

MODULE 5 ASSIGNMENT

1. What are the key features of Wi-Fi 6, 6E, and 7 and how do they differ from previous standards like Wi-Fi 5 (802.11ac)?

- **Wi-Fi 6 (802.11ax):**
 - OFDMA for better efficiency and lower latency.
 - MU-MIMO on uplink and downlink.
 - Target Wake Time (TWT) for improved power efficiency.
 - Higher performance in dense environments.
 - WPA3 for better security.
- **Wi-Fi 6E:**
 - Extends Wi-Fi 6 into the 6 GHz band.
 - Up to 1,200 MHz of extra bandwidth.
 - Less interference from legacy devices.
 - More available channels → better performance.
- **Wi-Fi 7 (802.11be):**
 - Supports 320 MHz channels (double from Wi-Fi 6).
 - 4K QAM for higher data rates.
 - Multi-Link Operation (MLO) for better throughput and reliability.
 - Reduced latency for AR/VR and real-time use cases.

2. Explain the role of OFDMA in Wi-Fi 6 and how it improves network efficiency.

- Divides a Wi-Fi channel into multiple smaller sub-channels (RUs).
- Allows simultaneous data transfer for multiple devices.
- Reduces latency by serving multiple users in one transmission.
- Enhances performance in congested environments.
- Improves spectrum utilization.

3. Discuss the benefits of Target Wake Time (TWT) in Wi-Fi 6 for IoT devices.

- Allows scheduling when devices wake to send/receive data.

- Minimizes power usage — ideal for battery-powered IoT.
- Reduces contention and network congestion.
- Extends battery life of devices.
- Supports scalable and energy-efficient networks.

4. Explain the significance of the 6 GHz frequency band in Wi-Fi 6E.

- Offers a clean, uncongested spectrum.
- Supports up to 59 new 20 MHz channels.
- Reduces interference from legacy devices.
- Enables wider channels (up to 160 MHz) for high throughput.
- Ideal for high-bandwidth applications like 4K/8K streaming and VR.

5. Compare and contrast Wi-Fi 6 and Wi-Fi 6E in terms of range, bandwidth, and interference

Feature	Wi-Fi 6	Wi-Fi 6E
Frequency Bands	2.4 GHz and 5 GHz	6 GHz (new spectrum)
Range	Better range, especially on 2.4 GHz	Slightly reduced range due to higher frequency
Bandwidth	Limited by existing 5 GHz spectrum	Supports more channels and wider bandwidth
Channel Availability	Fewer non-overlapping channels	Up to 59 new 20 MHz channels
Interference	Higher interference from legacy devices	Very low interference (clean 6 GHz band)
Use Case	Suitable for general use and backward compatibility	Ideal for high-performance, low-latency applications
Device Support	Compatible with most modern Wi-Fi devices	Requires Wi-Fi 6E compatible devices

6. What are the major innovations introduced in Wi-Fi 7 (802.11be)?

- 320 MHz channel width.

- 4K QAM for up to 20-30% more throughput.
- Multi-Link Operation (MLO) across multiple bands.
- Enhanced Channel Sounding and beamforming.
- Lower latency and jitter for real-time applications.

7. Explain the concept of Multi-Link Operation (MLO) and its impact on throughput and latency.

- Allows simultaneous use of multiple links (e.g., 5 GHz + 6 GHz).
- Increases total throughput by combining bandwidth.
- Improves link reliability and load balancing.
- Reduces latency and supports seamless data flow.
- Enhances performance for time-sensitive applications.

8. What is the purpose of 802.11k and v, and how does it aid in roaming?

- **802.11k:**
 - Devices receive neighbor reports for nearby APs.
 - Speeds up scanning and selection of best AP.
- **802.11v:**
 - AP suggests optimal APs for roaming.
 - Devices can transition more intelligently.
- Improves roaming experience and reduces disruptions.

9. Explain the concept of Fast BSS Transition (802.11r) and its benefit in mobile environments.

- Enables fast and secure handoff between APs.
- Reduces latency during roaming.
- Pre-authenticates client with nearby APs.
- Ideal for applications like VoIP, video conferencing.
- Supports smooth transitions without service interruption.

10. How do 802.11k/v/r work together to provide seamless roaming in enterprise networks?

- 802.11k: Helps client discover nearby APs.
- 802.11v: Assists in choosing the best AP based on signal and load.
- 802.11r: Speeds up authentication during handoff.
- Together, they:
 - Enhance roaming decisions.
 - Reduce delay and packet loss.
 - Improve user experience in enterprise and large networks.