Location Based Services
Best Practice

1 Summary

The purpose of this document is to give a condensed overview of the Proximity and Awareness features in the AirDefense Services Platform (ADSP). This includes an overview of the features, summary of the setup requirements, and best practices. Location Based Services is a set of features in ADSP that provides presence detection, real-time location tracking, and historical location analytics for Wi-Fi devices. The LBS set of features also includes the ability for setting up Virtual Regions on areas of a floor plan, so that ADSP can generate alerts based on device entering, exiting, containment within, and proximity to these areas. These location events as well as other location information can also be accessed through a built-in programming API that allows for the ability to tie this data into a third party application. Keep in mind that the Location Based Services feature set is also just one part of the already proven advanced Wi-Fi security, management, and readiness testing abilities of the AirDefense Services Platform.

This extensive set of features and tools gives the ADSP Location Based Services (LBS) the ability to provide a wide range of services as well the ability to scale to meet demand. They also allow for the ability to build a wide range of applications that can react to location information and triggers to give the end user a rich and interactive experience. The live and historical information can give valuable information into end user patterns, so that processes can be adjust and optimized to give them a better experience in any environment.

2 Document Conventions

The following graphical alerts are used in this document to indicate notable situations:

NOTE Tips, hints, or special requirements that you should take note of.

CAUTION Care is required. Disregarding a caution can result in data loss or equipment malfunction.

WARNING! Indicates a condition or procedure that could result in personal injury or equipment damage.

3 Inventory List

3.1 Hardware

- AirDefense Services Platform (ADSP) appliance running 9.0 or later
- Presence Services - any AP/Sensor hardware running any firmware supported by ADSP
- Real-Time Location Services - AP/Sensors running WiNG 5.2.1 or later (excluding M400, M5x0, AP5131 and AP300). This includes APs running Radio Share
- PC Laptop with an 802.11a/b/g/n wireless adapter running Windows
    - Windows XP SP3
    - Windows Vista SP1
    - Windows 7

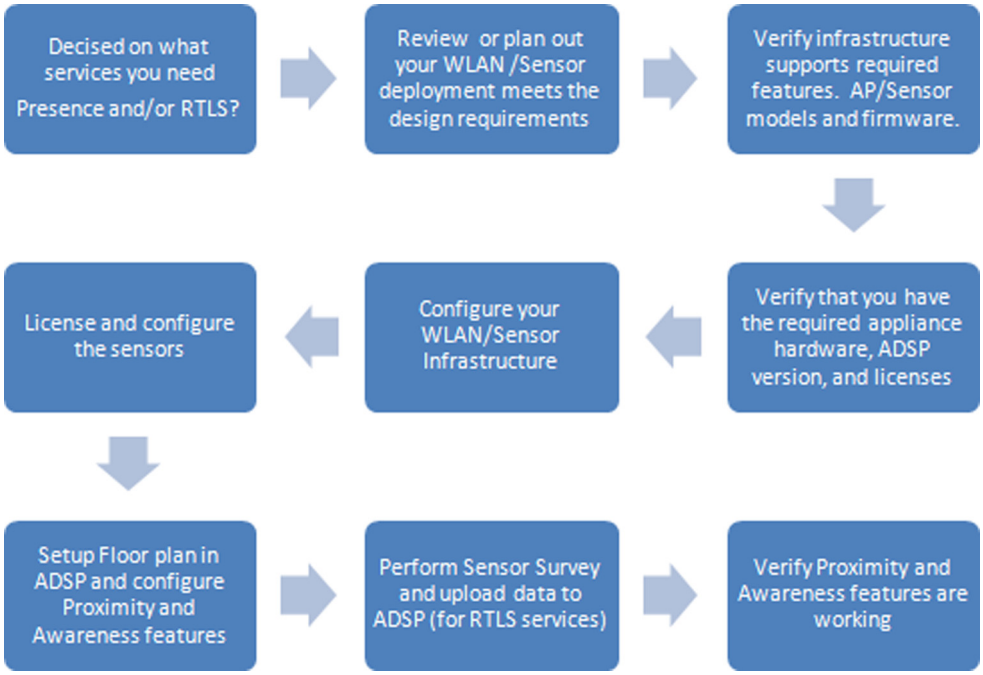
3.2 Software

- AirDefense Mobile (ADM) 6.2 or later
- LANPlanner 13 or later

3.3 Licenses

- AirDefense Services Platform
    - Proximity and Awareness (license for each sensor used for presence or locationing)
- AirDefense Mobile (One of the below)
    - AirDefense Mobile SiteSurvey license (MB-SWSU-P-1)
    - AirDefense Mobile Bundle license (MBB-SWWS-P-1)

4 Setup Workflow



5 Sensors - Numbers

It is critical that there are an optimal number of sensors in order to locate stations continuously and accurately throughout the tracking area.

- Most importantly if a sensor cannot hear a station at around -80dBm or better than ADSP will have difficulty detecting presence or locating it.

> ***NOTE*** You must use the client with lowest transmit characteristics expected in the environment. For example, a VoIP phone or Smartphone.

- Remember that a sensor must be on or scanning through the channel the device is on or probing on in order to hear it.

5.1 Presence Services

- Very Little Overlap - Presence services only require complete sensor coverage with very little overlap for the area that presence detection is required.
- 1 Sensor - only one sensor is required to detect the presence of a device in the environment

5.2 Real-Time Location Services

- 95% Coverage - To get the most accurate location multiple sensing nodes need to simultaneously be able to see the device in 95% of the coverage area at around -80dBm or better.
- Sensor Numbers - For accurate location tracking there are some rules for the minimum number of network elements that can hear the device, but of course the more the better.
    - 1 Sensor - if only one sensor can hear a device then ADSP will basically make a guess of where the device is around that sensor.
    - 2 Sensors - if two sensors can hear a device then ADSP can narrow down the possible locations based on the RF footprint, but will have a degradation in accuracy.
    - 3 Minimum for Accuracy - at minimum in 95% of the tracking area 3 sensing devices need to hear the station at around -80dBm or better to get an accurate location.
    - 4 Ideal -ideally in 95% of the tracking area at least 4 sensing devices need to hear the device at around -80dBm or better to get the most accurate location.
- Environment - The environment will also be a factor in determining the number of sensors. Just like with an AP the sensors will be affected by attenuation of obstacles. For an environment that is open like a warehouse fewer sensors will be needed. In an environment with lots of walls like an office building more sensors will be needed.

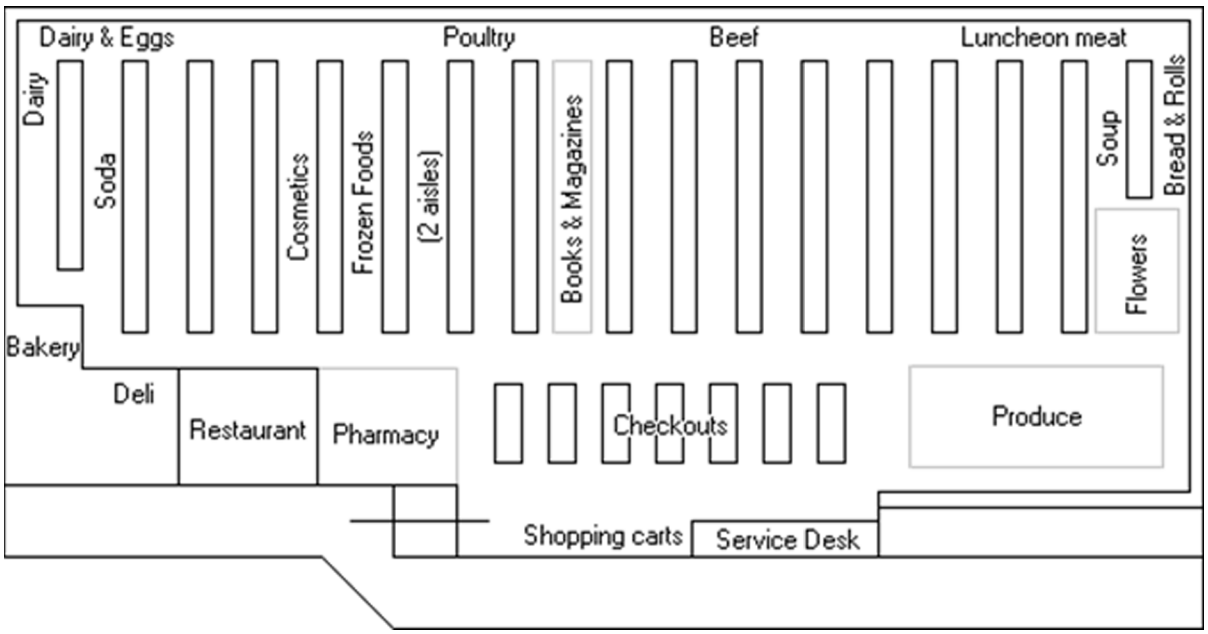
6 Sensors - Location

Placement of the sensors is also very important to the accuracy of determining station locations.

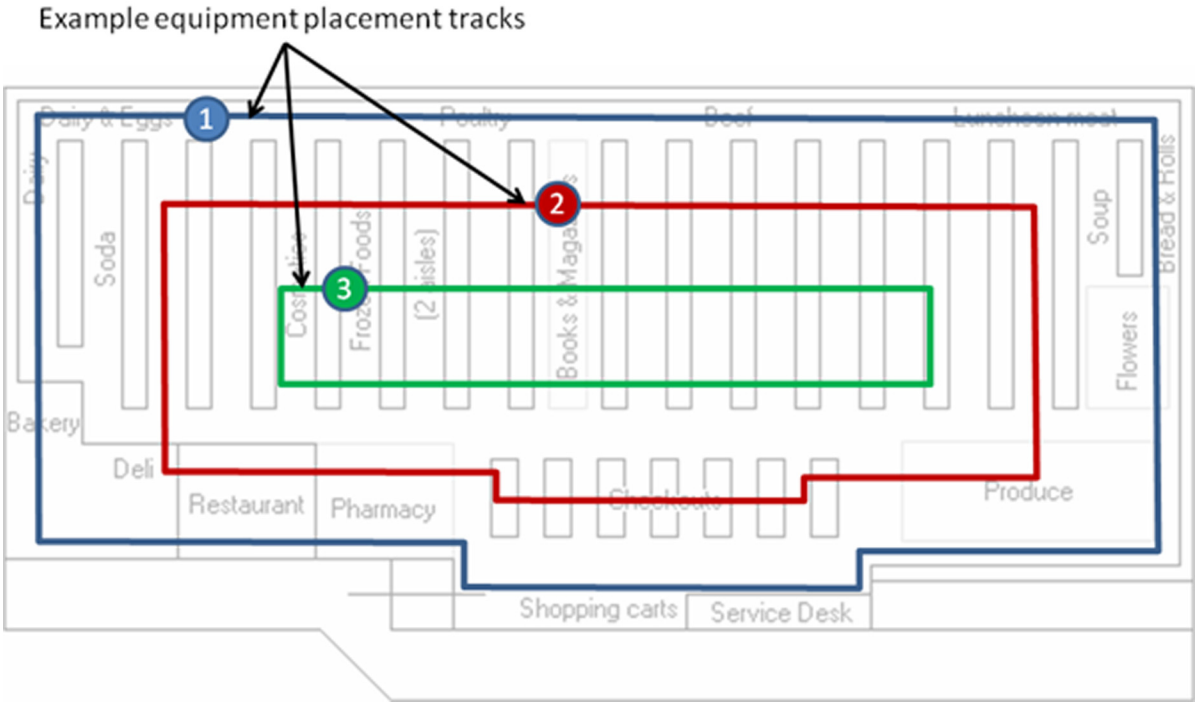
- Avoid Clustering - try not to cluster sensors together. The more evenly spaced and scattered the better.
- Perimeter - the sensors will give more accurate locations when they are placed toward the perimeter of a building or coverage area.
- Outdoors - if outdoor tracking is desired than there are two scenarios to consider: Presence or Location.
    - Presence - If it is only desired to pick up a device that has arrived outside the building then sensors could be placed just inside doorways or windows. Could also place a few outdoor sensors. This essentially only lets you know the device is outside the building and possibly in what direction.
    - Location - If the location of devices outside is needed then outdoor sensors will need to be placed. In this scenario placement and numbers would be determined by the guidelines for accurate location tracking.

6.1 How to Place Sensors for RTLS Services

The following illustration provides a simple store layout in which a real-time location solution is to be enabled in the interior.

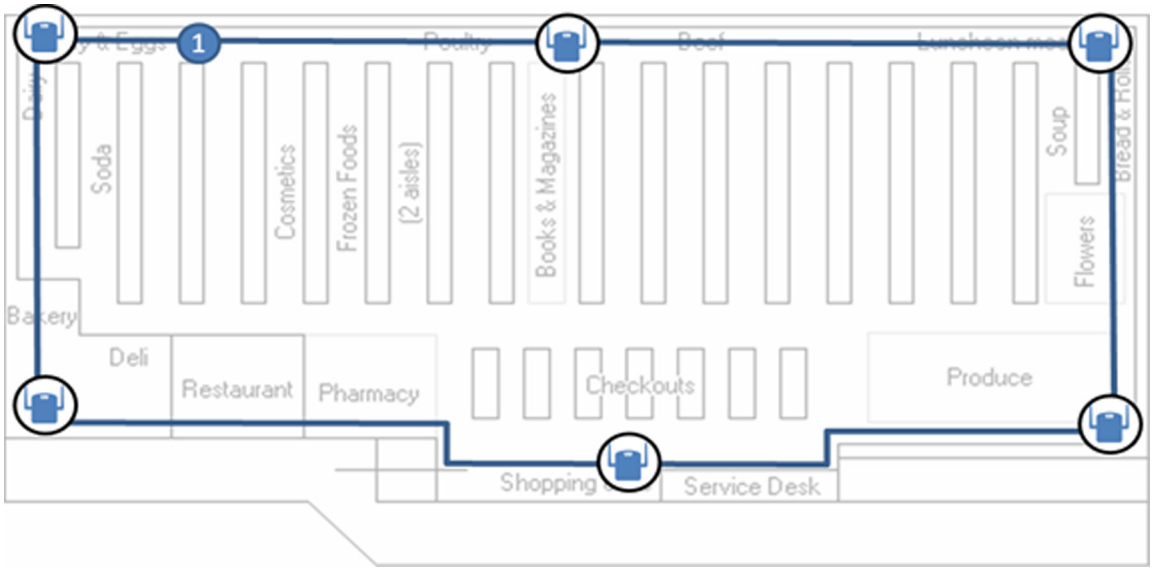


The next illustration overlays the store layout with several concentric polygons, the boundaries of which represent tracks along which to consider placing equipment. The polygons are labeled 1 to 3, with polygon 1 being the outermost polygon and the closest to the outer wall of the store.

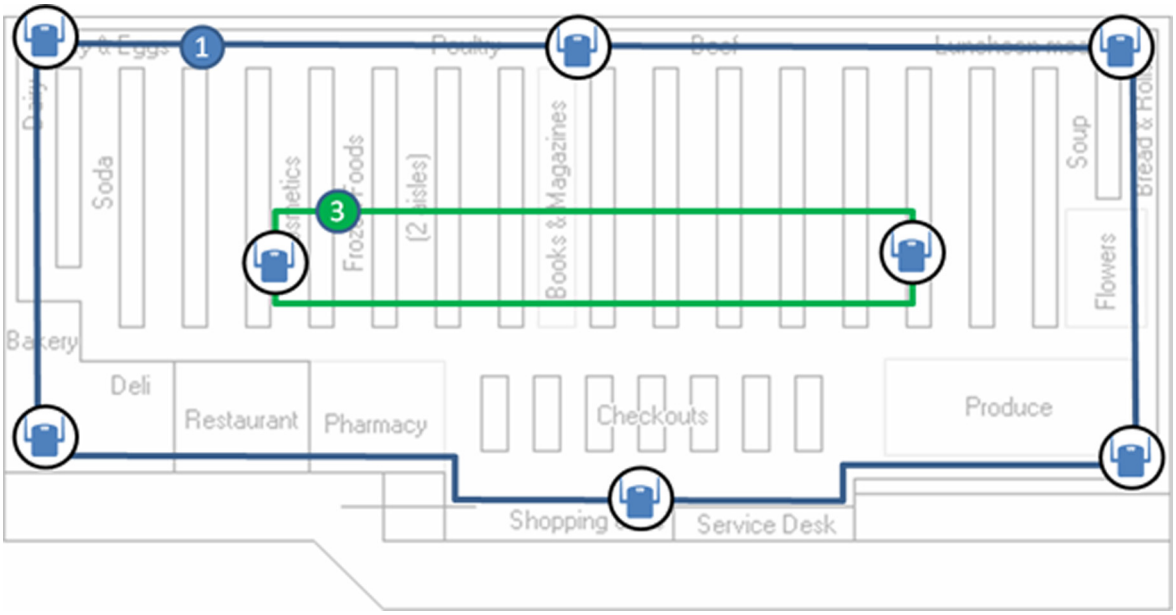


Historically, a traditional design approach to provide indoor coverage would be to consider placing equipment roughly following polygon 2's boundary, positioning equipment further from the outer wall. This is undesirable for

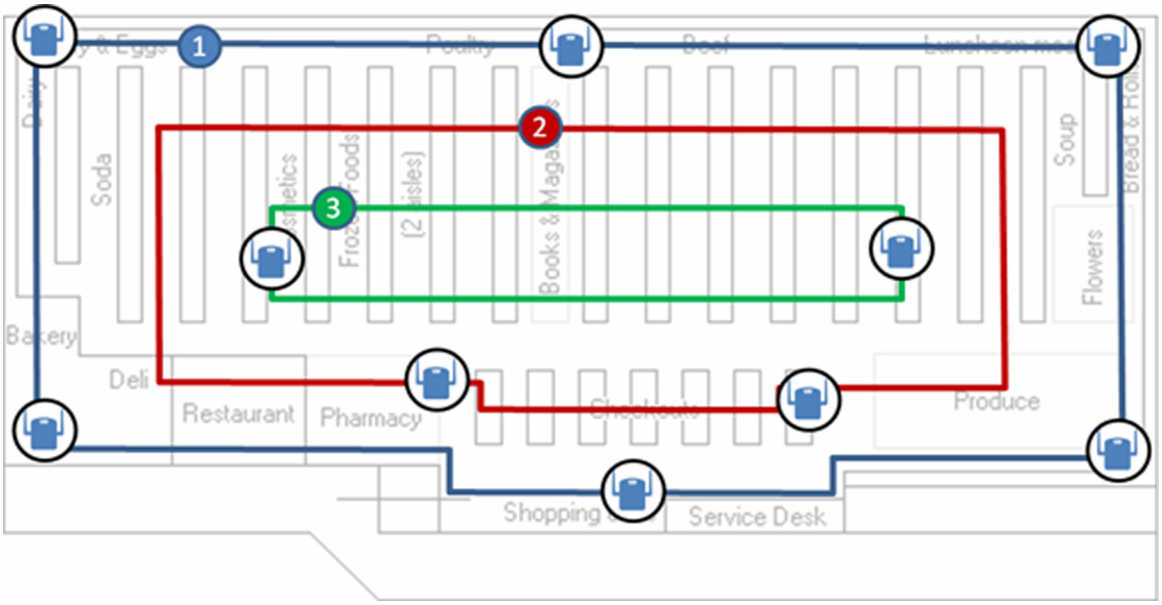
networks that are to provide accurate proximity estimations. Instead, proceed with the design by placing equipment along the polygon 1 boundary as shown in this illustration.



Follow this by placing equipment along the polygon 3 boundary to fill any coverage or performance holes in the building interior.



Round out the deployment by placing equipment along the polygon 2 boundary as needed.



Following this basic practice will achieve the goal of positioning equipment closer to the outer wall of the facility while still maintaining a robust network deployment.

7 Sensors - Choosing Model and Radio Operational Mode

There are a number of options for the sensor hardware and they can be run in several different scan modes. These options and modes will be determined by the environment and requirements.

7.1 Sensor Hardware

7.1.1 Presence

- Presence services are supported by any sensor hardware and firmware supported by ADSP.
- If it is planned to use Radio Share mode with Presence services then WiNG 5.2.1 or later is required along with hardware that supports it.
- If RSSI updates from the sensors faster than 1 minute are desired then WiNG 5.2.1 or later is required along with hardware that supports it.

7.1.2 Real-Time Location Services

- Any AP that can run WiNG 5.2.1 or newer (excluding M400, M5x0, AP5131 and AP300) can perform Real-Time Location Services functions.

7.2 Sensor Radio Operational Modes

- Sensor Mode - when a radio is in Sensor mode it will not service clients and will only perform the functions defined by its ADSP licenses and profiles.

NOTE Location Tracking RSSI scan must be enabled on the sensor for ADSP to get RSSI updates faster than 1 minute for RTLS features.

- Radio Share Mode - when a radio is in Radio Share mode it can service clients and perform the functions defined by its ADSP licenses and profiles.

NOTE The sensor capabilities are limited to the channel and WLANs defined on that radio. Location Tracking RSSI scan must be enabled on the sensor for ADSP to get RSSI updates faster than 1 minute for RTLS features.

  - Promiscuous - captures every frame it sees on the channel the radio is set for. Note: Promiscuous mode must always be used for all Proximity and Awareness features.
  - In-Line - only captures frames from associated clients.
- Single-radio models - Can only run in one mode at a time
  - WLAN Mode - service clients
  - Sensor Mode - perform sensor functions
  - Radio Share Mode - service clients and perform limited sensor functions
- Multi-radio models - can run in a combination of radio modes
  - Sensor radio and a WLAN radio on the same device
  - Dual sensor radios to divided up RF scan patterns
  - Dual WLAN radios in Radio Share mode
  - Combination of Radio Share and Sensor

7.3 Choosing Hardware and Operational Mode

With the combinations of AP models and operational modes there is a variety of choices for deploying a sensor network for LBS. When choosing models and modes you will want to keep in mind the sensor recommendations and design requirements for LBS, but also be efficient in covering the desired area.

NOTE A sensing device must either be listening on or scanning through the channel the tracked station is on for it to be able to hear it. Radio Share devices listen to only one channel and Sensor devices scan through all channels they are set for.

7.3.1 Sensor Overlay Network

This type of sensor network gives the most visibility into the environment by overlaying a full sensor network over the WLAN network. Since every sensor is scanning through all channels fewer devices are required to see the entire RF spectrum. Therefore every sensor near a tracked station can hear it no matter what channel the station is on. This can make it easy to meet the sensor number requirements for accurate location calculations. *The only drawback is that if the sensors are scanning a large number of channels it will take too long for them to send updates for real-time locations. If a sensor is relied upon for RSSI data for location tracking then its channel scan pattern must be limited to 3 or 4 channels per radio.*

7.3.2 Radio Share Network

This type of sensor network only utilizes Radio Share and limits the channels being scanned to only those each WLAN radio is set too. With this type of sensor network you must limit the channels used in the WLAN so that there is enough overlap between APs/Sensors on the same channel. Say the station is on channel 1 you would need three Radio Share radios on channel 1 to hear the device to get an accurate location. This would also require that the number of 5GHz channels be restricted to a smaller number, so there are enough sensing devices on the same channel to hear a device. *At this time, a Radio Share network is probably the most economical deployment for location services, but may not be ideal for high density/high throughput environments.*

7.3.3 Radio Share/Sensor Network

A sensor network made up of a combination of full sensors and Radio Share devices that is designed correctly can be the most efficient design for providing WLAN access and having enough sensing devices on each channel. This will allow for the sensors to scan through all channels and your WLAN radios in Radio Share mode to give RSSI information on their set channel as well. *Keep in mind that if Radio Share will be used for location tracking then channel planning restrictions will most likely have to be imposed, especially on 5GHz.*

8 ADSP - Floor Plan Design

There are a few items to keep in mind when setting up or looking over the current ADSP floor plan design.

- Accurate Drawing - an up-to-date drawing of the floor plan is critical for the station locations to best correlate to the physical layout.
- Scaling Floor Plan - for the station locations and visualizations to more precisely correspond to the physical location the floor plan needs to be scaled as accurately as possible.
- Placing Sensors - The sensors need to be placed as precisely as possible on the floor plan so that the location information is precise. *The sensors must be placed on the floor plan for location tracking to work because without this information ADSP does not know the relationship of the physical sensor locations.*

9 ADSP - Enabling Proximity and Awareness Features

There are several actions that have to be performed in order to enable Location Based Services.

- Applying Licenses to the Sensors

  Before ADSP can enable the location information from the sensors the appropriate licenses must be applied to them. This is done in the licensing interface located at **Configuration** > **Appliance Platform** > **Appliance Licensing**.

  - Proximity and Awareness - this license gives the sensors the ability to give presence and RTLS information. The sensor design and system setup will determine if ADSP will use them for Presence and/or RTLS features.

- Enabling and Configuring Location Tracking RSSI Scan

  For sensors to send location tracking information to ADSP, the Location Tracking RSSI Scan has to be enabled in **Configuration** > **Operational Management** > **Sensor Operation**. This instructs the sensors to send device RSSI data to ADSP at a user defined rate. The lower the value the faster station locations can be updated and the larger the longer it will take to update. For real time updates, the maximum for this value is 5 seconds. These settings can be overridden and set at any level of the organizational tree.

NOTE During a sensor survey the poll interval should be set to 1 second. Also, if you want sub 1 minute updates for Presence services you must enable this as well.

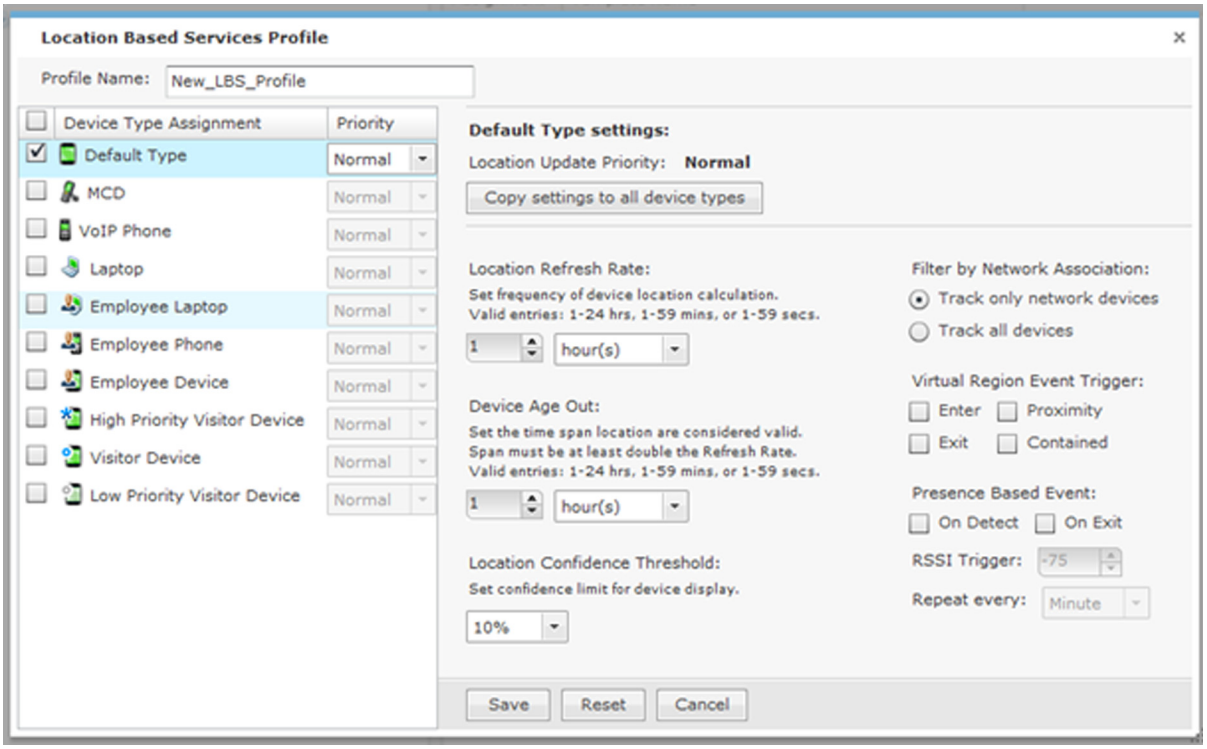
- Configuring the Channel Scan Mode

  The Scan Mode instructs the sensor on what channels to scan. This setting is also found in the Sensor Operation settings window. There are several predefined modes with selected channel lists as well as the ability to lock a sensor to one channel if desired. For RTLS, the Custom Scan is probably going to be the most useful, because in this mode you can select which channels the sensors will scan. This allows you to limit the channel scan to the channels that your WLAN is using and your stations will be on

NOTE The more channels a sensor has to scan the longer it will take to send RSSI data back to ADSP for each channel. This will increase device location update times. Therefore if you relying on dedicated sensors for RTLS feature the scan list should be as small as possible, around 3 channels per radio. Also, this value does not affect Radio Share devices.

10 ADSP - Location Based Services Profile

LBS Profiles are used to let ADSP know what types of clients are most important to track. You can see below in the figure of the LBS Profile window there are many options to work with. The LBS Profiles work just like any other profile and can be assigned to different scopes and be inherited or overridden at lower levels. This allows for scalability and granularity of location tracking priorities at many different sites.



The first things you will notice are the many client types. These can be manually assigned to devices, but they can also be assigned automatically through Auto Classification or through Device Imports.

- Device Type Assignment List—from this list you can assign what devices types you want to assign to this level of the scope. Any client types that are not enabled will be ignored and will not show up for location tracking.
- Device Type Priority—setting the priority lets LBS know what devices are most important to track. It will then update the device locations with higher priority types first.

  When you assign a Client Type to the profile you will want to adjust the parameters for each one. Depending on what these values are set for will also affect what devices are tracked, how a device location is shown and updated, and how it will interact with other LBS features.

- Location Refresh Rate—the interval at which you want LBS to re-calculate a devices location. For Real-Time Location tracking this value should be set to 1 second.
- Device Age Out—the interval at which you want LBS to consider the device is no longer present. If this value is set for 2 minutes and LBS has not seen the device for over 2 minutes then it assumes the device has left. This value should be greater than the Location Refresh Rate. Presence based 'On Exit' events are tied to this value as well. An 'On Exit' event will be triggered when the device age out has been reached.
- Location Confidence Threshold—this value is LBS's confidence that location it has calculated for a device is correct. The higher the percentage the more confident it is on its location calculation. The higher this value the more accurate the location for that type would be. The drawback for setting this value too high would be that LBS could be ignoring a lot of devices. You would set this value higher for types that you only want to know locations that ADSP is very confident about.
- Filter by Network Association—this setting limits client type tracking depending on network association.
    - Track only network devices—selecting this value would tell LBS to only track devices of this type that are currently connected to a sanctioned BSS.
    - Track all devices—selecting this value would tell LBS to track all devices of this type no matter what network they are connected too.
- Virtual Region Event Trigger
    - Enter Region—selecting this value tells LBS to trigger an event when this device type enters a region with the enter trigger enabled.
    - Exit Region—selecting this value tells LBS to trigger an event when this device type exits a region with the exit trigger enabled.
    - Contained—selecting this value tells LBS to trigger an event when this device type is contained in a region with the contained trigger enabled.
    - Proximity—selecting this value tells LBS to trigger an event when this device type is in proximity to a region with the proximity trigger enabled.
- Presence Based Events
    - On Detect—selecting this value tells LBS to trigger an event when this device type has been detected at the specified RSSI level.
    - On Exit—selecting this value tells LBS to trigger an event when this device type's RSSI has dropped below the specified level.
    - RSSI Trigger—this value is the RSSI level used to determine when to trigger an On Detect or On Exit event.
    - Repeat Every—this value is the time interval at which to raise an alert for an On Detect or On Exit event. If it is set for 1 hour then no matter how many times a device triggers a presence event LBS will only send one alert per hour for each device.

11 ADSP - Setting Up Regions

Regions are areas that are applied over the floor plan that can affect location placement or have event triggers associated to them. When a client location interacts with a region in a specified way an alert is raised. There are two types of regions, Virtual Regions and Exclusion Regions. Exclusion Regions are simply areas on the floor plan that a station could not physically be located or location placement is not wanted. Virtual Regions are areas that event triggers can be associated too, so that alerts can be raised when a station's location interacts with it.

11.1 Virtual Region Triggers

- Enter - sets a region to trigger an alert when a station enters.
- Exit - sets a region to trigger an alert when a station exits.
- Proximity - sets a region to trigger an alert when a station's location is within a certain distance to it.
- Contained - sets a region to trigger an alert as long as a station's location is within it.

12 AD Mobile - Performing Sensor Survey

Before the Location Based Services engine can give accurate tracking information it must have a reference to associate the signal strength the sensors see from a client and its possible location. This is done by creating an RSSI fingerprint by performing a Sensor Survey with AirDefense Mobile. Note: Every time a sensor is added, moved or significant changes are made to the physical environment then a Sensor Survey will need to be performed again.

- Importing the Design

  Before the Sensor Survey can be started the design must be imported from ADSP. Once the design is imported ADM has the floor plan along with sensor/AP locations. As well as any other design information like scale and wall modeling.

- Synchronizing the Time and Poll Interval

  When the design is being imported ADM will retrieve the server time and the sensor RSSI poll interval. It uses this information to synchronize its time and set its sampling rate. Note: the Location Tracking RSSI poll interval should be set to 1 second in ADSP during the Sensor Survey.

- Channel Settings for Survey

  During the survey the WLAN infrastructure should have 1 channel assigned to each band. This means that every 2.4GHz radio should be set on the same channel and every 5GHz radio should be set on the same channel. This is to allow for the Sensor Survey to gather complete sensor coverage for every Radio Share sensor.

- Connecting to a WLAN

  In order to perform a Sensor Survey the measurement card must be connected to a WLAN network. This is because ADM will be generating network traffic on this interface, so that the sensor can hear the station as it moves around.

- Determining Sampling Time

  The sampling time that will be used by AD Mobile during a Sensory Survey may need to be adjusted. The default sample time is 20 seconds.

  - In a standard scan mode the sensor spends 1 second on each channel. You will also need to keep in mind that an AP with two sensor radios will set one sensor to 2.4GHz and the other to 5GHz. Probably more importantly though is that an AP with a single sensor radio will scan both bands. So say the sensors are scanning 1, 6, 11 and 36, 48, 149 then a single radio sensor will take 6 seconds to scan all channels. You need to set the sample time, so that the sensor can get 6 samples per location. Again you will want to make sure the sensor poll interval in ADSP is set to 1 second at least for the Sensor Survey.
  - In order to decrease the required sampling time it is recommended to reduce the sensor scan pattern to one 2.4GHz channel and one 5GHz channel.

- Performing the Survey

  To perform the Sensor Survey a technique must be followed, so that enough data is collected to get an accurate fingerprint. The survey will be performed using Sensor Mode sampling. This means that it will record measurements automatically at the specified sampling time between each click.

  Sample Spacing

  - Typical environments samples need to be taken at about every 8 - 10 feet
  - Open environments with few obstructions samples need to be taken every 10 - 15 feet
  - Closed environments with lots of dense obstructions samples need to be taken every 5 - 8 feet

Survey Process

This is the process that should be followed.

NOTE Break up the survey into multiple measurement runs.

1. Press the play button to start the measurement run
2. Go to sampling location
3. Click on the location on the floor plan to start sampling
4. Do not move from that position until the displayed countdown is complete
5. Move 8 - 10 feet to the next location
6. Repeat steps 3 - 5 until complete with measurement run
7. Now press the stop button to end the measurement run
8. Perform a save on your project

- Fetching RSSI Information

  Once the survey is complete the RSSI data must be retrieved from ADSP. This is because a Sensor Survey is recording what the sensors seeing from the client, so ADSP has the RSSI data. ADM downloads the RSSI data from ADSP and uses the time stamps to match up to the locations from the samples that were recorded. This is why the time is synched up before the survey. This is done by selecting the 'Fetch Sensory Survey RSSI Data' option in the file menu.

- Exporting Data to ADSP

  After ADM has matched up the RSSI data to the location samples this information must now be exported to ADSP. The LBS engine then takes this data to create an RSSI fingerprint for the surveyed area. To export the data to ADSP select the 'Export to ADSP' option in the file menu.

13 Wall/Obstacle Attenuation

In the absence of sensor survey data ADSP will use wall/obstacle attenuation calculations to help determine station locations. This information can be entered into ADSP in several ways.

NOTE Note: For the most accurate location, wall attenuation should not be relied upon. A Sensor Survey should be done.

- ADSP Floor Plan Editing Tools - the floor plan can be opened up on ADSP and some of the most common wall and obstacle materials can be applied to the floor plan. This is done by selecting the appropriate material and then drawing lines along and around the walls and obstacles.
- LANPlanner - the floor plan can also be imported into LANPlanner and the tools can be used to draw lines along and around obstacles that represent its construction material. LANPlanner has a large list of default materials and also allows for manual configuration of attenuation factors if needed.
- LANPlanner Optimization - a conventional coverage survey can be done and the data can be loaded into LANPlanner to optimize the wall/obstacle attenuation based on real measured data.

14 ADSP - LBS Integration API

ADSP has an extensive API for the Location Based Services that gives access to location information and event triggers to external applications. This allows for developers to integrate location information into their applications to allow them to perform actions based on location or event triggers generated from the ADSP LBS engine.

15 Decision Questions

- What area do you want to be able to track devices?
- Is all or part of the area outdoors?
- Where do you want to first pick up a station for tracking?
- How precise does the location need to be?
- Do you need precise locations for the entire area or sections?
- Do you just need presence information for some areas?
- What is the maximum number of devices that will be tracked?
- What type of clients do you want to track?
- How often do you want updates on station locations?

Motorola Solutions Support Center

If you have a problem with your equipment, contact support for your region. Support and issue resolution is provided for products under warranty or that are covered by an Enterprise Mobility Services agreement. Contact information and web self-service is available by visiting *http://supportcentral.motorola.com/*.

When contacting Enterprise Mobility support, please provide the following information:

- *Serial number of the unit*
- *Model number or product name*
- *Software type and version number*

Motorola Solutions responds to calls by email or telephone within the time limits set forth in support agreements. If you purchased your Enterprise Mobility business product from a Motorola Solutions business partner, contact that business partner for support.

Customer Support Web Sites

Motorola Solutions' Support Central Web site, located at *http://supportcentral.motorola.com/* provides information and online assistance including developer tools, software downloads, product manuals and online repair requests.

Manuals

http://supportcentral.motorola.com/support/product/manuals.do

Motorola Solutions, Inc.
1301 E. Algonquin Rd.
Schaumburg, IL 60196-1078, U.S.A.
http://www.motorolasolutions.com

72E-163233-01 Rev A
April 2012