AirDefense Services Platform
Proximity & Analytics
Design Guide

Contents

1 Overview

Proximity Awareness and Analytics module is comprised of several features within the AirDefense Services Platform (ADSP). When the Proximity and Analytics licenses are applied to the system, all of these features are avaiable for use. The device tracking feature is comprised of three functional levels: Presence, Wi-Fi Zone Tracking, and Wi-Fi Position Tracking. There are not individual licenses for each feature or functional level.

1.1 Feature Breakdown

The following picture depicts the key components and features of Proximity Awareness and Analytics module.

PRESENCE
- Presence Based on Signal Strength
- Detect Devices on Premises
- Generate Alarms and Events Based on Presence

WI-FI ZONE TRACKING
- Locate Devices Based on Zone Membership
- Trigger Events Based on Device Region
- Real-Time Device Density by Region

WI-FI POSITIONING
- Locate Devices in the Environment
- Trigger Events Based on Device Location
- Real-Time Device Density by Location

ANALYTICS
- Track Detailed Statistics About Device Activity
- Enable Better Understanding of Environment
- Track Single/Multiple Devices
- Find Where Devices Go in the Environment
- View Historical Patterns

PROXIMITY API
- 3rd Party can Receive Proximity Data
- 3rd Party can Receive Events
- 3rd Party can Retrieve Historical Proximity Data

PROXIMITY & ANALYTICS
- Licensed Feature
- Enables Several Services and Functionality

1.2 How Proximity Tracking Works

All of the Proximity functionality in ADSP is based on Wi-Fi signal strength from a client to an AP or Sensor. Each functional level is slightly different from the others in terms of how they use this information.

1.2.1 Data Acquisition

The data from the Access Points (APs) and Sensors is gathered and collected by ADSP in the same manner for all functional levels. They hear transmissions from a client and send the Received Signal Strength Indication (RSSI) for those transmissions to ADSP. ADSP will take this information to determine where a client is located based on setup and configuration.
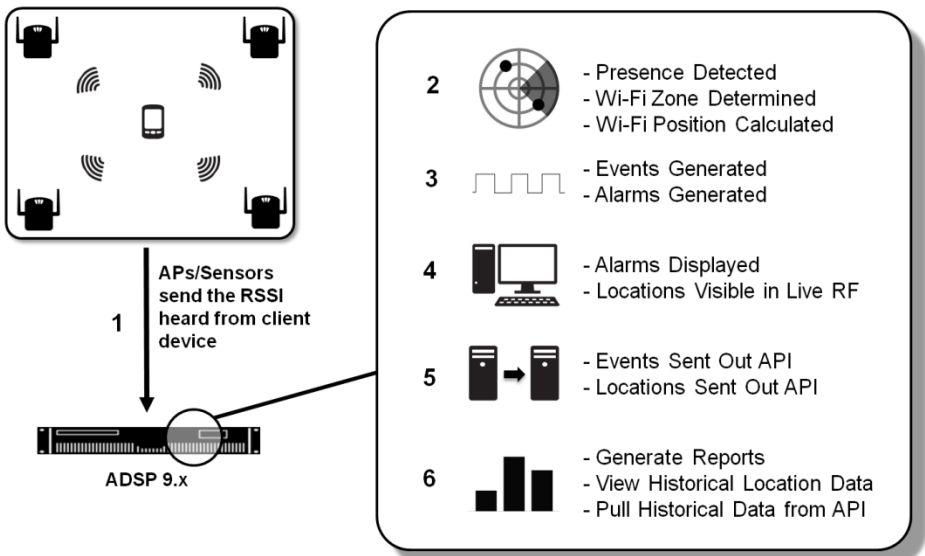
Presence

Presence takes the RSSI information and compares it to configured RSSI thresholds to determine if a client device is outside, near, or inside the monitored environment.

Wi-Fi Zone Tracking

Wi-Fi Zone Tracking takes the RSSI information and determines the associated zone of a client device based on how close it is to a specific sensor in the monitored environment.

Wi-Fi Position Tracking

Wi-Fi Position Tracking takes the RSSI information and uses data from several APs and Sensors to calculate a location for the client device in the monitored environment.

2 Supporting Features

The Proximity and Analytics feature set utilize functions that are inherently available within the AirDefense Services Platform (ADSP) and WiNG Infrastructure. In relation to designing for Proximity and Analytics, this document will only cover how radio configuration in WiNG and Sensor Operation settings affect sensor functionality.

2.1 Understanding Sensor Radio Configuration

WiNG allows for the radios on an AP to be configured in several different ways. When a radio on an AP is set as a sensor it will connect to the configured ADSP appliance. ADSP will then send sensor related configuration to the AP based on configuration profiles. All AP radios except the AP622/AP6522 are band unlocked, which means that they can operate in either the 2.4GHz or 5GHz band.

⚠️   *CAUTION*   Radio 1 on the AP622 and AP6522 is band locked to 2.4GHz.

✔   *NOTE*   A tri-radio AP with all radios set to sensor mode does not increase the scanning ability of the AP. It functions the same as a dual radio AP with all radios set to sensor mode.

2.1.1   Dedicated Sensor

A dedicated sensor is an AP with all its radios set to sensor mode. There are two basic options with dedicated sensor APs: an AP with a single radio or an AP with dual radios. On a dual radio AP each radio can be configured separately.

Single Radio Dedicated Sensor

A single radio set in sensor mode will scan both the 2.4GHz and 5GHz bands. The channels that are scanned by the sensor radio are determined by the Sensor Operation settings in ADSP.
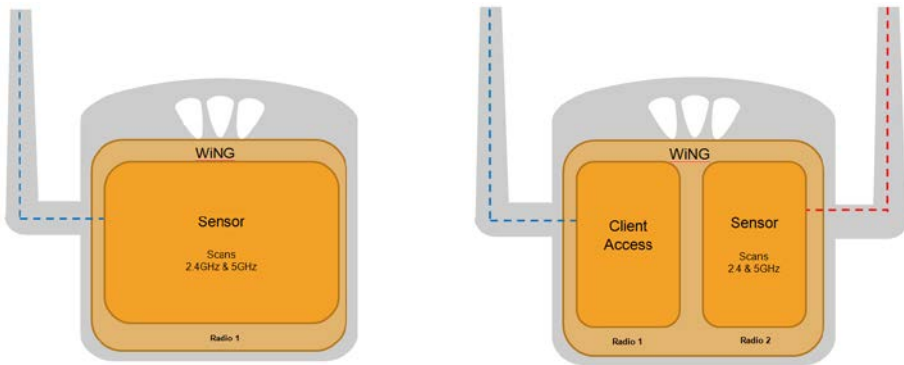
Dual Radio Dedicated Sensor

When both radios on a dual radio AP are set to sensor mode, one radio will scan 2.4GHz and the other will scan 5GHz. The channels that are scanned by these radios are determined by the Sensor Operation settings in ADSP.
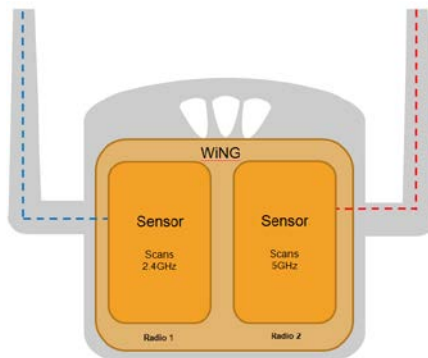
2.1.2   Radio Share Sensor

Radio Share is a feature in WiNG that allows a WLAN radio to send information to ADSP as a sensor would. The key difference is that a radio with Radio Share enabled can only send data for the channel that the WLAN radio is set to.

Radio Share Modes

Radio Share has two different modes: In-Line and Promiscuous.

In-Line – only sends information for frames directed to its BSSs, which a majority are data frames from associated stations.

Promiscuous – sends all frames it hears from the environment that are transmitted on its channel. This is the mode that must be used with Proximity and Analytics.

⚡   *WARNING!*   When using Radio Share with Proximity and Analytics, the Promiscuous mode must be enabled.

There is no operational difference between a single and dual Radio Share enabled AP. A dual radio AP will be able to listen on two channels instead of just one.
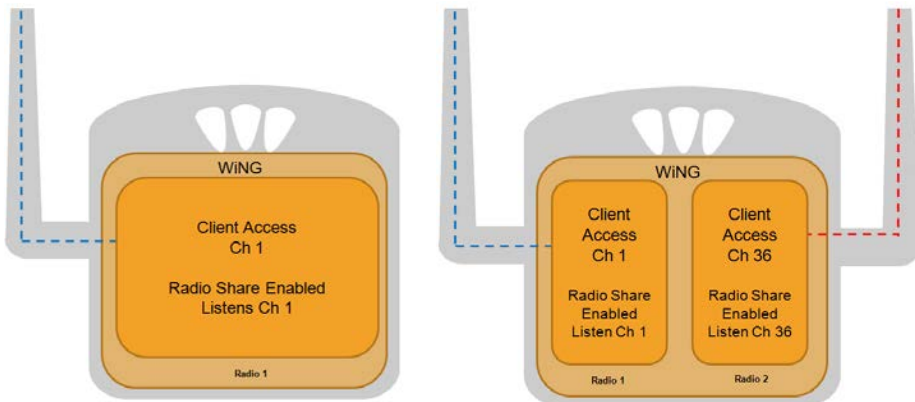
2.1.3 Mixed Dedicated and Radio Share Sensor

When a dual radio AP has a WLAN radio with Radio Share Promiscuous enabled and the other radio configured as a dedicated sensor, the dedicated sensor will automatically skip the channel the WLAN radio is on. This occurs even if it is configured to scan that channel.
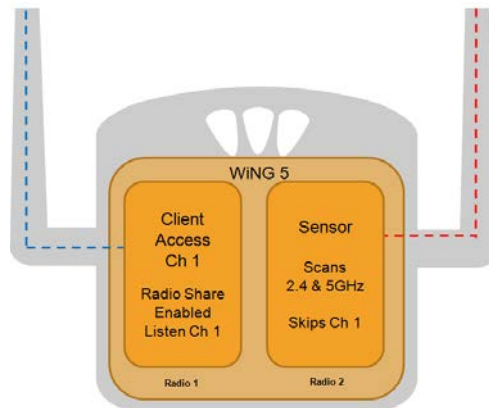
2.1.4 Sensor Scalability

The following table depicts maximum number of sensors that can be enabled with Proximity Awareness and Analytics license on different Airdefense platforms.

Hardware Platform	Max LBS Sensors Supported
NX9500	1500
SV-3652	250
SV-4250	250
SV-1252	100

2.2   Adaptive Scan

In ADSP 9.1, the Adaptive Scan has been updated to better support Proximity and Analytics. It can be enabled in the Sensor Operation settings and allows ADSP to adjust channel scanning patterns on sensors to spend more or less time on channels as necessary. When Adaptive Scan and the Location Tracking RSSI Scan are enabled at the same time, the updated algorithm will assume that any channel with a Sanctioned BSS is a Proximity channel. Adaptive Scan will then adjust its scanning to better support Proximity channels on dedicated sensor radios. It effectively puts higher priority on Proximity channels and then rotates non-Proximity channels in the open scan time. Adaptive Scan does not affect Radio Share radios.

A dual radio Sensor can support a maximum of all 2.4GHz and 30 x 5GHz channels as Proximity channels. A single radio sensor is going to be a combination of 2.4GHz and 5GHz and the below table can be used to determine Proximity channel combinations. It should be noted that the more Proximity channels (Sanctioned BSS Channels) there are fewer time slots are available to rotate non-Proximity channels through. A value of '0' in the table means that there are no free slots to rotate in non-Proximity channels.

ADSP 9.1 Adaptive Scan - Single Radio Sensor - Open non-Proximity Channel Slots

# of 5GHz Proximity Channels (Sanctioned 5GHz BSS Channels) / # of 2.4GHz Proximity Channels (Sanctioned 2.4GHz BSS Channels)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2
1	29	27	25	23	21	19	17	15	13	11	9	7	5	3	1
2	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0
3	27	25	23	21	19	17	15	13	11	9	7	5	3	1	
4	26	24	22	20	18	16	14	12	10	8	6	4	2	0	
5	25	23	21	19	17	15	13	11	9	7	5	3	1		
6	24	22	20	18	16	14	12	10	8	6	4	2	0		
7	23	21	19	17	15	13	11	9	7	5	3	1			
8	22	20	18	16	14	12	10	8	6	4	2	0			
9	21	19	17	15	13	11	9	7	5	3	1				
10	20	18	16	14	12	10	8	6	4	2	0				
11	19	17	15	13	11	9	7	5	3	1					
12	18	16	14	12	10	8	6	4	2	0					
13	17	15	13	11	9	7	5	3	1						
14	16	14	12	10	8	6	4	2	0						
15	15	13	11	9	7	5	3	1							
16	14	12	10	8	6	4	2	0							
17	13	11	9	7	5	3	1								
18	12	10	8	6	4	2	0								
19	11	9	7	5	3	1									
20	10	8	6	4	2	0									
21	9	7	5	3	1										
22	8	6	4	2	0										
23	7	5	3	1											
24	6	4	2	0											
25	5	3	1												
26	4	2	0												
27	3	1													
28	2	0													
29	1														
30	0														

More Proximity Channels than Modified Adaptive Scan supports (ADSP 9.1) with a single radio Sensor

3   Functional Level Application

Before beginning the design process one has to know on which of the Proximity and Analytics features are to be used. Then decide what functional level - Presence Detection, Wi-Fi Zone Tracking, or Wi-Fi Position Tracking, gives the granularity needed. It should be kept in mind that moving up from one functional level to the next increases design, setup, and configuration time and complexity. In most cases moving from one functional level to the next also increase the required AP density.

3.1   Presence Detection

Presence Detection is the simplest and easiest functional level to implement, but it also gives the lowest proximity granularity. It can be used to determine if a device is outside, near, inside, or has left the environment.

This data can be used to determine information like how many new devices have been seen, how long someone stays, or how many people outside the environment actually come inside. This information can also be used to interact with a user, for example, by sending a message when they arrive or sending a message when they have not been seen in a long time.

Design and setup for Presence requires ensuring that there are enough APs/Sensors to see the devices throughout the environment. Typically WIPS sensors can be used as Proximity sensors for Presence Detection.

3.2   Wi-Fi Zone Tracking

Wi-Fi Zone Tracking is fairly easy to design and setup, but can also give a higher proximity granularity than Presence Detection. It can be used to determine an area of the environment that a device is in. The granularity can be higher or lower depending on the sensor density and configuration of Zone RSSI threshold. It can be used to locate a device in part of the environment or throughout the environment. A device's specific location is not determined but is associated to the closest proximity sensor that hears it.

The data from Wi-Fi Zone Tracking can be used to determine information such as; which zones devices are going to, which zones are most popular, or the density of devices in defined zones in the environment.

Design and setup for Wi-Fi Zone Tracking is accomplished by placing APs/Sensors in key areas to track devices in specific zones. They can also be placed throughout the environment to track a device's general location.

✓   ***NOTE***   Wi-Fi Zone Tracking is available in ADSP 9.1 or later.

3.3   Wi-Fi Position Tracking

Wi-Fi Position Tracking is the most complex to design and setup, but gives the most granularity for a specific device's location. Data from several sensors is used to determine where a device is actually located within 10 meters or less.

The data from Wi-Fi Position Tracking can be used to determine information such as; where a device is specifically located or device density throughout the environment.

Design and setup for Wi-Fi Position Tracking is accomplished by placing APs/Sensors in a high density throughout the environment. To get the best accuracy they must be well placed throughout the environment and the RSSI updates must get back to ADSP at a high rate. There are limitations on the number of channels that can be supported in the environment.

4   Design

Now that there is an understanding of the different Sensor modes and the fundamental differences in the Proximity functional levels, the AP layout can be designed for the desired application.

4.1   Licensing Requirements

The Proximity and Analytics license is all that is needed for all the Proximity features. The number of licenses depends on number of APs/sensors used in the Proximity deployment. It is applied per AP/Sensor that will participate in the Proximity functions. Moving from one functional level to the next basically requires a different density of APs/Sensors and therefore a matching number of Proximity and Analytics licenses.

4.2   Presence

Presence is the easiest Proximity functional level to design for. The proper coverage can be achieved with as little as one sensor up to many sensors depending on the size of the environment.

4.2.1   Hardware/Software Requirements

These are the hardware and software requirements for the ADSP appliance, APs/Sensors, and wireless clients for Presence Detection.

Appliance

- 64bit ADSP appliance
- ADSP 9.0 or later (latest version recommend)
- Proximity and Analytics licenses for Sensors/Radioshare AP

APs/Sensors

- Any ADSP supported AP/Sensor
- Any ADSP supported firmware (5.4.1 or later recommended)
- 5.2.x or later WiNG firmware required for (5.4.1 ro later recommended)
    - o   Radio Share capability
    - o   Sub 1 minute RSSI updates

Wi-Fi Clients

- Must have Wi-Fi enabled

4.2.2   Design Requirements

Design Tools

- LANPlanner 13.1 or later

Environment Information

- Floor plan of the environment (LANPlanner layout preferred)
- Current AP and Sensor placement (LANPlanner layout preferred)

4.2.3   Design Guidelines

Presence Detection design has two main guidelines.

- Enough sensor coverage to monitor the environment
- Sensors listening on channels that the clients will be transmitting

Sensor Coverage

The first guideline is the sensor coverage, which will be determined by where a client device needs to be detected first. There are three configurable Enter thresholds for Presence Detection. Determining how these thresholds will be used will help determine where sensors need to be placed. The lowest boundary should not be below -95 dBm.

Presence Enter – Threshold 1 – this is the outer most boundary and would represent like a device entering a parking lot.

Presence Enter – Threshold 2 – this is an intermediate boundary and would represent the like a device near the building.

Presence Enter – Threshold 3 – this is the inner most boundary and would represent like a device entering the building.
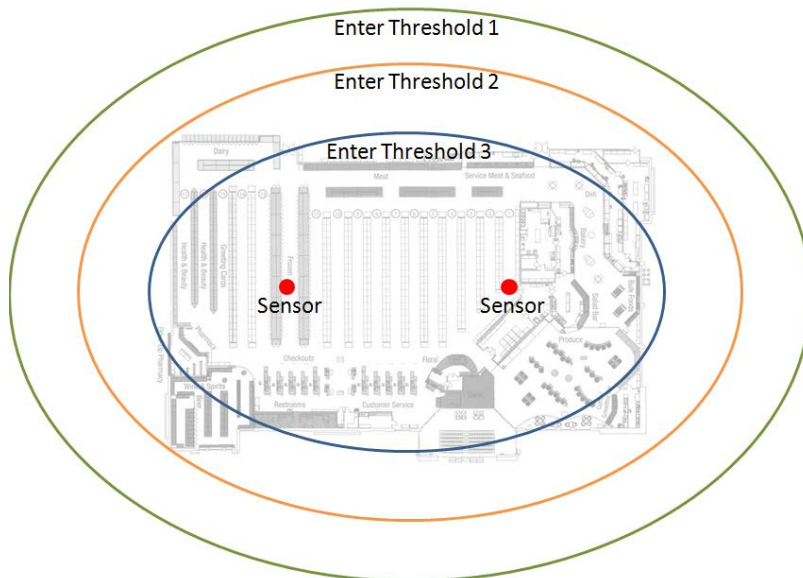
Sensor Channel Scanning

In order for Presence Detection to work, the sensors used for Proximity must be scanning channels that the clients will be transmitting on. Any type of sensor will work, but a dedicated sensor will be the most comprehensive for monitoring all channels. If there are currently WIPS sensors in the environment, they can have the Proximity and Analytics licenses applied. Radio Share sensors can also be used, but remember they only monitor one channel. A single Radio Share sensor would be able to detect unassociated devices that are probing its channel and clients that are associated to it or other APs on its channel. To get good coverage with Radio Share devices, the Proximity and Analytics licenses would need to be applied to the entire WLAN infrastructure.

4.2.4   Designing

Designing for Presence Detection is fairly easy, because it is a matter of making sure there is enough sensor coverage for the entire environment. If there is already good WIPS coverage then there may be very little needed to change or add for Presence Detection. LANPlanner can be used to verify or plan for Presence Detection. The scope of this document will not go into detail about how to setup a layout or placing APs/Sensors in LANPlanner, but only the tools required to verify Presence Detection coverage.

⚠️   *CAUTION*   In LANPlanner, do not use Sensor object, but instead use all AP objects. In the AP settings enable "Client Access" and/or "Device Sensing" depending on if they are dedicated sensors or have Radio Share enabled. This must be done for each 802.11 standard that is being simulated.

Reverse Link RSSI Coverage

To determine proper coverage for Presence Detection decide where a device should be first detected. For example in the parking lot of a building, the sensors must be able to hear the device at about -95 dBm or greater. Other thresholds will need to be defined to determine if the devices are near the building or inside the building. These thresholds and AP placement can be determined with a prediction of the Reverse Link RSSI Coverage. This is the signal level expected to be heard by a sensor from a client.
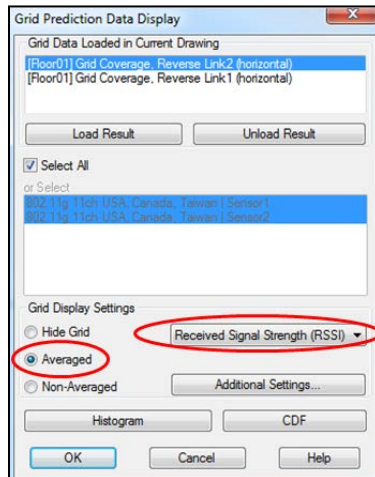
To enable this, perform a Quick Predict and do a Grid Prediction with a Reverse Link in LANPlanner.   In the next window, select the APs that are either Sensors or will have Radio Share enabled.
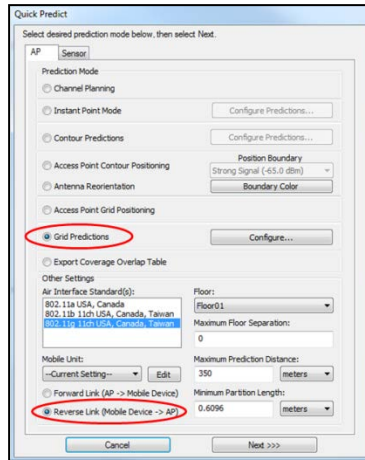
For the data display, select Averaged Received Signal Strength (RSSI).

A heat map showing the predicted average reverse link RSSI will be shown. From this heat map, it can be determined if there are defined RSSI thresholds that can be used and if there is complete sensor coverage. In the example, it can be seen that there are 3 key RSSI regions. Anything from -95dBm to -70dBm is outside the building. Another area from -70dBm to -60dBm can be defined as near the building. The final area inside the building is -60dBm or higher. The other main item to notice is that in the predicted coverage the entire interior area is covered by the sensors.
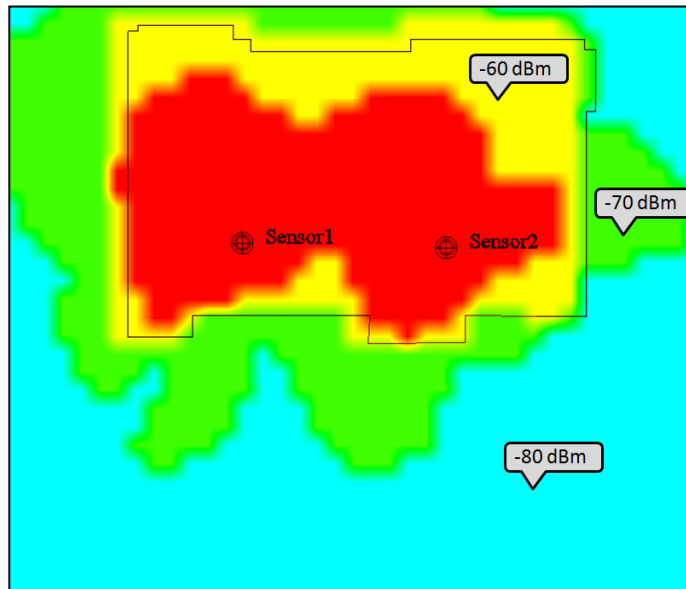
In this example, the predicted thresholds defined in ADSP for Presence Detection would be approximately:

- Enter Threshold 1: -95dBm

- Enter Threshold 2: -70dBm

- Enter Threshold 3: -60dBm

Once the sensors are deployed, the actual thresholds will need to be determined with a survey.

4.3   Wi-Fi Zone Tracking

Wi-Fi Zone Tracking is fairly easy to design for. The proper coverage depends on the application and can range from just one sensor to define a single zone to many sensors for covering the entire environment with zones.

4.3.1   Hardware/Software Requirements

These are the hardware and software requirements for the ADSP appliance, APs/Sensors, and wireless clients for Wi-Fi Zone Tracking to be supported and work properly.

Appliance

- 64bit appliance hardware
- ADSP 9.1 or later (latest version recommended)
- Proximity and Analytics licenses for Sensors/Radioshare AP

APs/Sensors

- Any ADSP supported AP/Sensor
- Any ADSP supported firmware (5.4.1 or later recommended)
- 5.2.x or later WiNG firmware required for (5.4.1 or later recommended)
   - Radio Share capability
   - Sub 1 minute RSSI updates

Wi-Fi Clients

- Must have Wi-Fi enabled

4.3.2   Design Requirements

Design Tools

- LANPlanner 13.1 or later

Environment Information

- Floor plan of the environment (Current LANPlanner layout preferred)
- Current AP and Sensor placement (Current LANPlanner layout preferred)

4.3.3   Design Guidelines

Wi-Fi Zone Tracking design has three main guidelines.

- Enough sensor coverage for the key zones or environment
    - Zone resolution
    - Number of zones
- Zone separation
- Sensors listening on channels that the clients will be transmitting

Sensor Coverage

Keep in mind that one sensor's coverage area constitutes a zone. The zone boundary is set by configuring the Wi-Fi Tracking RSSI threshold.

The number of zones is going to be determined by the purpose of the deployment. Zones can be setup to cover key areas or the entire environment. This will determine the number of sensors needed.

The next item that needs to be determined is the resolution, how small or large the zone or zones need to be. The Wi-Fi Tracking RSSI threshold is a global value for that scope and lower scope levels unless there is an override at a lower level. This value is an RSSI level that the client must reach in relation to a Proximity sensor before it is considered in that sensor's zone. This RSSI level should be no higher than -30dBm and the lower limit should be set at a reasonable level for the zone tracking application. Generally the Wi-Fi Tracking RSSI threshold should be set around -50dBm.
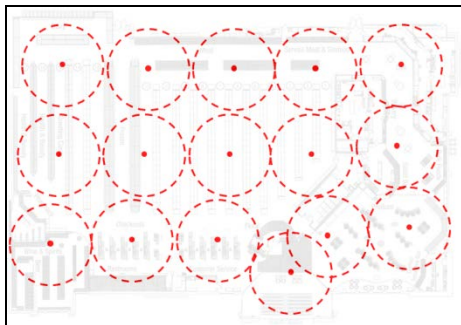
Zone Separation

In Zone Tracking, if there are two zones that overlap and a station is within the Wi-Fi Tracking RSSI threshold then it will be located in the zone with the sensor that sees it at the highest level. ADSP has methods to keep the station from jumping back and forth from one zone to the other. It is still recommended to keep some separation in the zones.

Sensor Channel Scanning

In order for Wi-Fi Zone Tracking to work, the sensors used for Proximity must be scanning channels that the clients will be transmitting on. A dedicated sensor will be the most comprehensive for monitoring all channels.

Radio Share sensors would work with unassociated stations that are probing through channels. The issue with Radio Share, in the Zone Tracking scenario, is associated stations that will not be probing as often on other channels. If a station is near the Zone 2 Radio Share sensor and associated to the Zone 1 Radio Share sensor the station might get placed in the wrong location. It also might not get placed at all if it is not within the Zone Tracking RSSI threshold of Zone 1.
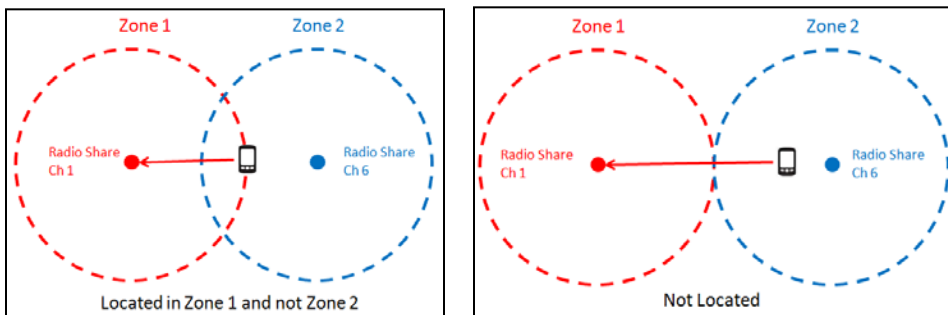
4.3.4 Designing

Designing for Wi-Fi Zone Tracking is fairly simple. It is basically taking Presence Detection design to a smaller scale. LANPlanner can be used to verify or plan for Wi-Fi Zone Tracking. The scope of this document will not go into detail about how to setup a layout or placing APs/Sensors in LANPlanner, but only the tools required to verify Wi-Fi Zone Tracking coverage.

⚠️   *CAUTION*   In LANPlanner, do not use Sensor object, but instead use all
                   AP objects. In the AP settings enable "Client Access" and/or
                   "Device Sensing" depending on if they are dedicated
                   sensors or have Radio Share enabled. This must be done
                   for each 802.11 standard that is being simulated.

Reverse Link RSSI Coverage

To determine proper coverage for Wi-Fi Zone Tracking, the application must
first be determined.   In this example, a device in the entire environment needs
to be tracked and the Zone Tracking RSSI threshold should be around -
50dBm.

Perform a Quick Predict and do a Grid
Prediction with a Reverse Link. In the next
window select the APs that will be the
Proximity sensors.
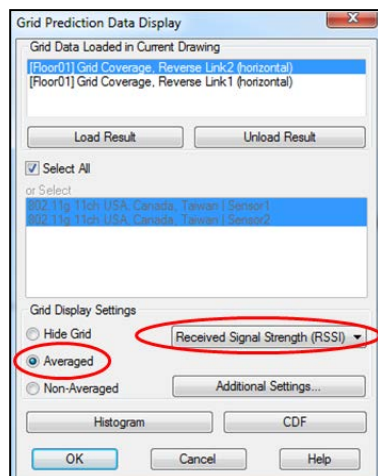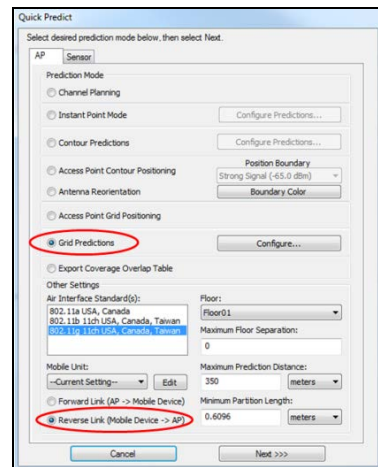
For the data display select Averaged
Received Signal Strength (RSSI).

A heat map showing the predicted average reverse link RSSI will be shown and the predicted -50 RSSI threshold can be found. It can then be determined if the layout and number of APs is going to give full coverage of zones to track a device throughout the environment.
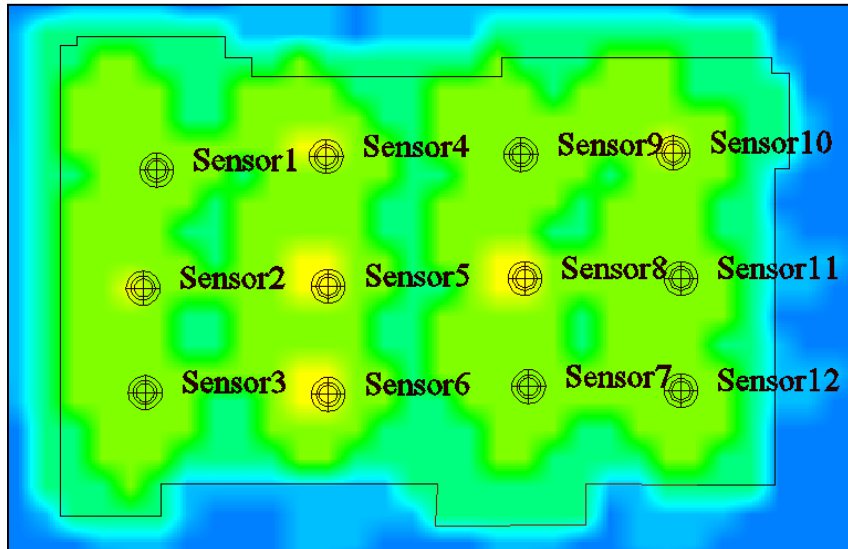
In this example, there are 12 zones defined with about a -50dBm Wi-Fi Zone Threshold. With this deployment a station could be located within 12 areas of the environment.

4.4   Wi-Fi Position Tracking

Wi-Fi Position Tracking is probably the most complex Proximity functional level to design for. It requires a minimum of 3 sensors, but will most likely require many more than this based on the environment size and desired channel support. If the sensor layout is properly designed it can be expected to see an accuracy of 10 meters or less.

4.4.1   Hardware/Software Requirements

These are the hardware and software requirements for the ADSP appliance, APs/Sensors, and wireless clients for Wi-Fi Position Tracking to be supported and work properly.

Appliance

- 64bit appliance hardware
- ADSP 9.0 or later (latest version recommended)
- Proximity and Analytics licenses for Sensors/Radio Share APs

APs/Sensors

- Any AP that supports WiNG firmware 5.4.1 or later firmware
  - Does not include M400 or M5x0 sensors
  - Does not include AP300 or AP5131 APs
- Firmware WiNG 5.4.1 or later (latest firmware recommended)

Wi-Fi Clients

- ADSP 9.0.0 to ADSP 9.0.3 require Wi-Fi clients to be associated to a wireless network
- ADSP 9.1 and later only requires that Wi-Fi be enabled

4.4.2   Design Requirements

Design Tools

- LANPlanner 13.1 or later

Environment Information

- Floor plan of the environment (Current LANPlanner layout preferred)

- Current AP and Sensor placement (Current LANPlanner layout preferred)

4.4.3 Design Guidelines

Wi-Fi Position Tracking design has five main guidelines.

- 3 or 4(ideally) sensors hear a station at any location

- -80 dBm reverse link RSSI to sensors

- Monitoring the channels the devices are transmitting on

- Optimal Sensor Layout

- Appliance Scalability for Proximity

Reporting Sensor Count at -80dBm Reverse Link

For the best performance for Wi-Fi Position Tracking, it is required that four or more sensors be able to hear the station at -80dBm or better. Operationally, only 3 sensors are required to hear the device to calculate a location, but depending on the sensor scanning pattern, there is a chance that all sensors will not be able to report RSSI information every update. For this reason it is recommended to use a minimum of 4 sensors, so that accuracy is maintained.

Channel Monitoring

In order for a sensor to hear the device, it must be monitoring or scanning the channel the station is transmitting on. If it is an active, unassociated station it will probe through all of its supported channels. Associated stations are going to transmit the majority of the time on the channel they are associated to.

In general, all WLAN APs should have Radio Share configured for Promiscuous Mode and have Proximity and Analytics licenses loaded. All Sensors should have Proximity and Analytics licenses loaded.

Radio Share – These APs will report back on the channel they are configured for and will usually give the most visibility into the environment for Wi-Fi Position Tracking.

Dedicated Sensors – Dedicated sensors will help with location tracking. If a dedicated sensor will be relied on for one of the 4 required data points in Wi-Fi Position Tracking, either Adaptive Scan must be enabled (ADSP 9.1 or later) or its channel scan pattern must be manually configured.

Sensor Layout

For Wi-Fi Position Tracking to give the most accurate results, the Sensors - Dedicated and Radio Share, must be laid out optimally in accordance to the channels they are scanning. Here are a few guidelines to follow for layout.

- At least 4 sensors monitoring a channel
- Perimeter of sensors around tracking area
- Do not place similar channel sensors in a straight line

In general the sensor layout will normally come out to be about one sensor every 2500 square feet.

Below are a couple of examples of bad and good layouts. Each color dot represents a channel that a Radio Share sensor is monitoring. These are just layout examples and they are not scaled.

The following design is a bad layout. Notice that the orange sensors are in a line and there are not enough blue sensors for Wi-Fi Position Tracking. The green sensors look like they might be in a good pattern, but there are only 3 sensors and there is not full coverage for that channel in the environment.
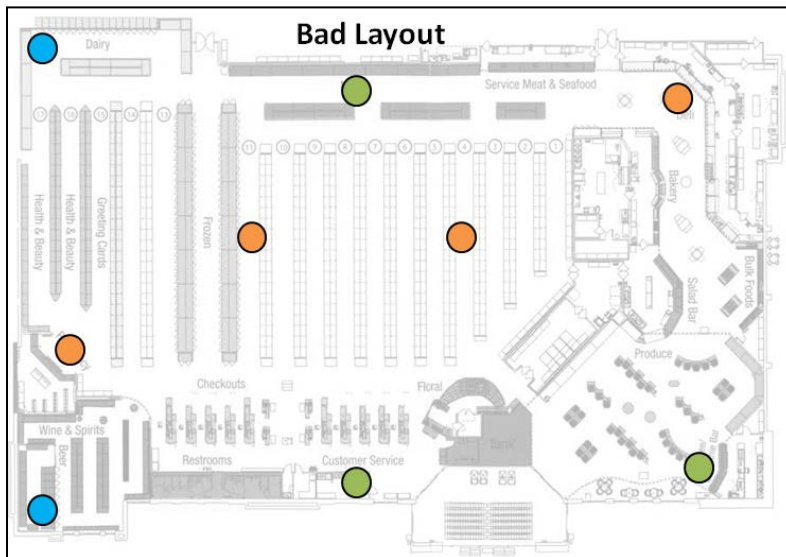
This design is a good layout. There are 4 or more sensors per channel and they are spread throughout the environment. There is also a perimeter created that contains sensors for each channel.
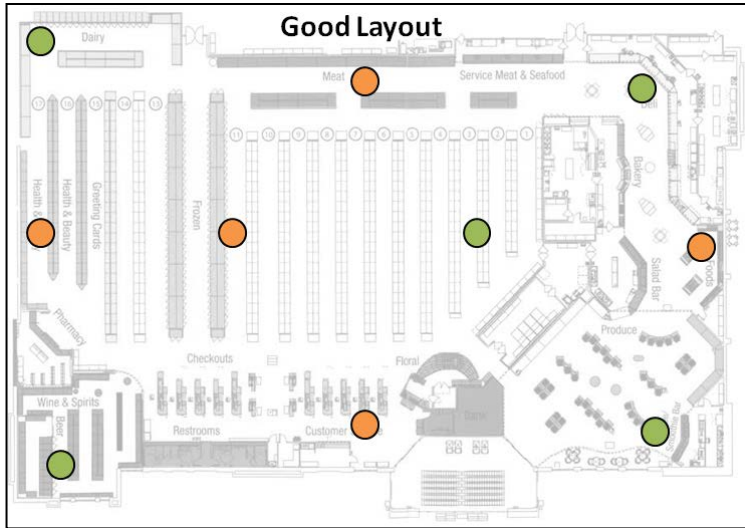
A general step by step method is to place sensors around the perimeter. Once the perimeter is configured, place sensors in the center. Finally, fill in the gaps between the perimeter and center to complete coverage.
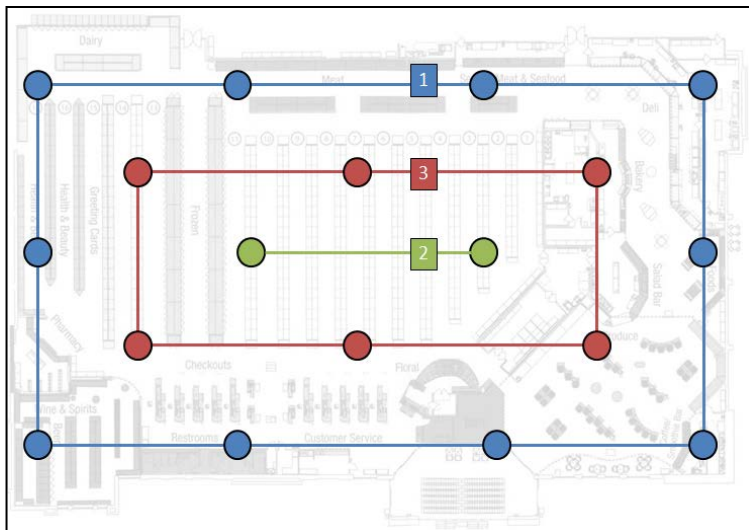
4.4.4   Designing

The Wi-Fi Position Tracking is the most complex Proximity functional level to design for. Time and effort should be put into designing for Wi-Fi Position Tracking, because if the design does not meet the application needs it will be more difficult to compensate post installation. LANPlanner can be used to verify or plan for Wi-Fi Position Tracking. The scope of this document will not go into detail about how to setup a layout or placing APs/Sensors in LANPlanner, but only the tools required to verify Wi-Fi Zone Tracking coverage.

⚠️   *CAUTION*   In LANPlanner, do not use Sensor object, but instead use all AP objects. In the AP settings enable "Client Access" and/or "Device Sensing" depending on if they are dedicated sensors or have Radio Share enabled. This must be done for each 802.11 standard that is being simulated.

There are a few different visualizations that show relatively the same information in different formats. They all have advantages and disadvantages, so verifying a design with all them gives a clearer picture of what the final result will be. The following steps walkthrough these different visualizations. Before beginning the predictions, an existing layout will need to be loaded or a new layout be created. The wall materials and layout should be drafted as accurately as possible and optimized with live survey data, if available.

Even if a manual channel plan will not be used, one based on the design guidelines must be created for running the visualizations. First, determine the number of channels in a particular band that will be used on the infrastructure. Then divide the number of APs by that number. For example, if there are 18 APs and there will be 4 x 5GHz channels supported then 4 or 5 APs would be selected. Remember that for optimum performance for Wi-Fi Position Tracking at least 4 sensing devices must hear the device at any location.

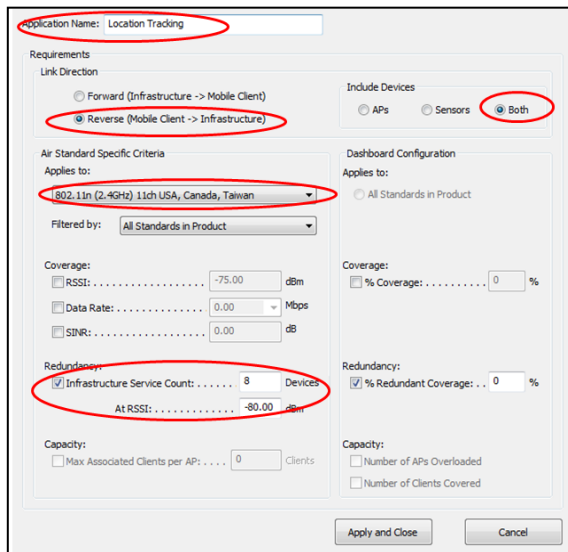**Location Tracking Application Visualization**

The Location Tracking Application visualization in LANPlanner is probably the easiest to run, but has the limitation that the results per channel cannot be viewed. It can give a preliminary picture when the right parameters are used. Predictions will need to run on all the 802.11 standards that will be used in the environment. Since this is a reverse link prediction, it is likely that only 802.11n (2.4GHz) and 802.11n (5GHz) will need to be tested.

To bring up the Application Planning menu in LANPlanner, navigate to "Network Design → Application Planning" and the menu will open to the left.
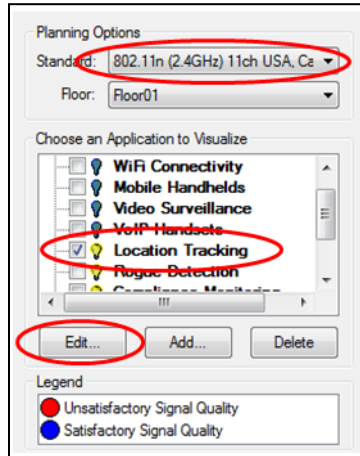

The "Location Tracking" application will need to be enabled for the standards that are being visualized. The "Location Tracking" parameters will need to be updated for Wi-Fi Position Tracking. Click the Edit button.

Verify that the "Location Tracking" application was opened. Verify that "Link Direction" is set to *Reverse* and "Include Devices" is set to *Both*. For each Standard, change the "Infrastructure Service Count" to at least 8 devices and the "At RSSI" field to -80dBm. Apply and Close.

Now that these changes have been made, verify that the "Location Tracking" application is selected and the correct "Standard" is selected. A pass/fail heat map with failed coverage in red and successful coverage in blue will be generated. The following shows a heat map with bad coverage.
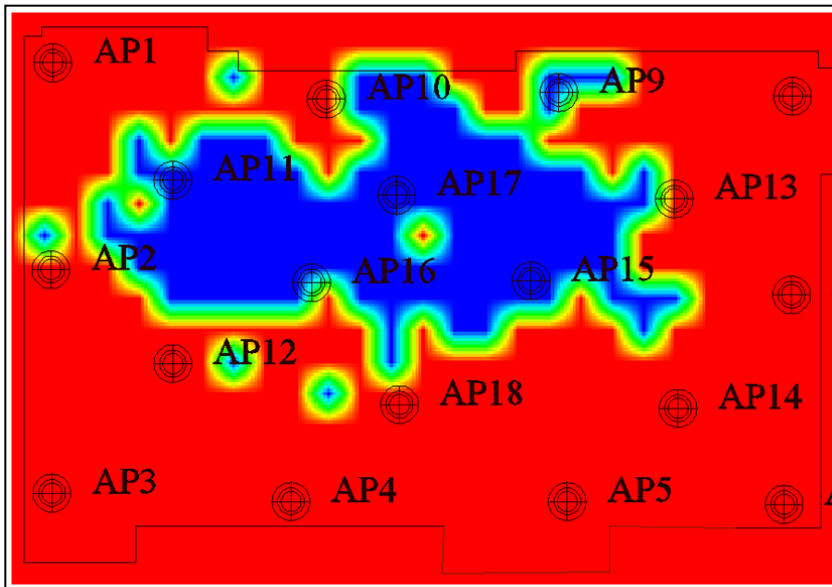
This visualization gives a general idea of the coverage for Wi-Fi Position Tracking and the values set above are assuming a larger deployment. If it is a smaller deployment, the "Infrastructure Service Count" may need to be decreased.

The value is going to depend on the number of Sensors/APs (Radio Share) and the number of Proximity channels that need to be supported. The service count can be turned down if there are a lower number of Proximity channels to support. However, never set the service count below 4, because at least 4 sensing devices need to hear a station for optimal coverage. All 4 of those devices need to be monitoring the channel the station is on.

If the layout meets the requirements set, then the heat map should look similar to example below. Keep in mind that this is just a general view of the overall coverage. If this prediction model passes, then other prediction models should be executed.
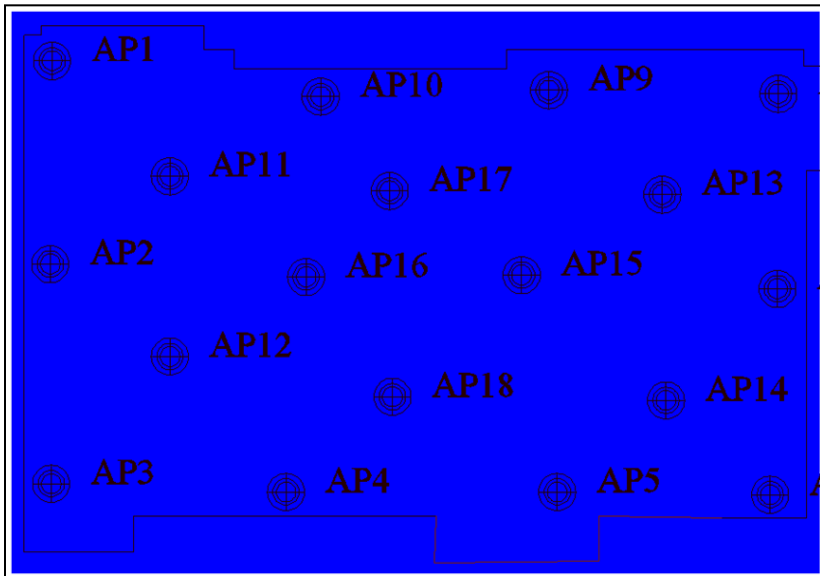
Service Count

The Service Count prediction is very similar to the "Location Tracking" application in that it shows a heat map based on the number of sensors that see a station throughout the environment. This visualization differs because it shows more breakpoints than just pass/fail. Even though it does not have a filter specifically for channels, channel coverage can be verified by selecting APs and Sensors that would be monitoring a particular channel.

Open "Network Design → Quick Prediction…". On the "AP" tab select "Grid Predictions". Select the standard to test and set to "Reverse Link"

Select "Next" and in the following window select all the APs/Sensors that will be on or monitoring a particular channel. Use the custom channel layout previously created to select a group of APs/Sensors with similar channels.
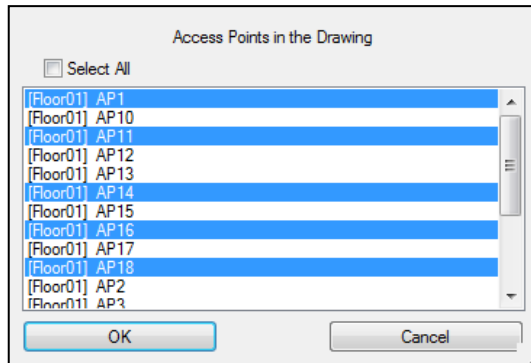
In the next window select the Grid that was just created. Choose Averaged Service Counts. Select Additional Settings.
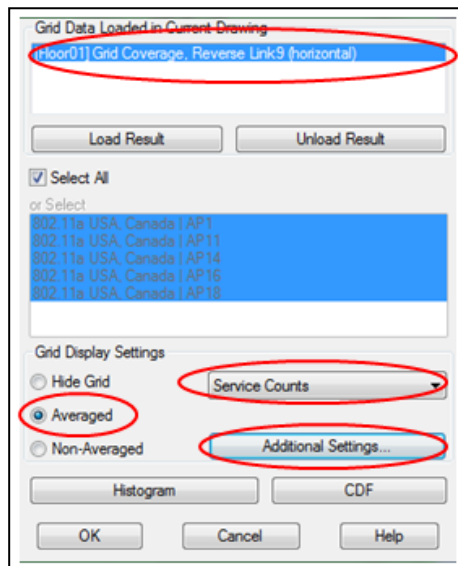
In the following window open the Colors settings.
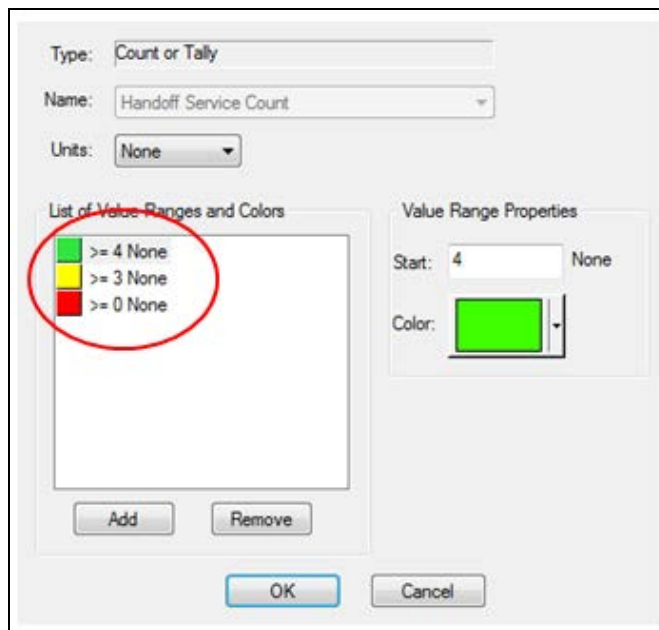

Set the colors to Red = 0, Yellow = 3, and Green = 4.

Navigate back to the first window and run the prediction. A heat map showing the number of sensors that can hear a device throughout the environment is generated. Remember, if APs on only one channel were selected, then the heat map will show coverage for that channel.

This is an example of when coverage does not meet requirements. Having a few areas of yellow is acceptable, but it should be a small percentage.
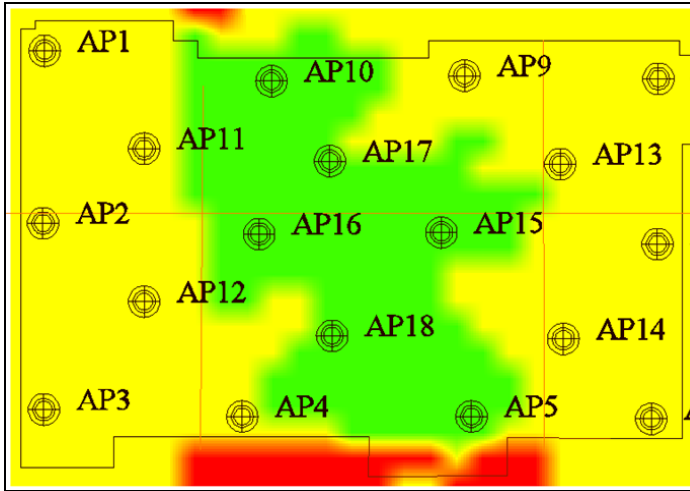
The heat map below is an example of what it should look if the requirements are met. It may not be all green like below, but green is what is desired in
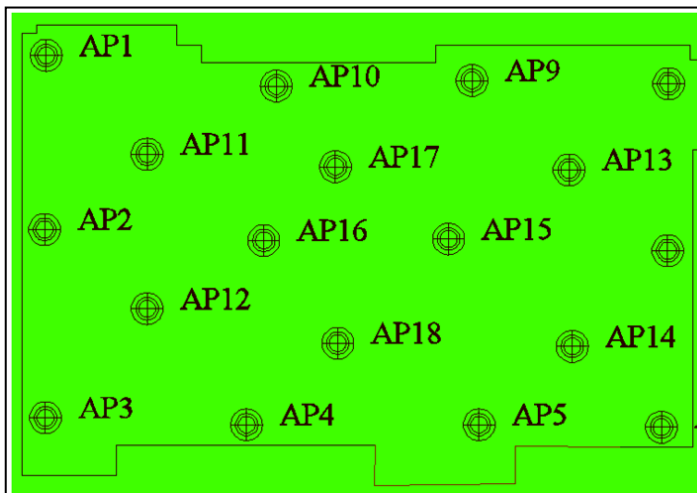
areas where the coverage is required.

Instant Point

Instant Point is very similar to Service Count as well, but it is a real-time visual. It allows the mouse curser to be placed in different locations and lines will be drawn from that location to the sensors that it predicts will be able to see the device.

Open "Network Design → Quick Predict…" and on the "AP" tab select "Instant Point Mode". Select the standard to test and set to "Reverse Link"


Select the "Configure Predictions" next to 'Instant Point Mode". In this window enable and set the "RSSI Cutoff" to -80. Click "OK".

Select "Next >>>" and in the following window select all the APs/Sensors that will be on or monitoring a particular channel. Use the channel layout that was created to select a group of APs/Sensors with similar channels. Click "OK" to continue.
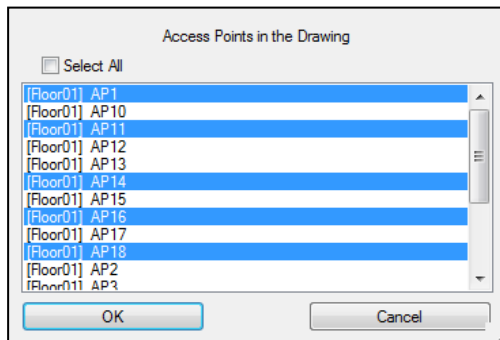
The floor plan will display lines from the APs that were selected to the point where the mouse is located. These lines are connected to the APs that are predicted to see a device at -80dBm or better at the selected location. If the selected APs are on a particular channel then only coverage for that particular channel will be displayed. Use this view to verify locations throughout the floor plan, but particularly in the corners and areas with lots of obstacles around them.
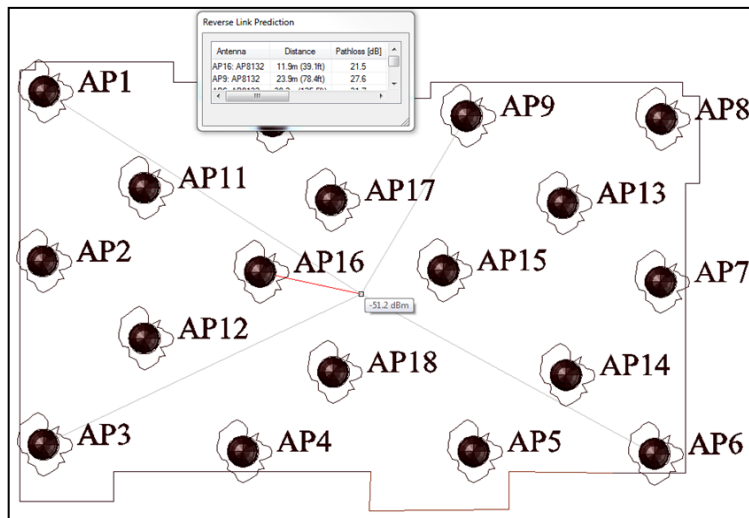
The Service Count and Instant Point predictions should be performed for each group of APs on the same channel that was determined with the manual channel layout. The overall design will be ready once all predictions show compliance with the Wi-Fi Position Tracking requirements. Typically the AP density will come out to about an AP every 2500 square feet.

4.5 High Ceiling LBS Deployments

4.5.1 Challenges

There are some challenges for location based service to deliver optimal performance in high ceiling deployments. The height of the ceilings where APs and sensors are mounted will have direct impact on the expected location accuracy.

In general, higher ceilings negatively impact the relationship between RSSI and distance on which location based solutions rely on. When an AP is mounted at typical ceiling heights like 10 to 15 feet, then moving distance of the mobile user translates proportionally to absolute distance to the AP, and therefore RSSI values. On the other hand, when an AP is mounted very high from mobile users on the floor, then moving the Wi-Fi client away by certain distance translates to moving only a fraction of the absolute distance from the AP, and therefore an effect on the RSSI versus distance relationship.

For example, if at low ceiling height, 1 unit (dB) of RSSI difference is equivalent to 1meter of horizontal distance, then at high ceiling height, that same 1 unit of RSSI might equal 3 meters of horizontal distance. This is the distance necessary to move to see a 1 unit drop in RSSI values. As a result, the loss of accuracy is inevitable.
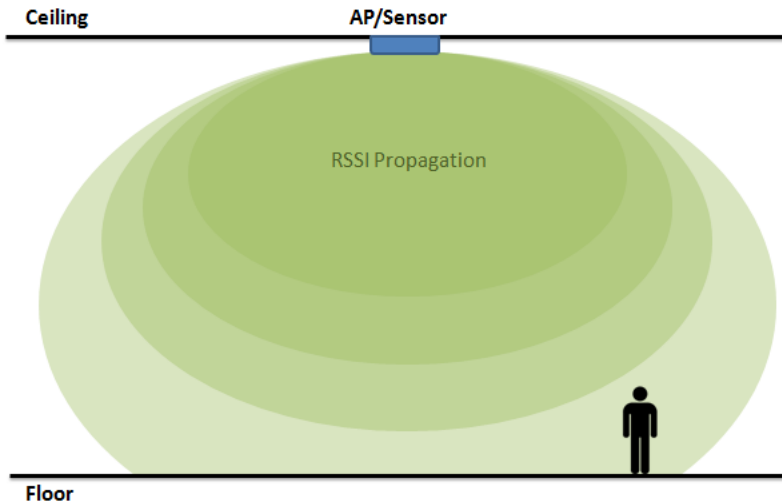
The following diagram illustrates positive correlation of RSSI vs distance, for an AP at 12 feet ceiling height, with standard dipole antenna.
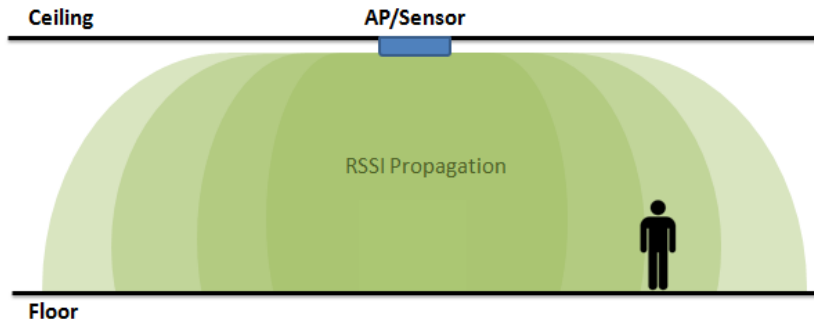
The following diagram illustrates distorted correlation of RSSI vs distance, for an AP at 30 feet ceiling height, with standard dipole antenna.

The following diagram illustrates positive correlation of RSSI vs distance, for an AP at 30 feet ceiling height, with external narrow beam panel antenna.
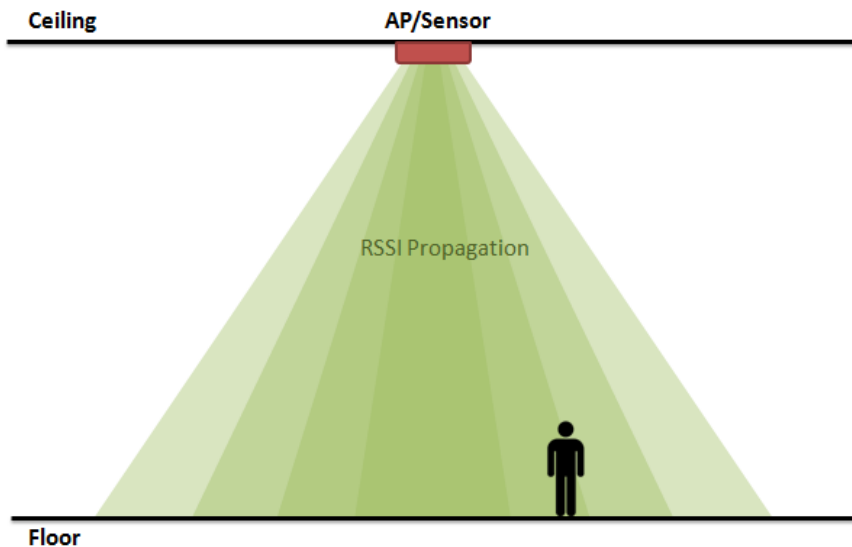
4.5.2   Design Considerations

The following guidelines should be followed for LBS deployments where ceiling height is over 18-20 feet.

Directional Antennas - The directional external antennas are recommended for high ceiling location based deployments. The locationing engine depends on the RSSI values from different APs/sensor for determining location of a client device. A large change in RSSI over a short distance is required for better estimation of the location of the device. Directional antennas helps this phenomena by warping the coverage contours such that moving a short horizontal distance results in a greater difference in RSSI values, which helps to deliver better accuracy.

Zebra recommends symmetrical narrow beam width antennas, which point towards the floor, to improve the location accuracy.

Consistency in Height - All the APs and sensors participating in location based services are recommended to be at same height, but within 2 to 3 ft variation. Also, the maximum ceiling height where these APs are mounted should not exceed 40 feet for optimal location accuracy.

For example, for Presence, if there are some APs/sensors which are mounted at 15 feet and some at 30 feet, the Presence RSSI thresholds will not translate the same way across the environment. If the RSSI threshold is set to -60dbm in the places where the APs/Sensors are at 30 feet, a Wi-Fi client may never reach an AP/sensor at that signal level.

Likewise, Zone Tracking has a similar issue as Presence, with APs/Sensors at drastically different heights. If the Zone RSSI threshold is set to -50dbm, that should work with APs/sensors at 15 feet. But if there are some APs/sensors at 35 feet, then Wi-Fi client devices may never get located in those AP/Sensor zones, because they are so high from the floor that a Wi-Fi client may never reach that RSSI level in relation to those APs/Sensors.

Higher Density of APs/Sensors: As the coverage area with narrow beam antenna is smaller compared to that of a standard dipole antenna, it is implicit that more number of APs is required to deliver better location accuracy in high ceiling deployments.

Zebra recommends an AP every 2500 square feet along with a dedicated sensor around the perimeter at every 100 feet. But, needless to say that it varies from one environment to other, and also with the different ceiling heights.

✔ *NOTE* To meet the typical operating metrics, all of the recommended best practices should be followed. Even when following best practices it is not necessarily guaranteed that system delivers typical metrics.

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