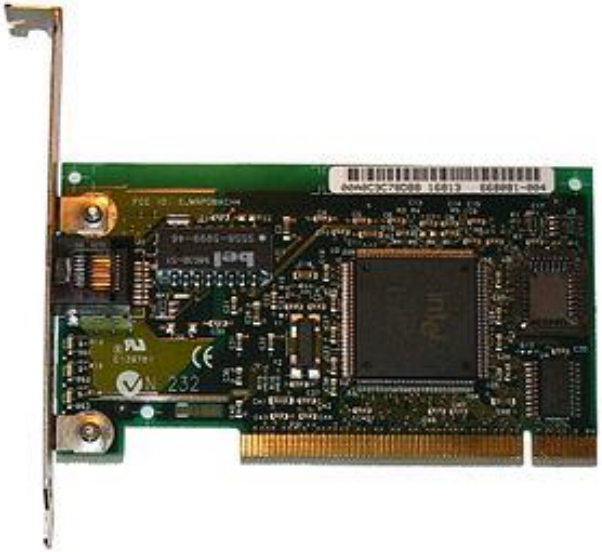
Chapter 13

Wired LANs : Ethernet

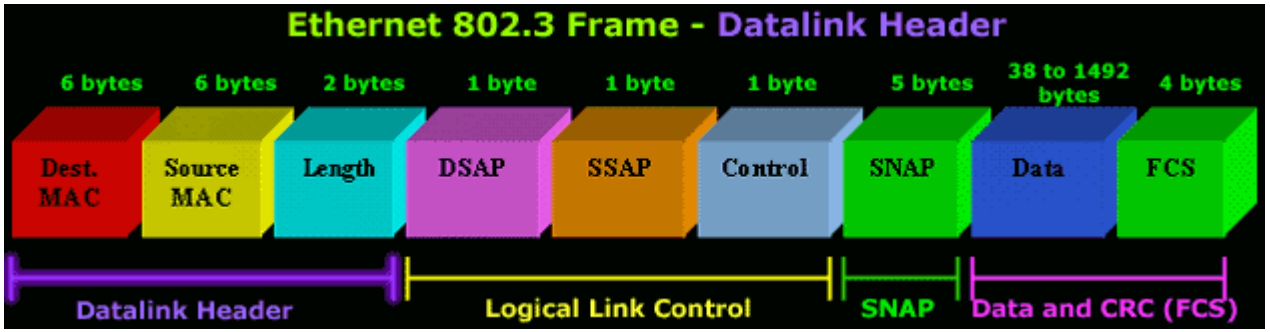
Objetive

- Ethernet protocol: LLC and MAC sub-layers for all LANs including Ethernet.
- Standard Ethernet: CSMA/ CD.
- Fast Ethernet, Gigabit Ethernet and 10 Gigabit Ethernet.



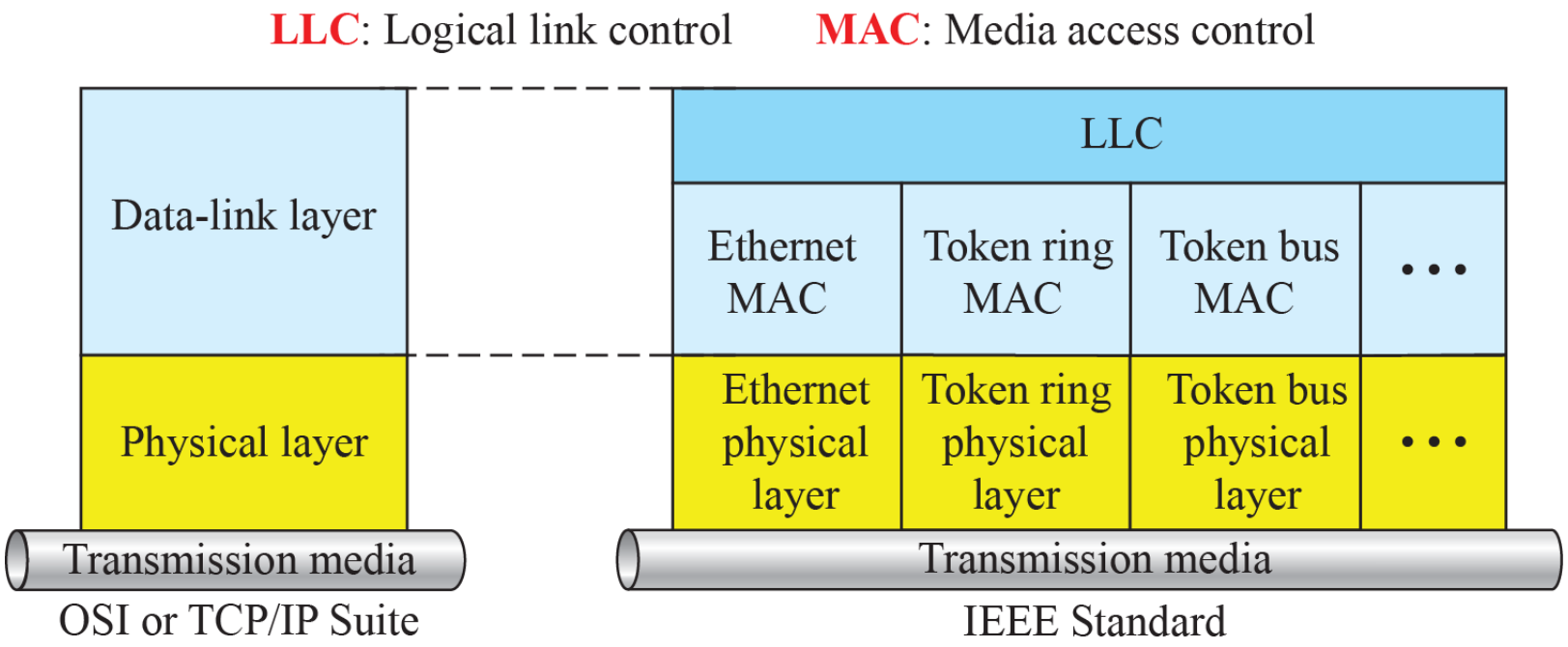
Ethernet Protocol

- The data-link layer and the physical layer are the territory of the local and wide area networks; we are talking about networks that are using them.
- As we see in this and the following two chapters, we can have wired or wireless networks.



IEEE Project 802

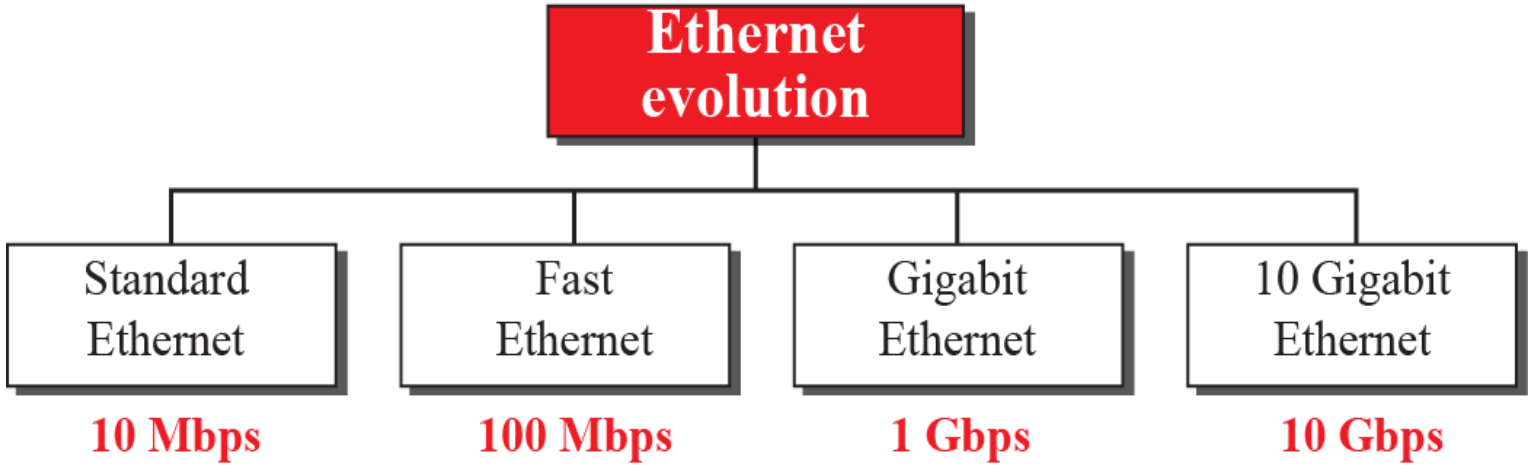
- In 1985, the Computer Society of the IEEE started a project, called **Project 802**, to set standards to enable intercommunication among equipment from a variety of manufacturers.
- Project 802 does not seek to replace any part of the OSI model or TCP/IP protocol suite.
- Instead, it is a way of specifying functions of the physical layer and the data-link layer of major LAN protocols.



IEEE standard for LANs

Ethernet Evolution

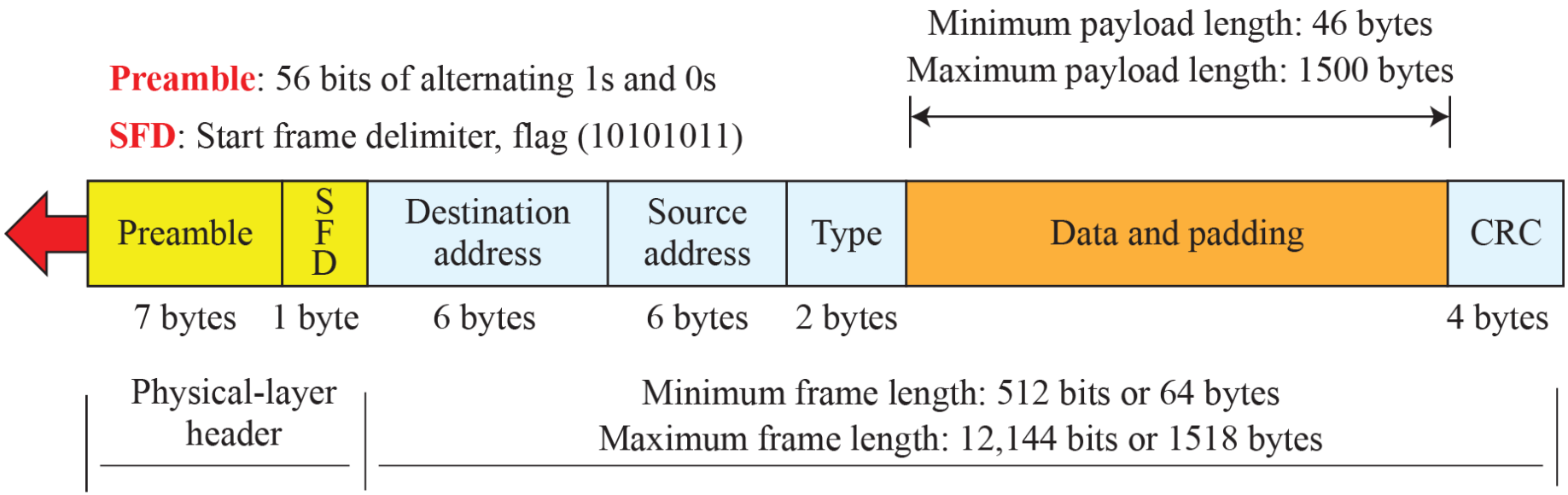
- The Ethernet LAN was developed in the 1970s. Since then, it has gone through four generations: Standard Ethernet (10 Mbps), Fast Ethernet (100 Mbps), Gigabit Ethernet (1 Gbps), and 10 Gigabit Ethernet (10 Gbps).



Ethernet evolution

Standard Ethernet

- We refer to the original Ethernet technology with the data rate of 10 Mbps as the Standard Ethernet.
- Although most implementations have moved to other technologies in the Ethernet evolution, there are some features of the Standard Ethernet that have not changed during the evolution.
- Let us first discuss some characteristics of the Standard Ethernet.



Ethernet frame

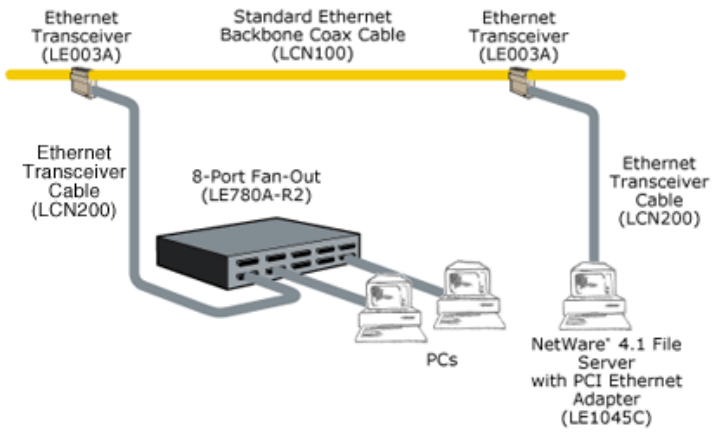
Addressing

- Each station on an Ethernet network (such as a PC, workstation, or printer) has its own network interface card (NIC).
- The NIC fits inside the station and provides the station with a link-layer address. The Ethernet address is 6 bytes (48 bits), normally written in hexadecimal notation, with a colon between the bytes.
- For example, the following shows an Ethernet MAC address:

4A:30:10:21:10:1A

Access Method

- Since the network that uses the standard Ethernet protocol is a broadcast network, we need to use an access method to control access to the sharing medium.
- The standard Ethernet chose CSMA/CD with 1-persistent method.



Efficiency of Standard Ethernet

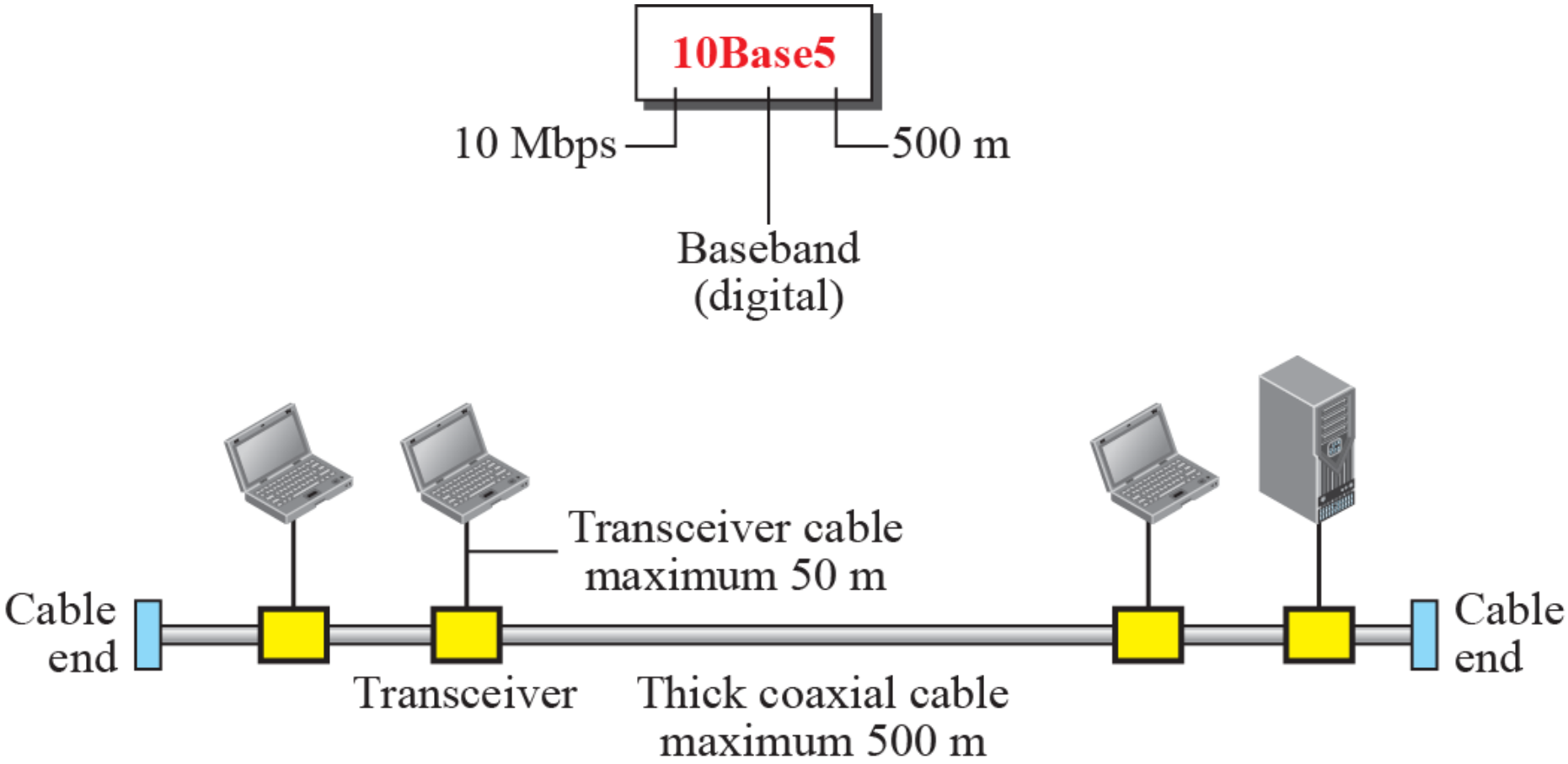
- The efficiency of the Ethernet is defined as the ratio of the time used by a station to send data to the time the medium is occupied by this station.
- The practical efficiency of standard Ethernet has been measured to be

$$\text{Efficiency} = 1 / (1 + 6.4 \times a)$$

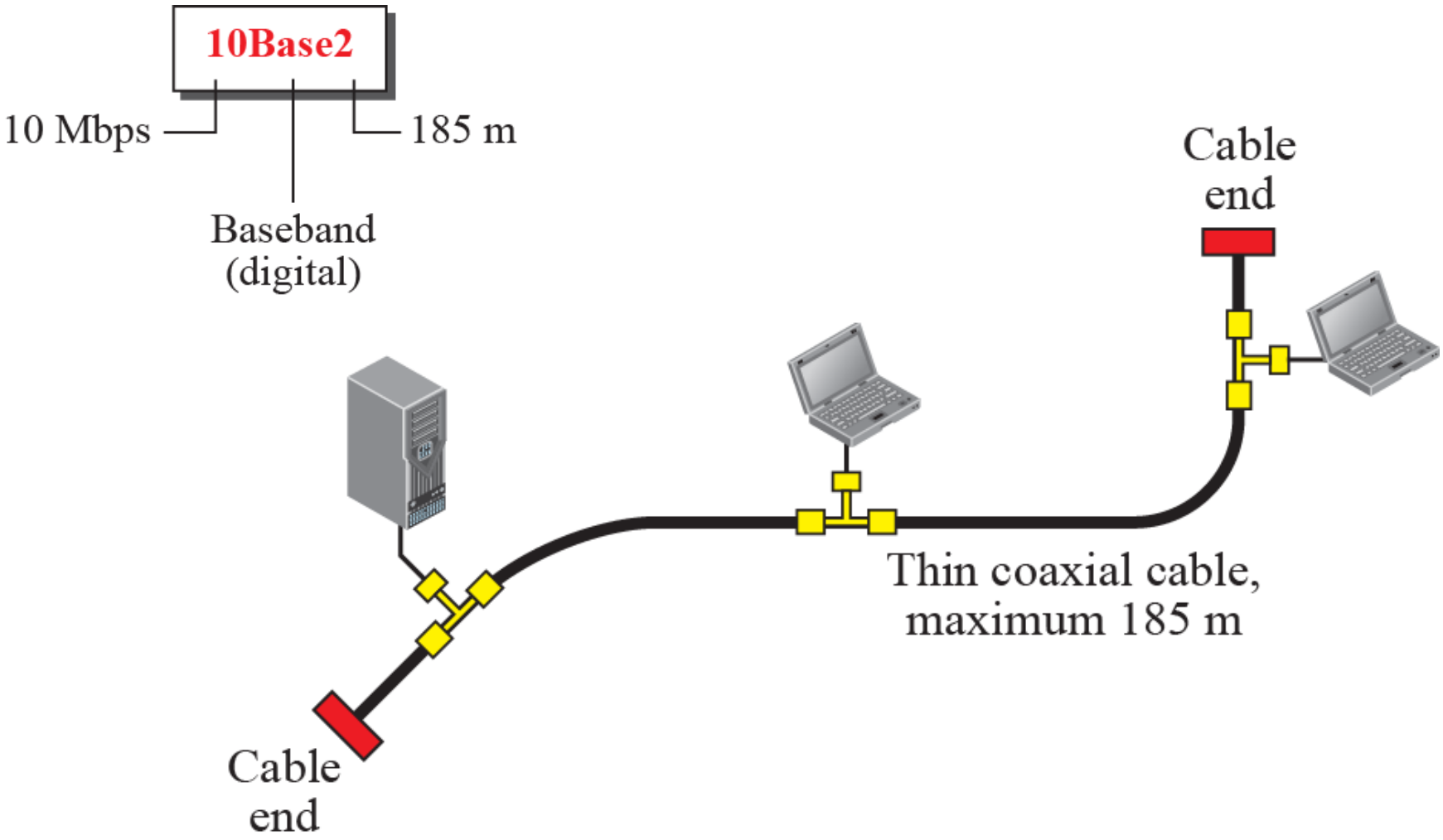
$$\alpha = \frac{propagation\ delay}{transmission\ delay}$$

Ethernet Implementation

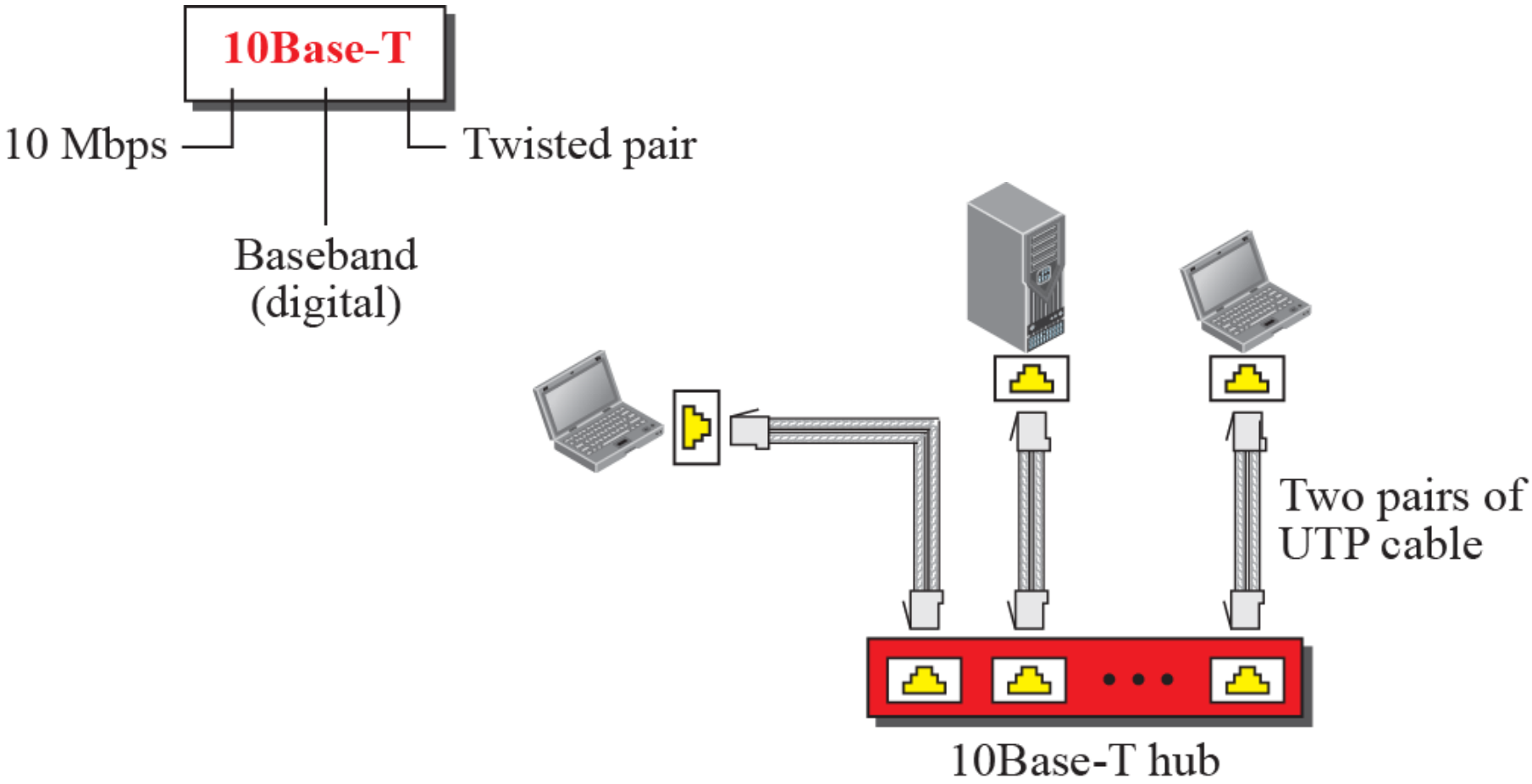
- Standard (Thick) Ethernet (10BASE5)
- Thin Ethernet (ThinNet) (10BASE2)
- Twisted-Pair Ethernet (10BASE-T)
- Fiber Optic Ethernet (10BASE-F)



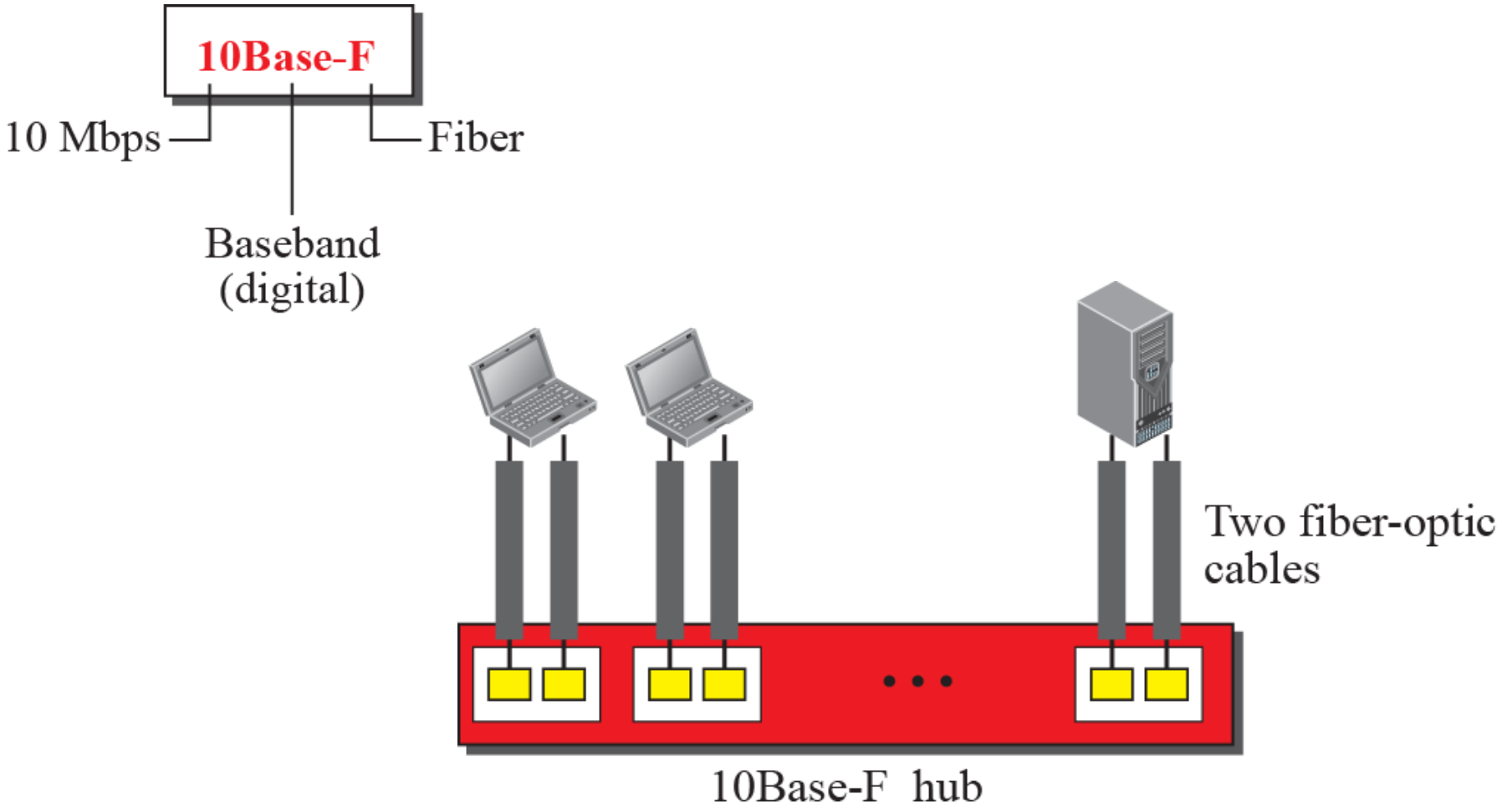
10Base5 implementation



10Base2 implementation

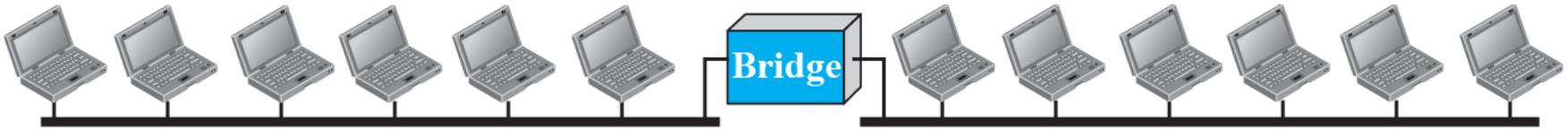


10Base-T implementation



10Base-F implementation

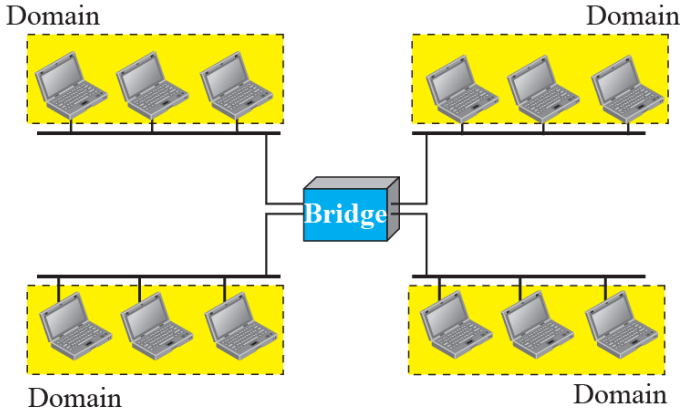
a. Without bridging



b. With bridging

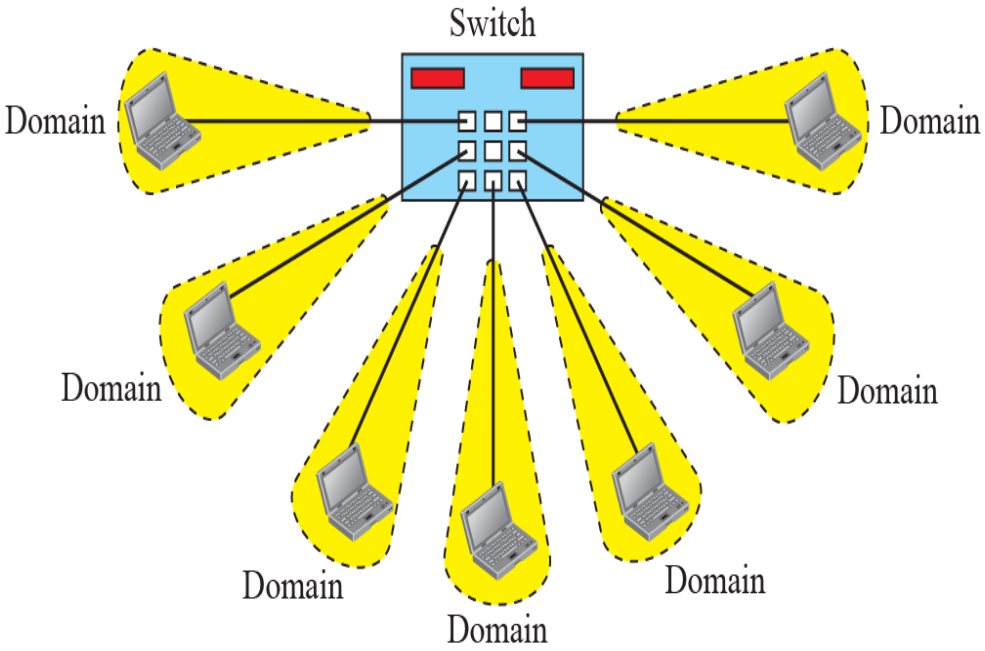
A network with and without bridging

a. Without bridging

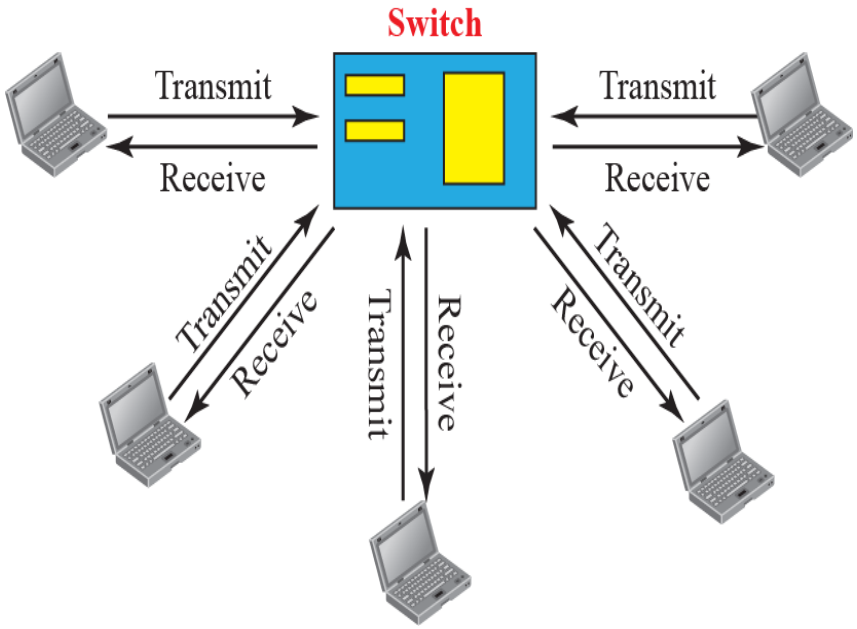


b. With bridging

Collision domains



Switched Ethernet



Full – duplex switched Ethernet

Changes in the Standard

- Before we discuss higher-rate Ethernet protocols, we need to discuss the changes that occurred to the 10-Mbps Standard Ethernet.

- These changes actually opened the road to the evolution of the Ethernet to become compatible with other high-data-rate LANs.

Fast Ethernet

- In the 1990s, Ethernet made a big jump by increasing the transmission rate to 100 Mbps, and the new generation was called the **Fast Ethernet.**
- The designers of the Fast Ethernet needed to make it compatible with the Standard Ethernet.
- The MAC sublayer was left unchanged. But the features of the Standard Ethernet that depend on the transmission rate, had to be changed.

Access Method

- We remember that the proper operation of the CSMA/CD depends on the transmission rate, the minimum size of the frame, and the maximum network length. If we want to keep the minimum size of the frame, the maximum length of the network should be changed.

- In other words, if the minimum frame size is still 512 bits, and it is transmitted 10 times faster, the collision needs to be detected 10 times sooner, which means the maximum length of the network should be 10 times shorter (the propagation speed does not change).

Gigabit Ethernet

- The need for an even higher data rate resulted in the design of the Gigabit Ethernet Protocol (1 Gbps). The IEEE committee calls it the Standard 802.3z.

- The goals of the Gigabit Ethernet were to upgrade the data rate to 1 Gbps, but keep the address length, the frame format, and the maximum and minimum frame length the same.

MAC Sublayer

- A main consideration in the evolution of Ethernet was to keep the MAC sublayer untouched. However, to achieve a data rate of 1 Gbps, this was no longer possible.
- Gigabit Ethernet has two distinctive approaches for medium access: half-duplex and full-duplex.
- Almost all implementations of Gigabit Ethernet follow the **full-duplex approach**, so we mostly ignore the half-duplex mode.

10-Gigabit Ethernet

- In recent years, there has been another look into the Ethernet for use in metropolitan areas.
- The idea is to extend the technology, the data rate, and the coverage distance so that the Ethernet can be used as LAN and MAN (metropolitan area network).
- The IEEE committee created 10 Gigabit Ethernet and called it Standard 802.3ae.

Implementation

- 10 Gigabit Ethernet operates only in full-duplex mode, which means there is no need for contention; CSMA/CD is not used in 10 Gigabit Ethernet.

- Four implementations are the most common: 10GBase-SR, 10GBase-LR, 10GBase-EW, and 10GBase-X4.