The bridge to possible

Advanced RF Tuning w/Catalyst Wireless:

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

Jim Florwick – Technical Leader, TME Meraki Catalyst Wireless

BRKEWN-3413

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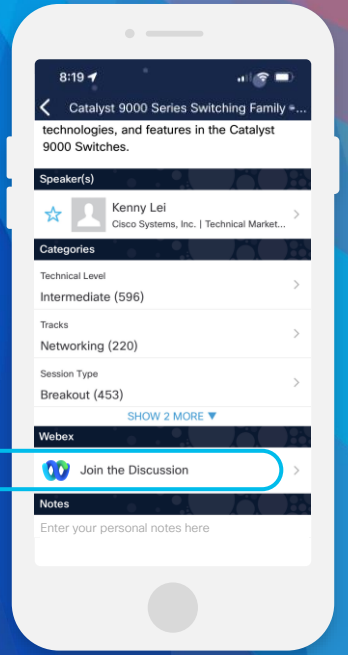

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Agenda

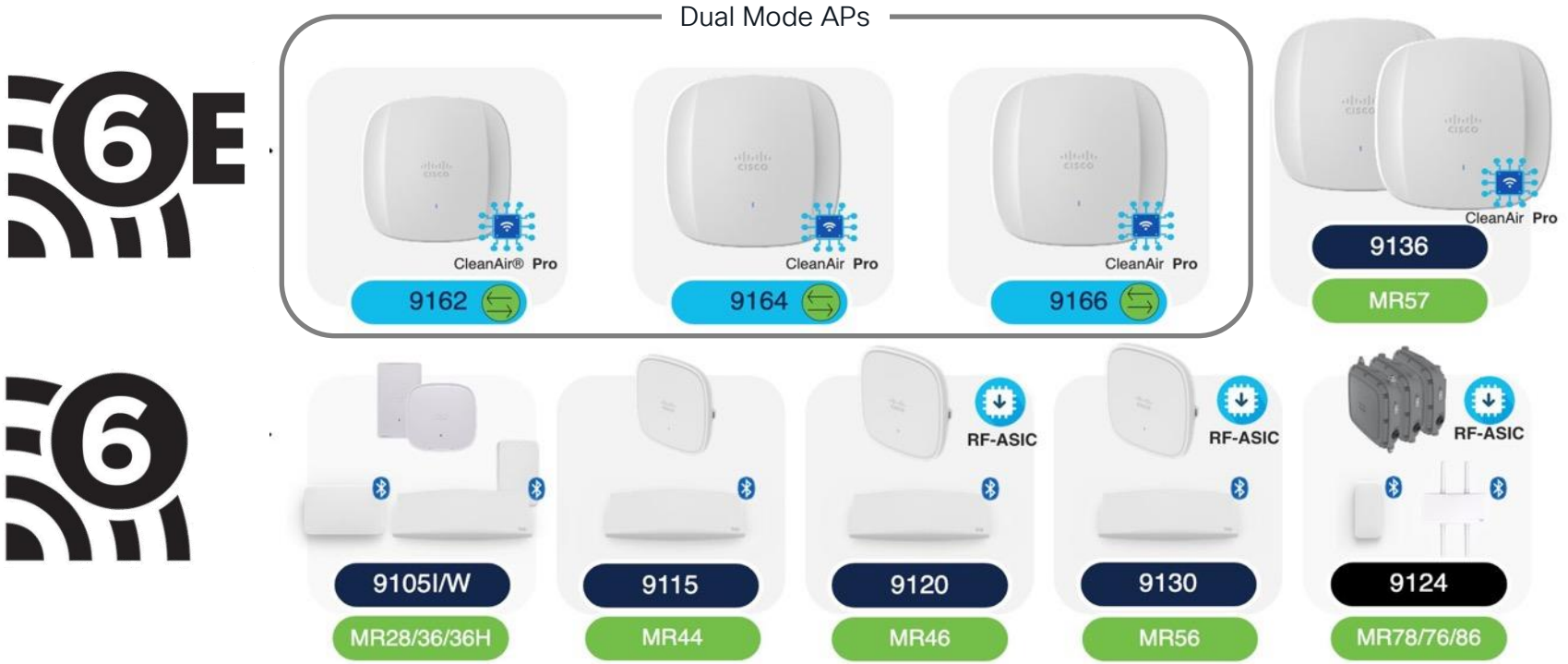
- Wi-Fi 6E Design Guidance
- Sustainability and Wireless
- AI-Ops - Cisco RF Excellence
  - AI Enhanced RRM for All
  - AI-AutoRF
    - AI Channel Planning
    - Auto Busy hour
- Catalyst Feature Update
- Catalyst C9104 Stadium Antenna
- Deploying CW9166D1

Wi-Fi 6E Design Guidance

Best Practices

cisco Live!

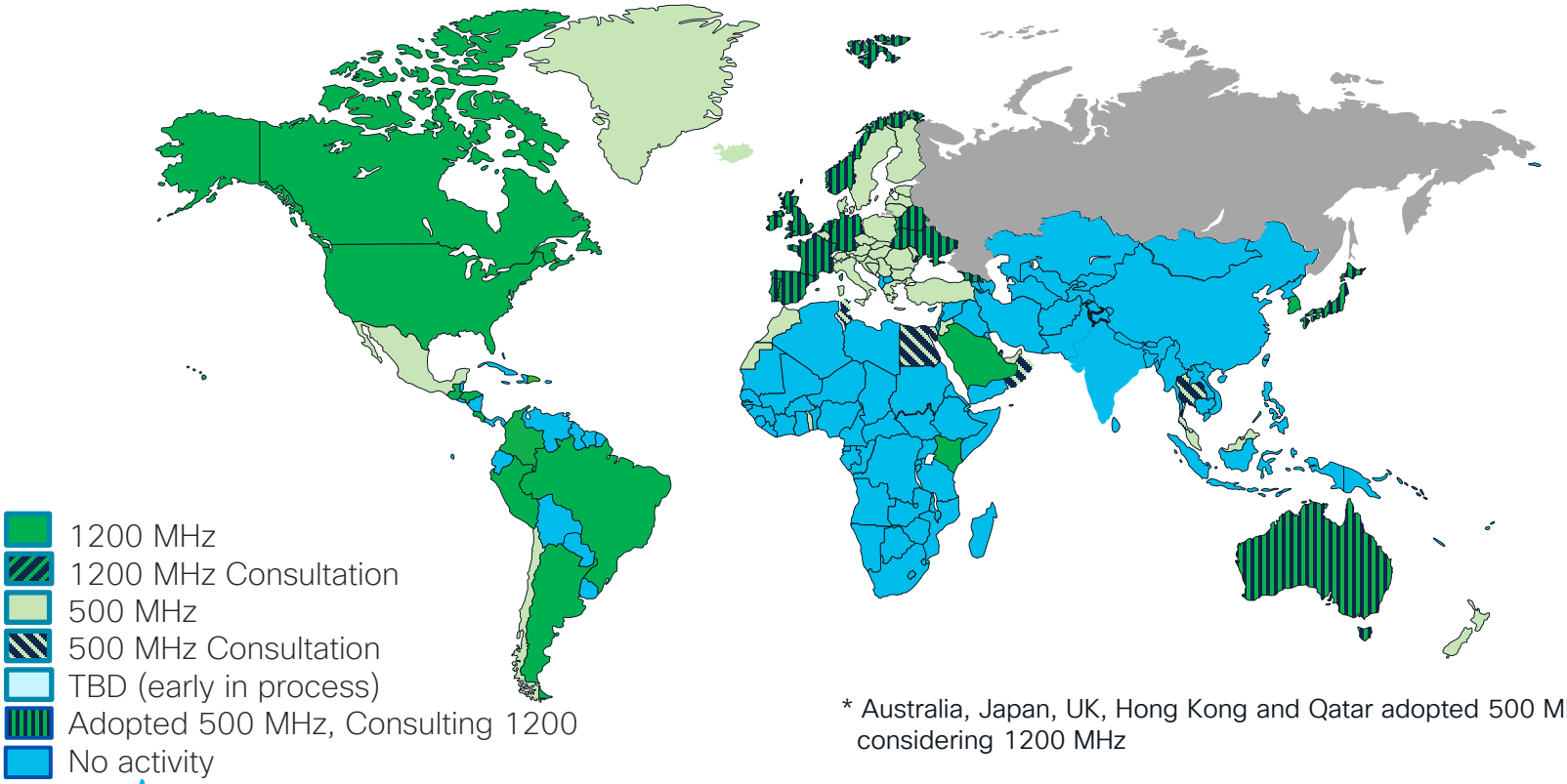
Wi-Fi 6 & 6E Access Points



Management mode can be changed

Global availability of 6 GHz band for Wi-Fi

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



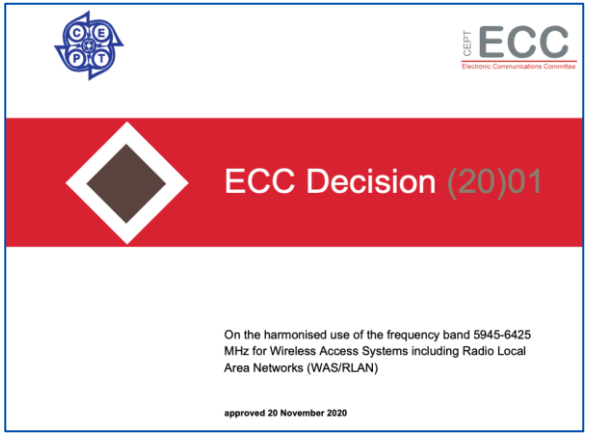
* Australia, Japan, UK, Hong Kong and Qatar adopted 500 MHz and now considering 1200 MHz

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*

Mode	Country (Frequency Range MHz)	Max Tx Power EIRP AP (dBm)	Max Tx Power EIRP Client (dBm)	Max PSD EIRP AP (dBm)	Max PSD EIRP Client (dBm)	Max EIRP
	FCC (5925-7125)	30	24			
	ETSI (5945-6425)	23				
	UK (5925-6425)					
	S Korea (5925-7125)					
	Mal					
					-1	
			24	5	-1	
		30	24	5	-1	
		24	24			
	(5925-7125)	30	24	10	10	
	ATU (5945-6425) (Kenya/Uganda/Congo/Niger/Ghana)	23	23	10	10	
	Morocco (5945-6425)	23	23			
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	FCC (5925-7125)	30	24	5	-1
	ETSI (5945-6425)	23	23	10	10
	UK (5925-6425)	24	24	11	11

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

Summary 6GHz Tx Requirements

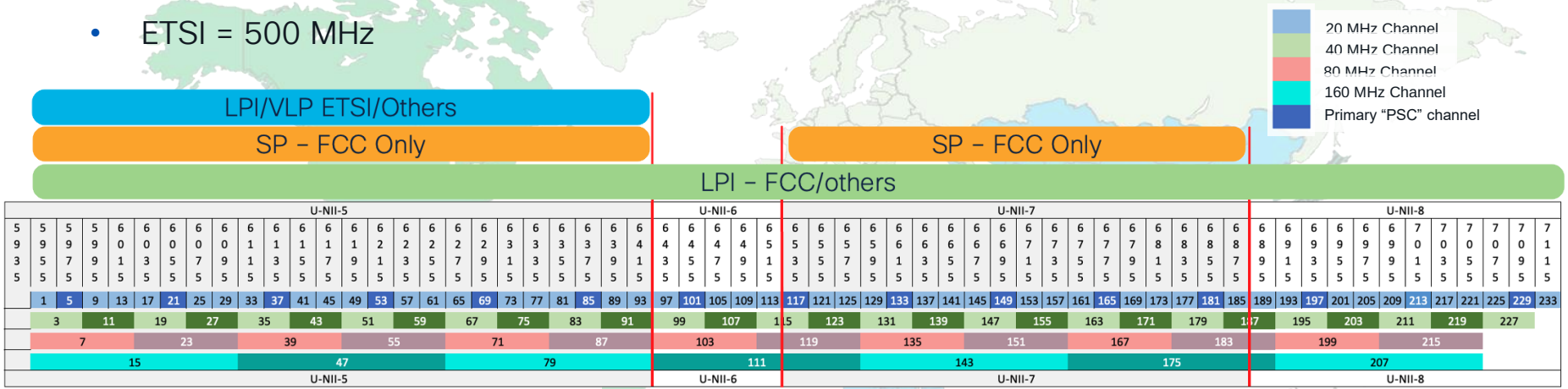
- Breaking down the PSD Values vs Max TX EIRP
  - FCC = 3 dB more power per channel width doubling and MAX TX EIRP of 30 dBm
  - ETSI/UK = PSD value = MAX TX EIRP at 20 MHz, remaining channel widths = Max TX EIRP

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

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

The new 6 GHz band :

- Two main proposals being reviewed or accepted by world regulators
  - FCC = 1200 MHz
  - ETSI = 500 MHz



59 FCC, 24 ETSI @20 MHz

29 FCC, 12 ETSI @40 MHz

14 FCC, 6 ETSI @80 MHz

7 FCC, 3 ETSI @160 MHz

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

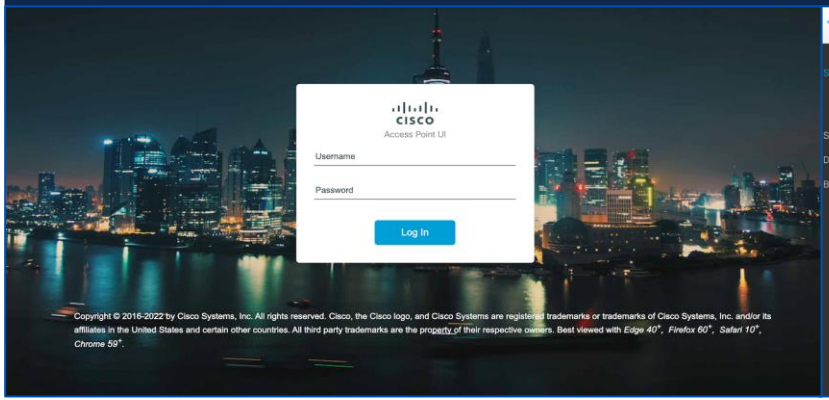
1. Change AP to site survey mode > exec command “ap site-survey”

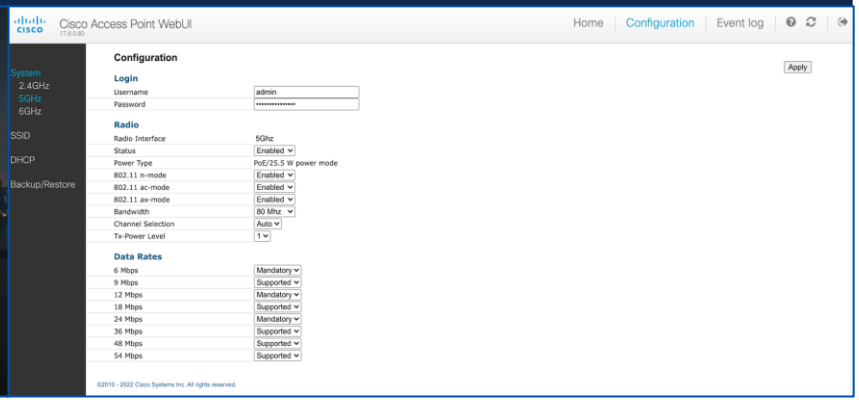
```
C9136#ap ?
  capwap       Switch to CAPWAP AP type
  site-survey  Switch to Site Survey AP type
```

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*)

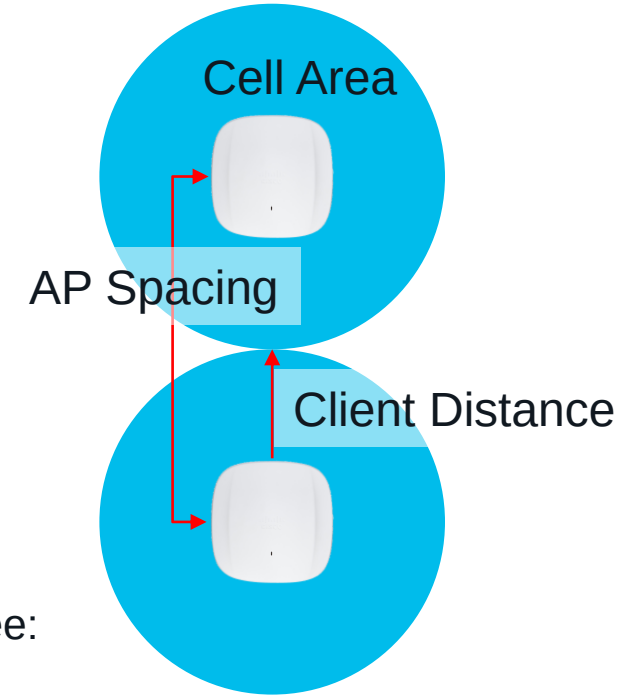




Dimensioning 5 GHz

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

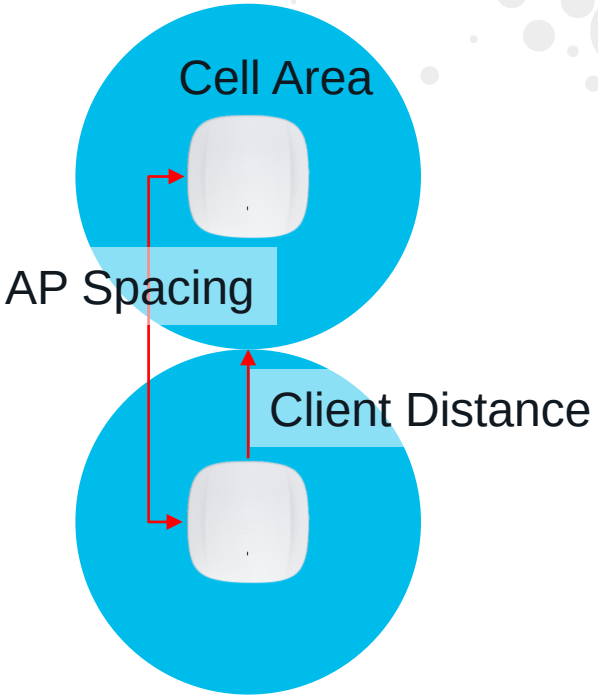
Cell Edge/ Clients 20-25 feet (6-7.5 meters)



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

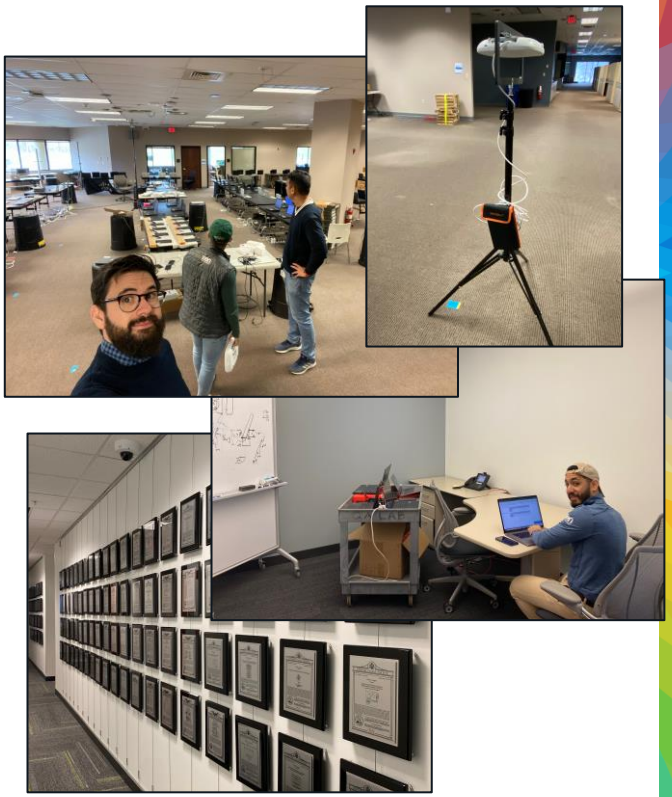
5 GHz Design Considerations

- Most modern Carpeted Enterprise 5 GHz Wi-Fi are installed at an AP Density between 1.2-2K f^2 /110-185 m^2
- 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.



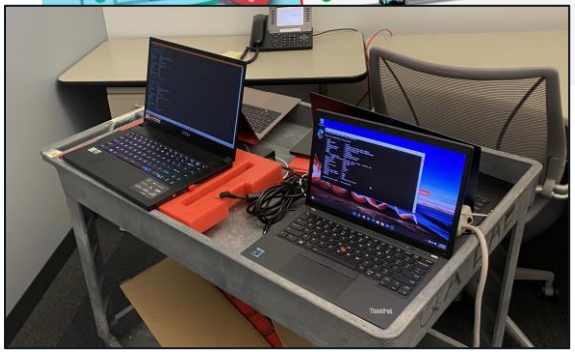
What we Tested

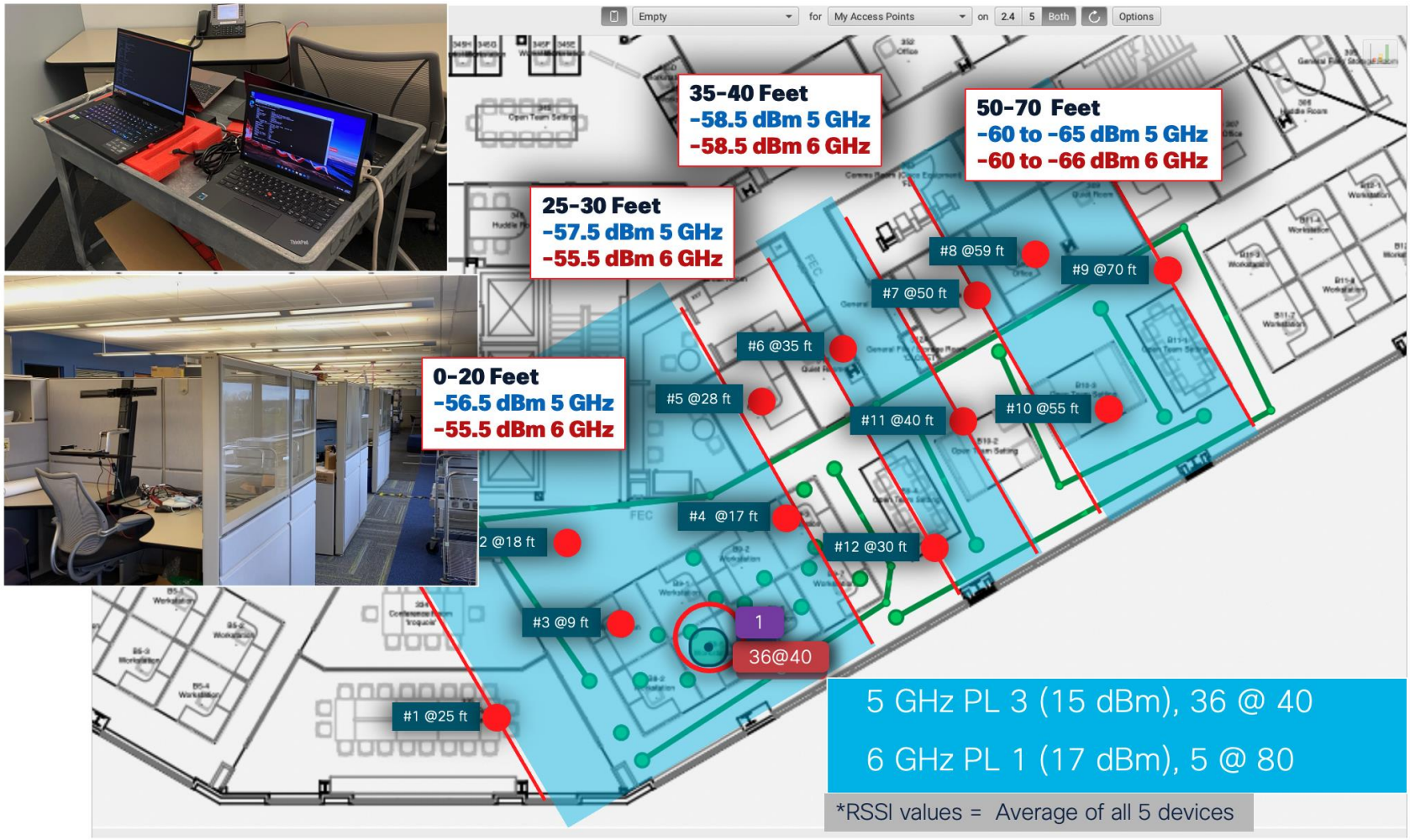
1. Propagation for 6 GHz as it compares to 5 GHz propagation – Using Clients
   - Use clients to record RSSI @ 5 and 6 GHz measuring at 12 points across the Richfield, OH Cisco offices
   - Compare 5 GHz and 6 GHz readings from each device at each point
2. Compare Ekahau AI-Pro Site Survey/Sidekick 1 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



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**

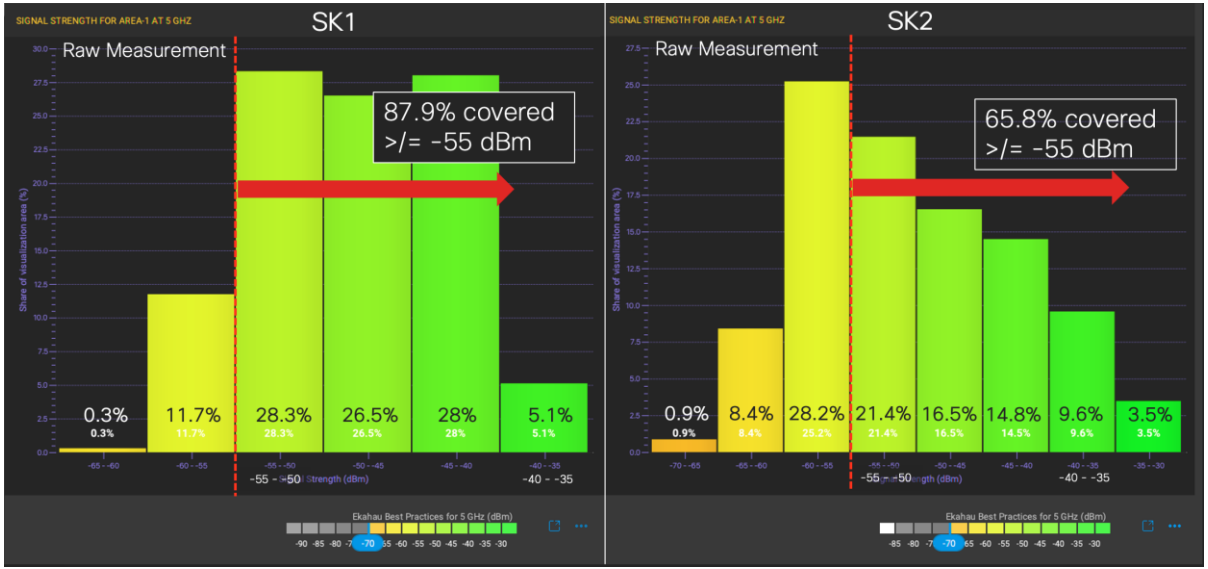
- *Conclusion 1 –*
  With an appropriate power offset (~2 dB), 5 and 6 GHz LPI Cells can be made co-resident at normal Enterprise Densities.

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

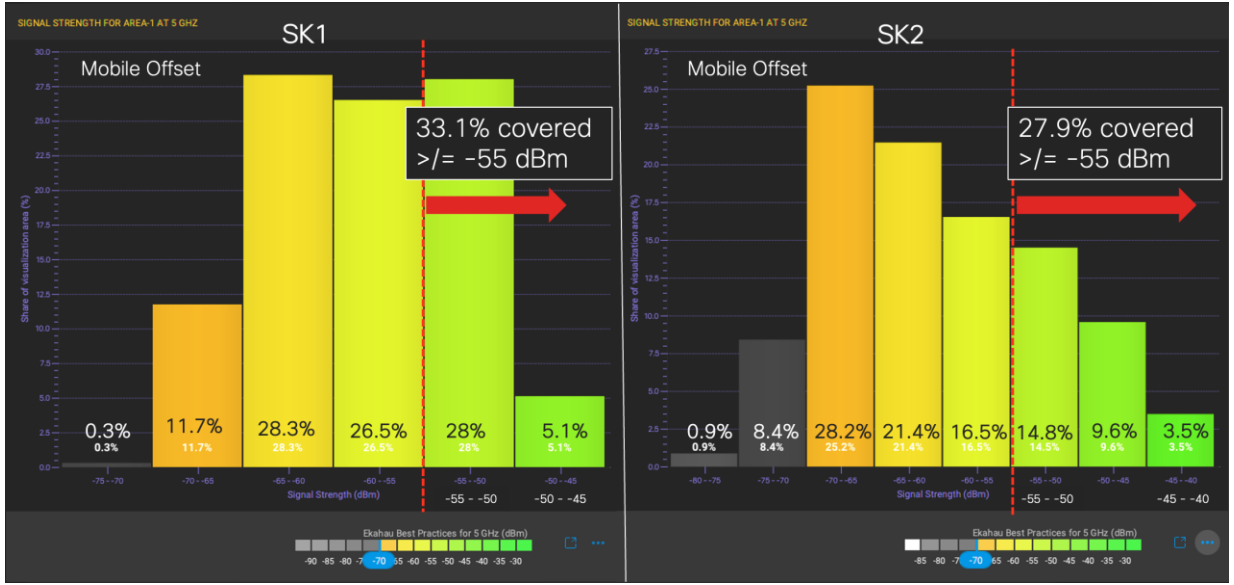
How does the Ekahau SK1 and SK2 compare?

- Comparing measurements from both devices shows relative sensitivity of each radio
- Its important, you will probably have to compare older SK1 data with SK2 data some day
- The Raw measurements differ significantly
- Sidekick 1 see's 22% more coverage @-55 dBm in the same Area, with the same AP
- Test equipment can be a lot more sensitive than the clients



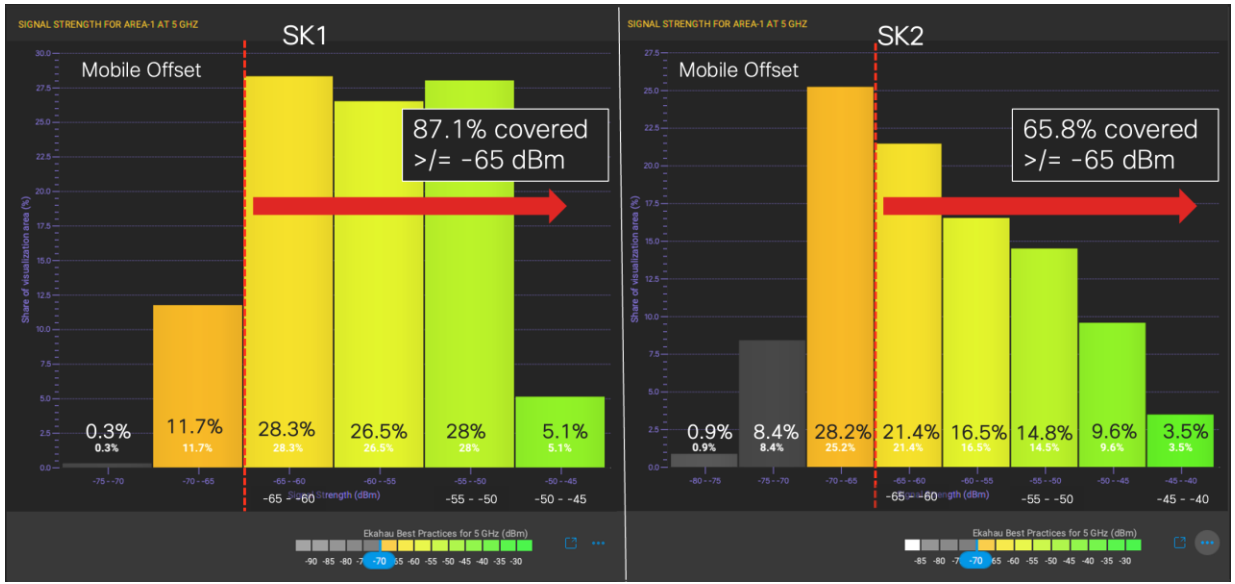
Comparing W/ Mobile Device View Mode

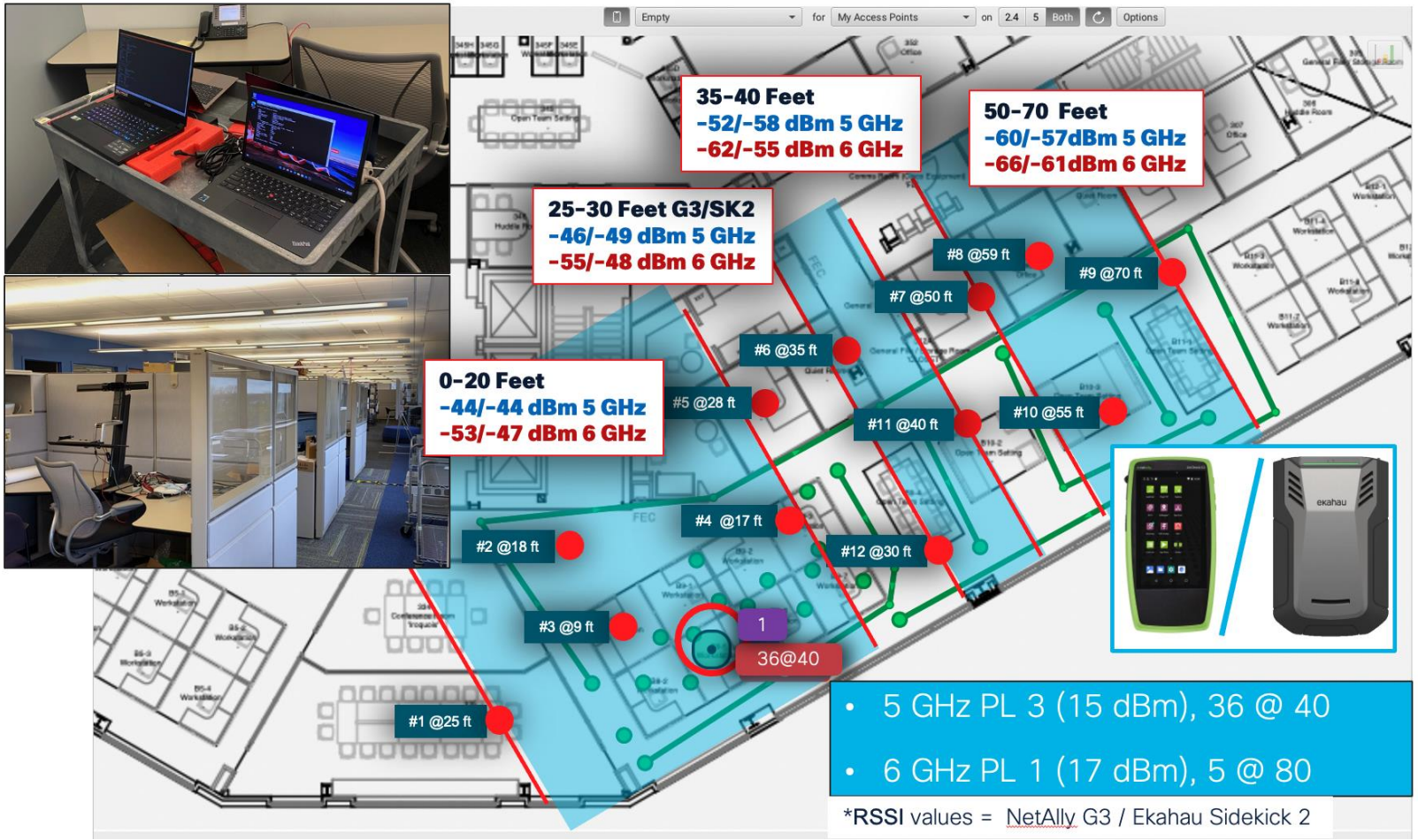
- Ekahau AI Pro offers a “View as Mobile device” mode
- This offsets the radio sensitivity and matches it to what a consumer device is likely to see
- Visualizing the coverage at -55 dBm with Mobile mode enabled looks closer between the two samples



Comparing W/ Mobile Device View Mode

- But what if we move this back to the normal survey value we want of -65 dBm
- Again, we see that the SK1 is more sensitive than SK2
- This is a good thing actually – SK2 is truer to reality for a client





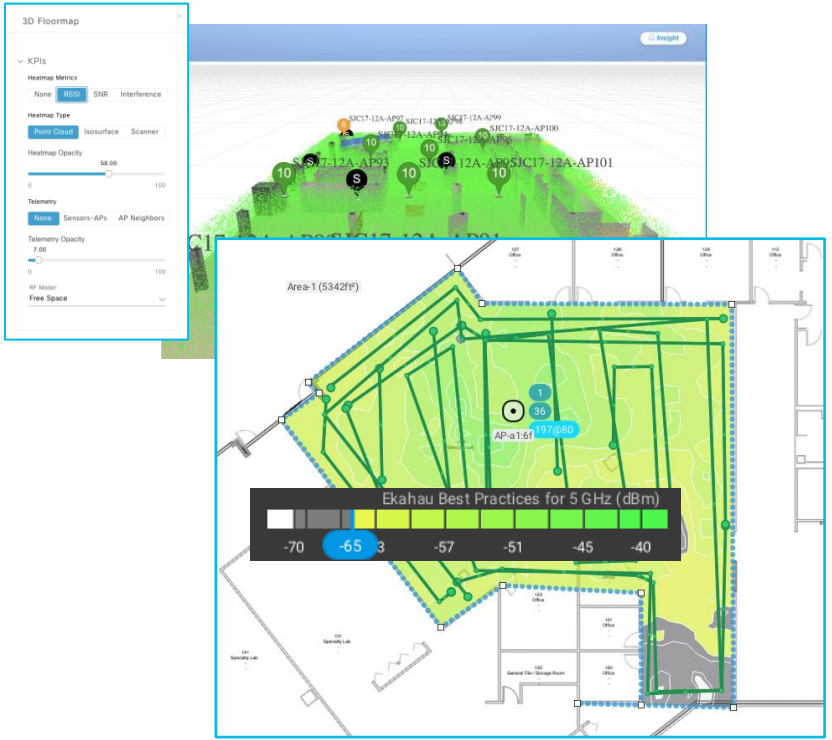
Raw Data – Client/Test Set RSSI

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

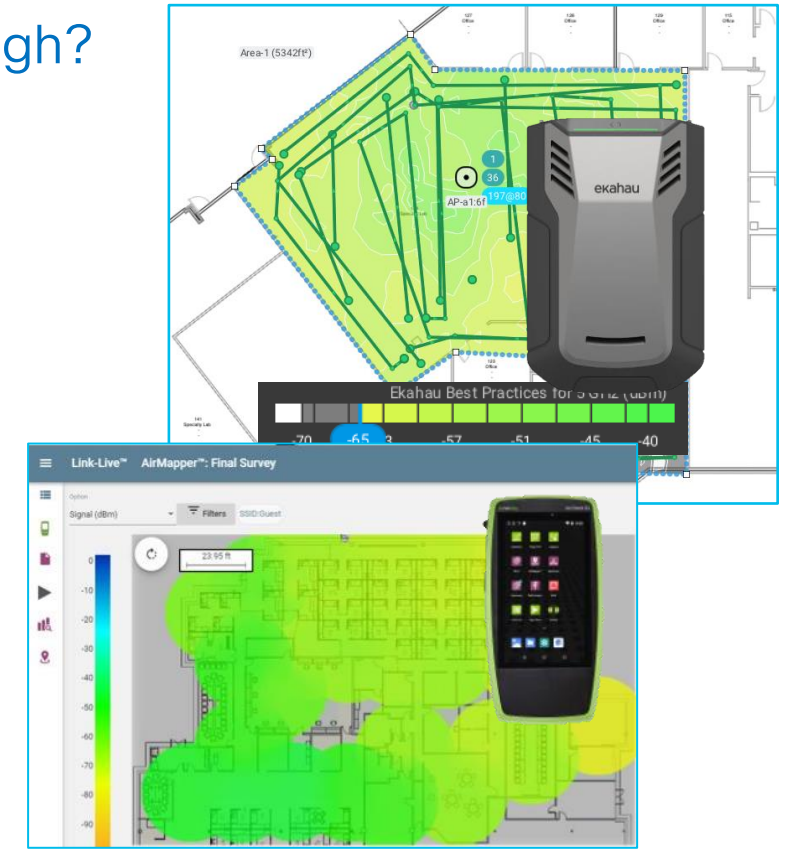
Predictive vs Measured
When is good enough, good enough?

- 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 visualized in a heatmap as coverage
- Available tools can be quite sophisticated and provide good visualizations



Predictive vs Measured
When is good enough, good enough?

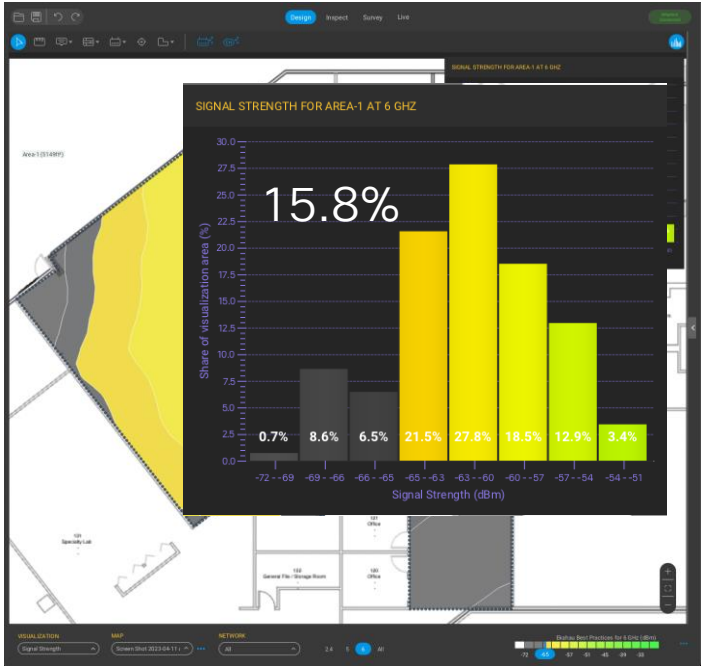
- A Measured Site Survey is an actual measurement of the RF Coverage in each space
- Measurement tools range from off the shelf client devices to specialized scanning radios and applications
- Ekahau and NetAlly both have Instruments specifically for measuring Wi-Fi at 2.4 => 6 GHz



How to Calibrate
Ekahau AI Pro 11.2

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



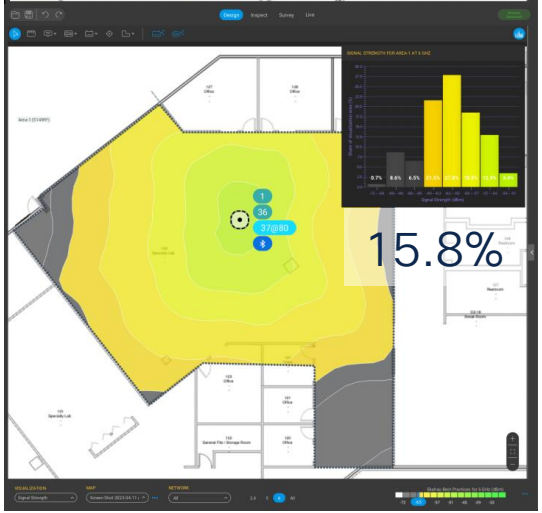
How to Calibrate
Ekahau AI Pro 11.1.5

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

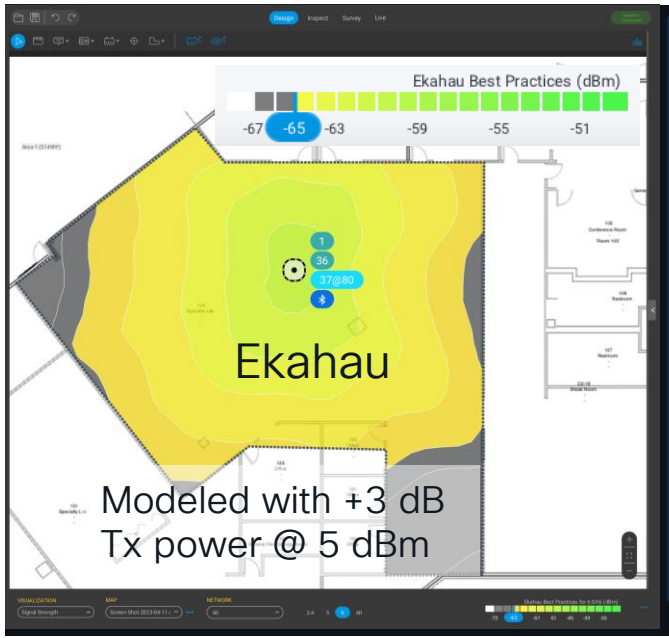
Measured

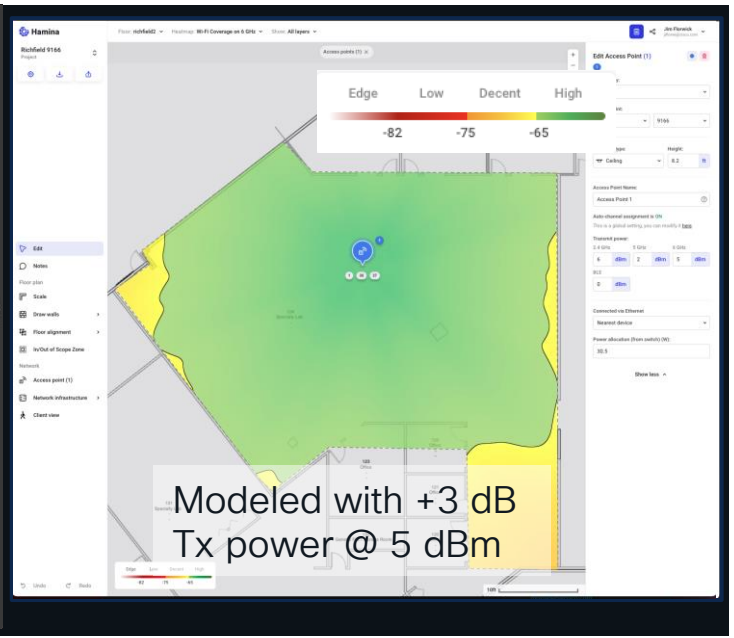
Simulated



Referencing Predictive Models
Ekahau AI Pro 11.1.5 And Hamina Wireless

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





A Table of Offsets

*As an example only mileage may vary

AP Model	Ekahau AI Pro v.11.1.5		Hamina Wireless		5100 ft² /475 m² open office
	5 GHz Offset/dB	6 GHz Offset/dB	5 GHz Offset/dB	6 GHz Offset/dB	Measured@ 5/6 GHz
C9136	+2	+/- 0	+4	+.5	3 /4 dBm 5 / 6 dBi
MR57	+/-0	+2	+/-0	+3	2/2 dBm
C9162	+7	+6	-1	+3	2 / 5 dBm 6 / 6 dBi
C9166i	+5	+3	+1	+3	2 /2 dBm 5 / 6dBi

- *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 Analyzer 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.

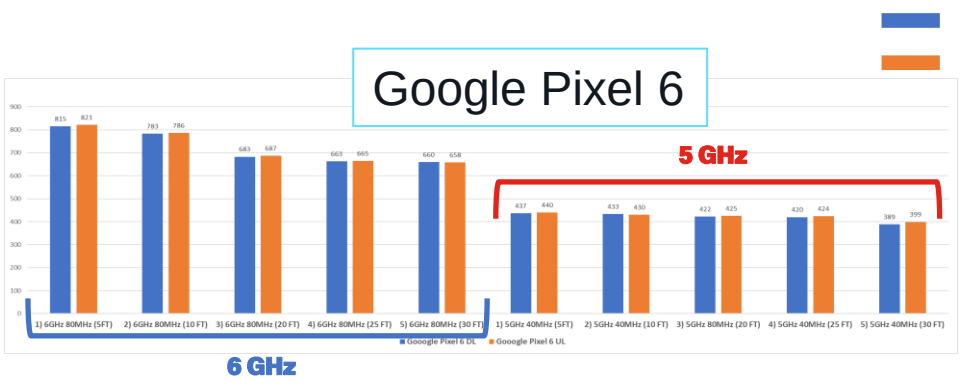
It does have Manual offsets that can be entered in dB to compensate – BUT – Calibrate

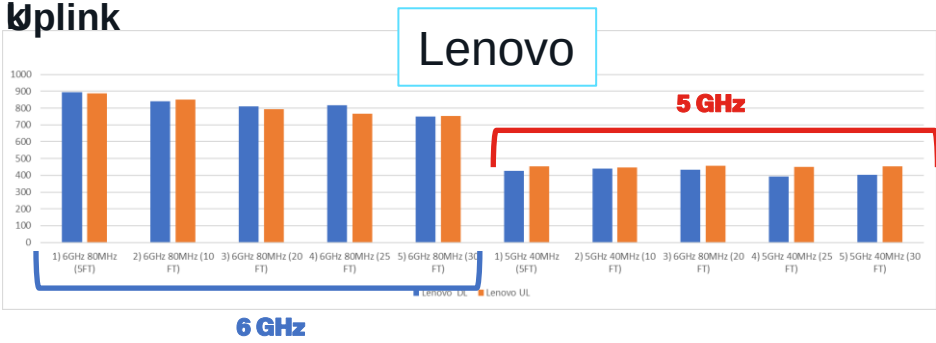
See BRKEWN-2024 – Anand Gurumurthy Architecting
Next Generation Wireless Networks with Catalyst Wi-Fi 6E AP's

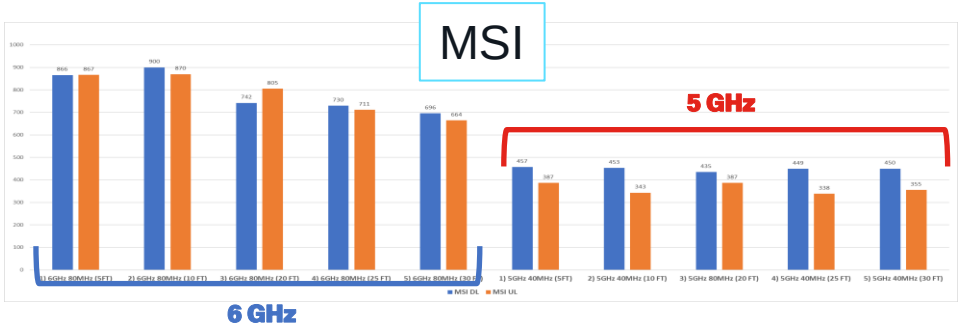
2. Range vs Rate Performance

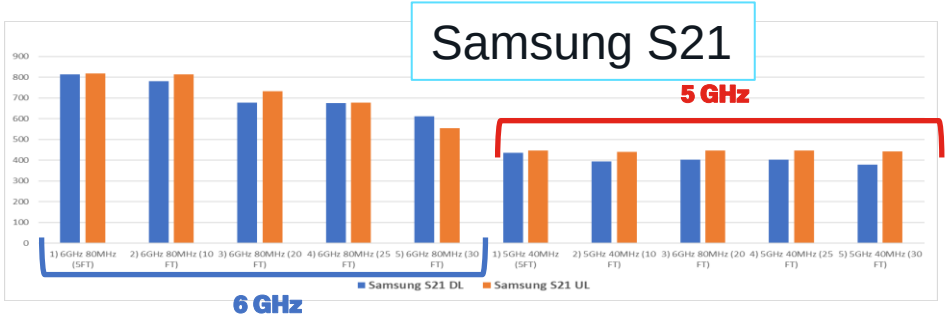
- At Enterprise densities (1.2-2K f^2) Cell boundary is ~25 Feet max from AP
- Testing 5 clients TCP throughput @ 5 and 6 GHz
- Test Range uses Cisco C9136 -B configured for 5 GHz PL 4 (17 dBm EIRP), chn 36@40 and 6 GHz PL 2 (20 dBm EIRP), chn 5@80
- Data gathered at 5,10,20,25, and 30 foot distances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

UL and DL compared – 6 GHz and 5 GHz









- *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 $m^{2)}$

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?

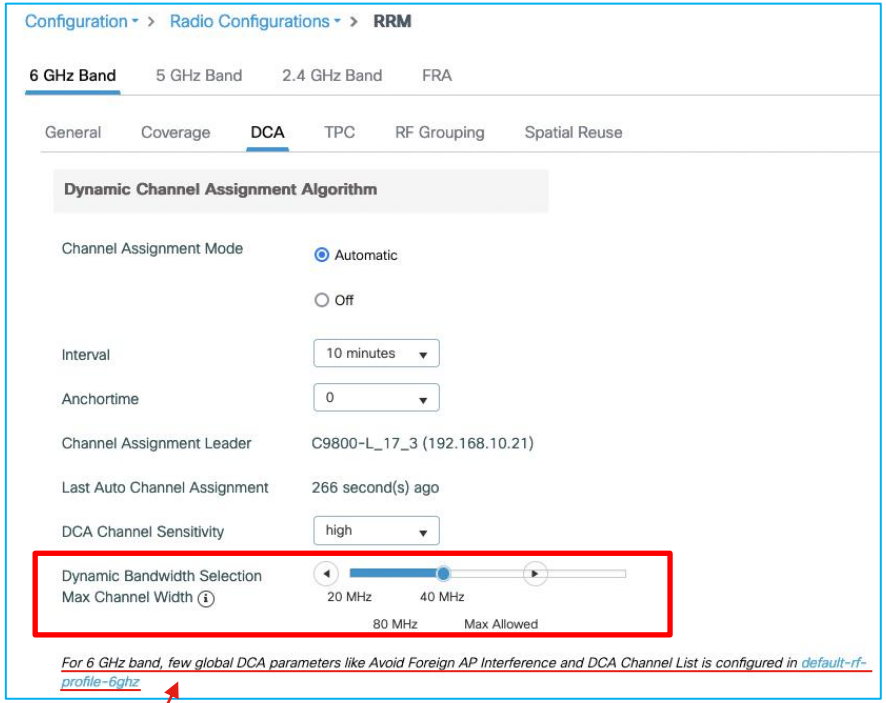
A2: Yes. *Assuming 1.2 – 2k f^2 average AP density, carpeted office normal ceiling (3 m /10 ft)

Q3: If network is less dense 3-5 f^2 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.

Cisco RRM and 6 GHz

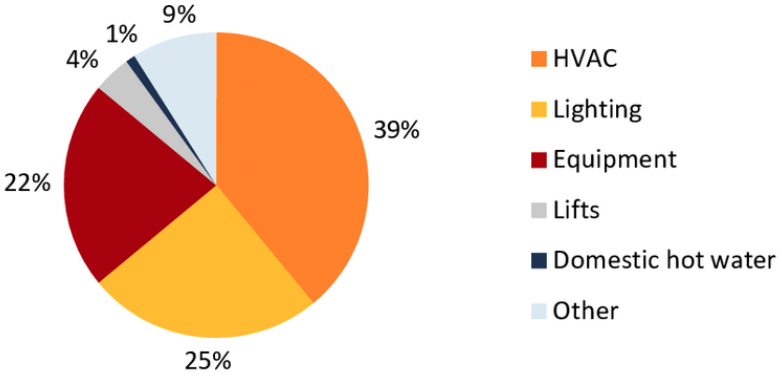
- RRM for 6 GHz – Channel width will be managed by DBS. There is only A “Best” configuration. You can limit the max width allowed.
- In some regulatory (FCC) power is regulated by the channel bandwidth – which makes this a more interesting problem to solve
- In FCC and other 1200 MHz, DBS (Dynamic Bandwidth Selection) will assign 80 MHz (14 channels and Max EIRP of 24 dBM)
- Regions with 500 MHz, DBS will assign 40 MHz (12 channels and Max EIRP 23-24 dBm)
- Other DCA settings – interference thresholds etc – have been moved to the RF Profile settings

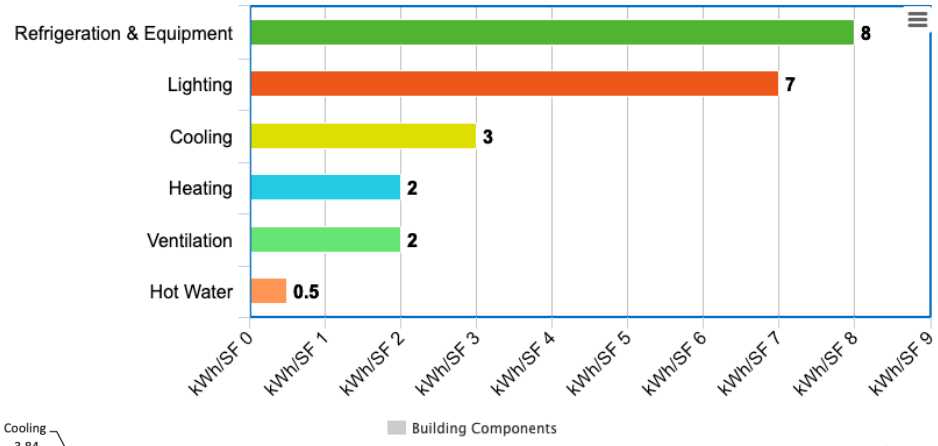


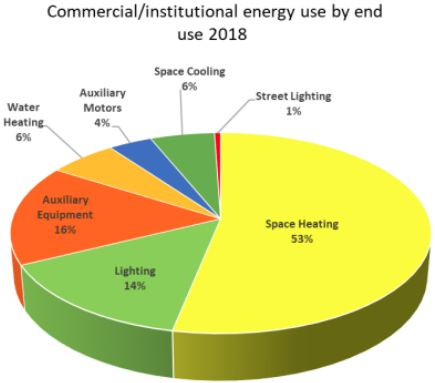
For 6 GHz band, few DCA parameters like Avoid Foreign AP interference and DCA Channel List is configured in default-rf-profile-6ghz

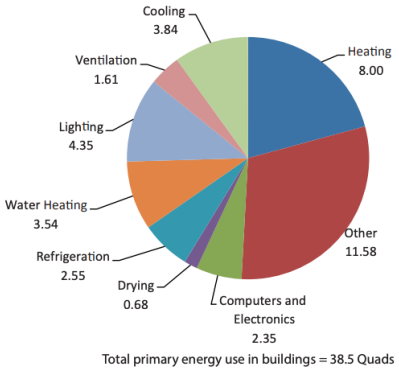
Sustainability

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









Different views of Energy consumption breakdown in office building

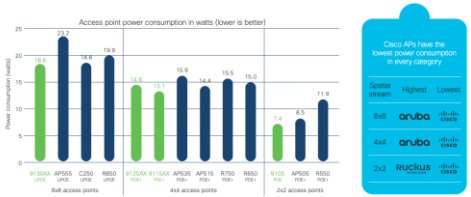
So...

1. In order to provide some tangible energy savings to customers, the network needs to help save on other resources like HVAC and lighting >
2. 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)
3. Need to maximize 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



Source: Miercom

- 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 Power Save 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 maximize your energy savings

MAX savings

Why not just turning off the radios?

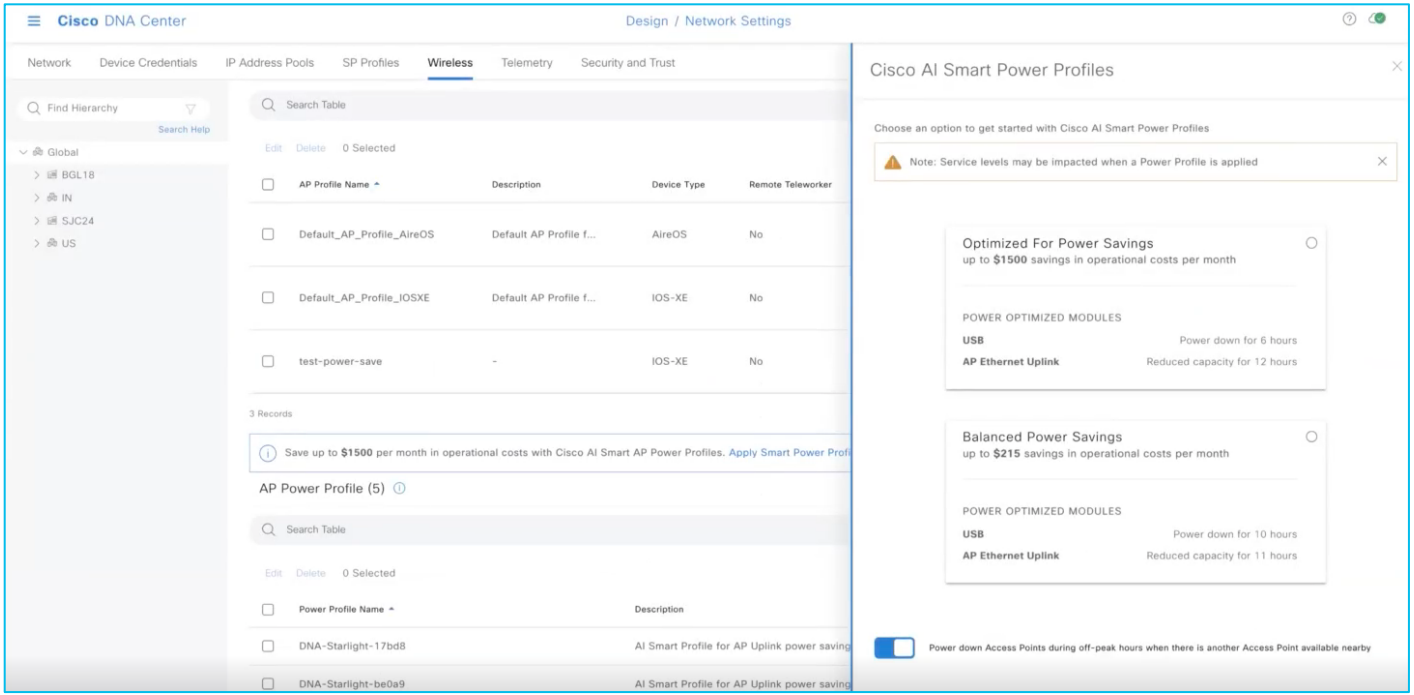
- Turning off all radios with “ap name <> shutdown” command gives 0.5-0.8 W max saving (I guess it depends on AP model, see next slide)
- C9164 AP in idle with radios up:

```
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
```

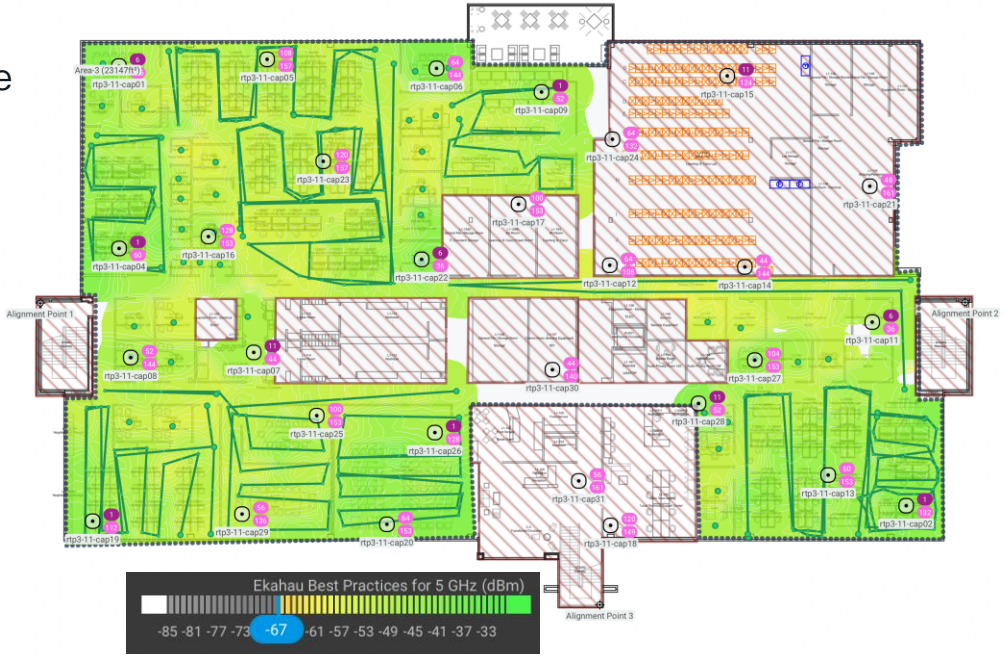
AI Power Profiles – Hackathon winner



Designing for Sustainability

Capacity vs Coverage

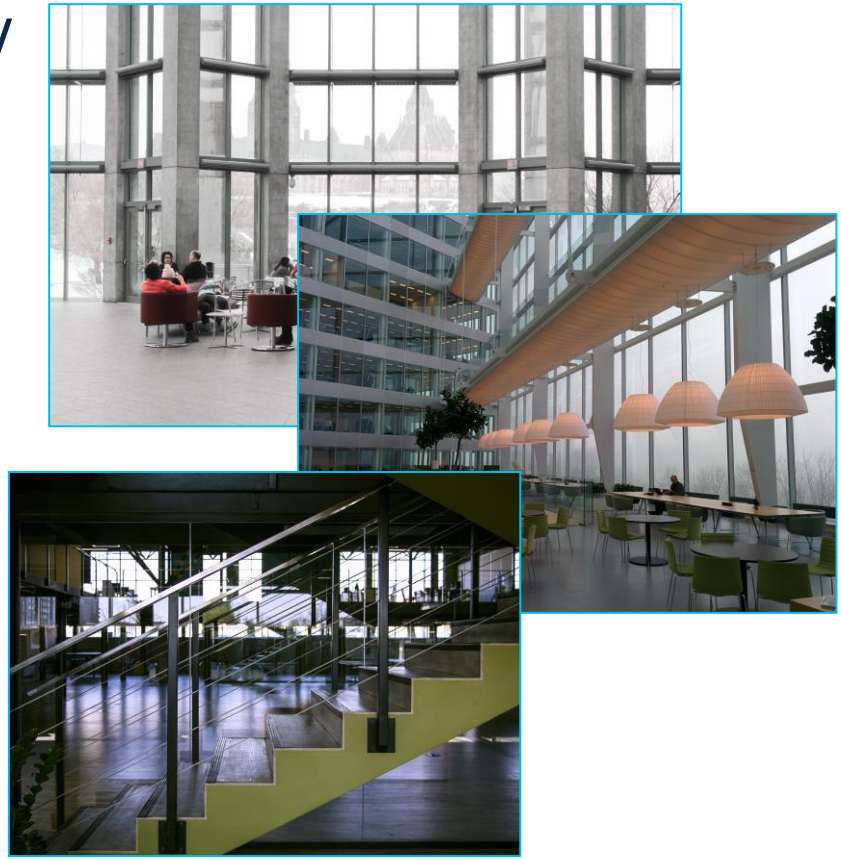
- Enterprise networks are built to provide capacity over coverage
  - An Access Point (AP) represents a finite amount of bandwidth
  - That bandwidth will be shared with every device on that cell
  - Multiple Cells are needed to handle the numbers of users required ***during business hours***
- What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



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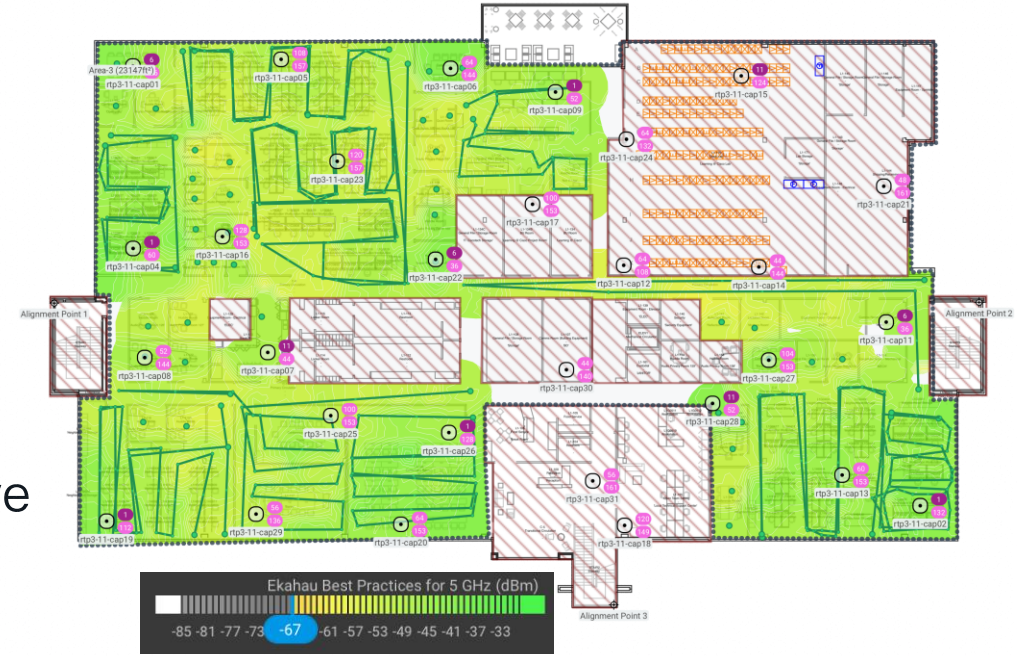
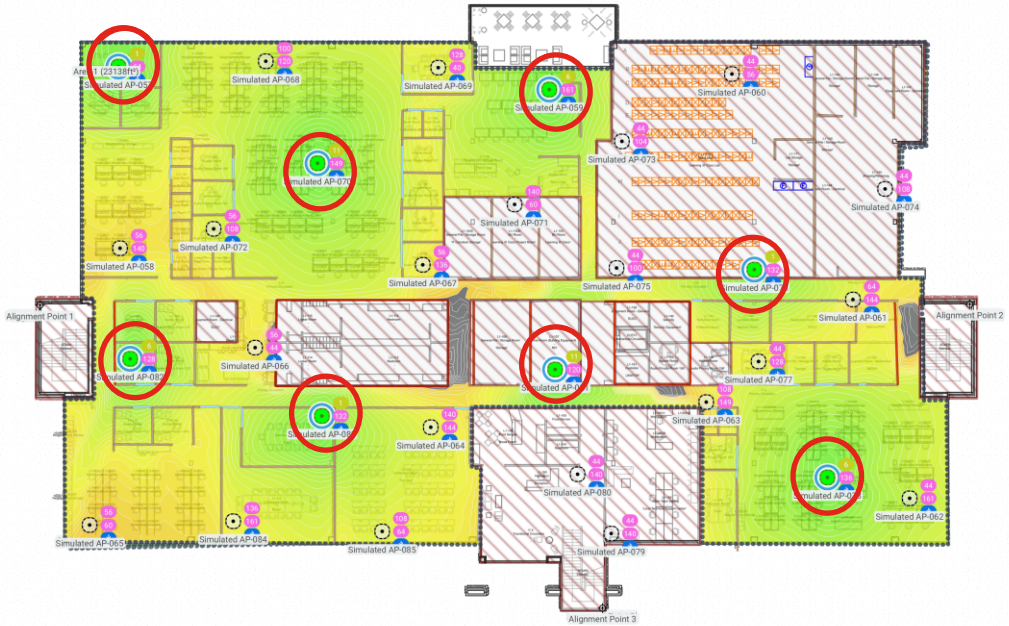


Designing for Sustainability

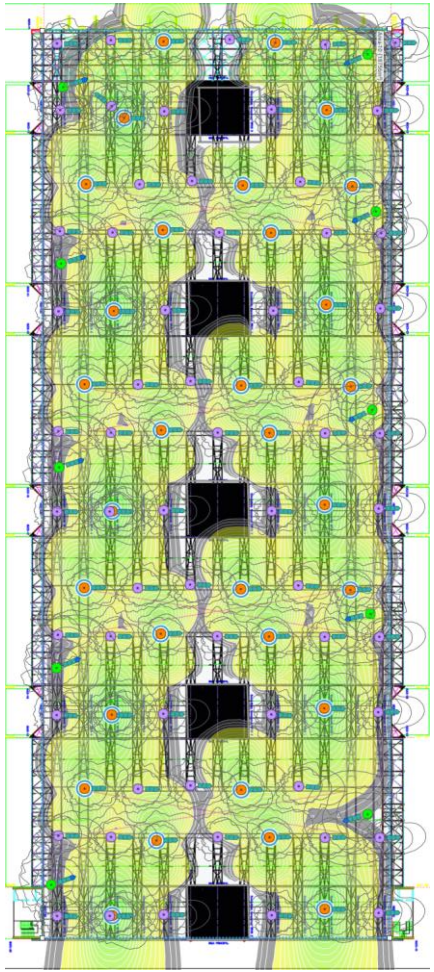
Capacity vs Coverage

- Survey reveals a normal high-density enterprise office space, well covered at -60 dBm
- 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 isn't adequate
- Increasing the power to 14 dBm provides coverage at -67 to near 100%, with a 70% fewer APs



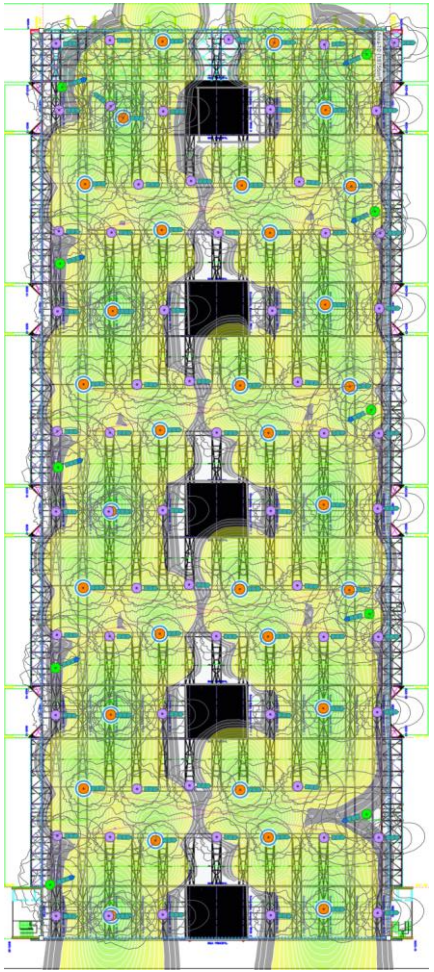
At Scale Sustainability = Versatility

- A Prime opportunity to optimize 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.
- Shows of different sizes do not need all of the capacity that can be provided, its possible to re-configure the C9104 to cover in different densities without having to move the antennas with careful design.



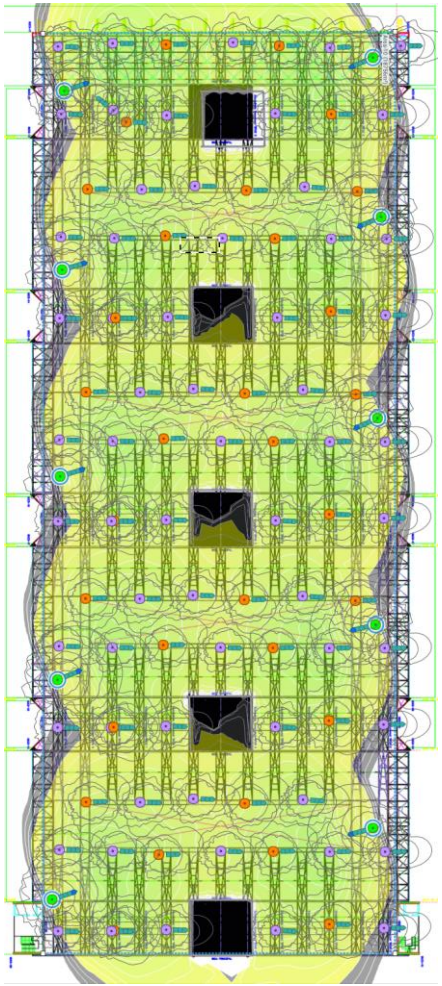
At Scale Sustainability = Versatility

- By reconfiguring (Software) the beamwidth to 20 degrees off center for interface 1 and 2, (Orange AP's)
- Most of the hall is well covered with 31 APs each supporting 2x 5 GHz interfaces
- For reference, shutting off an AP saves ~15 W at rest. Shutting of a single interface only saves roughly .8 watts.
- Relying on dual 5 GHz to back fill for another AP and shutting it off, nets a much higher return



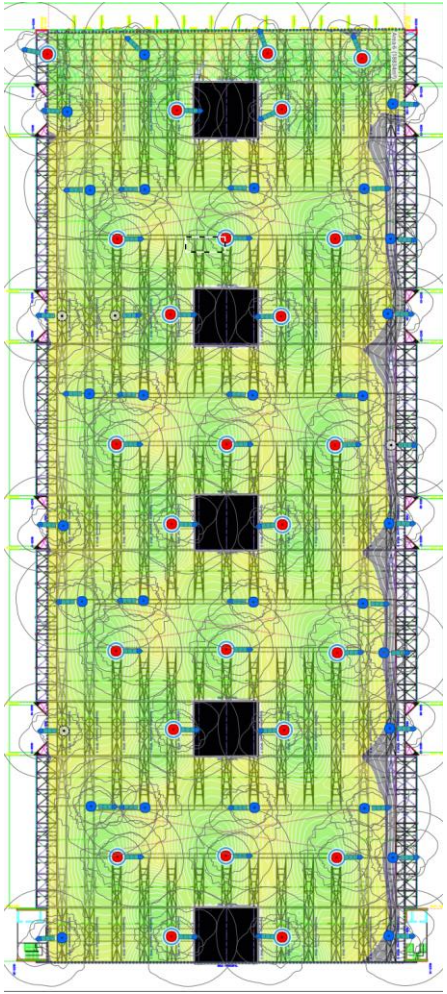
Sustainability – Off Peak Coverage

- 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.



Next Steps??

- See BRKEWN-2043 Simone Arena from this year's CL (was on Monday) Saving Money and Energy with Cisco Wireless Networks
- Be creative
- Look for more on this – lots more

So…

- See BRKEWN-2043 Simone Arena - *Saving Money and Energy with Cisco Wireless Networks*
- Be creative
- Look for more on this – lots more

AI-Enhanced RRM
AI-Powered Auto RF
Intelligent RF Optimization

Pain points with enterprise Wi-Fi
Expectations vs. reality

Expectations of Wi-Fi

- It's plug and play
- Gigabit speeds
- Always full bars
- Seamless experience

Nature of RF

- Dynamic
- Interference
- Noise
- Lots of users
- …

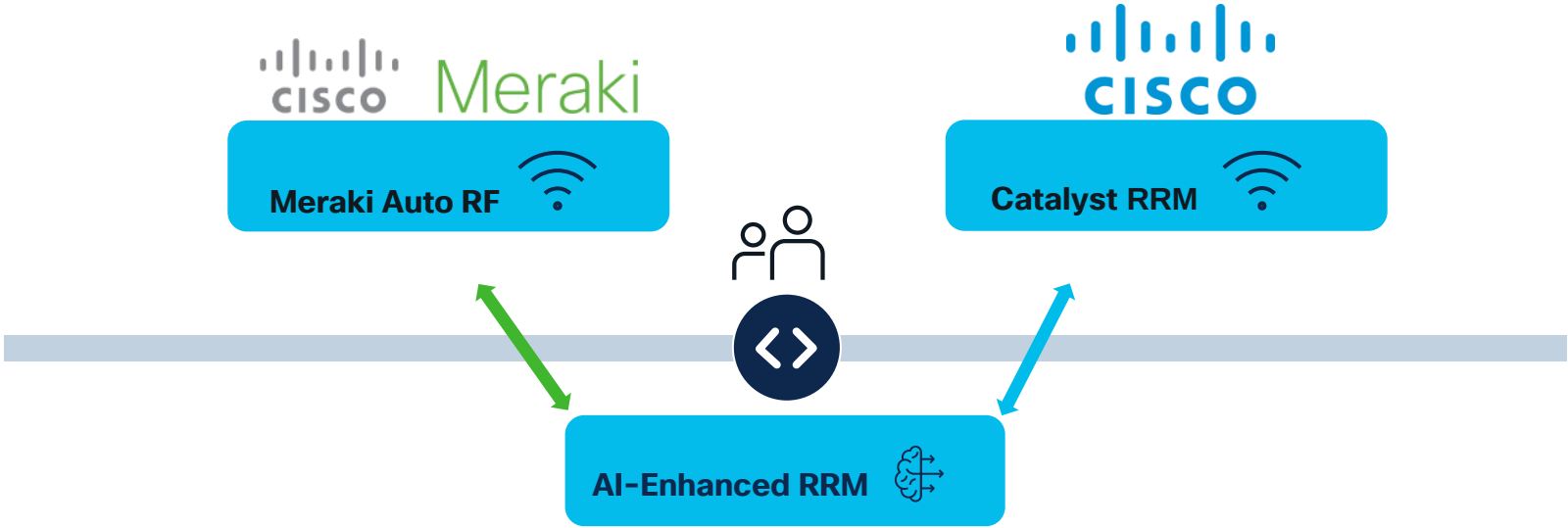
Reality of Wi-Fi

- RF tuning required for optimal performance
- 10 Mbps? Lucky you!
- Sticky clients
- Bad client drivers
- Random disconnects

What mitigates
RF pain points?

Radio Resource Management
Catalyst AI-Enhanced RRM
Meraki AI-Powered Auto RF

Customer Choices – Outcomes Matter Experience Matters



Cisco + Meraki = The largest and most comprehensive data lake in the industry

Cisco + Meraki = Every Vertical and Every industry segment

The benefits of AI-Power

First steps towards an intelligent autonomous network!

Maximize

efficiency with AI-driven optimizations

Reduce

interruptions by up to 50%

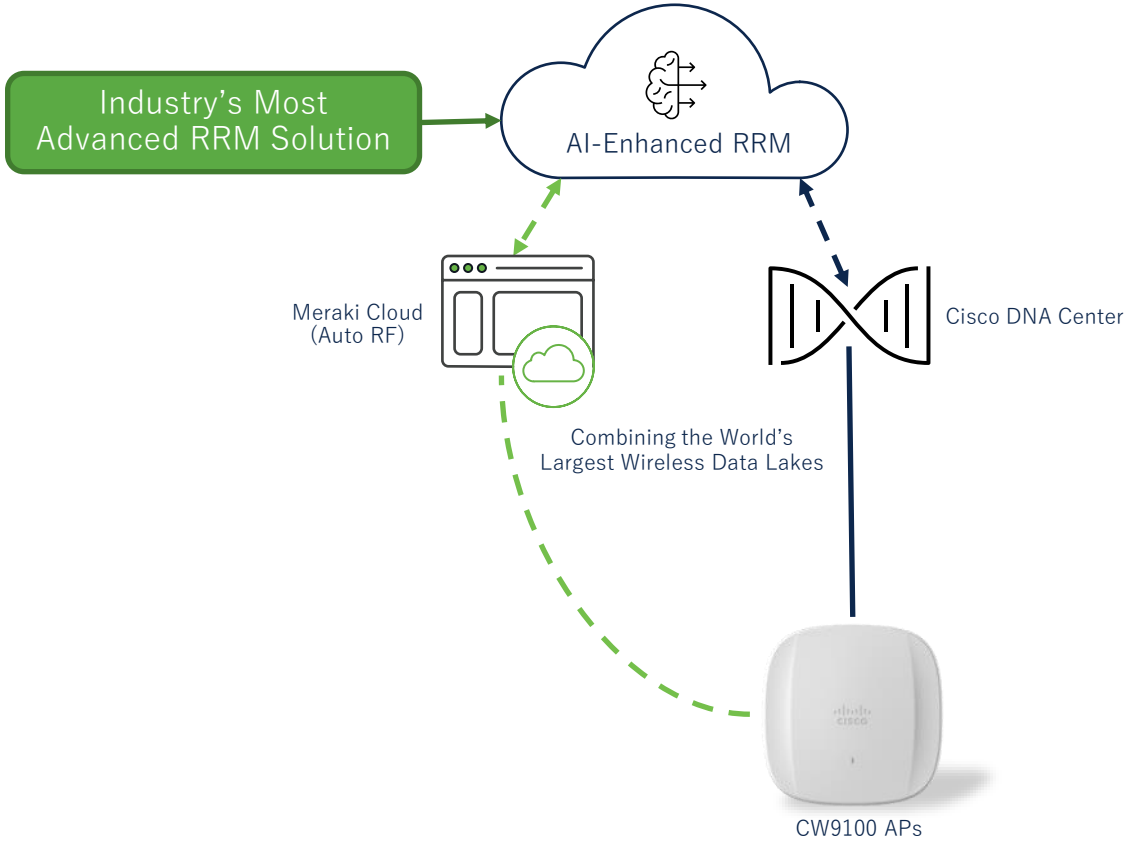
Minimize

channel changes in busy hours

In Progress

Maximize

Efficiency by integrating AI-Enhanced RRM



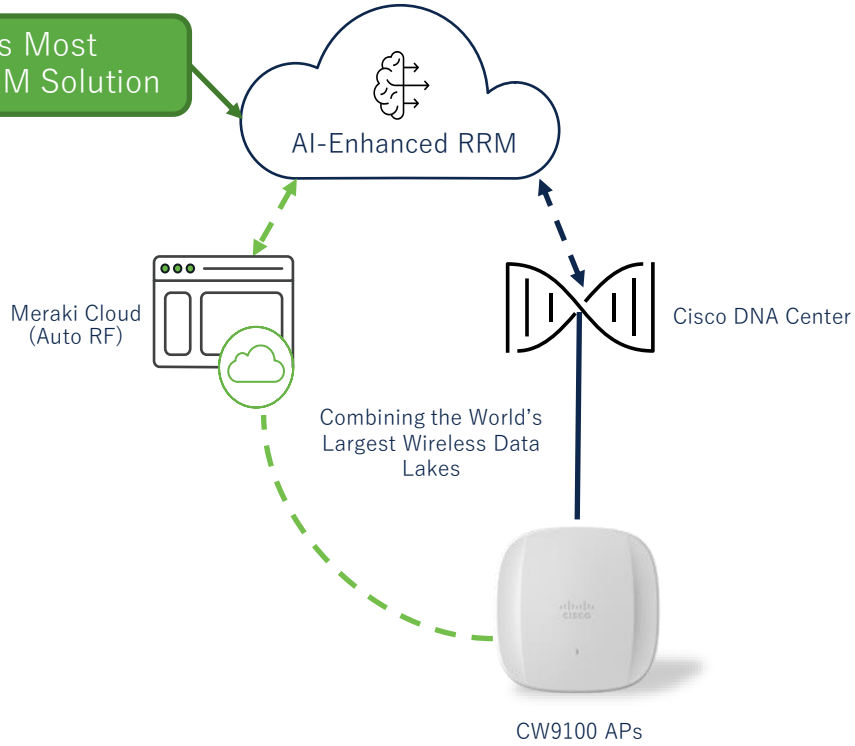
Integrating Meraki's Auto RF with AI-Enhanced RRM
Driving Cisco Meraki's RF Excellence Towards an Enterprise Vision

RRM North Star Vision

Cisco Wireless deployments regardless if it's Cloud or on-prem, must have capability to support wireless deployments of any scale and complexity.

Benefits and Outcomes

Customers will get a unified, and consistent RF automation and recommendations engine in hybrid, cloud and on-prem deployments.



Top 3 Priorities for Auto RF after Integrating with AI-Enhanced RRM Priority is focused on improving the end user's wireless experience

1 Trend Based RRM Optimization

Promotes RF Convergence Efficiency

Allows RRM to understand and avoid spikes within the ingested RF telemetry (e.g., nF), which allows for RRM changes only when needed, allowing a network to achieve system convergence more efficiently.

2 Flexible Radio Assignment

Mitigates Congestion, Increases Coverage

When optimal, change a radio's band between monitor/2.4/5 GHz or monitor/5/6 GHz. FRA will provide instant benefits to the network, especially in the 2.4 GHz band, where the spectrum is often overutilized.

3 Actionable RF Insights

Optimizes RF/RRM Configurations

Good wireless experience stems from a properly configured RF profile. RF Insights will use data-driven analysis to recommend to users the optimal RRM settings such as DCA channel list, DBS width, TPC threshold, and FRA enablement with can be inherited from AI-Enhanced RRM.

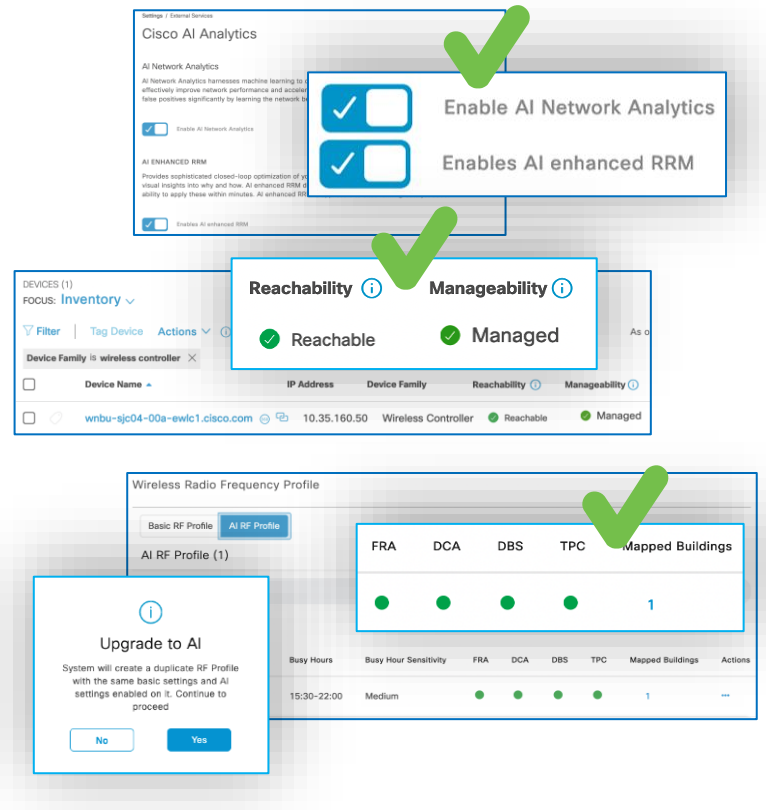
Legacy Controller based RRM vs AI Enhanced

Areas	Traditional RRM	AI Enhanced RRM
RF Telemetry Inputs	Snapshot [10 mins]	RF Trends [14 days]
Config Workflow	Manual [50+ RF Savvy knobs]	Automated (AI Assisted) [Minimal Config Knobs]
Segment Services	No [Cannot Segment within WLC]	Yes [Service Segmentation by Buildings]
Visualization	Controller UI [List View/ Does not group radios by site]	RRM Control Center [Group collocated radios by Building/Site]
Interrupt Cognizant	No [Reactive optimizations]	Yes [Scheduled RF Tuning]
Reward Based Decisions	No [Decisions based on composite RRM Metrics]	Yes [Maximize WCAE Performance Score]
Emulate What-If Scenarios	No [Doesn't support emulation mode]	Yes [RRM Simulator]
Troubleshooting	Complex [Requires multiple service logs from WLC/AP]	Simplified [Integrated One-Click Service Bundle]

Onboarding a Site to Cisco DNA Center

AI Enhanced RRM Onboarding

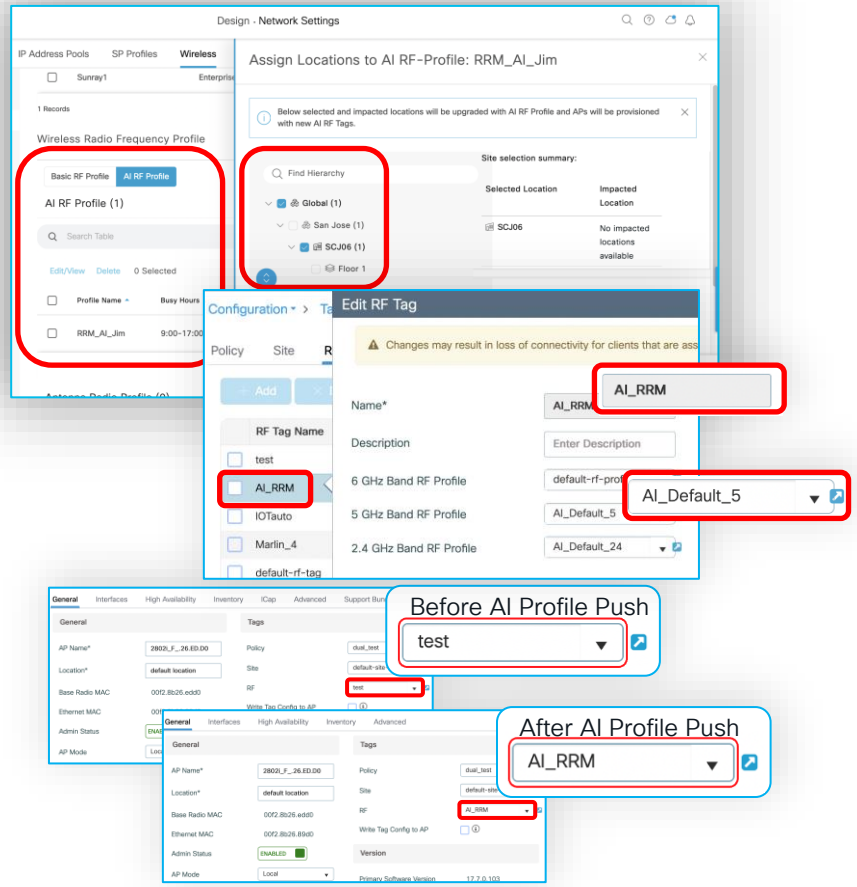
- Subscribe to the Cisco AI Analytics Cloud
  - Ad AI Enhanced RRM Service
- Add the Sites C9800 WLC and APs into the DNAc Inventory
  - Provision the Site C9800 WLC and APs
- Create and Assign an AI RF Profile to the controller/site (s)
  - When applied, the system creates a duplicate RF Profile with the same Basic Settings Enabled
  - Reverting, simply applies the Duplicate Basic profile (i.e. RF Tag) back to the WLC



Onboarding the WLC

AI Enhanced RRM Onboarding

- On the DNA Center console, Select the site to apply the AI Profile that was created
- When the site gets assigned, the AI RF Profile gets pushed to the WLC and replaces the legacy RF Tag/Profile
- All of the APs on the WLC are assigned the AI RF Profile (small interruption)
- All the sites on a controller must be assigned. A WLC can either run legacy RRM or AI Enhanced RRM but not both



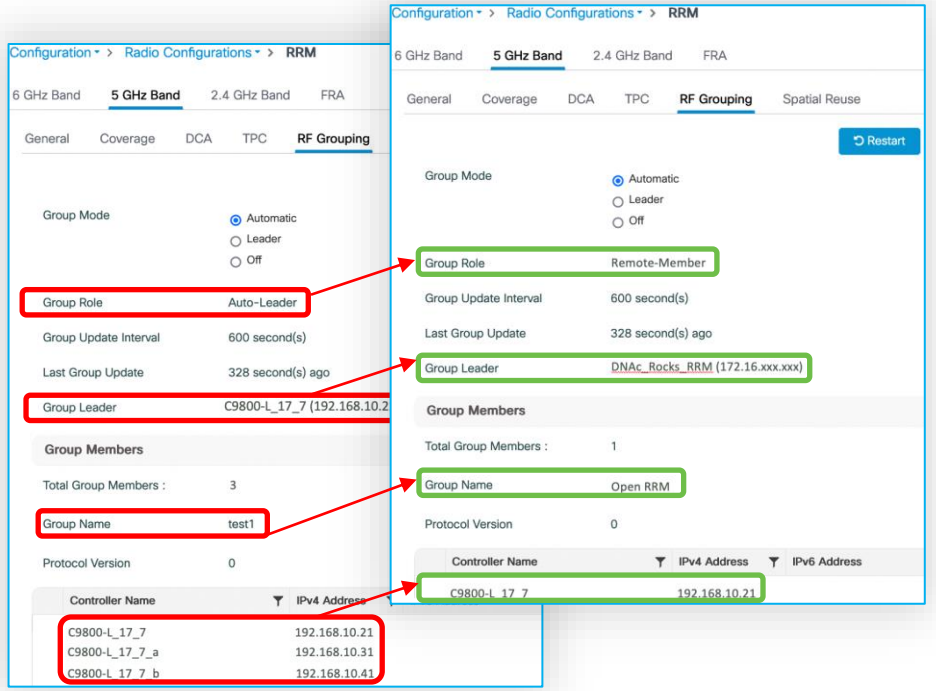
What Happens at the WLC ?

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

After AI RF Profile

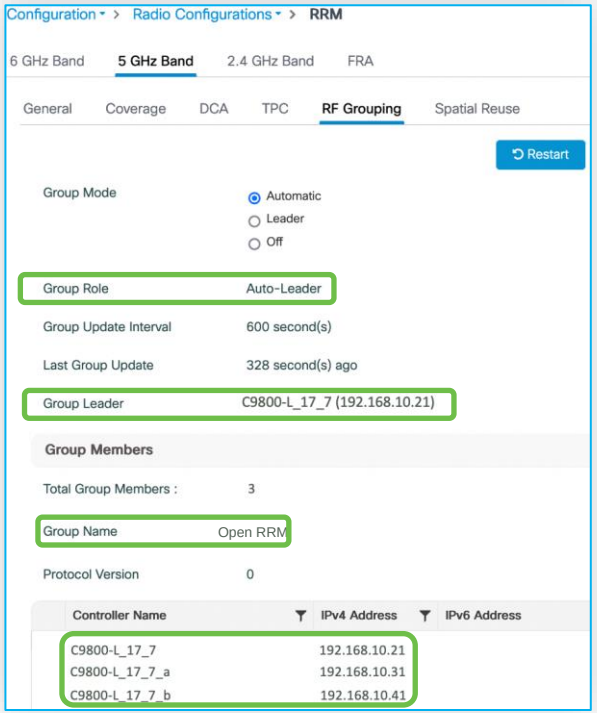


What Happens if the AI-RF Group Leader is lost?

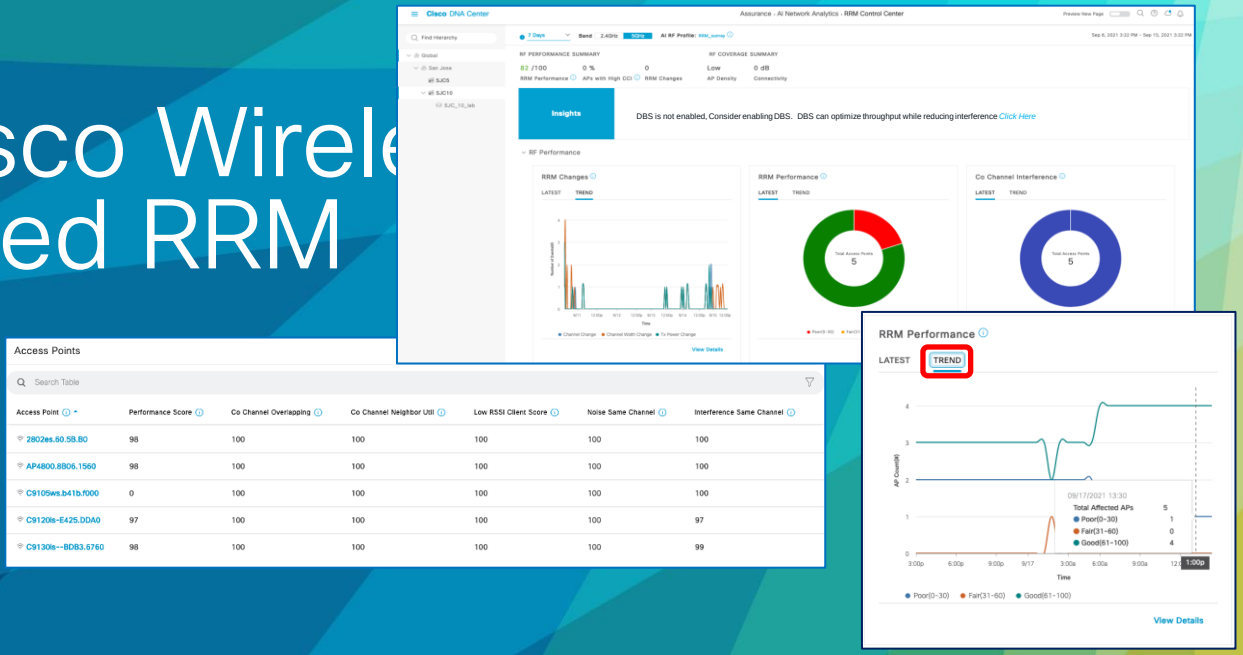
AI Enhanced RRM Operations

- AI Enhanced RRM means that the RF Group Leader is operating in the Cisco AI Analytics cloud.
- 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!



Demo- Cisco Wirele
AI-Enhanced RRM

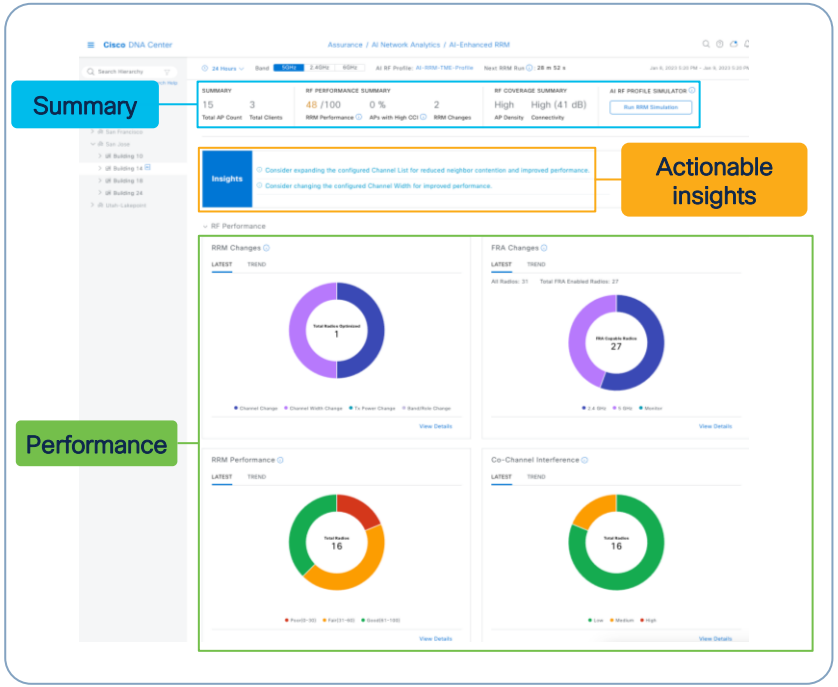


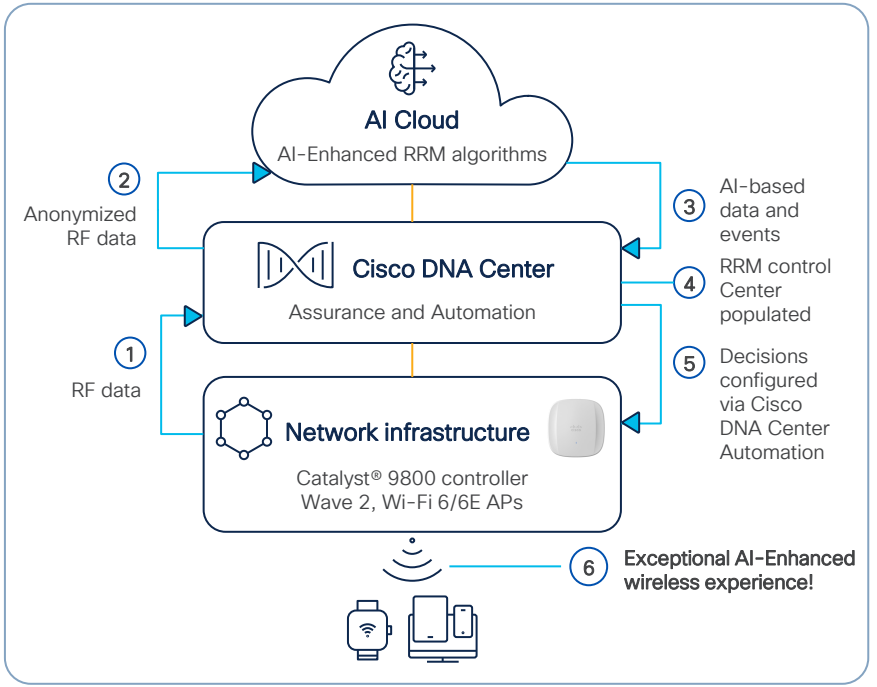
cisco Live!

What is AI-Enhanced RRM?

Catalyst's AI-Driven RRM solution

Deep RF visibility & advanced control **Proactive optimizations for all deployment s**





North Star Vision of Cisco Wireless's AI-Driven RRM Solution

RRM should be Designed for Wireless Deployments of All Sizes and Complexities (SMB to Enterprise)

Wireless Client Disruption

RRM Services Ready at Any Scale

Supports RRM services, DCA, DBS, TPC, FRA, and AP zone-level configurations for deployments of all sizes and use cases.

Trend, Reward, Client-Based RRM

Uses AI to optimize based on historical trends, RF performance, and client-side telemetry.

Interrupt Cognizant RF Tuning

Defers optimizations after peak hours to minimize disruptions but uses peak hour data for relevance to clients' activity times.

Trust & Visibility

RF Visibility Widgets

Provides org-to-AP level visibility of RF health, RRM changes, co-channel interference, etc.

RF Insights and Recommendation

AI reviews customer config against intended outcomes and provides insight recommendations to ensure goals are met.

Config Simplification

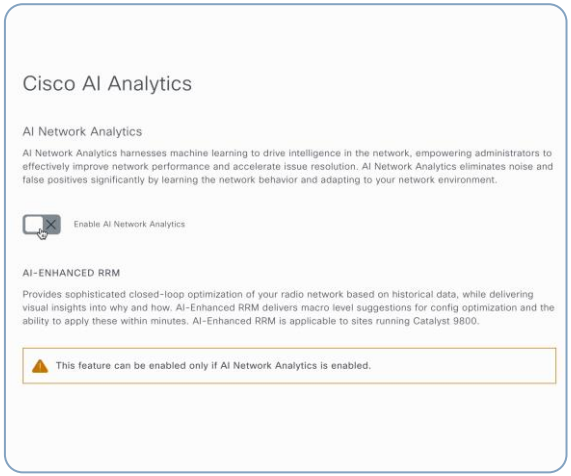
Predictive RF Simulator

Uses historical data to predict outcomes of RRM config changes, giving admins peace of mind before applying them.

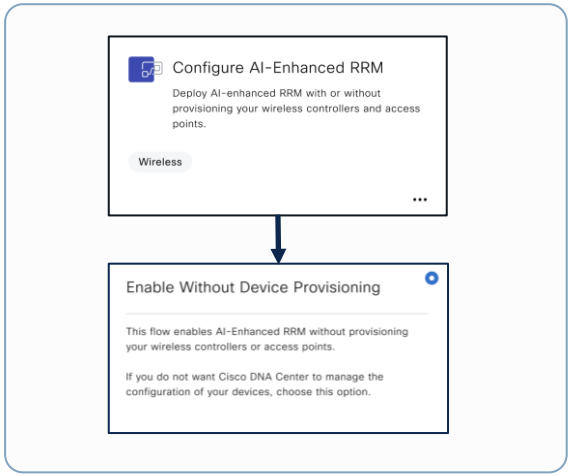
AI-Enhanced RRM Supports Assurance-Only Users

Newly redesigned and simplified deployment workflow for an improved user experience!

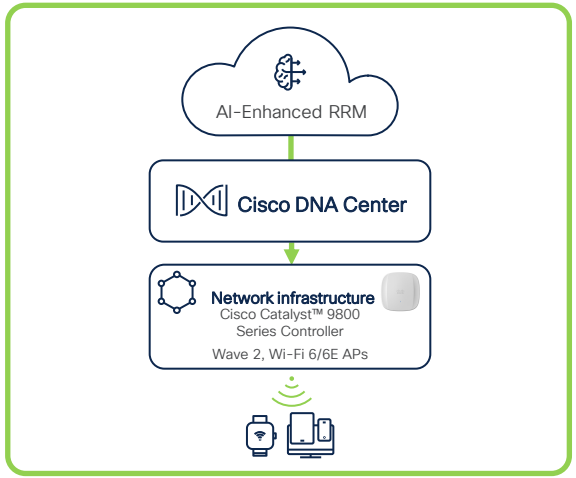
1 Enable AI-Enhanced RRM cloud access in Settings



2 Select the newly designed workflow and deployment option!



3 AI-Enhanced RRM is enabled without device provisioning!

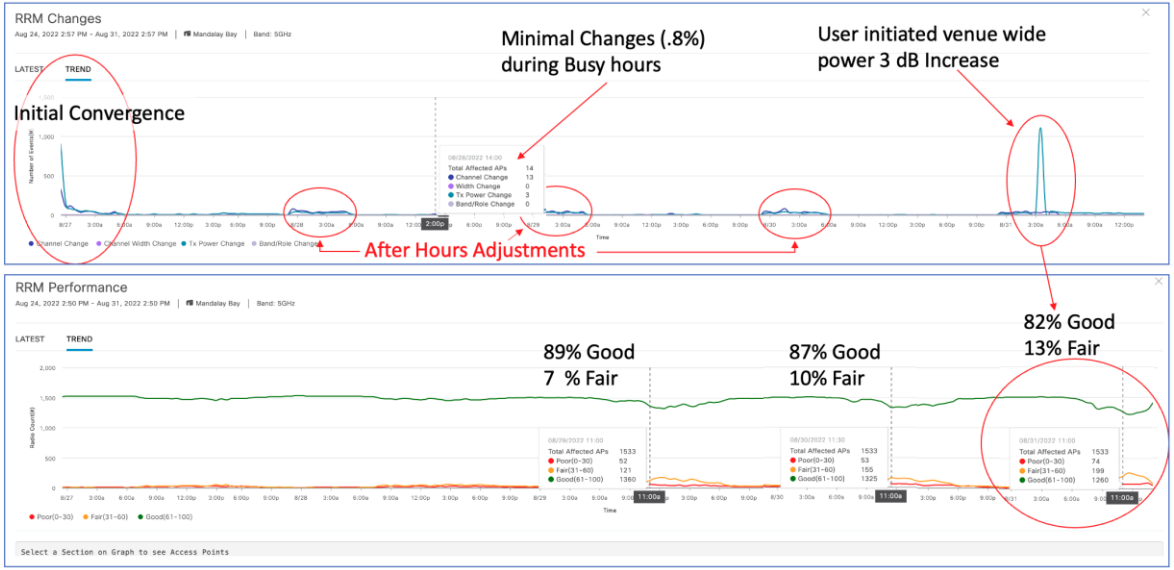


Cisco Impact August 2022
AI-Enhanced RRM In Action

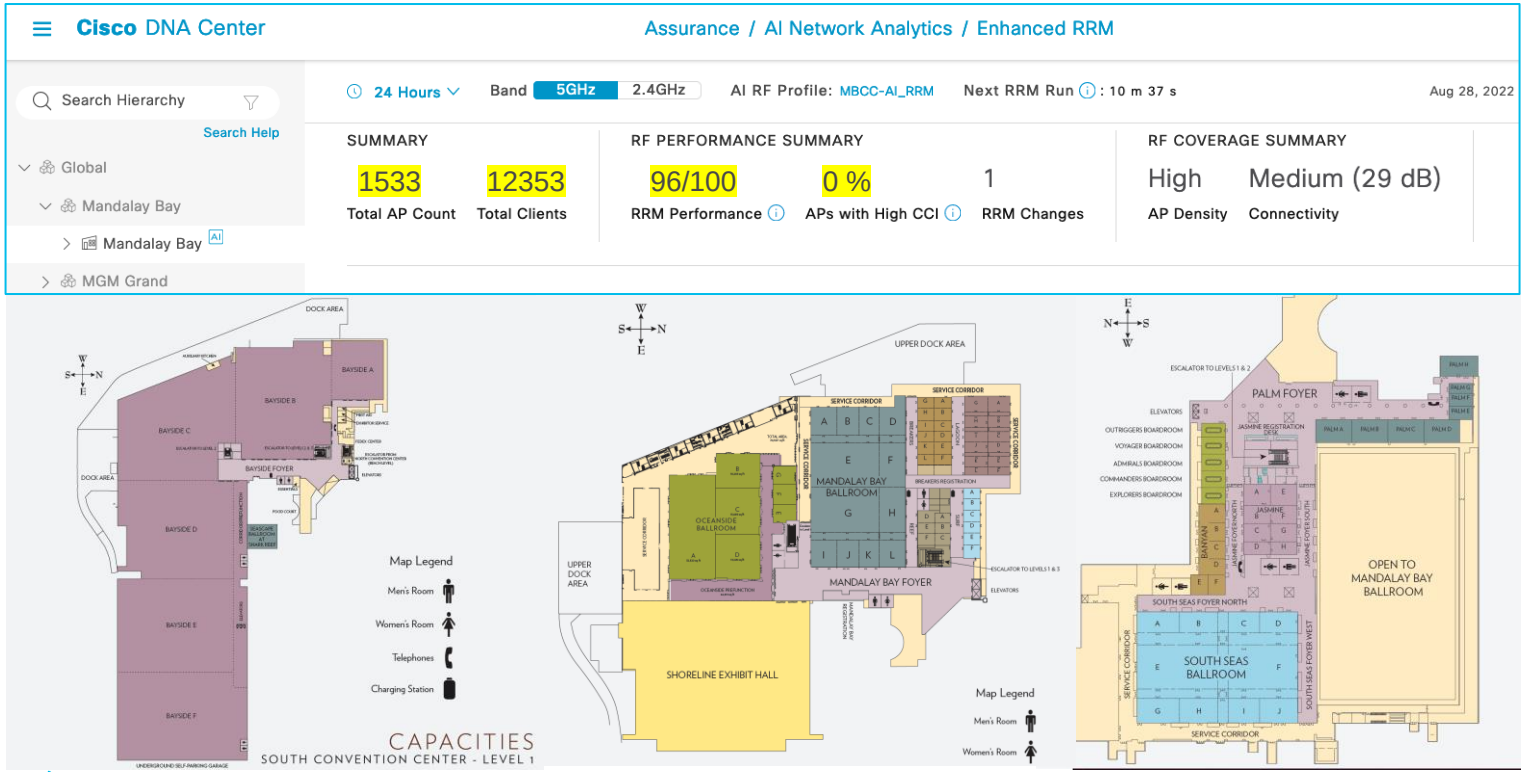
- 2x C9800-80 SSO Pair for MGM Facility 17.6.3 for stability in Keynote
  - Keynote had 73 AP's
    - 37 C9120 with Dual AIR-ANT2513-P4N-R
    - 36 C9104 (C9130-STA)
  - AP3800 with single -ANT2513-P4N-R for the balance in MGM
- 2x C9800-80 SSO Pair for Mandalay bay running 17.8.1
  - Mandalay Bay ballrooms and events center 1533 x AP3800 with single -ANT2513-P4N-R
  - All AP's Managed by AI-Enhanced RRM
- 2x DNAC XL Appliances running DR, all AP's managed by single DNAc
- DNA Spaces used for Mazemap and OpenRoaming
- All AP's belonged to MGM except Keynote AP's

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



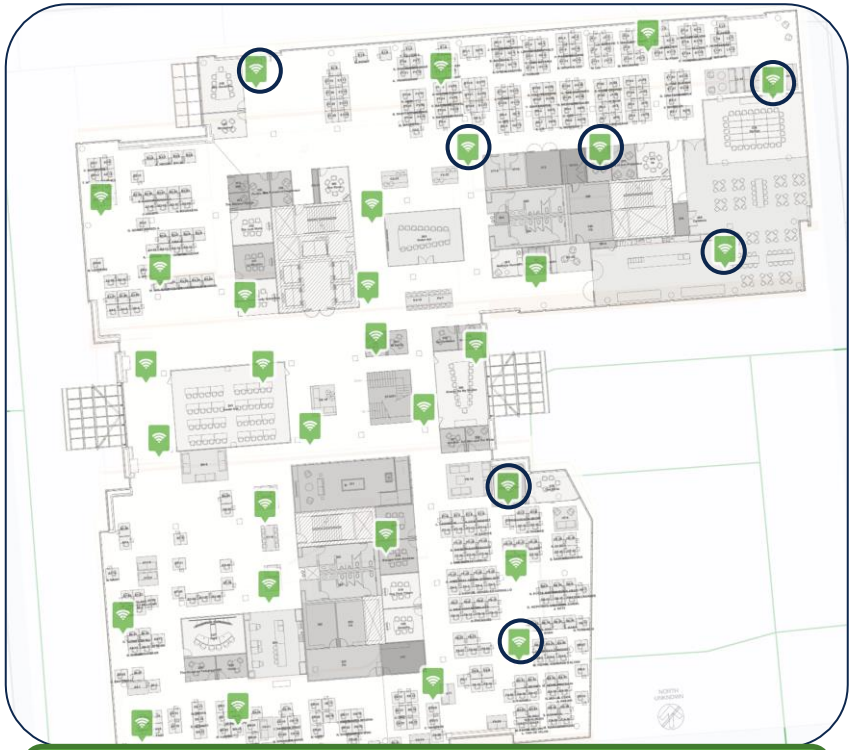
Mandalay Bay South Convention Center



Now Beta
GA soon!

Reduce

Client Disruptions via **AI Channel Planning**

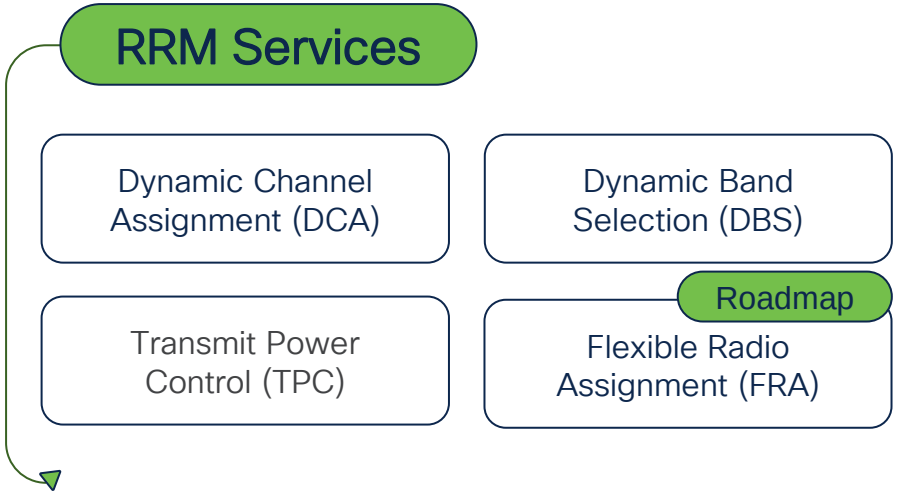


Retain **historical DFS events**, **Auto-update RF Profile** to **avoid DFS**-impacted channel

Powered by
AI-Enhanced RRM

What is Meraki's AI-Powered Auto RF?

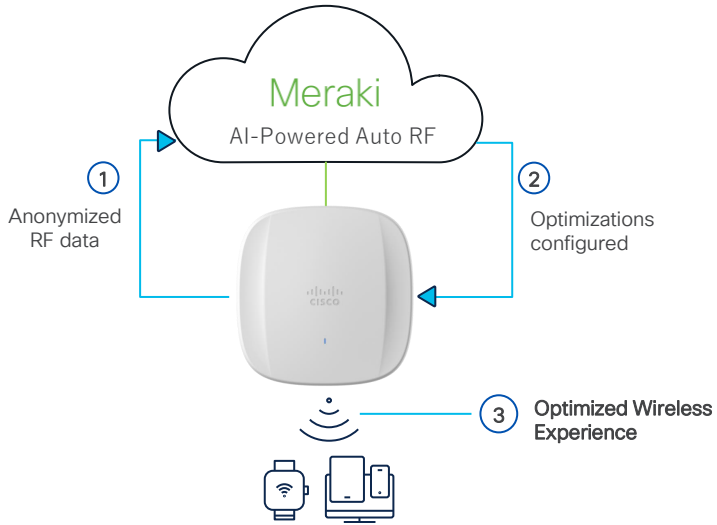
AI-Powered Auto RF is Cisco Meraki's radio resource management (RRM) solution, that optimizes wireless configurations to improve RF performance.



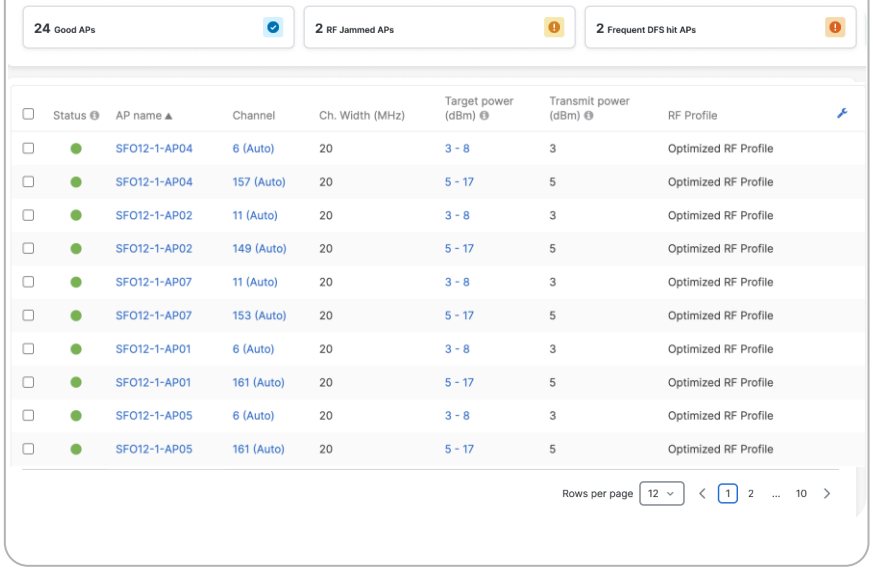
How does AI-Powered Auto RF work?

Cisco Meraki's AI-driven RRM solution

Topology



Simplified Visibility & Automated Control



How does AI Channel Planning work?

Channels that face a DFS or channel jammed event with will be put on an avoid list starting at severity 6.

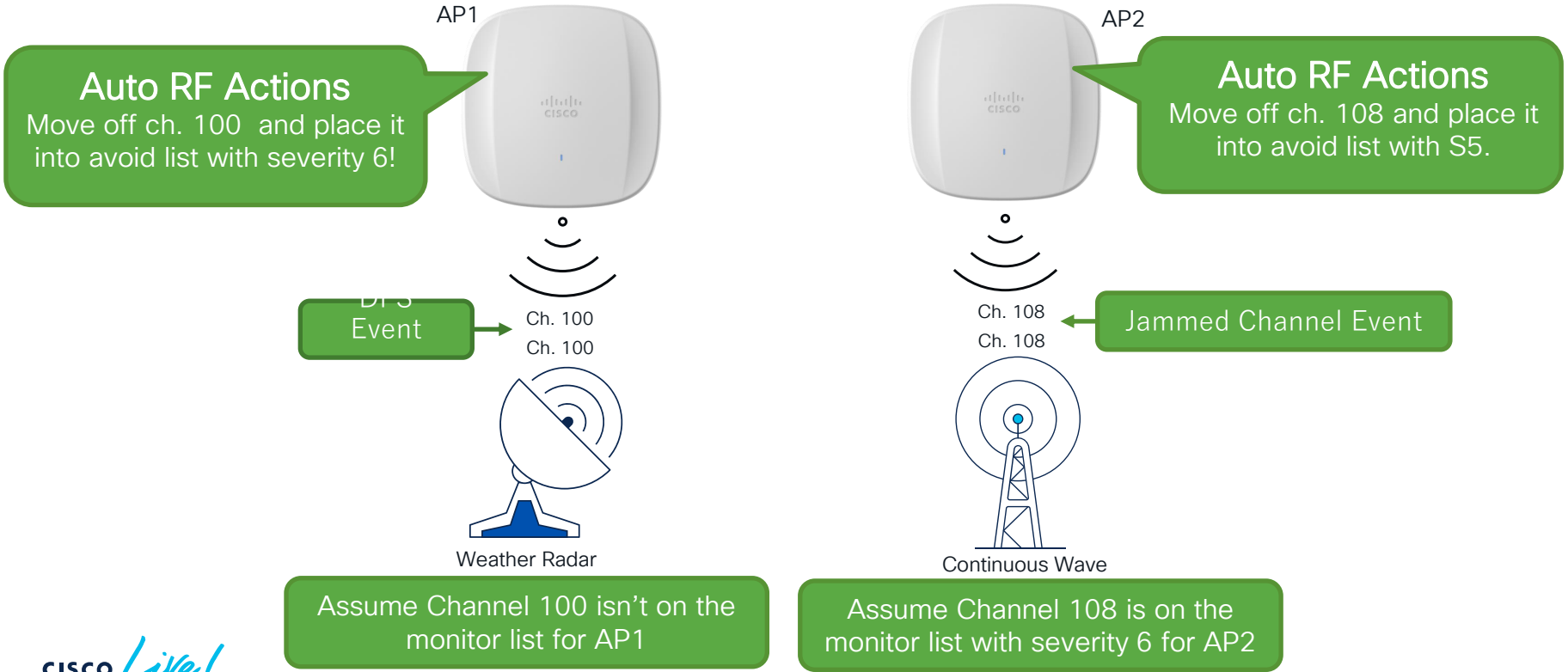
Avoid List – Channels on this list won't be used; after the period, it'll be added to the monitor list with the same severity.

Monitor List – If a DFS or jammed channel event occurs, the channel is added to the avoid list and the severity is increased.

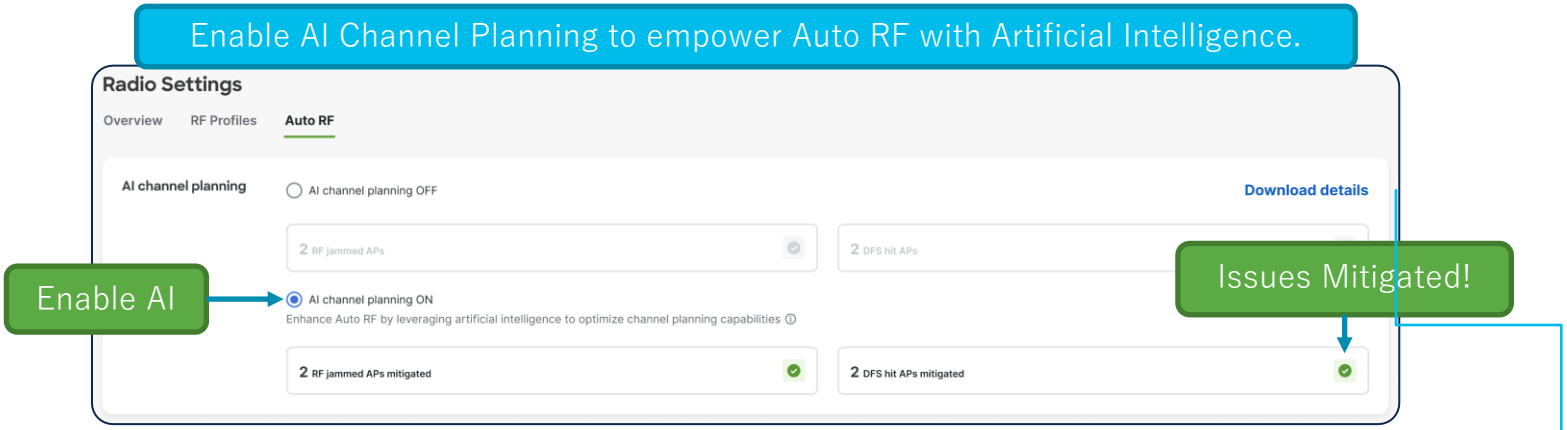
Severity	Avoid Period	Monitor Period
6	1 Day	1 hour
5	2 Days	2 hours
4	4 Days	3 hours
3	8 Days	4 hours
2	14 Days	5 hours
1	30 Days	6 hours

Why is AI Channel Planning so powerful?

- Avoids channels with reoccurring interference at a per-AP Level

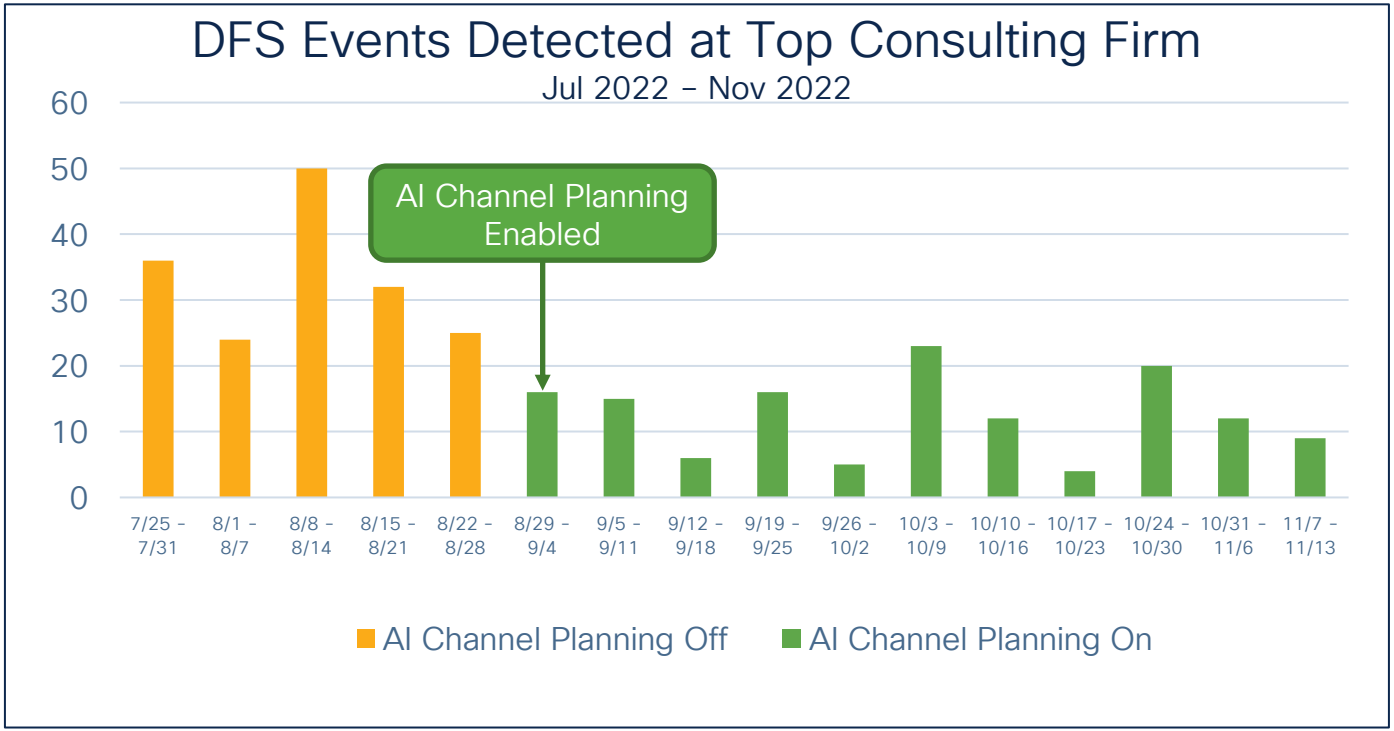


How do I enable AI Channel Planning?



AP Name	Issue	Band (GHz)	Channel	AI Channel Planning Mitigation	Start Time	End Time
<APn>	<None, Frequent DFS Hit, RF Jammed>	<2.4, 5, 6>	<Channel>	<Channel Avoided, Channel Monitored, Feature Disabled>	<Start Time>	<End Time>
AP1	RF Jammed	6	104	Channel Avoided	3/23/23 - 12:45 PM	3/25/23 - 12:45 PM
AP1	Frequent DFS Hit	5	108	Channel Monitored	3/23/23 - 5:45 PM	4/23/23 - 5:45 PM
AP2	RF Jammed	6	100	Channel Avoided	3/23/23 - 5:45 PM	3/27/23 - 5:45 PM
AP3	RF Jammed	6	100	Feature Disabled	N/A	N/A

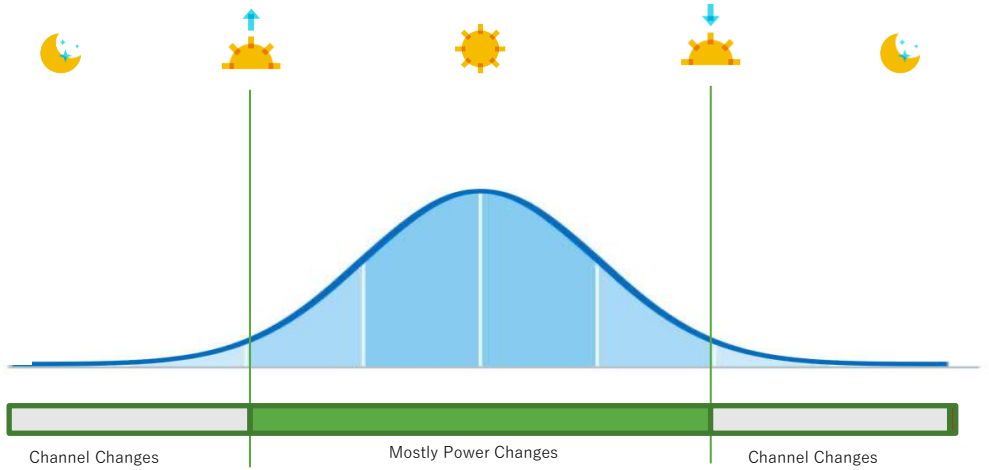
AI Channel Planning Reduced DFS Hits by ~50% in a customer's network



Now Beta
GA soon!

Minimize

Client Disruption via Busy Hours



Promotes seamless connectivity for users by minimizing channel and width changes during peak hours.

Powered by
AI-Enhanced RRM

Why is Busy Hour so powerful?

Because work hours are different for different networks…

Stadium

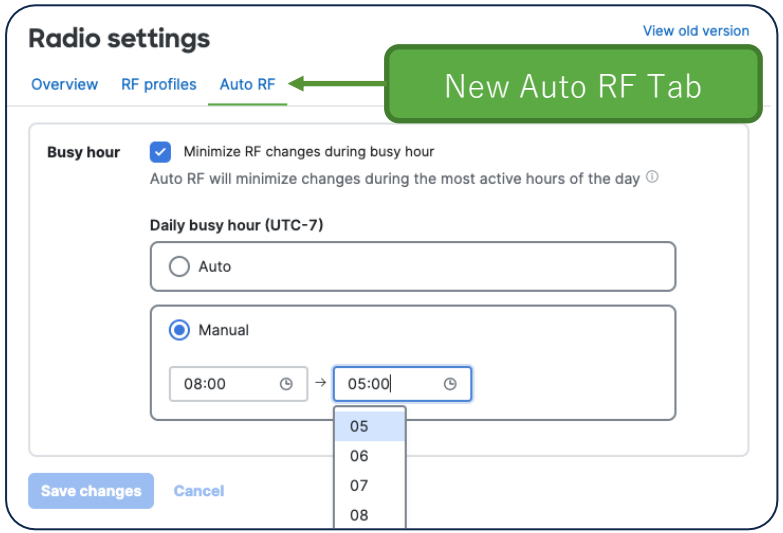
Retail

Corporate

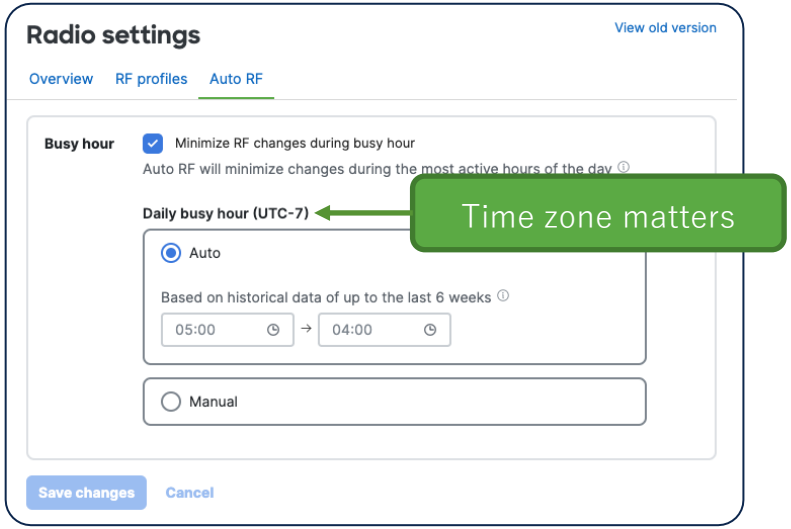
… and Busy Hour allows for automatic network-level enablement!

What are the options for enabling Busy Hour?

Control or simplicity, it's your choice!



Configure time range manually…



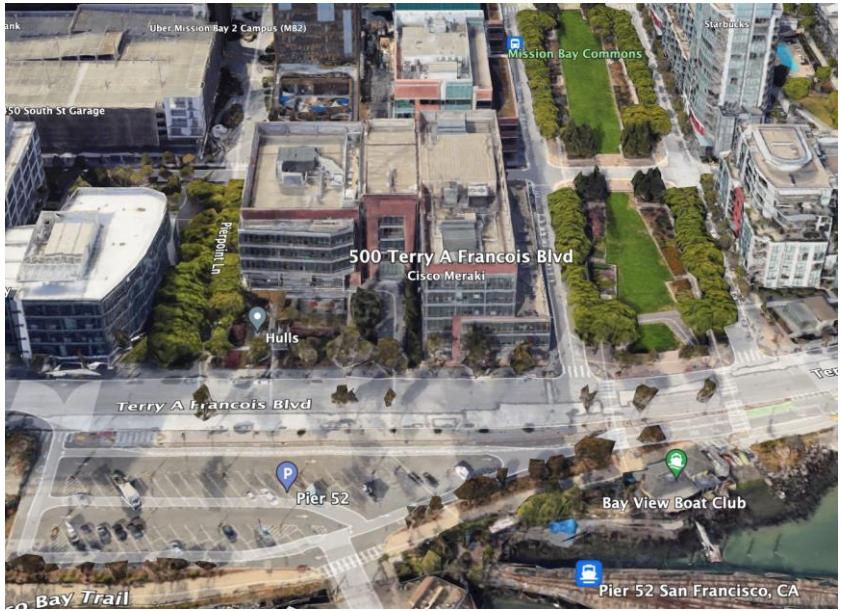
…or have AI decide for you!

Derived from 6 weeks of client count & traffic data

To Validate our Hypothesis we Observe SFO12

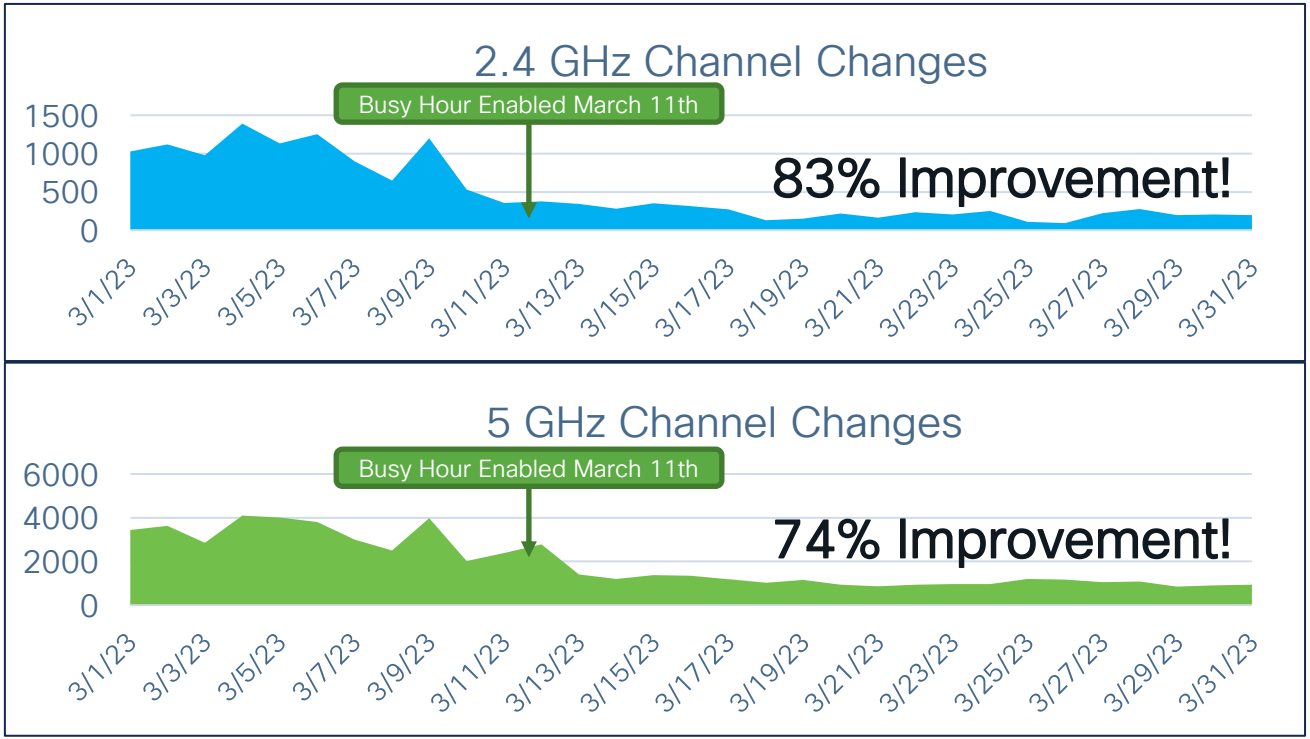
To Validate: AutoRF Busy Hour was enabled using 5 weeks data from Feb and March 2023 with the goal of demonstrating a channel change reduction

- SFO12 is a downtown SFO location – with lots of neighbors
- Multiple RF labs – of course
- We compared the daily average of channel changes during Busy and Non-Busy hours



Busy Hour Significantly Minimizes the Number of Channel Changes

Meraki SFO 12 Building with 143 APs and 2k+ Clients

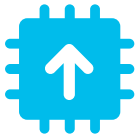


CleanAir™ Pro

RF Excellence

Introducing Cisco CleanAir Pro™

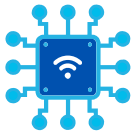
15 years of innovations and excellence carried forward



Cisco CleanAir®

RF ASIC-based excellence

Purpose built for 2.4- and 5-GHz wireless



Cisco CleanAir™ Pro

Evolving Wi-Fi excellence into 6 GHz

- Full 2.4-, 5-, and 6-GHz band support
- Multiradio architecture
- AI/ML-driven scanning radio decoding HE frames
- ML-based interferer classification, on AP

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)

Great for client device testing and validation

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)

Above & Beyond

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

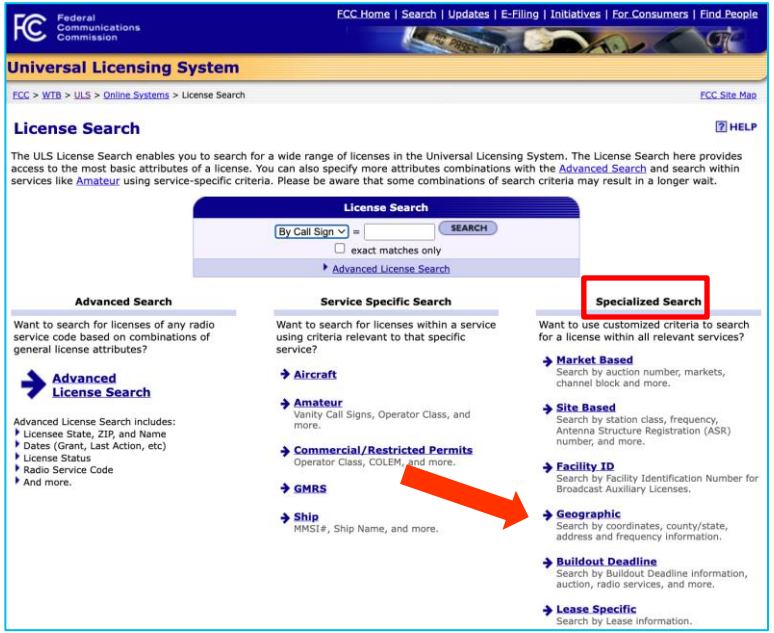
IOS-XE 17.10 6 GHz Detection

** Still to be committed

FCC Universal Licensing System
and 6 GHz Incumbents/Licensed users

CleanAir Pro™

- The US FCC's Universal Licensing System tracks all FCC License activity, including any incumbent operating in 6 GHz
- The ULS is a major enablement factor for Standard Power Wi-Fi 6E and Automatic Frequency Coordination (AFC) system
- Best of all, since the US Citizens pay for this – it's FREE!
- Online search capabilities are extensive, just to get an idea, use Specialized Search, Geographic

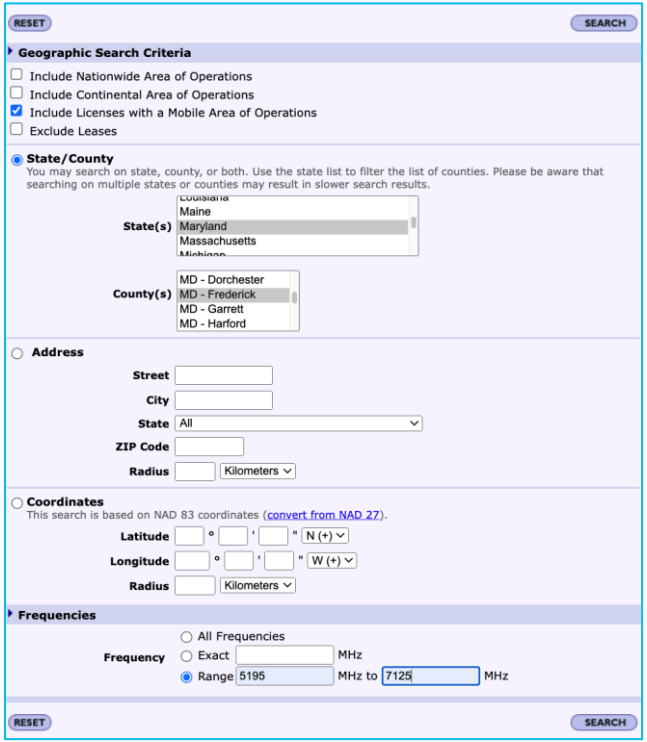


https://wireless2.fcc.gov/UlsApp/UlsSearch/searchLicense.jsp

FCC Universal Licensing System
and 6 GHz Incumbents/Licensed users

CleanAir Pro™

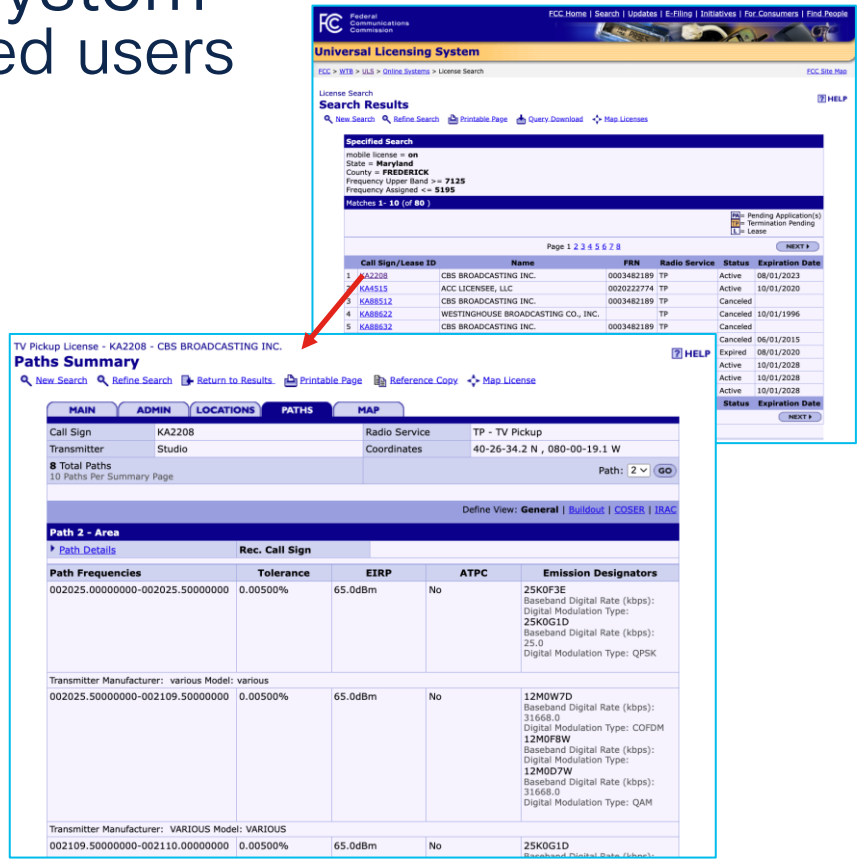
- Extensive Search Criteria
- Include Licenses for Mobile Ops – will get electronic media sites
- Search by State and County, Address, Coordinates
- Specify Frequency Range
- And search –



FCC Universal Licensing System
and 6 GHz Incumbents/Licensed users

CleanAir Pro™

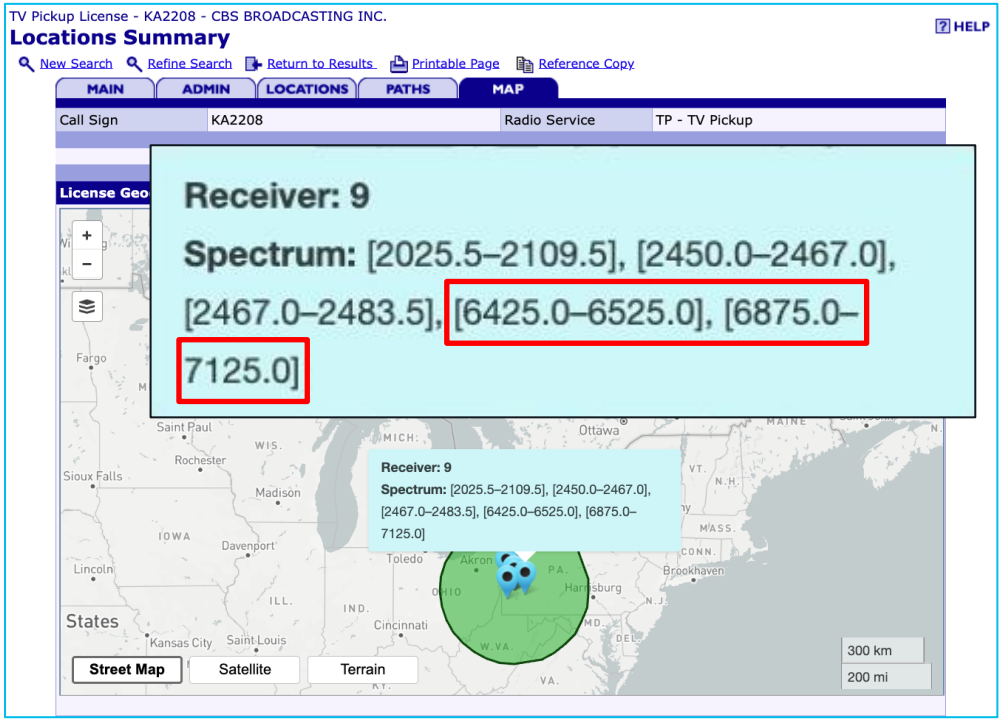
- Loads of information, 8 Pages here
- Select a call sign on the list for more detail
- Main =License holder and address
- Select Paths for specific transmitter details, including location coordinates.
- 65 dBm, hmmmmm



FCC Universal Licensing System
and 6 GHz Incumbents/Licensed users

CleanAir Pro™

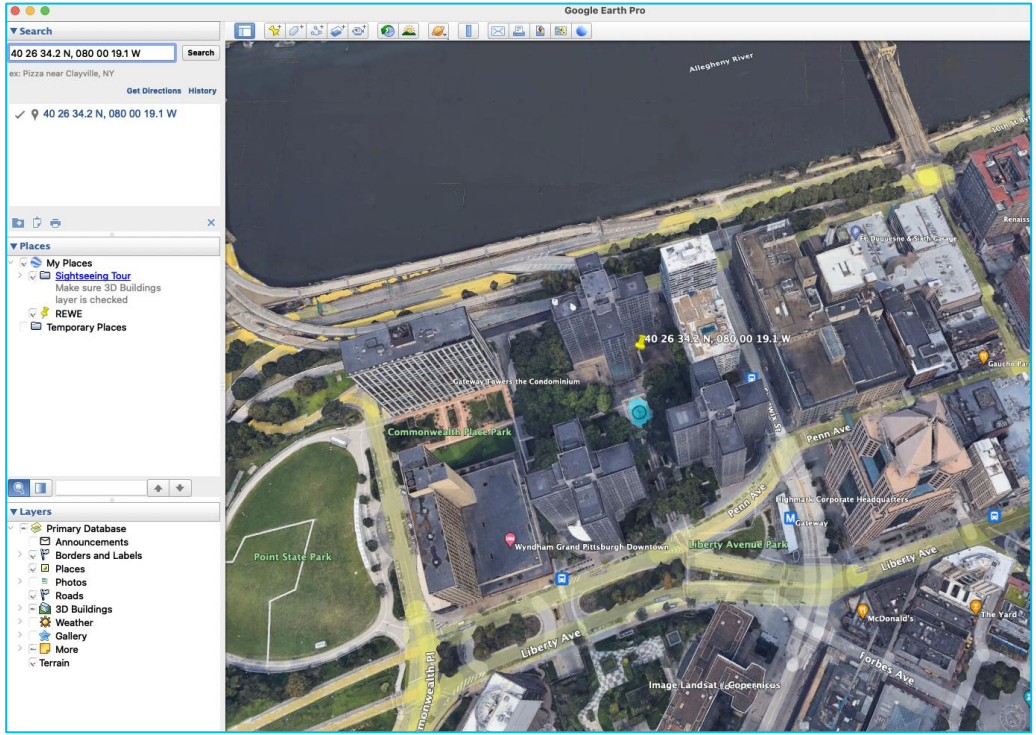
- Nestled up in the hills of the Allegheny valley, with an area radius that covers most of Western Maryland (And Frederick County)
- Legal for 65 dBm 6425.0 -6525.0 or U-Nii 6, and 6875.0 – 7125.0 or U-Nii 8



FCC Universal Licensing System
and 6 GHz Incumbents/Licensed users

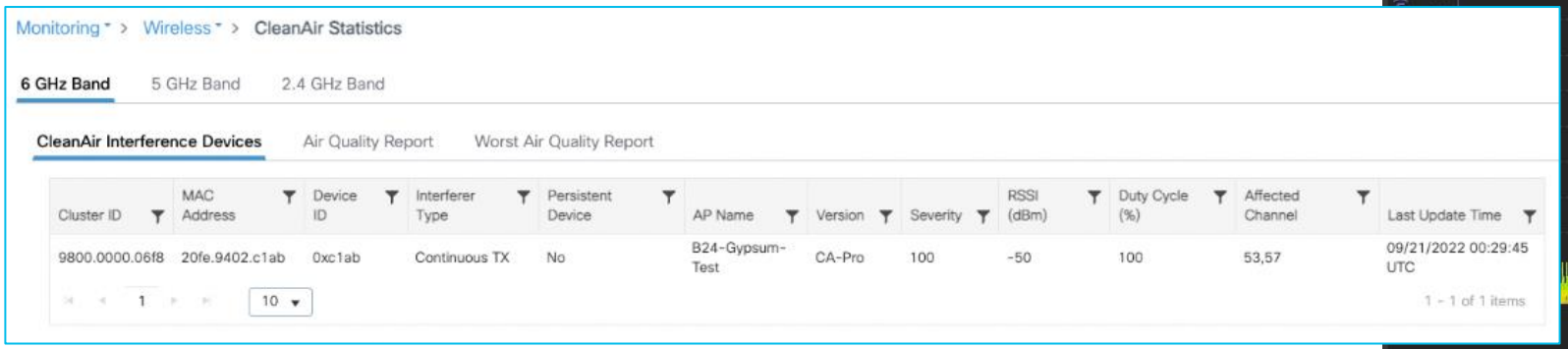
CleanAir Pro™

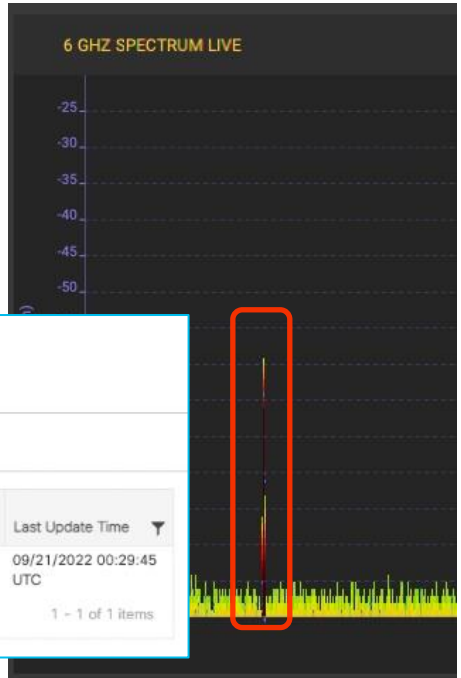
- Put the coordinates into Google Earth or Google Maps to locate
- Right in Downtown Pittsburgh is where these transmitters live –
- So – we are relying on LPI to prevent interference with the Incumbents.
- Incumbents have no such allowances for Wi-Fi 6E LPI

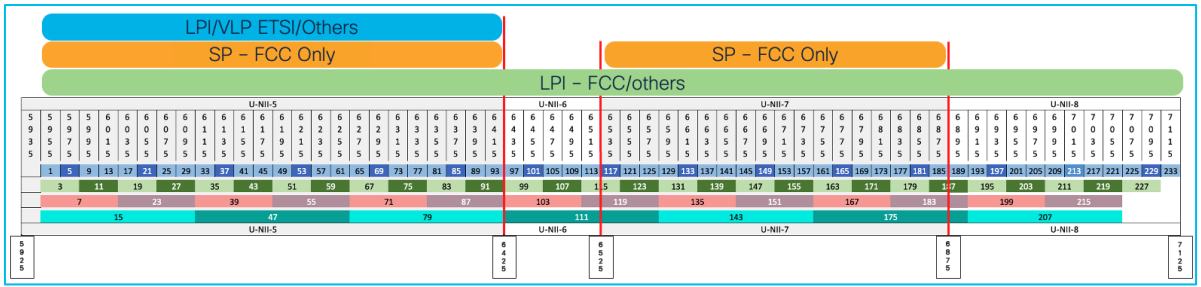


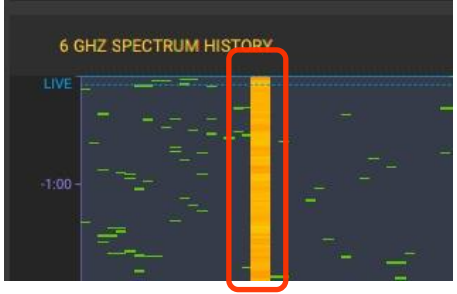
6 GHz Interference Detection CleanAir Pro™

- YES! 17.10









Zero Wait DFS

Avoid service outage when switching on DFS channels

Zero Wait DFS*

Without Zero Wait DFS:

- An AP on Wi-Fi Channels 52-144 (16 channels) must NEVER interfere with Radar
- Are required to scan a channel for 60-600s before transmitting
- Must immediately abandon the channel if radar detected
- And require minimum 60s scan before resuming operations

With Zero Wait DFS:

- An AP pre-scans one to many of the channels on power up
- After scan is completed – AP can use any of the channels on the list with no delay
- Eliminating 60-600s delay before Clients can use the network again

*Supported on Catalyst C9130AX and CW9166AXI -B and -E running IOS-XE 17.10 and later
C9130AX only in 17.9

Zero Wait DFS – Maintaining Channel Lists

S1 @ Chn 52/56
S2 @ Chn 124/128

In FCC

- Inclusion List = Serving Channels and Reserve Channels on CAC completion
- On Radar Detection, Channel removed from inclusion added to exclusion list

For ETSI

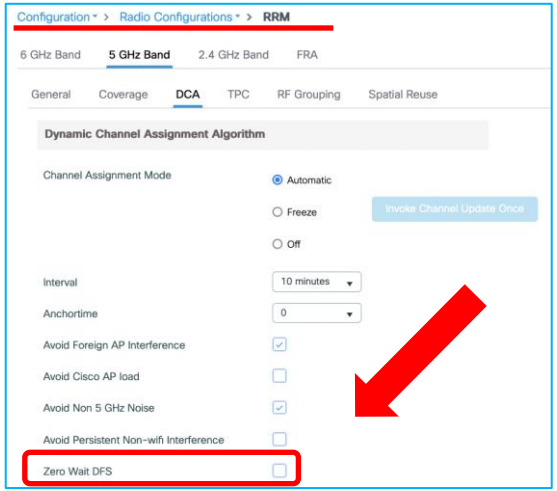
- AP is provided with Channel list to scan, when pre-CAC status complete it adds all channels scanned to the Inclusion list
- All channels remain in the inclusion list itil radar detected, or AP rebooted
- Radar Detection adds channel to the exclusion list

```
#sh ap name C9130i_9f.6e.a0 config slot 1 | s Zero
  Zero Wait DFS Parameters
    Zero Wait DFS Capable        : Yes
    CAC Domain                   : FCC
    Zero Wait DFS Enabled        : Enabled
    DFS Channel Inclusion list   : 52,56,108,112
                                   124,128
    DFS Channel Exclusion list   : 60,64,100,104,
                                   116,120,132, 136
                                   140,144
    Pre-CAC Status               : NA
    Reserved Channel CAC Status  : Complete
    Reserved Channel             : 108
    Reserved Channel Width       : 40 MHz
```

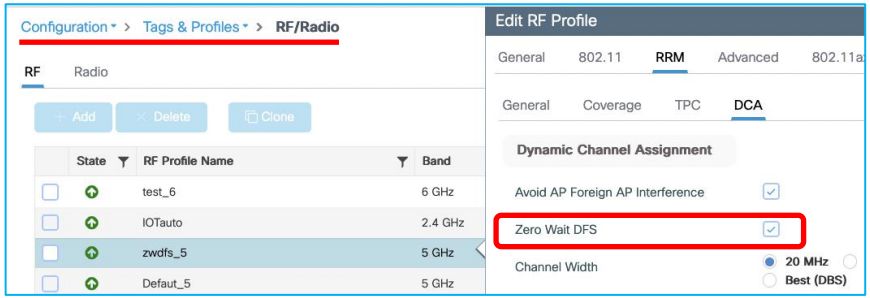
Configuring Zero Wait DFS

- Zero Wait DFS is configured under Dynamic Channel Assignment (DCA) at both the Global and the RF Profile levels

Global



RF Profile



Zero Wait DFS WLC Show Commands

C9800-L_17_10#*show ap name <name> config slot 1/2 | s Zero*

FCC

```
#sh ap name C9130i_9f.6e.a0 config slot 1 | s
Zero
  Zero Wait DFS Parameters      Zero Wait DFS
   Capable                        : Yes
   CAC Domain                     : FCC
   Zero Wait DFS Enabled          : Enabled
   DFS Channel Inclusion list     :52,56,108,112
                                   124,128
   DFS Channel Exclusion list     :60,64,100,104,
                                   116,120,132,136
                                   140,144
   Pre-CAC Status                 : NA
   Reserved Channel CAC Status    : Complete
   Reserved Channel               : 108
   Reserved Channel Width         : 40 MHz
```

ETSI

```
#sh ap name C9130E-E-53.4e.20 config slot 1 | s
Zero
  Zero Wait DFS Parameters     Zero Wait DFS
  Capable                        : Yes
  CAC Domain                     : ETSI
  Zero Wait DFS Enabled          : Enabled
  DFS Channel Inclusion list     :52,132,56,60,64
                                 100,104,108,112
                                  116,120,124,128
                                  132,136,140
  DFS Channel Exclusion list     :
  Pre-CAC Status                 : Complete
```

#sh ap dot11 5ghz channel | i Zero
Zero Wait DFS
: Disabled

#sh ap rf-profile name new5g detail | i Zero
Zero Wait DFS : Enabled

Zero Wait DFS – CLI – sh and config

Global Status

```
C9800-L_17_10#sh ap dot11 5ghz channel | i Zero
  Zero Wait DFS                              : Enabled
```

RF-Profile Status

```
C9800-L_17_10#sh ap rf-profile name zwdfs_5 detail | i Zero
Zero Wait DFS                        : Enabled
```

Global Enable/Disable

```
C9800-L_17_10(config)#ap dot11 5ghz rrm channel zero-wait-dfs
C9800-L_17_10(config)#no ap dot11 5ghz rrm channel zero-wait-dfs
```

RF Profile Enable/Disable

```
C9800-L_17_10(config)#ap dot11 5ghz rf-profile zwdfs_5
C9800-L_17_10(config-rf-profile)#channel zero-wait-dfs
C9800-L_17_10(config-rf-profile)#no channel zero-wait-dfs
```

Cisco Catalyst C9104?

- Large public venues:
  - stadiums, arenas, convention centers, theaters, and auditoriums
- Present unique RF challenges.
  - Ultra high density of users
  - Limited overhead mounting locations
  - Changing seating configurations
- Installation challenges – catwalks, aesthetic desires, ceiling height
- Wi-Fi Cells need Isolation!
- What IF?

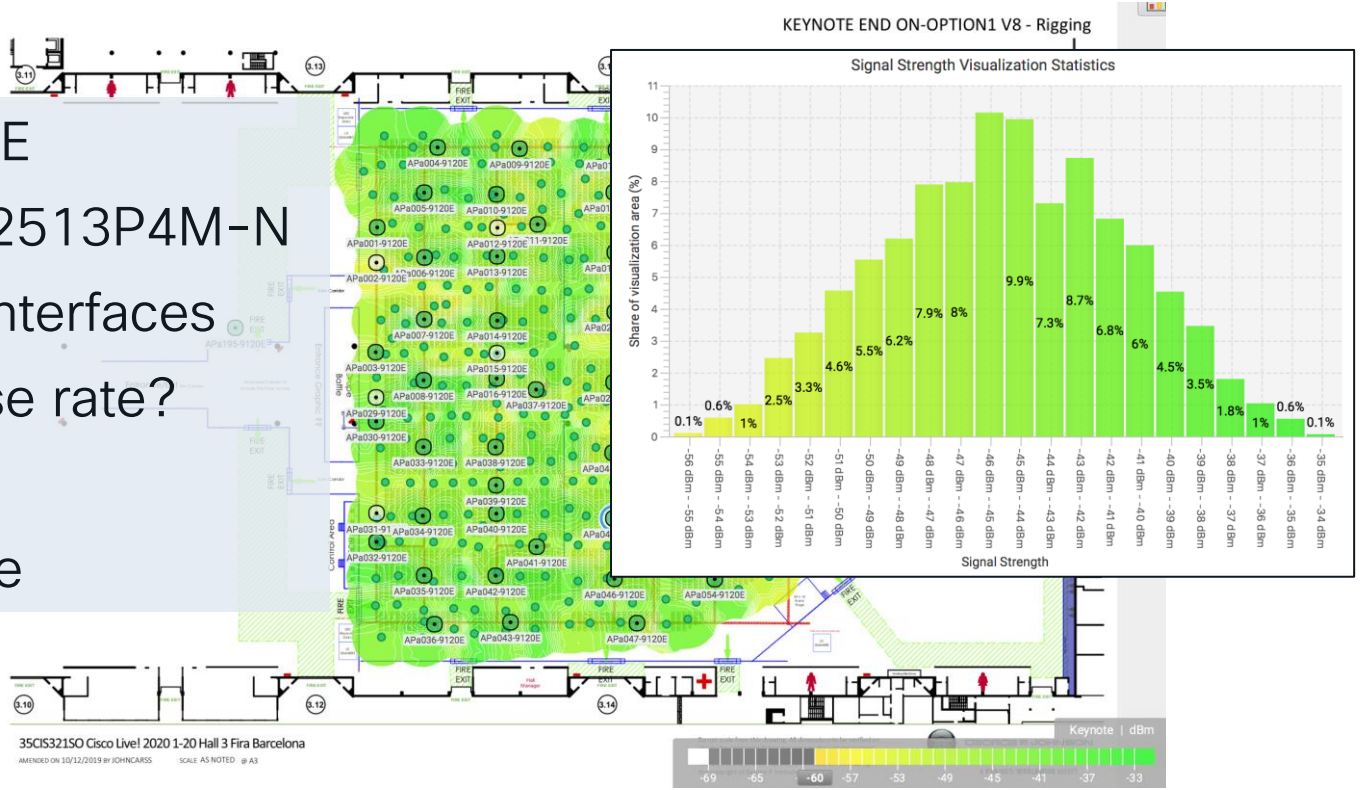
What Would the Perfect Stadium antenna look like?

- Stadiums and Large Public venues are often unique around the world.
- Each venue makes a statement for the comunity
- They’re usually really big places
- And there’s usually a LOT of people who want to all be on the internet sharing the experience

CiscoLive EU Opening Keynote 1/27/2020

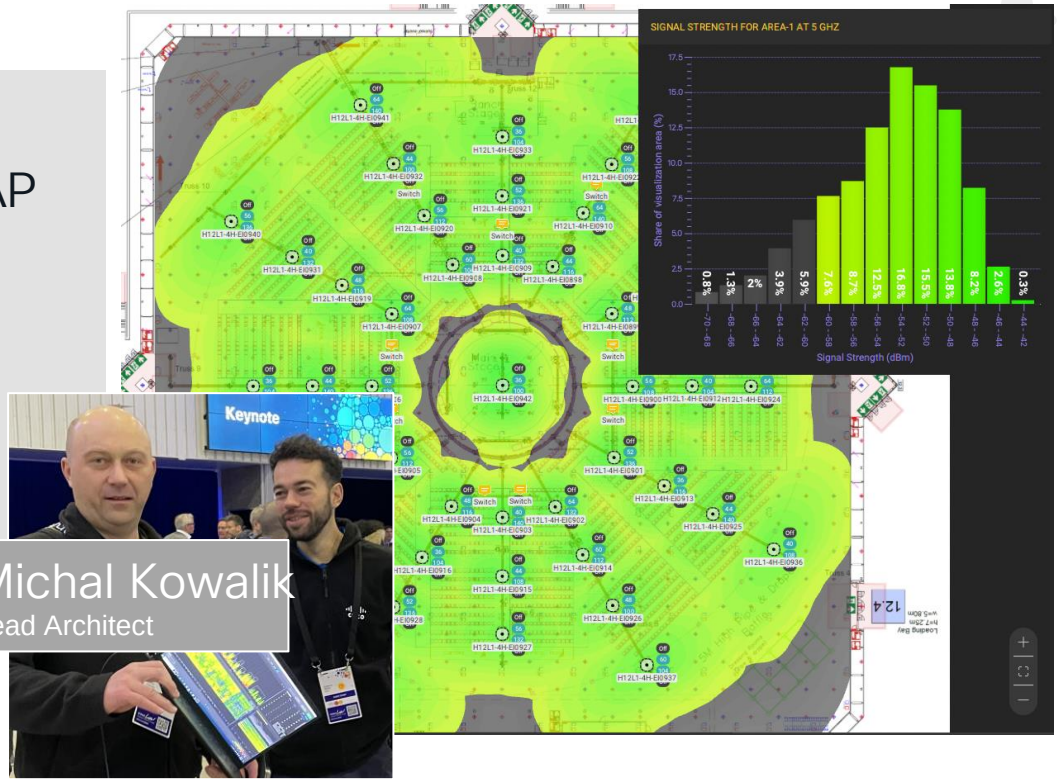
- Catalyst Powered with C9120AX-E

- 61 C9120AX-E
- 122 AIR-ANT2513P4M-N
- 122 x 5 GHz Interfaces
- Channel re-use rate?
  - N=6.4
- Spatial Re-Use



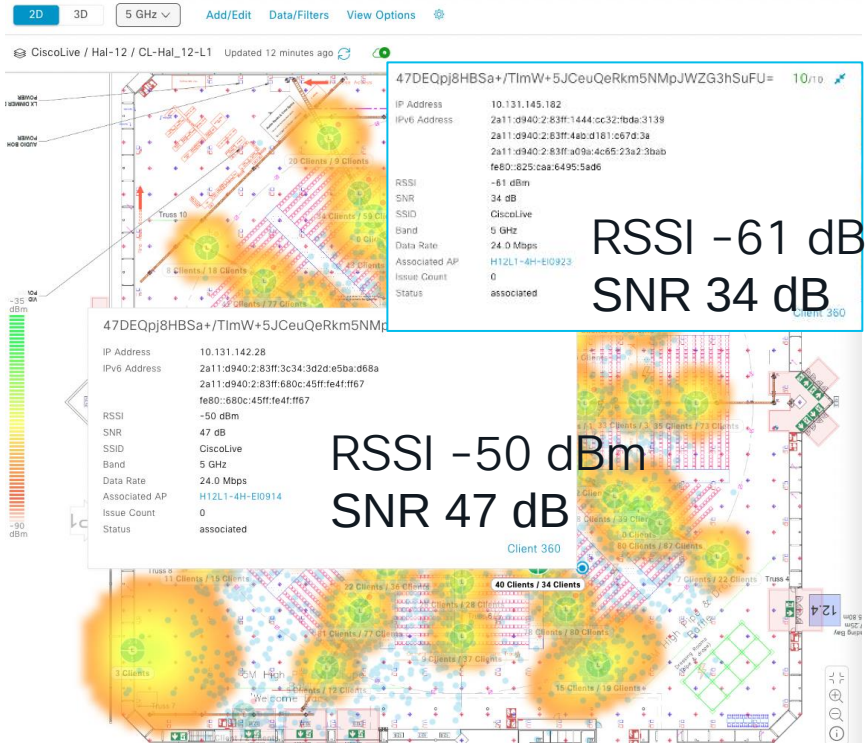
Keynote CiscoLive Amsterdam 2023

- 46 C9130AX-E -STA
  =C9104 Antenna w- C9130 AP
- 92 x 5 GHz Interfaces
- Channel re-use rate?
  - N=4.6
- 4K Seats, Planned 50 users/interface



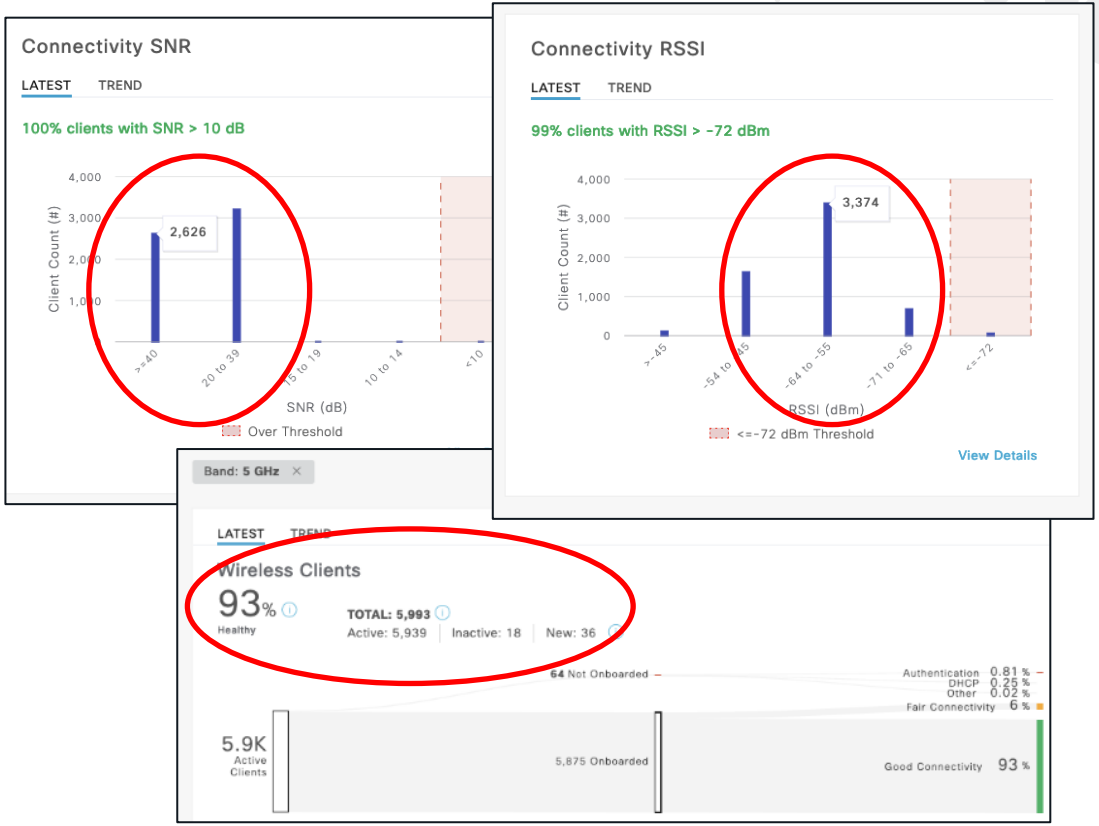
So how well does it work?

- Does it work? YES
- Actually in two ways
  - Very tight control of the side lobes = excellent signal rejection
  - Lower gain = less noise into the environment
- By comparison, with the Gillaroo we see a higher noise floor, and less SNR



CiscoLive US – 2023 KeyNote

- Over 6300 in attendance
- Average SNR was 40 dB
- 50% over 40 dB!
- 100% of arena Clients above -65 dBm at the floor
- 93% Client Health
- In a key Note....

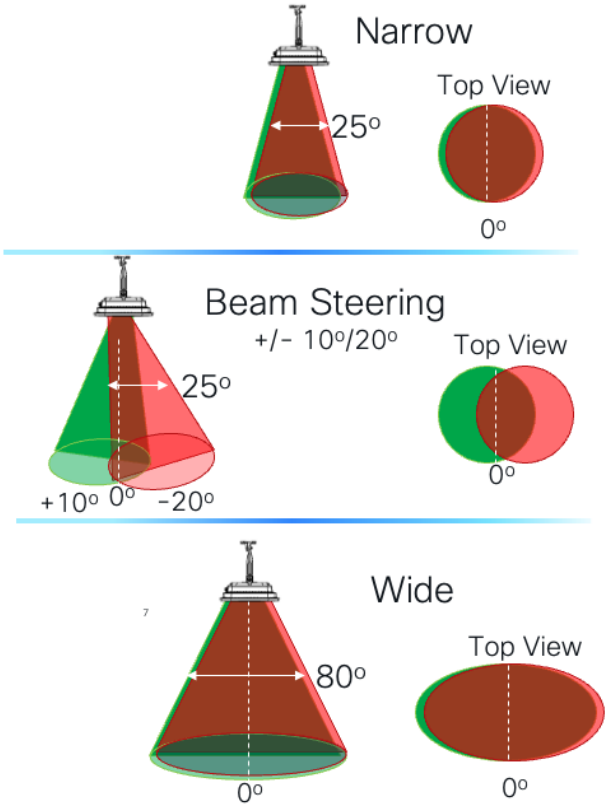


Dream Features – What's Needed?
Steerable Angles & Switchable Beamwidths

- Narrow beamwidth
  - focused, dual 4x4, 5 GHz coverage
  - Gain 10 dBi

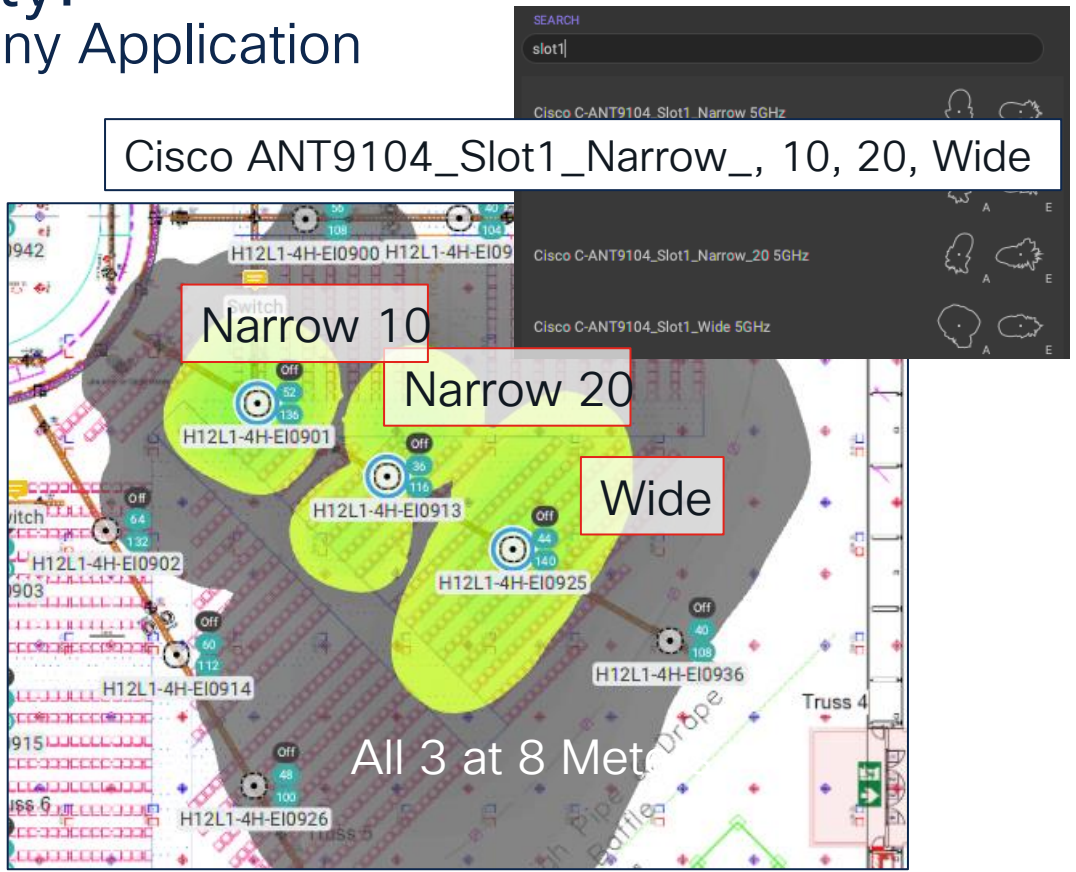
- Electrically steerable beam
  - Each 4x4 may steer +/- 10º,20º off center
  - Gain = 10 dBi

- Wide sector beamwidth
  - dual 4x4 5GHz (80ºx25º)2.4 GHz (75ºx85º)
  - Gain = 8 dBi



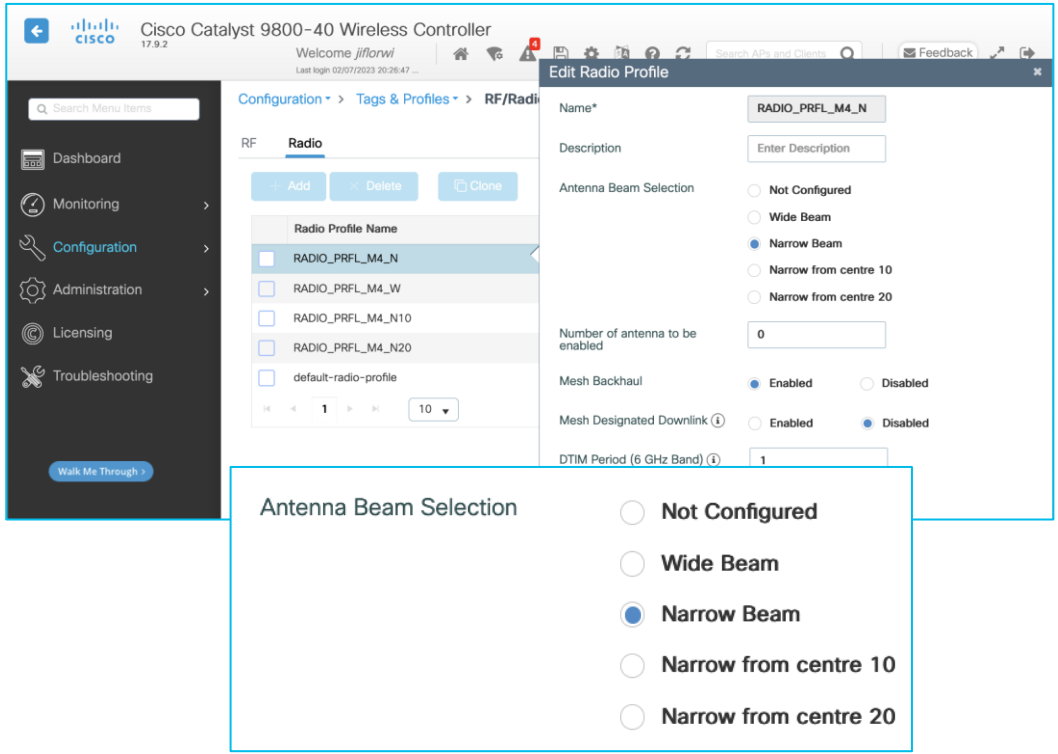
Unmatched Versatility!
Configurable Options For any Application

- Software Configurable angles and Beamwidth allows flexible configuration to maximize coverage
- Unlimited applications in small to large public venues
- Outdoor coverage with capacity (IP-65 rated)



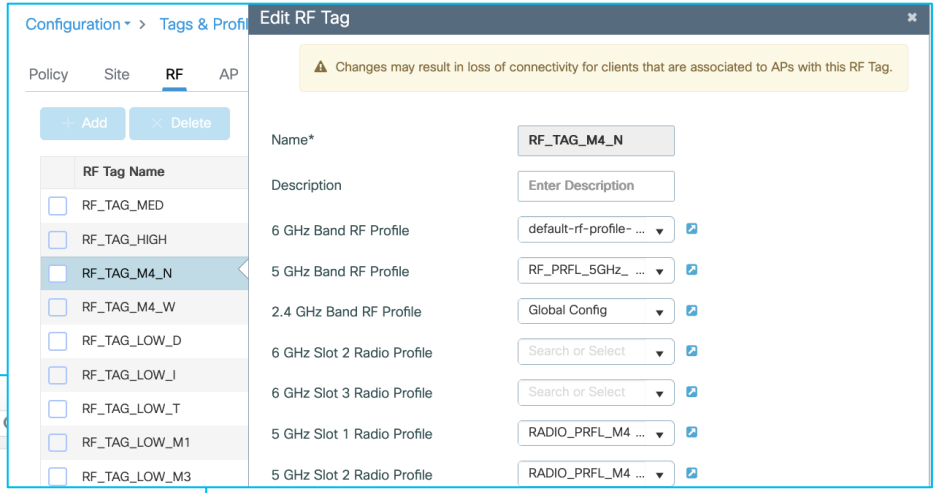
Catalyst 9800 Configuration

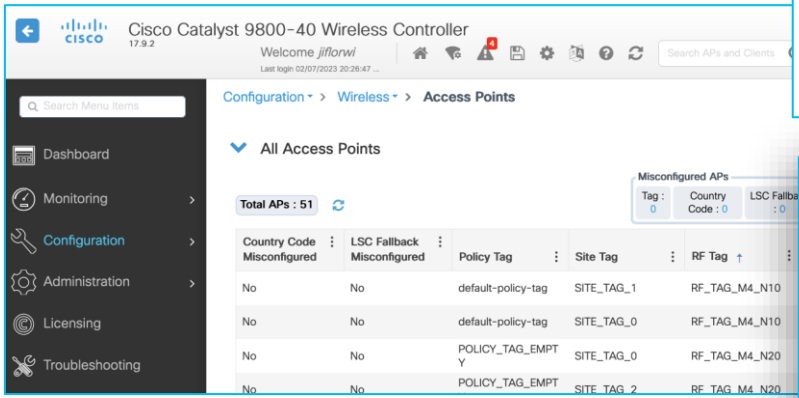
- Antenna Beamwidths are set through the Radio Profile
- A radio profile can be assigned to each Slot ½ individually
- Allows any combination of W,10,20 to be applied to each interface individually



Catalyst 9800 Configuration

- Radio Profiles are then aggregated through RF Tags for assignment of the right beamwidth per slot – and applied to the AP





Policy Tag	Site Tag	RF Tag	Location	Country
POLICY_TAG_EMPTY	SITE_TAG_0	RF_TAG_M4_N20	West Plenary 2	NL
default-policy-tag	SITE_TAG_0	RF_TAG_MED	default location	NL
POLICY_TAG_EMPTY	SITE_TAG_2	RF_TAG_M4_N20	COP26	NL
POLICY_TAG_EMPTY	SITE_TAG_2	RF_TAG_M4_N20	default location	NL

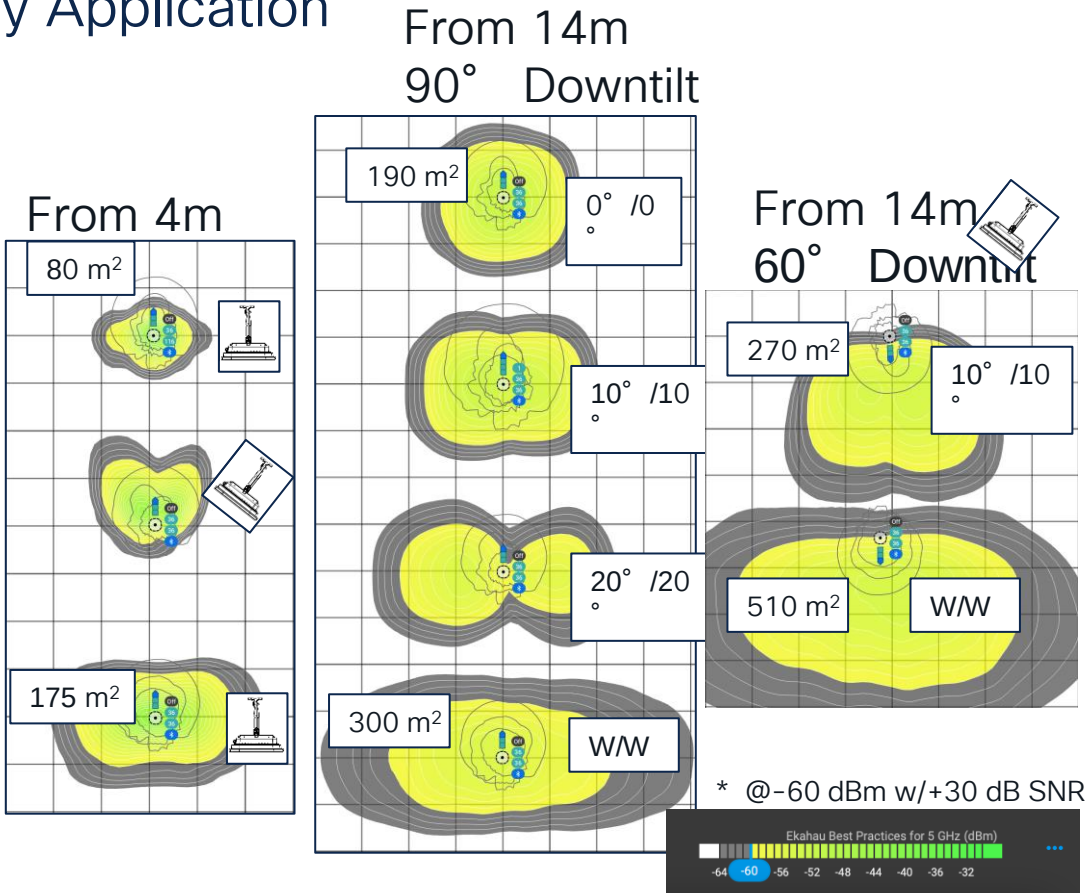
Cisco Catalyst C9130AXI-STA Stadium Antenna

- Integrated Antenna w/C9130AXE
- Operates as dual 4x4x4 5GHz, 4x4x4 2.4 GHz antenna
- Electrical Beam Steering
- IP-67 Rated
- Band Locked (Slot 1 = Unii2/3, Slot 2=Unii1

Manual channel config – **NO RRM/FRA**

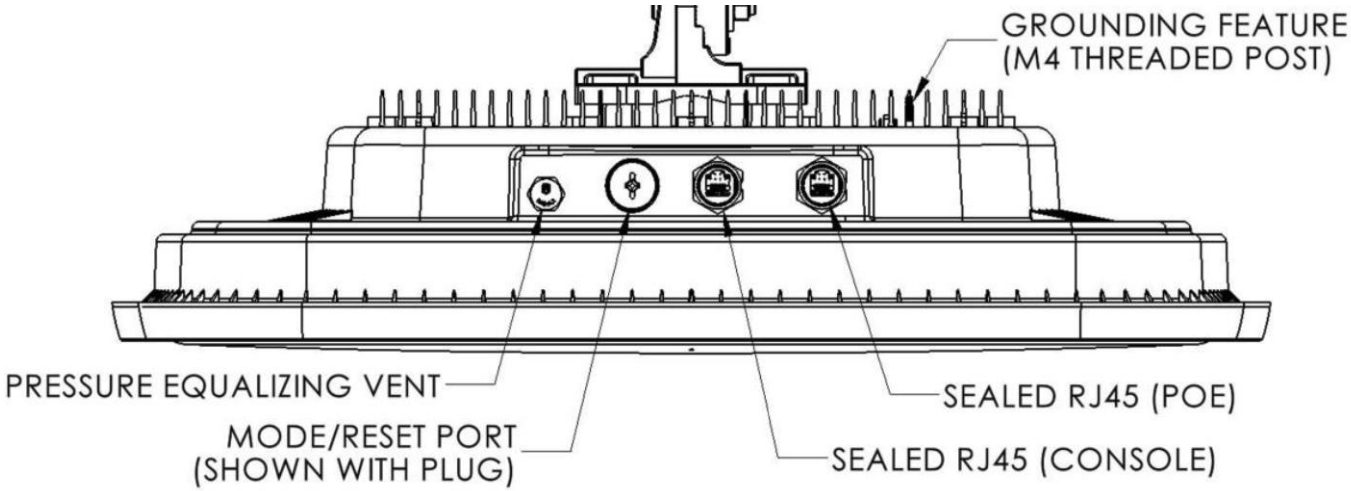
Unmatched Versatility!
Configurable Options For any Application

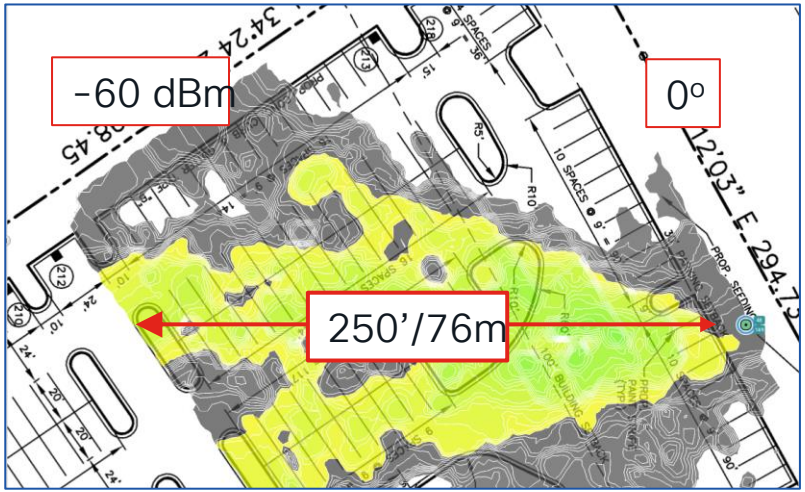
- Software Configurable angles and Beamwidth allows configuring equal cells with varying height and angles
- Unlimited applications in small to large public venues
- Outdoor coverage with capacity (IP-65 rated)

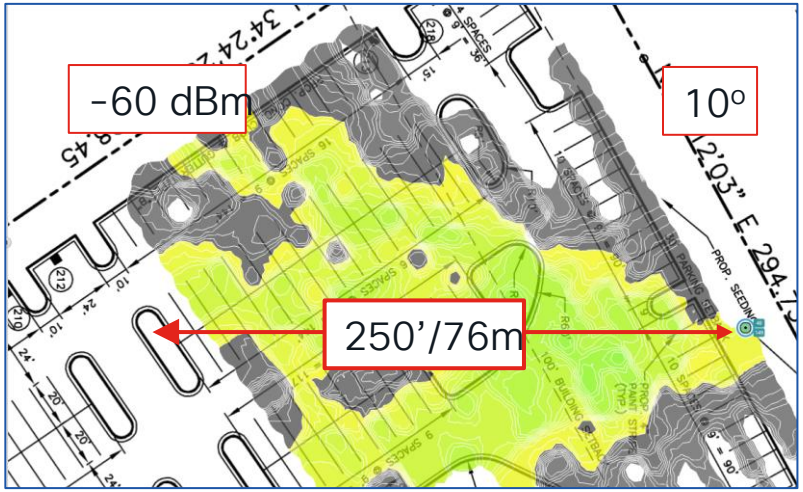


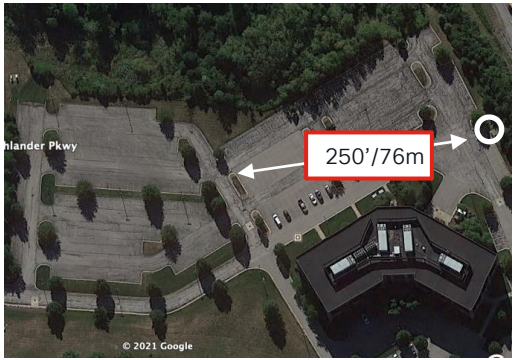
Outdoor Rated Enclosure – Inbuilt Dart, PoE mGig

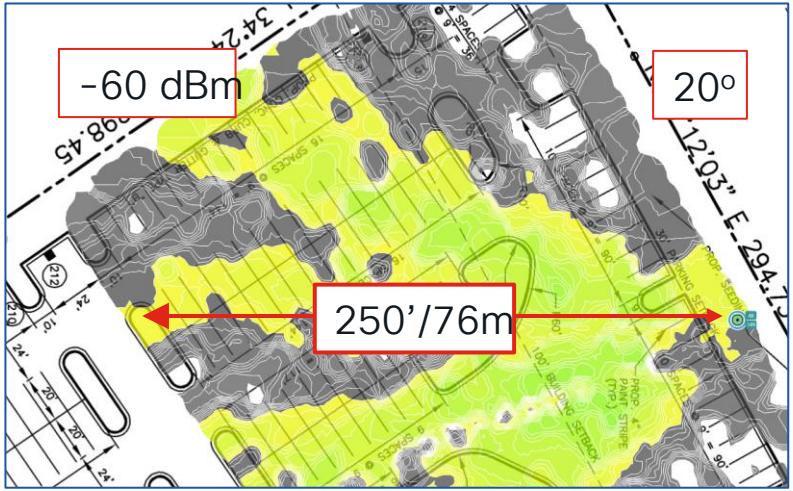
Order separate or a combined SKU with C9130 installed





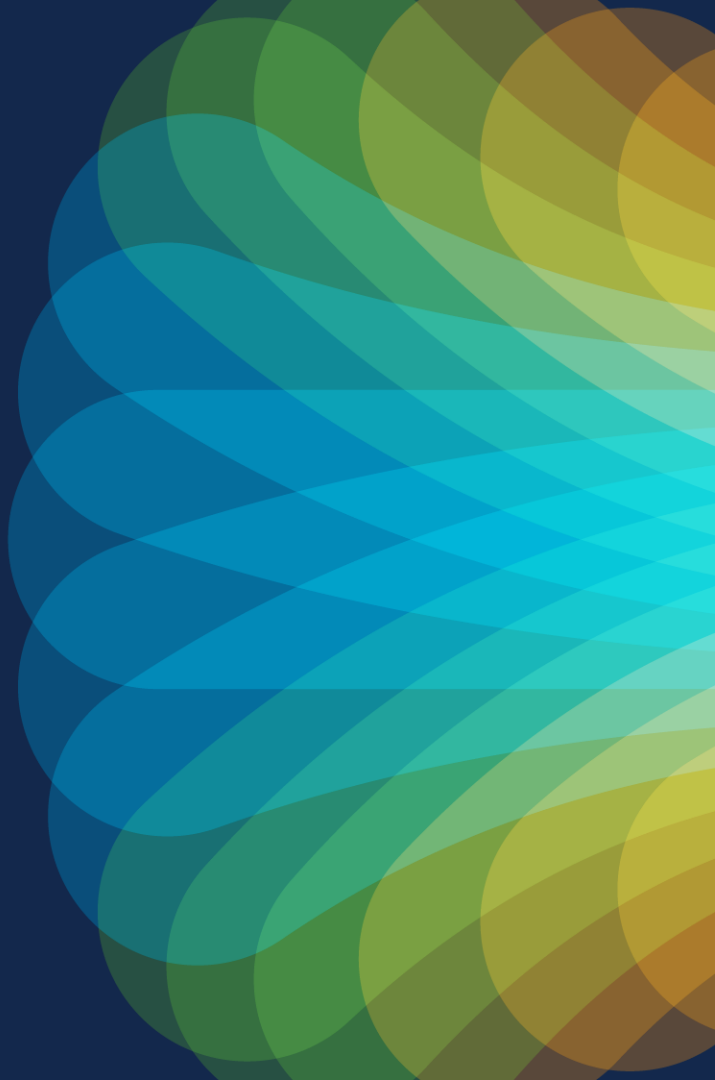






Hall 3

Catalyst Wireless CW-9166D



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Cisco Catalyst Wireless (CW) 6E Access Points

Ideal for Small to Medium-sized deployments › Best In Class, Flexibility › Mission Critical, Performance

CW9162

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

(*) Available with IOS-XE 17.9.2

CW9164

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

CW9166i/D

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

C9136

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

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

Dedicated Radio for CleanAir Pro | Same Brackets | Same Industrial Design | AP Power Optimization

9166D1 Wi-Fi 6 Access Point

NEW

Cisco® Catalyst® 9166D1-x

Directional, Tri-Radio with 12 Spatial Streams!

Orderability in FY ’24 Q1

Penta-Radio Architecture

1. 2.4 GHz Client Radio: 4x4:4SS
2. 5 GHz Client Radio: 4x4:4SS
3. 6 GHz Client Radio 4x4:4SS (XOR to 5GHz)
4. Dedicated tri-band auxiliary radio
5. 2.4 GHz IoT Radio

- **Directional antenna architecture**
- 2.4+5 GHz: 6 dBi gain (70x70 deg), 6 GHz: 8 dBi (60x60)*
- Same X,Y as CW9166I – and only 0.1cm taller!
- Wide support for pan/tilt combinations

Internet of Things Capabilities

- Built-In Environmental Sensors
- Application Hosting Technology
- USB port with 4.5 W power output

5 Multigigabit (mGig) PoE Port

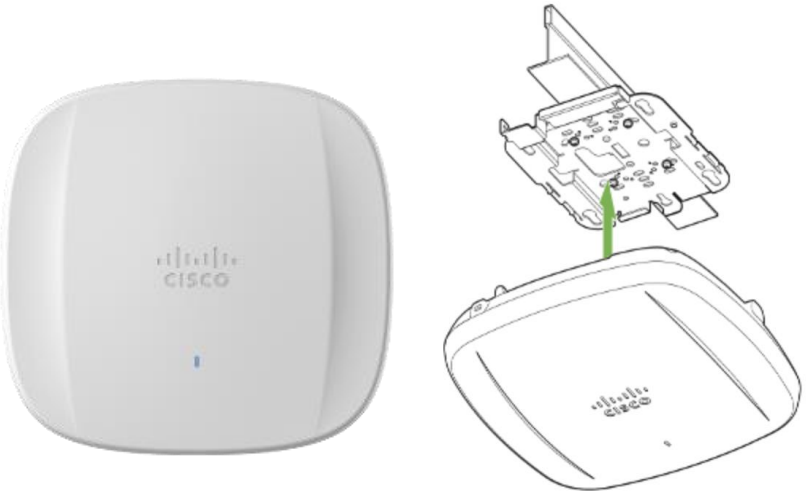
- Optional DC Power

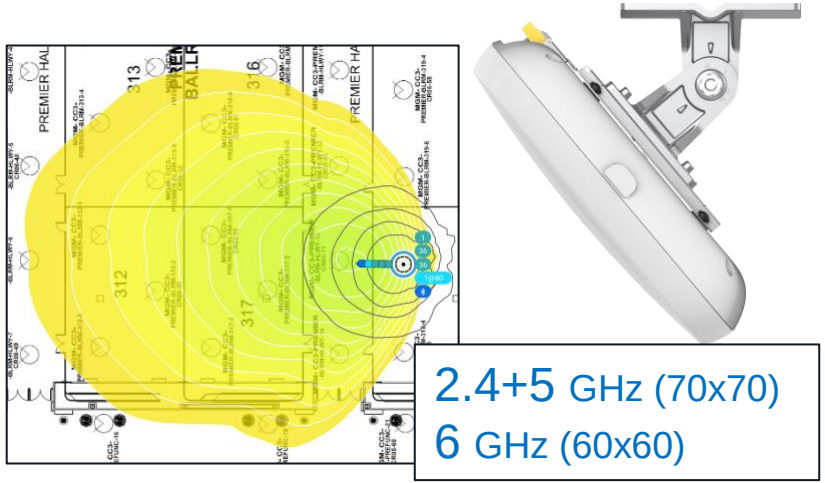
Subject to change

*2/5/6 mode

†SW support post-FCS

What's the difference between CW9166i and CW9166D1?

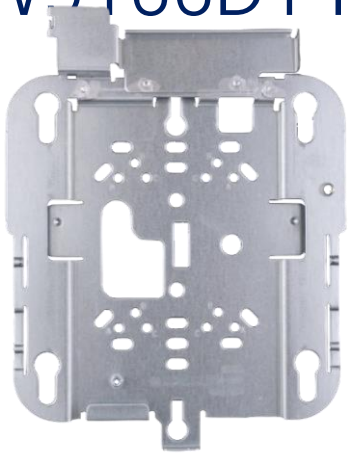


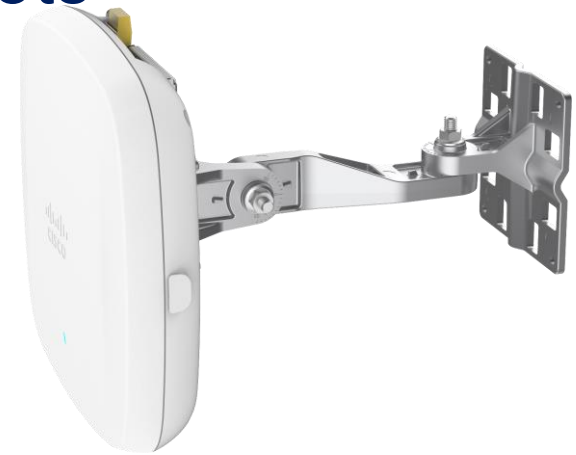


CW9166i designed with an integrated omni-directional antenna ceiling mount for a "360 degree" coverage pattern – ideal for enterprise offices, conventional buildings

CW9166D1 designed with an integrated directional antenna allowing the coverage pattern to favor the area the AP is facing - ideal for high ceiling warehouse, auditoriums etc.

CW9166D1 Mounting Brackets





AIR-AP-Bracket-2

The default bracket shipped with the 9166D designed to adapt to electrical boxes ideal for ceiling or wall mounting. Adapts to Articulating Arm.

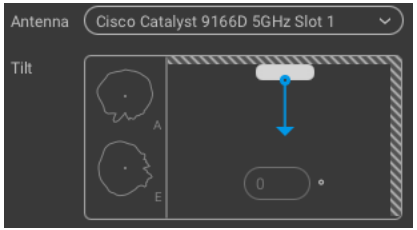
Articulating Arm

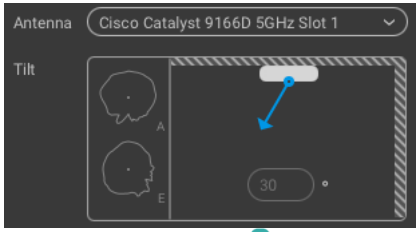
Optional bracket kit that attaches to AIR-AP-Bracket-2 allowing the AP to be articulated to cover many different mounting positions (left, right, up, down) etc. Recommended for the most flexibility in aiming the radio signal.

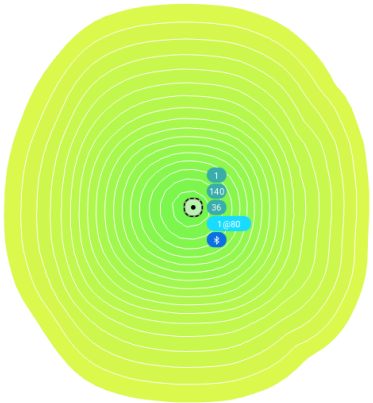
Simple Performance boosting Directionality and Isolation

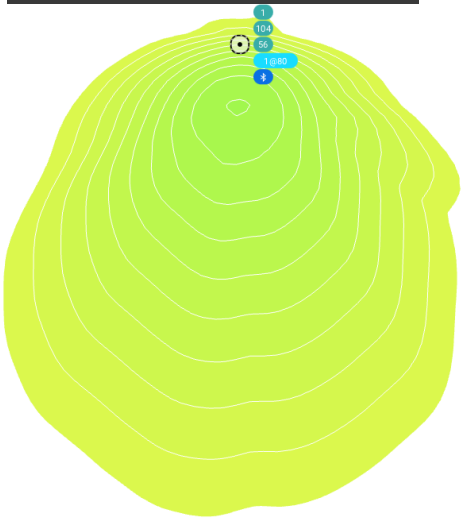
Wi-Fi 6E for challenging environments

- Provides 2x 4x4 5 GHz at 70x70
- Also 1x 4x4 6 GHz at 60 x 60
- Mounted with the antenna parallel to the floor provides nice even coverage 2.4/5 and 6 GHz
- Suitable mounting heights from 10-35’ for Tri Band coverage

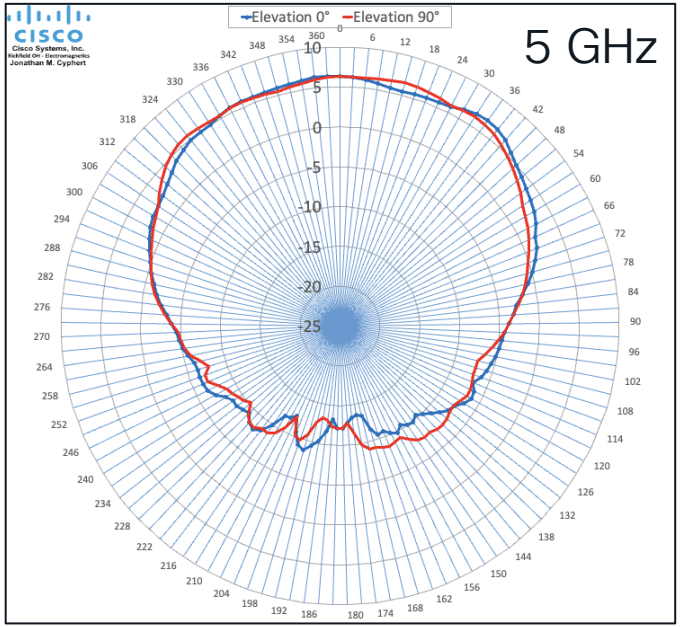


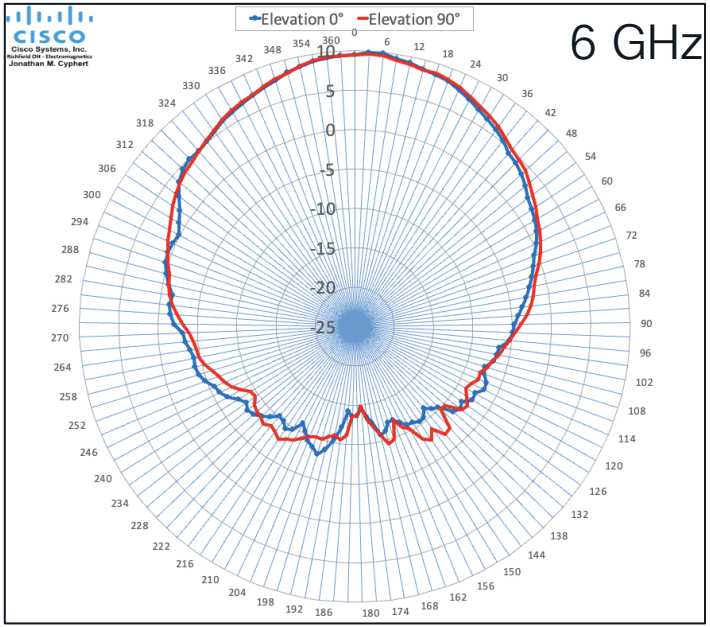






Hi-Gain Performance with Balanced Coverage

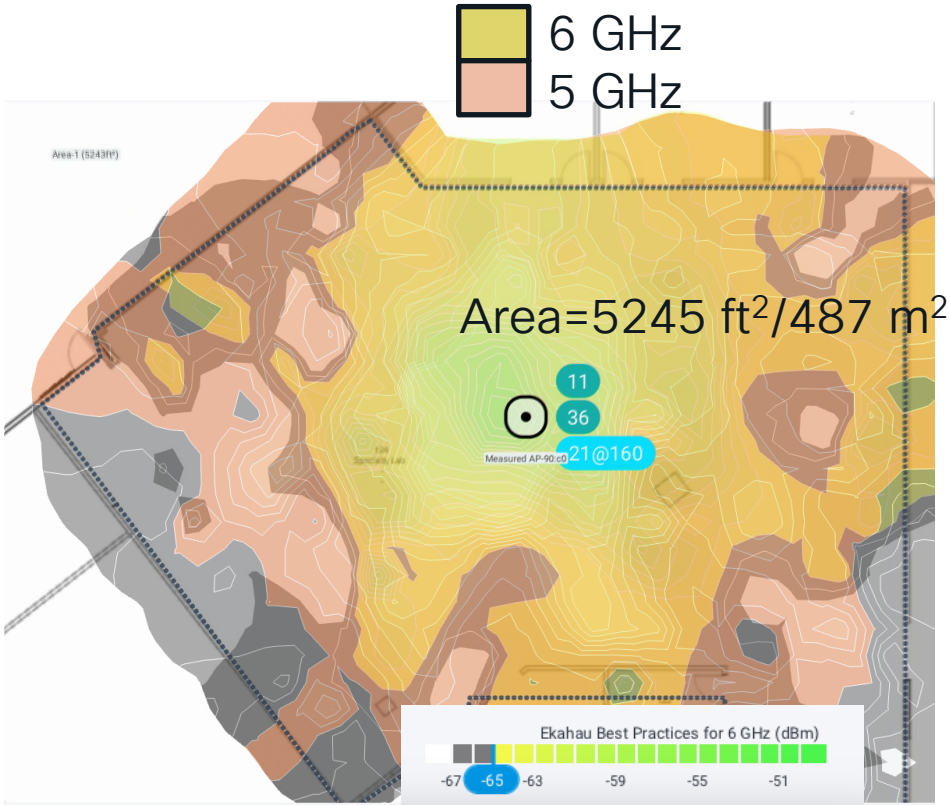




Wi-Fi 6E Low Power Indoor – High Density

Filling in the Wi-Fi 6E LPI blanks

- Indoor mounted at 12 feet/3.6m
- Power levels 6 GHz (3 dBm PL6/8) 5 GHz (2 dBm PL8/8)
- The visualization is at -65 at the floor
- Orange is 6 GHz, Brown is 5 GHz
- Great isolation and easily accommodate 3 x 160 MHz channels @ 6 GHz and 3x40 MHz channels @ 5GHz



The bridge to possible

Thank you

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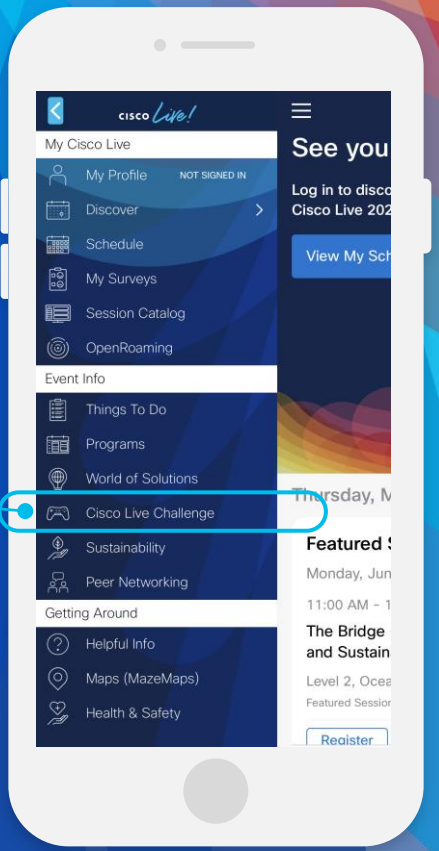

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