer
Physical Layer
Ten-Gigabit Ethernet

Note

In the full-duplex mode of Gigabit Ethernet, there is no collision; the maximum length of the cable is determined by the signal attenuation in the cable.

Figure 13.22 *Topologies of Gigabit Ethernet*



a. Point-to-point

b. Star

c. Two stars

d. Hierarchy of stars

Figure 13.23 *Gigabit Ethernet implementations*

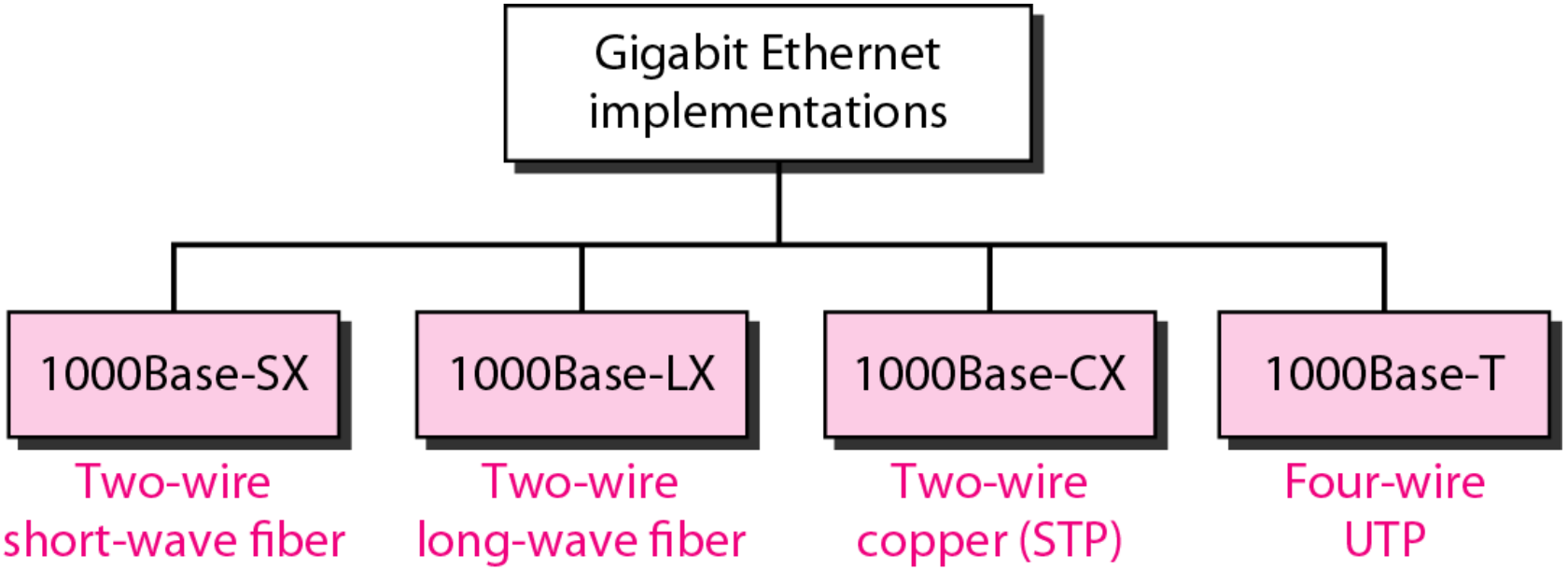


Table 13.3 *Summary of Gigabit Ethernet implementations*

Characteristics	*1000Base-SX*	*1000Base-LX*	*1000Base-CX*	*1000Base-T*
Media	Fiber short-wave	Fiber long-wave	STP	Cat 5 UTP
Number of wires	2	2	2	4
Maximum length	550 m	5000 m	25 m	100 m
Block encoding	8B/10B	8B/10B	8B/10B	
Line encoding	NRZ	NRZ	NRZ	4D-PAM5

Table 13.4 *Summary of Ten-Gigabit Ethernet implementations*

Characteristics	*10GBase-S*	*10GBase-L*	*10GBase-E*
Media	Short-wave 850-nm multimode	Long-wave 1310-nm single mode	Extended 1550-mm single mode
Maximum length	300 m	10 km	40 km