

High Density Wi-Fi Design, Deployment, and Optimization

cisco Live !

Matt Swartz
Cisco Wireless,
Distinguished Engineer, CCIE #13232

Josh Suhr
Cisco Customer Experience,
Principal Architect, CCIE #39980

Cisco Webex App

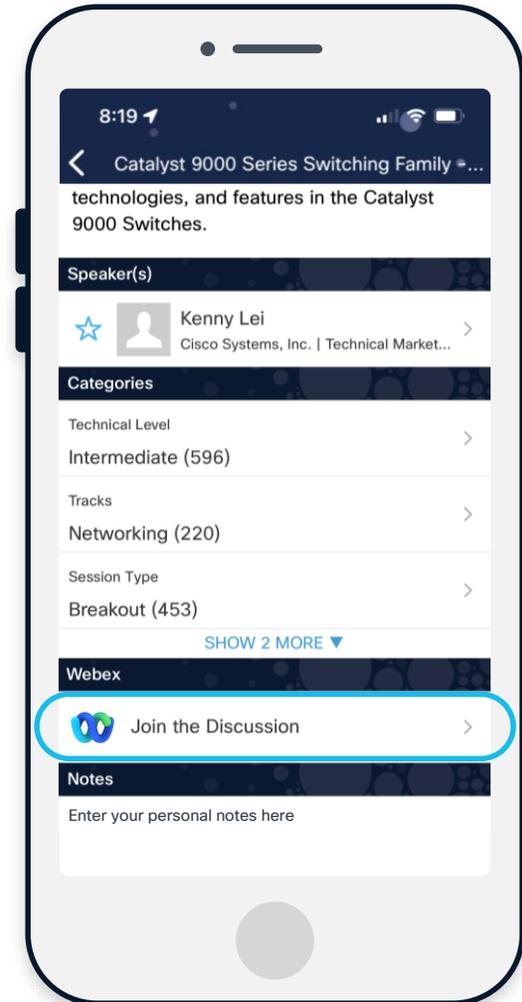
Questions?

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 13, 2025.



Agenda

- 01 HD RF Design Fundamentals
- 02 AP/Antenna Selection
- 03 All About CW9179F
- 04 AP/Antenna Placement
- 05 6GHz HD Considerations
- 06 Maximizing the Spectrum
- 07 HD Config Fundamentals
- 08 Common Mistakes
- 09 Our Favorite Tools



Matt Swartz

Distinguished Engineer, Cisco Wireless
CCIE #13232 (R/S, Wireless)

First HD WiFi Project: New York Yankees, 2008

Husband, dad, mountain biker, likes food 😊





Josh Suhr

Principal Architect, Cisco Customer Experience (CX)
CCIE #39980 (Wireless)

First HD WiFi Project: Sporting Kansas City, 2011

Long-time husband & recent dad; BBQ lover



Key Trends in High Density Wi-Fi

High Density is everywhere!

CW9179F: Software-defined antenna + Integrated AP

6 GHz / WiFi 6E & WiFi 7

Auto authentication & OpenRoaming



Designing RF for High Density

The Fundamentals

Designing for the 3 Key RF Relationships

Designing for the 3 Key RF Relationships

1 AP to Client: How does the client device “hear” the AP?

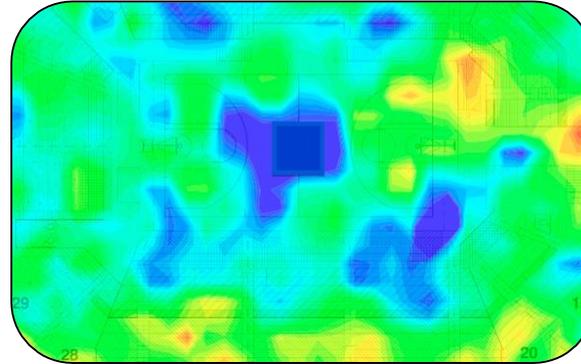


Designing for the 3 Key RF Relationships

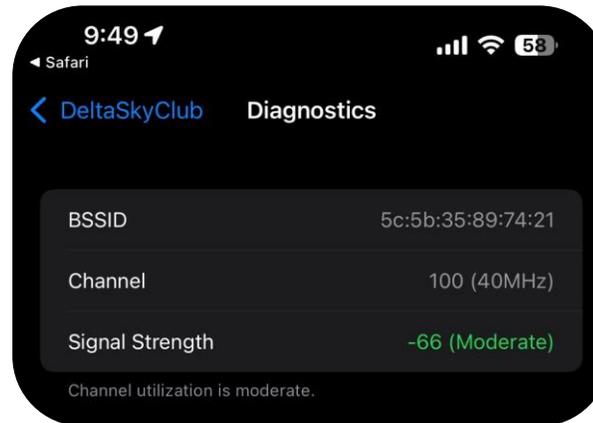
1 AP to Client: How does the client device “hear” the AP?



Verify with:



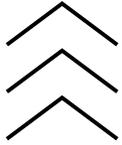
Site Survey



Real Clients

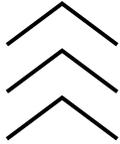
Designing for the 3 Key RF Relationships

2 Client to AP: How does the AP “hear” the client device?



Designing for the 3 Key RF Relationships

2 Client to AP: How does the AP “hear” the client device?



Verify with:

Device Type	iPhone 12
Device OS	iOS 15.4.1
Client Performance	Signal Strength: -66 dBm Signal Quality: 30 dB Ch BW(Negotiated/Capable): 20 MHz/80 MHz
Capabilities	802.11ax - 2.4 GHz
Fabric Status	Disabled

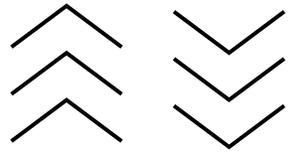
*WLC UI or
CLI*

CLIENTS			
Joshua-Ds-iPhone 			
Overview	Connections	Performance	Timeline
Status	📶 associated since May 3 07:55		
SSID	5g		
Access point	Josh's Office AP topology		
Splash	N/A		
Signal	<div style="width: 100%; height: 10px; background-color: #28a745;"></div> 50dB (channel 48, 5 GHz)		
Device type	iPhone 13 Pro iOS16.4.1 		

*Cloud
Dashboard*

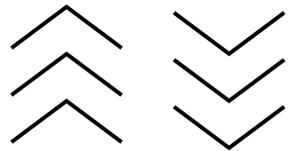
Designing for the 3 Key RF Relationships

3 AP to AP: How do AP's "hear" each other? (especially co-channel)



Designing for the 3 Key RF Relationships

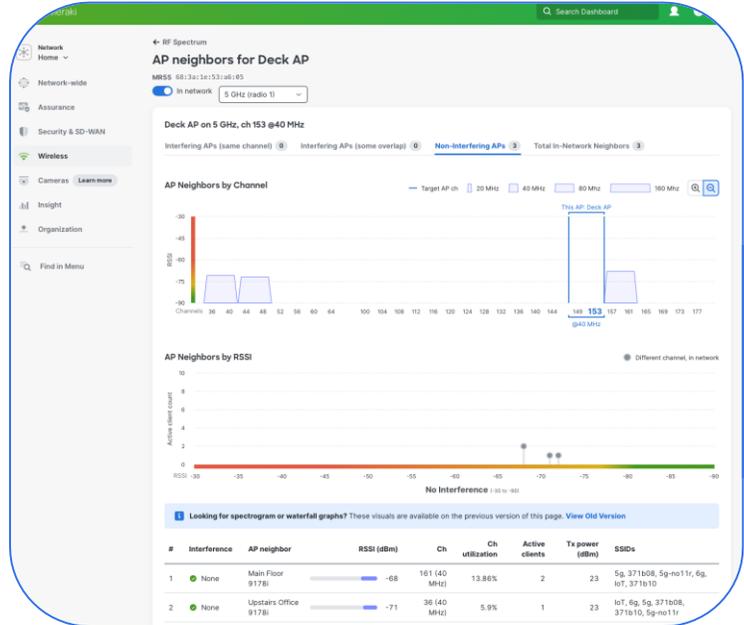
3 AP to AP: How do AP's "hear" each other? (especially co-channel)



Verify with:

Name	Slot	Channel	Power Level	Power dBm	Neigh. Name	Neigh. Slot	Neigh. Channel	Neigh. Power	Compensated Power
AP12	1	112	6	4	AP1	1	52	-42	-57
AP12	1	112	6	4	AP2	1	144	-51	-66
AP12	1	112	6	4	AP3	1	120	-53	-65
AP12	1	112	6	4	AP4	1	100	-53	-65
AP12	1	112	6	4	AP5	1	124	-57	-66
AP12	1	112	6	4	AP6	1	60	-61	-73
AP12	1	112	6	4	AP7	1	136	-62	-74
AP12	1	112	6	4	AP8	1	44	-69	-69
AP12	1	112	6	4	AP9	1	104	-79	-85
AP12	1	112	6	4	AP10	1	60	-80	-89
AP12	1	112	6	4	AP11	1	153	-81	-84

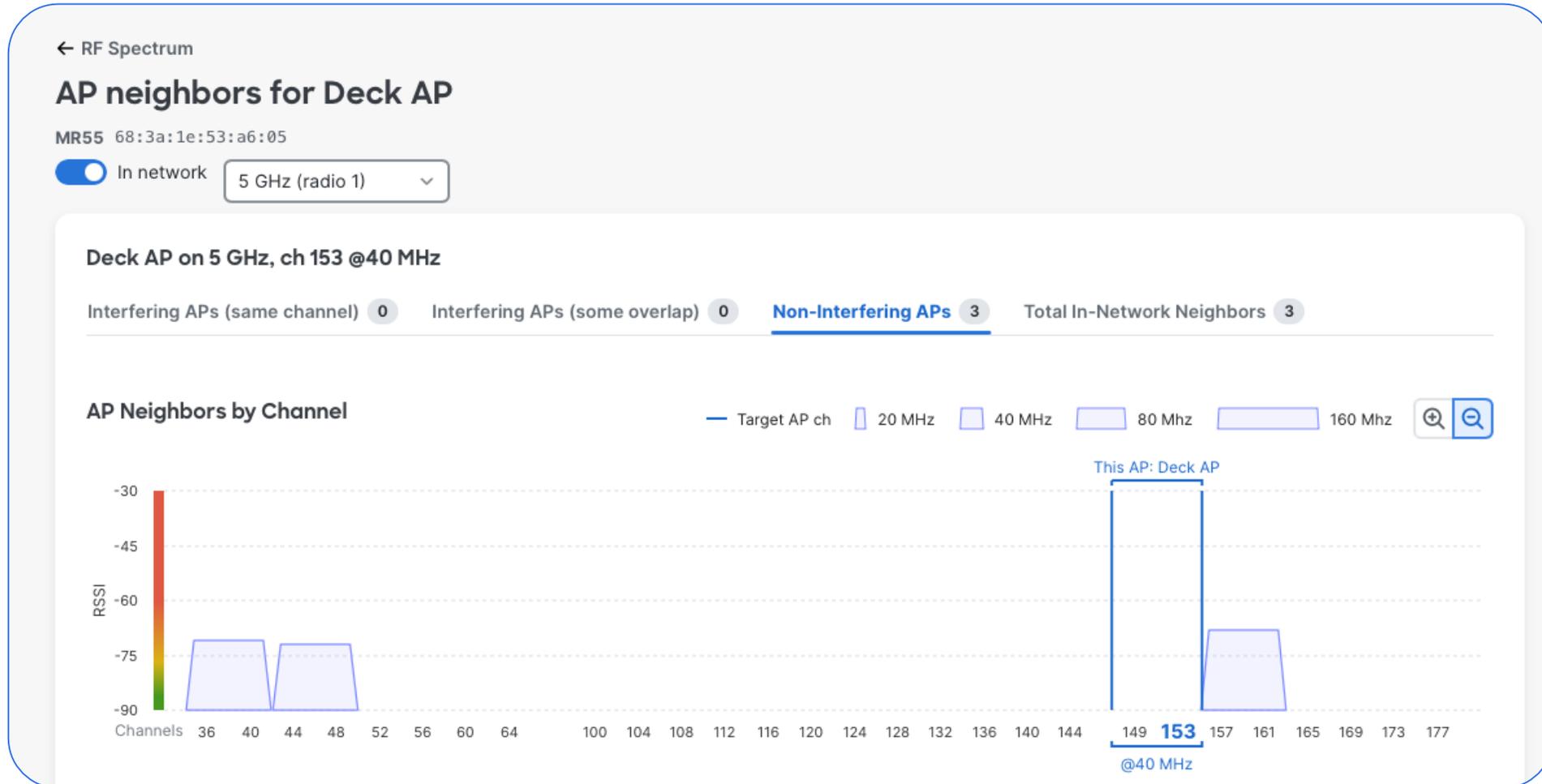
WCAE



Cloud Dashboard

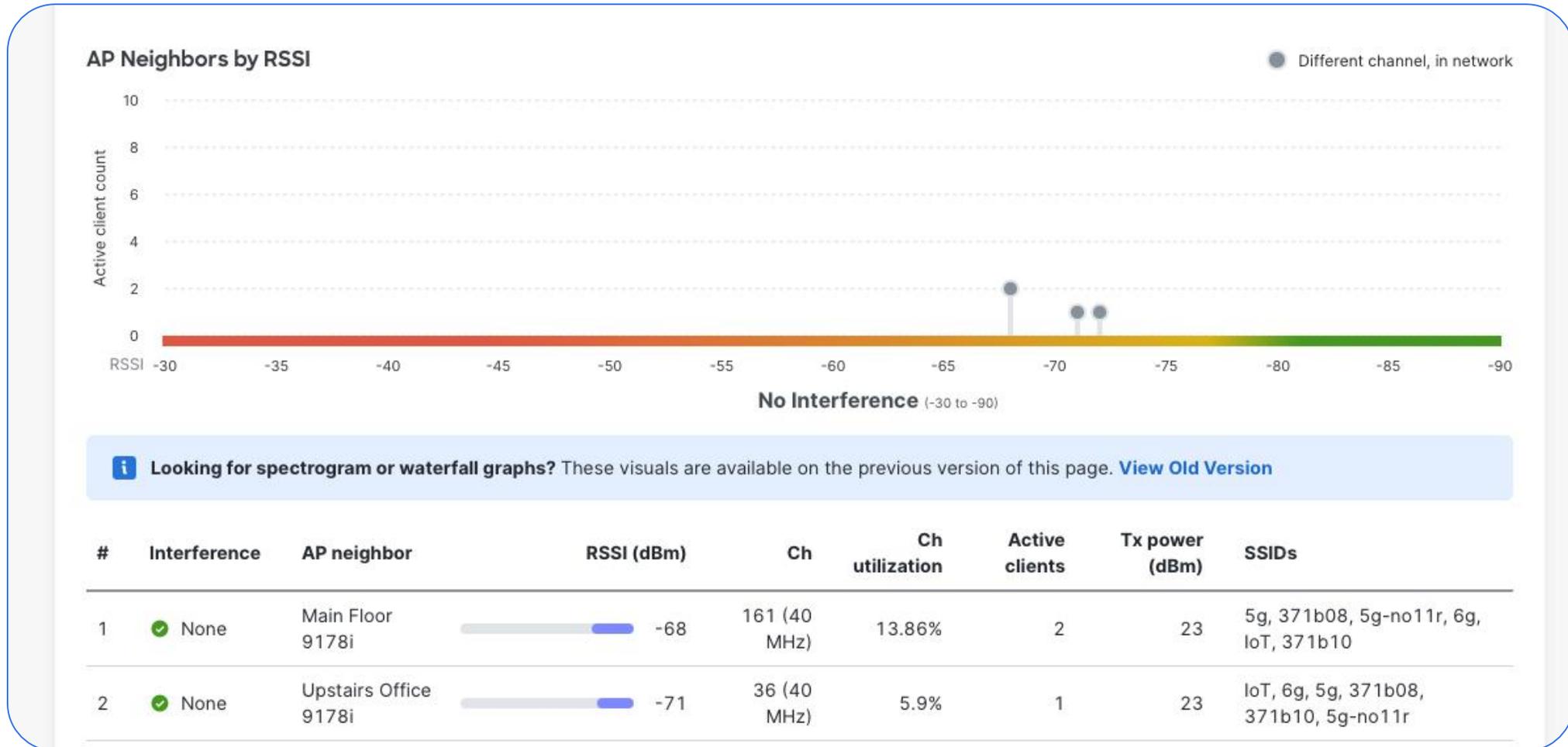
Designing for the 3 Key RF Relationships

A Closer Look: AP → AP Relationships



Designing for the 3 Key RF Relationships

A Closer Look: AP → AP Relationships



How Clients Hear AP's - C9800 UI

The screenshot displays the Cisco Catalyst 9800-40 Wireless Controller interface. The main view is the 'Client' page for a specific client (360 View). The 'Client Scan Reports' section is highlighted with a blue box and shows a table of scan results. The table includes columns for BSSID, Time, Channel, RSSI (dBm), and SNR (dB). The scan results show that the client has heard multiple APs within range, with varying signal strengths and SNR values.

Client Scan Reports
Last Report : 04/21/2022 08:42:53

BSSID	Time	Channel	RSSI (dBm)	SNR (dB)
3c41.0e5f.854c	04/21/2022 08:31:32	128	-80	15
3c41.0e5f.d4cc	04/21/2022 08:31:13	100	-80	15
6c41.0e45.988c	04/21/2022 08:31:13	56	-83	12
3c41.0e5f.6d2c	04/21/2022 08:31:32	157	-83	13
3c41.0e5f.7da3	04/21/2022 08:31:32	36	-86	10

Client Scan Report shows how this client hears all AP's within range

How AP's Hear Clients – C9800 UI

The screenshot displays the Cisco Catalyst 9800-40 Wireless Controller interface. The main navigation menu on the left includes Dashboard, Monitoring, Configuration, Administration, Licensing, and Troubleshooting. The current view is 'Monitoring > Wireless > Clients'. The 'Clients' tab is active, showing a list of clients with columns for Client MAC Address, IPv4 Address, and IPv6 Address. A search filter is set to 'Device Type *Contains* iPhone'. The '360 View' for a selected client is shown, including a 'General' section with fields for User Name, MAC Address, Uptime, WLAN Name, AP Name, Device Type, and Device OS. A 'Client Performance' section is highlighted with a red box, showing Signal Strength: -66 dBm, Signal Quality: 30 dB, and Ch BW(Negotiated/Capable): 20 MHz/80 MHz. To the right, a 'Top Applications' pie chart shows iTunes at 62.0% and Google Services at 33.0%. Below this, a 'Client Scan Reports' table shows the last report at 04/21/2022 08:42:53, with columns for BSSID, Time, Channel, RSSI (dBm), and SNR (dB).

BSSID	Time	Channel	RSSI (dBm)	SNR (dB)
3c41.0e5f.854c	04/21/2022 08:31:32	128	-80	15
3c41.0e5f.d4cc	04/21/2022 08:31:13	100	-80	15
6c41.0e45.988c	04/21/2022 08:31:13	56	-83	12
3c41.0e5f.6d2c	04/21/2022 08:31:32	157	-83	13
3c41.0e5f.7da3	04/21/2022 08:31:32	36	-86	10

Client Performance readings show how the currently associated AP hears this client

How AP's Hear Clients: Catalyst AP

For a table of **all** clients on an AP, at AP CLI:

Telnet/SSH to AP and use “show dot11 clients” for immediate client RSSI readings of ALL clients associated to the specified radio

```
ap#show dot11 clients
AP Mode - Local
Client MAC          Slot ID WLAN ID AID      WLAN Name RSSI Maxrate WGB
FC:F8:AE:60:98:34   1      3      1 AbrahamLinksys -47 MCS82SS No
00:24:D7:7E:48:D8   1      3      2 AbrahamLinksys -54 M23 No
78:F8:82:EF:2E:A0   1      3      3 AbrahamLinksys -37 MCS82SS No
84:38:35:42:E1:F0   1      3      4 AbrahamLinksys -71 MCS82SS No
```

How AP's Hear Clients: Catalyst AP

For a detail on a [single client](#), at AP CLI:

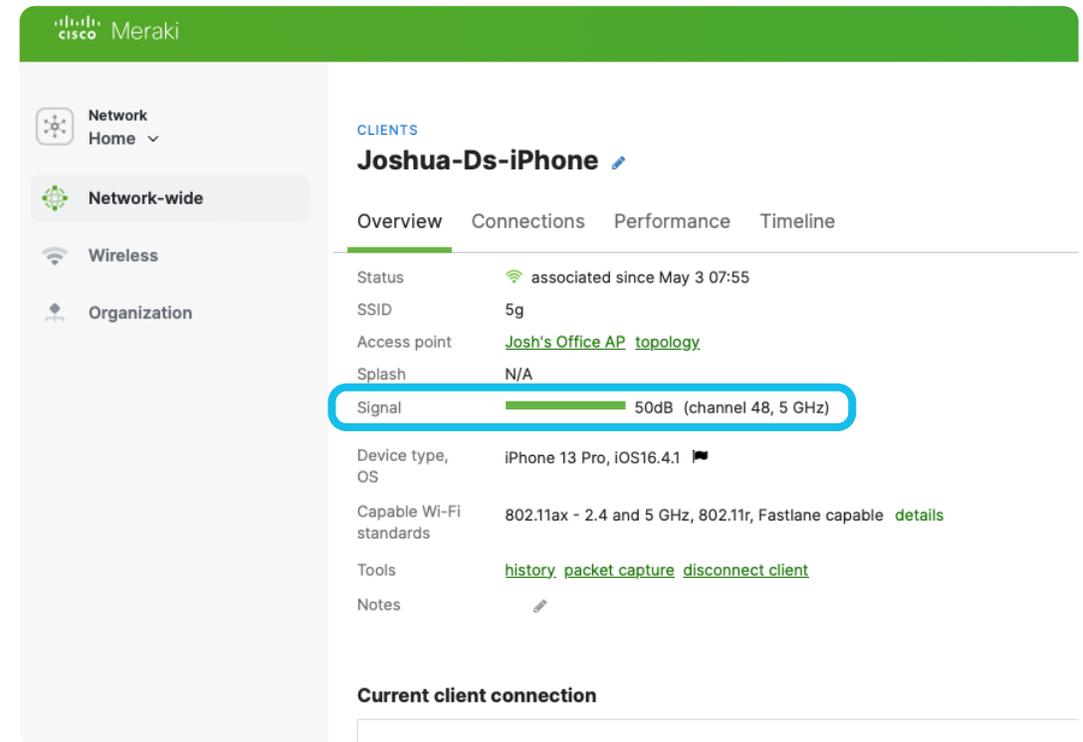
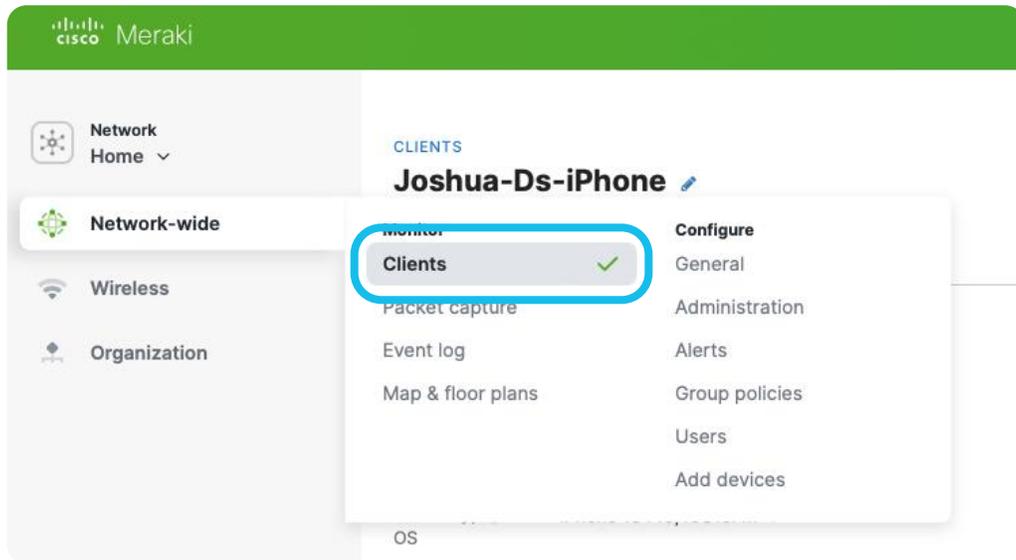
Telnet/SSH to AP and use “show controller d <0|1> client <mac-addr>” for immediate client RSSI readings of a single client

```
10#sho controller d 1 client FC:F8:AE:60:98:34
<clip>
Additional info for client FC:F8:AE:60:98:34
RSSI: -47
<clip>
Statistics for client FC:F8:AE:60:98:34
mac          <clip> stats_ago expiration
FC:F8:AE:60:98:34 <clip> 0.700000 0
```



How long ago were these stats updated (in sec)?

How AP's Hear Clients: Cloud-Managed AP



AP + Antenna Selection

RF Design: AP & Antenna Selection

AP & Antenna Selection:

Decide which antenna is right for the job.

Consider:

- Density of clients to be served
- Available mounting assets
 - Within 65'/20m of furthest client (or 200'/60m with CW9179F)

Antenna Placement:

Where will this antenna provide the best throughput and most reliable service?

Consider:

- Line of sight
- Isolation from ambient RF
- Angle of incidence to client devices

Directional AP/Antenna Selection

	AP/Antenna	Beamwidth	Approx. Distance
	Integrated AP + Directional Antenna CW9166D1 (WiFi 6E) / Indoor <i>Cloud- or On-Prem-managed</i>	2.4: 70° 5GHz: 70° 5GHz XOR : 60° 6GHz: 60°	15'/5m – 30'/10m from AP to clients
	Integrated AP + Directional Antenna CW9176D1 (WiFi 7) / Indoor <i>Cloud- or On-Prem-managed</i>	2.4: 80° 5GHz: 70° 6GHz: 70°	15'/5m – 30'/10m from AP to clients
	Dual-Band “Wide” Patch Antenna AP: 9120AXE/P, 9130AXE Antenna: AIR-ANT2566P4W-R	2.4GHz: 105/70 ° 5GHz: 125/60°	< 30' / 10m from AP to clients
	Integrated AP + Antenna: High Gain CW9179F / Indoor or Outdoor* <i>Cloud- or On-Prem-managed</i>	2.4GHz: 70° 5/6GHz: 70x35 (Wide) 5/6GHz: 35x35 (Narrow)	Primary overhead coverage (i.e. seating areas / conference halls; <u>> 30'/10m, <200'/60m to clients</u>

All About the CW9179F (!)

CISCO WIRELESS

Launching at Cisco Live!!

Industry's first Wi-Fi 7 access point for large venues

Wi-Fi that reaches everywhere

Wi-Fi 7 speed and performance for everyone in the audience and more

Designed for every venue

Indoor/Outdoor, concourse-ready and multi-use all-in-one, integrated access point

Configurable and flexible installation

Comprehensive coverage to get the best value from your install

On-Prem or Cloud-Managed

One PID, flexible management options



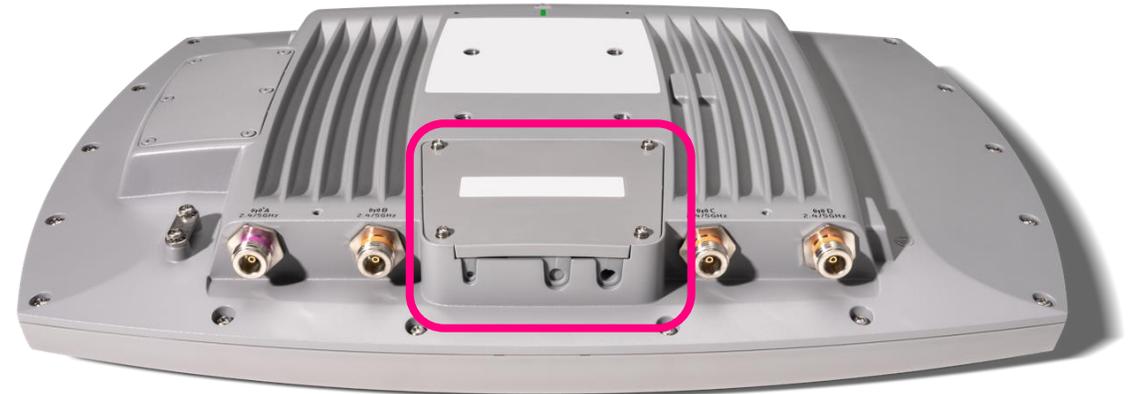
CW9179F

CW9179F – Indoor & Outdoor Usage

Indoor Deployment / LPI Mode



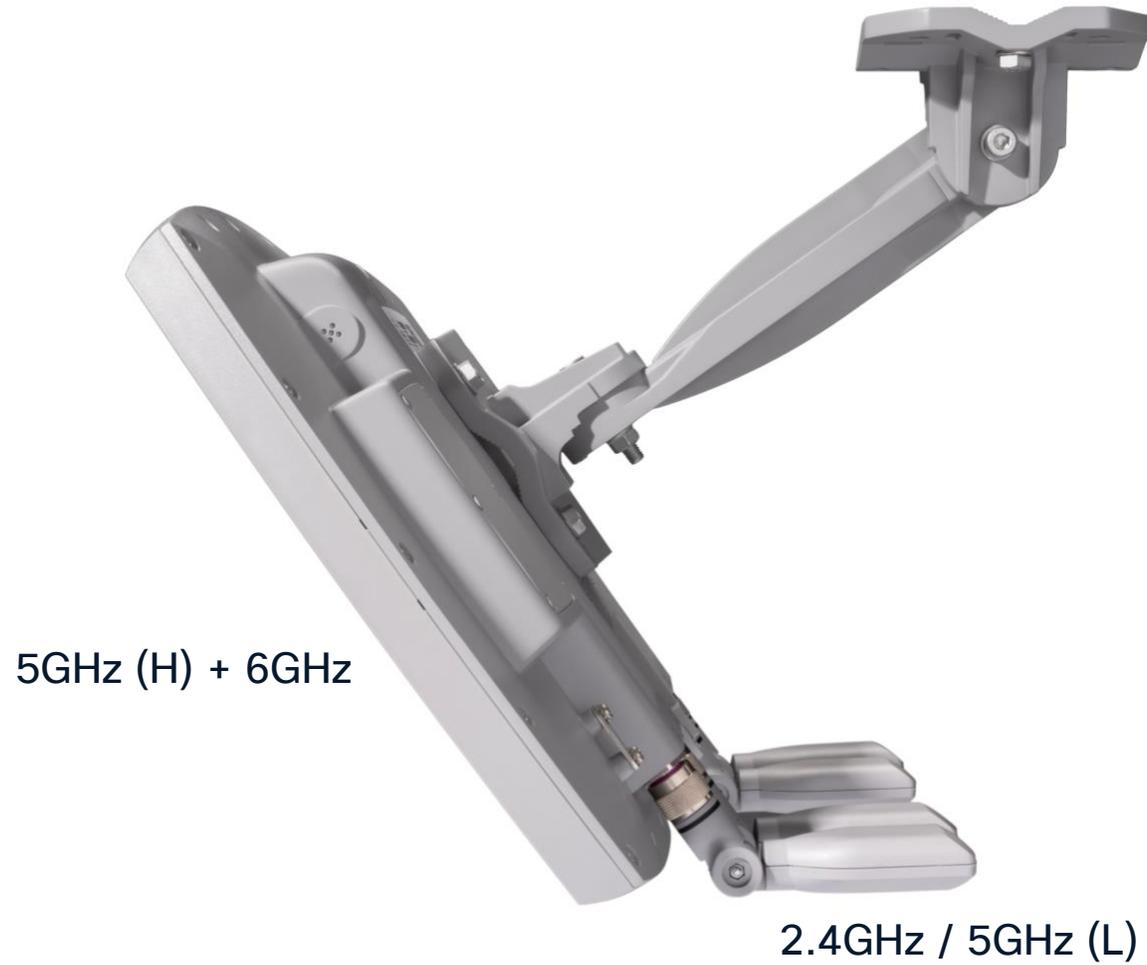
Outdoor Deployment / SP Mode
(with Environment Pack)



Environment Pack: Weatherizes & Signals to AP that it is Standard Power only



CW9179F – Back-Facing Infill (2.4GHz / 5GHz-Low)



CW9179F: Key Things to Know

WiFi 7, “Swiss Army Knife” / Stadium / LPV Indoor/Outdoor AP



Antenna Design Improvements

Cover Clients from Long Distances (up to 200' / 60m line-of-sight)

Integrated Unit, Outdoor-Rated

AP + Antenna all-in-one, no enclosures required, outdoor-rated

Deployment Flexibility

Choose between narrow/wide beams, meet the needs of multiple different coverage types

Indoor or Outdoor

Use the Environment Pack to convert from indoor to outdoor deployment capability

CW9179F: Deployment Checklist



Physical Installation

Indoor (default) vs. Outdoor (requires Environment Pack)
GPS/GNSS signal accessibility (external antenna available)
Front-and-back mode – antenna selection
Portrait & Landscape installation orientations

Channel & Power Planning

Tx power balance between 5GHz slots

Beam Configuration

Plan & configure beam modes per survey data

CW9179F: Balancing 5GHz Power

Key Considerations

- 5GHz slots are band-locked and will vary in Tx power
- Not quite as big of a concern in Wide mode with -15 / +15 degrees of separation for the 5GHz cells
- In Boresight (Narrow) mode – this means overlapping 5GHz cells that may have different Tx Power values (in dBm)
- The “hotter” slot will take more clients

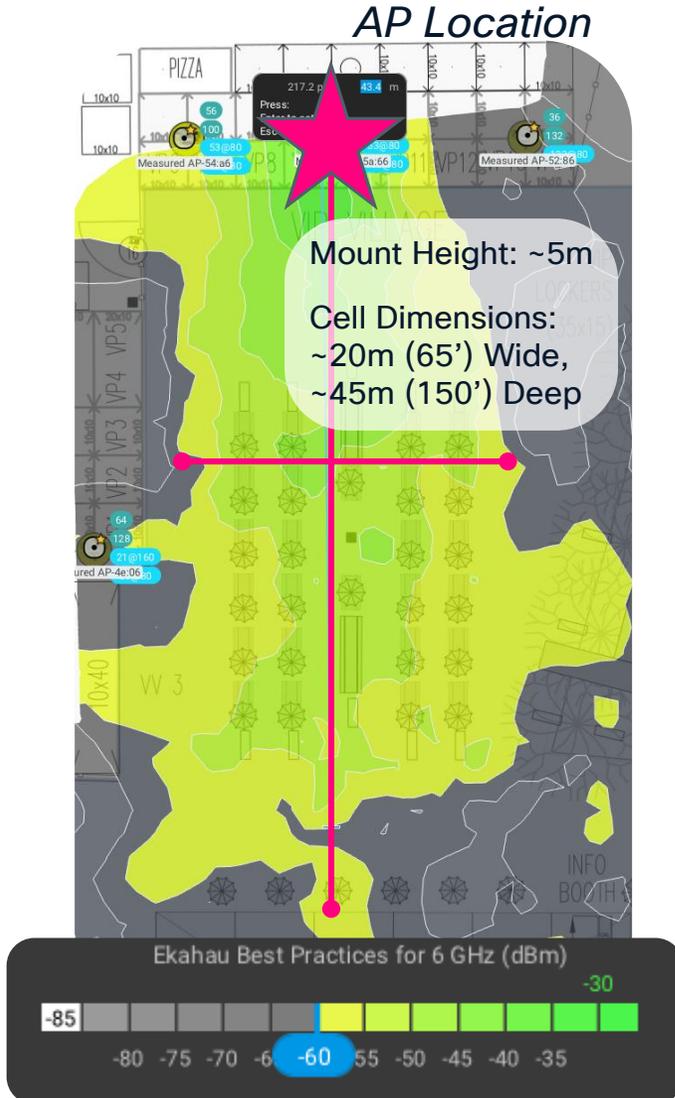
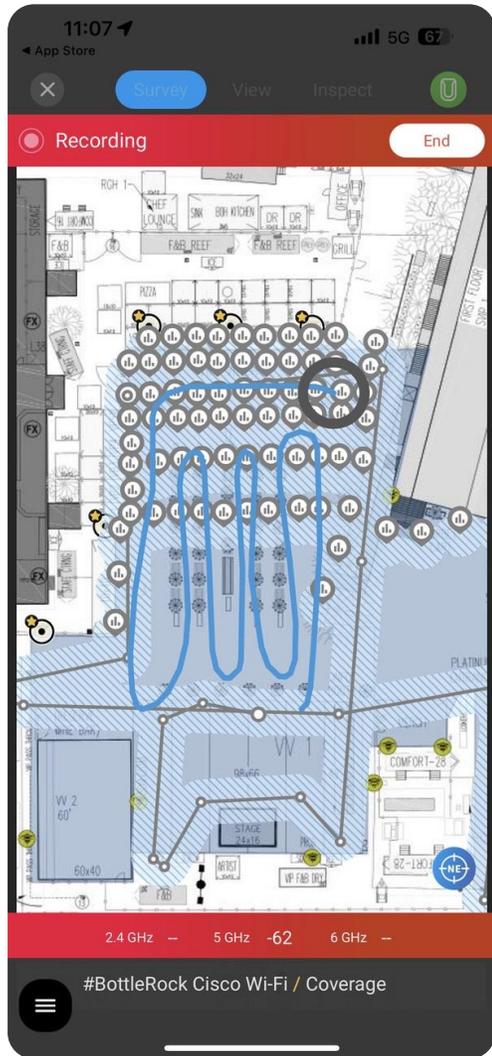
What to do

- A) Use this to your advantage where possible (e.g., portrait mode / use Slot 1-UNII3 for longer throw areas)
- B) Use min/max TPC or set static Tx power, paying attention to dBm values, to ensure the two slots are as close to each other as possible



CW9179F – Real World Data

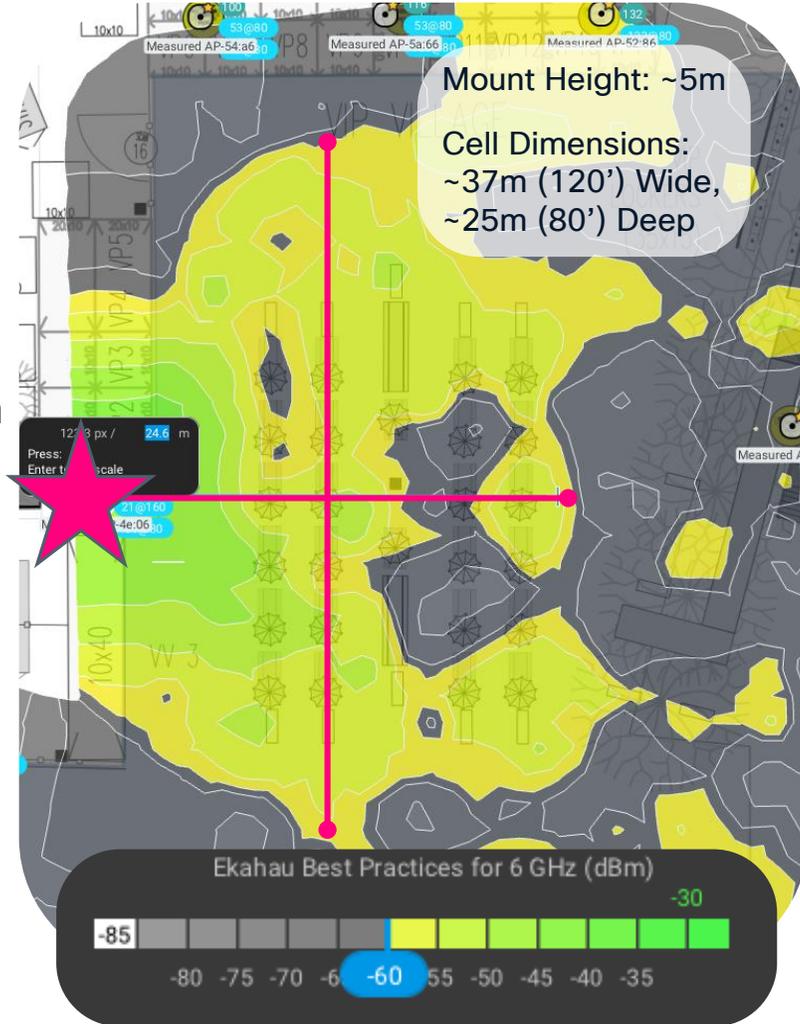
6GHz – Boresight Beam Mode



CW9179F – Real World Data

6GHz – Wide Beam Mode

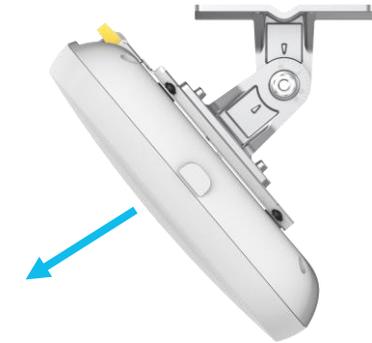
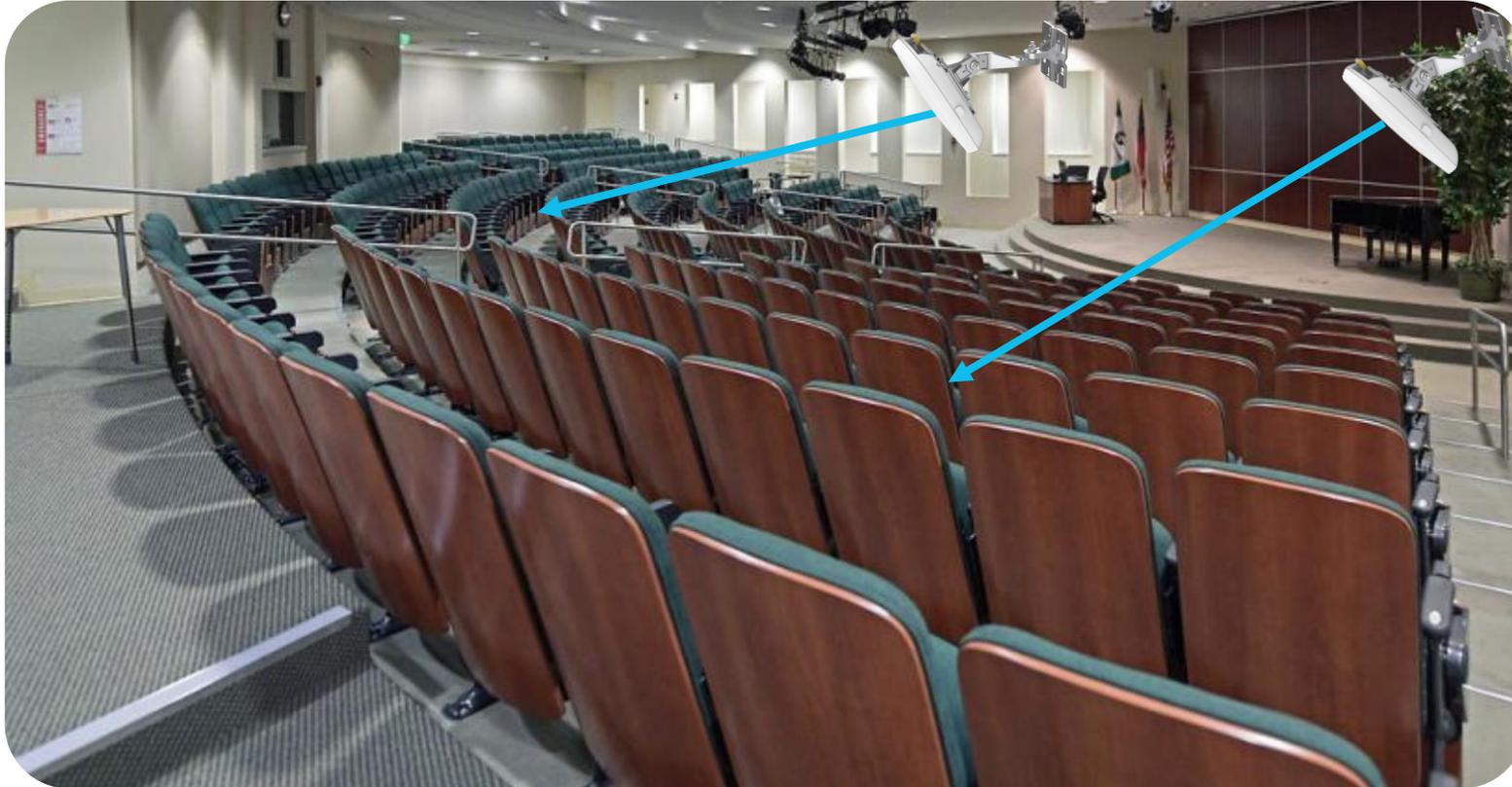
AP Location





AP + Antenna Placement

Classrooms & Auditoriums



Directional antennas:
more coverage cells in
the same physical area,
better control of the RF
environment

Directional antennas (e.g., CW9176D1) strongly preferred over omnis

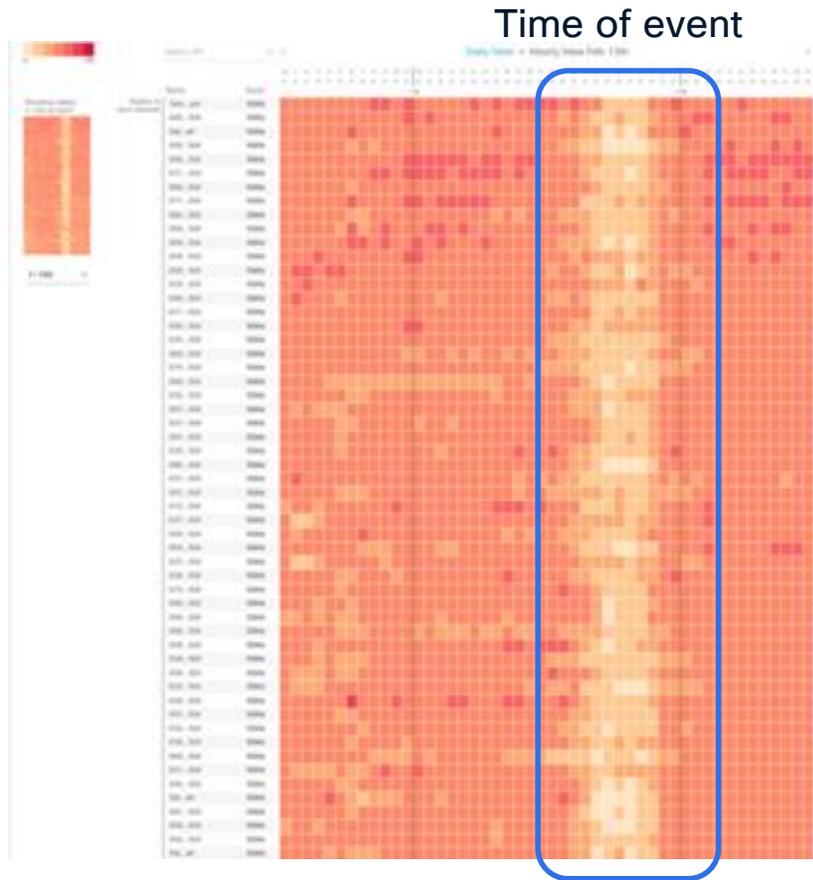
Conference Halls, Airports, Open Atriums

High Density Open Areas – Conference Halls, Classrooms

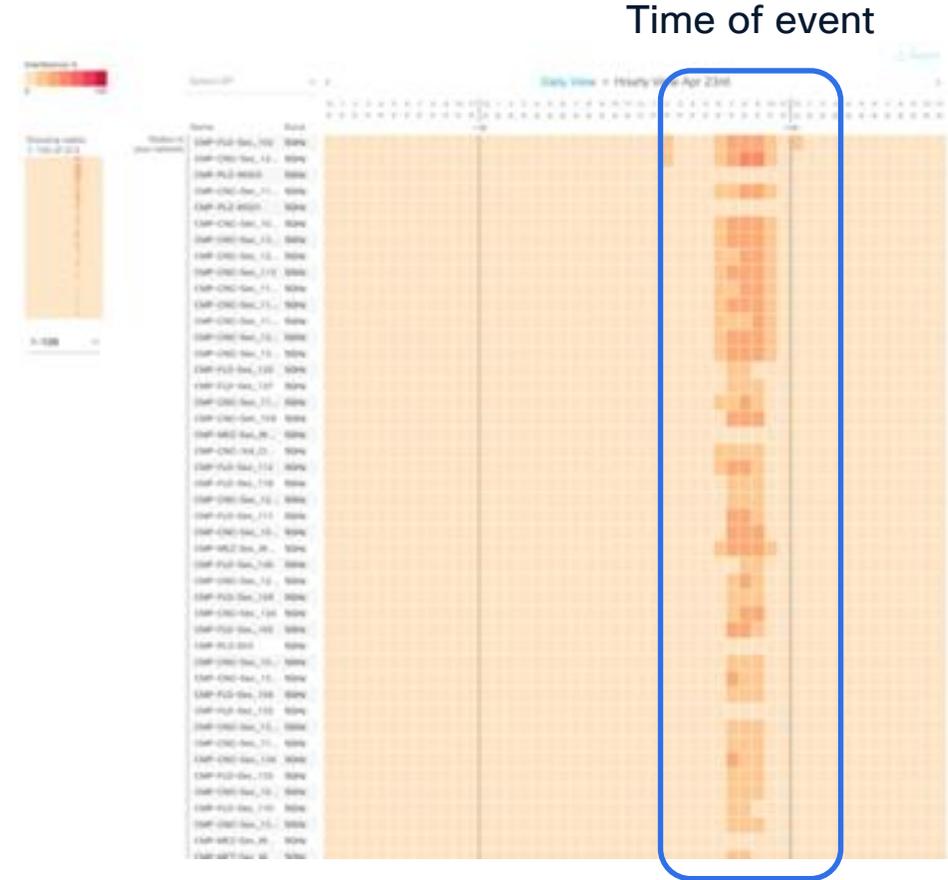


- Omnis not advised for open, high-ceiling areas where high capacity is needed
- Create smaller cells with directional antennas mounted above, aimed directly downward
- Understand RRM implications of this type of design – it may not work as you expect

Performance Comparison: Overhead / Under-Seat



Under Seat / Omni



Overhead/Directional

Red = High CCI / Poor Performance

Why directional?

A recent airport example, omnis everywhere...

Many radios at max client count

40MHz channel width

Persistently high channel utilization
(even on low-client count APs)

Signal	SNR	Channel	Channel Utilization	Stations	Channel Width
-66 dBm	26 dB	100	86%	101	40 MHz
-53 dBm	40 dB	112	72%	200	40 MHz
-80 dBm	11 dB	100	72%	200	40 MHz
-74 dBm	19 dB	112	60%	200	40 MHz
-68 dBm	25 dB	100	58%	108	40 MHz
-73 dBm	23 dB	56	57%	200	40 MHz
-90 dBm	2 dB	44	55%	200	40 MHz
-81 dBm	13 dB	56	54%	197	40 MHz
-88 dBm	11 dB	56	54%	151	40 MHz
-88 dBm	7 dB	44	53%	87	40 MHz
-88 dBm	3 dB	64	52%	186	40 MHz
-69 dBm	19 dB	56	51%	102	40 MHz
-79 dBm	14 dB	112	51%	120	40 MHz
-75 dBm	11 dB	64	50%	136	40 MHz
-85 dBm	10 dB	64	47%	149	40 MHz
-77 dBm	6 dB	112	46%	185	40 MHz
-79 dBm	14 dB	64	45%	160	40 MHz
-67 dBm	26 dB	44	43%	200	40 MHz
-78 dBm	15 dB	44	41%	152	40 MHz
-58 dBm	37 dB	64	40%	200	40 MHz
-44 dBm	49 dB	44	38%	189	40 MHz
-80 dBm	13 dB	44	35%	200	40 MHz
-62 dBm	31 dB	36	32%	200	40 MHz

HD AP/Antenna Selection & Placement

Summary



- 1 | Favor directional antennas vs. omni for HD areas
- 2 | Favor overhead placement vs. near-proximity
- 3 | Favor clear line-of-sight from clients to antennas
- 4 | Consider AP-client distance when selecting antennas

6GHz Wi-Fi HD Deployment Considerations

Wi-Fi 6E + Wi-Fi 7: More Spectrum

Radio spectrum is finite! More channels = more “room” for our devices to talk to each other

Wi-Fi 6E + Wi-Fi 7: More Spectrum

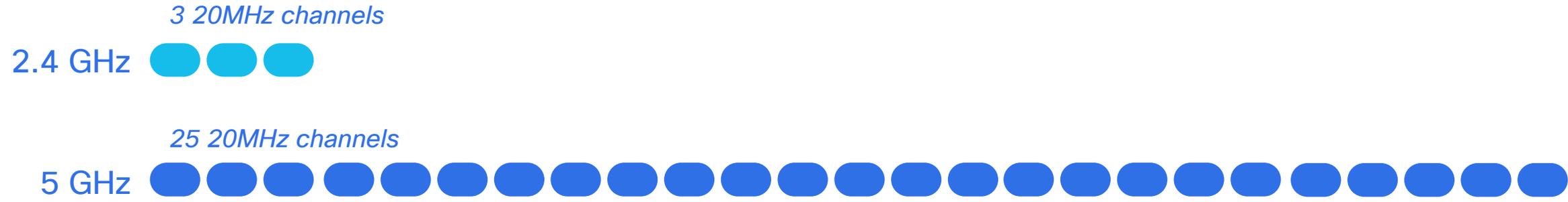
Radio spectrum is finite! More channels = more “room” for our devices to talk to each other

3 20MHz channels

2.4 GHz 

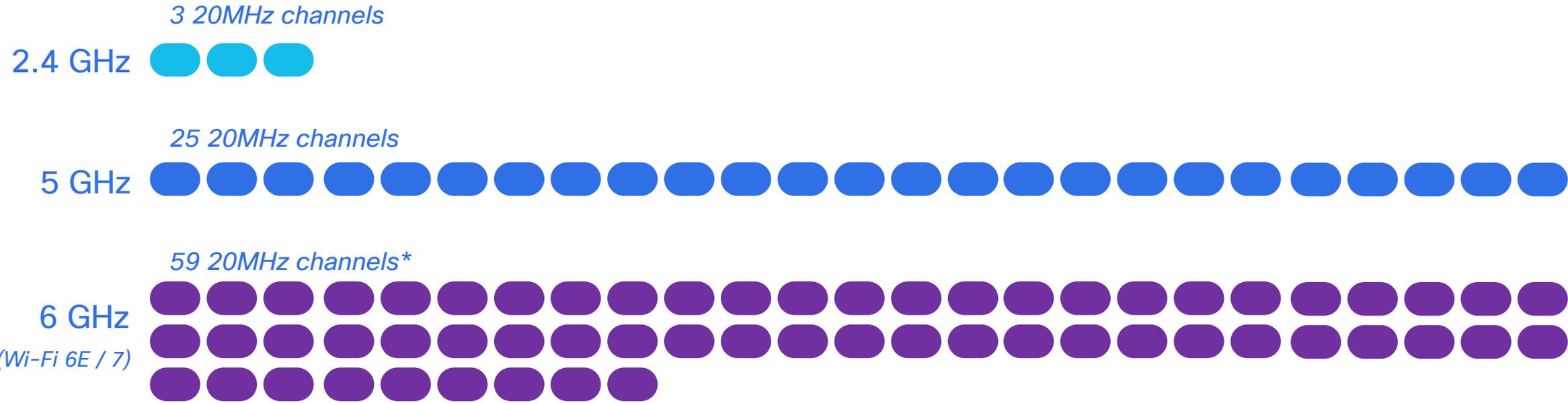
Wi-Fi 6E + Wi-Fi 7: More Spectrum

Radio spectrum is finite! More channels = more “room” for our devices to talk to each other



Wi-Fi 6E + Wi-Fi 7: More Spectrum

Radio spectrum is finite! More channels = more “room” for our devices to talk to each other

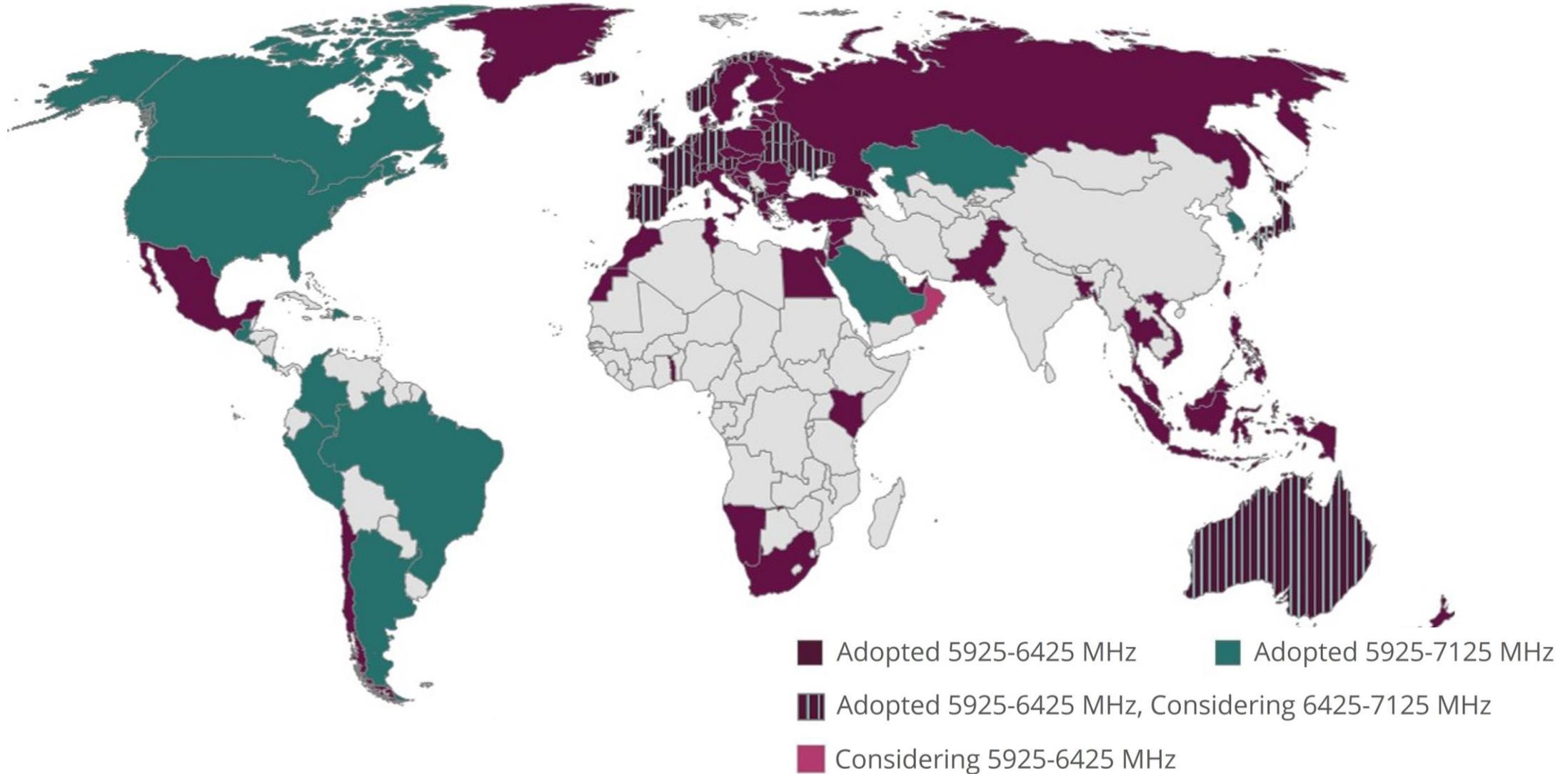


+ many protocol improvements for speed & efficiency

*Region-specific views: <https://www.wi-fi.org/regulations-enabling-6-ghz-wi-fi>

Global availability of 6 GHz band for Wi-Fi

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



Planning for 6GHz: Key Considerations

Avoid “**salt and pepper**” designs

Client adoption drives SSID configuration strategy

Low Power Indoor & Standard Power

Preserve a stable end-user experience

Deploy 6GHz in “whole areas”, not in areas where users may constantly roam between 5GHz- and 6GHz-capable APs

Monitor capabilities & experience of key clients

For both 6E and 7, client capabilities will be enabled at different times; unless your need for 6GHz is truly more important than client experience – favor the client experience

LPI = Indoors Only, No Enclosures

When designing – ensure you understand regulatory requirements

Security Planning: [WPA3 Deployment Guide](#)

Other Session Recommendations

FULL CONFERENCE IT LEADERSHIP

Advanced Wi-Fi Tuning: Become an Expert While Getting a Little Help from AI - BRKEWN-3413

Jim Florwick, Principal TME, Cisco - Distinguished Speaker, Hall of Fame Elite Speaker

Waitlist Full **Wednesday, Jun 11 | 10:30 AM - 12:00 PM PDT | SDCC - Upper Level, Ballroom 20A**

FULL CONFERENCE IT LEADERSHIP

Tune your Cisco Wireless networks for Roaming clients and demanding Real-Time applications...with some help from AI! - BRKEWN-2926

Jerome Henry, Distinguished Engineer, Cisco - Distinguished Speaker, Hall of Fame Elite Speaker

Schedule **Monday, Jun 9 | 11:00 AM - 12:00 PM PDT | SDCC - Upper Level, Room 6B**

FULL CONFERENCE IT LEADERSHIP

Wi-Fi 7 is Here - Are you Ready? - BRKEWN-2025

Anand Gurumurthy, Sr. Technical Leader, Technical Marketing, Cisco

Schedule **Monday, Jun 9 | 10:00 AM - 11:30 AM PDT | SDCC - Upper Level, Ballroom 20D**

FULL CONFERENCE IT LEADERSHIP

Understanding RF in a Wireless First World - BRKEWN-2048

Mark Krischer, Principal Wireless Architect, Cisco - Distinguished Speaker

Schedule **Tuesday, Jun 10 | 11:00 AM - 12:30 PM PDT | SDCC - Upper Level, Ballroom 20A**

FULL CONFERENCE IT LEADERSHIP

Design and Deploy Cisco Cloud Managed Enterprise Wireless Networks - BRKEWN-2046

Justin Loo, Technical Marketing Engineer, Cisco

Schedule **Tuesday, Jun 10 | 11:00 AM - 12:30 PM PDT | SDCC - Upper Level, Room 28AB**

EXPLORER FULL CONFERENCE IT LEADERSHIP 

Scale and Enhance Wireless for the Enterprise - PSOENT-1018

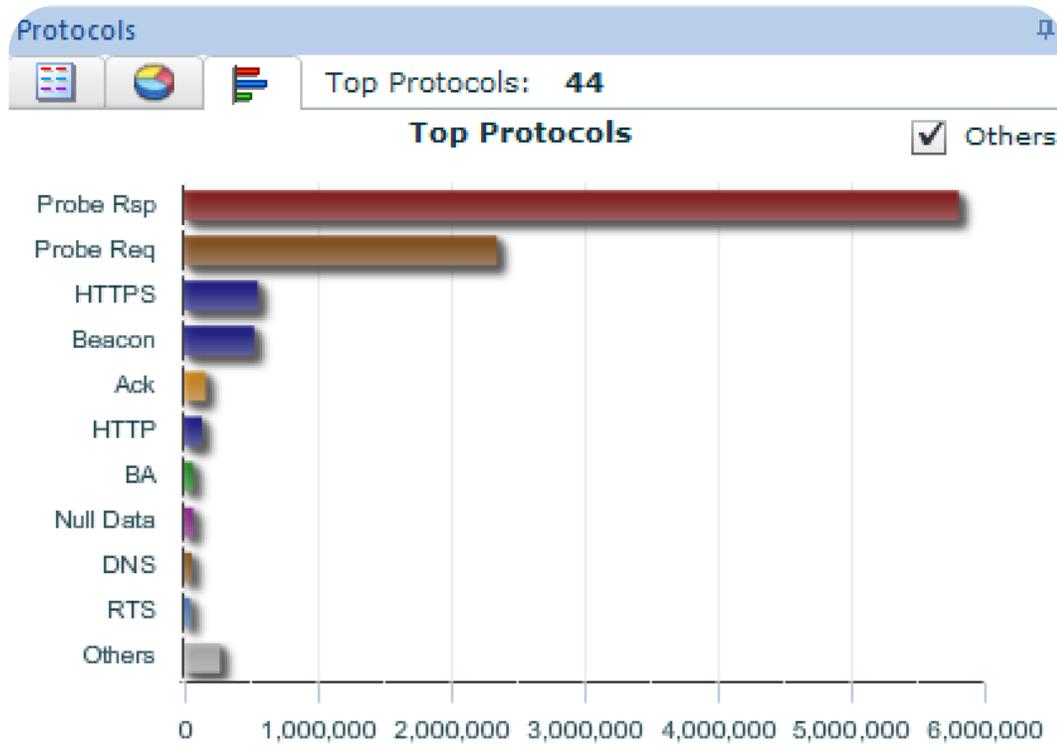
Travis Schlafke, Engineering Product Manager, Cisco
Stefani Johnson, Product Marketing Manager, Cisco

Schedule **Thursday, Jun 12 | 10:30 AM - 11:00 AM PDT | SDCC - Hall F, Cisco Theater 2**

Maximizing the Spectrum

Maximizing the Spectrum

Avoiding Excessive Management Traffic

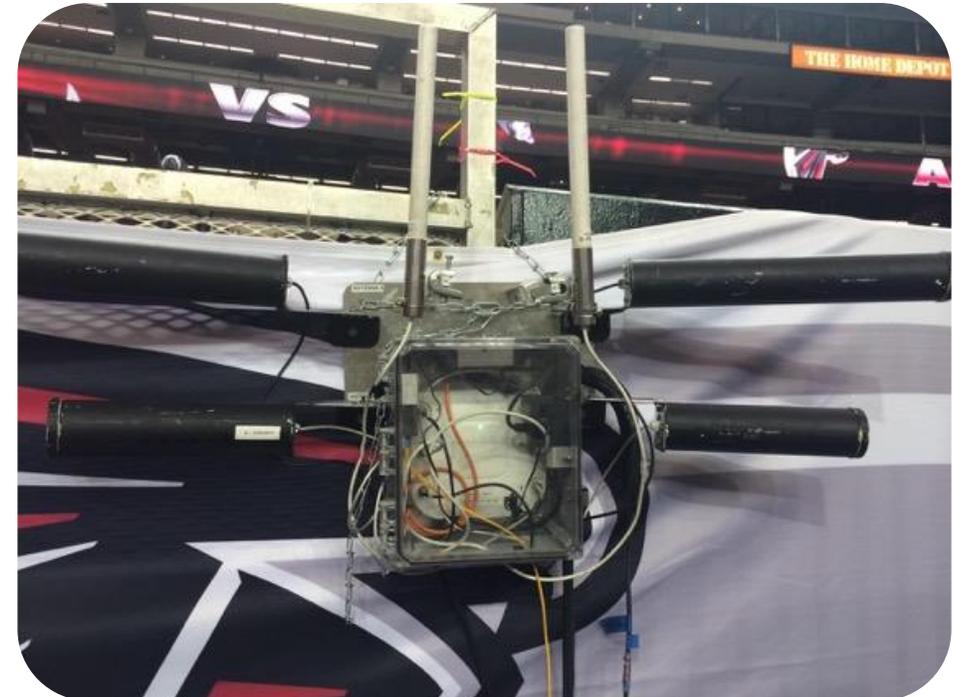
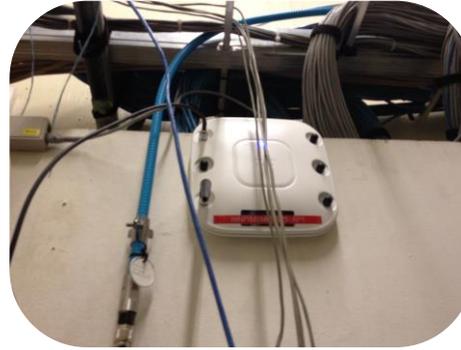


- Always aim for fewer SSIDs
 - Especially in high density areas
- **More SSID's = Worse Performance**
- Why?
 - Each SSID requires a separate beacon
 - Each SSID will beacon at the minimum mandatory data rate
 - Radios will respond to null probe requests for each broadcast SSID
 - **Exponential** amounts of airtime wasted!

Maximizing the Spectrum

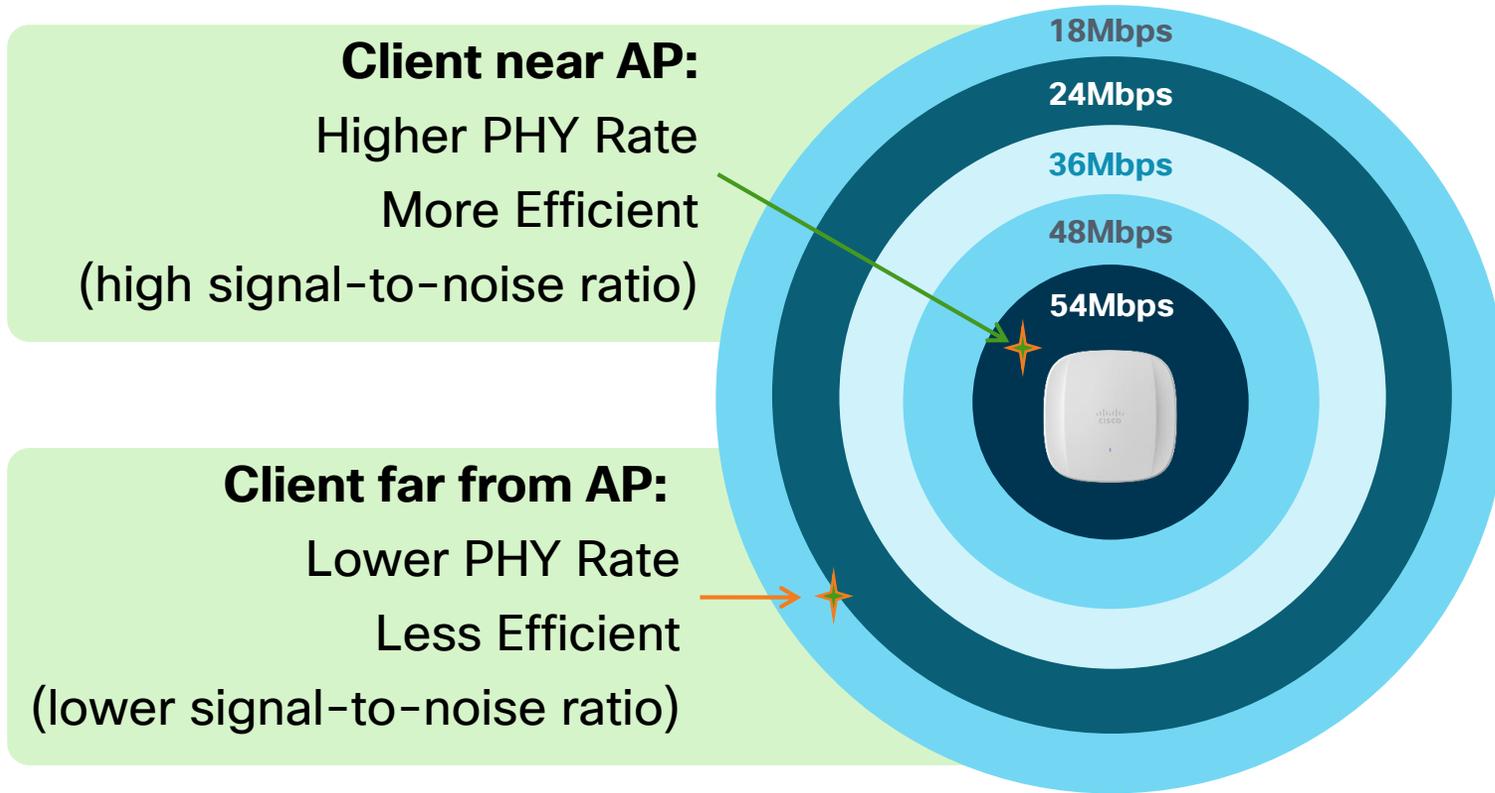
Integrate Existing WLANs

- Common to see various existing WiFi deployments in venues
- Efficient HD WLANs are deployed holistically - one infrastructure
- Benefits?
 - Configuration consistency
 - Airtime efficiency
 - Legacy management traffic that once chewed up 30-40% of airtime typically drops to < 1% of airtime



Maximizing the Spectrum

PHY Rate Tuning: Why PHY Rates Matter

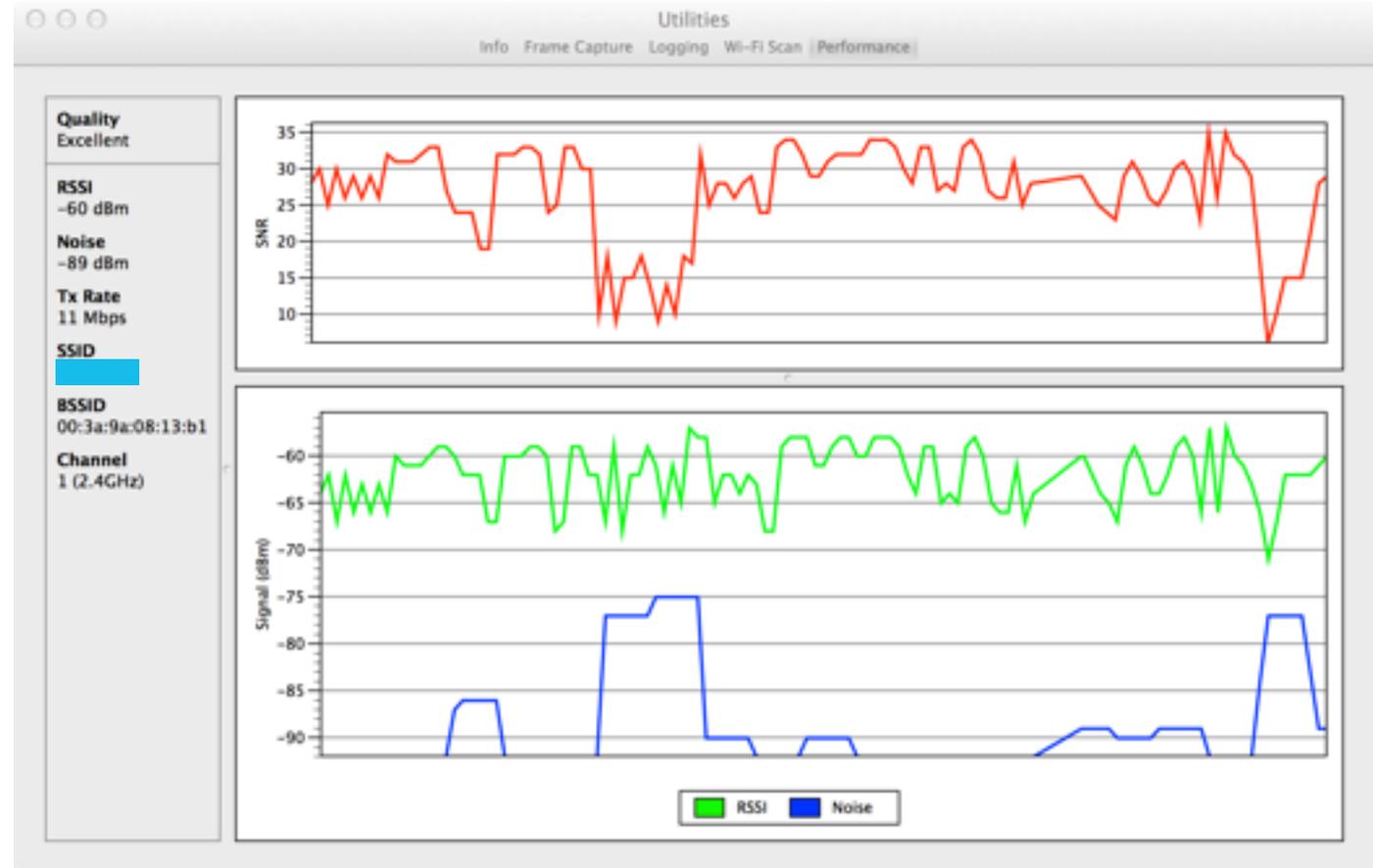


- Tune your **Minimum Mandatory** and **Supported** data rates to optimize airtime
- Higher rates require higher SNR – don't be too aggressive
- Leave 1 or 2 rates below your Minimum Mandatory rate as “supported” to provide a “soft landing” and allow some SNR flexibility
- Generally, no need to adjust MCS rates (client compatibility)
- Common starting points (5ghz):
18mbps Minimum Mandatory,
12mbps Supported, <12 disabled,
>18 Supported

Maximizing the Spectrum

RSSI vs. SNR

- Check your noise floor in each band during peak usage
 - Packet captures with a NIC that you trust (MacBook Pro, etc.)
 - Fluke AirCheck
 - Spectrum Expert
 - Metageek Chanalyzer for Clean Air



Maximizing the Spectrum

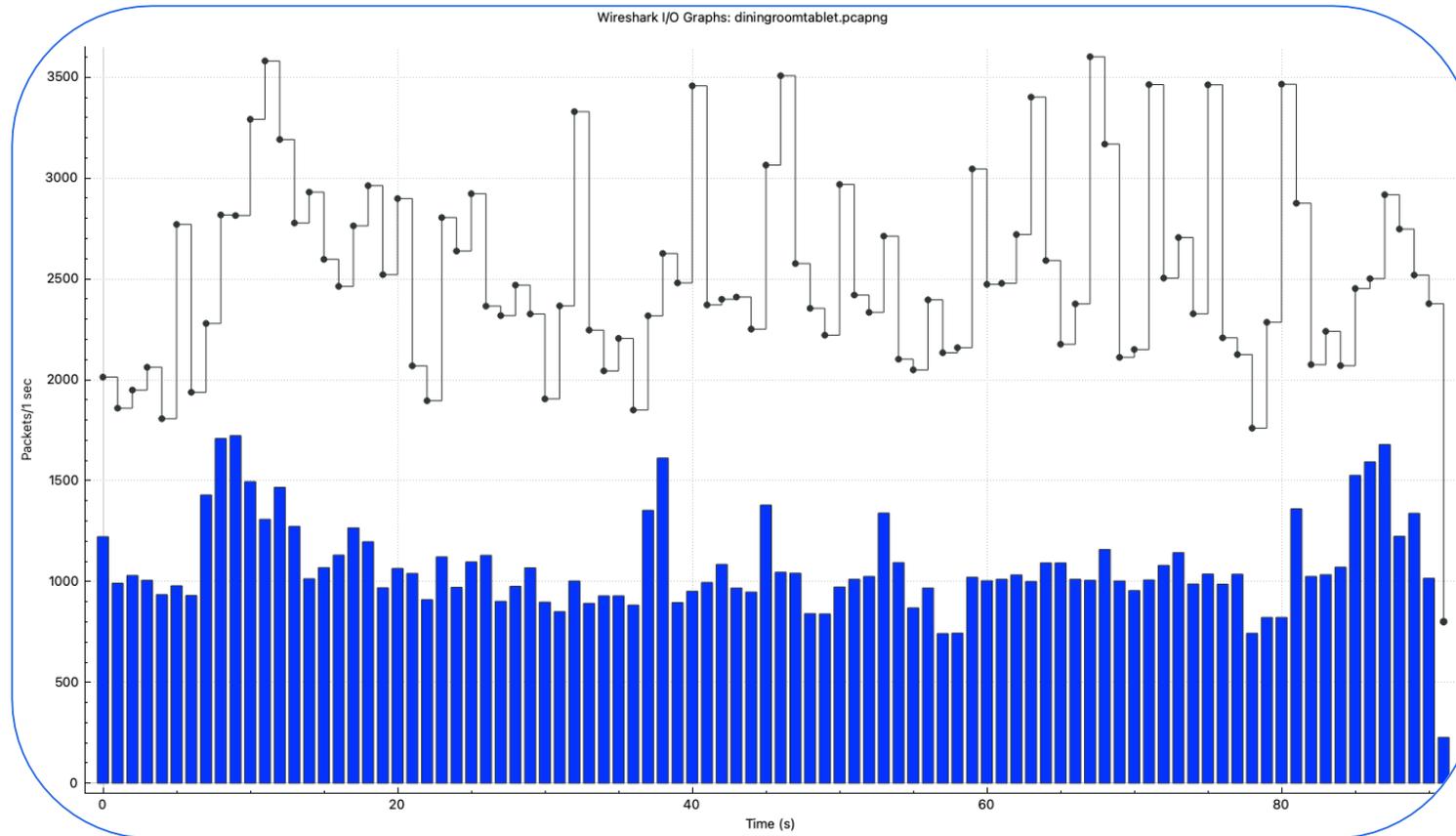
Ease-of-Use & Client Induced Interference



- Ask yourself – how difficult is it to get on your WiFi network?
- Ease-of-use directly impacts airtime efficiency
- Low take rate = lots of probe request noise (1mb, max power, all channels)
 - Results in Client Induced Interference
- **A device on the network is far less damaging than a device off the network!**
- **Make captive portals easy, implement OpenRoaming, etc.**

Maximizing the Spectrum

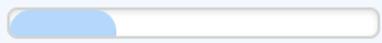
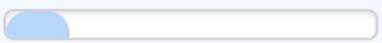
Eliminating unnecessary traffic over the air



Propagation of
mDNS & IPv6
traffic consuming
>40% of airtime
across all channels

Maximizing the Spectrum

Eliminating unnecessary traffic over the air

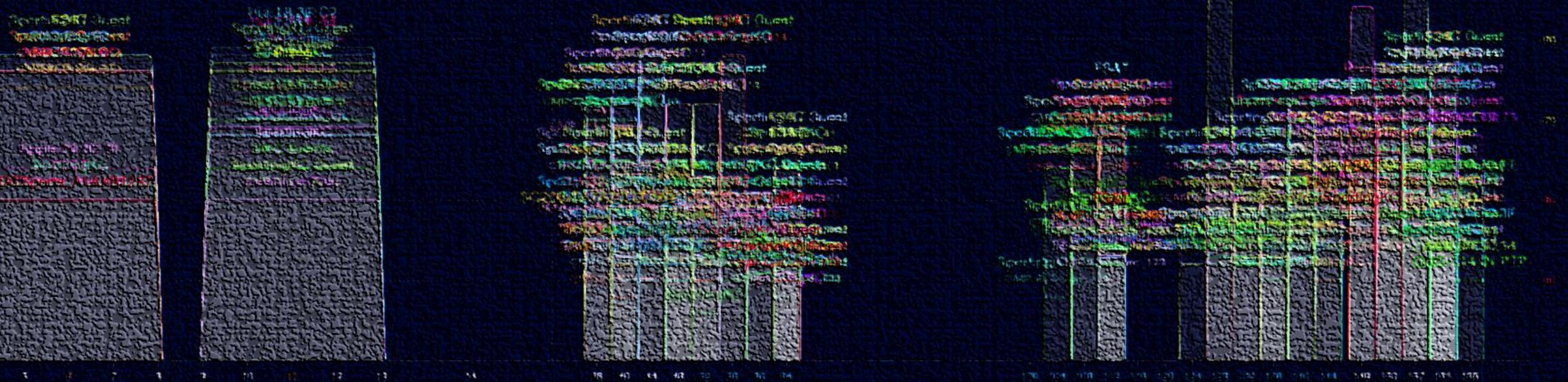
	<i>Before Optimization</i>	<i>After Optimization</i>
	Slot 1 (5 GHz)	Slot 1 (5 GHz)
Radio Type	802.11ax - 5 GHz	802.11ax - 5 GHz
Radio Role (Radio Mode)	Automatic (Local)	Automatic (Local)
Admin Status	Enabled	Enabled
Number of Clients	1	1
Current Channel	153	153
Power Level ⓘ	*6/8 (8 dBm)	*6/8 (8 dBm)
Channel Utilization	34% 	17% 
Transmit Utilization	29% 	17% 
Receive Utilization	0% 	0% 

Optimized PHY rates

Carefully optimized RX-SOP
(stay tuned 😊)

Maximize your Spectrum *Summary*

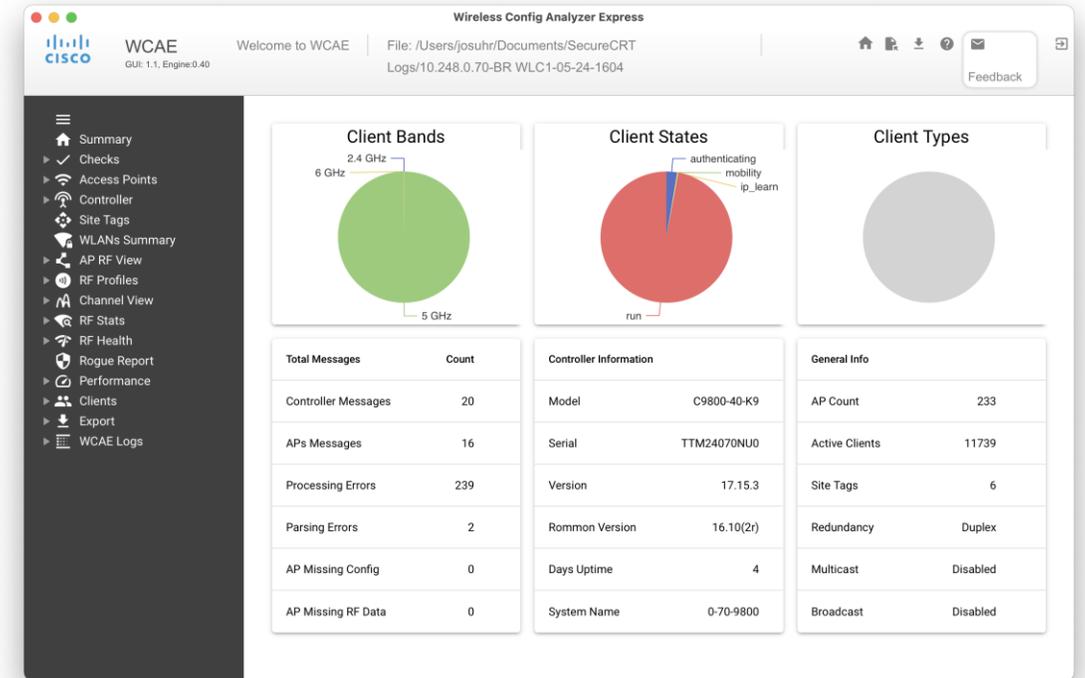
- Limit SSIDs (reduce management traffic)
- Integrate existing networks
- Optimize PHY Rates
- Monitor Noise Floor & use power adjustments
- Remove barriers to entry



Config Basics: RF Profiles, TPC, DCA

First - a handy (free!) tool: WCAE

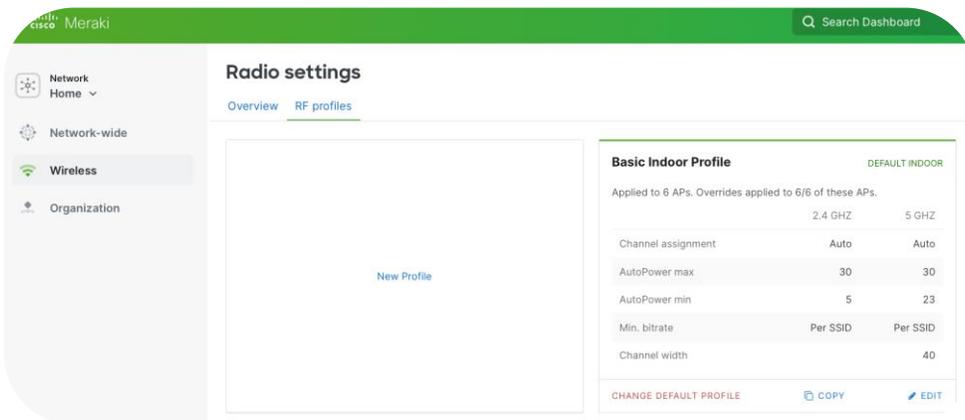
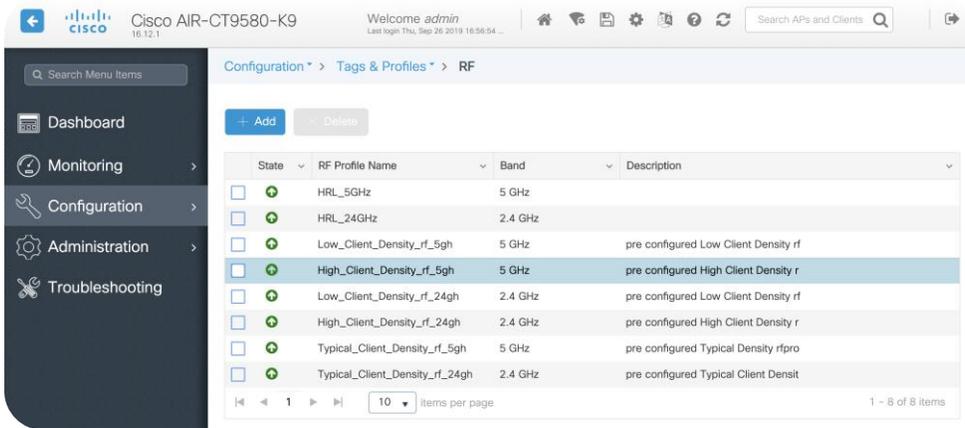
- **Wireless Config Analyzer Express (WCAE)** is an extremely valuable tool when validating and optimizing a Cisco Wi-Fi WLC-based deployment
- **Feed your WLC “show tech wireless” output to WCAE and it will help you:**
 - Find and troubleshoot problems quickly
 - Identify top areas for RF optimization
 - Check configs against best practices
 - RRM overview with the RF Summary



Download: <https://developer.cisco.com/docs/wireless-troubleshooting-tools/>

More info: [Cisco Live Amsterdam 2025 – BRKEWN-3006](#)

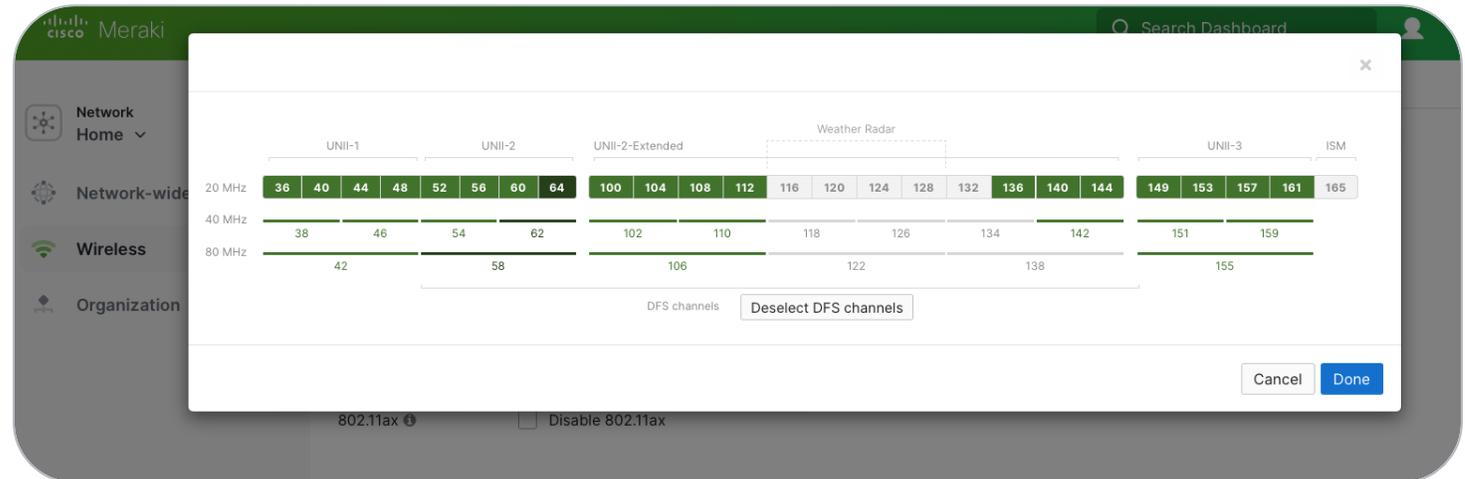
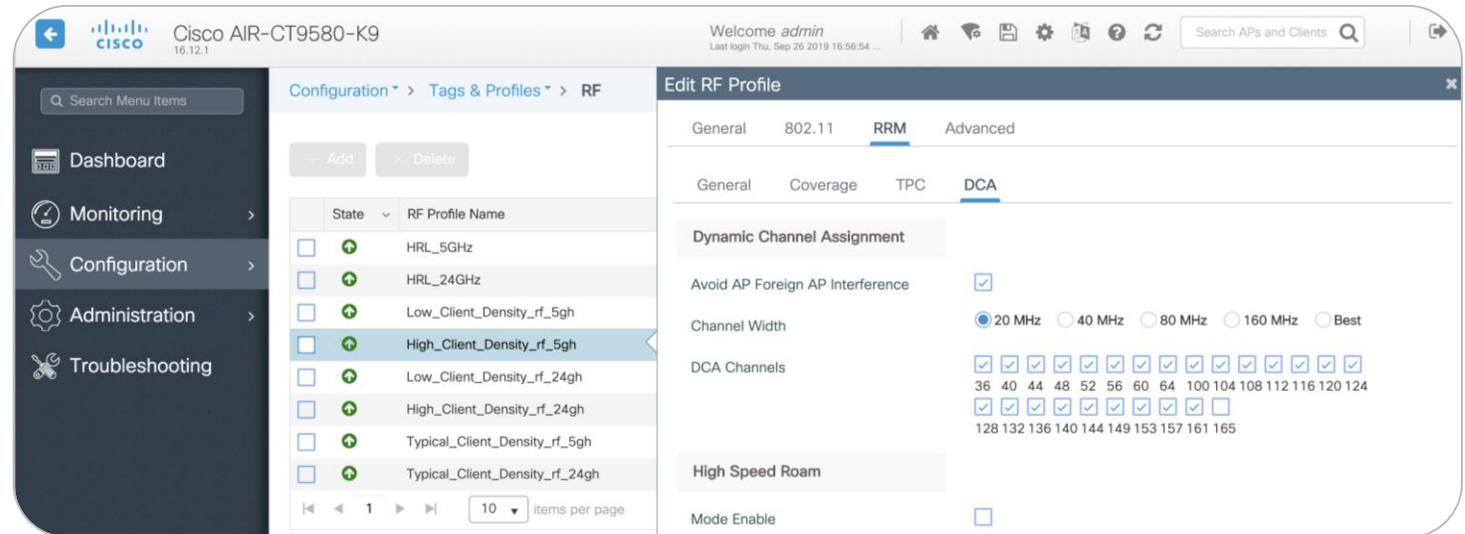
High Density WLAN Features & Configurations



- WiFi deployments **are not “one-size-fits-all”**
- **Use RF Profiles** on both On-Prem and Cloud-Managed deployments for granular RF control
 - **Configure network-wide channel parameters:** remove channels as needed, set channel widths
 - **Configure transmit power min/max:** ensure balance, avoid “client magnets”
 - **Configure RX-SOP thresholds** to selectively reduce radio sensitivity where needed
- On C9800, **plan Site Tags** to balance APs across processes for best distribution of load

Channel Planning with RF Profiles

- Plan channels with **Dynamic Channel Allocation (Catalyst)** or **AutoChannel (Meraki)** via RF Profile
- If needed – **eliminate unusable channels** for business-critical areas (DFS, etc)
- Reserve channels for use by other systems



Catalyst Tip: Identifying Potentially Unhealthy Channels

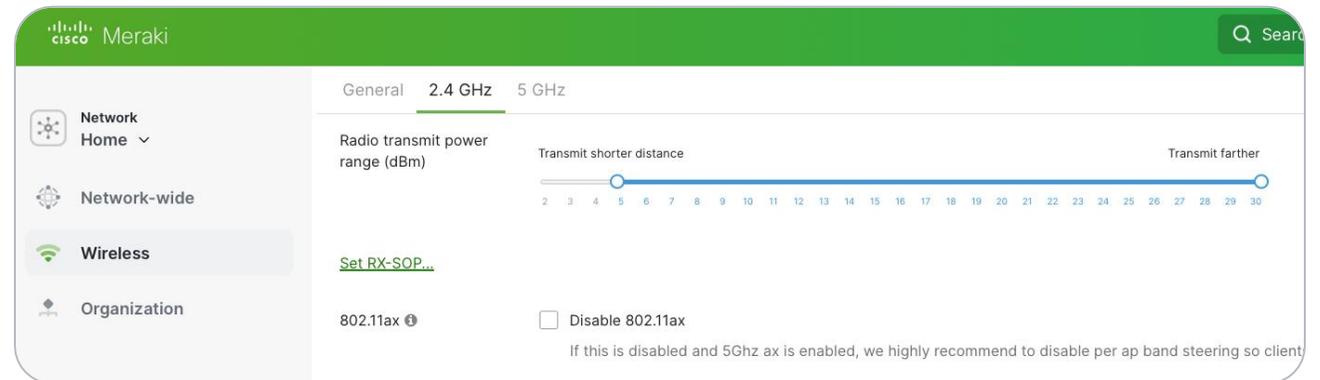
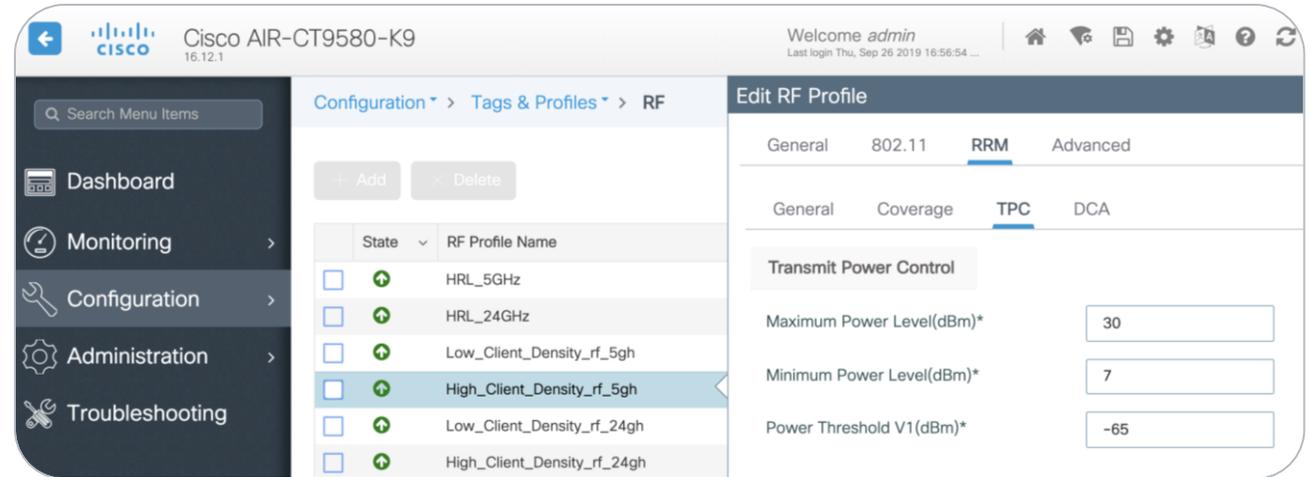
WCAE - 'APs RF Summary' tab - "High Channel Changes" column

Model	Mode	Chann	TX Pow	TX Power dB	Total Clients	RX SOP	CH Util	CH TX Util%	CH RX Util%	Channel Changes	High Channel Chang
C9130AXI-B	Client Serving	108	3	9	18	medium(-78)	50	3	0	18	Yes
C9130AXI-B	Client Serving	140	2	12	8	medium(-78)	73	50	0	20	Yes
C9130AXI-B	Client Serving	52	2	11	17	medium(-78)	46	5	0	20	Yes
C9130AXI-B	Client Serving	64	2	11	4	medium(-78)	11	0	0	25	Yes
C9130AXI-B	Client Serving	100	3	9	12	medium(-78)	49	2	0	30	Yes
C9130AXI-B	Client Serving	44	5	9	7	medium(-78)	47	8	0	23	Yes
C9130AXI-B	Client Serving	100	3	9	13	medium(-78)	38	7	0	19	Yes
C9130AXI-B	Client Serving	56	2	11	22	medium(-78)	46	17	0	28	Yes
C9130AXI-B	Client Serving	132	3	9	14	medium(-78)	37	8	0	32	Yes
C9130AXI-B	Client Serving	52	2	11	15	medium(-78)	45	1	0	18	Yes
C9130AXI-B	Client Serving	56	2	11	23	medium(-78)	42	7	10	25	Yes
C9130AXI-B	Client Serving	116	3	9	9	medium(-78)	24	3	0	22	Yes
C9130AXE-B	Client Serving	52	2	15	0	medium(-78)	2	0	0	19	Yes
C9130AXE-B	Client Serving	36	2	19	0	medium(-78)	1	0	0	20	Yes
C9130AXE-B	Client Serving	56	2	15	0	medium(-78)	1	0	0	30	Yes
C9130AXE-B	Client Serving	149	2	20	0	medium(-78)	2	0	0	22	Yes
C9130AXE-B	Client Serving	124	2	15	88	medium(-78)	78	19	10	70	Yes
C9130AXE-B	Client Serving	48	2	20	0	medium(-78)	2	0	0	66	Yes
C9130AXE-B	Client Serving	36	2	19	0	medium(-78)	2	0	0	19	Yes
C9130AXE-B	Client Serving	44	2	20	0	medium(-78)	2	0	0	21	Yes
C9130AXE-B	Client Serving	108	2	15	0	medium(-78)	1	0	0	25	Yes
C9130AXE-B	Client Serving	149	2	20	0	medium(-78)	1	0	0	21	Yes

"High Channel Change: Yes" triggered for radios with more than 4 channel changes per day

Balancing Transmit Power with RF Profiles

- **TPC (Catalyst) and AutoPower (Meraki)**
- **Ensures AP-to-AP consistency** (no “client magnets”) and 2.4GHz to 5GHz balance (5GHz hotter, 2.4GHz cooler)
- **TPC/AutoPower Min** – lower power limit specified for a given radio. TPC/AutoPower will never adjust power below this level.
- **TPC/AutoPower Max** – upper power limit specified for a given radio. TPC/AutoPower will never adjust power above this level.



Identifying Possible Power Imbalance

WCAE - 'APs RF Summary' tab - "TX Power dBm" and "Total Clients" columns

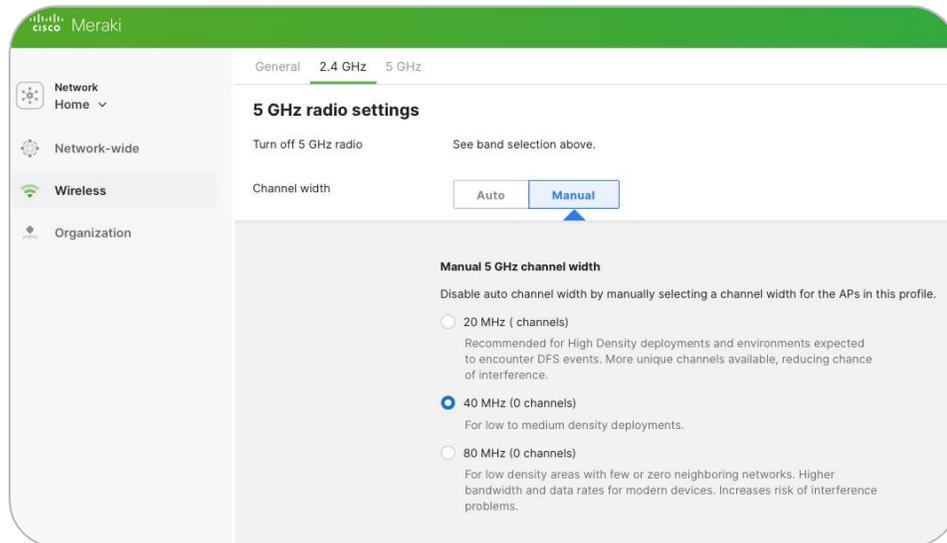
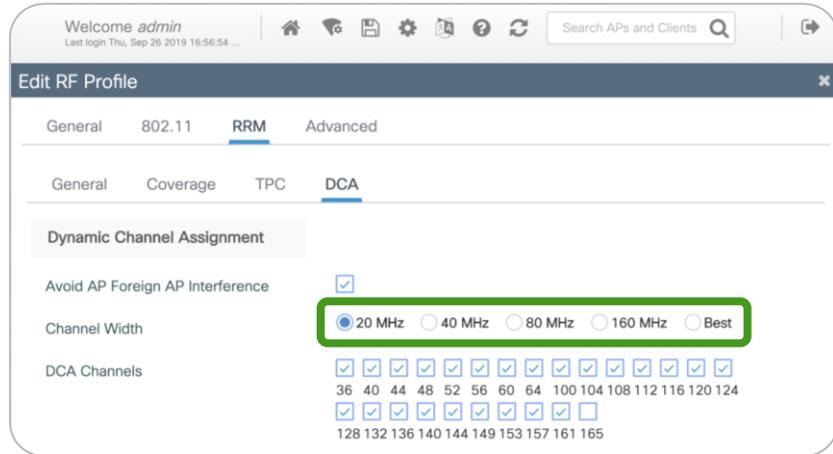
Name	Slot	Band	Channel	TX Power	TX Power dBm	Total Clients
AP1	1	5	100	1	17	21
AP1	2	5	48	1	23	70

6dB power difference = client imbalance

Refer to AP power tables to determine max TX power per UNII band

Use "show controller" on a sample AP for all details

Selecting Channel Width with RF Profiles



5GHz

- In general, **20MHz channels** provide the most channel reuse (capacity) for high density environments
- **Wider channels may be used selectively** in more isolated areas – smaller classrooms, lobbies, conference rooms, etc.

6GHz

- Heavily dependent on regulatory domain
- Note! Higher channel width results in higher max Tx power for data frames (but not beacons – remember when surveying!)

Site Tags & Balancing AP Load on 9800

Key Considerations



In High Density Deployments – **balance your APs across Site Tags**. Do not use the default site tag.

Site Tag does not necessarily equate to a physical “Site”!

Site Tag assigns an AP to a WNCd (9800 logical processor)
(# of available WNCd’s differs per HW platform)

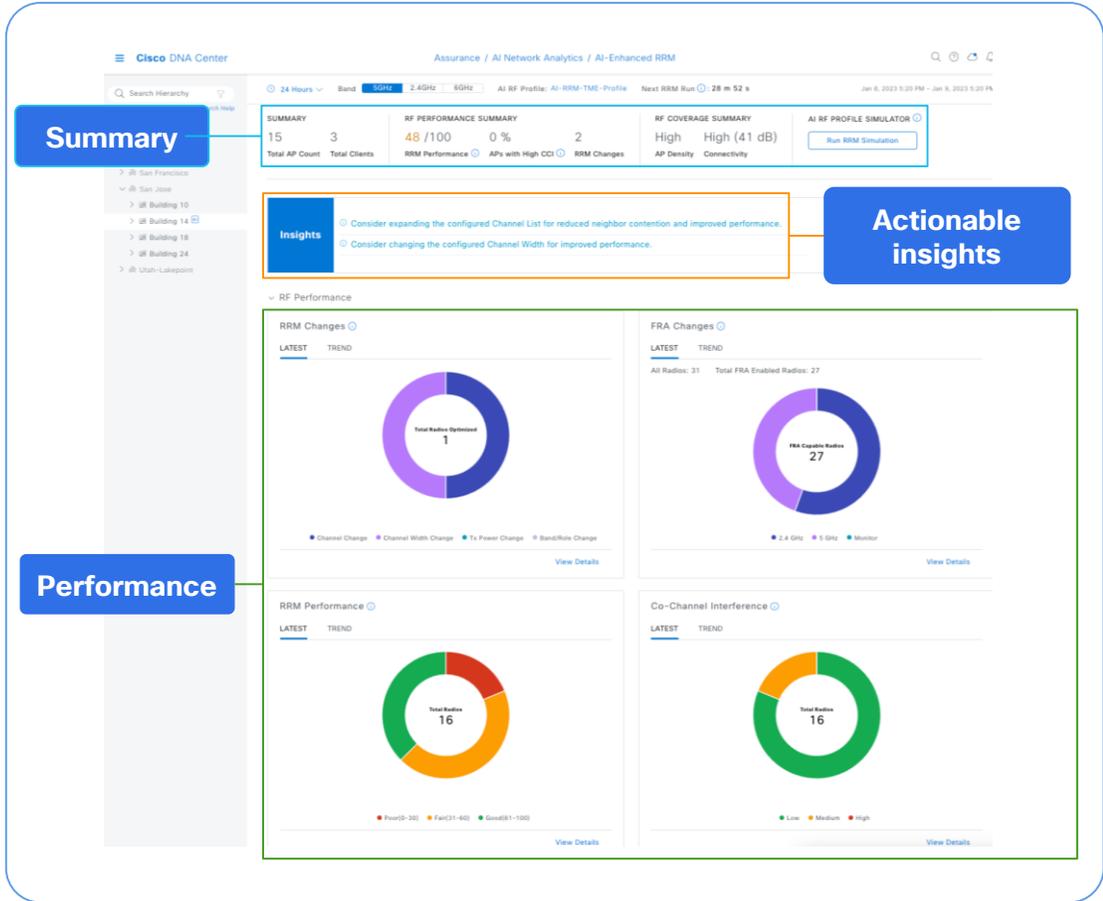
Organize Site Tags into approximate roaming domains

Refer to the [C9800 Best Practices](#) guide for the latest guidance

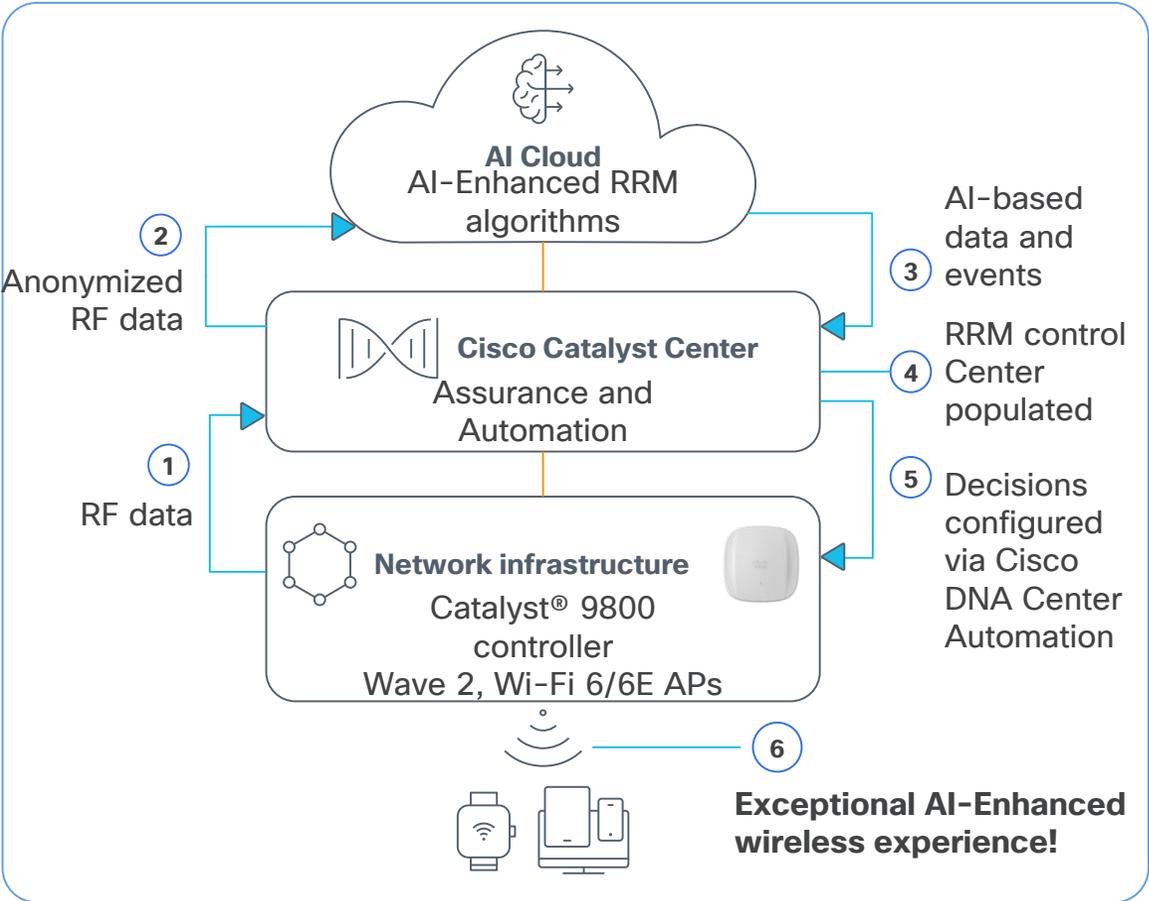
What is AI-Enhanced RRM?

AI-Driven RRM solution

Deep RF visibility & advanced control



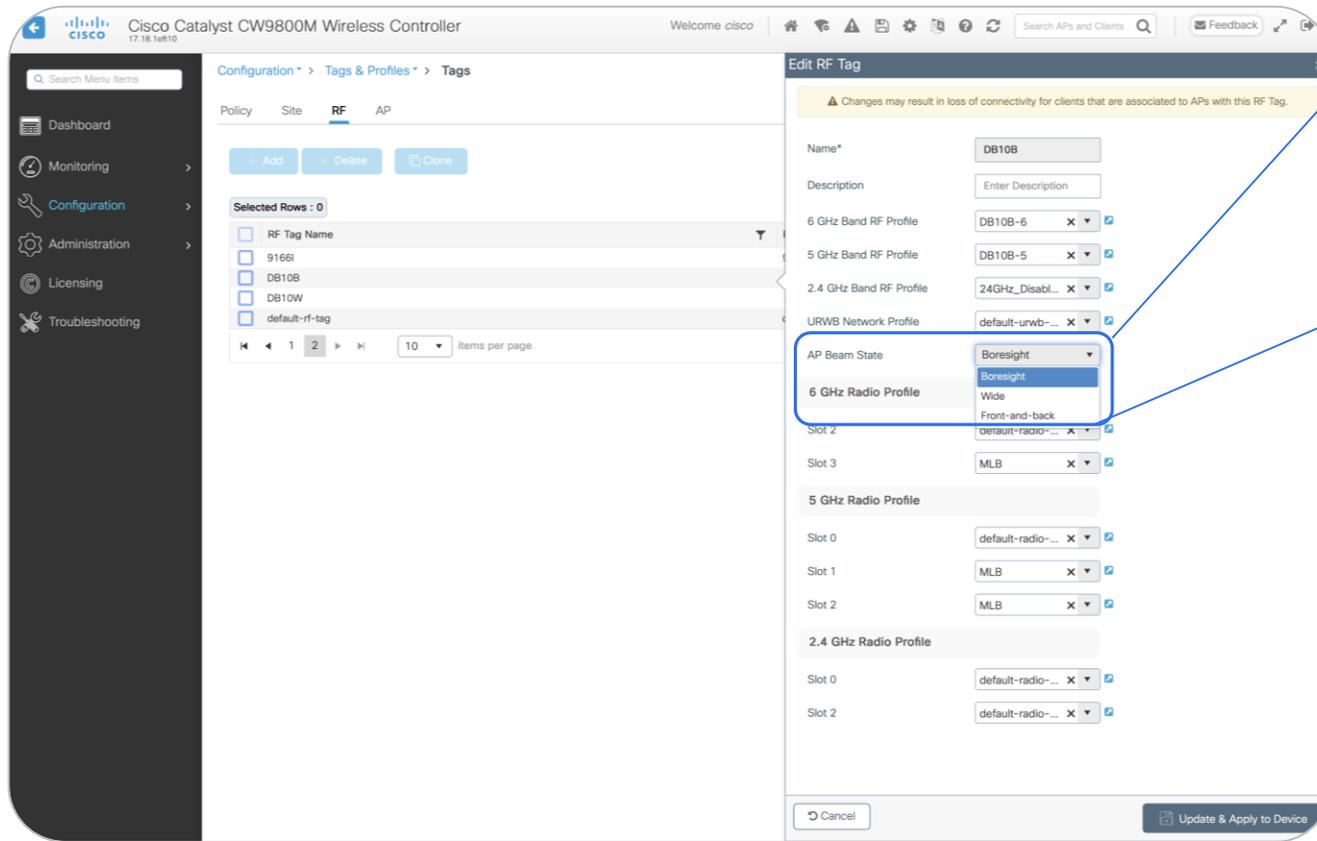
Proactive optimizations for all deployment sizes



CW9179F: Config Tips

CW9179F: Beam Configuration Options

9800: Configuration > Tags & Profiles > Tags > RF



AP Beam State

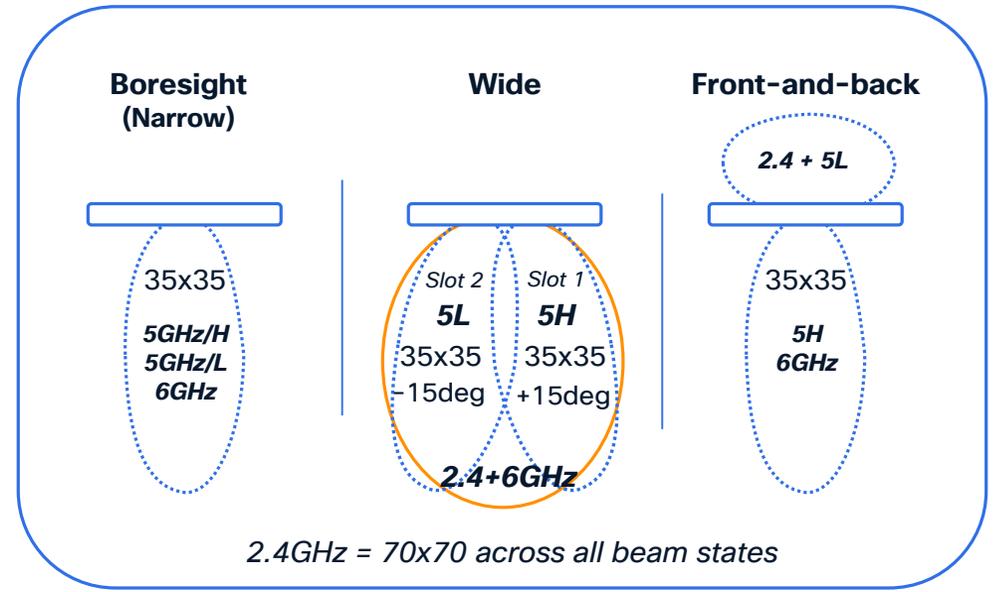
Boresight

6 GHz Radio Profile

Boresight

Wide

Front-and-back



Note: Radio Profiles are not applicable to CW9179F

CW9179F: Beam Configuration Options

Dashboard: Wireless > Radio Settings > RF Profiles > Select Existing or Create New

The screenshot displays the Meraki dashboard interface for configuring antenna beam settings. The top navigation bar is green and includes the Meraki logo, a search bar labeled "Search Dashboard", and icons for user profile, help, and notifications. The left sidebar contains navigation options: Global Overview, Organization (Matt Swartz), Network (MCG_test_network), Network-wide, Assurance, Wireless (highlighted), Insight, and Find in Menu. The main content area is titled "Antenna beam state" and features three tabs: General, 2.4 GHz, 5 GHz, and 6 GHz. The "General" tab is active, showing three beam configuration options:

- Boresight (Default)**: Represented by a blue circle. 2.4 GHz: 70x70 beamwidth; 5 low/5 high/6 GHz: 35x35 beamwidth. Legend: 2.4 GHz + 5 GHz low + 5 GHz high + 6 GHz.
- Wide**: Represented by three overlapping circles (red, green, purple). 2.4 GHz: 70x70 beamwidth; 5 low/5 high GHz: 35x35 beamwidth (+/- 15° offset); 6 GHz: 70x35 beamwidth. Legend: 5 GHz low, 5 GHz high, 2.4 GHz + 6 GHz.
- Front-and-back**: Represented by a teal circle with a dashed box above it labeled "External antenna". 2.4 GHz: External antenna; 5 low GHz: External antenna; 5 high/6 GHz: 35x35 beamwidth forward. Legend: 5 GHz high + 6 GHz.

CW9179F: Validating Beam and Tilt

9800: Monitoring > Wireless > AP Statistics

The screenshot shows the 'AP Statistics' page for AP 'DB10_Indoor'. The 'General' tab is active, displaying various configuration and status details. A map on the right shows the AP's location. Callout boxes highlight the following information:

- AP Environment Mode: Indoor Use
- Sensor Accelerometer Tilt: 110 Degree [Show more](#)
- AP Beam State: Wide

AP Environment Mode Indoor Use

Sensor Accelerometer Tilt 110 Degree [Show more](#)
AP Beam State Wide

Meraki: Wireless > Monitor > Access Points > Select AP

The screenshot shows the Meraki dashboard for AP 'DB10_Indoor'. The 'Wireless' section is expanded, showing radio settings and RF profile. Callout boxes highlight the following information:

- Down Tilt Angle: 69°
- Environment: Indoor
- Antenna beam state: Boresight

Down Tilt Angle Angle: 69°

Environment: Indoor
Antenna beam state: Boresight

*Accelerometer must be enabled to see tilt measurement

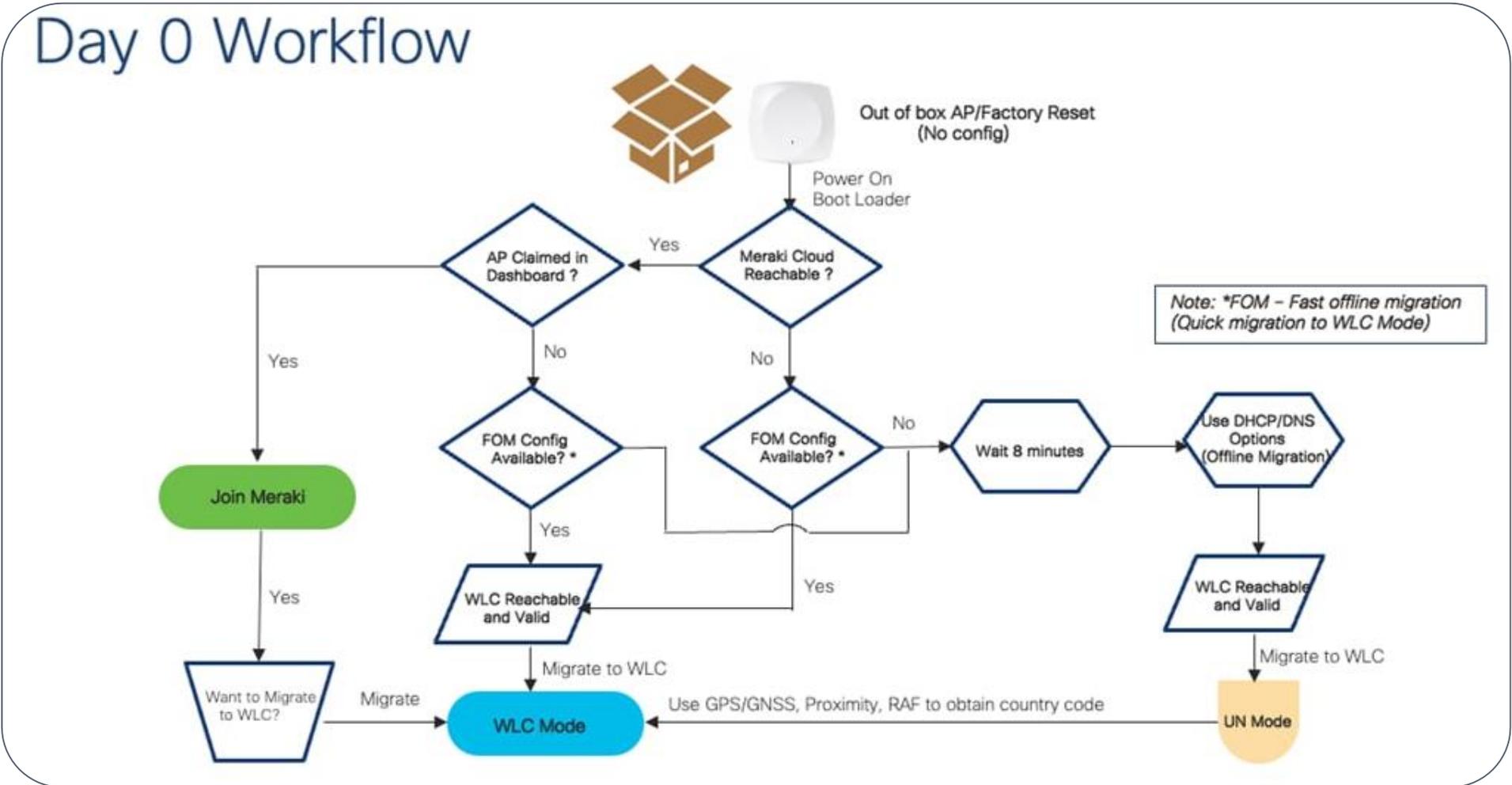
CW9179F: Enabling the Accelerometer

The screenshot shows the Cisco Catalyst 9800-L Wireless Controller configuration interface. The main content area is titled "Edit AP" and shows the configuration for the AP "DB10_Outdoor". The "Accelerometer" setting is highlighted with a red box and a callout bubble, indicating it is "ENABLED".

Section	Field	Value
General	AP Name*	DB10_Outdoor
	Location*	default location
	Base Radio MAC	ecf4.0ccd.ee20
	Ethernet MAC	8c88.8176.b8d0
	MLD Base MAC ⓘ	eef4.0ccd.ee30
	Admin Status	ENABLED <input checked="" type="checkbox"/>
	AP Mode	Local
	Operation Status	Registered
	Fabric Status	Disabled
	Accelerometer	ENABLED <input checked="" type="checkbox"/>
LED Settings	LED State	ENABLED <input checked="" type="checkbox"/>
	Brightness Level	8
	Flash Settings	Flash State: DISABLED
Time Statistics	Uptime	6 days 5 hrs 35 mins 7
	Buttons	Cancel, Update & Apply to Device

Accelerometer

WiFi 7 - Global Use AP Considerations



Cisco Wireless Global Use Access Points Deployment Guide

Migrating Between Management Modes

Cloud > On-Prem

The screenshot shows the Cisco Meraki dashboard interface. The top navigation bar includes the Meraki logo, a search bar, and user profile icons. The left sidebar contains navigation options: Global Overview, Organization (Matt Swartz), Network (MCG_test_network), Network-wide, Assurance, Wireless (highlighted), and Insight. The main content area is titled 'Access Points' and shows a 'List' view of access points. A notification banner at the top of the main area provides information about proactive packet capture. Below this, a summary row shows 0 Offline, 0 Alerting, 1 Online, and 0 Repeaters. A table of access points is displayed with columns for Status, Name, MAC address, Connectivity (UTC-7), Serial number, and Local IP. The first row, 'DB10_indoor', is selected. Action buttons for the selected item include 'Tag', 'Move', 'Remove', and 'Migrate to WLC', which is highlighted with a red box.

Status	Name	MAC address	Connectivity (UTC-7)	Serial number	Local IP
<input checked="" type="checkbox"/>	DB10_indoor	8c:88:81:76:ba:20	<div style="width: 100%;"></div>	Q5BH-6TNN-LAPU	192.168.128.212
<input type="checkbox"/>	DB10_Outdoor	8c:88:81:76:b8:d0	<div style="width: 0%;"></div>	Q5BH-M2HE-TB8X	192.168.128.159
<input type="checkbox"/>	AP6CEF.BDB1.B9A0	6c:ef:bd:b1:b9:a0	<div style="width: 0%;"></div>	Q5BK-G3AH-AU9U	192.168.128.158

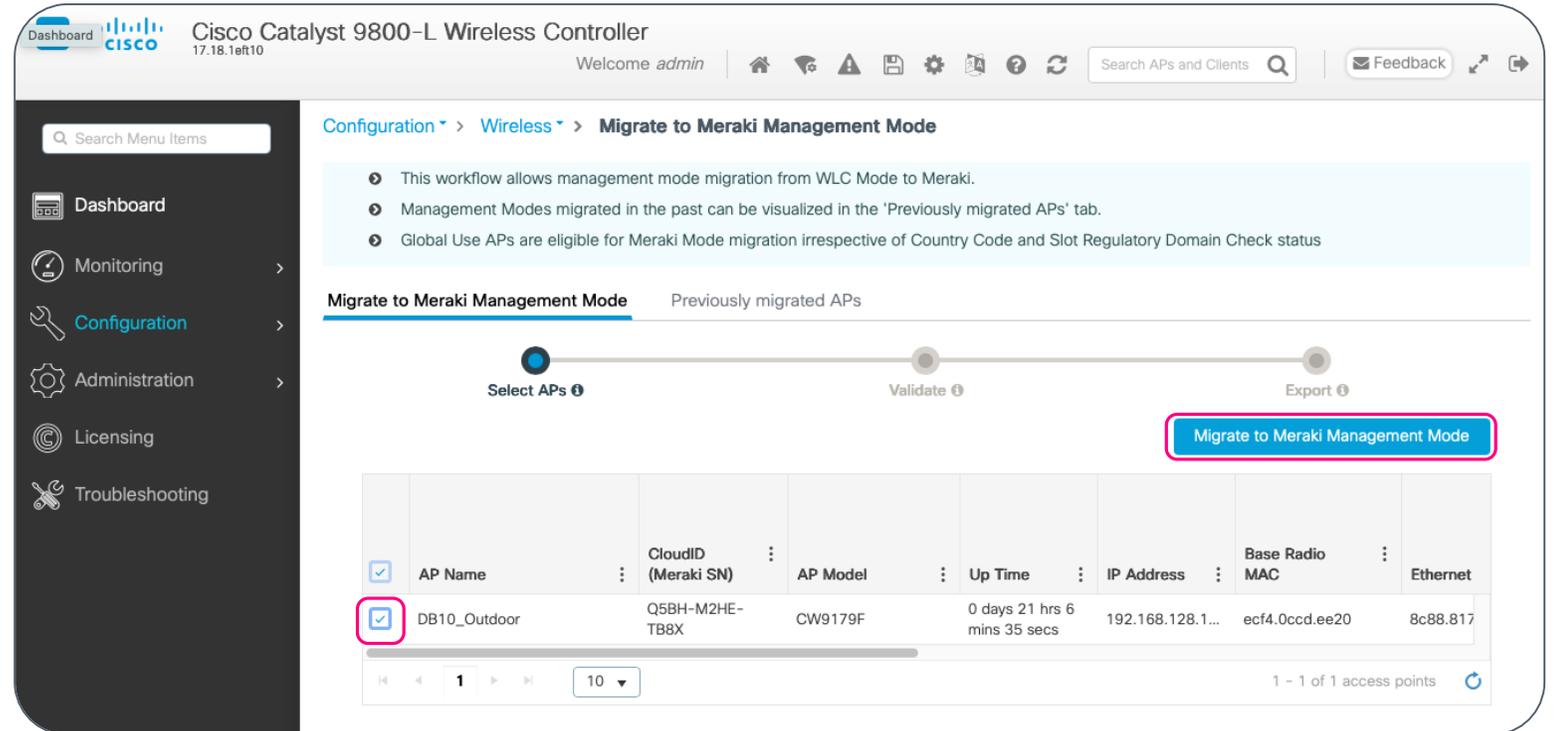
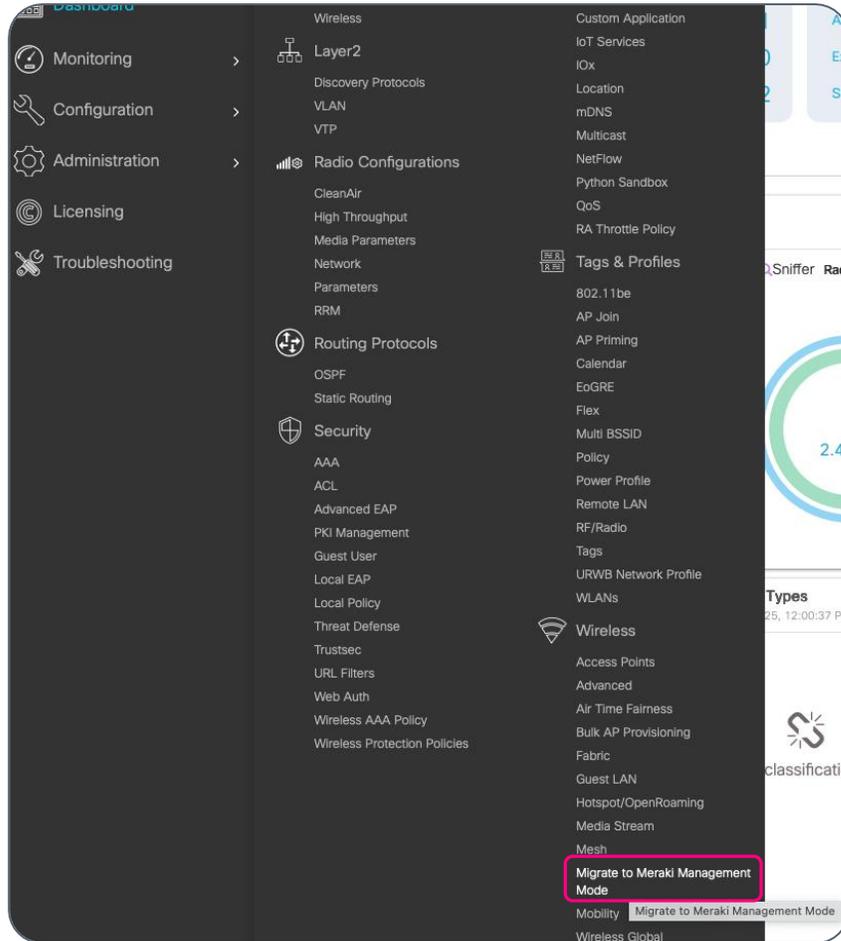
Note: You must have a 9800 up and accessible on the network for the converted AP to find a new “home”!

[Global Use APs: Migrating Between Management Modes](#)

Migrating Between Management Modes

On-Prem > Cloud

Configuration > Wireless > Migrate to Meraki Management Mode



Global Use APs: Migrating Between Management Modes

AFC Configuration

CW9800: Enabling Standard Power / AFC

Edit RF Profile

General 802.11 RRM Advanced 802.11ax 802.11be

Name* DB10_6_SP

Radio Band 6 GHz Band

Status **ENABLED**

Description Enter Description

NDP Mode **AUTO**

AFC

Standard-Power Service **ENABLED** ⓘ
Standard Power(SP) Only 6E APs will be automatically allowed to use AFC with no additional configuration.

Show Me How ▶

Cloud Dashboard: Enabling AFC

General 2.4 GHz **5 GHz** 6 GHz

6 GHz radio settings

Turn off 6 GHz radio See band selection above.

Standard power service Enable to allow access points to operate at Standard Power Mode using Automatic Frequency Coordination (AFC) as per FCC requirements. AFC uses location and height of the access point to determine the power limits of each channel, ensuring that it does not interfere with licensed incumbents.

Check location availability using GNSS USB module for indoor WiFi 6E/7 access points ⓘ

On Off

[Cisco AFC FAQ](#) | [CW9800 AFC Configuration Guide](#) | [Meraki AFC Configuration Guide](#)

Campus Gateway

Enterprise-class cloud functionality

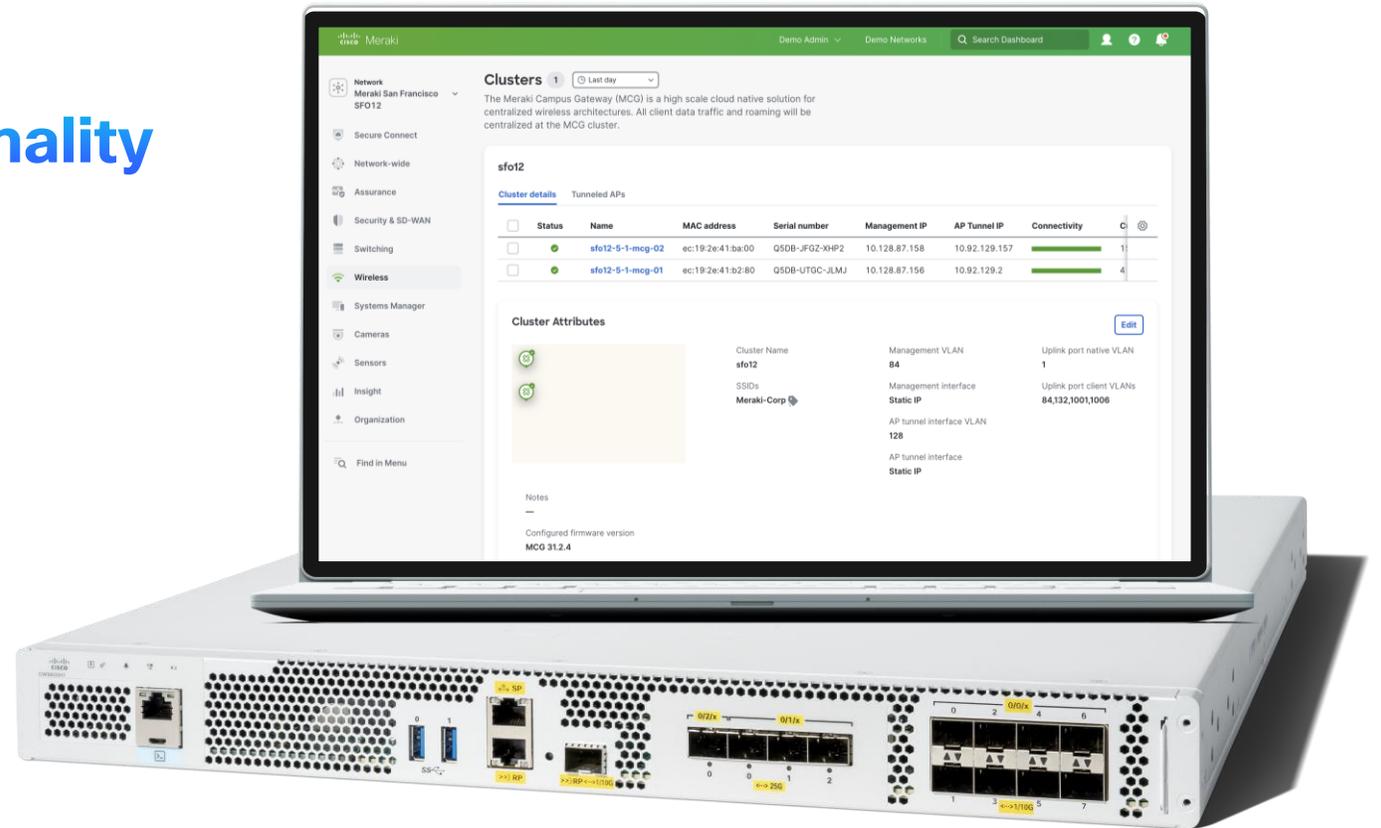
Support critical campus wireless services with cloud management and real-time control plane

Deploy without redesign

Deploy Campus Gateway with little to no redesign of the on-premises wireless network architecture

Seamless roaming at scale

Scale up to 50,000 client devices and 5,000 access points with a single Campus Gateway



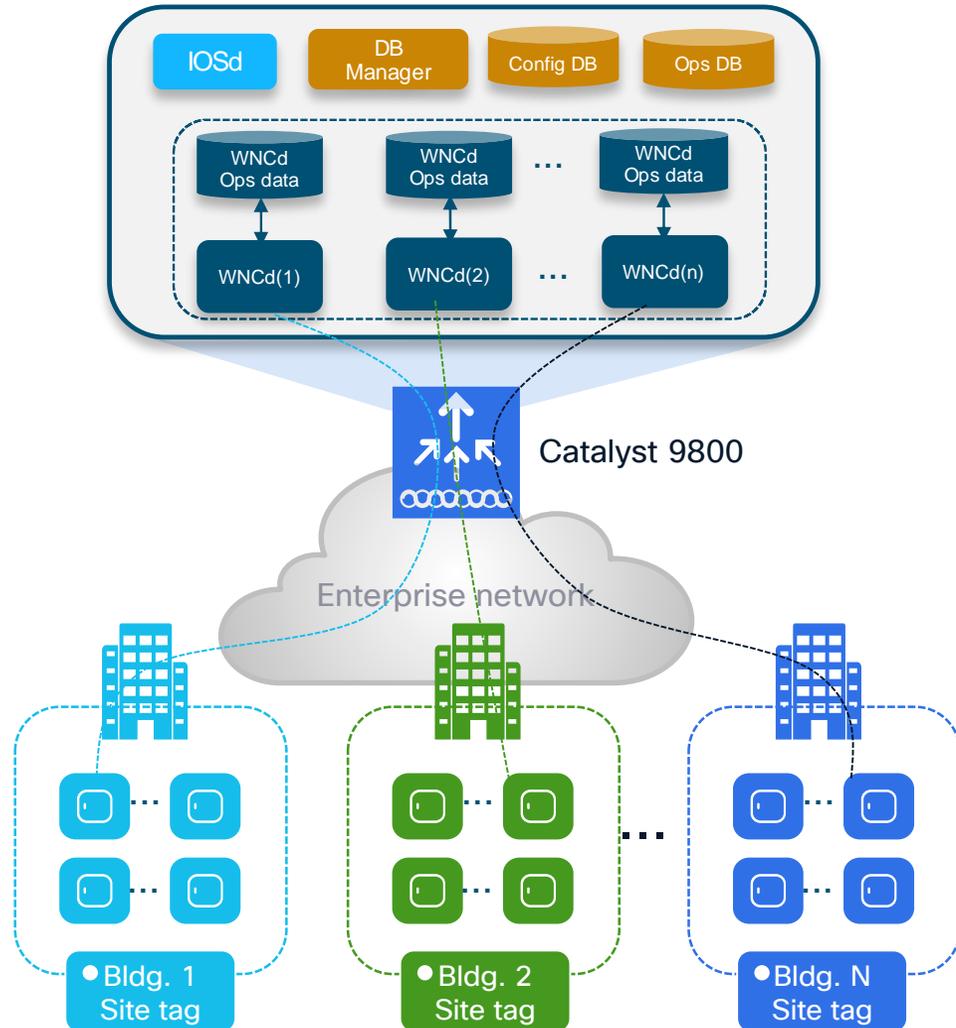
Cloud-Managed High Density

The screenshot displays the Cisco Meraki management console. On the left is a navigation sidebar with categories: Network Home, Network-wide, Wireless (selected), and Organization. The main content area is titled 'Configuration overview' and shows details for a specific SSID named '5g'. The SSID is currently 'enabled'. Below this, various configuration options are listed, including Name (rename), Access control (edit settings), Encryption (PSK (WPA2)), Sign-on method (None), Bandwidth limit (unlimited), Client IP assignment (Local LAN), Clients blocked from using LAN (no), Wired clients are part of Wi-Fi network (no), VLAN tag (n/a), and VPN (Disabled). A 'Splash page' section is also visible, with 'Splash page enabled' set to 'no' and 'Splash theme' set to 'n/a'. A small help icon and a '(Please ...)' prompt are visible at the bottom right of the configuration area.

Similarly to “traditional” Catalyst networks:

- Manage AP Tx power appropriately
- Tune PHY rates
- Limit SSID count per AP as much as possible
- Optimize channels
- Leverage RX-SOP (carefully, when needed)

Site Tags – Design considerations



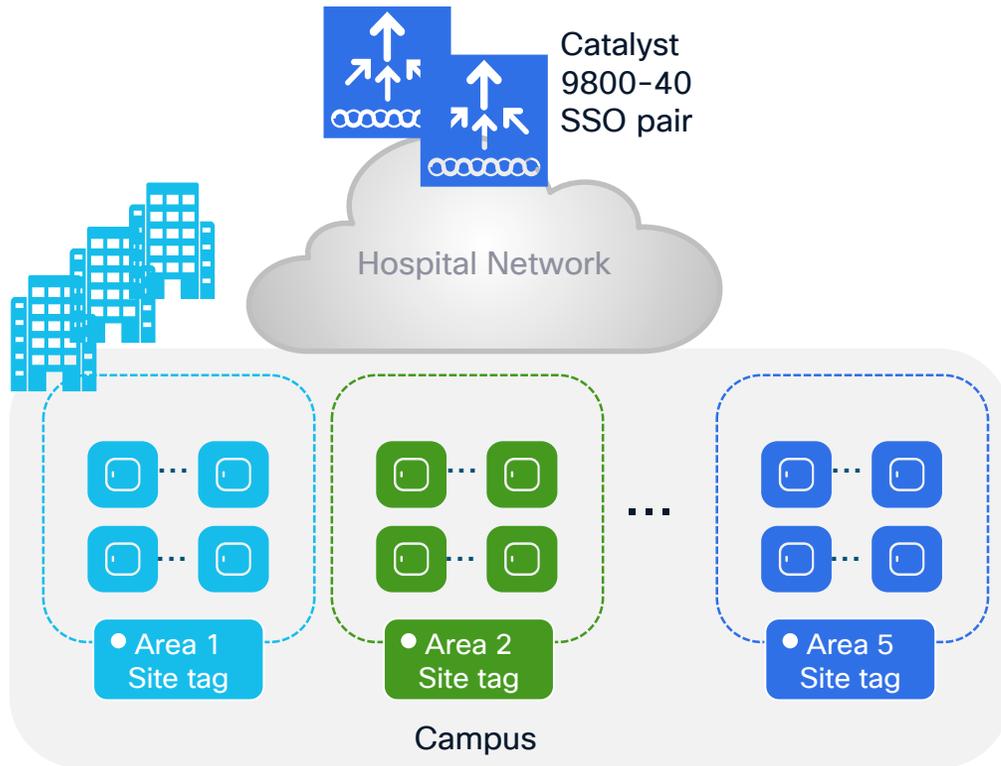
A few more important suggestions:

- Distributing APs (and clients) across custom Site Tags (and thus WNCd's) gives better scale and performance
- In large public venues, avoid having more Site Tags than # of WNCd's
- The number of WNCd varies from platform to platform:

Platform	# of WNCd instances
EWC (on AP or C9k switch)	1
C9800-L	1
C9800-CL (small)	1
C9800-CL (medium)	3
C9800-40	5
C9800-CL (large)	7
C9800-80	8

The following command shows the # of WNCd's processes:
`9800#sh processes platform | inc wncd`

C9800 Site Tag Design in High Density



- Custom Site Tags deterministically distribute APs across C9800 processes, aka “WNCd’s”
- Always use Custom Site Tags – not Default – to ensure load is balanced in a predictable way
- Recommended AP count per Site Tag will vary based on the environment
- Consider roaming patterns and minimize roaming between Site Tags

Refer to the [C9800 Best Practices](#) guide for the latest guidance

Site Tag Limitations

Platform	Maximum number of APs per site tag*
C9800-80, C9800-CL (medium and large)	1600
C9800-40	800
Any other C9800 platform	Equal to the maximum number of APs supported

Platform	Recommended number of site tags
C9800-80	8 or a multiple (16, 24, ...)
C9800-CL (large)	7 or a multiple (14, 21,..)
C9800-40	5 or a multiple (10, 15, ...)
C9800-CL (medium)	3 or a multiple (6, 9, ...)

Always refer to the [C9800 Best Practices](#) guide for the latest guidance

Helpful Site Tag Monitoring Commands

show wireless stats ap loadbalance summary

- Shows summary of APs assigned to each WNCd

```
██████████#show wireless stats ap loadbalance summary
DTLS drop - 380
```

WNCd	APs Discovered	APs Joined	APs Timedout
0	179	179	8715

show wireless loadbalance tag affinity wncd <wncd-number>

- Shows which site tags are assigned to each WNCd

```
██████████#show wireless loadbalance tag affinity wncd 0
```

Tag	Tag type	No of AP's Joined
██████████	SITE TAG	177
██████████	SITE TAG	1

Other 9800 Tips: L2/L3

On 9800's - **Don't assign an IP Address to SVI's** without good reason!
(Can quickly overwhelm upstream L3 hops)

Primary reasons you may need an SVI:

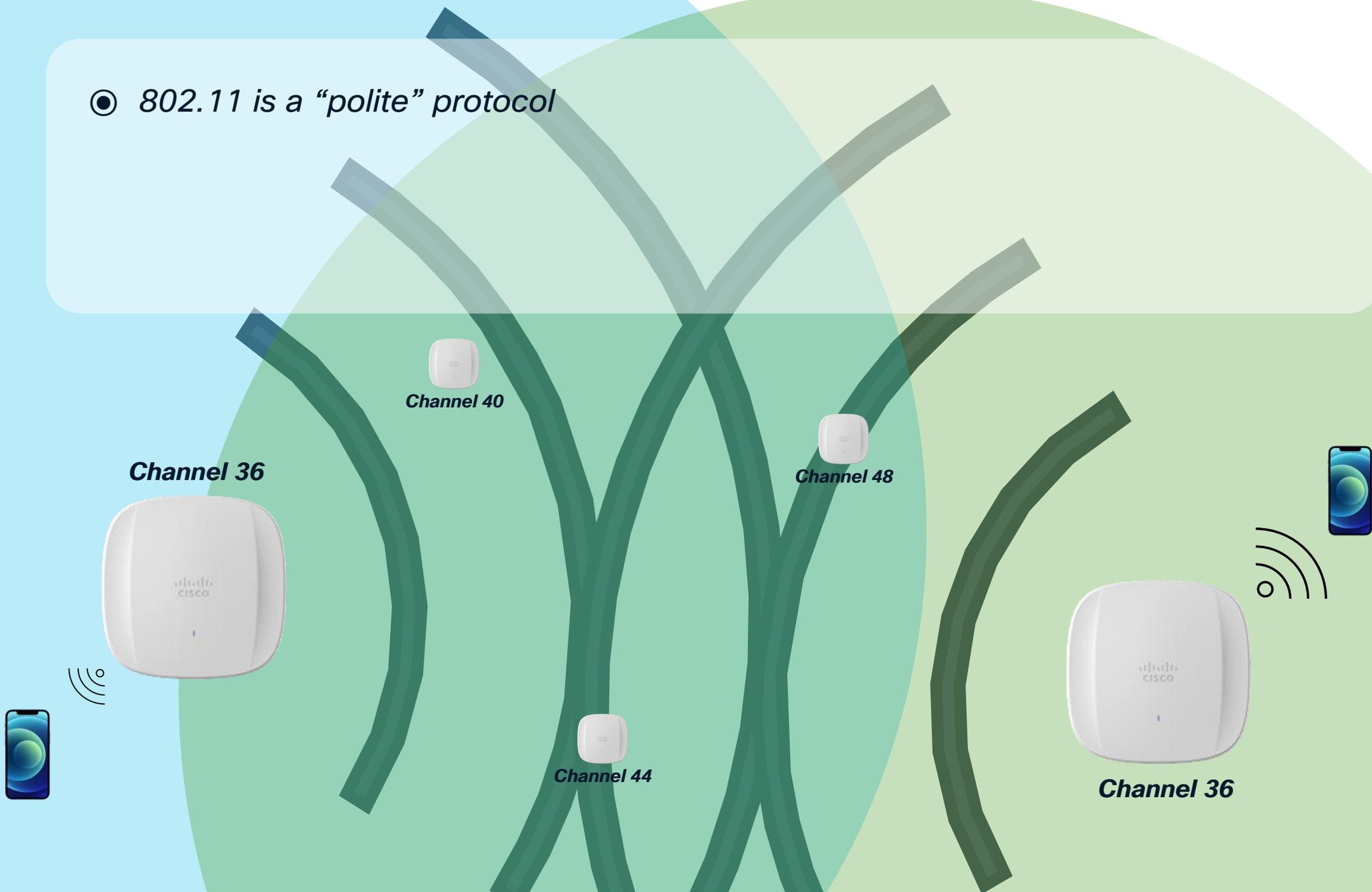
- mDNS
- DHCP Relay (uncommon in High Density)

If you need an SVI - plan Layer 3 scale upstream accordingly!

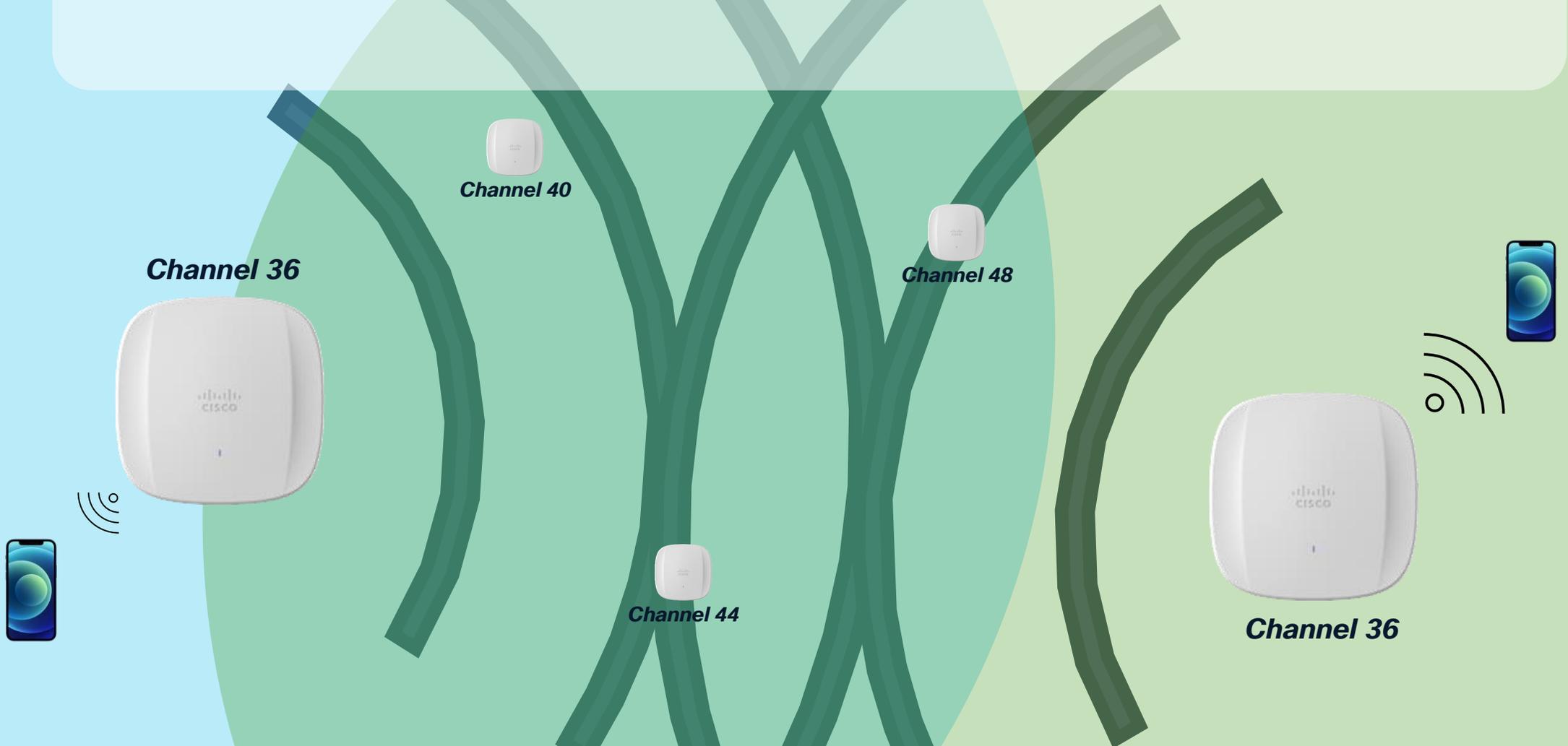
<https://www.cisco.com/c/en/us/products/collateral/wireless/catalyst-9800-series-wireless-controllers/guide-c07-743627.html>

The (Not So) Secret High Density Weapon: RX-SOP

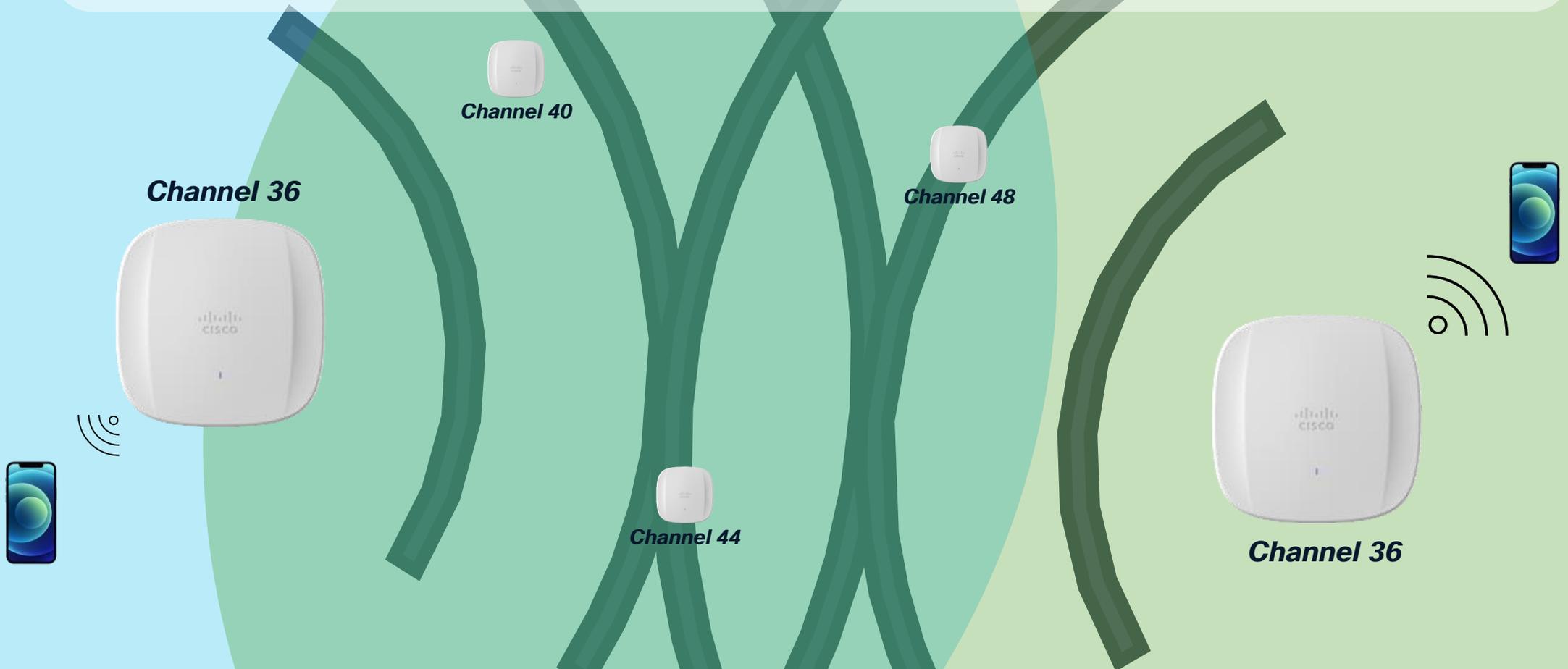
© 802.11 is a “polite” protocol



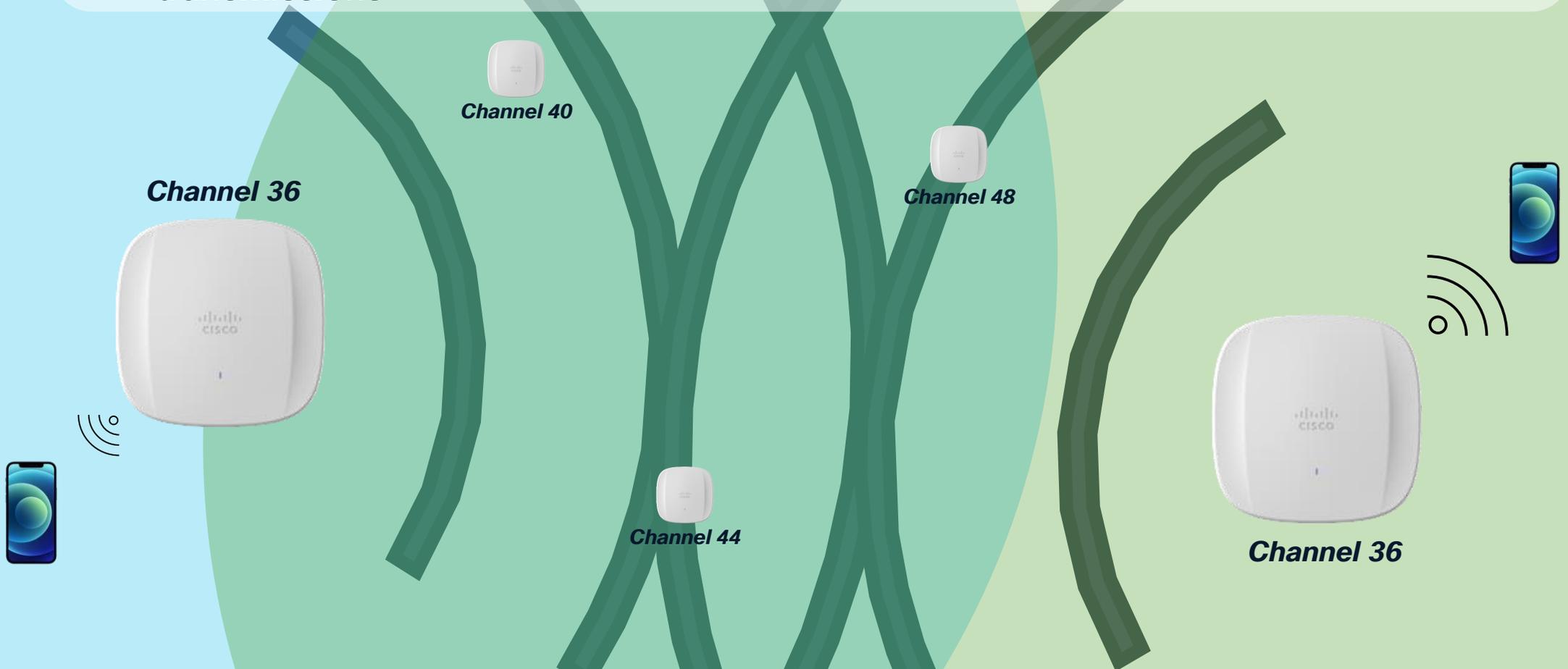
- 802.11 is a “polite” protocol
- I must listen before I start to talk - I will not talk until it’s “quiet” on my channel



- 802.11 is a “polite” protocol
- I must listen before I start to talk – I will not talk until it’s “quiet” on my channel
- In dense deployments, you will have co-channel AP’s in range of each other



- 802.11 is a “polite” protocol
- I must listen before I start to talk – I will not talk until it’s “quiet” on my channel
- In dense deployments, you will have co-channel AP’s in range of each other
- RX-SOP optimization helps us tune out the most distant co-channel transmissions



Receive Sensitivity Threshold (RX-SOP)

What does it do?

Reduces “receive” sensitivity of the AP to a pre-determined power level

Example: ignore everything coming into the radio at lower than -80dBm , because those devices are unlikely to be in our cell

Why is it helpful?

Allows us to transmit more often to clients in our intended cell



Receive Sensitivity Threshold (RX-SOP)

Without Custom RX-SOP Threshold
(Default / “Auto” Radio Sensitivity)

Radio processes
everything that
it can hear – any
frame with
enough SNR

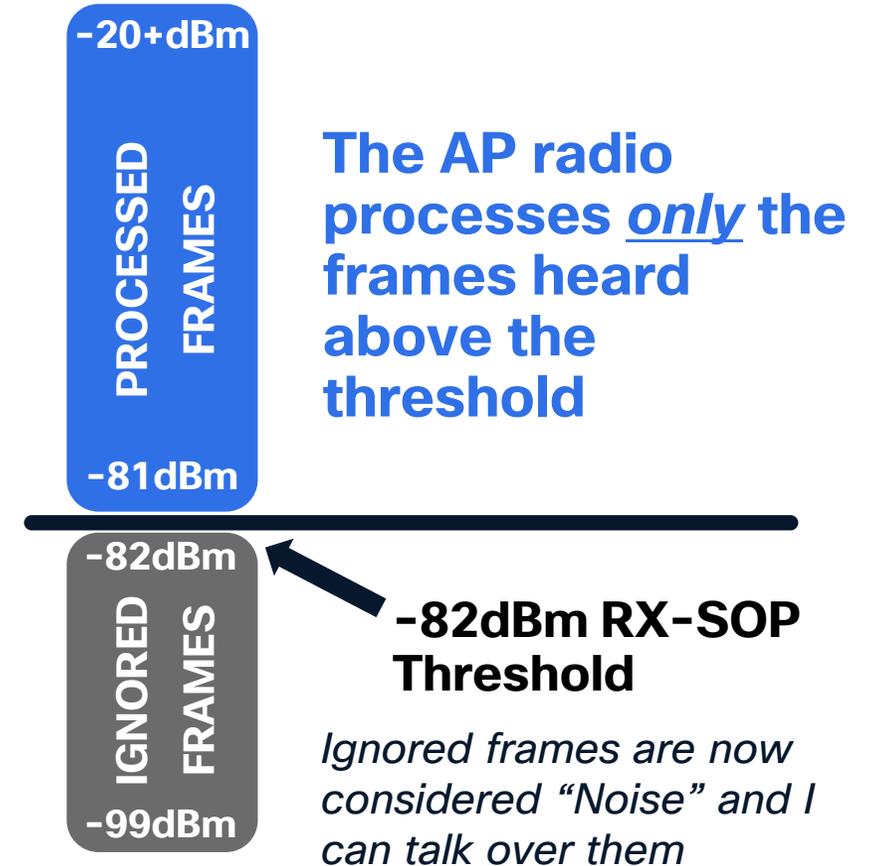


Receive Sensitivity Threshold (RX-SOP)

Without Custom RX-SOP Threshold
(Default / "Auto" Radio Sensitivity)

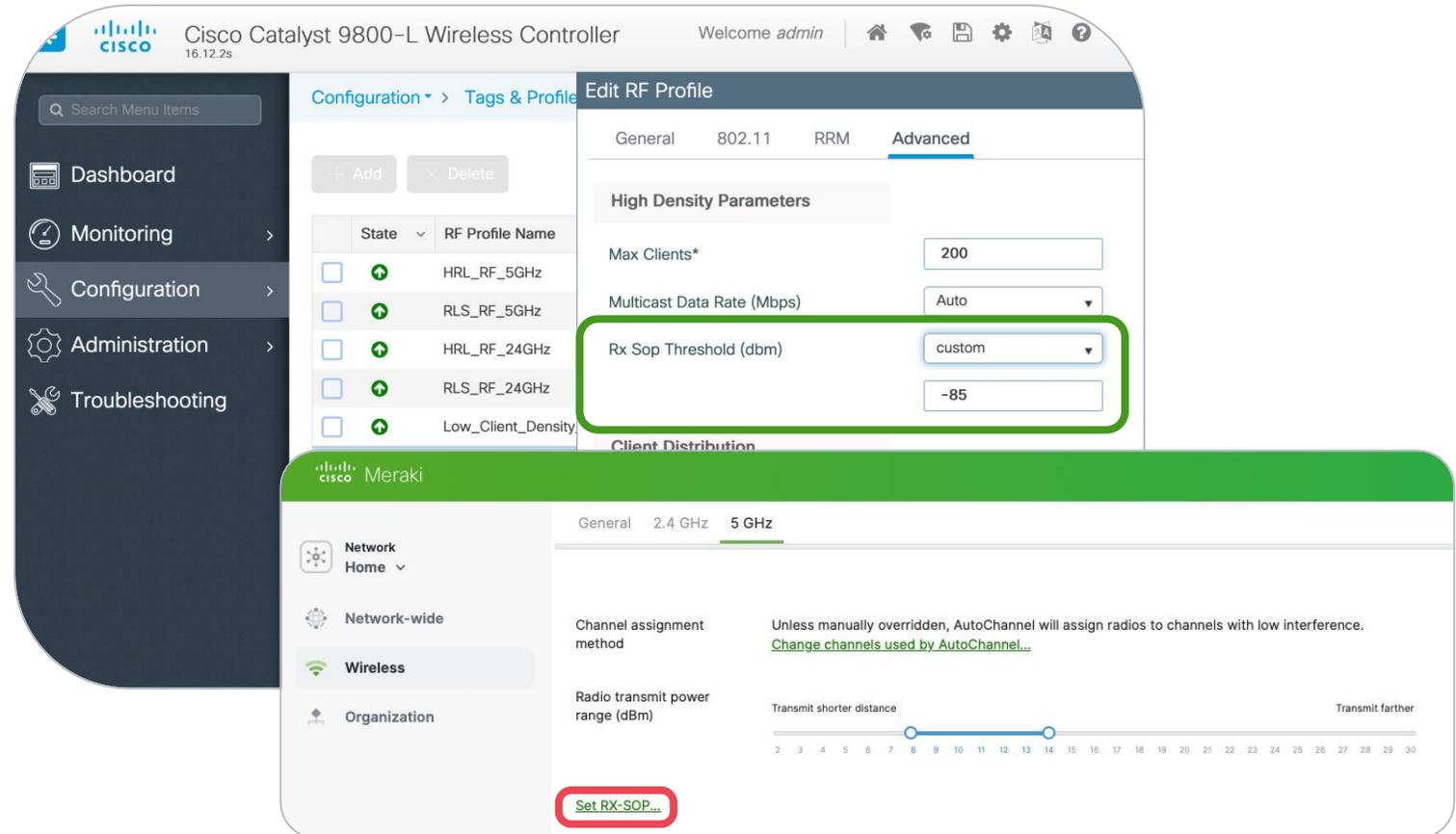


With Custom RX-SOP Threshold



Receive Sensitivity Threshold (RX-SOP)

- Configure in the RF Profile (On-Prem or Cloud)



The screenshot displays the Cisco Catalyst 9800-L Wireless Controller configuration interface. The main navigation menu on the left includes Dashboard, Monitoring, Configuration, Administration, and Troubleshooting. The central pane shows the 'Edit RF Profile' configuration for a specific profile, with the 'Advanced' tab selected. Under 'High Density Parameters', the 'Rx Sop Threshold (dbm)' is set to 'custom' with a value of '-85'. Below this, the 'Meraki' interface is visible, showing the '5 GHz' radio configuration. The 'Radio transmit power range (dBm)' is set to a range from 8 to 14 dBm, and a 'Set RX-SOP...' button is highlighted at the bottom.

Receive Sensitivity Threshold (RX-SOP)



- **Configure in the RF Profile (On-Prem or Cloud)**
- **Be careful and make small adjustments**
 - Generally, start in the -80's

Receive Sensitivity Threshold (RX-SOP)



- **Configure in the RF Profile (On-Prem or Cloud)**
- **Be careful and make small adjustments**
 - Generally, start in the -80's
- Remember – adjusting the RX-SOP threshold **doesn't impact the actual RF energy on the channel**, but it does impact APs' sensitivity to it
 - High Channel Utilization still affects all clients
- **WiFi6, WiFi6E, and/or use of C9104/CW9179F may reduce the need for RX-SOP** in some environments; continue to monitor your Channel Utilization and adjust as needed

HOW TO: Optimize RX-SOP Thresholds

- 1 Choose client devices and representative areas to test
- 2 Create a temporary SSID on one AP in the test area so your client doesn't roam

(see hidden slides for tips on AireOS / 9800)

- 3 Monitor the AP's view of test clients throughout the cell

(from WLC UI, WLC CLI, or AP CLI)

- 4 Pad the worst reading by another 15dB or more = initial RX-SOP threshold

Example: Worst AP-observed RSSI value is -72; initial RXSOP threshold with 15dB cushion = -87 (or higher)

The screenshot shows the Cisco Catalyst 9800-L Wireless Controller configuration interface. The main navigation menu on the left includes Dashboard, Monitoring, Configuration, Administration, and Troubleshooting. The current view is 'Configuration > Tags & Profiles > Edit RF Profile'. The 'Advanced' tab is selected, showing 'High Density Parameters'. The 'Rx Sop Threshold (dbm)' is set to 'custom' with a value of '-85', which is highlighted with a green box. Other parameters include Max Clients* (200), Multicast Data Rate (Mbps) (Auto), Client Distribution, Load Balancing Window* (5), Load Balancing Denial Count* (3), and ATF Configuration (DISABLED).

State	RF Profile Name
<input type="checkbox"/>	HRL_RF_5GHz
<input type="checkbox"/>	RLS_RF_5GHz
<input type="checkbox"/>	HRL_RF_24GHz
<input type="checkbox"/>	RLS_RF_24GHz
<input type="checkbox"/>	Low_Client_Density
<input type="checkbox"/>	High_Client_Density
<input type="checkbox"/>	Low_Client_Density
<input type="checkbox"/>	High_Client_Density
<input type="checkbox"/>	Typical_Client_Dens
<input type="checkbox"/>	Typical_Client_Dens

HOW TO: Optimize RX-SOP Thresholds (9800)

1. Pick the client device(s) you want to test
2. Pick the representative area(s) you want to test
3. Create a new temporary WLAN and Policy Tag
4. Assign the Policy Tag to the test AP
5. Join your client device(s) to the new SSID and monitor how the AP hears your client(s) (from AP CLI - “show controller d 1 client <mac-addr>”)
6. Test for “worst case scenario” - bodies between device and AP, furthest corner of the cell, etc. Continually check RSSI from AP side.
7. Take your “worst” RSSI value, add a 10-15dB cushion, and use that as your initial RXSOP threshold for that cell type (set in RF Tag)

Example: Worst RSSI value is -72; initial RXSOP with 15dB cushion = -87

Review: How AP's Hear Clients

For a detail on a [single client](#), at AP CLI:

Telnet/SSH to AP and use “show controller d <0|1> client <mac-addr>” for immediate client RSSI readings of a single client

```
10#sho controller d 1 client FC:F8:AE:60:98:34
<clip>
Additional info for client FC:F8:AE:60:98:34
RSSI: -47
<clip>
Statistics for client FC:F8:AE:60:98:34
mac          <clip> stats_ago expiration
FC:F8:AE:60:98:34 <clip> 0.700000 0
```

↑
How long ago were these stats updated (in sec)?

HOW TO: Optimize RX-SOP Thresholds (AireOS)

1. Pick the client device(s) you want to test
2. Pick the representative area(s) you want to test
3. Create a new temporary SSID and a new AP Group
4. Add the AP's you want to test to the new AP group
5. Join your client device(s) to the new SSID and monitor how the AP hears your client(s) (from AP CLI – “show controller d 1 client <mac-addr>”)
6. Test for “worst case scenario” – bodies between device and AP, furthest corner of the cell, etc. Continually check RSSI from AP side.
7. Take your “worst” RSSI value, add a 10-15dB cushion, and use that as your initial RXSOP threshold for that cell type

Example: Worst RSSI value is -72; initial RXSOP with 15dB cushion = -87

Tuning RX-SOP Thresholds: GUI

The screenshot displays the Cisco Catalyst 9800-L Wireless Controller GUI. The main interface shows the configuration for an RF Profile named 'High-Client-Density-802.11a'. The 'High Density Parameters' tab is active, and the 'Rx Sop Threshold Parameters' section is highlighted with a green box, showing a value of -78 dBm. A red '8.7+' is overlaid on the screenshot. A secondary window shows the 'Advanced' tab of the RF Profile configuration, where the 'Rx Sop Threshold (dbm)' is set to 'custom' and '-85'.

© 2025 Cisco and/or its affiliates. All rights reserved.

BRKEWN-2087

Hidden Slide - For Your Reference

CISCO

RF Optimization: Radio Settings Overview

The screenshot shows the Meraki dashboard navigation menu. The 'Wireless' menu item is highlighted with a red circle. Under the 'Configure' sub-menu, the 'Radio settings' option is also highlighted with a red circle and a green checkmark.



The screenshot shows the 'Radio settings' page in the Meraki dashboard. The page displays a table of radio settings for 12 radios. The table has columns for Status, AP name, Channel, Ch. Width (MHz), Target power (dBm), Transmit power (dBm), and RF Profile. The 'Radio settings' option in the navigation menu is highlighted with a grey background.

<input type="checkbox"/>	Status	AP name	Channel	Ch. Width (MHz)	Target power (dBm)	Transmit power (dBm)	RF Profile
<input type="checkbox"/>	●	Basement AP	157 (Auto)	40	23 - 30	25	Basic Indoor Profile
<input type="checkbox"/>	●	Deck AP	149 (Auto)	40	23 - 30	25	Basic Indoor Profile
<input type="checkbox"/>	●	Josh's Office AP	48 (Auto)	40	23 - 30	25	Basic Indoor Profile
<input type="checkbox"/>	●	Main Floor Office AP	36 (Auto)	40	23 - 30	23	Basic Indoor Profile
<input type="checkbox"/>	●	Basement AP	11 (Auto)	20	5 - 30	11	Basic Indoor Profile
<input type="checkbox"/>	●	Deck AP	11 (Auto)	20	5 - 30	14	Basic Indoor Profile
<input type="checkbox"/>	●	Josh's Office AP	6 (Auto)	20	5 - 30	23	Basic Indoor Profile
<input type="checkbox"/>	●	Main Floor Office AP	1 (Auto)	20	5 - 30	8	Basic Indoor Profile

RF Optimization: Radio Settings Overview

The screenshot displays the Meraki Radio settings interface. The left sidebar shows navigation options: Network Home, Network-wide, Wireless (selected), and Organization. The main content area is titled "Radio settings" and includes tabs for "Overview" and "RF profiles". Below the tabs are filter dropdowns for BAND, CHANNEL, AP TAG, AP MODEL, RF PROFILE, and REGULATORY DOMAIN (FCC Edit). A search bar labeled "Search by AP name..." shows "12 Radios". Action buttons for "Update auto channels" and "Edit settings..." are present. The main table lists radio configurations with columns for Status, AP name, Channel, Ch. Width (MHz), Target power (dBm), Transmit power (dBm), and RF Profile.

<input type="checkbox"/>	Status ⓘ	AP name	Channel ▼	Ch. Width (MHz)	Target power (dBm) ⓘ	Transmit power (dBm) ⓘ	RF Profile	
<input type="checkbox"/>	●	Basement AP	157 (Auto)	40	23 - 30	25	Basic Indoor Profile	
<input type="checkbox"/>	●	Deck AP	149 (Auto)	40	23 - 30	25	Basic Indoor Profile	
<input type="checkbox"/>	●	Josh's Office AP	48 (Auto)	40	23 - 30	25	Basic Indoor Profile	
<input type="checkbox"/>	●	Main Floor Office AP	36 (Auto)	40	23 - 30	23	Basic Indoor Profile	
<input type="checkbox"/>	●	Basement AP	11 (Auto)	20	5 - 30	11	Basic Indoor Profile	
<input type="checkbox"/>	●	Deck AP	11 (Auto)	20	5 - 30	14	Basic Indoor Profile	
<input type="checkbox"/>	●	Josh's Office AP	6 (Auto)	20	5 - 30	23	Basic Indoor Profile	
<input type="checkbox"/>	●	Main Floor Office AP	1 (Auto)	20	5 - 30	8	Basic Indoor Profile	

- Sortable / Filterable table for radio settings per AP
- Channel
- Width
- Min/Max Power
- Current Power
- RF Profile

RF Optimization: RF Profiles

The screenshot shows the Meraki dashboard interface. The left sidebar contains navigation options: Network Home, Network-wide, Wireless, and Organization. The main content area is titled 'Radio settings' and has a sub-tab 'RF profiles' highlighted with a red circle. Below this, there are three profile cards:

- Basic Indoor Profile** (DEFAULT INDOOR): Applied to 6 APs. Overrides applied to 6/6 of these APs. Settings table below.
- Basic Outdoor Profile** (DEFAULT OUTDOOR): Applied to 0 APs. Settings table below.
- 5GHz Only**: Applied to 0 APs. Settings table below.

	2.4 GHZ	5 GHZ
Channel assignment	Auto	Auto
AutoPower max	30	30
AutoPower min	5	23
Min. bitrate	Per SSID	Per SSID
Channel width		40

	2.4 GHZ	5 GHZ
Channel assignment	Auto	Auto
AutoPower max	30	30
AutoPower min	5	8
Min. bitrate	Per SSID	Per SSID
Channel width		Auto

	2.4 GHZ	5 GHZ
Channel assignment	Auto	Auto
AutoPower max	30	30
AutoPower min	5	8
Min. bitrate	9	6
Channel width		40

The 'Create an RF Profile' dialog box is shown, offering several options:

- [New Profile From Scratch](#)
- Auditorium Profile**: For auditorium deployments accommodating a large number of devices. Limits coverage area per AP and optimizes client roaming. [Customize]
- Classroom Profile**: For classroom deployments. Provides good coverage and optimizes client roaming. [Customize]
- Open Office Profile**: For open office deployments. Balances performance and coverage. [Customize]
- Conference Room Profile**: For conference room deployments. Provides good coverage and encourages client roaming once outside of the room. [Customize]
- Outdoors Profile**: For outdoor deployments. Prioritizes coverage and connectivity for distant and legacy clients. [Customize]

RF Optimization: RX SOP

The screenshot shows the Cisco Meraki configuration interface for a wireless network. The top navigation bar is green with the Cisco Meraki logo. On the left, there is a sidebar with menu items: Network Home, Network-wide, Wireless (highlighted), and Organization. The main content area is titled '5 GHz' and contains the following settings:

- Channel assignment method:** Unless manually overridden, AutoChannel will assign radios to channels with low interference. [Change channels used by AutoChannel...](#)
- Radio transmit power range (dBm):** A slider control ranging from 2 to 30 dBm. The slider is currently set between 8 and 14 dBm. Labels 'Transmit shorter distance' and 'Transmit farther' are positioned at the ends of the slider.
- Set RX-SOP...:** A button located below the slider, highlighted with a red rounded rectangle.

RF Optimization: RX SOP

The screenshot shows the Cisco Meraki configuration page for the 5 GHz band. The left sidebar contains navigation options: Network Home, Network-wide, Wireless (selected), and Organization. The main content area has tabs for General, 2.4 GHz, and 5 GHz. Under the 5 GHz tab, there are two settings: 'Channel assignment method' and 'Radio transmit power range (dBm)'. The 'Channel assignment method' is set to 'AutoChannel' with a note that it assigns radios to channels with low interference and a link to 'Change channels used by AutoChannel...'. The 'Radio transmit power range (dBm)' is a slider ranging from 2 to 30 dBm, with markers at 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, and 30. The slider is currently positioned between 8 and 14 dBm. Below the slider is a link 'Set RX-SOP...'. A red box highlights the 'Proceed' button in the warning dialog below.

Min. received power (RX-SOP)



PROCEED WITH CAUTION! MISUSE OF THIS OPTION CAN CAUSE SEVERE PERFORMANCE ISSUES WITH YOUR WIRELESS IMPLEMENTATION.

You should only use this option if you have a clear understanding of the nuances of RX-SOP and have conducted a site survey.

Proceed

Hide this option

RF Optimization: RX SOP

Meraki

General 2.4 GHz 5 GHz

Network Home

Network-wide

Wireless

Organization

Channel assignment method: Unless manually overridden, AutoChannel will assign radios to channels with low interference. [Change channels used by AutoChannel...](#)

Radio transmit power range (dBm): Transmit shorter distance [8-14] Transmit farther

[Set RX-SOP...](#)

Min. received power (RX-SOP)

! PROCEED WITH CAUTION! MISUSE OF THIS OPTION CAN CAUSE SEVERE PERFORMANCE ISSUES WITH YOUR WIRELESS IMPLEMENTATION

You should only use this option if you have a clear understanding of the nuances of RX-SOP and have conducted a site survey.

Proceed

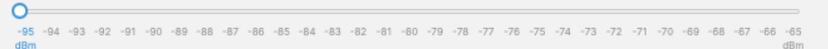
Min. received power (RX-SOP)

Disabled

Enabled

Listen for clients farther away

Ignore weaker clients



RF Optimization: RX SOP

Min. received power (RX SOP)

Disabled

Enabled

Listen for clients farther away

Ignore weaker clients

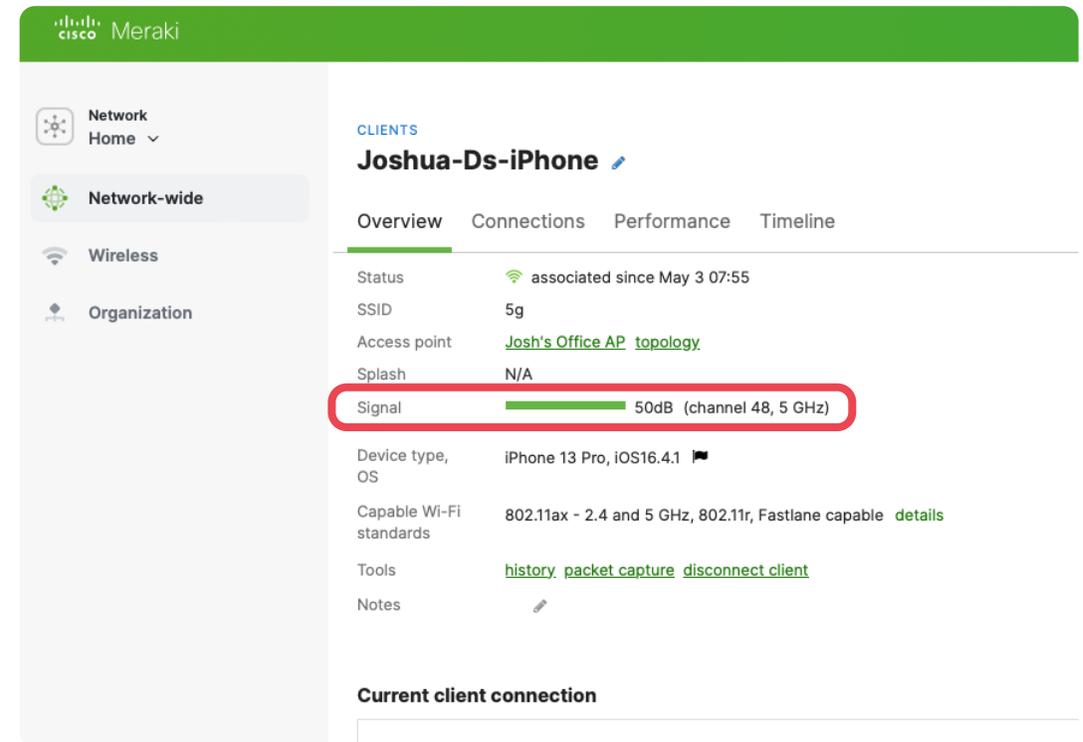
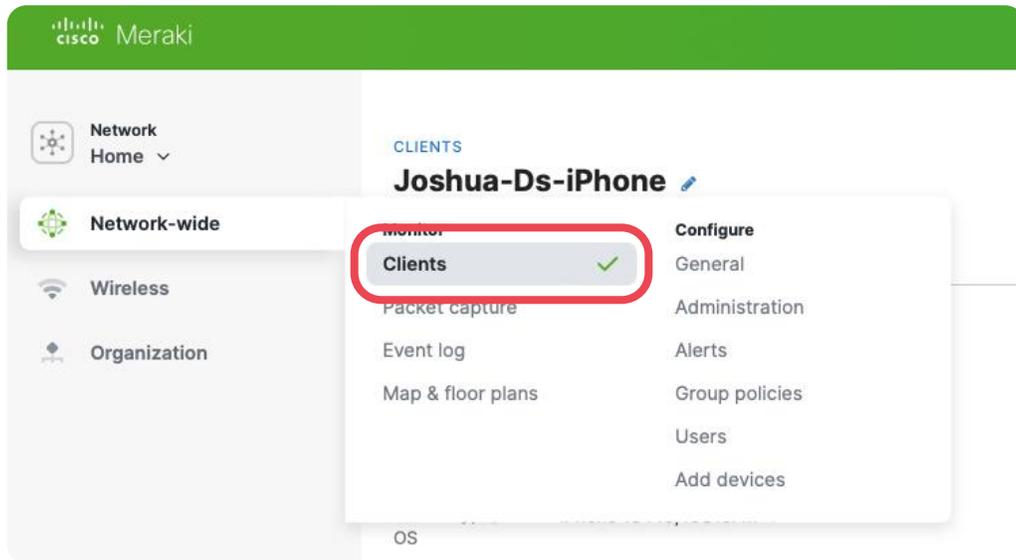


-95 dBm

-94 -93 -92 -91 -90 -89 -88 -87 -86 -85 -84 -83 -82 -81 -80 -79 -78 -77 -76 -75 -74 -73 -72 -71 -70 -69 -68 -67 -66 -65 dBm

-65 dBm

Monitoring Client RSSI @ AP for RXSOP Testing



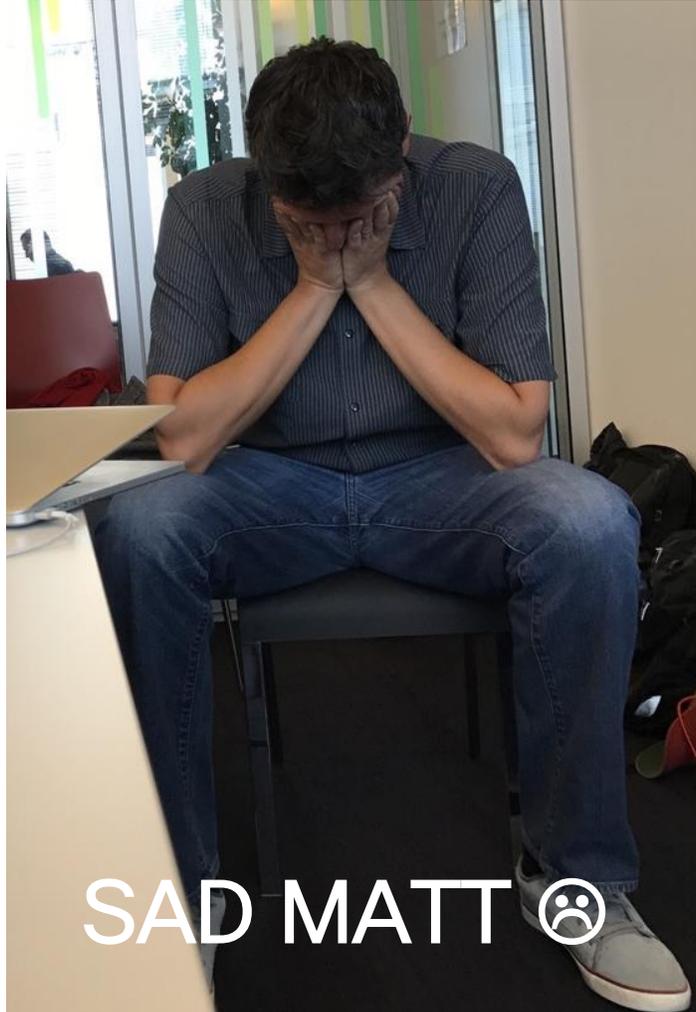
HOW TO: Optimize RX-SOP Thresholds

A key takeaway:

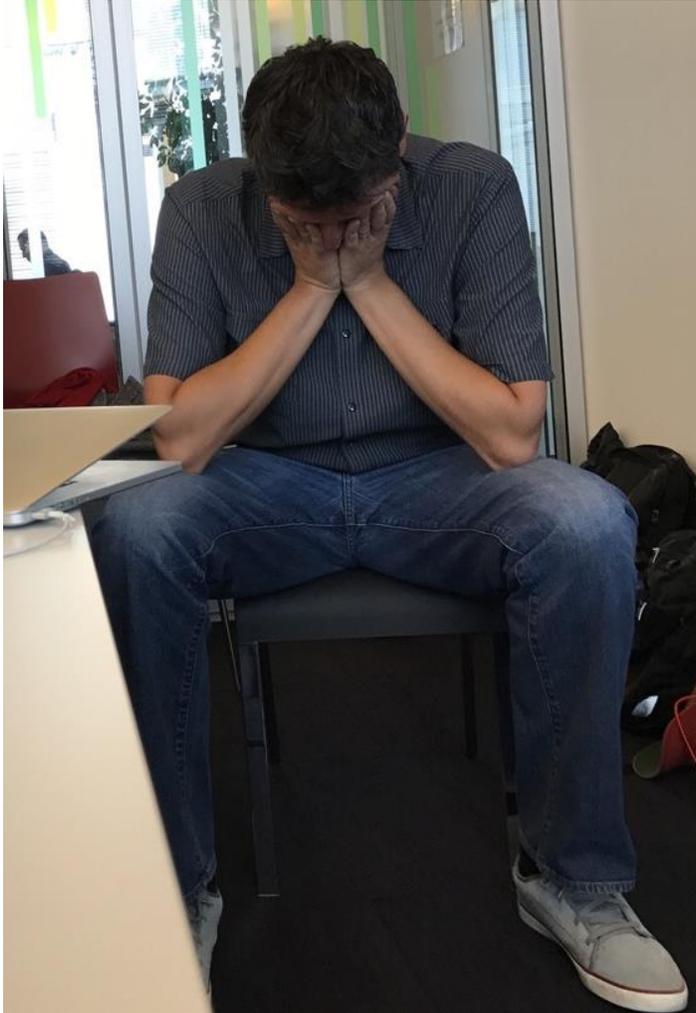
Be conservative and make small adjustments!

Common High Density Mistakes

Common High Density Optimization Mistakes



Common High Density Optimization Mistakes



- ❑ AP-to-AP transmit power imbalance (causes “Magnet” / overloaded AP’s)



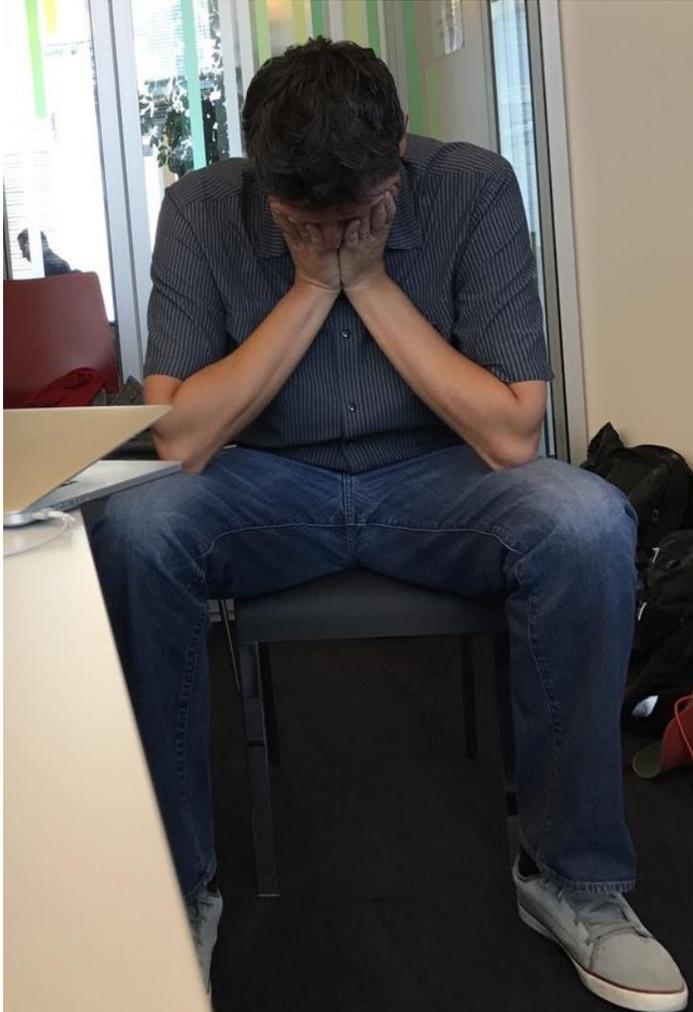
5GHz TX Power: 7dB
2 clients



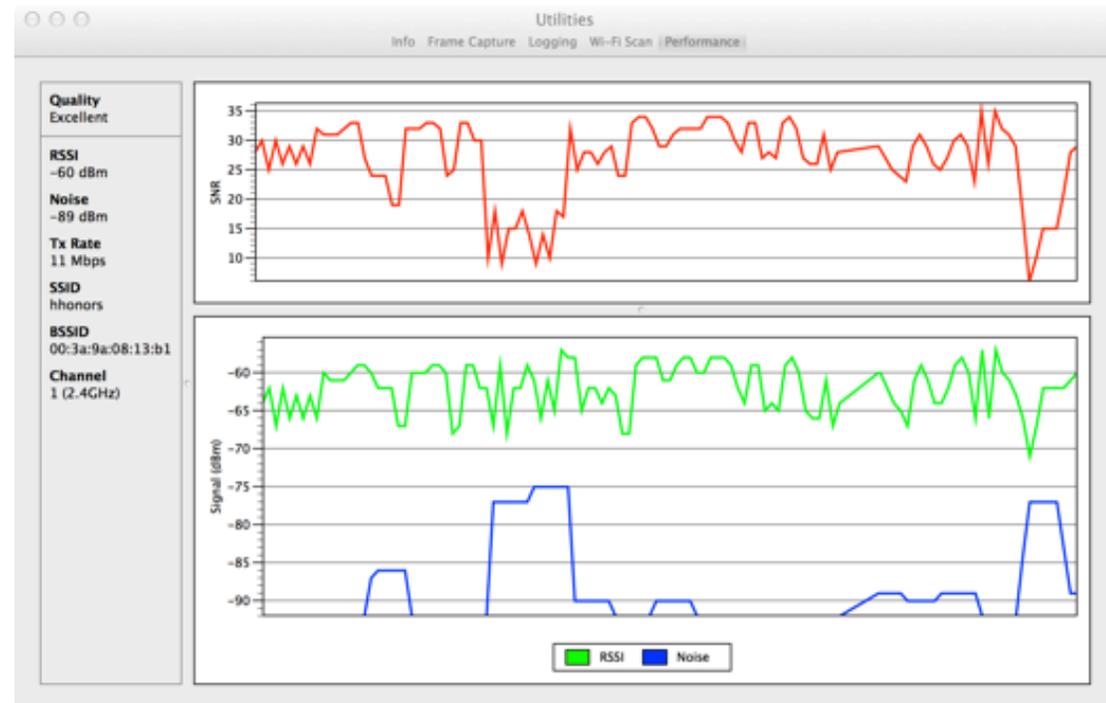
5GHz TX Power: 17dB
50 clients

Note: This also applies to the dual-5GHz C9104!

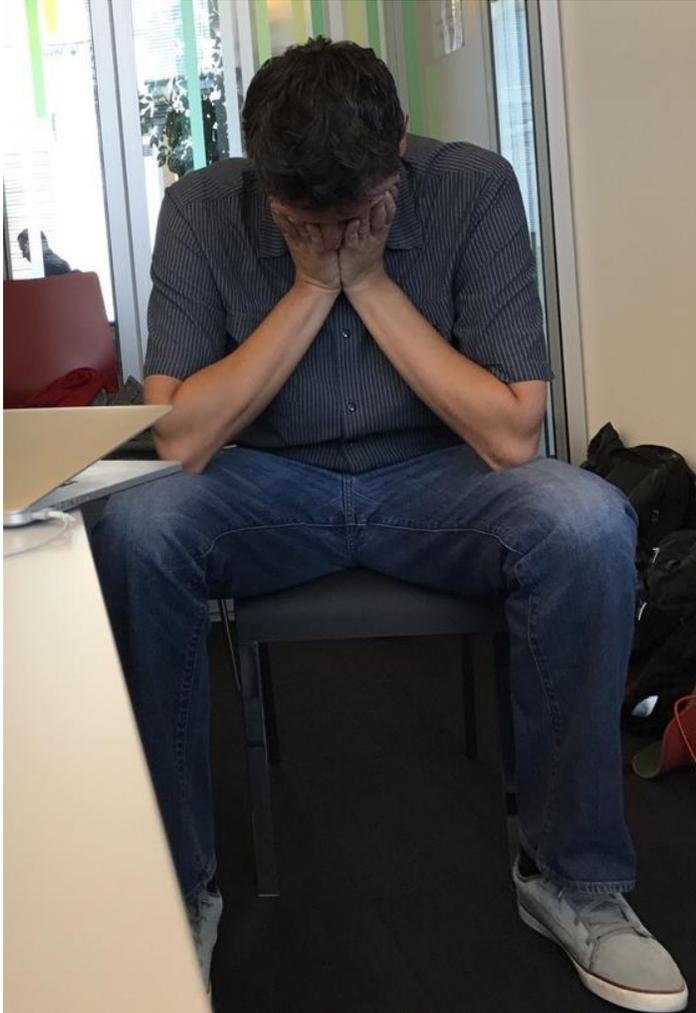
Common High Density Optimization Mistakes



- ❑ AP-to-AP transmit power imbalance (causes “Magnet” / overloaded AP’s)
- ❑ Transmit power too low to overcome noise floor

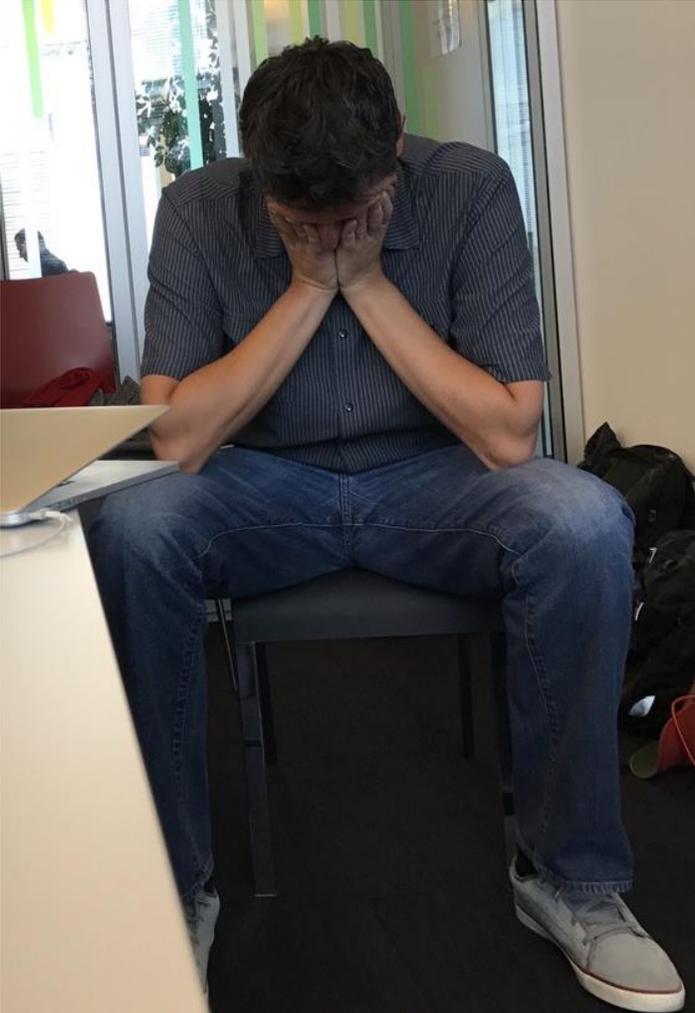


Common High Density Optimization Mistakes



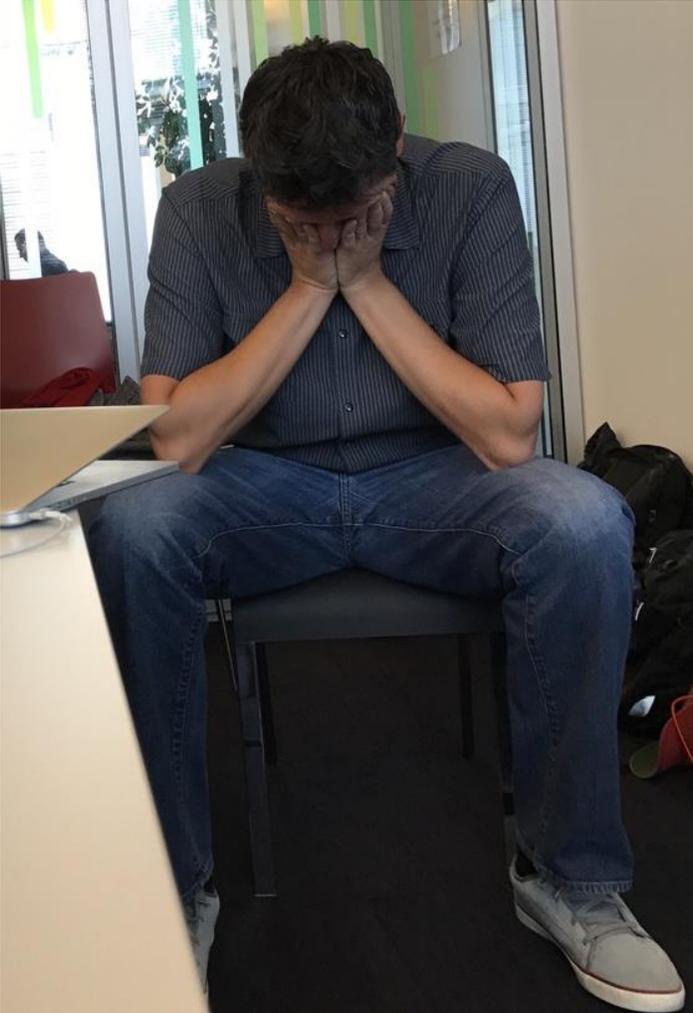
- ❑ AP-to-AP transmit power imbalance (causes “Magnet” / overloaded AP’s)
- ❑ Transmit power too low to overcome noise floor
- ❑ Channel Utilization high without real traffic

Common High Density Optimization Mistakes



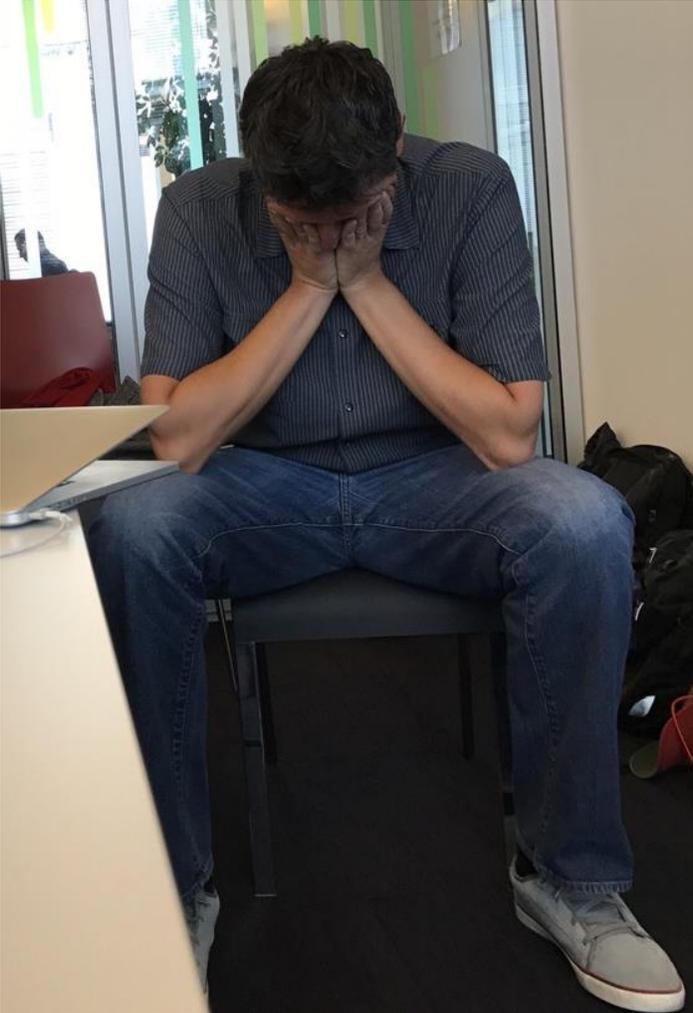
- ❑ AP-to-AP transmit power imbalance (causes “Magnet” / overloaded AP’s)
- ❑ Transmit power too low to overcome noise floor
- ❑ Channel Utilization high without real traffic
- ❑ Minimum mandatory PHY rate improperly tuned (too high or too low)

Common High Density Optimization Mistakes



- ❑ AP-to-AP transmit power imbalance (causes “Magnet” / overloaded AP’s)
- ❑ Transmit power too low to overcome noise floor
- ❑ Channel Utilization high without real traffic
- ❑ Minimum mandatory PHY rate improperly tuned (too high or too low)
- ❑ Too many SSID’s enabled (not using AP Groups to control where SSID’s are enabled)

Common High Density Optimization Mistakes



- ❑ AP-to-AP transmit power imbalance (causes “Magnet” / overloaded AP’s)
- ❑ Transmit power too low to overcome noise floor
- ❑ Channel Utilization high without real traffic
- ❑ Minimum mandatory PHY rate improperly tuned (too high or too low)
- ❑ Too many SSID’s enabled (not using AP Groups to control where SSID’s are enabled)
- ❑ Unusable channels (especially 5GHz)

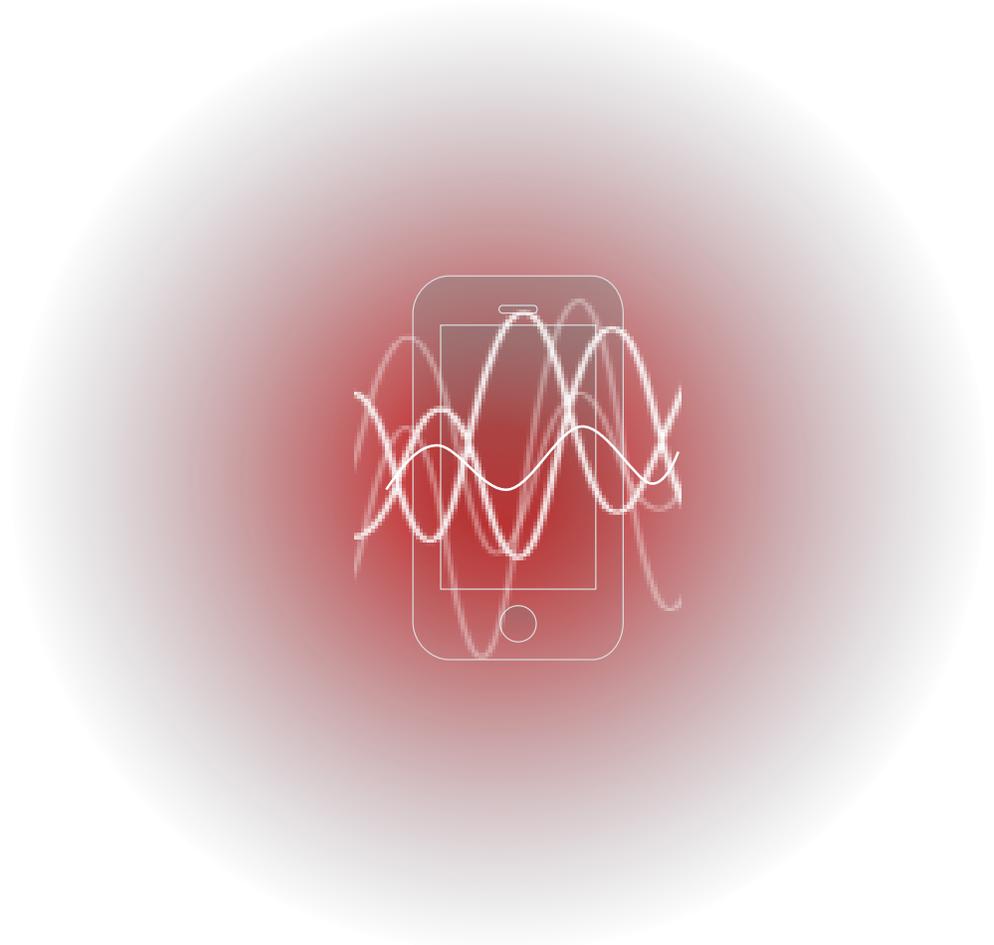
Common High Density Optimization Mistakes



- ❑ AP-to-AP transmit power imbalance (causes “Magnet” / overloaded AP’s) **TPC**
- ❑ Transmit power too low to overcome noise floor **TPC**
- ❑ Channel Utilization too high **Env. Cleanup / RXSOP**
- ❑ Minimum mandatory PHY rate improperly tuned (too high or too low) **PHY Rate tuning**
- ❑ Too many SSID’s enabled (not using AP Groups to control where SSID’s are enabled) **Policy Tags**
- ❑ Unusable channels (especially 5GHz) **DCA**

Smartphone Roaming Challenges

- As a rule, smartphones pick the loudest AP, then stick to that AP as long as possible
- Many phones won't go looking for a "better" AP unless things are REALLY bad (low RSSI/SNR)
- We attack this problem with workarounds (Optimized Roaming feature) and standards-based features (11k, 11v, adaptive 11r)
- Standards-based methods are best!!



Rogue APs

- DSL/cable modems
 - Are often auto-configured on “least loaded” channel on 2.4ghz
- MiFi's, Eye-Fi's, and hotspot-enabled smartphones
- Low PHY rates, max power
- Often on overlapping channels due to least-congested channel selection
- Causes exponential load on the air due to probe requests/responses and beacons



Looks like it belongs... but it doesn't

Hidden Slide – For Your Reference

Non-WiFi Interferers

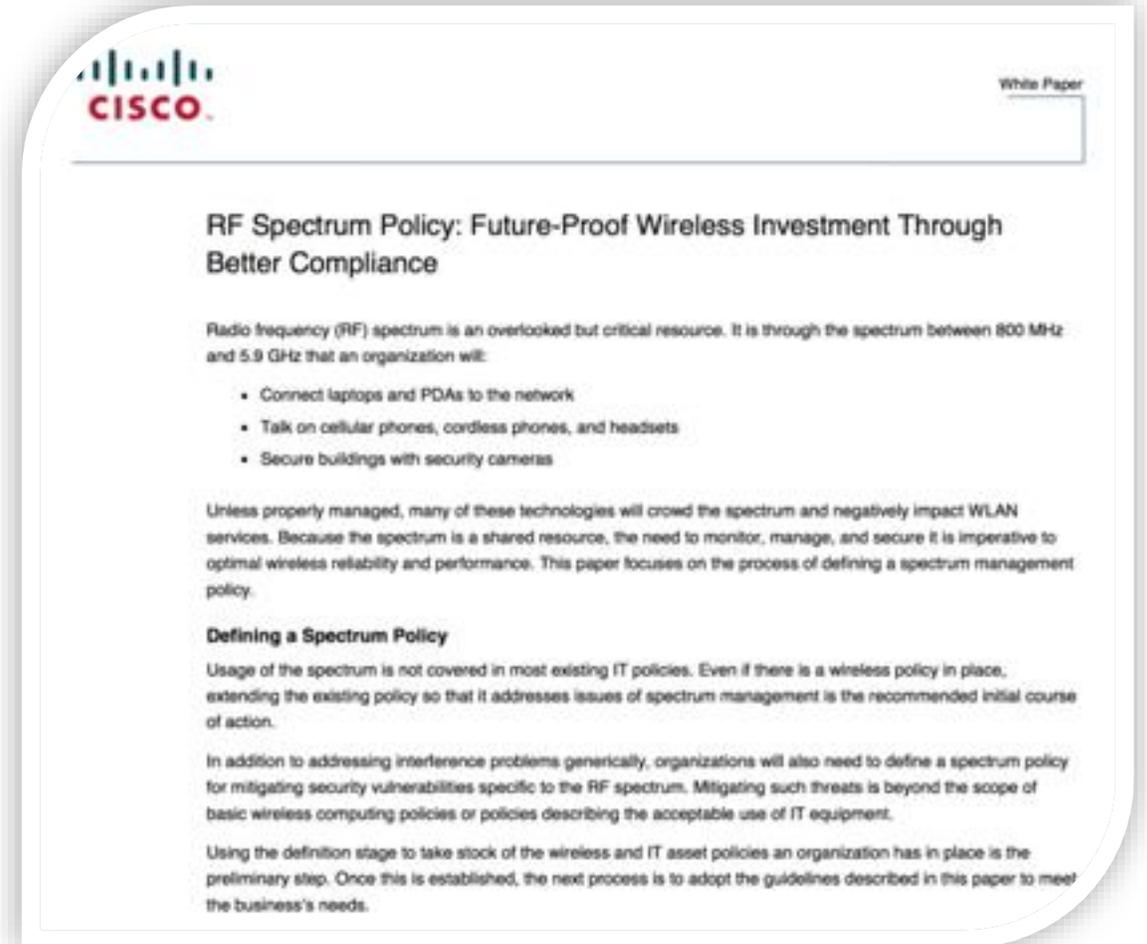


- Video cameras, wireless audio (Coachcomm, Zaxcom), lighting, pyro, and cryo systems, etc.
- Ever look at a Fluke meter and see zero AP's where you'd expect to see dozens? Non-WiFi Interferers often drown out 802.11 altogether.
- Mitigation: remove them altogether or change frequency if possible

What can we do?

Develop and Enforce an RF Policy

- Employ an effective RF policy
- Identify:
 - what's permitted in your environment
 - what is not permitted in your environment
 - whom to contact for further information



Our Favorite Tools

Our Favorite Tools

Cisco Wireless Troubleshooting & Analysis Tools (Free)



Wi-Fi Hawk



WCAE



WLAN Poller

Intuitibits Tools (Mac)



WiFi Explorer



AirTool



WiFi Signal

Intuitibits Tools (Windows)



WiFi Explorer Lite

Packet Capture & Analysis Tools



Metageek Chanalyzer



Wireshark



Meraki

(Article)

Analyzing Wireless Packet Captures

Site Survey Tools



Hamina



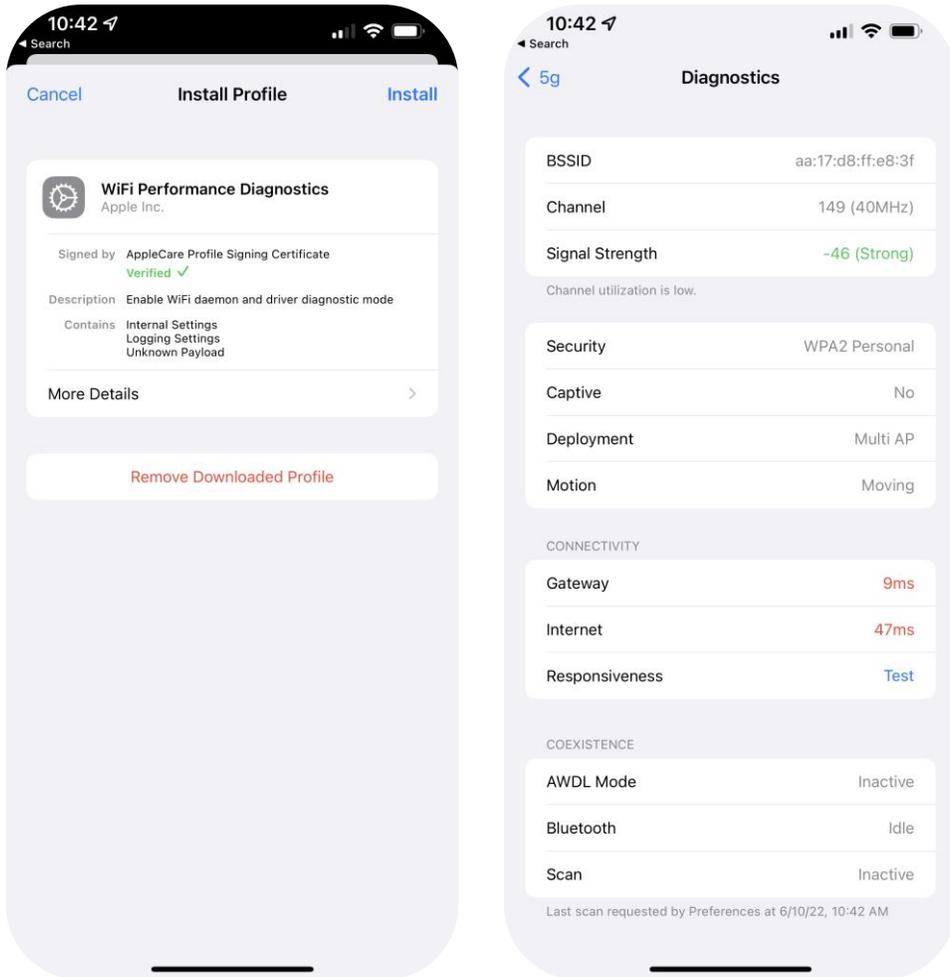
Ekahau

NetOps, AIOps, DevOps Tools



Cisco Catalyst Center Assurance

iOS Wi-Fi Diagnostics with iOS



Diagnostics Profile for installation on iOS devices extends on-device WiFi diagnostics capabilities

More Info:

<https://tidbits.com/2022/04/22/use-apples-networkquality-tool-to-test-internet-responsiveness/>

Profile Download:

- 1 Use the “easy” button from our friend Jiri
- 2 Download & install the profile from Apple

Note: Profile auto-expires after 7 days and must be re-installed when needed

Wireless Troubleshooting Tools

- Overview
 - [Wireless Troubleshooting Tools](#)
- WLCCA
 - Wireless Config Analyzer
 - Config Checks and Messages
 - Features
 - RF Analysis
 - RF Health
 - Support
- WCAE
 - Wireless Config Analyzer Express
 - How to use - Cloud
 - How to use - mini-Desktop
 - Changelog
 - Support
- WLAN Poller

Wireless Troubleshooting Tools

In order to help people in the field, doing Wireless networks troubleshooting and RF analysis, the WNG Escalation, TAC and Development teams have made available several tools to facilitate some of the most common tasks.

- [Wireless Config Analyzer Express - WCAE](#)
 - [Cloud Version](#)
 - [Mini Desktop Version](#) For access, please request to wcae@cisco.com
- [Wireless Lan Config Analyzer - WLCCA - Download V4.4.14](#)
 - For access, please request to wlc-conf-app-dev
- [WLAN Poller - Download Windows or Mac OS](#)

Next generation, multi platform Wireless Analyzer tool, including checks from WLCCA, and several new additions

Support for AireOS and 9800 IOS-XE controllers, you can use the Cloud version (summary view, all checks), or the Desktop version, providing a detailed XLS or text report, with RF analysis output, Flex summarisation and more... Now with Windows 10 or Mac OS support.

It is desktop Windows application, oriented primarily towards AireOS controllers Provides around 300+ configuration checks, RF analysis and RF Health evaluation

Bulk data collection script system, focused on capturing debugging data, flash che

[Chat with Us!](#)

Download: <https://developer.cisco.com/docs/wireless-troubleshooting-tools/>

Wireless Troubleshooting Tools

- **Wireless Config Analyzer Express** (WCAE) is an extremely valuable tool when validating and optimizing a Cisco Wi-Fi deployment
- WCAE helps us determine:
 - Configuration consistency across multiple WLC's
 - RF Problem Finder – determine likely “problem” RF areas
 - AP Neighbors – how do AP's hear each other? Too well, not well enough?
 - Additional views of CleanAir data
 - RRM overview with the RF Summary

Table of contents
Generated: 2023-01-30 11:06
WCAE Version: 0.12

Total Message Counts	
Errors:	9
Warnings:	30
Informational:	21
Program Execution	
Parsing Errors:	0
Processing Errors:	17

Configuration Checks:

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

Controller: ----

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

Client Audit

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

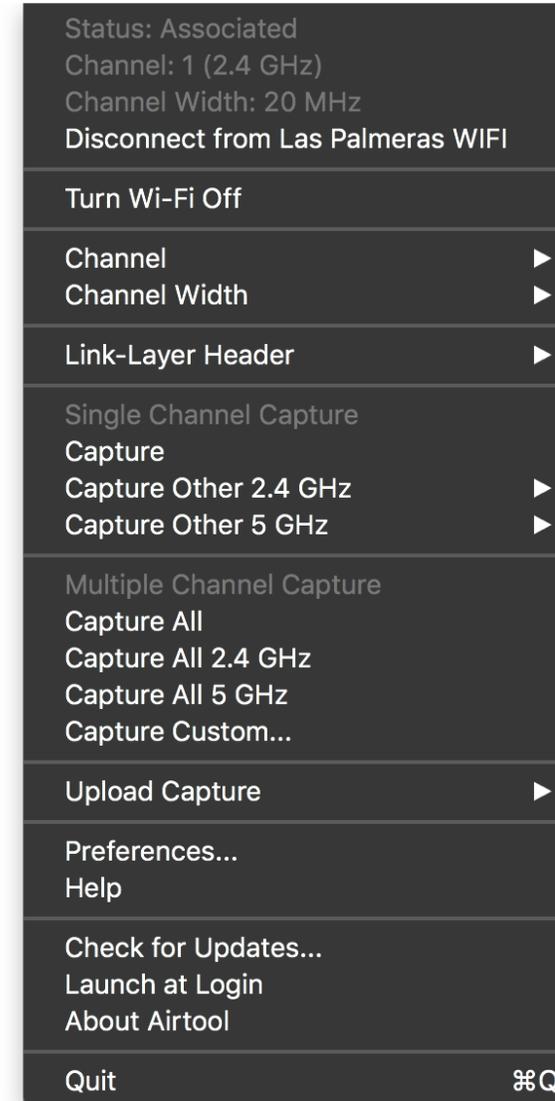
AP Information

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

Download: <https://developer.cisco.com/docs/wireless-troubleshooting-tools/>

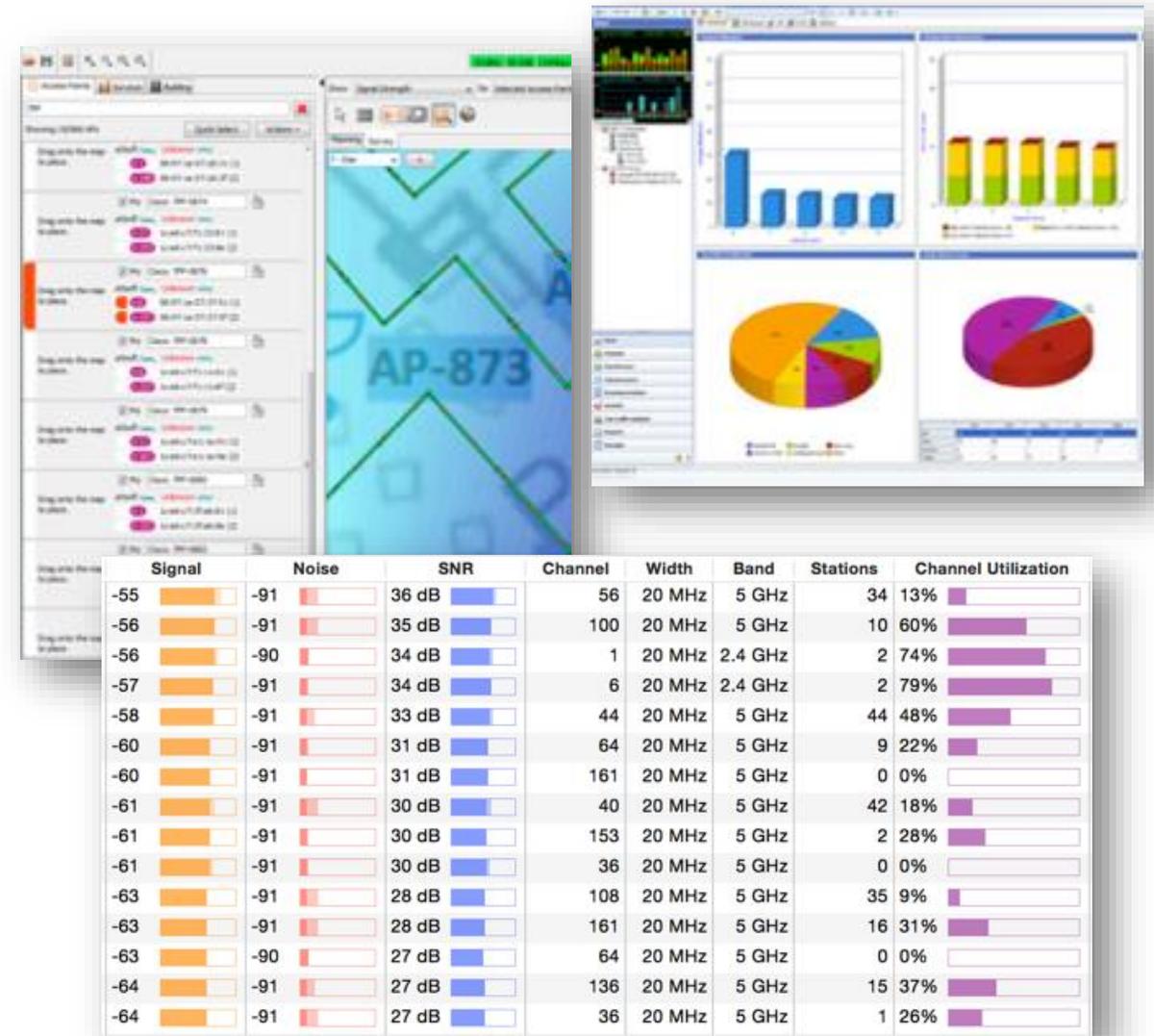
Packet Captures

- OmniPeek/Wireshark
 - For packet captures of the WLAN, including beacons and other management traffic
 - Helpful for troubleshooting of problems at the source
- AirTool
 - Free app for Mac – simplifies packet capture process
 - <https://www.adriangranados.com/apps/airtool>



Site Surveys

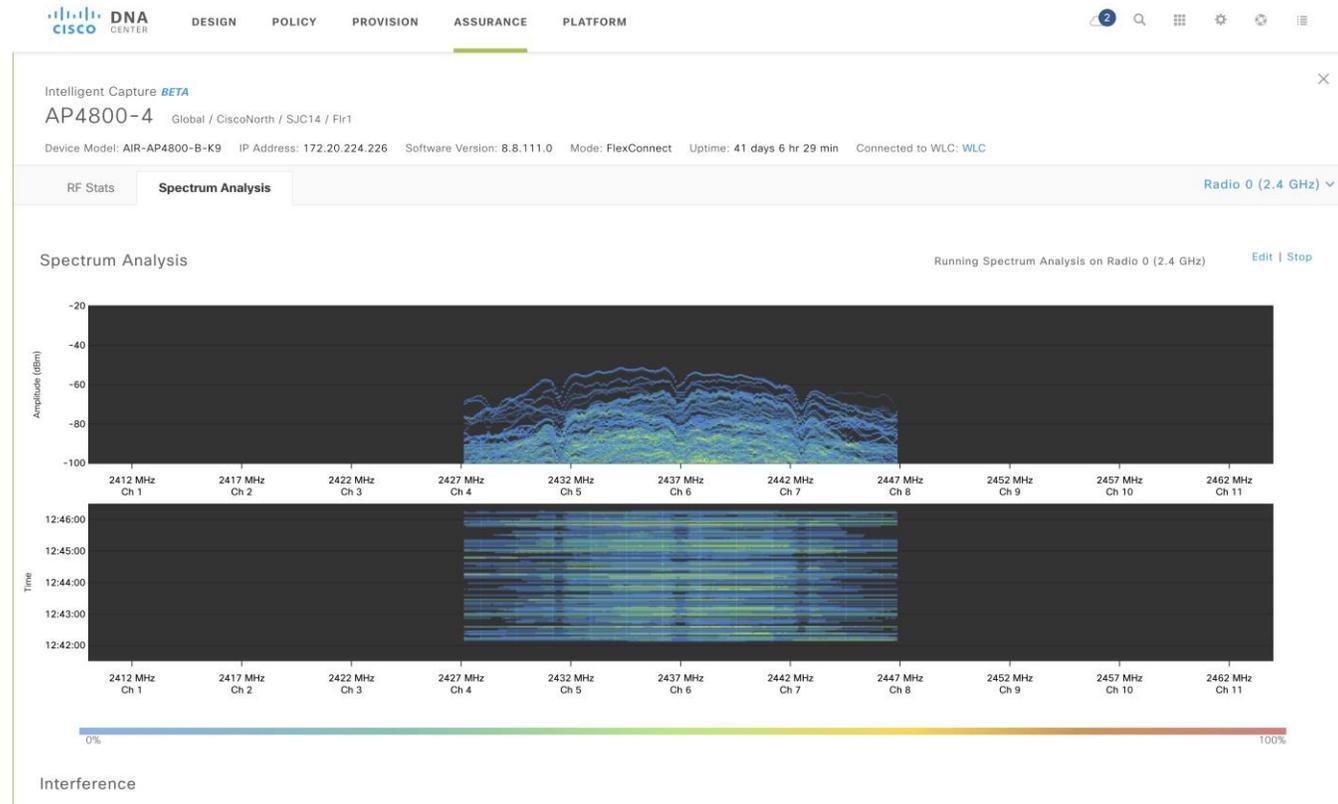
- Ekahau Site Survey Pro
 - Design & Verify
 - Determine differences in coverage that occur as a result of tuning changes



Spectrum Analysis

Cisco Catalyst Center Intelligent Capture / Cloud Dashboard

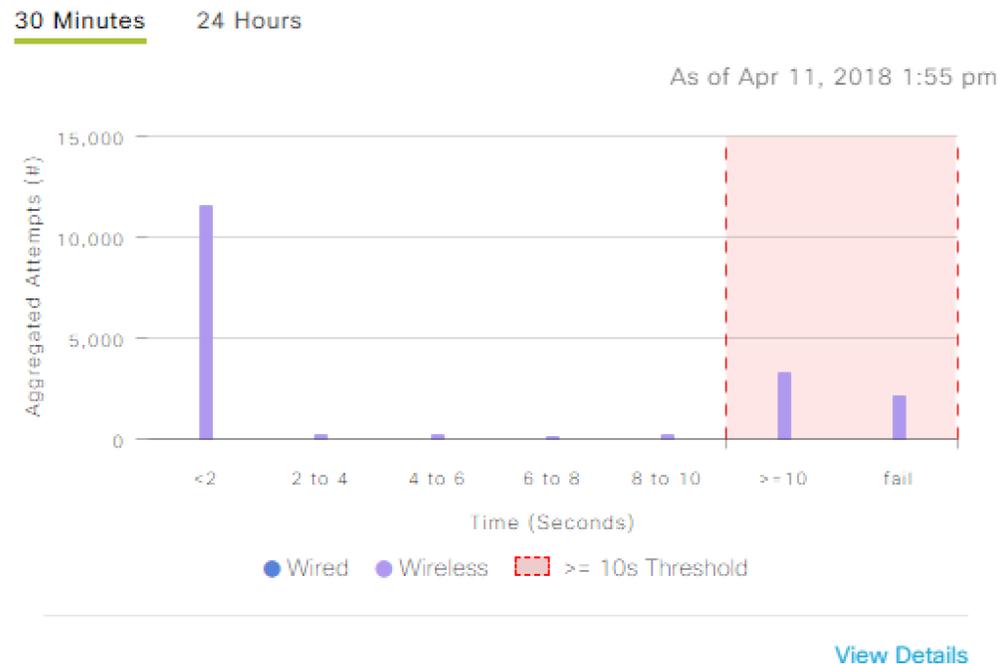
- Layer 1
- Provides a view of real energy on a channel
- Identify interferers of all types
- Critical part of the “big picture”



Cisco Catalyst Center Assurance

Broad applicability to High Density deployments

Client Attempts by Onboarding Times



- iOS Analytics
- Detailed client onboarding analysis
- Aironet Active Sensor support
- Intelligent Capture
- Network Time Travel

...and much more!

<https://clnv.s3.amazonaws.com/2018/usa/pdf/BRKEWN-2034.pdf>

Key Takeaways

- Design the RF environment with appropriate **antennas** and sensible physical **placements**
- Learn and understand your region's specific 6GHz Wi-Fi regulations and begin your planning
- Employ HD-focused **feature configurations** such as RF Profiles for more flexible and robust designs
- Get comfortable with **Wi-Fi analysis and optimization tools** to make informed, data-driven decisions

Complete your session evaluations



Complete a minimum of 4 session surveys and the Overall Event Survey to be entered in a drawing to win 1 of 5 full conference passes to Cisco Live 2026.



Earn 100 points per survey completed and compete on the Cisco Live Challenge leaderboard.



Level up and earn exclusive prizes!



Complete your surveys in the Cisco Live mobile app.

Continue your education



Visit the Cisco Showcase for related demos



Book your one-on-one Meet the Engineer meeting



Attend the interactive education with DevNet, Capture the Flag, and Walk-in Labs



Visit the On-Demand Library for more sessions at www.CiscoLive.com/on-demand

Contact us at: josuhr@cisco.com / mswartz9@cisco.com

Thank you

CISCO Live !

