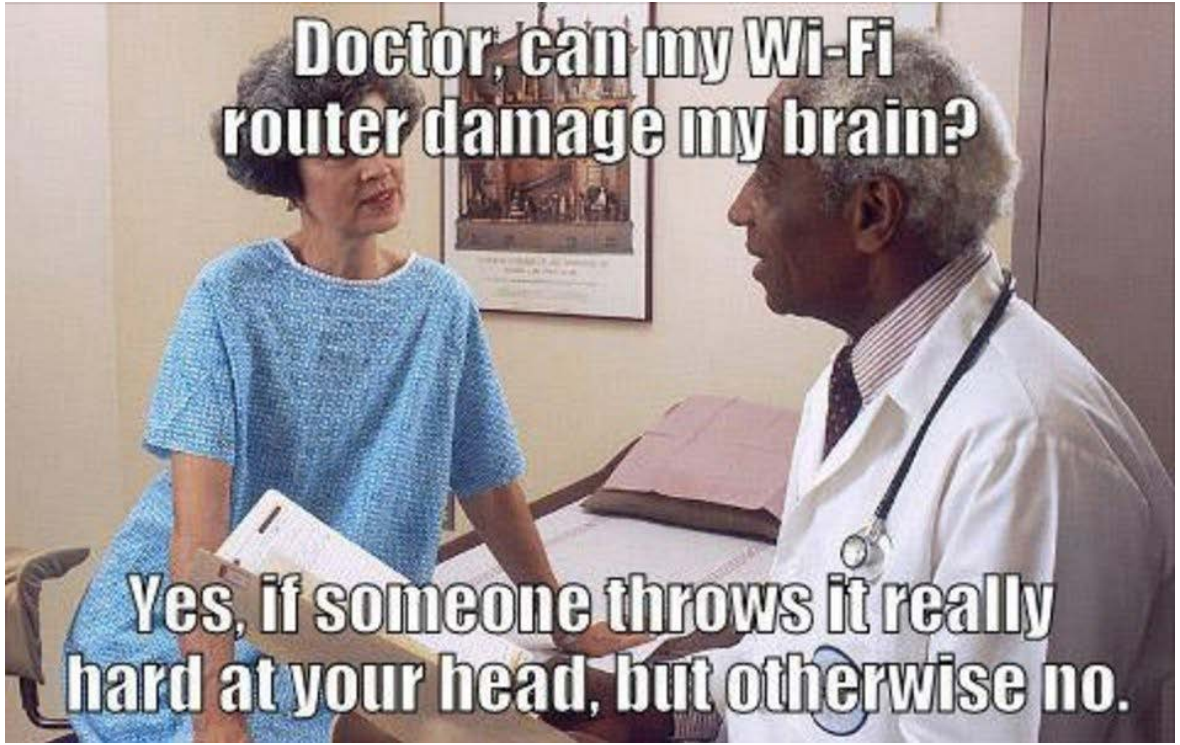
Misconception of Wi-Fi



Wireless Agenda

- Wireless Standards, Organizations, and Fundamentals
- Radio Frequency Fundamentals
- Wireless Network Technologies
- WLAN Design and Troubleshooting
- Site Survey Fundamentals
- Very High Throughput (VHT) 802.11ac wave 1 and wave 2

Wireless Organizations, and Standards

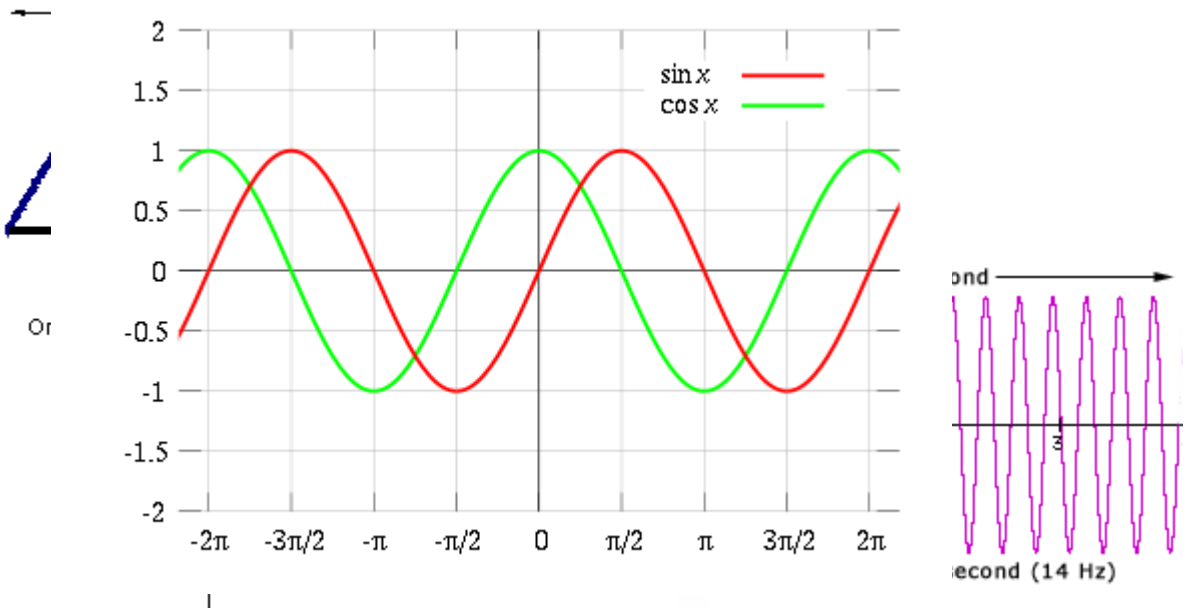
IEEE

TABLE 1: IEEE 802.11 PHY STANDARDS						
Release date	Standard	Band (GHz)	Bandwidth (MHz)	Modulation	Advanced antenna technologies	Maximum data rate
1997	802.11	2.4	20	DSSS, FHSS	N/A	2 Mbits/s
1999	802.11b	2.4	20	DSSS	N/A	11 Mbits/s
1999	802.11a	5	20	OFDM	N/A	54 Mbits/s
2003	802.11g	2.4	20	DSSS, OFDM	N/A	54 Mbits/s
2009	802.11n	2.4, 5	20, 40	OFDM	MIMO, up to four spatial streams	600 Mbits/s
2012 (expected)	802.11ad	60	2160	SC, OFDM	Beamforming	6.76 Gbits/s
2013 (expected)	802.11ac	5	40, 80, 160	OFDM	MIMO, MU-MIMO, up to eight spatial streams	6.93 Gbits/s

http://www.ieee802.org/11/Reports/802.11_Timelines.htm

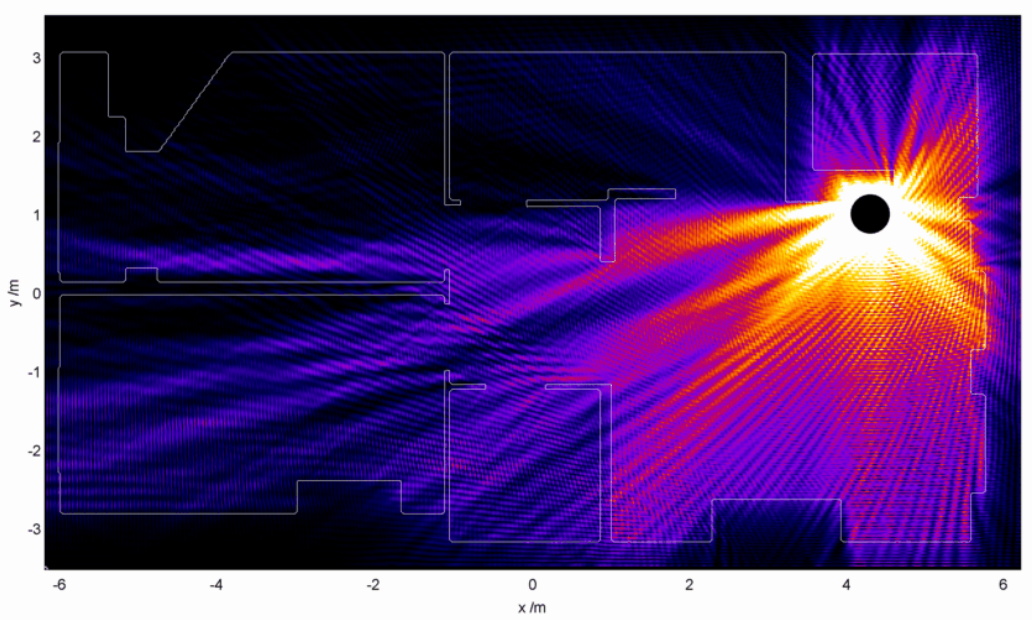
Radio Frequency Characteristics

- Wavelength
- Amplitude
- Frequency
- Phase



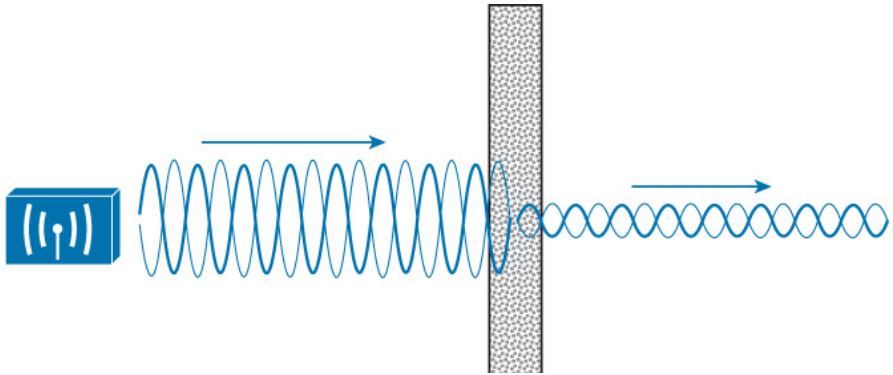
Radio Frequency Behaviors

- Wave Propagation

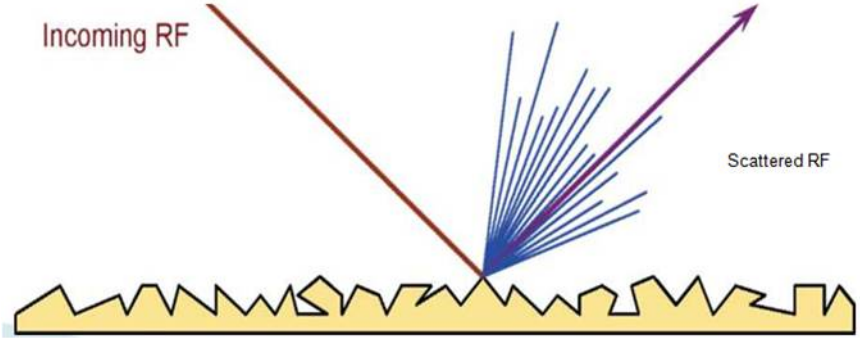


Radio Frequency Behaviors - cont

- Absorption

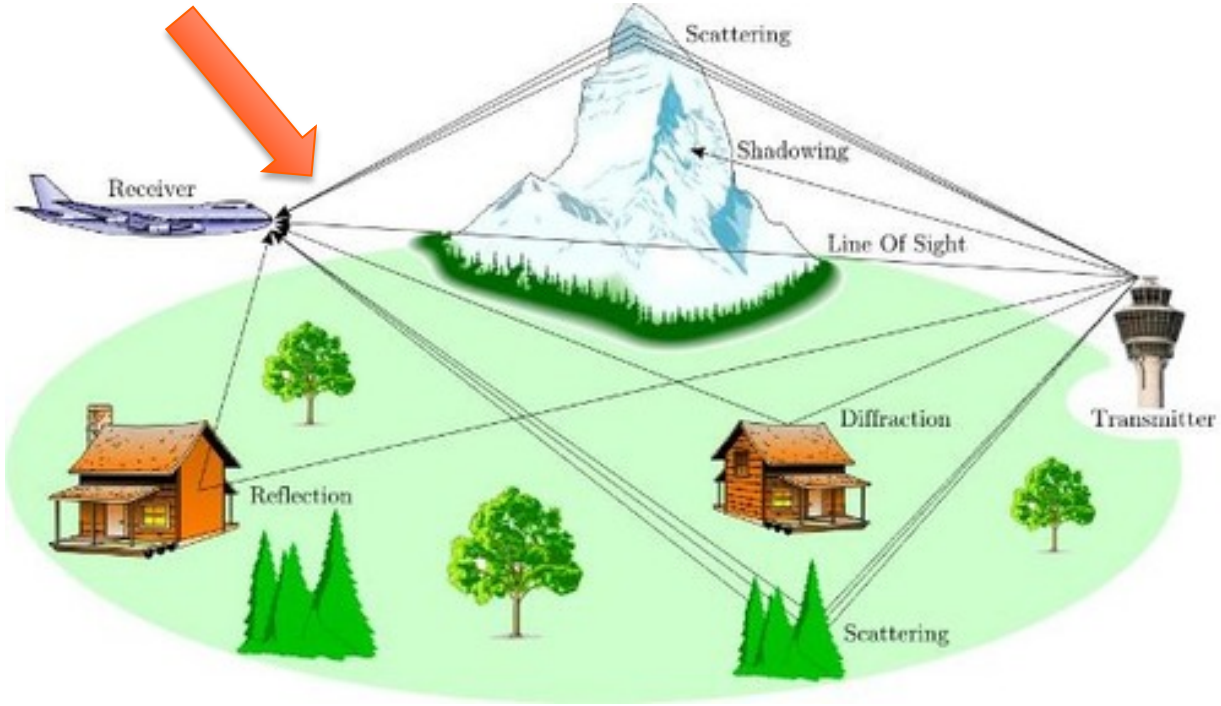


- Scattering



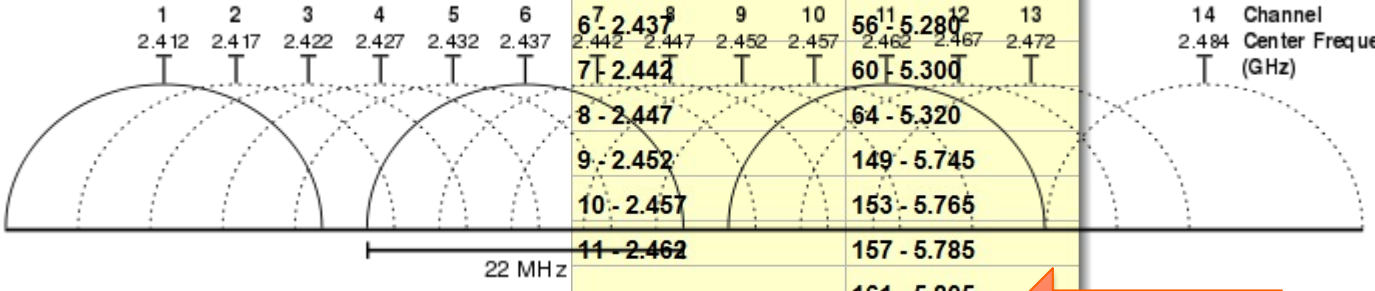
Radio Frequency Behaviors - cont

- MultiPath



Wireless Network Technologies

- ISM Bands – Industrial, Scientific, and Medical
  - 900Mhz
  - 2400Mhz
  - 5800Mhz

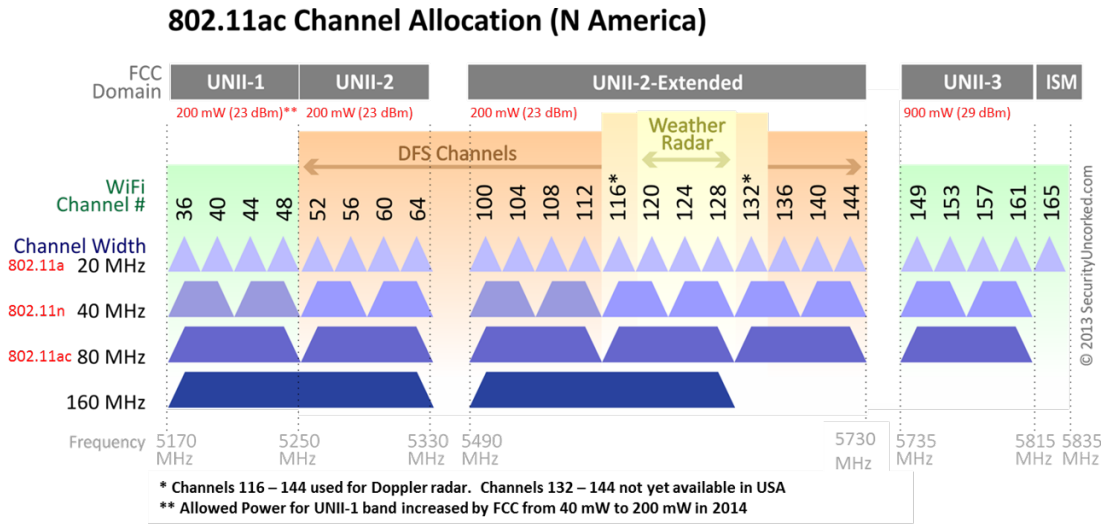


2.4GHz Band	5GHz Band
1 - 2.412	36 - 5.180
2 - 2.417	40 - 5.20
3 - 2.422	44 - 5.220
4 - 2.427	48 - 5.240
5 - 2.432	52 - 5.260
6 - 2.437	56 - 5.280
7 - 2.442	60 - 5.300
8 - 2.447	64 - 5.320
9 - 2.452	149 - 5.745
10 - 2.457	153 - 5.765
11 - 2.462	157 - 5.785
	161 - 5.805
	165 - 5.825

ISM Bands

Wireless Network Technologies - cont

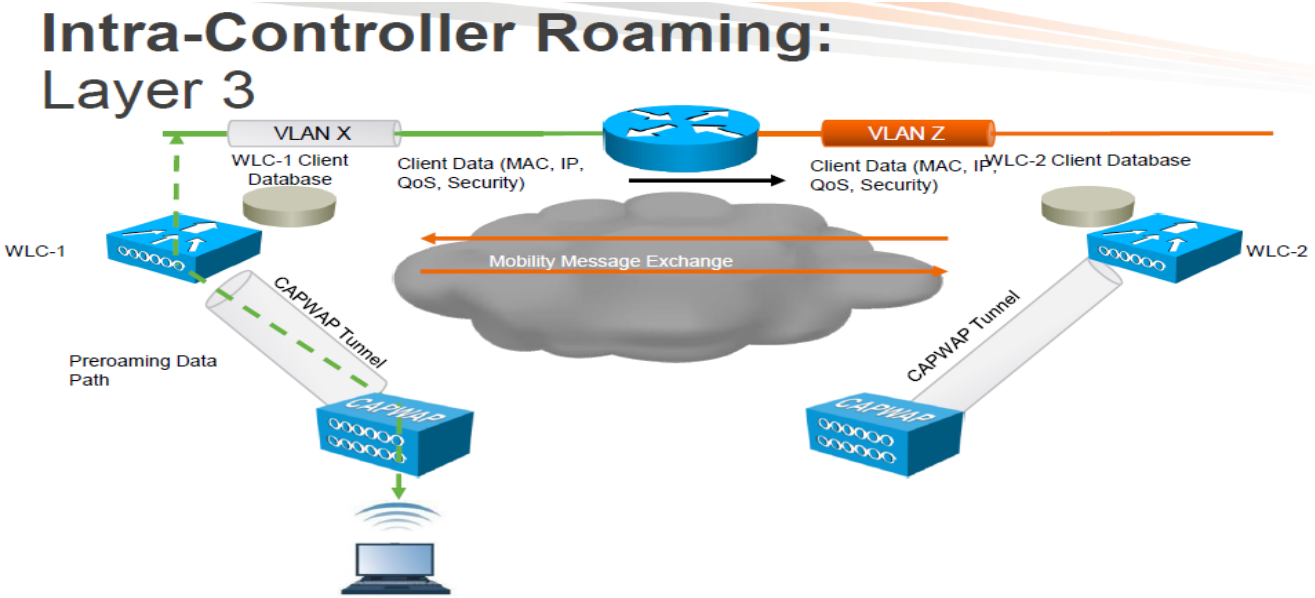
- UNII Bands– Unlicensed National Information Infrastructure
  - U-NII-1
  - U-NII-2
  - U-NII-2 Extended
  - U-NII-3



WLAN Design and Troubleshooting

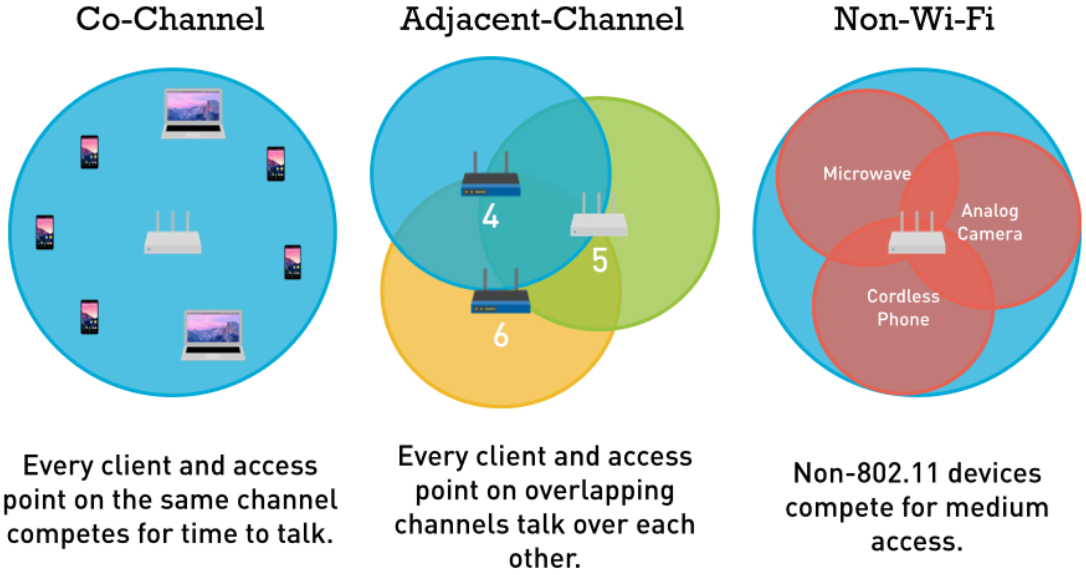
- Coverage Considerations
  - Roaming
  - Co-Channel Interference
  - Channel Reuse
  - High vs Low density design
- Capacity vs Coverage

- Roaming vs Layer-3 Roaming



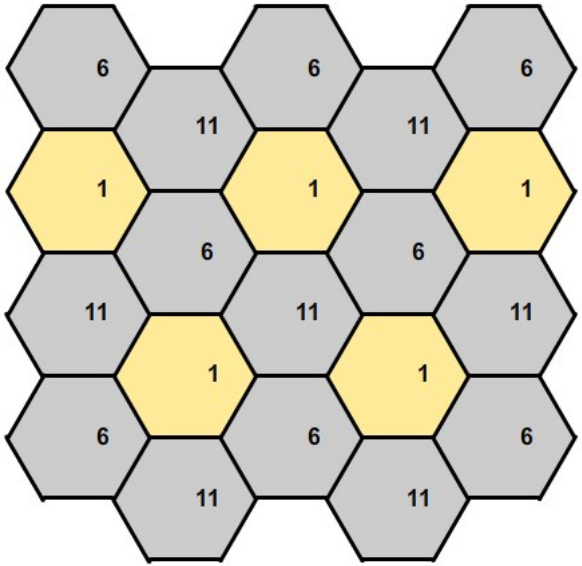
WLAN Design and Troubleshooting - cont

Co-Channel Interference and Adjacent-Channel Interference



WLAN Design and Troubleshooting - cont

- Channel Re-Use Plan

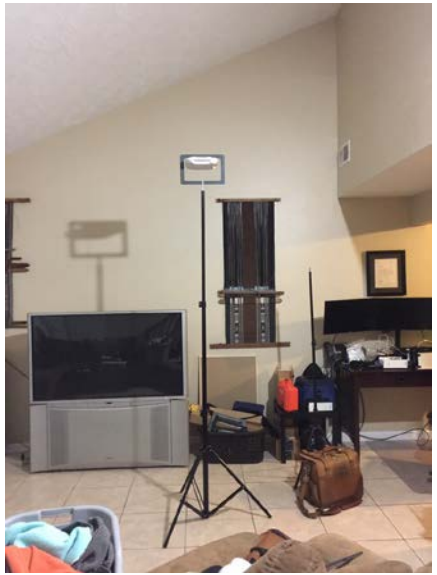


WLAN Design and Troubleshooting – cont

- High Density vs Low Density design

Site Survey Fundamentals

- Business Requirements
- Capacity vs Coverage
- Security Requirements
- Tools and Equipment
- Active vs Passive Survey
- Manual vs Predictive



Very High Throughput (VHT) 802.11ac 1 & 2

- Modulation Techniques
- Channel Bonding
- SU-MIMO vs MU-MIMO

Very High Throughput (VHT) 802.11ac 1 & 2

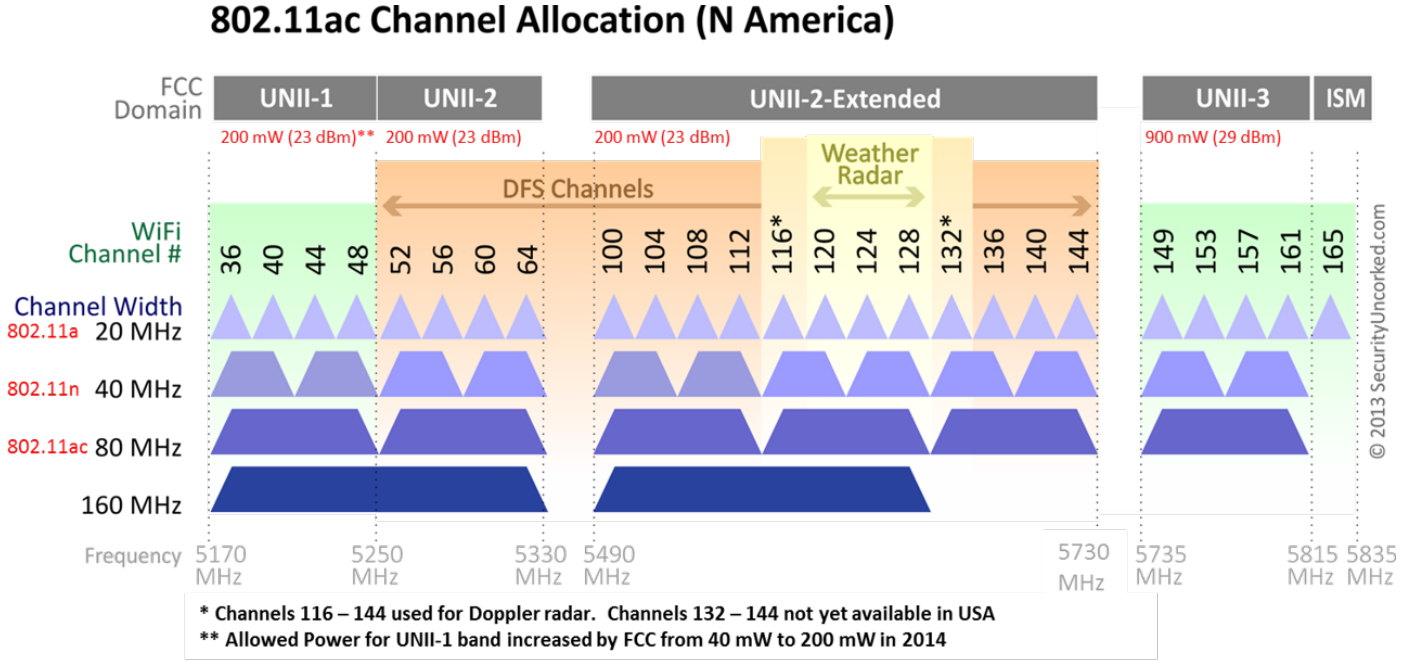
- Modulation Techniques
- QAM – Quadrature Amplitude Modulation

802.11ac OFDM Data Rates

MCS	Modulation	Bits per Symbol	Coding Ratio	20-MHz		40-MHz		80-MHz		160-MHz	
				800ns	400ns	800ns	400ns	800ns	400ns	800ns	400ns
1 Spatial Stream				Data Rate (Mbps)							
MCS 0	BPSK	1	1/2	6.5	7.2	13.5	15.0	29.3	32.5	58.5	65.0
MCS 1	QPSK	2	1/2	13.0	14.4	27.0	30.0	58.5	65.0	117.0	130.0
MCS 2	QPSK	2	3/4	19.5	21.7	40.5	45.0	87.8	97.5	175.5	195.0
MCS 3	16-QAM	4	1/2	26.0	28.9	54.0	60.0	117.0	130.0	234.0	260.0
MCS 4	16-QAM	4	3/4	39.0	43.3	81.0	90.0	175.5	195.0	351.0	390.0
MCS 5	64-QAM	6	2/3	52.0	57.8	108.0	120.0	234.0	260.0	468.0	520.0
MCS 6	64-QAM	6	3/4	58.5	65.0	121.5	135.0	263.3	292.5	526.5	585.0
MCS 7	64-QAM	6	5/6	65.0	72.2	135.0	150.0	292.5	325.0	585.0	650.0
MCS 8	256-QAM	8	3/4	78.0	86.7	162.0	180.0	351.0	390.0	702.0	780.0
MCS 9	256-QAM	8	5/6	N/A	N/A	180.0	200.0	390.0	433.3	780.0	866.7
2 Spatial Streams				Data Rate (Mbps)							
MCS 0	BPSK	1	1/2	13.0	14.4	27.0	30.0	58.5	65.0	117.0	130.0
MCS 1	QPSK	2	1/2	26.0	28.9	54.0	60.0	117.0	130.0	234.0	260.0
MCS 2	QPSK	2	3/4	39.0	43.3	81.0	90.0	175.5	195.0	351.0	390.0
MCS 3	16-QAM	4	1/2	52.0	57.8	108.0	120.0	234.0	260.0	468.0	520.0
MCS 4	16-QAM	4	3/4	78.0	86.7	162.0	180.0	351.0	390.0	702.0	780.0
MCS 5	64-QAM	6	2/3	104.0	115.6	216.0	240.0	468.0	520.0	936.0	1040.0
MCS 6	64-QAM	6	3/4	117.0	130.0	243.0	270.0	526.5	585.0	1053.0	1170.0
MCS 7	64-QAM	6	5/6	130.0	144.4	270.0	300.0	585.0	650.0	1170.0	1300.0
MCS 8	256-QAM	8	3/4	156.0	173.3	324.0	360.0	702.0	780.0	1404.0	1560.0
MCS 9	256-QAM	8	5/6	N/A	N/A	360.0	400.0	780.0	866.7	1560.0	1733.3
3 Spatial Streams				Data Rate (Mbps)							
MCS 0	BPSK	1	1/2	19.5	21.7	40.5	45.0	87.8	97.5	175.5	195.0
MCS 1	QPSK	2	1/2	39.0	43.3	81.0	90.0	175.5	195.0	351.0	390.0
MCS 2	QPSK	2	3/4	58.5	65.0	121.5	135.0	263.3	292.5	526.5	585.0
MCS 3	16-QAM	4	1/2	78.0	86.7	162.0	180.0	351.0	390.0	702.0	780.0
MCS 4	16-QAM	4	3/4	117.0	130.0	243.0	270.0	526.5	585.0	1053.0	1170.0
MCS 5	64-QAM	6	2/3	156.0	173.3	324.0	360.0	702.0	780.0	1404.0	1560.0
MCS 6	64-QAM	6	3/4	175.5	195.0	364.5	405.0	N/A	N/A	1579.5	1755.0
MCS 7	64-QAM	6	5/6	195.0	216.7	405.0	450.0	877.5	975.0	1755.0	1950.0
MCS 8	256-QAM	8	3/4	234.0	260.0	486.0	540.0	1053.0	1170.0	2106.0	2340.0
MCS 9	256-QAM	8	5/6	260.0	288.9	540.0	600.0	1170.0	1300.0	N/A	N/A

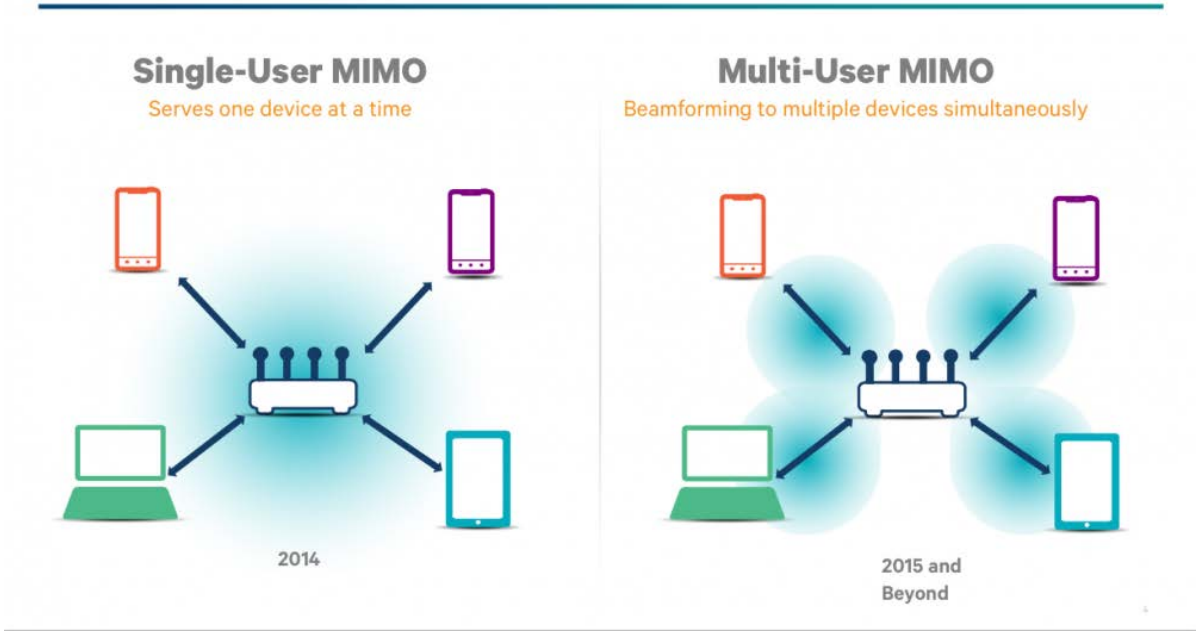
Very High Throughput (VHT) 802.11ac 1 & 2

Channel Bonding



Very High Throughput (VHT) 802.11ac 1 & 2

- SU-MIMO vs MU-MIMO



LINKS:

www.cwnp.com

www.ekahau.com

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www.wlanpros.com

www.metageek.com

www.wi-fi.org

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Thank You!

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