M3: Metropolitan and Local Area Wireless Network

1) Basic Configuration of Wireless LAN Network:

A basic wireless LAN (Local Area Network) configuration typically includes the following components:

- **Wireless Access Points (APs):** These are devices that enable **wireless devices** to connect to the **network**. **APs** act as the bridge between **wired** and **wireless networks.**
- **Wireless Clients**: These are the **devices** that connect to the **wireless network**, such as laptops, smartphones, tablets, or other Wi-Fi-enabled devices.
- **Wireless Router or Switch**: In many wireless LAN setups, a router or switch is used to connect the **wireless network** to the **wired infrastructure**, enabling communication between wired and wireless devices.
- **SSID (Service Set Identifier):** The SSID is the **network name** that wireless clients use to identify and connect to the wireless network.
- **Security Mechanisms:** Security measures such as **WPA (Wi-Fi Protected Access)** or WPA2, along with encryption methods like WEP (Wired Equivalent Privacy) or AES (Advanced Encryption Standard), are implemented to secure the wireless communication.
- **Channel Configuration:** Wi-Fi operates on different channels within the frequency spectrum. **Proper channel selection and configuration** help minimize interference and optimize network performance.

2) BSS and ESS in Wireless LAN:

- **BSS (Basic Service Set):** A BSS is the basic building block of a wireless LAN. It consists of a single access point (AP) and the devices associated with it. In infrastructure mode, a BSS is created around a single AP, and devices connect directly to that AP.
- **ESS (Extended Service Set):** An ESS is a set of interconnected BSSs. In other words, it's a collection of BSSs connected by a distribution system. Devices within an ESS can seamlessly roam between different BSSs, maintaining continuous connectivity.

Roles:

- BSS: The BSS provides the basic connectivity within a localized area, typically around a single AP. It's the smallest unit in a wireless LAN network.
- ESS: The ESS allows for the extension of the wireless network over a larger geographical area. Devices in an ESS can move between different BSSs while maintaining connectivity, enabling seamless roaming.

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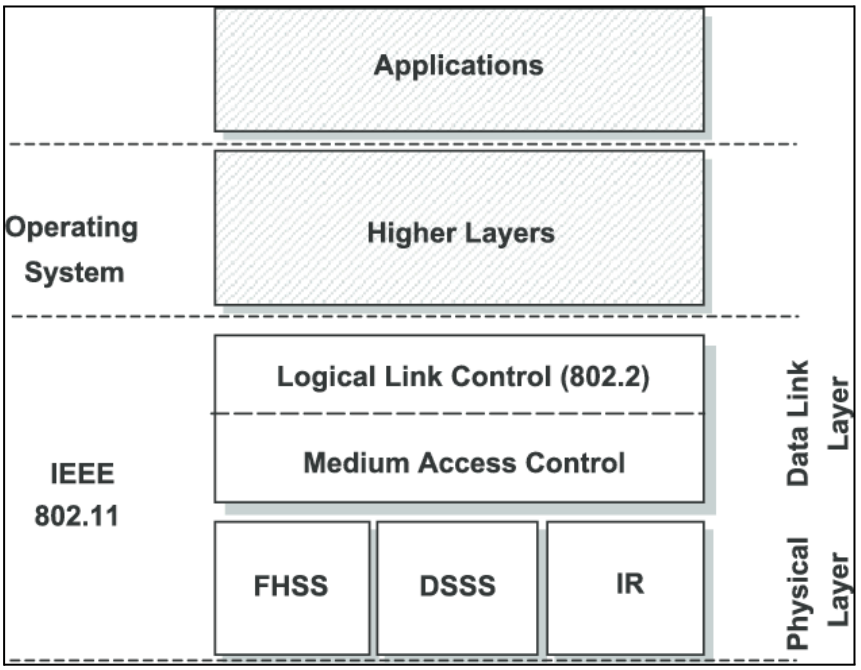
3)Draw and explain the protocol stack for IEEE 802.11

The protocol stack for IEEE 802.11, which defines the standards for wireless LANs, includes the following layers:

- **Physical Layer (PHY)**: The PHY layer defines the physical characteristics of the wireless transmission, such as frequency, modulation, and channel access methods.
- **Medium Access Control (MAC):** The MAC layer is responsible for managing access to the wireless medium, including frame formatting, addressing, and error checking. It handles aspects like contention resolution and defines different access methods (e.g., CSMA/CA - Carrier Sense Multiple Access with Collision Avoidance).
- **Logical Link Control (LLC):** The LLC layer provides a connectionless service to the network layer and is responsible for flow control and error recovery.
- **Internet Layer (Network):** This layer handles IP addressing, routing, and packet forwarding.
- **Transport Layer:** Responsible for end-to-end communication, error detection, and recovery.
- **Application Layer:** The top layer where applications interact with the network.

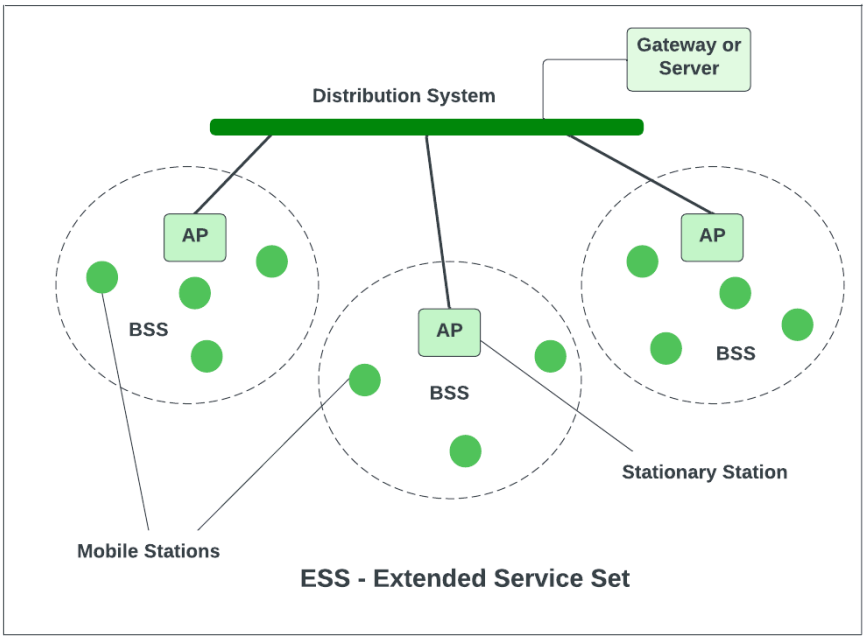


4.Explain the operating principle of OFDM used for IEEE 802.11a.

Orthogonal Frequency Division Multiplexing

- OFDM Basis: **Divides spectrum into orthogonal subcarriers for simultaneous transmission.**
- Orthogonality: Subcarriers are mathematically perpendicular, minimizing interference.
- Subcarrier Allocation: **52 subcarriers** in IEEE 802.11a for data transmission.
- Data Mapping: **Parallel data streams mapped** onto subcarriers.
- Guard Intervals: Inserted between symbols to **combat multipath interference.**
- FFT (Fast Fourier Transform): Converts parallel data into frequency-domain OFDM symbols.
- Transmission: **Simultaneous transmission** of modulated OFDM symbols.
- IFFT (Inverse Fast Fourier Transform): Converts received signals back to time-domain at the receiver.
- Demodulation: Demodulated signals combined to reconstruct the original data stream.
- Data Recovery: Guard intervals aid in mitigating multipath effects for reliable data recovery.
- Benefits: **High data rates, spectrum efficiency, and robust performance in wireless communication.**

5)Explain the architecture of wireless LAN Network with suitable diagram.



Wireless Stations (Clients):

- Laptops, Smartphones, Tablets, etc.: These are the end-user devices that connect to the wireless network. They are equipped with wireless network interfaces (Wi-Fi adapters) to communicate with access points.

Access Points (APs):

- Access points act as bridges between wireless clients and the wired network infrastructure.
- They are responsible for managing the wireless communication, providing authentication and encryption, and forwarding data between wireless clients and the wired network.

Distribution System (DS):

- The distribution system connects multiple access points in a wireless network to the wired backbone (typically an Ethernet network).
- It enables communication between wireless clients associated with different access points and facilitates their connection to the wired network.

6)Compare IEEE 802.11DSSS and IEEE 802.11FHSS.

IEEE 802.11 DSSS (**Direct Sequence Spread Spectrum**):

- Uses direct sequence modulation, spreading the signal across a wide frequency band.
- Operates in the 2.4 GHz band.
- Better suited to handle interference due to signal spreading.
- Generally provides higher data rates (1 or 2 Mbps).
- Considered more spectrally efficient.
- Can be more power-efficient in certain scenarios.
- Commonly used in mainstream consumer WLANs.

IEEE 802.11 FHSS (**Frequency Hopping Spread Spectrum**):

- Rapidly changes the carrier frequency according to a hopping sequence.
- Operates in the 2.4 GHz band but adaptable to other frequency bands.
- Provides resistance to interference due to frequency hopping.
- Typically offers lower data rates (around 1 Mbps).
- May be less spectrally efficient.
- May consume more power due to frequent frequency changes.
- Historically used in industrial and military applications; less common in consumer WLANs.

7)Explain the frame structure of IEEE 802.11DSSS / IEEE 802.11FHSS.

1. Preamble:
   - DSSS: Short and long preambles for synchronization.
   - FHSS: Typically includes a synchronization sequence.
2. Start Frame Delimiter (SFD):
   - Marks the start of the frame.
3. Frame Control:
   - Contains frame type, duration, addressing, and control info.
4. Duration/ID:
   - Specifies time (in microseconds) for medium occupation.
5. Address Fields:
   - Includes MAC addresses of transmitter and receiver.
6. Frame Body:
   - Carries the actual data payload.
7. Frame Check Sequence (FCS):
   - CRC/FCS for error-checking.
8. Inter-Frame Spacing (IFS):
   - Introduces time gaps between frames for medium access.
9. Acknowledgment (ACK):

- Sent by the receiver for successful frame reception.

10. Optional Frame Types:
    - Additional frames like Probe, Beacon, Authentication, and Association frames may exist.

8)Explain back off algorithm.

9)Explain hidden and exposed station problem with suitable scenario.

10)Explain WEP frame security mechanism.

11)What are main differences between Wimax and wifi.

WiMAX:

- **Broad coverage** over longer distances.
- Used for broadband wireless access, both fixed and mobile.
- Operates in **licensed and unlicensed bands.**
- Supports **high-speed mobility.**
- Governed by **IEEE 802.16 standards.**
- WiMAX **guarantees Quality of Service (QoS).**
- Requires dedicated infrastructure.
- **Deployment by service providers.**
- WiMAX networks operate on a connection-oriented MAC.
- WiMAX network can reach about **50-90 km.**

Wi-Fi:

- **Shorter ranges,** common in local areas.
- Used for **local wireless networking within homes and businesses.**
- Primarily operates in **unlicensed bands.**
- Suited for stationary or **low-mobility scenarios.**
- Governed by **IEEE 802.11 standards.**
- **Does not guarantee any Quality of Service (QoS).**
- Easy and cost-effective infrastructure setup.
- **Widely deployed in homes, businesses, and public spaces.**
- WiFi uses the conflict-based CSMA/CA protocol which is not connection-oriented.
- The WiFi network range is around **100 meters.**

12)Write short note on IEEE 802.16.

IEEE 802.16: WiMAX (Worldwide Interoperability for Microwave Access)

- Standardization: IEEE 802.16 is a family of standards defining broadband wireless communication, commonly known as WiMAX.
- Broadband Wireless Access: Designed for providing wireless broadband access over a range of frequencies, including licensed and unlicensed bands.
- Coverage and Range: Supports both fixed and mobile deployments, with the ability to cover longer distances compared to Wi-Fi.
- Mobility Support: Evolved to include mobile WiMAX (802.16e) to facilitate high-speed connectivity for mobile devices in addition to fixed deployments.
- Quality of Service (QoS): Incorporates QoS mechanisms to prioritize different types of traffic for improved performance in diverse applications.
- Frequency Bands: Operates in various frequency bands, allowing flexibility in deployment and accommodating different regulatory environments.
- Standard Evolution: Multiple amendments and revisions, including 802.16d (fixed WiMAX), 802.16e (mobile WiMAX), and subsequent updates for enhanced capabilities.
- Infrastructure Deployment: Requires dedicated infrastructure, typically deployed by service providers to offer wireless broadband services.
- Global Applicability: WiMAX has been deployed worldwide for providing last-mile connectivity, backhaul solutions, and internet access in areas lacking wired infrastructure.
- Challenges: Faced challenges in competition with LTE (Long-Term Evolution) for 4G wireless communication, and the focus on mobile broadband shifted towards LTE technologies.
- Legacy Status: While newer technologies like 4G LTE and 5G have gained prominence, WiMAX remains in use in certain niche applications and specific regions.

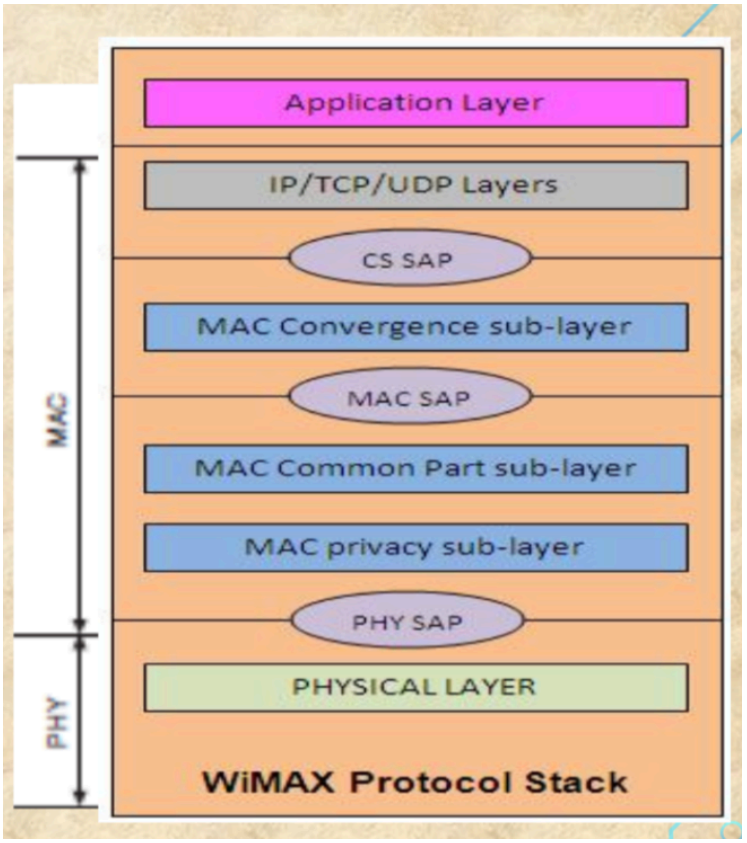
13)Draw and explain IEEE 802.16 architecture.

IEEE 802.16 Architecture: WiMAX

- BS (Base Station): Central component, connects to subscriber stations and manages the wireless network.
- ASN (Access Service Network): Comprises one or more BSs and their associated components, handling radio resource management.
- CSN (Connectivity Service Network): Manages subscriber authentication, IP address allocation, and connection setup.
- SS (Subscriber Station): User device connecting to the WiMAX network, communicates with the BS for access and services.
- MAC (Medium Access Control): Manages channel access, scheduling, and QoS for efficient data transmission.
- PHY (Physical Layer): Handles modulation, coding, and transmission/reception of signals over the air interface.
- Mesh Mode (Optional): Allows direct communication between SSs, enhancing network flexibility and coverage.
- Network Reference Model: Defines connectivity, service, and management relationships among BS, ASN, and CSN.
- Mobility Support: Introduced in mobile WiMAX (802.16e), enabling seamless handovers and high-speed connectivity for moving devices.
- Security Features: Incorporates mechanisms for subscriber authentication, encryption, and privacy protection.
- Service Flows: Support for multiple service flows with different QoS requirements, accommodating diverse applications.
- IP Connectivity: Enables seamless integration with IP-based networks, supporting various services and applications.
- Point-to-Multipoint Topology: Designed for last-mile broadband access, supporting multiple SSs served by a single BS.

14)Write short note on IEEE 802.16 protocol stack.

- PHY (Physical Layer): Modulation, encoding, and transmission of signals.
- MAC (Medium Access Control):
    - Channel access, scheduling, QoS.
    - Ranging, common, security, and management sublayers.
- Ranging Sublayer: Initial synchronization for subscriber stations.
- Security Sublayer: Encryption, authentication, privacy protection.
- Management Sublayer: Network entry, handovers, configuration.
- Convergence Sublayer (CS): Interface with upper-layer protocols.
- SSCS (Service-Specific Convergence Sublayer): Adapt upper-layer protocols for WiMAX.
- MAC Common Part: Connection establishment, bandwidth requests, power management.
- PHY Common Part: Common PHY functionalities, initial ranging.
- Privacy Sublayer: Ensures privacy protection for subscriber stations.



15)Draw the frame format of Wimax MAC frame and explain various fields.

16)List the features of Wimax.

- Broad Coverage:
    - Designed for providing wireless broadband access over a wide coverage area.
- Long Range:
    - Capable of covering longer distances, making it suitable for both metropolitan and rural deployments.
- High Data Rates:
    - Supports high data rates, enabling broadband connectivity for various applications.
- Fixed and Mobile Deployments:
    - Supports both fixed and mobile wireless broadband access scenarios.
- Frequency Bands:
    - Operates in both licensed and unlicensed frequency bands, offering flexibility in deployment.
- Quality of Service (QoS):
    - Incorporates QoS mechanisms to prioritize traffic and ensure reliable performance for different applications.
- Security Features:
    - Implements security measures such as encryption, authentication, and privacy protection to secure communication.
- Mobility Support:
    - Evolved to include mobile WiMAX (802.16e) with enhanced support for high-speed mobility.
- Flexibility in Deployment:
    - Can be deployed in various environments, including urban, suburban, and rural areas.
- Scalability:
    - Scales to accommodate a growing number of subscribers and devices.
- Last-Mile Connectivity:
    - Provides a solution for last-mile broadband access, particularly in areas without wired infrastructure.
- Mesh Networking (Optional):
    - Allows for direct communication between subscriber stations, enhancing network flexibility and coverage.
- Integration with IP Networks:
    - Seamlessly integrates with IP-based networks, supporting a wide range of services and applications.
- Service Flows:
    - Supports multiple service flows with different QoS requirements, catering to diverse applications.
- Interoperability:
    - Adheres to standards, ensuring interoperability among different WiMAX equipment and network elements.
- Global Deployment:
    - WiMAX has been deployed globally, addressing connectivity needs in various regions.
- Infrastructure Investment:

    - Requires dedicated infrastructure, often deployed by service providers to offer wireless broadband services.
- Legacy Status:
    - While newer technologies have gained prominence, WiMAX may still be in use for specific applications and regions.