Hyperlocation Deployment Guide

Revised: November 19, 2015,

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What makes Hyperlocation work?

Cisco Hyperlocation with Advanced Security is achieved by combining industry leading infrastructure with industry-leading location-based data acquisition and analytics. The components of hyperlocation are:

Hyperlocation with Advanced Security module and Hyperlocation Antenna Array on Cisco Access Points: The Cisco Hyperlocation Solution consists of two products: the Hyperlocation Module and the Hyperlocation Antenna. The module plugs into the socket on the back of the Aironet 3600 and 3700 access points. The module provides Advanced Security for wireless, BLE, and FastLocate technologies. The Hyperlocation Antenna plugs into the Hyperlocation Module and wraps around the edges of the 3600 or 3700 access points. The addition of the antenna adds angle-of-arrival "AoA" capabilities to the Hyperlocation Solution.

Hyperlocation in Cisco Connected Mobile Experiences: The Hyperlocation Solution substantially increases the location accuracy of the Connected Mobile Experiences. The FastLocate technology boosts the refresh rate so CMX captures more location data points. And the angle of arrival capabilities increases location accuracy to as close as one meter. The improved accuracy provides more granular analytics data and more relevant push content to the customer.

Subsequent Bluetooth Low Energy "BLE" support for CMX: Through the Hyperlocation Solution, BLE beacons can be used to enhance the accuracy and engagement of the experience. The Hyperlocation Solution can detect BLE beacons installed in the venue. And the Hyperlocation Module includes a BLE radio that doesn't require a battery.

New Analytics for CMX: With the launch of the new Connected Mobile 10.0, real-time analytics are now available. As a result, CMX can deliver actionable data that enables a venue to customize offers and staffing to adapt to current conditions in the venue.

Minimum Software Requirements for Hyperlocation

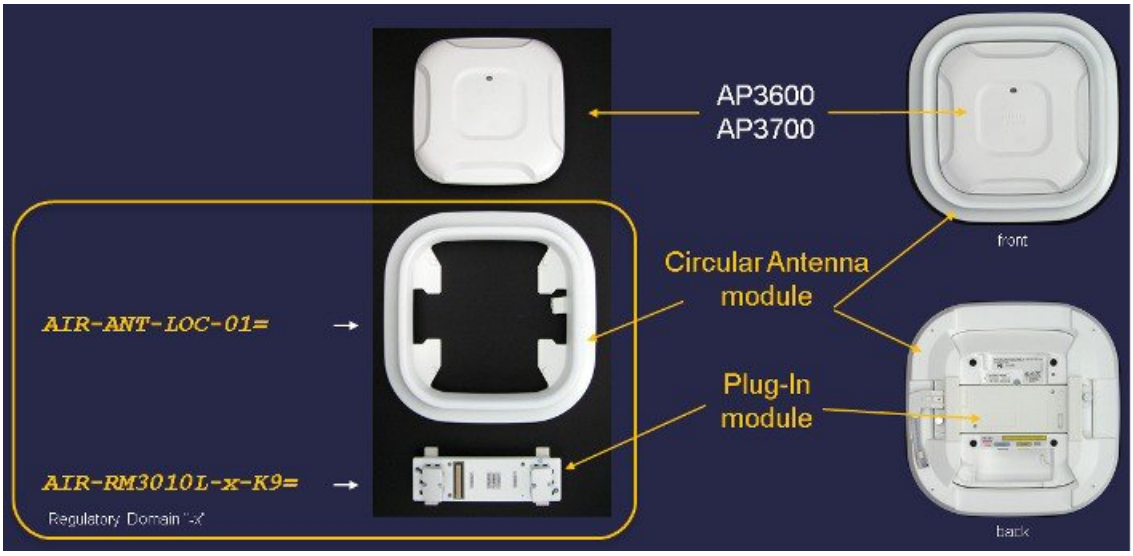
- **Cisco Prime version 3.0 or higher—** The function of this software is to correctly place the Access Points on a map and describe the orientation of the Antenna. Exporting maps to CMX 10.2.x
- **Cisco CMX 10.2.1 or higher—** The function of this software is to receive the information from the Hyperlocation module and antennas and then calculate the location. Furthermore, it provides this location via a display on a map of client locations and an API with the calculated location. The L-AD-LS-1AP-N **–** CMX Advanced License for 1 AP is required.
- **Cisco Unified controller 8.1(MR3) or higher—** The function of this software is to support the new hardware and provide a tunnel for the information from the WSM to get to the CMX 10.2.1 server
- In addition to these components, you will also need an NTP server (application or router running on same subnet) as you will need to configure the controller to sync with an NTP server through the Hyperlocation settings. You will also need to configure a gateway on the switch and controller.

Minimum Hardware Requirements for Hyperlocation

- Suitable Cisco controller such as 2500, 5508, 5520 etc. running 8.1(MR3) or higher
- AP-3600 or AP-3700 These are the current Cisco Access Points supporting Hyperlocation modularity
- AIR-RM3010L-x-K9= Hyperlocation Module with Advanced Security
- AIR-ANT-LOC-01= Hyperlocation Circular Antenna

- Wireless clients (tablets, smartphones and so on)

Figure 1: Modular Components for Hyperlocation



Hyperlocation Feature Introduction

Overview of Hyperlocation

Hyperlocation is a combination of a new Hyperlocation module with Advanced Security that replaces the older WSSI/WSM: AIR-RM3000M module which does not support Hyperlocation as it lacks the ability to support an advanced Hyperlocation antenna system.

- Advanced WSM support (as a stand-alone module) similar to the older WSM but with 802.11 20,40 and 80 MHz support (non-serving radio)
- Advanced WSM & location when used with the Hyperlocation antenna
- FastLocate support (non-serving radio)
- Integrated Bluetooth Low Energy “BLE” Beacon transmit capability.

The Hyperlocation methodology of calculating location using Angle of Arrival (AoA) tracks 802.11 OFDM clients (meaning 802.11a/g/n/ac clients) that are associated (connected) on the network and is able to do so with much higher accuracy than conventional Real Time Location Systems (RTLS) that rely on only RSSI (RF Signal Strength).

The final calculation of location not only utilizes Cisco's AoA method but also takes into account many other factors including RSSI for a very accurate location assessment.

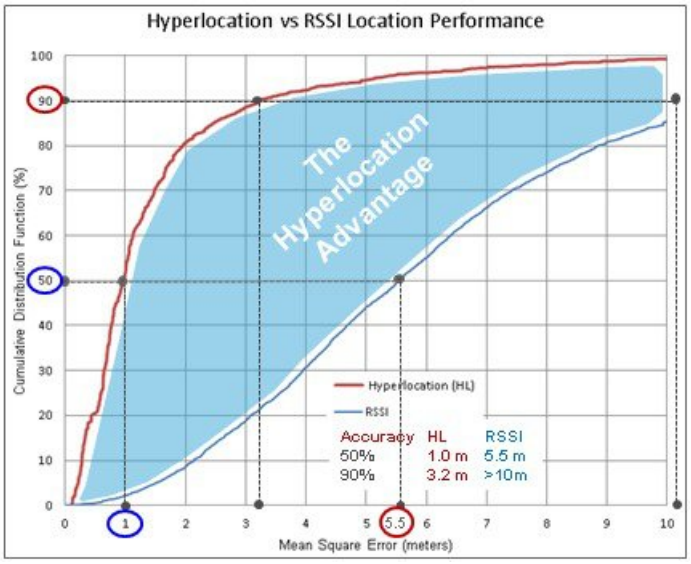
Note AoA Hyperlocation (at this time) does not track “pure” 802.11b clients as AoA works best with OFDM emissions meaning 802.11a/g/n/ac associated clients so 802.11b clients will be tracked using conventional RSSI data.

Hyperlocation is not designed (in this software release) to track passive/active (non-WiFi) RFID tags or Bluetooth Low Energy “BLE” beacons, or non-associated clients with Hyperlocation accuracy.

Note While the hardware is capable of tracking such devices, these features using Hyperlocation high precision accuracy are not available today in software and are being considered in subsequent releases.

Hyperlocation provides a distinct increase in location calculation capabilities, (as shown in Figure 2 below) increases in location accuracy with the bottom curve on the chart is a Cumulative Error Distribution Function (CDF) based on calculating location using the standard RSSI method and the top curve is the CDF function of a location calculated using Hyperlocation technology. The difference between the two curves is the increase in accuracy you get by using Hyperlocation technology.

Figure 2: Increases in Location Accuracy with Hyperlocation



Hardware SKUs for Hyperlocation Access Point components

The Hardware SKUs that are required for Hyperlocation are:

- **Hyperlocation with Advanced Security Module—**Cisco P/N AIR-RM3010L-x-K9
- **Hyperlocation antenna array—**Cisco P/N AIR-ANT-LOC-01=

These are shown in Figure 1

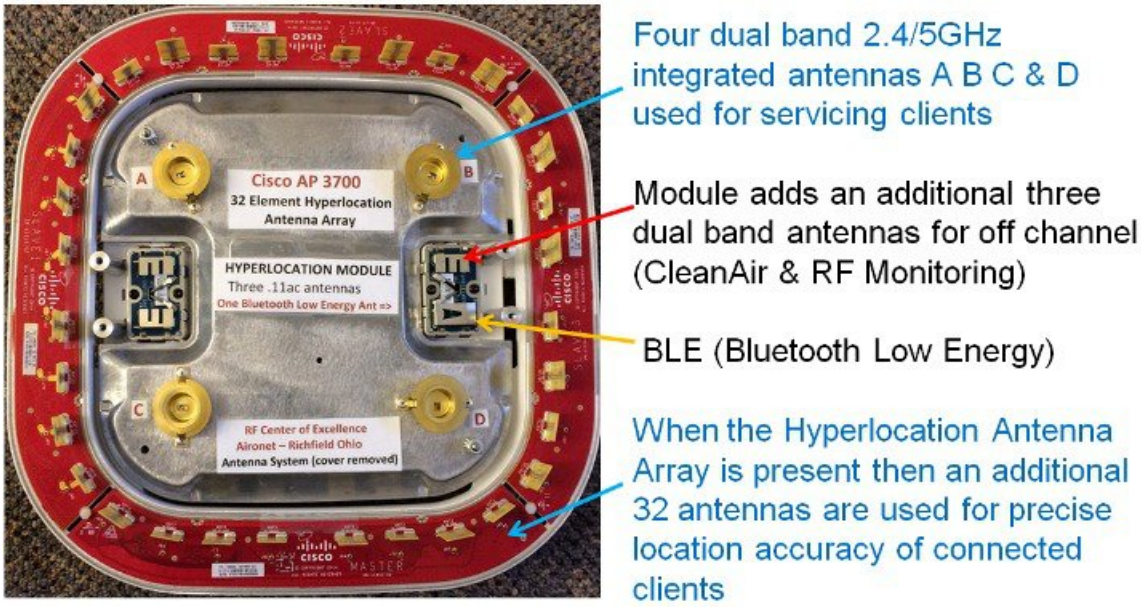
Hyperlocation—Overview of the Antenna System

The Hyperlocation (Circular Antenna Array) is a 32-element antenna design that provides 360-degree coverage around the Access Point. It is designed to integrate into the Hyperlocation module with Advanced Security providing precise RF Angle of Arrival (AoA) information allowing the embedded software the data required to calculate location using a more granular approach.

The antenna array and Hyperlocation Module with Advanced Security integrate into the Cisco 3600 and 3700 Series Access Points using the module option allowing both module antennas (center) and Hyperlocation circular array (outside) example below is an AP-3700.

If you could take the cover off the product, here is how it would break down (module in middle) antenna array around the AP. All of the antennas (around the AP) determine precise location.

Figure 3: WSM w/Advance Security and Hyperlocation Circular Antenna (a look at the antenna systems)



Hyperlocation Module with Advanced Security Overview

Hyperlocation Module with Advanced Security features and caveats include:

- No requirement to deploying a separate and dedicated overlay of AP's in monitor mode for full spectrum monitoring

  Eliminates the need for an extra cable pull and additional infrastructure costs Module draws its power from the Access Point

- A field-upgradable 3rd Radio module add-on to the AP3600 and AP3700 Series APs Dedicated 2.4 GHz and 5 GHz radio—both bands supported in a single module.
- No configuration required—module automatically scans all channels on both bands Independent integrated antennas within the module 3 Tx antennas x 3 Rx antennas Additional antenna and radio for Bluetooth beacon functionality
- Enables 3600 & 3700 Series Access Points to be the only AP to concurrently:

  Serve clients on 2.4 and 5 GHz—with internal integrated radios and antennas 4x4:3

  Perform wIDS/wIPS security scanning on both 2.4 and 5 GHz bands all channels

Perform CleanAir spectrum analysis on both 2.4 and 5 GHz bands on all channels

- Offloads CleanAir monitoring and WIDS/WIPS Security capabilities to the Monitor Module CleanAir, wIDS/wIPS, Context-ware location, Rogue Detection and RRM

  Always on full spectrum analysis, on all channels for both 2.4 and 5 GHz bands.

- Hyperlocation with Advanced Security Module can be purchased with or without the Hyperlocation antenna array.

  Customers will be able to field upgrade existing 3600 and 3700 APs with WSM or WSM +Hyperlocation

- No configuration is required - easy field upgrade customers simply:

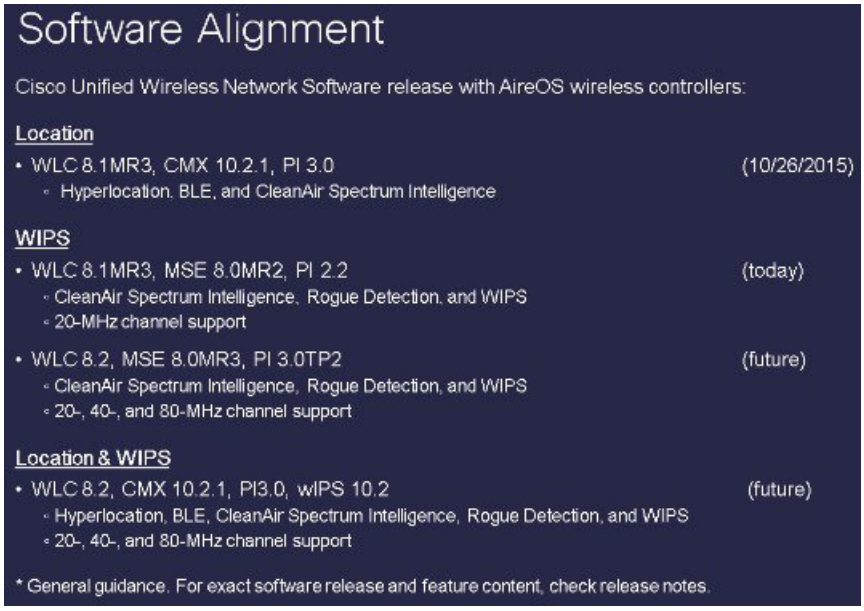
  Install the Wireless Security Module or WSM + HYPERLOCATION into the bottom of the Access point (see figure 1) Power on the AP and all the Monitoring and Security capabilities will automatically be offloaded to the Monitor Module

Installing the Hyperlocation Module

Power down the 3600 or 3700 Series AP.

Install the Hyperlocation module with Advanced Security into the bottom of the Access point (see figure 1) Power on the AP and all the Monitoring and Security capabilities will automatically be offloaded to the Monitor Module.

Figure 4: Software alignment with new Hyperlocation Module



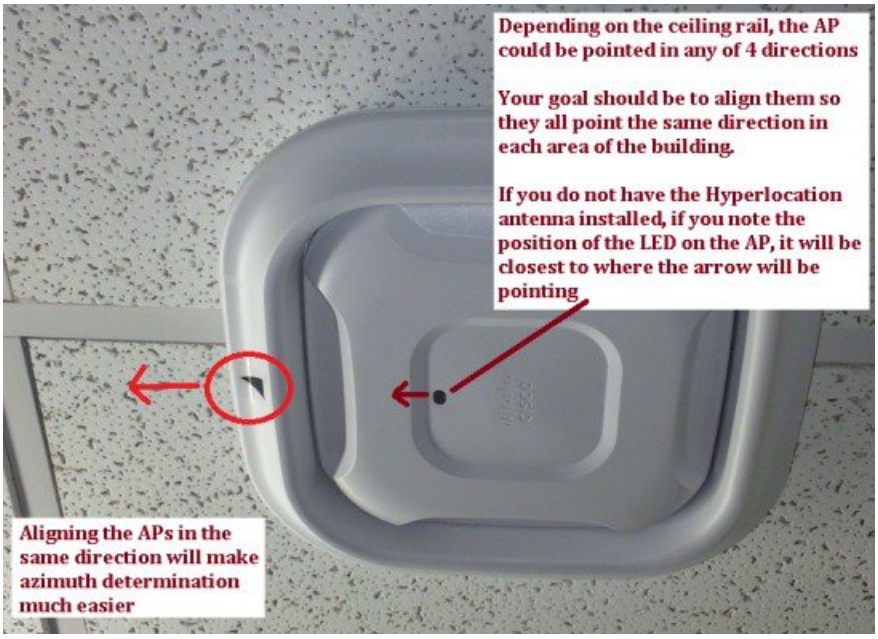
Preparing an existing site for Hyperlocation

In this initial release, before installing Hyperlocation it would be good for the installer/operator to become familiar with the operation of Cisco Prime, CMX and current methods of performing Real Time Location Systems (RTLS) using conventional signal strength (RSSI) if possible before the introduction of Hyperlocation hardware or it is suggested to install with the Hyperlocation hardware installed but initially disabled.

This will enable to user to make current location assessments are using RSSI based methods and then to see the marked improvement once Hyperlocation is installed rather than try and debug or determine location / accuracy issues without an RSSI or similar location baseline in place.

To prepare the environment, (assuming Access Points are installed and you are going to add the Hyperlocation components later, the Access Points if currently installed on the ceiling rails have the possibility of being installed in any of four 90 degree positions. Ideally you want to get the APs in a position where they are all aligned similar so you can easily determine "arrow" AP orientation <azimuth>, X-Y and ceiling height information and minimize confusion and user entered errors.

Figure 5: Understanding AP placement and alignment



Hyperlocation

Getting started—AP Placement and Installation instructions

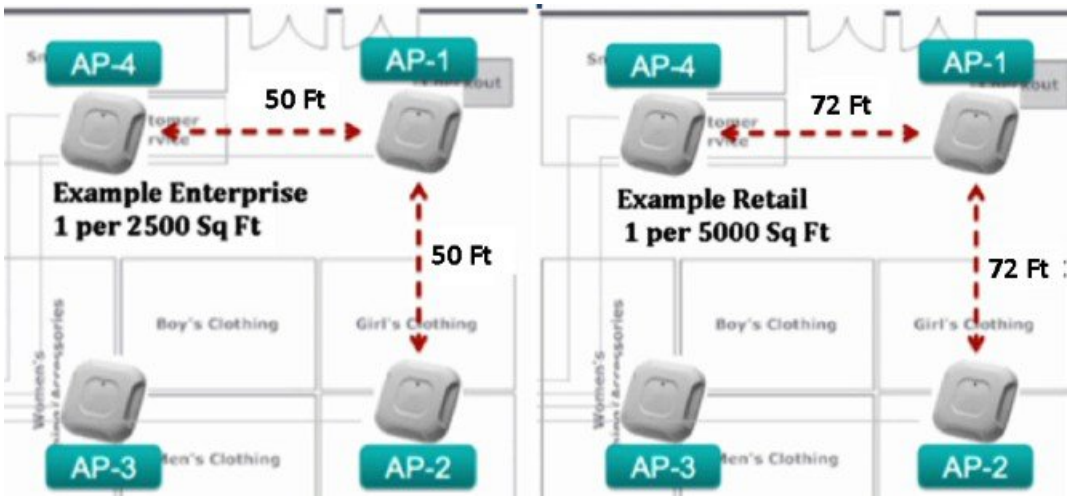
1. In this release, we have a limitation on 1 x WLC to 1 x CMX 10.2.x. Right now no other CMX or MSE system should be assigned to the same WLC during your testing or it may impact AoA. Any given controller can only talk to a single CMX 10.2.x system running AoA. (A second non-Hyperlocation CMX 10.x system can be added, but ensure that this system NEVER has Hyperlocation feature enabled).
2. Install the Hyperlocation Access Points; try to keep the spacing between 30 to 70 ft (maximum) apart. Ideally 50 ft. apart is recommended (make sure to document your spacing) – Bring them in closer if you have lots of walls, clutter etc. 50-60 ft or closer is best to get AoA locations calculated. When the AP is much further away from the client there is more likelihood that the client will not be located via Hyperlocation.
3. Installation should be done using AIR-AP-BRACKET-2 which should be supplied with the module. Bracket1 and Bracket-3 (in-tile bracket) are not designed to be used with the HYPERLOCATION array.

4 A general rule of thumb is to have 3 or 4 access points that are within line of sight of the device at a distance of less than 70 feet. (Please note, if you are conducting this test in Meters, please make sure to translate all numbers, the CMX 10.2.x software only supports display of the X,Y location of clients in feet.

Note 1m = 3.28 ft.

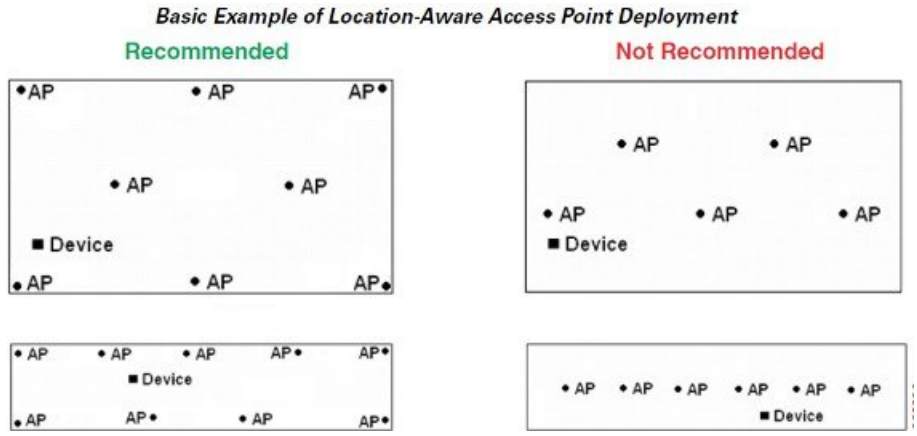
Some basic guidelines on Site Surveys/deployments…

- Survey or try to maintain consistent -65 dBm RSSI for data, voice, video, location
- 10 to 20% cell overlap for optimized roaming and location calculations
- A good rule of thumb is 1 Access Point per 2,500 square feet (best performance)
- For high density applications perhaps add an additional AP in the middle.



Note Provide spacing during the installation for better accuracy and add one in the middle.

Figure 6: Note Spacing during Installation - avoid metal obstructions near the AP antennas



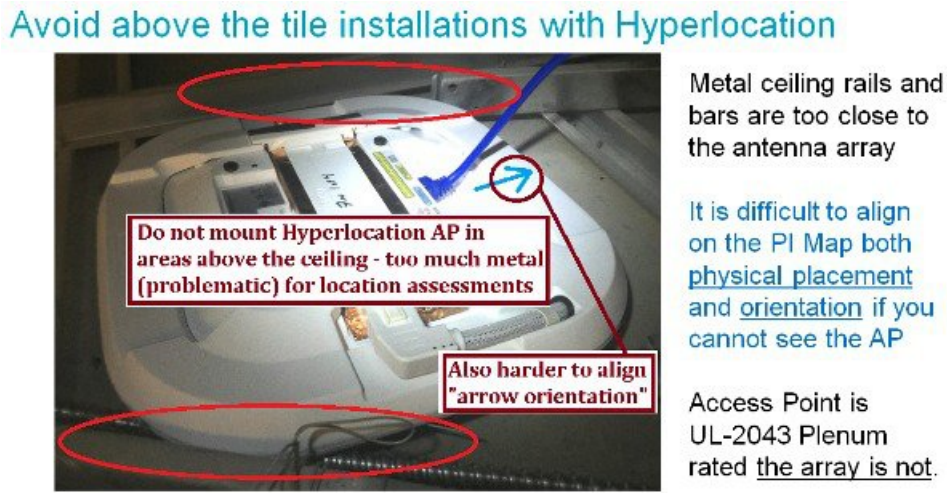
Note Spacing during Installation - avoid metal obstructions near the AP antennas

Figure 7: AIR-BRACKET-3 is not compatible with Hyperlocation Antenna AIR-ANT-LOC-01=

AIR-BRACKET-3 is not compatible with Hyperlocation Antenna AIR-ANT-LOC-01= AIR-BRACKET-3 is not supported due to the mechanicals of the Hyperlocation Antenna Array and the requirement for a precise Azimuth location.

Note It may be used when only the Hyperlocation Module is used for Security and FastLocate.

Figure 8: Avoid mounting the Hyperlocation AP above the ceiling tiles

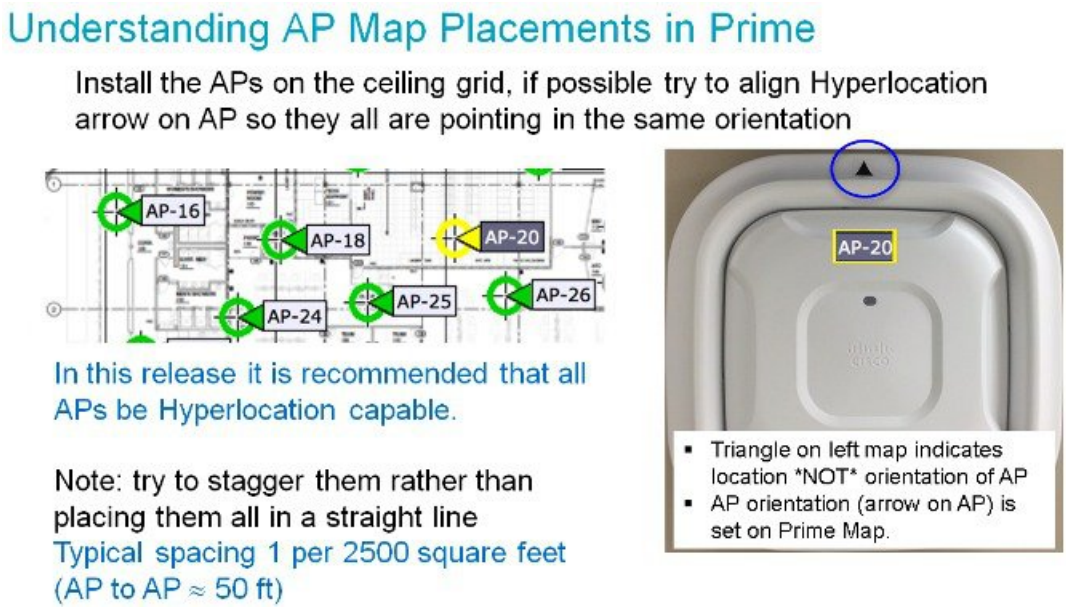


Importance of AP Placement when using Hyperlocation

With Hyperlocation, it is essential that the EXACT location of an AP be recorded and correctly entered into Prime Infrastructure (PI). The location needs to be accurate down to several inches. Location error is compounded by location of several AP's being off, so it is essential that the X-Y and height of the AP in relation to the map in Prime be correct down to 1 inch. In addition, the orientation of the antenna needs to be correctly set in Prime and correct to within 5 degrees.

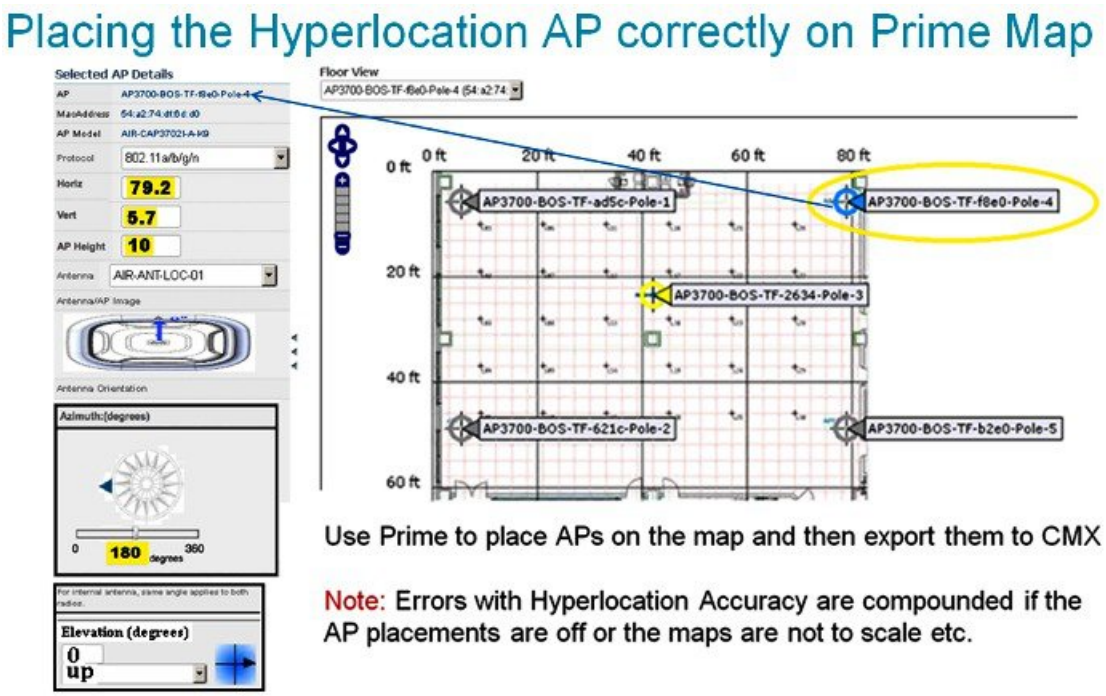
Please record these four attributes of each AP and double check these before they are entered into PI.

Figure 9: Understanding AP Map Placements in Prime



Now let's set the AP position on the Prime Map.

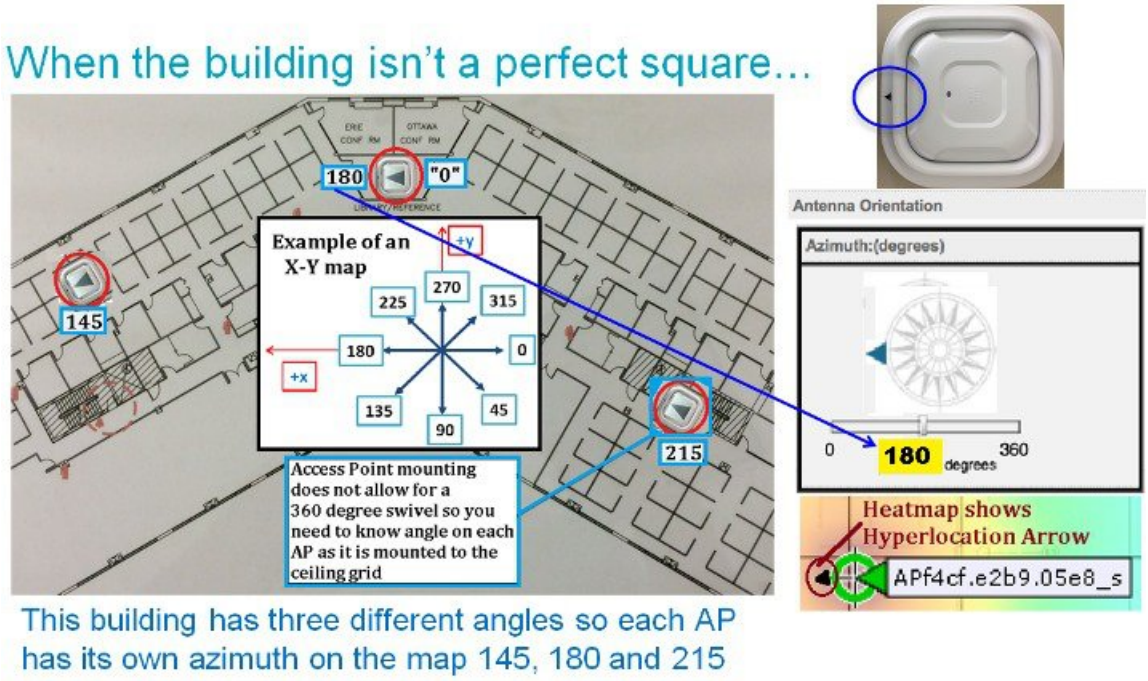
Figure 10: Placing the AP on the Prime map



Prime defaults on Azimuth (right=0) (left=180) in this case the AP is pointing with the arrow to the left.

Azimuth gets more complicated when the building map isn't a "perfect square" this is why it is strongly suggested that the Access Points be installed so they are all aligned facing the same direction.

Figure 11: Placing the AP on the Prime map



Prime defaults on Azimuth (right=0) (left=180) in this case the AP in the top of the picture is pointing left and so 180 is entered in the Azimuth.

Of course the X-Y map can be in other orientations, and in the case of this particular building (only the top of the building) is a "square" so the angle of the left and right sections of the building needs to be determined.

Since ceiling grid rails are most likely the best source of a "true angle" for azimuth, it is recommended that each "group of APs" say all those on the left have their orientation in the same way if possible then once that angle (azimuth) is determined it should remain constant for the other APs in that area. This minimizes user errors as each individual Access Point has its own properties and azimuth adds to the complexity.

Additionally, the orientation angle for the Access Point internal antenna (the antenna servicing clients) its angles should be set to the same as the Hyperlocation antenna.

Figures below shows simply reinforce azimuth angles should be consistent.

Figure 12: Configuring orientation of Internal Antenna

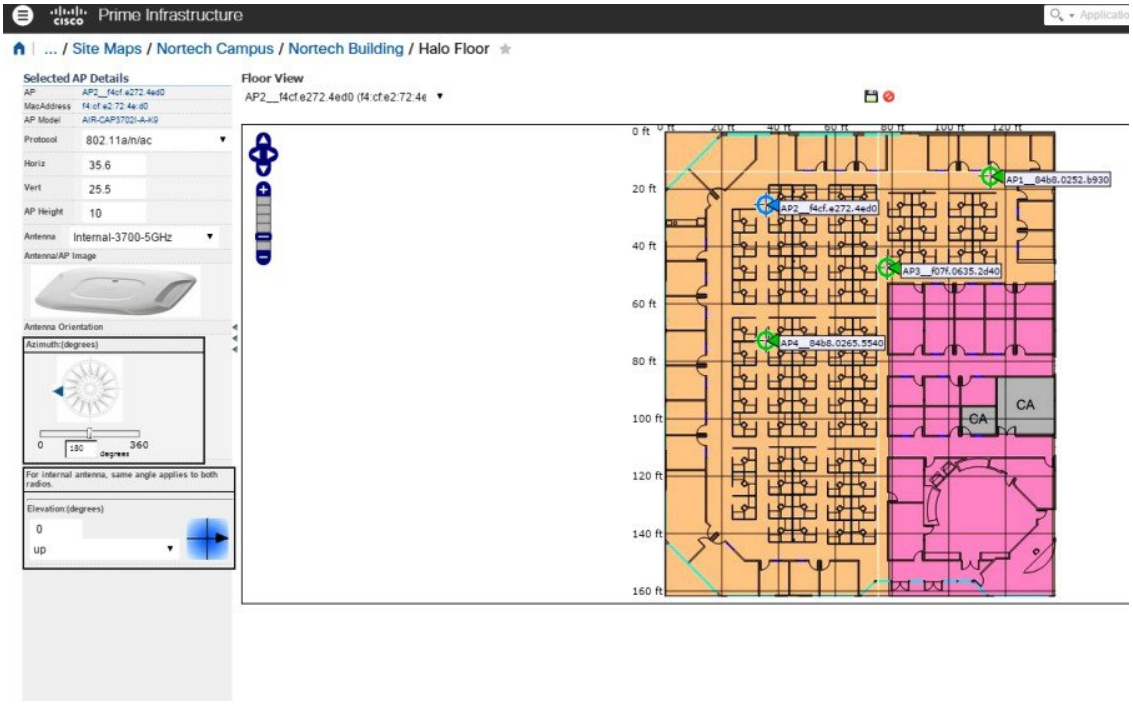
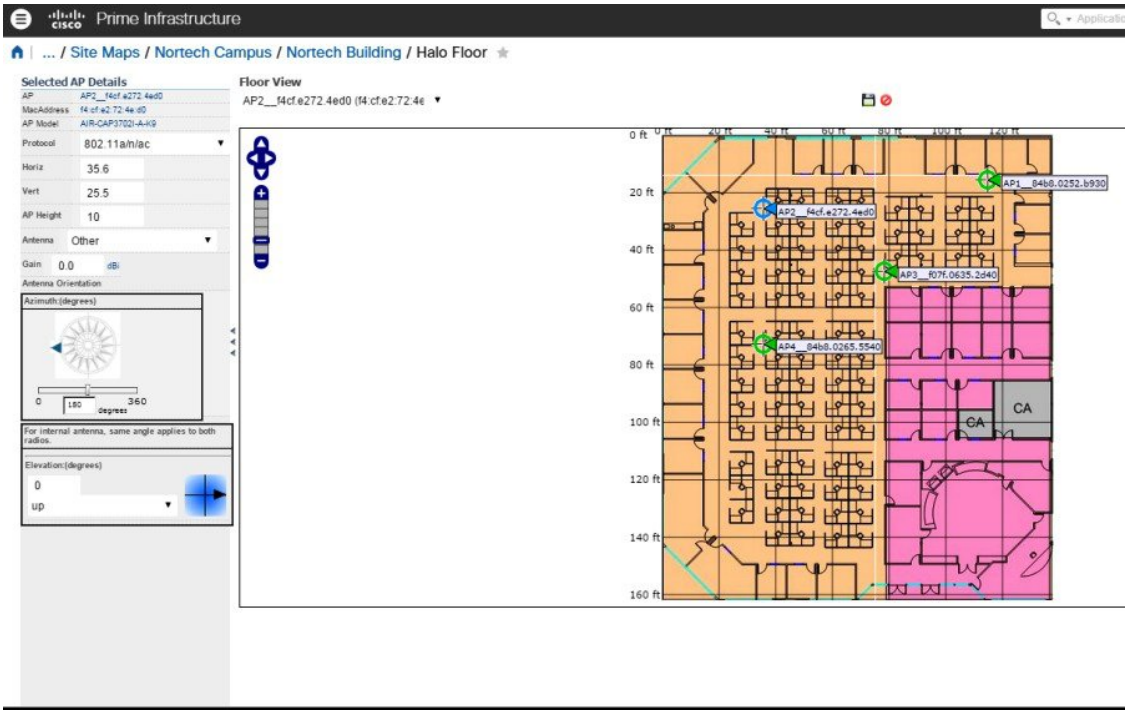


Figure 13: Configuring orientation of Hyperlocation Antenna



Some suggestions to help ensure that these four pieces of data are correct are:

- Use a laser measure to record the height of the AP and to check the distance between access points and fixed locations.
- Photograph the access point to ensure that the light and the direction that the AP is correctly recorded.
- Record data on chart before entering into Prime.

Note The importance of the location accuracy cannot be underestimated. There are many times when the maps that are being imported are not accurate. As such, it can be a problem to place the AP with respect to landmarks on the map as the landmarks may be incorrectly place. Also, when looking at maps in Prime and then later in MSE, pay attention to the orientation of the maps as they might not be in the same orientation when importing and exporting maps.

A good technique is to use a floor roller to map the distances between access points. This can be used to correct the location of APs on the map. The process would be to fix one AP and then measure the distance to additional Access Points.

These additional Access points can be measured in both the X and Y direction and this offset can be verified to be correct in Prime. This is a manual process but is essential for getting to the +/- 1 Meter accuracy that is possible with this module.

Note Sometimes it is easier to mark the floor with the location of the Access Point by using a “plumb bob”. This allows the floor roller to measure the location without guessing your position.

Getting Started with Hyperlocation

To get started with the Hyperlocation,perform the following steps:

Procedure

Step 1 Install the WLC Software.

Step 2 Install the MSE Software.

Step 3 Install the PI Software.

Step 4 Ensure all systems are communicating with each other.

a) The WLC should be added to PI and the APs should appear in PI.

b) The MSE should be configured to communicate with PI and the basic maps should be synced from PI to the MSE.

Step 5 Install APs.

Step 6 Place AP on MAP in Prime.

Step 7 Orient AP antenna in Prime.

Step 8 Update MAPS in MSE by resyncing from PI to MSE.

Step 9 DISABLE HYPERLOCATION Module. This is performed in the controller software “Slot 2” on the radio.

Step 10 Test Basic Location using RSSI only (i.e. Test standard location).

Step 11 Enable the Hyperlocation Module in WLC.

Step 12 Enable Hyperlocation in CMX 10.2.x.

Step 13 Test Hyperlocation with a location accuracy test of 20 points with at least 2 devices and track results.

Step 14 ENABLE HYPERLOCATION Module and switching to Hyperlocation mode for location calculations. This should be a test using all of the standard defaults.

Step 15 Test Hyperlocation with a location accuracy test of 20 points with at least 2 devices and track results.

Step 16 Enable BLE Beacons in WLC.

Step 17 Test BLE with at least two devices in at least four locations.

Step 18 Document and track results.

CMX 10.2 Installation Steps

Before proceeding with doing location accuracy testing, you should ensure that CMX 10.2 is correctly installed.

A CMX 10.2 Installation/configuration guide is available on CCO, this is a quick overview of the steps required.

- Deploy the Installation OVA using VMWare 5.5 (VMWare versions below that are not supported).

  If VMWare 5.0 is only available, you can install a CMX 10.1 system from CCO and upgrade it to CMX 10.2.x.

- Follow the Installation Guide

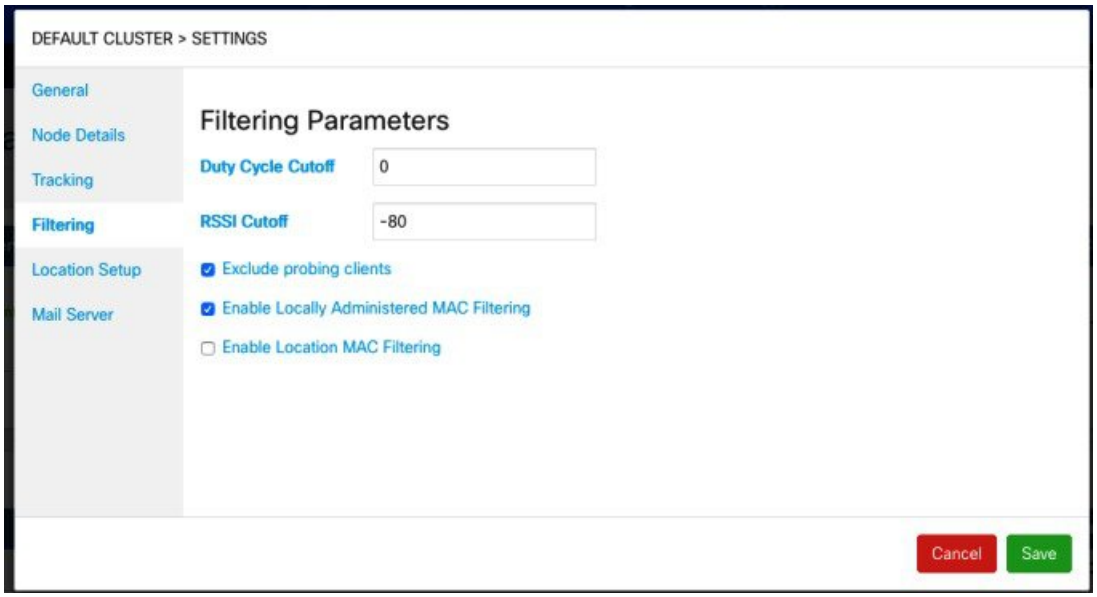
  The Installation file to use will have a file name similar to this one (depends on version used) Cisco_CMX-10.2.0-150.ova

  Make sure that the system is designed to use the large-scale CMX 10.2.1 deployments. Specifically 16vCPU, 32Gig RAM and at least 500 Gig HD space.

- Upgrade the Installation immediately to .CMX version 1108.

- Upgrade procedure is in the Installation Guide. Use the GUI based upgrade.

  To setup CMX 10.2.1 to track only associated clients; please make sure that the checkbox "Exclude Probing Clients" is checked as shown:



PI 3.0 Installation

Please install latest posted Prime Infrastructure (3.0 or higher).

PI-APL-3.0.0.0.65-1-K9.iso Should have an ISO with a similar name as above (depends on version).

The size of the PI instance does not have an impact on the solution. Please do not associate any other MSE with this PI instance until basic location is validated and working.

Procedure to Bring up the AP and join with the Controller

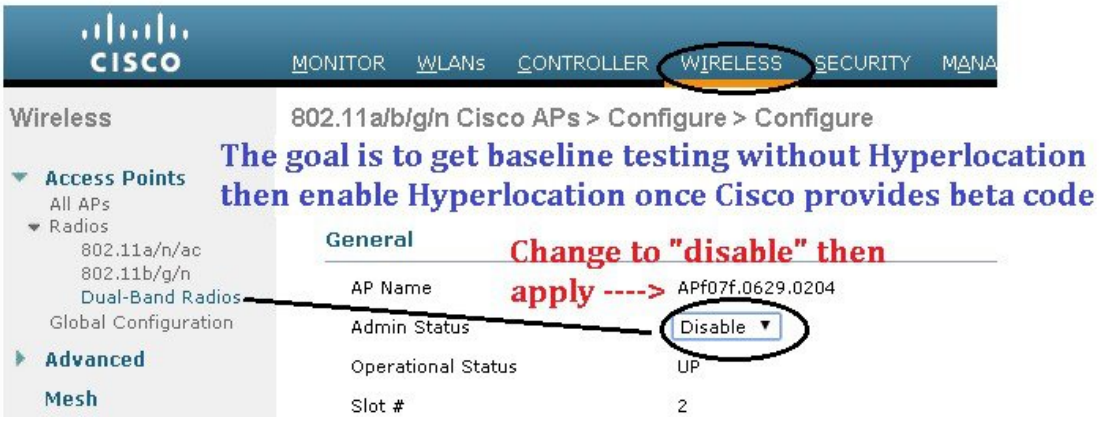
Procedure

Step 1 Verify the APs join the controller, if they do not - then verify date/time is accurate on controller, verify you have the same gateway defined in the controller & switch and they are reachable, also make sure the switch can provide PoE+ (802.3at power) or use local power or AIR-PWR-INJ4 PoE mid-span injector.

Step 2 Again if you have not done so, you will need to configure a gateway on the switch making sure the gateway is reachable from all the ports the APs are connected to.

Step 3 Once the AP has joined the controller you can verify see below.

Note For now you may want to disable the Hyperlocation module if you are going to do location testing initially without the Hyperlocation device.



At this point, the AP should be connected to the controller and running without the Hyperlocation with Advanced Security module running.

Placing AP on Map in Prime

For a basic overview on location-based services (reference only) see the following URL
http://www.cisco.com/c/en/us/td/docs/solutions/Enterprise/Mobility/WiFiLBS-DG.pdf

This is an older design guide based on RSSI (Signal Strength) but has good best practice information to be used along with this deployment guide.

If you have not done so, now is the time to place AP's on the map using Prime 3.x noting the orientation of the Hyperlocation module. It is important to emphasis that the locations entered into Prime must be accurate.

Note

- You must use the PI 3.0 or higher in order to set the orientation of the AP on the map.
- You will want to note the position of the AP on the map in CMX10.2.x (see Arrow or location marker "0 degree" on the AP).

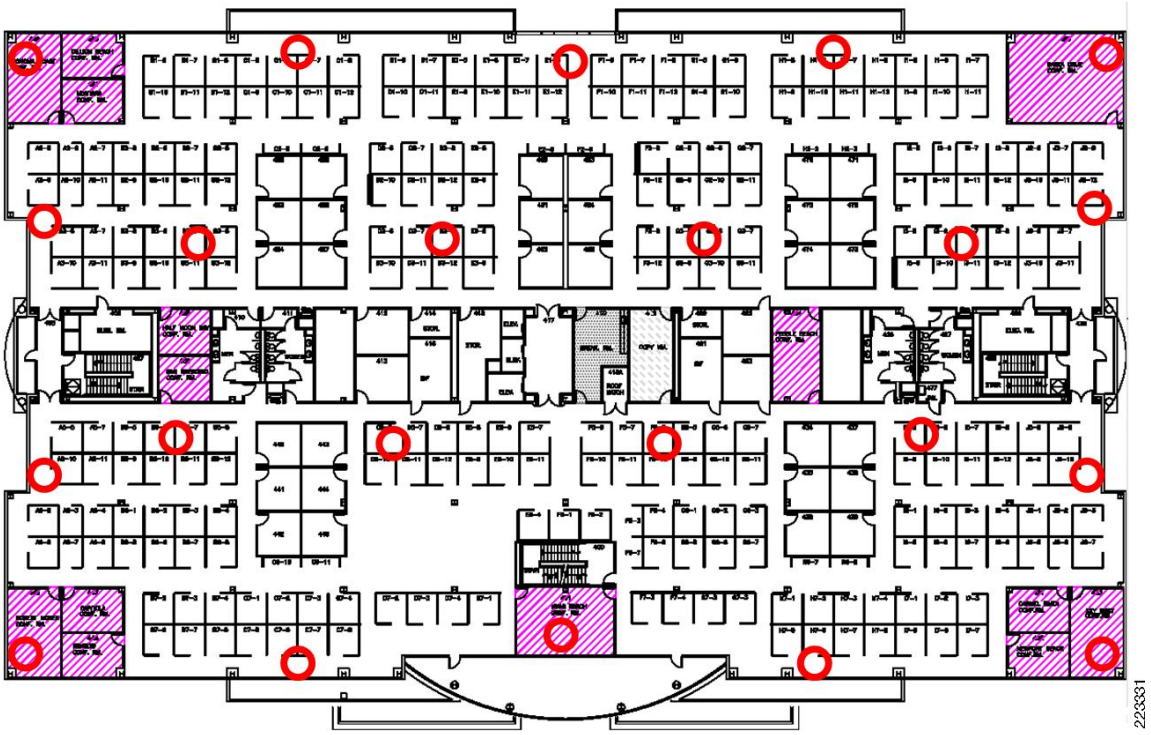
For an overview on maps within Prime see the following URL.
http://www.cisco.com/c/en/us/td/docs/wireless/ncs/1-0/configuration/guide/NCS10cg/maps.html

Figure 14: Hyperlocation array with azimuth marker location arrow (circled in red) needs to be indicated on the map

It is very important that you indicate on the PI map the orientation of the AP.

If your map has good granularity such as the map below, Enterprise indoor location map showing cubicles) then it should be easily able to determine client accuracy – If however, this is a warehouse or other large area, you may need to best determine accuracy by perhaps placing grid coordinates on the floor or fine tuning the maps with landmarks in your environment. Cisco Internal.

Figure 15: Enterprise Indoor Location Map Showing Cubicles



Note You will want to limit your location assessments to active associated clients since Hyperlocation (in this release) only tracks associated clients.

At this point, you may want to spend some time performing location assessments using standard RSSI based location. This will allow you to verify the system works without the Hyperlocation components and gives you a baseline before going to Hyperlocation.

Please spend some time to get familiar with the environment and collect screenshots and location accuracy test should be completed without the Hyperlocation components enabled.

Setup many different clients associated to the network, note their positions on the map, perhaps run some baseline throughput testing, as it would be good to characterize the AP performance without Hyperlocation and then again using Hyperlocation.

At this point, baseline testing is complete and we can move to enabling the Hyperlocation module and testing location accuracy with the module enabled.

Procedure to Ensure AP are Correctly Positioned on MAP in PI

To ensure AP are correctly placed on MAP in PI, perform the following steps:

Procedure

Step 1 Make sure map is updated on PI with correct AP placement and orientation noting the “zero degree” placement (triangle on the AP) closest to the LED on the AP (in the case of 3700).

Step 2 How to do this has been previously defined.

Step 3 You should be able to verify Access Point placements on heatmap with arrows.

The next step in the installation involved getting the CMX 10.2.1 system synced with the MAPS and the CONTROLLER of the PI 3.0 system.

This can be done with either the GUI method or by using Import / Export method. Both methods are detailed below. The GUI method is recommended.

GUI Method for Importing WLC and Maps from PI to CMX 10.2

To import WLC and Maps from PI to CMX 10.2, perform the following steps:

Procedure

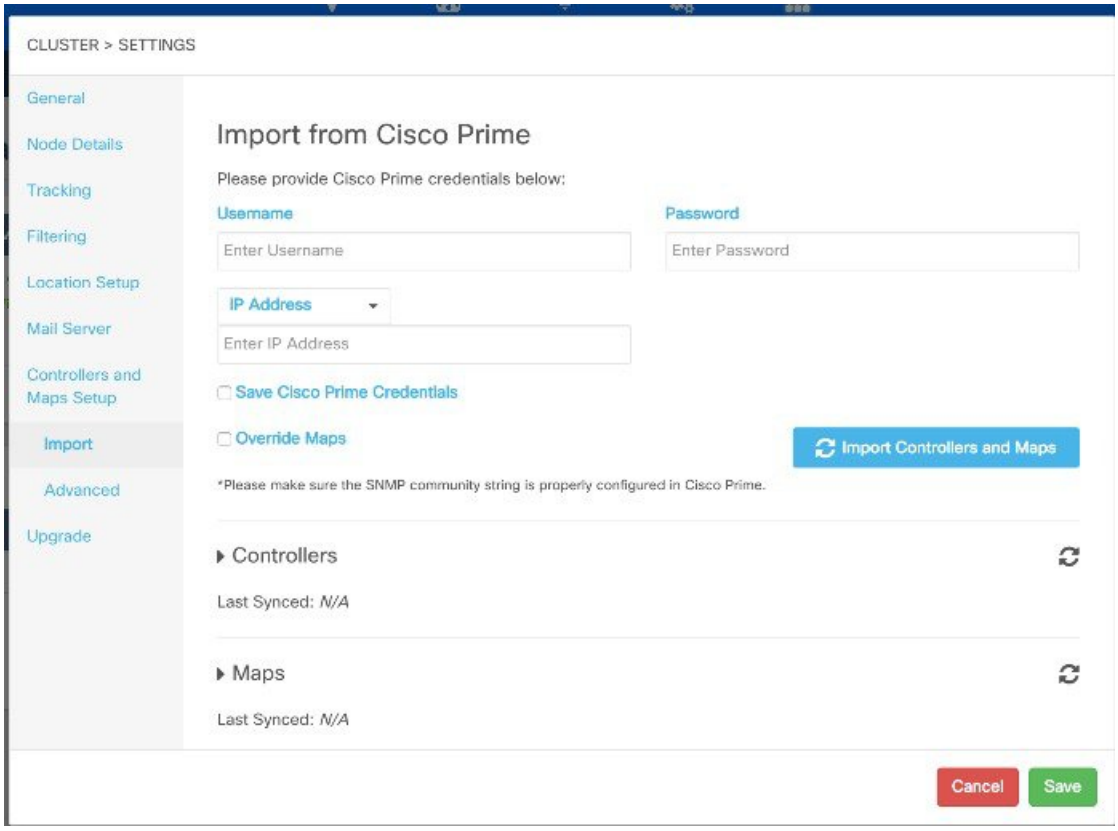
Step 1 Navigate to the SYSTEM -> * setting page on CMX 10.2.x.

Step 2 Click Controllers and maps setup.

Step 3 Enter the credentials for PI like IP address, Username and Password

Step 4 Check **Override Maps** and **Save Cisco Prime Credentials** checkbox.

Figure 16: Import Parameters on CMX 10.2.x



Step 5 Click **Save**.
The system will use SNMP to extract all of the data required and the WLC and Maps will be synced to the CMX 10.2 instance.

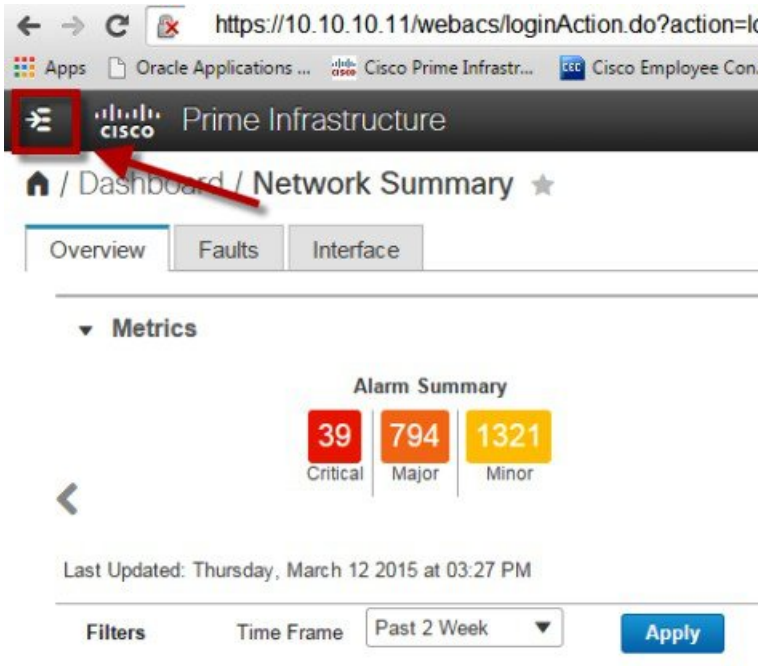
Import and Export Method to extract WLC and MAPS from PI to CMX 10.2

To extract WLC and MAPS from PI to CMX 10.2 using import or export method, perform the following steps:

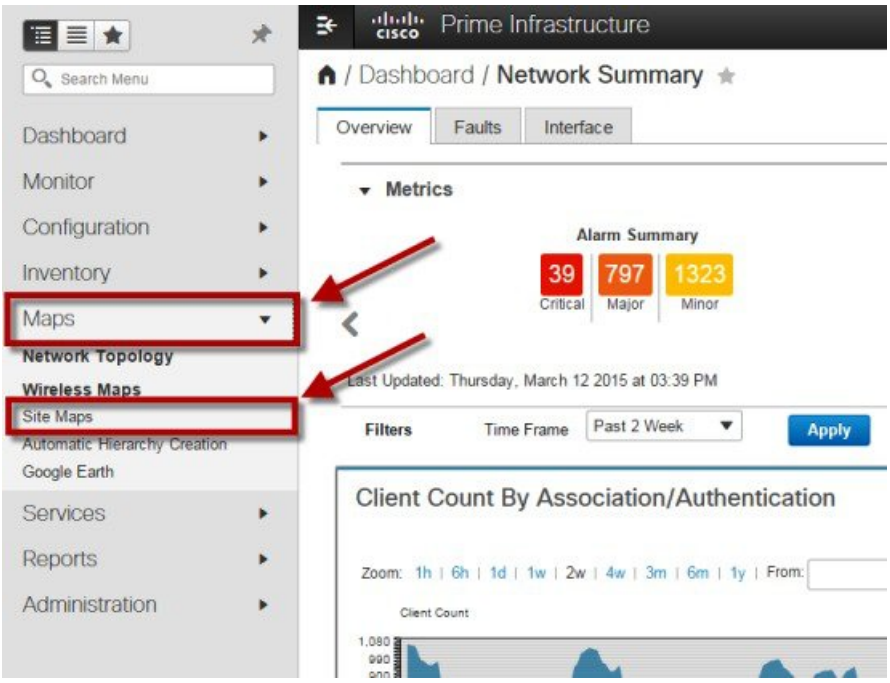
Procedure

Step 1 Export the maps from PI 3.0.

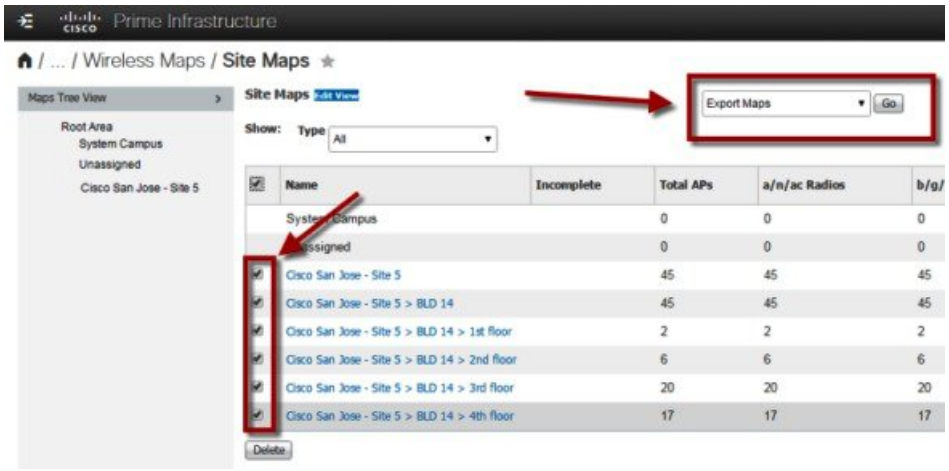
a) Click **Navigation** to view the options.



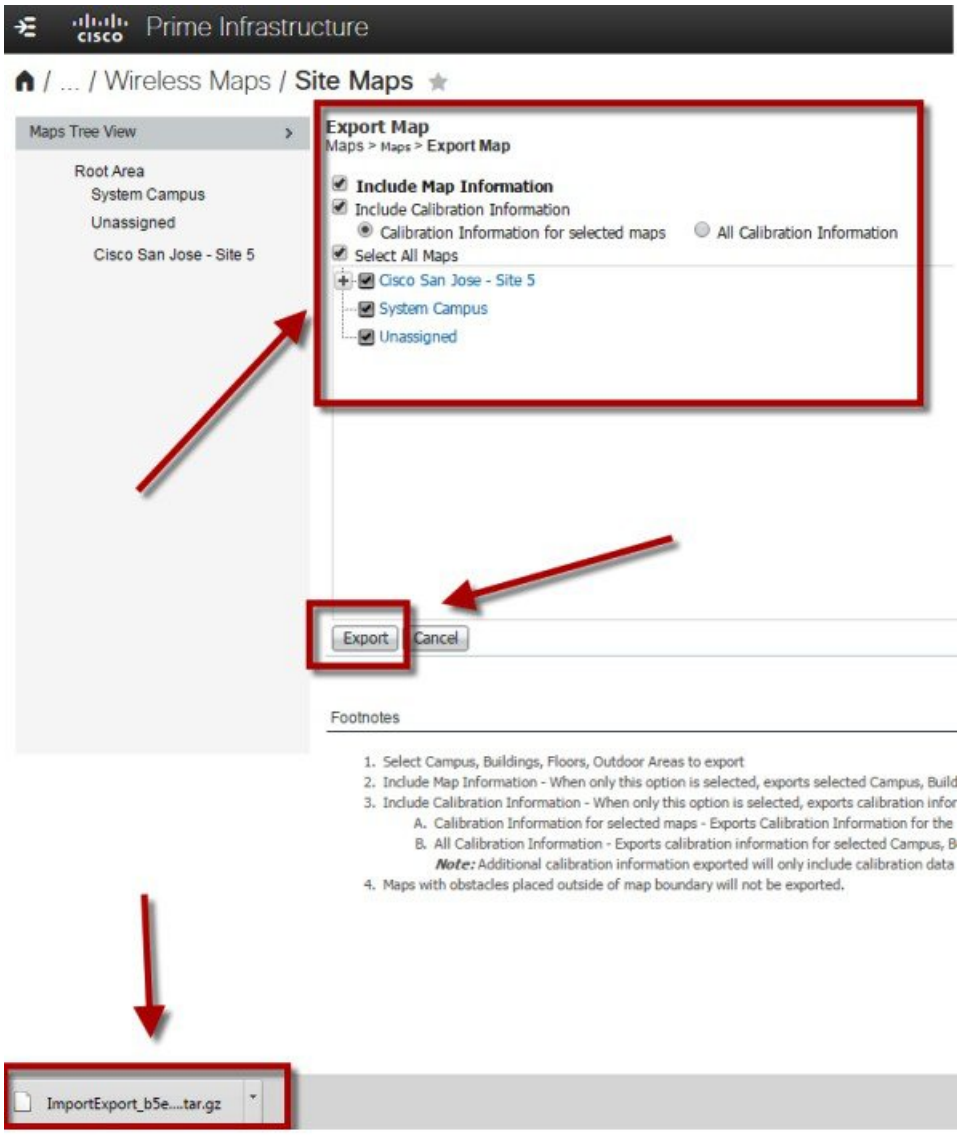
b) Select Maps and then Site Maps.



c) Select the maps you want to export. On the right drop down menu select Export and then click **Go**.



d) Click **export**.
Make sure the maps are selected for Export.



Step 2 SSH into the CMX 10.2 server using any method.

Import Maps

Procedure

Step 1 Run **cmxctl config maps import** to import Maps from PI directly.

```
[root@mse-halo ~]#
[root@mse-halo ~]# cmxctl config maps import
Please specify import type [PI / FILE] [FILE]: PI
Please enter PI ip address: 10.10.10.11
Please enter PI username [root]: root
Please enter PI password [Public123]:

Import successfully started from PI 10.10.10.11. Check import status using cmxctl config import status.
[root@mse-halo ~]#
```

Step 2 Additionally you could import maps to CMX 10.2 manually. The first step in this is to copy the maps from your directory to the /home/cmxadmin directory of the system. You can only login with the “cmxadmin” USERID. Root does not have ability to ssh or sftp or scp into the system.

```
[root@mse-halo ~]#
[root@mse-halo ~]# dir
anaconda-ks.cfg                halo.answers                                  ImportExport_e92e4d14bc054498.tar.gz  install.log         qless-py-workers
cisco_cmx-10.0.0-beta.1059.x86_64.rpm  ImportExport_666e6658533db87f.tar.gz  ImportExport_f2aa97761653a3fa.tar.gz  install.log.syslog  tmp
[root@mse-halo ~]#
[root@mse-halo ~]#
[root@mse-halo ~]#
[root@mse-halo ~]# cmxctl config maps import
Please specify import type [PI / FILE] [FILE]:
Please enter map import path: ImportExport_e92e4d14bc054498.tar.gz

Imported /root/ImportExport_e92e4d14bc054498.tar.gz
[root@mse-halo ~]#
```

Step 3 Run **cmxctl config maps import --type FILE --path <path to .tar.gz file>**.

```
[root@mse-halo ~]#
[root@mse-halo ~]# dir
anaconda-ks.cfg                halo.answers                                  ImportExport_e92e4d14bc054498.tar.gz  install.log         qless-py-workers
cisco_cmx-10.0.0-beta.1059.x86_64.rpm  ImportExport_666e6658533db87f.tar.gz  ImportExport_f2aa97761653a3fa.tar.gz  install.log.syslog  tmp
[root@mse-halo ~]#
[root@mse-halo ~]#
```

Add Controllers

Procedure

Step 1 Run **cmxctl config controllers import to impor**t controllers from PI directly and follow the prompt.

```
[root@mse-halo ~]#
[root@mse-halo ~]# cmxctl config controllers import
Please specify import type [PI / FILE] [FILE]: PI
Please enter PI ip address: 10.10.10.11
Please enter PI username [root]: root
Please enter PI password [Public123]:

Import successfully started from PI 10.10.10.11. Check import status using cmxctl config import status.
[root@mse-halo ~]#
```

Step 2 Run **cmxctl config controllers add** to add each controller manually and follow the prompt. Repeat for each controllers.

```
[root@mse-halo ~]#
[root@mse-halo ~]# cmxctl config controllers add
Please enter controller type [WLC / NGWC] [WLC]:
Please enter controller ip: 10.10.10.5
Please enter the controller version [Optional]:
Please enter controller SNMP version [v1 / v2c / v3] [v2c]:
Please enter controller SNMP write community [private]:
```

Step 3 By default SNMP connection timeout is 60 seconds. If this timeout is not sufficient and has to be further increased to support slower controllers, export SNMP_CONN_TIMEOUT_MS environment variable with the number of milliseconds For instance, if the overall SNMP connection timeout is to be increased to 90 seconds, **export SNMP_CONN_TIMEOUT_MS**=90000.

Note Configuration and NMSP have to be restarted after the variable is exported. On a proxy node, NMSP proxy has to be restarted.

Step 4 Please enter controller type [WLC / NGWC] [WLC]: WLC

Step 5 Please enter controller ip: 1.1.1.1

Step 6 Please enter controller SNMP version [v1 / v2c] [v2c]:

Step 7 Please enter controller SNMP write community [private]:

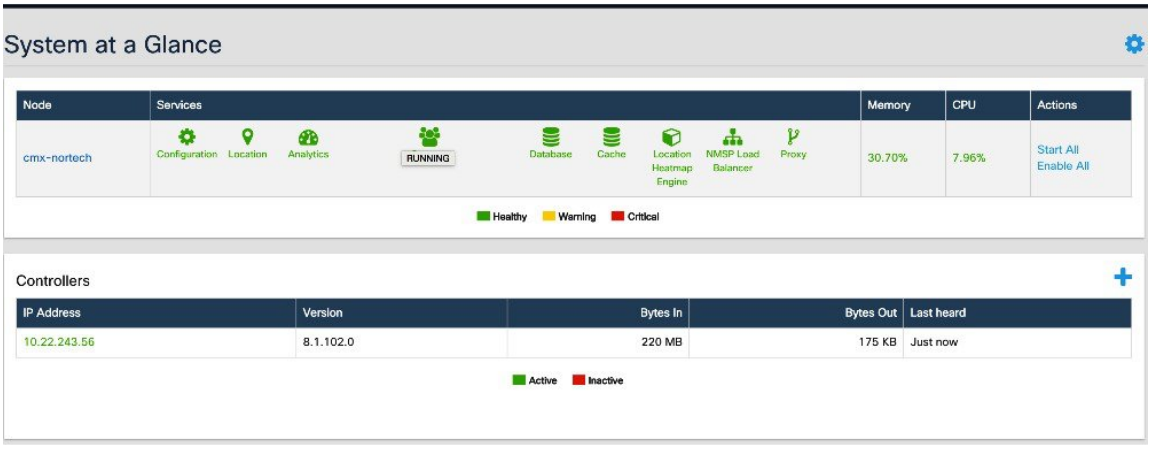
Verifying Import Status in UI

Procedure

Step 1 Logon to UI using default **username/password of admin/admin**. http://<MSE-IP>/.

Step 2 Check Systems tab to verify list of controllers and its connection status.

Step 3 The controllers that are running correctly will appear in GREEN



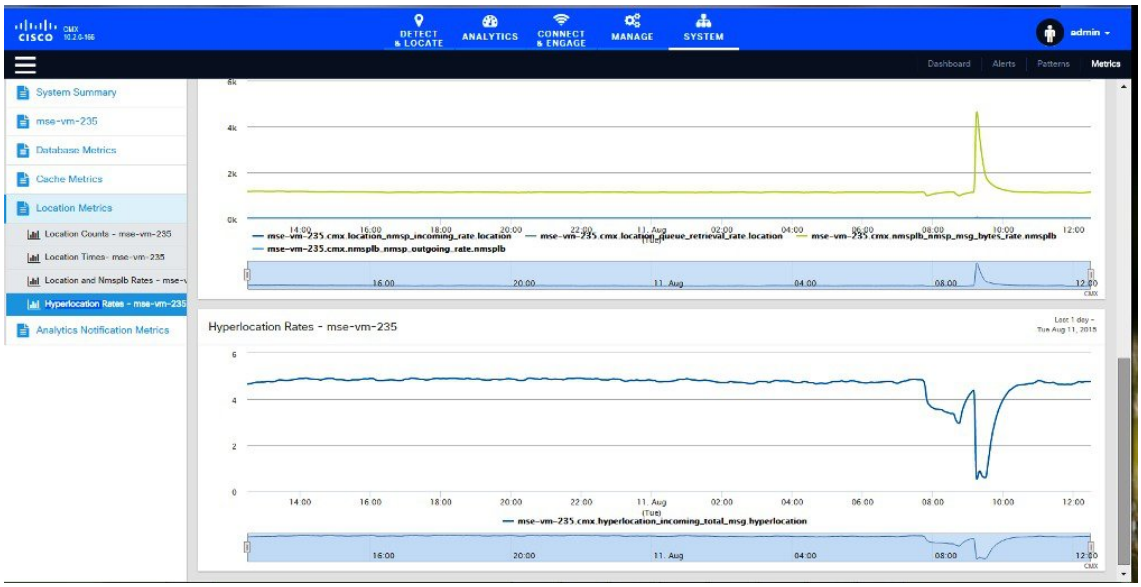
Step 4 Check 'Detect and Location' tab to verify clients on the MAP.

Step 5 Check 'Analytics' tab to verify current visitor count and dwell time.

Monitoring the System

You can monitor the system to ensure that Hyperlocation packets are coming in and being process with the system GUI. The LOCATION tab has a METRIC for Hyperlocation calculations that can quickly be used to determine if Hyperlocation is functioning correctly.

This Metric is as shown. If this metric is zero, troubleshooting of the installation is required.



Firewalls and Packet Flow

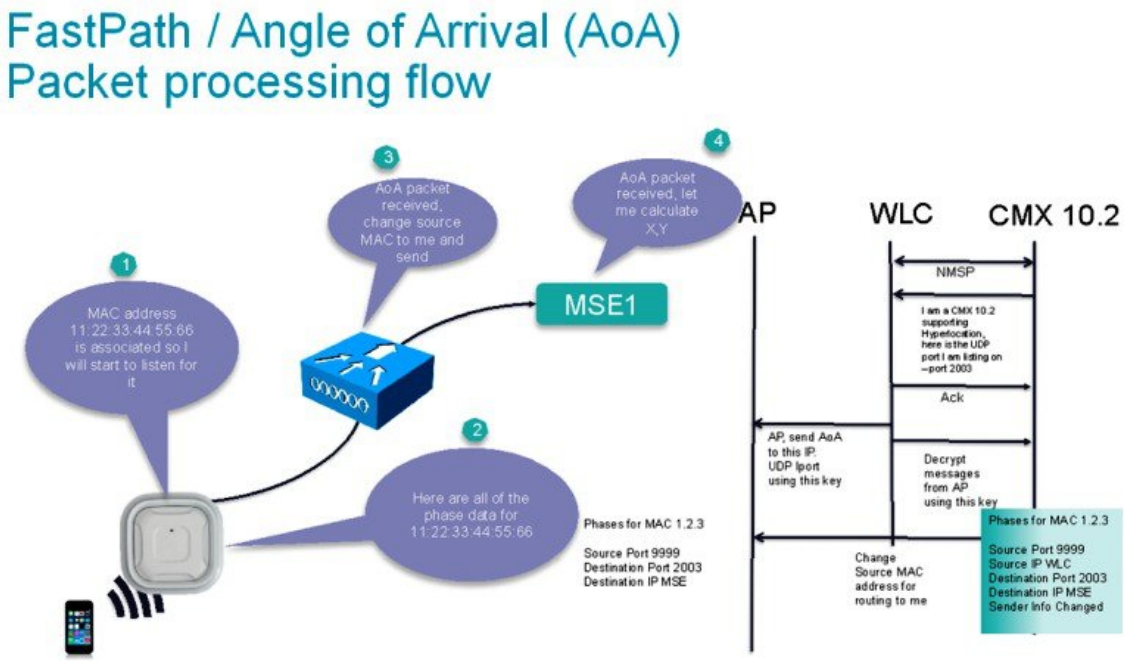
If any firewalls exist between the WLC and the CMX 10.2.x Server, the following ports need to be open. 16113 NMSP, 2003 AoA,80 HTTP,443 HTTPS,ICMP,SNMP 161,162.

Open Port List

16113, 2003, 80, 443, ICMP, 161,162

Packet Flow

It is important to understand the packet flow for Hyperlocation. Each AP is provided with the IP address and UDP port of the CMX10.2.1 server. It creates a packet that has all of the AoA information that it has generated and sends these packets at a rate of about 1 packet per second per AP to the WLC who uses an ARP to determine if it should send locally or send to the default gateway the packet as it is destined for the IP address for the CMX 10.2.1 server.



NTP and Clocks

In previous location solutions, a synced NTP clock was option. However, with Hyperlocation, this is a hard requirement to get the system enabled.

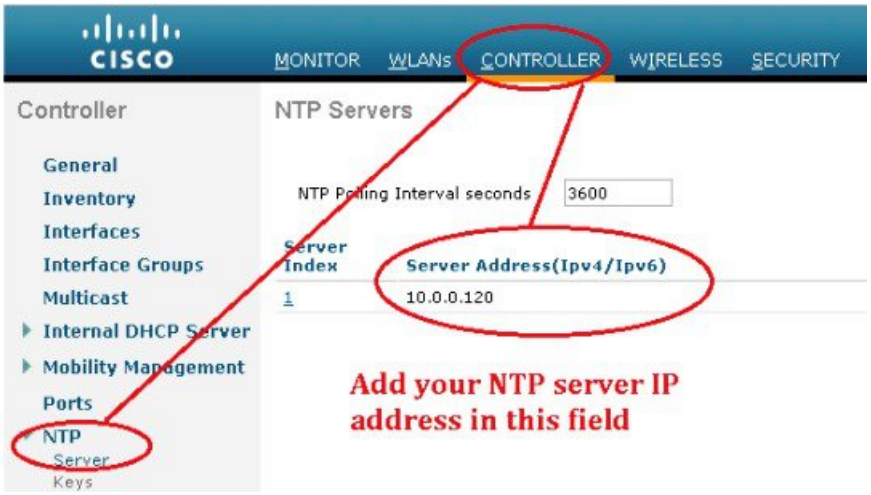
- An NTP server (application or router running on same subnet), Note if you don't have an NTP server, the following standalone NTP server was tested ad-hoc with good success on Windows
    - https://www.meinbergglobal.com/english/sw/ntp.htm

Both the WLC controller (who provides this clock to the AP) and CMX 10.2 server should be connected to the same NTP server and that server is defined in the controller.

Note The same time zones is required, the CMX will not sync with the WLC if the time is behind that of the WLC.

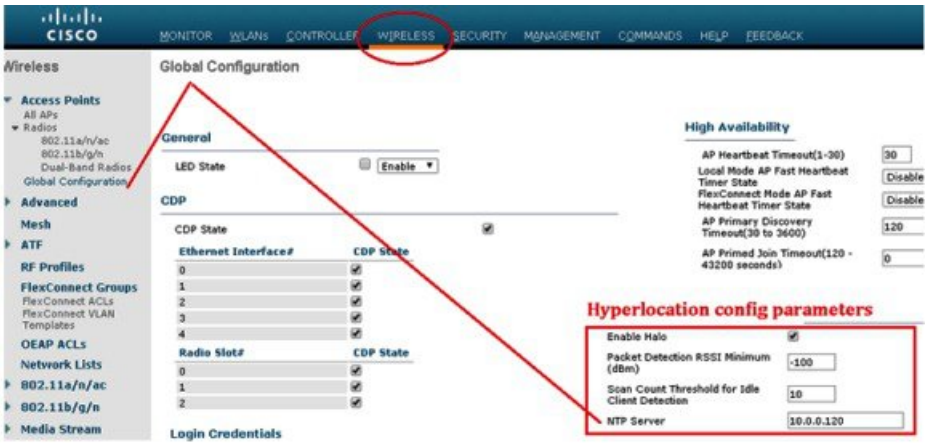
Make sure when you installed CMX10.2.x; that the NTP server is the same as defined in WLAN controller. At this point you should also have your controller upgraded to 8.1.MR3 or later.

Figure 17: Adding the NTP time server address into the controller



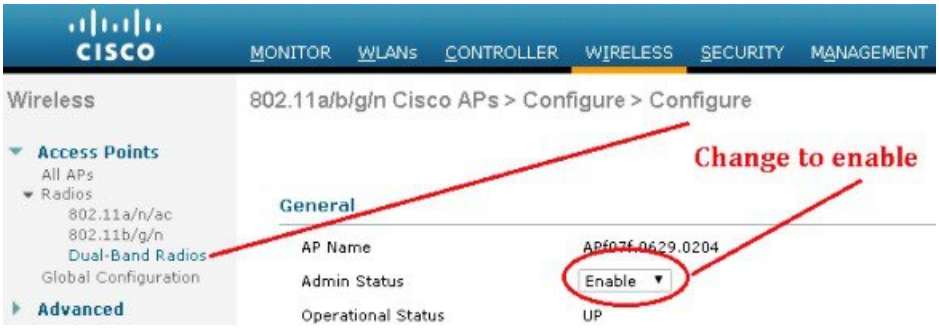
You also need to set NTP on the CMX 10.2.1 server. In addition, you need to configure the controller to sync with NTP server through the hyperlocation setting that is reachable from the subnet of the access points

Figure 18: Adding NTP time to Hyperlocation parameters



Once you have verified, it is time to enable the hyperlocation module.

Figure 19: Enabling the Hyperlocation and WSM module



CLI Command for Verifying Hyperlocation Status

You can verify that hyperlocation is enabled and functional using the following CLI command on CMX10.2.

- Verify that AoA messages are being used on the CMX 10.2.x. These messages are sent to the CMX using UDP destination port 2003, with a source port 9999 on the Ethernet interface of the CMX
- CMX currently uses port (16113) for NMSP traffic between the WLC and the CMX. In addition you need to also open a few additional ports are 2003 as well as HTTP, HTTPS, DNS, ICMP,SNMP,161 and 162.

Run **tcpdump –XX –i eth0 dst port 2003** on the CMX console; note this will require to be run as root; ctrl+C to break

This command is only required if there is issues with seeing the AoA Packet count increasing via the GUI.

Determining Connection of WLC with CMX 10.2.x

At this point, the WLC and CMX 10.2.x should be able to communicate. You can verify that they are by looking at the controller list. If it is green then the controller is active and sending data that the CMX 10.2 system can parse.

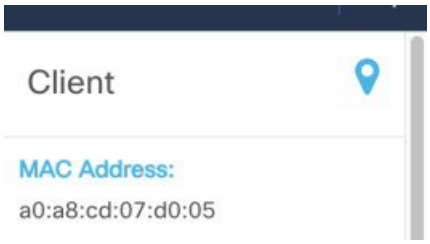
If one has added a new WLC you may lose sync between the AP and the MSE. This will be evident if you no longer have traffic between the AP and MSE. The resolution should be to DELETE the WLC completely from the MSE and add it back. This issue is CSCuv93732 and will likely be resolved in a later release. This may also be resolved with reboot of the WLC. If you do not have sync between MSE and AP, please reboot the WLC.

If you have an NTP server that is 12 digits long, for example 100.100.100.100, the last digit may not be transferred to the AP to allow them to sync with the correct clock. This should be resolved by using an NTP server with 11 or less digits such as 100.10.10.10.

Location Accuracy Tests

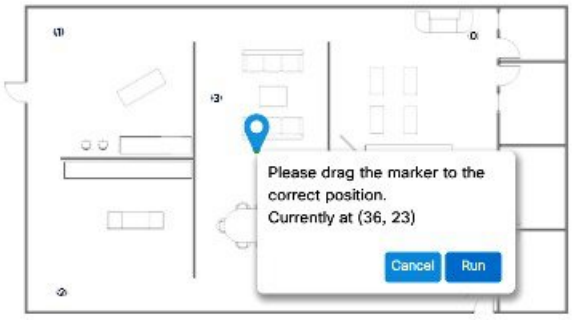
The systemic way to do a location assessment is to use the location accuracy tool.

The first step is to select a client on the map. This brings up the icon to start the location accuracy test.

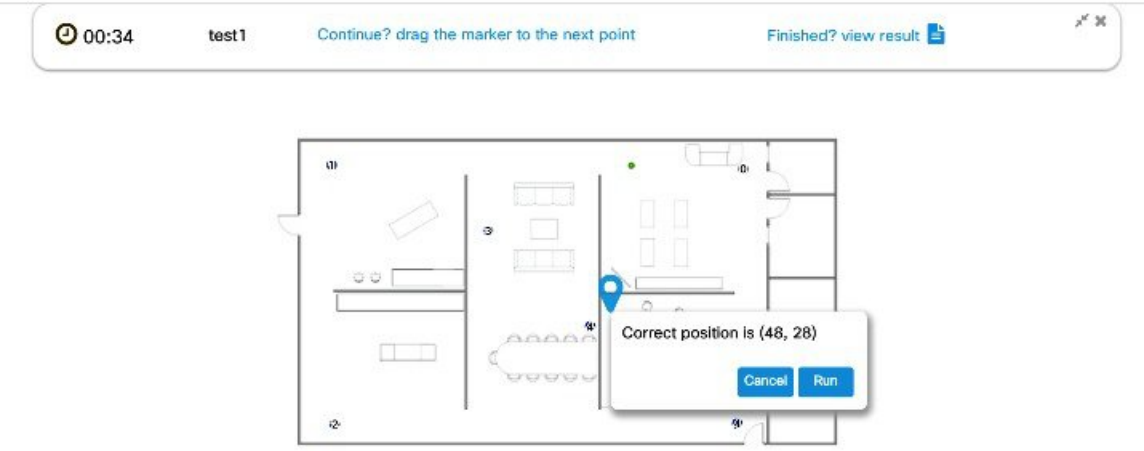


Once a client is selected, an accuracy test can be run. These are run by having entering a name for the test.

Then starting the test by dragging the particular client dot to where the client is actually located.



Then pause the test and move the client to a new location to test again.



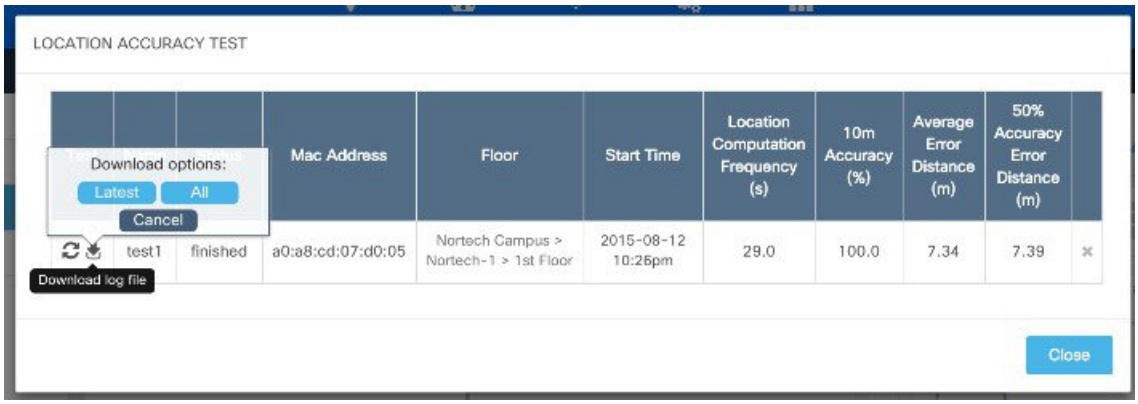
This should be repeated between 10 and 30 locations for a single test run (recommended to test at 20 points).A client should wait at each location for 2 mins. You should pause the test, go to new location, wait for 30 seconds and then start the test (click the “RUN” Button) at the new location.

At least 3 devices should be tested and the most important clients should be used for the test.

The clients must associate with the Hyperlocation AP. This may require a separate SSID.

When completed you can select “finished” and a report will be generated with an estimated error.

The data on this report is stored and available for download by selecting the Location Accuracy log.



This will be the primary testing method that is used to debug problems with client accuracy.

There is a manual method to download the logs also.

Important Components

Some of the important components of this screen are:

- Connect client count at top.
- X,Y location of cursor on screen at bottom right
- The (*) cog button that changes the screen refresh rate (from 1 to 10 seconds)
- The search function that allows you to search for clients across floors.

Methods for Troubleshooting Problems

There are additional methods of extracting information from the servers that may be required if the traditional Location tests and accuracy are not functioning as required. This is if the logs are not providing the information required to troubleshoot the issues.

Using API Commands to Extract Data from CMX 10.2.x

CMX 10.2 has a series of API that can be executed by entering a REST API command into CHROME browser. It is recommended that you install browser extensions to parse JSON messages to make them easier to read. A suggested extension is JSON FORMATTER.

The method to use these API to check is to login to the CMX 10.2.x system, go to the location page and then open up another browser TAB on the same application. This ensures that your browser is authenticated for the request.

The first API is that is helpful for verifying that CMX 10.2.x is running correctly is http://CMX-IP/locationcontainer/container/

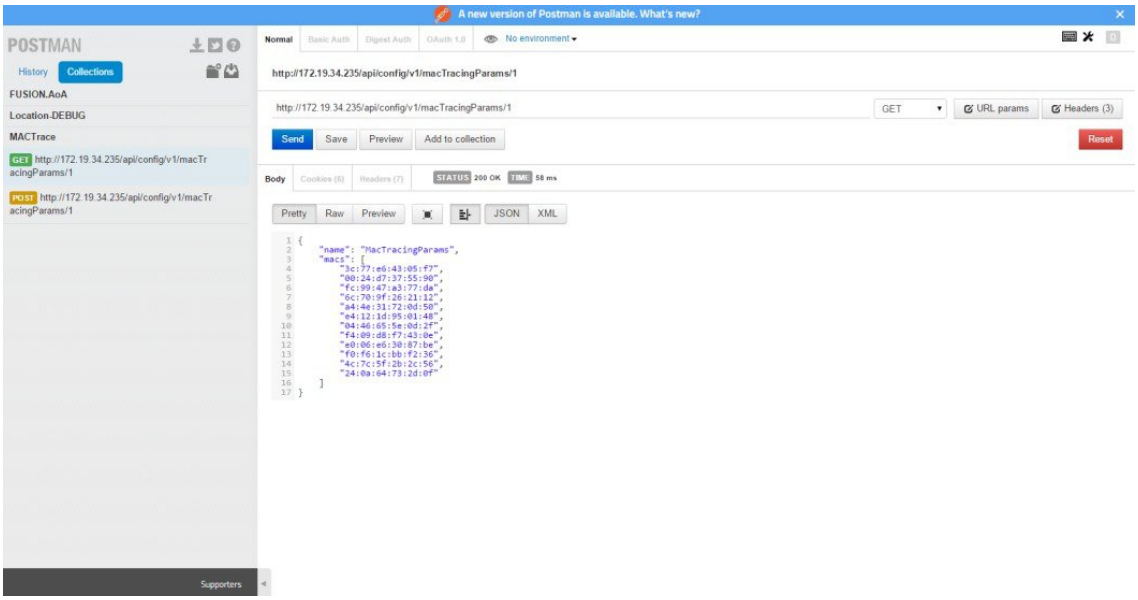
The results that you are looking for are below: AoA calculations are being performed.

A second API that is used is: http://CMX-IP/hyperlocationcontainer/container/This shows the rate at which Hyperlocation UDP data packets are coming into the CMX 10.2 system.

A third set of API's are required to initiate a MAC trace.

The results of a MAC address trace are as follows:

A MAC trace is requested using a POSTMAN client with the following API…



Finally and API that helps to determine if the angle of the AP antenna is set correctly is http://CMXIP/api/config/v1/aps
The sample output from this is;

```
[
  {
    "floorId": 727035828890501200,
    "angle": 1.57,
    "apType": 2,
    "switchName": null,
    "height": 0,
    "name": "CMX-AP05-61af.42c4",
    "radioMacAddress": "b8:38:61:b4:53:60",
    "ethMacAddress": null,
    "ipAddress": null,
    "numOfSlots": 3,
    "mapCoordinates": {
      "x": 8.261274,
      "y": 46.50164,
      "z": 10,
      "unit": "FEET"
    },
    "apMode": "LOCAL",
    "apInterfaces": [
      {
        "band": "IEEE_802_11_B",
        "slotNumber": 0,
        "channelAssignment": 1,
        "channelNumber": 11,
        "txPowerLevel": 7,
        "antennaPattern": "Internal-3700-2.4GHz",
        "antennaAngle": 1.57,
        "antennaElevAngle": 0,
        "antennaGain": 8,
        "antennaDiversity": 3,
        "antennaMode": 1,
        "antennaType": 1,
        "txPowerControl": 1
      },
```


Note The antenna angle above is in Radians, 1.57 Radians is 90 degrees. This API will be helpful in troubleshooting incorrectly placed antenna.

BLE Testing Process

The Hyperlocation module comes with the ability to send out BLE Beacons. The can be used for various different applications that can run on phones and tablets that support detecting Beacons. Currently iPhone5S and later and most Android devices post 2012 support this.

1. Configure BLE on the AP with different UUID and Major and Minor
2. Use the BLE Beacon Locate app from Radius Networks on Android and iPhone.
3. Determine the signal strength of the received Beacon.

Bluetooth Low Energy Beacons

Bluetooth Low Energy (BLE) technology works by utilizing beacon signals emitted from a small tag device or the access point's Wireless Security Module (WSM). The purpose of the BLE technology is to provide physical proximity information to a smartphone device.

This proximity knowledge can enable services on smartphone applications for the benefit of the client/customer as well as the enterprise that deployed the beacons. Following are few examples:

- Targeted advertising—Offering users promotions or discounts on products they are standing close to (not giving them a Plasma TV promotion when they are clearly looking at refrigerators).
- Tie at-home browsing to in-store benefit—If customer likes a specific product in the application, it can remind her when she enters the store that sells it. It can also deliver department-specific offers throughout the store, so that the boots she like show up at the most useful time in the shoe department.
- Accurate user location for check-in functionality in loyalty programs.
- Accurate in-store mapping, which allows users to navigate to the product they are looking for within the cavernous space of a big-box store.
- Getting sales assistance.

The beacon signals follow the BLE standard (advertising mode) as well as the Apple iBeacon standard (which dictates the content and format of the payload). The BLE advertising mode signal does frequency hopping on three channels that do not overlap the common US WLAN channels (1, 6, and 11), thereby not interfering or being interfered with.

The payload structure includes a MAC address, Manufacturer ID, UUID, major and minor fields, and RSSI. The major and minor fields carry information regarding the actual physical location of the tag.

Following illustrations shows how the proximity is set, depending on the customers relative distance from the tag (or source of BLE.

Figure 20: AP 3700 with WSM Module Performing Bluetooth Low Energy Beaconing

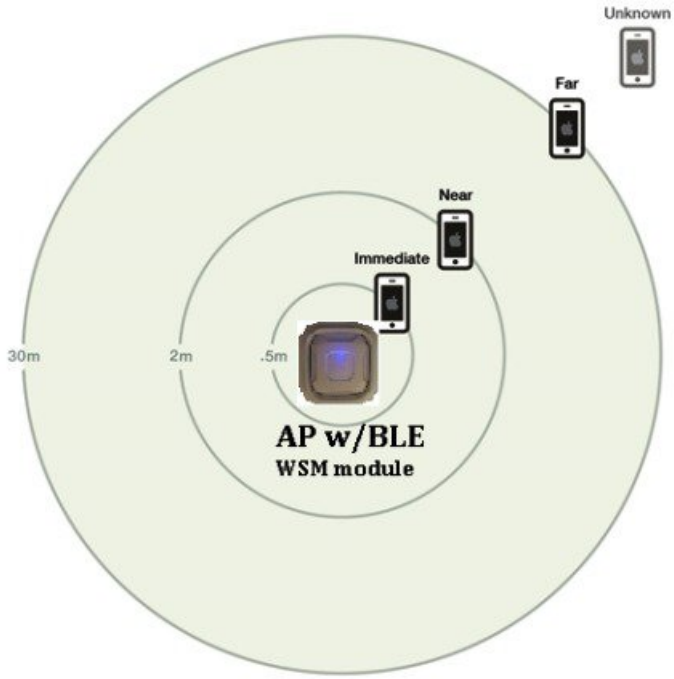
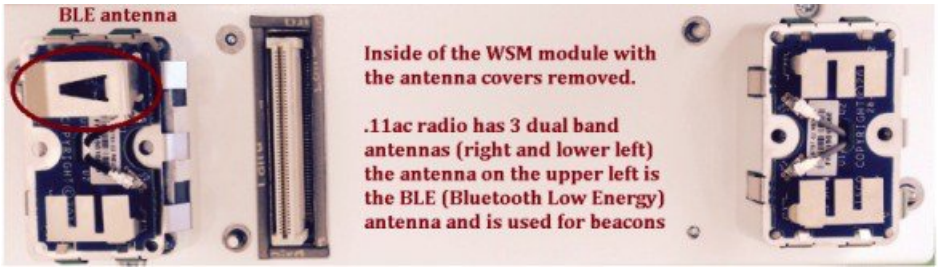


Figure 21: Inside Look of WSM Module Antenna System



The antenna system in the Hyperlocation with Advanced Security module allows the module to work and support BLE even if a Hyperlocation antenna is not installed..

While the radio system inside the WSM module is a four antenna 11ac system, only three are used for .11ac when the hyperlocation module is not present. Inside the WSM module, there are four antennas and we use that 4th antenna for BLE.

When the Hyperlocation antenna array is installed, the WSM module brings out all four .11ac radio chains to the antenna array (for receive) and CleanAir decoding for BLE detection. However, all transmit functions happen on the internal antennas.

This is important to understand as the BLE transmitter is not being directed through the circular antenna array. So, how far the beacon goes is really a factor of two things.

1 The more the AP is away from the clients the more RF power you need for the beacon to transmit to cover location in the immediate, near, and far. But, this also has dependencies on the type of device you are expecting to hear the BLE.

2 The device that is hearing the BLE Beacon

For example, some preliminary testing seems to indicate a device like an Apple Ipad2 can hear a BLE packet better than an iPhone6. So, it is expected that different ranges may happen depending upon the device used.

This guide includes some data on how different devices can detect the Hyperlocation with Advanced Security module in an OPEN AIR environment. This would be the best case and typical office, retail or other environments will have the beacons detected at a much lower level.

Note Bluetooth BLE functionality is not enabled until beacons are configured.

While working with Bluetooth beacons, remember the following:

- You need a Bluetooth sniffer, for example, Texas Instruments sniffer **CC2540EMK-USB**.

  You can also test with Apple iPhones or Android devices using suitable utilities.
- BLE beacons hop across channels that do not interfere with 1, 6, and 11 WLAN, so they typically use channels 37, 38, and 39.
- The beacons are sent on all three channels one after the other starting with 37. Each time a beacon is broadcast, it is broadcast on all three channels. It takes about 2 ms to transmit each beacon on all three advertising channels.
- Channel 37 is centered on 2.402 GHz, channel 38 is centered on 2.426 GHz, and channel 39 is centered on 2.480 GHz. Channel spacing is 2 MHz. There are 40 BLE channels 2 MHz apart. Channel 37 has lowest frequency followed by channels 0 – 10, channel 38, channels 11-36, and finally channel 39.
- Beacons have a MAJOR and a MINOR field. They are numerical 0-65535. The MAJOR value could be a number representing the store name with a MINOR being the department and so on.

The following table shows a preliminary look at the range data using a TI sniffer.

Note Different devices can detect BLE energy at different distances, in this example the iPad was able to detect energy further.

Table 1: Bluetooth Range Test

Tx Power	iPhone6	iPad2	@20 ft	@40 ft
0 dBm	222 ft*	428 ft*	-52 dBm	-68 dBm
-4 dBm	141 ft	285 ft*	-56 dBm	-72 dBm
-8 dBm	108 ft	214 ft*	-60 dBm	-76 dBm
-12 dBm	85 ft	138 ft	-64 dBm	-80 dBm
-16 dBm	59 ft	123 ft	-68 dBm	-84 dBm
-20 dBm	44 ft	89 ft	-72 dBm	—
-24 dBm	27 ft	60 ft	-76 dBm	—

Tx Power	iPhone6	iPad2	@20 ft	@40 ft
-28 dBm	18 ft	49 ft	-80 dBm	—
-32 dBm	10 ft	35 ft	-84 dBm	—
-36 dBm	5 ft	20 ft	—	—
-40 dBm	—	11 ft	—	—
-44 dBm	—	6 ft	—	—

* Data was collected outdoors (completely open air) when operating indoors maximum distance is often 150 feet. Also Access Point is often further away then a typical BLE beacon as the AP will likely be ceiling mounted. .

Note How to read the above chart; the iPhone6 detected the beacon at any amount as far as 222ft away in an open air environment. The iPad at 428ft.

The TI sniffer at 20ft away from the AP detected the BEACON at a RSSI of -52dbM.

Note Assuming 0 dBm attenuation power level is approximately 0 dBm output power as measured by compliance test (0.8 dBm and 0.2 dBm) by two different testers on 2 different units.

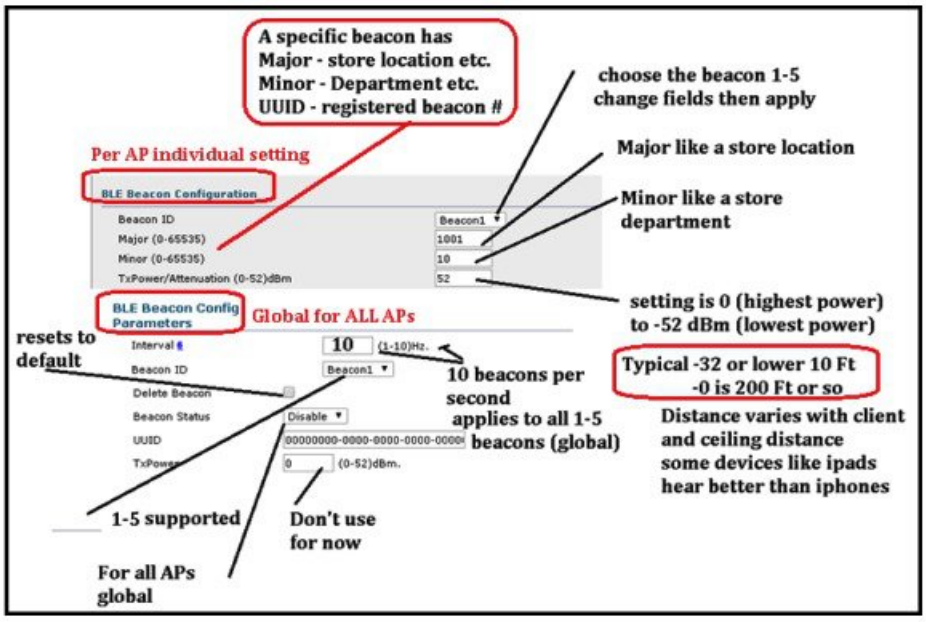
The receiver sensitivity affects the range that a beacon can be seen at. iPad has much more receiver sensitivity than iPhone which in turn is only slightly better than the TI Sniffer. You may find android phone or other devices to also vary.

Configuring BLE Beacons for Applications

Short range for BLE beacons is considered to be 1 – 3 meters. But with a 10 ft ceiling mount, you must have this at a minimum of 3 meters. So, optimally the short range for an iPhone6 would be from -30 dBm to -32 dBm. The mid range is from 3 meters to 10 meters, so under ideal conditions this would be from -22 dBm to -28 dBm. The long range is greater than 10 meters, which would be from 0 dBm to -22 dBm.

Note If you are mounted on a ceiling higher than 10 ft, you must start with medium range as a short range beacon because short range would not reach the floor.

Figure 22: Examining the BLE Beacon Settings

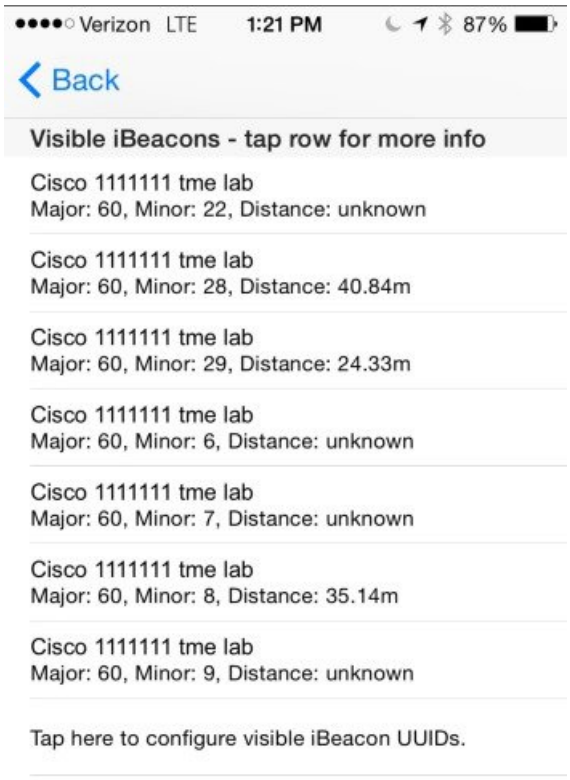


BLE Testing with Common Applications

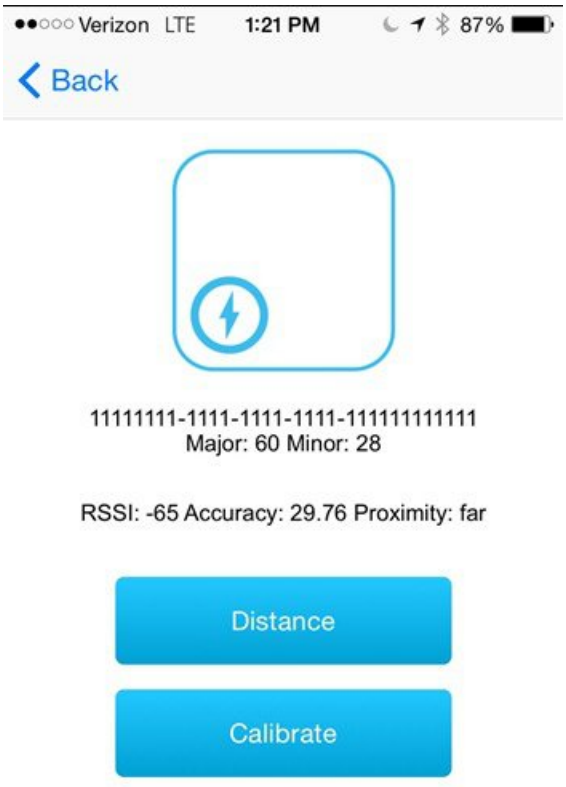
There is an iPhone app and Android app known iLocate from RADIUS NETWORKS"that to determine the signal strength of a received BEACON and has been validated to work with the Hyperlocation module.

When installing the App, make sure that you allow the app to use location services to detect Beacons.

The App should be programmed to listen for the specific UUID that is being beaconed by the Hyperlocation module. It will then report the signal strength that it hears and the different MAJOR and MINORS that are being beaconed out from the specific APS. If the signal strength is strong enough, the underlying OS calculates a distance, than this is also displayed. The algorithm as to when iOS displays a distance is not revealed by APPLE, but a distance is shown when the signal strength is high.



When a specific BEACON is selected, the specific RSSI of that Beacon detection is also shown. As well as the iOS calculated distance from the BEACON and the iOS inferred distance (i.e. “immediate, near or far”).

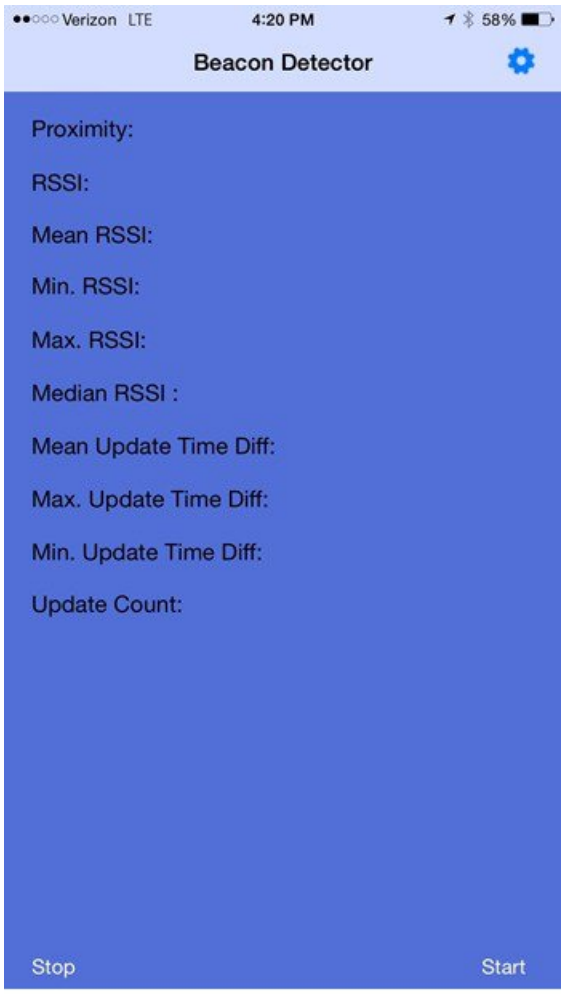


A methodology to test the Beacons that are transmitted by the Hyperlocation module is as follows:

1. Configure each BEACON to transmit a unique MINOR code per AP
2. Configure each BEACON to transmit the same MAJOR code for all AP
3. Configure each WLC to transmit several (up to 5) different UUID
4. Test that at different locations you can see different AP at varying signal strengths with the appropriate UUID, MAJOR and MINOR. Record the detected signal strength and distance if provided.

   There are 3rd party applications and early test utilities that can be installed on an iPhone5S or later and should be able to be configured with the BEACON it needs to detect.

   Some of these utilities can show specific details of the detected beacon for example:.

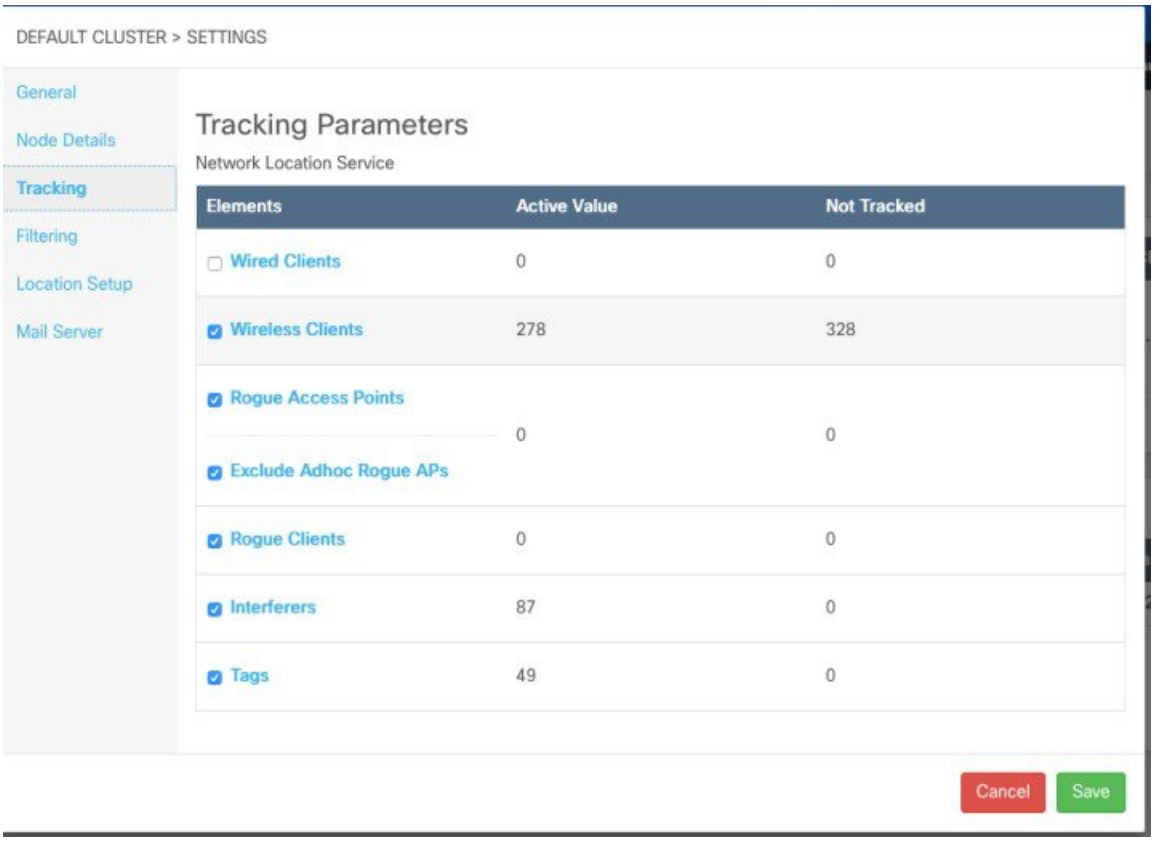


Viewing BLE Beacons on CMX 10.2

CMX 10.2 can display the location of BLE Beacons, including Beacons that are broadcast from the Hyperlocation module. In order to do this, CLEANAIR must be enabled on the WLC.

If CleanAir is enabled, then you need to enable interferer tracking on the CMX at the following tracking location tab in the services menu.

The interferers box needs to be enabled to track BLE Beacon location.



To display BLE Beacons, you need to enable them in the Location tab of an MSE. This filtering occurs on this page.

Note Beacons that come from access point are displayed as ROUGE until they are classified.It can take 10-12 minutes after a beacon has started broadcasting to be located on this screen.

When it is located on this screen you should be able to see the UUID, MAJOR and MINOR when clicking on a beacon as follows.

There is also a CLI command that allows you to determine what the WLC sees as Beacons.

You can use the following command:

```
test clearair show idr all
```

Figure 23:

CLI Commands for CMX 10.2

Here are some of the CMX 10.2 CLI commands:

```
- cmxctl version (check build version)
- cmxctl stop -a (stop all services)
- cmxctl restart (restart CMX services)
- cmxctl start (start CMX services)
- cmxctl status (check status of CMX services)
- cmxctl config controllers add (add controller/s)
- cmxctl config controllers show
- cmxctl config maps import (you can either provide PI credentials for MSE to
grab maps or put map export file in /opt and give file path /opt/pi_export_file)
- cmxconfig maps delete (delete campus, have to give name).
```

CLI Commands for CMXOS (Upgrading and BACKUPS)

```
[cmxadmin@cmx-nortech ~]$ cmxos --help
Usage: __main__.py [OPTIONS] COMMAND [ARGS]...
Configure OS
Options:
--help Show this message and exit.
Commands:
addswap Adds a 10GB swap space to the node
adminui Start and Stop Admin UI
backup Backup of the node.
checkpostgresdatasize postgres data size
configure Configure network and OS parameters
firstboot Setup CMX from scratch
fixhaproxy Fix HAProxy permissions
monit Monit commands
openports Open ports based on node role.
reconfigure Reconfigure Network post CMX installation
restore Restore of the node.
upgrade Upgrade CMX with new .cmx file
verify Verify machine configuration
[cmxadmin@cmx-nortech ~]$
Cisco
```

Bluetooth Beacon Commands

Here goes, a sample setup with strongest signal on first beacon and weakest on the last beacon. Attenuation from 0 dBm to 40 dBm in 10 dBm increments. Third beacon should have around a 60 ft range and the last beacon should have a 10-15 foot range (assuming about a 10 ft ceiling).

```
// set up the UUIDs (on a per controller basis)
Config advanced hyperlocation ble-beacon beacon-id 1 add uuid 11111111-1111-1111-1111-111111111111
Config advanced hyperlocation ble-beacon beacon-id 2 add uuid 22222222-2222-2222-2222-222222222222
Config advanced hyperlocation ble-beacon beacon-id 3 add uuid 33333333-3333-3333-3333-333333333333
Config advanced hyperlocation ble-beacon beacon-id 4 add uuid 44444444-4444-4444-4444-444444444444
Config advanced hyperlocation ble-beacon beacon-id 5 add uuid 55555555-5555-5555-5555-555555555555

// set up the majors (on a per AP basis)
Config advanced hyperlocation ble-beacon beacon-id 1 add ap-name <AP NAME> major 1001
Config advanced hyperlocation ble-beacon beacon-id 2 add ap-name <AP NAME> major 2002
Config advanced hyperlocation ble-beacon beacon-id 3 add ap-name <AP NAME> major 3003
Config advanced hyperlocation ble-beacon beacon-id 4 add ap-name <AP NAME> major 4004
Config advanced hyperlocation ble-beacon beacon-id 5 add ap-name <AP NAME> major 5005
// Set up the minors (on a per AP basis)
Config advanced hyperlocation ble-beacon beacon-id 1 add ap-name <AP NAME> minor 10
Config advanced hyperlocation ble-beacon beacon-id 2 add ap-name <AP NAME> minor 11
Config advanced hyperlocation ble-beacon beacon-id 3 add ap-name <AP NAME> minor 12
Config advanced hyperlocation ble-beacon beacon-id 4 add ap-name <AP NAME> minor 13
Config advanced hyperlocation ble-beacon beacon-id 5 add ap-name <AP NAME> minor 14
// Set up the Attenuation (Tx Power) (on a per AP basis)
Config advanced hyperlocation ble-beacon beacon-id 1 add ap-name <AP NAME> txpwr 0
Config advanced hyperlocation ble-beacon beacon-id 2 add ap-name <AP NAME> txpwr 10
Config advanced hyperlocation ble-beacon beacon-id 3 add ap-name <AP NAME> txpwr 20
```

```
Config advanced hyperlocation ble-beacon beacon-id 4 add ap-name <AP NAME> txpwr 30
Config advanced hyperlocation ble-beacon beacon-id 5 add ap-name <AP NAME> txpwr 40
// set up the transmission frequency (on a per Controller basis)
Config advanced hyperlocation ble-beacon interval 10
// turn individual beacons on/off (enable/disable) (on a per Controller basis)
Config advanced hyperlocation ble-beacon beacon-id 1 enable
Config advanced hyperlocation ble-beacon beacon-id 2 enable
Config advanced hyperlocation ble-beacon beacon-id 3 enable
Config advanced hyperlocation ble-beacon beacon-id 4 enable
Config advanced hyperlocation ble-beacon beacon-id 5 enable
```

Note that I do not know the id of the AP you will be using and its name/id should be substituted where it says <AP NAME> above.

Using the above configuration will result in the following ble-beacons each being generated at a 10 Hz frequency:

```
# UUID                                 Major Minor Attenuation
Beacon 1 11111111-1111-1111-1111-111111111111 1001 10    0
Beacon 2 22222222-2222-2222-2222-222222222222 2002 11   10
Beacon 3 33333333-3333-3333-3333-333333333333 3003 12   20
Beacon 4 44444444-4444-4444-4444-444444444444 4004 13   30
Beacon 5 55555555-5555-5555-5555-555555555555 5005 14   40
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```

HyperLocation Troubleshooting Process

As part of the deployment, you should be aware of what to do if things go wrong. Here is a list of the process to follow when starting to troubleshoot issues. The idea is to first ensure that everything is correct on packets flowing correctly from the AP and that the AP are placed correctly on the map. The step below will help to ensure this.

Items to be verified on the WLC and AP

1. Check that AP are seen and up on WLC
2. Check that the AP have the correct antenna setting
3. Check that the Hyperlocation setting are set
4. Check that the WLC can ping the CMX 10.2

Items to be verified on Prime

1. Check that PRIME is able to see the WLC
2. Check that the AP are seen by PRIME
3. Check that the AP are correctly placed on the map
4. Check the dimensions on the map
5. Check the placement of the AP on the map

Items to be verified in CMX 10.2

1. Check that the controller is online
2. Check that Hyperlocation is enabled
3. Check that the maps are seen in DETECT / LOCATE

4 Check that clients are seen on the map

5 Check that filter of unassociated clients is enabled (optional)

WLC/AP Troubleshooting Process

When troubleshooting issues with the WLC and Access Point, you want to ensure everything is communicating correctly and exchanging all of the information required to calculate location.

Some of the communications that should occur are:

- The WLC should be seeing all of the Hyperlocation APs as having the correct antenna setup.
- The AP should be able to see and connect to the NTP server.
- The AP should be able to get a list of neighbor AP that also supports Hyperlocation.
- The AP should be able to send UDP packets to the CMX 10.2 software via the WLC.

Procedure

Step 1 [WLC] Check that Hyperlocation modules on APs are detected.
This is to ensure that the AP has the module installed. If this command does not return the correct results, the module may not be seated or installed correctly. Please refer to the hardware AP installation guide for more on this. Here is the command to show a list of the Access Points with modules.

```
(Cisco Controller) >show ap module summary all

AP Name            External Module Type
------------------ ----------------------
AP4__84b8.0265.5540 Hyperlocation Module w/Antenna
AP1__84b8.0252.b930 Hyperlocation Module w/Antenna
AP2__f4cf.e272.4ed0 Hyperlocation Module w/Antenna
AP3__f07f.0635.2d40 Hyperlocation Module w/Antenna
```

Step 2 [WLC] Check that hyperlocation is enabled and configured on all Hyperlocation APs.
This is normally configured in the WLC GUI. This CLI command can confirm if the configuration that was done in the GUI was correctly processed on the WLC.

```
(Cisco Controller) >show advanced hyperlocation summary

Hyperlocation..................................... UP
Hyperlocation NTP Server.......................... 171.68.38.65
Hyperlocation pak-rssi Threshold.................. -100
Hyperlocation pak-rssi Trigger-Threshold......... 10
Hyperlocation pak-rssi Reset-Threshold........... 8
Hyperlocation pak-rssi Timeout.................... 3
AP Name     Ethernet MAC     Slots   Hyperlocation
---------------   ------------------ ------- ------------
AP1__84b8.0252.b930 84:b8:02:5d:b9:30 3      UP
AP4__84b8.0265.5540 84:b8:02:65:55:40 3      UP
AP3__f07f.0635.2d40 f0:7f:06:35:2d:40 3      UP
AP2__f4cf.e272.4ed0 f4:cf:e2:72:4e:d0 3      UP
```

Step 3 [WLC] Check whether CMX is associated to WLC (check MAC).
The CMX 10.2 system needs to exchange NMSP message to exchange keys for the subsequent UDP messages. NSMP sync is also required to transport the traditional RSSI messages from the WLC to the CMX 10.2 instance.

These commands run on the WLC can ensure that the connection is up. This can also be checked in the CMX 10.2 GUI where the up controllers are shown as green.

```
(Cisco Controller) >show nmsp status

MSE IP Address Tx Echo Resp Rx Echo Req Tx Data Rx Data
-------------  ------------ ----------- ------- -------
172.19.35.189 2990 2990 35667 8
172.19.34.235 10895 10895 129772 41
172.19.35.66 156 156 1754 7
```

Step 4 [WLC] Check forwarding entry (custom MAC 0001.0203.0405) for CMX on WLC.

```
(Cisco Controller) >debug fastpath dump scbdb
FP0.00:
SCB DB:
FP0.00:
FP0.00:  [0001.0203.0405 ifIndexToDs 100 ifIndexToDsLocalBridge 100
ifIndexToSta 1152 ifIndexToPeer 0 ifIndextoNbar 65535 tun_user 0
ap 0 wlan 1025 rwlan 1 rs 3 ms 1 IPv4 acl 65535 IPv6 acl 65535
L2 acl 65535 system-acl 65535 qosPolicy 0 tclas 65535,
65535 QoS acl 0,0,0,0 radio 0,max1p 0, learnIpPktCount 1
ipAddr 10.22.212.120 rtBktId 4294967295 nonrtBktId 4294967295
sendHttpFlag 0  ] dpOwner 0 tunnelType 0 cipher 0 nbarOwner 255
tun_upstream_key 0 tun_downstream_key 0, dfGw 0.0.0.0,
qinqEnabled 0,  qinqOuterVlanId 0 ActiveIPv6 0
orphanIpv6Addr 0 Flags 10 eogre_vlan 0
```

Step 5 [AP] Check CMX configuration and reachability on AP.

This command is entered on the AP directly. Please see WLC documentation for telnetting into the AP. This command is to ensure that the IP address of the CMX server is correctly being sent to the APs. This can be incorrect if more then one MSE/CMX system is associated to the same WLC.

```
AP1__84b8.0252.b930#show capwap client rcb
AdminState : ADMIN_ENABLED
HYPERLOCATION ADMIN STATE : 1
WLC GATEWAY MAC : 00:1C:F6:E6:75:A1
WLC HYPERLOCATION SRC PORT : 9999
BLE Module State : ENABLED
MSE IP[0] : 172.19.34.235
MSE PORT[0] : 2003
```

Step 6 [AP] Check AP sync to NTP server.

This command is to ensure that the AP can see the NTP server and that he NTP server is providing Time information for synchronization. If the NTP is not synced, that could be related to a firewall issue. NTP sync is important to ensure that all AP are on the same channel at the same time. This is configured in the WLC GUI.

```
AP1__84b8.0252.b930#show sntp
SNTP server Stratum Version Last Received
171.68.38.65             1      4     00:01:01       Synced
```

Checking Location Scan List Configuration

Procedure

Step 1 [WLC] Check WLC/CMX scan list request and response messages.
Each AP has a list of neighbors that is calculated by CMX and provided to the AP. These commands can verify if the neighbor list is correctly coming from the CMX to the WLC and then being propagated to the APs.

```
(Cisco Controller) >debug nmsp events enable
(Cisco Controller) >debug nmsp errors enable
(Cisco Controller) >debug capwap info enable
```

Step 2 [AP] Check location scan list on AP.
This command is executed on the AP and shows the MAC address of the neighbor AP. If this list contains MAC addresses that are incorrect, this may be an indication of incorrect placement of APs. This is an important command for verifying that the neighbors exists and are correctly speaking to each other.

```
AP1__84b8.0252.b930#show capwap rm hyperlocation level1-list
Level-1 List for 2.4GHz Band
----------------------------
Channel Width Serving MAC     Max Clients
------- ----- -------------- -----------
1           0 f07f.0635.2d40    8
1           0 f4cf.e272.4ed0    8
1           0 84b8.0265.5540    8
1           0 84b8.025d.b930    8
Level-1 List for 5GHz Band
----------------------------
Channel Width Serving MAC     Max Clients
------- ----- -------------- -----------
36 0     84b8.025d.b930             8
36 0     f07f.0635.2d40             8
36 0     f4cf.e272.4ed0             8
36 0     84b8.0265.5540             8
```

Step 3 [AP] Check location scans are ongoing in sync across APs (timestamp match for chnl).

```
P1__84b8.0252.b930#debug capwap rm prl events
CAPWAP RM PRL events display debugging is on
Aug 14 06:57:47.441: PRL: ntpSyncSetL1Idx: 0 ntpSyncSetL2Idx: 0
Aug 14 06:57:47.517: PRL: PAK RSSI Report: 0
Aug 14 06:57:47.517: PRL: reported client entries: 0 of 0, final: 1
Aug 14 06:57:47.517: PRL: tblFullCnt: 0, AP entries: 19
Aug 14 06:57:47.677: PRL: ntpSyncChanIdx: 6 duration: 143
Aug 14 06:57:47.677: PRL: ntpSyncSetL1Idx: 0 ntpSyncSetL2Idx: 3
Aug 14 06:57:47.677: PRL: band: 2 channel submitted: 64 width: 0
Aug 14 06:57:47.821: PRL: ntpSyncChanIdx: 0 duration: 249
Aug 14 06:57:47.821: PRL: ntpSyncSetL1Idx: 4 ntpSyncSetL2Idx: 0
Aug 14 06:57:47.821: PRL: band: 2 channel submitted: 36 width: 0
Aug 14 06:57:48.017: PRL: PAK RSSI Report: 0
Aug 14 06:57:48.017: PRL: reported client entries: 1 of 1, final: 1
Aug 14 06:57:48.017: PRL: tblFullCnt: 0, AP entries: 19
```

Checking Location Scan Results

Procedure

Step 1 [AP] Check BAR-BA exchange with clients.

BAR-BA exchanges are to ensure that clients that may not be sending data packets can still be have a location calculated. This is done by exciting the client to send a packet and using the response packet to calculate location. This is for associated clients. These debug commands show what is occurring on the AP.

```
AP1__84b8.0252.b930#debug dot11 hyperlocation-BAR general
dot11 HALO BAR debugging is on:
Aug 14 07:08:59.815: HYPERLOCATION_BAR:Scanning chan 1 on radio 0
Aug 14 07:08:59.815: HYPERLOCATION_BAR:Chan 1 on radio 0 is supported on this AP
Aug 14 07:08:59.847: HYPERLOCATION_BAR:Timer for radio 0 expired
Aug 14 07:08:59.847: HYPERLOCATION_BAR:Dwell Duration - 0 ms
Aug 14 07:09:00.071: HYPERLOCATION_BAR:Scanning chan 36 on radio 1
Aug 14 07:09:00.071: HYPERLOCATION_BAR:Chan 36 on radio 1 is supported on this AP
Aug 14 07:09:00.103: HYPERLOCATION_BAR:Timer for radio 1 expired
Aug 14 07:09:00.103: HYPERLOCATION_BAR:Dwell Duration - 15 ms
Aug 14 07:09:00.103: HYPERLOCATION_BAR:Client-240a.6473.2d0f:Seq-1,
  BARs Sent-15,BARs Done-15,Duration-3 ms,State-AWAKE
Aug 14 07:09:00.103: HYPERLOCATION_BAR:Client-3c77.e643.05f7:Seq-2,
  BARs Sent-15,BARs Done-15,Duration-3 ms,State-AWAKE
Aug 14 07:09:00.103: HYPERLOCATION_BAR:LMA frame sent.
Aug 14 07:09:00.319: HYPERLOCATION_BAR:
Hyperlocation dwell collection complete. MSE record len = 113
```

Step 2 [AP] Check location scan results generation on module.

```
AP1__84b8.0252.b930#debug dot11 hyperlocation-BAR general
dot11 HALO BAR debugging is on:
Hyperlocation dwell collection complete. MSE record len = 98
Report byte dump:
0x00 0x84 0xB8 0x02 0x5D 0xB9 0x30 0x8B 0x5B 0x5B 0x01 0x81 0x24 0x0A 0x02 0x3C:
0x30 0x52
Aug 14 07:11:50.359: HYPERLOCATION_BAR:
Version = 0
AP base mac = 84:B8:02:5D:B9:30
TS = 0x8B5B5B
Num Dwell records = 1
Aug 14 07:11:50.359: HYPERLOCATION_BAR:
type = 1
bms = 4
channel = 36
R[7]-BandID[6-3]-SlotID[2-0] = 0x0A
num of client records = 2
Aug 14 07:11:50.359: HYPERLOCATION_BAR:
Client[0 ].mac = 3C:77:E6:43:05:F7
Client[0 ].RelTS = 25
Client[0 ].RSSI = -52 (0xCC)
Client[0 ].antmap = 0xFFFFFFFF
Client[0 ].error = 15
Aug 14 07:11:50.359: HYPERLOCATION_BAR:
Client[0 ].antval[0 ] = 0x0135
```

```
Client[0 ].antval[1 ] = 0x016A
Client[0 ].antval[2 ] = 0x0117:
```

Step 3 [AP] Check location results message count increment on AP.
This command executed on the AP is a doublecheck to ensure that Hyperlocation traffic is being generated and sent. Incrementing numbers is what you should be looking for.

```
AP1__84b8.0252.b930#show capwap client traffic | Include Hyperlocation
Hyperlocation Packets transmitted : 297515
AP1__84b8.0252.b930#show capwap client traffic | Include Hyperlocation
Hyperlocation Packets transmitted : 297528
AP1__84b8.0252.b930#show capwap client traffic | Include Hyperlocation
Hyperlocation Packets transmitted : 297548
```

Step 4 [WLC] Check location results message count increment on WLC.
This debug command on the WLC is one of the first that can be used if an issue is seen. It ensures that packets are flowing from the AP directly to the MSE. This command should be run several times and incrementing numbers are what you should be looking for. This indicates that data is flowing from the AP and to the CMX server.

```
(Cisco Controller) >debug fastpath dump stats
FP0.00:
FP0.00: OK - RX (Hyperlocation) from AP : 1406890 (+ 1406890)
FP0.00: OK - TX (Hyperlocation) to MSE : 1406890 (+ 1406890):
(Cisco Controller) >debug fastpath dump stats
FP0.00:
FP0.00: OK - RX (Hyperlocation) from AP : 1407016 (+ 126)
FP0.00: OK - TX (Hyperlocation) to MSE : 1407016 (+ 126)
```

QA on Hyperlocation

Q: What is the difference between the integrated WSM BLE and all Clean Air APs with 8.0?

A: The WSM module can also be a BLE beacon and send out BLE energy. With ClearAir, we detected BLE. In MSE 10.0, you get BLE awareness (detect BLE devices) using CleanAir APs.

BLE radio integrated into the WSM is a full Tx/Rx radio that allows BLE to act as a beacon, and also allows you to use the BLE radio in the WSM to configure other beacons in future releases.

Q: Can the AP be placed either vertically or horizontally and still provide this accuracy?

A: Integrated Hyperlocation circular array antenna requires ceiling mount or optional “wedge” type wall mount from third party companies such as http://www.oberonwireless.com/ additionally optional external antennas provide horizontal flexibility.

Q: Will the Hyperlocation module support CleanAir, as the WSSI does today?

A: The Hyperlocation solution consists of two items such as an active antenna array and a new Wireless Security Module (WSM). WSM is the new name for WSSI, and it supports all the same features but has an 11ac radio for 20/40/80 MHz bandwidths.

Q: Will HyperLocation work in both 3600 and 3700?

A: Of course that is the value of a modular based architecture and this is how Cisco can deliver emerging technologies like BLE and location to existing AP platforms.

Q: Will these modules support MU-MIMO?

A: Hyperlocation and WSM through the antenna array is a listen only mode. The module has an 11ac chipset but not for client data. Data is handled through the AP's integrated antennas. MU-MIMO is an 11ac Wave-2 function, so it is not supported at this time.

Q: Will new external antenna array have a Plenum rating?

A: Integrated "ring" antenna is not Plenum as designed to remain below the Plenum airspace. External antennas are under development and likely to be Plenum but that has not been fully determined yet.

Q: When one Hyperlocation is present and other APs are non Hyperlocation, does only the Hyperlocation information used for location? meaning, Probes and RSSI are not used?

A: No. All data is used but Hyperlocation Angle of Arrival (AoA) data is obviously weighed heavier when making location assessments. When both RSSI and AoA are collected and sent to the MSE, we refer to that feature as "fusion".

Q: Can I perform location with a single Hyperlocation device?

A: Yes

Q: If a connected client is attached to a non-hyperlocation AP, are the other APs that have Hyperlocation still able to hear and track the client making AoA assessments?

A: Yes. For example, AP #1 is aware of the other Hyperlocation APs on different channels and can schedule those APs to have their WSM modules to go off channel to monitor AP #1's channel to capture location information on its behalf. This information along with RSSI from AP1 are all weighed in the location assessment.

Q: Can the WSM and Hyperlocation module do location based services and wIPS at the same time?

A: Yes. The WSM module is a newer version of the WSM (formally WSSI) module. Once the antenna array is connected to the WSM module, it will support both.

Q: What is the optimal placement for Hyperlocation accuracy?

A: For best performance, you should have a few Access Points that are in line of sight of the device and less then than 70 feet away. While Hyperlocation will work with only 1 AP (greater accuracy) occurs when 3 or more are used.

Q: What methods are used to show the improved accuracy?

A:The CMX 10.2 shows the updated location more quickly on the map and with a higher degree of accuracy. There is no visual indication that a device was located via Hyperlocation vs using the traditional location method. The location accuracy test should show that the location is calculated more frequently and with a higher degree of accuracy.

Q: Is there any change in the Location API?

A: There is no change in the location API. There is no indication in the API if the device was located using Hyperlocation or traditional location methods.

Q: Packet detection RSSI minimum—This looks to default to –100 db. In our retail environment, which is approximately 4000 square feet, with nine APs approximately 25 – 30 apart, should we reduce this to the –75 range?

A: 4000 square feet APs separation with -75 will help location accuracy.

Q: What is the impact of sliding the min RSSI on both resources (AP, WLC,CMX 10.2) and location accuracy?

A: This will help the location accuracy and roaming by only allowing stronger signals to be part of the location solution.

Q: Scan count threshold for idle client detection—What specifically does this mean, how are we defining an idle client?

A: Every client idle timeout is different, for example; iPhone and android has its own settings. When a client is not sending data for X scan periods it is considered idle and the Hyperlocation module schedule the primary radio to send a packet to wake the device so it can be located.

Q. What applications can we use to test BLE functionality?

A. Radius Networks Locate iBeacons App, Cisco provided App, Phunware application.

Q. Can we combine Non HyperLocation and HyperLocation AP's together on the same floor map?

A. Not in this release, all of the devices that are on a specific floor should be either HyperLocation or Non HyperLocation APs.

Q. My AP is showing the IP address of the MSE as 127.0.0.1 ?

A. This will likely be fixed by FCS, but this was a problem that occurred when the HOSTNAME file is incorrectly set on the CMX 10.2 instance. Please check that the /etc/hosts file has an IP address assigned to the local host.

Q. I'm getting a "disk space is full" how do I clear it before upgrading to a later version of CMX?

A. Remove all of the old versions of code from /home/cmxadmin. Remove all of the old versions of logs from /opt/cmx/srv/var/logs/ (all files more then 1 month old)

Q. I know probing clients are not tracked via AoA – Can we use AoA for a client that is associated, but not authenticated (not in RUN state). For example, typical guest WLAN with a WebAuth configuration, client has IP, client is associated to AP but client is not in run state, but in WebAuth state until they accept an AUP or login with credentials.

A. Yes this should work

Q. I am enquiring about an opportunity for Hyperlocation in a warehouse environment to track tags which are placed onto static vehicles. Will Hyperlocation support active RFID Tags?

A. While the Hyperlocation unit is hardware capable, this is a feature being considered for subsequent releases, and is more likely to be done with ACTIVE ASSOCIATED RFID Tags

Q: Is there a height requirement for AP, i.e. for a warehouse environment should we attempt to keep it below 10ft?

A: No requirement to keep to 10 Ft or below, higher ceilings also work.

Q: For some reason I'm still unable to get the MSE IP to show up on the AP which I'm assuming is why hyper location isn't working for me. I've rebooted the controller and the HALO AP a couple times, toggled hyper location on/off under the global settings on the controller a couple times and toggled the module itself on/off a couple times. Normal RSSI location is working

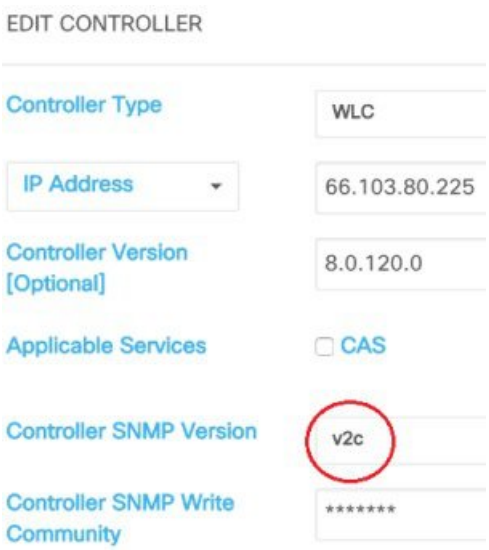
A: Disabling and Enabling HyperLocation on the WLC is one way to get the AP to relearn the IP address of the MSE.Another method would be to delete the WLC from the MSE and add it back.This works best if you have SNMPv2 enabled on the WLC.

Q: Does Hyperlocation require the exact location, elevation and orientation of the AP to be entered into Prime?

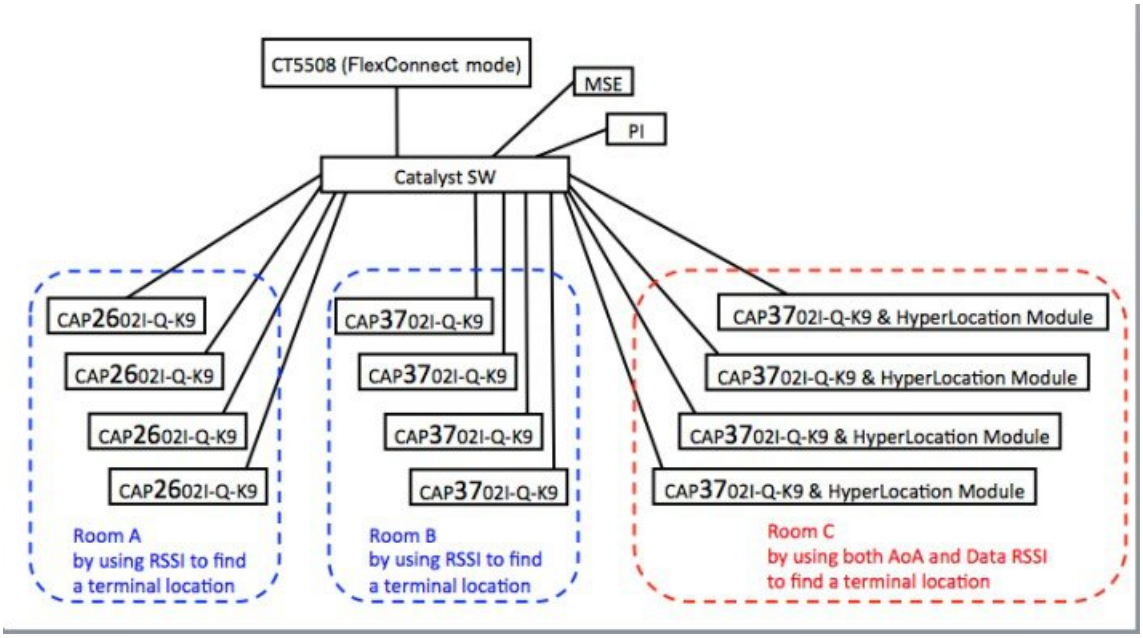
A: Yes, in this release that is how it works, much like a "laser pointer" you need to be precise in knowing where you are before you can know where something else (like a client) is with precision. We are working on making this easier in subsequent releases

Q: How do you enable SNMPv2?

A: This is done in the MSE WLC GUI screen



Q: It is possible to deploy by separating the room into different groups so I can see the difference between simple RSSI location and RSSI + Hyperlocation (AoA)?



A: Yes you can create two maps. One that has Hyperlocation and one that does not and then switch between the two maps.

Q: Does the Hyperlocation with advanced security module RM3010L use Probe RSSI or Data RSSI?

A: RM3010L only helps with Data packet RSSI. It does not participate in Probe packet location algorithms

Q: I understand Hyperlocation module does not currently track BLE beacons (only associated clients) but uses Cisco's Clean Air to track and display beacons based on RSSI. Do you know what version of code CleanAir supports this?

A: Minimum version for BLE detection is WLC 8.0MR1 and does not require the Hyperlocation module, this works with ANY Cisco CleanAir enabled Access Point.

Q: Can I use an earlier version of Prime (prior to 3.0) for Hyperlocation?

A: No – Prime 3.0 has an azimuth feature to correctly orientate the Hyperlocation antenna array.

Q: A customer is looking to use Advanced WIPS and CMX Guest. Given that CMX 10.x doesn't yet support WIPS is there any issue with running CMX 10.2 Base and Advanced, and a second VM with MSE 8.0 with aWIPS licenses?

A: Yes they can run both CMX 10.x for guest and MSE 8.0 for WIPS.

Q: When using CMX 10.1 for BLE beacons tracking, is there any limit on the maximum number of beacons that can be tracked? Would it be also depending on the capacity of the WLC?

A: BLE Beacons use up CLEANAIR slots on an AP. The maximum number of BLE is the same as the max number of interferers.

Q: How does a single Hyperlocation know, how far away the client is ?

A: The angle or 30 degree pitch area is used primarily when only 1 AP is present, and reasonable assessments are done based on RSSI and AoA of course the more Hyperlocation units the better for accuracy.

Q: How much weight does the Hyperlocation antenna + WSM module add to the AP?

A: Module is 0.3 kg. Ant. 1.1 kg.

Q: Hyperlocation/AoA works for associated clients only correct? Is there capability in CMX 10.2 to see both probing/associated clients?

A: Yes for unassociated, you get your traditional RSSI accuracy.

Q: How many UUIDs can the BLE beacon on the hyperlocation module broadcast at one time?

A: We can have up to 5x UUID each with a different power level.

Q: Are CMX and MSE synonyms?

A: MSE is the actual hardware/engine, CMX is the solution name

Q: What is the recommended distance to place Hyperlocation Access Points ?

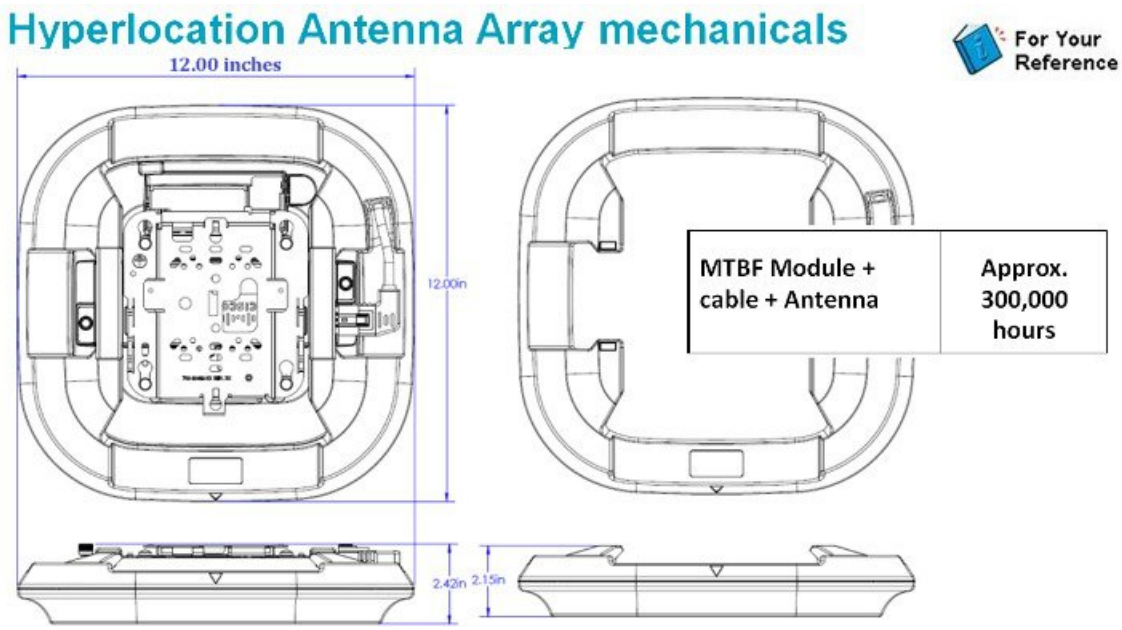
A: Standard 1 in 2500 Square Feet or approximately 40-50 Ft apart

Q: Is there an in-tile mount or a wall “wedge” type mount for the Hyperlocation solution?

A: We are working with 3rd party companies who will be offering same.

Reference Material

Hyperlocation module dimensions:



Hardware Requirements for Power over Ethernet

AP 3600/3700 Power Requirements

		Description	AP Functionality	PoE Budget* (Watts)	802.3af	E-PoE	802.3at PoE+ PWRINJ4
3600	PoE 802.3af	3600 – Out of the Box	4x4:3 on 2.4/5 GHz	15.4	✔	✔	✔
		2.4GHz radio disabled + Wireless Security Location Module	4x4:3 on 5 GHz only + WSM	15.4	✔	n/a	n/a
		2.4GHz radio disabled + 802.11ac Module	4x4:3 on 5 GHz only + 11ac	15.4	✔	n/a	n/a
	PoE+ 802.3at	3600 + Wireless Security Location Module	4x4:3 on 2.4/5 GHz + WSM	19.6	✗	✔	✔
		3600 + 802.11ac Module	4x4:3 on 2.4/5 GHz + 11ac	19.6	✗	✔	✔
		3600 + 3G Small Cell Module	4x4:3 on 2.4/5 GHz + 3G	22	✗	✗	✔
3700	PoE+ 802.3at	3700 – Out of the Box	4x4:3 on 2.4/5 GHz	16.8	✗	✔	✔
		3700 + Hyperlocation Module Adv. Security	4x4:3 on 2.4/5 GHz + WSM	19.6	✗	✔	✔
	PoE 802.3af	3700 – Out of the Box	3x3:3 on 2.4/5 GHz	15.4	✔	n/a	n/a
		3700 + Wireless Security Location Module	2x2:2 on 2.4/5 GHz + WSM	15.4	✔	n/a	n/a

* This is the power required at the PSE, which is a switch or injector.
Also local (Non-PoE) supply AIR-PWR-B will also work at 18W

Reference

Cisco AP-3700 deployment guide

http://www.cisco.com/c/en/us/td/docs/wireless/technology/apdeploy/8-0/Cisco_Aironet_3700AP.html

CMX Licensing information

http://www.cisco.com/c/en/us/solutions/collateral/enterprise-networks/connected-mobile-experiences/guide-c07-734430.pdf

Hyperlocation information

http://www.cisco.com/c/en/us/products/interfaces-modules/aironet-hyperlocation-module-advanced-security/index.html

http://www.cisco.com/c/en/us/products/interfaces-modules/aironet-access-point-modules/datasheet-listing.html

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