Cisco Connected Mobile Experiences (CMX) Hyperlocation Quick Start Guide

This document details the procedure involved in using the Hyperlocation add-ons to the Cisco 3600 and Cisco 3700 Access Points to calculate the location of Wi-Fi clients.

The Cisco Hyperlocation module utilizes the Angle-of-Arrival (AoA) information gathered from a phase-array antenna to locate associated Wi-Fi clients more precisely and quickly than traditional RSSI based location solutions.

The overall system that include the Cisco Hyperlocation modules requires a combination of a specific version of the Cisco Wireless LAN Controller (WLC) that enables the gathering of measurements from the phase-array antenna. A version of Cisco Prime Infrastructure (PI) is required during the initial setup, but is not a part of the ongoing location calculations. Cisco PI is used to record the placement or change in placement of the APs, including X, Y, height, and orientation. A version of Cisco Connected Mobile Experiences (CMX) 10.2.2 is also required. Cisco CMX uses the locations of the Aps, the phase array data and RSSI data to calculate the location of an associated Wi-Fi client, which is then used by the Cisco CMX API or as an input for Cisco CMX Analytics.

Summary of the Installation and Setup Process

The process involved in setting up a Hyperlocation Proof of Concept (POC) deployment is the same as setting up a traditional location-enabled wireless network. The additional steps pertains to the work that is done within the existing GUIs that are required to set up the network that a system administrator normally works with.

The major steps involved in setting up a Hyperlocation system are:

1. Assemble the APs and mount them to the ceiling, recording the exact X, Y, height, and orientation of the devices.
2. Install Cisco WLC and connect the APs to Cisco WLC.
3. Enable the functions that are required, including Hyperlocation, in Cisco WLC.
4. Import Cisco WLC into Cisco PI.
5. Place the AP on the map in Cisco PI.
6. Save and export the map from Cisco PI to a local storage point.
7. Install Cisco CMX.
8. Configure and enable Hyperlocation.
9. Import the map from the local storage point.
10. Verify that the system is showing the clients correctly on the map and that the APs are placed and oriented correctly.
11. Complete Location Accuracy testing of static clients to determine the level of accuracy obtained.

By following these basic steps, a system can be up and running within one day, and the accuracy of the system can be gauged.

Note: Improving the accuracy of the system can be accomplished by adding additional APs into areas where clients may not be seen correctly.

Assumptions and Recommendations

It is important to understand that Hyperlocation requires a certain set of configurations. Besides this, there are some assumptions that need to be understood when deploying a system.

- Please read and understand this document completely before beginning the installation.
- All the APs on a specific floor *must* have Hyperlocation modules.
- Hyperlocation is used only to calculate the location of *associated* devices. The location of non-associated devices in the same network is calculated using the standard probe-packet location via triangulation.

- For Hyperlocation to be calculated, a client should have a clear Radio Frequency (RF) Line-of-Sight (LoS) of at least 3 or preferably 4 APs.
- Due to the inherent nature of RF energy, a Wi-Fi client location will have some jumpiness, that is, a static client will have a calculated location that is different than previous location by 1 to 10M from the previous location when using location updates.
- Notifications of a client entering or leaving a zone can take as long as 20 seconds.
- Clients should be within the convex hull of APs for a valid location to be calculated.
- APs be placed no more than 20 ft. high, and no more than 50 ft apart.
- APs must be accurately placed, including their X, Y, height, and orientation, for a valid location to be calculated.
- Only the high-end Cisco MSE Virtual Appliance (vMSE) hardware specifications or the physical Cisco MSE 3365 are supported.
- Network Address Translation (NAT) between the Cisco WLC and Cisco CMX is not supported. There must be an open non-NAT connection from the Cisco WLC to Cisco CMX to allow incoming and outgoing Network Mobility Service Protocol (NMSP), location, and Simple Network Management Protocol (SNMP) packets.

Recommended Software Versions

The following software versions are recommended to start a Hyperlocation deployment:

Product Name	Software Version	Available At
Cisco WLC	8.1.131.20	- Available via TAC - Alternatively, contact your account team
Cisco Prime Infrastructure	3.1	Available and posted on Cisco.com
Cisco CMX	10.2.2-340	Available and posted on Cisco.com

Physical Deployment

The physical steps for installing a Hyperlocation module and Hyperlocation antenna are available at:

http://www.cisco.com/c/en/us/td/docs/wireless/antenna/installation/guide/hyperloc-ant.pdf

Important: Note that Hyperlocation components can only be ordered as spares. As such, you can order a spare module (AIR-RM3010L-x-K9=) and spare antenna (AIR-ANT-LOC-01=), acquire a Cisco 3600 AP or Cisco 3700 AP, and put them together for the installation.
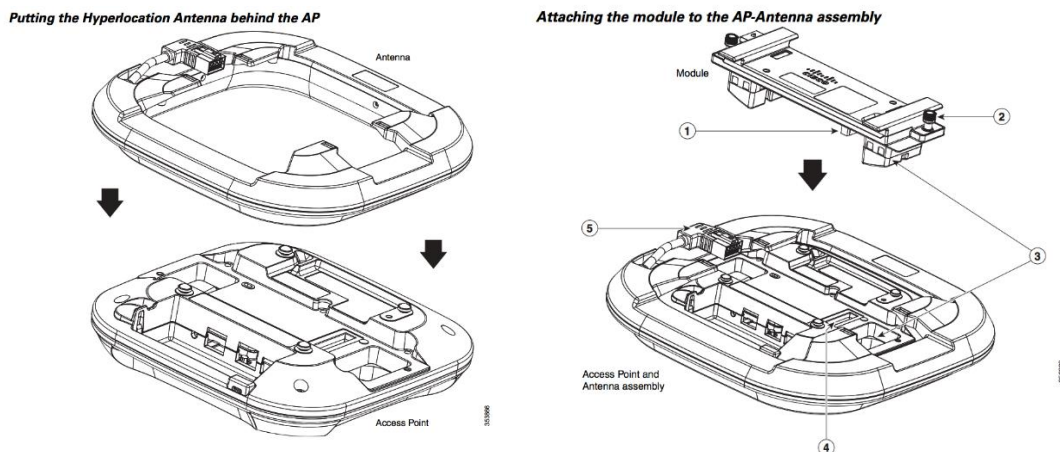

Figure 1 Hyperlocation AP assembly

The physical placement of the APs is an essential component in generating a valid and accurate location with Hyperlocation.

The APs should be placed 50 ft (15 m) apart on the outside edge of a space, and then additional APs should be placed working in to the center of the floor. Each location should be seen in the LoS of at least three Hyperlocation-enabled APs.

The APs should be staggered down long hallways, if any.
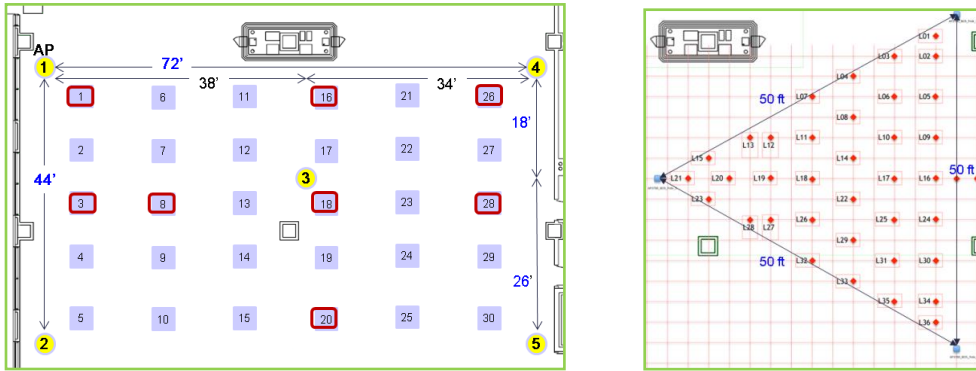
The recommended height for AP placement is 10 ft.

Figure 2 Recommending AP placments

Providing Cisco PI with the correct physical orientation of the APs is essential. The following are the ways in which this can be made quicker:

-   Have all the APs pointing in the same direction with reference to the orientation mark on the APs.
-   Have all the APs pointing at 90^0 (default orientation in Cisco PI).
-   After each AP is placed, saving the placement in Cisco PI ensures that the orientation is not lost.

Wireless LAN Controller Deployment

The following software versions are recommended to start a Hyperlocation deployment:

Product Name	Version
Cisco WLC	8.1.131.20

The following items should be set on Cisco WLC to enable Hyperlocation.

Figure 3 Hyperlocation Configuration

A Network Time Protocol (NTP) server is an essential component in a Hyperlocation deployment because each AP must be synchronized to the same clock. This can be accomplished by having an NTP client on the AP that is

configured using the parameters shown in the figure above. The AP should be able to directly access this NTP server.

The **Packet Detection RSSI Minimum** of **-100 dBm** and the **Scan Count Threshold for Idle Client Detection** of **10** should not be changed. The latter parameter refers to the length of time, in seconds, for there to be no traffic from the client for the AP for the AP decide to send BAR packets to request that the associated client to replay with BAR-ACK packets to provide packets that can be measured to allow a location to be calculated.

In addition, to ensure that clients are associated with the correct AP, **Rx SOP** (Receiver Start of Packet Detection Threshold) should be set to **High** and **Optimized Roaming** enabled, as shown in the figure below. Please be aware that setting **Rx SOP** will force clients to roam, and this can have a negative impact on clients that are not optimized to roam between APs.

For a complete understanding of the effects of enabling Rx SOP, please see the blog at:
http://blogs.cisco.com/wireless/white-paper-rx-sop-101

These settings are configured in the WLC under Wireless -> Advanced
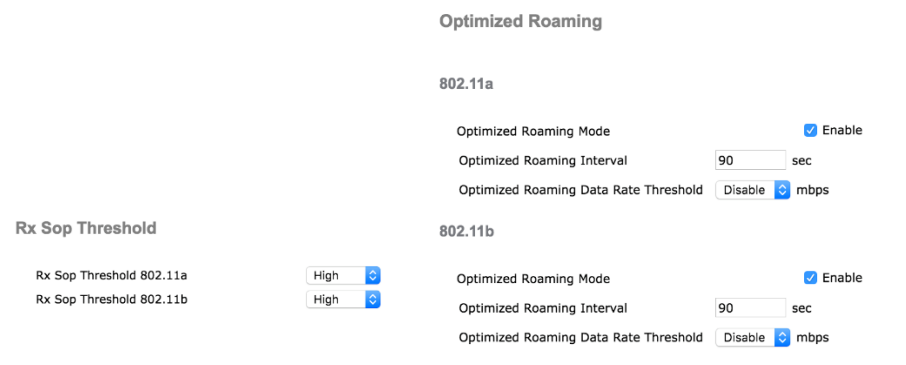

Figure 4 Rx SOP and Optimized Roaming configuration GUI

CleanAir should be enabled on each AP, as shown in the figure below to ensure that Cisco WLC is recognizing the circular Hyperlocation antenna correctly.

AP Name	Radio Slot#	Module Type	Base Radio MAC	Admin Status	Operational Status	CleanAir Admin Status	CleanAir Oper Status	Antenna	
CMX-AP01-6193.9720	2	AIR-RM3010L-B-K9	b8:38:61:a8:bc:60	Enable	UP	Enable	UP	Circular	
CMX-AP06-6193.96e4	2	AIR-RM3010L-B-K9	b8:38:61:a8:ba:a0	Enable	UP	Enable	UP	Circular	
CMX-AP04-61a6.84ac	2	AIR-RM3010L-B-K9	b8:38:61:b1:c8:d0	Enable	UP	Enable	UP	Circular	
CMX-AP03-61af.42cc	2	AIR-RM3010L-B-K9	b8:38:61:b4:53:70	Enable	UP	Enable	UP	Circular	
CMX-AP05-61af.42c4	2	AIR-RM3010L-B-K9	b8:38:61:b4:53:60	Enable	UP	Enable	UP	Circular	
CMX-AP02-6509.8990	2	AIR-RM3010L-B-K9	3c:08:f6:d9:08:a0	Enable	UP	Enable	UP	Circular	

Current Filter: None   [Change Filter] [Clear Filter]

Figure 5 Sample of how AP should appear on the Cisco WLC

Cisco Prime Infrastructure Deployment

Cisco PI 3.1 is the recommended image for Hyperlocation deployment.

The main work that is required in Cisco PI is the accurate placement of APs and their correct orientation. Any change that is made in the location of an AP after a system is started must be made in Cisco PI, after which the maps should be exported to Cisco CMX again.

This can be accomplished by importing Cisco WLC into Cisco PI and then creating a map in Cisco PI and placing the APs that are associated with Cisco WLC in the correct locations on the map.

Detailed instructions for placing APs on maps can be found here:

http://www.cisco.com/c/en/us/td/docs/net_mgmt/prime/infrastructure/3-0/user/guide/pi_ug/wireless-maps.html

The following are some important items to remember:

- A Campus has to be created first.
- All designs have a hierarchy of Campus, Building, and then Floor.
- APs are placed at floor level.
- All the APs on a floor must have Hyperlocation enabled (100% deployment).
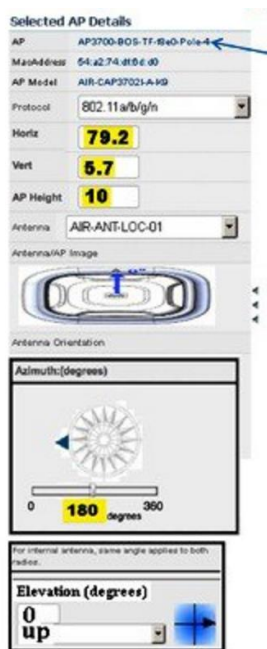- If GPS data points are required in the Cisco CMX API output, GPS markers must be placed in Cisco PI.

Recommendations:

- Place no more than 50 APs per floor because Cisco PI might take a long time to save maps.
- Orient and check each AP in Cisco PI individually to ensure that the following are accurate:
  - X, Y to within 1 ft of true
  - Height to within 1 ft of true
  - Orientation to within 5^{0} of true
- Save your AP after each AP is placed.

Most of the tasks pertaining to Hyperlocation take place in the window displayed in the following figure.

Note: Elevation should be left at zero (0).

The 802.11 a/b/g/n must be dropped down to get to the Hyperlocation antenna.

X, Y, Height, and Orientation of each AP should be set and checked in Cisco PI and Cisco CMX.

Figure 6 AP Orientation Setting in Cisco PI

Cisco CMX Deployment

Cisco CMX 10.2.2-340 or later is recommended for Hyperlocation deployments.

1. The first step you will need to do on the Cisco CMX 10.2.2 instance is to import the maps.

   Note: The best practice is to export a map from Cisco PI 3.1 as a file and then save the file to a local drive.
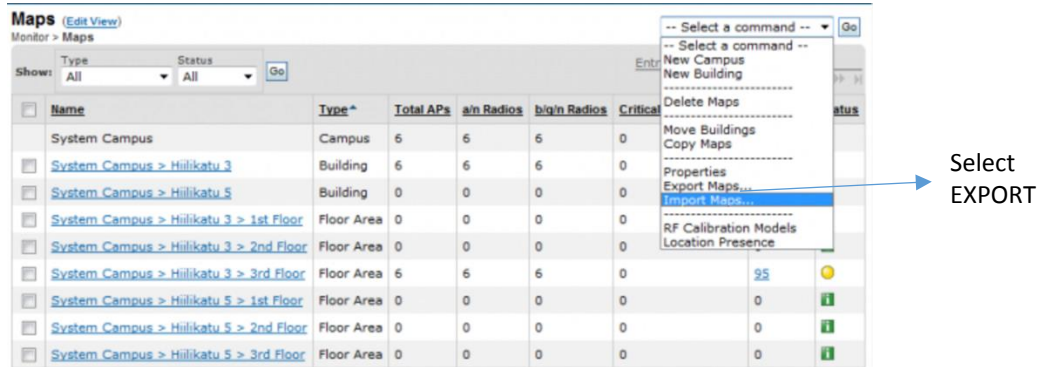
   Exporting a Map from Cisco PI

Figure 7 Exporting Map from Cisco PI

2. Upload the file via the GUI to Cisco CMX 10.2.2 by choosing **System > Settings > Controllers and Maps Setup > Advanced**.
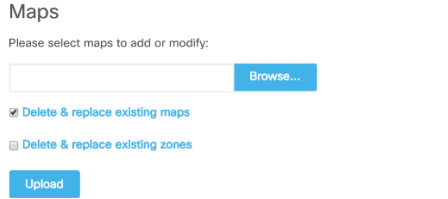

Figure 8 Advanced Map Import GUI on CMX

3. Synchronize Cisco WLC with Cisco CMX.

   Note: The best practice is to have an SNMPv2 READ/WRITE community string specifically for the Cisco CMX POC.

4. Add Cisco WLC to Cisco CMX using the **Advanced** tab, as shown in the following figure. The recommended version of Cisco WLC is 8.1.131.20.

   Note: Be sure to set the correct VERSION of Cisco WLC.

Figure 9 Advanced Controller config on CMX

With Cisco CMX 10.2.2, enable Hyperlocation in the configuration to start the communications between Cisco WLC and the Cisco CMX instance.

Figure 10 Location Calculations Parameters on CMX

After Hyperlocation is enabled, you should see packet counts increasing on the graph that you can access by choosing **System > Metrics > Location Metrics**.

If the graph is all zero, this means the system is not set up correctly. If the graph shows values, Hyperlocation packets are flowing between the APs, Cisco WLC, and the Cisco CMX 10.2.2 system. If traffic is not flowing, verify that there is no firewall between Cisco WLC and the Cisco CMX system.
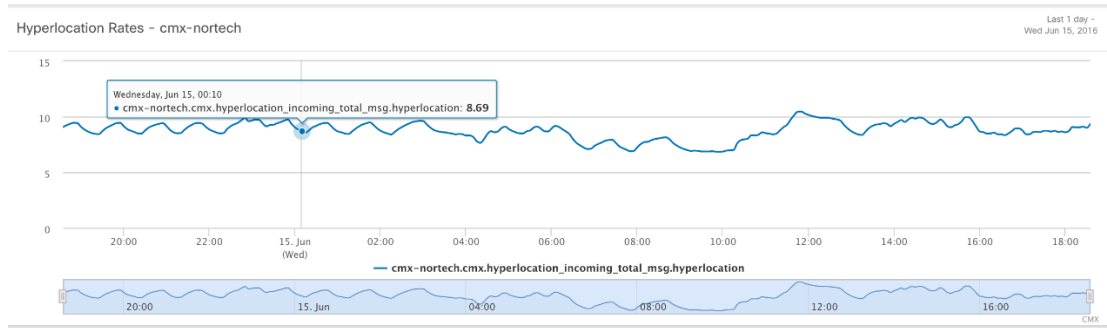

Figure 11 Hyperlocation graph

If Hyperlocation packets are flowing from the controller to the Cisco CMX 10.2.2 system the next thing to check is that the orientation of all the APs is correct. Check this using the **DETECT and LOCATE** window on Cisco CMX 10.2.2 system.

By selecting each AP, you should see data that is similar to the one displayed below, and the AP should state that there is a third slot and that AIR-ANT-LOC-01-2.4GHz is installed. Note that even though it is labelled as a 2.4Ghz Antenna is is both a 2.4Ghz and 5Ghz antenna

→ Verify the X, Y Position of the AP

→ Verify the height of the AP

→ Verify the orientation of the AP

ACCESS POINT

MAC Address:
3c:08:f6:d9:08:a0

Client Information:
2 connected clients

52 detected clients

Co-ordinates:
X: 67.1

Y: 5

Name:
CMX-AP02-6509.8990

Height:
10

Angles:
Slot 0 : 270
Slot 1 : 270
Slot 2 : 270

Antenna Pattern:
Slot 0 : Internal-3700-2.4GHz
Slot 1 : Internal-3700-5GHz
Slot 2 : AIR-ANT-LOC-01-2.4GHz

AP Name:
CMX-AP02-6509.8990

Hyperlocation Module:
Present

Figure 12 Hyperlocation AP Information in Detect and Location Page

A full deployment of a floor with APs and clients, as shown in the figure below, should be displayed in the **DETECT and LOCATE** window.
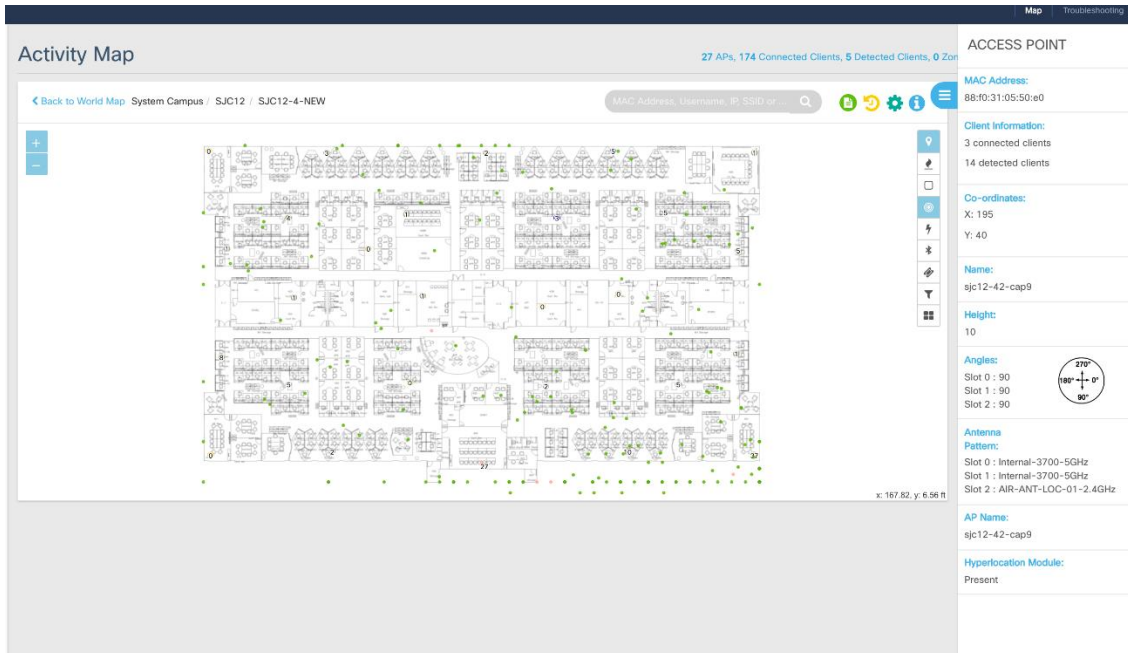
Figure 13 Detect and Location Screen with HyperLocation Enabled

System Verification Steps

To verify that Hyperlocation is working as required, there are at least five different types of tests that you can conduct:

- **Full Test** – This is a 20-point test, where you stay for 2 mins at each point. Assuming a collection rate of 6 points per minute, this test should have 6 * 2 * 20 = 240 test points. This test should be conducted by going to 20 equally spaced locations across a single floor and testing at all these locations.

- **Quick Test** – This is test where 5 locations that are within the convex hull of set of AP is chosen, and you perform a location accuracy test at each point for 2 minutes or 5 points, whichever comes first, This quick test would generate at least 25 data points and be able to give a quick assessment of location accuracy.
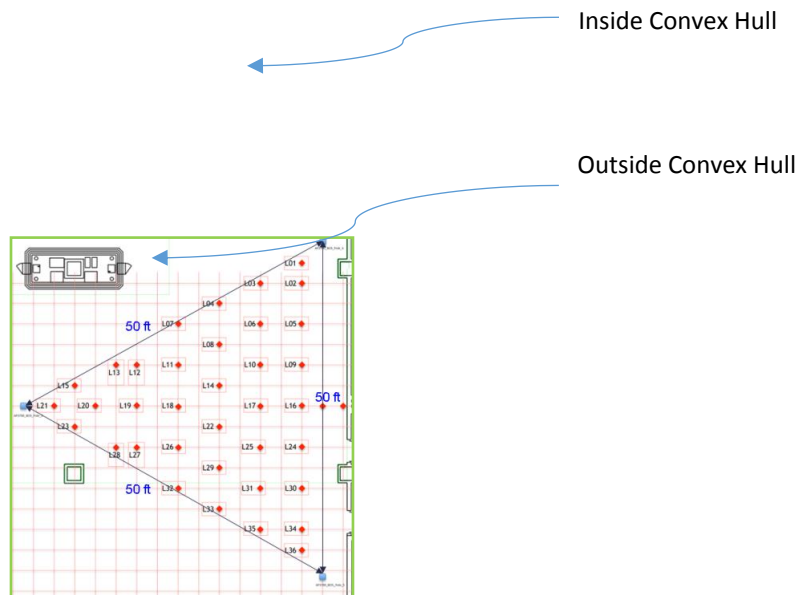

Inside Convex Hull

Outside Convex Hull

Figure 14 Example of inside and outside of Convex Hull

- **Cisco CMX App Test** – This is a test where you utilize the Cisco CMX Admin app from the Apple app store (https://itunes.apple.com/us/app/cisco-cmx/id1064244863?mt=8) and use it to perform a test at several locations. The advantage of this test is that the device is portable and easy to move around.
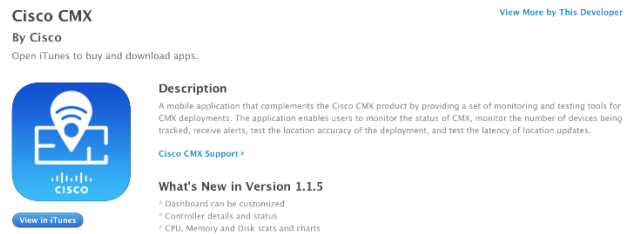

Figure 15 Description of CMX Admin App in Apple App Store

- **Single-Point Test with Laptop** – To conduct this test, you would gather the MAC address of the local laptop that has GUI access to CMX. Then you would complete a standard location accuracy test with this one device. This tests helps you visually check the location of a device, as shown in the **Detect and Locate** window vs where it actually is located.

   Note: This test generally lets you know how well Hyperlocation is working, but is not something that is statistically accurate.

- **Negative Test** – To conduct this test you select a location that is outside of the convex hull of the APs. This test at a "bad" locations is to determine how poor location accuracy is outside the areas that it has been optimized. When testing outside the convex hull, location accuracy can be off by more than 10 m in some spots.

Troubleshooting

Details about advanced troubleshooting can be found in the *Hyperlocation Design Guide.* The first step in troubleshooting is to execute the Hyperlocation troubleshooting process. This process is executed by selecting **Detect and Locate** and then selecting the Troubleshooting sub-menu at the right of the screen. Executing this system requires you to provide Cisco CMX with the credentials to Cisco WLC and the associated Hyperlocation APs. This command executes a series of tests to verify that the system is functioning correctly.
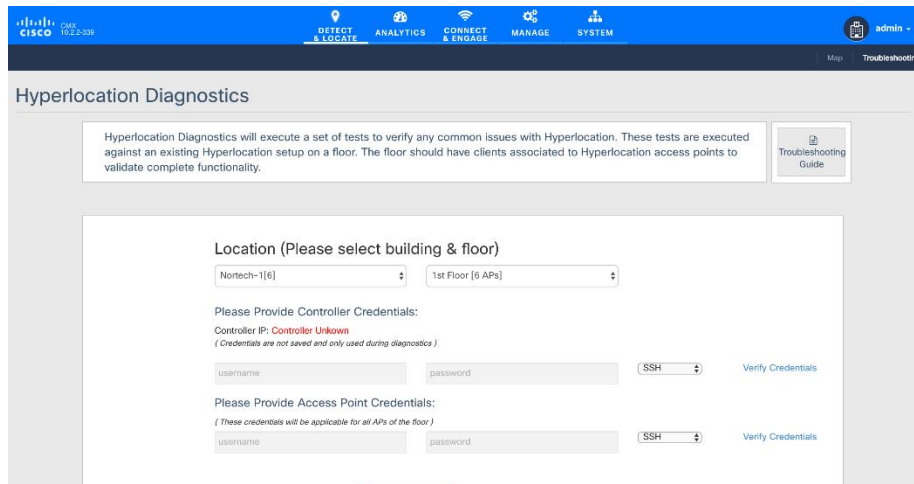

Figure 16 Hyperlocation Diagnostic screen

Workaround to Known Issues

In some situations, a special workaround is required. The following are procedures for two of these known issues that have workarounds:

- Cisco recommend that you change the *stalerssiinmins* parameter from the default value of 3 to 1.

Note: In Cisco CMX Release 10.2.3, this will be the default value.

```
Execute below REST API on CMX CLI to make config changes on CMX.
curl -X POST -H "Content-Type: application/json" -d '{"staleRSSIInMins":1}'
http://localhost/api/config/v1/locationsetup/1
Queries to check after applying the three config changes above:
          curl -X GET http://localhost/api/config/v1/locationsetup/1
```

- If there are a very large number of Hyperlocation APs in an area, a customer may run into CSCva24807, which is a known bug that requires a change in the size of the heatmap. This is normally seen when a Hyperlocation group has more than 15 APs. For information about the workaround for this issues, contact the Cisco Technical Assistance Center (TAC).

How to Execute a **Full Test**

1. Choose between 15-20 points in your area of interest. These points should be inside the "convex hull" (i.e., inside the perimeter of the APs). These points can be in the open with LoS to multiple APs, or in conference rooms with no LoS, that is, whatever representative environment you want to test.
2. Make sure that you mark the exact true location of these 15-20 points.
3. Choose a device you want to test with. We recommend that you use an iPhone 6. (You can perform this test separately with a different device, for example, a Samsung device or a laptop, later on.)
4. We recommend that you enable a 5-Ghz SSID, and associate the device to this SSID for testing.
5. Walk over to point 1, enter the true location on the map, turn on the device and associate to the network, and make sure that the device is sending packets. You can do this by streaming music, opening a live video session, or enabling the Cisco CMX instance to send ping packets to the wireless device. Remain in the location for at least 2 mins. The number of data points collected will increment. Whatever the amount of duration you decide on, make sure that you measure for the same duration in each of the other 14-19 points to ensure that data is not skewed. You can decide to rotate the device by 90^0 after 30 seconds to get a more complete sample. You can capture the exact and repeatable locations by marking them on the floor (see the following figure) and using a tray with a stand to keep the phone up at the same height. Note that you should get a new data point every 4-8 seconds on an average.

    i.

    ii.   *Figure 17 Example of Ensuring Correct Location of a Client by using a location testing rig*

6. Move over to the next point and start the test again. Repeat this for all the 15-20 points.
7. In the end, Cisco CMX creates a summary report about the accuracy of all these tests.
8. The following figure shows a map of typical building where testing was done using a Lenovo X1 carbon laptop.
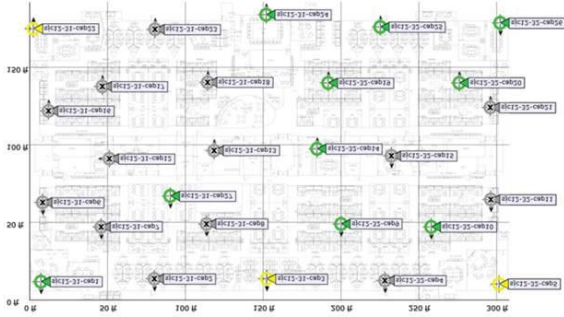
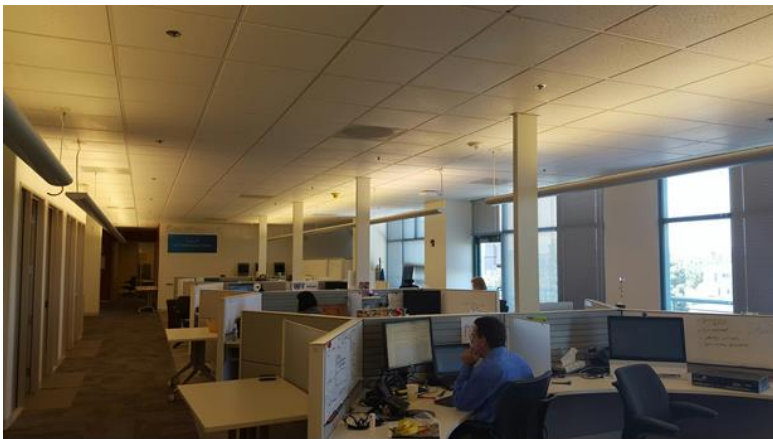*Figure 18 Example of well place Access Points for large indoor floor*

Figure 19 Typical indoor office Testing Location

Summary

If you follow all the steps outlined in this document and test according to the System Verification Steps outlined, you should have a successful Hyperlocation deployment.

Cisco MSE Licensing Help

For technical support related to licensing, contact the Cisco Technical Assistance Center (TAC) at 800 553-2447 or tac@cisco.com. For questions relating to your licensing order, contact Cisco Customer Service at http://www.cisco.com/go/customerservice.

For More Information

- For more information about Cisco MSE, visit http://www.cisco.com/go/mse or the Cisco MSE Support site at http://www.cisco.com/en/US/products/ps9742/tsd_products_support_series_home.html.

- For additional licensing information, visit the Cisco licensing website at http://www.cisco.com/go/license.

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