Date: 4th- Sept- 2024

Internal Assessment – 3

Write a short note on Integrated Services Digital Network (ISDN)

Last Date of submission:

on or before 8th Sept 2024 (mid-night)

How to submit: Use the form

https://forms.gle/3FQrAB1GzonRRuVj8

Chapter 13

Wired LANs: Ethernet

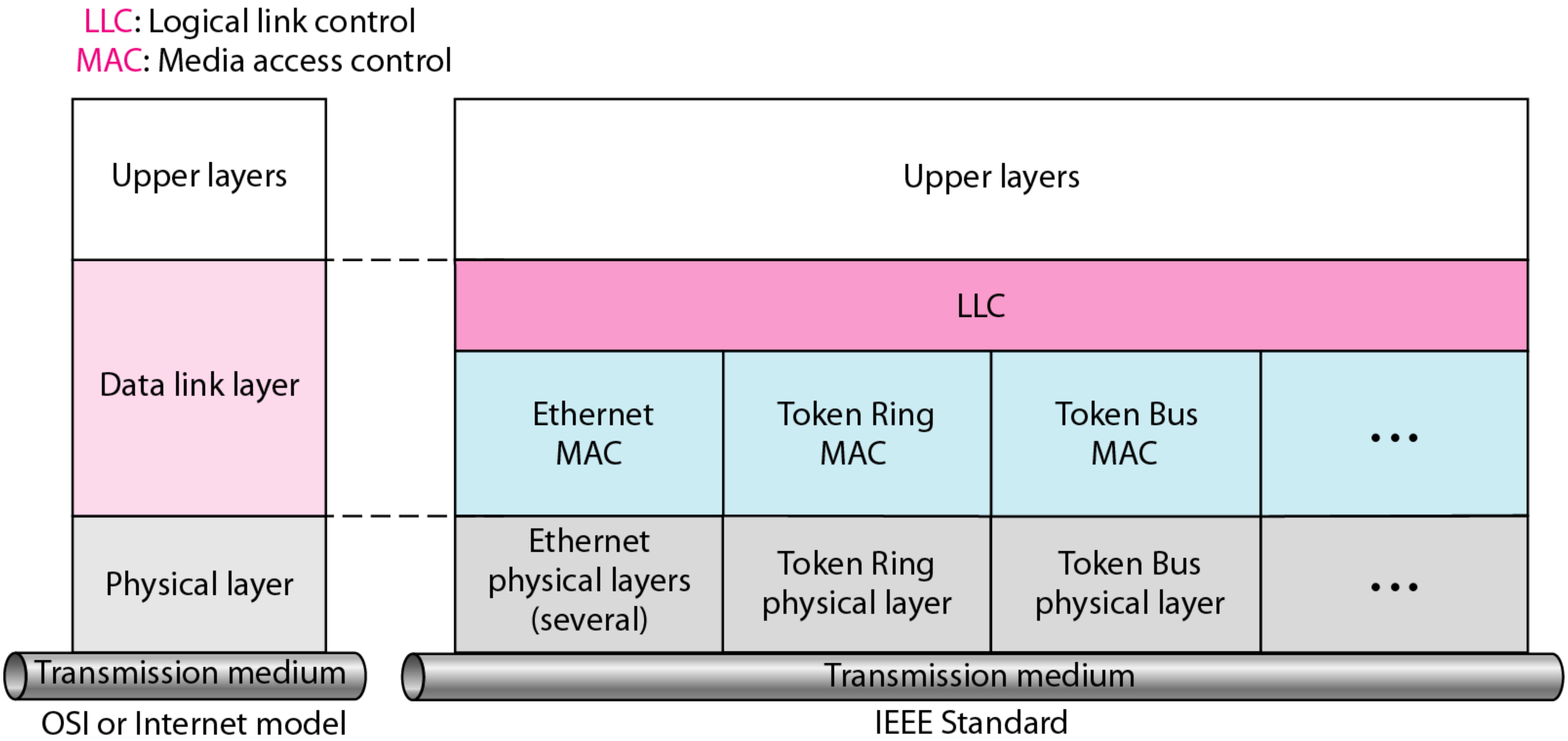
13-1 IEEE STANDARDS

- ***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*



13-1 IEEE STANDARDS: Project 802

- ✓ IEEE has subdivided the **data link layer** into **two sublayers**:
  1) Logical Link Control (**LLC**) and
  2) Media Access Control (**MAC**).

13-1 IEEE STANDARDS: Project 802

Logical Link Control (LLC):

- ✓ Deals with **flow control**, **error control**, and **part of the framing** duties
- ✓ It provides one **single** data link control **protocol for all IEEE LANs.**
- ✓ A single LLC protocol can provide interconnectivity between different LANs because it makes the MAC sublayer transparent (hidden from the network layer or upper layers).

13-1 IEEE STANDARDS: Project 802

Media Access Control (MAC):

- ✓It defines the **specific access method for each LAN**.
- ✓For example,
  - ✓it defines **CSMA/CD** **(Carrier Sense Multiple Access with Collision Detection)** as the media access method for Ethernet LANs and
  - ✓the **token passing** method for Token Ring and Token Bus LANs
- ✓**Part** of the **framing** function is also handled by the MAC layer

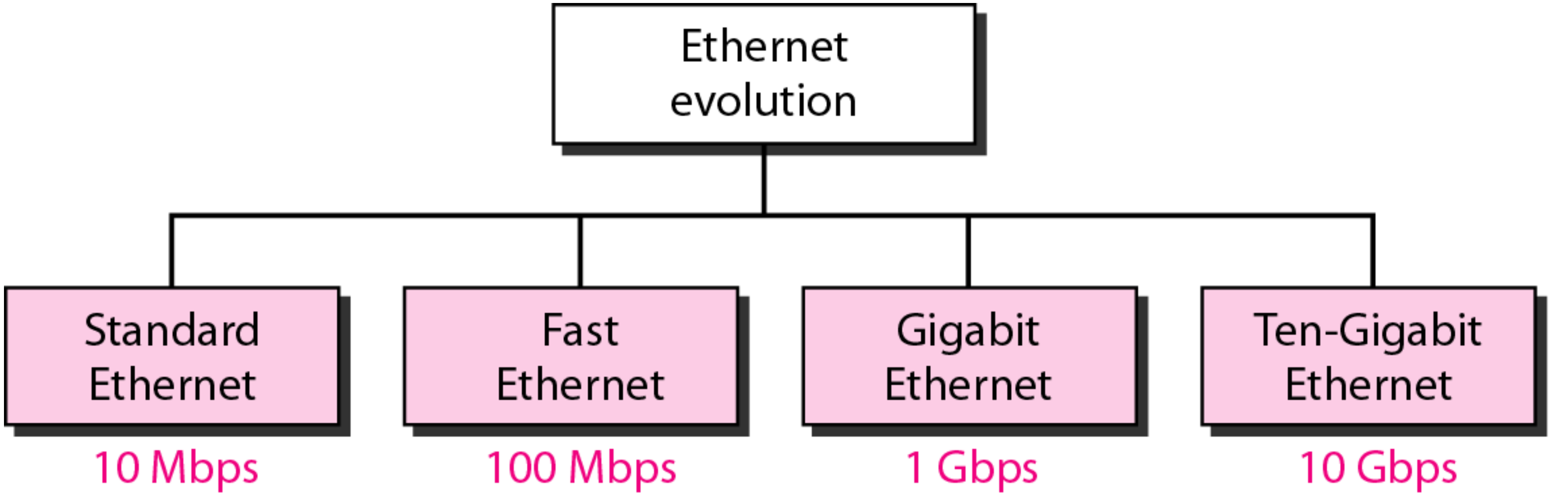
13-2 STANDARD ETHERNET

- ✓ 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*

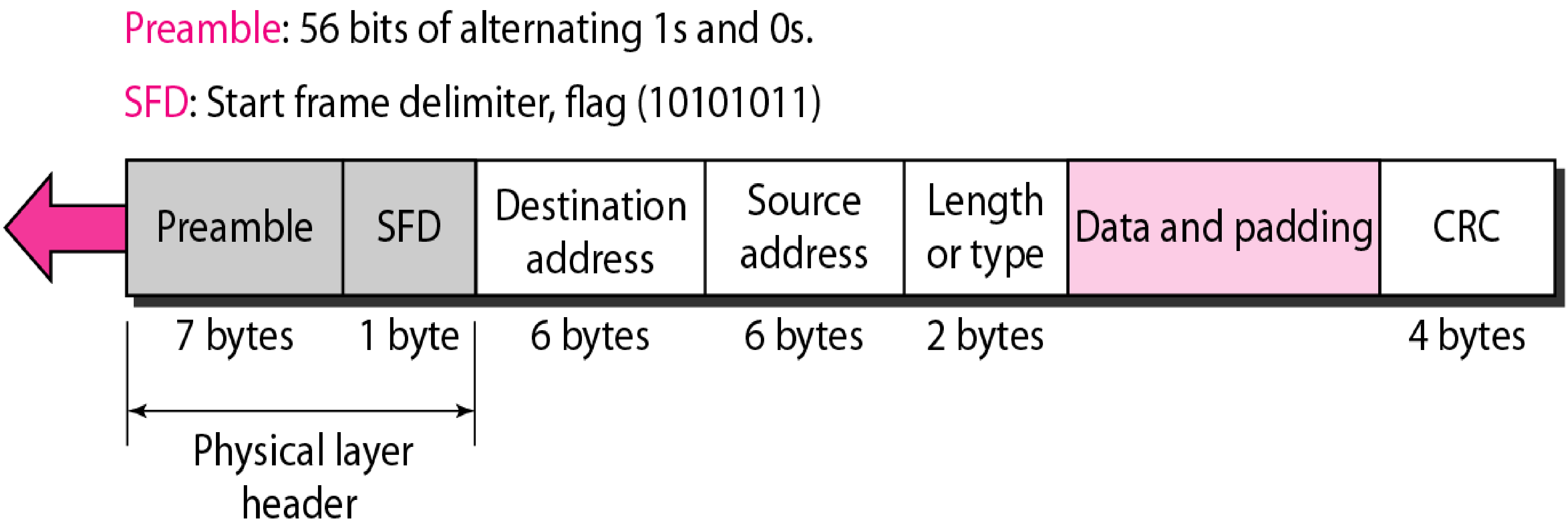


13-2 STANDARD ETHERNET

MAC Sublayer

- ✓ ***The*** MAC sublayer governs the **operation of the access method.**
- ✓ It also **frames** data received from the upper layer and passes them to the physical layer

Figure 13.4 *802.3 MAC frame*

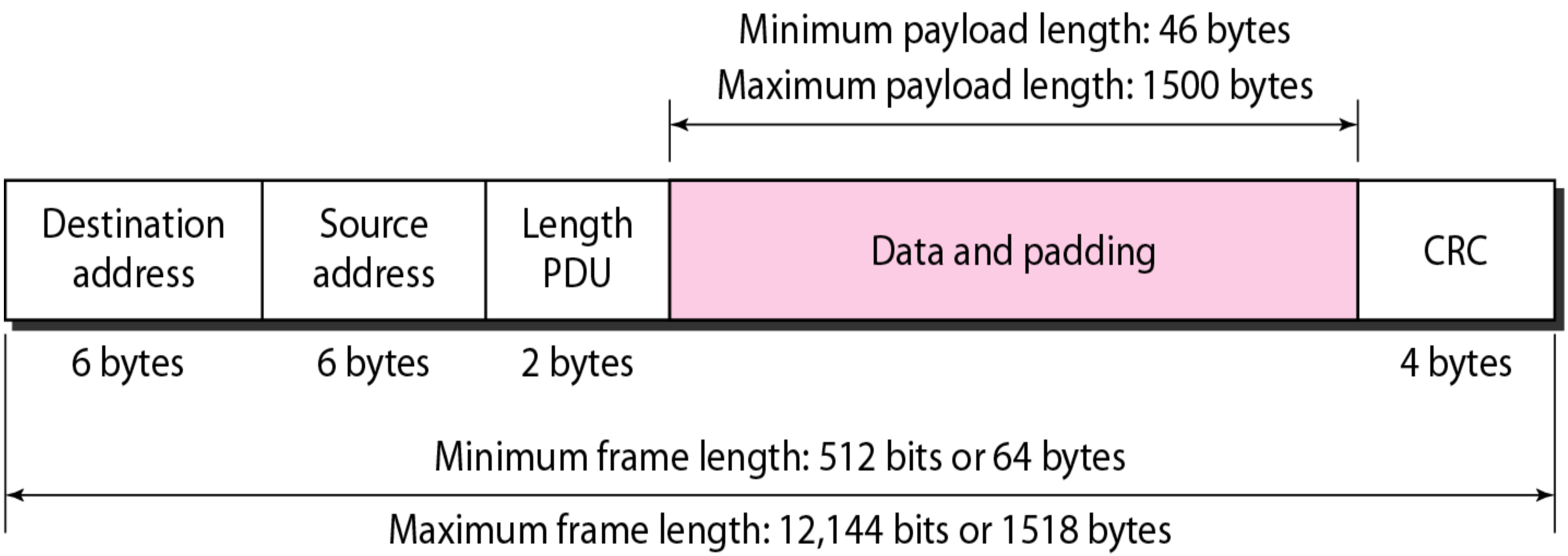


13-2 STANDARD ETHERNET

Frame Format

- ✓ Ethernet frame contains **seven fields**:
  - ✓ Preamble, SFD, DA, SA, length or type of protocol data unit (PDU), upper-layer data, and the CRC.
- ✓ Ethernet does not provide any acknowledgment.
- ✓ Acknowledgments must be implemented at the higher layers.
- ✓ **Preamble**: alerts the receiving system to the coming frame and enables it to **synchronize its input timing**.
- ✓ Start frame delimiter (**SFD**): signals the beginning of the frame. The last 2 bits is 11 and alerts the receiver that the next field is the destination address.
- ✓ **CRC**. The last field contains **error detection information**, in this case a **CRC-32**

Figure 13.5 *Minimum and maximum lengths*



Note

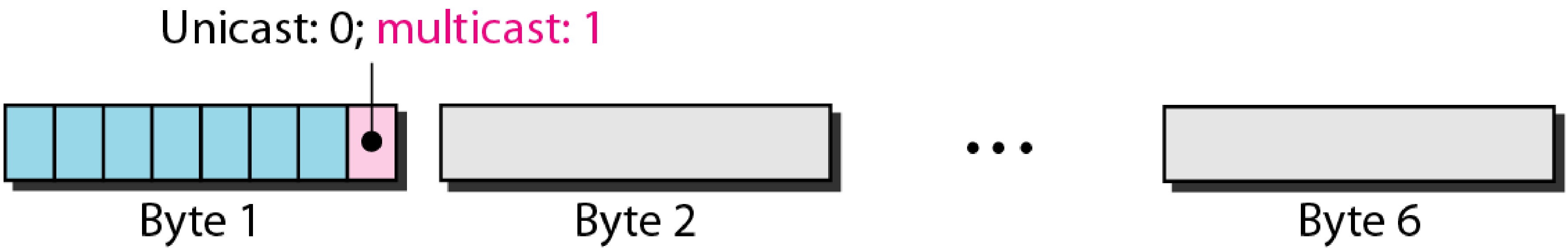
Frame length:

Minimum: 64 bytes (512 bits)

Maximum: 1518 bytes (12,144 bits)

Figure 13.6 ***Ethernet address in hexadecimal notation***

Figure 13.7 *Unicast and multicast addresses*



- ✓ A **source address is always a unicast** address-the frame comes from only one station.
- ✓ The **destination address**, however, can be **unicast, multicast, or broadcast**.
- ✓ **Least significant bit** of the first byte in a destination address is:
  - ✓ 0: address is unicast
  - ✓ 1: address is multicast

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.

0100 0111 : 0010 0000 : 1B : 2E : 08 : EE

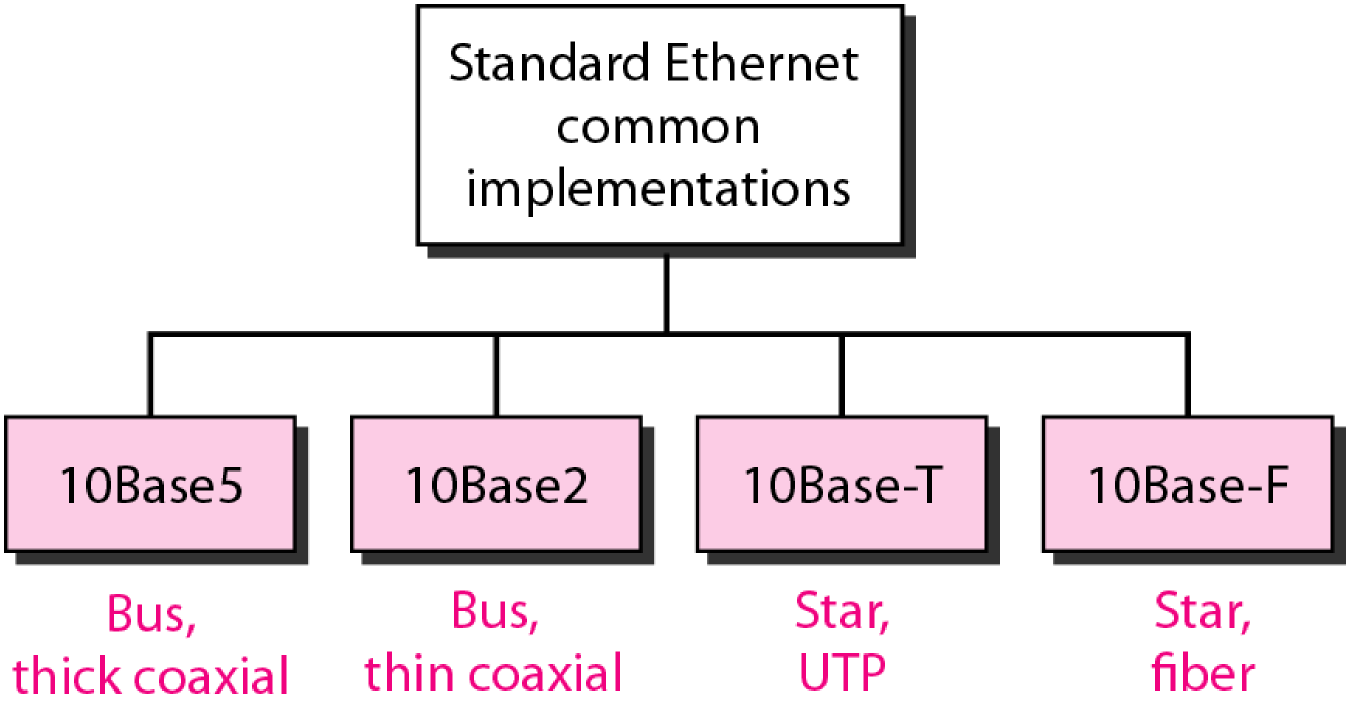
Solution

- ✓ ***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

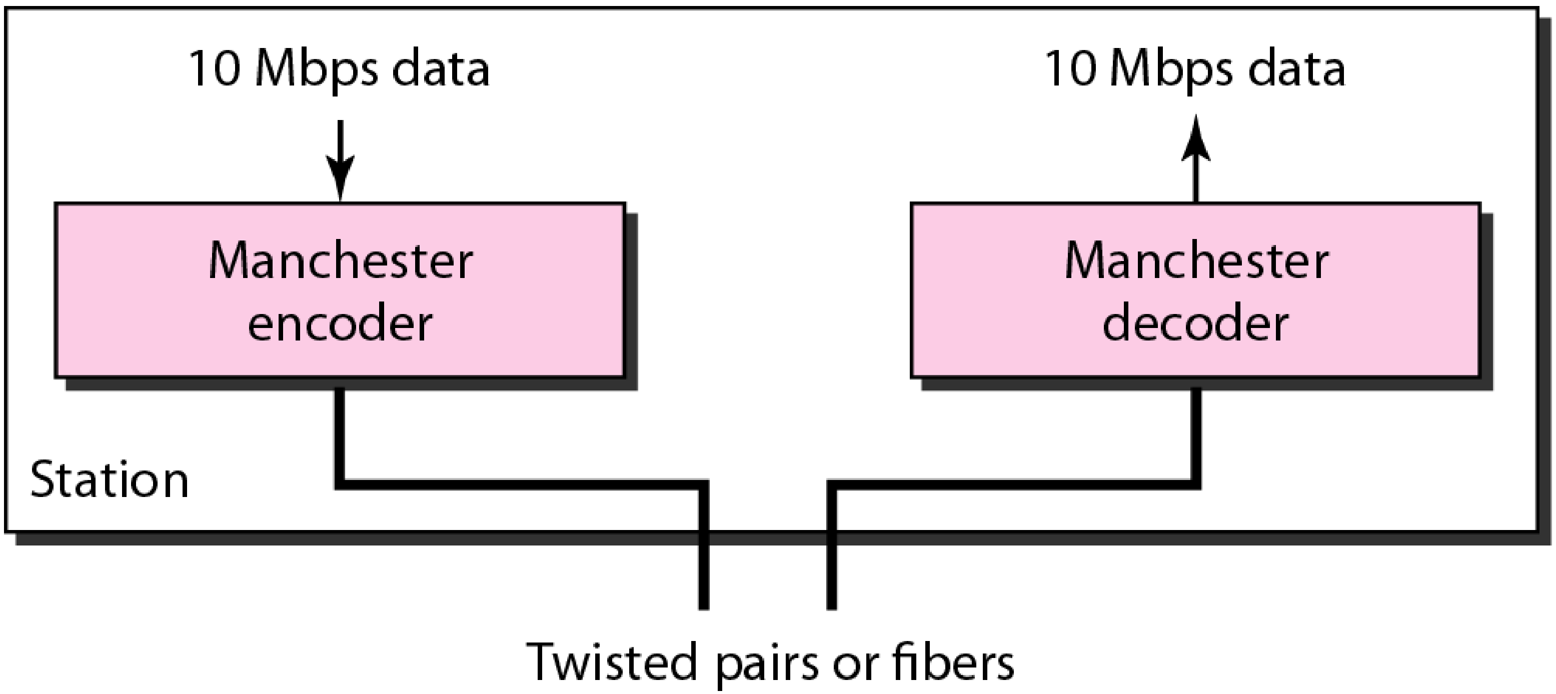
Physical Layer

Figure 13.8 ***Categories of Standard Ethernet implementations***



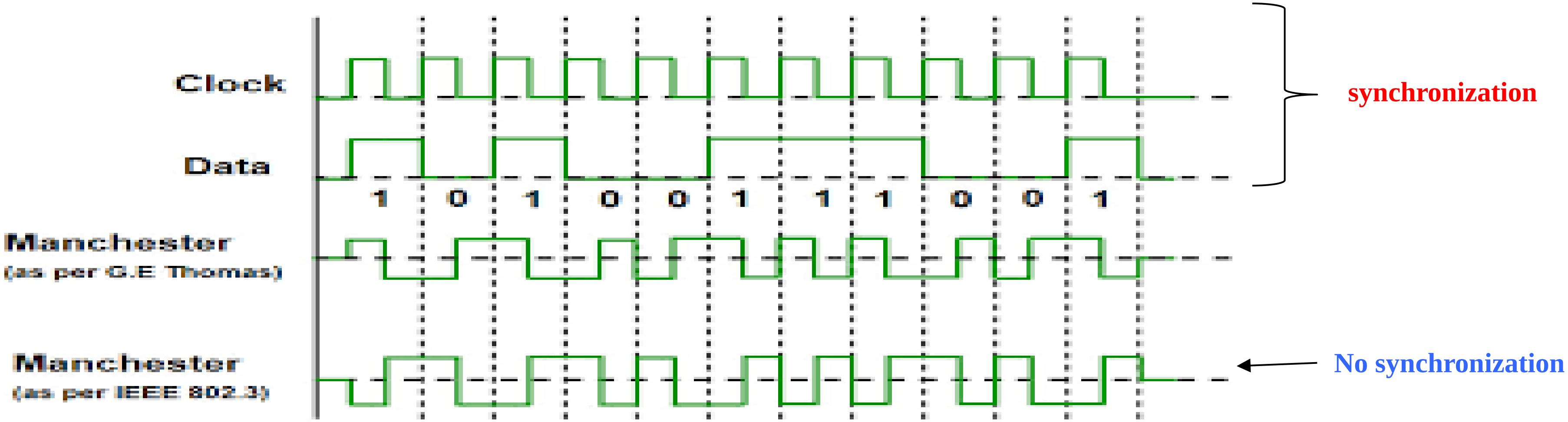
Physical Layer

Figure 13.9 *Encoding in a Standard Ethernet implementation*



Physical Layer

Figure: Manchester Encoding *in a Standard Ethernet*



Manchester encoding:

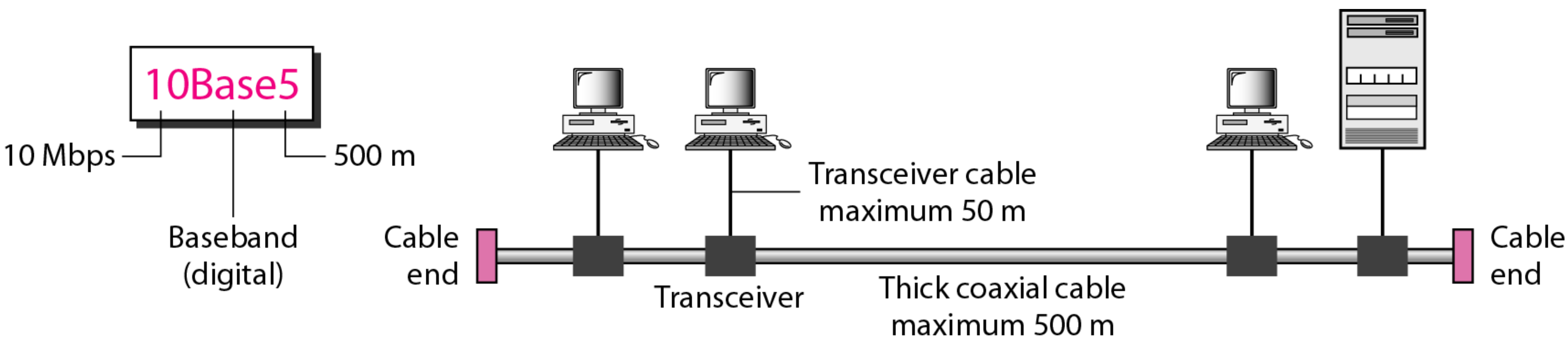
- ✓ A logical 0 is represented by a high-to-low transition in the middle of the bit period.
- ✓ A logical 1 is represented by a low-to-high transition in the middle of the bit period.

✓ This method ensures that there is always a transition in the signal for each bit, which helps with synchronization between the sender and the receiver.

Physical Layer

- ✓ 10Base5, or thick Ethernet, or Thicknet
- ✓ First Ethernet specification to use a **bus topology** with an external **transceiver** (transmitter/receiver/detecting collisions)
- ✓ Repeaters can be used upto five segments (each max. of 500m).

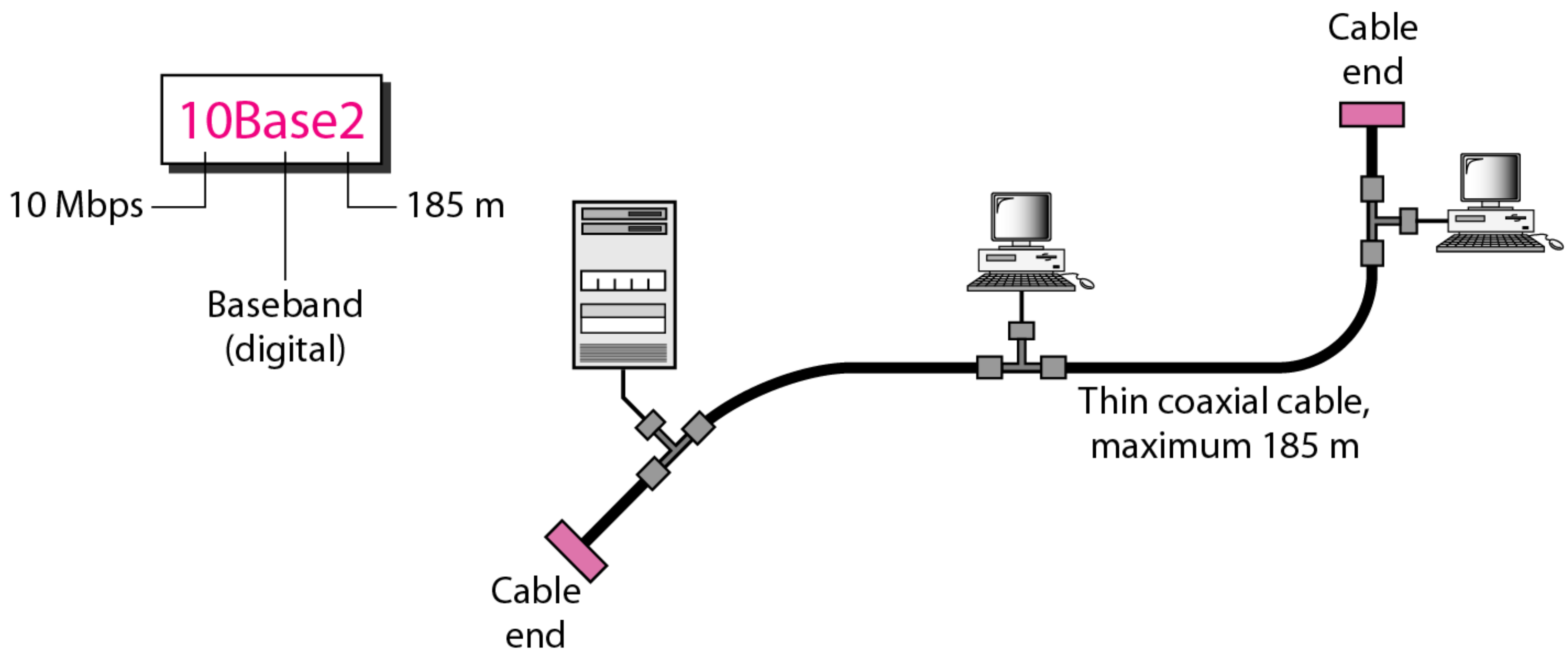
Figure 13.10 ***10Base5 implementation***



Physical Layer

- ✓ 10Base2, or thin Ethernet, or Cheapernet
- ✓ Use a **bus topology** with thinner and flexible cable (less expensive)
- ✓ Transceiver is part of the network interface card (NIC)

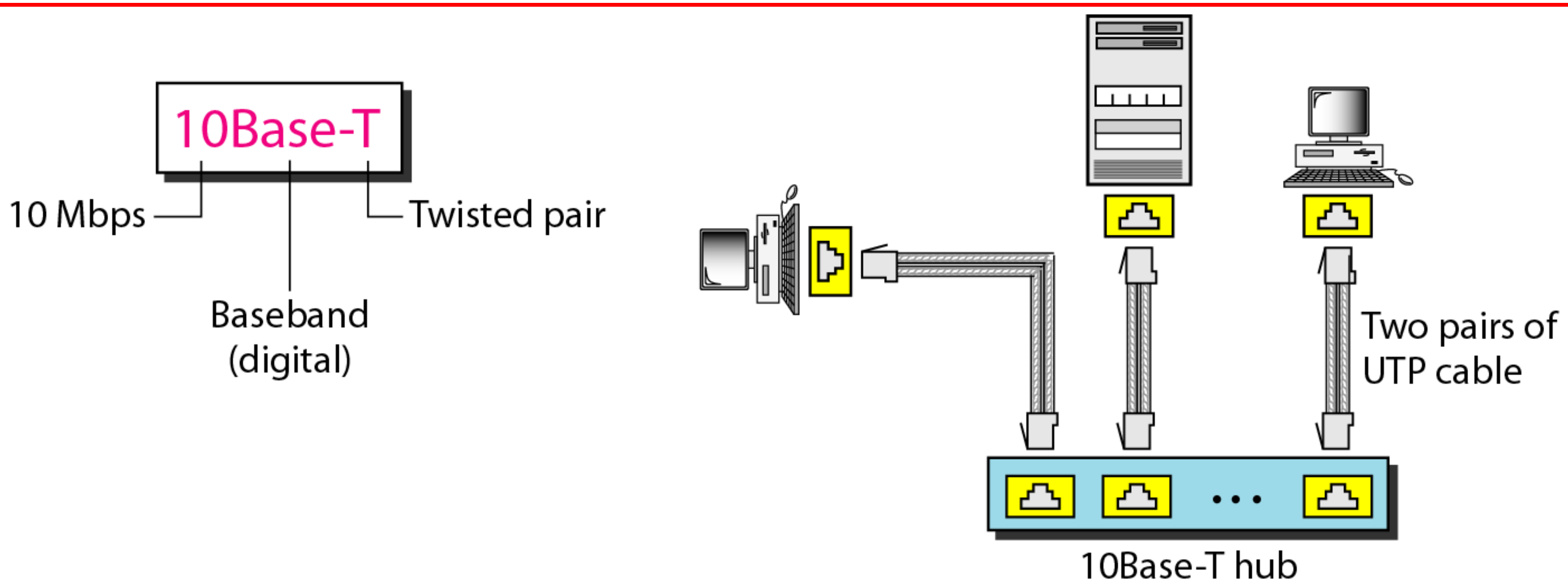
Figure 13.11 ***10Base2 implementation***



Physical Layer

- ✓ 10Base-T, or twisted-pair Ethernet (physical **star topology**)
- ✓ Stations are connected to a hub via two pairs of twisted cable
- ✓ Collision happens in the hub (Layer-1: single collision domain)
- ✓ Maximum length of the twisted cable here is 100 m, to minimize the attenuation

Figure 13.12 ***10Base-T implementation***



Physical Layer

- ✓ 10Base-F; 10 Mbps Ethernet
- ✓ Uses a physical **star topology** to connect to a hub
- ✓ Stations are connected to the hub using two fiber-optic cables.

Figure 13.13 ***10Base-F implementation***

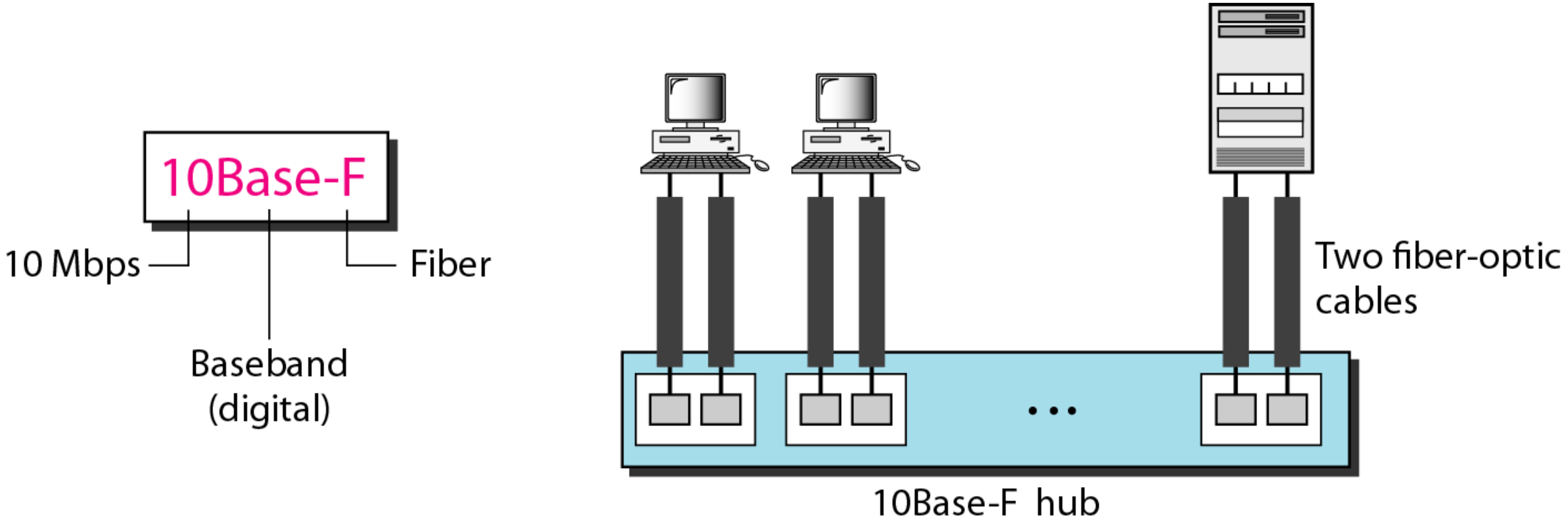


Table 13.1 *Summary of Standard Ethernet implementations*

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.*

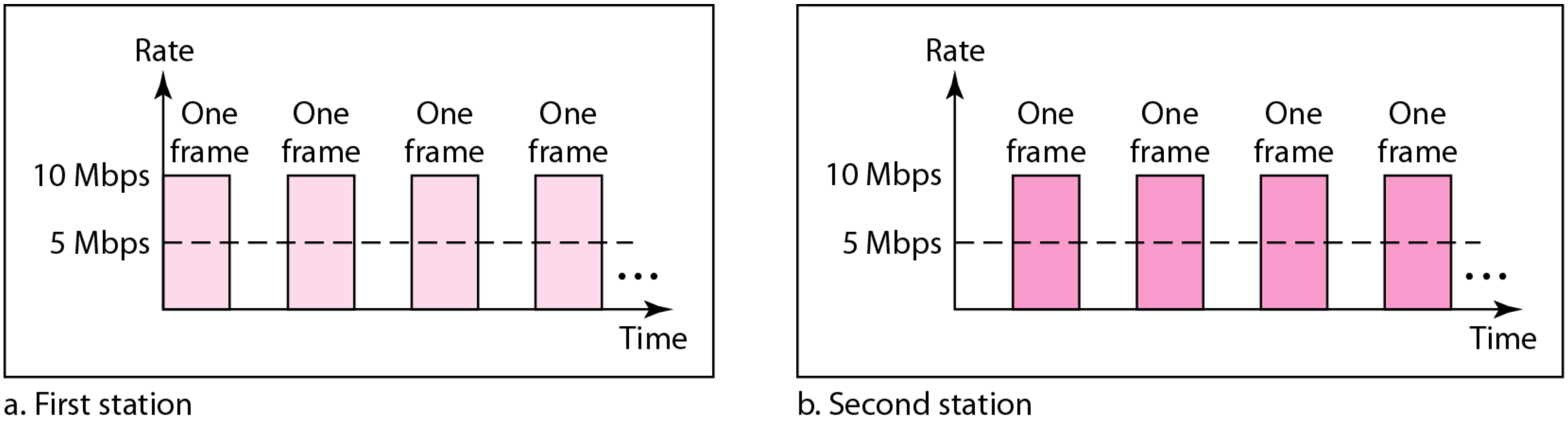
Topics discussed in this section:

Bridged Ethernet
Switched Ethernet
Full-Duplex Ethernet

Bridged Ethernet

- ✓ Bridges divides LAN
- ✓ Have two effects on an Ethernet LAN:
  - ✓ They raise the bandwidth and
  - ✓ They separate collision domains

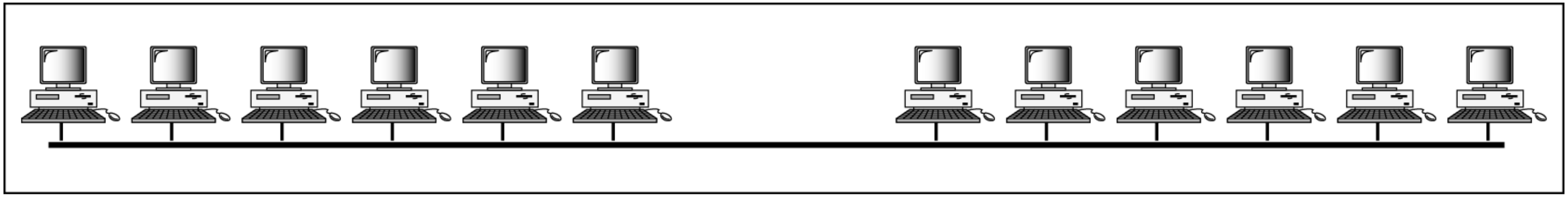
Figure 13.14 ***Sharing bandwidth by*** alternating the usage



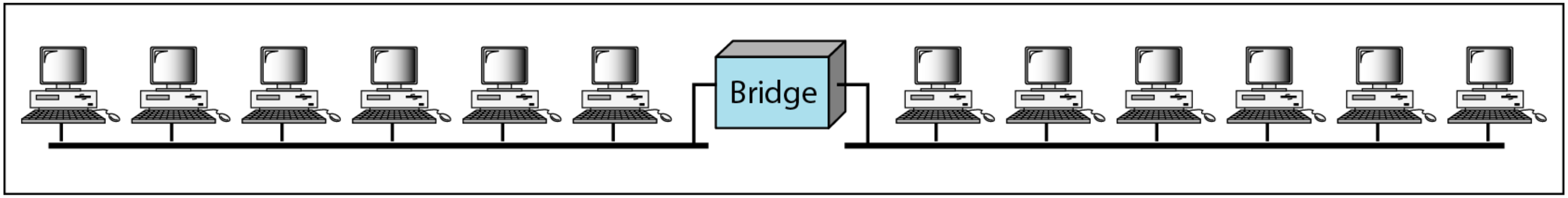
Bridged Ethernet

- ✓ First case: bandwidth for each station is 10/12 Mbps
- ✓ Second case: bandwidth for each station is 10/6 Mbps with **two** collision domains

Figure 13.15 ***A network with and without a bridge***



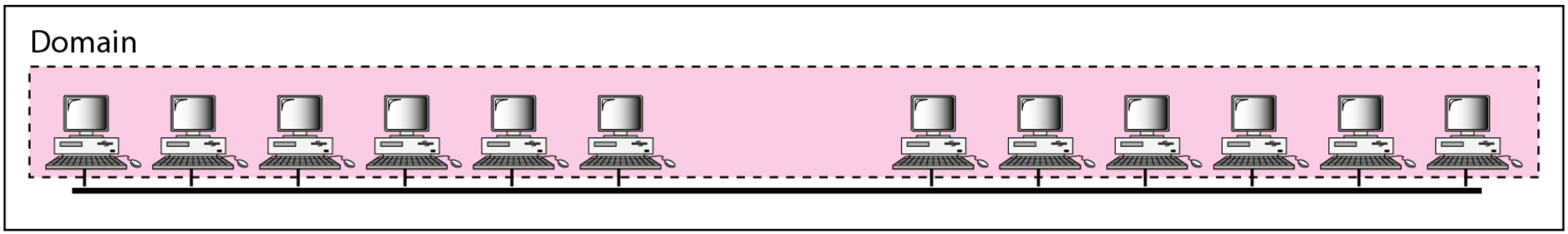
a. Without bridging



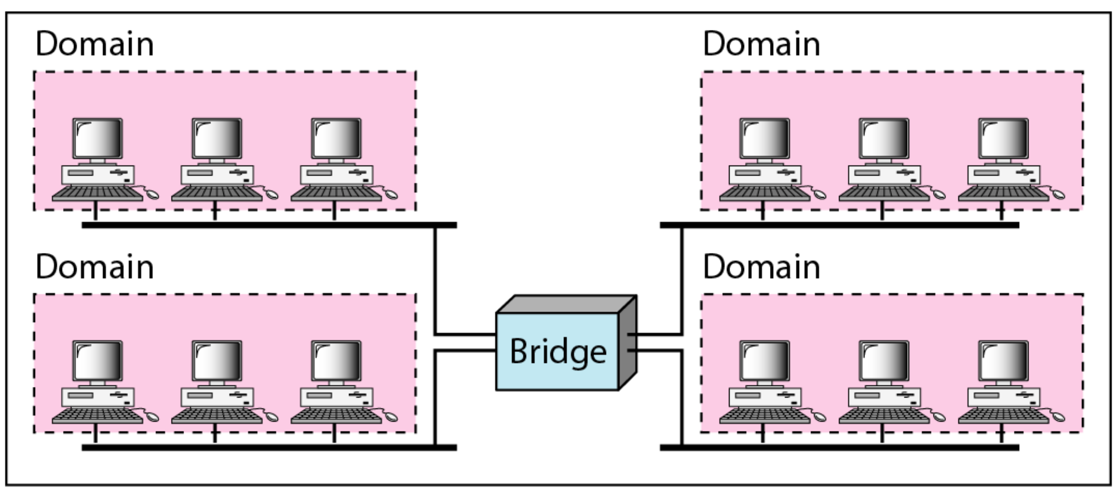
b. With bridging

Bridged Ethernet

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



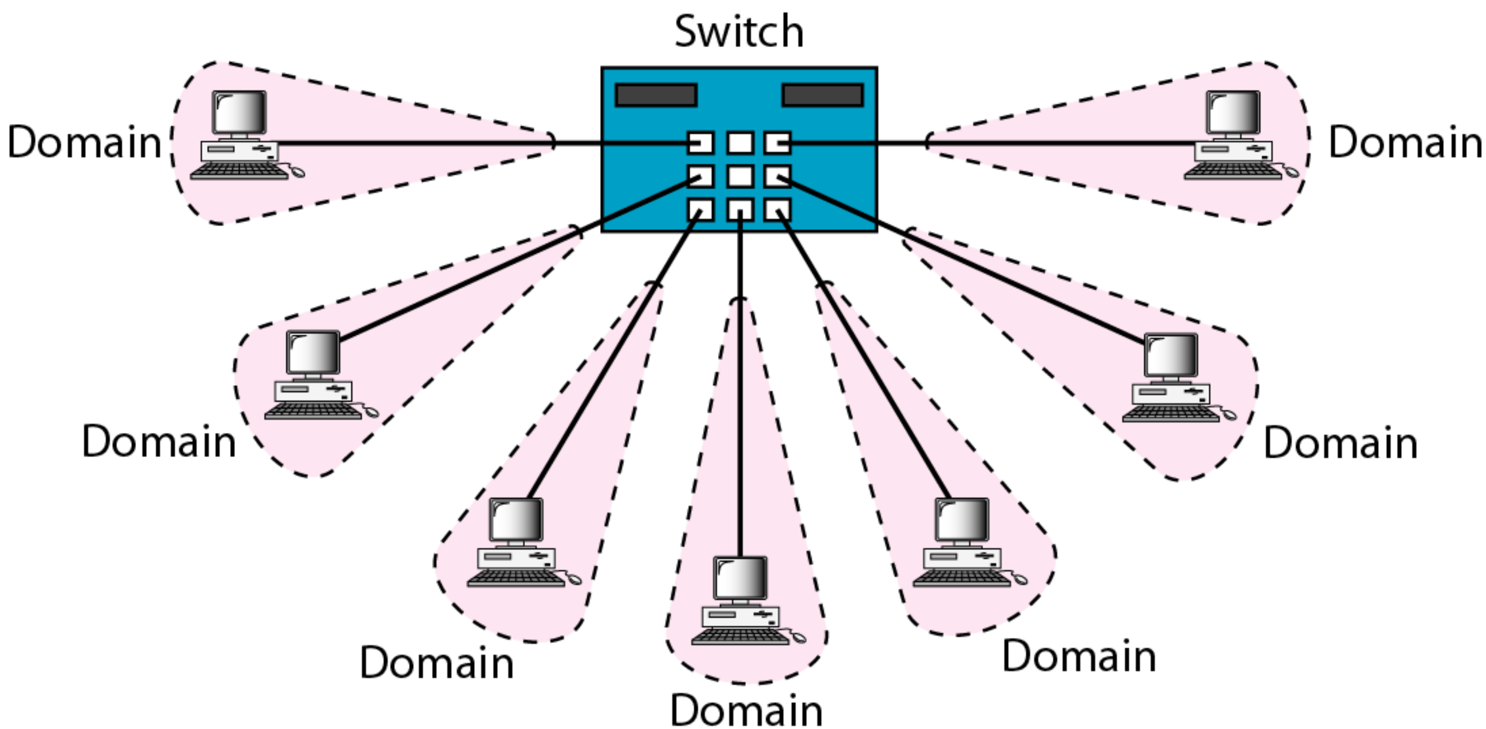
a. Without bridging



b. With bridging

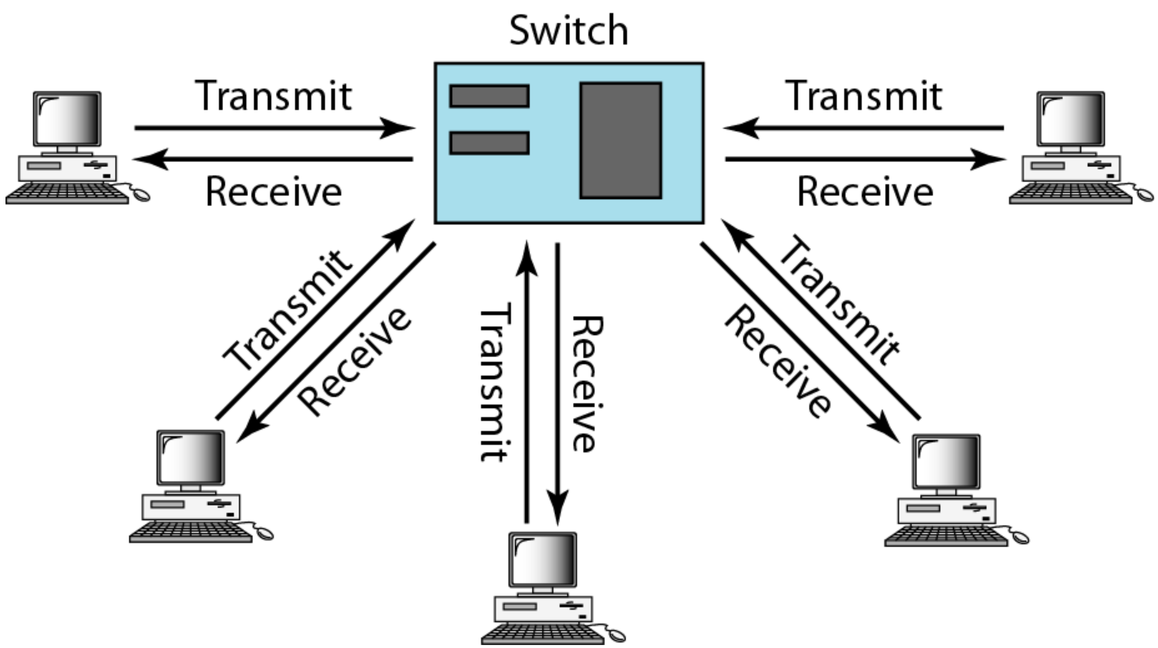
- ✓ A **layer-2 switch is an *N-port* bridge** with additional sophistication that allows faster handling of the packets

Figure 13.17 ***Switched Ethernet***



- **Limitations of 10Base5 and 10Base2**: **communication is half-duplex** (10Base-T is full-duplex)
- **No need for CSMA/CD**
- To provide for flow and error control in full-duplex switched Ethernet, a new sublayer, called the MAC control, is added between the LLC sublayer and the MAC sublayer.

Figure 13.18 *Full-duplex switched Ethernet*



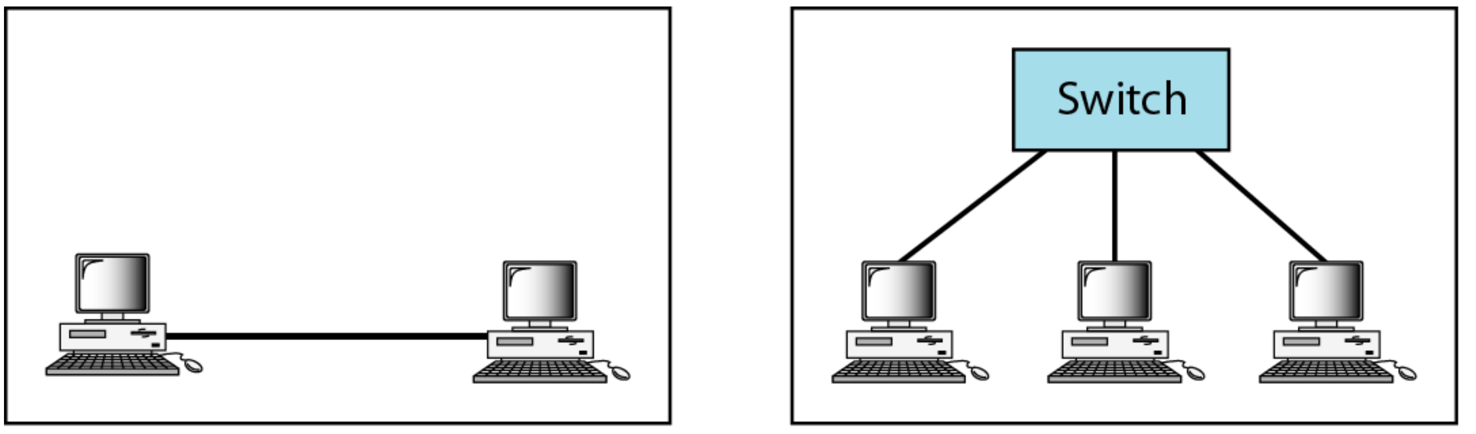
13-4 FAST ETHERNET

- ✓ Fast Ethernet was designed to compete with LAN protocols such as Fiber Distributed Data Interface (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*

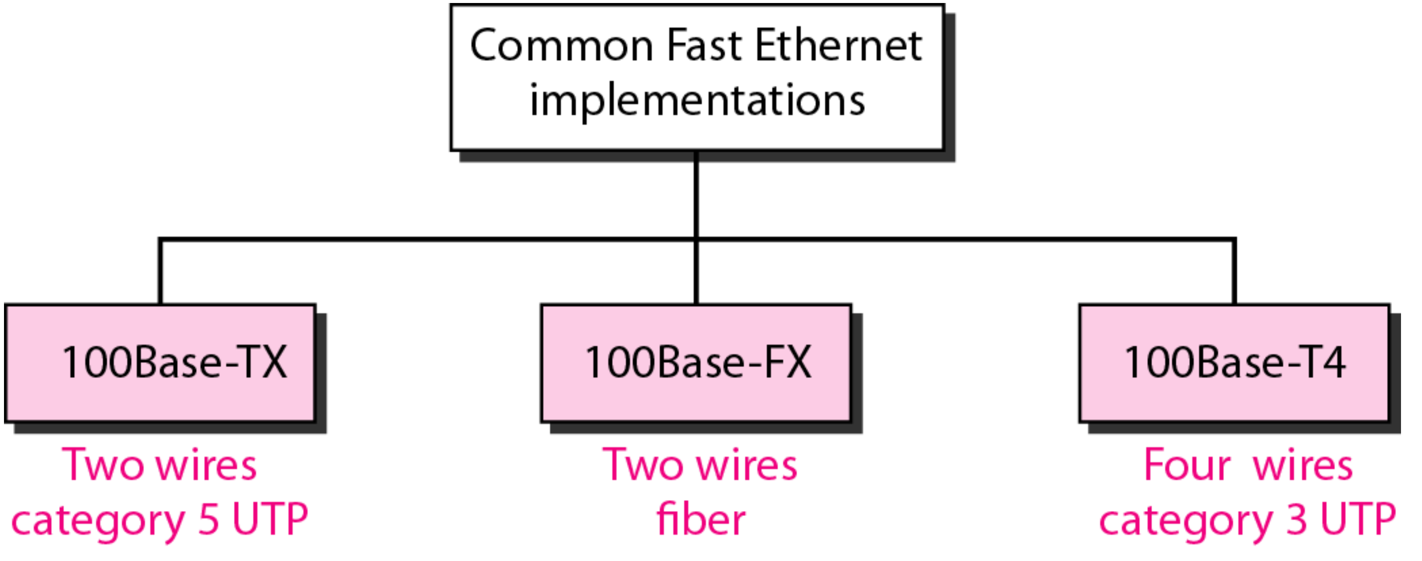
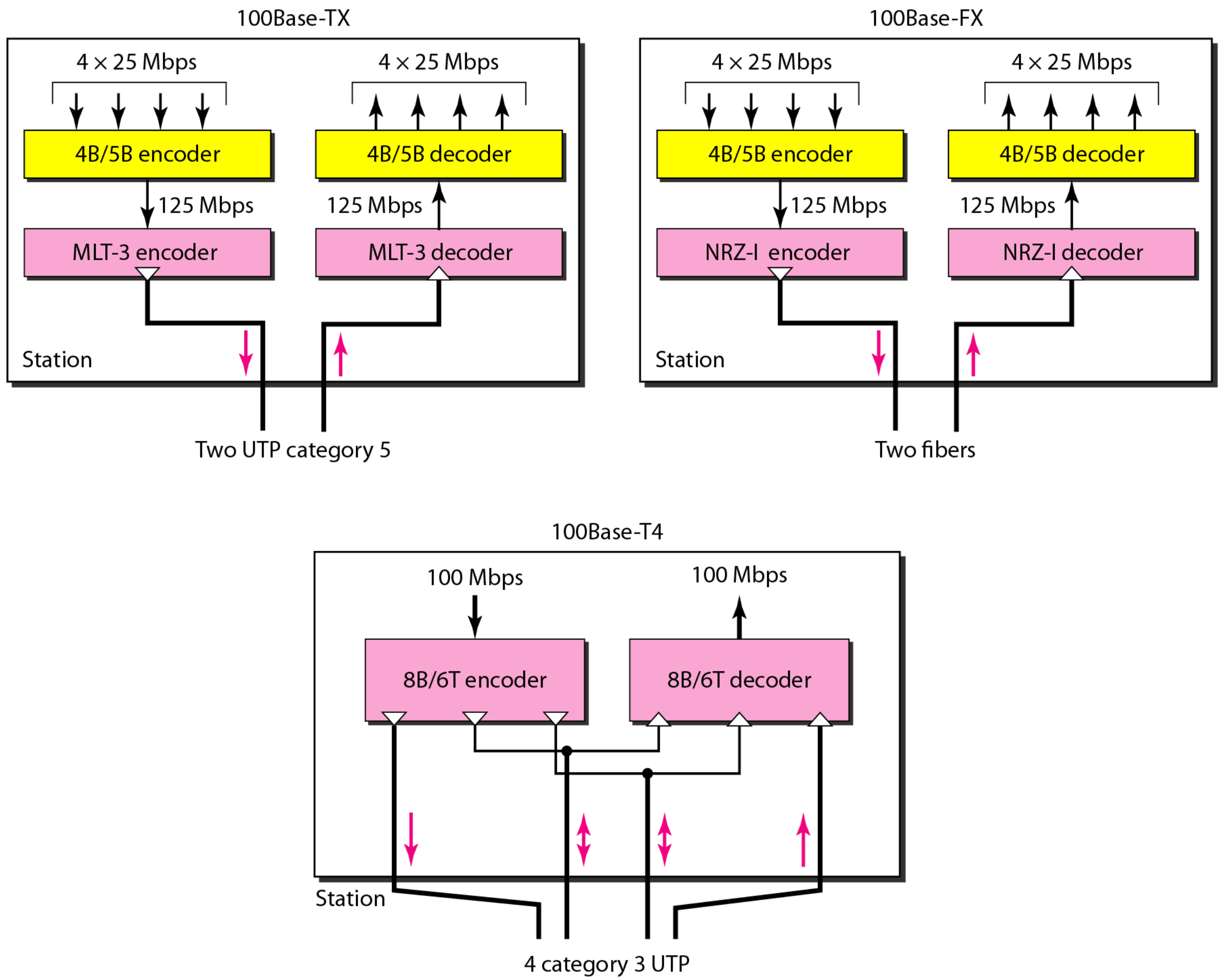


Figure 13.21 *Encoding for Fast Ethernet implementation*



- ✓ (**M**ulti-**L**evel **T**ransmit-**3**) is line encoding scheme.
- ✓ A binary 1 causes the signal to transition to the next voltage level in a cyclic manner
- ✓ A binary 0 causes no transition
- ✓ **4 bit / 5 bit** block encoding scheme
- ✓ Non-Return-to-Zero (**NRZ**) is a line coding
- ✓ **8-bit to 6 ternary** line encoding

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**.

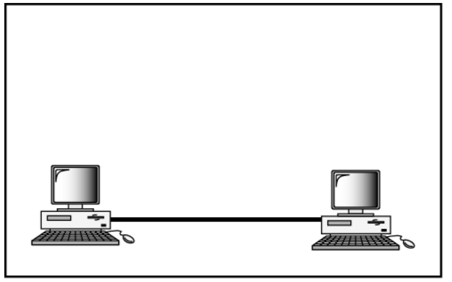
<u>Topics discussed in this section:</u>

MAC Sublayer
Physical Layer
Ten-Gigabit Ethernet

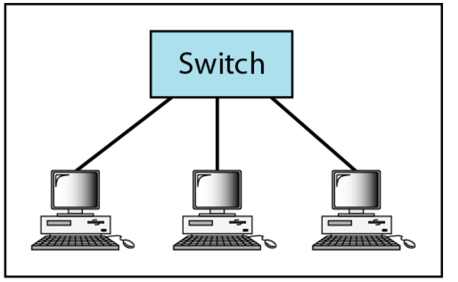
Note

**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.**

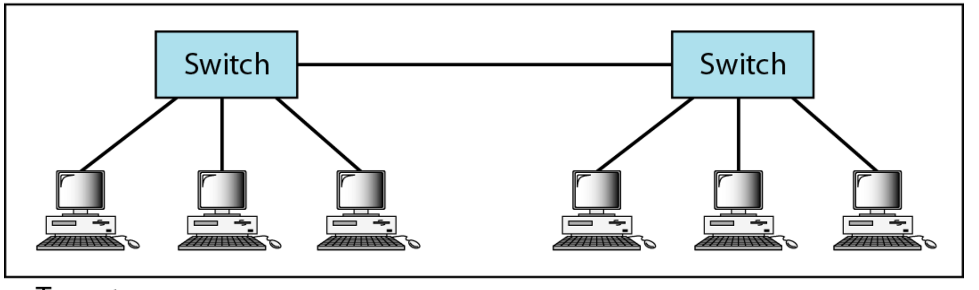
Figure 13.22 *Topologies of Gigabit Ethernet*



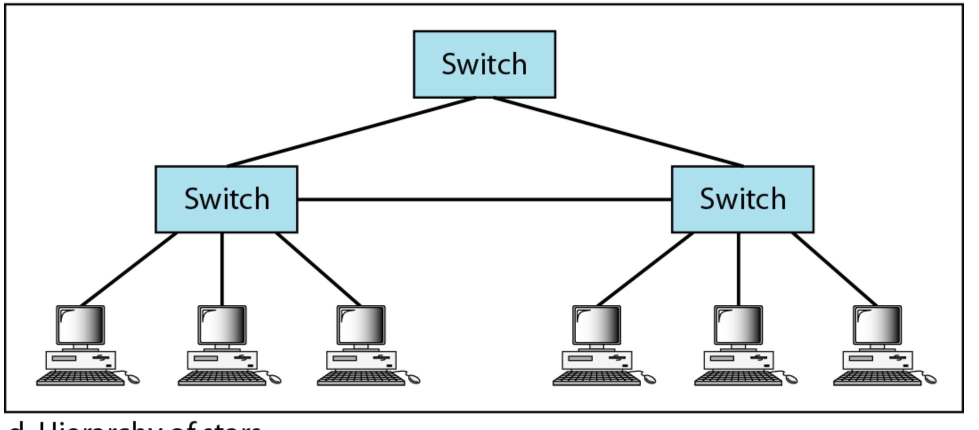
a. Point-to-point



b. Star



c. Two stars



d. Hierarchy of stars

Figure 13.23 *Gigabit Ethernet implementations*

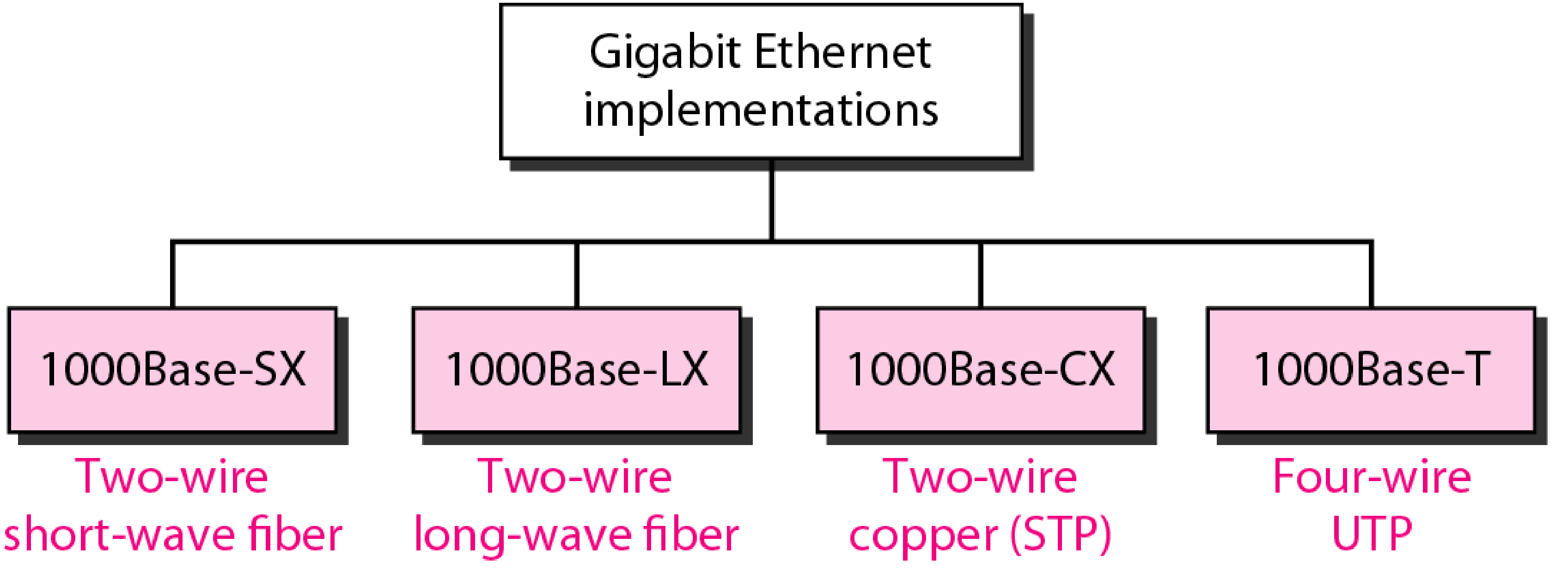


Figure 13.24 *Encoding in Gigabit Ethernet implementations*

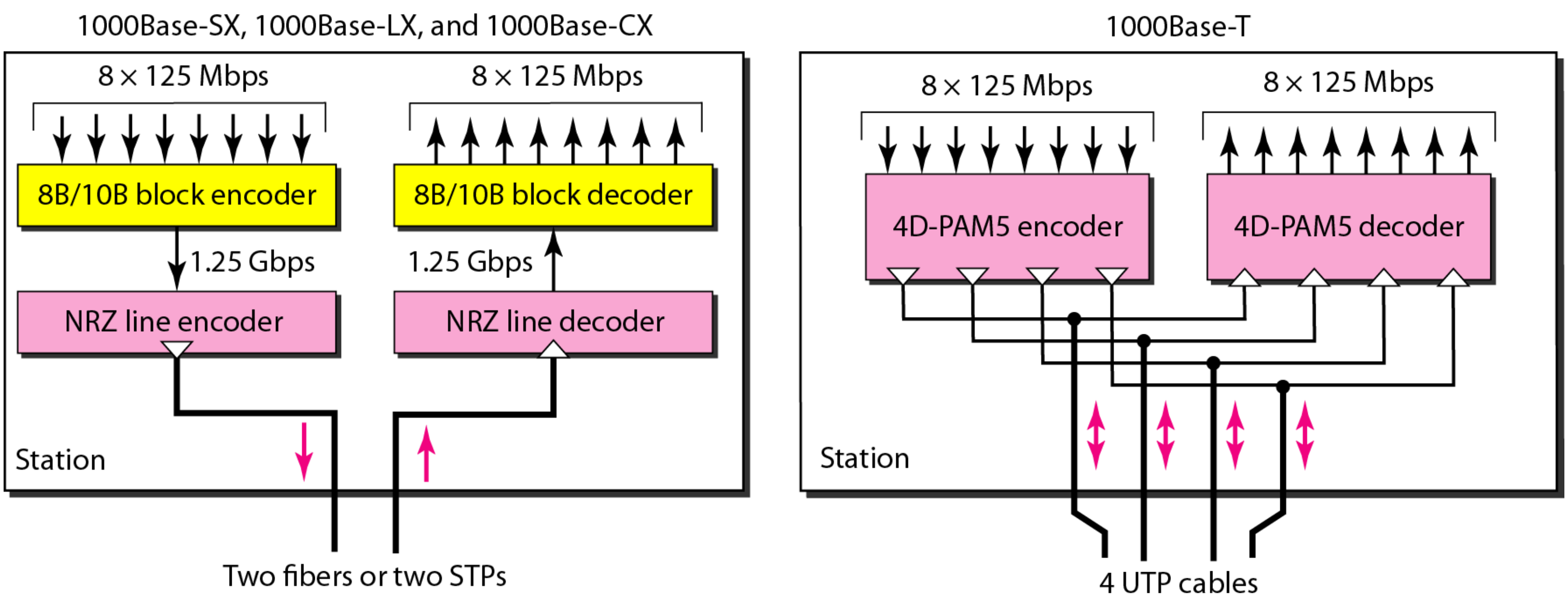


Table 13.3 *Summary of Gigabit Ethernet implementations*

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* (**802.3ae**) *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

Date: 11th- Sept- 2024

Internal Assessment – 4

1. Explain the key components of the **FDDI** network architecture. Describe the dual-ring topology and explain the primary and secondary rings. How does FDDI use the secondary ring in case of a failure?
2. Differentiate between FDDI’s MAC (Media Access Control) and LLC (Logical Link Control) layers. How does FDDI ensure data integrity and reliable transmission across its network?
3. Explain how the token-passing method works in FDDI. Compare this mechanism to Ethernet’s CSMA/CD approach for media access.
4. Describe how FDDI handles data frames, including error detection and correction mechanisms.
5. FDDI was widely used in the 1990s for backbone networks, but has largely been replaced by Gigabit Ethernet and other technologies. What factors contributed to the decline of FDDI in favor of newer standards?

Contd…

Date: 11th- Sept- 2024

Internal Assessment – 4

Submission Guidelines:

1. Write your responses in a 3-5 page document.
2. Include diagrams where necessary, especially for explaining the dual-ring topology and token-passing.
3. Provide the references for your answers, including real-world examples, research papers, or technical sources.

Last Date of submission:

on or before 21st Sept 2024 (mid-night)

How to submit: Use the form

https://forms.gle/pn2kNtGhKDarHQAF7