802.11ac REFERENCE

HIGHLIGHTS

802.11ac WAVE 1
- Single-user MIMO
- 3 Spatial Streams (3SS)
- 20/40/80 MHz channel
- 256-QAM modulation and coding
- Explicit transmit beamforming

802.11ac WAVE 2
- Multi-user MIMO
- 4 Spatial Streams (4SS)
- 20/40/80/160 MHz channel
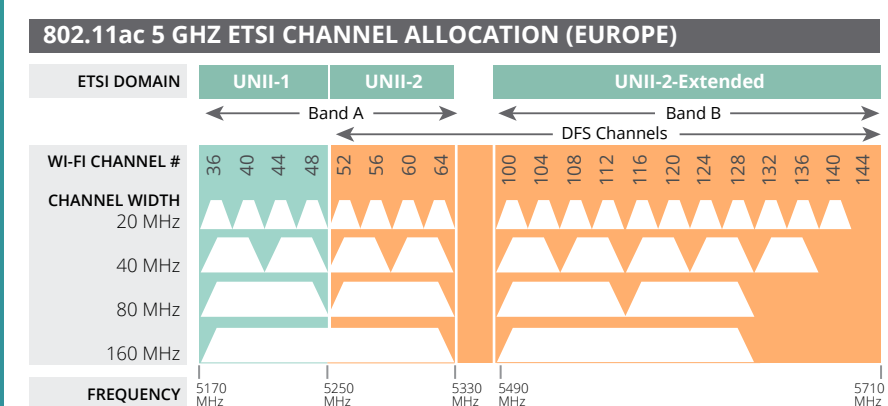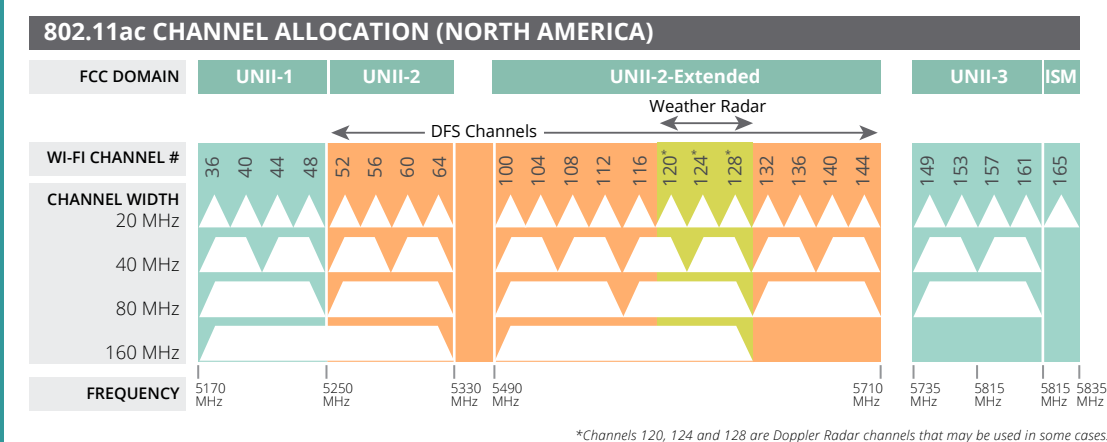- 256-QAM modulation and coding
- Explicit transmit beamforming

SUPERB WI-FI PERFORMANCE

WIDER CHANNELS

802.11ac provides wider channels that enable faster data transmission on 80 MHz and 160 MHz bands. However, until governments open up more spectrum in 5 GHz bands, 160 MHz channels are not recommended because they'll lead to channel planning and co-channel interference.

802.11ac CHANNEL ALLOCATION (NORTH AMERICA)

*Channels 120, 124 and 128 are Doppler Radar channels that may be used in some cases.

802.11ac 5 GHZ ETSI CHANNEL ALLOCATION (EUROPE)

MODULATION & NET BIT RATE (PER STREAM)

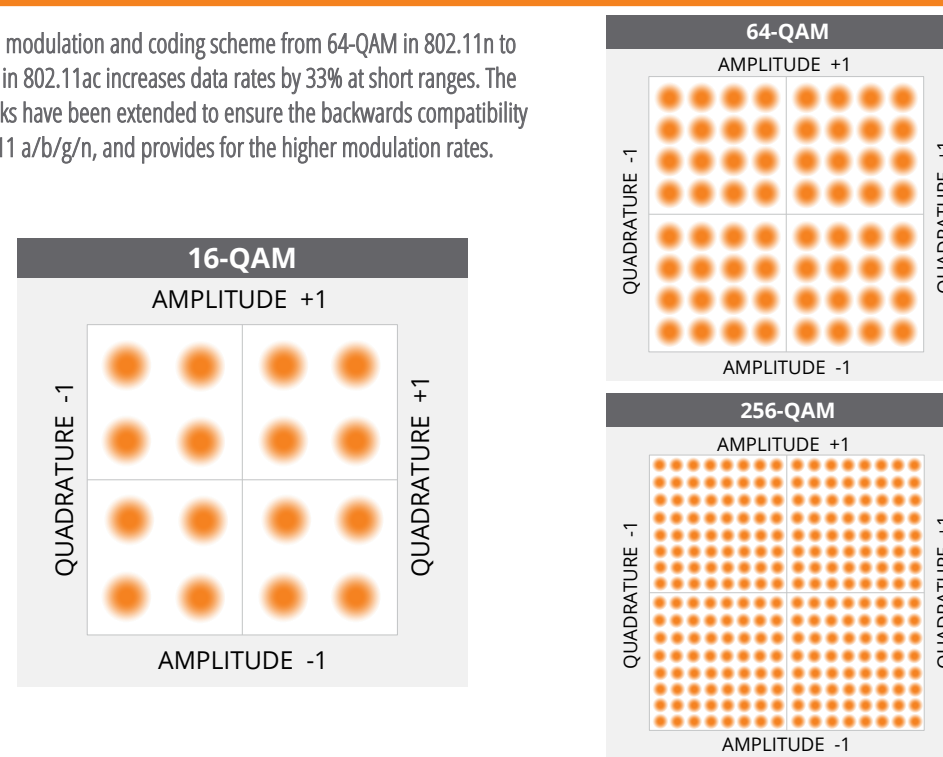| MCS INDEX	MODULATION	CODING	20 MHz	40 MHz	80 MHz	160 MHz
0	BPSK	1/2	7.2	15.0	32.5	65.0
1	QPSK	1/2	14.4	30.0	65.0	130.0
2	QPSK	3/4	21.7	45.0	97.5	195.0
3	16-QAM	1/2	28.9	60.0	130.0	260.0
4	16-QAM	3/4	43.3	90.0	195.0	390.0
5	64-QAM	2/3	57.8	120.0	260.0	520.0
6	64-QAM	3/4	65.0	135.0	292.5	585.0
7	64-QAM	5/6	72.2	150.0	325.0	650.0
8	256-QAM	3/4	86.7	180.0	390.0	780.0
9	256-QAM	5/6	96.3	200.0	433.3	866.7

INCREASED DATA RATES

802.11ac Wave 1 products, certified by the Wi-Fi Alliance (WFA) since mid-2013, deliver a gigabit Wi-Fi network with the maximum data rate of 1.3 Gbps. With 4 spatial stream clients operating in 80 MHz channels, the new 802.11ac Wave 2 technology increases the data rate by 30% to 1.7 Gbps.

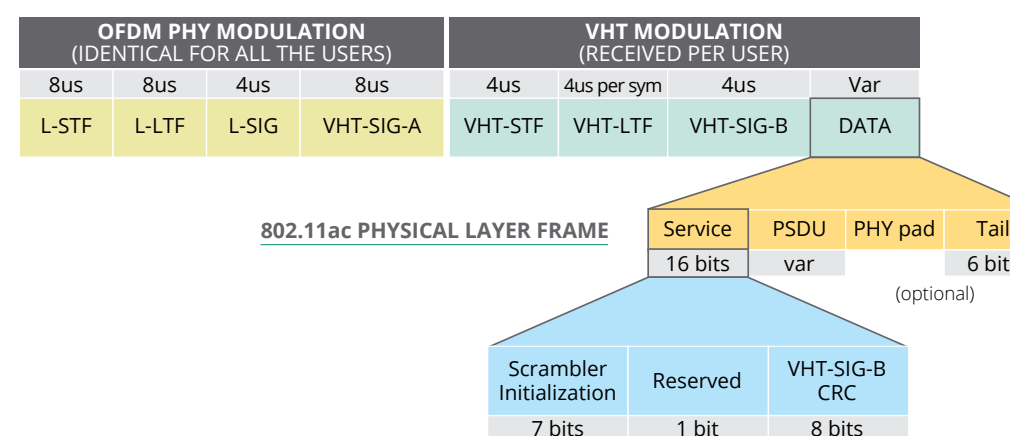| CHANNEL BANDWIDTH	1 SS	2 SS	3 SS	4 SS
20 MHz 802.11n (2.4 GHz)	72.2 Mbps	144.4 Mbps	216.7 Mbps	288.9 Mbps
40 MHz 802.11n (2.4/5 GHz)	150 Mbps	300 Mbps	450 Mbps	600 Mbps
80 MHz 802.11ac (5 GHz)	433 Mbps	867 Mbps	1300 Mbps	1733 Mbps
160 MHz 802.11ac (5 GHz)	867 Mbps	1733 Mbps	2600 Mbps	3467 Mbps

* Data rates may vary depending on client availability.

MORE EFFICIENT ENCODING WITH 256-QUADRATURE AMPLITUDE MODULATION (QAM)

Enhanced modulation and coding scheme from 64-QAM in 802.11n to 256-QAM in 802.11ac increases data rates by 33% at short ranges. The frameworks have been extended to ensure the backwards compatibility with 802.11 a/b/g/n, and provides for the higher modulation rates.

802.11ac PHYSICAL LAYER FRAME FORMAT

OFDM PHY MODULATION (IDENTICAL FOR ALL THE USERS)				VHT MODULATION (RECEIVED PER USER)			
8us	8us	4us	8us	4us	4us per sym	4us	Var
L-STF	L-LTF	L-SIG	VHT-SIG-A	VHT-STF	VHT-LTF	VHT-SIG-B	DATA

802.11ac PHYSICAL LAYER FRAME

Service	PSDU	PHY pad	Tail
16 bits	var		6 bits
			(optional)

Scrambler Initialization	Reserved	VHT-SIG-B CRC
7 bits	1 bit	8 bits

## ENHANCED USER EXPERIENCE

MULTI-USER MIMO (MU-MIMO)

MU-MIMO is one of the key features introduced with 802.11ac Wave 2. It allows simultaneous data transmission to multiple Wave 2 devices, enabling enterprises to increase network efficiency and device density of APs.

SU-MIMO (UP TO 3 WASTED STREAMS)

MU-MIMO (WAVE 2 CLIENTS)
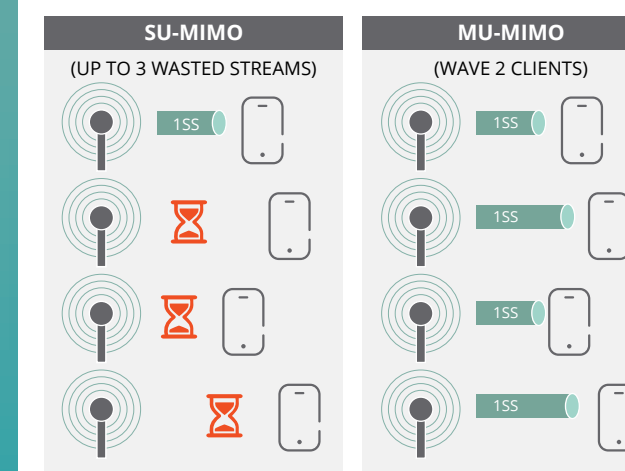
MU-MIMO BEST CASE THROUGHPUTS
75% EFFICIENCY FOR 1 SS CLIENTS   65% EFFICIENCY FOR 2 SS CLIENTS

MU-MIMO	1 SS CLIENTS	2 SS CLIENTS
3 SS VHT 80 MHz AP	683	622
4 SS VHT 80 MHz AP	910	789

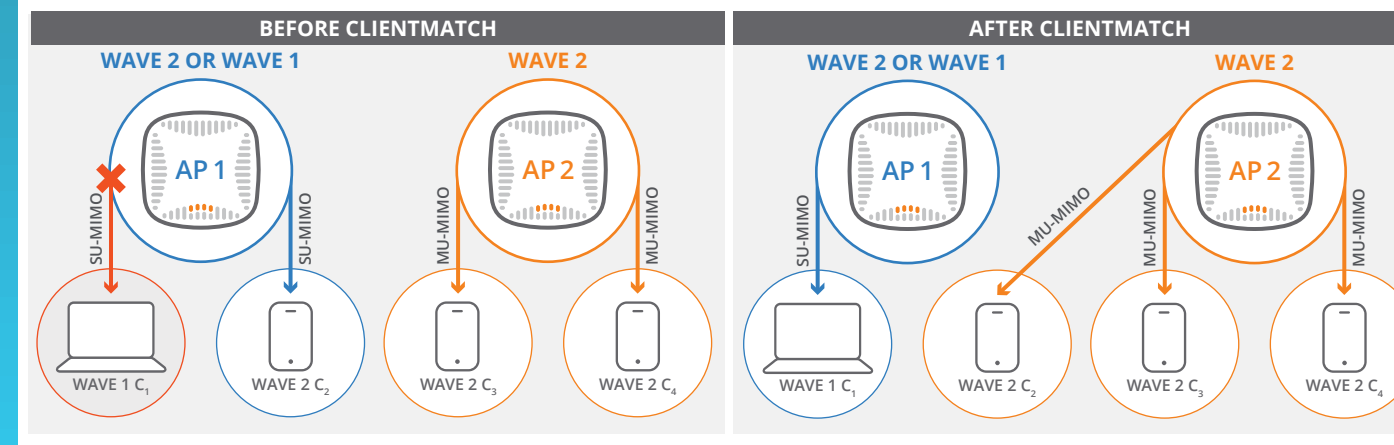| MU-MIMO	MAX 1 SS CLIENTS	MAX 2 SS CLIENTS
3 SS VHT 160 MHz AP	1365	1244
4 SS VHT 160 MHz AP	1820	1578

802.11ac EXPLICIT BEAMFORMING

802.11ac beamforming is standards-based and implemented in 802.11ac chip sets. It enhances the signal-to-noise ratio for higher data rates at a given range. Implemented in baseband, it works with all antenna subsystems and creates infinite beamforming combinations to improve wireless performance in dynamic RF environments.

OMINI NON-BEAMFORMING

4 ANTENNA ELEMENTS BEAMFORMING TO CLIENT 1

4 ANTENNA ELEMENTS BEAMFORMING TO CLIENT 2
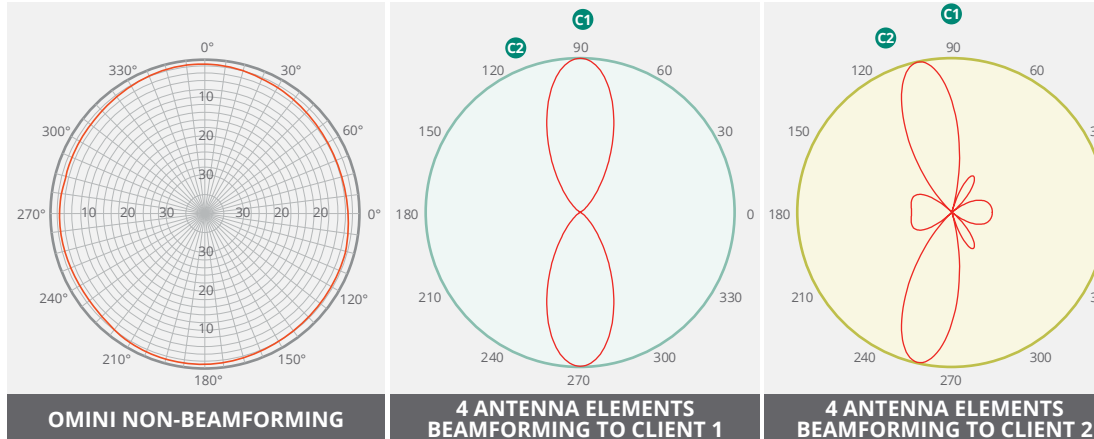
ARUBA ENHANCED CLIENTMATCH

Aruba enhanced ClientMatch brings patent-pending MU-MIMO awareness into the client steering algorithms. It groups MU-MIMO capable clients in an AP for simultaneous data transmission, improving network efficiency and creating a better user experience.

BEFORE CLIENTMATCH

AFTER CLIENTMATCH