Wired and Wireless Communication Standards

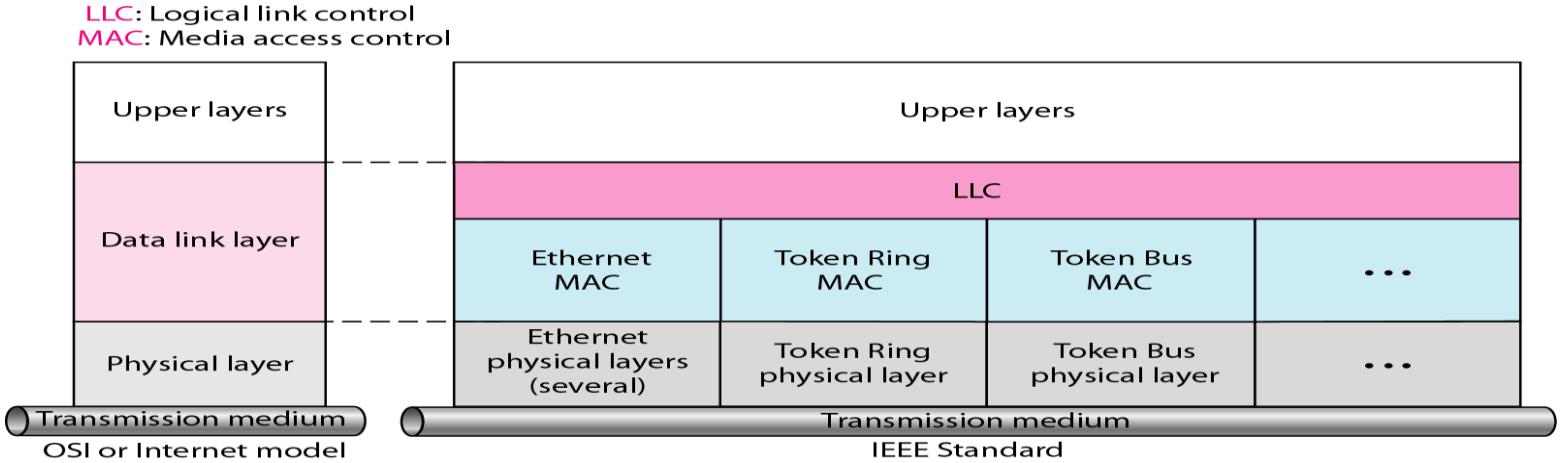
Session Objectives

After completion of the session you will be able to understand

- The project 802 for standard
- IEEE Ethernet Standards 802.2, 802.5
- Ethernet Frame format for communication
- Wireless Standard for Communication, 802.11
- Wireless frame format for communication

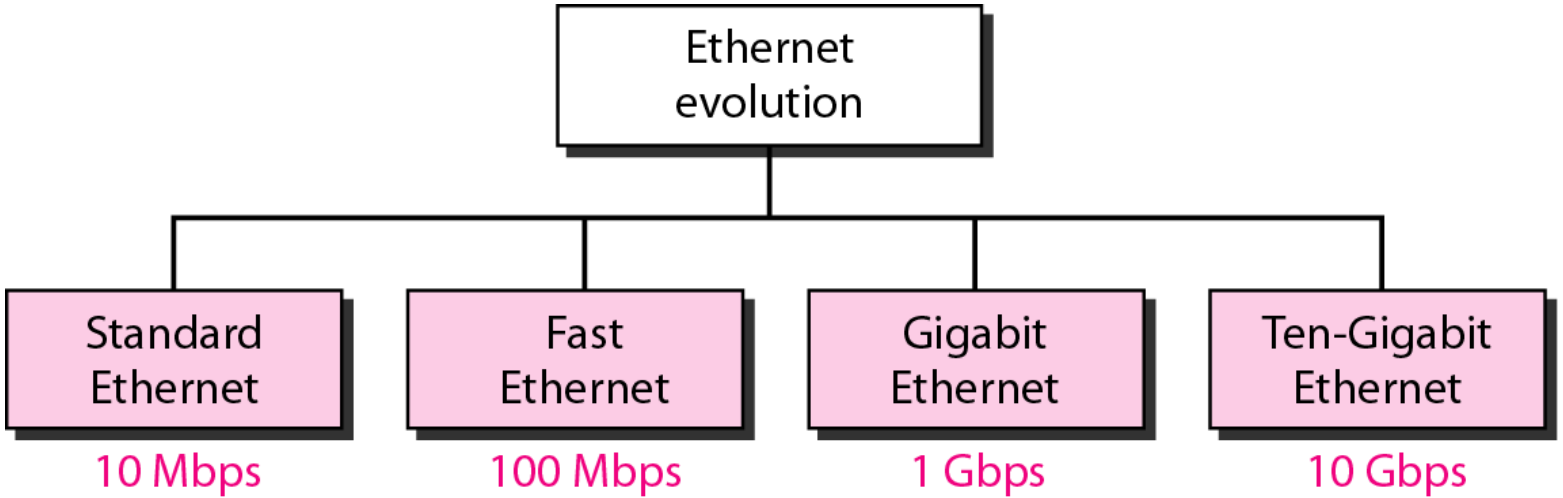
Introduction

- In **1985**, the Computer Society of the IEEE started a project, called **Project 802**.
- The objective was to set standards to **enable intercommunication** among equipment from a **variety of manufacturers**.
- Project 802 **does not seek to replace** any part of the OSI model or TCP/IP protocol suite. Instead, it is a way of **specifying functions of the physical layer and the data-link layer** of major LAN protocols.



Ethernet Evolution through four Generations

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

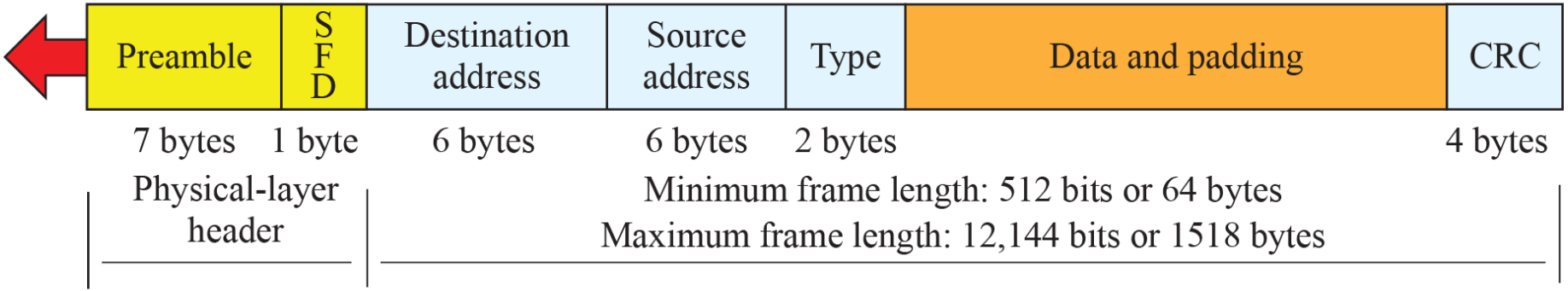


Standard Ethernet (10Mbps)

- The **original Ethernet** technology with the data rate of **10 Mbps** is called as the Standard Ethernet.
- **Examples**: 10Base2, 10Base5, 10Base T, 10Base F
- The frame format is shown in figure below.

Preamble: 56 bits of alternating 1s and 0s

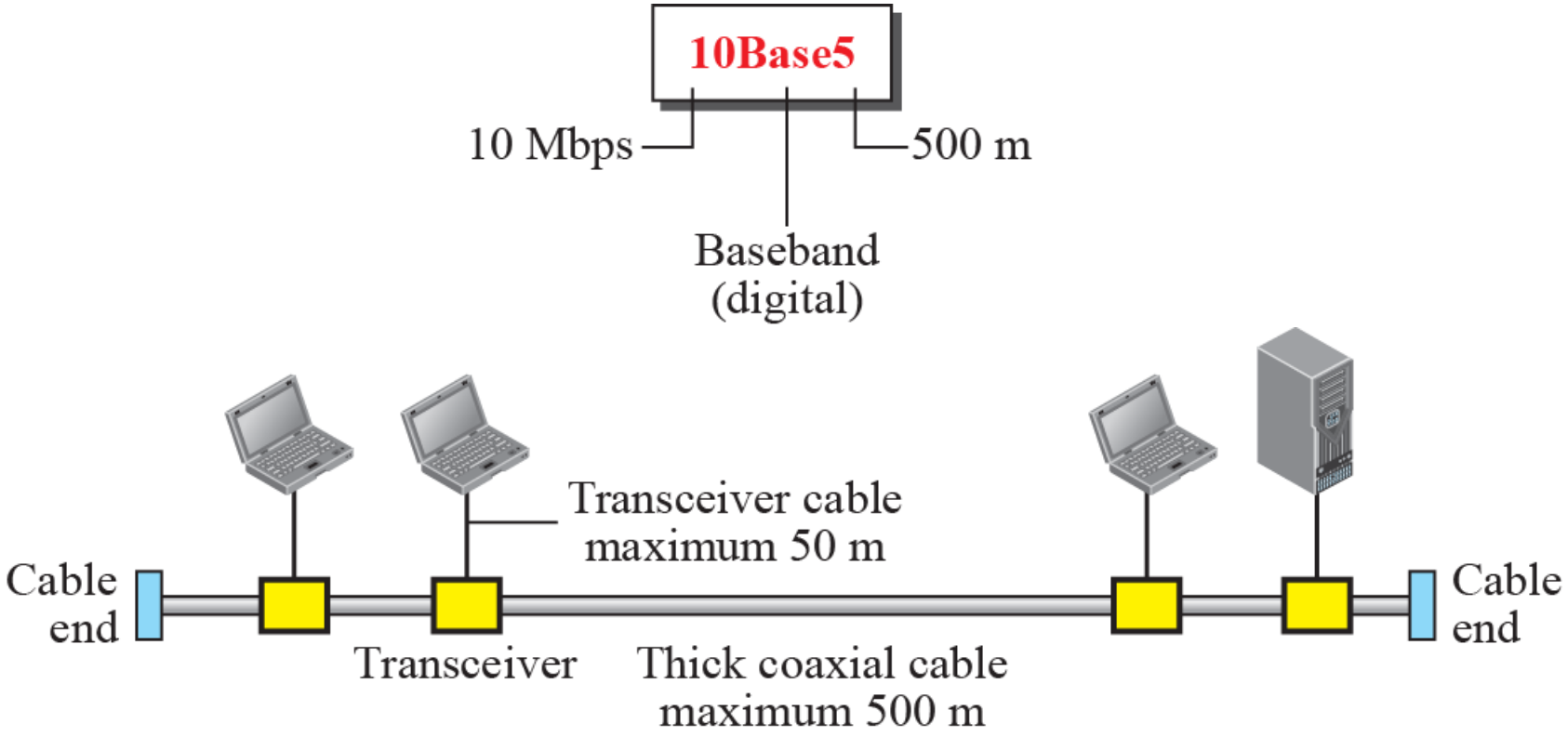
SFD: Start frame delimiter, flag (10101011)



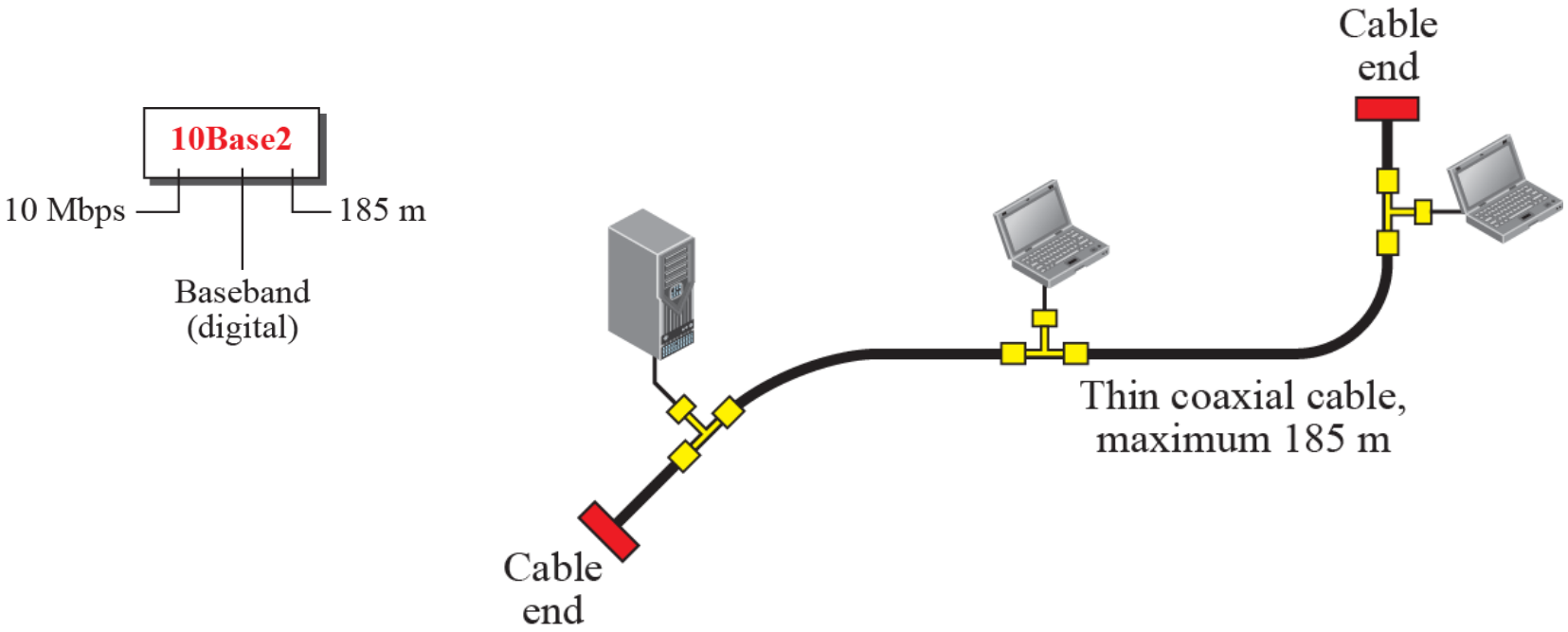
Summary of Standard Ethernet Implementation

Implementation	*Medium*	*Medium Length*	*Encoding*
10Base5	Thick coax	500 m	Manchester
10Base2	Thin coax	185 m	Manchester
10Base-T	2 UTP	100 m	Manchester
10Base-F	2 Fiber	2000	Manchester

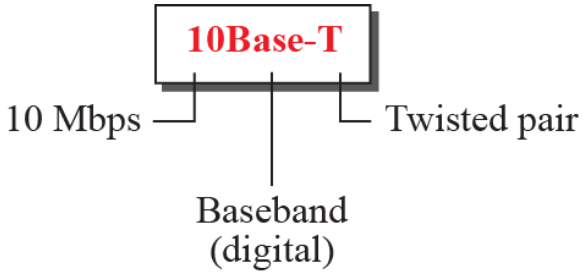
10Base5 Ethernet Implementation

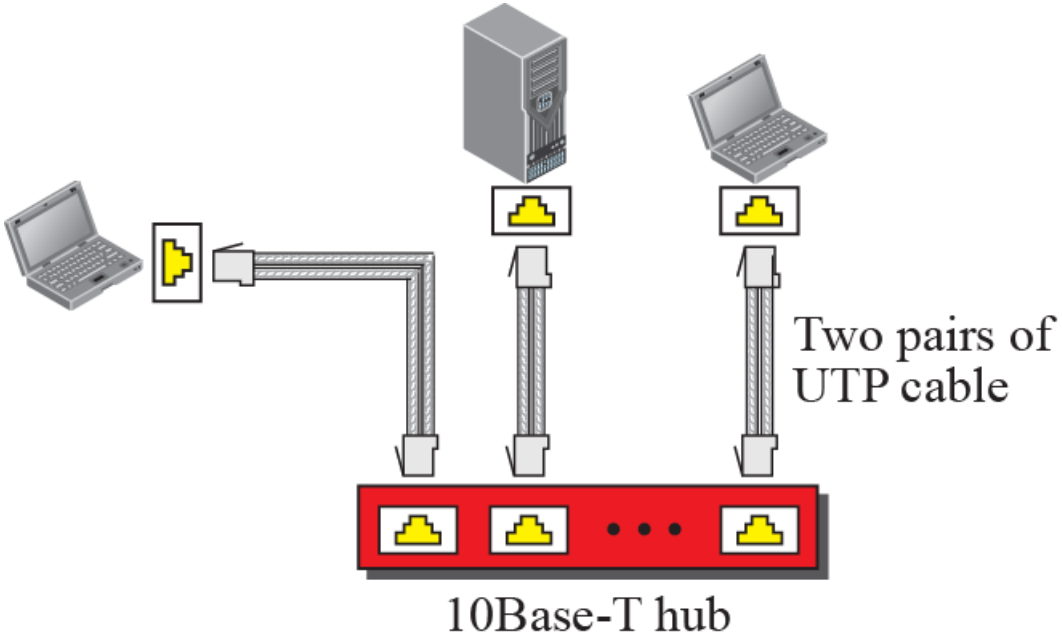


10Base2 Ethernet Implementation

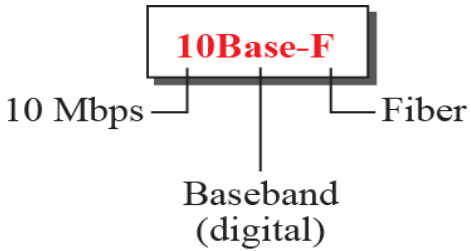


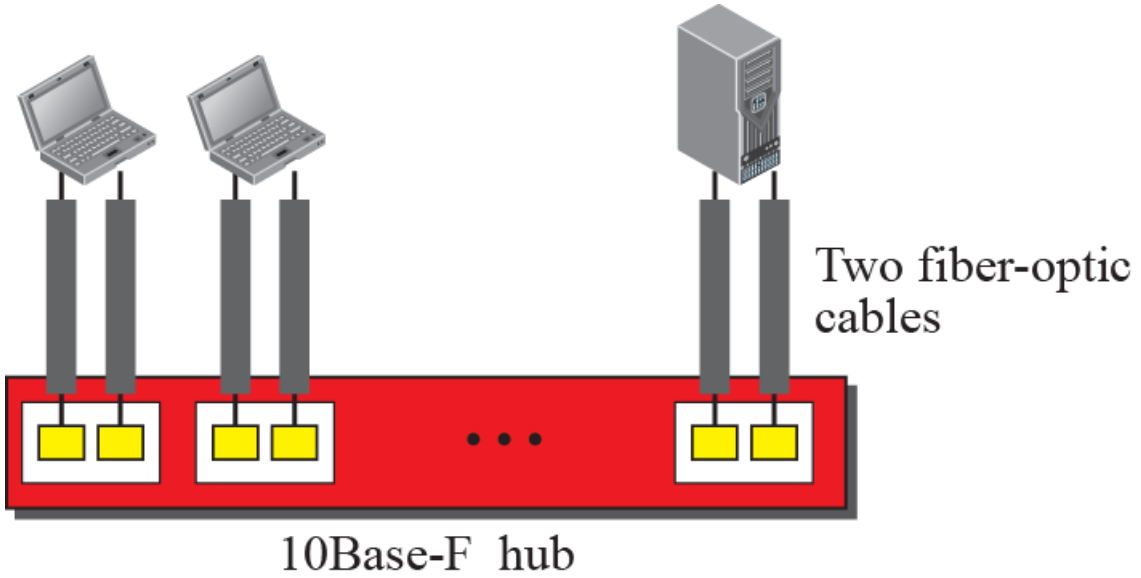
10Base T Ethernet Implementation





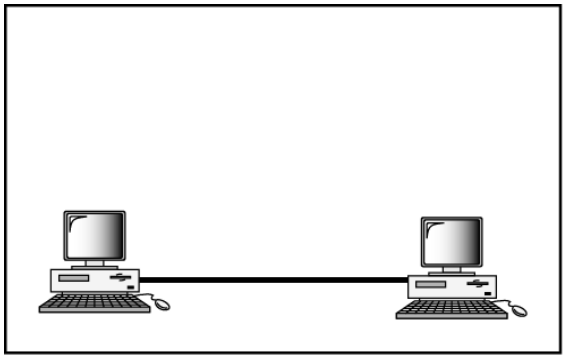
10Base F Ethernet Implementation



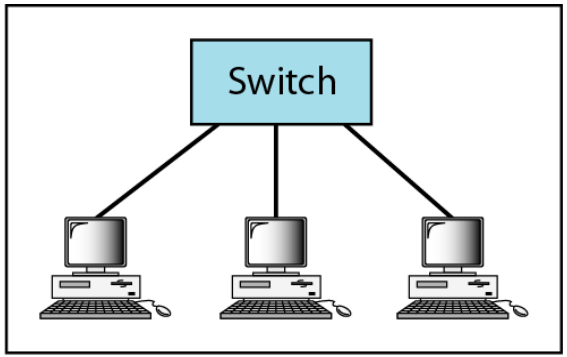


Fast Ethernet Standard (100Mbps)

- In the **1990s,** Ethernet transmission rate increased to **100 Mbps**, and called generation of **Fast Ethernet.**
- The designers of the Fast Ethernet needed to **make it compatible** with the Standard Ethernet.
- The MAC sublayer was left unchanged and the features of the Standard Ethernet that depend on the transmission rate, had to be changed.



a. Point-to-point

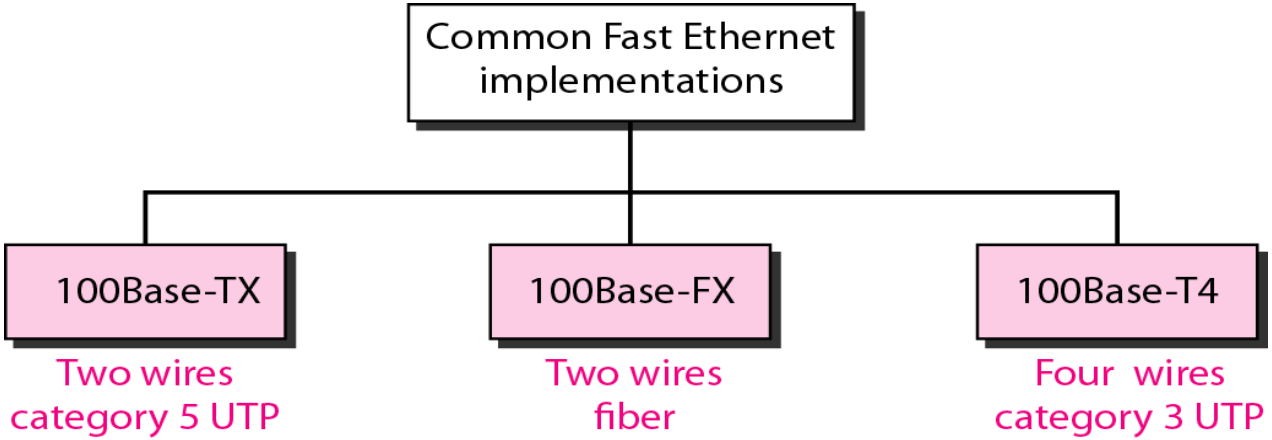


b. Star

Summary of Fast Ethernet Standard Implementation

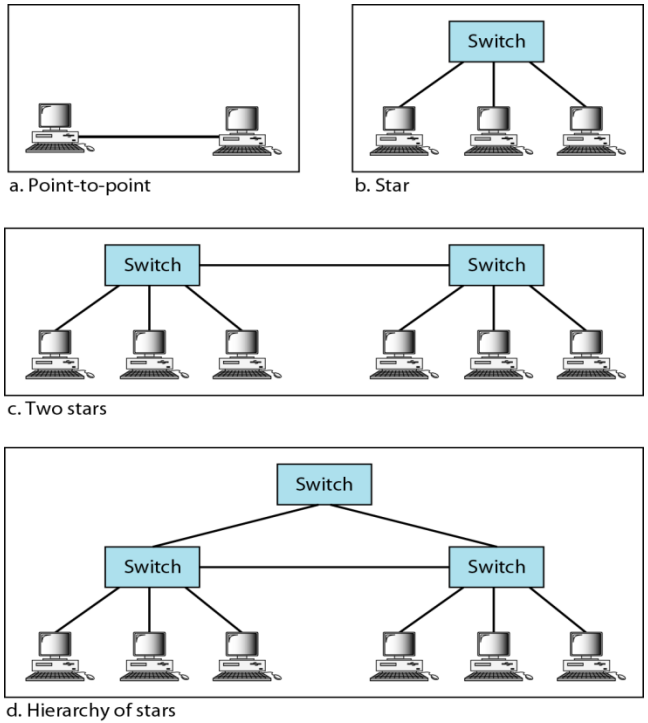
Implementation	*Medium*	*Medium Length*	*Wires*	*Encoding*
100Base-TX	STP	100 m	2	4B5B + MLT-3
100Base-FX	Fiber	185 m	2	4B5B + NRZ-I
100Base-T4	UTP	100 m	4	Two 8B/6T

Fast Ethernet Standard Implementation



Gigabit Ethernet Standard (1Gbps)

- The goals of the **Gigabit Ethernet** were to upgrade the data rate to 1 Gbps.
- Challenge was to keep the address length, the frame format, and the maximum and minimum frame length the same.
- The IEEE committee calls it the Standard **802.3z.**
- The standard is compatible with **high speed fiber optical** communication.
- Gigabit Ethernet has two distinctive approaches for medium access: **half-duplex and full-duplex.**



a. Point-to-point

b. Star

c. Two stars

d. Hierarchy of stars

Gigabit Ethernet Standard Implementation

Implementation	*Medium*	*Medium Length*	*Wires*	*Encoding*
1000Base-SX	Fiber S-W	550 m	2	8B/10B + NRZ
1000Base-LX	Fiber L-W	5000 m	2	8B/10B + NRZ
1000Base-CX	STP	25 m	2	8B/10B + NRZ
1000Base-T4	UTP	100 m	4	4D-PAM5

Gigabit Ethernet Standard (10Gbps)

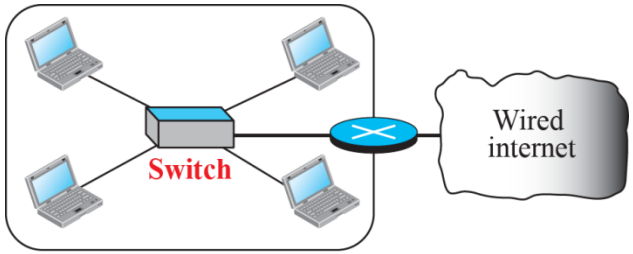
- The idea is to **extend** the technology, the **data rate**, and the **coverage distance** so that the Ethernet can be used as **LAN and MAN** (metropolitan area network).
- The IEEE committee called it Standard **802.3ae**.
- It operates only in **full-duplex mode**, which means there is no need for contention .
- **Four implementations** are the most common: 10GBase-SR, 10GBase-LR, 10GBase-EW, and 10GBase-X4.

10 Gigabit Ethernet Standard Implementation

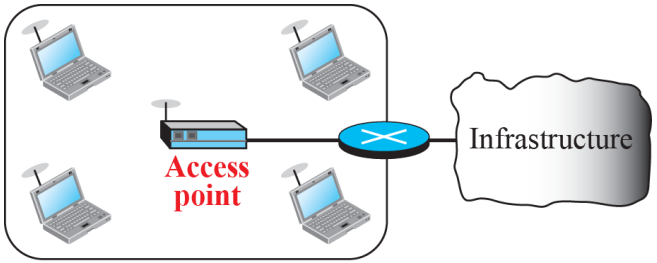
Implementation	*Medium*	*Medium Length*	*Number of wires*	*Encoding*
10GBase-SR	Fiber 850 nm	300 m	2	64B66B
10GBase-LR	Fiber 1310 nm	10 Km	2	64B66B
10GBase-EW	Fiber 1350 nm	40 Km	2	SONET
10GBase-X4	Fiber 1310 nm	300 m to 10 Km	2	8B10B

Wireless LAN Standard 802.11

- Wireless communication is one of the **fastest-growing** technologies.
- The demand for connecting devices **without the use of cables** is increasing everywhere.
- Wireless LANs can be found on college campuses, in office buildings, and in many public areas.
- IEEE has defined the specifications for a wireless LAN, called **IEEE 802.11**.
- It **covers** the physical and data-link layers.
- The public uses the term **WiFi** (short for wireless fidelity) as a synonym for wireless LAN.
- The difference between wire and wireless LAN is shown in the figure below:



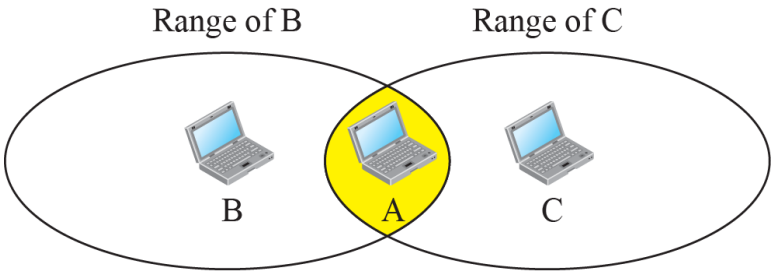
Wired LAN



Infrastructure network

Wireless LAN Challenges

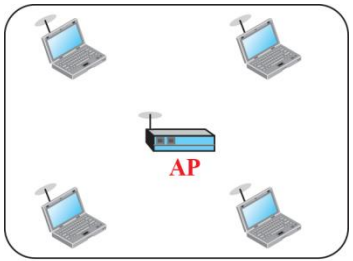
- **Access Control** - how a wireless host can get access to the shared medium (air).
- The CSMA/CD algorithm **does not work** in wireless LANs for **three** reasons:
  - ✓ Wireless hosts do not have enough power to send and receive at the same time.
  - ✓ The hidden station problem prevents collision detection
  - ✓ The distance between stations can be great.
- The hidden and exposed terminal problem.



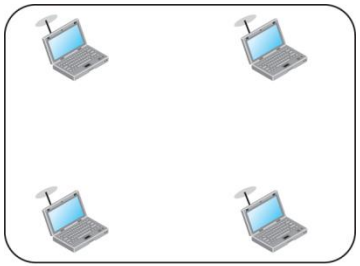
a. Stations B and C are not in each other's range.

Wireless LAN Architecture

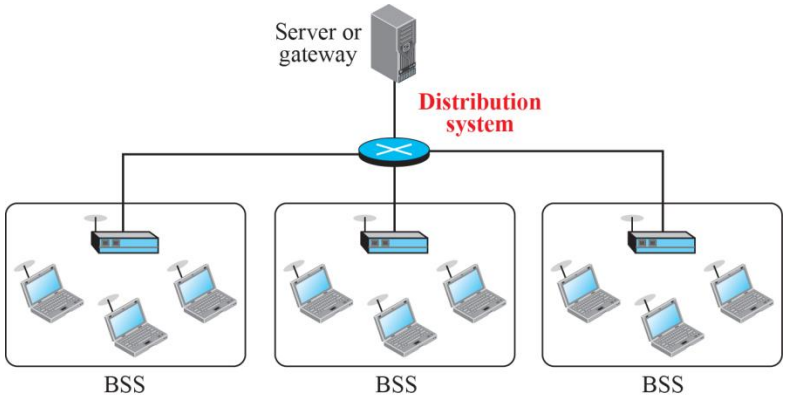
- The standard defines **two kinds** of services: the basic service set (**BSS**) and the extended service set (**ESS**).



Infrastructure BSS



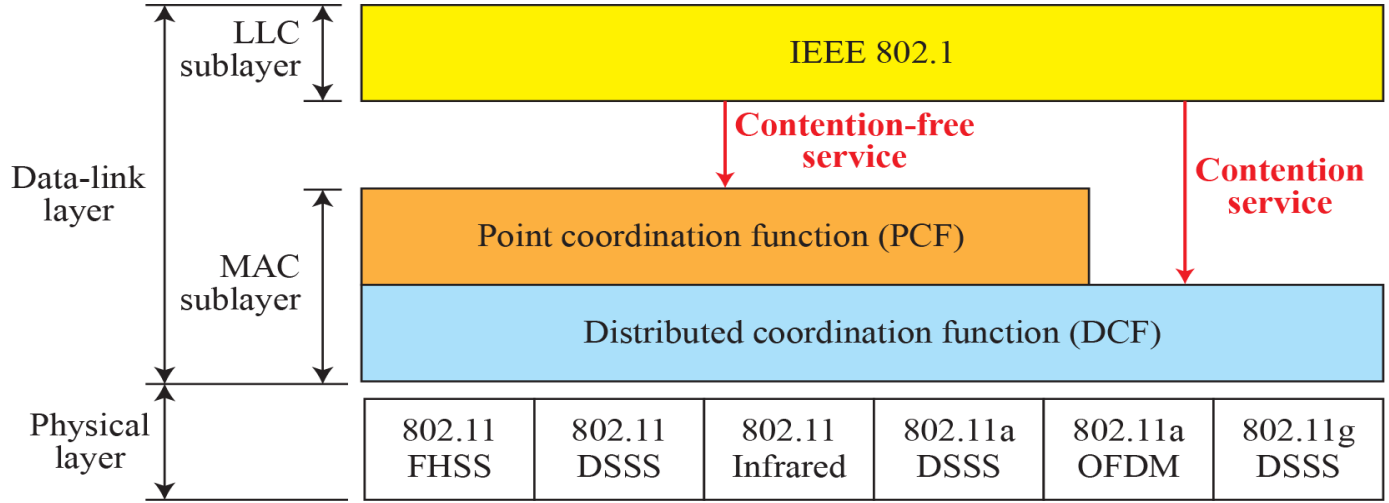
Ad hoc BSS



Extended service set (ESS)

MAC Layer in 802.11 Standard

- IEEE 802.11 defines **two MAC sublayers**: the distributed coordination function (**DCF**) and point coordination function (**PCF**).
- Figure below shows the **relationship** between the **two MAC sublayers**, the **LLC sublayer**, and the **physical layer**.



Contention-free pollable (CF-Pollable)

- It is a state of operation for wireless networking nodes. The condition is saying that the node is able to use the Point Coordination Function, as opposed to the Distributed Coordination Function, within a wireless LAN.
- A device that is able to use point coordination function is one that is able to participate in a method to provide limited Quality of service (for time sensitive data) within the network.

Contention services

In statistical time division multiplexing, contention is a media access method that is used to share a broadcast medium. In contention, any computer in the network can transmit data at any time (first come-first served).

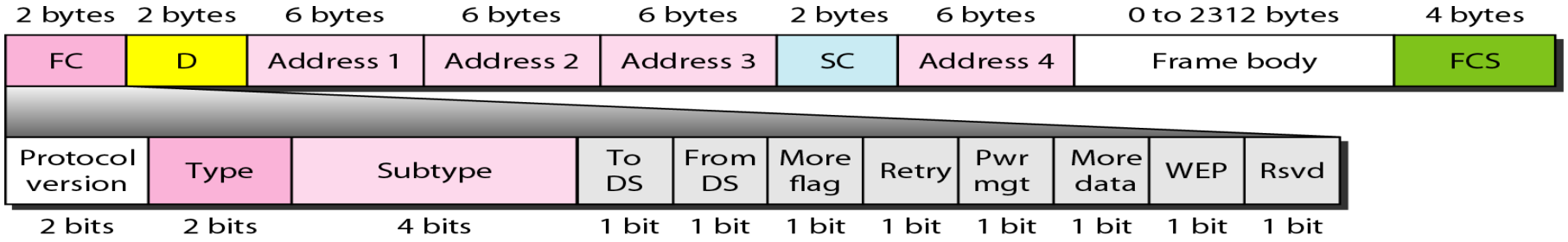
Point coordination function (PCF)

- It is an optional technique used to prevent collisions in IEEE 802.11-based WLAN standard including Wi-Fi. It is a medium access control (MAC) sublayer technique used in areas where carrier-sense multiple access with collision avoidance (CSMA/CA) is used.

Distributed coordination function (DCF)

It is a mandatory technique used to prevent collisions in IEEE 802.11-based WLAN standard (Wi-Fi). It is a medium access control (MAC) sublayer technique used in areas where carrier-sense multiple access with collision avoidance (CSMA/CA) is used.

802.11 Frame Format



Field	*Explanation*
Version	Current version is 0
Type	Type of information: management (00), control (01), or data (10)
Subtype	Subtype of each type (see Table 14.2)
To DS	Defined later
From DS	Defined later
More flag	When set to 1, means more fragments
Retry	When set to 1, means retransmitted frame
Pwr mgt	When set to 1, means station is in power management mode
More data	When set to 1, means station has more data to send
WEP	Wired equivalent privacy (encryption implemented)
Rsvd	Reserved

•**Frame Control** −It is a 2 bytes starting field composed of 11 subfields. It contains control information of the frame. The 11 subfields are −

1.Version: It is a 2 bit long field which indicates the current protocol version which is fixed to be 0 for now.

2.Type: It is a 2 bit long field which determines the function of frame i.e management(00), control(01) or data(10). The value 11 is reserved.

3.Subtype: It is a 4 bit long field which indicates sub-type of the frame like 0000 for association request, 1000 for beacon.

4.To DS: It is a 1 bit long field which when set indicates that destination frame is for DS(distribution system).

5.From DS: It is a 1 bit long field which when set indicates frame coming from DS.

6.More frag (More fragments): It is 1 bit long field which when set to 1 means frame is followed by other fragments.

7.Retry: It is 1-bit long field, if the current frame is a retransmission of an earlier frame, this bit is set to 1.

8.Power Mgmt (Power management): It is 1-bit long field that indicates the mode of a station after successful transmission of a frame. Set to 1 the field indicates that the station goes into power-save mode. If the field is set to 0, the station stays active.

9.More data: It is 1-bit long field that is used to indicate receiver that a sender has more data to send than the current frame. This can be used by an access point to indicate to a station in power-save mode that more packets are buffered or it can be used by a station to indicate to an access point after being polled that more polling is necessary as the station has more data ready to transmit.

10.WEP: It is 1 bit long field which indicates that the standard security mechanism of 802.11 is applied.

11.Order(Rsvd): It is 1 bit long field, if this bit is set to 1 the received frames must be processed in strict order.

- **Duration** − It is a 2-byte field that specifies the time period for which the frame and its acknowledgement occupy the channel.
- Address fields: There are three 6-byte address fields containing addresses of source, immediate destination and final endpoint respectively.
- **Sequence control** − It a 2 bytes field that stores the frame numbers. It detects duplicate frames and determines the order of frames for higher layers. Among the 16 bits, the first 4 bits provides identification to the fragment and the rest 12 bits contain the sequence number that increments with each transmission.
- **Data** − This is a variable sized field that carries the payload from the upper layers. The maximum size of data field is 2312 bytes.
- **Frame Check Sequence (FCS)** − It is a 4-byte field containing error detection information.
- **Address 1 to 4 –**These are 6 bytes long fields which contain standard IEEE 802 MAC addresses (48 bit each). The meaning of each address depends on the DS bits in the frame control field.

Various 802.11 Standard

IEEE	*Technique*	*Band*	*Modulation*	*Rate (Mbps)*
802.11	FHSS	2.4 GHz	FSK	1 and 2
	DSSS	2.4 GHz	PSK	1 and 2
		Infrared	PPM	1 and 2
802.11a	OFDM	5.725 GHz	PSK or QAM	6 to 54
802.11b	DSSS	2.4 GHz	PSK	5.5 and 11
802.11g	OFDM	2.4 GHz	Different	22 and 54

Summary

In this session we have learned

- IEEE Ethernet Standards for communication
- IEEE Frame format for communication
- IEEE Wireless Standard for Communication along with frame format
- Challenges associated with Wireless Communication


Thank
you!