atmosphere'22 MEETUP

Designing Aruba WLAN in the era of Wi-Fi 6 and 6E

aruba
a Hewlett Packard Enterprise company

Agenda

Wi-Fi 6 and 6E Overview
How it differs from previous generations

Aruba Wireless Differentiators
Aruba is poised to leverage Wi-Fi 6 and 6E

Wi-Fi 6E Design
Where to get started

Wi-Fi 6 and 6E Overview

Wi-Fi 6 shifts the focus of spectrum usage from high throughput to high efficiency.

802.11n

- 2.4 and 5 GHz support
- Wider Channels (40 MHz)
- Multiple Input Multiple Output (MIMO) introduced
- Up to 3 simultaneous clients
- Max PHY rate 600 Mbps

802.11ac

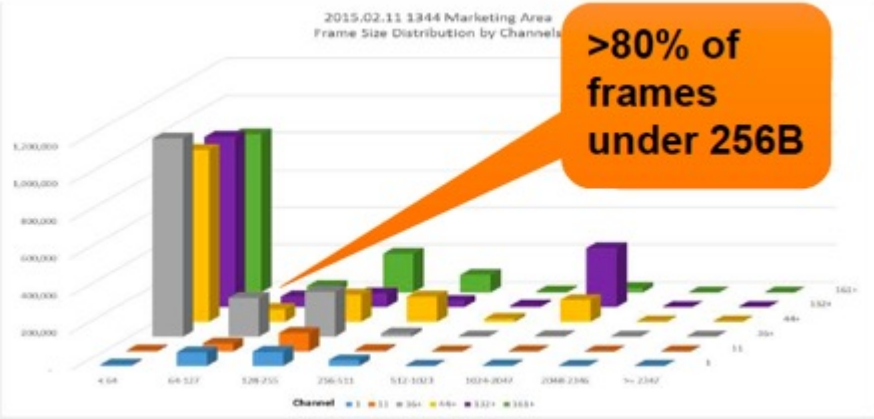
- 5 GHz support
- Even wider channels (160 MHz)
- Downlink Multi-user MIMO (MU-MIMO)
- Up to 4 simultaneous clients
- Max PHY rate ~3.5 Gbps

802.11ax

- 2.4 and 5 GHz support
- Variable multi-user channel widths (160 MHz max)
- Uplink and downlink MU-MIMO
- Up to 37 simultaneous clients (with OFDMA)
- Max PHY rate ~11 Gbps

HT → VHT → HE

Data packet size, end user device design, and limitations in the 802.11 protocol contribute to issues in pre-Wi-Fi 6 deployments.



Studies show typical Wi-Fi network traffic consists of a large quantity of users sending a many small packets. This degrades system efficiency affecting performance.

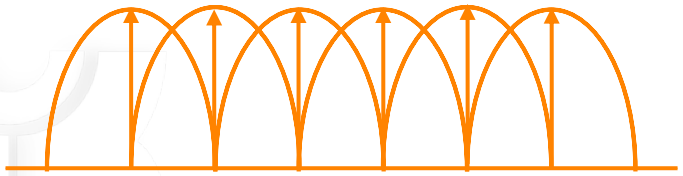
Many devices are capable of only 1 spatial stream and do not use all available streams in 802.11ac.

Smaller Subcarrier Spacing – Larger Symbol Size

- Subcarrier spacing is 78.125 kHz vs 312.5 kHz in 802.11ac
- Carry 4 times more data than 802.11ac
- OFDM symbol duration and cyclic prefix increased 4X
- Efficiency & robustness in indoor/outdoor improved

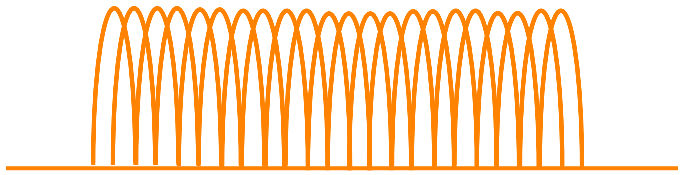
802.11ac

OFDM: Subcarrier Spacing is 312.5 kHz

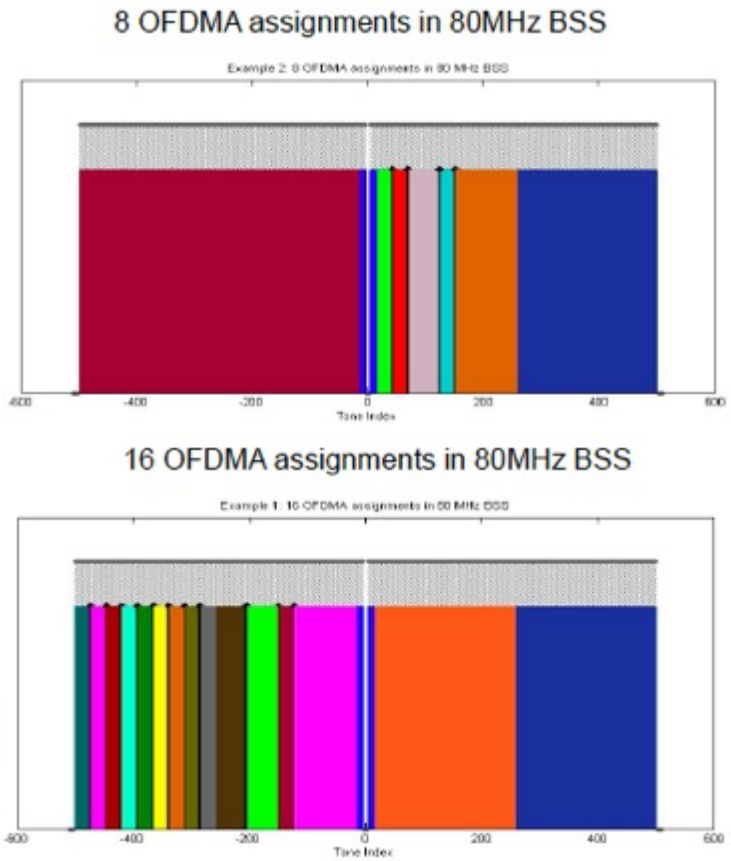


802.11ax

OFDMA: Subcarrier Spacing is 78.125 kHz, only ¼ of OFDM



802.11ax achieves high efficiency utilizing dynamic assignment of time-frequency resource units (RUs) through OFDMA



Two snapshots in time of the RU assignments on an 80 MHz channel.

"The Wi-Fi is slow so I switched to cellular"

- RUs will be assigned to users by a scheduler in the access point
- OFDMA – Orthogonal Frequency-Division Multiple Access – the protocol used to assign RUs.
  - Cellular technology also uses OFDMA
- Allows for parallel transmissions with each user getting a chunk of spectrum from 2 to 40 MHz wide
- RUs can be constantly changing, even for the same user performing the same task
- A maximum of 37 two MHz RUs can theoretically exist simultaneously

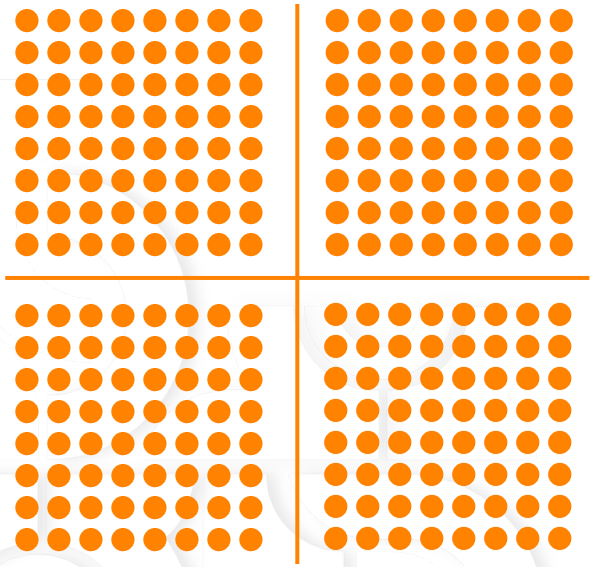
Data Rate and Power Saving improvements in 802.11ax

New MCS data rate:
- MCS 10 (1024 QAM with 3/4 code rate)
- MCS 11 (1024 QAM with 5/6 code rate)

Target Wake Time (TWT):
- Allows clients to sleep for periods of time and wake up in pre-scheduled (target) time.
- Improve sleep efficiency and battery life in mobile & IoT clients

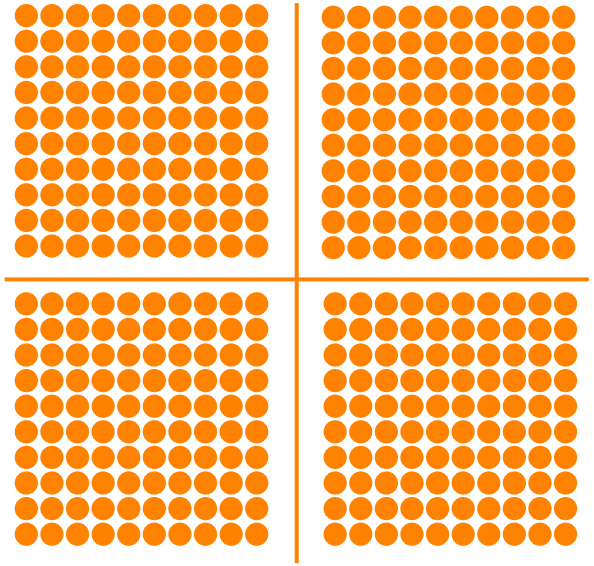
802.11ac

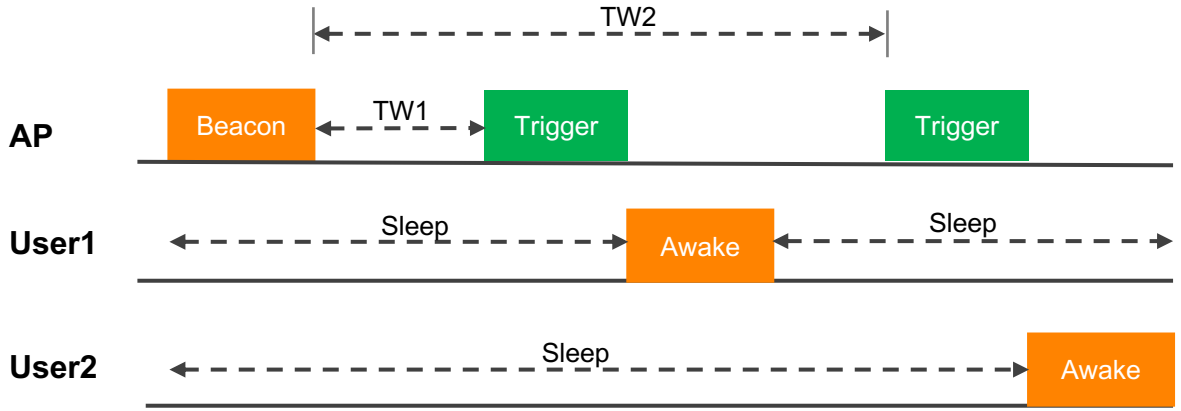
256 QAM



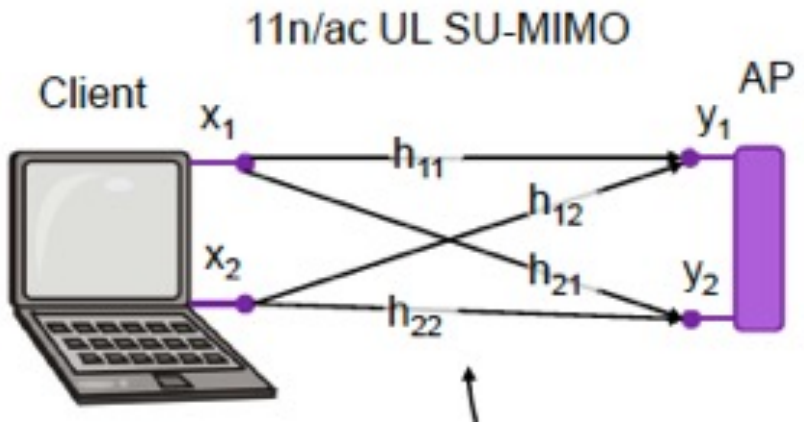
802.11ax

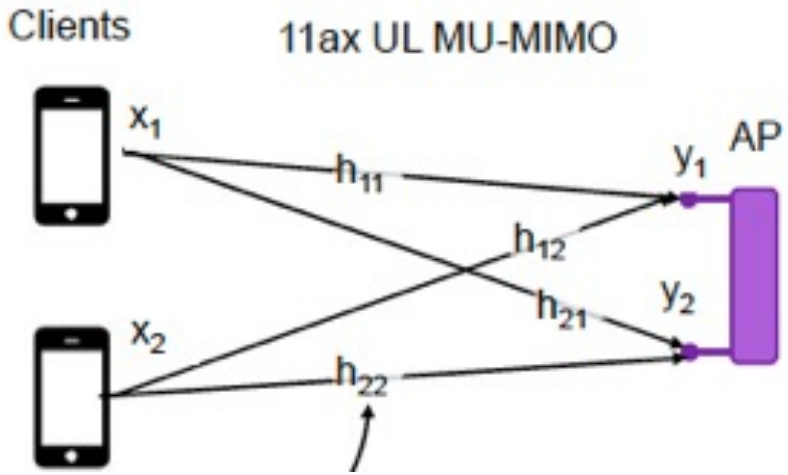
1024 QAM





MU-MIMO improvements in 802.11ax





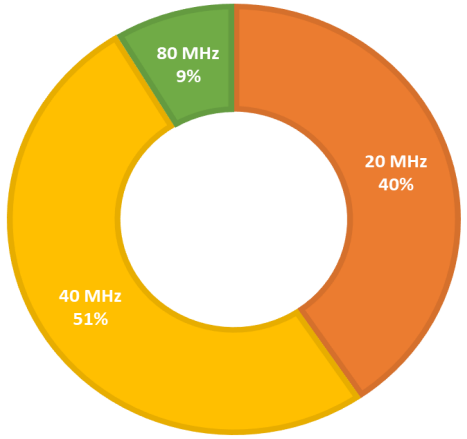
- MU-MIMO only took effect if the client device had multiple antennas in Wi-Fi5
- Single stream client devices were only received on single antennas

- MU-MIMO is now available in the uplink direction
- Single stream client data will be received at multiple receiver antennas improving performance

Wi-Fi 6 Benefits Summary

Feature	Benefit	Improvements over 802.11ac
New OFDM symbol	Increases efficiency by reducing guard interval and pilot tone overhead	20% higher data rates over 802.11ac
OFDMA downlink & uplink	More clients, lower latency. More efficient for low data rates, short packets	~ 3x system capacity for short packets or many clients
MU-MIMO downlink and uplink for up to 8 clients	More efficient in grouping clients, reducing sounding and ACK overhead	~ 2x capacity over 802.11ac
High-order modulation of 1024 QAM	Higher data rates under good RF conditions	25% over 802.11ac
Target Wait Time	Extended sleep mode for improved battery life on supported clients	~ 3-10x battery life

TODAY'S WIRELESS NETWORKS ARE LIMITED BY AVAILABLE SPECTRUM AND LEGACY DEVICES



91% CHANNELS

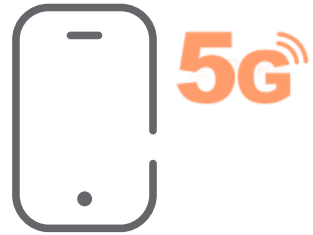
DEPLOYED ARE <80 MHZ

Source: HPE, customer study

6.2B CLIENT DEVICES

WILL BE IN USE THIS YEAR

Source: Gartner

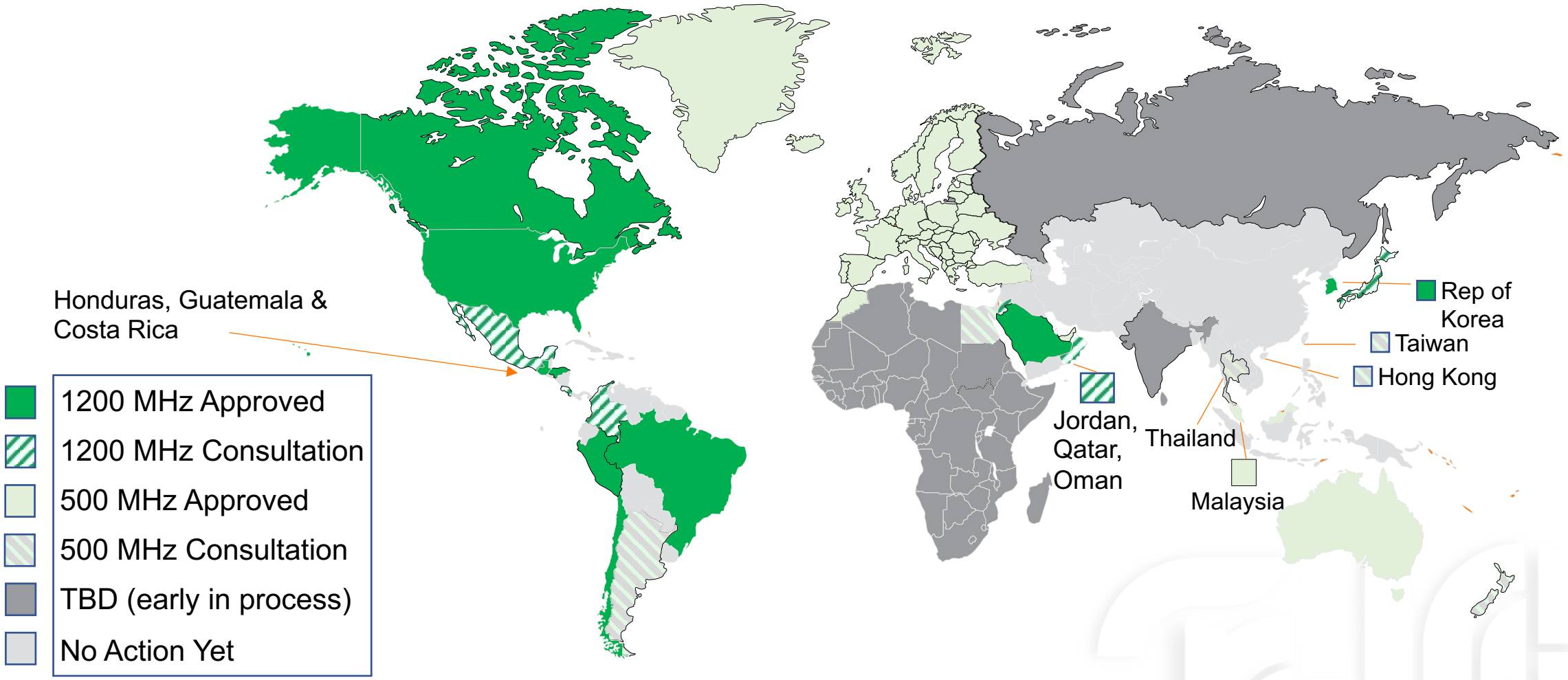


63% TRAFFIC

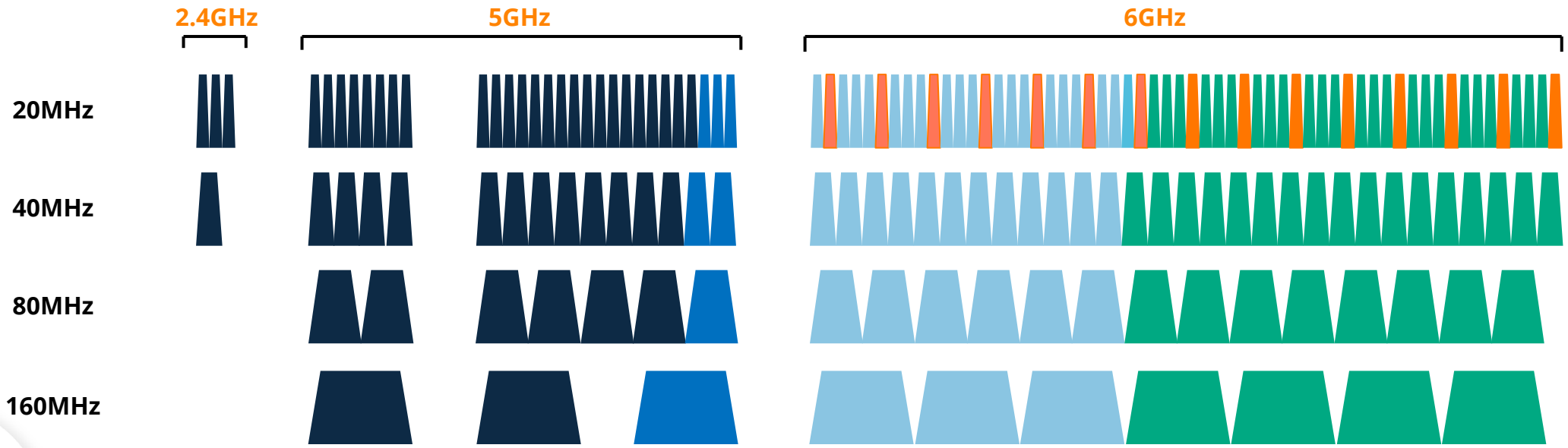
FROM MOBILE IS OFFLOADED TO WI-FI

Source: Wi-Fi Alliance

6 GHz Unlicensed: A Global Movement



Why 6 GHz? Massive increase in capacity enabling high bandwidth use-cases

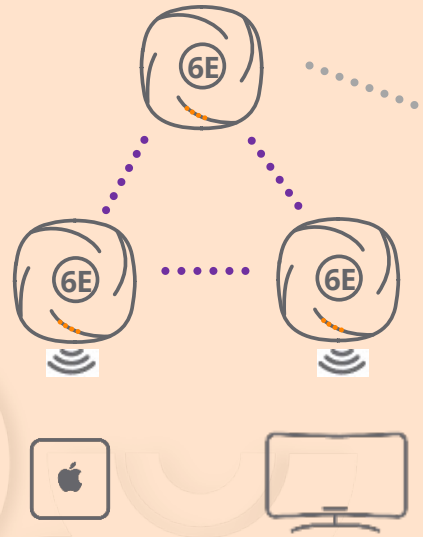


- More than 2x the existing amount of unlicensed spectrum depending on country
- Up to seven 160 MHz wide channels

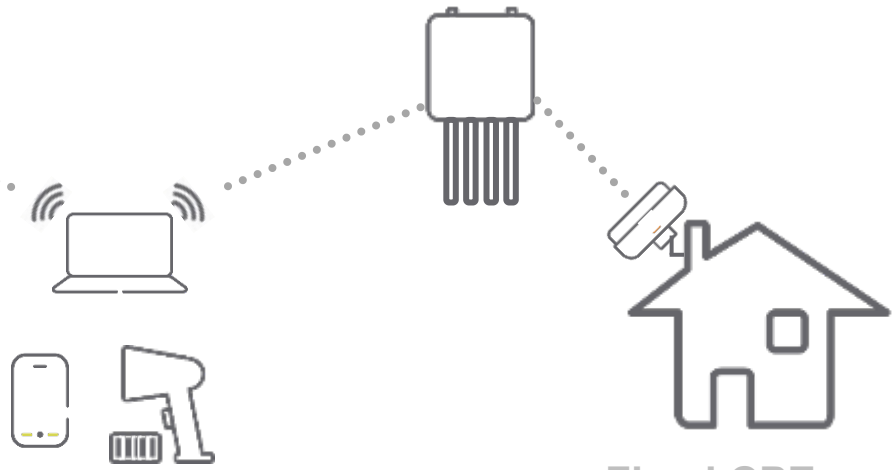
	European Model	Americas Model
20 MHz	24	59
40 MHz	12	29
80 MHz	6	14
160 MHz	3	7

Device Classes in 6 GHz

Low Power Indoor (LPI) AP
- Fixed indoor only
- No antenna connectors
- No weatherproofing
- Powered via wire



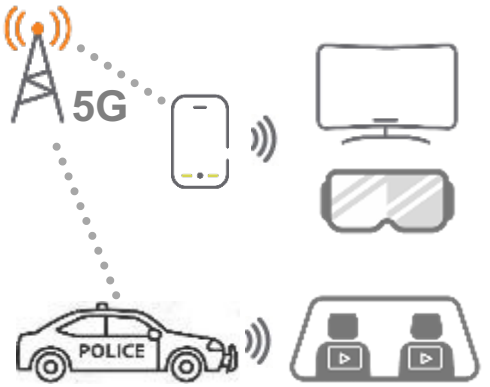
Standard Power (SP) AP
- Fixed indoor / outdoor
- Controlled by AFC database
- Automated geolocation
- Pointing angle restriction



Mobile Client
- Indoor / outdoor
- 4X less power than connected AP

Fixed CPE
- To run at full power, must behave like an AFC-controlled device

Very Low Power (VLP) AP
- Mobile indoor / outdoor
- 160X lower energy

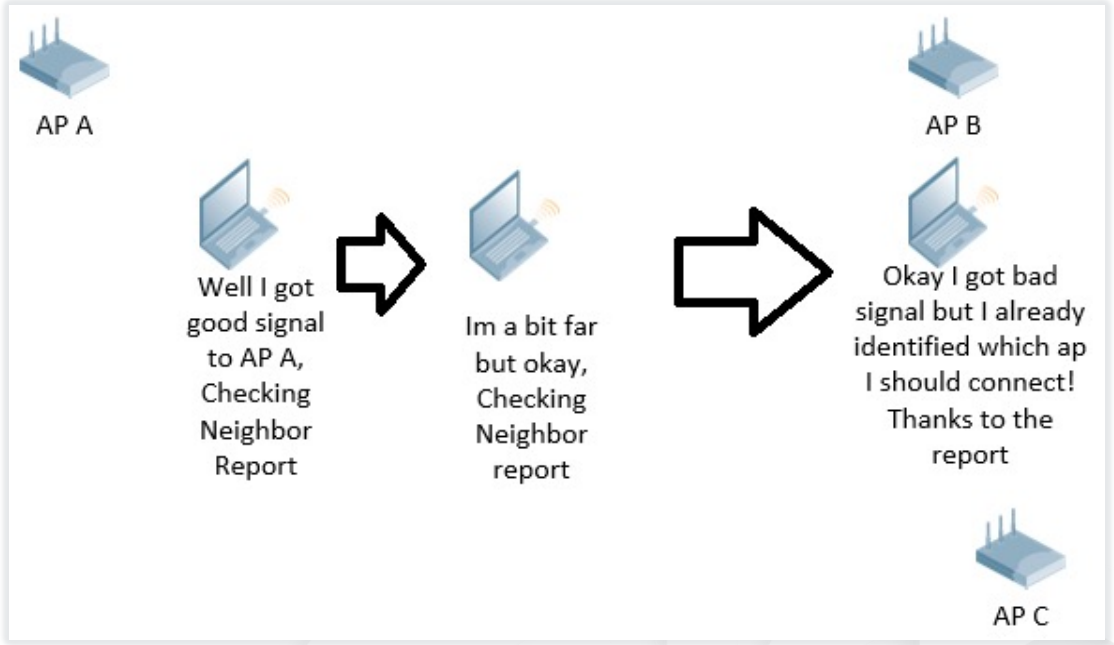


~2 Gbps throughput with sub-ms latency at 3m

Aruba Differentiators

Wireless networks have unique challenges that require intelligent solutions

- If you don't have a **reliable connection** between a device and AP, you don't have a wireless network
  - This is a very different challenge than a wired network where physical layer failures are rare
- Wireless clients are selfish
  - Connects to the **first and/or strongest signal** (usually 2.4 GHz) and like to stay put
- Wireless clients are moving
  - The 802.11 standard puts the decision to roam **in the hands of the client device**, not the network which has a better view
- There is **no dedicated cable/port** per client
- The air is **constantly changing**
- To appreciate the full capabilities of the 802.11ax standard, **802.11ax devices must be the only clients on a radio**

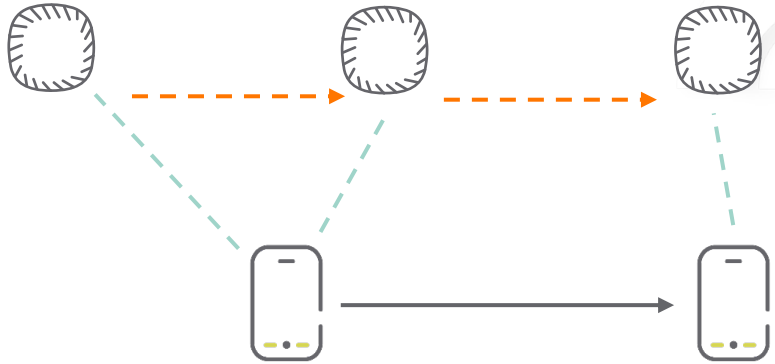


Roaming with 802.11k

ClientMatch: Aruba's first AI/ML offering launched in 2013

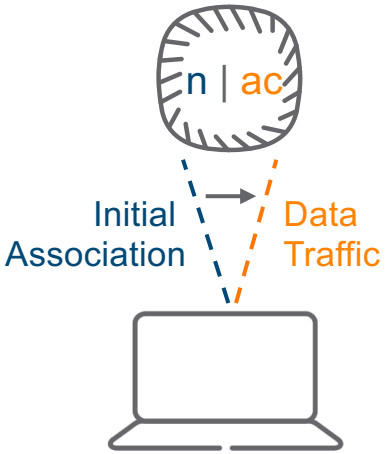
Aruba infrastructure proactively moves devices from one radio to another to improve client experience.

Load balance stationary clients



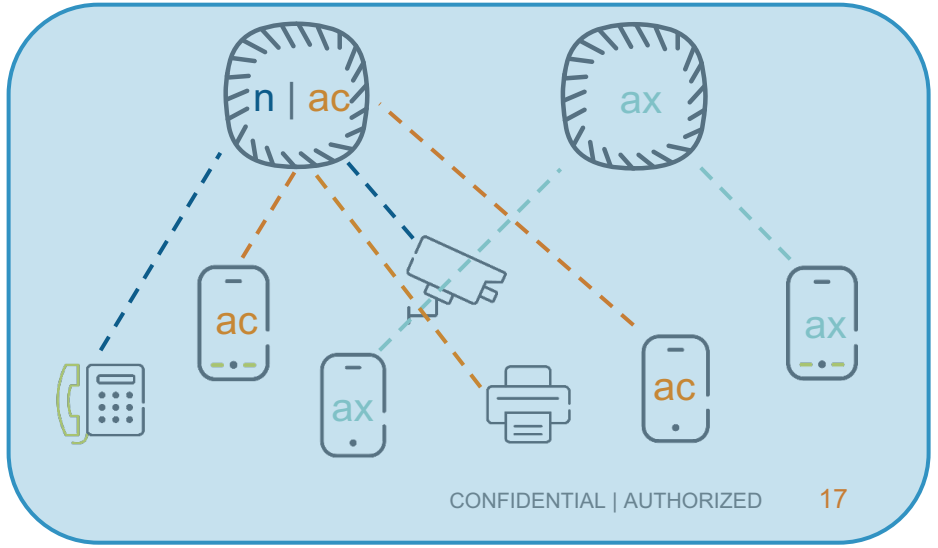
Proactively roaming clients

Band steering



Grouping similar generation clients

Aruba fully supports Wi-Fi 6 / 6E and legacy clients on the same infrastructure at the same time performing to their maximum potential.



Intelligent RF radio resource management with Aruba AirMatch

Features

– Self-optimizing RF channelization and power

– Real-time reactive optimization mitigates co-channel interference, high noise events, and radar events

– Enhanced roaming for clients by providing an even distribution of EIRP across AP radios

– Enables Live Upgrade service and other services including ClientMatch

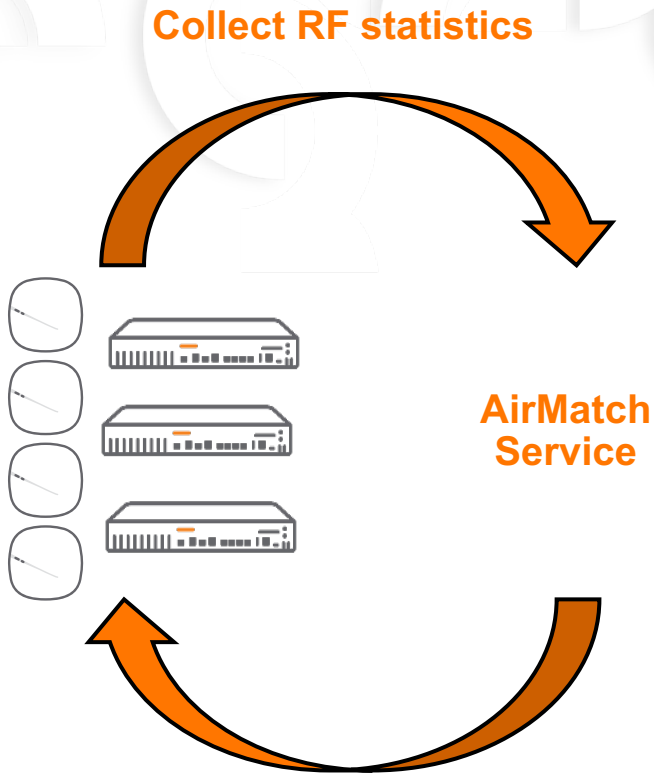
How it works

– Radio density is derived using pathloss values

  – The prior 24 hours of RF data is used for calculation

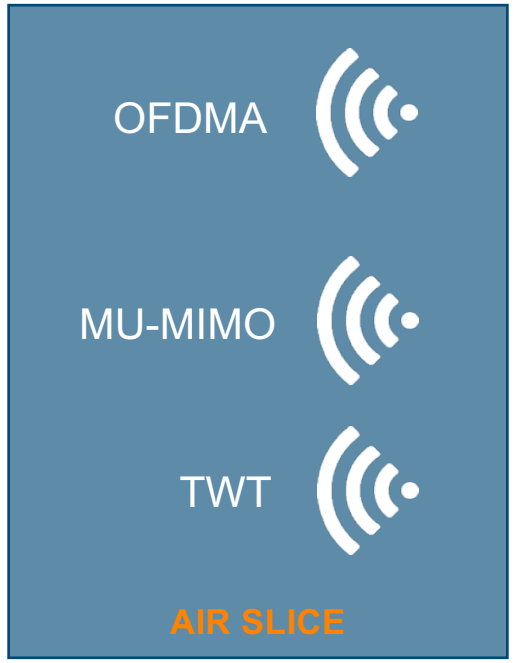
– EIRP is assigned based on the configured EIRP range, AP feasibility parameters, and radio density

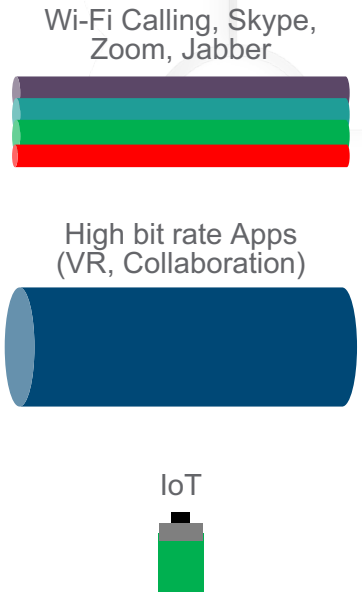
– Channels and channel bandwidth are assigned per RF partition

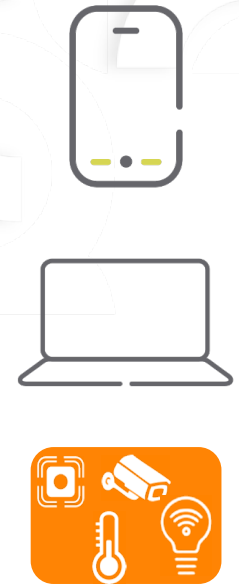


Air Slice: Application aware Quality of Service Wi-Fi 6 and 6E client devices

Usage based app prioritization







Application identification via Aruba's **Layer 7 DPI engine**

Identifies out-of-the-box and up to **5 custom applications**

Scheduling intelligence provides **fine-grained QoS assurance** for individual applications

RF SLAs: **Guaranteed bit rate, improved battery life, bounded latency/jitter/packet loss**

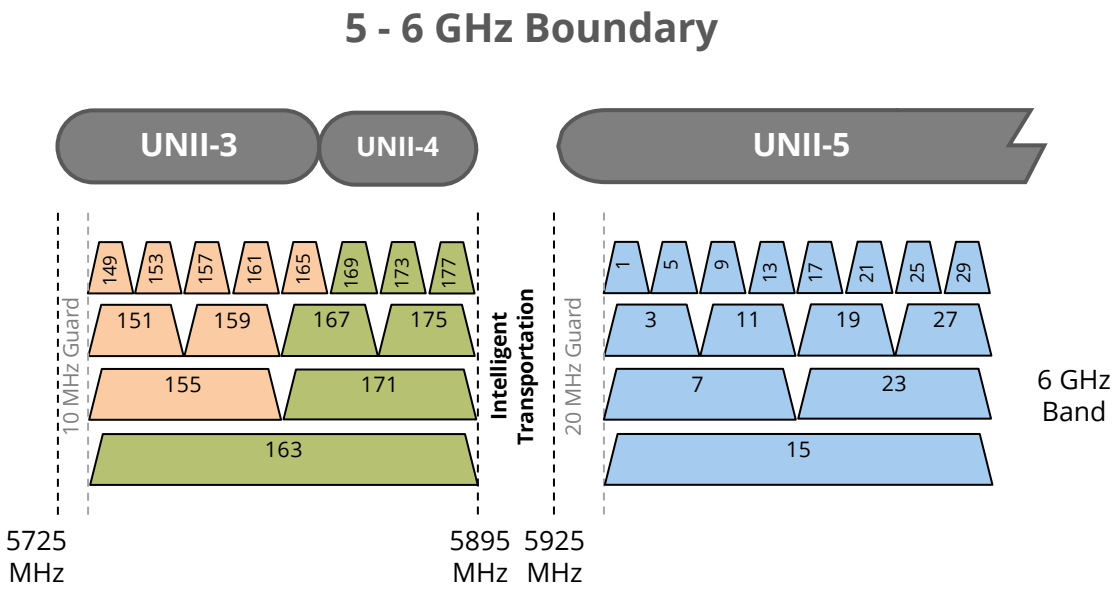
Built on top of **Wi-Fi 6 constructs**: MU-MIMO, OFDMA, TWT (Target Wake Time)

Benefits both Wi-Fi 6 and previous generations of client devices, based on use of internal queuing

Ultra-tri band filtering for maximum channel reuse in W-Fi 6E

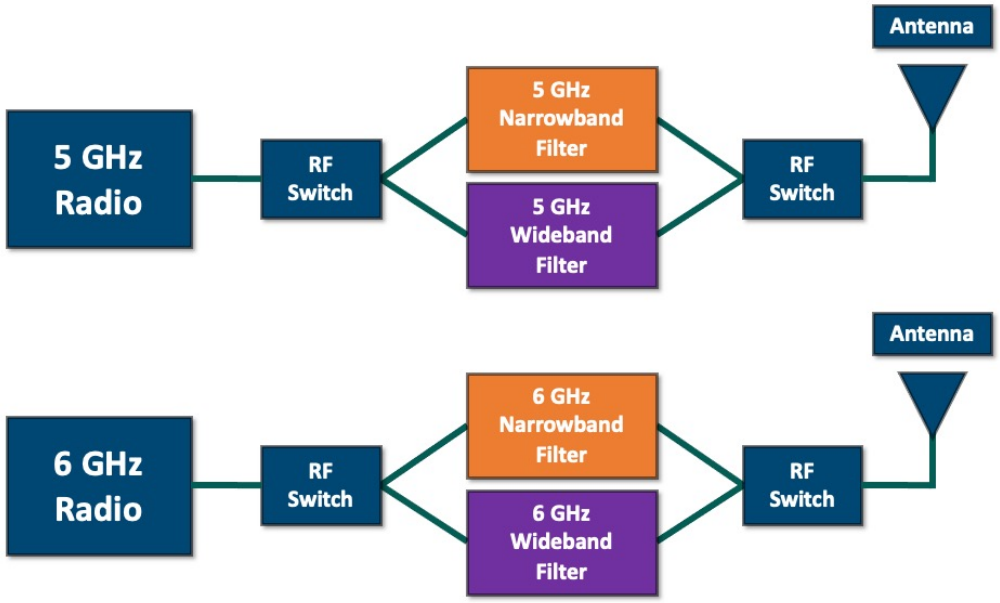
CHALLENGE:

The 5 and 6 GHz are separated by just 50 MHz, which may cause interference between radios using traditional filtering



SOLUTION:

Aruba's ultra tri-band technology delivers dynamic filtering



RESULT:

Less interference and unrestricted channel selection between radios for better spectrum utilization

Wi-Fi 6E Design

Things to think about
Where to get started

New ways to think about network design with Wi-Fi 6E

- RF Design
  - Advice on adding 6GHz APs to your current WLAN deployment
  - Present some ideas that *may* be useful for high density and shared real estate use cases, for example
  - *Resource: https://www.arubanetworks.com/assets/wp/WP_Wi-Fi-6E.pdf*
- Power
  - Power consumption varies by model and features, check your data sheet
  - Aruba Intelligent Power Management (IPM) allows customization of power usage when access switch does not provide full power to the AP
- Throughput
  - Aggregate throughput on a tri-band tri-radio AP can reach up to 2-4 Gbps depending on the configuration and model
  - Access switch port rate needs to be considered to maintain the speed through the WLAN
- Redundancy
  - Wireless as the primary connection medium is becoming the norm not the exception in the industry
  - We will present design options to improve resiliency, considering wireless layout and wired connections

5 GHz EIRP versus 6 GHz PSD

Low Power Indoor APs† in 6 GHz are limited to 5 dBm per 1 MHz Power Spectral Density (PSD). PSD compensates for noise floor rise, thus incentivizing use of wide channels.

Channel Width		20 MHz	40 MHz	80 MHz	160 MHz	320 MHz
Noise Floor Rise vs. 20MHz			+3 dB	+6 dB	+9 dB	+12 dB
5 GHz UNII-2b	**EIRP**	**30 dBm**	**30 dBm**	**30 dBm**	**30 dBm**	**30 dBm**
	PSD (dBm/MHz)	17	14	11	8	5
	EIRP - Noise	30 dBm	27 dBm	24 dBm	21 dBm	18 dBm
6 GHz LPI	**EIRP**	18 dBm	21 dBm	24 dBm	27 dBm	30 dBm
	PSD (dBm/MHz)	**5**	**5**	**5**	**5**	**5**
	EIRP - Noise	18 dBm	18 dBm	18 dBm	18 dBm	18 dBm

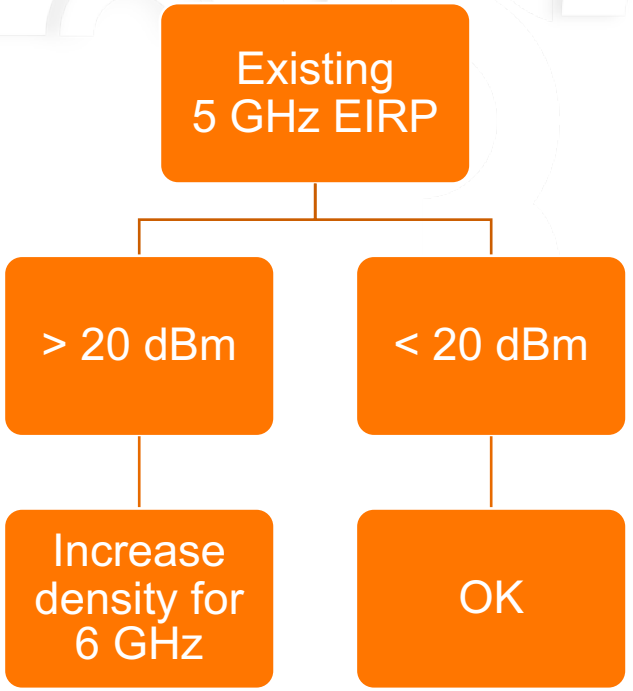
"Effective EIRP" drops in wide channels due to noise floor rise

With constant PSD, the AP increases power to compensate added noise in wider channels

† *Note: AFC APs in 6 GHz are limited by EIRP.*

6 GHz RF Design: AP Density

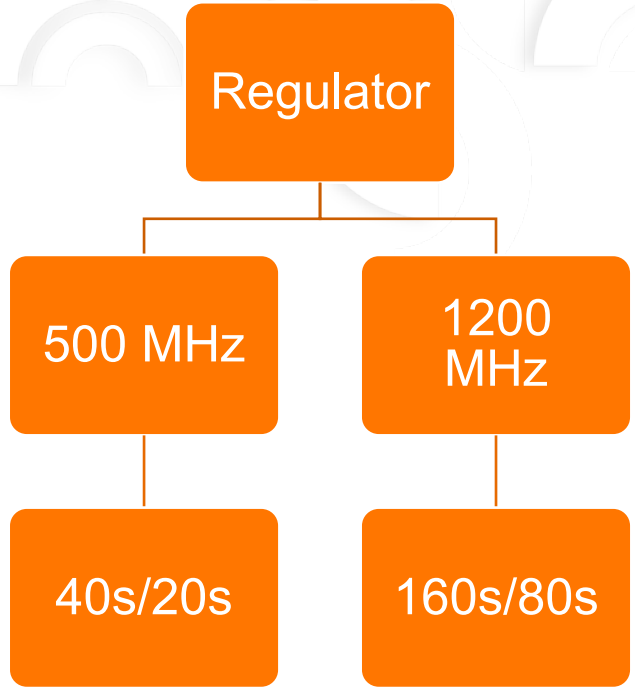
- The different EIRP and PSD power capping mechanisms found in 5 GHz and 6 GHz force evaluation of current deployments in brownfield upgrade efforts.
- When the *current* 5 GHz EIRP is **above 20 dBm**, the designer must consider increasing AP density to meet their 6 GHz capacity requirements.
- When the *current* 5 GHz EIRP is **below 20 dBm**, the nuance between bands is minimal for typical indoor enterprise deployments.
- Recommendations:
  - Deployments with EIRP > 20 dBm
    - 5 GHz coverage-based deployment
    - *Likely requires increased AP density to support 6 GHz*
  - Deployments with EIRP < 20 dBm
    - Existing 5 GHz capacity-based deployment with overlapping cells
    - OK for 6 GHz



6 GHz RF Design: Channelization

- Available spectrum varies for each country (regulator)
- Consider different channel widths based on available spectrum
- Wider channels offer many benefits
  - More RUs = Greater simultaneous clients
  - Higher aggregate throughput
  - Higher effective EIRP for 6 GHz when limited by PSD

	European Model	Americas Model
20 MHz	24	59
40 MHz	12	29
80 MHz	6	14
160 MHz	3	7



RF Design: 600 Series versus AP 555

	AP 555	AP 655	AP 635
			
Number of Wi-Fi Radios	2 or 3 (dual 5 GHz)	3	3
Supported Bandwidths	20/40 (2.4GHz) 20/40/80/(80+80) (5GHz)	20/40 (2.4GHz) 20/40/80/(80+80) (5GHz) 20/40/80/160 (6GHz)	20/40 (2.4GHz) 20/40/80 (5GHz) 20/40/80/160 (6GHz)
MIMO Type	4x4:4 (2.4GHz) 8x8:8 or dual 4x4:4 (5GHz)	4x4:4	2x2:2
Number of RUs (OFDMA)	37	37	8 (2.4GHz & 5GHz) / 37 (6GHz)

RF Design: AP Selection Advice

- 500 and 600 series AP both support the same 802.11ax IEEE standard.
- The 600 series adds support for 6 GHz.
  - Wi-Fi 6 refer to 2.4 / 5 GHz
  - Wi-Fi 6**E** refers to Wi-Fi 6 operating in 6 GHz ('**E**').
- 500 and 600 series should not be intermixed within the same contiguous RF service area.
  - Aruba always recommends to use the same AP model within a contiguous RF service area (RF block).
  - Consider a RF block as a roaming domain which could be by building or floor within a building (depending on perspective and user requirements).
- AP-635 (2x2 tri-band tri-radio):
  - Augment current mid-range 500 series deployments
  - Be deployed for new 6 GHz applications
  - OFDMA: 8 RUs in 2.4/5 and 37 RUs in 6 GHz
- AP-655 (4x4 tri-band tri-radio):
  - Augment current flagship and high-end 500 series deployments
  - Be deployed for new 6 GHz applications
  - Benefits over 635
    - More robust links due to better RvR and higher MCS at distance
    - Higher max aggregate throughput
    - OFDMA: 37 RUs in all bands
    - DL/UL MU-MIMO support
    - PoE: Smart PoE for power combining versus failover only
    - Ethernet ports: 2x 5 Gbps versus 2x 2.5 Gbps.

Wi-Fi 6E Security Requirements

New security requirements

- WPA3-Personal or WPA3-Enterprise
  - WPA3-Enterprise with 192-bit cryptographic strength is optional
- Protected Management Frames (PMF)
- Enhanced Open (OWE)

Not allowed and not supported in 6 GHz

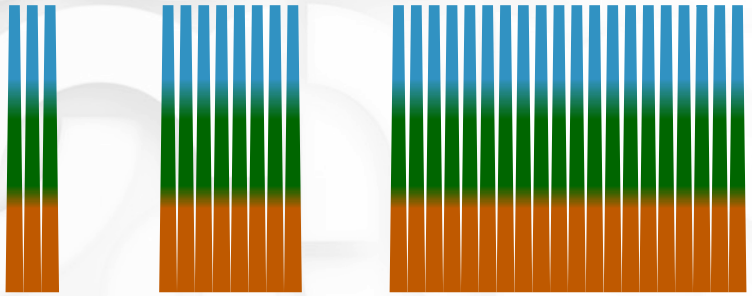
- WEP, TKIP, or WPA
- Open Authentication
- WPA2-Personal or WPA2-Enterprise
- Transition Mode for WPA3-Personal or WPA3-Enterprise
- Transition Mode for Enhanced Open

6 GHz Offers Wireless Architects Unprecedented Options

– Example – Redeployment of SSIDs between bands to optimize experience

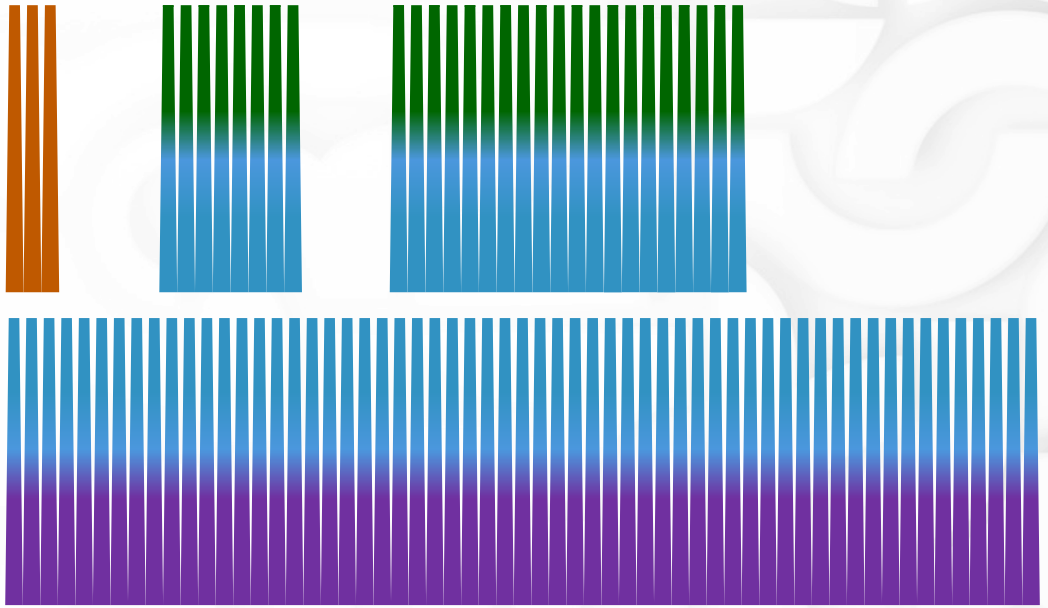
Conventional Dual-band SSID

2.4 GHz Radio	5 GHz Radio
Corp_SSID (802.1X)	Corp_SSID (802.1X)
Guest_SSID (Open)	Guest_SSID (Open)
IOT_SSID (PSK)	IOT_SSID (PSK)



Tri-Band 6E SSID Strategy

2.4 GHz Radio	5 GHz Radio	6 GHz Radio
	Corp_SSID (802.1X)	Corp_SSID (802.1X)
IOT_SSID (PSK)	Guest_SSID (OWE)	Corp_SSID_6E (802.1X)



– Dual-Band ends up with 2-3 SSIDs across all bands

– ***Tri-Radio allows the network to design for 6 GHz as the next high-performance zone, with 5 GHz as the general access, and leverage 2.4 GHz for IoT/IIoT***

New WLAN Design Possibility
Dual Layer, Dual Band Partitioned

AP LAYER 1

SSID 1, SSID 2, … SSID x

AP LAYER 2

SSID 3, SSID 4, … SSID x

6 GHz Radio

BAND 6A – 13 x 40 MHz CHANNELS (573 MBPS)

BAND 6B – 8 x 80 MHz CHANNELS (1.2 GBPS)

5 GHz Radio

BAND 5A – 12 x 20 MHz CHANNELS (287 MBPS)
NO DFS RESTRICTIONS

BAND 5B – 8 x 40 MHz CHANNELS (573 MBPS)
DFS ONLY

2.4 GHz Radio

What do my APs Need?

Power over Ethernet Options

Wi-Fi Standard	AP Series	Power Options	Notes
Wi Fi 6 CERTIFIED	500 Series	DC · 802.3af · 802.3at · 802.3bt	
	510 Series	DC · 802.3af · 802.3at · 802.3bt	▪ PoE is available via Eth0 Only
	530 Series	DC · 802.3af · 802.3at · 802.3bt	▪ PoE is available via Eth0 and/or Eth1 (Sharing)
	550 Series	DC · 802.3af · 802.3at · 802.3bt	▪ PoE is available via Eth0 and/or Eth1 (Sharing)
Wi Fi 6E CERTIFIED	630 Series	DC · 802.3af · 802.3at · 802.3bt	▪ PoE is available via Eth0 or Eth1 (Failover)
	650 Series	DC · 802.3af · 802.3at · 802.3bt	▪ PoE is available via Eth0 and/or Eth1

Take Away ***The datasheets provide the minimum PoE standard and class that is required for each model and the features that are disabled for low power modes with and without IPM enabled.***

What do my APs Need?
Intelligent Power Monitoring (IPM)

- By default, we disable specific features on APs operating in power constrained environments
  - Disabled features vary by AP series and the supplied power (see datasheets)
- IPM allows you to control which features your APs disable
  - Implemented using profiles
  - You configure the features can be disabled and their priorities
- Also useful for measuring and reporting the APs actual power consumption

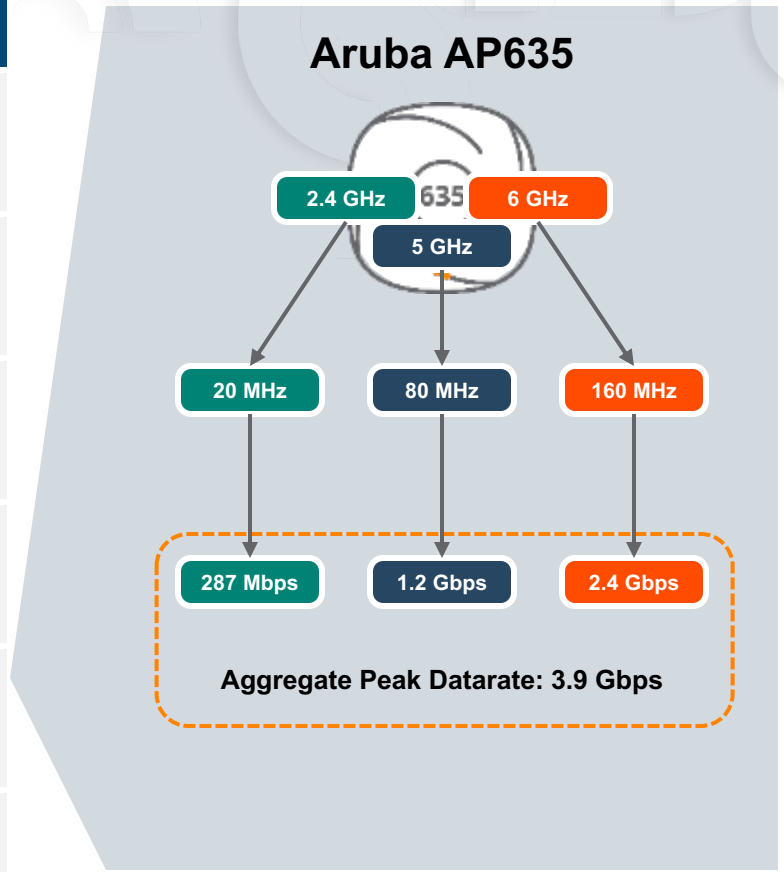
Parameter	Description
cpu_throttle_25	Reduces CPU frequency to 25% of normal.
cpu_throttle_50	Reduces CPU frequency to 50% of normal.
cpu_throttle_75	Reduces CPU frequency to 75% of normal.
disable_alt_eth	Disables 2nd Ethernet port.
disable_pse	Disables Power Sourcing Equipment (PSE)
disable_usb	Disables the USB port.
radio_2ghz_chain_1x1	Reduces 2.4 GHz chains to 1x1.
radio_2ghz_chain_2x2	Reduces 2.4 GHz chains to 2x2.
radio_2ghz_chain_3x3	Reduces 2.4 GHz chains to 3x3.
radio_2ghz_disable	Disables 2.4 GHz radio
radio_2ghz_power_3dB	Reduces 2.4 GHz radio power by 3 dB from the maximum value.
radio_2ghz_power_6dB	Reduces 2.4 GHz radio power by 6 dB from the maximum value.
radio_5ghz_chain_1x1	Reduces 5 GHz chains to 1x1.
radio_5ghz_chain_2x2	Reduces 5 GHz chains to 2x2.
radio_5ghz_chain_3x3	Reduces 5 GHz chains to 3x3.
radio_5ghz_disable	Disables 5 GHz radio
radio_5ghz_power_3dB	Reduces 5 GHz radio power by 3 dB from the maximum value.
radio_5ghz_power_6dB	Reduces 5 GHz radio power by 6 dB from the maximum value.
radio_6ghz_chain_1x1	Reduces 6 GHz chains to 1x1
radio_6ghz_chain_2x2	Reduces 6 GHz chains to 2x2
radio_6ghz_chain_3x3	Reduces 6 GHz chains to 3x3
radio_6ghz_power_3dB	Reduces 6 GHz radio power by 3 dB from the maximum value.
radio_6ghz_power_6dB	Reduces 6 GHz radio power by 6 dB from the maximum value.
radio_6ghz_disable	Disables 6 GHz radio

Take Away

IPM is a valuable tool for environments that requires the latest APs but are not yet ready or able to refresh their access layer switches!

What do my APs Need?
Ethernet PHY Options

Wi-Fi Standard	AP Series	Eth0	Eth1
Wi Fi 6 CERTIFIED	500 Series	1 GbE, 5 GbE	1 GbE, 5 GbE
	510 Series	1 GbE, 2.5 GbE, 5 GbE	1 GbE, 5 GbE
	530 Series	1 GbE, 2.5 GbE, 5 GbE	1 GbE, 2.5 GbE, 5 GbE
	550 Series	1 GbE, 2.5 GbE, 5 GbE	1 GbE, 2.5 GbE, 5 GbE
Wi Fi 6E CERTIFIED	630 Series	1 GbE, 2.5 GbE, 5 GbE	1 GbE, 2.5 GbE, 5 GbE
	650 Series	1 GbE, 2.5 GbE	1 GbE, 2.5 GbE



Take Away

While you will never be able to achieve the maximum aggregate PHY rates of the radios in terms of throughput, modern APs do have the potential to exceed the capacity of single Gigabit Ethernet port…

What do my APs Need?
End-to-End Cabling

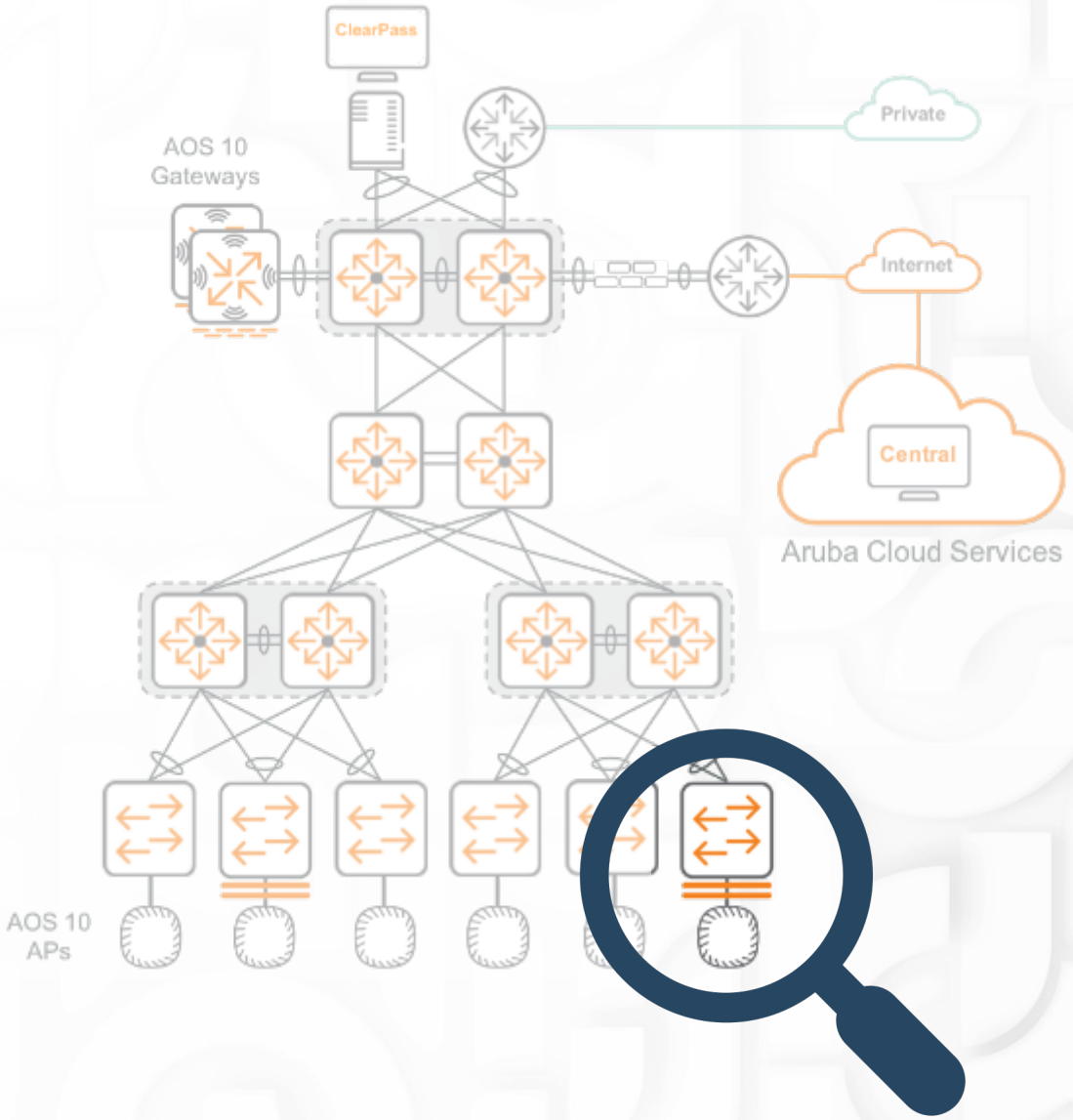
Ethernet PHY Rate	Cable Type	Cable Length
1 Gbps	CAT5e / Class D (or better)	100 m (328 ft.)
2.5 Gbps	CAT5e / Class D (or better)	100 m (328 ft.)
5 Gbps	CAT5e / Class D (or better)	55 m (180 ft.) High Alien Noise Environment
		100 m (328 ft.) Low Alien Noise Environment
	Shielded CAT5e / Class D (or better)	100 m (328 ft.)
	CAT6 Class E (or better)	100 m (328 ft.)
10 Gbps	CAT6 Class E (or better)	55 m (180 ft.)
	CAT6A Class E (or better)	100 m (328 ft.)

Take Away

CAT6 cabling uses bigger connectors and requires larger bend radiuses! Aruba sells a handy dandy accessory (AP-CBL-EXT10) to hide CAT6 path cables on APs if needed!

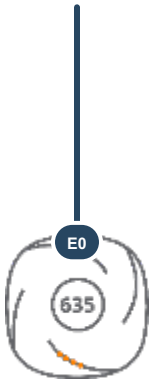
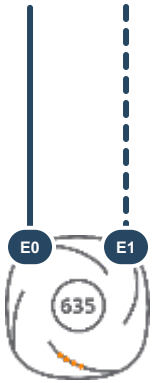
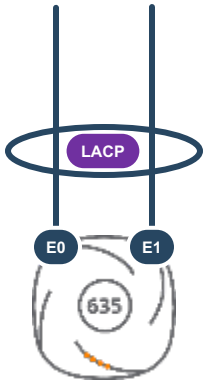
High Availability
Access Layer Switching

- There are various high-availability options and considerations for the access layer
- You need to balance the cost with the availability options that meet your business needs
- Redundancy considerations include:
  - AC Circuits and UPS
  - Number of Power Supplies
  - Stack Members and I/O Modules
  - Diverse Fiber Paths
  - Diverse Ethernet Drops
  - Datalink / Network Layer



High Availability

AP > Switch Redundancy Options

Single Uplink	Active / Standby	Active / Active
		
✗ PoE Redundancy	✓ PoE Redundancy	✓ PoE Redundancy
✗ Path Redundancy	✓ Path Redundancy	✓ Path Redundancy
✗ Aggregated Goodput	✗ Aggregated Goodput	✓ Aggregated Goodput

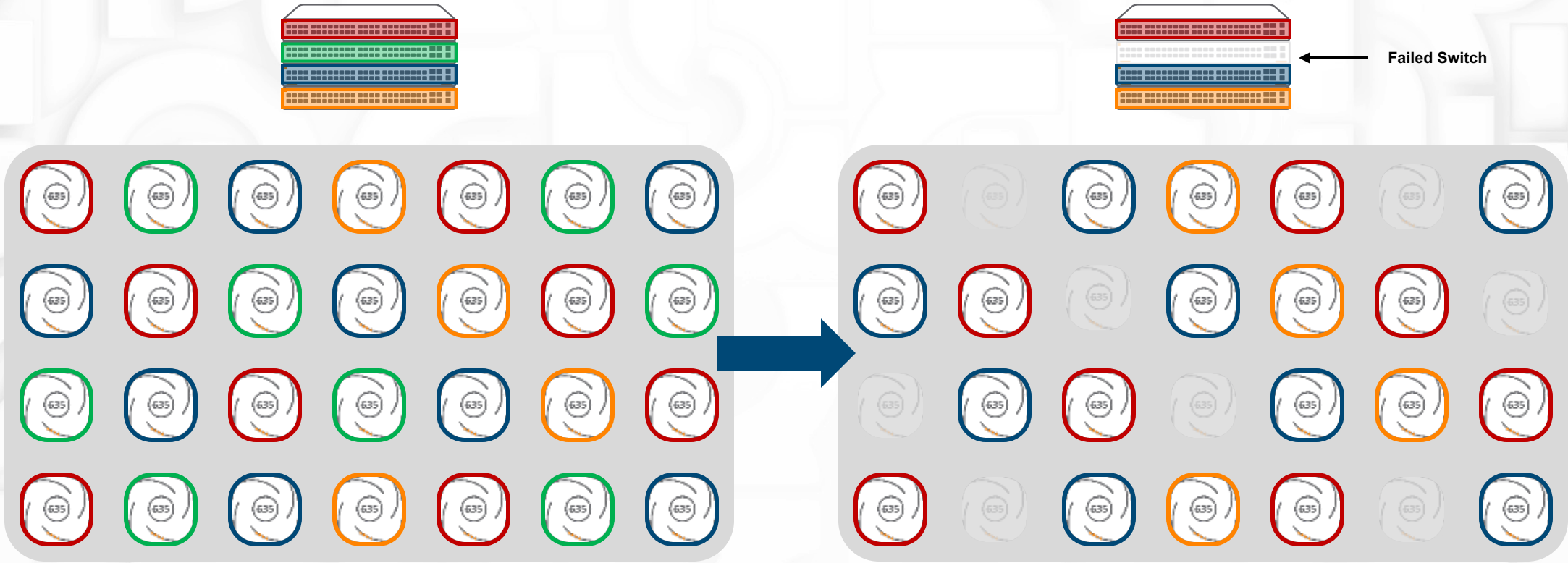
High Availability

Not all APs are created equally!

	AP 535	AP 635	AP 655
			
PoE Redundancy	**PoE Sharing**	**PoE Failover**	**PoE Sharing**
Max Aggregate Data Rates (All Radios)	3 Gbps (20 MHz + 80 MHz)	3.9Gbps (20MHz + 80MHz + 160MHz)	7.8 Gbps (20MHz + 80MHz + 160MHz)
Max Aggregated Uplink Throughput (LACP)	10 Gbps (2 x 5 Gbps)	5Gbps (2 x 2.5Gbps)	10 Gbps (2 x 5 Gbps)
Max PoE Consumption (Worst Case without USB)	26.4W	23.8W	40.3W
Max PoE Consumption (Worst Case with USB)	32.1W	29.4W	46.5W

High Availability

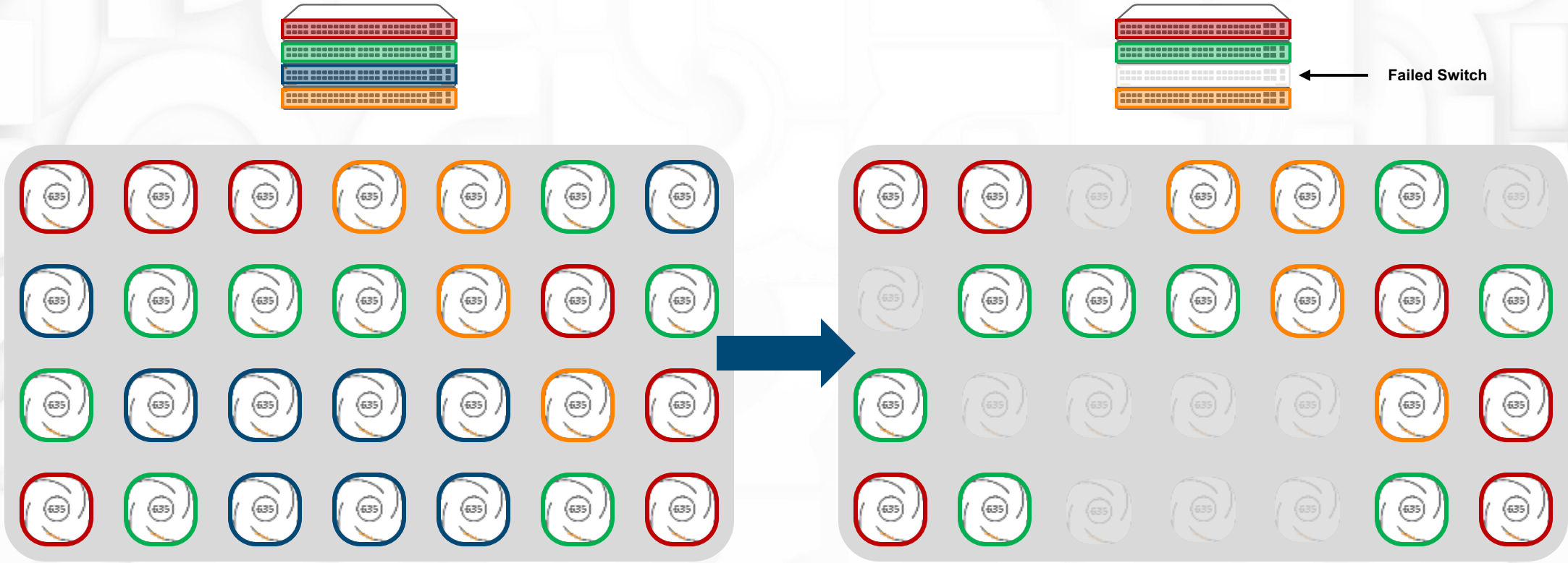
AP > Switchport Distribution



Take Away

Distribute neighboring APs between stack members or I/O modules to minimize the impact of an individual switch or I/O module failure

High Availability
AP > Switchport Distribution

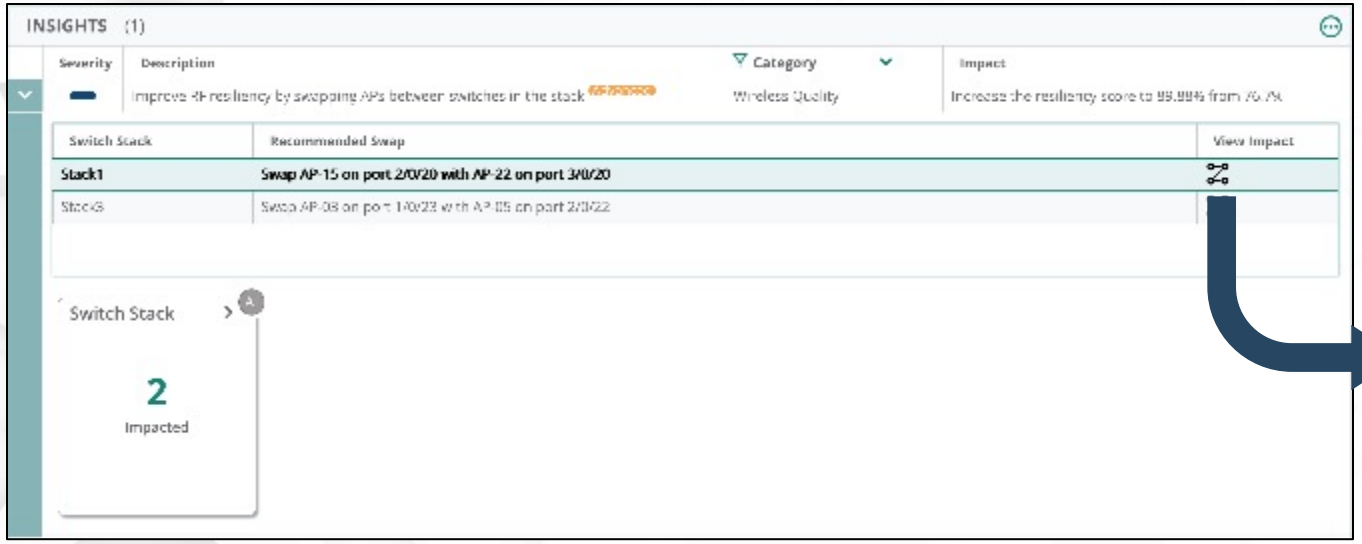


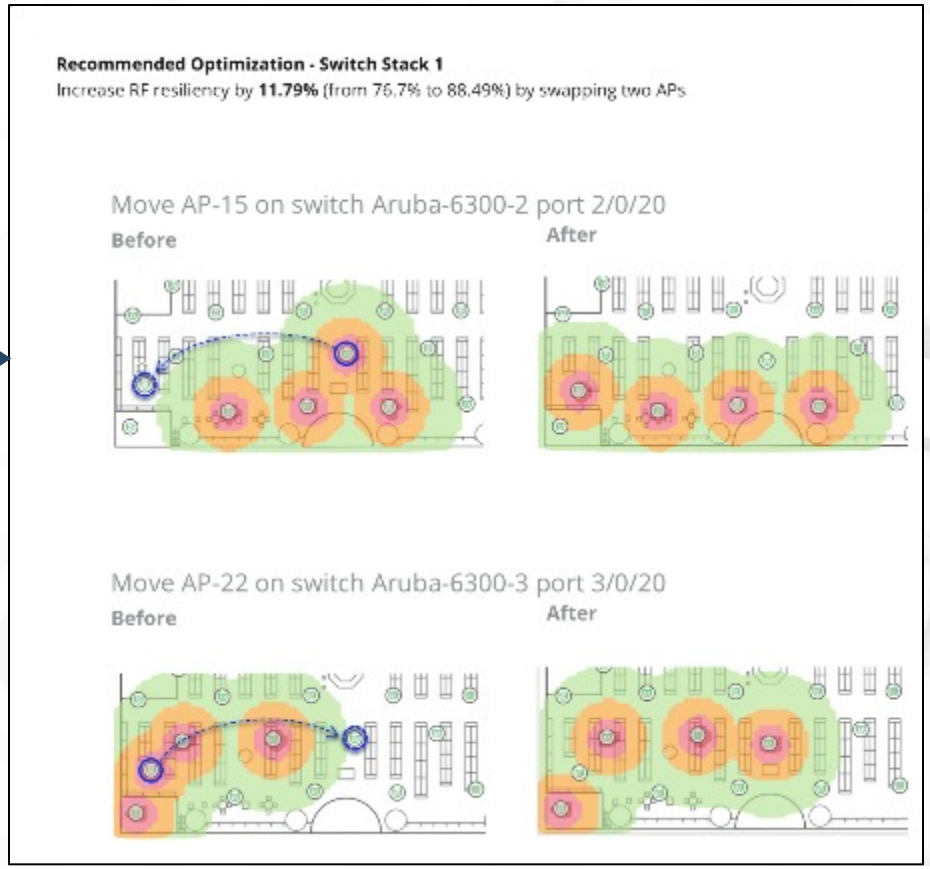
Take Away

Review AP > Switchport distribution determine your RF coverage fault domains and move if needed. Central also provides useful tools and Insights to help you!

High Availability

RF Resilience AI Insight Example





Take Away

The RF Resiliency Insight provides clear concise recommendations as to which APs to move to improve your RF coverage resiliency!

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Thank You

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a Hewlett Packard Enterprise company