

The background features a vibrant, abstract design with a color gradient from dark blue on the left to bright yellow and white on the right. The design consists of overlapping, wavy horizontal bands and a series of radiating lines that create a sense of motion and energy, resembling a stylized sunburst or a dynamic wave pattern.

CISCO *Live!*

Let's go



The bridge to possible

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

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Senior Technical Leader, Technical Marketing

# Agenda

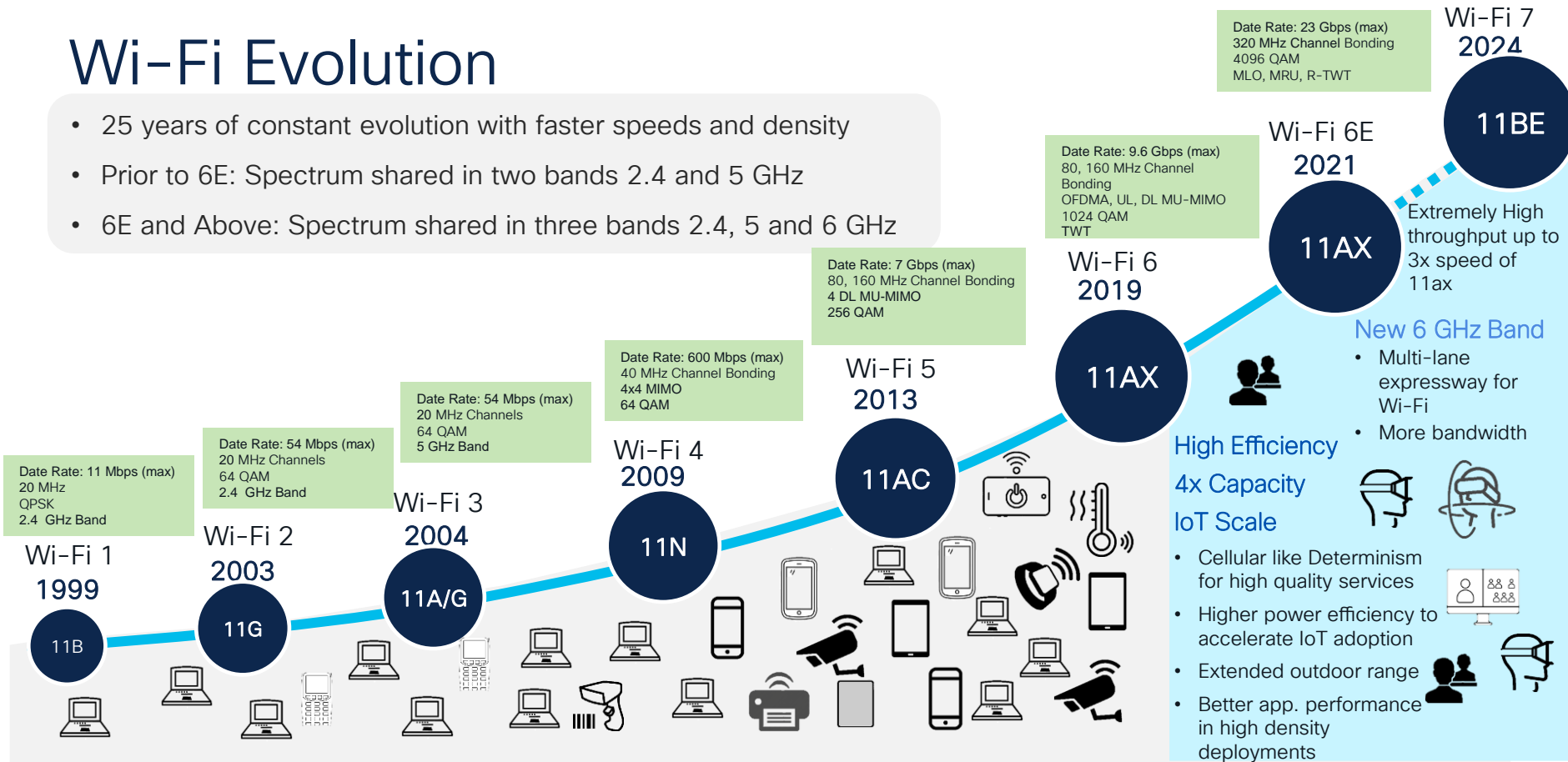






# Wi-Fi Evolution

- 25 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





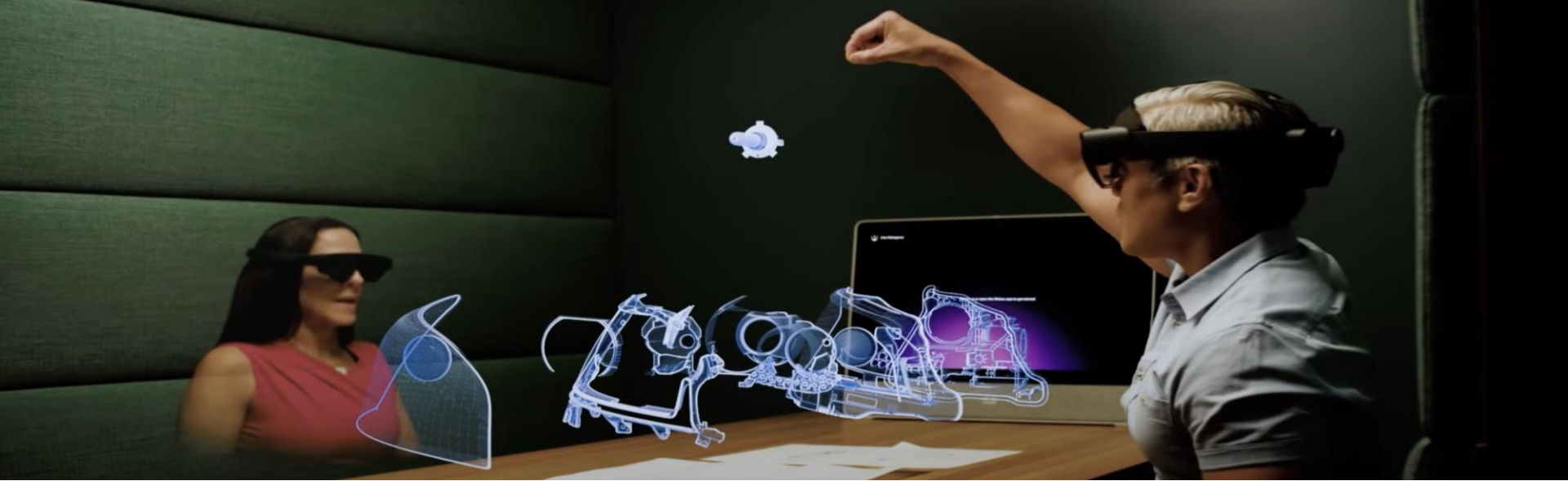
# Why Wi-Fi 6E ?



# Primitive applications of the past to ....



# Immersive Experiences of Today...

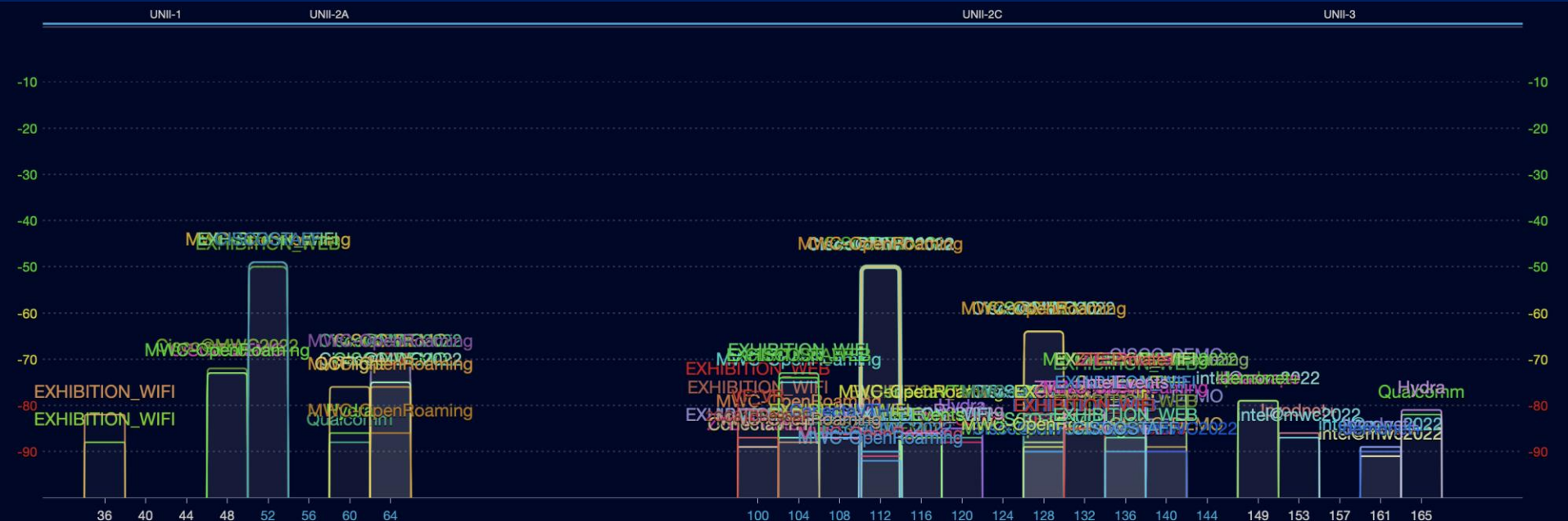


Webex Hologram <https://www.youtube.com/watch?v=YEx7h0NKnXE>

# and Tomorrow...

# What is the Problem?

- Existing 2.4 GHz and 5 GHz spectrum is congested
- Interference
- Limited re-usable channels
- No way to use 80 or 160 MHz channels



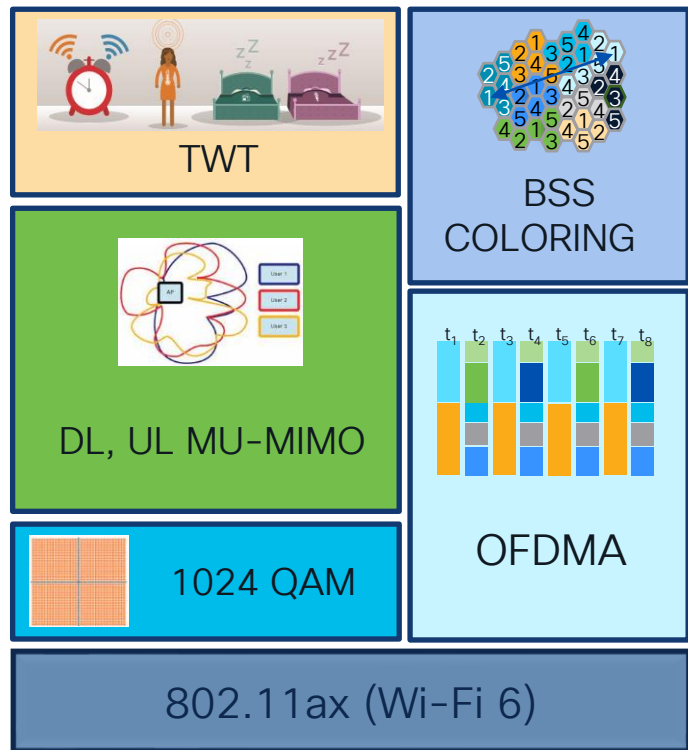


# Pre Wi-Fi 6E



# 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

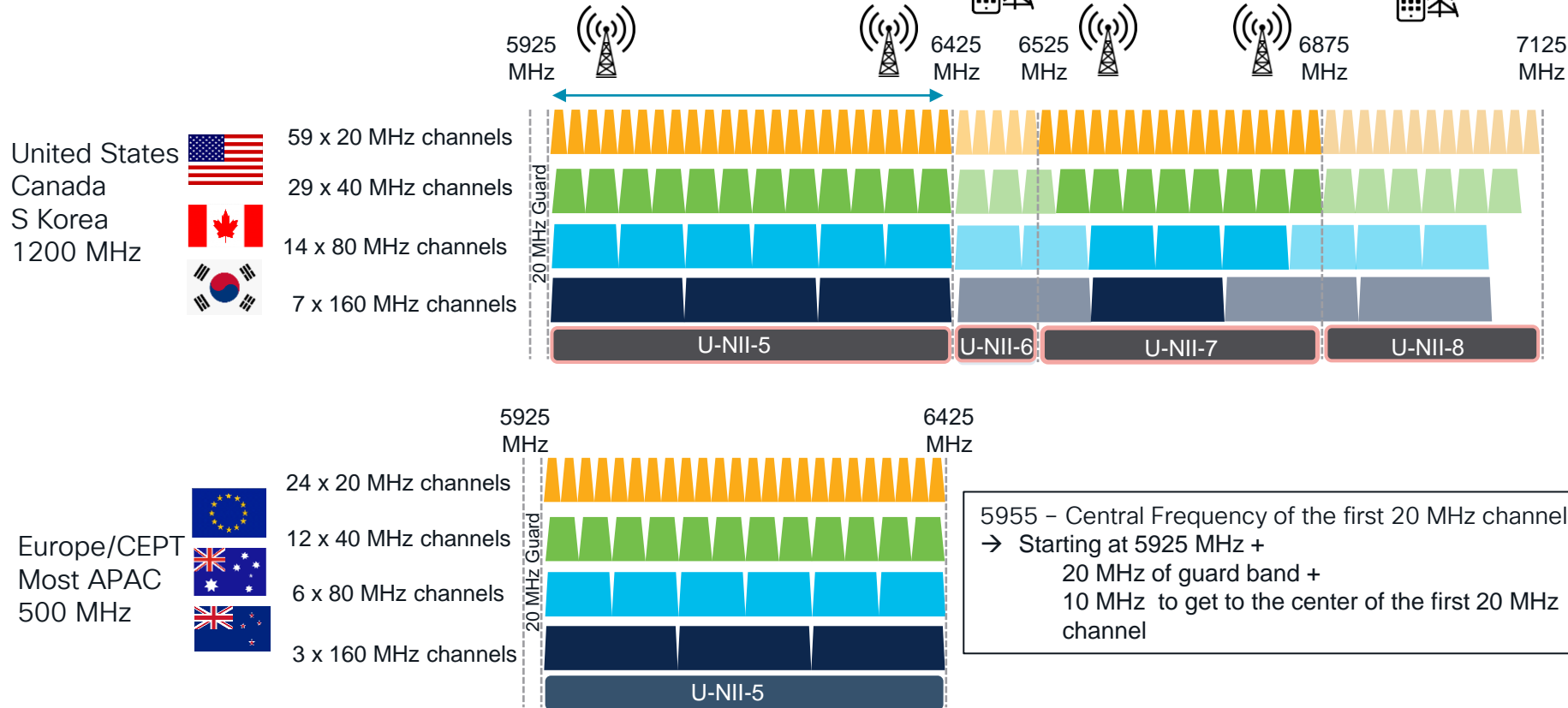
1200 MHz

- 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

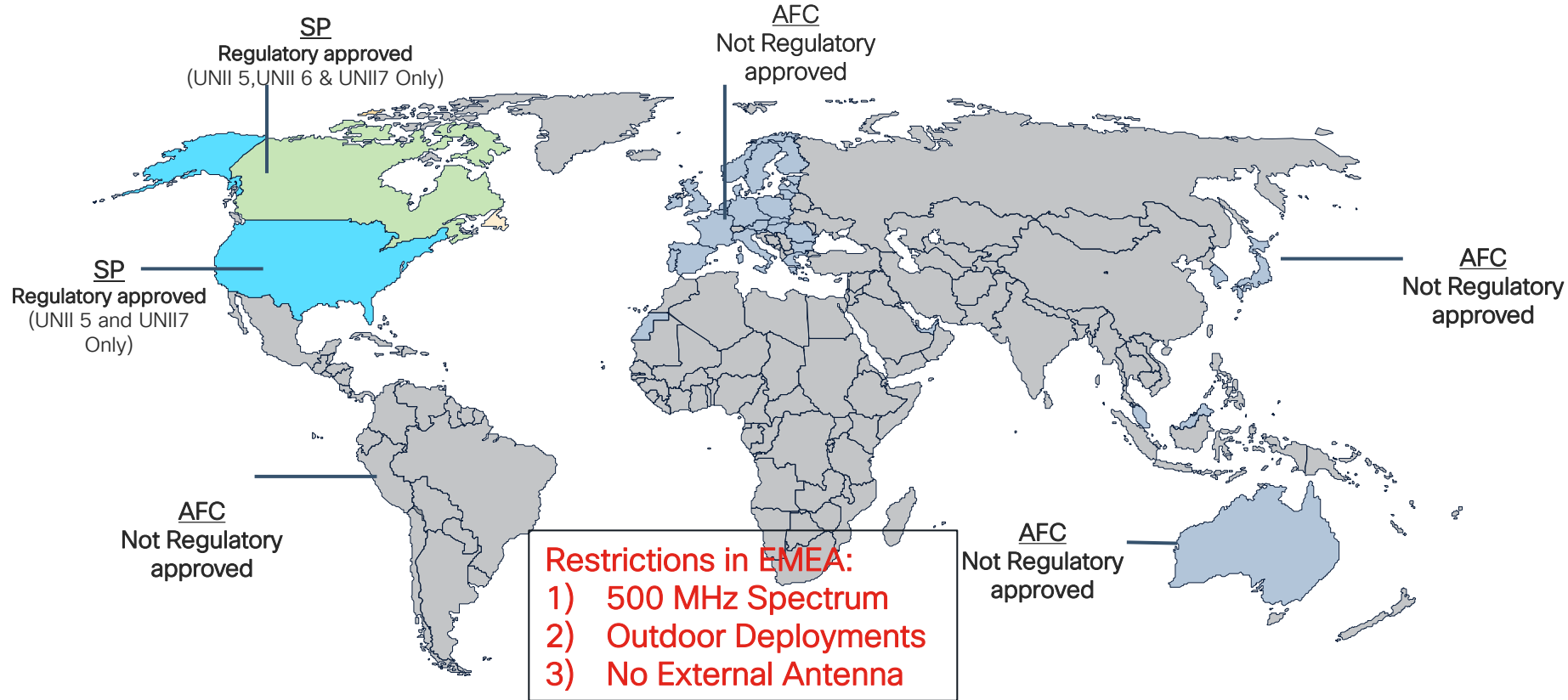


Client Devices

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

Regulations vary by country

# External(SP)/Outdoor Antenna 6GHz Status



AFC approved in USA & Canada

# What's next for spectrum in Europe?



- Equal status to Wi-Fi and 5G in 6425–7125 MHz in Region 1
- Saudi Arabia has allotted 1200 MHz for Indoor & Outdoor; Russia going to allot 100% of spectrum for 5G.
- Rules & Implementation may vary from country to country
- CEPT currently has couple ongoing work items studying 6 GHz use cases.
  - Low Power Indoor (LPI) use in 6425–7125 MHz
  - Outdoor and higher power use in the lower band (5945–6425 MHz)

# In the interim ....



- Use of 1200 MHz for outdoor operation on an exceptional or lightly licensed basis.
- Possible applications include football stadiums, hospitals, large factories, mining.
- Cisco is working with regulators to make this opportunity a reality.

# Summary 6GHz Tx Requirements

- Breaking down the PSD Values vs Max TX EIRP
  - FCC = 3 dB more power per channel width doubling and MAX TX EIRP of 30 dBm
  - ETSI/UK = PSD value = MAX TX EIRP at 20 MHz, remaining channel widths = Max TX EIRP

Mode	Country	Max Tx Power EIRP		Max PSD EIRP	
	(Frequency Range MHz)	AP (dBm)	Client (dBm)	AP (dBm)	Client (dBm)
	FCC (5925-7125)	30	24	5	-1
	ETSI (5945-6425)	23	23	10	10
	UK (5925-6425)	24	24	11	11

	20 MHz	40 MHz	80 MHz	160 MHz
FCC 5 dBm/MHz	18 dBm	21 dBm	24 dBm	27 dBm
ETSI 10 dBm/MHz	23 dBm	26 > 23 dBm	29 > 23 dBm	32 > 23 dBm
UK 11 dBm/MHz	24 dBm	27 > 24 dBm	30 > 24 dBm	33 > 24 dBm

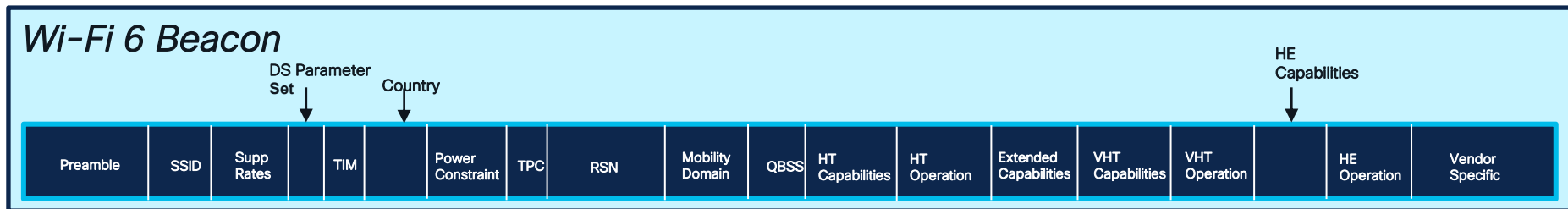




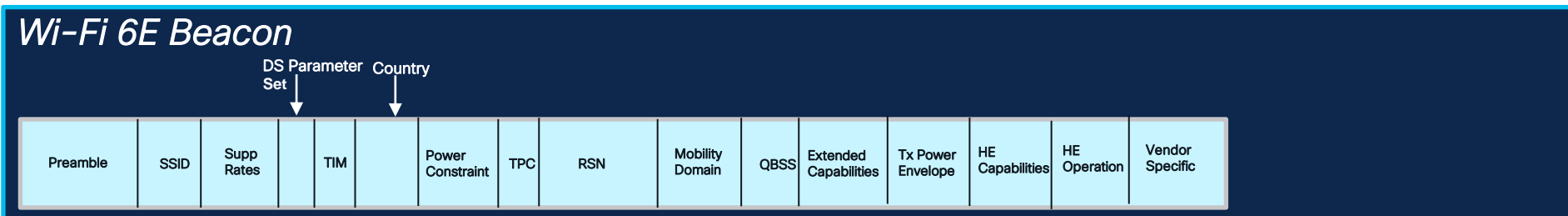
# Wi-Fi 6E – Protocol Optimizations

# Wi-Fi 6E Beacon Changes

Legacy HT/VHT Information Element Removed



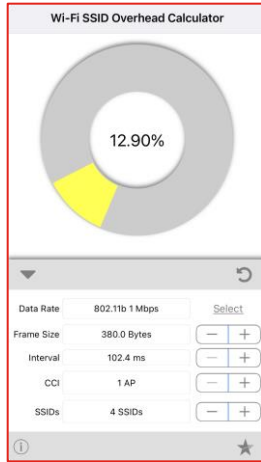
Comparison of Wi-Fi 6 and Wi-Fi 6E Beacon Frame



Reduced Beacon Size helps conserve airtime

# Multiple BSSID

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



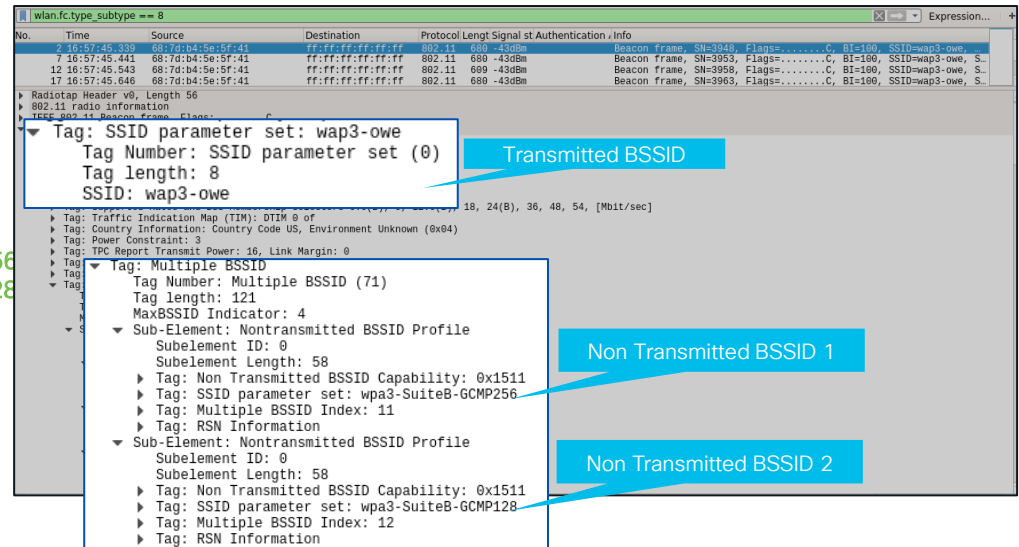
13% Overhead for 4 SSIDs with 1 AP



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



- Conserves Airtime
- Mandated in Wi-Fi 6E





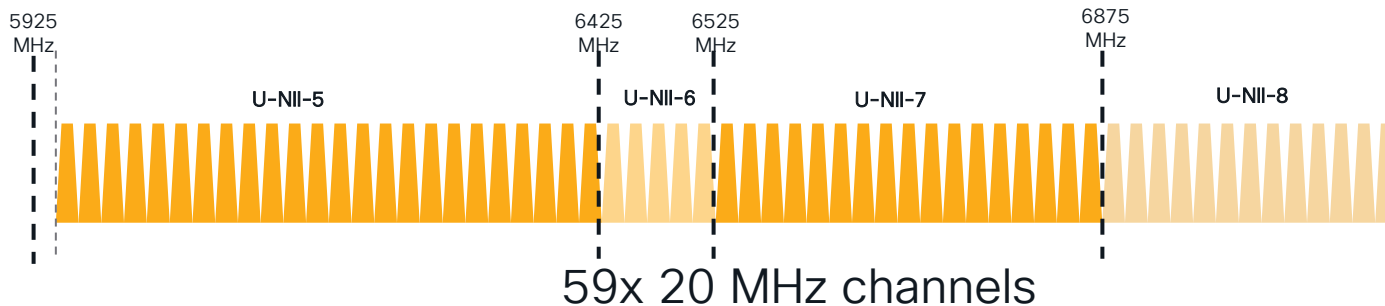
# Wi-Fi 6E 6GHz SSID Discovery

# AP Discovery by Wireless Clients – Legacy Methods

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



# 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

**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**



wlan.fc.type_subtype == 5									
No.	Time	Source	Destination	Protocol	Len	Signal	st	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)

Channel Number: 69

Neighbor AP Information

.....00 = TBTT Information Field: 0

.....11 = TBTT Filtered Neighbor AP: 1

.....0000 = TBTT Information Count: 0

Neighbor AP TBTT Offset subfield, the BSSID subfield, the Short SSID subfield, the BSS Parameters subfield and

TBTT Information

Neighbor AP TBTT Offset: 255

BSSID: 687db45e5f40

Short SSID: 0x4f27e7b9

BSS Parameters: 0x4e

.....0 = OCT Recommended: False

.....11 = Same SSID: True

.....11 = Multiple BSSID: True

.....11 = Transmitted BSSID: True

.....0 = Member of ESS with 2.4/5 GHz Co-located AP: True

.....0 = Unsolicited Probe Responses: True

.....0 = Reserved: 0x0

PSD Subfield: 254dBm/MHz

TBTT Information

Neighbor AP TBTT Offset: 255

BSSID: 687db45e5f40

Short SSID: 0x4f27e7b9

BSS Parameters: 0x4e

.....0 = OCT Recommended: False

.....11 = Same SSID: True

.....11 = Multiple BSSID: True

.....11 = Transmitted BSSID: True

.....0 = Member of ESS with 2.4/5 GHz Co-located AP: False

.....0 = Unsolicited Probe Responses: False

.....11 = Co-located AP: True

.....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!

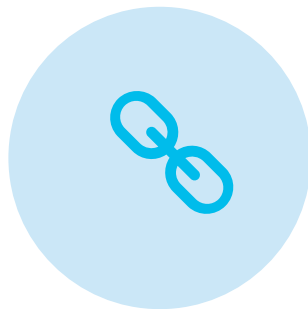


# FILS Discovery Frames helps AP Discovery Faster

## Reduces AirTime Utilization by Management Frames



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

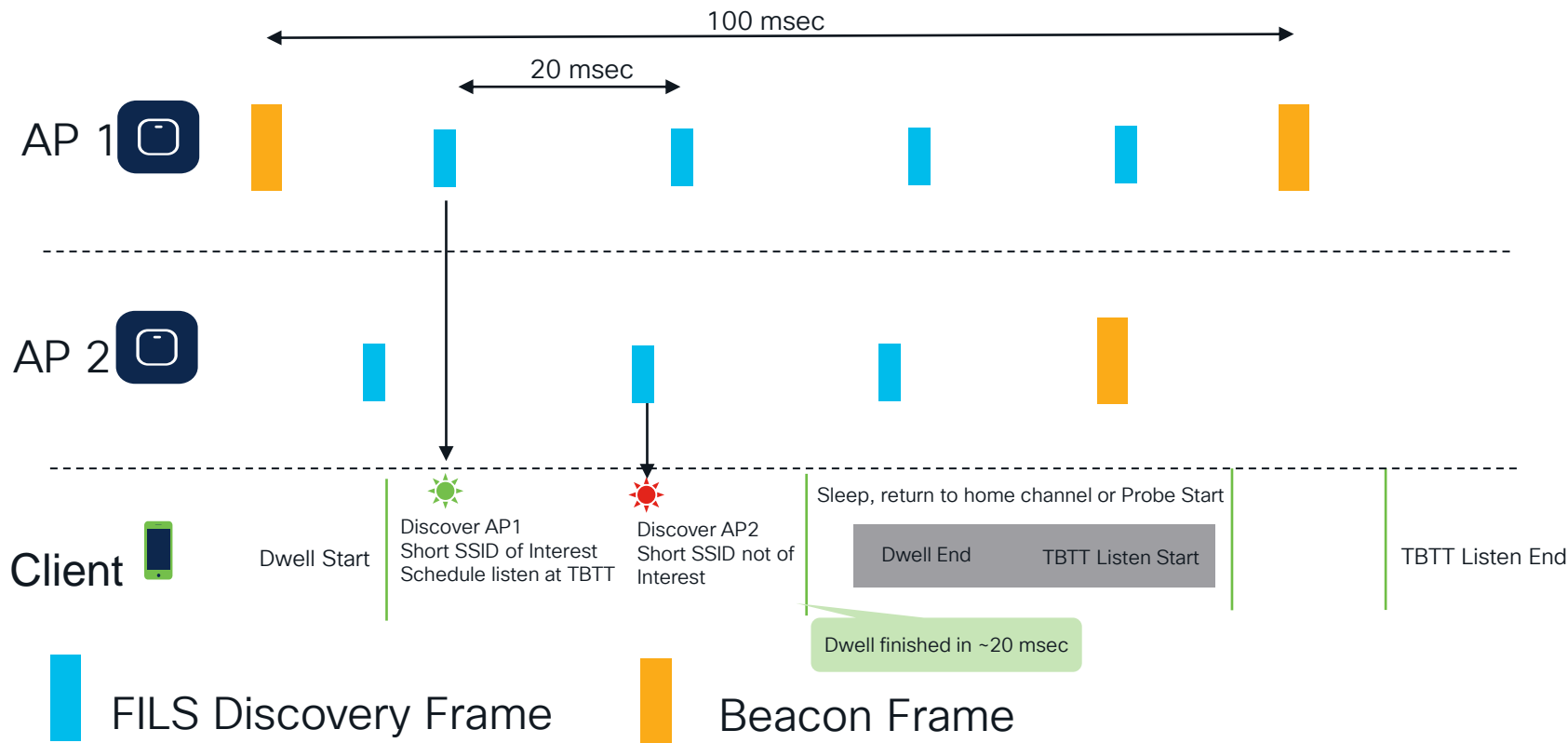


CONTAINS INFORMATION FOR  
THE CLIENT TO DECIDE ON THE  
AP TO CONNECT (SHORT SSID,  
CHANNEL, TBTT ETC)



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	559	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)

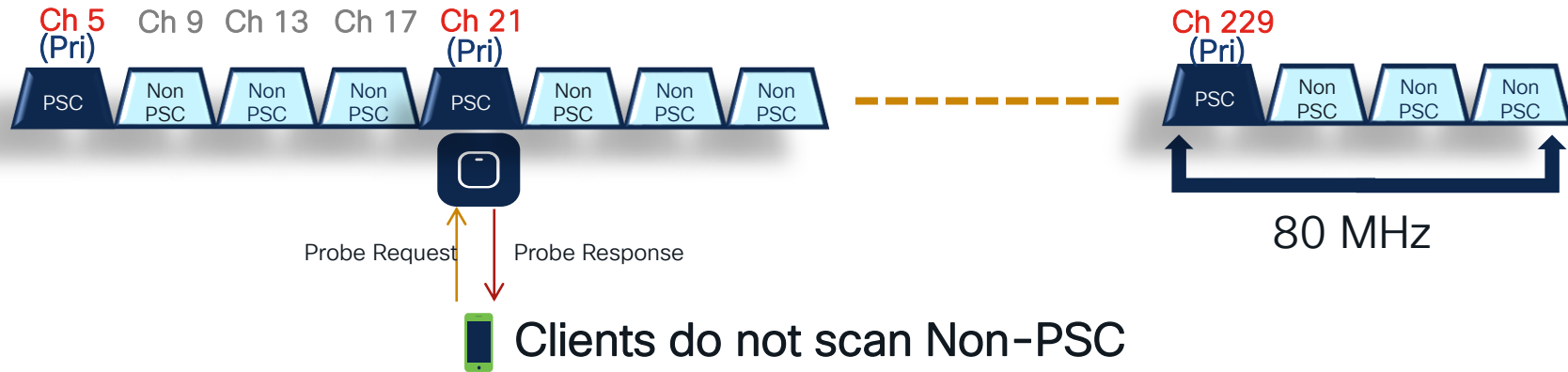


Probe responses are always broadcast.

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

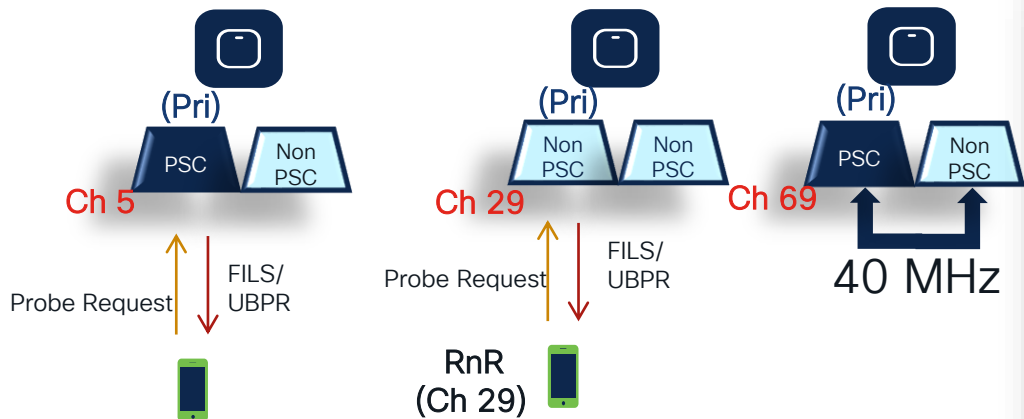


PSC Channel List:

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 biases to 40 MHz Channel Width



Not recommended

Dynamic Channel Assignment

Avoid AP Foreign AP Interference ☒

DBS Channel Width Min 20 MHz Max 40 MHz

DCA Channels

<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 5	<input checked="" type="checkbox"/> 9	<input checked="" type="checkbox"/> 13	<input checked="" type="checkbox"/> 17	<input checked="" type="checkbox"/> 21
<input checked="" type="checkbox"/> 25	<input checked="" type="checkbox"/> 29	<input checked="" type="checkbox"/> 33	<input checked="" type="checkbox"/> 37	<input checked="" type="checkbox"/> 41	<input checked="" type="checkbox"/> 45
<input checked="" type="checkbox"/> 49	<input checked="" type="checkbox"/> 53	<input checked="" type="checkbox"/> 57	<input checked="" type="checkbox"/> 61	<input checked="" type="checkbox"/> 65	<input checked="" type="checkbox"/> 69
<input checked="" type="checkbox"/> 73	<input checked="" type="checkbox"/> 77	<input checked="" type="checkbox"/> 81	<input checked="" type="checkbox"/> 85	<input checked="" type="checkbox"/> 89	<input checked="" type="checkbox"/> 93
<input checked="" type="checkbox"/> 97	<input checked="" type="checkbox"/> 101	<input checked="" type="checkbox"/> 105	<input checked="" type="checkbox"/> 109	<input checked="" type="checkbox"/> 113	<input checked="" type="checkbox"/> 117
<input checked="" type="checkbox"/> 121	<input checked="" type="checkbox"/> 125	<input checked="" type="checkbox"/> 129	<input checked="" type="checkbox"/> 133	<input checked="" type="checkbox"/> 137	<input checked="" type="checkbox"/> 141
<input checked="" type="checkbox"/> 145	<input checked="" type="checkbox"/> 149	<input checked="" type="checkbox"/> 153	<input checked="" type="checkbox"/> 157	<input checked="" type="checkbox"/> 161	<input checked="" type="checkbox"/> 165
<input checked="" type="checkbox"/> 169	<input checked="" type="checkbox"/> 173	<input checked="" type="checkbox"/> 177	<input checked="" type="checkbox"/> 181	<input checked="" type="checkbox"/> 185	<input checked="" type="checkbox"/> 189
<input checked="" type="checkbox"/> 193	<input checked="" type="checkbox"/> 197	<input checked="" type="checkbox"/> 201	<input checked="" type="checkbox"/> 205	<input checked="" type="checkbox"/> 209	<input checked="" type="checkbox"/> 213
<input checked="" type="checkbox"/> 217	<input checked="" type="checkbox"/> 221	<input checked="" type="checkbox"/> 225	<input checked="" type="checkbox"/> 229	<input checked="" type="checkbox"/> 233	

PSC Enforcement ☐ DISABLE

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

Configuration → Tags & Profiles → RF/Radio

# 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

# One Product – Two Management Modes



**Cisco DNA Management Mode**  
C9800 & DNAC Stack

**Meraki Management Mode**  
MR Dashboard Stack



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

Low End



Mid Size



Most Enterprise



Mission Critical & High Density



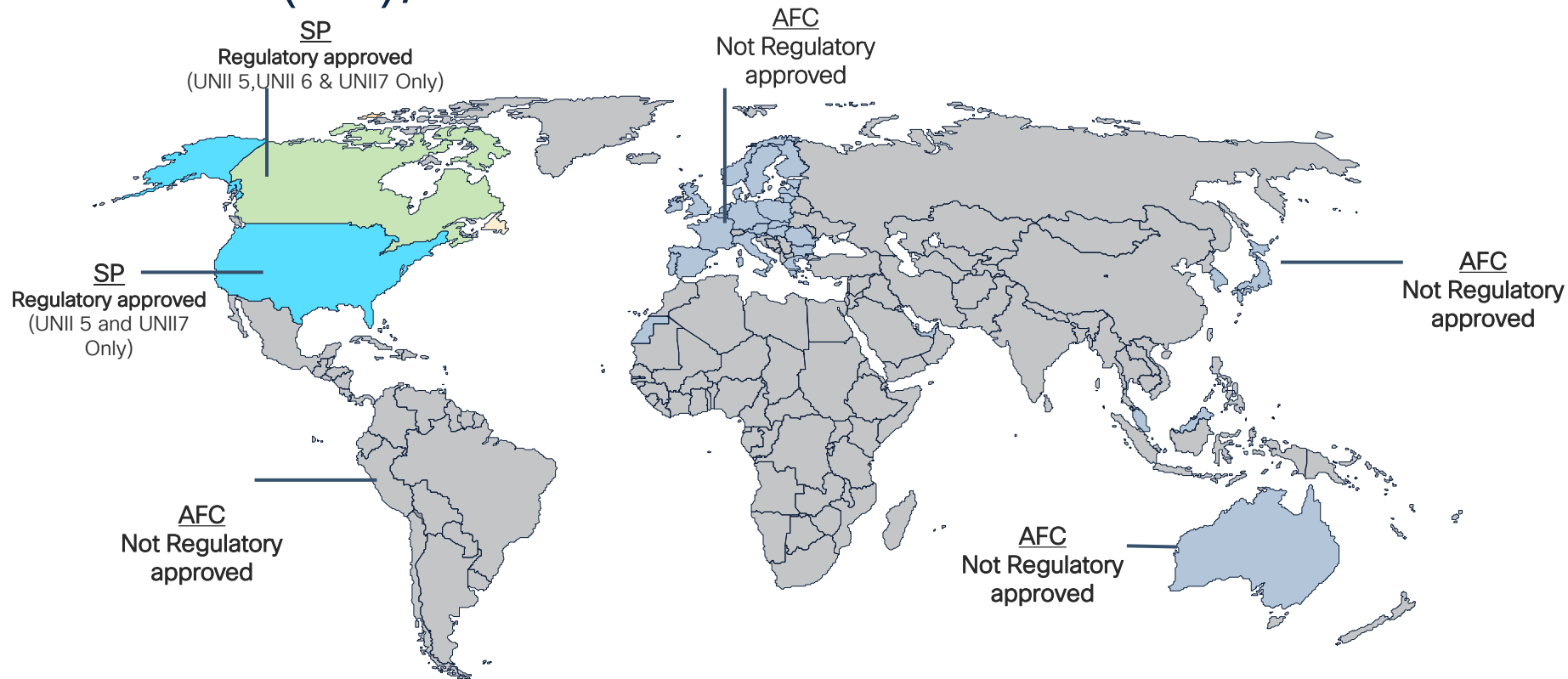
Outdoor



Indoor Access Points

Outdoor Access Points

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



AFC approved in USA & Canada

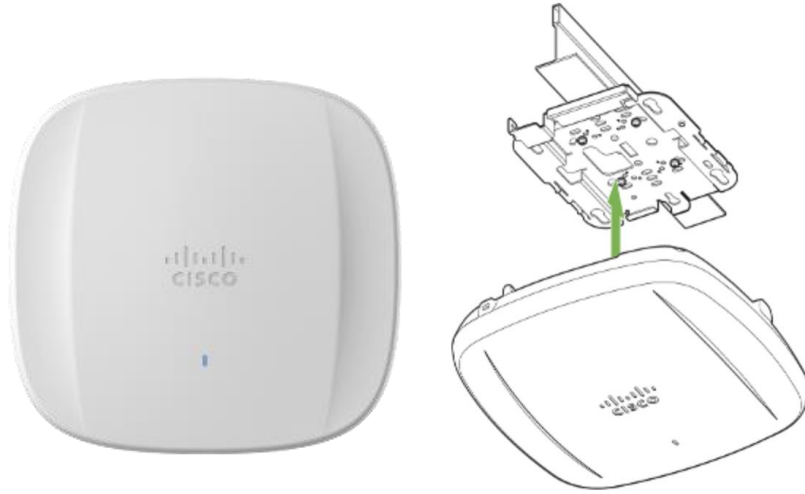
# Solution: Add a directional array to the 9166 Series

## Introducing the CW9166D1 Series Directional AP

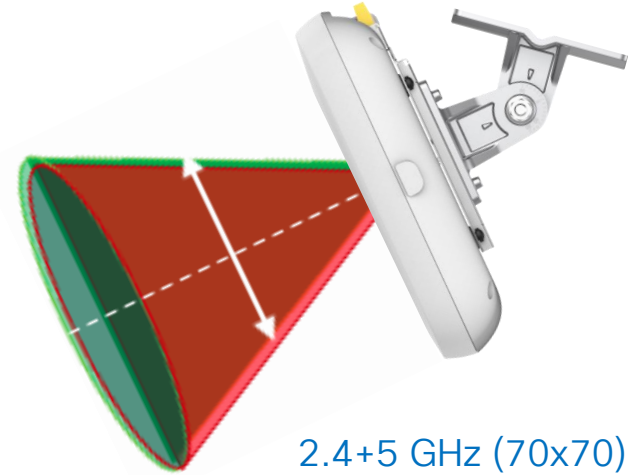


- Simplifies installation costs (less to mount)
- No bulky cables, expensive adapters...
- Similar coverage pattern as previous products using 6 dBi directional antennas
- Solves most popular external antenna cases world-wide irrespective of regulations
- Less components – resulting in a better MTBF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

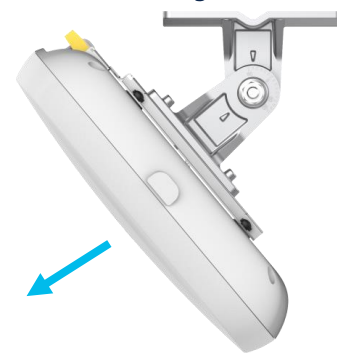
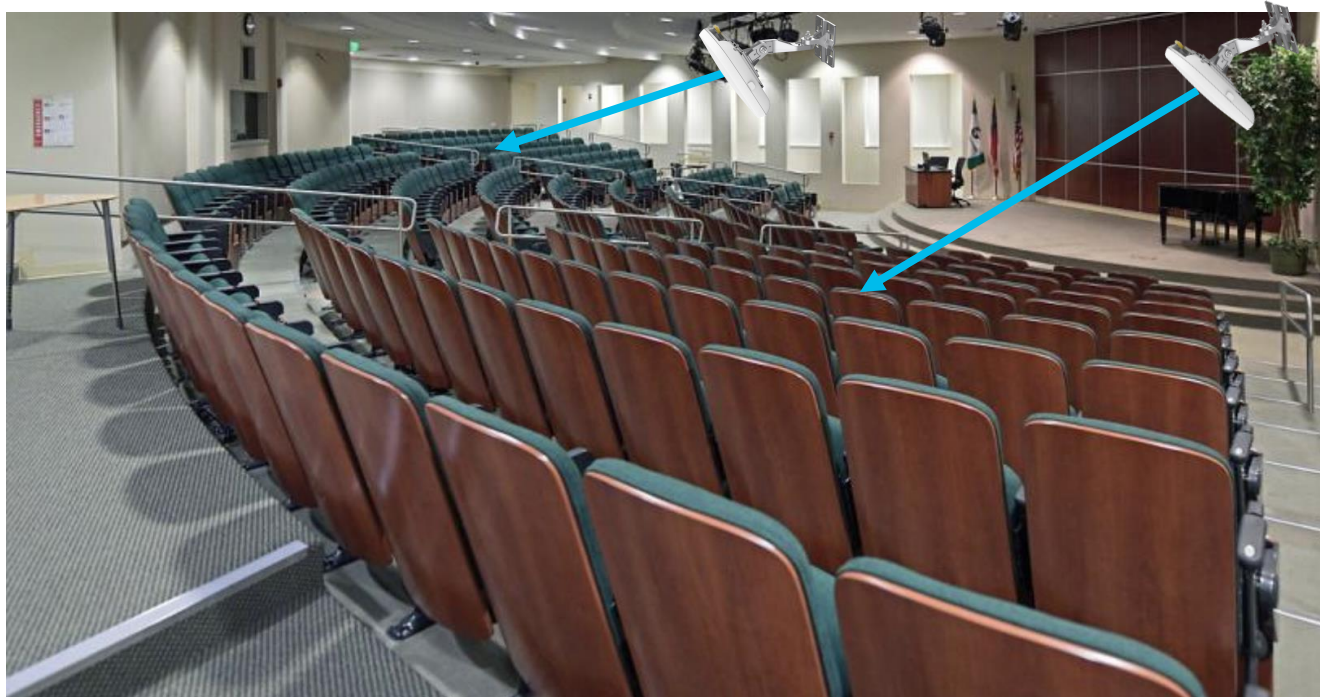


### 5 Multigigabit (mGig) PoE Port

- Optional DC Power

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

# Use cases - Auditoriums (Focused connectivity)



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

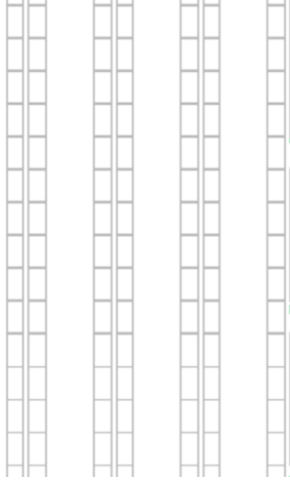
While an Omni-Directional would work, in this fashion, RF connectivity is optimized as each AP is focused into a specific area



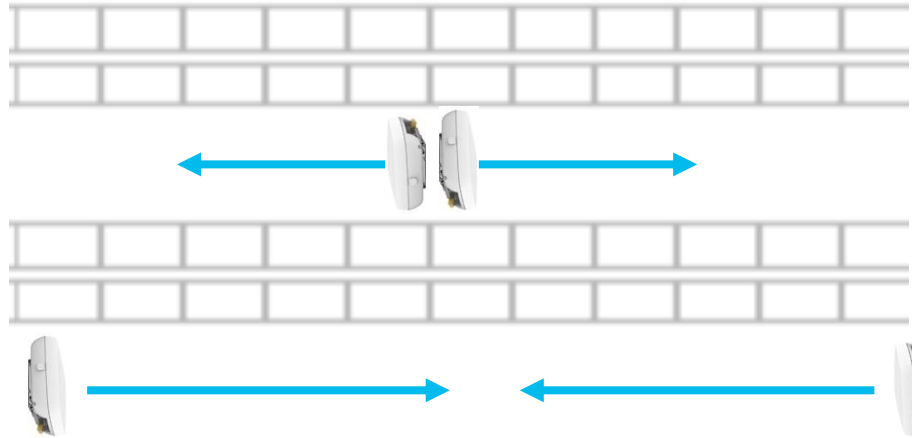
# Use cases - Warehouse (High ceilings / long aisles)

## 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

# Outdoor Access Points

MR78/76/86



- 802.11AX, MU-MIMO, OFDMA
- MR76/78: 2x2 MR86: 4x4
- Integrated Scanning Radio
- Integrated BLE Radio
- Cloud based RF Optimization
- MR76/78: 1G MR86: 2.5G (RJ45)
- MR76/78: .3af MR86: .3at
- Integrated L7 Firewall
- Real-time WIDS/WIPS
- Enhanced transmit power and receive sensitivity

C9124



- 802.11AX, MU-MIMO, OFDMA
- 4x4 + 4x4:4
- Cisco RF ASIC next-gen Cisco CleanAir
- IoT ready
- 1x 2.5G mGig/SFP/1Gbe PoE-Out
- PoE-In 802.3af/at/bt/UPOE
- DC power input (24 to 56 VDC)
- 30 dBm Transmit Power(Same as 1572 and higher than 1562)
- Centralized, FlexConnect, Bridge, Flex+Bridge & EWC

CW9163E



- 802.11AX, MU-MIMO, OFDMA
- 2x2(2.4GHz) + 2x2(5GHz) + 2x2(6GHz)\*
- Tri-band Scanning Radio with next-gen CleanAirPro
- IoT ready
- 1x 2.5G mGig
- In-built GPS module
- PoE-In 802.3af/at

\* 6GHz subject to AFC availability

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

## 6GHz-ready 4x4 outdoor and industrial access point

### Catalyst IW9167I/E 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



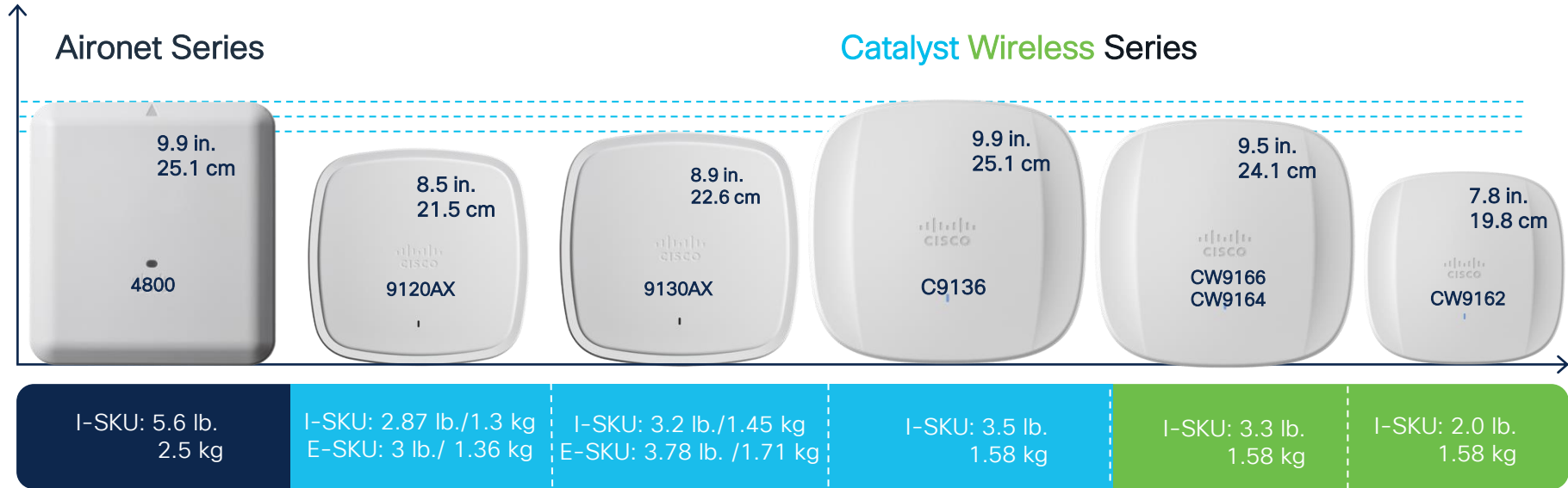
GNSS, scanning radio

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

# Mechanical Specifications

# Indoor Access Point Dimensions

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

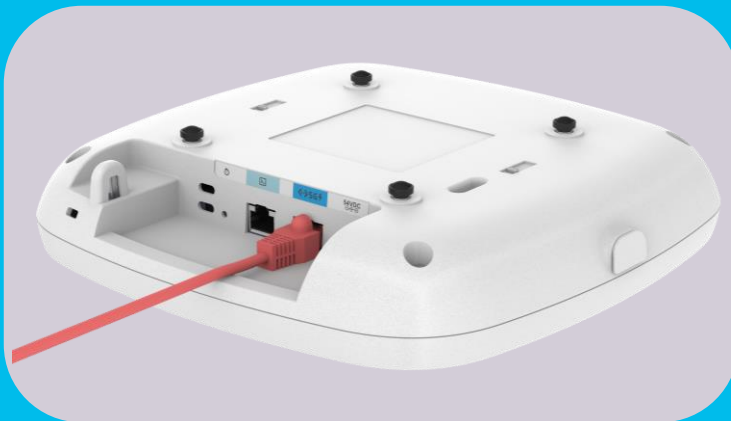




# Catalyst C9136/CW9166/9164/9162

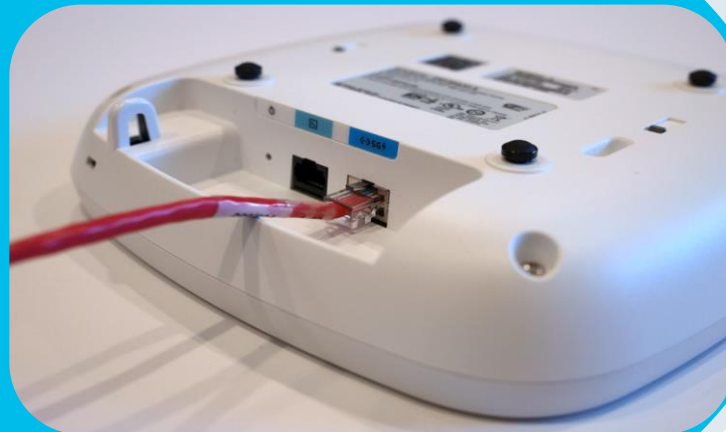
Enhanced cabling experience

C9136/CW66/64/62 – Lowered Edge



Larger Recessed Area  
Allow Wires not to be Bent During  
Connection

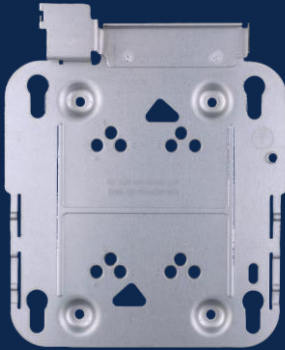
C9130 – Higher Edge and Smaller Area



More Easily Accessible Port  
Allow for Better Deployment Experience



# AIR-AP-BRACKET-1 photos



Front side

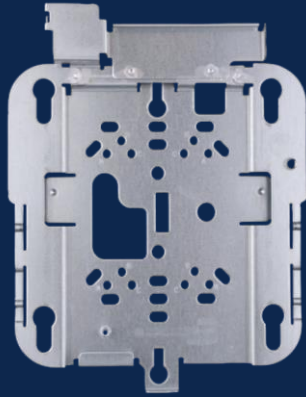


AP mounted



Back side

# AIR-AP-BRACKET-2 photos



Front side



AP mounted



Back side

# Conversion overview



Done from C9800 WLC

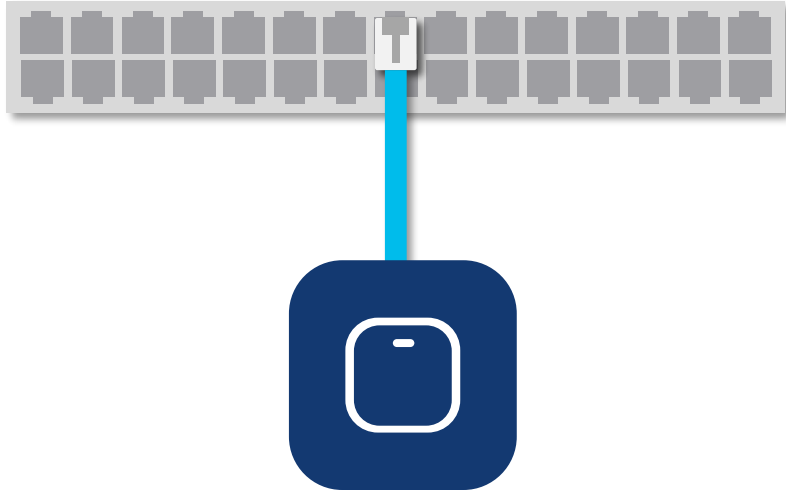


Call Meraki Support  
(Needs license)

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

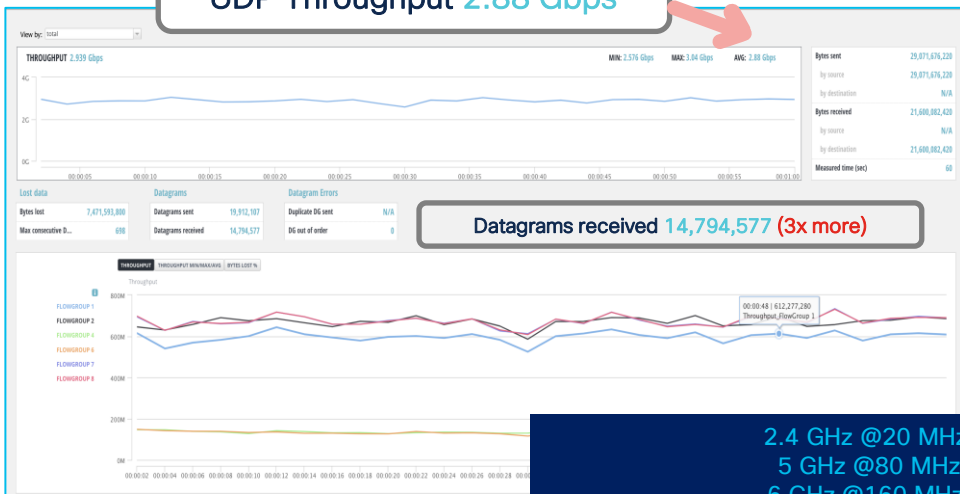
CDP = Cisco Discovery Protocol  
LLDP = Link Layer Discovery Protocol  
Cat = Category (of ethernet cable)

# Wi-Fi 6E Performance Comparison

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

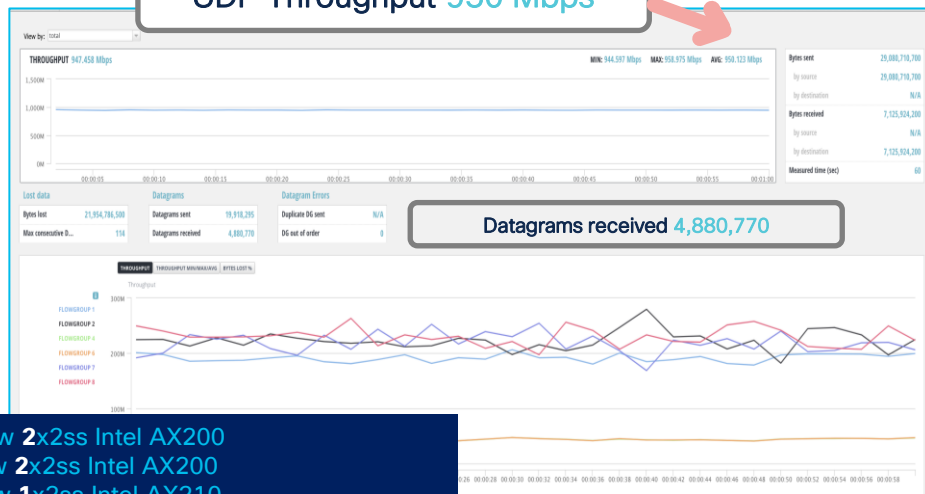
Wi-Fi 6E Performance with **mGig (5 Gig) Switch**

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



AP C9136

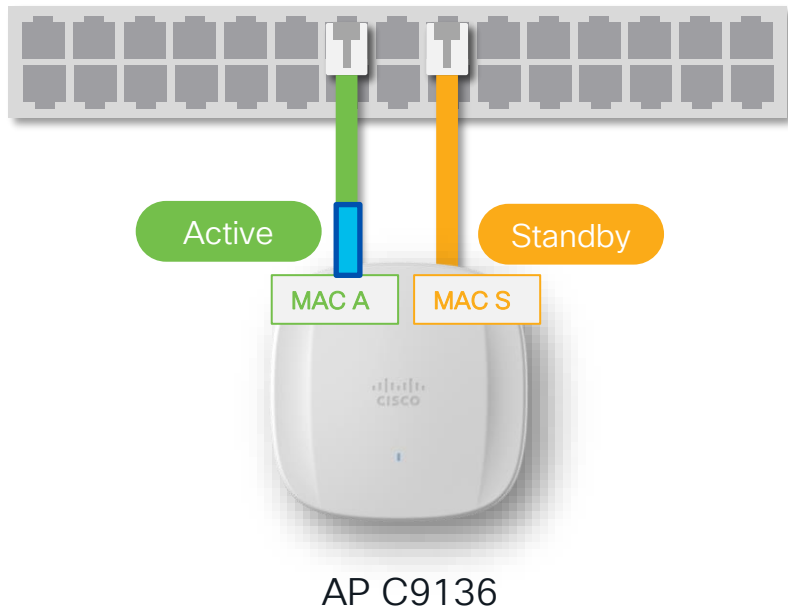
C9136 has two mGig uplink ports

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

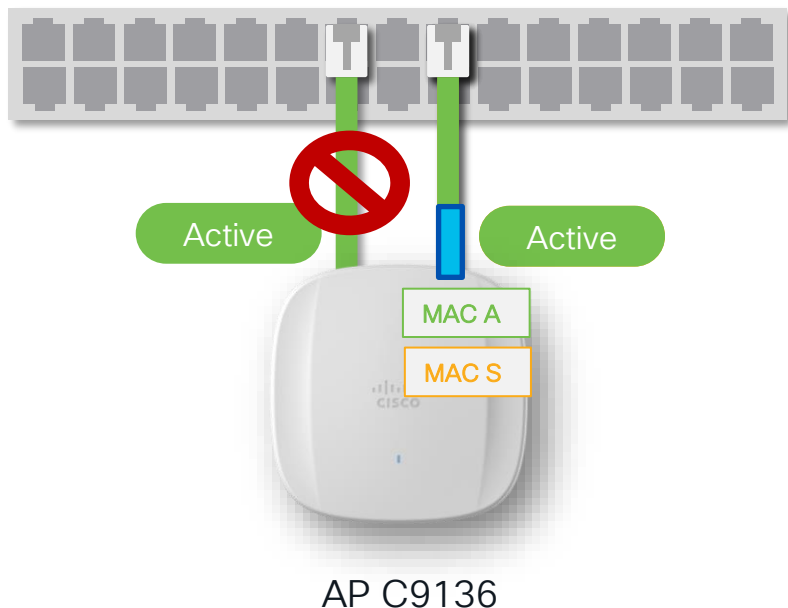


- When configured as standalone ports, one becomes **active** and the other one **standby**
  - If power is equal on both ports, Port 0 becomes **active**. Otherwise, the one with more power
- Traffic is exchanged on **active** port using active **MAC A** (CAPWAP, ARP, etc.)
- **Standby** port only exchanges 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



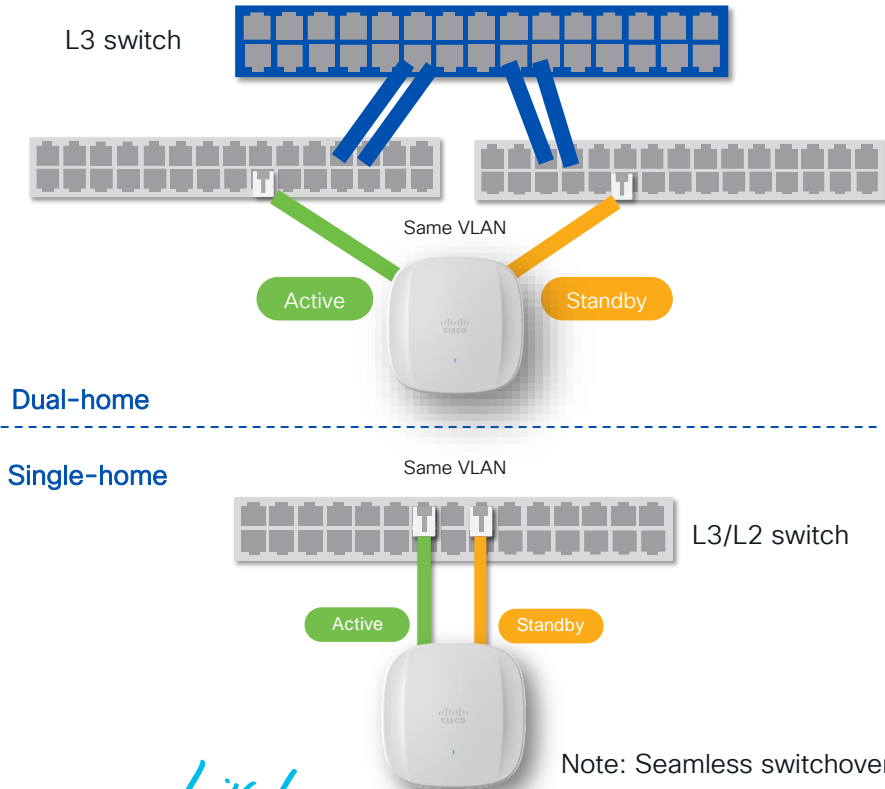
# Catalyst AP C9136 to Switch connection



- 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

Note: Seamless switchover with AP port authentication with dot1x/mab currently not supported

# Catalyst AP C9136 to Switch connection

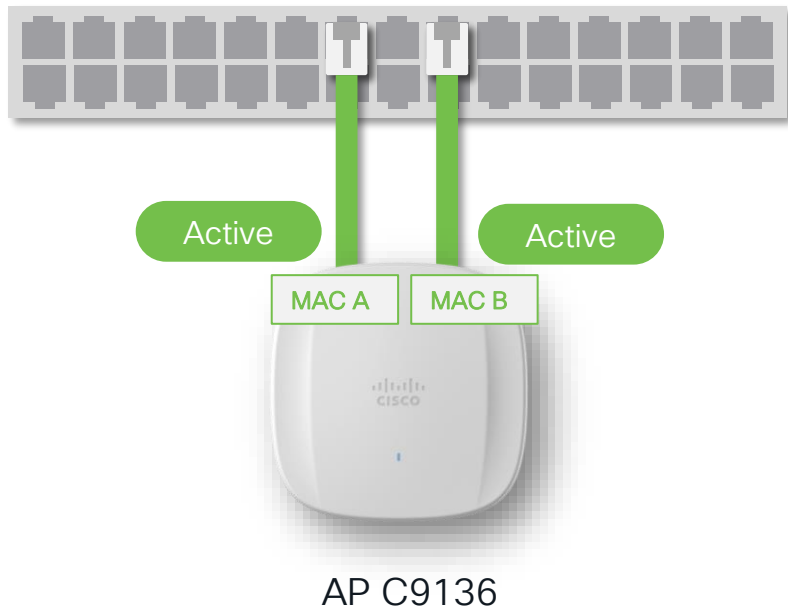


- When configured with standalone ports, you have two options...
- Dual-home to two different switches
  - Recommend to connect to switches in different IDF, whenever possible
- Single-home to one logical switch (Stack Wise, Multi-layer switch, etc.)
  - Recommend to connect to two different members 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

Note: Seamless switchover in dual home in SDA not supported currently

# 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

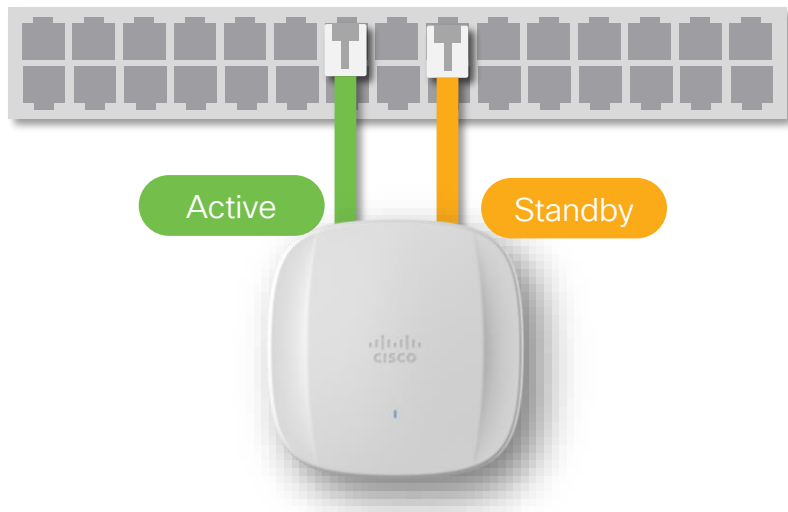
### Note:

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)



Power Allocated

Power Consumed

48.3 W

16.5 W

48.3 W

0.5 W

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

# 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	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	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

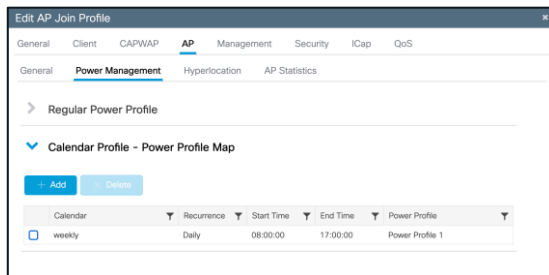
# AP Power Optimizations Feature Suite

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.

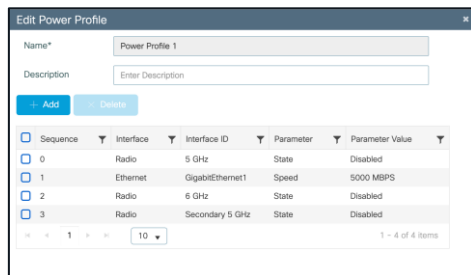


IOS-XE 17.8

## 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

# To know more about Wireless Sustainability



## Saving Energy and Money with Your Cisco Wireless Network - BRKEWN-2043

Simone Arena, Distinguished TME, Cisco Systems, Inc. - **Distinguished Speaker**

Learn how your Cisco wireless network can accelerate progress toward your sustainability goals and reduce your energy costs. Get answers to these important questions: Why does sustainability matter in networking? Why act now? How do you build an energy-efficient wireless network? Get to know Cisco's commitment to sustainability and what it means for you, and how to start saving energy, emit less CO2, and reduce OpEx today.

**Technical Level:** Intermediate

**Technology:** Meraki, Wi-Fi 6E, Enterprise Wireless

**Session Type:** Breakout

**Session Length:** 60 Minutes

**Percentage of New Content:** 25% New

**Eligible for Continuing Education Credit:** Yes

Thursday, Feb 8 | 1:30 PM - 2:30 PM CET | Session Room A1

# Section Summary

1

Catalyst Wi-Fi 6E Access Point Portfolio

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

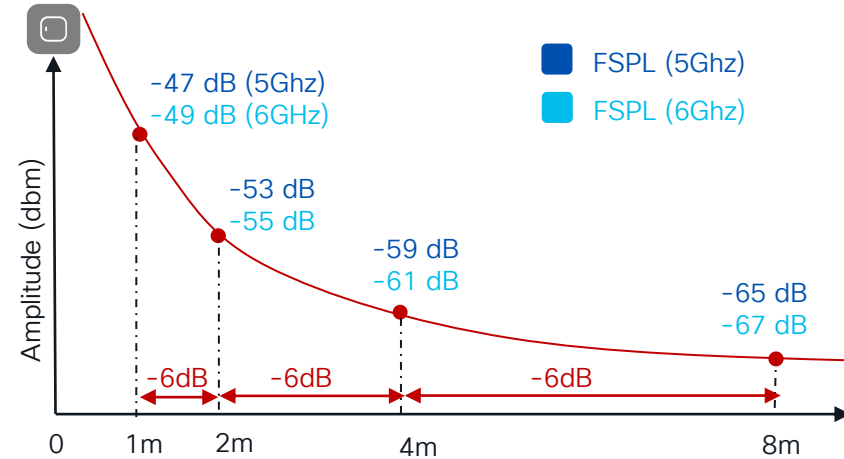
- AP Specs
- Power Requirements
- Switching Infrastructure

## RF Design

- AP Coverage
- AP Density
- Site Survey Mode

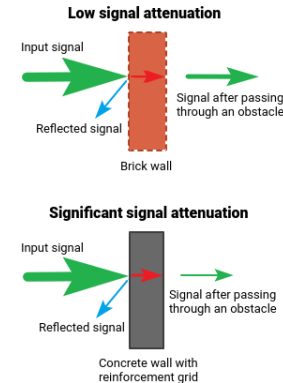
# What you need to consider?

- **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



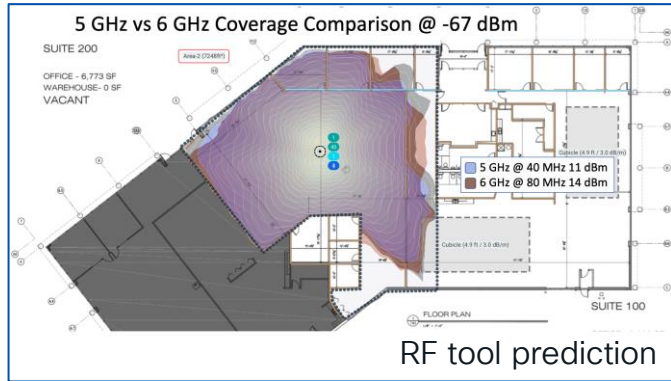
(\*) FSPL = Free Space Path Loss: [https://en.wikipedia.org/wiki/Free-space\\_path\\_loss](https://en.wikipedia.org/wiki/Free-space_path_loss)

<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 f<sup>2</sup> (140–190 m<sup>2</sup>) 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



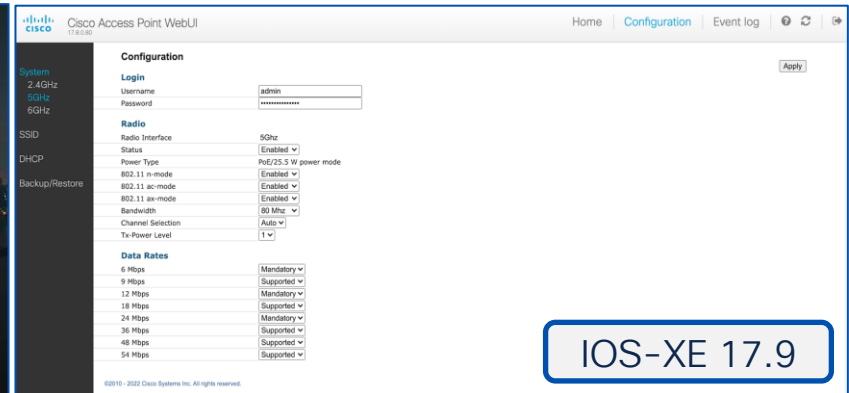
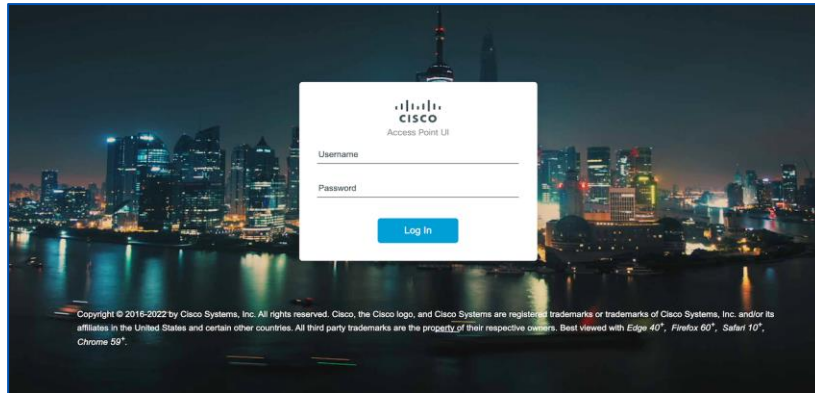
AP in standalone mode, broadcasting SSIDs across all 3 bands  
Embedded DHCP server provides Client IP

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.

# To get an in-depth understanding of RF Design ....

## Advanced RF Tuning for Wi-Fi6E with Catalyst Wireless: Become an Expert, While Getting a Little Help from AI - BRKEWN-3413



Jim Florwick, Technical Marketing Engineering Technical Leader, Cisco Systems, Inc. - **Distinguished Speaker**

Participants will learn the RF design and implementation guidelines necessary to plan, configure, and implement Wi-Fi networks that meet the evolving regulatory (6 GHz) and customers RF demands. Wi-Fi is changing and there has never been a more exciting time to be in RF technologies. In this session you will learn about Cisco's newest Catalyst Wireless Access Points and Antenna's including the latest Wi-Fi 6E Access Point and the new Wi-Fi 6 stadium antennas. Participants will learn and understand the current coverage and design best practices as well as what this means to the evolving RF landscape around the world. Everything we know is evolving.

This session will provide a deep dive on how to think about and manage Wi-Fi6e, RRM, Spectrum Intelligence and the evolution of Multi Band Operations within the infrastructure. The evolution to Wi-Fi 6e brings amazing RF capacity gains. Wi-Fi6e also means new pressures on the wired infrastructures capacity and power that supports it. Attendees will learn what to expect and how to manage and plan the future needs now. Session attendees will be able to successfully use the information to navigate and understand today's fluid RF and Mobility landscapes and to articulate the benefits to their customers enabling the Best wireless and mobility experiences yet.

**Technical Level:** Advanced

**Technology:** Wifi 6, Enterprise Mobility

Thursday, Feb 8 | 3:00 PM - 4:30 PM CET | Elicium 2

# 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

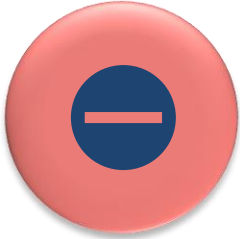
# Wi-Fi 6E Security



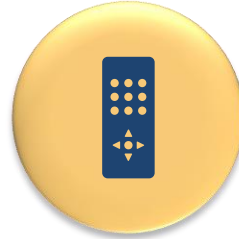
Wi-Fi 6E uplevels security.  
WPA3 L2 Security: OWE,  
SAE\*, 802.1x-SHA256



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



# WLAN Design Considerations – IOS-XE 17.12.1

## 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 802.11b/g

- 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 WPA2 Policy

GTK WPA3 Policy

Randomize Transition Disable

WPA2/WPA3 Encryption

AES(CCMP128) GCMP256

GCMP128 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 PSK

CKM SAE

FT + SAE OWE

FT + 802.1X FT + PSK

802.1X-SHA256 PSK-SHA256

WFA = Wi-Fi Alliance

# WLAN design considerations

Before 17.12.1

- **Option 2:** Single SSID but different AKM per band. For Cisco today, this means creating an additional WLAN for 6GHz, with same SSID name but different WLAN profile name and security settings (AKM):

Existing WLAN serving 2.4 and 5GHz

The screenshot shows the 'General' tab of a Cisco WLAN configuration page. The 'Profile Name\*' is 'employee' and the 'SSID\*' is 'employee', both highlighted with red boxes. The 'WLAN ID\*' is '9'. The 'Status' is 'ENABLED' with a green checkmark. The 'Broadcast SSID' is also 'ENABLED' with a green checkmark. On the right, the 'Radio Policy' section shows three bands: '6 GHz' (Status: DISABLED), '5 GHz' (Status: ENABLED), and '2.4 GHz' (Status: ENABLED). The '2.4 GHz' band has a dropdown menu set to '802.11b/g Policy'.

New WLAN, same SSID name serving 6GHz

The screenshot shows the 'General' tab of a Cisco WLAN configuration page for a new WLAN. The 'Profile Name\*' is 'employee-6GHz' and the 'SSID\*' is 'employee', both highlighted with red boxes. The 'WLAN ID\*' is '10'. The 'Status' is 'ENABLED' with a green checkmark. The 'Broadcast SSID' is also 'ENABLED' with a green checkmark. On the right, the 'Radio Policy' section shows three bands: '6 GHz' (Status: ENABLED), '5 GHz' (Status: DISABLED), and '2.4 GHz' (Status: DISABLED). The '6 GHz' band has a dropdown menu set to '802.11b/g Policy'. Below the band status, there are green checkmarks for 'WPA2 Disabled', 'WPA3 Enabled', and 'Dot11ax Enabled'.

AKM = Authentication and Key Management



# Option 2 sub-options for 2.4/5 GHz

Before 17.12.1

Two options for WLAN security settings in 2.4/5GHz band:

- a) WPA3 Transition mode
- b) WPA/WPA2

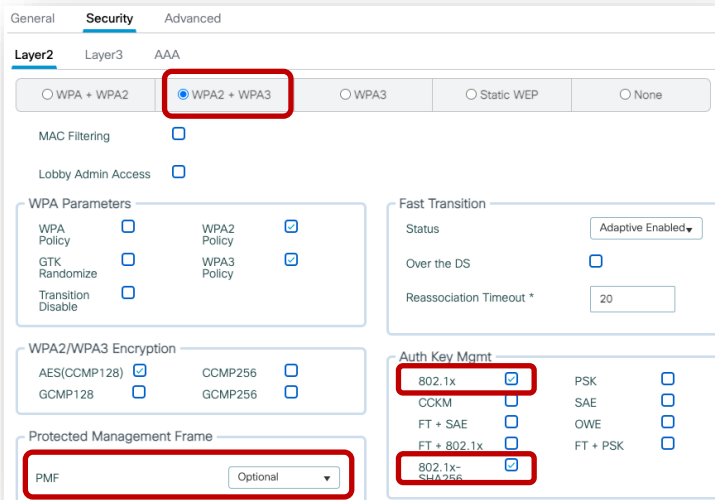
Things to keep in mind:

- From the initial testing done, some older drivers clients may have issues in connecting to a WPA3 transition mode
- Today Cisco doesn't support seamless roaming across WLANs, so for both options it will be a hard roam across bands.

# Option 2a (dot1x SSID)

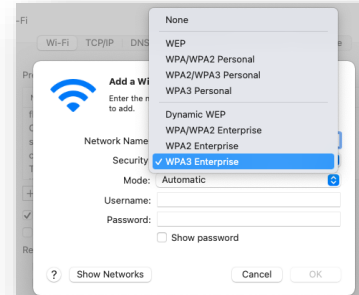
Before 17.12.1

WLAN security configuration for 2.4/5GHz > Enable WPA3-Enterprise Transition mode (a.k.a. mixed mode):



The screenshot shows the 'Security' tab of a WLAN configuration interface. The 'Layer2' tab is selected. Under 'Security', 'WPA2 + WPA3' is selected and highlighted with a red box. Below this, 'WPA Parameters' shows 'WPA2 Policy' and 'WPA3 Policy' both checked. 'WPA2/WPA3 Encryption' shows 'AES(CCMP128)' and 'GCMP128' both checked. 'Protected Management Frame' shows 'PMF' selected and 'Optional' in the dropdown menu, both highlighted with a red box. 'Auth Key Mgmt' shows '802.1x' and '802.1x-SHA256' both checked, highlighted with a red box. 'Fast Transition' shows 'Adaptive Enabled' in the dropdown and 'Over the DS' checked.

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



The screenshot shows a client's network configuration window. The 'Security' dropdown menu is open, showing 'WPA3 Enterprise' selected and highlighted with a blue box. Other options include 'WPA2/WPA2 Personal', 'WPA2/WPA3 Personal', 'WPA3 Personal', 'Dynamic WEP', 'WPA/WPA2 Enterprise', and 'WPA2 Enterprise'. The 'Mode' is set to 'Automatic'.

# Option 2b (dot1x SSID)

Before 17.12.1

WLAN security configuration on 2.4/5GHz:

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 ☐ OSN Policy ☐

WPA2 Encryption

AES(CCMP128) ☒ CCMP256 ☐

GCMP128 ☐ GCMP256 ☐

Protected Management Frame

PMF

Fast Transition

Status

Over the DS ☐

Reassociation Timeout \*

Auth Key Mgmt

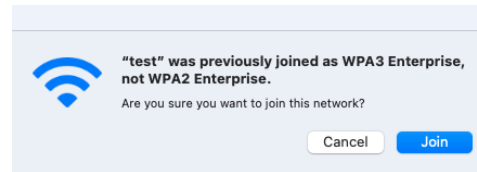
802.1x ☒ PSK ☐

Easy-PSK ☐ CCKM ☐

FT + 802.1x ☐ FT + PSK ☐

802.1x-SHA256 ☐ PSK-SHA256 ☐

- L2 Security would be **WPA+WPA2**. AKM should be set to **802.1x-SHA1**. PMF Disabled
- Make sure you don't have WFA "Transition Disable" feature turned on on the **6GHz WLAN**
- How to configure the client side?
  - For legacy clients just keep the existing **WPA2 profile**
  - For clients that are configured for 6GHz with a WPA3 profile, connecting to the 2.4/5GHz WLAN could be seen as a security downgrade attack. **Note:** MacOS gives you a warning:



**Important:** This option should only be recommended if planning for a full coverage at 6GHz. In this case, 6GHz capable clients would not need to connect to 2.4/5GHz.

# Option 3



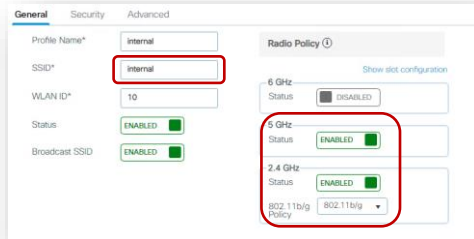
# Option 3 – WLAN design considerations

- **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

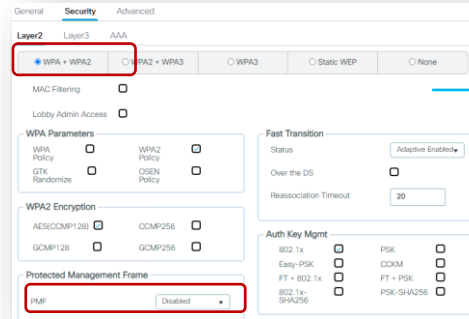
Radio Policy (1)

6 GHz Status 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 OSN Policy

WPA2 Encryption

AES(CCMP128) CCMP256

GCMP128 GCMP256

Protected Management Frame

PMF Disabled

Fast Transition

Status Adaptive Enabled

Over the DS

Reassociation Timeout 20

Auth Key Mgmt

802.1x PSK

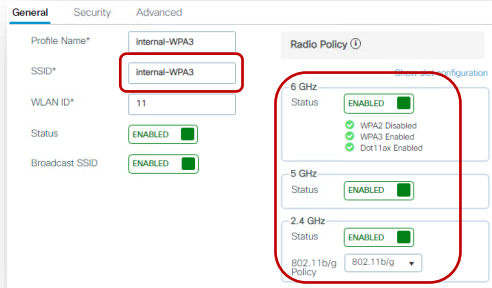
Easy-PSK CCKM

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

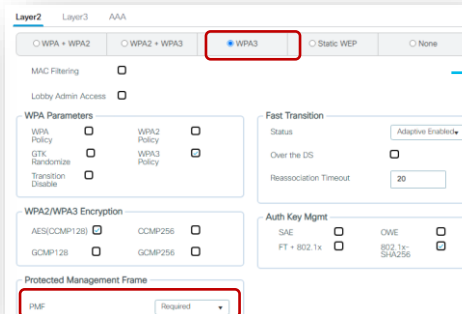
Radio Policy (1)

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 WPA3 Policy

Transition Disable

WPA2/WPA3 Encryption

AES(CCMP128) CCMP256

GCMP128 GCMP256

Protected Management Frame

PMF Required

Fast Transition

Status Adaptive Enabled

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

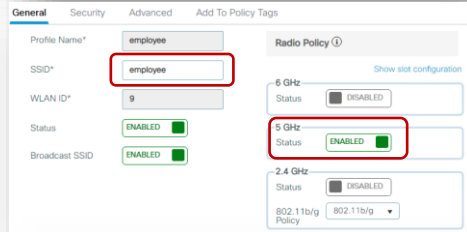
6 GHz Status DISABLED

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

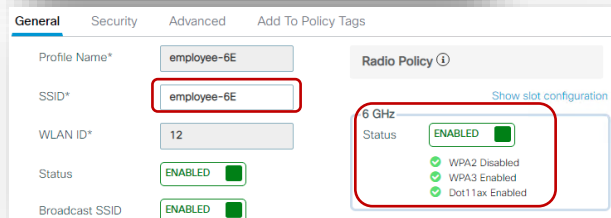
6 GHz Status DISABLED

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

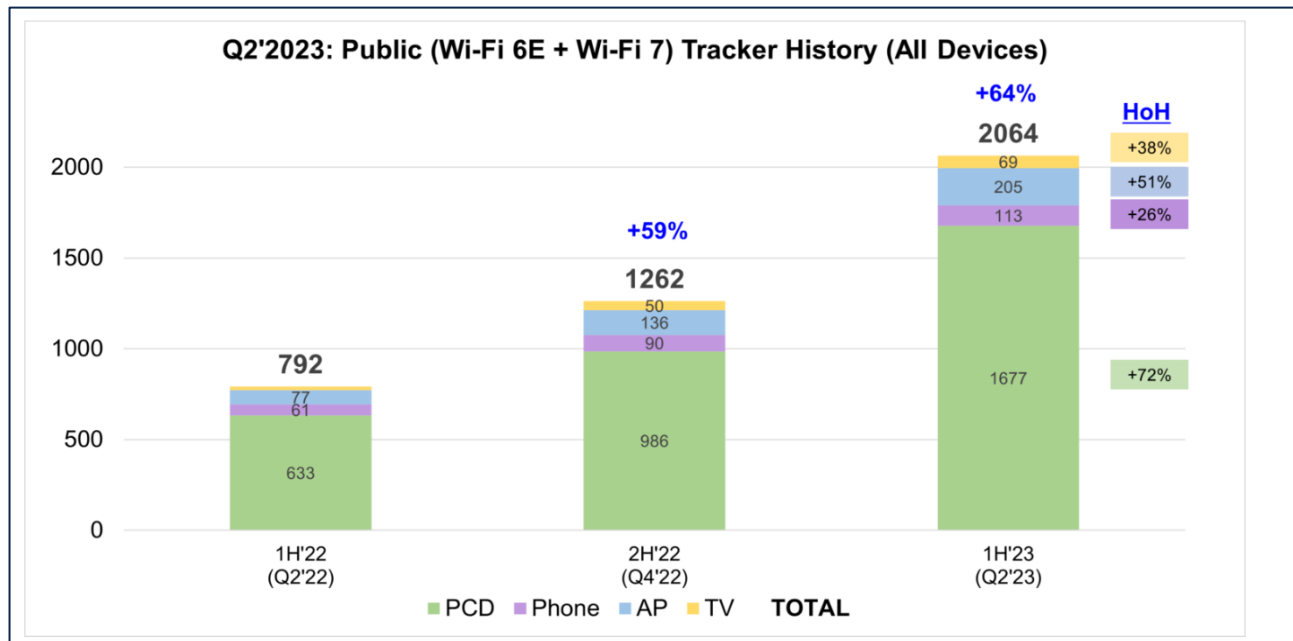
WPA3 on all bands, for the newer clients



# Wi-Fi 6E – Client Eco System



# Wi-Fi 6E Device Support



**Broad range of Wi-Fi 6E Client Set:**  
Phones, Tablets, Laptops, TVs,  
Scanners, Desktop

1000+ Laptops  
300+ Desktops  
100+ Phones



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 *always* 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

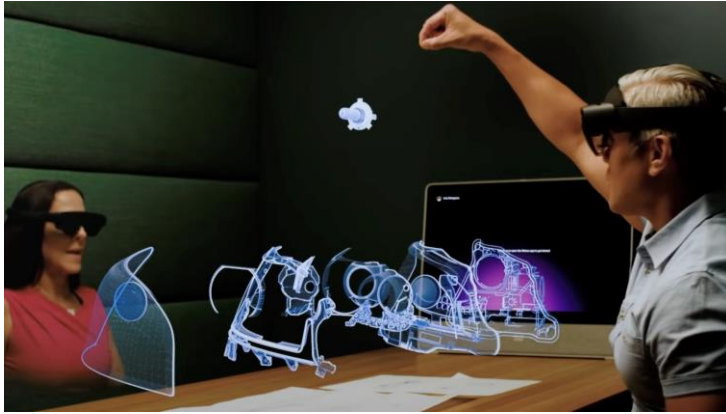
## WLAN Design

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

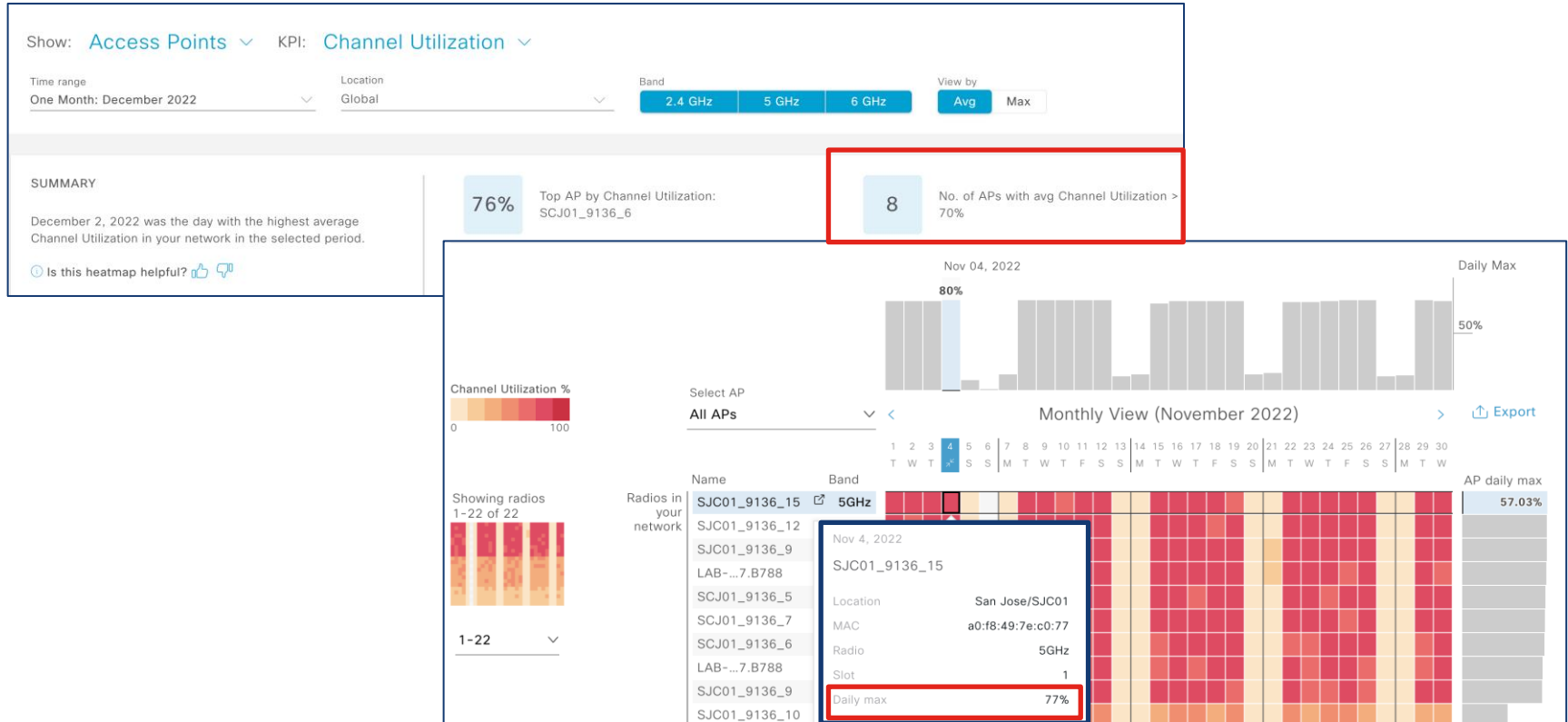
## Wi-Fi Network Design

- 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

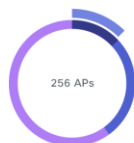
- Wi-Fi 6E Associated
- Wi-Fi 6 Associated

[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

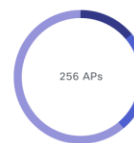
[View Details](#)

### AP Distribution by Protocol

LATEST

TREND

22.33% of APs are Wi-Fi 6E capable



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

[View Details](#)

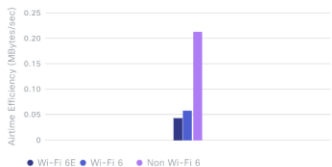
### Wireless Airtime Efficiency

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

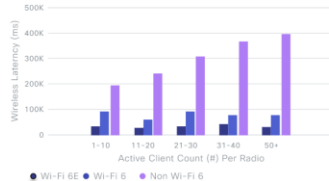
[View Details](#)

### Wireless Latency by Client Count

LATEST

TREND

View: Voice ▾



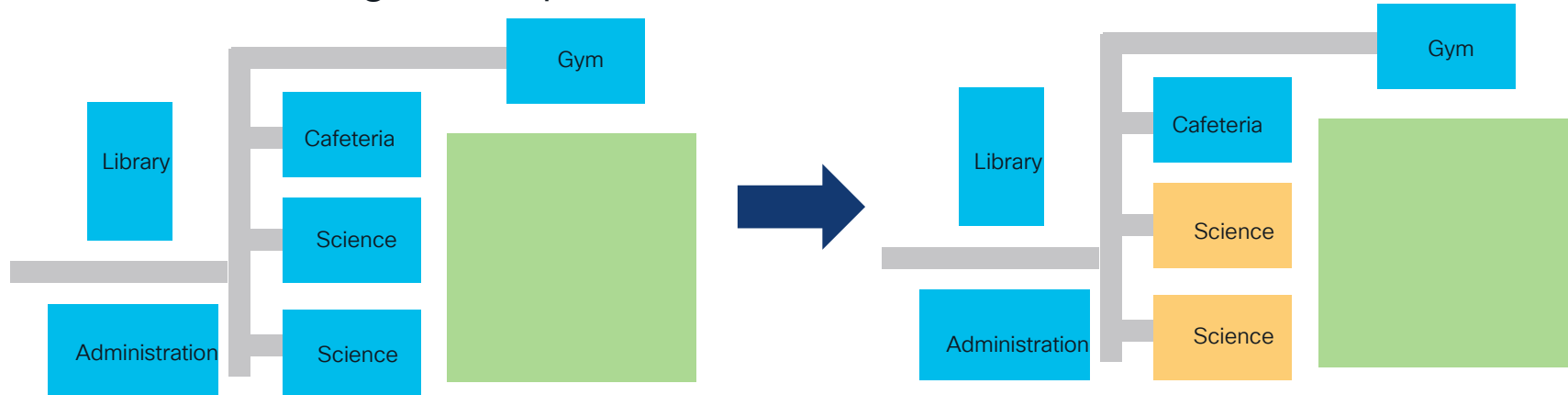
- Wi-Fi 6E
- Wi-Fi 6
- Non Wi-Fi 6

[View Details](#)

Benefits

# Migration Scenarios

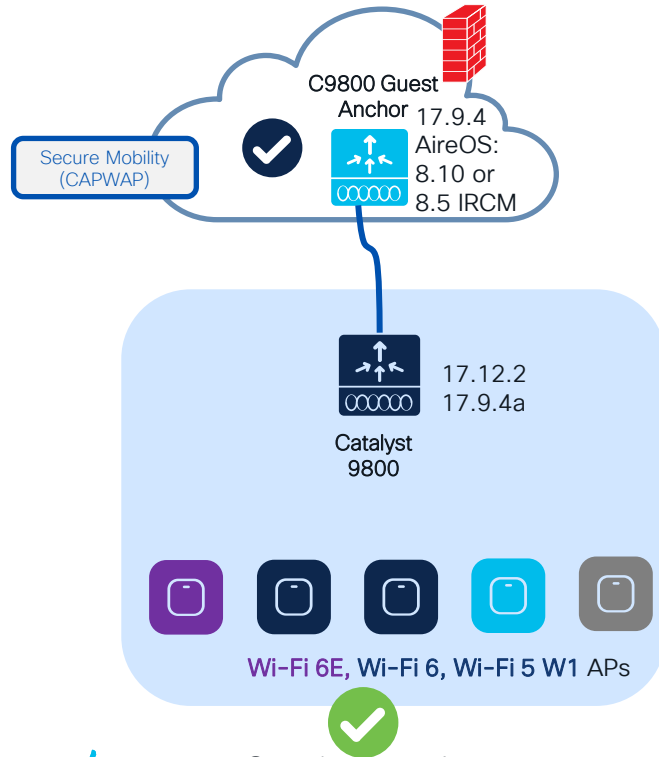
- Move “per RF blocks”
- Move a building or complete floor into the new hardware and software



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



# How do I start adopting 6GHz?



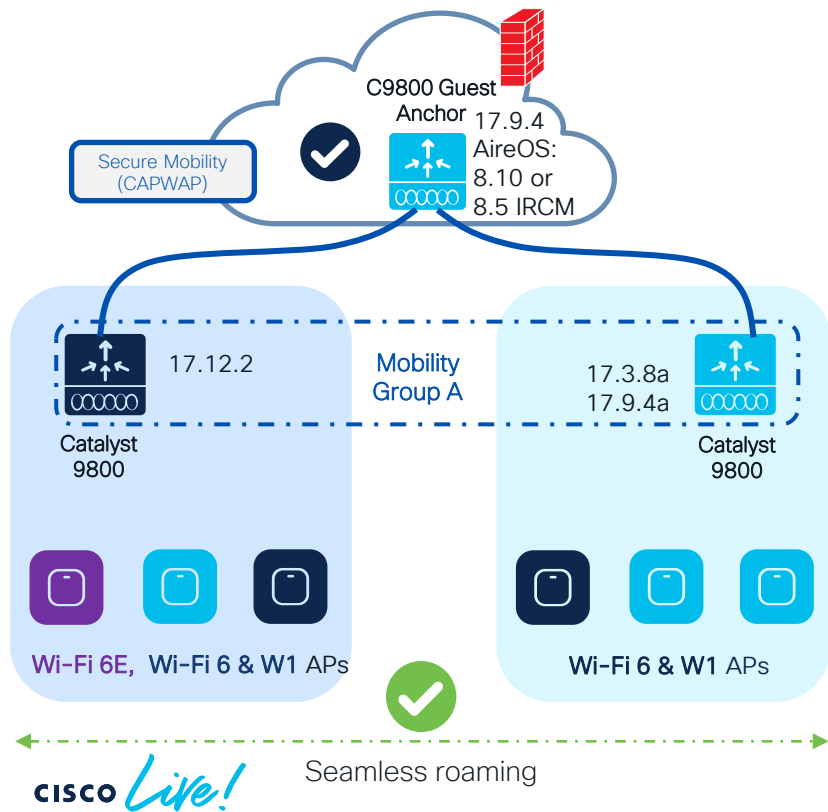
## Scenario 1: If you have already started your C9800 journey

- Controller code is 17.12.2
- 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](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)



## Scenario 2: If you're in IOS-XE 17.3.x, 17.6.x, 17.9.x code

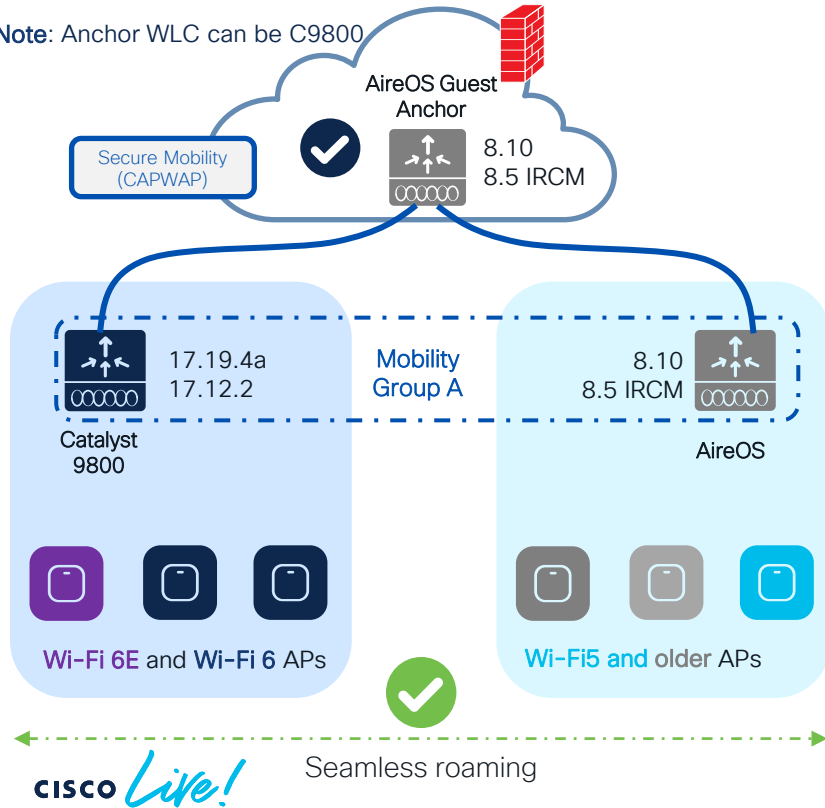
- If you have already started your C9800 journey... & need to introduce CW9166D1
- Introduce new AP hardware on the new supported IOS XE release and support seamless roaming and Guest Anchor with existing C9800 networks
- The release combinations shown have been tested at scale, check IRCM deployment 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-airesos\\_ircm\\_dg.html](https://www.cisco.com/c/en/us/td/docs/wireless/controller/technotes/8-8/b_c9800_wireless_controller-airesos_ircm_dg.html)

# How do I start adopting 6GHz?

## Answer: Inter Release Controller Mobility (IRCM)

**Note:** Anchor WLC can be C9800



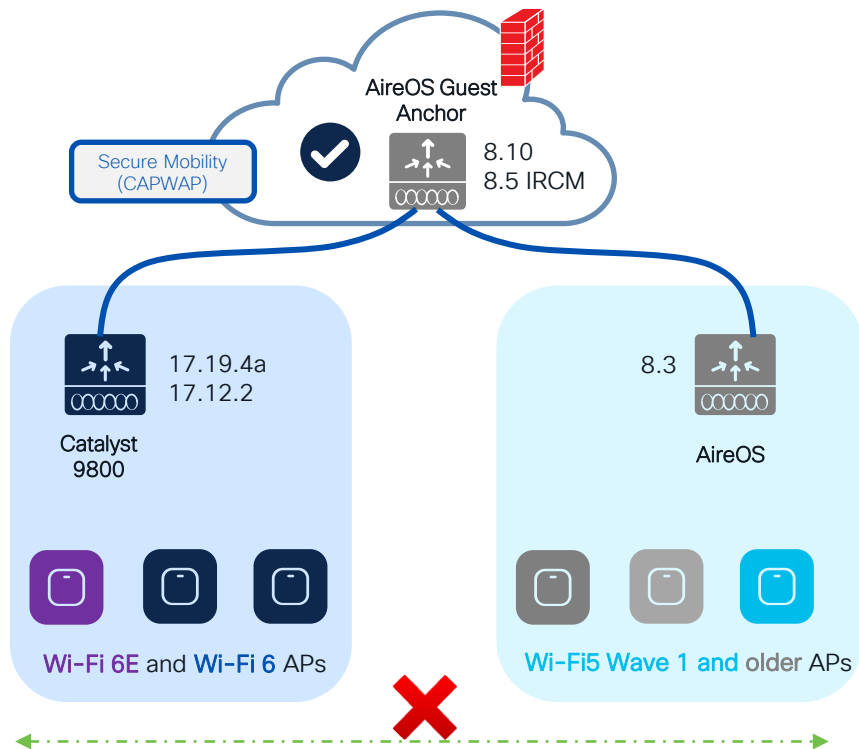
### Scenario 1: Legacy Controller Supports IRCM

- 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-aireos\\_ircm\\_dg.html](https://www.cisco.com/c/en/us/td/docs/wireless/controller/technotes/8-8/b_c9800_wireless_controller-aireos_ircm_dg.html)

# How do I start adopting 6GHz?

Answer: Inter Release Controller Mobility (IRCM)



## 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-aireos\\_ircm\\_dg.html](https://www.cisco.com/c/en/us/td/docs/wireless/controller/technotes/8-8/b_c9800_wireless_controller-aireos_ircm_dg.html)

Wi-Fi 6E is here,  
are you ready?

# Wi-Fi 6E is here, 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



The bridge to possible

# Thank you

CISCO *Live!*

The background of the slide is a vibrant, abstract graphic. It features a large, stylized cloud shape on the left side, composed of overlapping, semi-transparent layers of orange, red, and yellow. To the right of the cloud, a bright, multi-colored sunburst or starburst pattern radiates outwards, transitioning through a spectrum of colors including yellow, green, blue, and purple. The overall effect is energetic and colorful.

cisco *Live!*

Let's go