UNIT-5

IEEE STANDARDS

IEEE stands for "Institute of Electrical and Electronics Engineers". IEEE was founded in the year 1884. Project 802 is one of the famous projects regarding to IEEE. This project contains the features which are lead to the essential development in LAN and its usage.

Project 802 sets high-level standards in components that are using in inter-communication between systems. Any manufacturer must follow the standards while preparing the components.

IEEE also provides the support for OSI reference model and its supported layers. Especially for Data link layer and Physical layer. According OSI reference model data link layer and physical layer is performing the most of the responsibility in data transfer.

Generally LAN is used for connecting limited group of systems in limited area. LAN can provide sharing of resources. LAN concept is also supporting WAN or internet. LAN is one of the mostly used technologies.

LAN is having several technologies (versions):

1) Ethernet.
2) Token Ring.
3) Token Bus.
4) ATM LAN.

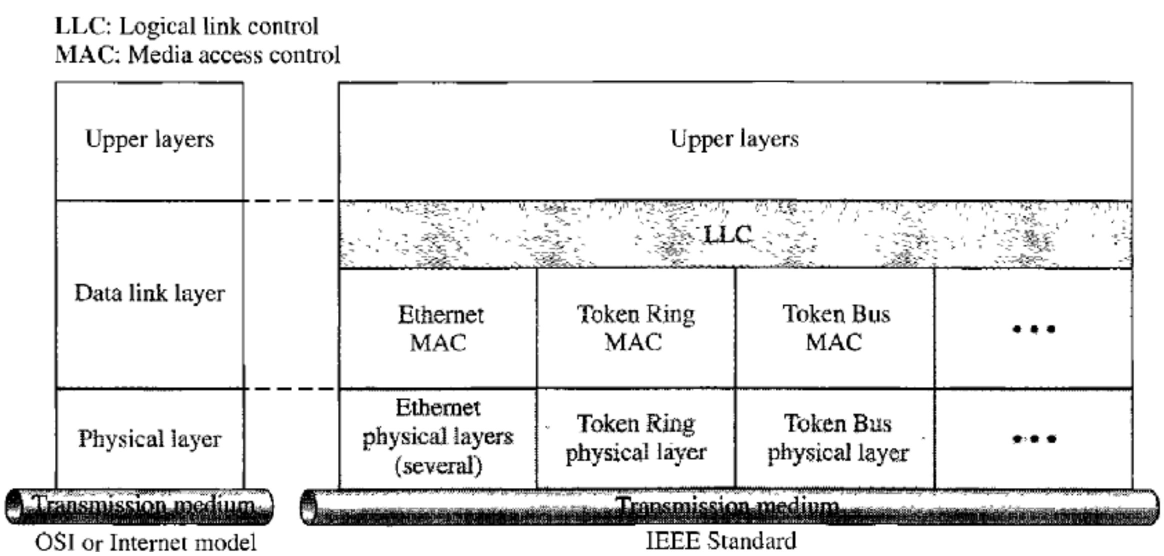
IEEE provides supports for any type of LAN version and also working along with Data link and physical layer.

Data Link Layer:

The IEEE has subdivided the data link layer into two sub layers:

1) Logical Link Control (LLC).
2) Media Access Control (MAC).

IEEE has also created several physical layer standards for different LAN protocols.



We know that **data link control handles framing, flow control, and error control**.
In IEEE Project 802, flow control, error control, and part of the framing duties are collected into one sub layer called the logical link control. But Framing is handled in both the LLC sub layer and the MAC sub layer.

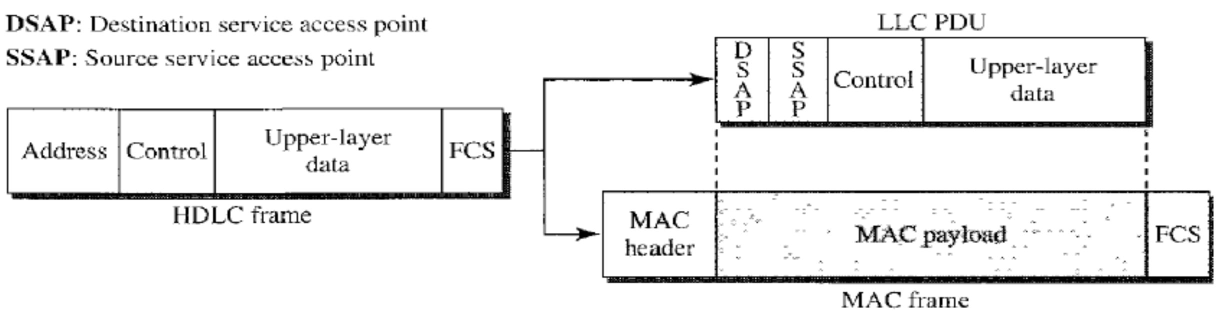
Logical Link Control (LLC):

The LLC provides **one single data link control protocol** for all different IEEE LANs. It also provides the interconnectivity between different LAN's. But MAC sublayer provides **different protocols** for different LANs. In LLC a frame is called as **PDU** and in MAC it is called as Frame.

HDLC frame and its fields are divided into PDU in LLC frame, and also MAC frame in MAC sub layer. LLC defines a protocol data unit (PDU) that is somewhat similar to that of HDLC frame.

The header contains a **control field** like the one in HDLC; this field is used for **flow control** and **error control**.
The purpose of the LLC is to provide flow control and error control for the **upper-layer protocols** (OSI upper layers) that are actually demand these services.

The **two other header fields** define the **upper-layer protocol** at the **source and destination** that uses LLC. These fields are called as **destination service access point** (**DSAP**) and the **source service access point** (**SSAP**).



Media Access Control (MAC):

In MAC sub layer generally we are having multiple access methods including **random access**, **controlled-access**, and **channelization**.

The IEEE Project 802 has created a sublayer called media access control that defines the specific access method for each LAN.
For example, it defines **CSMA/CD** as the media access method for **Ethernet LANs** and the **token-passing** method for **Token Ring** and **Token Bus LAN**s.

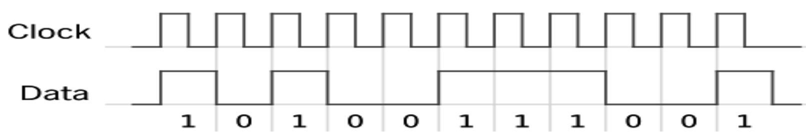
For each different type of LAN's we are having different types of modules in LLC and MAC.

Physical Layer:

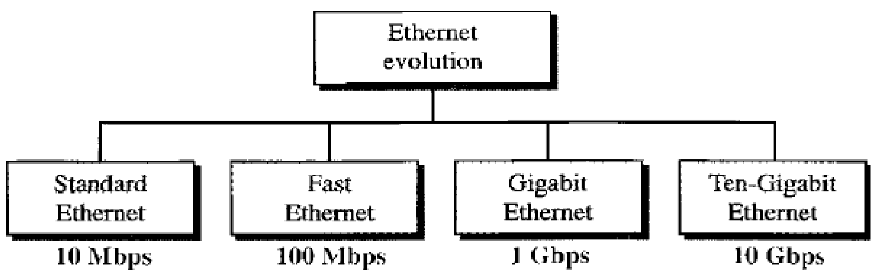
The physical layer is dependent on the implementation and type of physical media used. IEEE defines detailed specifications for each LAN implementation.

Manchester Encoding:

In data transmission, Manchester encoding is a form of digital encoding in which data bits are represented by transitions from one logical state to the other. This is different from the more common method of encoding, in which a bit is represented by either a high state such as +5 volts or a low state such as 0 volts.
When the Manchester code is used, the length of each data bit is set by default. This makes the signal self-clocking. The state of a bit is determined according to the direction of the transition. In some systems, the transition from low to high represents logic 1, and the transition from high to low represents logic 0. In other systems, the transition from low to high represents logic 0, and the transition from high to low represents logic 1.



Ethernet Types:



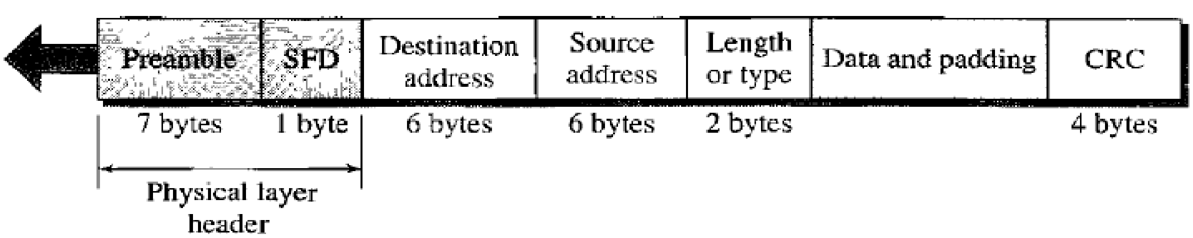
The original Ethernet was created in 1976, since it has gone through four generations:
Standard Ethernet (l0Mbps). Fast Ethernet (100 Mbps). Gigabit Ethernet (l Gbps). Ten-Gigabit Ethernet (l0 Gbps).

STANDARD ETHERNET:

In Standard Ethernet, the **MAC sublayer** handles the operation of the access method. It performs the preparing of "frames" by dividing the data received from the upper layer and also passes or sends the frames to the physical layer in its supported format.

In IEEE 802.3 standard Ethernet the frame format contains 7 layers:

Preamble: 56 bits of alternating 1s and 0s.
SFD: Start frame delimiter, flag (10101011)



Preamble:

The **preamble** is actually added at the physical layer and is not (formally) part of the frame.
The first field of the IEEE 802.3 frame contains 7 bytes (56 bits) of alternating O's and 1's.
The pattern provides only an alert and a timing pulse. This field is used for **alerts the receiving system** for **incoming frame** and enables it to synchronize its input timing (receive in proper time and from proper sender and sequence order).

Start frame delimiter (SFD):
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.

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

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

Length or Type:
This field is defined as a type field or length field. 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.

Data:
This field carries data. The data coming from the upper-layer protocols is encapsulated and placed in this field. This field contains minimum of 46 and a maximum of 1500 bytes of encapsulated data.

CRC: The last field is CRC and it contains error detection information, here we are using CRC-32.

Frame length:
The minimum length restriction is required for the correct operation of CSMA/CD. 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 (6 bytes of source address, 6 bytes of destination address, 2 bytes of length or type, and 4 bytes of CRC), then the minimum length of data from the upper layer is 64 - 18 = **46 bytes**.

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 (such as a PC, workstation, or printer) has its own Network interface card (**NIC**). The NIC fits inside the station and provides the station with a 6-byte **physical address**.

Ethernet address is 6 bytes (48 bits), normally written in hexadecimal notation, with a colon between the bytes.

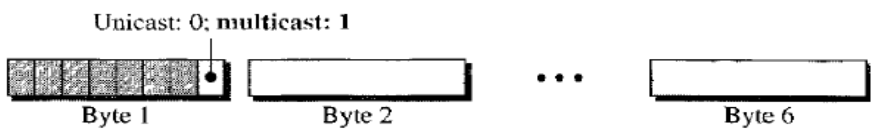
We are having 3 categories in address:

1) Unicast.
2) Multicast.
3) Broadcast.

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

6 bytes = 12 hex digits = 48 bits

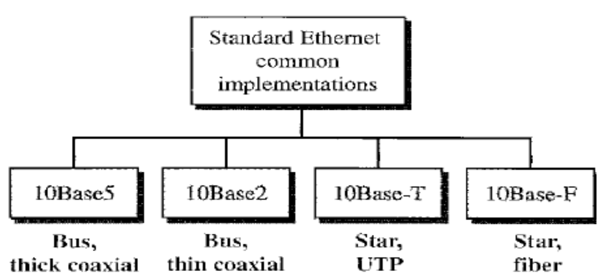
A **source address** is **always** a **unicast address**. That means the frame comes from only one station. The destination address, however, can be unicast, multicast, or broadcast.



The **least significant bit** of the **first byte** defines the type of address. If the least significant bit of the first byte in a destination address is 0, the address is unicast; otherwise, it is multicast.

A unicast destination address defines only one recipient; the relationship between
The sender and the receiver is one-to-one. A multicast destination address defines a group of addresses; the relationship between the sender and the receivers is one-to-many.
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 **1's**.

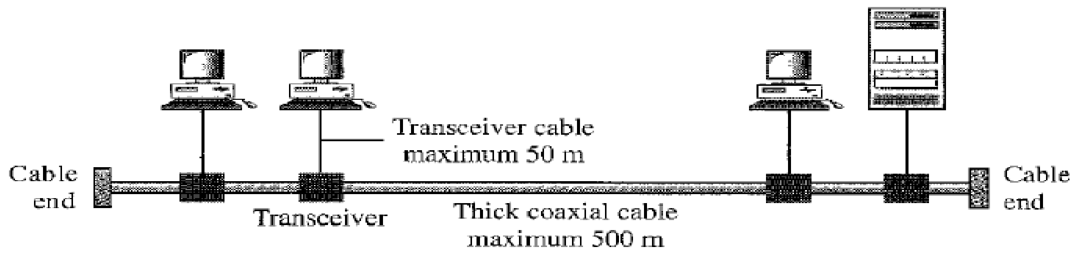
Physical Layer:
Encoding and Decoding:
All standard implementations use digital signaling (baseband) at 10 Mbps. At the sender, data are converted to a digital signal using the Manchester scheme; at the receiver, the received signal is interpreted as Manchester and decoded into data.



10 BASE S: THICK ETHERNET

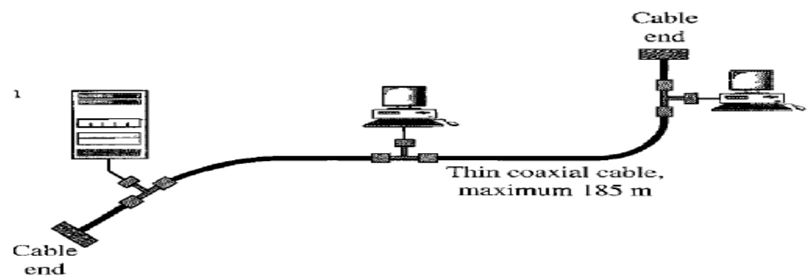
The first implementation of Ethernet is called as **10BaseS;** it is also called as **thick Ethernet,** or **Thicknet.** 10BaseS Ethernet specification to use a **bus topology** with an external **transceiver** (transmitter/receiver) connected via a tap to a thick coaxial cable.
The transceiver is responsible 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. This means that collision can only happen in the coaxial cable.

The maximum length of the coaxial cable must not exceed 500 m, If length of more than *500* m is needed, then we need to add **repeaters** for better data transfer.



10BASE2: THIN ETHERNET

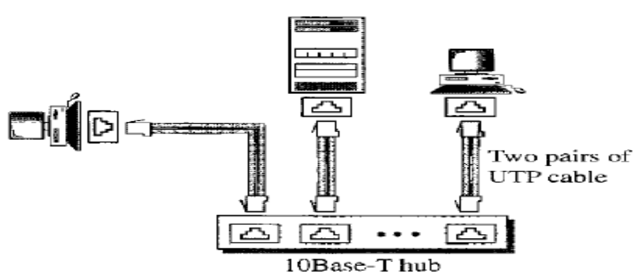
The second implementation is called 10Base2, **thin** Ethernet, or Cheaper net. 10Base2 also uses a bus topology, but the cable is much thinner and more flexible. The cable can be bent to pass very close to the stations. In this case, the transceiver is normally part of the network interface card (NIC),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



Installation of 10BASE 2 is simple and it takes less cost, because the thin coaxial cable is very flexible. The length of each segment cannot exceed 185 m (close to 200 m).

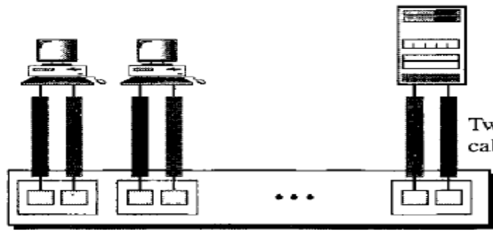
10 BASE –T: TWISTED PAIR:

The third implementation is called 10Base-T or twisted-pair Ethernet. 1OBase-T uses a physical **star topology**. The stations are connected to a hub via two pairs of twisted cable. Two pairs of twisted cable create two paths one for sending and one for receiving between the station and the hub. Any collision here happens in the hub, because the hub replacing the cable. The maximum length of the twisted cable here is 100 m.



10 Base-F: FIBER ETHERNET:

10 Base-F uses a **star topology** to connect stations to a hub. The stations are connected to the hub using **two fiber-optic cables**.



FAST ETHERNET:

Fast Ethernet was designed to **compete** with LAN protocols such as FDDI (Fiber Distributed Data Interface) 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 goals of Fast Ethernet as follows:
1. Upgrade the data rate to 100 Mbps.
2. Make it compatible with Standard Ethernet.
3. Keep the same 48-bit address.
4. Keep the same frame format.
5. Keep the same minimum and maximum frame lengths.

MAC Sublayer:

The main reason for evaluation of Ethernet from 10 to 100 Mbps was to keep the MAC sublayer untouched and a decision was made to drop the bus topologies and keep only the star topology.
For the star topology, there are two choices:

1) **Half duplex.**
2) **Full duplex**.

In the half-duplex approach, the stations are connected via a **hub**; and in the full-duplex approach, the connection is made via a **switch** with buffers at each port.

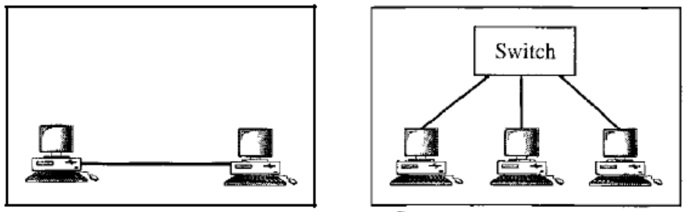
Auto-Negotiation:
A new feature added to Fast Ethernet is called auto negotiation. Auto -Negotiation allows two devices to negotiate with each to perform the mode of operation.

1) To allow incompatible devices to connect to one another. For example, a device with a maximum capacity of 10 Mbps can communicate with a device with a 100 Mbps capacity (but can work at a lower rate).
2) To allow one device to have multiple capabilities.
3) To allow a station to check a hub's capabilities.

Physical Layer

The physical layer in Fast Ethernet is more complicated than in Standard Ethernet.

Fast Ethernet is designed to connect two or more stations together. If there are **only two stations**, they can be connected **point-to-point**. If there are three or more stations need to be connected it uses **star topology** with a **hub** or a **switch** at the center.



a. Point-to-point   **b. Star**

Fast Ethernet implementation at the physical layer can be categorized in two ways:

1) Two-wire.
2) Four-wire.

UTP standards (unshielded twisted pair).
In the two-wire implementation can be either **category 5 UTP** (100 Base-TX) or fiber-optic cable (100 Base-FX).
The four-wire implementation is designed only for **category 3 UTP** (l00Base-T4).

IEEE 802.11: Wireless LAN

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.
Mostly used two promising wireless technologies for LANs:

1) **IEEE 802.11 wireless LANs** (or) **wireless Ethernet**.
2) Bluetooth (Technology for small wireless LANs).

IEEE 802.11 Architecture:
The standard defines two kinds of services:

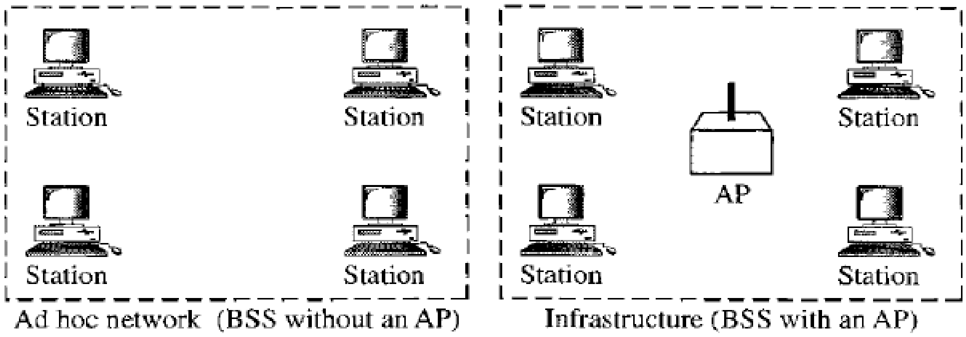
1) Basic service set (**BSS**).
2) Extended service set (**ESS**).

Basic Service Set:

IEEE 802.11 defines the basic service set (**BSS**) as the **building block** of a **wireless LAN**. A basic service set is made of **stationary or mobile wireless stations** and an optional central base station, known as the **access point** (AP). A BSS with an AP is sometimes referred to as an "**infrastructure"** network.

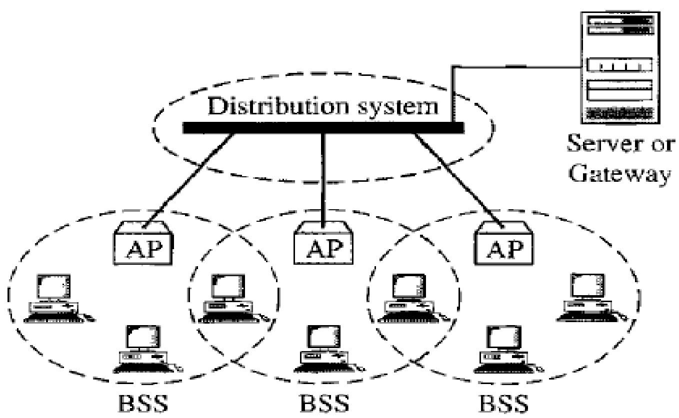
The BSS without an AP is a stand-alone network and cannot send data to other BSSs. It is called an "**ad hoc architecture"**. In this architecture, stations can form a network without the need of an AP; they can locate one another and agree to be part of a BSS.

Simply, a BSS without an AP is called an ad hoc network; a BSS with an AP is called an infrastructure network.



Extended Service Set:

An extended service set (ESS) is made up of two or more BSSs with APs. In this case, the BSSs are connected through a distribution system, which is usually a wired LAN. The distribution system connects the APs in the BSSs. IEEE 802.11 does not restrict the distribution system; it can be any IEEE LAN such as an Ethernet.



Station Types

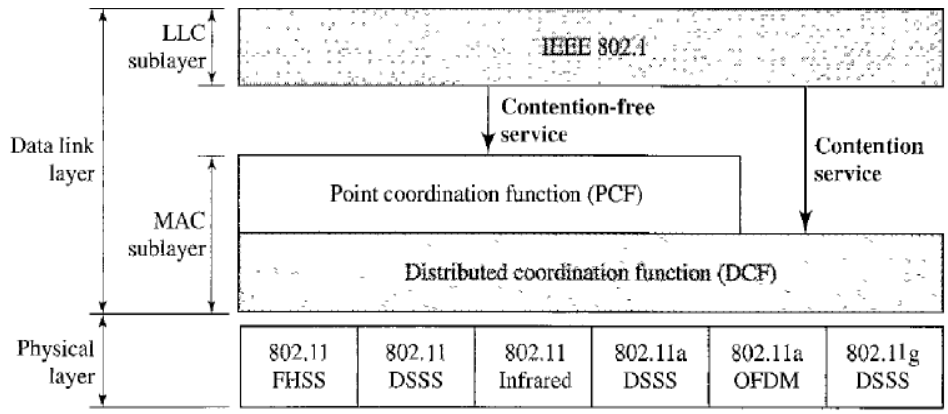
IEEE 802.11 defines three types of stations based on their mobility in a wireless LAN:
1) No-transition Mobility.
2) BSS-transition Mobility.
3) ESS-transition mobility.

A station with no-transition mobility is either stationary (not moving) or moving only inside a BSS.
A station with BSS-transition mobility can move from one BSS to another, but the movement is confined inside one ESS.
A station with ESS-transition mobility can move from one ESS to another.

IEEE 802.11 **does not guarantee** that **communication is continuous during the move**.

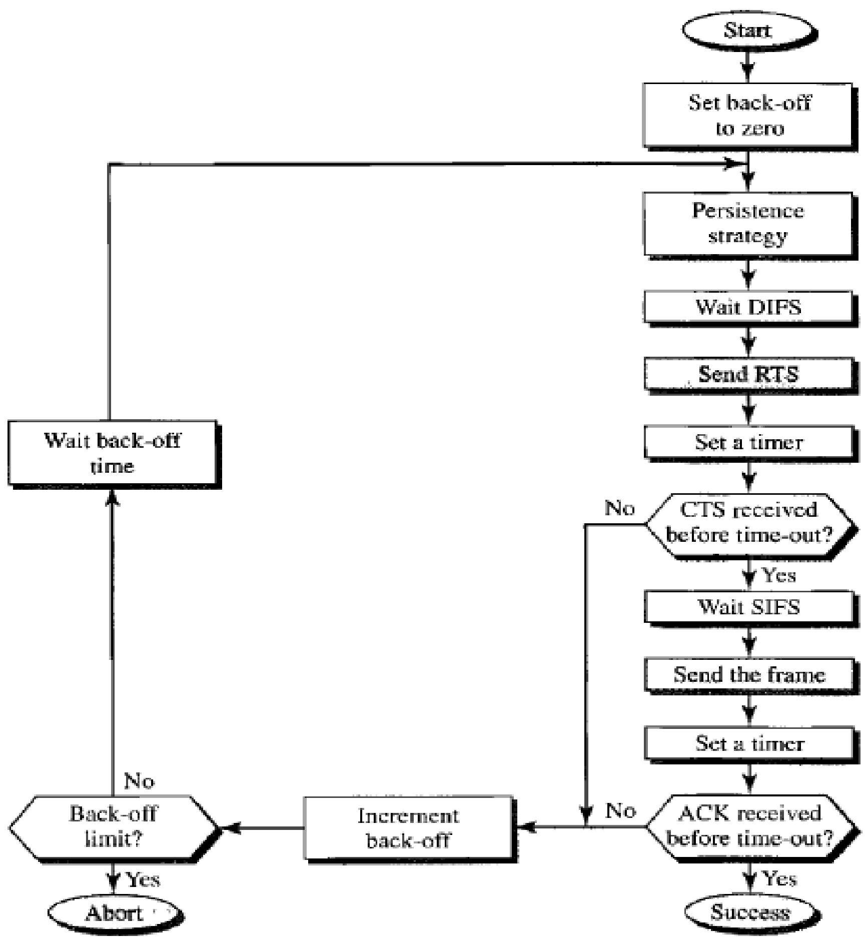
MAC Sublayer:

IEEE 802.11 defines two MAC sublayer:
1) The distributed coordination function (DCF).
2) Point coordination function (PCF).

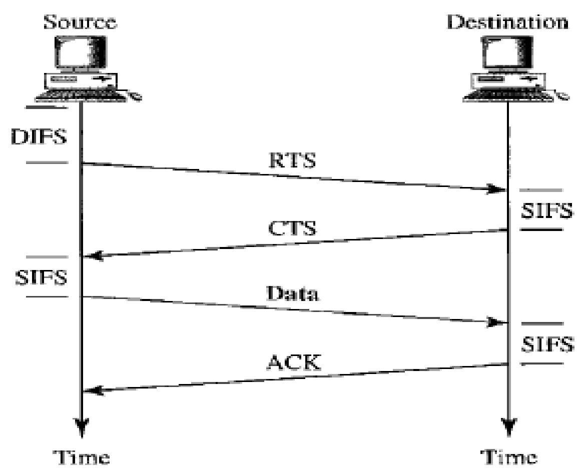


Distributed Coordination Function (DCF) :

It is one of the protocols defined by IEEE at the MAC sublayer. DCF uses **CSMA/CA** as the access method.



1) Before sending a frame, the source station senses the medium by checking the energy level at the carrier frequency. It uses a persistence strategy with back-off until the channel is idle. **After the station is found to be idle**, the station waits for a period of time called the distributed interframe space (**DIFS**); then the station sends a **control frame** called the **request to send** (**RTS**).
2) After receiving the request to send frame (RTS frame) and waiting a period of time called the **short interframe space** (**SIFS**), the **destination** station **sends** a **control frame**, called the **clear to send** (**CTS**), to the source station. This control frame indicates that the destination station is ready to receive data.
3) The source station sends data after waiting an amount of time equal to SIFS.
4) The destination station, after waiting an amount of time equal to SIFS, sends an acknowledgment to show that the frame has been received. Acknowledgment is needed in this protocol because to indicate the data is received successfully to the destination without any collision or loss.



Point Coordination Function (PCP):

The point coordination function (PCF) is an optional access method that can be implemented in an infrastructure network (not in an ad hoc network). It is implemented on top of the DCF and is used mostly for time-sensitive transmission.

PCF has a centralized, contention-free polling access method. The AP performs polling for stations that are capable of being polled. The stations are polled one after another, sending any data they have to the AP.

To give priority to PCF over DCF, another set of interframe spaces has been defined: PIFS and SIFS. The SIFS is the same as that in DCF, but the PIFS (PCF IFS) is shorter than the DIFS.

Frame structure:

The wireless environment is very noisy. That error –oriented. Generally a corrupt frame has to be retransmitted. Because of this reason the protocol recommends fragmentation: it means the large frame must be divided into smaller ones. Because, it is more efficient to resend a small frame than a large frame.

2 bytes	2 bytes	6 bytes	6 bytes	6 bytes	2 bytes	6 bytes	0 to 2312 bytes	4 bytes
FC	D	Address 1	Address 2	Address 3	SC	Address 4	Frame body	FCS

1) **Frame control** (FC):. The FC field is 2 bytes long and defines the type of frame and some control information.
2) **D:** This field defines the duration of the transmission.
3) **Addresses**: There are four address fields, each 6 bytes long. The meaning of each address field depends on the value of the **To DS** and **From DS** subfields.
4) **Sequence control** (SC): This field defines the sequence number of the frame to be used in flow control.
5) **Frame body**: This field, which can be between 0 and 2312 bytes, contains information based on the type of data.
6) **FCS**: The FCS field is 4 bytes long and contains a CRC-32 error detection sequence.

Frame Types:

IEEE 802.11 Wireless LAN has three categories of frames:
1) Management frame.
2) Control frame.
3) Data frame.

Management frames are used for the initial communication between stations and access points. Like link establishment.
Control frames are used for accessing the channel and acknowledging frames.

Subtype	*Meaning*
1011	Request to send (RTS)
1100	Clear to send (CTS)
1101	Acknowledgment (ACK)

Data frames are used for carrying data and control information.

Addressing Mechanism:

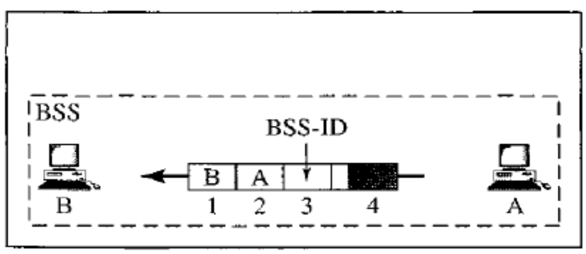
The IEEE 802.11 addressing mechanism specifies four cases, defined by the value of the two flags in the FC field, To DS and From DS. The type of MAC frame depends on the value of these flags. Each flag can be either 0 or 1. It results four different situations.

To DS	*From* DS	*Address* 1	*Address* 2	*Address* 3	*Address* 4
0	0	Destination	Source	BSS ID	N/A
0	1	Destination	SendingAP	Source	N/A
1	0	Receiving AP	Source	Destination	N/A
1	1	Receiving AP	SendingAP	Destination	Source

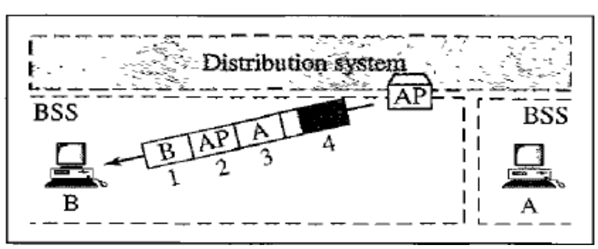
Note that address 1 is always the address of the next device. Address 2 is always the address of the previous device. Address 3 is the address of the final destination station if it is not defined by address I. Address 4 is the address of the original source station if it is not the same as address 2.

Case 1: 00
In this case, *To DS* = 0 and *From DS* = O. This means that the frame is not going to a distribution system *(To DS* = 0) and is not coming from a distribution system *(From DS* =0).

The frame is going from one station in a BSS to another without passing through the distribution system. The ACK frame should be sent to the original sender.

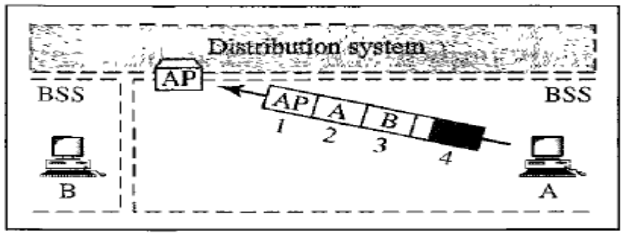


Case 2: 01
In this case, *To DS* = 0 and *From DS* = 1. This means that the frame is coming from a distribution system *(From* DS = 1). The frame is coming from an AP and going to a station. The ACK should be sent to the AP. Here Address 3 contains the original sender of the frame (in another BSS).



Case 3: 10

In this case, *To DS* =1 and *From DS* =O. This means that the frame is going to a distribution system (*To DS* = 1). The frame is going from a station to an AP. The ACK is sent to the original station. Here address 3 contains the final destination of the frame.



Case 4:11

In this case, *To DS* =1 and *From DS* =1. In this case the distribution system is wireless. The frame is going from one AP to another AP in a wireless distribution system. Here, we need four addresses: the original sender, the final destination, and two intermediate APs.