Lecture 6

Ethernet

(Chapter 13 of “Data Communications and Networking” [B. A. Forouzan])

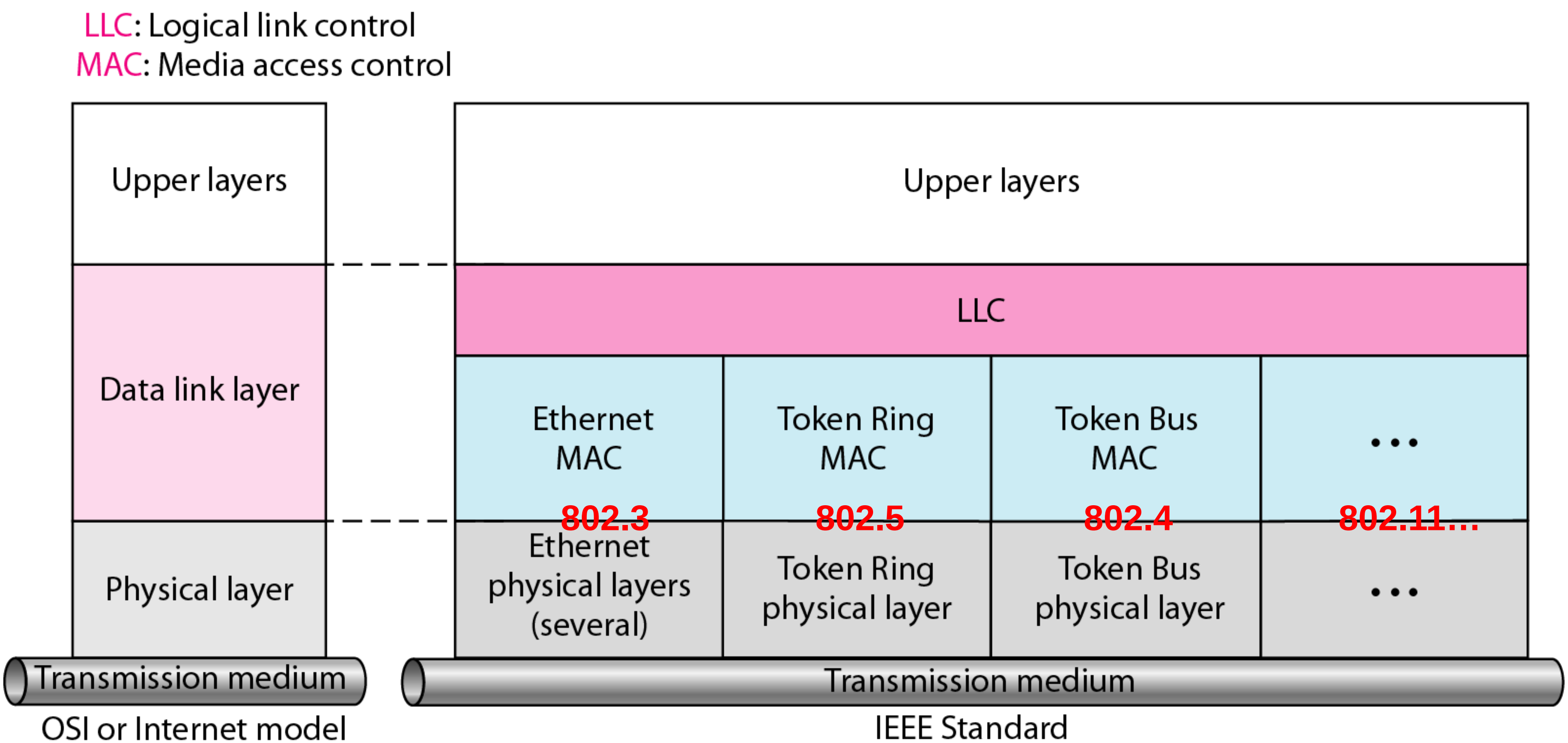
13-1 IEEE STANDARDS

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

Figure 13.1 *IEEE standard for LANs*



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*

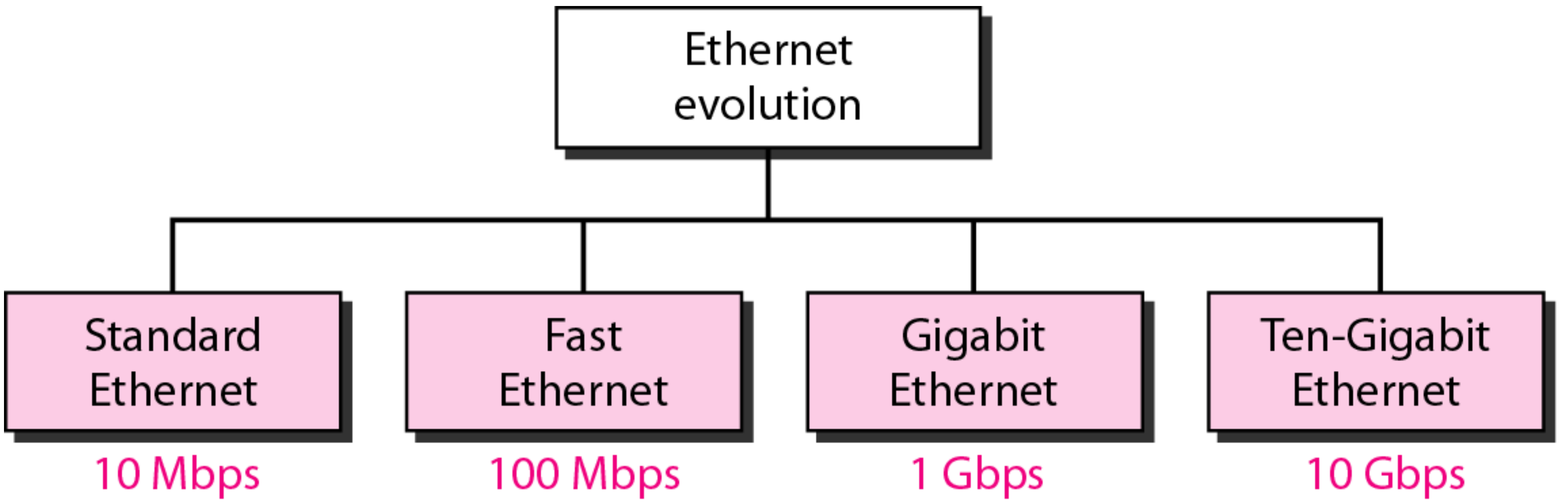
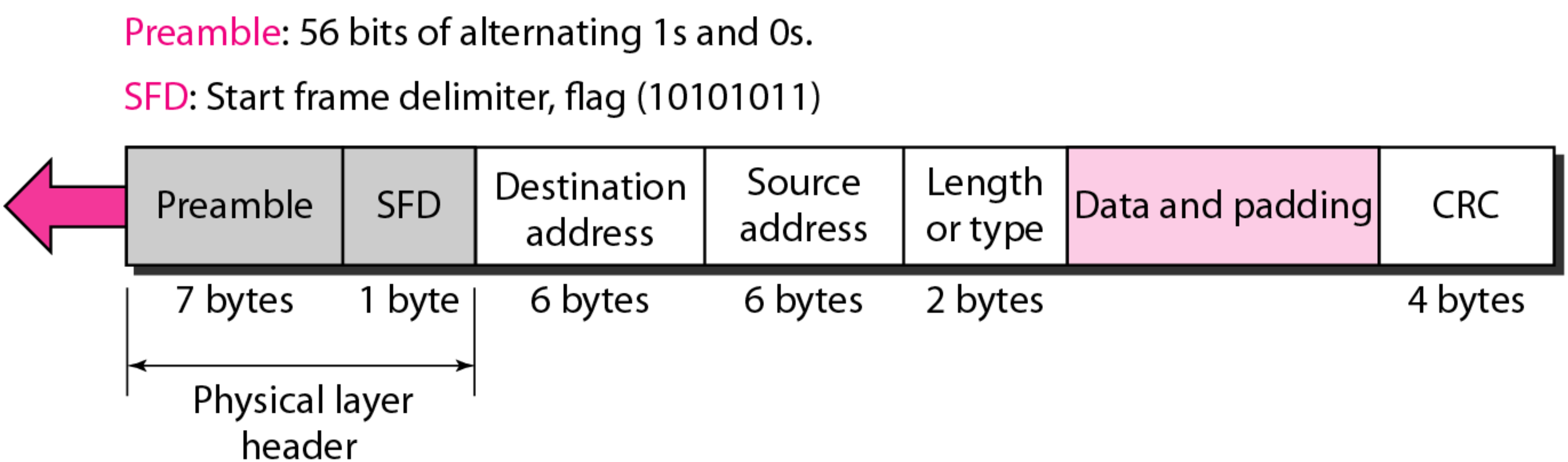
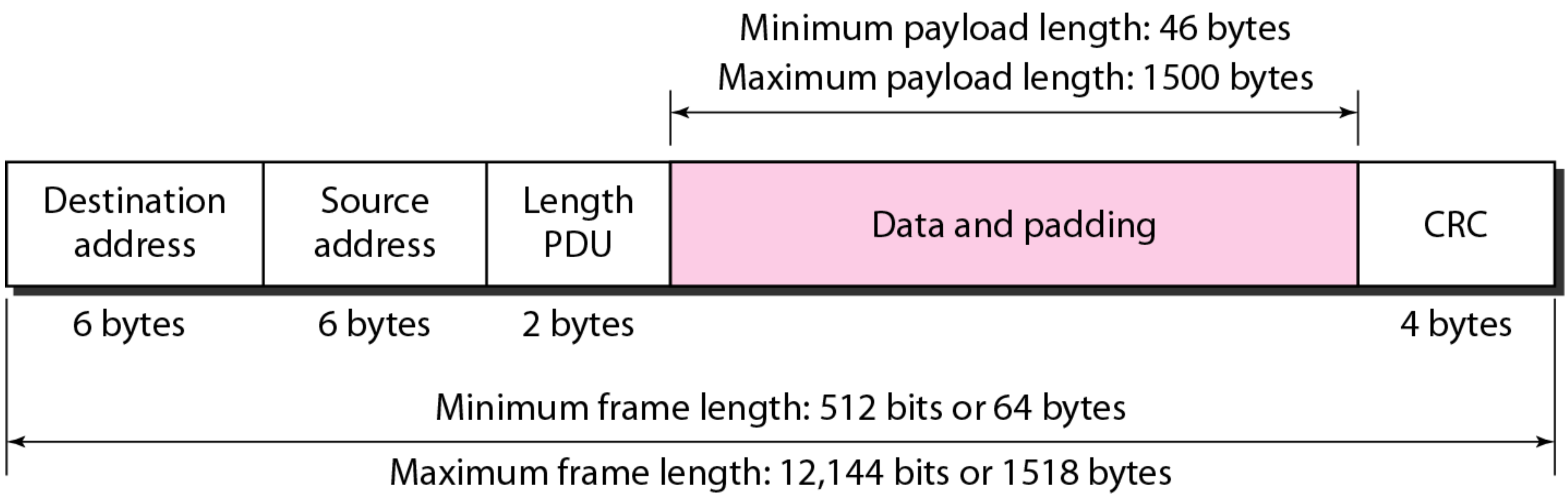


Figure 13.4 *802.3 MAC frame*



Preamble: to alert the receiver to the coming frame and enable it to synchronize its input timing.
Start Frame Delimiter (SFD): '10101011'. The last chance for synchronization.

Figure 13.5 *Minimum and maximum lengths*



Padding: if the upper layer packet is less than 46 bytes, padding is added to make up the difference.

Note

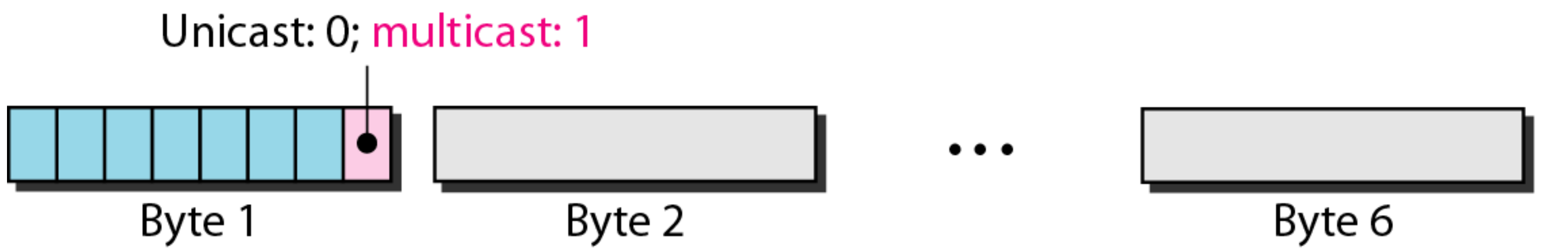
Frame length:

Minimum: 64 bytes (512 bits)

Maximum: 1518 bytes (12,144 bits)

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:

← 11100010 00000100 11011000 01110100 00010000 01110111

Figure 13.8 *Categories of Standard Ethernet*

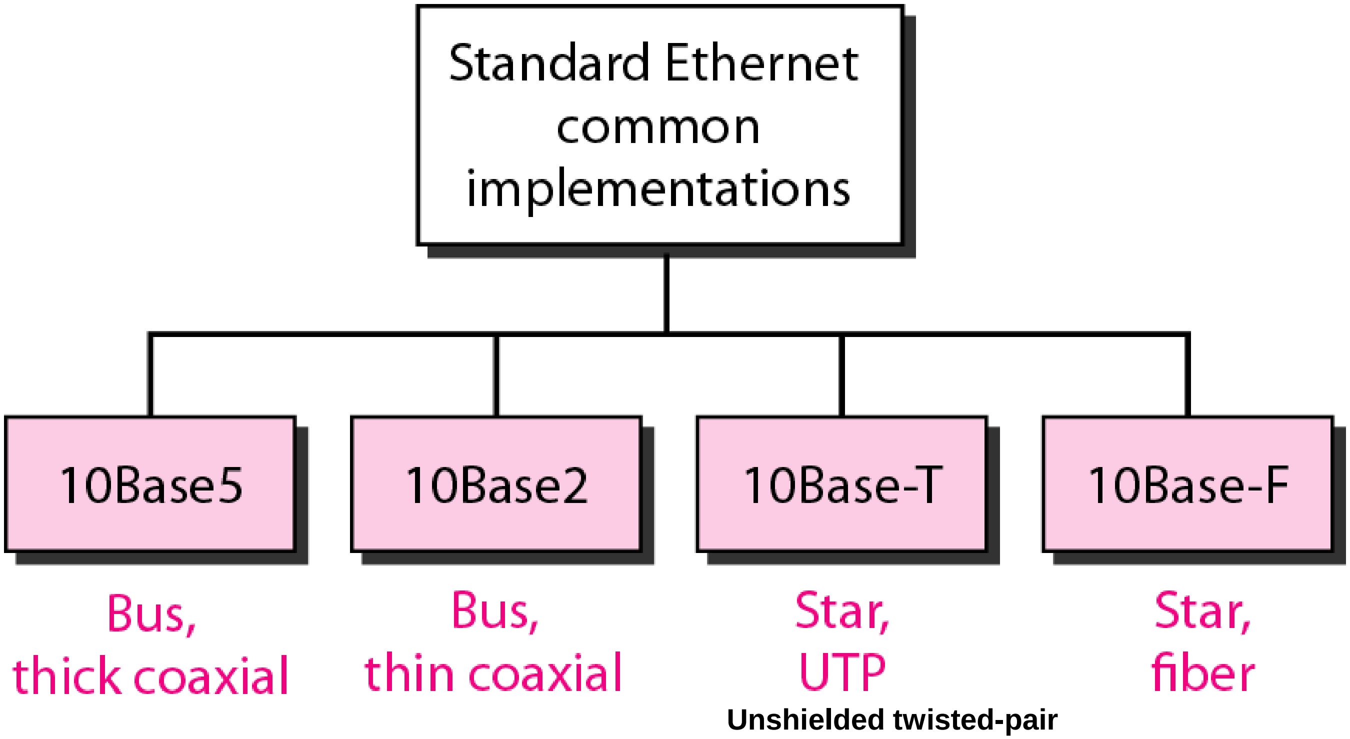
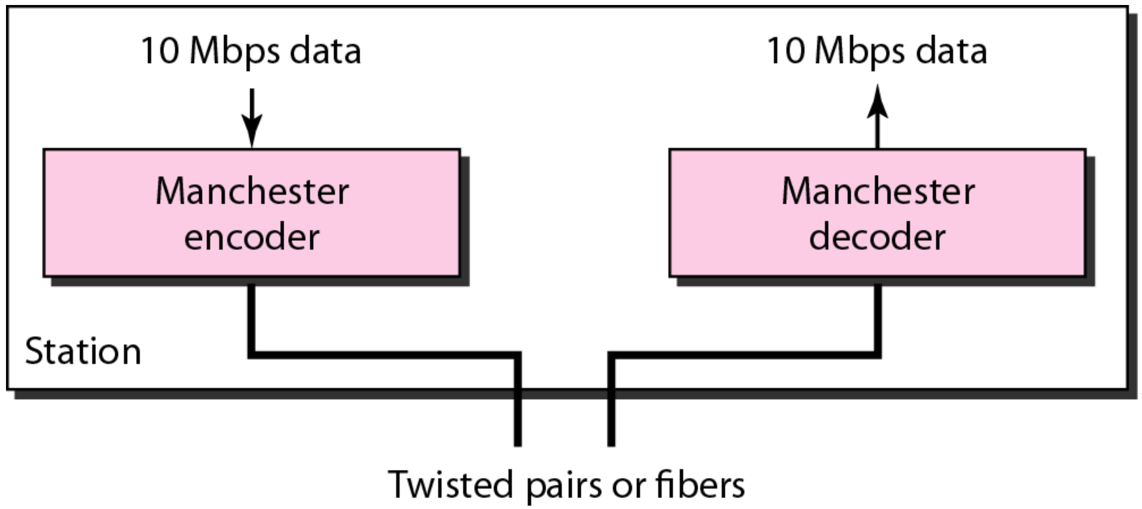
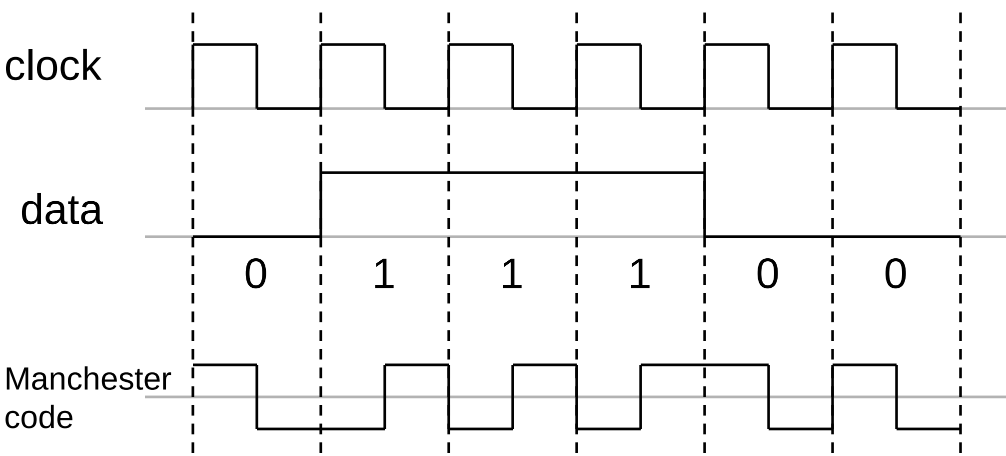


Figure 13.9 *Encoding in a Standard Ethernet implementation*



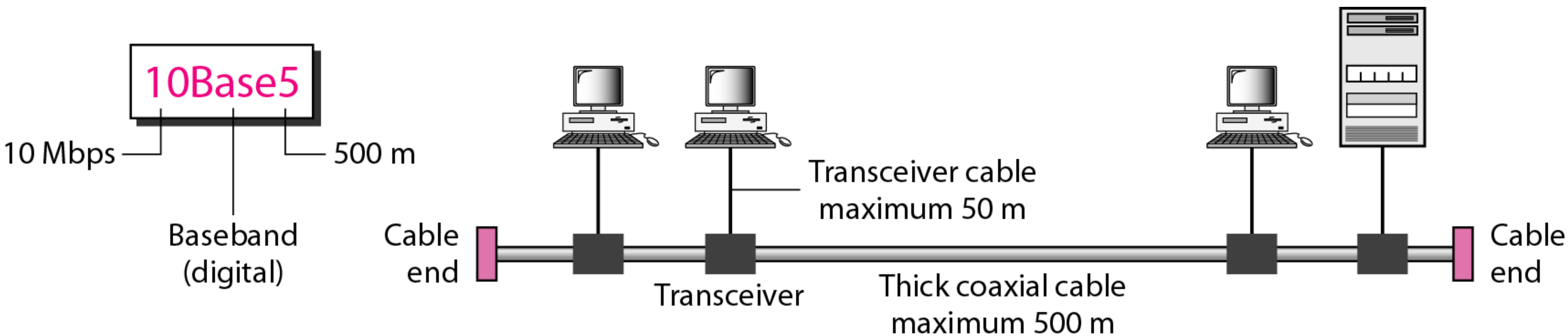


At receiver side, if the receiver gets this waveform, the receiver does not know how many bits are sent by the sender.

Bit ‘0’: high to low
Bit ‘1’: low to high

Advantages: Easy to recover clock from the received signal at receiver.

Figure 13.10 *10Base5 implementation*

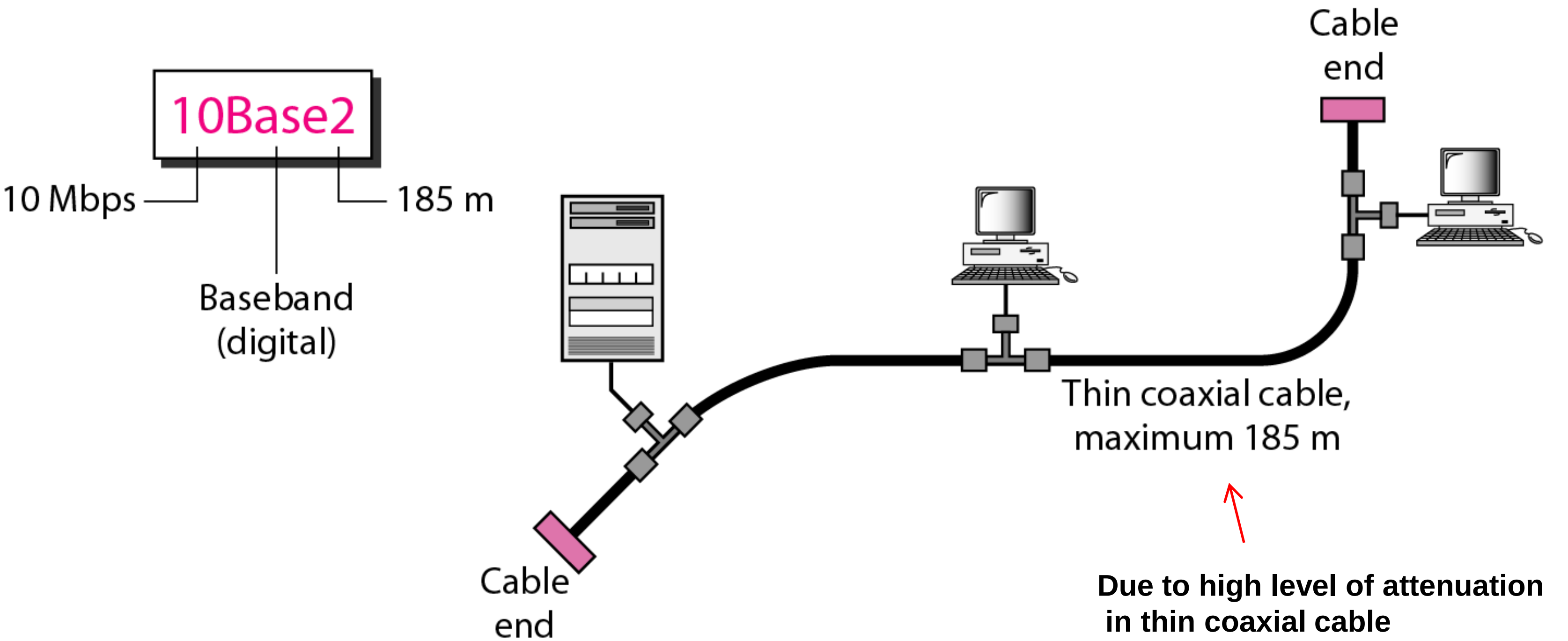


Thick cable: was the first Ethernet specification to use a bus topology. Stiff to bend with your hand.

Transceiver: responsible for transmitting, receiving, and detecting collisions. It has separate paths for transmitting to and receiving from the station.

Collisions only happen in the coaxial cable.

Figure 13.11 *10Base2 implementation*

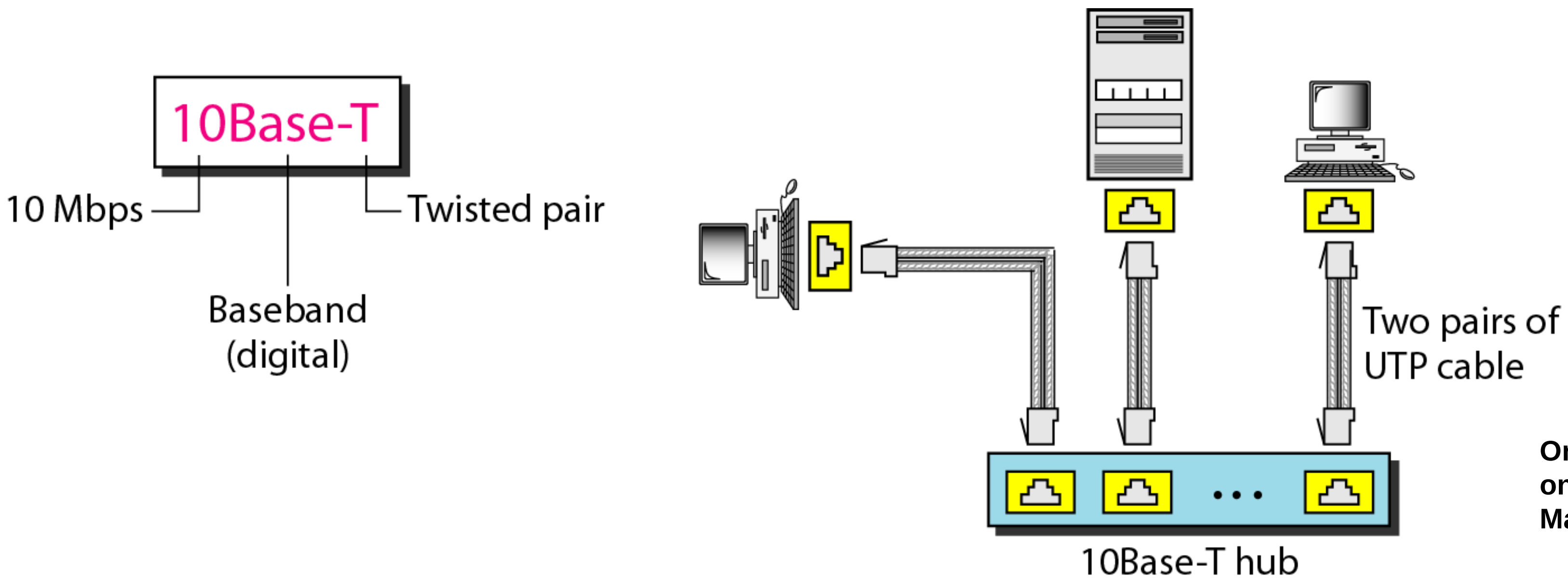


Due to high level of attenuation in thin coaxial cable

Because the cable can be bent to pass very close to the stations

Transceiver is normally part of the network interface card (NIC), which is installed inside the station.
Thin cable: cheaper and more flexible.

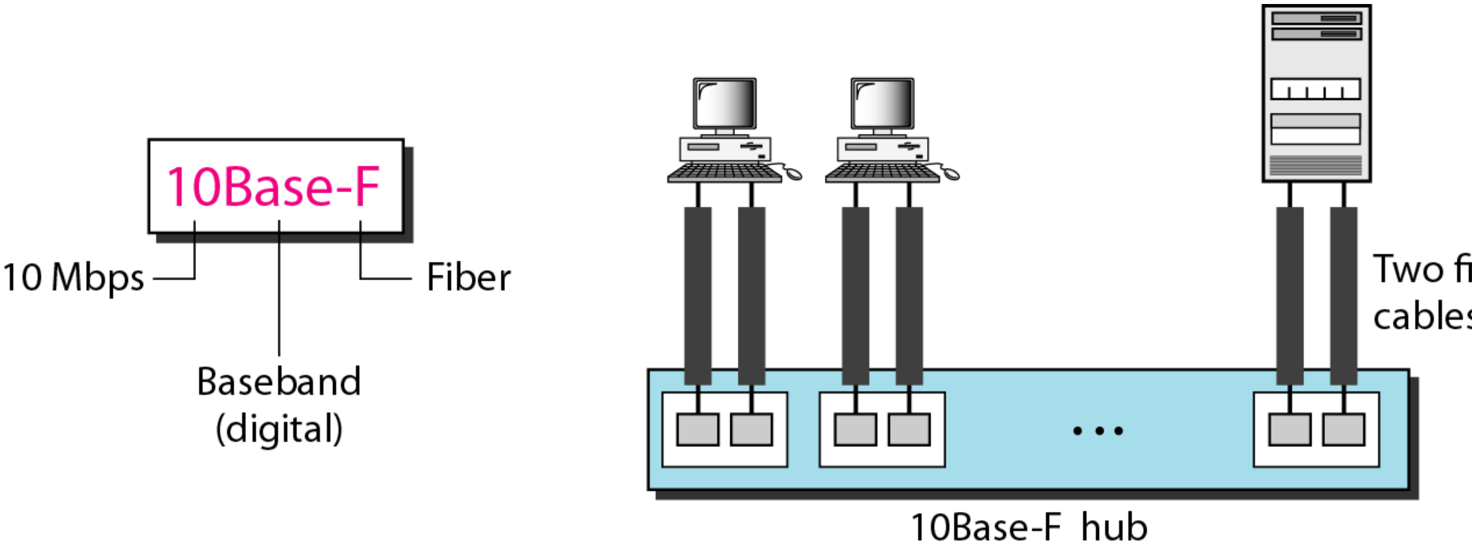
Figure 13.12 *10Base-T implementation*



One for sending,
one for receiving.
Max length: 100m

UTP: Unshielded twisted-pair

Figure 13.13 *10Base-F implementation*



One for sending,
one for receiving.
Max length: 2000m

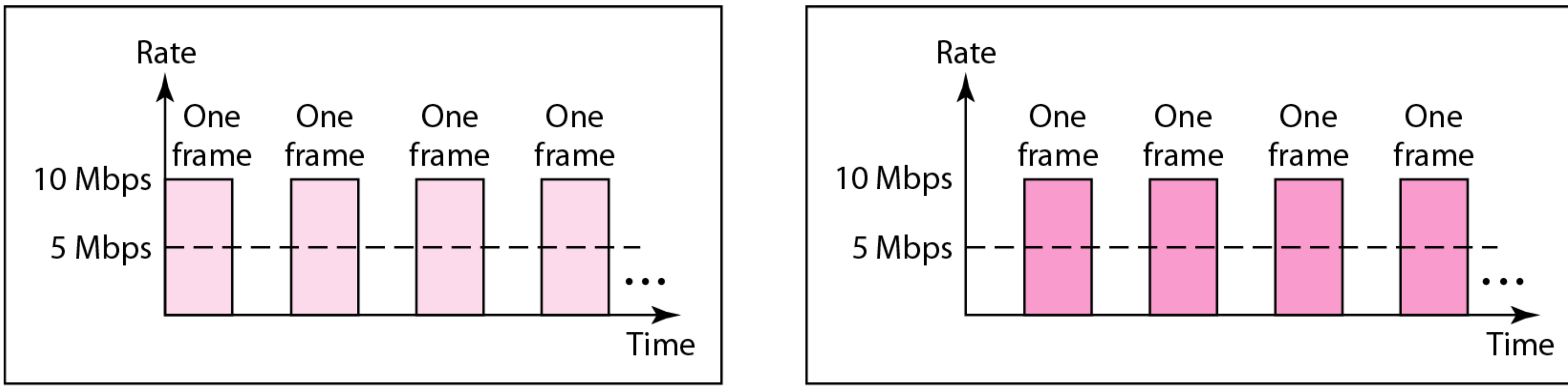
Table 13.1 ***Summary of Standard Ethernet implementations***

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.

Figure 13.14 *Sharing bandwidth*

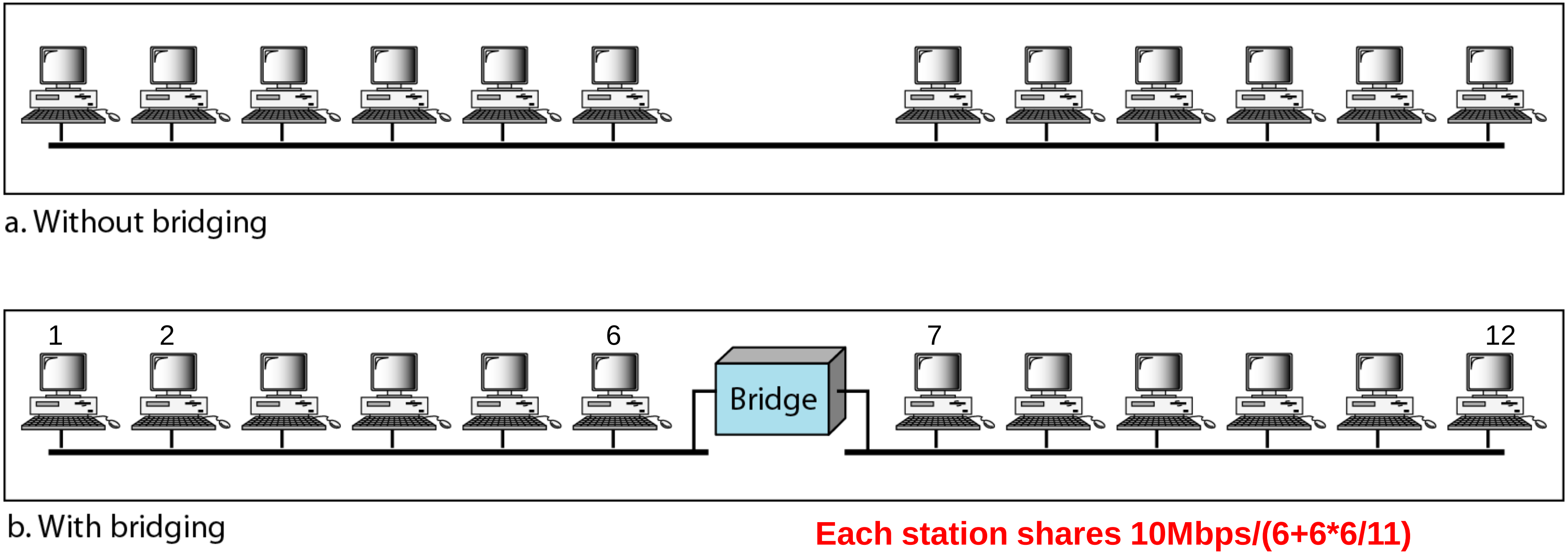


a. First station

b. Second station

Figure 13.15 *A network with and without a bridge*

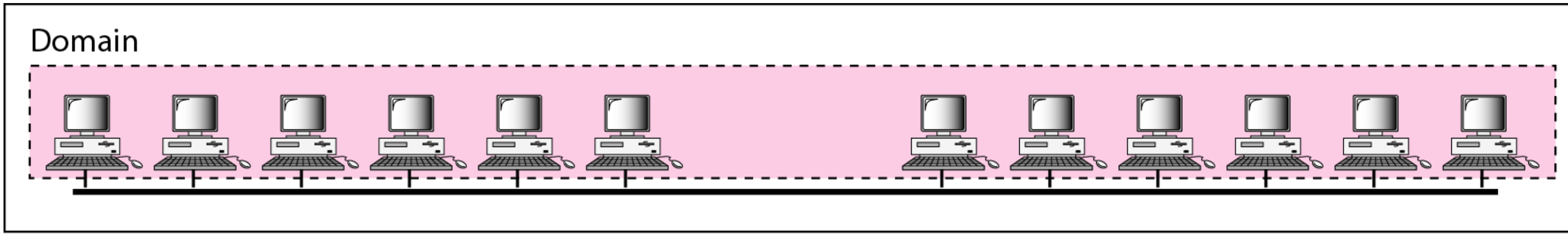
Each station shares 10Mbps/12



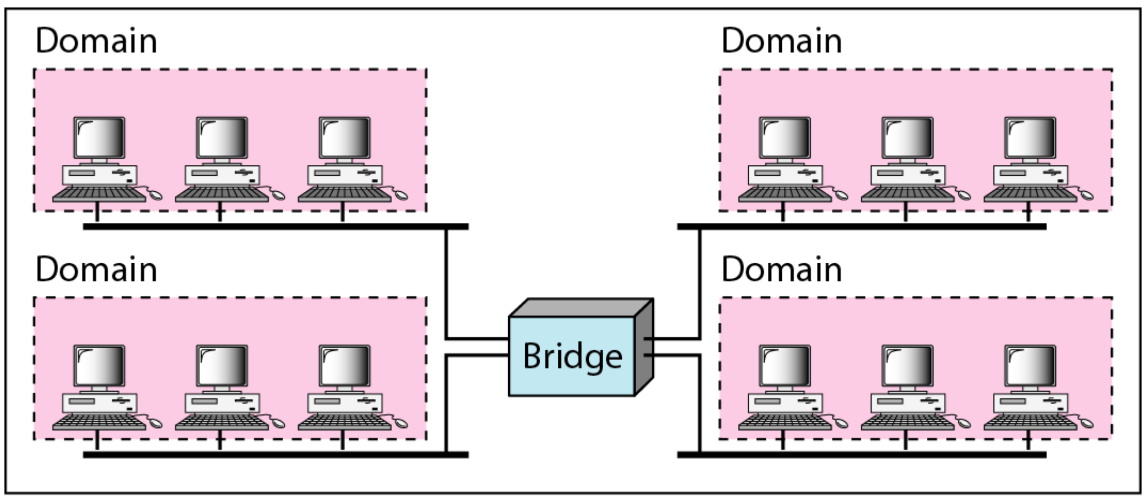
Each station shares 10Mbps/(6+6*6/11)

From a port, if the bridge gets a frame with destination at the same side of the port, the bridge does nothing. If the bridge gets a frame whose destination is connected to another port, the bridge forwards the frame to the other port.
The bridge raises the bandwidth

Figure 13.16 *Collision domains in an unbridged network and a bridged network*



a. Without bridging



b. With bridging

Each station shares 10Mbps/(3+9*3/11)

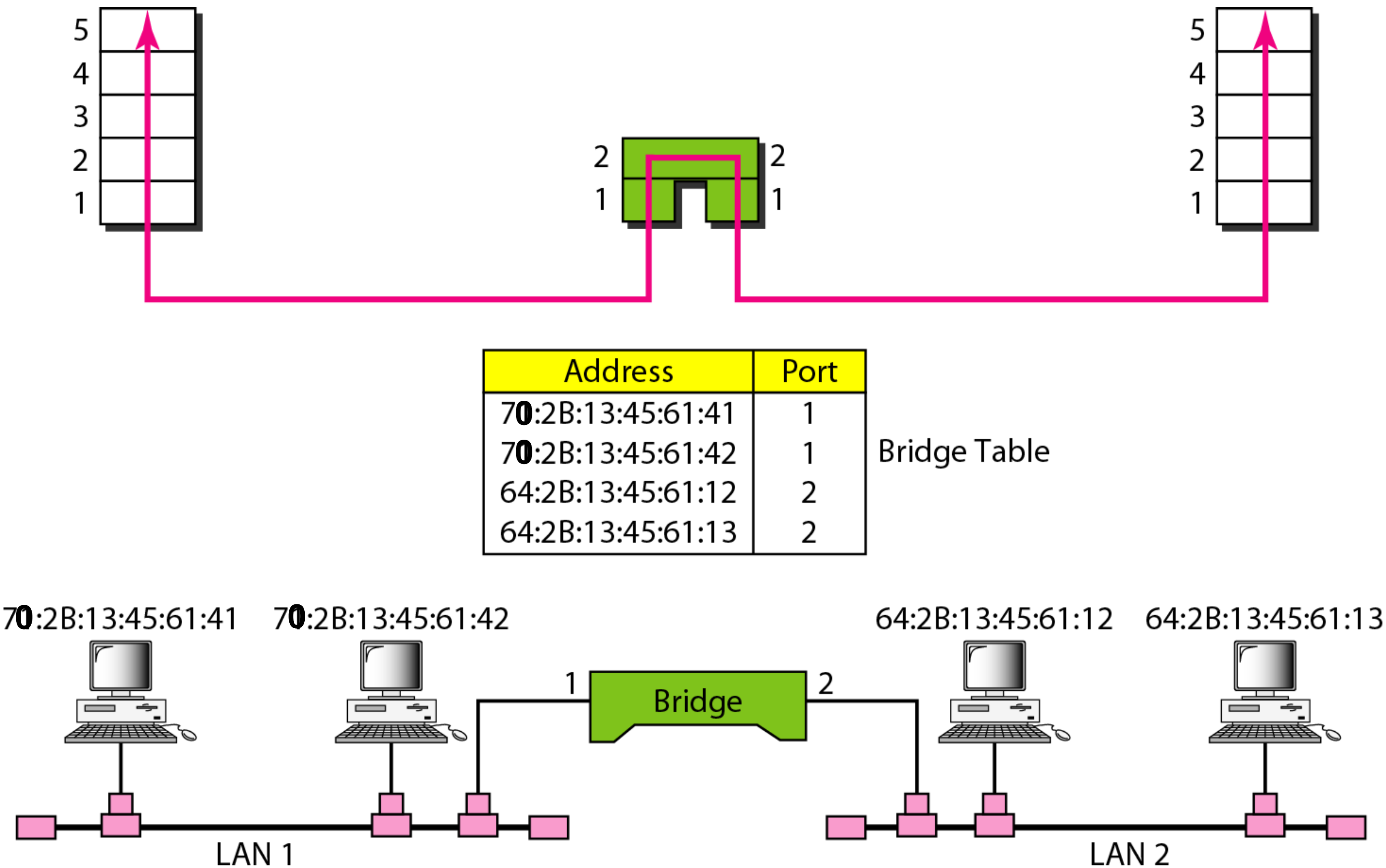
The bridge separates the collision domain

The following slides are from Chapter 15 of the textbook.

Note

A bridge has a table used in filtering decisions.

Figure 15.5 *A bridge connecting two LANs*

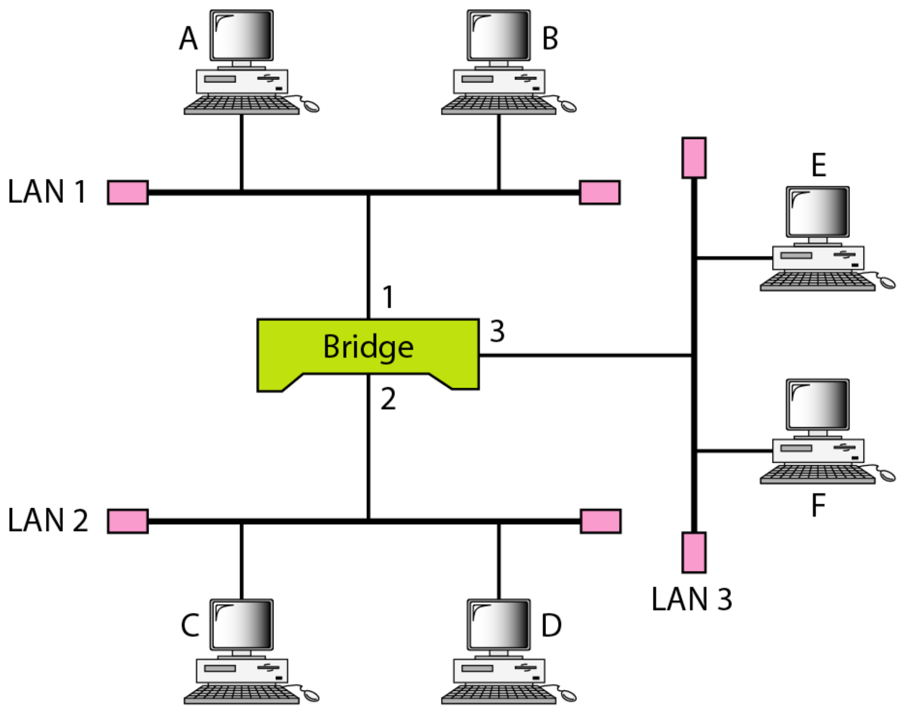


Address	Port
70:2B:13:45:61:41	1
70:2B:13:45:61:42	1
64:2B:13:45:61:12	2
64:2B:13:45:61:13	2

Note

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

Figure 15.6 *A learning bridge and the process of learning*



Address	Port

a. Original

Address	Port
A	1

b. After A sends a frame to D

Address	Port
A	1
E	3

c. After E sends a frame to A

Address	Port
A	1
E	3
B	1

d. After B sends a frame to C

The stations are unaware of the bridge.