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MODULE I

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

Wi-Fi technology fits in the Layer 1 i.e. **Physical Layer** and Layer 2 i.e. **Data Link Layer** of the OSI Model.

PHYSICAL LAYER:

- Wi-Fi handles the actual transmission and reception of radio signals. This includes modulation techniques like DSSS (Direct Sequence Spread Spectrum) for 802.11b or OFDM (Orthogonal Frequency Division Multiplexing) for 802.11a/g/n/ac/ax.
- The physical layer manages frequency bands (2.4GHz, 5GHz, or 6GHz), channel widths (20MHz, 40MHz, 80MHz, 160MHz), and all the radio frequency characteristics that enable wireless communication.

DATA LINK LAYER:

- **Logical Link Control (LLC)**: Handles multiplexing protocols, flow control, and error checking
- **Media Access Control (MAC)**: Manages how devices gain access to the medium and permission to transmit data. The 802.11 MAC layer is particularly complex because it must handle collision avoidance (CSMA/CA rather than CSMA/CD in Ethernet), authentication, association, and power management for mobile devices.

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.

a) Laptop

Current Connection	**:**	Wi-Fi 6 (802.11ax)
Description	**:**	MediaTek MT7921 Wi-Fi 6 802.11ax PCIe Adapter
Radio Type	**:**	802.11 ax
Band	:	5 GHZ
Speed	:	866.6 Mbps
Wi-Fi Generation	:	Wi-Fi 6 (802.11ax) supported

b) Mobile Phone

Current Connection	**:**	Wi-Fi 5 (802.11ac)
Description	**:**	Gokulam__5G

Radio Type	**:**	802.11 ac
Band	:	5 GHZ
Speed	:	433 Mbps
Wi-Fi Generation	:	Wi-Fi 5 (802.11 ac) supported

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

There is 1 interface on the system:

    Name                   : WiFi 2
    Description            : MediaTek MT7921 Wi-Fi 6 802.11ax PCIe Adapter
    GUID                   : 3fc0f2e0-68e2-4b31-b30b-f77eb65a43b7
    Physical address       : 10:68:38:25:fc:9b
    Interface type         : Primary
    State                  : connected
    SSID                   : Gokulam__5G
    AP BSSID               : b4:a7:c6:ca:22:04
    Band                   : 5 GHz
    Channel                : 153
    Network type           : Infrastructure
    Radio type             : 802.11ac
    Authentication         : WPA2-Personal
    Cipher                 : CCMP
    Connection mode        : Auto Connect
    Receive rate (Mbps)    : 866.7
    Transmit rate (Mbps)   : 866.7
    Signal                 : 86%
    Profile                : Gokulam__5G
    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?

- **BSS (Basic Service Set):** A single access point (AP) and connected clients form a basic wireless network. Communication in a BSS always flows through the AP, even between devices on the same network, and each BSS is identified by a unique BSSID (typically the AP's MAC address).
- **ESS (Extended Service Set):** Multiple BSS units interconnected, allowing seamless roaming within a large network, such as in universities or corporate offices. All BSSs in an ESS share the same SSID but use different BSSIDs, allowing devices to move between coverage areas while maintaining continuous network connectivity.
- While a BSS suits small deployments like homes or coffee shops, an ESS is essential for larger spaces like offices or campuses where multiple APs are needed for full coverage.

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

A Wi-Fi Access Point enables wireless devices to connect to a wired network.

Key functions:

- **Signal Broadcasting:** Transmits SSID for network discovery.
- **Network Bridging:** Connects wired and wireless devices.
- **Security Enforcement:** Implements WPA/WPA2/WPA3 authentication.
- **Bandwidth Management:** Allocates bandwidth efficiently across devices.

5. Difference between Bridge mode and Repeater mode

Description	Bridge Mode	Repeater Mode
Primary Function	Connects two separate network segments at Layer 2 (data link layer	Extends the range of an existing wireless network
Operation	Creates a point-to-point or point-to-multipoint link between networks	Receives and retransmits all wireless traffic
Traffic Handling	Only passes traffic destined for the other network segment	Repeats all traffic, effectively doubling the airtime usage
SSID Handling	Typically maintains different SSIDs on each side of the bridge	Typically uses the same SSID as the main network
Security	Often uses dedicated point-to-point encryption	Inherits the main network's security settings
Bandwidth	Full bandwidth available as it doesn't share airtime with clients	Shared between clients and the uplink to the main AP
Topology	Doesn't extend the existing network, but rather connects two networks	Extends the same broadcast domain and IP subnet
Application	Connecting two buildings' networks wirelessly	Extending Wi-Fi coverage in a home or office

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

1. Frequency Band: 802.11a operates on 5 GHz, while 802.11b uses 2.4 GHz.
2. Speed: 802.11a supports speeds up to 54 Mbps, whereas 802.11b has a maximum of 11 Mbps.
3. Range: 802.11a has a shorter range, while 802.11b covers a longer distance.
4. Interference: 802.11a experiences less interference due to the 5 GHz band, while 802.11b is more prone to interference from devices like microwaves and Bluetooth.
5. Penetration: 802.11b signals penetrate walls better than 802.11a, which struggles with obstacles.
6. Adoption: 802.11b was more widely adopted, making it common in early Wi-Fi networks.
7. Power Consumption: 802.11a consumes more power due to higher frequency operation, while 802.11b is more power-efficient.
8. Cost: Devices using 802.11a were initially more expensive than those using 802.11b.
9. Use Cases: 802.11a was preferred for enterprise and business networks, while 802.11b was common in home and public Wi-Fi.
10. Compatibility: 802.11a and 802.11b are not compatible with each other due to different frequency bands.

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	5 GHz
Radio Type	802.11 n	802.11 ac
Authentication	WPA/WPA2-Personal	WPA/WPA2-Personal
Band	2.4 GHz	5 GHz
Channel	1	153
Receive Rate	72 Mbps	866 Mbps
Transmit Rate	72 Mbps	866 Mbps
Signal Strength	Fair	Poor

Range	Longer Range	Less Range

8. What is the difference between IEEE and WFA

- IEEE (Institute of Electrical and Electronics Engineers): Develops wireless communication standards like 802.11.
- WFA (Wi-Fi Alliance): Certifies devices for interoperability, security, and performance.

DIFFERENCES:

- **Standard vs Implementation:** IEEE creates the standard; WFA ensures implementations work together
- **Technical vs Practical:** IEEE defines how it should work; WFA defines how to make products that work together
- **Scope:** IEEE covers all 802 standards; WFA only Wi-Fi
- **Output:** IEEE produces standards documents; WFA offers certification
- **Branding:** IEEE uses technical names (802.11ax); WFA uses consumer-friendly names (Wi-Fi 6)

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

Wi-Fi backhaul refers to the infrastructure that connects wireless access points to the core network or internet. The Primary Types are:

1. Wired Ethernet Backhaul
2. Fiber Optic Backhaul
3. Microwave Point-to-Point
4. DSL/Cable Modem Backhaul
5. Cellular Backhaul (4G/5G)
6. Satellite Backhaul
7. Powerline Networking
8. Mesh Wi-Fi Backhaul

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

1. Infrastructure Mode – Used in homes, offices, and enterprises for structured wireless communication.

2. Ad-Hoc Mode – Ideal for temporary or emergency peer-to-peer networking without an access point.
3. Mesh Network – Provides seamless coverage in smart cities, large campuses, and IoT networks.
4. Wi-Fi Direct – Enables direct device-to-device communication for file sharing and gaming.
5. Extended Service Set (ESS) – Supports roaming users in large areas like malls, airports, and universities.