



AirWave and Aruba Best Practices Guide
AWMS 7.0

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1 - Overview

This document provides best practices for leveraging the AirWave Wireless Management Suite (AWMS) to monitor and manage your Aruba infrastructure. Aruba wireless infrastructure provides a wealth of functionality (firewall, VPN, remote AP, IDS, IPS, and ARM) as well as an abundance of statistical information. Follow the simple guidelines in this document to garner the full benefit of Aruba's infrastructure.

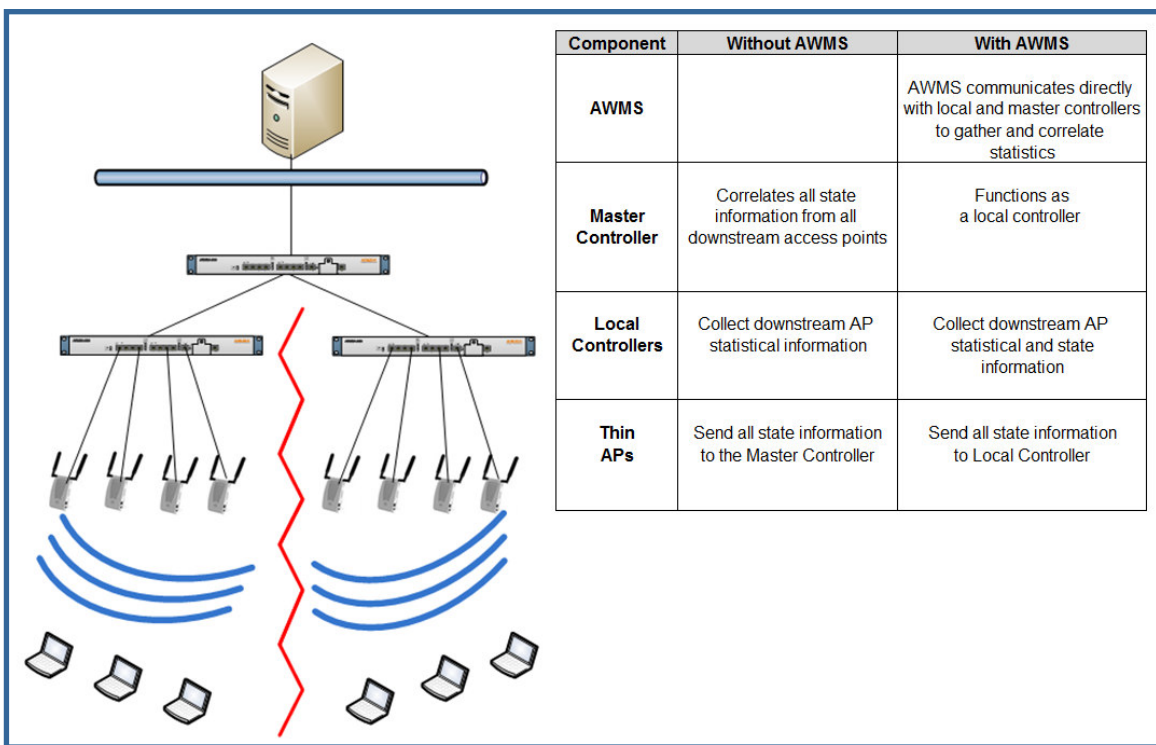
Minimum Requirements

- AWMS version 6.0 or higher
- Aruba OS (AOS) 3.x or higher

Understanding Aruba Topology

Here is a typical Master-Local deployment.

Figure 1 – Typical Aruba Deployment



Note: There should never be a Local controller managed by an AWMS server whose Master controller is also not under management.

1.1 - Prerequisites for Integrating Aruba Infrastructure

You will need the following information to monitor and manage your Aruba infrastructure.

- SNMP community string (monitoring & discovery)
- Telnet/SSH credentials (configuration only)
- "enable" password (configuration only)

Note: Without proper Telnet/SSH credentials AWMS will not be able to acquire license and serial information from controllers.

- SNMPv3 credentials are required for wms offload.
 - Username
 - Auth password

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- Privacy password
- Auth protocol

1.2 - Known and Recently Resolved Issues

AOS Impact	AWMS Impact Ver.	Description	Resolution
3.3.x	6.x	11n client BW OIDs resetting very frequently under heavy load. This results in AMWS reporting inflated BW usage.	Fixed in AOS 3.3.2.17 & AWMS 6.3
3.3.x	6.x	Encryption type is not populated for wireless users.	Fixed in AOS 3.4 & AWMS 6.4
3.3.1		Can't create an SNMPv3 and management user with the same name on a controller.	
3.3.x		Reduced accuracy when locating clients, because of improper neighbor and client SNR values.	Fixed in AOS 3.3.2.6 & AWMS 6.0.9
	5.3 – 6.x	When two wireless users appear on the controller's UI with the same MAC (VMware, Parallels, or VPN) AWMS displays only one user, but flip flops between IP addresses.	ETA 7.0
3.3.2.x	6.1 – 6.2	Controller MIB indicates radio down when the radios are actually up.	Fixed in AOS 3.3.2.13 & AWMS 6.1
3.3.x	All	AOS improperly initializes engine_id in SNMPv3 informs.	Fixed in AOS 3.4.x, 3.3.2 FIPS AWMS 7.0
3.3.x	All	When deleting virtual APs (SSIDs) AP's and Radios disappear when device is in Air Monitor Mode.	Fixed AOS 3.3.2.14 & AWMS 6.2
3.3.x	All	MIB reports incorrect switch port for APs	Removed from AWMS UI in 6.3 AOS – no ETA for fix
3.3.x	6.3	wms offload caused SNMP inform queue on controller to overflow.	Fixed in AOS 3.3.2.14 & AWMS 6.3
3.3.x	6.x	When aggressive key caching is enabled in AOS users may show in AWMS associated to wrong AP.	Fixed in AOS 3.3.2.17 & AWMS 6.3
3.3.x	6.x	After enabling wms offload and running the command 'show wms general' which shows wms is offloaded the local controllers do not send stats to AWMS server.	Fixed in AOS 3.3.2.14 & AWMS 6.2 See Appendix A for work around prior to 3.3.2.14 for restarting wms on local controllers.
3.3.x	6.3	`show user-table` command in AOS reports different user totals than AWMS displays in the UI. `show user-table` shows wired and wireless users as well as duplicative IP addresses for the same user. AWMS only shows 1 user/IP per MAC and only wireless users associated to the WLAN.	ETA AOS fix in 4.1

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AOS Impact	AWMS Impact Ver.	Description	Resolution
3.3.x	6.3	If you are using AWMS templates to configure your controllers, there are some settings pushed from the Master to Local controllers that are not written into startup config which causes AWMS mismatches after pushing a change from AWMS.	Execute `write mem` on each local controller or Convert to AWMS GUI Config No ETA in AOS
3.3.2.x		Authentication failure trap “wlsxNUserAuthenticationFailed” only fires in AOS when trap “wlsxUserAuthenticationFailed” is also enabled.	Enable non “N” trap in AOS No ETA in AOS
3.3.x	All	AP-105s report noise floor at 20 dBm worse than actual. AMP utilizes noise floor to calculate client signal quality. Poor signal quality can reduce location accuracy.	VisualRF adds 20 dBm to client signal in order to increase location accuracy. AMP will show very low signal for all client associated with AP-105s. ETA – AOS 5.0
3.3.x	6.4	The 651 controllers do not provide signal quality and BW for clients associated to the internal AP.	
		wms offload does not work for APs on tagged ports. This cause client tracking issues in AMP	
All	Pre 7.0	AMP device classification would stop working, because it did not support wms offload message RAP_MT_CLASS_OFF	Upgrade to AWMS 7.0
Pre 5.0	Pre 6.4.7	AMP was very slow to rebuild classifications on the controllers after a reboot when wms was offloaded.	Upgrade to AWMS 6.4.7 and AOS 5.0
Pre 3.4.1	All	Controllers reported transmit power of 30 dB when the actual was 21 dB. This caused VisualRF to display inaccurate heatmaps.	Upgrade to AOS 3.4.1
3.3.x	All	SNMP agent timeouts on 6000 series controllers.	Change SNMP settings within AOS
All	All	Because of telnet service contention AMP device auditing fails and causes mismatches on Aruba controllers	7.1 will provide a more efficient method to fetching controller settings.
3.4	All	AOS could stop sending authentication failure traps in 3.3.2.x and prior versions	3.4.2.1 provides a fix
5.0	All	Cipher information is not reported in the MIB in Bridge and Split Tunnel Mode.	5.1 will provide a fix

1.3 - Aruba Feature Implementation Schedule for AWMS

Feature	AWMS Implementation
Automated WMS offloading	6.1
Support for monitoring Remote AP wired users	6.1
Support for Guest Provisioning (pre 3.4 settings)	6.1
Mesh monitoring and visualization support	6.1
Ability to import floor plans from Aruba Controllers	6.1
Support device coordination amongst controllers for WIPS/WIDS	6.2
Support device coordination amongst controllers for ARM	6.2
Ability to provision AMs	6.2
Ability to send ARM/WIPS/WIDS classification to controllers	6.2
Ability to support AP based RTLS and WiFi Tags in VisualRF	6.2
Support for AOS 3.3.2.x	6.2
Support for RAP-5WN & RAP-5	6.2
Auto ARM/WIPS/WIDS classification distributed to controllers	6.3
Support for AP-65-WB, RAP-2WG	6.3
AOS GUI configuration support for Profiles and AP Groups	6.3
Show user cipher type	6.4
Support for 600 series Branch Office infrastructure	6.4
Support for AP-105	6.4
Support per radio AM monitoring	6.4
Support for AOS 3.3.3, 3.4, and 3.4.1	6.4
Replace RF Plan with VisualRF Plan	6.4
Standardized dashboard, navigation, and graphs with AOS	6.4
Support AP-105s and 650 series controllers	6.4
Support AES as a privacy protocol option for SNMPv3	6.4
Ability filter User Session by AOS roles	7.0
AOS 5.0 support	7.0
RAP white list management for RN 3.1	7.0
Added support for rogue containment	7.0
Added support for configuring controller specific overrides	7.0
Client dot11counter status	7.0
AP dot11counter statistics	7.1

2 - Configure AWMS to Optimally Manage Aruba Infrastructure (Global)

2.1 - AMP Setup General Page (Rate Limiting)

There are several SNMP tuning parameters which must be configured in order for AWMS to properly monitor Aruba infrastructure.

Figure 2 – SNMP Rate Limiting

Performance Tuning	
Monitoring Processes (1-2):	2
Maximum number of configuration processes (1-20):	10
Maximum number of audit processes (1-12):	10
SNMP Configuration Verbose Debugging:	<input checked="" type="radio"/> Yes <input type="radio"/> No
SNMP Rate Limiting for Monitored Devices:	<input checked="" type="radio"/> Yes <input type="radio"/> No

- Navigate to **AMP Setup → General** page
- Locate the **Performance Tuning** section
- Enable SNMP Rate Limiting for Monitored Devices

Note: Enabling the SNMP Rate Limiting for Monitored Devices option above adds a small delay between each SNMP Get request, thus the actual polling intervals will be longer than what is configured in Section 3. For example a 10 minute polling interval will result in an actual 12 minute polling interval.

- Click on the “Save”

2.2 - Device Setup Communication Page (Credential & Timing)

Credentials

AWMS requires several credentials to properly interface with Aruba infrastructure. The Discover process detailed in Section 3 requires proper global credential configuration.

- Navigate to **Device → Setup Communication** page
- Locate the **Default Credentials** section
- Click on the Aruba link

Figure 3 – Credential Setup

Device Communication	
If this device is down because its IP address or management ports have changed, update the fields below with the correct information.	
IP Address:	10.51.3.109
SNMP Port:	161
If this device is down because the credentials on the device have changed, update the fields below with the correct information.	
This device is currently using SNMP version 2c.	
Community String:
Confirm Community String:
SNMPv3 Username:	admin
Auth Password:
Confirm Auth Password:
SNMPv3 Auth Protocol:	SHA-1
Privacy Password:
Confirm Privacy Password:
SNMPv3 Privacy Protocol:	DES
Telnet/SSH Username:	admin
Telnet/SSH Password:
Confirm Telnet/SSH Password:
"enable" Password:

Required Fields for Discovery

- Enter SNMP Community String

Note: Be sure to note the community string, because it must match the SNMP Trap community string which is configured later in this document.

Required Fields for Configurations and Basic Monitoring

- Enter Telnet/SSH Username
- Enter Telnet/SSH Password
- Enter “enable” Password

Additional Required Fields for wms Offload

- Enter SNMPv3 Username
- Enter Auth Password
- Enter Privacy Password

Note: Auth and Privacy passwords must match; because the wms offload command only accepts a single password that is leveraged for both options.

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Prior to AWMS 6.3 SNMPv3 Auth Protocol was a configurable option. In AWMS 6.3 and later AWMS automatically configures the Auth Protocol to SHA.

- SNMPv3 Auth Protocol (Applicable to AWMS 6.2 and earlier)

Note: Note: Auth Protocol must be configured to SHA. Privacy Protocol must be configured to DES..

Warning: *If you are using SNMPv3 and the controller's date/time is incorrect, the SNMP agent will not respond to SNMP requests from AWMS SNMP manager. This will result in the controller and all of its downstream access points showing down in AWMS.*

Leveraging NTP for your Aruba infrastructure and your AWMS server is recommended to ensure time synchronization.

Timeout & Retries

- Locate the **SNMP Setting** settings
- Change SNMP Timeout setting to "3"
- Change SNMP Retries to "3"
- Click the "Save" button to apply the changes

Figure 4 – SNMP Time & Retries

SNMP Settings	
SNMP Timeout (3-60 sec):	<input type="text" value="3"/>
SNMP Retries (1-20):	<input type="text" value="3"/>

3 - Creating an Aruba Specific Policy (Group) in AWMS

It is prudent to establish an Aruba Group within AWMS. During the discovery process you will move new discovered controllers into this group.

3.1 – Basic Monitoring Configuration

- Navigate to **Groups → List** page
- Click the “Add” button
- Enter a Name that represents the Aruba infrastructure from a security, geographical, or departmental perspective and click the “Add” button
- You will be redirected to **Group → Basic** page for the Group you just created. On this page you will need to tweak a few Aruba-specific settings.
- Find the **SNMP Polling Periods** section of the page
 - Change Override Poll Period for Other Services to “Yes”
 - Ensure User Data Polling Period is set to “10 minutes”

Do not configure this interval lower than “5 minutes”

Note: Enabling the SNMP Rate Limiting for Monitored Devices option above adds a small delay between each SNMP Get request, thus the actual polling interval is 12 minutes for 10 minute polling interval.

- Change Device-to-Device Link Polling Period to “30 minutes”
- Change Rogue AP and Device Location Data Polling Period to “30 minutes”.

Figure 5 – Group Polling Configuration

SNMP Polling Periods	
Up/Down Status Polling Period:	5 minutes
Override Polling Period for Other Services:	<input checked="" type="radio"/> Yes <input type="radio"/> No
User Data Polling Period:	5 minutes
Thin AP Discovery Polling Period:	15 minutes
Device-to-Device Link Polling Period:	5 minutes
Device Bandwidth Polling Period:	10 minutes
802.11 Counters Polling Period:	15 minutes
Rogue AP and Device Location Data Polling Period:	30 minutes
CDP Neighbor Data Polling Period:	30 minutes

- Find the **Aruba/Alcatel-Lucent** section of page
 - Configure the proper SNMP version for monitoring the Aruba infrastructure.
 - The other options in this section are addressed later in this document or in the AOS Configuration Guide.

Figure 6 – Group SNMP Version for Monitoring

Aruba/Alcatel-Lucent	
SNMP Version:	2c

- Click the “Save and Apply” button

Note: You should reference the Aruba Configuration Guide for additional information on Policy configuration.

3.2 – Configuration

Reference the AOS Configuration Guide located on **Home → Documentation** page for detailed instructions.

4 - Discovering Aruba Infrastructure

AWMS utilizes Aruba's topology to efficiently discover downstream infrastructure.

Prerequisites for discovery:

- Section 2 - credentials
- Section 3 – creating Aruba policies (Groups)

Summarized procedure for discovery and managing Aruba Infrastructure:

- Discover Master controllers
- Manage Master controllers which automatically discovers Local controllers affiliated with the Master controller
- Manage Local controllers which automatically discovers Thin APs affiliated to the Local controllers
- Manage Thin APs

*Note: Always add **one** Controller and its affiliated Thin APs into management or monitoring mode in a serial fashion, one at a time. Adding new devices is a very CPU intensive process for AWMS and can quickly overwhelm all of the processing power of the server if hundreds of Thin APs are added (migrated from New to Managed or Monitoring) simultaneously.*

4.1 - Master Controller Discovery

- Scan networks containing Aruba Master controllers from **Device → Discover** page. This will use your Global Credentials configured in the previous section.
 - or -
- Manually enter the Master controller on the **Device → Add** page.
 - Select the controller type and click "Add" button
 - Enter IP Address

Required Fields for Discovery

- Enter SNMP Community String

Note: Be sure to note the community string, because it must match the SNMP Trap community string which is configured later in this document.

Required Fields for Configurations and Basic Monitoring

- Enter Telnet/SSH Username
- Enter Telnet/SSH Password
- Enter "enable" Password

Additional Required Fields for WMS Offload

- Enter SNMPv3 Username
- Enter Auth Password
- Enter Privacy Password

Note: Auth and Privacy passwords must match; because the wms offload command only accepts a single password that is leveraged for both options.

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Prior to AWMS 6.3 SNMPv3 Auth Protocol was a configurable option. In AWMS 6.3 and later AWMS automatically configures the Auth Protocol to **SHA**.

- SNMPv3 Auth Protocol (Applicable to AWMS 6.2 and earlier)

Note: Note: Auth Protocol must be configured to SHA. Privacy Protocol must be configured to DES.

Warning: If you are using SNMPv3 and the controller's date/time is incorrect, the SNMP agent will not respond to SNMP requests from AWMS SNMP manager. This will result in the controller and all of its downstream access points showing down in AWMS.

- Assign controller to a Group & Folder
- Ensure "Monitor Only" option is selected
- Click the "Add" button
- Navigate to **APs/Devices → New** page
 - Select the Aruba Master controller
 - Ensure "Monitor Only" option is selected
 - Click the "Add" button

Figure 7 – Add New Controller

To discover more devices, visit the [Discover](#) page.

Device	Controller	Type	IP Address	LAN MAC Address	Discovered
<input type="checkbox"/> Aruba3600	-	Aruba 3600	10.51.3.77	00:0B:86:61:12:D0	3/21/2008 3:02 PM

Select All - Unselect All

[View Ignored Devices](#)

Group: Access Points (SSID: default) ▼

Folder: Top ▼

☒ Monitor Only + Firmware Upgrades

☐ Manage Read/Write

4.2 - Local Controller Discovery

- Local controllers are discovered via the Master controller. After waiting for the Thin AP Polling Period or executing a "Poll Now", the Local controllers will appear on the **APs/Devices → New** page. "Poll Now" button is located on the **Device → Monitoring** page.
- Add the Local controller to Group defined above. Within AWMS Local controllers can be split away from the Master controller's Group.

4.3 - Thin AP Discovery

- Thin APs are discovered via the Local controller. After waiting for the Thin AP Polling Period or executing a "Poll Now", thin APs will appear on the **APs/Devices → New** page. "Poll Now" button is located on the **Device → Monitoring** page.
- Add the Thin APs to the Group defined above. Within AMWS thin APs can be split away from the controller's Group. You can split thin APs into multiple Groups if required.

5 - AWMS and Aruba Integration Strategies

Integration Goals	All Masters Architecture	Master Local Architecture
Rogue & Client Info		enable stats
Rogue containment only	ssh access to controllers	ssh access to controllers
Rogue & Client containment	wms offload	wms offload
Reduce Master Controller Load		wms offload debugging off
IDS & Auth Tracking	Define AWMS as trap host	Define AWMS as trap host
Track Tag Location	enable RTLS wms offload	enable RTLS wms offload

Key Integration Points:

- IDS Tracking does **not** require “wms offload” in an All Master or Master Local environment
- IDS Tracking does require enable stats in a Master Local environment
- “wms offload” will hide the **Security Summary** tab on Master Controller’s web interface
- “wms offload” encompasses “enable stats” or “enable stats” is a subset of “wms offload”
- Unless you “enable stats” on the Local Controllers in a Master Local environment, the Local Controllers do not populate their MIBs with any information about clients or rogue devices discovered/associated with their APs. Instead the information is sent upstream to Master Controller.

5.1 - Example Use Cases

Example of When to Use Enable Stats

- Customer wants to pilot AMWS and doesn’t want to make major configuration changes to their infrastructure or manage configuration from AWMS.

Note: Enable Stats still pushes a small subset of commands to the controllers via SSH.

Examples of When to Use WMS Offload

- Customer has older Aruba infrastructure in Master Local environment and their Master controller is fully taxed. Offloading WMS will increase the capacity of the Master Controller by offloading statistic gathering requirements and device classification coordination to AWMS.
- Customer is replacing MMS with AWMS and already had WMS offloaded for performance reasons.
- Customer wants to use AWMS to distribute client and rogue device classification amongst multiple Master controllers in a Master Local environment or in an all Masters environment

Examples of When to Use RTLS

- A Hospital wants to achieve very precise location accuracy (5 -15 feet) for their medical devices which are associating to the WLAN.
- A customer wants to locate items utilizing WiFi Tags.

Note: RTLS could negatively impact your AWMS server’s performance.

Example to Define AWMS as Trap Host

- Customer wants to track IDS events within the AWMS UI.
- Customer is in the process of converting their older 3rd Party WLAN devices to Aruba and wants a unified IDS dashboard for all WLAN infrastructure.

- Customer wants to relate Auth failures to a client device, AP, Group of APs, and controller. AWMS provides this unique correlation capability.

5.2 - Prerequisites for Integration

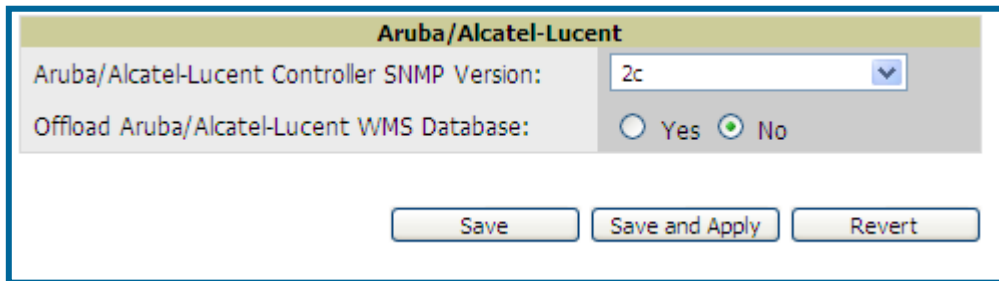
If you have not discovered the Aruba infrastructure or configured credentials, proceed to Sections 3 and 4 of this document.

5.3 - Enable Stats Utilizing AWMS GUI

To enable stats on the Aruba controllers:

- Navigate to **Groups→Basic** page
- Locate the Aruba/Alcatel Lucent section
- Disable “Offload Aruba/Alcatel-Lucent WMS Database
- Click “Save and Apply” button

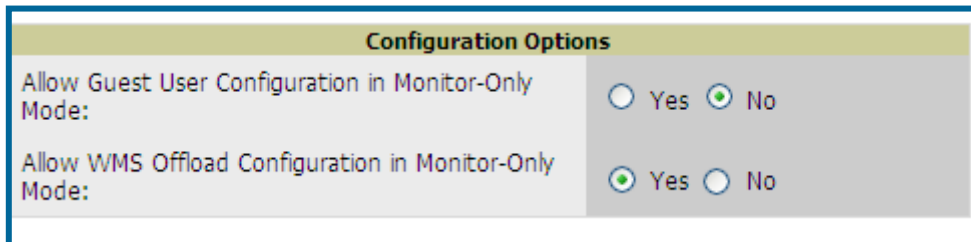
Figure 8 – Enable Stats



Aruba/Alcatel-Lucent	
Aruba/Alcatel-Lucent Controller SNMP Version:	2c
Offload Aruba/Alcatel-Lucent WMS Database:	<input type="radio"/> Yes <input checked="" type="radio"/> No
<div>Save Save and Apply Revert</div>	

- Navigate to **AMP Setup → General** page
- Locate Configuration Options section
- Enable “Allow WMS Offload Configuration in Monitor-Only Mode”
- Click the “Save” button

Figure 9 – WMS Offload Configuration Options (enable stats)



Configuration Options	
Allow Guest User Configuration in Monitor-Only Mode:	<input type="radio"/> Yes <input checked="" type="radio"/> No
Allow WMS Offload Configuration in Monitor-Only Mode:	<input checked="" type="radio"/> Yes <input type="radio"/> No

This will push a set of commands via SSH to all Aruba local Controllers. AWMS must have read/write access to the controllers in order to push these commands. See **Device Setup Communication Section** below for help configuring your device credentials.

Note: This process will not reboot your controllers.

Warning: If you don't follow the above steps local controllers will not be configured to populate statistics. This decreases AWMS' capability to trend client signal information and to properly locate devices. See Appendix A on how to utilize AOS CLI to enable stats on Aruba infrastructure.

*Note: If your credentials are invalid or the changes are not applied to the controller, error messages will display on the controller's **Device → Monitoring page** under the **Recent Events***

section. If the change fail, AWMS does not audit these setting (display mismatches) and you will need to apply to the controller by hand, see Appendix A for detailed instructions.

Commands Pushed by AWMS during Enable Stats (Do not enter these commands)

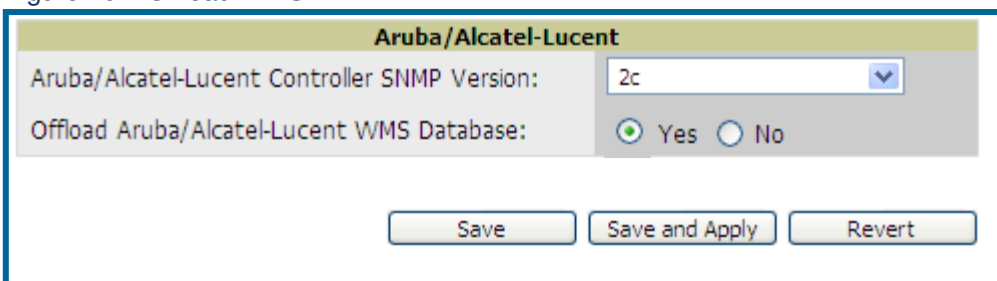
```
configure terminal
no mobility-manager <Active WMS IP Address>
wms
general collect-stats enable
stats-update-interval 120
show wms general
write mem
```

5.4 - WMS Offload Utilizing AWMS GUI

To Offload WMS on the Aruba controllers:

- Navigate to **Groups→Basic** page
- Locate the Aruba/Alcatel Lucent section
- Enable “Offload Aruba/Alcatel-Lucent WMS Database
- Locate the Configuration section
- Enable or Disable “Allow WMS Offload Configuration in Monitor-Only Mode”
- Click “Save and Apply” button

Figure 10 – Offload WMS



The screenshot shows a configuration window titled "Aruba/Alcatel-Lucent". It contains two main settings: "Aruba/Alcatel-Lucent Controller SNMP Version:" with a dropdown menu showing "2c", and "Offload Aruba/Alcatel-Lucent WMS Database:" with radio buttons for "Yes" (selected) and "No". At the bottom, there are three buttons: "Save", "Save and Apply", and "Revert".

This will push a set of commands via SSH to all Aruba Master Controllers. If the controller does not have an SNMPv3 user that matches AWMS’ database it will automatically create a new SNMPv3 user. AWMS must have read/write access to the controllers in order to push these commands.

Note: This process will not reboot your controllers. See Appendix A on how to utilize AOS CLI to enable stats or wms offload.

Warning: The SNMPv3 user's Auth Password and Privacy Password must be the same.

*Note: Auth Protocol **must** be configured to **SHA**. Privacy Protocol **must** be configured to **DES**.*

Commands Pushed by AWMS during WMS Offload (Do not enter these commands)

```
configure terminal
mobility-manager <AWMS IP> user <AWMS SNMPv3 User Name> <AWMS Auth/Priv PW>
stats-update-interval 120
write mem
```

Note: In AOS 3.3.2.14 and later versions AWMS will configure SNMPv2 traps with the mobile manager command.

Other Processes for wms offload

AWMS will issue an SNMPGet on table (wlsxSysExtHostname) to complete the offload process (OID=.1.3.6.1.4.1.14823.2.2.1.2.1.2.0.)

Diagnostic Steps if you are not seeing Rogue devices appear in AWMS in AOS versions prior to 3.3.2.14

- If you are able, upgrade to latest 3.3.x or 3.4 AOS version and it will automatically resolve this issue.
- or -
- Ensure “Is Master” flag is not enabled on local controllers, SSH into each local controller, enter “enable” mode, and issue the following commands:

```
(Controller-Name) # show wms general

General Attributes
-----
Key                               Value
---                               -
poll-interval                     60000
poll-retries                      3
ap-ageout-interval                30
sta-ageout-interval               30
learn-ap                          disable
persistent-known-interfering      enable
propagate-wired-macs              enable
stat-update                       enable
collect-stats                     enable
classification-server-ip           10.2.32.3
rtls-port                         8000
wms-on-master                     disable
use-db                            disable
calc-poll-interval                60000
Switch IP                         10.51.5.109
Is Master                         enable
```

If the “Is Master” flag is enabled as shown above and you are not able to upgrade your AOS, use the following instructions to resolve the issue.

- To ensure local controllers are populating rogue information properly, SSH into each local controller, enter “enable” mode, and issue the following commands:

```
(Controller-Name) # configure terminal
Enter Configuration commands, one per line. End with CNTL/Z

(Controller-Name) (config) # process restart wms
```

Note: You will need to wait until the next Rogue Poll Period or execute a “Poll Now” for each local controller to see rogue devices begin to appear in AWMS after doing a “restart wms” in AOS.

Note: This command will need to be reissued after each configuration change from the Master Controller.

5.5 - Define AWMS as Trap Host using AOS CLI

To ensure the AWMS server is defined a trap host, SSH into each controller (Master and Local, enter “enable” mode, and issue the following commands:

```
(Controller-Name) # configure terminal
Enter Configuration commands, one per line. End with CNTL/Z

(Controller-Name) (config) # snmp-server host <AWMS IP ADDR> version 2c <SNMP
COMMUNITY STRING OF CONTROLLER>
```

Note: Ensure the SNMP community matches what was configured in Section 2.

```
(Controller-Name) (config) # snmp-server trap source <CONTROLLER'S IP>
```

```
(Controller-Name) (config) # write mem
```

Saving Configuration...

Saved Configuration

Warning: Do not configure the SNMP version to v3, because AWMS does not support SNMPv3 traps/informs. Prior to AOS 3.4 there were queue overflow issues related to SNMPv3 informs.

- AOS Traps utilized by AWMS

Auth Traps Utilized by AWMS

- wlsxNUserAuthenticationFailed
- wlsxUserAuthenticationFailed
- AMP does not use this trap, but in AOS 3.3.2.x wlsxNUserAuthenticationFailed will not fire unless wlsxUserAuthenticationFailed (no “N”) is enabled
- wlsxNAuthServerReqTimedOut

IDS Traps Utilized by AWMS

- wlsxSignatureMatchAP
- wlsxSignatureMatchSta
- wlsxSignAPNetstumbler
- wlsxSignStaNetstumbler
- wlsxSignAPAsleap
- wlsxSignStaAsleap
- wlsxSignAPAirjack
- wlsxSignStaAirjack
- wlsxSignAPNullProbeResp
- wlsxSignStaNullProbeResp
- wlsxSignAPDeauthBcast
- wlsxSignStaDeauthBcastwlsxChannelFrameErrorRateExceeded
- wlsxChannelFrameFragmentationRateExceeded
- wlsxChannelFrameRetryRateExceeded
- wlsxNlpSpoofingDetected
- wlsxStalmpersonation
- wlsxReservedChannelViolation
- wlsxValidSSIDViolation
- wlsxStaPolicyViolation
- wlsxRepeatWEPIVViolation
- wlsxWeakWEPIVViolation
- wlsxFrameRetryRateExceeded
- wlsxFrameReceiveErrorRateExceeded
- wlsxFrameFragmentationRateExceeded

- wlsxFramBandWidthRateExceeded
- wlsxFramLowSpeedRateExceeded
- wlsxFramNonUnicastRateExceeded
- wlsxChannelRateAnomaly
- wlsxNodeRateAnomalyAP
- wlsxNodeRateAnomalySta
- wlsxEAPRateAnomaly
- wlsxSignalAnomaly
- wlsxSequenceNumberAnomalyAP
- wlsxSequenceNumberAnomalySta
- wlsxApFloodAttack
- wlsxInvalidMacOUIAP
- wlsxInvalidMacOUISta
- wlsxStaRepeatWEPIVViolation
- wlsxStaWeakWEPIVViolation
- wlsxStaAssociatedToUnsecureAP
- wlsxStaUnAssociatedFromUnsecureAP
- wlsxAPImpersonation
- wlsxDisconnectStationAttackAP
- wlsxDisconnectStationAttackSta

Diagnostic Steps to Ensure IDS & Auth Traps Display in AWMS

- Validate your AOS configuration by exiting the “configure terminal” mode and issuing the following command:

```
(Controller-Name) # show snmp trap-list
```

If any of the traps above don't show as enabled enter configure terminal mode and issue the following command:

```
(Controller-Name) (config) # snmp-server trap enable <TRAPS FROM LIST ABOVE>
```

Note: See Appendix A for the full command that can be copied and pasted directly into the AOS CLI.

This section applies to AOS 5.0 and higher only.

Enter one of these two commands depending on how AOS is interfacing with AWMS.

AWMS Communication via a VLAN interface

```
(Controller-Name) (config) # controller-ip vlan <vlan id>
```

Since controller IP address will change, connectivity to this controller might be affected. Do you want to proceed with this action [y/n]: y

or

AWMS Communication via Loopback interface

```
(Controller-Name) (config) # controller-ip loopback
```

Since controller IP address will change, connectivity to this controller might be affected. Do you want to proceed with this action [y/n]: y

```
(Controller-Name) (config) # write mem
```

```
Saving Configuration...
```

```
Saved Configuration
```

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- Ensure the source IP of the traps match the IP that AWMS utilizes to manage the controller. Navigate to **Device** → **Monitoring** page to validate the IP address.

Figure 11 – Verify IP Address on Device → Monitoring Page

Status: Up (OK)		Configuration: Mismatched (The settings on the device do not match the desired configuration policy.)					
Firmware:	3.3.2.11	Licenses (3 Expired)					
Controller Role:	Local	VRRP IP:	10.1.1.242				
Type:	Aruba 3600	Last Contacted:	6/1/2009 1:50 PM	Uptime:	46 days 18 hrs 31 mins		
LAN MAC Address:	00:0B:86:51:12:40	Serial:	AC0000303	Location:	1344 Server Room	Contact: Aruba IT	
IP Address:	10.1.1.241	SSID:	-	Total APs:	266	Total Users: 62	
Notes:		Bandwidth: 2435 kbps					

- Verify that there is a SNMPv2 community string that matches the SNMP Trap community string on the controller.

```
(Controller-Name) # #show snmp community
```

```
SNMP COMMUNITIES
```

```
-----  
COMMUNITY  ACCESS      VERSION  
-----
```

```
public      READ_ONLY  V1, V2c
```

```
(Controller-Name) # #show snmp trap-host
```

```
SNMP TRAP HOSTS
```

```
-----  
HOST          VERSION      SECURITY NAME  PORT  TYPE  TIMEOUT  RETRY  
-----  
10.2.32.4      SNMPv2c    public        162   Trap  N/A      N/A
```

- Verify firewall port 162 (default) is open between AWMS and the controller.
- Validate traps are making it into AWMS by issuing the following commands from AWMS command line.

```
[root@AWMS ~]# qlog enable snmp_traps
```

```
[root@AWMS ~]# tail -f /var/log/amp_diag/snmp_traps
```

```
1241627740.392536 handle_trap|2009-05-06 09:35:40 UDP: [10.2.32.65]->[10.51.5.118]:-32737 sends trap: DISMAN-EVENT-MIB::sysUpTimeInstance = Timeticks: (127227800) 14 days, 17:24:38.00 SNMPv2-MIB::snmpTrapOID.0 = OID: SNMPv2-SMI::enterprises.14823.2.3.1.11.1.2.1106 SNMPv2-SMI::enterprises.14823.2.3.1.11.1.1.60 = Hex-STRING: 07 D9 05 06 09 16 0F 00 2D 08 00 SNMPv2-SMI::enterprises.14823.2.3.1.11.1.1.5.0 = Hex-STRING: 00 1A 1E 6F 82 D0 SNMPv2-SMI::enterprises.14823.2.3.1.11.1.1.6.0 = STRING: "aruba-ap" SNMPv2-SMI::enterprises.14823.2.3.1.11.1.1.1.0 = Hex-STRING: 00 1A 1E C0 2B 32 SNMPv2-SMI::enterprises.14823.2.3.1.11.1.1.56.0 = INTEGER: 2 SNMPv2-SMI::enterprises.14823.2.3.1.11.1.1.17.0 = STRING: "aruba-124-c0:2b:32" SNMPv2-SMI::enterprises.14823.2.3.1.11.1.1.18.0 = INTEGER: 11 SNMPv2-SMI::enterprises.14823.2.3.1.11.1.1.58.0 = STRING: "http://10.51.5.118/screens/wmsi/reports.html?mode=ap&bssid=00:1a:1e:6f:82:d0"
```

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Note: You will see many IDS and Auth Traps from this command. AWMS only processes a small subset of these Traps which display within AWMS UI. The Traps that AWMS does process are listed above.

Ensure you disable qlogging after testing as it could negatively impact AWMS performance if left turned on.

```
[root@AWMS ~]# qlog disable snmp_traps
```

5.6 - Understanding WMS Offload Impact on Aruba Infrastructure

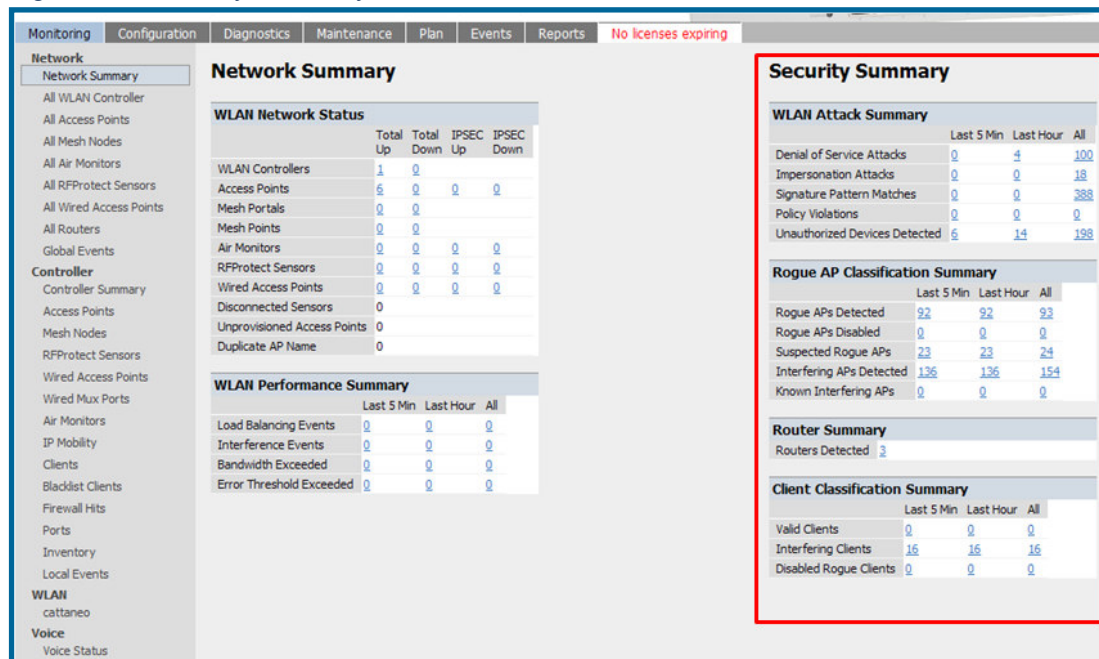
When offloading WMS it is important to understand what functionality is migrated to AWMS and what functionality is deprecated.

The following Tabs and sections are deprecated after offload wms

- Plan Tab - where floor plans are stored and heatmaps are generated. Prior to offloading wms ensure that you have exported floor plans from the AOS and imported into AWMS. All functionality within the Plan Tab is incorporated with the VisaulRF module in AWMS.
- Report Tab – All reports are incorporate within AWMS.
- Events Tab – the majority of functionality within this Tab is incorporate within AWMS Reports and Alerts sections with the exception of:
 - Interference Detected
 - Rogue AP
 - Station Failed
 - Suspected Rogue AP

One important area to note is the Security Summary display disappears after offloading WMS. The data is still being processed by the Master Controller, but the summary information is not available. AWMS does provide ability to view some of this information in detail and summary form.

Figure 12 – Security Summary on Master Controller



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WLAN Attack Summary

- DOS Attacks – no summary data available in AWMS
- Impersonation Attacks – no summary data available in AWMS
- Signature Pattern Matches – partial summary data available on **Home** and **RAPIDS → Overview** pages
- Policy Violations – no summary data available in AWMS
- Unauthorized Devices Detected – no summary data available in AWMS

Rogue AP Classification Summary

- Rogue APs Detected – summary data available on **RAPIDS → Overview** page
- Rogue APs Disabled – no summary data available in AWMS
- Suspected Rogue APs – partial data is available in AWMS on each AP's **Device → Management** page
- Interfering APs Detected – partial data is available in AWMS on each AP's **Device → Management** page
- Known Interfering APs – partial data is available in AWMS on each AP's **Device → Management** page

Router Summary

- Routers Detected – no summary data available in AWMS

Client Classification Summary

- Valid Clients – summary data available on all pages in the dashboard
- Interfering clients – no summary data available in AWMS
- Disabled Clients – no summary data available in AWMS

See section 6.4 for more information on Security, IDS, WIPS, WIDS, classification, and RAPIDS.

6 - Aruba Specific Capabilities within AWMS

6.1 - Aruba Traps for RADIUS Auth & IDS Tracking

The authentication failure traps are received by the AWMS server and correlated to the proper controller, AP, and user. See Figure below showing all authentication failures related to a controller.

Figure 13 – RADIUS Authentication Traps as Seen in AWMS

RADIUS Authentication Issues for HQ-Aruba-Controller in group Acme Corporation in folder Top > Acme Corporation > Corporate HQ | Return to AP/Device Monitor page

Event Type ▲	Last 2 Hours	Last 24 Hours	Total
Client authentication failed	0	4	1103

1-20 of 1103 RADIUS Authentication Issues Page 1 of 56 > >|

Event	Username	User MAC Address	AP	Radio	RADIUS Server	Time ▼
Client authentication failed for 00:0B:7D:0C:19:E9	-	00:0B:7D:0C:19:E9	-	-	-	4/2/2008 5:24 PM
Client authentication failed for 00:17:3F:20:99:6B	-	00:17:3F:20:99:6B	-	-	-	4/2/2008 4:21 PM

The IDS traps are received by the AWMS server and correlated to the proper controller, AP, and user. See Figure below showing all IDS traps related to a controller.

Figure 14 – IDS Traps as Seen in AWMS

IDS Events for HQ-Aruba-Controller in group Acme Corporation in folder Top > Acme Corporation > Corporate HQ | Return to AP/Device Monitor page

Attack ▲	Last 2 Hours	Last 24 Hours	Total
Deauth-Broadcast	0	0	47
Netstumbler Generic	13	122	1756
Null-Probe-Response	22	263	2776
3 Attack Types	35	385	4579

1-20 ▼ of 4579 IDS Events Page 1 ▼ of 229 > >|

Attack	Attacker	AP	Radio	Channel	SNR	Precedence	Time ▼
Null-Probe-Response	00:20:A6:49:92:AE	HQ-Aruba-Boardroom	802.11a	-	13	-	7/17/2008 1:58 PM
Null-Probe-Response	00:0D:97:00:81:6A	HQ-Northeast-Corner-b6b6	802.11bg	-	23	-	7/17/2008 1:56 PM
Null-Probe-Response	00:20:A6:49:92:AE	HQ-Southwest-Corner-eb3e	802.11a	-	39	-	7/17/2008 1:41 PM

6.2 - Remote AP & Wired Networking Monitoring

- From the Device → List page you can distinguish and sort on Mode “Remote”
- To view detailed information on the remote device click on the device name.

Figure 15 – Remote AP Detail Page

ServerRoom-AL39	Up	5	70	17 days 10 hrs 20 mins	Good	Acme Corporation	.HQ	ethersphere-lms4	Aruba200	Remote AP
S.Hoss.Home	Up	0	0	8 days 3 hrs 14 mins	Good	Acme Corporation	Top	ethersphere-lms4	Aruba200	Remote AP

Monitoring S.Hoss.Home in group Acme Corporation in folder Top Poll Controller Now

This Device is in monitor-only-with-firmware-upgrades mode.

Status: Up (OK)	Configuration: Good	Firmware: 3.3.2.10-m-3.0-beta	Controller Interface: 1/0	Uptime: 8 days 3 hrs 14 mins
Controller: Aruba200	Type: Aruba AP 70	Last Contacted: 2/6/2009 4:59 PM	Serial: AS0163866	Location: Not Available
LAN MAC Address: 00:0B:86:CE:E1:84	Mode: Remote AP	Total Users: 0	Bandwidth: 0 kbps	
SSID: -	First Radio: 802.11bg	MAC Address: 00:0B:86:6E:18:40	Users: 0	Bandwidth: 0 kbps Channel: 11
Second Radio: 802.11a	MAC Address: 00:0B:86:6E:18:50	Users: 0	Bandwidth: 0 kbps	Channel: 48
Wired Interface: Enet0 (uplink only)	MAC Address: 00:0B:86:CE:E1:84	Users: 0		
Wired Interface: Enet1	MAC Address: 00:0B:86:CE:E1:85	Users: 0		

- You can see if there are users plugged into the wired interfaces.

Note: This feature is only available in AWMS version 6.2 or greater and AOS 3.3.2.10 or greater when the remote APs are in split tunnel and tunnel modes.

6.3 - View Controller License Information

- Navigate to the Device → Detail page of a controller under AWMS management
- Click on the License link

Figure 16 – License Popup

License Table for alpha-local-1:

Service Type	Installed	Expires	Flag	Key
Client Integrity Module	4/29/2005 12:36 PM		E	n9XQpMZN-kUMfht6z-j98lcV0J-TSikt4In-xA2LIFT0-v58
External Services Interface	4/29/2005 12:35 PM		E	PIF8DrBV-nBXlKp75-z8TT2NS-aj4oa8/h-VVm+CxB6-zVU
External Services Interface	4/29/2005 12:34 PM		E	OMsNveDX-W3wEHSKx-TpXkQbHV-NyTb3HAN-OYAIZnY-VDs
Indoor Mesh Access Points: 256	10/19/2007 6:54 PM		E	IKwFlaJR-6y8p6rm+-CzOUh7tl-bMhkMA1v-1DV+2m+H-kZE
MMC AP	10/19/2007 6:54 PM		E	WP6JN8I5-y4AoaG9p-P2r7wVtk-/PXV3JgR-C0fq3d4-LLk
Ortronics Access Points: 256	10/19/2007 6:54 PM		E	+jl6oDRK-PIRXv5nF-l1DMwrDJ-oES1ydXR-4K7sFEHQ-SmU
Outdoor Mesh Access Points: 100	5/2/2007 2:51 PM	Expired		99CSOvuL-jL4Z0YkS-Q8lov2bI-BS+Y0Vxi-YkC9TT0V-5js
Outdoor Mesh Access Points: 256	10/19/2007 6:54 PM		E	RKC/wjVj-fcRQGLDi-K/F8vuvv-oYRwgCuG-CsmY7wYh-w18
Outdoor Mesh Access Points: 64	8/1/2007 3:59 PM		E	C5/bSfb-yVOxft0h-BVWUVEVe-Glb2xz4A-LKcq440D-DXQ
Policy Enforcement Firewall	4/29/2005 12:30 PM		E	vDXRo7pz-Jo8asgU2-HG7w74h-zz3yGKu-zz7w3rj+-/1I
Remote Access Points: 256	10/19/2007 6:54 PM		E	QnR882W+-o1Kb2XcR-2vrePyl+-J+-rWbXh-jtCqjH3h-LPU
Remote Access Points: 48	4/29/2005 12:38 PM		E	5zz7c0jO-LpDgDbLH-4bEnzNbg-p/oEnS2a-nTtHaS8t-ms0
Voice Services Module	10/19/2007 6:54 PM		E	Lj/ByOfs-wMdJU3Xv-5djAkCIJ-vJ9zRok3-sWZ4Z2bn-aH4
VPN Server	4/29/2005 12:32 PM		E	SOKR1Sa8-KKMjj/Gv-HlcJcwaK-uEZuPvcs-c/LIzjg0-2IE
Wireless Intrusion Protection	4/29/2005 12:33 PM		E	xVc/llqw-Os1ei+yL-b1CqzoTr-UwGp2OAI-LD6wHOW2-qSw
xSec Module	4/29/2005 12:37 PM		E	ukxUwAcB-PE+GeyB9-7u7IMtQ1-CaibELI2-LuqdRsqA-fac

6.4 - Device Classification

Only utilize this section if you have completed WMS offload procedure above. After offloading WMS, AWMS maintains the primary (ARM, WIPS, and WIDS) state classification for all devices discovered over-the-air.

WIPS/WIDS to AWMS Controller Classification Matrix

AWMS 'Controller Classification'	AOS (WIPS/WIDS)
Unclassified (default state)	Unknown
Valid	Valid
Suspected Neighbor	Interfering
Neighbor	Known Interfering
Suspected Rogue	Suspected Rogue
Rogue	Rogue
Contained Rogue	DOS

To check and reclassify rogue devices

- Navigate to the **Rogue → Detail** page for the device
- Select the proper classification from the Controller Classification Pull Down

Figure 17 – Rogue Detail

Name:	3Com Access Point	Model:	3COM AP7250	First Discovered:	1/14/2009 11:59 AM
Acknowledge:	<input type="radio"/> Yes <input checked="" type="radio"/> No	IP Address:	10.51.1.24	First Discovery Method:	-
Controller Classification:	Rogue	SSID:	3com	First Discovery Agent:	-
RAPIDS Classification:	Unclassified	Channel:	11	Last Discovered:	5/29/2009 4:20 PM
Classification Rule:	-	WEP:	No	Last Discovery Method:	Wireless AP scan
RAPIDS Classification Override:	- No Override -	WPA:	No	Last Discovery Agent:	00:1a:1e:c6:d5:c2
Threat Level:	-	Network Type:	AP		
Threat Level Override:	5				
Radio MAC Address:	00:0D:54:A7:A2:80				
Radio Vendor:	3Com Ltd				
LAN MAC Address:	00:0D:54:A7:A2:80				
LAN Vendor:	3Com Ltd				
OUI Score:	4 (Override score)				
Operating System:	-				
OS Detail:	-				
Last Scan:	-				
Notes:	3COM Wireless LAN Dual Mode Access Point				
<input type="button" value="Update"/> <input type="button" value="Ignore"/> <input type="button" value="Delete"/> <input type="button" value="Identify OS"/> Refresh this page for updated results.					

BSSID	Interface Type	Desired Classification	Confidence	Classification on Device
00:0D:54:A7:A2:80	802.11a	Rogue	100	<unknown>
00:0D:54:A7:A2:80	802.11b	Rogue	100	Rogue

Warning: Changing the controller's classification within the AWMS UI will push a reclassification message to all controllers managed by the AWMS server that are in Groups with "Offloading the WMS database" set to "Yes". To reset the controller classification of a rogue device on AWMS, change the controller classification on the AWMS UI to "unclassified".

Controller classification can also be updated from **RAPIDS → List** page via the modify-these-devices mechanism.

All rogue devices will be set to a default controller classification of "unclassified" when wms is first offloaded except for devices classified as "valid". Rogue devices classified in AOS as "valid" will also be classified within AWMS as "valid" for their controller classification as well. As APs report subsequent classification information about rogues, this classification will be reflected within AWMS UI and propagated to controllers that AWMS manages. It is probable that the device classification reflected in the Controller's UI and in AWMS' UI will not match, because the Controller/APs do not reclassify rogue devices frequently.

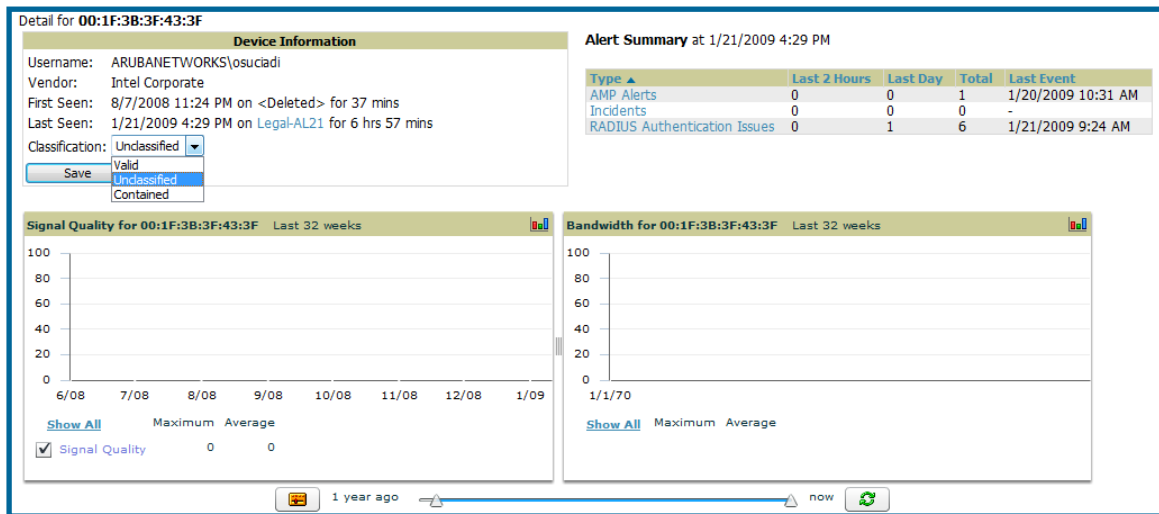
To update a group of devices' controller classification to match the AOS device classification navigate to **RAPIDS → List** page and utilize the modify-these-devices mechanism combined with the multiple sorting a filtering features.

ARM to AWMS Classification Matrix

AWMS	AOS (ARM)
Unclassified (default state)	Unknown
Valid	Valid
Contained	DOS

- Navigate to the **User → Detail** page for the user
- Select the proper classification from the Classification Pull Down

Figure 18 – User Classification



Warning: Changing User Classification within the AWMS UI will push a user reclassification message to all controllers managed by the AWMS server that are in Groups with "Offloading the WMS database" set to "Yes".

All users will be set to a default classification of "unclassified" when wms is first offloaded. As APs report subsequent classification information about users, this classification will be reflected within AWMS UI and propagated to controllers that AWMS manages. It is probable that the user's classification reflected in the Controller's UI and in AWMS' UI will not match, because the Controller/APs do not reclassify users frequently.

There is no method in the AWMS UI to update user classification on mass to match the controller's classification. Each client must be updated individually within the AWMS UI.

Appendix A - CLI AOS & AWMS Commands

A.1 - Enable Stats Utilizing AOS CLI (Local Controller in Master Local Environment)

Note: Do not use these commands if using AWMS GUI to set these commands.

SSH into the controller, and enter “enable” mode, and issue the following commands:

```
(Controller-Name) # configure terminal
Enter Configuration commands, one per line. End with CNTL/Z

(Controller-Name) (config) # wms general collect-stats enable

(Controller-Name) (config) # write mem
Saving Configuration...

Saved Configuration
```

A.2 - Offload WMS Utilizing AOS CLI and AWMS CLI (SNMP Walk)

Note: Do not use these commands if using AWMS GUI to set these commands.

AOS CLI

SSH into all controllers (local and master), and enter “enable” mode, and issue the following commands:

```
(Controller-Name) # configure terminal
Enter Configuration commands, one per line. End with CNTL/Z

(Controller-Name) (config) # mobility-manager <AMP IP> user <MMS-USER> <MMS-
SNMP-PASSWORD> trap-version 2c (trap-version was added in 3.3.2.14 to prevent
the SNMPv3 inform queue overflow on the controller)
```

Note: This command creates an SNMPv3 user on the controller with authentication protocol configured to 'sha' and privacy protocol 'DES'. The user and password must be at least **eight** characters, because the Net-SNMP package in AWMS adheres to this IETF recommendation. AOS automatically creates Auth and Privacy passwords from this single password. If mobility-manager is already using a preconfigured SNMPv3 user ensure the Privacy & Authentication passwords are the same.

Note: This command also creates the AWMS server as an SNMPv3 Trap Host in the controller's running configuration

Sample: mobility-manager 10.2.32.1 user airwave123 airwave123

```
(Controller-Name) (config) # write mem

Saving Configuration...

Saved Configuration
```

AWMS SNMP

Login into the AMWS server with proper administrative access and issue the following command for all controllers (master and locals):

Note: Do not use these commands if using AWMS GUI.

```
[root@AWMS ~]# snmpwalk -v3 -a SHA -l AuthPriv -u <MMS-USER> -A <MMS-SNMP-  
PASSWORD> -X <MMS-SNMP-PASSWORD> <ARUBA CONTROLLER IP ADDRESS>  
wlsxSystemExtGroup
```

```
WLSX-SYSTEMEXT-MIB::wlsxSysExtSwitchIp.0 = IPAddress: 10.51.5.222  
WLSX-SYSTEMEXT-MIB::wlsxSysExtHostname.0 = STRING: aruba-3600-2  
.  
.  
.  
WLSX-SYSTEMEXT-MIB::wlsxSysExtSwitchLastReload.0 = STRING: User reboot.  
WLSX-SYSTEMEXT-MIB::wlsxSysExtLastStatsReset.0 = Timeticks: (0) 0:00:00.00  
esponse
```

```
[root@AWMS ~]#
```

Note: unless this SNMP walk command is issued properly on all of the controllers they will not properly populate client and rogue statistics. Ensure the user and passwords match exactly to those entered in above sections.

Sample: `snmpwalk -v3 -a SHA -l AuthPriv -u airwave123 -A airwave123 -X airwave123 10.51.3.222 wlsxSystemExtGroup`

Because the MIB walk/touch does not persist through a controller reboot, you must add a cronjob on the AWMS server to ensure continue statistical population.

A.3 - Ensuring Master Controller Pushes Config to Local Controllers Utilizing AOS CLI

Note: Do not use these commands if using AWMS GUI.

```
(Controller-Name) (config) # cfgm mms config disable
```

Note: This command ensures configuration changes made on the master controller will propagate to all local controllers.

```
(Controller-Name) (config) # write mem  
Saving Configuration...
```

```
Saved Configuration
```

A.4 - Disable Debugging Utilizing AOS CLI

If you are experiencing performance issues on the Master Controller, you want to ensure debugging is disabled. It should be disabled by default. Debugging coupled with gathering the enhanced statistics can put a strain on the controllers CPU, so it is highly recommended to disable debugging.

To disable debugging, SSH into the controller, enter “enable” mode, and issue the following commands:

```
(Controller-Name) # show running-config | include "logging level debugging"
```

If there is output then use the following commands to remove the debugging:

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```
(Controller-Name) # configure terminal
Enter Configuration commands, one per line. End with CNTL/Z

(Controller-Name) (config) # no logging level debugging <module from above>

(Controller-Name) (config) # write mem
Saving Configuration...

Saved Configuration
```

A.5 - Restart WMS on Local Controllers Utilizing AOS CLI

To ensure local controllers are populating rogue information properly, SSH into each local controller, enter “enable” mode, and issue the following commands:

```
(Controller-Name) # configure terminal
Enter Configuration commands, one per line. End with CNTL/Z

(Controller-Name) (config) # process restart wms
```

Note: You will need to wait until the next Rogue Poll Period on execute a “Poll Now” for each local controller to see rogue devices begin to appear in AWMS after doing a “restart wms” in AOS.

A.6 – Copy & Paste to Enable Proper Traps Utilizing AOS CLI

To ensure the proper traps are configured on Aruba controllers copy and paste the following command after entering “enable” mode and issuing the “configure terminal command”:

Copy & Paste the Text Below

```
snmp-server trap enable wlsxNUserAuthenticationFailed
snmp-server trap enable wlsxUserAuthenticationFailed
snmp-server trap enable wlsxNAuthServerReqTimedOut
snmp-server trap enable wlsxSignatureMatchAP
snmp-server trap enable wlsxSignatureMatchSta
snmp-server trap enable wlsxSignAPNetstumbler
snmp-server trap enable wlsxSignStaNetstumbler
snmp-server trap enable wlsxSignAPAsleap
snmp-server trap enable wlsxSignStaAsleap
snmp-server trap enable wlsxSignAPAirjack
snmp-server trap enable wlsxSignStaAirjack
snmp-server trap enable wlsxSignAPNullProbeResp
snmp-server trap enable wlsxSignStaNullProbeResp
snmp-server trap enable wlsxSignAPDeauthBcast
snmp-server trap enable wlsxSignStaDeauthBcastwlsxChannelFrameErrorRateExceeded
snmp-server trap enable wlsxChannelFrameFragmentationRateExceeded
snmp-server trap enable wlsxChannelFrameRetryRateExceeded
snmp-server trap enable wlsxNIPspoofingDetected
snmp-server trap enable wlsxStaImpersonation
snmp-server trap enable wlsxReservedChannelViolation
snmp-server trap enable wlsxValidSSIDViolation
snmp-server trap enable wlsxStaPolicyViolation
```

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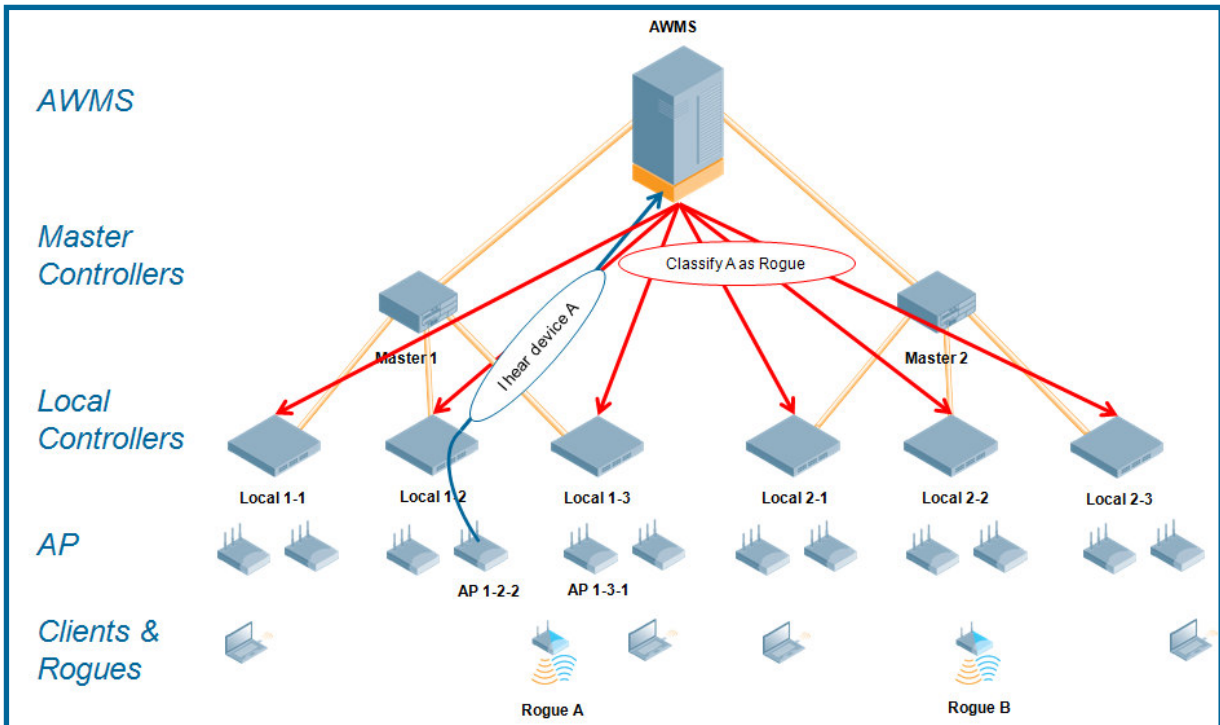
```
snmp-server trap enable wlsxRepeatWEPIVViolation
snmp-server trap enable wlsxWeakWEPIVViolation
snmp-server trap enable wlsxFrameRetryRateExceeded
snmp-server trap enable wlsxFrameReceiveErrorRateExceeded
snmp-server trap enable wlsxFrameFragmentationRateExceeded
snmp-server trap enable wlsxFrameBandWidthRateExceeded
snmp-server trap enable wlsxFrameLowSpeedRateExceeded
snmp-server trap enable wlsxFrameNonUnicastRateExceeded
snmp-server trap enable wlsxChannelRateAnomaly
snmp-server trap enable wlsxNodeRateAnomalyAP
snmp-server trap enable wlsxNodeRateAnomalySta
snmp-server trap enable wlsxEAPRateAnomaly
snmp-server trap enable wlsxSignalAnomaly
snmp-server trap enable wlsxSequenceNumberAnomalyAP
snmp-server trap enable wlsxSequenceNumberAnomalySta
snmp-server trap enable wlsxApFloodAttack
snmp-server trap enable wlsxInvalidMacOUIAP
snmp-server trap enable wlsxInvalidMacOUISta
snmp-server trap enable wlsxStaRepeatWEPIVViolation
snmp-server trap enable wlsxStaWeakWEPIVViolation
snmp-server trap enable wlsxStaAssociatedToUnsecureAP
snmp-server trap enable wlsxStaUnAssociatedFromUnsecureAP
snmp-server trap enable wlsxAPImpersonation
snmp-server trap enable wlsxDisconnectStationAttackAP
snmp-server trap enable wlsxDisconnectStationAttackSta
```

Note: You will need to issue the “write mem” command.

Appendix B – WMS Offload Details

WMS offload instructs the Master controller to stop correlating ARM, WIPS, and WIDS state information amongst its Local controllers, because AWMS will assume this responsibility. Figure 4 below depicts how AWMS communicates state information with Local controllers.

Figure 19 – ARM/WIPS/WIDS Classification Message Workflow



B.1 - State Correlation Process

1. AP-1-3-1 hears rogue device A
2. Local controller 1-3 evaluates devices and does initial classification and sends a classification request to the AWMS
3. AWMS receives message and re-classifies the device if necessary and reflects this within AWMS GUI and via SNMP traps, if configured.
4. AWMS sends a classification message back to all Local controllers managed by Master controller 1, (1-1, 1-2, and 1-3)
5. AWMS sends a classification message back to all additional Local controllers managed by the AWMS server. In this example all Local controllers under Master controller 2, (2-1, 2-2, and 2-3) would receive the classification messages.
6. If an administrative AWMS user manually overrides the classification, then AWMS will send a re-classification message to all applicable local controllers.
7. AWMS periodically polls each Local controller's MIB to ensure state parity with AWMS' database. If the Local controller's device state does not comply with AWMS' database, AWMS will send a re-classification message to bring it back into compliance.

Important notes:

- Customers upgrading to AWMS 6.2 or later will have all their rogue devices set to a default controller classification of “unclassified”. Customers will need to classify these devices manually from the AWMS UI. AWMS updates the classification of a rogue device based on SNMP polling only if the controller classification defined on AWMS is set to “unclassified”.
- The **Rogue Detail Page** displays a BSSID table for each rogue that displays the desired classification and the classification on the device.

Benefits of using AWMS as Master Device State Manager:

- Ability to correlate state amongst multiple Master controllers. This will reduce delays in containing a rogue device or authorizing a valid device when devices roam across a large campus.
- Ability to correlate state of 3rd party access points with ARM. This will ensure Aruba infrastructure interoperates more efficient in a mixed infrastructure environment.
- Ability to better classify devices based on AWMS wire-line information not currently available in AOS.
- AWMS provides a near real-time event notification and classification of new devices entering air space.
- RAPIDS gains additional wire-line discovery data from Aruba controllers.

Appendix C – AOS OIDs used by AWMS

The table below details which AOS OIDs are ready from AWMS.

Meaning	AOS OID	Status
Client Signal to Noise Ratio (SRN)	wlanStaRSSI	Active
Client Bytes Ingress	wlanStaRxBytes	Deprecated 3.3.2
Client Bytes Egress	wlanStaTxBytes	Deprecated 3.3.2
Client Bytes Ingress	wlanStaRxBytes64,	Active in 3.3.3
Client Bytes Egress	wlanStaTxBytes64,	Active in 3.3.3
Client Retry Frame Rate	wlanStaFrameRetryRate	Active
Client Low Speed Frame Rate	wlanStaFrameLowSpeedRate	Active
Client Non Unicast FrameRate	wlanStaFrameNonUnicastRate	Active
Client Fragmentation Rate	wlanStaFrameFragmentationRate	Active
Client Retry Error Frame Rate	wlanStaFrameRetryErrorRate	Active
Client's associated AP's Name	wlanAPName	Active
Client's associated AP's AP IP Address	wlanAPIpAddress	Active
Client's associated AP/Radio's BSSID	wlanAPBssidAPMacAddress	Active
Client's associated AP/Radio's Noise Floor	wlanAPChNoise	Active
Client User Name	nUserName	Active
Client User Role	nUserRole	Active
Client VLAN ID	nUserCurrentVlan	Active
Client Authentication Method	nUserAuthenticationMethod,	Active
Client Sub Authentication Method	nUserSubAuthenticationMethod,	Active
Client PHY Type	nUserPhyType,	Active
Client HT Mode	nUserHTMode,	Active
Client BSSID of Association	nUserApBSSID,	Active
Client's associated AP's location	nUserApLocation,	Active
Client Connection Mode (Wired or Wireless)	nUserIsWired,	Active
Wired Client Connected Port	nUserConnectedPort	Active
Unassociated Client PHY Type	monStaInfoPhyType,	Active
Unassociated Client Classification	monStaInfoClassification,	Active
Unassociated Client RSSI	monStaInfoRSSI,	Active

Appendix D – Converting from MMS RF Live to AWMS VisualRF

The instructions below will enable you to seamlessly migrate all building, campus, and floor plan information previously entered into MMS or AOS into AWMS.

Pre conversion checklist

- The conversion tool is only supported for **IE6** and **E7**.
- Ensure you increase VisualRF memory prior to beginning the MMS export option. Navigate to **VisualRF → Setup** and use the pull-down menu for Memory Allocation

Number of Floor Plans	Memory in GB
1 – 75	.5
76 – 250	1
251 – 500	1.5
501 – 1,000	2

D.1 - Migrating Floor Plans from MMS to AWMS Process

- **Navigate to VisualRF → Import Page**
- Select the “Import floor plans from MMS” link
- Detailed instructions will appear on the screen
- Select the “Begin Importing Floor Plans” link
- Input the following information:
 - Host – enter the hostname or IP address of the MMS server
 - Username – enter the MMS administrative user account.
 - Password
 - Context (optional) – leave this blank unless you have enabled context on you MMS. Most customers do not utilize context.

Note: If you are using context, then you will have to enter a different user for each context defined within MMS.
- Click on the “Export” button and the program will automatically redirect to the page below detailing the status of the export.

Figure 20 – MMS Export Instructions

Add New Floor Plan

Import Floor Plans From AMP Backup

Import Floor Plans from WCS

Import Floor Plans from MMS

This option enables automatic importation for campuses, buildings, and floor plans from MMS into VisualRF.

Prior to clicking the *Begin Importing Floor Plans* link below, ensure you are using IE7 and VisualRF's memory allocation is sufficient for the anticipated number of floors plans. To change the memory allocation, navigate to the *VisualRF Setup* page and configure the memory allocation accordingly. Memory allocation should equal .5 GB for 1 – 75 floor plans, 1 GB for 76 – 250 floor plans, 1.5 GB for 251 – 500 floor plans, and 2 GB for 501 – 1,000 floor plans.

Note: Importing a large number of floor plans can impact performance of the AWMS server. The VisualRF service must create a thumbnail, provision APs, create attenuation grid, and locate all clients on each imported floor plan. This can cause the VisualRF --> Floor Plans page to be unresponsive.

[Begin Importing Floor Plans](#)

Import Floor Plans from an Aruba Controller

Batch Import Floor Plans Wizard

Figure 21 – MMS Export to AWMS window

MMS 2.x Migration to VisualRF

Please provide the following information from MMS

Host

Username

Password

Context

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Figure 22 – MMS export

```
Performing MMS export
When this link <Validate> is available the MMS export is complete and ready for validation.
The output log will automatically refresh every 5 seconds until complete

M2A login succeeded.
Converting MMS data model to AWP ...
Write campus [Main Campus]
Write campus [Dev Campus]
Write building [RF Lab]
Writing floor [RF Lab : Floor 1]
Writing floor image [/var/airwave/data/batch/0a05366b-cd14-46e7-85a9-8f5b728041dc/building--2689597b-118e295e4b5--7fcc.1.jpg]
Writing floor [RF Lab : Floor 2]
Writing floor image [/var/airwave/data/batch/0a05366b-cd14-46e7-85a9-8f5b728041dc/building--2689597b-118e295e4b5--7fcc.2.jpg]
Write campus [Campus13]
Write campus [Campus12]
Write campus [Campus11]
Write campus [Campus10]
Write building [Building 12]
Writing floor [Building 12 : Floor 1]
Writing floor image [/var/airwave/data/batch/0a05366b-cd14-46e7-85a9-8f5b728041dc/building-6766dea5-11959361124--7fdd.1.jpg]
Write building [Building 11]
Writing floor [Building 11 : Floor 1]
Writing floor image [/var/airwave/data/batch/0a05366b-cd14-46e7-85a9-8f5b728041dc/building-6766dea5-11959361124--7fdf.1.jpg]
Write building [Building 10]
Writing floor [Building 10 : Floor 1]
Writing floor image [/var/airwave/data/batch/0a05366b-cd14-46e7-85a9-8f5b728041dc/building-6766dea5-11959361124--7fe1.1.jpg]
Write building [Building 9]
Writing floor [Building 9 : Floor 1]
Writing floor image [/var/airwave/data/batch/0a05366b-cd14-46e7-85a9-8f5b728041dc/building-6766dea5-11959361124--7fe3.1.jpg]
Write building [Building 8]
Writing floor [Building 8 : Floor 1]
Writing floor image [/var/airwave/data/batch/0a05366b-cd14-46e7-85a9-8f5b728041dc/building-6766dea5-11959361124--7fe5.1.jpg]
Write building [Building 7]
Writing floor [Building 7 : Floor 1]
```

- Once the exportation process is complete the <Validate> tag will change to a clickable link.
- Click the “Validate” link to validate the XML exported from MMS. This will automatically redirect you to the Bulk Importation Wizard to import the exported floor plans into AWMS.
- If APs in the XML that are not in AWMS, the following screen will be displayed. Set the APs to be ignored or identify them as planned, and click the “Override” button to continue.

Figure 23 – Override

Override	
Access Point id[4322ac37-4aec-4740-828a-9370ab6b59ee] name[AP 1.4] not found.	set to: <ignored>
Access Point id[21155bed-d8b9-4ffd-817f-4c0928ae6706] name[ap-65-7] mac[00:0b:86:c1:0b:52] not found.	set to: <planned>
Access Point id[b57e0f8d-2ce3-4689-960b-e300e5448459] name[ap-60-4] mac[00:0b:86:c2:11:25] not found.	set to: <planned>
Access Point id[ec88dc55-1de2-47e6-aa16-b790a40e1ab0] name[ap-60-5] mac[00:0b:86:c2:22:4a] not found.	set to: <planned>
Access Point id[a0db99a0-ec21-45d2-a621-98c6491ddd90] name[ap-60-6] mac[00:0b:86:c2:22:88] not found.	set to: <planned>
Access Point id[0f8a176d-8f0f-4163-9c58-f85ac91f99fc] name[AP 2.2] not found.	set to: <ignored>

- If there are no new APs, click the “Next” button to complete the process.

*Note: Importing a large number of floor plans can impact performance on the AMWS server; once the batch process is initiated, it can take up to 30 minutes to complete the import process. The VisualRF service must create a thumbnail, provision APs, create attenuation grid, and locate all clients on each imported floor plan. This can cause the **VisualRF → Floor Plans** page to be unresponsive.*

D.2 - Migrating Floor Plans from AOS (Controller) to AWMS

Process on Aruba Controller

- Login into the Aruba controller's Web UI
- Navigate to the **Plan → Building List** page.
- Select the buildings to be exported and click on the “Export” button.
- When the dialog box appears, make sure that you have included all images and click the “Save to a file” button.

Process to Import within AWMS

- Navigate to **VisualRF → Import** page
- Select the “Import floor plans from an Aruba Controller” link
- A detailed set of directions will appear.
- Click on the “Begin Importing Floor Plans” link at the bottom of the instructions and it will automatically redirect to the file upload explorer.
- Browse for the file that was saved during the controller export process above.
- Click the “Upload” button to validate the XML exported from the controller.
- If there are errors in the XML you will see errors on screen.

*Note: Importing a large number of floor plans can impact performance on the AMWS server. The VisualRF service must create a thumbnail, provision APs, create attenuation grid, and locate all clients on each imported floor plan. This can cause the **VisualRF → Floor Plans** page to be unresponsive.*

Figure 24 – Import Floor Plans from an AOS (Controller)

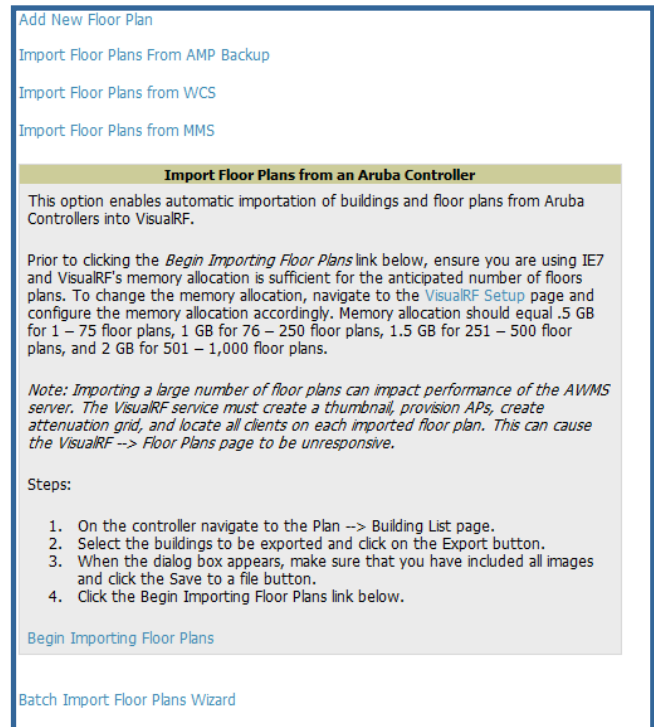
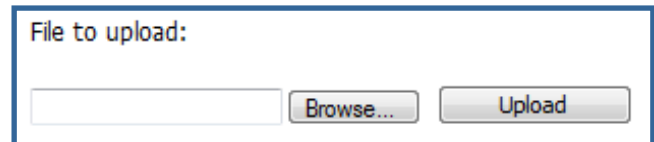


Figure 25 – File Upload Explorer



D.3 - Migrating Floor Plans from RF Plan to AWMS

Process with RF Plan

- Navigate to the **File → Export** page.
- From Export drop down select “**Controller WebUI Format 3.0**” or “**VisualRF Format**”
- Within the dialog box, name the export file
- From the Campus Building tree, select the Campuses and Buildings you want to export
- Click the **Next** button

Process to Import within AWMS

- Navigate to **VisualRF → Import** page
- Select the “Import floor plans from an RF Plan ” link
- A detailed set of directions will appear.

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- Click on the “Begin Importing Floor Plans” link at the bottom of the instructions and it will automatically redirect to the file upload explorer.
- Browse for the file that was saved during the RF Plan export process above.
- Click the “Upload” button to validate the XML exported from the controller.
- If there are errors in the XML you will see errors on screen.

Appendix E – Increasing Location Accuracy

E.1 – Understand Band Steering’s Impact on Location

Band steering can negatively impact location accuracy when testing in highly mobile environment. The biggest hurdle is scanning times in 5 GHz frequency

Operating Frequency	Total Channels	Scanning Frequency	Scanning Time	Total Time One Pass
2.4 GHz	11 (US)	10 seconds	110 milliseconds	121.21 seconds
5 GHz	24 (US)	10 seconds	110 milliseconds	242.64 seconds

E.2 – Leveraging RTLS to Increase Accuracy

Overview

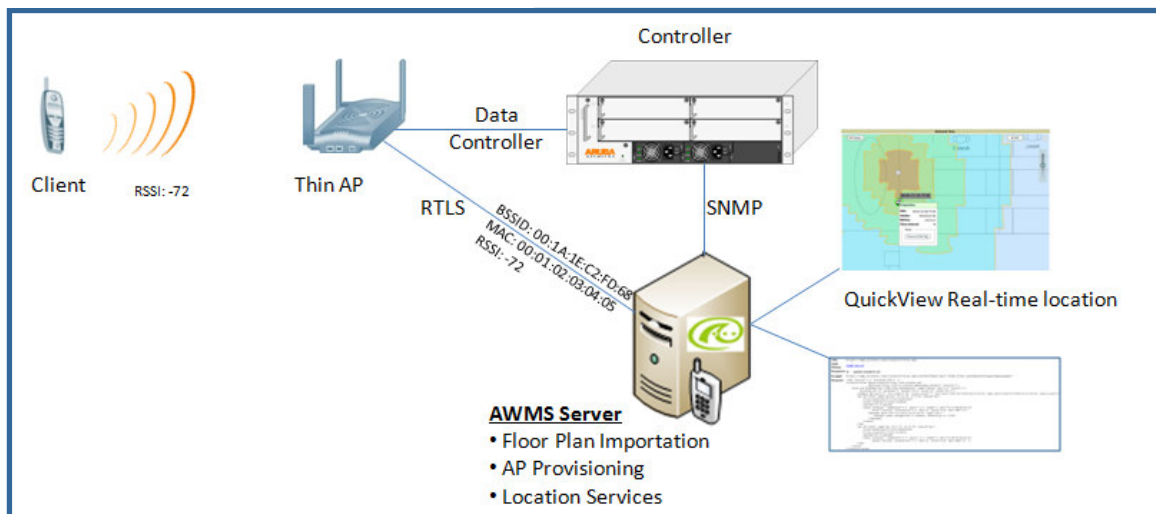
This section provides instructions for integrating the AWMS, Aruba WLAN infrastructure and Aruba’s RTLS feed for more accurately locating wireless clients and WiFi Tags.

Minimum Requirements

- AWMS version 6.2 or higher
- Aruba OS (AOS) 3.1.x or higher

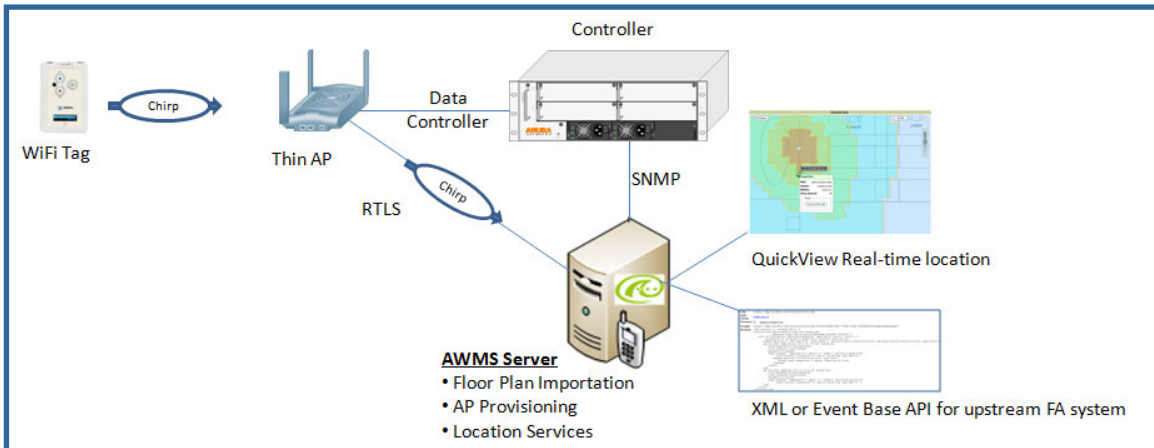
Deployment Topology

Figure 26 – Typical Client Location



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Figure 27 – Typical Tag Deployment



Prerequisites

You will need the following information to monitor and manage your Aruba infrastructure.

- Ensure AWMS server is already monitoring Aruba infrastructure
- Ensure WMS offload process is complete
- Ensure firewall configuration for port 5050 (default port) supports bidirectional UDP communication between the AWMS server's IP address and each access point's IP address.

Known Issues

AOS	AWMS	Description	Resolution
3.x	6.x	Wi-Fi Tags will only display in VisualRF. Wi-Fi Tags will not display within AWMS' UI or the controller's UI.	AWMS 7.1

Enable RTLS service on the AWMS server

- Navigate to **AMP Setup → General** page
- Locate the **AMP Additional Services** section
- Select "Yes" to Enable RTLS Collector
- A new section will automatically appear with the following settings
 - RTLS Port – match controller default is 5050
 - RTLS Username – match the SNMPv3 "MMS" username configured on controller
 - RTLS Password – match the SNMPv3 "MMS" password configured on controller
- Click on the "Save" button at the bottom of the page.

Figure 28 – RTLS Setup

Additional AMP Services

Enable FTP Server: required to manage Cisco Aironet 4800 APs, also optionally for Aruba, Cisco IOS and Trapeze firmware upgrades. ☐ Yes ☒ No

Enable RTLS Collector: Aruba/Alcatel-Lucent only ☒ Yes ☐ No

RTLS Port: 5050

RTLS Username: rttest

RTLS Password:

Confirm RTLS Password:

Use Embedded Mail Server: ☒ Yes ☐ No

Enable RTLS on Controller

Note: RTLS can only be enabled on the master controller and it will automatically propagate to all local controllers.

- SSH into master controller, enter “enable” mode, and issue the following commands:

```
(Controller-Name) # configure terminal
Enter Configuration commands, one per line. End with CNTL/Z

(Controller-Name) (config) # ap system-profile <PROFILE USED BY THIN APs>

(Controller-Name) (AP system profile "default") # rtls-server ip-addr <IP OF AWMS SERVER> port 5050 key <SNMPv3 "MMS" PASSWORD CONFIGURED ON CONTROLLER>

(Controller-Name) (AP system profile "default") # write mem
Saving Configuration...
```
- To validate exit configuration mode

```
(Controller-Name) # show ap monitor debug status ip-addr <IP ADDRESS OF ANY THIN ACCESS POINTS>
```

```
...
RTLS configuration
-----
Type          Server IP    Port    Frequency  Active
-----
MMS           10.51.2.45   5070    120
Aeroscout     N/A         N/A     N/A
RTLS         10.51.2.45 5050    60         *
```

Trouble Shooting RTLS

- Ensure the RTLS service is running on your AWMS server. SSH into your AWMS server.

```
[root@AWMSServer]# daemons | grep RTLS
root      17859 12809  0 10:35 ?          00:00:00 Daemon::RTLS
```

or

Navigate to System → Status page and look for the RTLS service

Figure 26 – RTLS Service Status

RFprotect Detection	OK	/var/log/sensor_rf_detection
Rogue Filter	OK	/var/log/rogue_filter
RTLS Collector	OK	/var/log/rtls
Sensor Discovery	OK	/var/log/sensor_discovery

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- Check the RTLS log file to ensure Tag chirps are making it to the AWMS server. SSH into your AWMS server.

```
[root@AWMSServer]# logs
[root@AWMSServer]# tail rtls

payload:
00147aaf01000020001a1ec02b3200000001000000137aae0100000c001a1ec02b3
20000001a1e82b322590006ddff02

1224534900.588245 - got 96 bytes from 10.51.1.39 on port 5050

Mon Oct 20 13:35:00 2008: 1224534900.588338 - got 96 bytes from
10.51.1.39 on port 5050

payload:
0014c9c90100003c001a1ec050780000000200000013c9c70100000c001a1ec0507
80000000d54a7a280540001ddff020013c9c80100000c001a1ec050780000000cdb
8ae9a90000006c4ff02

1224534900.588245 - got 96 bytes from 10.51.1.39 on port 5050

Mon Oct 20 13:35:00 2008: 1224534900.588338 - got 96 bytes from
10.51.1.39 on port 5050

payload:
0014c9c90100003c001a1ec050780000000200000013c9c70100000c001a1ec0507
80000000d54a7a280540001ddff020013c9c80100000c001a1ec050780000000cdb
8ae9a90000006c4ff02
```

- Ensure chirps are published to Airbus by snooping on proper topics

```
[root@AWMS server]# airbus_snoop rtls_tag_report
```

```
Snooping on rtls_tag_report:
Mon Oct 20 13:49:03 2008 (1224535743.54077)
%
    ap_mac => 00:1A:1E:C0:50:78
    battery => 0
    bssid => 00:1A:1E:85:07:80
    channel => 1
    data_rate => 2
    noise_floor => 85
    payload => ""
    rssi => -64
    tag_mac => 00:14:7E:00:4C:E4
    timestamp => 303139810
    tx_power => 19
```

- Verify external applications can see WiFi Tag information by exercising the Tag XML API.

- <https://<AWMS SERVER IP>/visualrf/rfid.xml>

You should see the following XML output

```
<visualrf:rfids version="1">
  <rfid battery-level="0" chirp-interval="" radio-mac="00:14:7E:00:4C:E0"
    vendor="">
    <radio phy="g" xmit-dbm="10.0"/>
    <discovering-radio ap="SC-MB-03-AP10" dBm="-91" id="811" index="1"
```

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```
        timestamp="2008-10-21T12:23:30-04:00"/>
    <discovering-radio ap="SC-MB-03-AP06" dBm="-81" id="769" index="1"
        timestamp="2008-10-21T12:23:31-04:00"/>
    <discovering-radio ap="SC-MB-01-AP06" dBm="-63" id="708" index="1"
        timestamp="2008-10-21T12:23:31-04:00"/>
    <discovering-radio ap="SC-MB-02-AP04" dBm="-88" id="806" index="1"
        timestamp="2008-10-21T12:22:34-04:00"/>
</rfid>

<rfid battery-level="0" chirp-interval="" radio-mac="00:14:7E:00:4B:5C"
    vendor="">
    <radio phy="g" xmit-dbm="10.0"/>
    <discovering-radio ap="SC-MB-03-AP06" dBm="-74" id="769" index="1"
        timestamp="2008-10-21T12:23:20-04:00"/>
    <discovering-radio ap="SC-MB-01-AP06" dBm="-58" id="708" index="1"
        timestamp="2008-10-21T12:23:20-04:00"/>
    <discovering-radio ap="SC-MB-03-AP02" dBm="-91" id="734" index="1"
        timestamp="2008-10-21T12:23:20-04:00"/>
</rfid>

<rfid battery-level="0" chirp-interval="" radio-mac="00:14:7E:00:4D:06"
    vendor="">
    <radio phy="g" xmit-dbm="10.0"/>
    <discovering-radio ap="SC-SB-GR-AP04" dBm="-91" id="837" index="1"
        timestamp="2008-10-21T12:21:08-04:00"/>
    <discovering-radio ap="SC-MB-03-AP06" dBm="-79" id="769" index="1"
        timestamp="2008-10-21T12:22:08-04:00"/>
    <discovering-radio ap="SC-MB-01-AP06" dBm="-59" id="708" index="1"
        timestamp="2008-10-21T12:23:08-04:00"/>
    <discovering-radio ap="SC-MB-02-AP04" dBm="-90" id="806" index="1"
        timestamp="2008-10-21T12:22:08-04:00"/>
</rfid>
</visualrf:ruids>
```

Wi-Fi Tag Setup Guidelines

- Ensure tags can be heard by at least 3 access points from any given location. The recommended is 4 for best results.
- Ensure tags chirp on all regulatory channels.