

CISCO *Live!*



#CiscoLive



The bridge to possible

# Wi-Fi 6E is Here!

Are You Ready?

Simone Arena, Principal Technical Marketing Engineer

BRKEWN-2038



#CiscoLive

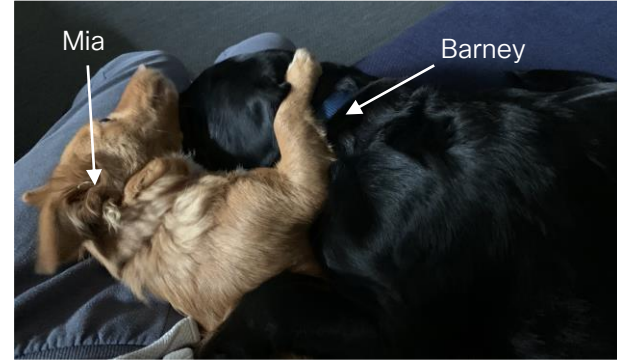


Anita, Giulia, Viola



Harry

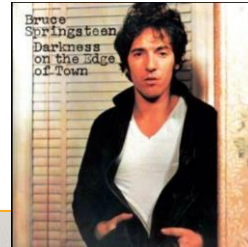
Ginny



Mia

Barney

The Boss, what else??



Tube amplifier



Sagrantino di Montefalco  
Caprai 2013



Fiorentina soccer fan



CISCO *Live!*



# Agenda

- Why Wi-Fi 6E
- Are you ready?
  - Setting the stage..
  - Access Point Deployment
  - Radio Frequency Design
  - Wireless Network Design
- Conclusions

# Cisco Webex App

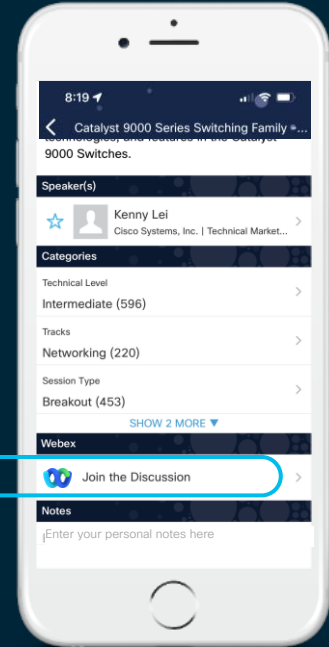
## Questions?

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 June 17, 2022.



<https://ciscolive.ciscoevents.com/ciscolivebot/#BRKEWN-2038>

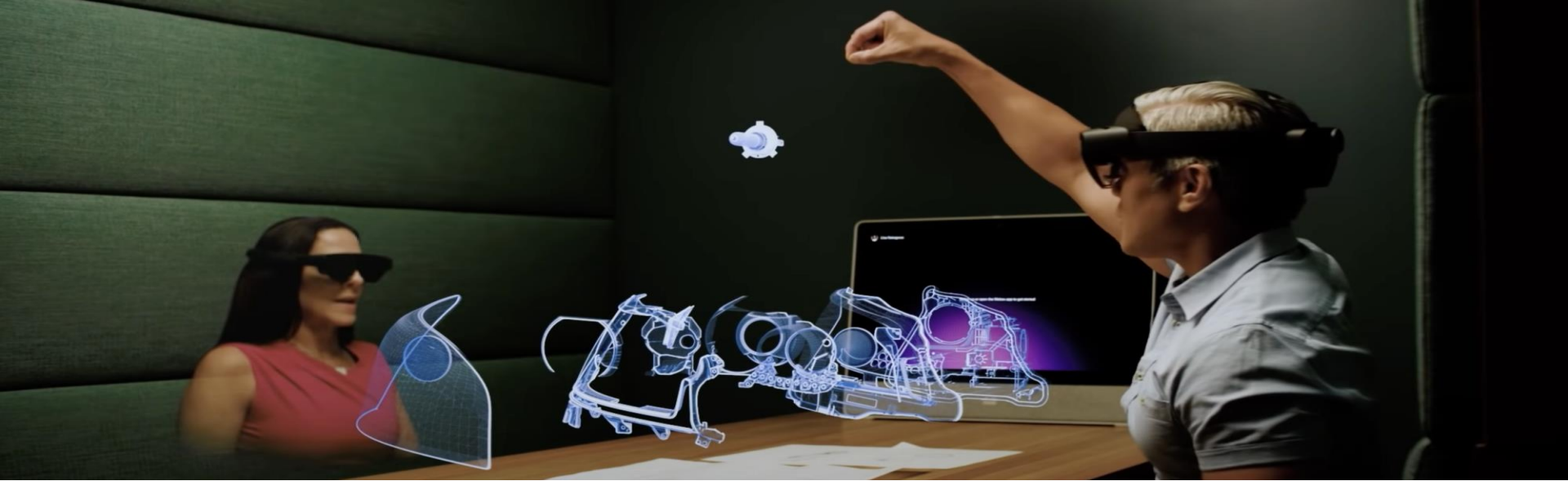
# Shall I adopt 6Ghz now?





# Immersive Experiences of Today...





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

# and Tomorrow...



# It's all About the Wireless Experience!

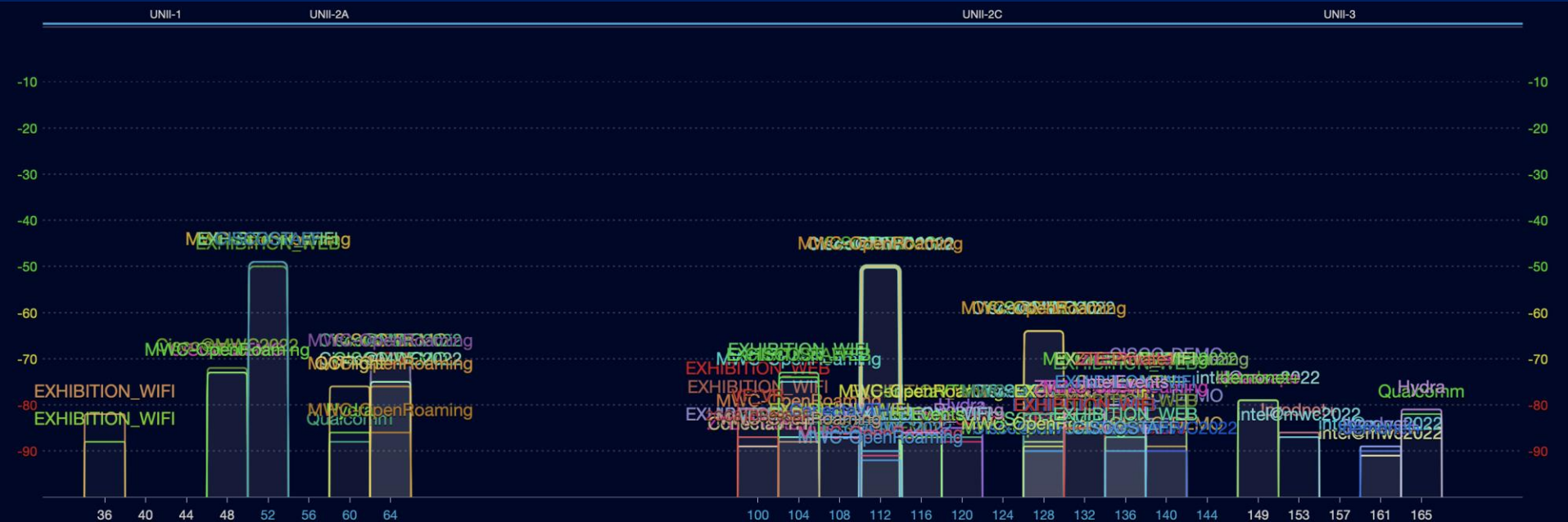
- New technology trends > new requirements:
  - More IoT devices, M2M communication > high density and critical communication
  - SLA-bound applications, video and delay sensitive apps > need for less latency, minimal jitter
  - VR/AR and High-resolution video > more throughput

Wi-Fi 6 is all about efficiently use the spectrum...

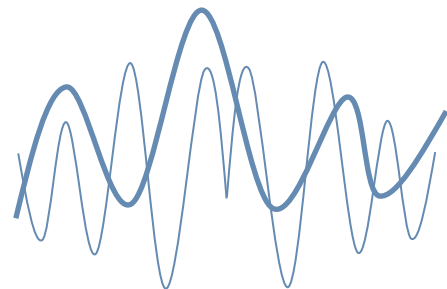
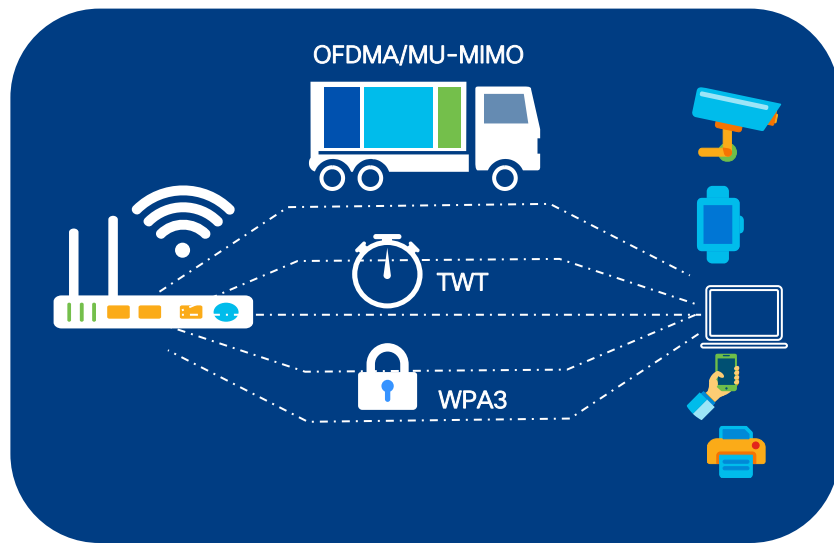
Service Level Agreement (SLA)  
Internet of Things (IoT)  
Machine to Machine (M2M)  
Virtual reality/Augmented Reality (VR/AR)

# What is the Problem?

- Existing 2.4 GHz and 5 GHz spectrum is congested
- Legacy clients
- No way to use 80 or 160 MHz channels



# 6E = Extending the Capabilities of Wi-Fi 6 to clean 6GHz spectrum



- ✓ 1200 MHz spectrum
- ✓ Greenfield 6GHz band!
- ✓ No legacy devices
- ✓ No DFS (for radar)
- ✓ Legacy Interference Free!

Orthogonal frequency-division multiple access (OFDMA)  
Multiple User, Multiple Input, Multiple Output (MU-MIMO)  
Target Wait Time (TWT)  
Wi-Fi Protected Access v3 (WPA3). | GHz = gigahertz  
Dynamic Frequency Selection (DFS). | MHz = megahertz

# Are you Ready for Wi-Fi 6E?

## Wi-Fi Network design

- Adoption/Migration
- WLAN/SSID design

## RF design

- AP coverage
- AP density
- RRM for 6GHz

## AP deployment

- Choose the right AP model
- AP specs
- Power requirements
- Switching infrastructure

## Setting the stage...

- Regulatory considerations
- Client ecosystem
- Wi-Fi 6E AP type

AP = Access Point  
Radio Resource Management (RRM)  
Radio Frequency (RF)  
WLAN = Wireless LAN  
SSID = Service Set Identifier

# Setting the stage...

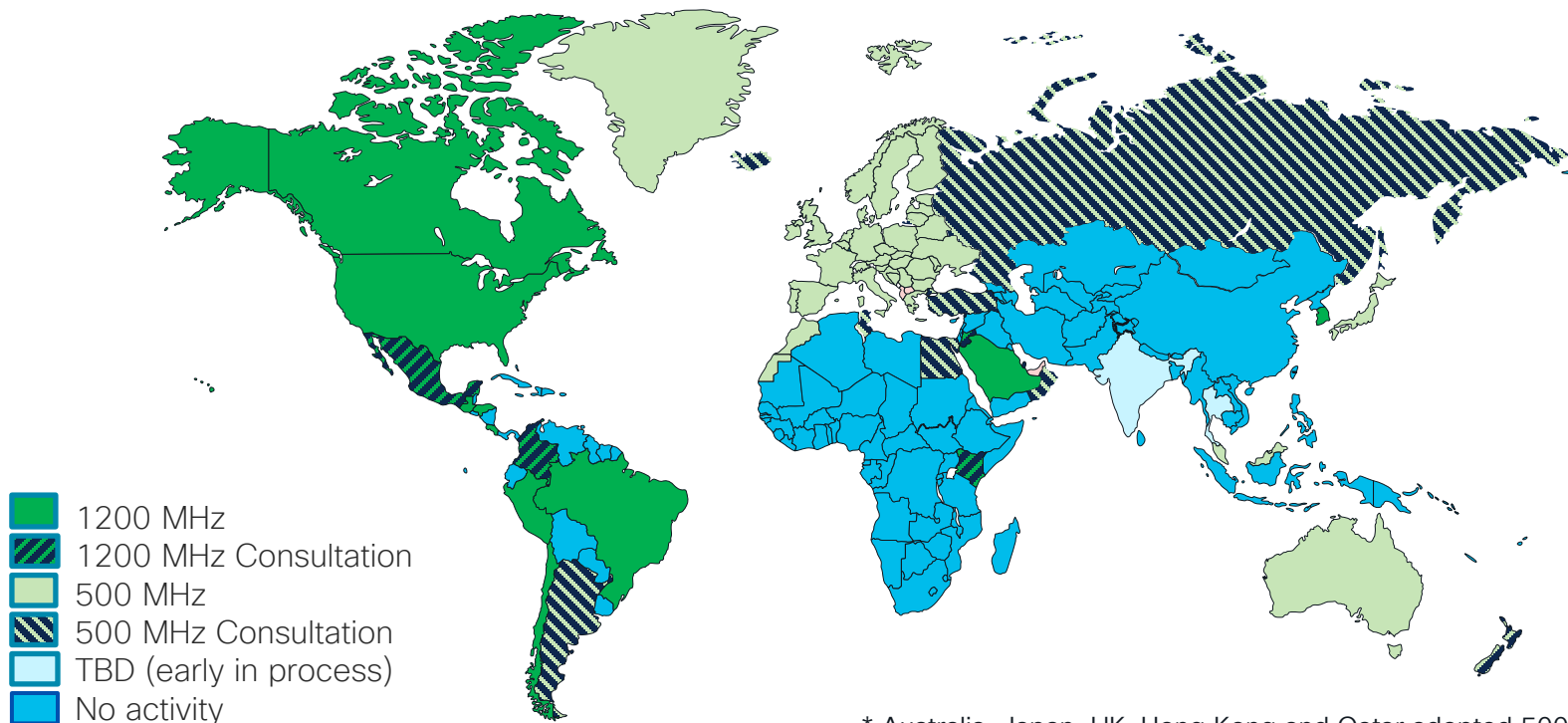
## Setting the stage...

- Regulatory considerations
- Client ecosystem
- Wi-Fi 6E AP type



# Global availability of 6 GHz band for Wi-Fi

(<https://www.wi-fi.org/countries-enabling-wi-fi-6e>)



\* Australia, Japan, UK, Hong Kong and Qatar adopted 500 MHz and now considering 1200 MHz

# Wi-Fi 6E Client Device Eco System

Wide range of client support ..



Useful link:

<https://www.androidcentral.com/these-android-phones-support-wi-fi-6e>  
<https://www.intel.com/content/www/us/en/products/details/wireless/wi-fi-6e-series.html>

# 6 GHz – New Device Classes

- Wi-Fi 6E introduces new device classes for optimized capability
- Regulations vary by country

|                                                                                                                                                               |                                                                                                                                                                                                         |                                                                                                                                    |                                                                                                                                                                                                  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                              |                                                                                                                        |                                                 |                                                                                                               |
| Low Power Indoor (LPI) AP                                                                                                                                     | Standard Power (SP) AP                                                                                                                                                                                  | Very Lower Power (VLP) AP                                                                                                          | Client Devices                                                                                                                                                                                   |
| <ul style="list-style-type: none"><li>• Indoor Only</li><li>• Integrated Antenna Required</li><li>• Can use the full 1200 MHz</li><li>• Wired Power</li></ul> | <ul style="list-style-type: none"><li>• Indoor or Outdoor</li><li>• Integrated or External Antenna</li><li>• UNII-5 and UNII-7 Only (US)</li><li>• No support in ETSI</li><li>• Requires AFC*</li></ul> | <ul style="list-style-type: none"><li>• Mobile Indoor or Outdoor</li><li>• Limited Range</li><li>• Does not require AFC*</li></ul> | <ul style="list-style-type: none"><li>• Indoor or Outdoor</li><li>• Only Indoor under control of LPI AP</li><li>• 6 dBm lower power than AP for FCC</li><li>• Same power of AP in ETSI</li></ul> |

(\*) Automatic Frequency Co-ordination

# AP Deployment

## Setting the stage...

- Regulatory considerations
- Client ecosystem
- Wi-Fi 6E AP type

## AP deployment

- Choose the right AP model
- AP specs
- Power requirements
- Switching infrastructure

# Cisco Catalyst Wireless (CW) 6E Access Points

Ideal for Small to Medium-sized deployments

Best In Class, Flexibility

Mission Critical,  
Performance



## CW9162\*

- 2x2 + 2x2 + 2x2
- 2.5 Gbps mGig
- Power: PoE, DC Power
- IoT ready + Bluetooth 5.x
- iCAP for Management Frames
- USB – 4.5 W

(\*) Available with IOS-XE 17.9.2



## CW9164

- 2x2, 4x4, 4x4
- 2.5 Gbps mGig
- Power: PoE, DC Power
- IoT Ready + Bluetooth 5.x
- iCAP for Management Frames
- USB- 4.5 W



## CW9166

- 4x4 + 4x4 + 4x4 (XOR 5/6)
- 5 Gbps mGig
- Power: PoE, DC Power
- IoT ready + Bluetooth 5.x
- USB – 4.5W
- Full Packet Capture (iCAP)
- Environmental Sensor
- Zero-Wait DFS\*



## C9136

- 4x4, 8x8, 4x4 /4x4, 4x4+4x4, 4x4
- Dual 5 Gbps mGig
- Power: PoE only
- IoT ready + Bluetooth 5.x
- Environmental Sensor
- PoE and Link Redundancy
- Full Packet Capture (iCAP)
- Zero-Wait DFS\*
- USB – 9W

*\*Available in Future*

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

Dedicated Radio for CleanAir Pro

Same Brackets

Same Industrial Design

AP Power Optimization

# More on 6GHz and Cisco Wi-Fi 6E APs?

## Architecting Next Generation Wireless Network with Catalyst Wi-Fi 6E Access Points - BRKEWN-2024

Anand Gurumurthy, Technical Marketing Engineering Technical Leader, Cisco Systems, Inc.

 **Schedule**

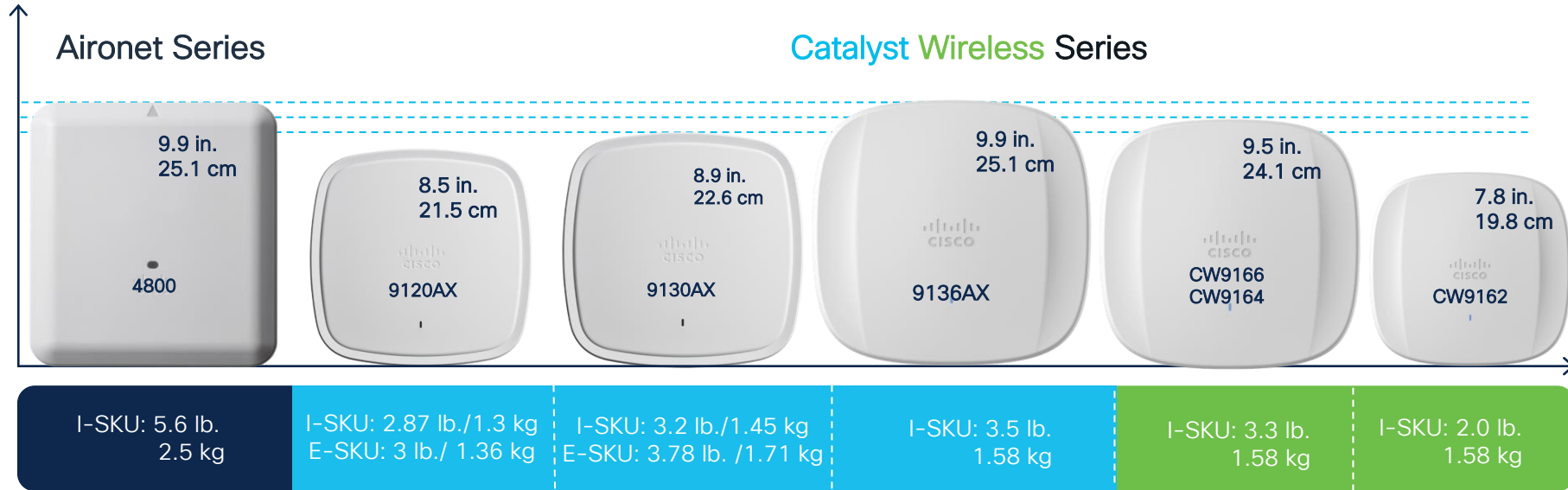
**Monday, Jun 13 | 9:30 AM - 10:15 AM PDT**

This session deep dives into the newly introduced Wi-Fi6E standard in 6GHz band. It begins with an overview of the 6GHz band and the worldwide regulations and then dives into the specifics of WI-FI 6E protocol including device classes and AP discovery. The session covers aspects of the protocol optimization introduced for the clients to discover the WLANs and AP in 6 GHz band. Security in the 6GHz WI-FI 6E world is now mandated with WPA3 This session covers the key WI-FI 6E security takeaways that the end user needs to be aware of. This session also covers technical deep dive of the new converged Wi-Fi 6E Access Point and walks through the deployment options with Onprem and Cloud, features, capabilities, power requirements and migration.

You can watch the recording of this great session from Anand!

# Indoor Access Point Dimensions

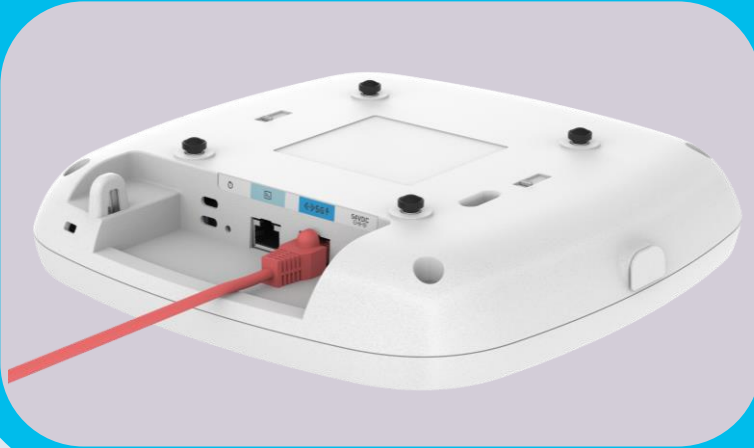
Wi-Fi 6E - Similar in size but significantly more capabilities



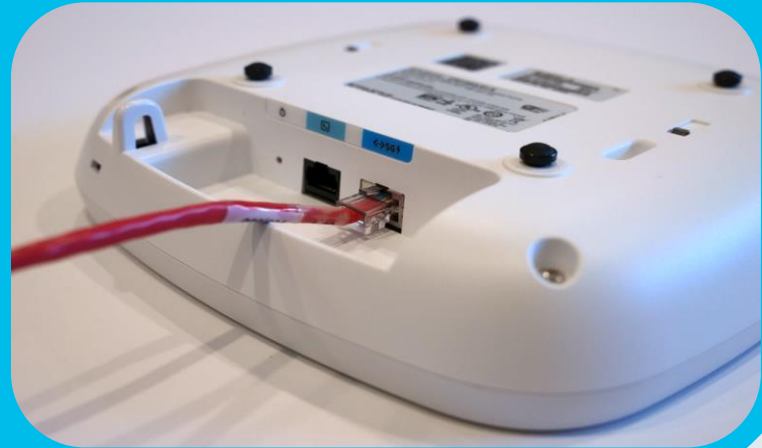
# Catalyst C9136/CW9166/9164/9162

Enhanced cabling experience

C9136/CW66/64/62- Lowered Edge



C9130 - Higher Edge and Smaller Area

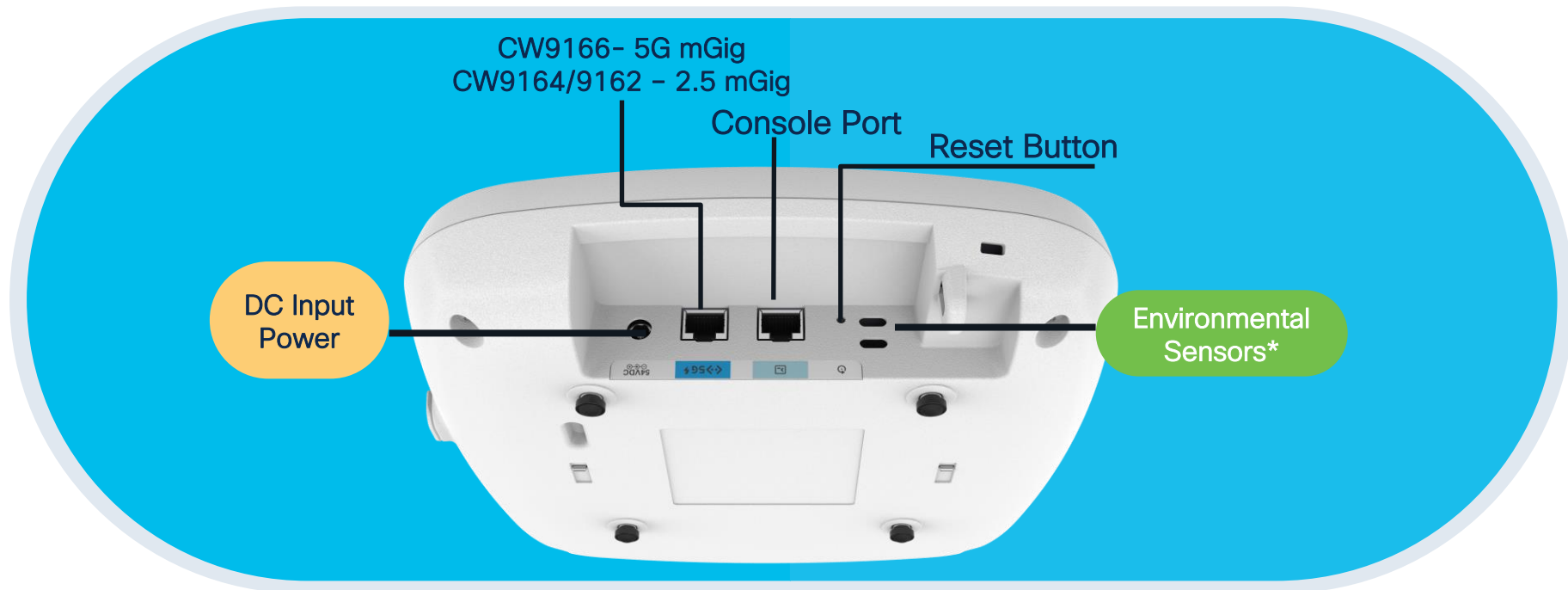


**Larger Recessed Area**  
Allow Wires not to be Bent During Connection

**More Easily Accessible Port**  
Allow for Better Deployment Experience

# Catalyst CW9166/64/62

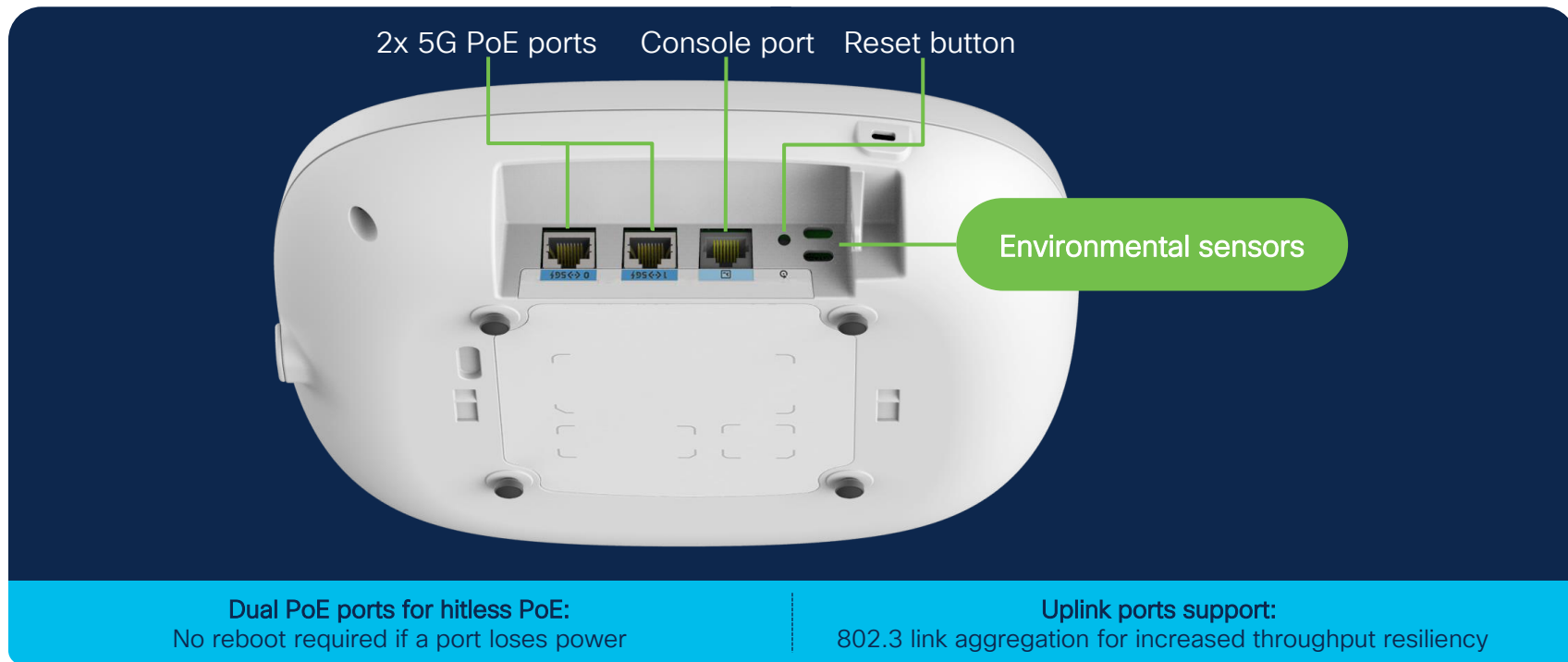
## Ports and connections



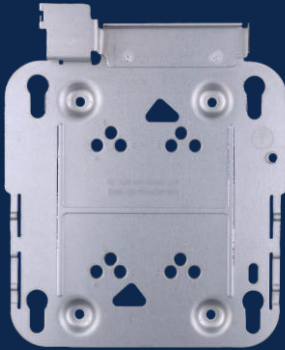
\* Environmental Sensors Available only in CW9166

# Catalyst 9136 ports

## Ports and connections



# AIR-AP-BRACKET-1 photos



Front side

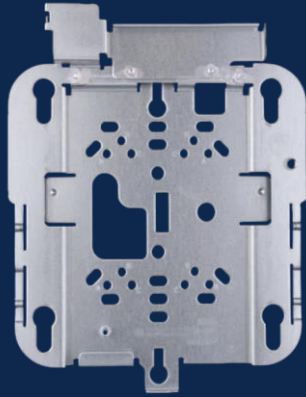


AP mounted



Back side

# AIR-AP-BRACKET-2 photos



Front side



AP mounted



Back side

# What about 6E AP with external antennas?

Two important things:

- C9136 and CW916x are LPI access points
- In FCC LPI can only have internal antennas

## A. Low-power indoor access points (6ID) operating in the 5.925-7.125 GHz band

A low-power indoor access point (6ID) is a device that operates in a master mode as defined in Section 15.202, which can transmit without receiving an enabling signal. This mode can select a channel and initiate a network by sending enabling signals to client devices. A low-power indoor-

Limited to indoor locations, have integrated antenna

wireless

These devices are limited to indoor locations, have an integrated antenna, and cannot use a weatherized enclosure.

Low-power indoor access points devices are prohibited on oil platforms, cars, trains, boats, and aircraft, except large aircraft while flying above 10,000 feet.

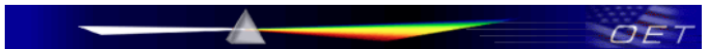
Low-power indoor access points must be powered by a wired connection and not by battery power [7]. Low-power indoor access points may use battery backup only during power outages.

Label information required in the exhibit types ID Label/Location Info  
FCC ID  
Indoor Use only [13]  
E-labelling is permitted on devices qualifying for e-labelling.

The device user manual must contain the following information. The user manual must be filed as an exhibit in the application filing [14].

- o FCC regulations restrict the operation of this device to indoor use only.
- o The operation of this device is prohibited on oil platforms, cars, trains, boats, and aircraft,

Part 15 Subpart E U-NII 6 GHz General Guidance Bands 5, 6, 7, 8



Federal Communications Commission  
Office of Engineering and Technology  
Laboratory Division Publication

February 4 2021

**Part 15 Subpart E U-NII 6 GHz  
General Guidance Bands 5, 6, 7, 8**

Table of Contents:

- I. Introduction
- II. U-NII 6 GHz Bands 5, 6, 7, 8 Overview
- III. Set of Indoor Devices
  - A. Low-power indoor Access Points
  - B. Subordinate
  - C. Indoor Client
  - D. Application Requirements
- IV. Standard Access Device and Associated Clients
  - A. Standard power access Points
  - B. Dual Client
  - C. Standard Client
  - D. Fixed Client
  - E. Application Requirements
- V. Composites
- VI. Modules
- VII. RF Exposure

Appendix A: Required Form 731 Application Exhibits  
Appendix B: Attestation Examples

FCC = Federal Communications Commission

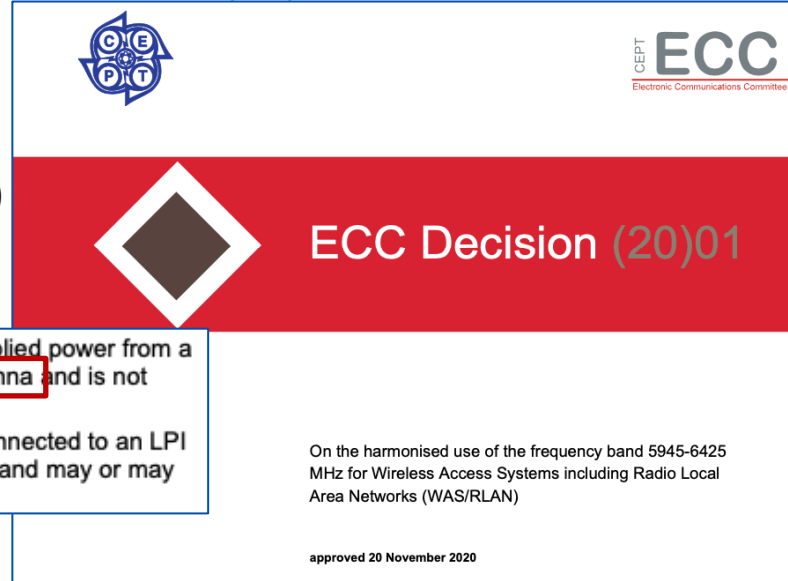
# What about 6E AP with external antennas? ETSI

ECC/DEC/(20)01 document

Two important things:

- In EU, as per ECC document, only LPI (Low Power Internal) and VLP (Very Low Power) are allowed in 6GHz UNII-5 band (5925 – 6425 MHz)
- LPI can only have internal antennas:

|                    |                                                                                                                                                                                                                                                                                                 |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Category of device | <p>An LPI access point or bridge that is supplied power from a wired connection, has an integrated antenna and is not battery powered.</p> <p>An LPI client device is a device that is connected to an LPI access point or another LPI client device and may or may not be battery powered.</p> |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|



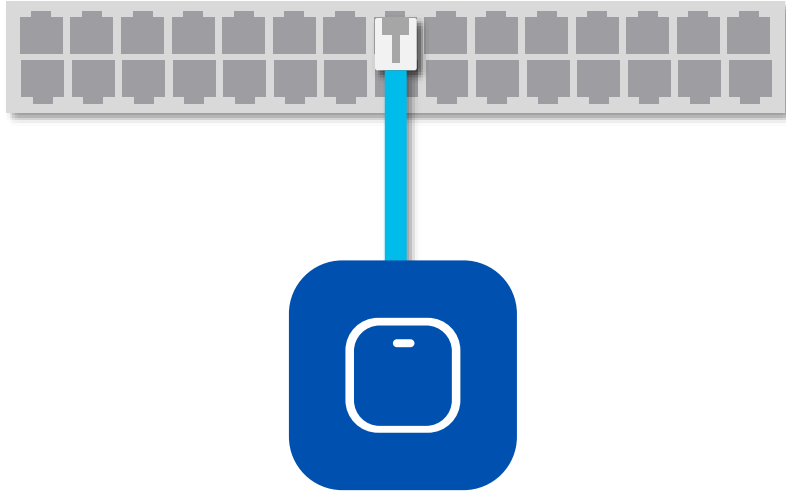
<https://docdb.cept.org/download/1448>

ECC = Electronic Communications Committee  
DEC = Decision

# Catalyst AP to switch connection



# 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)

# Catalyst AP 9136 to Switch connection



AP 9136

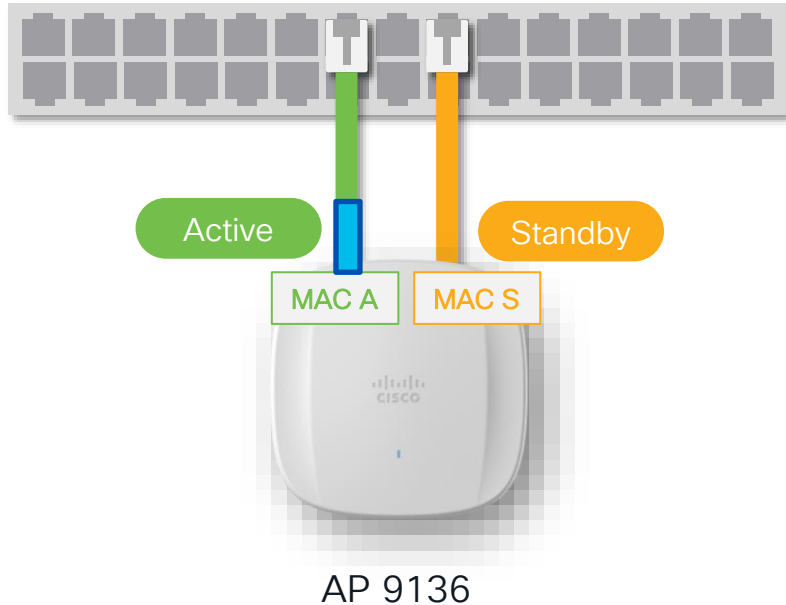
C9136 has two mGig uplink ports

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

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

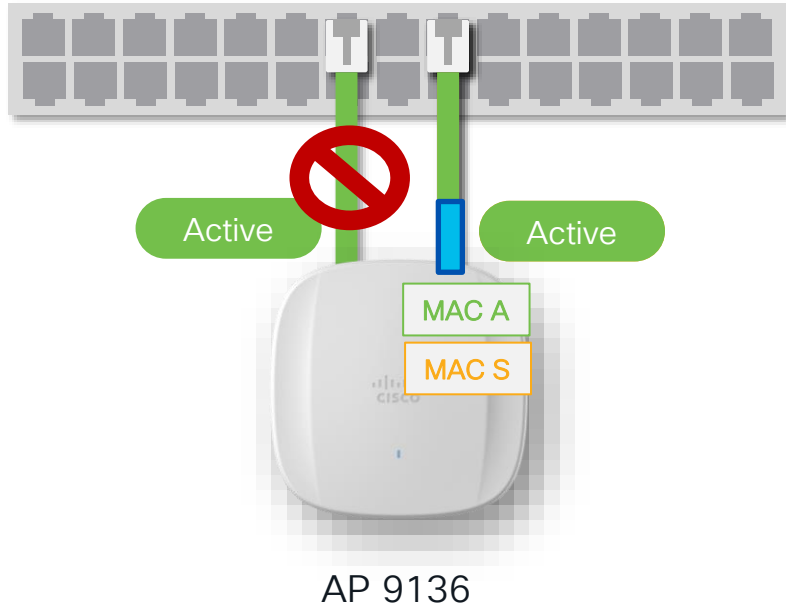
mGig = multi gigabit ethernet  
PoE = Power over Ethernet  
LAG = Link Aggregation Group

# Catalyst AP 9136 to Switch connection



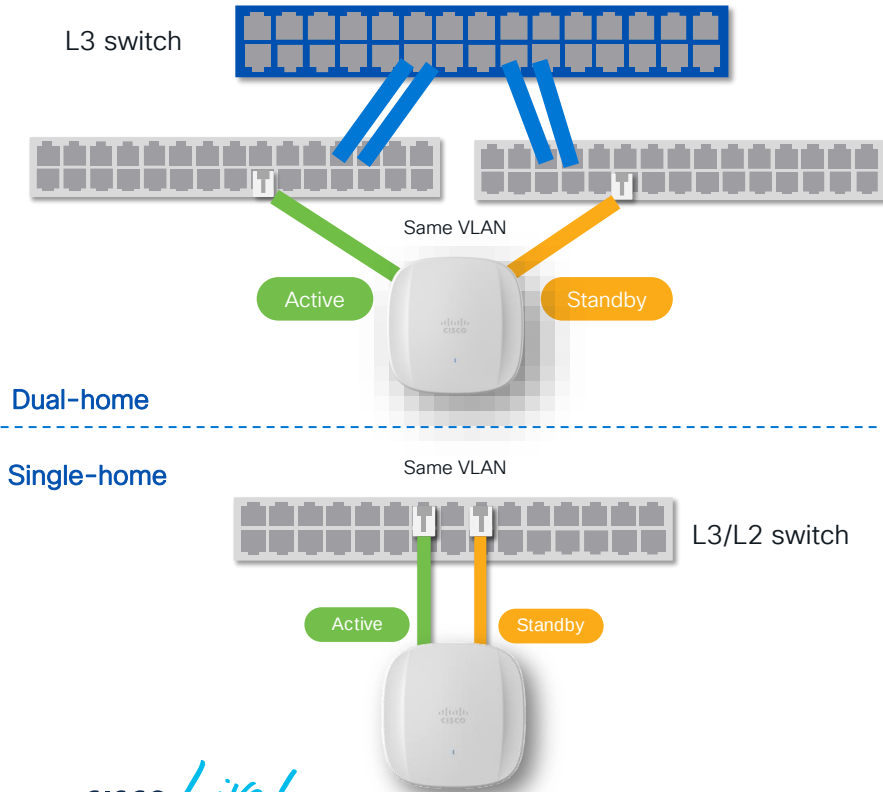
- When configured as standalone ports, one becomes **active** and the other one **standby**
  - If power is equal on both ports, Port 0 becomes **active**. Otherwise, the one with more power
- Traffic is exchanged on **active** port using active **MAC A** (CAPWAP, ARP, etc.)
- **Standby** port only exchanges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

# Catalyst AP 9136 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

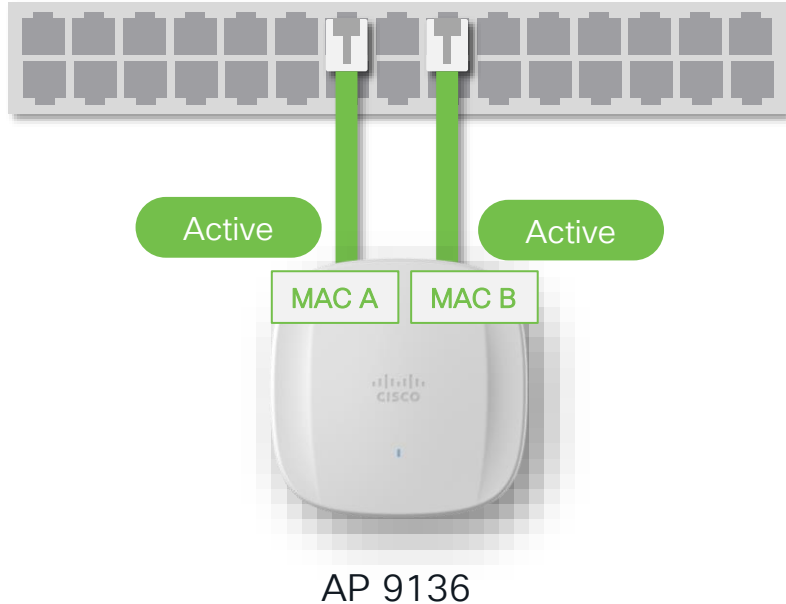
# Catalyst AP 9136 to Switch connection



- 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, vPC, 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  
vPC = virtual Port Channel

# Catalyst AP 9136 to Switch connection



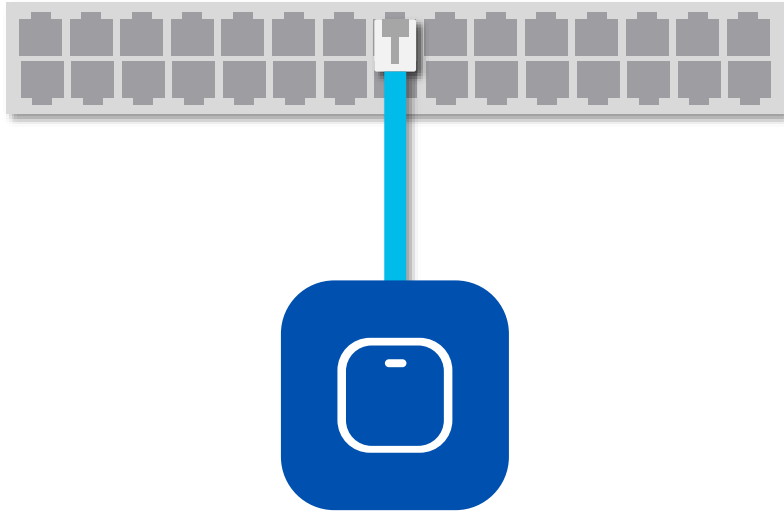
- When configured with LAG, both ports are **Active**
- LAG must be configured on both AP and switchport side.
- AP supports static LAG config (mode on) or dynamic with LACP
- Traffic is load balanced across the two links using **src-dst-port** algorithm. CAPWAP uses random source UDP ports
- LAG must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



48.3 W

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 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 | 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         | 2.5G            | Disabled | Y                           |
| 802.3bt      | 10                       | 2x2           | 4x4         | 4x4         | 2.5G            | Y/4.5 W  | Y                           |
| DC Power     | 10                       | 2x2           | 4x4         | 4x4         | 2.5G            | Y/4.5 W  | Y                           |

### Note:

1. AIR-PWRINJ7 is C9164I's official 802.3bt Power Injector
2. Actual Power Draw data will be available later (as final testing is in progress)

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

# Catalyst CW9166 Power over Ethernet

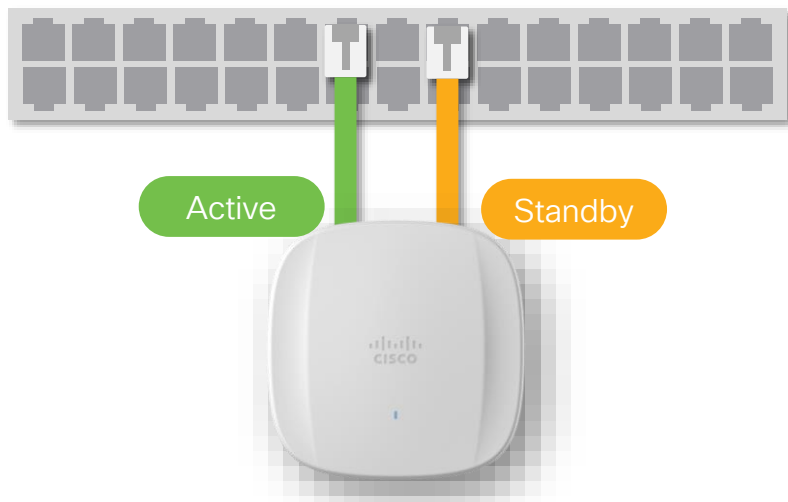
## Default Configuration (Fixed Power profile)

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

**Note:**

1. AIR-PWRINJ7 is C9166I's official 802.3bt Power Injector
2. Actual Power Draw data will be available later (as final testing is in progress)

# 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             | 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

# RF Design



## Setting the stage...

- Regulatory considerations
- Client ecosystem
- Wi-Fi 6E AP type

## AP deployment

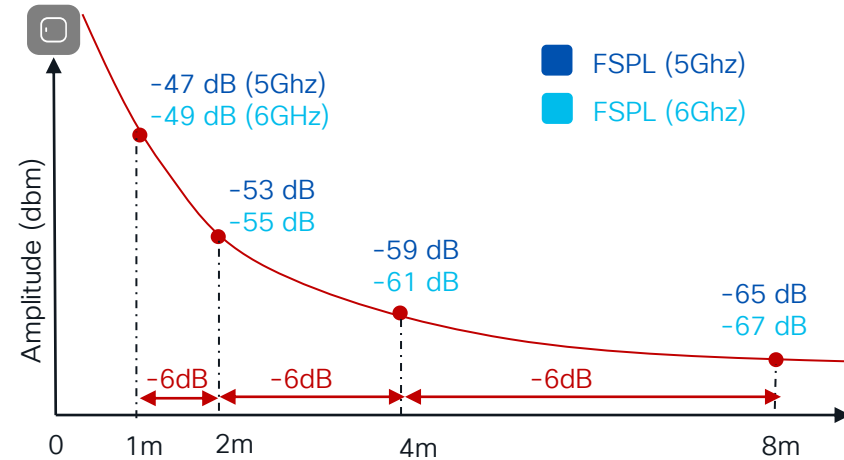
- Choose the right AP model
- AP specs
- Power requirements
- Switching infrastructure

## RF design

- AP coverage
- AP density
- RRM for 6GHz

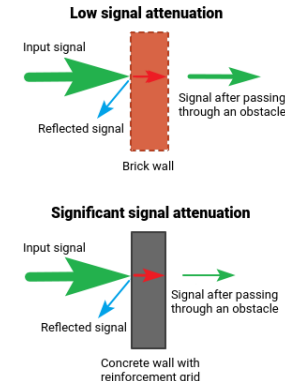
# What you need to consider?

- **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



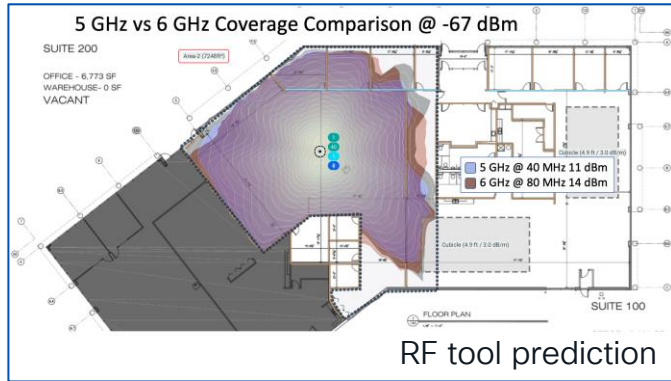
(\*) FSPL = Free Space Path Loss: [https://en.wikipedia.org/wiki/Free-space\\_path\\_loss](https://en.wikipedia.org/wiki/Free-space_path_loss)

<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**



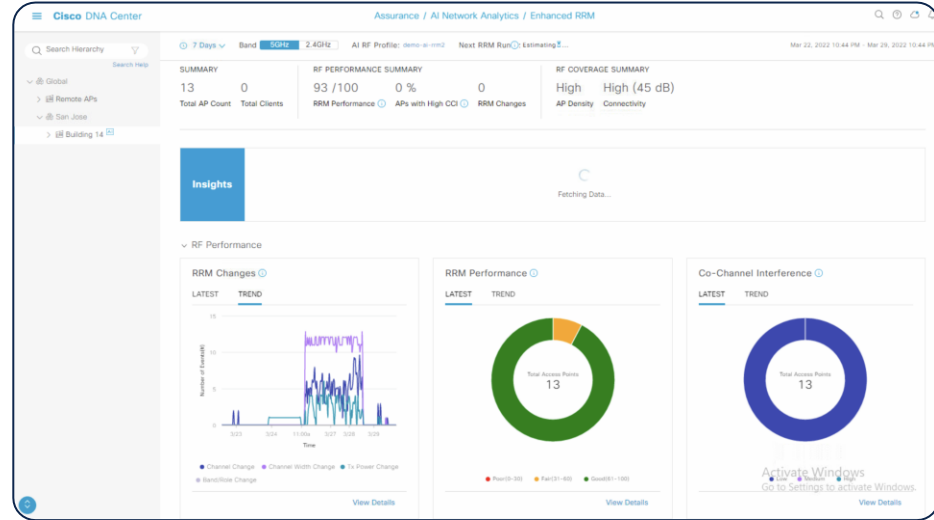
- 5GHz @40 MHz 11dbm
- 6GHz @80 MHz 14 dbm

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

# RF Design considerations

- **1:1 AP replacement for brownfield**, assuming:
  - Cell size 1500/2000 ft<sup>2</sup> (140 – 190 m<sup>2</sup>) with 10 ft. (3 m) ceiling height
  - Power levels of 11–15 dBm in 5 GHz > power can easily be adjusted upward for 6 GHz to match 5GHz cell coverage
- For **greenfield**, a site survey is recommended: leverage the **new site survey mode** on Cisco Wi-Fi 6E APs
- **Mixing** Wi-Fi6E APs with existing APs in the same area is **not recommended** > avoid “salt & pepper” design if you can





AI Enhanced RRM

# AI-Enhanced RRM Early Adoption Program!

**Customer Benefit:** Direct access to the AI-Enhanced RRM Team to have this solution deployed on your network ASAP!

## Minimum requirements:

1. Cisco DNA Center 2.3.2 or later
2. Catalyst 9800 17.7.1 or later
3. Use Cisco DNA Center Automation

Email [AIRRM-adoption@cisco.com](mailto:AIRRM-adoption@cisco.com) to get started today!

# RRM for 6GHz: Where are my channels??

...and a bunch of other DCA and TPC settings?

Configuration > Radio Configurations > RRM > 5GHz

6 GHz Band 5 GHz Band 2.4 GHz Band FRA

General Coverage **DCA** TPC RF Grouping Spatial Reuse

**Dynamic Channel Assignment Algorithm**

Channel Assignment Mode

☒ Automatic

☐ Freeze

☐ Off

Interval 10 minutes

Anchortime 0

Avoid Foreign AP Interference ☐

Avoid Cisco AP load ☐

Avoid Non 5 GHz Noise ☐

Avoid Persistent Non-with Interference ☐

Channel Assignment Leader C9800-OEAP (10.58.55.25)

Last Auto Channel Assignment 524 second(s) ago

DCA Channel Sensitivity medium

Channel Width ☐ 20 MHz ☒ 40 MHz ☐ 80 MHz ☐ 160 MHz ☐ Best (DBS)

Dynamic Bandwidth Selection Max Channel Width 1

Auto-RF Channel List

☐ 36 ☐ 40 ☐ 44 ☐ 48 ☐ 52 ☐ 56 ☐ 60 ☐ 64 ☐ 100 ☐ 104 ☐ 108 ☐ 112 ☐ 116 ☐ 120 ☐ 124 ☐ 128

☐ 132 ☐ 136 ☐ 140 ☐ 144 ☐ 149 ☐ 153 ☐ 157 ☐ 161 ☐ 165

VS.

Configuration > Radio Configurations > RRM > 6GHz

6 GHz Band 5 GHz Band 2.4 GHz Band FRA

General Coverage **DCA** TPC RF Grouping Spatial Reuse

**Dynamic Channel Assignment Algorithm**

Channel Assignment Mode

☒ Automatic

☐ Off

Interval 10 minutes

Anchortime 0

Channel Assignment Leader C9800-OEAP (10.58.55.25)

Last Auto Channel Assignment 237 second(s) ago

DCA Channel Sensitivity medium

Dynamic Bandwidth Selection Max Channel Width 40 MHz

For 6 GHz band, few global DCA parameters like Avoid Foreign AP Interference and DCA Channel List is configured in default-rf-profile-6ghz

Do you you notice anything else here?

# RRM for 6GHz

RRM settings are under 6GHz RF Profile configuration:

Configuration > Tags & Profiles > RF/Radio

RF Radio

+ Add × Delete Clone

|                          | State | RF Profile Name                | Band    | Description           |
|--------------------------|-------|--------------------------------|---------|-----------------------|
| <input type="checkbox"/> |       | My5GHz_profile                 | 5 GHz   |                       |
| <input type="checkbox"/> |       | my6GHz_profile                 | 6 GHz   |                       |
| <input type="checkbox"/> |       | default-rf-profile-6ghz        | 6 GHz   | default rfprofile for |
| <input type="checkbox"/> |       | Low_Client_Density_rf_5gh      | 5 GHz   | pre configured Low    |
| <input type="checkbox"/> |       | High_Client_Density_rf_5gh     | 5 GHz   | pre configured High   |
| <input type="checkbox"/> |       | Low_Client_Density_rf_24gh     | 2.4 GHz | pre configured Low    |
| <input type="checkbox"/> |       | High_Client_Density_rf_24gh    | 2.4 GHz | pre configured High   |
| <input type="checkbox"/> |       | Typical_Client_Density_rf_5gh  | 5 GHz   | pre configured Typi   |
| <input type="checkbox"/> |       | Typical_Client_Density_rf_24gh | 2.4 GHz | pre configured Typi   |

- DBS prefers 80MHz for FCC and 40 MHz for ETSI
- Preferred Scan Channel (PSC) recommended

CISCO *Live!*

Edit RF Profile

General 802.11 RRM Advanced 802.11ax

General Coverage TPC DCA

Dynamic Channel Assignment

Avoid AP Foreign AP Interference ☒

Channel Width

☐ 20 MHz ☐ 40 MHz ☐ 80 MHz ☐ 160 MHz  
☒ Best (DBS)

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

ENABLE ☒

PSC Channel List

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

Client Network Preference

Default

# Want to know more about RF design?

## Cisco Catalyst Wi-Fi, Understanding Catalyst Wi-Fi 6/6E and Beyond - BRKEWN-3005

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



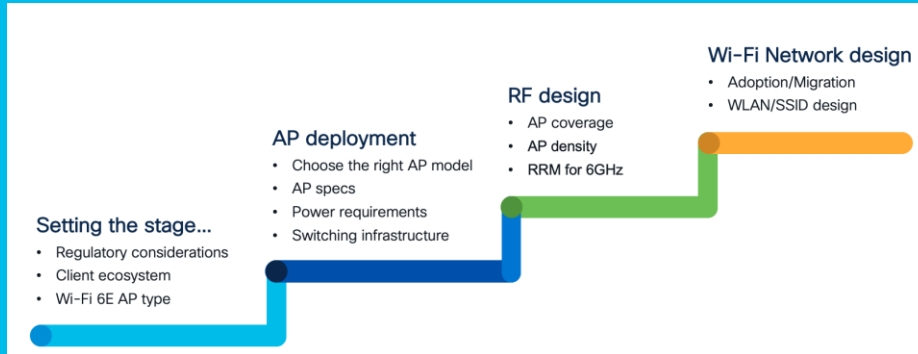
Schedule

**Monday, Jun 13 | 2:30 PM - 3:15 PM PDT**

Learn the RF design and implementation guidelines necessary to plan, configure, and implement Wi-Fi to 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 wireless. 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. Learn and understand the current coverage and design best practices as well in context of the evolving RF landscape around the world. Everything we know is evolving. This session will provide a deep dive on how to think about Wi-Fi6e, RRM, Spectrum Intelligence and the evolution of Multi Band Operations. Wi-Fi 6e brings amazing RF capacity

You can watch the recording from the RRM guru! 😊

# Wi-Fi Network Design



# Wi-Fi 6/6E runs on Cisco Catalyst Wireless



## Supported Access Points

Wi-Fi 6/6E

C9136



CW9166/64



CW9162



Wi-Fi 6

9130



9124



9120



9115

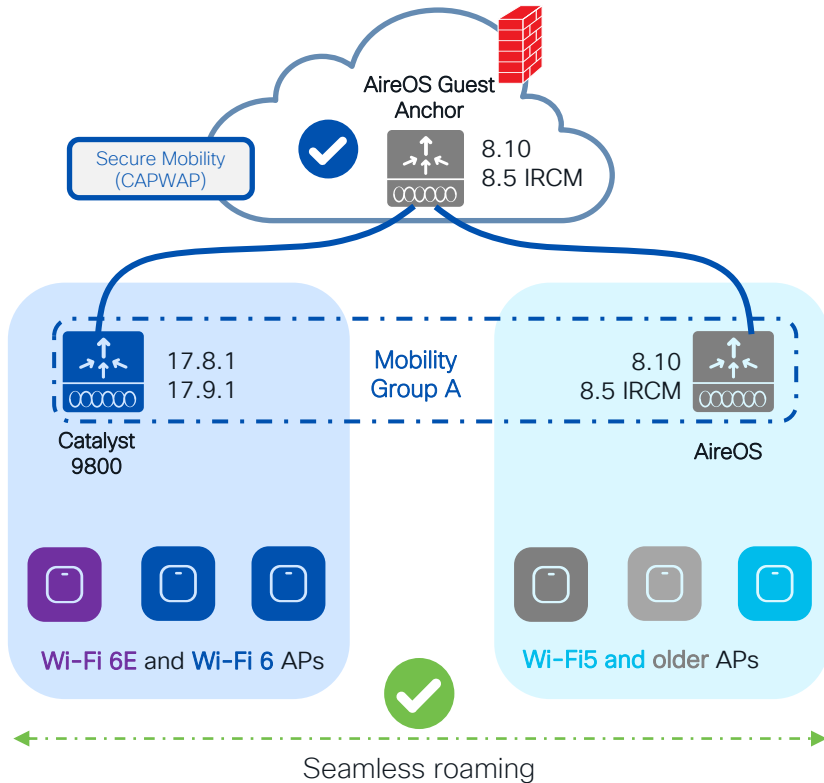


9105



# How do I start adopting 6GHz?

Answer: Inter Release Controller Mobility (IRCM)



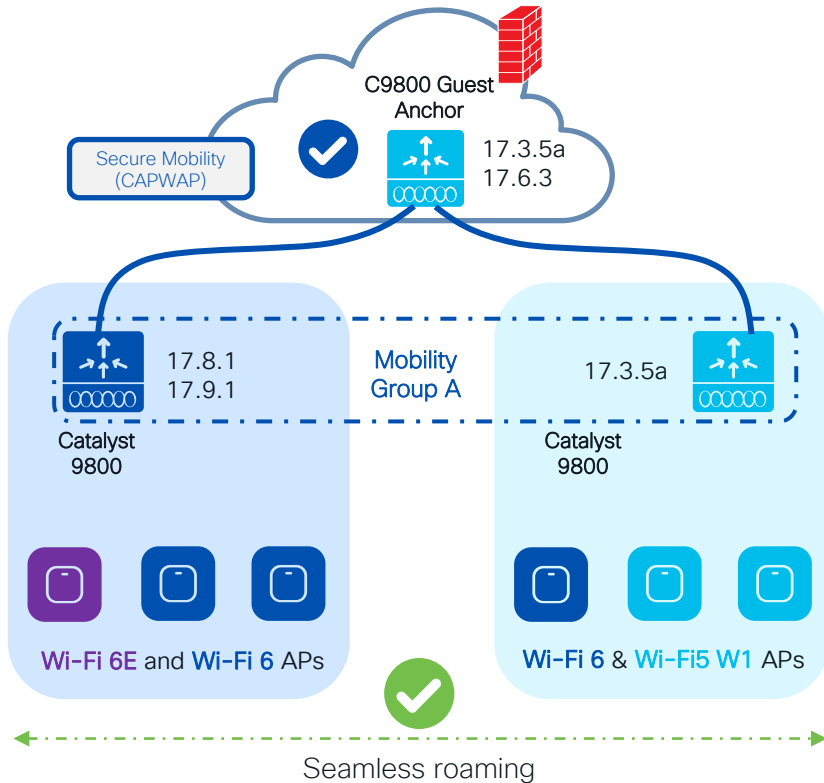
## IRCM enabled adoption:

- Adoption is not something that happens overnight...
- IRCM allows you to plan the 6GHz network adoption at your pace
- Introduce new 6/6E AP hardware on the new C9800 and support seamless roaming, single RF domain, and Guest Anchor with existing networks
- The release combinations shown have been tested at scale, check IRCM deployment guide\*
- **Note:** Anchor WLC can be C9800

(\*) [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)



## IRCM enabled adoption:

- If you have already started your Catalyst Wireless journey...
- 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\*
- **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](https://www.cisco.com/c/en/us/td/docs/wireless/controller/technotes/8-8/b_c9800_wireless_controller-aios_ircm_dg.html)

# WLAN/SSID Design



# 6GHz WLAN Design Considerations

## 6GHz SSID Requirements

- WPA3 L2 Security: OWE, SAE or 802.1x-SHA256
- Protected Management Frame (PMF) enabled
- Any non-WPA3 L2 security method is not allowed – **no mixed mode possible**

## 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 multiple WLANs with the 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**

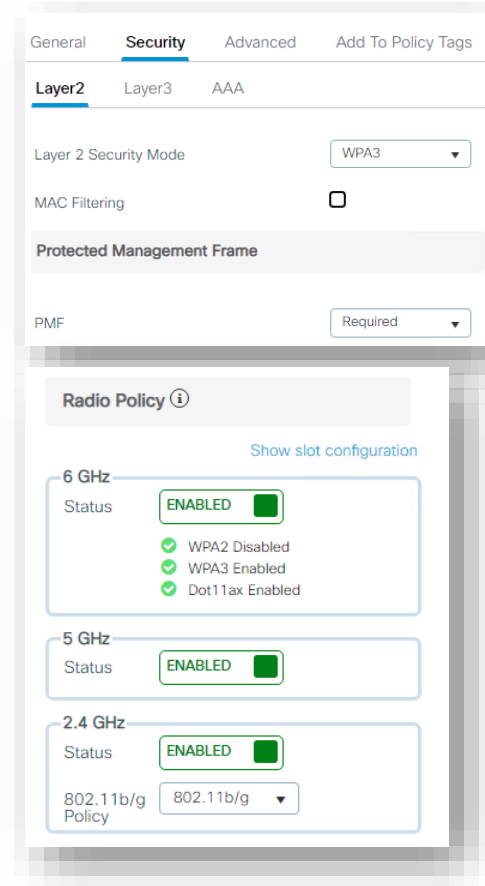
Most likely your current SSID configuration would prevent it from being broadcasted on 6GHz  
Note: as 17.9.1, there is a limit of 8 SSIDs broadcasted on 6GHz radio

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

# Option 1 Design: Apple Clients

- Reconfigure the existing SSID to meet Wi-Fi 6E requirements (WPA3 and PMF). Need to verify if the new settings are supported by the existing clients.
- Apple Support:
  - **AKM:** SAE or 802.1x-SHA256. **OWE not supported**
  - **WPA3 support:** iPhone 7 or later, iPad 5th generation or later, Apple TV 4K or later, Apple Watch series 3 or later, Mac computers (late 2013 on, with 802.11ac or later). Need iOS 13 and MacOS Catalina
  - **PFA support:** iPhone 6 or later, iPad Air 2 or later, Apple TV HD or later, Apple Watch series 3 or later, Mac computers (late 2013 on, with 802.11ac or later)
  - With SAE AKM: only H2E is supported and Fast Transition (FT) Adaptive is not supported
  - For MacOS: 802.11r support is only on M1 based platform

**Note:** Our tests showed that some devices need the latest software (e.g., iPhone 6, iPhone 10 worked with 15.4.1 but not earlier code, same for iPad Air 2)



# Option 2



# WLAN design considerations

- **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 '6 GHz' band, there are three green checkmarks indicating 'WPA2 Disabled', 'WPA3 Enabled', and 'Dot11ax Enabled'.

AKM = Authentication and Key Management

# Option 2 sub-options for 2.4/5 GHz

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

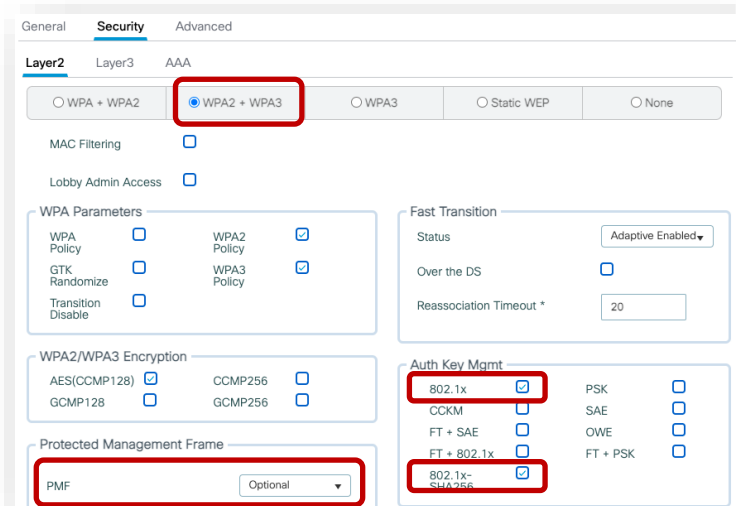
- a) WPA3 Transition mode
- b) WPA/WPA2

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.

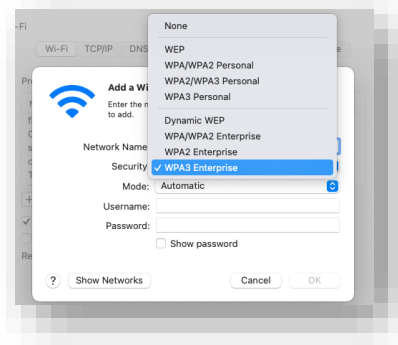
# Option 2a (dot1x SSID)

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 'WPA + WPA3', the 'WPA2 + WPA3' option is selected and highlighted with a red box. Below this, 'WPA Parameters' are configured: 'WPA Policy' is unchecked, 'WPA2 Policy' is checked, 'GTK Randomize' is unchecked, 'WPA3 Policy' is checked, and 'Transition Disable' is unchecked. In the 'WPA2/WPA3 Encryption' section, 'AES(CCMP128)' is checked, 'GCMP128' is unchecked, 'CCMP256' is unchecked, and 'GCMP256' is unchecked. In the 'Protected Management Frame' section, 'PMF' is selected and highlighted with a red box, and the mode is set to 'Optional'. In the 'Auth Key Mgmt' section, '802.1x' is checked and highlighted with a red box, 'FT + 802.1x' is checked and highlighted with a red box, and '802.1x-SHA256' is checked and highlighted with a red box. Other options like 'PSK', 'SAE', 'OWE', and 'FT + PSK' are unchecked.

- 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 6GHz, configure a **WPA2 profile**
  - For clients that support 6GHz, 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 selection screen. A dropdown menu is open, showing various security options. The 'WPA3 Enterprise' option is selected and highlighted with a blue box. Other options visible include 'None', 'WEP', 'WPA/WPA2 Personal', 'WPA2/WPA3 Personal', 'WPA3 Personal', 'Dynamic WEP', 'WPA/WPA2 Enterprise', 'WPA2 Enterprise', and 'WPA3 Enterprise'. The 'Network Name' field is empty, and the 'Security' dropdown is set to 'WPA3 Enterprise'. The 'Mode' is set to 'Automatic'. The 'Username' and 'Password' fields are empty. There is a 'Show password' checkbox and 'Show Networks', 'Cancel', and 'OK' buttons at the bottom.

# Option 2a



## Pros

- Provide an adoption path to more secure Wi-Fi via WPA3 Transition mode
- No new SSID profile to be managed on the client side



## Cons

- Older clients may have issues connecting to an SSID with WPA3 Transition mode
- Roaming across different WLANs (same SSID) is not supported
- Not supported by Cisco DNA Center Automation

# Option 2b (dot1x SSID)

## 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    | <input type="checkbox"/> | WPA2 Policy | <input checked="" type="checkbox"/> |
| GTK Randomize | <input type="checkbox"/> | OSN Policy  | <input type="checkbox"/>            |

WPA2 Encryption

|              |                                     |         |                          |
|--------------|-------------------------------------|---------|--------------------------|
| AES(CCMP128) | <input checked="" type="checkbox"/> | CCMP256 | <input type="checkbox"/> |
| GCMP128      | <input type="checkbox"/>            | GCMP256 | <input type="checkbox"/> |

Protected Management Frame

PMF Disabled

Fast Transition

Status Adaptive Enabled

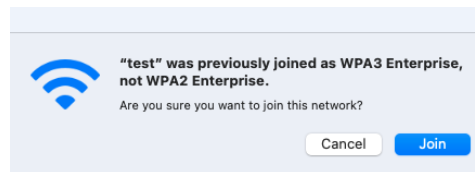
Over the DS ☐

Reassociation Timeout \* 20

Auth Key Mgmt

|               |                                     |            |                          |
|---------------|-------------------------------------|------------|--------------------------|
| 802.1x        | <input checked="" type="checkbox"/> | PSK        | <input type="checkbox"/> |
| Easy-PSK      | <input type="checkbox"/>            | CCKM       | <input type="checkbox"/> |
| FT + 802.1x   | <input type="checkbox"/>            | FT + PSK   | <input type="checkbox"/> |
| 802.1x-SHA256 | <input type="checkbox"/>            | PSK-SHA256 | <input type="checkbox"/> |

- 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 2b



### Pros

- Maintain support for older clients using WPA/WPA2.
- No new SSID profile to be managed on the client side



### Cons

- WPA2 only for 2.4/5GHz > not as secure as using WPA3
- Clients may complain going from a WPA3 SSID to a lower security
- Roaming across different WLANs (same SSID) is not supported
- Not supported by Cisco DNA Center Automation

# Option 3



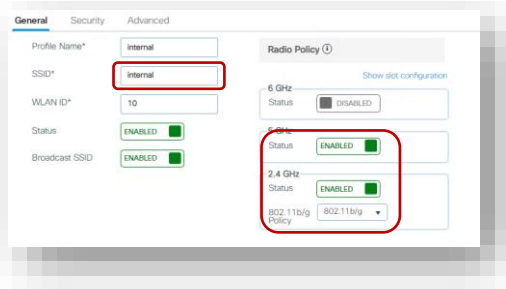
# Option 3 – WLAN design considerations

- **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

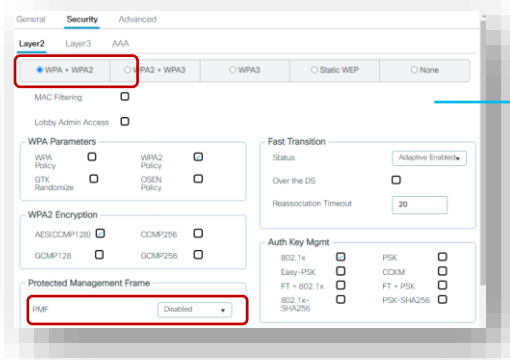
# Option 3 > Example 1

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

Legacy SSID



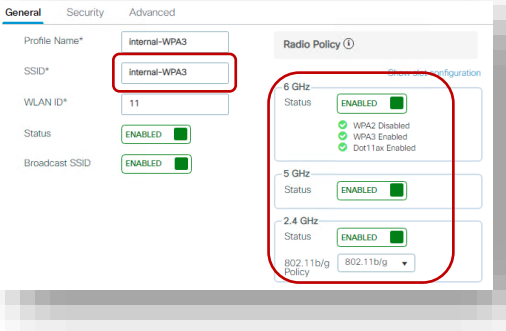
The screenshot shows the 'General' tab of a Cisco WLC configuration page for a legacy SSID. The 'Profile Name\*' is 'internal'. The 'SSID\*' is 'internal', highlighted with a red box. The 'WLAN ID\*' is '10'. The 'Status' is 'ENABLED'. The 'Broadcast SSID' is 'ENABLED'. The 'Radio Policy' is '802.11b/g', highlighted with a red box. The '6 GHz' status is 'ENABLED'. The '2.4 GHz' status is 'ENABLED'. The '802.11b/g Policy' is '802.11b/g'.



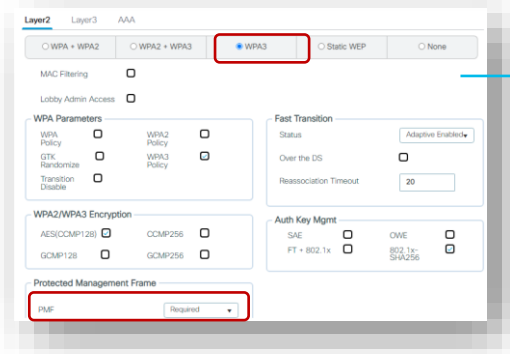
The screenshot shows the 'Security' tab of the Cisco WLC configuration page for the legacy SSID. The 'Layer2' tab is selected. The 'WPA + WPA2' radio button is selected, highlighted with a red box. The 'WPA Parameters' section shows 'WPA Policy' and 'WPA2 Policy' both set to 'Open Policy'. The 'WPA2 Encryption' section shows 'AES/CCMP128' and 'GCMP128' both set to 'Disabled'. The 'Protected Management Frame' section shows 'PMF' set to 'Disabled', highlighted with a red box.

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

New SSID



The screenshot shows the 'General' tab of a Cisco WLC configuration page for a new SSID. The 'Profile Name\*' is 'Internal-WPA3'. The 'SSID\*' is 'Internal-WPA3', highlighted with a red box. The 'WLAN ID\*' is '11'. The 'Status' is 'ENABLED'. The 'Broadcast SSID' is 'ENABLED'. The 'Radio Policy' is '802.11b/g', highlighted with a red box. The '6 GHz' status is 'ENABLED'. The '2.4 GHz' status is 'ENABLED'. The '802.11b/g Policy' is '802.11b/g'.



The screenshot shows the 'Security' tab of the Cisco WLC configuration page for the new SSID. The 'Layer2' tab is selected. The 'WPA3' radio button is selected, highlighted with a red box. The 'WPA Parameters' section shows 'WPA Policy' and 'WPA2 Policy' both set to 'Open Policy'. The 'WPA2/WPA3 Encryption' section shows 'AES/CCMP128' and 'GCMP128' both set to 'Disabled'. The 'Protected Management Frame' section shows 'PMF' set to 'Required', highlighted with a red box.

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

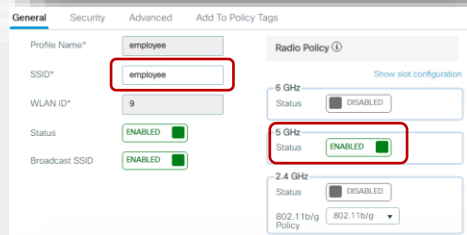
6 GHz Status DISABLED

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

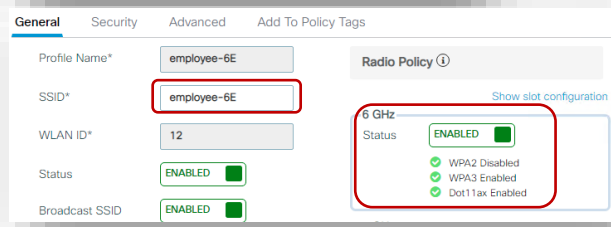
6 GHz Status DISABLED

5 GHz Status ENABLED

2.4 GHz Status DISABLED

802.11b/g Policy 802.11b/g

5GHz dedicated to majority of existing clients



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 6GHz band only, for the newest 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



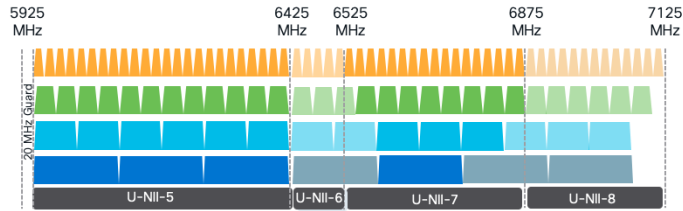
## Cons

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

Wi-Fi 6E, are you  
ready?

# 6GHz: is it all beautiful and green?

- Unexplored spectrum (> 5.9GHz) for consumer devices



- Wi-Fi 6E devices need to provide consistent performance over a much larger frequency > good quality of hardware components
- Most devices will be tri-band (2.4/5/6 GHz) > challenging from RF design, integration, heat dissipation, etc.



<https://www.pinterest.com/timouskidi/beautiful-green-things/>

# 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



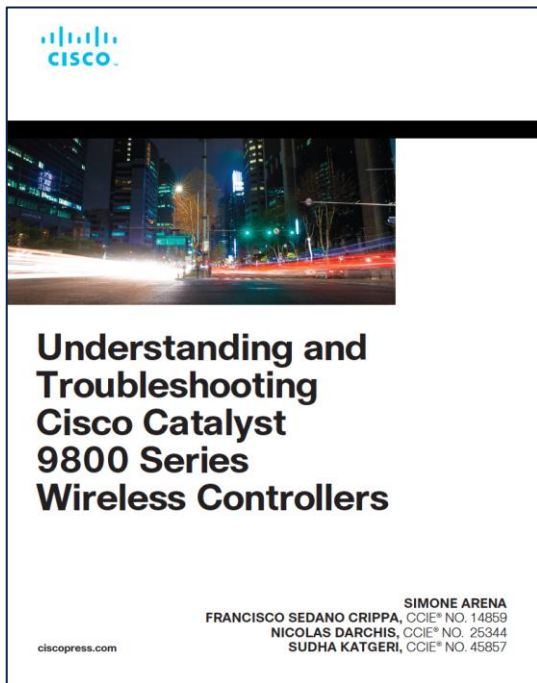
Prepare your wireless



Evaluate the implications on RF and WLAN design

# Understanding and Troubleshooting Cisco Catalyst 9800 Series Wireless Controllers 1st Edition

by [Simone Arena](#) (Author), [Francisco Crippa](#) (Author), [Nicolas Darchis](#) (Author), [Sudha Katgeri](#) (Author)



Coming soon (July) to any  
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The bridge to possible

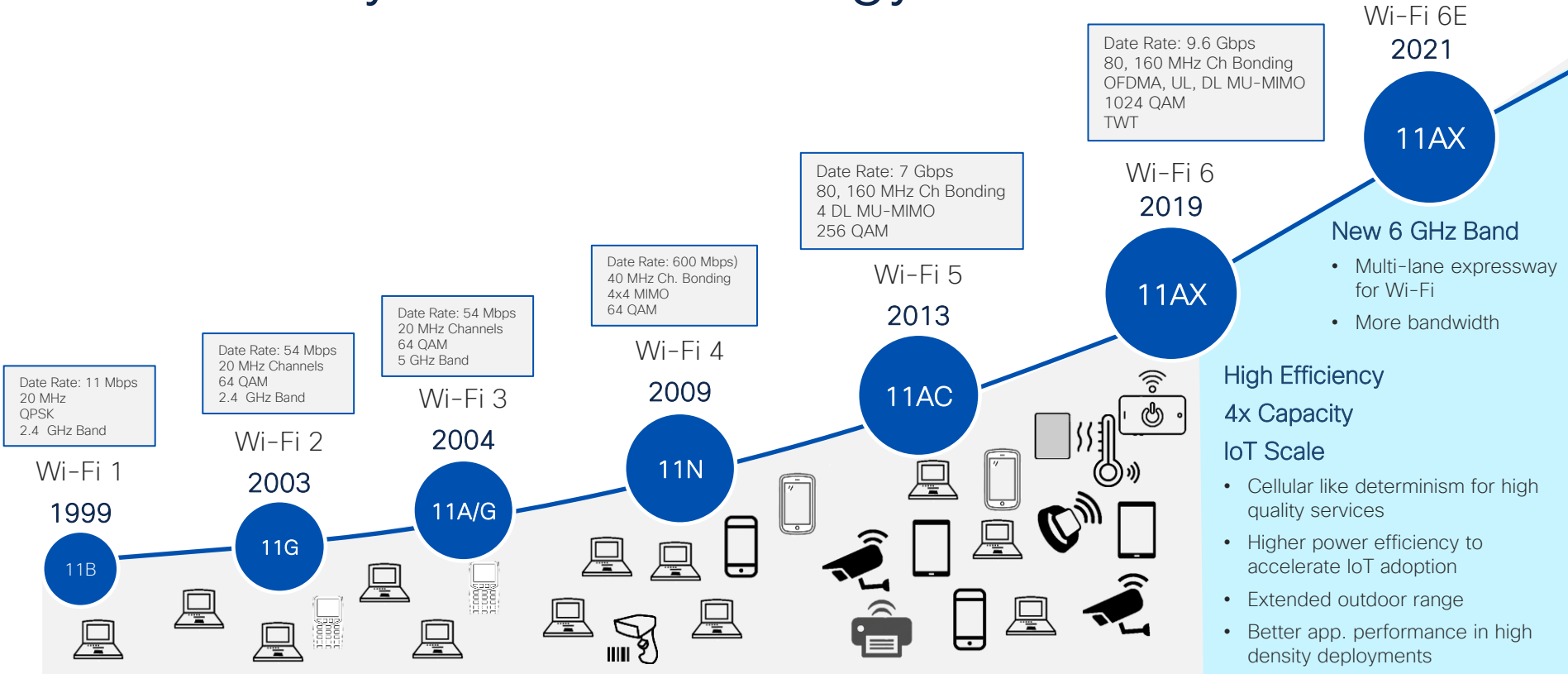
# Thank you

CISCO *Live!*



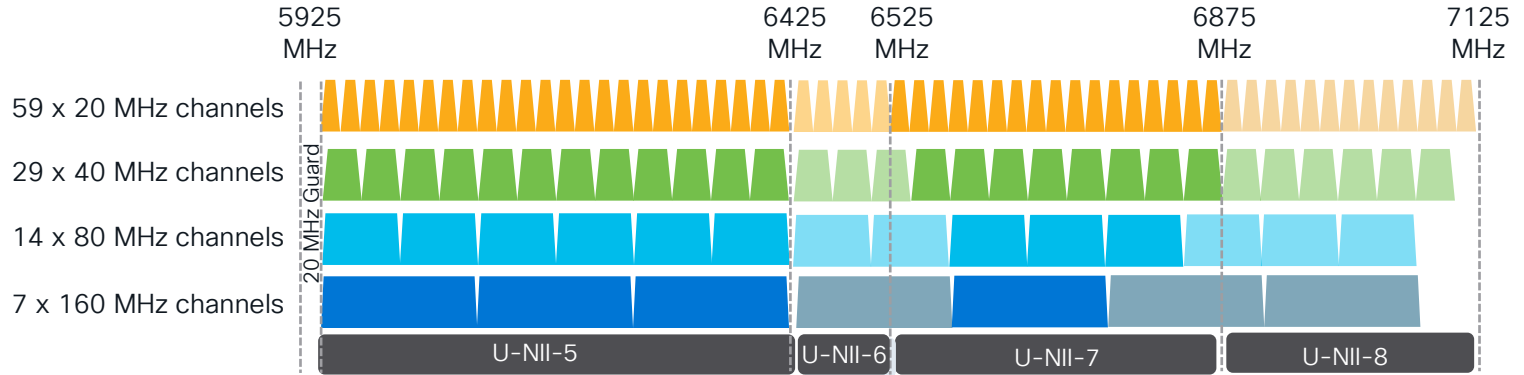
#CiscoLive

# Wi-Fi: 20 years of technology evolution

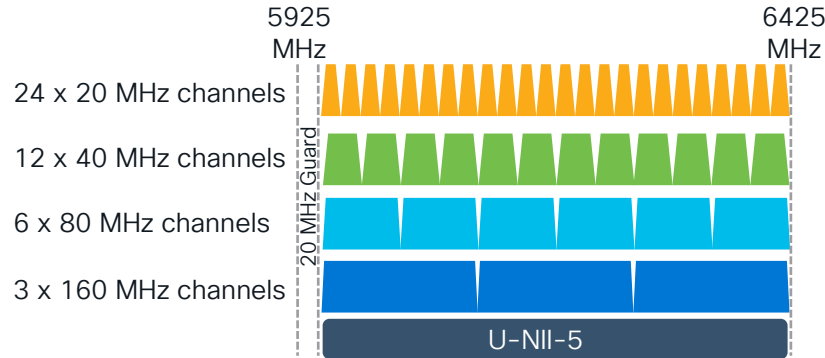


# The new 6 GHz band :

United States  
1200 MHz (FCC)



Europe/CEPT(\*)  
500 MHz



FCC = Federal Communications Commission  
ETSI = European Telecommunications Standards Institute  
CEPT = European Conference of Postal and Telecommunications Administrations

# AP – switchport config

# Catalyst AP to Switch connection



Local mode AP

## Local mode AP - switchport config:

```
interface ten 1/0/1
description to_AP_LOCAL
switchport access vlan 200
switchport mode access
spanning-tree portfast
```

```
3560-CX#sh interfaces ten 1/0/1
```

```
TenGigabitEthernet1/0/1 is up, line protocol is
up (connected)
```

```
Description: to_AP_LOCAL
```

```
Full-duplex, 5000Mb/s, media type is
100/1G/2.5G/5G/10BaseT
```

# Catalyst AP to Switch connection



Flex mode AP

## Flex mode AP - switchport config:

```
interface ten 1/0/1
description to_AP_FLEX
switchport trunk native vlan 100
switchport trunk allowed vlan 20,100
switchport mode trunk
spanning-tree portfast trunk
```

```
3560-CX#sh interfaces ten 1/0/1
```

```
TenGigabitEthernet1/0/1 is up, line protocol is
up (connected)
```

```
Description: to_AP_FLEX
```

```
Full-duplex, 5000Mb/s, media type is
100/1G/2.5G/5G/10GBaseT
```

# Other RF considerations

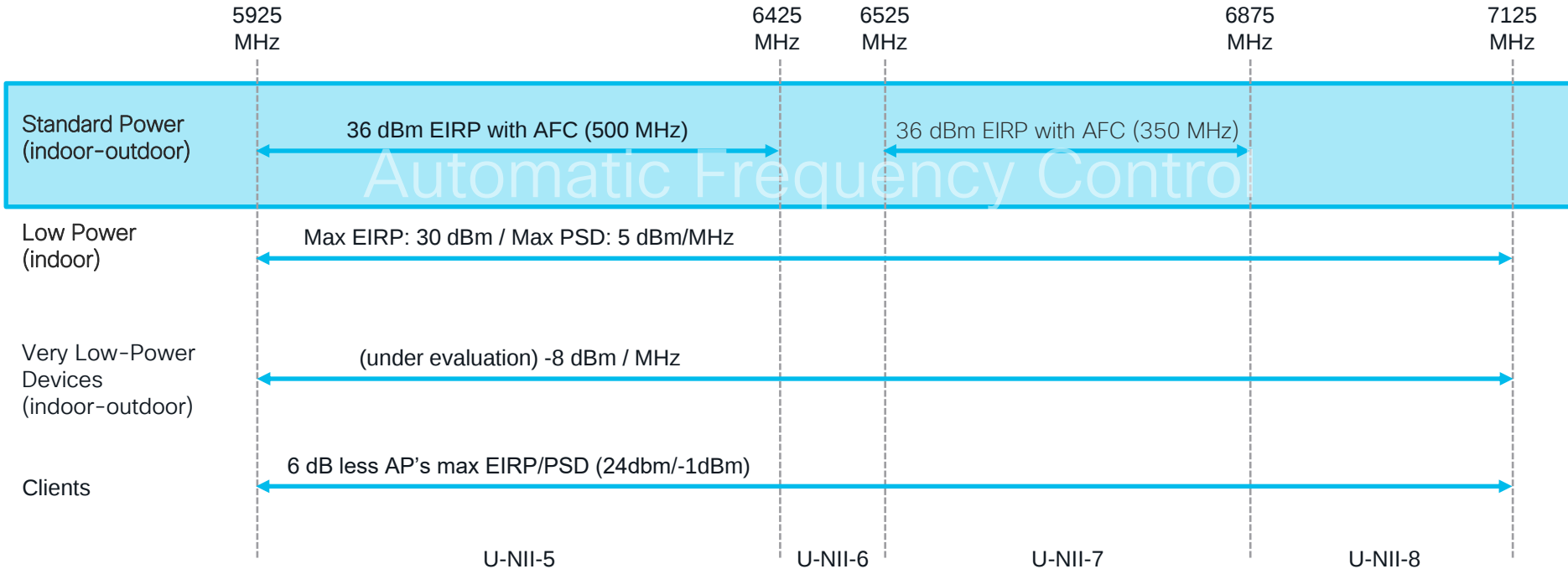


# 6GHz Transmit (Tx) power requirements\*

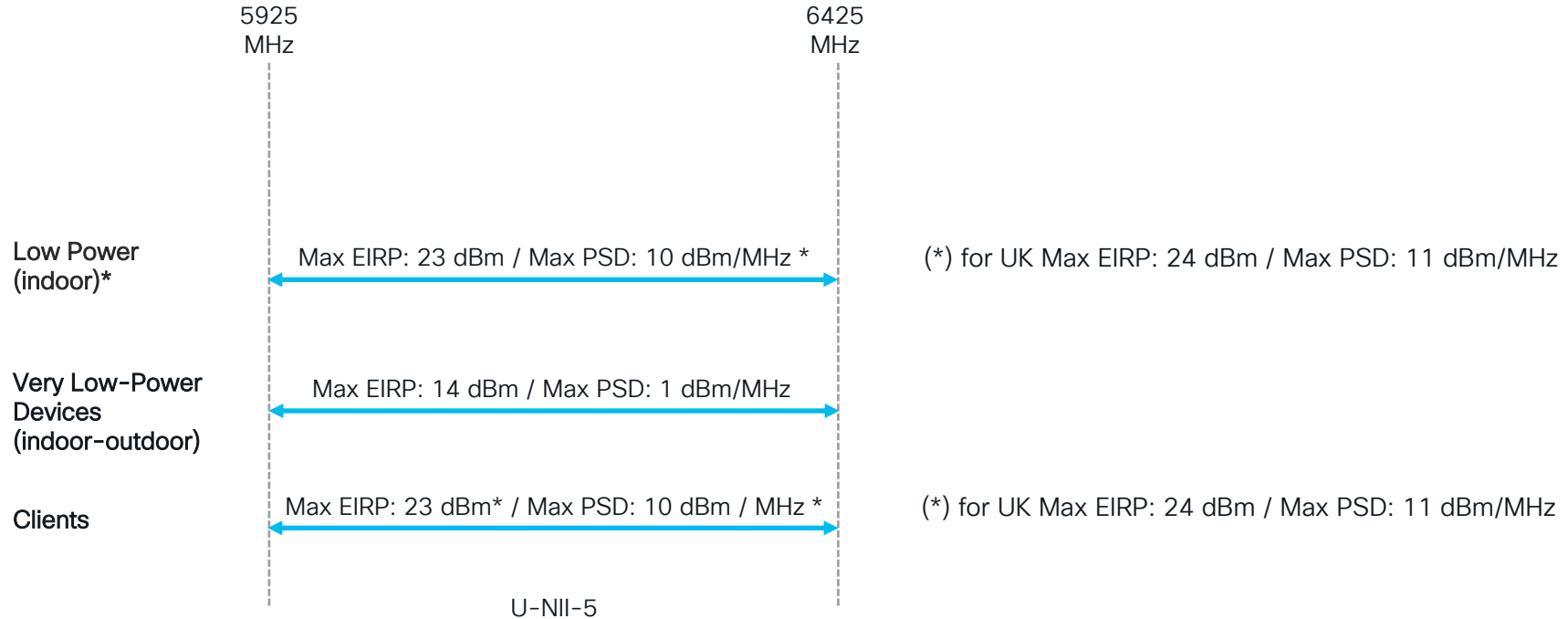
| Mode | Country                                             | Max Tx Power EIRP |              | Max PSD EIRP |              | Max Ch BW |
|------|-----------------------------------------------------|-------------------|--------------|--------------|--------------|-----------|
|      | (Frequency Range 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    |
|      | S Korea (5925-7125)                                 |                   |              | 2            | 2            | 160       |
|      | 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)<br>(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       |

\* Includes only the countries and regions that approved the allocation; Empty cell means regulation is silent

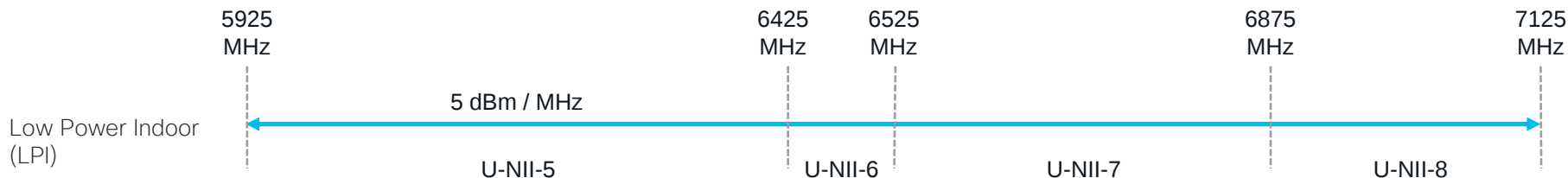
# The new power levels - FCC



# The new power levels - ETSI



# Low-Power Access Points (indoor) - FCC



6 GHz power is measured as **Power Spectral Density (PSD)** a  
Maximum of 5 dBm/MHz is permitted for LPI

5 dBm = 3.162278 mW

$3.162278 \text{ mW} \times 20 \text{ MHz} = 63.24556 \text{ mW} = 18 \text{ dBm}$

$3.162278 \text{ mW} \times 40 \text{ MHz} = 126.4911 \text{ mW} = 21 \text{ dBm}$

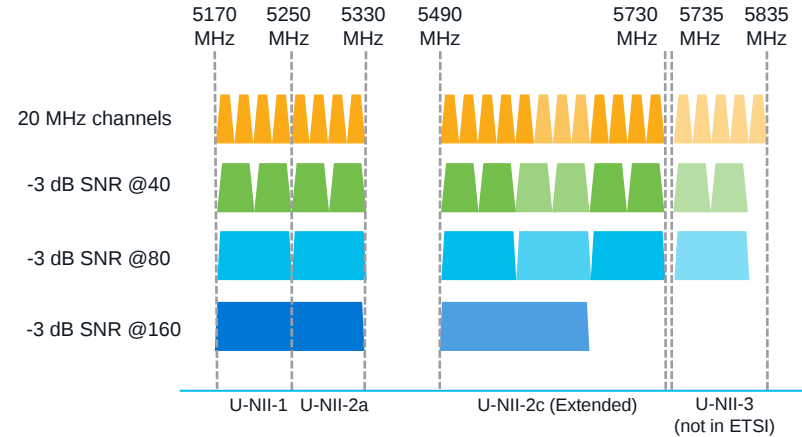
Client power also has a PSD rule of 6 dB less than the AP's  
max EIRP

| Channel BW | AP EIRP | Client EIRP |
|------------|---------|-------------|
| 20 MHz     | 18 dBm  | 12 dBm      |
| 40 MHz     | 21 dBm  | 15 dBm      |
| 80 MHz     | 24 dBm  | 18 dBm      |
| 160 MHz    | 27 dBm  | 21 dBm      |

Note: Indoor AP's with an external antenna, must operate  
under the Standard Power rules, LPI only applies to I models

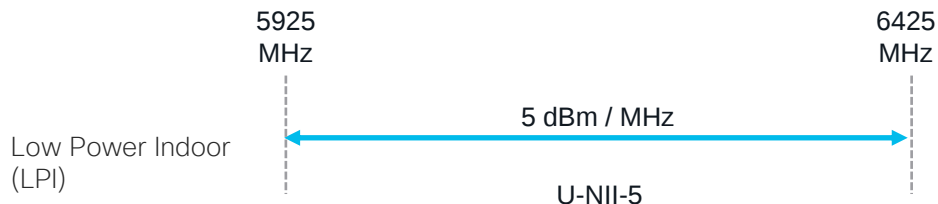
# Bonded Channels and Noise 5 GHz vs 6 GHz

- A wider channel creates more noise
- Increased noise – decreases SNR
- In 5 GHz, every doubling of a channel width takes a corresponding 3 dB hit in SNR,
- A 3 dB reduction in SNR is equivalent to a 3 dB decrease in the RSSI performance wise
- Wi-Fi 6 E power rules in PSD of 5 dBm/MHz increases the EIRP as the channel gets wider
- This off-sets the corresponding SNR loss
- Comparing Effective EIRP – 6 GHz favors wider channels



| Effective EIRP improvements |        |        |        |         |
|-----------------------------|--------|--------|--------|---------|
| BW width                    | 20 MHz | 40 MHz | 80 MHz | 160 MHz |
| 5 GHz, U-NII-1              | 23 dBm | 20 dBm | 17 dBm | 14 dBm  |
| 6 GHz, U-NII-5              | 18 dBm | 21 dBm | 24 dBm | 27 dBm  |

# Low-Power Access Points (indoor) - ETSI



6 GHz power is measured as **Power Spectral Density (PSD)**  
a Maximum of 10 dBm/MHz is permitted for LPI

10 dBm = 10 mW

10 mW x 20 MHz = 200 mW = 23 dBm

10 mW x 40 MHz = 400 mW = 26 dBm (above max allowed)

In ETSI, you can really claim PSD as an advantage in using  
higher TX power to support larger bandwidth

| Channel BW | AP<br>PSD EIRP | AP<br>EIRP |
|------------|----------------|------------|
| 20 MHz     | 23 dBm         | 23 dBm     |
| 40 MHz     | 26 dBm         | 23 dBm     |
| 80 MHz     | 29 dBm         | 23 dBm     |
| 160 MHz    | 31 dBm         | 23 dBm     |

# AP deployment: Channel width feasibility

| 5GHz channel width feasibility                                      |                          |                           |                         |                         |
|---------------------------------------------------------------------|--------------------------|---------------------------|-------------------------|-------------------------|
| Environment                                                         | 20 MHz (25)<br>ETSI (19) | 40 MHz (12)/<br>ETSI (10) | 80 MHz (6)/<br>ETSI (4) | 160 MHz (2)<br>ETSI (1) |
| High Density<br>[1000 ft <sup>2</sup> ]<br>[92 m <sup>2</sup> ]     | Green                    | Red                       | Red                     | Red                     |
| Typical Density<br>[1200 ft <sup>2</sup> ]<br>[111 m <sup>2</sup> ] | Green                    | Yellow                    | Red                     | Red                     |
| Low Density<br>[3000 ft <sup>2</sup> ]<br>[278 m <sup>2</sup> ]     | Green                    | Green                     | Yellow                  | Red                     |

| 6GHz channel width feasibility                                      |                          |                          |                          |                          |
|---------------------------------------------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Environment                                                         | 20 MHz (59)<br>ETSI (24) | 40 MHz (29)<br>ETSI (12) | 80 MHz (14)/<br>ETSI (6) | 160 MHz (7)/<br>ETSI (3) |
| High Density<br>[1000 ft <sup>2</sup> ]<br>[92 m <sup>2</sup> ]     | Green                    | Green                    | Diagonal (Green/Red)     | Red                      |
| Typical Density<br>[1200 ft <sup>2</sup> ]<br>[111 m <sup>2</sup> ] | Green                    | Green                    | Diagonal (Green/Red)     | Diagonal (Yellow/Red)    |
| Low Density<br>[3000 ft <sup>2</sup> ]<br>[278 m <sup>2</sup> ]     | Green                    | Green                    | Green                    | Green                    |

*Note: Experience based on relative amount of AP co-channel interference at the AP based on EIRP power and channels available.*

6GHz allows for wider channels: 80 MHz is the new 40MHz!

# Site Survey Mode



# Assess environmental RF coverage using the Catalyst 9136I's site survey mode



Puts AP in standalone mode and enables it to broadcast 2.4-, 5-, and 6-GHz SSIDs and have clients join via internal DHCP.

Supports 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 > exec 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 CiscoAirProvision SSID with open authentication security.
4. Connect your wireless client with the CiscoAirProvision SSID and it'll receive an IP from 10.0.23.0/24.
5. Access the Catalyst® 9136l's Site Survey WebUI via 10.0.23.1.

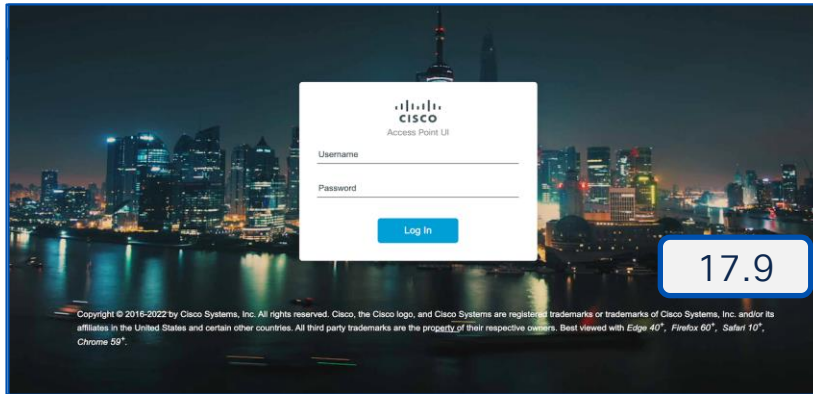


Figure 1. Site survey mode

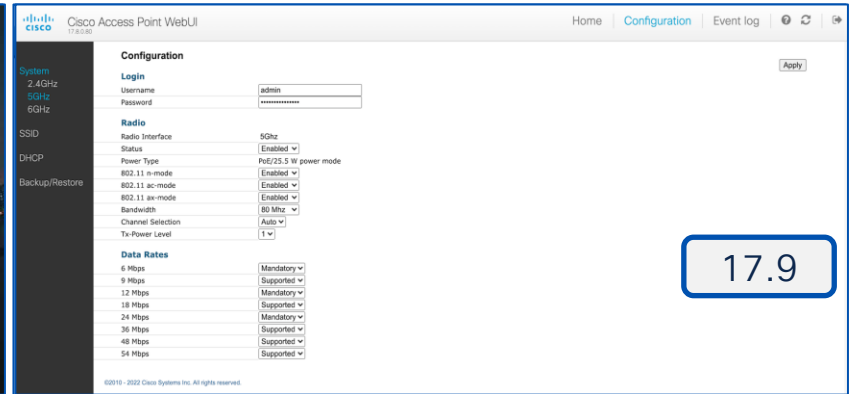
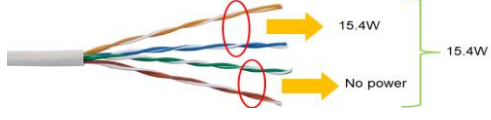
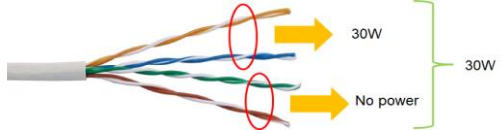
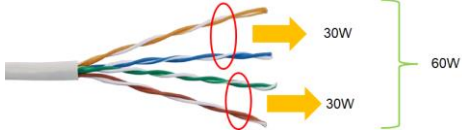


Figure 2. Site Survey mode

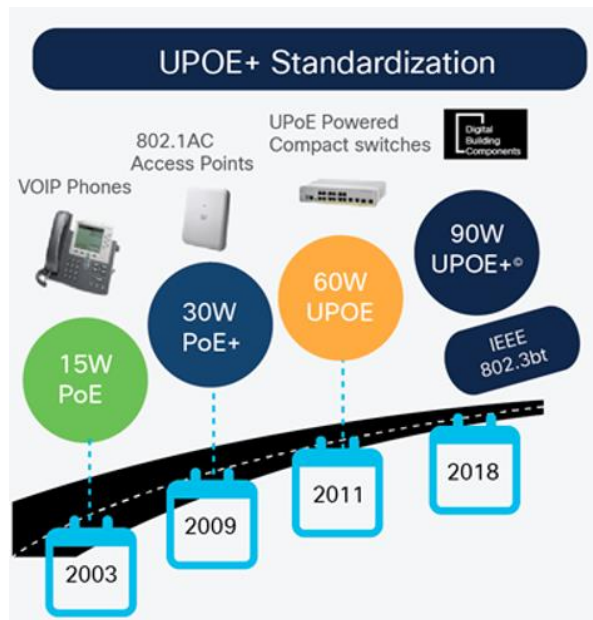
# Other Power considerations



# Power Over Ethernet Categorization

| PoE Standard       | Type | Class | Max Power | Power over wire pairs                                                               |
|--------------------|------|-------|-----------|-------------------------------------------------------------------------------------|
| 802.3af (PoE)      | 1    | 0-3   | 15.4W     |  |
| 802.3at (PoE+)     | 2    | 4     | 30W       |  |
| Cisco UPOE         | (2)  | (4)   | 60W       |  |
| 802.3bt (60W, 90W) | 3    | 5, 6  | 60W       |                                                                                     |
|                    | 4    | 7, 8  | 90W       |  |

# Power over Ethernet (POE)

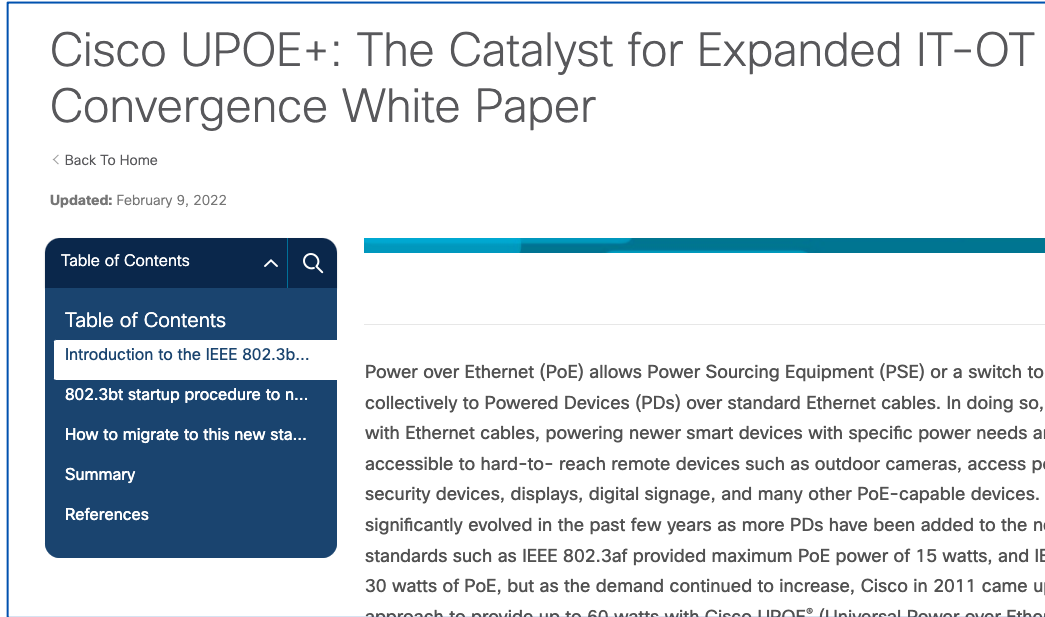


| Type | Class  | Power over twisted pairs | PoE standard          | Maximum power from PSE | Maximum power to PD |
|------|--------|--------------------------|-----------------------|------------------------|---------------------|
| 0    | 0      | 2 pairs                  | Cisco Phone Discovery | 15.4W                  | 12.95W              |
| 1    | 0 to 3 | 2 pairs                  | 802.3af (PoE)         | 15.4W                  | 12.95W              |
| 2    | 4      | 2 pairs                  | 802.3at (PoE+)        | 30W                    | 25.5W               |
|      |        | 4 pairs                  | Cisco UPOE            | 60W                    | 51W                 |
| 3    | 5, 6   | 4 pairs                  | 802.3bt (60W)         | 60W                    | 51W                 |
| 4    | 7, 8   | 4 pairs                  | 802.3bt (90W)         | 90W                    | 71W                 |

**Power Sourcing Equipment (PSE)** – network device that provides power

**Powered Devices (PDs)** – IT or IoT device

# What Catalyst switch to use?



The screenshot shows the top portion of a Cisco white paper titled "Cisco UPOE+: The Catalyst for Expanded IT-OT Convergence White Paper". It includes a "Back To Home" link, an update date of February 9, 2022, and a table of contents sidebar. The main content area begins with an introduction to Power over Ethernet (PoE) and its evolution.

Cisco UPOE+: The Catalyst for Expanded IT-OT Convergence White Paper

< Back To Home

Updated: February 9, 2022

Table of Contents

- Table of Contents
- Introduction to the IEEE 802.3b...
- 802.3bt startup procedure to n...
- How to migrate to this new sta...
- Summary
- References

Power over Ethernet (PoE) allows Power Sourcing Equipment (PSE) or a switch to p... collectively to Powered Devices (PDs) over standard Ethernet cables. In doing so, i... with Ethernet cables, powering newer smart devices with specific power needs an... accessible to hard-to- reach remote devices such as outdoor cameras, access po... security devices, displays, digital signage, and many other PoE-capable devices. P... significantly evolved in the past few years as more PDs have been added to the ne... standards such as IEEE 802.3af provided maximum PoE power of 15 watts, and IEE... 30 watts of PoE, but as the demand continued to increase, Cisco in 2011 came up... approach to provide up to 60 watts with Cisco UPOE® (Universal Power over Ether...

All you need to know is here!

Reference URL: <https://www.cisco.com/c/en/us/solutions/collateral/enterprise-networks/nb-06-upoe-plus-it-ot-wp-cte-en.html>

# AP Power Save mode



# AP Power Save Mode

- Goal is to reduce power consumption for APs during certain period of operations (non-business hours, weekends, etc.)
- **Power saving mode**: APs can switch into a low power mode when no clients are associated
- Power saving mode is implemented via **Power Profiles** and **Calendar Profiles**

## Supported Access Points

9136



CW9166/64



CW9162



9130



9120



9115



# AP Power Profile



## AP Power Profile

- Prioritized set of rules that define how the AP will turn down power
- Interface states that can be configured:

Radios: 6GHz, 5GHz, 2.4GHz

Ethernet: uplinks and RLAN

USB Port



## Caveats

- If clients still need to connect, leave at least 1 radio enabled.
- As of 17.8.1, Ethernet speed will always use the Fixed Power Profile speed even if configured
- If APs do not support configured settings (ex. 6GHz or additional uplink port), the settings will not be applied.

# Calendar Profile



Defines the dates and times when the AP will enter Power Save Mode



When the Calendar Profile is active, the applicable settings from mapped AP Power Profile will be applied to the AP



When the Calendar Profile is active, the AP Profile is applied IF there are no client connected

Can be used to define operational times such as work hours, after-work hours, and non-workdays.

# Design Consideration with Calendar Profiles



- Cannot make a profile going into the next day
- Requires making multiple calendar profiles

Example: Required Calendar Profile from 5:00 PM to 8:00 AM

Calendar Profile 1

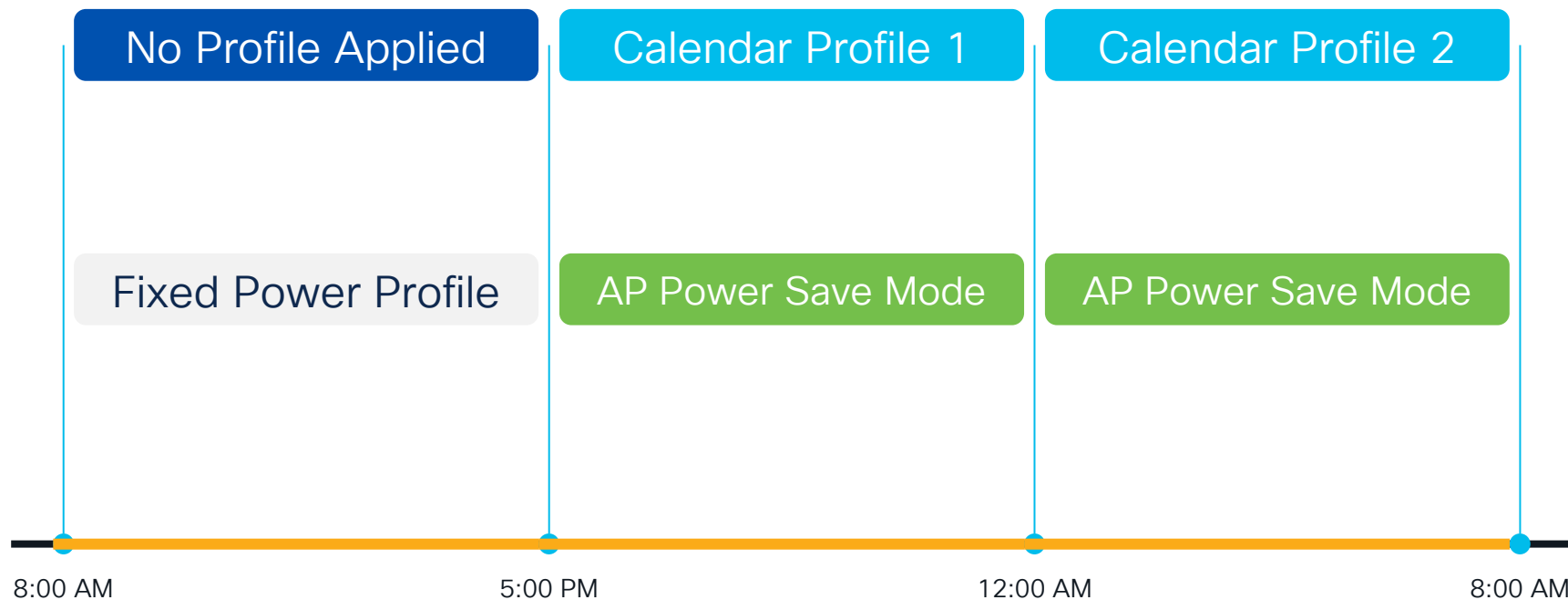
05:00:00 PM to 11:59:59 PM

Calendar Profile 2

12:00:00 AM to 08:00:00 AM

# AP Power Save Mode - Workday

## Typical Workday



# AP Power Save Mode - Non-Working Day

Non-Working Day

Calendar Profile 3

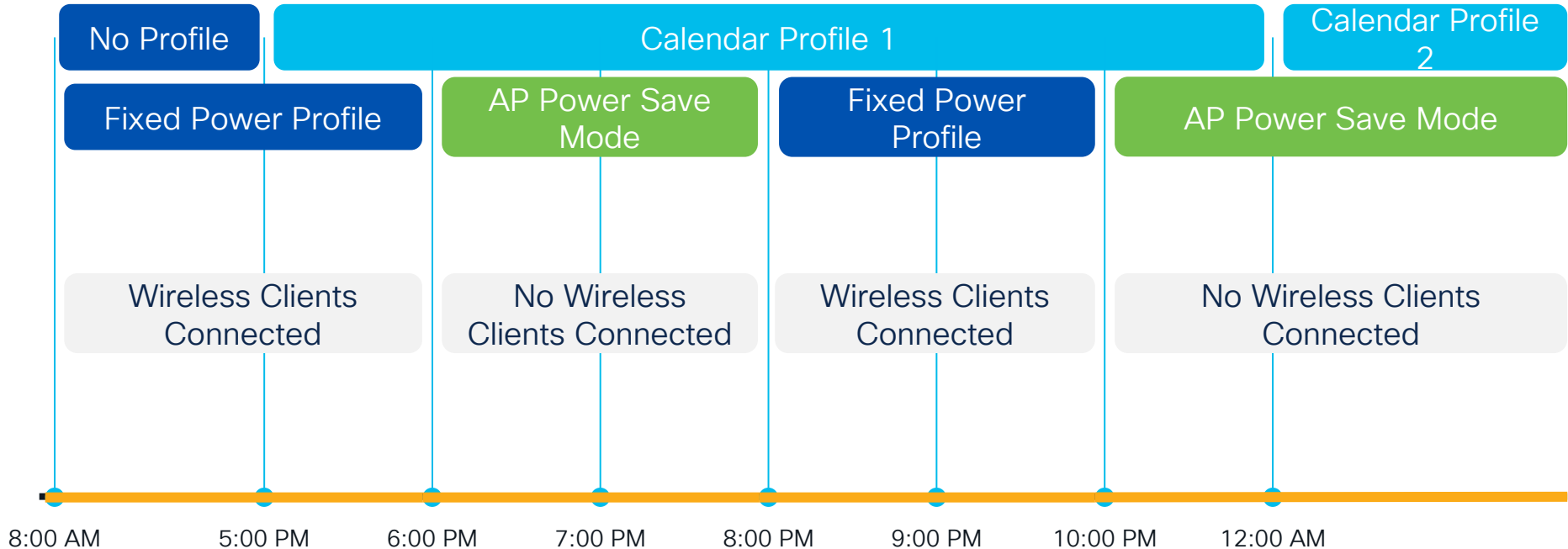
AP Power Save Mode

12:00 AM

11:59 PM

# AP Power Save Mode - with Clients

## Typical Workday



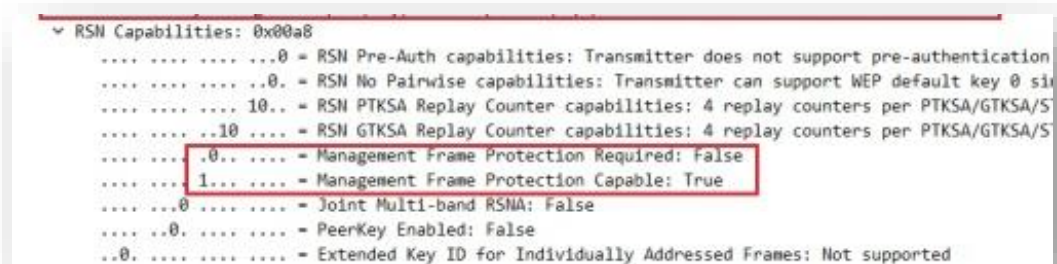
# WLAN Design (additional slides)



# What is WPA3-Enterprise transition mode?

(a.k.a. WPA3 mixed mode)

- AP shall enable at least AKM suite selectors 00-0F-AC:1 (IEEE 802.1X with SHA-1) and 00-0F-AC:5 (IEEE 802.1X with SHA-256) in the BSS
- STA shall allow at least AKM suite selectors 00-0F-AC:1 and 00-0F-AC:5 to be selected for an association
- AP shall set MFPC to 1, MFPR to 0
- STA shall set MFPC to 1, MFPR to 0



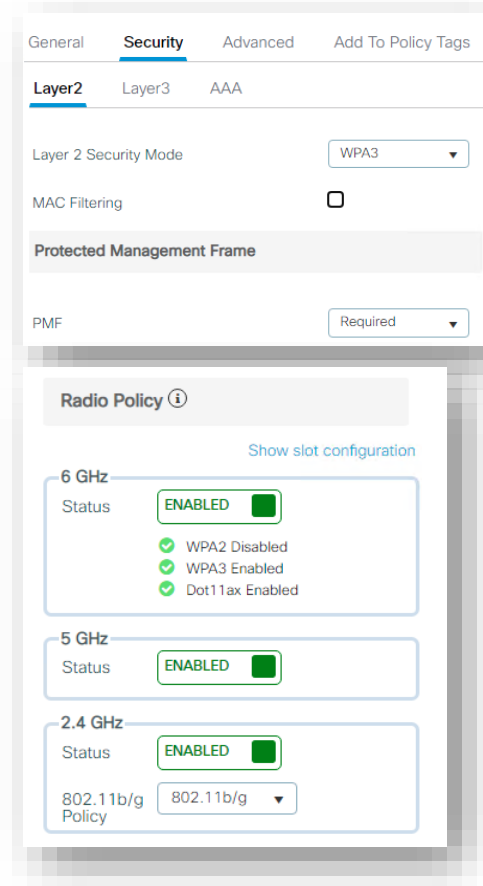
```
▼ RSN Capabilities: 0x00a8
.....0 = RSN Pre-Auth capabilities: Transmitter does not support pre-authentication
.....0 = RSN No Pairwise capabilities: Transmitter can support WEP default key 0 six
.....10.. = RSN PTKSA Replay Counter capabilities: 4 replay counters per PTKSA/GTKSA/S
.....10.. = RSN GTKSA Replay Counter capabilities: 4 replay counters per PTKSA/GTKSA/S
.....0... = Management Frame Protection Required: False
.....1... = Management Frame Protection Capable: True
.....0..... = Joint Multi-band RSNA: False
.....0..... = PeerKey Enabled: False
.....0..... = Extended Key ID for Individually Addressed Frames: Not supported
```

# Option 1



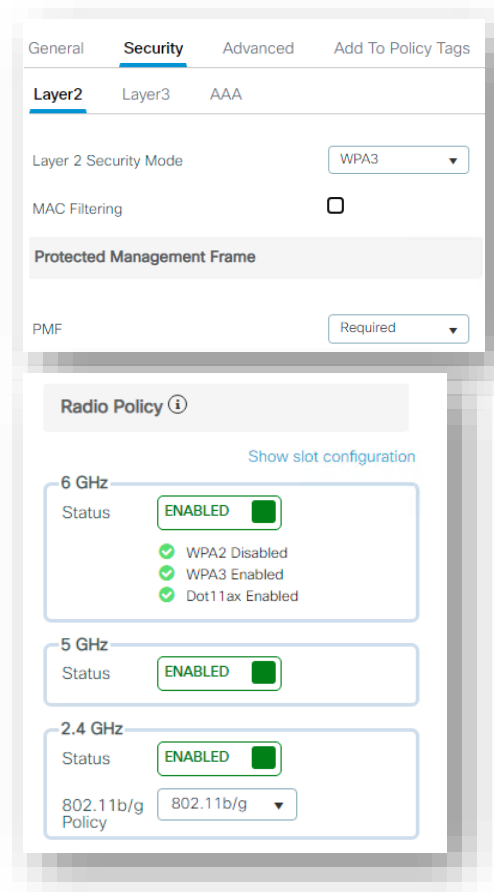
# Option 1 Design: Apple Clients

- Reconfigure the existing SSID to meet Wi-Fi 6E requirements (WPA3 and PMF). Need to verify if the new settings are supported by the existing clients.
- Apple Support:
  - **AKM:** SAE or 802.1x-SHA256. **OWE not supported**
  - **WPA3 support:** iPhone 7 or later, iPad 5th generation or later, Apple TV 4K or later, Apple Watch series 3 or later, Mac computers (late 2013 on, with 802.11ac or later). Need iOS 13 and MacOS Catalina
  - **PFA support:** iPhone 6 or later, iPad Air 2 or later, Apple TV HD or later, Apple Watch series 3 or later, Mac computers (late 2013 on, with 802.11ac or later)
  - With SAE AKM: only H2E is supported and FT Adaptive is not supported
  - For MacOS: 802.11r (FT) support is only on M1 based platform
- Our tests showed that some devices need the latest software (e.g., iPhone 10 worked with 15.4.1 but not earlier code, same for iPad Air 2)



# Option 1 Design: Android Clients

- **Option 1:** Reconfigure the existing SSID to meet Wi-Fi 6E requirements (WPA3 and PMF). Need to verify if the new settings are supported by the existing clients.
- Android support:
  - **AKM:** OWE, SAE or 802.1x-SHA256
  - **WPA3 support:** WPA3 introduced in Android 10, but Android 12 supports Transition Disable indication to instruct a device to only use WPA3
  - **PFA support:** should follow the support of WPA3
  - With SAE: on 6GHz only H2E is supported and FT Adaptive is not supported



# WLAN design considerations

## Intel Clients

- **Option 1:** Reconfigure the existing SSID to meet Wi-Fi 6E requirements (WPA3 and PMF. Need to verify if the new settings are supported by the existing clients.
- Intel clients:
  - **AKM:** OWE, SAE or 802.1x-SHA256
  - **WPA3 support:** Intel Wi-Fi 6E AX210/211, Wi-Fi 6 AX201/200, Wireless-AC 9560/9462/9461/9260
  - **PFA support:** should follow the support of WPA3
  - With SAE AKM: only H2E is supported and FT Adaptive is not supported
  - With SAE: 802.11r (FT) is not supported on Windows
  - **Windows 11** recommended, but should work with Windows 10 2004 or later
- **Recommendation** for all devices: always verify the specific driver documentation

The screenshot displays a configuration interface with tabs for General, Security, Advanced, and Add To Policy Tags. The Security tab is active, showing Layer2, Layer3, and AAA sub-tabs. Under Layer2, the Layer 2 Security Mode is set to WPA3, MAC Filtering is disabled, and Protected Management Frame (PMF) is set to Required. Below this, the Radio Policy section is expanded, showing settings for 6 GHz, 5 GHz, and 2.4 GHz bands. Each band has a Status set to ENABLED and a list of supported protocols: WPA2 Disabled, WPA3 Enabled, and Dot11ax Enabled. The 2.4 GHz band also shows a radio policy dropdown set to 802.11b/g.

| Band    | Status  | WPA2     | WPA3    | Dot11ax | Radio Policy |
|---------|---------|----------|---------|---------|--------------|
| 6 GHz   | ENABLED | Disabled | Enabled | Enabled |              |
| 5 GHz   | ENABLED |          |         |         |              |
| 2.4 GHz | ENABLED |          |         |         | 802.11b/g    |

# Option 1



## Pros

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



## Cons

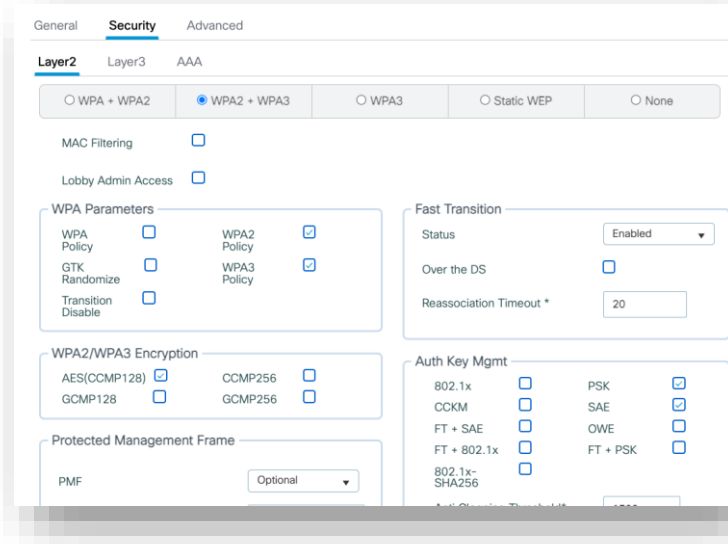
- Breaks support for existing clients that don't support WPA3 and PMF in 2.4 and 5GHz
- Requires full control on client devices and drivers

# Option 2



# Option 2a with PSK/SAE SSID

WLAN security configuration on 2.4/5GHz > Enable WPA3-Personal transition mode (a.k.a. mixed mode):



The image shows the 'Security' tab of a Cisco WLAN configuration interface. The 'Layer2' sub-tab is active. Under 'Security', 'WPA2 + WPA3' is selected. 'MAC Filtering' and 'Lobby Admin Access' are disabled. In the 'WPA Parameters' section, 'WPA2 Policy' and 'WPA3 Policy' are both enabled. 'Fast Transition' is set to 'Enabled'. 'WPA2/WPA3 Encryption' shows 'AES(CCMP128)' and 'GCMP128' as options. 'Protected Management Frame' is set to 'Optional'.

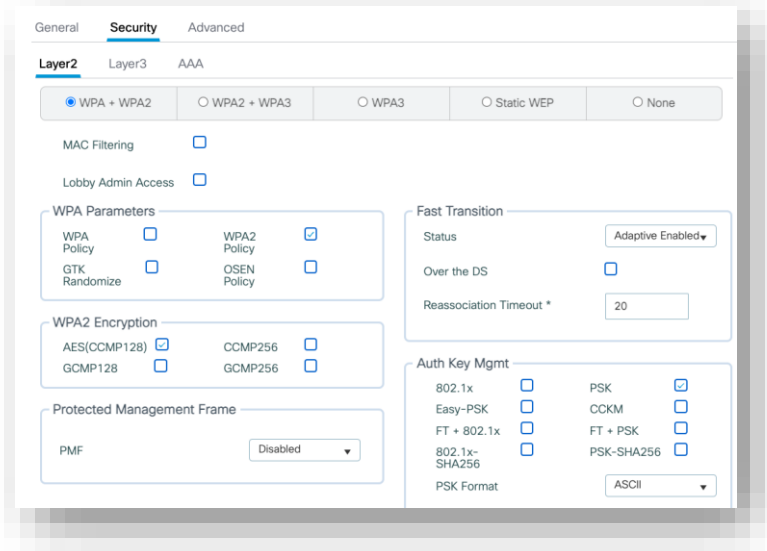
- L2 Security set to **WPA2+WPA3**. AKM configured with both **PSK** and **SAE** enabled. PMF as **Optional**. Use the same password
- **The security level of the SSID is equivalent to WPA2-PSK**
- If WPA3-Personal Transition Mode does not meet the security requirements, WPA3-Personal and WPA2-Personal should be deployed on individual SSIDs using unique passwords and logically separated/isolated network segments
- Select **WPA2/WPA3** Personal on clients



The image shows a 'Add a Wi-Fi network profile' dialog box. The 'Security' dropdown menu is open, showing a list of options: 'None', 'WEP', 'WPA/WPA2 Personal', 'WPA2/WPA3 Personal' (which is selected with a checkmark), 'WPA3 Personal', 'Dynamic WEP', 'WPA/WPA2 Enterprise', 'WPA2 Enterprise', and 'WPA3 Enterprise'.

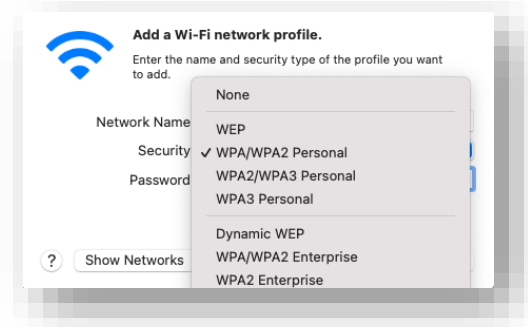
# Option 2b with PSK/SAE SSID

## WLAN security configuration on 2.4/5GHz



The screenshot shows the 'Security' tab in the Cisco WLAN configuration interface. The 'Layer2' sub-tab is active, showing radio button options for 'WPA + WPA2' (selected), 'WPA2 + WPA3', 'WPA3', 'Static WEP', and 'None'. Below these are checkboxes for 'MAC Filtering' and 'Lobby Admin Access'. The 'WPA Parameters' section includes checkboxes for 'WPA Policy', 'WPA2 Policy' (checked), 'GTK Randomize', and 'OSN Policy'. The 'WPA2 Encryption' section has checkboxes for 'AES(CCMP128)' (checked), 'CCMP256', 'GCMP128', and 'GCMP256'. The 'Protected Management Frame' section shows 'PMF' set to 'Disabled'. The 'Fast Transition' section has 'Status' set to 'Adaptive Enabled', 'Over the DS' unchecked, and 'Reassociation Timeout' set to 20. The 'Auth Key Mgmt' section shows checkboxes for '802.1x', 'Easy-PSK', 'FT + 802.1x', and '802.1x-SHA256', with 'PSK' (checked) and 'CCKM' also selected. The 'PSK Format' is set to 'ASCII'.

- L2 Security set to **WPA+WPA2**. AKM configured with **PSK**. PMF Disabled
- How to configure the client side?
  - For clients that don't support 6GHz, configure a **WPA/WPA2 Personal** profile
  - For clients that support 6GHz, use **WPA3 Personal**



The screenshot shows the 'Add a Wi-Fi network profile' dialog box. It prompts the user to 'Enter the name and security type of the profile you want to add.' The 'Network Name' field is empty. The 'Security' dropdown menu is open, showing options: 'None', 'WEP', 'WPA/WPA2 Personal' (selected with a checkmark), 'WPA2/WPA3 Personal', 'WPA3 Personal', 'Dynamic WEP', 'WPA/WPA2 Enterprise', and 'WPA2 Enterprise'. The 'Password' field is empty. At the bottom, there is a 'Show Networks' button with a question mark icon.