



Cisco *live!*

6-9 March 2018 • Melbourne, Australia

Location Based Services Design

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BRKEWN-2650

Agenda

- Introduction to Cisco Connected Mobile Experience
- Wi-Fi Location
 - RSSI based vs. AoA - Hyperlocation
 - Design and Best Practice

Connected Mobile Experiences (CMX) Family of Products



CMX (On Premise & Cloud)

Hyperlocation Solution

CMX Analytics

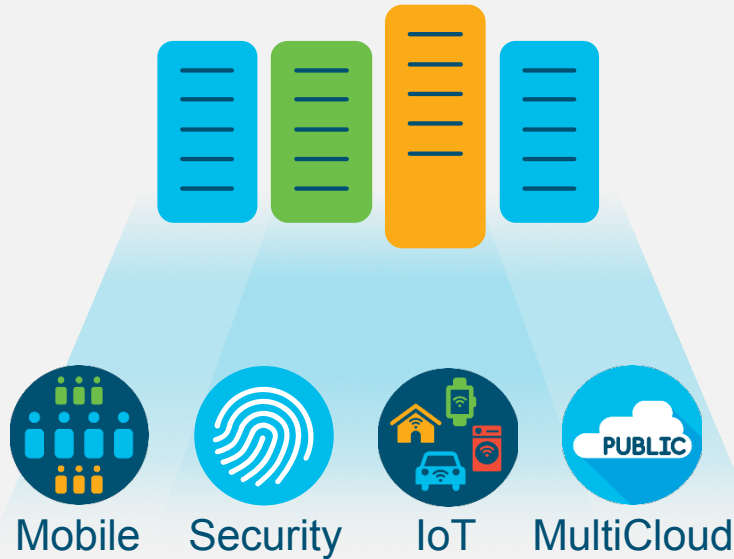
CMX Engage

Workplace Analytics

Operational Insights

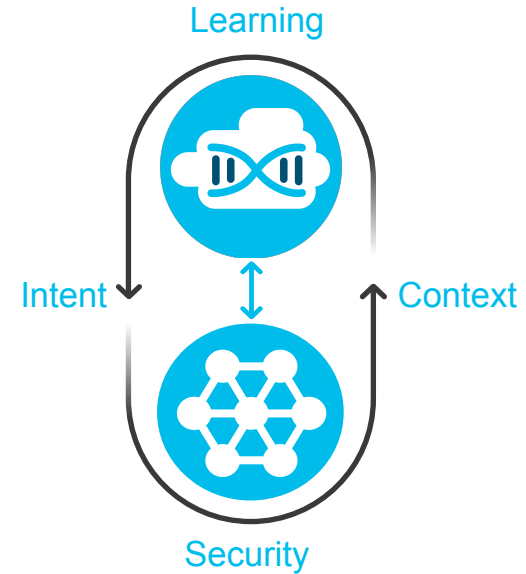
Intent-based Networking

Digital Business



Business Insights

Network



Powered By Intent. Informed by Context.

Drive Outcomes and Experiences with CMX



Analytics

- Presence Analytics
- Location based Analytics
- Work Place Analytics



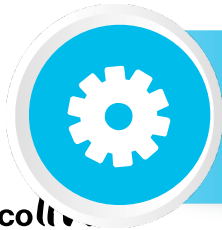
Customer Experience

- Custom Guest Experience
- Context based profiling
- Multi-Channel Engagement



Mobile Experience

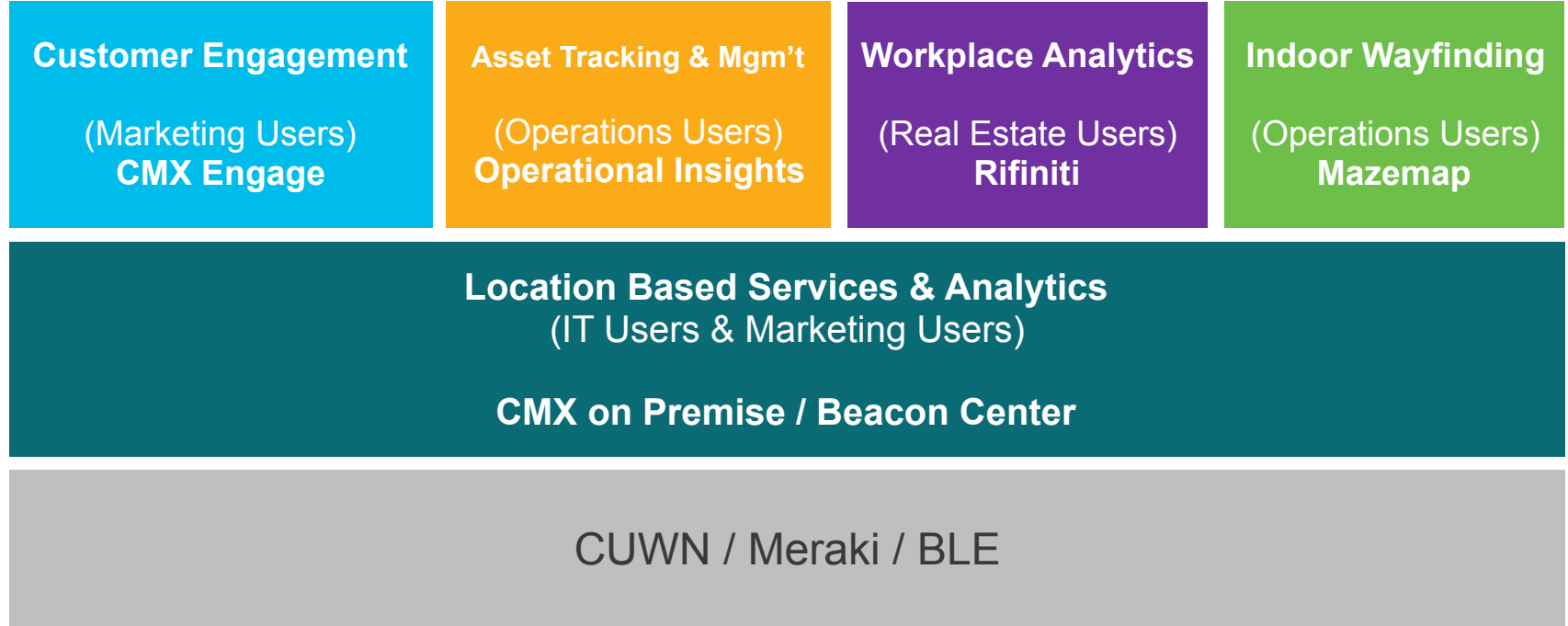
- Navigation & Way finding
- Phone SDK & Mobile App
- Marketing Automation



Operational Analytics

- Asset visibility & traceability
- Operational insights
- Asset & Tag management

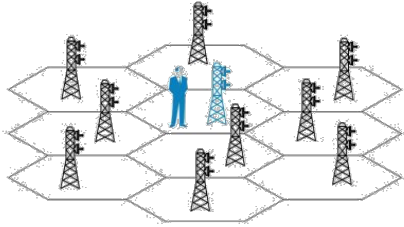
CMX Portfolio



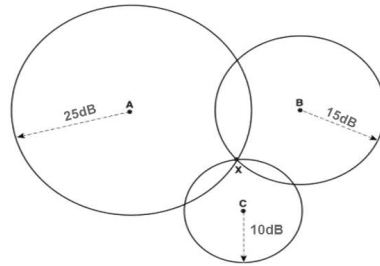
Introduction to Indoor Positioning

Location Tracking Approaches

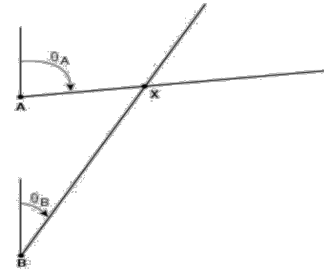
- Real-time location tracking and positioning systems can be classified by the measurement techniques they employ to determine mobile device location
- Approaches differ in terms of the specific technique used to sense and measure the position of the mobile device in the target environment
- Real-Time Location Systems (RTLS) can be grouped into four basic categories of systems that determine position on the basis of the following:



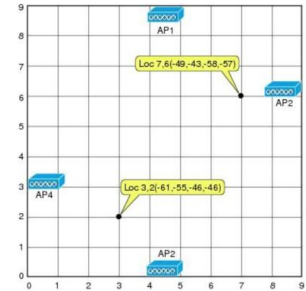
Cell of origin (nearest cell)



Distance based (lateration)



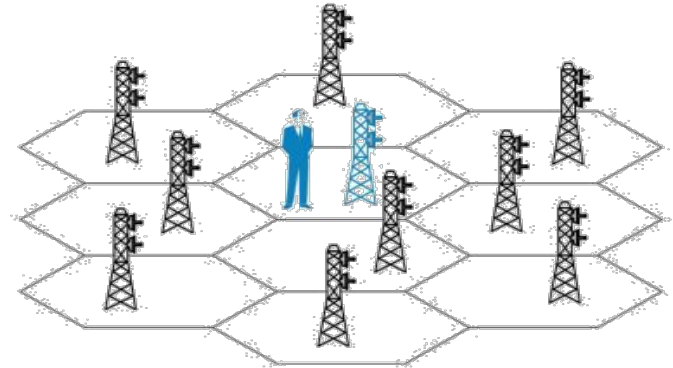
Angle based (Angulation)



Location patterning

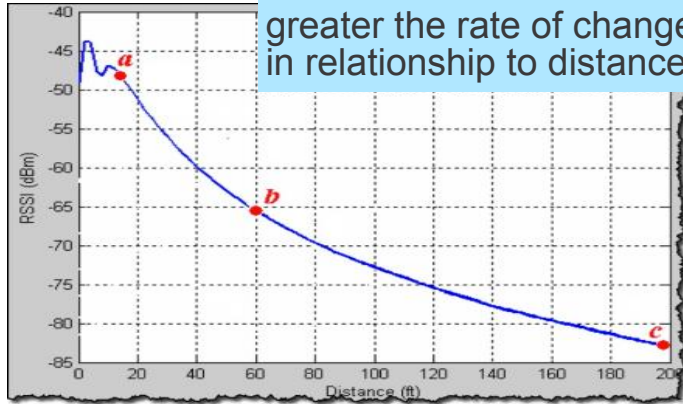
Cell of Origin

- One of the simplest mechanisms of estimating approximate location in any system based on RF cells is the concept of 'cell of origin' (or 'associated access point' in Wi-Fi 802.11 systems)
- When receiving cells, provide received signal strength indication (RSSI) for mobile devices; the use of the highest signal strength technique can improve location granularity over the cell of origin.



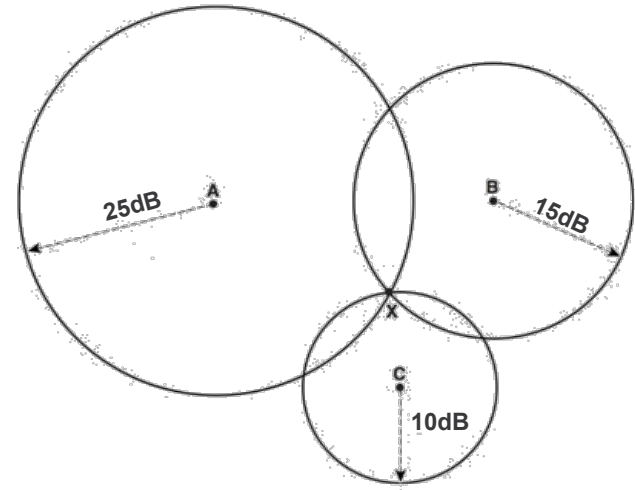
Distance-Based (Trilateration) Techniques

- Trilateration can be performed by using received signal strength (RSS)
- Measured by either the mobile device or the receiving sensor



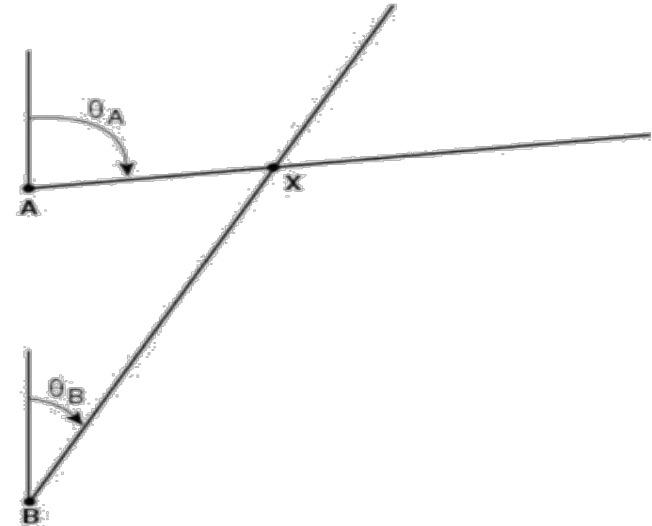
The closer the distance the greater the rate of change in RSS in relationship to distance

The change in RSS in relationship to distance flattens out at greater distances



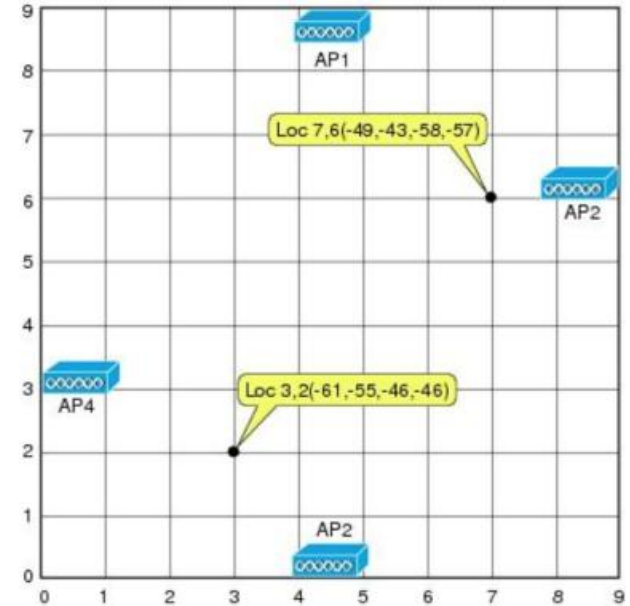
Angle-Based (Angulation) Techniques

- The AoA locates the mobile station by determining the angle of incidence at which signals arrive at the receiving sensor
- Requires two receiving sensors for location estimation, with improved accuracy coming from at least three or more receiving sensors (triangulation)



Location Patterning (Fingerprinting)

- Location patterning is based on the sampling and recording of radio signal behaviour patterns in specific environments
- Each potential device location ideally possesses a distinctly unique RF "signature"



Because of fading and other phenomena, the observed signal strength of a mobile device at a particular location is not static but is seen to vary over time. As a result, calibration phase software typically records many samples of signal strength for a mobile device during the actual sampling process.

Where is Data for Location Measured and Calculated?

	Method	Data	Data Collection	Location Calculation
GPS	TDOA	TOA	Mobile Device	Mobile Device

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Wi-Fi Hyperlocation	AoA	RSSI and AoA of Data Frames	Infrastructure (Hyperlocation AP)	Infrastructure (CMX)

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Wi-Fi Location Patterning	Location Patterning	AP Beacon RSSI and MAC	Mobile Device (special chipset / driver)	Mobile Device or Infrastructure

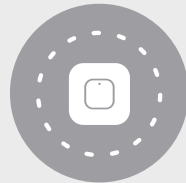
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BLE Beacon	Proximity	Beacon ID / RSSI	Mobile Device	Mobile Device or Infrastructure

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BLE Beacon	Proximity	Beacon ID / RSSI	Mobile Device	Mobile Device or Infrastructure
BLE Beacons for Location	Multiple Proximities	Multiple Beacon IDs / RSSI	Mobile Device	Mobile Device or Infrastructure (Fingerprint)

Wi-Fi Location



Wi-Fi Presence

- Based on Probe requests send by mobile device: RSSI
- Accuracy: 20m
 - Device is inside or outside the store
- Works for non-associated devices
 - BUT: Device might use Random MAC*
- 1 AP for small locations:
 - Small shop / restaurant / café



Good for

CMX Presence Analytics

- Dwell time
- Repeat visitors

Basic Wi-Fi Location

- Based on Probe Requests send by mobile device: RSSI
- Accuracy 7m – 10m
- Update Frequency depending on device probing (30sec – 5min)
- Works for non-associated devices
 - BUT: Device might use Random MAC*
- **Good for**
 - **CMX Location Analytics**
 - **CMX Engage**



*Apple iOS MAC Randomisation

- Introduced in iOS 8, improved in iOS 9
- Changing MAC every 63sec when not connected
- Real MAC only used when connecting to configured SSID
- No Analytics for non-connected Devices
- Probing about 2 times per Minute

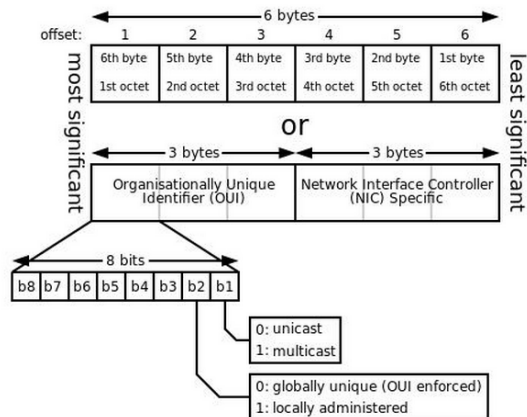
MAC Address



In iOS 8, Wi-Fi scanning behavior has changed to use random, locally administrated MAC addresses

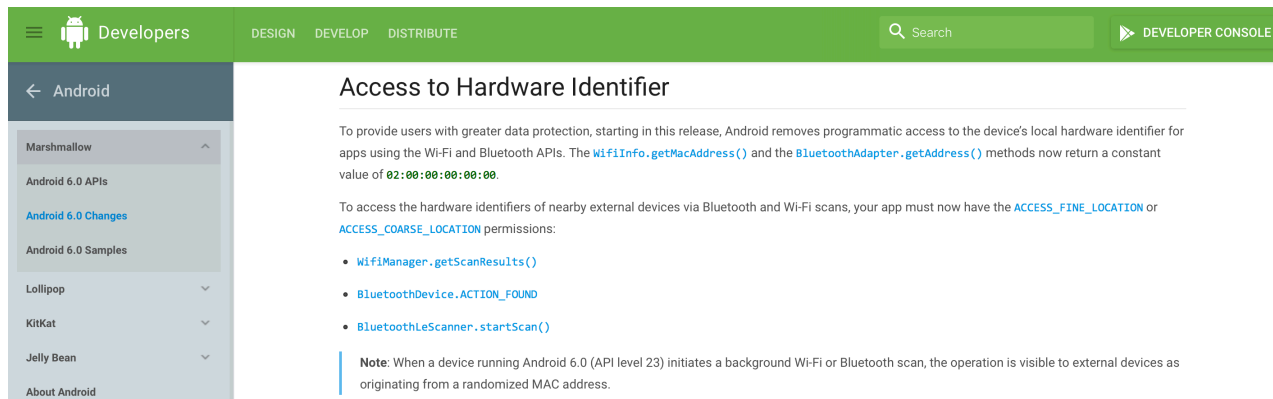
- Probe requests (management frame sub-type 0x4)
- Probe responses (management frame sub-type 0x5)

The MAC address used for Wi-Fi scans may not always be the device's real (universal) address

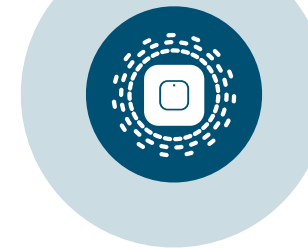


*Android 6 MAC Randomisation

- Introduced in Android 6
- Real MAC only used when connecting to configured SSID
- Probing behaviour depending on Battery Saving Settings
 - But about 1-2 times per Minute



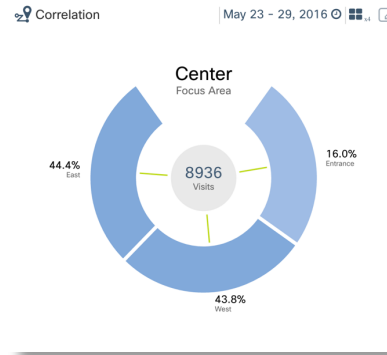
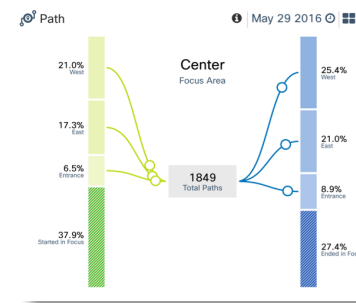
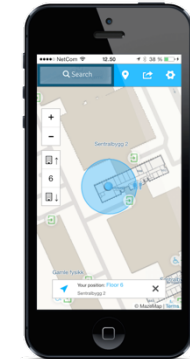
The screenshot shows the Android Developers website. The top navigation bar is green with the Android logo and 'Developers' text. Below it, there are tabs for 'DESIGN', 'DEVELOP', and 'DISTRIBUTE'. A search bar and a 'DEVELOPER CONSOLE' button are also present. The left sidebar shows a navigation menu with 'Android' selected, and sub-items like 'Marshmallow', 'Android 6.0 APIs', 'Android 6.0 Changes', 'Android 6.0 Samples', 'Lollipop', 'KitKat', 'Jelly Bean', and 'About Android'. The main content area is titled 'Access to Hardware Identifier' and contains text explaining that Android 6.0 removes programmatic access to the device's local hardware identifier. It lists the `WifiInfo.getMacAddress()` and `BluetoothAdapter.getAddress()` methods, which now return a constant value of `02:00:00:00:00:00`. It also mentions that to access hardware identifiers of nearby external devices via Bluetooth and Wi-Fi scans, an app must have the `ACCESS_FINE_LOCATION` or `ACCESS_COARSE_LOCATION` permissions. A list of code snippets is provided: `WifiManager.getScanResults()`, `BluetoothDevice.ACTION_FOUND`, and `BluetoothLeScanner.startScan()`. A note at the bottom states: 'Note: When a device running Android 6.0 (API level 23) initiates a background Wi-Fi or Bluetooth scan, the operation is visible to external devices as originating from a randomized MAC address.'

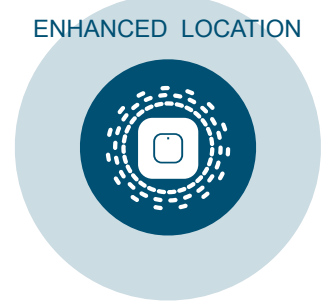


Wi-Fi Location with Fast Locate

- Based on Data Frames send by mobile device: RSSI
- Accuracy 5m – 7m
- Update Frequency depending on application behavior or wakeup frames from AP (5 – 20 sec)
- Works only for associated devices

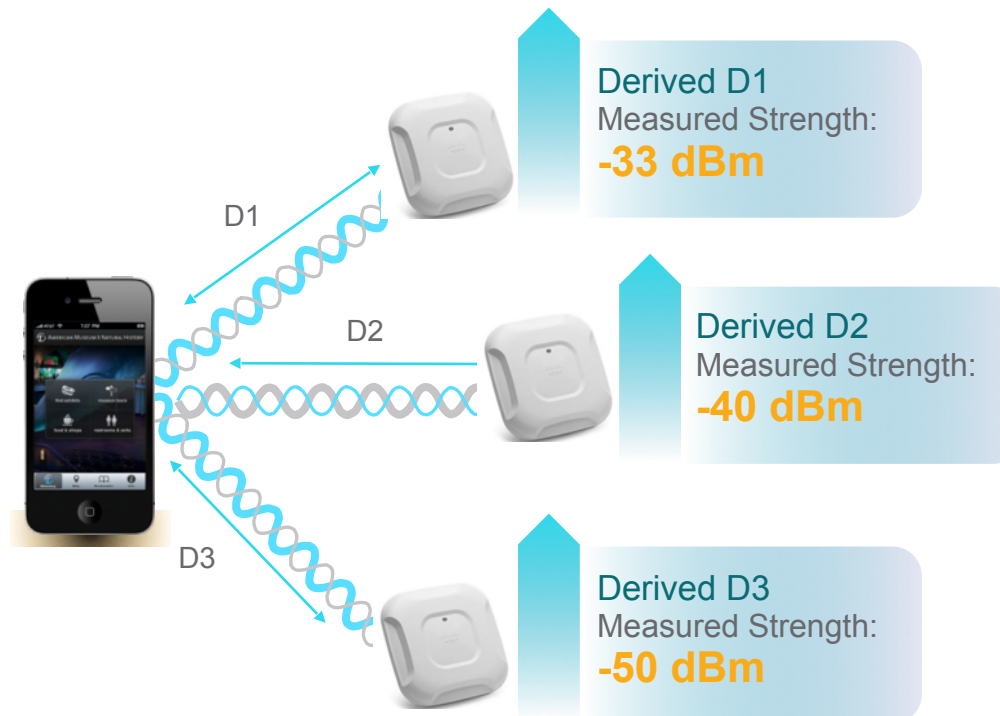
- **Good for**
 - CMX Analytics
 - CMX Connect
 - Blue Dot Applications
 - App Engage





How Location Is Calculated with FastLocate

- Access points detect mobile devices and measure RSSI from all frames sent over Wi-Fi.
- Client is associated just to one AP, other APs have to scan the same channel
- APs synchronise to measure RSSI at multiple APs at the same time using:
 - Enhanced Local Mode
 - Additional WSM Radio Module

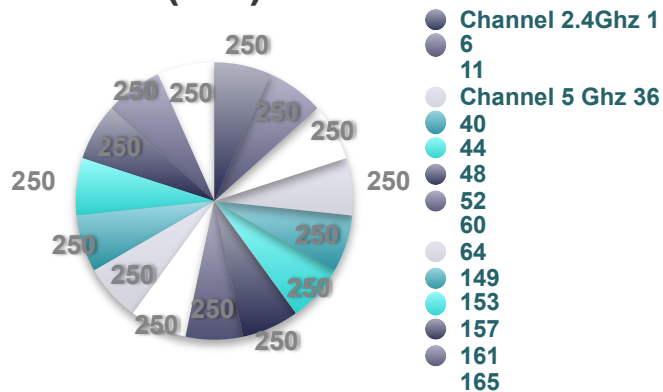


Fast Locate – WSM Module

Scan Time

on

Channels
(ms)



- When a client is constantly sending packets on a channel, network will get a packet EVERY 4 seconds (250ms x 16 channels) and be able to gather values once every 4 seconds.
- Location is calculated approximately 1 every 8 seconds. (~8 times per Minute)

Hyperlocation

Indoor Location Accuracy Continuum

GOOD

BETTER

BEST



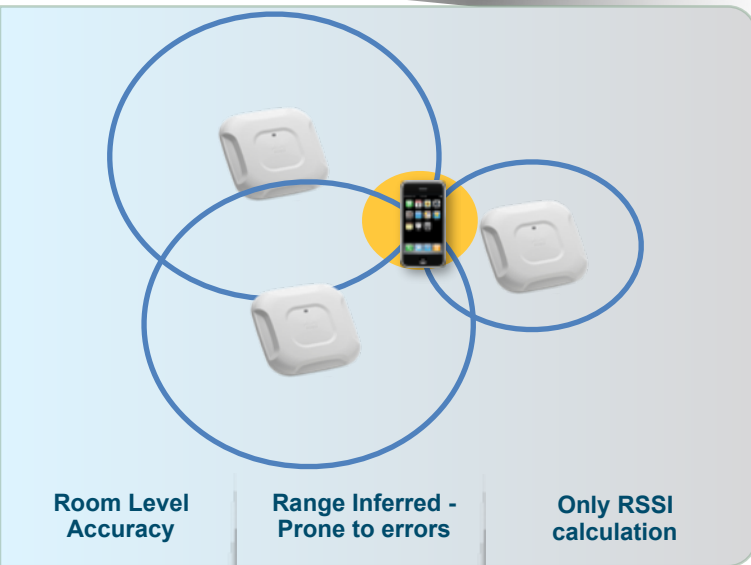
Greater Location **Granularity**

Increased Business **Value**

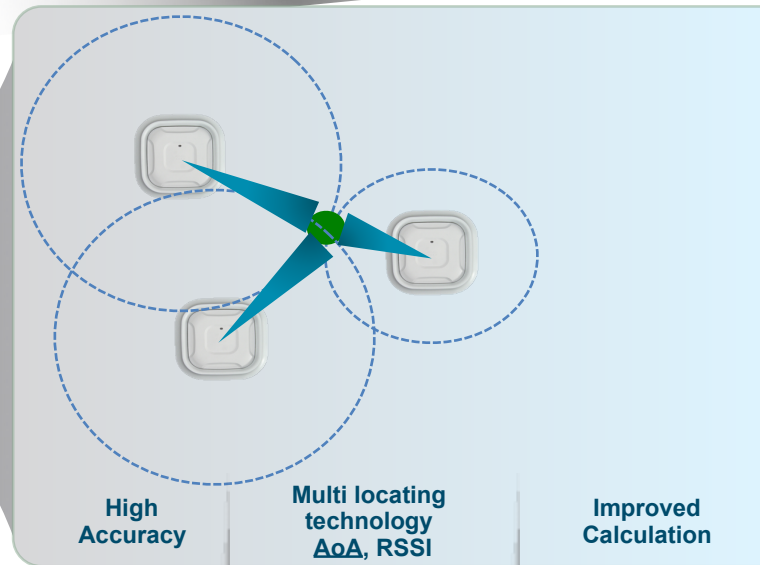
Best: Hyperlocation

Before: Location approximated based on RSSI -
 ± 5 to 10 meter accuracy

After: Determine direction (AoA) to client in addition to
distance $\Rightarrow$ 1-3 meter accuracy (50% CFD)



Engage & Improve Guest Experience



Hyperlocation Module



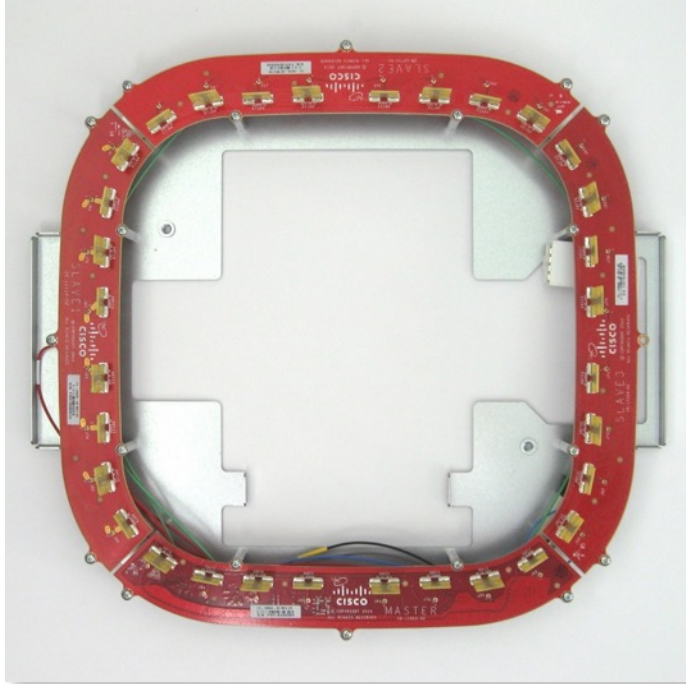
- Hyperlocation module wraps around AP
- 32 extra antennas to provide Angle of Arrival
 - 16 Dual-Band 2,4GHz & 5GHz
 - 16 5GHz
- The Advanced Security and Hyperlocation module includes Bluetooth capability as well

Hyperlocation Module



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Hyperlocation Module



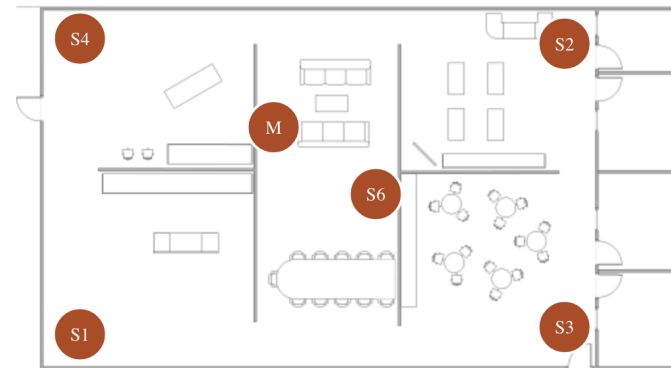
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How Does Hyperlocation Work?



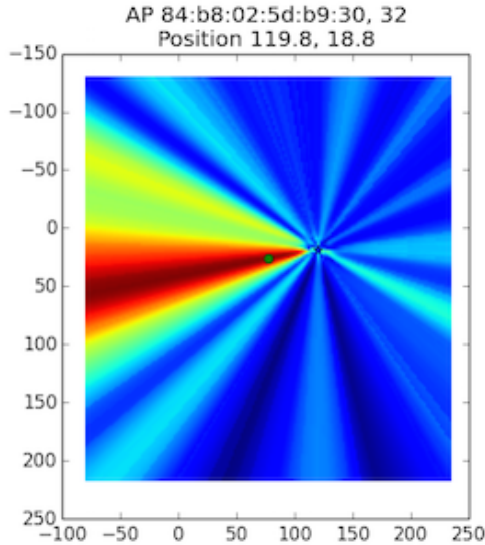
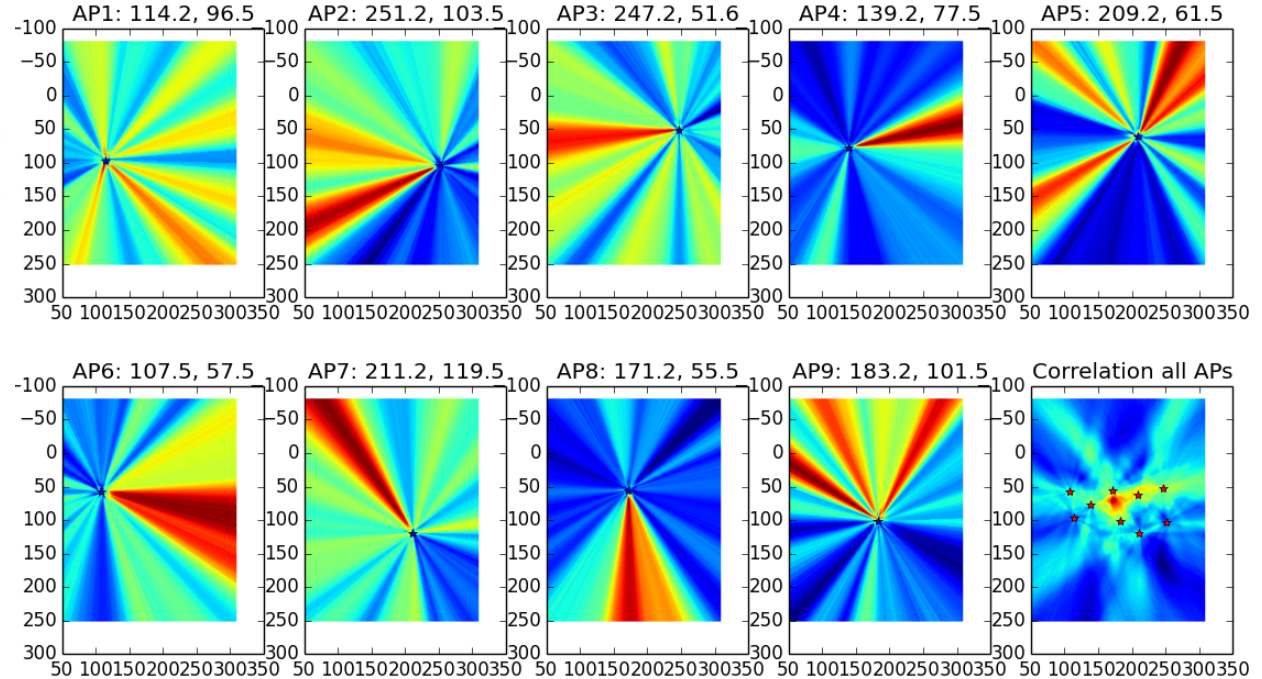
Location Calculations with Hyperlocation Module

- Hyperlocation Module and Antenna are programmed with which MAC addresses they should report for, this is based on the associated clients of “surrounding” AP’s
- Surrounding AP are based on which AP can hear a packets from the serving radio that has the Hyperlocation AP (L1 List)
- When clients are “quiet” the serving radio is interrupted to send a BAR packets to radio to awake it up.
- Location is a “FUSION” of the RSSI calculated location and AoA calculated location if both are available.



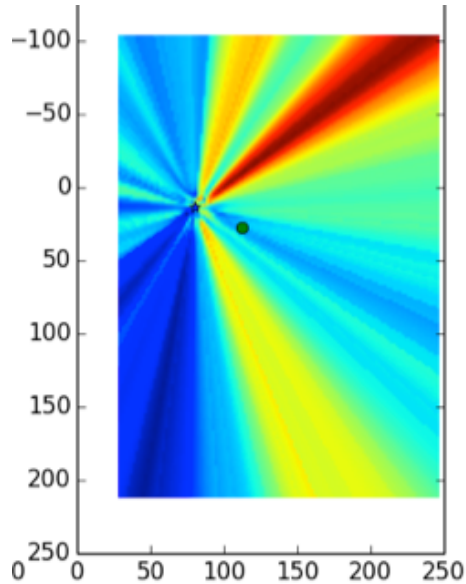
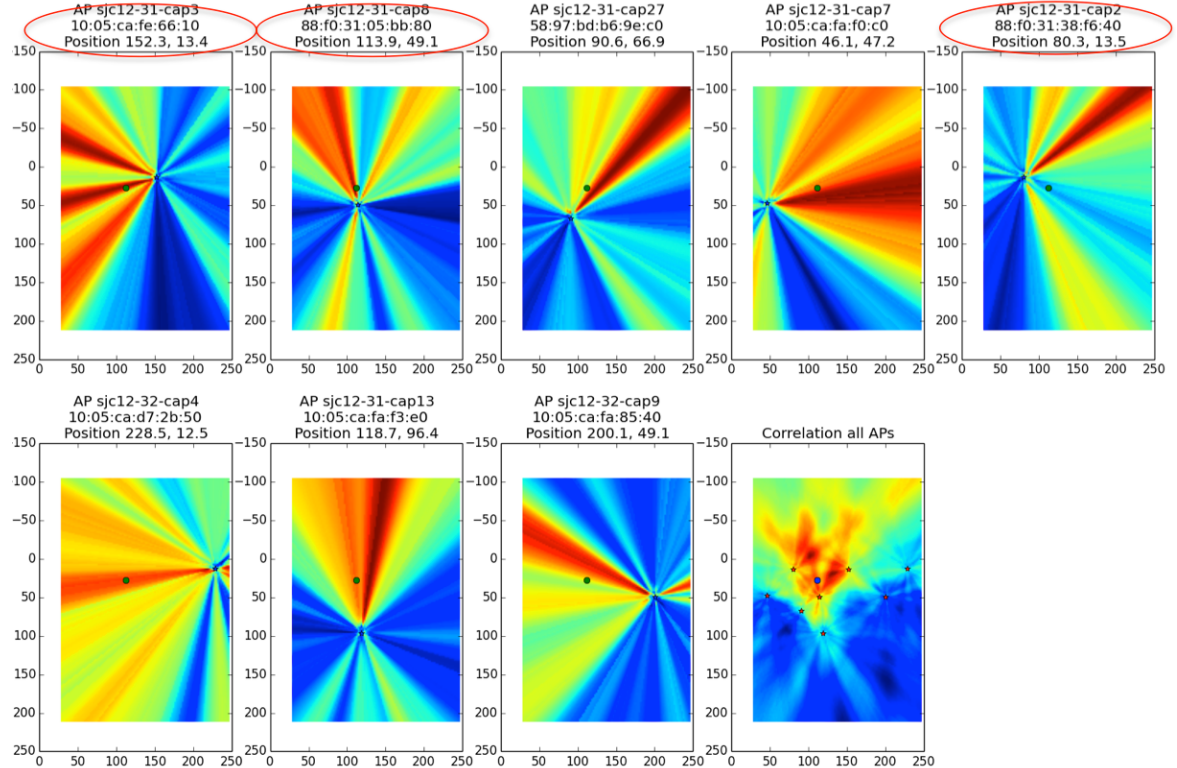
How Do We Calculate X,Y? - Heatmaps

Good Signal:



How Does Reflection affect Hyperlocation?

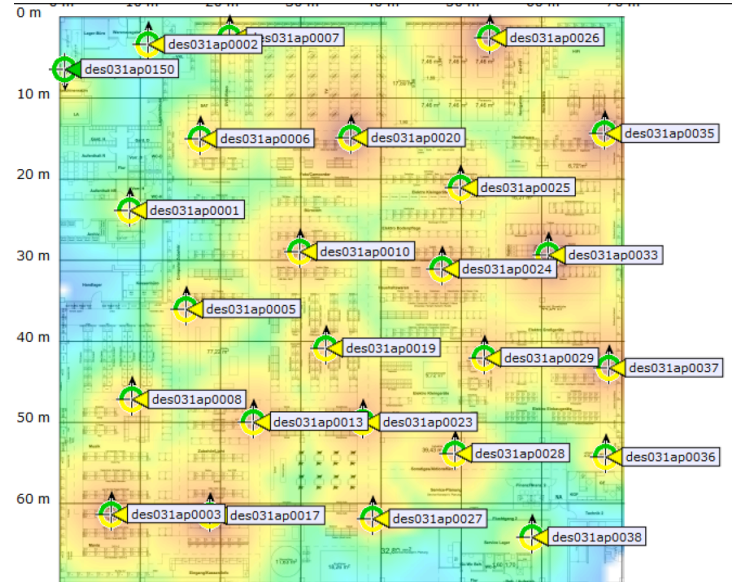
Bad Signal with
Strong Reflection



Hyperlocation - Retail Store

- Size: 70m x 70m (4900 m2)
- 25 APs (196 m2 per AP / 16m Cell Size)

Location Computation Frequency (s)	10m Accuracy (%)	Average Error Distance (m)	90% Accuracy Error Distance (m)	75% Accuracy Error Distance (m)	50% Accuracy Error Distance (m)
2.7	100.0	0.71	1.33	0.68	0.54
2.8	100.0	0.91	1.72	1.20	0.77
5.1	100.0	1.68	2.13	1.47	1.46
3.4	100.0	1.33	1.69	1.64	1.45



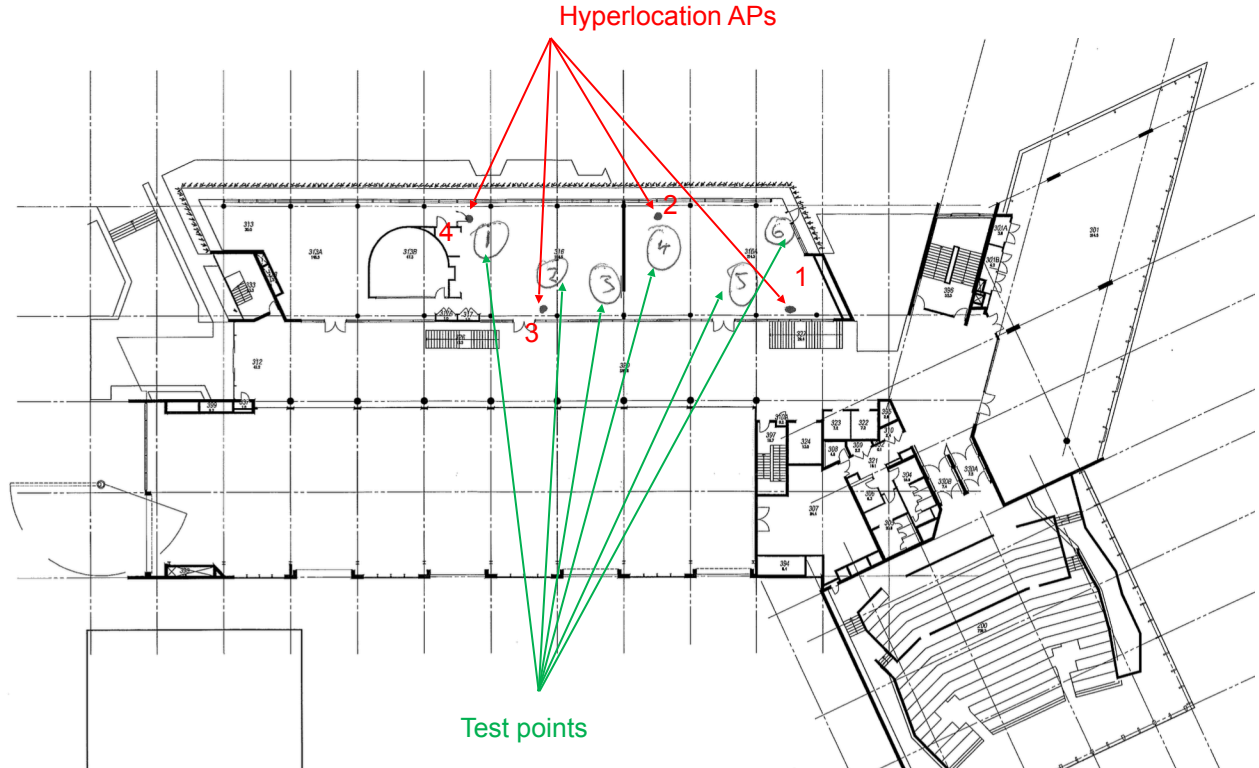
Comparing 15m to 21m AP to AP distance

Accuracy %	15m Store	21m Store	Delta 15m vs 21m	
90%	2.7m	3.2m		0.5m
75%	1.9m	2.7m		0.8m
50%	1.3m	2.1m		0.8m

Australian PoC Overview

APs 15m apart except the left two that were ~13m apart

Purposely had test point 5 on the edge of the AP boundary and test point 6 outside the boundary.





AP3

AP2



AP1



Looking down the rooms from between
AP 3 and 4

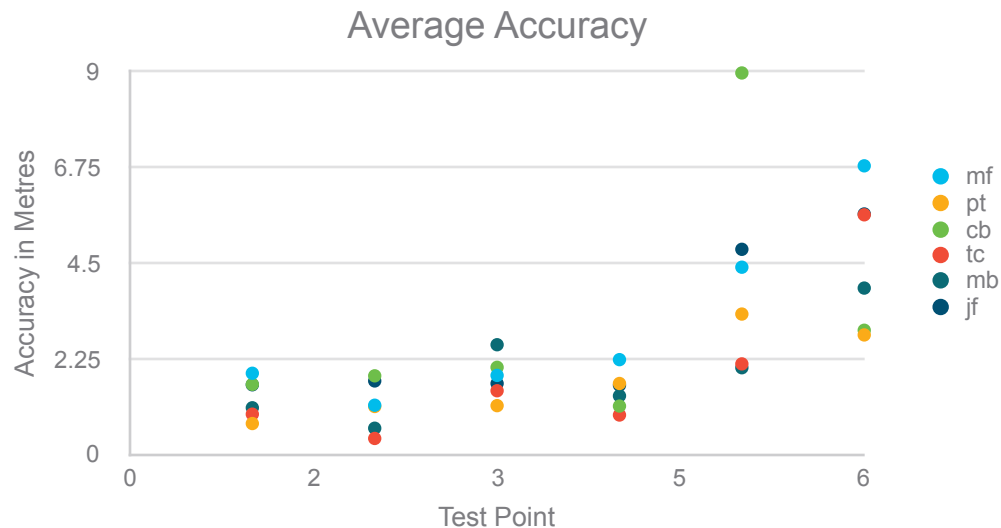


AP4

AP1

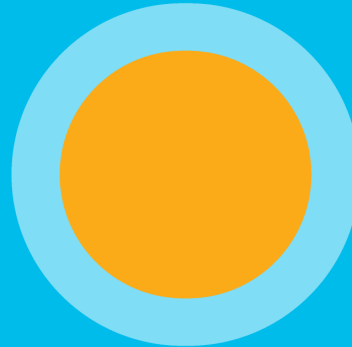


Average Accuracy



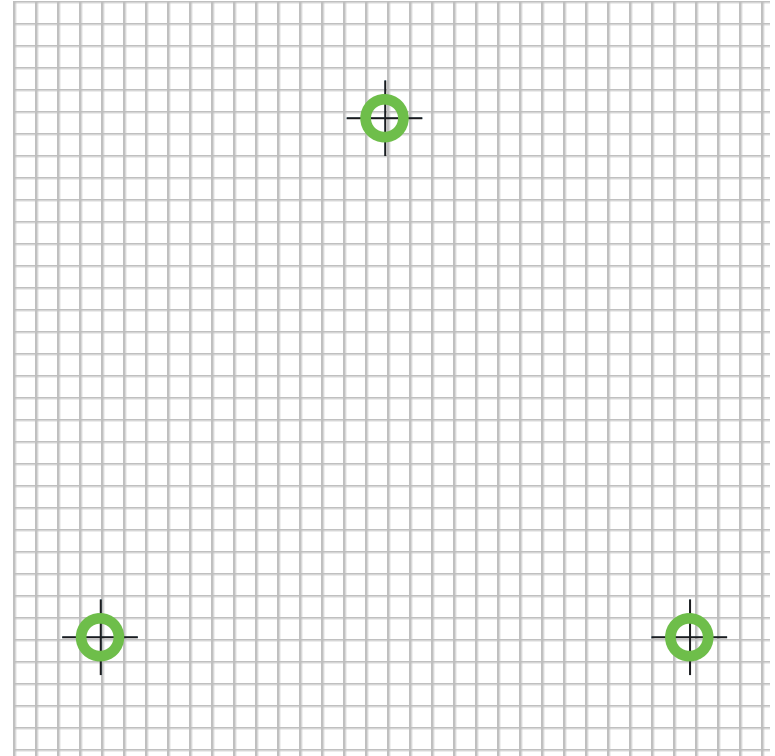
mf = iPhone6 Plus
pt = iPad Air
cb = iPhone6
tc = iPhone6s Plus
mb = iPhone6s
jf = iPhone5s

Design and Best Practices



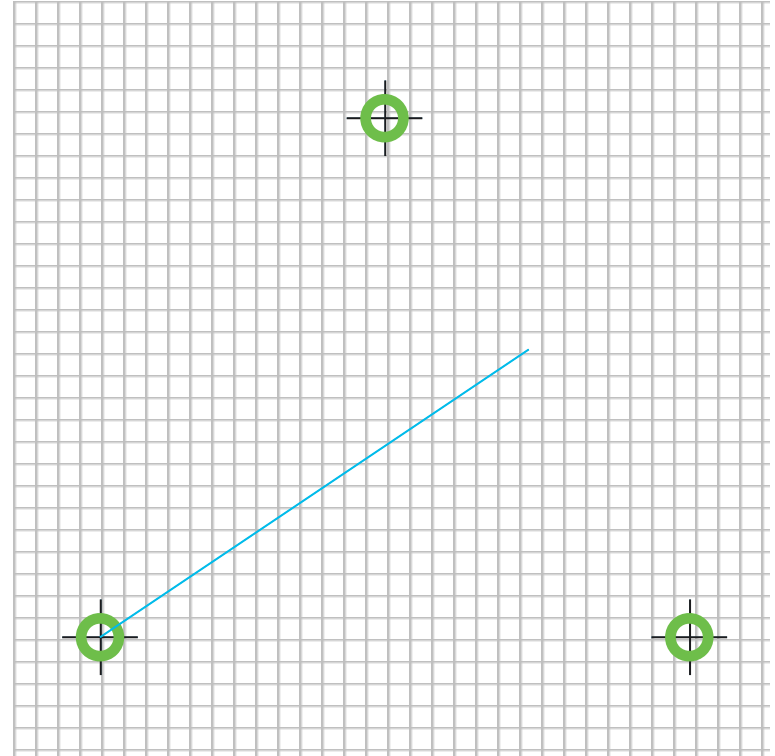
AP Positioning errors affecting accuracy

- How good are your floor plans?
- Do you know your exact AP Positions?
 - Often about 1-2 m off
- Do you know your AP Orientation?
 - Did not matter before Hyperlocation



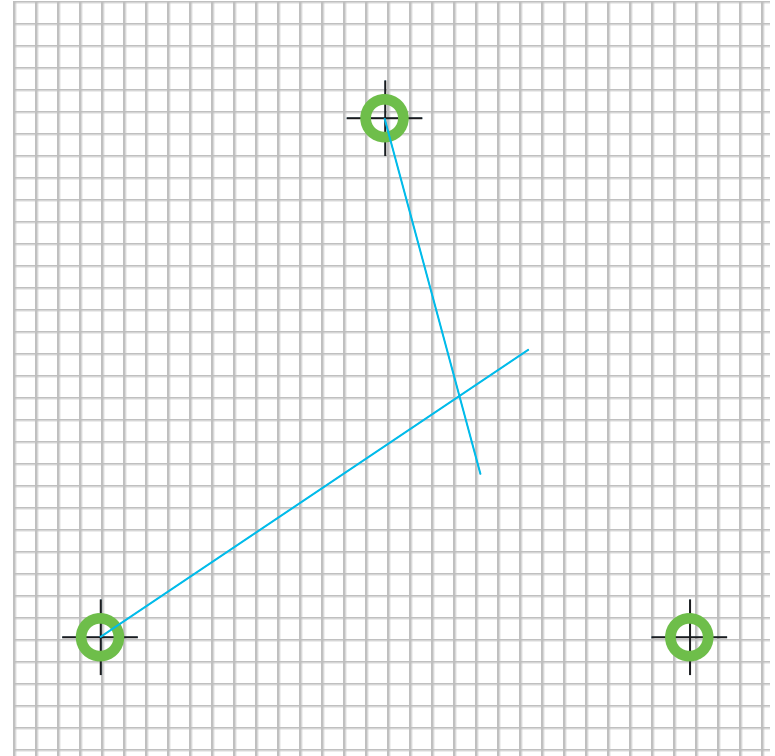
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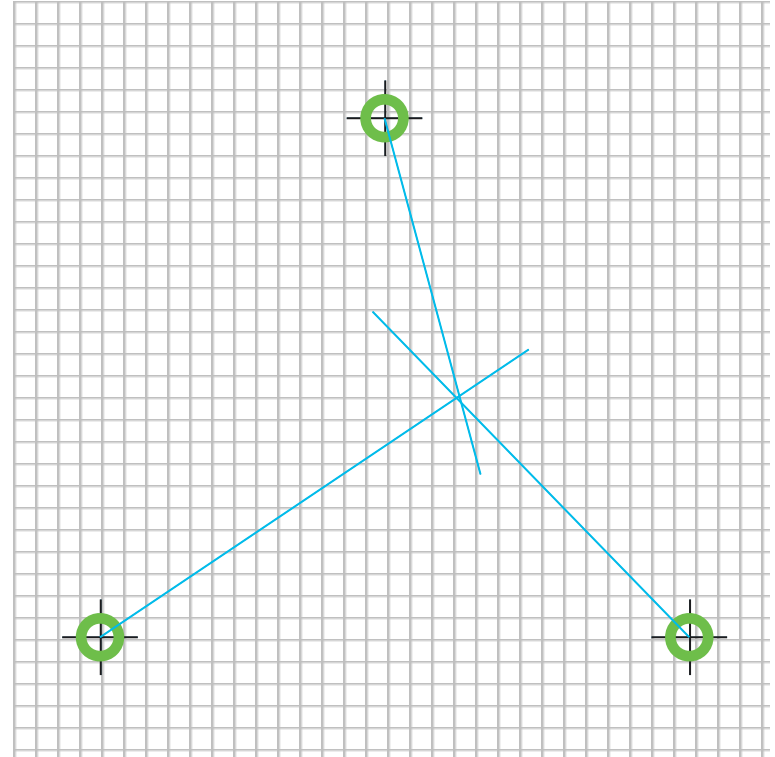
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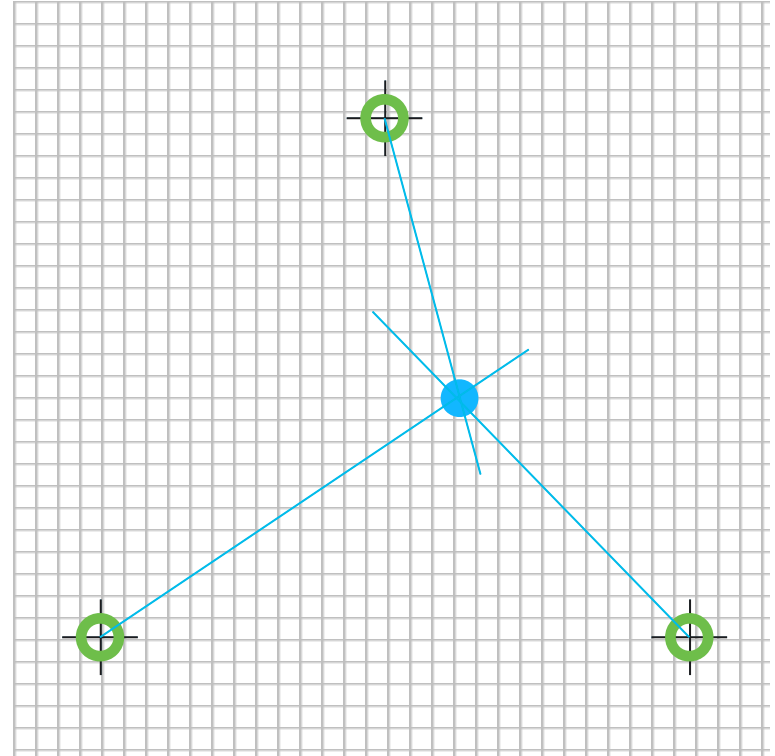
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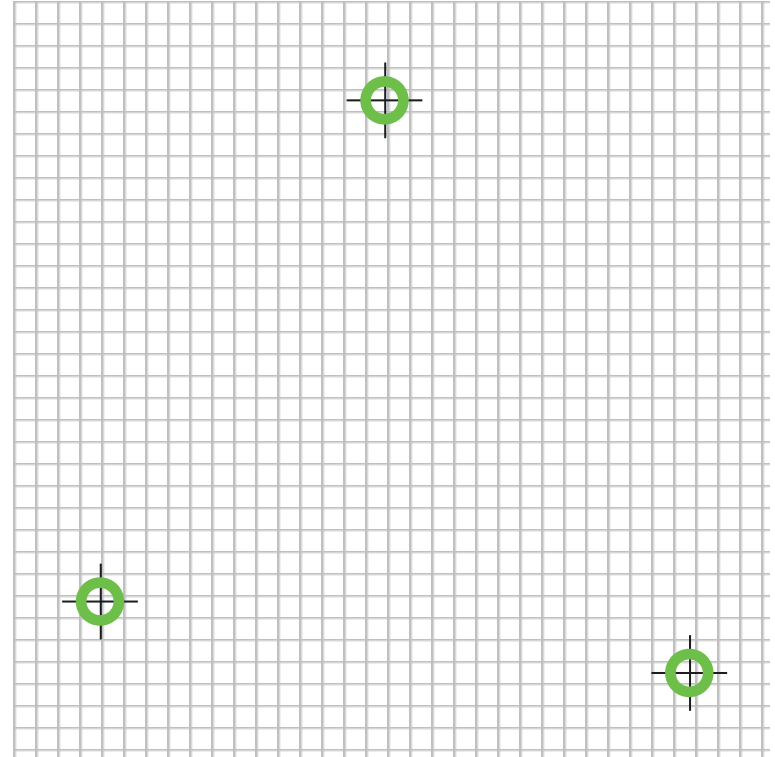
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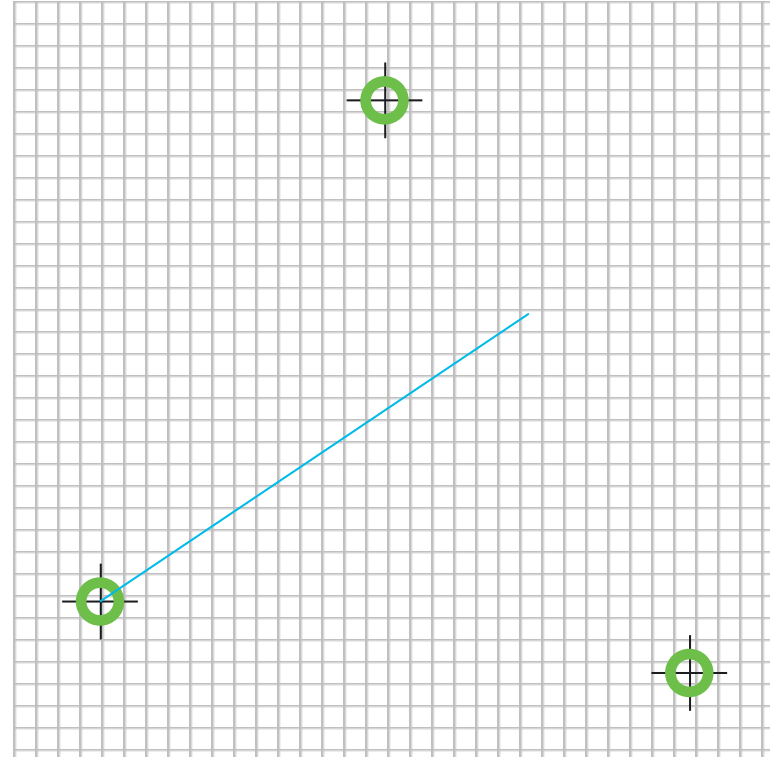
Inaccurate AP Position

- AP Position on Map wrong by 1m



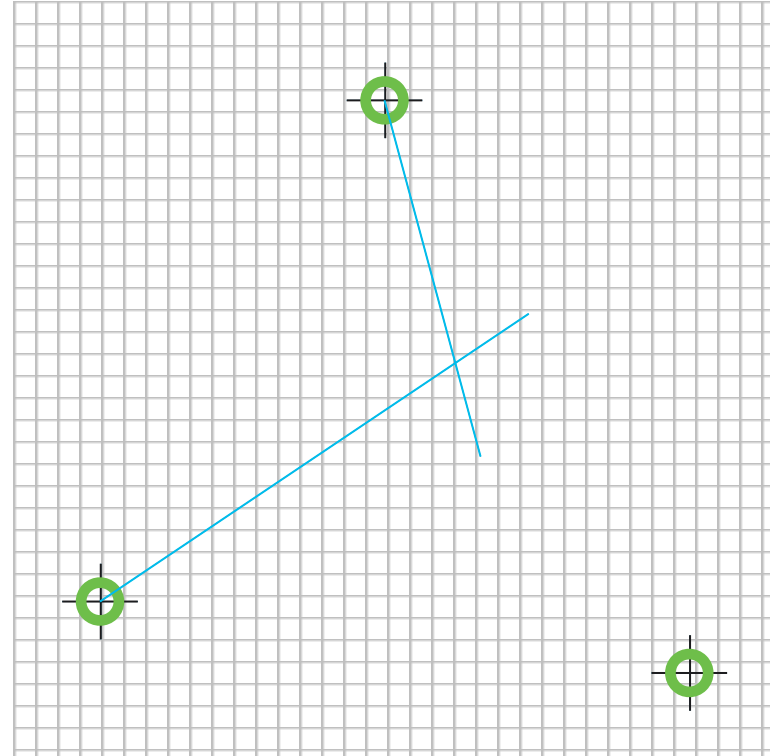
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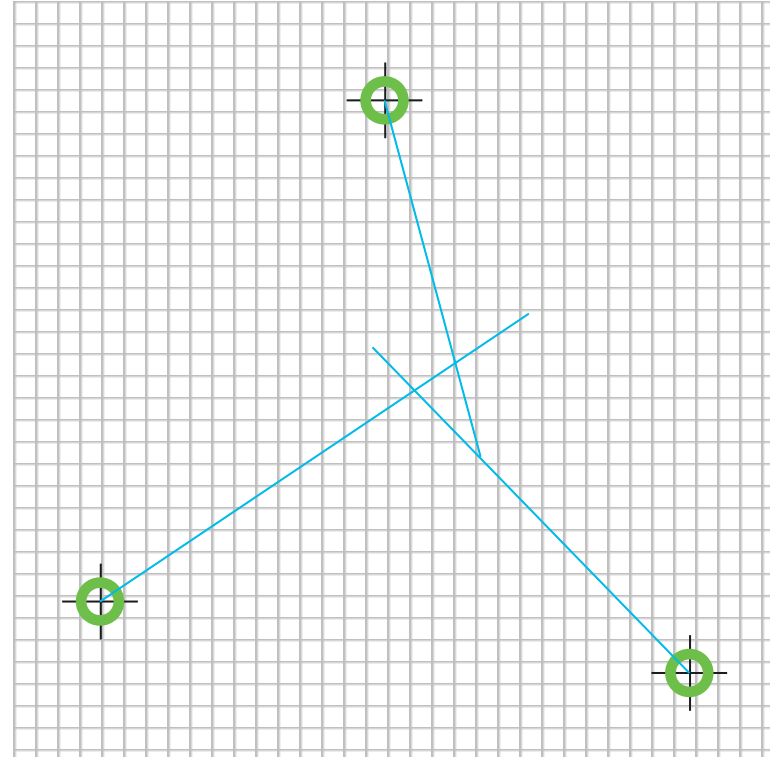
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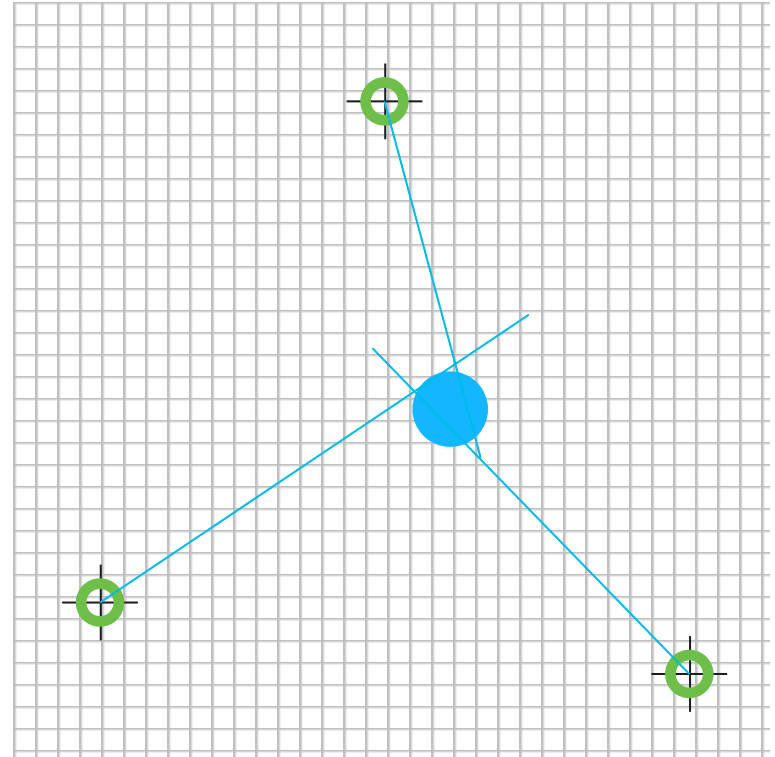
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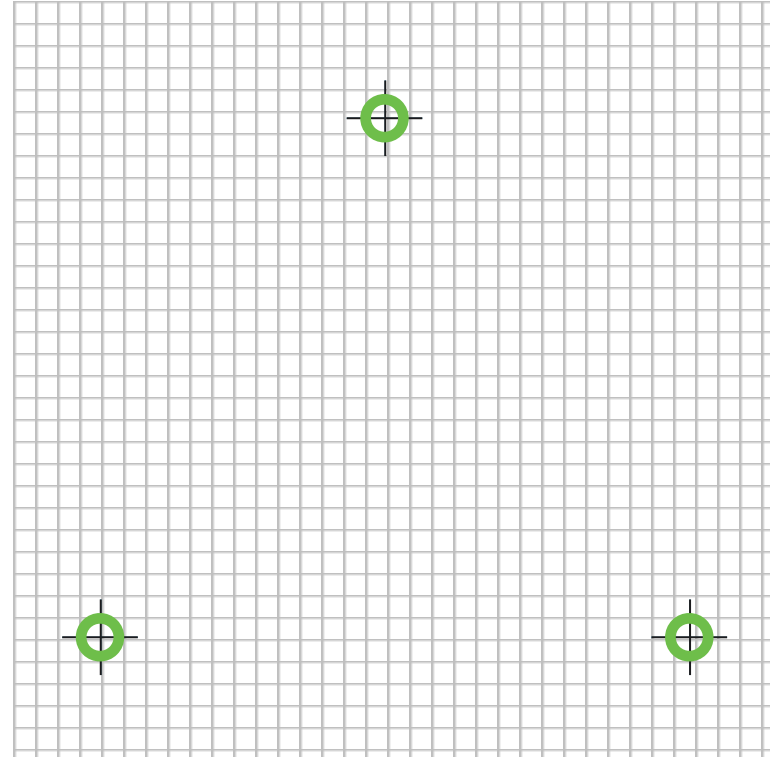
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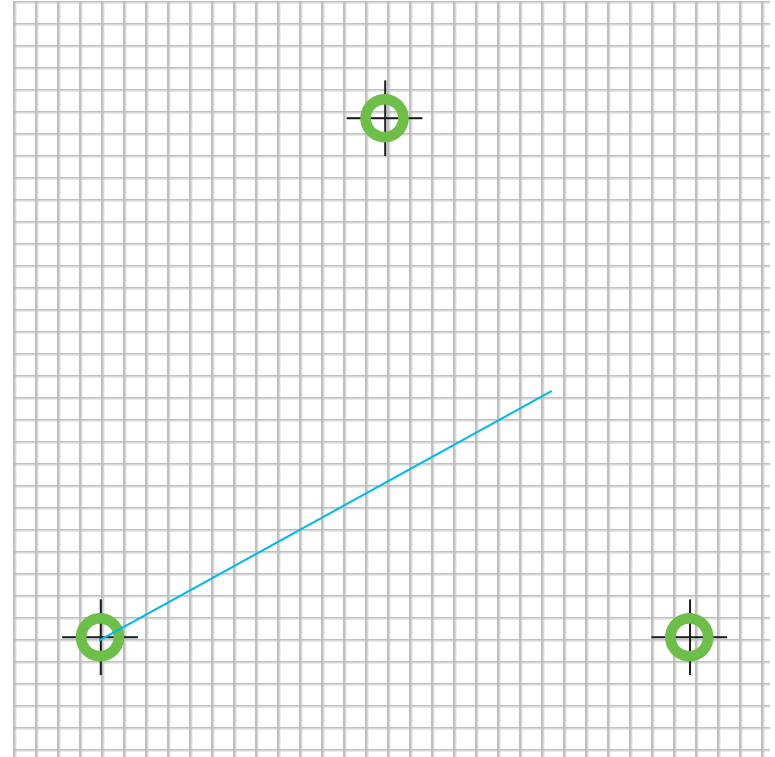
Inaccurate AP Orientation

- AP orientation on Map wrong by 5°
- at 10 m about 1 m divergence



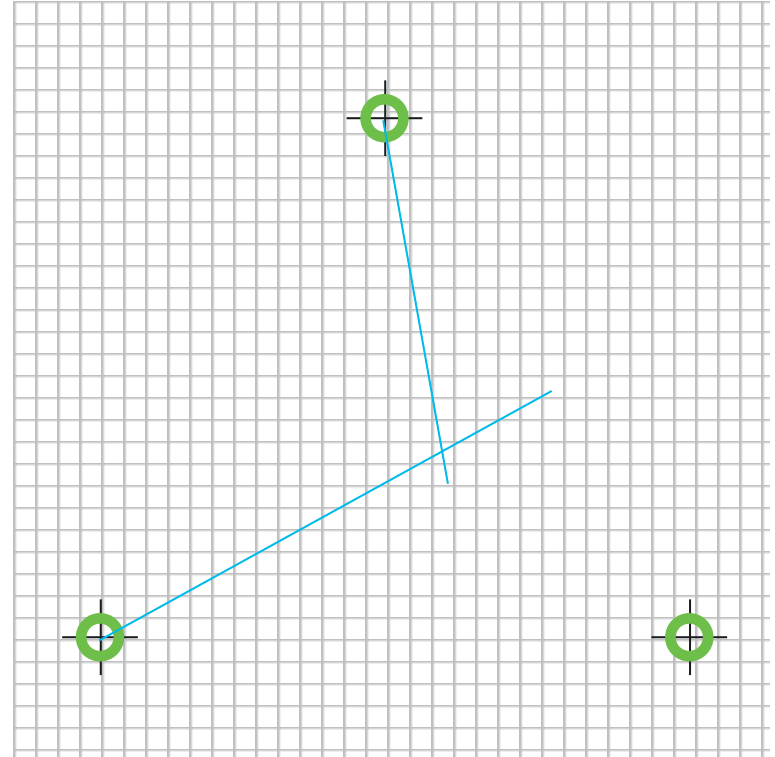
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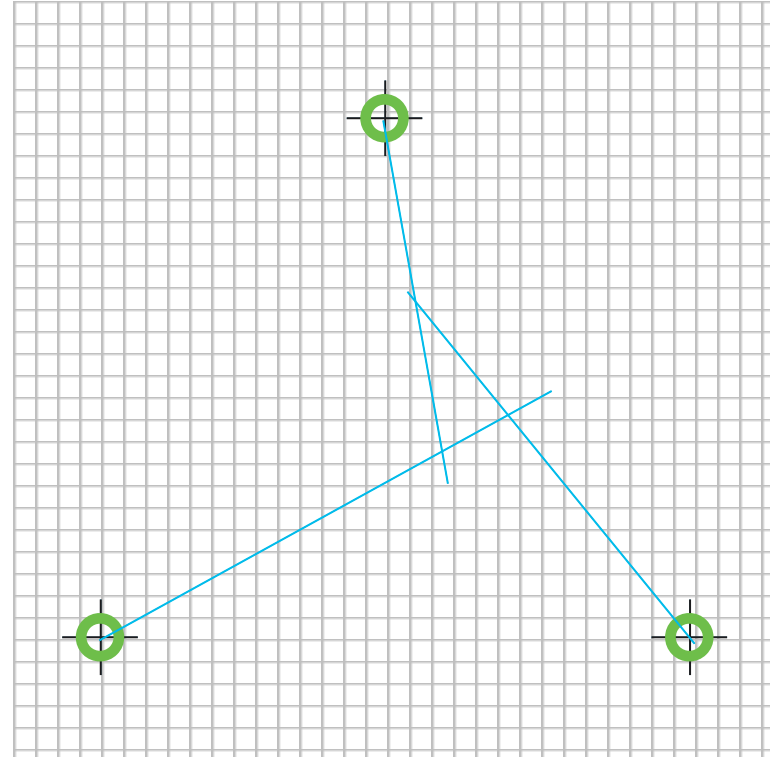
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- AP orientation on Map wrong by 5°
- at 10 m about 1 m divergence



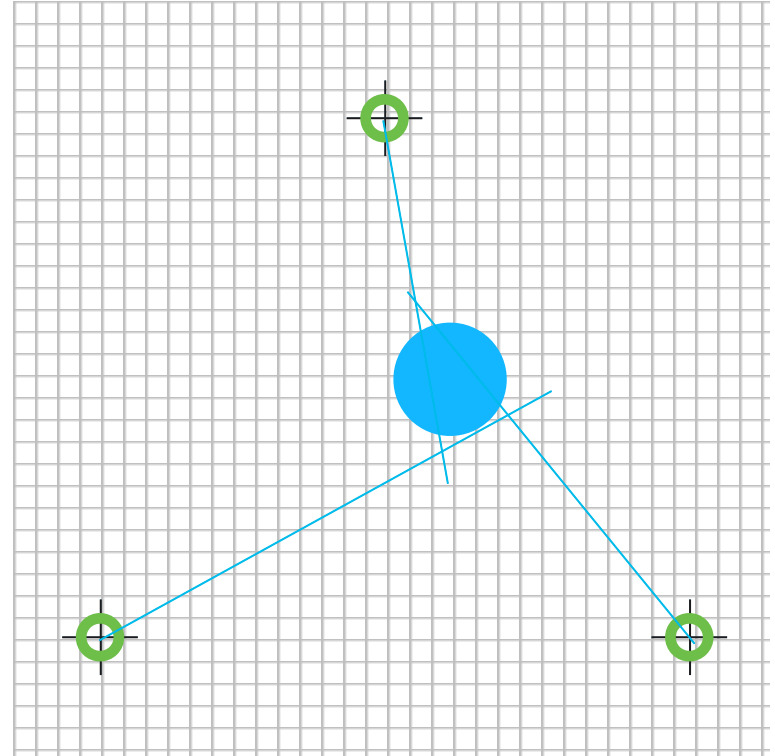
Inaccurate AP Orientation

- AP orientation on Map wrong by 5°
- at 10 m about 1 m divergence



Inaccurate AP Orientation

- AP orientation on Map wrong by 5°
- at 10 m about 1 m divergence



How to Successfully Deploy Wireless Location?

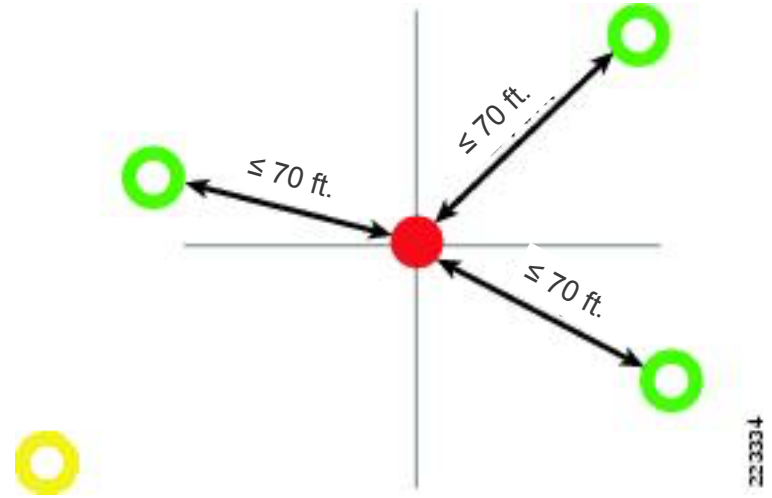
- AP Positions
- Site Survey
- AP Placement in Prime Infrastructure

Performance – The Small Print

- General Guidelines: Performance is dependent on the physical and RF environment and no two environments are alike.
- Users should test a representative Hyperlocation (HL) sample in own environment to ensure that the results are consistent with their expectation before deployment
- The numbers are not to the exclusion of other combinations. E.g. iPad, MAC, laptop, Android pad are expected to perform similarly, but not extensive test data is available. A extensive test would involved of 1000's of data points to generate a statistically complete data set.
- Data associated with other conditions (e.g. heterogeneous deployments, higher ceiling, Higher/Lower AP density, AP above ceiling, client outside AP, client seeing only 2 APs, etc) should become available as more such cases/deployments arise.

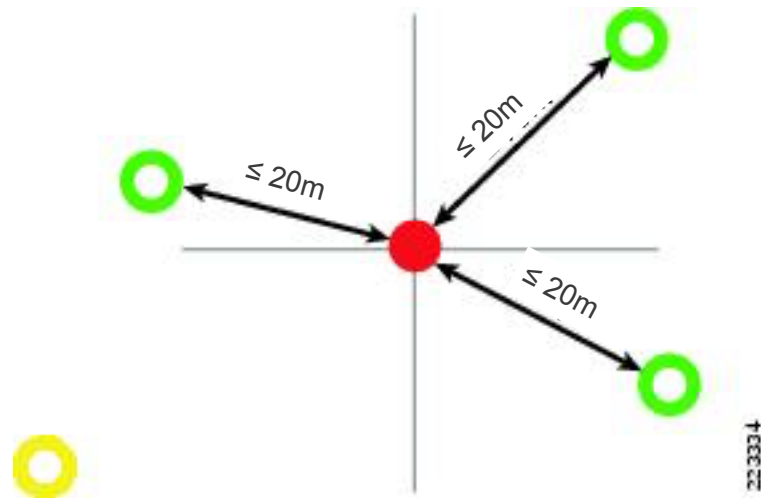
Line of Sight to 3 APs – a MUST for Hyperlocation

- If possible, mount antennas such that they have an unencumbered 360° view of all areas around them without being blocked at close range by large objects like a pillar, column, advertisement boards.
- AP to AP Distance: 40 – 70 ft.
- Height: below 18 ft
- -75 dBm Client RSSI on 3 APs
- In some cases however, inter-access point spacing below 40 ft may be necessary to satisfy the requirements of some applications for high signal strength thresholds, especially in environments where high path loss is present.



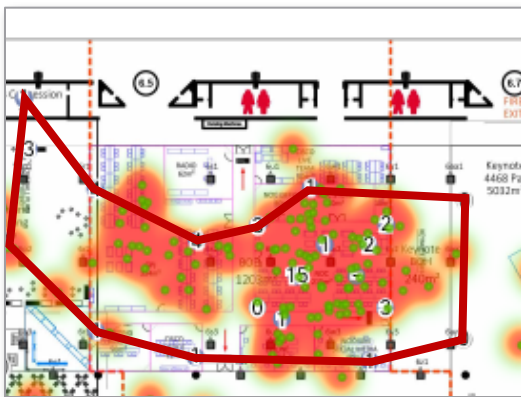
Line of Sight to 3 APs – a MUST for Hyperlocation

- If possible, mount antennas such that they have an unencumbered 360° view of all areas around them without being blocked at close range by large objects like a pillar, column, advertisement boards.
- AP to AP Distance: 12 – 20m
- Height: below 6m
- -75 dBm Client RSSI on 3 APs
- In some cases however, inter-access point spacing below 12 m may be necessary to satisfy the requirements of some applications for high signal strength thresholds, especially in environments where high path loss is present.



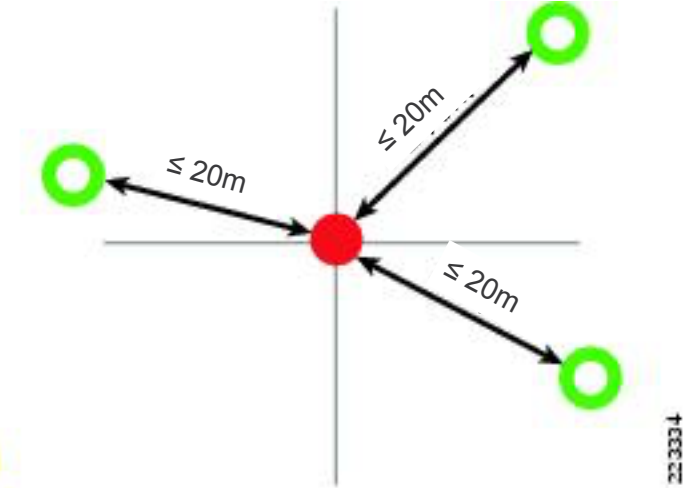
Stay Inside the Convex Hull

- Real example
 - Venue APs deployment is designed for coverage of the exhibition space
 - No APs at the perimeter and in the corners
 - No APs covering the main walkways
 - Location of Clients near outside walls is shifted about 15m inside the building

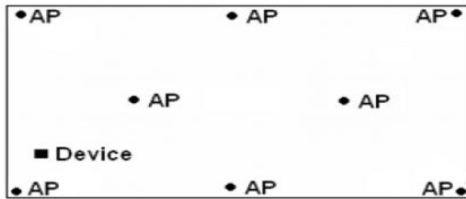
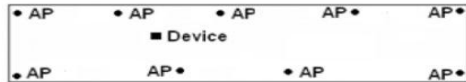


Basic Rules – Often Not Followed

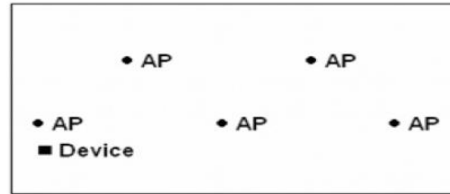
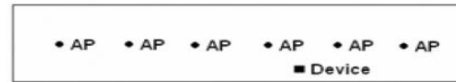
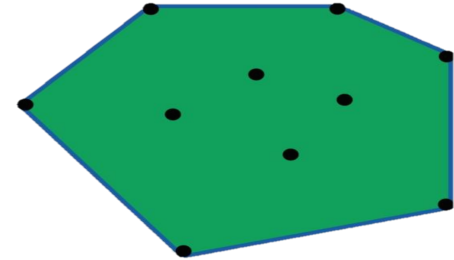
- Deploy minimum of 4 APs per floor
- One AP around client in each quadrant
- -75 dBm Client RSSI on 3 APs
- Create a convex hull around location area



Recommended

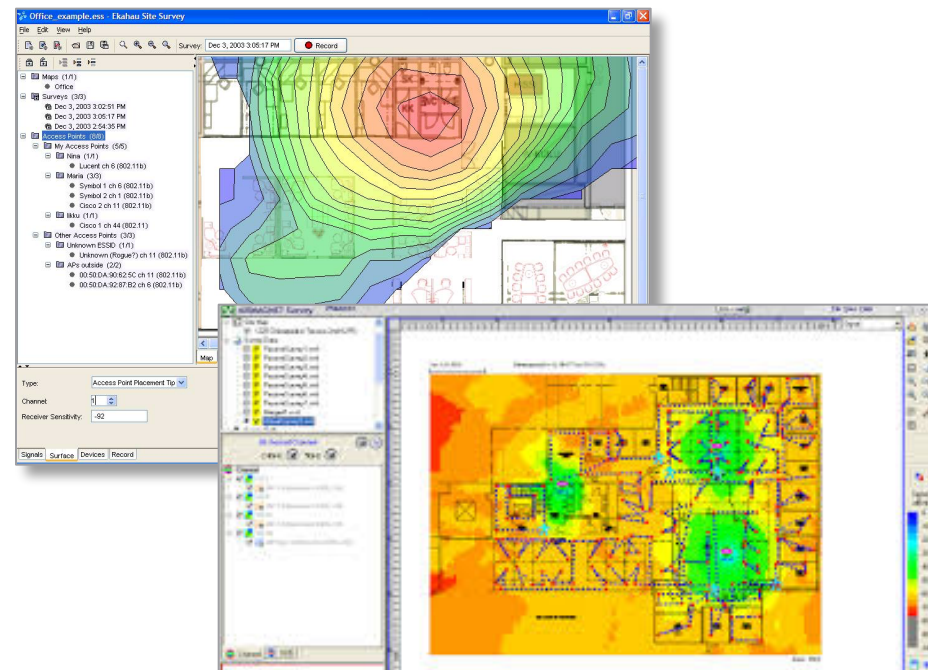


Not Recommended



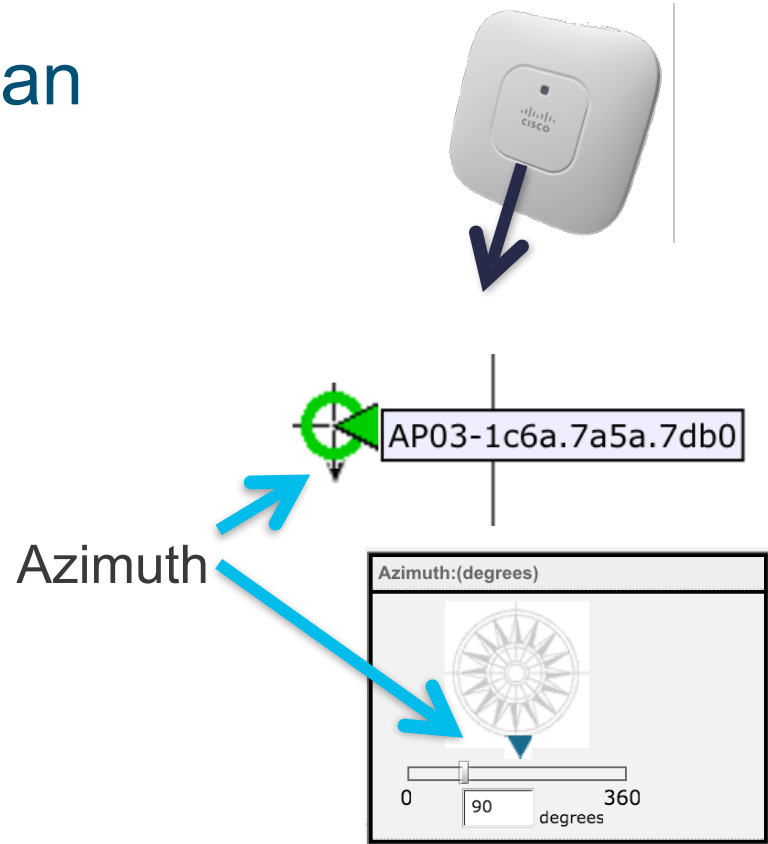
Rule of Thumb for Site Survey

- Example for Predictive Site Survey with Ekahau or AirMagnet Planner
 - Design for 5 GHz
 - Signal Strength ≥ -65 dBm
 - SNR ≥ 20 dB
 - Number of APs = 3
 - Packet Loss = 10%
 - Transmit Power 10mW
- Rule of thumb is 1 AP per:
 - 460 m² (5000 sq ft) for Data
 - 230 m² (2500 sq ft) for Voice / Location
- Line of Sight? – so be careful



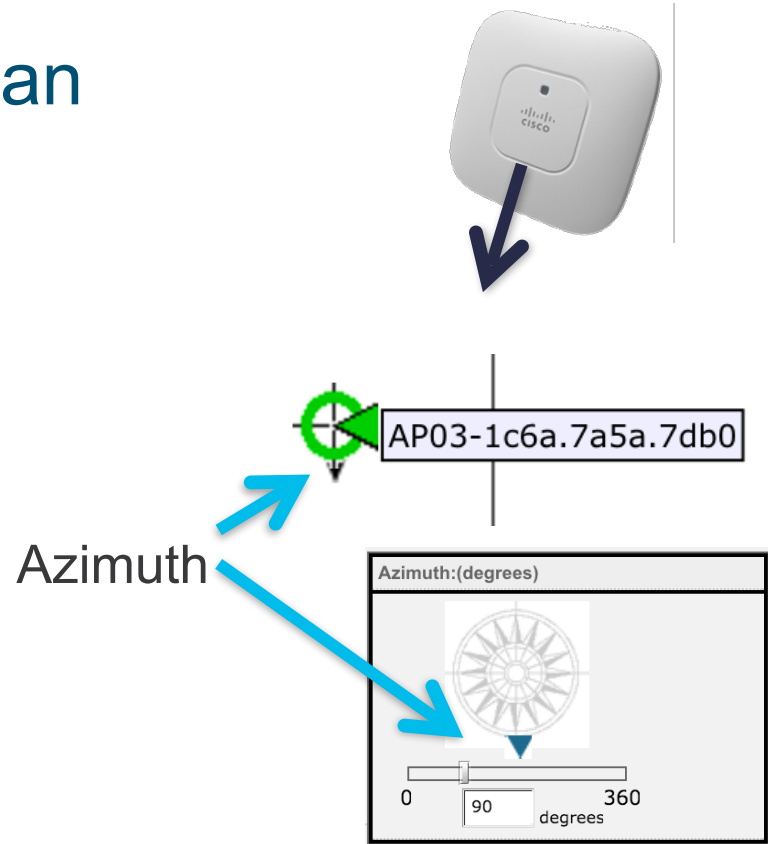
AP Positioning on the Floorplan

- Arrow points in the direction shown
 - Away from Ethernet Ports
 - Don't let the arrow in the map confuse you!
 - Arrow will always point in direction of Azimuth
- Needs to be configured for ALL radios
- Default: Ceiling Mount
 - Put the AP on the table
 - logo facing DOWN
 - Ethernet Ports away from you facing NORTH
 - rotate azimuth
 - rotate elevation



AP Positioning on the Floorplan

- Arrow points in the direction shown
 - Away from Ethernet Ports
 - Don't let the arrow in the map confuse you!
 - Arrow will always point in direction of Azimuth
- Needs to be configured for ALL radios
- Default: Ceiling Mount
 - Put the AP on the table
 - logo facing DOWN
 - Ethernet Ports away from you facing NORTH
 - rotate azimuth
 - rotate elevation



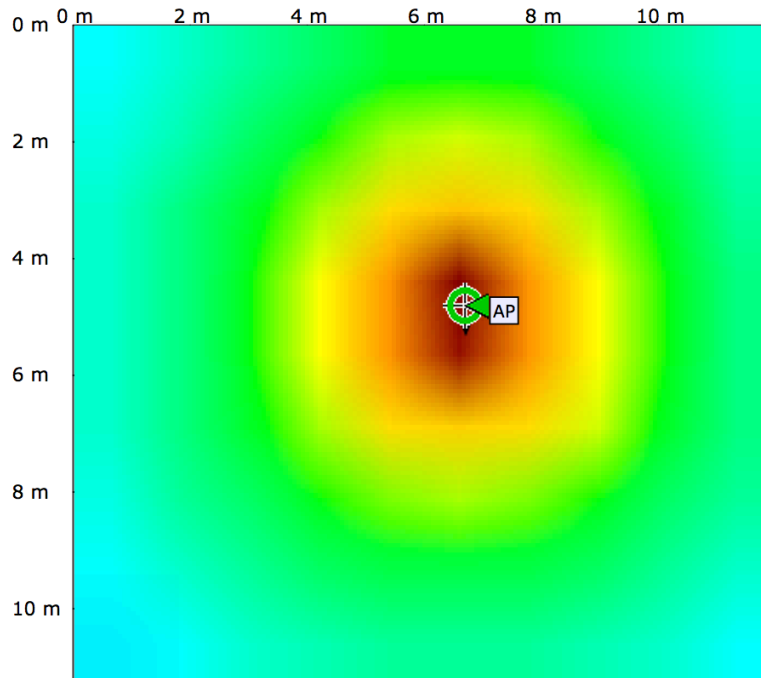
Tip: Mount APs in Default Orientation

AP Positioning Default - Ceiling Mount

- Default: Ceiling Mount
 - Logo facing DOWN
 - Ethernet Ports pointing NORTH
 - Arrow pointing SOUTH
- Azimuth: 90°
- Elevation: 0° up
- AP height defaults to ceiling height

Selected AP Details

AP	AP
MacAddress	5c:50:15:d8:c5:60
AP Model	AIR-CAP3602I-E-K9
Protocol	802.11a/n/ac
Horiz	6
Vert	6
AP Height	2
Antenna	Internal-3600-5GHz
Antenna/AP Image	
	
Antenna Orientation	
Azimuth:(degrees)	
	
0 180 360	
For internal antenna, same angle applies to both radios.	
Elevation:(degrees)	
0 up	



AP Positioning – East Wall

Not recommended for Location
Not supported for Hyperlocation
with AIR-ANT-LOC01

- Wall Mount
 - Logo facing WEST
 - Ethernet Ports pointing UP
 - Arrow pointing EAST
- Azimuth: 0°
- Elevation: 90° down
- Configure ALL Radios

Selected AP Details

AP	AP
MacAddress	5c:50:15:d8:c5:60
AP Model	AIR-CAP3602I-E-K9
Protocol	802.11a/n/ac
Horiz	6
Vert	5
AP Height	2
Antenna	Internal-3600-5GHz

Antenna/AP Image



Antenna Orientation

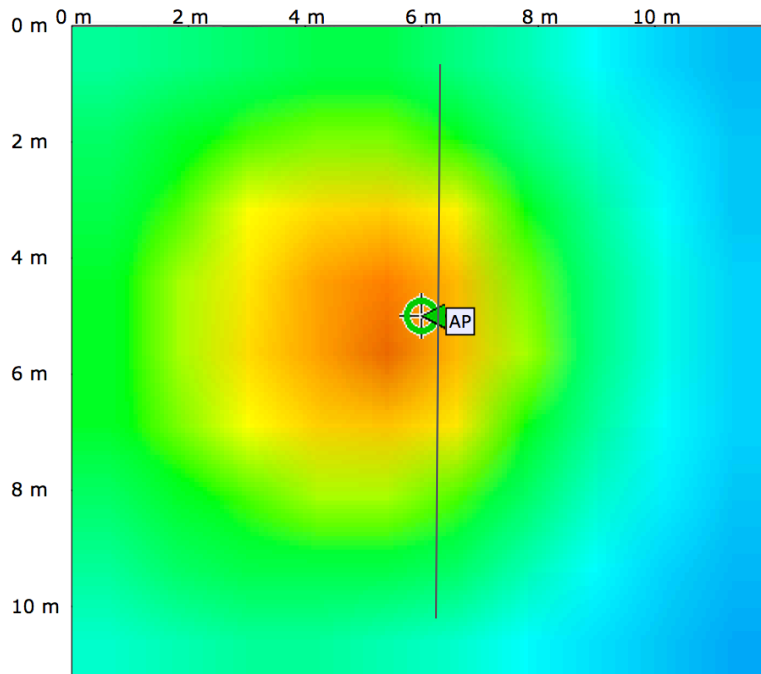
Azimuth:(degrees)



For internal antenna, same angle applies to both radios.

Elevation:(degrees)

90
down



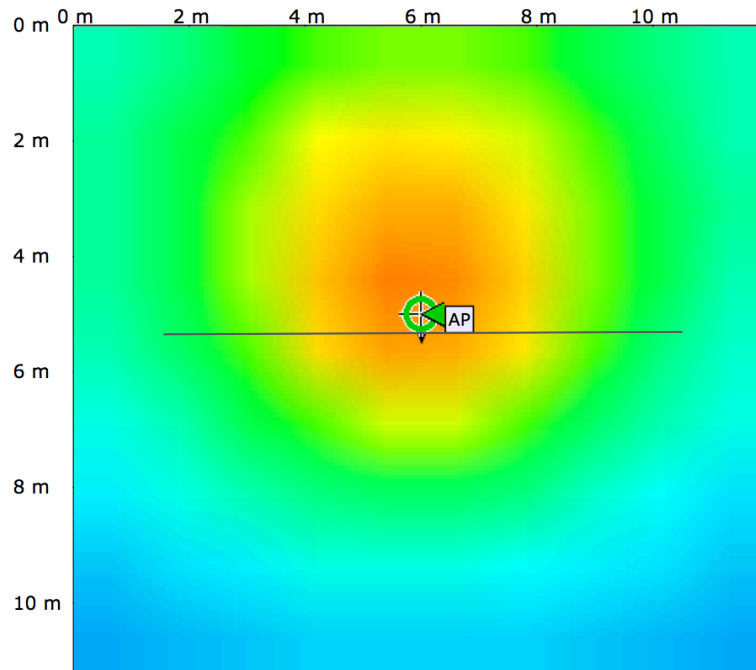
AP Positioning – South Wall

Not recommended for Location
Not supported for Hyperlocation
with AIR-ANT-LOC01

- Wall Mount
 - Logo facing NORTH
 - Ethernet Ports pointing UP
 - Arrow pointing SOUTH
- Azimuth: 90°
- Elevation: 90° down
- Configure ALL Radios

Selected AP Details

AP	AP
MacAddress	5c:50:15:d8:c5:60
AP Model	AIR-CAP3602I-E-K9
Protocol	802.11a/n/ac
Horiz	6
Vert	5
AP Height	2
Antenna	Internal-3600-5GHz
Antenna/AP Image	
	
Antenna Orientation	
Azimuth:(degrees)	
	
0 90 360	
For internal antenna, same angle applies to both radios.	
Elevation:(degrees)	
90	
down	
	



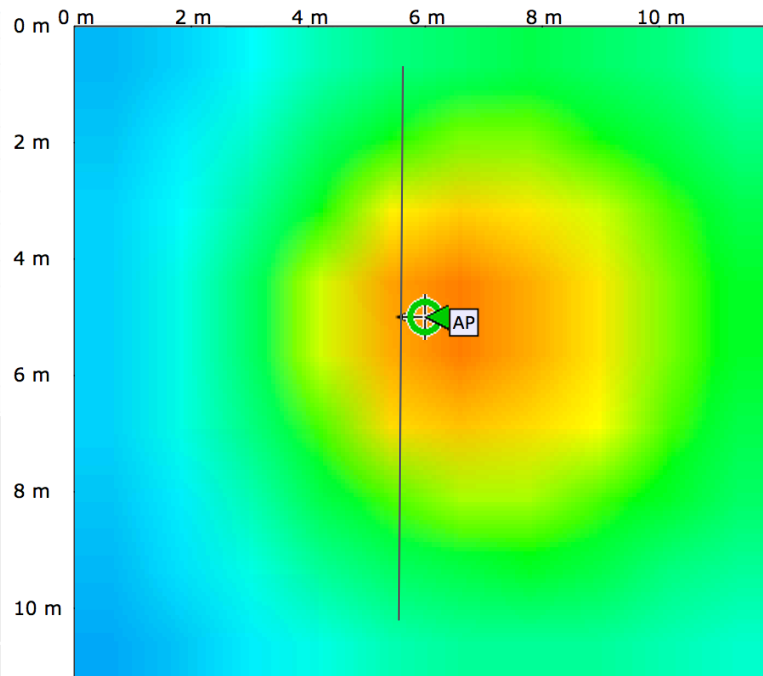
AP Positioning – West Wall

Not recommended for Location
Not supported for Hyperlocation
with AIR-ANT-LOC01

- Wall Mount
 - Logo facing EAST
 - Ethernet Ports pointing UP
 - Arrow pointing WEST
- Azimuth: 180°
- Elevation: 90° down
- Configure ALL Radios

Selected AP Details

AP	AP
MacAddress	5c:50:15:d8:c5:60
AP Model	AIR-CAP3602I-E-K9
Protocol	802.11a/n/ac
Horiz	6
Vert	5
AP Height	2
Antenna	Internal-3600-5GHz
Antenna/AP Image	
Antenna Orientation	
Azimuth:(degrees)	 0 180 360
For internal antenna, same angle applies to both radios.	
Elevation:(degrees)	90 down



AP Positioning – North Wall

Not recommended for Location
Not supported for Hyperlocation
with AIR-ANT-LOC01

- Wall Mount
 - Logo facing SOUTH
 - Ethernet Ports pointing UP
 - Arrow pointing NORTH
- Azimuth: 270°
- Elevation: 90° down
- Configure ALL Radios

Selected AP Details

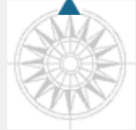
AP	AP
MacAddress	5c:50:15:d8:c5:60
AP Model	AIR-CAP3602I-E-K9
Protocol	802.11a/n/ac
Horiz	6
Vert	1
AP Height	2
Antenna	Internal-3600-5GHz

Antenna/AP Image



Antenna Orientation

Azimuth:(degrees)



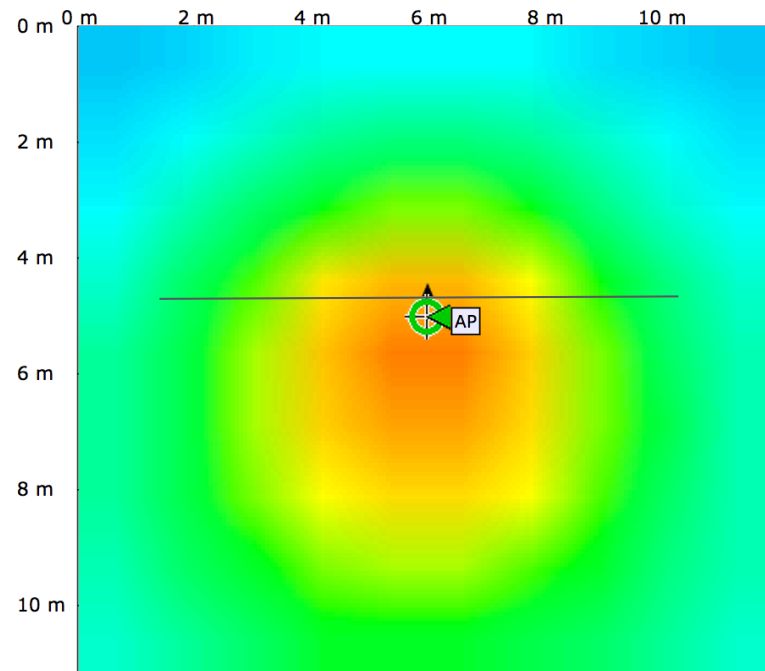
0 270 360

For internal antenna, same angle applies to both radios.

Elevation:(degrees)

90

down



AP Positioning – Angled North Wall 45°

Not recommended for Location
Not supported for Hyperlocation
with AIR-ANT-LOC01

- Wall Mount
 - Logo facing SOUTH 45°down
 - Ethernet Ports pointing UP
 - Arrow pointing NORTH
- Azimuth: 270°
- Elevation: 45° down
- Configure ALL Radios

Selected AP Details

AP	AP
MacAddress	5c:50:15:d8:c5:60
AP Model	AIR-CAP3602I-E-K9
Protocol	802.11a/n/ac
Horiz	6
Vert	5
AP Height	2
Antenna	Internal-3600-5GHz

Antenna/AP Image



Antenna Orientation

Azimuth:(degrees)



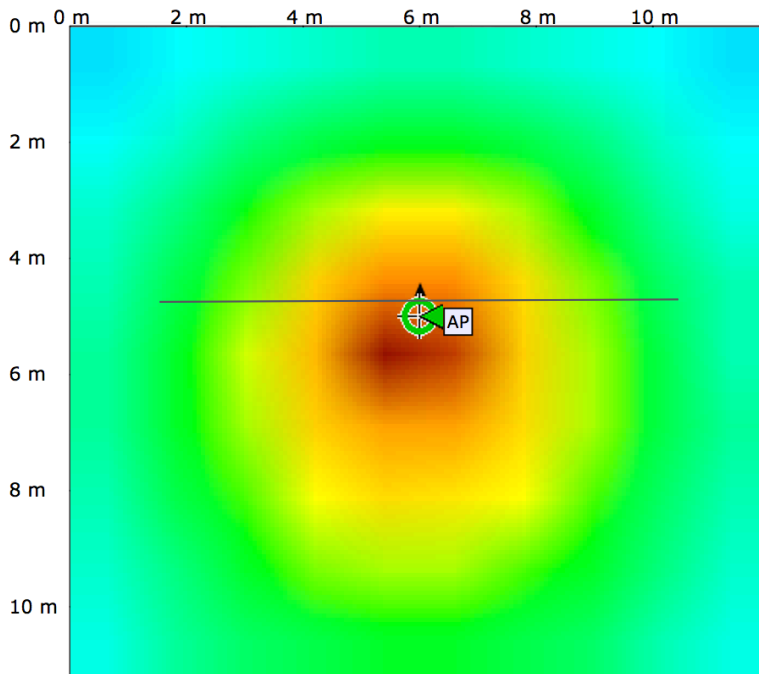
0 270 360

For internal antenna, same angle applies to both radios.

Elevation:(degrees)

45

down



Patch Antenna – AIR-ANT2566P4W-R

Option for Location
Not supported for Hyperlocation
with AIR-ANT-LOC01

- Facing South
 - Front facing SOUTH
 - Cable pointing DOWN (Water!)
 - Arrow pointing SOUTH
- Azimuth: 90°
- Elevation: 0° up
- Configure ALL Radios

Selected AP Details

AP	AP
MacAddress	64:d9:89:46:69:a0
AP Model	AIR-CAP3602E-E-K9
Protocol	802.11a/n/ac
Horiz	6
Vert	5
AP Height	2
Antenna	AIR-ANT2566P4W-R-5GHz

Antenna/AP Image



Antenna Orientation

Azimuth:(degrees)



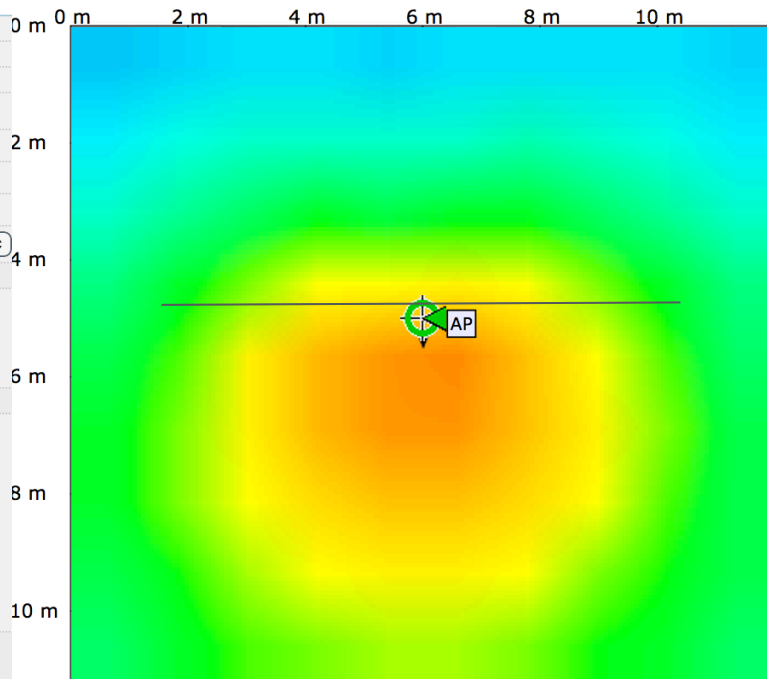
0 360

For internal antenna, same angle applies to both radios.

Elevation:(degrees)

0

up

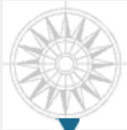


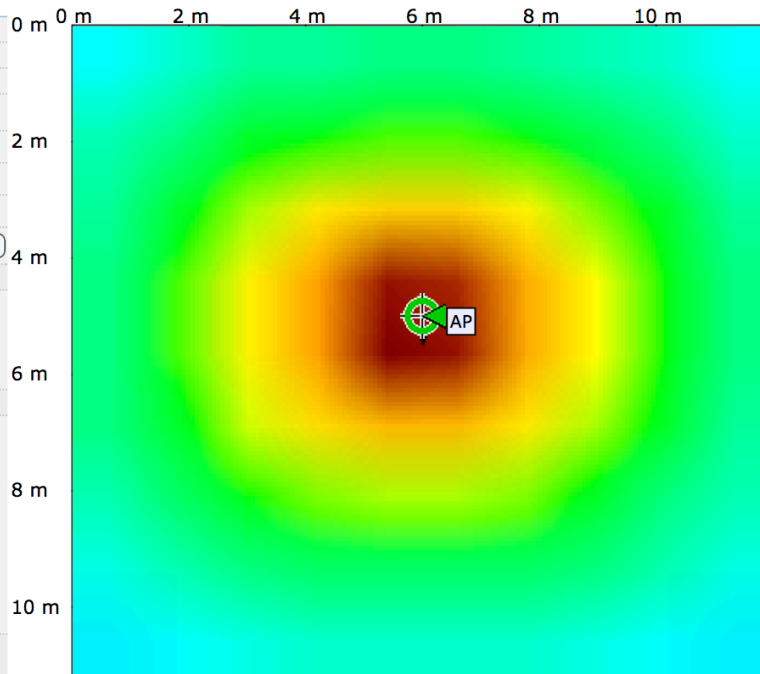
Patch Antenna – AIR-ANT2566P4W-R

Option for Location
Option for Hyperlocation
with AIR-ANT-LOC01

- High Ceiling
- Facing DOWN
 - Front facing DOWN
 - Cable pointing NORTH
 - Arrow pointing SOUTH
- Azimuth: 90°
- Elevation: 90° down
- Configure ALL Radios

Selected AP Details

AP	AP
MacAddress	64:d9:89:46:69:a0
AP Model	AIR-CAP3602E-E-K9
Protocol	802.11a/n/ac
Horiz	6
Vert	5
AP Height	2
Antenna	AIR-ANT2566P4W-R-5GHz
Antenna/AP Image	
Antenna Orientation	
Azimuth:(degrees)	
	
0 180 360	
For internal antenna, same angle applies to both radios.	
Elevation:(degrees)	
90	
down	
	



Patch Antenna – AIR-ANT2513P4M-N

- High Ceiling
- Facing DOWN
 - Front facing DOWN
 - Cable pointing NORTH
 - Arrow pointing SOUTH
- Azimuth: 90°
- Elevation: 90° down
- Configure ALL Radios



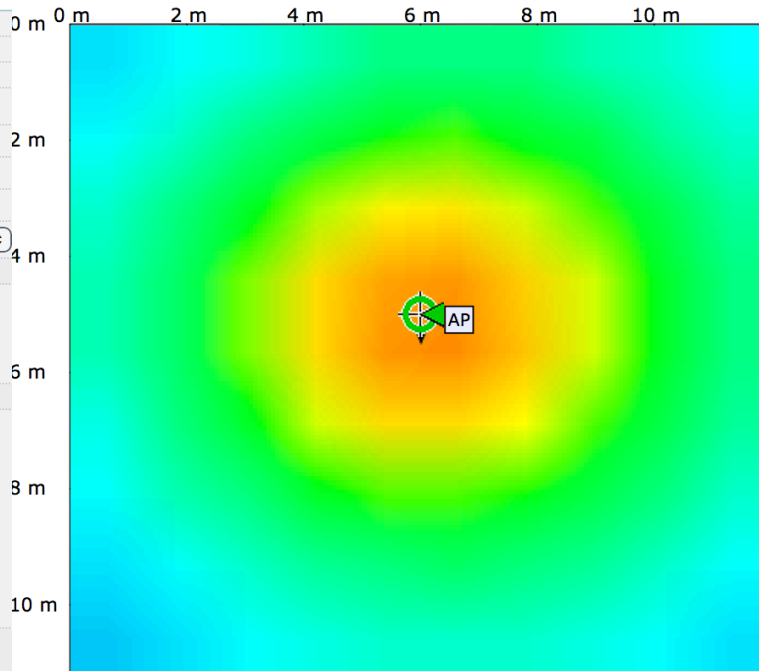
Omni Antenna – AIR-ANT2524V4C

Option for Location
Not supported for Hyperlocation
with AIR-ANT-LOC01

- Default: Ceiling Mount
 - Logo facing DOWN
 - Cable pointing UP
 - Arrow pointing SOUTH
- Azimuth: 90°
- Elevation: 0°up
- Configure ALL Radios

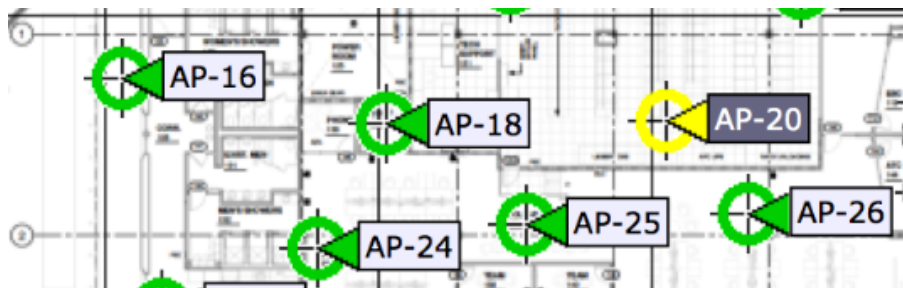
Selected AP Details

AP	AP
MacAddress	64:d9:89:46:69:a0
AP Model	AIR-CAP3602E-E-K9
Protocol	802.11a/n/ac
Horiz	6
Vert	5
AP Height	2
Antenna	AIR-ANT2524V4C-R-5GHz
Antenna/AP Image	
	
Antenna Orientation	
Azimuth:(degrees)	
	
0 90 360	
For internal antenna, same angle applies to both radios.	
Elevation:(degrees)	
0	
up	
	



Hyperlocation AP Map Placements in Prime

Install the APs on the ceiling grid, if possible try to align Hyperlocation arrow on AP so they all are pointing in the same orientation

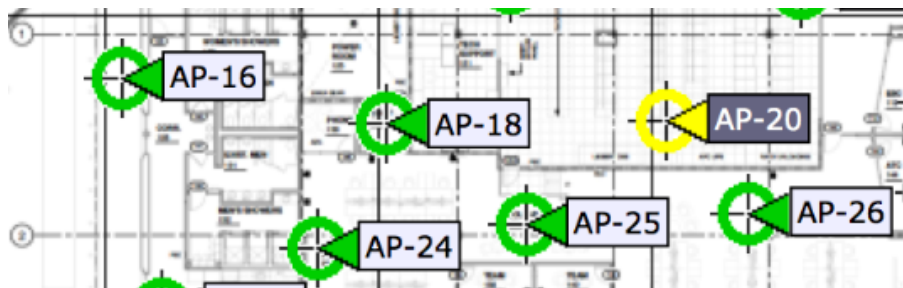


In this release all APs be in the same map need to be Hyperlocation capable.



Hyperlocation AP Map Placements in Prime

Install the APs on the ceiling grid, if possible try to align Hyperlocation arrow on AP so they all are pointing in the same orientation

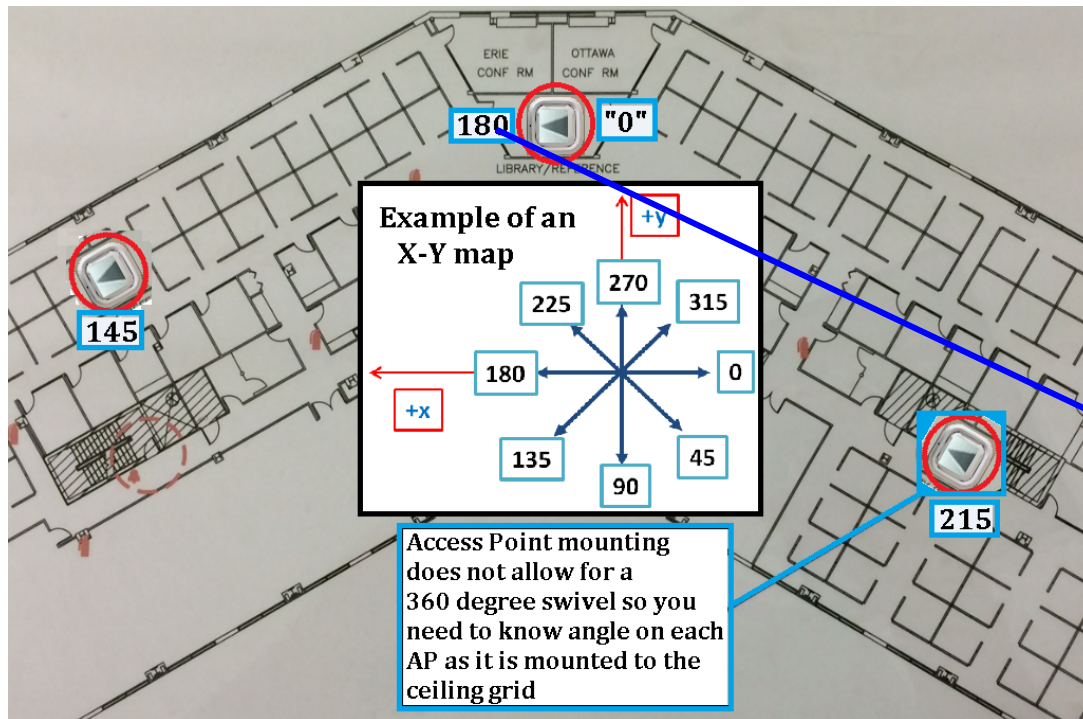


In this release all APs be in the same map need to be Hyperlocation capable.

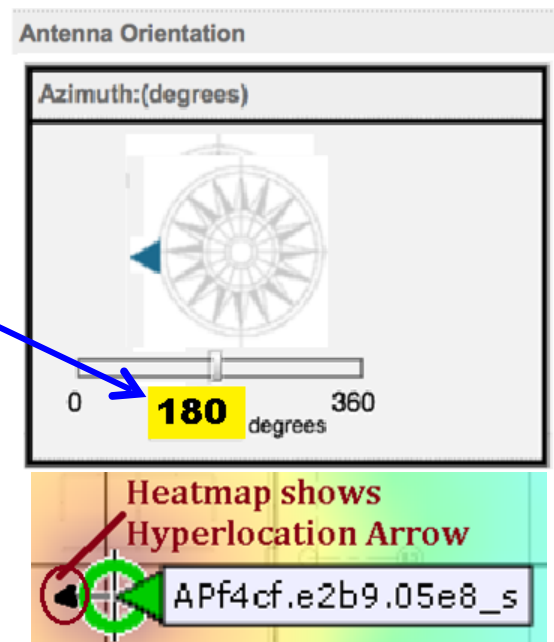
Best Practice: Mount APs in Default Orientation



When the Building isn't a Perfect Square...



This building has three different angles so each AP has its own azimuth on the map 145, 180 and 215



Location Antennas

Expanding the Hyperlocation tool box

AP3600/3700 add on
Enterprise office, retail,...
(horizontal install)

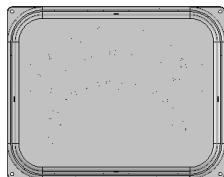
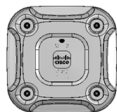


Omni Location + no WiFi

- PID: AIR-ANT-LOC-01=
- 3602i/e, 3702i/e
- Enterprise office, retail , ...
- Horizontal install, on ceiling
- DART (HL mod)
- Dual-band
- ≈ 2x12x12"
- Oct. 2015

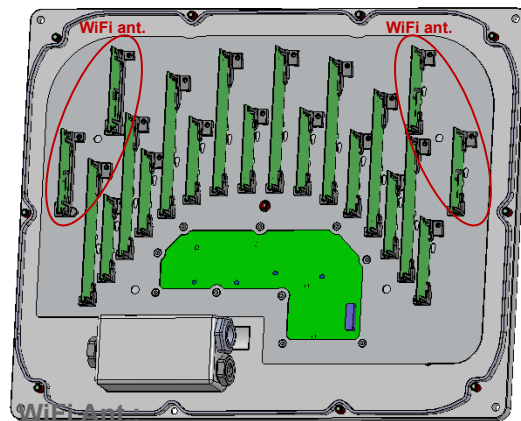
Cisco *live!*

Large hall, warehouse, atrium,
high ceiling, Outdoors
(vertical install)



Directional Location + Directional WiFi

- PID: AIR-ANT25-LOC-02=
- AP 3702I, 3702E, & 3702P
- Large Hall, Warehouse, Atrium
- Vertical install, outdoor rated
- DART (Location) + 4 RP-TNC (WiFi), 3 ft
- Dual-band
- ≈ 2x14x18"
- ≈ Q4/CY17



Az/EI ≈ 2G: 105°/60° 5G: 105°/60°
Gain ≈ 2G: 4 dBi 5G: 5 dBi

HL Ant.:
Az/EI ≈ 2G: 145°/90° 5G: 145°/90°

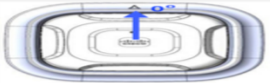
Hyperlocation – AIR-ANT-LOC-01

- Default: Ceiling Mount
 - Logo facing DOWN
 - Ethernet Ports pointing SOUTH
 - Arrow on ANT pointing SOUTH
 - Arrow on Map pointing SOUTH
- Azimuth: 90°
- Elevation: 0° up
- AP height defaults to ceiling height

Selected AP Details

AP	AP03-1c6a.7a5a.7db0
MacAddress	1c:6a:7a:5b:d7:60
AP Model	AIR-CAP3702L-E-K9
Protocol	802.11a/b/g/n
Horiz	28.4
Vert	23.4
AP Height	9.8
Antenna	AIR-ANT-LOC-01

Antenna/AP Image



Antenna Orientation

Azimuth:(degrees)

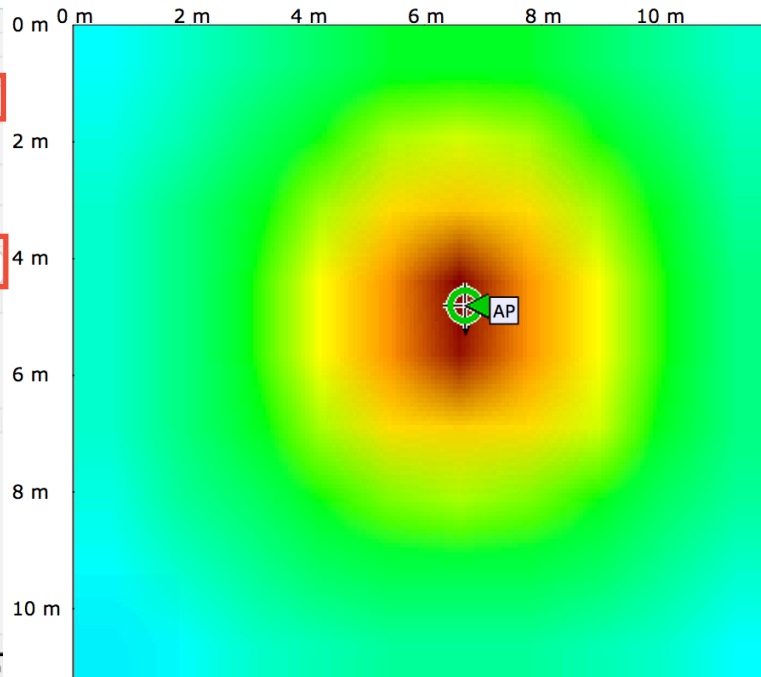


0 90 360 degrees

For internal antenna, same angle applies to both radios.

Elevation:(degrees)

0 up



Prime Infrastructure 3.3

- New Map Editor
 - Allows positioning APs by
 - 3 Points or 2 Walls
- Antenna Templates

The screenshot displays the Cisco Prime Infrastructure 3.3 interface. The main window shows a site map with various access points (APs) and antennas positioned on a floor plan. A sidebar on the left contains navigation options: Configuration, AP Source, AP Selection, Schedule, and Deploy Status. The top navigation bar includes links to Maps, Wireless Maps, and Site Maps, along with a search bar and a 'Recompute' button. The right sidebar shows 'Selected AP Details' for a specific AP, including its name, MAC address, model, and physical dimensions. A pop-up window titled 'Configuration / Templates / Lightweight Access Points / Lightweight AP Template Detail : PointAntennaDown' is open, showing the configuration for a specific antenna template. This window has tabs for Template Basic, AP Parameters, Mesh, 802.11a/n/ac, 802.11a SubBand, 802.11b/g/n, 802.11a/b/g/n, CDP, and FlexConnect. The '802.11b/g/n' tab is active, showing parameters for channel assignment, channel width, admin status, power assignment, clean air, and antenna selection. The 'Antenna Configuration' section is expanded, showing settings for antenna mode, diversity, type, name, gain, azimuth, elevation, and up/down status. A 3D model of the antenna is shown on the right side of the configuration window.

How to Test Accuracy with CMX?

- Use the build in tool

1. Click to start a test

2. Enter a name

3. Drag the marker

4. Run the test

Keep the device static and collect minimum of 20 samples

Lessons Learned from Live Deployments

- Steer Clients to 5GHz -> Hyperlocation
- Stay inside Convex Hull etc.
- No calibration or additional effort with 15m/50ft AP to AP spacing
 - we had spec'ed out the product to do 1-3 m 50% of the time
 - we were doing <1m 50% accuracy
- Customer experienced issues around accuracy drop and root caused were:
 - Somebody moved the AP on the store floor and maps were not updated
 - Someone enabled HL on second CMX and the first one stopped receiving HL data from AP

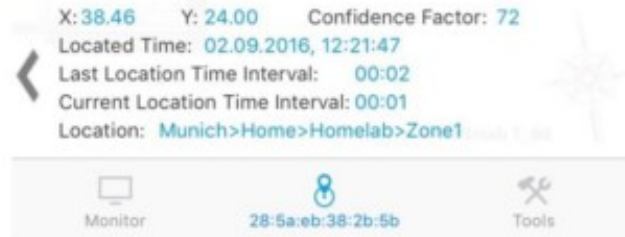
Verifying Hyperlocation

Verify Installation

- Connect a client
- Verify Location Metrics
 - Hyperlocation Rate should not be 0
- Use iPhone with CMX Admin App



CiscoLive!



Check Hyperlocation Grouping

AP01#show capwap rm hyperlocation level1-list



AP01-7db0#show capwap rm hyperlocation level1-list
Level-1 List for 2.4GHz Band

Channel	Width	Serving MAC	Max Clients
1	0	1c6a.7a68.8ce0	18
11	0	1c6a.7a5b.d760	18
1	0	1c6a.7a68.8d00	18

Level-1 List for 5GHz Band

Channel	Width	Serving MAC	Max Clients
44	1	1c6a.7a68.8d00	18
100	1	1c6a.7a5b.d760	18
132	1	1c6a.7a68.8ce0	18

How to test accuracy?

- Use the built-in tool

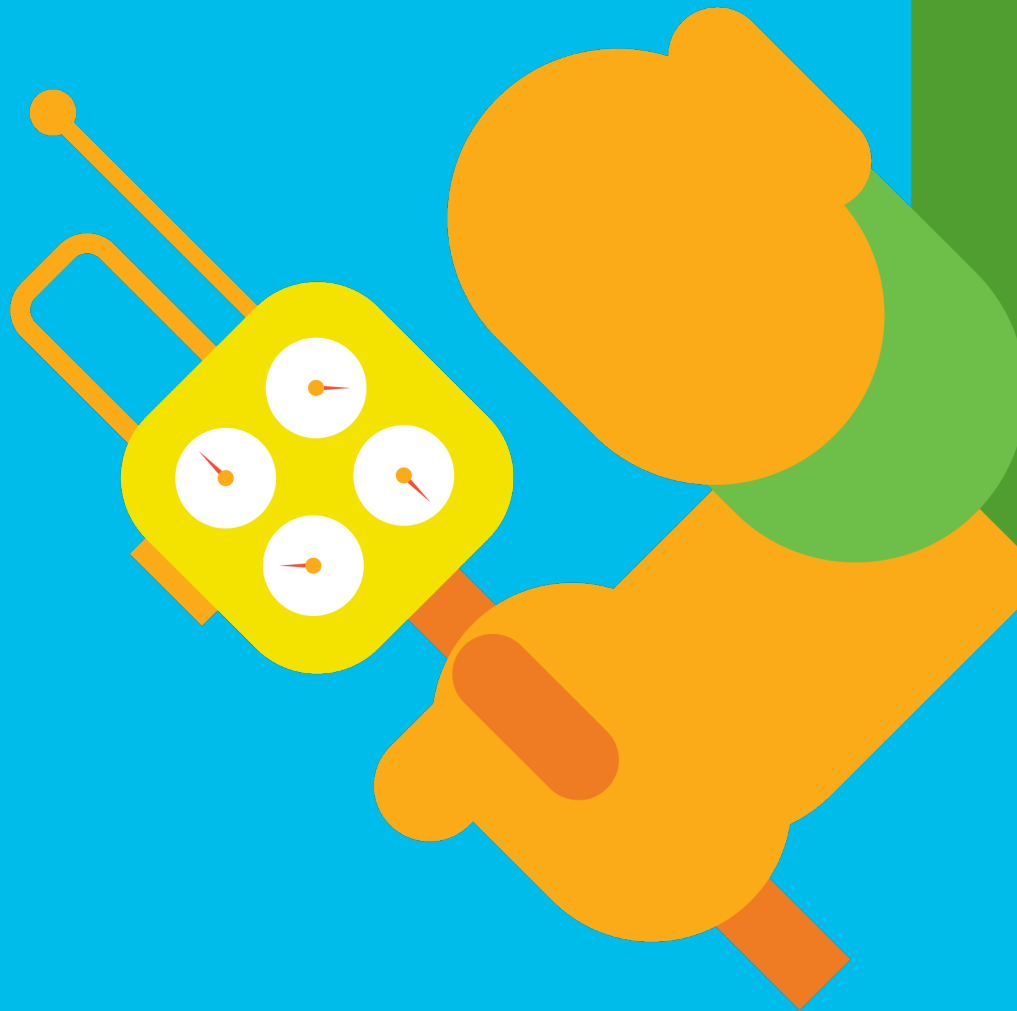
The screenshot displays the Cisco Activity Map interface. At the top, the title "Activity Map" is shown alongside statistics: "6 APs, 8 Connected Clients, 63 Detected Clients, 1 Zone". Below this, a navigation bar includes a "Back to World Map" link and the current location "Nortech Campus / Nortech-1 / 1st Floor". A search bar is available for "MAC Address, Username, IP, SSID or ...".

The main map area shows a floor plan with a blue location pin. A tooltip above the pin indicates the "Correct position is (53 , 13)". A control bar at the top of the map area shows a timer at "00:00", the test name "AccuracyTest", and a prompt "Drag the marker to the test position".

On the right side, a "Client" details panel is visible, containing the following information:

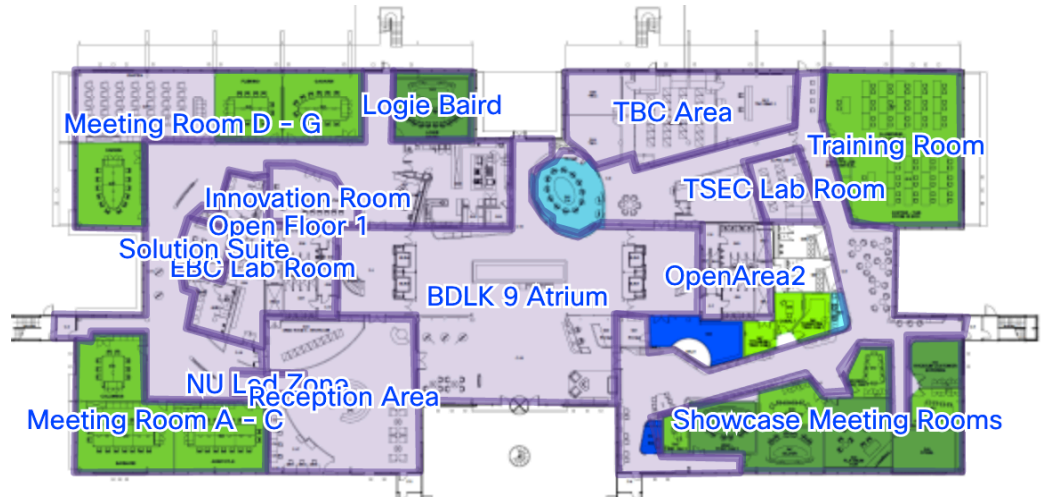
- MAC Address:** a0:a8:cd:07:d0:05
- Status:** ASSOCIATED
- IP Address:** 10.22.243.155
- Co-ordinates:**
 - X: 53.26
 - Y: 11.59
- Last Seen:** 1s ago

Zone Best Practices



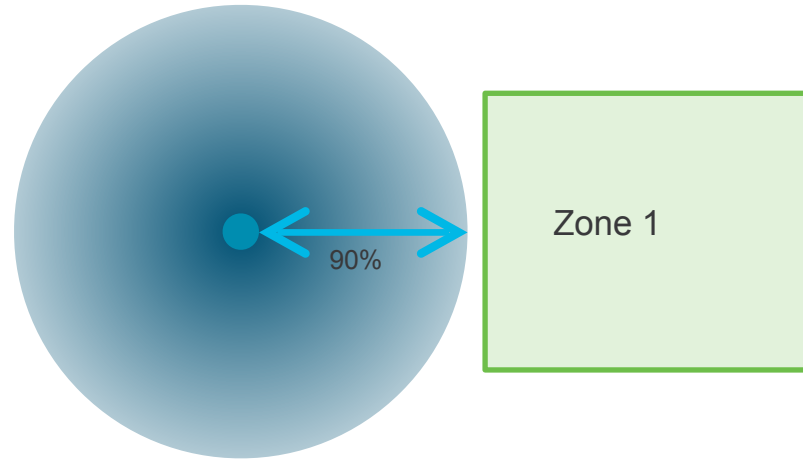
What is a Zone?

- Area (Polygon) on the map to subdivide a floor to
 - generate notifications
 - count devices
 - measure fill levels
 - calculate dwell times



Zone Design

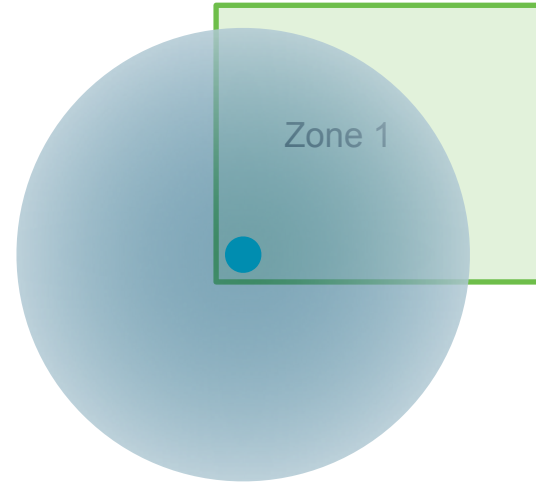
- Size and separation should match accuracy (90% accuracy distance)
- Not possible to suggest absolute sizes and distances
- Absolute numbers depend on achieved location accuracy



Zone Design

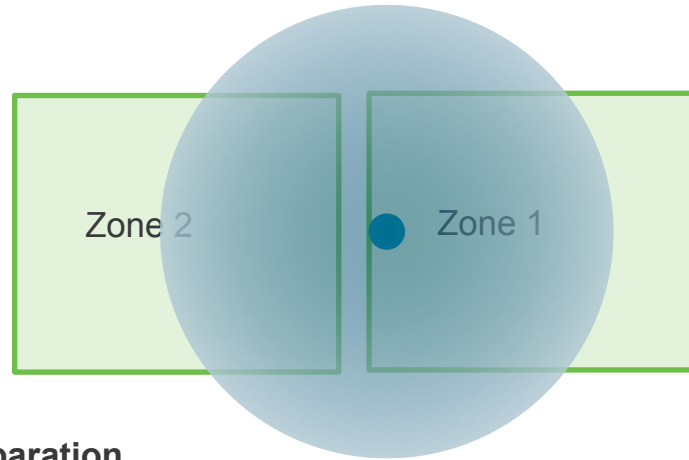
- Size and Separation should match accuracy
- Much larger than “90% accuracy” distance

Problem: **Zone too small**
Device in Zone 1
but only $\frac{1}{4}$ of the 90% in the Zone



Zone Design

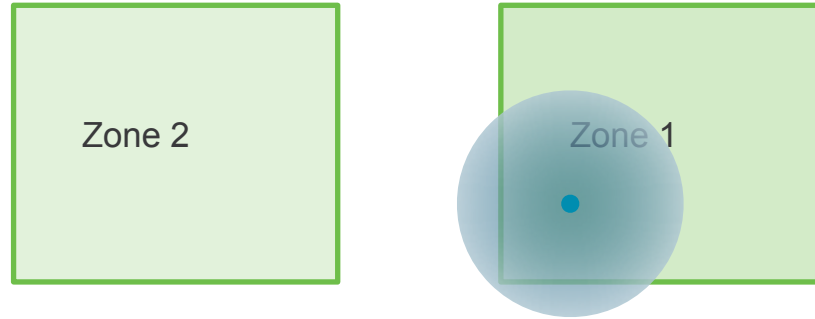
- Size and Separation should match accuracy
- Much larger than “90% accuracy” distance
- About “90% accuracy” apart from each other



Problem: **Not enough separation**
Device in Zone 1
but high probability to be located in Zone 2

Zone Design – Better Accuracy

- Better Accuracy allows smaller zones and less separation



Good Separation and Zone Size

How to integrate 3rd Party Applications

How Cisco CMX Works (CMX 10.x)



Realtime
Notifications

Pull Data
REST API

How Cisco CMX Works (CMX 10.x)

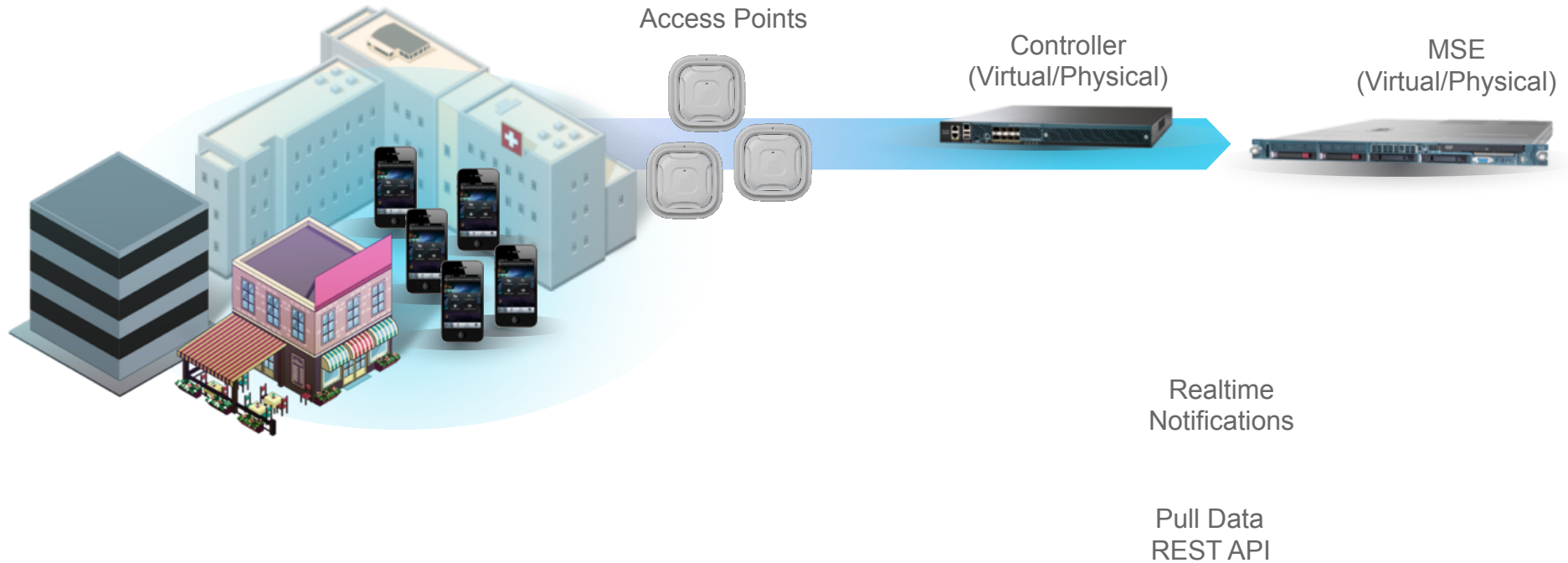


Access Points

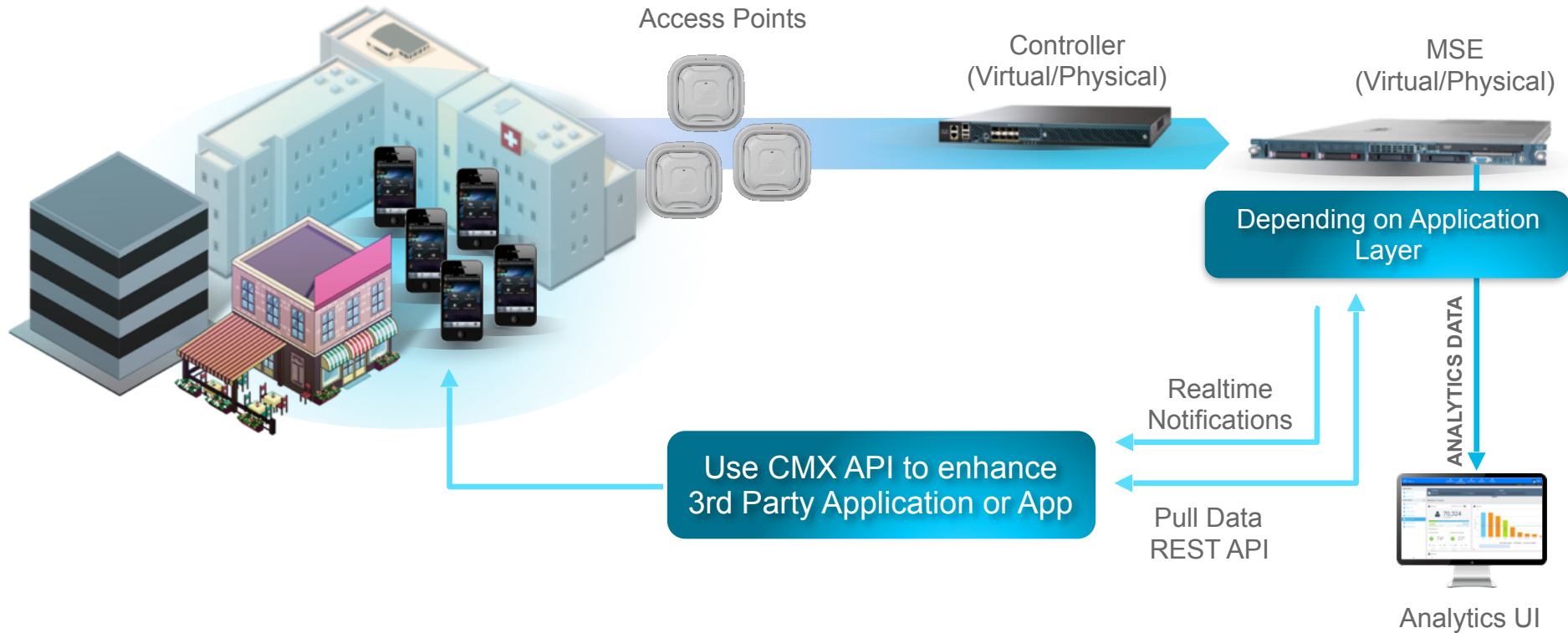
Realtime
Notifications

Pull Data
REST API

How Cisco CMX Works (CMX 10.x)



How Cisco CMX Works (CMX 10.x)



Application host requirements

- Push method using CMX northbound notifications.
 - For realtime you can setup northbound notifications on CMX to be send to the application host. This would not require the application host to connect to CMX and the host could then be even hosted in the cloud.
- Pull method using REST API
 - You need to put the application host in the DMZ, application host needs to be able to do REST API calls to CMX.

CMX API Overview

- Interactions are in the form of:
 - REST API calls for the configuration, location and analytics services
 - APIs accept JSON content and response are sent in JSON format.
 - API calls support both http and https
 - Northbound notifications from the location service

Location API vs. Northbound Notifications

```
macAddress : 00:00:2a:01:00:22
mapInfo {5}
  mapHierarchyString : DevNetCampus>DevNetBuilding>DevNetZone
  floorRefId : 723413320329068590
  floorDimension {6}
  image {7}
  tagList [1]
  mapCoordinate {4}
  currentlyTracked : true
  confidenceFactor : 40
  statistics {4}
  historyLogReason : null
  geoCoordinate : null
  networkStatus : ACTIVE
  changedOn : 1476286041347
  ipAddress [1]
    userName : value
    ssid : test
    sourceTimestamp : null
    band : IEEE_802_11_B
    apMacAddress : 00:2b:01:00:06:00
    dot11Status : ASSOCIATED
    manufacturer : Trw
```

```
object {1}
  notifications [1]
    0 {17}
      apMacAddress : 00:2b:01:00:06:00
      associated : true
      band : IEEE_802_11_B
      confidenceFactor : 48
      deviceId : 00:00:2a:01:00:21
      entity : WIRELESS_CLIENTS
      eventId : 2535187
      floorId : 723413320329068500
      geoCoordinate {3}
      ipAddress [1]
      lastSeen : 2016-10-12T16:24:33.382+0100
      locationCoordinate {4}
        locationMapHierarchy : DevNetCampus>DevNetBuilding>DevNetZone
        notificationType : locationupdate
        ssid : test
        subscriptionName : cgauer
        timestamp : 1476285873382
```


CMX API Documentation

- All API documentation is available directly from the MSE once deployed
 - Live API documents <http://mseIP/apidocs>
 - API Documentation has an embedded “Try it!” button, allowing you to try each of the APIs online with just a click of a button.

The screenshot shows the Cisco CMX API Documentation interface. The left sidebar contains a navigation menu with 'Home', 'CMX', and 'Code'. The main content area features the heading 'Detect, Connect and Engage Users In-Venue' and a description of Cisco Connected Mobile Experiences (CMX). Below this is a blue button labeled 'Explore Cisco CMX'. To the right, there is a grid of four API categories: Configuration, Location, Analytics, and Connect. Each category has a brief description and a 'View details' button. A fifth category, 'Presence', is located below the others. Four blue arrows point from a yellow text annotation 'Click on a link to expand' to the 'View details' buttons of the Configuration, Location, Analytics, and Presence categories.

Configuration
Use the Configuration REST APIs to configure different aspects of MSE.
[View details »](#)

Location
Use the Location based REST APIs to find location specific details on visitors.
[View details »](#)

Analytics
Use the Analytics based REST APIs to find analytical data on visitors.
[View details »](#)

Connect
Use the Connect based REST APIs to find user session information.
[View details »](#)

Presence
Use the Presence REST APIs to find presence data on visitors.
[View details »](#)

Click on a link to expand

Example - Location API

Location API

[Toggle All Endpoints](#) | [Toggle All Methods](#)

Active Clients API

[List Methods](#) | [Expand Methods](#)

GET

This API returns active clients count </api/location/v2/clients/count>

GET

This API returns collection of active clients macaddresses </api/location/v2/clients/active>

GET

This API returns all clients </api/location/v2/clients>

Tags Information API

[List Methods](#) | [Expand Methods](#)

Beacon Management API

[List Methods](#) | [Expand Methods](#)

Clients History API

[List Methods](#) | [Expand Methods](#)

Northbound notification types and attributes API

[List Methods](#) | [Expand Methods](#)

Northbound Notification

- In addition to the API calls, a third party application can also be configured to receive location update notifications.
 - Notifications can either be manually configured by an administrator, or subscribed to via API call from the third party app making a put request to `http://msename/api/config/v1/notification`
- A notification payload consists of three parts:
 - Notification subscription name
 - Notification rules or the attributes that trigger the notification
 - Notification receiver address
 - JSON Payload with Client MAC, coordinates, timestamp etc.

Documentation of Notification payload

https://swaggerhub.com/apis/cgauer/CMX_Notification/1.0.0

Notification

POST	/Absence	Absence notifications
POST	/AreaChange	Area change notifications
POST	/Association	Area change notifications
POST	/LocationUpdate	Location Update Notification
POST	/Movement	Location Update northbound notifications
POST	/NetworkDesignChange	Notification when the network design changed.

JSON example

```
{
  "apMacAddress": "1c:6a:7a:68:8c:e0",
  "associated": true,
  "band": "IEEE_802_11_A",
  "confidenceFactor": 80,
  "deviceId": "e4:58:e7:40:11:5e",
  "entity": "WIRELESS_CLIENTS",
  "eventId": 184,
  "floorId": 720575987623920300,
  "floorRefId": 720575987623920300,
  "geoCoordinate": {
    "latitude": 48.09189905905088,
    "longitude": 11.535149317682393,
    "unit": "DEGREES"
  },
  "ipaddress": [
    "192.168.0.102",
    "fe80:0000:0000:0000:0c1f:3d4a:ee9f:9227"
  ],
  "lastSeen": "2016-07-27T11:05:58.905+0200",
  "locComputeType": "AOA",
  "locationCoordinate": {
    "x": 40.782036,
    "y": 25.887224,
    "z": 0,
    "unit": "FEET"
  }
}
```

Description

Location Update	▼ { ↵
apMacAddress	string example: 1c:6a:7a:68:8c:e0 MAC address of connected AP
associated	boolean example: true True if client is associated
band	string example: IEEE_802_11_A 2.4 or 5GHz
confidenceFactor	number example: 80 The confidence factor defines the size of the 95% confidence square
deviceId	string example: e4:58:e7:40:11:5e Device MAC Address
entity	string example: WIRELESS_CLIENTS Type of device wireless client, tag, interferer
eventId	string example: 184 event ID
floorId	number example: 720575987623920300 Floor reference ID of the map

– CMX - Digital Transformation through Location Analytics and Innovations [BRKEWN-2012]



Mark Krischer, Wireless Evangelist, Asia Pacific and Japan, CISCO

SCHEDULE

Wednesday, Mar 07, 12:50 p.m. - 02:20 p.m. | 217



Session Presentation

Cisco's Connected Mobile Experience is transforming the Wi-Fi network from connectivity infrastructure to a driver of business intelligence and innovation. Learn how indoor location analytics and innovations are enabling informed business decisions and creating opportunities to engage with customers and empower your employees across every vertical. CMX supports a wide range of capabilities from advanced location and hyperlocation analytics to BLE technologies and application integration, from new ways to connect and engage customers, to extending location to IoT with asset tracking, management and operational insights. The CMX partner eco-system further expands the capabilities of the platform through social engagement, wayfinding, workforce and facilities planning and management and asset resource optimisation. Explore how CMX, together with our partner solutions can solve your business challenges.

Technical Level: Intermediate

Technology: Wireless

Session Type: Technical Breakouts

Learning Paths: Enterprise Networking, Mobility

Tracks: Enterprise Networks

Spark url for mobile: <http://cs.co/ciscolivebot#BRKEWN-2012>

— Location Based Application Development Showdown: Cisco Unified Wireless CMX Notifications vs. Cisco Meraki Location Scanning API [DEVNET-2057]



Matthew Denapoli, Developer Evangelist, CISCO

SCHEDULE

Tuesday, Mar 06, 02:00 p.m. - 02:45 p.m. | DevNet Workshop 1

SCHEDULE

Friday, Mar 09, 03:00 p.m. - 03:45 p.m. | DevNet Workshop 1



Session Presentation

Please Note: By registering for this session, it does not guarantee you a seat. Seating is available on a first come first seated basis. Wifi and Bluetooth Location services are a potentially powerful tool in a wide swath of industries. As a purely horizontal solution, the vertical applications are limited only by the imagination. Asset tracking and wayfinding are just the catchphrases of implementation as those concepts can be applied across all conceivable industries where wireless network connectivity is employed. Cisco has two platforms that support this, which means two different ways of approaching application development. In this session we'll deep dive into the infrastructure differences, but more importantly the differences to developers in developing and deploying location based applications. Finally we'll clear the air on what CMX really means. Takes place in DevNet Zone.

Technical Level: Intermediate

Technology: Security

Session Type: DevNet

Learning Paths: IoT, Mobility, Software Development

Tracks: DevNet

Spark url for mobile: <http://cs.co/ciscolivebot#DEVNET-2057>

Q & A

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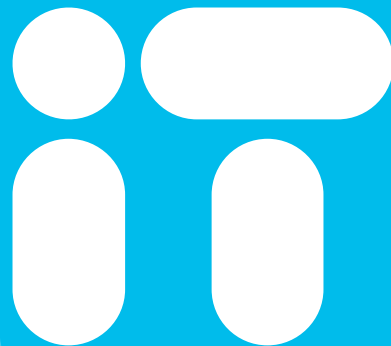




Thank you



You're



Cisco *live!*