



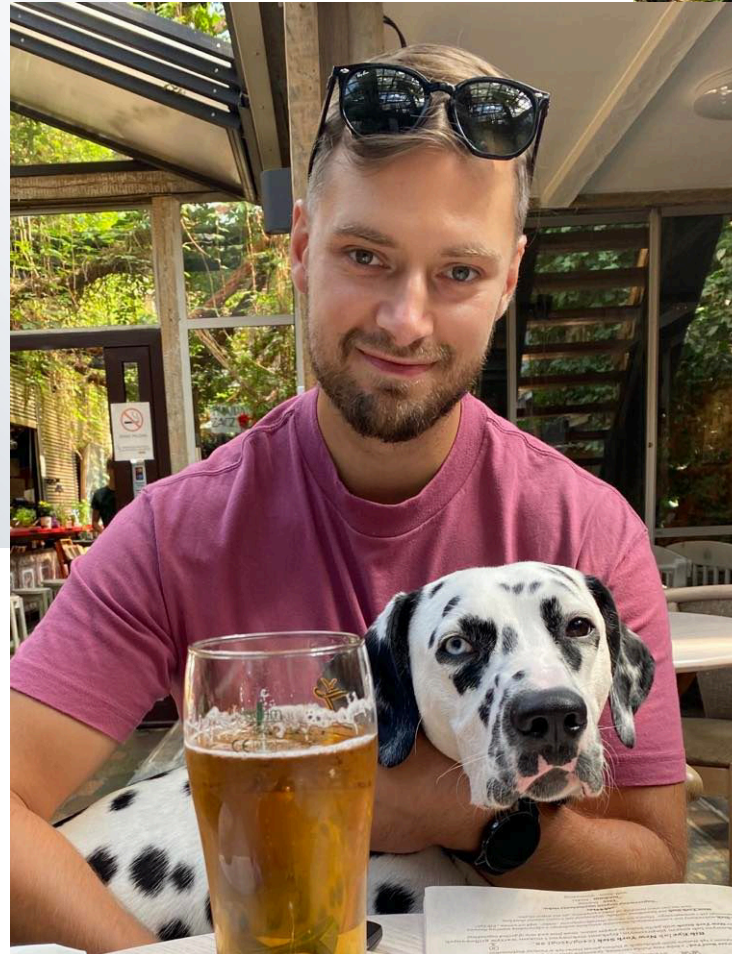
Wireless Counselling

Understanding the Love triangle in Wi - Fi Networks

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Meraki Escalations

21/03/2024

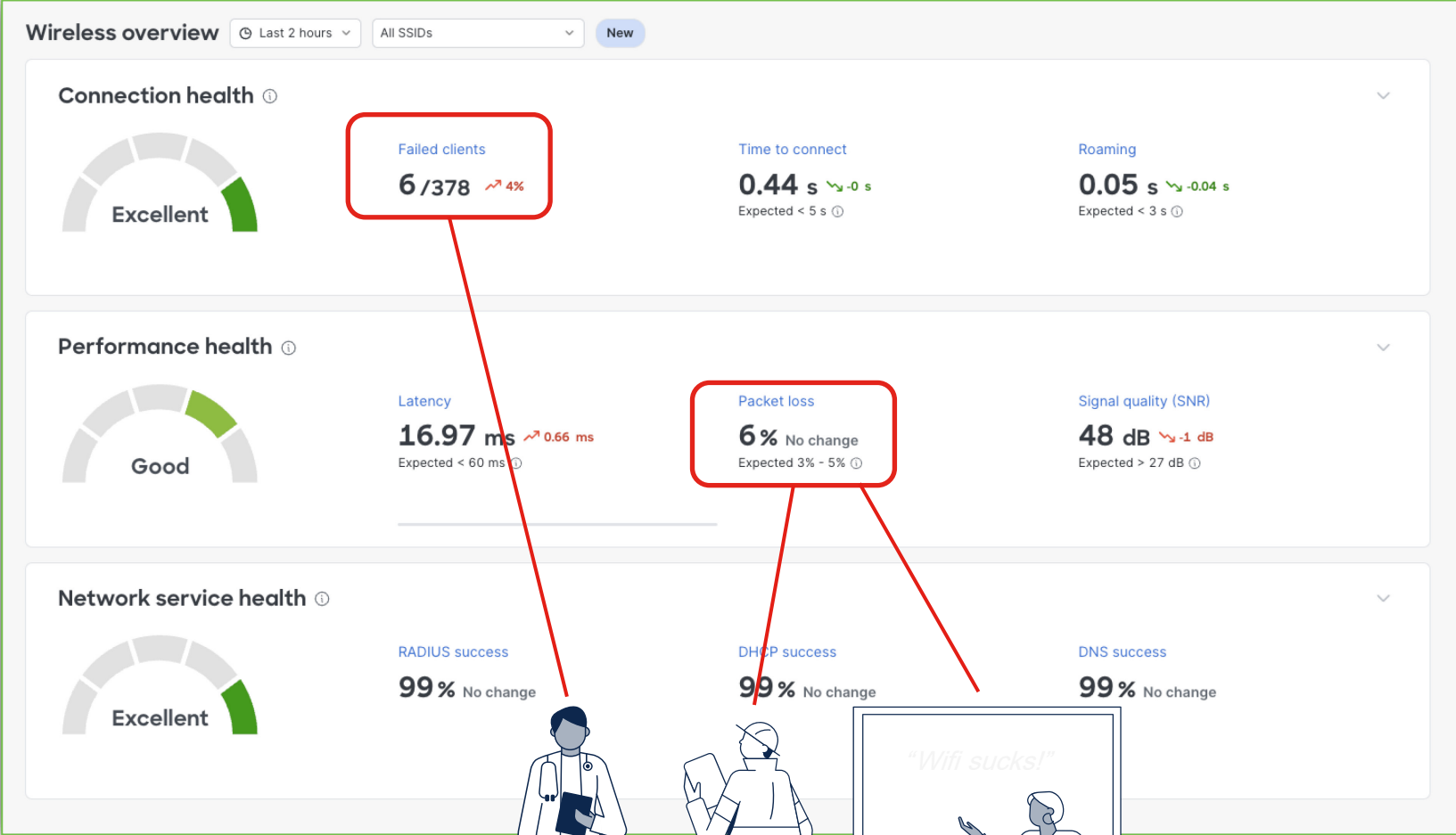
Who is this guy?



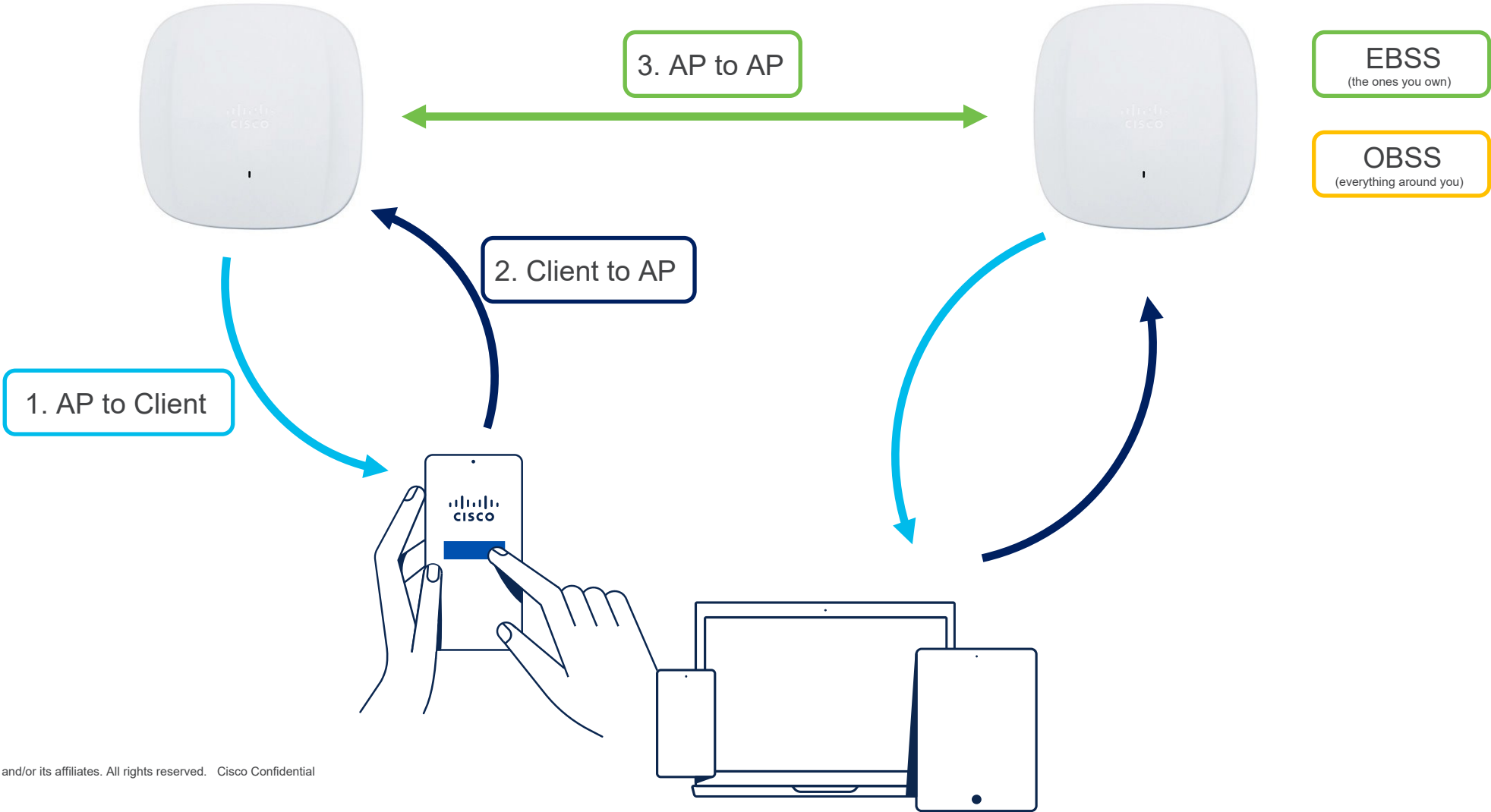
Agenda

- Identify key relationships in Wireless
- Define everyone's responsibilities
- Real life examples

Good wireless is more than high RSSI

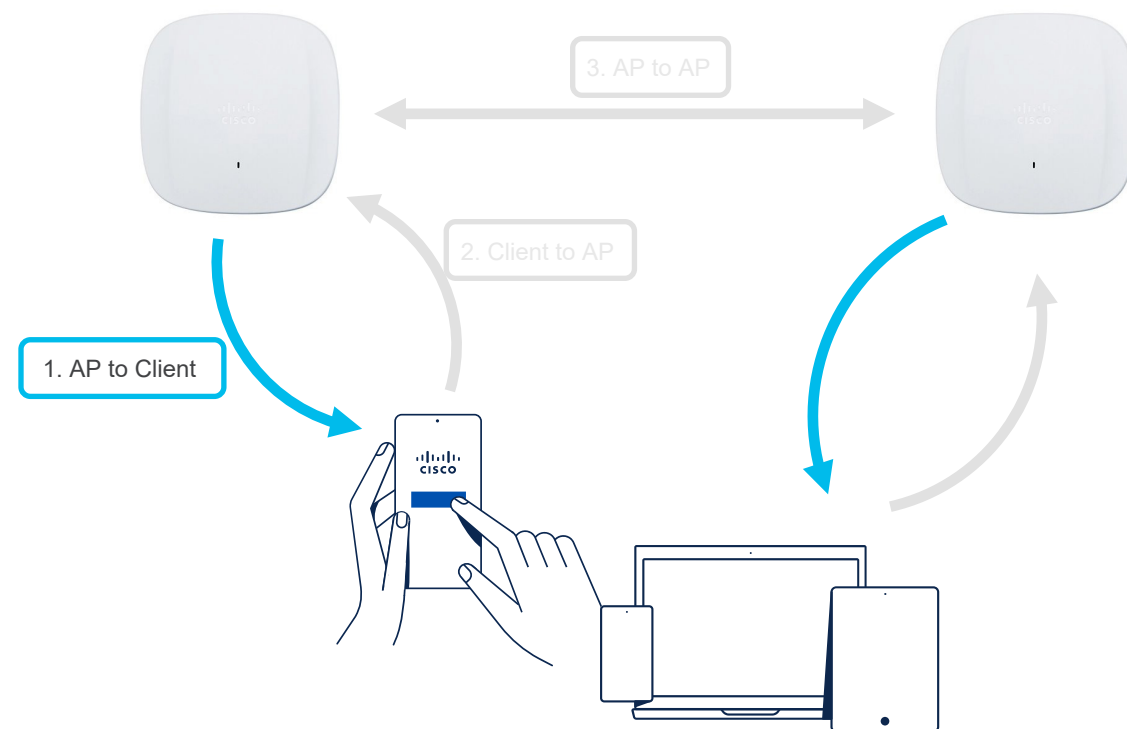


How many Wireless relationships do we see?



AP is the one "wearing the trousers"

- Usually mounted above client devices
- Very sensitive to environment around it
- Control freak
- Must obey by the same rules as others
- Highly customizable
 - Different antenna types and capabilities
 - TX power
 - Data rates
 - Channel assignment
 - More advanced options
 - RX-SOP, 11k/v...



Client is the “submissive” one

- Less powerful
- Only sees what’s around it
- Power mode may dictate its operations
- Not as customizable in most cases
- High reliance on vendor docs
- Decides when to roam

Trigger threshold

This is the minimum signal level a client needs to maintain a connection.

iPhone, iPad and iPod touch monitor and maintain the Basic Service Set Identifier (BSSID)’s connection until the Received Signal Strength Indicator (RSSI) exceeds -70 dBm. Then the device scans for roam candidate BSSIDs for the new Extended Service Set Identifier (ESSID).

Bear this in mind when you design wireless cells and calculate their signal overlap. For example, you might design 5 GHz cells that have a -67 dBm overlap. In this case, the device keeps its connection to the BSSID longer than you expect. This is because the device uses -70 dBm as the trigger. If the BSSID's RSSI is greater than -65 dBm, the device prefers a 5 GHz network.

Be sure to use the target device to measure cell overlap. Antennas on a laptop computer are much larger and more powerful than antennas on a smartphone or tablet. So if you use a laptop to measure overlap, iPhones and iPads will have different cell boundaries than you expect.

When the device sends or receives data, it picks target BSSIDs whose RSSI is eight dB or greater than the current BSSID’s RSSI. When the device doesn't send or receive data, use a 12 dB differential.

For example, the RSSI of the current connection might drop to -75 dBm during a Voice over WLAN (VoWLAN) call. When this happens, the device will later search for BSSIDs that have an RSSI of at least -67 dBm.

Other APs are the *family* or the *noisy neighbours*

- AP needs to make it work and keep everyone happy
- Over RF
 - How well I can hear APs and on what channels
 - The ones I **want to** care about
 - The ones I **have to** care about
 - Necessary for well functioning RRM
- Over wire
 - Every vendors shares different data in many ways
 - Key management
 - Client information
 - Probably more

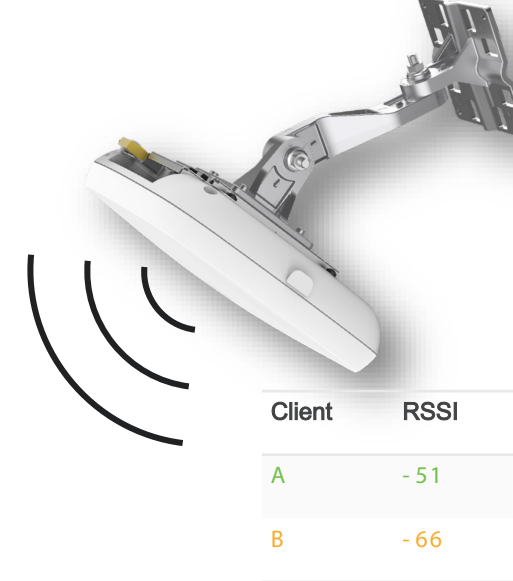
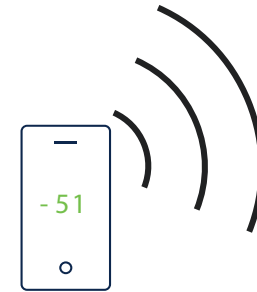


Let's put that into practice

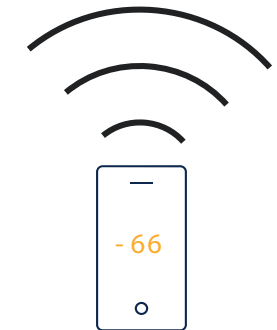


RSSI directly impacts the performance

- High RSSI usually equals high MCS
 - At least that's the logic
- Well designed network should result with *as equal as possible* RSSI on Client and AP and consistent rates
- RSSI imbalance may result with frequent downshifts and retries
- It is common to see 6 – 15dB difference between AP and client



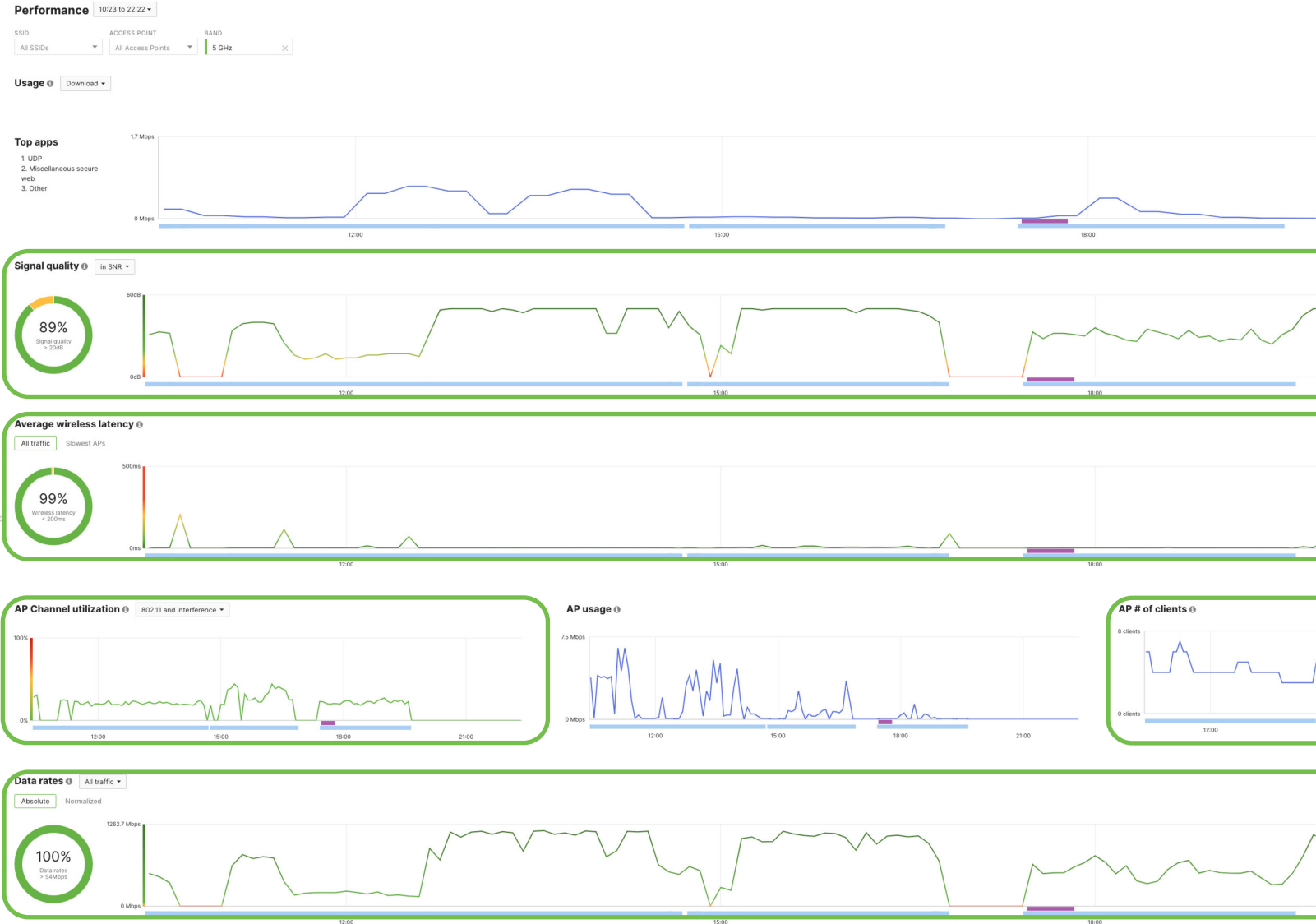
Client	RSSI
A	-51
B	-66





Creative config can make things worse

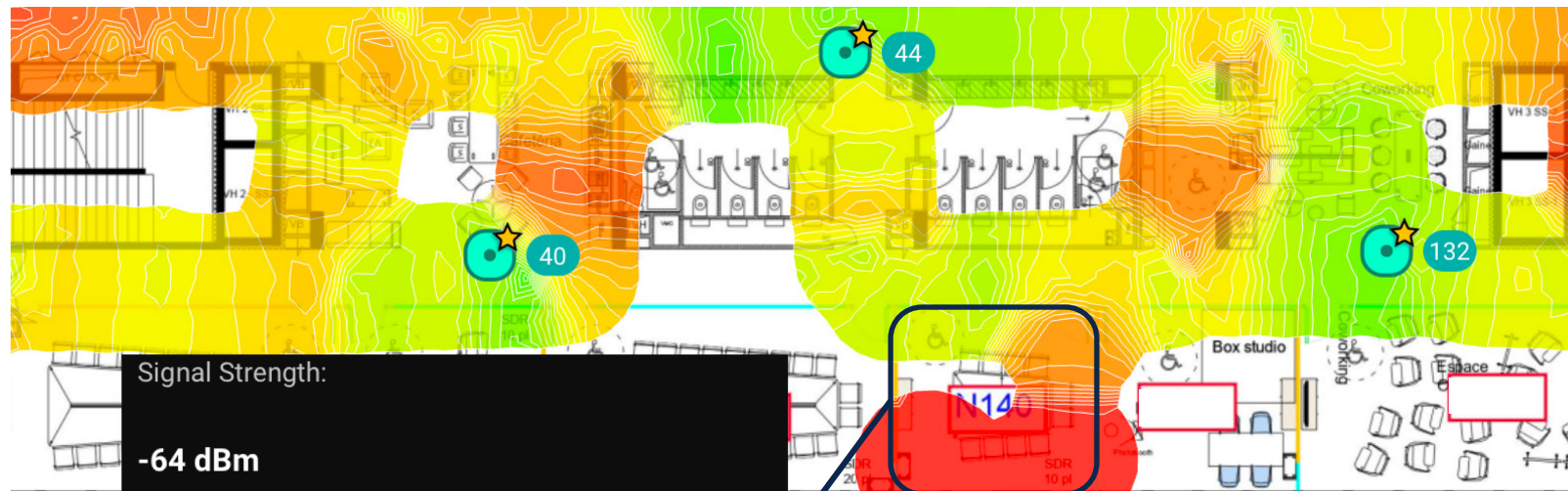
Data Rate	Sequence nu	Info
1080.9	3313	QoS Data, SN=3313, FN=0, Flags=.p. R.F.C
1080.9	3313	QoS Data, SN=3313, FN=0, Flags=.p. .F.C
1080.9	3313	QoS Data, SN=3313, FN=0, Flags=.p. R.F.C
1080.9	3313	QoS Data, SN=3313, FN=0, Flags=.p. R.F.C
1080.9	3313	QoS Data, SN=3313, FN=0, Flags=.p. R.F.C
1080.9	3313	QoS Data, SN=3313, FN=0, Flags=.p. R.F.C
960.8	3313	QoS Data, SN=3313, FN=0, Flags=.p. R.F.C
960.8	3313	QoS Data, SN=3313, FN=0, Flags=.p. R.F.C
960.8	3313	QoS Data, SN=3313, FN=0, Flags=.p. R.F.C
960.8	3313	QoS Data, SN=3313, FN=0, Flags=.p. R.F.C
960.8	3313	QoS Data, SN=3313, FN=0, Flags=.p. R.F.C
960.8	3313	QoS Data, SN=3313, FN=0, Flags=.p. R.F.C
960.8	3313	QoS Data, SN=3313, FN=0, Flags=.p. R.F.C
960.8	3313	QoS Data, SN=3313, FN=0, Flags=.p. R.F.C
960.8	3313	QoS Data, SN=3313, FN=0, Flags=.p. R.F.C
864.7	3313	QoS Data, SN=3313, FN=0, Flags=.p. R.F.C
864.7	3313	QoS Data, SN=3313, FN=0, Flags=.p. R.F.C
864.7	3313	QoS Data, SN=3313, FN=0, Flags=.p. R.F.C
24.0		802.11 Block Ack, Flags=.....C
24.0		802.11 Block Ack, Flags=.....C



APs away from users also has its consequences

QUICK MATHS

$$-64 + \text{device offset} = \text{average / poor end} - \text{user experience}$$



Signal Strength:

-64 dBm

NAME(MAC)	CHANNEL	RSSI (dBm)
Measured AP-29:0f(2a:3f:1b:57:40)		-64
Measured AP-29:03(2a:3f:1b:...	44	-70
Measured AP-2c:bb(2a:3f:1b:5...	132	-71

View as: Measured

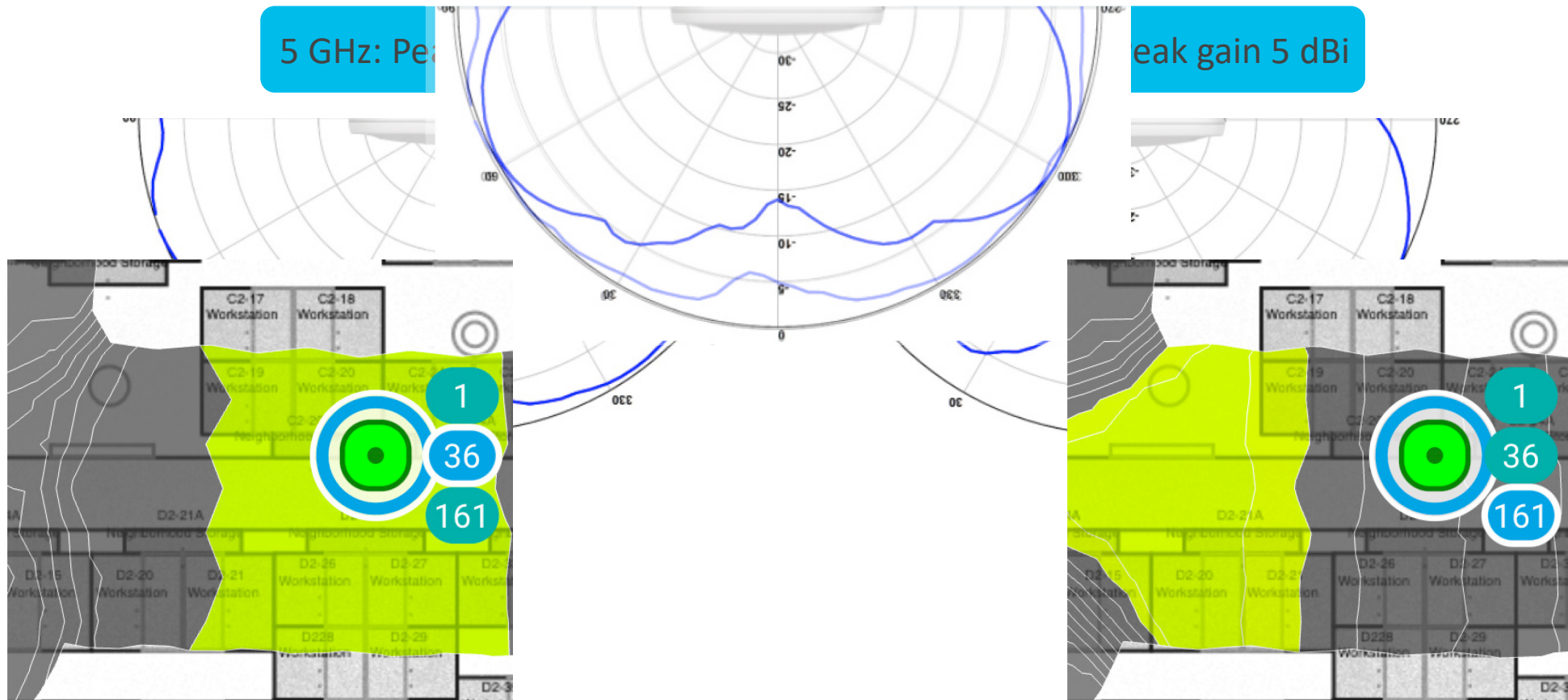
Target power (dBm) ⓘ	Transmit power (dBm) ⓘ
8 - 17	8
8 - 17	8
8 - 17	8
8 - 17	8
8 - 17	8
8 - 17	8
8 - 17	8
8 - 17	8
8 - 17	8
8 - 17	8
8 - 17	8
8 - 17	8
8 - 17	8
8 - 17	8
8 - 17	8
8 - 17	8
8 - 17	8
8 - 17	8
8 - 17	8

Bad TX will cause capacity imbalance



- Tri- band APs are everywhere
 - Can be used in multiple set ups
 - 5GHz and 6Ghz
 - Dual 5GHz
- Cells should be balanced to keep things sweet
 - It's not only about the - 7dBm for 2.4GHz
 - It's also about the antenna gain and pattern

Bad TX will cause capacity imbalance



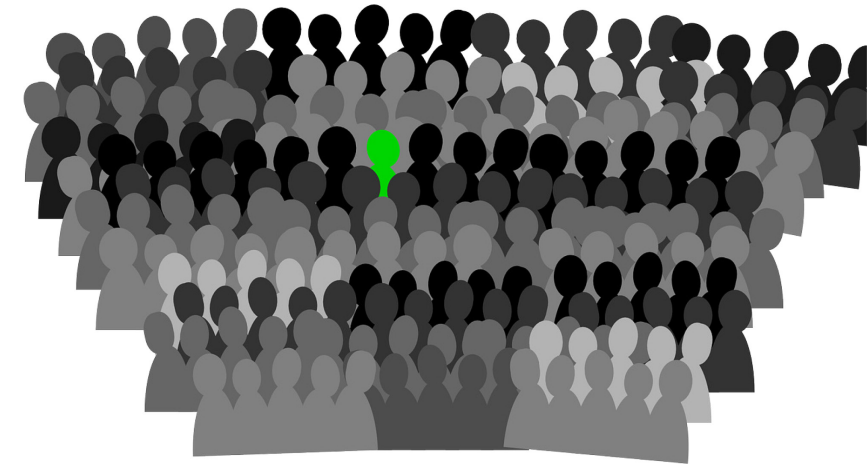
Bad TX will cause capacity imbalance



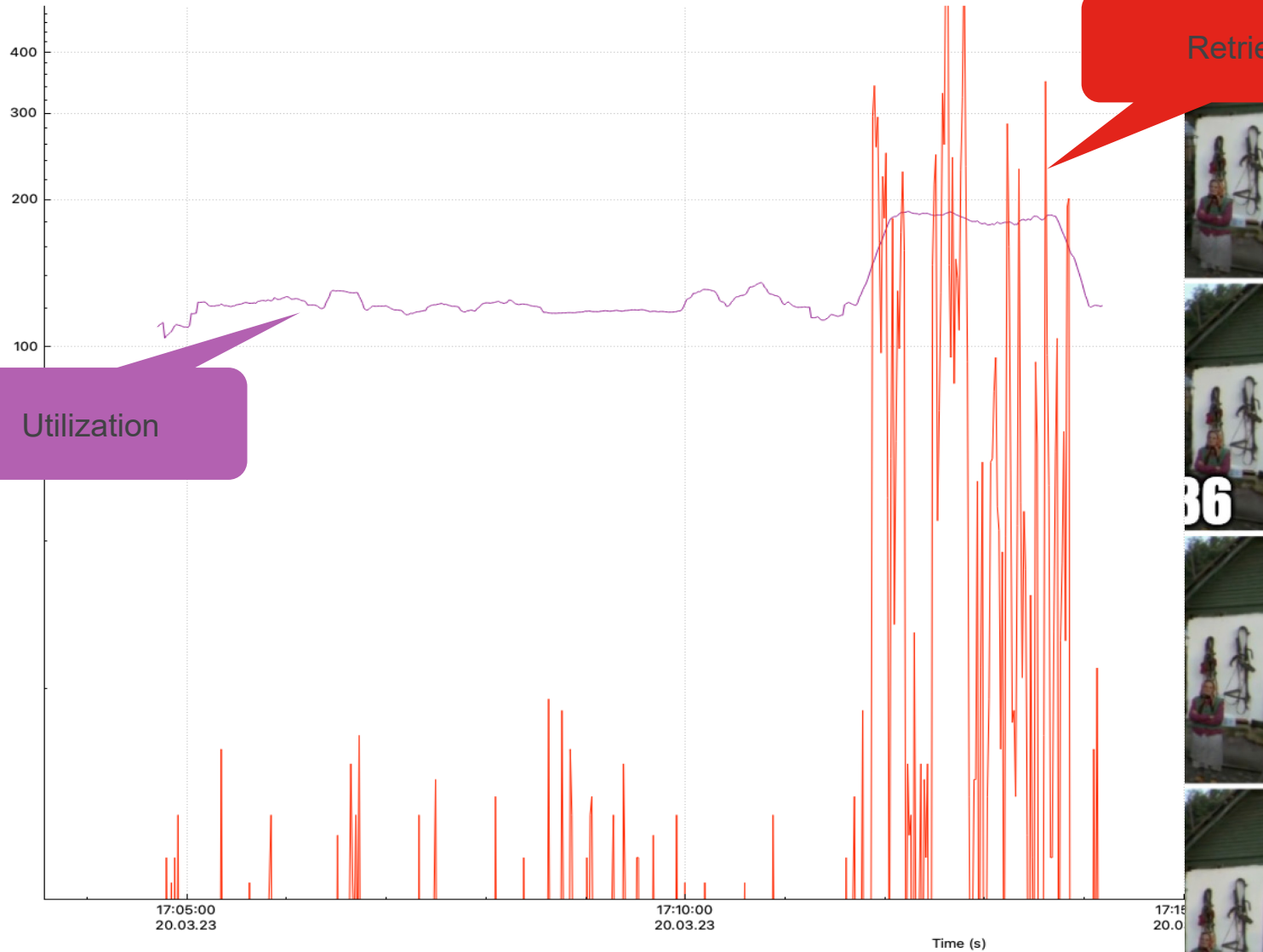
RADIO SETTINGS
2.4 GHz: 1 (20 MHz; 2 dBm)
5 GHz: 36 (20 MHz; 2 dBm)
5 GHz: 104 (20 MHz; 7 dBm)

Channel	Current channel width	Signal strength	Port	Tools
36	20	45 dB	—	Ping
36	20	50 dB	—	Ping
104	20	40 dB	—	Ping
104	20	45 dB	—	Ping
104	20	39 dB	—	Ping
104	20	40 dB	—	Ping
104	20	45 dB	—	Ping
104	20	42 dB	—	Ping
104	20	48 dB	—	Ping
104	20	48 dB	—	Ping
104	20	43 dB	—	Ping
104	20	43 dB	—	Ping
104	20	46 dB	—	Ping

- Wireless is a shared medium
- Devices on **ch.36** will have different experience than devices on **ch.104**



And medium is busy and get's busier



Retries


Utilization

Neighboring networks we don't control

dBm ▼	Channel	Mode
-52	64	802.11ax (802.1x)
-56	64	802.11ax (802.1x)
-61	48	802.11ax (802.1x)
-62	48	802.11ax (802.1x)
-74	44+ (80 MHz)	802.11ax (WPA2)
-74	48	802.11ax (WPA2)
-75	132	802.11ax (802.1x)
-77	36	802.11n (WPA2)
-77	132	802.11ax (802.1x)
-78	36+ (80 MHz)	802.11ax (WPA2)
-78	36	802.11ax (802.1x)
-78	36	802.11ax (802.1x)
-78	36+ (40 MHz)	802.11n (WPA2)
-78	132	802.11ax (802.1x)
-78	136 (40 MHz)	802.11ax (WPA2)
-79	36	802.11ax (802.1x)
-79	36+ (40 MHz)	802.11n (WPA2)
-79	36	802.11ax (open)
-79	132	802.11ax (802.1x)
-80	36+ (80 MHz)	802.11ac (open)
-80	36+ (40 MHz)	802.11ac (WPA2)
-80	36	802.11ax (802.1x)
-80	36	802.11ax (802.1x)
-80	36	802.11ax (802.1x)
-80	52	802.11ax (802.1x)
-80	44+ (80 MHz)	802.11ax (WPA2)
-81	36+ (80 MHz)	802.11ac (open)
-81	36+ (80 MHz)	802.11ac (open)
-81	36	802.11ax (802.1x)
-81	36+ (40 MHz)	802.11ac (WPA2)
-81	36+ (80 MHz)	802.11ac (open)
-81	36+ (80 MHz)	802.11ac (open)
-81	36+ (40 MHz)	802.11ac (WPA2)
-81	52	802.11ax (802.1x)
-81	100	802.11ax (802.1x)
-81	100	802.11ax (802.1x)
-82	36+	802.11a (open)
-82	36+ (40 MHz)	802.11ac (open)
-82	36+ (80 MHz)	802.11ac (open)
-82	36+ (80 MHz)	802.11ac (open)
-82	36+ (80 MHz)	802.11ac (open)
-82	36+ (160 MHz)	802.11ax (WPA2)
-82	36	802.11n (WPA2)
-82	36+ (80 MHz)	802.11ac (open)
-82	36+ (40 MHz)	802.11n (WPA2)
-82	36+ (80 MHz)	802.11ac (open)
-82	36+ (40 MHz)	802.11ac (WPA2)

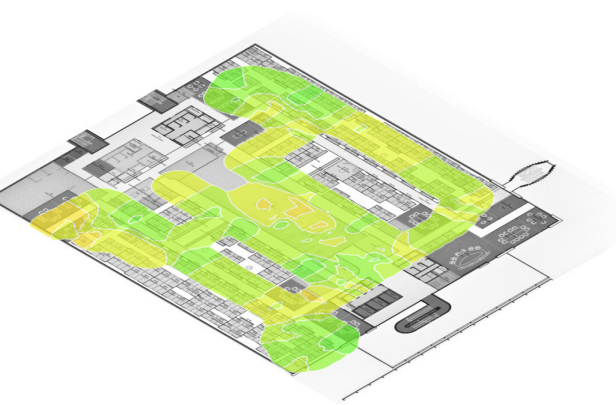


With the right tools we can manage the spectrum

 **Matt Starling**

1st_floor

Best thing since sliced bread 13:10



1st_floor 100

Metric	Floor	Project
Primary Coverage	100%	100%
Secondary Coverage	99%	99%
Signal to Noise Ratio	100%	100%
Channel Interference	38%	38%
Network Health	0%	0%
Average	67%	68%

[View Details](#)

← RF Overview

AP neighbors for SFO12-5-AP32 (32 total)

MR46 a0:eb:44:a3:03:21

In network 5 GHz All SSIDs [Refresh data](#)

SFO12-5-AP32 on 5 GHz ch 44 @ 40 MHz

Network status

Here you can see potential issues found in your network and actions required to resolve them. Review the action plan for optimizing your network and deploy necessary changes or export the plan for later implementation.

Coverage	Optimize	Excellent primary coverage
Mobility	Optimize	Excellent secondary coverage
Spectrum	Optimize	Reduce channel interference
Coverage	Optimize	Excellent signal to noise ratio
Security	Optimize	Mitigate interfering devices
Performance	Optimize	Adjust channel widths
Performance	Optimize	Change MFP settings
Performance	Optimize	Adjust minimum basic rate (MBR)
Security	Optimize	Change encryption settings
Performance	Optimize	Change your SSIDs configuration

1	Same ch	SFO12-5-AP33	-46	44 (40 MHz)	10%	8	5	Meraki corp, Meraki guest +3
2	Same ch	SFO12-5-AP31	-47	44 (40 MHz)	25%	10	4	Blizzard, Meraki corp, Meraki guest
3	Same ch	SFO12-5-AP39	-50	44 (40 MHz)	50%	8	4	Blizzard, Meraki corp, Meraki guest +6
4	Same ch	SFO12-5-AP30	-51	44 (40 MHz)	10%	3	5	Blizzard, Meraki corp, Meraki guest +6

Rows per page 100

With RF being optimized, let's look at client device

I do 3 things

1. *Uplink** data rates
2. Roaming decision
3. Randomly disconnect



Good roaming makes users happy

What can trigger a roam?

- Client is between 2+ high coverage cells
- AP triggered
 - Auto RF, DFS
- AP encouraged
 - 11k/v
- Client triggered
 - Device movement, driver logic

What happens behind the scenes?

- Might go off channel to look for target APs
 - Time varies on number of channels enabled and supported
- Select the candidate and connect
- Derive PMK and PTK
 - In PSK environments it's quick
 - In dot1x it varies
 - What EAP type used and connection to AS?
 - What Roaming protocols are used?
 - *Enterprise voice requires $\leq 150ms$ transition times*

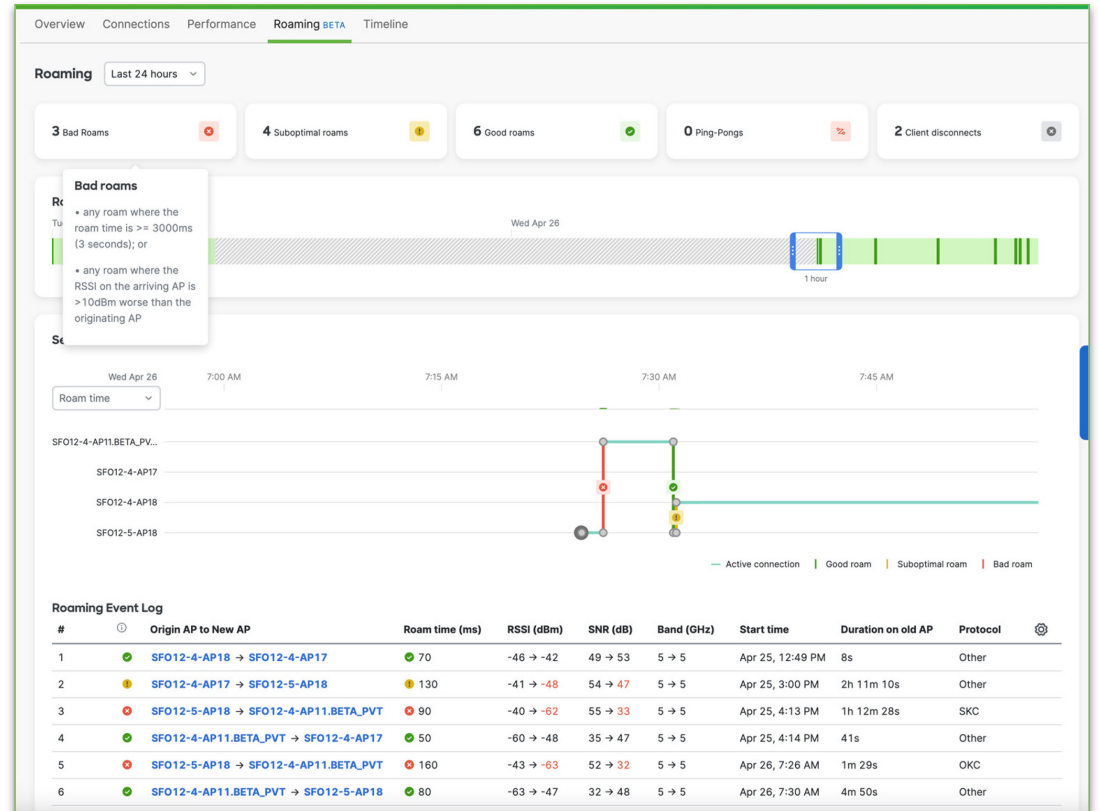
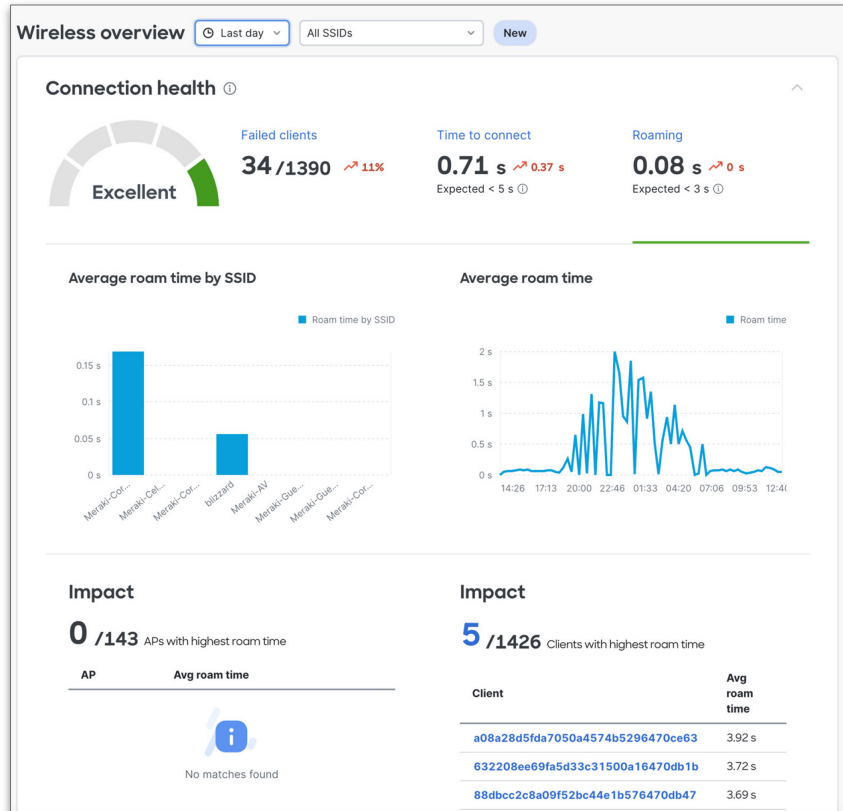


Roaming is complex to troubleshoot and monitor



Meraki makes it simple

Roaming ~~is~~ was complex to troubleshoot and monitor



So was retrospective troubleshooting

Aug 5 12:34:35

- Poor performance connection to SSID **WGTC-Public** for 4 hours on AP **DOUWAP-LibraryMR53** due to suboptimal AP selection.

CHANNEL	BAND	SNR ⓘ
11	2.4 GHz	12 dB

Sticky Client ⓘ

- Manually disconnect the client and check if it connects to an AP with a stronger signal.

Evidence

Recommendations

Try to force the client to re-select a more optimal AP by having the client disassociate and reassociate.

Note: Client devices choose which AP to connect to. Meraki APs cannot force a client to choose a particular AP. [Read more...](#)

This may temporarily disrupt the client's connection.

[Disconnect client](#)

Was this helpful? 👍 👎

Overview
Connections
Performance
Timeline

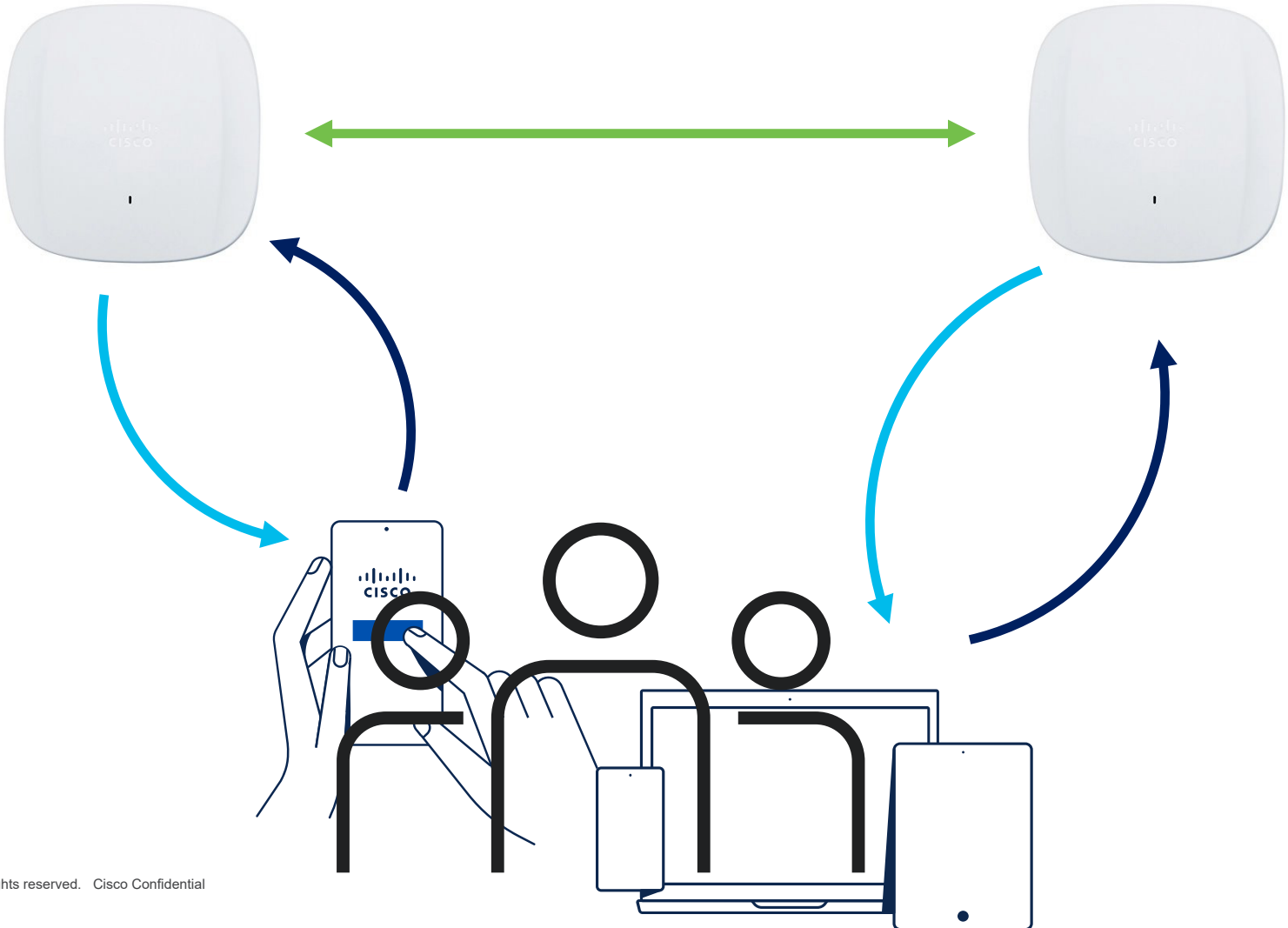
Status	📶 associated since Sep 27 10:31
SSID	228 Sweeny 5G
Access point	Living room AP topology
Splash	N/A
Signal	<div style="width: 75%; height: 10px; background: linear-gradient(to right, green, gray);"></div> 30dB (channel 40)
Device type, OS	iPhone XS, IOS14.8 🚩
Capabilities	802.11ac - 2.4 and 5 GHz, Fastlane capable details

Sep 26 16:09:01

- Successful connection to SSID **MANAGEMENT** for a few seconds on AP **68:3a:1e:fc:6b**.

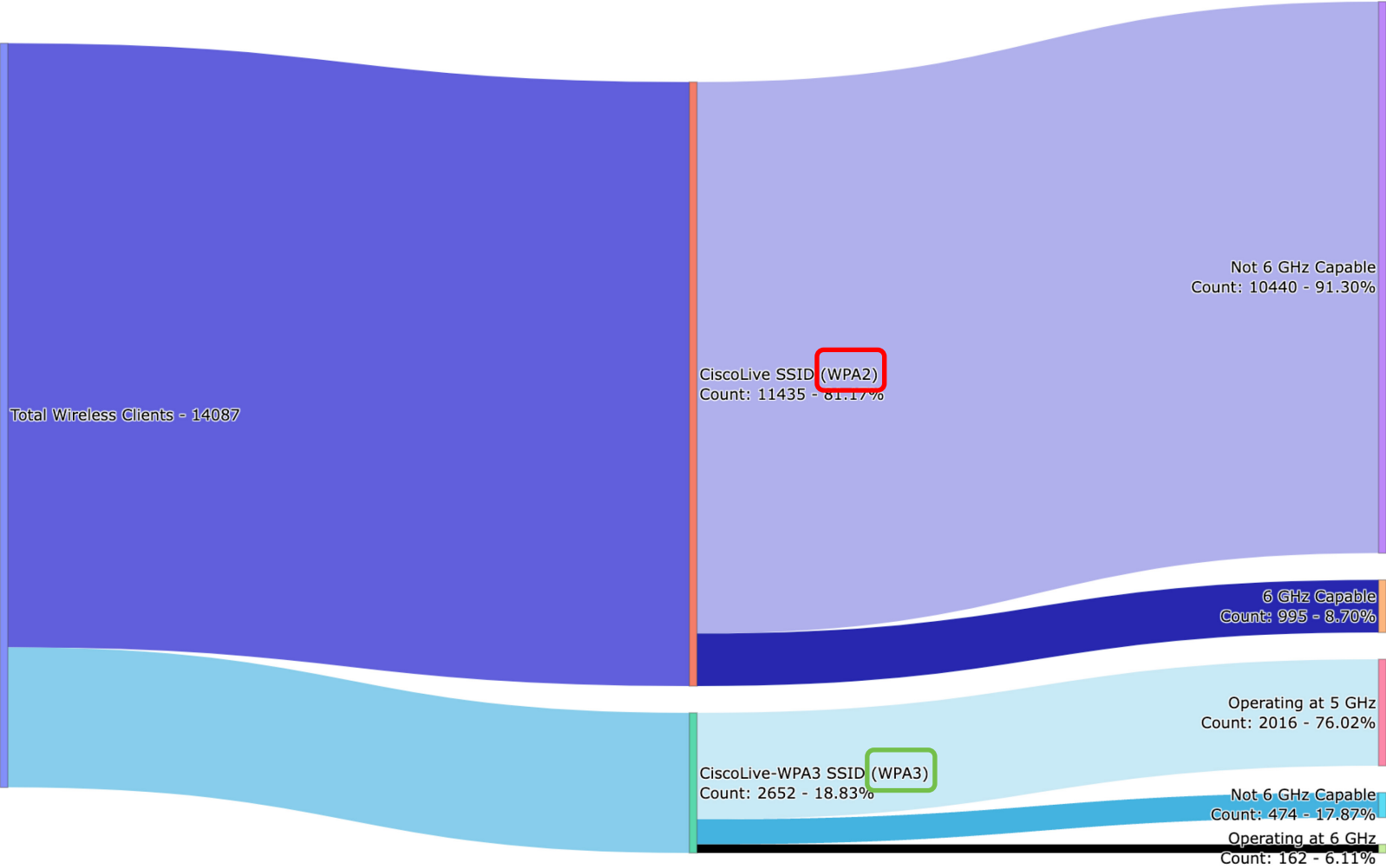
CHANNEL	BAND	SNR ⓘ	TIME TO CONNECT	DISASSOCIATION REASON (IOS) ⓘ
60	5 GHz	27 dB	320 ms	Manually disabled Wi-Fi

But there is one more



Make the most from latest technologies

Get on 6GHz





1k 6GHz clients on WPA2





That's 1000 devices that missed out on 6GHz




Because they used the wrong SSID



 CiscoLive 

IP Address: 10.131.44.200
Router: 10.131.255.254
Security: WPA2 Personal
BSSID: 6c:d6:e3:b4:57:8a
Channel: 100 (5 GHz, 20 MHz)
Country Code: NL
RSSI: -51 dBm
Noise: -101 dBm
Tx Rate: 286 Mbps
PHY Mode: 802.11ax
MCS Index: 11
NSS: 2



 DOWNLOAD Mbps  UPLOAD Mbps

115.61 148.52




Ping ms  5  166  104

 CL-OPS 

IP Address: 10.100.240.85
Router: 10.100.240.254
Security: WPA2 Enterprise
BSSID: 6c:d6:e3:b4:57:87
Channel: 53 (6 GHz, 80 MHz)
Country Code: NL
RSSI: -53 dBm
Noise: -92 dBm
Tx Rate: 1,200 Mbps
PHY Mode: 802.11ax
MCS Index: 11
NSS: 2

 DOWNLOAD Mbps  UPLOAD Mbps

581.19 658.27

Ping ms  5  37  35



The bridge to possible