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#CiscoLiveAPJC



Advanced RF Tuning w/Cisco Wireless:

Become an expert, while getting a little help from
Cisco AI

Jim Florwick – Principal, TME

BRKEWN-3413

Cisco Webex App

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- 1 Find this session in the Cisco Live Mobile App
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Webex spaces will be moderated by the speaker until November 15, 2024.



<https://ciscolive.ciscoevents.com/ciscolivebot/#BRKEWN-3413>



Agenda

- Cisco AI-Ops and Cisco RF Excellence
 - Cisco NDP – Neighbor Discovery Protocol
 - AI-Enhanced RRM
- Sustainability in Wireless?
- 6GHz Design Guidance
- Design Partner integration for Dashboard and Catalyst Center
- CleanAir Pro

Join the Discussion Webex Space

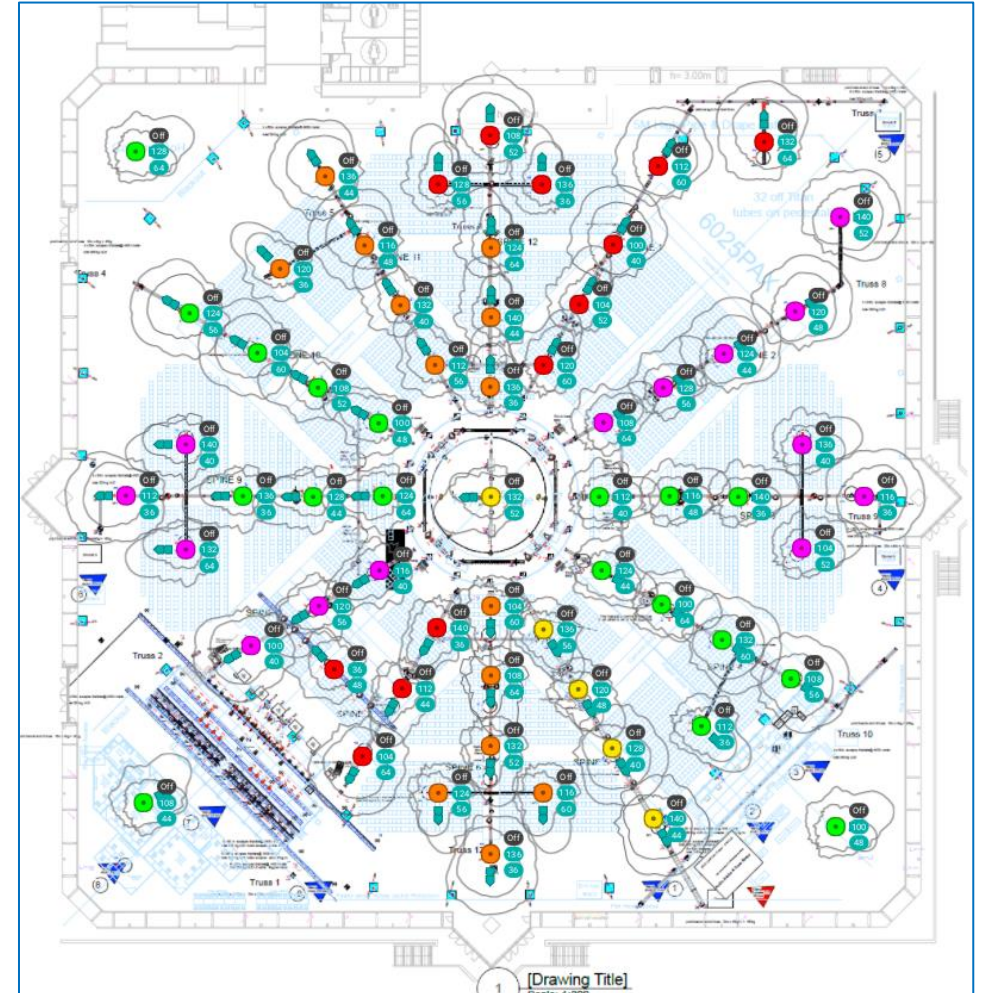
BRKEWN-3413:

Advanced RF Tuning for Wi-Fi6E
with Catalyst Wireless:

Cisco AI-Op's – Cisco RF Excellence

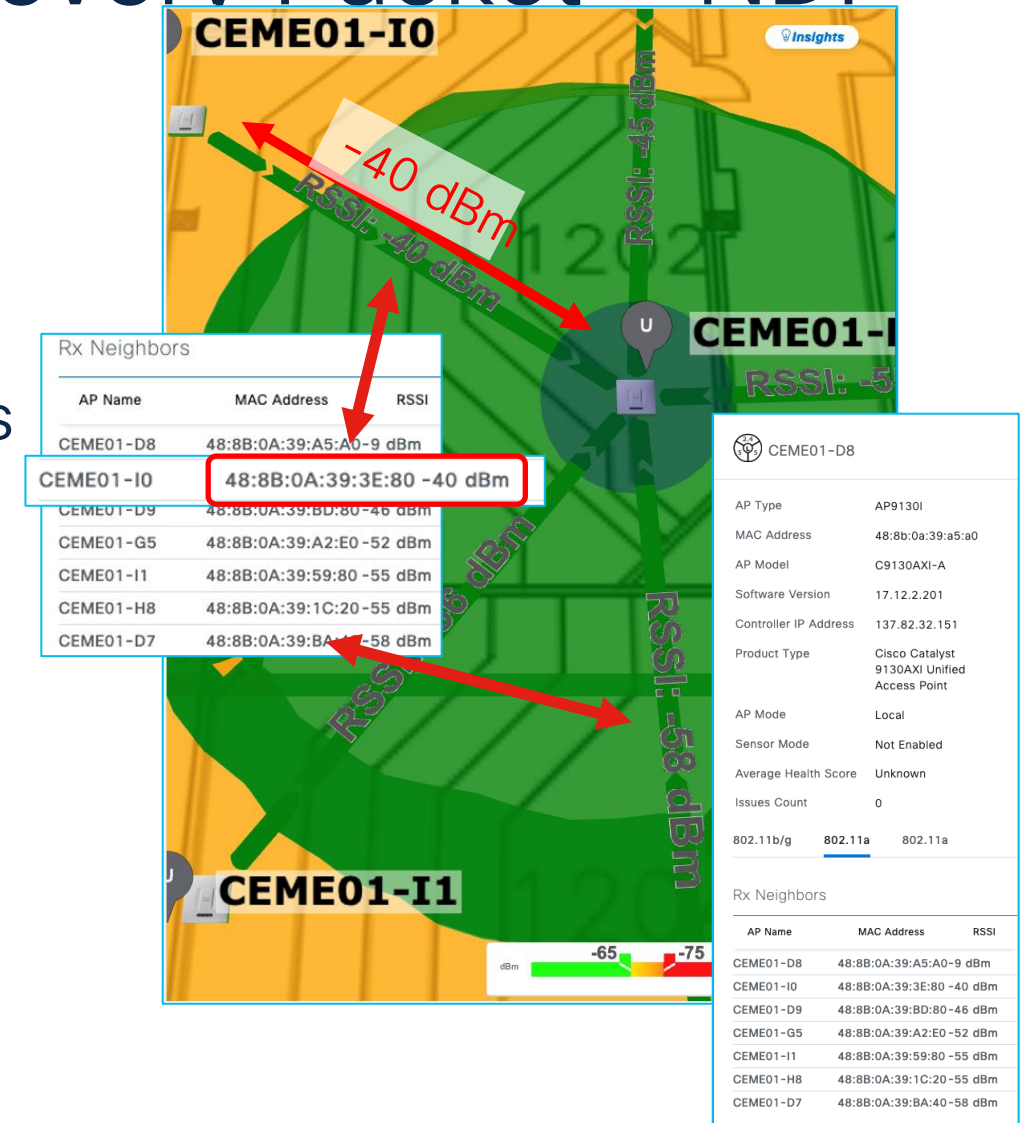
Wi-Fi and Radio Resource Management Measurement Data

- Radio Resource Management – RRM
 - Channel Planning, Tx Power, Channel bandwidth
- Coordinates multiple APs for Wi-Fi coverage
- Knowing the RF Distance is key to Interference Management
 - Beacon Measurement
 - Fast, and data efficient
 - Works well, for Moderate AP density
 - Coordinates Channel/TX power for Closest Neighbors
 - But – Neighbor Relations do change with power and data rate
 - Neighbor Discovery Protocol – NDP
 - Like a beacon, but designed for RF ranging
 - Provides a consistent RF distance regardless of AP power level or Beacon data rate



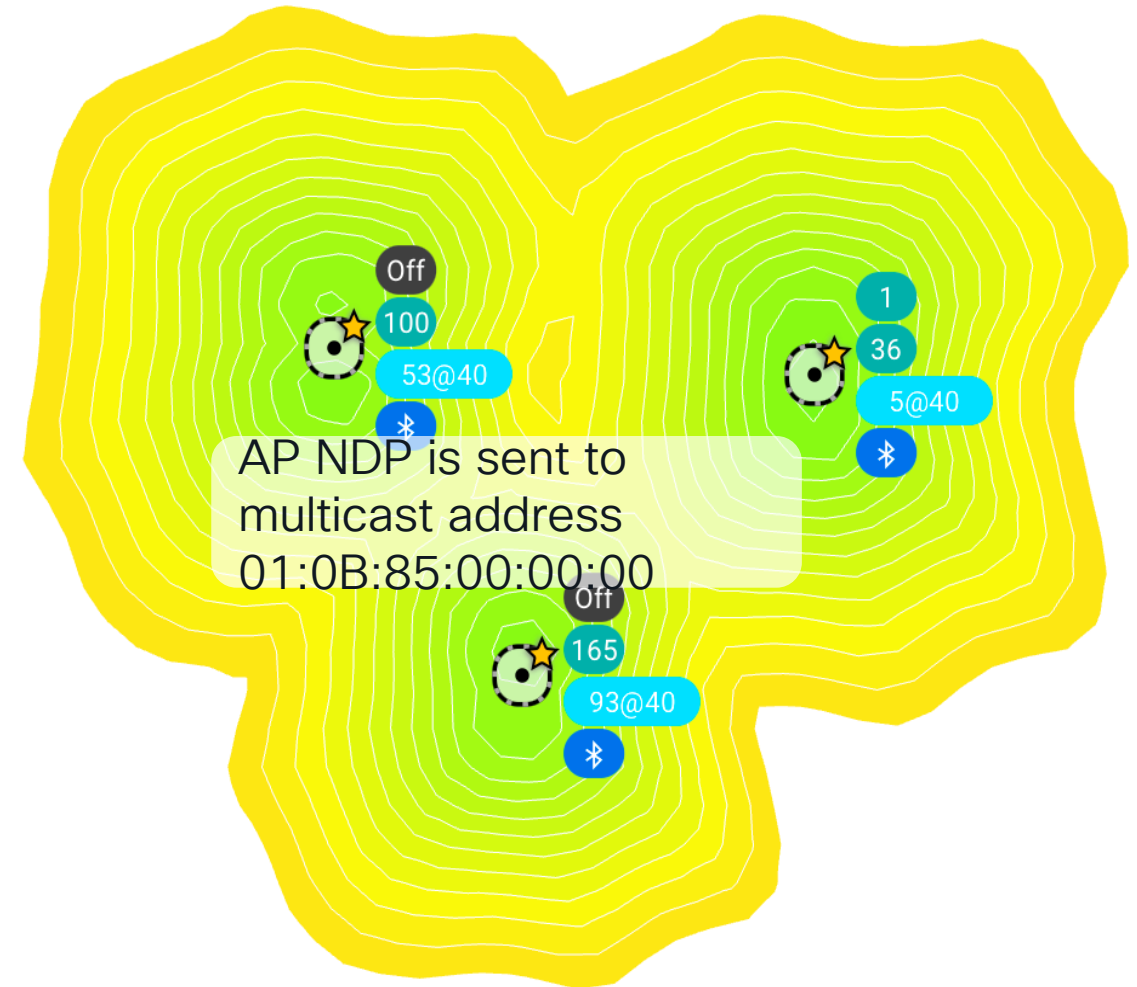
Wi-Fi and the Neighbor Discovery Packet – NDP

- All Cisco WLCs since 2004 have relied on Cisco's RRM
- Cisco's native NDP protocol provides RF Distance information to the RRM algorithms in order to make good decisions
 - DCA – Dynamic Channel Assignment
 - TPC – Transmit Power Control
 - FRA – Flexible Radio Assignment
 - CHD – Coverage Hole Detection
- Quality outcomes require Quality Metrics!



Cisco's Over The Air NDP- Protocol

- NDP is a proprietary broadcast message that the AP's all transmit and listen for.
- These messages are always sent at the highest power level for the channel and lowest data rate supported
- The intent is for the packet to reach as far as possible to be heard by as many AP's as can be reached
- RRM knows the RF Distance between every AP
- We know how it is heard and by whom



The Cisco NDP packet

Field Name	Description
Radio Identifier	Slot ID for the sending radio
Group ID	IP Address and Priority code of senders WLC
Hash	RF Group name converted to a hash for authentication
IP Address	The IP address of the sending AP's RRM Group Leader
Encrypted?	Are we using Encrypted NDP?
Version	Version of NDP
APs Channel	The operating channel of the sending radio
Encryption Key Length	Key Length
Encryption Key Name	Key Name
Message Channel	The channel the NDP was sent on
Message Power	The power (in dBm) the message was sent at
Antenna	Antenna pattern of the sending radio

Off Channel NDP

- NDP is sent both on and off channel and must cover all channels being used within 180 seconds
- If 25 channels, then every 7.2 seconds an NDP is sent
- If 59 channels, then every 3 seconds there will be an NDP
- Observing one channel = every 180 seconds

wlan.ra == 01:0b:85:00:00:00		
Time	Destination	Source
2024-01-24 18:01:14.274540	Cisco_00:00:00	Cisco_5e:e9:a0
2024-01-24 18:01:40.594185	Cisco_00:00:00	Cisco_53:4e:60
2024-01-24 18:01:41.220849	Cisco_00:00:00	Cisco_a2:9d:c0
2024-01-24 18:02:26.557463	Cisco_00:00:00	Cisco_5f:f1:a0
2024-01-24 18:02:26.846786	Cisco_00:00:00	Cisco_5f:cf:b0
2024-01-24 18:02:41.609155	Cisco_00:00:00	Cisco_24:4c:20
2024-01-24 18:02:42.579039	Cisco_00:00:00	Cisco_fe:0e:20
2024-01-24 18:03:03.627873	Cisco_00:00:00	Cisco_5f:56:f0
2024-01-24 18:04:14.400432	Cisco_00:00:00	Cisco_5e:e9:a0
2024-01-24 18:04:40.800864	Cisco_00:00:00	Cisco_53:4e:60
2024-01-24 18:04:41.330394	Cisco_00:00:00	Cisco_a2:9d:c0
2024-01-24 18:05:26.452214	Cisco_00:00:00	Cisco_5f:f1:a0
2024-01-24 18:05:26.973481	Cisco_00:00:00	Cisco_5f:cf:b0
2024-01-24 18:05:32.869715	Cisco_00:00:00	Cisco_5f:b6:f0
2024-01-24 18:05:40.968370	Cisco_00:00:00	Cisco_24:4c:20
2024-01-24 18:05:42.500896	Cisco_00:00:00	Cisco_fe:0e:20



How to see NDP

- From the command line - you can see an AP's neighbors using the `sh ap auto-rf dot11 5` and the NDP is displayed for every AP in the nearby APs. This information will continue for every AP associated
- You can also use the WCAE and parse the `sh tech wireless` to gain detailed insight

```
Nearby APs
AP 2c57.4154.eb07 slot 2      : -33 dBm on ( 52, 20 MHz) (10.130.240.17)
AP 6cd6.e3b4.464f slot 1      : -57 dBm on ( 56, 20 MHz) (10.130.240.17)
AP a4b2.3905.f54f slot 1      : -60 dBm on ( 40, 20 MHz) (10.130.240.17)
AP a4b2.3906.6d07 slot 2      : -67 dBm on ( 44, 20 MHz) (10.130.240.17)
AP a4b2.3906.6eaf slot 1      : -69 dBm on ( 64, 20 MHz) (10.130.240.17)
AP a4b2.3906.72af slot 1      : -72 dBm on ( 60, 20 MHz) (10.130.240.17)
AP a4b2.3906.72a7 slot 2      : -72 dBm on (100, 20 MHz) (10.130.240.17)
AP 6871.6136.71cf slot 1      : -74 dBm on (132, 20 MHz) (10.130.240.17)
AP ac2a.a12f.4aaf slot 1      : -75 dBm on ( 36, 20 MHz) (10.130.240.17)
AP a4b2.3906.7547 slot 2      : -76 dBm on ( 64, 20 MHz) (10.130.240.17)
AP 6871.6136.702f slot 1      : -77 dBm on (112, 20 MHz) (10.130.240.17)
AP 6871.6135.d36f slot 1      : -78 dBm on (140, 20 MHz) (10.130.240.17)
AP 6871.6135.e0ef slot 1      : -78 dBm on (116, 20 MHz) (10.130.240.17)
AP 6871.6135.e42f slot 1      : -78 dBm on (100, 20 MHz) (10.130.240.17)
AP 6871.6135.d54f slot 1      : -79 dBm on (136, 20 MHz) (10.130.240.17)
AP 6871.6135.d86f slot 1      : -79 dBm on (120, 20 MHz) (10.130.240.17)
```

Name	Radio Mac	Model	RX Neighbors	Highest RX Neighbor	On Channel Neighbor Count	Highest RX Neighbor on Channel	Lowest RX Neighbor	TX Neighbors	
HC	D1265	68-71-61-	CW9166D1-MR	22	-35	2	-35	-62	41
HC	D1224	68-71-61-	CW9166D1-MR	22	-46	1	-46	-63	40
HC	D1260	68-71-61-	CW9166D1-MR	24	-39	3	-51	-69	11
HC	D1245	68-71-61-	CW9166D1-MR	21	-44	4	-53	-62	46
HC	D1252	68-71-61-	CW9166D1-MR	24	-47	2	-53	-66	30
HC	D1264	68-71-61-	CW9166D1-MR	24	-40	3	-53	-65	13
HC	D1266	68-71-61-	CW9166D1-MR	24	-38	3	-54	-66	11
HC	0869	AC-2A-A1-	CW9166I-E	24	-45	1	-56	-66	25
HC	D1262	68-71-61-	CW9166D1-MR	24	-43	2	-56	-71	4
HC	D1241	68-71-61-	CW9166D1-MR	24	-42	2	-57	-71	5
HC	D1236	68-71-61-	CW9166D1-MR	23	-47	3	-58	-63	56
HC	D1246	68-71-61-	CW9166D1-MR	23	-44	1	-58	-63	54
HC	0872	6C-8D-77-	CW9166I-E	24	-45	2	-59	-66	26
HC	0890	AC-2A-A1-	CW9166I-E	24	-44	1	-59	-64	25
HC	1312	EC-F4-0C-	CW9166I-MR	23	-49	3	-59	-64	52
HC	D1223	68-71-61-	CW9166D1-MR	24	-44	1	-59	-66	23
HC	D1225	68-71-61-	CW9166D1-MR	23	-54	3	-59	-67	30
HC	0860	6C-8D-77-	CW9166I-E	24	-41	2	-60	-68	21
HC	0875	AC-2A-A1-	CW9166I-E	24	-41	1	-60	-65	26
HC	0881	6C-8D-77-	CW9166I-E	24	-46	1	-60	-63	26
HC	0893	AC-2A-A1-	CW9166I-E	24	-50	4	-60	-65	30
HC	D1235	68-71-61-	CW9166D1-MR	24	-49	2	-60	-64	41
HC	D1250	68-71-61-	CW9166D1-MR	24	-35	3	-60	-67	10
HC	0879	6C-8D-77-	CW9166I-E	24	-47	1	-61	-65	26
HC	0882	6C-8D-77-	CW9166I-E	24	-41	1	-61	-65	26

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

Name		Radio Mac	Model	RX Neighbors	Highest RX Neighbor	On Channel Neighbor Count	Highest RX Neighbor on Channel	Lowest RX Neighbor	TX Neighbors
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HC	1312	EC-F4-0C-	CW9166I-MR	23	-49	3	-59	-64	52
HC	D1223	68-71-61-	CW9166D1-MR	24	-44	1	-59	-66	23
HC	D1225	68-71-61-	CW9166D1-MR	23	-54	3	-59	-67	30
HC	0860	6C-8D-77-	CW9166I-E	24	-41	2	-60	-68	21
HC	0875	AC-2A-A1-	CW9166I-E	24	-41	1	-60	-65	26
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Cisco WCAE tools - <https://developer.cisco.com/docs/wireless-troubleshooting-tools/>

The screenshot shows the Cisco DevNet website's 'Wireless Troubleshooting Tools' page. The header includes the Cisco DevNet logo, navigation links for Documentation, Learn, Technologies, Community, and Events, a search icon, and buttons for 'SIGN UP FREE' and 'LOG IN'. The breadcrumb trail is 'Documentation > All > Wireless Troubleshooting Tools'. The left sidebar contains an 'Overview' section with a search bar and a list of tools: Wireless Config Analyzer Express - WCAE, WLAN Poller, 9800 Guestshell scripts, WiFi Hawk, Wireless Lan Config Analyzer - WLCCA, 9800 Traces to ELK - Github, 9800 Telemetry Pipeline - Github, Wireless Debug Analyzer, and WLC Config Converter BETA. Below this is a 'WCAE' section with links to 'Wireless Config Analyzer Express - Engine', 'Wireless Config Analyzer Express - GUI', 'What is new! (engine)', 'What is new! (GUI)', 'Checks available in tool', 'RF Health', and 'How to use - Cloud'. The main content area is titled 'Wireless Troubleshooting Tools' and includes an introductory paragraph. It features a grid of tool links with update dates: 'New! WCAE GUI (updated February-24)', 'WiFi Hawk (updated Feb-23)', 'WCAE (updated December-23)', '9800 Guestshell scripts', 'Wireless Debug Analyzer', 'Wireless Detector (updated May-23)', 'AireOS to Meraki Translation', and 'WLAN Poller'. At the bottom, there is a section for 'Wireless Config Analyzer Express - WCAE' with links for 'Cloud Version', 'Mac OS', 'Windows 10/11', and 'Mini Desktop'.

Overview

Wireless Troubleshooting Tools

- Wireless Config Analyzer Express - WCAE
- WLAN Poller
- 9800 Guestshell scripts
- WiFi Hawk
- Wireless Lan Config Analyzer - WLCCA
- 9800 Traces to ELK - Github
- 9800 Telemetry Pipeline - Github
- Wireless Debug Analyzer
- WLC Config Converter BETA

WCAE

- [Wireless Config Analyzer Express - Engine](#)
- Wireless Config Analyzer Express - GUI
- What is new! (engine)
- What is new! (GUI)
- Checks available in tool
- RF Health
- How to use - Cloud

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.

New! WCAE GUI (updated February-24)	WiFi Hawk (updated Feb-23)	WCAE (updated December-23)
9800 Guestshell scripts	Wireless Debug Analyzer	Wireless Detector (updated May-23)
	AireOS to Meraki Translation	WLAN Poller

Wireless Config Analyzer Express - WCAE

- [Cloud Version](#)
- [Mac OS](#)
- [Windows 10/11](#)
- [Mini Desktop](#)

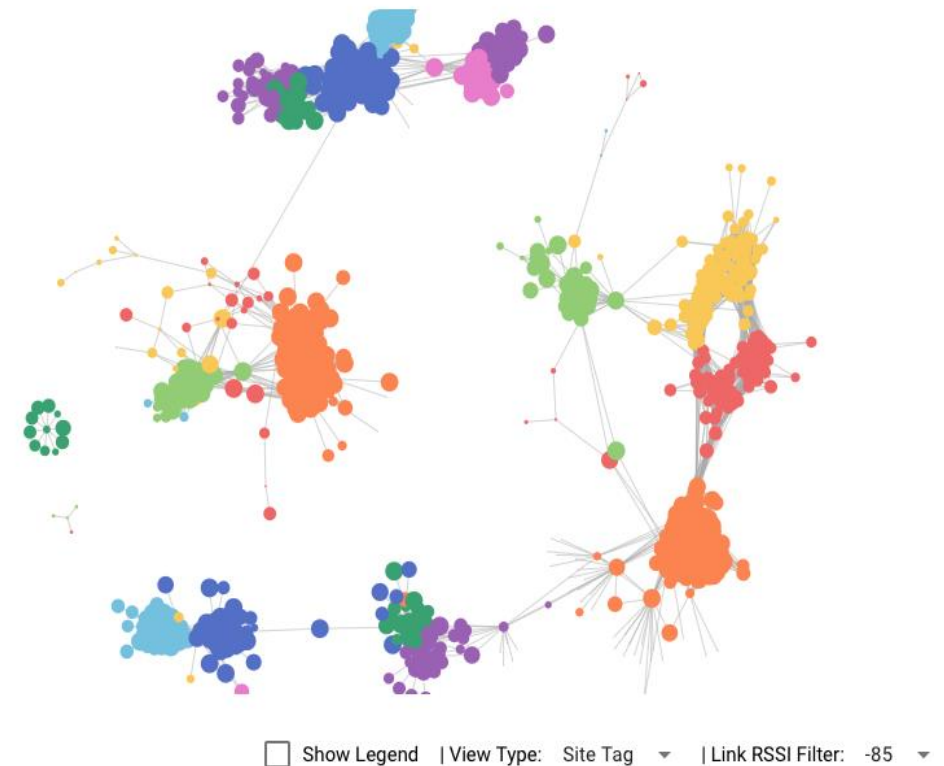
Javier Contreras – Principal Engineer BRKEWN-3628 How to Troubleshoot Catalyst 9800 Controllers

How RRM Uses NDP

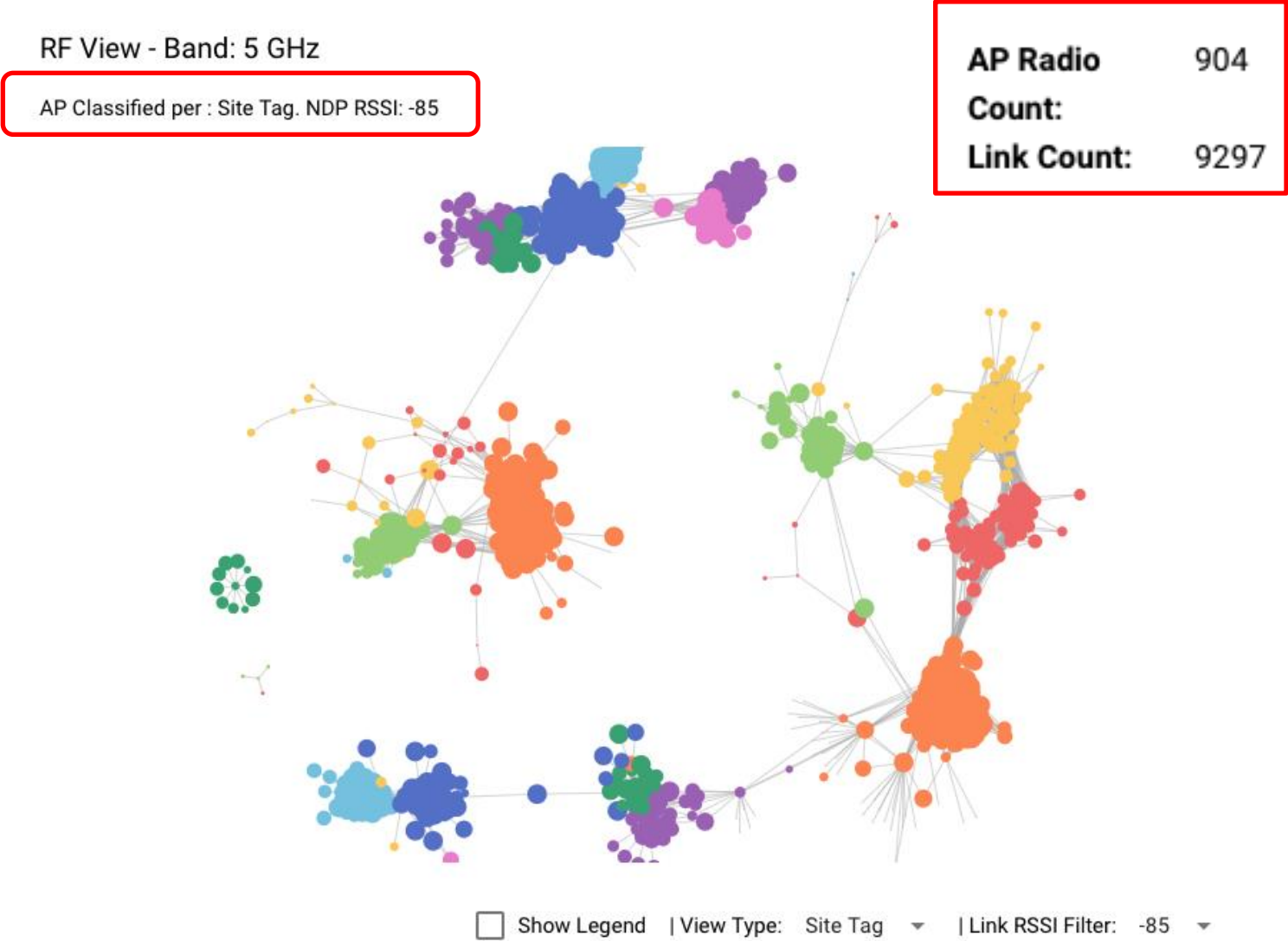
- RRM has an RF Group leader – the admin anchor
- And RF Neighborhoods – Clusters of APs that are close enough they need their channel and power calculated together
- APs require isolation
- Its all fun until you get more AP's than you have channels available

RF View - Band: 5 GHz

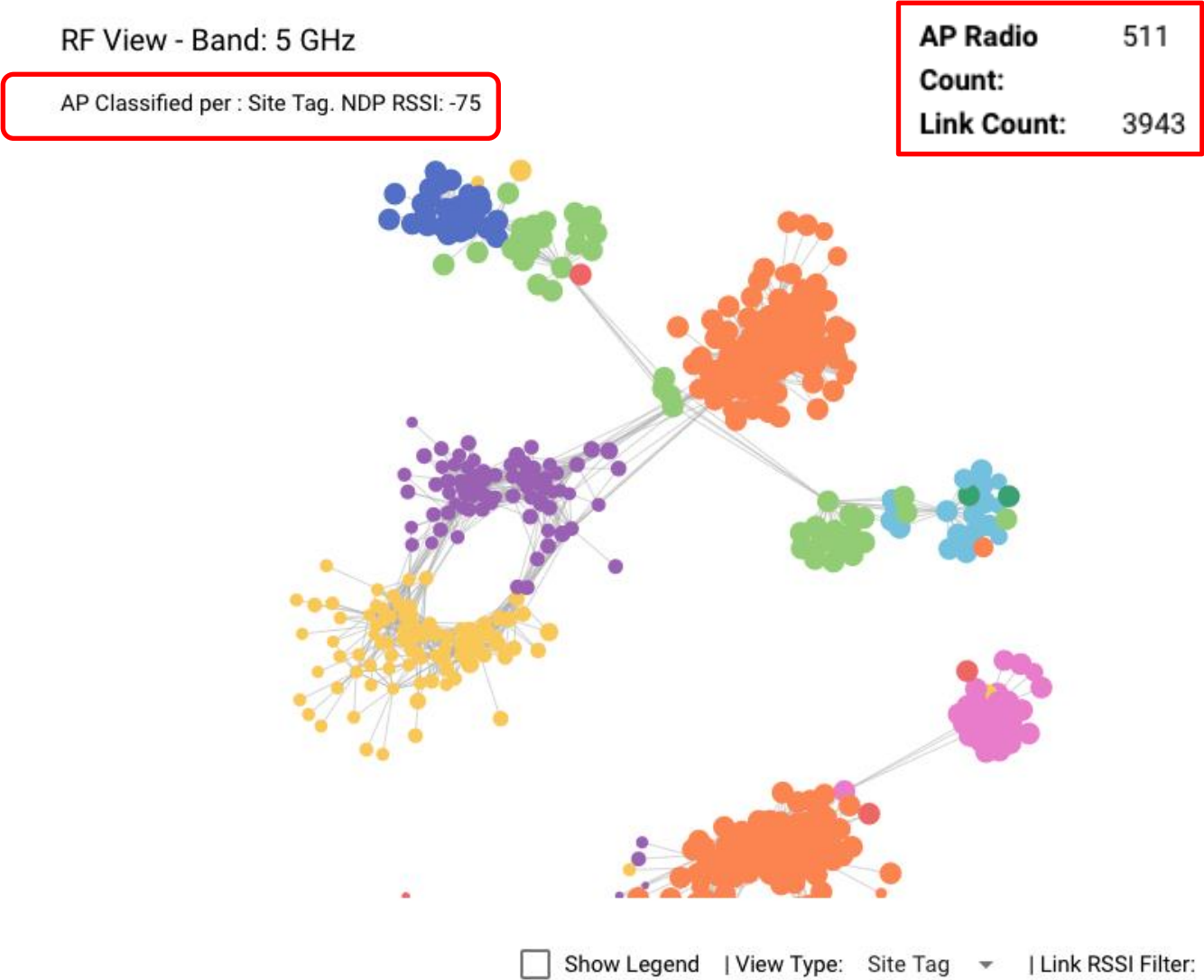
AP Classified per : Site Tag, NDP RSSI: -85



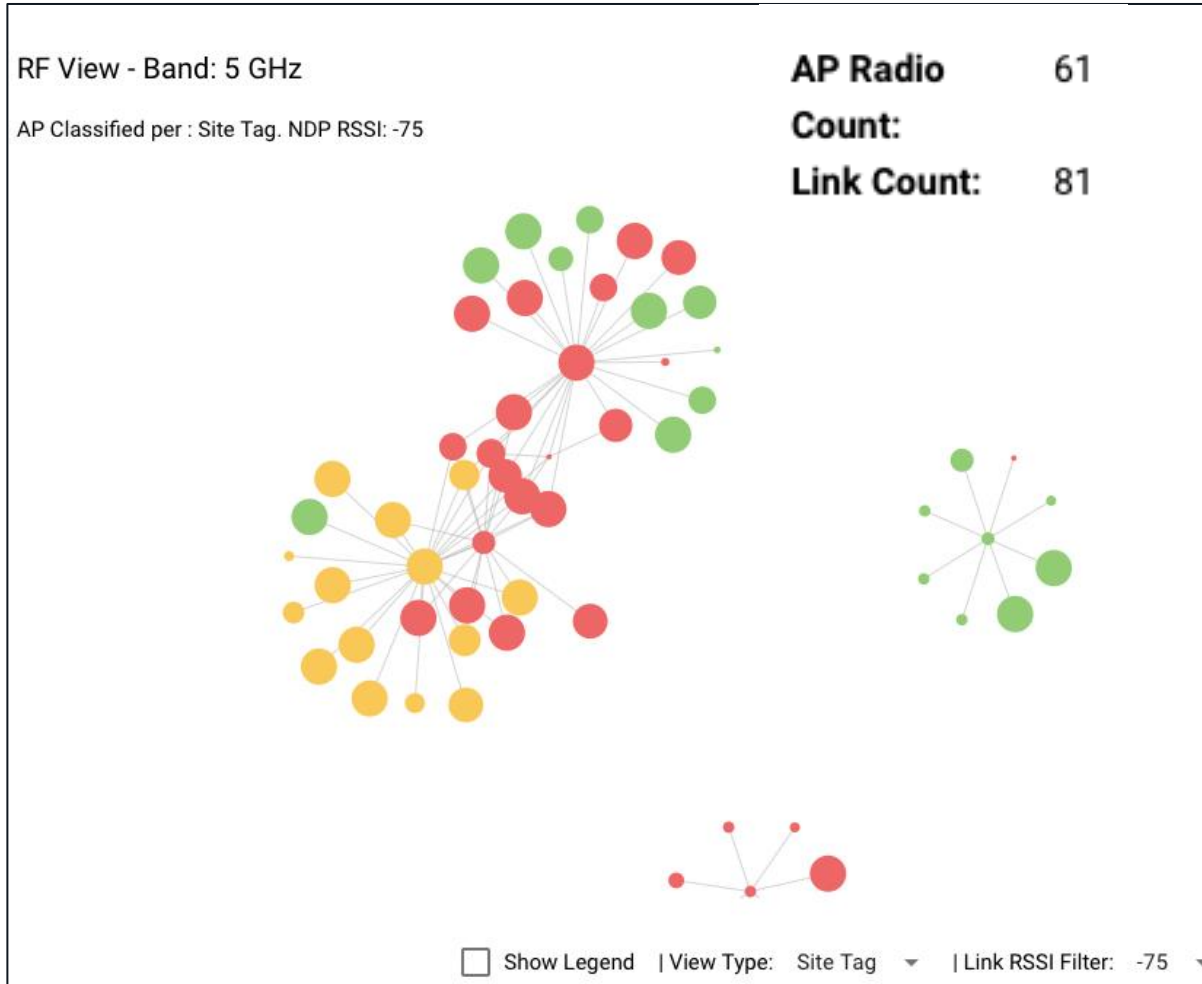
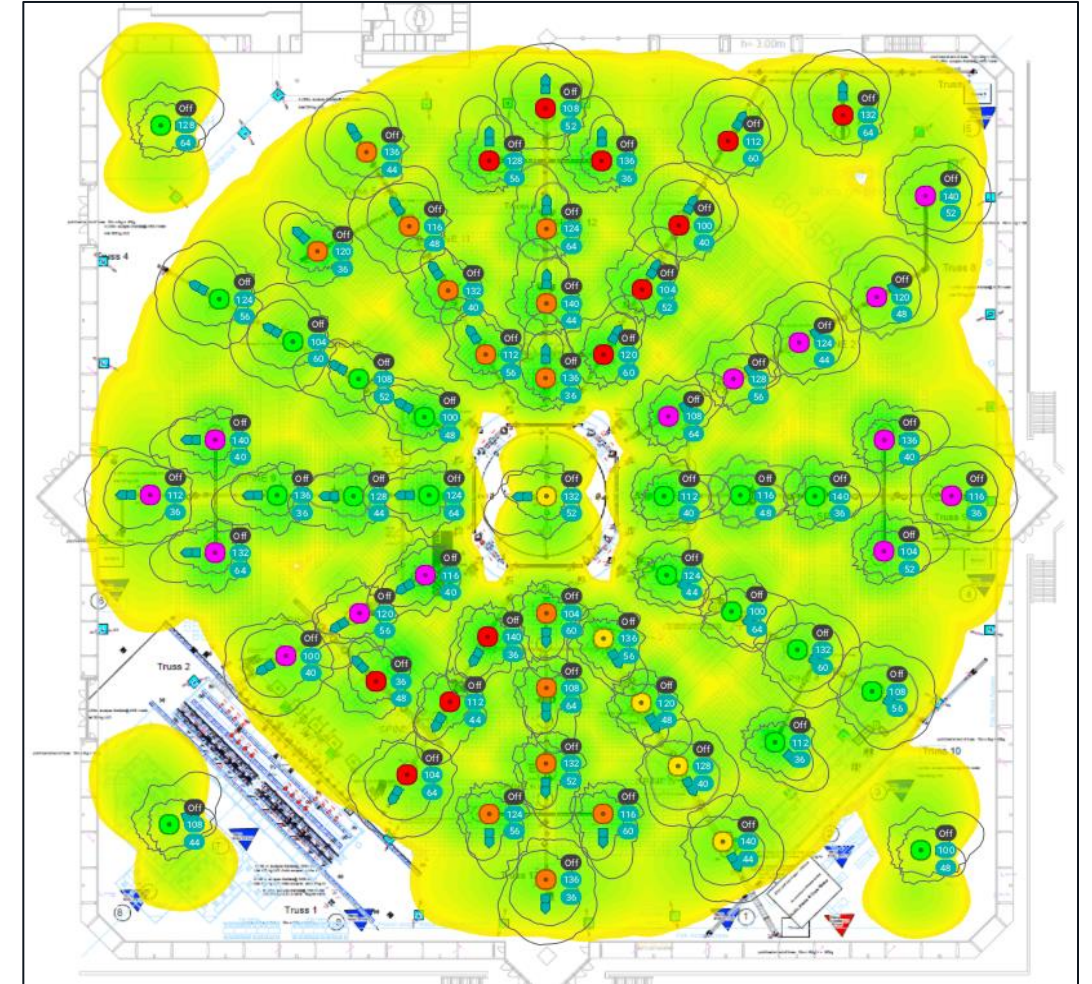
Using the GUI version – AP's RF View



Using the GUI version – AP's RF View



The view From the keynote – and The C9104 antenna



Spectrum Management Requires Data

Off Channel Scanning – on Every Cisco AP

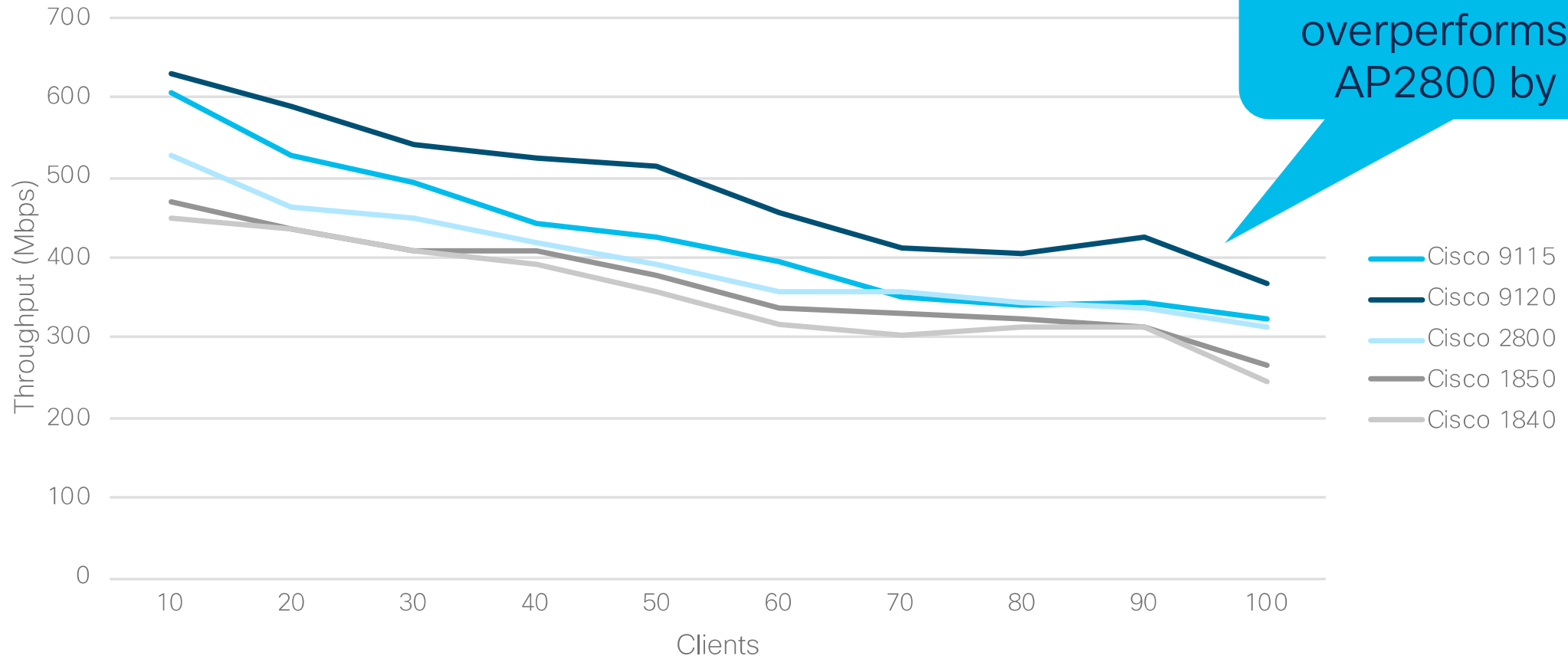
- Off Channel Scanning - legacy AP (anything with 2 radio interfaces today)
 - All Channels must be scanned EVERY 180s within 3 Minutes
 - Dwell time is 50 ms, 10 ms for channel change = 60 ms off channel
 - $180s / 25 \text{ Channels} = \text{off channel dwell every } 7.2s$
- Off Channel Scanning for WSSI/WSM module and 4800 AP
 - Continuous cycle 1200 ms Dwell across 2.4 and 5 GHz
 - Supports RRM, aWIPS/WIDS, Rogue, fastLocate, Cleanair
 - Serving Radio still required for NDP Tx off channel as the module/third radio has no active transmitter
- All WI-Fi6e capable APs have dedicated Scanning Radios



High-Density Client Test- Results

Cisco Wi-Fi 6 vs Cisco Wave 2 APs

Multi-Client Performance

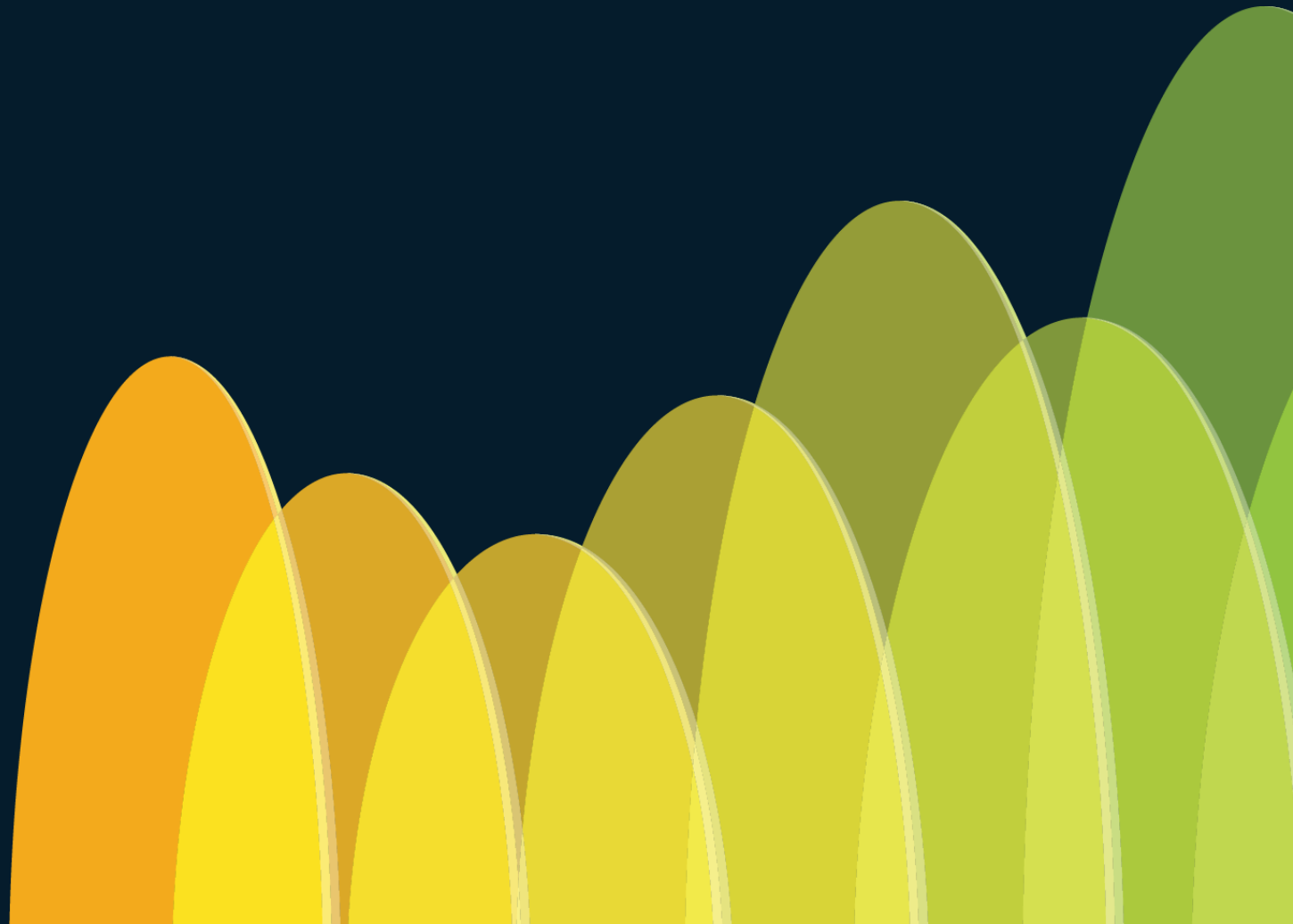


Cisco 9120AX
overperforms Cisco
AP2800 by 25%

Cisco 9100 series APs has clear advantage over Cisco Wave 2 APs

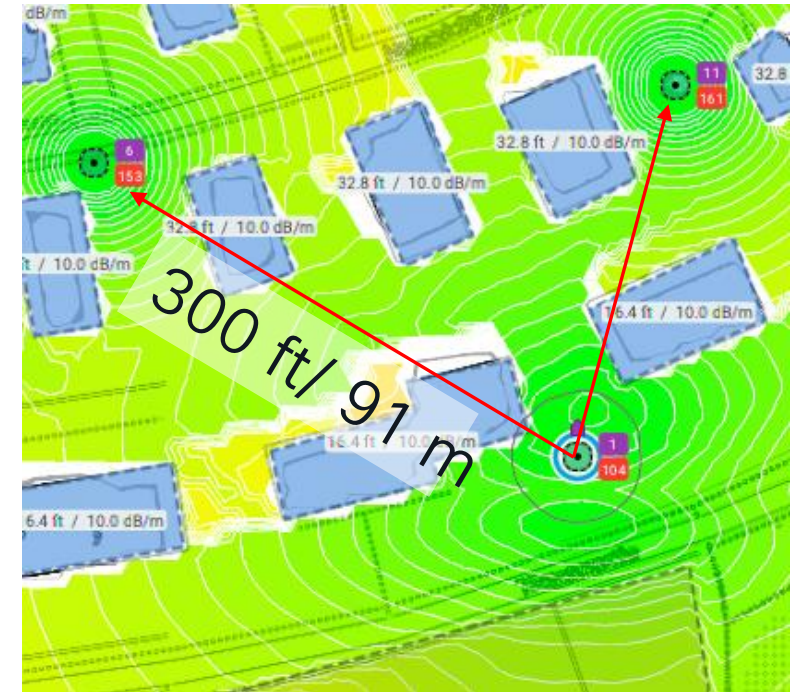
On-Channel NDP

C9124 and the New Neighbor Discovery Protocol



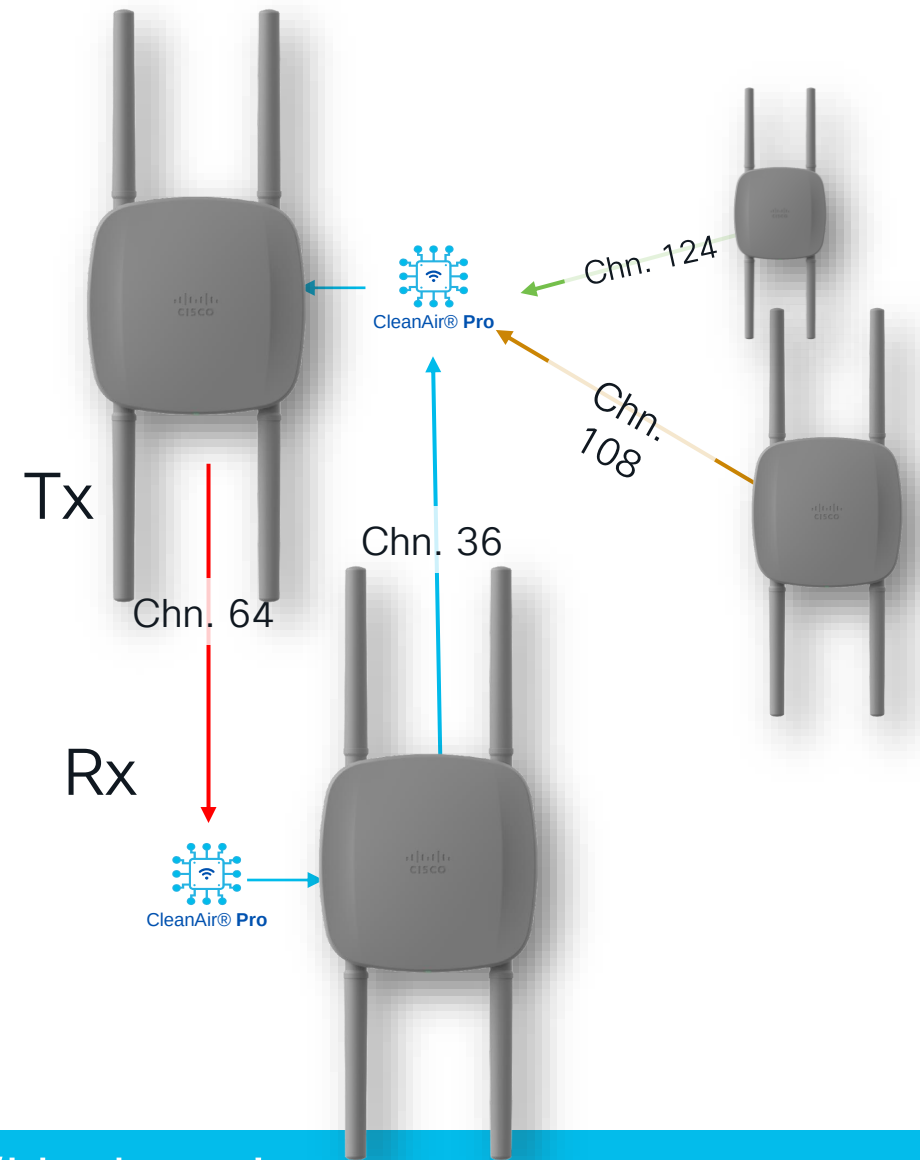
Cisco Optimised Neighbor Discovery

- The Catalyst family of APs introduced the world to the power of the Cisco RF -ASIC
- In Cisco Wireless (CW) APs the scanning radio is responsible for all off channel intelligence including the NDP protocol which offloads the serving radios duty
- This boosts performance under full load by as much as 25% against legacy APs and with increased resolution as well – more for less!
- The outdoor AP and MESH use cases differ with lower AP density and greater distances between nodes than indoor
- 6 GHz adds an additionally 1200 MHz to scan and increasing time between updates as a result
- Time to Innovate!



Cisco On-Channel NDP

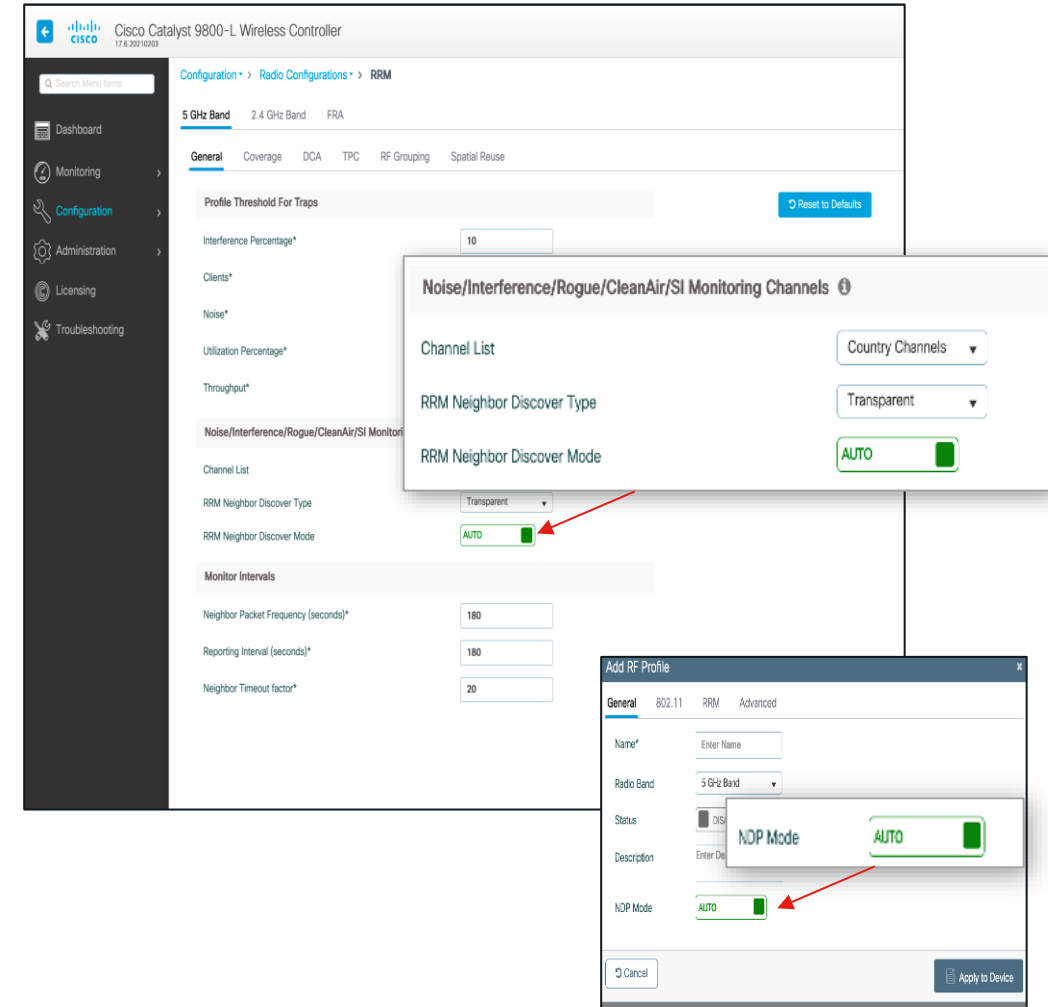
- NDP frames transmitted on channel by the serving radio
 - Serving radio transmits NDP frames once every 450ms
- Received on the RF-ASIC
 - Dedicated scanning
 - 925ms dwell on 5Ghz (in FCC, 23 sec)
 - 1130ms on 2.4Ghz (in FCC, 3.2 sec)
 - Neighbor discovery within ~46 seconds of RF-ASIC Rx scan for both bands



Faster Neighbor Acquisition/Updates!

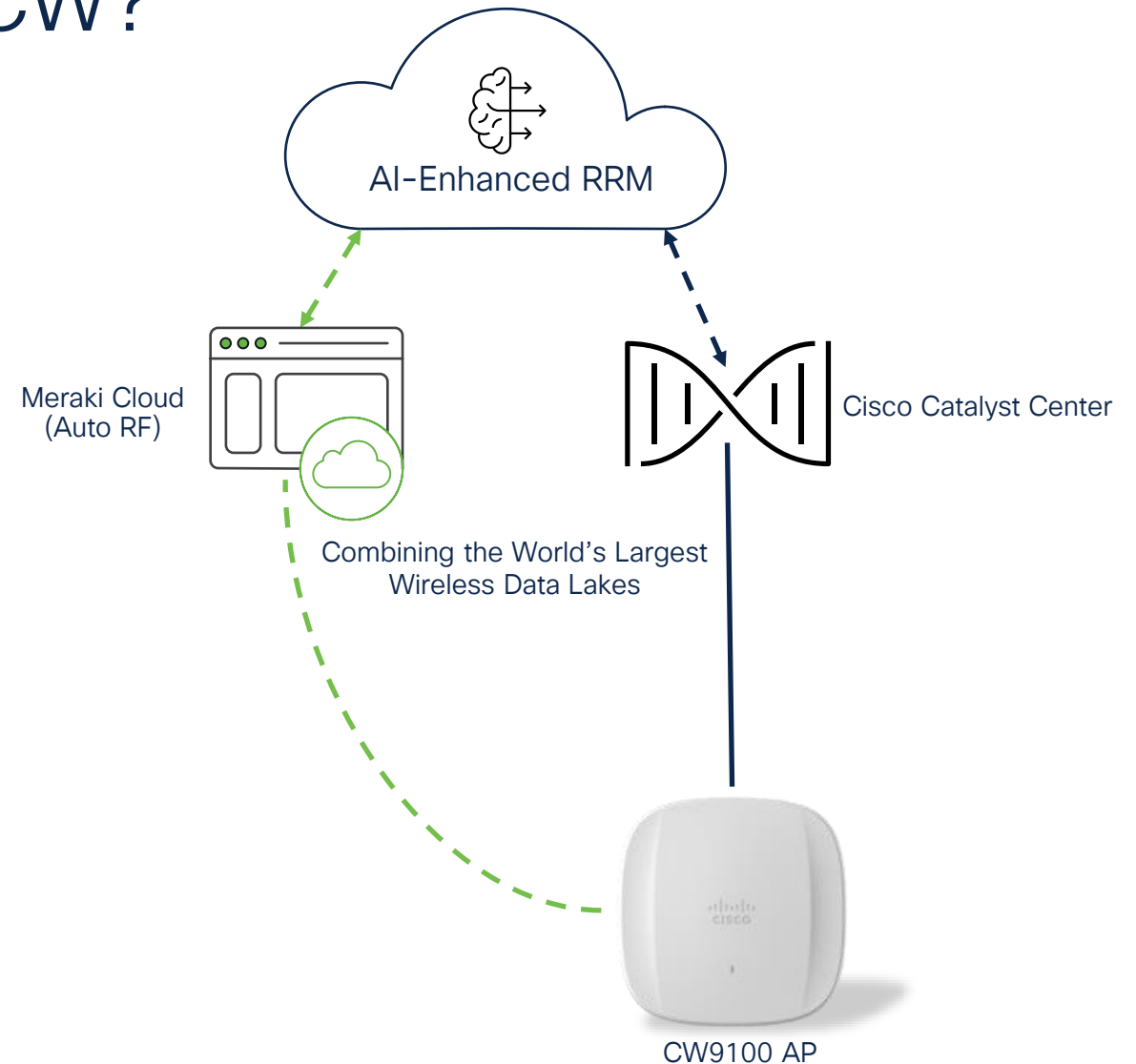
Cisco On-Channel NDP

- Two Ways to operate NDP – Not interchangeable!
- Mixed Mode Operation?
- RF-ASIC/Scanning required for on-Channel NDP
- NDP “Type” Configuration at the Global and RF Profile levels
 - Auto = WLC chooses based on RF-ASIC
 - Off Channel = Legacy off-channel NDP
 - RF-ASIC if present, will Tx/Rx NDP



Cisco Cloud – NDP for all of CW?

- Today, AutoRF relies on Beacon based neighbor knowledge
- Coming in release R31, Cloud networks will use NDP to populate the neighbor list
- AI AutoRF is about to meet AI-Enhanced RRM – Stay Tuned



AP Isolation, Operating Density, and Performance

- Wi-Fi operates on Contention, 2 AP's that hear one another, will share (each get half) the bandwidth
 - 3 APs that hear one another will each get 1/3
 - 4 APs.....
- If you have more channels than APs, all will be isolated
- Channel bonding requires more channels
- Dual 5 GHz requires 2x the channels per per AP
- AP's must should not hear one another on the same channel above -82 dBm (-78 possible with RX-SOP) interference starts to play a role

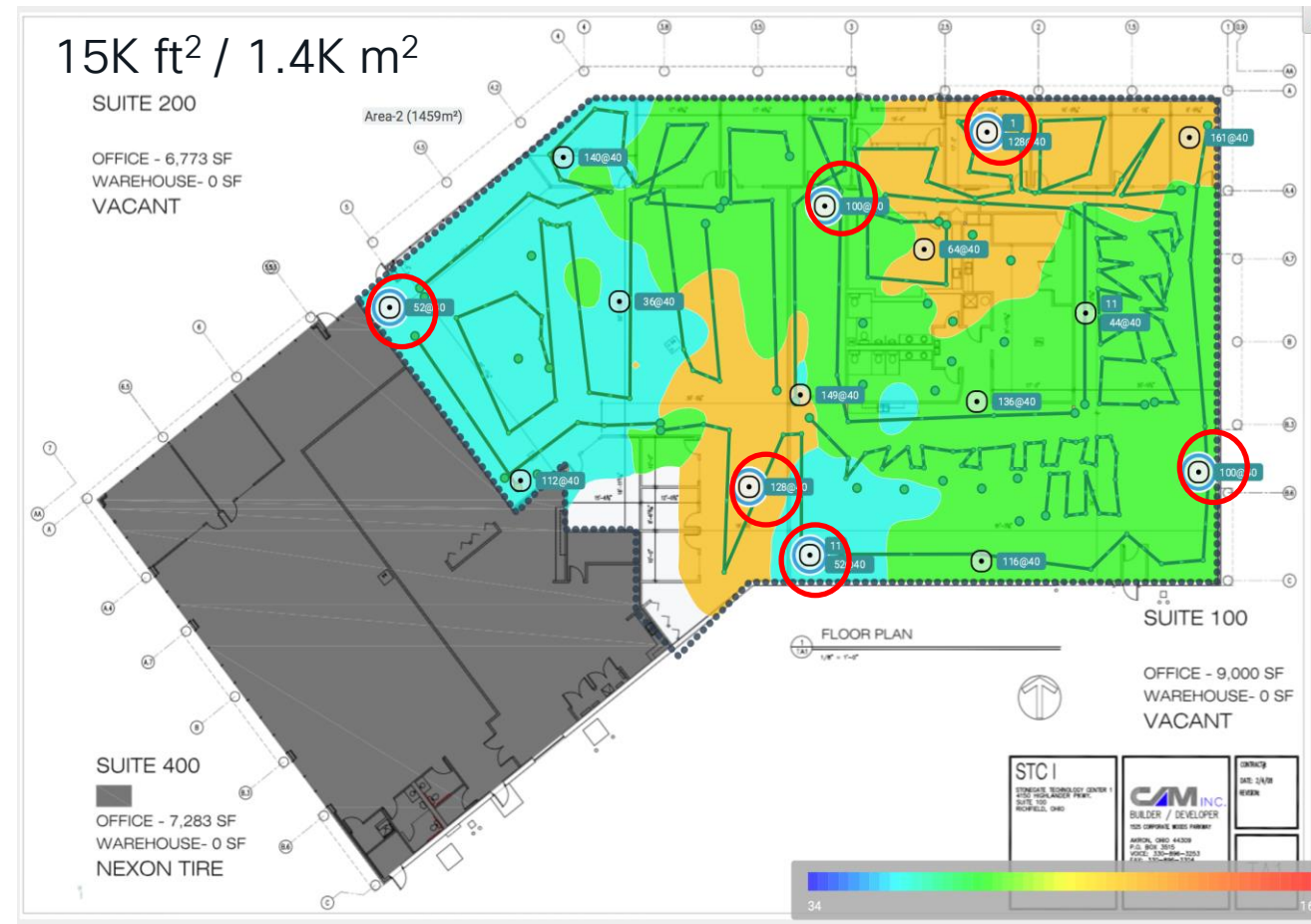


Available ETSI channels by Width	
20 MHz	19
40 Mhz	10
80 Mhz	4
160 MHz	2

Very Dense = 1K ft² / 93 m² @40 MHz

1 AP every 36 ft / 11 m

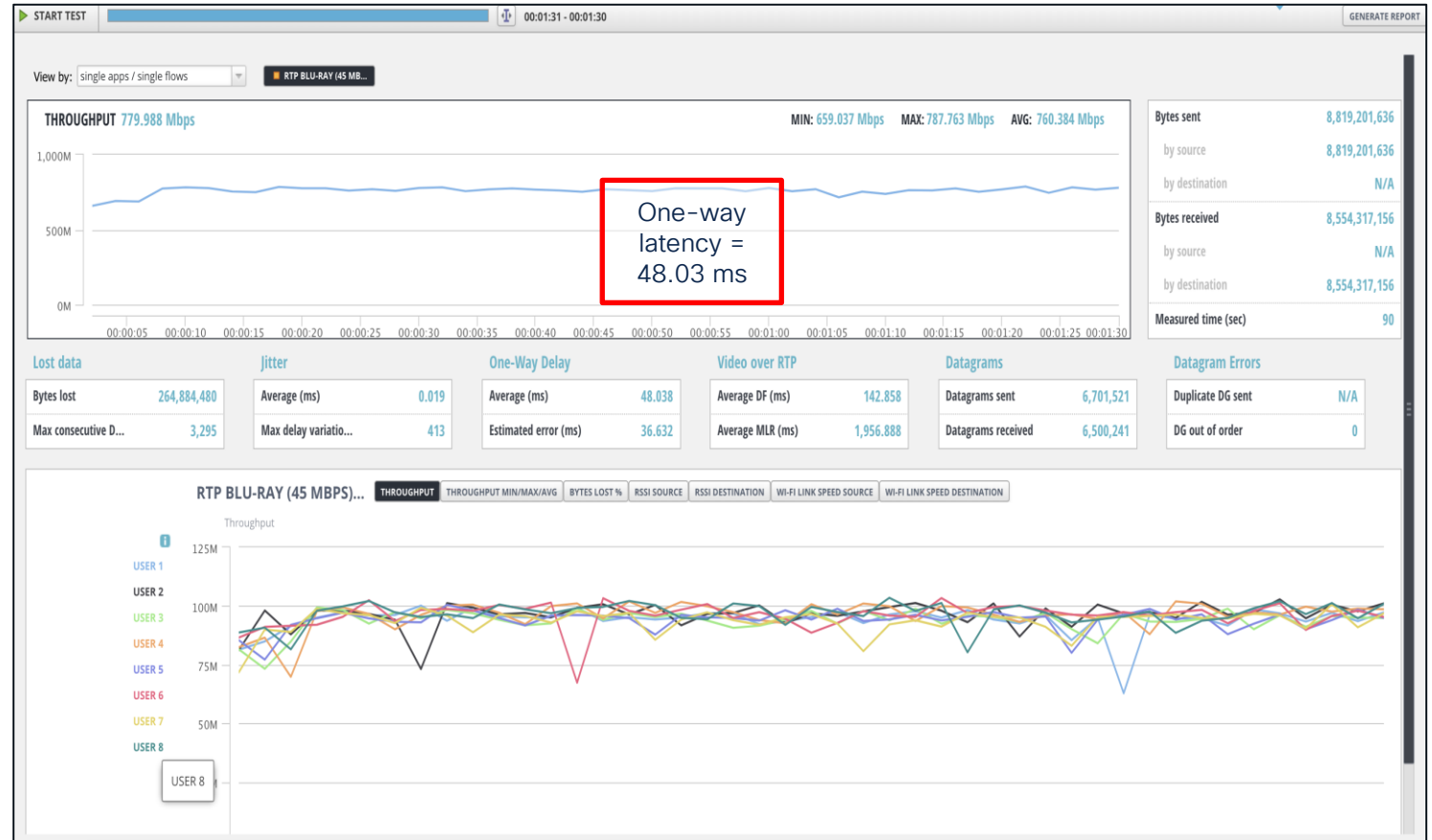
- The Channel Plan requires:
 - 15x 5 GHz interfaces @ 40 MHz
 - 12 x 40 MHz Channels Available in US
 - 15 (APs)/12(Channels)=Plan reused 1.25 times
 - 3 APs needed to re-use channels
- Channel power between these pairs was high at -70 dBm, -64 dBm and -54 dBm
 - Well above the -78 required for isolation
- To evaluate we chose a co-channel pair and tested both simultaneously
- We used the -64 dBm pair, and loaded each cell with 8 Clients ea.
 - As expected, the results show that each cell received roughly half the bandwidth



TEST: 40 MHz, 8 x 8K Video Client – Single AP

Throughput / Latency reference

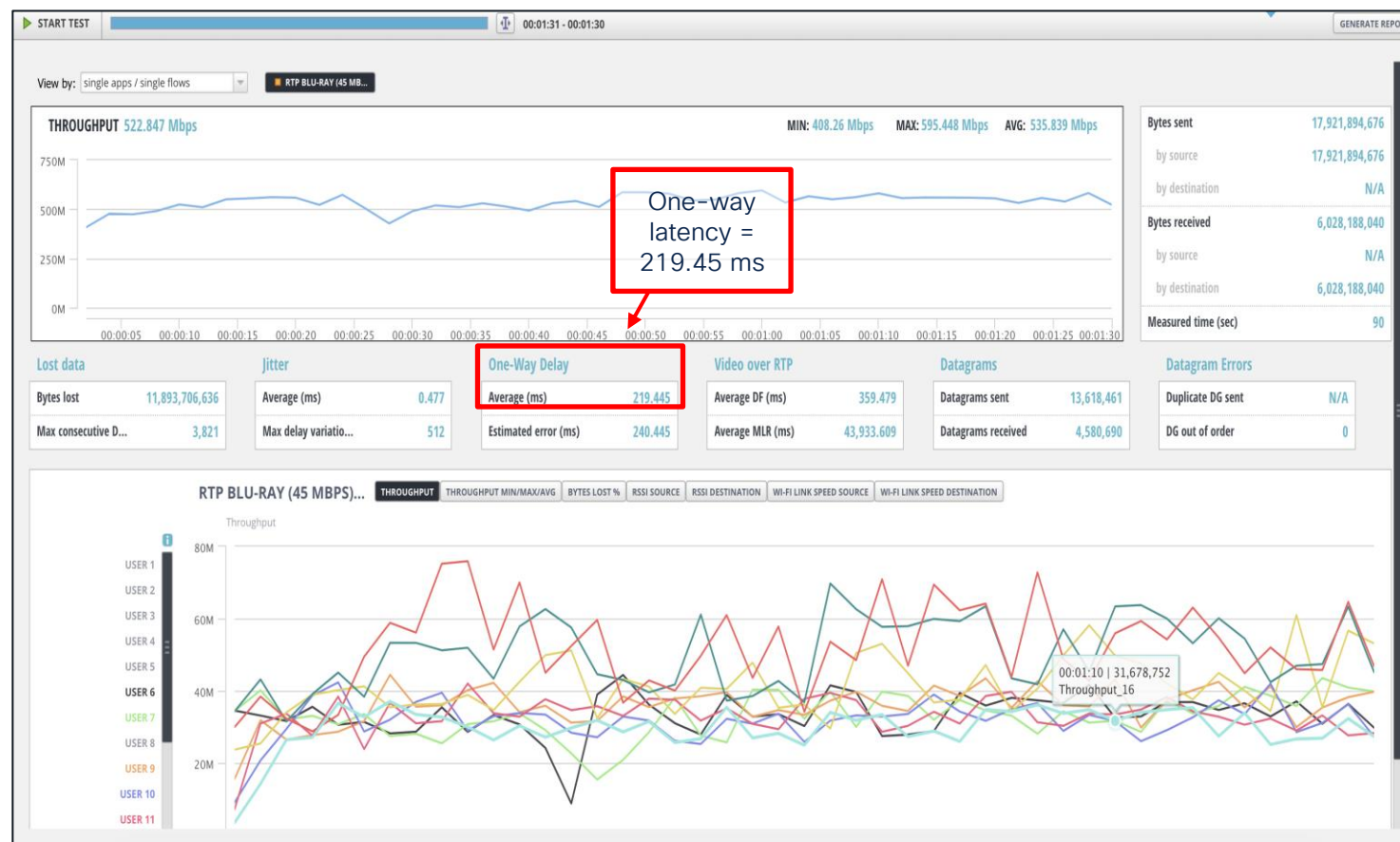
- 40 MHz single cell throughput for 8x 8K video clients performed very well
- 760 Mbps or > 90 Mbps supported for all 8 clients
- One-Way latency <50 ms
- No issues – excellent performance



TEST: 40 MHz, 16 x 8K Video Client x 2 APs

Co-Channel interference = Reduced QOE

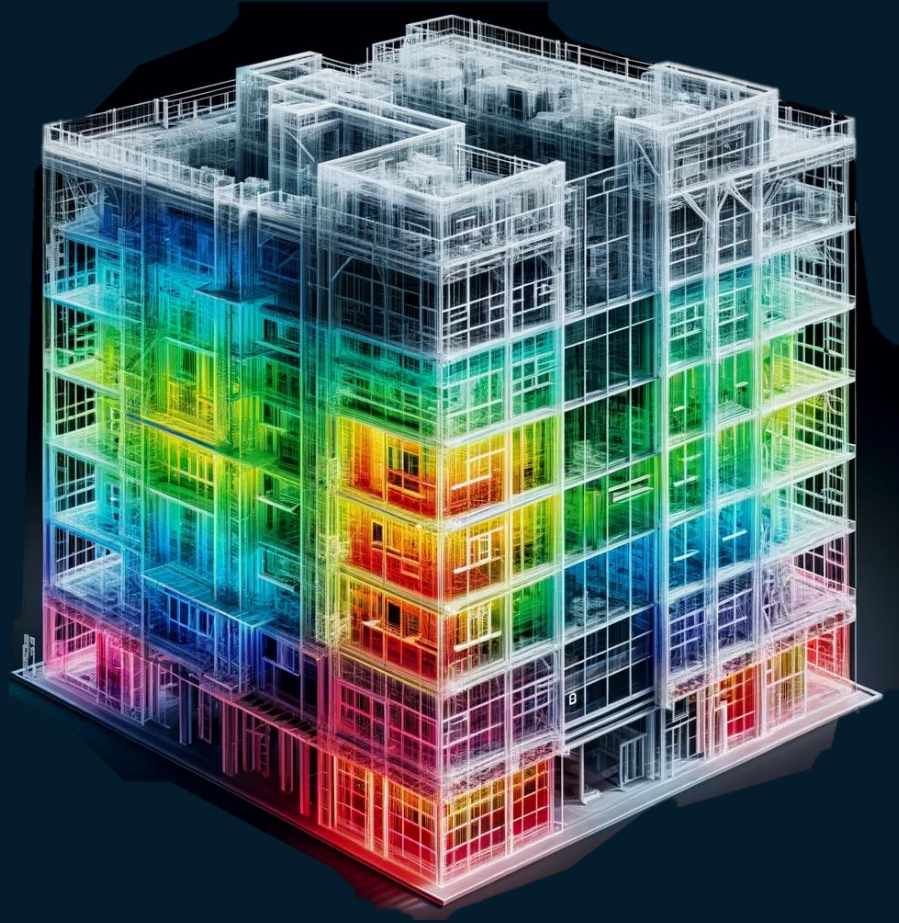
- Total bandwidth is 535 Mbps or 33 Mbps /client avg.
- Latency quadruples 219.44 ms One-Way avg. **unacceptable** for RT Video/Voice
- Individual Client experience ranged anywhere from 20 Mbps to 60 Mbps, not smooth
- Quality of Experience suffers



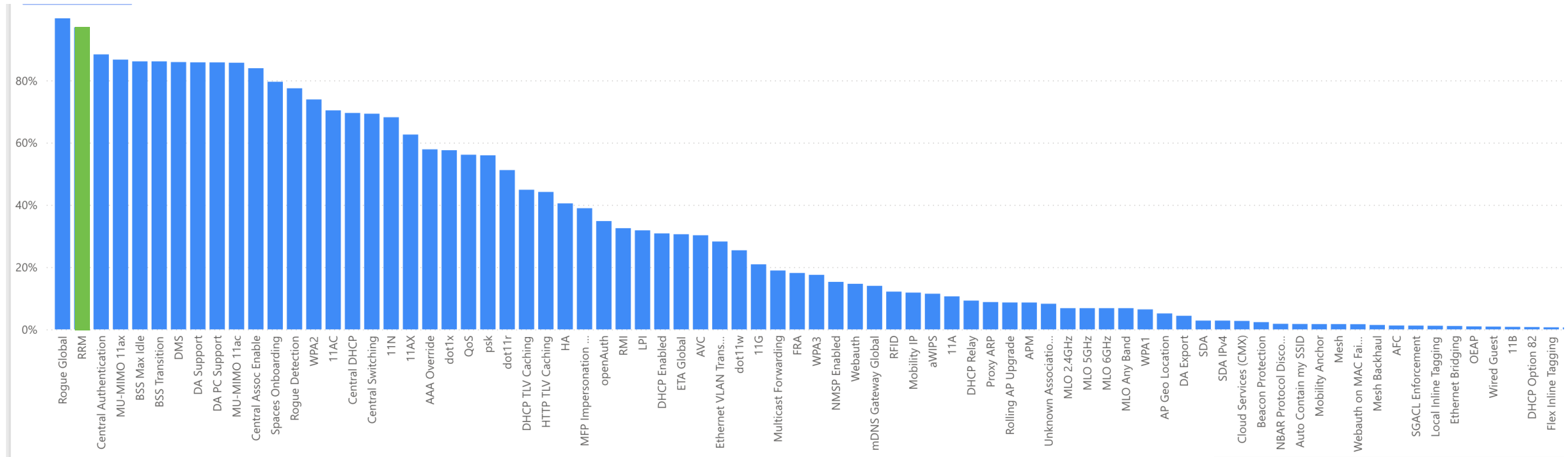
NOTE: RX-SOP is only effective down to -78 dBm

Cisco Wireless AI-RRM Update

Can AI run my RF Configuration?



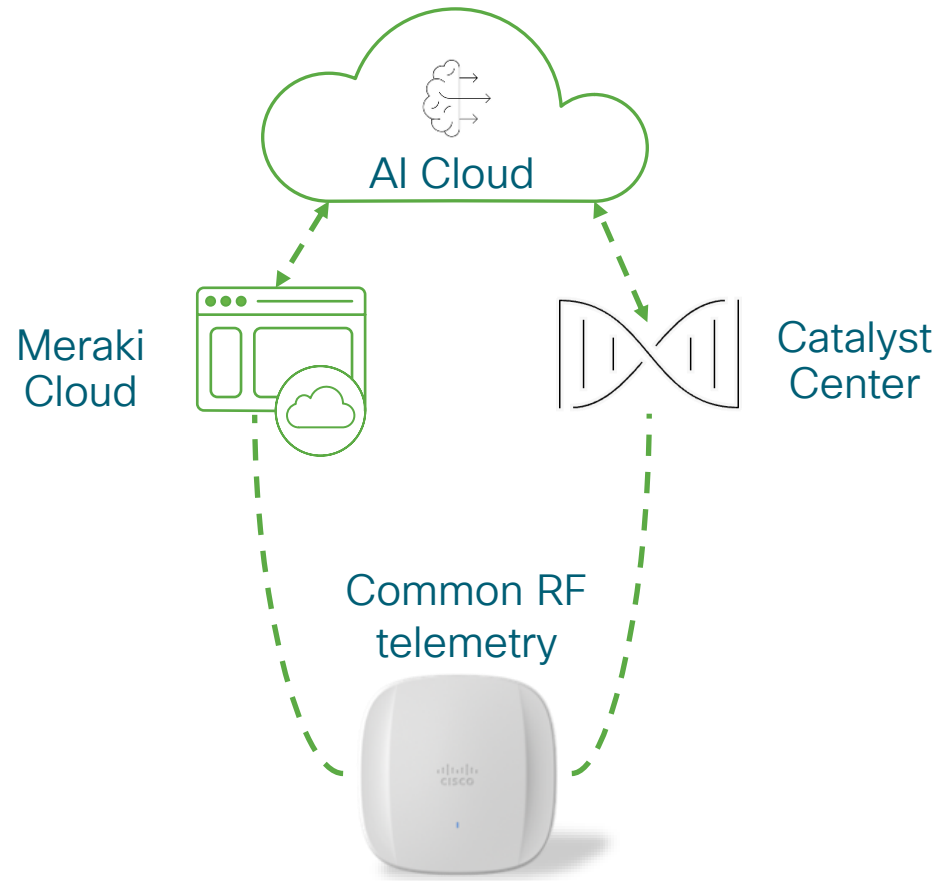
RF Automation is the second most used feature



97%

Unified AI across all Cisco Wireless

RF Intelligence from the World's Largest Wireless Data Lakes



Autonomous Wi-Fi

for Constant Optimization

Closed-Loop AI Operations

AP Radio Telemetry

Client Telemetry

Close-Loop Automation

Unified AI

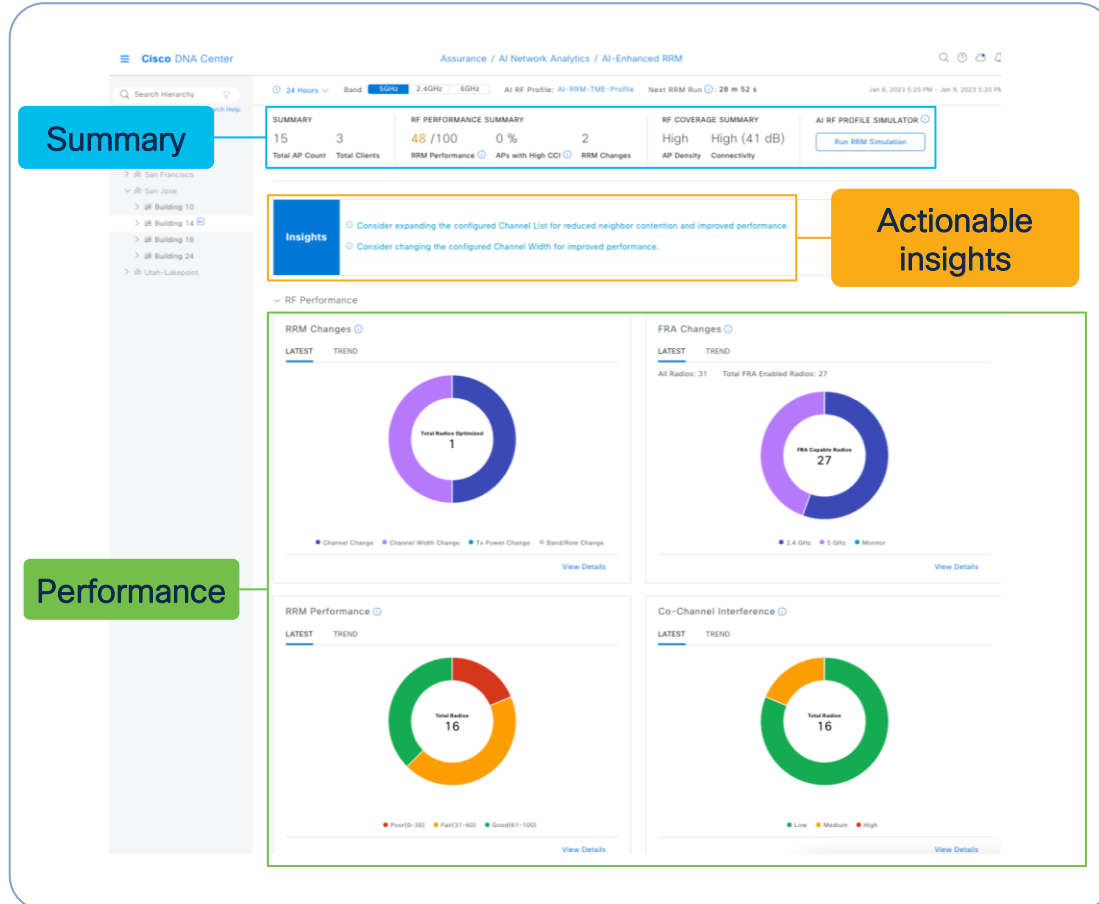
Infrastructure, Unified
Wireless AP

Unified RF Telemetries

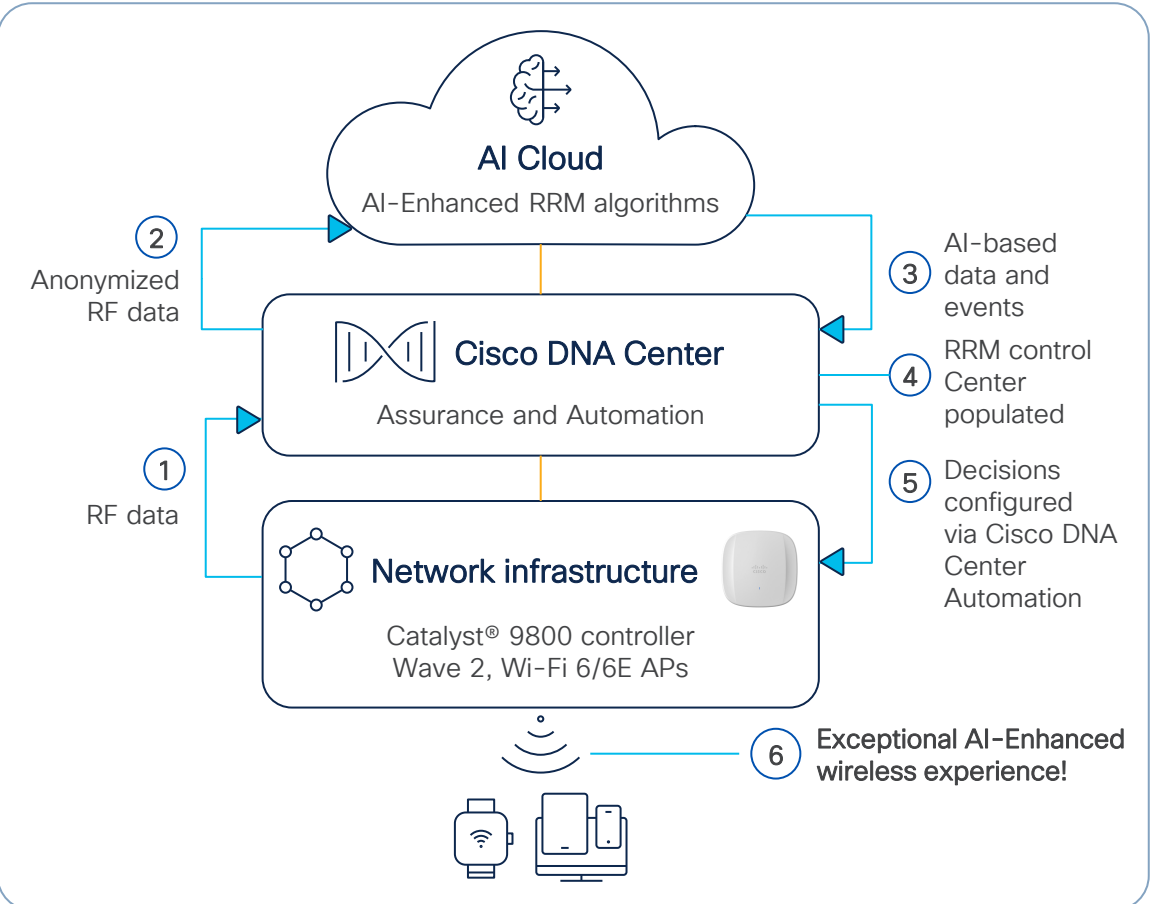
What is AI-Enhanced RRM?

On-Prem AI-Driven RRM solution

Deep RF visibility & advanced control

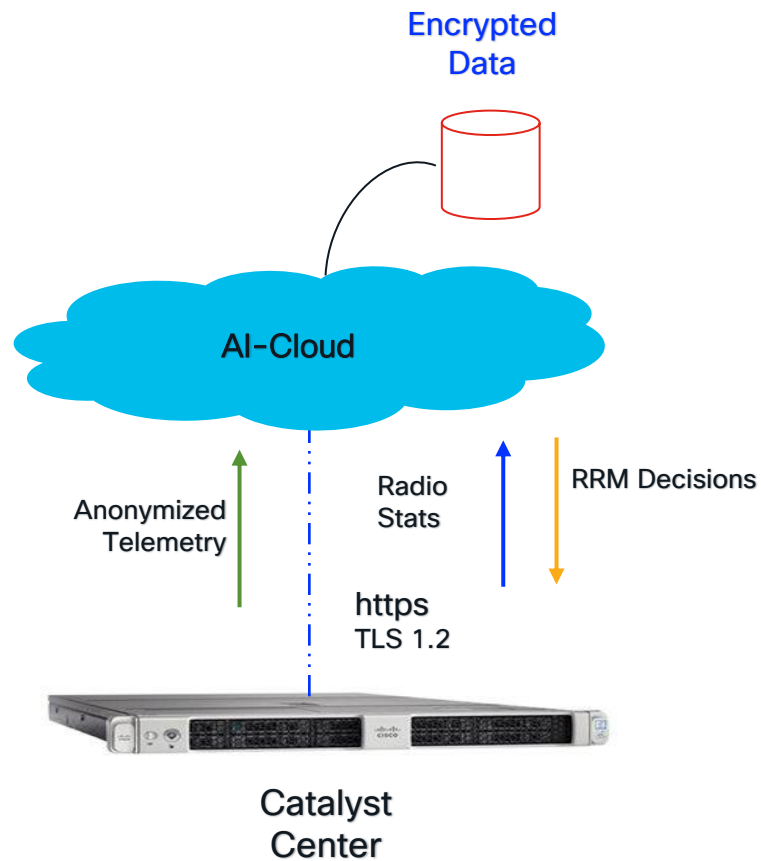


Proactive optimizations for all deployment sizes



AI Cloud telemetry collection

Utilizing Raw Device Telemetry Exclusively



RF Stats	Radio Configs	Network Information
PHY Stats	Channel	WLC IP
MAC Stats	Power	Base Radio MAC
Client Count	Bandwidth	WLC MAC
RF Events (Interrupts)	Operational Mode	AP Ethernet MAC

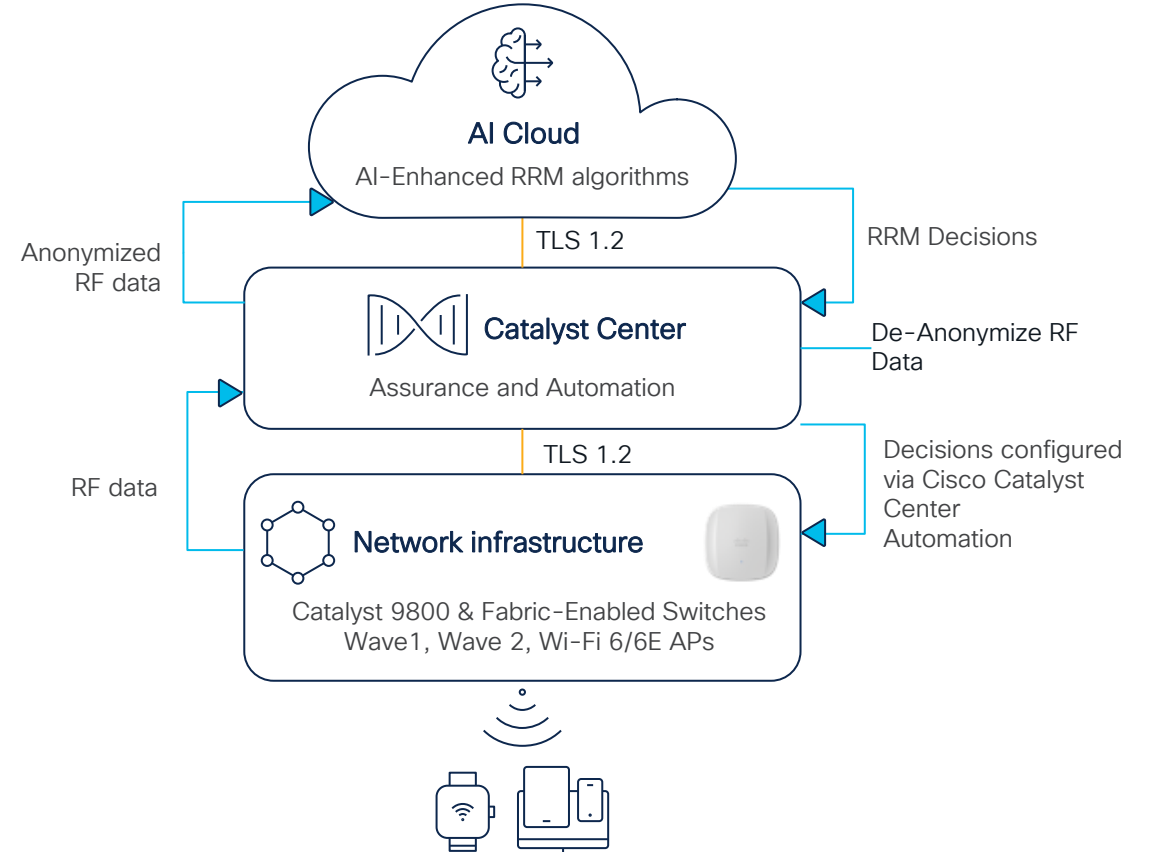
Protecting Your Data in the Cloud

with AI-Enhanced RRM Privacy Measures

Anonymized RF Data is encrypted with AES256 CTR and Base64 Encoding

Encryption Key is locally stored on Cisco Catalyst Center

All Data Stored in the AI Cloud is encrypted



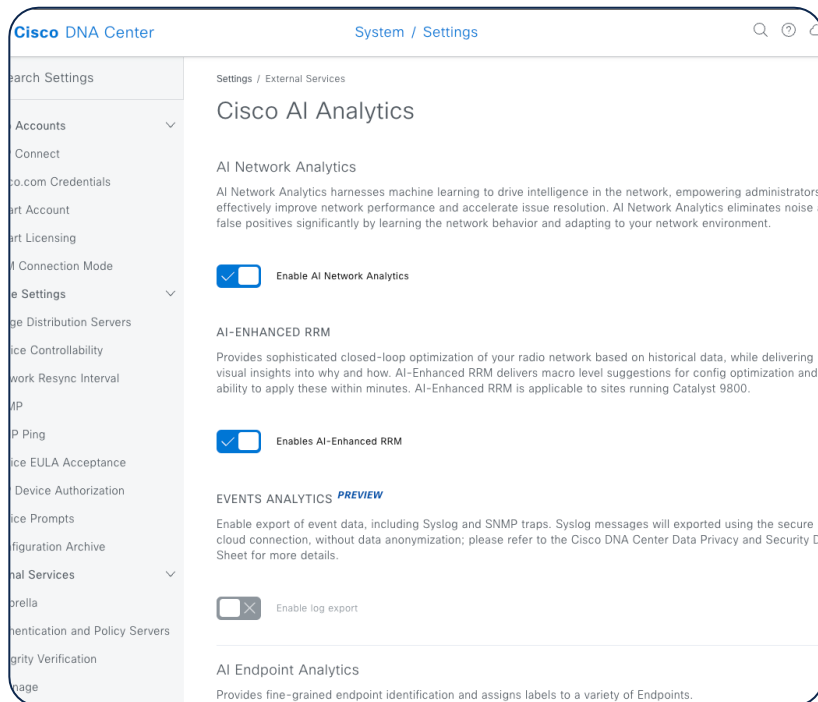
Refer to [Cisco Catalyst Center Privacy Data Sheet](#) for more information on Cisco Catalyst Center Data Privacy!

Enabling AI-Enhanced RRM for Provisioning-Enabled Deployments

Catalyst Center manages Catalyst 9800 configurations through Network Settings

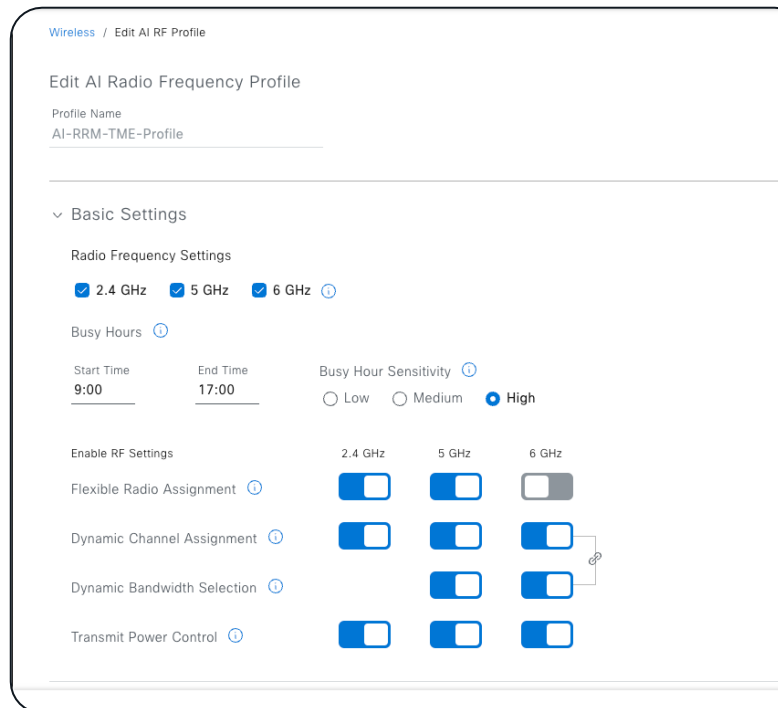
1

Give AI-Enhanced RRM Cloud Access in Settings.



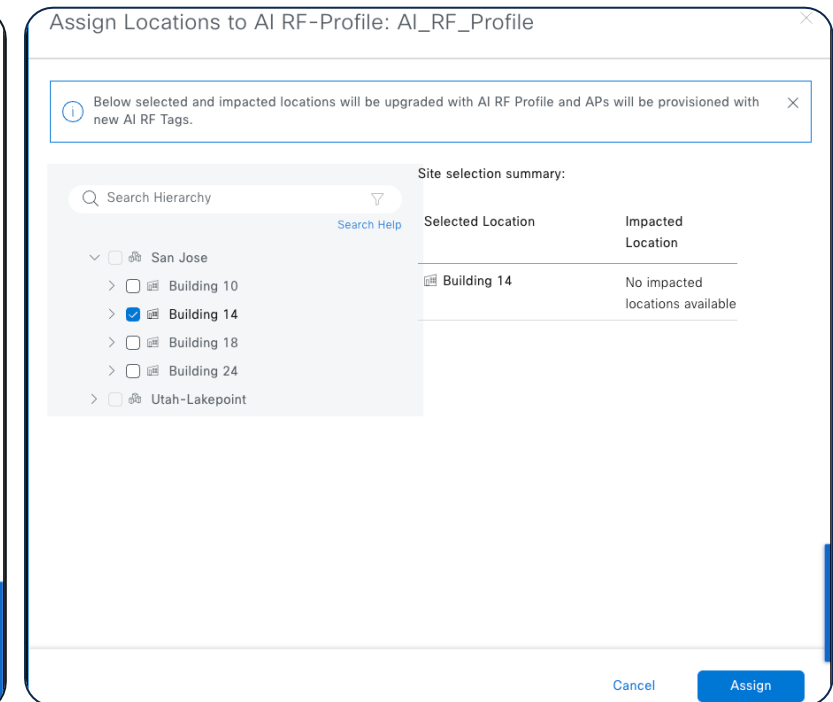
2

Create an AI RF Profile.



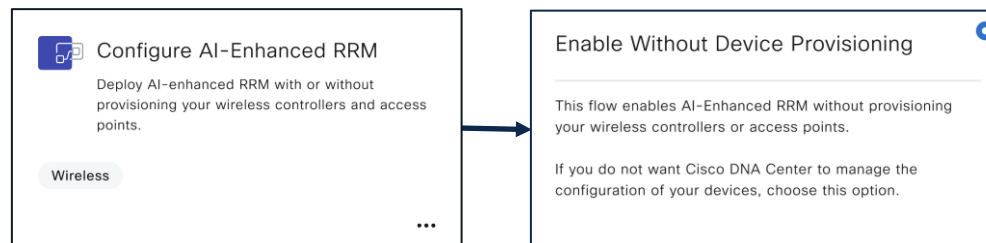
3

Assign AI RF Profile to a building, and **provision** your C9800 & APs.





Don't want to
Provision the WLC?



New AI-Enhanced RRM Workflow
for Assurance Only Customers!

Benefits of the AI-Enhanced RRM Workflow

Easier to Enable, with the Same Power of AI!

Doesn't Require C9800 to be Provisioned on Catalyst Center!

- Taking away this requirement means that all Catalyst Center users with supported hardware can leverage the power of AI.
- Users can continue managing their network settings on their C9800 directly.

Greatly Simplified Workflow!

- Combined all steps to enable AI-Enhanced RRM to a single workflow within the Workflow page titled, "Configure AI-Enhanced RRM -> Enable Without Device Provisioning".
- Admins no longer need to jump to different areas on Catalyst Center to figure out how to enable AI-Enhanced RRM!

Power of AI Remains the Same

- While enabling AI-Enhanced RRM has gotten significantly easier, all the amazing customer benefits remain the same.
- There are no loss with regards to solution capability.

Use the Power of AI-RRM, Without Provisioning in Catalyst Center!

1

Enable AI-Enhanced RRM cloud access in Settings

Cisco AI Analytics

AI Network Analytics

AI Network Analytics harnesses machine learning to drive intelligence in the network, empowering administrators to effectively improve network performance and accelerate issue resolution. AI Network Analytics eliminates noise and false positives significantly by learning the network behavior and adapting to your network environment.



Enable AI Network Analytics

AI-ENHANCED RRM

Provides sophisticated closed-loop optimization of your radio network based on historical data, while delivering visual insights into why and how. AI-Enhanced RRM delivers macro level suggestions for config optimization and the ability to apply these within minutes. AI-Enhanced RRM is applicable to sites running Catalyst 9800.

⚠ This feature can be enabled only if AI Network Analytics is enabled.

2

Select the newly designed workflow and deployment option!



Configure AI-Enhanced RRM

Deploy AI-enhanced RRM with or without provisioning your wireless controllers and access points.

Wireless

...

Enable Without Device Provisioning

This flow enables AI-Enhanced RRM without provisioning your wireless controllers or access points.

If you do not want Cisco DNA Center to manage the configuration of your devices, choose this option.

3

AI-Enhanced RRM is enabled without device provisioning!



AI-Enhanced RRM



Cisco Catalyst Center



Network infrastructure

Cisco Catalyst™ 9800
Series Controller
Wave 2, Wi-Fi 6/6E APs



Walk-me available for AI-Enhanced RRM workflow



Interactive Help :

How can we help you?

Search for help...

Launch Workflows

View Your Journey Maps

Assurance

Configure Site Analytics Settings

View Site Analytics

View the AI-Enhanced RRM Dashboard

Design

Get Started

Configure AI-Enhanced RRM

Before You Begin
You must have write permissions.

Complete the following steps:

[Step 1: Build the network hierarchy](#)

[Step 2: Provision the AI-capable wireless controller and APs to the site.](#)

Note: This step is optional if you are configuring AI-Enhanced RRM without device provisioning.

[Step 3: Enable AI-Enhanced RRM.](#)

[Step 4: Enable device controllability.](#)

[Step 5: Create an AI RF profile.](#)

[Step 6: Run the AI-Enhanced RRM workflow.](#)

Note: If you are unable to complete all the steps in one go, you can restart this walkthrough and click the step that you want to go to.

Click **Next** to continue or click **Cancel** to exit.

View the AI-Enhanced RRM Dashboard

Cisco AI Network Analytics uses machine learning algorithms to define the behavior of an RF network within a building enabled with AI-Enhanced Radio Resource Management (RRM).

Before You Begin

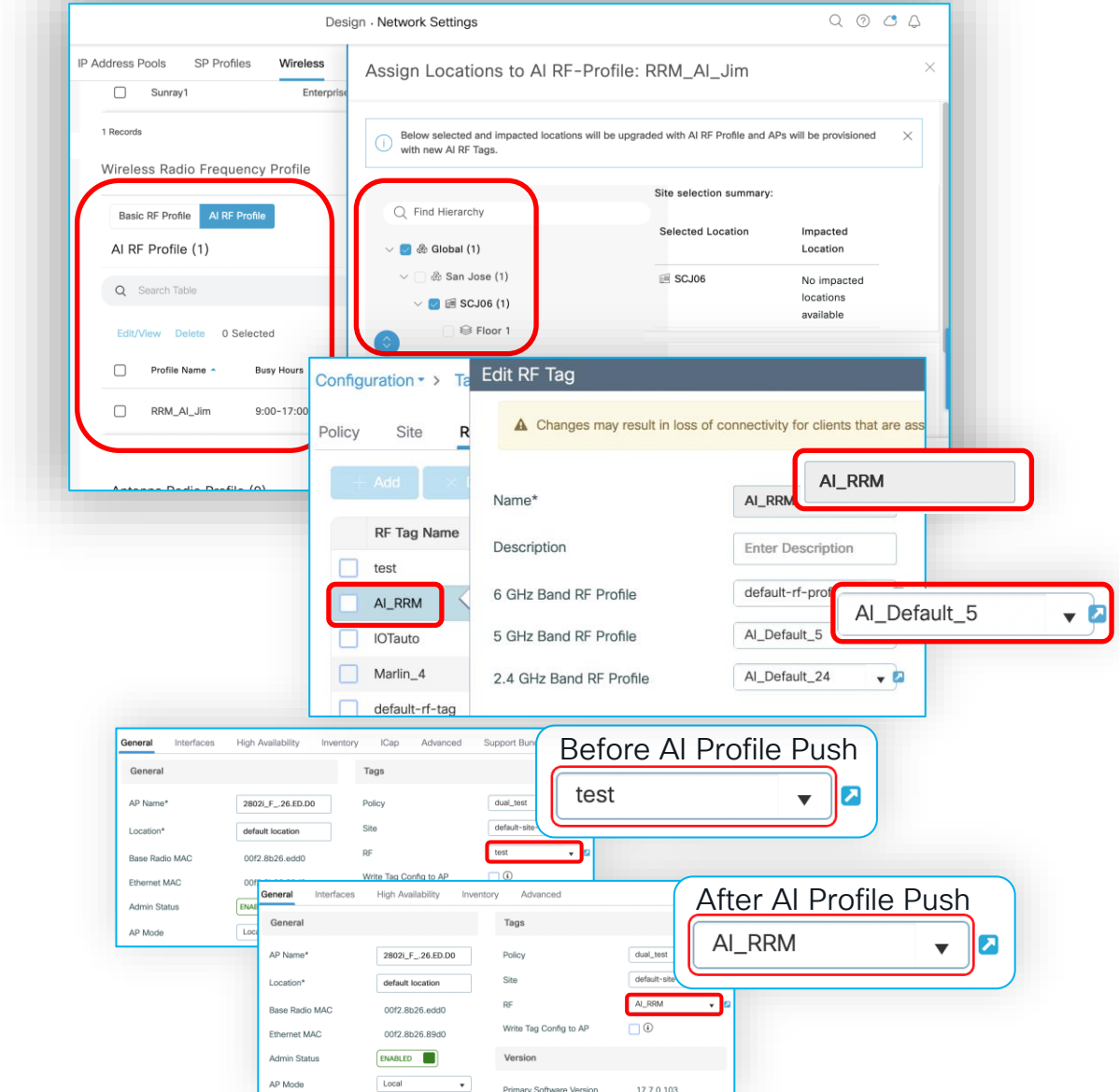
- You must have write permissions.
- You must [Configure AI-Enhanced RRM](#).
- You must assign a location to an AI RF profile to view the AI-Enhanced RRM dashboard.
- Cisco AI-Enhanced RRM is supported only on Cisco Catalyst 9800 Series Wireless Controllers and Cisco IOS XE Release 17.7.1 or later.

Click **Next** to continue or click **Cancel** to exit.

Onboarding the WLC

AI Enhanced RRM Onboarding

- On the DNA Center console, Select the site to apply the AI Profile that was created
- If there is more than one site on a WLC, ALL sites will need to run AI-Enhanced RRM
- Once assigned, the AI RF Profile gets pushed to the WLC and replaces the legacy RF Tag/Profile
- APs on the WLC are assigned the AI RF Profile
- A single WLC can either run legacy RRM or AI Enhanced RRM but not both



What Happens at the WLC ?

AI Enhanced RRM Onboarding

- When the AI RF Profiles are updated on the WLC, the RF Group Leader Role changes from Auto-Leader to “Remote-Member”
- The RF group Group Leader Changes from “C9800-L_17_7” to “DNAc_Rocks_RRM”
- The RF Group Name changes from “test1” to “Open RRM”
- Other WLCs that were a member of this WLCs RF group as Members will assign a new RF group leader and continue using the existing configurations

Before AI RF Profile

Configuration > Radio Configurations > RRM

6 GHz Band 5 GHz Band 2.4 GHz Band FRA

General Coverage DCA TPC RF Grouping

Group Mode: ☒ Automatic, ☐ Leader, ☐ Off

Group Role: Auto-Leader

Group Update Interval: 600 second(s)

Last Group Update: 328 second(s) ago

Group Leader: C9800-L_17_7 (192.168.10.21)

Group Members

Total Group Members: 3

Group Name: test1

Protocol Version: 0

Controller Name	IPv4 Address
C9800-L_17_7	192.168.10.21
C9800-L_17_7_a	192.168.10.31
C9800-L_17_7_b	192.168.10.41

After AI RF Profile

Configuration > Radio Configurations > RRM

6 GHz Band 5 GHz Band 2.4 GHz Band FRA

General Coverage DCA TPC RF Grouping Spatial Reuse

Restart

Group Mode: ☒ Automatic, ☐ Leader, ☐ Off

Group Role: Remote-Member

Group Update Interval: 600 second(s)

Last Group Update: 328 second(s) ago

Group Leader: DNAc_Rocks_RRM (172.16.xxx.xxx)

Group Members

Total Group Members: 1

Group Name: Open RRM

Protocol Version: 0

Controller Name	IPv4 Address	IPv6 Address
C9800-L_17_7	192.168.10.21	

What Happens if the AI-RF Group Leader is lost?

AI Enhanced RRM Operations

- So, what does it mean if the RF Group leader is in the cloud for AI-Enhanced RRM systems?
- What Happens if the cloud gets interrupted?
 - AI Enhanced RRM has a keepalive timer that runs every 20 minutes
 - If interrupted the WLC simply assumes Auto-Leader role and RRM runs locally with the AI Profiles!

Graceful Recovery!

Configuration > Radio Configurations > RRM

6 GHz Band 5 GHz Band 2.4 GHz Band FRA

General Coverage DCA TPC RF Grouping Spatial Reuse

Restart

Group Mode

☒ Automatic
☐ Leader
☐ Off

Group Role Auto-Leader

Group Update Interval 600 second(s)

Last Group Update 328 second(s) ago

Group Leader C9800-L_17_7 (192.168.10.21)

Group Members

Total Group Members : 3

Group Name Open RRM

Protocol Version 0

Controller Name	IPv4 Address	IPv6 Address
C9800-L_17_7	192.168.10.21	
C9800-L_17_7_a	192.168.10.31	
C9800-L_17_7_b	192.168.10.41	

Cisco IMPACT Las Vegas 2023 Deployment with AI-Enhanced RRM Displayed the Power of AIOps in High-Density Wireless!

Busy Hour reduced the number of channel changes by 83% during peak hours!

Average SNR was 25 dB before AI-Enhanced RRM and was improved to 29 dB after!

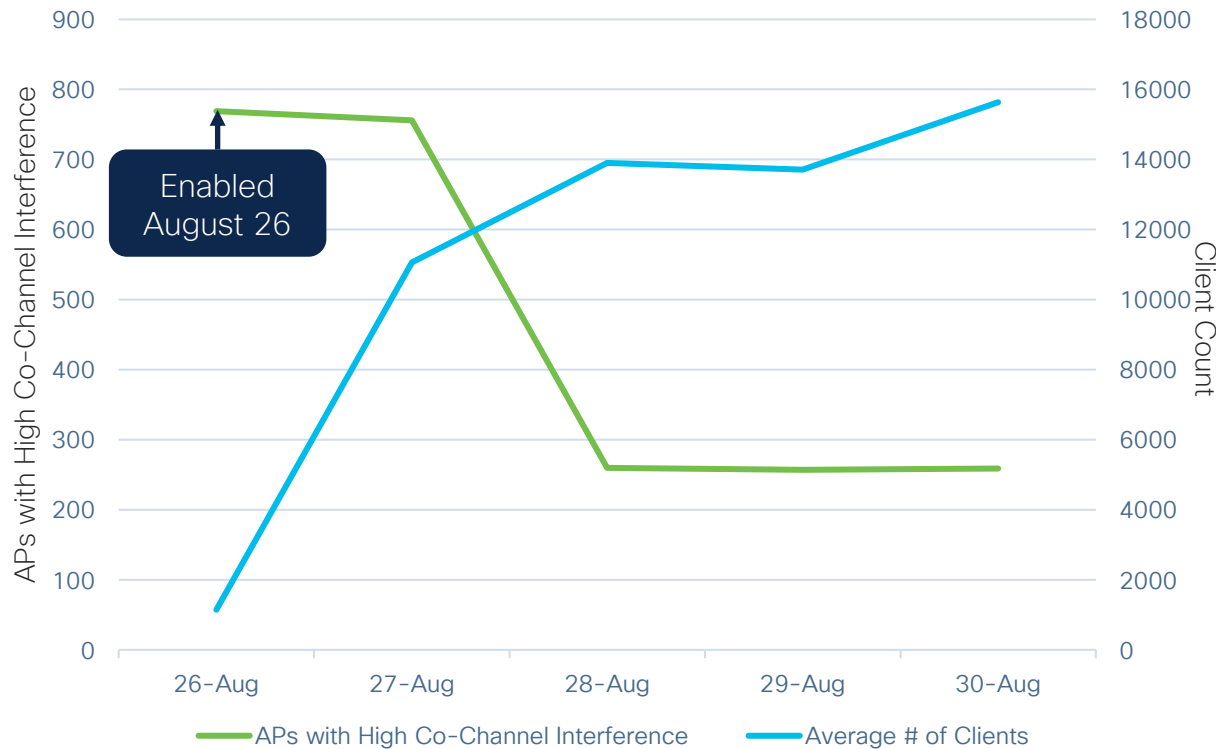
% of APs with High CCI was at 43% before AI-Enhanced RRM and was improved to 15% after!

AI-Enhanced RRM Deployment

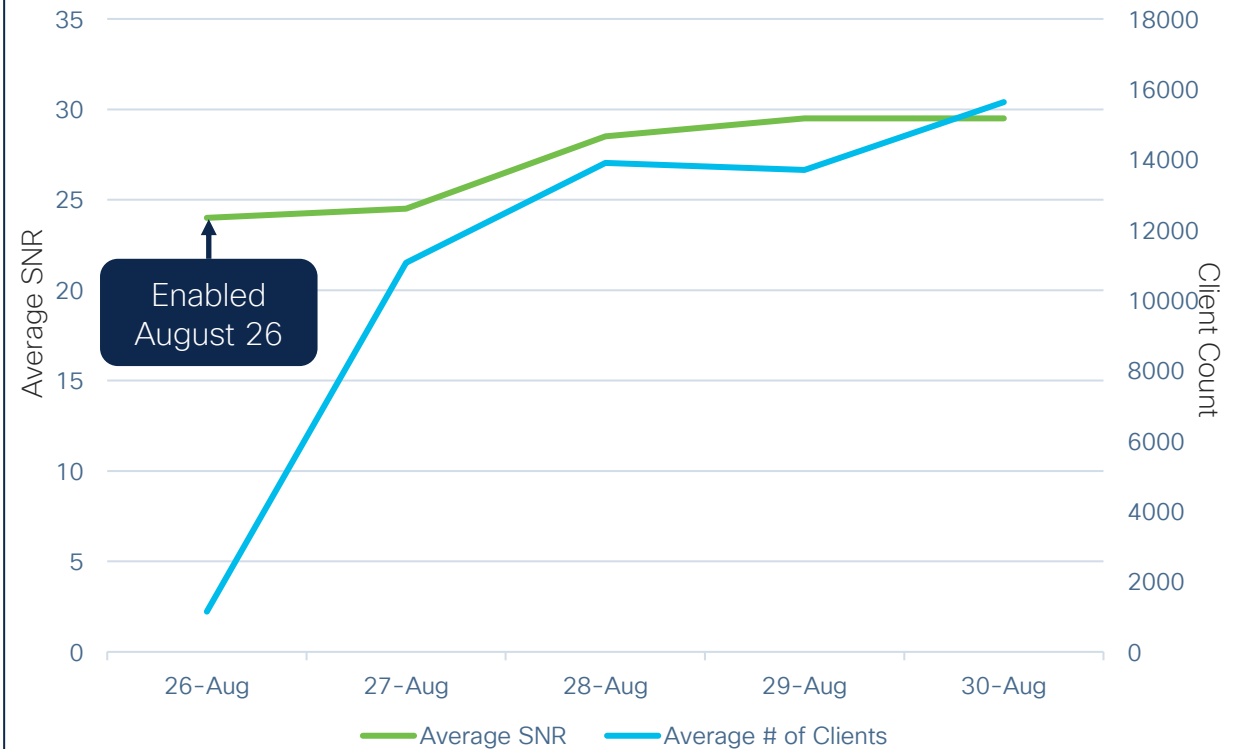
- Location: Mandalay Bay, MGM Grand, Delano
- Contiguous Square Footage: 3 m ft/2 (280 Km/2)
- Market Segment: Convention Center
- WLC Count: 2 x C9800-80 in HA
- WLC Version: 17.9.3
- AP Type: 3800s and 9130E with RP-TNC connector Antenna
- AP Count: 2352 (with 2526 enabled radios)
- Catalyst Center: 1 Running 2.3.3.7
- Spectrum: 5 GHz

AI-Enhanced RRM Significantly Improved the Wireless Experience at Cisco IMPACT in August 2023

APs with High Co-Channel Interference Decreased by 28%!



Client SNR Increased by ~4dB!

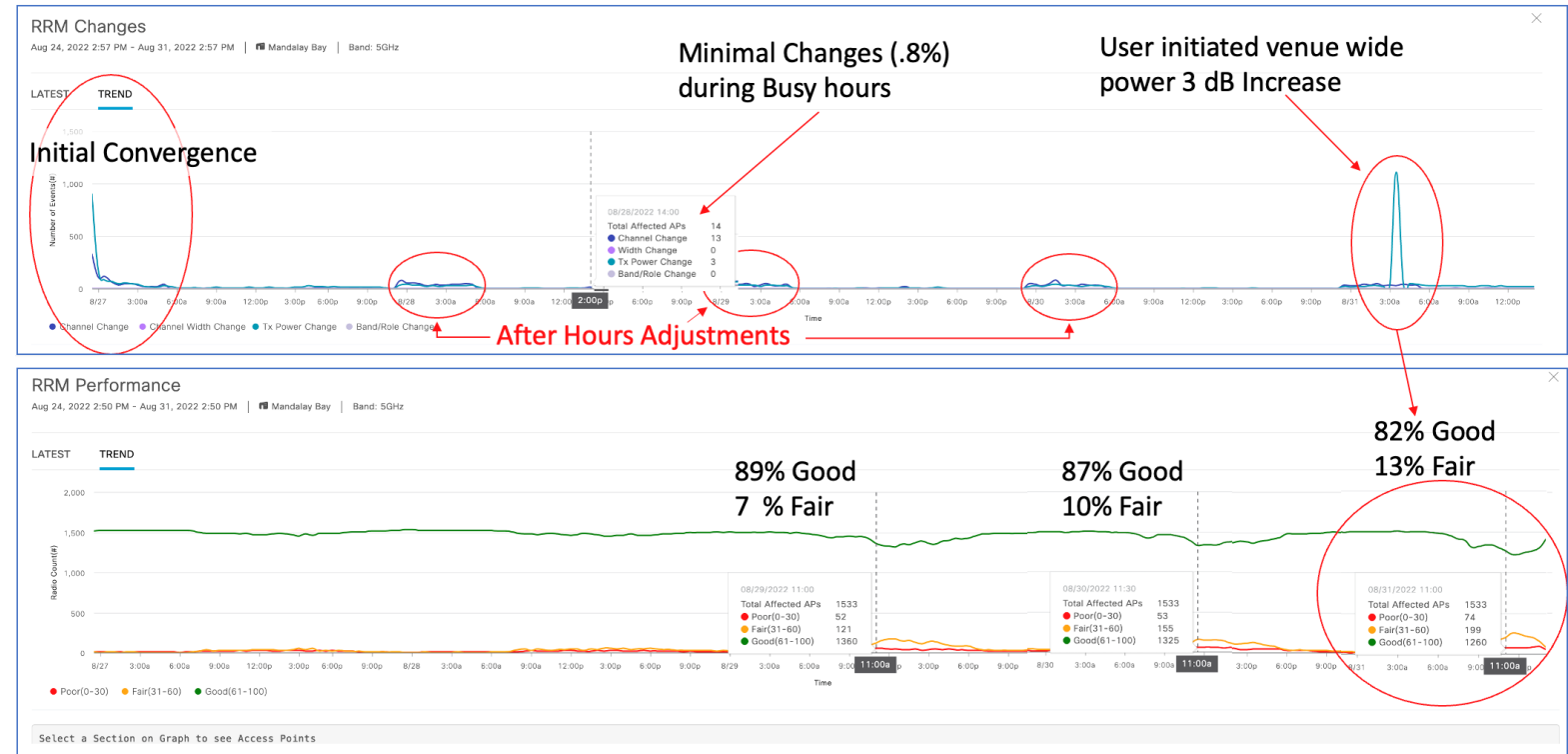


AI-Enhanced RRM converged the wireless network within 6 hours and continued to improve the wireless experience in the high-density environment after a large influx of clients began to join.

When AI beat The team

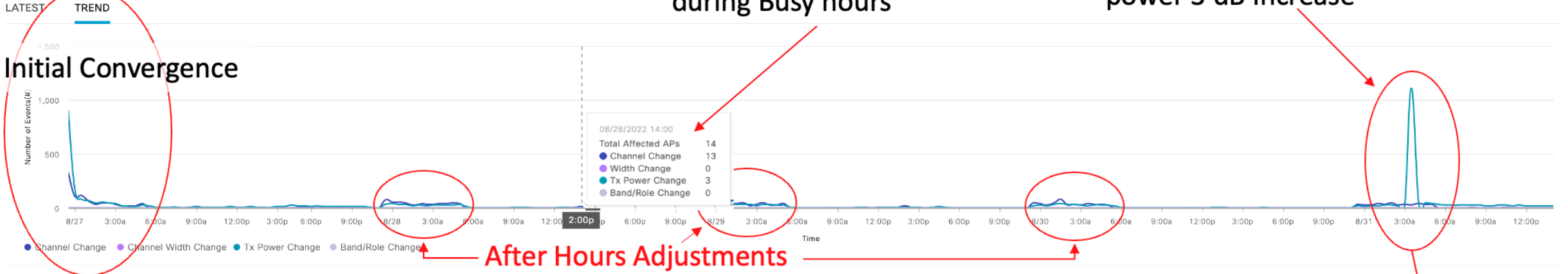
Cisco Impact August 2022 AI-Enhanced RRM In Action

- Initial Convergence ~3 Hours
- Changes made at Night
- Health stayed above 85% (very good with load)
- Manual Changes made last day, easy to spot the decrease in efficiency



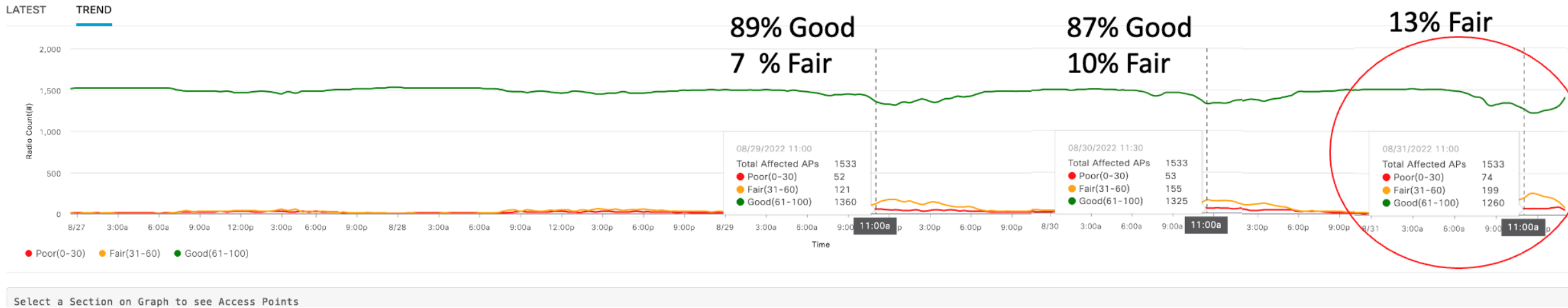
RRM Changes

Aug 24, 2022 2:57 PM - Aug 31, 2022 2:57 PM | Mandalay Bay | Band: 5GHz



RRM Performance

Aug 24, 2022 2:50 PM - Aug 31, 2022 2:50 PM | Mandalay Bay | Band: 5GHz



Software and Hardware Support Matrix

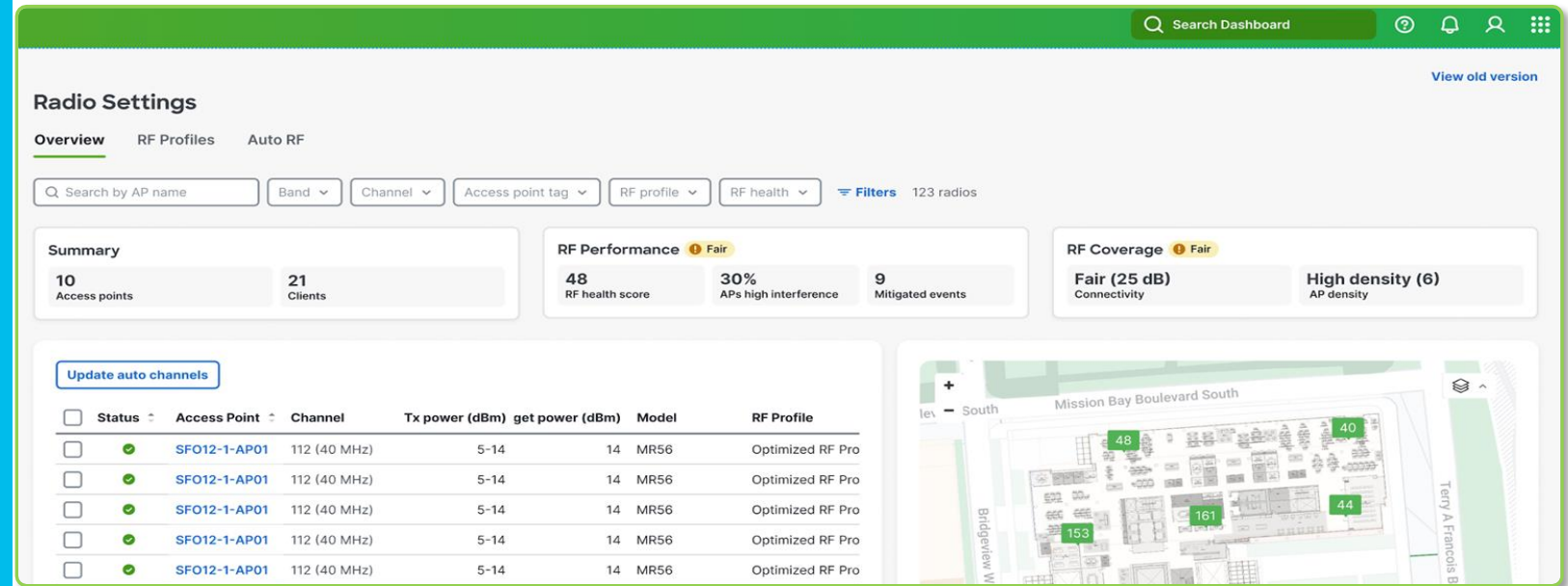
for AI-Enhanced RRM's Workflow for Assurance-Only Deployments

Cisco IOS XE WLC Software	Cisco Catalyst Center Software and Licensing
17.9.5 or newer (17.12.3 recommended)	2.3.7.6 with DNA Advantage License
Cisco Access Point Hardware	
Wave 1, Wave 2, Catalyst Wi-Fi 6, 6E Access Points (Wi-Fi 7 support coming)	
Cisco IOS XE WLC Hardware	
C9800-CL	
C9800-L	
C9800-40 / C9800-80	
CW9800-M / CW9800-H1 / CW9800-H2	

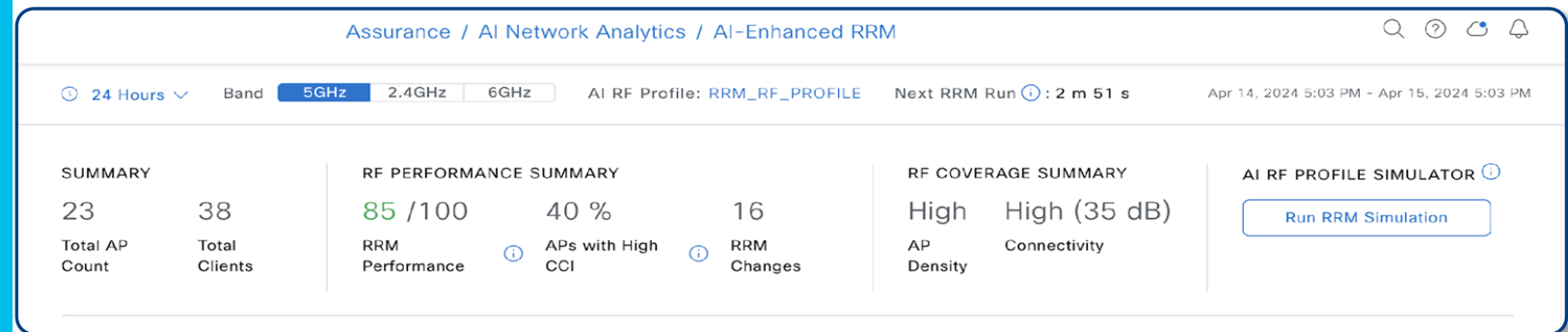
AI-RRM for Cloud?

- Autonomous Wi-Fi
- Zero-Touch Operation
- Closed-Loop AI Operations
- Unified AI Infrastructure,
- Unified Wi-Fi device Telemetry

Meraki Dashboard

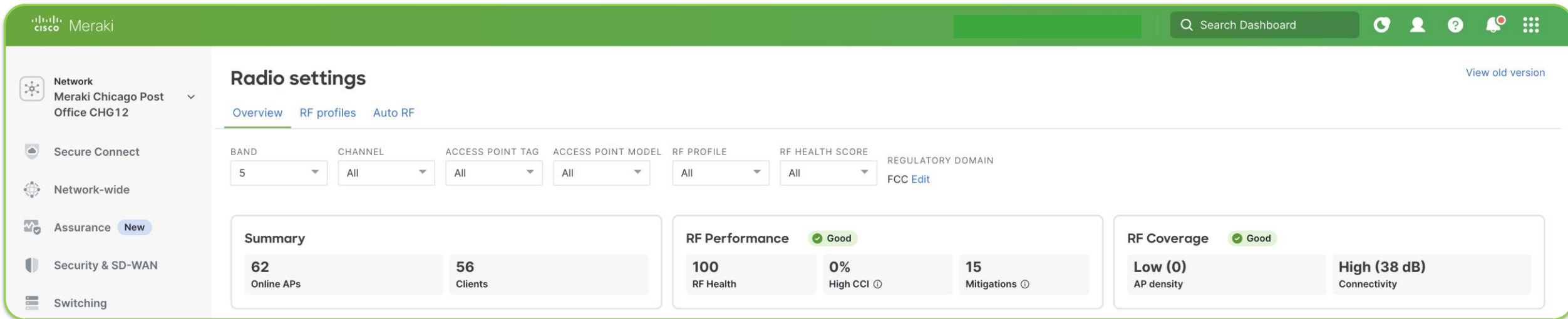


Catalyst Center

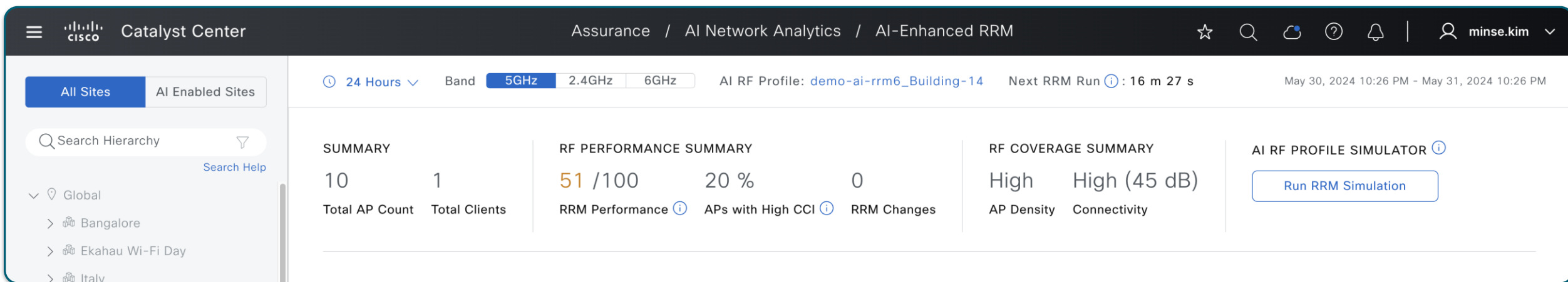


Unified AI across all Cisco Wireless

RF Intelligence from the World's Largest Wireless Data Lakes



The screenshot shows the Meraki dashboard interface. The top navigation bar is green with the Cisco Meraki logo on the left, a search bar in the center, and user icons on the right. The left sidebar contains navigation links: Network (selected), Secure Connect, Network-wide, Assurance (marked as New), Security & SD-WAN, and Switching. The main content area is titled "Radio settings" and includes tabs for Overview, RF profiles, and Auto RF. Below the tabs are filter dropdowns for BAND (5), CHANNEL (All), ACCESS POINT TAG (All), ACCESS POINT MODEL (All), RF PROFILE (All), RF HEALTH SCORE (All), and REGULATORY DOMAIN (FCC Edit). The dashboard displays three summary cards: "Summary" showing 62 Online APs and 56 Clients; "RF Performance" showing 100 RF Health, 0% High CCI, and 15 Mitigations; and "RF Coverage" showing Low (0) AP density and High (38 dB) Connectivity. A "View old version" link is located in the top right corner.



The screenshot shows the Catalyst Center AI Network Analytics dashboard. The top navigation bar is dark blue with the Cisco Catalyst Center logo on the left, the breadcrumb "Assurance / AI Network Analytics / AI-Enhanced RRM" in the center, and user icons on the right. The left sidebar contains a search bar and a list of locations: Global, Bangalore, Ekahau Wi-Fi Day, and Italy. The main content area displays a summary of RF performance and coverage. It includes a "SUMMARY" section with 10 Total AP Count and 1 Total Clients. The "RF PERFORMANCE SUMMARY" section shows 51 / 100 RRM Performance, 20 % APs with High CCI, and 0 RRM Changes. The "RF COVERAGE SUMMARY" section shows High AP Density and High (45 dB) Connectivity. The "AI RF PROFILE SIMULATOR" section includes a "Run RRM Simulation" button. The top of the main content area shows filters for 24 Hours, Band (5GHz), and AI RF Profile (demo-ai-rrm6_Building-14). The bottom of the main content area shows the Next RRM Run time (16 m 27 s) and the date range (May 30, 2024 10:26 PM - May 31, 2024 10:26 PM).

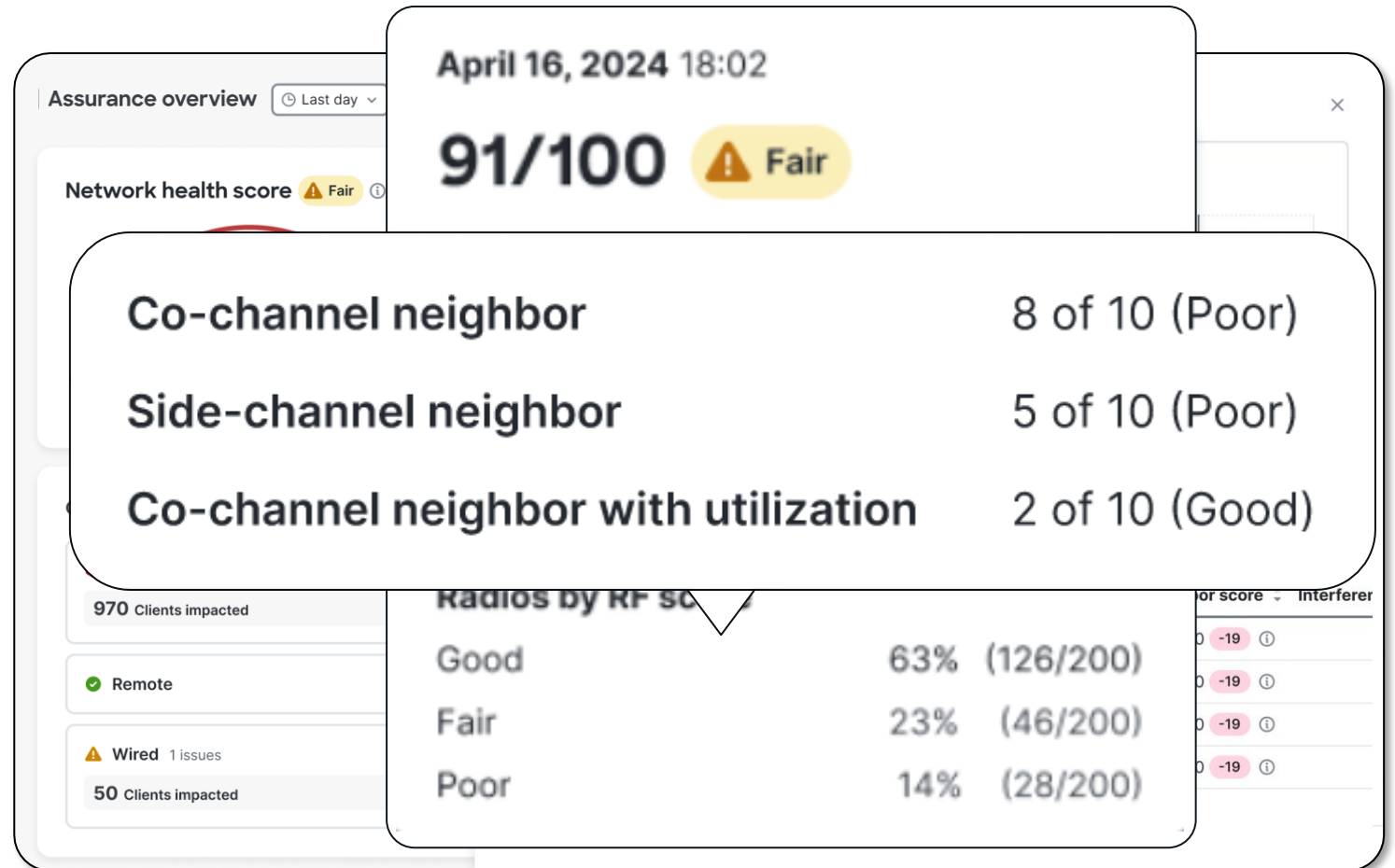
cisco *Live!*

In Progress

RF Health

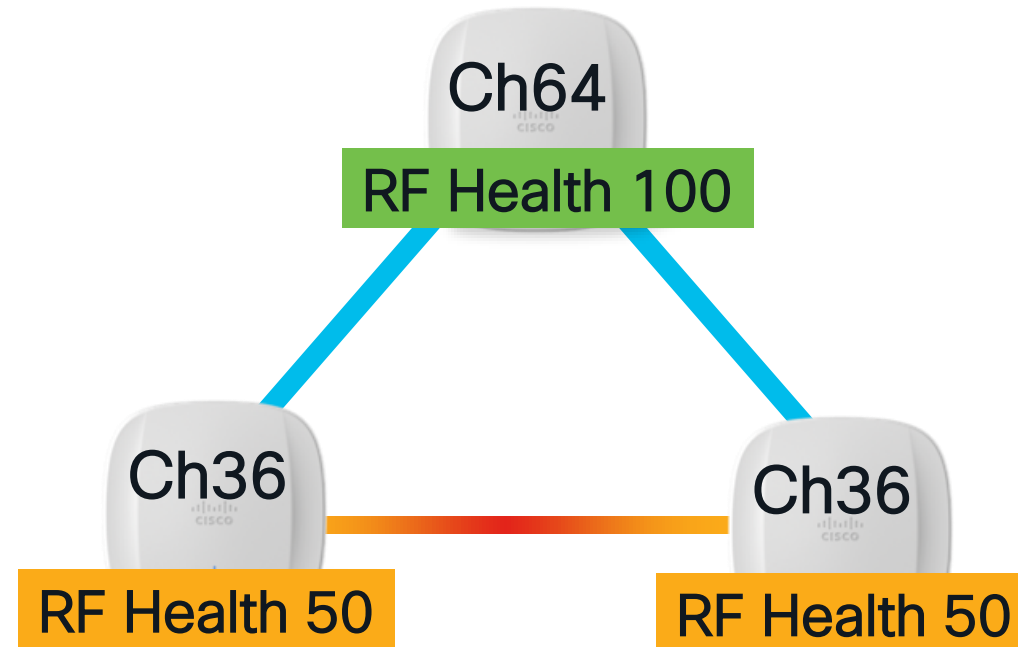
on Assurance Overview

- Highlights problematic frequency bands – 2.4, 5, 6 GHz
- Provide per-radio RF scoring, the same algorithm used for AI-RRM
- Provides further scoring and insights on critical RF categories – neighbors, interference, noise, and client connectivity



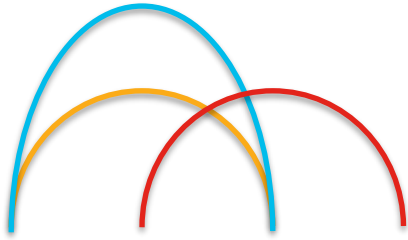
RF Health

RF Design and operation validation metric



RF Health is a value from 0 to 100 to represent a simple-to-understand metric with the RF quality state of AP radio (0% is dead, 100% is fully healthy)

RF Health ingredients



Neighbor: Co channel neighbor, side channel neighbor, Co-channel utilization



Interference: CCA Busy, Channel Interference RSSI, Interference Duty cycle, Side channel interference, Interferer Utilization



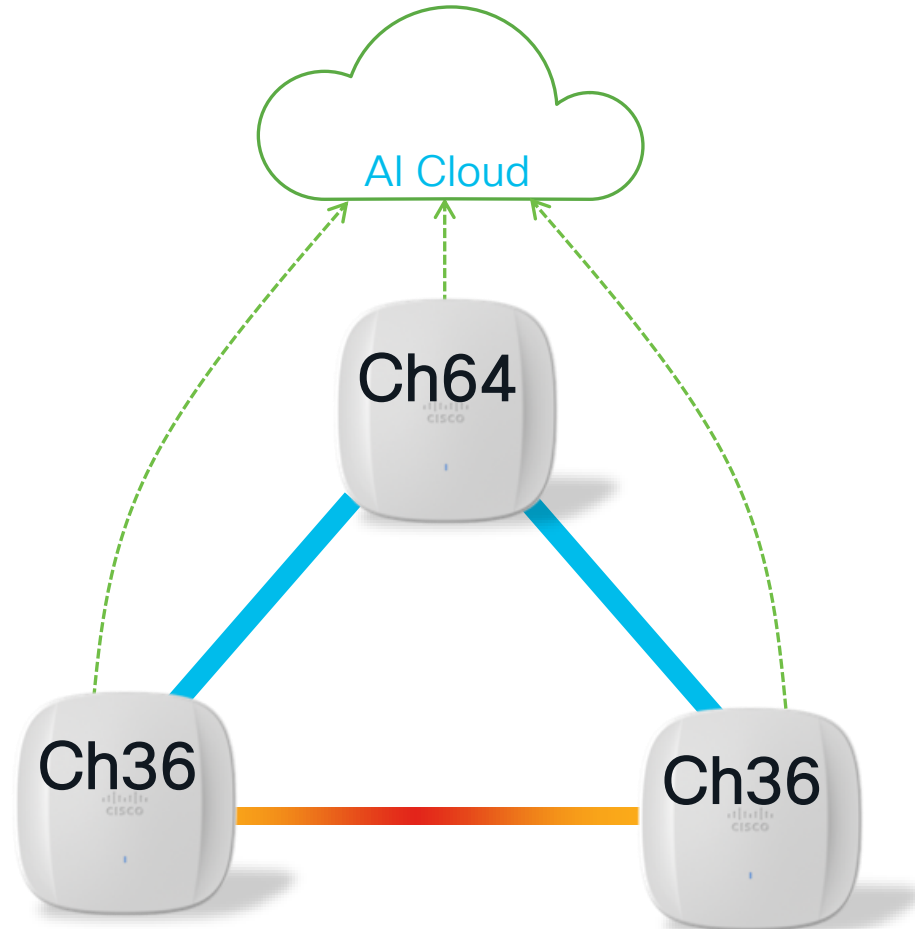
Noise: Noise Floor, Side channel noise



Client: Low RSSI Client, Low SNR client

Advanced Neighbor Visibility

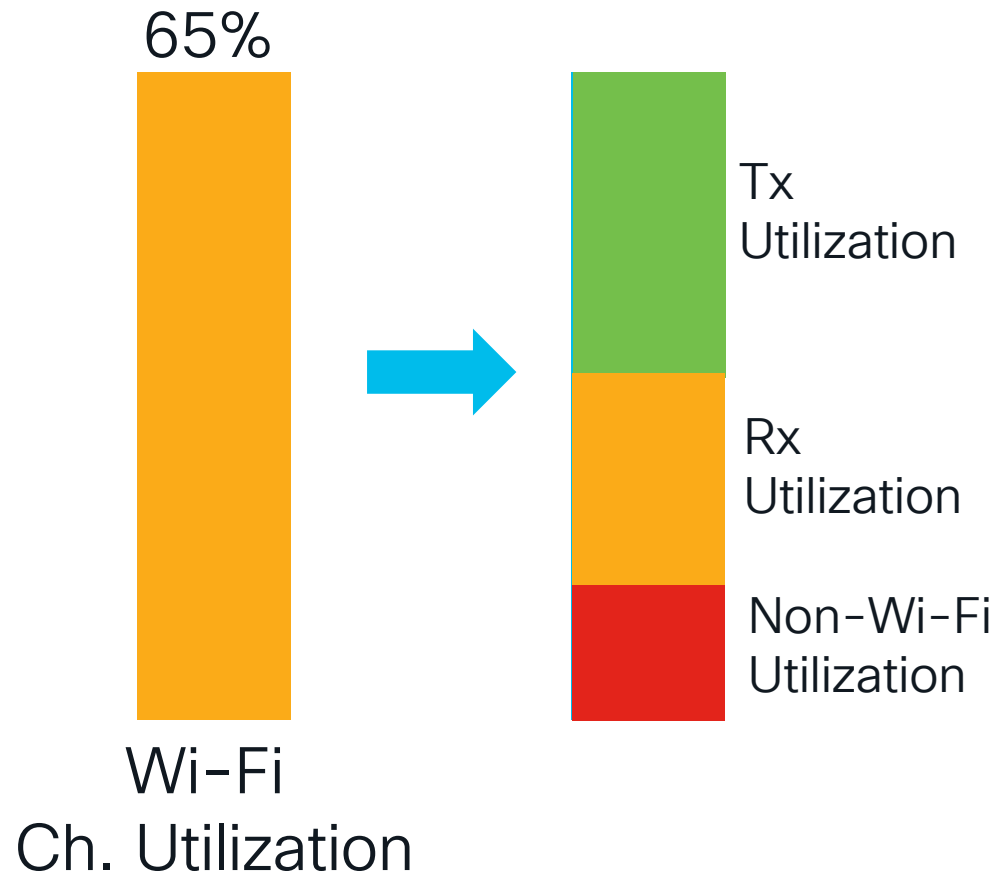
AI-RRM can leverages comprehensive RF telemetry



- NDP – Neighbor Discovery Protocol
- Cisco APs to evaluate neighbor connectivity and RF environment for RRM purposes
- NDP frames offer **reference radio measurement** between APs
 - Being sent in consistent Tx power
 - Send across all channel
 - Include Comprehensive infos such as Antenna level, Power level etc
- Received NDP info gets reported to AI Cloud

Channel Utilization breakdown

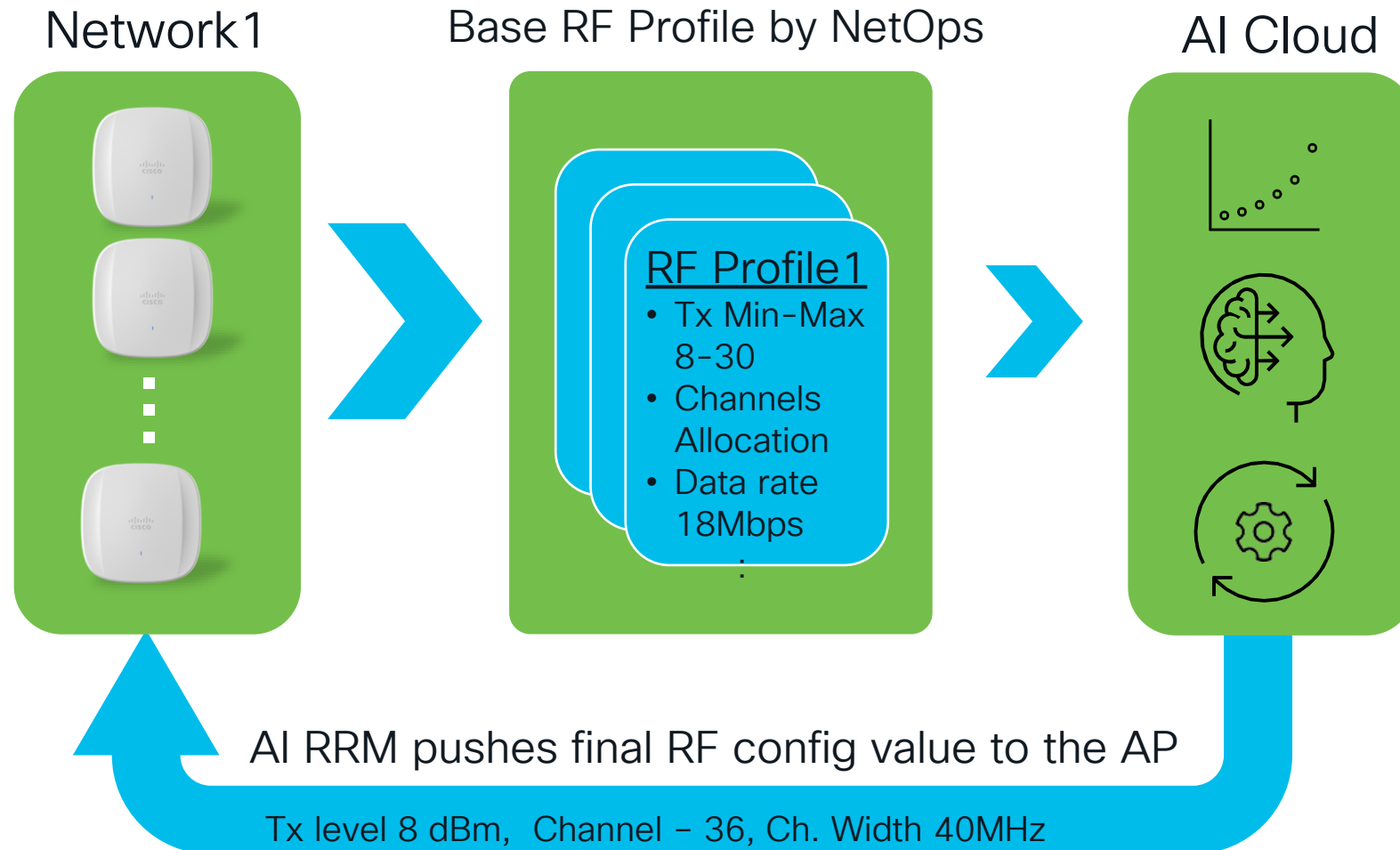
High Channel utilization is NOT always bad



- “Who” caused the High Channel utilization ?
- Total Ch. Utilization consisted with
 - Tx Utilization
 - Rx Utilization
 - Non Wi-Fi source utilization

AI-RRM Control Path

AI-RRM honors network RF Profile config



AI-Enhanced RRM Can Significantly Improve Meraki's Wi-Fi!

Trend-Based RRM

Optimize RF with 2 weeks of data enabling more sophisticated & efficient RRM optimization!



Flexible Radio Assignment

Place radios on the most optimal band/mode to minimize interference on 2.4 GHz at the touch of a button!



Enhanced Busy Hour

Optimizations are deferred until after the busy hour, using busy hour data, rather than just suppressed!



Radio Settings

OverviewRF ProfilesAI-RRM

Trend-based RRM☒ Enable
Trend-based RRM uses an AI engine to improve the performance of your network ⓘ

Flexible radio assignment☐ Enable FRA
FRA optimizes the 2.4 GHz band by strategically disabling redundant radios to reduce interference ⓘ

AI channel planning☒ Enable AI channel planning
Improved Channel Assignment by leveraging artificial intelligence to optimize channel planning capabilities ⓘ

Busy hour

☐ Enable busy hour
AI-RRM will minimize changes during the most active hours of the day ⓘ

Sensitivity ⓘ ☐ Low ☐ Medium ☒ High

☒ **Auto schedule**
Based on historical data of up to the last 6 weeks ⓘ
23:00 → 08:00 ⓘ

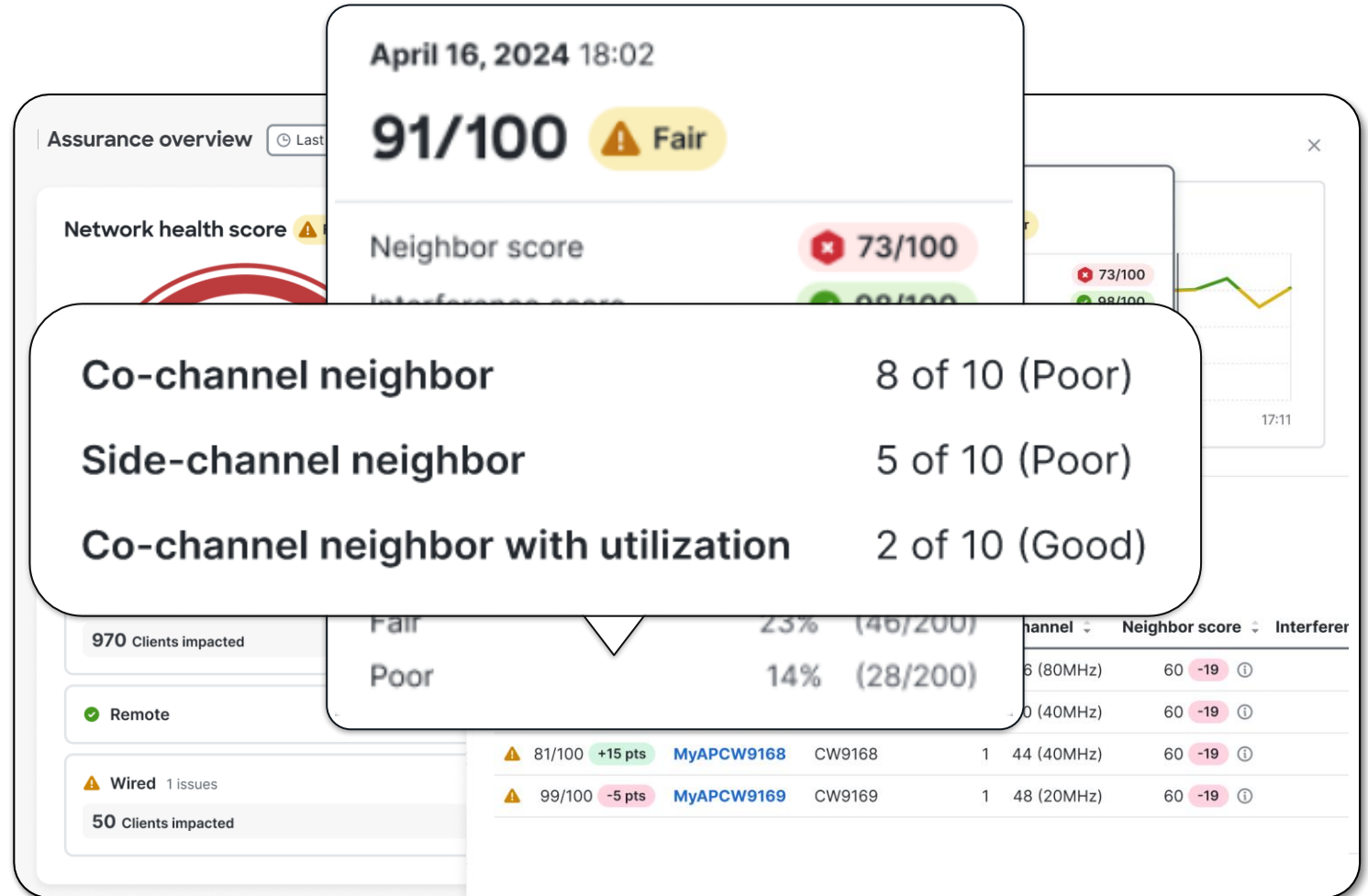
☐ **Manual schedule**

In Progress

RF Health

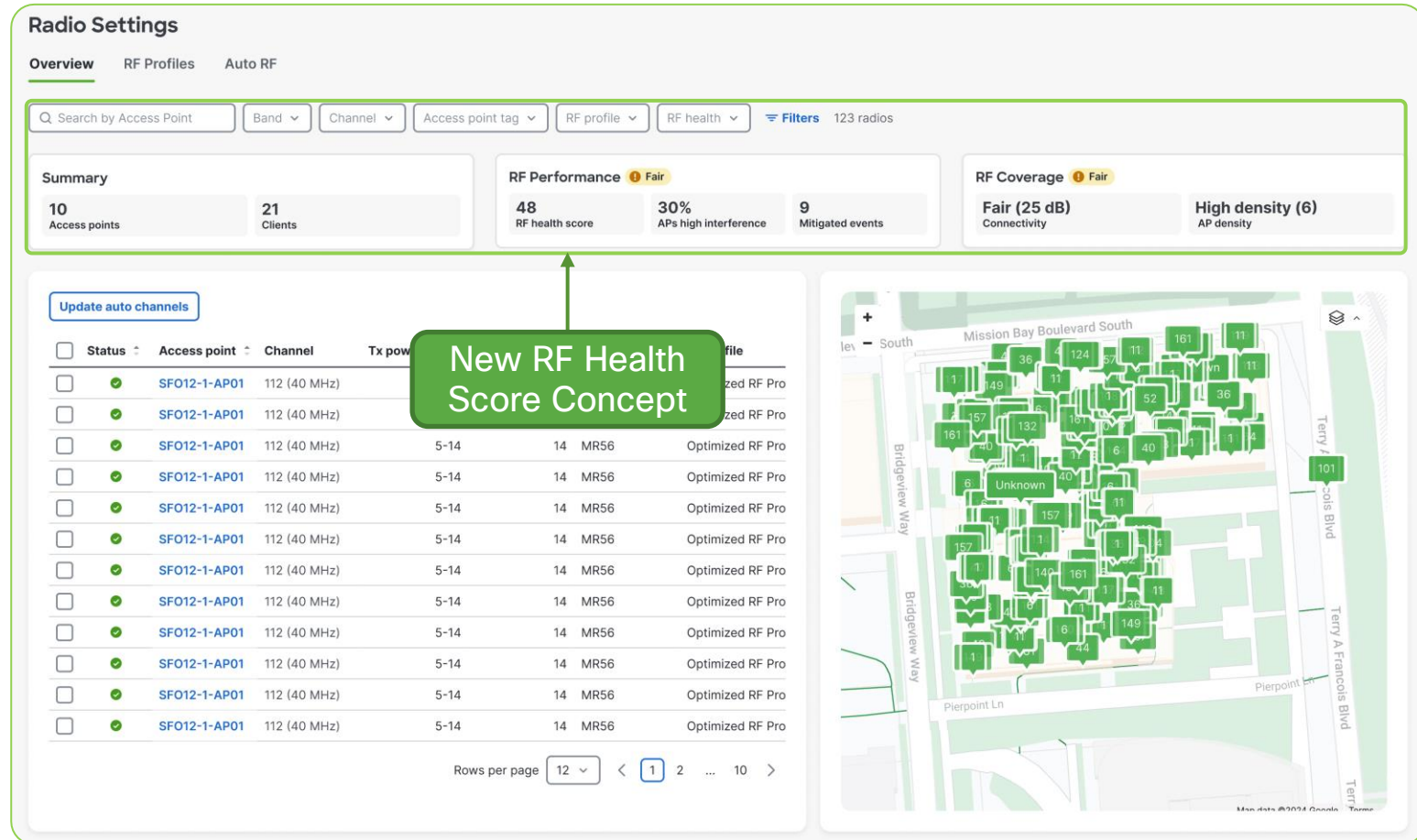
on Assurance Overview

- Highlights problematic frequency bands – 2.4, 5, 6 GHz
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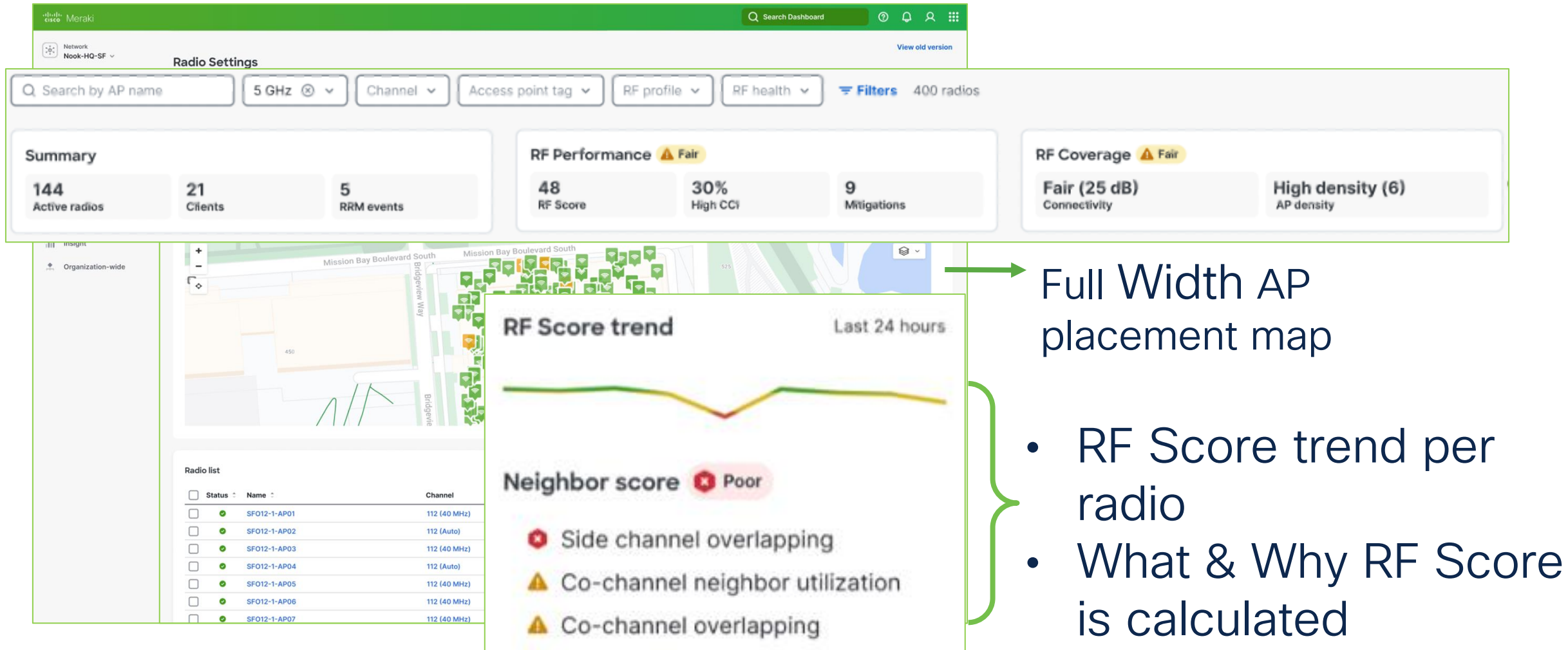
RF Summary Bar in Radio Settings

- Understand RF Performance at-a-glance per network
- RF health score considers all critical RF metrics
- Mitigated events shows benefits of AI Channel Planning
- New discovery workflow with advanced filtering



Same AI engine with similar visibility as Catalyst Center's AI-RRM Control Center!

RF Overview – Redefined

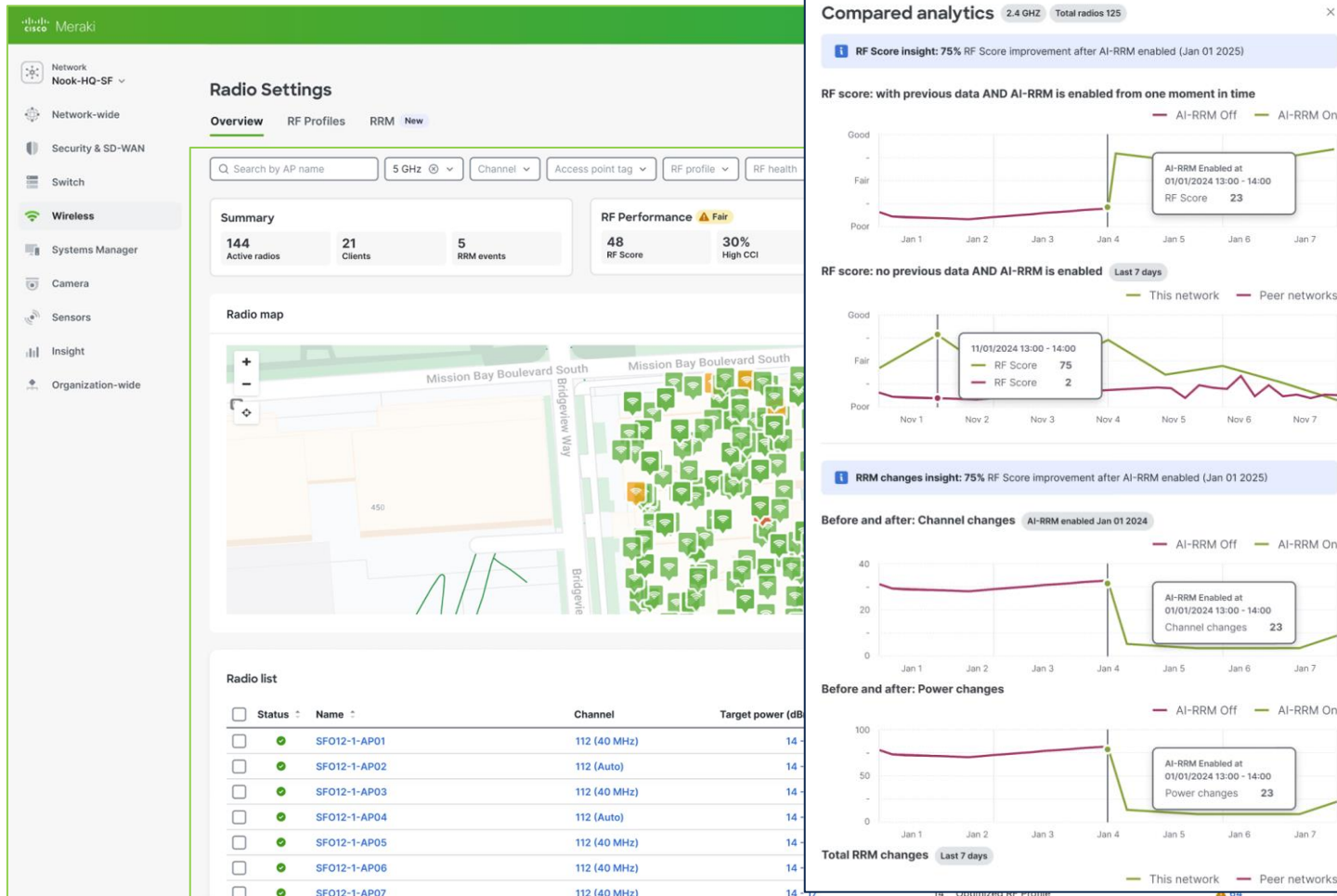


Full Width AP
placement map

- RF Score trend per radio
- What & Why RF Score is calculated

Comparative Analytics

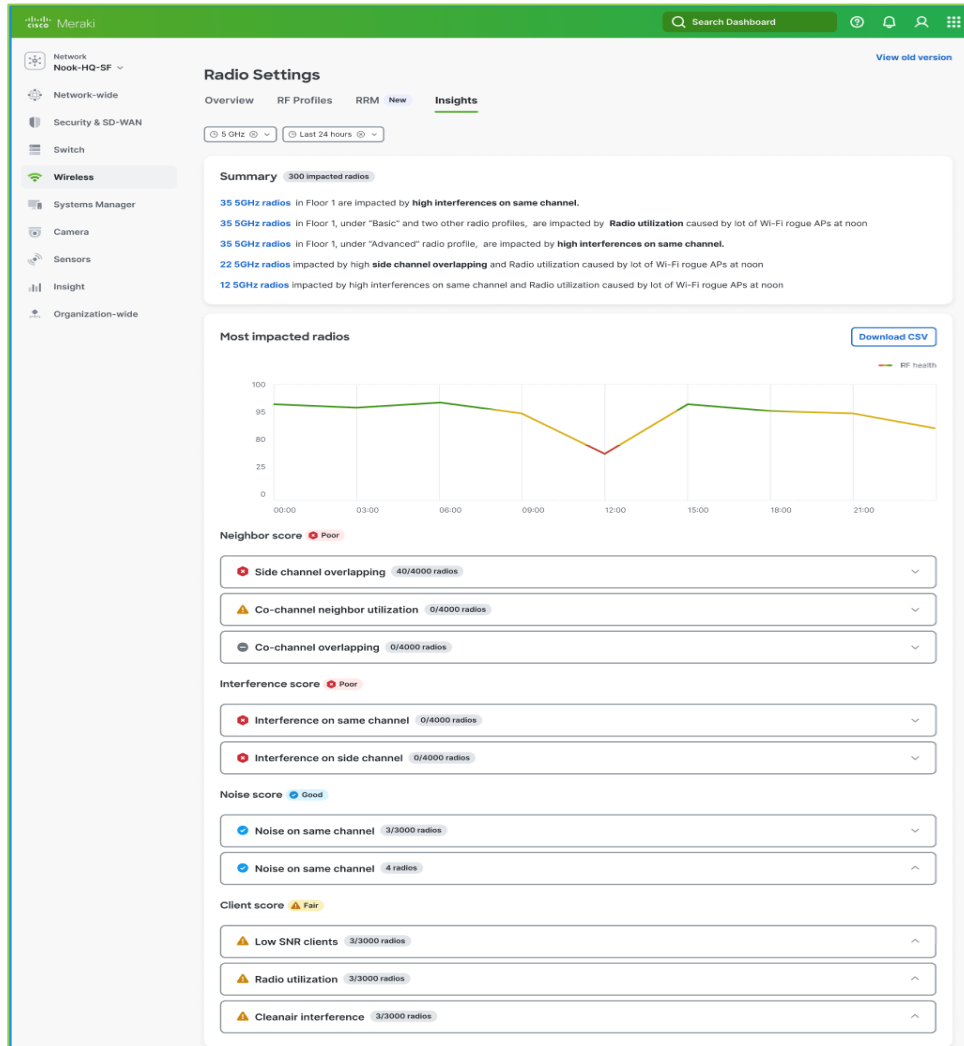
RF Visibility



- Comparative Analytics offers impact & benefit of AI-RRM
- Visualise impact and benefit of AI Operations
- Channel Changes count differences between AI-RRM vs. RRM
- Power changes count differences between AI-RRM vs. RRM

AI-RRM Insight

In Progress



Summary 300 impacted radios

35 5GHz radios in Floor 1 are impacted by **high interferences on same channel**.

35 5GHz radios in Floor 1, under "Basic" and two other radio profiles, are impacted by **Radio utilization** caused by lot of Wi-Fi rogue APs at noon

Impacted Radio Trends

Download Raw data for serviceability

Identify what's the most prevalent root cause of the impact

- o Neighbor score
- o Interference score
- o Noise score
- o Client score

AutoRF – Co-Channel Interference



RADIOS (8)

AP NAME	TECH	CH	SNR	RSSI
---------	------	----	-----	------

	6	40 (20)	36	-54	1
	6	40 (20)	36	-54	1
	6	40 (20)	20	-69	1
	6	40 (20)	13	-77	1
	6	40 (20)	18	-72	1
	6	40 (20)	17	-73	1
	6	40 (20)	16	-74	1
	6	40 (20)	16	-74	1

7 AP's on same channel
@ -54 to -74

VISUALIZATION

Channel Interference

MAP

NETWORK

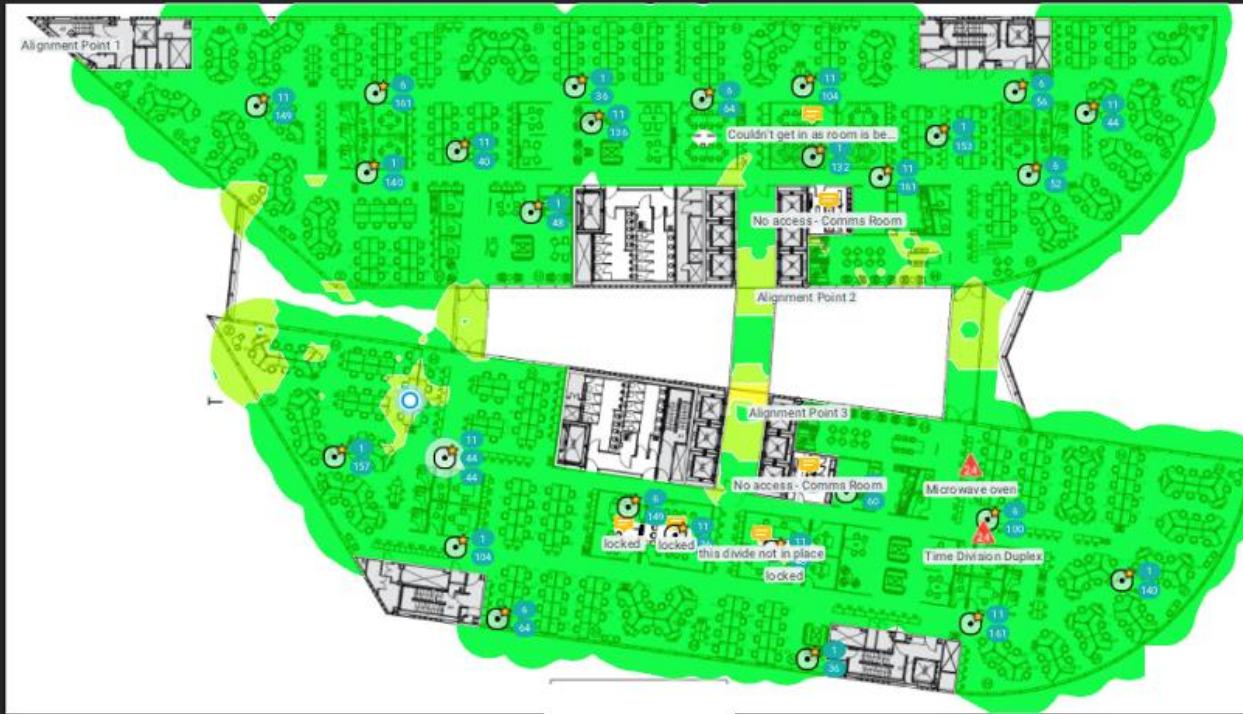
BAND SELECTION

2.4 5 6 All

Ekahau Best Practices for 5 GHz



AI-RRM – Co-Channel Interference



RADIOS (2)

AP NAME	TECH	CH	SNR	RSSI
---------	------	----	-----	------

		44 (20)	23	-65
--	--	------------	----	-----

		44 (20)	3	-84
--	--	------------	---	-----

2 AP's on Same Channel
-65 dBm and -84 dBm

VISUALIZATION

Channel Interference

MAP

17.MLP_L6

NETWORK

EYstaff

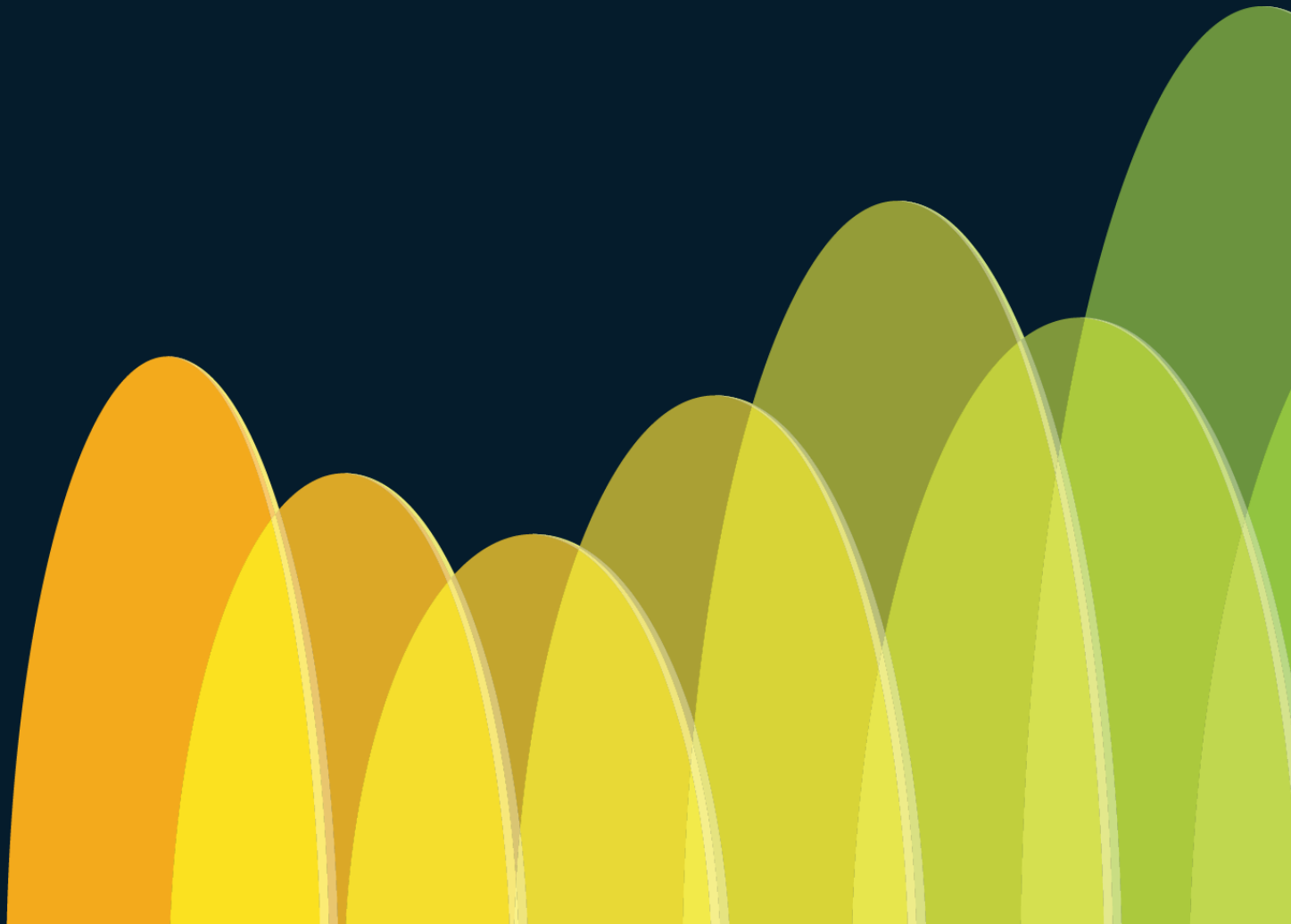
BAND SELECTION

2.4 5 6 All

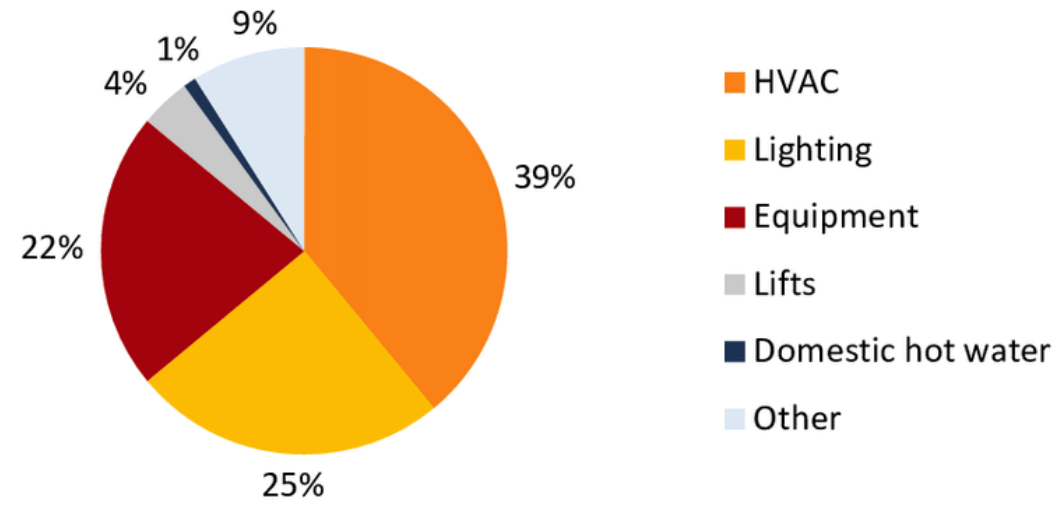
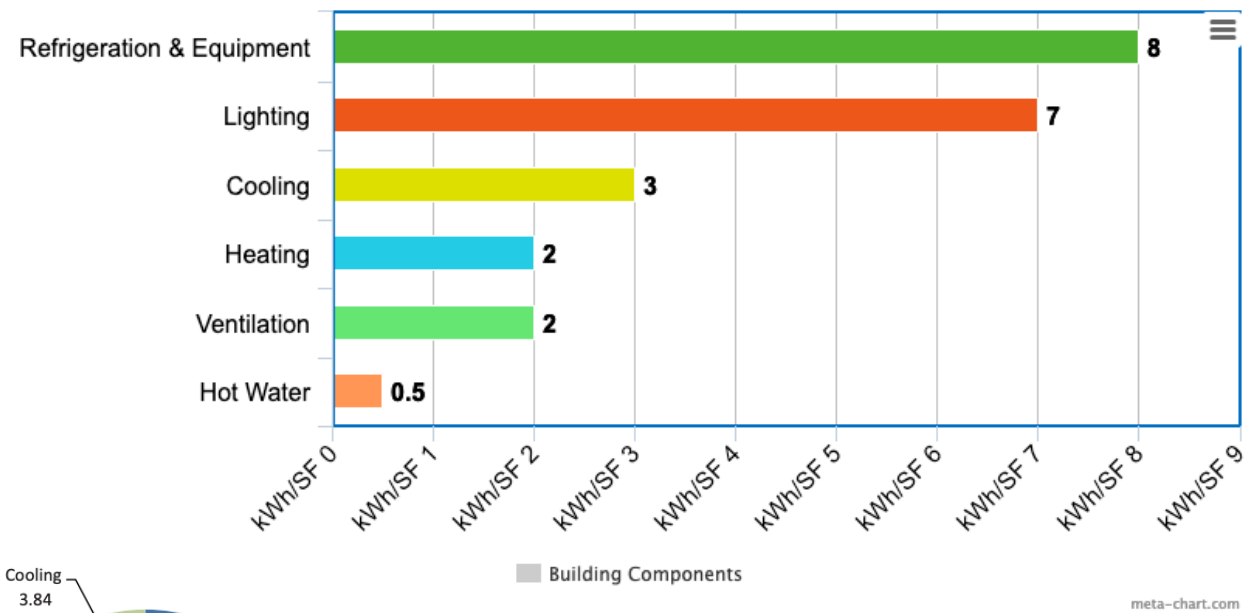
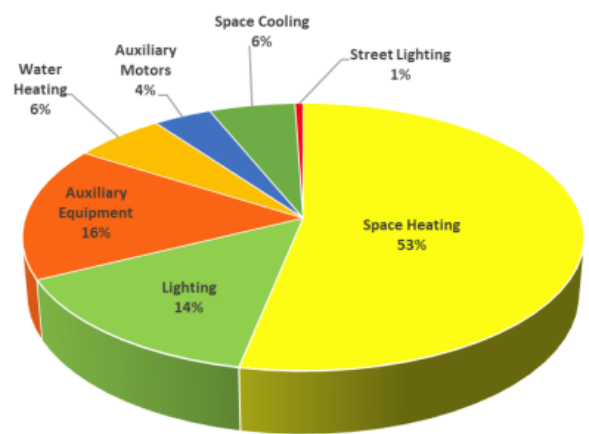
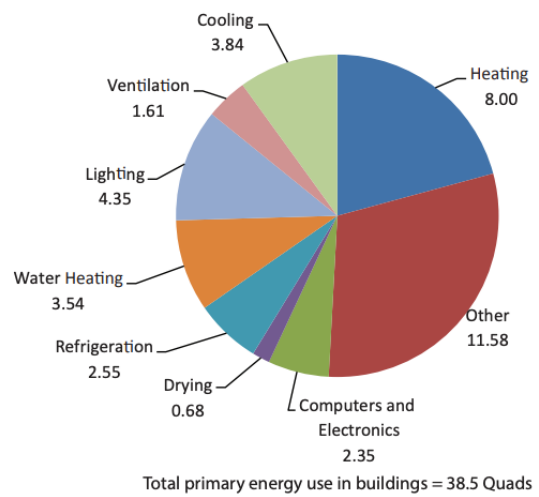
Ekahau Best Practices for 5 GHz



Sustainability



Network Energy Consumption Is not the first concern for customers...



Different views of Energy consumption breakdown in office building

So...

In order to provide some tangible energy savings to customers, the network needs to help save on other resources like HVAC and lighting >

The network can provide valuable information in terms of occupancy, environmental data (temperature, humidity, etc.) that can be passed to the Building Management system (Cloud/API integration)

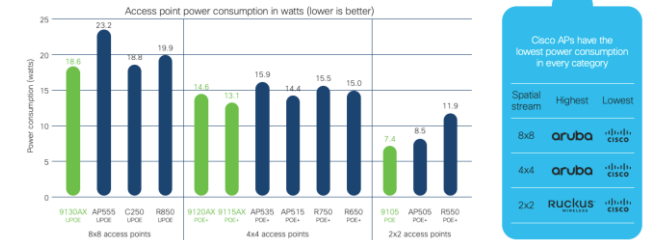
Need to maximise network energy saving in order to be relevant

Calculating AP energy savings



If you want calculate AP energy savings, you need to consider four different tiers/modes of operations for the APs when it comes to energy consumption:

- **AP is fully operational/full power** > Catalyst Wi-Fi 6 and 6E APs have the highest power efficiency in the market thanks to the Cisco hardware and software innovation
- **AP in idle mode (no clients)** > Power save mode optimizations apply and can save an additional 20% in energy cost vs. regular idle mode
- **AP on degraded power** (e.g., C9166 with .3at power) > Power distribution (starting release 17.10) allows you to allocate available power to the functions you need most
- **AP is off** > Automating the power off/on of the switchport during off-peak, you can maximise your energy savings



AP Power Save Mode



MAX savings

Why not just turning off the radios?

- Turning off all radios with “ap name <> shutdown” command gives 0.5–0.8 W max saving (I guess it depends on AP model, see next slide)

- C9164 AP in idle with radios up:

```
3560-CX#sh power inline gig 1/0/3 detail | i Mea
```

Measured at the port: **11.7** <<this is an average as with this command, I see a LOT of fluctuations

- C9164 AP in shut down:

```
3560-CX#sh power inline gig 1/0/3 detail | i Mea
```

Measured at the port: **11.1**

AI Power Profiles – Hackathon winner

The screenshot displays the Cisco DNA Center interface for configuring AI Smart Power Profiles. The main navigation bar includes Network, Device Credentials, IP Address Pools, SP Profiles, **Wireless**, Telemetry, and Security and Trust. The left sidebar shows a hierarchy with Global, BGL18, IN, SJC24, and US. The central table lists AP Power Profiles:

AP Profile Name	Description	Device Type	Remote Teleworker
Default_AP_Profile_AireOS	Default AP Profile f...	AireOS	No
Default_AP_Profile_IOSXE	Default AP Profile f...	IOS-XE	No
test-power-save	-	IOS-XE	No

Below the table, a notification states: "Save up to \$1500 per month in operational costs with Cisco AI Smart AP Power Profiles. Apply Smart Power Profile".

The right panel, titled "Cisco AI Smart Power Profiles", offers two options:

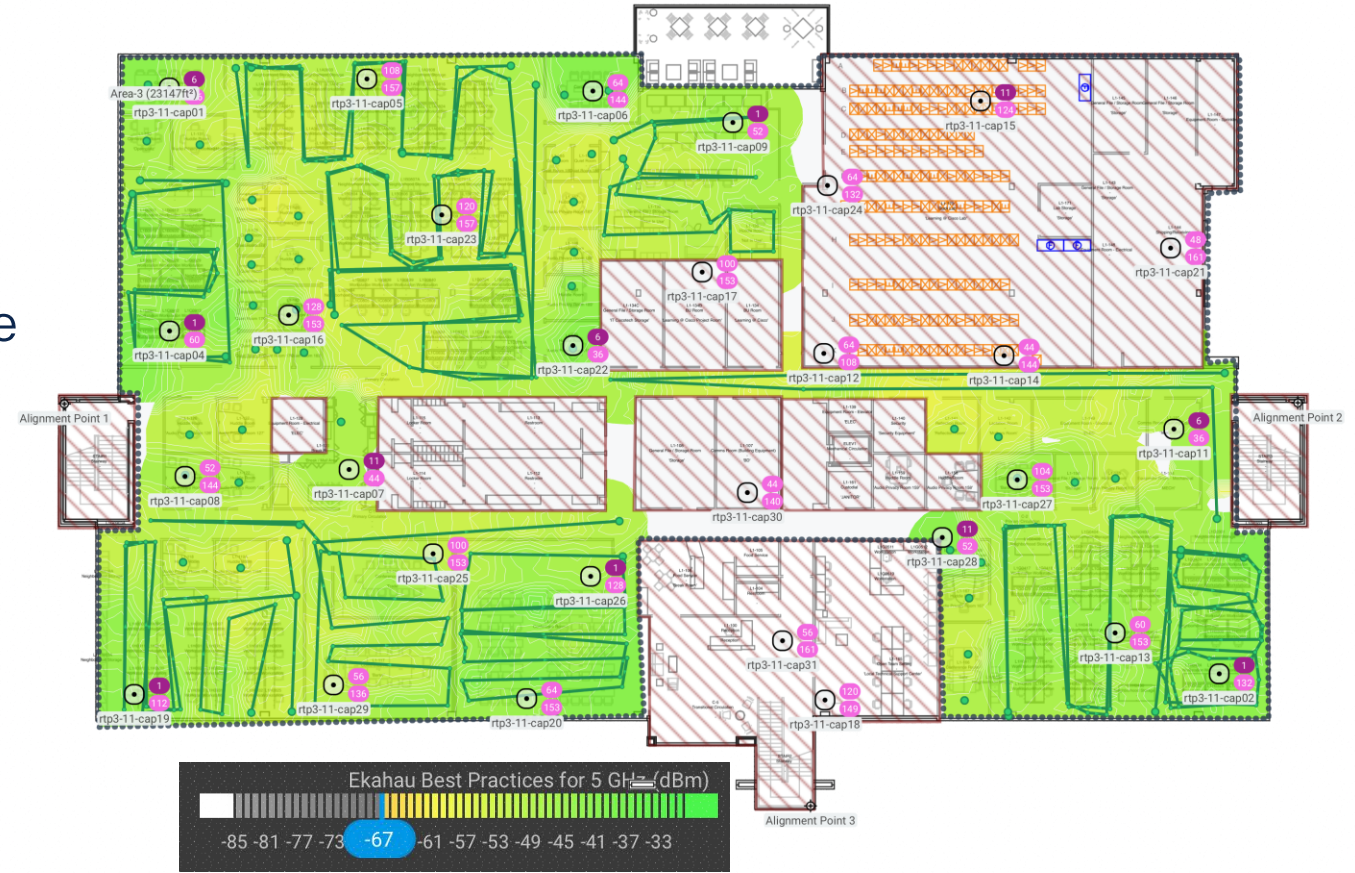
- Optimized For Power Savings**: up to \$1500 savings in operational costs per month. It includes POWER OPTIMIZED MODULES: USB (Power down for 6 hours) and AP Ethernet Uplink (Reduced capacity for 12 hours).
- Balanced Power Savings**: up to \$215 savings in operational costs per month. It includes POWER OPTIMIZED MODULES: USB (Power down for 10 hours) and AP Ethernet Uplink (Reduced capacity for 11 hours).

At the bottom, a toggle switch is labeled "Power down Access Points during off-peak hours when there is another Access Point available nearby".

Designing for Sustainability

Capacity vs Coverage

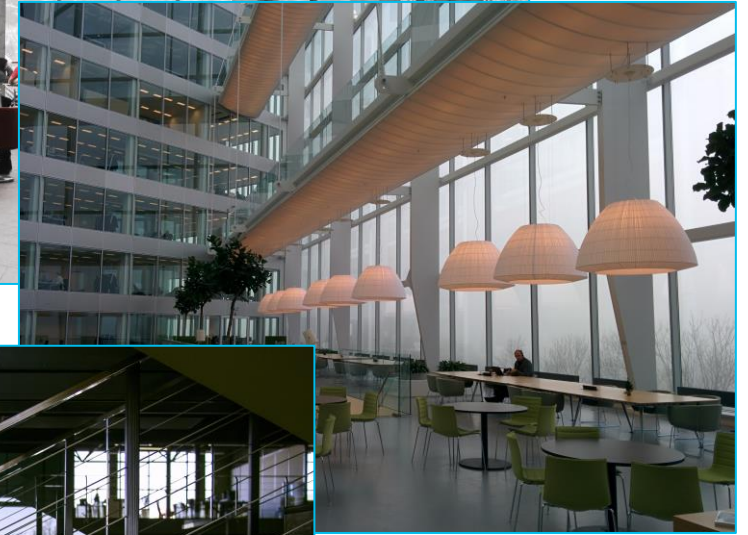
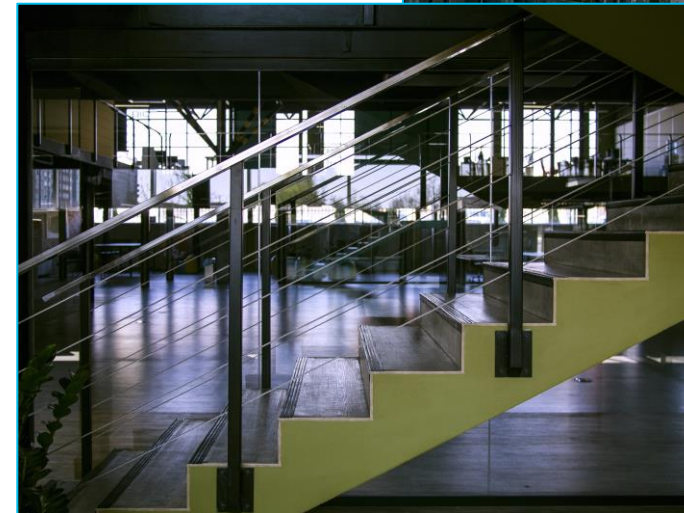
- Enterprise networks are built to provide capacity over coverage
 - An Access Point (AP) represents a finite amount of bandwidth
 - That bandwidth will be shared with every device on that cell
 - Multiple Cells are needed to handle the numbers of users required **during business hours**
- What about afterhours?
- How do you get the information to make that determination?
- Can you shut down portions of your network to optimise consumption?



Designing for Sustainability

Capacity vs Coverage

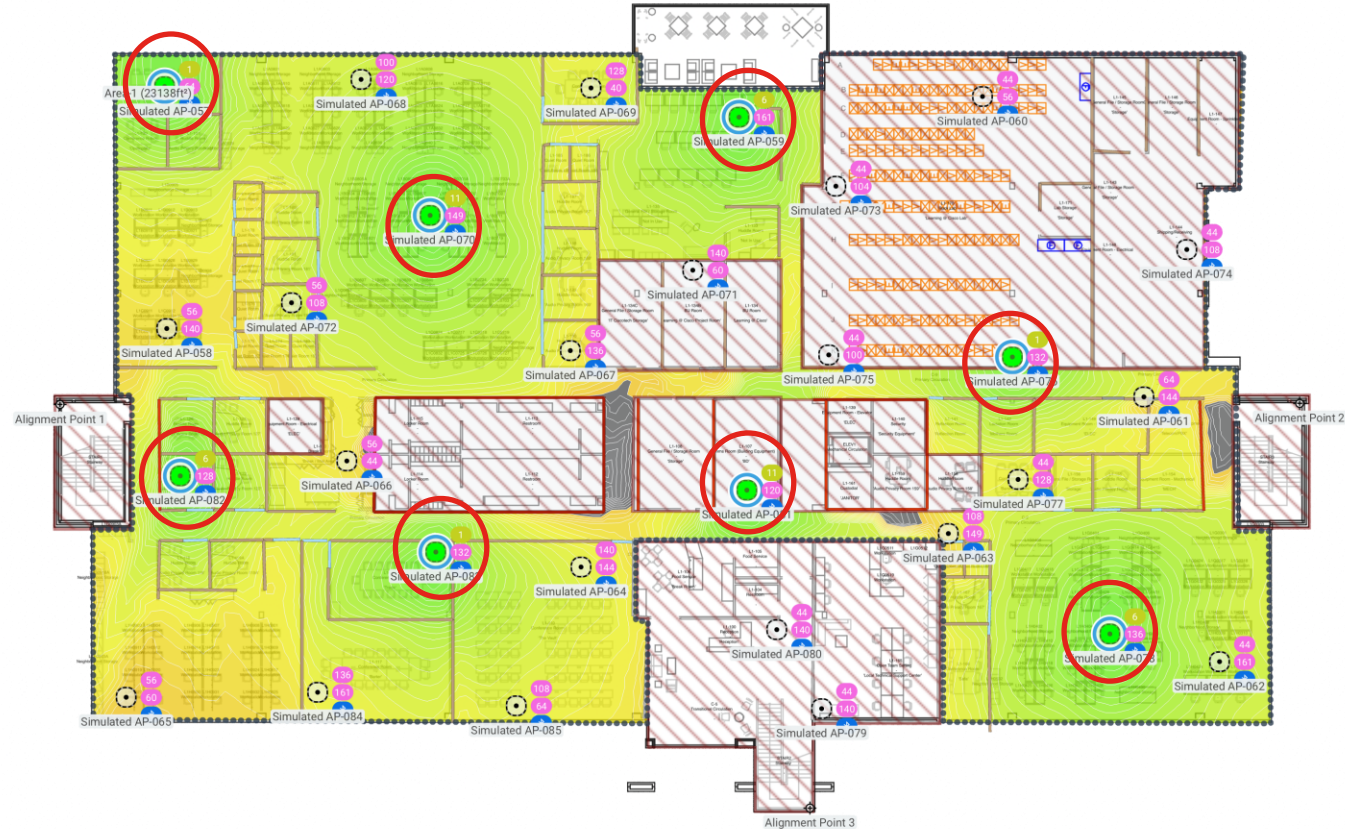
- What are the requirements?
 - Complete Lights out?
 - Partial Shutdown/Skeleton coverage?
- What hours?
 - Do you know your Busy Hours?
 - Do you know it for every Campus?
- Speaking of hours, how long before its needed, do you have to turn it back on?
- Is that a blanket answer?



Designing for Sustainability

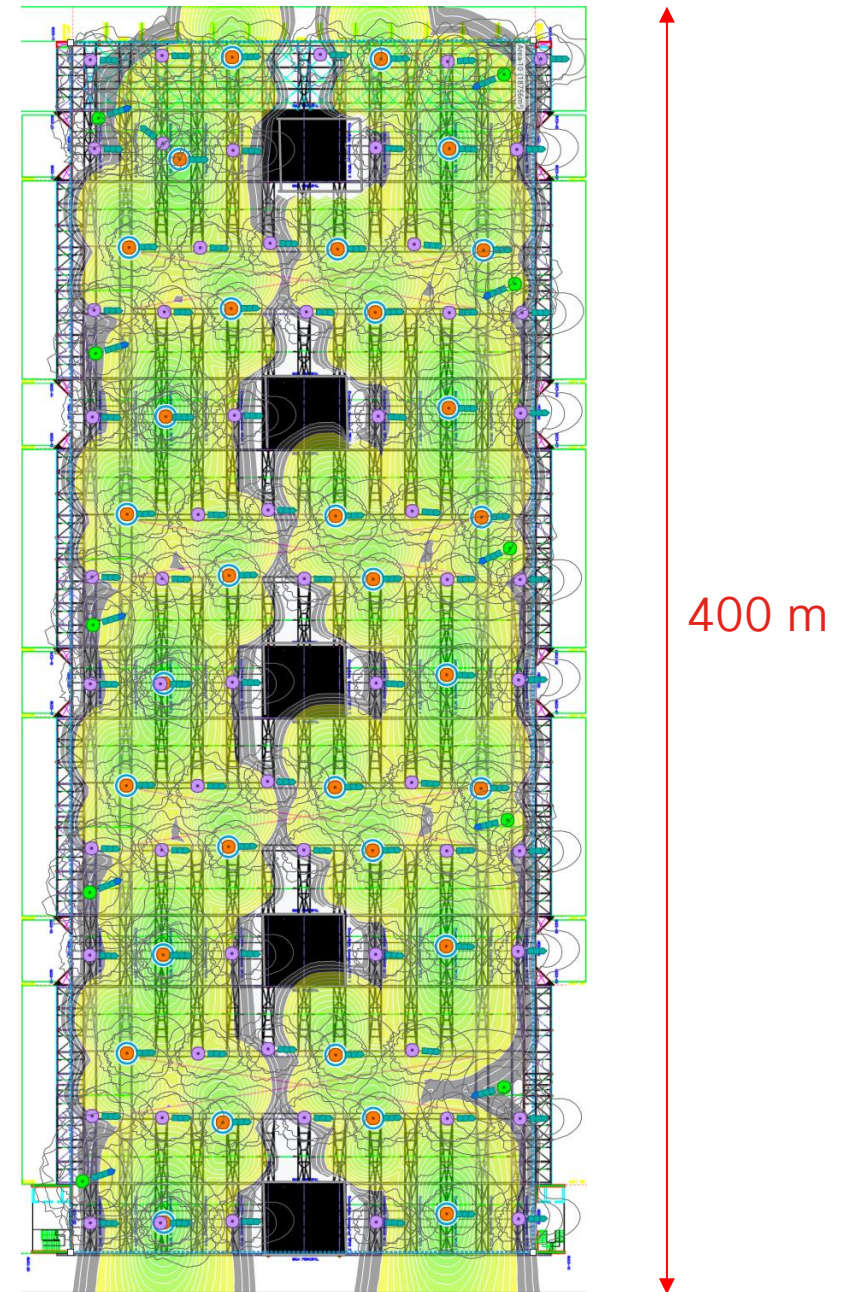
Capacity vs Coverage

- Survey reveals a normal high-density enterprise office space, well covered at -60 dBm
- With an SNR of 30 dB or better
- A Project plan is created to model solutions, the measured Survey is used to calibrate the model
- 29 Active APs are considered, 8 are selected for the bare coverage model
- At the original 11 dBm, coverage wasn't adequate
- Increasing the power to 14 dBm provides coverage at -67 to 100%, with 70% fewer APs!



At Scale Sustainability Requires Forethought

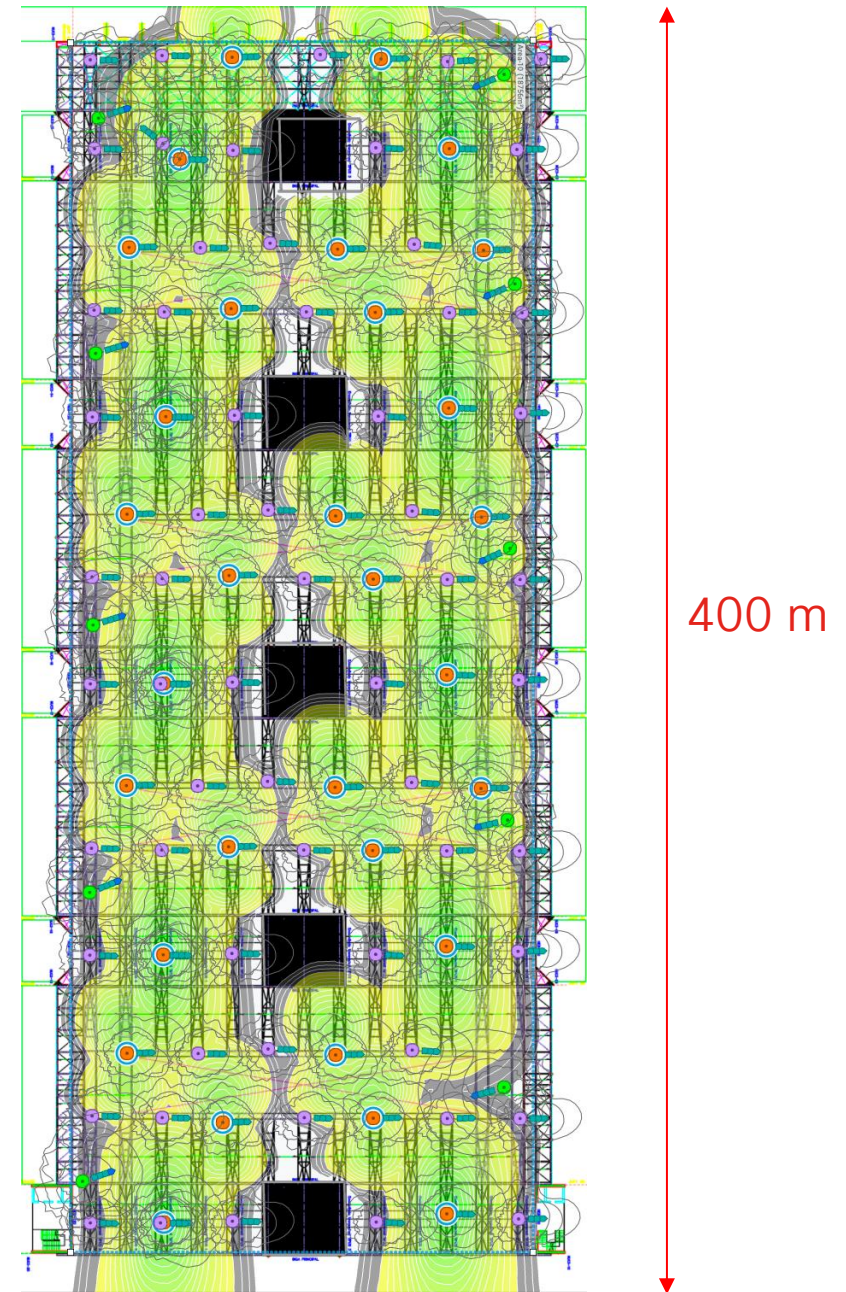
- A Prime opportunity to optimise power usage exists particularly in LPV environments.
- Halls often sit idle for significant periods of time
- If all of the AP's are on, this constitutes a tremendous amount of power wasted.
- Exhibitions come in all sizes not all the capacity is always needed
- Factoring in the versatility of the C9104 into the design-it is possible to provide only the coverage needed and save a tremendous amount of power
- By managing the capacity, not the coverage to the requirements you can right size the network for the task at hand and reduce waste



At Scale Sustainability Requires Forethought

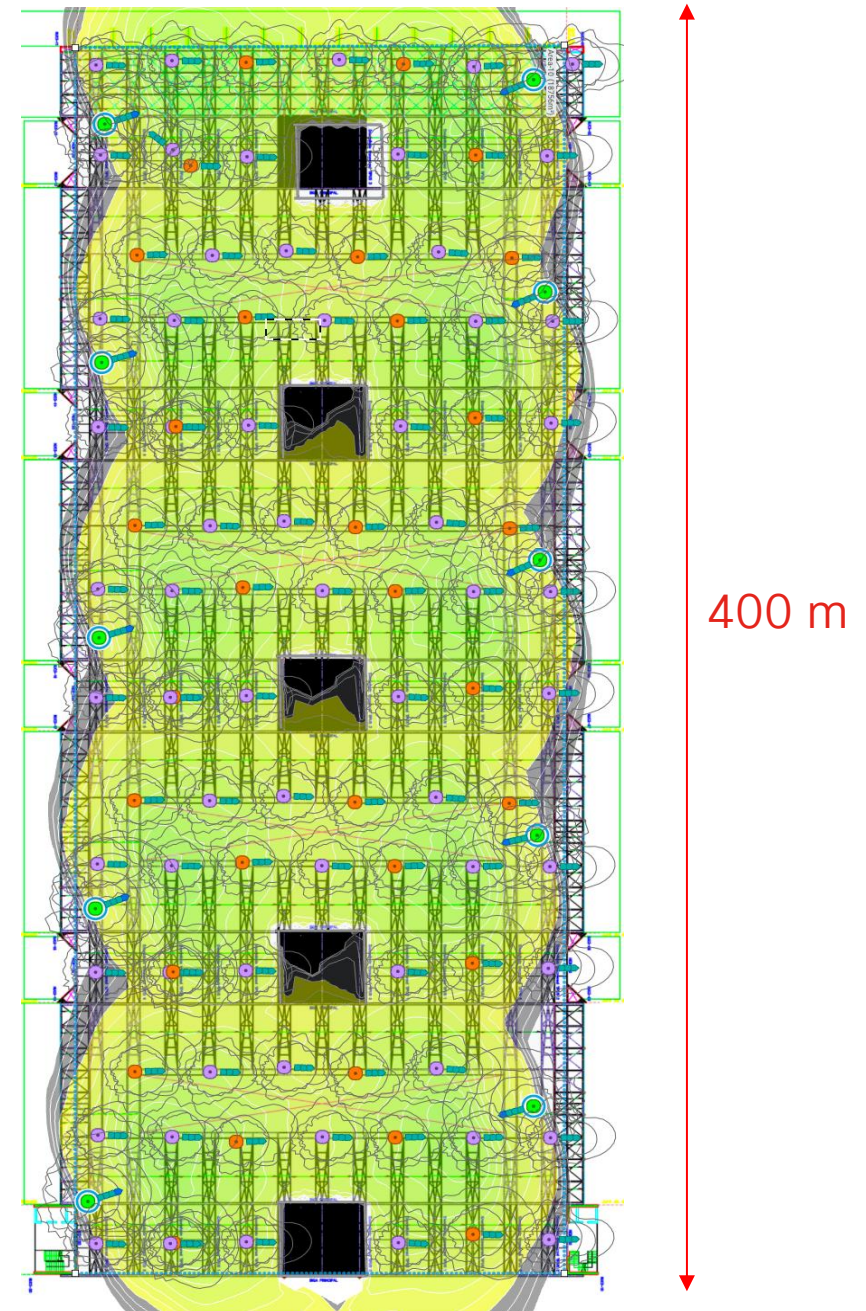
Spoiler Alert – We thought about it.....

- Here coverage is maintained using the C9104 Stadium Antenna by changing the antenna beamwidth (SW command) to 2x20 degree wide setting for interfaces 1 and 2, (Orange AP's)
- Most of the hall is well covered with 31 APs each supporting 2x 5 GHz interfaces a 65% reduction of powered up APs
- Shutting off an AP saves ~15 W at rest. Shutting of a single interface only saves roughly .8 watts.



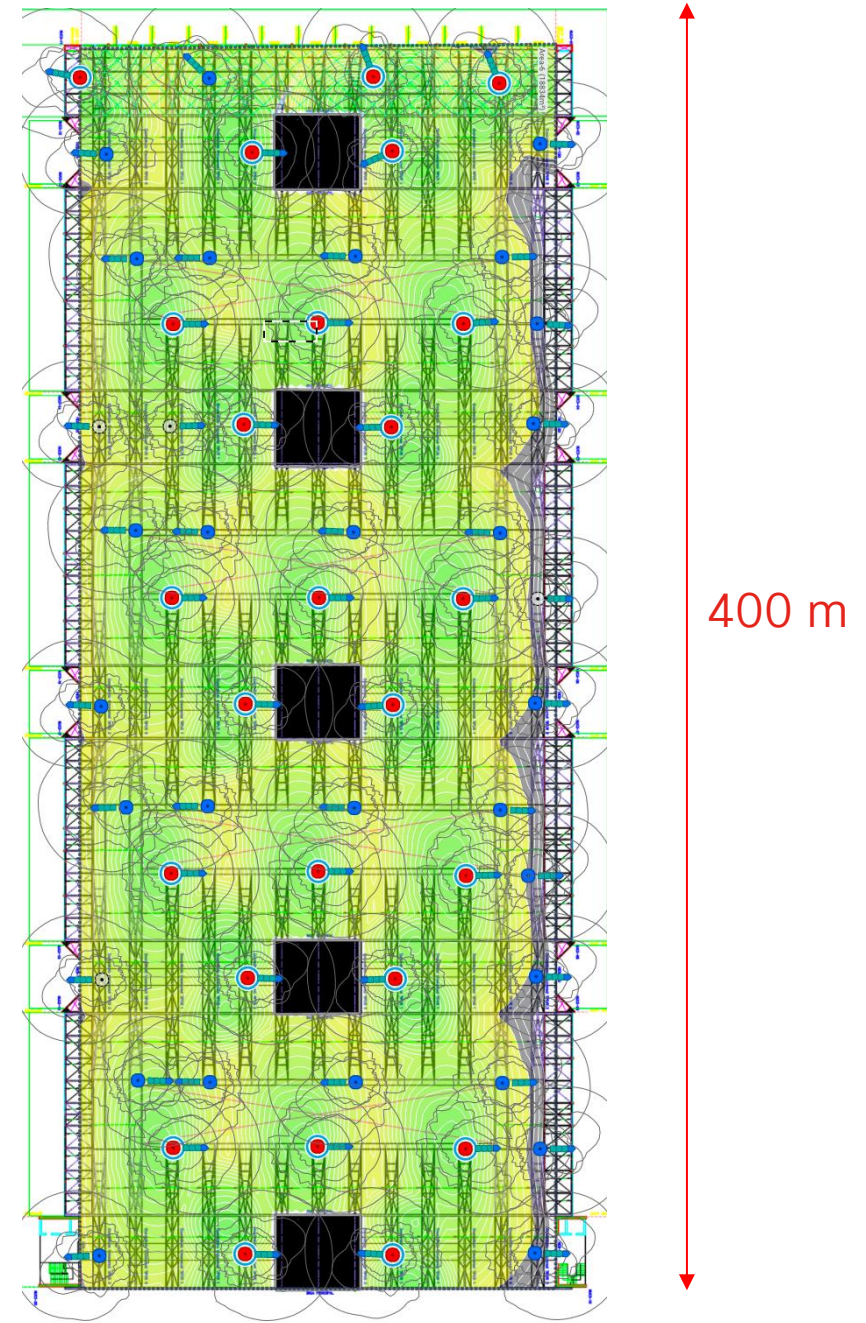
Sustainability – Off Peak Coverage

- Another way to ensure minimal coverage is to install APs strictly for afterhours coverage.
- These would be running when the main hall APs are not
- Installed specifically to cover the entire floor with a large practical low density cell design.
- In this drawing, 10 APs provide viable high speed, low capacity (10-20 per interface) coverage for the entire hall



C9104, for Lower Density

- There are multiple options to provide the right balance between coverage and sustainability
- In this design, we reduced the AP count to 85 by tilting the AP angle 15 degrees
- After hours coverage can be configured using the wide Settings and medium to Medium high Capacity can be provided with just 25 APs (red) with the remaining APs shut down.



Wi-Fi 6E Design Guidance Best Practices



Complete Wi-Fi 6E portfolio



CleanAir® Pro

9162 



CleanAir® Pro

9164 



NEW

CleanAir® Pro

9166D1 



CleanAir® Pro

9166I 



CleanAir® Pro

9136



CleanAir® Pro

MR57



NEW

CleanAir® Pro

9163E 

Indoor Access Points

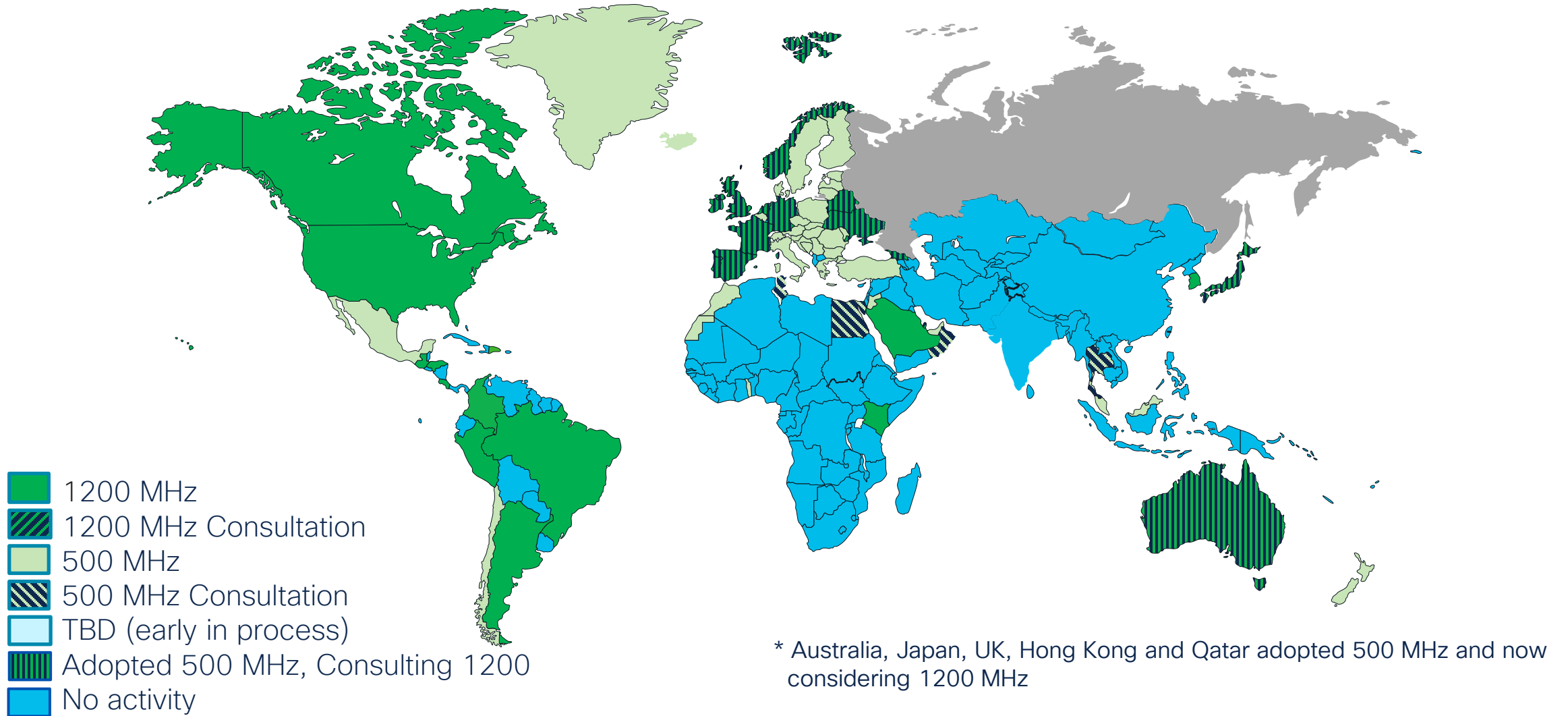
Outdoor Access Points



 Management mode can be changed

Global availability of 6 GHz band for Wi-Fi

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

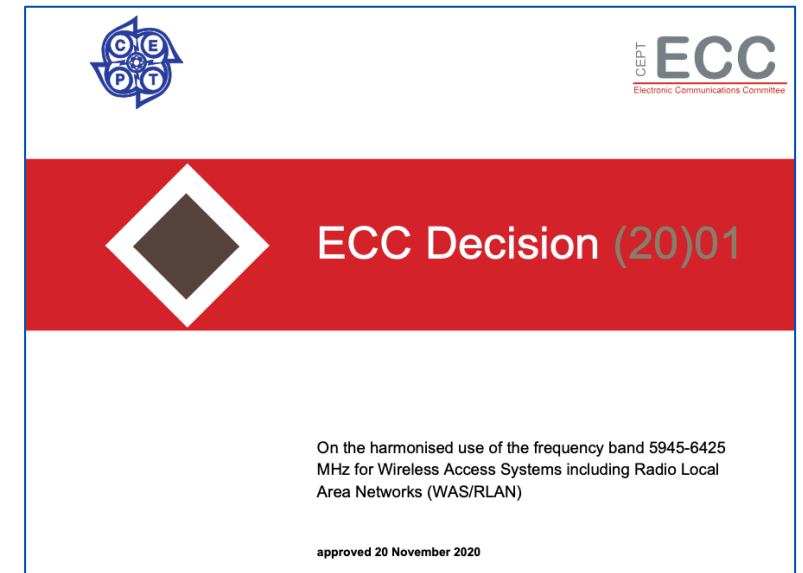


What are the important rules?

- 6 GHz Rules
- The requirements for low power use are as follows:
 - Must be indoors (the AP is not allowed to be “weatherized”).
 - Must have a permanently attached antenna.
 - May not be battery powered.
 - Must employ a contention-based protocol.
 - Maximum EIRP is 5 dBm/MHz
 - Client maximum power is 6 dB below the AP maximum allowed EIRP (power)
- There is only one option possible outdoors:
Standard Power w/AFC



Federal
Communications
Commission



Summary Wi-Fi 6E/6GHz Tx Requirements*

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

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

Summary 6GHz Tx Requirements*

Mod e	Country	Max Tx Power EIRP		Max PSD EIRP		Max Power Spectral Density (W)
	(Frequency Range MHz)	AP (dBm)	Client (dBm)	AP (dBm)	Client (dBm)	
	FCC (5925-7125)	30	24	Max PSD EIRP		
	ETSI (5945-6425)	23		AP (dBm)	Client (dBm)	
	UK (5925-6425)			5	-1	
	S Korea (5925-7125)			10	10	
	Malaysia (5925-7125)			11	11	
Mode	Country	Max Tx Power EIRP		Max PSD EIRP		Max Power Spectral Density (W)
	(Frequency Range MHz)	AP (dBm)	Client (dBm)	AP (dBm)	Client (dBm)	
	FCC (5925-7125)	30	24	5	-1	
	ETSI (5945-6425)	23	24	5	-1	
	UK (5925-6425)	24	24			
	Malaysia (5925-7125)	30	24	10	10	
	ATU (5945-6425) (Kenya/Uganda/Congo/Niger/Ghana)	23	23	10	10	
	Morocco (5945-6425)	23	23			
SP	FCC (U-NII-5/7)	36 (21<30°)	30	23	17	320

Summary 6GHz Tx Requirements

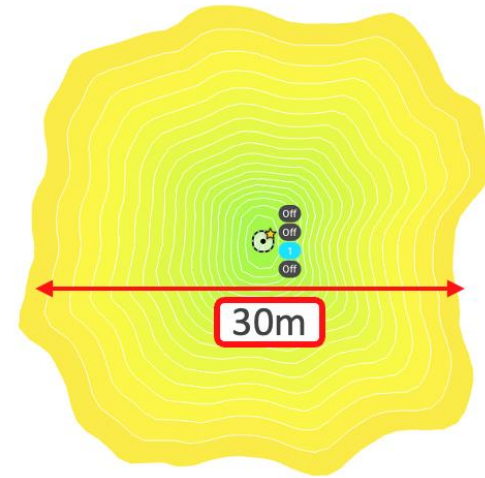
- Breaking down the PSD Values vs Max TX EIRP
 - FCC = 3 dB more power per channel width doubling and MAX TX EIRP of 30 dBm
 - ETSI/UK = PSD value = MAX TX EIRP at 20 MHz, remaining channel widths = Max TX EIRP

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

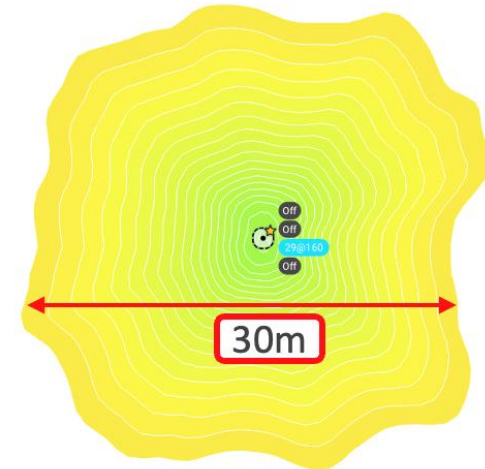
	20 MHz	40 MHz	80 MHz	160 MHz
FCC 5 dBm/MHz	18 dBm	21 dBm	24 dBm	27 dBm
ACMA 5 dBm/MHz	18 dBm	21 dBm	24 dBm	27 dBm
ETSI 10 dBm/MHz	23 dBm	26 > 23 dBm	29 > 23 dBm	32 > 23 dBm
UK 11 dBm/MHz	24 dBm	27 > 24 dBm	30 > 24 dBm	33 > 24 dBm

Wi-Fi 6E Low Power Indoor

- Under FCC LPI Rules – The maximum EIRP for a 20 MHz transmission is 18 dBm
- Management traffic is always sent on the primary channel – will always be limited to 18 dBm
- Beacon Power under LPI is limited to 18 dBm – and sets the limit of the cell edge
- The Cell size is determined by the management frames reach



6 GHz
Ch.1 @ **20** MHz
18 dBm EIRP



6 GHz
Ch.15 @ **160** MHz
18 dBm EIRP

A site survey measures beacon Strength –
20 MHz or 160 MHz – it is the same size cell

Why Service Provider (SP) Mode Matters

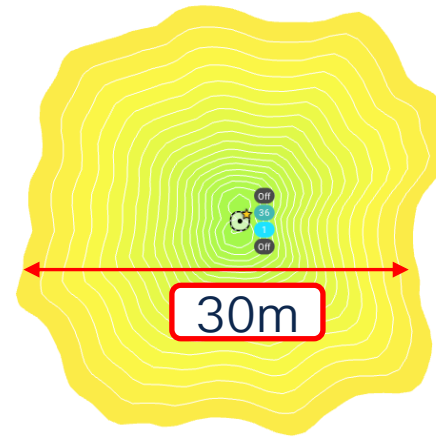
- For the US, Canada and others to follow- Wi-Fi 6E
- Allowed outdoors (and indoors) – with Automatic Frequency Control – AFC
- Allows the use of external antennas
- Permits higher power limits and delivers higher performance

Mode	Country	Max Tx Power EIRP		Max PSD EIRP	
		AP(dBm)	Client (dBm)	AP(dBm/MHz)	Client (dBm/MHz)
LPI	6 GHz Bandwidth				
LPI	FCC (1200 MHz)	30	24	5	-1
LPI	ETSI (500 MHz)	23	23	10	10
LPI	UK (500 MHz)	24	24	11	11
LPI	ISED	30	24	5	-1
SP	FCC (860 MHz)	36 (21 if >30°)	30	23	17
SP	ISED (860 MHz)	36 (21 if >30°)	30	23	17

Wi-Fi 6E SP Indoors

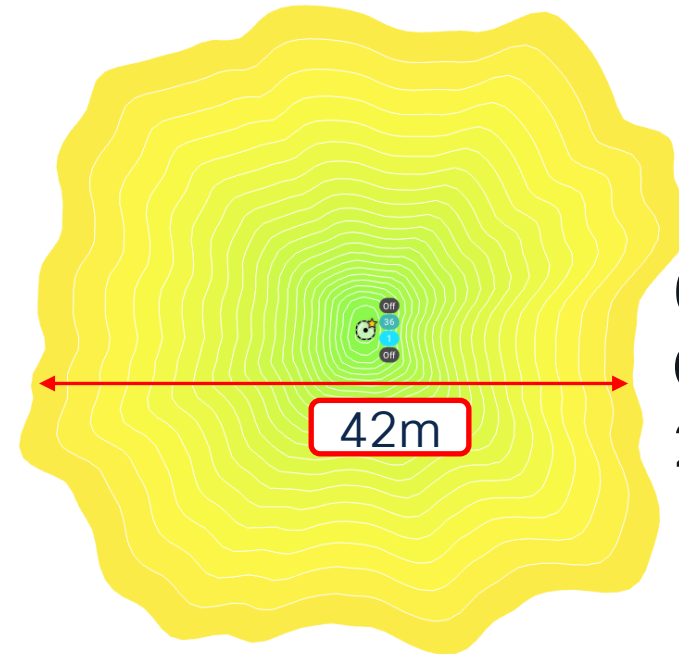
Higher Power In 20 MHz

- Allowing higher power in the first 20 MHz
 - Creates a larger cell size
 - Allows more power to reach the floor with a higher ceiling!
- High Ceiling Warehouse – larger Cells, less Clients – SP
- Atriums, high ceilings, loading docks, a lecture hall, Stairwells etc.
- Many installations have some or all of the above
- Wi-Fi 6E indoors – allows these use cases to be covered with 6 GHz too!



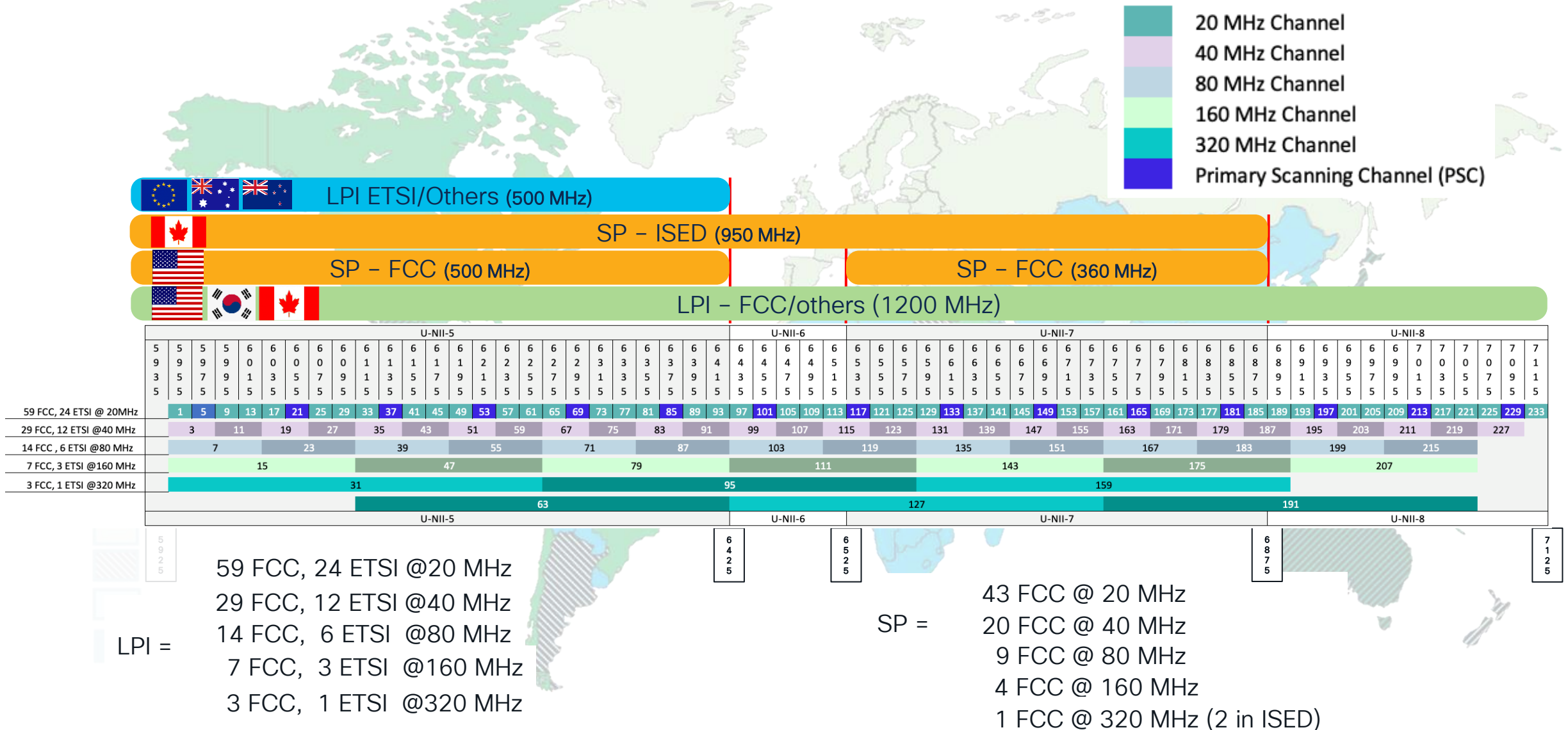
CW9166i @ 2.4m Height

6 GHz
Ch 1@20-160 MHz
18 dBm EIRP LPI



6 GHz
Ch 1@20-160 MHz
27 dBm EIRP SP

The 6 GHz band :



Site Survey @6GHz: Something to think about...

- On the definition of Low Power Indoor AP, there is the following technical conditions regarding the use of batteries to power the device: May **not** be **battery powered**



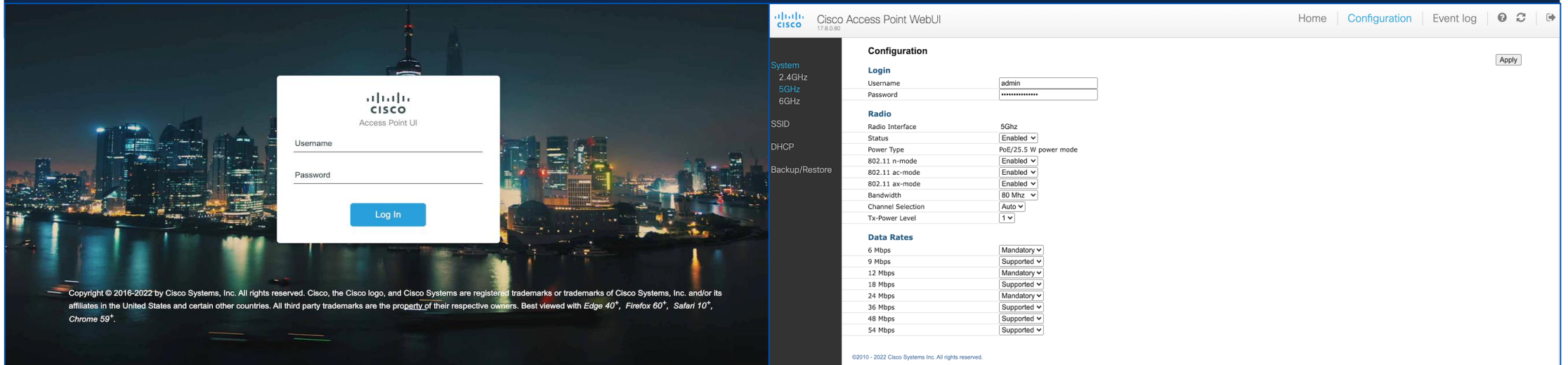
=



- Cisco legal recommends the surveyor to attach a physical label that says something like “Indoor RF survey use only”

Catalyst AP: Site Survey mode configuration steps

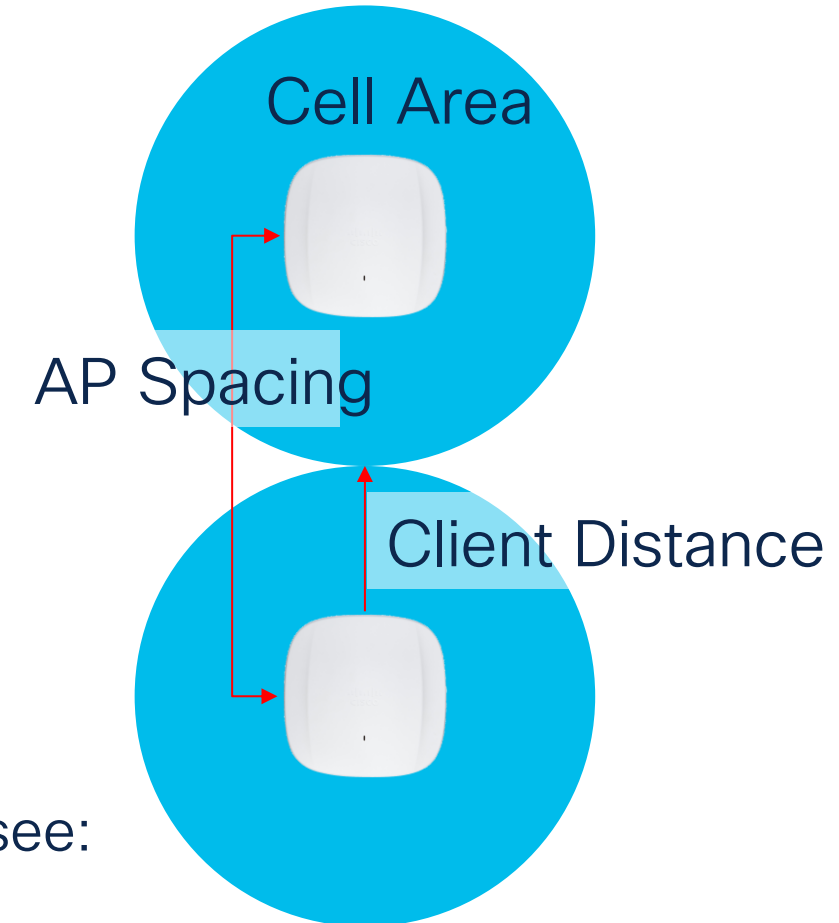
1. Change AP to site survey mode > exec command “ap site-survey”
C9136#ap ?
 capwap Switch to CAPWAP AP type
 site-survey Switch to Site Survey AP type
2. After bootup, the AP is automatically assigned a static IP of 10.0.23.1. CLI prompt changes
site-survey-AP#
(default credentials Cisco/Cisco)
3. AP will start broadcasting the CiscoAirProvision SSID with open authentication security
4. Connect your wireless client with the CiscoAirProvision SSID and it'll receive an IP from 10.0.23.0/24.
5. Access the Catalyst Site Survey WebUI via 10.0.23.1 *(default credentials admin/admin)*



Dimensioning 5 GHz

Cell Area/Coverage	AP Spacing 1 AP every	Max Client Distance to AP
1k ft ² /92m ²	36 f /11 m	18 f / 5.5 m
1.2k ft ² /111m ²	40 f /12 m	20 f / 6 m
1.5k ft ² /140 m ²	44 f /13.5 m	22 f / 6.7 m
2K ft ² /185 m ²	50 f /15.2 m	25 f / 7.6 m
2.8K ft ² /260 m ²	60 f /18.2 m	60 f / 18.2 m

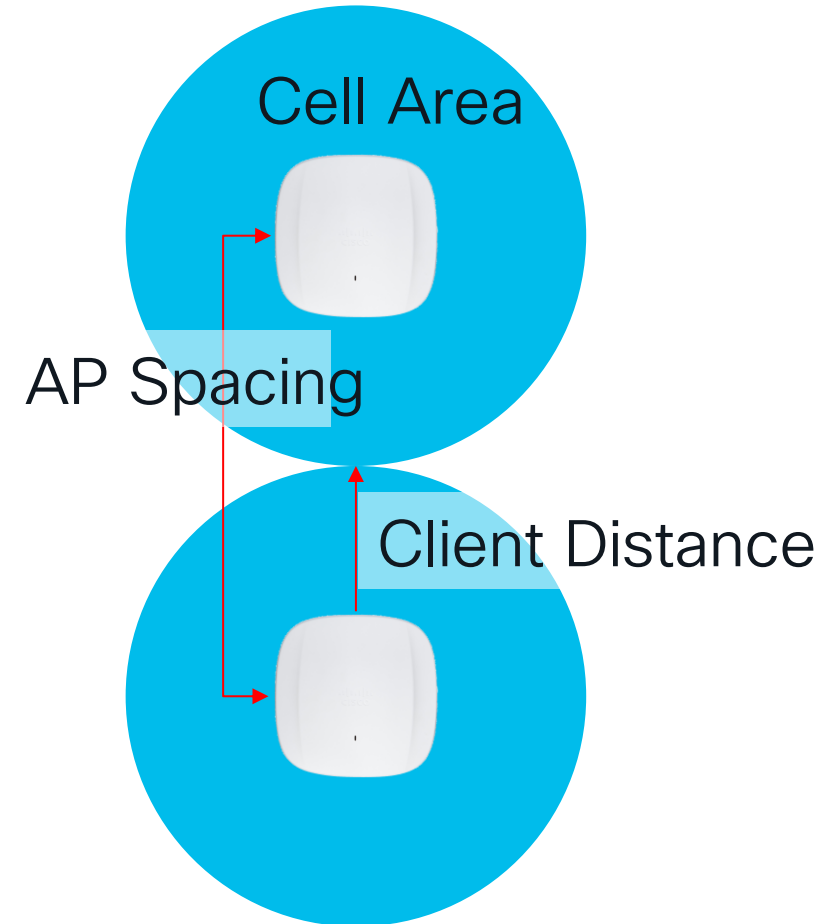
Cell Edge/ Clients 20-25 feet (6-7.5 meters)



For more information on channel planning and AP density see:
Cisco High Density AP/Deployment
<https://www.youtube.com/watch?v=c8w6Mfck0nQ>

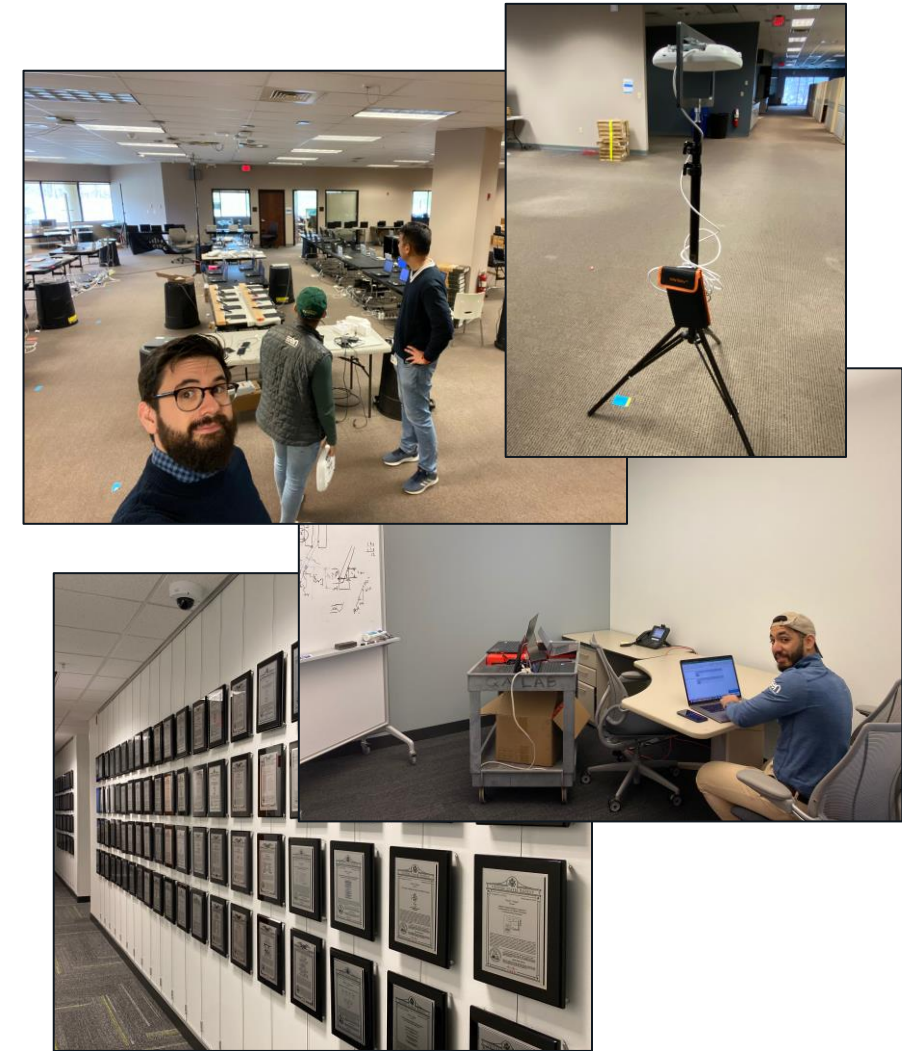
5 GHz Design Considerations

- Most modern Carpeted Enterprise 5 GHz Wi-Fi are installed at an AP Density between 1.2-2K f² /110-185 m²
- The Spatial Reuse factors are:
 - # Channels (dual 5 GHz =minimum 2 channels/AP)
 - The density of the AP's (how close together they are)
 - TX Power (Same Channel Interference range)
- Enterprise/healthcare/Higher Education networks are operating with **Tx powers 11-15 dBm** (PL3-4) depending on density.



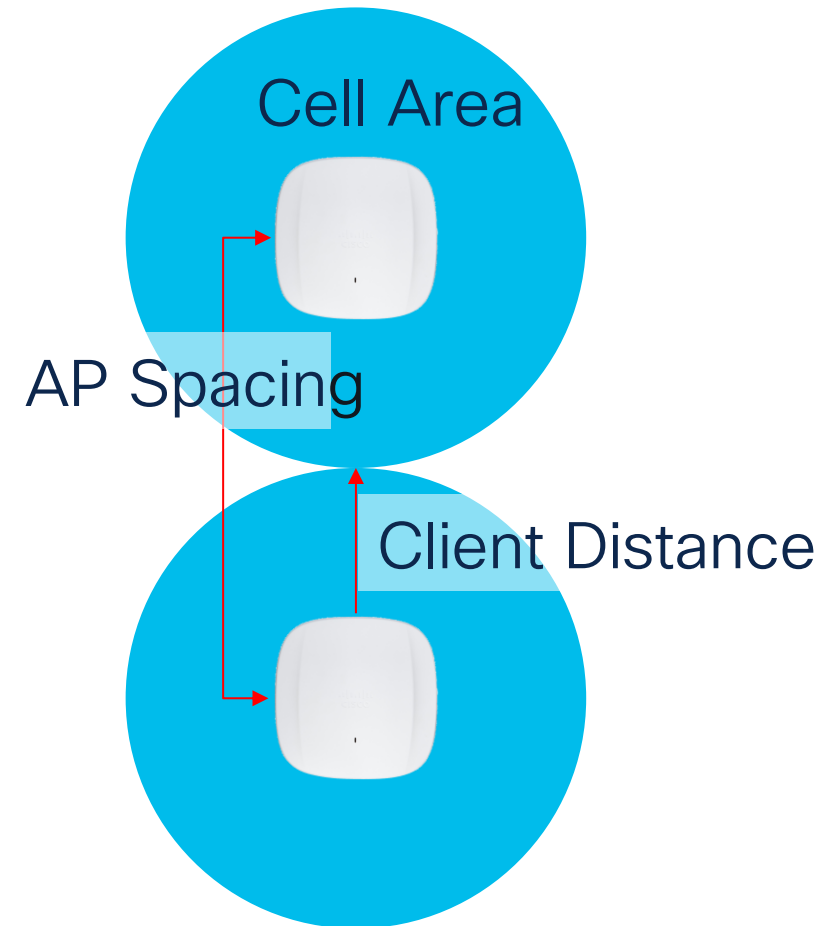
What we Tested

1. Propagation for 6 GHz as it compares to 5 GHz propagation – Using Clients
 - Use clients to record RSSI @ 5 and 6 GHz measuring at 12 points across the Richfield, OH Cisco offices
 - Compare 5 GHz and 6 GHz readings from each device at each point
2. Compare Ekahau AI-Pro Site Survey/Sidekick 1 and 2 and NetAlly AirCheck G3 Measurements
3. Range vs Rate testing for 5 GHz vs 6 GHz
 - Compare 5 vs 6 GHz implementation on Various clients
 - Demonstrate effectiveness of a practical coverage plan



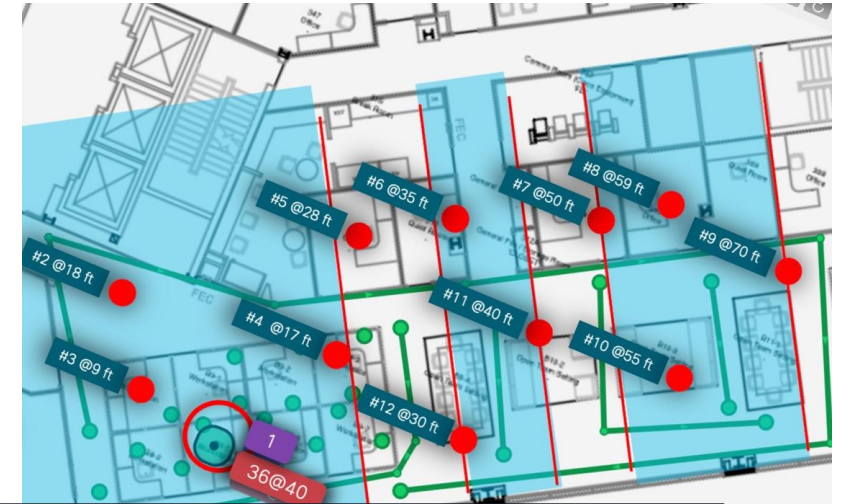
5 GHz Design Considerations

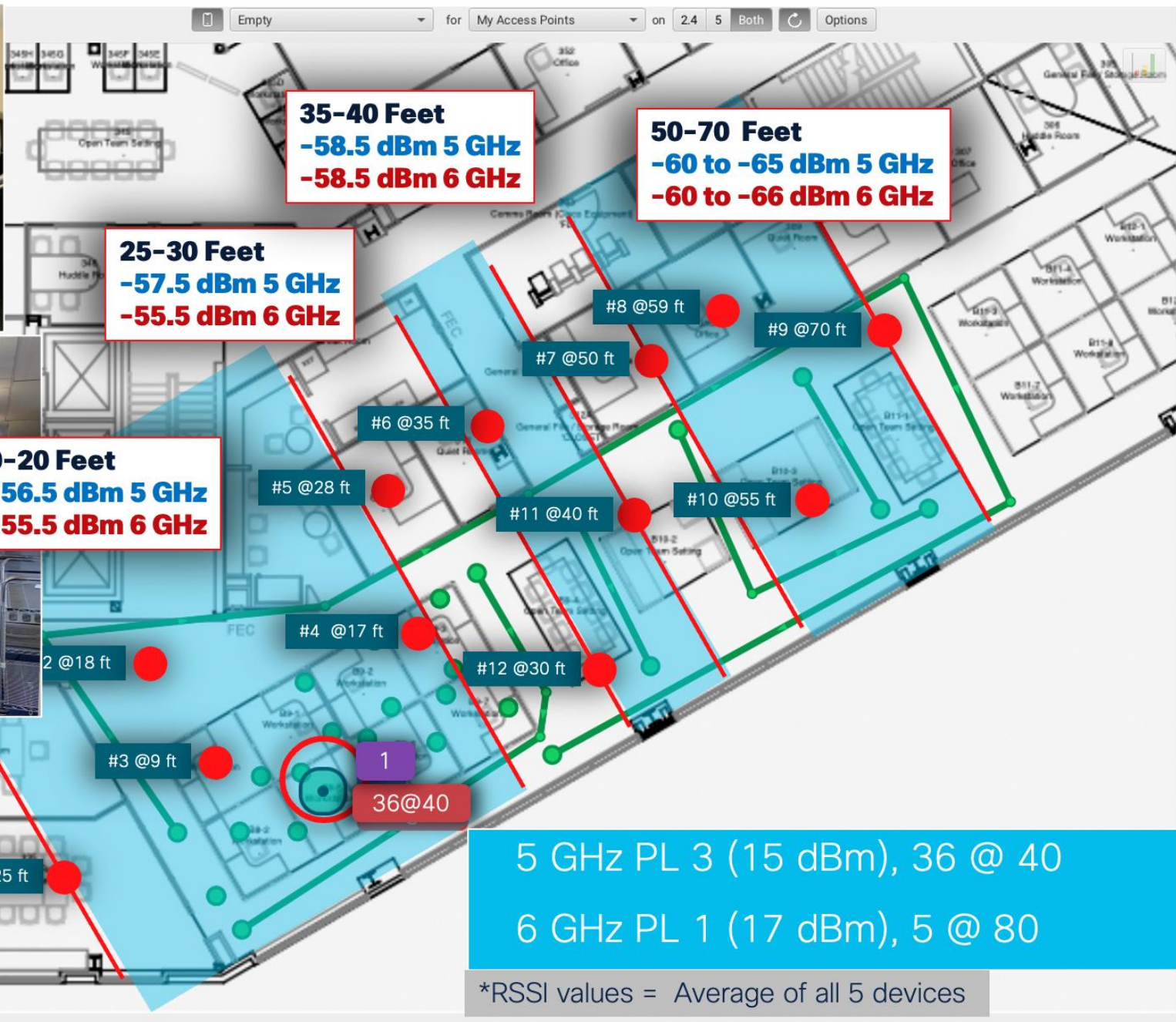
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- Enterprise/healthcare/Higher Education networks are operating with **Tx powers 11-15 dBm** (PL3-4) depending on density.



1. Propagation Comparison 5/6 GHz

- Multiple Test Points 1–12 with 5 Tri band Client Devices
 - 1 Lenovo, 2x Samsung and 1 MSI Laptops
 - Samsung S-21 Phone
- Record and Compare Measurements between clients @ both 5 and 6 GHz
- Compare 5 GHz Measurements with Ekahau site survey
 - Validate Survey vs Client observation
 - Ekahau Sidekick – Mobile Device mode





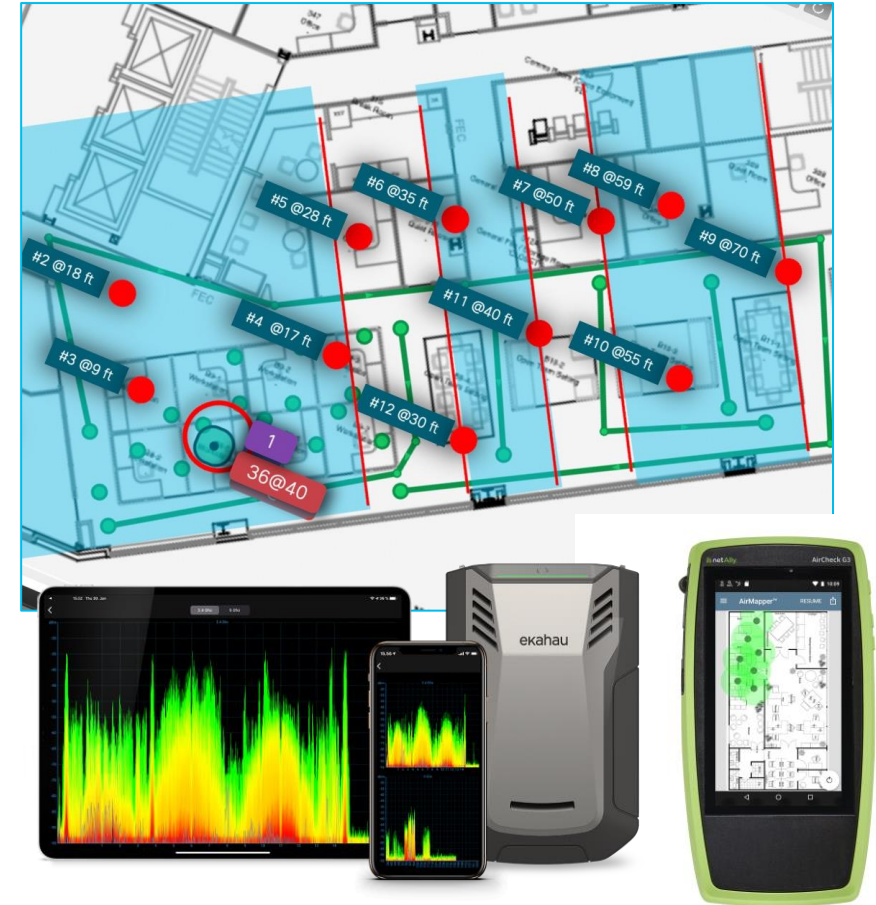
Raw Data – Client RSSI

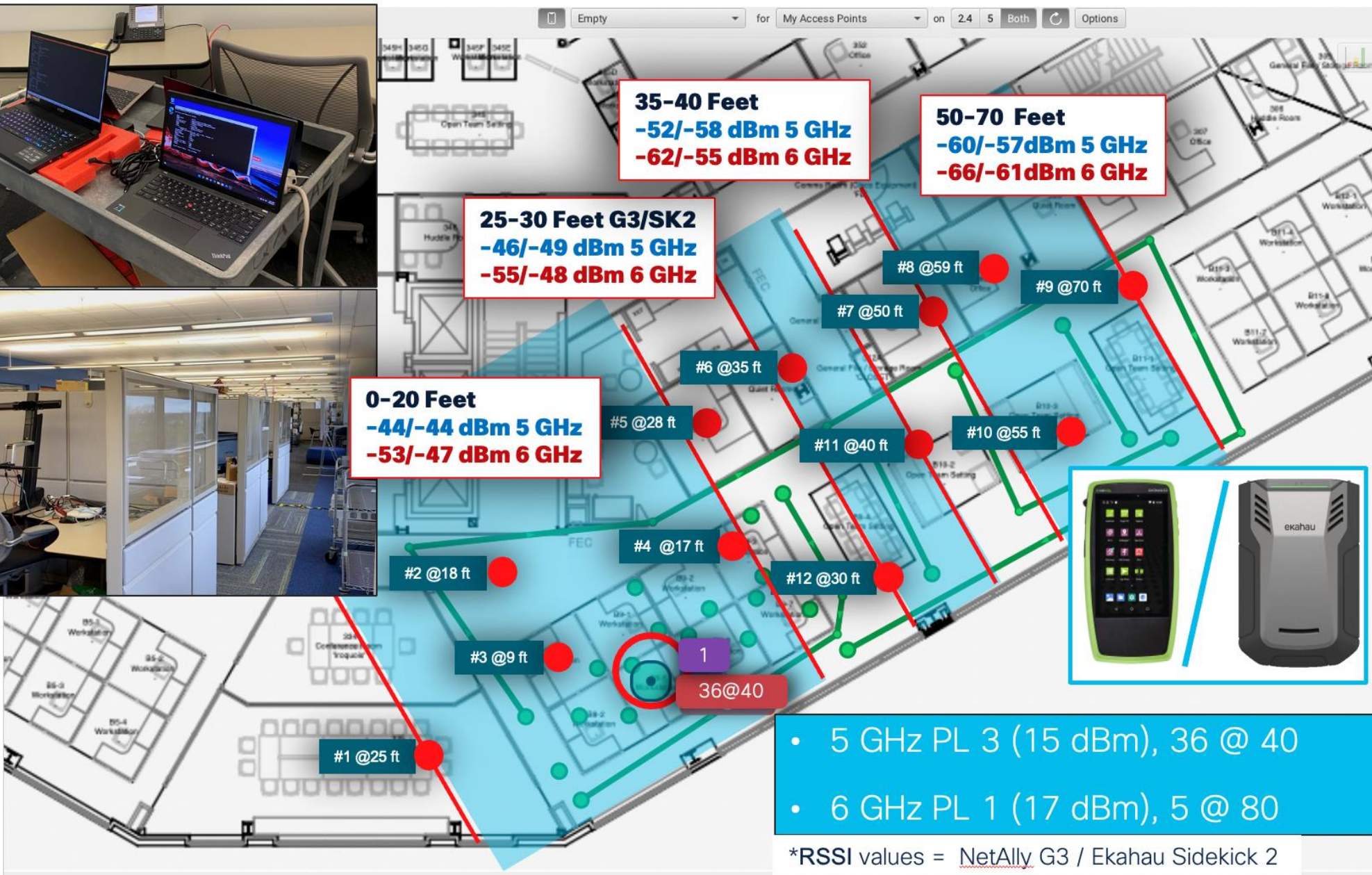
5 GHz Clients (6E AX210)	RSSI Value (From Client - 1)	RSSI Value (From Client - 2)	RSSI Value (From Client - 3)	RSSI Value (From Client - 4)	RSSI Value (From Client- 5)	RSSI Value (From Client - 6)	RSSI Value (From Client- 7)	RSSI Value (From Client- 8)	RSSI Value (From Client-9)	RSSI Value (From Client-10)	RSSI Value (From Client-11)	RSSI Value (From Client-12)
Ekahau – Mobile Device	-62	-62	-56	-58	-60	-63	-65	-67	-69	-63	-62	-58
Distance from AP	25	18	9	17	28	35	50	59	70	55	40	30
Lenovo	-56	-57	-57	-57	-57	-59	-60	-60	-59	-58	-58	-58
Samsung Book	-60	-58	-59	-60	-60	-60	-63	-70	-74	-64	-60	-60
MSI	-58	-59	-59	-59	-59	-60	-60	-63	-63	-63	-60	-58
Samsung S21	-56	-50	-51	-52	-53	-52	-59	-64	-67	-60	-58	-58
Samsung Notebook	-56	-58	-58	-58	-58	-58	-60	-60	-64	-61	-60	-58
Average	-57.2	-56	-56.7	-56.92	-57.2	-57.4	-60	-63.2	-65.2	-61	-59	-58.1
6 GHz Clients (6E AX210)	RSSI Value (From Client - 1)	RSSI Value (From Client - 2)	RSSI Value (From Client - 3)	RSSI Value (From Client - 4)	RSSI Value (From Client- 5)	RSSI Value (From Client - 6)	RSSI Value (From Client- 7)	RSSI Value (From Client- 8)	RSSI Value (From Client-9)	RSSI Value (From Client-10)	RSSI Value (From Client-11)	RSSI Value (From Client-12)
Distance(f) from AP	25	18	9	17	28	35	50	59	70	55	40	30
Lenovo	-56	-56	-56	-56	-56	-56	-57	-60	-59	-59	-59	-57
Samsung Book	-57	-57	-57	-57	-59	-58	-65	-79	-59	-58	-58	-58
MSI	-64	-56	-55	-55	-57	-59	-60	-63	-59	-59	-59	-66
Samsung S21	-60	-52	-57	-57	-61	-63	-71	-75	-64	-65	-58	-61
Samsung Notebook	-59	-56	-56	-57	-56	-58	-59	-59	-57	-59	-57	-57
Average	-59.1	-55.4	-56.1	-56.3	-57.7	-58.8	-62.4	-66.9	-59.4	-59.6	-58.2	-59.5

- *Conclusion 1* –
With an appropriate power offset (~2 dB), 5 and 6 GHz LPI Cells can be made co-resident at normal Enterprise Densities.

2. Characterize New Test tools

- Using the same Test points in the setup, Validate New test hardware against the client's truth
- Measurements made using:
 - Ekahau Sidekick 2
 - 2.4, 5, 6 GHz
 - Ekahau AI Pro
 - Ekahau Analyzer
 - Ekahau Sidekick 1
 - Compared 5 GHz only w SK2
 - NetAlly Aircheck G3
 - 2.4, 5, 6 GHz
 - NetAlly Link-Live





Raw Data – Client/Test Set RSSI

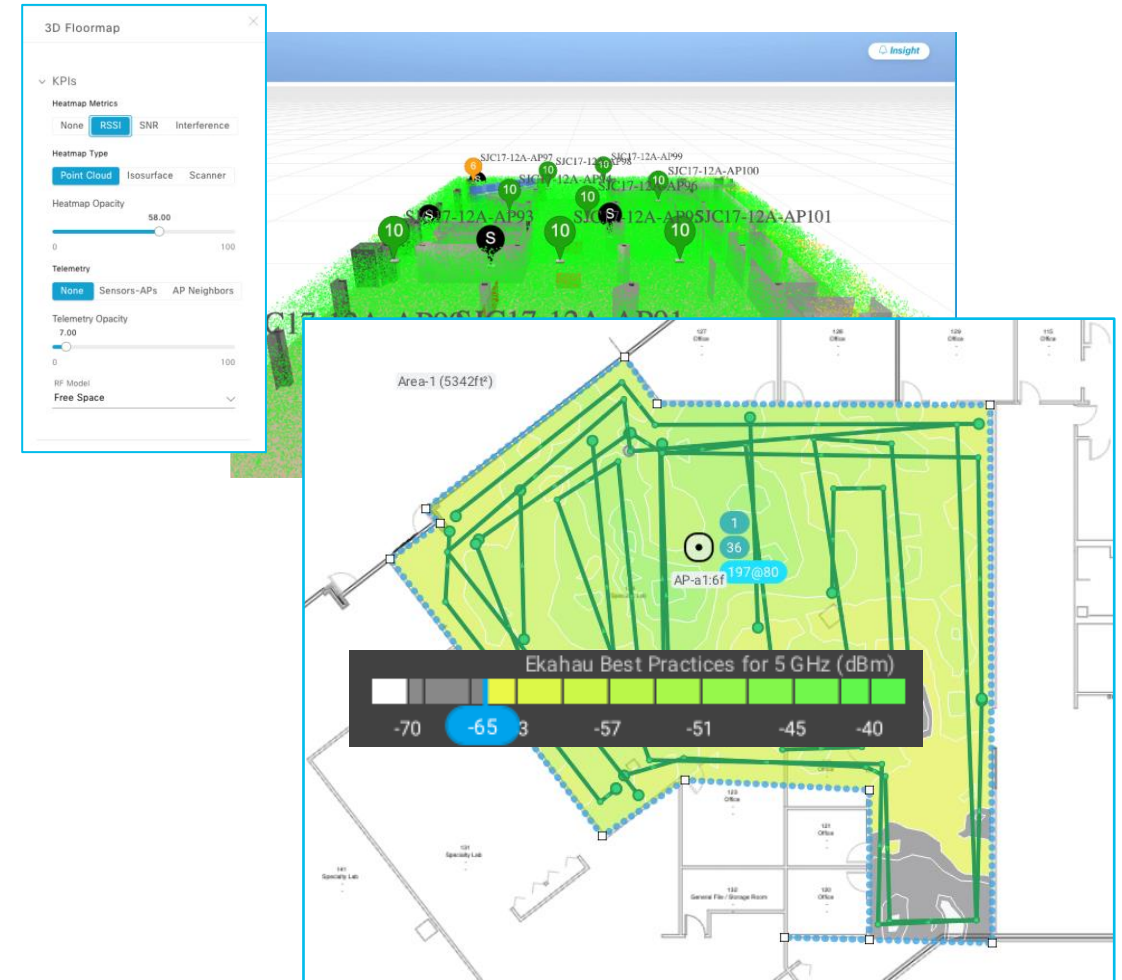
Clients WI-Fi 6E 5 GHz	RSSI Value Point 1	RSSI Value Point 2	RSSI Value Point 3	RSSI Value Point 4	RSSI Value Point 5	RSSI Value Point 6	RSSI Value Point 7	RSSI Value Point 8	RSSI Value Point 9	RSSI Value Point10	RSSI Value Point 11	RSSI Value Point 12
Ekahau Sidekick1	-62	-62	-56	-58	-60	-63	-65	-67	-69	-63	-62	-58
Lenovo	-56	-57	-57	-57	-57	-59	-60	-60	-59	-58	-58	-58
Samsung Book	-60	-58	-59	-60	-60	-60	-63	-70	-74	-64	-60	-60
MSI	-58	-59	-59	-59	-59	-60	-60	-63	-63	-63	-60	-58
Samsung S21	-56	-50	-51	-52	-53	-52	-59	-64	-67	-60	-58	-58
Samsung Notebook	-56	-58	-58	-58	-58	-58	-60	-60	-64	-61	-60	-58
Client Average	-57	-56	-57	-57	-57	-57	-60	-63	-65	-61	-59	-58
NetAlley G3	-45	-47	-45	-51	-51	-57	-63	-64	-57	-58	-47	-41
Ekahau Analyzer/SideKick2	-43	-44	-44	-45	-52	-55	-59	-61	-59	-51	-61	-45
Ekahau AI Pro/SideKick2 Mob	-55	-57	-51	-56	-57	-64	-70	-72	-70	-68	-61	-60

Clients WI-Fi 6E 6 GHz	RSSI Value Point 1	RSSI Value Point 2	RSSI Value Point 3	RSSI Value Point 4	RSSI Value Point 5	RSSI Value Point 6	RSSI Value Point 7	RSSI Value Point 8	RSSI Value Point 9	RSSI Value Point10	RSSI Value Point 11	RSSI Value Point 12
Lenovo	-56	-56	-56	-56	-56	-56	-57	-60	-59	-59	-59	-57
Samsung Book	-57	-57	-57	-57	-59	-58	-65	-79	-59	-58	-58	-58
MSI	-64	-56	-55	-55	-57	-59	-60	-63	-59	-59	-59	-66
Samsung S21	-60	-52	-57	-57	-61	-63	-71	-75	-64	-65	-58	-61
Samsung Notebook	-59	-56	-56	-57	-56	-58	-59	-59	-57	-59	-57	-57
Average Client	-59.1	-55.4	-56.1	-56.3	-57.7	-58.8	-62.4	-66.9	-59.4	-59.6	-58.2	-59.5
NetAlley G3	-50	-54	-52	-56	-57	-62	-67	-70	-65	-62	-61	-54
Ekahau Analyzer/SideKick2	-46	-47	-49	-48	-50	-56	-60	-64	-63	-57	-54	-45
Ekahau AI Pro/SideKick2 Mob	-59	-57	-56	-59	-67	-67	-70	-70	-72	-69	-64	-61

Predictive vs Measured

When is good enough, good enough?

- A “Predictive Survey” is an RF design created using a predictive modeling tool, specific to RF
- Using scale floor plan, antenna patterns provided by manufacturers, the predicted RF coverage can be visualised in a heatmap as coverage
- Available tools can be quite sophisticated and provide good visualisations



Predictive vs Measured

When is good enough, good enough?

- A Measured Site Survey is an actual measurement of the RF Coverage in each space
- Measurement tools range from off the shelf client devices to specialised scanning radios and applications
- Ekahau and NetAlly both have Instruments specifically for measuring Wi-Fi at 2.4 => 6 GHz



How to Calibrate Ekahau AI Pro 11.6

A measurement, is the ground truth

1. A Catalyst C9166 AP was measured on channel 37@80 MHz, 2 dBm power
2. Using the Signal Strength for Area tool in Ekahau – The measured coverage that's below -65 = 15.5 %
3. Modeling a Catalyst 9166 @ 2 dBm channel 37@80 MHz Measures 41% below -65 dBm
4. Adjust the power in the model until the same approximate coverage area is reached – adding 3 dB to make TX power 5 dBm



How to Calibrate Ekahau AI Pro 11.6

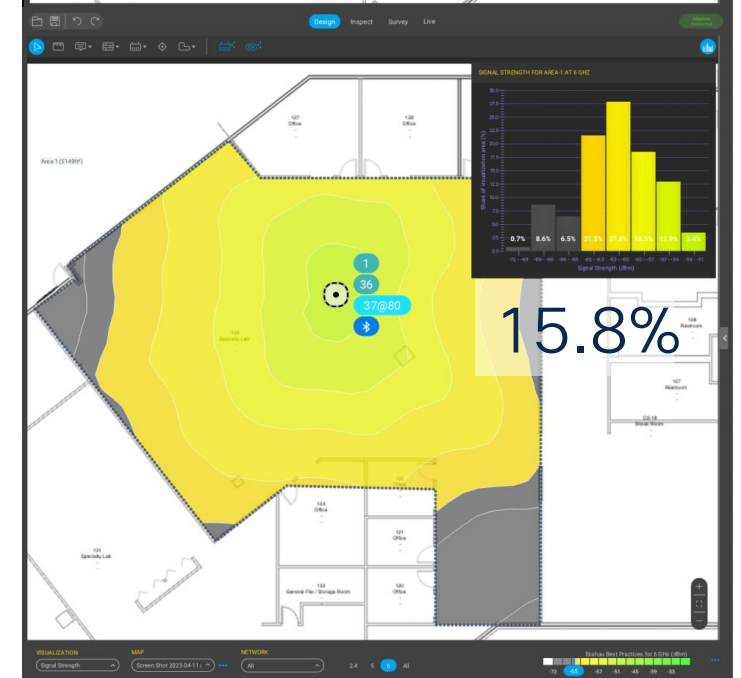
A measurement, is the truth

- The Measured coverage is more complex, but this is measured in a room full of tables filled with wi-fi devices to measure
- The Model covers more smoothly, but looks pretty good with a +3 dB TX power increase and measures 15.8% to the actual measured 15.5% above -65 dBm
- Then for the C9166 in 6 GHz in an open office space - add 3 dB to the TX power and design with confidence

Measured



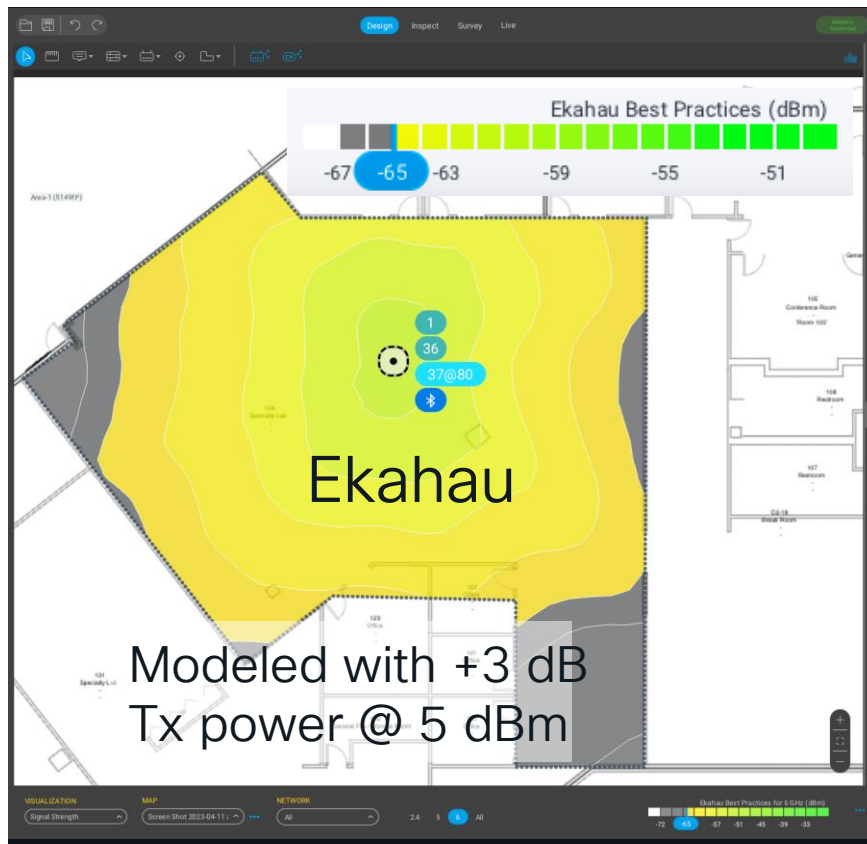
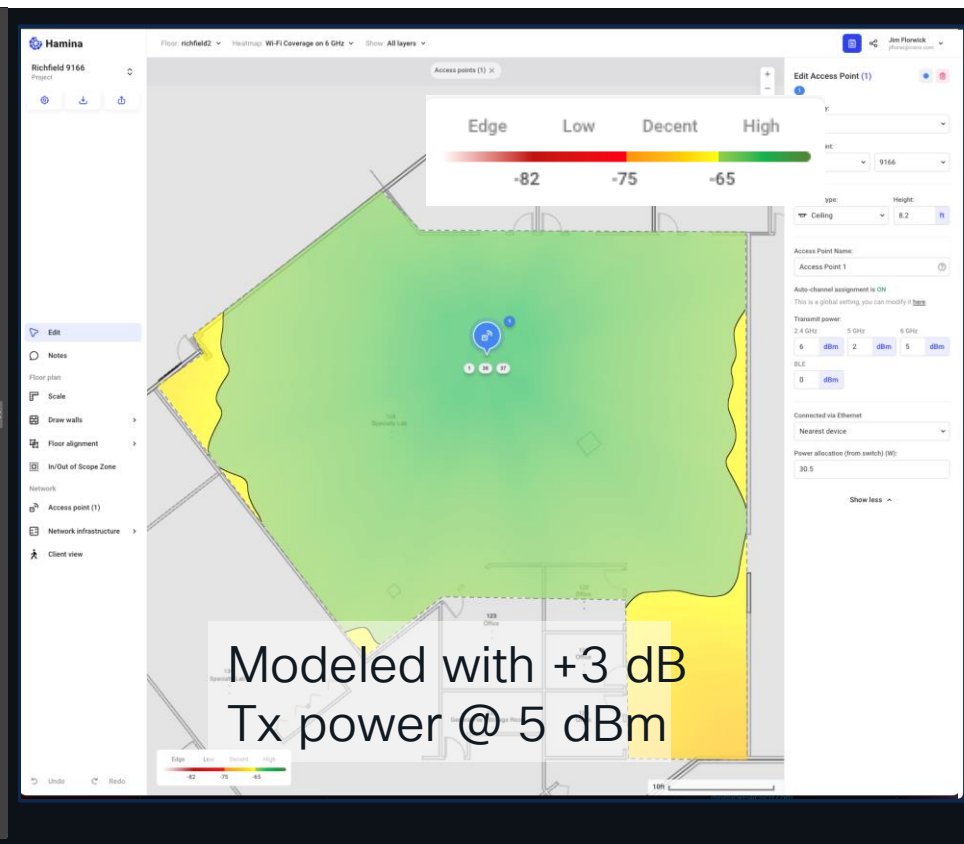
Simulated



Referencing Predictive Models

Ekahau AI Pro 11.6 And Hamina Wireless

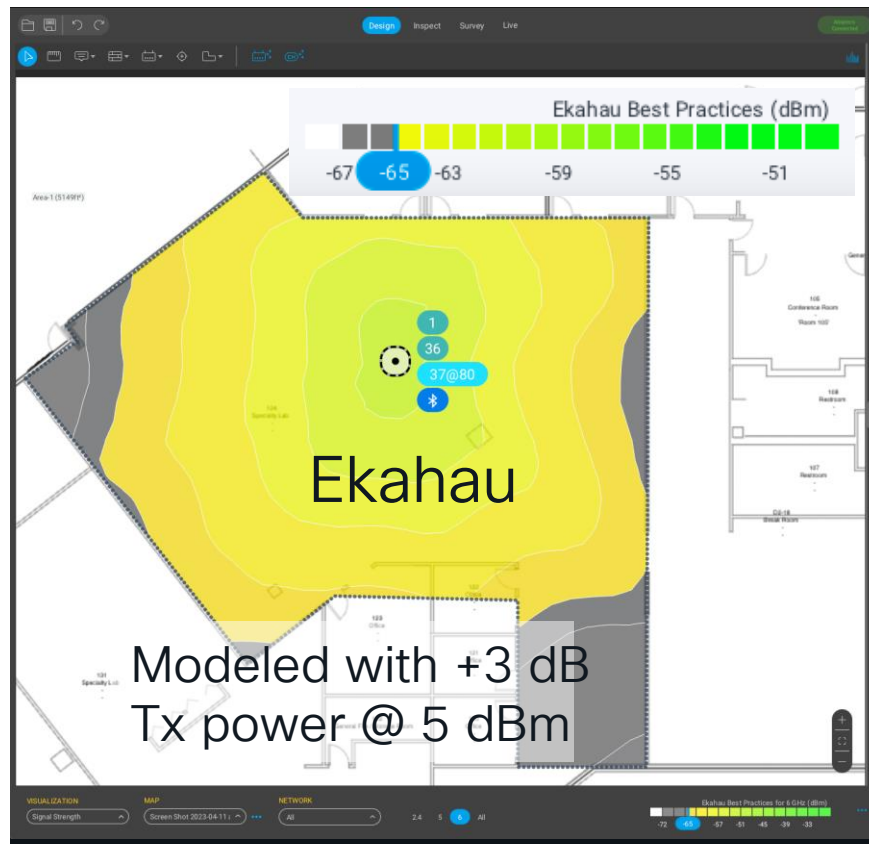
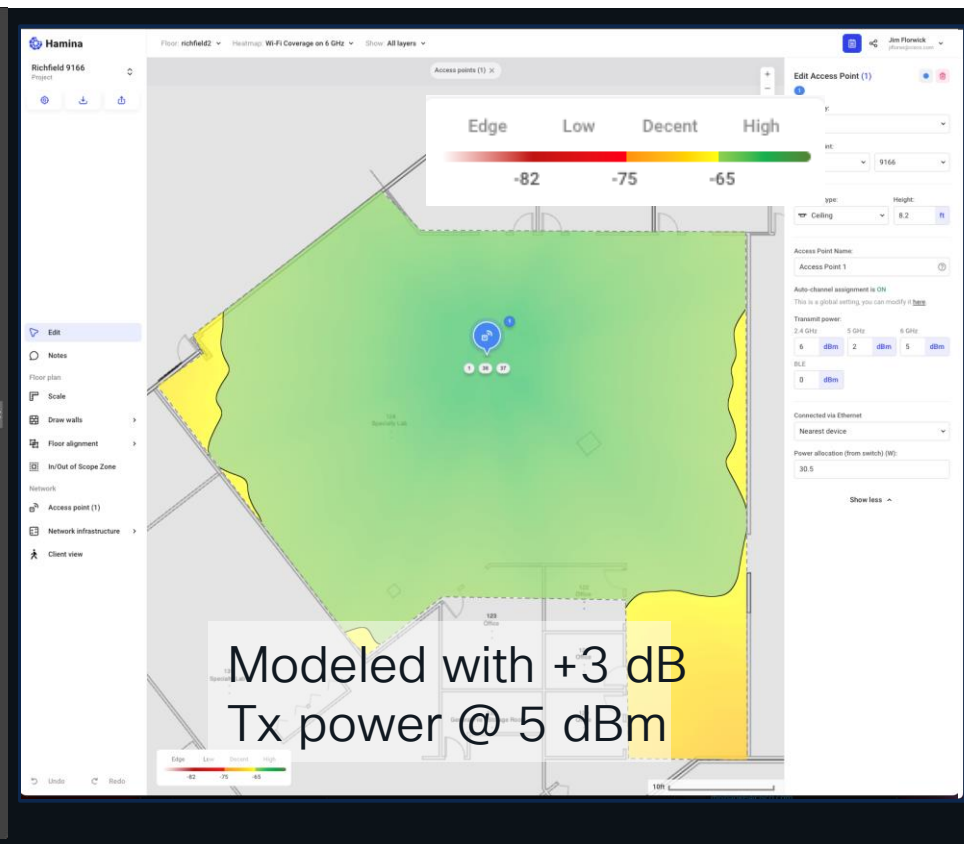
Once there is a scale Predictive Model, can be used to reference other tools



Referencing Predictive Models

Ekahau AI Pro 11.6 And Hamina Wireless

Once there is a scale Predictive Model, can be used to reference other tools



- Conclusion 2

Know your Tools – and Calibrate!

Using Ekahau tools note that SK1 and SK2 are both fine tools, SK1, more sensitive than SK2 and overestimates Client level RF, SK2 better

Know the measurement differences and how to employ View as Mobile Device mode and why

AI Pro and Analyser applications both have View s Mobile Device mode

NetAlly G3 Is a bit more sensitive and does not have an automatic offset to get it closer to Client Device reality.

It does have Manual offsets that can be entered in dB to compensate – BUT – Calibrate

See BRKEWN-2024 – Anand Gurumurthy Adoption and Getting ready with Wi-Fi 7

2. Range vs Rate Performance

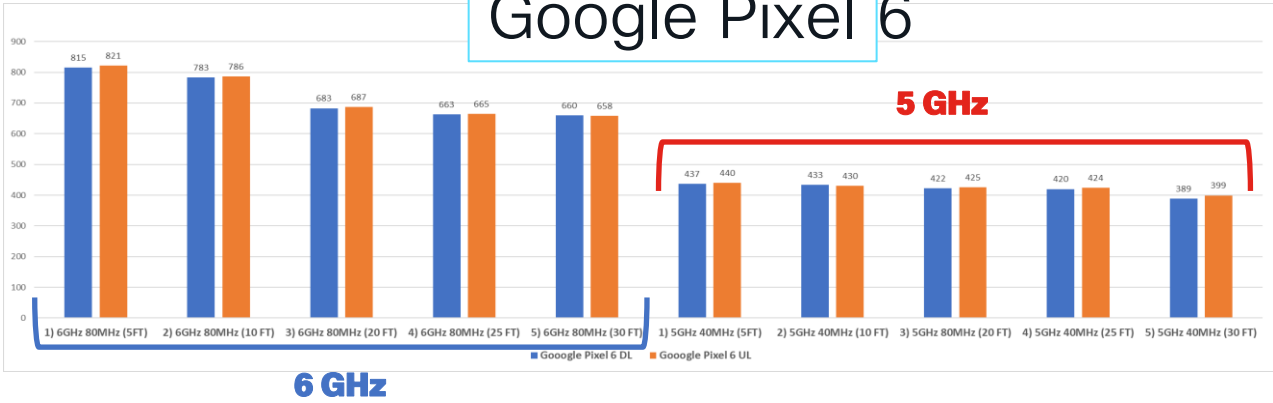
- At Enterprise densities (1.2-2K f²) Cell boundary is ~25 Feet max from AP
- Testing 5 clients TCP throughput @ 5 and 6 GHz
- Test Range uses Cisco C9136 -B configured for 5 GHz PL 4 (17 dBm EIRP), chn 36@40 and 6 GHz PL 2 (20 dBm EIRP), chn 5@80
- Data gathered at 5,10,20,25, and 30 foot distances from the AP
- All devices 2ss @ 5 and 6 GHz



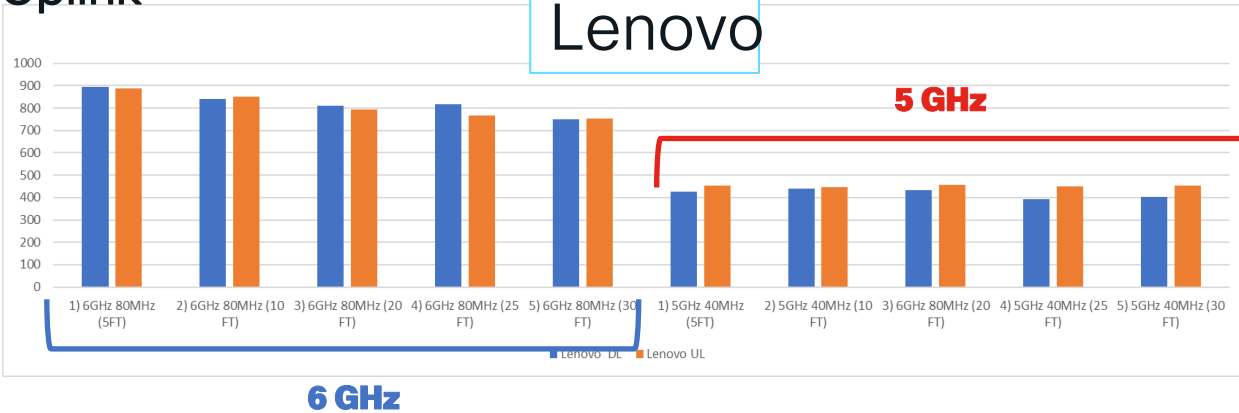
UL and DL compared – 6 GHz and 5 GHz

Downlink
Uplink

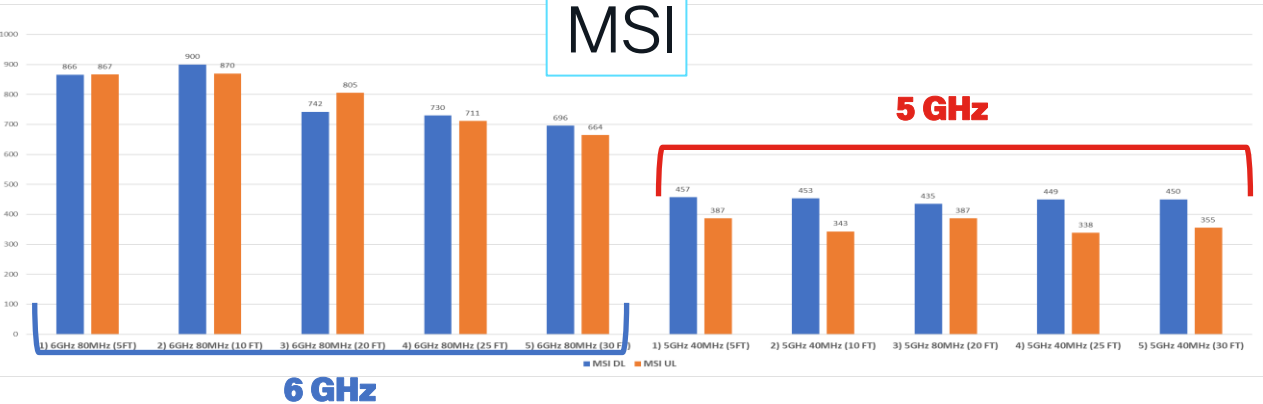
Google Pixel 6



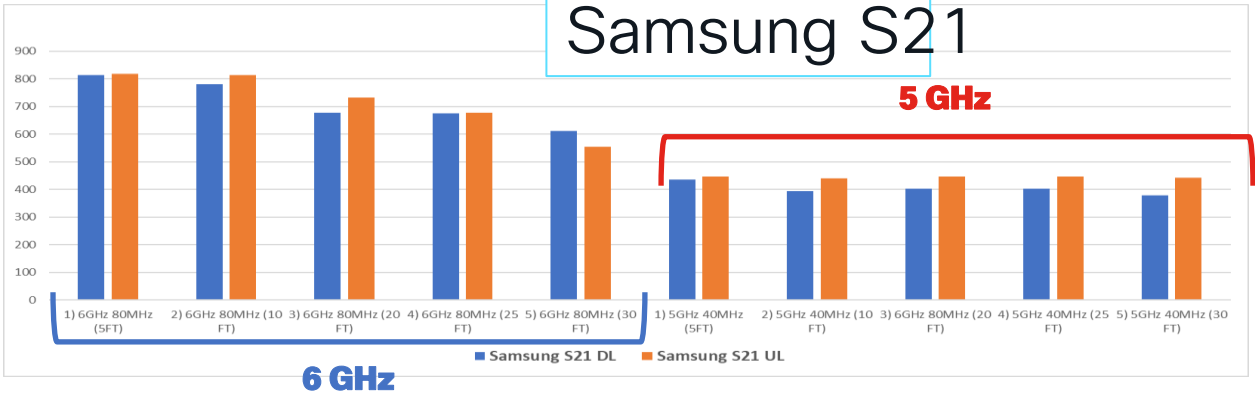
Lenovo



MSI



Samsung S21



- Conclusion 3

Throughput UL/DL almost equal in Each band 5–6 GHz for the devices tested

More than adequate throughput for each at the distances tested (111–270 m²)

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 capacity?

A1: Yes!

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

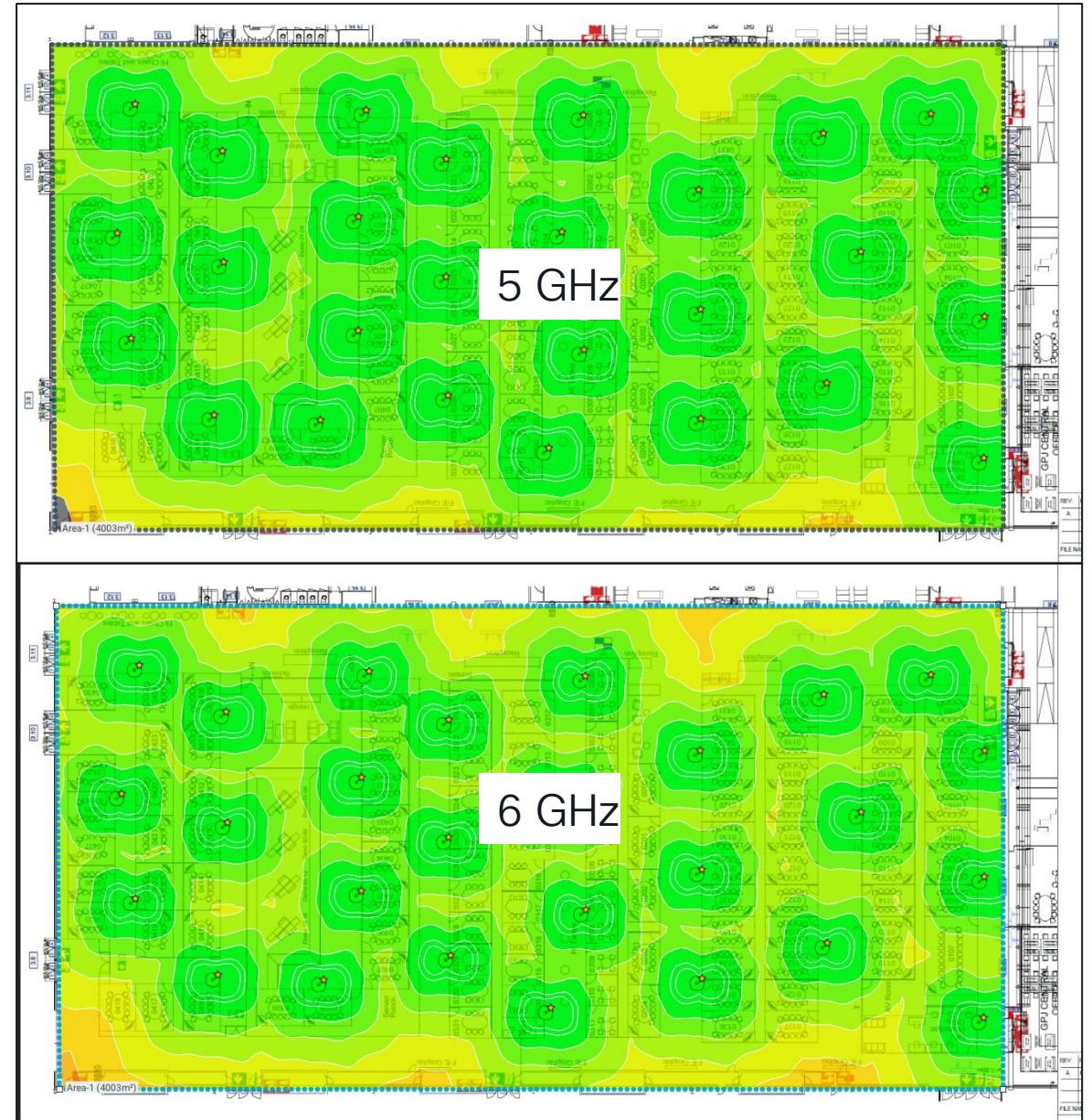
A2: Yes. *Assuming 1.2 – 2k f² average AP density, carpeted office normal ceiling (3 m /10 ft)

Q3: If network is less dense 3-5 f² Then 15-20% increase in density to accommodate 6 GHz coverage expected

- 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
- Edges and less dense Areas need to be identified and augmented.

And, How does it work?

- Comparing 5 and 6 GHz coverage after RRM did its thing, 6 GHz needed to come up $\frac{1}{2}$ dB
- Or did it?
- We were able to hold the 6 GHz connection into the next hall, why?
- Low noise floor – high SNR



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

Ekahau Sidekick 2

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



Hamina Nomad

- 2.4, 5 & 6 GHz
- Hamina Onsite App

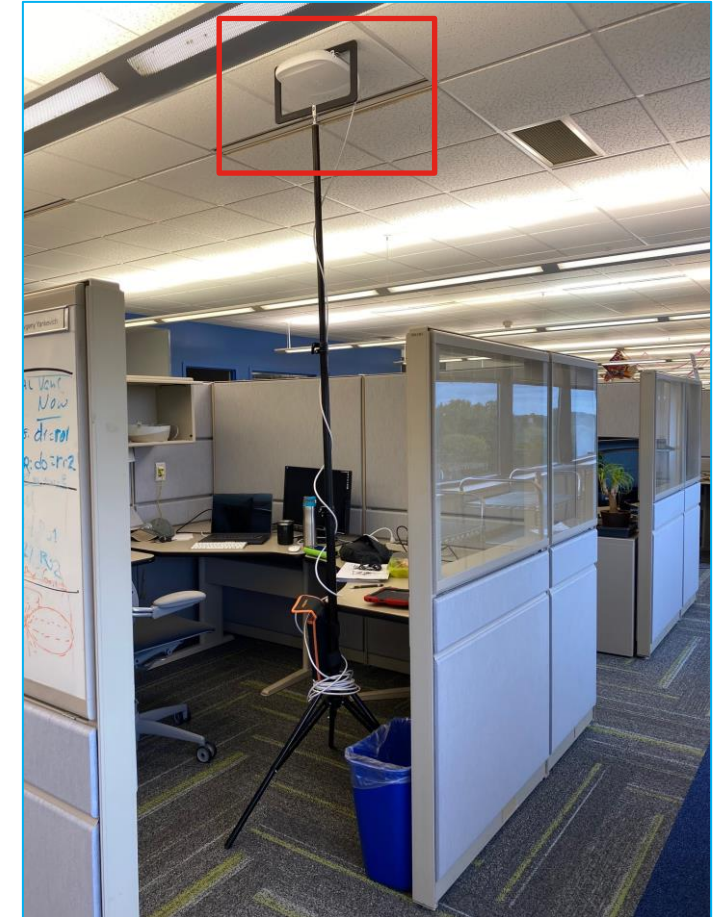


NetAlly Aircheck G3 Pro

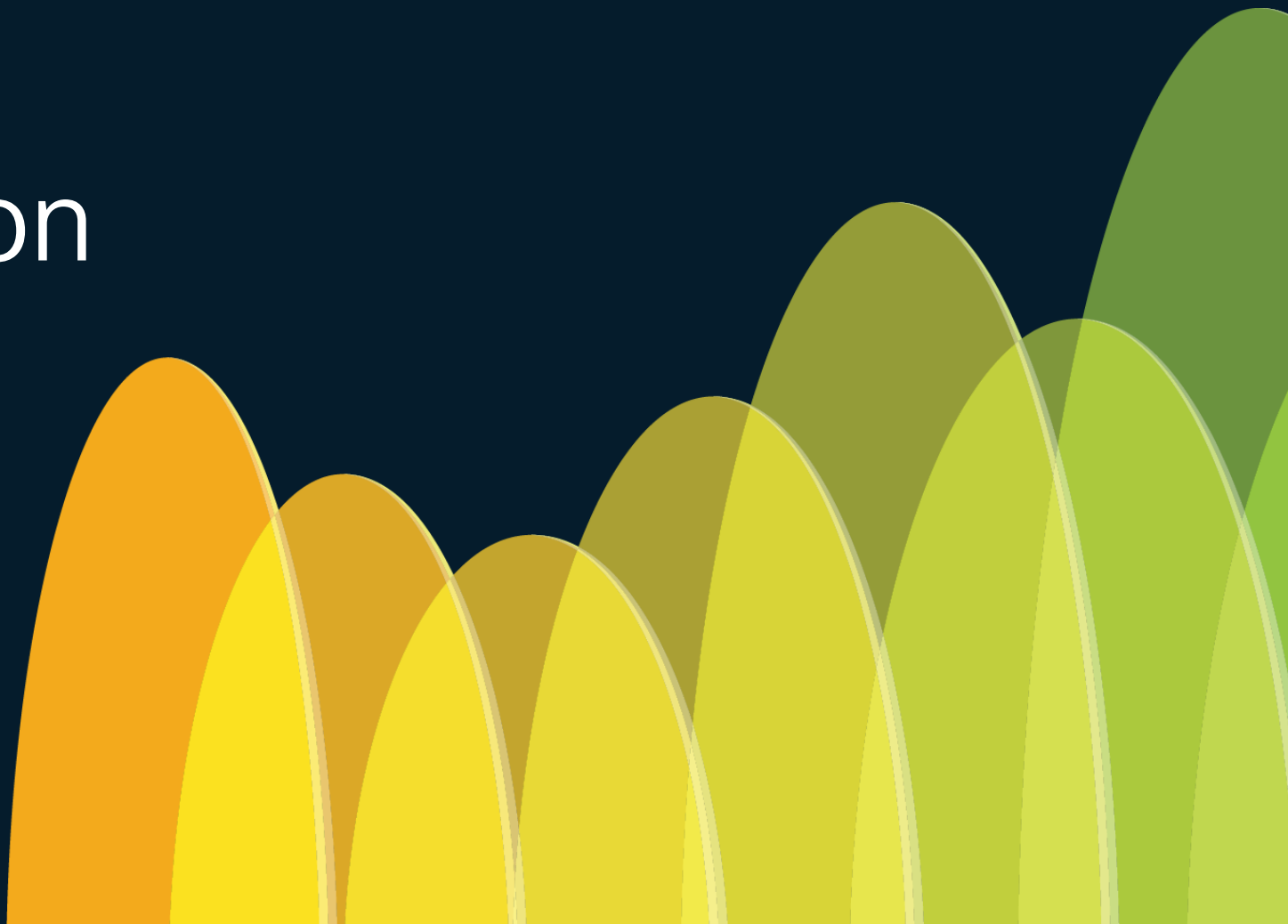
- 2.4, 5, 6 GHz
- NetAlly Link-Live



cisco *Live!*



Partner Integration Wi-Fi Design



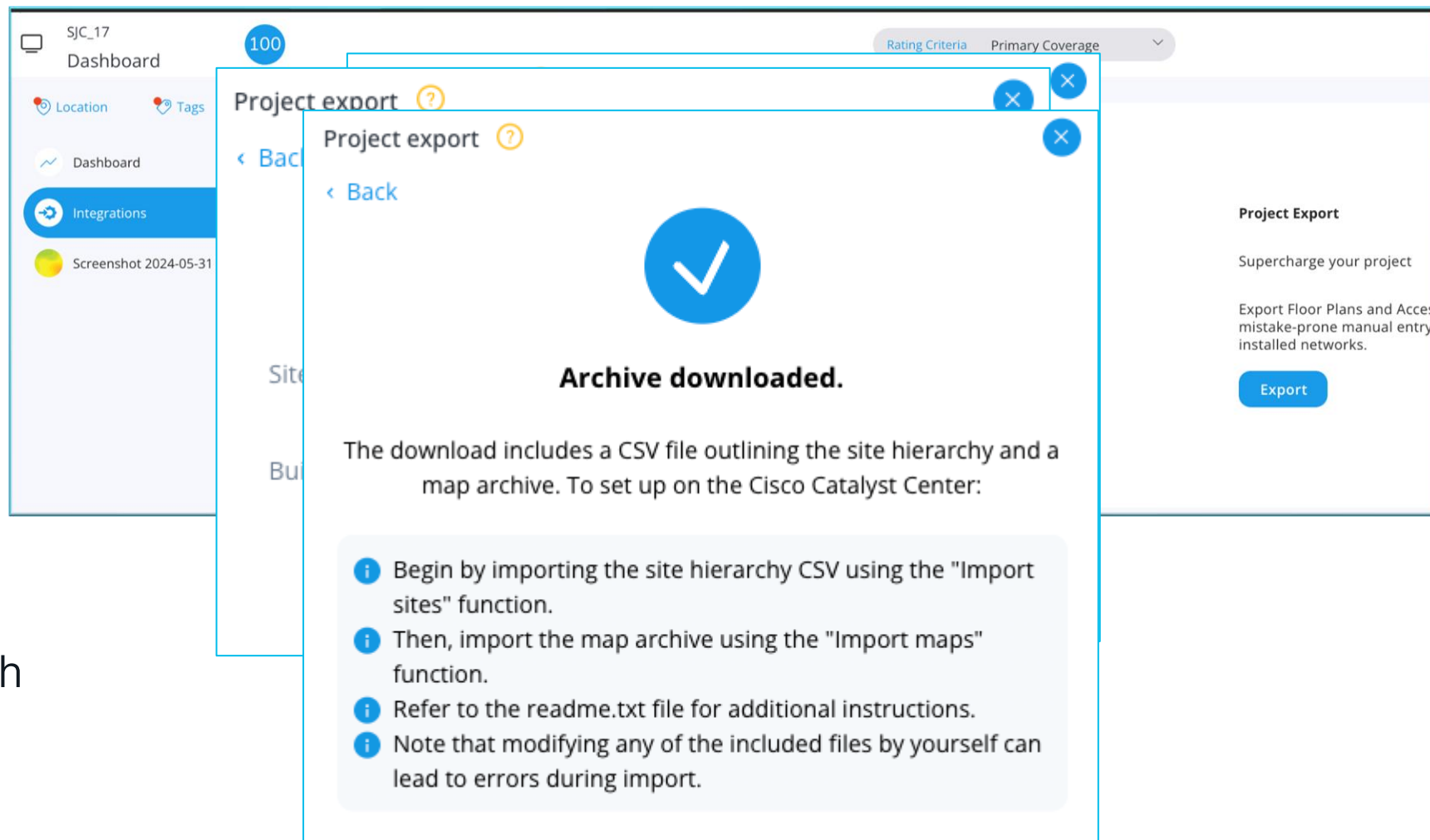


Ekahau Project import on Catalyst Center API

Import directly from
Ekahau cloud

Requirements:

- Ekahau cloud account
- Use ekahau.cloud to for project export –
 - Cloud to on Prem
 - Or, Downloaded Tar
- Enter the site path you wish to put the building in and continue



CISCO Live!

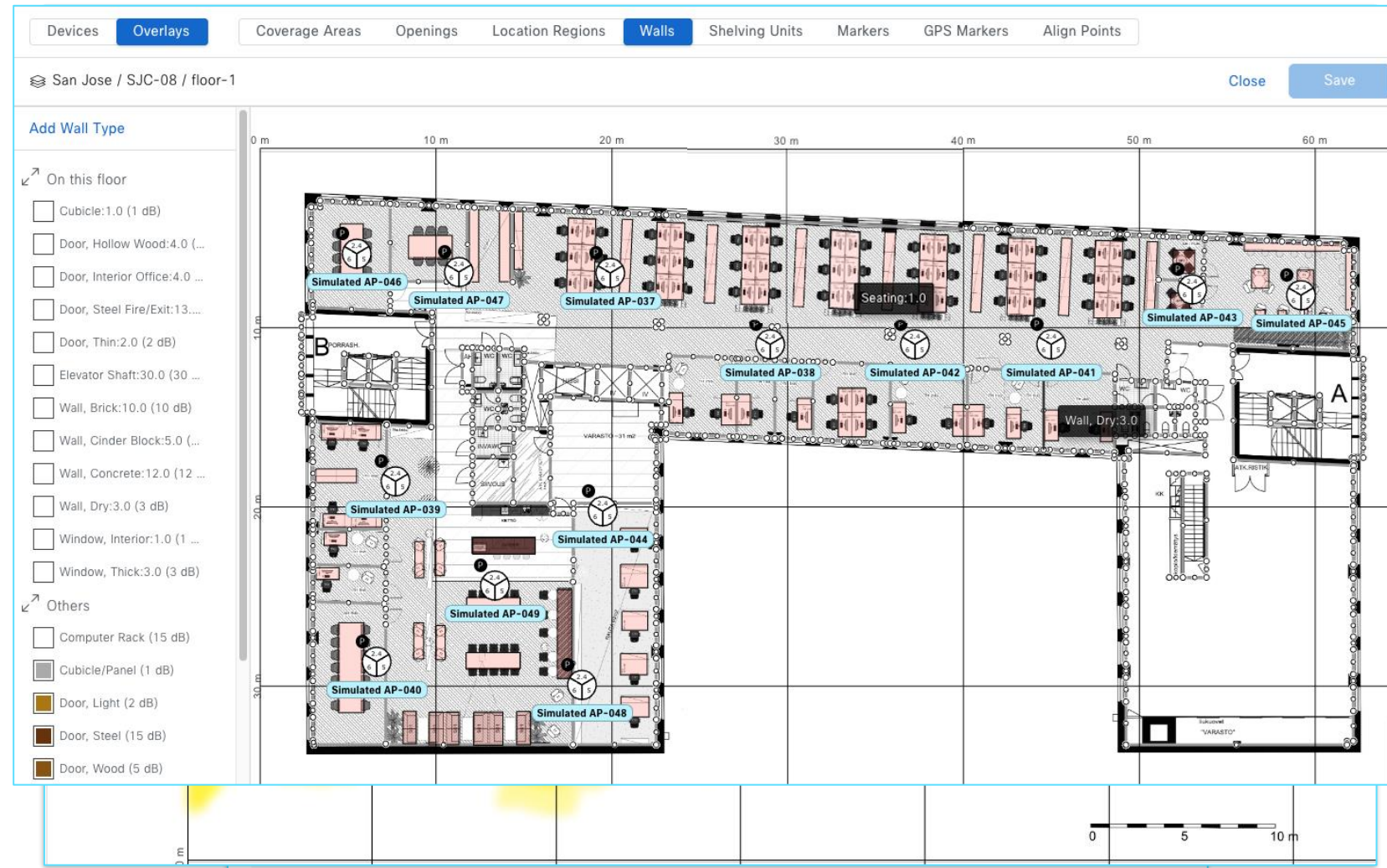


Catalyst Center Version 2.3.7.6 Minimum

Ekahau Project import on Catalyst Center API

Upload Project File to Catalyst Center

- From the Design>Network Hierarchy – Import Sites
- From the Design>Network Hierarchy – Import-Map Archive
- View the SJC-08 Floor 1 from the Hierarchy
- Note- all Obstacles are included in the import process and the values and name are unchanged

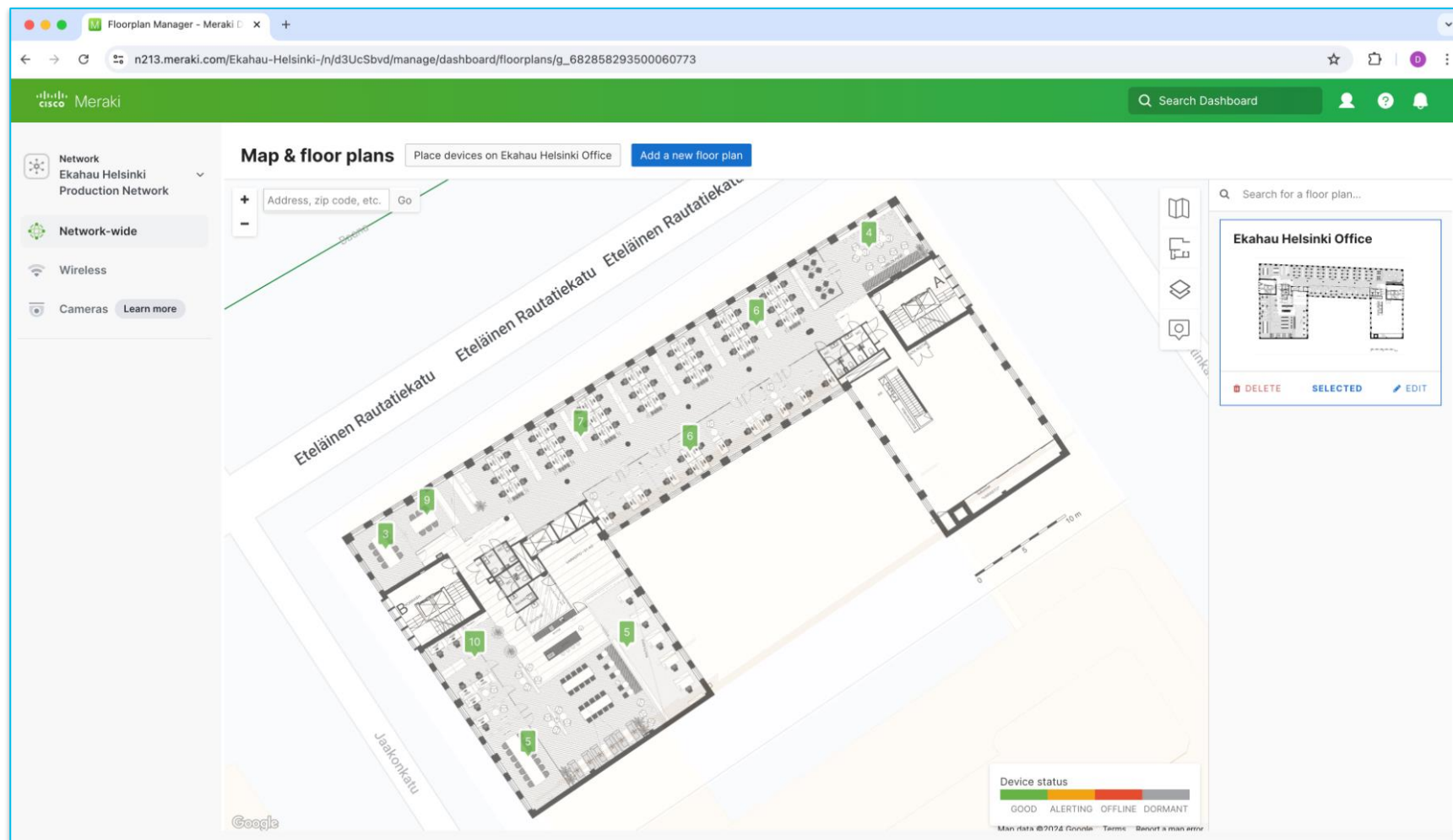




Ekahau - Zero Touch Onboarding with Meraki

Import directly from Ekahau cloud

- Begin by selecting project to export
- Choose Meraki
- Enter the API Key for the target network
- Select Org, and Network
- Align the floor plan, And Continue and the project exports
- The network is Created, AP's are placed and Onboarded



cisco Live!



Ekahau AI Pro and Cloud Connect!

CleanAir™ Pro RF Excellence



Cisco CleanAir Pro™

The Evolution of Cisco Wi-Fi Excellence into 6 GHz

6E Ready

- 6E Packet capture (iCap)
- WIDS/WIPS/Rogue Detection

IOS-XE 17.7
DNAC 2.3.2 (Frey)

Spectrum Based Features

- 6 GHz Spectrum Analysis (iCap)
- 6 GHz RRM enhancements
- FastLocate

IOS-XE 17.8
DNAC 2.3.3 (Guardian)

Spectrum Insight is foundational for great Wi-Fi

*Classification & Reporting

- ML based interference classifier
- RF Interference Detection Reports
- Air Quality Index Reports

IOS-XE 17.9 *2.4 and 5 GHz only
DNAC 2.3.4 (Groot)

6 GHz Classifiers

- Continuous TX
- Video Repeater
- 6 GHz Merging enhancements

IOS-XE 17.10 6 GHz Detection

6 GHz Mitigation

- ED-RRM for 6 GHz
- Automated Signature Capture for ML

IOS-XE 17.13 6 GHz Mitigation

Above & Beyond

- AFC integration**
- ML driven Dynamic Interference signature updates & capture**
- IoT Radio integration**

Great for client device testing and validation

** Still to be committed

Cisco CleanAir Pro™

The Evolution of Cisco Wi-Fi Excellence into 6 GHz

Is Cisco CleanAir Pro still CleanAir ?

Detect and Classify Non – Wi-Fi interference

To Wi-Fi, if it's not Wi-Fi – then its noise

Set Severity Metric per Interferer

Important to identify which source is causing the most harm

Establish Air Quality for all interfaces on the AP

Track how much the combined impact is affecting Wi-Fi service in the cell

Merge same Type interferers

Correlation of duplicate alarms from other neighboring APs of same event

CleanAir	CleanAir Pro
✓	✓
✓	✓
✓	✓
✓	✓
✓	✓

Cisco CleanAir Pro™

Detect and Classify

CleanAir Pro =CA-Pro

5 GHz Video Camera is on Channel 157

- All the CleanAir and CleanAir Pro radios agree – channel 157 is messed up
- Depending on RSSI, Duty Cycle and persistence a Severity is assigned
- Some Disagreement on device type
- All agree on the Duty Cycle

Monitoring > Wireless > CleanAir Statistics

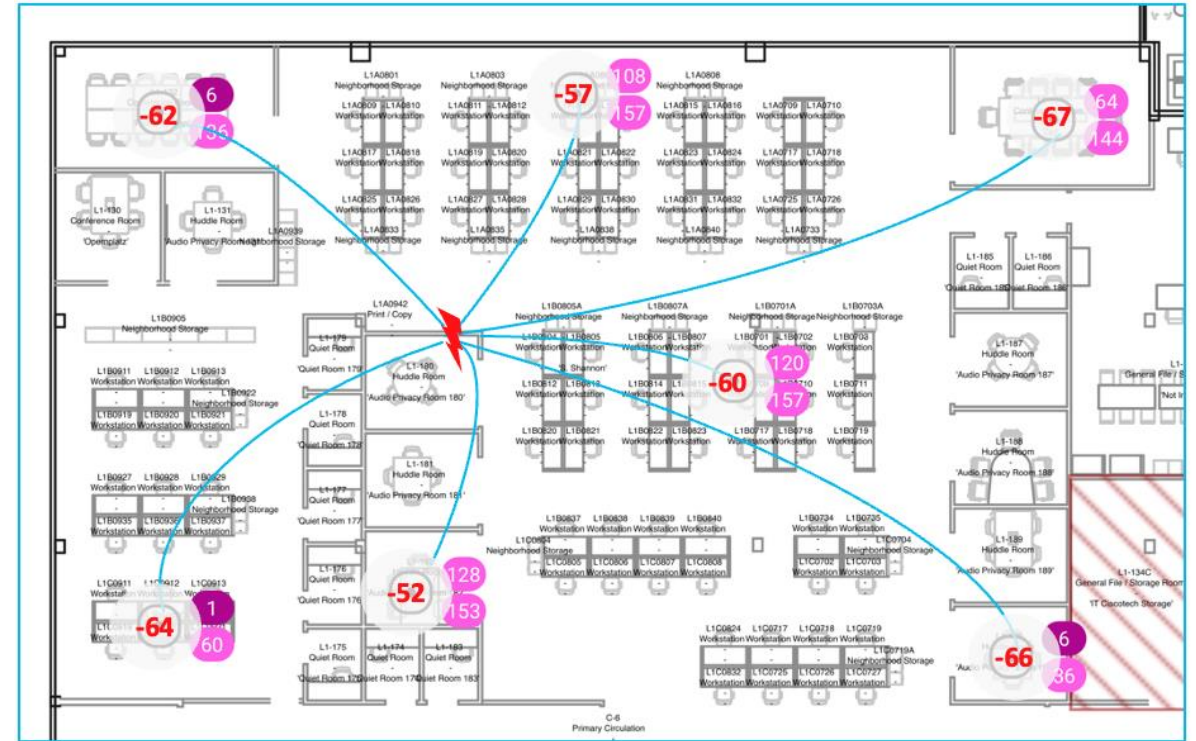
6 GHz Band 5 GHz Band 2.4 GHz Band

CleanAir Interference Devices SI Interference Devices Air Quality Report Worst Air Quality Report

Cluster ID	Interferer Type	AP Name	Version	Severity	RSSI (dBm)	Duty Cycle (%)	Affected Channel	Last Update Time
d500.0000.00ea	Continuous TX	C9130i_9f.6e.a0	CA	5	-93	100	157	9/28/2023 22:04:14 EST
d500.0000.00ea	Continuous TX	C9130i_9f.6e.a0	CA	4	-93	100	157	9/28/2023 22:04:14 EST
d500.0000.00ea	Video camera	Marlin_4_91.4260	CA	88	-65	100	157	9/28/2023
d500.0000.00ea	Continuous TX	C9120_E-a2:9d:c0	CA	--	-80	100	157	9/28/2023 22:04:29 EST
d500.0000.00ea	Video camera	C9120_E-a2:9d:c0	CA	35	-86	100	157	9/28/2023 22:04:29 EST
d500.0000.011c	Continuous TX	CW9166i_Fe.0e20	CA-Pro	100	-52	100	157	9/28/2023 22:04:08 EST
d500.0000.011c	Continuous TX	C9136.5F:09e0	CA-Pro	100	-55	100	157	9/28/2023 22:04:24 EST
d500.0000.011c	Continuous TX	C9136_5f.f1.a0	CA-Pro	3	-74	100	157	9/28/2023 22:04:21 EST

CleanAir Pro™ – Merging The Challenge

- A non Wi-Fi device in a Wireless office will be heard at more than one AP
- Multiple detections = multiple reports of the same device from different sources.
- Only Cisco's CleanAir Pro can Identify individual devices
- CleanAir Pro Merging Algorithms Correlate and identify individual Interference devices



CleanAir Pro™ – Cluster ID Merging

- Is it 8 Bluetooth devices or some number being reported multiple times?
- CleanAir Pro – like CleanAir's Patented technology is able to tell the difference
- Merged devices share a unique Cluster ID which Identifies the closest AP, as well as all other AP's detecting the same device

Monitoring > Wireless > CleanAir Statistics

6 GHz Band 5 GHz Band 2.4 GHz Band

CleanAir Interference Devices SI Interference Devices Air Quality Report Worst Air Quality Report

Cluster ID	MAC Address	Device ID	Interferer Type	Persistent Device	AP Name	Version	Severity	RSSI
d800.0000.0d3f	0c4f.1740.80c7	0x80c7	BT Link	No	CW9163E-4f.1740	CA-Pro	4	-76
d800.0000.0d3f	20fe.0e20.ebe2	0xebe2	BT Link	No	CW9166i_F...	CA-Pro	11	-70
d800.0000.0d3f	20fe.8620.ccbf	0xccbf	BT Link	No	CW9166i_f...	CA-Pro	6	-48
d800.0000.0d3f	b45e.e9a0.6b4c	0x6b4c	BT Link	No	C9136_5e....	CA-Pro	3	-68
d800.0000.0d3f	b45f.09e0.4834	0x4834	BT Link	No	C9136__p3...	CA-Pro	3	-73
d800.0000.0d3f	b45f.b6f0.5be3	0x5be3	BT Link	No	C9136_5f.b...	CA-Pro	7	-71
d800.0000.0d3f	b45f.cfb0.6b2f	0x6b2f	BT Link	No	C9136_5f.c...	CA-Pro	9	-54
d800.0000.0d3f	b45f.f1a0.eb7d	0xeb7d	BT Link	No	C9136_5f.f...	CA-Pro	9	-63

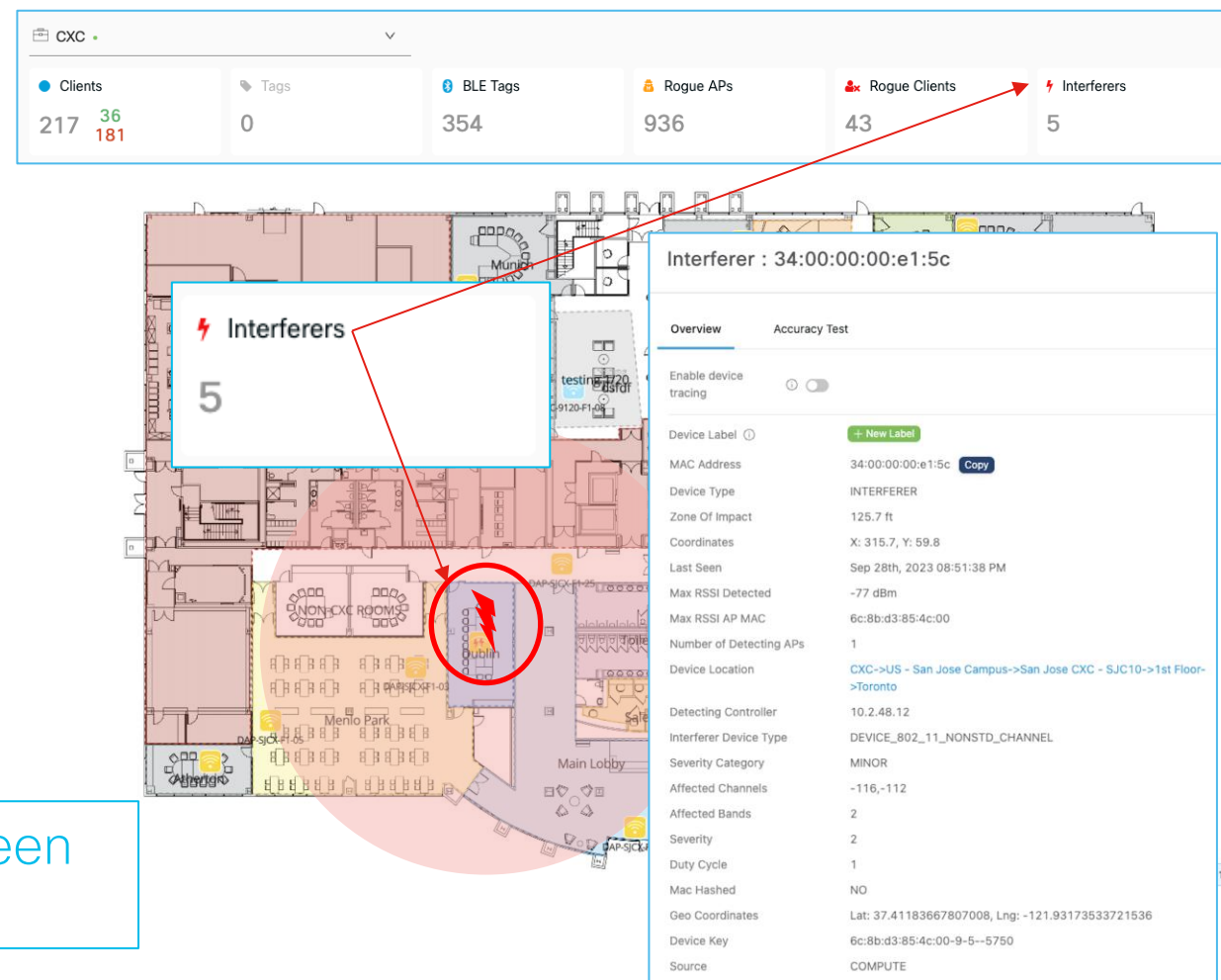
10 items per page 1 - 8 of 8 items

Actionable Information!

CleanAir Pro™ – Cisco Spaces Location

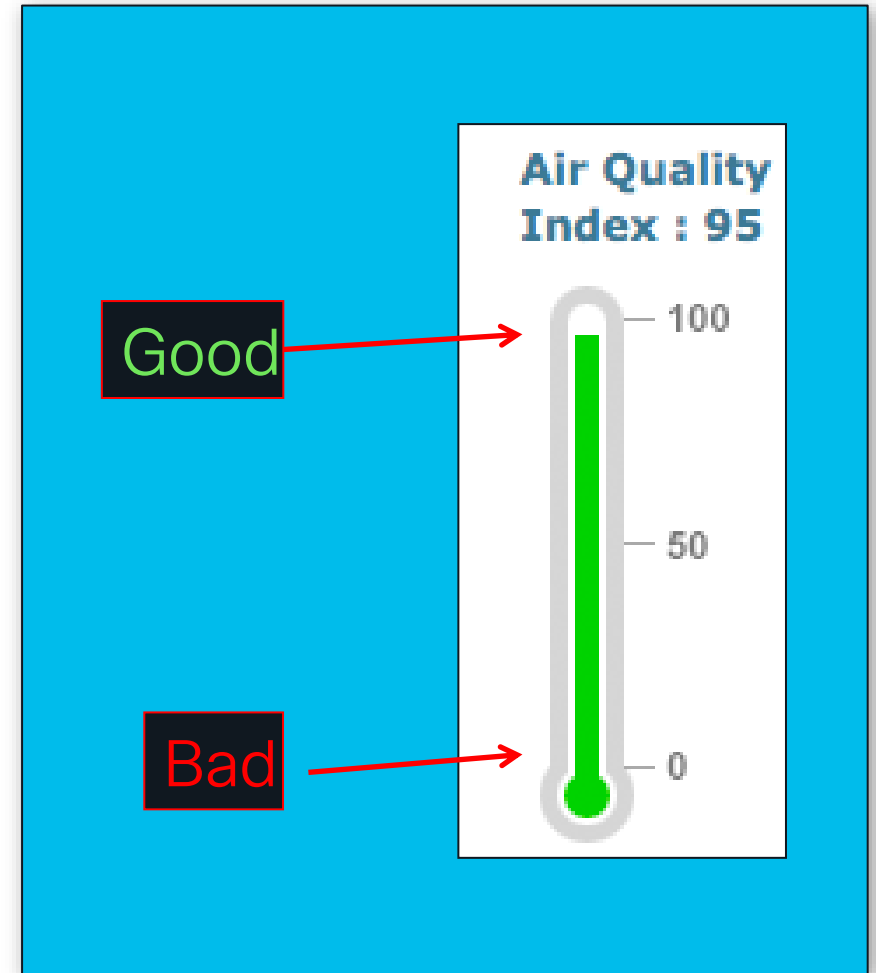
- In the merging process, the RF coordinates for geospatial location are shared with Cisco Spaces Detect and Locate application
- Cluster telemetry data are processed and placed on the map
- An interference radius is calculated
 - The RSSI determines the size of the zone
 - The severity determines the opacity darker = worse

“Actionable Information is the difference between knowing there is a problem and Mitigating it”



CleanAir Pro™ – Severity and Air Quality

- CleanAir Pro Identifies non Wi-Fi interference devices, but it also characterises the impact
- **Severity** is assessed for individual devices by detecting APs. Based on its RSSI, Duty Cycle and waveform a severity from 1-100 is assigned (1 is good, 100 is very bad).
- **Air Quality (AQ)** measures air time lost to an AP's cell from the cumulative interference sources being detected
- The AQI (Air Quality Index) begins at 100% and decrements based on the cumulative Non Wi-Fi interference severity subtracted from AQ



CleanAir Pro™ – Mitigation Persistent Device Avoidance

- A microwave oven is incredibly bad for Wi-Fi, but only when in operation.
- RRM will react if its on long enough. Worse though, it can disappear for hours and RRM may need those channels.
- Persistent Device integrates with RRM to intelligently avoid, and monitor for reoccurrence allowing the RF environment to be proactive and simply plan around it
- Telemetry maps the impacted APs and RRM does the rest.
- Cisco Best Practice = Enabled

Configuration > Radio Configurations > RRM

6 GHz Band 5 GHz Band 2.4 GHz Band FRA

General Coverage DCA TPC RF Grouping Spatial Reuse

Dynamic Channel Assignment Algorithm

Channel Assignment Mode

☒ Automatic

☐ Freeze [Invoke Channel Update Once](#)

☐ Off

Interval 10 minutes

Anchortime 0

Avoid Foreign AP Interference ☒

Avoid Cisco AP load ☐

Avoid Non 5 GHz Noise ☒

Avoid Persistent Non-Wi-Fi Interference ☒

Zero Wait DFS ☒

Channel Assignment Leader C9800-L_2 (192.168.10.22)

Last Auto Channel Assignment 206 second(s) ago

DCA Channel Sensitivity medium

CleanAir Pro™ – Mitigation Energy Detect – RRM

- Because Wi-Fi is Listen to Talk, it will politely not try as long as something else is using the frequency.
- A high Duty Cycle device can shut down and Access Point and all clients connected.
- ED-RRM allows CleanAir Pro to positively ID a Non Wi-Fi interference signal and change the APs channel within 30 seconds
- Triggered by a low AirQuality (AQ) alert. Thresholds are Low = 35, Medium=50, High=60.

Configuration > Radio Configurations > RRM

6 GHz Band 5 GHz Band 2.4 GHz Band FRA

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

DCA Channel Sensitivity medium

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

Dynamic Bandwidth Selection Max Channel Width 20 MHz 40 MHz 80 MHz Max Allowed

Auto-RF Channel List

☒ 36 ☒ 40 ☒ 44 ☒ 48 ☒ 52 ☒ 56 ☒ 60 ☒ 64 ☒ 100 ☒ 104 ☒ 108 ☒ 112 ☒ 116

☒ 120 ☒ 124 ☒ 128 ☒ 132 ☒ 136 ☒ 140 ☒ 144 ☒ 149 ☒ 153 ☒ 157 ☒ 161 ☐ 165

Event Driven RRM

EDRRM ☒

Sensitivity Threshold Low

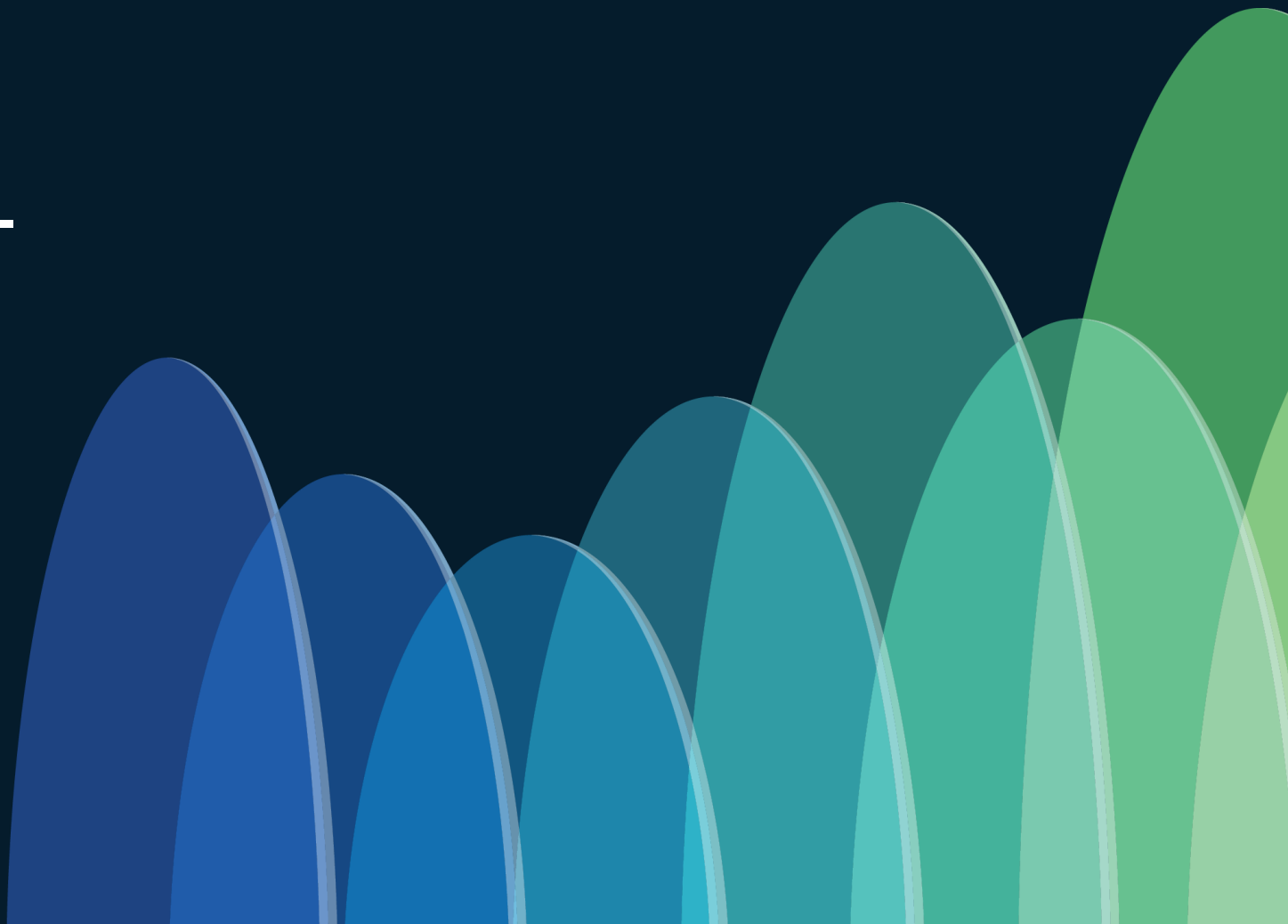
Rogue Contribution ☒

Rogue Duty-Cycle 80

Low Medium High Custom

Low

CleanAir Pro ED- RRM Demo



ScreenFlow File Edit Mark Clip Insert Actions Font Arrange View Window Help

Scanning: Wi-Fi | Not associated

Default All 2.4 GHz 5 GHz 6 GHz Open Secure

BSSID	Network Name	Vendor
10:F9:20:FE:86:27	wi-fi_6E	Cisco Systems Inc
EC:F4:0C:0E:41:E7	wifi_6E	Cisco Systems Inc

UNI-5

-91 -65 -39 dBm

30:30 -

31:00 -

31:30 -

32:05 -

-10

-20

-30

-40

-50

-60

-70

-80

-90

wi-fi_6E
CW9166I_fe8620

1 5 9 13 17 21 25 29 33 37 41 45 49 53 57 61 65 69

Networks Found: 67, Displayed: 2 (2%)

Line: 1:11 Plain Text Tab Size: 4

Cisco Catalyst 9800-L Wireless Controller

Welcome admin

Configuration > Wireless > Access Points

All Access Points

Total APs : 3

AP Name	AP Model	Slot No	Base Radio
CW9166I_Fe.0e20	CW9166I-B	3	10f9.20fe.0e20
CW9166I_fe8620	CW9166I-B	3	10f9.20fe.8620
C9136__p32b.5f.09e0	C9136I-B	4	687d.b45f.09e0

6 GHz Radios

Total 6 GHz radios : 3

AP Name	Slot No	Base Radio
CW9166I_Fe.0e20	2	10f9.20fe.0e20
CW9166I_fe8620	2	10f9.20fe.8620
C9136__p32b.5f.09e0	3	687d.b45f.09e0

5 GHz Radios

2.4 GHz Radios

Dual-Band Radios

Country

LSC Provision

Edit Radios 6 GHz Band

Configure Detail

General

AP Name CW9166I_fe8620

AP Mode Local

Admin Status ENABLED

CleanAir Admin Status ENABLED

Operating Power Mode And Capabilities

AP 6GHz Power Mode	Low Power Indoor Capable	Standard Power Capable
Low Power Indoor	Yes	Yes

Antenna Parameters

Antenna Type Internal

Antenna Mode Omni

Radio Profile default-radio-profile

Number of Antennas Selected 4

MIMO 4x4

Supported Antenna Modes 1x1, 2x2, 4x4

Antenna Gain (in .5 dBi units) 8

Role Assignment

Assignment Method Auto

Client Serving

Monitor

Sniffer

Band Selection 6ghz

Dart Connector Status Not Applicable

RF Channel Assignment

Current Channel 5

Channel Width 160 MHz

Assignment Method Custom

Channel Number 5

Tx Power Level Assignment

Current Tx Power Level 1

Assignment Method Global

BSS Color

BSS Color Configuration Global

BSS Color Global Admin Status Disabled

BSS Color Radio Operational Status Disabled

BSS Color Radio Admin Status ENABLED

Current BSS Color 34

Update & Apply

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Thank you

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