

Predictive Wireless LAN Capacity Plan

Project Name: Project Name or Description Date: March 22, 2017

Network Infrastructure	Selections	Description
Access Point Type:	802.11ac Wave-2 3SS AP	Select the access point type that will be deployed in the environment.
5 GHz Channel Width:	40 MHz	Select the 5 GHz channel width APs will use. 20 MHz is used for 2.4 GHz.
Client Distribution between Bands:	86.5%	Define the percentage of all clients desired on 5 GHz (including 2.4 GHz-only clients).
Association Limit per-AP Radio:	45	Define the maximum desired client associations per-radio.
Concurrent Associated Client %:	75%	Define the percentage of clients concurrently associated to the WLAN during peak times.
Concurrent Active Client %:	66%	Define the percentage of clients concurrently consuming bandwidth during peak times.
Number of Enabled SSIDs:	2	Define the number of SSIDs enabled on the WLAN (including hidden SSIDs).
Minimum Basic Data Rate (2.4 GHz):	802.11b 1 Mbps	Select the minimum Basic / Mandatory data rate configured on the 2.4 GHz band.
Minimum Basic Data Rate (5 GHz):	802.11a 6 Mbps	Select the minimum Basic / Mandatory data rate configured on the 5 GHz band.
RF Coverage Design:	Capacity / Voice / Location	Select the RF coverage design type that matches the minimum signal quality for clients.
RF Environment:	Office Environment (Neighboring Facilities)	Describes the noise floor and available airtime for clients in the environment.
Desired Capacity Available for Growth:	0%	Define the desired percentage of capacity that should remain available for future growth.
Device Sub-Total to Display:	Airtime Per-Device	Select the metric to display for per-device subtotals in the table below.

Index	Client Device	Application or Throughput SLA	Device Quantity	Which Concurrent Limits Apply?	Application Throughput	2.4 GHz Band			5 GHz Band		
						Assoc.	Active	Airtime	Assoc.	Active	Airtime
1	Laptop (11n, 2SS, 40 MHz)	5 Mbps per-device throughput SLA	666	None	5 Mbps	90	90	6.93%	576	576	3.71%
2	Laptop (11ac, 3SS, 80 MHz)	5 Mbps per-device throughput SLA	334	None	5 Mbps	45	45	5.13%	289	289	2.06%
3	Tablet (11n, 2SS, 40 MHz)	3 Mbps per-device throughput SLA	200	Both	3 Mbps	20	18	4.62%	130	114	2.23%
4	Tablet (11ac, 2SS, 80 MHz)	3 Mbps per-device throughput SLA	134	Both	3 Mbps	14	12	4.62%	87	76	1.86%
5	Smart Phone (11ag)	1 Mbps per-device throughput SLA	333	Both	1 Mbps	34	30	6.41%	216	190	6.41%
6	Smart Phone (11n, 1SS, 40 MHz)	1 Mbps per-device throughput SLA	333	Both	1 Mbps	34	30	4.62%	216	190	3.34%
	Smart Phone (11n, 1SS, 40 MHz)	Web Browsing & Email (Moderate)	333	Both	500 Kbps						
7	Apple TV 3rd Gen (11n, 1SS, 20 MHz)	3 Mbps per-device throughput SLA	50	Both	3 Mbps	5	4	8.31%	33	29	8.31%

Capacity Distribution

- Equal - balance capacity between 2.4 GHz and 5 GHz frequency bands
- Weighted - based on the number of available channels in each band
- Manual - based on the configured client distribution value
- Dedicated 5 GHz Mesh - all clients will connect on 2.4 GHz

Additional Options:

- Set a limit on the number of 2.4 GHz radios to deploy:
- Plan for all capacity growth to be in the 5 GHz frequency band

AP Form-Factor

- Dual-Radio APs (All Radios Enabled)
- Dual-5 GHz Capable APs
- Dual-Radio APs (Some Radios Disabled)
- Display Radio Quantities Only

Capacity Results

	2050 Devices	2.4 GHz Band	5 GHz Band
Associated Devices:	1,789	242	1,547
Active Devices:	1,693	229	1,464
AP Radios Required:		22.30	66.56
+ Capacity for Growth:	0%	0.00	0.00
AP Radios to Deploy:		23	67
Throughput:	6.309 Gbps	852.00 Mbps	5.457 Gbps
Band Steering Ratio:	68.7%	67 Dual-Radio AP(s) with 44 Radio(s) Disabled in 2.4 GHz	

Capacity requirements are driven by airtime in both frequency bands.

Capacity Available for Growth

Given current client and application mix:	2.4 GHz	5 GHz
Additional Device Associations (per Band):	793	1,468
Additional Active Devices (per Band):	7.15	9.58
Additional Throughput (per Band):	26.61 Mbps	35.70 Mbps
Additional Device Associations (per Radio):	34.48	21.91
Additional Active Devices (per Radio):	0.31	0.14
Additional Throughput (per Radio):	1.16 Mbps	0.53 Mbps

Capacity Breakdown per Radio

	Dual-Band AP	2.4 GHz Radio	5 GHz Radio
Available Channels		3 (20 MHz)	9 (40 MHz)
Frequency Reuse Required:		7 - 8	7 - 8
Airtime Utilization (ea):		73.16%	79.49%
Associated Devices:	33.61	10.52	23.09
Active Devices:	31.81	9.96	21.85
Avg. Throughput:	118.49 Mbps	37.04 Mbps	81.45 Mbps



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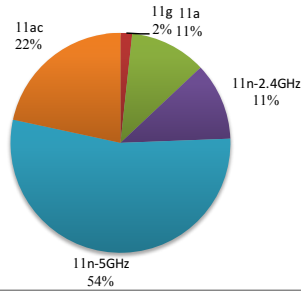
Notice: These results are only an estimate. Perform RF coverage planning through predictive modeling and site surveying using this capacity estimate as a starting point. The WLAN design must balance capacity and coverage requirements through frequency re-use to minimize co-channel interference (CCI) in order to effectively deliver the desired capacity.

Wi-Fi Capacity Plan Analysis

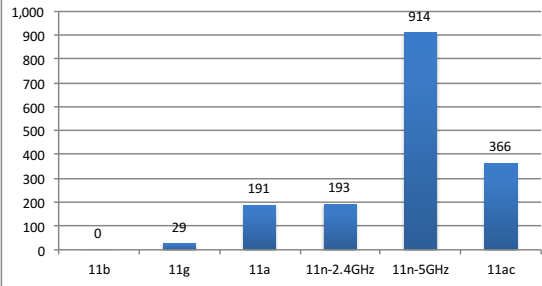
WLAN Configuration:

802.11ac Wave-2 3SS AP, 40 MHz Channel Width in 5 GHz,
-67 dBm Min RSSI (2.4 GHz), -67 dBm Min RSSI (5 GHz)

Active Clients by Protocol



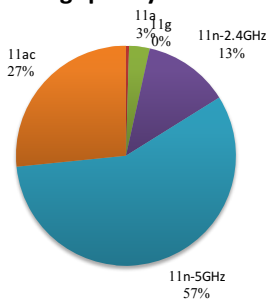
Active Clients by Protocol



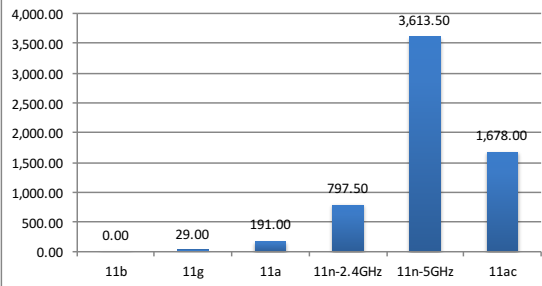
Active Clients by Protocol Version

11b	0	0.00%
11g	29	1.71%
11a	191	11.28%
11n-2.4GHz	193	11.40%
11n-5GHz	914	53.99%
11ac	366	21.62%

Throughput by Protocol



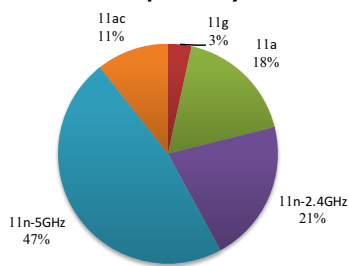
Throughput by Protocol



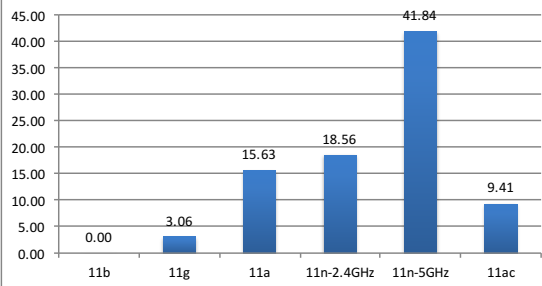
Throughput by Protocol Version (Mbps)

11b	0.00	0.00%
11g	29.00	0.46%
11a	191.00	3.03%
11n-2.4GHz	797.50	12.64%
11n-5GHz	3,613.50	57.28%
11ac	1,678.00	26.60%

AP Radios Required by Protocol



AP Radios Required by Protocol



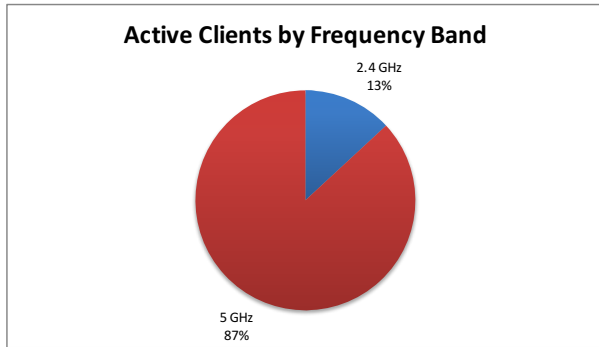
Airtime Demand by Protocol Version (AP Radios Required)

11b	0.00	0.00%
11g	3.06	3.45%
11a	15.63	17.66%
11n-2.4GHz	18.56	20.97%
11n-5GHz	41.84	47.28%
11ac	9.41	10.64%

Wi-Fi Capacity Plan Analysis

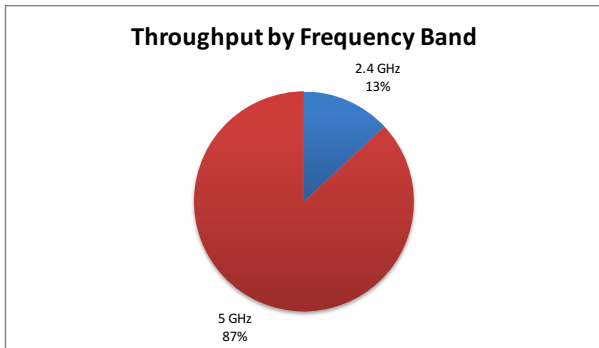
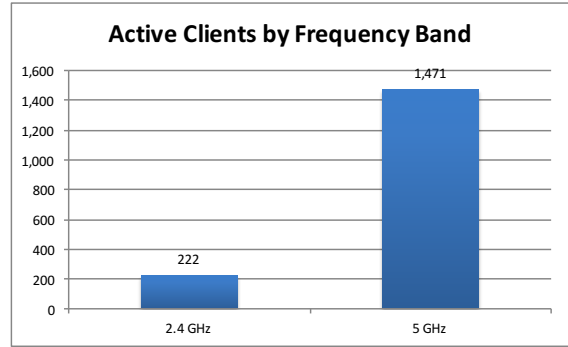
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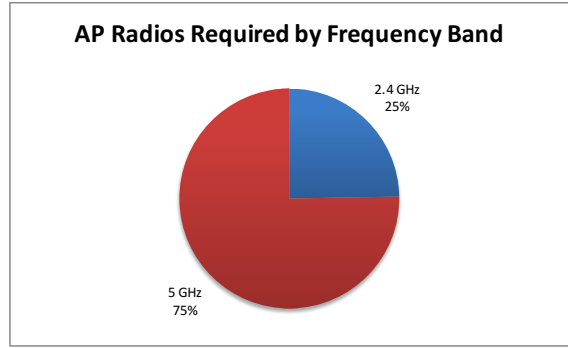
Active Clients by Frequency Band

2.4 GHz	222	13.11%
5 GHz	1,471	86.89%



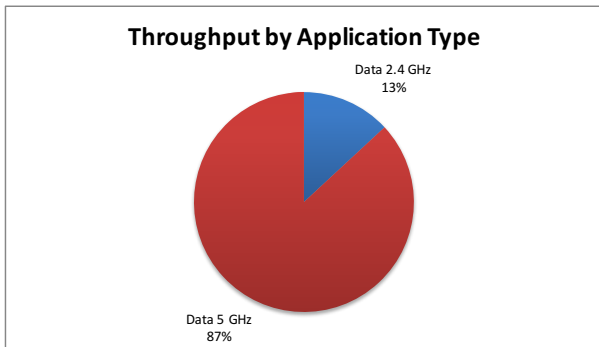
Throughput by Frequency Band (Mbps)

2.4 GHz	826.50	13.10%
5 GHz	5,482.50	86.90%



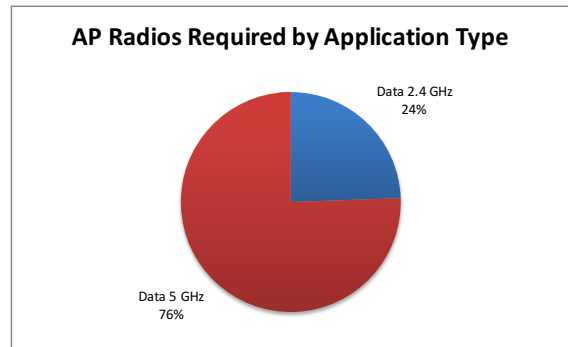
Airtime Demand by Frequency Band (AP Radios Required)

2.4 GHz	22.00	24.72%
5 GHz	67.00	75.28%



Throughput by Application Type (Mbps)

Data 2.4 GHz	826.50	13.10%
Data 5 GHz	5,482.50	86.90%
VoIP/RT 2.4 GHz	0.00	0.00%
VoIP/RT 5 GHz	0.00	0.00%



Airtime Demand by Application Type (AP Radios Required)

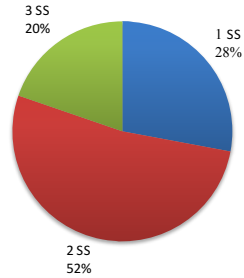
Data 2.4 GHz	21.62	24.43%
Data 5 GHz	66.89	75.57%
VoIP/RT 2.4 GHz	0.00	0.00%
VoIP/RT 5 GHz	0.00	0.00%

Wi-Fi Capacity Plan Analysis

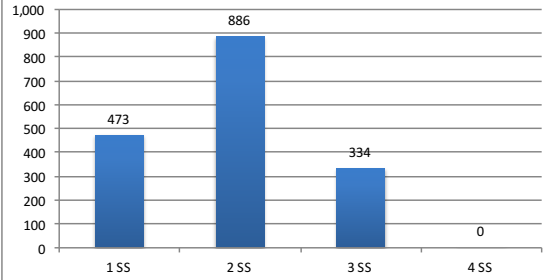
WLAN Configuration:

802.11ac Wave-2 3SS AP, 40 MHz Channel Width in 5 GHz,
-67 dBm Min RSSI (2.4 GHz), -67 dBm Min RSSI (5 GHz)

Active Clients by Spatial Streams



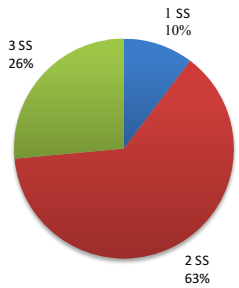
Active Clients by Spatial Streams



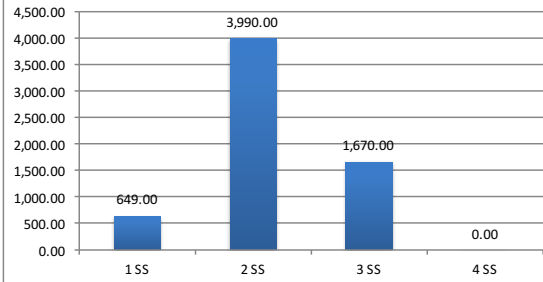
Active Clients by Spatial Streams

1 SS	473	27.94%
2 SS	886	52.33%
3 SS	334	19.73%
4 SS	0	0.00%

Throughput by Spatial Streams



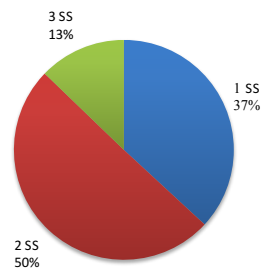
Throughput by Spatial Streams



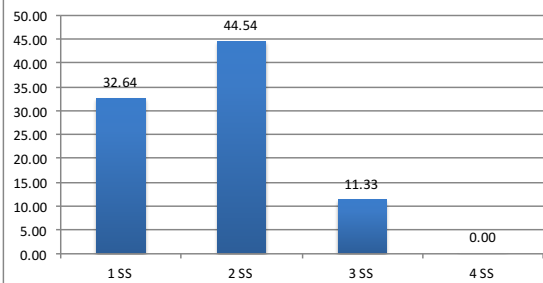
Throughput by Spatial Streams (Mbps)

1 SS	649.00	10.29%
2 SS	3,990.00	63.24%
3 SS	1,670.00	26.47%
4 SS	0.00	0.00%

AP Radios Required by Spatial Streams



AP Radios Required by Spatial Streams



Airtime Demand by Spatial Streams (AP Radios Required)

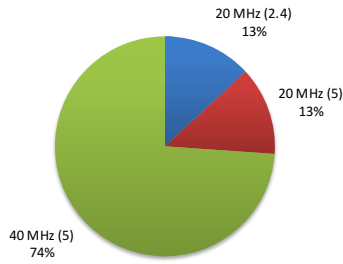
1 SS	32.64	36.87%
2 SS	44.54	50.33%
3 SS	11.33	12.80%
4 SS	0.00	0.00%

Wi-Fi Capacity Plan Analysis

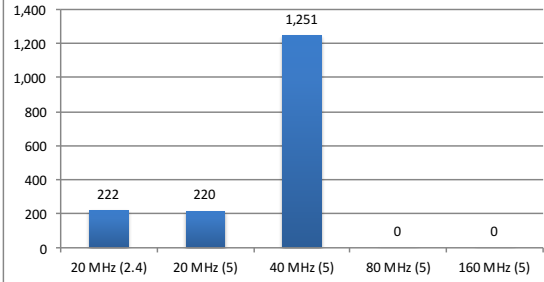
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Active Clients by Channel Width



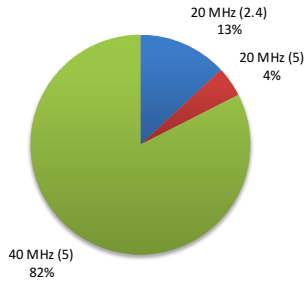
Active Clients by Channel Width



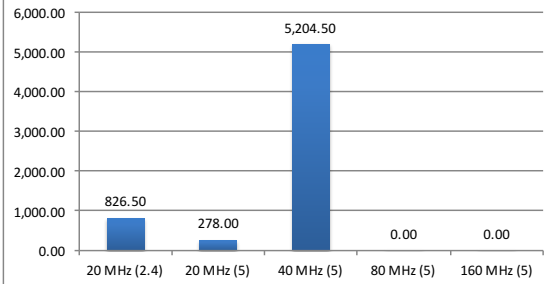
Active Clients by Channel Width

20 MHz (2.4)	222	13.11%
20 MHz (5)	220	12.99%
40 MHz (5)	1,251	73.89%
80 MHz (5)	0	0.00%
160 MHz (5)	0	0.00%

Throughput by Channel Width



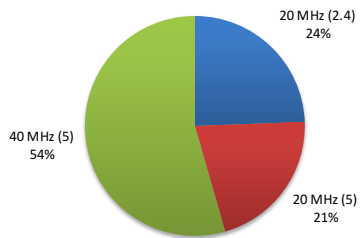
Throughput by Channel Width



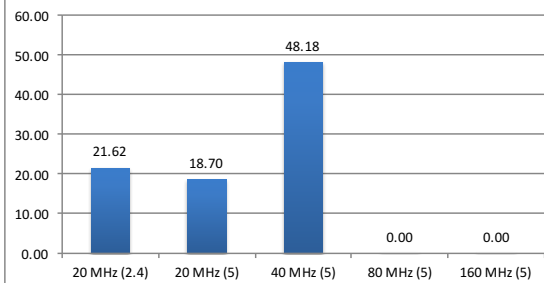
Throughput by Channel Width (Mbps)

20 MHz (2.4)	826.50	13.10%
20 MHz (5)	278.00	4.41%
40 MHz (5)	5,204.50	82.49%
80 MHz (5)	0.00	0.00%
160 MHz (5)	0.00	0.00%

AP Radios Required by Channel Width



AP Radios Required by Channel Width



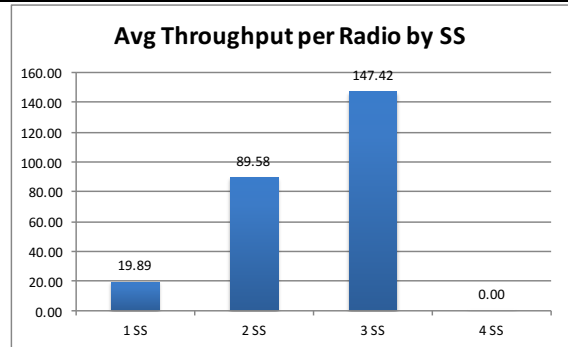
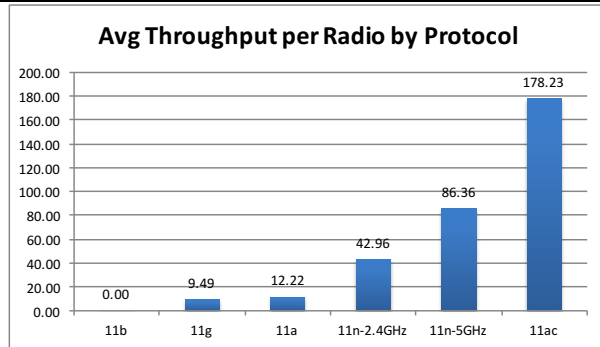
Airtime Demand by Channel Width (AP Radios Required)

20 MHz (2.4)	21.62	24.43%
20 MHz (5)	18.70	21.13%
40 MHz (5)	48.18	54.44%
80 MHz (5)	0.00	0.00%
160 MHz (5)	0.00	0.00%

Wi-Fi Capacity Plan Analysis

WLAN Configuration:

802.11ac Wave-2 3SS AP, 40 MHz Channel Width in 5 GHz,
-67 dBm Min RSSI (2.4 GHz), -67 dBm Min RSSI (5 GHz)

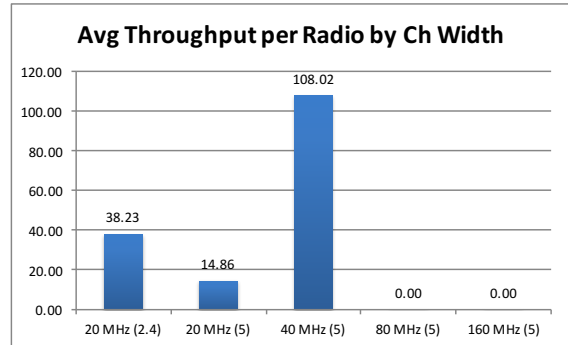
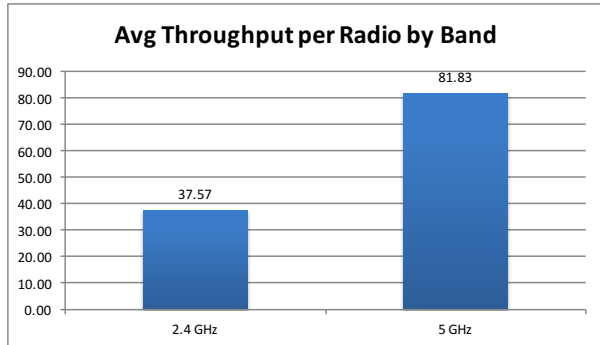


Airtime Efficiency by Protocol Version (Average Mbps per Radio)

11b	0.00
11g	9.49
11a	12.22
11n-2.4GHz	42.96
11n-5GHz	86.36
11ac	178.23

Airtime Efficiency by Spatial Streams (Average Mbps per Radio)

1 SS	19.89
2 SS	89.58
3 SS	147.42
4 SS	0.00

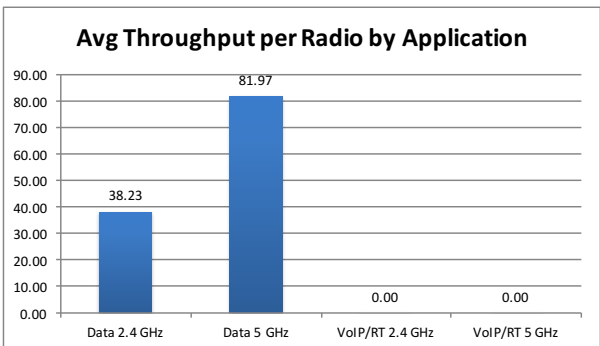


Airtime Efficiency by Frequency Band (Average Mbps per Radio)

2.4 GHz	37.57
5 GHz	81.83

Airtime Efficiency by Channel Width (Average Mbps per Radio)

20 MHz (2.4)	38.23
20 MHz (5)	14.86
40 MHz (5)	108.02
80 MHz (5)	0.00
160 MHz (5)	0.00



Airtime Efficiency by Application Category (Average Mbps per Radio)

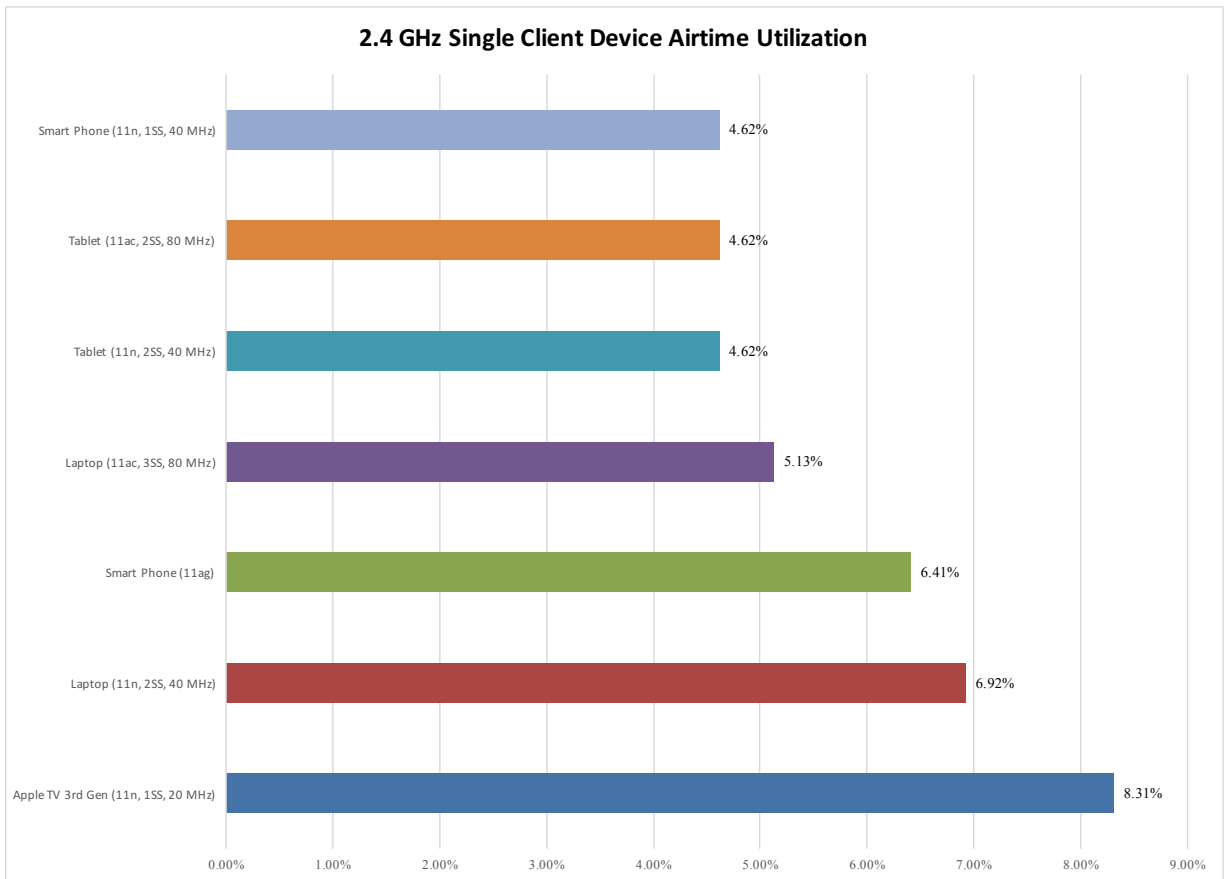
Data 2.4 GHz	38.23
Data 5 GHz	81.97
VoIP/RT 2.4 GHz	0.00
VoIP/RT 5 GHz	0.00



Wi-Fi Capacity Plan Analysis

WLAN Configuration:

802.11ac Wave-2 3SS AP, 40 MHz Channel Width in 5 GHz,
-67 dBm Min RSSI (2.4 GHz), -67 dBm Min RSSI (5 GHz)



2.4 GHz Airtime Utilization by Client Device

Index	Device	SNR	Mbps	Airtime	per-Mbit
7	Apple TV 3rd Gen (11n, 1S:	26	3.00	8.31%	2.77%
1	Laptop (11n, 2SS, 40 MHz)	25	5.00	6.92%	1.38%
5	Smart Phone (11ag)	21	1.00	6.41%	6.41%
2	Laptop (11ac, 3SS, 80 MHz)	24	5.00	5.13%	1.03%
3	Tablet (11n, 2SS, 40 MHz)	21	3.00	4.62%	1.54%
4	Tablet (11ac, 2SS, 80 MHz)	21	3.00	4.62%	1.54%
6	Smart Phone (11n, 1SS, 40	21	1.00	4.62%	4.62%

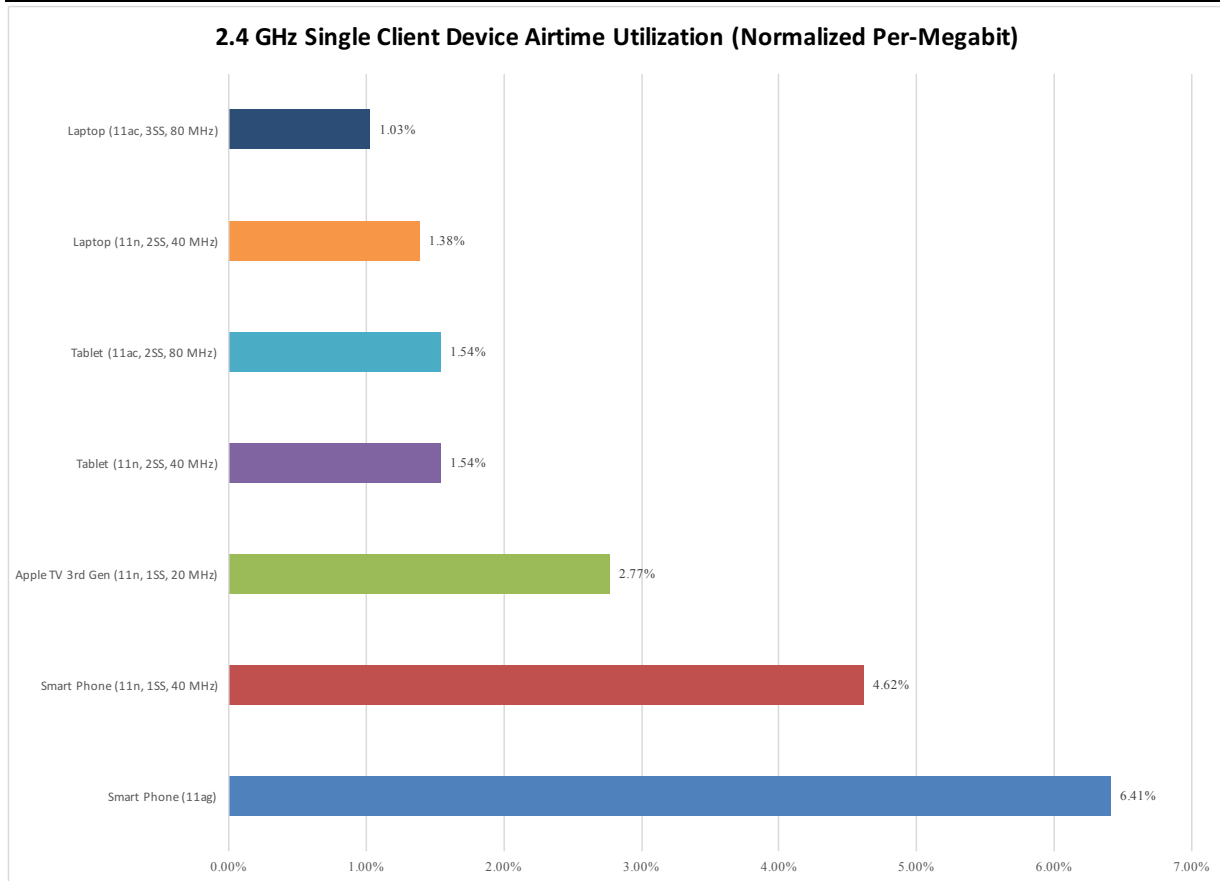
Table filtering and sorting must be reapplied if capacity plan data is changed.

1. Clear filter on the the Airtime column, then filter Airtime values that do not equal zero.
2. Sort the Airtime column values in ascending or descending order.

Wi-Fi Capacity Plan Analysis

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-67 dBm Min RSSI (2.4 GHz), -67 dBm Min RSSI (5 GHz)



2.4 GHz Airtime Utilization by Client Device

Index	Device	SNR	Mbps	Airtime	per-Mbit
5	Smart Phone (11ag)	21	1.00	6.41%	6.41%
6	Smart Phone (11n, 1SS, 40	21	1.00	4.62%	4.62%
7	Apple TV 3rd Gen (11n, 1S	26	3.00	8.31%	2.77%
3	Tablet (11n, 2SS, 40 MHz)	21	3.00	4.62%	1.54%
4	Tablet (11ac, 2SS, 80 MHz)	21	3.00	4.62%	1.54%
1	Laptop (11n, 2SS, 40 MHz)	25	5.00	6.92%	1.38%
2	Laptop (11ac, 3SS, 80 MHz)	24	5.00	5.13%	1.03%

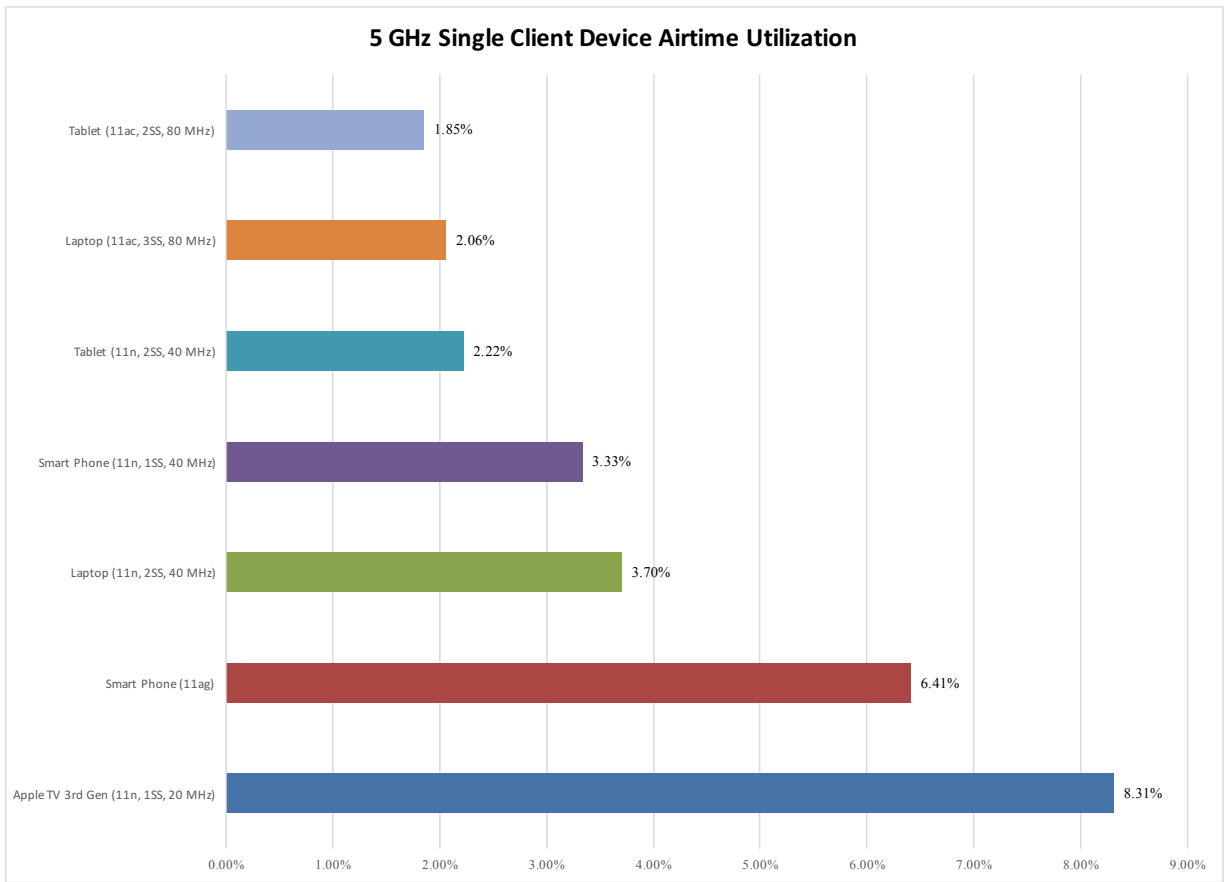
Table filtering and sorting must be reapplied if capacity plan data is changed.

1. Clear filter on the the per-Mbit column, then filter per-Mbit values that do not equal zero.
2. Sort the per-Mbit column values in ascending or descending order.

Wi-Fi Capacity Plan Analysis

WLAN Configuration:

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-67 dBm Min RSSI (2.4 GHz), -67 dBm Min RSSI (5 GHz)



5 GHz Airtime Utilization by Client Device

Index	Device	SNR	Mbps	Airtime	per-Mbit
7	Apple TV 3rd Gen (11n, 1S:	25	3.00	8.31%	2.77%
5	Smart Phone (11ag)	20	1.00	6.41%	6.41%
1	Laptop (11n, 2SS, 40 MHz)	25	5.00	3.70%	0.74%
6	Smart Phone (11n, 1SS, 40	20	1.00	3.33%	3.33%
3	Tablet (11n, 2SS, 40 MHz)	24	3.00	2.22%	0.74%
2	Laptop (11ac, 3SS, 80 MHz	24	5.00	2.06%	0.41%
4	Tablet (11ac, 2SS, 80 MHz)	24	3.00	1.85%	0.62%

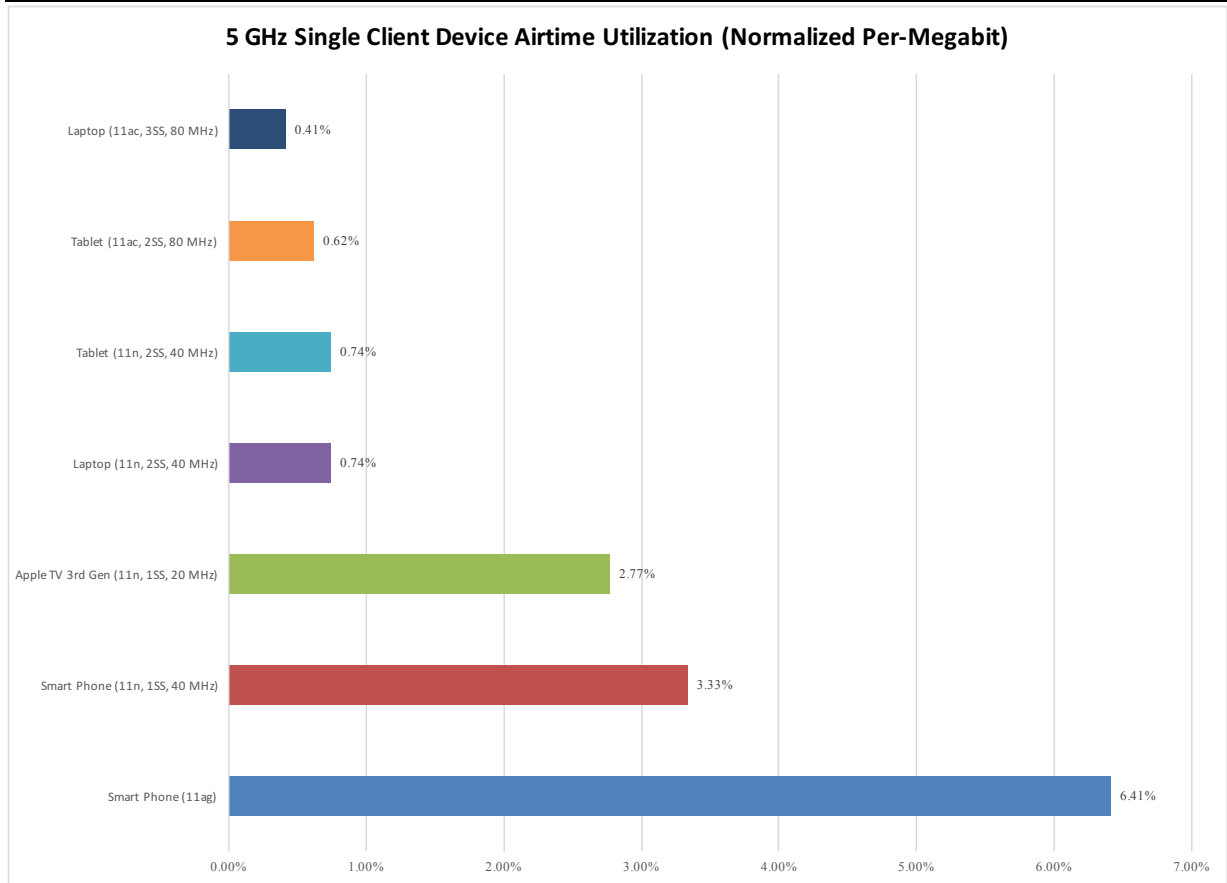
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2. Sort the Airtime column values in ascending or descending order.

Wi-Fi Capacity Plan Analysis

WLAN Configuration:

802.11ac Wave-2 3SS AP, 40 MHz Channel Width in 5 GHz,
-67 dBm Min RSSI (2.4 GHz), -67 dBm Min RSSI (5 GHz)



5 GHz Airtime Utilization by Client Device

Index	Device	SNR	Mbps	Airtime	per-Mbit
5	Smart Phone (11ag)	20	1.00	6.41%	6.41%
6	Smart Phone (11n, 1SS, 40	20	1.00	3.33%	3.33%
7	Apple TV 3rd Gen (11n, 1S	25	3.00	8.31%	2.77%
1	Laptop (11n, 2SS, 40 MHz)	25	5.00	3.70%	0.74%
3	Tablet (11n, 2SS, 40 MHz)	24	3.00	2.22%	0.74%
4	Tablet (11ac, 2SS, 80 MHz)	24	3.00	1.85%	0.62%
2	Laptop (11ac, 3SS, 80 MHz	24	5.00	2.06%	0.41%

Table filtering and sorting must be reapplied if capacity plan data is changed.

1. Clear filter on the the per-Mbit column, then filter per-Mbit values that do not equal zero.
2. Sort the per-Mbit column values in ascending or descending order.