

1. In which OSI layer the Wi-Fi standard/protocol fits.

The IEEE 802.11 Wi-Fi standard operates at **Layer 1 (Physical)** and **Layer 2 (Data Link)** of the OSI model:

- **Layer 1:** Defines radio frequencies (2.4 GHz, 5 GHz, etc.), modulation, and signal transmission via radio waves.
- **Layer 2:** Manages MAC addresses, BSSIDs, and frame formatting for device communication.
 - BSSID (Basic Service Set Identifier) is a unique 48-bit MAC address used to identify a specific access point (AP) or wireless router

2. Can you share the Wi-Fi devices that you are using day to day life, share that device's wireless capability/properties after connecting to network. Match your device to corresponding Wi-Fi Generations based on properties

1. Laptop (Realtek RTL8852BE Wi-Fi 6 802.11ax PCIe Adapter)

- **Current Connection:** Wi-Fi 4 (802.11n)
- **Radio Type:** 802.11n
- **Band:** 2.4 GHz
- **Speed:** 144.4 Mbps
- **Supports:** Wi-Fi 6 (802.11ax), but currently connected using Wi-Fi 4.
- **Wi-Fi Generation:** Wi-Fi 6 (802.11ax) supported, but using Wi-Fi 4 (802.11n) in this case.

2. Phone

- **Current Connection:** Wi-Fi 4 (802.11n)
- **Transmit Speed:** 72 Mbps
- **Receive Speed:** 72 Mbps
- **Band:** 2.4 GHz
- **Wi-Fi Generation:** Wi-Fi 4 (802.11n)

```
C:\Users\SARAVANAN>netsh wlan show interfaces
```

There is 1 interface on the system:

Name	: Wi-Fi
Description	: Realtek RTL8852BE WiFi 6 802.11ax PCIe Adapter
GUID	: 84fb0c85-bdcc-4e98-9586-e409fb743728
Physical address	: cc:5e:f8:86:e0:bd
Interface type	: Primary
State	: connected
SSID	: saravanapalani
BSSID	: a8:da:0c:93:7c:3e
Network type	: Infrastructure
Radio type	: 802.11n
Authentication	: WPA2-Personal
Cipher	: CCMP
Connection mode	: Auto Connect
Band	: 2.4 GHz
Channel	: 1
Receive rate (Mbps)	: 144.4
Transmit rate (Mbps)	: 144.4
Signal	: 86%

My phone supports Wi-Fi 4 (802.11n) with a max speed of 72 Mbps on 2.4 GHz. My laptop has a Wi-Fi 6 (802.11ax) adapter, but my current connection is using Wi-Fi 4 (802.11n) on 2.4 GHz with a speed of 144.4 Mbps

3. What is BSS and ESS?

Basic Service Set (BSS):

A **Basic Service Set (BSS)** is the fundamental building block of a Wi-Fi network, consisting of a single access point (AP) and the devices connected to it. Each BSS is uniquely identified by a **BSSID**, which is the MAC address of the AP. In a **home Wi-Fi setup**, for example, your router creates a single BSS, and all connected devices communicate through it. BSS networks do not support seamless roaming, meaning if a device moves out of range, the connection is lost unless it reconnects to another AP.

Extended Service Set (ESS):

An **Extended Service Set (ESS)** is a network that consists of multiple **BSSs** connected through a wired backbone, allowing devices to roam seamlessly between them. Each access point in an ESS broadcasts the same **SSID**, enabling continuous connectivity across a large area, such as in offices, universities, or shopping malls. As a user moves from one location to another, their device automatically switches between APs without dropping the connection, providing a smooth and uninterrupted Wi-Fi experience.

4. What are the basic functionalities of Wi-Fi Accesspoint?

1. Provides a Wi-Fi network for devices to connect without cables using radio signals.
2. Connects wireless devices to a wired Ethernet network, enabling seamless communication.
3. Uses encryption (WPA2/WPA3), MAC filtering, and firewalls to prevent unauthorized access.
4. Supports seamless roaming between multiple APs and optimizes performance using dual-band (2.4 GHz & 5 GHz) .

5. Difference between Bridge mode and Repeater mode

Feature	Bridge Mode	Repeater Mode
Purpose	Connects two separate networks, allowing seamless communication	Extends the coverage of an existing Wi-Fi network
Connection Type	Typically connects wired-to-wired or wired-to-wireless networks	Works wirelessly by rebroadcasting the existing Wi-Fi signal
IP Address Handling	Devices retain IP addresses from the main network	May assign new IP addresses to connected devices
Effect on Speed	No significant speed loss as it simply forwards traffic	Reduces speed due to retransmission of data
Use Case	Used in businesses or large setups to unify multiple networks	Ideal for expanding Wi-Fi coverage in homes, offices, or large areas
Implementation	Requires specific hardware or configuration on routers	Can be done with a Wi-Fi extender or a router in repeater mode

6. What are the differences between 802.11a and 802.11b.

802.11a operates in the 5 GHz frequency band, offering a maximum speed of 54 Mbps. Due to its higher frequency, it has a shorter range (around 50 feet indoors) but experiences less interference since fewer devices operate in this band. This makes it ideal for enterprise environments where high-speed data transfer and minimal interference are important. However, 802.11a hardware is generally more expensive and less commonly used in consumer devices.

802.11b, operates in the 2.4 GHz frequency band, providing a maximum speed of 11 Mbps. While it is slower than 802.11a, it has a longer range (up to 150 feet indoors) and is more cost-effective. However, since many household devices like microwaves, Bluetooth, and cordless phones use the 2.4 GHz band, interference is higher, which can lead to reduced performance in congested environments.

7. Configure your modem/hotspot to operate only in 2.4Ghz and connect your laptop/Wi-Fi device, and capture the capability/properties in your Wi-Fi device. Repeat the same in 5Ghz and tabulate all the differences you observed during this

Feature	2.4 GHz (Saravanapalani)	5 GHz (Sarav_5G_JIOWIFI123)
Radio Type	802.11n	802.11ac
Authentication	WPA2-Personal	WPA2-Personal
Cipher	CCMP	CCMP
Band	2.4 GHz	5 GHz
Channel	1	153
Receive Rate	144.4 Mbps	866.7 Mbps
Transmit Rate	144.4 Mbps	866.7 Mbps
Signal Strength	84%	91%
Interference	More interference	Less interference
Range	Longer range, but slower	Shorter range, but faster

8. What is the difference between IEEE and WFA

- **IEEE:** Develops technical standards (e.g., 802.11a/b/g/n/ac/ax)
- **WFA:** Certifies devices for interoperability and brands generations (Wi-Fi 4/5/6)

IEEE (Institute of Electrical and Electronics Engineers):

- Standards development organization
- Defines the technical specifications for 802.11 standards
- Creates the technical foundation for Wi-Fi technology
- Focuses on technical aspects and protocol definitions
- Names standards with 802.11 followed by letters (e.g., 802.11ax)

WFA (Wi-Fi Alliance):

- Industry consortium of companies
- Certifies products for interoperability and compliance
- Markets Wi-Fi technology and creates user-friendly names (Wi-Fi 6 instead of 802.11ax)
- Develops additional specifications beyond IEEE (like WPA3, WMM, etc.)
- Ensures consumers can expect compatibility across certified devices

9. Types of Wi-Fi Internet Connectivity Backhaul:

- Fiber Backhaul

- Microwave Backhaul
- Satellite Backhaul
- Cellular (4G/5G) Backhaul
- Ethernet Backhaul
- Mesh Wi-Fi Backhaul , this is prevalent in college due to
- **Flexibility:** Easily extendable coverage across campus without significant infrastructure changes.
- **Scalability:** Additional access points can be added as needed to accommodate more users or areas.
- **Cost-Effectiveness:** Reduces the need for extensive cabling, making it a financially viable option for large spaces.
- **Performance:** Capable of supporting high bandwidth demands typical in educational settings.

10. Wi-Fi Topologies & Use Case

1. **Infrastructure Mode** – Used in homes, offices, and public networks.
2. **Repeater Mode** – Extends Wi-Fi coverage in large buildings.
3. **Bridge Mode** – Connects two separate networks wirelessly.
4. **Ad-Hoc Mode** – Direct device-to-device communication without an access point.
5. **Mesh Network** – Ensures seamless connectivity in large areas like smart cities.