Ethernet – An Overview

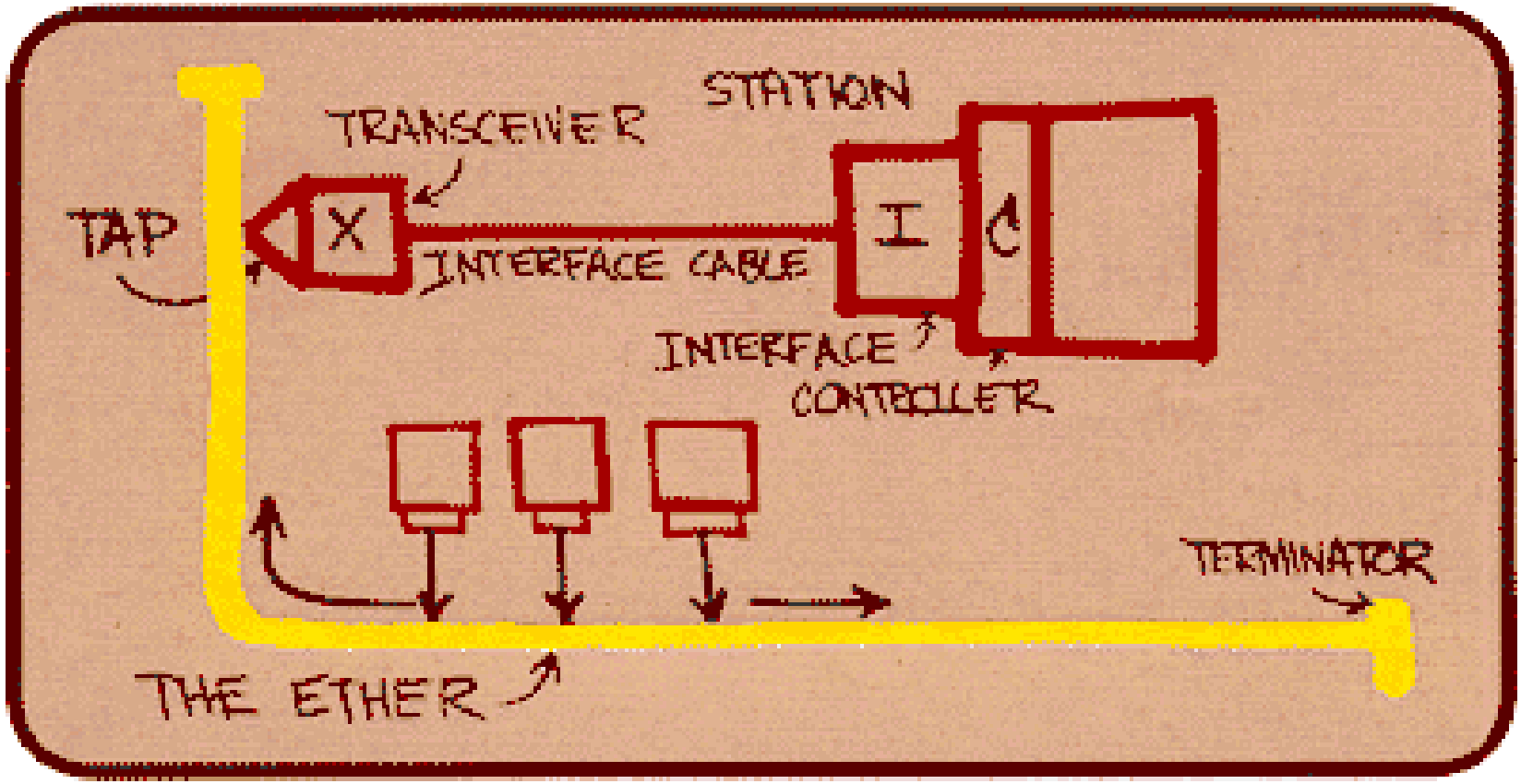
Simple Observation

A computer is more likely to communicate with computers that are nearby than with computers that are distant

Lecture Outline

- **Ethernet**
- Switched Ethernet
- Fast Ethernet
- Giga Ethernet
- Logical Link Control

Metcalfe's Original Sketch



Evolution of the Ethernet

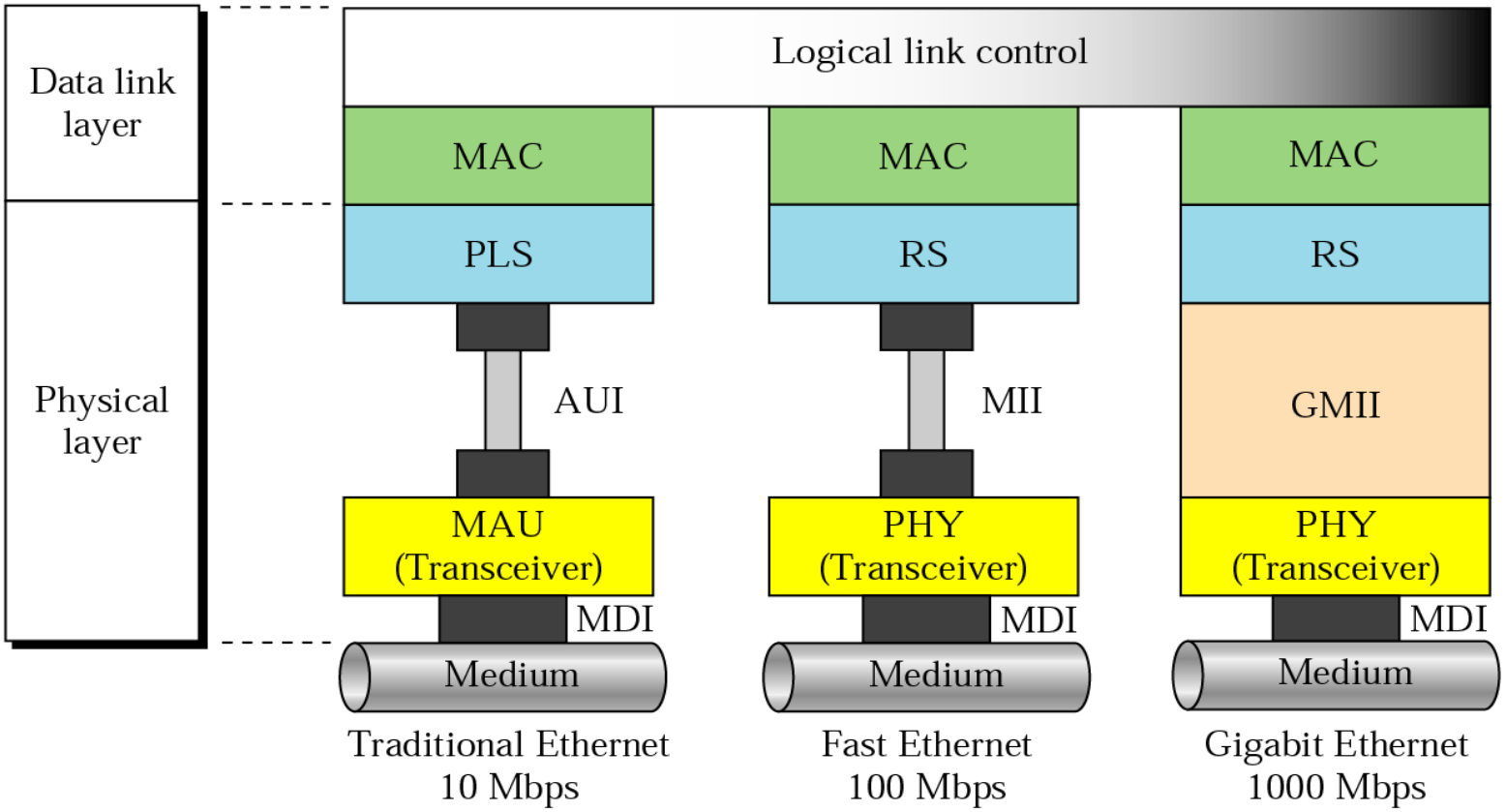
Name	Technical Name	Maximum Speed
Ethernet	802.3, CSMA/CD	10 Mbps
Fast Ethernet	802.3u	100 Mbps
Gigabit Ethernet	802.3z	1 Gbps
10 Gbps Ethernet	802.3ae	10 Gbps

Ethernet Layered Model

AUI: Attachment Unit Interface
MAC: Media Access Control
MAU: Medium Attachment Unit

MDI: Medium-Dependent Interface
MII: Medium-Independent Interface
GMII: Gigabit Medium-Independent Interface

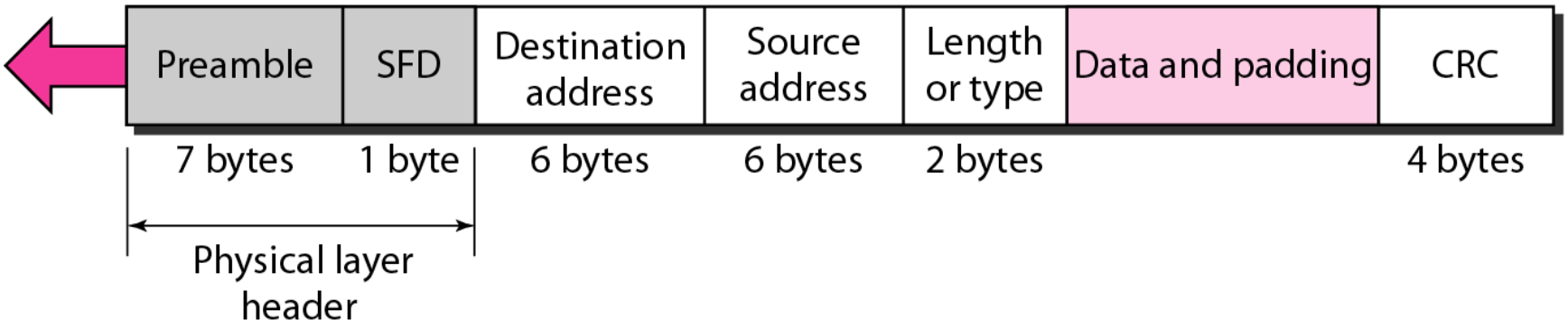
PHY: Physical Layer Entity
PLS: Physical Layer Signaling
RS: Reconciliation Signaling



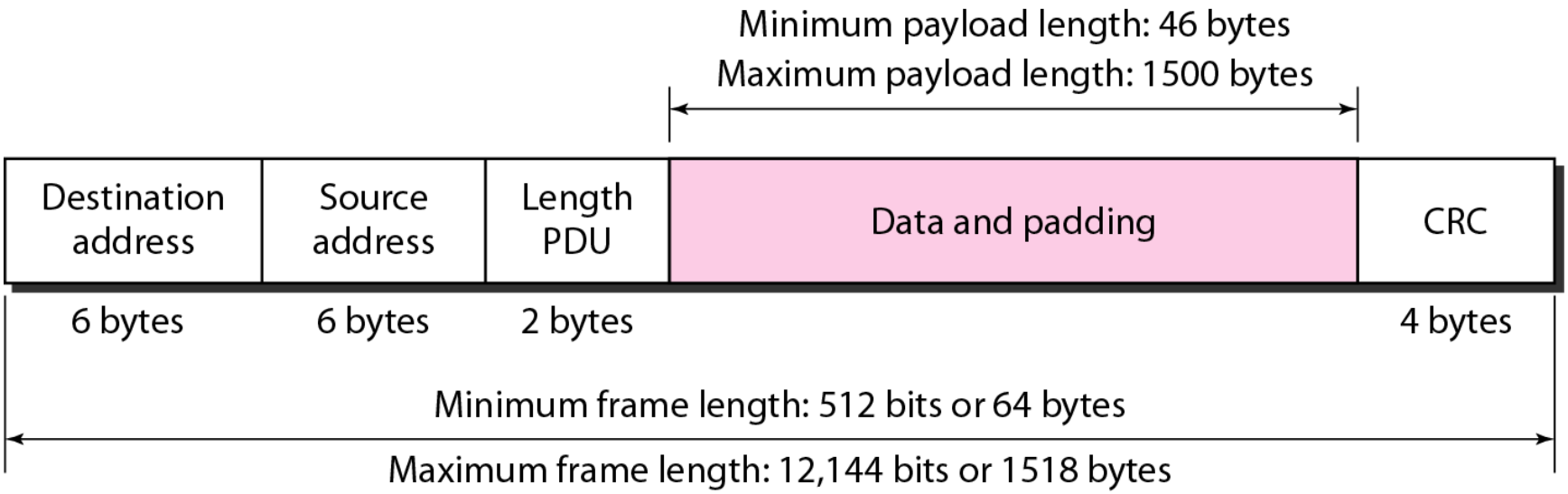
802.3 MAC Frame

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

SFD: Start frame delimiter, flag (10101011)



Frame Size Limitations



Minimum Frame Size

Minimum frame length

Fmin= F(network speed, max. cable length)

As the network speed goes up, the minimum frame length must go up or the maximum cable length must come down proportionally.

For a 2500-meter LAN operating at 1 Gbps, the minimum frame size would have to be 6400 bytes.

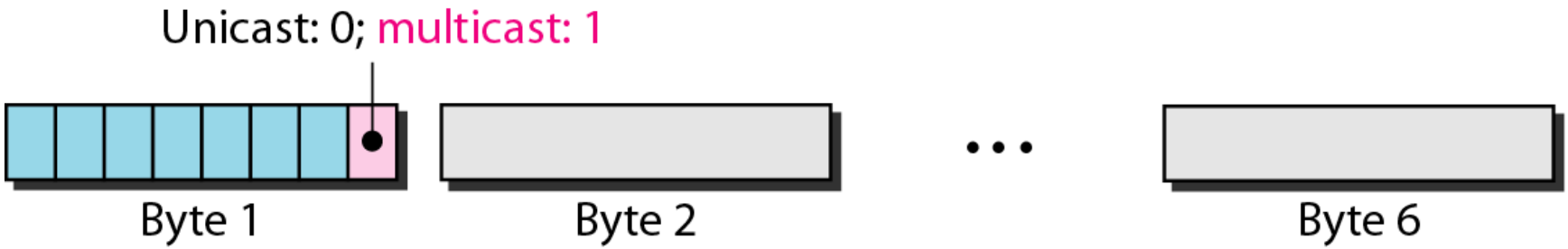
Alternatively, the minimum frame size could be 64 bytes and the maximum distance between any two stations 250 meters.

Ethernet Address

06 : 01 : 02 : 01 : 2C : 4B

6 bytes = 12 hex digits = 48 bits

Address Transmission Convention



MAC Address Types

Define the type of the following destination addresses:

a. 4A:30:10:21:10:1A *b. 87:20:1B: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.

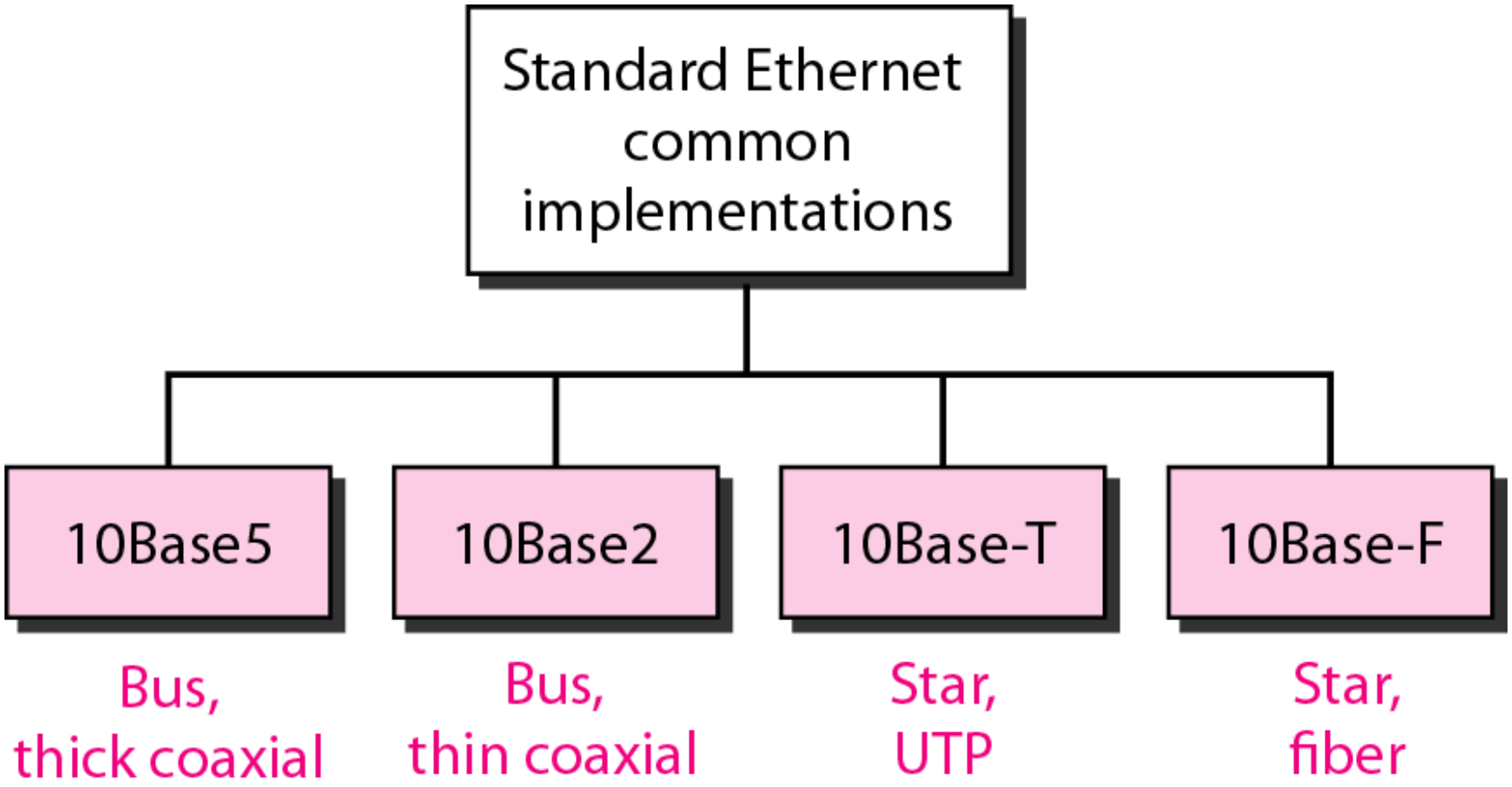
Address Transmission

Show how the address 87:20:1B:2E:08:EE is sent out on line.

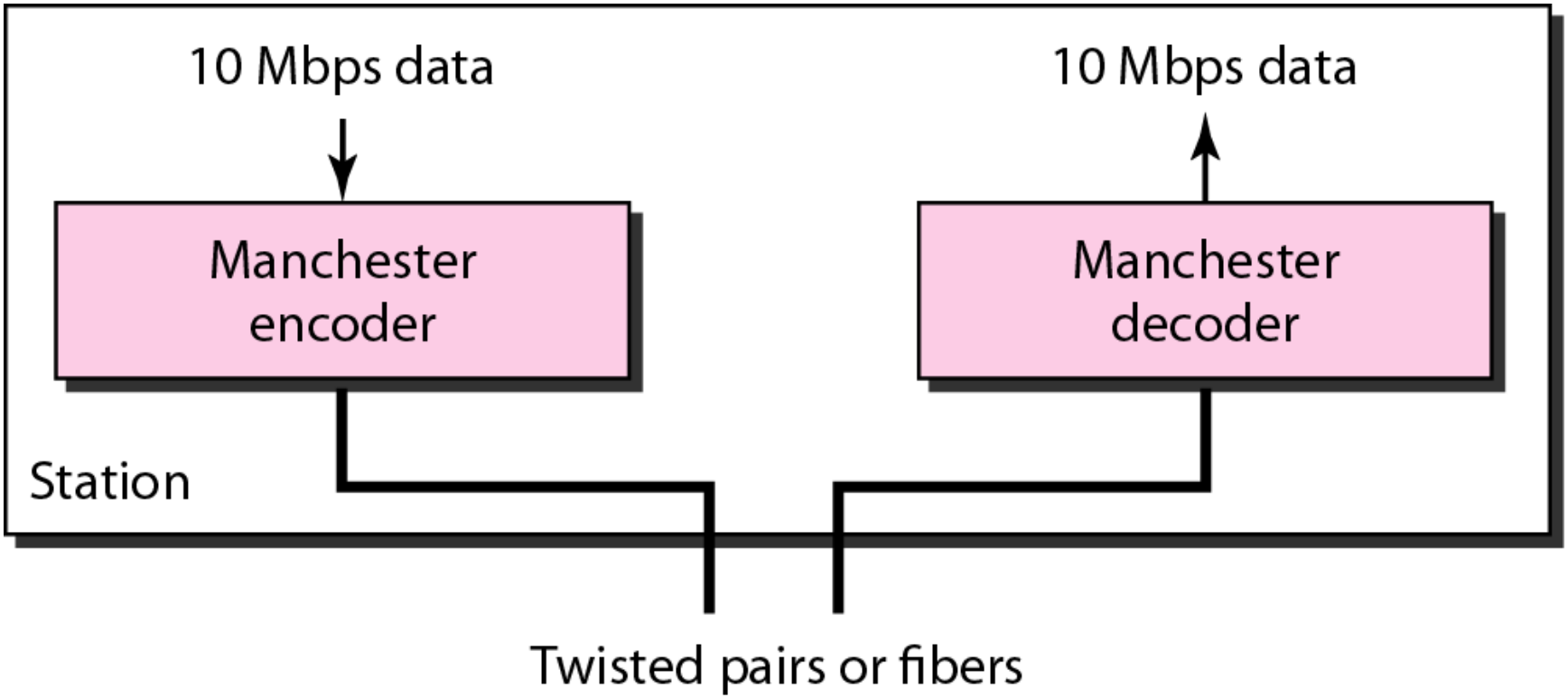
Solution

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:

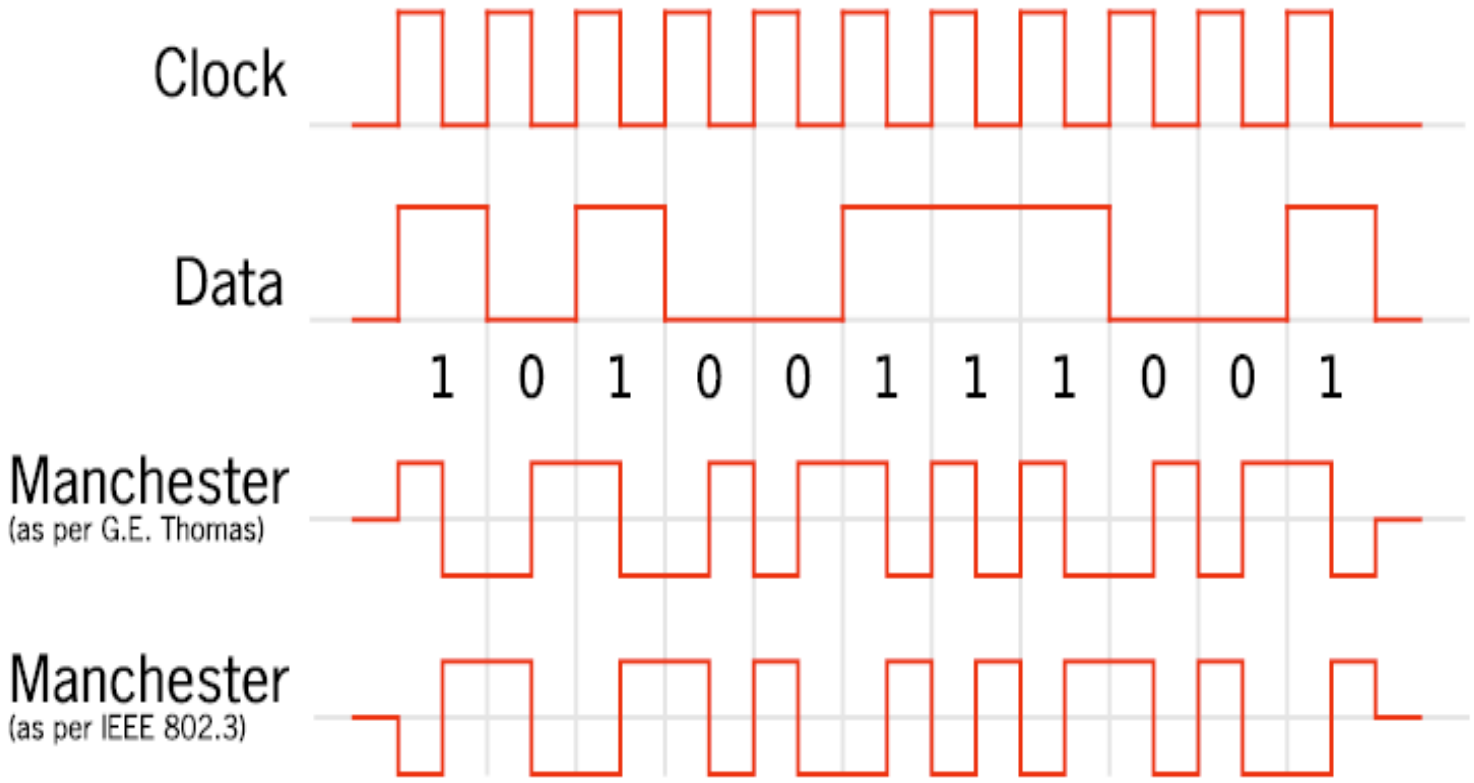
Categories of Standard Ethernet Cables



Line Encoding and Decoding



Manchester Encoding



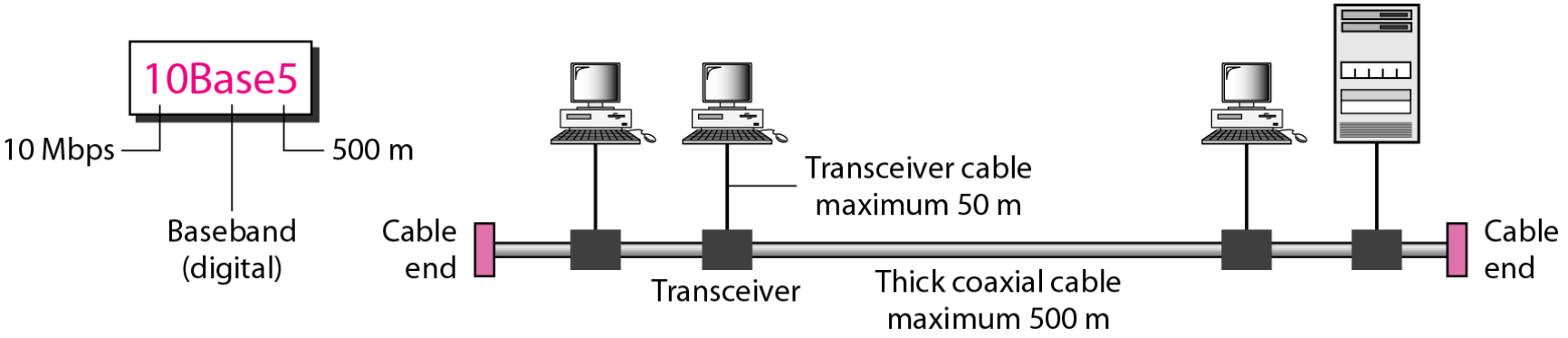
Implication: A 10 Mbps Ethernet needs a signal speed of 20M.

Cable Naming Conventions

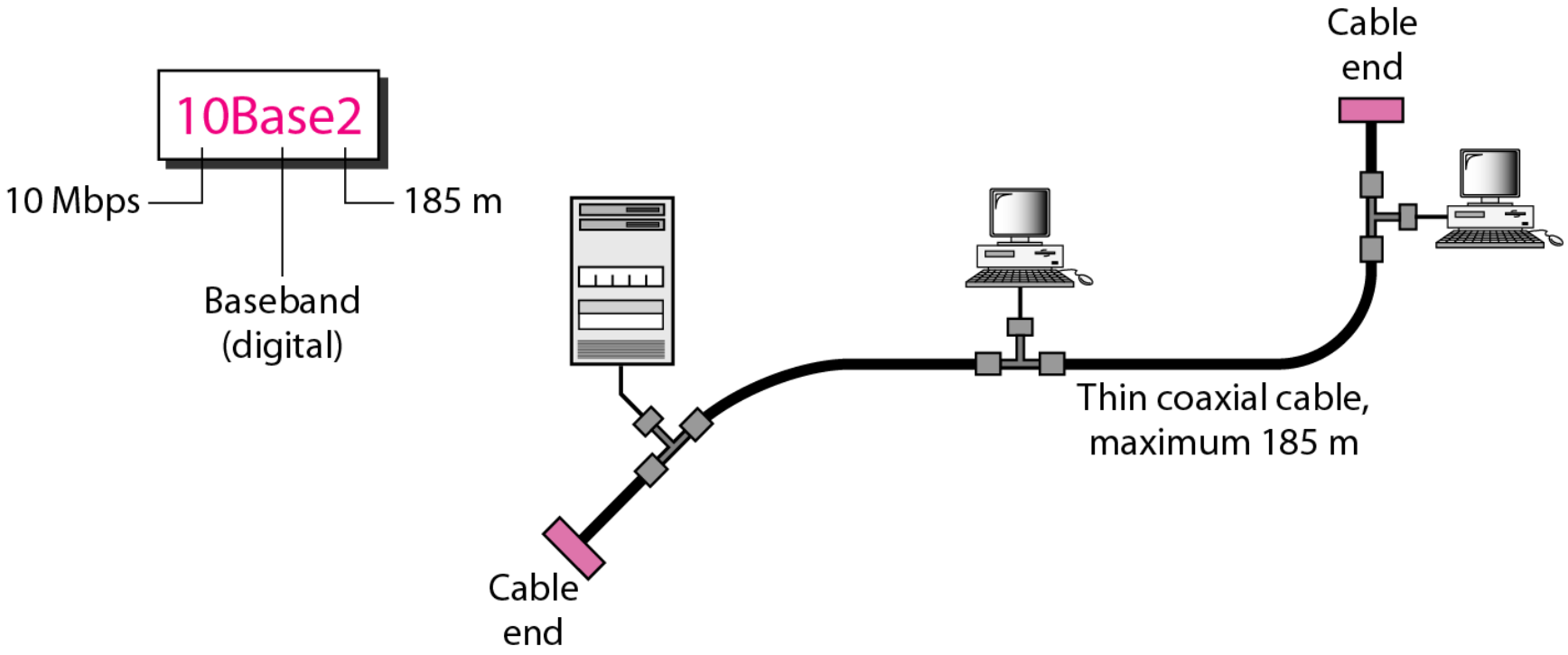
Structure: [rate][modulation][media or distance]

- 10Base5 (10Mbps, baseband, coax, 500m)
- 10Base-T (10Mbps, baseband, twisted pair)
- 100Base-TX (100Mbps, baseband, 2 pair)
- 100Base-FX (100Mbps, baseband, fiber)
- 1000Base-CX for two pairs balanced copper cabling
- 1000Base-LX for long wavelength optical transmission
- 1000Base-SX for short wavelength optical transmission.

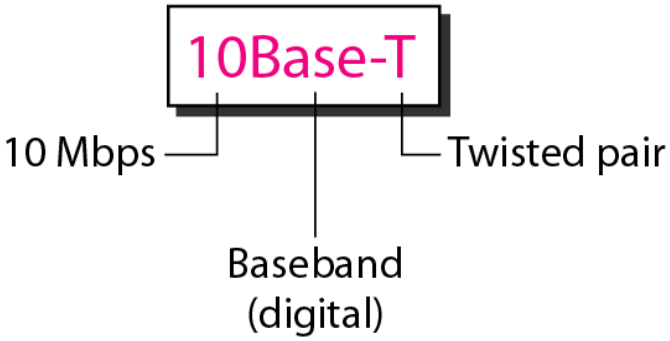
10Base5 Implementation

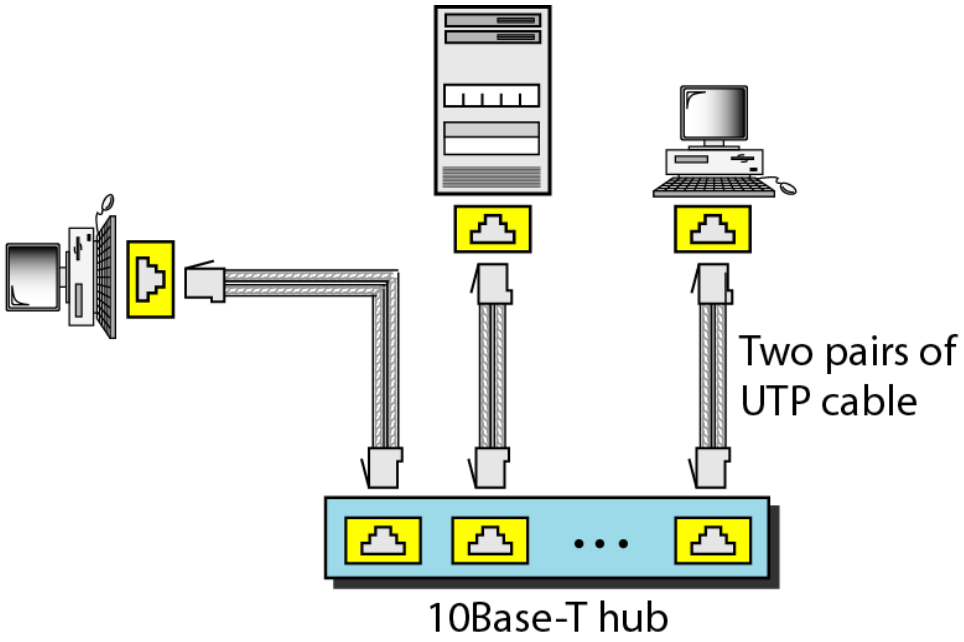


10Base2 Implementation

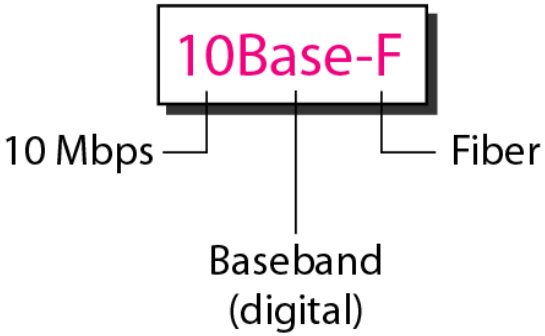


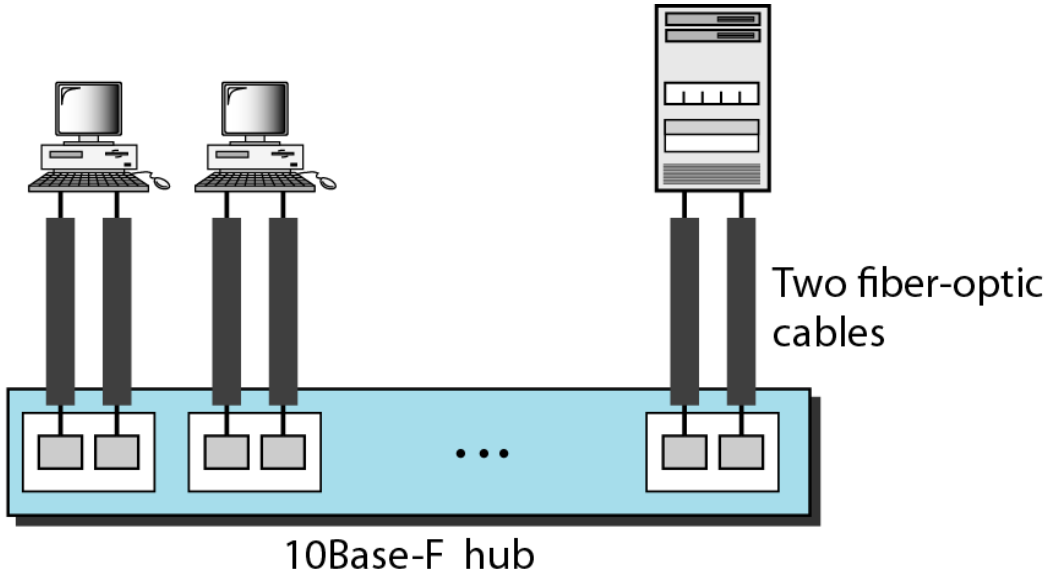
10BaseT Implementation





10Base-F Implementation



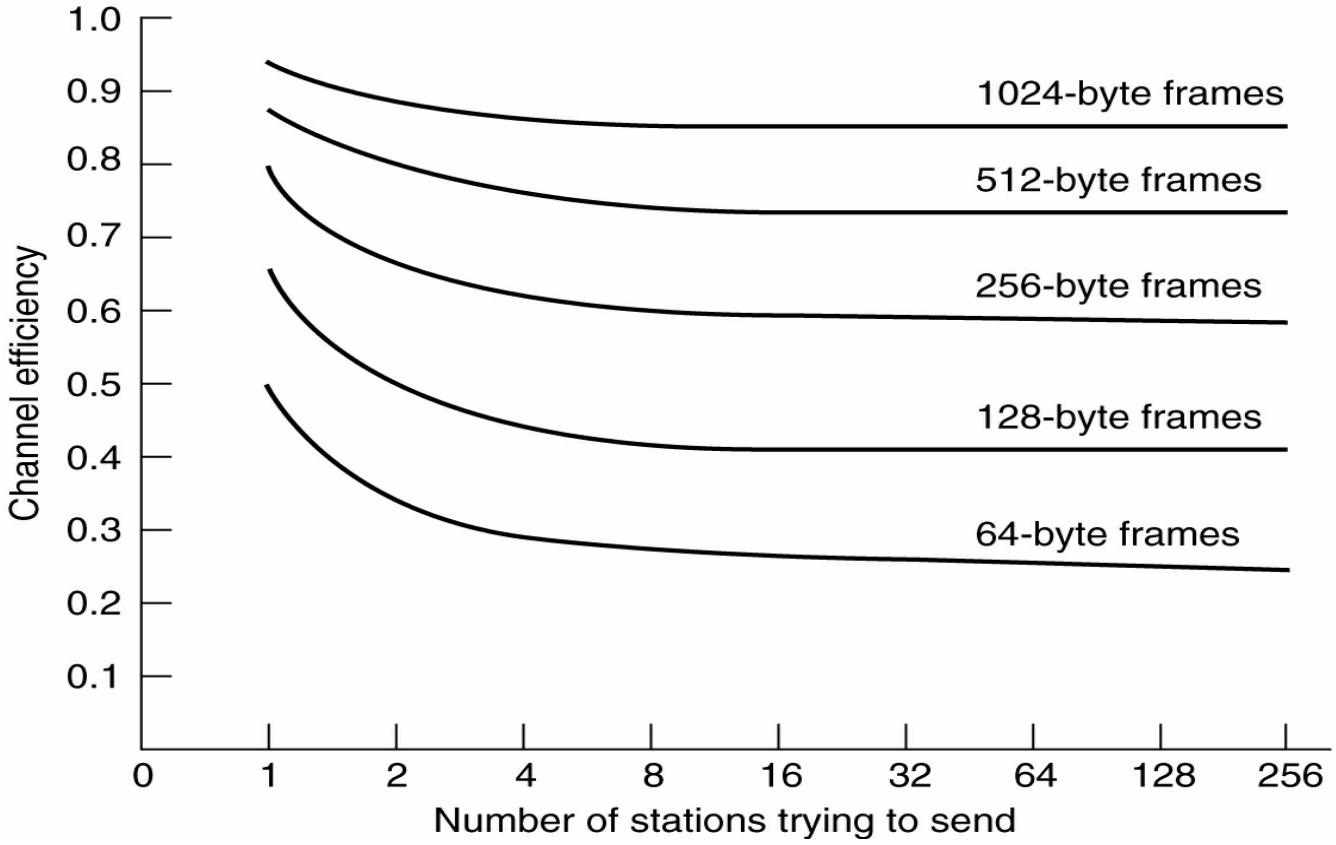


Summary of Ethernet Implementations

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

Ethernet Performance

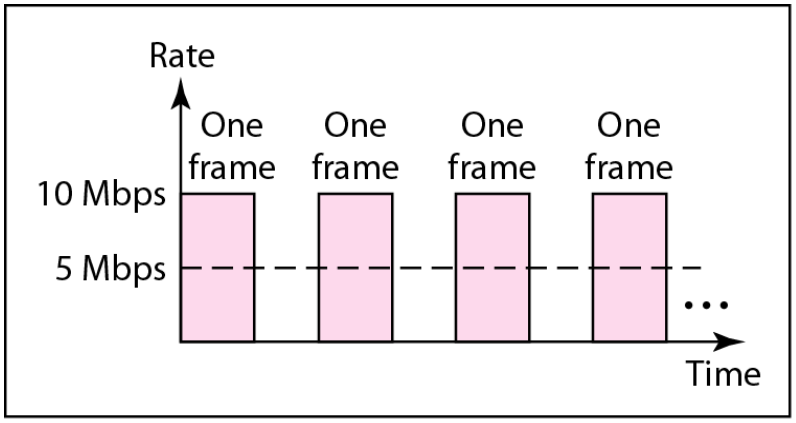
Efficiency of Ethernet at 10 Mbps with 512-bit slot times.



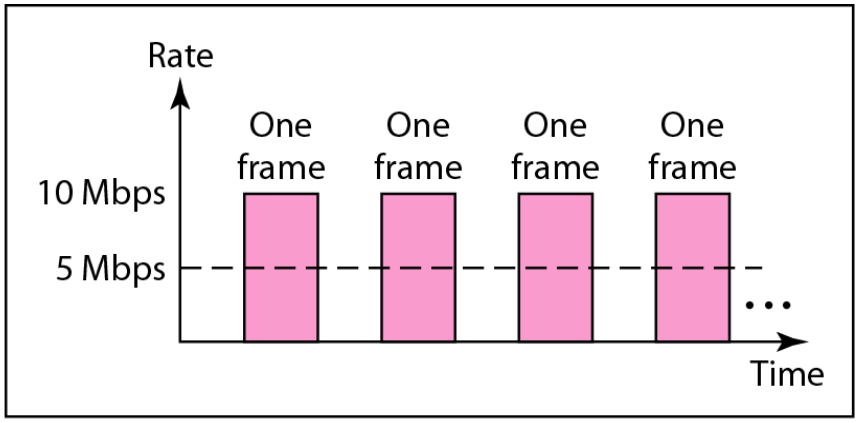
Lecture Outline

- Ethernet
- **Switched Ethernet**
- Fast Ethernet
- Giga Ethernet
- Logical Link Control

Sharing Bandwidth

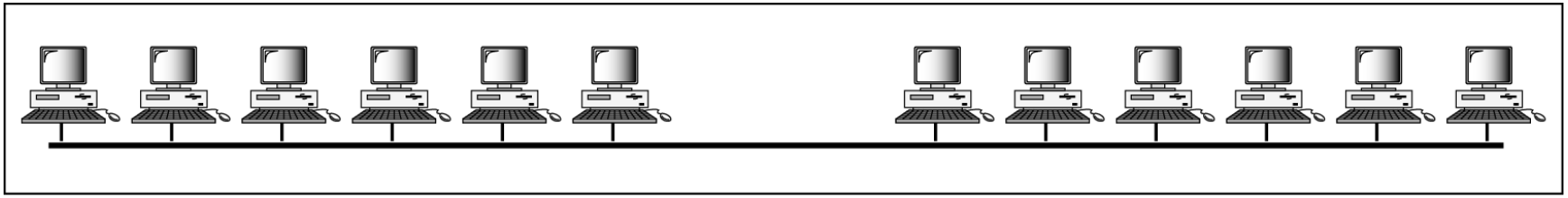


a. First station

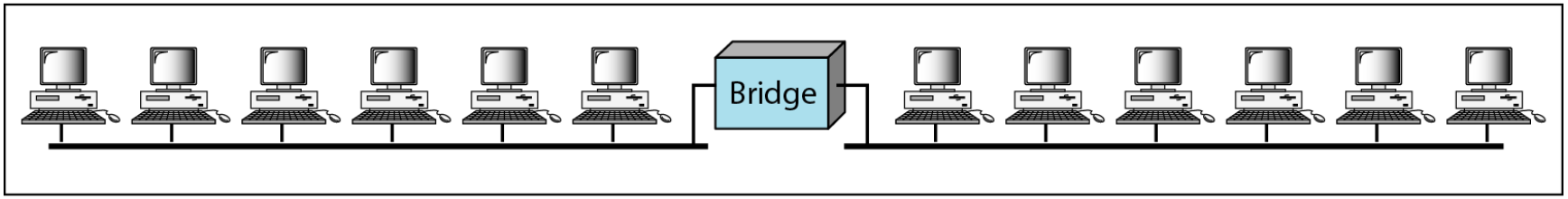


b. Second station

Bridged Ethernet

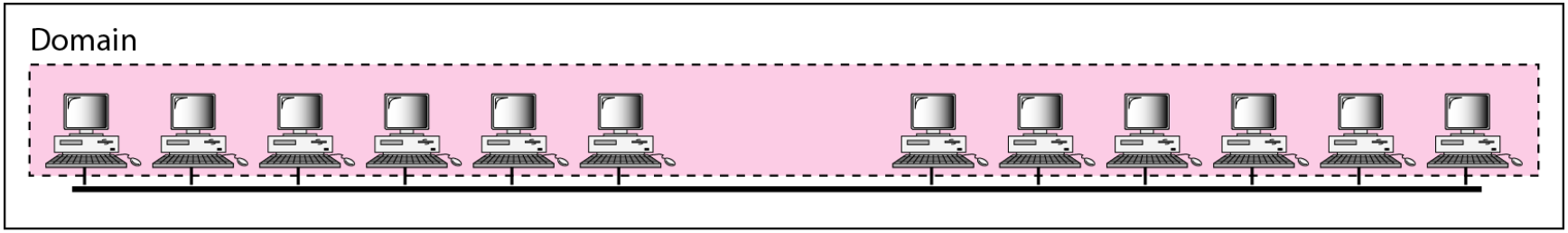


a. Without bridging

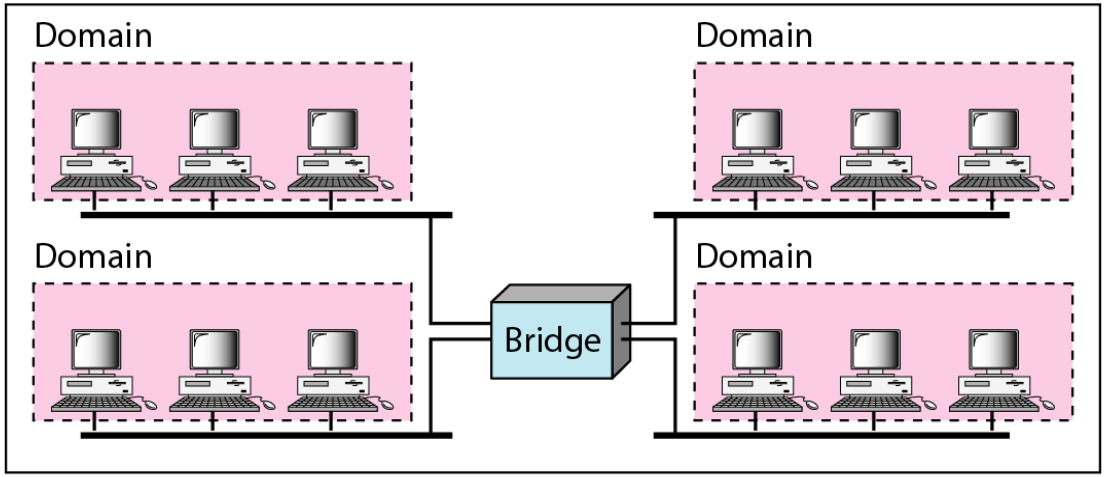


b. With bridging

Change in Collision Domain

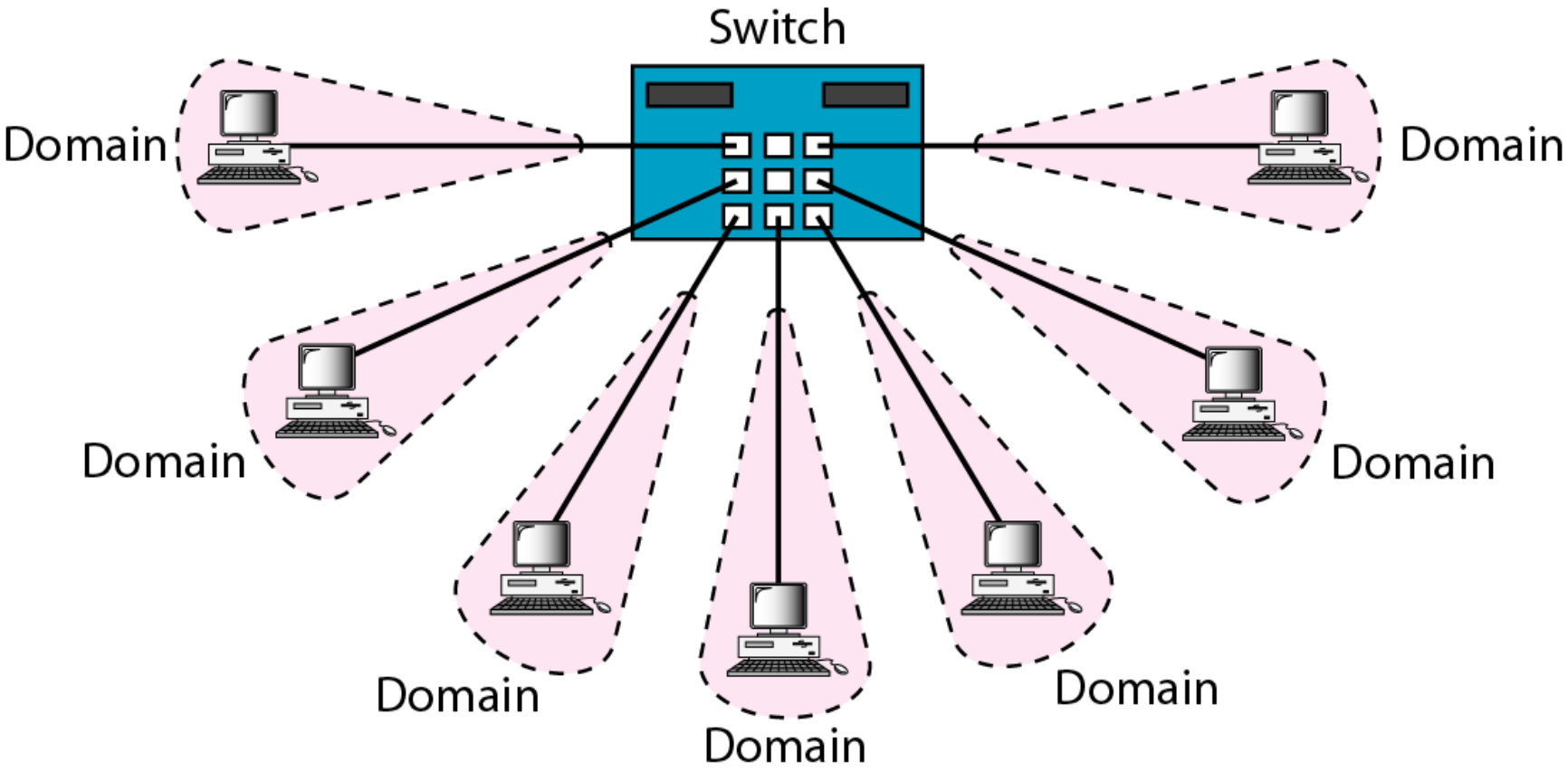


a. Without bridging

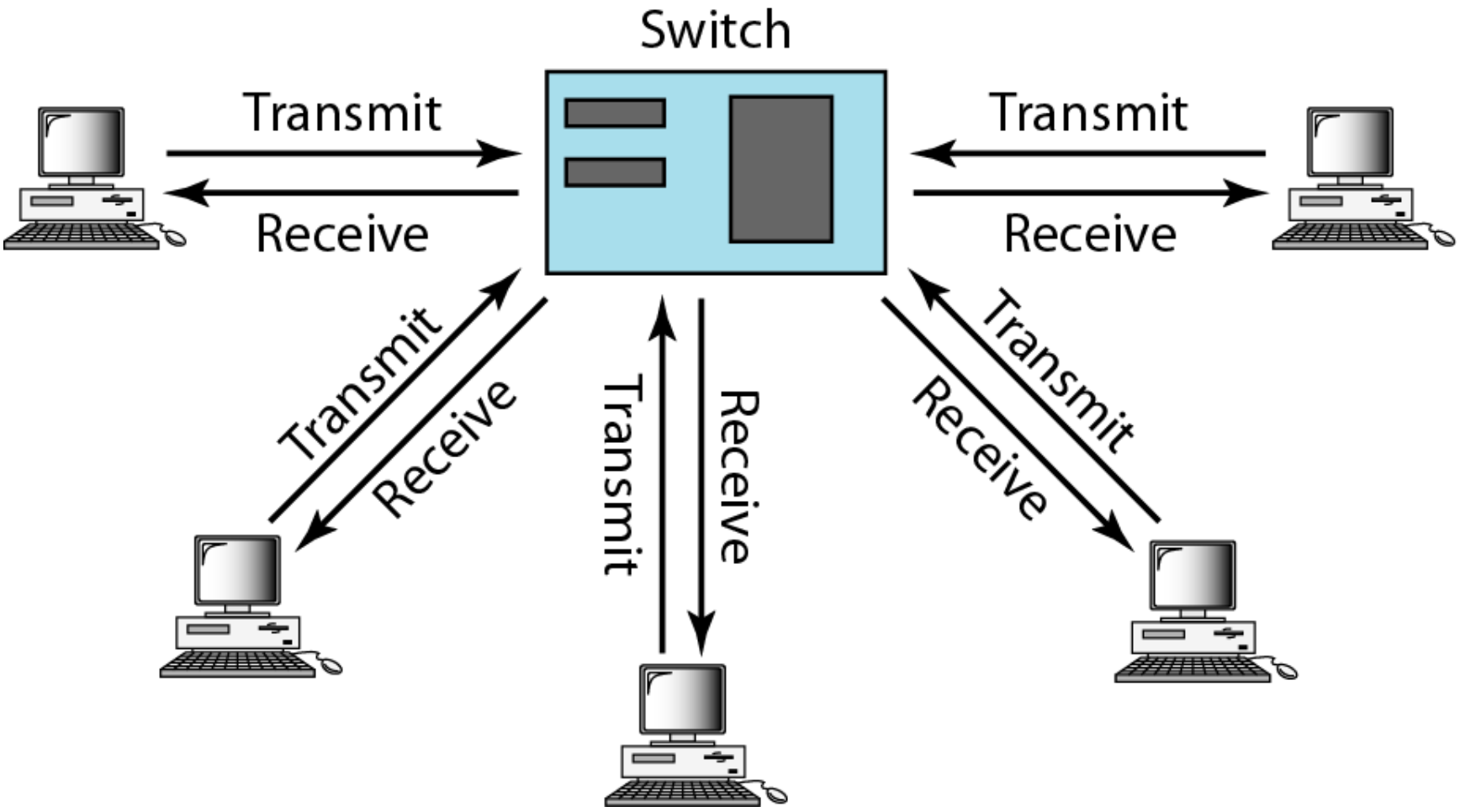


b. With bridging

Switched Ethernet



Full Duplex Switch



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Why Fast Ethernet?

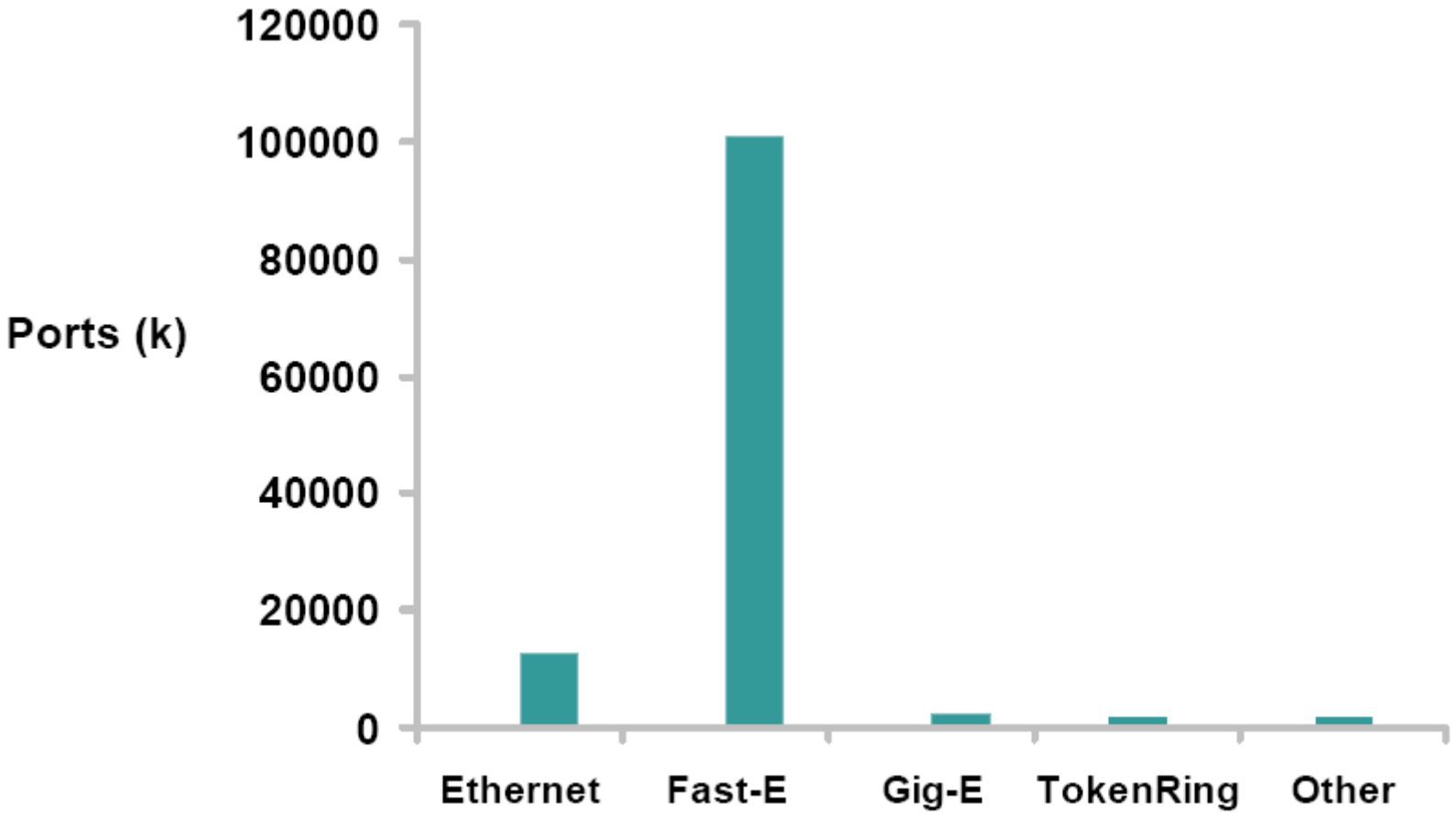
Fast Ethernet was designed to compete with LAN protocols such as FDDI or Fiber Channel. IEEE created Fast Ethernet under the name 802.3u. Fast Ethernet is backward-compatible with Standard Ethernet, but it can transmit data 10 times faster at a rate of 100 Mbps.

The Thing About Records…

Congratulations. I knew the record would stand until it was broken.

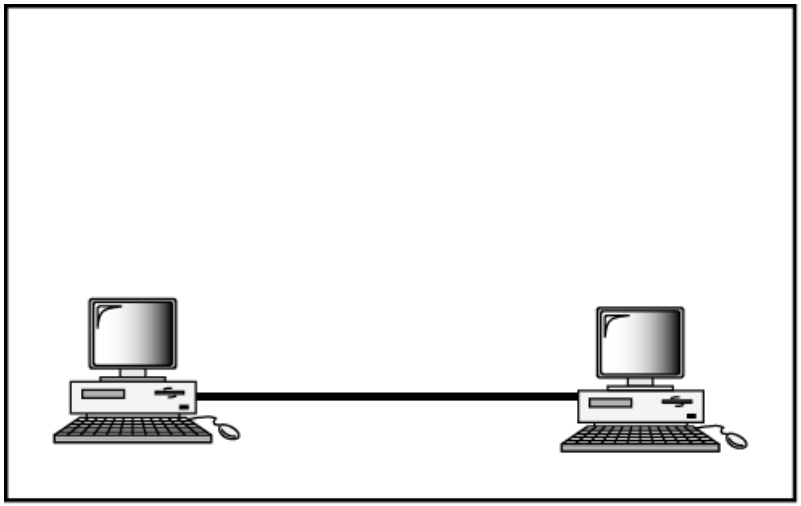
Yogi Berra

Ethernet Ports Shipped in 2000

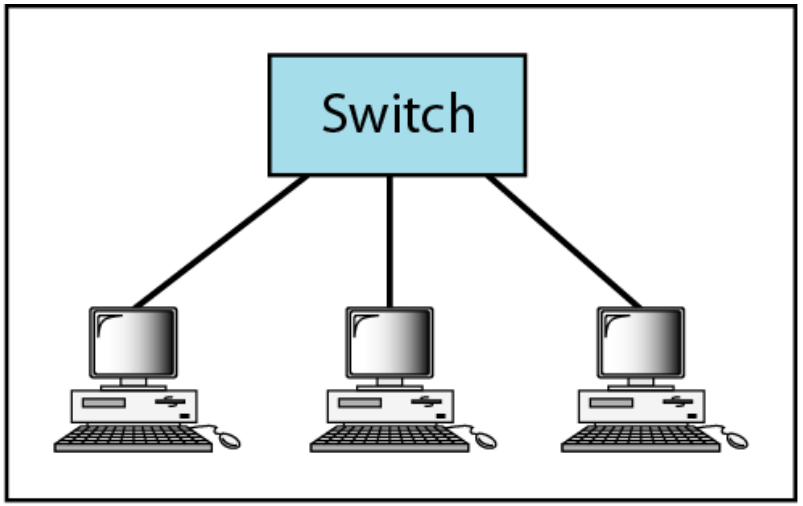


Source: Cahners In-Stat group

Fast Ethernet Topologies

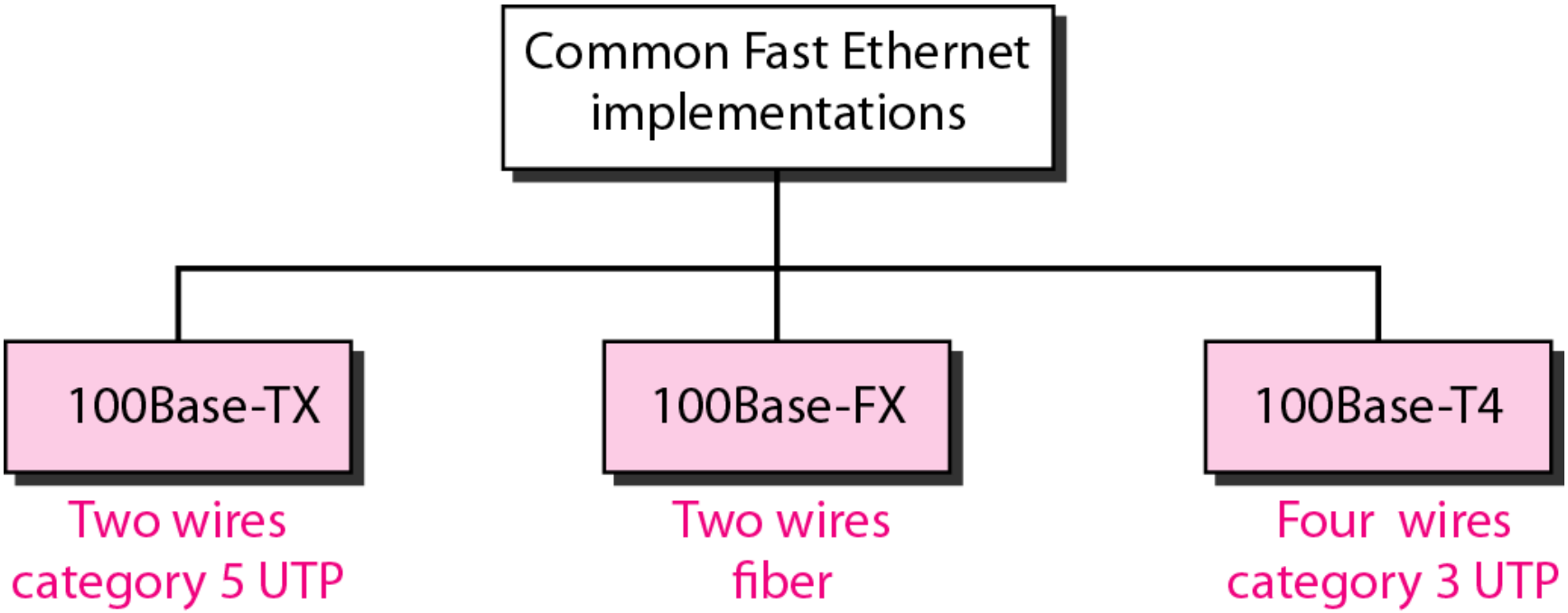


a. Point-to-point

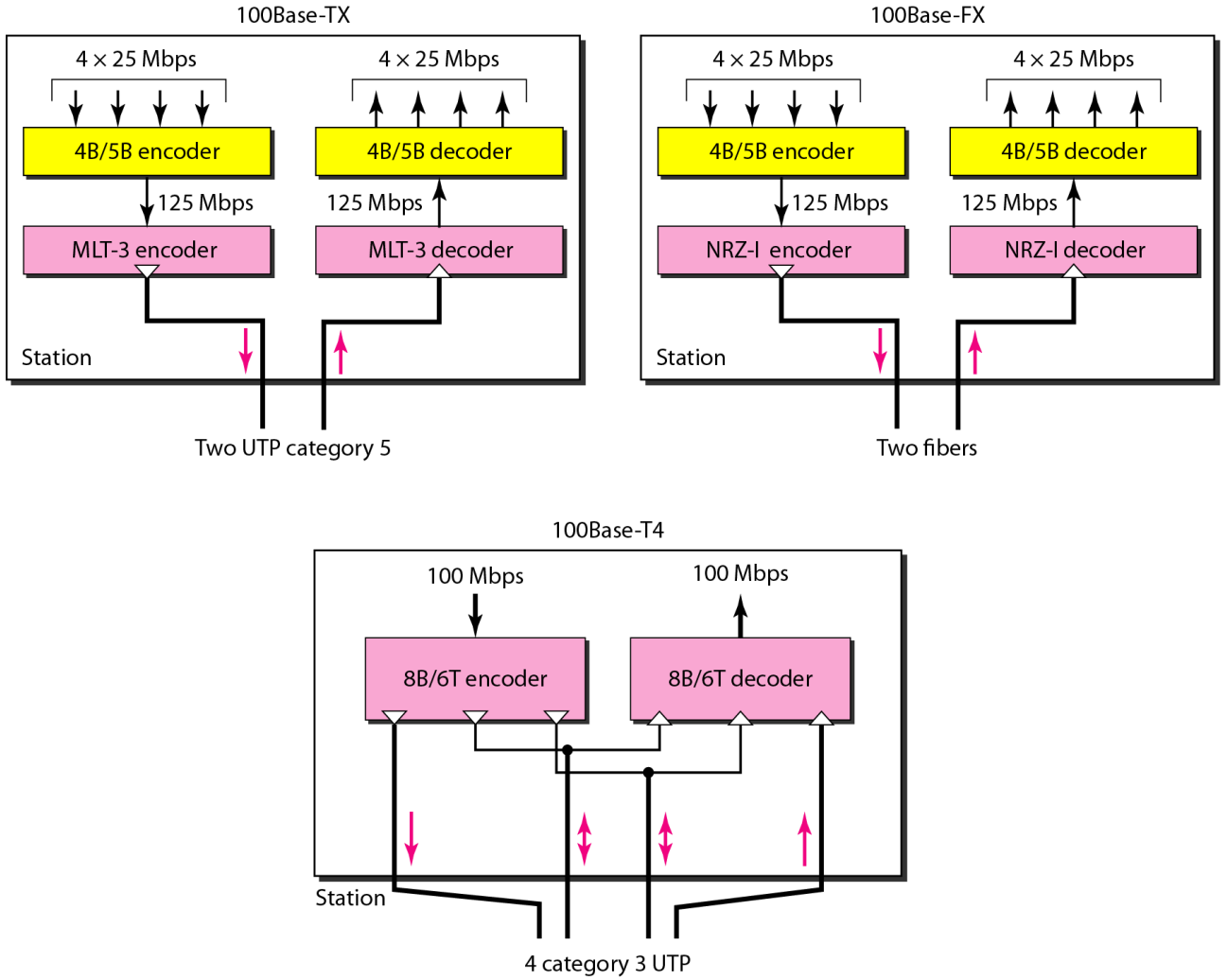


b. Star

Fast Ethernet Implementations



Channel Encoding for Fast Ethernet



Fast Ethernet Summary

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

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- Ethernet
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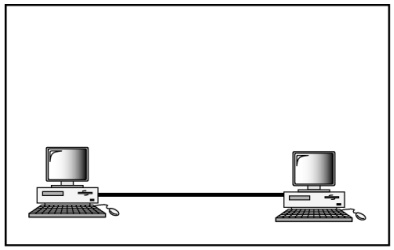
- **Giga Ethernet**
- Logical Link Control

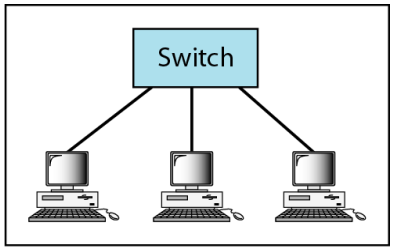
Gigabit Ethernet

- *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.

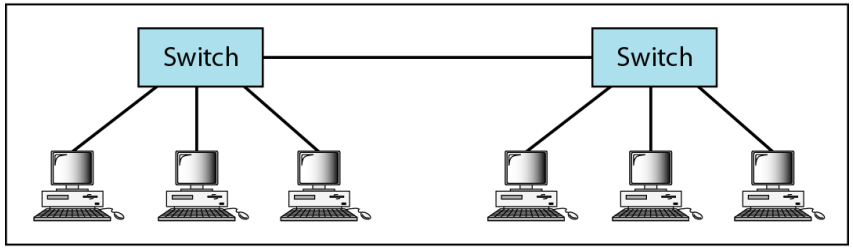
Topologies of Gigabit Ethernet



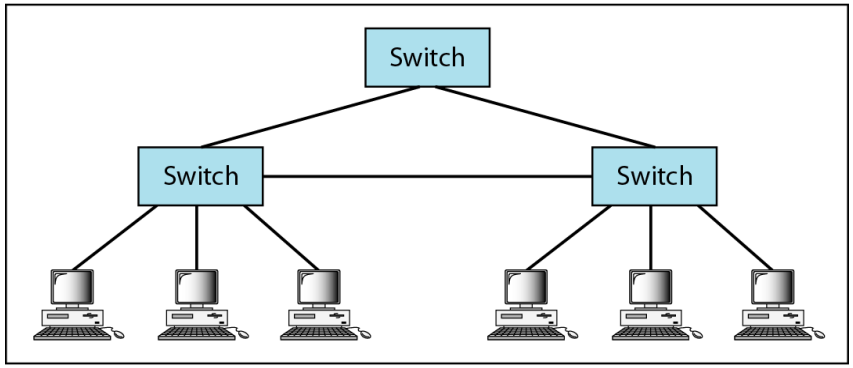
a. Point-to-point



b. Star

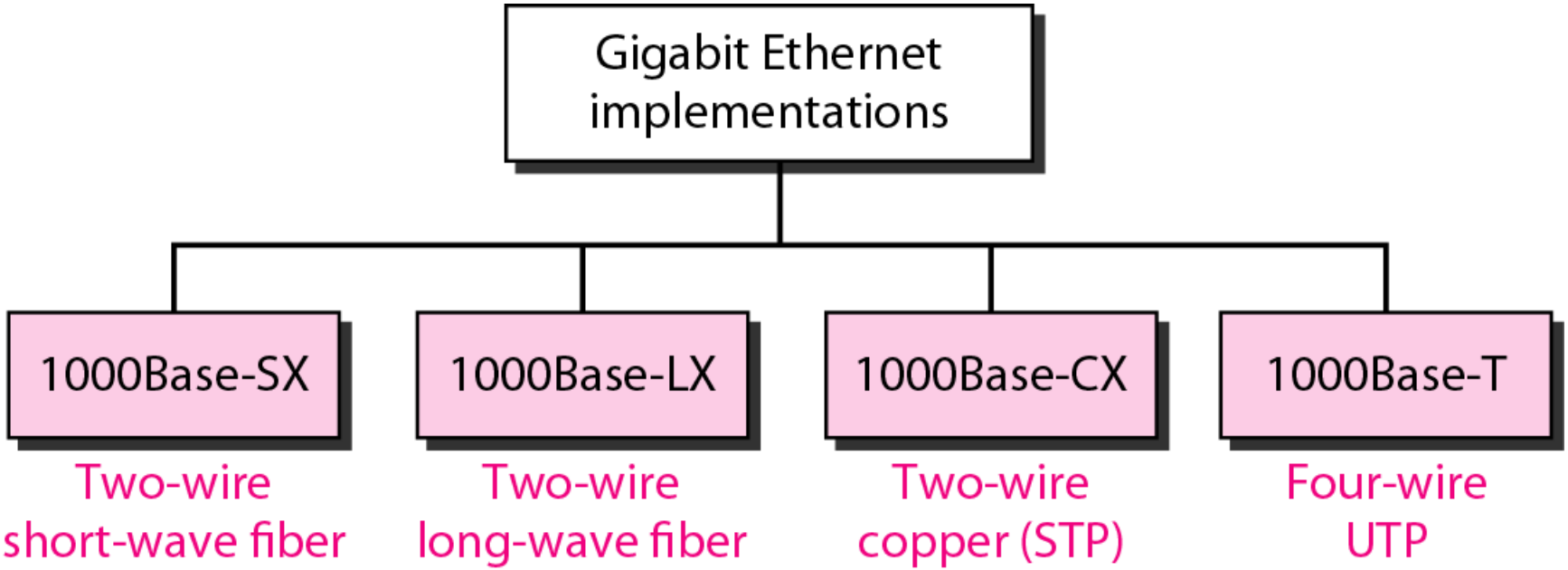


c. Two stars

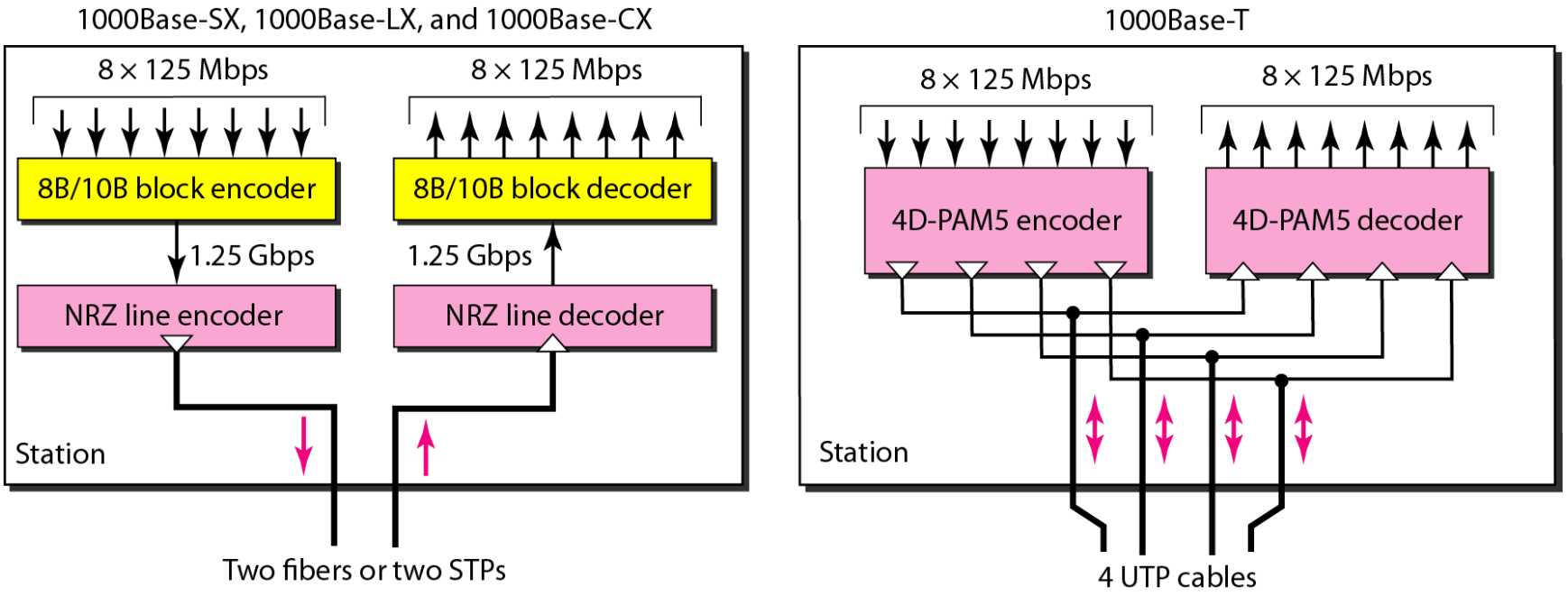


d. Hierarchy of stars

Gigabit Ethernet Implementations



Line Encoding



Gigabit Ethernet Summary

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

10 Gigabit Ethernet Standard

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

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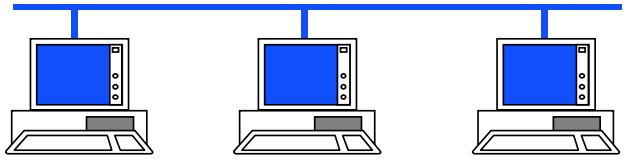
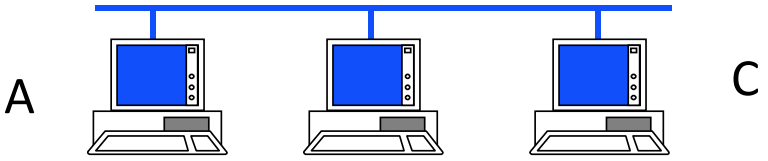
- **Logical Link Control**

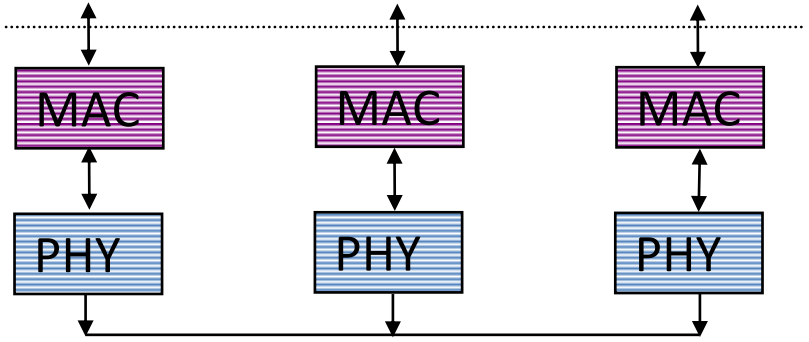
Logical Link Control (LLC) Sublayer

- IEEE 802.2: LLC enhances service provided by MAC

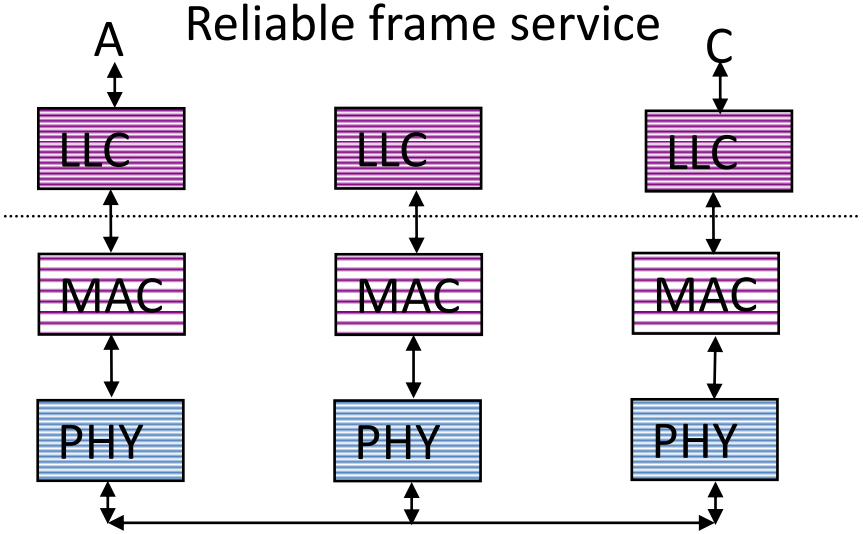




Unreliable Datagram Service



Reliable frame service



LLC Services

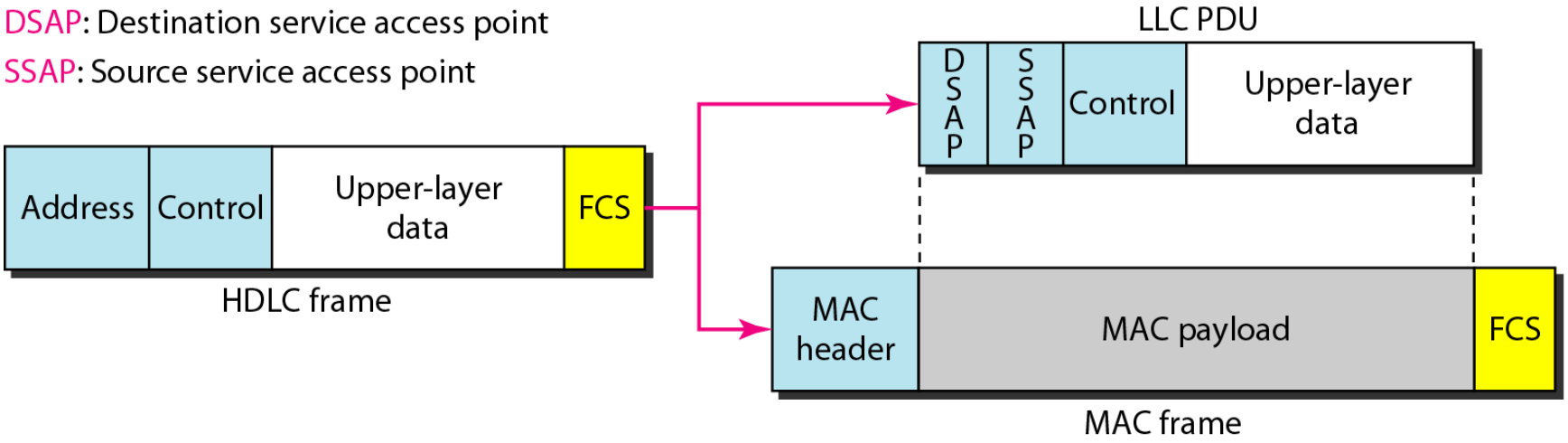
- Type 1: Unacknowledged connectionless service
  - Unnumbered frame mode of HDLC
- Type 2: Reliable connection-oriented service
  - Asynchronous balanced mode of HDLC
- Type 3: Acknowledged connectionless service

- Additional addressing
  - A workstation has a single MAC physical address
  - Can handle several logical connections, distinguished by their SAP (service access points)

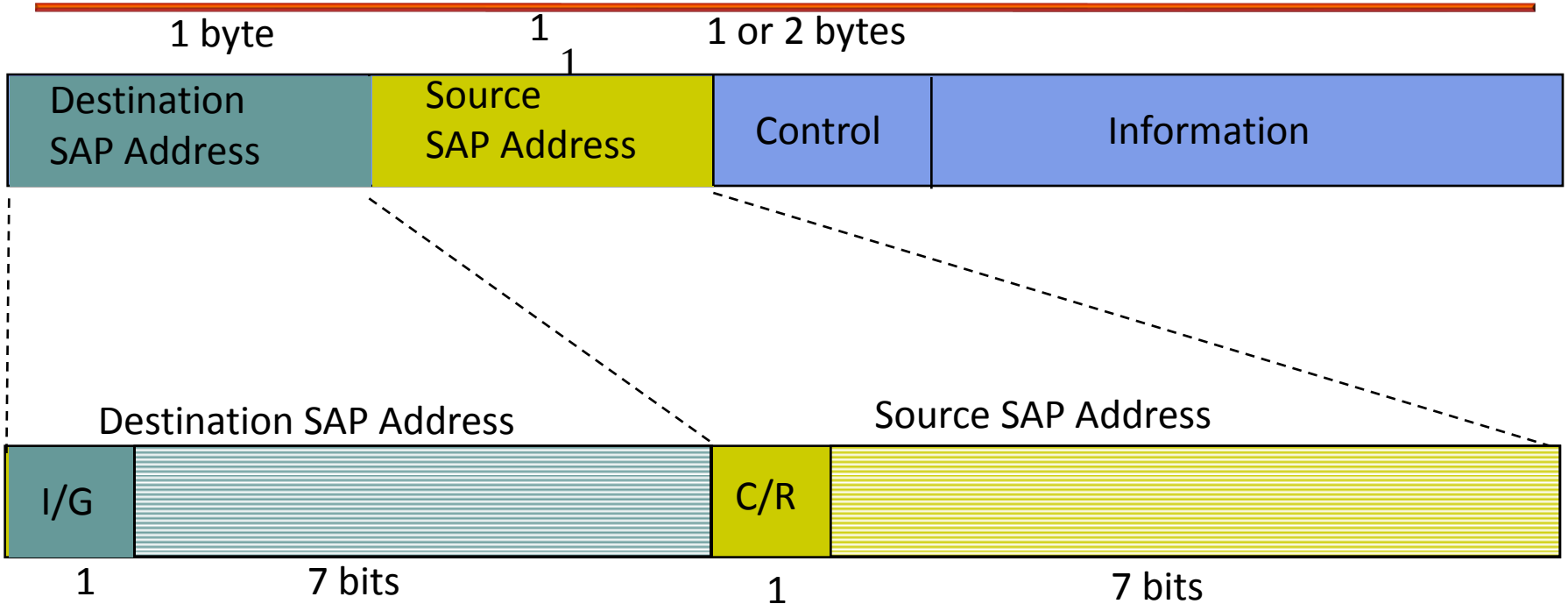
HDLC vs LLC+MAC Frames

DSAP: Destination service access point

SSAP: Source service access point



LLC PDU Structure

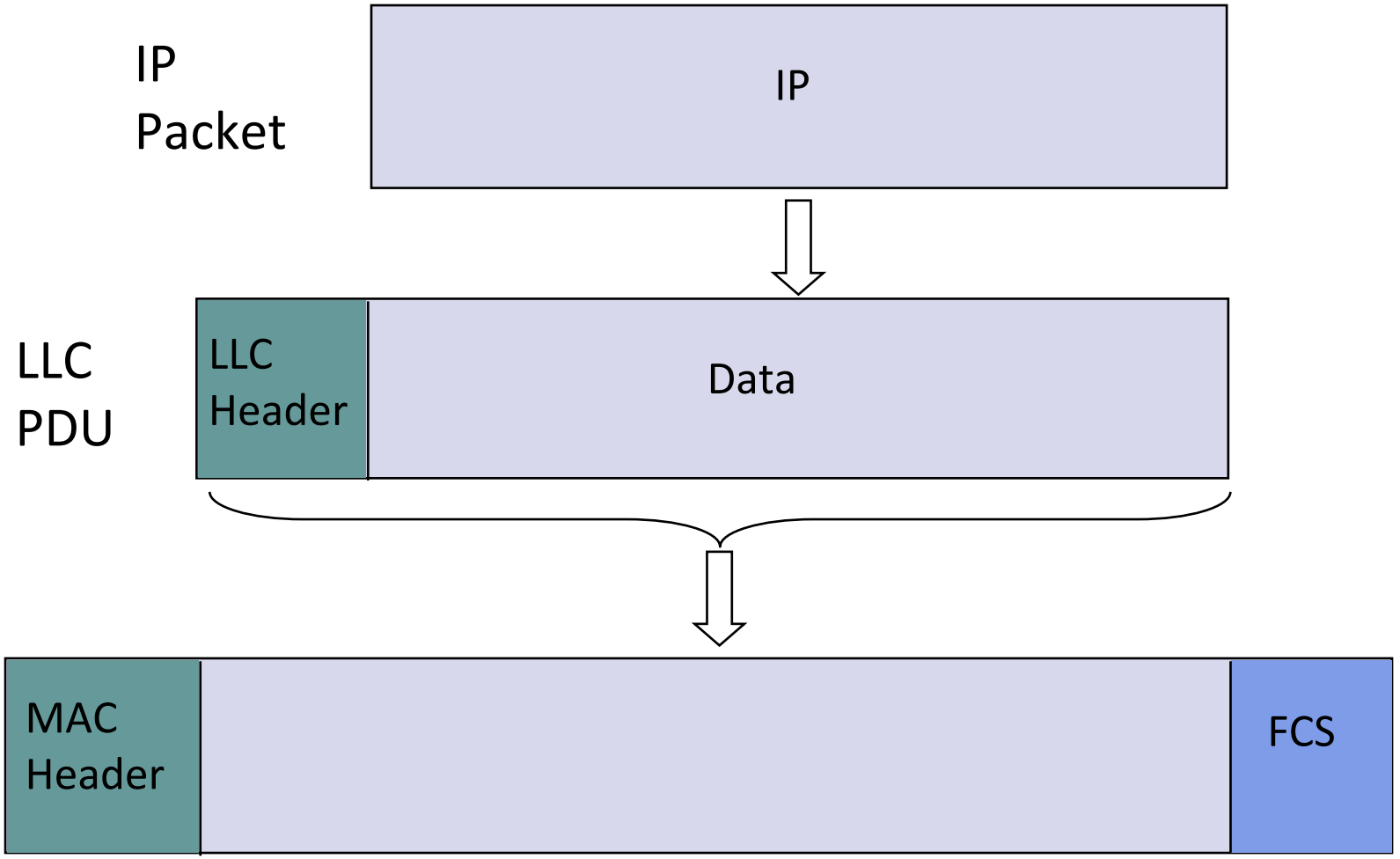


I/G = Individual or group address
C/R = Command or response frame

Examples of SAP Addresses:

06	IP packet
E0	Novell IPX
FE	OSI packet
AA	SubNetwork Access protocol (SNAP)

Encapsulation of MAC Frames



Typical Ethernet Deployment