

Wired LANs and Ethernet

Outline

- IEEE standards for LAN/MAN/WAN
- Traditional Ethernet
- Unicast and multicast addresses
- Fast Ethernet
- Gigabit Ethernet
- Ten-Gigabit Ethernet

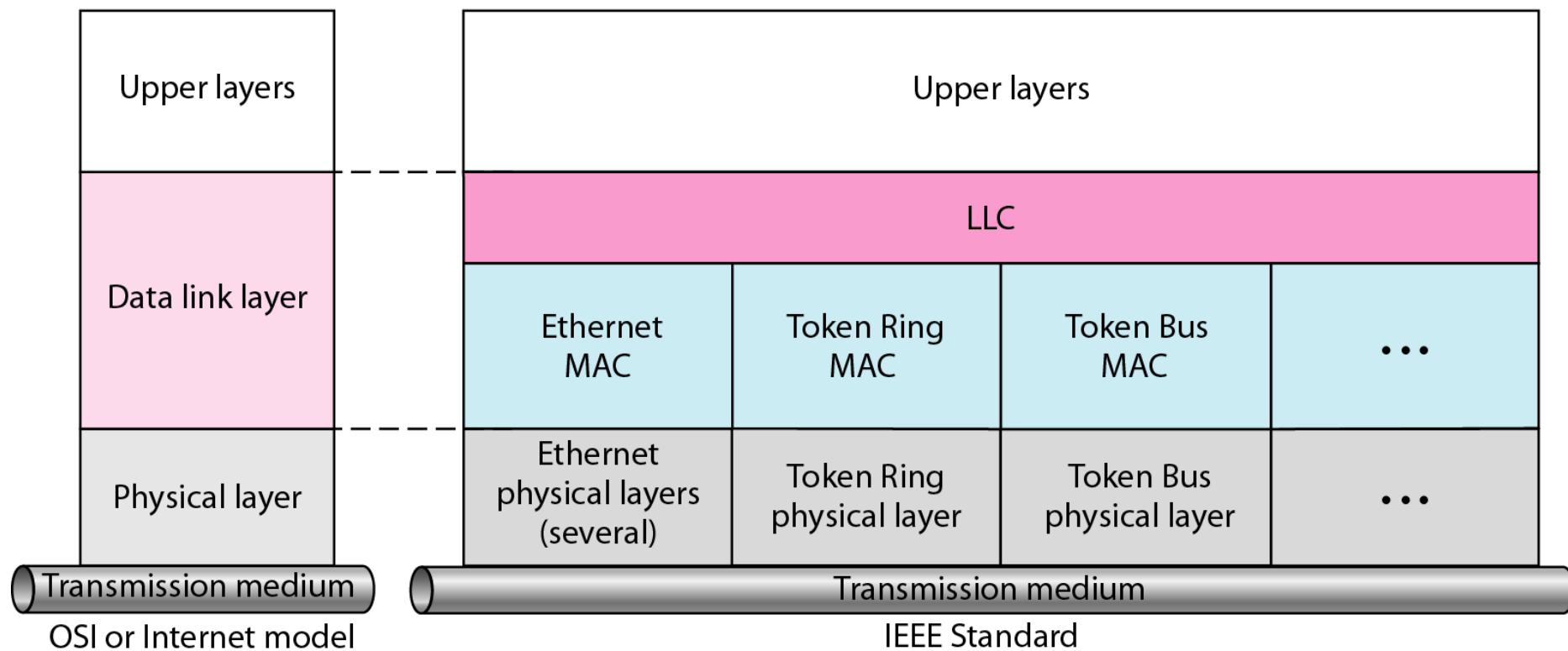
IEEE Standards

- Project 802
 - standards for enabling **intercommunication** among equipment from a **variety of manufacturers**
- E.g.,
 - IEEE 802.3 → Ethernet
 - IEEE 802.11 → Wireless LAN (Wi-Fi)
 - IEEE 802.15 → Wireless PAN (Bluetooth, *etc*)
- http://en.wikipedia.org/wiki/IEEE_802

IEEE Standards for LANs

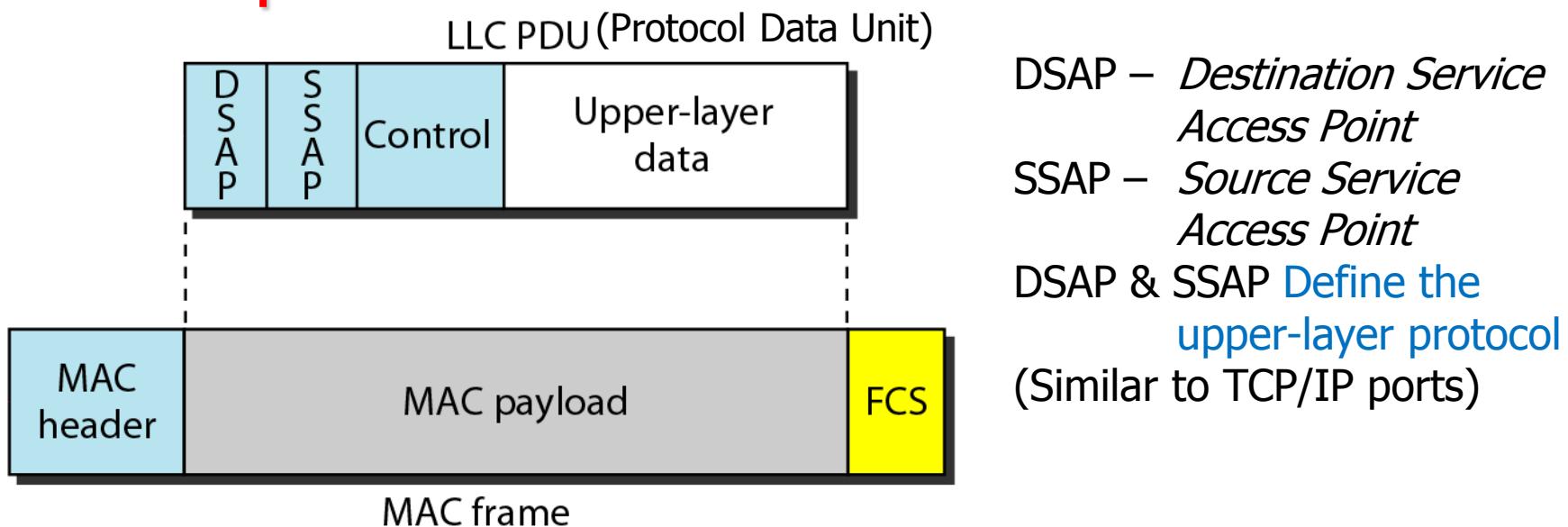
LLC: Logical link control

MAC: Media access control



Logical Link Control Sublayer

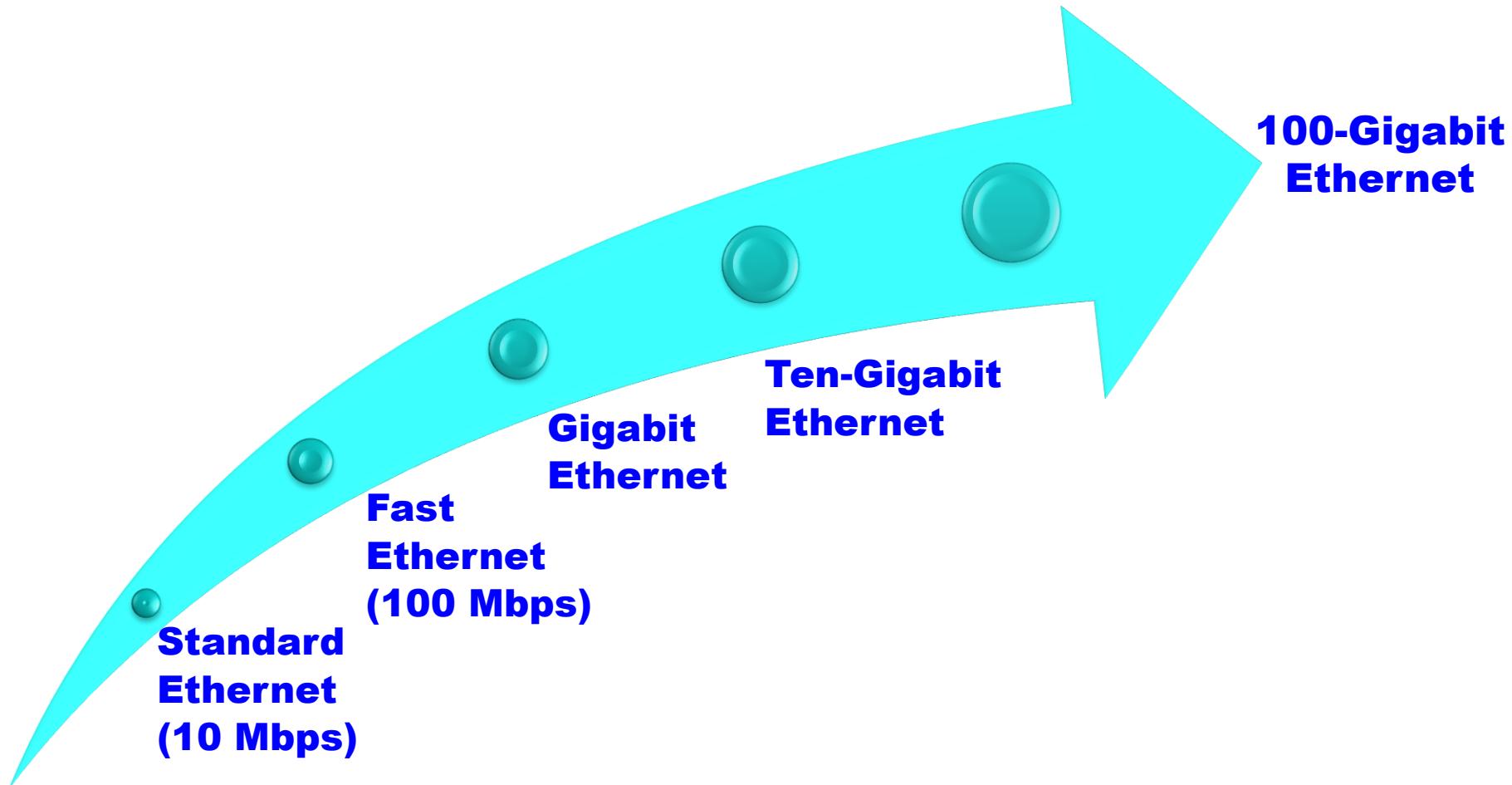
- Provides flow and error control for upper layer protocols that actually demand these services
- Most upper layer protocols (such as IP) do not require such services



Wired Ethernet

- "Traditional" or "Original" Ethernet created at [Xerox's Palo Alto Research Center](#) (PARC) in 1976
- Ethernet standards are set by [IEEE 802.3](#) working group
- It defines [CSMA/CD](#) as the media access method for Ethernet LANs.

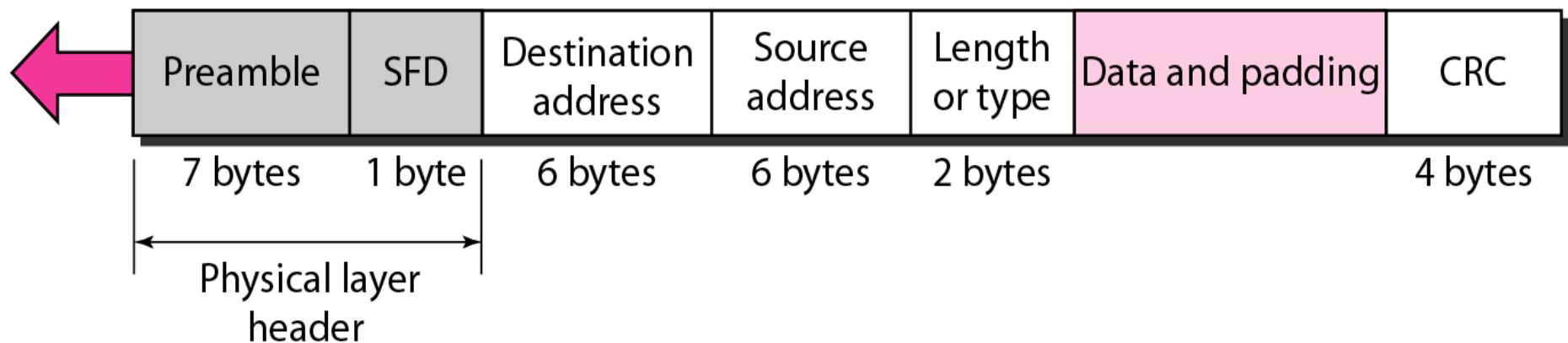
Evolution of Ethernet



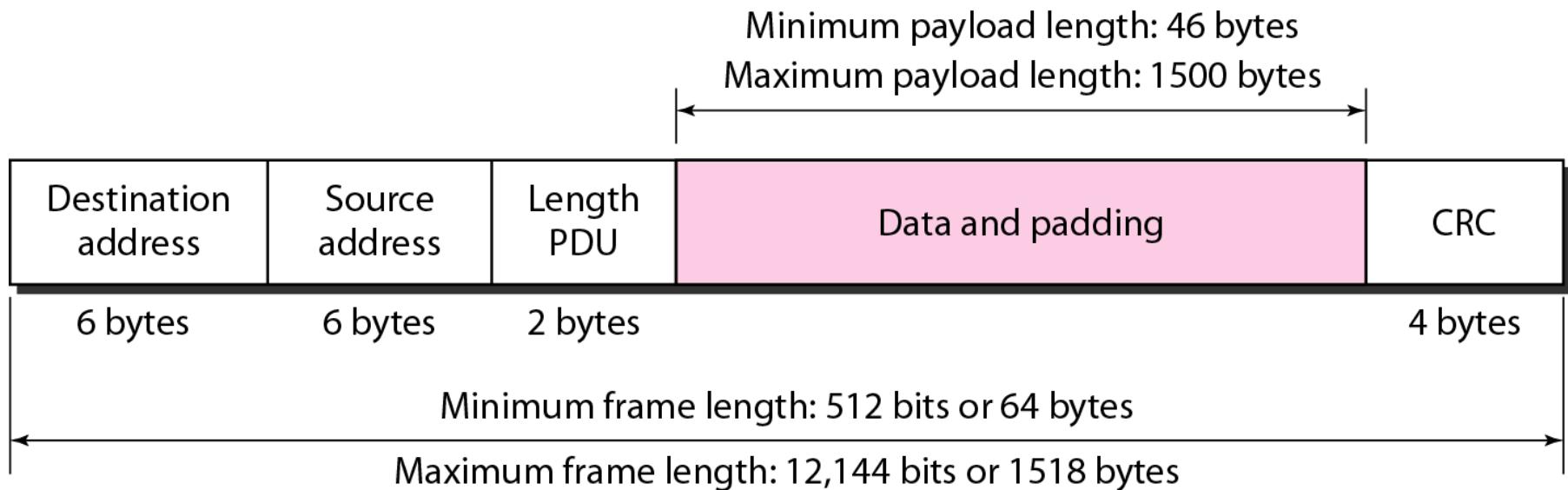
IEEE 802.3 MAC Frame

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

SFD: Start frame delimiter, flag (10101011)



Min and Max Frame Length



Ethernet Addresses

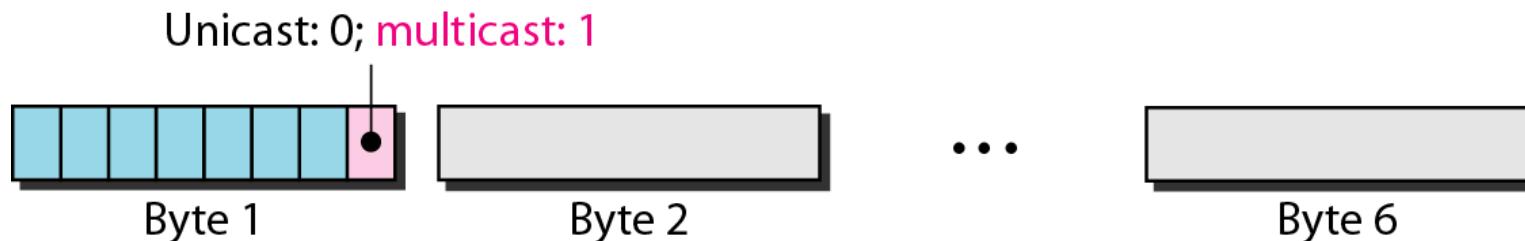
- 48 bits (**6 bytes**) in length
- **Uniquely** assigned to each Ethernet network interface card (**NIC**)
- Usually written in hexadecimal notation
- E.g.,

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

6 bytes = 12 hex digits = 48 bits

Unicast vs. Multicast Addresses

- A **unicast address** defines one recipient
 - A **multicast address** defines a group of recipients
 - The **broadcast address** defines a group of all stations in the same LAN
 - A special case of multicast addresses
 - All bits are **1s**



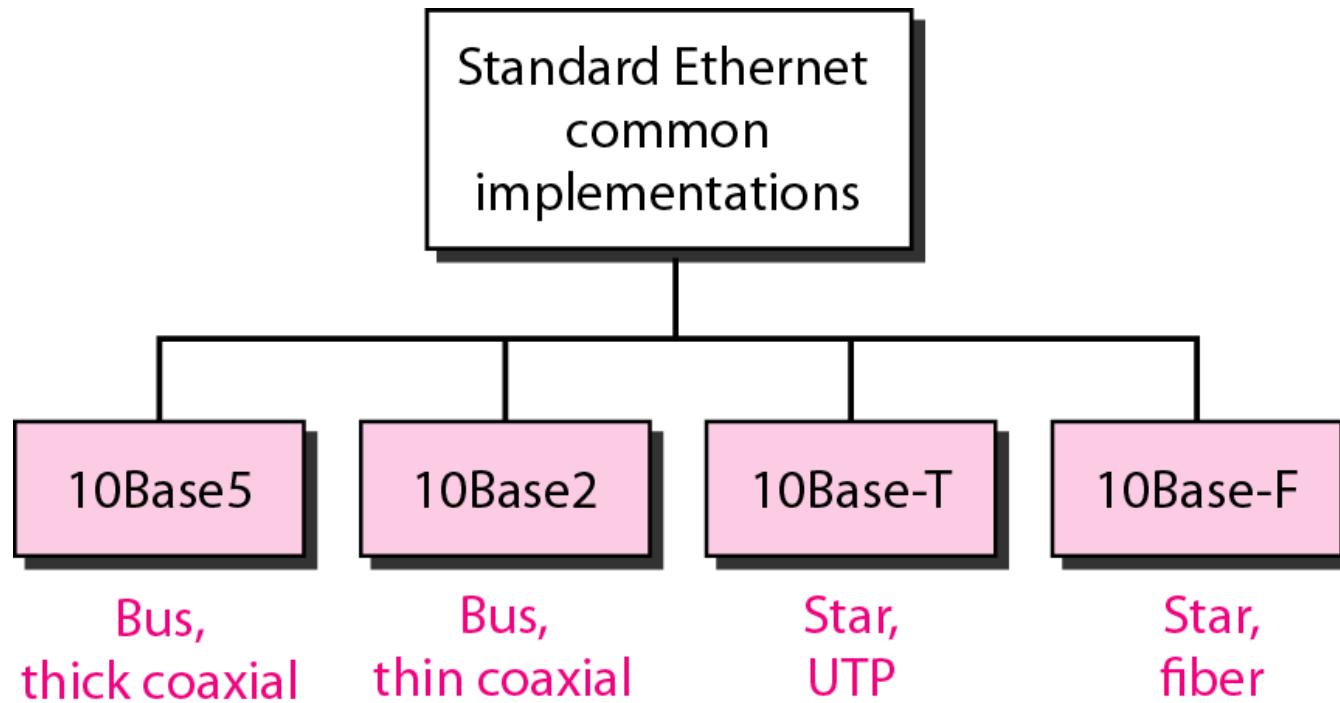
Example

- Define the type of the following destination addresses:
 - 4A:30:10:21:10:1A
 - 47:20:1B:2E:08:EE
 - FF:FF:FF:FF:FF:FF

Standard Ethernet

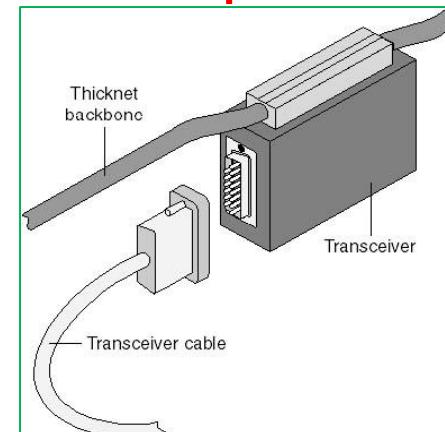
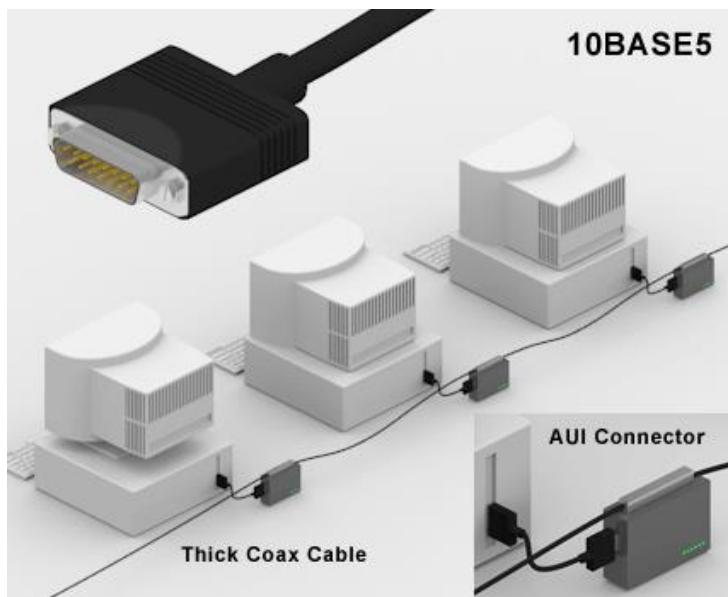
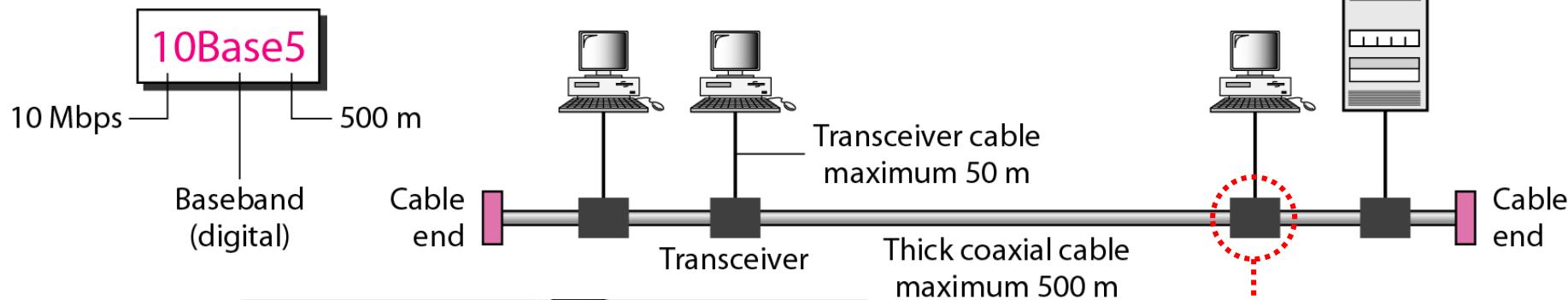
6:00 AM

Categories of Standard Ethernet

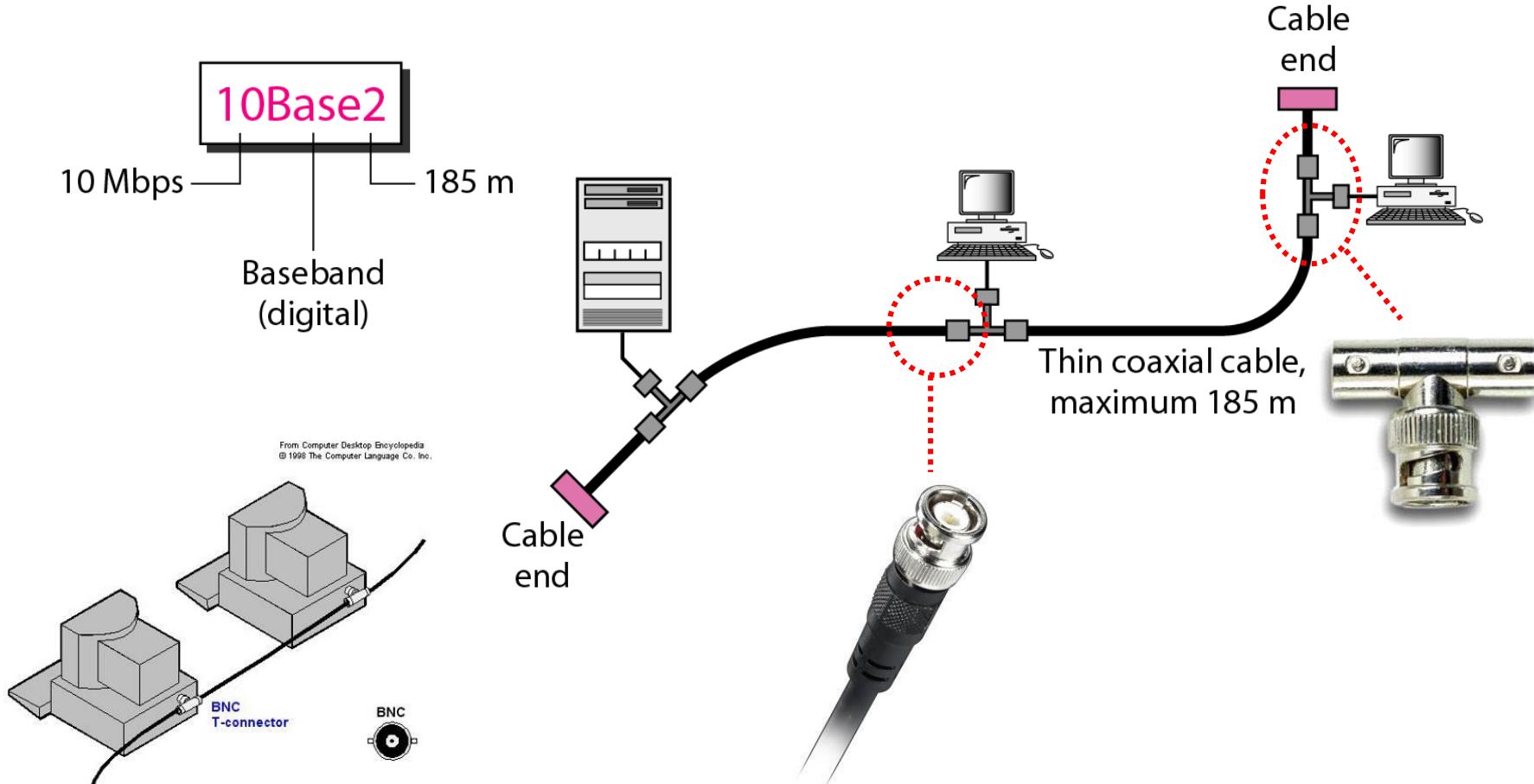


10Base5 Implementation

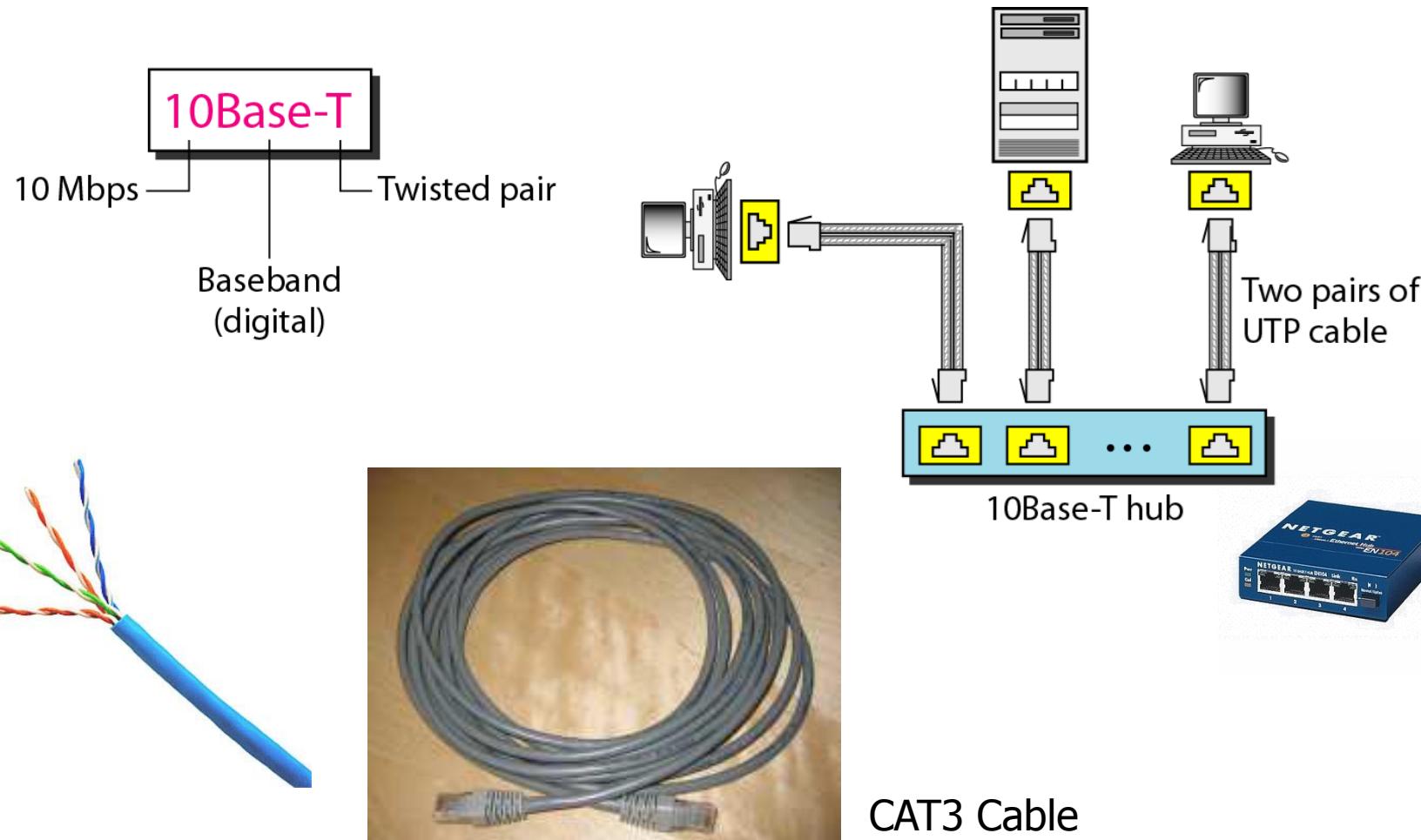
The **transceiver** is responsible for transmitting, receiving, and detecting collisions.



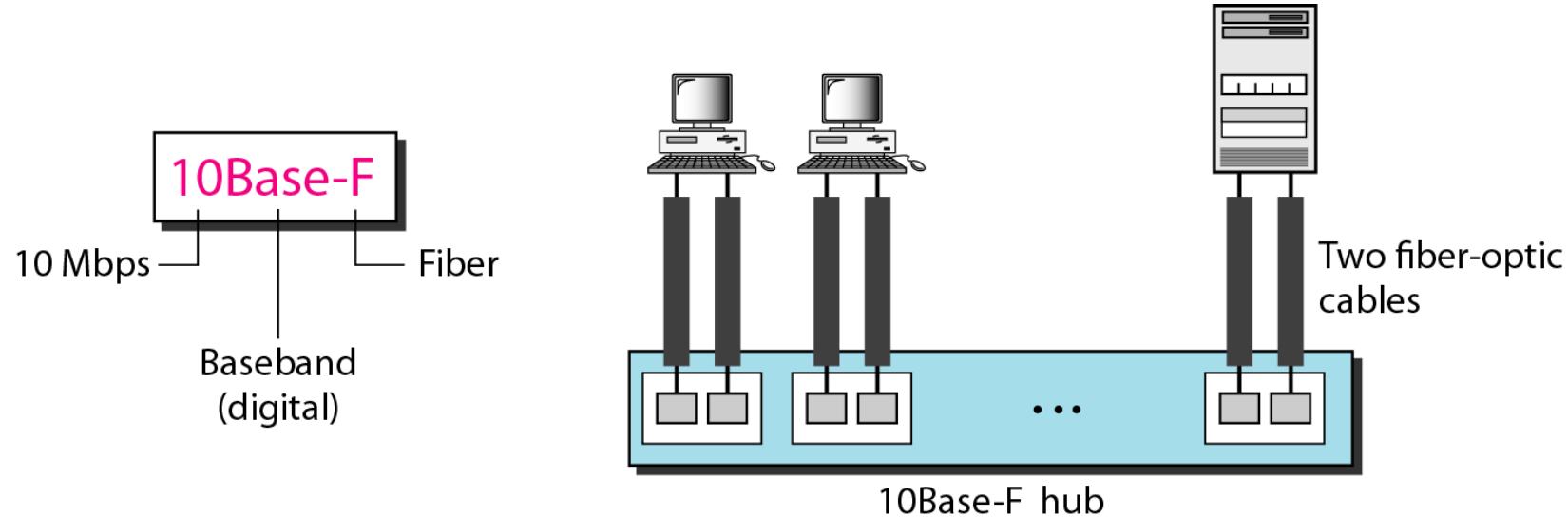
10Base2 Implementation



10Base-T Implementation



10Base-F Implementation

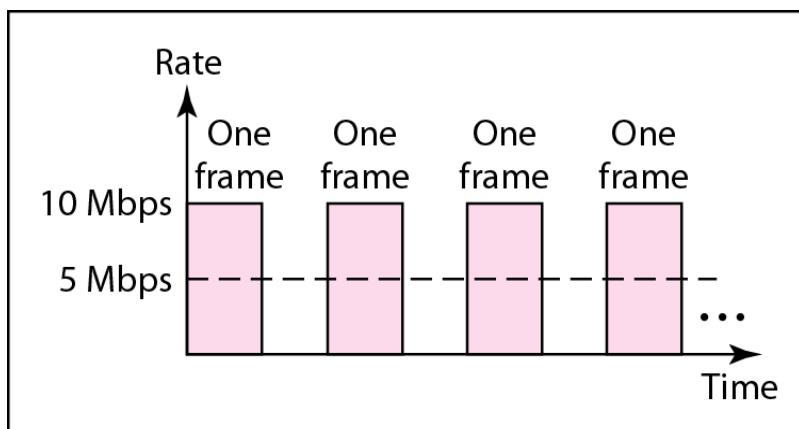


Standard Ethernet Summary

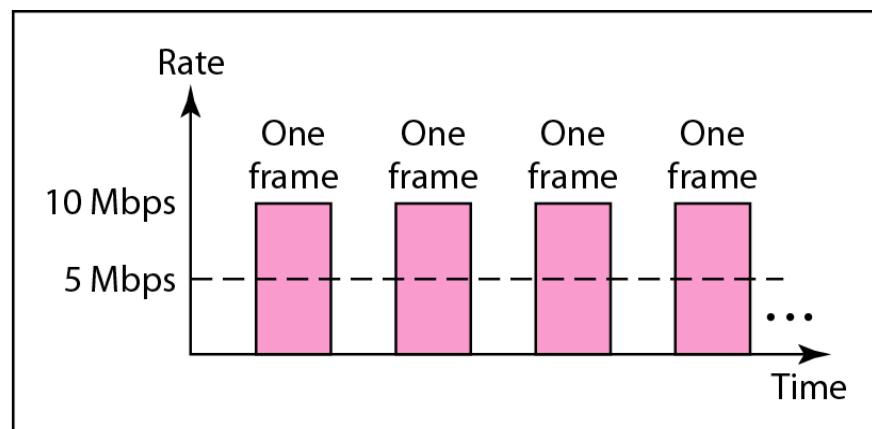
<i>Characteristics</i>	<i>10Base5</i>	<i>10Base2</i>	<i>10Base-T</i>	<i>10Base-F</i>
Media	Thick coaxial cable	Thin coaxial cable	2 UTP	2 Fiber
Maximum length	500 m	185 m	100 m	2000 m
Line encoding	Manchester	Manchester	Manchester	Manchester

Raising the Bandwidth

- The total capacity (10 Mbps) is **shared** among all stations.
- When one station is sending, the other one refrains from sending.



a. First station



b. Second station

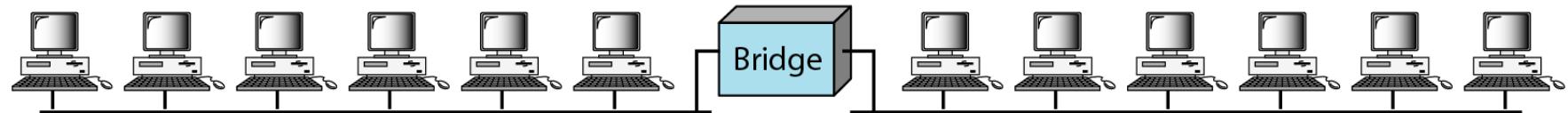
Each station **on average**, sends at a rate of **5 Mbps**.

Bridged Ethernet

- A bridge **divides** a network into two or more **segments**
- Each segment is **independent** of one another, bandwidth-wise



a. Without bridging



b. With bridging

6:00 AM

Collision Domain

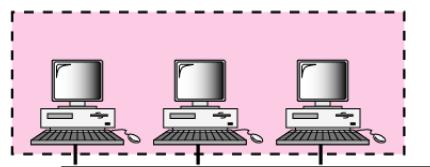
- Bridges help split collision domain into smaller ones

Domain

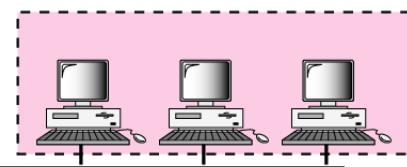


a. Without bridging

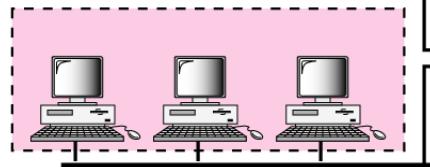
Domain



Domain



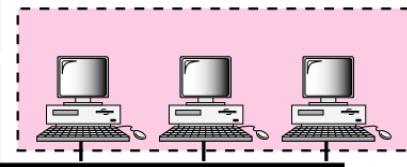
Domain



Bridge



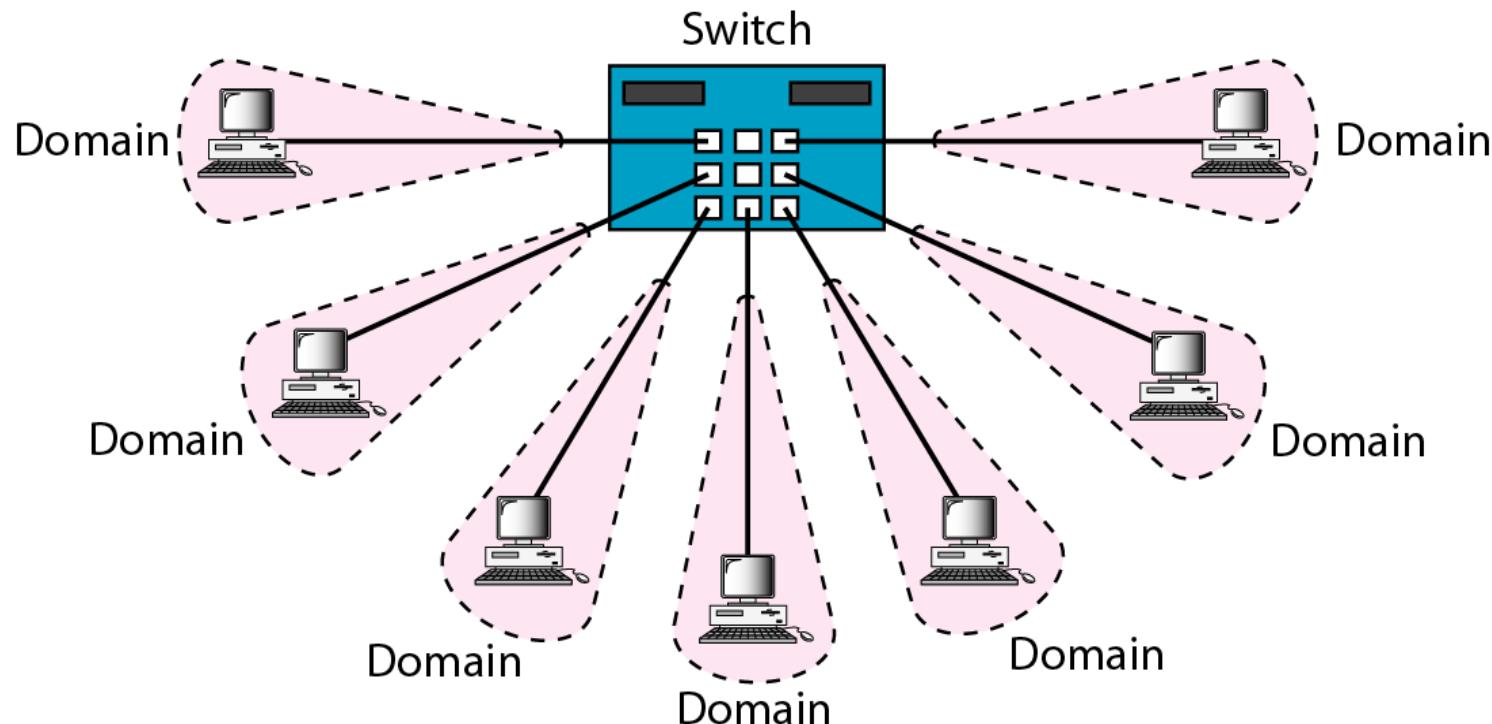
Domain



6:00 AM

b. With bridging

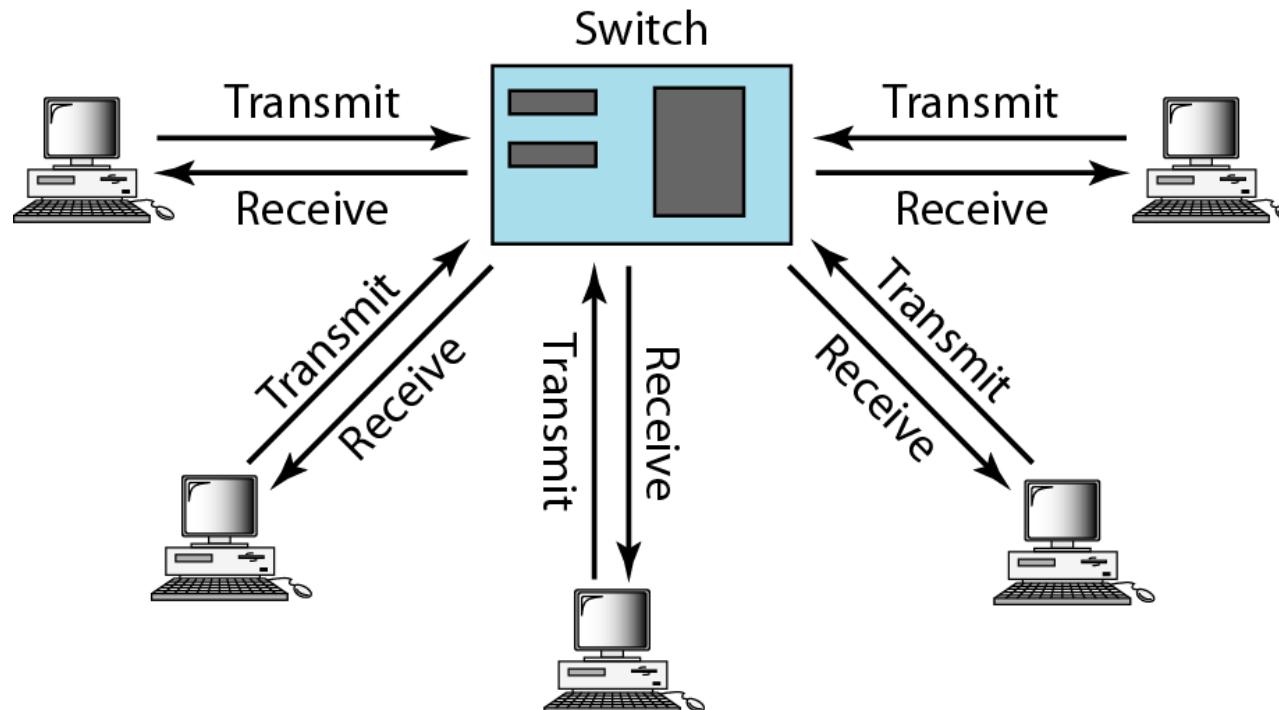
Switched Ethernet



- the bandwidth is shared only between the station and the switch (5 Mbps each).
- The collision domain is divided into N domains.

Full-Duplex Ethernet

- ❖ 10Base5 and 10Base2 networks is **half-duplex**, a station can either send or receive.
- ❖ 10Base-T is always **full-duplex**
- ❖ **Switched Ethernet in full-duplex mode increases the capacity of each domain from 10 to 20 Mbps.**

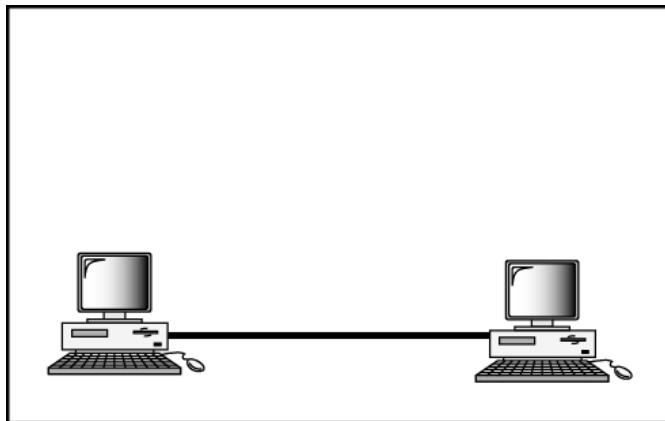


Fast Ethernet

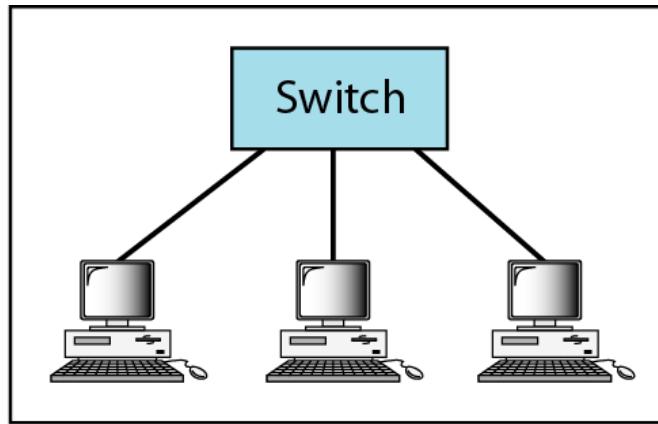
Fast Ethernet

- Data rate: **100 Mbps**
- Standard → IEEE 802.3u
- Backward-compatible with Standard Ethernet

Fast Ethernet Topologies

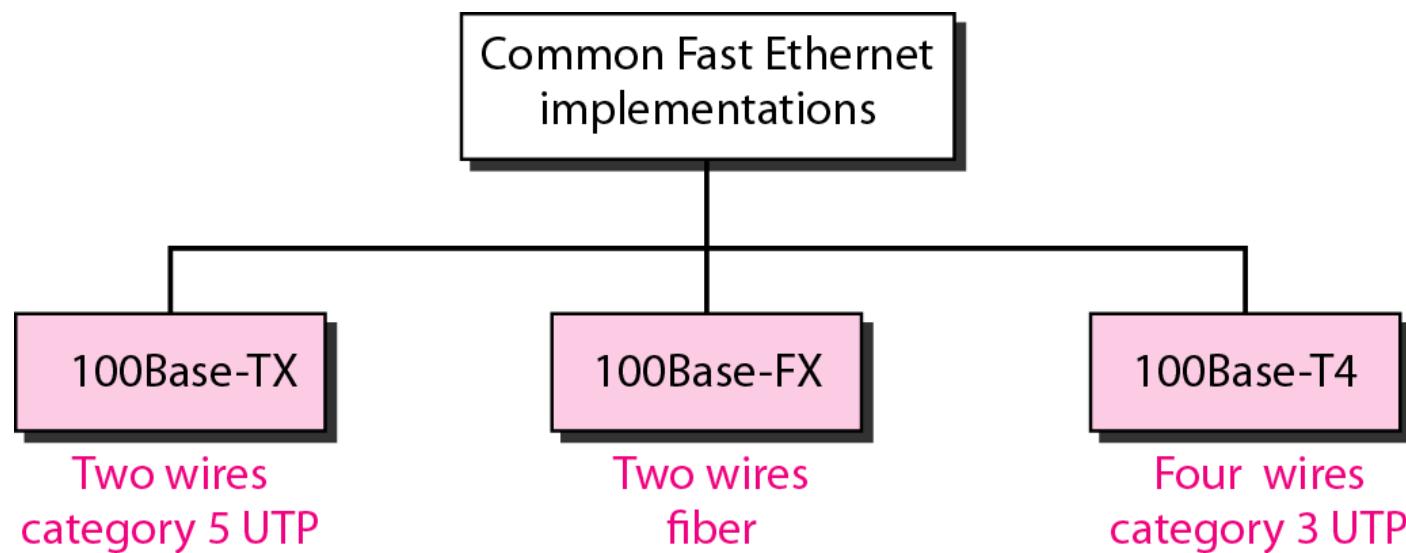


a. Point-to-point



b. Star

Fast Ethernet Implementations



Fast Ethernet Summary

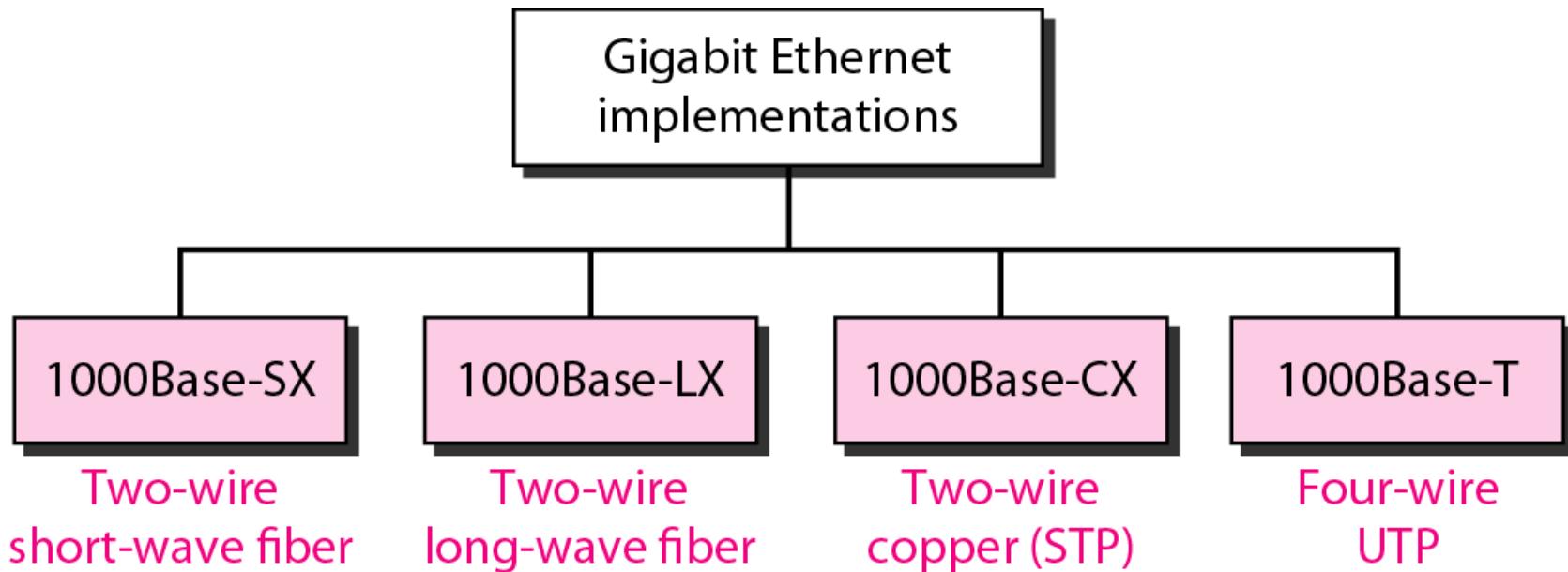
<i>Characteristics</i>	<i>100Base-TX</i>	<i>100Base-FX</i>	<i>100Base-T4</i>
Media	Cat 5 UTP or STP	Fiber	Cat 4 UTP
Number of wires	2	2	4
Maximum length	100 m	100 m	100 m
Block encoding	4B/5B	4B/5B	
Line encoding	MLT-3	NRZ-I	8B/6T

Gigabit Ethernet

6:00 AM

Gigabit Ethernet

- 1000 Mbps
- Standard → IEEE 802.3z, 802.3ab



Gigabit Ethernet Summary

<i>Characteristics</i>	<i>1000Base-SX</i>	<i>1000Base-LX</i>	<i>1000Base-CX</i>	<i>1000Base-T</i>
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 and Up

■ IEEE Standards

- 802.3ae → 10GbE over fiber
- 802.3ak → 10GbE over twin coaxial cable (10GBASE-CX4)
- 802.3an → 10GbE over UTP (10GBASE-T)
- 802.3ba → 40GbE and 100GbE

تم بحمد الله

6:00 AM