

Wi-Fi Training Program

Module 5 – Assignment Answers

1. Key Features of Wi-Fi 6, 6E, and 7 and Differences from Wi-Fi 5 (802.11ac)

Feature	Wi-Fi 5 (802.11ac)	Wi-Fi 6 (802.11ax)	Wi-Fi 6E	Wi-Fi 7 (802.11be)
Frequency Bands	5 GHz only	2.4 GHz + 5 GHz	2.4 GHz + 5 GHz + 6 GHz	2.4 + 5 + 6 GHz
Efficiency	Basic	Improved via OFDMA and MU-MIMO	Same as Wi-Fi 6	Much improved (MLO, CMU-MIMO)
Speed	Up to 3.5 Gbps	Up to 9.6 Gbps	Same	Up to 46 Gbps
Latency	Moderate	Lower (OFDMA)	Lower	Ultra-low latency
Key Tech	MU-MIMO	OFDMA, TWT, BSS Coloring	Access to clean 6 GHz	MLO, 320 MHz channels, 4K-QAM

Wi-Fi 6 introduced OFDMA, MU-MIMO improvements, and Target Wake Time (TWT).

Wi-Fi 6E expanded into 6 GHz band for more capacity.

Wi-Fi 7 brings Multi-Link Operation (MLO), higher speeds, even lower latency.

2. Role of OFDMA in Wi-Fi 6 and How It Improves Efficiency

OFDMA (Orthogonal Frequency Division Multiple Access) splits one Wi-Fi channel into many small sub-channels.

- Multiple devices can transmit/receive simultaneously, instead of waiting one after another.
- Reduces latency and improves network efficiency especially in crowded environments (e.g., stadiums, offices).
- Example: In Wi-Fi 5, one device hogs the whole channel. In Wi-Fi 6, many small devices (like IoT) can talk at the same time using OFDMA.

3. Benefits of Target Wake Time (TWT) in Wi-Fi 6 for IoT

TWT schedules when devices should wake up and sleep.

- Reduces battery usage for IoT devices (like sensors, smart home gadgets).
- Minimizes contention by avoiding unnecessary wake-ups.
- Improves overall network performance by reducing "noise" from idle devices.

4. Significance of the 6 GHz Frequency Band in Wi-Fi 6E

The 6 GHz band adds more spectrum (up to 1200 MHz) for Wi-Fi.

- Clean fewer legacy devices, less interference.
- More channels (59 extra 20 MHz channels) better performance.
- Enables wider channels (80/160 MHz) for faster speeds.
- Great for high-bandwidth applications like 4K/8K streaming, AR/VR, low-latency gaming.

5. Compare and Contrast Wi-Fi 6 and Wi-Fi 6E (Range, Bandwidth, Interference)

Aspect	Wi-Fi 6	Wi-Fi 6E
Frequency Bands	2.4 GHz and 5 GHz	2.4 GHz, 5 GHz, and 6 GHz
Range	Good (especially 2.4 GHz)	Slightly lower (6 GHz has shorter range)
Bandwidth	Good	Better (more available channels in 6 GHz)
Interference	Moderate (crowded 2.4/5 GHz)	Low (6 GHz is cleaner)

Wi-Fi 6E is faster and cleaner, but shorter range compared to traditional Wi-Fi 6.

6. Major Innovations in Wi-Fi 7 (802.11be)

Wi-Fi 7 introduces several big improvements:

- MLO (Multi-Link Operation): Use multiple bands at once (2.4, 5, 6 GHz together).
- 320 MHz Channels: Double the width of 160 MHz channels - much faster.
- 4K-QAM (4096-QAM): Higher modulation - more data per transmission.
- CMU-MIMO: Coordinated MU-MIMO across APs for better performance.
- Extremely low latency: Ideal for real-time apps like VR, AR, gaming.

7. Concept of Multi-Link Operation (MLO) and Its Impact

MLO lets a device connect to multiple Wi-Fi bands at the same time.

- Increased throughput: More lanes open for faster speeds.
- Lower latency: Traffic can be dynamically balanced.
- Improved reliability: If one link is bad, others can pick up the slack.

Impact:

Huge performance boost for gaming, video streaming, and critical enterprise apps.

8. Purpose of 802.11k and 802.11v in Roaming

802.11k:

- Helps devices find better nearby APs faster by providing a neighbor report (list of nearby APs).

802.11v:

- Enables network to suggest roaming to a better AP (BSS Transition Management).

Purpose:

- Optimize roaming.
- Reduce delay when moving between APs.
- Improve connection reliability.

9. Concept of Fast BSS Transition (802.11r) and Its Benefit

802.11r (Fast BSS Transition):

- Speeds up the authentication process when a device roams between APs.
- Allows pre-authentication before moving.

Benefit:

- Devices like phones, tablets, or VoIP handsets can roam without dropping the connection — critical for voice calls, video conferencing, and gaming.

10. How 802.11k/v/r Work Together for Seamless Roaming

Working Together:

- 802.11k: Device knows where to roam (neighbor list).
- 802.11v: Network can tell the device where it should move.
- 802.11r: Device roams quickly with minimal reauthentication delay.

Result:

- Seamless roaming across APs.
- No noticeable drop in connectivity for end users.
- Critical for enterprise Wi-Fi, VoIP, mobile-first workspaces.