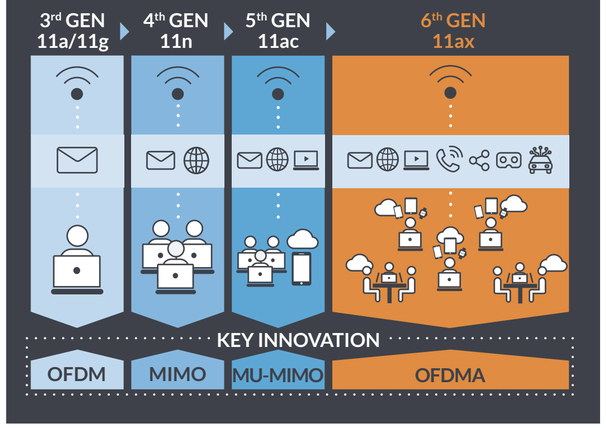
802.11ax

Wi-Fi 6 Quick Guide

JUNIPER driven by Mist AI

Wi-Fi Evolves



Comparing 802.11ac and 802.11ax

Feature	802.11ac	802.11ax	Benefit
OFDMA	N	Y	Improves RF efficiency by centralizing scheduling, reducing contention
1024-QAM	N (256-QAM)	Y	Improves data rate for clients near AP with high SNR
MU-MIMO	Y Downlink	Y Uplink + Downlink	Supports higher density; group size increased from 4 to 8 users
BSS Coloring	N	Y	Adds spatial reuse for better efficiency in dense networks
Target Wake Time (TWT)	N	Y	Reduces power usage and contention; important for low-power IoT devices
Spatial Streams	4	4-8	When combined with MU-MIMO, throughput is improved with more available streams
Transmission Fragmentation	Y Static	Y Dynamic	This enables improved scheduling efficiency and reduces overhead
Carrier Spacing	312.5 kHz	78.125 kHz	Boosts performance by reducing overhead/spacing

Innovation: "AI for AX"

Due to the complexity of 802.11ax, it is even more critical that you leverage AI to automate and optimize your network. You should look to your vendor to optimize the following key areas with AI:

- Intelligent load balancing between radios/bands
- Service levels that monitor and enforce orthogonal frequency-division multiple access (OFDMA) subcarrier assignments
- Basic Service Set (BSS) coloring assignments for high-density Wi-Fi environments
- Sticky client prevention using AI-driven algorithms

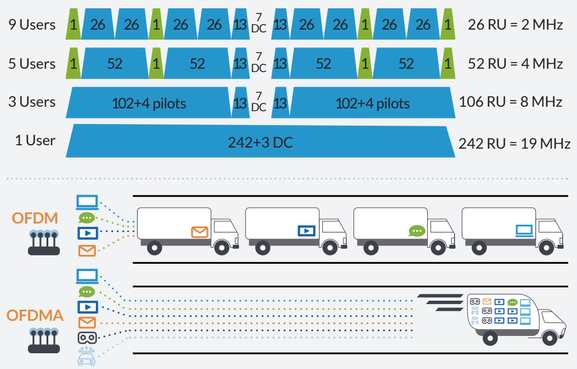
Improved Density with OFDMA Scheduling

Wireshark Filter for OFDMA Trigger Frame

```
▾ IEEE 802.11 Trigger, Flags: ........
    Type/Subtype: Trigger (0x0012)
  ▸ Frame Control Field: 0x2400
  ▾ User Info
    ▾ User Info: 0x5020350007
      .... .... .... .... .... 0101 000. .... .... .... = RU Allocation: 40 (52 tones)
```

Wireshark filter = Wlan.fc eq 0x2400

OFDMA RU Allocation Options (20MHz Channel Shown)



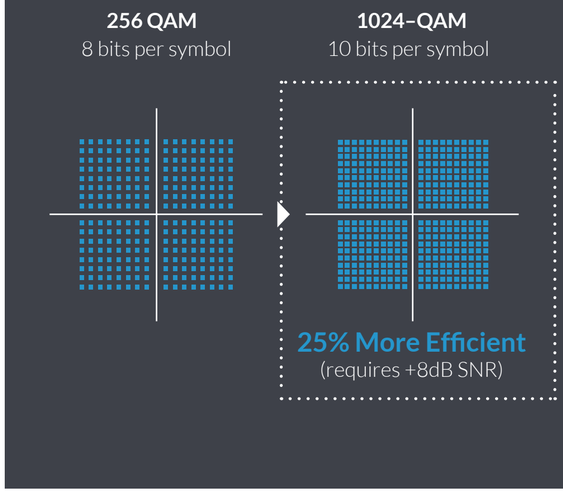
802.11ax Rate Set Per Stream

Modulation and coding schemes for single spatial stream

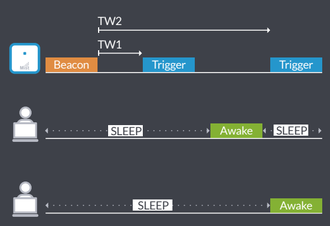
MCS Index[a]	Modulation Type	Coding Rate	Data Rate (in Mb/s)[b,d]					
			20 MHz Channels		40 MHz Channels		80 MHz Channels	
			1600 ns GI[c]	800 ns GI	1600 ns GI	800 ns GI	1600 ns GI	800 ns GI
0	BPSK	1/2	8.1	8.6	16.3	17.2	34	36
1	QPSK	1/2	16.3	17.2	32.5	34.4	68.1	72.1
2	QPSK	3/4	24.4	25.8	48.8	51.6	102.1	108.1
3	16-QAM	1/2	32.5	34.4	65	68.8	136.1	144.1
4	16-QAM	3/4	48.8	51.6	97.5	103.2	204.2	216.2
5	64-QAM	2/3	65	68.8	130	137.6	272.2	288.2
6	64-QAM	3/4	73.1	77.4	146.3	154.9	306.3	324.3
7	64-QAM	5/6	81.3	86	162.5	172.1	340.3	360.3
8	256-QAM	3/4	97.5	103.2	195	206.5	408.3	432.4
9	256-QAM	5/6	108.3	114.7	216.7	229.4	453.7	480.4
10	1024-QAM	3/4	121.9	129	243.8	258.1	510.4	540.4
11	1024-QAM	5/6	135.4	143.4	270.8	286.8	567.1	600.5

Notes: **a.** MCS 9 is not applicable to all channel width/spatial stream combinations. **b.** A second stream doubles the theoretical data rate, a third one triples it, etc. **c.** GI stands for the guard interval. **d.** 3200 ns GI is also supported.

Boosting Performance with 1024-QAM



Supporting IoT Devices with TWT

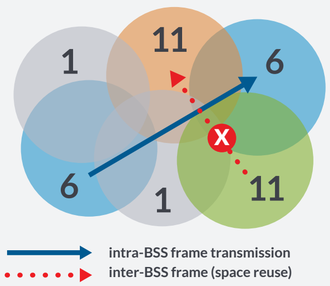


Target Wake Time adds ability to schedule wakeup times for stations. This enables clients to sleep longer and extends battery life.

Extend Battery Up to 7X with Target Wake Time

Minimizes Co-Channel Interference with Coloring

BSS Coloring boosts RF efficiency by introducing the ability to have APs on the same channel overlap their RF coverage such that client/AP will only listen to APs of the same "color".



Octets	Element ID	Length	Element ID Extension	HE Operation Parameters	BSS Color Information	Basic HE-MCS & NSS Set	VHT Operation Information	Max Co-Located BSSID Indicator
	1	1	1	3	1	2	0 or 3	0 or 1

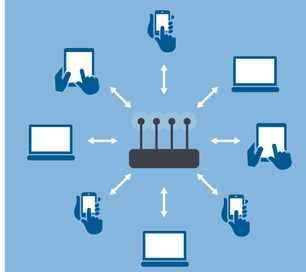
Bits	BSS Color	Partial BSS Color	BSS Color Disabled
	6	1	1

Value Range 1 – 63

View BSS Color as a Column in Wireshark

Title: BSS Color
Column Type: Custom
Field: wlan.ext_tag.bss_color_information
Occurrence: 0

Extending MU-MIMO for Upstream Traffic



MU-MIMO (multi-user multi input multi output) leverages bandsteering and multiple antennas to be able to transmit/receive from multiple clients at the same time.

Learn More: visit What is Wi-Fi 6

https://juni.pr/41FZyed

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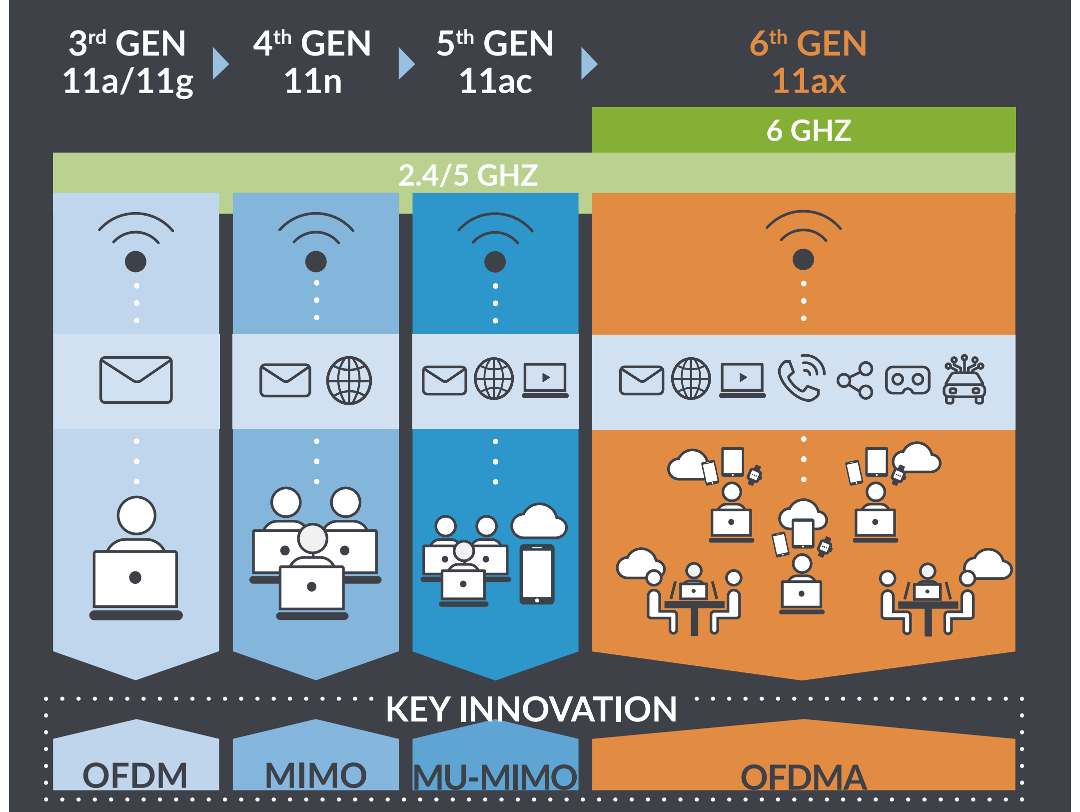
Wi-Fi 6E Quick Guide

Juniper driven by Mist AI

Wi-Fi 6E is the extension of Wi-Fi 6 (also known as 802.11ax), enabling the operation of features in the unlicensed 6 GHz band, in addition to the currently supported 2.4 GHz and 5 GHz bands.

Wi-Fi Evolves



Wi-Fi 6E brings Wi-Fi to 6Ghz

- **Gigabit speeds**
  More, contiguous spectrum (up to an additional 1200 MHz; varies by country)
- **Extremely low latency**
  Wider channels
- **High capacity**
  Less interference and uncongested bandwidth

Key AP Specs

	AP45/45E	AP34
Deployment	Indoor	Indoor
Wi-Fi Standard	802.11ax (Wi-Fi 6) 4x4 : 4SS	802.11ax (Wi-Fi 6) 2x2 : 2SS
Wi-Fi Radios	Dedicated fourth radio	Dedicated fourth radio
Antenna Options	Internal/External	Internal
BLE	vBLE 16-element Directional Antenna Array + Omni Bluetooth Antenna	Omni BLE
Warranty	Limited Lifetime	Limited Lifetime
Frequencies Supported	2.4GHz 5GHz 6GHz	2.4GHz 5GHz 6GHz

Innovation: "AI for Wi-Fi 6 and 6E"

Due to the complexity of 802.11ax in Wi-Fi 6E, it is even more critical that you leverage AI to automate and optimize your network. You should look to your vendor to optimize the following key areas with AI:

- Intelligent load balancing between radios/bands
- Service levels that monitor and enforce orthogonal frequency-division multiple access (OFDMA) subcarrier assignments
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Unlicensed Spectrum and Channel Allocations

2.4 GHz Channel Allocations 80 MHz

ISM BAND

Channel	1	6	11	
Center Frequency	2.412	2.437	2.462	QTY 3

5 GHz Channel Allocations 500 MHz

Radio Band	Center Frequency	20 MHz	40 MHz	80 MHz	160 MHz
U-NII-1	5.180	36	38	42	50
U-NII-1	5.200	40			
U-NII-1	5.230	44	46		
U-NII-1	5.240	48			
U-NII-2a (DFS Channels)	5.260	52	54	58	
U-NII-2a (DFS Channels)	5.280	56			
U-NII-2a (DFS Channels)	5.300	60	62		
U-NII-2a (DFS Channels)	5.320	64			
U-NII-2c (Extended (DFS Channels)	5.500	100	102	106	114
U-NII-2c (Extended (DFS Channels)	5.520	104			
U-NII-2c (Extended (DFS Channels)	5.540	108	110		
U-NII-2c (Extended (DFS Channels)	5.560	112			
U-NII-2c (Extended (DFS Channels)	5.580	116	118	122	
U-NII-2c (Extended (DFS Channels), TDWR	5.600	120			
U-NII-2c (Extended (DFS Channels), TDWR	5.620	124	126		
U-NII-2c (Extended (DFS Channels), TDWR	5.640	128			
U-NII-2c (Extended (DFS Channels)	5.660	132	134	138	
U-NII-2c (Extended (DFS Channels)	5.680	136			
U-NII-2c (Extended (DFS Channels)	5.700	140	142		
U-NII-2c (Extended (DFS Channels)	5.720	144			
U-NII-3	5.745	149	151	155	
U-NII-3	5.765	153			
U-NII-3	5.785	157	159		
U-NII-3	5.805	161			
U-NII-3	5.825	165			165 was ISM, now U-NII-3
		QTY 25	QTY 11	QTY 5	QTY 2

6 GHz Channel Allocations 1,200 MHz

FCC – USA

Radio Band	Lower Power Indoor	Allowed Unlicensed Usage	Incumbents
U-NII-5	5925 5dBm/MHz – Net EIRP 18dBM	Low Power Indoor	Fixed Service, Satellite Service
U-NII-6	6425	Low Power Indoor, Standard Power AP	Satellite Service, TV & Broadcast Services
U-NII-7	6525	Low Power Indoor	Fixed Service, Satellite Service
U-NII-8	6875 – 7125	Low Power Indoor, Standard Power AP	Satellite Service, TV and Broadcast Services

Radio Band	Center Frequency	20 MHz	40 MHz	80 MHz	160 MHz
U-NII-5	5.955	1	3	7	15
U-NII-5	5.975	5			
U-NII-5	5.995	9	11		
U-NII-5	6.015	13			
U-NII-5	6.035	17	19	23	
U-NII-5	6.055	21			
U-NII-5	6.075	25	27		
U-NII-5	6.095	29			
U-NII-5	6.115	33	35	39	47
U-NII-5	6.135	37			
U-NII-5	6.155	41	43		
U-NII-5	6.175	45			
U-NII-5	6.195	49	51	55	
U-NII-5	6.215	53			
U-NII-5	6.235	57	59		
U-NII-5	6.255	61			
U-NII-5	6.275	65	67	71	79
U-NII-5	6.295	69			
U-NII-5	6.315	73	75		
U-NII-5	6.335	77			
U-NII-5	6.355	81	83	87	
U-NII-5	6.375	85			
U-NII-5	6.395	89	91		
U-NII-5	6.415	93			
U-NII-6	6.435	97	99	103	111
U-NII-6	6.455	101			
U-NII-6	6.475	105	107		
U-NII-6	6.495	109			
U-NII-6	6.515	113	115	119	
U-NII-7	6.535	117			
U-NII-7	6.555	121	123		
U-NII-7	6.575	125			
U-NII-7	6.595	129	131	135	143
U-NII-7	6.615	133			
U-NII-7	6.635	137	139		
U-NII-7	6.655	141			
U-NII-7	6.675	145	147	151	
U-NII-7	6.695	149			
U-NII-7	6.715	153	155		
U-NII-7	6.735	157			
U-NII-7	6.755	161	163	167	175
U-NII-7	6.775	165			
U-NII-7	6.795	169	171		
U-NII-7	6.815	173			
U-NII-7	6.835	177	179	183	
U-NII-7	6.855	181			
		185	187		
U-NII-8	6.895	189			
U-NII-8	6.915	193	195	199	207
U-NII-8	6.935	197			
U-NII-8	6.955	201	203		
U-NII-8	6.975	205			
U-NII-8	6.975	209	211	215	
U-NII-8	7.015	213			
U-NII-8	7.035	217	219		
U-NII-8	7.055	221			
U-NII-8	7.075	225	227		
U-NII-8	7.095	229			
U-NII-8	7.115	233			
		QTY 59	QTY 29	QTY 14	QTY 7

Learn More: visit What is Wi-Fi 6E
https://juni.pr/2XRJzOd