CSS2C08

COMPUTER NETWORKS

MODULE 4

1. LINK LAYER SERVICES
2. ERROR DETECTION AND CORRECTION
3. MULTIPLE ACCESS PROTOCOLS
4. LAN ADDRESS
5. ARP
6. ETHERNET
7. HUBS ,BRIDGES and SWITCHES
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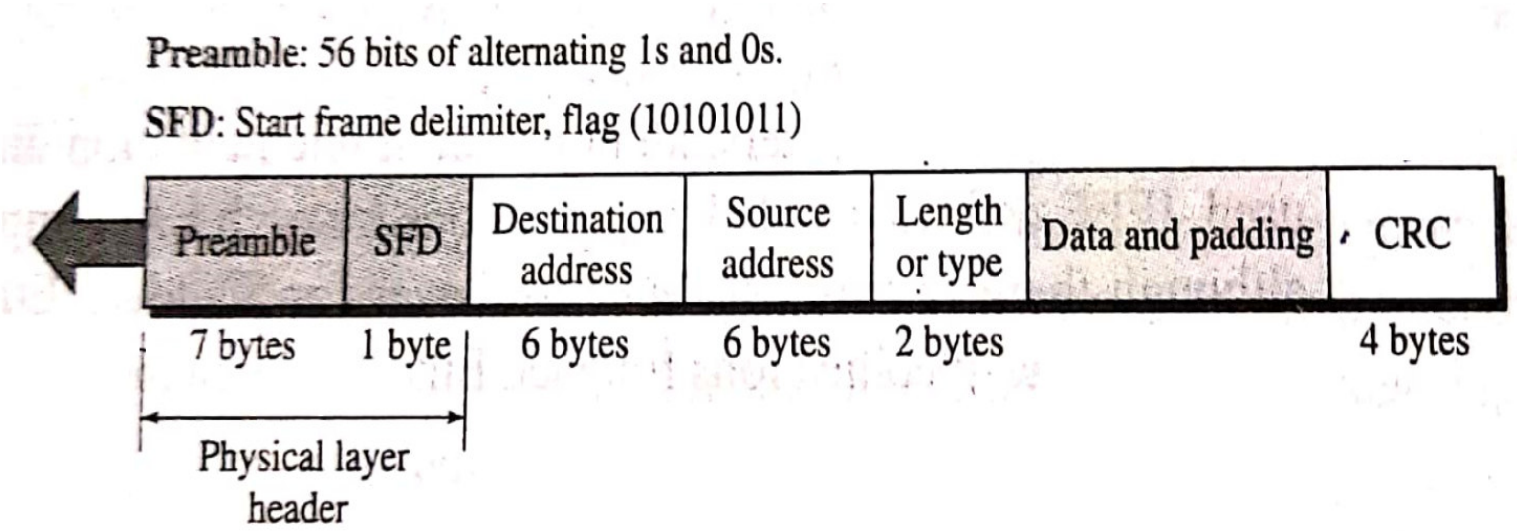
ETHERNET (802.3)

- The original Ethernet was created in 1976 at Xerox's Palo Alto Research Center (PARC). Since then, it has gone through four generations:
  1. Standard Ethernet (10 Mbps)
  2. Fast Ethernet (100 Mbps)
  3. Gigabit Ethernet (1 Gbps)
  4. Ten-Gigabit Ethernet (10 Gbps)

1. Standard Ethernet (10 Mbps)

- In Standard Ethernet, 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.
- **802.3 MAC Frame Format:**



❖ The Ethernet frame contains seven fields:

a) **Preamble:** The first field of the 802.3 frame contains 7 bytes (56 bits) of alternating 0s and 1s that alerts the receiving system to the coming frame and enables it to synchronize its input timing. The pattern provides only an alert and a timing pulse. The 56-bit pattern allows the stations to miss some bits at the beginning of the frame. The preamble is actually added at the physical layer and is not (formally) part of the frame.

b) **SFD(Start frame delimiter):**The second field (l byte: 10101011) signals the beginning of the frame. The SFD warns the station or stations that this is the last chance for synchronization. The last 2 bits is 11 and alerts the receiver that the next field is the destination address.

c) **DA(Destination address):**The DA field is 6 bytes and contains the physical address of the destination station or stations to receive the packet.

d) **SA(Source address):**The SA field is also 6 bytes and contains the physical address of the sender of the packet.

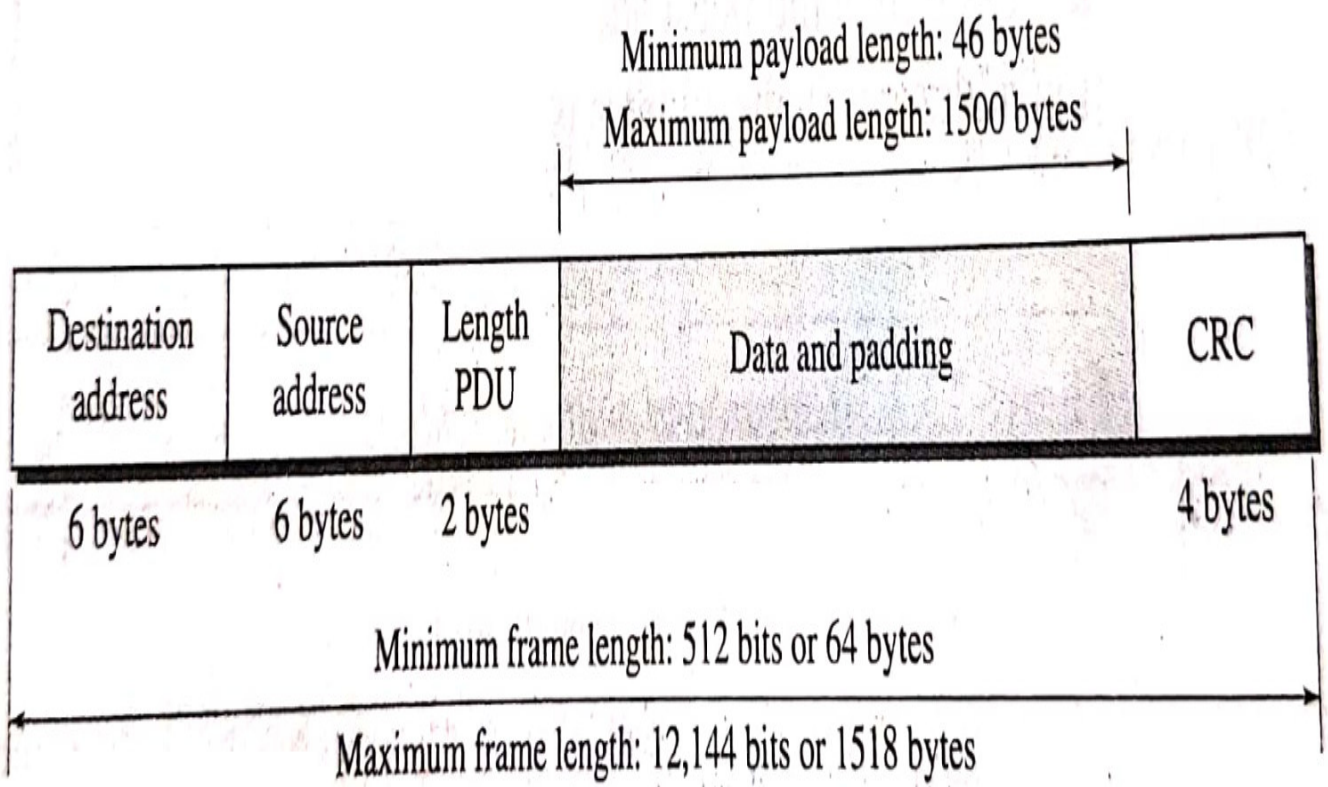
e) **Length or type :**The original Ethernet used this field as the type field to define the upper-layer protocol using the MAC frame. The IEEE standard used it as the length field to define the number of bytes in the data field.

f) **Data:** This field carries data encapsulated from the upper-layer protocols. It is a minimum of 46 and a maximum of 1500 bytes.

g) **CRC :** The last field contains error detection information, in this case a CRC-32

❖ Ethernet does not provide any mechanism for acknowledging received frames, making it what is known as an unreliable medium. Acknowledgments must be implemented at the higher layers.

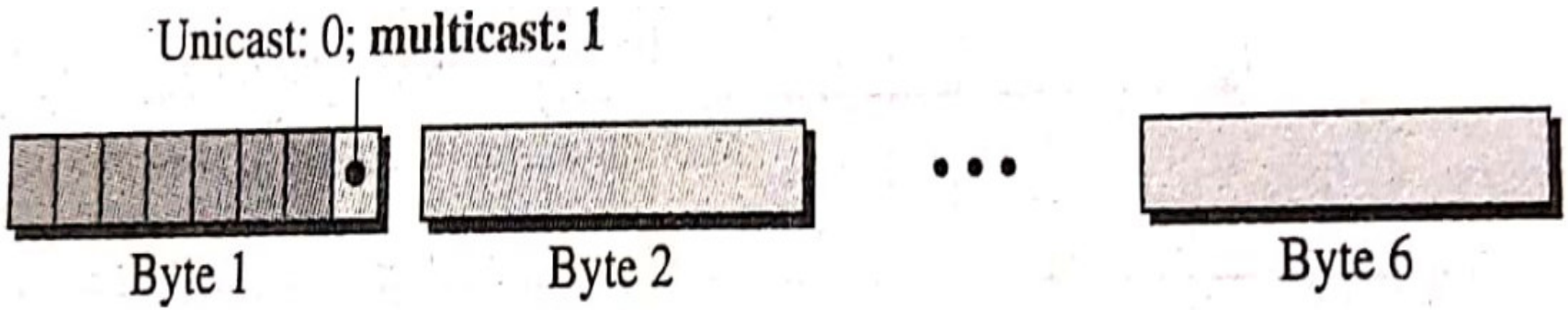
- **Frame Length:**



- An Ethernet frame needs to have a minimum length of 512 bits or 64 bytes. Part of this length is the header and the trailer. If we count 18 bytes of header and trailer, then the minimum length of data from the upper layer is 64 - 18 = 46 bytes. If the upper-layer packet is less than 46 bytes, padding is added to make up the difference.
- The standard defines the maximum length of a frame as 1518 bytes. If we subtract the 18 bytes of header and trailer, the maximum length of the payload is 1500 bytes.

- **Addressing:**
  - Each station on an Ethernet network has its own network interface card (NIC). The NIC fits inside the station and provides the station with a 6-byte physical address. The Ethernet address is 6 bytes (48 bits), nominally written in hexadecimal notation, with a colon between the bytes.
  - Example:06:01:02:01:2C:4B(6bytes=12 hex digits=48 bits)
  - A source address is always a unicast address-the frame comes from only one station.
  - The destination address, can be unicast, multicast, or broadcast.

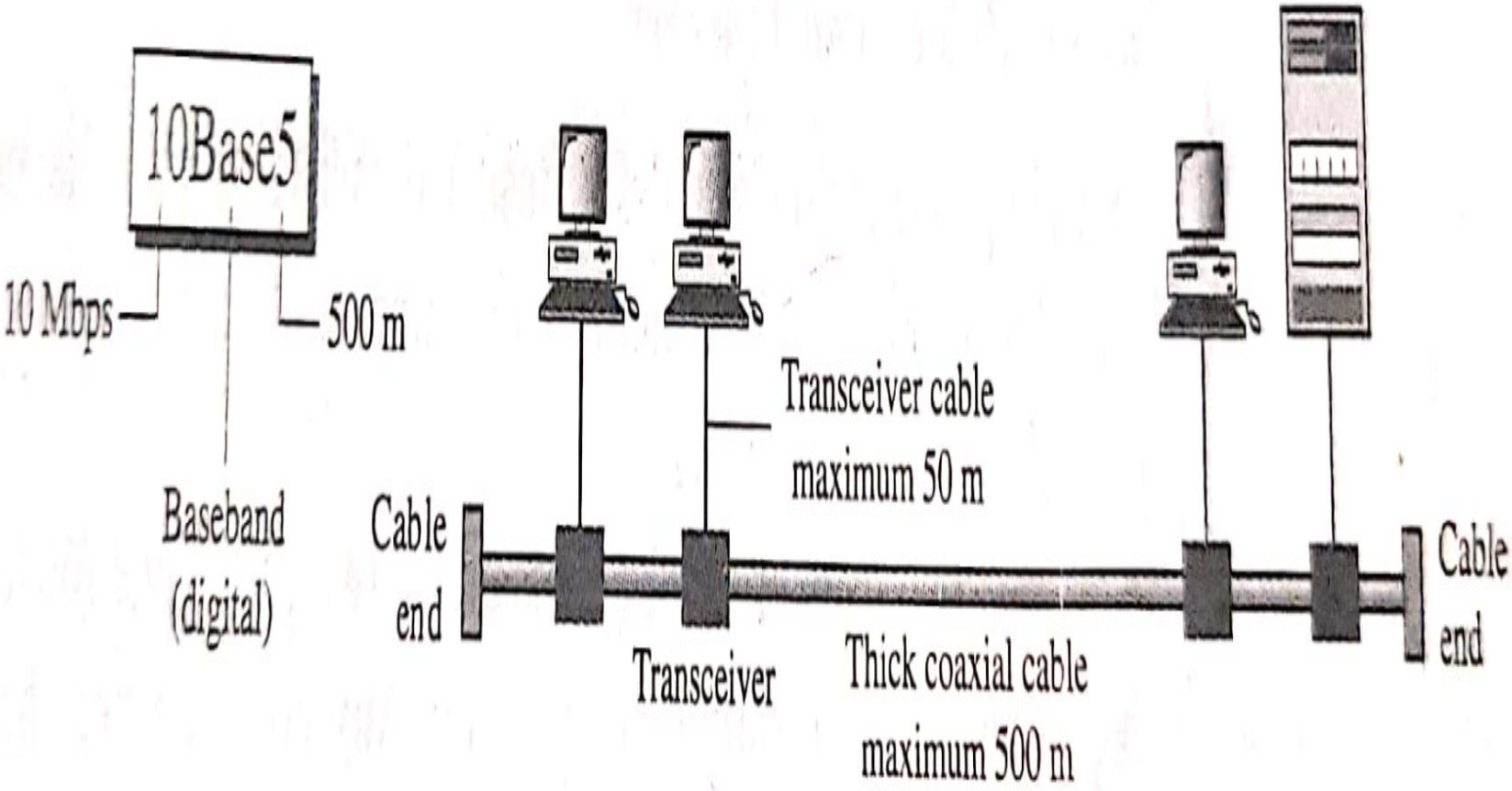
- If the least significant bit of the first byte in a destination address is 0, the address is unicast; otherwise, it is multicast. The broadcast address is a special case of the multicast address; the recipients are all the stations on the LAN. A broadcast destination address is forty-eight 1s.



- **Categories of Standard Ethernet:**

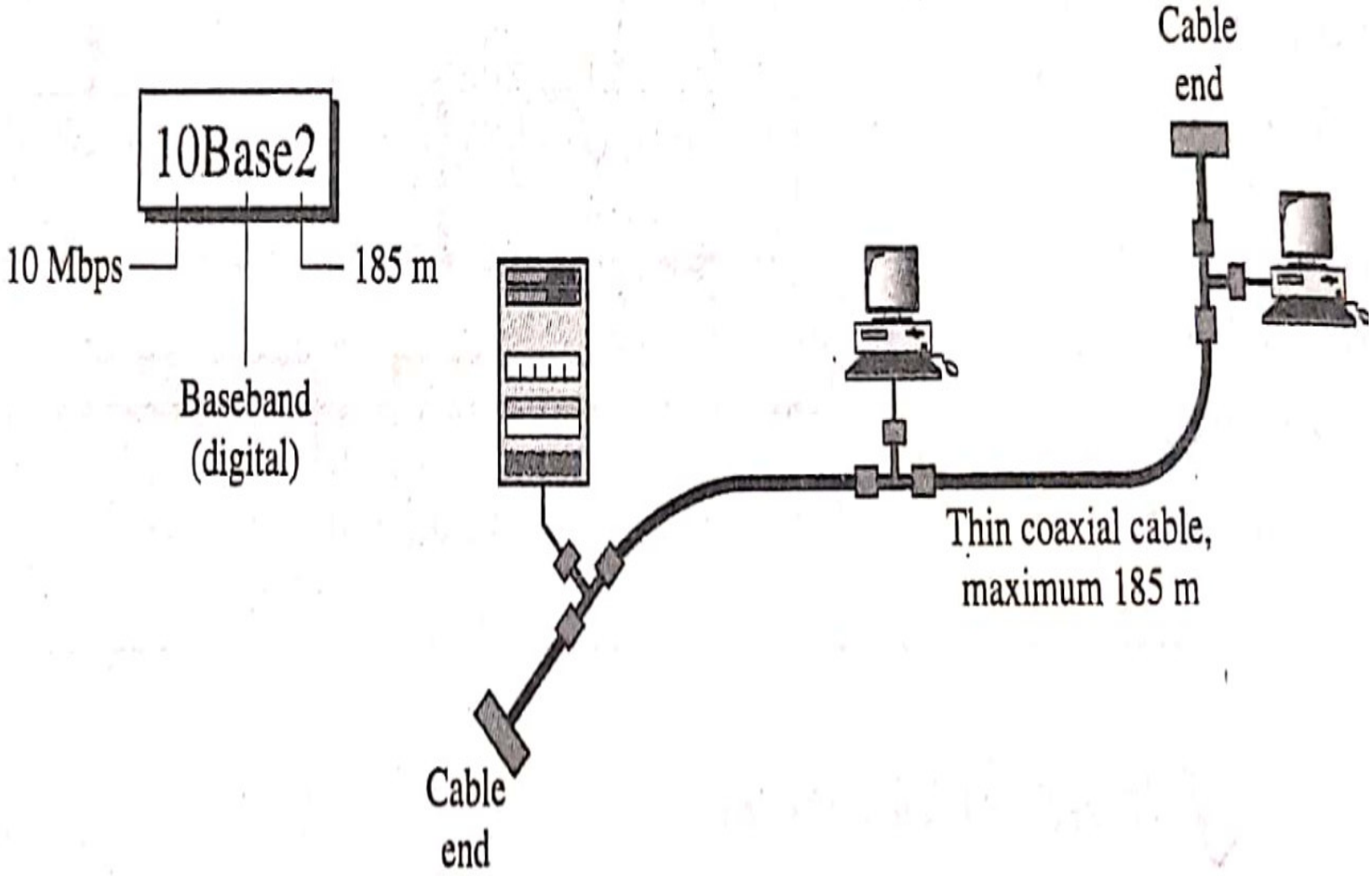
1. **10Base 5:Thick Ethernet**

   - The first implementation is called 10Base5, thick Ethernet, or Thicknet.
   - 10Base5 was the first Ethernet specification to use a bus topology with an external transceiver (transmitter/receiver) connected via a tap to a thick coaxial cable.
   - The transceiver is responsible for transmitting, receiving, and detecting collisions. The transceiver is connected to the station via a transceiver cable that provides separate paths for sending and receiving. The maximum length of the coaxial cable must not exceed 500 m.


10Base5
10 Mbps
500 m
Baseband
(digital)
Transceiver cable
maximum 50 m
Cable
end
Transceiver
Thick coaxial cable
maximum 500 m
Cable
end

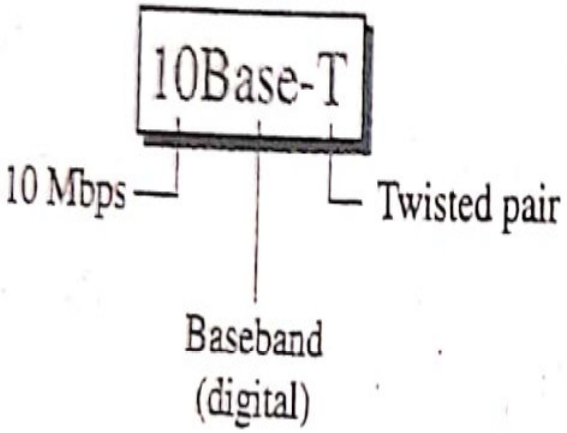
2. 10Base2:Thin Ethernet

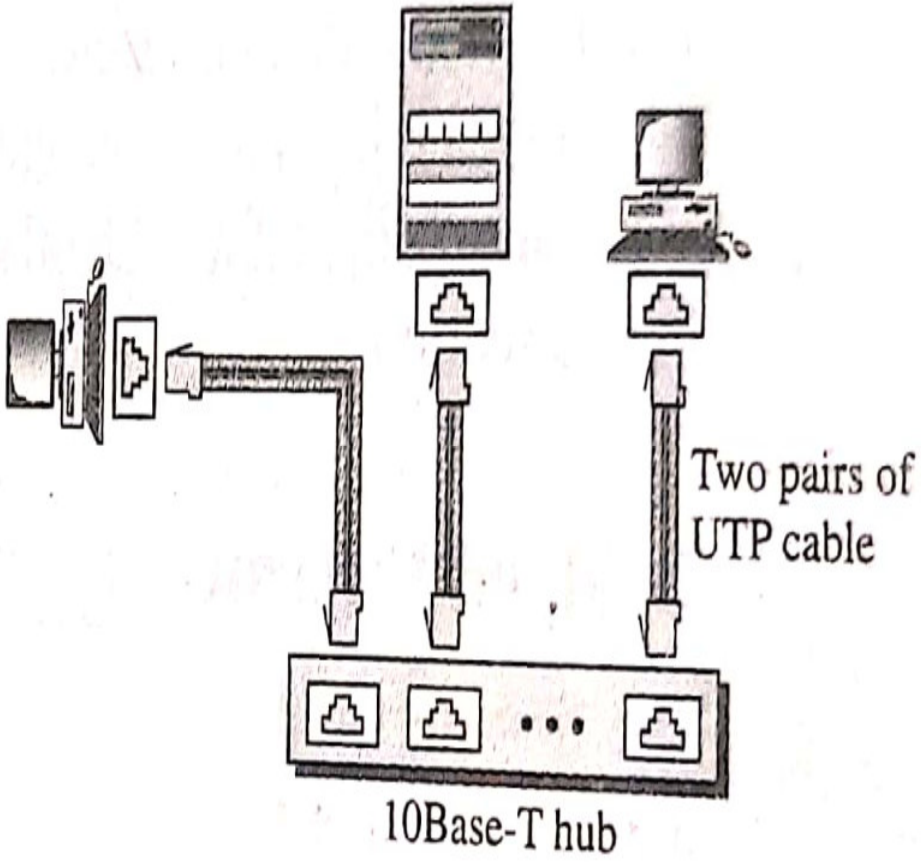
- The second implementation is called 10Base2, thin Ethernet, or Cheapernet.
- 10Base2 also uses a bus topology, but the cable is much thinner and more flexible. The cable can be bent to pass very close to the stations. In this case, the transceiver is normally part of the network interface card (NIC), which is installed inside the station.


10Base2
10 Mbps
185 m
Baseband
(digital)
Cable
end
Thin coaxial cable,
maximum 185 m
Cable
end

3. 10Base-T:Twisted-Pair Ethernet:

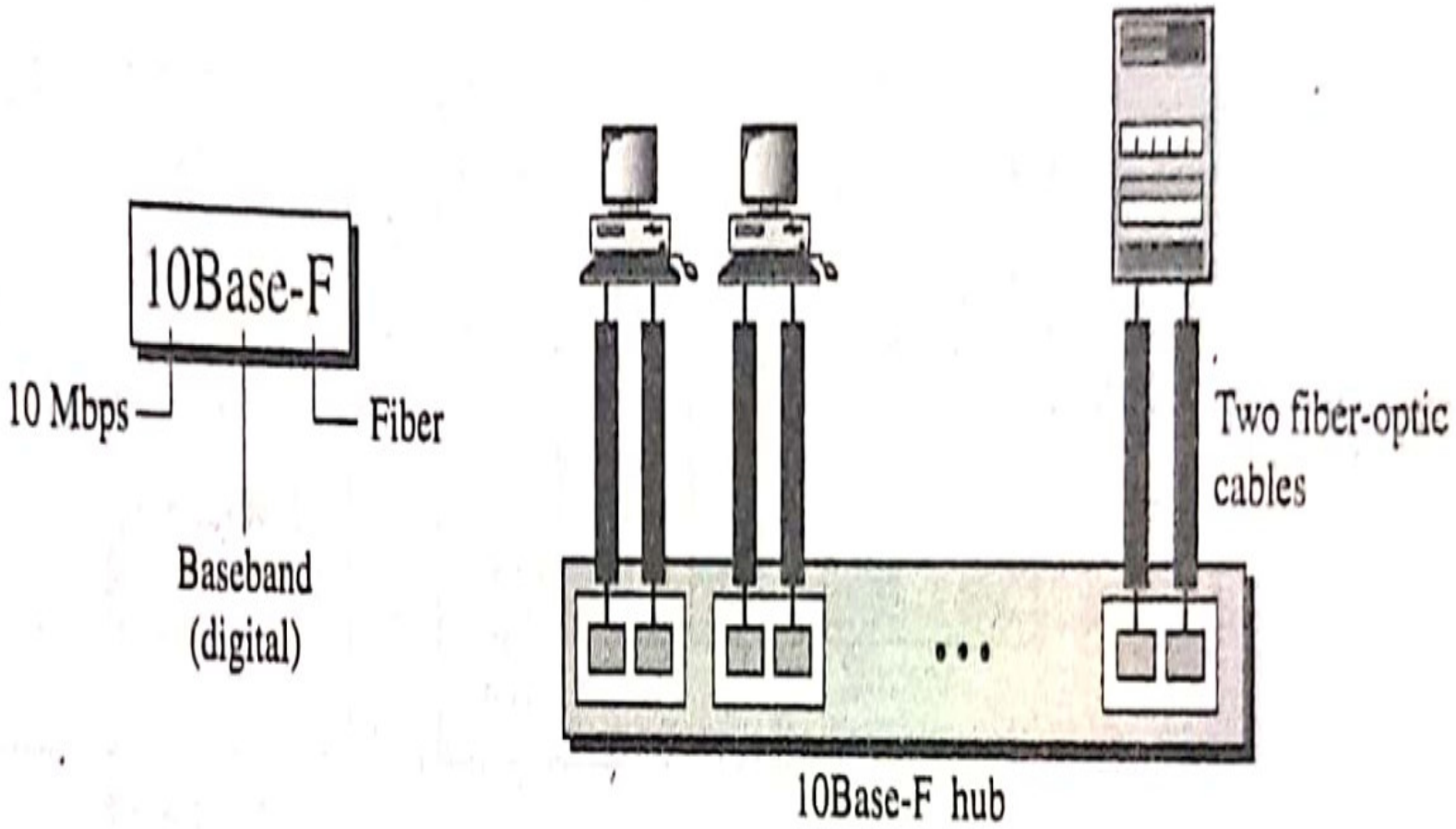
- The third implementation is called 10Base-T or twisted-pair Ethernet.
- 10Base-T uses a physical star topology. The stations are connected to a hub via two pairs of twisted cable.
- Note that two pairs of twisted cable create two paths between the station and the hub. Any collision here happens in the hub. Compared to 10Base5 or 10Base2, we can see that the hub actually replaces the coaxial cable as far as a collision is concerned. The maximum length of the twisted cable here is defined as 100 m, to minimize the effect of attenuation in the twisted cable.


10Base-T
10 Mbps
Twisted pair
Baseband
(digital)


Two pairs of
UTP cable
10Base-T hub

4. 10Base-F:Fiber Ethernet

- Although there are several types of optical fiber 10-Mbps Ethernet, the most common is called 10Base-F. 10Base-F uses a star topology to connect stations to a hub. The stations are connected to the hub using two fiber-optic cables


10Base-F
10 Mbps
Fiber
Baseband
(digital)
Two fiber-optic
cables
10Base-F hub

2. Fast Ethernet (100 Mbps)

- 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.
- The goals of Fast Ethernet:
  a) Upgrade the data rate to 100 Mbps.
  b) Make it compatible with Standard Ethernet.
  c) Keep the same 48-bit address.
  d) Keep the same frame format.
  e) Keep the same minimum and maximum frame lengths.

3. Gigabit Ethernet (1 Gbps)

- 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.
- The goals of the Gigabit Ethernet:
  a) Upgrade the data rate to 1 Gbps.
  b) Make it compatible with Standard or Fast Ethernet.
  c) Use the same 48-bit address.
  d) Use the same frame format.
  e) Keep the same minimum and maximum frame lengths.
  f) To support autonegotiation as defined in Fast Ethernet.

4. Ten-Gigabit Ethernet (10 Gbps)

- The IEEE committee created Ten-Gigabit Ethernet and called it Standard 802.3ae.
- The goals of the Ten-Gigabit Ethernet:
  a) Upgrade the data rate to 10 Gbps.
  b) Make it compatible with Standard, Fast, and Gigabit Ethernet.
  c) Use the same 48-bit address.
  d) Use the same frame format.
  e) Keep the same minimum and maximum frame lengths.
  f) Allow the interconnection of existing LANs into a metropolitan area network (MAN) or a wide area network (WAN).
  g) Make Ethernet compatible with technologies such as Frame Relay and ATM.