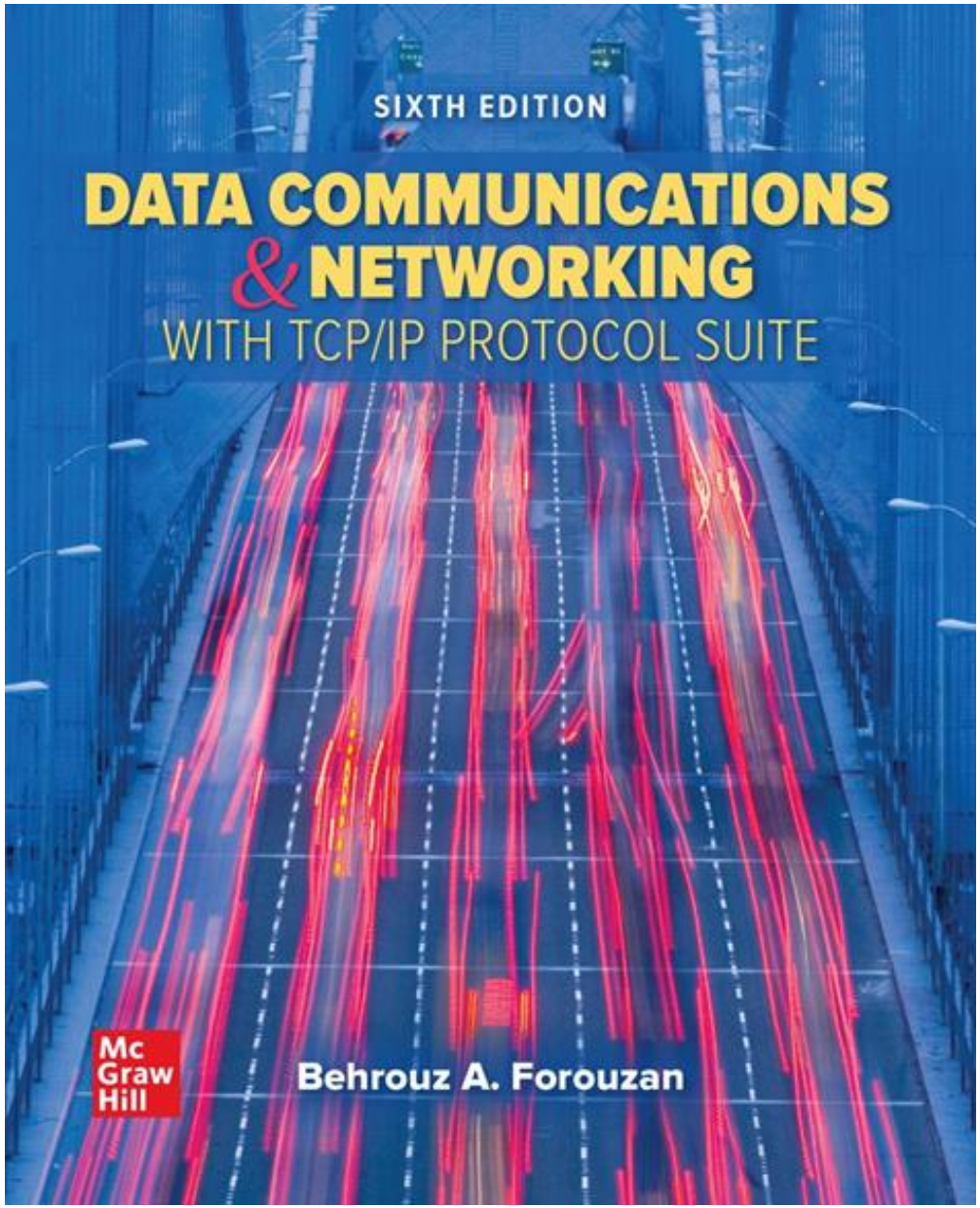
Chapter 04

Local Area Network: LANs

- Data Communications and Networking, With TCP/IP protocol suite Sixth Edition
- Behrouz A. Forouzan



Chapter 4: Outline

- 4.1 ETHERNET

IEEE STANDARDS

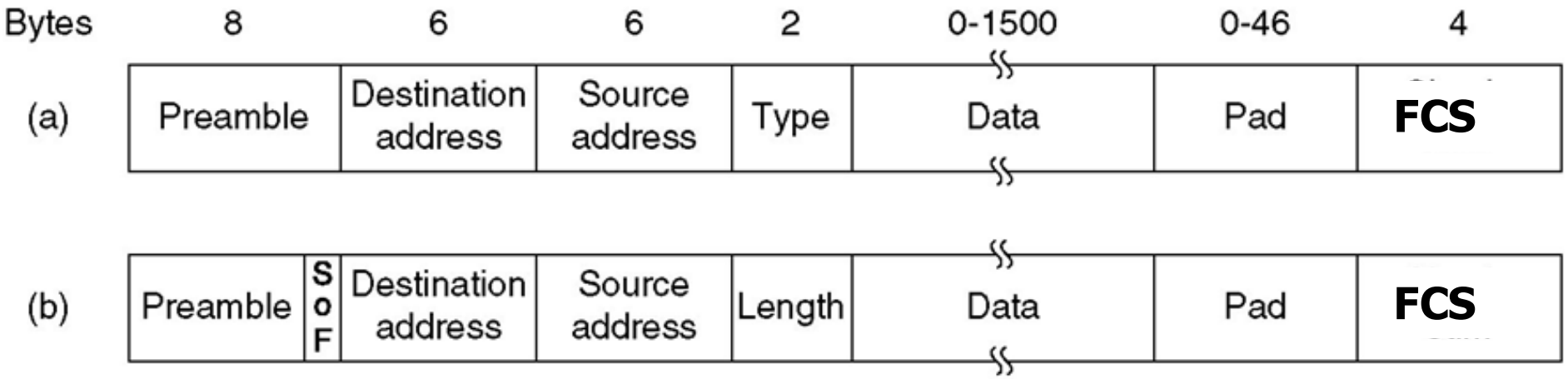
Ethernet: It is a LAN Data link layer protocol that is used in Bus and Star topologies and implements CSMA/CD as the medium access method

- Original (traditional) Ethernet developed in 1980 by three companies: **D**igital, **I**ntel, **X**erox (DIX).

- 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.
  - Current version is called **IEEE Ethernet**

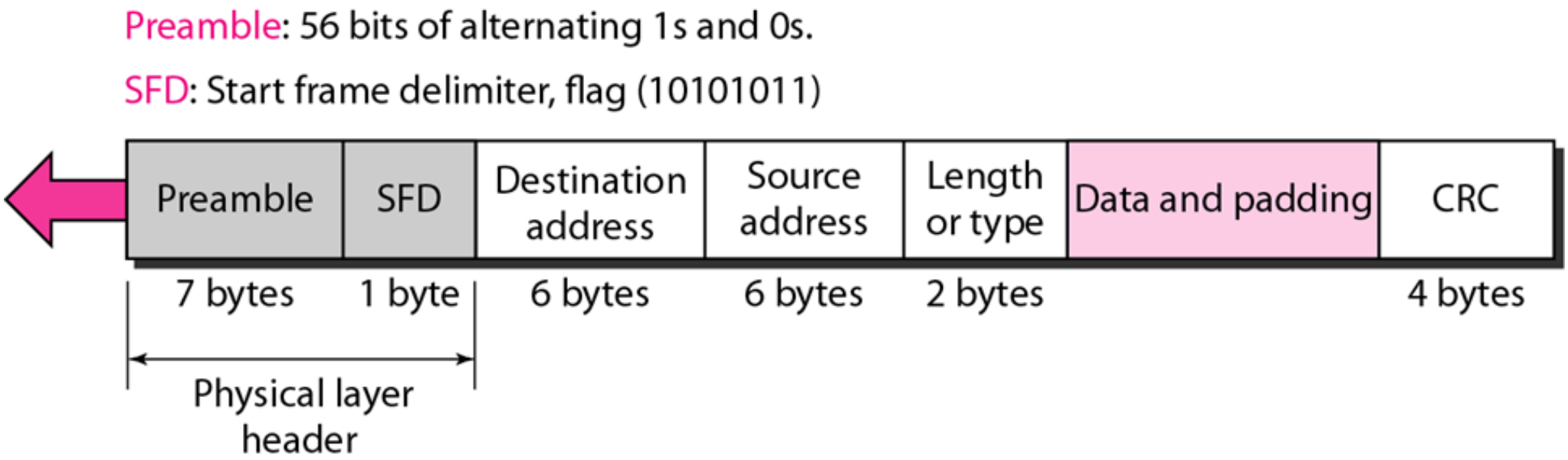
Ethernet

- **Ethernet Frame format**



Frame formats. (a) DIX Ethernet , (b) IEEE 802.3.

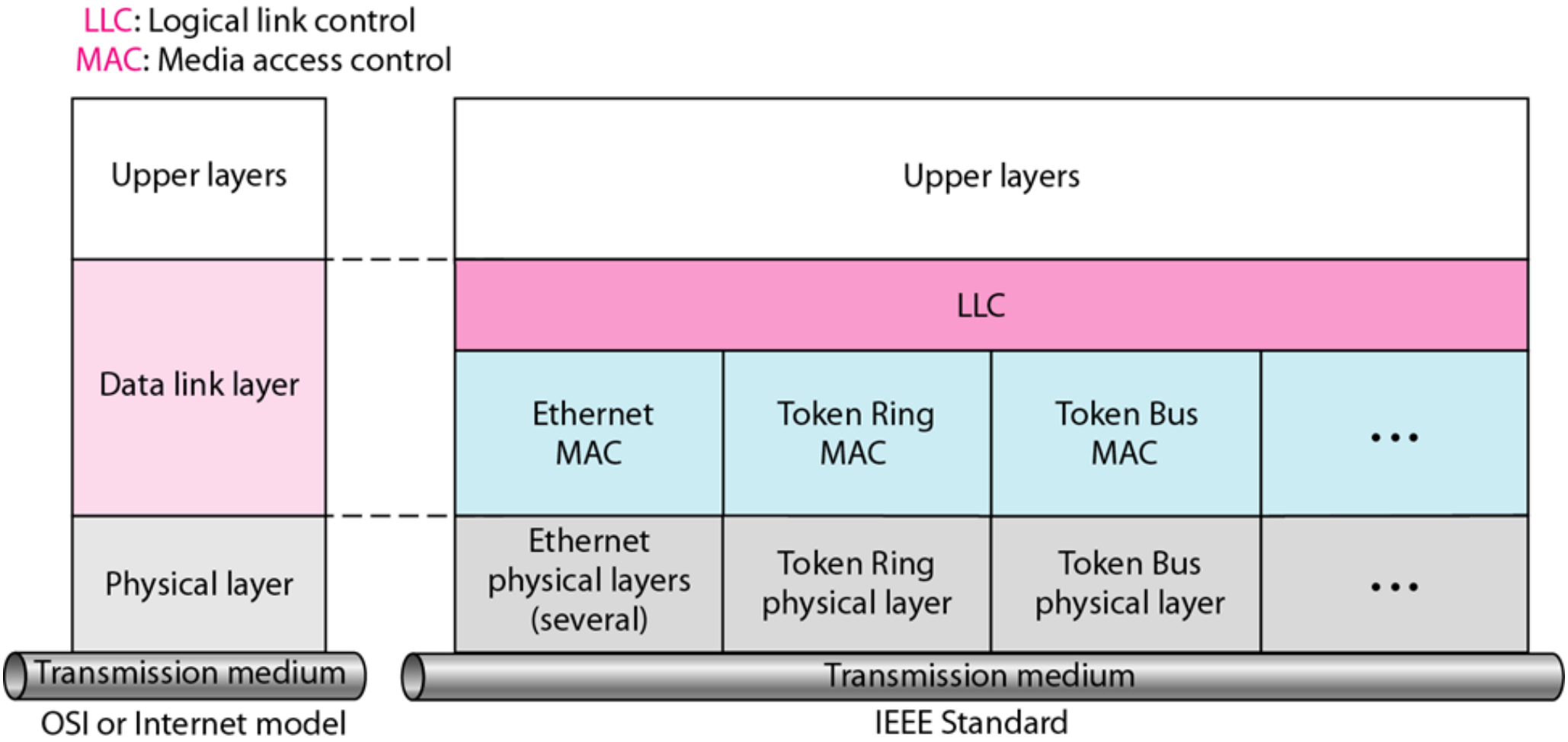
Figure *802.3 MAC frame*



IEEE Ethernet

- In IEEE 802.3 Ethernet Data link layer is split into two sublayers:
  - Bottom part: MAC
    - The subframe is called **IEEE 802.3**
    - Handles part of framing, MAC addressing, Medium Access control
    - **Specific implementation for each LAN p**rotocol
      - Defines **CSMA/CD** as the access method for Ethernet LANs and **Token passing** method for Token Ring.
  - Top part: LLC (Logical Link Control)
    - The subframe is called **IEEE 802.2**
    - Handles another part of Framing
    - Provides **error and flow control** if needed
    - It makes the MAC sublayer transparent
      - Allows interconnectivity between different LANs data link layers

Figure *IEEE standard for LANs*



Ethernet Frame

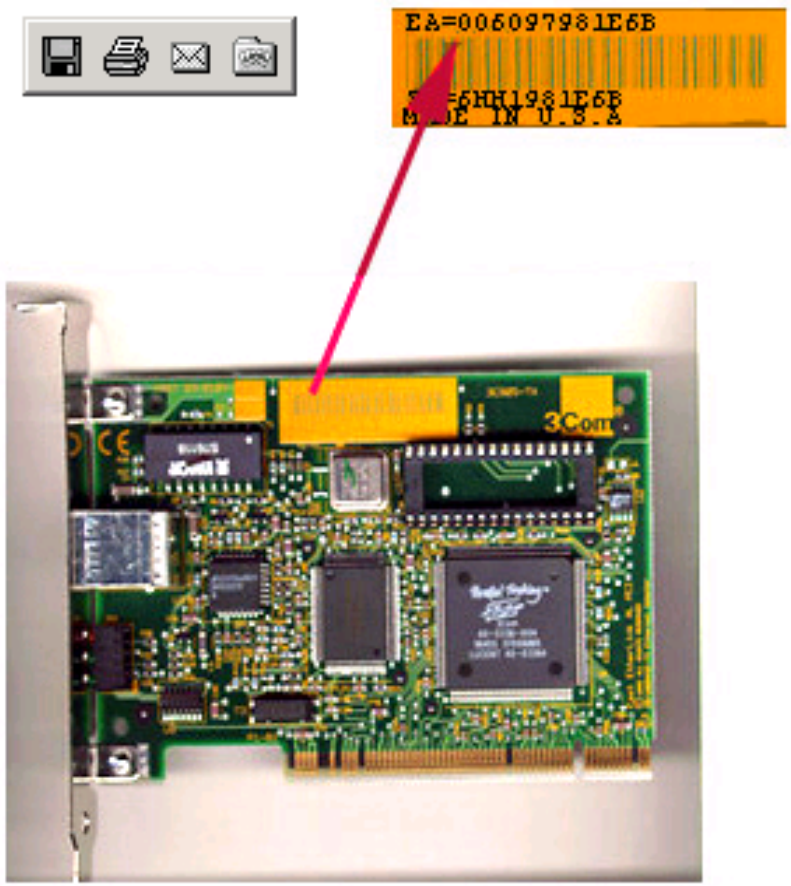
- Preamble:
  - 8 bytes with pattern 10101010 used to synchronize receiver, sender clock rates.
  - In IEEE 802.3, eighth byte is start of frame (10101011)
- Addresses: 6 bytes (explained latter)
- Type (DIX)
  - Indicates the type of the **Network layer protocol** being carried in the **payload (data)** field, **mostly IP** but others may be supported such as IP (**0800**), Novell IPX (**8137**) and AppleTalk (**809B**), ARP (**0806**))
  - Allow **multiple network layer** protocols to be supported on a single machine (multiplexing)
  - Its value starts at **0600h (=1536 in decimal)**
- Length (IEEE 802.3): number of bytes in the **data field**.
  - Maximum 1500 bytes **(= 05DCh)**
- CRC: checked at receiver, if error is detected, the frame is **discarded**
  - CRC-32
- Data: carries data encapsulated from the upper-layer protocols
- Pad: Zeros are added to the data field to make the **minimum data length = 46 bytes**

Ethernet address

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

- Six bytes = 48 bits
- Flat address not hierarchical
- Burned into the NIC ROM
- First three bytes from left specify the vendor. Cisco 00-00-0C, Juniper 00-05-85 and the last 24 bit should be created uniquely by the company
- Destination Address can be:
  - Unicast: second digit from left is even (one recipient)
  - Multicast: Second digit from left is odd (group of stations to receive the frame – conferencing applications)
  - Broadcast (ALL ones) (all stations receive the frame)
- Source address is always Unicast

Ethernet Address for Desktop PC ethernet card



The ethernet address for the above network card is : 006097981E6B

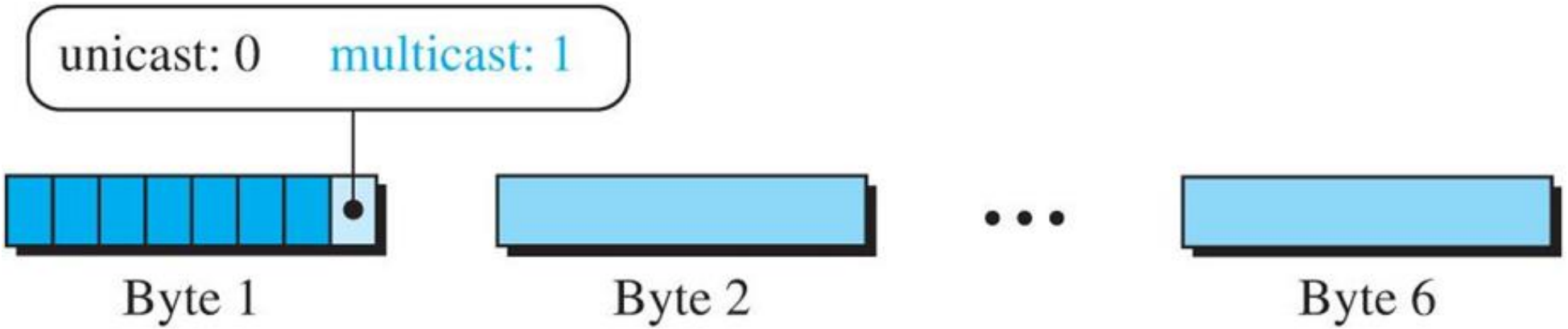
Note

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.

Figure *Unicast and multicast addresses*



Example

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

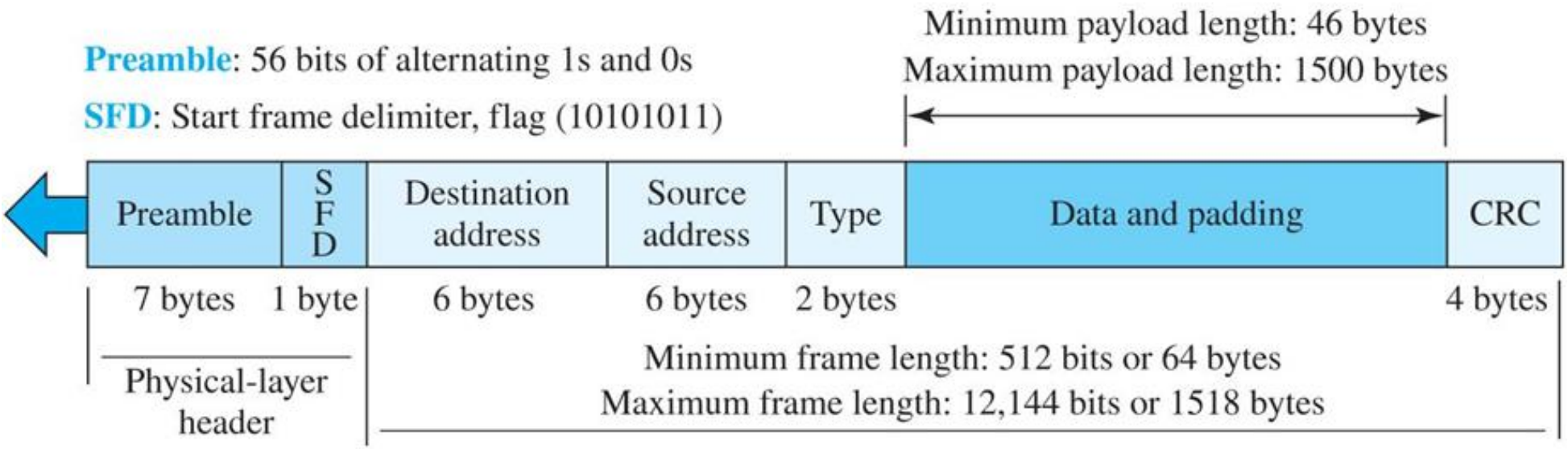
To find the type of the address, we need to look at the second hexadecimal digit from the left. If it is even, the address is unicast. If it is odd, the address is multicast. If all digits are F's, the address is broadcast. Therefore, we have the following:

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.

Figure : Ethernet frame



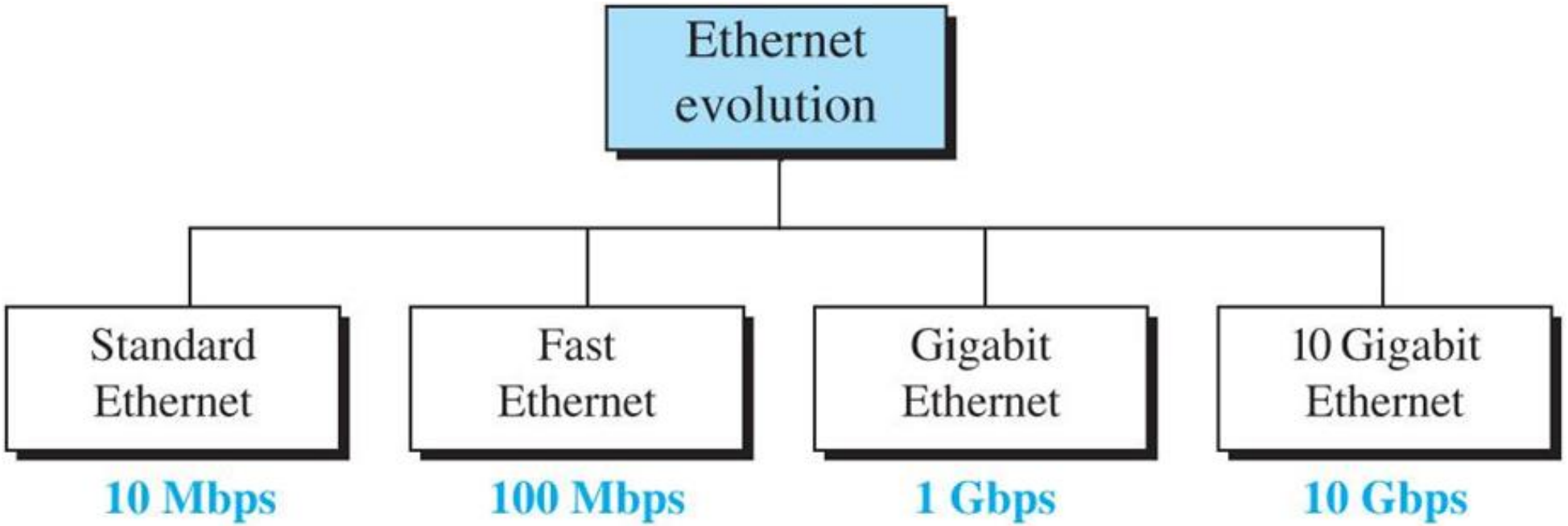
Note

Frame length:

Minimum: 64 bytes (512 bits)

Maximum: 1518 bytes (12,144 bits)

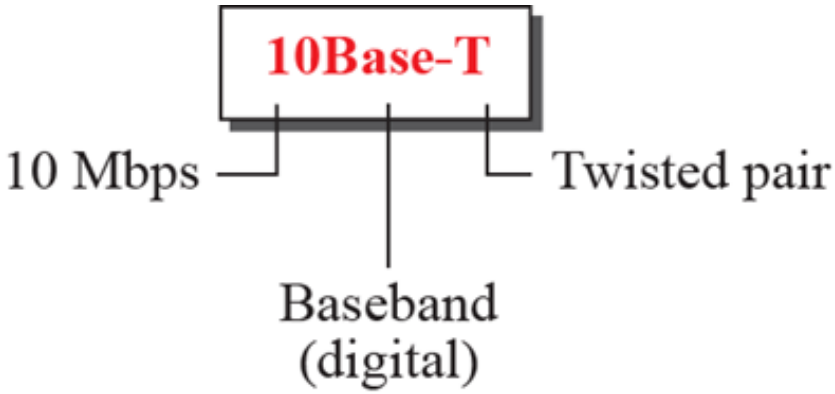
Figure *Ethernet evolution through four generations*



Ethernet Standards

- Fast Ethernet (100 Base T, 100 Base F)
  - Star topology
  - 100 Mbps transmission rate
  - media: twisted pair or fiber optic cable
- Gigabit Ethernet (1000 Base T, 1000 Base F)
  - Star topology
  - 1000 Mbps transmission rate
  - media: twisted pair or fiber optic cable
- 10 Gigabit Ethernet (10gigabit F)
  - Star topology
  - 10000 Mbps transmission rate
  - media: fiber optic cable only

Figure 10Base-T implementation



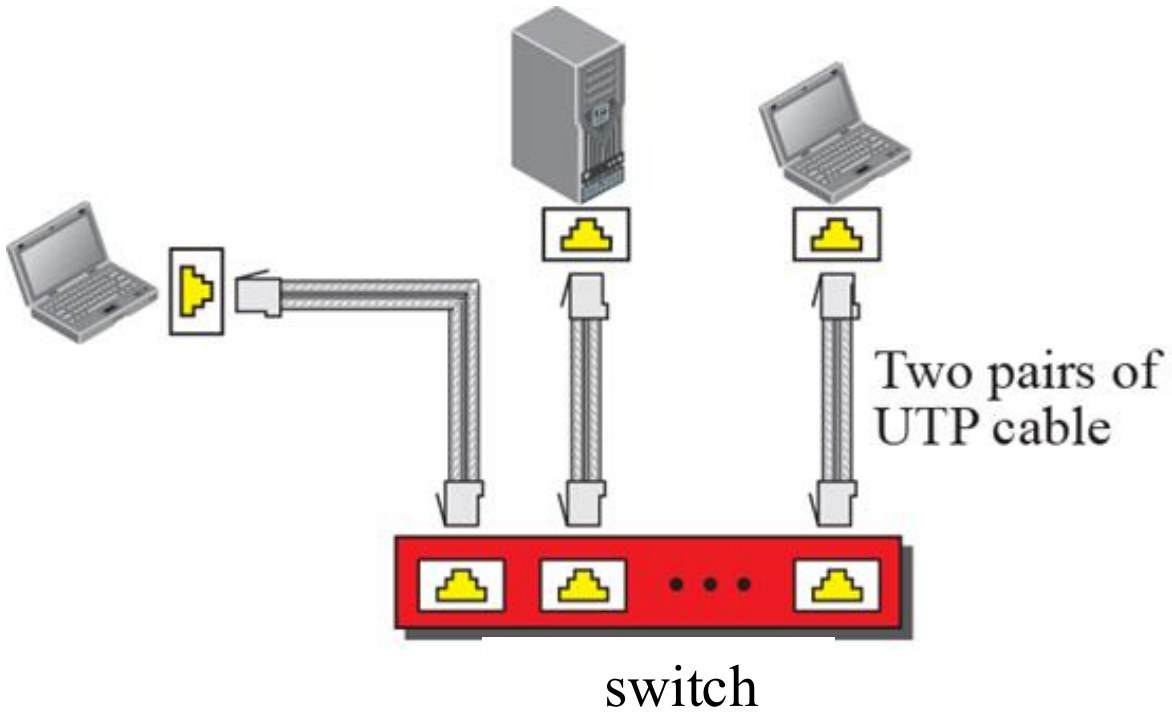


Figure : 10Base-F implementation

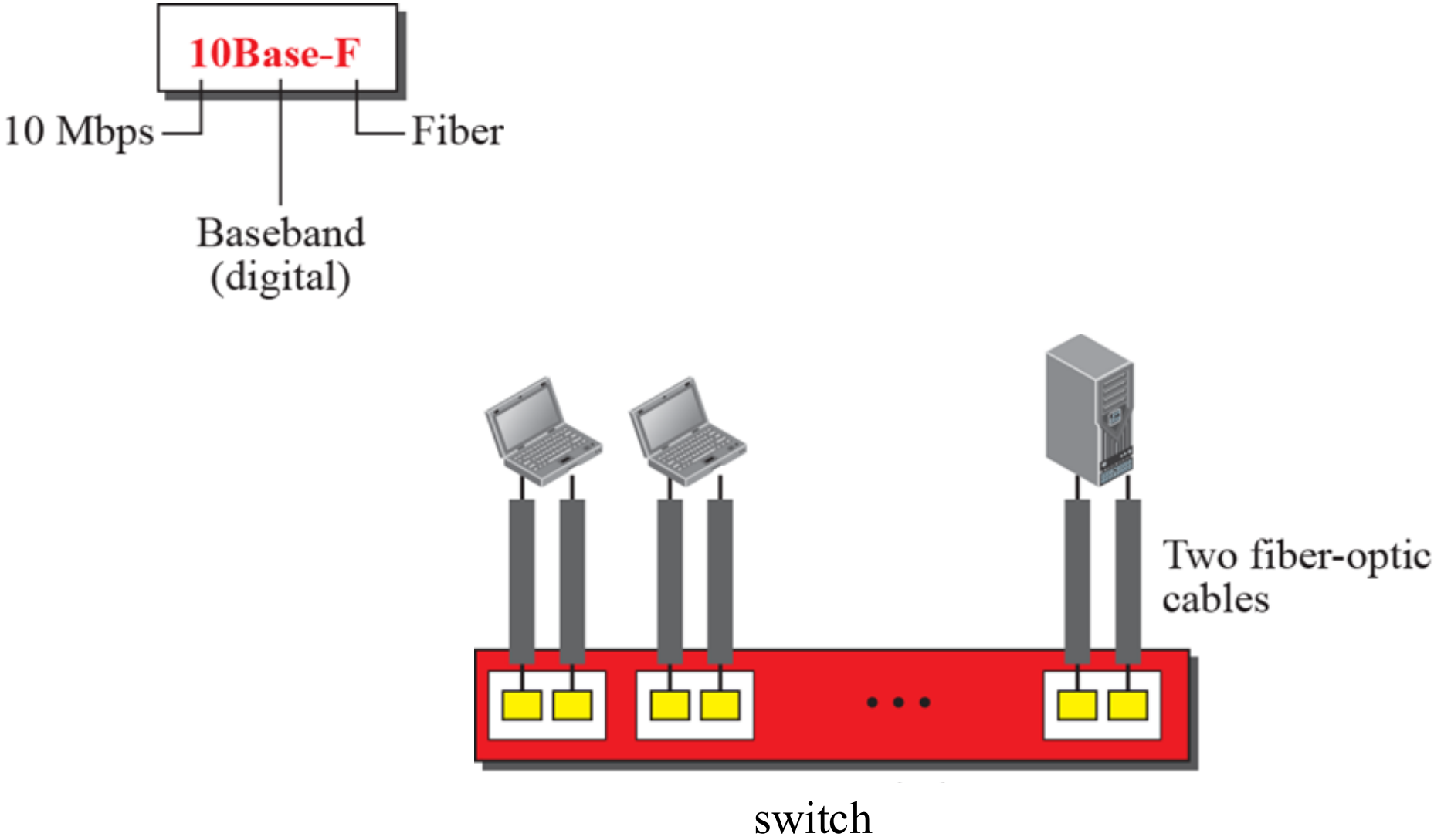


Figure *Fast Ethernet implementations*

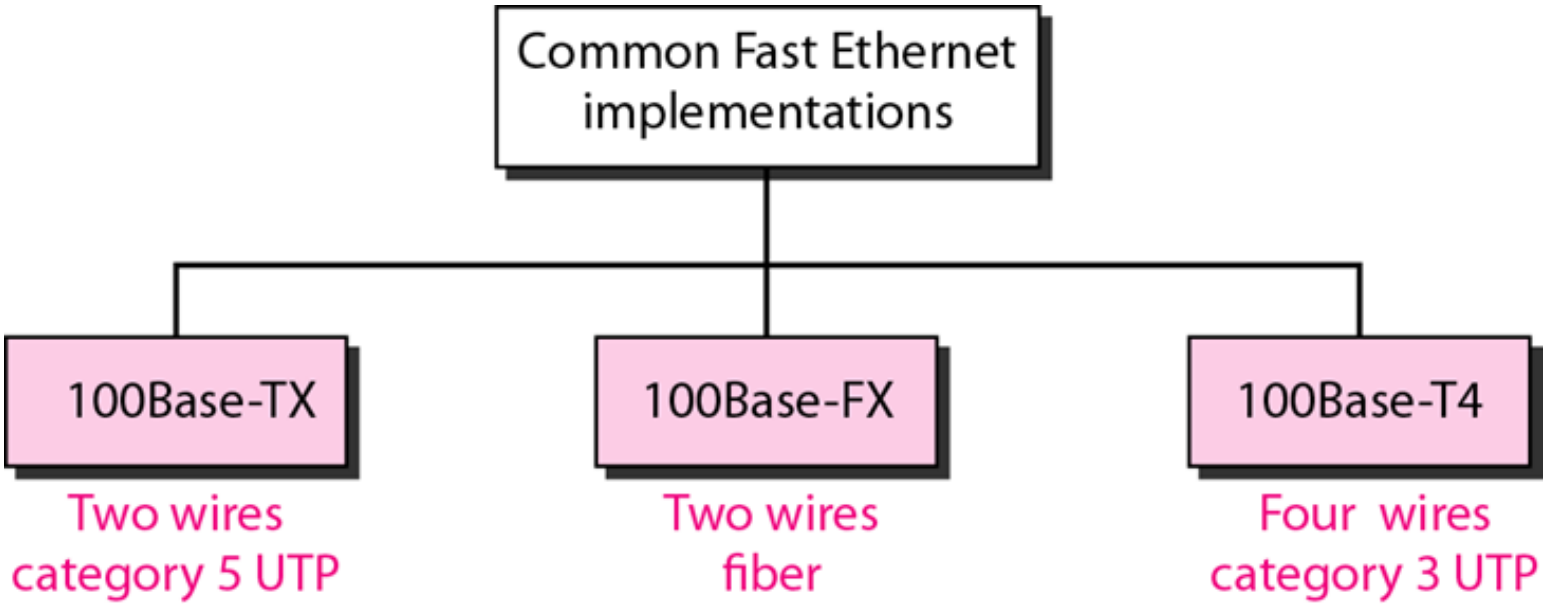
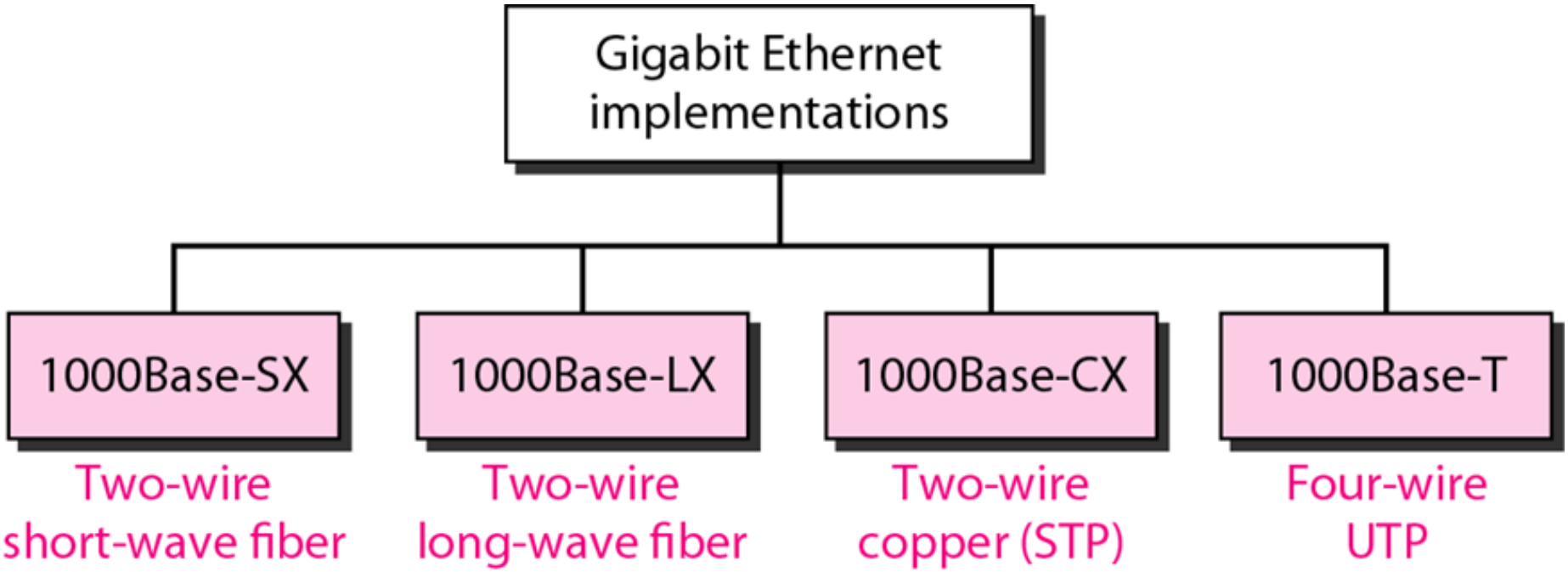


Figure *Gigabit Ethernet implementations*



Full Duplex Operation

- Traditional Ethernet is half duplex because of (CSMA/CD)
  - Either transmit or receive but not both **simultaneously**
- With full-duplex, station can transmit and receive *data* **simultaneously**
- With full duplex, **Throughput** (actual transmission rate) is **doubled**.
  - 100-Mbps Ethernet in full-duplex mode, theoretical transfer rate becomes 200 Mbps
  - 1Gbps Ethernet in full-duplex mode, theoretical transfer rate becomes 2Gbps
- **Changes that should be made with any computer in order to operate in Full-Duplex Mode**
  1) Attached stations must have **full-duplex NIC** cards
  2) Must use **two pairs** of wire one pair for transmitting from host to switch (inbound) and the other pair for transmitting from switch to host (outbound)
  3) Must use **a switch as a central** device **not a hub**
  4) Devices must be connected point-to-point (**dedicated**) to the **switch**
  - Each station constitutes separate collision domain
    - CSMA/CD algorithm **no longer needed (no collision)**

Figure *Full-duplex switched Ethernet*

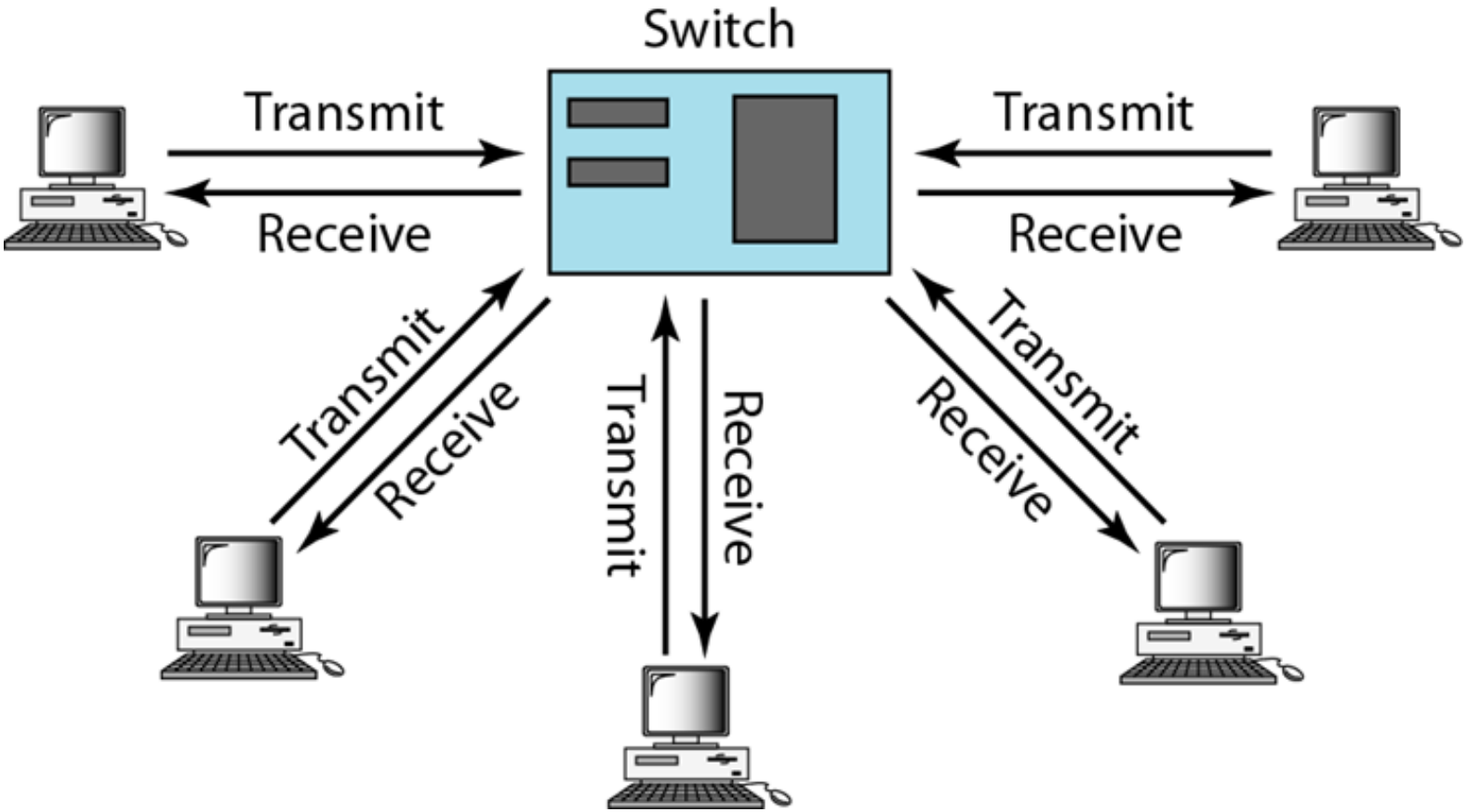


Figure *Switched Ethernet*