



Wi-Fi 6 & 6GHz

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agenda

-Introduction

PHY Comparison.

-Wi-Fi 6

OFDMA.

Other Features.

-Wi-Fi 6E

Overview.

AP & Clients Classification.

Channelization & BW.

WPA3.

How is WI-FI 6E different from WI-FI 6?



Introduction.

PHY Comparison

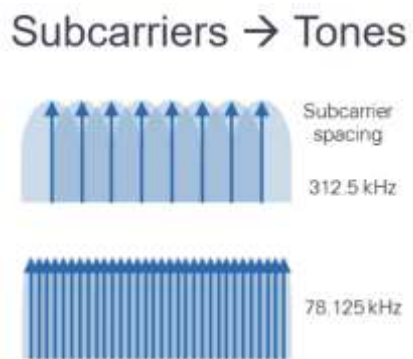
	802.11n	802.11ac	802.11ax
Channel Size (MHz)	20, 40	20, 40, 80, 80 + 80 & 160	20, 40, 80, 80 + 80 & 160
Subcarrier Spacing	312.5 KHz	312.5 KHz	78.125 KHz
Symbol Time (max)	4 μ s	4 μ s	16 μ s
Frequency Multiplexing	OFDM, HT-OFDM	OFDM, HT-OFDM	OFDM, HT-OFDM, & OFDMA
Modulation	BPSK, QPSK, 16-QAM, 64-QAM	BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM	BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM
MU-MIMO	N/A	Downlink	Downlink & Uplink
Spectrum Bands	2.4GHz & 5GHz	5GHz	2.4GHz & 5GHz

Wi-Fi 6 – 802.11 AX.

- OFDMA – Orthogonal Frequency Division Multiple Access.
- BSS Coloring.
- Multi TID.
- Multi-User.



- OFDMA:



- OFDMA allows sub-carriers in a channel bandwidth to be grouped into smaller portions called “Resource Units” (RU). These Subcarriers are further split into granular component called tones.
- RU tones of 26, 52, 106, 242, 484 and 996.

Wi-Fi 6 – 802.11 AX, cont.



- OFDMA:



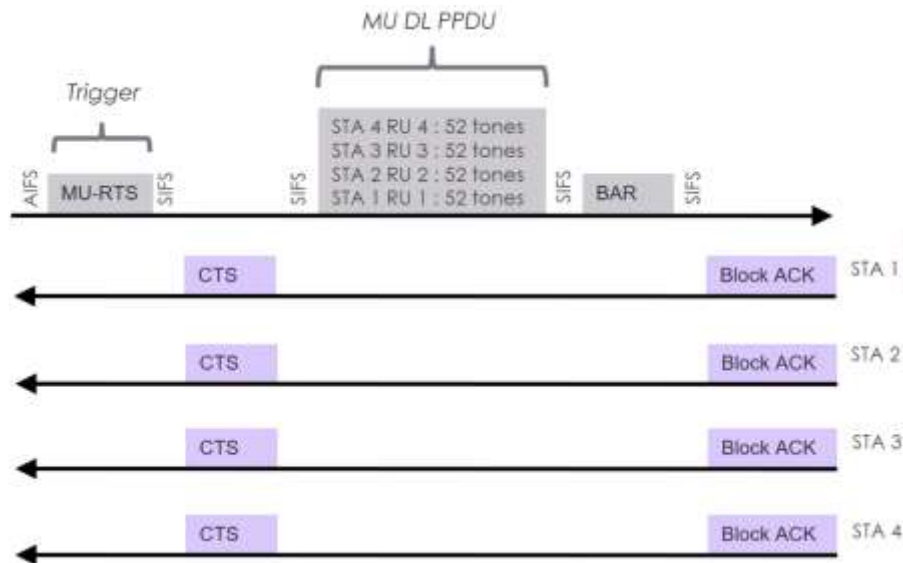
- 9 – users for 26, 4 – users for 52, 2 – users for 106, 1 user for 242.
- RU allotments in both downlink and uplink directions are performed by the AP on a per TxOP basis.
- A single RU type can assign to one user.

Wi-Fi 6 – 802.11 AX, cont.



- OFDMA:

- Frame Exchange Process – Downlink.



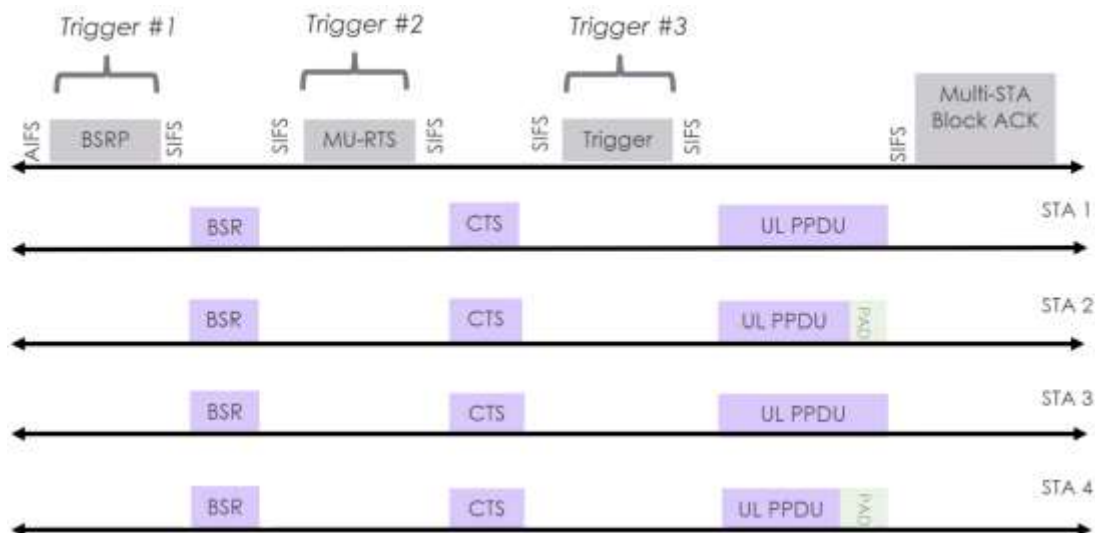
- MU-RTS – An extended trigger frame from AP to sync upstream
- MU-RTS is sent across whole 20 MHz
- CTS responses from the clients in parallel (on assigned RU's)
- DL MU PPDU data transmissions from AP to the OFDMA clients.
- Block ACK – Auto Block ACK or BAR/BA.

Wi-Fi 6 – 802.11 AX, cont.



- OFDMA:

- Frame Exchange Process – Uplink.

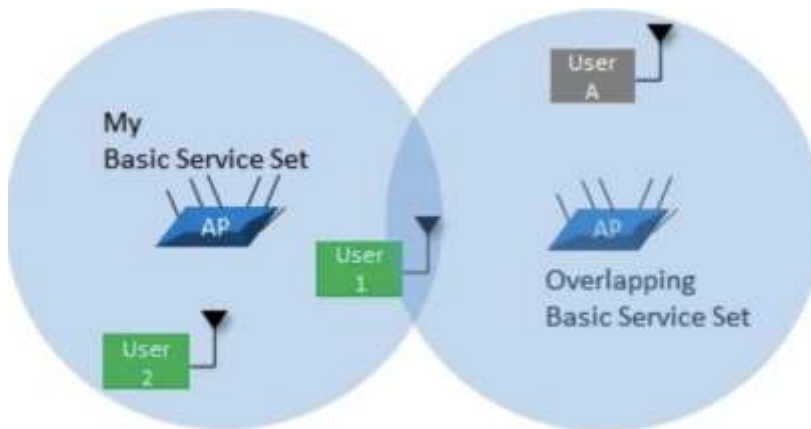


- AP Sends a BSRP Req (Buffer Status report Poll)
- Clients responds as BRS with AID, Data length, QoS, etc
- AP sends a Trigger frame MU-RTS and client responds to parallel RU.
- AP sends a basic trigger frame to allocate the RU's and time sync.
- Clients send UL DATA on their assigned RU's
- Multi-user Block ACK from AP.
- BSR Efficiency - Padding

Wi-Fi 6 – 802.11 AX, cont.



- BSS Coloring:

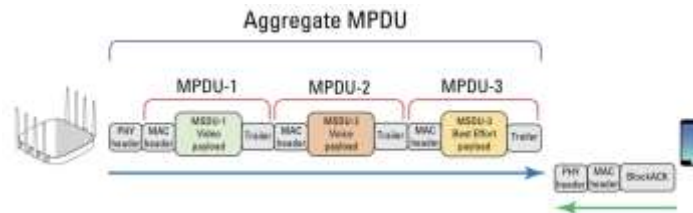


- Station detect RF energy
- Clear channel assessment suggests whether energy threshold is above -82 or below
- If RSSI greater than -82 and station checks whether it can demodulate traffic
- If yes, then it will read frame header to see color of the frame
- If its same color, then its means frame is from intra-BSS and
- will have to go through normal CSMA/CA process.
- If color is not same as its own BSS, then it's an inter-BSS frame.

Wi-Fi 6 – 802.11 AX, cont.

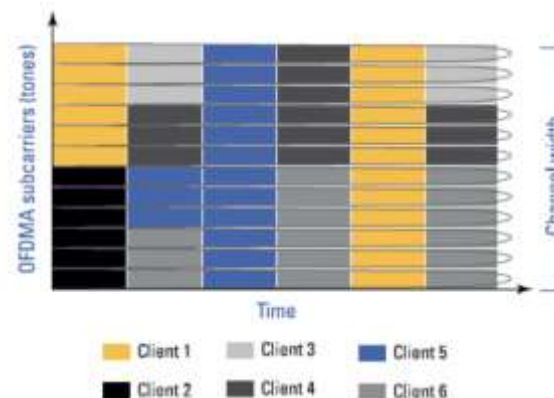


- Multi- TID
 - AMPDU which allows the aggregation of frames from multiple traffic identifiers (TIDs), from the same or different QoS.
- Multi – User (MU)
 - Transmissions can occur between the AP and clients simultaneously.



802.11 ax supports two types of MU.

- MU-MIMO
 - MU-MIMO allows for multiple-user access by using different spatial streams.
 - The maximum number of users supported is 8.
 - DL only.
- OFDMA
 - OFDMA allows for multiple-user access by subdividing a channel.
 - Supports 9 users in a single 20 MHz channel BW.
 - UL and DL.



• Wi-Fi 6E – 802.11 AX

• Overview

- Early 2020 FCC announced the opening of the 6 GHz
- 6th generation EXTENDED.
- Wi-Fi 6E regulatory status
 - US, South Korea, Saudi Arabia, Brazil opened 1200MHz
 - Europe to allocate the band 5945 – 6425.
- From here, where does Wi-Fi go?
 - 6 Increase efficiencies to provide greater throughput, 6E Supports greater capacity and wider channels to support multigigabit traffic, ideal for high-definition video and AR/VR (Augmented Reality/Virtual Reality)
- Benefits of Wi-Fi 6E:
 - High Capacity : 59 new 20 MHz channels available in the 6 GHz band.
 - Higher Speed : 7 new 160 MHz channels and 14 new 80 MHz channels.
 - Low Latency: only 802.11ax (OFDMA, MU-MIMO, 1024 QAM) capable devices, enable < 1 ms latency for 6E devices.
- Requires Wi-Fi 6 and OFDMA only no slow legacy devices (802.11a/b/g/n/ac)
- Clean RF: Low noise, less congestion.



6E

• Wi-Fi 6E – 802.11 AX, cont.

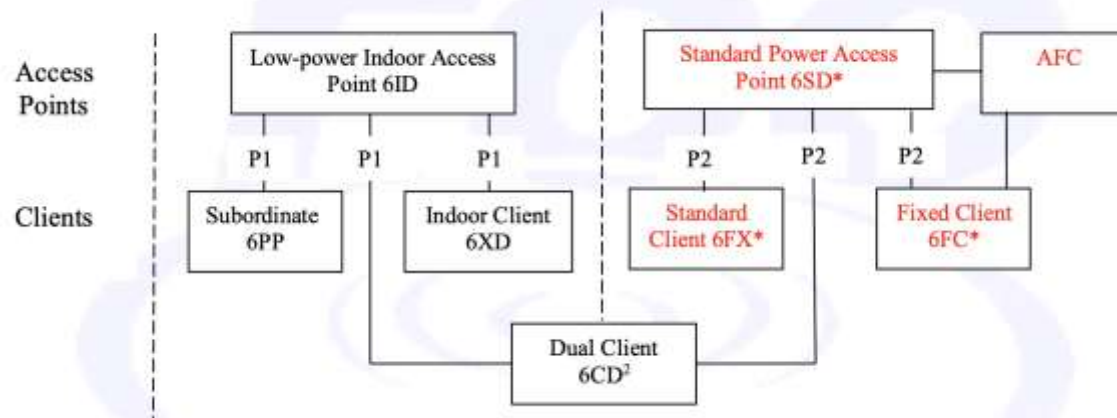
6E

- AP & Clients Classification:

- Use of the 6 Gigahertz Band

Device Class	Operating Bands	Maximum EIRP	Maximum EIRP Power Spectral Density
Standard-Power Access Point (AFC Controlled)	U-NII-5 (5.925-6.425 GHz)	36 dBm	23 dBm/MHz
Client Connected to Standard-Power Access Point	U-NII-7 (6.525-6.875 GHz)	30 dBm	17 dBm/MHz
Low-Power Access Point (indoor only)	U-NII-5 (5.925-6.425 GHz)	30 dBm	5 dBm/MHz
Client Connected to Low-Power Access Point	U-NII-6 (6.425-6.525 GHz) U-NII-7 (6.525-6.875 GHz) U-NII-8 (6.875-7.125 GHz)	24 dBm	-1 dBm/MHz

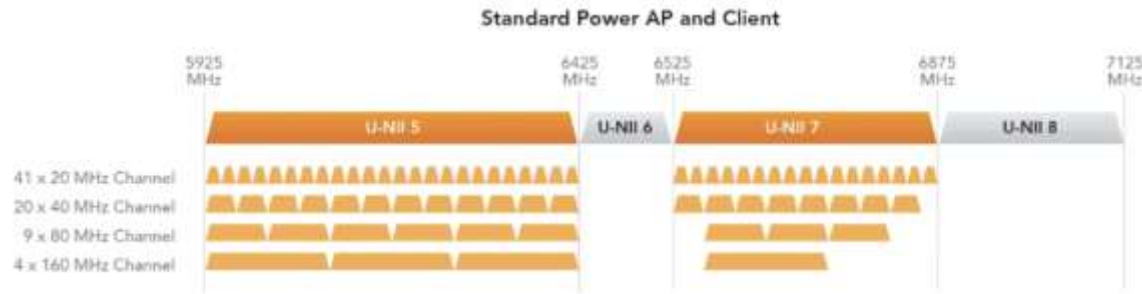
- Seven equipment classes.



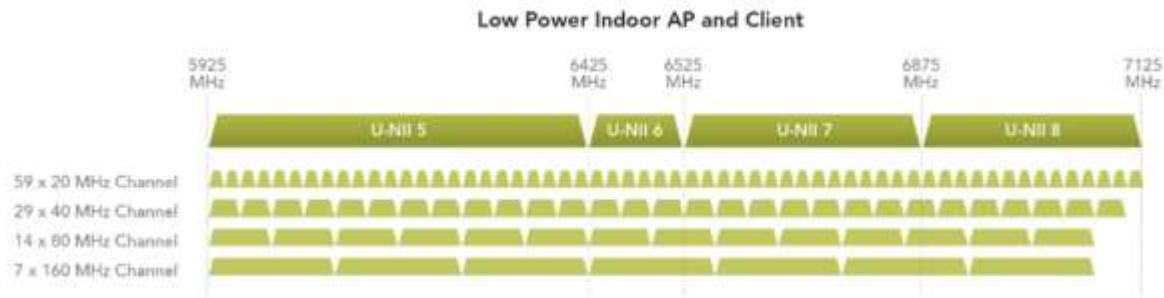
• Wi-Fi 6E – 802.11 AX, cont.

- AP & Clients Classification:
 - Standard Power (Indoor/Outdoor)

6E



- Standard power APs can operate at full power in the U-NII 5 and U-NII 7 bands both indoors and outdoors, but they must be controlled by an automatic frequency coordination (AFC) system.
- LPI (Low Power Indoor)



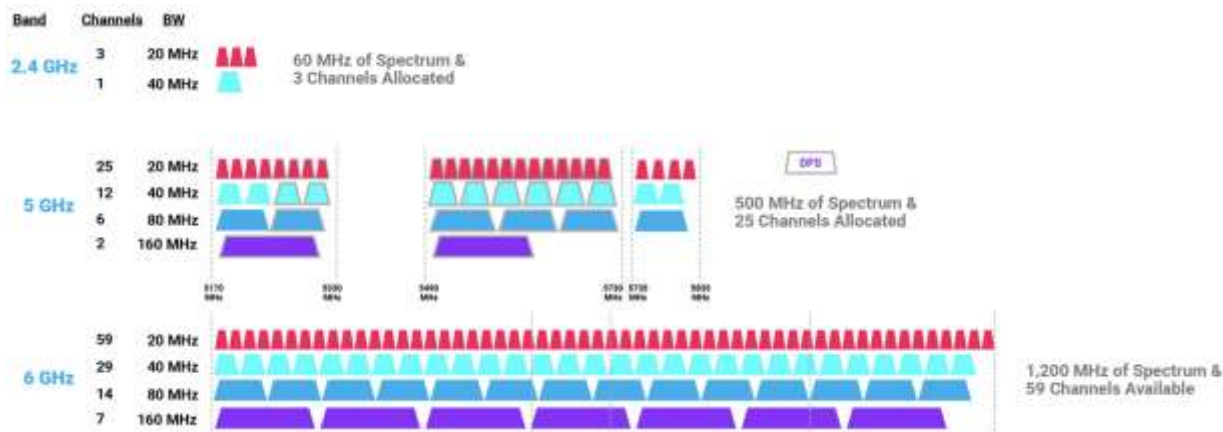
- LPI APs can function without the requirement for AFC over the full 6 GHz band (U-NII 5, U-NII 6, U-NII 7, and U-NII 8) for indoor use only.

6E

- Wi-Fi 6E – 802.11 AX, cont.

- Channelization & BW:

- 6 GHz band with 1200 MHz of contiguous Wi-Fi channel access.



- Active Scanning:

Every fourth channel will be designated as preferred scanning (PSC), with access points expected to use these channels for beaconing and clients scanning them first.

- Passive Scanning:

Fast Initial Link Setup (FILS) discovery announcement frames.

Unsolicited probe response frames.

• Wi-Fi 6E – 802.11 AX, cont.

6E

- Security – WPA3:

- Wi-Fi Alliance is mandating WPA3 security certification for all Wi-Fi 6E devices, with no backward compatibility support for WPA2 security
- WPA3 is the replacement of PSK authentication with Simultaneous Authentication of Equals (SAE).
- Uses Dragonfly technology which means a user or device must prove knowledge of a password without revealing the password
- Two Modes:
 - WPA3-Personal Only
 - WPA3-Personal Transition

- SAE

- Two phases
 - SAE Commit – Key exchange phase.
 - SAE Confirm – Key verification phase
- Once the SAE exchanges are complete, a unique pairwise master key (PMK) is derived and installed on the client station. The PMK is the seeding material for the 4-Way Handshake that is used to generate dynamic encryption keys

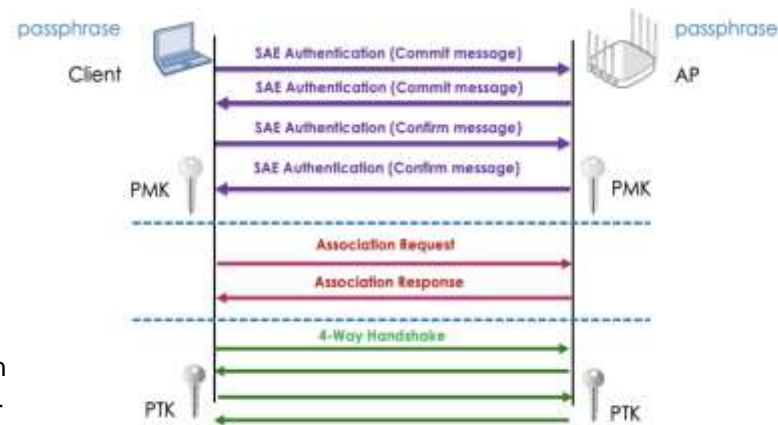


Figure 2 - Simultaneous Authentication of Equals

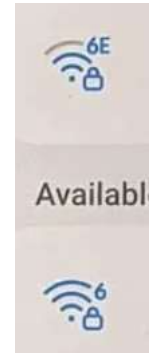
• Wi-Fi 6E – 802.11 AX

- The following is a list of some of the currently available 6E routers and clients.

- Linksys Hydra Pro 6E.
- Nighthawk® Tri-Band Wi-Fi 6E Router
- Comcast XB8.
- ASUS ROG Rapture Wi-Fi 6E

6E Clients	Type Of Client	Wi-Fi SoC	NSS
Dell 5420	Laptop	Intel AX210	2x2
Samsung Galaxy S21 Ultra	Mobile	Broadcom	2x2
Samsung Z Fold3	Mobile	Qualcomm	2x2
AYA Neo	Gaming Console	MediaTek	2x2
Google Pixel 6 Pro	Mobile	Broadcom	2x2
Samsung Galaxy Book Pro 360	Laptop	Intel AX210	2x2
Razer	Gaming - Laptop	Intel AX210	2x2
Intel® NUC 12 Extreme	NUC	Intel AX210	2x2
MSI GE76 Raider	Gaming- Laptop	Intel AX210	2x2
Samsung Galaxy S22 Ultra 5G	Mobile		2x2
Samsung Galaxy S22+ 5G	Mobile		2x2
Samsung Galaxy Tab S8	Tablet		2x2
HP	Laptop	Intel AX411	2x2
Samsung Galaxy Book2 Pro	Laptop		2x2

6E





• Sources:

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- <https://blogs.cisco.com/networking/wi-fi-6-ofdma-resource-unit-ru-allocations-and-mappings>
- <https://www.extremenetworks.com/extreme-networks-blog/ofdm-and-ofdma-subcarriers-what-are-the-differences/>
- <https://www.extremenetworks.com/extreme-networks-blog/how-does-an-802-11ax-ap-allocate-resource-units/>
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- <https://www.extremenetworks.com/extreme-networks-blog/wireless-security-in-a-6-ghz-wi-fi-6e-world/>
- https://www.extremenetworks.com/wp-content/uploads/2021/09/9781119807889_WiFi-6-For-Dummies_-Extreme-Networks-2nd-Special-Edition.pdf