Design and Deployment of Location-Based Service for WLANs
Abstract

- The Cisco Context Aware Mobility solution (which includes location-based services) is an important advanced service that can be provided with the Cisco unified WLAN network. This session focuses on design and deployment fundamentals, as well as operational best practices to optimize the performance and accuracy when tracking wireless devices (tags and wireless clients) using the Cisco Context-Aware Mobility solution.

Agenda

- Principles of Context-Aware Mobility Solution
- Cisco MSE 3350 Architecture Overview
- Client Tracking—Indoor (Office Environment)
- Tag Tracking—Indoor (Office Environment)
- Tag Tracking—Outdoor/Outdoor-Like Environments
- Design Guidelines—Best Practices
Receive Signal Strength Indication (RSSI) Overview

- Location calculated based on signal strength measured by either the mobile device or the receiving sensor
- Following metrics are required to determine location of Wi-Fi element:
  - $TX_{PWR}$: transmitter output power
  - $Loss_{TX}$: transmit-side cable and connector losses (dB)
  - $Gain_{TX}$: transmit-side antenna gain (dBi)
  - $Gain_{RX}$: receive-side antenna gain (dBi)
  - $Loss_{RX}$: receive-side cable and connector losses
  - PL: path loss model

$$RX_{PWR} = TX_{PWR} - Loss_{TX} + Gain_{TX} - PL + Gain_{RX} - Loss_{RX}$$
RSSI—Distance Calculation

\[ D = \left( \text{inv. log} \left( \frac{\text{RX}_{\text{PWR}} - \text{TX}_{\text{PWR}} + \text{Loss}_{\text{TX}} - \text{Gain}_{\text{TX}} + \text{PL}_{\text{meter}} - S + \text{Loss}_{\text{RX}} - \text{Gain}_{\text{RX}}}{10} \right) \right)^{1/n} \]

- Additional variables used to calculate distance:
  - \( S \): degree of shadow fading present in the environment (dB)
  - \( \text{PL}_{\text{meter}} \): reference path loss when the receiver-to-transmitter distance is 1 meter (dB)
  - \( n \): path loss exponent \((n)\) is a function of frequency, environment, and obstructions. Common values:
    - 2: open free space to values greater than
    - > 2: environments where obstructions are present
    - 3.3: indoor office environment (2.4 GHz)
    - 4.5: dense home environment (2.4 GHz)

Receive Signal Strength Indications (RSSI) Overview

- Cisco RSSI-based location tracking solution based on “network-side” RSSI measurements
- Requires min. of three AP’s; optimal accuracy requires more than 3 AP’s
- Best suited for indoor office-like environments (carpeted, low ceiling, i.e., < 20 feet)
- Two main factors affecting accuracy:
  - AP density
  - AP placement
  - environment
**Time Difference of Arrival (TDoA)**

**Overview**

- Location technique based on the difference in time of arrival of the transmission signal from a Wi-Fi device at different TDoA receivers
- Based on principle of “hyperbolic lateration”
  - Hyperbola: locus of points where the difference in the distance to two fixed points (called the foci) is constant
  - Lateration: computes the position of an object by measuring its distance from multiple reference positions. Calculating an object’s position in two dimensions requires distance measurements from three non-collinear points
- Requires min. of three time-synchronized TDoA receivers

**Hyperbolic Lateration**

- The time difference of arrival between each pair of TDOA receivers is calculated as follows:
  
  \[
  \text{TDOA(B-A) = |TB} - TA| \\
  \text{TDOA(C-A) = |TC} - TA|
  \]

- Hyperbolic plots are created using the above equations representing all possible difference of distances of the transmitting device from each pair of receivers
- Intersection of two or more hyperbolas defines the position of the mobile device
Time Difference of Arrival
Overview (Cont.)

- Each TDOA installation must have at least one
  synchronization source
  - Depending on the size of the site, may require more than one
    synchronization source
  - TDoA receiver can act as a synchronization source as well as a
    TDOA receiver for locating transmitting devices
- Physical placement of TDoA receivers must be non-collinear
- Operates well in multipath and high-ceiling environments
  - Possible to achieve high accuracy (3–5m) even in difficult,
    industrial environments
New Acronyms and Definitions

- MSE (Mobility Services Engine)—Cisco hardware appliance for running multiple services. Context Aware Mobility is one of the services supported on this platform.
- Context Aware Software—software running on the MSE platform for tracking Wi-Fi devices (clients and tags).
- Context-Aware Engine for Clients—Cisco location engine for tracking client devices
- Context-Aware Engine for Tags—partner location engine for tracking tags

MSE Hardware Details

- 1-RU server sold as Cisco SKU (AIR-MSE-3350-K9)
- Redundant hard drives and AC power supplies
- Will host multiple software services
  - In software release 5.1, hosting only CAMS
  - In subsequent software releases, option to host other services
Product Specifications

<table>
<thead>
<tr>
<th>Form Factor</th>
<th>1U Rack Form Factor 1.75 Inches (4.45 cm) Width, 27.75 Inches (70.5 cm) Depth</th>
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<tr>
<td>Processor</td>
<td>Two Quad-Core Intel Xeon Processor (2.33 GHz)</td>
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<tr>
<td>Memory</td>
<td>8 GB PC2-5300 (4 x 2 GB)</td>
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<tr>
<td>Hard Drive</td>
<td>Hot Plug SAS drives: 2 x 146 GB (10K RPM)</td>
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<tr>
<td>Connectivity</td>
<td>Network: Two Embedded Multifunction Gigabit Network Adapters with TCP/IP Offload Engine</td>
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<tr>
<td>Power Supplies</td>
<td>Two Redundant 120/240V AC (Hot Swappable)</td>
</tr>
<tr>
<td>Network Management</td>
<td>Cisco WCS Location v5.1 or Greater Running Internet Explorer 6.0/Service Pack 1 or Later</td>
</tr>
</tbody>
</table>

Context Aware Mobility Engines

- MSE supports:
  - Context-aware engine for clients (Cisco)
  - Context-aware engine for tags (partner)

- Environments supported:
  - Indoor (e.g., offices)
  - Indoor high ceiling (e.g. manufacturing facilities, airplane hangars)
  - Outdoor

- Default software on MSE is
  - Cisco mobility services infrastructure software
  - Context-aware mobility services module
  - Context-aware engine for clients
Context Aware Software Architecture

Business Application

Context Aware Engine for Clients

Context Aware Engine for Tags

RSSI / TDOA

Indoor Environment

Indoor & Outdoor Environments

Use Case Scenarios

INDOOR + Clients (RSSI)

INDOOR + Clients + Tags (RSSI)

HIGH CEILING + Clients + Tags (RSSI & TDOA)

OUTDOOR + Tags (TDOA)

BASELINE ASSUMPTIONS:

- Pervasive Cisco Unified Wireless Network
- Controller Based Architecture
- WCS Software

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## Deployment Environments

<table>
<thead>
<tr>
<th>Environment</th>
<th>Wi-Fi Clients</th>
<th>ACTIVE Wi-Fi RFID Tags</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDOOR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office Environment, Hospitals, University Classrooms…</td>
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<td>✓</td>
</tr>
<tr>
<td>INDOOR HIGH CEILING</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Manufacturing Warehouse</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>OUTDOOR</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Parking Lots / Yards</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Open Mobility Services Architecture

Centralize Mobility Services to Scale

![Diagram of Open Mobility Services Architecture](attachment:image.png)
Cisco Context Aware Mobility Solution
Moving from Cisco 2710 to Cisco MSE Platform

Cisco 2700 Series
Wireless Location Appliance

- Indoor only
- 2500 tags and clients
- RSSI only
- Industry’s first location solution integrated into the WLAN infrastructure
- Location only
- Open API
- WCS management

Cisco 3300 Series
Mobility Services Engine

- Indoor, outdoor, high ceilings
- 18,000 tags and clients
- RSSI and TDOA
- Next-generation
- Open API
- WCS management
- Robust architecture for adding other technologies (UWB, passive)
- Shared platform for other mobility services (incl. future)

Cisco Context Aware Mobility Solution
Tracking Tags and Clients

- Tracking tags (indoor and outdoor/outdoor-like)
- Context-aware engine for tags (partner engine)
- Utilizes:
  - LWAPP infrastructure for indoor environments
  - Wi-Fi TDOA receivers for outdoor and outdoor-like environments
  - Partner HW/SW managed by System Manager (partner) and Cisco WCS
- Tracking clients (indoor)
- Context aware engine for clients (Cisco engine)
- Utilizes LWAPP infrastructure
- Managed by Cisco WCS
## Context Aware Solution: SKUs & Pricing

<table>
<thead>
<tr>
<th>Cisco Part #</th>
<th>Description</th>
<th>List Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSE</td>
<td>Mobility Services Engine</td>
<td>$19.995</td>
</tr>
<tr>
<td>AIR-MSE-3350-K9</td>
<td>Context Aware Engine for 3K Clients License</td>
<td>$6,000</td>
</tr>
<tr>
<td>AIR-CAS-3KC-K9</td>
<td>Context Aware Engine for 6K Clients License</td>
<td>$11,000</td>
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<tr>
<td>AIR-CAS-12KC-K9</td>
<td>Context Aware Engine for 12K Clients License</td>
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<tr>
<td>AIR-CAS-3KT-K9</td>
<td>Context Aware Engine for Tags License for 3K Tags</td>
<td>$15,000</td>
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<tr>
<td>AIR-CAS-6KT-K9</td>
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<td>AIR-CAS-12KT-K9</td>
<td>Context Aware Engine for Tags License for 12K Tags</td>
<td>$55,000</td>
</tr>
</tbody>
</table>

## Context Aware Solution: SKUs & Pricing (Cont.)

<table>
<thead>
<tr>
<th>Cisco Part #</th>
<th>Description</th>
<th>List Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASCT-INDR-LR-A</td>
<td>Indoor Wi-Fi TDOA Receiver For US And Canada</td>
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<tr>
<td>ASCT-INDR-LR-E</td>
<td>Indoor Wi-Fi TDOA Receiver For Europe</td>
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<tr>
<td>ASCT-INDR-LR-J</td>
<td>Indoor Wi-Fi TDOA Receiver For Japan</td>
<td>$2,000</td>
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<tr>
<td>ASCT-LP-A-K9</td>
<td>Outdoor Wi-Fi TDOA Point - Wired Config For US And Canada</td>
<td>$5,400</td>
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<td>ASCT-LP-E-K9</td>
<td>Outdoor Wi-Fi TDOA Point - Wired Config For Europe</td>
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<td>ASCT-LP-J-K9</td>
<td>Outdoor Wi-Fi TDOA Point - Wired Config For Japan</td>
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<tr>
<td>ASCT-LR-LIC</td>
<td>License for Wi-Fi TDOA Receiver</td>
<td>$2,400</td>
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</tbody>
</table>

### Chokepoints (Exciters)

- **ASCT-EX3200**: Compact Exciter, $850
- **ASCT-EX2000**: Exciter, $1,200
- **ASCT-EXCMGR**: Exciter Manager Software, $4,000
Client Tracking—Indoor Environments

Cisco Context Aware Mobility—Client Tracking (Indoor Environments)

Building Wi-Fi (RSSI, Chokepoint)  Access Points

Use Case
Room and Floor Level Tracking of High Value or High Utility Items Indoor

Calculation Method
Received Signal Strength Indication Chokepoint for Zone Level Location

Wi-Fi Devices
(Wireless Phones, Laptops, Handheld Devices)
Overview

- Same location solution as prior software releases, i.e. uses Cisco engine
- Uses Cisco calibration mechanism (as per prior software releases for Cisco 2710)
- Existing calibration models can be used with MSE running “Context-Aware engine for Clients”
- Key differences/changes:
  - New hardware → higher element count (18,000 vs. 2,500)
  - New location features in Cisco 2710 software versions 3.1 and 4.0 (and associated WLC/WCS versions)
Deploying Context Aware Engine for Clients

- Context Aware Engine for Clients ships by default on all MSE 3350 appliances
- Requires Cisco WCS
  - manage MSE
  - client tracking on floor maps
  - calibration
  - location readiness tool
  - accuracy testing
- In addition to purchasing MSE, customers need to purchase licenses for client tracking
Cisco Context Aware Mobility—
Tag Tracking (Indoor Environments)

Use Case
Room and Floor Level Tracking of High Value or High Utility Items Indoor

Calculation Method
Received Signal Strength Indication Chokepoint for Zone Level Location

Cisco Context Aware Mobility Solution—
Tag Tracking (Indoor)
Overview

- Tag tracking based on Context Aware Engine for Tags from partner
- Separate engine that needs to be purchased, downloaded from partner and installed
- Requires Cisco WCS and AeroScout System Manager and Analyzer
  - **Cisco WCS**: manages MSE, displays floor maps
  - **AeroScout System Manager**: configuring Wi-Fi TDOA receivers and exciters, calibration, displaying tags on floor maps
  - **AeroScout Analyzer**: coverage, accuracy, synchronization analysis and system performance diagnostics
- Need to use AeroScout calibration mechanism—cannot reuse calibration models from Cisco Context Aware Engine for Clients
- Uses Cisco unified wireless infrastructure (Cisco AP’s) for connectivity and collecting data from tags

AeroScout System Manager
AeroScout Analyzer

- AeroScout Analyzer enables analysis of information recorded by the Context Aware Engine for Tags:
  - Assess the coverage and accuracy of the location system
  - Optimize the location calculation by creating calibration mesh files
  - Alert on problems in the configuration or the site
  - Advanced analysis of the location-related traffic

- AeroScout Analyzer modules:
  - **Coverage Analysis** - indicates the coverage of the devices in terms of the signal strength received by the TDOA Receivers and/or Access Points
  - **Accuracy Analysis** - provides information on the accuracy of tag positioning data. The analysis results indicate the deviation between the actual location of the tag and the measured location.
  - **Mesh Creation** - builds a calibration file for optimal location determination
  - **Diagnostics tool** - analyzes the configuration and recorded data, alerts on problematic findings and provides better visibility of abnormalities
  - **Playback Parser** - allows to view, filter and analyze specific problems of exchanges between tags/devices and the Location Engine.

Installing/Starting Partner Engine

- Install Context Aware Engine for Tags via CLI using RPM
  
  ```
  [root@mse ~]#rpm -Uvh <partner rpm file>
  ```

- Start partner engine
  
  ```
  [root@mse ~]#service aeroscout-engine-wd start
  ```

- Verify that partner engine is running
  
  ```
  [root@mse ~]#service aeroscout-engine-status
  ```

  Response from MSE should be:
  “AeroScout Positioning Engine is running”

- Verify that partner WatchDog service is running
  
  ```
  [root@mse ~]#service aeroscout-engine-wd status
  ```

  Response from MSE should be:
  AeroScout Positioning Engine WatchDog is running <process number>
Tag Tracking—
Outdoor/Outdoor-Like
Environments

Cisco Context Aware Mobility—
Tags (Outdoor/Outdoor-Like)

Campus
Wi-Fi (TDOA,
Chokepoint)

Wi-Fi TDOA Receivers
and/or Chokepoints

Use Case
Room and Floor Level Tracking of
High Value or High Utility Items
Outdoor or RF Challenging
Environments

Wi-Fi Devices or Active Tags
(Battery Powered)
Price Between $50–$80
Telemetry and Sensor Capabilities

Calculation Method
Time Difference of Arrival
Overview

- For customers that need to track tags in outdoor or "outdoor-like" locations (e.g., indoor facilities with high ceilings)
- Context Aware Engine for Tags (TDoA) hosted in MSE
- License for Context Aware Engine for Tags purchased through Cisco and downloaded from AeroScout
- Could be used in conjunction with Cisco unified wireless infrastructure (Cisco AP’s, wireless controllers) for connectivity
  
  Uses Wi-Fi TDOA receivers vs. AP’s (term used in WCS is “location sensors”)

  Location receivers/sensors do not connect via wireless controller; connect directly to Ethernet switch or bridge AP’s (Cisco AP1242)
Overview (Cont.)

Four Separate Management Tools Used to Manage This Solution

- **Cisco WCS**: used to manage placement of location sensors on map
- **AeroScout System Manager**: used to configure location receivers/sensors, calibration (AeroScout)
- **AeroScout MobileView**: used to collect location data from TDOA engine running on MSE and display location information on map
- **AeroScout Analyzer**: coverage, accuracy, synchronization analysis and system performance diagnostics

Installing/Starting Partner Engine

- Install Context Aware Engine for Tags via CLI using RPM
  
  ```bash
  [root@mse ~]# rpm -Uvh <partner rpm file>
  ```

- Start partner engine
  
  ```bash
  [root@mse ~]# service aeroscout-engine-wd start
  ```

- Verify that partner engine is running
  
  ```bash
  [root@mse ~]# service aeroscout-engine status
  Response from MSE should be:
  "AeroScout Positioning Engine is running"
  ```

- Verify that partner WatchDog service is running
  
  ```bash
  [root@mse ~]# service aeroscout-engine-wd status
  Response from MSE should be:
  AeroScout Positioning Engine WatchDog is running (<process number>)"
  ```
Add MSE to WCS

Change in WCS Menu from “Location/Location Servers” to “Mobility”/“Mobility Service Engine”

Separate Menu Items for “Location Server” and “Mobility Service Engine” (Cisco 2710) (Cisco 3350)
Place Location Sensors Using WCS Map Editor

Best Practices
Cisco Wireless Deployment with CAMS

Cisco Wireless LAN Controller

WCS Client Browser

HTTPS

Cisco WCS

Location Client

Location API via SOAP/XML over HTTPS

Cisco Mobility Services Engine (MSE)

NMSP – Network Mobility Services Protocol

WCS—Ports Used

<table>
<thead>
<tr>
<th>Name</th>
<th>Port Number</th>
</tr>
</thead>
<tbody>
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<td>Database</td>
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<td>FTP</td>
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<tr>
<td>TFTP</td>
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<tr>
<td>HTTPS</td>
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<td>HTTP Connector</td>
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<td>HTTP Connector Redirect</td>
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<tr>
<td>NTP</td>
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<td>RMI</td>
<td>1299</td>
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<td>Trap</td>
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<td>Web Container</td>
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MSE—Ports Used

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<td>SSH</td>
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<tr>
<td>HTTP</td>
<td>80</td>
</tr>
<tr>
<td>HTTPS</td>
<td>443</td>
</tr>
</tbody>
</table>

TDOA—Receiver Placement Guidelines

- Minimum of three receivers are required, but four receivers will yield better accuracy results.
- General rules for TDOA receiver density:
  - Outdoors—average density should be one TDOA receiver for every 20,000-50,000 sq ft.
  - Large indoor areas—average density should be one TDOA receiver every 5000–14,000 sq ft.
- May need to divide large areas into subareas (e.g., in case where large warehouse is section off by wall may need to be designed as two subareas)
- Best results when line of sight is maintained between synchronization source and the TDOA receivers
TDOA Receiver Placement

- TDOA receivers must be places along the outside perimeter and evenly spaced
- Additional TDOA receivers may be needed within the boundary of the perimeter receivers depending on the size of the area
- TDOA receivers should be evenly spaced, forming equilateral triangle (when three TDOA receivers are used), or squares (four or more TDOA receivers)

TDOA—Receiver Antenna Placement

- Must use diversity antennas to address multipath issues
- TDOA receiver along perimeter of the covered area should include directional antennas in order to concentrate the reception in the covered area only
  - The corner of a perimeter, use 90-degree directional antenna
  - Along the perimeter, use 180-degree directional antenna
- With omnidirectional antennas with TDOA receivers located within the perimeter
- Receiver antennas should point both to the synchronization source (most preferably line of sight) and to the area in question
TDOA—Receiver Antenna Placement (Cont.)

- Antennas should be placed in areas where they are not obstructed by obstacles as concrete walls, large metallic objects, or densely covered tree areas.
  Should be installed with a good line of sight (as much as possible) to the covered area.

- Preferred mounting height 3–5 meters above the tracked asset surface.
  When this is not possible due to the environment does not permit to do so, then the coverage pattern (i.e., elevation pattern; typical antennas have an elevation of approximately 35 degrees) must be taken into consideration.
  Along perimeter, antennas at high placements should be tilted towards the coverage area (up to 30 degrees down to compensate for the elevation).

RSSI—AP Placement Guidelines

- Maximum effective distance between a tag and access point:
  In most sites: 150 ft. (46m)
  Sites with thick concrete walls: 100 ft. (30.5m)

- Optimal accuracy is normally received with more than 3 AP’s.

- In quadrilateral area, min. of four AP’s should be installed at the four corners of the area.

- Factors affecting accuracy: AP placement, wall materials, large moving objects, RF interference.

- May need to floor space into sub-areas and design sub-areas independently to account for large barriers that obstructs RF signals.
### RSSI—AP Density

<table>
<thead>
<tr>
<th>Expected Accuracy</th>
<th>Ideal Environment</th>
<th>Normal Environment</th>
<th>Harsh Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 ft. (4m)</td>
<td>3,500 ft$^2$ (320m$^2$)</td>
<td>2,000 ft$^2$ (184m$^2$)</td>
<td>N/A</td>
</tr>
<tr>
<td>20 ft. (6m)</td>
<td>6,500 ft$^2$ (595m$^2$)</td>
<td>3,500 ft$^2$ (320m$^2$)</td>
<td>2,000 ft$^2$ (184m$^2$)</td>
</tr>
<tr>
<td>30 ft. (9m)</td>
<td>10,000 ft$^2$ (915m$^2$)</td>
<td>6,500 ft$^2$ (595m$^2$)</td>
<td>3,500 ft$^2$ (320m$^2$)</td>
</tr>
</tbody>
</table>

### RSSI—General Deployment Guidelines

- APs should preferably be positioned along and within the perimeter of an enclosed area.
- APs should be distributed evenly, i.e., APs should be relatively equa-distant from each other.
- Physical placement of APs should be non-colinear— even when placed at equal distances from each other.
- Geometric shapes formed by the distribution of APs affect accuracy.
  - Equilateral triangles placement will yield better accuracy than APs that form an obtuse triangle.
  - Square deployment placement yields better results than APs that form rectangles.
Use Location Readiness Tool

- Use prior to calibration to gauge AP placement and coverage holes
- A point on map is location-ready if:
  - min. of 4 AP’s are deployed
  - min. of 3 AP’s are within 70 ft
  - At least 1 AP placed in each of at least 3 surrounding quadrants.

Location Optimized Monitor Mode

- Before 5.0 release (wireless controller and WCS)
  Regular AP (local mode) + monitor mode AP (rogue, IPS)
- With 5.0 release (wireless controller and WCS)
  Same as above + LOMM AP’s
- Only for tags (not clients) with Edgewood release
- Good for periphery of buildings to improve location accuracy without adding extra traffic that may impact voice or client services
- Ensure that channels on LOMM AP’s are configured to be the same as the local mode AP’s
  Controller CLI for changing monitor mode channels
Location Optimized Monitor Mode—Supported Platforms

- Controllers:
  - WLC module for Cisco ISR platforms
  - Cisco 2106 series wireless LAN controllers
  - Cisco 4400 series wireless LAN controllers
  - Cisco Catalyst 6500 Series Wireless Services Module (WiSM)

- Access points:
  - All IOS-based lightweight APs
  - Not supported in Cisco 1000 Series or mesh APs

Design Criteria—Voice and Location

- Balance AP placement to optimize for voice coverage and location accuracy
- For location, three APs placed oriented in >=3 out of 4 quadrants within 40–70 ft. of all locations within the convex hull of APs to meet 90%/10m accuracy without detailed calibration
- Local-mode APs: place APs evenly spaced on perimeter (50–70 ft. spacing), quadrant-based deployment within perimeter
  - Shuffle APs to even out perimeter and inside APs spacing
Design Criteria—
Voice and Location (Cont.)

- Local + LOMM (Location Optimized Monitor Mode): quadrant-based deployment inside like for voice/location coverage plus APs evenly placed around the perimeter (110 ft. spacing)
- Leverage new location deployment tools introduced in location appliance 4.0 software release:
  - Location optimized monitor mode
  - Site survey and interpolated heat maps
  - Location accuracy tool
Site Survey and Calibration

- More data points are generated internally
- System obtaining more information from the network
- Point calibration: client at fixed location
- Linear calibration: data collected between two different points (straight line)
- Requires CCX v2 compatible client
  - Calibration with non-CCX clients will not be supported from Edgewood onwards
  - Old method of calibration will not be supported starting with Edgewood
- Faster calibration process vs. previous calibration mechanism

Following features can be used in the following scenarios:

MSE with Context Aware Engine for Clients
Cisco 2710 for tracking clients and/or tags
Calibration—Point Mode

Point Mode—Calibration Results
Calibration—Linear Mode

Rails and Regions

- Provides mechanism for network administrator to define inclusion/exclusion areas for location services
- Allows for certain regions in map to be defined as within our outside the scope of valid location area
- Three types of regions can be specified
  - Location inclusion region: tracked device cannot be outside of this polygon (examples: outside of building outer walls)
  - Location exclusion region: tracked device cannot be inside of this polygon (examples: open atrium)
  - Rails: tracked device must be within defined area with narrow band. Typically used within exclusion region (examples: conveyor belt).
- Regions defined in WCS and pushed (via synchronization process to location appliance)
Rails and Regions - Configuration

Step 1: Create Rails and Regions Using Map Editor

Step 2: Synchronize (Pass Rails and Regions Points to Location Appliance)

Example of:
- Inclusion Region
- Exclusion Region
- Rail (Will Be Prompted to Specify Exclusion Region Around Line)
Location Accuracy Tool

- Before WCS 5.0 release: difficult for customer to know what accuracy they were getting
  
  Accuracy not quantifiable using WCS/WLC/LBS

- With WCS 5.0 release
  
  Display tags as a reference, give real position to location server
  
  Systems tells network administrator what level of accuracy they are getting
  
  Generates detailed report with different levels of accuracy and error distribution over time and space

- Two forms of accuracy testing
  
  Scheduled accuracy
  
  On-demand accuracy

- User can choose any of the above methods after selecting the floor to run the accuracy test.
  
  All these tests on the same floor
Scheduled Accuracy

- Run on active environment (live network)
- Preposition clients and tags and schedule the test
- Uses “actual” location of an element vs. “measured” location
- User can modify the test by:
  - Adding/deleting elements
  - Changing positions
  - Changing the schedules
- Test can be run as a scheduled task and generate alarms if falls below certain range of accuracy
  - Should be retested periodically as RF environment may change, impacting location accuracy

Scheduled Accuracy Test

![Scheduled Accuracy Test](image-url)
On-Demand Accuracy

- To be run when a user does not have any active client/tag deployments yet and is interested in measuring accuracy
- Can be run when a floor does not have prepositioned tags/clients
- Conducted similar to pre-Edgewood accuracy test with single client
- User places client at a particular location and indicates that location on the map by dragging the test point and dropping it
- User clicks on 'start' and waits for few minutes for RSSI collection and clicks on 'stop' button and can continue to move to the next point
- When user has collected all the points, they can choose to run the test by clicking on 'analyze results' button. This will produce the accuracy result in a report.

Key Takeaways

- For optimal location accuracy, proper AP and Wi-Fi TDOA receiver placement is required
- Both AP/receiver placement and density are critical
- Need to design for voice, data and location
- Leverage location feature enhancements and tools:
  - WCS location readiness tool
  - AP deployment/design: location optimized monitor mode AP’s (for tags)
  - New calibration methods (point and linear)
  - Quantify accuracy using accuracy testing mechanisms in WCS Rails and regions (define location inclusion and exclusion regions)
Recommended Reading

- Wi-Fi Location-Based Services 4.1 Design Guide
- AeroScout Indoor Deployment Guide for Wi-Fi Access Points
- AeroScout TDOA Deployment Guide
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