Module 1 Assignment

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

   Ans. Wi-Fi Standard fits in Physical layer and data link layer of the OSI model.
   Physical Layer (L1) handles radio waves, frequency, modulation, and transmission.
   Data Link Layer (L2) handles MAC addressing, frame exchange, CSMA/CA, and security.

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

   Ans. Laptop,Mobile phone.

   Laptop capability: 802.11n
   Wifi Generation:Wi-Fi 4
   Max Data rate:600 Mbps
   Frequency:2.4 GHz / 5 GHz
   Year:2009

3. what is BSS and ESS?

Ans. In Wi-Fi networking, a Basic Service Set (BSS) is the fundamental unit of a wireless network, consisting of a single Access Point (AP) and one or more client devices (also called stations or STAs) connected to it. Each BSS is uniquely identified by a BSSID (Basic Service Set Identifier), which is essentially the MAC address of the AP. There are two types of BSS: Infrastructure BSS, where devices communicate via an AP (common in homes, offices, and public Wi-Fi networks), and Independent BSS (IBSS) or Ad-Hoc mode, where devices communicate directly without an AP (useful for peer-to-peer connections).

When multiple APs are interconnected via a wired distribution system (DS), they form an Extended Service Set (ESS), which allows devices to move seamlessly between APs while maintaining connectivity. Unlike BSS, which has a unique BSSID per AP, an ESS is identified by an SSID (Service Set Identifier), which remains the same across all APs in the network. This enables roaming, where a device can switch from one AP to another without losing connection, making ESS ideal for large environments like corporate offices, universities, and shopping malls. While BSS is limited to a single

AP’s coverage area, ESS expands the Wi-Fi network across multiple access points, providing broader coverage and better network reliability.

4. what are the basic functionalities of Wi-Fi Accesspoint

Ans. The basic functionalities are

1. Wireless Signal Transmission & Reception

A Wi-Fi AP transmits and receives data over radio frequencies (2.4 GHz, 5 GHz, and 6 GHz), enabling wireless devices to connect without physical cables.

2. Bridging Wired and Wireless Networks

APs act as a bridge between wireless devices (stations) and a wired network (LAN), typically through an Ethernet connection.

3. Managing Multiple Client Connections

APs support multiple devices simultaneously using MIMO (Multiple Input, Multiple Output) and MU-MIMO for better data handling and efficiency.

4. Assigning IP Addresses (DHCP Functionality)

Some APs function as DHCP servers, assigning IP addresses to connected devices, while others rely on an external DHCP server.

5. Security & Authentication

APs enforce wireless security using encryption standards like WPA2/WPA3, MAC filtering, firewall rules, and 802.1X authentication for enterprise networks.

6. SSID Broadcasting & Multiple SSIDs

APs broadcast SSID (Wi-Fi network name) to allow devices to connect. Enterprise APs support multiple SSIDs, enabling different network segments (e.g., guest Wi-Fi and employee Wi-Fi).

7. Seamless Roaming Between APs

In large networks, APs support 802.11r (Fast Roaming), 802.11k, and 802.11v, enabling devices to switch between APs without disconnecting.

8. Channel Selection & Interference Management

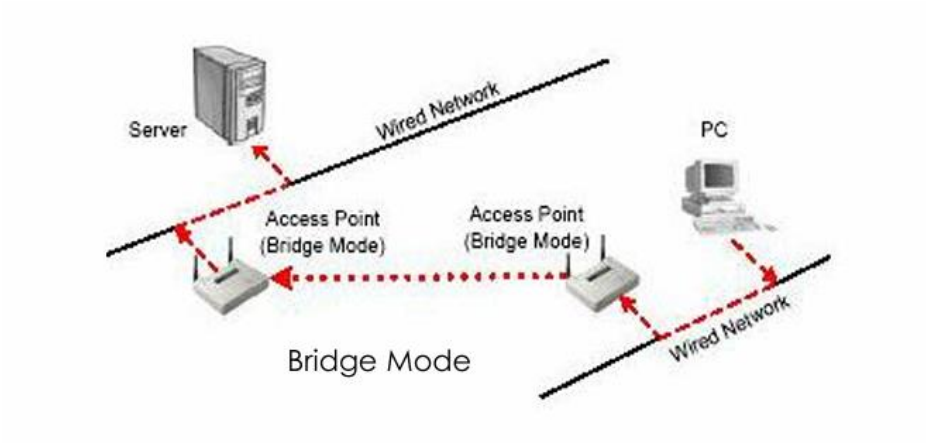
APs use Automatic Channel Selection and DFS (Dynamic Frequency Selection) to reduce interference from other Wi-Fi networks or devices.

9. Quality of Service (QoS) & Traffic Prioritization

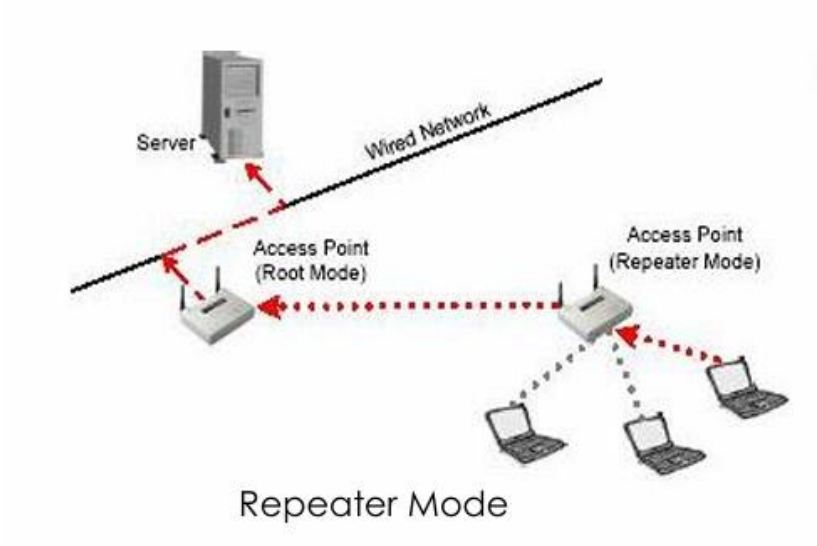
QoS mechanisms like Wi-Fi Multimedia (WMM) prioritize traffic, ensuring smoother performance for video streaming, VoIP, and gaming.

5. Difference between Bridge mode and Repeater mode

Bridge Mode is used for network segmentation or connecting different networks (e.g., wired to wireless).It has different IP range and the bandwidth remains same.
EX. Connecting different LANs, such as linking two office buildings



Repeater Mode is used to extend Wi-Fi coverage by retransmitting signals, but it can reduce speed due to signal duplication.It has same IP Range and the bandwidth is reduced.
For Ex: Extending Wi-Fi in large homes, offices, or dead zones



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

- 802.11a is faster (54 Mbps) but operates on 5 GHz, which limits range and increases cost.it uses OFDM.
  Ex:Enterprise networks
- 802.11b is slower (11 Mbps) but operates on 2.4 GHz, providing better range at a lower cost.It uses DSSS.
  Ex:Home Networks

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

Ans: 2.4 GHz

```
Radio type              : 802.11n
Authentication          : WPA2-Personal
Cipher                  : CCMP
Connection mode         : Auto Connect
Band                    : 2.4 GHz
Channel                 : 1
Receive rate (Mbps)     : 72.2
Transmit rate (Mbps)    : 72.2
Signal                  : 100%
```

5 GHz

```
Radio type              : 802.11ac
Authentication          : WPA2-Personal
Cipher                  : CCMP
Connection mode         : Auto Connect
Band                    : 5 GHz
Channel                 : 40
Receive rate (Mbps)     : 433.3
Transmit rate (Mbps)    : 433.3
Signal                  : 100%
```

8. What is the difference between IEEE and WFA

The **Institute of Electrical and Electronics Engineers (IEEE)** and the Wi-Fi Alliance (WFA) serve different but complementary roles in the **development and adoption of Wi-Fi technology.** The IEEE is responsible for creating and maintaining technical standards related to networking and communication, including the 802.11 Wi-Fi standards (such as 802.11a, 802.11b, 802.11n, and Wi-Fi 6). In contrast, the **Wi-Fi Alliance (WFA) is an organization that focuses on ensuring interoperability between devices by certifying products that meet IEEE-defined Wi-Fi standards**. While the IEEE defines the technical specifications of how Wi-Fi should work, the WFA tests and certifies devices to ensure they function correctly across different manufacturers.

Additionally, **IEEE is a global organization consisting of engineers and researchers who develop communication standards, whereas Wi-Fi Alliance is an industry consortium made up of Wi-Fi equipment manufacturers and vendors.** IEEE focuses on the technical development of standards, while WFA ensures that devices comply with those standards and work seamlessly together. For example, IEEE developed 802.11ax, which defines the technical specifications for Wi-Fi 6, while the Wi-Fi Alliance certifies that a device meets Wi-Fi 6 interoperability requirements before it reaches consumers.

9. List down the type of Wi-Fi internet connectivity backhaul, share your home/college's wireless internet connectivity backhaul name and its properties

Backhaul refers to the connection between a Wi-Fi access point (AP) or router and the wider internet. Different types of backhaul technologies are used depending on the infrastructure, speed requirements, and reliability needed.

1. Wired Backhaul

- Fiber Optic Backhaul: High-speed, low-latency connection using fiber optic cables (e.g., FTTH – Fiber to the Home).
- Ethernet Backhaul: Uses standard Ethernet cables (Cat5e, Cat6) to provide a stable wired connection.
- DSL (Digital Subscriber Line) Backhaul: Uses telephone lines for broadband internet but has slower speeds compared to fiber.
- Cable Internet Backhaul: Uses coaxial cables for internet, typically provided by cable TV operators (e.g., DOCSIS technology).

2. Wireless Backhaul

- Cellular Backhaul (4G/5G LTE): Uses mobile networks to provide internet, often used in remote areas or as backup connectivity.
- Microwave Backhaul: Uses high-frequency radio signals for long-distance wireless internet connectivity, commonly used by ISPs.
- Satellite Backhaul: Provides internet via satellites, useful for rural and remote locations (e.g., Starlink, VSAT).
- Wi-Fi Mesh Backhaul: Uses multiple Wi-Fi nodes to relay data without requiring wired connections between them.

10. List down the Wi-Fi topologies and use cases of each one.

1. Infrastructure Mode (Default Mode in Wi-Fi Networks)

- **Description**: In this mode, all wireless devices connect to a central **Access Point (AP) or Router**, which manages communication and provides internet access.
- **Use Case**: Used in **homes, offices, schools, airports, and public Wi-Fi hotspots** where a structured network with a central router is required.
- **Example**:
    - Your home Wi-Fi router creates a **Wi-Fi network** (SSID) for laptops and smartphones to connect.
    - An office **Wi-Fi network** where multiple employees connect through a centralized **enterprise-grade AP**.

2. Repeater Mode (Range Extender Mode)

- **Description**: A Wi-Fi repeater or extender **rebroadcasts** the signal from an existing router to extend the coverage area. It does not create a separate network but strengthens the original signal.
- **Use Case**: Used in **large homes, multi-floor buildings, and outdoor areas** where the main Wi-Fi router's signal does not reach every corner.
- **Example**:
    - A **Wi-Fi range extender** placed in a dead zone of your house rebroadcasts the signal from the main router to improve coverage in weak areas.
    - Hotels and conference halls use **repeaters** to enhance signal strength in far-reaching areas.

3. Bridge Mode (Connecting Two Networks)

- **Description**: A Wi-Fi bridge connects **two separate networks** to function as a single network. It is used when devices or networks need to communicate but are physically separated.
- **Use Case**: Used in **corporate buildings, data centers, and remote locations** where different LANs need to be linked over Wi-Fi.
- **Example**:
    - A company has **two office buildings**, and a **Wi-Fi bridge** connects their networks without laying Ethernet cables.
    - A **smart TV without Wi-Fi** is connected to a **Wi-Fi bridge device**, which links it to the main router for internet access.

4. Ad-Hoc Mode (Peer-to-Peer Mode)

- **Description**: Devices communicate **directly with each other** without requiring an access point or router. It is a decentralized, temporary network.
- **Use Case**: Used in **file sharing, emergency communication, and IoT networks** where a traditional infrastructure-based network is unavailable.
- **Example**:
    - **Wi-Fi Direct** allows two smartphones to **transfer files** without needing a router.
    - In **disaster recovery** situations, emergency responders use **ad-hoc mode** to set up instant Wi-Fi communication without an existing infrastructure.