Outdoor Wireless

Design & Tuning

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IBOEWN-2000



Webex App

Questions?

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1. Find this session in the Cisco Events mobile app
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Agenda

This is an interactive session ***so*** here are some topics to help guide us...

- Considerations when deploying outdoors for “normal” Wi-Fi
- Recent Mesh Enhancements / Tips
- Recent WGB Enhancements / Tips
- Hardware Capability Matrix / Review

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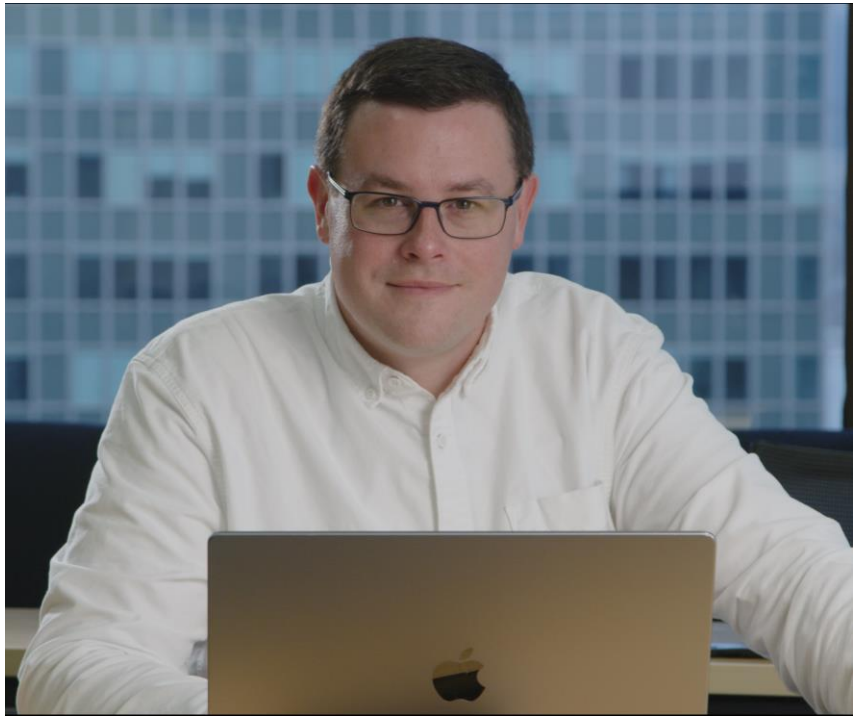
Your Speaker – Ian Procyk (iprocyk@cisco.com)



- University of B.C. (WLAN team) 2005-2009
- Canadian Coast Guard (Telecom) 2009-2010
- GBIT Logistics (IT Consultancy) 2010-2011
- Cisco Systems (Wireless Guy) 2011-today

- Ham Radio – Licensed 1997 - **VE7HHS**
- Run a WISP for EMCOMM (BCWARN.net)
- Support many amateur radio clubs / repeater sites

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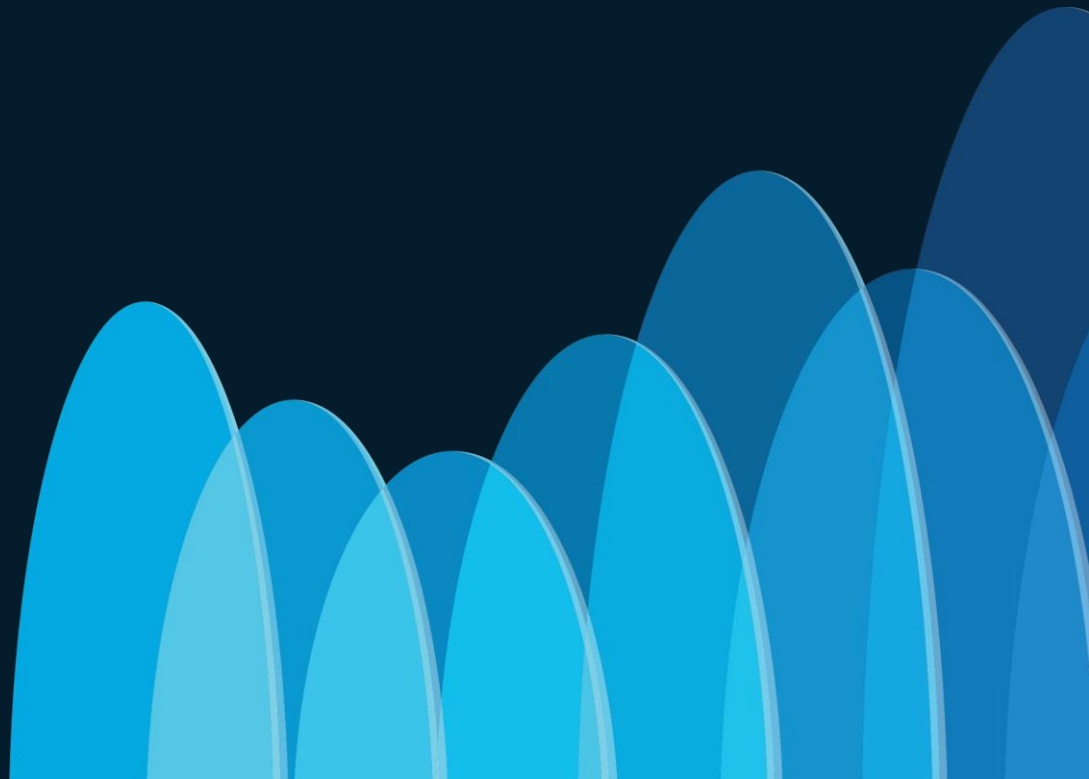
Considerations when deploying “normal” outdoor Wi-Fi



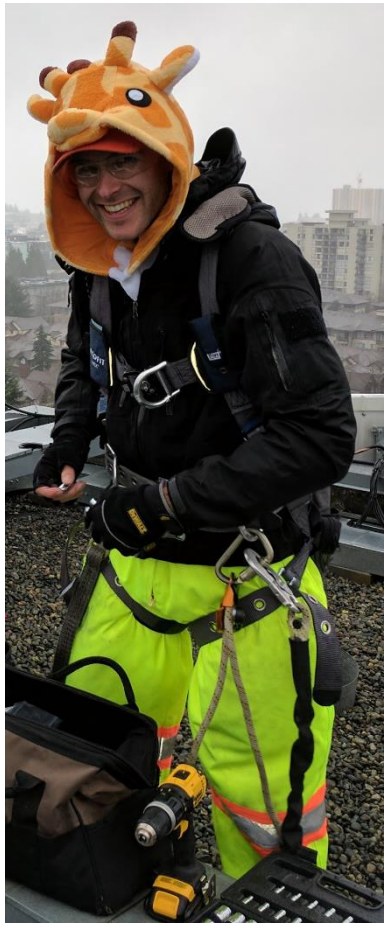
cisco Live!

Safety Considerations

- All staff trained in fall protection

- Current equipment
  -full body harness
  -horizontal lifelines
  -rope grabs
  -hardhats with chinstraps.





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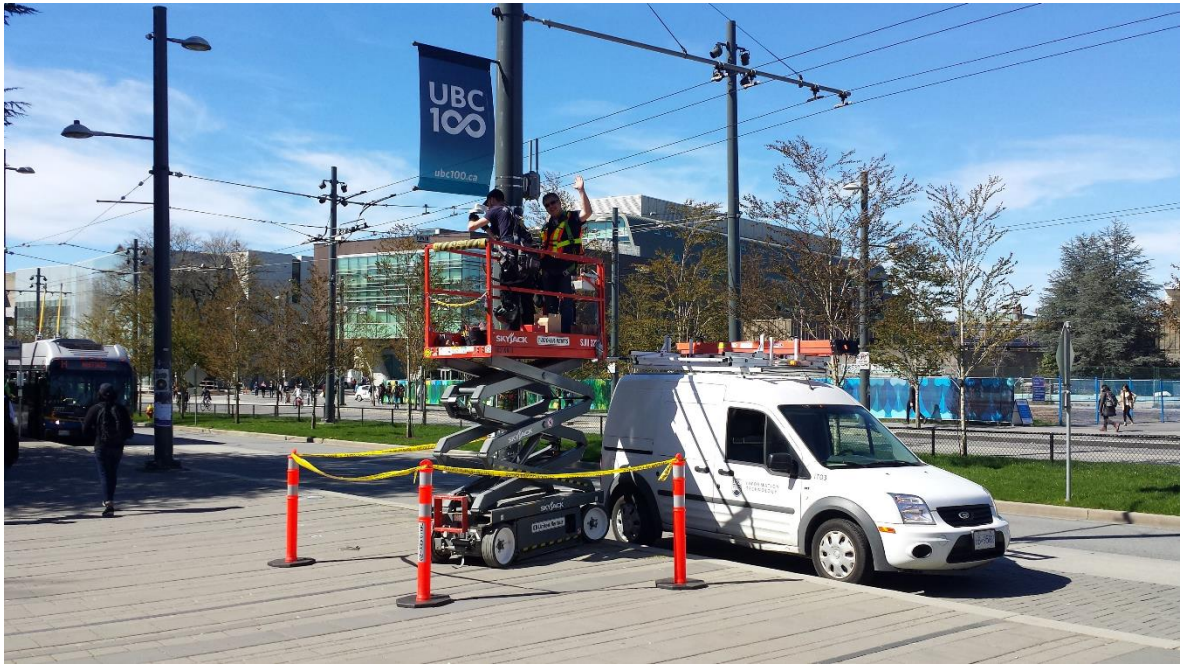
Safety Considerations

- Eliminate use of ladders where possible and practical.
- Make sure to isolate work area, especially in public spaces where “stuff” dropping can be of concern.



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Safety Considerations

- Staff trained on use of bucket trucks & boom lifts such as JLG’s.
- Installations above 30’ are very expensive and often impractical in high density areas.





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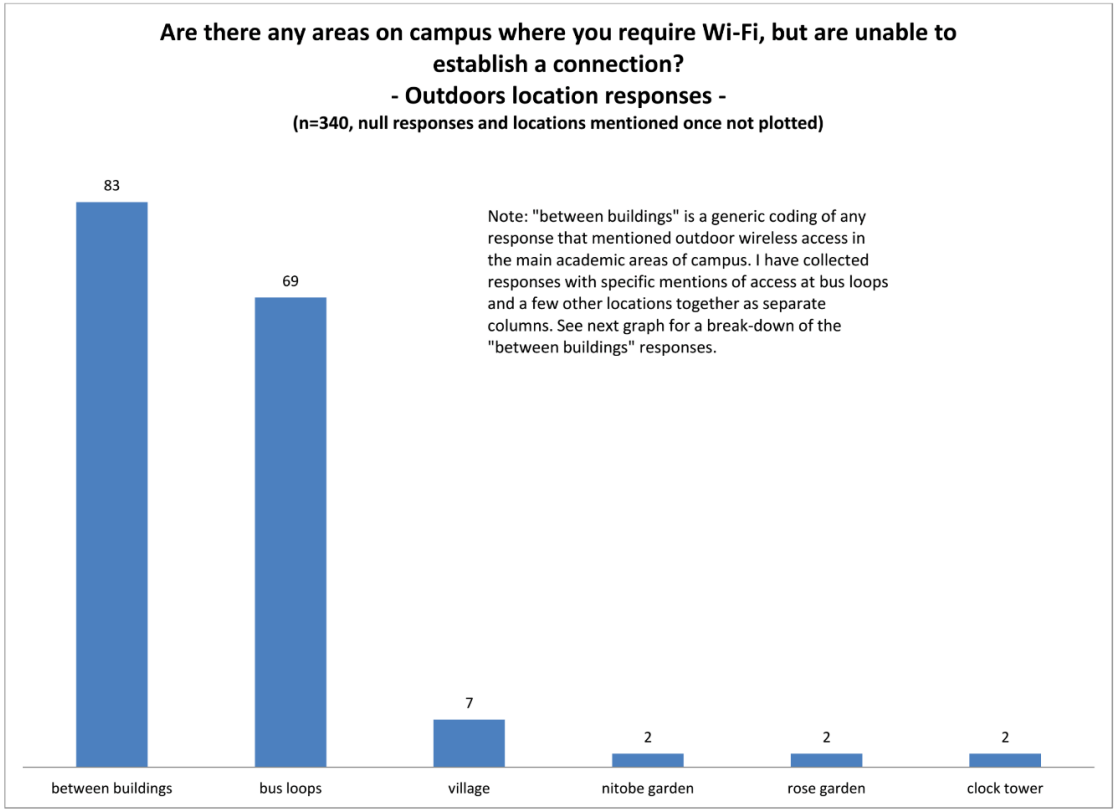
On Campus? Where do I start?



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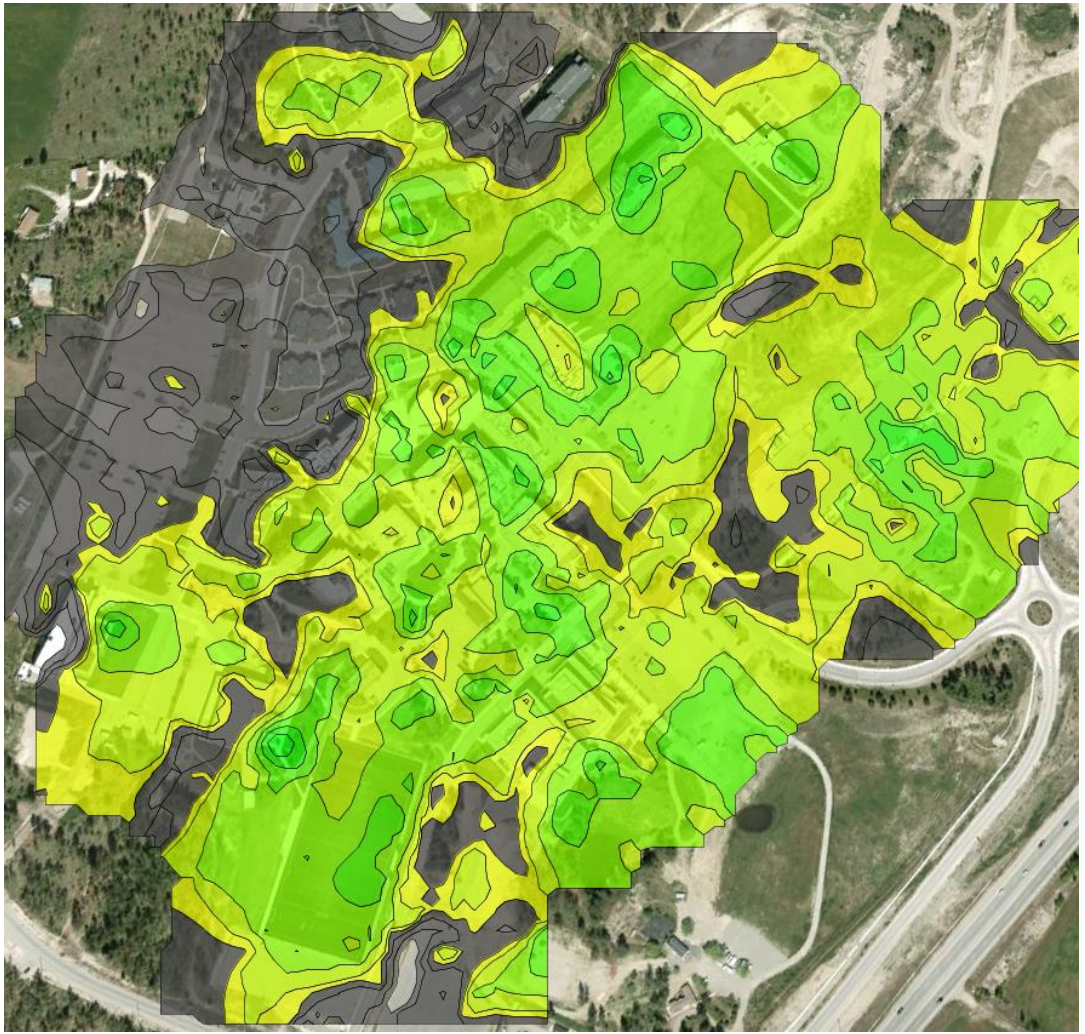
- Site survey path



- 5GHz coverage



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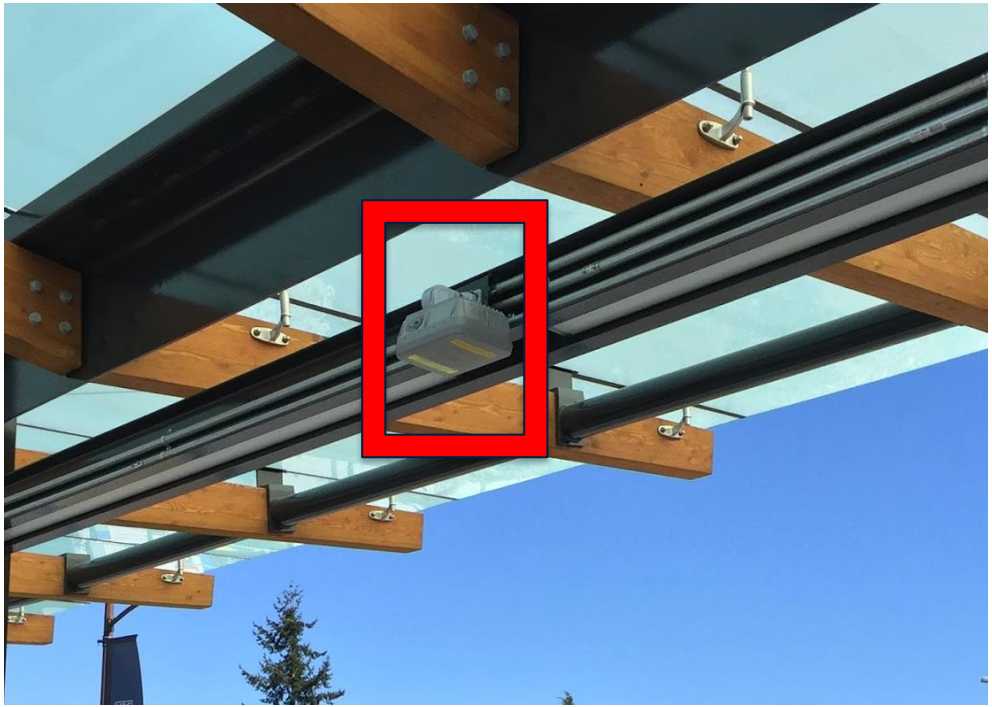



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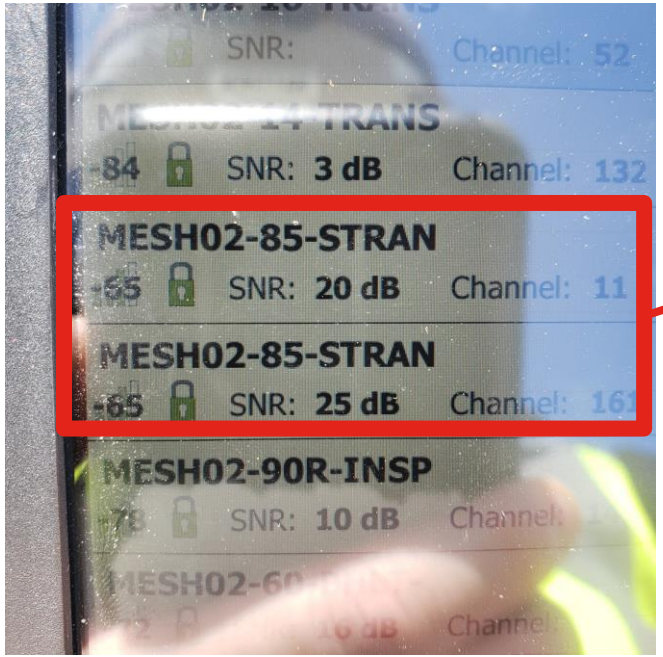
What About The Roof?



-65dBm... Not much headroom



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Blue Light / Emergency Phones

- Retrofit campus blue lights to include APs directly connected to SM fiber.
- Ideal mounting location, close to ground, good line of sight.
- High-capacity connection



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Blue Light / Emergency Phones





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No Pathway? Make One…





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No Pathway? Make One…





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Why do I need an Outdoor AP?



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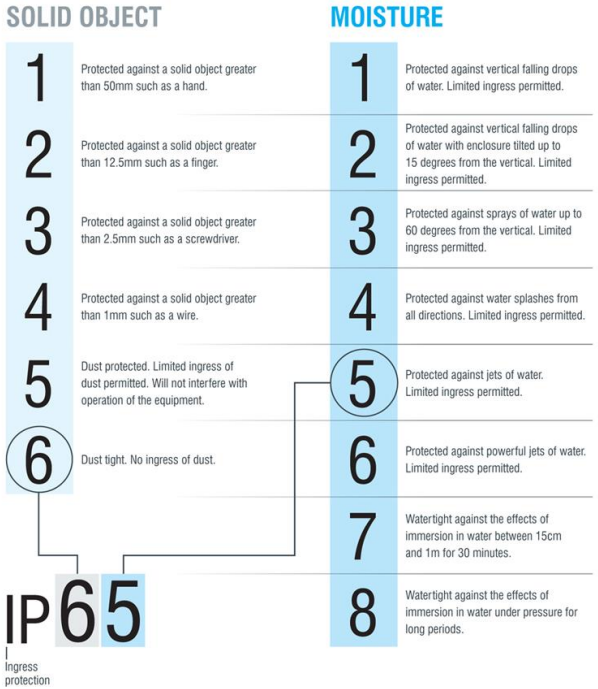
https://bboxblog.files.wordpress.com/2014/10/ipratings2-copy.jpg



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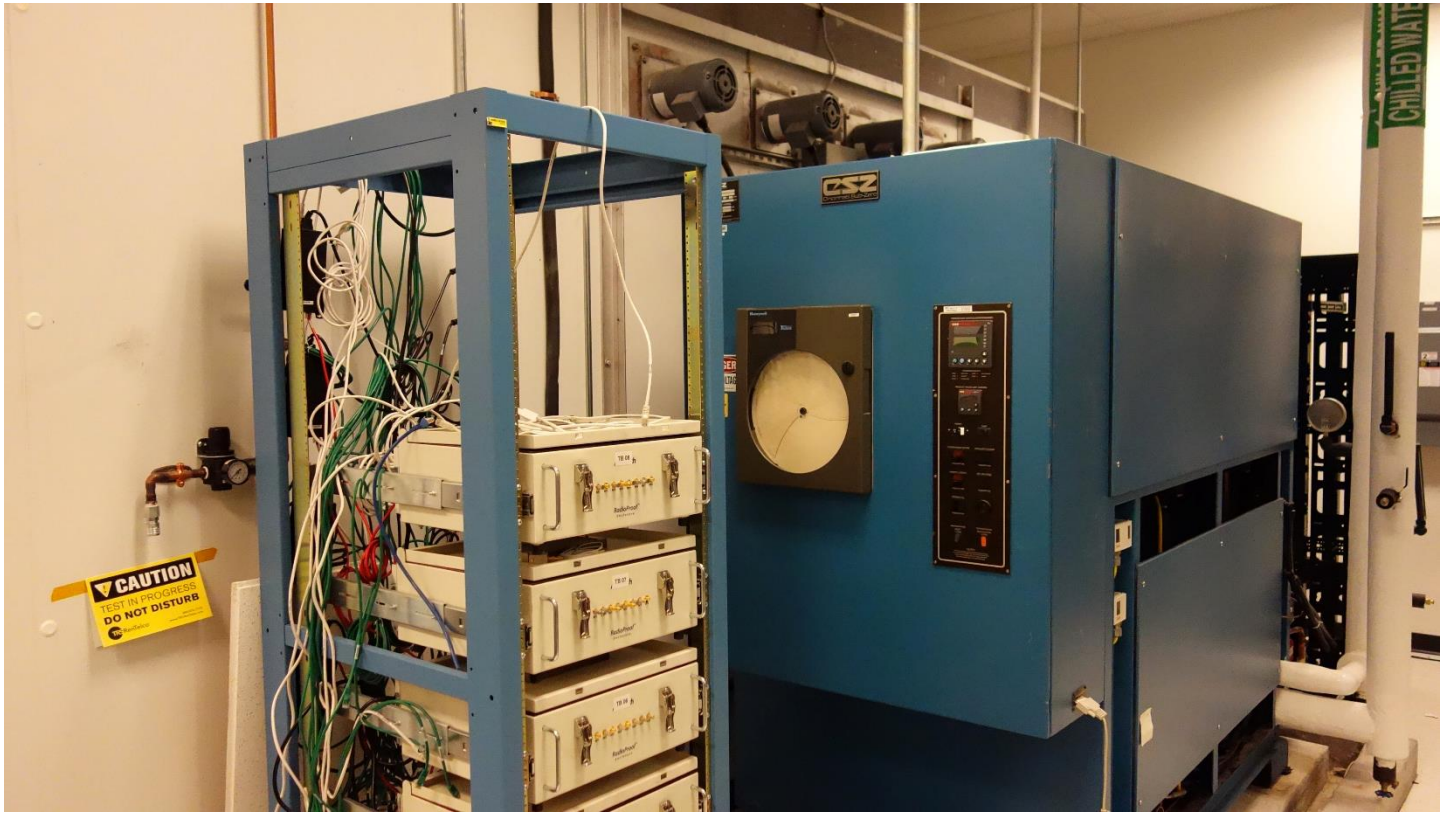
Environmental Testing



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Non-Penetrating Roof Mounts (NPRMs)

- Convenient, widely used in the cellular and satellite industry. Obtainable through telecom suppliers.
- No holes required in roof membrane as the supported load is counterweighted with paving bricks.
- Must sit on separate rubber mat to prevent damage to roof membrane. Suggest ½” rubber matt minimum.
- Building code may require seismic bracing of base and or engineering analysis of counterweight.



AP1552 shown with
10 foot mast on
on Wade antenna NPRM

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Non Penetrating Roof Mounts (NPRMs)





10x Trylon small ballast NPRMs (36”x36”) shown knocked down on left along side rubber matts. One 36x36 NPRM assembled with 20cm concrete blocks on right.

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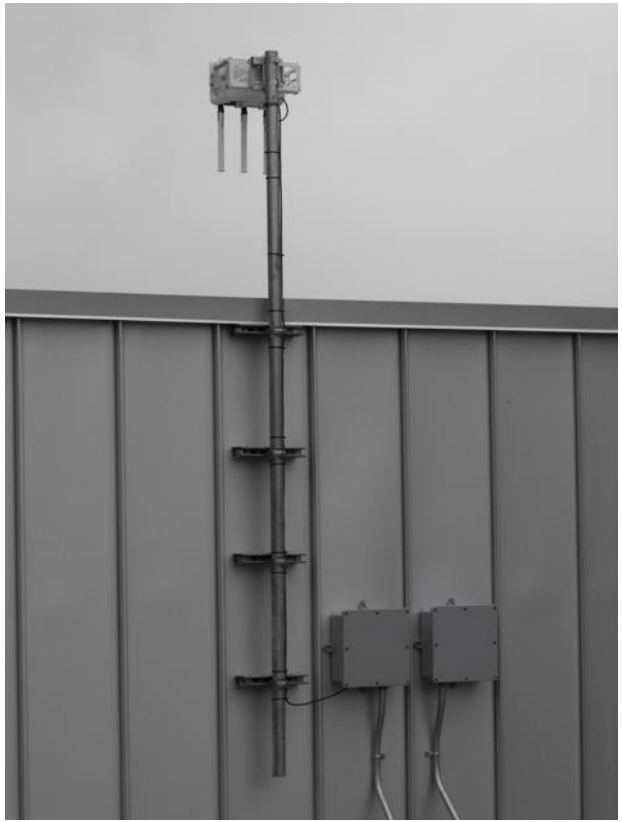
Wall Mounts
Using: Unistrut & conduit clamps





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Wall Mounts

Using: U-Bolts, clip mount with concrete anchors.





Clip Mount Kits

Our Clip Mount Kits are an extension of the adjacent clip angle kits but come standard with an additional reversible bottom angle. For wall mounting applications and sold separately, we have standard bracket options available on page 80 that can connect to concrete walls (5.951.0010.005) or combined concrete/brick walls (5.951.0011.005) up to 16" thick. See page



Kit #	Description	Qty	List Price	Wt
Small Clip Mount Kits				
5.960.0011.200	Small Clip Mount Kit	Ea	$40	6.6
5.960.0011.201	Small Clip Mount Kit fits 2⅜" OD pipe	Ea	$50	7.3
5.960.0011.202	Small Clip Mount Kit fits 3" OD pipe	Ea	$52	7.4
5.960.0011.203	Small Clip Mount Kit fits 3½" OD pipe	Ea	$54	7.4

Note: Two 9/16" holes are spaced on 6" centers.



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Custom Wall Mount
Fabricated in-house @ University Customer.



Not the most ideal setup (omni antennas against a wall). Aesthetics concerns at this location prevented an alternate location or design.

Signal from this AP covers a wide-open field which ends 350 feet away.

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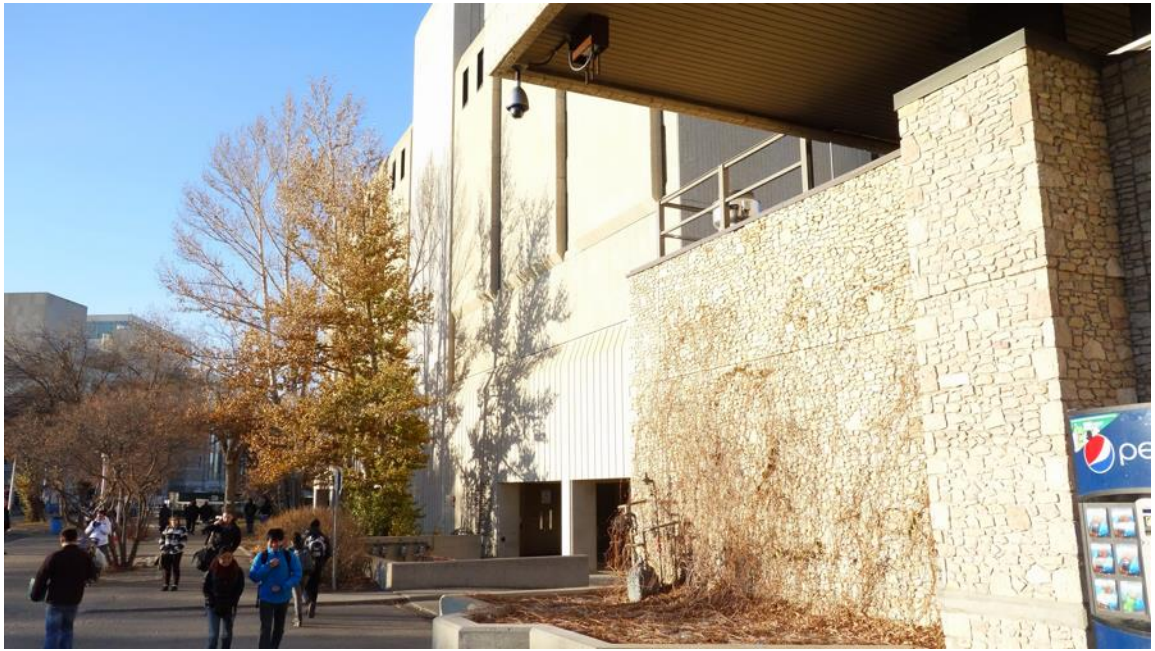
Custom Ceiling Mount
Fabricated in-house @ University In Canada





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Ideas for roof penetrations





A hole big enough for a 3” conduit was cored through the roof during renovation.
This hole was then covered over with a pre-cast slab which housed the CAT6 drop.
An elevated conduit pathway was established to AP location using rubber roof blocks obtained from Wesco Distribution (electrical supplier).



An electrical service entrance weather head provides a path for cables in this rooftop application

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Hardware Installation Guides

- A hardware deployment guide is published that accompanies each product Cisco makes.
- These guides are specifically helpful in understanding the various mounting brackets and installation options for each product.
- Grounding, lightning protection, antenna configurations and weatherproofing are also covered.



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Quick Summary

- The cost of deploying an AP outdoors is often **2-4x the cost of the hardware itself**.
- Fall protection training/equipment, engineering approval and pathway (coring etc.) drive installation cost up. As result, it is critical that time be spent up front to identify locations with the most “bang for buck”.
- Higher is not always better – ideal deployment height with Omni’s is often below 40’.
- Look to mount on building corners to maximum coverage areas
- Think about RF coverage like lighting – “where would I hang this light to minimize shadows? “

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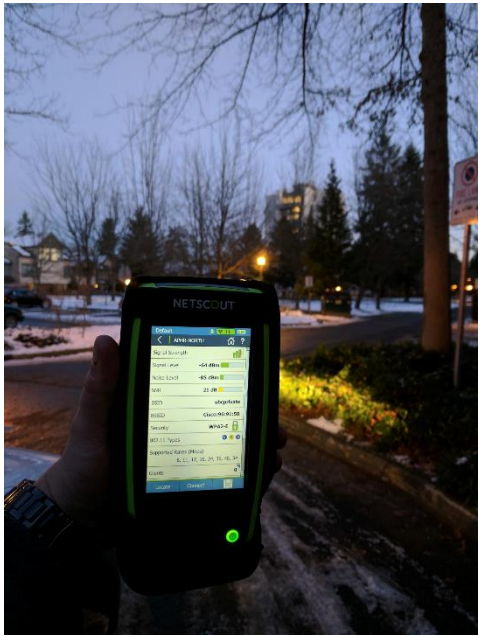
What’s in the air?



Building an Outdoor Sniffer





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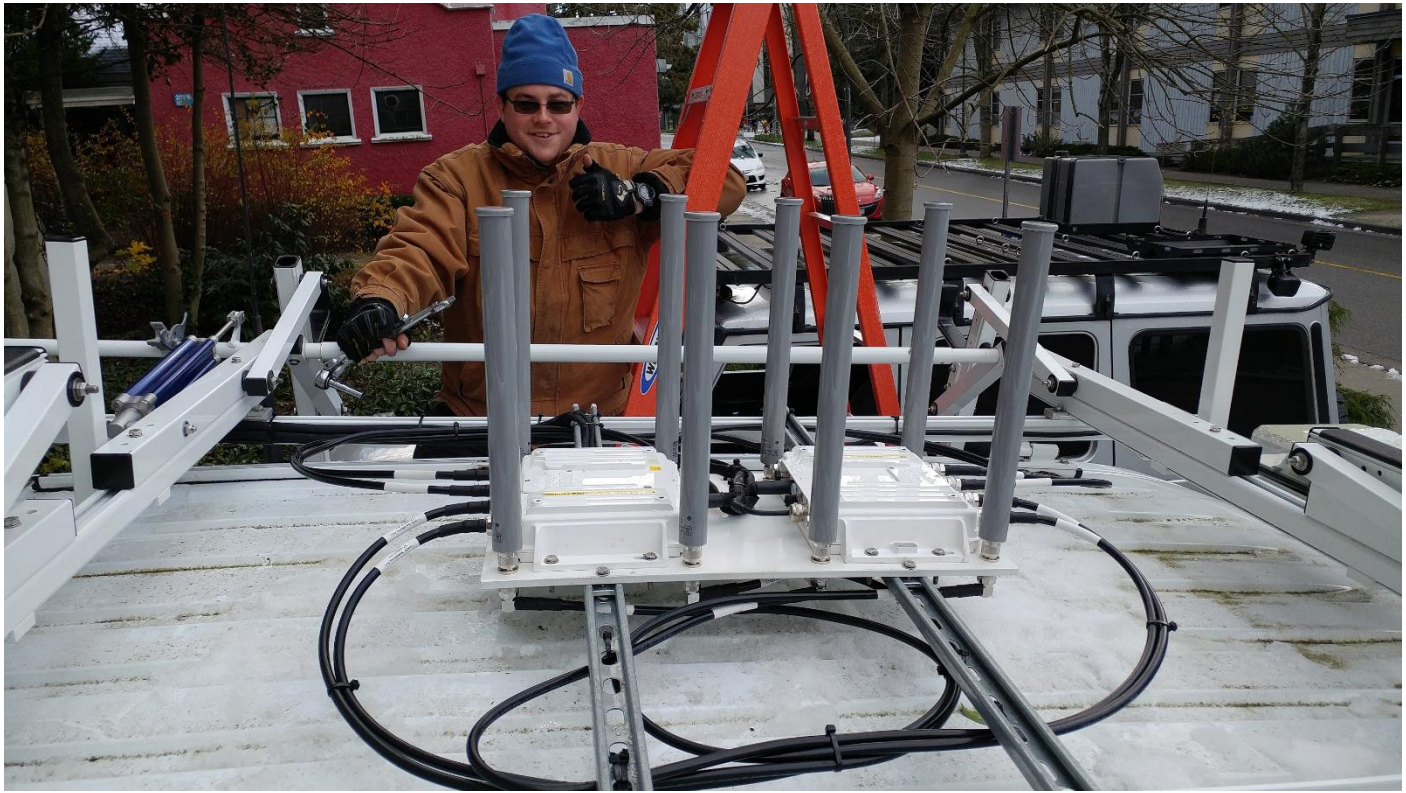

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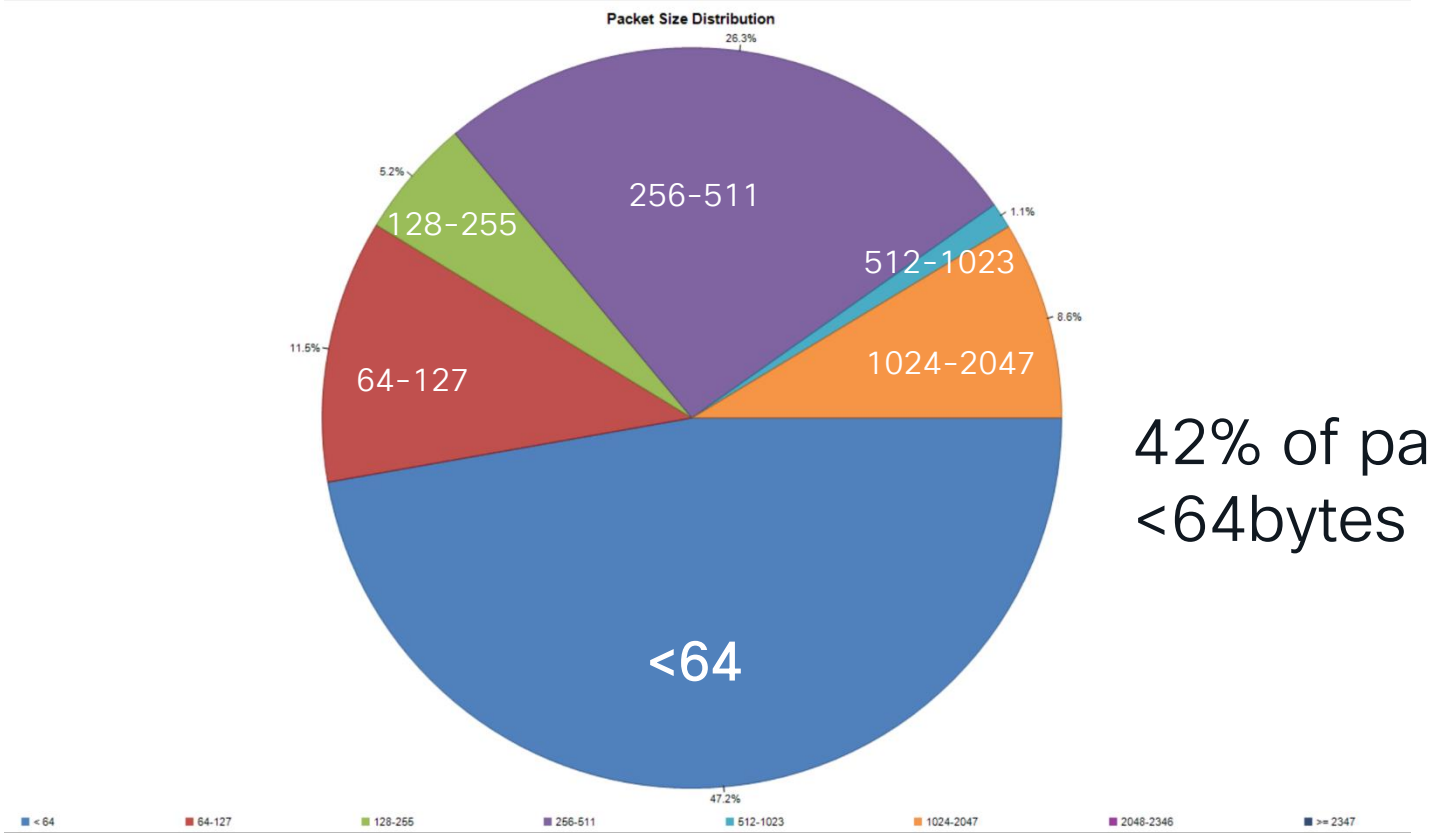
Over-The-Air Packet Size Distribution



42% of packets <64bytes

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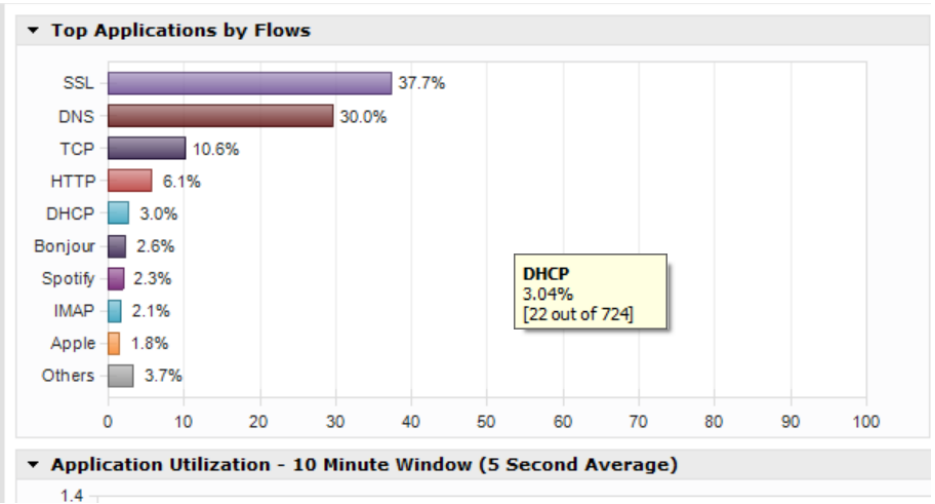
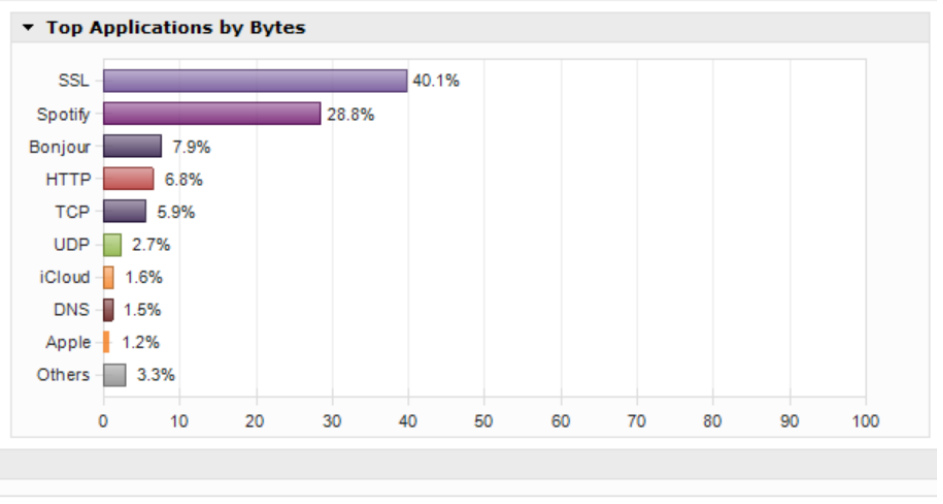
Protocol breakdown





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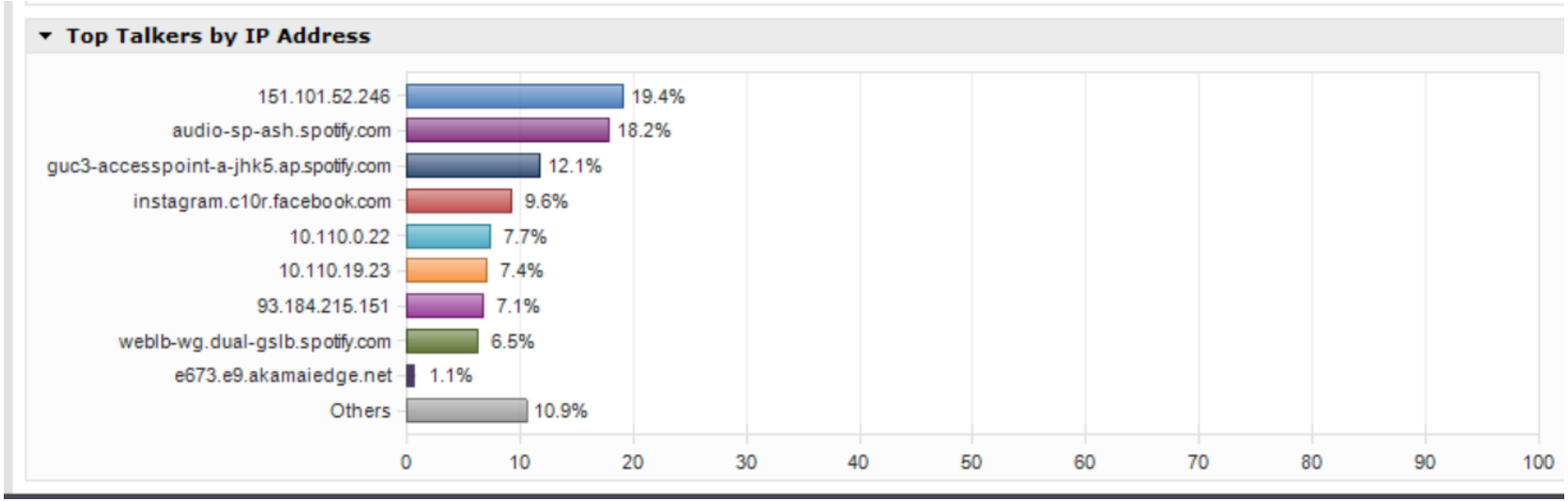
Top Applications

- Near the bookstore (Spotify)



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Comparing Indoor vs Outdoor Retry Rate

802.11 Analysis	Packets	Bytes	Value
Average Signal Strength			39.525
Average Signal dBm			-63.133
Average Noise			36.857
Average Noise dBm			-82.469
802.11 Data	19.275%	29.371%	
802.11 Management	18.706%	13.110%	
802.11 Control	34.189%	1.764%	
Local	54.059%	14.988%	
From DS	11.837%	27.[illegible]9%	
To DS	6.231%	2.098%	
DS-DS	0.043%	0.011%	
Retry	7.989%	13.112%	
Encrypted	16.409%	28.367%	
Decryption Errors	0.000%	0.000%	
Order	0.000%	0.000%	
Unprotected Data	1.440%	0.168%	
Minimum Data Rate Packets	0.043%	0.011%	

Indoor

Packets	Bytes	Value
		28.164
		-59.092
		26.725
		-79.848
18.357%	27.699%	
21.168%	23.499%	
34.525%	2.941%	
56.635%	26.600%	
10.397%	24.[illegible]0%	
6.895%	2.999%	
0.123%	0.051%	
19.453%	28.501%	
7.723%	16.337%	
0.000%	0.000%	
0.000%	0.000%	
1.455%	0.324%	
0.167%	0.074%	

Outdoor

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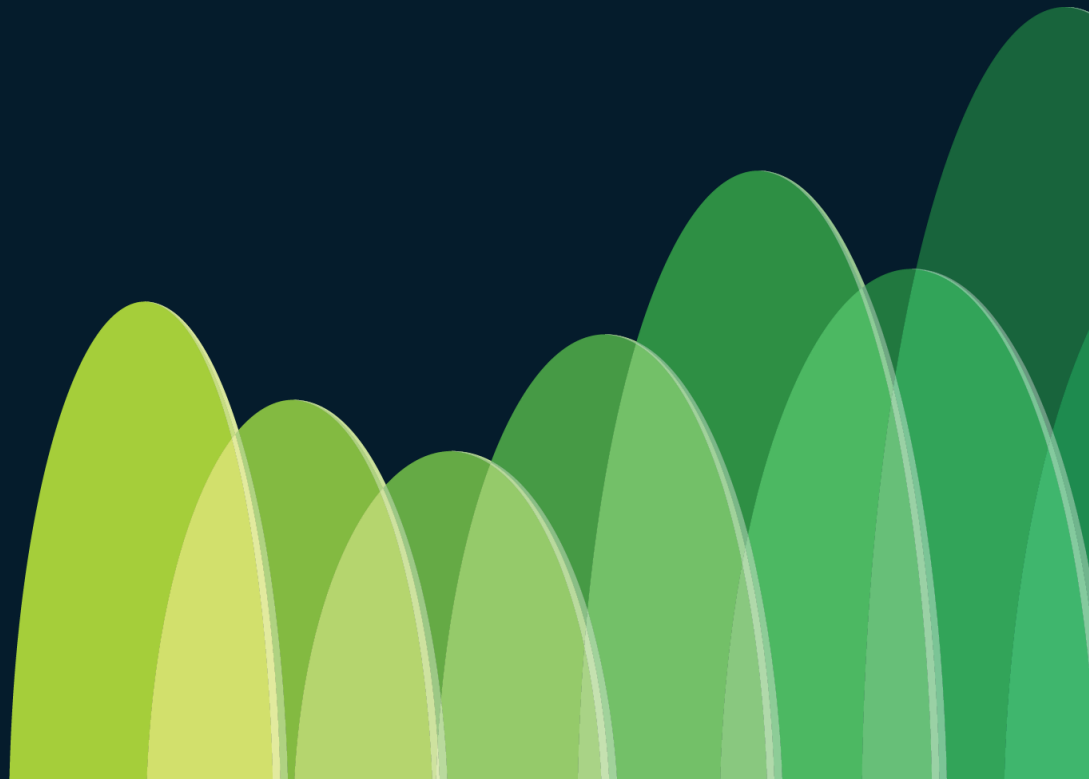
Recent MESH Improvements



Recent MESH Enhancements

Thanks to Anirban Karmakar (DE) & Vincent Cuissard (DE) + Pason Systems (Customer)

Release	Notable Feature
17.6	**Least congested channel scan on RAP boot-up:** Optimizes the initial channel the MESH starts on, before RRM gets a chance to start running
17.6	**Convergence Time Improvements**
17.7	**Serial Backhaul for 9124**
17.9	**Backhaul RRM Phase 1:** RAPs can change channels while MESH APs are connected
17.9	**Backhaul SNR cutoff lowered to 5dB SNR**
17.9	**Huge throughput increase on Ethernet Bridging (almost double ☺)**
17.12	**AP Boot Time Decrease (RS-232 @ 115,200 Baud)**
17.12	**More MESH OPER STATS in the Yang Model**
17.14	**Backhaul RRM Phase 2:** RAPs take RRM stats from the MAPS in the MESH tree into consideration

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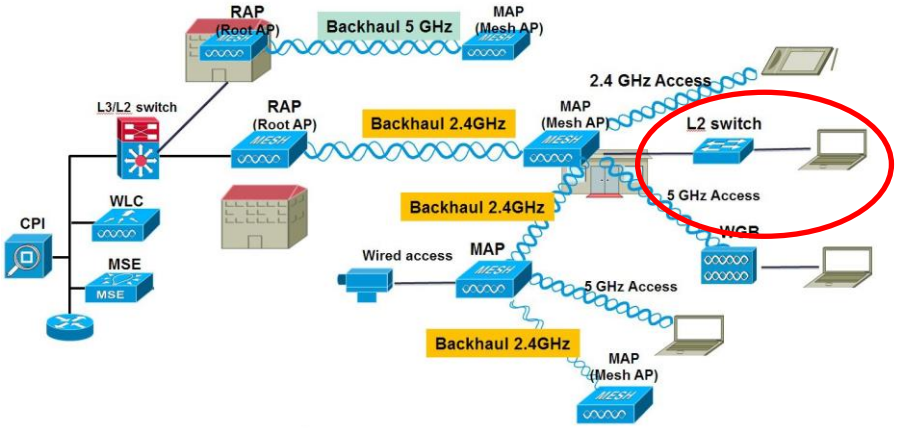
Recent MESH Fixes Related to MCAST / UNICAST Flooding

Thanks to Anirban Karmakar (DE)

Fixed Release	Notable Feature
17.9.5esc +17.12.4	CSCwi42112 - Wired Clients MAC address are being learn from the 9124 MAP port
17.9.5esc +17.12.4	CSCwj34753 - MAP is reflecting back client unicast traffic on the wired port



Note:
These are critical fixes to take advantage of if you have a switch operating behind your MAP.

<u>Especially</u> important if you have STP running (TCN's cause a temporary flood of traffic)

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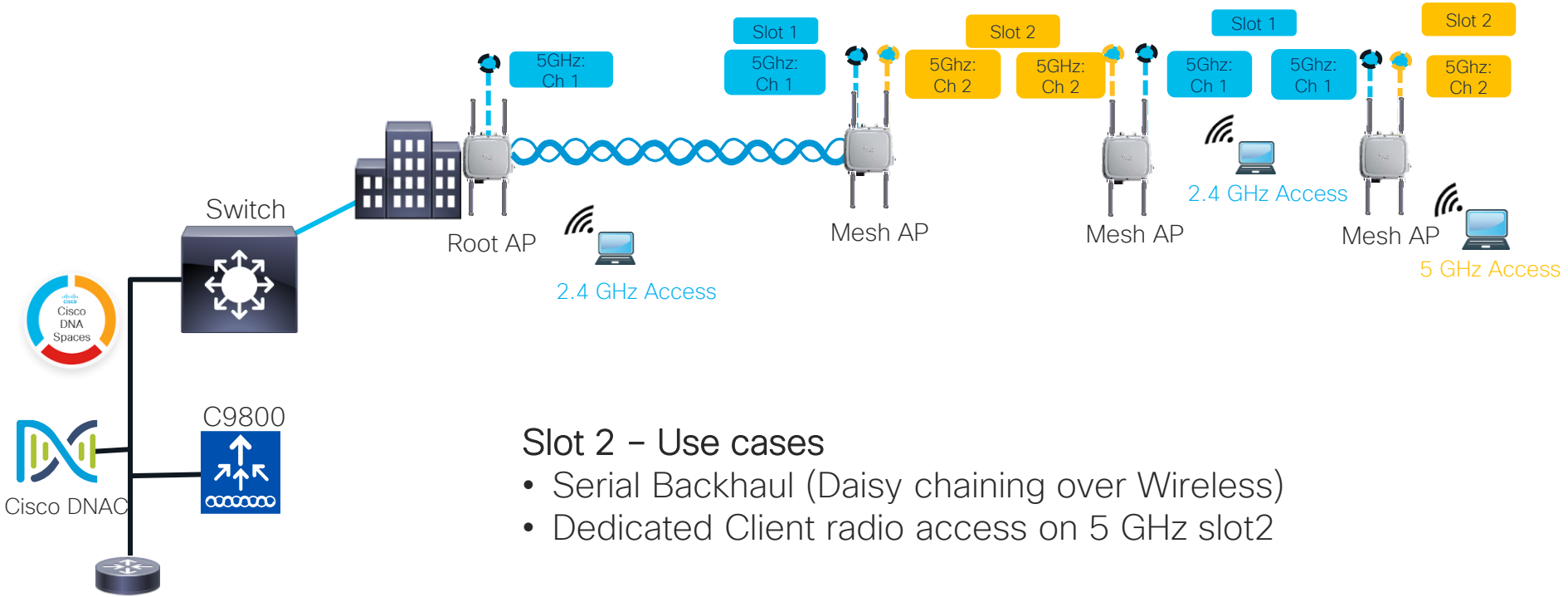
Solution Overview – Mesh Serial Backhaul



Slot 2 – Use cases

- Serial Backhaul (Daisy chaining over Wireless)
- Dedicated Client radio access on 5 GHz slot2

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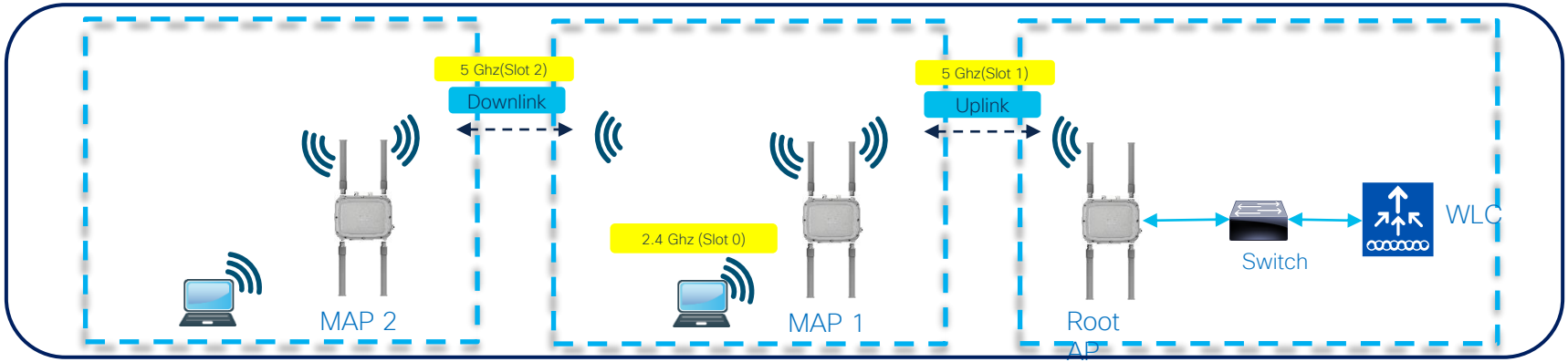
Mesh – Designated Downlink



- Mesh Serial Backhaul(SBH) allows us to maximize throughput over multiple mesh hops
- Allows network segregation.
- Enables us to use different channels on different backhauls, which helps in avoiding localized link interferences
- In above deployment, Slot 1 is used for Uplink, Slot 0 is for Client Access and Slot 2 is the designated Downlink

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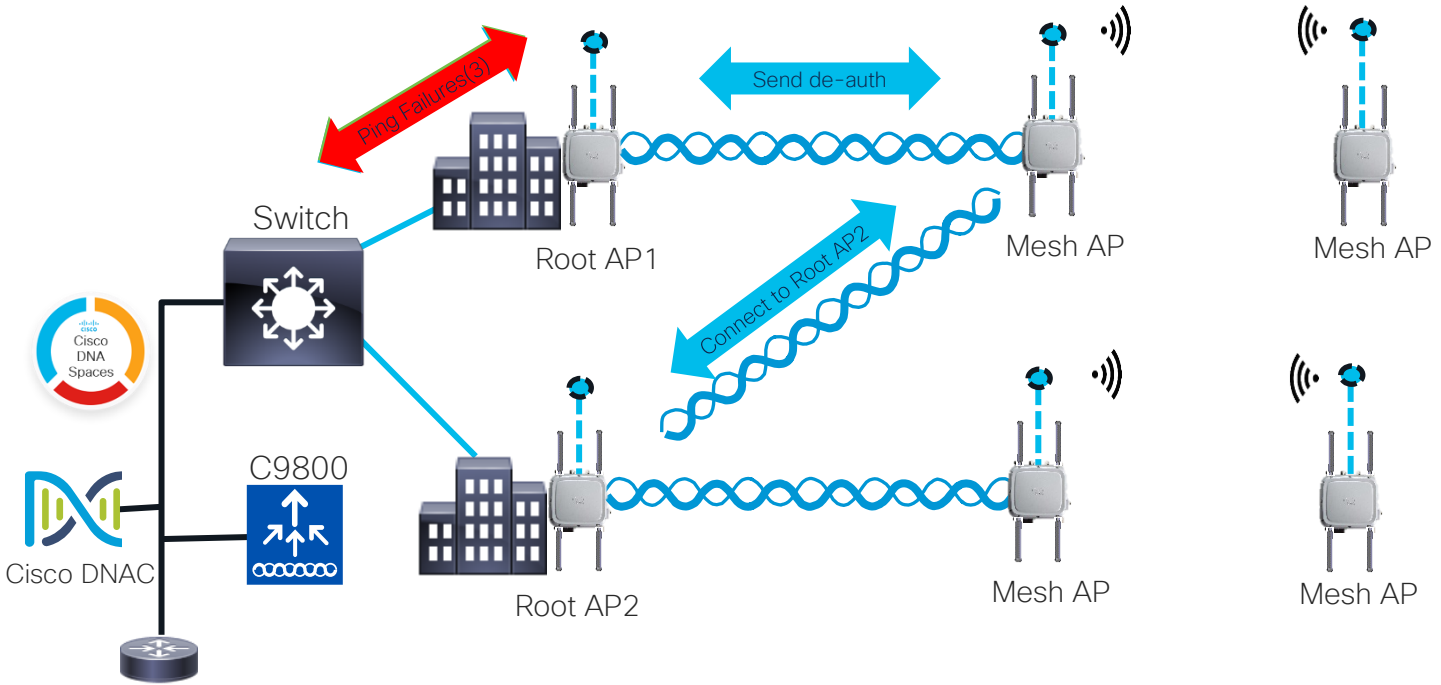
Fast Teardown – Gateway Down



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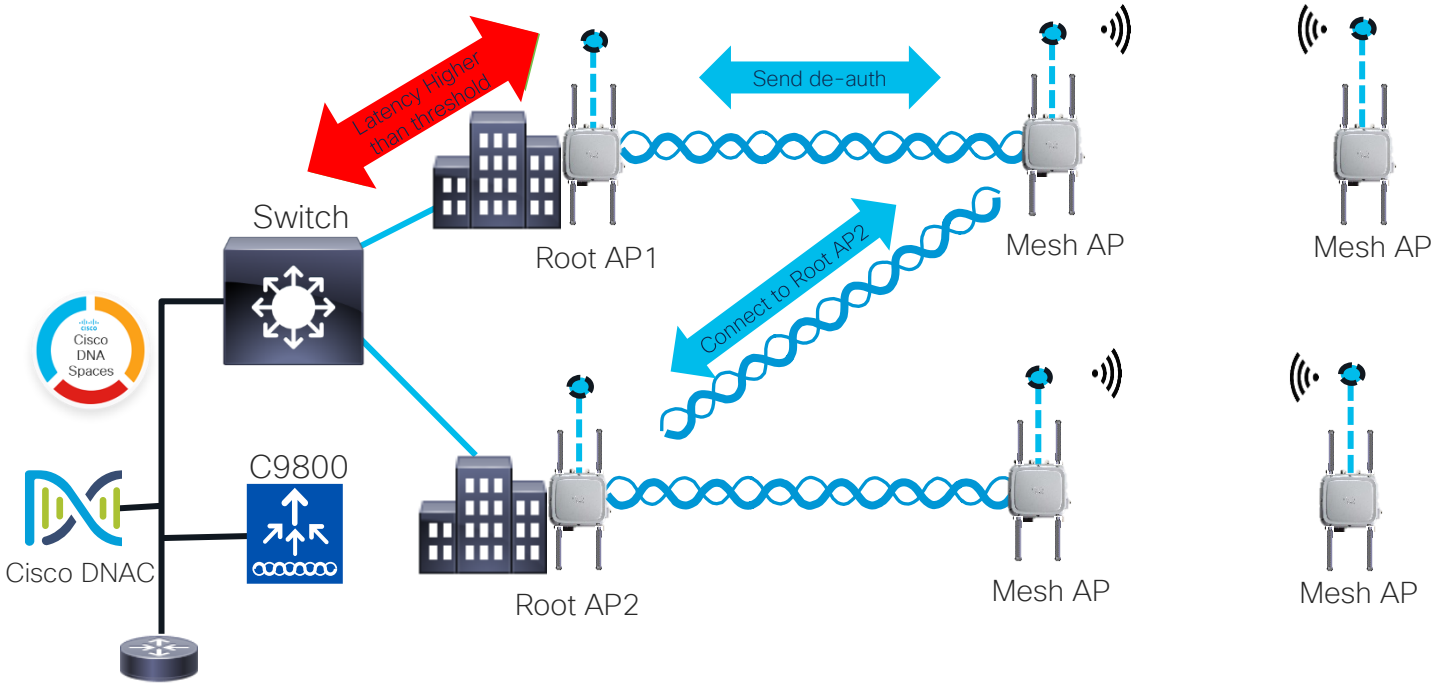
Fast Teardown- Latency High



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Channel Assignment – Initial Phase – Serial Backhaul

Design	❑ Uplink and Downlink channels shall be different ❑ All 5G radios shall respect a frequency guard between their operating channel (HW dependent, for example Ithaca (AP9124) 100Mhz) ❑ DFS channels shall be supported
RAP	❑ Uplink is Wired. The RAP uses the channel given by WLC
MAP	❑ The MAP connects to a Parent as first step. Once uplink is ready, then the MAP will select the best channel to be used. Different from Uplink, that respects frequency guard of the platform.

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Channel Assignment – Serial Backhaul

Radio Assignment	❑ No per-AP configuration, Uplink and Downlink radios are statically assigned as radio profiles. (e.g., radio 1 => Uplink, radio 2 => Downlink). Provides a control over field deployment on radio selection for uplink and downlink and connect antennas accordingly
Client Access	❑ Basic client access will be offered on 2.4 Ghz radio and 5 Ghz radio (not used by serial backhaul) ❑ Universal client access will be available only on the downlink backhaul radio
Role of WLC	❑ WLC provides configuration knob to enable/disable this feature. WLC does check if the AP supports serial backhaul feature by looking at AP capabilities

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Channel Assignment – Events – Serial Backhaul

Radar

- Each mesh node shall perform radar detection on DFS channel. In non-serial-backhaul mesh networks WLC receives DFS event and assigned a new channel to RAP.
- When a serial backhaul detects a radar event on its downlink channel, it sends this radar event to WLC, then the AP will select a new channel (by using FreqGuardFx({Channel list – { uplink-channel – DFS_radar_channel} })

Roaming

- When MAP roams to a new parent, it follows the initialization procedure:
  - ✓ Select the best downlink channel
  - ✓ Notify children of the change (CCA)

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Configurations – Serial Backhaul

Config

```
C9800(config)#wireless profile radio mesh-downlink
C9800(config)#mesh backhaul
C9800(config)#[no] mesh designated downlink

C9800(config)#wireless tag rf map-tag
C9800(config)#dot11 5ghz slot2 radio-profile mesh-downlink

Associate the RF Tag to the Access Point
```

Verify

```
C9800# show wireless profile radio detailed <profile>
Radio Profile name: <profile>
Description:
Beam-Selection: Not configured
Mesh
  Backhaul: <true/false>
  Designated downlink: <true/false>
```

- ✓ Executed in CLI radio profile config mode
- ✓ Enables/Disables the serial backhaul feature
- ✓ Once configured following warning is printed:

  "Warning! Designated downlink supported only on slot2 of mesh APs, associate in the rf tag accordingly"

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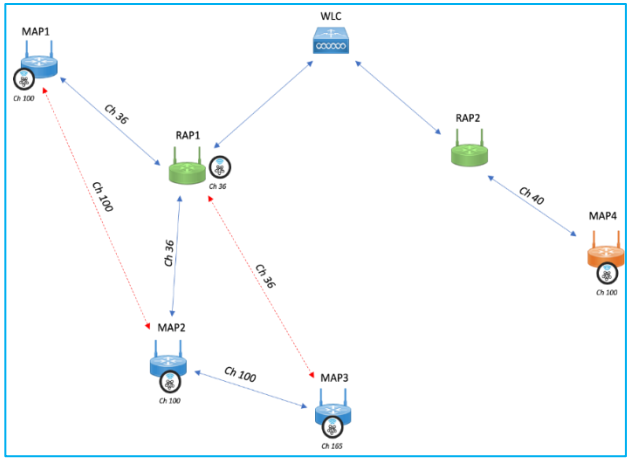
Mesh Config – Serial Backhaul

```
C9800# # show mesh config
AP Specific Configuration:
AP Role: Mesh AP
Backhaul Mode: 802.11a
Internal DHCP Running Status: Disabled
Strict Wired Uplink: Disabled
Background Scanning: Disabled
Strict Matching BGN: Disabled
Convergence Method: Standard Convergence, CCN mode: Disabled
Ethernet Bridging BPDU Allow: Disabled
Daisy Chain Mode: Disabled
.....
Preferred Parent: 00:00:00:00:00:00
CAPWAP Join Mode: Not configured
Daisychain STP Redundancy: Disabled
Bridge Group Name:
Mesh Block Child State: Allowed
Serial backhaul: Enabled
Radio config:
 Slot0:          [        backhaul:Enabled        supported_downlink:Disabled
designated_downlink:Disabled ]
  Slot1:         [        backhaul:Enabled        supported_downlink:Enabled
designated_downlink:Disabled ]
  Slot2:         [        backhaul:Enabled        supported_downlink:Enabled
designated_downlink:Enabled ]
```



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Solution Overview – Mesh Forced Roam

What?	❑ Detects the Uplink failure on Root AP (RAP) in the Mesh Sector
How?	❑ Periodic Ping Test to Gateway at frequent intervals ❑ Latency check of Ping Test
Action	❑ When there are Ping Failures (Configured Retries) or Ping Latency is higher than the configured threshold, the RAP triggers a de-auth in the MAP ❑ MAP roams to next available parent and resumes service

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Forced Roam – Configurations

Base Config	❑ All these configurations are part of IOS-XE Mesh profile
Configurable options	❑ Ping Interval – At what interval should the Ping to GW be sent ❑ Ping Retries – Acceptable number of failures to conclude Uplink down ❑ Ping Latency – Latency threshold to take decisions
Fallback	❑ Option to configure the wait time – Allow RAP backhaul to stabilize ❑ Configure time during which RAP should not accept MAPs

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Fast Teardown – Configurations

Config

```
C9800(config)#wireless profile mesh default-mesh-profile
C9800(config-wireless-mesh-profile)#fast-teardown
C9800(config-wireless-mesh-profile-fast-teardown)#
```

Verify

```
C9800#show wireless profile mesh detailed default-mesh-profile
Mesh Profile Name              : default-mesh-profile
-----------------------------------------------
Description                    : Default multi bssid profile
Bridge Group Name              : unconfigured
.......
Fast Teardown                  : ENABLED
  Number of Retries                : 4
  Interval in sec                  : 1
  Latency Threshold in msec        : 10
  Latency Exceeded Threshold in sec : 8
  Uplink Recovery Interval in sec  : 60

C9800#
```

Options

- **interval** : Retry interval
- **latency-exceeded-threshold** : Interval in which at least one ping must succeed in less than threshold time
- **latency-threshold** : Ping latency threshold
- **Retries** : Number of retries until gateway is considered unreachable
- **uplink-recovery-interval** : Time during which RAP uplink must be stable to accept child connections

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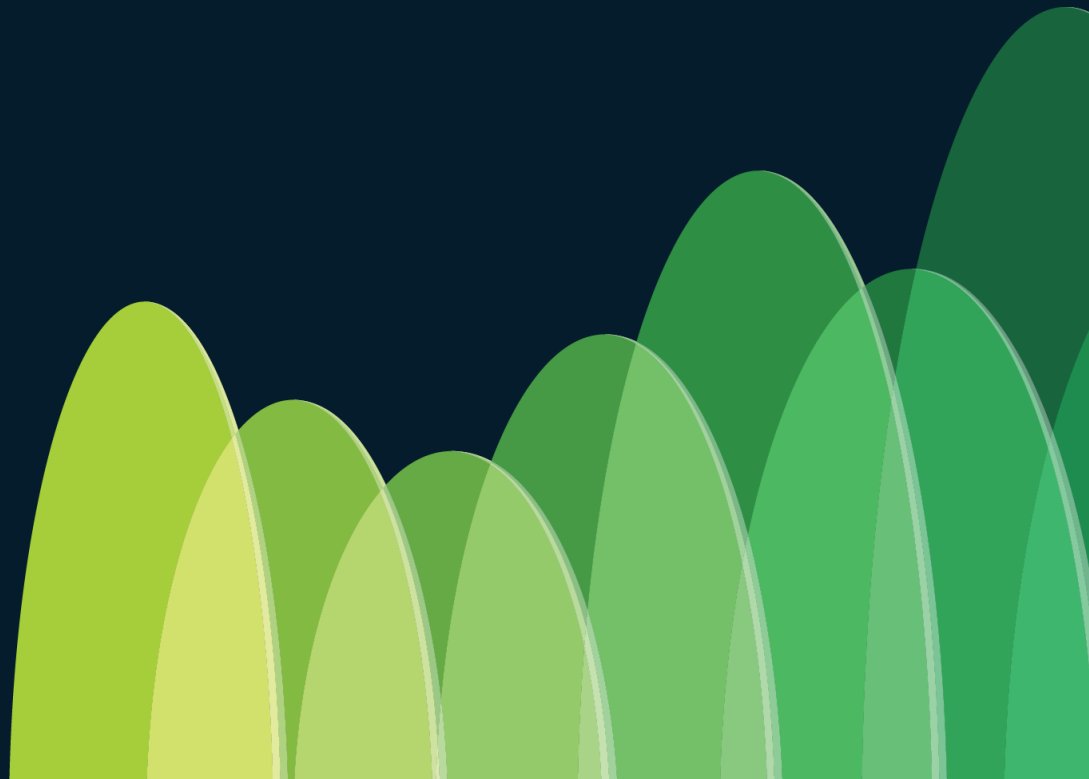
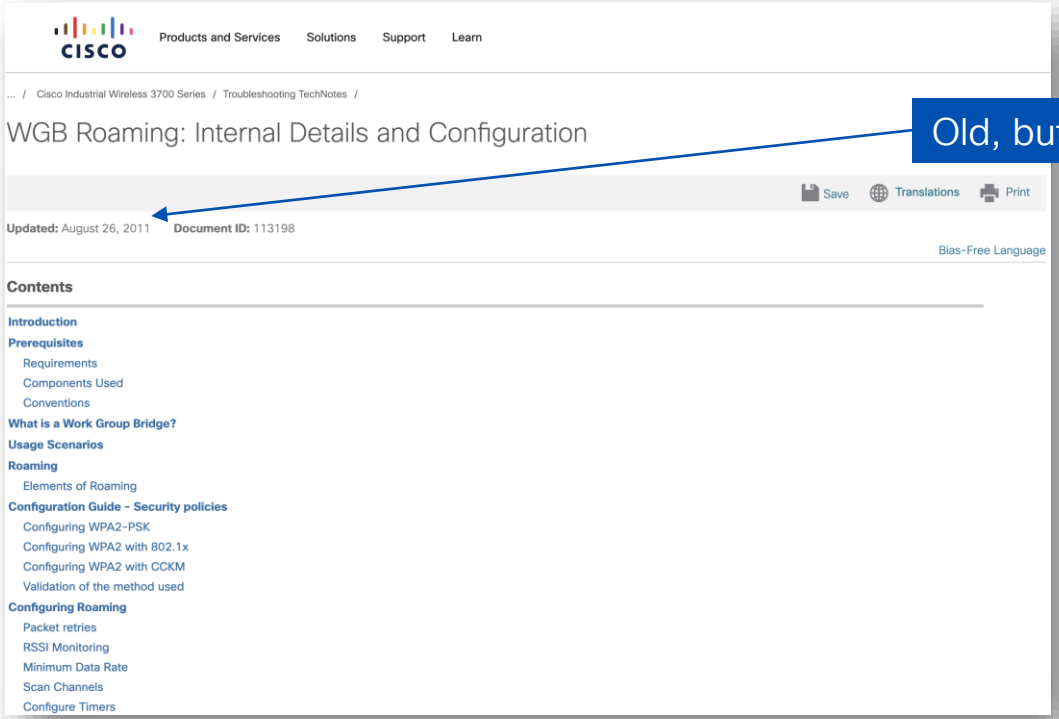
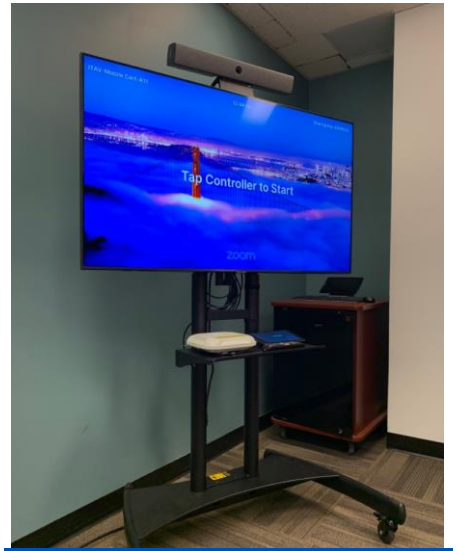
Recent WGB Improvements



Want to “dial in” older IOS WGBs?



Old, but good.



3702i WGB For AV Cart

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The AP | WGB | URWB Matrix...

Platform	CAPWAP AP	MESH	WGB	URWB
IW9167E				
IW9167I	17.12>			
IW9165E (no 2.4)	17.14>		17.13>	
IW9165D (no 2.4)				
9115				
9120				
9124				
9130				
CW9162,9164,9166				
CW9176,9178				Not Yet ☺

Recent WGB Enhancements

Release	Notable Feature
17.8	Workgroup Bridge (WGB) mode is now supported on 9105, 9115 and 9120 access points
17.9	Concurrent radio support for WGBs on Catalyst Aps (Good for fleet operators)
17.10	WGB mode support on 9124 and 9130
17.11	Site survey mode, WGB and UWGB support on IW9167
17.12	IAPP Refresh bug, impacting data forwarding post roam
17.13	Concurrent 5GHz Radio coordinated hand-off on 9130 & 9124
17.13	Low Latency profiles for 9165 IOT WGB
17.14	QoS, GPS and SNMP support on 9165 and 9167 WGBs
17.15	Using the scanning radio on the IW9167 to aid in roaming on 2.4GHz (where we only have a single radio)

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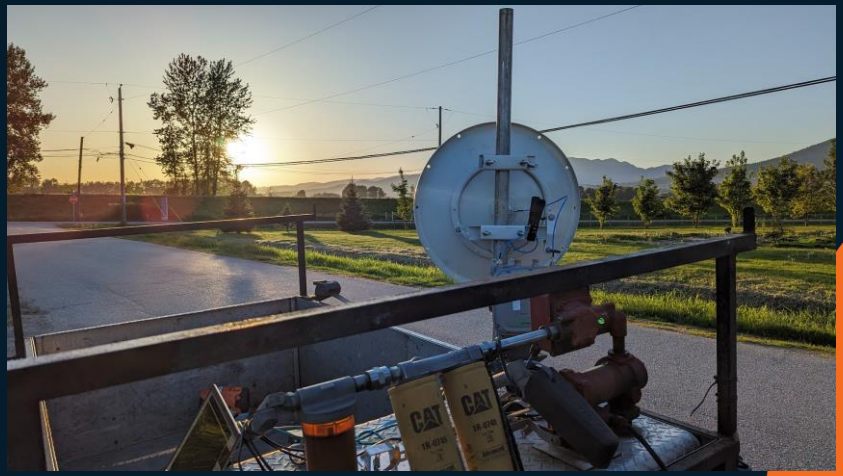
Field Test Results

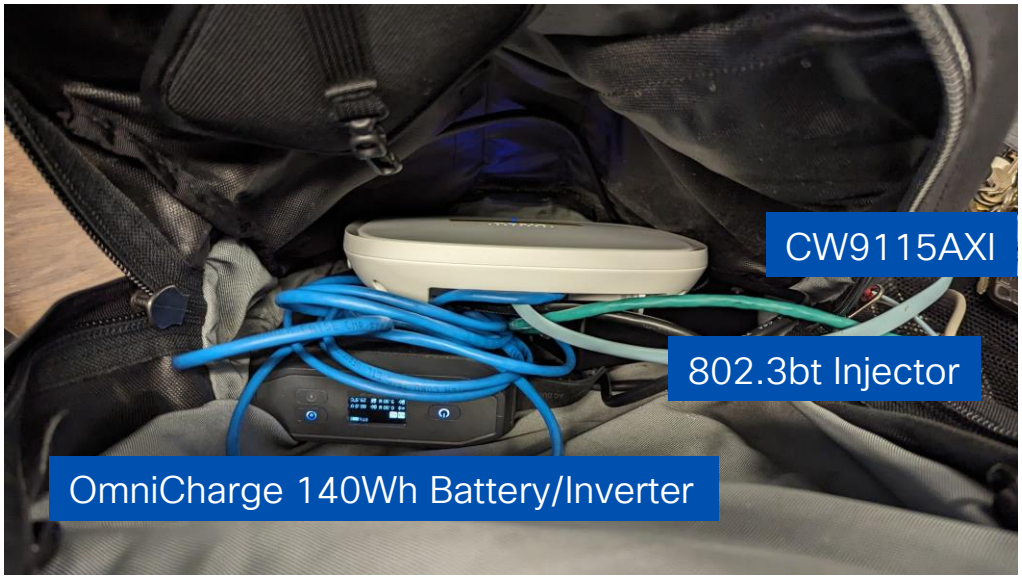


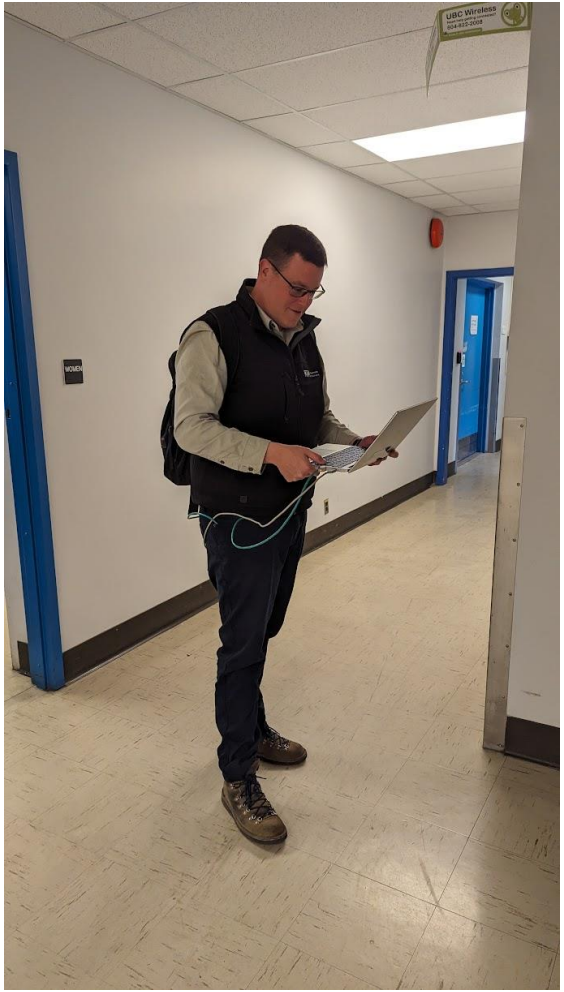
WGB Tests



Testing the 9115AXI as WGB

Using existing Indoor / Outdoor networks





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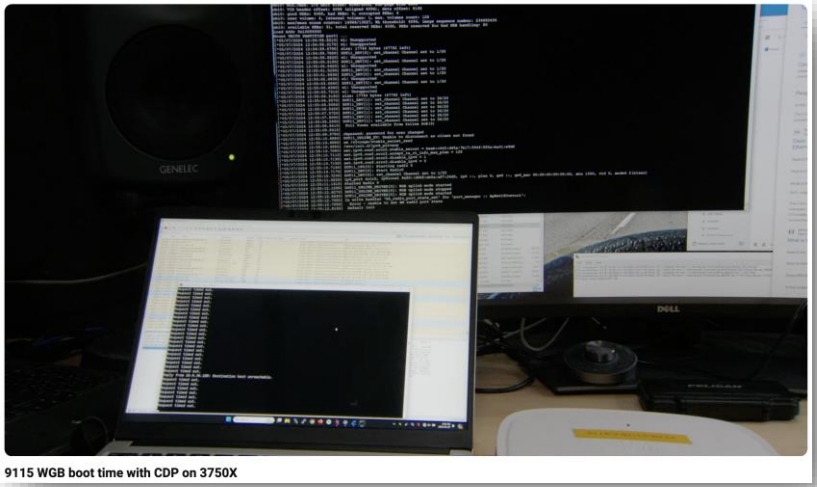
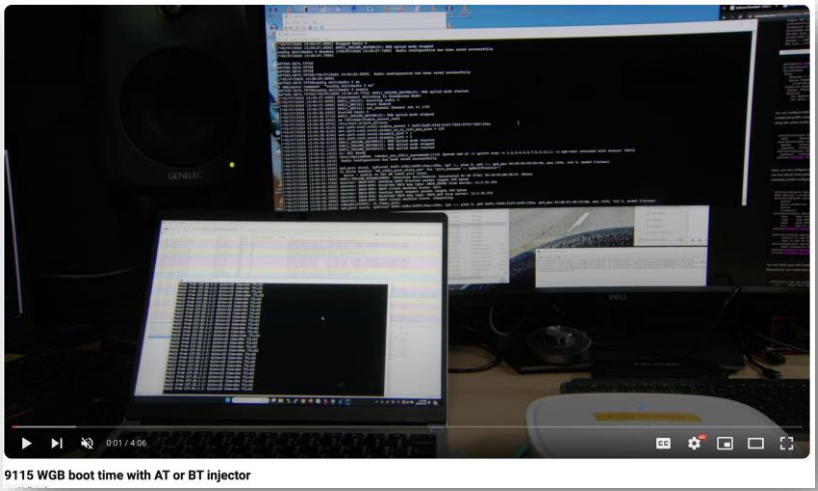
A Note on Boot Times

With CDP/LLDP (PoE Via switch): 2min 24sec



9115 WGB boot time with CDP on 3750X

Without CDP/LLDP (IE an injector only): 3min 18sec



9115 WGB boot time with AT or BT injector

```
[*05/07/2024 16:17:32.6353]  No good power or POE negotiation is not complete, wait for the
negotiation to complete or connect to required PSE
```

Without an injector, you will see this printed on console while we timeout CDP/LLP negotiation.

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Sample AP-COS WGB Config (Roaming Tweaks)

```
Rx Beacon Missing Action    : Enable
Rx Beacon Missing Count     : 30
Packet retries Action       : Reconnect
Packet retries Value        : 64
RSSI Threshold Value        : -70 dBm
Threshold timeout           : 20 sec
HSR-Scan status             : Disable
Auth response timeout       : 5000 Msec
Assoc response timeout      : 5000 Msec
WGB channel scan timeout    : 8 Msec
Dhcp response timeout       : 60 Sec
EAP timeout                 : 3 sec
Bridge table aging-time     : 300 Sec
Probe pak data rate type    : NA
Probe pak data rate         : 0
Antenna Band Mode           : Dual
Broadcast tagging           : Disable
Wired Client 802.1x Auth    : Disable
IGMP querier IP address : ::
```

Retries that can trigger an action

You will want to tweak based on your env.



Note:
This was the config I used for the 9115AXI in the backpack.
The 9115AXI is an "AP" with only two logical radios 2.4 | 5GHz

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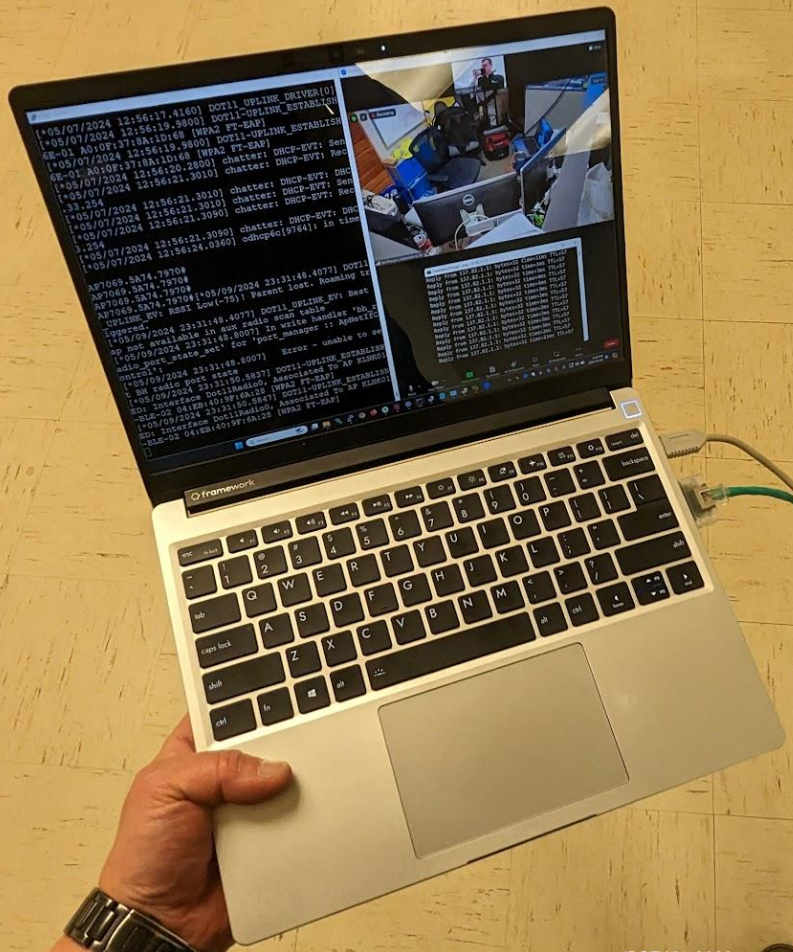

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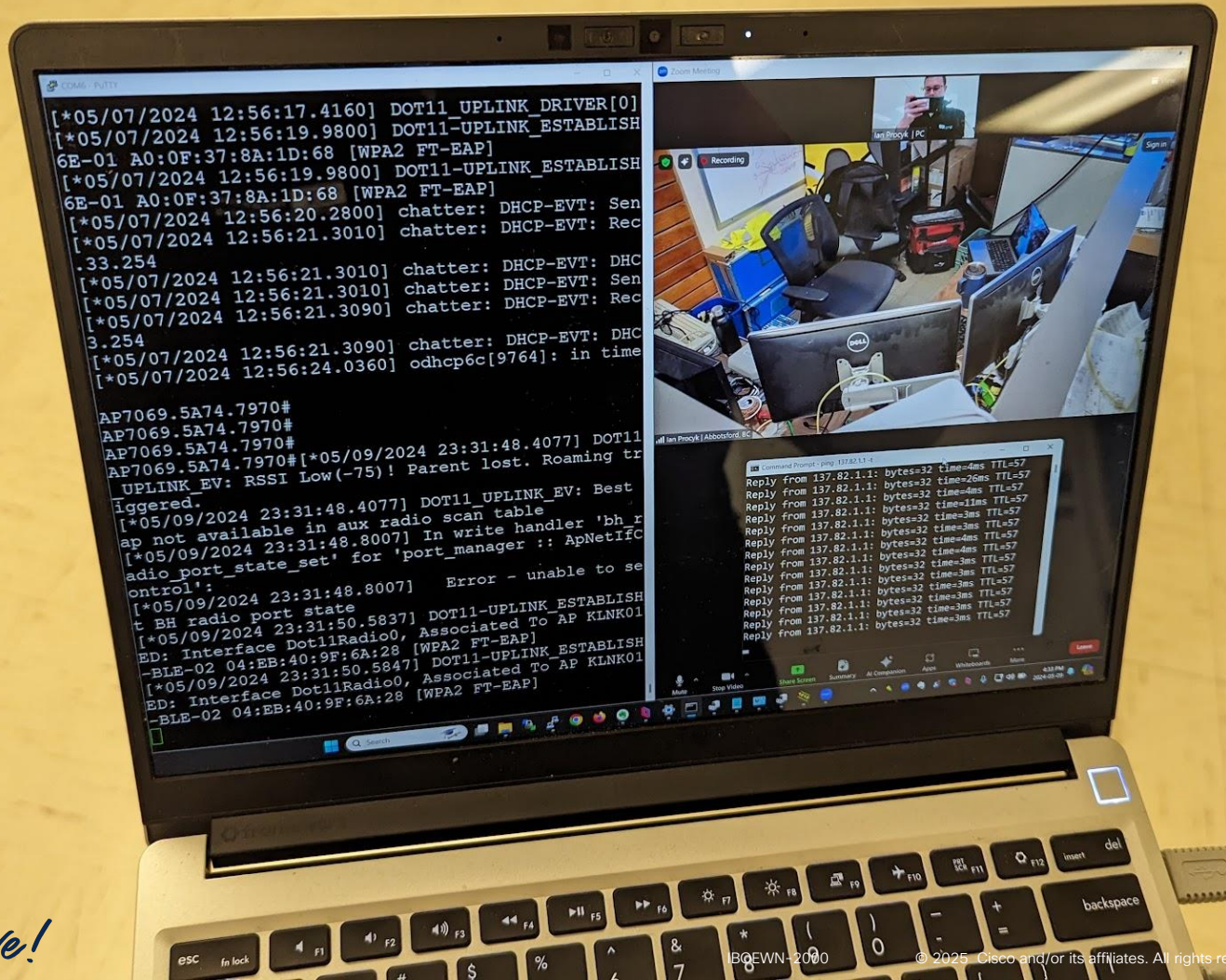

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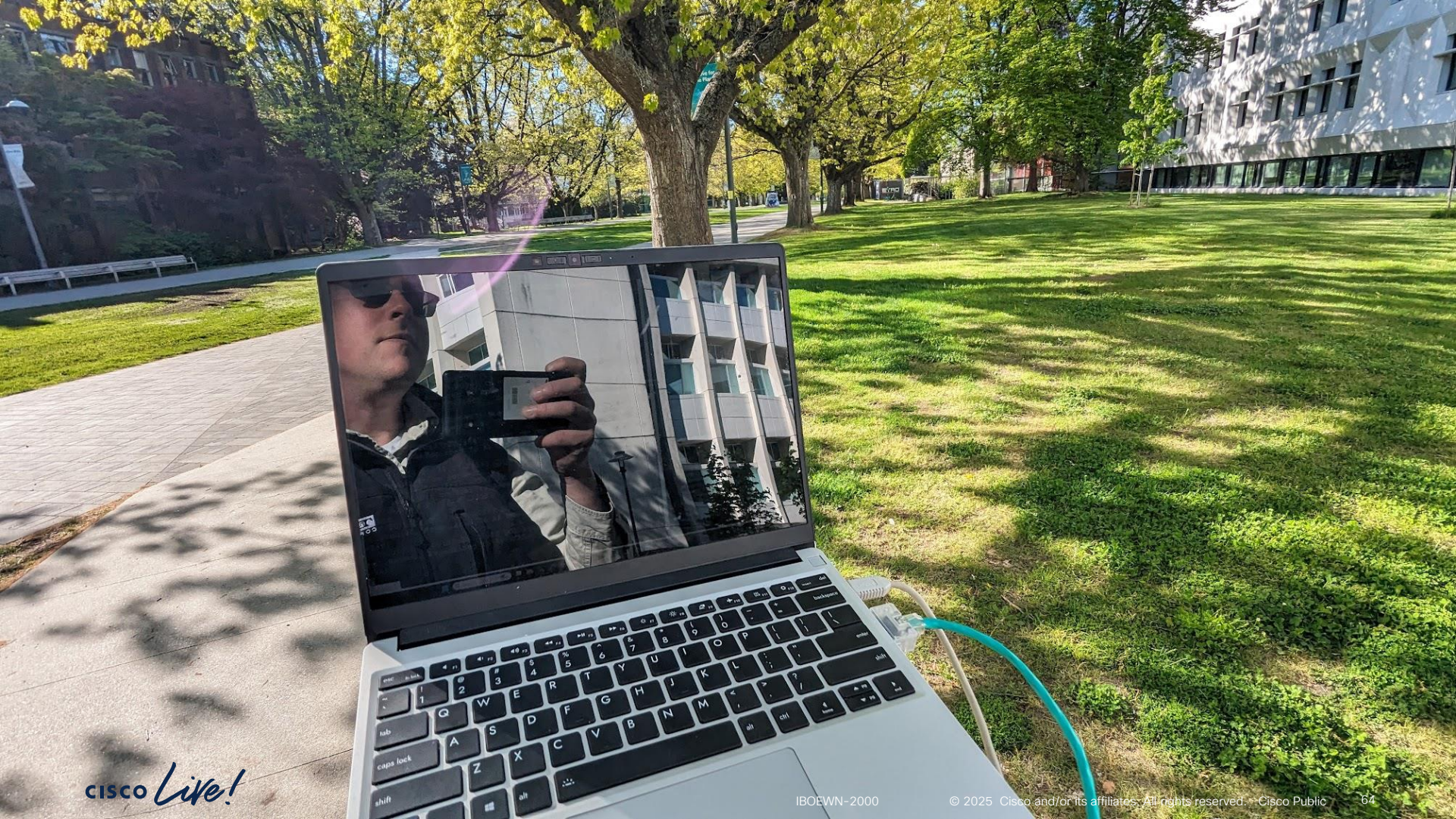

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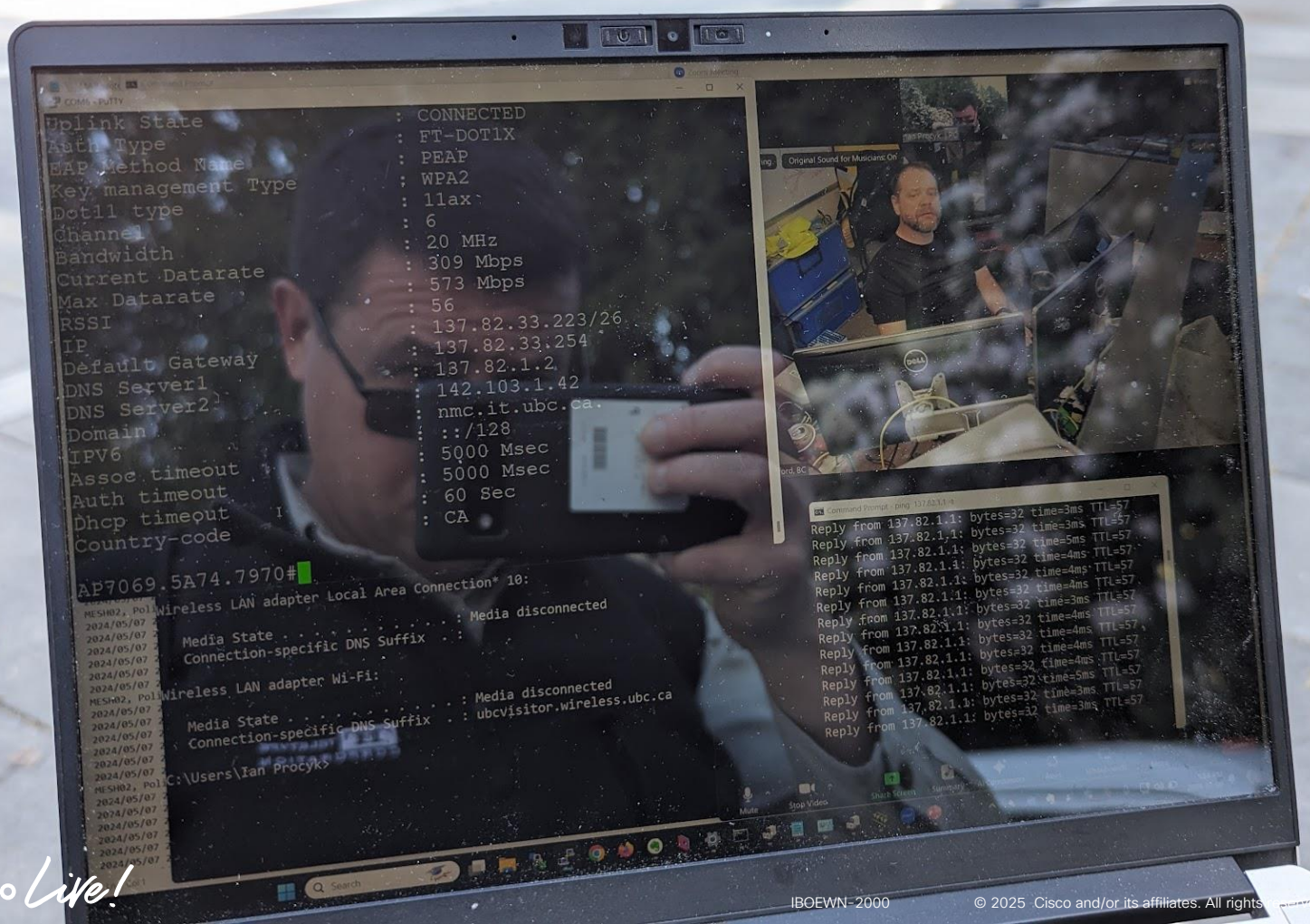

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Testing the 9115AXI as WGB
Using existing Indoor / Outdoor networks



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The IW9167 WGB Rig



The IW3702 / IW9167E Test Jig

- Magnetic mounted to vehicle
- 4SS setup
- 4x MobileMark OD2's Rugged 2.4GHz Antenna



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The IW3702 / IW9167E Test Jig



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The IW3702 / IW9167E Test Jig

```
[*05/10/2024 00:44:27.4028] DOT11_UPLINK_EV: RSSI Low(-77)! Parent lost. Roaming triggered.


[*05/10/2024 00:44:27.4028] DOT11_UPLINK_EV: Best ap not available in aux radio scan table


[*05/10/2024 00:44:29.2778] DOT11-UPLINK_ESTABLISHED: Interface Dot11Radio0, Associated To AP
KLNK01-A1 CC:DB:93:48:82:E8 [WPA2 FT-EAP]

[*05/10/2024 00:44:29.2798] DOT11-UPLINK_ESTABLISHED: Interface Dot11Radio0, Associated To AP
KLNK01-A1 CC:DB:93:48:82:E8 [WPA2 FT-EAP]


[*05/10/2024 00:45:29.2802] DOT11_UPLINK_EV: RSSI Low(-78)! Parent lost. Roaming triggered.


[*05/10/2024 00:45:29.2802] DOT11_UPLINK_EV: Best ap not available in aux radio scan table
```


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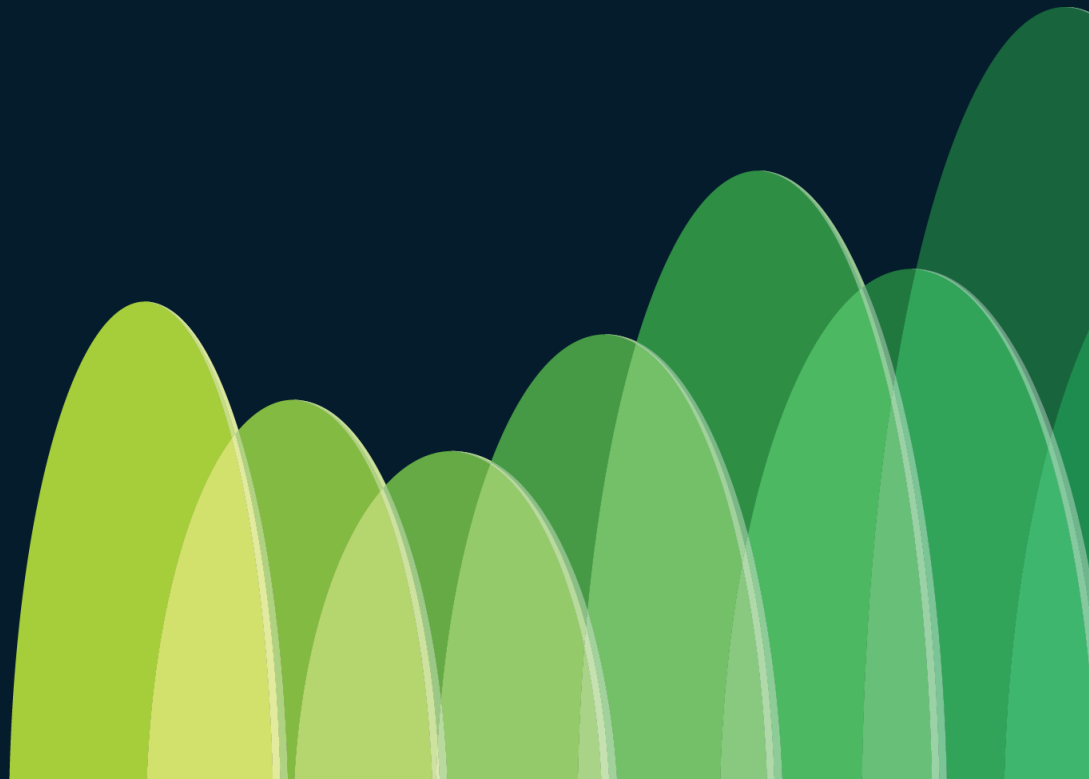
MESH Tests
<5.6km | 3.5mi



Pitt Lake Boat Launch: A Long, Relatively Straight Road, With Nothing Around!



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Rate & Range Testing – Vehicle Side



2513+9124 AXE on Vehicle

Video removed

What 5.6km / 3.5mi away from RAP looks like

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Rate & Range Testing - 9124

Base Station:

- 1x 9124AXE-A UNII-3 TX PWR 1
- 2x 14dBi 5114P2M-N Patches
- Tested out to 5.6KM / 3.5miles
- Mast @ 32ft

On Vehicle:

- 1x 9124AXE-A
- 1x 13dBi patch ANT2513P4M-N



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Rate vs Range for P2P RAP<->MAP Data

DISTANCE (Mi)	DISTANCE (m)	TCP UPLINK FROM MAP	TCP DOWNLINK TO MAP	Reported MESH SNR (dB)
0.03	50	735	506	56
0.06	100	725	730	56
0.12	200	272	500	40
0.25	400	678	519	49
0.50	800	220	357	29
0.62	1000	275	341	37
0.93	1500	262	397	37
1.24	2000	253	296	37
1.55	2500	215	268	32
1.86	3000	106	160	25
2.36	3800	69	85	21
2.55	4100	38	50.6	16
3.48	5600	10.4	19.1	12

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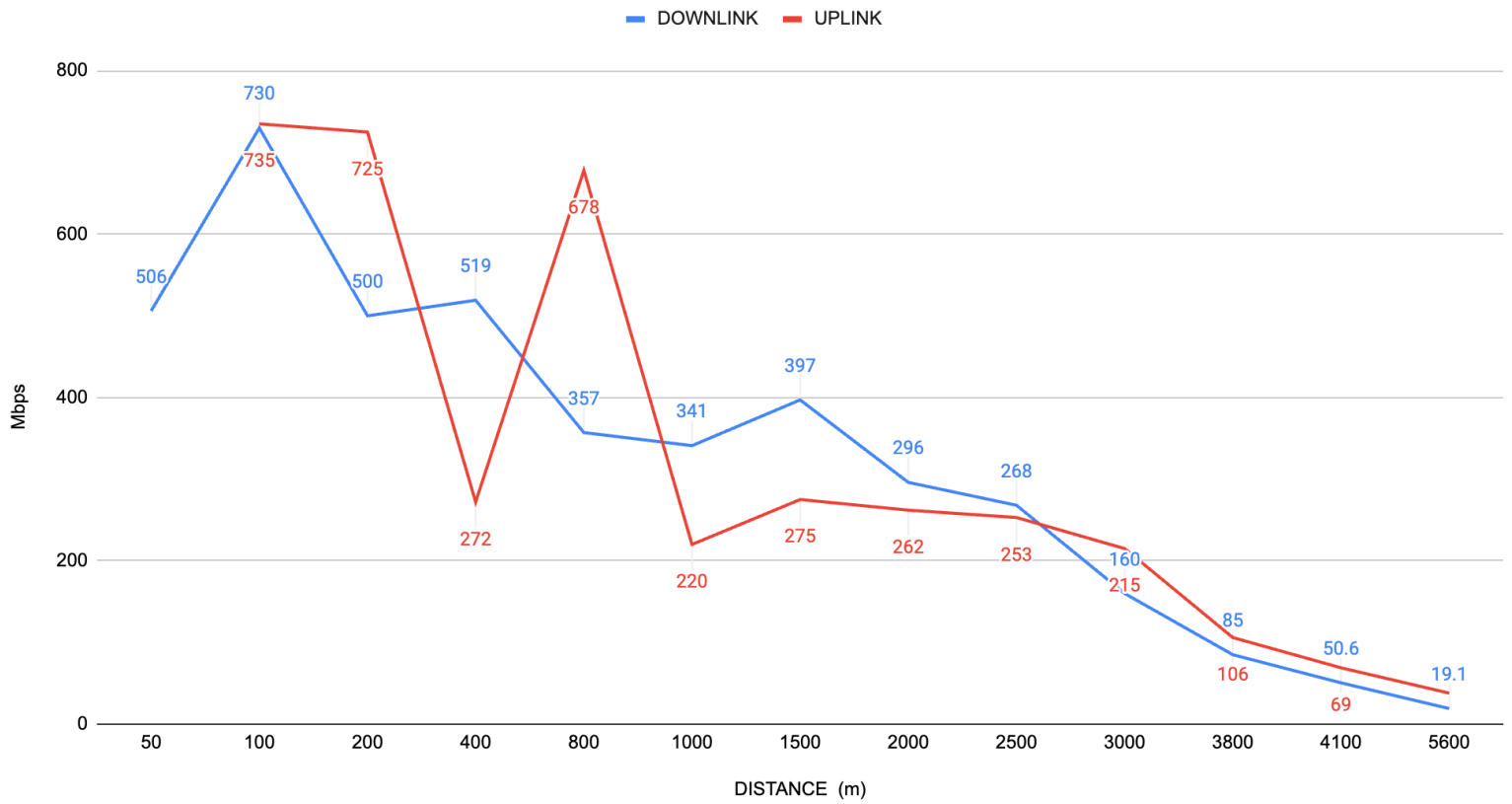
Rate vs Range For P2P RAP<->MAP

80MHz,UNII-3, 4chains with 2x5114 on RAP and 1x2513 on MAP



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How to Look @ MESH SNR / Parent Selection

```
9124AXE-MAP#show mesh adjacency parent

Mesh AWPP Radio adjacency info

Flags: Parent(P), Child(C), Neighbor(N), Reachable(R), CapwapUp(W),

       BlockListed(B), Authenticated(A), HTCapable(H), VHTCapable(V)

       OldParent(O), BGScan(S)

AdjInfo: Radio Backhaul: 1 [48:8B:0A:78:86:31]

Hops to Root: 1

Address           Cost RawCost LinkCost ReportedCost Snr BCount Ch  Width  Bgn Flags: P O C N R W B A H V S Rej

ect reason

4C:A6:4D:23:2A:71 64   80      64       16           56  0      149 80 MHz -   (T/F): T F F T T T F T T T F -


--------------------------------------------------------------------------------
```


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How To See Data Rates On AP-COS

HE=11ax | 2SS=2 Spatial Streams | MCS Rate | RSSI

```
9124AXE-MAP#debug dot11 client rate 4C:A6:4D:23:2A:71

May 30 22:03:32 9124AXE-MAP kernel: [*05/30/2024 14:03:32.3860] 4C:A6:4D:23:2A:71      61748       5993     HE-80,2SS,MCS11,GI0.8 (1200)      HE-80,4SS,MCS5,GI0.8 (1152)   -37    54          0
May 30 22:03:33 9124AXE-MAP kernel: [*05/30/2024 14:03:33.3870] 4C:A6:4D:23:2A:71      60660       5813     HE-80,2SS,MCS11,GI0.8 (1200)      HE-80,4SS,MCS5,GI0.8 (1152)   -37    54         89
May 30 22:03:34 9124AXE-MAP kernel: [*05/30/2024 14:03:34.3877] 4C:A6:4D:23:2A:71      61764       5963     HE-80,2SS,MCS11,GI0.8 (1200)      HE-80,4SS,MCS7,GI0.8 (1441)   -36    55          0
May 30 22:03:35 9124AXE-MAP kernel: [*05/30/2024 14:03:35.3886] 4C:A6:4D:23:2A:71      61481       5943     HE-80,2SS,MCS11,GI0.8 (1200)                                    12   -27    66          0
May 30 22:03:36 9124AXE-MAP kernel: [*05/30/2024 14:03:36.3892] 4C:A6:4D:23:2A:71      60896       5786     HE-80,2SS,MCS11,GI0.8 (1200)      HE-80,4SS,MCS7,GI0.8 (1441)   -36    57          0
May 30 22:03:37 9124AXE-MAP kernel: [*05/30/2024 14:03:37.3896] 4C:A6:4D:23:2A:71      60778       5894     HE-80,2SS,MCS11,GI0.8 (1200)                                    12   -27    66          0
```

Note:
If on a MAP, do show mesh-adj parent to see the radio mac being used for backhaul. Run the above debug on that MAC.

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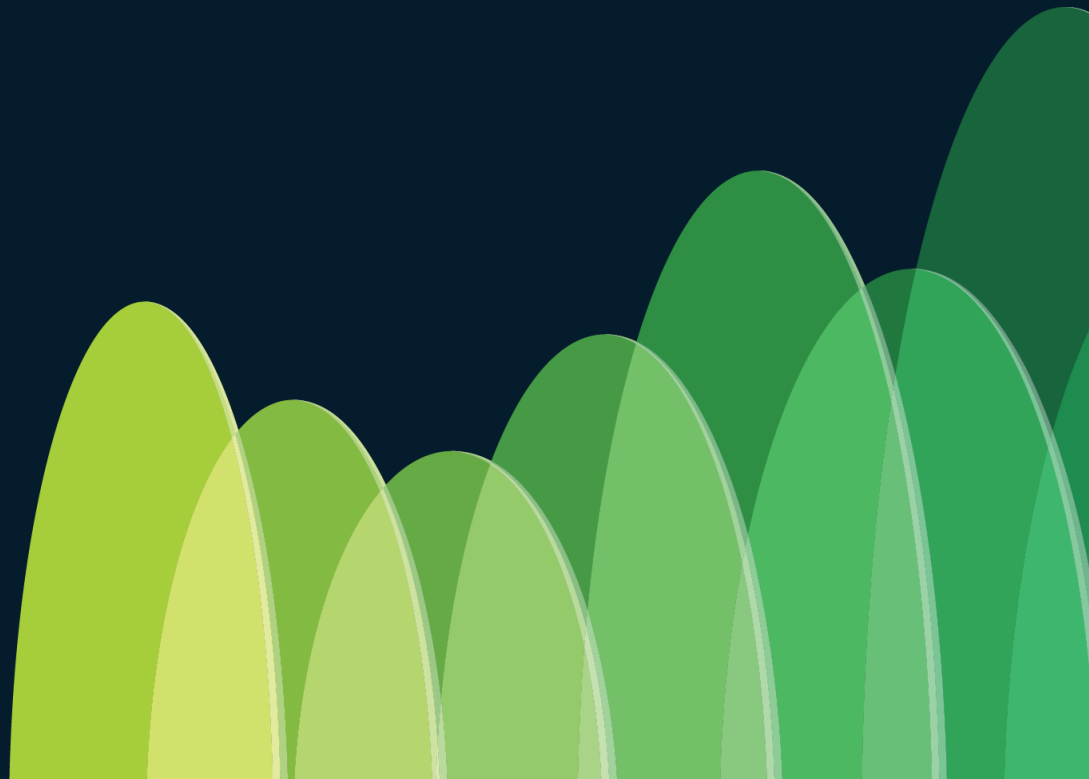
MESH Client Access Tests



Rate & Range (Laptop Testing)

Base Station:

- 1x 9124AXE-A 2.4GHz TX PWR 1
- 4x 4/7dBi 2547 Omni’s
- Tested out 800’
- Mast @ 32ft

Client:

- Panasonic Toughbook CF-30MK2
- 1x Intel AX210 2SS



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Rate & Range (Laptop Testing)



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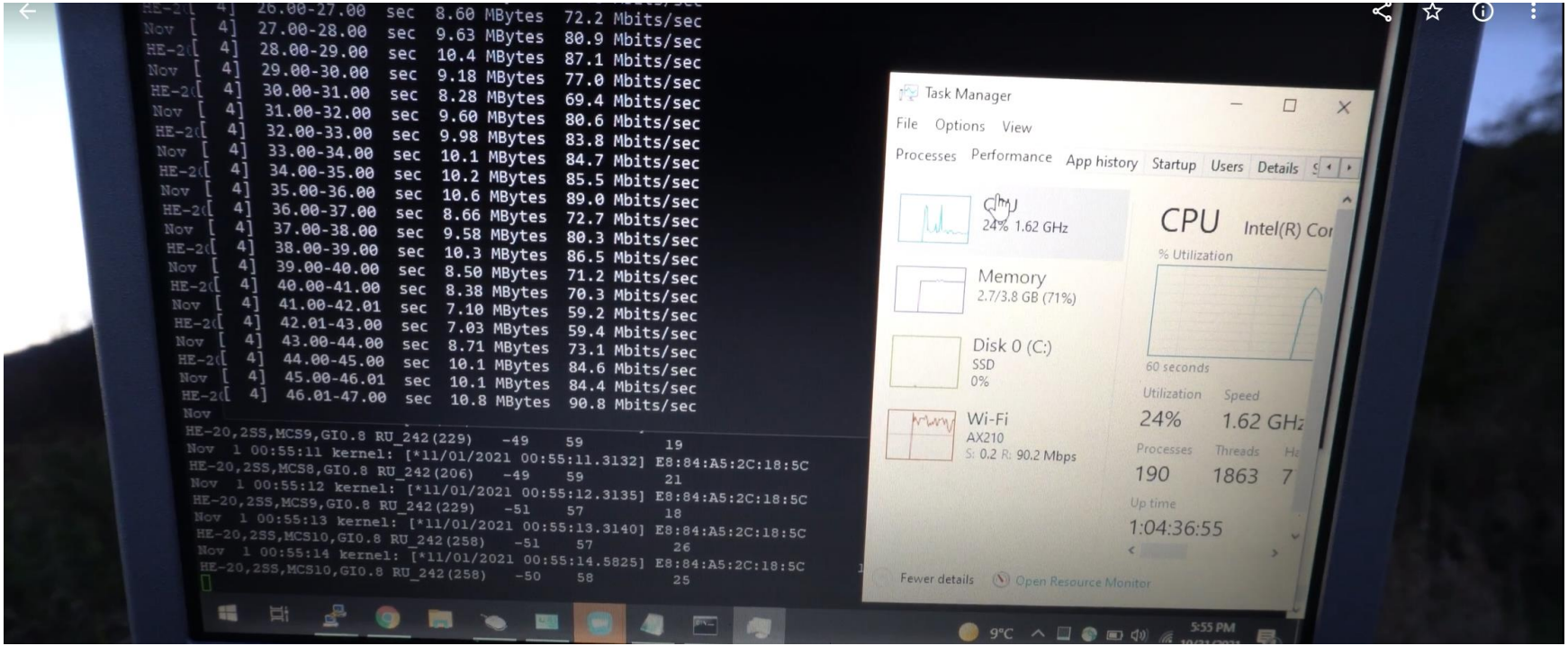
Rate & Range Testing – 9124AXE /w Laptop @ 800ft



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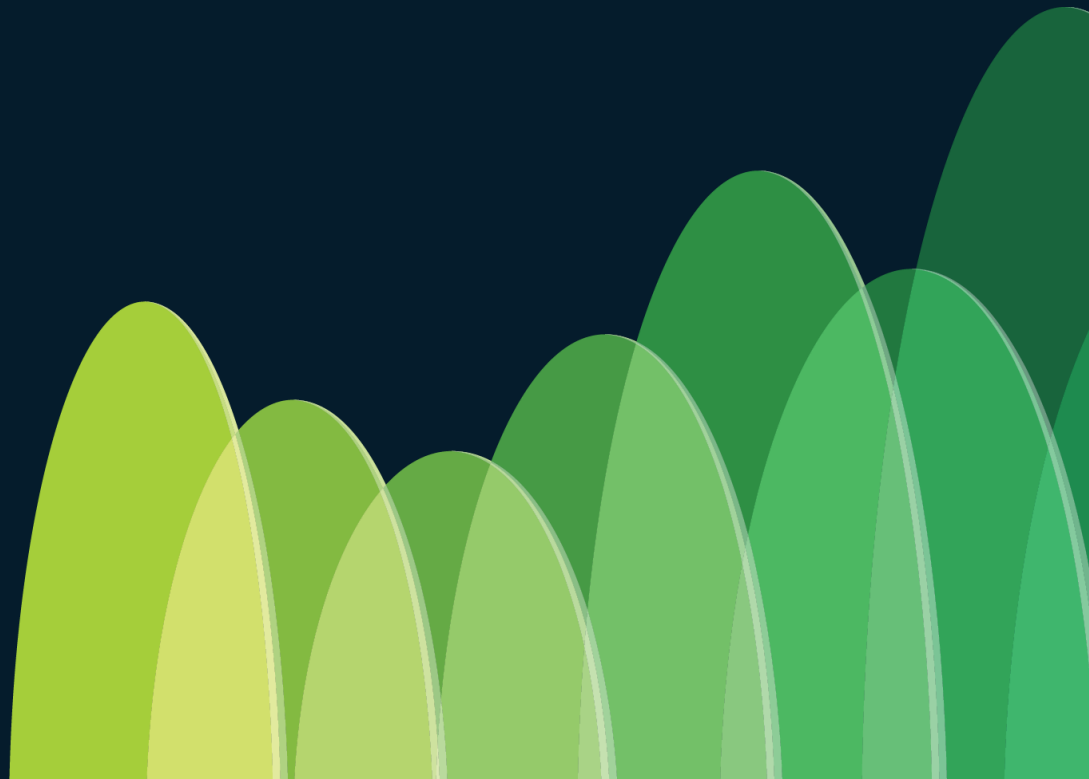
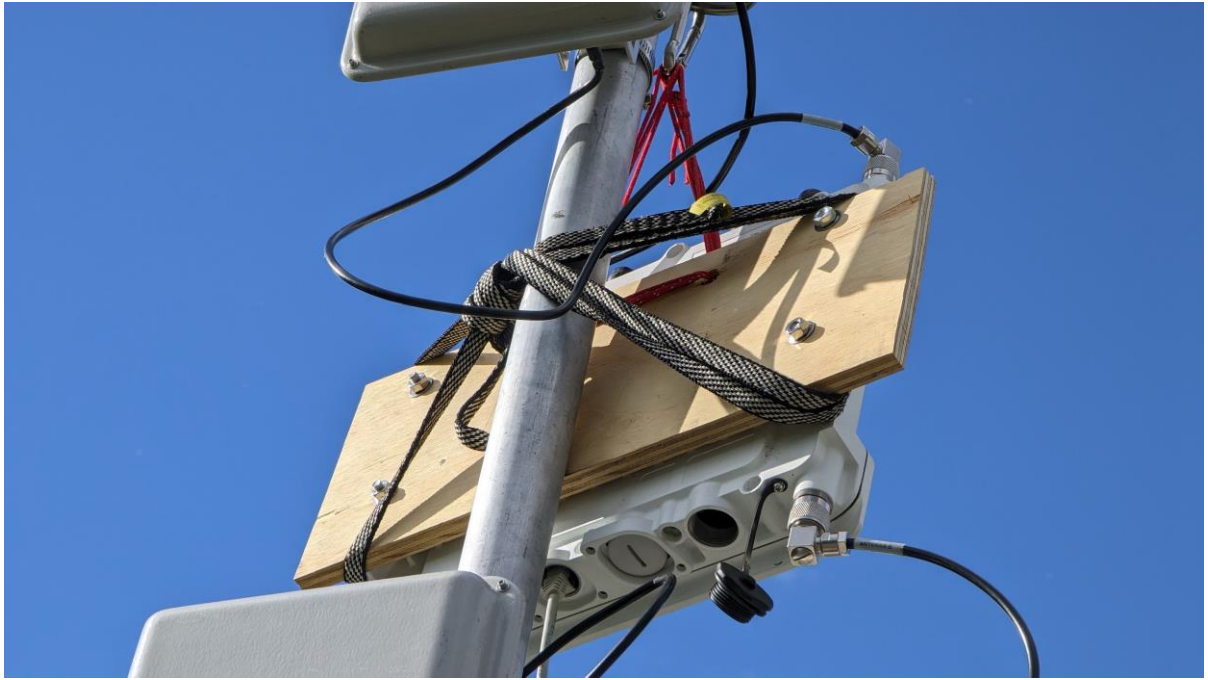
URWB P2P







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Rate vs Range for P2P URWB /w 9167E

DISTANCE (Mi)	DISTANCE (m)	TCP UPLINK FROM Vehicle	TCP Downlink From Vehicle	SIGNAL LEVEL (dBm)
0.03	50	714	730	-32
0.06	100	641	680	-44
0.12	200	447	509	-43
0.25	400	586	609	-46
0.50	800	414	407	-58
0.62	1000	386	493	-55
0.93	1500	405	445	-57
1.24	2000	396	398	-58
1.55	2500	255	389	-61
1.86	3000	179	198	-71
2.36	3800	95.3	95.6	-75
2.55	4100	78.7	98.8	-77
3.48	5600	22.5	29.2	-81

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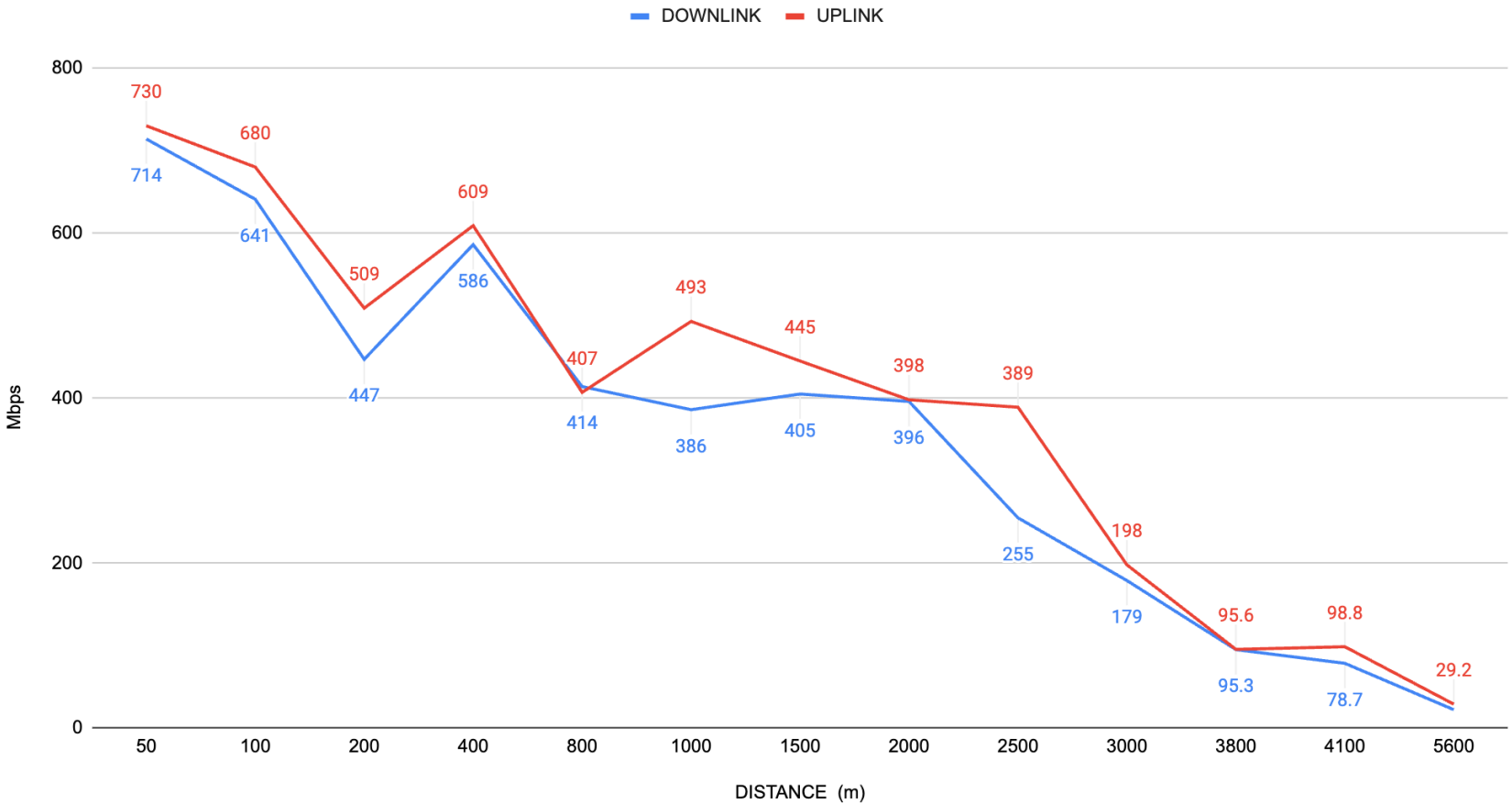
Rate vs Range For P2P URWB

80MHz,UNII-3, 4chains with 2x5114 on Mesh End and 1x2513 on Mesh Point



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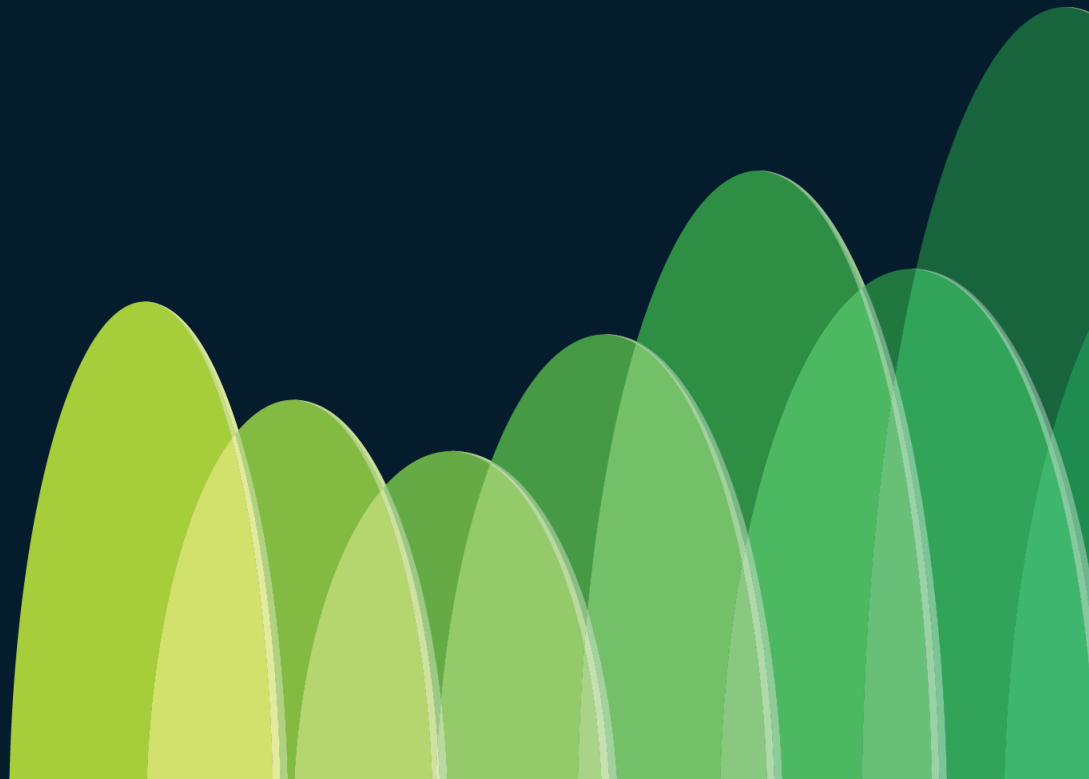
How Much Distance?



Building a Pan/Tilt Antenna Positioner





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Building a Pan/Tilt Antenna Positioner





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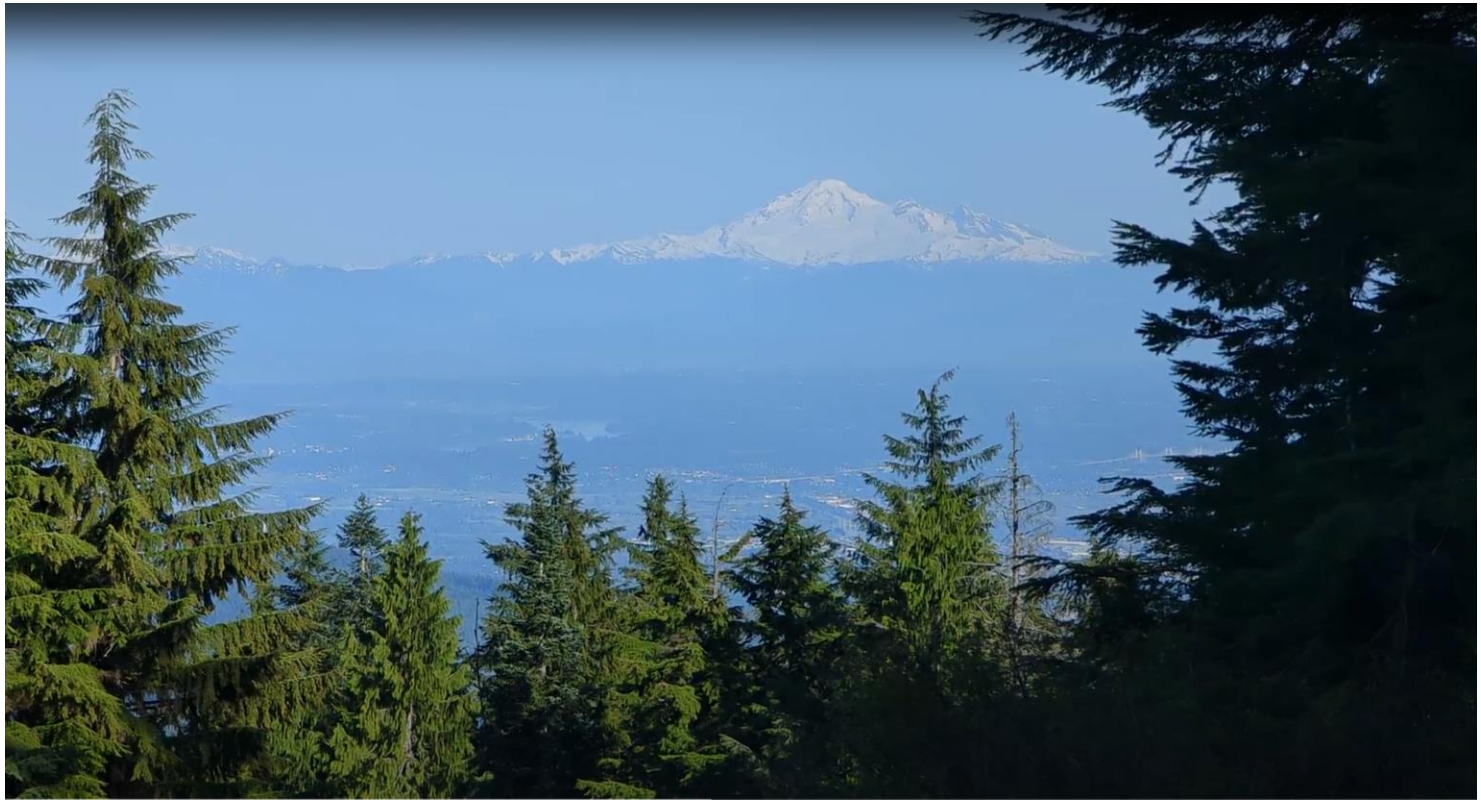
A WGB @ 21KM/13mi from a 9124?



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A WGB @ 21KM/13mi from a 9124?



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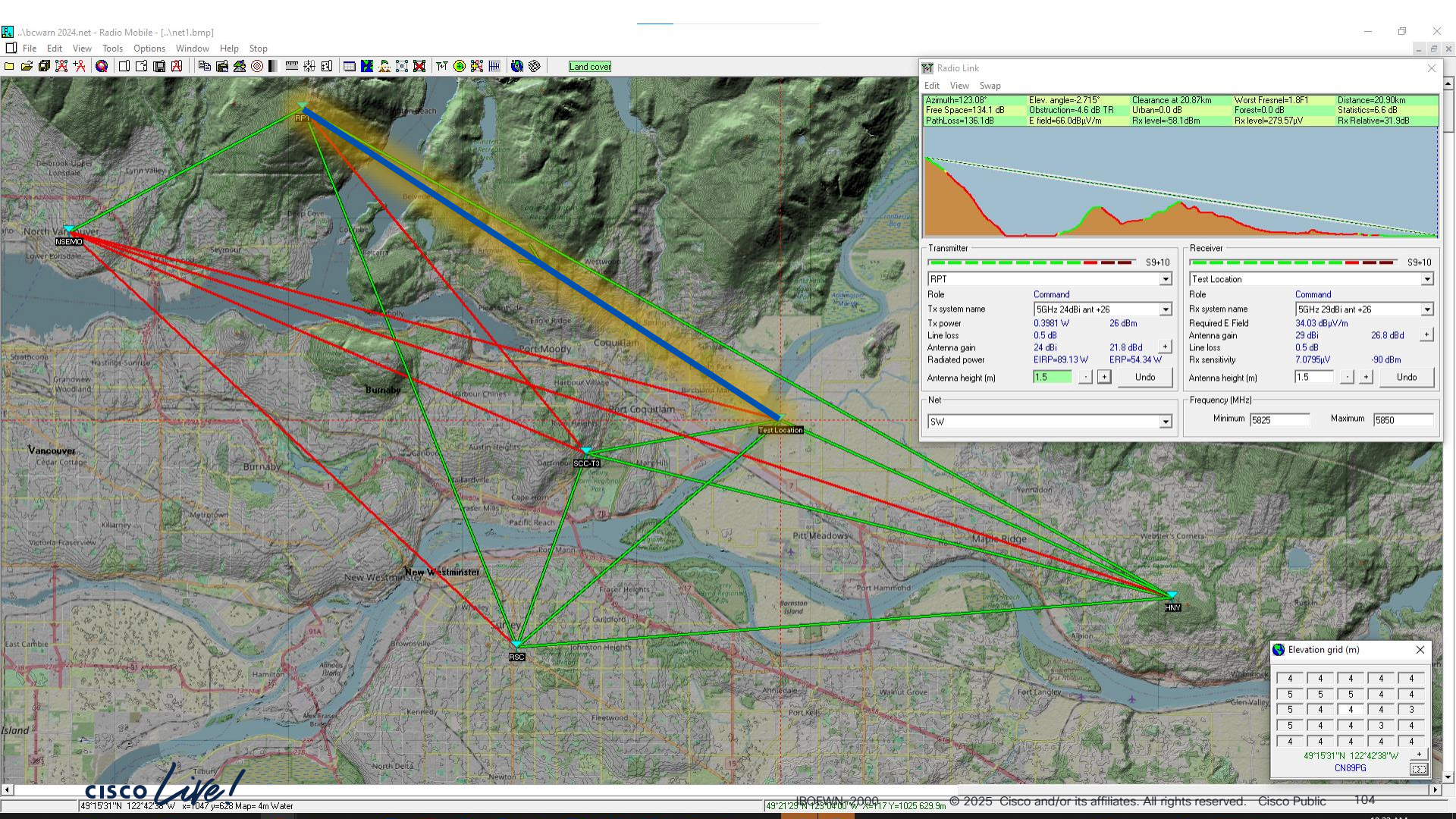

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A WGB @ 21KM/13mi from a 9124?



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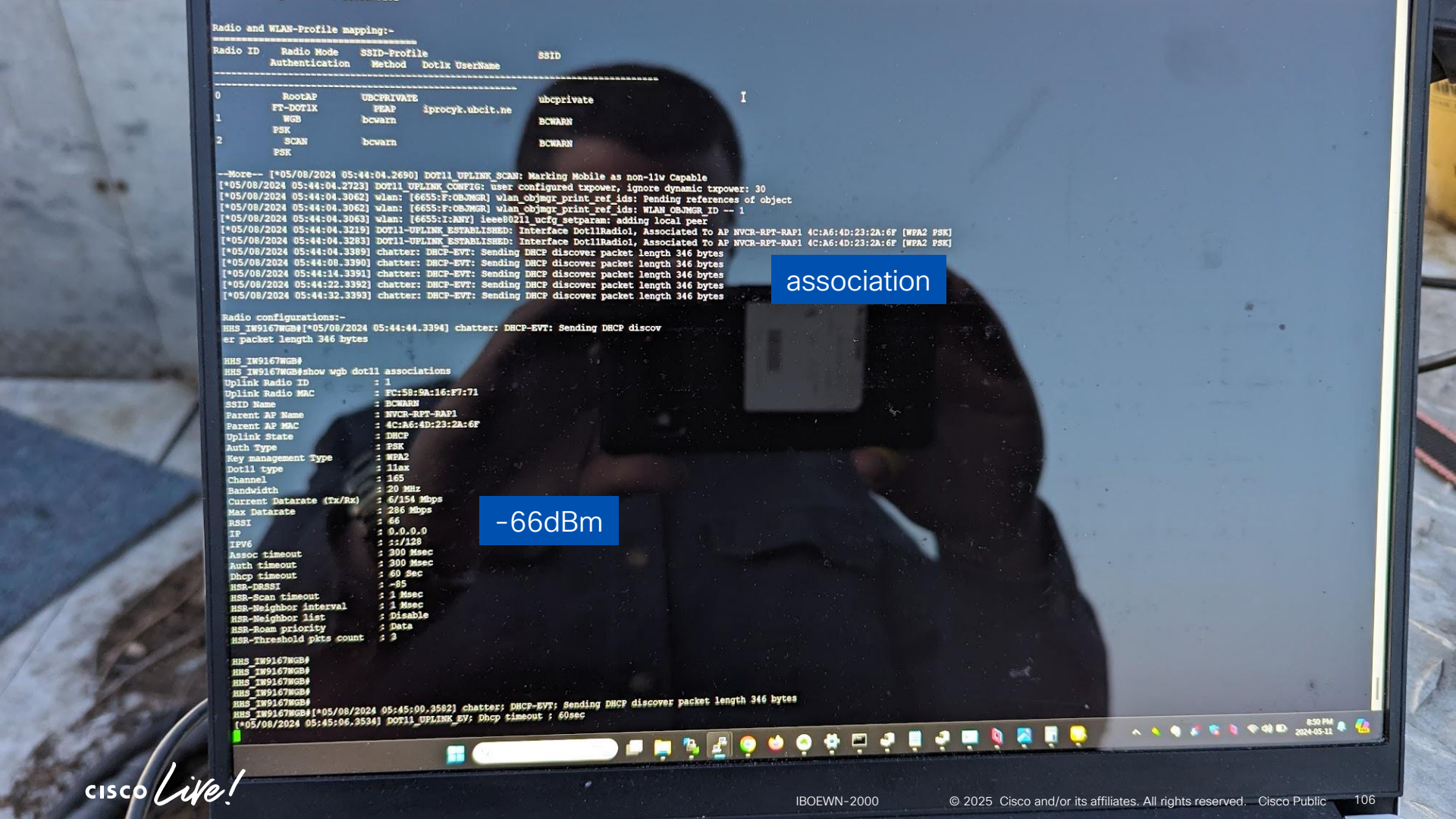

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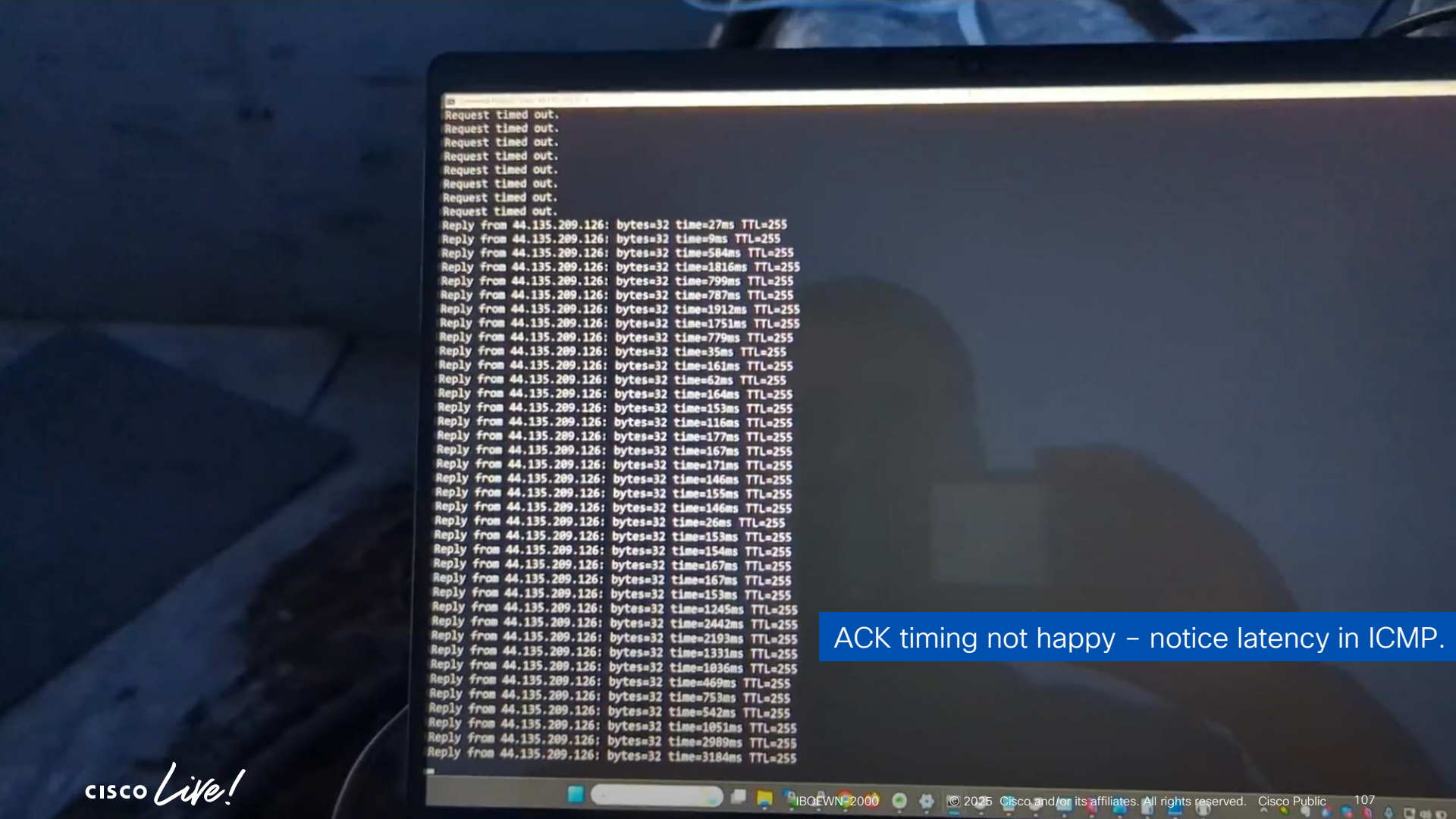

ACK timing not happy – notice latency in ICMP.

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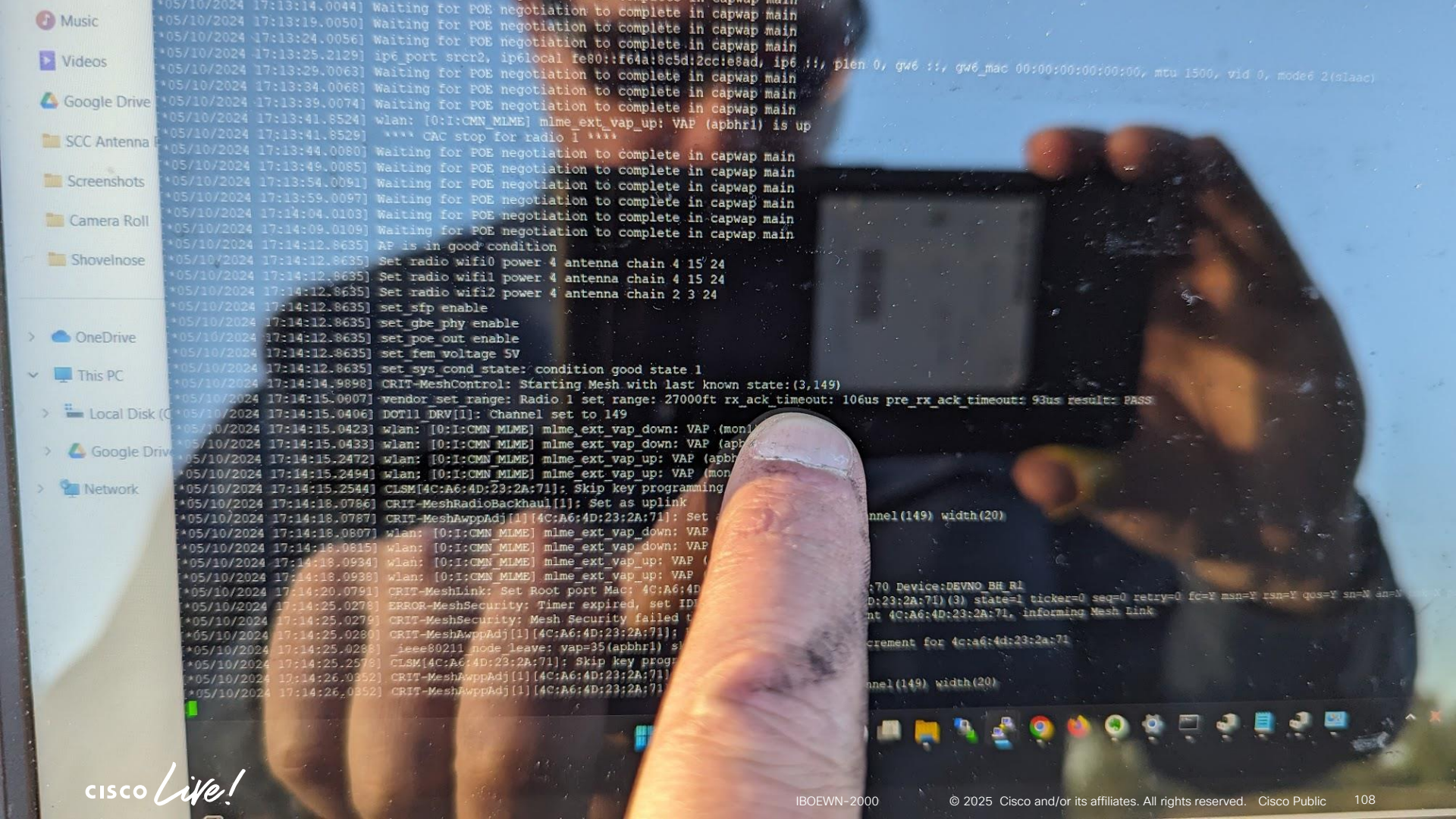

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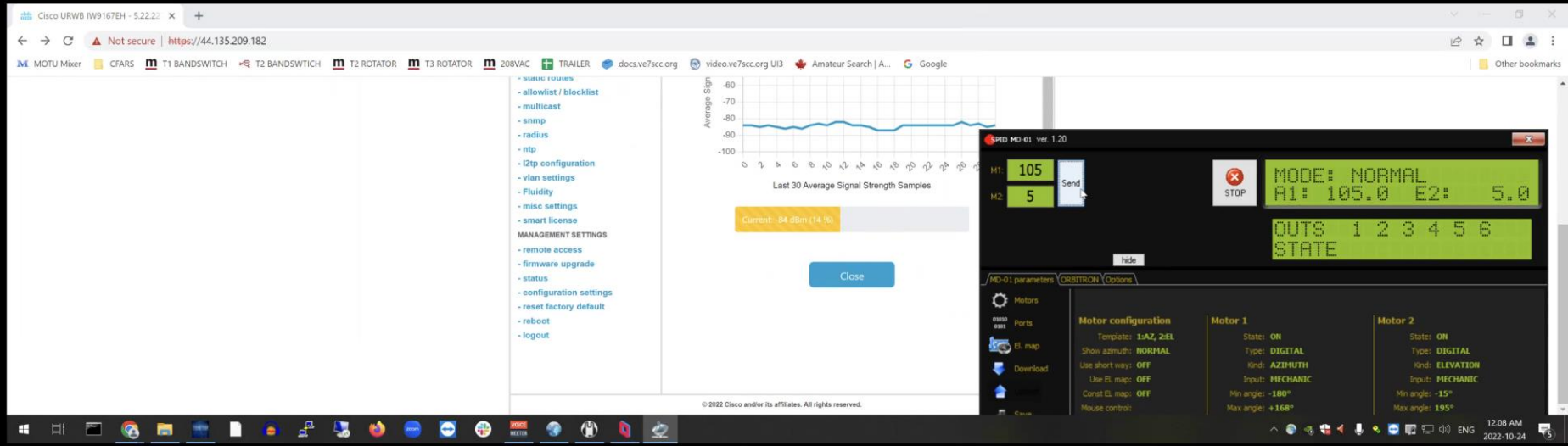

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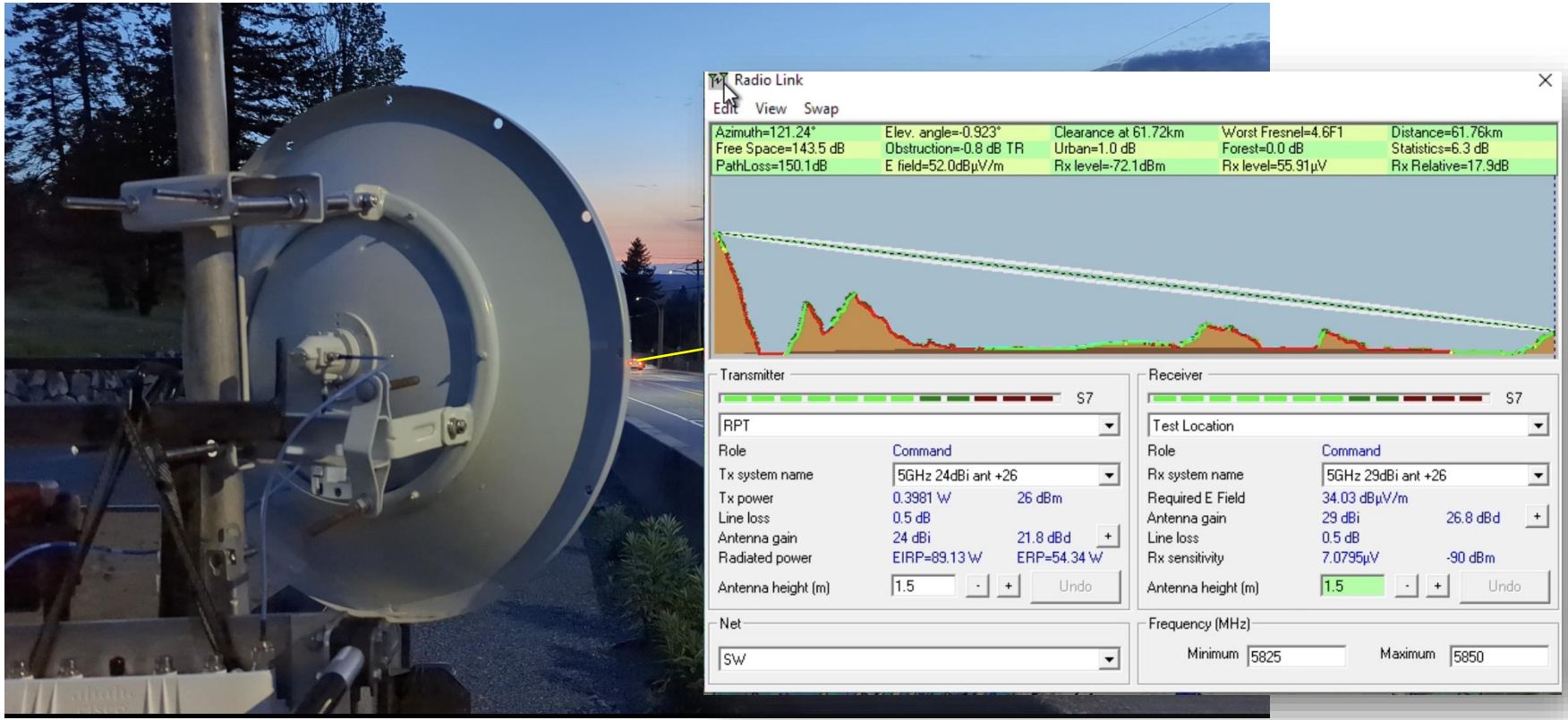
How About @ 62km | 38.5mi ?



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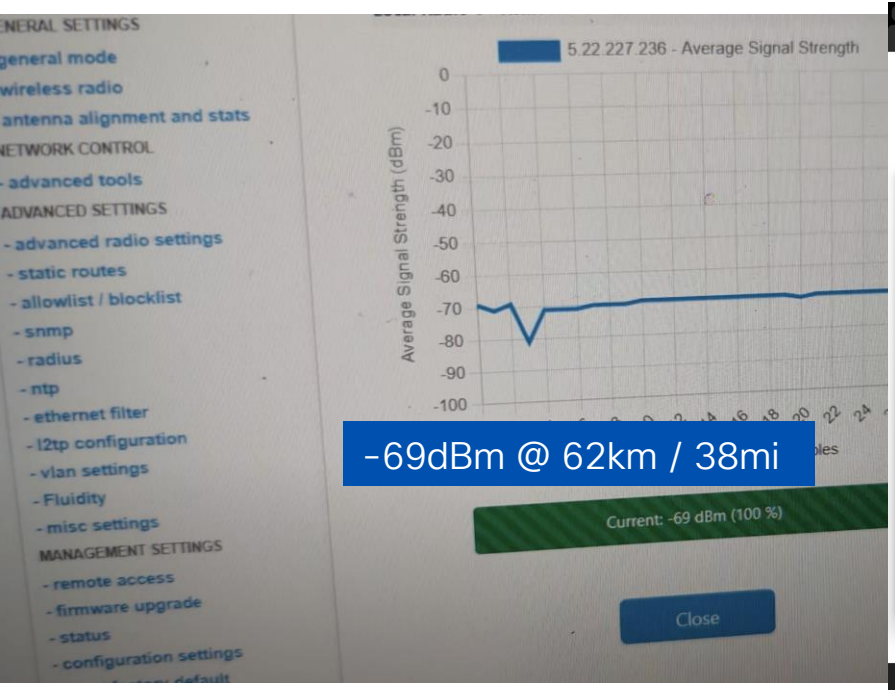
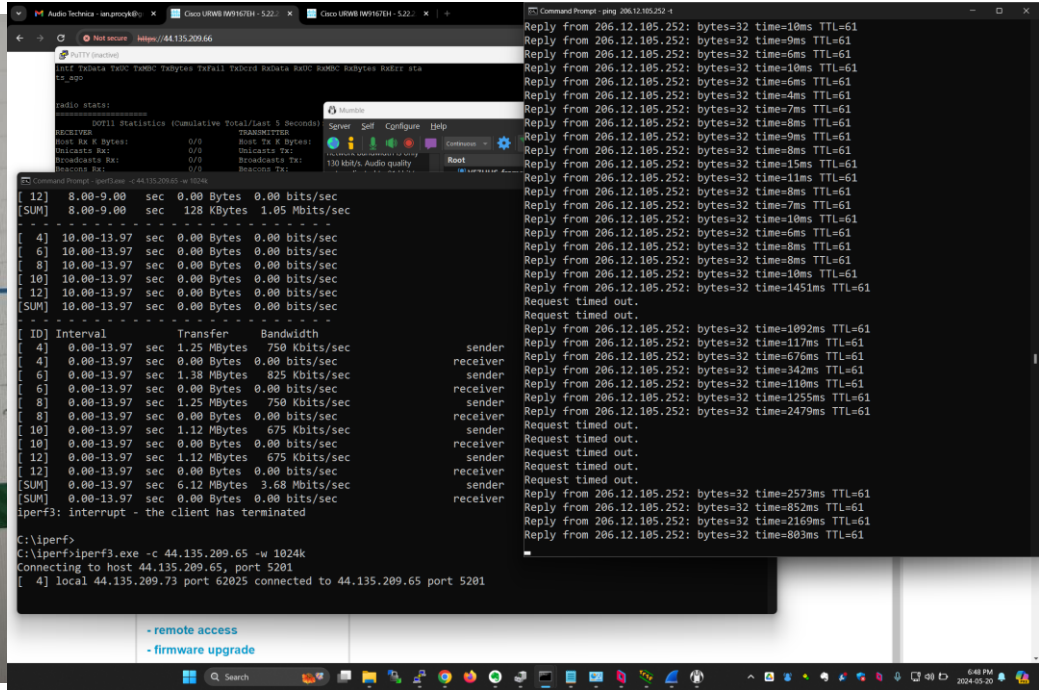
Lots of signal – but barley any packets…





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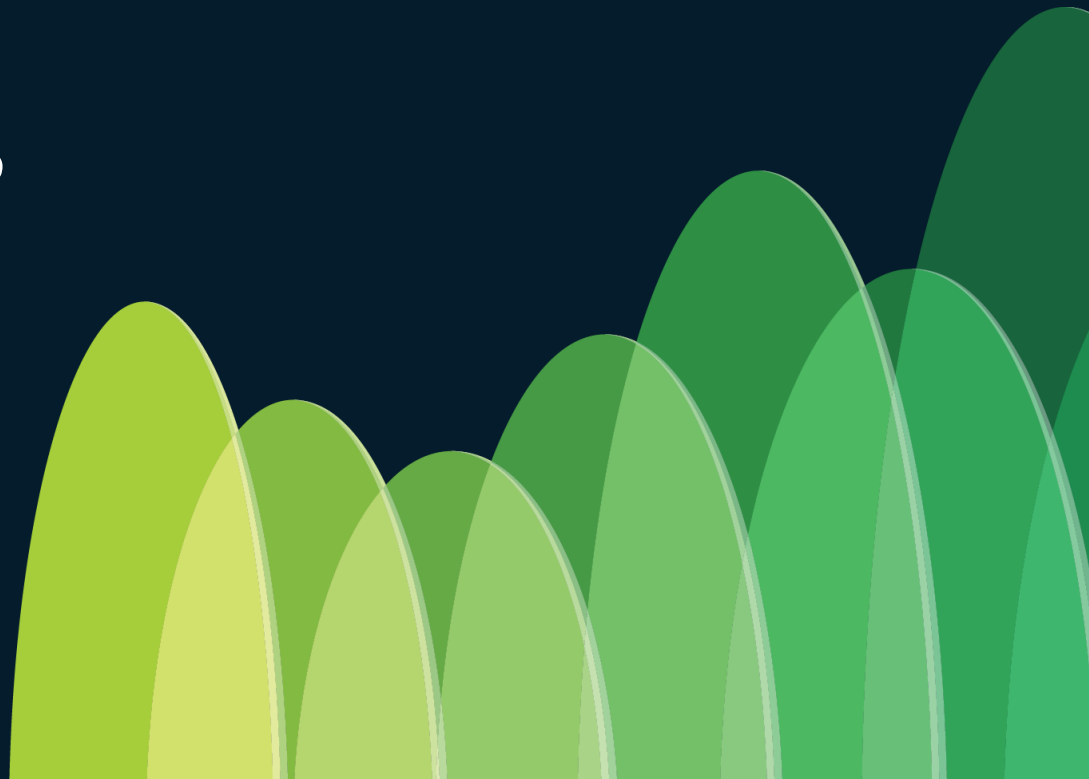
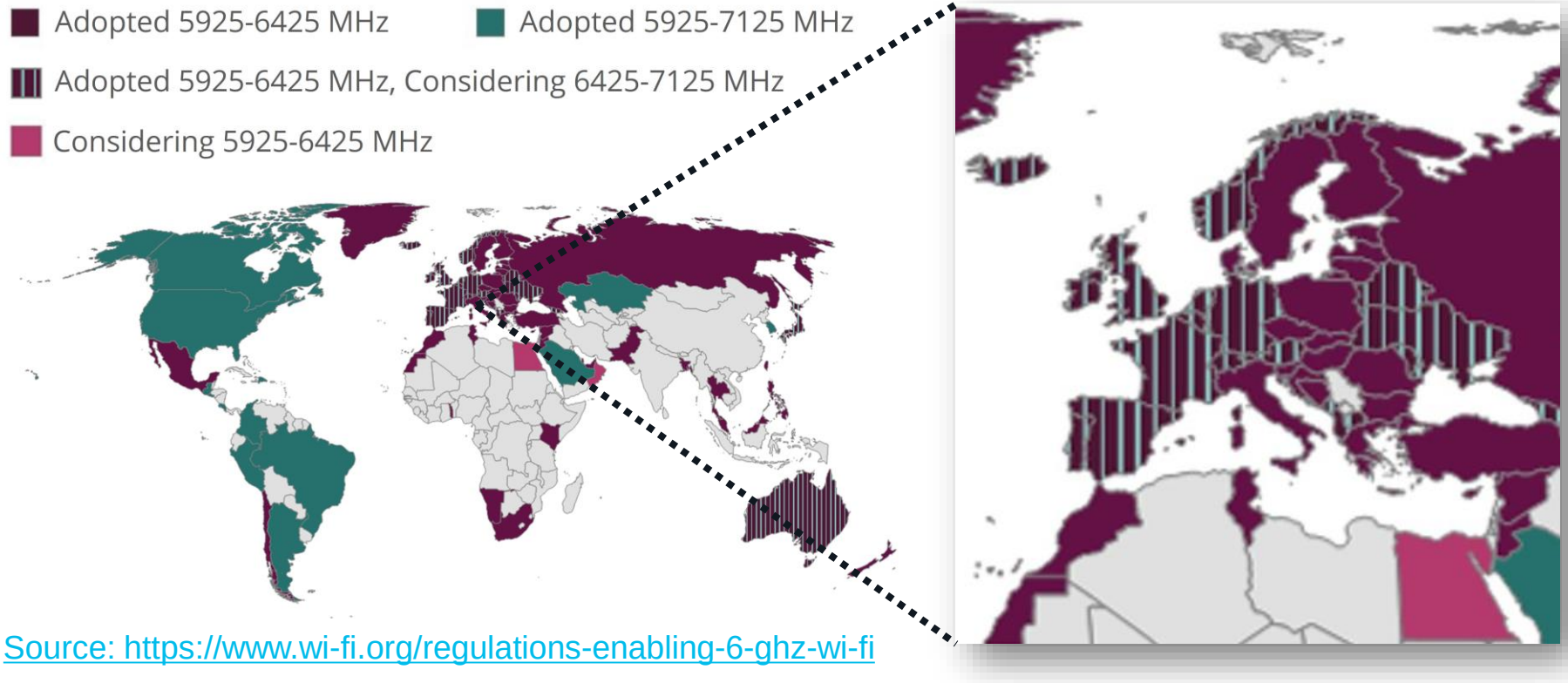
6GHz Outdoors?



6GHz Outdoors In Europe



Source: https://www.wi-fi.org/regulations-enabling-6-ghz-wi-fi

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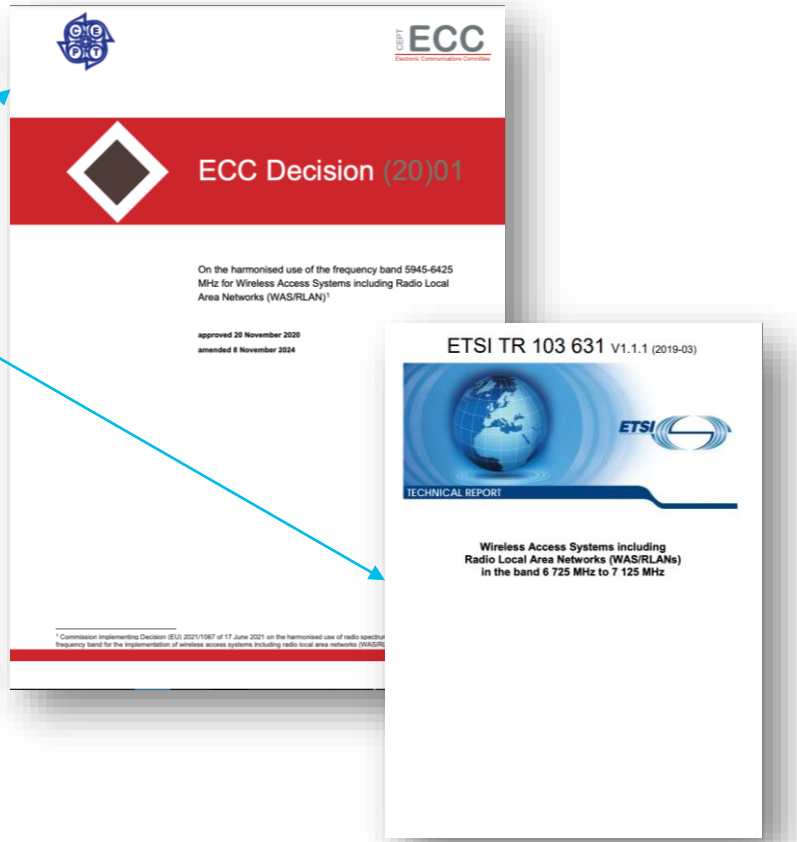
6GHz Outdoors In Europe

Netherlands	**Adopted**	5945-6425 MHz
	Considering	6425-7125 MHz
New Zealand	**Adopted**	5925-6425 MHz
Norway	**Adopted**	5945-6425 MHz
	Considering	6425-7125 MHz



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Questions?

Use the Webex app to chat with the speaker after the session

How

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2. Click “Join the Discussion”
3. Install the Webex app or go directly to the Webex space
4. Enter messages/questions in the Webex space

Webex spaces will be moderated by the speaker until February 28, 2025.



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Thank you

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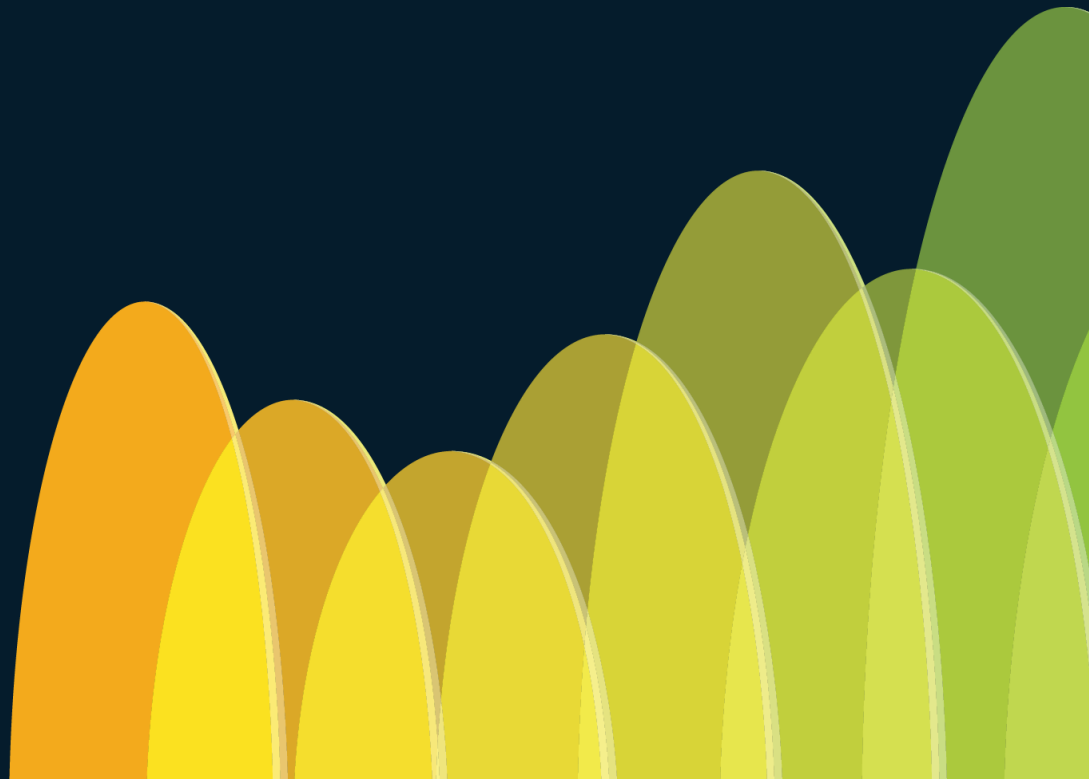
BACKUP / Reference Content



cisco Live!

Outdoor Access Points

MR78/76/86



- 802.11AX, MU-MIMO, OFDMA
- MR76/78: 2x2 MR86: 4x4
- Integrated Scanning Radio
- Integrated BLE Radio
- Cloud based RF Optimization
- MR76/78: 1G MR86:2.5G (RJ45)
- MR76/78: .3af MR86: .3at
- Integrated L7 Firewall
- Real-time WIDS/WIPS
- Enhanced transmit power and receive sensitivity

C9124



- 802.11AX, MU-MIMO, OFDMA
- 4x4 + 4x4:4
- Cisco RF ASIC next-gen Cisco CleanAir
- IoT ready
- 1x 2.5G mGig/SFP/1Gbe PoE-Out
- PoE-In 802.3af/at/bt/UPOE
- DC power input (24 to 56 VDC)
- 30 dBm Transmit Power(Same as 1572 and higher than 1562)
- Centralized, FlexConnect, Bridge, Flex+Bridge & EWC

* 6GHz subject to AFC availability

CW9163E



- 802.11AX, MU-MIMO, OFDMA
- 2x2(2.4GHz) + 2x2(5GHz) + 2x2(6GHz)*
- Tri-band Scanning Radio with next-gen CleanAirPro
- IoT ready
- 1x 2.5G mGig
- In-built GPS module
- PoE-In 802.3af/at

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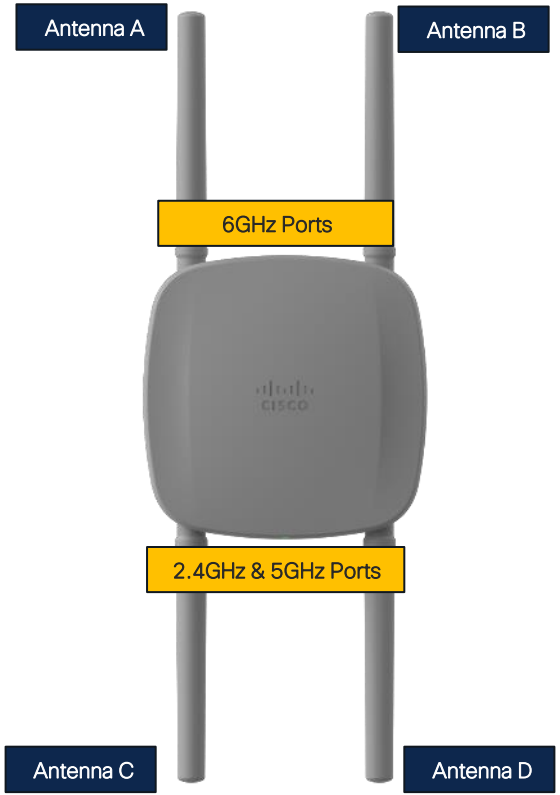
Catalyst 9163E – Ports & Environment Variables



H/W Capabilities	Catalyst 9163E
Antenna	External 2.4/5/6G bands
Number of Antenna Ports	4 WiFi and 1 GPS
External Antennas	WiFi: Triband Dipole (Omni) CW-ANT-O1-NS-00 WiFi: Triband Patch (Directional)-CW-ANT-D1-NS-00* GPS: Calif-1L1/L5 (Directional)
GNSS Receiver	L1/L5 dual bands GNSS receiver; 1x internal GPS antenna
Scanning Radio	2.4/5/6G 1x1
IoT (BLE/ZigBee/Thread)	Yes
Console	RJ-45
Reset Button	1 Pinhole push reset button
Wired Ports (WAN)	1 RJ-45 2.5mGig
Environmental Rating	IP66/67
Barometer	Yes

AP Radios will be turned off if any unsupported Antenna is connected

Supported Environment Specifications

- Non-operating (storage) temperature: -30 to 70 C (-22 to158 F)
- Operating temperature: -40 to +65 C (55° C with solar loading)
- Operating humidity: 5 to 95% (non-condensing)
- Operating altitude: 40 °C, 3000 meters (9843 feet)
- Non-operating (storage) altitude test: 25°C, 15,000 ft

***Available post FCS**

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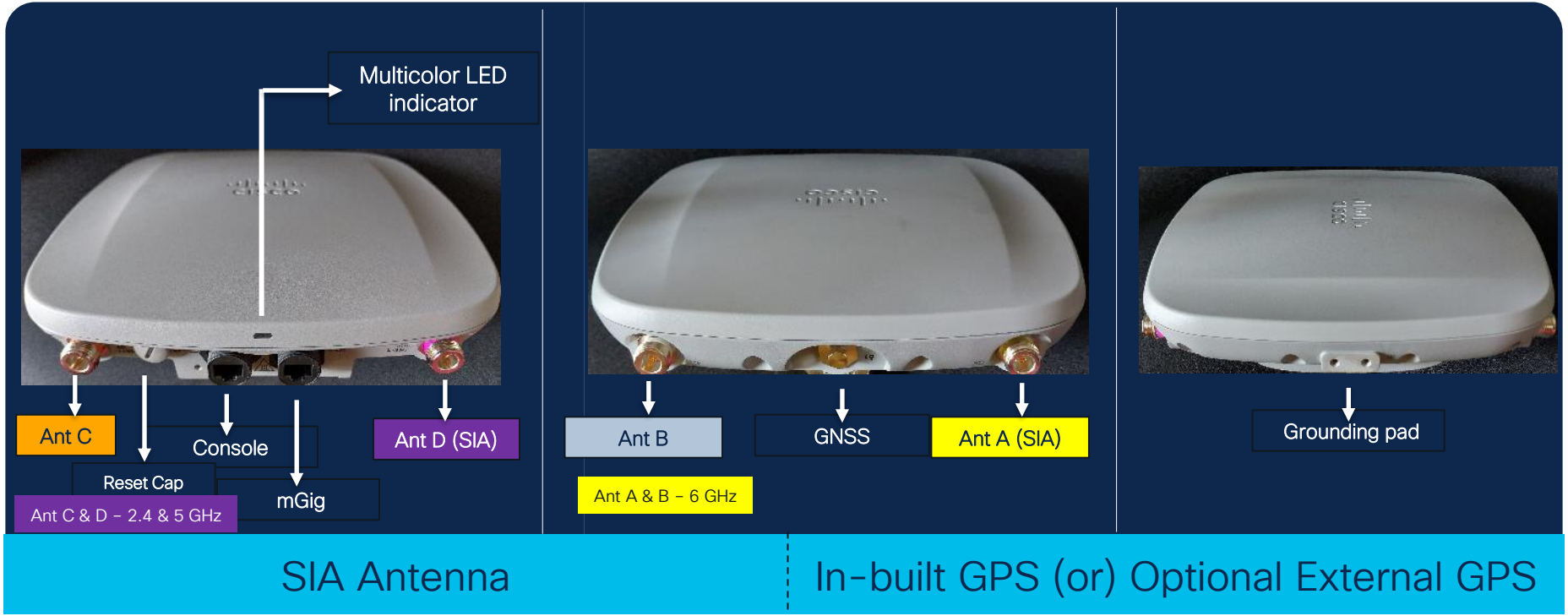
Catalyst CW9163E – Interfaces



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Catalyst CW9163E – Backside View



IP67 Rated



Existing Bracket Mounts

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Cisco Outdoor AP Dimensions

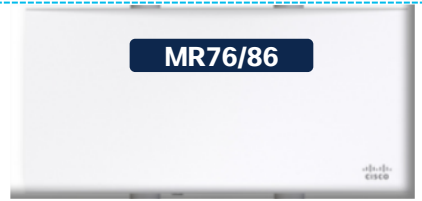
AP1562D/E: 5.7 lbs

MR 76/86: 2.9 lbs/ 3.3 lbs

C9124: < 7 lbs

CW9163E: < 3.3 lbs









1562I: 9.0 x 6.8 x 3.9 in.
(22.9 x 17.1 x 9.8 cm)

1562D: 9.0 x 6.8 x 4.3 in.
(22.9 x 17.1 x 10.9 cm)

1562E: 9.0 x 6.8 x 3.9 in.
(22.9 x 17.1 x 9.8 cm)

MR76/86
11.81 x 6.02 x 2.16 in.
(30 x 15.3 x 5.5 cm)

9124AXE: 10.2 x 9.2 x 3.2 in.
(25.9 x 23.3 x 8.1 cm)

9124AXI/D: 10.2 x 9.2 x 3.2 in.
(25.9 x 23.3 x 8.1 cm)

Catalyst 9163E:
9.64 x 964 x 2.5 in.
(24.5 x 24.5 x 6.35 cm)

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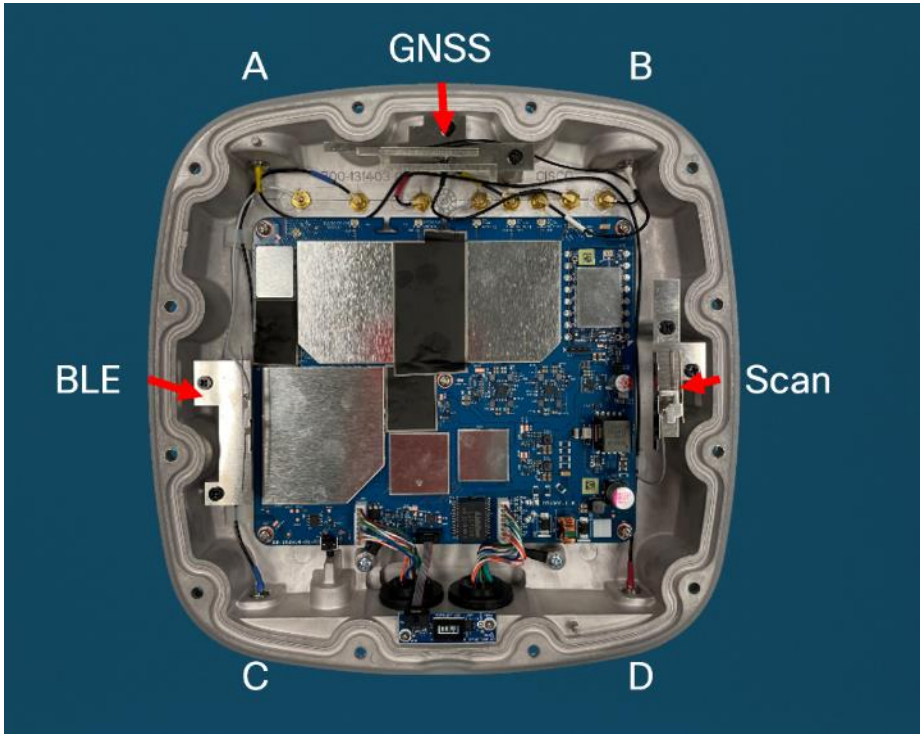
CW9163 Antenna Placement



Antenna #	Antenna Type	Band/Gain
C-D	Dual Band Wi-Fi 2.4/5 GHz	External
A-B	Wi-Fi 6GHz	External
Scan	Scanning	External
BLE	BLE	External
GNSS	L1/L5 GNSS Patch	External

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Catalyst CW9163E: Antenna Support

Antenna Type	Direct Attach Omni Directional Antenna, Tri-band
Antenna Beamwidth	Azimuth: Omni Elevation (3 dB bandwidth): 30° at 2.4 GHz; 30° at 5 GHz and 30° at 6 GHz
Antenna Gain	Max gain of 4 dBi at 2.4 GHz Max gain of 8 dBi at 5 and 6 GHz
Connection	Direct connect with N-Type (M) connector

CW-ANT-O1-NS-00
- Tri-band
- Supported in all 4 Antenna Ports

CW-ANT-O1-NS-00 & CW-ANT-D1-NS-00 are the only Antenna supported in 6GHz Ports

**CW-ANT-D1-NS-00 – First half of CY24*

CW-ANT-GPS2-S-00

Antenna Type	L1/L5 Dual Band RHCP GNSS antenna (active)(Optional)
Antenna Beamwidth	Azimuth: Omni
Antenna Gain	Max gain +2 dBi
Connection	10ft, low loss, RF pigtail cables with SMA(M) connector

Built-in Internal GPS Antenna in CW9163 with 3 dBi peak gain

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Catalyst CW9163E – Antenna Details



B

6 GHz Non-SIA

A

6 GHz SIA



D

2.4/5 GHz Non-SIA

C

2.4/5 GHz SIA

Omni-Directional



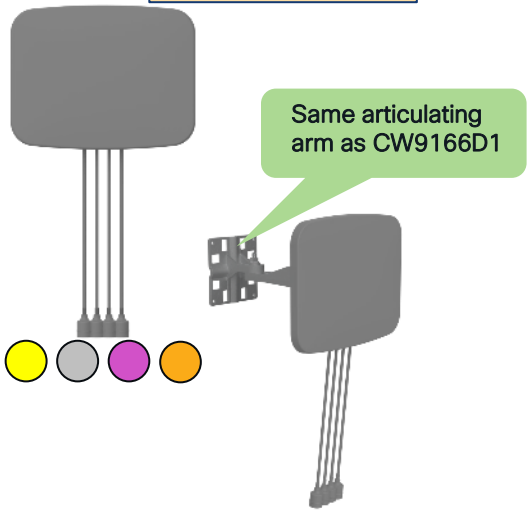
Black Ring

Tri-Band with SIA

CW-ANT-O1-NS-00

Size: 229.5.03 X 27.8 mm

Directional



CW-ANT-D1-NS-00

Size: 268.8 X 210.2 X 35 mm

Dual Band port colors consistent with existing color scheme

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Catalyst CW9163E- External GPS Antenna

GNSS/GPS based Geo Location mandatory for AFC.



External GPS Antenna Port
(SMA Connector)



External GPS Antenna

Max distance of Antenna Cable: 10 ft
PID: CW-ANT-GPS2-S-00

"S" for SMA

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Power options – Catalyst CW9163E

- Catalyst CW9163E AP supports various powering options
- AP works in different mode based on the input power option

Power Mode	PoE	2.4GHz	5GHz	6GHz	mGig link speed	Scan	BLE	GNSS
1	802.3af	1x1	1x1	Off	1G	Off	Off	On
2	802.3at	2x2	2x2	n/a	2.5G	On	On	On

Note: Meraki Mode AP needs 802.3at to operate. De-graded mode is not supported

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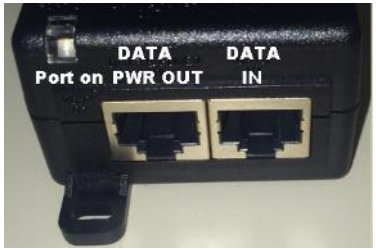
Power options – Injectors

- Following 30W and 60W Power Injectors can be used to power up the Catalyst CW9163E Access Points







Supported Power Injectors

- AIR-PWRINJ6
- AIR-PWRINJ7
- MA-INJ-6
- AIR-PWRINJ-60RGDMG
- AIR-PWRINJ5

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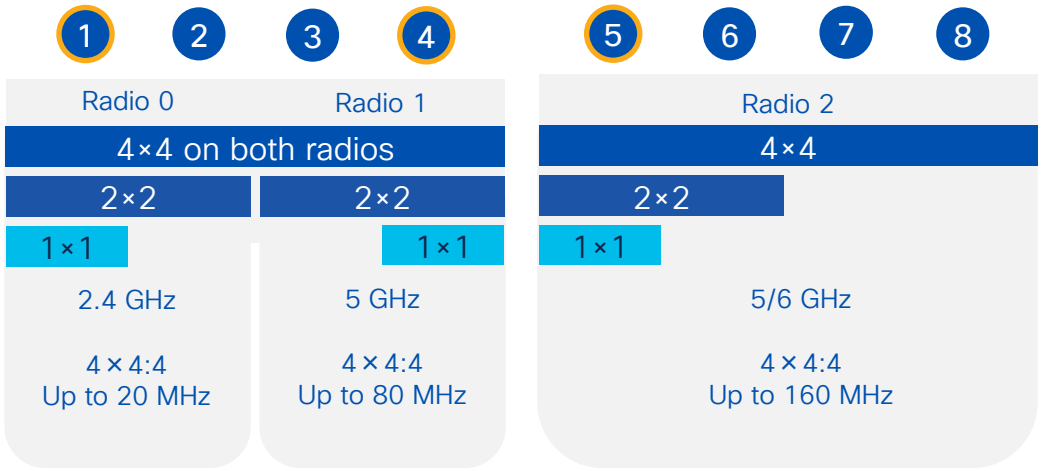
IW9167 – Flexible Antenna Assignment details





1 – 4 2.4 GHz and 5 GHz antenna ports – N(f)

5 – 8 5/6 GHz antenna ports – N(f)

4 IoT radio antenna (limits 2.4GHz radio to 2×2, when enabled)

GNSS TNC (f) antenna port

Self-identifying antenna port.
SIA-capable antenna is required for 6GHz operation.

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Catalyst 9124AX Outdoor Access Point

C9124AXI(D) Integrated Omni & Directional



Powered by Cisco RF ASIC

9124AXI, 9124AXD

- 4x4 + 4x4 in both 2.4 and 5 GHz
- MU-MIMO, OFDMA
- Cisco RF ASIC for next-gen Cisco CleanAir®
- Integrated BLE/IoT radio
- 2.5G mGig Wired uplink + 1G SFP+ 1Gbe with 802.3af power out – 15.4 watts
- 30 dBm Transmit Power(Same as 1572)
- 1024 QAM, data rate of 2.5 Gbps

C9124AX External Antennas



Powered by Cisco RF ASIC

9124AXE

- Dual Radio Mode: 4x4 + 4x4 in both 2.4 and 5 GHz
- Tri-Radio Mode: 2x2 + 2x2 + 2x2 in 2.4 Ghz, 5Ghz(Slot 1) & 5 Ghz(Slot 2)
- MU-MIMO, OFDMA
- Cisco RF ASIC for next-gen Cisco CleanAir
- Integrated BLE/IoT radio
- 2.5G mGig Wired uplink + 1G SFP + 1Gbe (802.3af power out-15.4 watts)
- 29 dBm Transmit Power
- Enhance Surge Protection & Lightning arrester for Ethernet ports and DC Input
- -E SKU: Six N-type connectors: Three ports support Self-Identifying Antenna (SIA)

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Cisco Outdoor AP Dimensions









9124AXE: 10.2 x 9.2 x 3.2 in.
(25.9 x 23.3 x 8.1 cm)

9124AXI/D: 10.2 x 9.2 x 3.2 in.
(25.9 x 23.3 x 8.1 cm)

1542I/D: 7.9 x 5.9 x 2.4 in.
(20 x 15 x 6.1 cm)

1562I: 9.0 x 6.8 x 3.9 in.
(22.9 x 17.1 x 9.8 cm)

1562D: 9.0 x 6.8 x 4.3 in.
(22.9 x 17.1 x 10.9 cm)

1562E: 9.0 x 6.8 x 3.9 in.
(22.9 x 17.1 x 9.8 cm)

1572EAC/1572EC: 11.8 x 7.9 x 6.3 in.
(30.0 x 20.1 x 16.0 cm)

1572IC: 11.8 x 7.9 x 7.9 in.
(30.0 x 20.1 x 20.1 cm)

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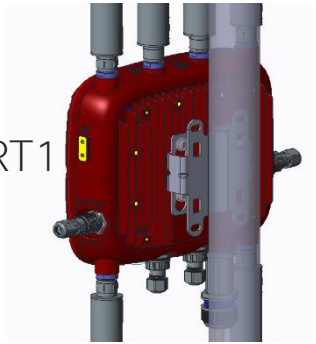
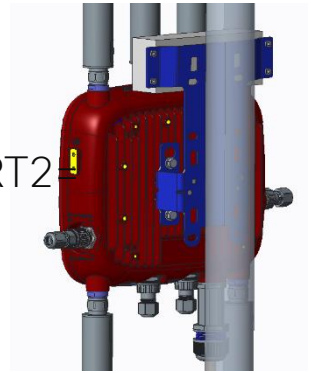
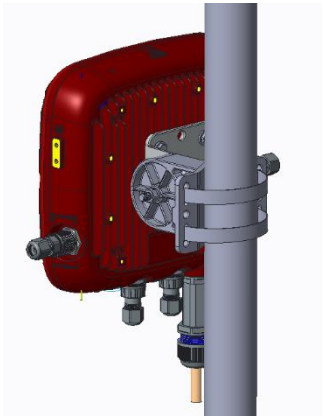
Catalyst 9124AX Series: Mounting Brackets

AIR-MNT-VERT1

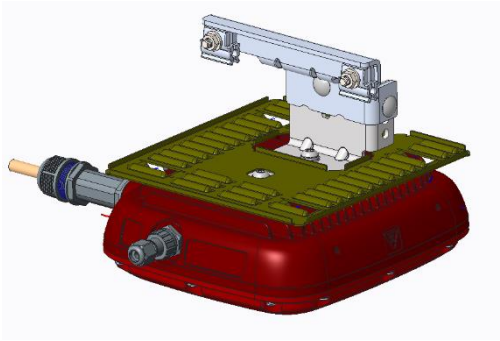


AIR-MNT-VERT2=

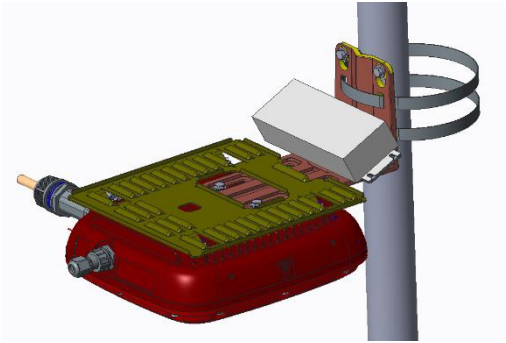




AIR-MNT-ART1=



AIR-MNT-STRAND1=



AIR-MNT-HORZ1= & AIR-MNT-HORZ1-PSU

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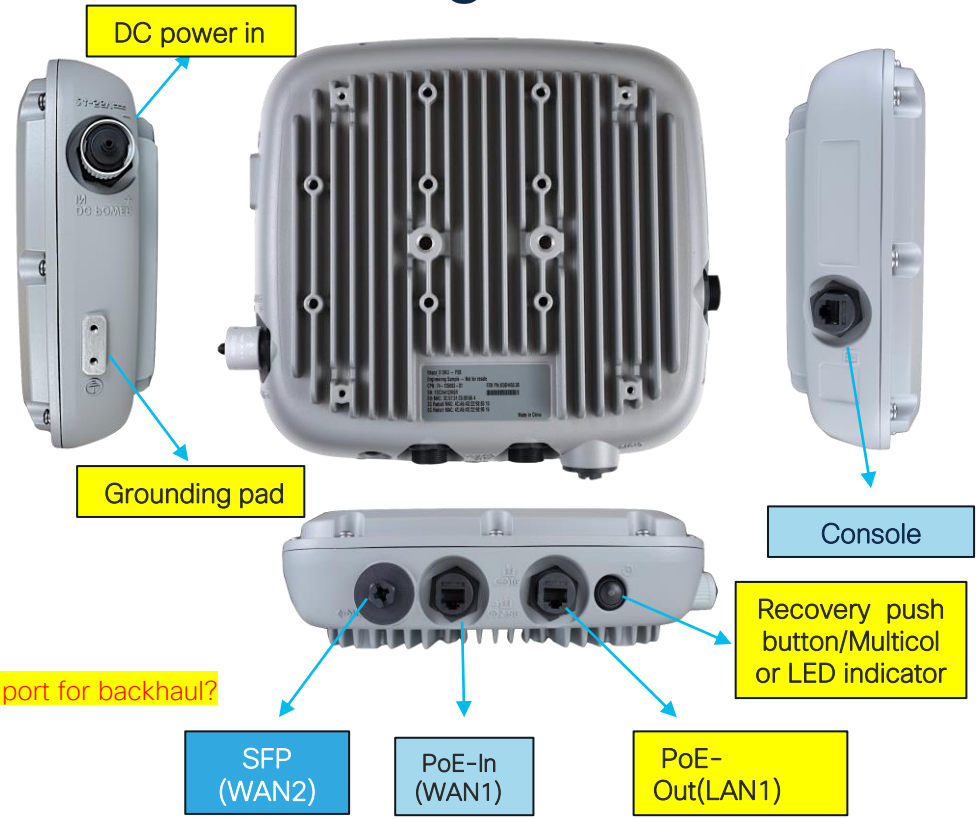
Catalyst 9124AXI/D – Ports / Plugs / Etc.





FAQ:

Q1: Can the AP be powered by an injector but use the SFP port for backhaul?

A1: YES.

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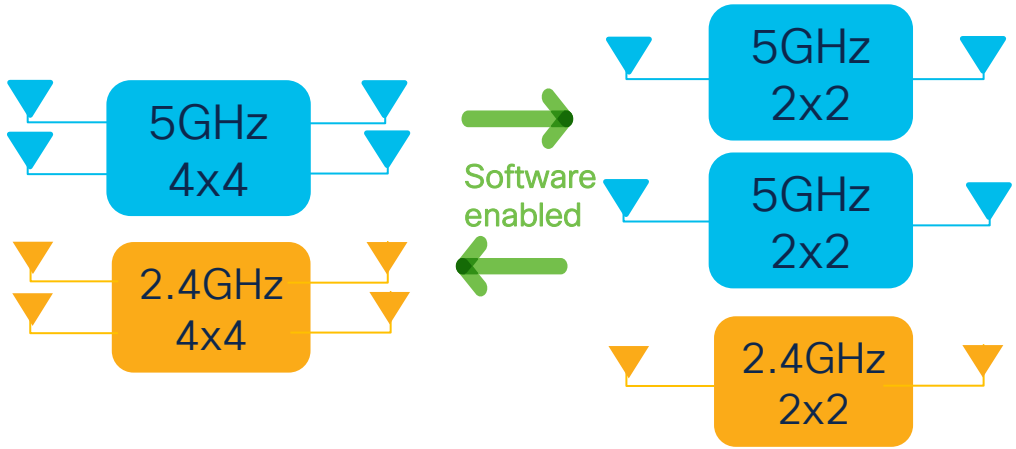
C9124AXE – Radio Mode 17.7+

Mode	2.4 Ghz (Slot 0)	5 Ghz (Slot 1)	5 Ghz (Slot 2)
Dual Radio	4x4	4x4	Down
Tri-Radio	2x2	2x2	2x2



Note: To enable Tri-Radio Mode, C9124AXE should be powered up by 802.3bt/UPOE/DC

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Catalyst 9124AXE – RF Port Mapping



Mode	Ports Used For 2.4 Slot 0	Ports Used For 5GHz Slot 1	Ports Used for 5GHz Slot 2
2.4GHz 1ss 5GHz 1ss 5GHz 1ss	1	3	5
2.4GHz 2ss 5GHz 2ss 5GHz 2ss	1,2	3,4	5&6
2.4GHz 4ss 5GHz 4ss 5GHz (off)	1,2,3,4	1,2,3,4	OFF

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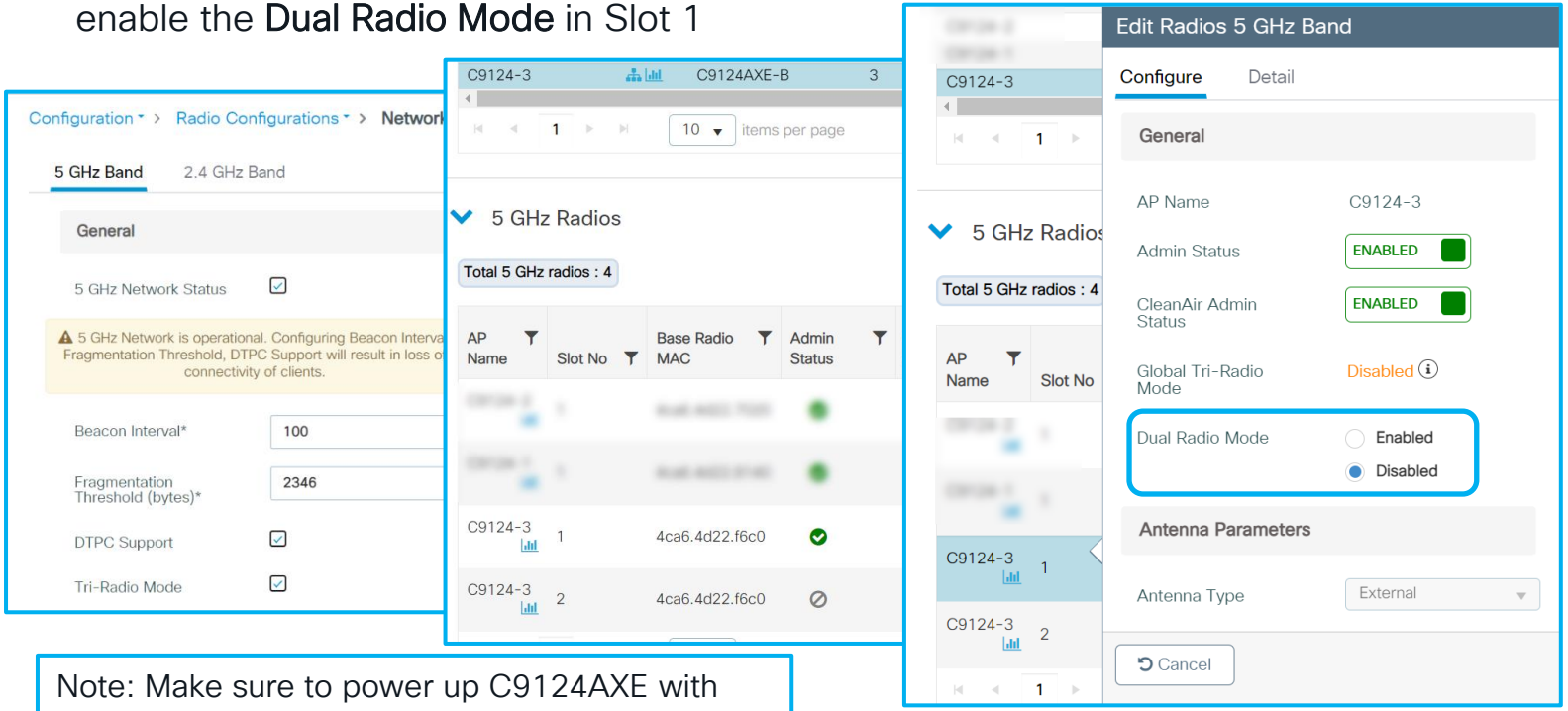
Catalyst 9124AXE – Tri-Radio Mode

- To enable Tri-Radio globally in UI, **Configuration > Radio Configurations > Network(5ghz)**
- In Access Point(**Configuration > Wireless > Access Points**), Expand the **5 Ghz Radios** and enable the **Dual Radio Mode** in Slot 1



Note: Make sure to power up C9124AXE with 60W source to operate in Tri-Radio Mode

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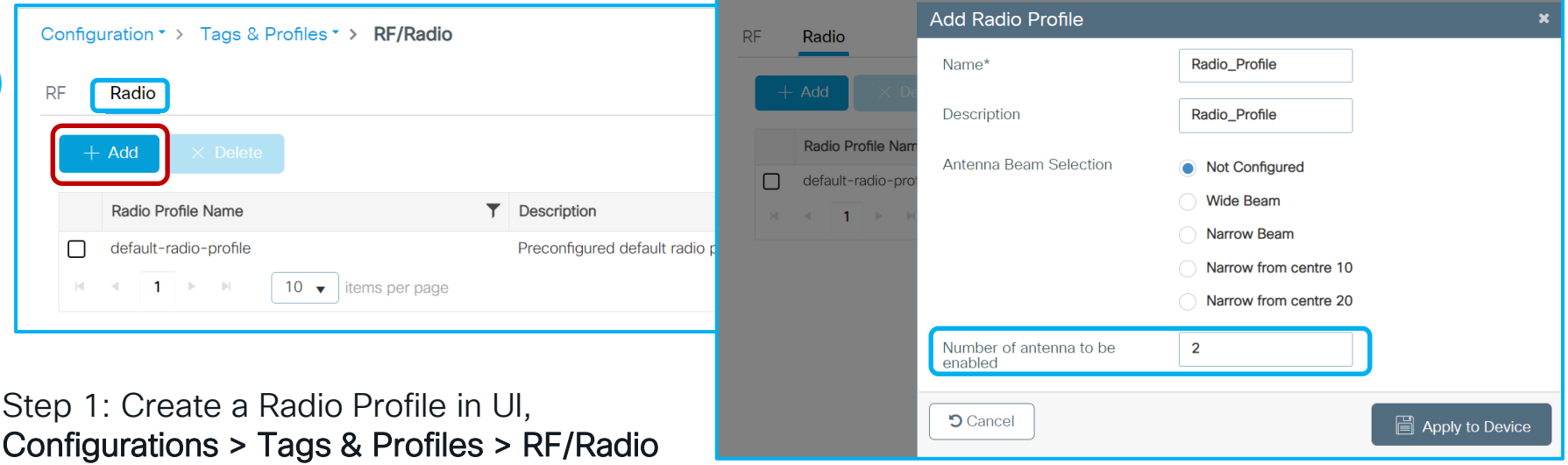
Catalyst 9124AX Series – Radio Profile

- In Cisco IOS-XE 17.6.1 SW, Catalyst 9124AX APs can operate in 1x1, 2x2 & 4x4 only
- With the introduction of Antenna Selection, Administrator can choose the mode manually and allowing the Access Point to choose the Antenna to be used



Step 1: Create a Radio Profile in UI,
Configurations > Tags & Profiles > RF/Radio

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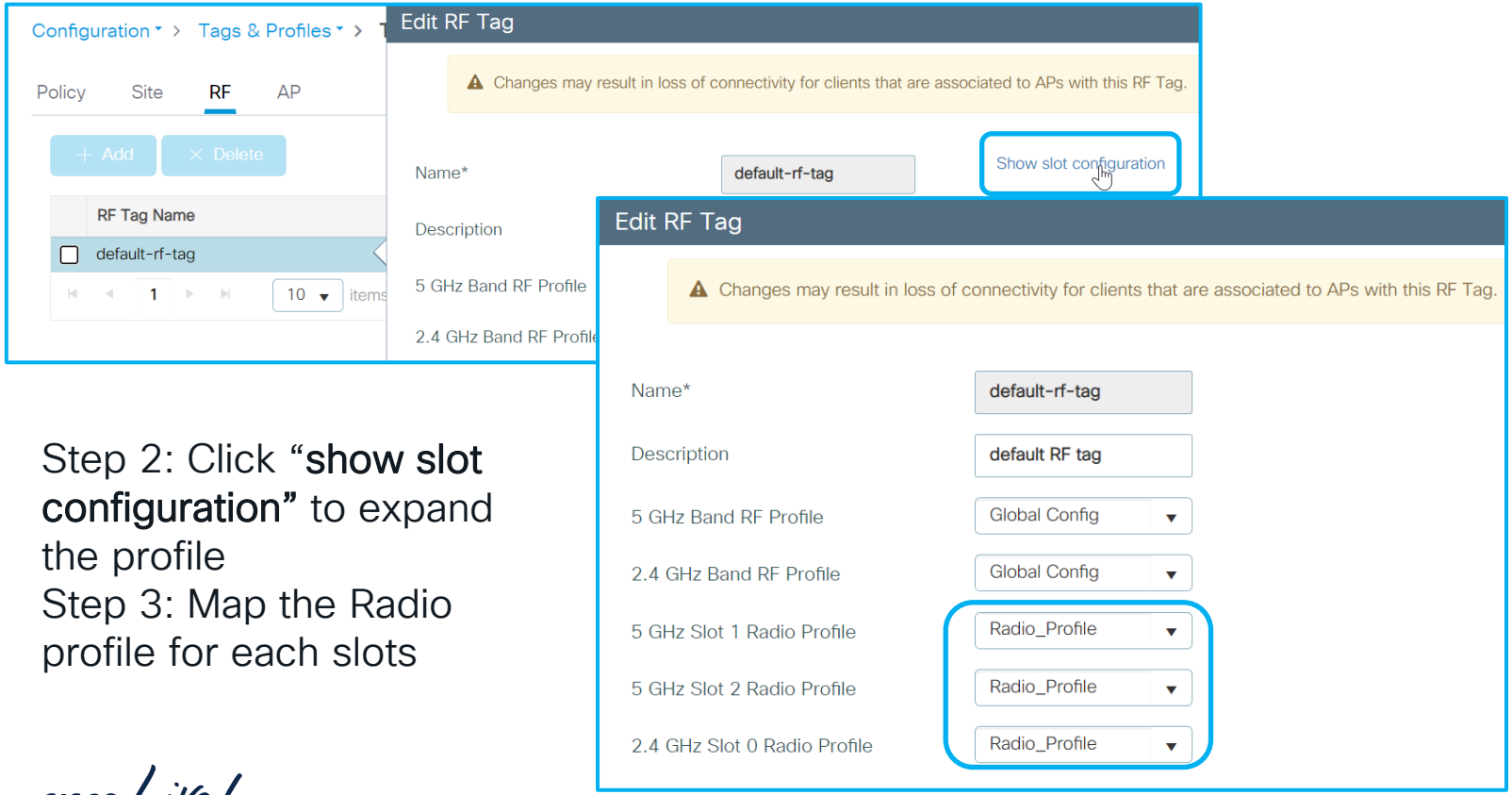
Catalyst 9124AX – Radio Profile



Step 2: Click “**show slot configuration**” to expand the profile

Step 3: Map the Radio profile for each slots

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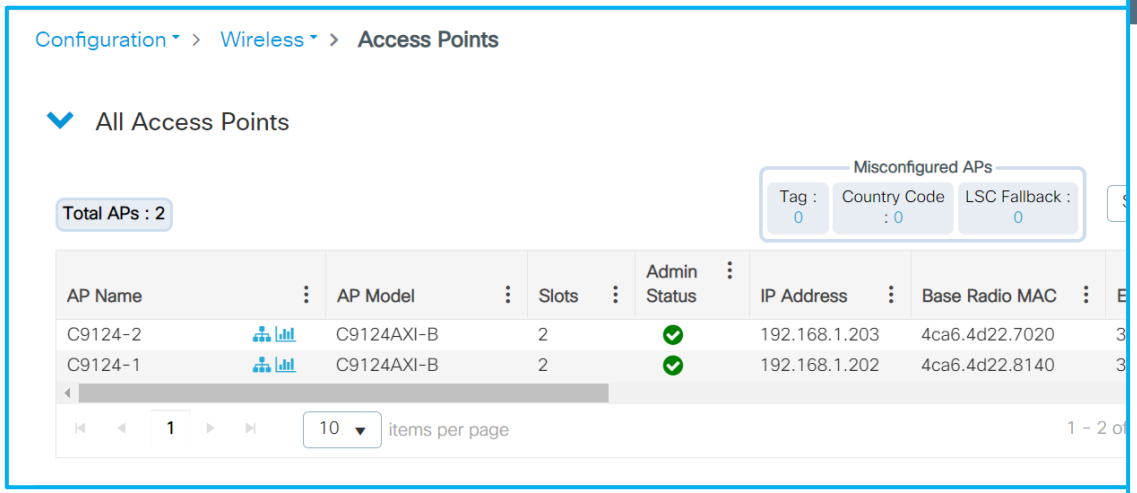
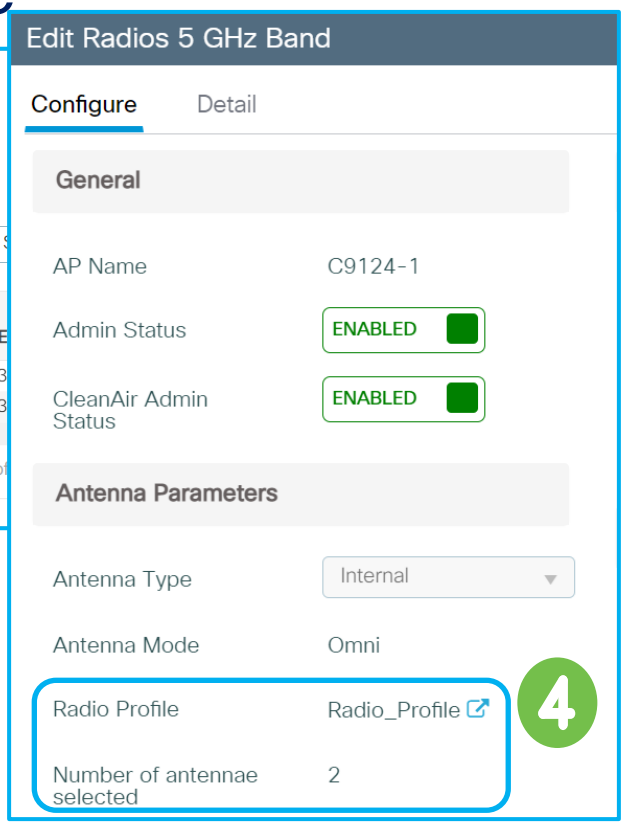
Catalyst 9124AX – Radio Profile





Step 4: Check the **Radio Profile** & **Number of Antennae selected** in the Access Point slots

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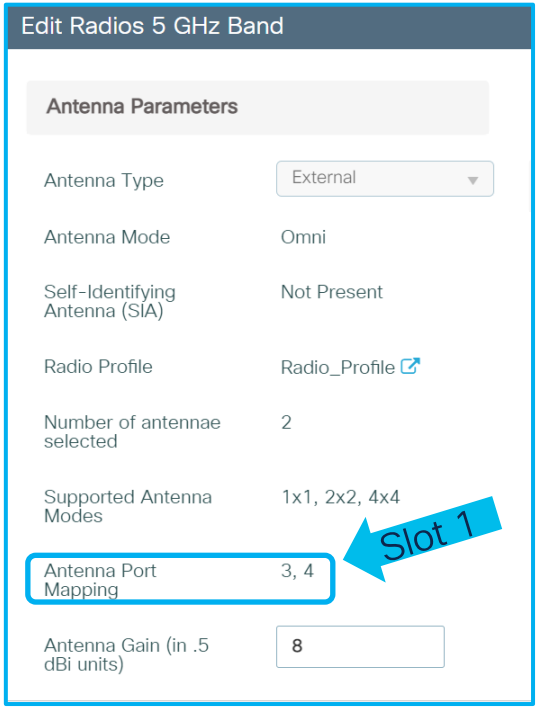
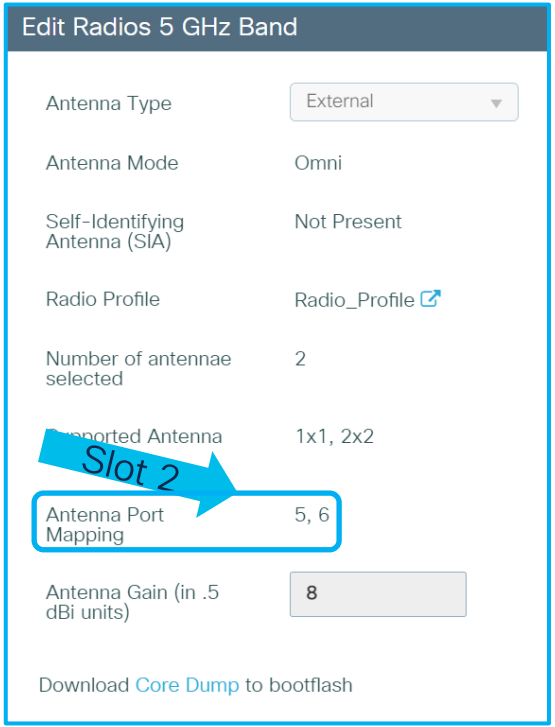
Catalyst 9124AXE – Radio Profile



Step 5 & 6: Antenna Port Mapping is also displayed in respective radio slots



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Catalyst 9124AXI/D: Antenna Configuration

- Catalyst 9124AXI/D APs support 4 Antenna Paths in both 5 Ghz and 2.4 GHz. A separate internal Antenna for IoT and pair of Antenna for AUX. Below table explains the different Antenna modes supported in C9124I/D.

	5Ghz Radio				2.4Ghz Radio				IoT	CW	
Mode	Path-0 Ant-1	Path-1 Ant-2	Path-2 Ant-3	Path-3 Ant-4	Path-0 Ant-1	Path-1 Ant-2	Path-2 Ant-3	Path-3 Ant-4	Path-0	Path-0	Path-1
1x1	Y	-	-	-	Y	-	-	-	Y	Y	Y
2x2	Y	Y	-	-	Y	Y	-	-	-	-	-
4x4	Y	Y	Y	Y	Y	Y	Y	Y	-	-	-
2x2(160)	Y	Y	-	-	-	-	-	-	-	-	-
4x4(160)	Y	Y	Y	Y	-	-	-	-	-	-	-



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Catalyst 9124AXE: Dual Radio Antenna Configuration

- The -E SKU supports one to six antenna configurations
- -E SKU IoT radio has internal dedicated Antenna, and the Aux radio will share the same antennas with serving radios through splitters

Catalyst® 9124AXE Dual-Radio Antenna Configurations:

	5Ghz Radio 1 (Primary)				5Ghz Radio 2 (Secondary)		2.4Ghz Radio				IoT
Mode	Path-0 Ant-3	Path-1 Ant-4	Path-2 Ant-1	Path-3 Ant-2	Path-0 Ant-5	Path-1 Ant-6	Path-0 Ant-1	Path-1 Ant-2	Path-2 Ant-3	Path-3 Ant-4	Path-0
1x1 (20/40/80)	Y	-	-	-	-	-	Y	-	-	-	Y
2x2 (20/40/80)	Y	Y	-	-	-	-	Y	Y	-	-	Y
4x4 (20/40/80)	Y	Y	Y	Y	-	-	Y	Y	Y	Y	Y



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Catalyst 9124AXE: Tri-Radio Antenna Configuration

Catalyst® 9124AXE Tri-Radio Antenna Configurations: Channel Bandwidth <=80 Mhz

	5Ghz Radio 1 (Primary)				5Ghz Radio 2 (Secondary)		2.4Ghz Radio				IoT
Mode	Path-0 Ant-3	Path-1 Ant-4	Path-2 Ant-1	Path-3 Ant-2	Path-0 Ant-5	Path-1 Ant-6	Path-0 Ant-1	Path-1 Ant-2	Path-2 Ant-3	Path-3 Ant-4	Path-0
1x1 (20/40/80)	Y	-	-	-	Y	-	Y	-	-	-	Y
2x2 (20/40/80)	Y	Y	-	-	Y	Y	Y	Y	-	-	Y



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Catalyst 9124AX Series: Re-usable Mounting kits

Mounting kit - Reusable	9124AXI	9124AXD	9124AXE
AIR-ACC1530-PMK1=	✗	✓	✓
AIR-ACC1530-PMK2=	✗	✓	✓

AIR-ACC1530-PMK1=
Fixed vertical mount





AIR-ACC1530-PMK2=
Tilting mount

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Catalyst 9124AXE: Antenna options

- Antennas (most of them) used in AP1562E can be re-used in C9124AXE access points. In addition, support for the new SIA Antenna(highlighted below) is also available in same band and gain

Product ID	Description	Gain
AIR-ANT2547V-N	Omnidirectional dual band (2.4/5 GHz)	2.4 Ghz: 4 dBi 5 Ghz: 7 dBi
AIR-ANT2547VG-N/**AIR-ANT2547VG-NS**	Omnidirectional dual band (2.4/5 GHz)	2.4 Ghz: 4 dBi 5 Ghz: 7 dBi
AIR-ANT2568VG-N/**AIR-ANT2568VG-NS**	Omnidirectional dual band (2.4/5 GHz)	2.4 Ghz: 6 dBi 5 Ghz: 8 dBi
AIR-ANT2588P3M-N=	3-port wall/pole mount directional (wide)	2.4 Ghz: 8 dBi 5 Ghz: 8 dBi
AIR-ANT2588P4M-NS=	4-port wall/pole mount directional (wide)	2.4 Ghz: 8 dBi 5 Ghz: 8 dBi
AIR-ANT2513P4M-N/**AIR-ANT2513P4M-NS=**	4-port wall/pole mount directional (narrow)	2.4 Ghz: 13 dBi 5 Ghz: 13 dBi
AIR-ANT2450V-N=	Omnidirectional (2.4 GHz)	2.4 Ghz: 5 dBi
AIR-ANT2480V-N=	Omnidirectional (2.4 GHz)	2.4 Ghz: 8 dBi
AIR-ANT2413P2M-N=/**AIR-ANT2413P2M-NS=**	2-port directional (2.4 GHz)	2.4 Ghz: 13 dBi
AIR-ANT5180V-N=	Omnidirectional (5 GHz)	5 Ghz: 8 dBi
AIR-ANT5114P2M-N=/**AIR-ANT5114P2M-NS=**	2-port directional (5 GHz)	5 Ghz: 14 dBi

- ✓ Support Self-Identifying Antennas (AP ANT ports 1, 3, 5) in Antennas:
  AIR-ANT2547VG-NS, AIR-ANT2568VG-NS, AIR-ANT2413P2M-NS=, AIR-ANT5114P2M-NS=, AIR-ANT2568VG-NS, AIR-ANT2513P4M-NS=

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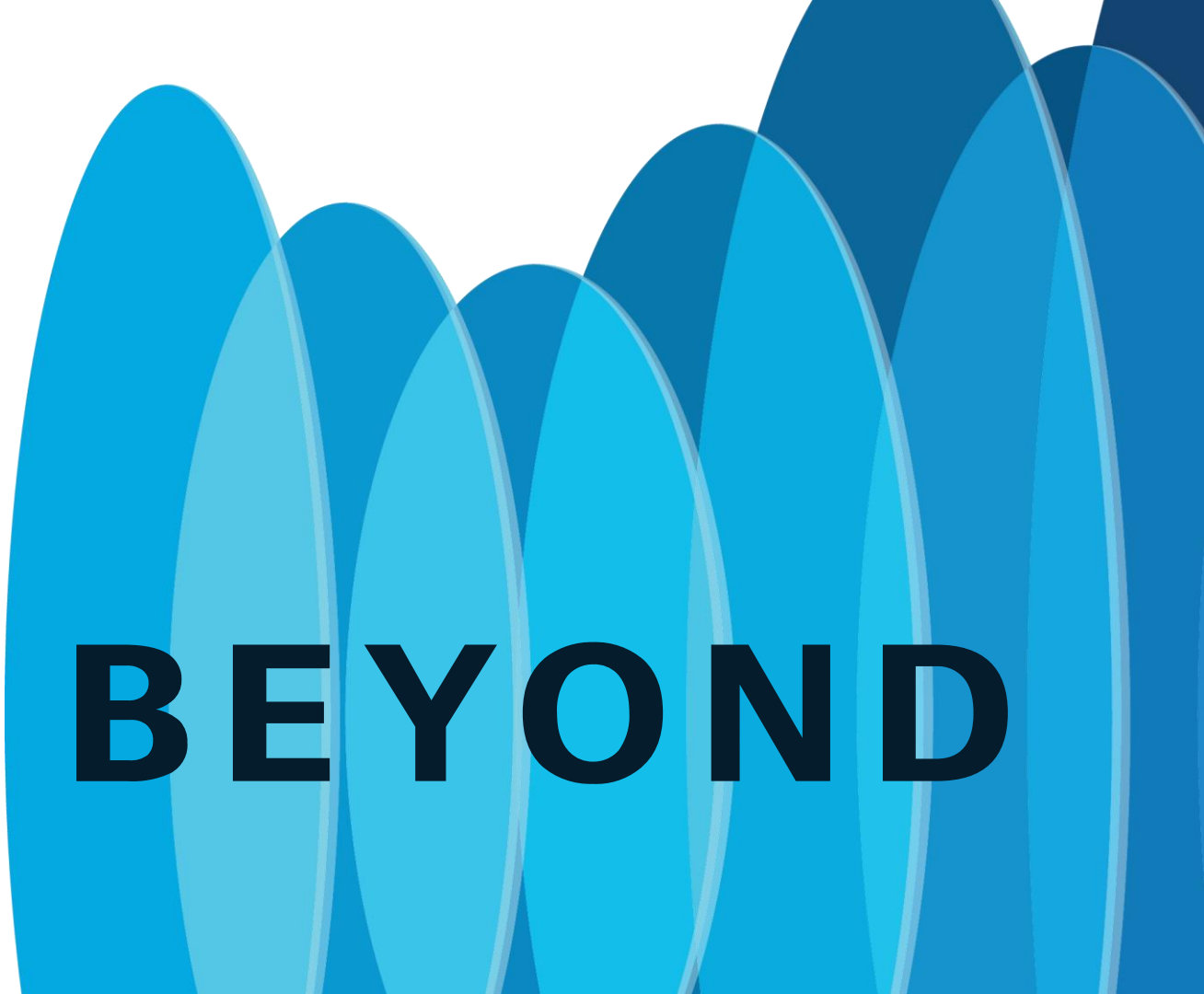

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