Wi-Fi 7

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Overview

Wi-Fi 5	Wi-Fi 6	Wi-Fi 6E	Wi-Fi 7
IEEE 802.11ac	IEEE 802.11ax	IEEE 802.11ax	IEEE 802.11be
Bands: 5 GHz	Bands: 2.4 GHz, 5 GHz	Bands: 6 GHz	2.4 GHz, 5 GHz, 6 GHz
160 MHz Bandwidth	160 MHz Bandwidth	160 MHz Bandwidth	320 MHz Bandwidth
256 QAM	1024 QAM	1024 QAM	4096 QAM
WPA 2 Security	WPA 3 Security	WPA 3 Security	WPA 3 Security

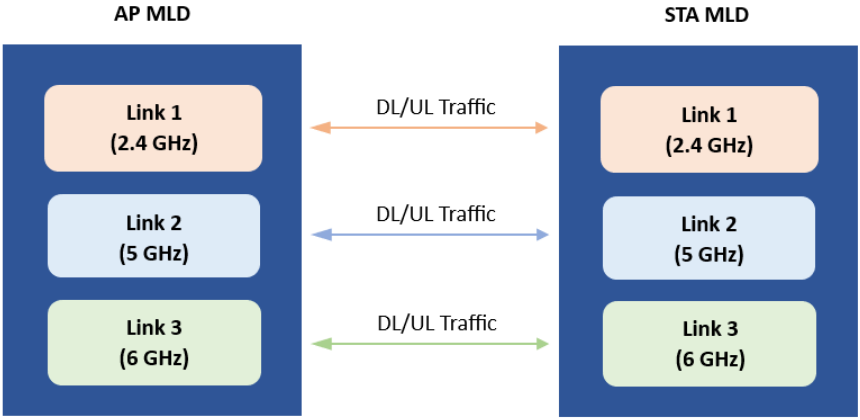
Wi-Fi 7 and Wi-Fi 6

Characteristics	Wi-Fi 6	Wi-Fi 7
IEEE standard	IEEE 802.11ax	IEEE 802.11be
Bandwidth (MHz)	20, 40, 80, 80+80, 160	Up to 320
Frequency bands (GHz)	2.4, 5, and 6	2.4, 5, and 6
Maximum data rate	9.6 Gbps	46 Gbps
Multilink operation	Not supported	Supported
Modulation	1024-QAM OFDMA	4096-QAM OFDMA
MIMO	8×8 MU-MIMO	8×8 MU-MIMO
Resource units (RUs)	No multi-RUs	Supports multi-RUs
Security protocol	WPA3	WPA3

Key Characteristics of Wi-Fi 7

- Multilink operation (MLO)
- 320 MHz Bandwidth
- 4096-QAM Modulation
- Multi-RUs
- Preamble Puncturing

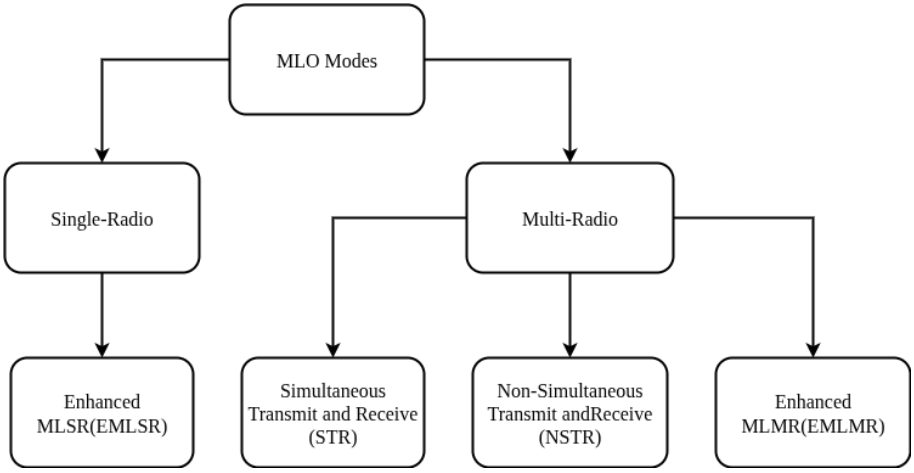
Multilink operation (MLO)



Multilink operation (MLO)

- Enhances coordinated operations across multiple links, offering a stark contrast to the traditional, isolated operations over multiple bands in existing Wi-Fi technologies
- Multiple links boost channel access opportunities, markedly reducing latency
- Supports duplication across links to ensure successful transmission
- Assign data flows to specific links, catering to the unique needs of applications and achieving effective traffic separation and differentiation

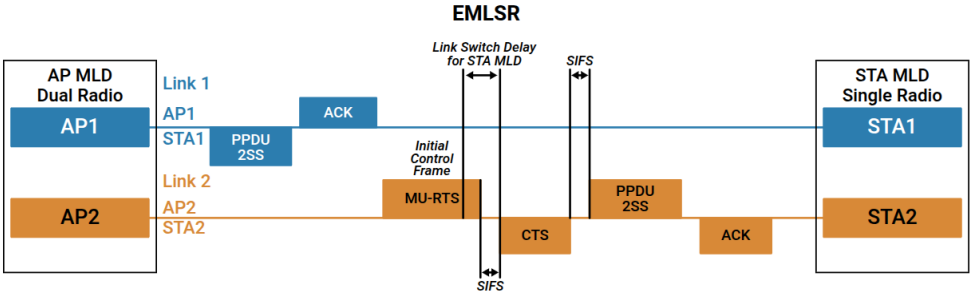
MLO Modes


MLO Modes
Single-Radio
Multi-Radio
Enhanced MLSR(EMLSR)
Simultaneous Transmit and Receive (STR)
Non-Simultaneous Transmit andReceive (NSTR)
Enhanced MLMR(EMLMR)

Wi-Fi 7 MLO Modes

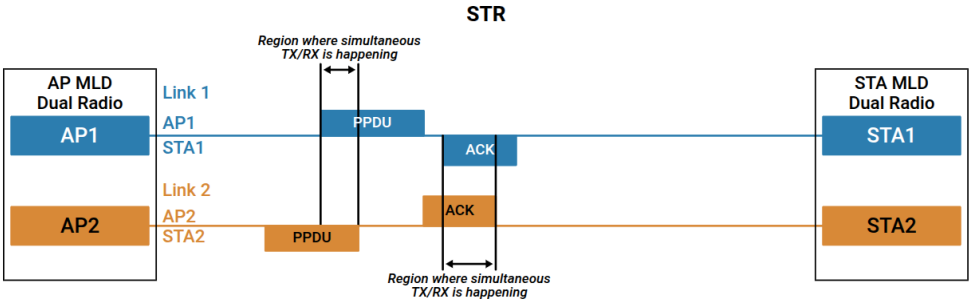
MLO Mode	Radios	Characteristics
EMLSR	1	Simultaneous listening on two links
STR	≥ 2	Simultaneous transmission and reception on multiple links
NSTR	≥ 2	Non-simultaneous transmission and reception on multiple links
EMLMR	≥ 2	Dynamically reconfigure spatial multiplexing on each link

Enhanced Multi Link Single Radio



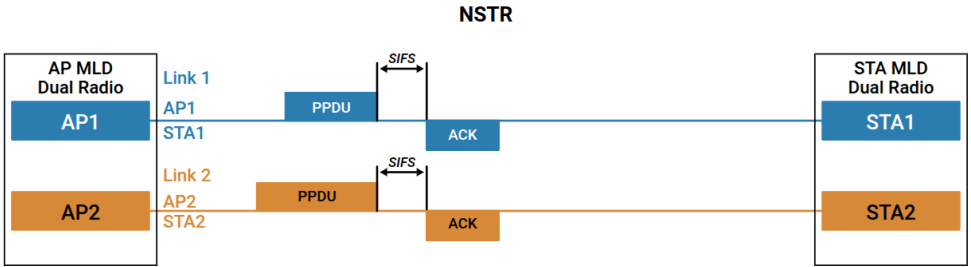
- Exchange between a dual-radio AP MLD and single-radio STA MLD
- Can not use multiple links at the same time
- Throughout the transmission period on Link 2, Link 1 is inactive

Simultaneous Transmit and Receive



- The AP MLD and STA MLD are dual-radio MLDs, and can transmit UL and DL frames asynchronously on Link 1 and Link 2 at the same time

Non Simultaneous Transmit and Receive

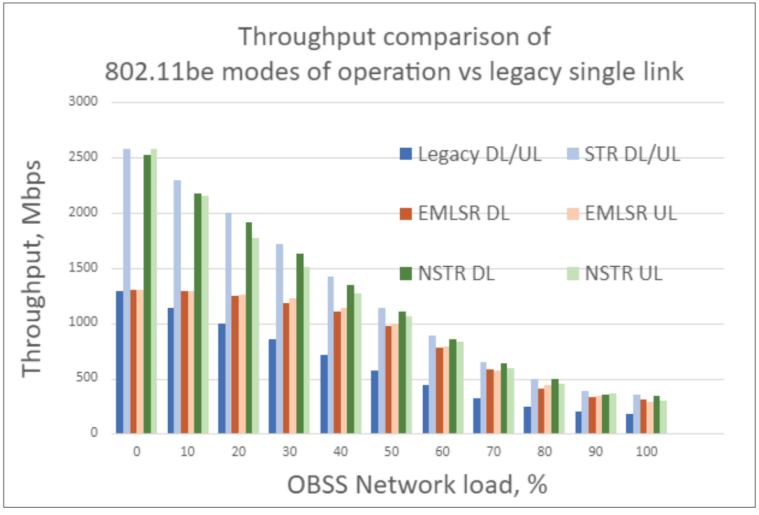


- The AP MLD and STA MLD can transmit and receive simultaneously on Link 1 and Link 2, but cannot transmit on one link while receiving on another

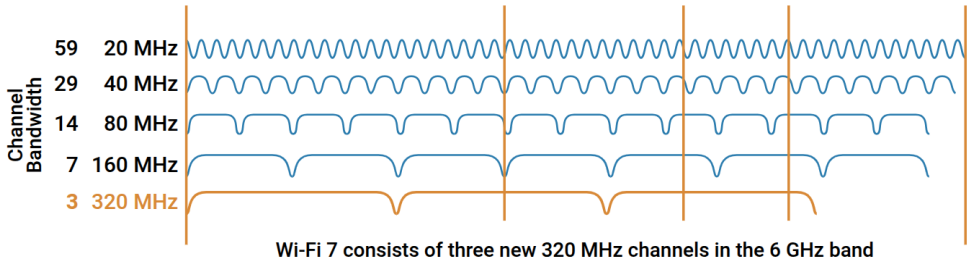
Throughput of MLO

- Overlapping BSSs (OBSSs) consisting of one AP and one STA
- Two links in 5 and 6 GHz bands, MCS-13, two spatial streams, 80 MHz bandwidth
- The data comes in bursts of 150 kb approximately every 8.3 ms
- OBSS network load from 0 to 100 percent by changing the number of OBSSs from 0 to 10 [2]

Throughput of MLO

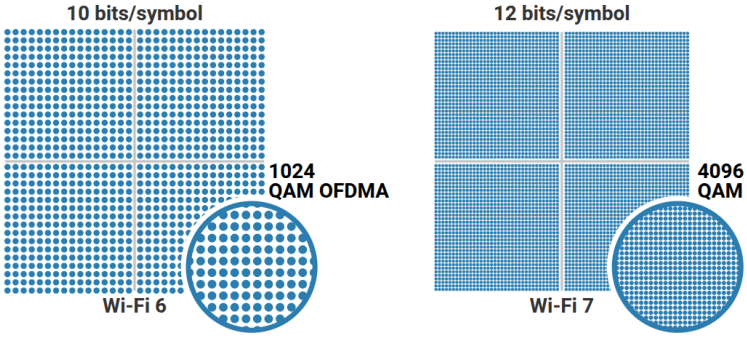


320 MHz Bandwidth



- To achieve a maximum throughput of at least 30 Gbps, Wi-Fi 7 introduces new bandwidth modes, including contiguous 320 MHz, and non-contiguous 160+160 MHz

4096-QAM Modulation

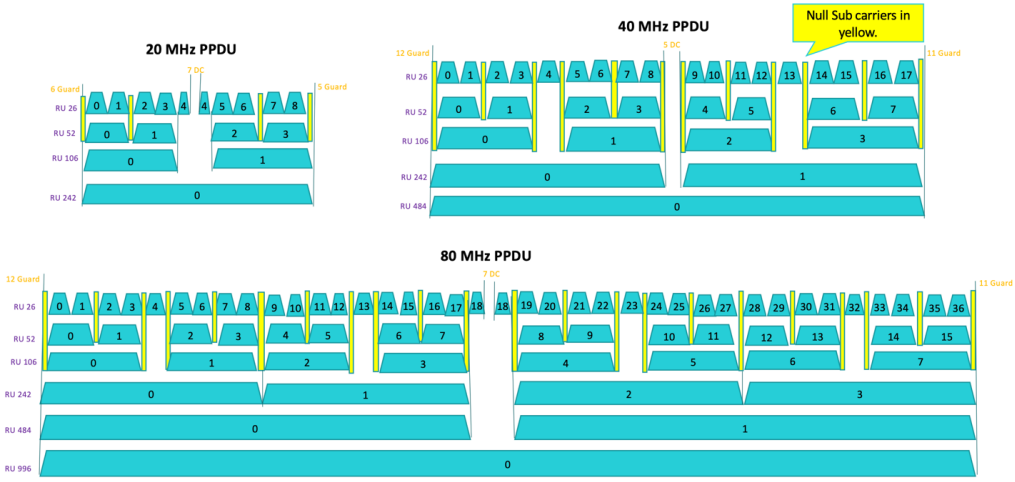


- Using the same coding, 4096-QAM achieves a 20% rate increase over 1024-QAM
- Users can achieve greater transmission efficiency with a higher transmission rate, resulting in faster downloads and uploads

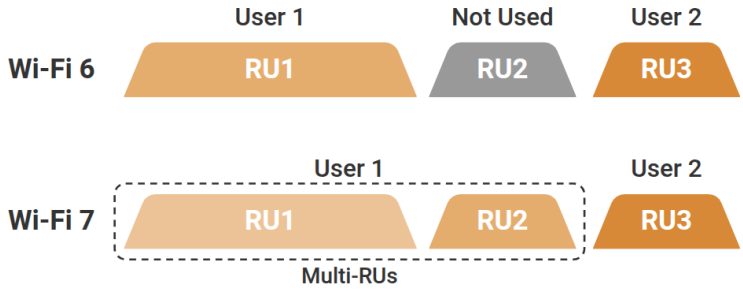
Resource Unit (RU)

- OFDMA allows sub-carriers in a channel bandwidth to be grouped into smaller portions called “Resource Units” (RU)
- Are all of these used for data transmission? Certainly, not. A few of them are DC (direct conversion), Guard, and unused (Null Sub carriers) tones
- RU tones of 26, 52, 106, 242, and 996, which include data and pilot subcarriers

RU Locations with Channel Widths



Multi-RUs



- Wi-Fi 6 users must send or receive frames on their allocated RUs
- Wi-Fi 7 introduces a mechanism that enables the allocation of multiple RUs to a single user

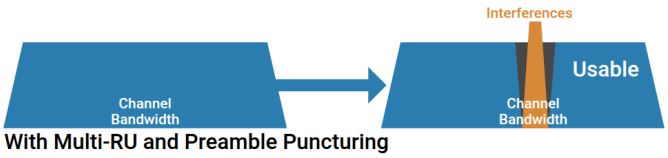
Resource Units (RUs) and Combinations

RU Size	Allowed RU Combinations
Small-size RU	• 26-tone • 52-tone • 106-tone • 26-tone + 106-tone RU for 20/40 MHz • 26-tone + 52-tone RU for 20/40/80 MHz

Resource Units (RUs) and Combinations

RU Size	Allowed RU Combinations
Large-size RU	• 242-tone • 484-tone • 996-tone, 2×996-tone, 3×996-tone • 242-tone + 484-tone RU for 80 MHz • 484-tone + 996-tone RU for 160 MHz • 242-tone + 484-tone + 996-tone RU for 160 MHz • 484-tone + 2×996-tone RU for 240 MHz • 2×996-tone RU for 240 MHz • 484-tone + 3×996-tone RU for 320 MHz • 3×996-tone RU for 320 MHz

Preamble Puncturing



- Isolates the affected part of the spectrum
- Use the rest of the channel, enhancing spectrum efficiency, by enabling wider channels in the face of interference, and accelerating data transmissions

References

IEEE Draft Standard for Information Technology–Telecommunications and Information Exchange between Systems Local and Metropolitan Area Networks–Specific Requirements.

IEEE

Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment: Enhancements for Extremely High Throughput (EHT)." *IEEE P802.11beD5.0*, November 2023, January 2024, 1–1045.

Overview and Performance Evaluation of Wi-Fi 7.

Chen, Cheng, Xiaogang Chen, Dibakar Das, Dmitry Akhmetov, and Carlos Cordeiro.

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Thank you for listening!

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