

## Wi-Fi Training Program

### Assignment Questions-Module 1

#### 1) Which of layer the Wi-Fi standard/protocol fits

Wi-Fi operates primarily at the Data Link Layer (Layer 2) of the OSI (Open Systems Interconnection) model, which is responsible for framing, addressing, and error detection in network communication. Within this layer, Wi-Fi functions in the MAC (Medium Access Control) sublayer, which manages access to the shared wireless medium, and the LLC (Logical Link Control) sublayer, which ensures reliable data transmission. Additionally, Wi-Fi also interacts with the Physical Layer (Layer 1) since it involves the transmission of radio waves. The IEEE 802.11 standard governs Wi-Fi communication, defining how wireless devices communicate while ensuring efficient and secure data transmission.

#### 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

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

There is 1 interface on the system:

Name                           : WiFi 2
Description                     : Intel(R) Dual Band Wireless-AC 8265
GUID                            : d54eed08-a2af-4e60-b7f4-a7de8d56ba72
Physical address                : ac:67:5d:96:57:f8
Interface type                  : Primary
State                           : connected
SSID                            : Samson's S23 Ultra
AP BSSID                        : c6:60:00:b7:52:78
Band                            : 5 GHz
Channel                         : 149
Network type                    : Infrastructure
Radio type                      : 802.11ac
Authentication                  : WPA2-Personal
Cipher                          : CCMP
Connection mode                 : Auto Connect
Receive rate (Mbps)             : 468
Transmit rate (Mbps)            : 468
Signal                          : 72%
Profile                         : Samson's S23 Ultra
QoS MSCS Configured             : 0
QoS Map Configured              : 0
QoS Map Allowed by Policy       : 0

Hosted network status           : Not available
```

#### 3) what is BSS and ESS?

Basic Service Set (BSS) and Extended Service Set (ESS)

BSS (Basic Service Set):

- A BSS is the fundamental unit of a Wi-Fi network.

- It consists of a single access point (AP) and the wireless devices (stations) connected to it.
- Each BSS has a unique BSSID (Basic Service Set Identifier), which is the MAC address of the AP.
- Devices within a BSS communicate through the AP.

ESS (Extended Service Set):

- An ESS is a collection of multiple BSSs interconnected through a wired network.
- It allows seamless connectivity across different APs using the same SSID (Service Set Identifier).
- Devices can roam between APs within an ESS without losing connection.

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

- **Wireless Signal Transmission and Reception**  
Converts wired Ethernet signals into wireless radio signals using antennas to send and receive data.
- **Network Bridging**  
Acts as a bridge between wireless devices and a wired network, allowing multiple devices to connect through a single wired connection.
- **Managing Wireless Clients**  
Handles multiple device connections, allocating bandwidth and managing traffic for stable communication.
- **Assigning IP Addresses (DHCP)**  
Functions as a DHCP server to assign unique IP addresses to connected devices.
- **Security and Authentication**  
Implements security protocols like WPA2, WPA3, along with authentication methods such as MAC filtering and 802.1X.
- **Roaming Support in Extended Networks**  
Enables seamless device roaming between multiple APs in an Extended Service Set (ESS) with fast handover (802.11r).
- **Frequency Band and Channel Management**  
Operates on 2.4 GHz, 5 GHz, or 6 GHz bands, managing channels to reduce interference and optimize performance.
- **Quality of Service (QoS)**  
Prioritizes traffic for applications like video streaming and VoIP, using 802.11e/WMM (Wi-Fi Multimedia) for improved performance.
- **Power Management (PoE Support)**  
Some APs support Power over Ethernet (PoE), receiving power and data over a single cable.
- **Mesh Networking and Range Extension**  
Supports mesh networking, allowing multiple APs to work together to expand coverage without requiring additional wired connections

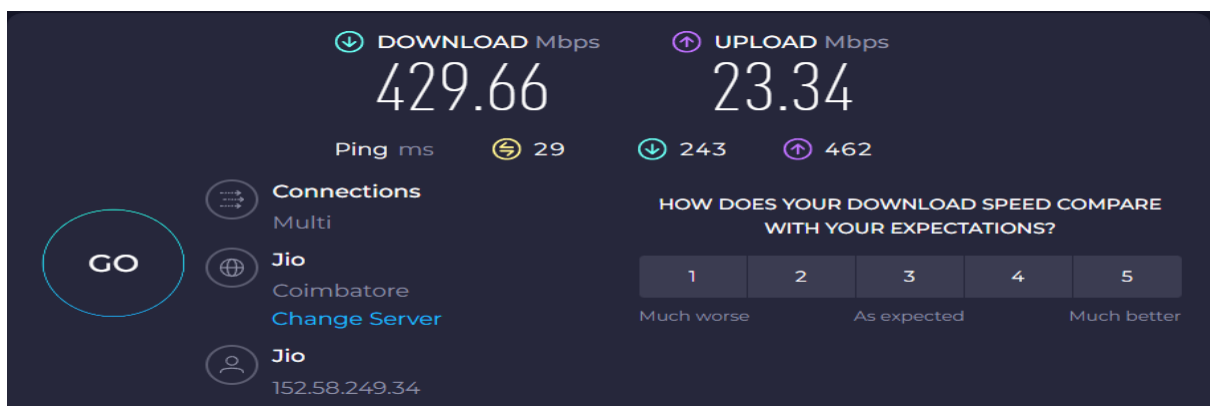
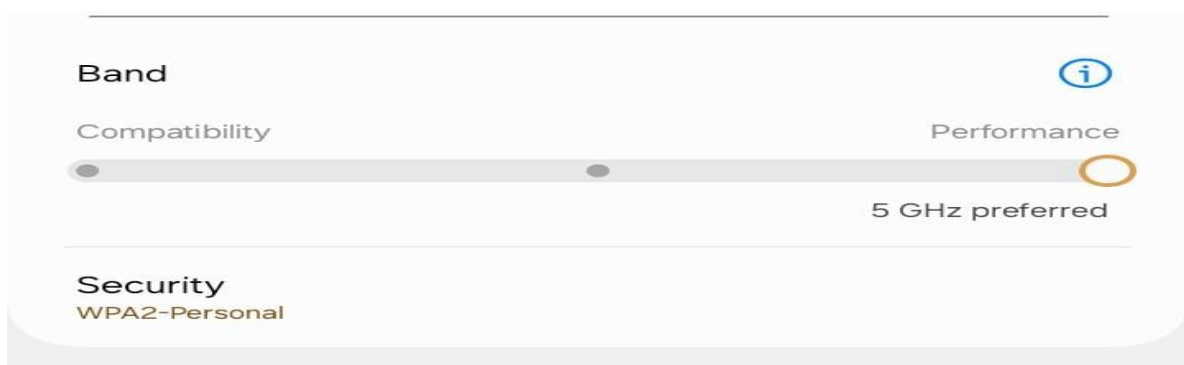
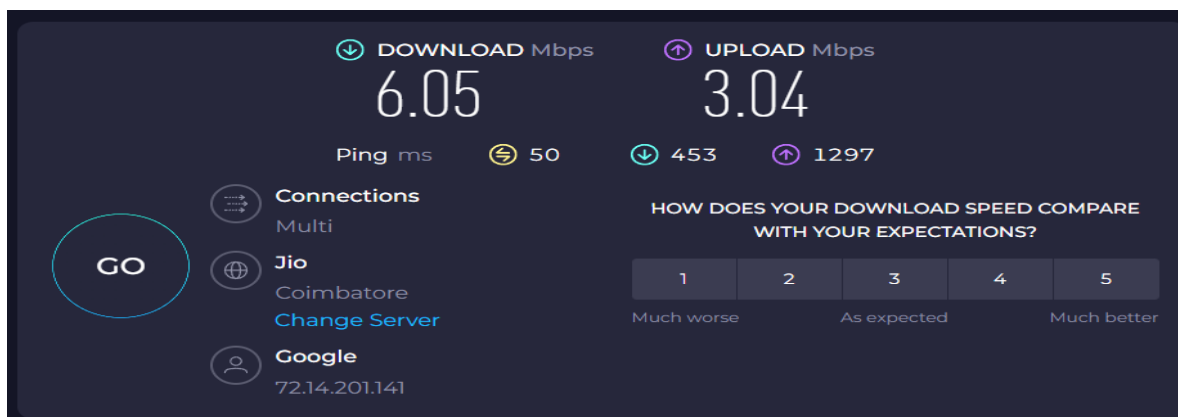
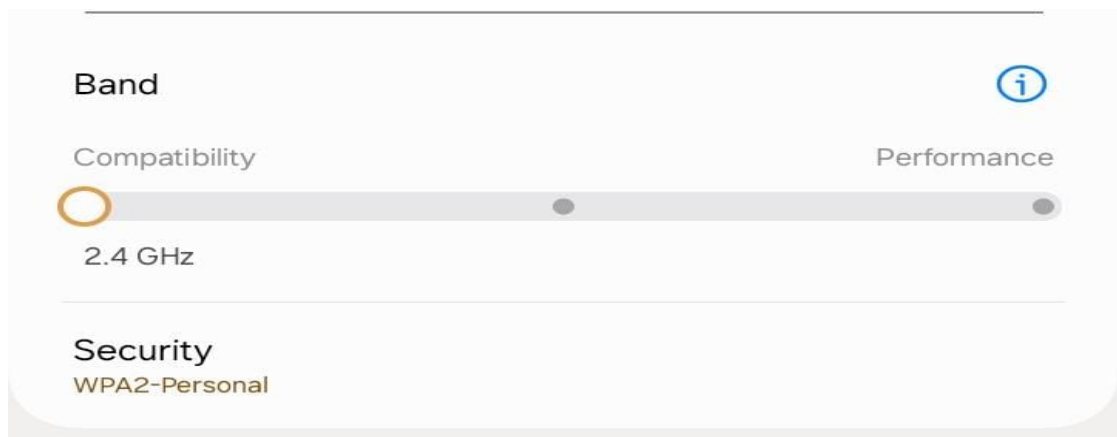
**5) Difference between Bridge mode and Repeater mode**

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**



When using 2.4 GHz, the network had a longer range and better penetration through walls, but the speed was lower. There was noticeable interference from other devices like microwaves and Bluetooth, which affected performance. Latency was slightly higher compared to 5 GHz, making it less ideal for activities like gaming or HD streaming. However, it was more stable over longer distances.

When switching to 5 GHz, the speed significantly improved, supporting higher bandwidth for streaming and gaming. There was minimal interference, leading to a more stable connection. However, the range was shorter, and signal strength dropped quickly when moving farther from the router. Walls and obstacles weakened the signal more compared to 2.4 GHz. Latency was lower, making real-time applications smoother.

## **8) What is the difference between IEEE and WFA**

IEEE (Institute of Electrical and Electronics Engineers) and WFA (Wi-Fi Alliance) are two important organizations in the development and certification of Wi-Fi technology, but they serve different roles.

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.

- Example: WFA ensures that a Wi-Fi 6 router works correctly with all Wi-Fi 6-certified smartphones and laptops.

**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.
- **Satellite Backhaul**
  - Uses satellites to provide internet to ground-based Wi-Fi networks.
  - High latency but useful for **rural and offshore connectivity**.
  - Services like **Starlink, HughesNet, and Viasat** use this method.

**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.