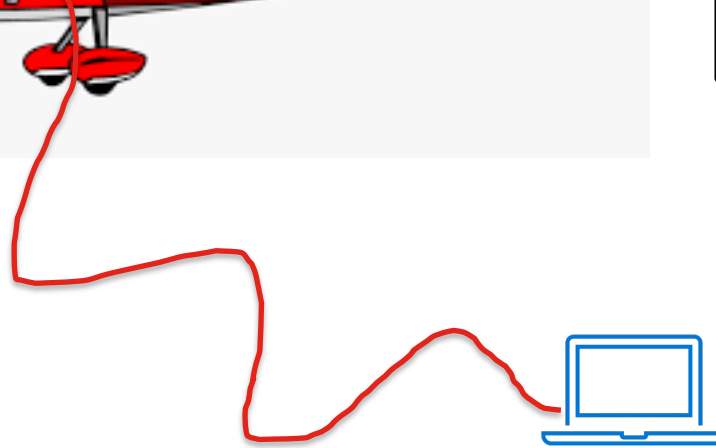


CISCO *Live!*



#CiscoLiveAPJC

How I Nearly Died for Location



Hi Tower
We need to
land NOW!

Lat: -12.4163733422924,
Long: 130.783199980327





The bridge to possible

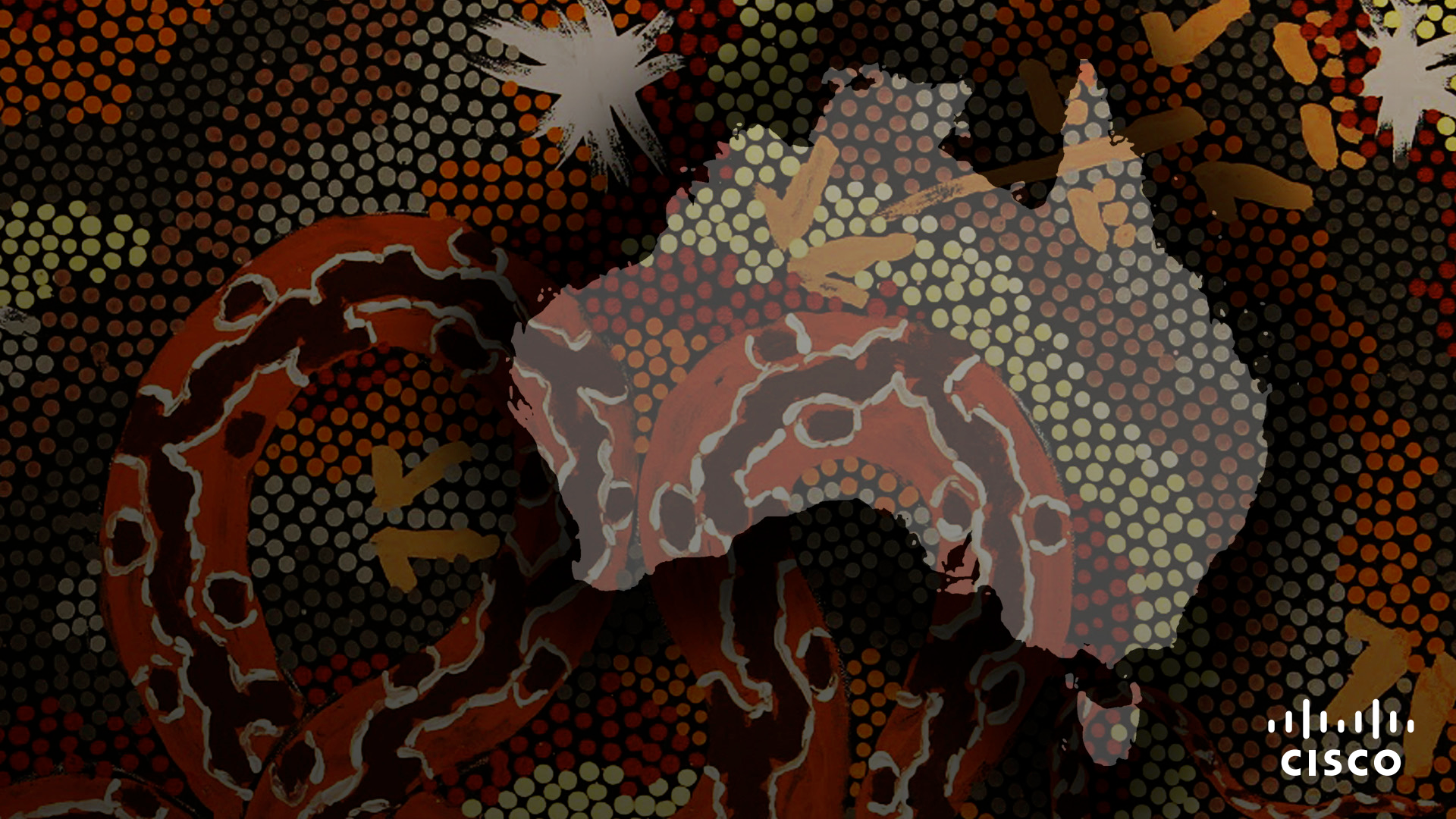
Implement and Troubleshoot Cisco Spaces

Delivering Next Generation Location Based Solutions

Leigh Jewell
Technical Solutions Architect
BRKEWN-2658



#CiscoLiveAPJC



Cisco Webex App

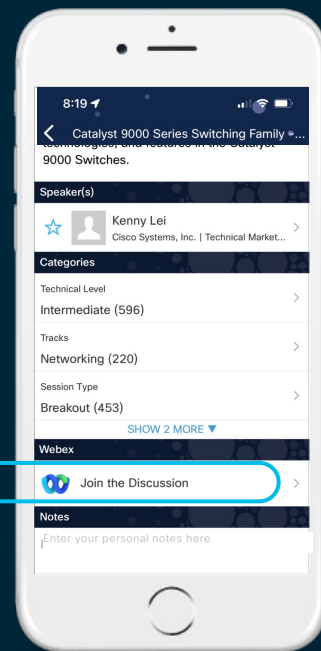
Questions?

Use Cisco Webex App to chat with the speaker after the session

How

- 1 Find this session in the Cisco Live Mobile App
- 2 Click “Join the Discussion”
- 3 Install the Webex App or go directly to the Webex space
- 4 Enter messages/questions in the Webex space

Webex spaces will be moderated by the speaker until Thursday 22 December, 2022.



<https://ciscolive.ciscoevents.com/ciscolivebot/#BRKEWN-2658>



Agenda

- Location fundamentals
- Client transmit power
- Bluetooth Low Energy Primer
- BLE Location Fundamentals
- Cisco Spaces architecture
- Designing a Location Ready Network
- Troubleshooting
- CW9100 AP and Cisco Spaces

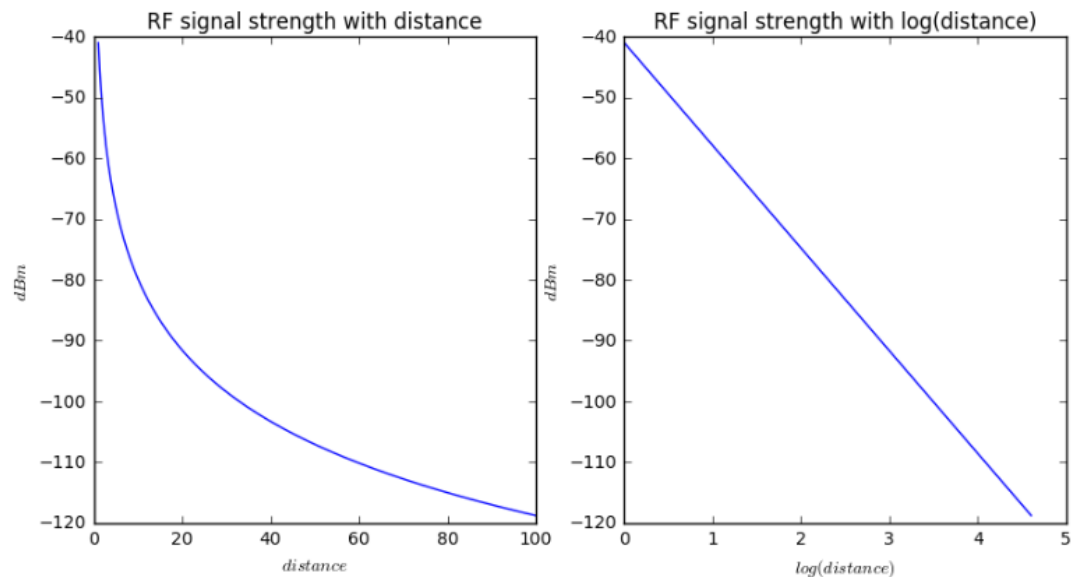
Location Fundamentals



WARNING

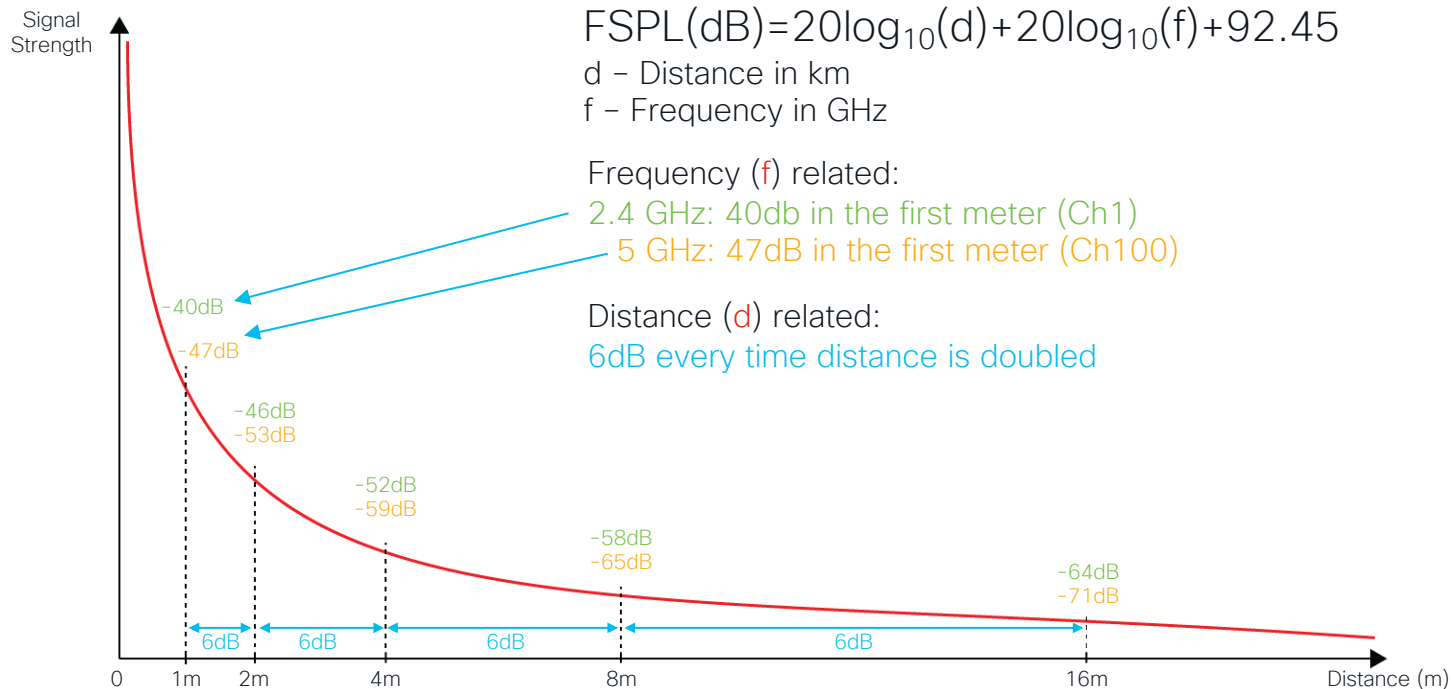
A little bit of
maths
approaching

Radio Signal Strength is a Function of Distance



$f(\text{distance}) = \text{Receiver Signal Strength Indicator (RSSI)}$

Why RSSI matters? Free Space Path Loss



Calculate Receiver Signal Strength

$$\begin{aligned}\text{Receiver Signal Strength (RSSI)} &= \text{Transmit Power (Tx)} - \text{Free Space Path Loss (FSPL)} \\ \text{then} \\ \text{FSPL} &= \text{Tx} - \text{RSSI}\end{aligned}$$

For example:

$$\begin{aligned}\text{Client Tx } 15\text{dBm} \text{ and RSSI} &= -55\text{dBm} \\ \text{FSPL} &= 15 - (-55) = 70\text{dBm}\end{aligned}$$

Know the Power = Calculate Distance

$$\text{FSPL} = \text{Tx} - \text{RSSI}$$

$$\text{FSPL is } 20 \log_{10}(\text{dist}) + 20 \log_{10}(\text{freq}) + 92.45 = \text{Tx} - \text{RSSI}$$

so

$$20 \log_{10}(\text{dist}) + 20 \log_{10}(\text{freq}) + 92.45 = \text{Tx} - \text{RSSI}$$

Rearrange the functions:

$$\text{dist} = 10^{\{(\text{Tx} - \text{RSSI}) - 20 \log(\text{freq}) - 92.45\}/20}$$

Does this really work?

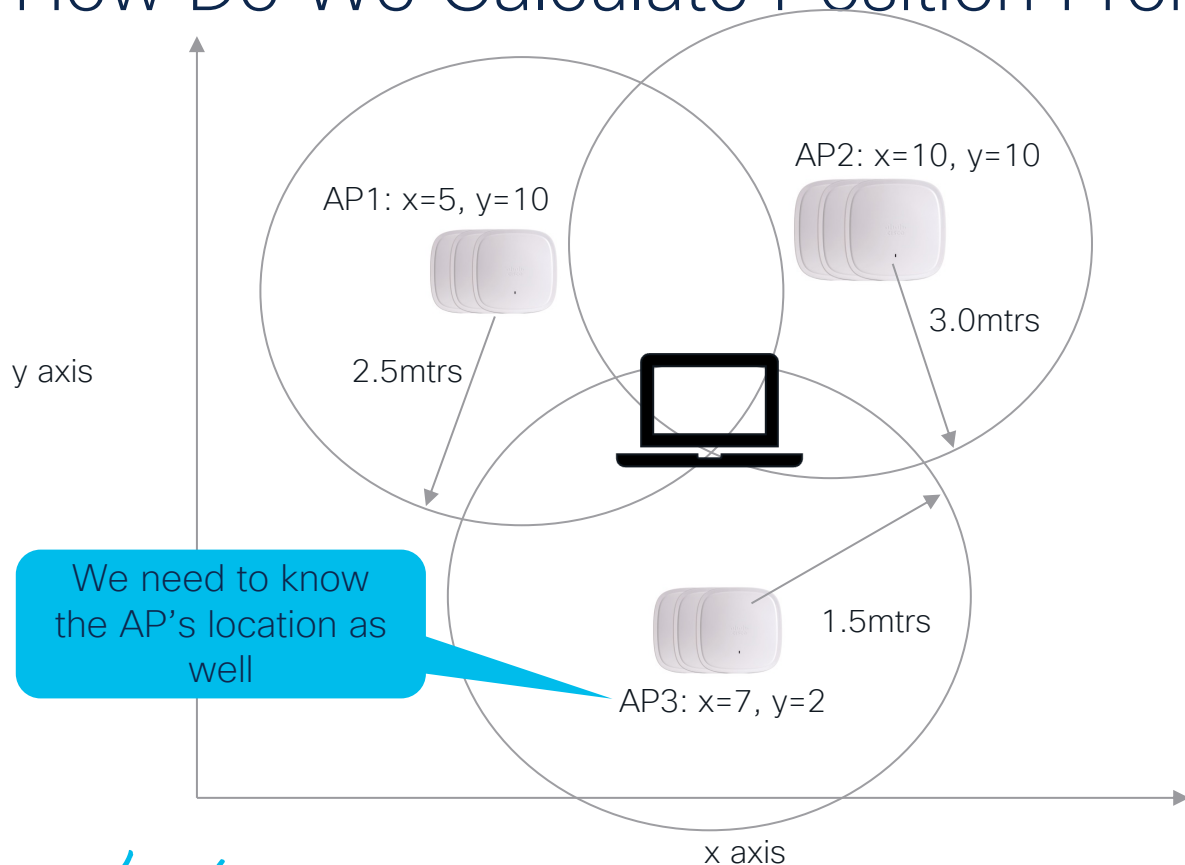
For $\text{Tx} = 15\text{dBm}$, $\text{RSSI} = -55\text{dBm}$ and $\text{freq} = 5\text{Ghz}$

$$\text{dist} = 10^{\{((15 - (-55)) - 20 \log(5) - 92.45)/20\}}$$

$$= 10^{-1.821}$$

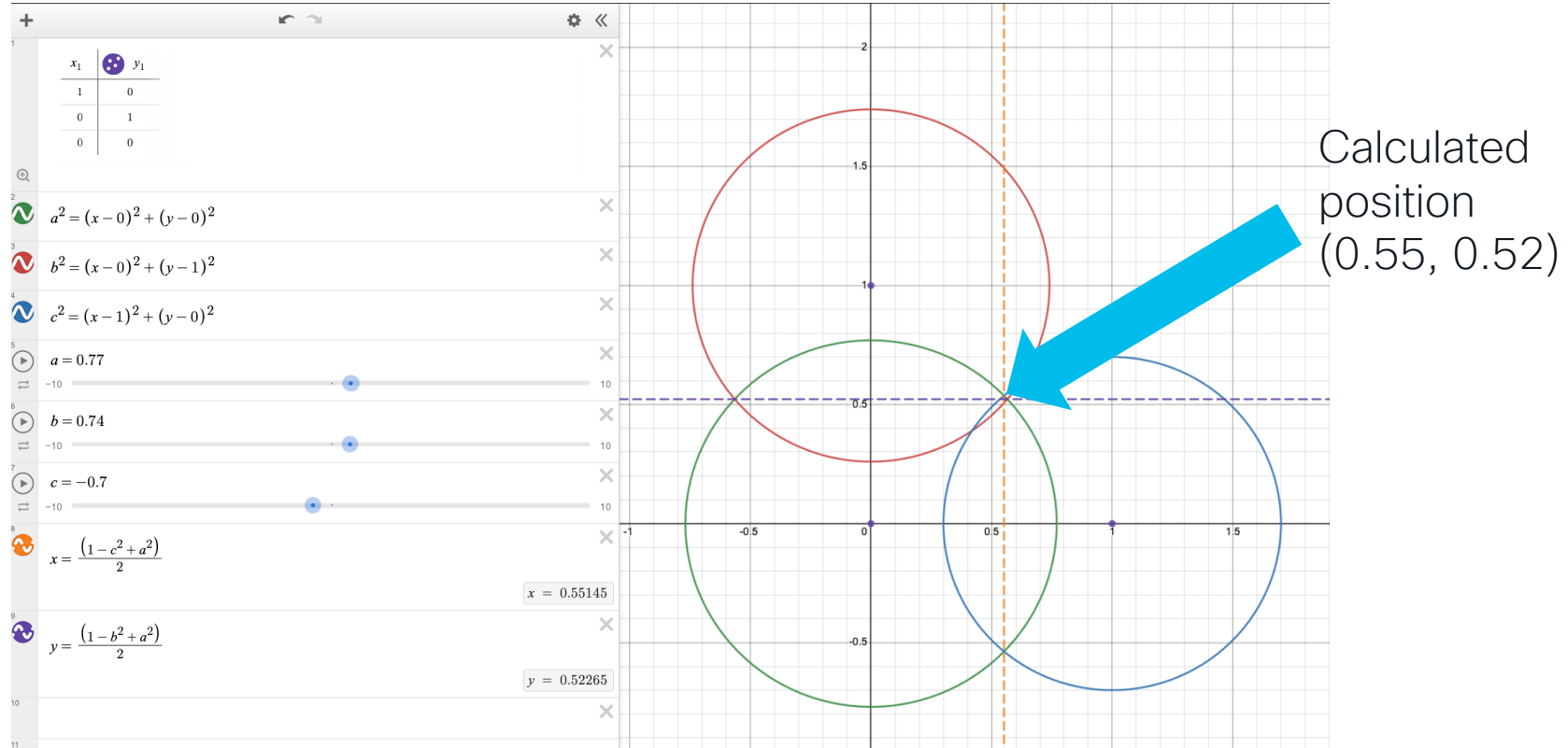
$$= 15 \text{ metres}$$

How Do We Calculate Position From Distance?



1. AP sends client RSSI to RTLS system
2. RTLS knows location of AP (x,y) on map
3. RSSI converted to distance
4. Device location calculated

Trilateration Calculations



Client Transmit Power and Location

To Calculate Path Loss We Need Transmit Power



Transmit Power = 20dBm

Received Power = -50dBm

Path Loss = 70dBm

How do we know
the client transmit
power?



Assumed Client Transmit Power



18dBm



15dBm

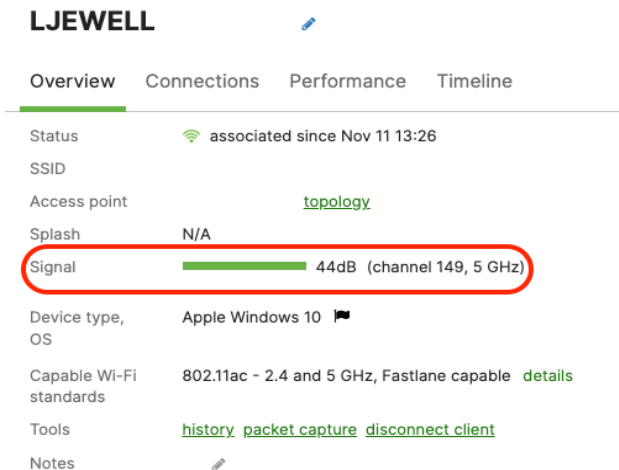


19dBm

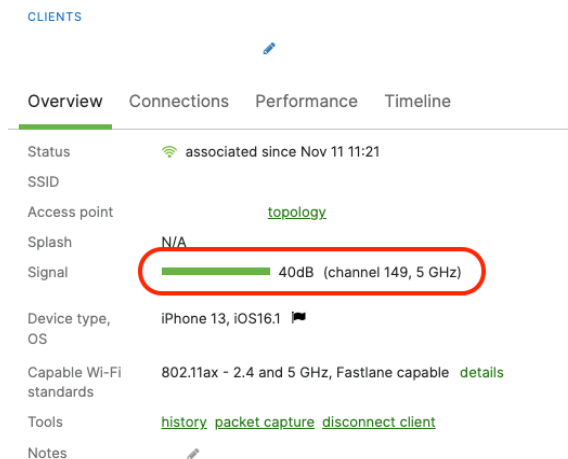
We make a best guess assumption

Example Client Transmit Power

Mac Book Pro and Apple iPhone are connected 6 metres from the AP
AP Transmit Power set to 14dBm



Mac Book Pro

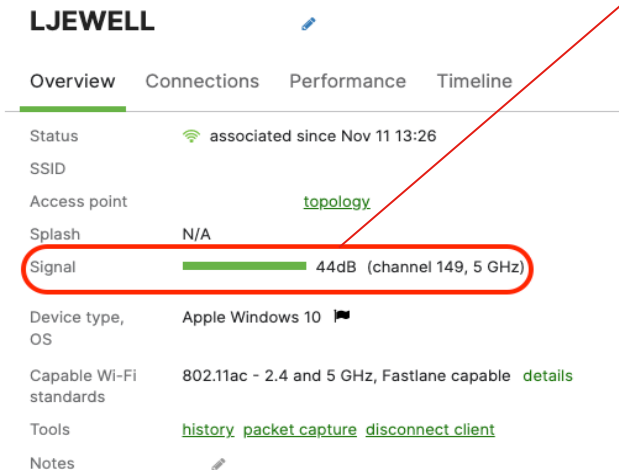


iPhone 13

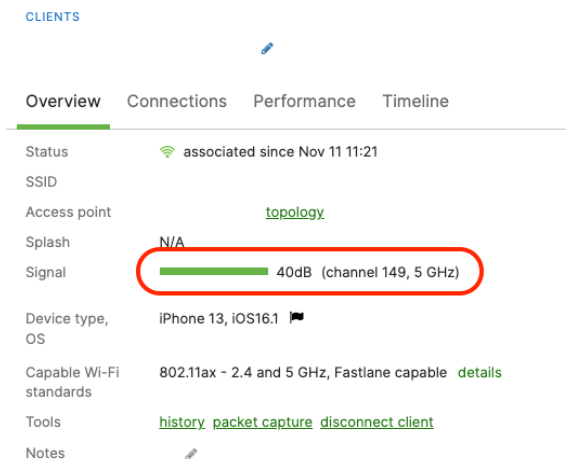
Example Client Transmit Power

Free Space Path Loss 6mtrs for 5Ghz = 63dBm

MBP Tx Power Estimation = 63 - 44 = 19dBm



Mac Book Pro



iPhone 13

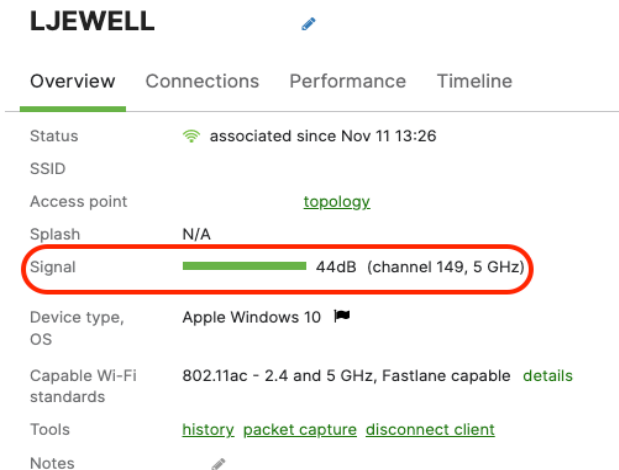
Example Client Transmit Power

Path Loss for
6mtrs = 63dBm

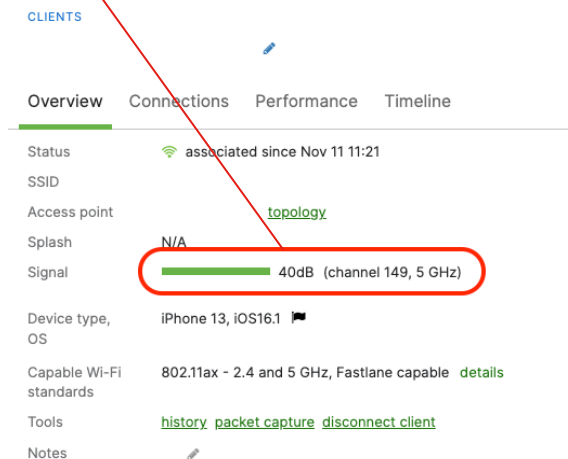
Free Space Path Loss 6mtrs for 5Ghz = 63dB

MBP Tx Power Estimation = $63 - 44 = 19\text{dBm}$

iPhone Tx Power Estimation = $63 - 40 = 23\text{dBm}$



Mac Book Pro



iPhone 13

Example Client Transmit Power

Compare client TX power to assumed Tx power
impact on distance error

Error results due to
clients TX power
difference to reference

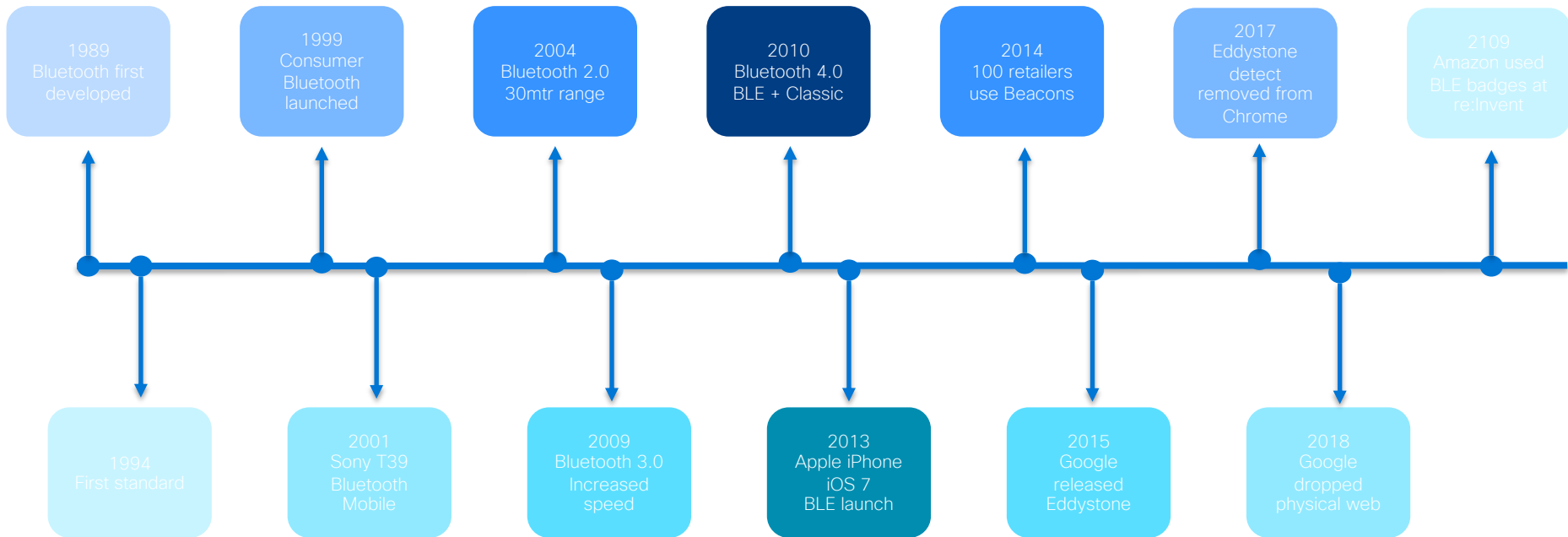
Device	Transmit Power (RSSI ¹)	Received Power	Calculated Distance	Error
MBP	19dBm	44dBm	6.7mtrs	
MBP (Reference)	15dBm	44dBm	4.3mtrs	-2.3mtrs
iPhone	23dBm	40dBm	6.7mtrs	
iPhone (Reference)	15dBm	40dBm	2.7mtrs	-4mtrs

Distance(km) = $\text{antiLog}_{10} [\{ (\text{RSSI}^1 - \text{RSSI}) - 92.45 - 20\text{Log}_{10}(f) \} / 20]$

RSSI¹ - RSSI = Path loss (RSSI at 1mtr and remote distance)

Bluetooth Low Energy (BLE) Primer

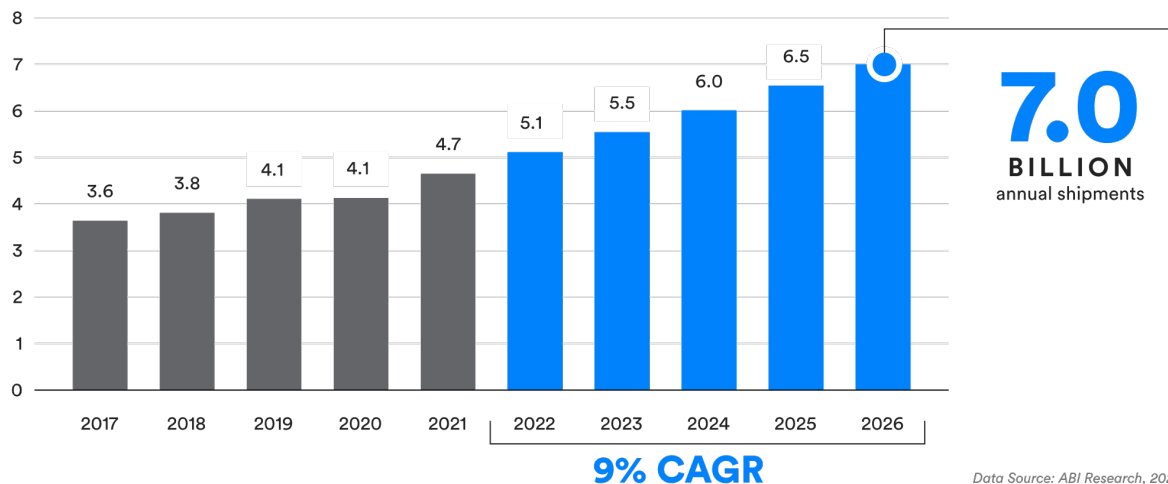
Bluetooth History Lesson



BLE is Taking over the World

Total Annual Bluetooth® Device Shipments

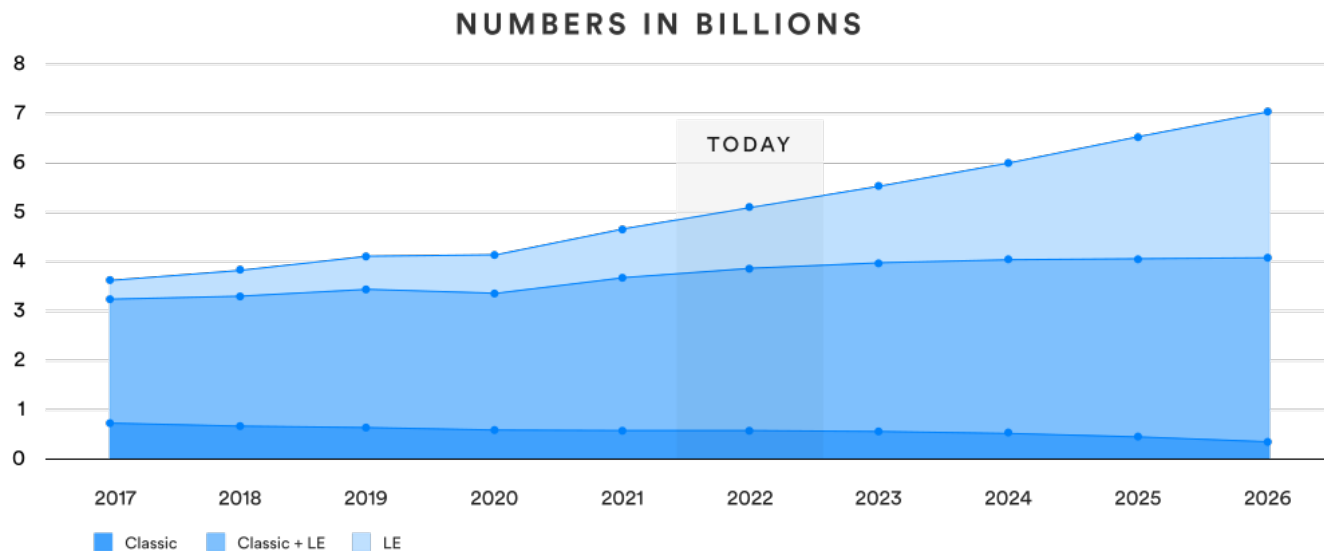
NUMBERS IN BILLIONS



Ref: <https://www.bluetooth.com/2022-market-update/>

Bluetooth 4.0 (BLE) is Growing Dramatically

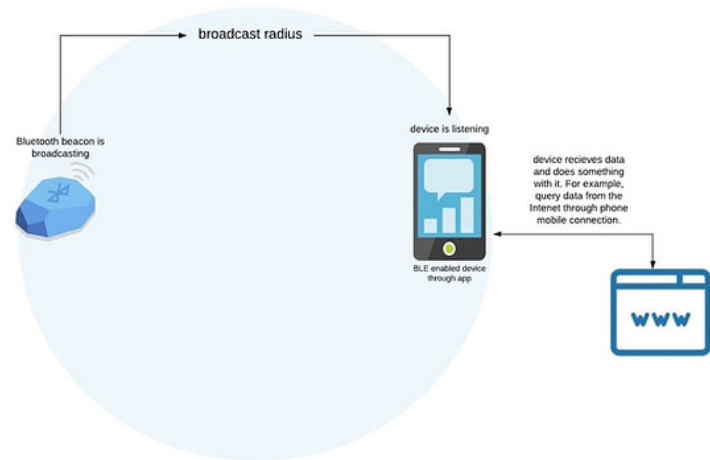
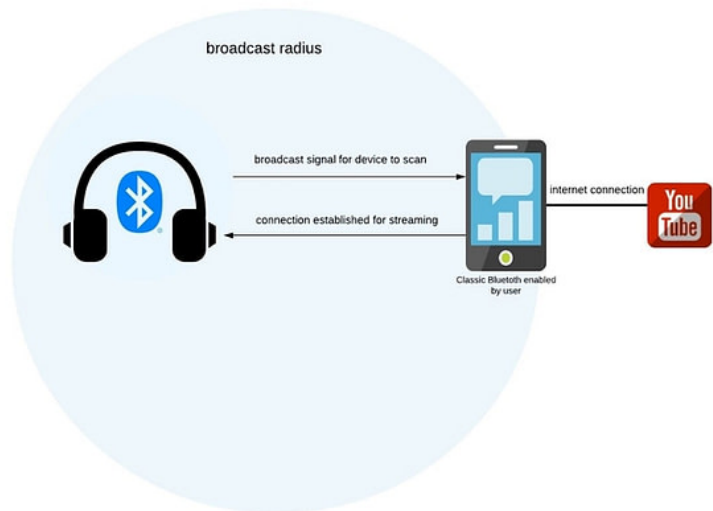
Bluetooth® Enabled Device Shipments by Radio Version



Ref: <https://www.bluetooth.com/2022-market-update/>

Data Source: ABI Research, 2022

Comparison of Classic to BLE



Source <https://novelbits.io/what-is-a-beacon-guide-to-bluetooth-beacon-technology/>

Bluetooth Classic = Two-way Communication



Broadcast Bluetooth device



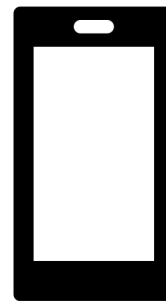
Connection established for streaming

2-way Communication

Bluetooth Low Energy = One-way Communication



Beacon from BLE device



2.4Ghz spectrum

3 primary channels

Up to 100mtrs (most 30mtrs)

1-way Communication

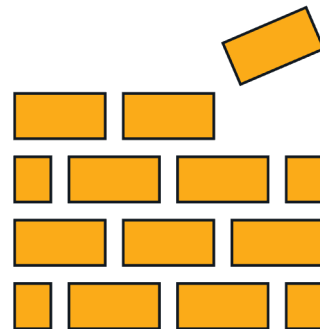
Why BLE?



Low Cost



Low Maintenance



Easy to install



How are BLE used Today?

The image shows the word "KICKSTARTER" in white, bold, uppercase letters on a solid green rectangular background.The image shows the word "tile" in a dark blue, lowercase sans-serif font, followed by "by Life360" in a smaller, lighter blue, lowercase sans-serif font.

\$2.6 million



Disneyland



Asian Art Museum
San Francisco

BLE Location Fundamentals

Do I need to deploy
more AP's for BLE?



BLE Transmit Power



1. Max ~ 20dBm(Europe 10dBm)
2. 1Mbps speed = 89 dBm cell edge
3. 160 mtrs theoretical range



1. Max ~23dBm (client dependent)
2. Typically deploy -75dBm cell edge
3. 260 mtrs theoretical range

BLE Default Transmit Power

Often Transmit Power is much less than the maximum

Kontakt BLE Beacon
Default setting (3) -12dBm
20mtrs of range.

Hexadecimal value	TX Power setting	Transmission power (decibel-milliwatts)	RSSI @ 3.2 ft (1 m)*	Approximate range**
e2	0	-30 dBm	-115	6.5 ft (2 m)
ec	1	-20 dBm	-84	13 ft (4 m)
f0	2	-16 dBm	-81	32 ft (10 m)
f4	3	-12 dBm	-77	65 ft (20 m)
f8	4	-8 dBm	-72	98 ft (30 m)
fc	5	-4 dBm	-69	131 ft (40 m)
00	6	0 dBm	-65	196 ft (60 m)
04	7	4 dBm	-59	229 ft (70 m)

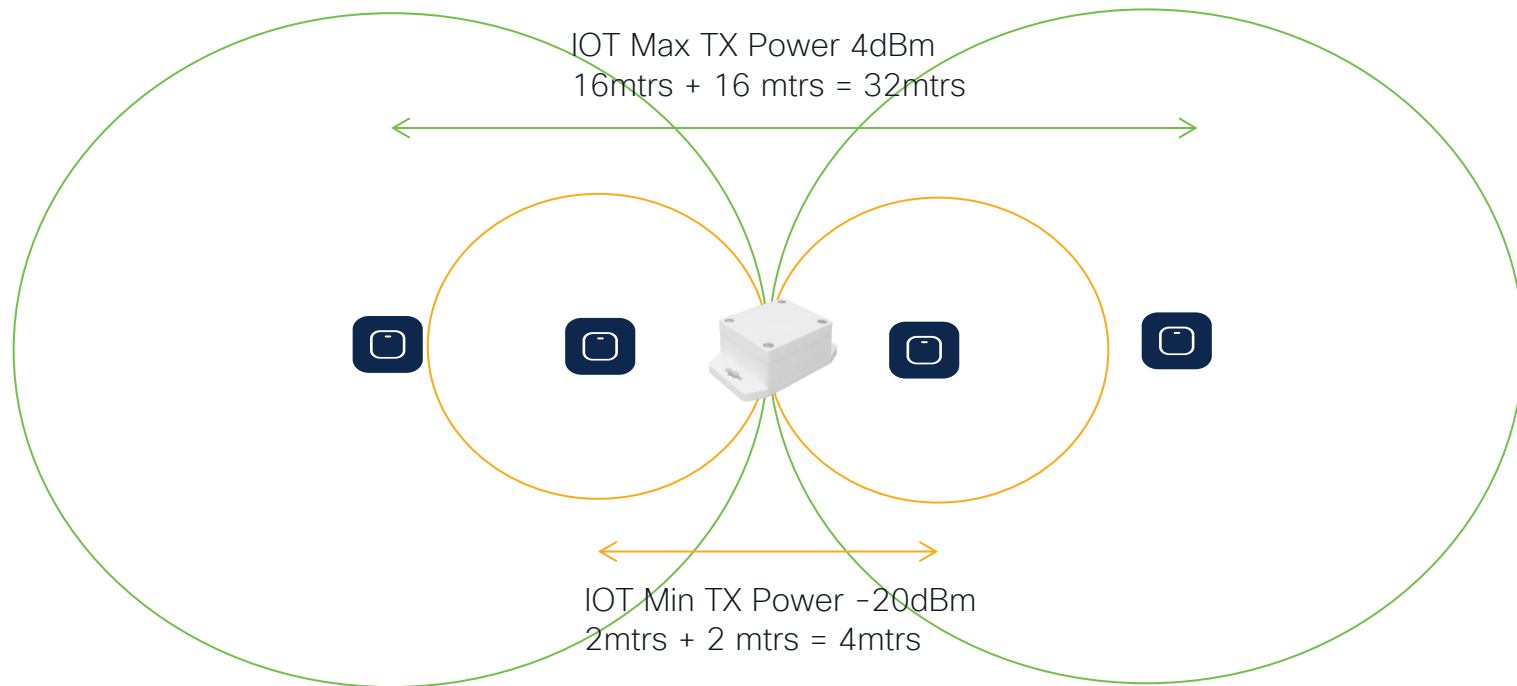
BLE Default Transmit Power

If you lowered it to setting 0
only have a range of 2 mtrs



Hexadecimal value	TX Power setting	Transmission power (decibel-milliwatts)	RSSI @ 3.2 ft (1 m)*	Approximate range**
e2	0	-30 dBm	-115	6.5 ft (2 m)
ec	1	-20 dBm	-84	13 ft (4 m)
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fc	5	-4 dBm	-69	131 ft (40 m)
00	6	0 dBm	-65	196 ft (60 m)
04	7	4 dBm	-59	229 ft (70 m)

AP to AP Distance BLE TX Power Impact

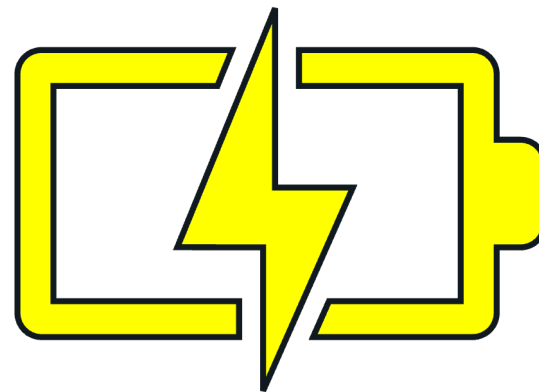


Why would we reduce power?



BLE = Low Energy

BLE as its name suggest is low energy
BLE are generally battery operated
Lower Transmit Power equals longer life



Transmit Power and Battery Life

Kontakt Recommendations on TX power and estimated battery life.



TX Power (device configuration)	Transmission Power	Expected range	Estimated Battery Life*
1	-20 dBm	13 ft (4 m)	Up to 52 months
3"	-12 dBm	65 ft (20 m)	Up to 50 months
7	4 dBm	230 ft (70 m)	Up to 35 months

Lowest power 4% increase life
Highest power 70% decrease life

What about BLE advertising interval?



BLE vs Wi-Fi Advertising Interval



Beacons at regular intervals
Very deterministic



Probes = dependent on client
Mobile sleep = no probes
Can use data packets

BLE Advertising Interval

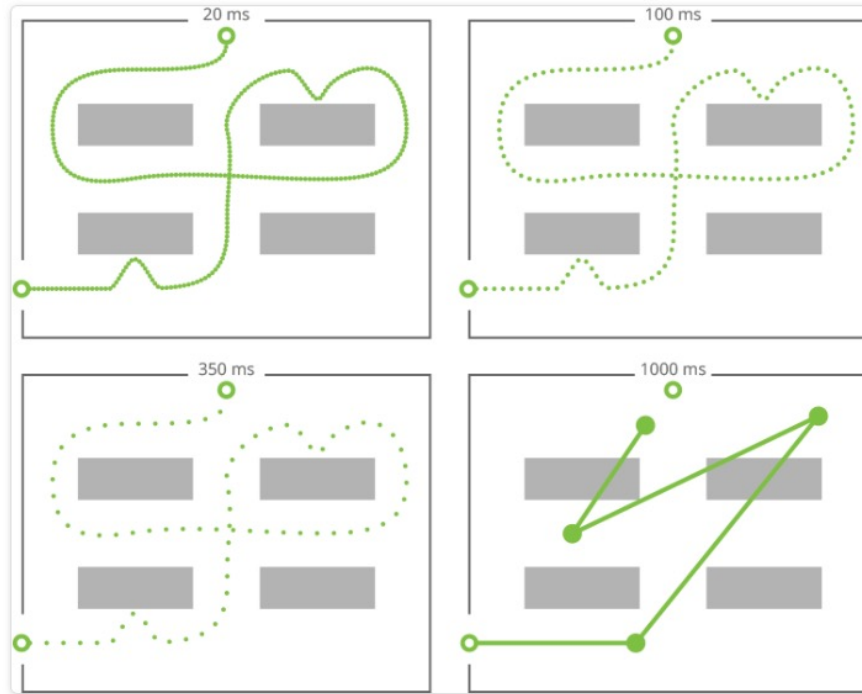
Kontakt Recommendations on TX interval and estimated battery life.

Highest interval 38% decrease life
Lowest interval 60% increase life

Interval	Interval used in	Tx Power	Expected range	Expected Battery life ¹
100ms	Apple iBeacon preset	-12 dBm	35 m	Up to ~19 months
350ms	Kontakt Beacon preset ²	-12 dBm	35 m	Up to ~50 months
200ms	Kontakt Eddystone™ profile	-12 dBm	35 m	Up to ~30 months
1000ms	with one packet	-12 dBm	35 m	~ 80 months

Ref: <https://support.kontakt.io/hc/en-gb/articles/4413251557650-Advertising-Interval-best-practices>

High Intervals Increased Location Fidelity

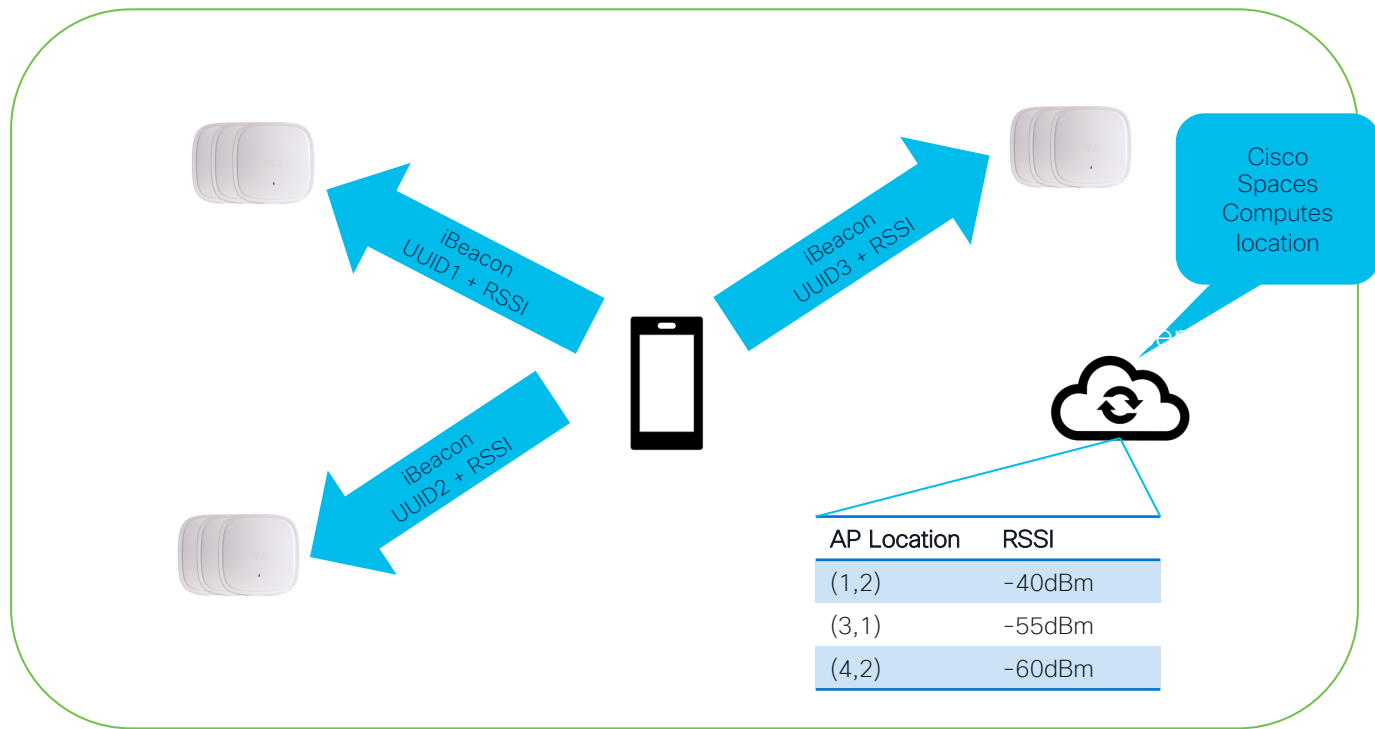


Ref: <https://support.kontakt.io/hc/en-gb/articles/4413251557650-Advertising-Interval-best-practices>

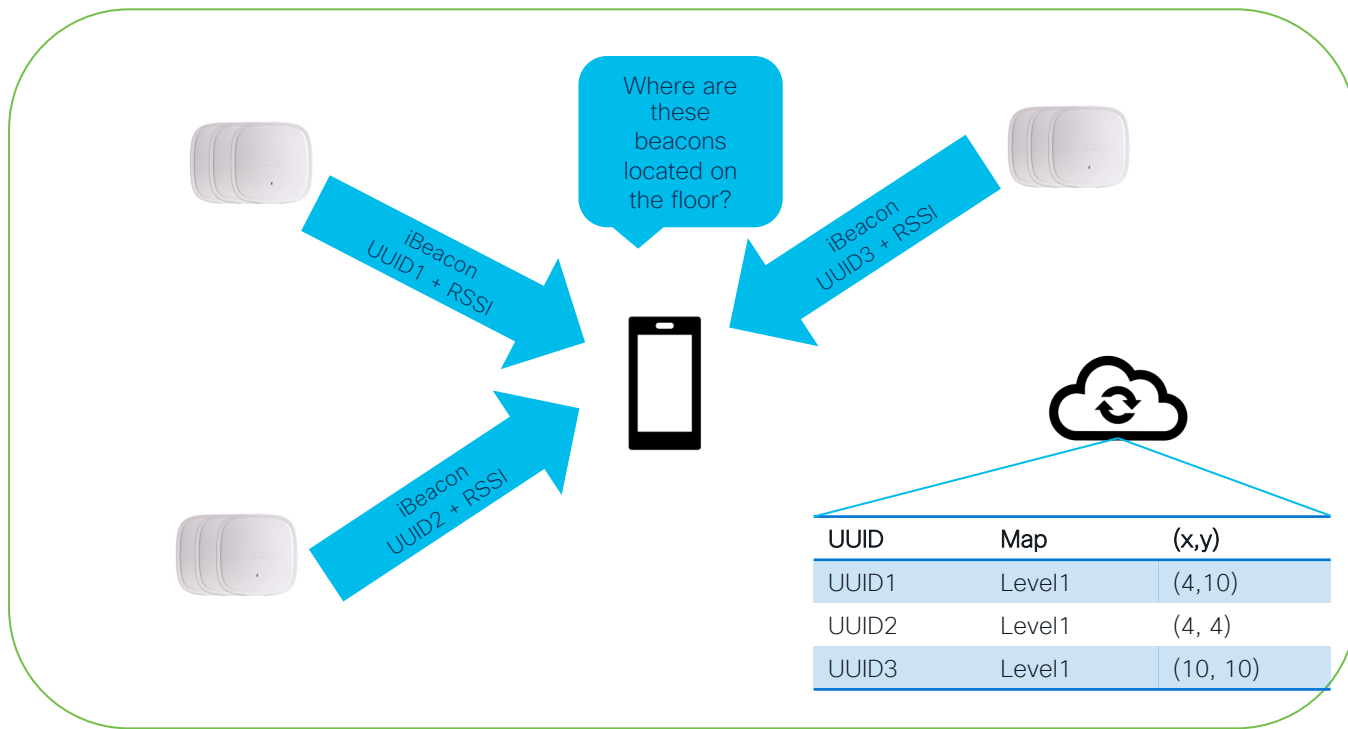
Are there different
ways to use BLE for
location?



RTLS Computed Location with BLE Beacons



Client Computed Location with BLE Beacons



Is BLE location more accurate than Wi-Fi?



BLE Beacon Reference RSSI

iBeacon RSSI @ 1mtr
Eddystone RSSI @ 0mtr

Example:
Kontakt Beacon packet

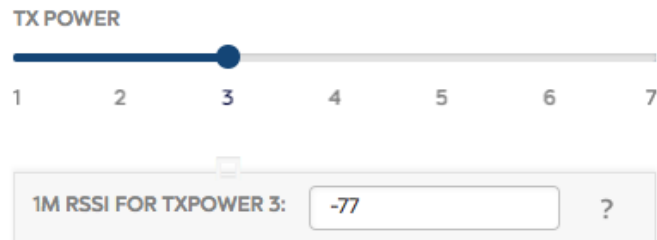
29	0xb3	Calibrated RSSI@1m (for TX power level 3)
----	------	---

Byte offset	Default value	Description
0	0x02	Data length - 2 bytes (constant preamble)
1	0x01	Data type - flags (constant preamble)
2	0x06	LE and BR/EDR flag (constant preamble)
3	0x1a	Data length - 26 bytes (constant preamble)
4	0x0f	Data type - manufacturer specific data (constant preamble)
5	0x4c	Manufacturer data (constant preamble)
6	0x00	Manufacturer data (constant preamble)
7	0x02	Manufacturer data (constant preamble)
8	0x15	Manufacturer data (constant preamble)
9	0x07	Proximity UUID 1st byte
10	0x82	Proximity UUID 2nd byte
11	0x6d	Proximity UUID 3rd byte
12	0xa6	Proximity UUID 4th byte
13	0x4f	Proximity UUID 5th byte
14	0xa2	Proximity UUID 6th byte
15	0x4e	Proximity UUID 7th byte
16	0x98	Proximity UUID 8th byte
17	0x80	Proximity UUID 9th byte
18	0x24	Proximity UUID 10th byte
19	0xbc	Proximity UUID 11th byte
20	0x5b	Proximity UUID 12th byte
21	0x71	Proximity UUID 13th byte
22	0xe0	Proximity UUID 14th byte
23	0x89	Proximity UUID 15th byte
24	0x3e	Proximity UUID 16th byte
25	xx*	Major 1st byte (randomly generated)
26	xx*	Major 2nd byte (randomly generated)
27	xx*	Minor 1st byte (randomly generated)
28	xx*	Minor 2nd byte (randomly generated)
29	0xb3	Calibrated RSSI@1m (for TX power level 3)

Reference RSSI

BLE includes a configurable reference RSSI at 1mtr

BLE can be more accurate than Wi-Fi
because of this



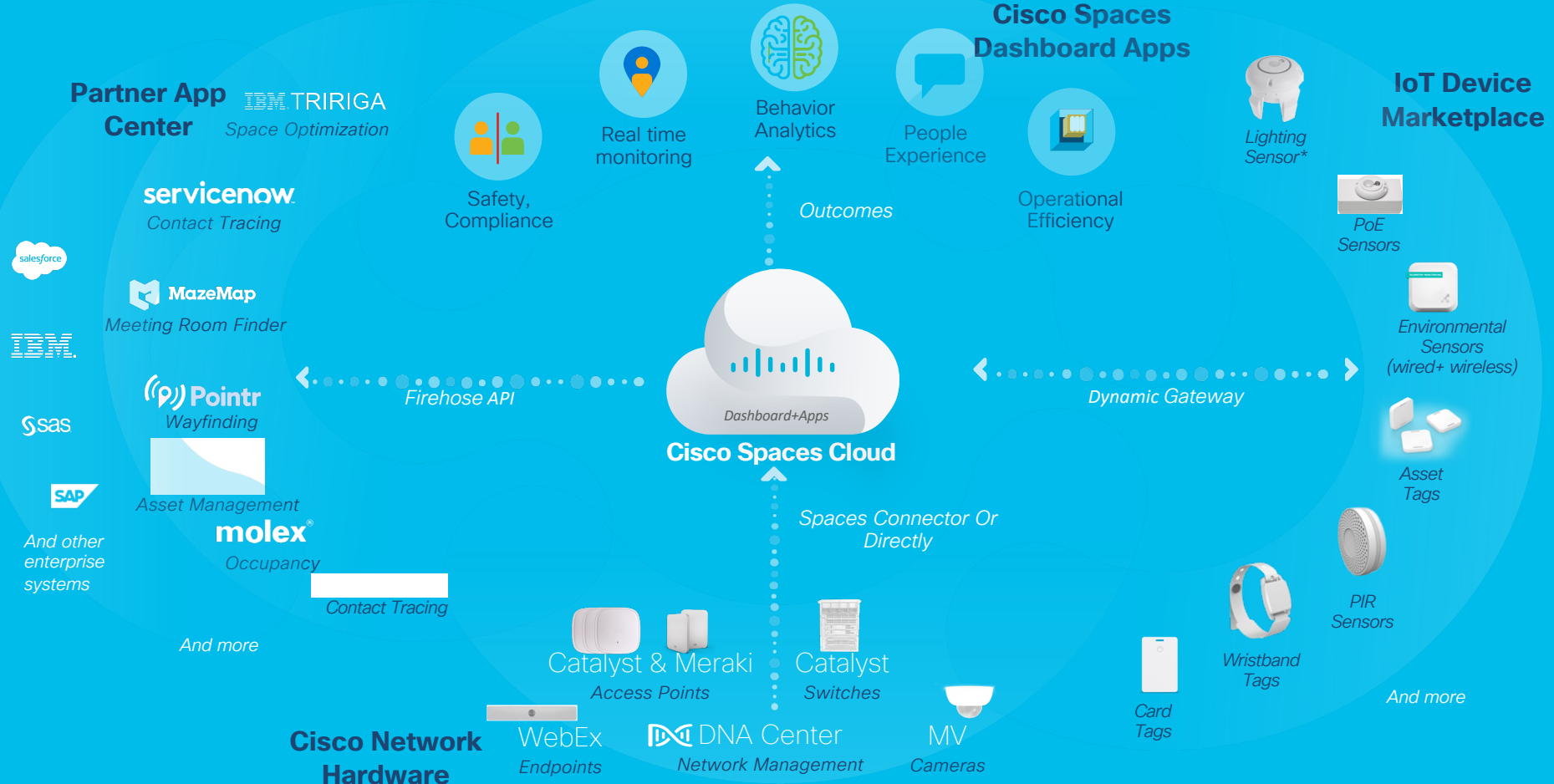
You can check the RSSI
@ 1mtr and calibrate
your tags.

Ref: <https://support.kontakt.io/hc/en-gb/articles/4413251557650-Advertising-Interval-best-practices>

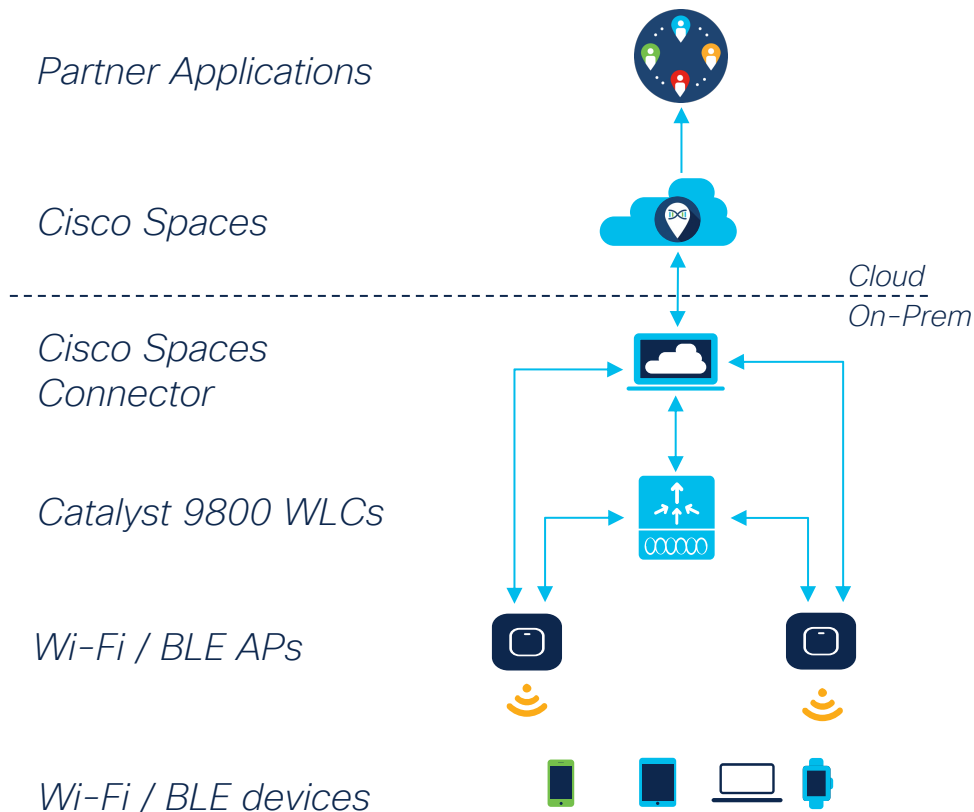
Architecture



High Level Data Flow Architecture



High level architecture for location data

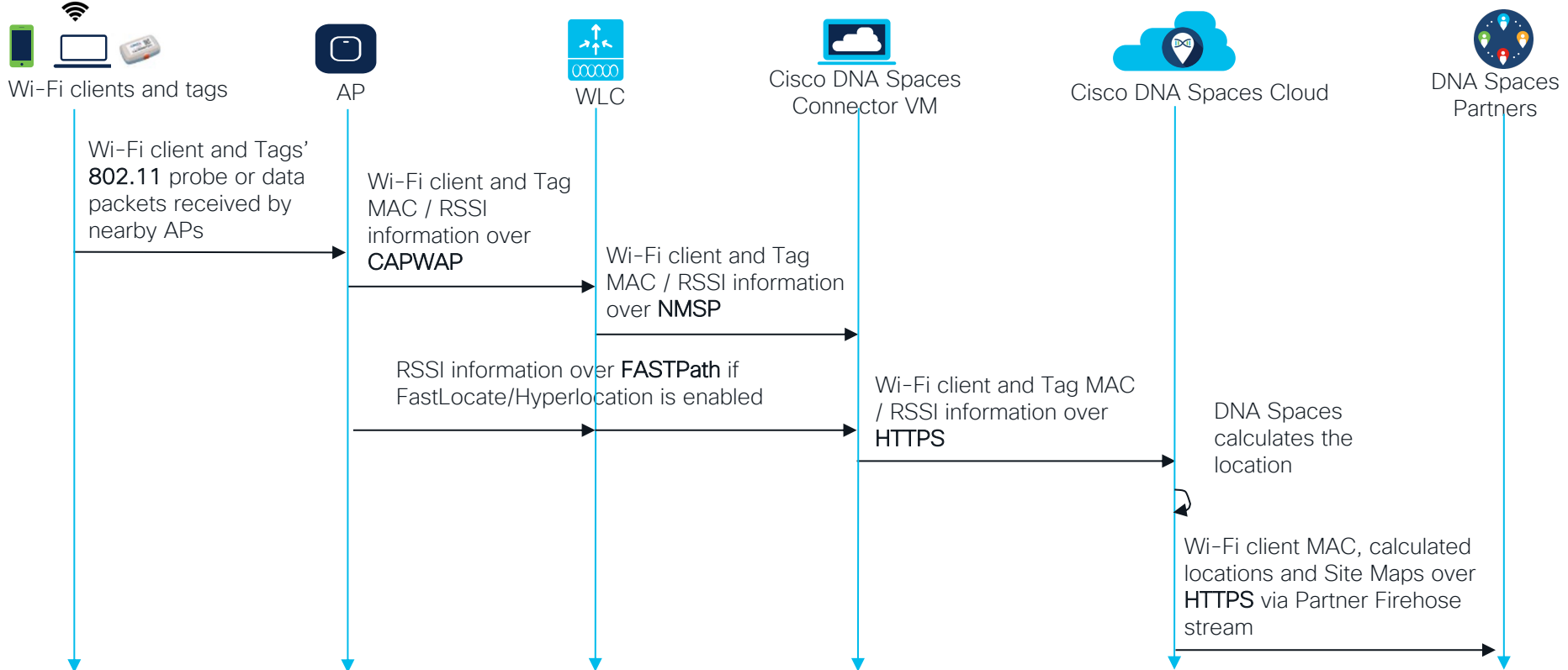


For BLE, This is the architecture that is needed.

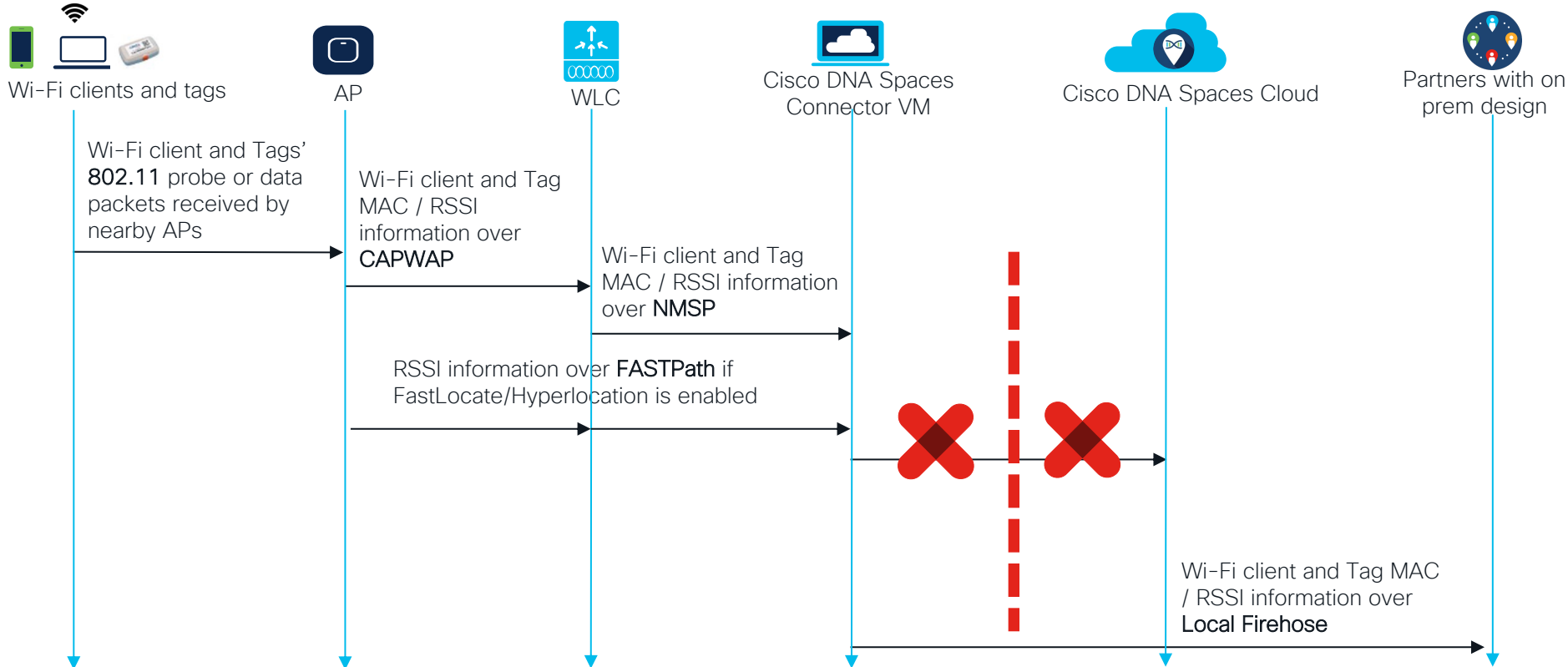
For Wi-Fi only, older WLCs would also work, and connector is not mandatory.

However, this is the recommended architecture for any DNA Spaces location deployment

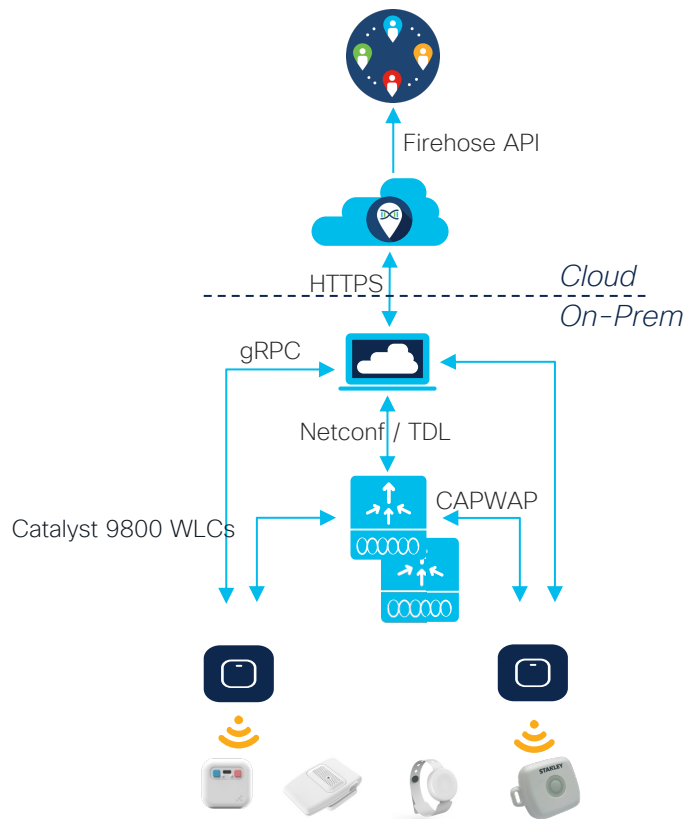
Data flow for Wi-Fi data for location calculation



Data flow for Wi-Fi data for location calculation



High level architecture for location data



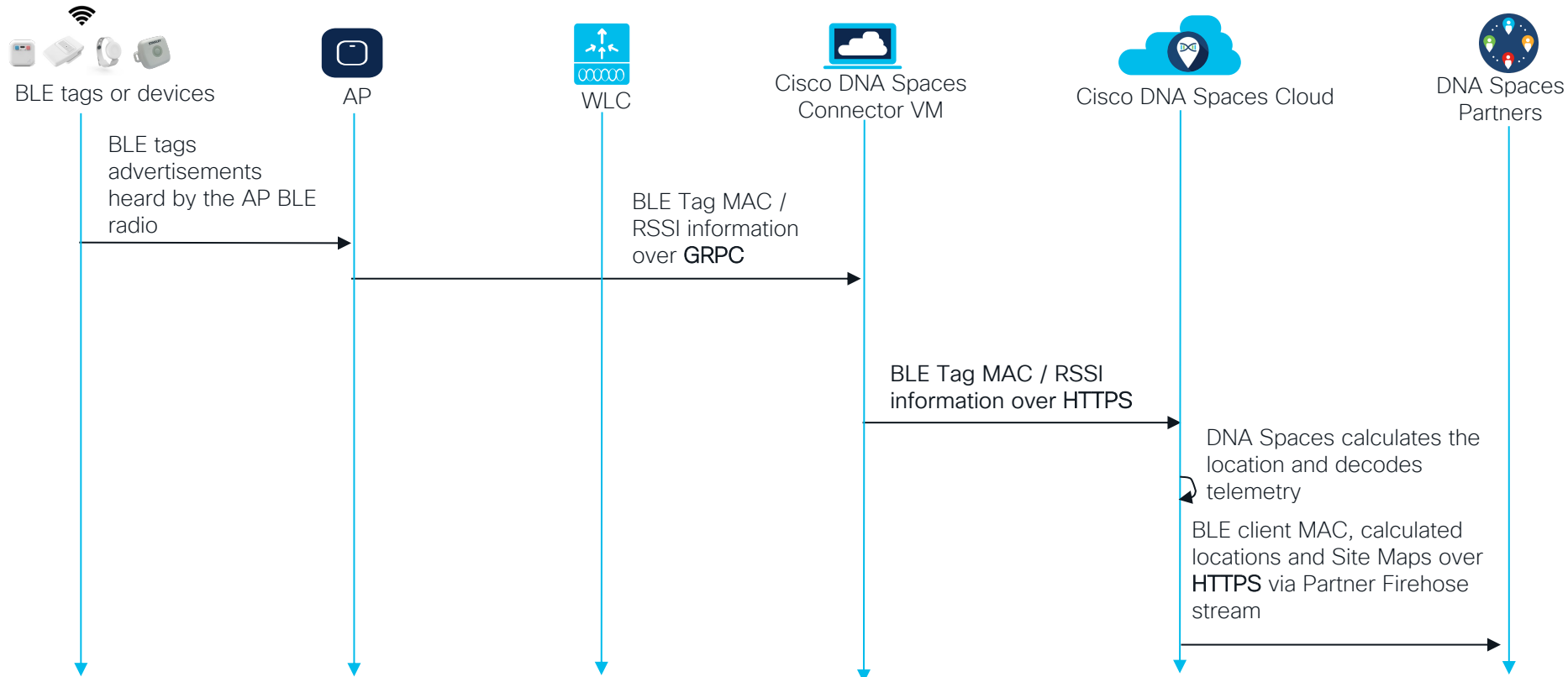
Architecture for BLE location

gRPC: BLE data and configuration channel between APs and Connector

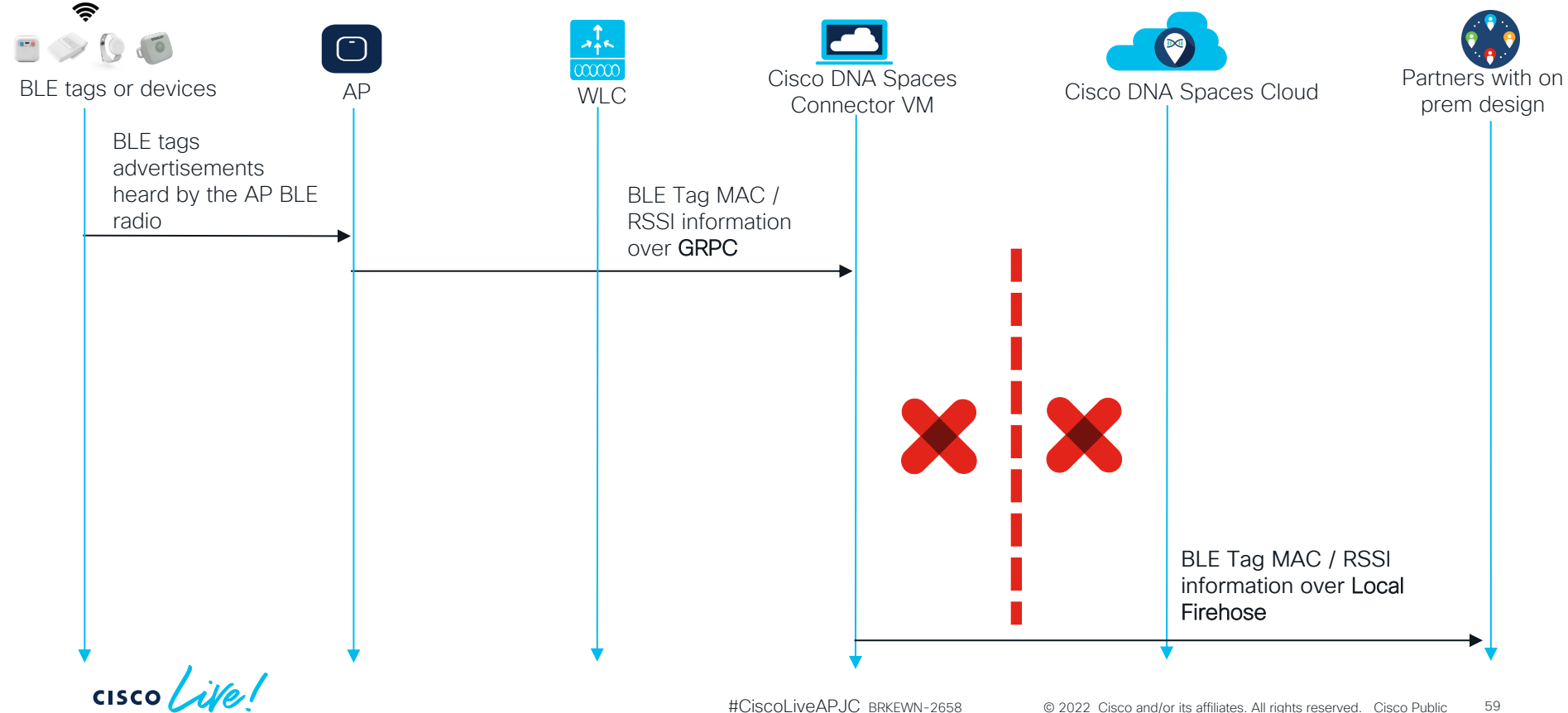
Netconf: Push Configuration to WLC

TDL: Read configurations from WLC

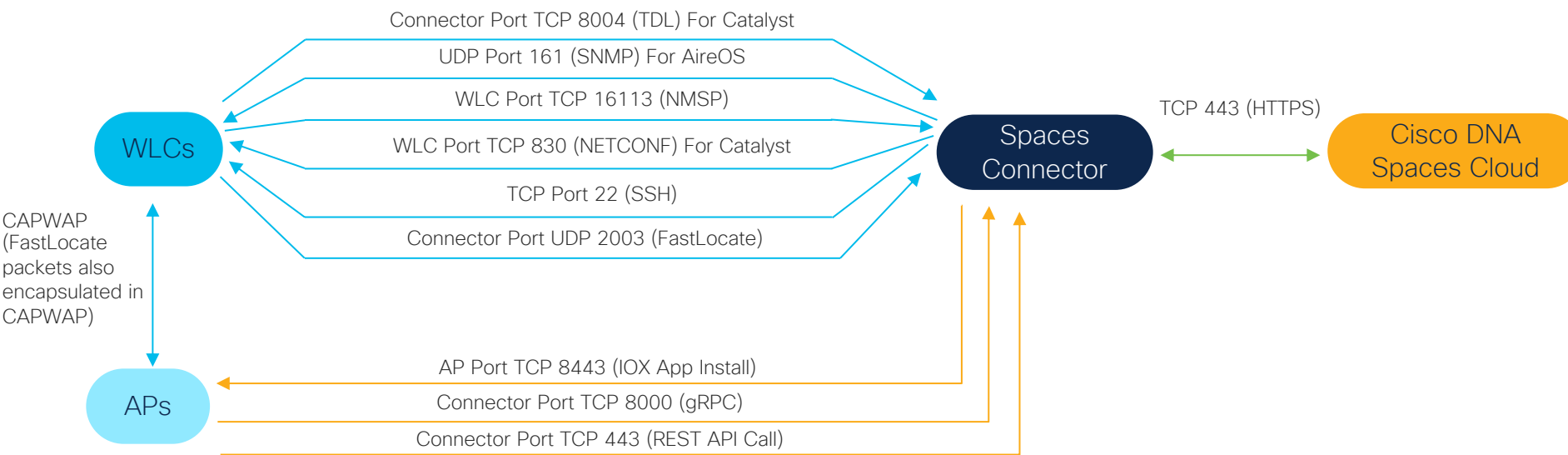
Data flow for BLE data for location calculation



Data flow for BLE data for location calculation



DNA Spaces Connector ports for location



This is only ports related to location (Wi-Fi or BLE).
 There are other ports and protocols used for other features such as Open Roaming, Wired IoT, Syslog etc.





* All models of Catalyst 9800 are supported EXCEPT
Embedded Wireless Controller (EWC)
Licensing: BLE requires DNA Spaces ACT license

Solution matrix and licensing

Wi-Fi Location

Wireless Infra Deployment Type	Catalyst 9800	AireOS	Meraki
	16.10 +	8.5+	Supported
Cisco DNA Spaces Deployment Type	Connector OVA	Direct Connect	CMX Tethering
	2.0 +	Supported	Supported

BLE Location

Wireless Infra Deployment Type	Catalyst 9800*	AireOS	Meraki
	IOS-XE 17.3.1+ (17.6 recommended)	Not Supported	Future
Cisco DNA Spaces Deployment Type	Connector OVA	Direct Connect	CMX Tethering
	2.3 +	Not Supported	Not Supported

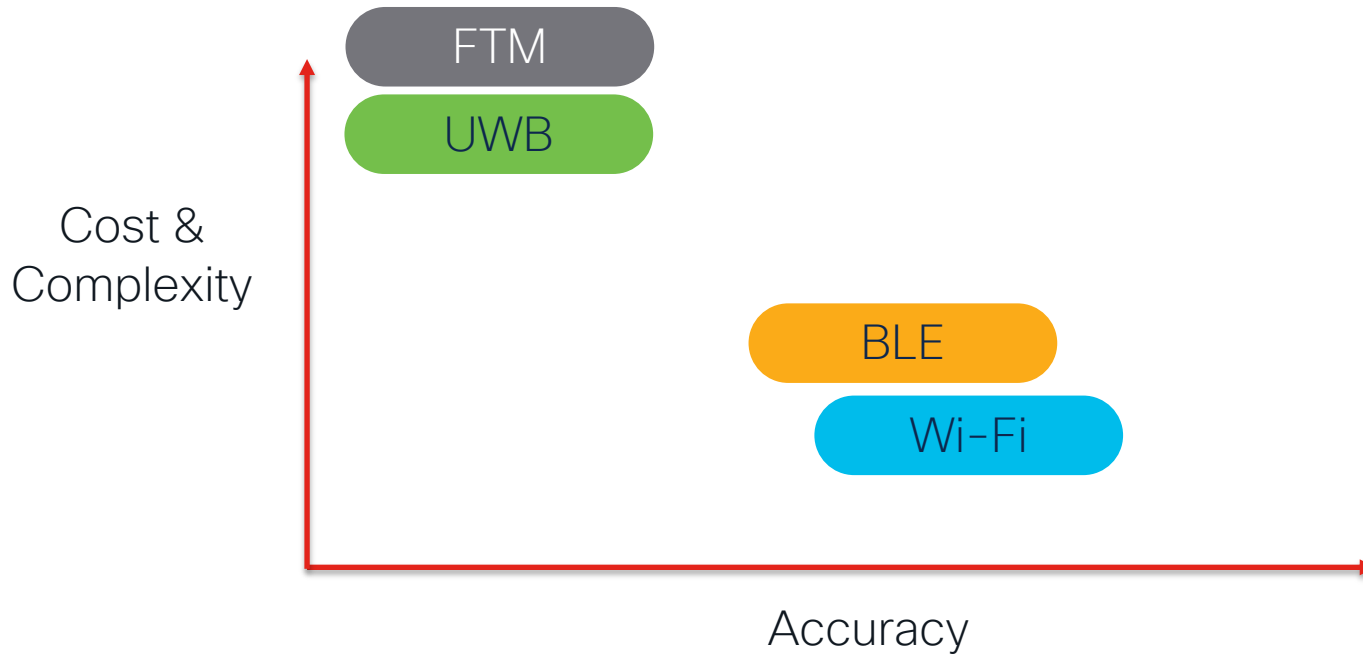
Designing a Location Ready Network



How accurate is the location?



Not all wireless based location solutions are same



Measures of Location Success



Accuracy

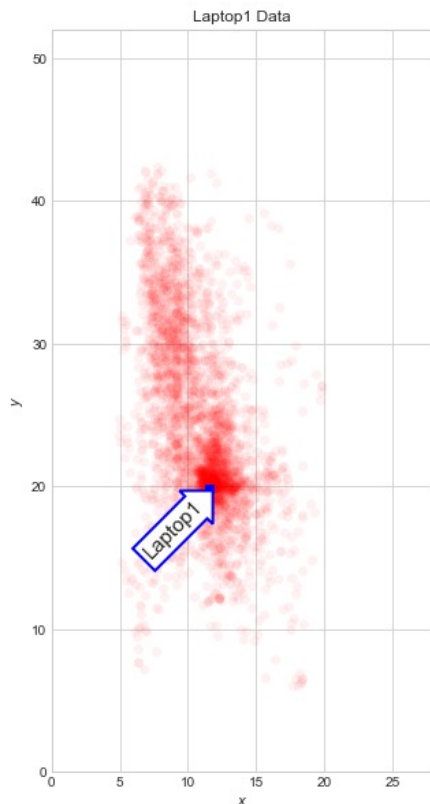


Precision



Latency

Location Performance Targets



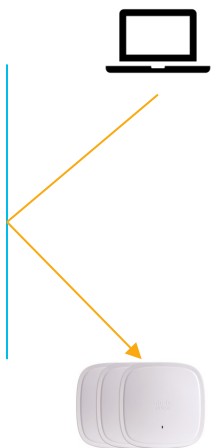
Precision is %
correct

RSSI location targets:
Accuracy $\geq$ 5mtrs @ 90% precision**

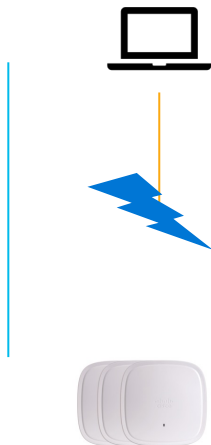
**Optimal conditions with RTLS deployment

Reasons for Bad Location Accuracy

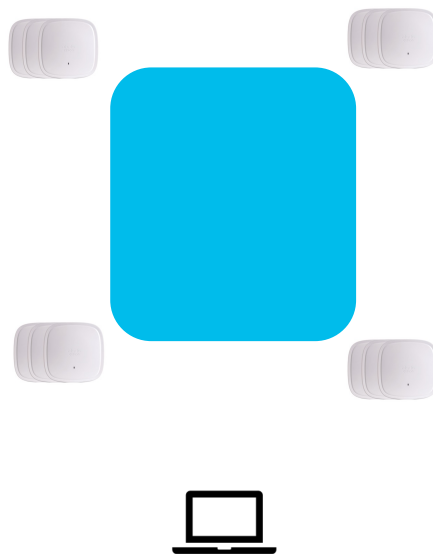
Multi-path



Interference



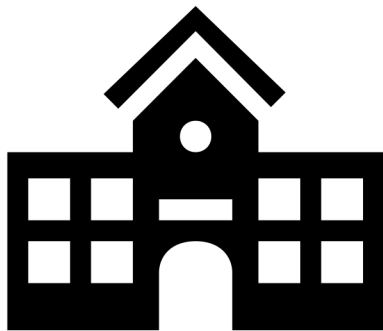
AP Placement



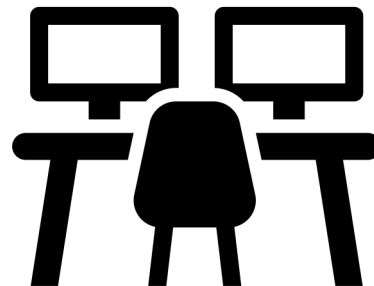
Accurate maps



What Does That Really Mean?



Building
Floor



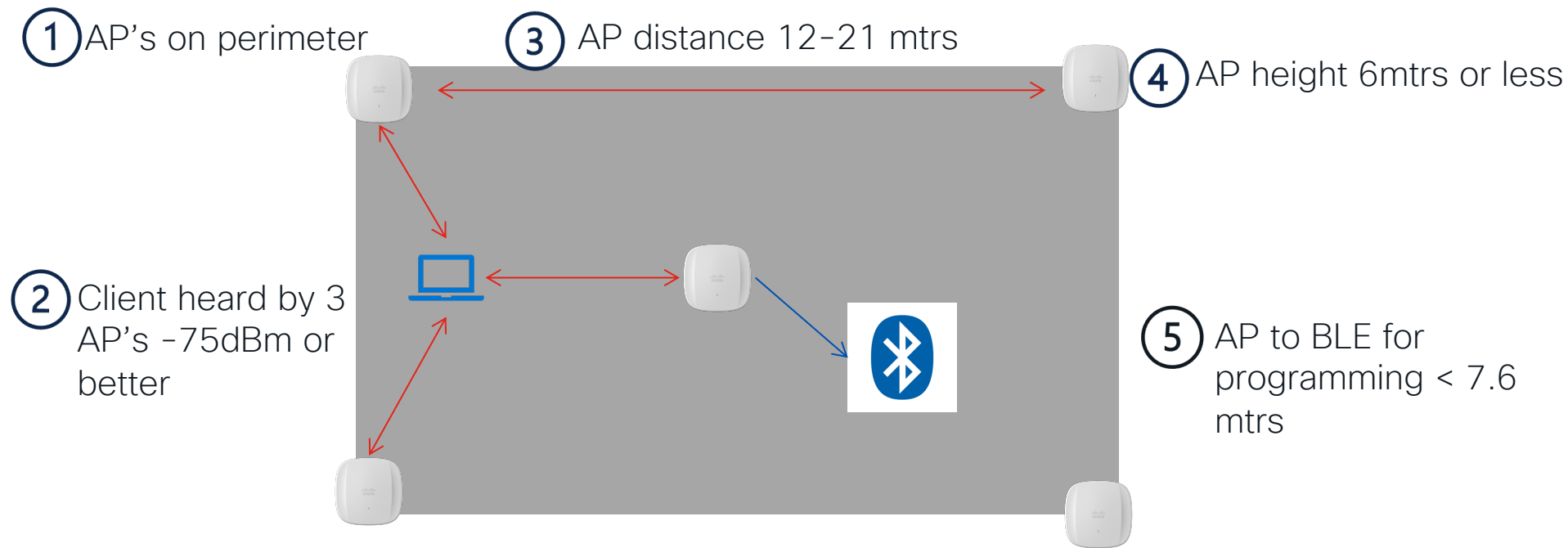
Desk level



Where do I put the Access Points?

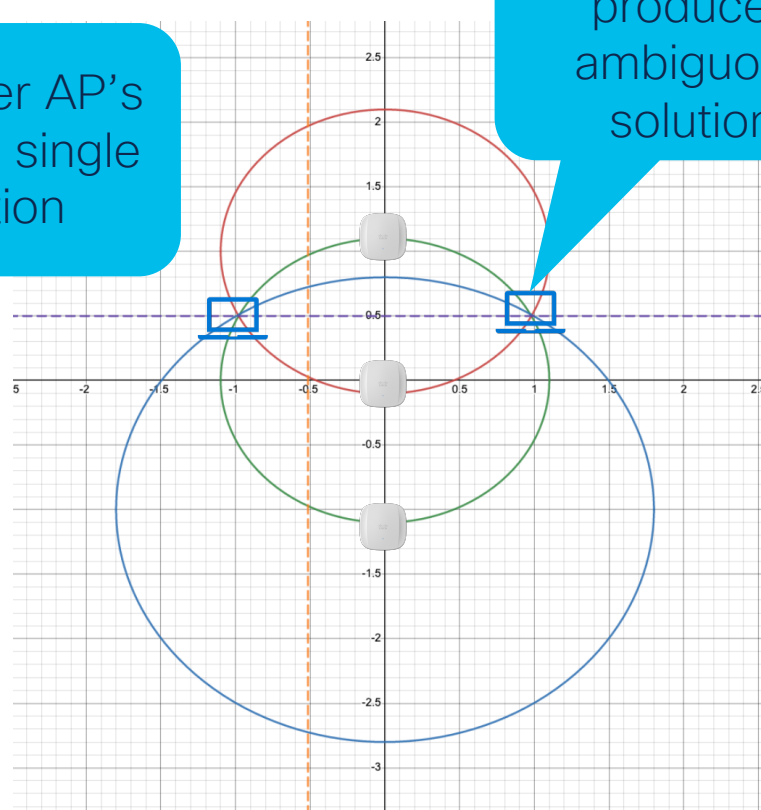
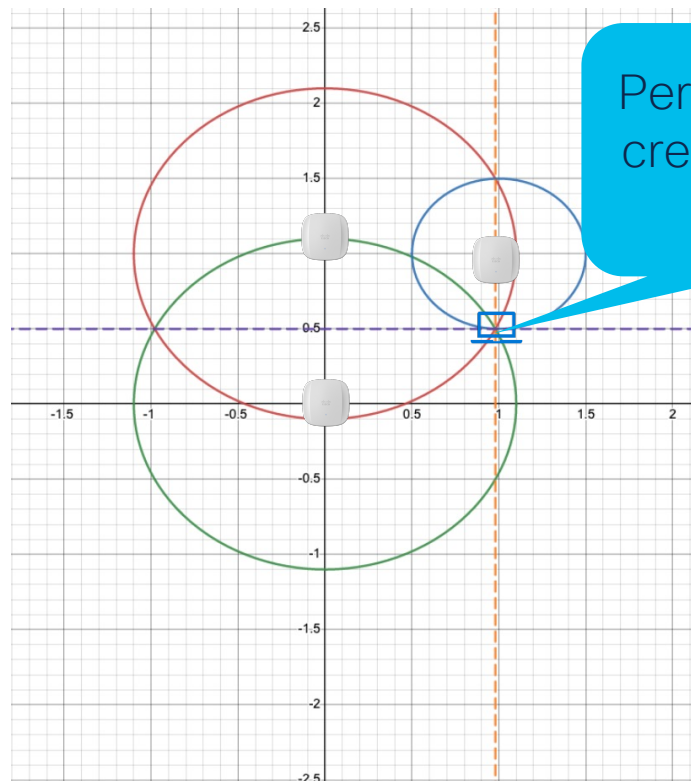


AP Placement Recommendations

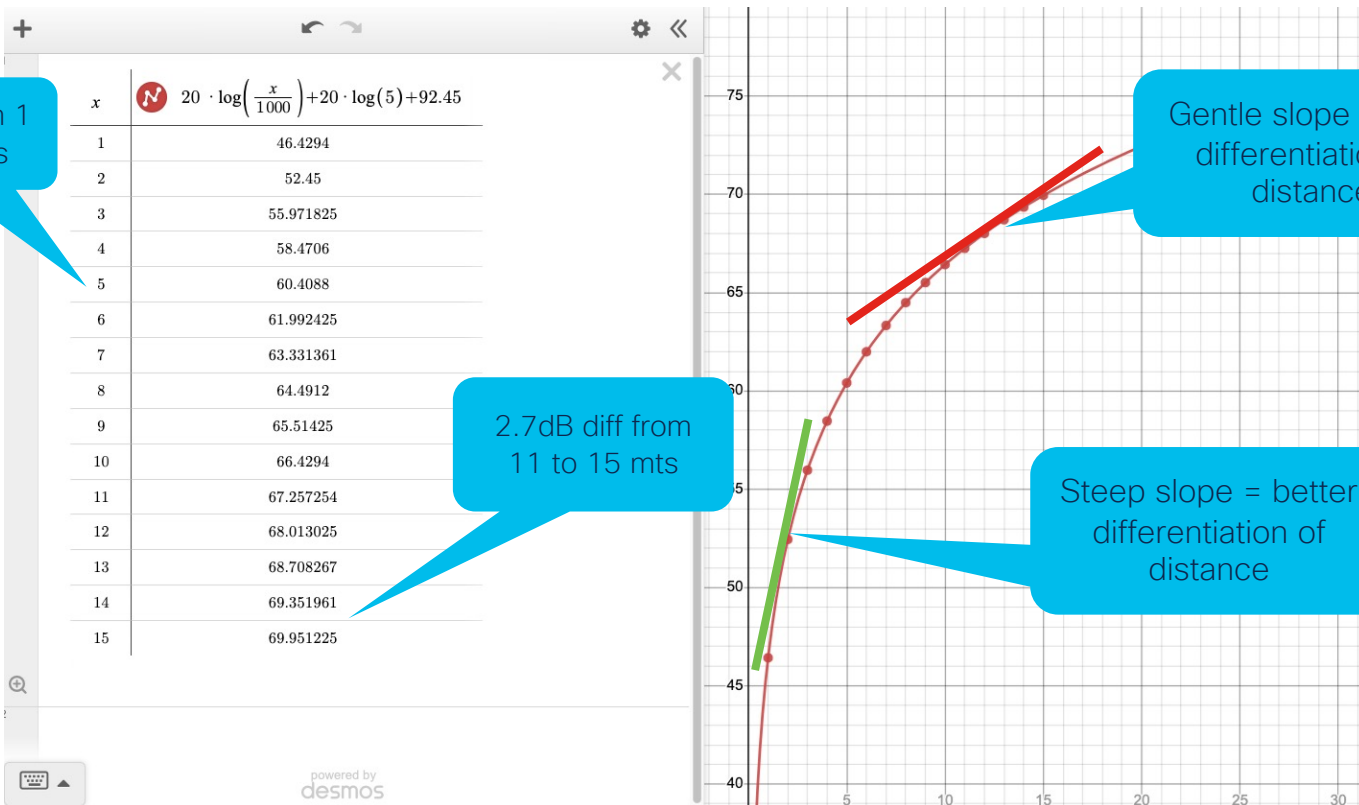


<https://www.cisco.com/en/US/docs/solutions/Enterprise/Mobility/emob30dg/Locatn.pdf>

Importance of Perimeter AP's

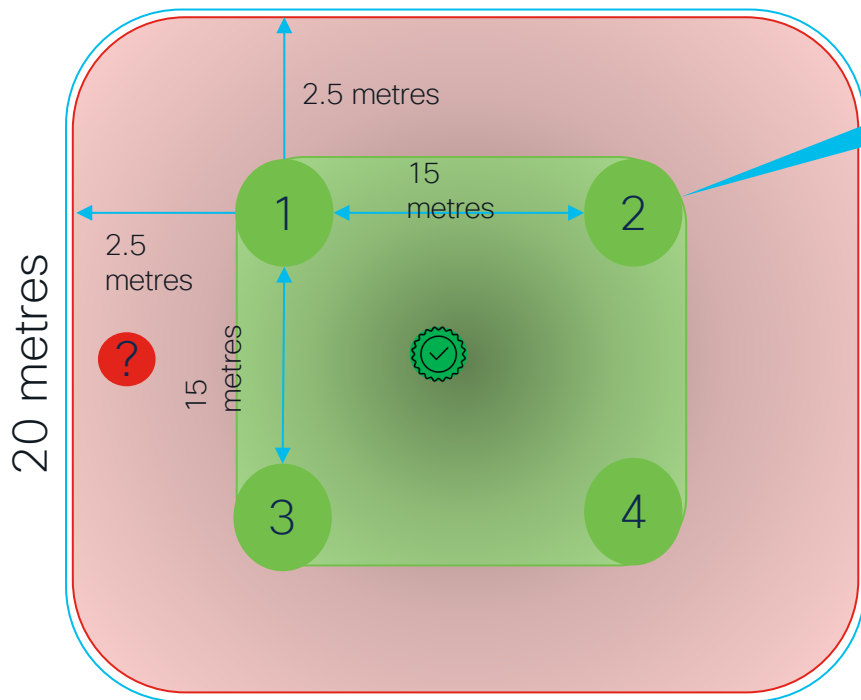


Free Space Path Loss and Accuracy



Wi-Fi Deployed for Data

20 metres



Placing AP's 2.5 metres from perimeter can greatly reduce accuracy

Total floor area = 400 sqm

AP placement 2.5 metres from edge

Good location = $15 \times 15 = 225$ sqm

Bad location = $400 - 225 = 175$ sqm

Good accuracy 5-10mtrs = 56% floor area

Poor accuracy 18mtrs = 44% floor area

Ref: [Wi-Fi Location-Based Services 4.1 Design Guide](#)

"10m/90% accuracy within the convex hull may deteriorate to 18m/90% "

Note: 1 AP per 100sqm is a very high density deployment.

How can I get fast location updates?



How does FastLocate work?



Probes 10sec to 5mins
Not deterministic



Data packets RSSI
Very frequent updates

FastLocate Checklist

- ✓ AP valid NTP server configured
- ✓ 17.1 for 9120 and 17.3 9130, 2800, 3800, 4800
- ✓ 9800 must use a SVI for management interface for this to work.
- ✓ Firewall rules to allow AP to WLC via CAPWAP DATA UDP/5247,
FastLocate packets are encapsulated inside CAPWAP
- ✓ Firewall rules to allow 9800 to Cisco Spaces Connector UDP/2003

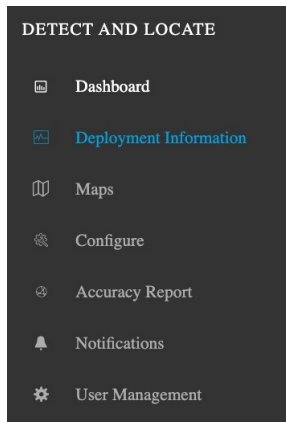
Why are maps so important?



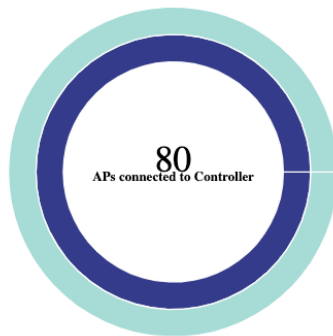


AP's Must be on the Map

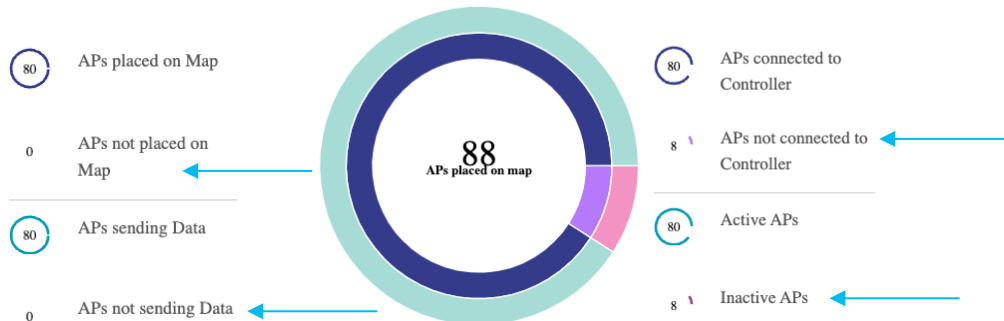
- Make sure all APs are on the maps.
- Use Detect and Locate Deployment Information page



APs connected to Controller



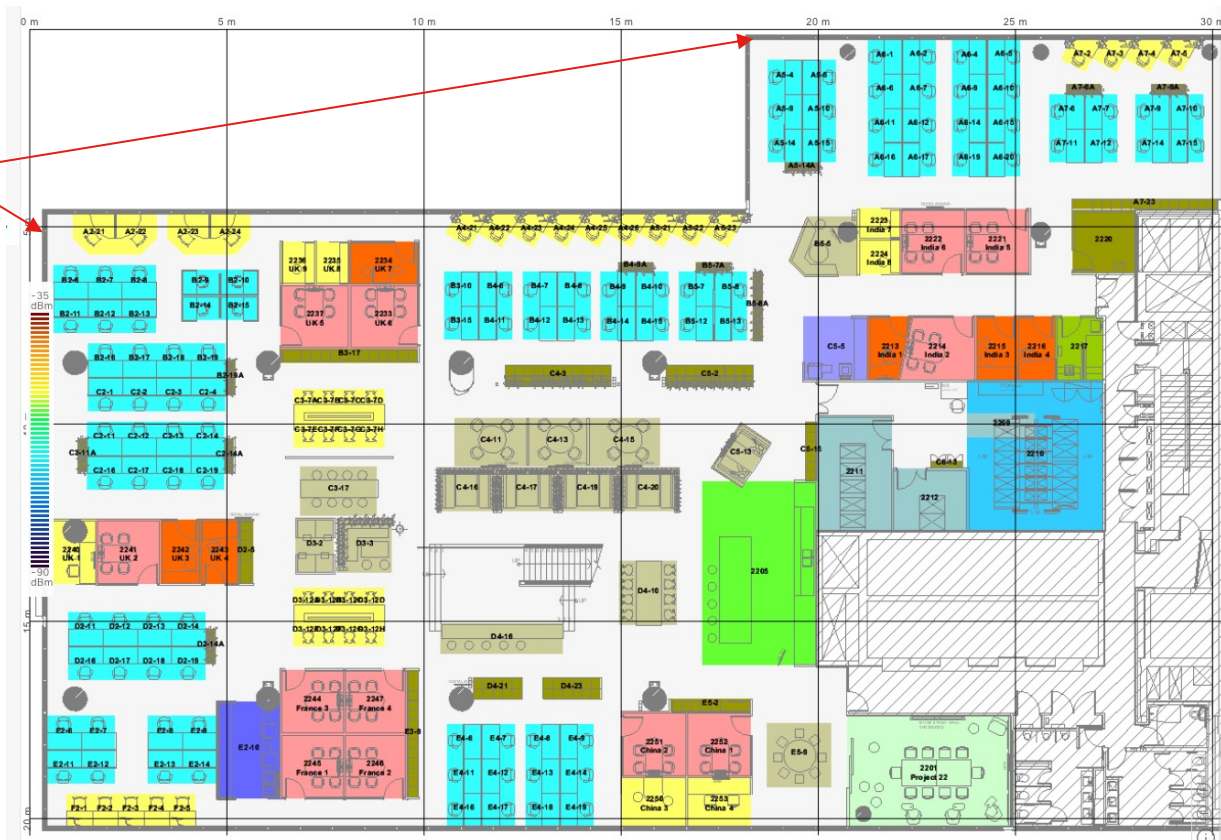
APs placed on Map





No White Space in the Floor Maps

Building and image
edge as close as
possible



Can I use different AP models?



Don't Mix your AP Models



Salt and pepper design of
AP models

Can I do location with directional antennas?



Problem with directional Antennas

Transmit power impacted by antenna gain 

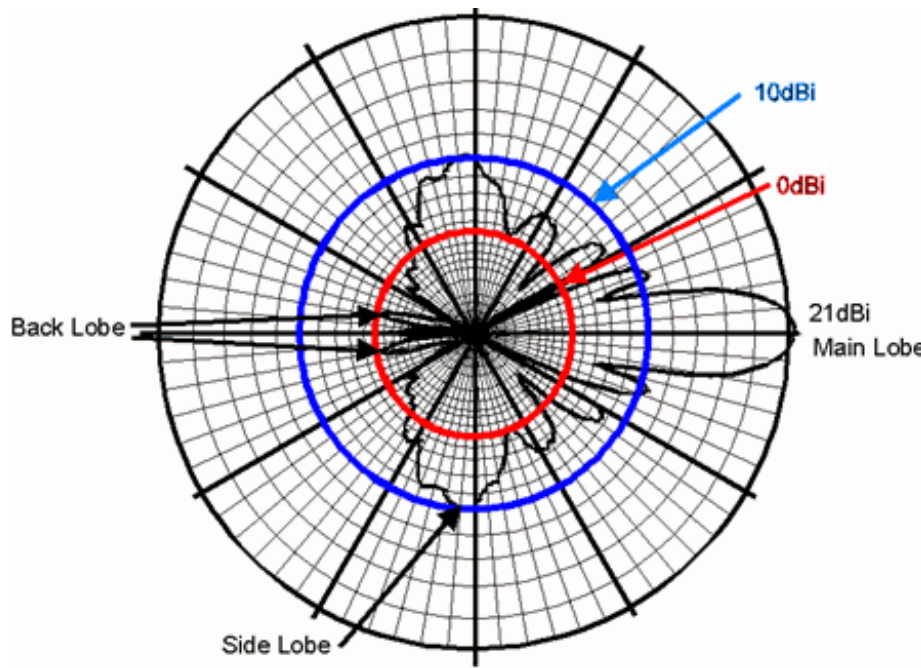
Receiver Signal Level also impacted by antenna gain 

Measure	Value
Tx Power (dBm)	10
Tx antenna Gain (dBi)	2.8
EIRP (dbM)	12.8
Path Loss (dB)	-80
Rx Antenna Gain (dBi)	5
Rx Signal Level (dBm)	-62.2

Problem with directional Antennas

Common for direction antennas to have a front to back ratio of 20dB

RSSI will differ depending if you are standing in front of or behind



What do I need to do for BLE?



BLE gateways: Base and Advanced

Base Gateway

AP 1800/2800/3800/4800*

- ✓ BLE Location (BLE Scanning) -OR-
- ✓ BLE Advertisement
- ✗ No Management of 3rd party BLE Beacons or tags. Customer would still require alternative costly methods
- ✗ Some APs require USB BLE dongle to turn on BLE functionality

*While AP4800s support Advanced Gateway, they are only recommended to be used in Base Gateway mode



Advanced Gateway

All 9100s

- ✓ BLE Location (BLE Scanning)
- ✓ BLE Advertisement
- ✓ Some APs support concurrent Scanning and Advertisement
- 📶 AP makes 2-way connection to tags for direct management
- ⚙️ Change configuration, Update Firmware, edit packets etc.
- 💰 AP functions same as a vendor's proprietary gateway installation

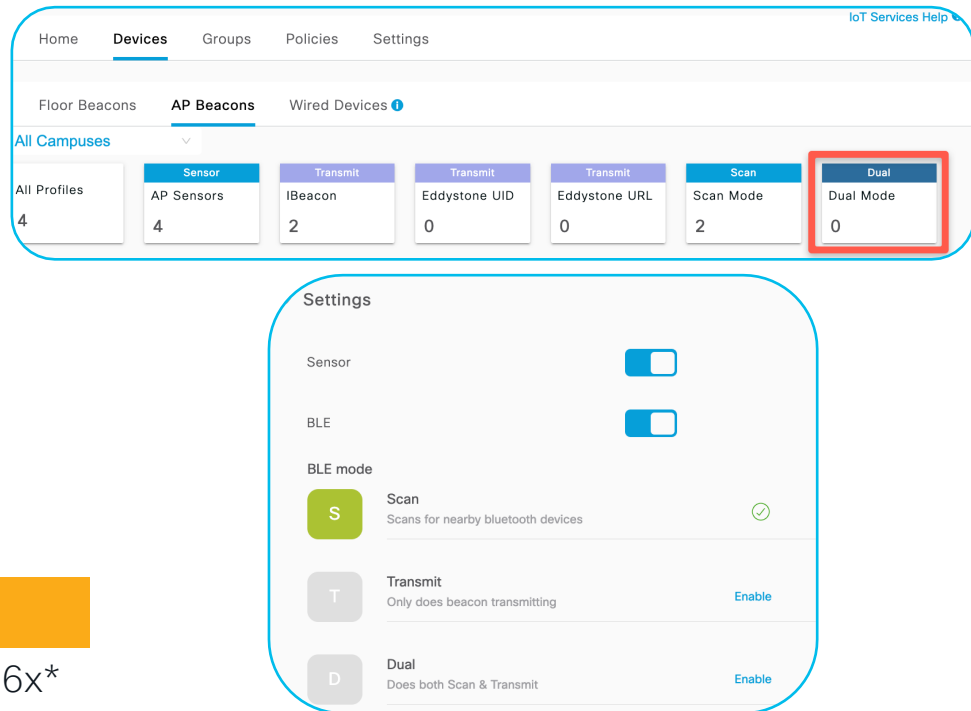
BLE gateways: Concurrent BLE Scan and Advertisement

- Starting with 17.9.1, some AP models to scan and advertise at the same time.
- The APs can be used for all BLE use cases: Asset Tracking, BLE wayfinding and navigation, Environmental tracking.
- Limitations on v-iBeacon
- There will be some reduction in scanning performance

Supported APs

C9105, C9120, C9124, C9130, C9136, CW916x*

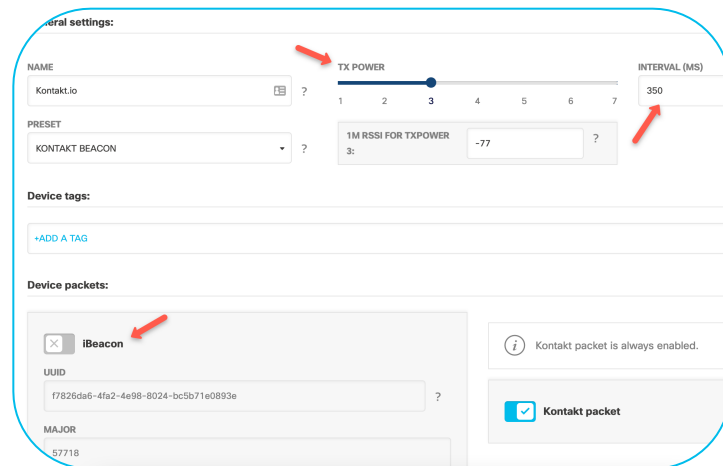
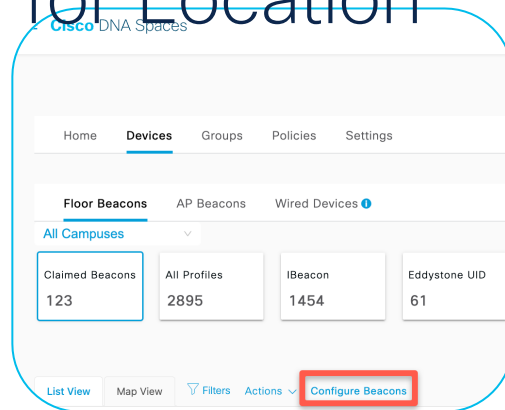
*when the CW916x AP is in DNA Persona



Design considerations for BLE for Location

Best practices for deploying a BLE Wayfinding use case:

- Grid of evenly spaced beacons
- BLE beacons may be needed
- Same time intervals and transmit power
- One beacon every 110 - 167 square metres
- Add beacons at floor changes e.g. hallways
- Line of sight is important
- For the iBeacon, easier to use
 - UUID for company,
 - Major for building or floor
 - Minor per beacon.
 - Advanced gateway APs can configure the beacons via Spaces.



Design considerations for Wi-Fi and/or BLE

AP Model	Wi-Fi Location	FastLocate	BLE Location	BLE Management (Adv. Gateway)	Concurrent BLE Scan and Transmit
C9105	Yes	No	Yes	Yes	Yes (17.9.1)
C9115	Yes	No	Yes	Yes	No
C9117	Yes	No	Yes	Yes	No
C9120	Yes	Yes	Yes*	Yes+	Yes (17.9.1)
C9124	Yes	Yes	Yes	Yes	Yes (17.9.1)
C9130	Yes	Yes	Yes*	Yes+	Yes (17.9.1)
C9136	Yes	Yes	Yes*	Yes+	Yes (17.9.1)

Only relies on probe-based location

Troubleshooting Location



BLE Location Troubleshooting

BLE

Make sure these pre-requisites are setup.

- Understand Firewall Rules and Ports needed to be open.
- C9800 needs to be added in DNA Spaces with full privilege credentials.
- Netconf needs to be enabled on C9800 on default port 830 and the credentials need to be allowed to use Netconf.
- Make sure the following commands are added in 9800 before adding it to DNA Spaces

```
9800WLC# configure terminal
9800WLC(config)#aaa authentication login default local
9800WLC(config)#aaa authorization exec default local
```

Troubleshooting Location

Wi-Fi/BLE

- Check if all the APs are reporting RSSI data. If some APs are not, check the AP health (i.e. radios are on) and on the map.

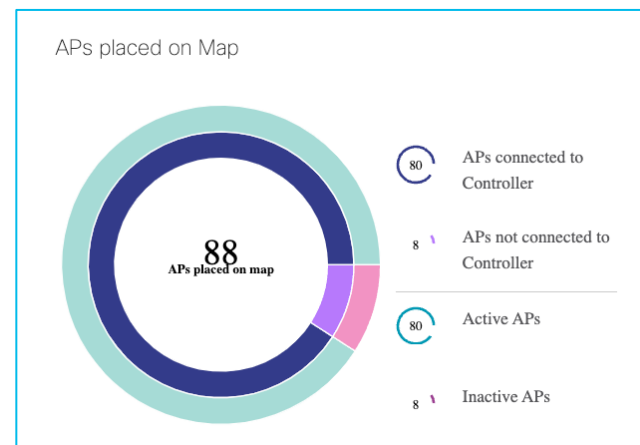
North Sydney

BLE Tags 13

Rogue APs 45

AP : nsd5-9130-ap1

MAC Address	48:8b:0a:3a:d2:e0
AP Name	nsd5-9130-ap1
Model	AP9130I
apPid	---
Coordinates	X: 65.05, Y: 18.5
Reporting RSSI Data	Yes
Connected Clients	0
Height	3.05 ft
Azimuth Angles	Slot 1: 0.00° Slot 2: 0.00° Slot 6: 2.00° Slot 7: 90.00° Slot 8: 0.00°
Elevation Angles	Slot 1: 0°



Troubleshooting location

Wi-Fi

- Make sure you have FastLocate turned on and are seeing compute type as FASTLOCATE_RSSI or FUSION*

The image contains two screenshots from the Cisco DNA Spaces and Catalyst 9800-L Wireless Controller interfaces.

The top screenshot shows the Cisco DNA Spaces 'Detect and Locate' page. On the left, a sidebar has 'Fast Locate' selected. The main area shows 'Fast Locate' with a toggle switch that is turned on.

The bottom screenshot shows the Catalyst 9800-L Wireless Controller 'Edit AP Join Profile' page. The 'AP' tab is selected, and the 'Hyperlocation' checkbox is checked. A red box highlights the 'Hyperlocation' checkbox, and a red arrow points to it.

The right screenshot shows the 'Client : 00:00:f7:eb:0c:01' page. The 'Overview' tab is selected. The 'Compute Type' is listed as 'FASTLOCATE-RSSI', with a red arrow pointing to it.

*Note that only some AP models support FastLocate.

Troubleshooting Location

Wi-Fi/BLE

- Check the connector and WLC connection health from DNA Spaces Dashboard to make sure they are up and active and counters are increasing

Cisco DNA Spaces

← Spaces Connectors

Name	# of Controllers	# of APs	Status	Last Modified	Last Heard
SJC CXC 9800 Connector Version: v2.0.609 IP Address: 	2	47	Active	May 10, 2022, 12:21:03 PM	May 10, 2022, 9:58:22 PM
BDLK-DNAS-Connector Version: v2.0.609 IP Address: 	1	33	Active	May 10, 2022, 12:19:31 PM	May 10, 2022, 9:58:20 PM
Sample Connector 3.0 Version: N/A IP Address: N/A	0	0	Inactive	Mar 3, 2022, 6:42:36 AM	Never

← Controllers

Controllers	Connector	# of APs	Type	Controller Status	Last Modified	Last Heard
SJC-CXC-DMZ-WLC-9800	SJC CXC 9800 Connector	47	Catalyst WLC	Active	Jul 9, 2021, 2:51:25 PM	May 10, 2022, 9:59:52 PM
ABC	SJC CXC 9800 Connector	0	WLC	Inactive	Feb 8, 2022, 2:08:03 AM	Never
WLC-BDLK-R6-03	BDLK-DNAS-Connector	33	Catalyst WLC	Active	Nov 19, 2020, 4:00:26 AM	May 10, 2022, 9:59:50 PM

Wi-Fi/BLE

- [illegible]

Troubleshooting Location

Wi-Fi/BLE

- Enable client debugs. Logs get uploaded to Cisco Spaces cloud and support team can analyze specific client in detail.

The screenshot displays the Cisco Spaces interface. On the left, a floor plan is visible with various rooms labeled, including 'Murphy', 'Sydney', 'Buenos Aires', 'Dublin', 'Main Lobby', and 'Atterton'. A red box highlights the 'Enable device tracing' toggle switch, which is currently turned off. A red arrow points to this toggle. The right panel shows the 'Client' details for a selected device, including fields for MAC Address, IP Address, Coordinates (X: 259.9, Y: 123.2), Location, Compute Type (RSSI), Last Seen, Manufacturer (AzureWave Technology Inc.), Connected AP Base Radio Mac, Connected AP Name, Associated AP Mac, Detecting Controller, SSID, Max RSSI Detected (-48 dBm), Max RSSI AP MAC, Username, Band (5 GHz), Bytes Sent (2.7 MB), Bytes Received (728.68 KB), Geo Coordinates, and Source (COMPUTE).

Troubleshooting BLE Location

BLE

- On DNA Spaces UI, check the 'floor beacon', 'AP beacon', BLE Mode and Request History.
- **Floor Beacon channel** = where BLE beacon information is carried. i.e., GRPC channel health. If it's down, then GRPC is down between AP and connector. It should be last heard within few seconds.
- **AP Beacon channel** = where AP information is carried. i.e., TDL channel health. If it's down, then TDL is down between WLC and connector. It should be last heard within an hour.

The screenshot shows the Cisco DNA Spaces interface for an AP Beacon. The left sidebar has tabs for Home, Devices, Groups, Policies, and Settings. The 'Devices' tab is selected, showing a list of devices. The selected device is 'AP Beacon - 68:9e:0b:4b:e6:60'. The right panel displays 'AP Information' with various fields. Key status indicators are highlighted with red boxes:

- Floor Beacon Channel Status**: DOWN
- Floor Beacon Channel Last Heard**: Mar 28th, 2022 11:49:30 PM
- AP Beacon Channel Last Heard**: Mar 28th, 2022 11:47:29 PM

Other visible fields include Mac Address (68:9e:0b:4b:e6:60), Name (AP0476.B06B.D6E0), AP Model, WLC IP (10.22.243.213), BLE MAC (00:00:00:00:00:00), BLE Type (Base), Location, and various capability flags like Zigbee Capable (No) and BLE Capable (Yes).

Troubleshooting BLE Location

BLE

- If GRPC is down, it needs to be brought up for BLE. Some common reasons can be IoT Streams not configured, Ports blocked or no path, NAT is used, certificate is failing. Check AP output and connector logs.

```
AP#show cloud connector connection detail
```

```
Connection State           : READY
Connection Url              : 10.22.243.59:8000
Certificate Available       : true
Controller Ip               : 10.22.243.58
Stream Setup Interval      : 30
Keepalive Interval         : 30
Last Keepalive Rcvd On     : 2022-05-11
Number of Dials             : 6
Number of Tx Pkts          : 1876803031
Number of Rx Pkts          : 300161
Number of Tx Dropped Pkts  : 122591
Number of Rx Dropped Pkts  : 0
Number of Rx Keepalive     : 300161
Number of Tx Keepalive     : 300163
Number of Rx Cfg Request   : 0
Number of Tx AP Cfg Resp   : 0
Number of Tx APP Cfg Resp  : 0
Number of Tx APP state pkts : 3
Number of Tx APP data pkts : 1876502868
Number of Tx AP Cfg Requests : 0
Number of Rx AP Cfg Response : 0
Number of BLE Scan Pkts    : 1876625453
```

```
AP#show cloud connector key access
```

```
Token Valid : Yes
Token Stats :
    Number of Attempts : 2837
    Number of Failures : 171
    Last Failure on     : 2022-05-10 17:43:53.942468684 +0000 UTC
    m=+8960028.533147224
    Last Failure reason : Received response code 503 from server
    Last Success on     : 2022-05-11 05:43:59.262726961 +0000 UTC
    m=+9003233.853405261
    Expiration time     : 2022-05-12 05:43:59 +0000 UTC
```

```
9800-cl#show ap grpc summary
```

AP Name	AP Mac	gRPC Status
AP9120	00ee.ab18.e0a0	Up

Troubleshooting location

BLE

- If TDL is down, it needs to be brought up for BLE. Some common reasons can be that WLC is using incorrect source or destination IP of WLC to Connector route. Or there are not enough subscriptions available on 9800. If that is the case, delete some unnecessary subscriptions.
- IDs 122-127 need to be up and connected for BLE. IDs 128-132 need to be up for wired IoT.
- Check connector logs for failure codes.

```
9800-c1#show telemetry ietf subscription all
```

ID	Type	State	State Description
122	Configured	Valid	Subscription validated
123	Configured	Valid	Subscription validated
124	Configured	Valid	Subscription validated
125	Configured	Valid	Subscription validated
126	Configured	Valid	Subscription validated
127	Configured	Valid	Subscription validated
128	Configured	Valid	Subscription validated
129	Configured	Valid	Subscription validated
130	Configured	Valid	Subscription validated
131	Configured	Valid	Subscription validated
132	Configured	Valid	Subscription validated

BLE

Wired
IoT

```
9800-c1#show telemetry ietf subscription 122 detail
Telemetry subscription detail:
```

Subscription ID: 122

```
Type: Configured
State: Valid
Stream: native
Filter:
  Filter type: tdl-uri
  TDL-URI: /services;serviceName=ewlc_oper/ble_ltx_ap
Update policy:
  Update Trigger: periodic
  Period: 360000
Encoding: encode-tdl
Source VRF:
Source Address: 10.22.243.58
Notes: Subscription validated
Named Receivers:
Name                                     Last State Change      State
cloud-native://10.22.243.59:8004        02/22/22 09:05:49      Connected
```

Troubleshooting location

BLE

- If BLE devices are suspected to not be heard, check if beacons are being seen (check Last Heard) and check Detect and Locate. If not BLE devices are seen, then likely AP is not sending BLE data. Or battery died on the beacon or it's not in range of the APs.
- Make sure AP is not in pure BLE transmit mode. Check AP's scan counters

For AP in Base GW

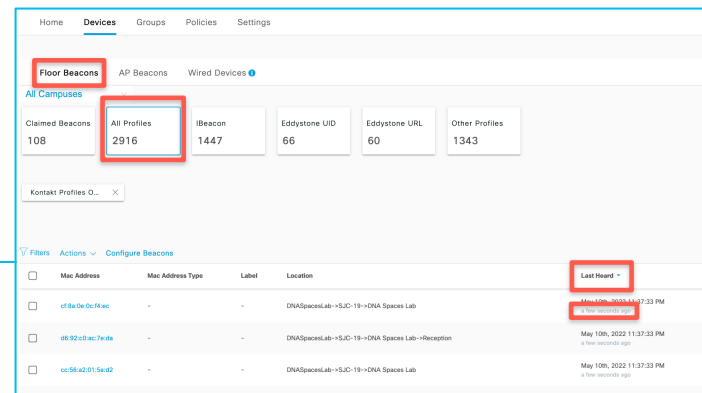
```
AP#show controllers ioTRadio ble 0 Scan brief
Profile      MAC    RSSI(-dBm)  RSSI@lmeter(-dBm)  Last-heard
iBeacon 04:EE:03:53:60:4A    77        70      0D:00H:00M:01S
iBeacon B4:E3:F9:70:0D:D8    58       211     0D:00H:00M:01S
iBeacon F1:0D:C4:13:47:B5    77        77      0D:00H:00M:01S
iBeacon FD:81:C5:95:AE:4F    81        65      0D:00H:00M:01S
```

For AP in Advanced GW

```
AP#connect iox application
```

```
/ # cat /data/logs/dnas_ble_scans.log
```

```
Wed May 11 06:42:09 2022 [INFO]: Kontakt Telem CC:49:96:3C:A2:37 96 6 61S 0D:00H:00M:09S
Wed May 11 06:42:09 2022 [INFO]: iBeacon CC:49:96:3C:A2:38 97 12 9S 0D:00H:00M:16S
Wed May 11 06:42:09 2022 [INFO]: Kontakt Secure D7:49:E6:38:BC:5F 81 56 3S 0D:00H:00M:04S
Wed May 11 06:42:09 2022 [INFO]: Kontakt Telem D7:49:E6:38:BC:5F 81 70 2S 0D:00H:00M:00S
Wed May 11 06:42:09 2022 [INFO]: iBeacon D7:49:E6:38:BC:60 81 93 3S 0D:00H:00M:01S
```



CW916x APs + Cisco Spaces



Catalyst 916x Wi-Fi 6E APs with DNA Spaces

CW9162



CW9164



CW9166





BLE Radio



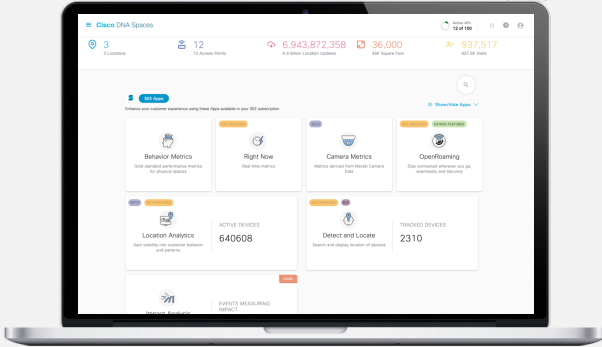
Indoor Air quality



Relative Humidity



Temperature

Manage, Visualize and Integrate via Cisco Spaces

Catalyst 916x Wi-Fi 6E APs with DNA Spaces

All features below are available with IOS-XE 17.9.2 release in DNA Persona

AP Model	Wi-Fi Location	Fast Locate	BLE Location	BLE Management (Advanced GW)	Concurrent BLE Scan and Transmit	IoT Sensors
CW9162	Yes (17.9.2)	Yes	Yes	Yes	Yes (17.9.2)	N/A
CW9164	Yes	Yes	Yes	Yes	Yes (17.9.1)	N/A
CW9166	Yes	Yes	Yes	Yes	Yes (17.9.1)	Yes

Cisco Prime

3.10.1

Cisco DNA Center

2.3.4.x

Features availability and changes to AP personas

DNA Persona

Open Roaming

Captive Portals

Analytics Apps (Behavior Metrics, Location Analytics, Right Now, Impact Analysis)

Proximity Reporting

Detect and Locate (Wi-Fi + BLE)

IoT Services (BLE Gateway and IoT Sensor)

Meraki Persona

Open Roaming

Captive Portals

Analytics Apps (Behavior Metrics, Location Analytics, Right Now, Impact Analysis)

Proximity Reporting

Essentially, Same behavior as other Catalyst APs

Essentially, Same behavior as other Meraki APs

Conclusion



Understand location fundamentals will ensure good design



Perimeter AP's are essential



BLE can be more accurate due to reference RSSI



CW916x APs continue to behave the same as their counterparts in Cisco Spaces context

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