CSE/PC/B/T/316
Computer Networks
Topic 7- IEEE 802.x

Sarbani Roy
sarbani.roy@jadavpuruniversity.in
Office: CC-5-7
Cell: 9051639328

IEEE 802

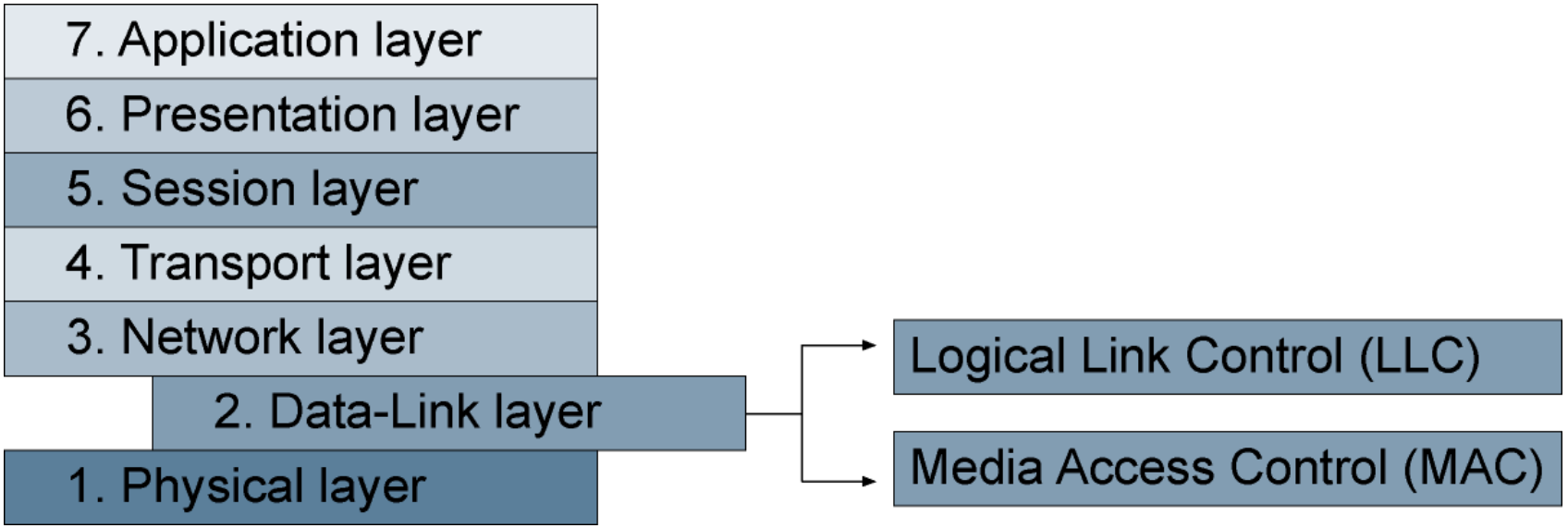
- **IEEE 802** is a family of IEEE standards dealing with LAN and MAN.
  - More specifically, the IEEE 802 standards are restricted to networks carrying variable-size packets.
  - By contrast, in cell relay networks data is transmitted in short, uniformly sized units called cells.
  - Isochronous networks, where data is transmitted as a steady stream of octets, or groups of octets, at regular time intervals, are also out of the scope of this standard.
- The number 802 was simply the next free number IEEE could assign, though “802” is sometimes associated with the date the first meeting was held — February 1980.

802 Specifications

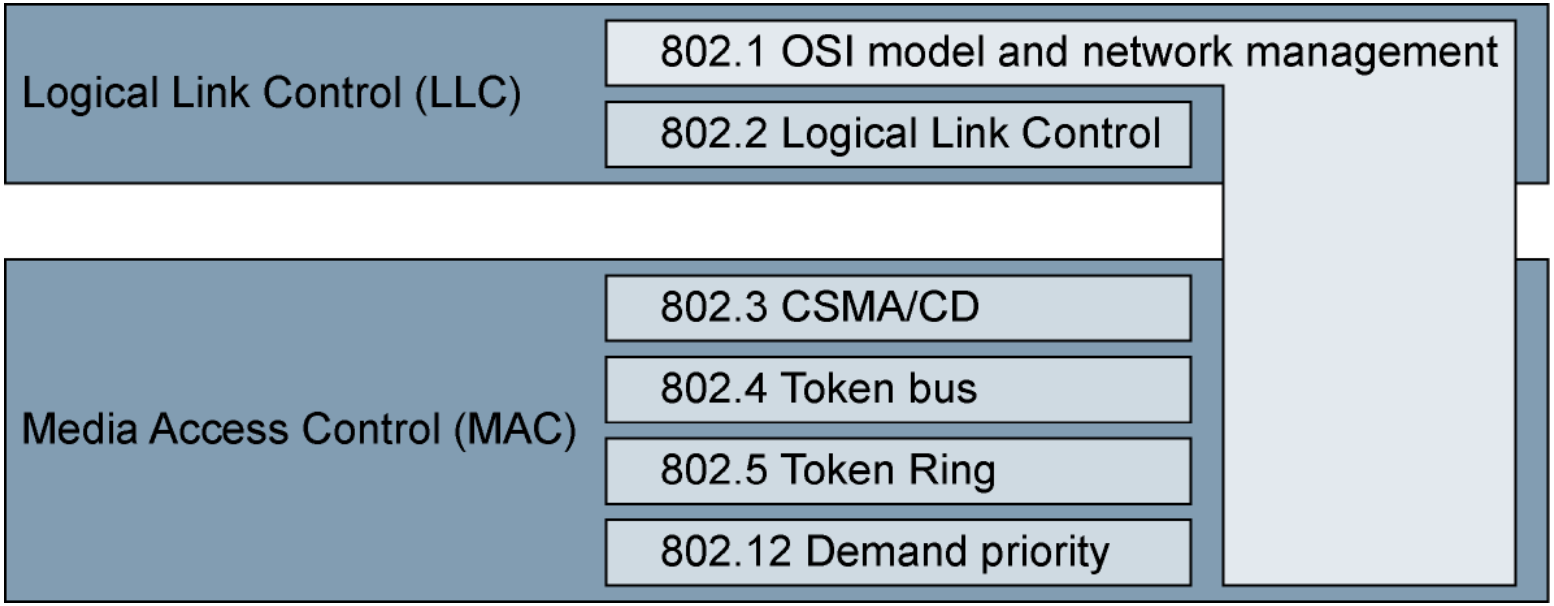
Set Standards for:

- Network Interface Cards (NICs)
- Wide area network (WAN) components
- Components used to create twisted-pair and coaxial cable networks

Project 802 LLC and MAC Sublayers



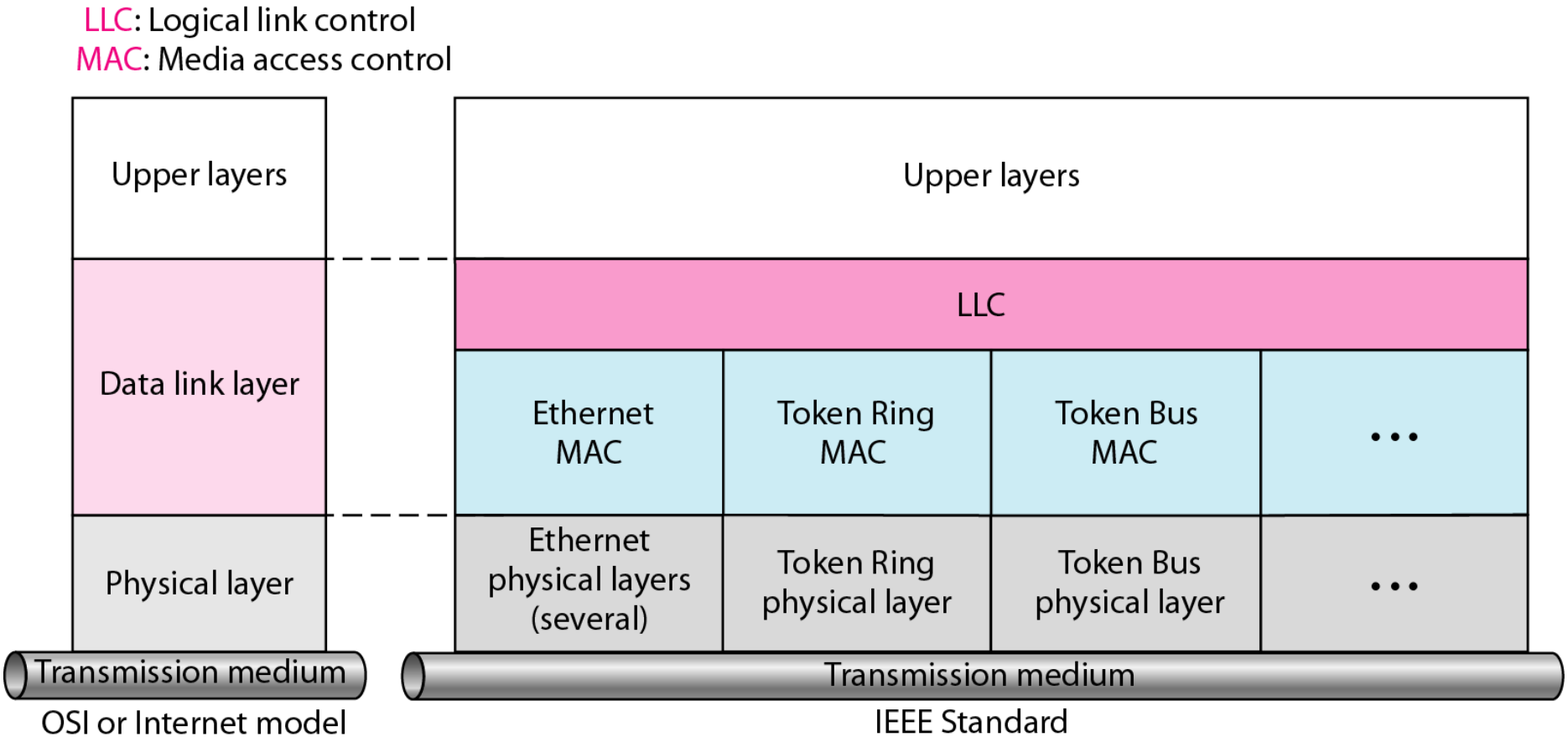
Project 802 LLC and MAC Standards



Name	Description	Note
IEEE 802.1	Higher Layer LAN Protocols (Bridging)	active
IEEE 802.2	LLC	disbanded
IEEE 802.3	Ethernet	active
IEEE 802.4	Token bus	disbanded
IEEE 802.5	Token ring MAC layer	disbanded
IEEE 802.6	MANs (DQDB)	disbanded
IEEE 802.7	Broadband LAN using Coaxial Cable	disbanded
IEEE 802.8	Fiber Optic TAG	disbanded
IEEE 802.9	Integrated Services LAN (ISLAN or isoEthernet)	disbanded
IEEE 802.10	Interoperable LAN Security	disbanded
IEEE 802.11	Wireless LAN (WLAN) & Mesh (Wi-Fi certification)	active
IEEE 802.12	100BaseVG	disbanded
IEEE 802.13	Unused[2]	Reserved for Fast Ethernet development[3]
IEEE 802.14	Cable modems	disbanded
IEEE 802.15	Wireless PAN	active
IEEE 802.15.1	Bluetooth certification	active
IEEE 802.15.2	IEEE 802.15 and IEEE 802.11 coexistence	
IEEE 802.15.3	High-Rate wireless PAN (e.g., UWB, etc.)	
IEEE 802.15.4	Low-Rate wireless PAN (e.g., ZigBee, WirelessHART, MiWi, etc.)	active
IEEE 802.15.5	Mesh networking for WPAN	
IEEE 802.15.6	Body area network	active

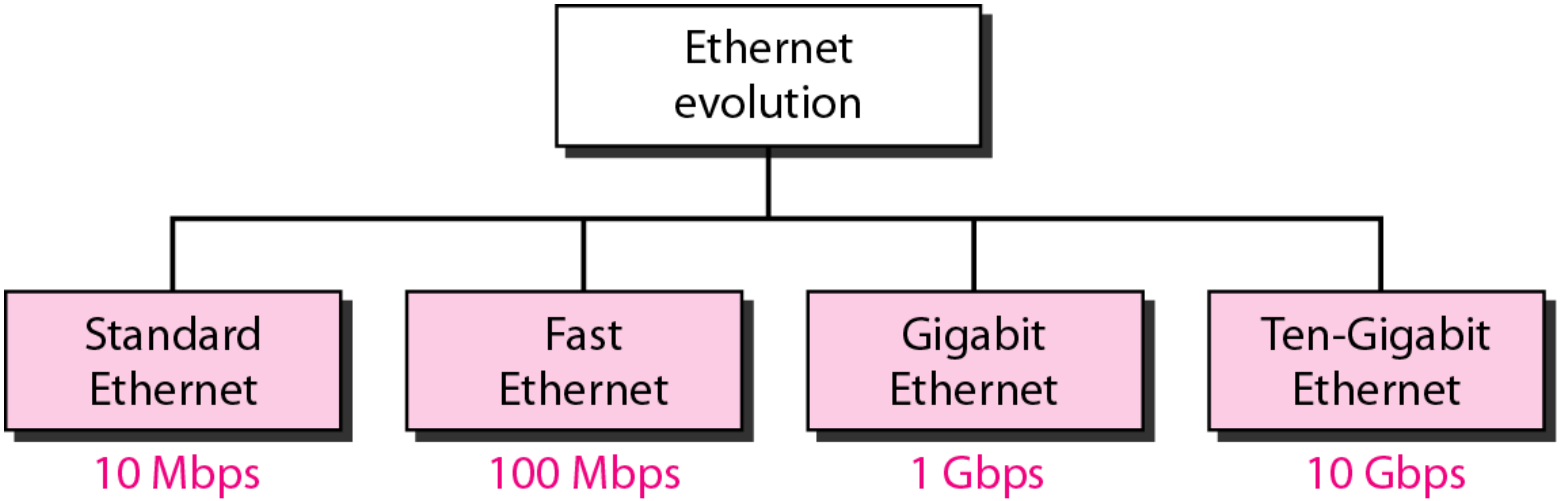
IEEE 802.15.7	Visible light communications	
IEEE 802.16	Broadband Wireless Access (WiMAX certification)	
IEEE 802.16.1	Local Multipoint Distribution Service	
IEEE 802.16.2	Coexistence wireless access	
IEEE 802.17	Resilient packet ring	hibernating
IEEE 802.18	Radio Regulatory TAG	
IEEE 802.19	Coexistence TAG	
IEEE 802.20	Mobile Broadband Wireless Access	hibernating
IEEE 802.21	Media Independent Handoff	
IEEE 802.22	Wireless Regional Area Network	
IEEE 802.23	Emergency Services Working Group	
IEEE 802.24	Smart Grid TAG	New (November, 2012)
IEEE 802.25	Omni-Range Area Network	

IEEE standards for LAN



- Traditional Ethernet uses 1-persistent CSMA/CD as the access method

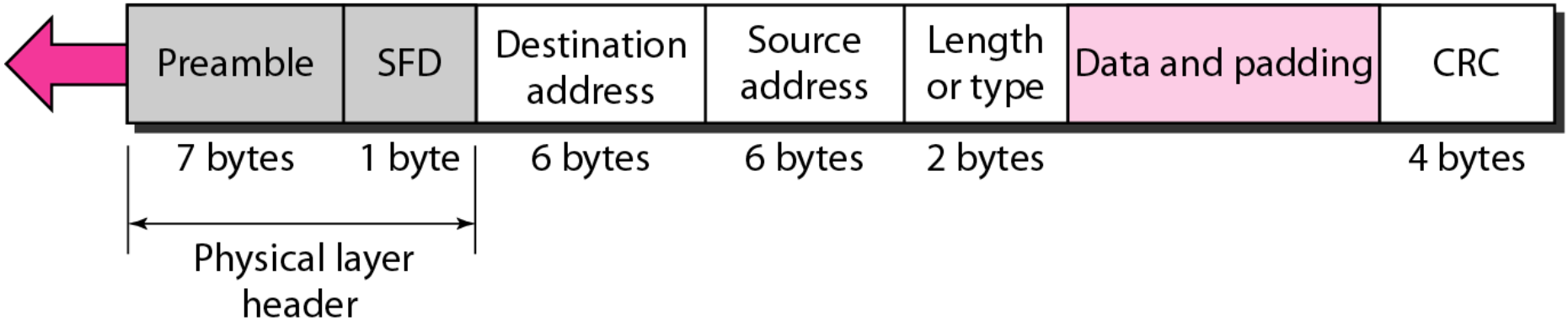
802.3 Ethernet



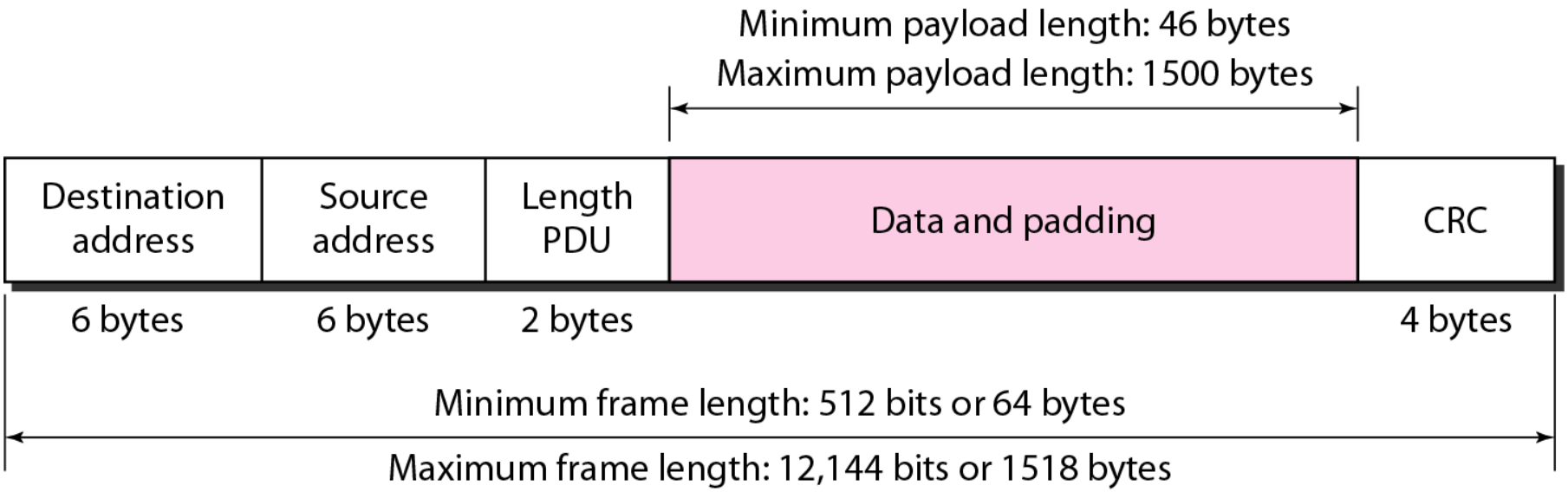
802.3 MAC frame

Preamble: 56 bits of alternating 1s and 0s.

SFD: Start frame delimiter, flag (10101011)



Minimum and Maximum Lengths



Note

Frame length:

Minimum: 64 bytes (512 bits)

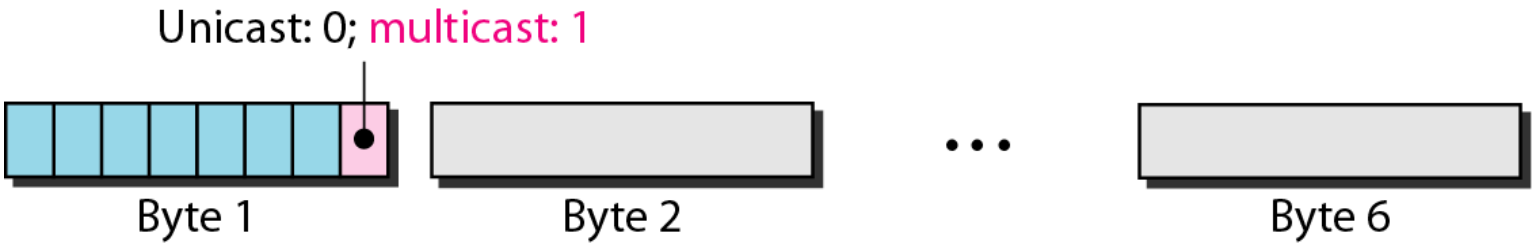
Maximum: 1518 bytes (12,144 bits)

Example of an Ethernet address in hexadecimal notation

- Source address is always a unicast
- Destination address can be unicast, multicast or broadcast

Unicast and multicast address

- 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.
- The broadcast destination address is a special case of the multicast address in which all bits are 1s.



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.

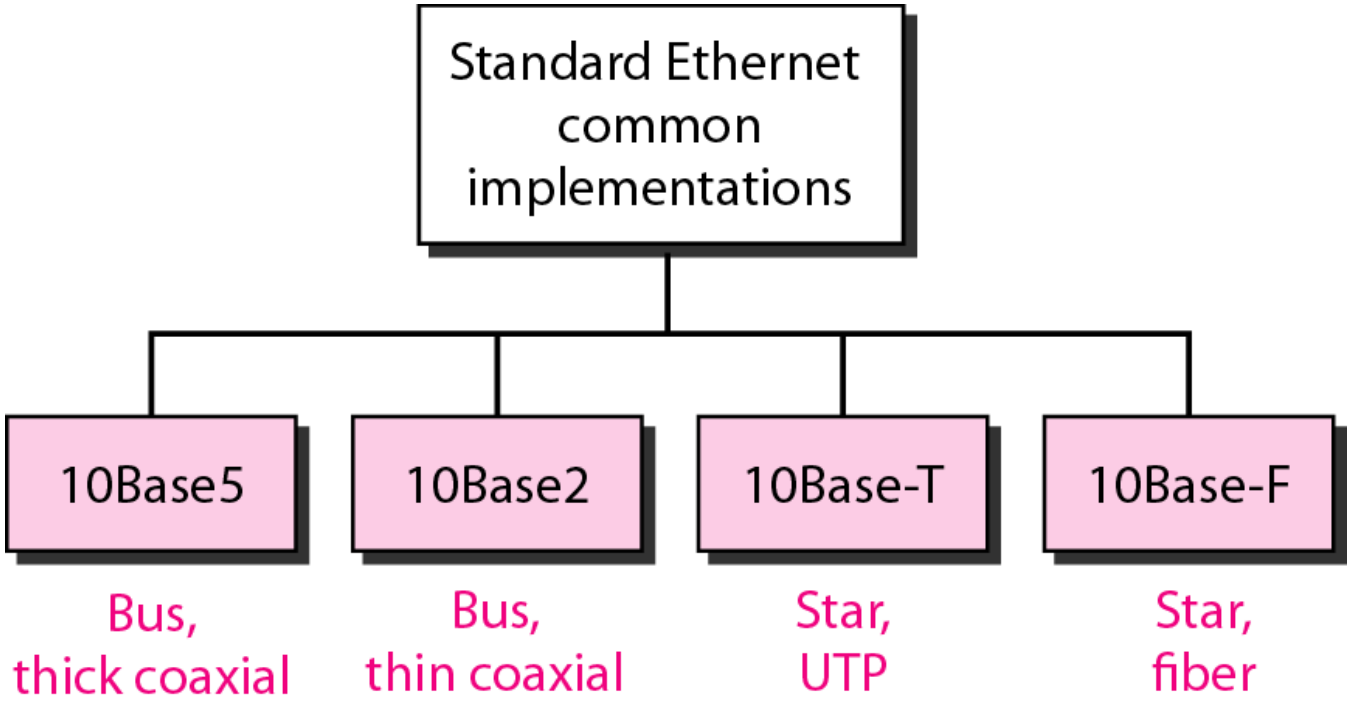
c. This is a broadcast address because all digits are F's.

Show how the address 47:20:1B:2E:08:EE is sent out on line.

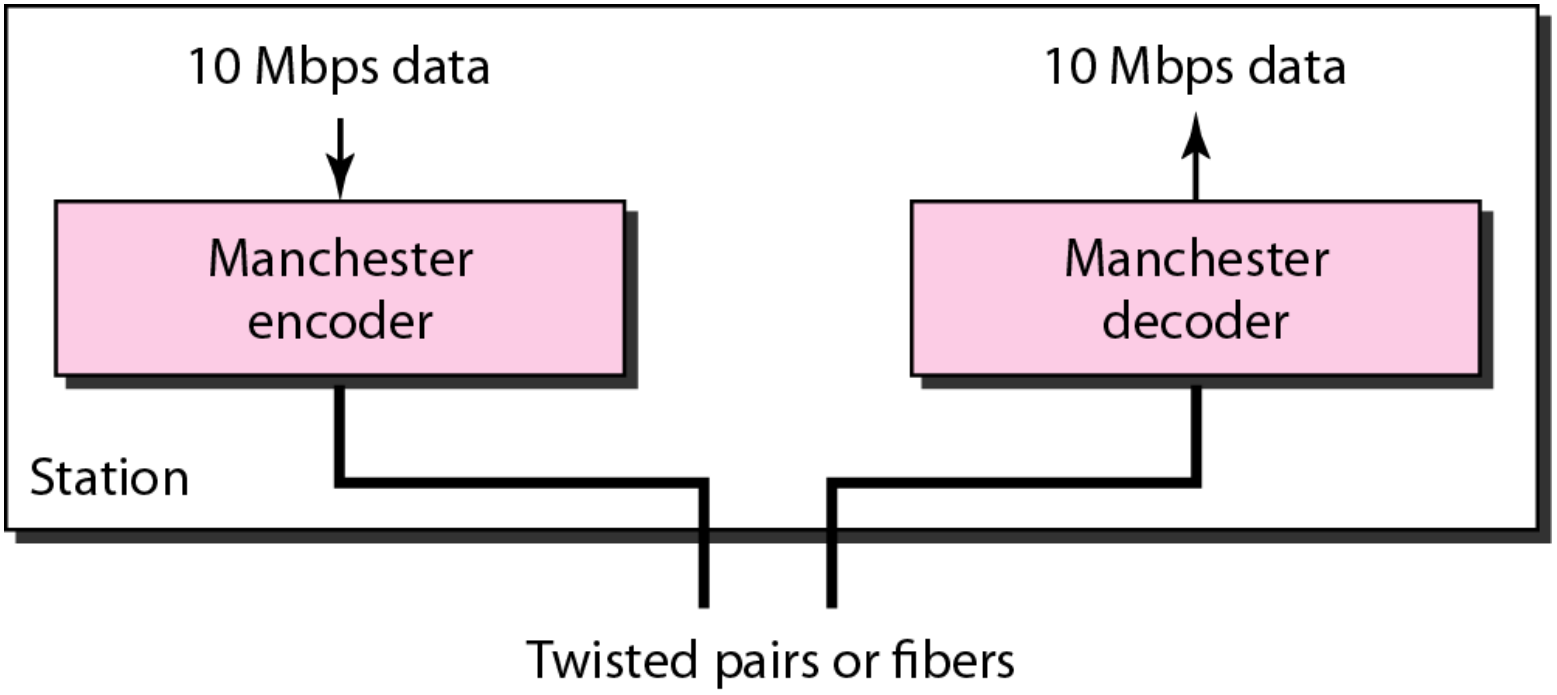
Solution

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:

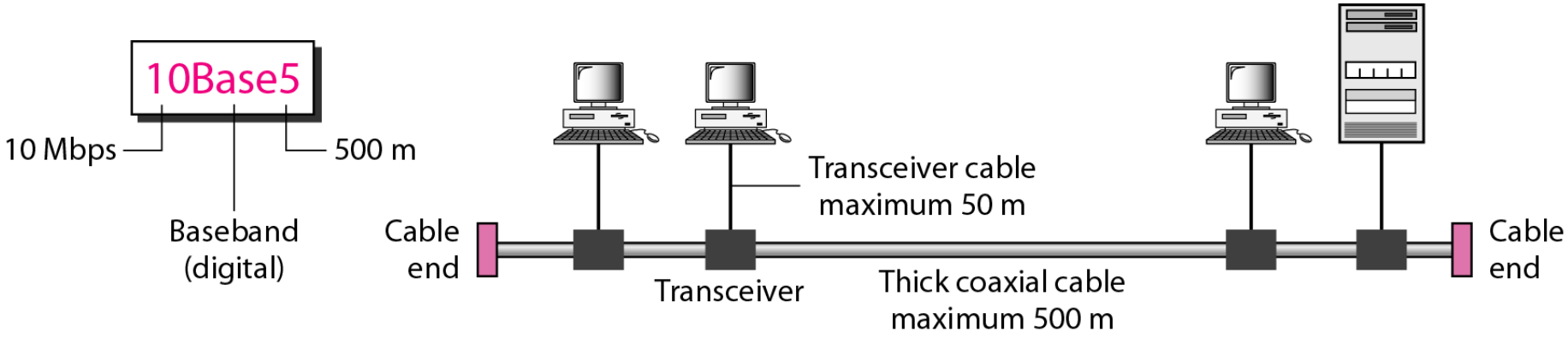
Categories of Standard Ethernet



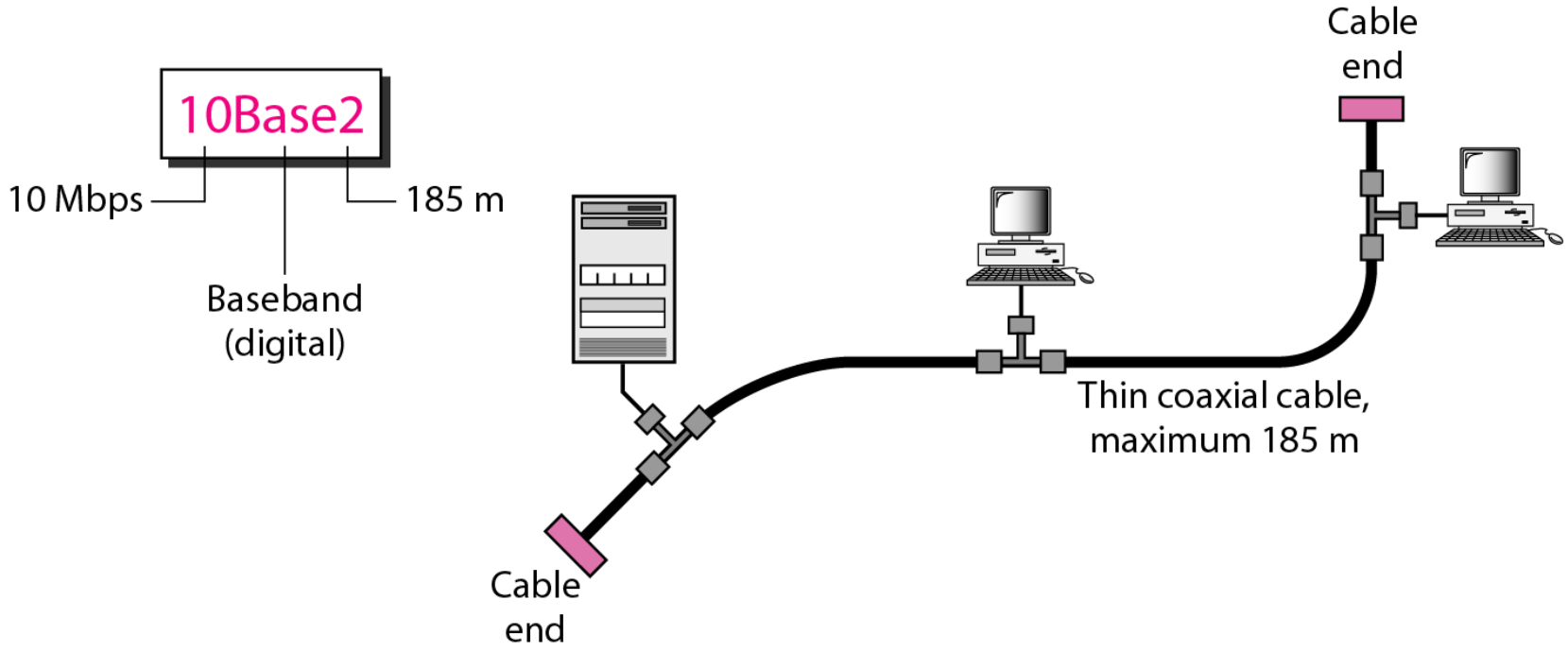
Encoding in a Standard Ethernet implementation



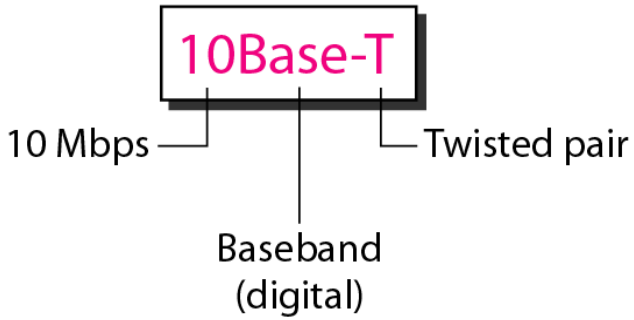
10Base5 implementation

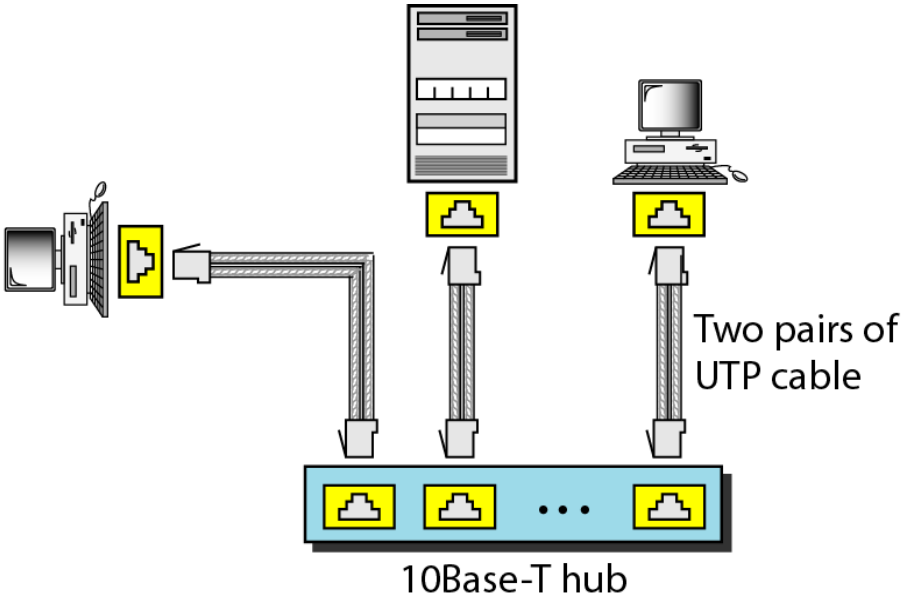


10Base2 implementation

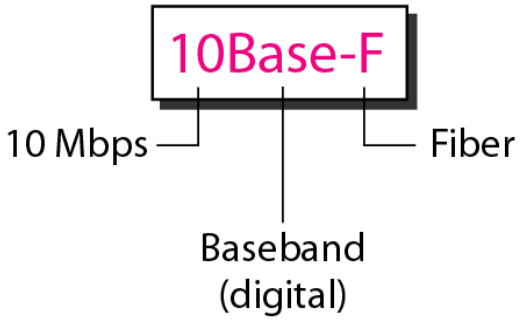


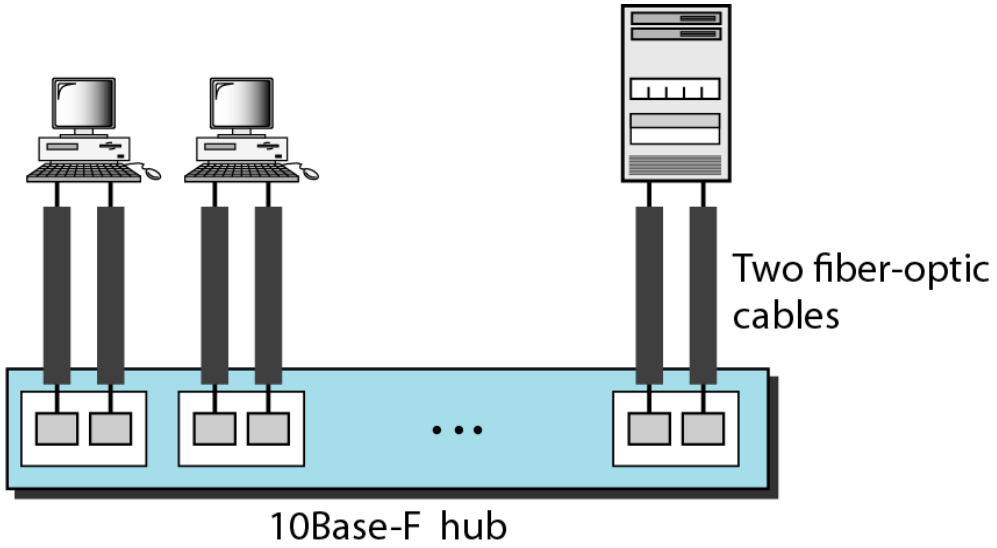
10Base-T implementation





10Base-F implementation





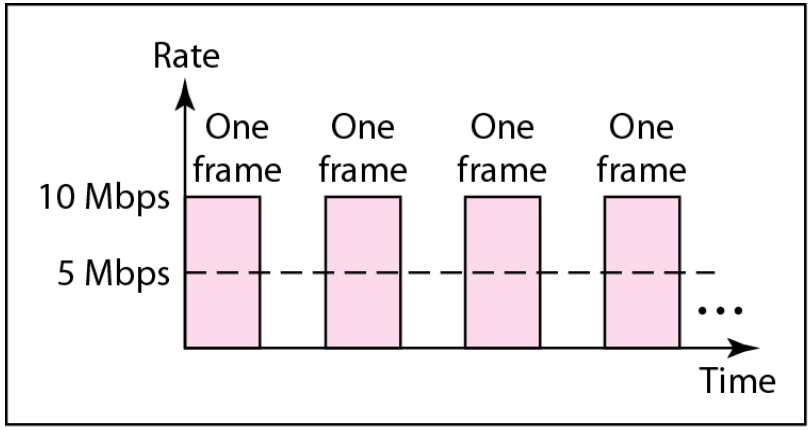
Summary of Standard Ethernet implementations

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

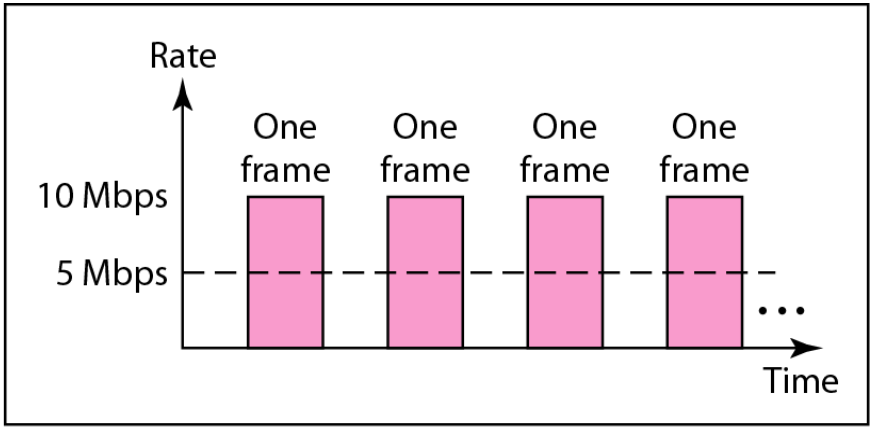
Changes

- 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.

Sharing bandwidth

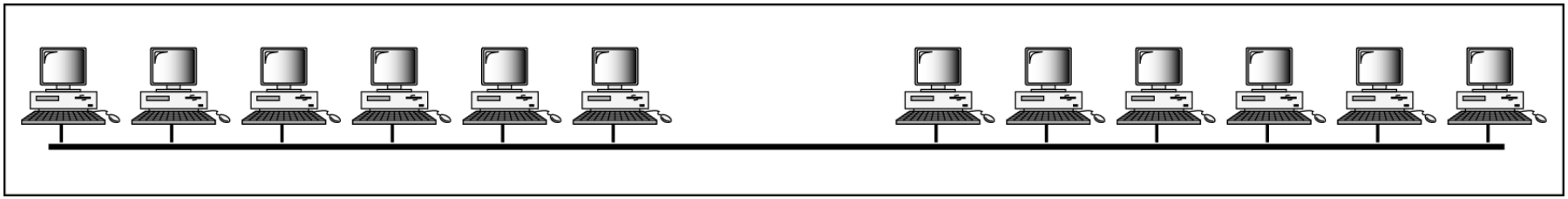


a. First station

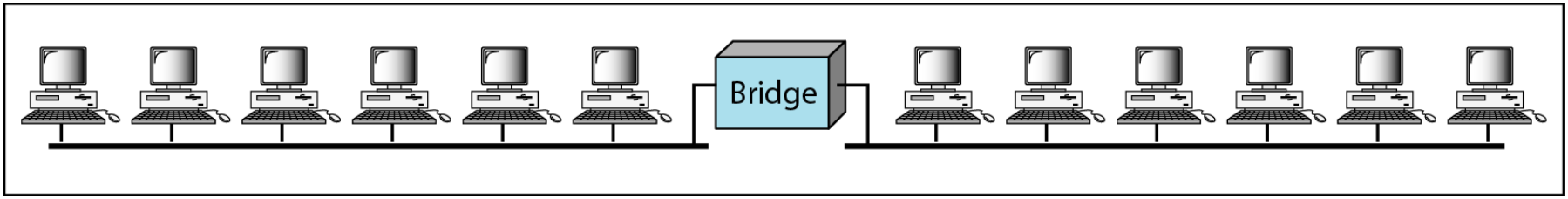


b. Second station

A network with and without a bridge

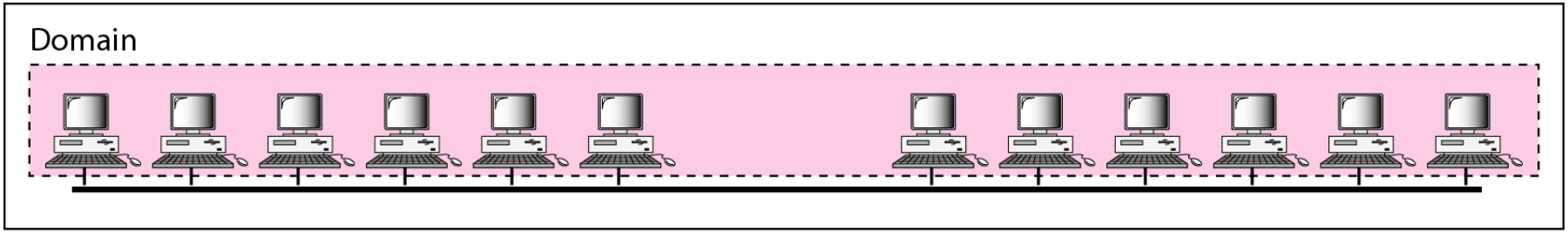


a. Without bridging

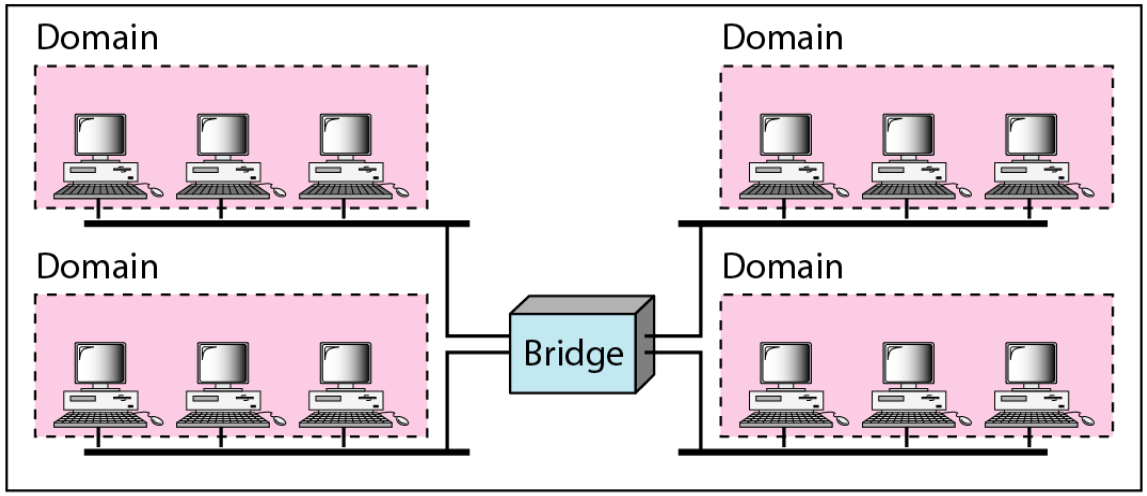


b. With bridging

Collision domains in an unbridged network and a bridged network

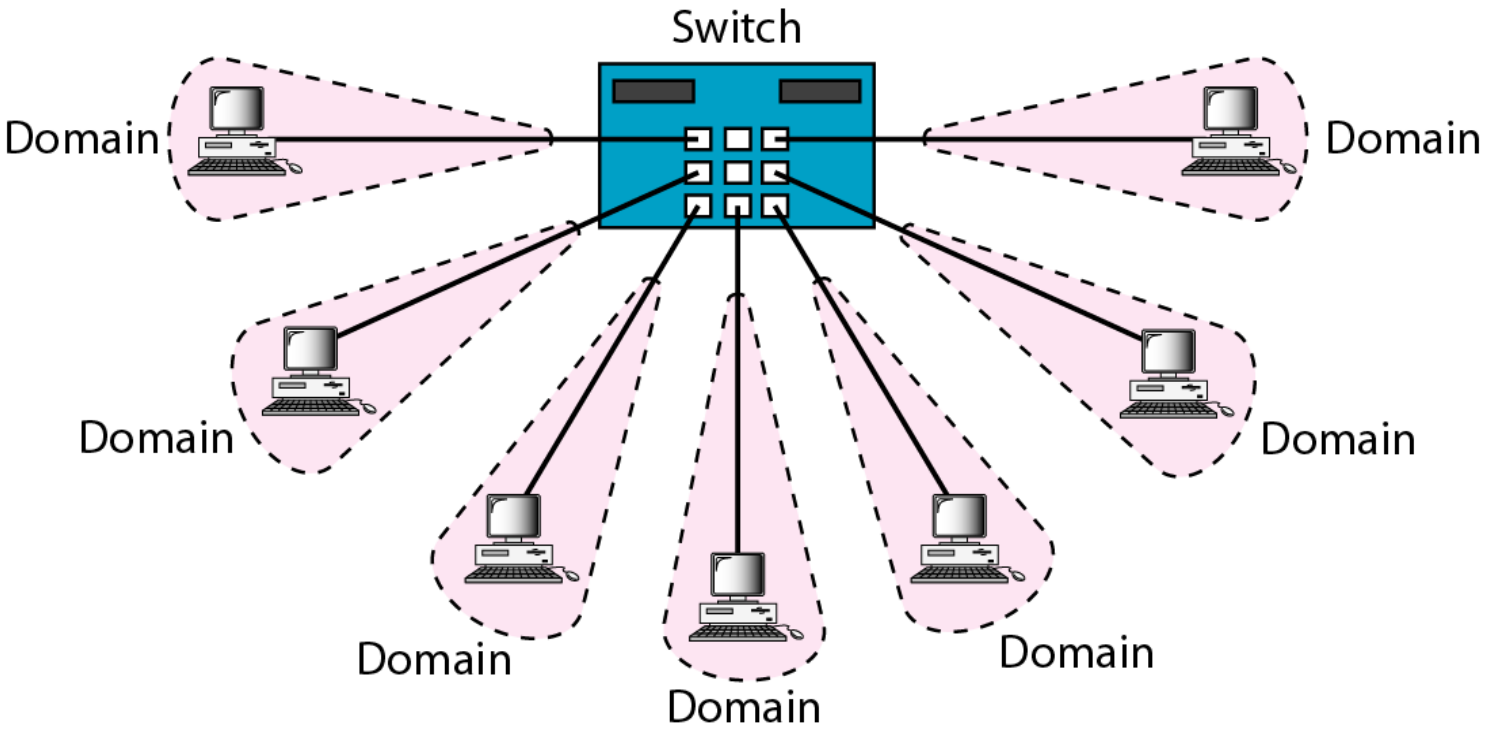


a. Without bridging



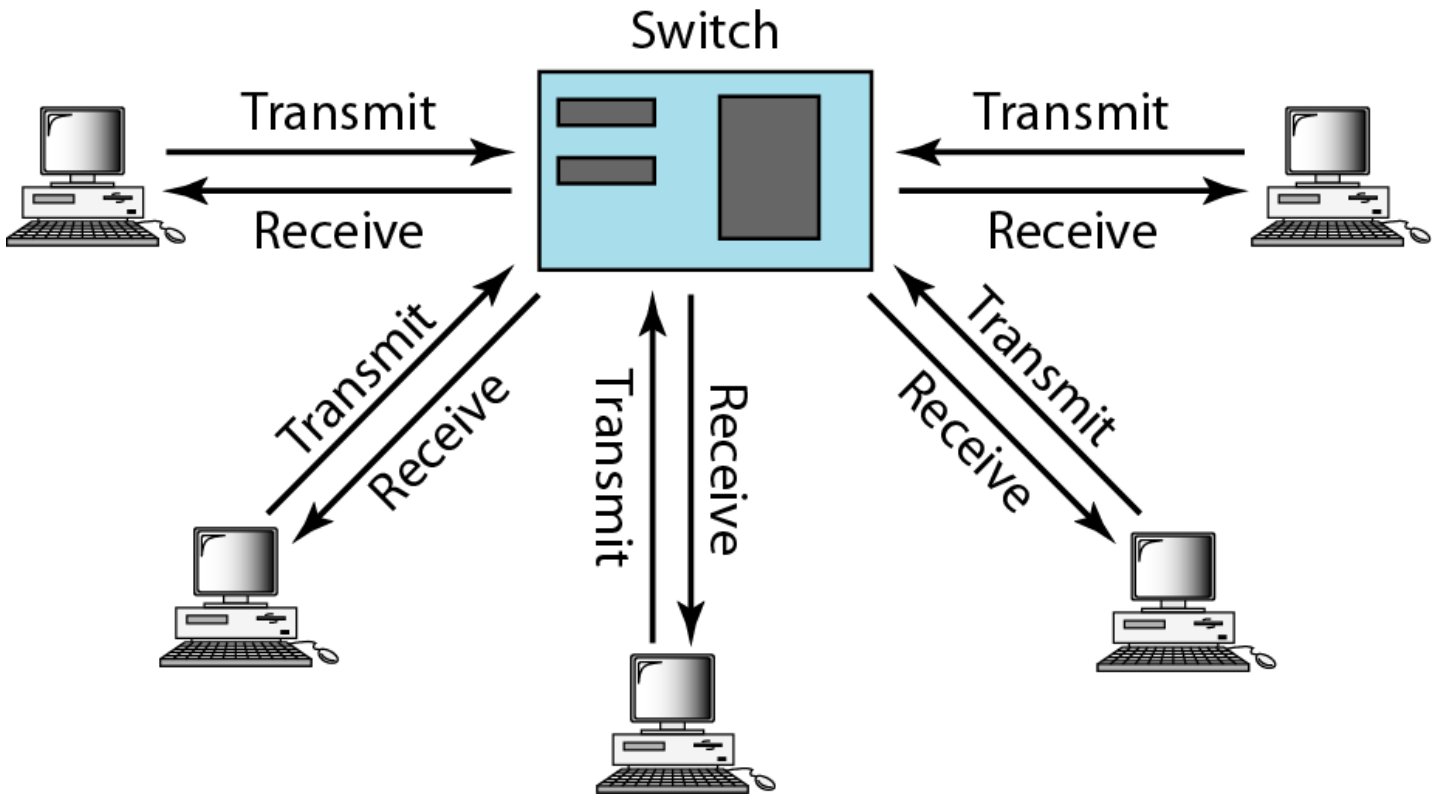
b. With bridging

Switched Ethernet



- Limitations of 10Base5 and 10Base2 is that communication is half duplex a station can either send or receive, but not at the same time
- 10BaseT is full duplex

Full-duplex switched Ethernet



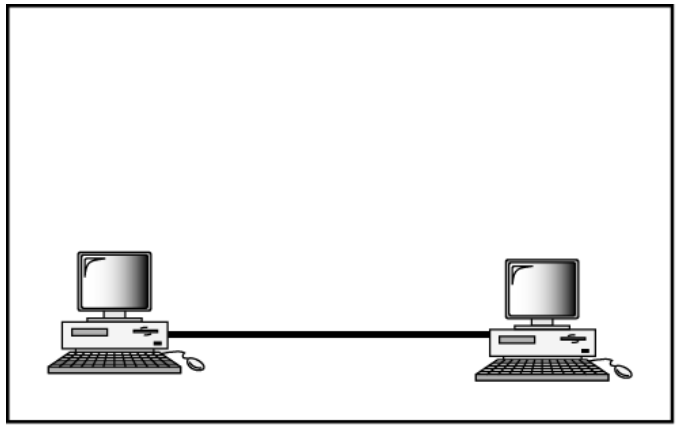
No need for CSMA/CD

- In full duplex switched Ethernet, there is no need for the CSMA/CD.
- Here, each node is connected to the switch via two separate links.
- Each link is a point-to-point dedicated path between the station and the switch.
- There is no more need for carrier sensing; there is no more need of collision detection.

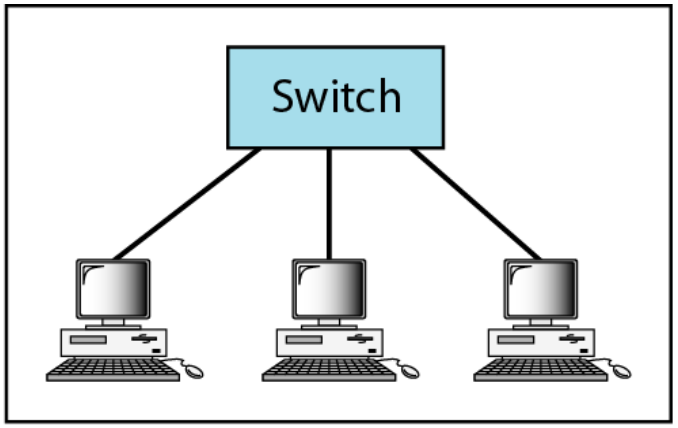
Fast Ethernet

- Fast Ethernet was designed to compete with LAN protocols such as 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.

Fast Ethernet topology

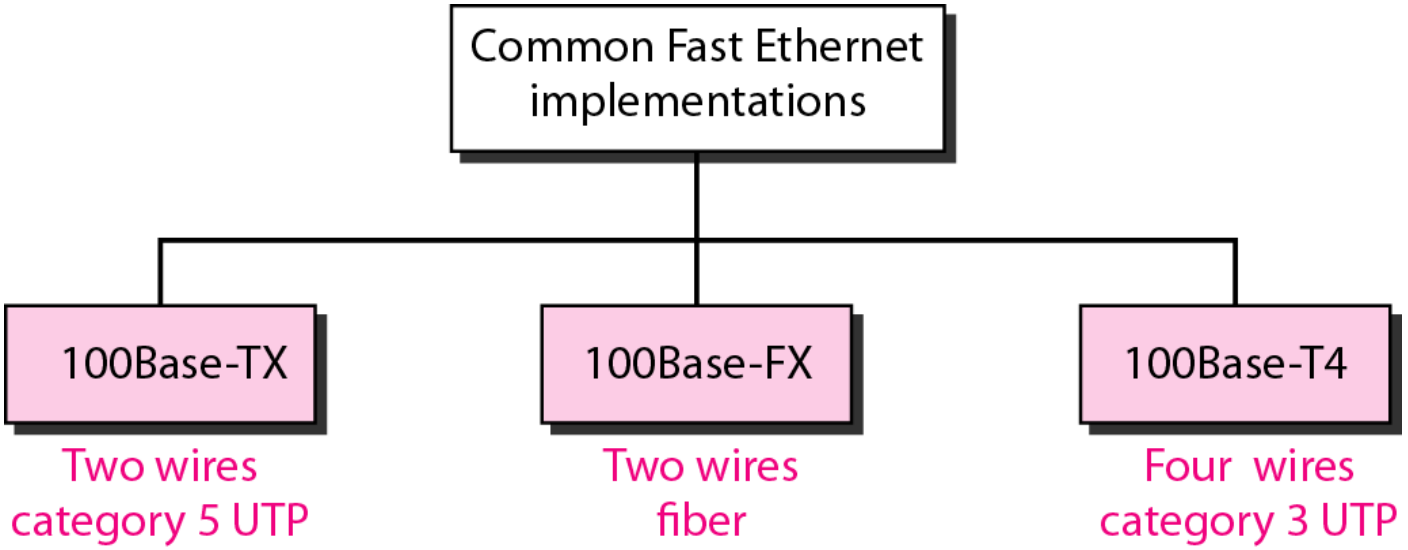


a. Point-to-point

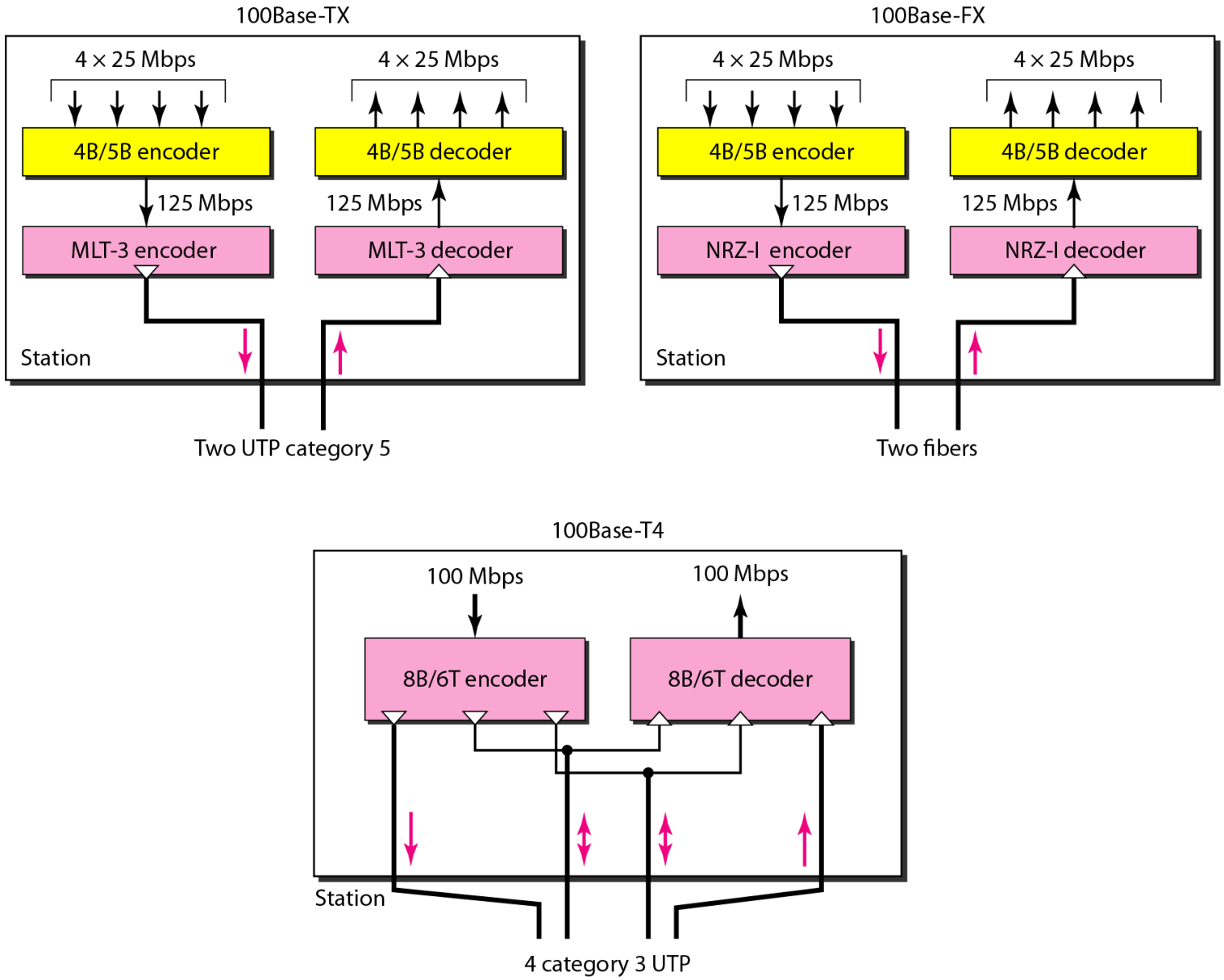


b. Star

Fast Ethernet implementations



Encoding for Fast Ethernet implementation



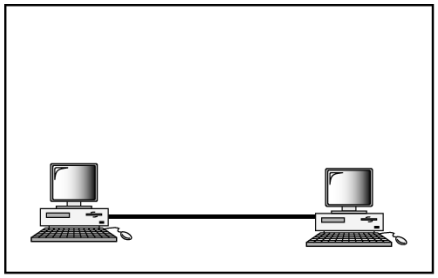
Summary of Fast Ethernet implementations

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

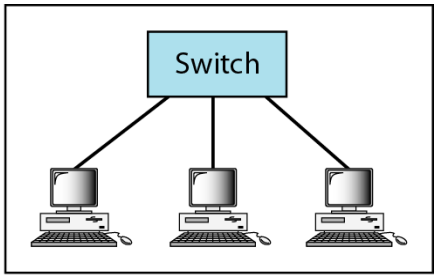
Gigabit Ethernet

- 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.
- 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.

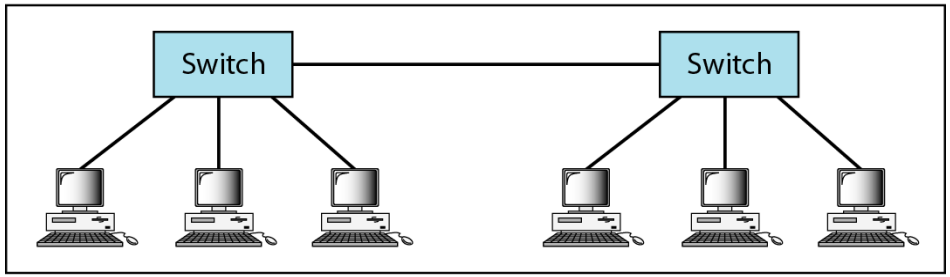
Topologies of Gigabit Ethernet



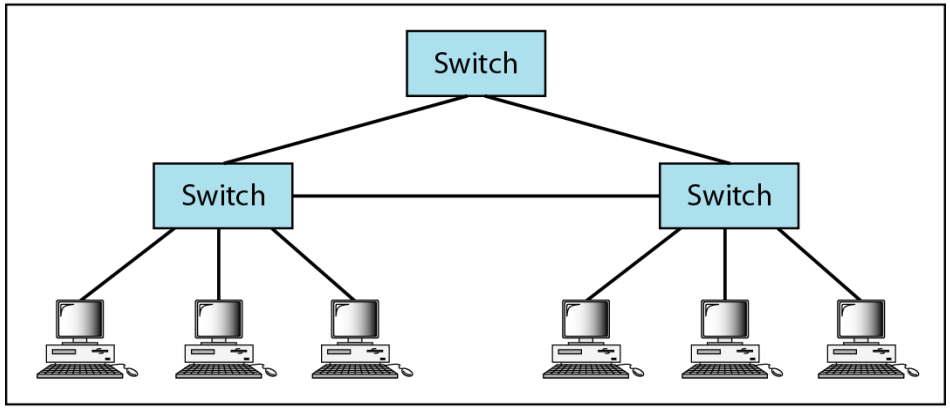
a. Point-to-point



b. Star

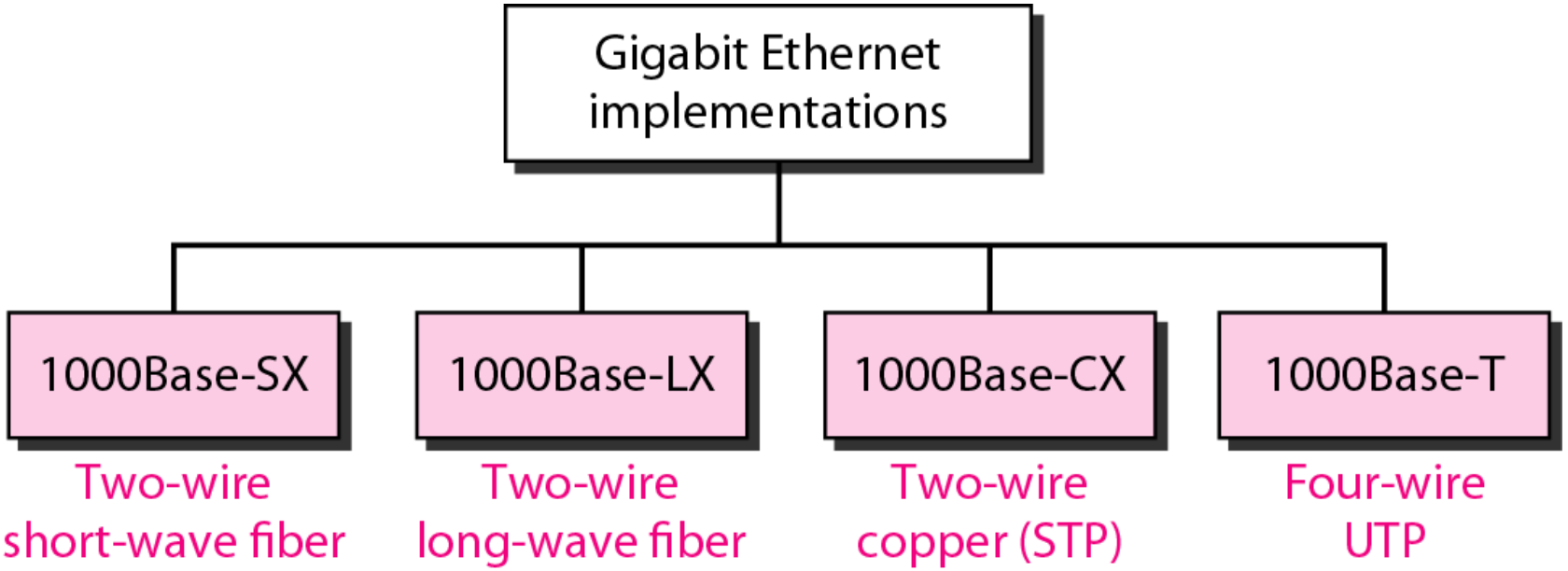


c. Two stars

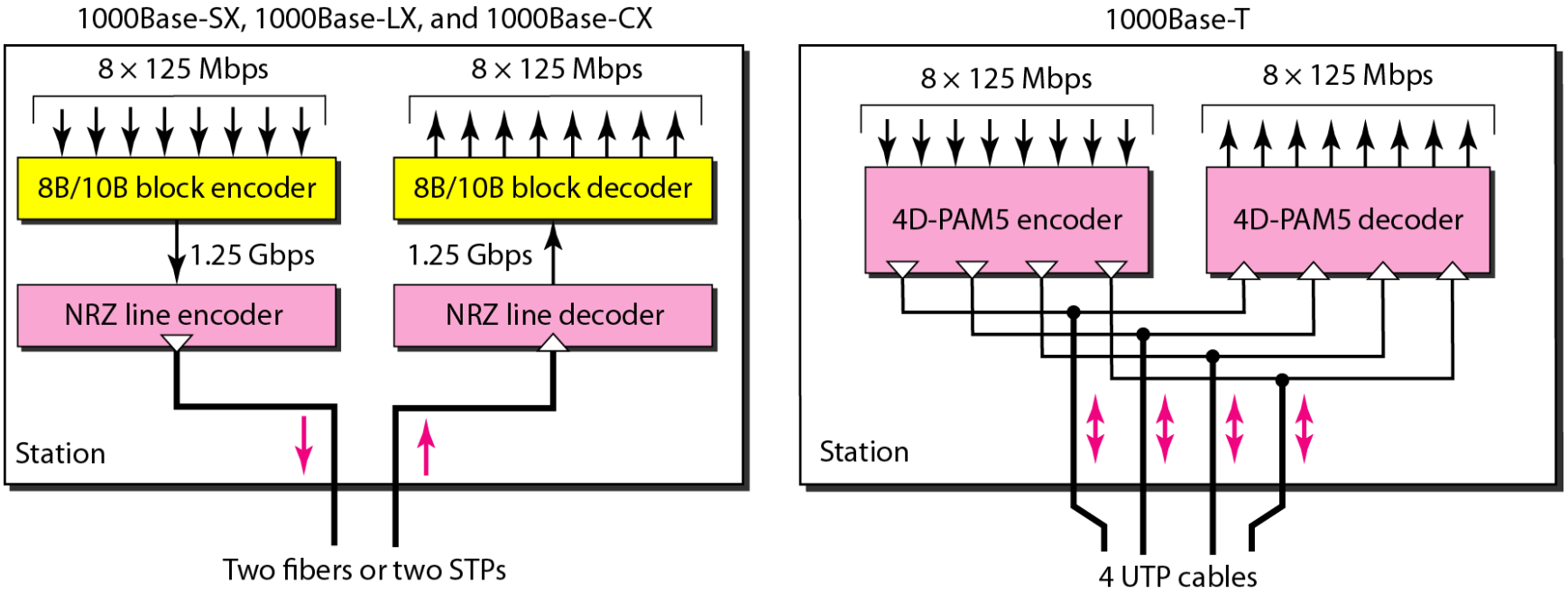


d. Hierarchy of stars

Gigabit Ethernet implementations



Encoding in Gigabit Ethernet implementations



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

Summary of Ten-Gigabit Ethernet 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