

The Cisco Live! logo, featuring the word "CISCO" in a dark blue, sans-serif font, followed by "Live!" in a dark blue, cursive script font.

CISCO *Live!*

The text "Let's go" in a large, dark blue, sans-serif font, positioned to the left of a bright white sunburst graphic that radiates across the right side of the image.

Let's go

#CiscoLiveAPJC



The bridge to possible

Architecting Next Generation Wireless Network with Catalyst Wi-Fi 6E Access Points

Anand Gurumurthy
Senior Technical Leader, Technical Marketing

BRKEWN-2024

CISCO *Live!*

#CiscoLiveAPJC

Cisco Webex App

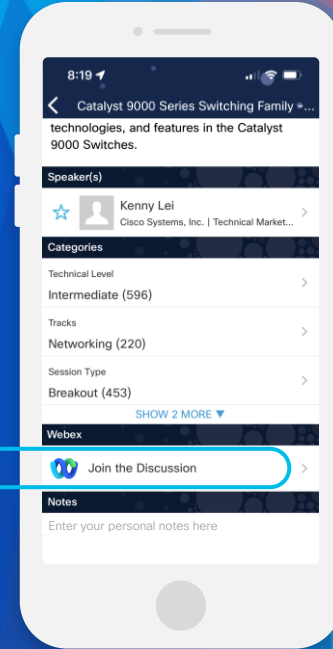
Questions?

Use Cisco Webex App to chat with the speaker after the session

How

- 1 Find this session in the Cisco Live Mobile App
- 2 Click “Join the Discussion”
- 3 Install the Webex App or go directly to the Webex space
- 4 Enter messages/questions in the Webex space

Webex spaces will be moderated by the speaker until December 22, 2023.



<https://ciscolive.ciscoevents.com/ciscolivebot/#BRKEWN-2024>

Agenda

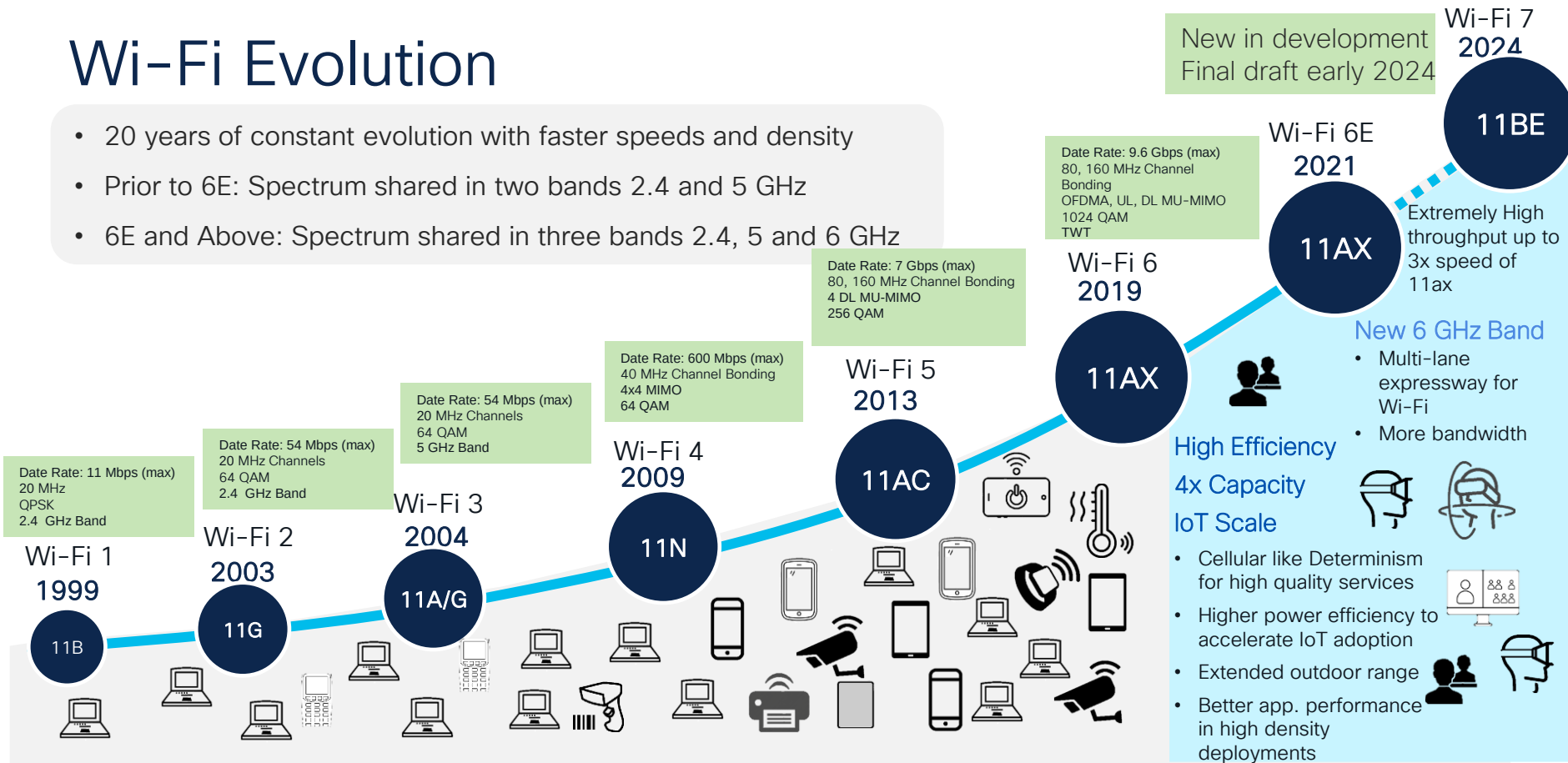




Why Wi-Fi 6E ?

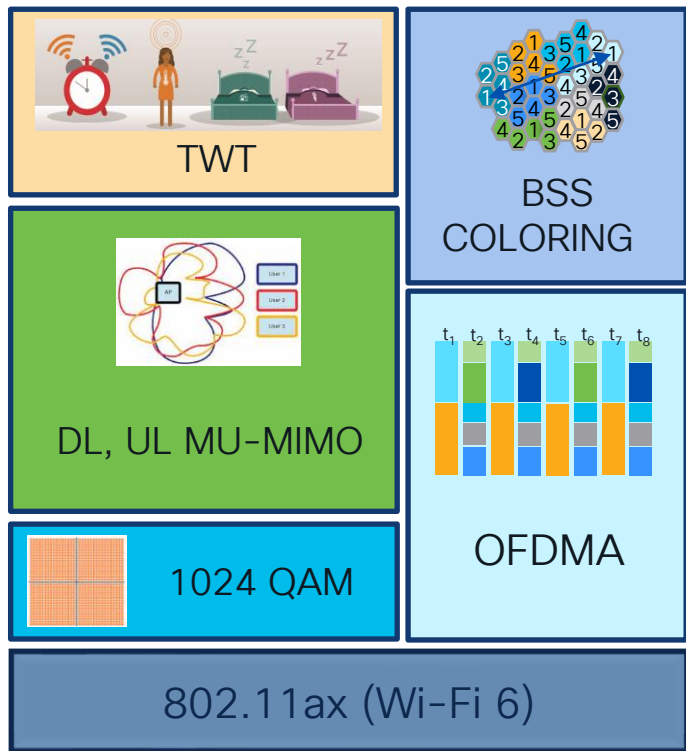
Wi-Fi Evolution

- 20 years of constant evolution with faster speeds and density
- Prior to 6E: Spectrum shared in two bands 2.4 and 5 GHz
- 6E and Above: Spectrum shared in three bands 2.4, 5 and 6 GHz



Wi-Fi 6E

Wi-Fi 6 and 6GHz are friends!



- 1 Additional Spectrum**
1200 MHz (5.925 to 7.125 MHz) – US
500 MHz (5.925 to 6.425) – EU
- 2 Security Upgrade**
WPA3 Mandatory
Improves Security
- 3 Clean RF**
(Fixed Mobile Service Operators in
UNI-5 and UNI-7)
- 4 No Legacy (Slow) Devices**
Improves performance
- 5 Protocol Enhancements**
Airtime Efficiency
- 6 Wider RF Channels**
80 MHz channels – 1200 MHz
40 MHz channels – 500 MHz

With Wi-Fi – 6E



Setting the stage

Setting the stage

- New 6 GHz Band
- Regulatory Considerations
- Protocol enhancements



Wi-Fi 6E – 6GHz Around the World

Global availability of 6 GHz band for Wi-Fi

- Adopted 5925-7125 MHz
- Adopted 5925/45-6425 MHz, and evaluating 6425-7125 MHz
- Adopted 5925-6425 MHz
- Recommended 5925-6425 MHz
- Under consultation

Region 2
1200 MHz

- Canada
- USA
- Honduras
- Costa Rica
- Brazil
- Peru
- Dominican Republic
- Colombia
- Argentina
- El Salvador
- 500 MHz (& evaluating 1200 MHz)
- Chile
- Mexico

Region 1
1200 MHz

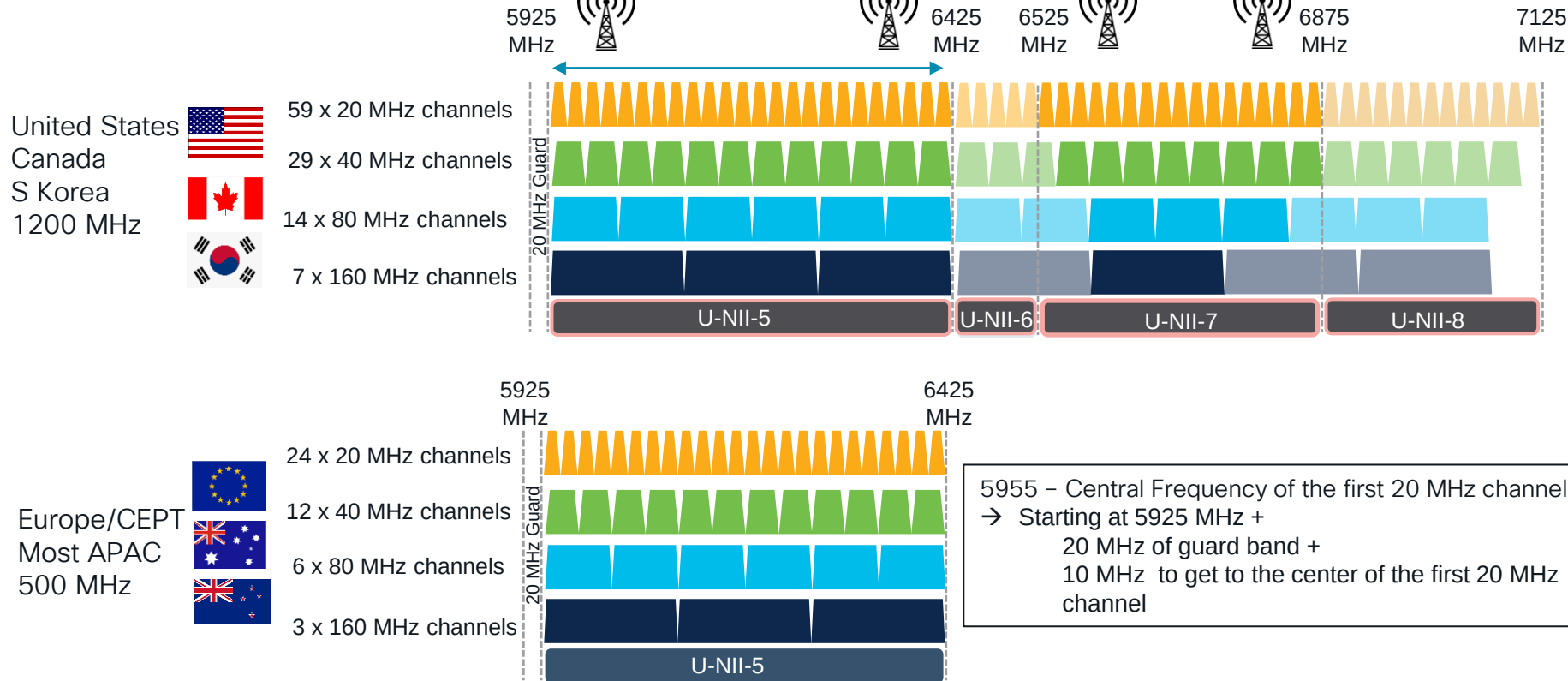
- Saudi Arabia
- 500 MHz (& evaluating 1200 MHz)
- CEPT Area
- European Union (480 MHz)
- Qatar
- United Kingdom
- 500 MHz
- Morocco
- UAE
- Jordan
- Kuwait
- Kenya
- Israel
- Mauritius (480 MHz)
- Bahrain
- Togo
- Russia
- South Africa
- Namibia
- Africa / ATU

Region 3
1200 MHz

- South Korea
- 500 MHz (& evaluating 1200 MHz)
- Australia
- Japan
- Taiwan
- Thailand
- 500 MHz
- Hong Kong
- Malaysia
- New Zealand
- Singapore

Source: <https://6ghz.info>

The new 6 GHz band :



6 GHz – New Device Classes

Wi-Fi 6E introduces new device classes for optimized capability



Low Power Indoor AP

- Indoor Only
- Integrated Antenna Required
- Can use the full 1200 MHz
- Wired Power



Standard Power AP

- Indoor or Outdoor
- Integrated or External Antenna
- UNII-5 and UNII-7 Only (US)
- Requires AFC



Very Lower Power AP

- Mobile Indoor or Outdoor
- Limited Range
- Can use the full 1200 MHz
- Does not require AFC

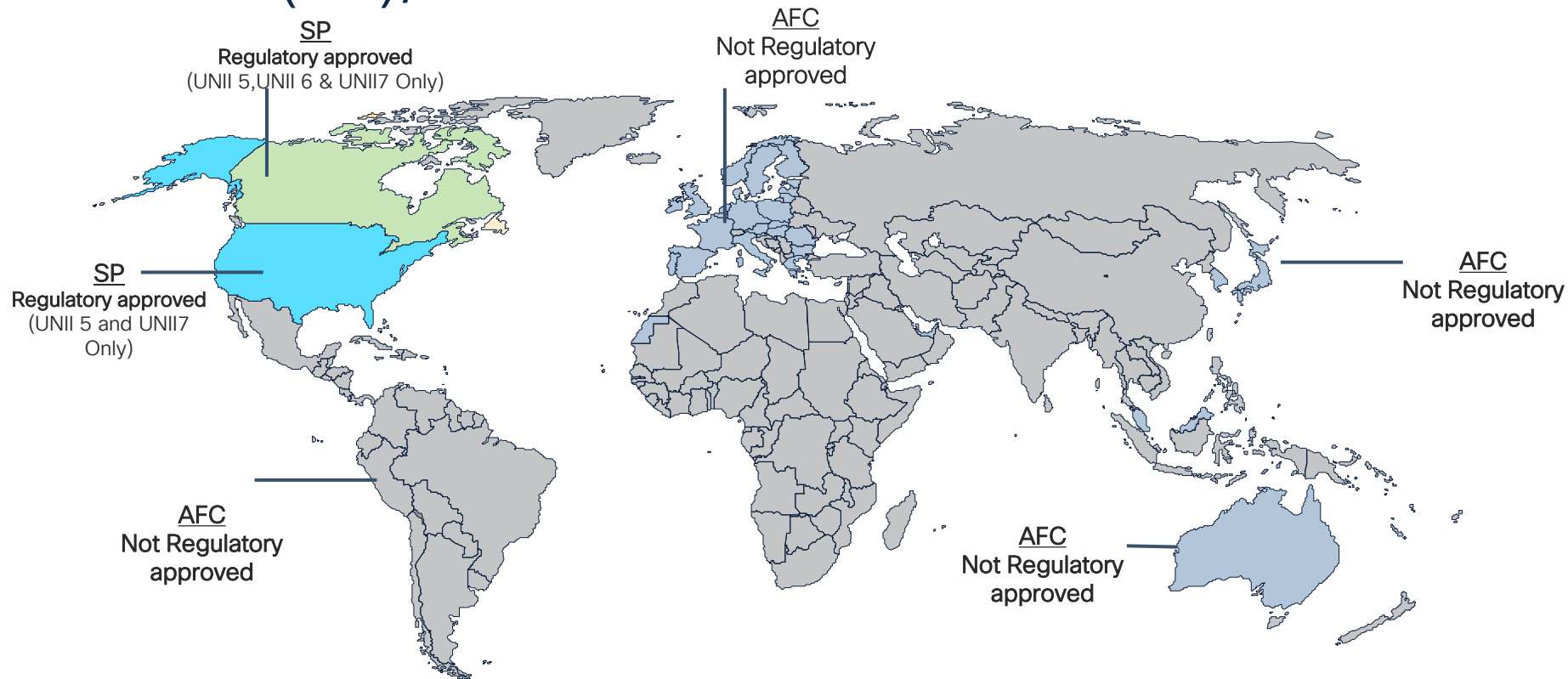


Client Devices

- Indoor or Outdoor
- Only Indoor under control of LPI AP
- 6 dBm lower power than AP

Regulations vary by country

External(SP)/Outdoor Antenna Wi-Fi 6E Status



AFC approved in USA & Canada



Reference

Summary 6GHz Tx Requirements*

Mode	Country	Max Tx Power EIRP		Max PSD EIRP		Max Ch BW
	(Frequency Range MHz)	AP (dBm)	Client (dBm)	AP (dBm)	Client (dBm)	(MHz)
LPI	FCC (5925-7125)	30	24	5	-1	320
	ETSI (5945-6425)	23	23	10	10	
	UK (5925-6425)	24	24	11	11	No Max
	Australia (5925-6425)	24	24	11	11	
	New Zealand (5925-6425)	24	24	11	11	
	S Korea (5925-7125)	24	24	2	2	160
	HongKong (5925-6425)	24	24			
	Malaysia (5925-6425)	23	23	10	10	
	Brazil (5925-7125)	30	24	5	-1	
	ISED (5925-7125)	30	24	5	-1	
	Chile (5925-7125)	30	24	5	-1	
	Peru (5925-7125)	30	24	5	-1	
	UAE (5925-6425)	24	24			
	Saudi Arabia (5925-7125)	30	24	10	10	
	ATU (5945-6425) (Kenya/Uganda/Congo/Niger/Ghana)	23	23	10	10	
	Morocco (5945-6425)	23	23			
SP	FCC (U-NII-5/7)	36 (21<30°)	30	23	17	320

Summary 6GHz Tx Requirements*



Reference

Mode	Country	Max Tx Power EIRP		Max PSD EIRP		Max Ch BW
	(Frequency Range MHz)	AP (dBm)	Client (dBm)	AP (dBm)	Client (dBm)	(MHz)
LPI	FCC (5925-7125)	30	24	5	-1	
	ETSI (5945-6425)					
	Country	Max Tx Power EIRP		Max PSD EIRP		Max Ch BW
	(Frequency Range MHz)	AP (dBm)	Client (dBm)	AP (dBm)	Client (dBm)	(MHz)
	Australia (5925-6425)	24	24	11	11	
	New Zealand (5925-6425)	24	24	11	11	
	S Korea (5925-7125)	24	24	2	2	160
	HongKong (5925-6425)	24	24			
	Malaysia (5925-6425)	23	23	10	10	
	UAE (5925-6425)	30	24	5	-1	
SP	Saudi Arabia (5925-7125)	24	24	10	10	
	ATU (5945-6425) (Kenya/Uganda/Congo/Niger/Ghana)	23	23	10	10	
	Morocco (5945-6425)	23	23			
	FCC (U-NII-5/7)	36 (21<30°)	30	23	17	320

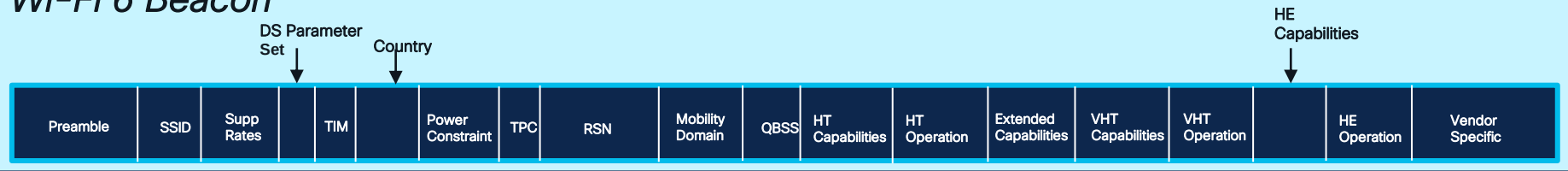


Wi-Fi 6E – Protocol Optimizations

Wi-Fi 6E Beacon Changes

Legacy HT/VHT Information Element Removed

Wi-Fi 6 Beacon



Comparison of Wi-Fi 6 and Wi-Fi 6E Beacon Frame

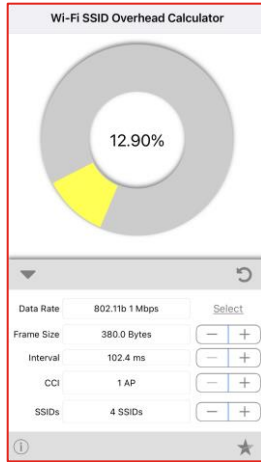
Wi-Fi 6E Beacon



Reduced Beacon Size helps conserve airtime

Multiple BSSID

- Capability originally specified in 802.11v
- Combines multiple SSID information in a single beacon frame



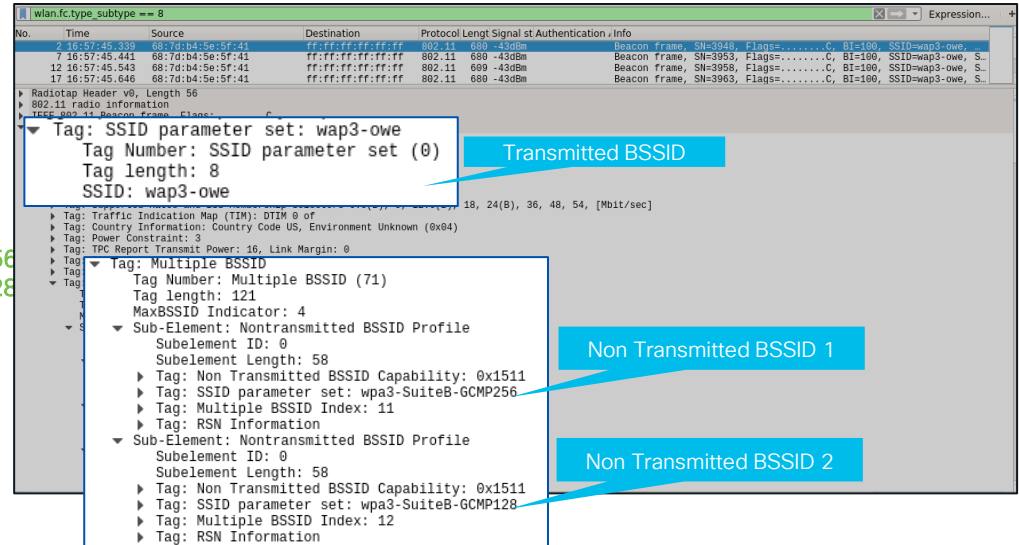
13% Overhead for 4 SSIDs with 1 AP



SSID: wpa3-owe
SSID: wpa3-SuiteB-GCMP256
SSID: wpa3-SuiteB-GCMP128



- Conserves Airtime
- Mandated in Wi-Fi 6E

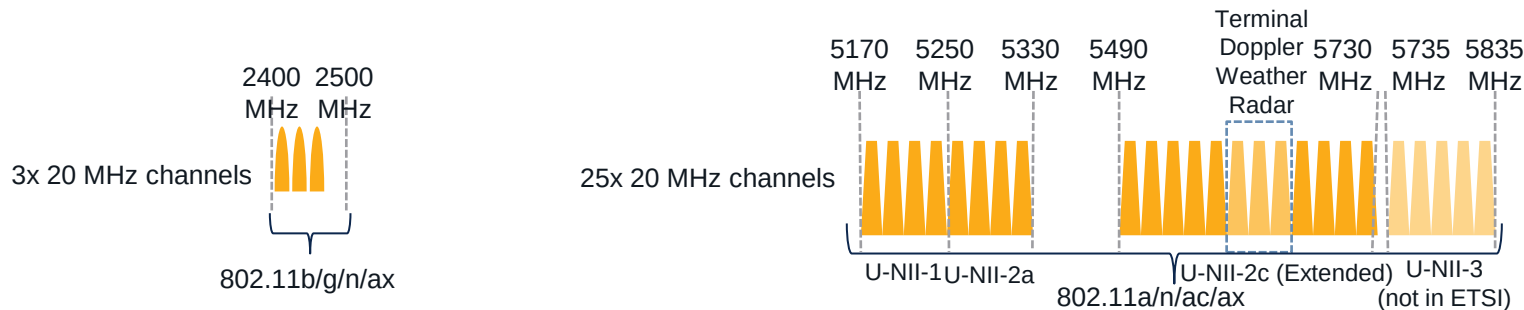
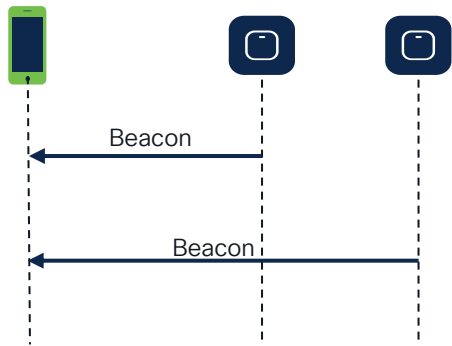




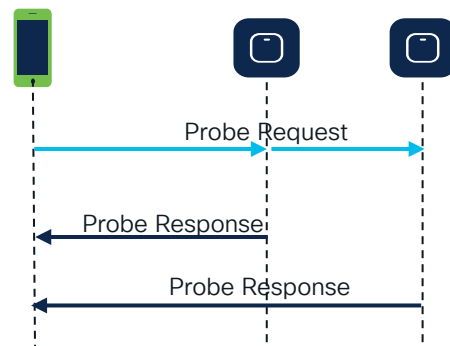
Wi-Fi 6E 6GHz SSID Discovery

AP Discovery by Wireless Clients – Legacy Methods

- Hunt and seek method to scan Basic Service Sets or for APs

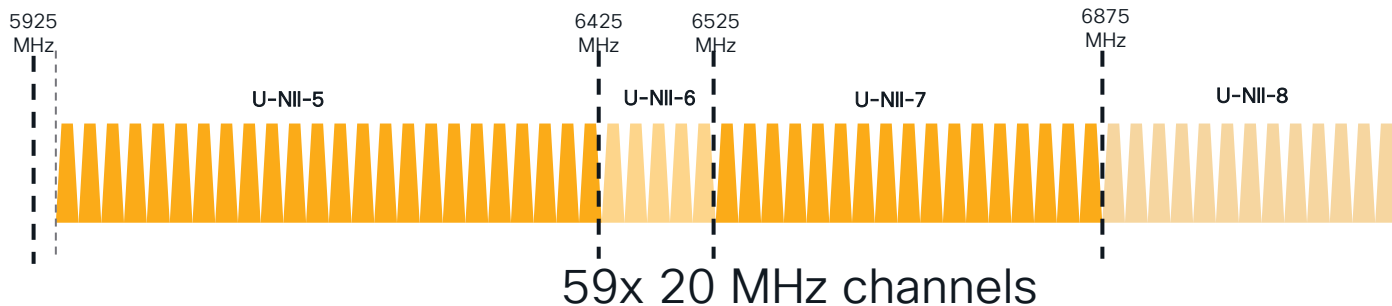


Passive Scanning



Active Scanning

Why won't Legacy Scanning Methods scale in 6 GHz ?



- A Whopping 59 x 20 MHz Channels!
- Wi-Fi Clients can send only Probe Requests on 20 MHz Channels
- 6 seconds to passive scan all 59 channels.

Wi-Fi 6E – New AP Discovery Mechanisms

Out of Band

Reduced Neighbor Report
Co-located Discovery



In Band

Passive Scan:

Fast Link Setup (FILS) Discovery Frames
Unsolicited Broadcast Probe Response Frames

Active Scan:

Preferred Scanning Channels (PSC)





Wi-Fi 6E Out of Band AP Discovery

Reduced Neighbor Report

Co-located “Neighbor” 6 GHz radio information in Beacon and Probe Response of 2.4 and 5 GHz radios.

Wi-Fi 6E AP

SSID: **employee**
5GHz Channel: **36**
2.4GHz Channel: **1**



Probe Request

Probe Response:
blizzard
RNR :
employee6
channel 69 (6 GHz)

SSID: **employee6**
6GHz Channel: **69**



No.	Time	Source	Destination	Protocol	Length	Signal	Authentication	Info
5	14:31:03.851	68:7d:b4:5e:5f:4f	68:2c:7b:cb:42:d6	802.11	525	-35dBm		Probe Response, SN=9, Flags=.....C, BI=100, SSID=cvoice
8	14:31:03.871	68:7d:b4:5e:5f:4f	68:2c:7b:cb:42:d6	802.11	525	-35dBm		Probe Response, SN=10, Flags=.....C, BI=100, SSID=cvoice
10	14:31:03.910	68:7d:b4:5e:5f:4f	98:01:a7:ec:5f:b6	802.11	525	-34dBm		Probe Response, SN=11, Flags=.....C, BI=100, SSID=cvoice
11	14:31:03.912	68:7d:b4:5e:5f:4f	98:01:a7:ec:5f:b6	802.11	525	-34dBm		Probe Response, SN=11, Flags=.....R...C, BI=100, SSID=cvoice
12	14:31:03.913	68:7d:b4:5e:5f:4f	98:01:a7:ec:5f:b6	802.11	525	-34dBm		Probe Response, SN=11, Flags=.....R...C, BI=100, SSID=cvoice
13	14:31:03.913	68:7d:b4:5e:5f:4f	98:01:a7:ec:5f:b6	802.11	525	-35dBm		Probe Response, SN=11, Flags=.....R...C, BI=100, SSID=cvoice
14	14:31:03.914	68:7d:b4:5e:5f:4e	98:01:a7:ec:5f:b6	802.11	514	-34dBm		Probe Response, SN=5, Flags=.....C, BI=100, SSID=cal-psk
15	14:31:03.915	68:7d:b4:5e:5f:4e	98:01:a7:ec:5f:b6	802.11	514	-35dBm		Probe Response, SN=5, Flags=.....R...C, BI=100, SSID=cal-psk
16	14:31:03.916	68:7d:b4:5e:5f:4e	98:01:a7:ec:5f:b6	802.11	514	-34dBm		Probe Response, SN=5, Flags=.....R...C, BI=100, SSID=cal-psk
17	14:31:03.917	68:7d:b4:5e:5f:4e	98:01:a7:ec:5f:b6	802.11	514	-35dBm		Probe Response, SN=5, Flags=.....R...C, BI=100, SSID=cal-psk

▼ Tag: Reduced Neighbor Report
Tag Number: Reduced Neighbor Report (201)
▼ Neighbor AP Information
.....00 = TBTT Information Field: 0
.....1.. = TBTT Filtered Neighbor AP: 1
.....0000 = TBTT Information Count: 0
Channel Number: 69
▼ TBTT Information
Neighbor AP TBTT Offset: 255
BSSID: 687db45e5f40
Short SSID: 0x4f27e7b9
▼ BSS Parameters: 0x4e
.....0 = OCT Recommended: False
.....1. = Same SSID: True
.....1. = Multiple BSSID: True
.....1. = Transmitted BSSID: True
.....0 = Member of ESS with 2.4/5 GHz Co-located AP: True
.....0 = Unsolicited Probe Responses: False
.....0 = Reserved: 0x0
PSD Subfield: 254dBm/MHz

Clients start with 2.4 and 5 GHz bands discovery mechanism to learn 6 GHz SSIDs



Wi-Fi 6E Inband AP Discovery

Wireless Clients always Probe!

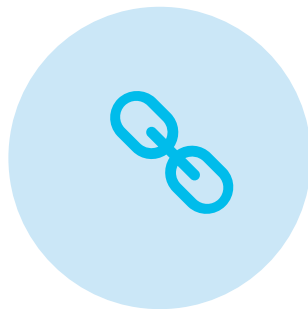


FILS Discovery Frames helps AP Discovery Faster

Reduces AirTime Utilization by Management Frames



SMALLER BEACONS THAT IS
TRANSMITTED MORE FREQUENTLY
(APPROX. 20 MSEC),
CONSUMES LESS AIR TIME.

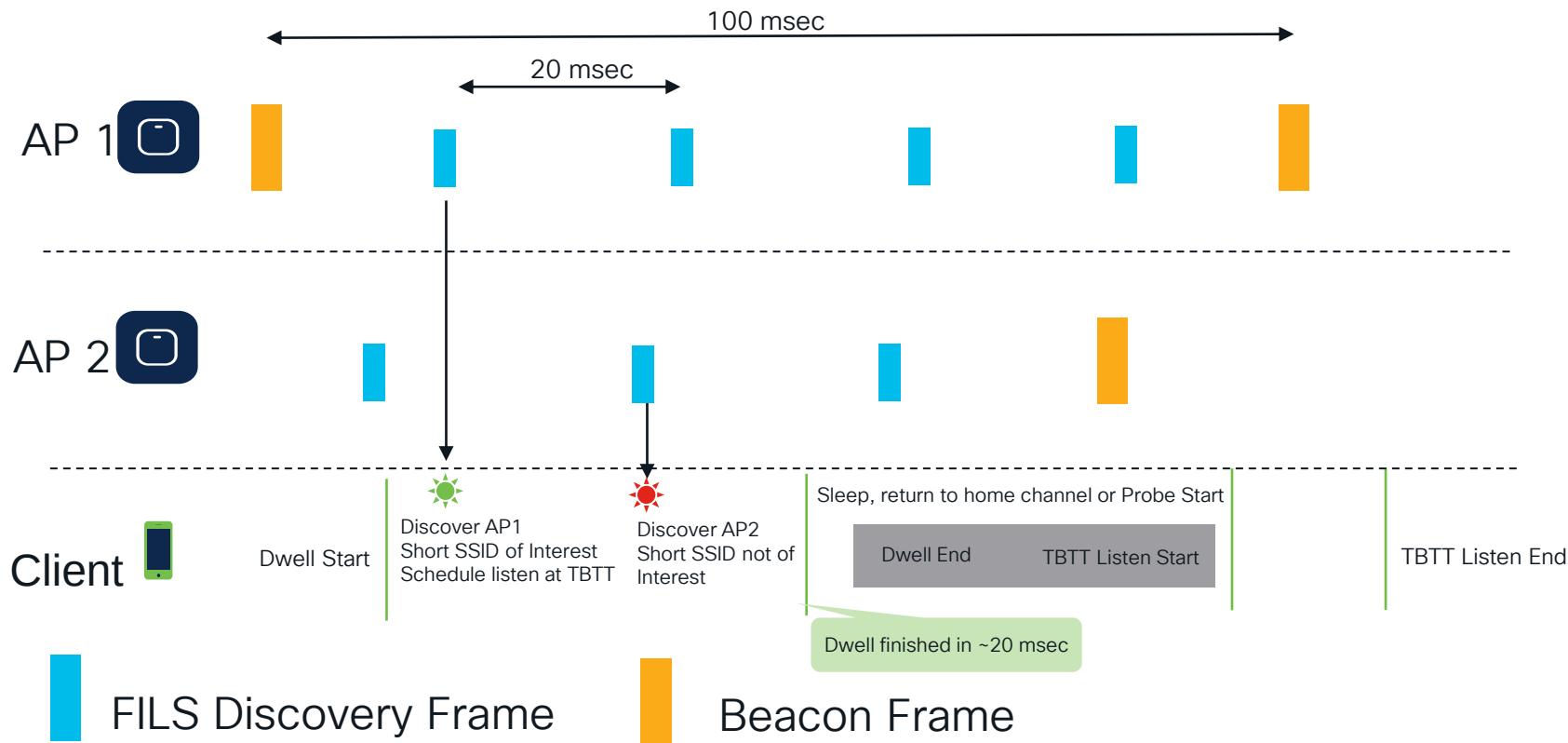


CONTAINS INFORMATION FOR
THE CLIENT TO DECIDE ON THE
AP TO CONNECT (SHORT SSID,
CHANNEL, TBTT ETC)



REDUCES PROBE REQUEST
OVERHEAD

Fast Initial Link Setup (FILS) Discovery Frames



FILS Discovery Frame – Packet Capture

Wireshark Filter Expression: `wlan.fixed.publicact == 0x22`

Category code: Public Action (4)
Public Action: FILS Discovery Request (0x22)

Short SSID: 0x4fa04e3e

Broadcast Action
Frames

Contains Short
SSID, Channel,
TBTT etc

Transmitted every
20 msec

Unsolicited Broadcast Probe Response



Reduces Probe Request
Overhead



Broadcast probe
response every 20 msec



Contains detailed
information as a Beacon

Helps Avoid Probe Storm

Unsolicited Broadcast Probe Response Packet Capture

Apply a display filter ... <Ctrl-/>

Expression...

No.	Time	Source	Destination	Protocol	Length	Info
1	16:36:27.556	68:7d:b4:5e:d2:f8	ff:ff:ff:ff:ff:ff	802.11	550	Beacon frame, SN=2635, Flags=.....C, BI=100, SSID=wpa3-sae, SSID=GCMP256, SSID=wpa...
2	16:36:27.577	68:7d:b4:5e:d2:f8	ff:ff:ff:ff:ff:ff	802.11	550	Probe Response, SN=2636, Flags=.....C, BI=100, SSID=wpa3-sae, SSID=GCMP256, SSID=w...
3	16:36:27.597	68:7d:b4:5e:d2:f8	ff:ff:ff:ff:ff:ff	802.11	550	Probe Response, SN=2637, Flags=.....C, BI=100, SSID=wpa3-sae, SSID=GCMP256, SSID=w...
4	16:36:27.618	68:7d:b4:5e:d2:f8	ff:ff:ff:ff:ff:ff	802.11	550	Probe Response, SN=2638, Flags=.....C, BI=100, SSID=wpa3-sae, SSID=GCMP256, SSID=w...
5	16:36:27.638	68:7d:b4:5e:d2:f8	ff:ff:ff:ff:ff:ff	802.11	550	Probe Response, SN=2639, Flags=.....C, BI=100, SSID=wpa3-sae, SSID=GCMP256, SSID=w...
6	16:36:27.659	68:7d:b4:5e:d2:f8	ff:ff:ff:ff:ff:ff	802.11	599	Beacon frame, SN=2640, Flags=.....C, BI=100, SSID=wpa3-sae, SSID=GCMP256, SSID=wpa...
7	16:36:27.679	68:7d:b4:5e:d2:f8	ff:ff:ff:ff:ff:ff	802.11	550	Probe Response, SN=2641, Flags=.....C, BI=100, SSID=wpa3-sae, SSID=GCMP256, SSID=w...
8	16:36:27.700	68:7d:b4:5e:d2:f8	ff:ff:ff:ff:ff:ff	802.11	550	Probe Response, SN=2642, Flags=.....C, BI=100, SSID=wpa3-sae, SSID=GCMP256, SSID=w...
9	16:36:27.720	68:7d:b4:5e:d2:f8	ff:ff:ff:ff:ff:ff	802.11	550	Probe Response, SN=2643, Flags=.....C, BI=100, SSID=wpa3-sae, SSID=GCMP256, SSID=w...
10	16:36:27.741	68:7d:b4:5e:d2:f8	ff:ff:ff:ff:ff:ff	802.11	550	Probe Response, SN=2644, Flags=.....C, BI=100, SSID=wpa3-sae, SSID=GCMP256, SSID=w...
11	16:36:27.761	68:7d:b4:5e:d2:f8	ff:ff:ff:ff:ff:ff	802.11	599	Beacon frame, SN=2645, Flags=.....C, BI=100, SSID=wpa3-sae, SSID=GCMP256, SSID=wpa...
12	16:36:27.782	68:7d:b4:5e:d2:f8	ff:ff:ff:ff:ff:ff	802.11	550	Probe Response, SN=2646, Flags=.....C, BI=100, SSID=wpa3-sae, SSID=GCMP256, SSID=w...
13	16:36:27.802	68:7d:b4:5e:d2:f8	ff:ff:ff:ff:ff:ff	802.11	550	Probe Response, SN=2647, Flags=.....C, BI=100, SSID=wpa3-sae, SSID=GCMP256, SSID=w...
14	16:36:27.822	68:7d:b4:5e:d2:f8	ff:ff:ff:ff:ff:ff	802.11	550	Probe Response, SN=2648, Flags=.....C, BI=100, SSID=wpa3-sae, SSID=GCMP256, SSID=w...
15	16:36:27.843	68:7d:b4:5e:d2:f8	ff:ff:ff:ff:ff:ff	802.11	550	Probe Response, SN=2649, Flags=.....C, BI=100, SSID=wpa3-sae, SSID=GCMP256, SSID=w...
16	16:36:27.863	68:7d:b4:5e:d2:f8	ff:ff:ff:ff:ff:ff	802.11	599	Beacon frame, SN=2650, Flags=.....C, BI=100, SSID=wpa3-sae, SSID=GCMP256, SSID=wpa...

Sent every 20 ms

Frame 2: 550 bytes on wire (4400 bits), 550 bytes captured (4400 bits) on interface 0

- RadioTap Header v0, Length 56
- 802.11 radio information
- IEEE 802.11 Probe Response, Flags:C
- IEEE 802.11 wireless LAN
 - Fixed parameters (12 bytes)
 - Tagged parameters (454 bytes)
 - Tag: SSID parameter set: wpa3-sae
 - Tag: Supported Rates and BSS Membership Selectors 6.0(B), 9, 12.0(B), 18, 24(B), 36, 48, 54, [Mbit/sec]
 - Tag: Country Information: Country Code US, Environment Unknown (0x04)
 - Tag: Power Constraint: 6
 - Tag: TPC Report Transmit Power: 23, Link Margin: 0
 - Tag: Extended Supported Rates and BSS Membership Selectors BSS requires support for direct hashing to elements in SAE, [Mbit/sec]
 - Tag: QSS Load Element 802.11e CCA Version
 - Tag: Multiple BSSID
 - Tag: RM Enabled Capabilities (5 octets)
 - Tag: Extended Capabilities (11 octets)
 - Ext Tag: HE Capabilities (IEEE Std 802.11ax/D2.0)
 - Ext Tag: HE Operation (IEEE Std 802.11ax/D2.0)
 - Ext Tag: 6GHz Band Capabilities
 - Ext Tag: Spatial Reuse Parameter Set
 - Ext Tag: MU EDCA Parameter Set
 - Tag: Vendor Specific: (null): WMM/WME: Parameter Element
 - Tag: Vendor Specific: (null): Unknown
 - Tag: Vendor Specific: (null)

Broadcast frames

Transmitted every
20ms

Carry Multiple BSSID

Contains all
information needed
for association

New Probe Restrictions in 6 GHz Band



Clients cannot do blind probing.
(Broadcast destination address using Wildcard SSID and BSSID not allowed)



Clients must wait at least the duration of
minimum probe delay interval (approx. 20
msec)

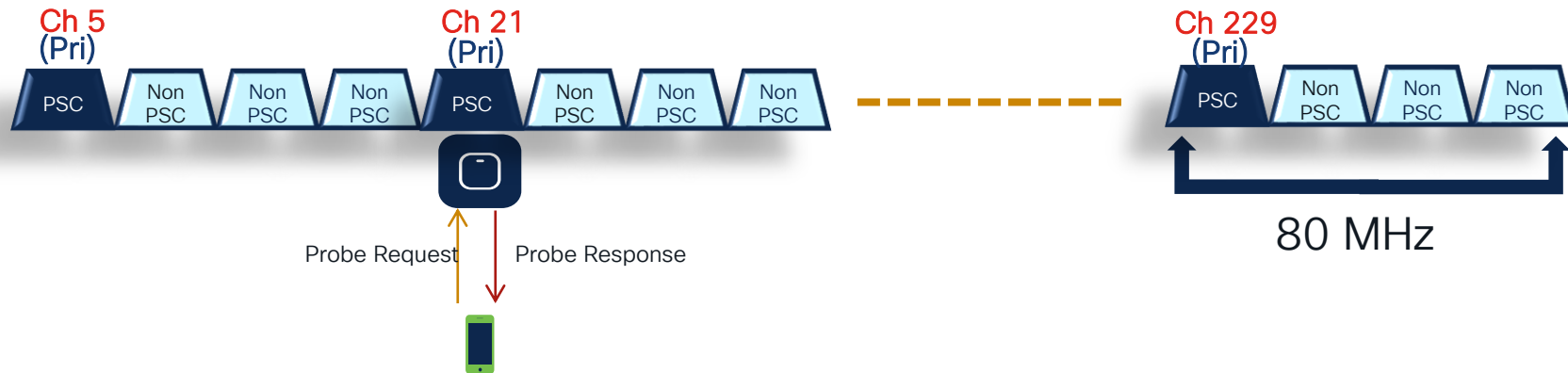


Probe responses are always broadcast.

Broadcast probe requests and probes with wildcard SSID create probe storm and impacts performance

Preferred Scanning Channels (PSC)

- Every fourth 20MHz channel designated for active probing by Wi-Fi 6E Clients; restricts scanning to 15 channels, instead of 59.
- PSC channels serve as the primary channel for channel bonding in 80 MHz

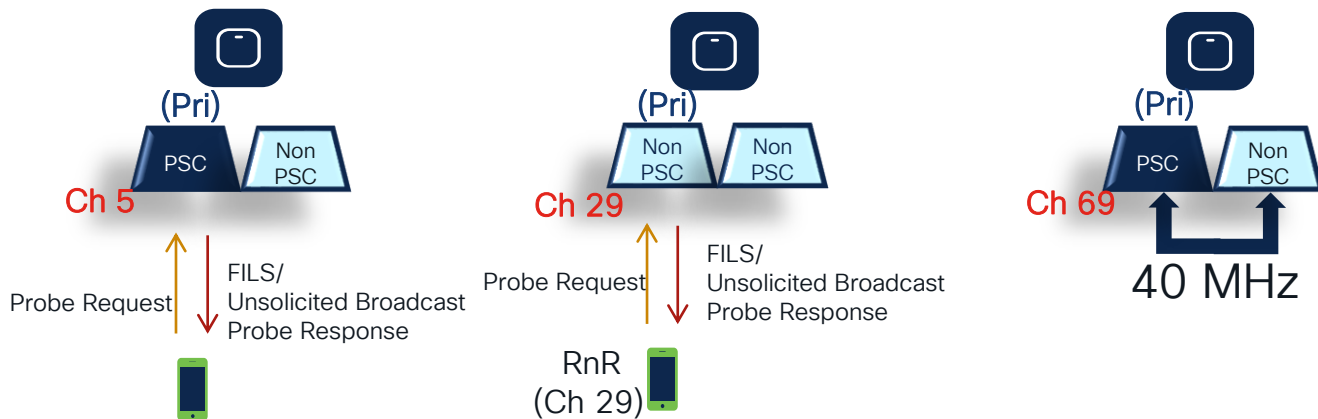


PSC Channel List:

5, 21, 37, 53, 69, 85, 101, 117, 133, 149, 165, 181, 197, 213 and 229

Preferred Scanning Channels with 40 MHz Channel

- 40 MHz Channel Width is reality in Countries with 500 MHz Spectrum.
- RRM algorithm allocates 40 MHz Channel Width



Clients do not scan Non-PSC

Key Takeaways

RNR

(Out-of-Band)

Most Clients use only RNR (through legacy bands) to discover WLANs in 6 GHz. They do not scan 6 GHz straightaway.

FILS vs UBPR

(In-Band - Passive Scan)

It's FILS or UBPR and not both. By default, if any legacy radio is operational, then FILS or UBPR are not transmitted.

PSC

(In-Band : Active Scan)

Wireless clients probe only PSC channels; scans Non-PSC if it detects from RNR

Section Summary

1

New 6 GHz Band: (5925 – 7125 MHz)
1200 MHz or 500 MHz

2

Device Classes: Low Power Indoor AP, Standard Power AP and Very Low Power AP

3

Protocol Optimizations: Reduced Beacon Size, Multiple BSSID (MBSSID)

4

AP Discovery: RnR (Out-of-Band), FILS, UBPR & PSC (In-Band)

AP Deployment

Setting the stage

- New 6 GHz Band
- Regulatory Considerations
- Protocol enhancements

AP Deployment

- AP Specs
- Power Requirements
- Switching Infrastructure



Catalyst Wi-Fi 6E Access Points

Cisco Wi-Fi 6E premium portfolio



Meraki MR57



	Transmitters	Receivers
2.4 GHz	4	4
5 GHz	4	4
6 GHz	4	4



- Dual 5G mGig Uplinks with failover
- PoE+ and UPoE+ compliant
- IoT Radio
- Monitor Radio



Catalyst 9136



	Transmitters	Receivers
2.4 GHz	4	4
5 GHz	4*	4*
	8	8
6 GHz	4	4

* Future SW



- Dual 5G mGig Uplinks with failover
- PoE+ and UPoE+ compliant
- IoT Radio
- Scanning Radio
- Environmental sensors

One Product – Two Management Modes



Cisco DNA Management Mode
C9800 & DNAC Stack

Meraki Management Mode
MR Dashboard Stack



1 AP, 2 Ways: CW 916x Access Points



Catalyst 9162

	Tx	Rx
2.4 GHz	2	2
5 GHz	2	2
6 GHz	2	2

- 2.5Gbps mGig Uplink
- PoE+ and UPoE compliant
- IoT Radio
- CleanAir Pro Radio



Catalyst 9164

	Tx	Rx
2.4 GHz	2	2
5 GHz	4	4
6 GHz	4	4

- 2.5Gbps mGig Uplink
- PoE+ and UPoE compliant
- IoT Radio
- CleanAir Pro Radio



Catalyst 9166

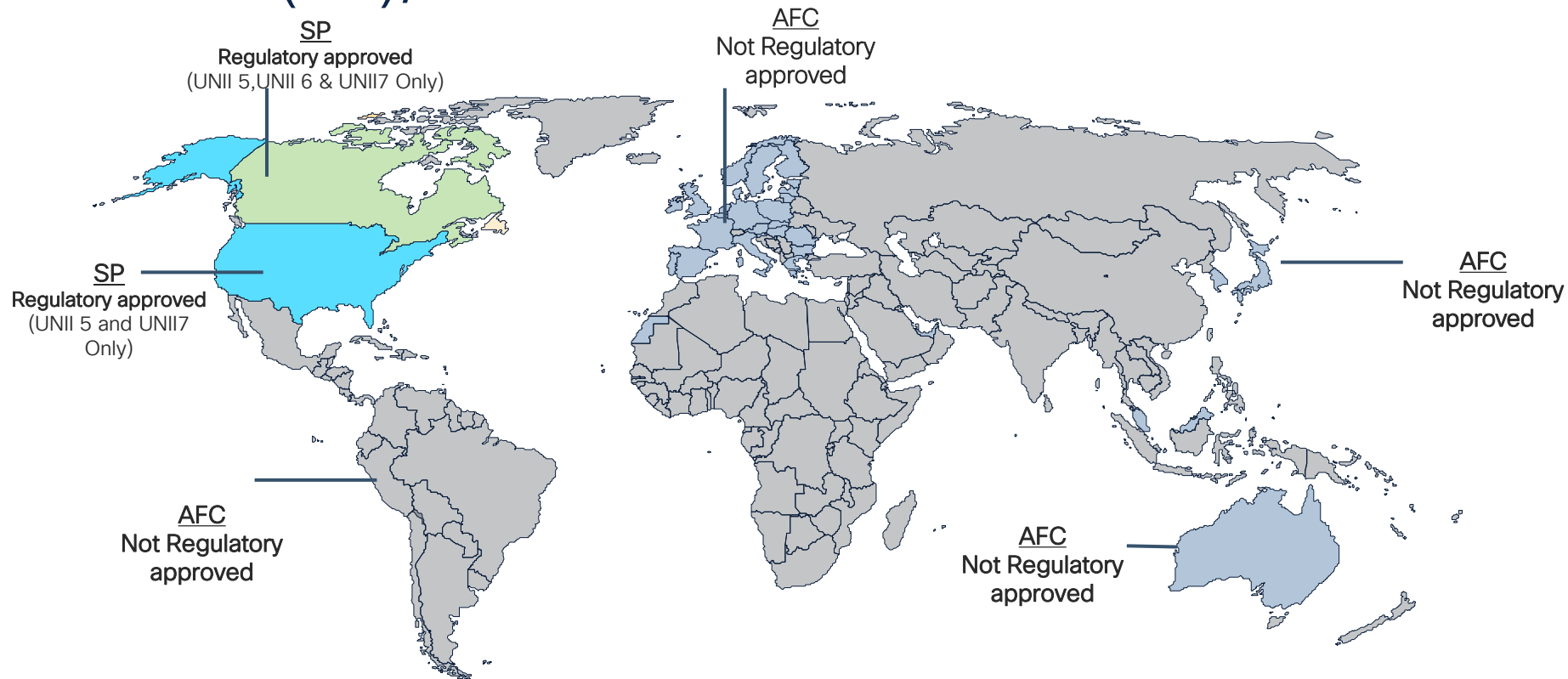
	Tx	Rx
2.4 GHz	4	4
5 GHz	4	4
6 GHz	4	4

- 5Gbps mGig Uplink
- PoE+ and UPoE compliant
- IoT Radio
- CleanAir Pro Radio
- XOR radios (low band/high band)
- Environmental sensors

Full radio capability (6 GHz @LPI) on single 30W PoE+

AP power optimization | Dedicated radio for CleanAir® Pro | Same bracket, same industrial design

External(SP)/Outdoor Antenna Wi-Fi 6E Status



AFC approved in USA & Canada

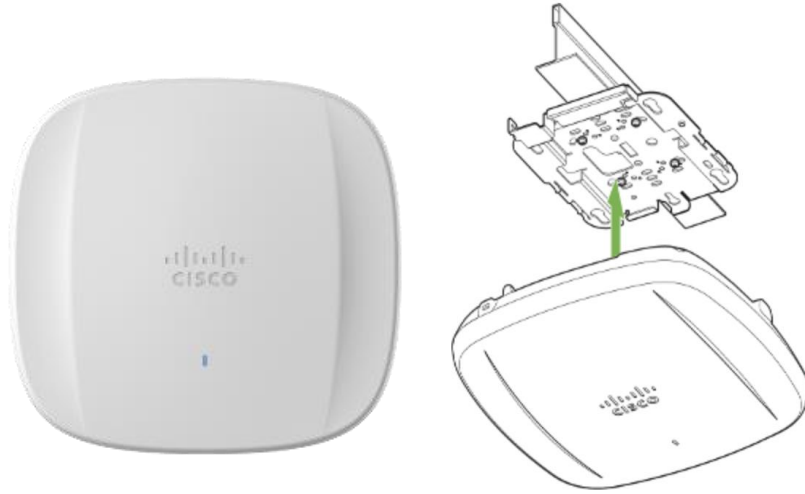
Solution: Add a directional array to the 9166 Series

Introducing the CW9166D1 Series Directional AP

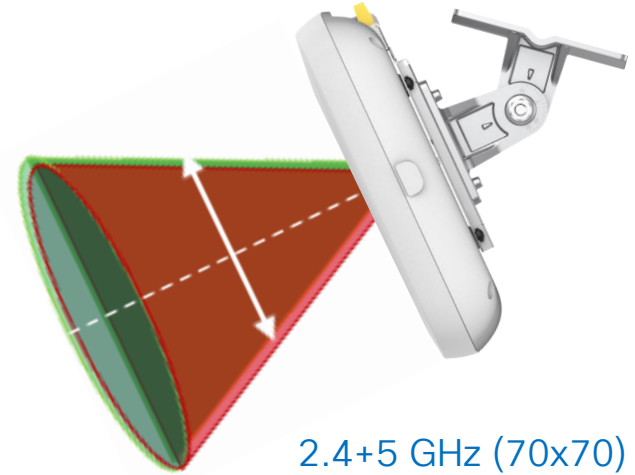


- Simplifies installation costs (less to mount)
- No bulky cables, expensive adapters...
- Similar coverage pattern as previous products using 6 dBi directional antennas
- Solves most popular external antenna cases world-wide irrespective of regulations
- Less components – resulting in a better MTBF – More aesthetically pleasing

Antenna differences between CW9166i and CW9166D1



CW9166i designed with an integrated omni-directional antenna ceiling mount for a “360 degree” coverage pattern – ideal for offices, conventional buildings



2.4+5 GHz (70x70)
6 GHz (60x60)

CW9166D1 designed with an integrated directional antenna allowing the coverage pattern to favor the area the AP is facing – ideal for warehouse, auditoriums etc.

Cisco® Catalyst® 9166D1-x

Directional, Tri-Radio with 12 Spatial Streams!



Available Now!

CISCO *Live!*

9166D1 Wi-Fi 6 Access Point



Penta-Radio Architecture

1. 2.4 GHz Client Radio: 4x4:4SS
2. 5 GHz Client Radio: 4x4:4SS
3. 6 GHz Client Radio 4x4:4SS (XOR to 5GHz)
4. Dedicated tri-band auxiliary radio
5. 2.4 GHz IoT Radio



Directional antenna architecture

- 2.4+5 GHz: 6 dBi gain (70x70 deg), 6 GHz: 8 dBi (60x60)*
- Same X,Y as CW9166I – and only 0.1cm taller!
- Wide support for pan/tilt combinations



Internet of Things Capabilities

- Built-In Environmental Sensors
- Application Hosting Technology
- USB port with 4.5 W power output



5 Multigigabit (mGig) PoE Port

- Optional DC Power

Subject to change
*2/5/6 mode
† SW support post-FCS

Articulating Mount Bracket Assembly (Wall / Pole Install)

Horz 60deg / Vert 0 Pivot



Horz 60deg / Vert -60 Pivot



Horz 0 / Vert -90 Pivot

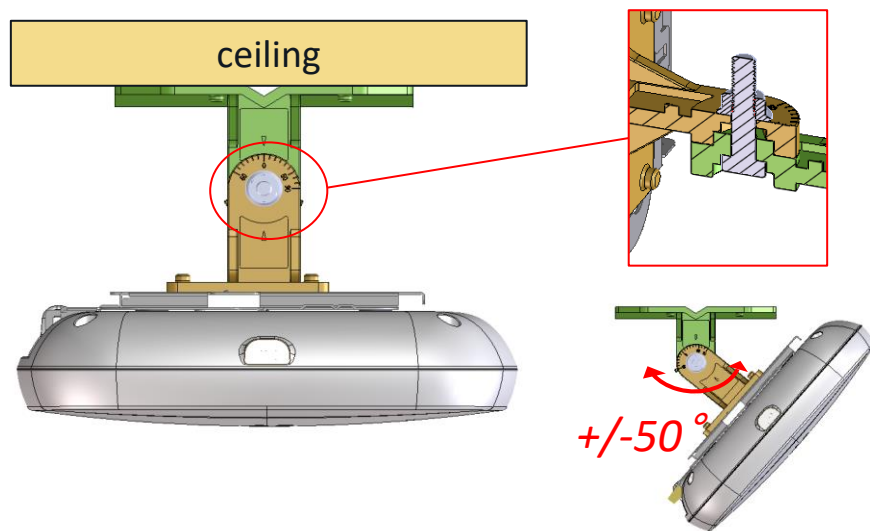


Horz 0 / Vert +60 Pivot



Articulating Mount Bracket Assembly

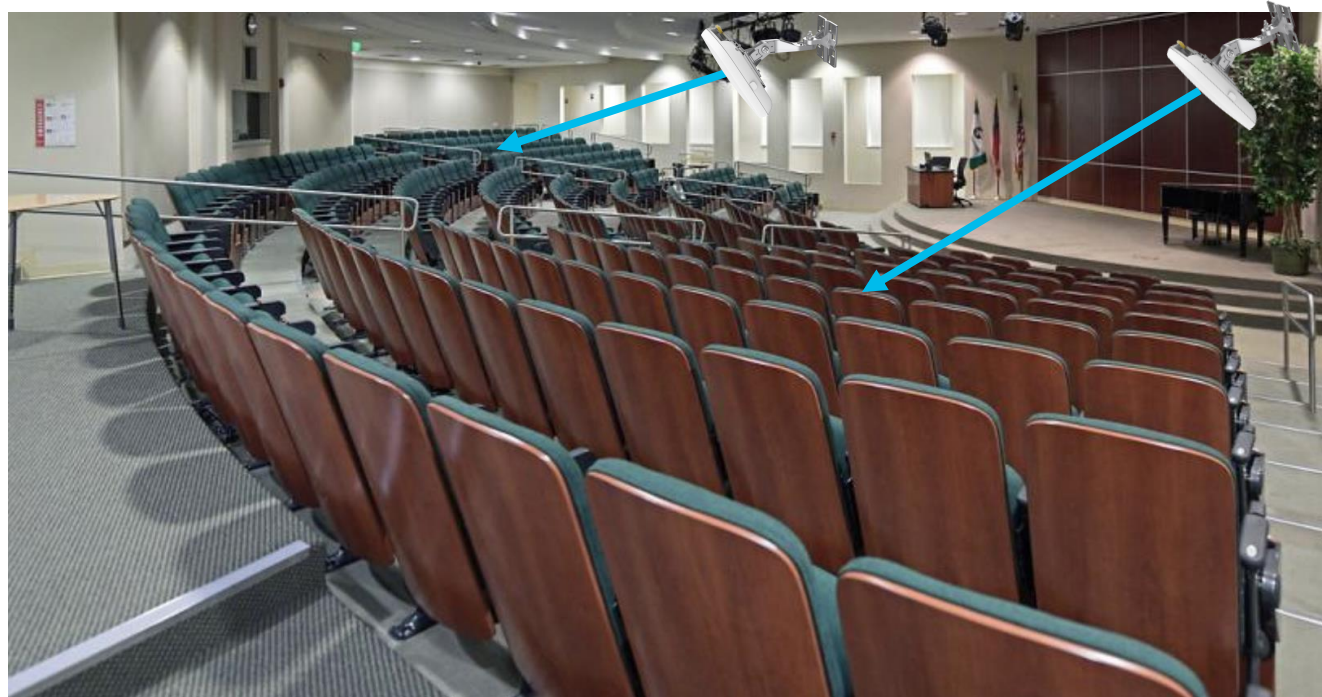
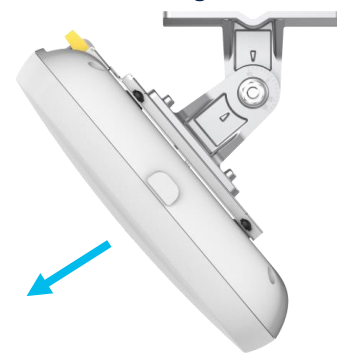
(Alternate Ceiling Single Axis Configuration)



Ceiling 50deg (side view)



Use cases - Auditoriums (Focused connectivity)



Focusing the direction of the signal improves range, increases signal strength and reduces retries improving overall performance

While an Omni-Directional would work, in this fashion, RF connectivity is optimized as each AP is focused into a specific area

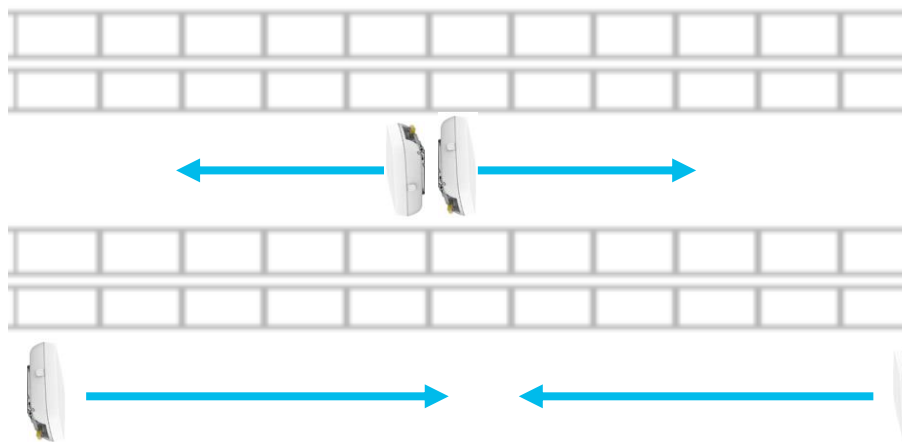
Use cases - Warehouse (High ceilings / long aisles)

Warehousing challenges

- High Ceilings
- Long aisles
- Stock material changes (seasonal)
- AP (distance to client) & mounting



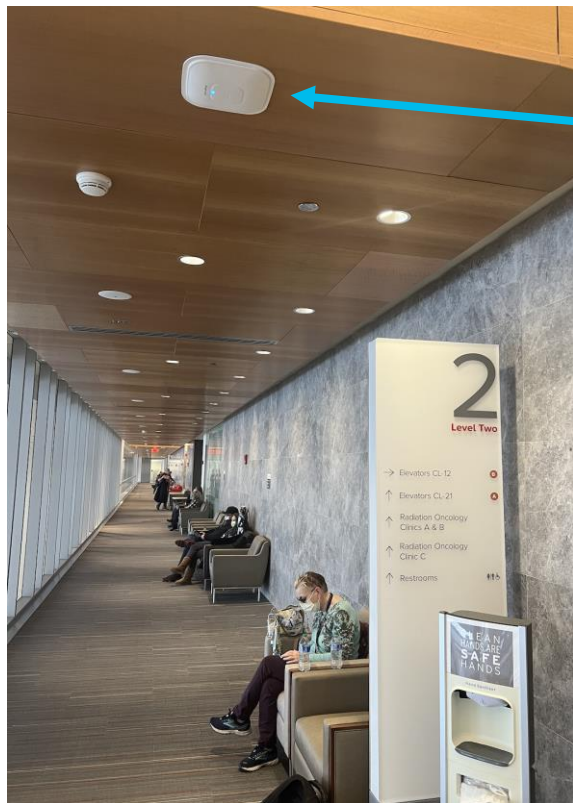
Back-to-Back units in center of aisle covering long aisles (Ability to adjust tilt)



Or perhaps at each end of the aisle shooting down the aisle

Omni-directional pattern is problematic in these areas as AP should be directional and located high to avoid tow motors, changing stock material etc.

Use cases – Healthcare (long hallways)



Long hallways are oftentimes handled with Omni-directional Access Points such as this Cisco Access Point flush mounted to a wooden ceiling.

When it becomes problematic or cost prohibitive to install multiple Access Points, a directional antenna unit can be installed on each end of the hallway assuming there are no metal doors or obstructions in the path



Catalyst
CW9166D1

Use cases – Airport Hangars and Bus Garages



Conventional Omni-directional Access Points are not always compatible with high ceilings or areas with a lot of metal.

A directional AP can be mounted on the ceiling or wall allowing the RF energy to be focused where needed

Note: Conventional APs very high on the ceiling and in near proximity to each other, can cause Radio Resource Management (RRM) to hear the AP stronger than the clients. This can result in RRM to believe there is over coverage turning the RF power down on the Access Points causing issues. Directional Access Points help mitigate this issue



Cisco Catalyst CW9163E Access Point

Expanding Wi-Fi 6E to Outdoor RF environments from IOS-XE 17.13.1 and Meraki R30

Cisco® Catalyst® CW9163E

Outdoor, Tri-Radio with 6 Spatial Streams!



Compatible with existing Antenna Mount of
Catalyst & Meraki



Penta-Radio Architecture

1. 2.4 GHz : 2x2:2 SS
2. 5 GHz : 2x2:2 SS
3. 6 GHz : 2x2:2 SS
4. Dedicated tri-band auxiliary radio
5. 2.4 GHz IoT Radio

* 6 GHz subject to
AFC availability



2.5 Gig (mGig) PoE Ports



Internet of Things Capabilities

- BLE/Thread/Zigbee Ready



Antenna

- Omni-directional Di-pole (PID: CW-ANT-O1-NS-00)
- Directional Patch (Future) (PID: CW-ANT-D1-NS-00)
- Inbuilt GPS to obtain Latitude/Longitude
- Optional External GPS Antenna

Dual mode: Cisco WLC or Meraki Cloud

Catalyst CW9163E – Antenna Details



B

6 GHz Non-SIA

A

6 GHz SIA



D

2.4/5 GHz Non-SIA

C

2.4/5 GHz SIA

Omni-Directional

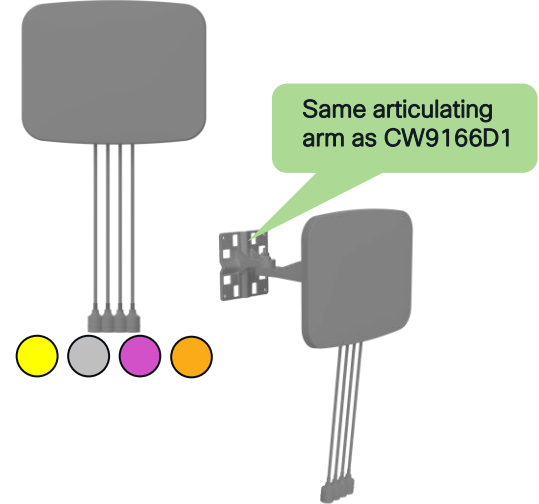


Tri-Band with SIA

Black Ring

CW-ANT-O1-NS-00

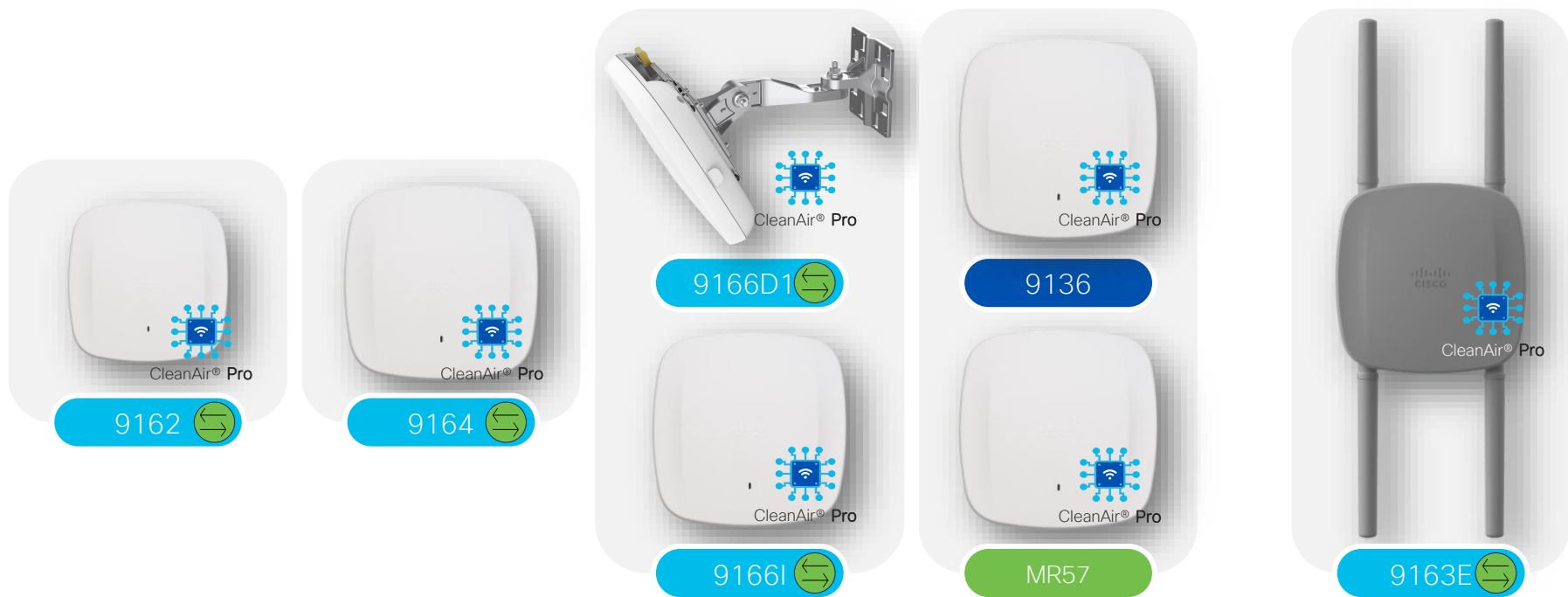
Directional



CW-ANT-D1-NS-00
(Available: First half of CY24)

Dual Band port colors consistent with existing color scheme

Industry's best & broadest Wi-Fi 6E portfolio



Indoor Access Points

Outdoor Access Points

Catalyst IW9167E Heavy Duty Access Point

One hardware, two wireless technologies

Catalyst IW9167E Heavy Duty Access Point



Choose your wireless technology

Choose Wi-Fi 6 or Cisco® Ultra-Reliable Wireless Backhaul (Cisco URWB). Evolve as your needs change.



High-performance wireless

Tri-radio (2.4 GHz, 5 GHz, 5/6 GHz), 6 GHz hardware support, high data rates (4x4:4 SS on each Radio)



Get more from your industrial assets.

Bluetooth Low Energy (BLE), GNSS, GPIO capabilities for advanced use cases.



Build for the harshest outdoor environments.

IP67 rated enclosure, -40° to +70° C, optional M12 adapters. EN50155 & HazLoc** (Class I, Division 2, Zone 2/22, ATEX, IECEx)

Premier Wi-Fi 6/6E outdoor and industrial access point

6GHz-ready 4x4 outdoor and industrial access point

Catalyst IW9167I Heavy Duty Access Point



Wi-Fi 6/6E*



Tri-radio (2.4GHz, 5GHz, 6GHz), 4x4, integrated omni-directional antennas [5-6 dBi]



Cast aluminum case, IP66/IP67, -40C to +70C



Multigigabit 5Gbps, RJ-45, SFP+, optional M12 adapter



Manage with Catalyst 9800 wireless LAN controllers and Cisco Catalyst Center



GNSS, scanning radio

Take your Wi-Fi network wherever you need it today. Be ready for tomorrow. With ease.

6 GHz Support in Catalyst Access Points for APJ Countries

6 GHz Availability in APJC

Catalyst

Country	Release	Timeline
Australia	17.12.1	Jul 2023
New Zealand	17.12.1	Jul 2023
Japan	17.12.1	Jul 2023
Hong Kong	17.12.1	Jul 2023
Malaysia	17.12.1	Jul 2023
Singapore	17.14.1	Mar 2024
Thailand	17.14.1	Mar 2024
Taiwan	Planned	

Meraki

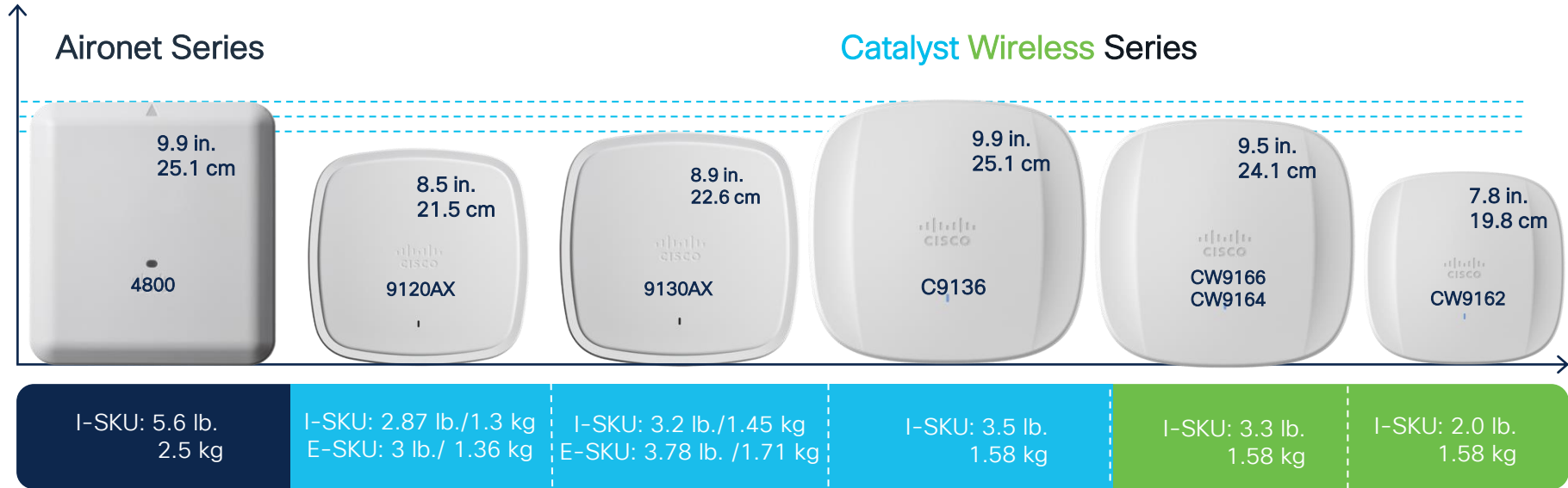
Country	Release	Timeline
Australia	R30.2	Nov 2023
New Zealand	R30.2	Nov 2023
Japan	R30.6	Feb 2024
Hong Kong	R30.6	Feb 2024
Malaysia	R30.6	Feb 2024
Singapore	R30.6	Feb 2024
Thailand	R30.6	Feb 2024
Taiwan	Planned	

Note: Support for S. Korea already present since launch of Wi-Fi 6E

Mechanical Specifications

Indoor Access Point Dimensions

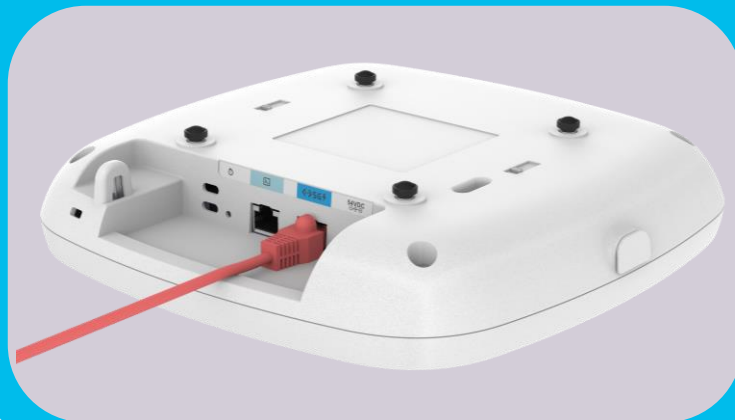
Wi-Fi 6E – Similar in size but significantly more capabilities



Catalyst C9136/CW9166/9164/9162

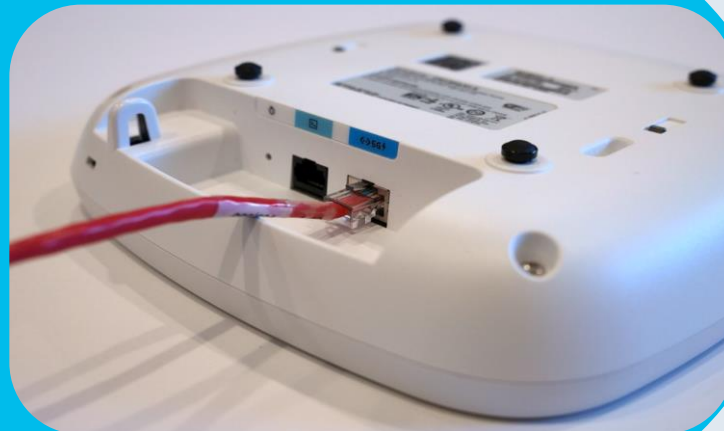
Enhanced cabling experience

C9136/CW66/64/62 – Lowered Edge



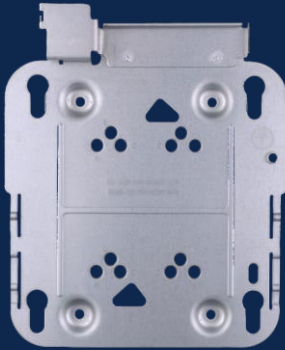
Larger Recessed Area
Allow Wires not to be Bent During
Connection

C9130 – Higher Edge and Smaller Area



More Easily Accessible Port
Allow for Better Deployment Experience

AIR-AP-BRACKET-1 photos



Front side

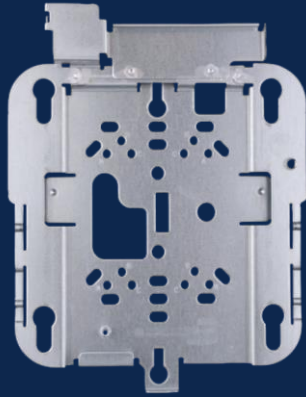


AP mounted



Back side

AIR-AP-BRACKET-2 photos



Front side



AP mounted



Back side

Conversion overview



Done from C9800 WLC

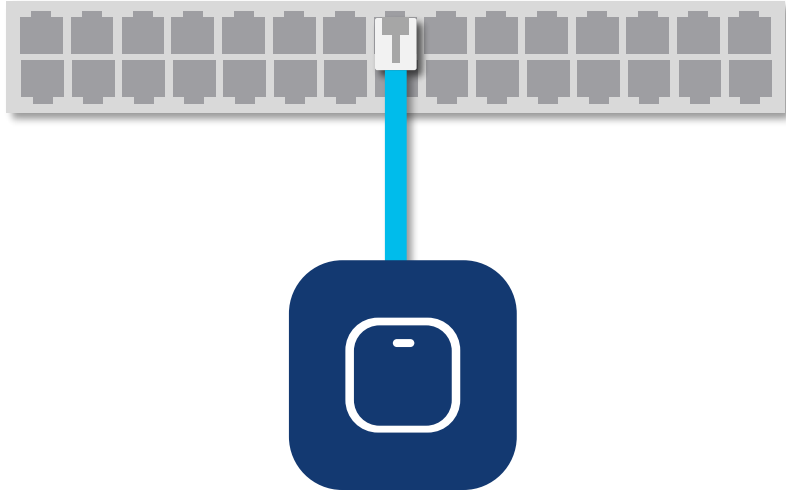


Call Meraki Support
(Needs license)

Migration Guide: <https://www.cisco.com/c/en/us/products/collateral/wireless/catalyst-9100ax-access-points/migrating-dna-to-meraki-mgmt-mode.pdf>

Network Infrastructure

Catalyst AP to Switch connection



AP negotiates power, speed and duplex at boot time via CDP/LLDP

MGig switchport is recommended as Wi-Fi 6/6E speed may exceed 1 Gbps

Cabling: Cat 6/6A recommended.
Cat 5e can support up to 5Gbps

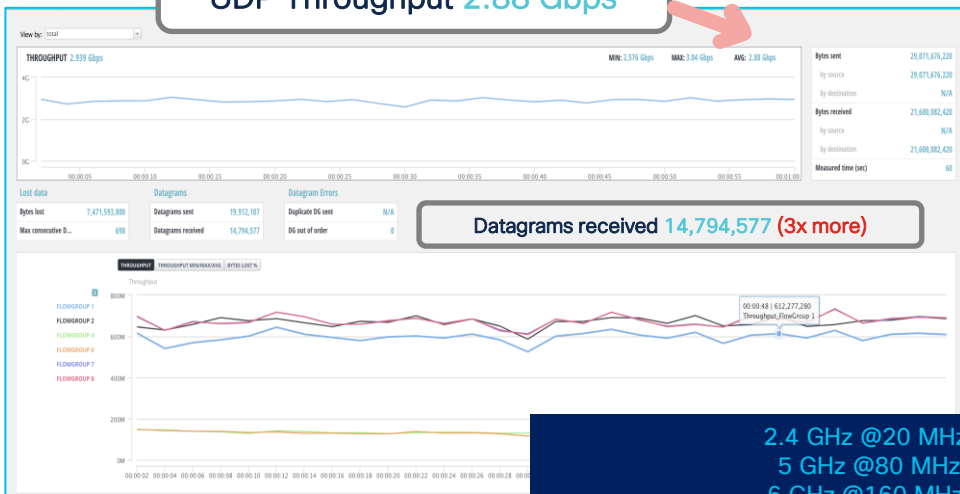
CDP = Cisco Discovery Protocol
LLDP = Link Layer Discovery Protocol
Cat = Category (of ethernet cable)

Wi-Fi 6E Performance Comparison

5 Gig (mGig) AP Uplink vs. 1 Gig AP Uplink

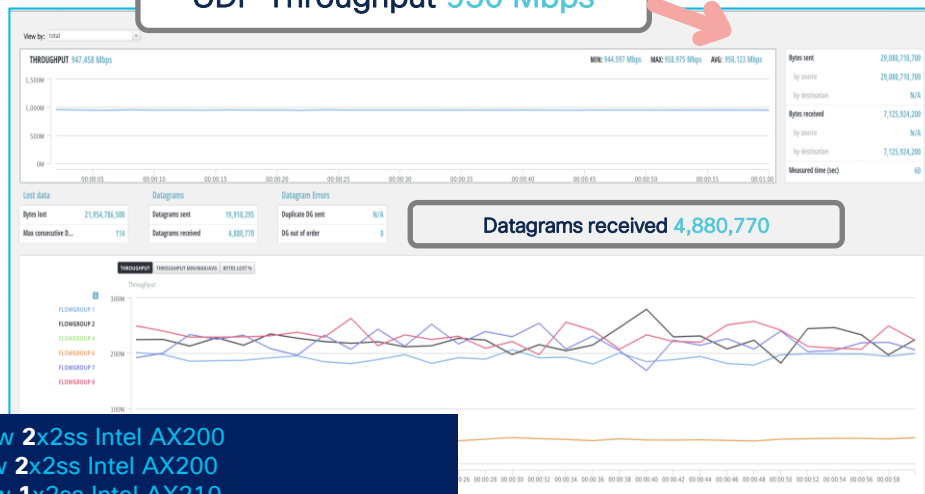
Wi-Fi 6E Performance with **mGig (5 Gig) Switch**

UDP Throughput **2.88 Gbps**



Wi-Fi 6E Performance with **Gigabit Switch**

UDP Throughput **950 Mbps**



2.4 GHz @20 MHz w 2x2ss Intel AX200
5 GHz @80 MHz w 2x2ss Intel AX200
6 GHz @160 MHz w 1x2ss Intel AX210

Catalyst AP C9136 to Switch connection



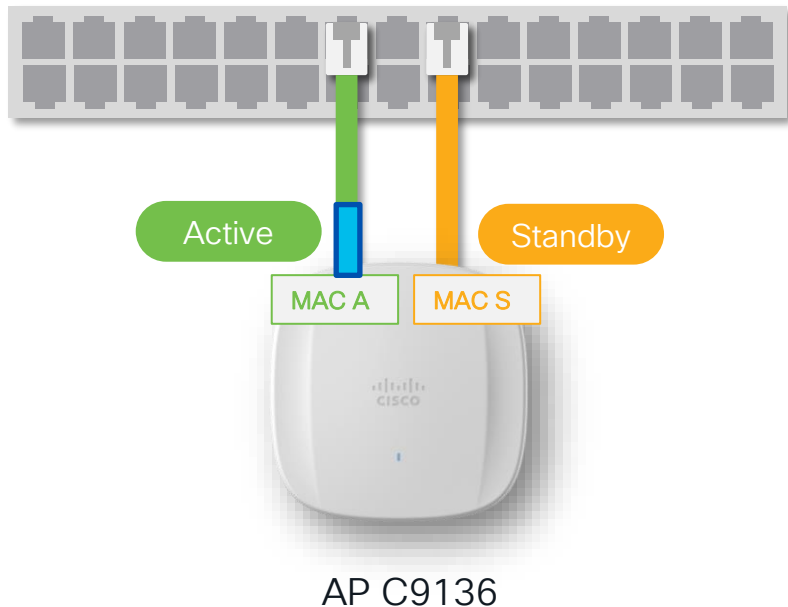
C9136 has two mGig uplink ports

Dual port is for PoE power and uplink redundancy with hitless failover

Switchport and AP can be configured for LAG or standalone ports (default)

mGig = multi gigabit ethernet
PoE = Power over Ethernet
LAG = Link Aggregation Group

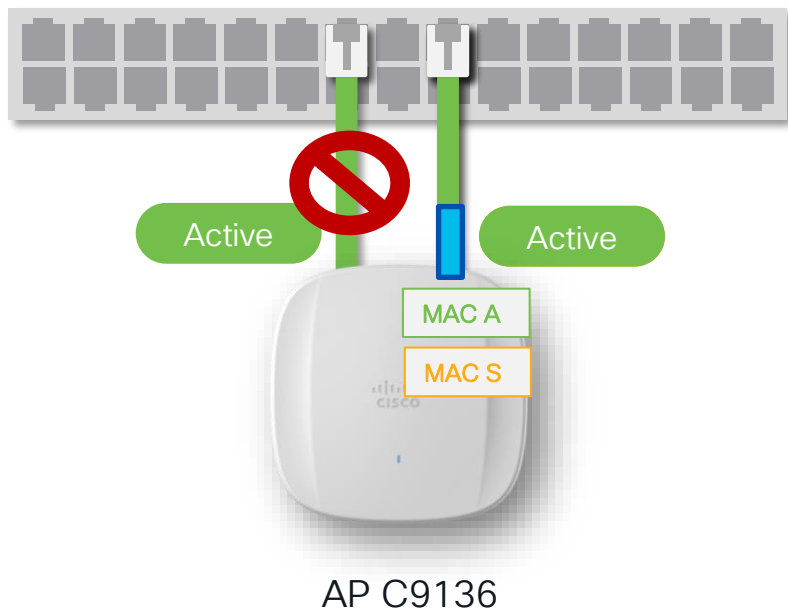
Catalyst AP C9136 to Switch connection



- When configured as standalone ports, one becomes **active** and the other one **standby**
 - If power is equal on both ports, Port 0 becomes **active**. Otherwise, the one with more power
- Traffic is exchanged on **active** port using active **MAC A** (CAPWAP, ARP, etc.)
- **Standby** port only exchanges CDP/LLDP messages with its own **MAC S**, no other traffic

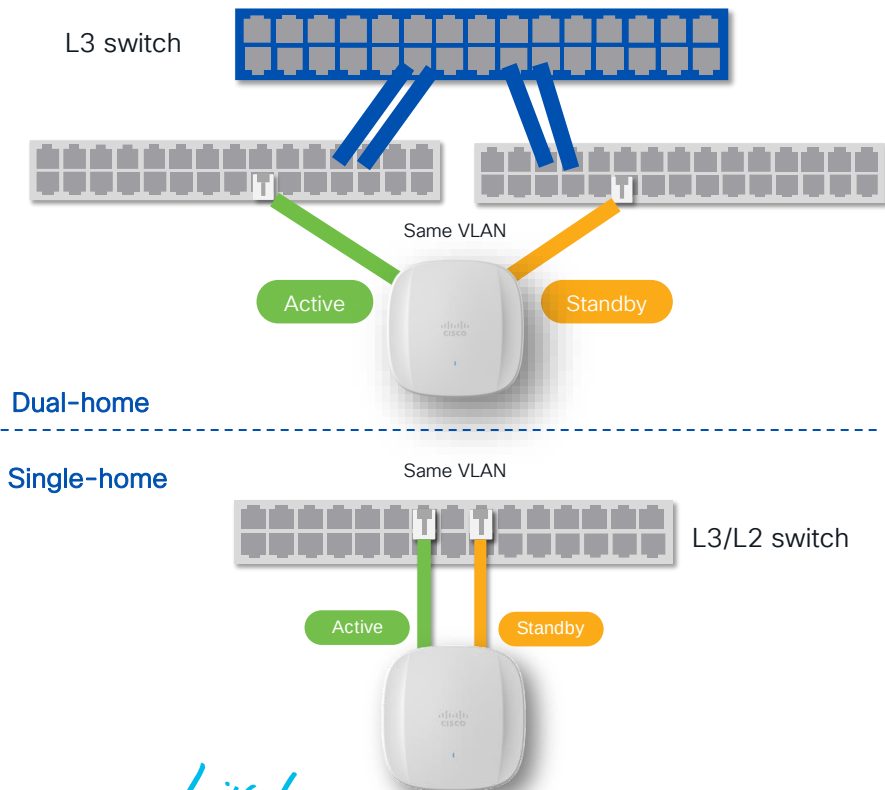
MAC = Media Access Control
ARP = Address Resolution Protocol
CAPWAP = Control and Provisioning of Wireless Access Points

Catalyst AP C9136 to Switch connection



- When configured as standalone ports, one becomes **active** and the other one **standby**
 - If power is equal on both ports, Port 0 becomes **active**. Otherwise, the one with more power
- Traffic is exchanged on **active** port using active **MAC A** (CAPWAP, ARP, etc.)
- **Standby** port only exchanges CDP/LLDP messages with its own **MAC S**, no other traffic
- In case of active port failure, **standby** becomes **active** and exchanges traffic using MAC A. Minimal to zero traffic interruption

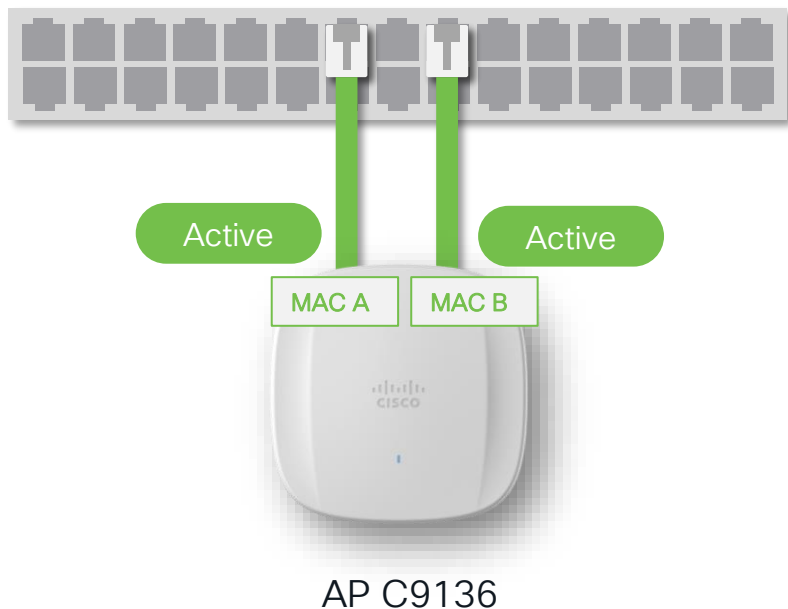
Catalyst AP C9136 to Switch connection



- When configured with standalone ports, you have two options...
- Dual-home to two different switches
 - Recommend to connect to switches in different IDF, whenever possible
- Single-home to one logical switch (Stack Wise, Multi-layer switch, etc.)
 - Recommend to connect to two different members of the stack or line-cards
- In both scenario, the switchports must be configured in the same VLAN

VLAN = Virtual Local Area Network
IDF = Intermediate Distribution Frame

Catalyst AP C9136 to Switch connection



- When configured with LAG, both ports are **Active**
- LAG must be configured on both AP and switchport side.
- AP supports static LAG config (mode on) or dynamic with LACP
- Traffic is load balanced across the two links using **src-dst-port** algorithm. CAPWAP uses random source UDP ports
- LAG must be connected to one single (physical or logical) switch

LACP = Link Aggregation Control Protocol
src-dst-port = source-destination-port

Power considerations

AP Power Consumption



Power Allocated

48.3 W

Power Consumed

16.5 W

PoE Power Negotiation happens at boot time through CDP/LLDP

Power allocation is what you need to consider for power budget

Actual Power consumption is dependent on the AP operation

Catalyst CW9162 Power over Ethernet

Default Configuration (Fixed Power profile)

Power Source	Number of Spatial Stream	2.4 GHz Radio	5 GHz Radio	6 GHz Radio (LPI)	mGig Link Speed	USB	AI/ML Driven Scanning Radio
802.3af	2	Disabled	1x1	1x1	1G	Disabled	Y
802.3at	6	2x2	2x2	2x2	2.5 G	Y/4.5 W	Y
802.3bt	6	2x2	2x2	2x2	2.5 G	Y/4.5 W	Y
DC Power	6	2x2	2x2	2x2	2.5 G	Y/4.5 W	Y

Note:

1. AIR-PWRINJ7/AIR-PWRINJ6 is C9162l's official 802.3bt Power Injector

USB = universal serial bus
AI = Artificial Intelligence
ML = Machine Learning

Catalyst CW9164 Power over Ethernet

Default Configuration (Fixed Power profile)

Power Source	Number of Spatial Stream	2.4 GHz Radio	5 GHz Radio	6 GHz Radio (LPI)	mGig Link Speed	USB	AI/ML Driven Scanning Radio
802.3af	n.a.	Disabled	Disabled	Disabled	1G	Disabled	Y
802.3at	10	2x2	4x4	4x4	2.5 G	Disabled	Y
802.3bt	10	2x2	4x4	4x4	2.5 G	Y/4.5 W	Y
DC Power	10	2x2	4x4	4x4	2.5 G	Y/4.5 W	Y

Note:

1. AIR-PWRINJ7 is C9164I's official 802.3bt Power Injector

USB = universal serial bus
AI = Artificial Intelligence
ML = Machine Learning

Catalyst CW9166 Power over Ethernet

Default Configuration (Fixed Power profile)

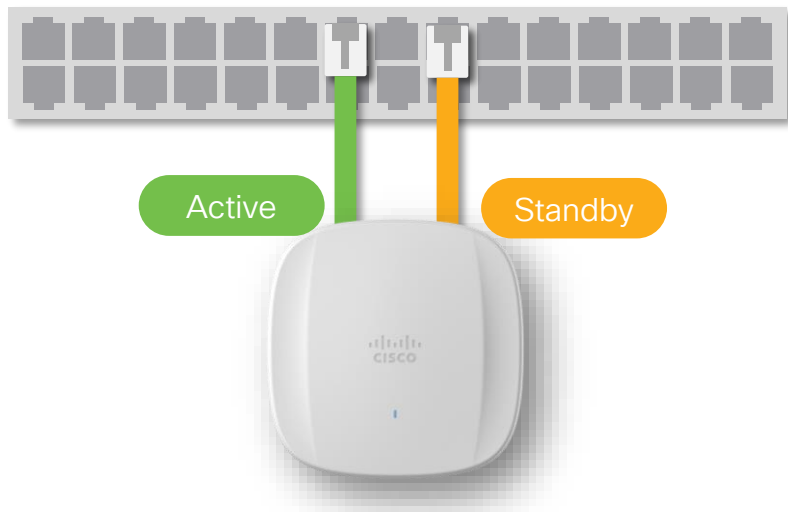
Power Source	Number of Spatial Stream	2.4 GHz Radio	5 GHz Radio	5 GHz / 6 GHz Radio (LPI)	mGig Link Speed	USB	Env Sensors	AI/ML Driven Scanning Radio
802.3af	n.a.	Disabled	Disabled	Disabled	1G	Disabled	Y	Y
802.3at	12	4x4	4x4	4x4	5G	Disabled	Y	Y
802.3bt	12	4x4	4x4	4x4	5G	Y/4.5 W	Y	Y
DC Power	12	4x4	4x4	4x4	5G	Y/4.5 W	Y	Y

Note:

1. AIR-PWRINJ7 is C9166I/D's official 802.3bt Power Injector

USB = universal serial bus
AI = Artificial Intelligence
ML = Machine Learning

Catalyst 9136 Power Consumption (dual port)



Both ports negotiate power and need to be considered for budget

If no-LAG, Standby port consumes very little power

If LAG, both ports are active, and they both draw power

Power Allocated

Power Consumed

48.3 W

16.5 W

48.3 W

0.5 W

Catalyst 9136I Power over Ethernet

Default Configuration (Fixed Power profile)

Power source	Number of spatial streams	2.4-GHz radio (slot 0)	Primary 5-GHz radio (slot 1)	Secondary 5-GHz radio (slot 2)	6-GHz radio (slot 3)	mGig PHY 0 link speed	mGig PHY 1 link speed	USB	AI/ML-driven scanning radio	Env. sensors	Max power draw
802.3af (PoE)	0	Disabled	Disabled		Disabled	1G	Disabled	Disabled	Y	Y	14W
802.3at (PoE+)	8	2x2	4x4	Disabled	2x2	2.5G	2.5G (Standby)	Disabled	Y	Y	24.4W
802.3bt (UPOE)	16	4x4	8x8 or dual 4x4		4x4	5G	5G	Yes/9W	Y	Y	47.3W

Note:

- Slot 2 can operate only together with slot 1 in 8x8 mode. Independent slot 2 operation is not supported until a future software release.
- AIR-PWRINJ7 is the 9136I's official 802.3bt power injector.

PHY = Physical layer
PoE = Power over Ethernet
UPoE = Universal Power over Ethernet

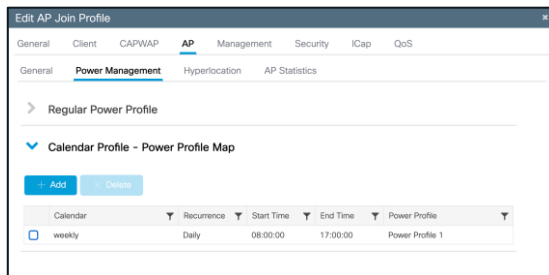
AP Power Optimizations Feature Suite

Save Power, Reallocate Power, and Visibility into Savings

AP Power Save Mode

Lower AP Power Usage

- Create a calendar profile for off-peak hours.
- Create a power profile to lower the power consumption budget during off-peak hours.
- Power Profile: Shut AP Radio or lower spatial Stream, lower port speed, disable USB port.

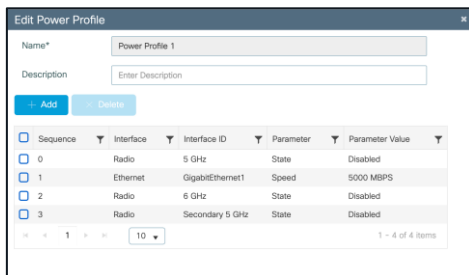


IOS-XE 17.8

AP Power Distribution

Control over how power is used

- Reallocate extra AP Power to different radios while operating on PoE+ (30W).
- Customization of your PoE power budget.
- Example: Disable 2.4 GHz radio -> use extra power for 6 GHz radio.



IOS-XE 17.10

AP Power Savings Insight

- Cisco Catalyst Center PoE dashboard integration.
- Power Savings, Money Savings, Emissions Reductions.
- Visibility into trends and insights.
- Both site level and AP level view.



Supported on 9115, 9120, 9130, 9136, 9166, 9164, 9162

Section Summary

1

Catalyst Wi-Fi 6E Access Point Portfolio:
CW9162, CW9164, CW9166(I & D1) & C9136
Meraki: MR57

2

Common Hardware and Migration

3

Switch Port Speed (> 1 G)
Cabling : Cat 5e, Cat 6, Cat 6A and above

4

PoE Requirements
Power Optimizations

5

Catalyst 9136 Dual mGig Link and PoE
Redundancy Options

RF Design



Setting the stage

-
- New 6 GHz Band
- Regulatory Considerations
- Protocol enhancements

AP Deployment

- AP Specs
- Power Requirements
- Switching Infrastructure

RF Design

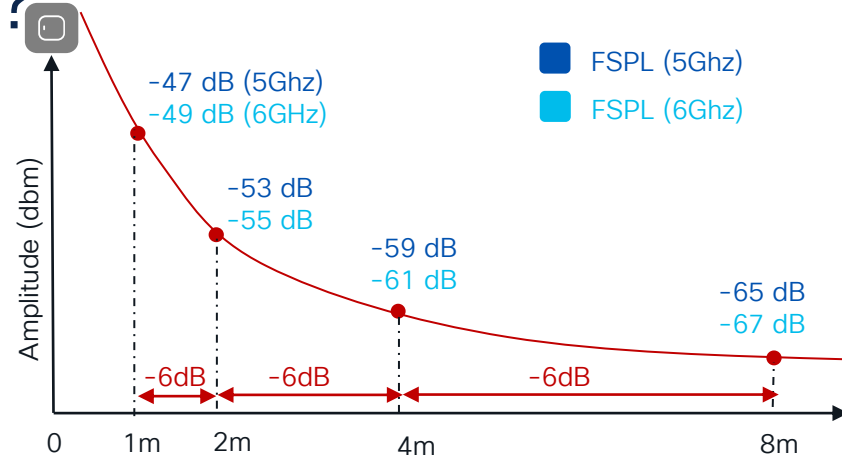
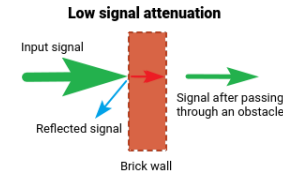
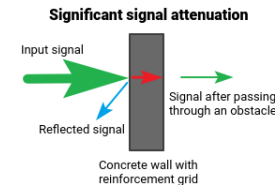
- AP Coverage
- AP Density
- Site Survey Mode

What you need to consider?

- **Path Loss (FSPL)*** - Path loss in the first meter is on average **2dB higher at 6GHz** vs. 5GHz. After that, the 6 dB rule applies: doubling the distance results in a 6 dB loss, regardless of the frequency
- **Cell Size** - At 6 GHz @ same power level cell is smaller vs. cell size at 5 GHz
- **Absorption/Reflectance** - 6 GHz will be attenuated more through wall or other surface
- **Noise floor** at 6 GHz is much lower than 5 GHz, at least for some time 😊
- **Coverage type**: Today 6GHz is indoor only

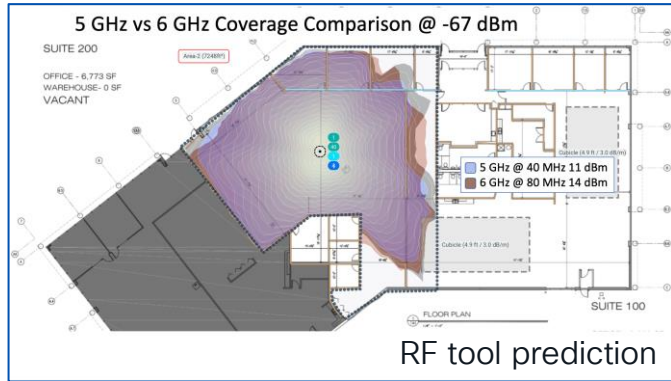
(*) FSPL = Free Space Path Loss: https://en.wikipedia.org/wiki/Free-space_path_loss

<https://help.keenetic.com/hc/en-us/articles/213968869-Wi-Fi-signal-attenuation-coefficients-when-passing-through-different-materials>



RF Design considerations

- AP antenna patterns at 6GHz are similar to 5GHz
- **AP coverage** between 5GHz and 6GHz will be similar, especially in open spaces BUT it does require to compensate with **power > 3dB higher in 6GHz**



- 5GHz @40 MHz 11dbm
- 6GHz @80 MHz 14 dbm

- With brick walls, elevator and other environments, you would probably need to measure and add few APs

Where are we then on 5 and 6 GHz assumptions?

Q1: Can a co-resident 6 GHz radio provide the same coverage as the 5 GHz cell while dramatically increasing performance?

A1: Yes!

Q2: Can a one for one replacement of Wi-Fi 6/5 APs with Wi-Fi 6E APs be achieved?

A2: Yes!

*Assuming 1.2 – 2k f² (140–190 m²) of average AP density, carpeted office normal ceiling (3 m /10 ft)



- 5 GHz network with RRM operating at power levels 3-4? >then equal 5 and 6 GHz coverage is possible with a one for one AP replacement in both ETSI and FCC. Assuming 80 MHz channel in FCC and 40 MHz channel in ETSI/UK
- If the power level is in 1-2, then you may need around 10 to 20% additional access points.

New Gear!!! Wi-Fi 6E Measurement !

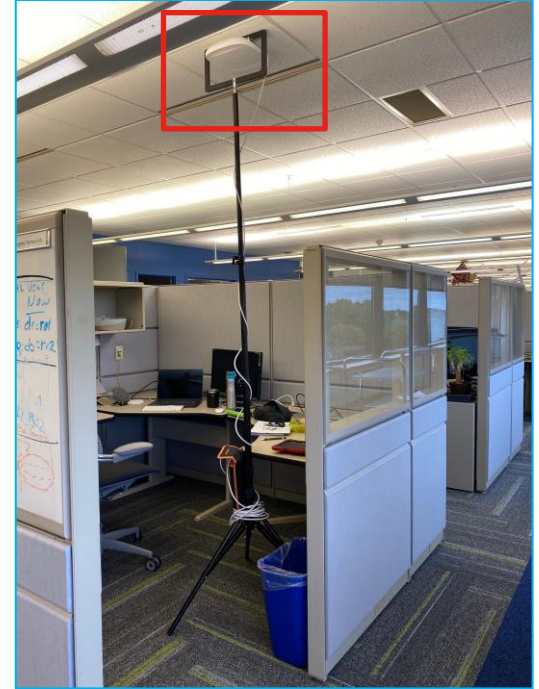
Ekahau Sidekick 2

- 2.4, 5, 6 GHz
- Ekahau AI Pro
- Ekahau Analyzer



NetAlly Aircheck G3 Pro

- 2.4, 5, 6 GHz
- NetAlly Link-Live



Hamina Integration – Work in progress!

Catalyst Wi-Fi 6E Site Survey Mode



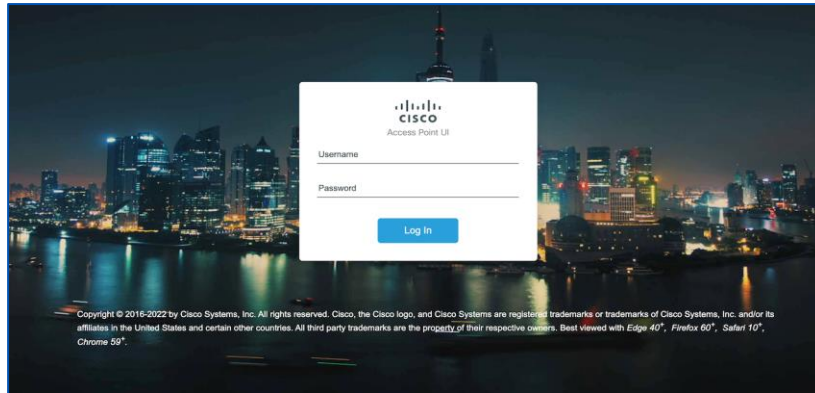
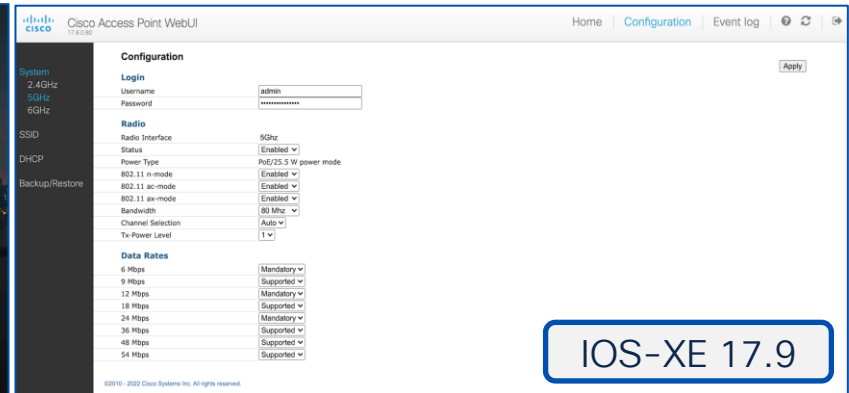
AP in standalone mode, broadcasting SSIDs across all 3 bands
Embedded DHCP server provides Client IP

WebUI access for easy configuration and viewing of various RF metrics for RF coverage and planning

Supports configuration of channel number, channel width, Tx power, SSID, and data rates

Site survey mode configuration steps

1. Change AP to site survey mode > Enter command “ap site-survey”
C9136#ap ?
capwap Switch to CAPWAP AP type
site-survey Switch to Site Survey AP type
2. After bootup, the AP is automatically assigned a static IP of 10.0.23.1.
3. AP will start broadcasting the **C9136_site_survey** with Open/OWE authentication security
4. Connect your wireless client with the site survey SSID and it'll receive an IP from 10.0.23.0/24
5. Access the Catalyst 9136 Site Survey WebUI via 10.0.23.1



6 GHz Predictive view with WCAE Tool

Get a taste of how the network would look, without adding any Aps!

WCAE Version: 0.9.11 or later

Configuration Checks:

- [Controller Checks Results](#)
- [APs Checks Results](#)

Controller: C9800-CL

- [Data Summary](#)
- [Log Summary](#)
- [Upgrade Advisor](#)
- [WLAN Summary](#)
- [Interface Summary](#)
- [RF Profiles 2.4 GHz](#)
- [RF Profiles 5 GHz](#)
- [RF Profiles 6 GHz](#)
- [Site Tags](#)
- [Resources](#)
- [AAA Server Details](#)
- [WNCD Load Distribution](#)
- [Tag/Policy Usage](#)
- [RF Stats 2.4GHz](#)
- [RF Stats 5GHz](#)
- [RF Stats 6GHz](#)
- [RF Health 2.4GHz](#)
- [RF Health 5GHz](#)
- [RF Health 6GHz](#)
- [Channel Stats 2.4GHz](#)
- [Channel Stats 5GHz](#)
- [Channel Stats 6GHz](#)

Client Audit

- [Apple IOS](#)
- [Cisco 8821](#)
- [Drager](#)
- [Spectralink](#)
- [Vocera](#)

AP Information

- [APs Configuration](#)
- [APs Slot Configuration](#)
- [APs Interface Status](#)
- [APs RF Summary 2.4GHz](#)
- [APs RF Summary 5GHz](#)
- [APs RF Summary 6GHz](#)
- [APs RF Health Details](#)
- [APs NDP Summarization 2.4GHz](#)
- [APs NDP Summarization 5GHz](#)
- [APs NDP Summarization 6GHz](#)
- [APs RF Neighbors 2.4GHz](#)
- [APs RF Neighbors 5GHz](#)
- [APs RF Neighbors 6GHz](#)
- [6GHz Predictive Planning](#)

6 GHz Predictive view with WCAE Tool

6GHz predictive” view of how the power distribution, Nearby relationships, and RSSI for clients would look.

Name	Radio Mac	Slot	Country	5GHz Power Level	5GHz Power dBm	6GHz Predicted Level	6GHz Predicted dBm	5GHz Effective Neighbors	Predicted 6GHz Neighbors
AP1	08-4F-A9-9C-E3-00	1	US	5	8	4	8	15	2
AP2	08-4F-A9-9C-E3-01	1	US	3	14	2	14	11	8
AP3	08-4F-A9-9C-E3-02	1	US	4	11	3	11	12	9
AP4	08-4F-A9-9C-E3-03	1	US	4	11	3	11	8	6
AP5	08-4F-A9-9C-E3-04	1	US	4	11	3	11	19	14
AP6	08-4F-A9-9C-E3-05	1	US	3	14	2	14	10	8
AP7	08-4F-A9-9C-E3-06	1	US	3	17	1	17	11	7
AP8	08-4F-A9-9C-E3-07	1	US	4	11	3	11	16	10
AP9	08-4F-A9-9C-E3-08	1	US	2	17	1	17	4	4
AP10	08-4F-A9-9C-E3-09	1	US	4	11	3	11	13	12
AP11	08-4F-A9-9C-E3-10	1	US	1	20	1	17	4	3
AP12	08-4F-A9-9C-E3-11	1	US	5	8	4	8	22	13
AP13	08-4F-A9-9C-E3-12	1	US	4	11	3	11	10	8
AP14	08-4F-A9-9C-E3-13	1	US	3	14	2	14	11	8
AP15	08-4F-A9-9C-E3-14	1	US	4	11	3	11	24	16
AP16	08-4F-A9-9C-E3-15	1	US	5	8	4	8	12	9
AP17	08-4F-A9-9C-E3-16	1	US	5	11	3	11	23	16
AP18	08-4F-A9-9C-E3-17	1	US	5	8	4	8	10	10
AP19	08-4F-A9-9C-E3-18	1	US	5	8	4	8	16	12
AP20	08-4F-A9-9C-E3-19	1	US	4	11	3	11	16	10
AP21	08-4F-A9-9C-E3-20	1	US	4	11	3	11	11	9
AP22	08-4F-A9-9C-E3-21	1	US	5	8	4	8	11	9
AP23	08-4F-A9-9C-E3-22	1	US	5	11	3	11	18	9
AP24	08-4F-A9-9C-E3-23	1	US	4	11	3	11	17	10
AP25	08-4F-A9-9C-E3-24	1	US	1	20	1	17	1	1
AP26	08-4F-A9-9C-E3-25	1	US	4	11	3	11	11	6
AP27	08-4F-A9-9C-E3-26	1	US	2	17	1	17	9	8
AP28	08-4F-A9-9C-E3-27	1	US	1	20	1	17	1	1
AP29	08-4F-A9-9C-E3-28	1	US	5	11	3	11	24	13
AP30	08-4F-A9-9C-E3-29	1	US	5	11	3	11	24	17
AP31	08-4F-A9-9C-E3-30	1	US	4	11	3	11	11	10
AP-HQS-SQN-2001	08-4F-A9-9D-B1-C0		US	4	14	2	14	16	10

Matches FCC or ETSI regulatory requirements.

WLAN Design

Setting the stage

-
- New 6 GHz Band
- Regulatory Considerations
- Protocol enhancements

AP Deployment

- AP Specs
- Power Requirements
- Switching Infrastructure

RF Design

- AP Coverage
- AP Density
- Site Survey Mode

WLAN Network Design

- Wi-Fi 6E Security
- WLAN/SSID Design
- Client Ecosystem



Wi-Fi 6E – Security

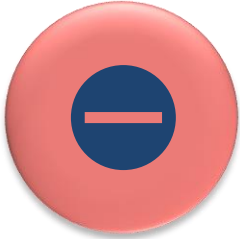
Wi-Fi 6E Security



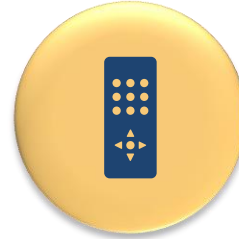
Wi-Fi 6E uplevels security.
WPA3 L2 Security: OWE,
SAE*, 802.1x-SHA256



WPA3 and Enhanced Open
Security made mandatory
for Wi-Fi 6E certification.



No backward compatibility
with Open and WPA2
Security.



Requires Protected
Management Frame (PMF)
in both AP and Clients.

*Only SAE-H2E (Hash to Element) Method Supported.
SAE (Hunting N Pecking) – Not Supported

AKM = Authentication and Key Management
OWE = Opportunistic Wireless Encryption
SAE = Simultaneous Authentication of Equals
SHA-256 = Secure Hash Algorithm (SHA) 256 bit

WLAN/SSID Design

6GHz WLAN Design Considerations

What options would you have?

1

"All-In" Option: Reconfigure the existing WLAN to WPA3, one SSID for all radio policies (2.4/5/6 GHz) – **Most unlikely**

2

"One SSID" Option: Configure one WLANs with same SSID name, different security settings – **Most conservative**

3

"Multiple SSIDs" Option: Redesign your SSIDs, adding specific SSID/WLAN with specific security settings – **Most flexible**

Most likely your current SSID configuration would prevent it from being broadcasted on 6GHz
Note: as of 17.9.4, there is a limit of 8 SSIDs broadcasted on 6GHz radio

Option 1



Pros

- Cleanest and simplest option
- No new WLAN and SSID to be managed
- Most secure with WPA3 everywhere



Cons

- Breaks support for existing clients that don't support WPA3 and PMF in 2.4 and 5GHz
- Requires full control on client devices and drivers

Option 2



Option 2 – WLAN Design Considerations

Single WLAN Profile for 2.4/5 and 6 GHz

General Security Advanced Add To Policy Tags

Profile Name* enterprise

SSID* enterprise

WLAN ID* 8

Status ENABLED

Broadcast SSID ENABLED

Radio Policy 1

6 GHz Status ENABLED

5 GHz Status ENABLED

2.4 GHz Status ENABLED

802.11b/g Policy

- L2 Security would be WPA2+ WPA3.
- AKM should be set to **802.1x-SHA256** and **802.1x (SHA1)** for Enterprise; SAE and PSK for Personal.
- PMF as **Optional**
- How to configure the client side?
 - For clients that don't support 6 GHz, configure a **WPA2 profile or WPA3 Enterprise with PMF as Optional** depending on the client support.
 - For clients that support 6 GHz, configure **WPA3 Enterprise**. They will use these settings to connect to both 2.4/5 GHz and 6GHz

General Security Advanced Add To Policy Tags

Layer2 Layer3 AAA

WPA + WPA2 WPA2 + WPA3 WPA3 Static WEP None

MAC Filtering

Lobby Admin Access

WPA Parameters

WPA Policy GTK Randomize WPA2 Policy WPA3 Policy Transition Disable

WPA2/WPA3 Encryption

AES(CCMP128) GCMP128 CCMP256 GCMP256

Protected Management Frame

PMF Optional

Association Comeback Timer* 1

Fast Transition

Status Adaptive Ena... Over the DS Reassociation Timeout * 20

Auth Key Mgmt

802.1X CCKM FT + SAE FT + 802.1X 802.1X-SHA256 PSK SAE OWE FT + PSK PSK-SHA256

WFA = Wi-Fi Alliance

Option 3



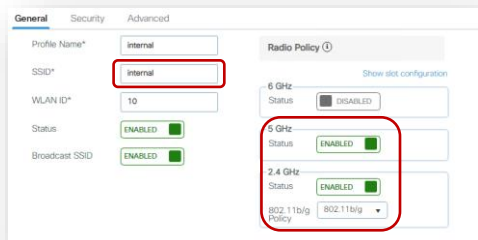
Option 3 – WLAN design considerations

- **Option 3:** Redesign the SSIDs. This entails adding a WPA3 separate SSID for 6GHz and then decide which bands to enable to address different customer use cases.
 - **Example 1:** customer wants to adopt 6GHz without touching the existing SSIDs > add a separate SSID with WPA3 and broadcast it in all bands.
 - **Example 2:** Customer wants to redesign the SSIDs dedicating each band for a specific device/use case

Option 3 > Example 1

Add a separate WLAN with different SSID name for WPA3 and broadcast it in all bands. Leave the existing WLAN/SSID untouched.

Legacy SSID



General Security Advanced

Profile Name* internal

SSID* internal

WLAN ID* 10

Status ENABLED

Broadcast SSID ENABLED

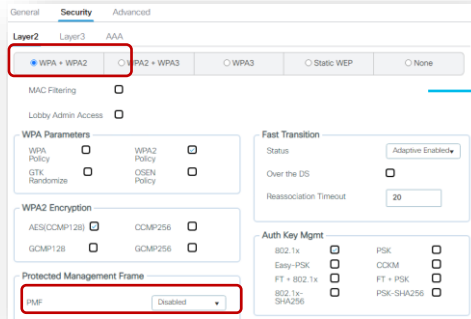
Radio Policy ①

6 GHz Status DISABLED

5 GHz Status ENABLED

2.4 GHz Status ENABLED

802.11b/g Policy 802.11b/g



General Security Advanced

Layer2 Layer3 AAA

WPA + WPA2 WPA2 + WPA3 WPA3 Static WEP None

MAC Filtering

Lobby Admin Access

WPA Parameters

WPA Policy WPA2 Policy

GTK Randomize GTK Randomize

WPA2 Encryption

AES/CCMP128 CCMP256

GCMP128 GCMP256

Protected Management Frame

PMF Disabled

Fast Transition

Status Adaptive Enable

Over the DS

Reassociation Timeout 20

Auth Key Mgmt

802.1x PSK

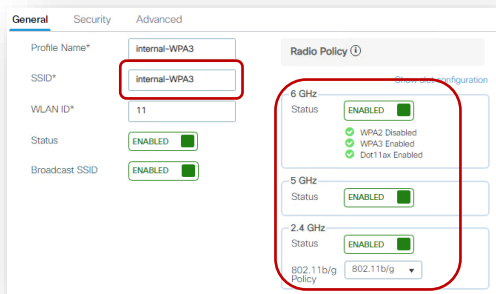
Easy-PSK CCKM

FT + 802.1x FT + PSK

802.1x- SHA256 PSK-SHA256

Existing WPA/WPA2 SSID in 2.4 and 5GHz for legacy clients

New SSID



General Security Advanced

Profile Name* Internal-WPA3

SSID* Internal-WPA3

WLAN ID* 11

Status ENABLED

Broadcast SSID ENABLED

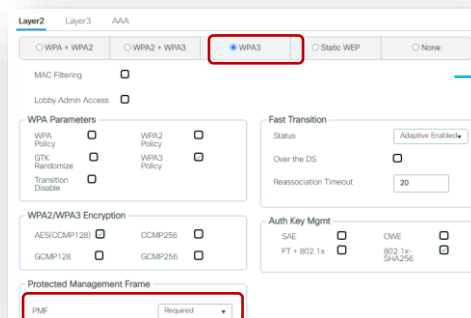
Radio Policy ①

6 GHz Status ENABLED

5 GHz Status ENABLED

2.4 GHz Status ENABLED

802.11b/g Policy 802.11b/g



General Security Advanced

Layer2 Layer3 AAA

WPA + WPA2 WPA2 + WPA3 WPA3 Static WEP None

MAC Filtering

Lobby Admin Access

WPA Parameters

WPA Policy WPA2 Policy

GTK Randomize GTK Randomize

WPA2/WPA3 Encryption

AES/CCMP128 CCMP256

GCMP128 GCMP256

Protected Management Frame

PMF Required

Fast Transition

Status Adaptive Enable

Over the DS

Reassociation Timeout 20

Auth Key Mgmt

SAE OWE

FT + 802.1x 802.1x- SHA256

Dedicated SSID for WPA3 (new name) capable clients in all bands. This is the SSID for 6GHz

Option 3 > Example 2

Redesign the WLANs, reserving each band for a specific device/use case



General Security Advanced Add To Policy Tags

Profile Name* IoT

SSID* IoT-2.4GHz

WLAN ID* 8

Status ENABLED

Broadcast SSID ENABLED

Radio Policy ①

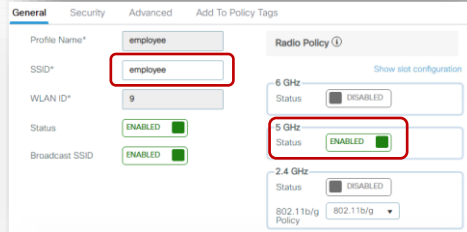
6 GHz Status DISABLED

5 GHz Status DISABLED

2.4 GHz Status ENABLED

802.11b/g Policy 802.11b/g

2.4GHz dedicated to specific devices. These could be legacy devices or IoT devices. If IoT will be mostly PSK



General Security Advanced Add To Policy Tags

Profile Name* employee

SSID* employee

WLAN ID* 9

Status ENABLED

Broadcast SSID ENABLED

Radio Policy ①

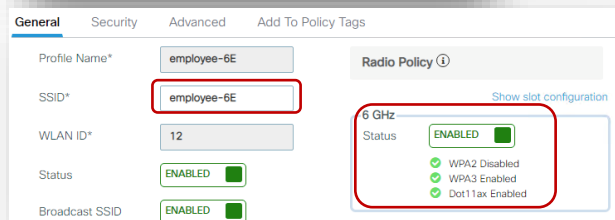
6 GHz Status DISABLED

5 GHz Status ENABLED

2.4 GHz Status DISABLED

802.11b/g Policy 802.11b/g

5GHz dedicated to majority of existing clients (WPA2)



General Security Advanced Add To Policy Tags

Profile Name* employee-6E

SSID* employee-6E

WLAN ID* 12

Status ENABLED

Broadcast SSID ENABLED

Radio Policy ①

6 GHz Status ENABLED

WPA2 Disabled

WPA3 Enabled

Dot11ax Enabled

WPA3 on on all bands, for the newer clients

Option 3



Pros

- Cleanest option from a client compatibility point of view
- Most secure options as clients can adopt WPA3 security
- WPA3 clients can roam across different bands
- Automated via DNA Center



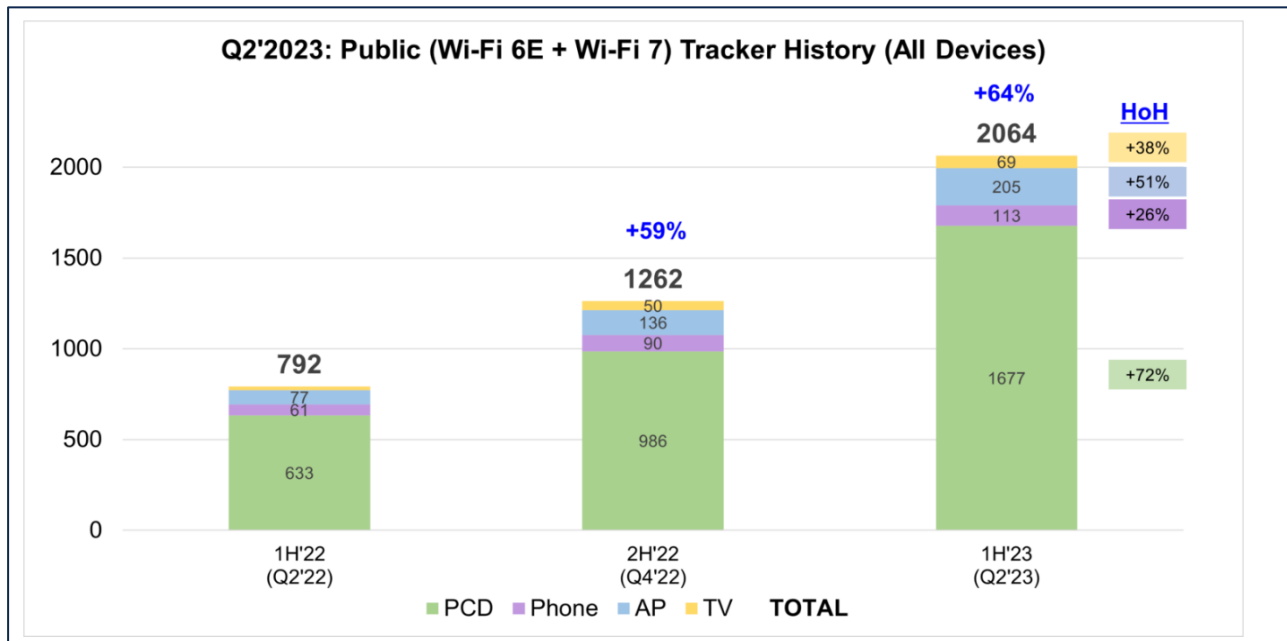
Cons

- Additional SSIDs to configure & manage on WLC
- Need to manage additional SSID profiles on clients



Wi-Fi 6E – Client Eco System

Wi-Fi 6E Device Support



Source: <https://wifinowglobal.com/news-blog/intel-ecosystem-tracking-2064-wi-fi-6e-devices-now-available-wi-fi-7-reaches-67-devices/>

Getting clients to join 6E – from bad to better

Bad: Early days of 6E

6E Capable clients *a/ways* preferred 5 GHz



Better: Now

More of 6E-capable clients join 6 GHz*



Working closely with client
device vendors



Recommendations:

1. Upgrade to the Latest Driver
2. Configure Client Steering Feature
(to move 6 GHz capable clients to 6 GHz Radio)

* Assuming latest driver

Section Summary

1

Wi-Fi 6E Security Uplevelled:
WPA3 with PMF Mandatory

2

WLAN Design : 3 Options
("ALL-IN", "One-SSID" and "Multiple-SSIDs")

3

Wi-Fi 6E Client Eco System

4

Recommendations

Wi-Fi Network Design

Setting the stage

- New 6 GHz Band
- Regulatory Considerations
- Protocol enhancements

AP Deployment

- AP Specs
- Power Requirements
- Switching Infrastructure

RF Design

- AP Coverage
- AP Density
- Site-Survey Mode

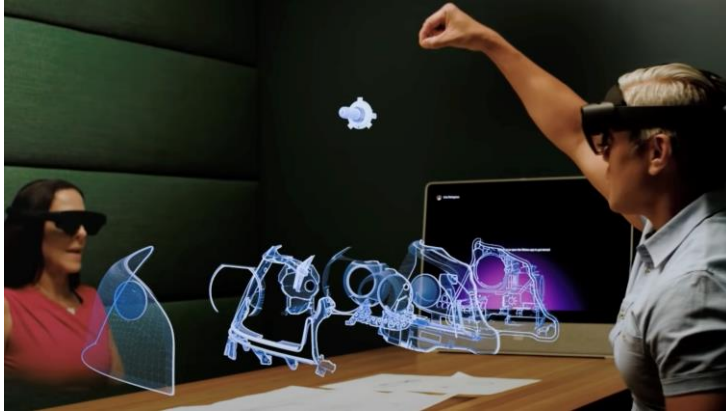
WLAN Design

- Wi-Fi 6E Security
- WLAN/SSID Design
- Client Ecosystem

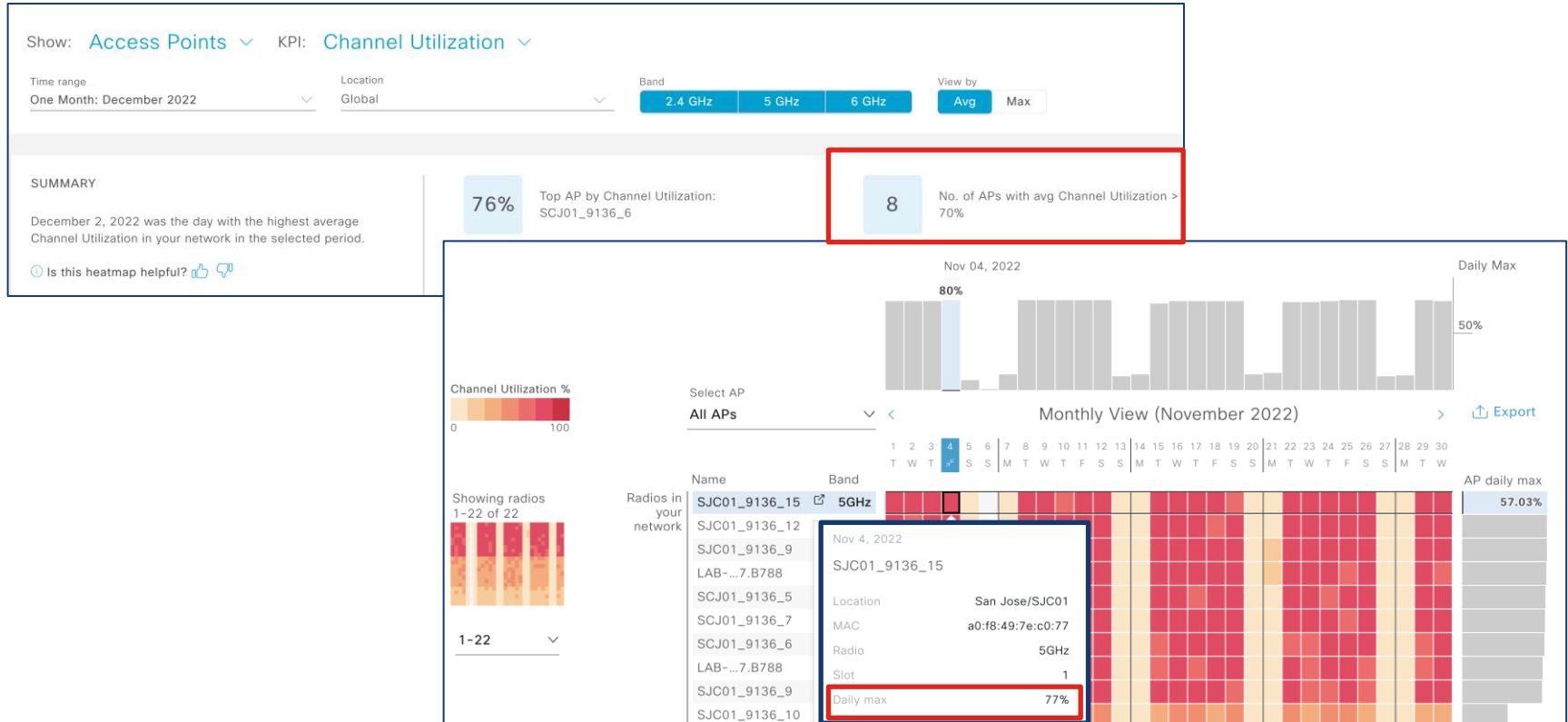
Wi-Fi Network Design

- Adoption
- Migration Scenarios
- IRCM

Start with Use Cases



Observe Channel Utilization in your Network



Observe the Client Types in your Network

Readiness and benefits of 6 GHz from Cisco DNAC 2.3.2

Readiness

Client Distribution by Capability

LATEST

TREND

Status: Wi-Fi 6E ▾

43% of Wi-Fi 6E clients are associated to a Wi-Fi 6E network



Client Capability

- Wi-Fi 6E
- Wi-Fi 6
- 11ac

Wi-Fi 6E Clients Status

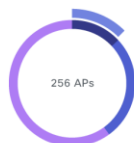
- Wi-Fi 6E Associated
- Wi-Fi 6 Associated

[View Details](#)

Network Readiness

Status: Wi-Fi 6E ▾

Your network is 100% Wi-Fi 6E enabled



Network

- Wi-Fi 6E APs
- Wi-Fi 6 APs
- Non Wi-Fi 6 APs

Wi-Fi 6E Status

- Enabled
- Partially Enabled

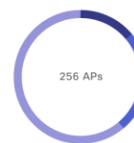
[View Details](#)

AP Distribution by Protocol

LATEST

TREND

22.33% of APs are Wi-Fi 6E capable



- Wi-Fi 6E
- Wi-Fi 6
- 11ac

[View Details](#)

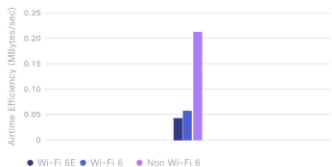
Wireless Airtime Efficiency

LATEST

TREND

View: Voice ▾

Voice is 70% more efficient on a Wi-Fi 6E network



- Wi-Fi 6E
- Wi-Fi 6
- Non Wi-Fi 6

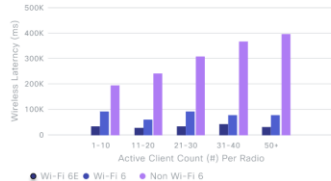
[View Details](#)

Wireless Latency by Client Count

LATEST

TREND

View: Voice ▾



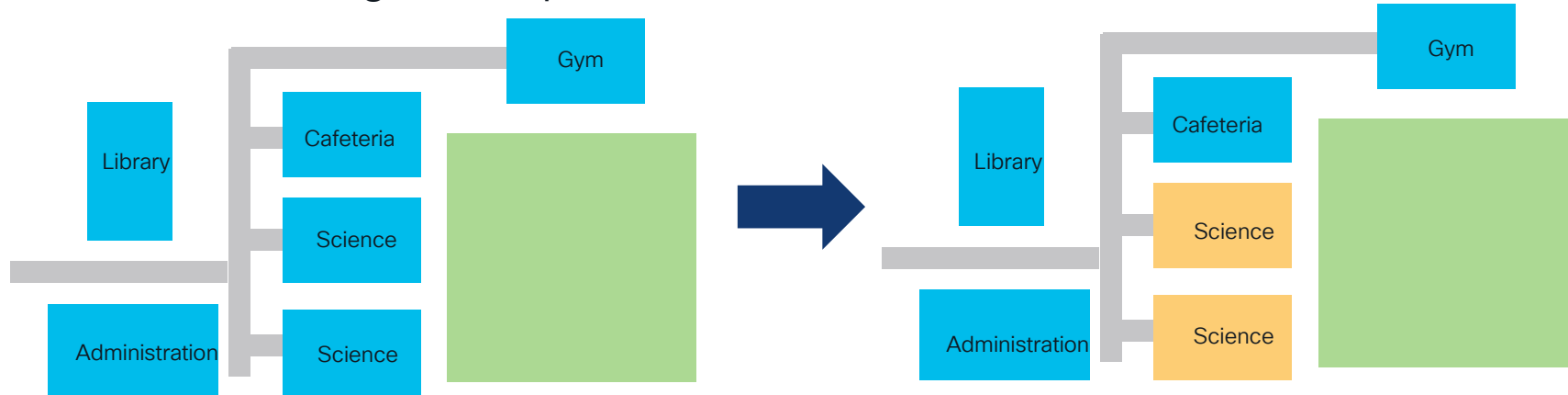
- Wi-Fi 6E
- Wi-Fi 6
- Non Wi-Fi 6

[View Details](#)

Benefits

Migration Scenarios

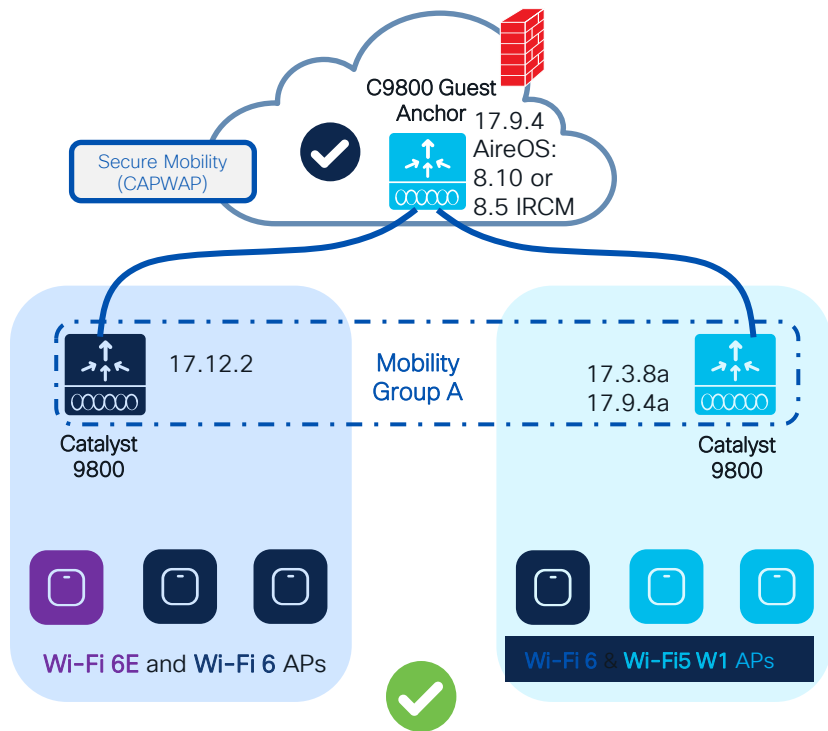
- Move “per RF blocks”
- Move a building or complete floor into the new hardware and software



Avoid “Sale & Pepper” Deployments. Do not mix APs on different controllers at same time.

How do I start adopting 6GHz?

Answer: Inter Release Controller Mobility (IRCM)

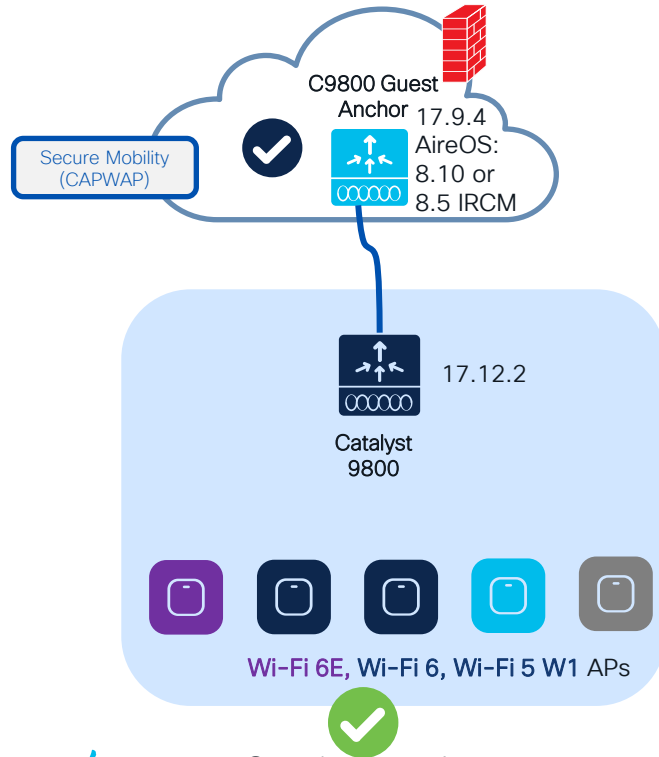


Scenario 1: If you're in IOS-XE 17.3.x, 17.6.x, 17.9.x code

- If you have already started your C9800 journey... & Wave 1 Aps are still present (1700/2700/3700).
- Introduce new AP hardware on the new supported IOS XE release and support seamless roaming and Guest Anchor with existing C9800 networks
- The release combinations shown have been tested at scale, check IRCM deployment guide*
- Fast & secure roam will only be supported if the WLAN profile is the same on the two WLCs
- **Note:** Anchor can be on AireOS as well (8.10 or 8.5 IRCM latest)

(*) https://www.cisco.com/c/en/us/td/docs/wireless/controller/technotes/8-8/b_c9800_wireless_controller-aios_ircm_dg.html

How do I start adopting 6GHz?



Scenario 2: If you have already started your C9800 journey

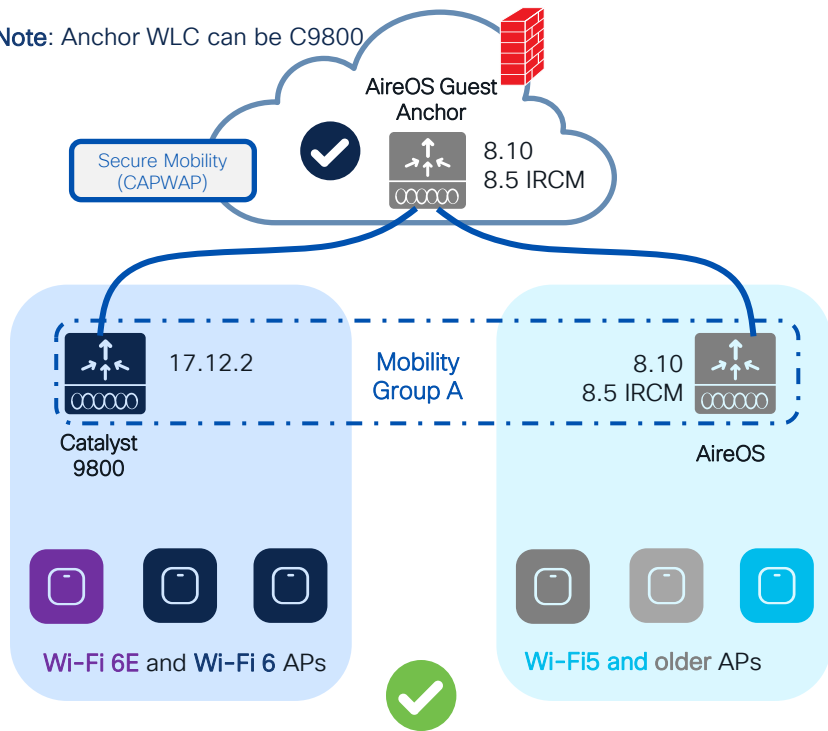
- Controller code is 17.12.1
- Wave 1 Aps support added (1700/2700/3700).
- **Note:** Anchor can be on AireOS as well (8.10 or 8.5 IRCM latest)
- **Note:** 17.12.1 for APJ Countries

(*) https://www.cisco.com/c/en/us/td/docs/wireless/controller/technotes/8-8/b_c9800_wireless_controller-aires_ircm_dg.html

How do I start adopting 6GHz?

Answer: Inter Release Controller Mobility (IRCM)

Note: Anchor WLC can be C9800



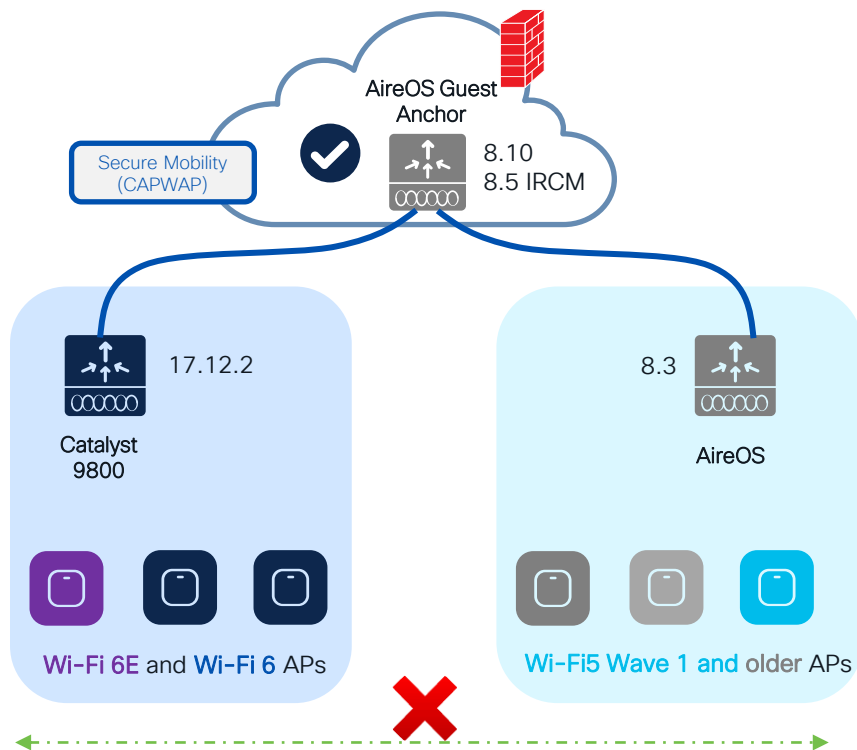
Scenario 1: Legacy Controller Supports IRCM

- Introduce new 6/6E AP hardware on the new C9800 and support seamless roaming and Guest Anchor with existing networks
- This method allows the smooth coexistence of both controllers, with RF areas migrated as needed, without any overnight switchover.
- Things to consider:
 - If the controller is limited to 8.5 (5508, 8510), we will need a special IRCM version (8.5.182.104), to connect them to IOS-XE
 - Best to split the RF network into different areas, configuring different RF group names between the legacy and IOS-XE controllers.
 - Always configure the primary/secondary controller name in access points. The new controllers will reject unsupported APs, but if any AP could work in both controller types, this will avoid APs joining the wrong one, or flip-flopping between them, until the migration is ready to proceed
- Fast & secure roam will only be supported if the WLAN profile is the same on the two WLCs

(*) https://www.cisco.com/c/en/us/td/docs/wireless/controller/technotes/8-8/b_c9800_wireless_controller-aires_ircm_dg.html

How do I start adopting 6GHz?

Answer: Inter Release Controller Mobility (IRCM)



No Seamless roaming

Scenario 2: Legacy Controller not supporting IRCM

- Not possible to establish IRCM between old controller and new 9800 handling 6E Aps
- Limits options available. Forces more aggressive migration process.
- Migration alternatives:
 - Keep the two networks separated ; migrate physical RF areas as new Aps are added.
 - Roaming is not possible.
 - Avoid migrations “per floor” as in most building types, it is normal to see clients roaming between Aps on different floor.
 - Temporarily, replace the legacy controller with one that supports IRCM.
- The release combinations shown have been tested at scale, check IRCM deployment guide*

(*) https://www.cisco.com/c/en/us/td/docs/wireless/controller/technotes/8-8/b_c9800_wireless_controller-aires_ircm_dg.html

Wi-Fi 6E, are you
ready?

Wi-Fi 6E, are you ready?



Is this the right time
to move to 6 GHz?



Start with use cases not technology: go with 6GHz if your 2.4/5GHz RF is crowded, if applications are delay sensitive and bandwidth hungry



Check your
infrastructure



Consider the switch infrastructure
Verify the power budget



Prepare your
wireless



Evaluate the implications on RF and WLAN design

CISCO *Live!*

Did you know?

You can have a
one-on-one session with
a technical expert!

Visit Meet the Expert in The HUB
to meet, greet, whiteboard & gain
insights about your unique questions
with the best of the best.



Meet the Expert Opening Hours:

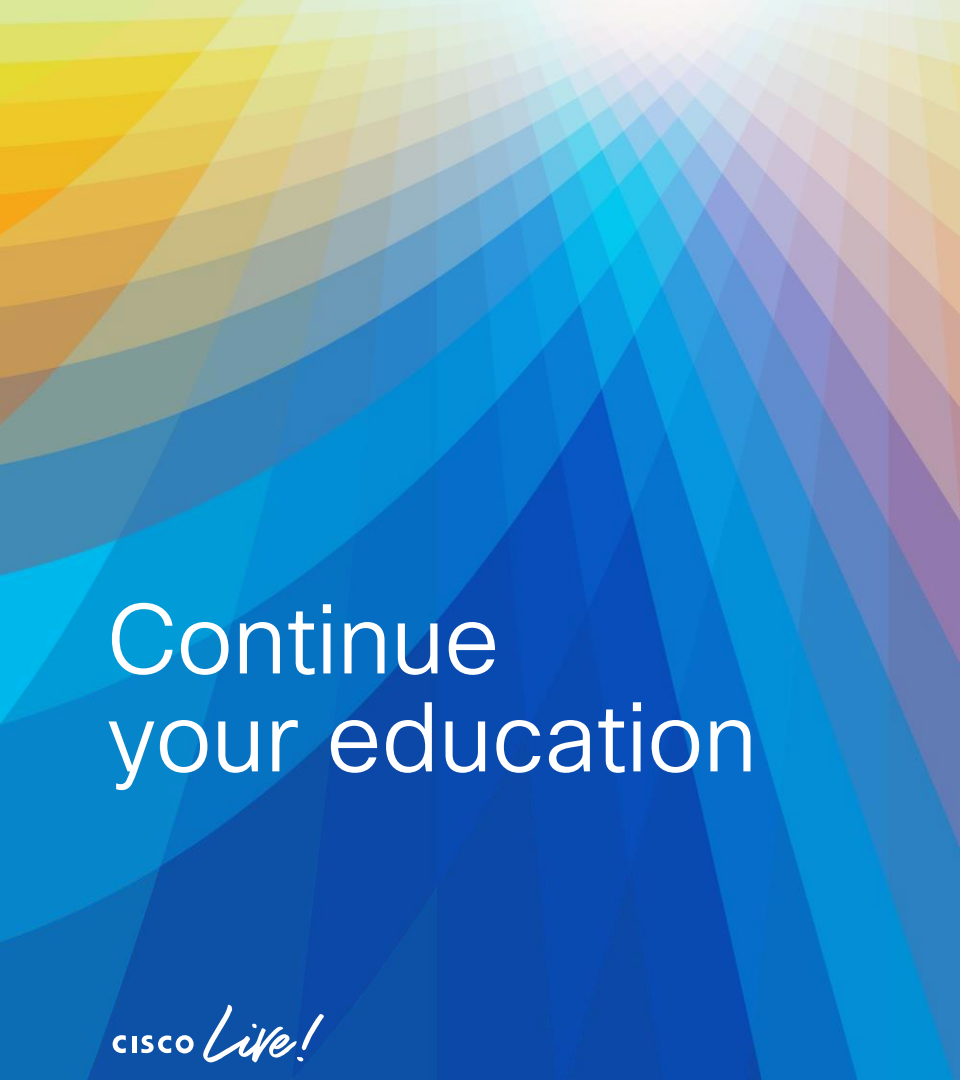
Tuesday	3:00pm – 7:00pm
Wednesday	11:15am – 7:00pm
Thursday	9:30am – 4:00pm
Friday	10:30am – 1:30pm

Session Surveys

We would love to know your feedback on this session!

- Complete a minimum of four session surveys and the overall event surveys to claim a Cisco Live T-Shirt





Continue your education

CISCO *Live!*

- Visit the Cisco Showcase for related demos
- Book your one-on-one Meet the Expert meeting
- Attend the interactive education with DevNet, Capture the Flag, and Walk-in Labs
- Visit the On-Demand Library for more sessions at www.CiscoLive.com/on-demand



The bridge to possible

Thank you

CISCO *Live!*

#CiscoLiveAPJC

The background features a vibrant, multi-colored abstract design. On the left, there are horizontal, wavy bands of color in shades of red, orange, yellow, and green. On the right, a bright white light source emits a series of colorful rays in shades of blue, green, and yellow, creating a sunburst effect.

cisco *Live!*

Let's go

#CiscoLiveAPJC