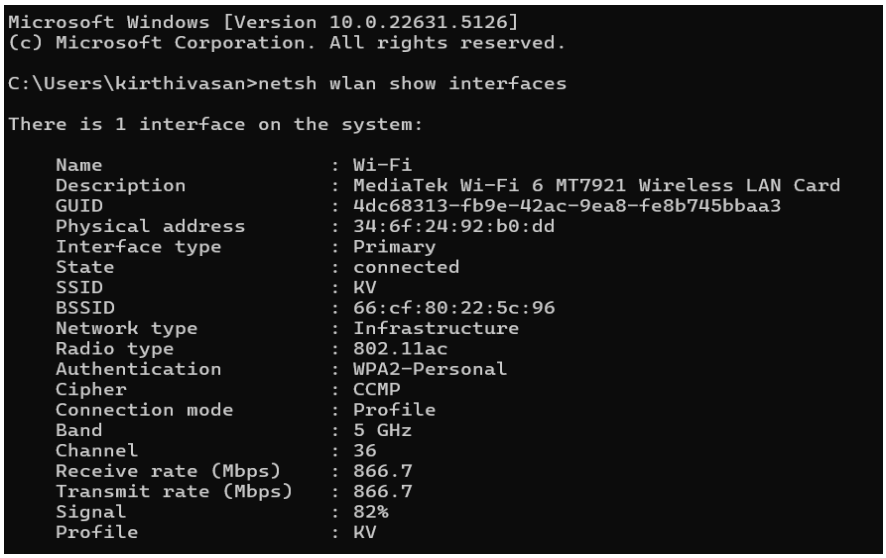
Module 1 Assignment

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

The Wi-Fi standard/protocol fits primarily in the **Data Link** Layer includes MAC (Media Access Control) and Logical Link Control (LLC) sublayers. Defines how devices access the medium, frame formats, and addressing .

It also works at **Physical layer** which defines radio frequencies, signal modulation, transmission rates (e.g., 2.4 GHz, 5 GHz bands, OFDM, etc.)

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**



```
Microsoft Windows [Version 10.0.22631.5126]
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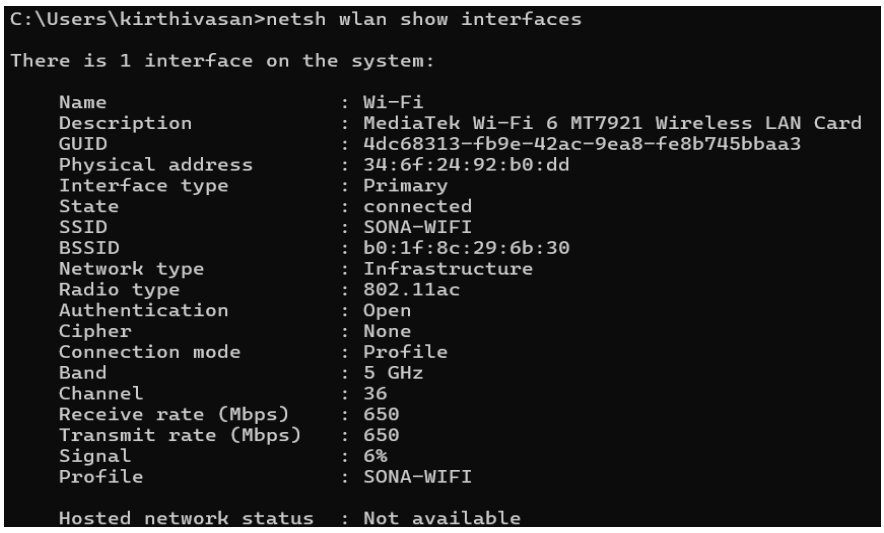
C:\Users\kirthivasan>netsh wlan show interfaces

There is 1 interface on the system:

    Name                   : Wi-Fi
    Description            : MediaTek Wi-Fi 6 MT7921 Wireless LAN Card
    GUID                   : 4dc68313-fb9e-42ac-9ea8-fe8b745bbaa3
    Physical address       : 34:6f:24:92:b0:dd
    Interface type         : Primary
    State                  : connected
    SSID                   : KV
    BSSID                  : 66:cf:80:22:5c:96
    Network type           : Infrastructure
    Radio type             : 802.11ac
    Authentication         : WPA2-Personal
    Cipher                 : CCMP
    Connection mode        : Profile
    Band                   : 5 GHz
    Channel                : 36
    Receive rate (Mbps)    : 866.7
    Transmit rate (Mbps)   : 866.7
    Signal                 : 82%
    Profile                : KV
```



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    Physical address       : 34:6f:24:92:b0:dd
    Interface type         : Primary
    State                  : connected
    SSID                   : SONA-WIFI
    BSSID                  : b0:1f:8c:29:6b:30
    Network type           : Infrastructure
    Radio type             : 802.11ac
    Authentication         : Open
    Cipher                 : None
    Connection mode        : Profile
    Band                   : 5 GHz
    Channel                : 36
    Receive rate (Mbps)    : 650
    Transmit rate (Mbps)   : 650
    Signal                 : 6%
    Profile                : SONA-WIFI

    Hosted network status  : Not available
```

3. **BSS and ESS**

BSS

A **BSS** is the basic building block of a Wi-Fi network. It consists of **One Access Point (AP)**

All client devices connected to that AP (laptops, phones, etc.)

Identified by a **BSSID** (MAC address of the AP)

ESS

An **ESS** is a **collection of multiple BSSs** that are interconnected to form a larger network.

It consists of **Multiple Access Points (APs)** with the **same SSID**

All APs in an ESS share the same SSID but have different BSSIDs

4 . **what are the basic functionalities of Wi-Fi Access point**

1. Wireless Signal Broadcasting

The AP broadcasts a **Wi-Fi signal** using radio frequencies (usually **2.4 GHz** and/or **5 GHz**).

2. Bridging Wired and Wireless Networks

It connects to a **wired LAN** via Ethernet and extends that network wirelessly.

3 . Handling Device Connections

Manages multiple simultaneous connections from wireless devices.

Assigns **IP addresses** (sometimes through a built-in DHCP server).

4 . Routing & Internet Sharing

Some APs are built into **wireless routers** that handle:

- **Network Address Translation (NAT)**
- **Routing between networks**
- **Firewall** functions
- **Sharing a single internet connection** with multiple users

5 . Data Transmission and Reception

Converts these packets between **wireless format (802.11)** and **Ethernet (802.3)** format.

5 . **Difference between Bridge mode and Repeater mode**

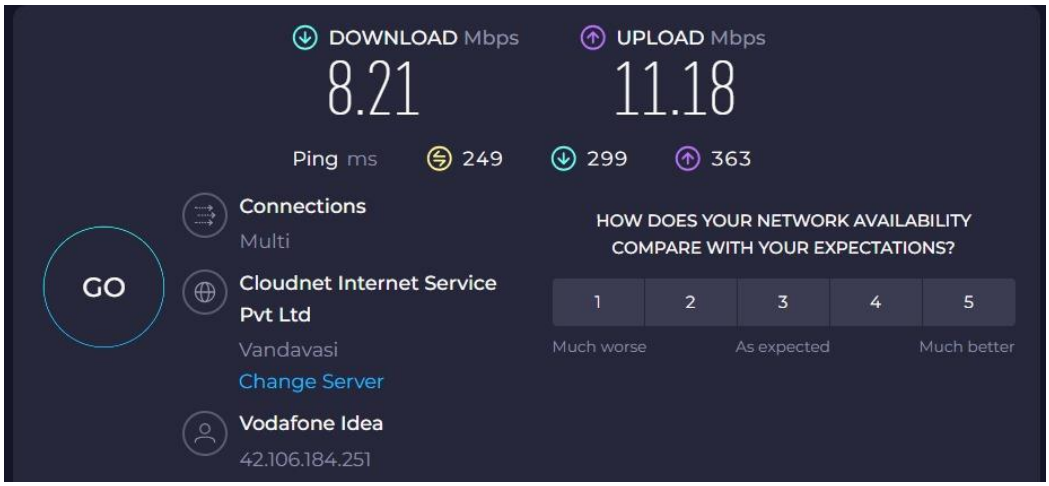
Feature	Bridge Mode	Repeater Mode
Function	Connects two networks	Extends Wi-Fi coverage
Network Type	Creates a single network by linking two different networks	Works within the same network
Performance	High-speed direct connection	Signal loss due to rebroadcasting
Use Case	Office networks, connecting distant locations	Expanding Wi-Fi range in homes/offices
Latency	Lower latency	Higher latency due to signal retransmission

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

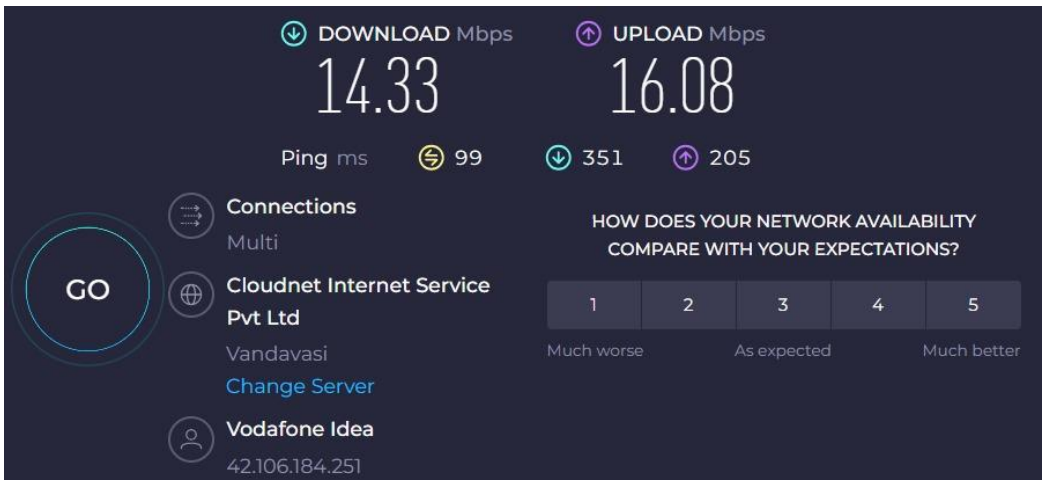
Feature	802.11a	802.11b
Frequency Band	5 GHz	2.4 GHz
Maximum Speed	54 Mbps	11 Mbps
Range	Shorter (~35m indoors)	Longer (~38m indoors)
Interference	Less interference (fewer devices on 5 GHz)	More interference (due to other 2.4 GHz devices)
Adoption	Used in businesses and enterprises	More common in homes and public networks
Wall Penetration	Weaker (high-frequency signals)	Stronger (low-frequency signals)
Availability	Less common today	Phased out, replaced by newer standards
Use Cases	High-speed applications, enterprise Wi-Fi	Low-cost, long-range Wi-Fi for homes

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

2.4 GHz



5 GHz



Feature/Aspect	2.4 GHz Band	5 GHz Band
Speed	Lower speeds compared to 5 GHz	Higher speeds suitable for HD streaming and gaming
Range	Longer range with better wall penetration	Shorter range; signal drops quickly with distance and obstacles
Interference	More interference from devices like microwaves and Bluetooth	Minimal interference, resulting in a more stable connection
Latency	Slightly higher, making it less ideal for real-time apps	Lower latency, ideal for smooth real-time applications
Stability Over Distance	More stable at longer distances	Less stable as distance from the router increases
Suitability	Better for general browsing and long-distance connectivity	Better for high-bandwidth tasks like streaming, gaming in close proximity

8 . **What is the difference between IEEE and WFA.**

IEEE (Institute of Electrical and Electronics Engineers)

- Function: Develops and standardizes Wi-Fi protocols under the IEEE 802.11 family.
- Focus: Technical and engineering aspects of wireless networking.
- Responsibilities:
    - Defines Wi-Fi standards like 802.11a/b/g/n/ac/ax.
    - Specifies how devices communicate wirelessly at the hardware level.
    - Ensures interoperability and efficiency in wireless networks.
- Example: IEEE created 802.11ax (Wi-Fi 6) as the next-generation wireless standard.

WFA (Wi-Fi Alliance)

- Function: Certifies Wi-Fi products to ensure compatibility and branding.
- Focus: Consumer-facing validation, interoperability, and marketing.
- Responsibilities:
    - Tests devices to confirm they meet IEEE 802.11 standards.
    - Issues the Wi-Fi Certified logo for compliant devices.
    - Develops additional features like Wi-Fi Direct, Wi-Fi Protected Access (WPA), and Wi-Fi Easy Connect.

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

- **Fiber Optic Backhaul**
    - Uses fiber-optic cables for high-speed and low-latency internet.
    - Provides speeds up to **10 Gbps** or more.
    - Ideal for high-demand networks like data centers, ISPs, and enterprises.
- **Ethernet Backhaul**
    - Uses wired Ethernet connections to link access points and routers.
    - More stable and reliable than wireless backhaul.
    - Common in home and office networks for **Gigabit speeds**.
- **Wireless Backhaul**
    - Uses radio signals (microwave, millimeter-wave, or Wi-Fi) for backhaul.
    - Can be **point-to-point (P2P)** or **point-to-multipoint (P2MP)**.
    - Used in rural areas, city-wide Wi-Fi, and ISP tower connections.
- **Cellular Backhaul (4G/5G)**
    - Uses mobile networks to provide internet to Wi-Fi routers.
    - Works in remote locations where fiber or Ethernet is unavailable.
    - Speed depends on the **LTE/5G network** and signal strength.

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

- **Infrastructure Mode**
  - Uses an Access Point (AP) as a central hub for devices to connect.
  - Devices communicate through the AP rather than directly with each other.
  - Use Cases: Home Wi-Fi, office networks, public hotspots, campus Wi-Fi.
- **Ad-Hoc Mode (Peer-to-Peer)**
  - Devices connect directly without an access point.
  - Creates a temporary, decentralized network.
  - Use Cases: File sharing, gaming (LAN parties), emergency communication.
- **Mesh Network**
  - Multiple APs work together, automatically routing data for optimal performance.
  - Provides seamless coverage across large areas.
  - Use Cases: Smart homes, enterprise Wi-Fi, city-wide networks.

- **Wi-Fi Direct**
  - Enables device-to-device communication without an AP.
  - Uses WPS (Wi-Fi Protected Setup) for quick pairing.
  - Use Cases: Wireless printing, file sharing, smart TV casting.
- **Hotspot (Tethering Mode)**
  - A mobile device shares its internet connection over Wi-Fi.
  - Acts as a mini Wi-Fi router for other devices.
  - Use Cases: Mobile internet sharing, travel connectivity, remote work.