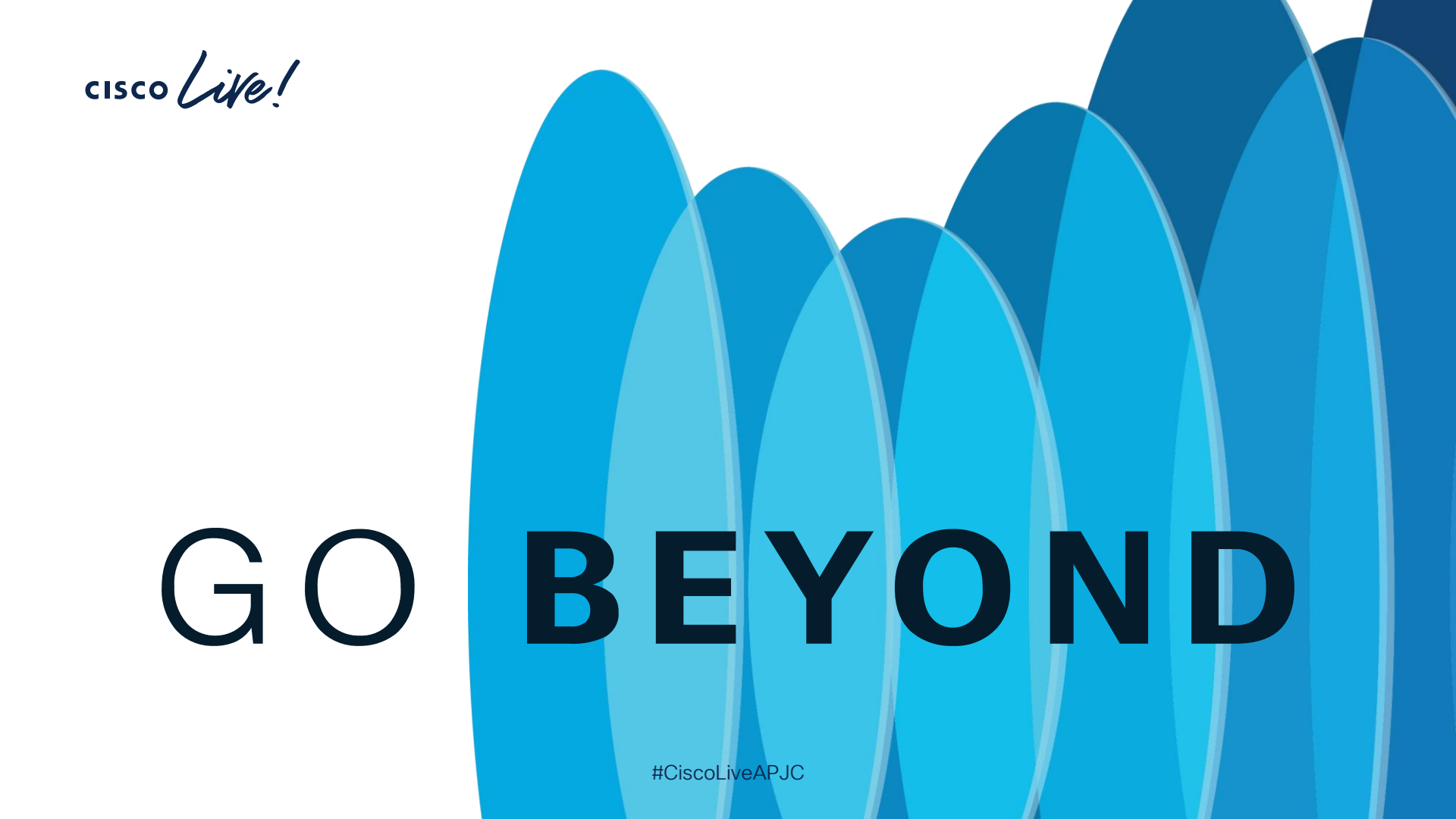
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#CiscoLiveAPJC

Wi-Fi 6E Adoption and Getting Ready with Wi-Fi 7

Anand Gurumurthy, Sr. Technical Leader, Technical Marketing

BRKEWN-2024

Cisco Webex App

https://ciscolive.ciscoevents.com/ciscolivebot/#BRKXXX-xxxx

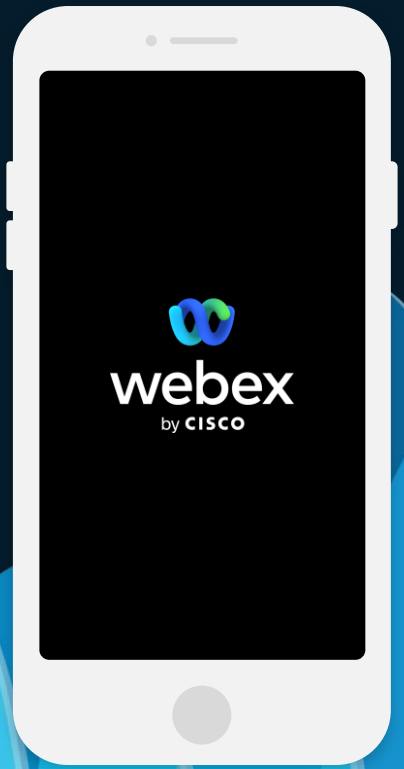
Questions?

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 November 15, 2024.



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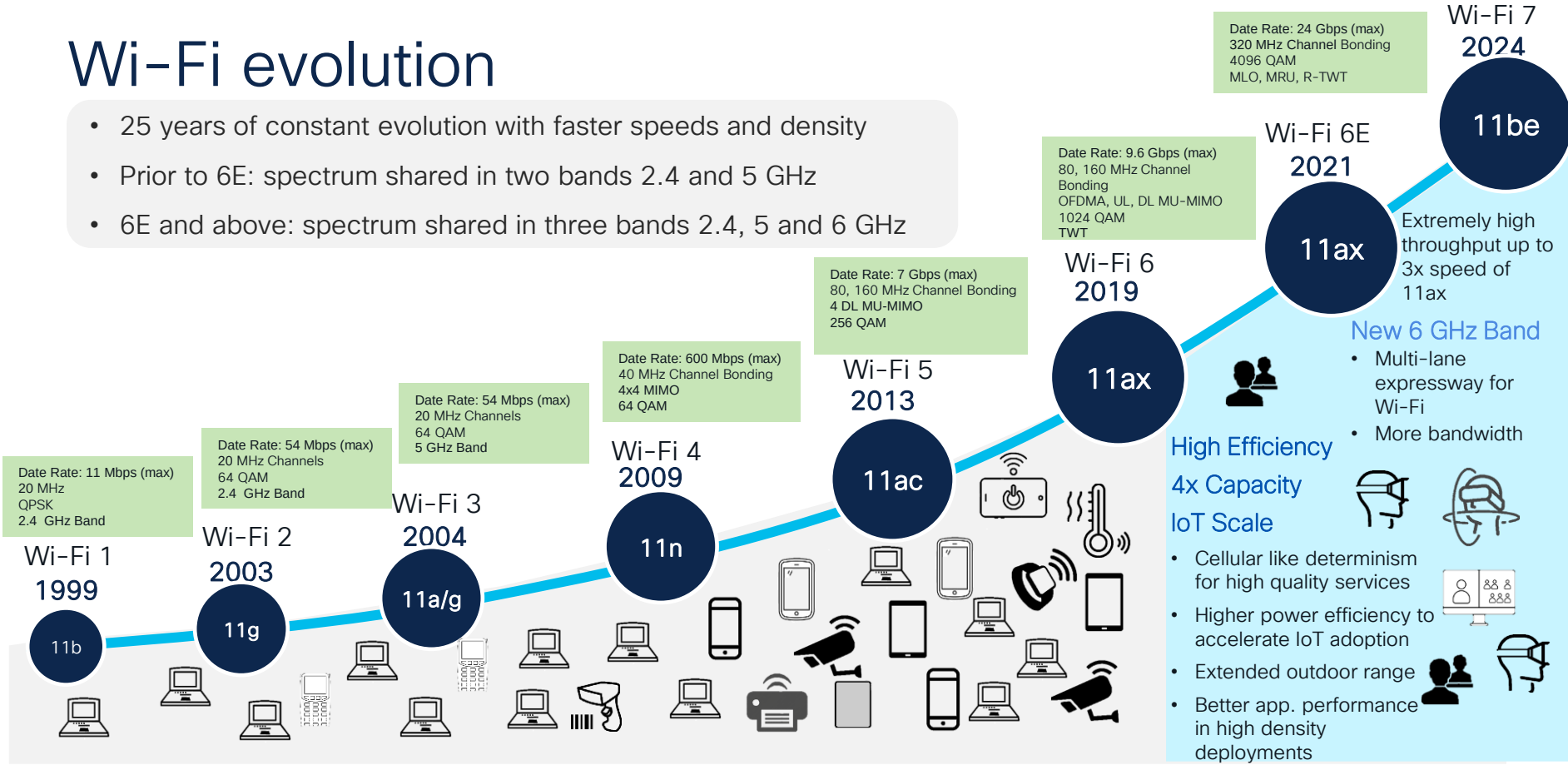
Agenda

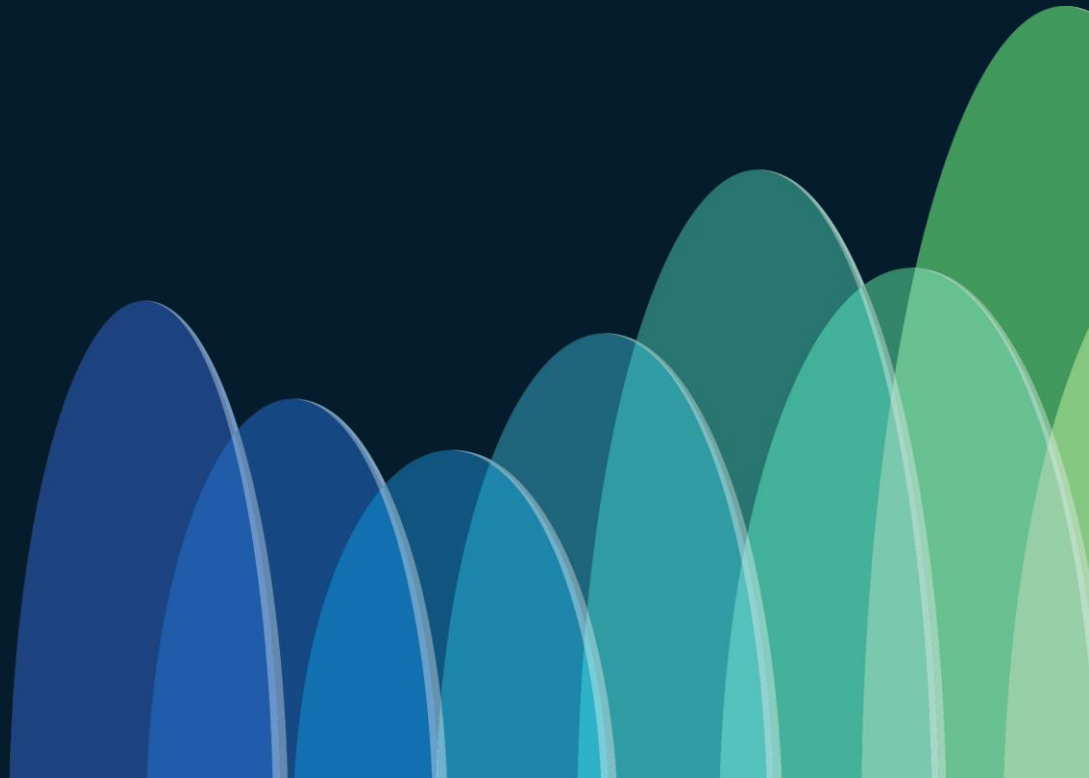
- Explore Wi-Fi 6E
- Deployment and migration considerations
- Get to know Wi-Fi 7
- The Wi-Fi 6E vs Wi-Fi 7 dilemma!

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

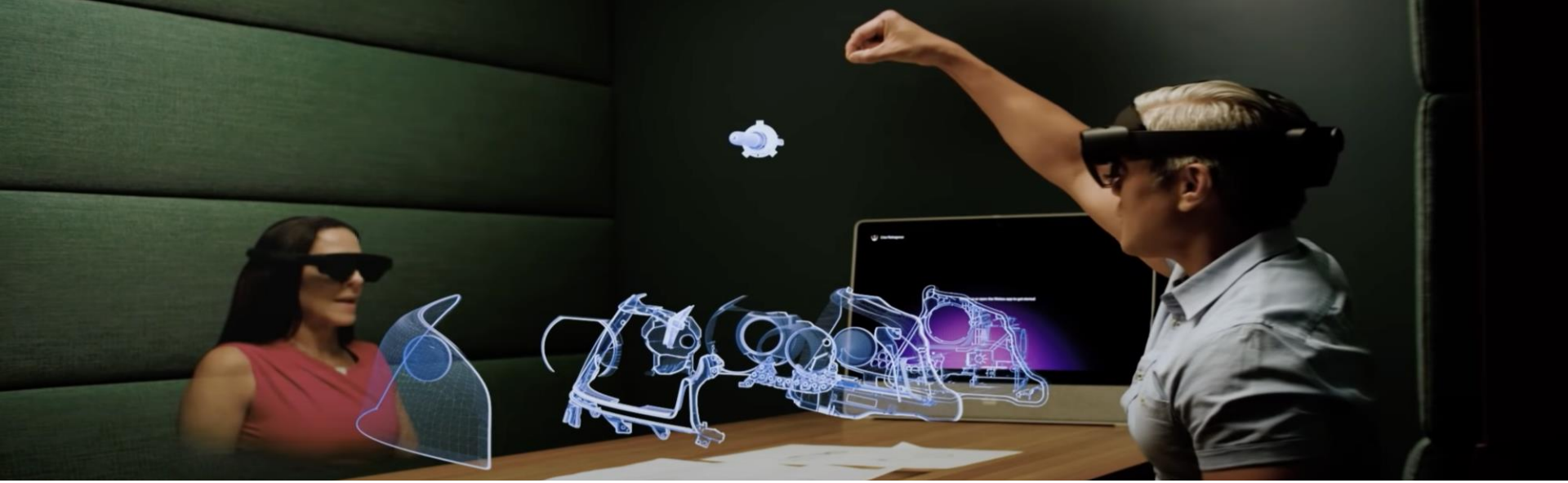


Why Wi-Fi 6E ?



Primitive applications of the past to ....

Immersive experiences of today...

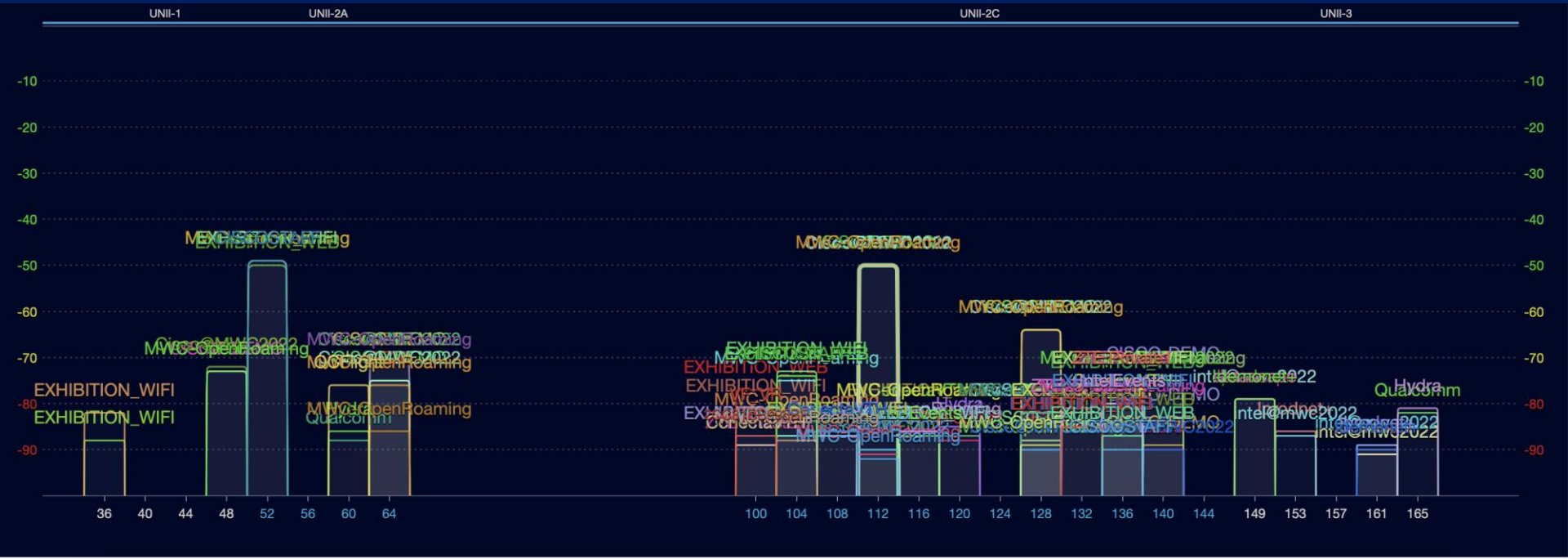


Webex Hologram https://www.youtube.com/watch?v=YEx7h0NKnXE

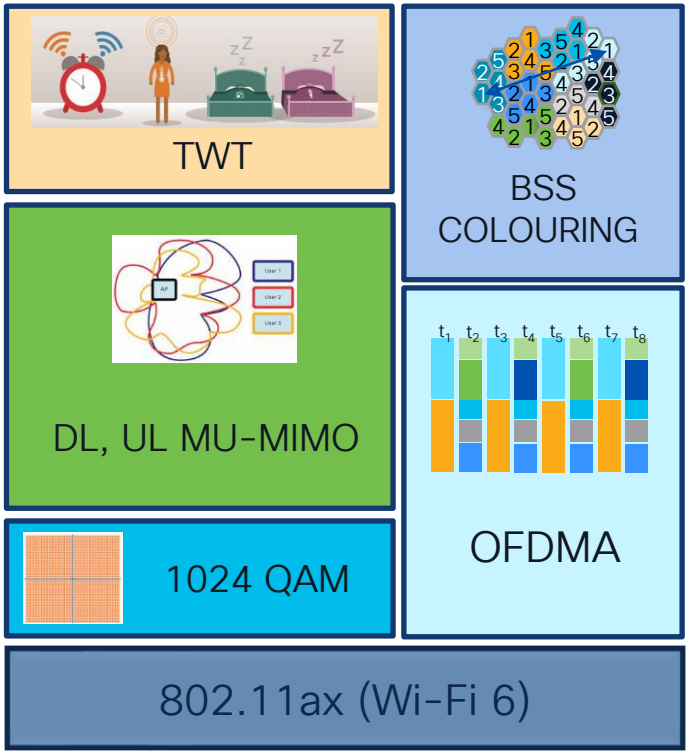
and tomorrow...

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



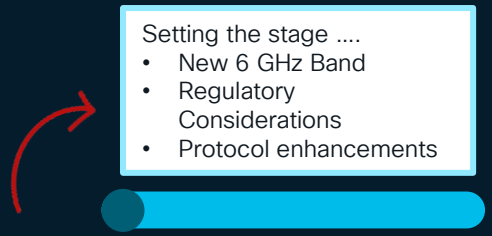
Wi-Fi 6E
Wi-Fi 6 and 6GHz are friends!

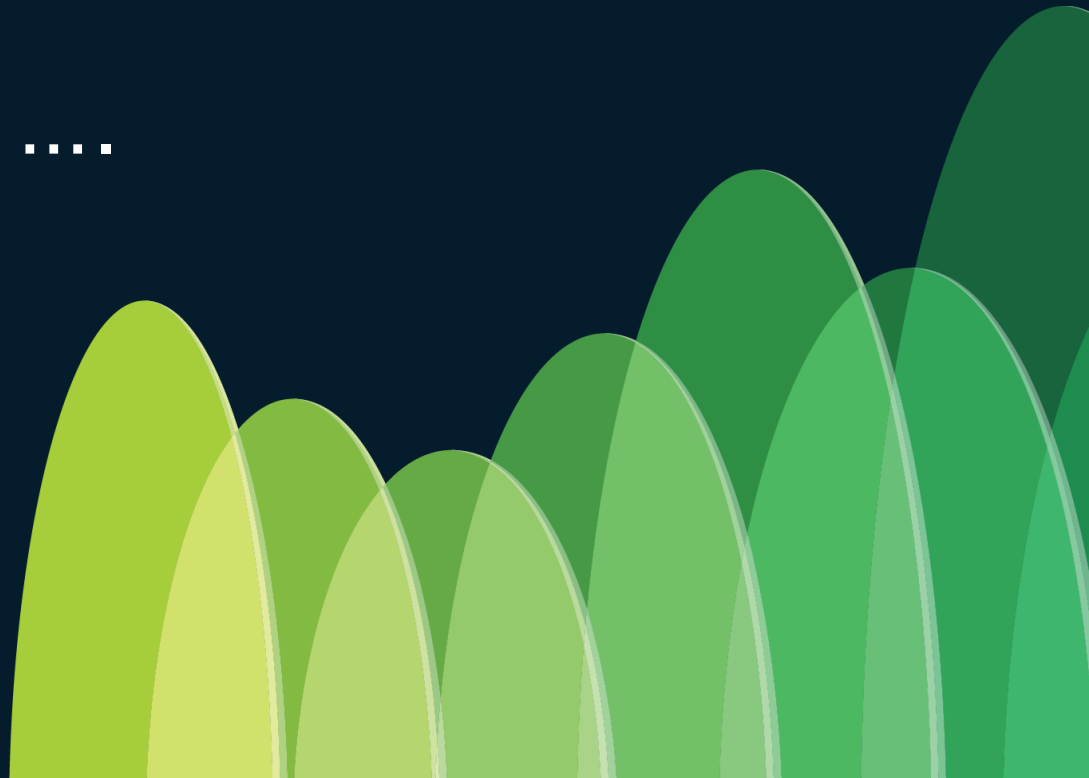


1. **Additional Spectrum**
   1200 MHz (5.925 to 7.125 MHz) – US
   500 MHz (5.925 to 6.425) - EU
2. **Security Upgrade**
   WPA3 Mandatory
   Improves Security
3. **Clean RF**
   (Fixed Mobile Service Operators in UNI-5 and UNI-7)
4. **No Legacy (Slow) Devices**
   Improves performance
5. **Protocol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

With Wi-Fi 6E ....

Setting the Stage ....





Wi-Fi 6E
6GHz Around the World

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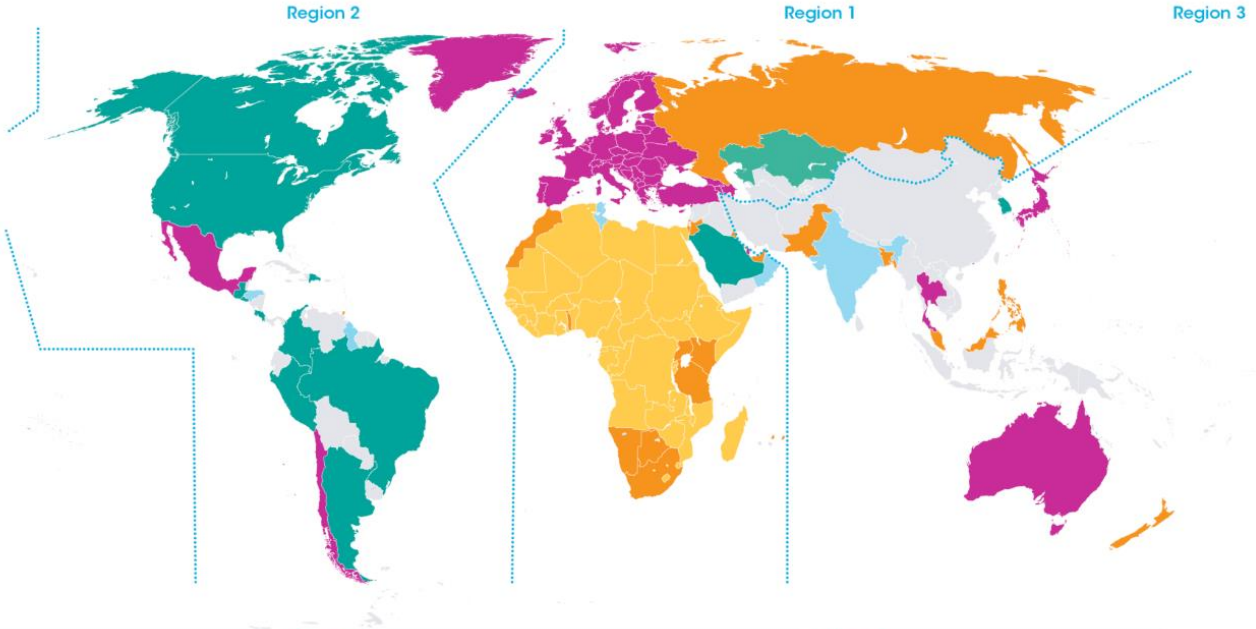
GLOBAL PROGRESS TOWARDS LICENCE-EXEMPT ACCESS TO THE 6 GHZ BAND



Region 2

1200 MHz
Argentina
Brazil
Canada
Colombia
Costa Rica
Dominican Republic
El Salvador
Guatemala
Peru
USA

500 MHz
(& evaluating 1200 MHz)
Chile
Mexico

500 MHz
Trinidad and Tobago

Region 1

1200 MHz
Kazakhstan
Saudi Arabia

500 MHz
(& evaluating 1200 MHz)
CEPT Area
European Union (480 MHz)
Qatar
United Kingdom

500 MHz
Africa / ATU
Bahrain
Botswana
UAE
Israel
Jordan
Kuwait
Kenya
Mauritius (480 MHz)
Morocco
Namibia
Oman
Russia
South Africa
Tanzania
Togo

Region 3

1200 MHz
South Korea

500 MHz
(& evaluating 1200 MHz)
Australia
Japan
Taiwan
Thailand

500 MHz
Bangladesh
Hong Kong
Macau
Malaysia
New Zealand
Pakistan
Phillipines
Singapore

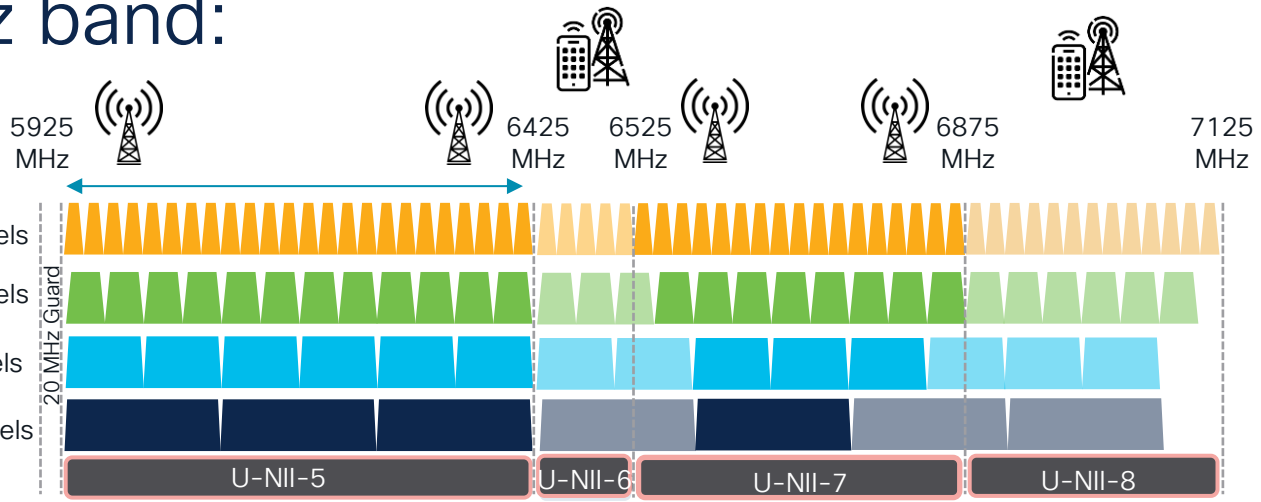
- Adopted 5925-7125 MHz
- Adopted 5925/45-6425 MHz and evaluating 6425-7125 MHz
- Adopted 5925-6425 MHz
- Recommended 5925-6425 MHz
- Under consultation

Data correct as of October 2024

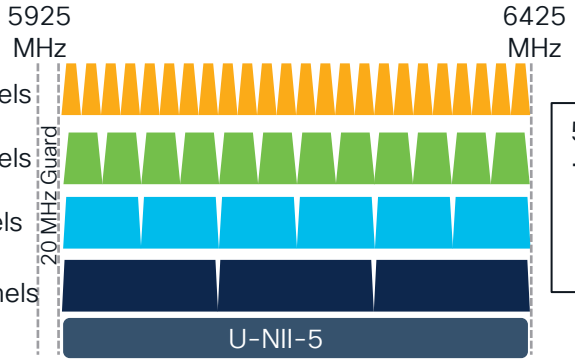
Source: https://6ghz.info

The new 6 GHz band:

United States
Canada
S Korea
1200 MHz



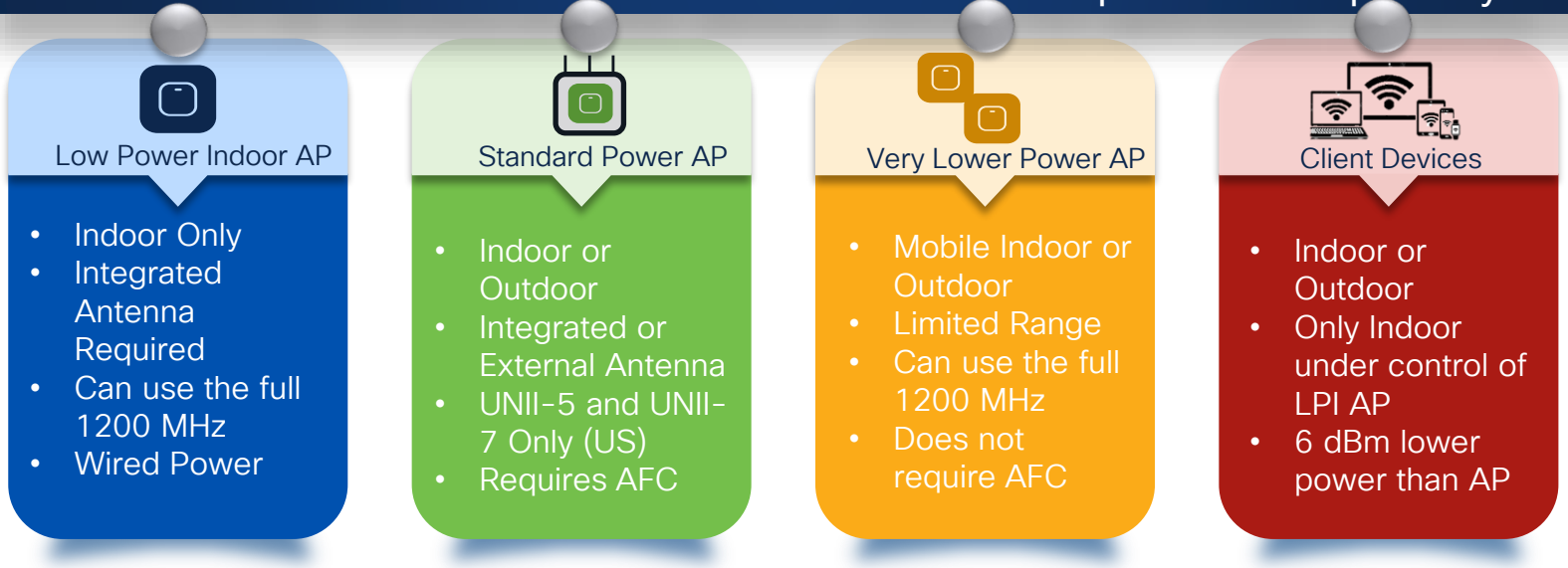
Europe/CEPT
Most APAC
500 MHz



5955 – Central frequency of the first 20 MHz channel
→ Starting at 5925 MHz +
20 MHz of guard band +
10 MHz to get to the center of the first 20 MHz channel

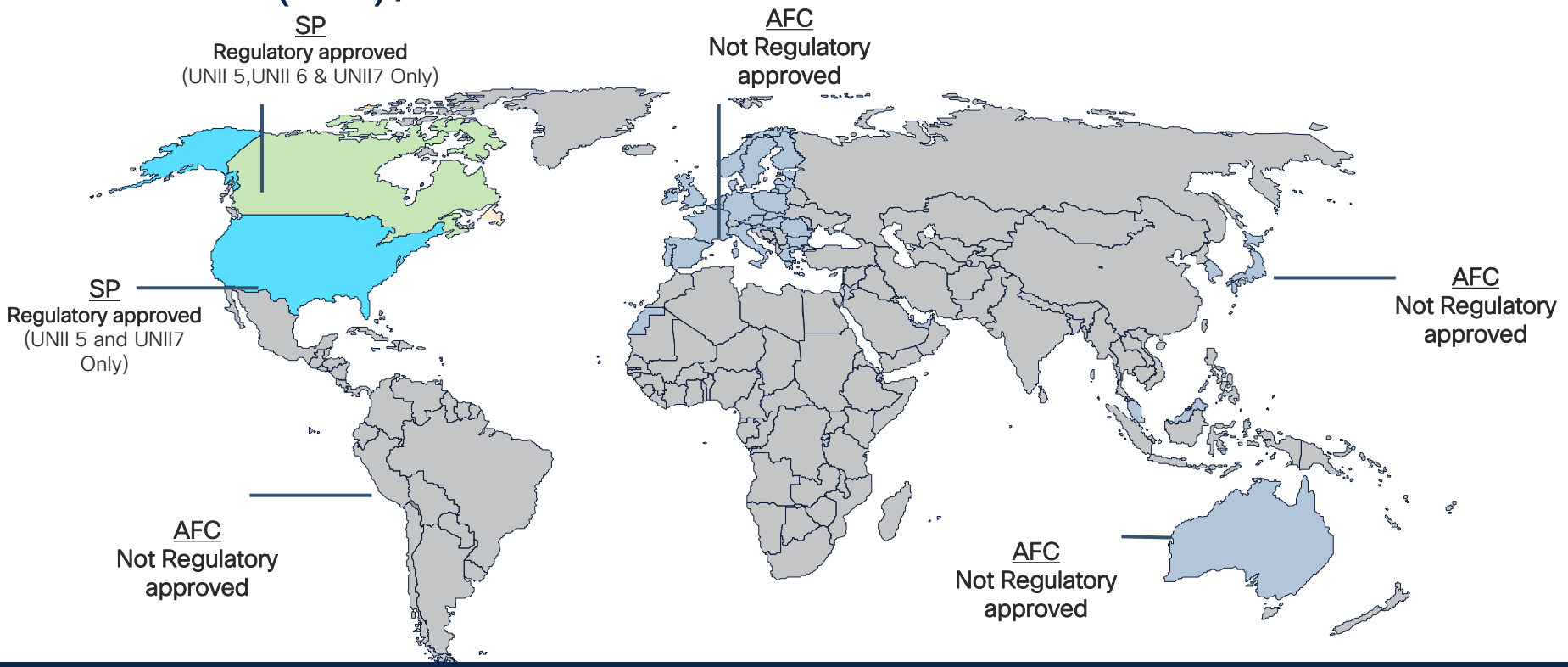
6 GHz – new device classes

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



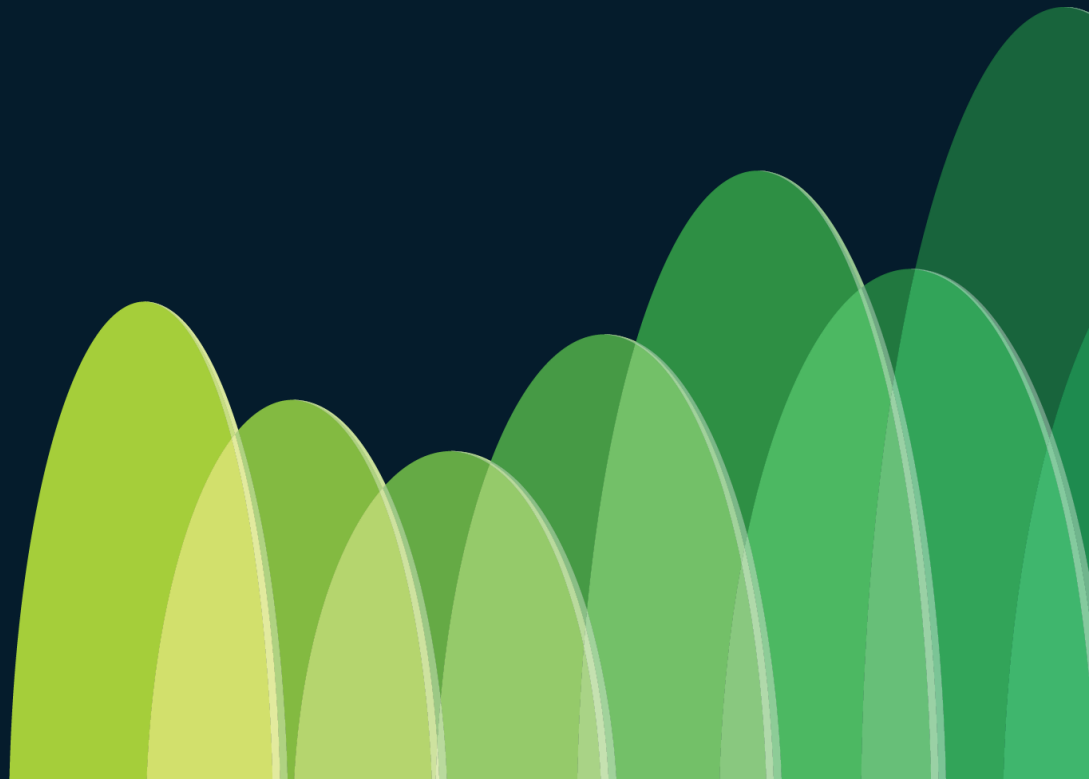
Regulations vary by country

External(SP)/outdoor antenna Wi-Fi 6E status



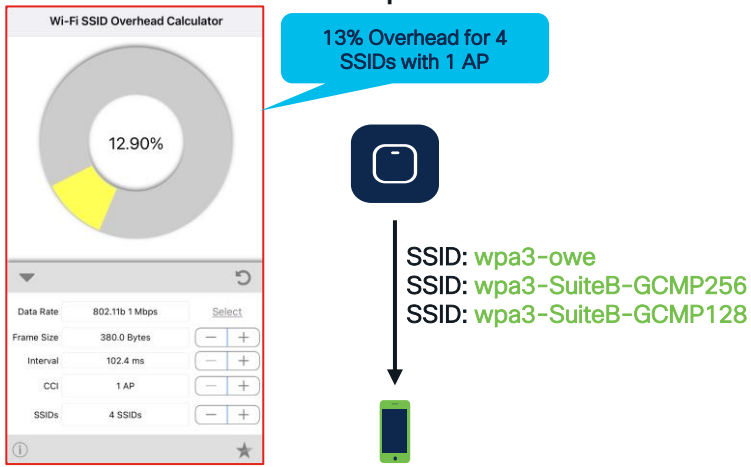
AFC approved and in production in USA

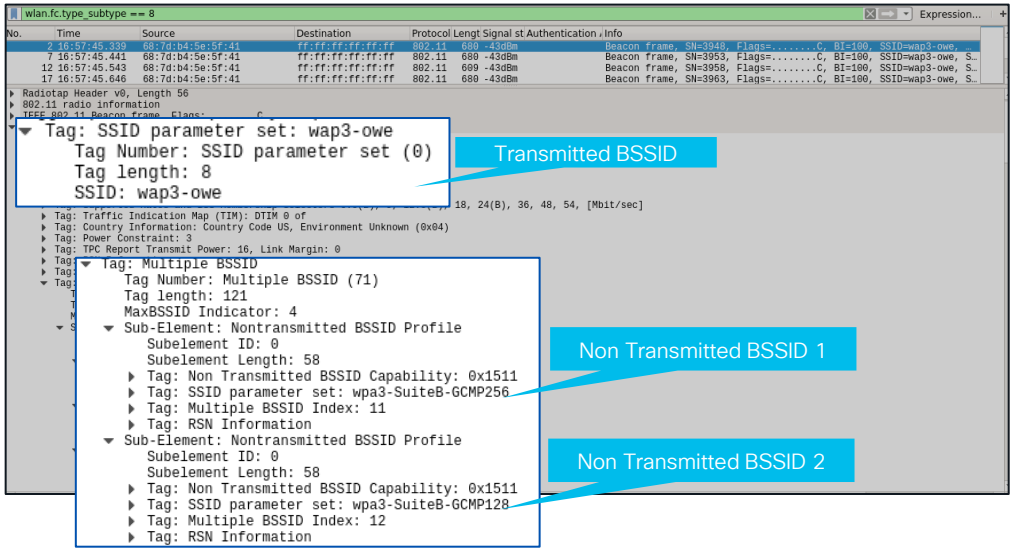
Protocol Enhancements



Multiple BSSID

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





- Conserves airtime
- Mandated in Wi-Fi 6E

Wi-Fi 6E - New AP discovery mechanisms

Out of band

Reduced neighbour report

Co-located discovery

In band

Passive scan:

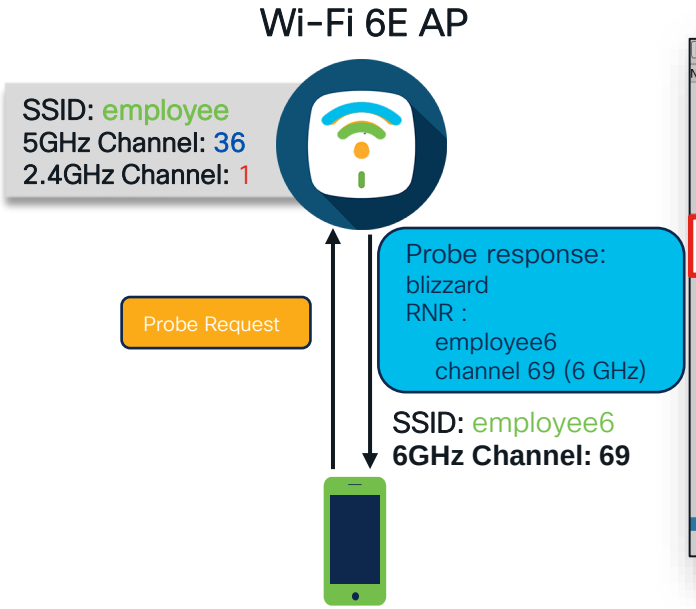
Fast link setup (FILS) discovery frames
Unsolicited broadcast probe response frames

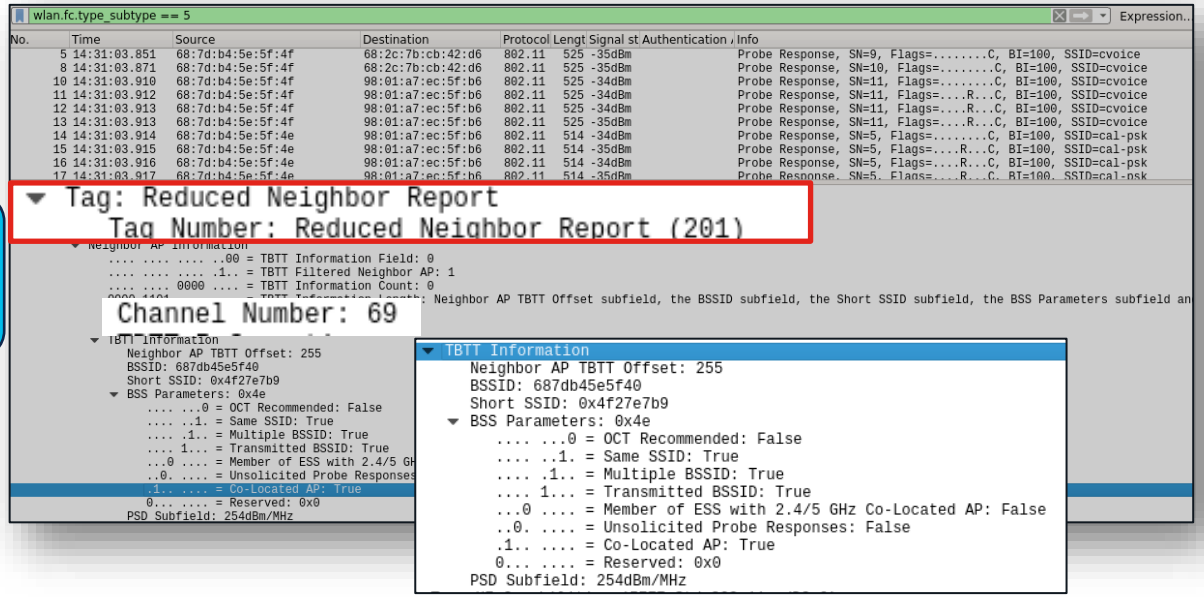
Active scan:

Preferred scanning channels (PSC)

Reduced neighbour report

Co-located “neighbour” 6 GHz radio information in beacon and probe response of 2.4 and 5 GHz radios.





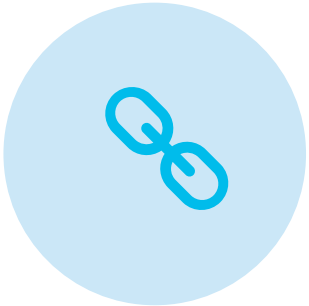
Clients start with 2.4 and 5 GHz bands discovery mechanism to learn 6 GHz SSIDs

Wireless clients always probe!

FILS discovery frames helps AP discovery faster

Reduces AirTime utilisation by management frames

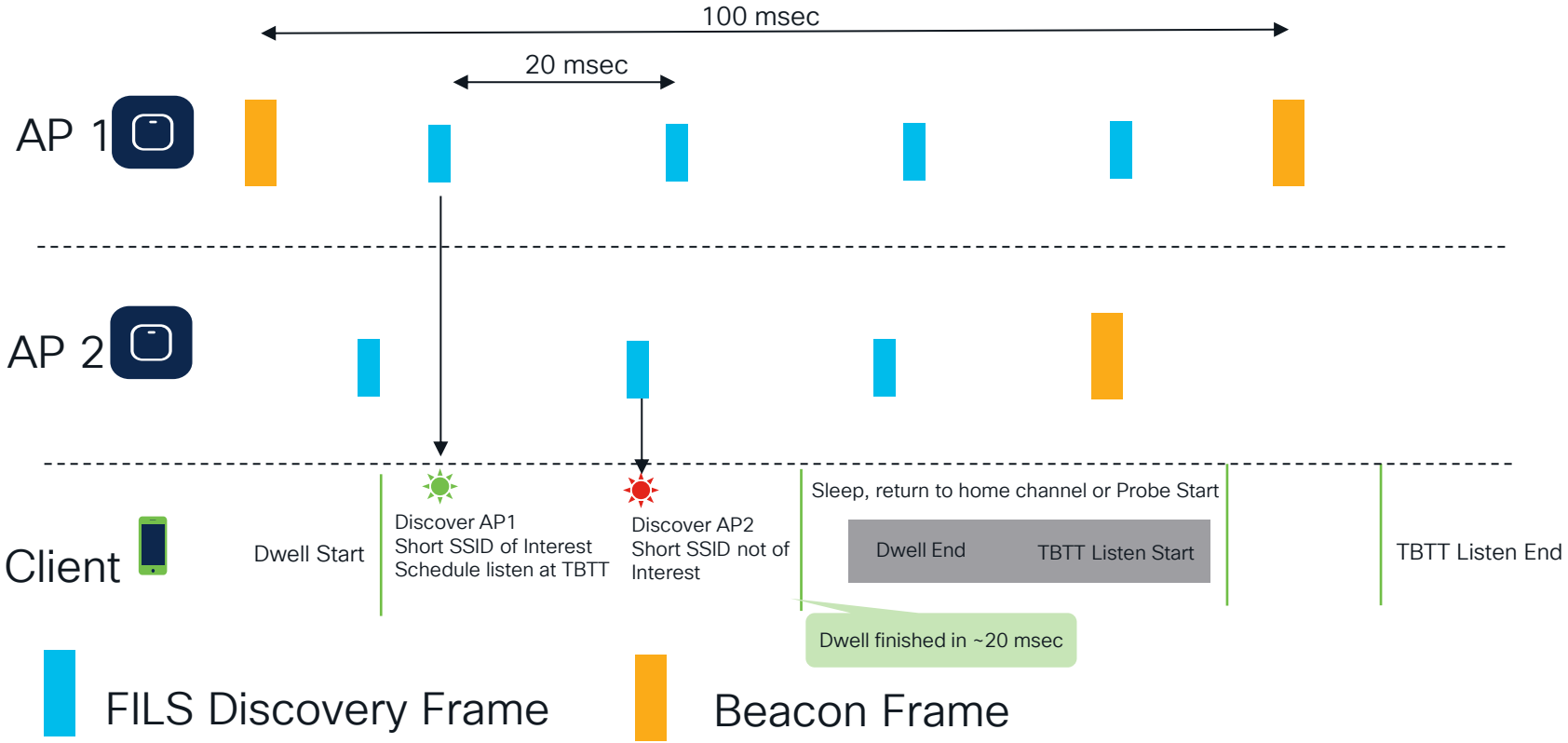
SMALLER BEACONS THAT IS TRANSMITTED MORE FREQUENTLY (APPROX. 20 MSEC), CONSUMES LESS AIR TIME.



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

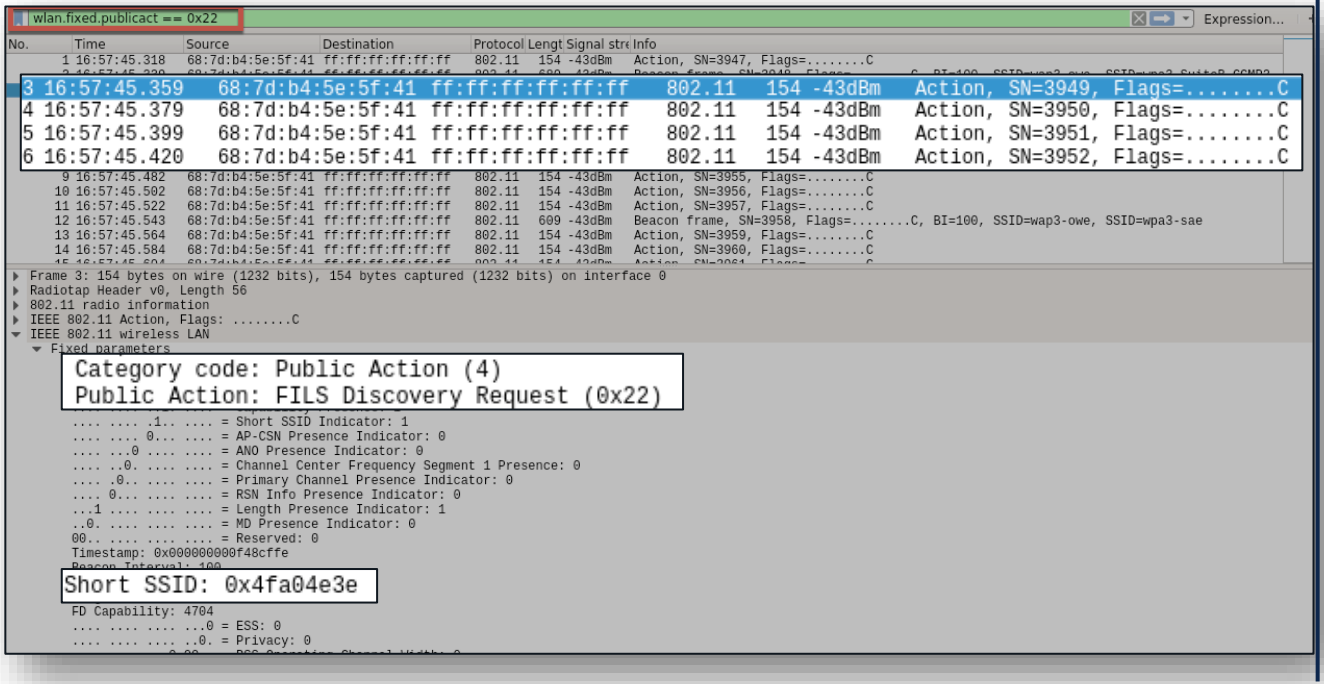
REDUCES PROBE REQUEST OVERHEAD

Fast initial link setup (FILS) discovery frames



FILS discovery frame – packet capture

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



- Broadcast action frames
- Contains short SSID, channel, TBTT, etc
- Transmitted every 20 msec

Unsolicited broadcast probe response

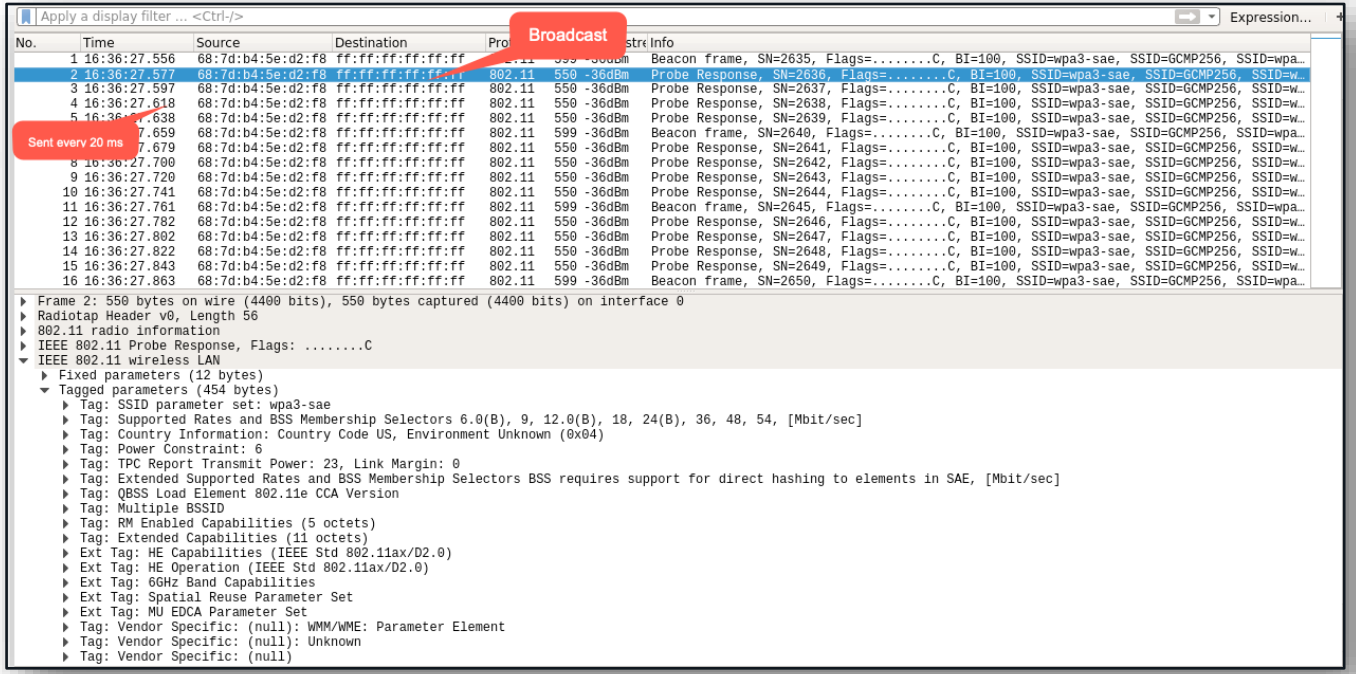
Reduces probe request overhead

Broadcast probe response every 20 msec

Contains detailed information as a beacon

Helps avoid probe storm

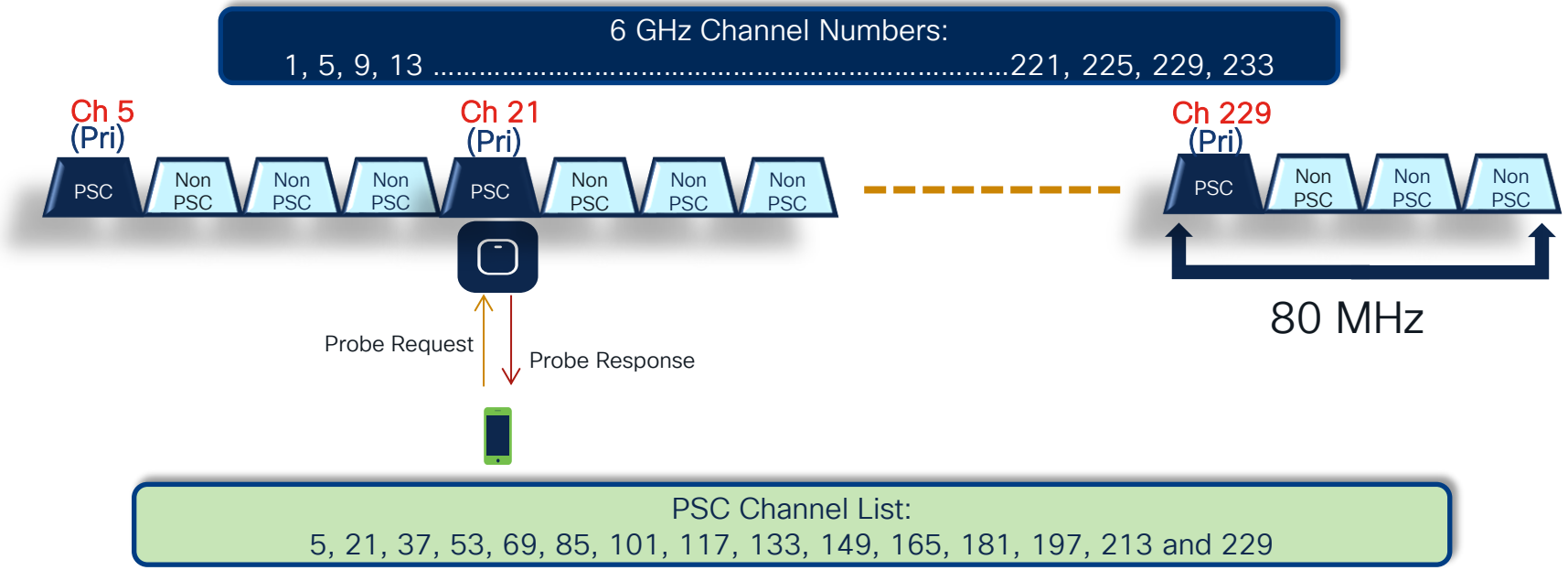
Unsolicited broadcast probe response packet capture



- Broadcast frames
- Transmitted every 20ms
- Carry Multiple BSSID
- Contains all information needed for association

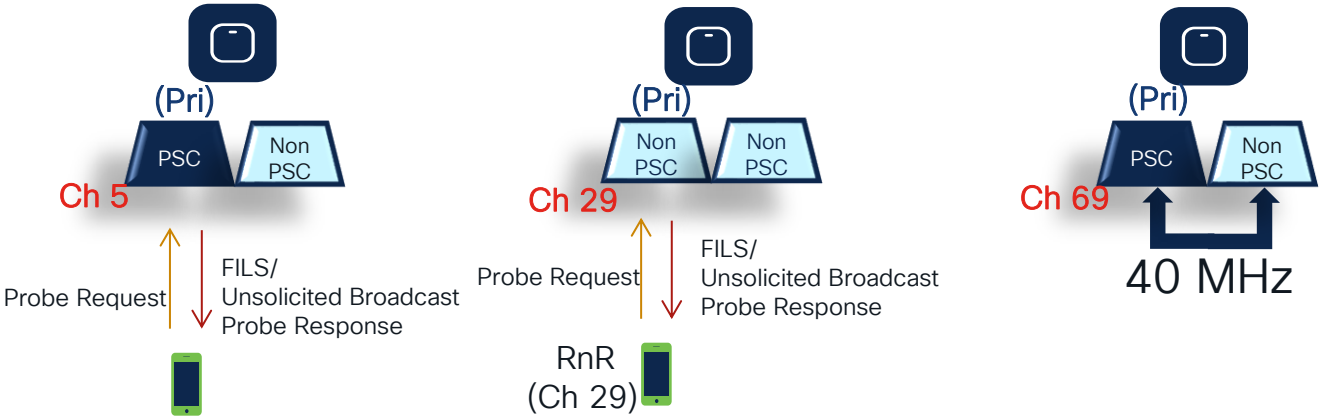
Preferred scanning channels (PSC)

- 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



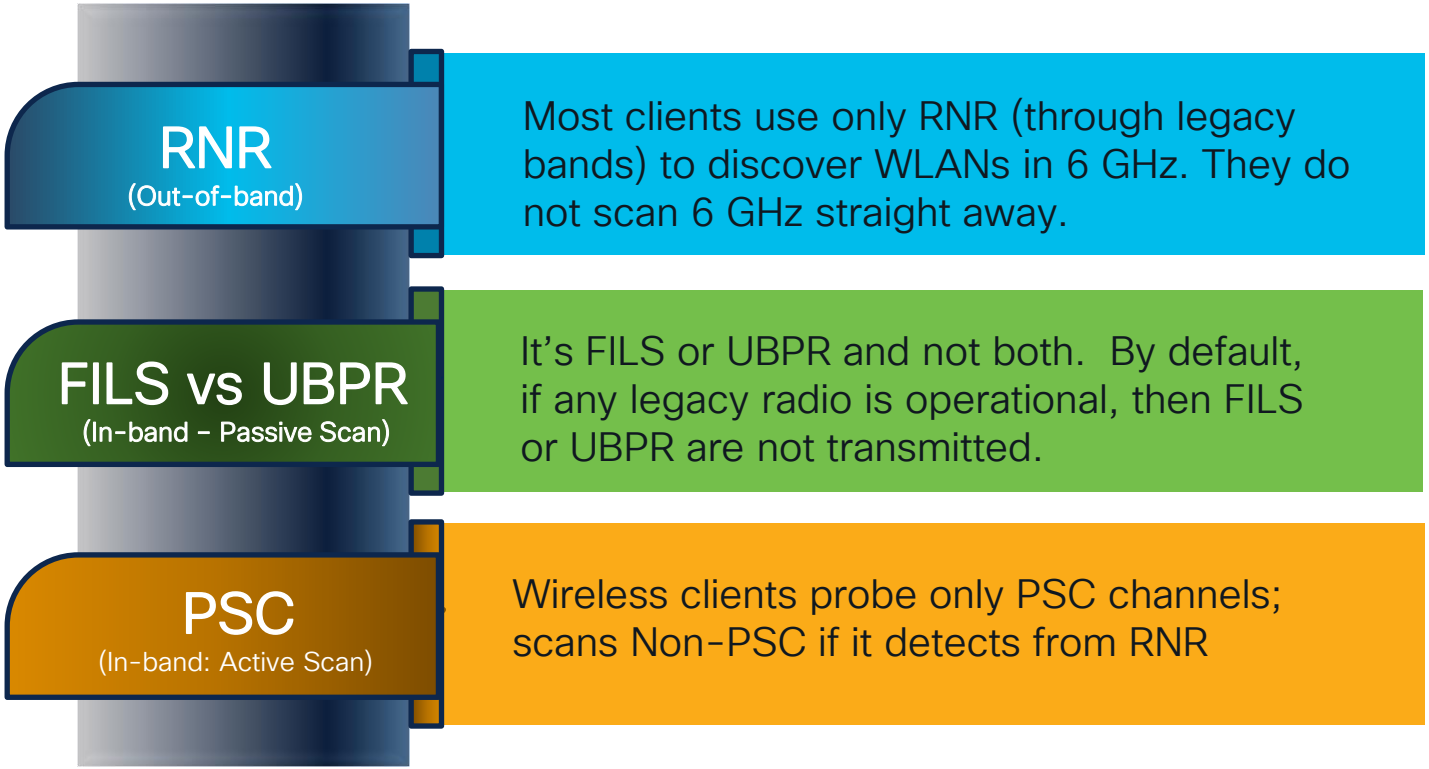
Preferred Scanning Channels with 40 MHz Channel

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

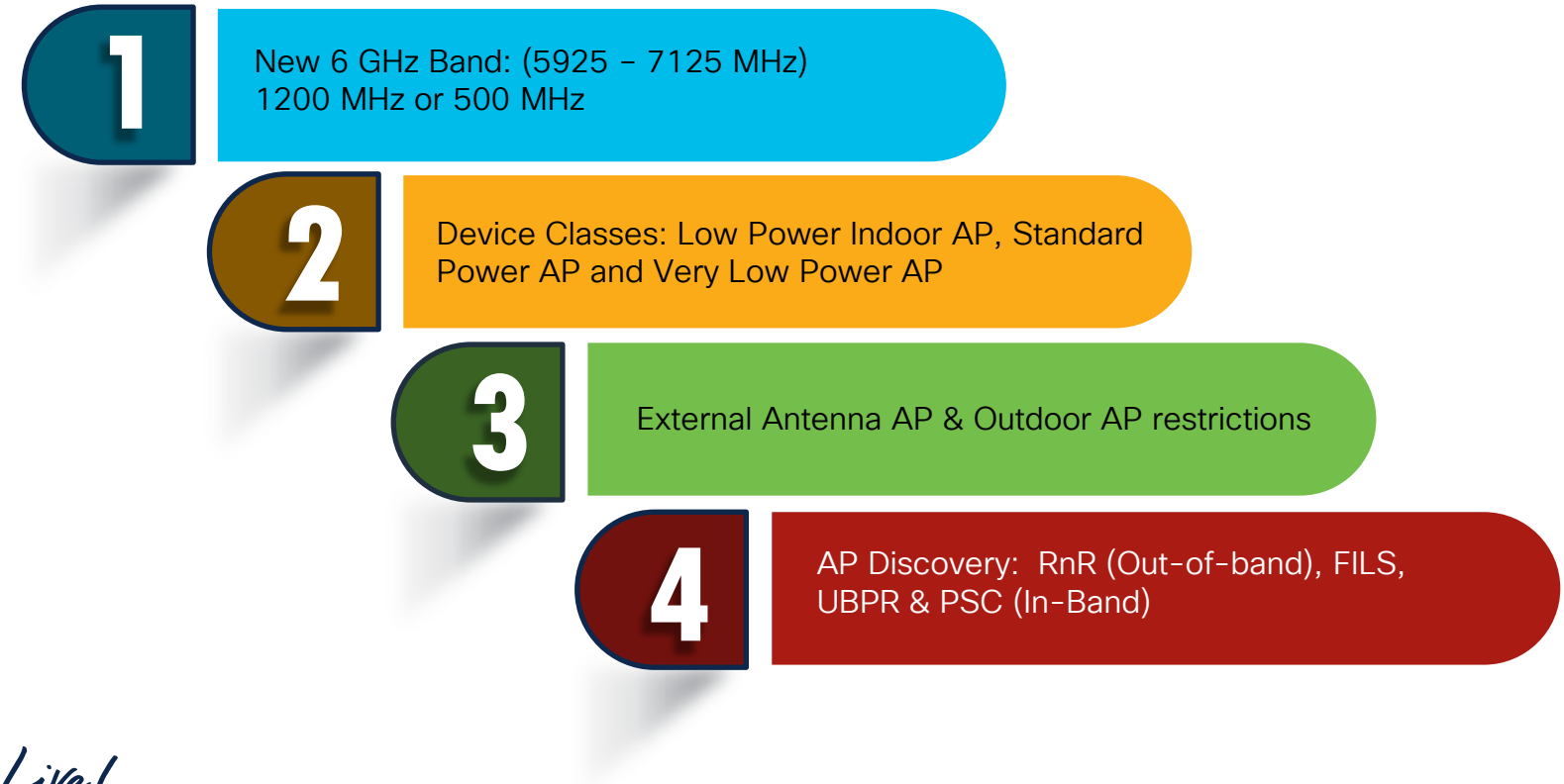


Clients do not scan Non-PSC channels

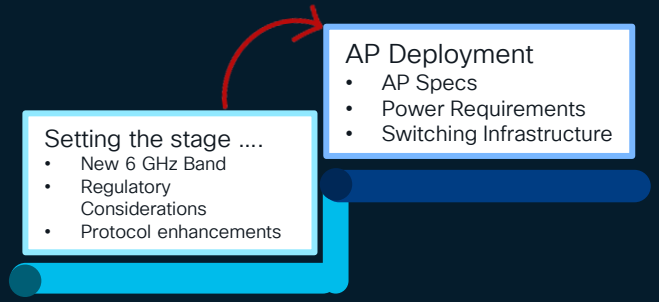
Key takeaways



Section Summary



AP Deployment

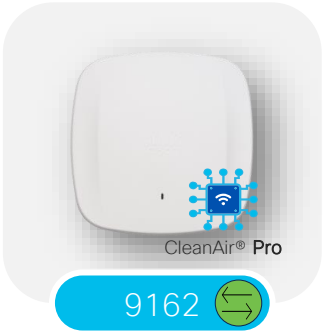


One product – two management modes

Cisco On-Prem **Management Mode**
C9800 & Catalyst Center Stack

Meraki **Management Mode**
MR Dashboard Stack

Industry’s best and broadest Wi-Fi 6E portfolio



9162

9164

9166D1

9166I

9136

MR57

9163E

Indoor Access Points

Outdoor Access Point

Management mode can be changed

Network Infrastructure

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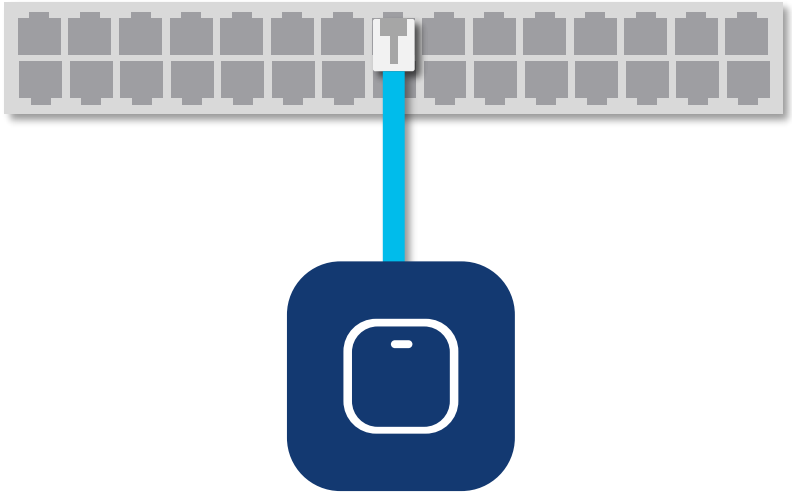
Catalyst AP to switch connection



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

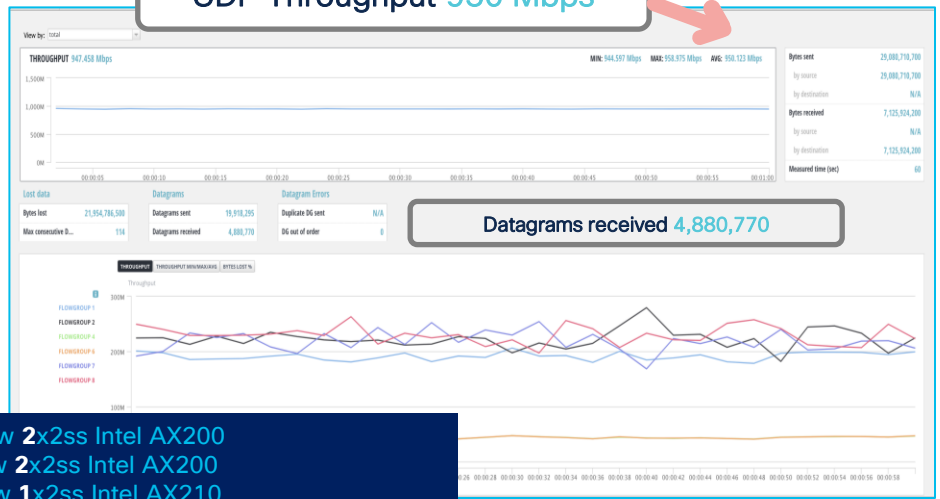
5 Gig (mGig) AP uplink vs 1 Gig AP uplink

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

Wi-Fi 6E Performance with Gigabit Switch

UDP Throughput 2.88 Gbps

UDP Throughput 950 Mbps



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

Catalyst AP C9136 to switch connection

AP C9136

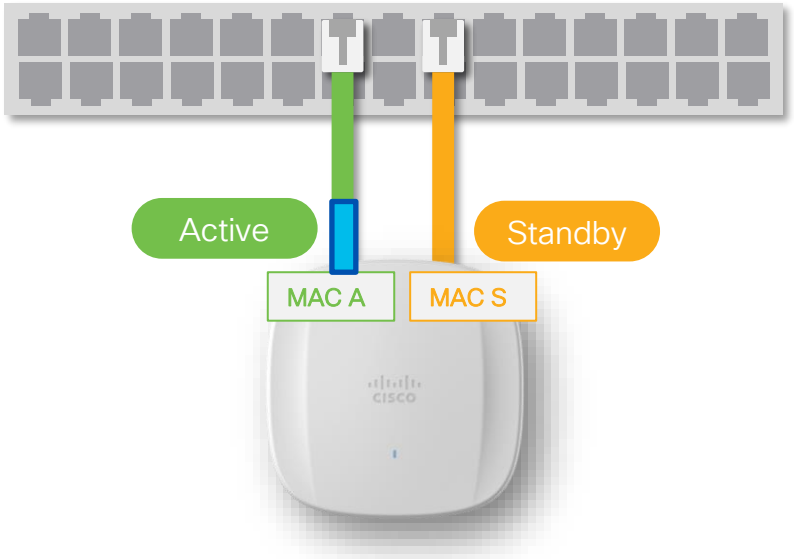
C9136 has two mGig uplink ports

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



AP C9136

- 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

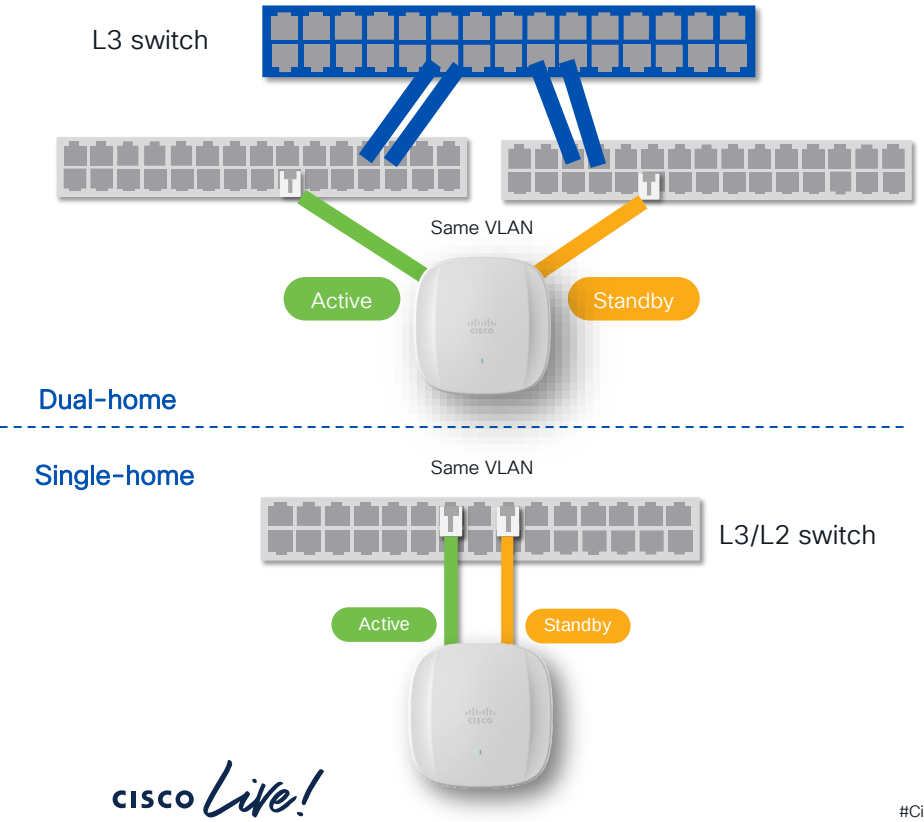
MAC = Media Access Control
ARP = Address Resolution Protocol
CAPWAP = Control and Provisioning of Wireless Access Points

Catalyst AP C9136 to switch connection

AP C9136

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

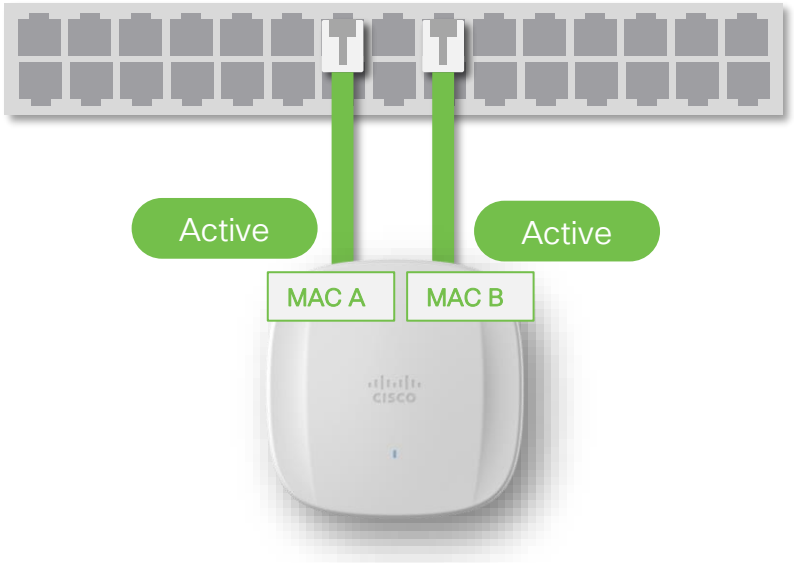
Catalyst AP C9136 to switch connection



- When configured with standalone ports, you have two options…
- Dual-home to two different switches
  - Recommend to connect to switches in different IDF, whenever possible
- Single-home to one logical switch (Stack Wise, 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 C9136 to switch connection



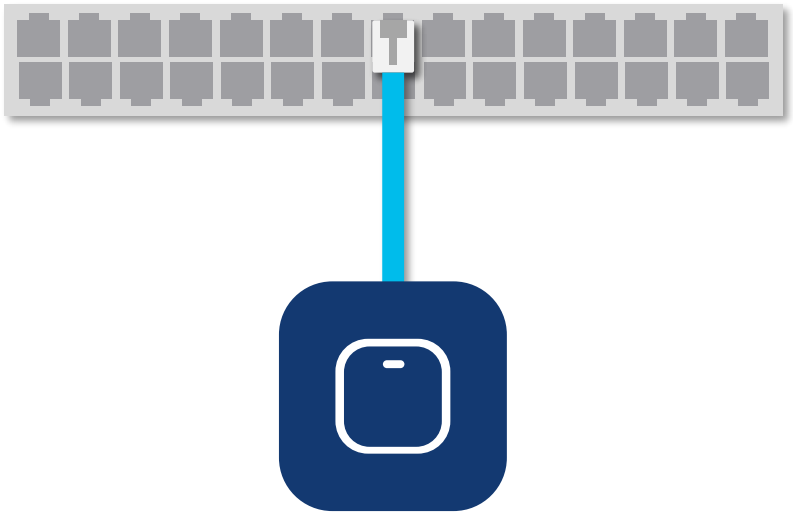
AP C9136

- 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



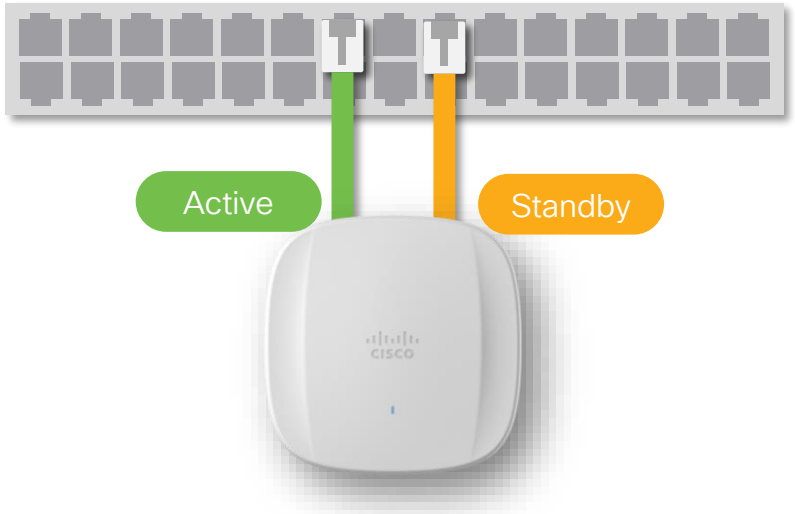
Power Allocated	Power Consumed
48.3 W	16.5 W

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 9136 power consumption (dual port)



	Power Allocated	Power Consumed
Port 0	48.3 W	16.5 W
Port 1	48.3 W	0.5 W

Both ports negotiate power and need to be considered for budget

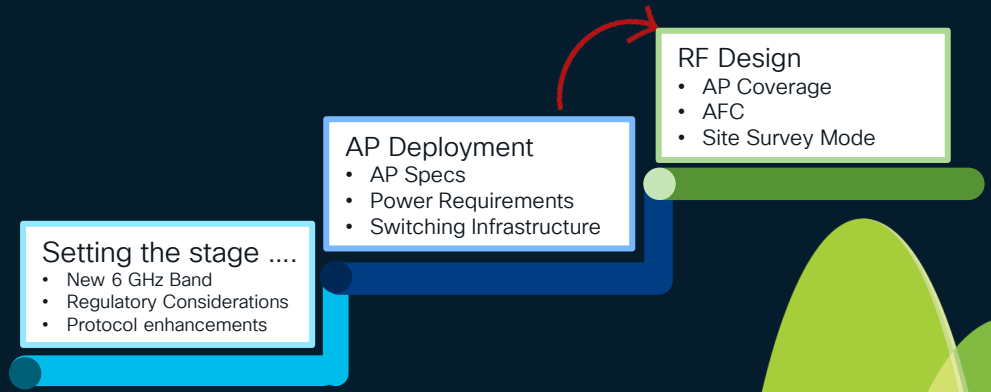
If no-LAG, standby port consumes very little power

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

Section summary

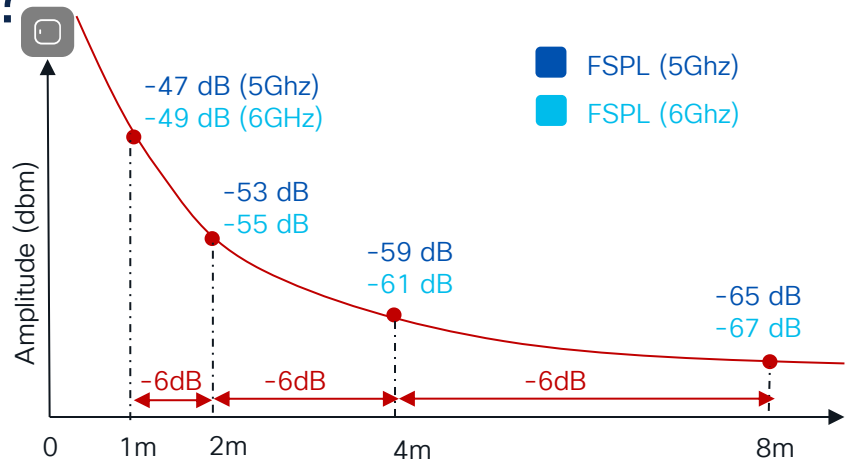
1. Catalyst Wi-Fi 6E Access Point Portfolio
2. Common Hardware and Migration
3. Switch Port Speed (> 1 G)
   Cabling : Cat 5e, Cat 6, Cat 6A and above
4. Power Considerations
5. Catalyst 9136 Dual mGig Link and PoE Redundancy Options

RF Design

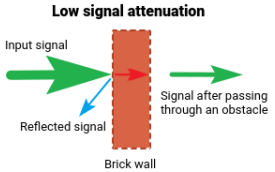

Setting the stage ....
• New 6 GHz Band
• Regulatory Considerations
• Protocol enhancements
AP Deployment
• AP Specs
• Power Requirements
• Switching Infrastructure
RF Design
• AP Coverage
• AFC
• Site Survey Mode

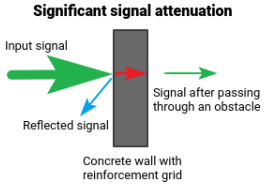
What you need to consider?

- Path Loss (FSPL)* – Path loss in the first meter is on average 2dB higher at 6GHz vs. 5GHz. After that, the 6 dB rule applies: doubling the distance results in a 6 dB loss, regardless of the frequency
- Cell Size – At 6 GHz @ same power level cell is smaller vs. cell size at 5 GHz



- Absorption/reflectance – 6 GHz will be attenuated more through wall or other surface
- Noise floor at 6 GHz is much lower than 5 GHz, at least for some time ☺
- Coverage type: Today 6GHz is indoor only



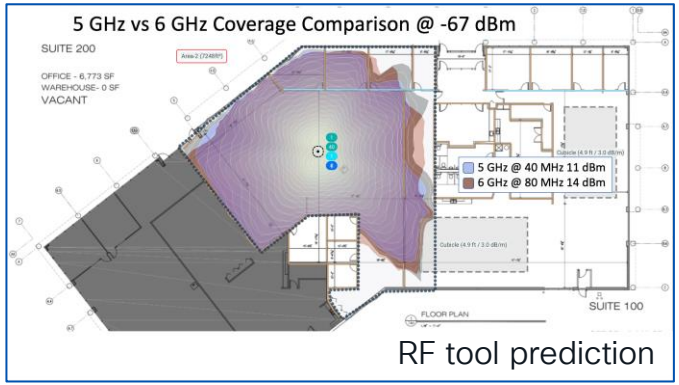


(*) FSPL = Free Space Path Loss: https://en.wikipedia.org/wiki/Free-space_path_loss

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

RF design considerations

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



RF tool prediction

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?

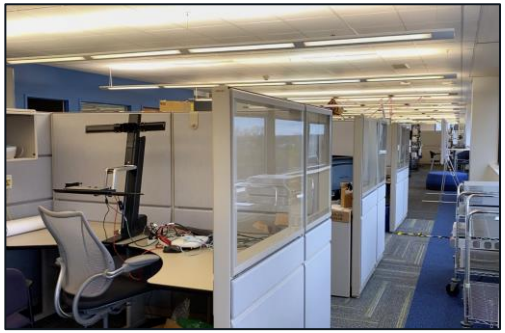
Q1: Can a co-resident 6 GHz radio provide the same coverage as the 5 GHz cell while dramatically increasing performance?

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^2 (140-190 m^2) of average AP density, carpeted office normal ceiling (3 m /10 ft)



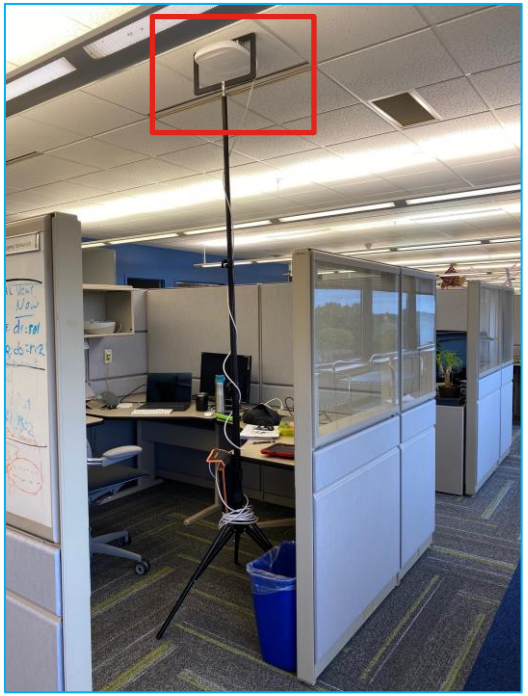
- 5 GHz network with RRM operating at power levels 3-4? >then equal 5 and 6 GHz coverage is possible with a one for one AP replacement in both ETSI and FCC. Assuming 80 MHz channel in FCC and 40 MHz channel in ETSI/UK.
- If the power level is in 1-2, then you may need around 10 to 20% additional access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

New gear!!! Wi-Fi 6E measurement !

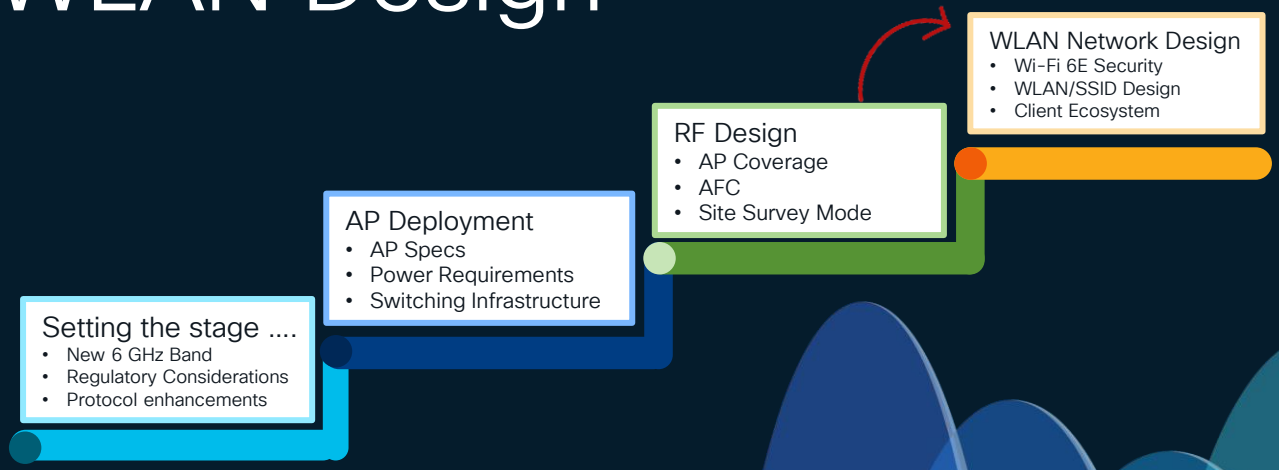
Ekahau Sidekick 2
- 2.4, 5, 6 GHz
- Ekahau AI Pro
- Ekahau Analyser

Hamina Nomad
- 2.4, 5 & 6 GHz
- Hamina Onsite App

NetAlly Aircheck G3 Pro
- 2.4, 5, 6 GHz
- NetAlly Link-Live



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
• AFC
• Site Survey Mode
WLAN Network Design
• Wi-Fi 6E Security
• WLAN/SSID Design
• Client Ecosystem

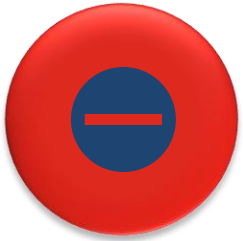
Wi-Fi 6E – Security

Wi-Fi 6E Security

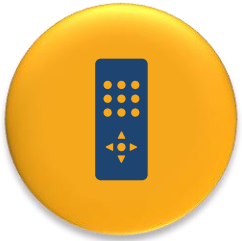
Wi-Fi 6E uplevels security.

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.

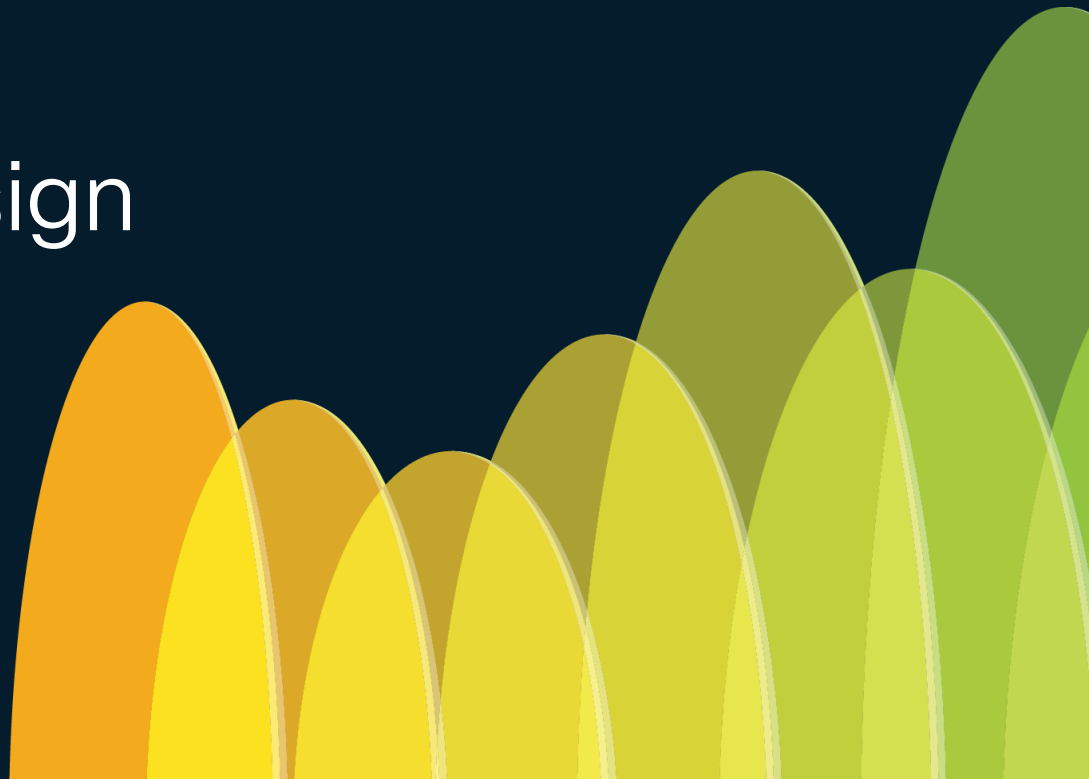


Requires Protected Management Frame (PMF) in both AP and Clients.

*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



cisco Live!

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. “Multiple SSIDs” Option: Redesign your SSIDs, adding specific SSID/WLAN with specific security settings – Most flexible
3. “One SSID” Option: Configure multiple WLANs with same SSID name, different security settings – Most conservative

Most likely your current SSID configuration would prevent it from being broadcasted on 6GHz
Note: as 17.12.3, there is a limit of 8 SSIDs broadcasted on 6GHz radio

Option 1

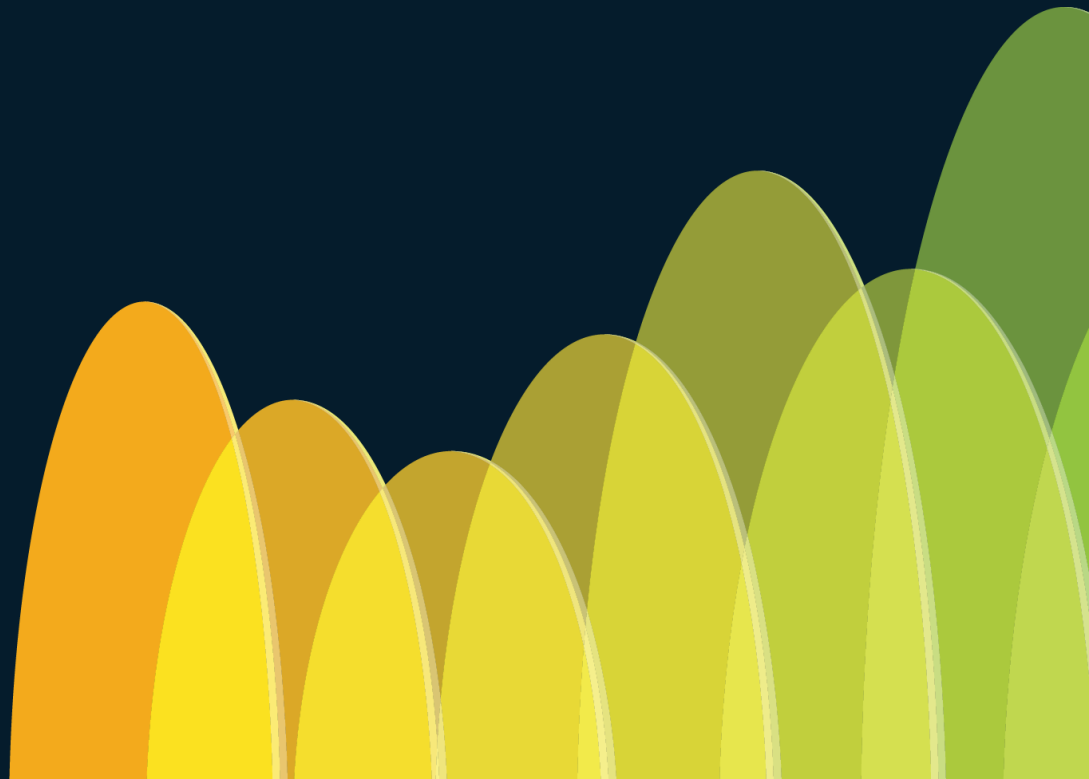
Pros

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

Cons

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

Option 2



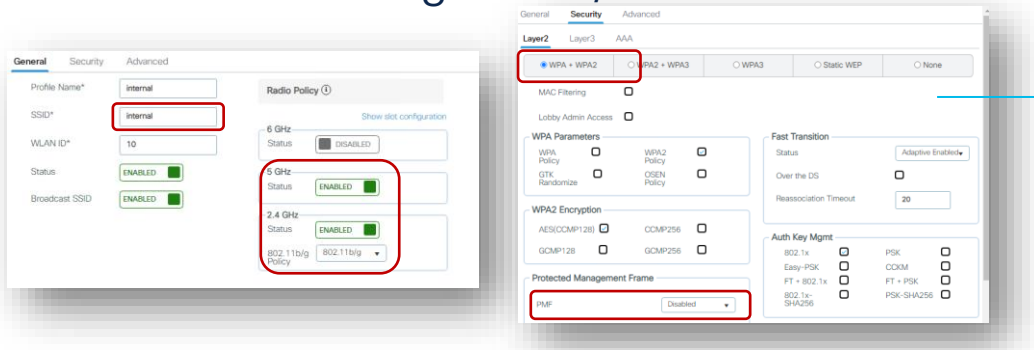
Option 2 – WLAN design considerations

- Option 2: 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 2 > example 1

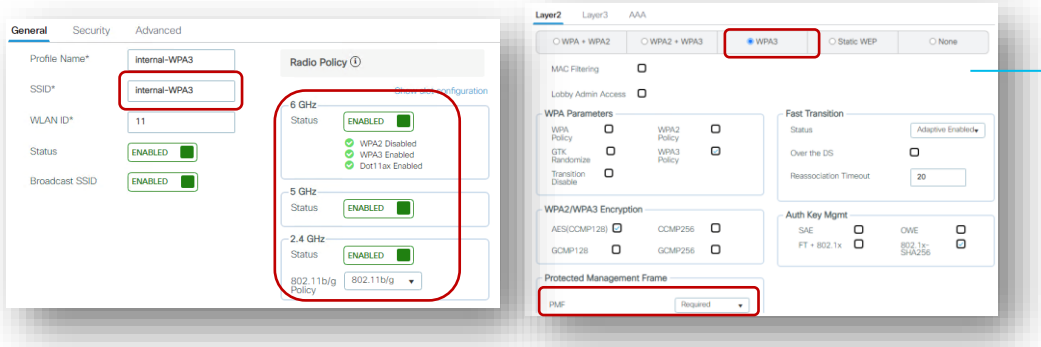
Add a separate WLAN with different SSID name for WPA3 and broadcast it in all bands. Leave the existing WLAN/SSID untouched.

Legacy SSID



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

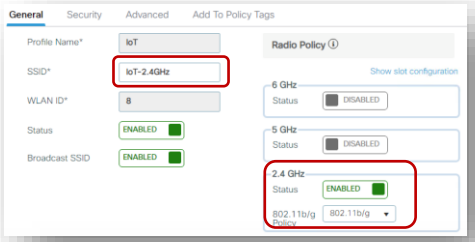
New SSID



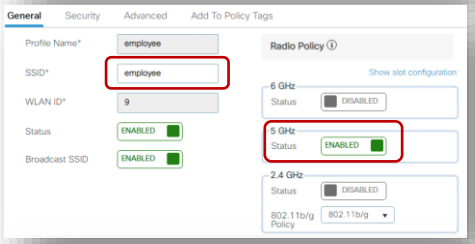
Dedicated SSID for WPA3 (new name) capable clients in all bands. This is the SSID for 6GHz

Option 2 > example 2

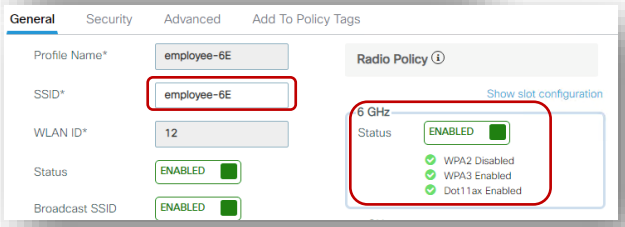
Redesign the WLANs, reserving each band for a specific device/use case



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



5GHz dedicated to majority of existing clients



WPA3 on 6GHz band only, for the newest clients

Option 2

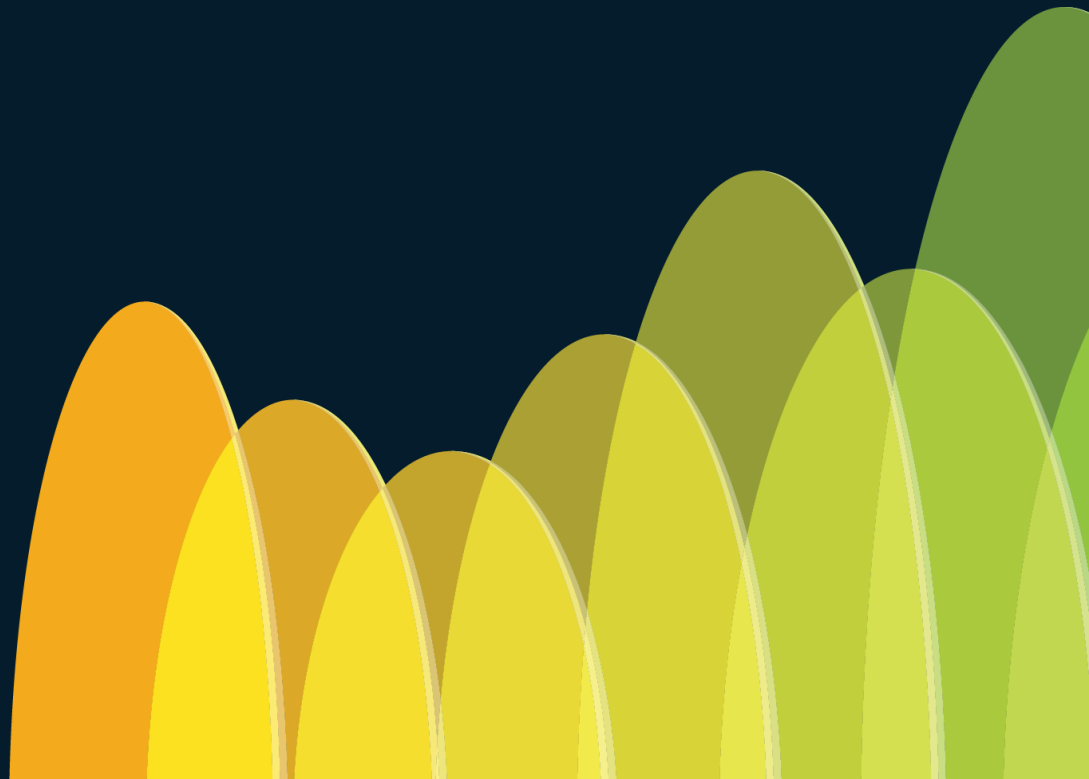
Pros

- 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 Catalyst Center

Cons

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

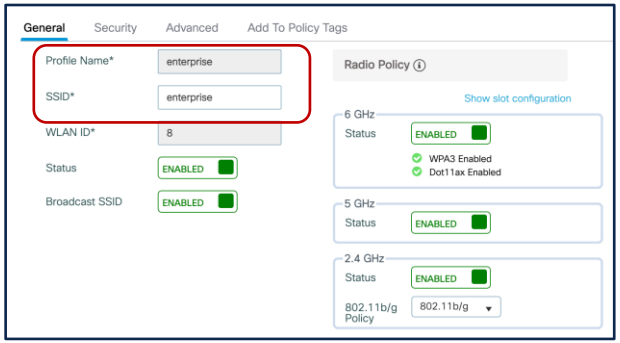
Option 3

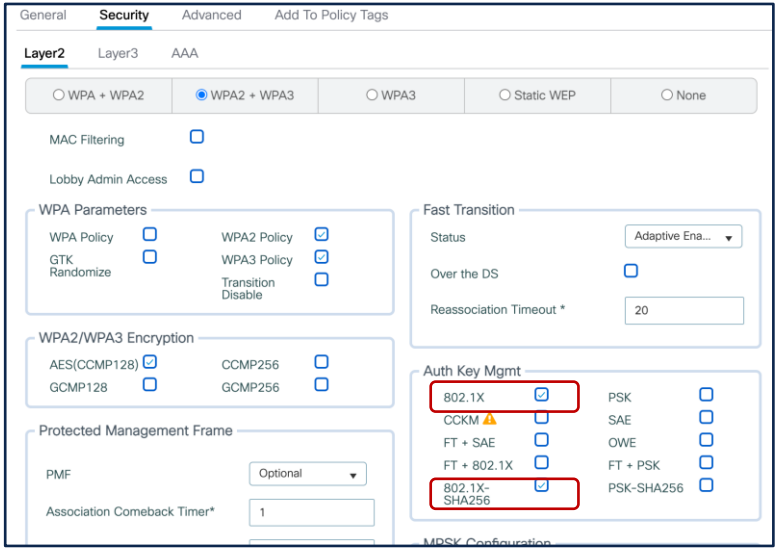


Option 3 – WLAN design considerations

Starting: IOS-XE 17.12.1

Single WLAN Profile for 2.4/5 and 6 GHz





- 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

WFA = Wi-Fi Alliance

Option 3

Pros

- Provide an adoption path to more secure Wi-Fi via WPA3 Transition mode
- Maintain support for older clients using WPA2.
- 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

Section summary

Wi-Fi Network Design

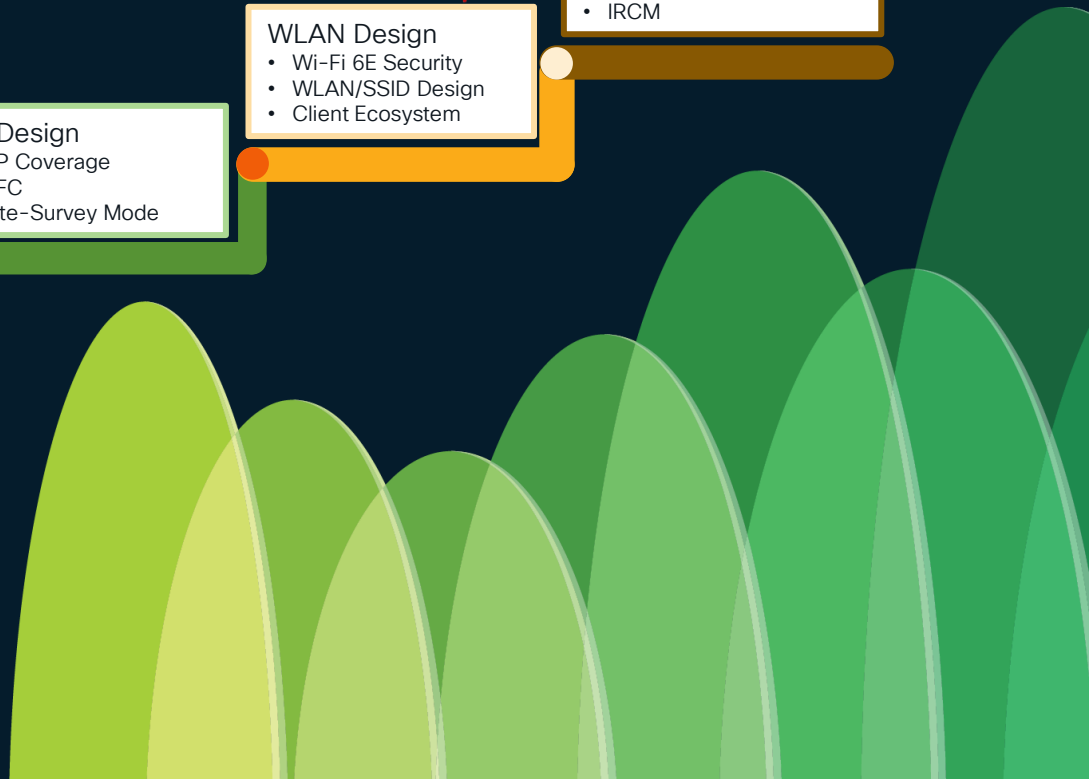
Setting the stage ....
- New 6 GHz Band
- Regulatory Considerations
- Protocol enhancements

AP Deployment
- AP Specs
- Power Requirements
- Switching Infrastructure

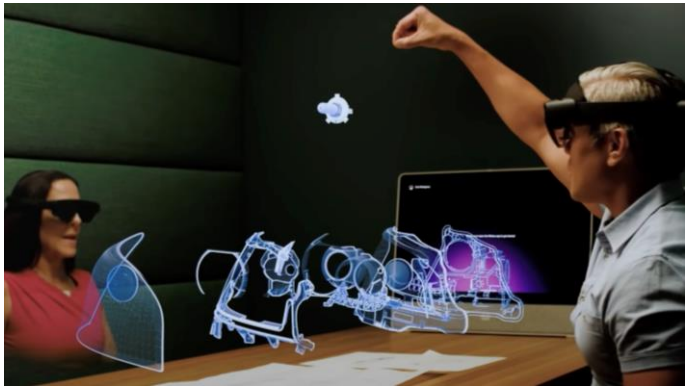
RF Design
- AP Coverage
- AFC
- Site-Survey Mode

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

Wi-Fi Network Design
- Adoption
- Migration Scenarios
- IRCM



Start with use cases

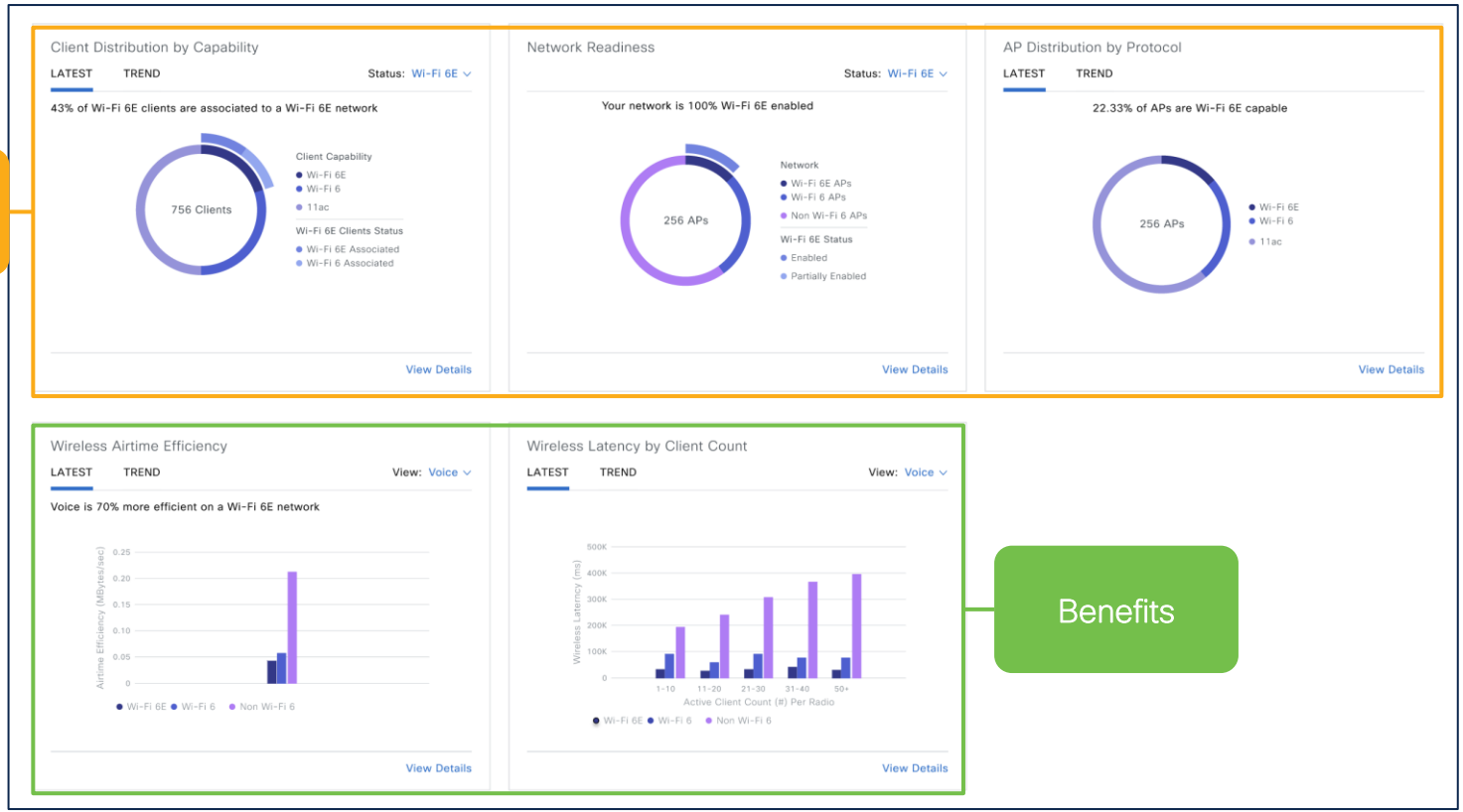


Observe channel utilisation in your network

Observe the client types in your network

Readiness and benefits of 6 GHz from Cisco Catalyst Center 2.3.2

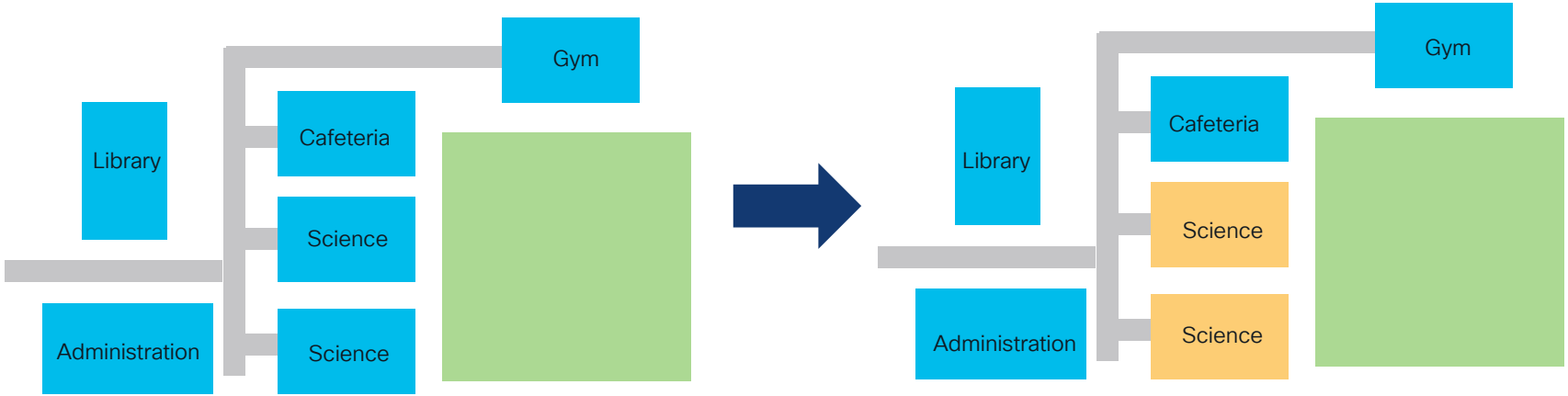
Readiness



Benefits

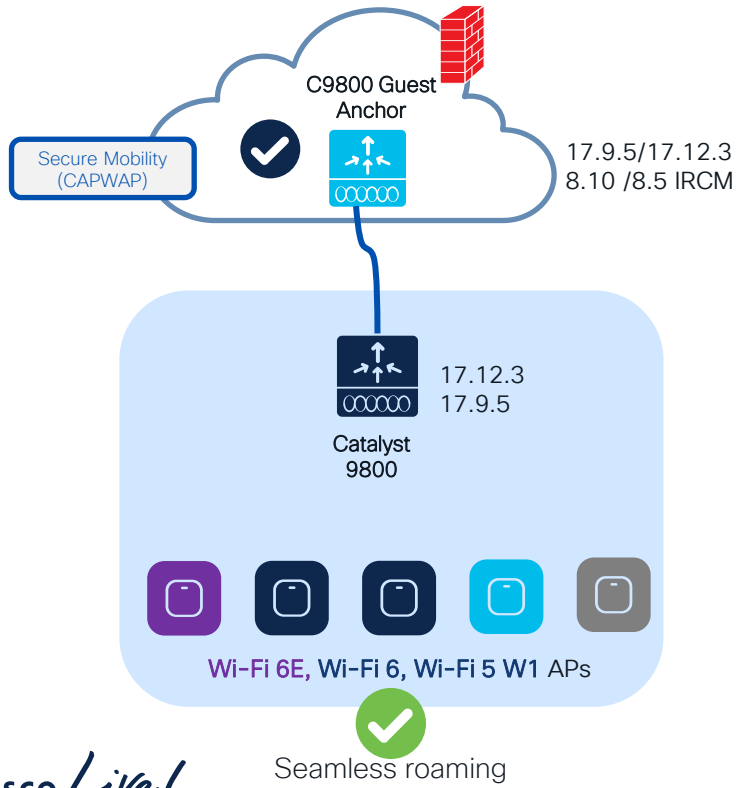
Migration scenarios

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



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

How do I start adopting 6GHz?

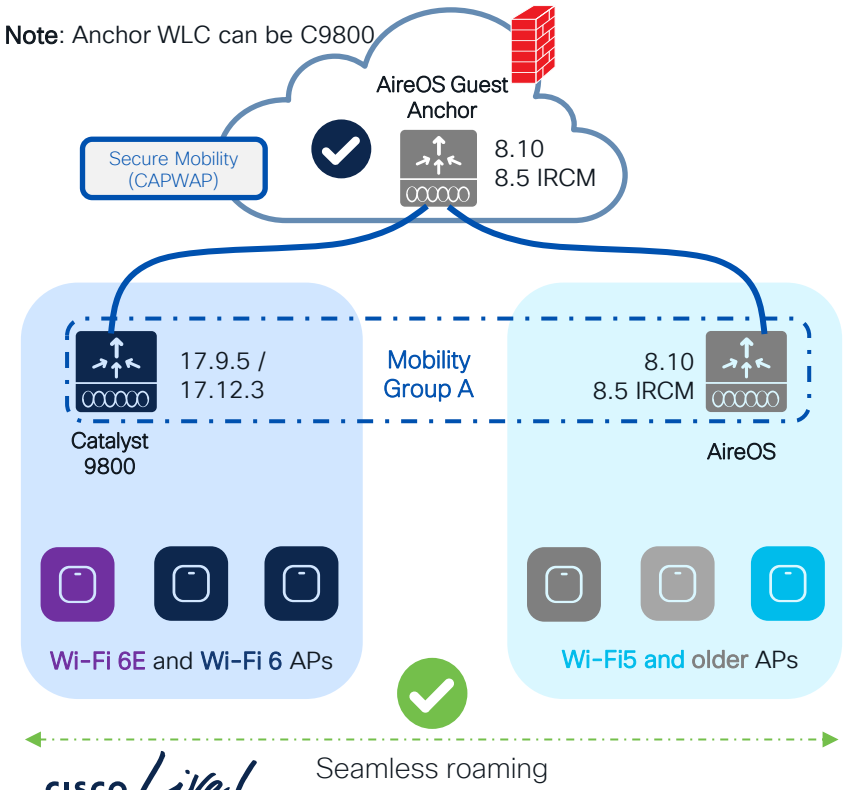


Scenario 1: If you have already started your C9800 journey

- Controller code is 17.12.3 or 17.9.5
- 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-aireos_ircm_dg.html

How do I start adopting 6GHz?
Answer: inter release controller mobility (IRCM)



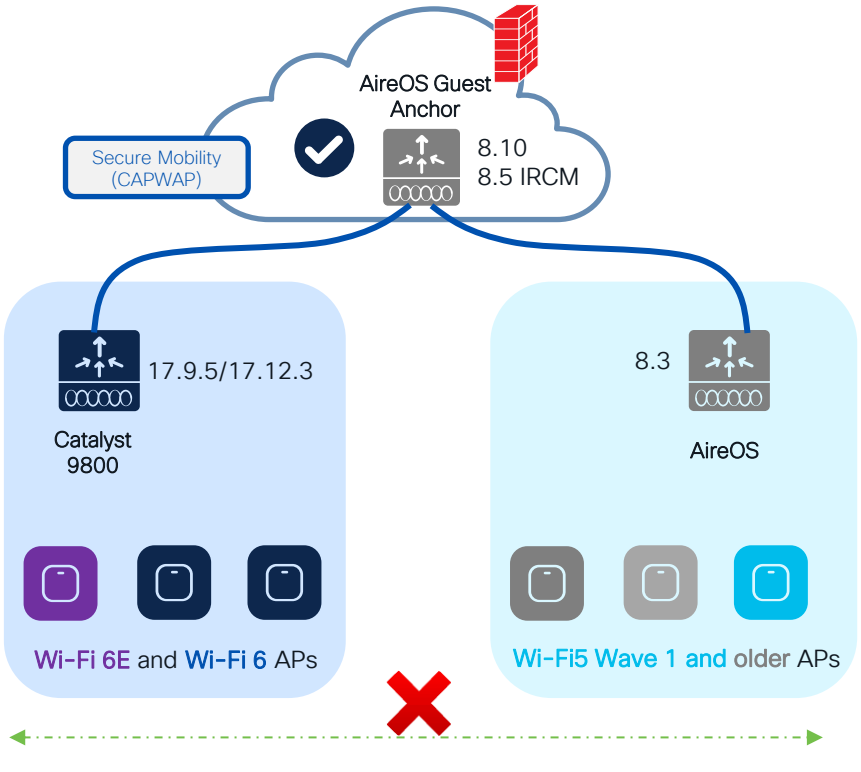
Scenario 1: legacy controller supports IRCM

- Introduce new 6/6E AP hadware 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 and 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

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

Wi-Fi 7

Setting the stage ....
- New 6 GHz Band
- Regulatory Considerations
- Protocol enhancements

AP Deployment
- AP Specs
- Power Requirements
- Switching Infrastructure

RF Design
- AP Coverage
- AFC
- Site survey

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

Wi-Fi Network Design
- Adoption
- Migration Scenarios
- IRCM

Wi-Fi 7
- Introduction
- The dilemma
- Ent Readiness

Wi-Fi 7 & 802.11be in 1 slide

Wi-Fi 7 R1 spec finalized in Jan ’24. WFA certification for R1 in progress. R2 expected Dec 2025. 802.11be final publication expected Feb/Mar 2025.

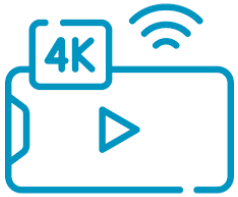
In the enterprise, Wi-Fi 7 is a modest upgrade compared to Wi-Fi 6E.

Wi-Fi 7 client availability picking momentum.

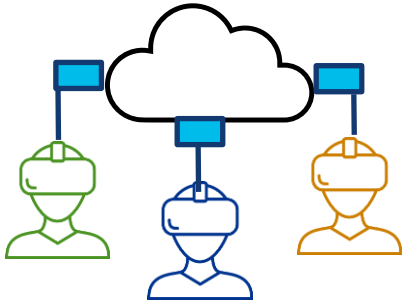
Cisco has been closely involved in development of Wi-Fi 7, and advocates for thorough client interop testing

6 GHz Wi-Fi with Wi-Fi 6E is mature

Wi-Fi 7 use cases



High Definition Video Streaming



Multi-user AR/VR/XR

Emergency Preparedness Communication Services

Industrial IoT

Hybrid Work

Immersive Gaming and Entertainment

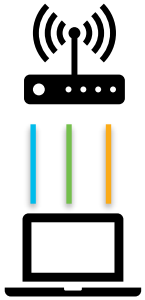
Automotive

Immersive Learning

What is Wi-Fi 7 (and a bit of 11be)

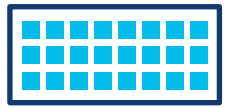
320 MHz in 6 GHz

4K QAM



MLO

Enhanced Security



Compressed Block Ack
(512 MPDUs)

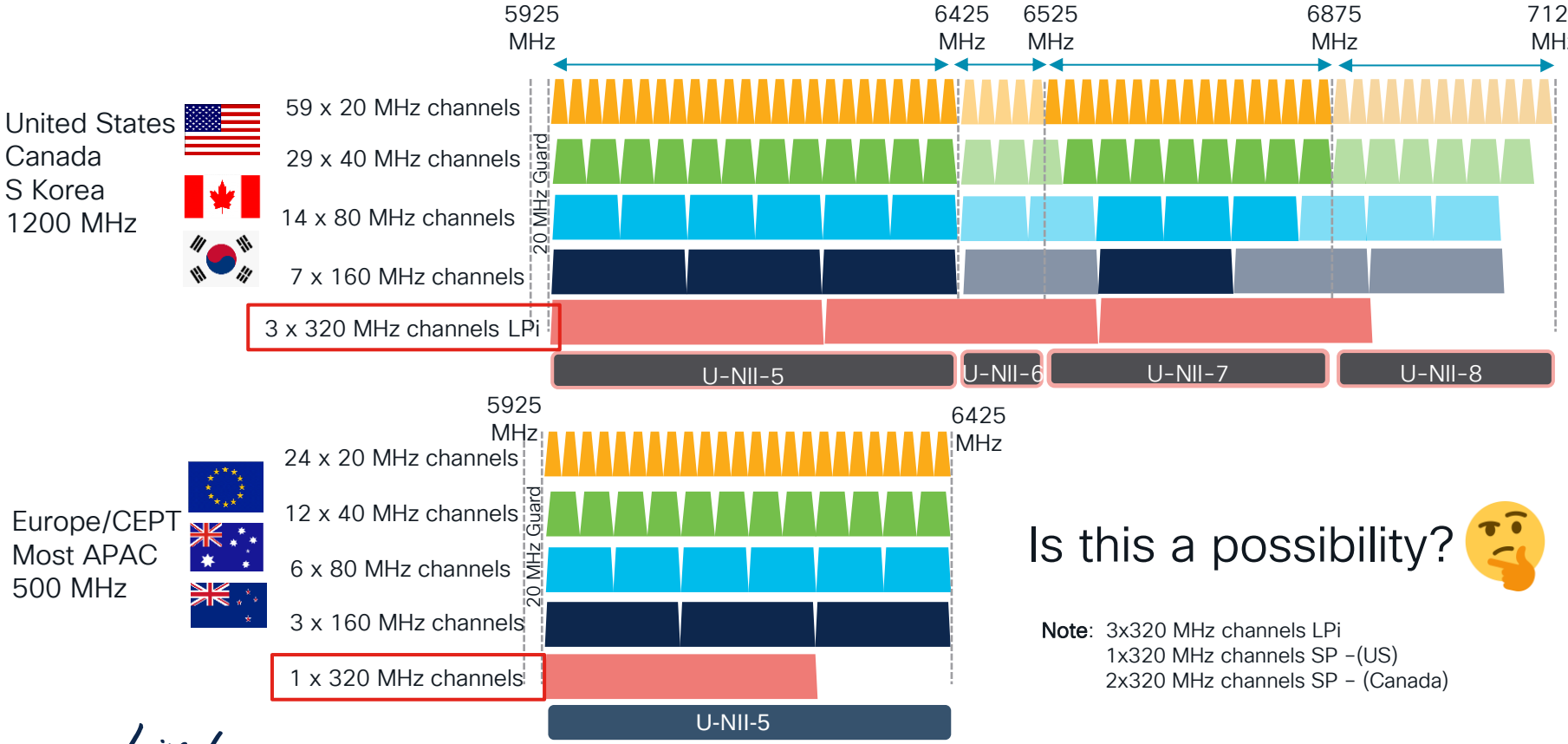
Multi-RU

Preamble puncturing
Mandatory in 6. Optional in 5
Min ch. width of 80

Triggered UL Access Optimisation

EPCS

Wi-Fi 7 – 320 MHz channel width



Is this a possibility? 🤔

Note: 3x320 MHz channels LPi
1x320 MHz channels SP –(US)
2x320 MHz channels SP – (Canada)

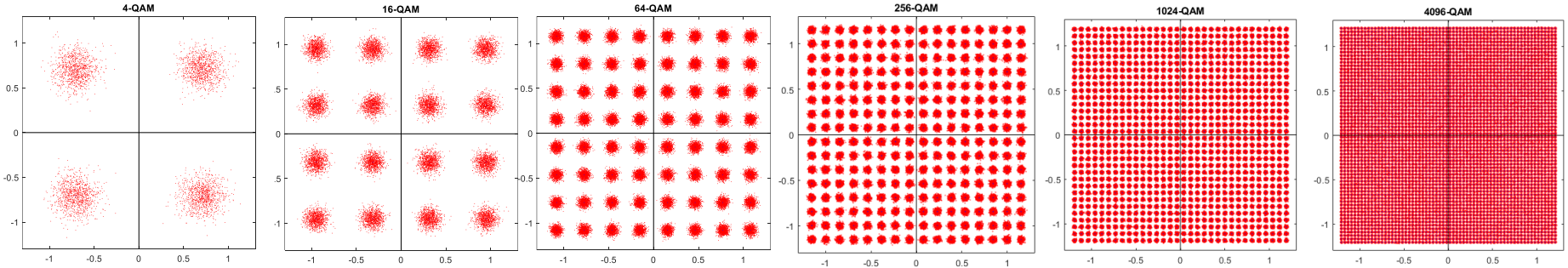
Wi-Fi 7 4K-QAM
(MCS12/13) increases the peak PHY data rate

- MCS 12 and MCS 13 indicate a 4096-QAM constellation with a code rate of ¾ and ⅚ respectively
- Very short range and most suited to a 1 antenna client with a multi-antenna AP (beamforming, MRC)

Need very high SNR for 4K QAM

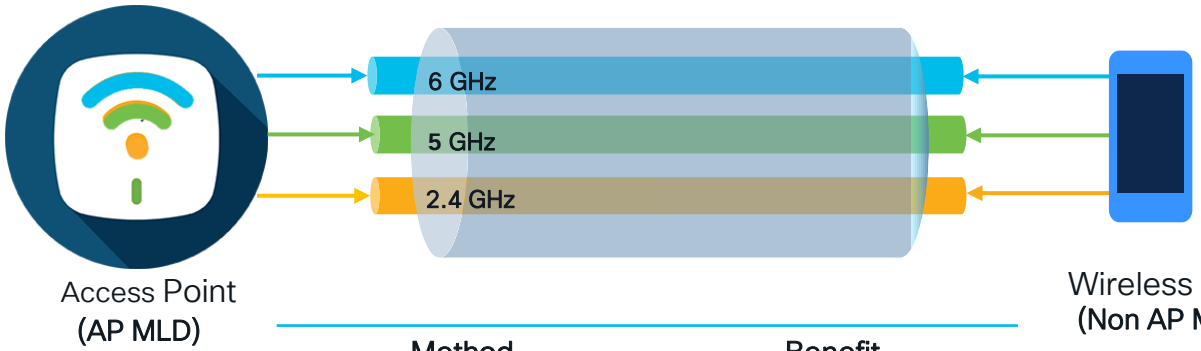
Each increment in constellation size reduces range by approx. 50%

Incremental data rate	+100%	+50%	+33%	+25%	+20%
Relative Range	80	40	20	10	5



Wi-Fi4 Wi-Fi5 Wi-Fi6 Wi-Fi7

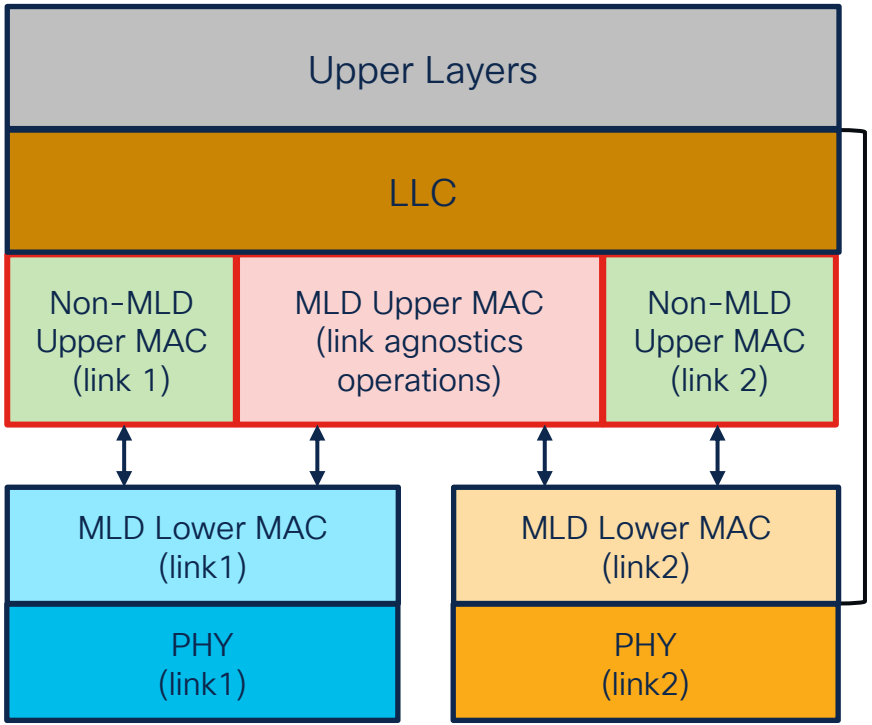
Wi-Fi 7 – multilink (MLO)



Method	Benefit
Aggregation	Throughput
Steering	Lower Latency
Redundancy	Reliability

MLD: Multi Link Device

Wi-Fi 7 MLD MAC layers



MLD upper MAC layer functions :

- Auth, (Re)association
- Security association
- SN assignment for unicast & groupcast frames
- Encryption/Decryption of unicast frames
- Power save buffering of unicast frames
- MLD level management frames
- Unified Block Ack scoreboard
- Packet re-ordering, replay detection
- Selection of MLD lower MAC for Tx

Non-MLD upper MAC layer functions:

- Non-MLO peer operation (above MLD lower MAC)
- Link specific group keys
- Link specific encryption/decryption of groupcast
- Power save buffering of groupcast frames

MLD lower MAC layer functions:

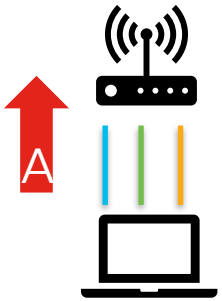
- Link specific mgmt. frames (beacons)
- Control Frames (RTS, CTS, Ack,...)
- Power save state and mode
- Per-link Block Ack scoreboard

The many “modes” of MLO

…because clients have different hardware capabilities

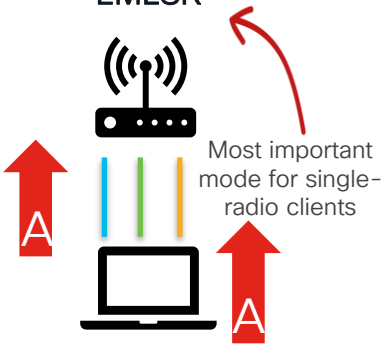
Single Radio

MLSR



Only one link operational at a given time

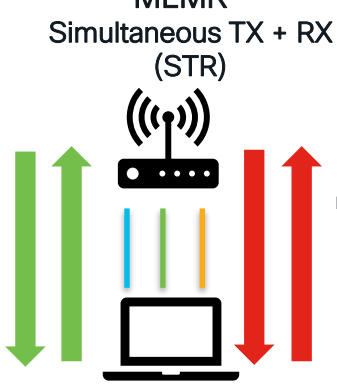
EMLSR



MLSR plus additional capability to listen to two links.

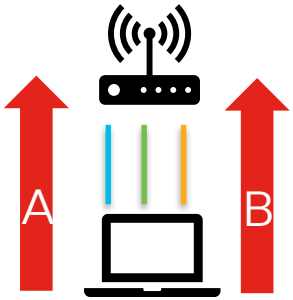
Multi Radio

MLMR Simultaneous TX + RX (STR)



Each link operating independently for Tx and Rx

MLMR Non-Simultaneous Tx+Rx (nSTR)



Tx or Rx at the same time on different links

(Not included in Wi-Fi 7 Certification)

Acronyms:
MLMR – Multi-link Multi Radio
MLSR – Multi-link Single Radio
EMLSR – Enhanced Multi-link Single Radio

Wi-Fi 7 MLO modes

MLO Modes	Number of Radios	Characteristics
Multi-Link Single Radio (MLSR)	1	Tx/Rx over one link at a time
Enhanced Multi-Link Single Radio (EMLSR)	1	MLSR with additional capability to listen on multiple links simultaneously in low capability mode
Simultaneous Tx and Rx (STR)*	>= 2	Simultaneous Tx/Tx, Rx/Rx or Tx/Rx on a pair of STR links independent of each other
Non-Simultaneous Tx and Rx (NSTR)*	>= 2	Simultaneous Tx/Tx or Rx/Rx over a pair of links with careful alignment of PPDUs end time
Enhanced Multi Link Multi Radio (EMLMR)*	>= 2	MLMR (STR) with additional capability to dynamically reconfigure spatial multiplexing support on each link

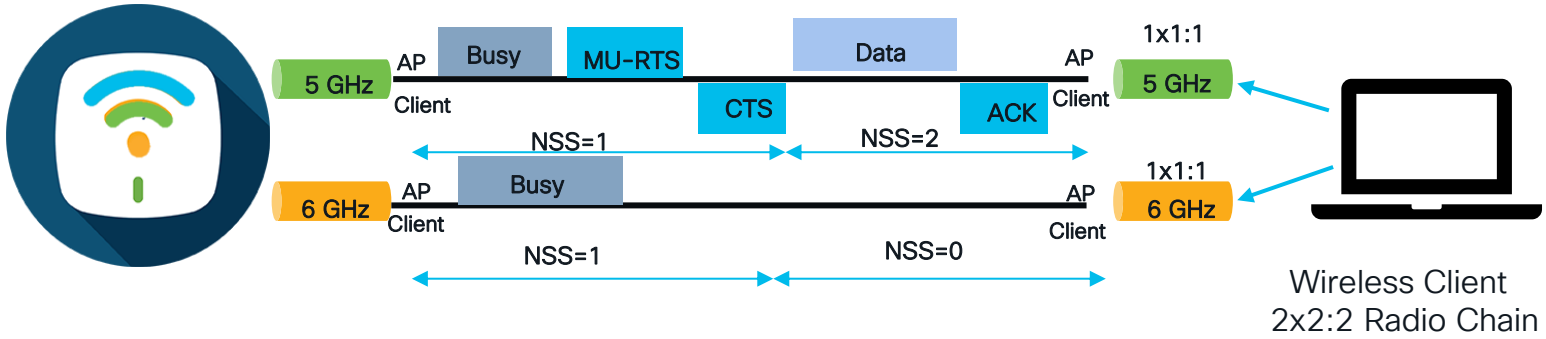
Requirement:

- MLSR is supported by all MLO devices.
- An AP MLD is required to support both EMLSR and STR .

* The last three modes are MLMR (Multi-Link Multi-Radio) operation modes. Only STR is part of Wi-Fi 7 R1. NSTR and EMLMR modes have significant implementation complexity and are not adopted in Wi-Fi 7.

Wi-Fi 7 – EMLSR operation

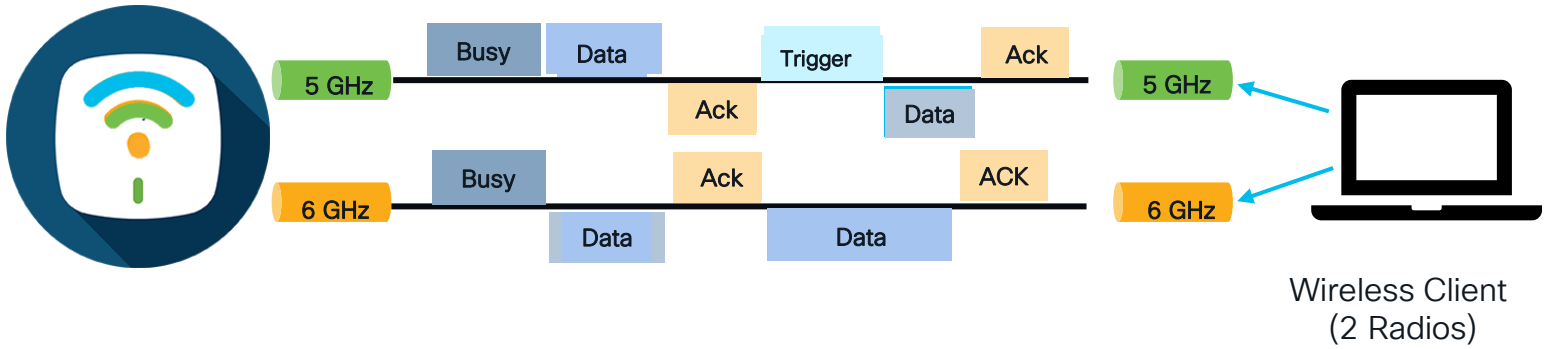
Downlink transmission from AP to EMLSR wireless client



- Single radio wireless clients with 2x2:2 radio listens to two channels
  Example: 1x1:1 on 5 GHz and 1x1:1 on 6 GHz
- Switches to 2x2:2 during active data transmission on the channel with TXOP
- After TxOP, goes back to listening mode with 1x1:1 on each channel.

Wi-Fi 7 – MLMR – STR operation

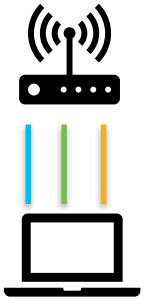
Downlink transmission from AP to MLMR-STR wireless client



- Each link can transmit or receive independently
- Maximum throughput and performance

On multilink operation (MLO)

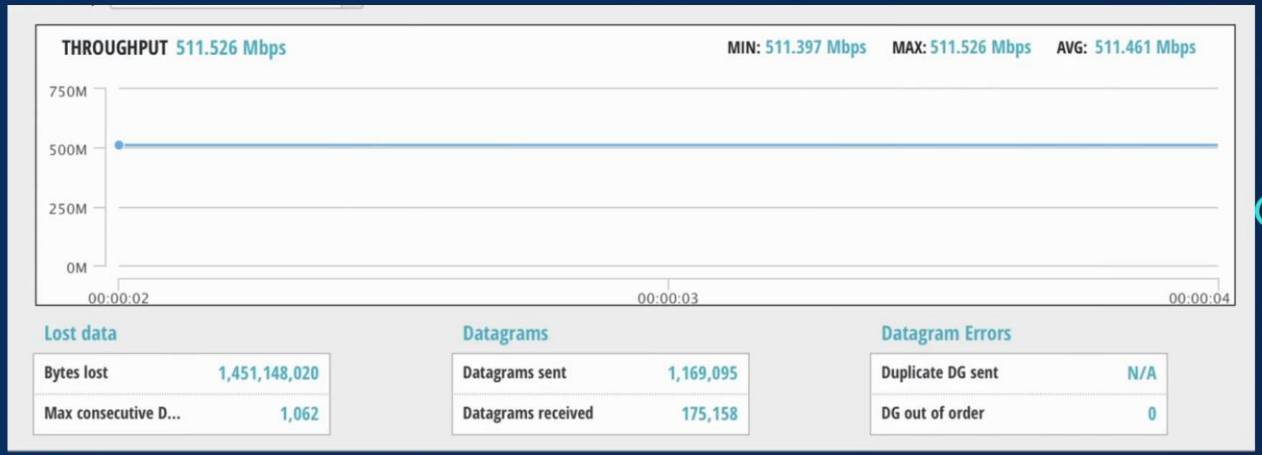
- Client (STA) connected on multiple bands to the **same** AP, **not** to multiple APs (that is Wi-Fi 8)
- MLO is most likely going to be 2 band on clients – not 3 band
- Single radio client – EMLSR on two links.
- Band-isolation on clients between 5 and 6 determines MLO capabilities; so some clients might “only” do 2.4 + 5, or 2.4 + 6 in MLMR-STR
- Devil is in the detail: single radio (SR) vs multi radio (MR). STR vs EMLSR
- Same AKM across all links in an MLO Group (!).



MLO

Downlink Throughput Test

MLO: 5+6GHz/40MHz
Average Throughput: 980Mbps



SLO: 5GHz/40MHz
Average Throughput: 510Mbps

Wi-Fi 7 preamble puncturing

Without preamble puncturing:

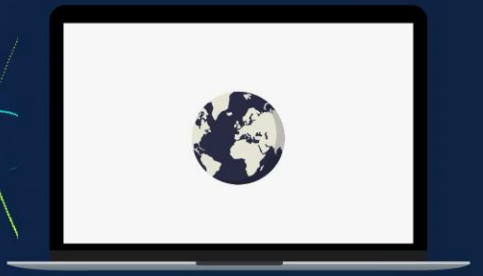
With preamble puncturing:

Puncturing allowed for
80 MHz channel width or wider

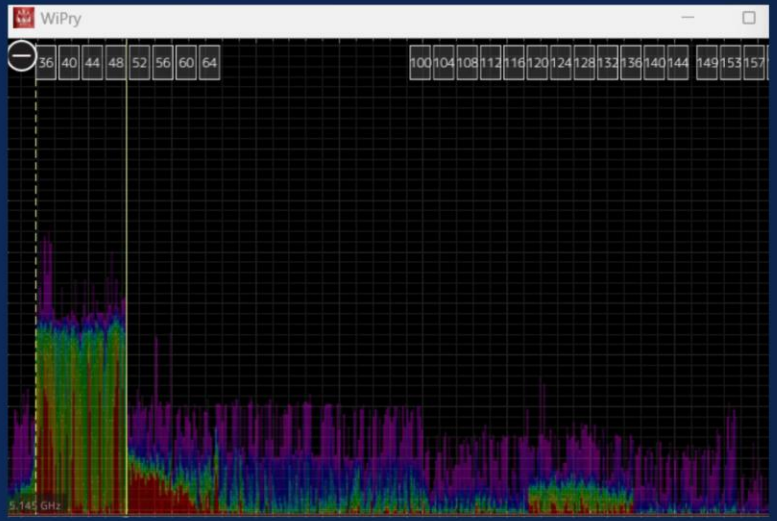
Channel Width	Allowed Puncturing
80 MHz	20 MHz
160 MHz	20 or 40 MHz
320 MHz	40 or 80 MHz (or) 40 + 80 MHz

Preamble Puncturing

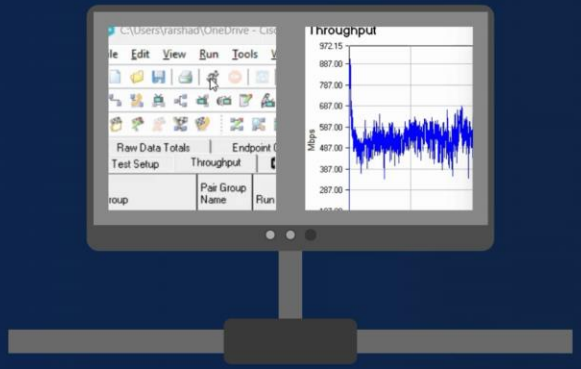
WiFi-7 AP



WiFi-7 Client



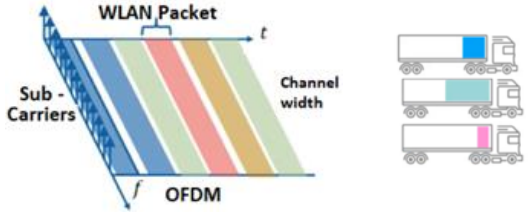
Spectrum Analyzer



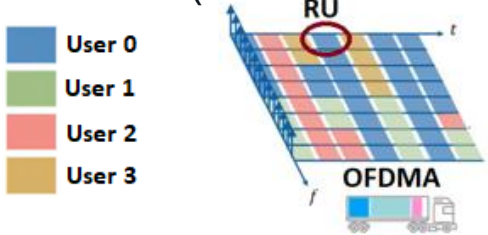
IxChariot

Wi-Fi 7 multiple resource unit (MRU)

OFDM (before Wi-Fi 6)



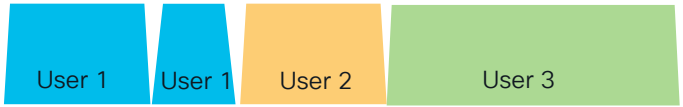
OFDMA (Wi-Fi 6 and later)



Wi-Fi 6

One user can have only one RU

Wi-Fi 7



One user can have multiple RUs

Resource unit (RU) is a unit to denote a group of subcarriers (tones) in OFDMA

Multiple RUs make efficient use of spectrum

16 spatial streams

- Won’t be supported in Wi-Fi 7
- Will stay at max 8 spatial streams
- Public docs refer to 16 spatial streams

Wi-Fi 7 Security

Wi-Fi 7 brings new AKM support for WPA3-SAE and new increased ciphers for OWE & SAE, WPA3 /OWE mandatory for EHT (11be MCS rates) & MLO

Cipher: GCMP 256 – Better Encryption & Speed; AKM: Better security

Legacy	Wi-Fi 6	Wi-Fi 6E (6 GHz)	Wi-Fi 7
Open	Open (OWE support required)	OWE (AKM: 18) (Cipher: CCMP 128)	OWE (AKM: 18) (Cipher: CCMP 128 or GCMP 256)
WPA1/WPA2/WPA3 Transition WPA3-Personal, PMF Optional	WPA2/WPA3 Transition/ WPA3-Personal, PMF Optional (WPA 2 - AKM – 2, 4 & 6) (WPA 3 – AKM – 8 & 9) (Cipher: CCMP 128 or AES)	WPA3-Personal, PMF Mandatory (AKM: 8 & 9) (Cipher: CCMP 128 or AES)	WPA3-Personal, PMF Mandatory (AKM: 24 & 25) (Cipher: CCMP128 or GCMP 256)
WPA1/WPA2/WPA3 Transition/ WPA3-dot1x (Enterprise), PMF Optional	WPA2/WPA3 Transition/ WPA3-dot1x (Enterprise), PMF Optional (AKM 1, 3 & 5, 11 & 12) (Cipher: AES, CCMP 128, GCMP128 GCMP256)	WPA3 Enterprise, PMF Mandatory (AKM: 3, 5, 11 & 12) (Cipher: CCMP128, GCMP 128 & GCMP 256)	WPA3 Enterprise, PMF Mandatory (AKM: 3, 5, 11 & 12) (Cipher: CCMP128, GCMP 128, GCMP 256)

Clients connecting to lower security, can connect to 2.4 & 5 GHz bands of Wi-Fi 7 AP, but restricted to 11ax or earlier. No 11be rates & MLO

Note: All devices since 2019 are required to support WPA3, regardless of generation

Wi-Fi 7 Certified Client List

As of October, 2024

Brand	Product	Model Number	Category
Samsung Electronics	SM-D629N	SM-D629N	Phones
Intel	Intel® Wi-Fi 7 BE200	BE200	Computers & Accessories
Fujitsu Client Computing Limited	M.2 Module /FCZSW11H85139-11be	FCZSW11H85139-11be	Computers & Accessories
Samsung Electronics	SM-D6300	SM-D6300	Phones
Samsung Electronics	SM-D629N	SM-D629N	Phones
Intel	Intel® Wi-Fi 7 BE201	BE201	Computers & Accessories
Microsoft	Surface Pro Tablet (WCN785x)	Surface Pro Tablet (WCN785x)	Tablets, Ereaders & Cameras
Microsoft	Surface Pro Tablet (WCN785x)	Surface Pro Tablet (WCN785x)	Tablets, Ereaders & Cameras
Microsoft	Surface Laptop (WCN785x)	2036,2037	Computers & Accessories
Microsoft	Surface Pro Tablet (WCN785x)	Surface Pro Tablet (WCN785x)	Tablets, Ereaders & Cameras
Intel	Intel® Wi-Fi 7 BE200	BE200	Computers & Accessories
Qualcomm	Qualcomm FastConnect 7800 Wi-Fi 7 Network Adapter	NCM835	Computers & Accessories
Qualcomm	Qualcomm FastConnect 7800 Wi-Fi 7 Network Adapter	NCM825	Computers & Accessories
Qualcomm	Qualcomm FastConnect 7800 Wi-Fi 7 Network Adapter	NCM825A	Computers & Accessories
Qualcomm	Qualcomm FastConnect 7800 Wi-Fi 7 High Band Simultaneous Network Adapter	NCM865A	Computers & Accessories
Intel	Intel® Wi-Fi 7 BE200	BE200	Computers & Accessories
Intel	Intel® Wi-Fi 7 BE200	BE200	Computers & Accessories
Qualcomm	Qualcomm FastConnect 7800 Mobile Connectivity system	WCN7850	Computers & Accessories
Qualcomm	Qualcomm FastConnect 7800 Mobile Connectivity system	NCM865	Computers & Accessories
Nubia Technology Co., Ltd.	5G Multi-Mode Digital Mobile Phone	NX721J	Phones
Samsung Electronics	TV/Monitor/AV	MT7925 Module	Televisions & Set Top Boxes
Realtek Semiconductor Corporation	RTL8922AE 802.11be and Bluetooth combo module	RTL8922	Computers & Accessories
Samsung Electronics	SM-S928U	SM-S928U	Phones
MediaTek Inc.	MediaTek MT6639	MediaTek Dimensity 9200/9300	Phones

- **Windows**:
  - Wi-Fi 7 support in Windows 11 24H2
- **MAC**:
  - No support yet
- **iPhone**:
  - iPhone 16/16 Pro
- **Android**:
  - Support available in Android 13 or greater
- **ChromeBook**:
  - Available 2H, 2024

Client support picking momentum

https://www.wi-fi.org/product-finderresults?sort_by=certified&sort_order=desc&categories=1,2,3,5,6,7&capabilities=1652&certifications=1275

Wi-Fi 7 for enterprise …

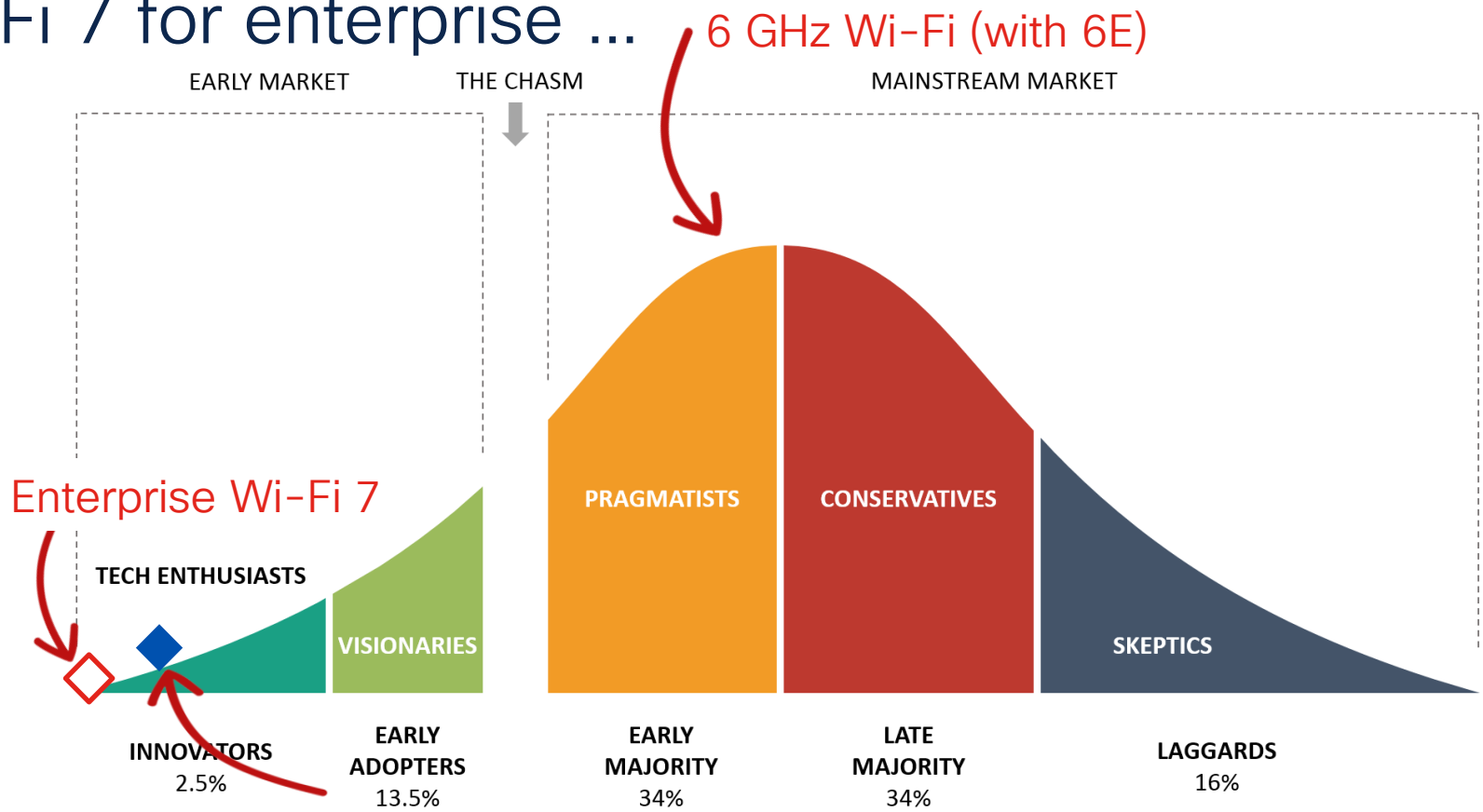
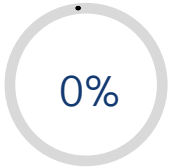


Image credit" https://www.business-to-you.com/crossing-the-chasm-technology-adoption-life-cycle/

Journey towards Unified Product ..



Wi-Fi 6

1 SKU per model

17+ SKUs per model

Wi-Fi 6E

- Day0 Separate SKUs (~10)
- Initial management Mode determined at purchase.
- Post-purchase/Day N option to migrate
- Separate lead time/RMA/license
- Same Warranty

Wi-Fi 7
Global Use AP

- Today! Lets talk about it

One Cisco Wireless Access Point

Global Use AP, Unified Product, Single SKU

Cisco Catalyst Management Mode
C9800 & Catalyst Center Stack

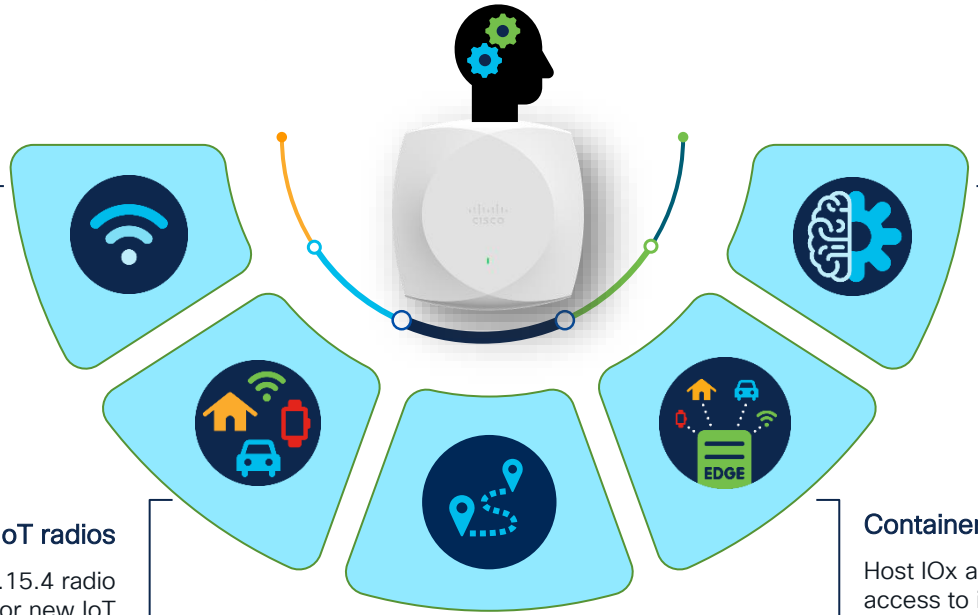
Meraki **Management Mode**
MR Dashboard Stack

Join any stack on Day 0, based on Intent
Management Mode Change from Day 1 to N

Catalyst Wi-Fi 7 series access points

Premium, multilingual AP platform for the future-ready digital enterprise

Unified Product, Single SKU, Global Use AP
Catalyst On-Prem or Meraki Cloud Ready



Unmatched Wi-Fi experience

Tri-band concurrent Flexible Radio Assignment (FRA) for changing needs.

Dedicated AI/ML-powered scanning radio

Smart, resilient infrastructure

Smart power consumption
Flexible feature uses given power budget
Dual 10 Gig uplink ports for resiliency

Multilingual IoT radios

Third-gen IoT 802.15.4 radio
USB with 4.5W for new IoT technology

Container hosting on AP

Host IOx applications at edge with access to integrated IoT radio and USB module

Hybrid Location System with GPS, Wi-Fi & UWB
AP Auto Locate, Indoor Navigation, Asset Tracking & AFC

The Wi-Fi 7 portfolio

CleanAir® Pro

CW9176I

12 Spatial Streams
4x4: 4 MU-MIMO
across 3 radios, 3 bands
(2.4GHz, 5GHz, 6GHz)

BLE/IoT radio

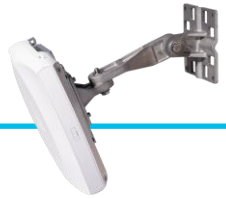
Single 10Gbps multigigabit

Ultra Wide Band (UWB)

USB 2.0 – 9W

Built-in GPS/GNSS, w/ support for ext. antenna

Integrated Omnidirectional Antenna



CleanAir® Pro

CW9176D1

12 Spatial Streams
4x4: 4 MU-MIMO
across 3 radios, 3 bands
(2.4GHz, 5GHz, 6GHz)

BLE/IoT radio

Single 10Gbps multigigabit

Ultra Wide Band (UWB)

USB 2.0 – 9W

Built-in GPS/GNSS, w/ support for ext. antenna

Integrated Directional Antenna
(70x70)

CleanAir® Pro

CW9178I

16 Spatial Streams
4x4: 4 MU-MIMO
across 4 radios, 3 bands
(2.4GHz, dual 5GHz, 6GHz)

BLE/IoT radio

Dual 10Gbps multigigabit

Ultra Wide Band (UWB)

USB 2.0 – 9W

Built-in GPS/GNSS, w/ support for ext. antenna

Integrated Omnidirectional Antenna

Same brackets as always

Already Wi-Fi 7 certified!

Deploying and migrating to Wi-Fi 7
Recommendations, tips, and tricks

Power considerations

Recommendation:
802.3bt (Cisco UPOE)
is the suggested
power input for full operation of

802.3at (PoE+) and 802.3af (PoE) are also supported by the CW9178I/CW9176I&D

Security requirements

Mandatory:
WPA3 is mandatory for 11be rates and MLO.

WPA3 was not required for prior Wi-Fi generations; hence, it must be top of mind.

Multigigabit switching

Recommendation:

Use a Multigigabit switch with 10G Capability.

Better user experiences with speeds beyond 1 Gbps. Cat 6/6A cabling recommended,

Wireless coverage

Recommendation:
Ensure uniform cell size for 5 and 6 GHz cells. 2.4 & 5 GHz does not need a new site survey

Review the current RF coverage of 5 GHz network to achieve similar coverage for 6 GHz network.

7 Key takeaways:

1. Wi-Fi in 6 GHz is the paradigm shift.
2. Cisco has a full portfolio of products to help customers realize 6 GHz Wi-Fi today.
3. Wi-Fi 7 adoption in enterprise is just beginning.
4. Client availability and stability needs to be considered.
5. Short to mid-term, Wi-Fi 7 brings only slight benefits in the enterprise vs 6E.
6. Plan for security upgrade. Client interop will be key!
7. Plan for more than 30W per port, and plan for more than 1 Gbps per port.

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Wednesday
10:30am –11:30am

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Smart, Secure, Seamless: Transforming Experiences with Next-Generation Networking

Level 2
Room 204

Harness a Bold New Era: Transform Data Centre and Service Provider Connectivity

Level 2
Room 203

Securing User to Application and Everything in Between

Level 2
Melbourne Room 2

Unlocking Digital Resilience through Unified Observability

The HUB
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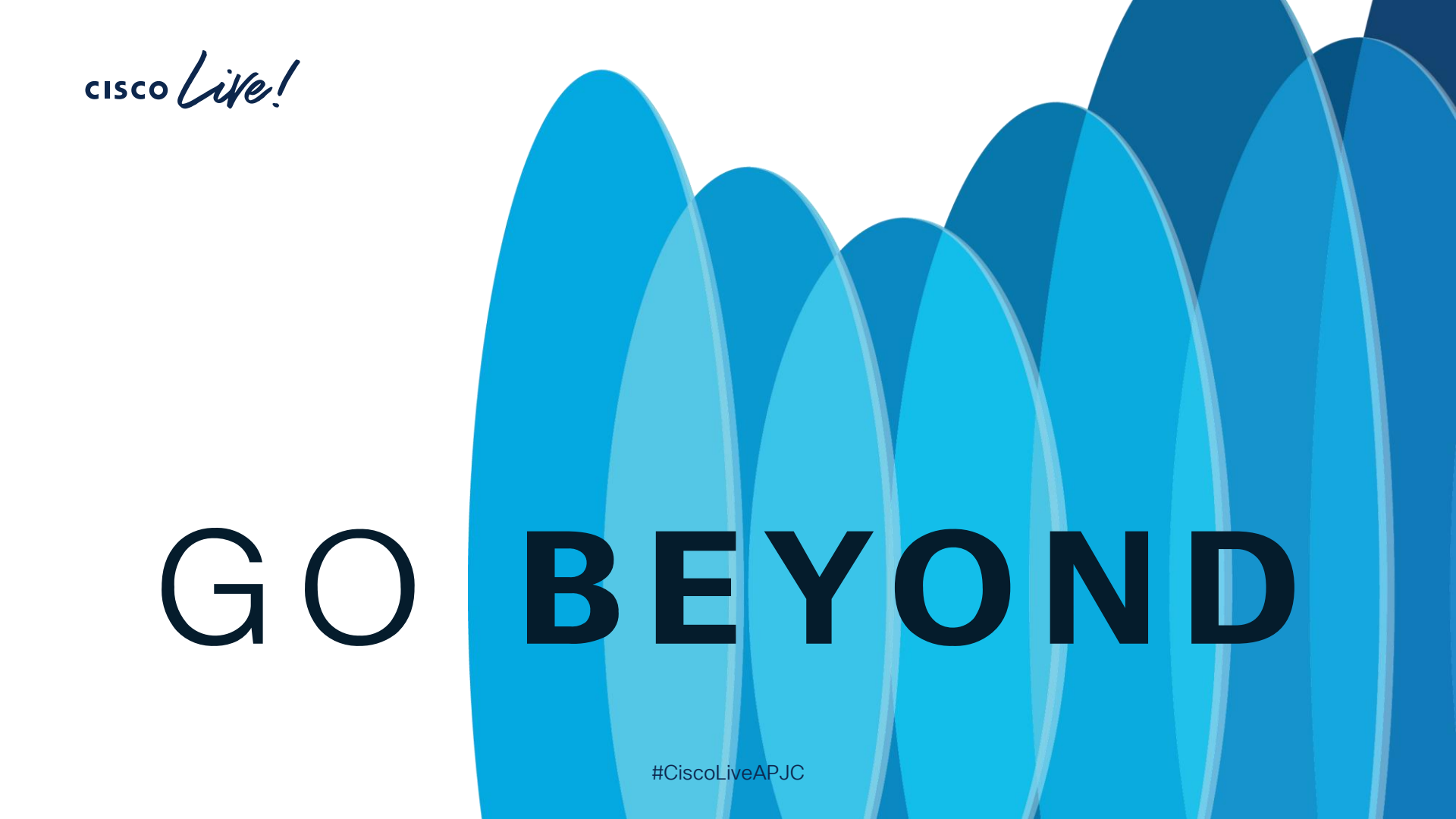
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