aruba
a Hewlett Packard Enterprise company

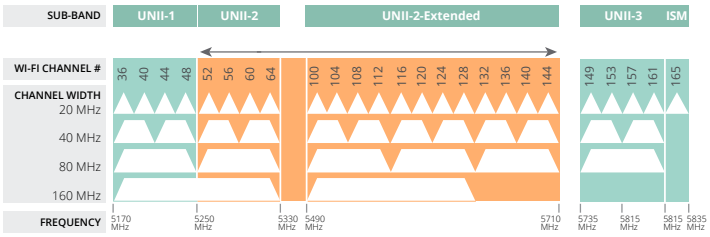
802.11ax REFERENCE

SUPERB WI-FI PERFORMANCE

802.11AX USES THE SAME 5GHZ AND 2.4GHZ CHANNELS AS 802.11N/AC

802.11ax supports channels widths of 20, 40, 80 and 160 MHz in the 5GHz band. While OFDMA allows for a more efficient use of the spectrum, the use of 160 MHz channels is still not recommended for high-density deployments due to limited channel availability. In the 2.4GHz band, 20 and 40 MHz channel widths are supported, but the use of 40 MHz is not recommended.

5GHZ CHANNEL ALLOCATION (NORTH AMERICA)



INCREASED DATA RATES

802.11ax delivers significantly higher peak data rates than 802.11ac in 5GHz and 802.11n in 2.4GHz. Note that support for 8SS was not widely adopted with 802.11ac, but is expected to be more common with 802.11ax.

CHANNEL BANDWIDTH	1 SS	2 SS	3 SS	4 SS	8 SS
20 MHz 802.11n (2.4 GHz)	*72 Mbps*	*144 Mbps*	*217 Mbps*	*289 Mbps*	*N/A*
20 MHz 802.11ac (5 GHz)	*87 Mbps*	*173 Mbps*	*289 Mbps*	*347 Mbps*	*693 Mbps*
20 MHz 802.11ax (2.4/5 GHz)	143 Mbps	287 Mbps	430 Mbps	574 Mbps	1147 Mbps
40 MHz 802.11n (2.4 GHz)	*150 Mbps*	*300 Mbps*	*450 Mbps*	*600 Mbps*	*N/A*
40 MHz 802.11ac (5 GHz)	*200 Mbps*	*400 Mbps*	*600 Mbps*	*800 Mbps*	*1600 Mbps*
40 MHz 802.11ax (2.4/5 GHz)	287 Mbps	574 Mbps	860 Mbps	1147 Mbps	2294 Mbps
80 MHz 802.11ac (5 GHz)	*433 Mbps*	*867 Mbps*	*1300 Mbps*	*1733 Mbps*	*2167 Mbps*
80 MHz 802.11ax (5 GHz)	600 Mbps	1201 Mbps	1801 Mbps	2402 Mbps	4804 Mbps
160 MHz 802.11ac (5 GHz)	*867 Mbps*	*1733 Mbps*	*2340 Mbps*	*3467 Mbps*	*6933 Mbps*
160 MHz 802.11ax (5 GHz)	1201 Mbps	2402 Mbps	3603 Mbps	4804 Mbps	9608 Mbps

** Data rate may vary depending on client availability.*

MODULATION & NET BIT RATE (PER STREAM)

MCS INDEX	MODULATION	CODING	2.0 MHz	4.1 MHz	8.3 MHz	18.9 MHz	37.8 MHz	77.8 MHz
0	BPSK	1/2	0.9	1.8	3.8	8.6	17.2	36.0
1	QPSK	1/2	1.8	3.5	7.5	17.2	34.4	72.1
2	QPSK	3/4	2.6	5.3	11.3	25.8	51.6	108.1
3	16-QAM	1/2	3.5	7.1	15.0	34.4	68.8	144.1
4	16-QAM	3/4	5.3	10.6	22.5	51.6	103.2	216.2
5	64-QAM	2/3	7.1	14.1	30.0	68.8	137.6	288.2
6	64-QAM	3/4	7.9	15.9	33.8	77.4	154.9	324.3
7	64-QAM	5/6	8.8	17.6	37.5	86.0	172.1	360.3
8	256-QAM	3/4	10.6	21.2	45.0	103.2	206.5	432.4
9	256-QAM	5/6	11.8	23.5	50.0	114.7	229.4	480.4
10	1024-QAM	3/4	13.2	26.5	56.3	129.0	258.1	540.4
11	1024-QAM	5/6	14.7	29.4	62.5	143.4	286.8	600.4

802.11ax PHYSICAL LAYER FRAME FORMAT

HE SU, EXTENDED RANGE SU, AND TRIGGER-BASED PPDU FORMATS

8µs	8µs	4µs	4µs	SU, TB: 8µs ER: 16µs	TB: 8µs SU, ER: 4µs	Variable durations per HE-LTF symbol				
L-STF	L-LTF	L-SIG	RL-SIG	HE-SIG-A	HE-STF	HE-LTF	•••	HE-LTF	DATA	PE

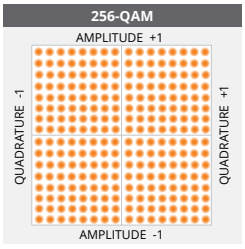
HE MU PPDU FORMAT

8µs	8µs	4µs	4µs	8µs	4µs per symbol	4µs per symbol	Variable durations per HE-LTF symbol				
L-STF	L-LTF	L-SIG	RL-SIG	HE-SIG-A	HE-SIG-B	HE-STF	HE-LTF	•••	HE-LTF	DATA	PE

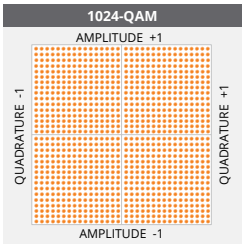
INCREASE IN DATA RATE WITH 1024 QAM

802.11ax has 1024 QAM modulation. Each OFDM symbol represents 10bits of data vs 8 for 256QAM in 802.11ac, which is a 25% increase in bits per symbol which translates to 25% decrease in error margin.

256-QAM



1024-QAM



HIGHLIGHTS

802.11AC WAVE 2

- Multi-User MIMO (downlink)
- 4 Spatial Streams (4SS)
- 20/40/80/160 MHz channel
- 256-QAM modulation and coding
- Explicit transmit beamforming

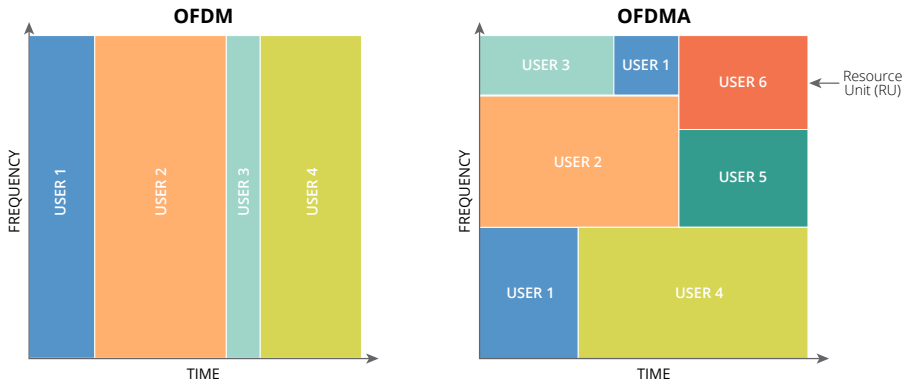
802.11ax

- 4x Average throughput per station in 2.4 & 5 GHz bands
- Multi-User MIMO (uplink and downlink)
- OFDMA uplink and downlink
- Higher rates (1024-QAM)
- Wait to Wake (Target Wake Time)
- Enhanced outdoor long-range performance

ENHANCED USER EXPERIENCE

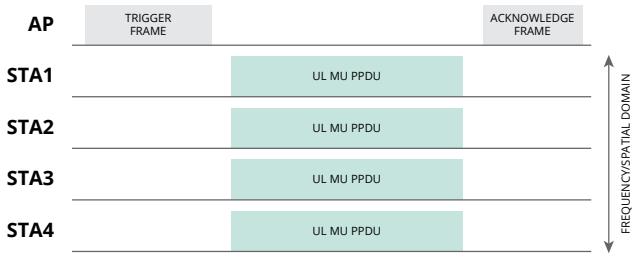
ORTHOGONAL FREQUENCY DIVISION MULTIPLE ACCESS (OFDMA)

OFDMA improves transmission efficiency in high density environments and where short packets are transmitted by combining users. The resulting benefit is a 4x improvement in average throughput per client in a dense deployment scenario as well as efficiently serving IOT type devices with standard enterprise clients.



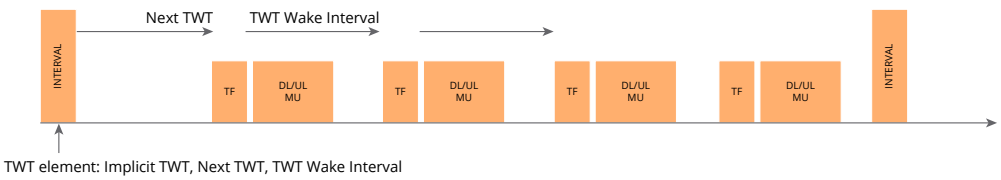
UPLINK ENHANCEMENTS

802.11ac introduced downlink MU-MIMO from AP to multiple users to improve downlink efficiency. 802.11ax enhances uplink transmission efficiency from multiple clients to AP in both OFDMA and MU-MIMO. The resulting benefit is faster uplink response times experienced by clients, which is required given that most traffic patterns now are symmetrical in nature.



POWER SAVING ENHANCEMENTS

Mechanisms such as Target Wake Time (TWT) negotiated between a client and an AP, Broadcast TWT for clients that have not negotiated pre-scheduled wake times, aggressively focus on improved power efficiency for stations. The resulting benefit is extended battery performance for client devices.

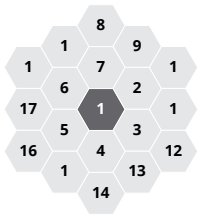


TWT element: Implicit TWT, Next TWT, TWT Wake Interval

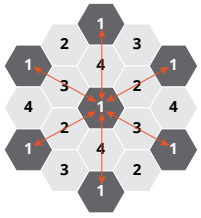
INCREASE NETWORK CAPACITY WITH BSS COLORING

New channel access behavior is introduced in 802.11ax by assigning a different "color" per BSS and allowing more simultaneous transmissions in same channels with different BSS colors. The resulting benefit is greater frequency reuse between BSS's with increase in network capacity.

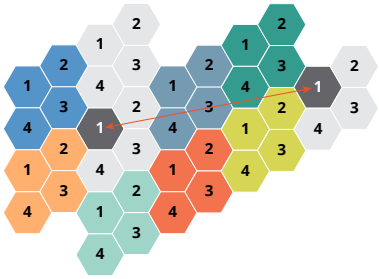
LOW FREQUENCY REUSE (W/ 20 MHZ CHANNELS)



INCREASED FREQUENCY REUSE (W/ 80 MHZ CHANNELS) ALL SAME-CHANNEL BSS BLOCKING



SAME-CHANNEL BSS ONLY BLOCKED ON COLOR MATCH



LEARN MORE: www.arubanetworks.com/802.11ax