ArubaOS 7.3

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User Guide

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This guide describes the instructions and examples for configuring the ArubaOS Mobility Access Switch.

This chapter covers:

What's New In ArubaOS 7.3

The following features and enhancements are introduced in ArubaOS 7.3:

Table 1: *New Features in ArubaOS 7.3*

Feature	Description
ClearPass Policy Manager Integration	Following enhancements are introduced in ArubaOS 7.3: • Define **ip access-list eth** and **ip access-list mac** ACL and reference them under user-role. • Define the following attributes in CPPM: **- qos-profile** **- interface-profile voip-profile** **- policer-profile** **- aaa authentication captive-portal** **- user-role re-authentication interval** • Support for Captive Portal downloadable role.
Small Form-factor Pluggable Diagnostics	Small Form-factor Pluggable (SFP) diagnostic allows administrators to view detailed information of the transceivers connected to the Mobility Access Switch.
Virtual Router Redundancy Protocol	Virtual Router Redundancy Protocol (VRRP) enables a group of layer 3 configured Mobility Access Switches to form a single virtual router. LAN clients may be configured with the virtual router IP as the default gateway.
Layer 3 Generic Router Encapsulation (L3 GRE)	This release of ArubaOS supports L3 connectivity through GRE tunnel. L3 GRE tunnel extends VLANs across Mobility Access Switches and Aruba controllers. GRE encapsulates Layer-3 frames with a GRE header and transmits the frames through an IP tunnel over the cloud.
Sticky MAC	Sticky MAC is a port security feature that dynamically learns MAC addresses on an interface and retains the MAC information in case the Mobility Access Switch reboots. Enable Sticky MAC with MAC limit to restrict the number of MAC addresses that can be learnt on an interface.
OSPFv2 with L3 GRE	OSPFv2 allows the Mobility Access Switch to be effectively deployed in a Layer 3 topology. This release of ArubaOS introduces OSPFv2 support for L3 GRE tunnel interface.

Table 1: *New Features in ArubaOS 7.3*

Feature	Description
Policy Based Routing	Policy-Based Routing (PBR) provides a flexible mechanism for forwarding data packets based on policies configured by a network administrator.
Auto-Trust of IAP	In this release of ArubaOS Mobility Access Switch, a new option, **aruba-device**is introduced under **qos trust** command to automatically trust Aruba IAPs.
Dynamic ARP Inspection (DAI)	Dynamic ARP Inspection (DAI) is a security feature that validates ARP packets in a network. DAI intercepts, logs, and discards ARP packets with invalid IP to MAC address bindings.
IP Source Guard(IPSG)	IP Source Guard (IPSG) functionality restricts IP addresses from untrusted interface to be included in the list of addresses in the DHCP binding database or manually configured IP source bindings to prevent IP spoofing attacks.
DHCP Snooping	This release of ArubaOS Mobility Access Switch supports DHCP Snooping. When DHCP snooping is enabled, the system snoops the DHCP messages to view DHCP lease information to build and maintain a database of valid IP-to-MAC address bindings called the DHCP snooping database. This functionality enables the switch to monitor and control DHCP messages received from untrusted devices connected to the Mobility Access Switch.
USB Operations	The Mobility Access Switch can read and write files to a USB drive. The USB drive can be used to upgrade software images or configuration files and also back up configurations or stored files on the local flash. Directories on the USB drive can also be created, deleted, or viewed in addition to renaming and deleting files.
Stateful Firewall Policy	This release of ArubaOS provides support for stateful firewall policies (session ACL) which perform a stateful packet inspection and keep track of the state of network connections.
Activate Integration	This release of ArubaOS provides support for Aruba Activate, a cloud-based service that allows you to provision the Aruba devices and maintain your inventory.
PoE Negotiation over LLDP	This release of ArubaOS provides support for PoE negotiation through LLDP and LLDP MED packets.
Router ACLs	This release of ArubaOS provides support for Router ACLs which perform access control on all traffic entering the specified Routed VLAN Interface.

Audience

This is intended for system administrators responsible for accessing networking infrastructures and assumes you are knowledgeable in Layer 2 and Layer 3 networking technologies.

Fundamentals

Throughout this document references are made to the Mobility Access Switch and configuring using the WebUI or command line interface (CLI).

WebUI

The WebUI is accessible through a standard Web browser from a remote management console or workstation. The WebUI includes a Quick Setup wizard that steps you through tasks that includes:

- Basic Information–Specify device name, domain name, password, date, and time
- Management–Specify switch management options, VLAN assignment, and static or DHCP IP address assignment
- Summary page– Displays the settings and allows you to print or save the summary from a separate window.

The WebUI also includes a post-setup Dashboard, Configuration, Diagnostic, and Maintenance screens.

CLI

The CLI is a text-based interface accessible from a local console connected to the serial port on the S3500 or through a Telnet or Secure Shell (SSH) session.

NOTE

By default, you can access the CLI from the serial port or from an SSH session. You must explicitly enable Telnet on your Mobility Access Switch in order to access the CLI using a Telnet session.

When entering commands remember that:

- commands are not case sensitive
- the space bar will complete your partial keyword
- the backspace key will erase your entry one letter at a time
- the question mark (?) will list available commands and options

Related Documents

The following documents are part of the complete documentation suite for the Aruba Mobility Access Switch:

- *Aruba S3500 Series Mobility Access Switch Installation Guide*
- *Aruba S2500 Series Mobility Access Switch Installation Guide*
- *Aruba S1500Series Mobility Access Switch Installation Guide*
- *ArubaOS Mobility Access Switch Command Line Reference Guide*
- *ArubaOS Mobility Access Switch Quick Start Guide*
- *Release Notes*

Conventions

The following conventions are used throughout this manual to emphasize important concepts:

Table 2: *Typographical Conventions*

Type Style	Description
Italics	This style is used to emphasize important terms and to mark the titles of books.
`System items`	This fixed-width font depicts the following: • Sample screen output • System prompts • Filenames, software devices, and specific commands when mentioned in the text
`Commands`	In the command examples, this bold font depicts text that you must type exactly as shown.
<Arguments>	In the command examples, italicized text within angle brackets represents items that you should replace with information appropriate to your specific situation. For example: `# send <text message>` In this example, you would type “send” at the system prompt exactly as shown, followed by the text of the message you wish to send. Do not type the angle brackets.
`[Optional]`	Command examples enclosed in brackets are optional. Do not type the brackets.
`{Item A | Item B}`	In the command examples, items within curled braces and separated by a vertical bar represent the available choices. Enter only one choice. Do not type the braces or bars.

The following informational icons are used throughout this guide:

NOTE

Indicates helpful suggestions, pertinent information, and important things to remember.

CAUTION

Indicates a risk of damage to your hardware or loss of data.

WARNING

Indicates a risk of personal injury or death.

Contacting Support

Table 3: *Contact Information*

Website Support	
Main Site	arubanetworks.com
Support Site	support.arubanetworks.com
Airheads Social Forums and Knowledge Base	community.arubanetworks.com
North American Telephone	1-800-943-4526 (Toll Free) 1-408-754-1200
International Telephone	http://www.arubanetworks.com/support-services/support-program/contact-support

Website Support	
Software Licensing Site	https://licensing.arubanetworks.com/
End of Support Information	http://www.arubanetworks.com/support-services/end-of-life-products/
Security Incident Response Team (SIRT)	http://www.arubanetworks.com/support-services/security-bulletins/
Support Email Addresses	
Americas, EMEA, and APAC	support@arubanetworks.com
Security Incident Response Team (SIRT)	sirt@arubanetworks.com

System basics is an introduction to the feature rich ArubaOS Mobility Access Switch and introduces functionalities that are presented in detail in the rest of this document. This chapter covers:

Factory Initial Configuration

The Mobility Access Switch is pre-loaded with a factory initial configuration. The default username/password to log in to the Mobility Access Switch is admin/admin123.

To view the initial factory setting, execute the **show running configuration** command with the initial factory option.

```
(host) #show running-config | include factory-initial
Building Configuration...
interface-profile poe-profile "poe-factory-initial"
interface-profile lldp-profile "lldp-factory-initial"
vlan-profile igmp-snooping-profile "igmp-snooping-factory-initial"
igmp-snooping-profile "igmp-snooping-factory-initial"
lldp-profile "lldp-factory-initial"
poe-profile "poe-factory-initial"
```

NOTE

By default, MSTP is enabled in the factory setting.

Spanning Tree Modes

The spanning tree mode is set to MSTP in factory default.

```
(host) #show running-config | begin spanning-tree
Building Configuration...
spanning-tree
   mode mstp
```

To change spanning tree modes, use the spanning tree mode command. After you change the spanning tree mode, the new spanning tree is automatically applied to all configured VLANs, including default VLAN 1.

```
(host)(config) #spanning-tree mode ?
mstp                    Multiple spanning tree mode
pvst                    Per-Vlan rapid spanning tree mode
(host)(config) #spanning-tree mode pvst
```

To verify the current spanning tree mode:

```
(host)(config) #show spanning-tree-profile
```

```
spanning-tree
-------------
Parameter           Value
---------           -----
spanning-tree-mode  pvst
```

For more information on spanning tree, see MSTP on page 156 and Rapid PVST+ on page 174.

Zero Touch Provisioning

The ArubaOS Mobility Access Switch supports zero touch provisioning by one of the following methods:

- By configuring a DHCP server to send the IP address of a TFTP server from where it may fetch a configuration file, or
- By configuring the Aruba Activate service to send the Mobility Access Switch information about an AirWave Management Platform that can provision it.

This process begins automatically when a Mobility Access Switch with a factory default configuration boots up. If the Mobility Access Switch is connected to the network and receives an IP address via DHCP, it first attempts to parse the DHCP offer message to obtain a TFTP server address and the configuration file name/path. If a configuration file name is not provided, it attempts to download a configuration file based on its own serial number (<SERIAL>.cfg).

If the Mobility Access Switch does not receive a TFTP server address via DHCP, it then attempts to contact the Aruba Activate server, where it can receive provisioning information about an assigned AirWave Management Platform (AMP). If the Mobility Access Switch is not able to contact Activate or does not receive AirWave provisioning information from Activate, it will attempt to contact the Activate server every five minutes. The zero touch provisioning process automatically stops if the **Quick Setup** dialog is triggered before DHCP or Activate provisioning completes.

For more details on Activate, see Automatic Configuration with Aruba Activate on page 68

NOTE

You can use any network port in stand-alone or stacking environments.

Important Points to Remember

- This process remains active for ten minutes. If the Mobility Access Switch is idle for 10 minutes and zero touch provisioning is not complete, you must manually configure the Mobility Access Switch.
- During the zero touch provisioning process, DHCP messages without zero touch provisioning parameters are ignored.
- If quick-setup mode (WebUI or CLI) is started, zero touch provisioning is disabled. If quick-setup mode is cancelled at any point, zero touch provisioning remains disabled.
- Additionally, zero touch provisioning is disabled when you attempt to configure an IP address for the VLAN interface or enable DHCP-client on the VLAN interface.
- If zero touch provisioning is successful, the Mobility Access Switch reboots after the configuration is downloaded.

The two options expected in the DHCP message are:

- TFTP server address– include this in siaddr or option 150 or both. If the server address is included in both, the siaddr takes precedence.
- Configuration file path– include this in boot file option or options 67 or both. The siaddr and the boot file options are part of the BOOTP parameters section of the DHCP message.

NOTE

If a server IP address is provided but a configuration file name is not included in the DHCP server option, the Mobility Access Switch attempts to download a configuration file name with its serial number (<serialnumber>.cfg).

When these options are processed, the Mobility Access Switch downloads the new configuration file, compares it with the configuration file in use, and if they differ, the new file is copied as default.cfg. Then the Mobility Access Switch reboots automatically and generates a message that a new configuration is loaded. A syslog message is logged for every failed and successful configuration download.

Trace Options

The tracing feature is important for debugging the sequence of events that occur inside a process or protocol, for example message processing, state machine transitions, configuration change events, or timer events.

You can enable or disable trace options for various modules such as mstp, lldp, igmp, ospf, pim, rmon, layer2-forwarding, interface-manager, chassis-manager, and stack-manager using the `traceoptions` command.

NOTE

The traceoption port references use the SNMP interface index number and not the X/Y/Z values.

You can use the following command to enable or disable the traceoptions for various modules:

```
(host) (config) #traceoptions
(host) (traceoptions) #?
chassis-manager         Control chassis manager trace options
dhcp-snoop              Control DHCP Snoop trace options
igmp                    Control igmp trace options
igmp-snooping           Control igmp-snooping trace options
interface-manager       Interface manager trace options
layer2-forwarding       Control Layer2 Forwarding trace options
lldp                    Control LLDP trace options
mstp                    Control MSTP trace options
no                      Delete Command
ospf                    Control ospf trace options
pim                     Control pim sparse mode trace options
rmon                    rmon trace options
routing                 Control layer3 manager trace options
stack-manager           Control stack-manager trace options
vrrp                    Control vrrp trace options
```

The following command displays the enabled trace options:

```
(host) #show trace ?

chassis-manager         Show the contents of chassis manager trace file
dhcp-snooping           Show the contents of dhcp-snooping trace file
igmp                    Show the contents of igmp trace file
igmp-snooping           Show the contents of igmp-snooping trace file
interface-manager       Show the contents of interface manager trace file
layer2-forwarding       Show the contents of layer2-forwarding trace file
lldp                    Show the contents of lldp trace file
mstp                    Show the contents of mstp trace file
ospf                    Show the contents of ospf trace file
pim                     Show the contents of pim trace file
rmon                    Show the contents of RMON trace file
stack-manager           Show the contents of stack-manager trace file
vrrp                    Show the contents of VRRP trace file
```

The following is an example configuration:

```
(host) (traceoptions) #layer2-forwarding flags fdb learning vlan
(host) (traceoptions) #show trace layer2-forwarding 10
```

For a complete list of trace options commands, see the *ArubaOS 7.3 User Guide Command Line Reference Guide*.

Profiles Management

The Mobility Access Switch supports profile based configuration for interfaces, interface-groups, port-channels, and VLANs. You can use profiles to apply the same configuration to multiple interfaces and VLANs. It is often tedious to configure a lot of interfaces individually. For example, instead of setting the interface characteristics such as speed and duplex multiple times for multiple interfaces, you can define them in a profile and apply the profile to the interfaces. This is beneficial when you have many interfaces that share the same characteristics where you can define the parameters in a profile and then reference the name of the profile on the interfaces. When you need a change later, the change needs to be made only on the profiles and not on the individual interfaces. The profile-based configuration helps you to avoid having to manage large configurations on every interface and VLAN.

This section includes the following topics:

Profiles for Interfaces

The Mobility Access Switch uses profile-based configuration for the physical interfaces. You can apply the same profile to multiple interfaces that share the same characteristics such as physical specifications, type, and VLAN membership. You can also apply these profiles to an interface-group, or a port-channel.

You can create and apply the following profiles to an interface:

Table 4: *Interface Profiles*

Interface Profile	Description	Reference
dhcp-relay-profile	Specifies the dhcp relay profile for an interface.	See Configuring DHCP Relay on page 207.
enet-link-profile	Specifies the physical properties of an interface.	See Creating and Applying an Ethernet Link Profile to an Interface on page 108.
gvrp-profile	Specifies the gvrp profile parameters for an interface.	See Enabling and Configuring GVRP Functionality on page 136.
igmp-profile	Specifies the igmp profile parameters for an interface.	See Configuring IGMP on page 223.
lacp-profile	Specifies the dynamic port-channel configuration parameters for an interface.	See Creating and Applying a Dynamic Port-Channel Profile to an Interface on page 120.

Interface Profile	Description	Reference
lldp-profile	Enables or disables the Link Level Discovery Protocol (LLDP) and LLDP MED extension.	See Verifying the LLDP Profile Configuration to Check LLDP-MED Status on page 146.
mirroring-in-profile	Specifies the ingress packet mirroring properties for an interface.	See Port Mirroring on page 354
mirroring-out-profile	Specifies the egress packet mirroring properties for an interface.	See Port Mirroring on page 354
mstp-profile	Specifies the MSTP configuration parameters for an interface.	See MSTP on page 156
oam-profile	Specifies the OAM configuration parameters for an interface.	See Operations, Administration, and Maintenance on page 124
ospf-profile	Specifies the OSPF configuration parameters for an interface.	See Configuring OSPF on page 212.
pim-profile	Specifies the PIM configuration parameters for an interface.	See Configuring PIM-SM End to End on page 223.
poe-profile	Specifies the PoE configuration parameters for an interface.	See Creating and Applying a PoE Profile to an Interface on page 114.
port-security-profile	Specifies the port security parameters for an interface.	See Configuring Port Security Functionality on page 246.
pvst-port-profile	Specifies the parameters for PVST bridge.	See Configuring using the Interface-based Profile on page 175.
switching-profile	Specifies the switching parameters such as VLAN and port mode for an interface.	See Creating and Applying a Switching Profile to an Interface on page 130.
tunneled-node-profile	Specifies the controller information for a tunneled node interface.	See Support for Tunneled Node Back-up Server on page 326.
voip-profile	Specifies the VOIP configuration parameters for an interface that is connected to the VOIP devices and/or PCs and Laptops.	See Creating and Applying VoIP Profile to an Interface on page 153.

Profiles for VLANs

You can configure the following profiles for a VLAN:

Table 5: *VLAN Profiles*

VLAN Profile	Description	Reference
dhcp-snooping-profile	Specifies the DHCP snooping configuration parameters for a VLAN.	See Configuring DHCP Snooping on page 242.
igmp-snooping-profile	Specifies the IGMP snooping configuration parameters for a VLAN.	See Creating and Applying an IGMP Snooping Profile to a VLAN on page 228.
mld-snooping-profile	Specifies the MLD snooping configuration parameters for a VLAN.	See Configuring MLD Snooping on page 232.
pvst-profile	Specifies the PVST profile configuration parameters for a VLAN.	See Configuring PVST+ on page 174.

Scope of the Profiles and Parameters

This section includes the following topics:

- Factory Initial vs Default vs Non-Default Profiles and Parameters on page 41
- Profiles and Parameters Assigned to the Interfaces and Groups on page 41
- AAA Profiles Assigned to the Interfaces, Groups, and VLANs on page 43
- Profiles and Parameters Assigned to the Port-Channel Members on page 44

Factory Initial vs Default vs Non-Default Profiles and Parameters

There are three factory initial profiles that are effective when you set the Mobility Access Switch to run on the factory initial setup. They are the following:

- `igmp-snooping-factory-initial` assigned to VLAN 1.
- `lldp-factory-initial` assigned to the default interface-group .
- `poe-factory-initial` assigned to the default interface-group.

The `lldp-factory-initial` and the `poe-factory-initial` profiles are also part of the default interface-group configuration and work as the default profiles for all the interfaces.

Any profile that has the `default` reserved keyword as the profile name is called the default profile. Similarly, any parameter assigned to the default interface-group is called the default value for the interface. Modifying any of the default parameters within the default profiles does not make the profile non-default. Similarly, modifying the default parameters for the default interface-group does not make the parameter non-default.

Profiles that you create with names other than `factory-initial` and `default` are called non-default profiles. Similarly, interface-groups that you create using other than the `default` keyword are called non-default interface-groups.

Profiles and Parameters Assigned to the Interfaces and Groups

The effective profile or the parameter for an interface is determined by the following concurrent rules:

1. A non-default profile or parameter takes precedence over the default profile or parameter irrespective of whether it is configured under the interface or the interface-group.
2. If the interface and the interface-group have a non-default profile or parameter, then an interface configuration takes precedence over interface-group configuration.

For example, the effective configuration is selected based on the rules in the following table:

Table 6: *Scope of the Interface Parameters and Profiles*

interface gigabitethernet <slot/module/port>	interface-group gigabitethernet <group-name>/default	Effective Profile/Parameter: show interface-config gigabitethernet <slot/module/port>
default	default	default
default	A (non default)	A (non default)
B (non default)	default	B (non default)
C (non default)	D (non default)	C (non default)

By default, all the interfaces belong to a default interface-group. To view the configuration of the default interface-group, use the **show interface-group-config gigabitethernet default** command. When you create new interface-groups, the interfaces that do not belong to the new interface-groups continue to belong to the default interface-group. Note that overlapping ranges of interfaces among interface-groups is not supported.

You can view the default interface-group configuration using the following command:

```
(host)# show interface-group-config gigabitethernet default
gigabitethernet "default"
-------------------------
Parameter                                   Value
---------                                   -----
Interface group members                     ALL
Interface MSTP profile                      default
Interface Tunneled Node profile             N/A
Interface VOIP profile                      N/A
Interface LLDP profile                      lldp-factory-initial
Interface PoE profile                       poe-factory-initial
Interface Ethernet link profile             default
Interface LACP profile                      N/A
QoS Profile                                 N/A
Policer Profile                             N/A
Interface AAA profile                       N/A
Interface Ingress Mirroring profile         N/A
Interface Egress Mirroring profile          N/A
Interface shutdown                          Disabled
mtu                                         1514
Ingress ACL                                 N/A
QoS Trust                                   Disabled
Interface switching profile                 default
Static Multicast Router port for the VLANs  N/A
Interface Trusted/Untrusted                 Trusted
```

You can change the default interface-group using the following command:

```
(host)(config)# interface-group gigabitethernet default
```

For example, the following table determines the effective configuration of the `shutdown` parameter for an interface:

Table 7: *Scope of the Shutdown Parameter*

interface gigabitethernet <slot/module/port>	interface-group gigabitethernet <group-name>/default	Effective Parameter
no shutdown (default)	no shutdown (default)	no shutdown (default)
no shutdown (default)	shutdown (non default)	shutdown (non default)
shutdown (non default)	no shutdown (default)	shutdown (non default)
shutdown (non default)	shutdown (non default)	shutdown (non default)

For example, the following table determines the effective configuration of the `mtu` parameter for an interface:

Table 8: *Scope of the MTU Parameter*

interface gigabitethernet <slot/module/port>	interface-group gigabitethernet <group-name>/default	Effective Parameter
1514 (default)	1514 (default)	1514 (default)
1514 (default)	2000 (non default)	2000 (non default)
1000 (non default)	1514 (default)	1000 (non default)
2500 (non default)	3000 (non default)	2500 (non default)

AAA Profiles Assigned to the Interfaces, Groups, and VLANs

If no AAA profile is configured on the interface, interface-group, or VLAN, then, the default AAA profile is applied to the untrusted interfaces implicitly. If there are different non-default AAA profiles assigned to the interface, interface-group, and VLAN, the effective AAA profile is selected based on the rules in the following table:

Table 9: *Scope of a AAA Profile*

interface gigabitethernet <slot/module/port>	interface-group gigabitethernet <group-name>/default	vlan <vlan-id>	Effective AAA Profile
N/A	N/A	N/A	default
N/A	N/A	A (non default)	A (non default)
N/A	B (non default)	C (non default)	B (non default)
D (non default)	E (non default)	F (non default)	D (non default)

The default AAA profile is defined below:

```
(host) #show aaa profile default

AAA Profile "default"
---------------------
Parameter                          Value
```

```
---------                              -----
Initial role                           logon
MAC Authentication Profile             N/A
MAC Authentication Default Role        guest
MAC Authentication Server Group        default
802.1X Authentication Profile          N/A
802.1X Authentication Default Role     guest
802.1X Authentication Server Group     N/A
Download Role from ClearPass           Enabled
L2 Authentication Fail Through         Enabled
RADIUS Accounting Server Group         N/A
RADIUS Interim Accounting              Disabled
XML API server                         N/A
AAA unreachable role                   N/A
RFC 3576 server                        N/A
User derivation rules                  N/A
SIP authentication role                N/A
Enforce DHCP                           Disabled
Authentication Failure Blacklist Time  3600 sec
```

You can modify the default AAA profile using the following command:

```
(host)(config)# aaa profile default
```

Profiles and Parameters Assigned to the Port-Channel Members

For port-channel members, apart from the following profiles and parameters, all the other profiles and parameters are inherited from the port-channel configuration:

- shutdown
- enet-link-profile
- lacp-profile
- lldp-profile

Creating a Profile

You can create the profiles using the WebUI or the CLI.

Using the WebUI

1. Navigate to the **Configuration > Ports** page.
2. Select the **Profile** tab.
3. Click **New** under the **Profile** list.
4. Enter the details in the **Profile Name** column.
5. Complete the details of the profile.
6. Click **Apply** and then **Save Configuration**.

Using the CLI

```
(host)(config)# aaa profile <profile-name>
   {parameters}
   exit
(host)(config)# vlan-profile igmp-snooping-profile <profile-name>
   {parameters}
   exit
(host)(config)# interface-profile enet-link-profile <profile-name>
   {parameters}
   exit
(host)(config)# interface-profile lacp-profile <profile-name>
   {parameters}
```

```
   exit
(host)(config)# interface-profile lldp-profile <profile-name>
   {parameters}
   exit
(host)(config)# interface-profile mirroring-profile <profile-name>
   {parameters}
   exit
(host)(config)# interface-profile mstp-profile <profile-name>
   {parameters}
   exit
(host)(config)# interface-profile poe-profile <profile-name>
   {parameters}
   exit
(host)(config)# interface-profile switching-profile <profile-name>
   {parameters}
   exit
(host)(config)# interface-profile tunneled-node-profile <profile-name>
   {parameters}
   exit
(host)(config)# interface-profile voip-profile <profile-name>
   {parameters}
   exit
(host)(config)# policer-profile <profile-name>
   {parameters}
   exit
(host)(config)# qos-profile <profile-name>
   {parameters}
   exit
```

Example:

```
(host) (config)# interface-profile enet-link-profile 10-HALF
(Ethernet Link "10-HALF") #duplex half
(Ethernet Link "10-HALF") #speed 10
(Ethernet Link "10-HALF") #exit
```

Viewing a Profile and its Parameters

You can view the profile and profile details using the CLI.

Displaying the List of Profiles Under Each Category

```
(host)# show aaa profile
(host)# show vlan-profile igmp-snooping-profile
(host)# show interface-profile enet-link-profile
(host)# show interface-profile lacp-profile
(host)# show interface-profile lldp-profile
(host)# show interface-profile mirroring-profile
(host)# show interface-profile mstp-profile
(host)# show interface-profile poe-profile
(host)# show interface-profile switching-profile
(host)# show interface-profile tunneled-node-profile
(host)# show interface-profile voip-profile
(host)# show policer-profile
(host)# show qos-profile
```

Example:

```
(host)# show aaa profile
AAA Profile List
----------------
Name              References  Profile Status
----              ----------  --------------
default           2
```

```
default-dot1x      0          Predefined (editable)
default-mac-auth   0          Predefined (editable)
profile-new        3
```

Displaying the Parameters Assigned to Each Profile

```
(host)# show aaa profile <profile-name>
(host)# show vlan-profile igmp-snooping-profile <profile-name>
(host)# show interface-profile enet-link-profile <profile-name>
(host)# show interface-profile lacp-profile <profile-name>
(host)# show interface-profile lldp-profile <profile-name>
(host)# show interface-profile mirroring-profile <profile-name>
(host)# show interface-profile mstp-profile <profile-name>
(host)# show interface-profile poe-profile <profile-name>
(host)# show interface-profile switching-profile <profile-name>
(host)# show interface-profile tunneled-node-profile <profile-name>
(host)# show interface-profile voip-profile <profile-name>
(host)# show policer-profile <profile-name> <profile-name>
(host)# show qos-profile <profile-name>
```

Example:

```
(host) #show aaa profile default

AAA Profile "default"
---------------------
Parameter                              Value
---------                              -----
Initial role                           logon
MAC Authentication Profile             N/A
MAC Authentication Default Role        guest
MAC Authentication Server Group        default
802.1X Authentication Profile          N/A
802.1X Authentication Default Role     guest
802.1X Authentication Server Group     N/A
Download Role from ClearPass           Enabled
L2 Authentication Fail Through         Enabled
RADIUS Accounting Server Group         N/A
RADIUS Interim Accounting              Disabled
XML API server                         N/A
AAA unreachable role                   N/A
RFC 3576 server                        N/A
User derivation rules                  N/A
SIP authentication role                N/A
Enforce DHCP                           Disabled
Authentication Failure Blacklist Time  3600 sec
```

Applying and Activating a Profile

You can apply and activate the profiles created on the Mobility Access Switch using the CLI.

Applying and Activating the Profiles for an Interface

```
(host)(config)# interface gigabitethernet <slot/module/port>
  dhcp-relay-profile <profile-name>
  enet-link-profile <profile-name>
  gvrp-profile <profile-name>
  igmp-profile <profile-name>
  lacp-profile <profile-name>
  lldp-profile <profile-name>
  mirroring-in-profile <profile-name>
  mirroring-out-profile <profile-name>
  mstp-profile <profile-name>
  ospf-profile <profile-name>
```

```
  pim-profile <profile-name>
  poe-profile <profile-name>
  port-security-profile <profile-name>
  pvst-port-profile <profile-name>
  switching-profile <profile-name>
  tunneled-node-profile <profile-name>
  voip-profile <profile-name>
```

Applying and Activating the Profiles for an Interface Group

```
(host)(config)# interface-group gigabitethernet {default|<group-name>}
  dhcp-relay-profile <profile-name>
  enet-link-profile <profile-name>
  gvrp-profile <profile-name>
  igmp-profile <profile-name>
  lacp-profile <profile-name>
  lldp-profile <profile-name>
  mirroring-in-profile <profile-name>
  mirroring-out-profile <profile-name>
  mstp-profile <profile-name>
  ospf-profile <profile-name>
  pim-profile <profile-name>
  poe-profile <profile-name>
  port-security-profile <profile-name>
  pvst-port-profile <profile-name>
  switching-profile <profile-name>
  tunneled-node-profile <profile-name>
  voip-profile <profile-name>
```

Applying and Activating the Profiles for a Port-Channel

```
(host)(config)# interface port-channel <ID>
  enet-link-profile <profile-name>
  mirroring-in-profile <profile-name>
  mirroring-out-profile <profile-name>
  mstp-profile <profile-name>
  switching-profile <profile-name>
```

Applying and Activating the Profiles for a VLAN

```
(host)(config)# vlan <ID>
  pvst-profile <profile-name>
  mld-snooping-profile <profile-name>
  igmp-snooping-profile <profile-name>
```

Deleting a Profile

You can delete a profile using the following CLI commands:

```
(host)(config)# no aaa profile <profile-name>
(host)(config)# no igmp-snooping-profile <profile-name>
(host)(config)# no interface-profile enet-link-profile <profile-name>
(host)(config)# no interface-profile lacp-profile <profile-name>
(host)(config)# no interface-profile lldp-profile <profile-name>
(host)(config)# no interface-profile mirroring-profile <profile-name>
(host)(config)# no interface-profile mstp-profile <profile-name>
(host)(config)# no interface-profile poe-profile <profile-name>
(host)(config)# no interface-profile switching-profile <profile-name>
(host)(config)# no interface-profile tunneled-node-profile <profile-name>
(host)(config)# no interface-profile voip-profile <profile-name>
(host)(config)# no interface-profile dhcp-relay-profile <profile-name>
(host)(config)# no interface-profile gvrp-profile <profile-name>
(host)(config)# no interface-profile igmp-profile <profile-name>
(host)(config)# no interface-profile ospf-profile <profile-name>
```

```
(host)(config)# no interface-profile pim-profile <profile-name>
(host)(config)# no interface-profile port-security-profile <profile-name>
(host)(config)# no interface-profile pvst-port-profile <profile-name>
```

Best Practices

You can manage the profiles efficiently by applying the following guidelines:

- You can use the following process to efficiently manage the profiles:
  a. Identify the various interface-groups that you need such as Admin, Finance, Marketing, Customer Support, Engineering, and QA.
  b. Identify the profiles that you need to create for each interface-group.
  c. Create and apply those profiles to the appropriate interface-groups and port-channels.
  d. Create and apply the non common profiles to the individual interfaces.
- Use the `show references` command to find out if the profile is used or not, and then, delete all the unused profiles to keep your configuration clean and easy to understand.

Understanding Interface Profiles

There are instances when multiple interfaces share the same characteristics; for example, physical interface characteristics, type of switch interface, and/or VLAN ID. Interface profiles are used when the same configuration is defined on a profile and applied to multiple interfaces.

The parameters are defined in the functional profile(s) and the name of the profile is referenced on the interfaces. The interface profile is particularly useful when a change is required. The change can be made on the profile without updating the individual interfaces. Table 10 lists the profiles and their functions.

Table 10: *Interface Profiles*

Profile Type	Description
dhcp-relay-profile	Configure a dhcp relay profile
enet-link-profile	Configure an Ethernet Link
gvrp-profile	Configure a GVRP profile
igmp-profile	Configure an Interface IGMP profile
lacp-profile	Configure an LACP
lldp-profile	Configure an LLDP Profile
mirroring-profile	Configure a Mirroring profile
mstp-profile	Configure an Interface MSTP
oam-profile	Configure an OAM profile.
ospf-profile	Configure an Interface OSPF profile
pim-profile	Configure an Interface PIM profile
poe-profile	Configure a Power over Ethernet profile

Profile Type	Description
port-security-profile	Configure a Port Security profile
pvst-port-profile	Configure an Interface PVST bridge
switching-profile	Configure a switching profile
tunneled-node-profile	Configure a Tunneled Node Server profile
voip-profile	Configure a VOIP profile

Interface Numbering Convention

The Mobility Access Switch numbering convention includes three separate numbers:

- First number denotes slot number; in stacking mode, the first number is the stack member identification.
- Second number denotes the base ports; where 0 indicates the base interfaces and 1 indicates the uplink interfaces.
- Third number denotes the individual interface/port number.

For example, the interface gigabitethernet 0/0/20 denotes the slot number zero (0), module 0 and port number 20. Note that interface/port numbering starts at 0.

Assigning an Interface Profile as an Access Port

To assign an interface as an access port belonging to a particular VLAN, configure the switching profile to reference the VLAN (for example VLAN 200). Then apply the switching profile to the interface itself (for example gigabitethernet 0/0/10).

Configuring switching-profile that references VLAN 200:

```
(host) (config) #interface-profile switching-profile vlan_200
(host) (switching profile "vlan_200") #access-vlan 200
```

Applying the switching-profile to the gigabitethernet 0/0/10 interface:

```
(host) (config) #interface gigabitethernet 0/0/10
(host) (gigabitethernet "0/0/10") #switching-profile vlan_200
(host) (gigabitethernet "0/0/10") #exit
```

Assigning an Interface Profile as a Trunk

Similar to configuring an interface as an access port, assigning and interface profile as a trunk uses the trunk mode:

```
(host) (config) #interface-profile switching-profile TRUNK_PORTS
(host) (switching profile "TRUNK_PORTS") #switchport-mode trunk
```

Applying the switching-profile to the gigabitethernet 0/0/11 interface:

```
(host) (config) #interface gigabitethernet 0/0/11
(host) (gigabitethernet "0/0/11") #switching-profile TRUNK_PORTS
```

Native VLAN setting:

```
(host) (config) #interface-profile switching-profile TRUNK_PORTS
(host) (switching profile "TRUNK_PORTS") #native-vlan 100
```

By default, a trunk port allows all VLANs to be transported. This can be changed if necessary via the trunk parameter in the switching-profile:

```
(host) (config) #interface-profile switching-profile TRUNK_PORTS
(host) (switching profile "TRUNK_PORTS") #trunk allowed vlan all
```

Understanding Interface Group

It is often time consuming and tedious to configure multiple interfaces, which share the same configuration, via the command line. These interface can be grouped together so that any interface within the group can share the same configuration. When an interface is a member of an interface group, applying a specific profile to the interface will take precedence over interface group.

Configuring Interface Group

Define a group, for example First_Floor, which will contain the interfaces that share the same configuration. Apply valid interfaces members in ascending order; that is, from 0/0/0 through 0/0/30, and
0/0/32:

```
(host) (config) #interface-group gigabitethernet FIRST_FLOOR
(host) (gigabitethernet "FIRST_FLOOR") #apply-to 0/0/0-0/0/30,0/0/32
```

Notice there is no space in the list of interfaces.

Additionaly, You can add or remove remove individual ports or ranges of ports without disrupting the existing port list using the following commands:

```
(host) (gigabitethernet "FIRST_FLOOR") #apply-to [add | remove] <interface-list>
```

Apply the switching-profile to the interface group:

```
(host) (gigabitethernet "FIRST_FLOOR") #switching-profile ACCESS_100
```

Verify your configuration or interface group using the **show interface-group-config** command.

```
(host) #show interface-group-config gigabitethernet FIRST_FLOOR

gigabitethernet "FIRST_FLOOR"
-----------------------------
Parameter                      Value
---------                      -----
Interface range members        0/0/0-0/0/30,0/0/32
...
```

Managing Controller IP

The Mobility Access Switch automatically chooses the loopback IP or the first VLAN IP address as the controller IP address (also known as the Switch-IP) during the initial boot. If loopback does not exist, then the Mobility Access Switch automatically chooses the first VLAN IP as the IP address of the controller.

Aruba recommends configuring the controller IP address as the loopback interface when using Ethernet and Mobility Access Switch functionalities.

NOTE

If the VLAN is first chosen (or configured) automatically as the controller IP address and if the VLAN has no active member, then the controller IP will be unreachable.

1. Set the loopback interface (0 in the example) address and mask:
```
(host)(config) #interface loopback 0
(host)(loopback "0") #ip address 10.10.10.1
```
2. Set the controller-ip loopback to interface 0.
```
(host)(config) #ip-profile
(host)(ip-profile) #controller-ip loopback 0
```
3. Verify your configuration with the **show switch ip** command.
```
(host)(loopback "0") #show switch ip

Switch IP Address: 10.10.10.1
Switch IP is from Loopback Interface: 0
```

```
(host)(loopback "0") #
```

Using the LCD

The S2500/S3500 LCD panel is located on the upper right side of their respective faceplates. The LCD displays:

- Boot status
- Hostname
- Alarm
- Interface LED modes: Admin, Speed/Duplex, PoE
- ArubaOS version
- Power supply, Fan status

LCD Management

In addition to displaying current status, LCD panel supports a user-interactive maintenance mode:

- ArubaOS software image upgrade
- Configuration file upload
- Erase configuration (write erase all)
- Factory default setting (restore factory-default stacking)
- Media (external USB) eject
- System reboot (reload)
- System Halt (halt)
- GUI Quick Setup

Using the LCD and USB Drive

You can upgrade your image or upload your pre-saved configuration by using your USB drive and your LCD commands.

Upgrade an image

1. Copy MAS software image onto your USB drive into a directory named */arubaimage*.
2. Insert the USB drive into the Mobility Access Switch's USB slot. Wait for 30 seconds for MAS to mount the USB.
3. Navigate to **Upgrage Image** in the LCD's **Maintenance** menu. Select **partition** and confirm the upgrade (Y/N) and then wait for Mobility Access Switch to copy the image from USB to the system partition.
4. Execute a system reboot either from the LCD menu or from the command line to complete the upgrade.

Upload a pre-saved configuration

1. Copy your pre-saved configuration and name the copied file **aruba_usb.cfg**.
2. Move your pre-saved configuration file onto your USB drive into a directory name **/arubaimage**.
3. Insert your USB drive into the Mobility Access Switch's USB slot. Wait for 30 seconds for MAS to mount the USB.
4. Navigate to the **Upload Config** in the LCD's Maintenance menu. Confirm the upload (Y/N) and then wait for the upload to complete.
5. Execute a system reboot either from the LCD menu or from the command line to reload from the uploaded configuration.

For detailed upgrade and upload instructions, see the *Upgrade Chapter* in the *Release Notes*.

LCD Functions with ArubaStack

Table 11 lists the LED Stack mode and Maintenance mode along with each function. Some functions can be executed from any member in the ArubaStack (Primary, Secondary, or Line Card) to affect just that member. Other functions are executed from the Primary only but affect all members of the ArubaStack. For example, system reboot can be executed on a member only to reboot just that member. Or, you can execute system reboot on the Primary to reboot all members of the ArubaStack.

Table 11: *LCD Functions Over Stacking*

Mode	Any Stack Member (affects only local member)	Primary Only (affects all stack members)
LED Mode	Yes	–
Status (display)		
Stack	Yes	–
AOS Version	Yes	–
PS Status	Yes	–
Fan Tray	Yes	–
Maintenance		
Upgrade Image	–	Yes
Upload Configuration	–	Yes
Erase Config	–	Yes
Media Eject	–	Yes
Factory Default	Yes	–
System Reboot	Yes	Yes
System Halt	Yes	Yes

Disabling LCD Menu Functions

For security purpose, you can disable all LCD menu functions by disabling the entire menu functionality using the following command:

```
(host) (config) #lcd-menu
(host) (lcd-menu) #disable menu
```

To prevent inadvertent menu changes, you can disable LCD individual menu function using the following commands:

```
(host) (lcd-menu) #disable menu maintenance ?
erase-config Disable config erase menu
factory-default Disable factory default menu
gui-quick-setup Disable quick setup menu on LCD
media-eject Disable media eject menu on LCD
system-halt Disable system halt menu on LCD
system-reboot Disable system reboot menu on LCD
```

```
upload-config Disable config upload menu on LCD
upgrade-image Disable image upgrade menu on LCD
```

To display the current LCD functionality from the command line, use the following command:

```
(host) (config) #show lcd-menu

lcd-menu
--------
Menu Value
---- -----
menu maintenance upgrade-image partition0 enabled
menu maintenance upgrade-image partition1 enabled
menu maintenance system-reboot reboot-stack enabled
menu maintenance system-reboot reboot-local enabled
menu maintenance system-halt halt-stack enabled
menu maintenance system-halt halt-local enabled
menu maintenance upgrade-image enabled
menu maintenance upload-config enabled
menu maintenance erase-config enabled
menu maintenance factory-default enabled
menu maintenance media-eject enabled
menu maintenance system-reboot enabled
menu maintenance system-halt enabled
menu maintenance gui-quick-setup enabled
menu maintenance enabled
menu enabled
```

Setting the System Clock

You can set the clock on a Mobility Access Switch manually.

In the CLI

To set the date and time, enter the following command in privileged mode:

```
(host) #clock set <year> <month> <date> <hour> <minutes> <seconds>
```

To set the time zone and daylight savings time adjustment, enter the following commands in configure mode:

```
(host) (config) #clock timezone <WORD> <-23 - 23>

clock summer-time <zone> [recurring]
   <1-4> <start day> <start month> <hh:mm>
   first <start day> <start month> <hh:mm>
   last <start day> <start month> <hh:mm>
   <1-4> <end day> <end month> <hh:mm>
   first <end day> <end month> <hh:mm>
   last <end day> <end month> <hh:mm>
   [<-23 - 23>]
```

Clock Synchronization

You can use NTP to synchronize the Mobility Access Switch to a central time source. Configure the Mobility Access Switch to set its system clock using NTP by configuring one or more NTP servers. For each NTP server, you can optionally specify the NTP iburst mode for faster clock synchronization. The iburst mode sends up to ten queries within the first minute to the NTP server. (When iburst mode is not enabled, only one query is sent within the first minute to the NTP server.) After the first minute, the iburst mode typically synchronizes the clock so that queries need to be sent at intervals of 64 seconds or more.

NOTE

The iburst mode is a configurable option and not the default behavior for the Mobility Access Switch, as this option is considered “aggressive” by some public NTP servers. If an NTP server is unresponsive, the iburst mode continues to send frequent queries until the server responds and time synchronization starts.

Configuring NTP Authentication

The Network Time Protocol adds security to an NTP client by authenticating the server before synchronizing the local clock. NTP authentication works by using a symmetric key which is configured by the user. The secret key is shared by both the Mobility Access Switch and an external NTP server. This helps identify secure servers from fraudulent servers.

The following example enables NTP authentication, adds authentication secret keys into the database, and specifies a subset of keys which are trusted. It also enables the iburst option.

```
(host) (config) #ntp authenticate
(host) (config) #ntp authentication-key <key-id> md5 <key-secret>
(host) (config) #ntp trusted-key <key-id>
(host) (config) #ntp <server IP> iburst key <key-id>
```

Managing Files on the Mobility Access Switch

You can transfer the following types of files between the Mobility Access Switch and an external server or host:

- ArubaOS image file
- A specified file in the Mobility Access Switch's flash file system, or a compressed archive file that contains the entire content of the flash file system.

NOTE

You can back up the entire content of the flash file system to a compressed archive file, which you can then copy from the flash system to another destination.

- Configuration files, either the active running configuration, startup configuration or stored configuration files.
- Log files

You can use the following protocols to copy files to or from a Mobility Access Switch:

- File Transfer Protocol (FTP): Standard TCP/IP protocol for exchanging files between computers.
- Trivial File Transfer Protocol (TFTP): Software protocol that does not require user authentication and is simpler to implement and use than FTP.
- Secure Copy Protocol (SCP): Protocol for secure transfer of files between computers that relies on the underlying Secure Shell (SSH) protocol to provide authentication and security.

NOTE

The SCP server or remote host must support SSH version 2 protocol.

Table 12 lists the parameters that you configure to copy files to or from a Mobility Access Switch.

Table 12: *File Transfer Configuration Parameters*

Server Type	Configuration
Trivial File Transfer Protocol (TFTP)	• IP address of the server • filename
File Transfer Protocol (FTP)	• IP address of the server • username and password to log into server • filename
Secure Copy (SCP) You must use the CLI to transfer files with SCP.	• IP address of the server or remote host • username to log into server • absolute path of filename (otherwise, SCP searches for the file relative to the user's home directory)

For example, you can copy an ArubaOS image file from an SCP server to a system partition on a Mobility Access Switch or copy the startup configuration on a Mobility Access Switch to a file on a TFTP server. You can also store the contents of a Mobility Access Switch's flash file system to an archive file which you can then copy to an FTP server. You can use SCP to securely download system image files from a remote host to the Mobility Access Switch or securely transfer a configuration file from flash to a remote host.

Transferring ArubaOS Image Files

You can download an ArubaOS image file onto a Mobility Access Switch from a TFTP, FTP, or SCP server. In addition, the WebUI allows you to upload an ArubaOS image file from the local PC on which you are running the browser.

When you transfer an ArubaOS image file to a Mobility Access Switch, you must specify the system partition to which the file is copied. The WebUI shows the current content of the system partitions on the Mobility Access Switch. You can optionally reboot the Mobility Access Switch with the transferred image file.

In the WebUI

1. Navigate to the **Maintenance > Image Management** page.
2. Select TFTP, FTP, SCP, or Local File.
3. Enter or select the appropriate values for the file transfer method.
4. Select the system partition to which the image file is copied.
5. Specify whether the Mobility Access Switch is to be rebooted after the image file is transferred, and whether the current configuration is saved before the Mobility Access Switch is rebooted.
6. Click **Upgrade**.
7. Click **Apply**.

In the CLI

```
copy tftp: <tftphost> <filename> system: partition [0|1]}
copy ftp: <ftphost> <user> <filename> system: partition {0|1}
copy scp: <scphost> <username> <filename> system: partition [0|1]
```

Backing Up and Restoring the Flash File System

You can store the entire content of the flash file system on a Mobility Access Switch to a compressed archive file. You can then copy the archive file to an external server for backup purposes. If necessary, you can restore the backup file from the server to the flash file system.

Backup the Flash File System in the CLI

```
backup flash
copy flash: flashbackup.tar.gz tftp: <tftphost> <destfilename>
copy flash: flashbackup.tar.gz scp: <scphost> <username> <destfilename>
```

Restore the Flash File System in the WebUI

1. Navigate to the **Maintenance > Copy Files** page.
2. For **Source Selection**, specify the server to which the flashbackup.tar.gz file was previously copied.
3. For **Destination Selection**, select Flash File System.
4. Click **Apply**.

Restore the Flash File System in the CLI

```
copy tftp: <tftphost> <srcfilename> flash: flashbackup.tar.gz
copy scp: <scphost> <username> <srcfilename> flash: flashbackup.tar.gz
restore flash
```

Copying Log Files

You can store log files into a compressed archive file which you can then copy to an external TFTP or SCP server. The WebUI allows you to copy the log files to a WinZip folder which you can display or save on your local PC.

In the WebUI

1. Navigate to the **Maintenance > Copy Logs** page.
2. For **Destination**, specify the TFTP or FTP server to which log files are copied.
3. Select **Download Logs** to download the log files into a WinZip file on your local PC.
4. Click **Apply**.

In the CLI

```
tar logs
copy flash: logs.tar tftp: <tftphost> <destfilename>
copy flash: logs.tar scp: <scphost> <username> <destfilename>
```

Copying Other Files

The flash file system contains the following configuration files:

- startup-config: Contains the configuration options that are used when the Mobility Access Switch is rebooted. It contains all options saved by clicking the **Save Configuration** button in the WebUI or by entering the **write memory** CLI command. You can copy this file to a different file in the flash file system or to a TFTP server.
- running-config: Contains the current configuration, including changes which have yet to be saved. You can copy this file to a different file in the flash file system, to the startup-config file, or to a TFTP or FTP server.

You can copy a file in the flash file system or a configuration file between the MAS and an external server.

In the WebUI

1. Navigate to the **Maintenance > Copy Files** page.
2. Select the source where the file or image exists.
3. Select the destination to where the file or image is to be copied.
4. Click **Apply**.

In the CLI

```
copy startup-config flash: <filename>
copy startup-config tftp: <tftphost> <filename>
copy startup-config ftp: <ip-address> <username> <filename>
copy startup-config scp: <ip-address> <username> <filename>
copy startup-config usb: <filename> [usbpartition <number>]
copy startup-config member <id> usb: <filename> [usbpartition <number>]

copy running-config flash: <filename>
copy running-config ftp: <ftphost> <user> <password> <filename> [<remote-dir>]
copy running-config startup-config
copy running-config tftp: <tftphost> <filename>
copy running-config scp: <ip-address> <username> <filename>
copy running-config usb: <filename> [usbpartition <number>]
copy running-config member <id> usb: <filename> [usbpartition <number>]
```

USB Operations

The Mobility Access Switch can read and write files to an attached USB drive which can be used to upgrade software images or configurations files and also backup configurations or stored files on the local flash. Directories on the USB drive can also be created, deleted or viewed in addition to renaming and deleting files.

The Mobility Access Switch supports the following USB operations:

- Read and write files to an attached USB drive which can be used to upgrade software images or configurations files.
- Backup configurations or stored files on the local flash.
- Create, view, and delete directories in addition to renaming and deleting files.

Creating a New USB Directory

You can use the following command to create the directory in USB:

```
(host) #mkdir usb: <usbdirname>
```

You can use the following command to create the directory in member USB:

```
(host) #mkdir member id usb: <usbdirname>
```

You can use the following command to create the directory in multipartition USB:

```
(host) #mkdir usb: <usbdirname> usbpartition <number>
```

You can use the following command to create directory at multipartition member USB:

```
(host) #mkdir member id usb: <usbdirname> usbpartition <number>
```

Deleting an Existing USB Directory

You can use the following command to delete the content of USB:

```
(host) #delete usb: <usbpathname>
```

You can use the following command to delete the content of multipartitioned USB:

```
(host) #delete usb: <usbpathname>  usbpartiton <number>
```

You can use the following command to delete the content of member USB:

```
(host) #delete member <id> usb: <usbpathname>
```

You can use the following command to delete the content of delete the content of multipartitioned member:

```
(host) # delete member <id> usb: <usbpathname>  usbpartiton <number>
```

Renaming an Existing USB Directory

You can use the following comand to rename the path(file/directory) in USB:

```
(host) #rename usb: <oldpathname> <newpathname>
```

You can use the following command to rename the path(file/directory) in multipartition USB:

```
(host) #rename usb: <oldpathname> <newpathname> usbpartition <number>
```

You can use the following command to rename the path(file/directory) in member USB:

```
(host) #rename member <id> usb: <oldpathname> <newpathname>
```

You can use the following command to rename the path(file/directory) in multipartition in member USB:

```
(host) #rename  member <id> usb: <oldpathname> <newpathname> usbpartiiton <number>
```

Uploading a Mobility Access Switch Software Image

You can use the following command to upload an image from USB:

```
(host) # copy usb: <filename> [usbpartition <number>] system: partition [0|1]
(host) # copy usb: <filename> [usbpartition <number>] member <id> system: partition [0|1]
```

Copying Files to USB:

You can use the following command to copy files from Mobility Access Switch to USB:

```
(host) #copy member: <id> flash: <filename>  usb: <usbfilename> [usbpartition <number>]
(host) #copy member: <id> flash: <filename> member: <destid> usb: <usbfilename> [usbpartition
<number>]
(host) #copy flash: <filename> member: <destid> usb: <usbfilename>[usbpartition <number>]
(host) #copy flash: <filename> usb: <usbfilename> [usbpartition <number>]
(host) #copy system: partition 0 usb: snapshot
```

Copying Files to Mobility Access Switch:

You can use the following commands to copy files from USB to Mobility Access Switch:

```
(host) #copy usb: <filename> [usbpartition <number>] flash: <flashfilename>
(host) #copy usb: <filename> [usbpartition <number>] system: partition [0|1]
(host) #copy usb: <filename> [usbpartition <number>] member <destid> flash: <flashfilename>
(host) #copy usb: <filename> [usbpartition <number>] member <destid> system: partition [0|1]
(host) #copy usb: snapshot system: partition [0|1]
(host) #copy member: <id> usb: <filename> [usbpartition <number>] member: <destid> usb: <usbfi
lename> [usbpartition <destnumber>]
(host) #copy member: <id> usb: <filename> [usbpartition <number>] member: <destid> flash: <fla
shfilename>
```

You can use the following commands to copy files from/to a remote server:

```
(host) #copy usb: <filename> [usbpartition <number>] tftp: <tftphost> <destfilename>
(host) #copy usb: <filename> [usbpartition <number>] ftp: <ftphost> <user> <password>
(host) #copy usb: <filename> [usbpartition <number>] scp: <scphost> <username> <destfilename>
(host) #copy member: <id> usb: <filename> [usbpartition <number>] tftp: <tftphost> <destfilena
me>
(host) #copy member: <id> usb: <filename>  [usbpartition <number>] ftp: <ftphost> <user> <pass
word>
(host) #copy member: <id> usb: <filename> [usbpartition <number>] scp: <scphost> <username> <d
estfilename>
```

Viewing the USB Directory

To display the USB content of the members:

```
(host) #dir member <id> usb:
```

To display the usb content of local member at one direcory level:

```
(host) #dir usb:
```

To display the directory content of USB:

```
(host) #dir usb: <usbpathname>
```

To display the directory content of a member USB:

```
(host) #dir member <id> <usbpathname>
```

To display the directory content of member of a multipartitioned USB:

```
(host) #dir member <id> <usbpathname> usbpartition <number>
```

To display the direcory content of local multipartitioned USB:

```
(host) #dir usb <usbpathname> usbpartition <number>
```

This chapter describes management access and tasks. It contains the following topics:

Management Users

User authentication to the management interface (CLI or WebUI) of the Mobility Access Switch is supported using either local management user accounts or external user accounts via Radius/Tacacs+. The Mobility Access Switch can support up to 10 local management users. The default management user is Admin and the default password is Admin123. This password must be changed before executing the **write memory** command.

To change the default password, execute the following commands:

```
(host) >enable
Password: enable
(host) #configure terminal
(host) (config) #mgmt-user admin root
Password: ******
Re-Type password: ******
```

In addition to the root role, the Mobility Access Switch supports a variety of other role types for management users:

- **guest-provisioning**: Allows the user to create guest accounts on a WebUI page. You can log into the CLI; however, you cannot use any CLI commands.
- **location-api-mgmt**: Permits access to location API information. You can log into the CLI; however, you cannot use any CLI commands.
- **network-operations**: Permits access to Monitoring, Reports, and Events pages in the WebUI. You can log into the CLI; however, you can only use a subset of CLI commands to monitor the Mobility Access Switch.
- **read-only**: Permits access to CLI show commands or WebUI monitoring pages only.
- **root**: Permits access to all management functions on the Mobility Access Switch.

For more information on enabling Radius/Tacacs+ authentication for management users, see Configuring Authentication Servers on page 265.

Management Password Policy

By default, the password for a new management user has no requirements other than a minimum length of six alphanumeric or special characters. However, if your company enforces a password policy for management users with root access to the network equipment, you can configure a password policy that sets requirements for management user passwords.

Defining a Management Password Policy

To define specific management password policy settings through the CLI, complete the following steps:

The table below describes the characters allowed in a management user password. The disallowed characters cannot be used by any management user password, even if the password policy is disabled.

Table 13: *Allowed Characters in a Management User Password*

Allowed Characters	Disallowed Characters
exclamation point: !	Parenthesis: ( )
underscore: _	apostrophe: '
at symbol: @	semi-colon: ;
pound sign: #	dash: -
dollar sign: $	equals sign: =
percent sign: %	slash: /
caret: ^	question mark: ?
ampersand: &	
star: *	
greater and less than symbols: < >	
curled braces: { }	
straight braces: [ ]	
colon :	
period: .	
pipe: |	
plus sign: +	
tilde: ~	
comma: ,	
accent mark: `	

In the CLI

```
aaa password-policy mgmt
   enable
   no
   password-lock-out
   password-lock-out-time
   password-max-character-repeat.
   password-min-digit
   password-min-length
   password-min-lowercase-characters
   password-min-special-character
   password-min-uppercase-characters
   password-not-username
```

Setting an Administrator Session Timeout

You can configure the number of seconds after which the WebUI or CLI session times out.

Setting a CLI Session Timeout

To define a timeout interval for a CLI session, use the command:

```
loginsession timeout <value>
```

The allowed range for the **timeout** value is 5 to 60 minutes or 1 to 3600 seconds, inclusive. You can also specify a timeout value of 0 to disable CLI session timeouts.

Setting a WebUI Session Timeout

To define a timeout interval for a WebUI session, use the command:

```
web-server sessiontimeout <session-timeout>
```

The allowed range for the **sessiontimeout** value is 30 to 3600 seconds, inclusive.

Bypassing the Enable Password Prompt

The bypass enable feature lets you bypass the enable password prompt and log into the privileged commands (config) mode after logging on to the Mobility Access Switch. This is useful if you want to avoid changing the enable password due to company policy.

Use the **enable bypass** CLI command to bypass the enable prompt and log into config mode. Use the **no enable bypass** CLI command to restore the enable password prompt.

Resetting the Admin or Enable Password

This section describes how to reset the password for the default administrator user account (admin) on the Mobility Access Switch. The default password is **admin123**.

Use this procedure if the administrator user account password is lost or forgotten.

1. Connect a local console to the serial port on the Mobility Access Switch.
2. From the console, login to the Mobility Access Switch using the username **password** and the password **forgetme!**.

NOTE

To recover the forgotten password in an ArubaStack, always use the local console of the primary member. Password recovery does not work on a re-directed console of the primary member or local console of the non-primary members.

3. Enter enable mode by typing in **enable**, followed by the password **enable**
4. Enter configuration mode by typing in **configure terminal**.
5. To configure the administrator user account, enter **mgmt-user admin root**. Enter a new password for this account. Retype the same password to confirm.
6. Exit from the configuration mode, enable mode, and user mode.

This procedure also resets the enable mode password to **enable**. If you have defined a management user password policy, make sure that the new password conforms to this policy.

Figure 1 is a CLI example of how to reset the password.

Figure 1 *Resetting the Password*

```
(host)
User: password
Password: forgetme!
(host) >enable
Password: enable
(host) #configure terminal
Enter Configuration commands, one per line. End with CNTL/Z

(host) (config) #mgmt-user admin root
Password: ******
Re-Type password: ******
(host) (config) #exit
(host) #exit
(host) >exit
```

After you reset the administrator user account and password, you can login to the Mobility Access Switch and reconfigure the enable mode password. To do this, enter configuration mode and type the **enable secret** command. You are prompted to enter a new password and retype it to confirm. Save the configuration by entering **write memory**.

Figure 2 details an example to reconfigure the enable mode password.

Figure 2 *Reconfigure the enable mode password*

```
User: admin
Password: ******
(host) >enable
Password: ******
(host) #configure terminal
Enter Configuration commands, one per line. End with CNTL/Z

(host) (config) #enable secret
Password: ******
Re-Type password: ******
(host) (config) #write memory
```

Certificate Authentication Concepts

The Mobility Access Switch supports client certificate authentication for users accessing the Mobility Access Switch using the CLI. You can use client certificate authentication with or without a username/password (if certificate authentication fails, the user can log in with a configured username and password). By default, the client certificate authentication is with username and password.

NOTE

Each Mobility Access Switch supports a maximum of ten management users.

Configuring Certificate Authentication

To use client certificate authentication, you must do the following:

1. Obtain a client certificate and import the certificate into the Mobility Access Switch. For more information on obtaining and importing a client certificate see Managing Certificates on page 64.

2. Configure certificate authentication for WebUI management. You can also optionally select username/password authentication.
3. Configure a user with a management role. Specify the client certificate for user authentication.

In the CLI

```
(host) (config)#web-server
(host) (Web Server Configuration) #mgmt-auth certificate
(host) (Web Server Configuration) #switch-cert <certificate>
(host) (Web Server Configuration) #mgmt-user webui-cacert <ca> serial <number> <username> < ro
le>
```

Public Key Authentication for SSH Access

The Mobility Access Switch supports public key authentication for users accessing the Mobility Access Switch using SSH. When you import an X.509 client certificate into the Mobility Access Switch, the certificate is converted to SSH-RSA keys. When you enable public key authentication for SSH, the Mobility Access Switch validates the client's credentials with the imported public keys. You can specify public key authentication with or without username/password (if the public key authentication fails, the user can login with a configured username and password). By default, the public key authentication is with username and password.

To use public key authentication, follow the steps below:

1. Import the X.509 client certificate into the Mobility Access Switch using the WebUI. For more information on importing client certificates, see Importing Certificates on page 66.
2. Configure SSH for client public key authentication. You can also optionally select username/password authentication.
3. Configure the username, role, and client certificate.

In the CLI

```
(host) (config) #ssh mgmt-auth public-key [username/password]
(host) (config) #mgmt-user ssh-pubkey client-cert <certificate> <username> <role>
```

Managing Certificates

This section contains the following topics:

- About Digital Certificates
- Obtaining a Server Certificate
- Obtaining a Client Certificate
- Importing Certificates
- Viewing Certificate Information

The Aruba Mobility Access Switch is designed to provide secure services through the use of digital certificates. Certificates provide security when authenticating users or clients and eliminate the need for less secure password-based authentication.

There is a default server certificate installed in the Mobility Access Switch to demonstrate the authentication of the Mobility Access Switch for WebUI management access. However, this certificate does not guarantee security in production networks. Aruba strongly recommends that you replace the default certificate with a custom certificate issued for your site or domain by a trusted Certificate Authority (CA). This section describes how to generate a Certificate Signing Request (CSR) to submit to a CA and how to import the signed certificate received from the CA into the Mobility Access Switch.

The Mobility Access Switch supports client authentication using digital certificates for specific user-centric network services, such as AAA FastConnect. Each service can employ different sets of client and server certificates.

During certificate-based authentication, the Mobility Access Switch provides its server certificate to the client for authentication. After validating the server certificate, the client presents its own certificate to the Mobility Access Switch for authentication. You can optionally configure the Mobility Access Switch to verify the user name in the certificate with the configured authentication server after validating the client's certificate.

About Digital Certificates

Clients and the servers to which they connect may hold authentication certificates that validate their identities. When a client connects to a server for the first time, or the first time since its previous certificate has expired or been revoked, the server requests the client to transmit its authentication certificate. The client's certificate is then verified against the CA which issued it. Clients can also request and verify the server's authentication certificate. For some authentication mechanisms such as 802.1x authentication, clients do not need to validate the server certificate.

Digital certificates are issued by a CA which can be a commercial third-party company or a private CA controlled by your organization. The CA is trusted to authenticate the owner of the certificate before issuing a certificate. A CA-signed certificate guarantees the identity of the certificate holder. This is done by comparing the digital signature on a client or server certificate with the signature on the certificate for the CA.

Digital certificates employ public key infrastructure (PKI), which requires a private-public key pair. A digital certificate is associated with a private key, known only to the certificate owner and a public key. A certificate encrypted with a private key is decrypted with its public key. For example, party A encrypts its certificate with its private key and sends it to party B. Party B decrypts the certificate with party A's public key.

Obtaining a Server Certificate

Aruba strongly recommends that you replace the default server certificate in the Mobility Access Switch with a custom certificate issued for your site or domain by a trusted CA. To obtain a security certificate for the Mobility Access Switch from a CA:

1. Generate a Certificate Signing Request (CSR) on the Mobility Access Switch using the CLI.
2. Submit the CSR to a CA. Copy and paste the output of the CSR into an email and send it to the CA of your choice.
3. The CA returns a signed server certificate and the CA's certificate and public key.
4. Install the server certificate, as described in Importing Certificates on page 66

NOTE

You can have only one outstanding CSR at a time in the Mobility Access Switch. Once you generate a CSR, you need to import the CA-signed certificate into the Mobility Access Switch before generating another CSR.

Table 14: *CSR Parameters*

Parameter	Description	Range
`key`	Length of private/public key.	1024/2048/4096
`common_name`	Host and domain name, as in www.yourcompany.com.	–
`country`	Two-letter ISO country code for the country in which your organization is located.	–
`state_or_province`	State, province, region, or territory in which your organization is located.	–

Parameter	Description	Range
city	City in which your organization is located.	–
organization	Name of your organization.	–
unit	Optional field to distinguish a department or other unit within your organization.	–
email	Email address referenced in the CSR.	–

In the CLI

1. Run the following command:

```
(host) (config) #crypto pki csr {rsa key_len <key_val> |{ec curve-name <key_val>} common-na
me <value> country <country> state_or_province <state> city <city> organization <org> unit
<string> email <email>
```

2. View the CSR output using the following command:

```
(host) #show crypto pki csr
```

3. Copy the CSR output between the BEGIN CERTIFICATE REQUEST and END CERTIFICATE REQUEST lines, paste it into an email and send it to the CA of your choice.

Obtaining a Client Certificate

You can use the CSR generated on the Mobility Access Switch to obtain a certificate for a client. However, since there may be a large number of clients in a network, you can obtain the client certificates from a corporate CA server. For example, in a browser window, enter **http://<ipaddr>/crtserv**, where **<ipaddr>** is the IP address of the CA server.

Importing Certificates

Use the WebUI or the CLI to import certificates into the Mobility Access Switch.

NOTE

You cannot export certificates from the Mobility Access Switch.

You can import the following types of certificates into the Mobility Access Switch:

- Server certificate signed by a trusted CA. This includes a public and private key pair.
- CA certificate used to validate other server or client certificates. This includes only the public key for the certificate.
- Client certificate and client's public key. (The public key is used for applications such as SSH which does not support X509 certificates and requires the public key to verify an allowed certificate.)

Certificates can be in the following formats:

- X509 PEM unencrypted
- X509 PEM encrypted with a key
- DER
- PKCS7 encrypted
- PKCS12 encrypted

In the CLI

Use the following command to import CSR certificates:

```
(host) (config) #crypto pki-import {der|pem|pfx|pkcs12|pkcs7} {PublicCert|ServerCert|TrustedC
A} <name>
```

The following example imports a server certificate named **cert_20** in DER format:

```
(host) (config) #crypto pki-import der ServerCert cert_20
```

Viewing Certificate Information

In the WebUI, navigate to the **Configuration > Certificates > Upload** page. Under the **Certificate Lists** section the certificates that are currently installed in the Mobility Access Switch are listed. Click on a certificate to view its contents .

To view the contents of a certificate using the CLI, execute the following commands:

Table 15: *Certificate Show Commands*

Command	Description
`show crypto-local pki trustedCA [<name>] <[attribute>]`	Displays the contents of a trusted CA certificate. If a name is not specified, all CA certificates imported into the Mobility Access Switch are displayed. If name and attribute are specified, then only the attribute in the specified certificate are displayed. Attributes can be CN, validity, serial-number, issuer, subject, or public-key.
`show crypto-local pki serverCert [<name>][<attribute>]`	Displays the contents of a server certificate. If a name is not specified, all server certificates imported into the Mobility Access Switch are displayed.
`show crypto-local pki publiccert [<name>][<attribute>]`	Displays the contents of a public certificate. If a name is not specified, all public certificates imported into the Mobility Access Switch are displayed.

NOTE

All certificates on Primary node get synchronized with Secondary node only. Line Cards do not have these certificates synchronized. However, the certificates get synchronized to the node when increasing the priority of the Line Card to make it primary.

This chapter describes the following topics:

Activate Integration Overview

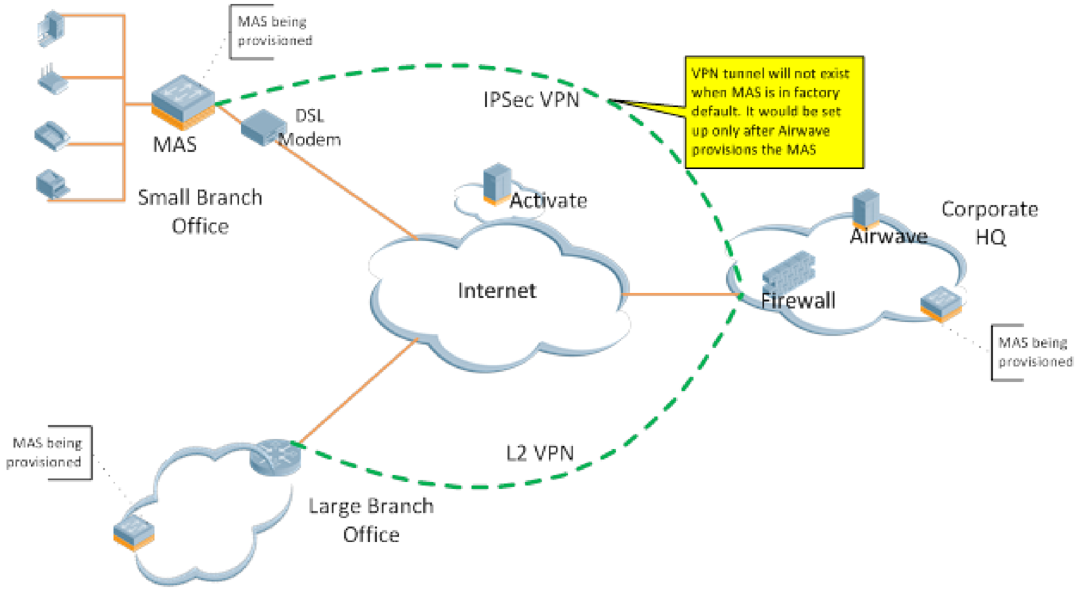
Activate is a cloud-based service that helps provision your Aruba devices and maintain your inventory. Activate automates the provisioning process, allowing a single IT technician to easily and rapidly deploy devices throughout a distributed enterprise. When your company orders a new Mobility Access Switch from Aruba, that device is automatically added to your inventory in Activate. Once a device is in your inventory, it can be automatically or manually associated to a folder and provisioning rule. A remote technician only needs to connect the Mobility Access Switch to the Internet, and that device will securely connect to Activate, retrieve its provisioning information, then use the provisioning information to connect to the AirWave server that has the desired Mobility Access Switch configuration.

Activate Provisioning Service

Activate customers must configure Activate with a provisioning rule for a Mobility Access Switch that provides each Mobility Access Switch with the IP address of the AirWave Management Platform and the AirWave group containing the switch configuration.

When an Activate-enabled ArubaOS 7.3.0.0 or higher Mobility Access Switch with a factory-default configuration becomes active on the network, it automatically contacts the Activate server, which responds with the AirWave server IP address and shared-secret-key, and the AirWave group and folder that contain its provisioning information.

Figure 3 *Activate/AirWave/Switch flow*



If your management VLAN does not have Internet access and you want to manually point your Mobility Access Switch to your local AirWave, you can provide your AirWave information via quick setup. Zero-Touch Provisioning (via Activate or DHCP) is disabled if the Mobility Access Switch enters quick-setup mode, even if quick setup is later canceled. If the Mobility Access Switch is manually configured, it will no longer attempt to use the Zero-Touch Provisioning feature.

A configuration manually defined using the quick setup wizard or WebUI takes precedence over the autoconfiguration settings downloaded from an AirWave server. If the Mobility Access Switch is manually configured, it will no longer download configuration updates from Activate.

> **NOTE**
> A best practice is to avoid making any configuration changes directly on a Mobility Access Switch whose configuration is managed through an AirWave. If login credentials or connectivity settings are changed directly on the Mobility Access Switch, AirWave may no longer be able to manage that device. Any required configuration changes should be managed through AirWave.

Activate and AirWave

Activate allows you to create rules to automatically provision devices with information about their configuration master. When a Mobility Access Switch in a factory-default mode sends its MAC address and serial number to Aruba Activate, Activate will respond with the AirWave IP address, shared secret, and the AirWave group and folder defined in the provisioning rule. Activate will only respond to a device when the device is associated with a customer that has enabled Activate and configured a provisioning rule.

When the Mobility Access Switch connects to the AirWave server, the device will either be automatically assigned to the specified group, or it will be available in the AirWave New Devices List (**APs/Devices > New** page).

- **Automatically Assigned Devices:** A factory default device provisioned from Activate will be automatically added to the group in AirWave only if at least one device already exists in the same group with the same shared secret.
- **Adding Devices from the New Devices List:** A factory default device that is not provisioned from Activate with the same shared secret and group will be added to the New Devices List in AirWave. For non-factory devices, AirWave will prompt you for the Community String, Telnet/SSH Username and Password, and the Enable Password. This information allows AirWave to import the configuration immediately when the device is added to the group.

The first device that is added to an AirWave group is added manually through the New Devices List and becomes the "golden" configuration for all subsequent devices that are added to the group. Ensure the stability of this configuration before pushing it to subsequent devices in the group. In addition, when adding this first device to AirWave, you must log in as an Admin user or provide the admin password in the device's Management profile. This is required in order to change the admin password of the factory default switch so that the configuration can be written and pushed to AirWave.

Additional devices can be added in either Monitor Only mode or Manage Read/Write mode. Devices that are added in Monitor Only mode will display with a mismatch in AirWave because the group configuration cannot be pushed in this mode. The group configuration will only be pushed if the Automatically Authorized Switch Mode option in **AMP Setup > General** is set to **Manage Read/Write**.

> **NOTE**
> The first device that is added and whose configuration is imported will display with a "Good" configuration state regardless of the Automatically Authorized Switch setting.

After a Mobility Access Switch appears as an associated device on the AirWave server, future configuration changes on the device must be made through AirWave. A caution message will display in the Mobility Access Switch WebUI if you attempt to make configuration changes directly on a switch that was provisioned with Activate and AirWave and that is managed by AirWave. In some cases, if settings are changed through the Mobility Access Switch WebUI, AirWave may no longer be able to manage that device.

Network Requirements for AirWave Provisioning

The Mobility Access Switch cannot use Activate/AirWave provisioning unless it has L3 access to the Activate server through the Internet. This connectivity must be available even when the Mobility Access Switch boots up with factory default settings, so the network into which the Mobility Access Switch is installed has the following requirements:

- Connectivity to the Internet is available over an untagged interface.
- DHCP-based address assignment.
- DNS entries via DHCP to resolve activate.arubanetworks.com.

AirWave uses SNMP polling to verify that the Mobility Access Switch is active on the network.

Activate Firmware Services

By default, the Mobility Access Switch contacts the Activate server upon initial bootup and then periodically every seven days to see if there is a new image version to which that switch can upgrade. If a new version is available, Activate prompts you to download and upgrade to the new image. The download process is not triggered automatically and requires admin intervention.

This feature is enabled by default. To disable the activate firmware services, issue the command **activate-service-firmware no enable**.

The ArubaStack feature enables simplified management by presenting a set of Mobility Access Switches as one entity, and reduces the operational complexity of managing multiple redundant links between access and distribution layer switches. Since the ArubaStack appears as one network node, loop prevention protocols are not required.

An ArubaStack is a set of interconnected Mobility Access Switches using stacking ports to form an ArubaStack. A stacking port is a physical port configured to run the stacking protocol. In factory default settings for Mobility Access Switches, uplink ports 2 and 3 (24/48 port models) and port 1 (12 port model) are pre-provisioned to be ArubaStack link ports. Once a port is provisioned for stacking, it is no longer available to be managed as a network port. A stacking port can only be connected to other Mobility Access Switches running the Aruba Stacking Protocol (ASP).

You can also configure the base ports as ArubaStack ports for specific topologies. You can use the following command to configure the base ports as ArubaStack:

```
(host) (config)# add stacking interface stack <module/port>
```

To delete a stacking port, execute the following command locally as it cannot be completed from the primary:

```
(host) (config)# delete stacking interface stack <module/port>
```

Use module=0 for base ports. For more information on adding a stacking interface, see *ArubaOS 7.3 Command Line Interface Guide*.

This chapter contains the following sections:

Important Points to Remember

- Dynamic Election–An ArubaStack is formed and roles are assigned based on Auto Discovery.
- ArubaStack Pre-provisioning–ArubaStack members and roles are configured before the ArubaStack is formed.

NOTE

Dynamic-election and Pre-provisioning cannot be configured together. You must choose one or the other for each ArubaStack.

- S2500s and S3500s can form an ArubaStack with other S2500s and S3500s.
- S1500s can form an ArubaStack with other S1500s,
- The ArubaStack members are Primary, Secondary and Line Card. A valid ArubaStack contains at least a Primary and a Secondary member.
  - Member–a collective term that includes Primary, Secondary, and Line Cards. All valid members run Aruba Stack Protocol (ASP) to discover each other.
  - Primary–runs all Layer2/Layer 3 functions and controls the ArubaStack. All configurations are performed on the Primary and then “pushed” to other members of the ArubaStack.
  - Secondary–back up for the Primary in the event of a hardware or software failure.

- Line Card–a member of the ArubaStack that is neither a Primary or Secondary. The Line Card includes all interfaces required to *switch* traffic.
- The connection between the Mobility Access Switches cannot go over a Layer 2/Layer 3 cloud.
- One or more stacking ports might be connected between two Mobility Access Switches. The interconnection between the switches can form common topologies; chain, ring, hub-and-spoke etc.
- A port provisioned for stacking can not be managed as a network port.

Stacking Topology

ArubaOS provides support for the following use cases:

- ArubaStack connected in a ring topology
- ArubaStack using base port links
  - Creating an ArubaStack with 10/100/1000 base ports
  - Creating an ArubaStack with S3500-24F base ports
  - Creating an ArubaStack across multiple wiring closets
- ArubaStack distributed wiring closet with redundancy
  - Creating an ArubaStack across two wiring closets with two layer redundancy

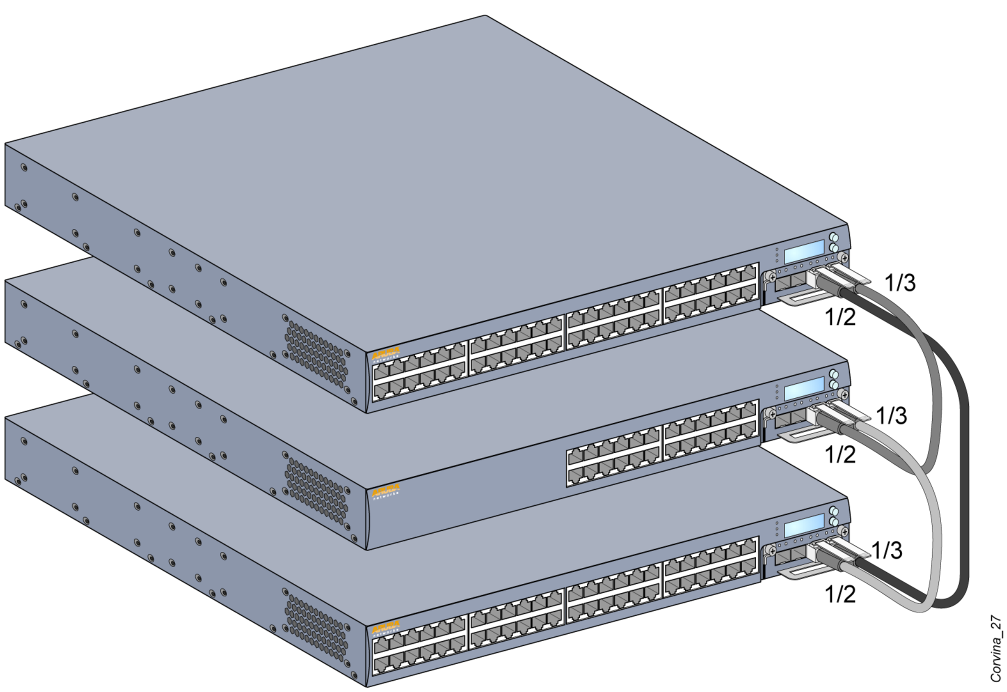
NOTE

All the use cases are supported only with the exact interconnections as illustrated in the figures 1 to 5 provided in this document..

ArubaStack connected in a Ring Topology

Figure 4 displays an ArubaStack connected in a ring topology. After the election process (see Primary Election on page 79), member 0 is the Primary, member 1 is the Secondary, and member 2 is a Line Card.

Figure 4 *ArubaStack Ring Topology*



ArubaStack using Base Port Links

The following use-cases are supported under ArubaStack using base port links:

- Creating an ArubaStack with 10/100/1000 base ports
- Creating an ArubaStack with S3500-24F base ports
- Creating an ArubaStack across multiple wiring closets

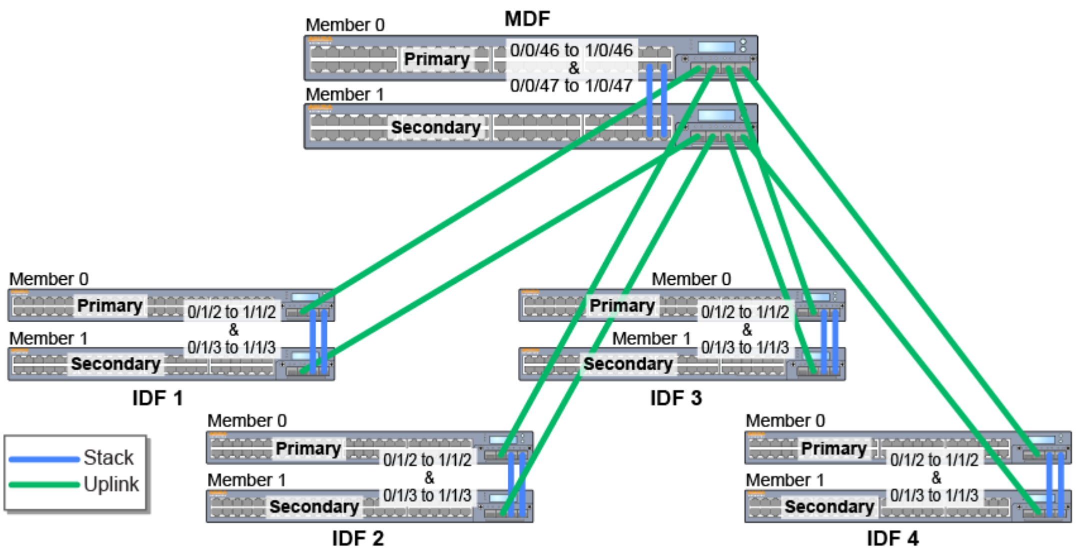
NOTE

All the ArubaStack using base port links support reduced ArubaStack bandwidth in MDF.

Creating ArubaStack with 10/100/1000 Base Ports

Figure 5 illustrates how to create an ArubaStack with 10/100/1000 base ports. This is useful when all the uplink ports are used for interconnecting with devices in the other locations.

Figure 5 *ArubaStack with 10/100/1000 Base Ports*



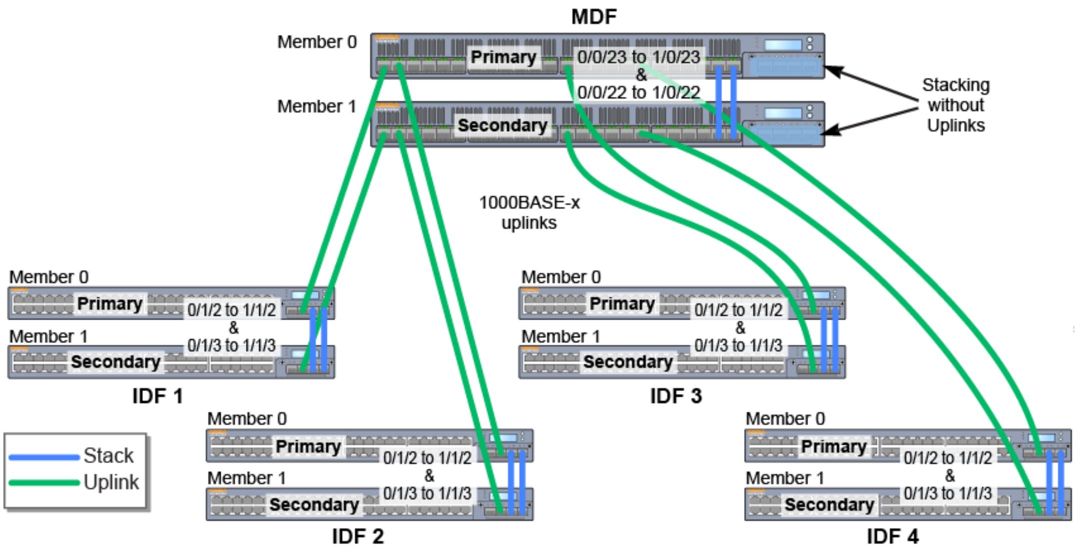
The characteristics of this topology are described below:

- Full redundancy is provided between every ArubaStack.
- Provides 1000BASE-T PoE on everyArubaStack.
- 1000Base-X (fiber) uplinks to MDF connect to the uplink ports.
- MDF stack is completed by 1000BASE-T base port links.
- x/0/x ports are stacked only with other x/0/x ports at MDF.

Creating ArubaStack with S3500-24F Base Ports

Figure 6 illustrates how to create an ArubaStack with S3500-24F base ports. This physical configuration is used to create a redundant S3500-24F aggregation layer without an uplink module.

Figure 6 *ArubaStack with S3500-24F Base Ports*



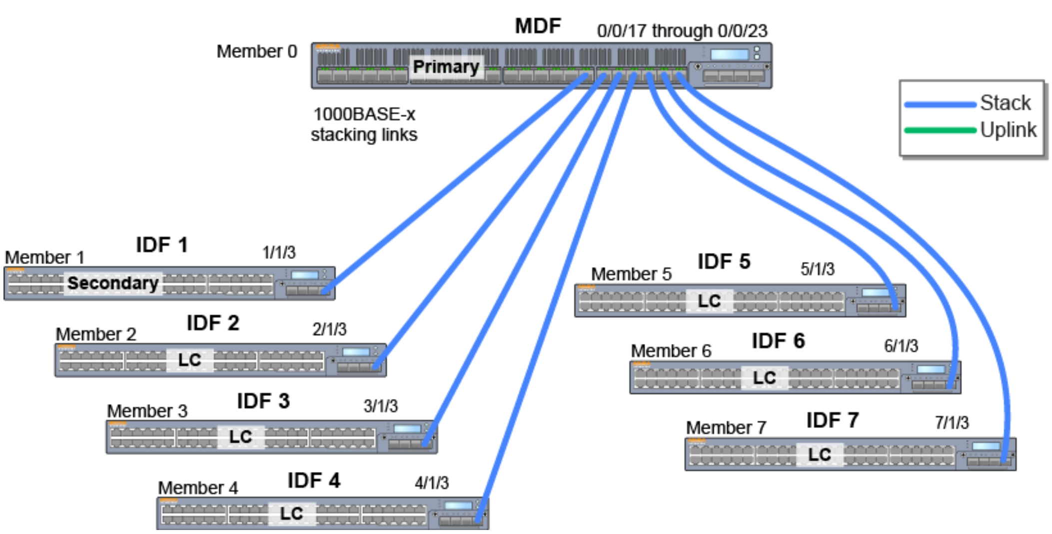
The characteristics of this topology are described below:

- Full redundancy is provided between every ArubaStack.
- No uplink module is required at MDF.
- 1000Base-X (fiber) uplinks to MDF connect to 1000Base-X base ports.
- MDF stack is completed by 1000BASE-X base port links.
- x/0/x ports are stacked only with other x/0/x ports at MDF.

Creating ArubaStack across Multiple Wiring Closets

Figure 7 illustrates how to create an ArubaStack across multiple wiring closets. This is an alternative star topology used for multiple remote wiring closets instead of the traditional ring topology.

Figure 7 *ArubaStack across Multiple Wiring Closets*



The characteristics of this topology are described below:

- MDF and IDFs are integrated as one ArubaStack for simplified management.
- 1000Base-X Fiber extends ArubaStack to a longer distance.
- No uplink module is required at MDF.
- 1000Base-X (fiber) uplinks to MDF connect to 1000Base-X base ports.

- A maximum of seven ArubaStack ports are allowed at MDF (S3500-24F shown).

NOTE

This topology does not provide ArubaStack redundancy for stack members.

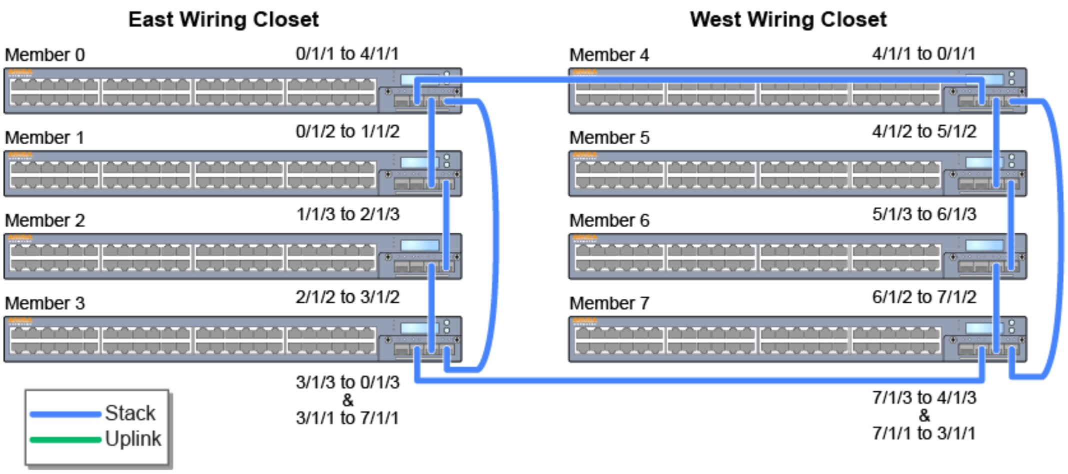
ArubaStack Distributed Wiring Closet with Redundancy

You can create an ArubaStack across two wiring closets with two layer redundancy. This use case provides redundancy through the traditional ring topology between the members within the wiring closet. It also provides a redundant ring between the members across the distributed wiring closets.

Creating ArubaStack across Two Wiring Closets with Two Layer Redundancy

Figure 8 illustrates how to create an ArubaStack across two wiring closets with two layer redundancy.

Figure 8 *ArubaStack across Two Wiring Closets with Two Layer Redundancy*



The characteristics of this topology are described below:

- Primary member is in one closet and the secondary is in the other.
- DAC is provided between the members within the closet and 10GE is provided between the closets.
- Full redundancy is provided in each wiring closet
- Full redundancy is provided between closets
- Provides simplified management.
- Redundant uplink interfaces are available to core.

Viewing the ArubaStack Information

There are several commands available that allow you to view ArubaStack information such as topology, members, routes, interface and neighbors to name a few.

```
(host)#show stacking ?
asp-stats                 Show asp stats on stacking interfaces
generated-preset-profile  Generate preset stack config from dynamic config
interface                 Show configured stacking interfaces
internal                  Show stacking internal details
location                  Show stacking location
members                   Show stacking members
neighbors                 Show directly connected stacking neighbors
topology                  Show stacking topology
```

For example, to view the ArubaStack topology, use the **show stacking topology** command.

```
(host)#show stacking topology
```

```
Member-id  Role       Mac Address       Interface  Neighbor Member-id
---------  ----       -----------       ---------  ------------------
0  *       Primary    000b.866a.f240    stack1/2   1
                                        stack1/3   2
1          Secondary  000b.866b.0340    stack1/3   0
                                        stack1/2   2
2          Linecard   000b.866b.3980    stack1/2   0
                                        stack1/3   1
```

Another example, to view the ArubaStack topology, use the **show stacking members** command.

```
(host) (config) #show stacking members

Member status: Active, Stack Id: 000b866af2404e339e0a
Stack uptime: 13 days 6 hours 3 minutes 52 seconds
Id    Role       MAC Address     Priority  State     Model            Serial
--    ----       -----------     --------  -----     -----            ------
0  *  Primary    000b.866a.f240  128       Active    ArubaS3500-24P   AU0000674
1     Secondary  000b.866b.0340  128       Active    ArubaS3500-24P   AU0000731
2     Linecard   000b.866b.3980  128       Active    ArubaS3500-24P   AU0000660

[S] - Split
[V] - Version Mismatch
[D] - Depleted Slots
[C] - Preset Configuration Mismatch
[I] - Preset Independent Stack
```

NOTE

The member with the asterisk (*) indicates that you are logged onto that member (the Primary in the example above).

Dormant State

An ArubaStack member will enter the dormant state if it cannot contact a valid primary member. A member can become dormant for one of the following reasons:

- Split [S]—This member cannot connect to the primary member after an ArubaStack split.
- Version Mismatch [V]—This member's version of ArubaOS does not match that of the primary member.
- Depleted Slots [D]—The number of ArubaStack members has exceeded the maximum.
- Preset Configuration Mismatch [C]—This member's pre-provisioned configuration does not match the configuration of the primary member.
- Preset Independent Stack [I]—This member is part of a pre-provisioned ArubaStack that has not completely merged with another pre-provisioned ArubaStack.

Dynamic Election

Dynamic election is a stack-formation process that is completed automatically with only optional configuration (setting the priority value) done before the Mobility Access Switches are physically connected. The stacking protocol sends information between the ArubaStack members and the election process is completed to determine the primary and secondary members. The primary then assigns member-IDs and roles to the remaining members.

Configuring Priority

When adding a Mobility Access Switch to an ArubaStack, you may need to manually set the priority value so that the switch enters the ArubaStack as a Line Card (or a Primary or Secondary).

The switches priority value is one condition in the election process (see Primary Election on page 79). In the example below, the priority value (election-priority) is set to the default 128 assuring that the switch enters the ArubaStack as a Line Card.

NOTE

In the example, the switch entering the ArubaStack has a previous member identification (member-id 2).

Using the WebUI

1. Navigate to the **Configuration > Stacking** page.
2. Click the **Add** button to add a MAS to the ArubaStack.
3. Enter the **Member ID**.
4. Enter the **Election Priority**.
5. Click **OK**.
6. Repeat this process until you have added all the necessary MAS's.
7. Set the **MAC persistence timeout** value.
8. Enable or disable **Split Detection** as required for your deployment.
9. Click **Apply** and **Save Configuration**.

Using the CLI

```
(host)(stack-profile) #member-id 1 election-priority 128
WARNING!! This profile will not be applied till the configuration is saved.

(host) (stack-profile) #member-id 1 location eng-building
WARNING!! This profile will not be applied till the configuration is saved.

(host)(stack-profile) #write memory
Saving Configuration...............

Configuration Saved.
```

NOTE

The command `member-id` <*member ID*> `location` is only available through CLI.

The Stacking Protocol

Each Mobility Access Switch runs an ArubaStack manager process that is responsible for running the stacking protocol. The stacking protocol is responsible for automatically:

- Identifying the ArubaStack neighbors and determining the ArubaStack topology.
- Assigning the switch's member ID to each member of the ArubaStack.
- Assigning each member of the ArubaStack a role; Primary, Secondary or Line Card.
- Setting up optimized communication path/channel between the ArubaStack members. This path/channel transports user data packets and the switch's own control packets.
- Converges the stacking topology during a ArubaStack link or ArubaStack member failure event; users and traffic are automatically re-routed via a different path.

Auto Discovery

The Stacking protocol exchanges information between Mobility Access Switches that are connected to each other and without any prior stacking related configuration. The protocol exchanges information between the different ArubaStack members, runs distributed election algorithm, and elects a Primary and Secondary members among the ArubaStack members. The Primary then assigns ArubaStack member IDs to all the members.

Primary Election

The ArubaStack manager discovers the ArubaStack topology. A Primary is elected based on the following in the order of priority.

1. Configured Priority (0-255). Priority is configured by administrator. Higher the priority, better the chances are for the MAS to become Primary. Default priority is 128.
2. Current Role (Primary, Secondary, LC). Weight associated with current role will be in descending order from Primary to LC. If the switch boots up in Dormant state it does not participates in election.
3. Uptime. Uptime for the switch in 100s of seconds.
4. Hardware Priority (0-31). Priority of becoming Primary if all of the above are same. This priority will be hardcoded based on the switch's hardware.
5. MAC Address of the switch. In Primary election, lower MAC wins.

Election Anatomy

The synchronization of the link state database also triggers a primary election task on all the ArubaStack members. This algorithm chooses one primary and one secondary amongst all the ArubaStack members based on the priority list in The Stacking Protocol on page 78.

The system's MAC address of the ArubaStack members is the final tiebreaker. The ArubaStack member selected as a Primary asks for an explicit acknowledgment from the remaining ArubaStack members. Upon success, it assigns a ArubaStack unit ID and ArubaStack role for the remaining ArubaStack members and then conveys this information to each ArubaStack member. The ArubaStack unit ID and the chassis-role assigned by the Primary is persistent on a stacking database on all the ArubaStack members. Reboots, therefore, do not result in changes in ArubaStack unit IDs or roles.

Only a Mobility Access Switch that has an un-assigned ArubaStack ID or the same ArubaStack ID as the Primary is allowed to participate fully in the ArubaStack election. In addition, the ArubaStack members must be running the same software version. A Mobility Access Switch with a different software version is admitted into the ArubaStack for the purpose of administration but cannot participate in forwarding network traffic.

Interfaces for such a Mobility Access Switch is not created in the Primary. In the case of incompatible software versions, you can manually upgrade the ArubaStack members, or if configured, the Primary can automatically upgrade the ArubaStack members.

ArubaStack Pre-Provisioning

The ArubaStack pre-provisioning feature allows you to configure the role and member-id of the members before the ArubaStack is created. In preset config the members are configured using their serial numbers, which can be found on the purchase order or can be located on the back of the Mobility Access Switch. Additionally, the CLI commands `show inventory` or `show stacking-profile` displays the serial number.

Configuring ArubaStack Pre-Provisioning

All configuration for ArubaStack pre-provisioning is completed on a single Mobility Access Switch. Configuration consists of setting all parameters of all eventual members of the ArubaStack. This can be configured using the WebUI or the CLI. These parameters are:

- Serial number: The switch's serial number is used to identify the unit for ArubaStack formation. This is located on the purchase order, the rear of the unit, or the commands `show inventory` or `show stacking members` or `show stacking generated-preset-profile`.
- ArubaStack-unit number: The member-ID (or slot number) assigned to the switch.
- Chassis-role: The role assigned to the switch when configuring the ArubaStack. The roles are primary-capable or line card. Primary-capable switches can become a primary, secondary, or line card.

NOTE

At least two Mobility Access Switches in the ArubaStack must be assigned as primary-capable.

After the configuration has been saved, all Mobility Access Switches are physically connected. The ArubaStack then forms a chassis as specified in the configuration.

After the preset ArubaStack configuration is applied to the connected switches, primary-capable members choose one primary and one secondary by running the Primary-Election algorithm. The switches configured as line-card capable will become line cards and receive the configured slot number defined in the preset config after the primary election algorithm.

Using the WebUI

1. Navigate to the **Configuration > Stacking** page.
2. Click the **Enable pre-provisioning** check box.
3. Click the **Add** button to add a MAS to the ArubaStack.
4. Enter the **Member ID**.
5. Enter the **Serial Number**.
6. Select the device **Role** from the drop-down menu.
7. Click **OK**.
8. Repeat this process until you have added all the necessary MAS's.
9. Set the **MAC persistence timeout** value.
10. Enable or disable **Split Detection** as required for your deployment.
11. Click **Apply** and **Save Configuration**.

Using the CLI

```
(host) (config) # stack-profile
(host) (stack-profile) #member-id 1
(host) (stack-profile) #member-id 1 serial-number AU00006600
(host) (stack-profile) #member-id 1 serial-number AU00006600 role line-card
(host) (stack-profile) #member-id 1 location eng-building
```

NOTE

The command `member-id` <*member ID*> `location` is only available through CLI.

ArubaStack Database

Information related to the ArubaStack is kept in persistent storage so that the ArubaStack's Primary election procedure converges faster after subsequent reboots. This ArubaStack information includes:

- ArubaStack ID
- MAC address, role and member ID of all the members

When the switch boots using the ArubaStack database, it assumes the last role it had according to the ArubaStack database.

To accommodate any change in the ArubaStack topology since the last boot, the Mobility Access Switch uses a count down timer and then it verifies as follows:

- If I was the Primary and...
  - I see the Secondary which means that both the previous Primary and previous Secondary are present in the ArubaStack. I continue as Primary.

- I do not see the Secondary, however, I can see more than half of the ArubaStack members in the database. I continue as Primary.
- I do not see the Secondary and I can only see less than half of the ArubaStack members in the database. I transition into dormant state. The network interfaces of the switch will remain down.

- If I was the Secondary and...
  - I see the Primary which means that both the previous Primary and previous Secondary are present in the ArubaStack. I continue as Secondary.
  - I do not see the Primary, however, I can see more than half of the ArubaStack members in the database. I change to Primary.
  - I do not see the Primary and I can only see less than half of the ArubaStack members in the database. I transition into dormant state. The network interfaces of the switch will remain down.
- If I was a Line Card and...
  - I do not see Primary nor Secondary. I move to dormant state.
  - I do see both Primary and Secondary, The Primary will assign me my appropriate role and member-id.
  - I see either the Primary or the Secondary. I will wait for instructions from the member I see (Primary or Secondary).

Removing an ArubaStack Database

An ArubaStack database can be removed at each individual ArubaStack member to return the device to factory default settings. Use the command below to remove an ArubaStack database. Once removed, the device will be automatically reboot.

```
(host) #restore factory-default stacking

All configuration and stack settings will be restored to
factory default on this member after reload.
Press 'y' to proceed with reload: [y/n]: y
System will now restart
............
```

Booting without an ArubaStack Database

When Mobility Access Switches boot without the ArubaStack database, various timers are launched to assure that ArubaStack ports are brought up and RTMs (Routing Topology Messages) are exchanged with other members before deciding on its role. These timers are used to avoid unnecessary transition in roles and changes in member-id. Because of these timers, the switch’s boot up time is longer than with the ArubaStack database.

Primary Switchover

Best practices recommends executing the **database synchronize** command before attempting a system switch over. To view the switch over status, use the `show system switchover` command to verify synchronization before executing the `database synchronize` command.

NOTE

Periodic synchronization is automatically executed every two minutes.

This command is successful only when both the Primary and Secondary are configured with the same stack-priority. Once this command is executed:

- the Secondary becomes the new Primary
- the old Primary becomes the new Secondary

The example below confirms that database synchronization to the secondary is current.

```
(host) #show system switchover

Secondary Switchover status
---------------------------
System-state  :  synchronized to primary
Configuration :  synchronized to primary
Database      :  synchronized to primary
```

ArubaStack Resiliency

When a member(s) of an ArubaStack exits the ArubaStack unexpectedly (due to hardware or software error for example) or members are removed from one ArubaStack to create another ArubaStack, it is known as a “stack split.” Keep-alive packets are exchanged among all the ArubaStack ports at regular intervals. When a member(s) of the ArubaStack exits the ArubaStack thereby isolating the remaining ArubaStack member(s), each ArubaStack member independently calculates the resultant state of the stack split.

Some rules governing the stack split are:

- After a stack split, members may transition to a dormant line card state regardless of their previous role.
- After a stack split, several members may form an inactive sub-stack of dormant line card switches.
- After a stack split if the Primary and Secondary members are within the same sub-stack, then that sub-stack is active and passing traffic.
- After a stack split if the Primary is in a different sub-stack than the Secondary, the active sub-stack is determined by the sub-stack with the most members.
- After a stack split if the Primary is in a different sub-stack than the Secondary *and* both sub-stacks contain the same number of members, the sub-stack with the Secondary becomes the active sub-stack. The Secondary rightly assumes that the Primary is completely offline.

NOTE

An ArubaStack (or sub-stack) can never have two Primaries. The ArubaStack is designed to transition to an inactive state to avoid a collision of two Primaries.

Split Detect

The split detect feature, which detects if a split occurs in an ArubaStack, is enabled by default. When your ArubaStack has only two members, best practices recommends that you disable the split detection feature to ensure that the Primary does not transition to a dormant state if the Secondary is powered down. The command to disable split detections is shown below; note that you must save your configuration.

```
(host)(stack-profile) #no split-detection
WARNING!! This profile will not be applied till the configuration is saved.

(host)(stack-profile) #write memory
Saving Configuration...........
```

The **no split-detection** command is applied to a 2 member ArubaStack only. If you apply this command to an ArubaStack with more than 2 members, save the command, then execute the **show stack member** command, a warning notice is displayed.

```
(host)(stack-profile) #show stacking members

Member status: Active, Stack Id: 000b866af2404e339e0a
Id    Role       MAC Address     Priority  State     Model             Serial
--    ----       -----------     --------  -----     -----             ------
0  *  Primary    000b.866a.f240  255       Active    ArubaS3500-24P    AU0000674
1     Secondary  000b.866b.0340  200       Active    ArubaS3500-24P    AU0000731
2     Linecard   000b.866b.3980  128       Active    ArubaS3500-24P    AU0000660
```

```
Note: no-split-detect configured but not in effect
```

NOTE

Split detect is not supported on pre-provisioned ArubaStacks.

Stack Join

Stack join occurs when a stack split creates two sub-stacks; an active sub-stack (includes the Primary and Secondary) and an inactive sub-stack with dormant Line Card members. The stack join pulls these two sub-stacks back together again as one active ArubaStack. The stack join is just resolving the broken connection between switches. There is no software command to issue. Once the connection is made, the stacking protocol will auto discover the ArubaStack topology. Original roles of the switches are maintained because all the switches in the ArubaStack know the identity of the ArubaStack Primary and Secondary and share the same ArubaStack ID.

Additionally, a stack join occurs when two or more MASs with factory default settings are connected via a stack port and then booted up. Those devices will join and the stack protocol will auto discover the stack topology. Each member's role is determined using the primary election algorithm (Primary Election on page 79).

Stack Merge—Dynamic Election

Stack merge takes place when two independently running ArubaStacks (with unique ArubaStack IDs) are connected to each other. Rules to determine which ArubaStack wins the merge are:

- A pre-provisioned ArubaStack wins over a dynamic-election ArubaStack
- An active ArubaStack wins over an inactive ArubaStack
- The ArubaStack with a higher stack priority (priority of the primary) wins
- The ArubaStack with more members wins over an ArubaStack with fewer members
- The ArubaStack with the lower ArubaStack uptime will merge into a higher uptime ArubaStack
- The tie breaker is the Stack ID; the ArubaStack with the lower Stack ID wins

The loosing ArubaStack members perform an automatic software reset to clear any previous software states and then those members join their place in the "winning" ArubaStack.

The following describes a merge scenario in which two MASs with less than 100 seconds of uptime are combined and a the device with the lowest MAC becomes the primary. In this scenario, Device-A is the 48-port S3500 and Device-B is the 24-port S3500.

- On Device-A:

```
(host) #show stacking  members

Member status: Active, Stack Id: 000b866a5ac04f7a3a6c
Stack uptime: 1 minutes 3 seconds
Id     Role       MAC Address     Priority  State     Model            Serial
--     ----       -----------     --------  -----     -----            ------
0   *  Primary    000b.866a.5ac0  128       Active    ArubaS3500-48P   AW0000155
```

- On Device-B:

```
(host) #show stacking  members

Member status: Active, Stack Id: 000b866a75004f7a3a41
Stack uptime: 1 minutes 51 seconds
Id     Role       MAC Address     Priority  State     Model            Serial
--     ----       -----------     --------  -----     -----            ------
0   *  Primary    000b.866a.7500  128       Active    ArubaS3500-24T   AU0000229
```

- On Device-A, now acting as the primary for the ArubaStack:

```
(host) #show stacking  members
```

```
Member status: Active, Stack Id: 000b866a5ac04f7a3a6c
Stack uptime: 22 minutes 20 seconds
Id     Role       MAC Address     Priority  State     Model             Serial
--     ----       -----------     --------  -----     -----             ------
0   *  Primary    000b.866a.5ac0  128       Active    ArubaS3500-48P    AW0000155
1      Secondary  000b.866a.7500  128       Active    ArubaS3500-24T    AU0000229
```

Stack Merge–Pre-Provisioning

Unlike ArubaStacks created by dynamic election, there is no automatic stack merge for deployments that include pre-provisioned ArubaStacks. If two ArubaStacks must be merged, the process of merging the members must be completed manually.

Pre-provisioned and Dynamic ArubaStacks Merge

In case of merge of one pre-provisioned ArubaStack and one dynamic-election ArubaStack, the pre-provisioned ArubaStack takes precedent. The two ArubaStacks will merge to form a single ArubaStack but the members from dynamic ArubaStack will become dormant if their config is not present in preset config. These members will remain dormant unless the pre-provisioned ArubaStack is modified to include members from dynamic ArubaStack. Complete the merge by taking the following steps.

1. The pre-provisioned ArubaStack will discover the new members and the members of the dynamic-election ArubaStack will become dormant.

   After merge:

```
Member status: Active, Stack Id: 000b866b4a804f3f01c6
Stack uptime: 17 minutes 3 seconds
Id     Role       MAC Address     Priority  State        Model             Serial
--     ----       -----------     --------  -----        -----             ------
0   *  Primary    000b.866b.4a80  Preset    Active       ArubaS3500-48P    AW0000257
1      Secondary  000b.866c.2640  Preset    Active       ArubaS3500-48P    AW0000625
?      Linecard   000b.866a.6280  255       Dormant [C]  ArubaS3500-24T    AU0000183
?      Linecard   001a.1e08.7d80  255       Dormant [C]  ArubaS2500-48P    BL0000028
```

2. Add the former members of the dynamic-election ArubaStack to the stack-profile of the pre-provisioned ArubaStack.

   After stack-profile update:

```
Member status: Active, Stack Id: 000b866b4a804f3f01c6
Stack uptime: 23 minutes 22 seconds
Id     Role       MAC Address     Priority  State     Model             Serial
--     ----       -----------     --------  -----     -----             ------
0   *  Primary    000b.866b.4a80  Preset    Active    ArubaS3500-48P    AW0000257
1      Secondary  000b.866c.2640  Preset    Active    ArubaS3500-48P    AW0000625
2      Linecard   000b.866a.6280  Preset    Active    ArubaS3500-24T    AU0000183
3      Linecard   001a.1e08.7d80  Preset    Active    ArubaS2500-48P    BL0000028
```

Pre-provisioned ArubaStacks Merge

If two pre-provisioned ArubaStacks are physically connected via a stack port, they will not merge automatically.

NOTE

Aruba recommends that you remove the stack-profile configuration or execute `restore factory-default stacking` on each member of the joining ArubaStack before physical connection.

The following is an example of how to remove the pre-provisioned settings from a ArubaStack that will be merged with another pre-provisioned ArubaStack:

```
(Stack-B) #show stacking members
```

```
Member status: Active, Stack Id: 000b866a76c04f877710
Stack uptime: 1 minutes 56 seconds
Id    Role       MAC Address     Priority  State     Model            Serial
--    ----       -----------     --------  -----     -----            ------
1     Linecard   000b.866b.e300  Preset    Active    ArubaS3500-24P   AU0001357
4  *  Primary    000b.866c.0ac0  Preset    Active    ArubaS3500-24P   AU0001517
7     Secondary  000b.866a.76c0  Preset    Active    ArubaS3500-24T   AU0000228

(Stack-B) #configure terminal
Enter Configuration commands, one per line. End with CNTL/Z

(Stack-B) (config) #stack-profile
(Stack-B) (stack-profile) #no member-id 1 serial-number AU0001357 role line-card
WARNING!! This profile will not be applied till the configuration is saved.

(Stack-B) (stack-profile) #no member-id 4 serial-number AU0001517 role primary-capable
WARNING!! This profile will not be applied till the configuration is saved.

(Stack-B) (stack-profile) #no member-id 7 serial-number AU0000228 role primary-capable
WARNING!! This profile will not be applied till the configuration is saved.

(Stack-B) (stack-profile) #end
(Stack-B) #
(Stack-B) #write memory
Saving Configuration......

(Stack-B) #show stacking  members

Member status: Active, Stack Id: 000b866a76c04f877710
Stack uptime: 16 minutes 3 seconds
Id    Role       MAC Address     Priority  State     Model            Serial
--    ----       -----------     --------  -----     -----            ------
1     Linecard   000b.866b.e300  128       Active    ArubaS3500-24P   AU0001357
4  *  Primary    000b.866c.0ac0  128       Active    ArubaS3500-24P   AU0001517
7     Secondary  000b.866a.76c0  128       Active    ArubaS3500-24T   AU0000228
```

In the case that two pre-provisioned ArubaStacks are physically connected before the stack-profile is removed from one of them, no merge will occur automatically. The following steps describe how to complete the merge without removing the physical connection:

Before Merge (primary ArubaStack, Stack-A):

```
(Stack-A) #show stacking members

Member status: Active, Stack Id: 000b866a75004f846b14
Stack uptime: 15 hours 25 minutes 2 seconds
Id    Role       MAC Address     Priority  State     Model            Serial
--    ----       -----------     --------  -----     -----            ------
4     Linecard   001a.1e08.8140  Preset    Active    ArubaS2500-24P   BJ0000025
5     Secondary  000b.866a.7500  Preset    Active    ArubaS3500-24T   AU0000229
7  *  Primary    000b.866a.5ac0  Preset    Active    ArubaS3500-48P   AW0000155
```

Before Merge (joining ArubaStack, Stack-B):

```
(Stack-B) #show stacking  members

Member status: Active, Stack Id: 000b866a76c04f875627
Stack uptime: 22 minutes 51 seconds
Id    Role       MAC Address     Priority  State     Model            Serial
--    ----       -----------     --------  -----     -----            ------
1     Linecard   000b.866b.e300  Preset    Active    ArubaS3500-24P   AU0001357
4     Secondary  000b.866c.0ac0  Preset    Active    ArubaS3500-24P   AU0001517
7  *  Primary    000b.866a.76c0  Preset    Active    ArubaS3500-24T   AU0000228
```

1. The two ArubaStacks are physically connected using the stacking interfaces.

NOTE

In this case, both ArubaStacks remain still independent, denoted by [I] but can see the members of the other ArubaStack.

After Physical Connection (primary ArubaStack, Stack-A):

```
(Stack-A) #show stacking members

Member status: Active, Stack Id: 000b866a75004f846b14
Stack uptime: 15 hours 27 minutes 31 seconds
Id     Role       MAC Address     Priority State        Model           Serial
--     ----       -----------     -------- -----        -----           ------
4      Linecard   001a.1e08.8140  Preset   Active       ArubaS2500-24P  BJ0000025
5      Secondary  000b.866a.7500  Preset   Active       ArubaS3500-24T  AU0000229
7   *  Primary    000b.866a.5ac0  Preset   Active       ArubaS3500-48P  AW0000155
?      Linecard   000b.866c.0ac0  Preset   Dormant [I]  ArubaS3500-24P  AU0001517
?      Linecard   000b.866a.76c0  Preset   Dormant [I]  ArubaS3500-24T  AU0000228
?      Linecard   000b.866b.e300  Preset   Dormant [I]  ArubaS3500-24P  AU0001357
```

After Physical Connection (joining ArubaStack, Stack-B):

```
(Stack-B) #show stacking  members

Member status: Active, Stack Id: 000b866a76c04f875627
Stack uptime: 26 minutes 59 seconds
Id     Role       MAC Address     Priority State        Model           Serial
--     ----       -----------     -------- -----        -----           ------
1      Linecard   000b.866b.e300  Preset   Active       ArubaS3500-24P  AU0001357
4      Secondary  000b.866c.0ac0  Preset   Active       ArubaS3500-24P  AU0001517
7   *  Primary    000b.866a.76c0  Preset   Active       ArubaS3500-24T  AU0000228
?      Linecard   001a.1e08.8140  Preset   Dormant [I]  ArubaS2500-24P  BJ0000025
?      Primary    000b.866a.5ac0  Preset   Dormant [I]  ArubaS3500-48P  AW0000155
?      Linecard   000b.866a.7500  Preset   Dormant [I]  ArubaS3500-24T  AU0000229
```

2. Remove the configured stack-profile from the joining ArubaStack (Stack-B).

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

(Stack-B) (config) #stack-profile
(Stack-B) (stack-profile) #no member-id 1 serial-number AU0001357 role line-card
WARNING!! This profile will not be applied till the configuration is saved.

(Stack-B) (stack-profile) #no member-id 4 serial-number AU0001517 role primary-capable
WARNING!! This profile will not be applied till the configuration is saved.

(Stack-B) (stack-profile) #no member-id 7 serial-number AU0000228 role primary-capable
WARNING!! This profile will not be applied till the configuration is saved.

(Stack-B) (stack-profile) #end
(Stack-B) #write memory
```

3. The members of the joining ArubaStack now merge with the primary ArubaStack.

```
(Stack-A) #show stacking  members

Member status: Active, Stack Id: 000b866a75004f846b14
Stack uptime: 15 hours 44 minutes 33 seconds
Id     Role       MAC Address     Priority State     Model           Serial
--     ----       -----------     -------- -----     -----           ------
0      Linecard   000b.866a.76c0  Preset   Active    ArubaS3500-24T  AU0000228
```

```
1     Linecard   000b.866b.e300  Preset    Active    ArubaS3500-24P   AU0001357
2     Linecard   000b.866c.0ac0  Preset    Active    ArubaS3500-24P   AU0001517
4     Linecard   001a.1e08.8140  Preset    Active    ArubaS2500-24P   BJ0000025
5     Secondary  000b.866a.7500  Preset    Active    ArubaS3500-24T   AU0000229
7  *  Primary    000b.866a.5ac0  Preset    Active    ArubaS3500-48P   AW0000155
```

Console Redirect

Logging onto the ArubaStack using a console connection, from any member, redirects the session to the Primary. You can use a control sequence to redirect between the Primary command line and the ArubaStack's local member's (secondary or line card) command line.

NOTE

If there is a disconnect between the Primary and its members, for example during an ArubaStack split or primary down, the console automatically redirects to a member command line until the new primary is elected.

Use the following control sequence to redirect console session:

- **Esc Ctrl-l** – redirects the console session from the Primary to a Secondary or Line Card member's command line.
- **Esc Ctrl-r** – redirects the Primary console session from a Secondary or Line Card member's session. This key sequence also enables the console redirect.

To verify the status of the console connection, execute the **show console status** command. In the example below, the ArubaStack has a Primary and a Secondary members only.

Management User Authentication

In an ArubaStack, management users are authenticated by a Primary member. The local user authentication credentials synchronize to all the members so that if the Primary becomes unreachable from other members, the authentication is performed locally. Apart from local admin users, you can configure an external authentication server.

From the Primary member console connection:

```
User:admin
Password: ******

(Primary) >enable
Password:******

(Primary) #show console status

Redirect State: Idle
Member Id: 0
```

From a Non-primary member console connection:

```
User:admin
Password: ******

(Primary) >enable
Password:******


(Primary) #show console status

Redirect State: Active
Member Id: 1
```

Enter **Esc Ctrl-l** to move to the local console. You will be required to login again.

```
*** CONNECTING TO LOCAL SLOT ***

(LC-1) #
User:admin
Password: ******

(LC-1) >enable
Password:******

(LC-1) #show console status

Redirect State: Disabled
Member Id: 1
```

ArubaStack Member Replacement

The ArubaStack features allows the user to replace one or more members of a ArubaStack without bringing down the complete ArubaStack. Following are best practices, based on dynamic and preset ArubaStack configurations.

NOTE

When replacing a unit with another unit that is not factory default, it is recommended to restore the unit to factory default as shown below.

```
(Aruba) #restore factory_default stacking

All configuration and stack settings will be restored to
factory default on this member after reload.
Press 'y' to proceed with reload: [y/n]: y
System will now restart
```

Dynamic ArubaStack Configuration

The following section describes how to replace a member of a dynamic ArubaStack.

Replacing a Linecard Member

```
(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 3 minutes 55 seconds
Id    Role       MAC Address     Priority  State    Model            Serial
--    ----       -----------     --------  -----    -----            ------
0  *  Primary    001a.1e08.7b00  128       Active   ArubaS2500-48T   BK0000016
1     Linecard   001a.1e08.7b80  128       Active   ArubaS2500-48T   BK0000018
2     Secondary  001a.1e08.7c00  128       Active   ArubaS2500-48T   BK0000015
3     Linecard   001a.1e08.7c80  128       Active   ArubaS2500-48T   BK0000014
```

In the above ArubaStack of four members, if Linecard member 1 is down and to be replaced, complete the following steps:

1. Verify stacking members. Member 1 is down and the status will be displayed as Away and the role will be Unknown.

```
(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 11 minutes 16 seconds
Id    Role       MAC Address     Priority  State    Model            Serial
--    ----       -----------     --------  -----    -----            ------
0  *  Primary    001a.1e08.7b00  128       Active   ArubaS2500-48T   BK0000016
1     Unknown    001a.1e08.7b80  128       Away     ArubaS2500-48T   BK0000018
2     Secondary  001a.1e08.7c00  128       Active   ArubaS2500-48T   BK0000015
```

```
3     Linecard   001a.1e08.7c80  128       Active    ArubaS2500-48T   BK0000014
```

2. To replace member 1, clear the stacking database from the ArubaStack using the clear command as shown below.

```
(host) #clear stacking member-id 1

Member-id: 0
------------
Deleting Member-id: 1

Member-id: 2
------------
Deleting Member-id: 1

Member-id: 3
------------
Deleting Member-id: 1
```

3. Stacking database will be cleared and member 1 will not be visible in the show stacking command as shown below.

```
(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 18 minutes 29 seconds
Id    Role       MAC Address     Priority  State     Model            Serial
--    ----       -----------     --------  -----     -----            ------
0  *  Primary    001a.1e08.7b00  128       Active    ArubaS2500-48T   BK0000016
2     Secondary  001a.1e08.7c00  128       Active    ArubaS2500-48T   BK0000015
3     Linecard   001a.1e08.7c80  128       Active    ArubaS2500-48T   BK0000014
```

4. Physically replace member with a new unit. The new unit will transition from an invalid unit Id shown by (?) and eventually be assigned the lowest stack-id available in the existing ArubaStack. In this case the new unit will be assigned unit ID 1.

```
(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 29 minutes 15 seconds
Id    Role       MAC Address     Priority  State     Model            Serial
--    ----       -----------     --------  -----     -----            ------
0  *  Primary    001a.1e08.7b00  128       Active    ArubaS2500-48T   BK0000016
2     Secondary  001a.1e08.7c00  128       Active    ArubaS2500-48T   BK0000015
3     Linecard   001a.1e08.7c80  128       Active    ArubaS2500-48T   BK0000014
?     Linecard   001a.1e08.7ac0  128       Active    ArubaS2500-48T   BK0000019

(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 29 minutes 17 seconds
Id    Role       MAC Address     Priority  State     Model            Serial
--    ----       -----------     --------  -----     -----            ------
0  *  Primary    001a.1e08.7b00  128       Active    ArubaS2500-48T   BK0000016
1     Linecard   001a.1e08.7ac0  128       Active    ArubaS2500-48T   BK0000019
2     Secondary  001a.1e08.7c00  128       Active    ArubaS2500-48T   BK0000015
3     Linecard   001a.1e08.7c80  128       Active    ArubaS2500-48T   BK0000014
```

Replacing a Secondary Member

NOTE

The new member joining the ArubaStack will assume the role of Secondary only if the priority is configured to be higher than the Linecard members. If the priority is the same for all the members an existing member of the ArubaStack will be elected as the secondary and the new member joining the ArubaStack will be a Linecard.

In this scenario member-ID 1 is configured for a higher priority.

```
(host) #show stack-profile

stack-profile "default"
-----------------------
Parameter                Value
---------                -----
MAC persistence timeout  15 Minutes
Split Detection          Enabled
Election Priority:
 Member 0                250
 Member 1                250

(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 42 minutes 40 seconds
Id    Role       MAC Address     Priority  State     Model            Serial
--    ----       -----------     --------  -----     -----            ------
0  *  Primary    001a.1e08.7b00  250       Active    ArubaS2500-48T   BK0000016
1     Secondary  001a.1e08.7ac0  250       Active    ArubaS2500-48T   BK0000019
2     Linecard   001a.1e08.7c00  128       Active    ArubaS2500-48T   BK0000015
3     Linecard   001a.1e08.7c80  128       Active    ArubaS2500-48T   BK0000014
```

In the above ArubaStack of four members, if the Secondary member 1 is down and needs to be replaced, here are the steps:

1. Verify stacking members. Secondary member 1 is down and the status will be displayed as Away and the role will be Unknown. An existing member will be elected as the secondary unless the secondary role is configured for a higher priority

```
(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 43 minutes 50 seconds
Id    Role       MAC Address     Priority  State     Model            Serial
--    ----       -----------     --------  -----     -----            ------
0  *  Primary    001a.1e08.7b00  250       Active    ArubaS2500-48T   BK0000016
1     Unknown    001a.1e08.7ac0  250       Away      ArubaS2500-48T   BK0000019
2     Secondary  001a.1e08.7c00  128       Active    ArubaS2500-48T   BK0000015
3     Linecard   001a.1e08.7c80  128       Active    ArubaS2500-48T   BK0000014
```

2. To replace member 1, clear the stacking database from the ArubaStack using the clear command as shown below.

```
(host) #clear stacking member-id 1

Member-id: 0
------------
Deleting Member-id: 1

Member-id: 2
------------
Deleting Member-id: 1

Member-id: 3
------------
Deleting Member-id: 1
```

3. Stacking database will be cleared and member 1 will not be visible in the show stacking command as shown below.

```
(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 44 minutes 46 seconds
Id    Role       MAC Address     Priority  State     Model            Serial
--    ----       -----------     --------  -----     -----            ------
0  *  Primary    001a.1e08.7b00  250       Active    ArubaS2500-48T   BK0000016
2     Secondary  001a.1e08.7c00  128       Active    ArubaS2500-48T   BK0000015
3     Linecard   001a.1e08.7c80  128       Active    ArubaS2500-48T   BK0000014
```

4. Physically replace member with a new unit. The new unit will transition from an invalid unit Id shown by (?) and eventually be assigned the lowest stack-id available in the existing ArubaStack. In this case the new unit will be assigned unit ID 1 and since member 1 is configured with higher priority it will be elected as secondary.

```
(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 47 minutes 6 seconds
Id    Role       MAC Address     Priority  State     Model            Serial
--    ----       -----------     --------  -----     -----            ------
0  *  Primary    001a.1e08.7b00  250       Active    ArubaS2500-48T   BK0000016
2     Secondary  001a.1e08.7c00  128       Active    ArubaS2500-48T   BK0000015
3     Linecard   001a.1e08.7c80  128       Active    ArubaS2500-48T   BK0000014
?     Unknown    001a.1e08.7a80  128       Away      ArubaS2500-48T   BK0000017

(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 48 minutes 53 seconds
Id    Role       MAC Address     Priority  State     Model            Serial
--    ----       -----------     --------  -----     -----            ------
0  *  Primary    001a.1e08.7b00  250       Active    ArubaS2500-48T   BK0000016
1     Secondary  001a.1e08.7a80  250       Active    ArubaS2500-48T   BK0000017
2     Linecard   001a.1e08.7c00  128       Active    ArubaS2500-48T   BK0000015
3     Linecard   001a.1e08.7c80  128       Active    ArubaS2500-48T   BK0000014
```

Replacing a Primay Member

The new member joining the ArubaStack will assume the role of Primary only if the priority is configured to be higher than the Secondary member. If the priority of the primary and secondary are same, the existing Secondary member of the ArubaStack will be elected as the Primary and the new member joining the ArubaStack will be elected as Secondary.

If the priority is the same for all the members an existing secondary will take over the role of Primary member, and an existing Linecard member will assume the role of Secondary. The new member joining the ArubaStack will be a Linecard.In this scenario member-id 0 and 1 are configured for a higher priority

```
(host) #show stack-profile

stack-profile "default"
-----------------------
Parameter               Value
---------               -----
MAC persistence timeout  15 Minutes
Split Detection         Enabled
Election Priority:
 Member 0               255
 Member 1               250

(host) #show stacking members
```

```
Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 1 hours 10 minutes 12 seconds
Id     Role       MAC Address     Priority  State     Model            Serial
--     ----       -----------     --------  -----     -----            ------
0   *  Primary    001a.1e08.7b00  255       Active    ArubaS2500-48T   BK0000016
1      Secondary  001a.1e08.7a80  250       Active    ArubaS2500-48T   BK0000017
2      Linecard   001a.1e08.7c00  128       Active    ArubaS2500-48T   BK0000015
3      Linecard   001a.1e08.7c80  128       Active    ArubaS2500-48T   BK0000014
```

In the above stack of four members, if the Primary member 0 is down and needs to be replaced, here are the steps:

1. Verify stacking members. Primary member 0 is down and the status will be displayed as Away and the role will be Unknown. An existing Secondary member will be elected as the Primary and an existing Linecard member will be elected as Secondary.

```
(host) # show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Id     Role       MAC Address     Priority  State     Model            Serial
--     ----       -----------     --------  -----     -----            ------
0      Unknown    001a.1e08.7b00  255       Away      ArubaS2500-48T   BK0000016
1      Primary    001a.1e08.7a80  250       Active    ArubaS2500-48T   BK0000017
2   *  Secondary  001a.1e08.7c00  128       Active    ArubaS2500-48T   BK0000015
3      Linecard   001a.1e08.7c80  128       Active    ArubaS2500-48T   BK0000014
```

2. To replace member 0, clear the stacking database from the ArubaStack using the clear command as shown below.

```
(host) #clear stacking member-id 0

Member-id: 1
------------
Deleting Member-id: 0

Member-id: 2
------------
Deleting Member-id: 0

Member-id: 3
------------
Deleting Member-id: 0
```

3. Stacking database will be cleared and member 0 will not be visible in the show stacking command as shown below.

```
(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 1 hours 17 minutes 13 seconds
Id     Role       MAC Address     Priority  State     Model            Serial
--     ----       -----------     --------  -----     -----            ------
1   *  Primary    001a.1e08.7a80  250       Active    ArubaS2500-48T   BK0000017
2      Secondary  001a.1e08.7c00  128       Active    ArubaS2500-48T   BK0000015
3      Linecard   001a.1e08.7c80  128       Active    ArubaS2500-48T   BK0000014
```

4. Physically replace member with a new unit. The new unit will transition from an invalid unit Id shown by (?) and eventually be assigned the lowest stack-id available in the existing ArubaStack. In this case the new unit will be assigned unit ID 0 and since member 0 is configured with highest priority it will be elected as Primary.

```
(host) # show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
```

```
Id    Role       MAC Address     Priority  State     Model            Serial
--    ----       -----------     --------  -----     -----            ------
1     Primary    001a.1e08.7a80  250       Active    ArubaS2500-48T   BK0000017
2  *  Secondary  001a.1e08.7c00  128       Active    ArubaS2500-48T   BK0000015
3     Linecard   001a.1e08.7c80  128       Active    ArubaS2500-48T   BK0000014
?     Unknown    001a.1e08.7b00  255       Away      ArubaS2500-48T   BK0000016

(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 47 minutes 6 seconds
Id    Role       MAC Address     Priority  State     Model            Serial
--    ----       -----------     --------  -----     -----            ------
0  *  Primary    001a.1e08.7b00  255       Active    ArubaS2500-48T   BK0000016
1     Secondary  001a.1e08.7a80  250       Active    ArubaS2500-48T   BK0000017
2     Linecard   001a.1e08.7c00  128       Active    ArubaS2500-48T   BK0000015
3     Linecard   001a.1e08.7c80  128       Active    ArubaS2500-48T   BK0000014
```

NOTE

To avoid another switchover happened when the new unit becomes the primary, you may want to modify ArubaStack profile to keep member-1 as primary and new unit as secondary.

```
(host) #show stack-profile

stack-profile "default"
-----------------------
Parameter                 Value
---------                 -----
MAC persistence timeout   15 Minutes
Split Detection           Enabled
Election Priority:
Member 0                 250
Member 1                 255
```

Preset ArubaStack Configuration

The following section describes how to replace a member of a preset ArubaStack.

In a preset ArubaStack configuration, the units are assigned role and slot number using the stack-profile configuration. Here is a ArubaStack of four members configured as below

```
(host) #show stack-profile

stack-profile "default"
-----------------------
Parameter                 Value
---------                 -----
MAC persistence timeout   15 Minutes
Split Detection           Enabled

Preset-profile:
---------------
Member-id         Serial-number  Role
 0                BK0000020      Primary-capable
 1                BK0000017      Primary-capable
 2                BK0000015      Line-card
 3                BK0000014      Line-card
```

Replacing a Linecard Member

```
(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 2 hours 19 minutes 26 seconds
```

```
Id     Role        MAC Address      Priority  State     Model             Serial
--     ----        -----------      --------  -----     -----             ------
0  *   Primary     001a.1e08.7bc0   Preset    Active    ArubaS2500-48T    BK0000020
1      Secondary   001a.1e08.7a80   Preset    Active    ArubaS2500-48T    BK0000017
2      Linecard    001a.1e08.7c00   Preset    Active    ArubaS2500-48T    BK0000015
3      Linecard    001a.1e08.7c80   Preset    Active    ArubaS2500-48T    BK0000014
```

In the above ArubaStack of four members, if Linecard member 2 is down and to be replaced, here are the steps:

1. Verify stacking members. Member 2 is down and the status will be displayed as Away and the role will be Unknown.

```
(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 2 hours 33 minutes 56 seconds
Id     Role        MAC Address      Priority  State     Model             Serial
--     ----        -----------      --------  -----     -----             ------
0  *   Primary     001a.1e08.7bc0   Preset    Active    ArubaS2500-48T    BK0000020
1      Secondary   001a.1e08.7a80   Preset    Active    ArubaS2500-48T    BK0000017
2      Unknown     001a.1e08.7c00   Preset    Away      ArubaS2500-48T    BK0000015
3      Linecard    001a.1e08.7c80   Preset    Active    ArubaS2500-48T    BK0000014
```

2. To replace member 2, clear the stacking database from the ArubaStack using the clear command as shown below.

```
(host) #clear stacking member-id 2

Member-id: 0
------------
Deleting Member-id: 2

Member-id: 1
------------
Deleting Member-id: 2

Member-id: 3
------------
Deleting Member-id: 3
```

3. Stacking database will be cleared and member 2 will not be visible in the show stacking command as shown below.

```
(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 2 hours 36 minutes 10 seconds
Id     Role        MAC Address      Priority  State     Model             Serial
--     ----        -----------      --------  -----     -----             ------
0  *   Primary     001a.1e08.7bc0   Preset    Active    ArubaS2500-48T    BK0000020
1      Secondary   001a.1e08.7a80   Preset    Active    ArubaS2500-48T    BK0000017
3      Linecard    001a.1e08.7c80   Preset    Active    ArubaS2500-48T    BK0000014
```

4. Delete the serial number of member 2.

```
(host) (stack-profile) #no member-id 2 serial-number BK0000018 role line-card
```

5. Physically replace member with a new unit. The unit will not be an active part of the ArubaStack until the serial number is added to the stack-profile and will be displayed as Dormant

```
(host) (stack-profile) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
```

```
Stack uptime: 4 hours 24 minutes 50 seconds
Id    Role       MAC Address    Priority  State        Model            Serial
--    ----       -----------    --------  -----        -----            ------
0   *  Primary  001a.1e08.7bc0  Preset    Active      ArubaS2500-48T   BK0000020
1      Secondary  001a.1e08.7a80  Preset    Active      ArubaS2500-48T   BK0000017
2      Linecard 001a.1e08.7b80  128      Dormant [C]  ArubaS2500-48T   BK0000018
3      Linecard 001a.1e08.7c80  Preset    Active      ArubaS2500-48T   BK0000014

[S] - Split
[V] - Version Mismatch
[D] - Depleted Slots
[C] - Preset Configuration Mismatch
[I] - Preset Independent Stack
```

6. Add the serial number of the new unit to the ArubaStack using the following command and save the configuration.

```
(host) (stack-profile) #member-id 2 serial-number BK0000018 role  line-card
WARNING!! This profile will not be applied till the configuration is saved.

(host) (stack-profile) #write memory
Saving Configuration......

Configuration Saved.

(host) #
```

7. The new unit will now be part of the ArubaStack

```
(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 3 hours 14 minutes 49 seconds
Id    Role       MAC Address     Priority  State     Model            Serial
--    ----       -----------     --------  -----     -----            ------
0   *  Primary    001a.1e08.7bc0  Preset    Active    ArubaS2500-48T   BK0000020
1      Secondary  001a.1e08.7a80  Preset    Active    ArubaS2500-48T   BK0000017
2      Linecard   001a.1e08.7b80  Preset    Active    ArubaS2500-48T   BK0000018
3      Linecard   001a.1e08.7c80  Preset    Active    ArubaS2500-48T   BK0000014
```

Replacing a Secondary Member

In a stack-preset configuration at least two members in a ArubaStack must be configured as primary capable.

- An existing Linecard member will be elected as the Secondary if there is a unit that has a role as primary-capable
- If all other units are configured as Linecard, no Secondary member will be elected.
- If the Secondary unit needs to be replaced, the best practices are listed below.

```
(host) #show stack-profile

stack-profile "default"
-----------------------
Parameter                Value
---------                -----
MAC persistence timeout  14 Minutes
Split Detection          Enabled

Preset-profile:
---------------
Member-id       Serial-number  Role
0               BK0000020      Primary-capable
1               BK0000017      Primary-capable
2               BK0000018      Line-card
3               BK0000014      Line-card
```

In the above ArubaStack of four members, if the Secondary member 1 is down and needs to be replaced, here are the steps:

1. Verify stacking members. Secondary member 1 is down and the status will be displayed as Away and the role will be Unknown.

```
(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 4 hours 17 minutes 39 seconds
Id    Role      MAC Address     Priority  State     Model            Serial
--    ----      -----------     --------  -----     -----            ------
0  *  Primary   001a.1e08.7bc0  Preset    Active    ArubaS2500-48T   BK0000020
1     Unknown   001a.1e08.7a80  Preset    Away      ArubaS2500-48T   BK0000017
2     Linecard  001a.1e08.7b80  Preset    Active    ArubaS2500-48T   BK0000018
3     Linecard  001a.1e08.7c80  Preset    Active    ArubaS2500-48T   BK0000014
```

2. To replace member 1, clear the stacking database from the ArubaStack using the clear command as shown below.

```
(host) #clear stacking member-id 1

Member-id: 0
------------
Deleting Member-id: 1

Member-id: 2
------------
Deleting Member-id: 1

Member-id: 3
------------
Deleting Member-id: 1
```

3. Stacking database will be cleared and member 1 will not be visible in the show stacking command as shown below.

```
((host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 4 hours 20 minutes 18 seconds
Id    Role      MAC Address     Priority  State     Model            Serial
--    ----      -----------     --------  -----     -----            ------
0  *  Primary   001a.1e08.7bc0  Preset    Active    ArubaS2500-48T   BK0000020
2     Linecard  001a.1e08.7b80  Preset    Active    ArubaS2500-48T   BK0000018
3     Linecard  001a.1e08.7c80  Preset    Active    ArubaS2500-48T   BK0000014
```

4. Delete the serial number of member 1 from the stack-profile.

```
(host) (stack-profile) #no member-id 1 serial-number BK0000017 role line-card
```

5. Physically replace member with a new unit.
6. The unit will not be an active part of the ArubaStack until the serial number is added to the stack-profile and will be displayed as Dormant.

```
(host) (stack-profile) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 4 hours 34 minutes 57 seconds
Id    Role      MAC Address    Priority  State       Model            Serial
--    ----      -----------    --------  -----       -----            ------
```

```
0   *  Primary  001a.1e08.7bc0  Preset    Active       ArubaS2500-48T   BK0000020
1      Linecard 001a.1e08.7b00  128       Dormant [C]  ArubaS2500-48T   BK0000016
2      Linecard 001a.1e08.7b80  Preset    Active       ArubaS2500-48T   BK0000018
3      Linecard 001a.1e08.7c80  Preset    Active       ArubaS2500-48T   BK0000014

[S] - Split
[V] - Version Mismatch
[D] - Depleted Slots
[C] - Preset Configuration Mismatch
[I] - Preset Independent Stack
```

7. Add the serial number of the new unit to the ArubaStack using the following command and save the configuration

```
(host) (config) #stack-profile member-id 1 serial-number BK0000016 role primary-capable
WARNING!! This profile will not be applied till the configuration is saved.

(host) (config) #write memory
Saving Configuration......

Configuration Saved.
```

8. The new unit will now be part of the ArubaStack

```
(host) (config) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 4 hours 47 minutes 18 seconds
Id     Role       MAC Address     Priority  State     Model            Serial
--     ----       -----------     --------  -----     -----            ------
0   *  Primary    001a.1e08.7bc0  Preset    Active    ArubaS2500-48T   BK0000020
1      Secondary  001a.1e08.7b00  Preset    Active    ArubaS2500-48T   BK0000016
2      Linecard   001a.1e08.7b80  Preset    Active    ArubaS2500-48T   BK0000018
3      Linecard   001a.1e08.7c80  Preset    Active    ArubaS2500-48T   BK0000014
```

Replacing a Primary Member

In a stack-preset configuration at least two members in a ArubaStack must be configured as primary capable.

- The Secondary member will be elected as a Primary.
- An existing Linecard member will be elected as the Secondary if there is a unit that has a role as primary-capable
- If all other units are configured as Linecard, no Secondary member will be elected.
- If the Primary unit needs to be replaced, the best practices are listed below.

In this scenario member-id 0 and 1 are configured as primary capable

```
(host) #show stack-profile

stack-profile "default"
-----------------------
Parameter                Value
---------                -----
MAC persistence timeout  14 Minutes
Split Detection          Enabled

Preset-profile:
---------------
Member-id         Serial-number  Role
 0                BK0000020      Primary-capable
 1                BK0000016      Primary-capable
 2                BK0000018      Line-card
 3                BK0000014      Line-card

(host) #show stacking members
```

```
Member status: Active, Stack Id: 001a1e087b004fcee152
Id     Role       MAC Address     Priority  State     Model            Serial
--     ----       -----------     --------  -----     -----            ------
0      Primary    001a.1e08.7bc0  Preset    Active    ArubaS2500-48T   BK0000020
1      Secondary  001a.1e08.7a80  Preset    Active    ArubaS2500-48T   BK0000017
3   *  Linecard   001a.1e08.7c80  Preset    Active    ArubaS2500-48T   BK0000014
4      Linecard   001a.1e08.7b80  Preset    Active    ArubaS2500-48T   BK0000018
```

In the above ArubaStack of four members, if the Primary member 0 is down and needs to be replaced, here are the steps:

1. Verify stacking members. Primary member 0 is down and the status will be displayed as Away and the role will be Unknown. An existing Secondary member will be elected as the Primary.

```
(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 4 hours 52 minutes 32 seconds
Id     Role       MAC Address     Priority  State     Model            Serial
--     ----       -----------     --------  -----     -----            ------
0      Unknown    001a.1e08.7bc0  Preset    Away      ArubaS2500-48T   BK0000020
1   *  Primary    001a.1e08.7b00  Preset    Active    ArubaS2500-48T   BK0000016
2      Linecard   001a.1e08.7b80  Preset    Active    ArubaS2500-48T   BK0000018
3      Linecard   001a.1e08.7c80  Preset    Active    ArubaS2500-48T   BK0000014
```

2. To replace member 0, clear the stacking database from the ArubaStack using the clear command as shown below.

```
(host) #clear stacking member-id 0

Member-id: 1
------------
Deleting Member-id: 0

Member-id: 2
------------
Deleting Member-id: 0

Member-id: 3
------------
Deleting Member-id: 0
```

3. Stacking database will be cleared and member 0 will not be visible in the show stacking command as shown below.

```
(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 5 hours 12 minutes 55 seconds
Id     Role       MAC Address     Priority  State     Model            Serial
--     ----       -----------     --------  -----     -----            ------
1   *  Primary    001a.1e08.7b00  Preset    Active    ArubaS2500-48T   BK0000016
2      Linecard   001a.1e08.7b80  Preset    Active    ArubaS2500-48T   BK0000018
3      Linecard   001a.1e08.7c80  Preset    Active    ArubaS2500-48T   BK0000014
```

4. Delete the serial number of member 0 from the stack-profile.

```
(host) (stack-profile) #no member-id 0 serial-number BK0000020 role line-card
```

5. Physically replace member with a new unit.

6. The unit will not be an active part of the ArubaStack until the serial number is added to the stack-profile and will be displayed as Dormant

```
(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 5 hours 24 minutes 32 seconds
Id    Role       MAC Address     Priority  State        Model            Serial
--    ----       -----------     --------  -----        -----            ------
0    Linecard  001a.1e08.7ac0  128      Dormant [C]  ArubaS2500-48T   BK0000019
1  * Primary   001a.1e08.7b00  Preset   Active       ArubaS2500-48T   BK0000016
2    Linecard  001a.1e08.7b80  Preset   Active       ArubaS2500-48T   BK0000018
3    Linecard  001a.1e08.7c80  Preset   Active       ArubaS2500-48T   BK0000014

[S] - Split
[V] - Version Mismatch
[D] - Depleted Slots
[C] - Preset Configuration Mismatch
[I] - Preset Independent Stack
```

7. Add the serial number of the new unit to the ArubaStack using the following command and save the configuration.

```
(host) (config) #stack-profile member-id 0 serial-number BK0000019 role primary-capable
WARNING!! This profile will not be applied till the configuration is saved.

(host) (config) #write memory
Saving Configuration......

Configuration Saved.
```

8. The new unit will now be part of the ArubaStack and be elected as Secondary

```
(host) #show stacking members

Member status: Active, Stack Id: 001a1e087b004fcee152
Stack uptime: 5 hours 29 minutes 51 seconds
Id    Role       MAC Address     Priority  State     Model            Serial
--    ----       -----------     --------  -----     -----            ------
0     Secondary  001a.1e08.7ac0  Preset    Active    ArubaS2500-48T   BK0000019
1  *  Primary    001a.1e08.7b00  Preset    Active    ArubaS2500-48T   BK0000016
2     Linecard   001a.1e08.7b80  Preset    Active    ArubaS2500-48T   BK0000018
3     Linecard   001a.1e08.7c80  Preset    Active    ArubaS2500-48T   BK0000014
```

The Mobility Access Switch family includes platforms that support 12, 24 or 48 gigabit ethernet network interfaces, up to four 10-gigabit ethernet (S2500/S3500), four gigabit ethernet (S1500-24/48) or two gigabit ethernet (S1500-12P) uplink interfaces and an out of band ethernet management port (S2500/S3500 only).

This chapter includes the following topics:

Configuring the Management Port

The management interface is located above the console port on the rear panel of the Mobility Access Switch. It is labeled as *mgmt.* The management port is a dedicated interface for out-of-band management purpose. This interface is specifically available for the management of the system and cannot be used as a switching interface. You can configure only the IP address and description for this interface. The management port can be used to access the Mobility Access Switch from any location and configure the system.

You can configure the management port using the CLI.

Using the CLI

```
(host)(config)# interface mgmt
   description <name>
   ip address <ip-address> <mask>
   ipv6 [ <prefix> prefix_len <prefix_len> | link-local <link-local-address> ]
   no {...}
   shutdown
```

Sample Management Port Configuration

```
(host)(config)# interface mgmt
   description MGMT_PORT
   ip address 10.1.13.1 255.255.255.0
   no shutdown
```

Gigabit Ethernet Network Interfaces

The Mobility Access Switch supports 12, 24, or 48 port gigabit ethernet interfaces of 10/100/1000 Mbps speeds. The S3500-24F supports 24 small form-factor pluggable (SFP) gigabit ethernet interfaces (SFPs sold separately).

A network gigabit ethernet interface is referred by its *<slot>/<module>/<port>*.

- Slot–The member ID of the stack.

- Module–There are two modules where the first one is the front-panel network module (0), while the other one is the uplink network module (1).
- Port–The individual port number.

For example, interface gigabitethernet 0/0/20 refers to the first stack member (0) on the front-panel network module (0) at port number (20).

NOTE

The Mobility Access Switch also supports two/four Gigabit Ethernet (S1500s) or four 10-Gigabit Ethernet interfaces (S2500/S3500) for stacking and uplink purposes. See the Hardware Installation Guide for more information on the uplink ports.

Small Form-factor Pluggable Diagnostics

A Small Form-factor Pluggable (SFP) module is a compact, hot-pluggable transceiver used for both telecommunication and data communications applications. Diagnostic information related to signal strength, temperature, etc can be polled from SFPs installed in the Mobility Access Switch.

This chapter includes the following topics:

- Important Points to Remember on page 101
- Viewing SFP Diagnostic Information on page 101
- Sample Configuration on page 102

Important Points to Remember

- SFP diagnostic is not supported on copper transceivers. Only fiber transceivers are supported.
- SFP diagnostic is supported on 1 Gbit/s and 10 Gbit/s fiber transceivers.
- Aruba supports most 1 Gbit/s and 10 Gbit/s transceivers. However, the following list is tested by Aruba:
  - 1 Gbit/s transceivers
    - OpNext TRF2716AALB400 (SFP-SX)
    - OpNext TRF2716AALB465 (SFP-SX)
    - Fiberxon, Inc. FTM-3012C-SLG (SFP-LX)
  - 10 Gbit/s transceivers
    - Finisar FTLX1371D3BCL (SFP-10GE-LRM)
    - OpNext TRS2001EN-0065 (SFP-10GE-SR)
    - OpNext TRS5020EN-S002 (SFP-10GE-LR)

Viewing SFP Diagnostic Information

You can view the SFP diagnostic information by issuing the following CLI commands.

Using the CLI

To display detailed interface transceiver diagnostic information, issue the following command:

```
(host) #show interface gigabitethernet 0/1/1 transceiver detail
```

To display detailed stacking interface transceiver diagnostic information, issue the following command:

```
(host) #show stacking interface stack 0/1 transceiver detail
```

To display basic transceiver information, issue the following command:

```
(host) #show interface transceiver brief
```

Sample Configuration

The following example displays detailed interface transceiver diagnostic information.

```
(host) #show interface gigabitethernet 0/1/0 transceiver detail
Vendor Name                                 : OPNEXT INC
Vendor Serial Number                        : L12J55161
Vendor Part Number                          : TRF2716AALB465
Aruba Supported                             : YES
Cable Type                                  : 1000BASE-SX
Connector Type                              : LC
Wave Length                                 : 850 nm
Last update of transceiver information      : 4 hours 41 min 50 sec
Module          Low Warning     Low Alarm       High Warning     High Alarm
Temperature     Threshold       Threshold       Threshold        Threshold
------------    ------------    ------------    ------------     ------------
37 C /          -10 C /         -15 C /         80 C /           85 C /
98.60 F         14.00 F         5.00 F          176.00 F         185.00 F
Low             Low             High            High
Warning         Alarm           Warning         Alarm
------------    ------------    ------------    ------------
Inactive        Inactive        Inactive        Inactive
Module          Low Warning     Low Alarm       High Warning     High Alarm
Voltage         Threshold       Threshold       Threshold        Threshold
------------    ------------    ------------    ------------     ------------
3404 mV         3100 mV         3000 mV         3500 mV          3600 mV
Low             Low             High            High
Warning         Alarm           Warning         Alarm
------------    ------------    ------------    ------------
Inactive        Inactive        Inactive        Inactive
Laser Bias      Low Warning     Low Alarm       High Warning     High Alarm
Current         Threshold       Threshold       Threshold        Threshold
------------    ------------    ------------    ------------     ------------
4 mA            1 mA            1 mA            14 mA            15 mA
Low             Low             High            High
Warning         Alarm           Warning         Alarm
------------    ------------    ------------    ------------
Inactive        Inactive        Inactive        Inactive
Laser TX        Low Warning     Low Alarm       High Warning     High Alarm
Power           Threshold       Threshold       Threshold        Threshold
------------    ------------    ------------    ------------     ------------
0.279 mW /      0.089 mW /      0.070 mW /      0.631 mW /       0.794 mW /
-5.54 dBM       -10.51 dBM      -11.55 dBM      -2.00 dBM        -1.00 dBM
Low             Low             High            High
Warning         Alarm           Warning         Alarm
------------    ------------    ------------    ------------
Inactive        Inactive        Inactive        Inactive
Laser RX        Low Warning     Low Alarm       High Warning     High Alarm
Power           Threshold       Threshold       Threshold        Threshold
------------    ------------    ------------    ------------     ------------
0.000 mW/       0.015 mW/       0.012 mW/       1.258 mW/        1.584 mW/
-40.00 dBM      -18.24 dBM      -19.21 dBM      1.00 dBM         2.00 dBM
Low             Low             High            High
Warning         Alarm           Warning         Alarm
------------    ------------    ------------    ------------
Active          Active          Inactive        Inactive
```

The following example displays the stacking interface transceiver diagnostic information.

```
(host) #show stacking interface stack 0/1 transceiver detail
Vendor Name                                 : OPNEXT INC
Vendor Serial Number                        : L12J55161
Vendor Part Number                          : TRF2716AALB465
Aruba Supported                             : YES
```

```
Cable Type                                  : 1000BASE-SX
Connector Type                              : LC
Wave Length                                 : 850 nm
Last update of transceiver information      : 1 min 44 sec
Module           Low Warning      Low Alarm        High Warning     High Alarm
Temperature      Threshold        Threshold        Threshold        Threshold
------------     ------------     ------------     ------------     ------------
40 C /           -10 C /          -15 C /          80 C /           85 C /
104.00 F         14.00 F          5.00 F           176.00 F         185.00 F
Low              Low              High             High
Warning          Alarm            Warning          Alarm
------------     ------------     ------------     ------------
Inactive         Inactive         Inactive         Inactive
Module           Low Warning      Low Alarm        High Warning     High Alarm
Voltage          Threshold        Threshold        Threshold        Threshold
------------     ------------     ------------     ------------     ------------
3404 mV          3100 mV          3000 mV          3500 mV          3600 mV
Low              Low              High             High
Warning          Alarm            Warning          Alarm
------------     ------------     ------------     ------------
Inactive         Inactive         Inactive         Inactive
Laser Bias       Low Warning      Low Alarm        High Warning     High Alarm
Current          Threshold        Threshold        Threshold        Threshold
------------     ------------     ------------     ------------     ------------
4 mA             1 mA             1 mA             14 mA            15 mA
Low              Low              High             High
Warning          Alarm            Warning          Alarm
------------     ------------     ------------     ------------
Inactive         Inactive         Inactive         Inactive
Laser TX         Low Warning      Low Alarm        High Warning     High Alarm
Power            Threshold        Threshold        Threshold        Threshold
------------     ------------     ------------     ------------     ------------
0.279 mW /       0.089 mW /       0.070 mW /       0.631 mW /       0.794 mW /
-5.54 dBM        -10.51 dBM       -11.55 dBM       -2.00 dBM        -1.00 dBM
Low              Low              High             High
Warning          Alarm            Warning          Alarm
------------     ------------     ------------     ------------
Inactive         Inactive         Inactive         Inactive
Laser RX         Low Warning      Low Alarm        High Warning     High Alarm
Power            Threshold        Threshold        Threshold        Threshold
------------     ------------     ------------     ------------     ------------
0.000 mW/        0.015 mW/        0.012 mW/        1.258 mW/        1.584 mW/
-40.00 dBM       -18.24 dBM       -19.21 dBM       1.00 dBM         2.00 dBM
Low              Low              High             High
Warning          Alarm            Warning          Alarm
------------     ------------     ------------     ------------
Active           Active           Inactive         Inactive
```

The following example displays transceiver diagnostic information in a tabular format.

```
(host) # show interface transceivers brief
Port     VendorName       VendorSN         ArubaSupported  CableType
----     -----------      --------         --------------  ---------
GE0/1/0  OPNEXT INC       L12J55161        YES             1000BASE-SX
```

Configuring Ethernet Interfaces

To set up your network, you can configure the various parameters for each ethernet network and uplink interfaces individually. You can also configure the parameters for a range of interfaces in case of identical configuration.

Using the CLI

To configure one interface at a time, use the following command :

```
(host)(config)# interface gigabitethernet <slot/module/port>
  aaa-profile <profile_name>
  backup interface {gigabitethernet <slot/module/port> | port-channel <0-7>}
  clone <source>
  description <description>
  enet-link-profile <profile_name>
  igmp-snooping mrouter-vlan {add | delete} <vlan-id>
  ip access-group in <in>
  lacp-profile <profile_name>
  lldp-profile <profile_name>
  mac-limit <limit>
  mirroring-in-profile <profile_name>
  mirroring-out-profile <profile_name>
  mstp-profile <profile_name>
  mtu <64-9216>
  no {...}
  poe-profile <profile_name>
  policer-profile <profile_name>
  preemption delay <10-300>
  preemption mode {forced | off}
  qos trust
  qos-profile <profile_name>
  shutdown
  switching-profile <profile_name>
  trusted port
  tunneled-node-profile <profile_name>
  voip-profile <profile_name>
  exit
```

To configure a range of interfaces at the same time, use the following command:

```
(host)(config) #interface range gigabitethernet <interface-list>
(host)(config-range)#?
  aaa-profile             Apply AAA profile to interface
  description             Interface description
  enet-link-profile       Apply ethernet link profile to interface
  gvrp-profile            Apply GVRP profile to interface
  ip                      Apply IP access control list
  lacp-profile            Apply LACP profile to interface
  lldp-profile            Apply lldp profile to interface
  mirroring-in-profile    Apply ingress mirroring profile to interface
  mirroring-out-profile   Apply egress mirroring profile to interface
  mstp-profile            Apply MSTP profile to interface
  mtu                     Set MTU on interface between 64 and 9216
  no                      Delete Command
  oam-profile             Apply OAM profile to interface
  poe-profile             Apply POE profile to interface
  policer-profile         Apply policer profile to interface
  port-security-profile   Apply security profile to interface
  pvst-port-profile       Apply PVST profile to interface
  qos                     Interface QoS
  qos-profile             Apply  QOS profile to interface
  shutdown                Shut down the selected interface
  switching-profile       Apply switchport profile to interface
  trusted                 Set trusted mode for the interface
  tunneled-node-profile   Apply Tunneled Node profile to interface
  voip-profile            Apply  VOIP profile to interface
```

Configuring Jumbo Frame Size

The Mobility Access Switch supports jumbo frames. You can enable jumbo frames on a per-interface basis with sizes from 64 to 9216 bytes. The default size is 1514 bytes.

```
(host)(config)# interface gigabitethernet 0/0/6
   mtu 9216
   exit
```

Verifying Jumbo Frame Size

You can verify the jumbo frame size on an interface using the following command:

```
(host)# show interface gigabitethernet 0/0/6
GE0/0/6 is administratively Up, Link is Down, Line protocol is Down
Hardware is Gigabit Ethernet, Address is 00:0b:86:6a:42:03
Encapsulation ARPA, Loopback not set
Configured: duplex (Auto), Speed (Auto), FC (Off), Autoneg (On)
Auto negotiation in progress
Interface index: 2
MTU 9216 bytes
Flags: Access, Trusted
Link status last changed:       0d 00:00:00 ago
Last update of counters:        0d 00:00:00 ago
Last clearing of counters:      0d 00:00:00 ago
<output truncated>
```

Displaying Interface Counters and Statistics

```
(host)# show interface gigabitethernet 0/0/1 counters
Port                         InOctets   InUcastPkts   InMcastPkts   InBcastPkts
GE0/0/1                             0             0             0             0
Port                        OutOctets  OutUcastPkts  OutMcastPkts  OutBcastPkts
GE0/0/1                             0             0             0             0

(host)# show interface gigabitethernet 0/0/1 statistics
Last update of counters:        0d 00:00:00 ago
Last clearing of counters:      0d 00:00:00 ago
Received Statistics:
   0 frames, 0 octets
   0 unicast, 0 multicast, 0 broadcast
   0 error frames, 0 error octets, 0 CRC events, 0 runts, 0 giants, 0 throttles
   0 drop events
Transmitted Statistics:
   0 frames, 0 octets
   0 unicast, 0 multicast, 0 broadcast
   0 throttles, 0 deferred
   0 collisions, 0 multiple collisions, 0 late collisions
Received and Transmitted Frame Size Statistics:
0 64 octet, 0 65-127 octet, 0 128-255 octet, 0 256-511 octet, 0 512-1023 octet, 0 1024-max oct
et
```

Configuring an Interface Group

In the CLI configuration, it is often tedious to individually configure interfaces when there are multiple interfaces that have the same configuration. In such scenarios, you can group the interfaces together so that any interface within the group has the same configuration. When you configure an interface that is a member of an interface-group, applying a non-default profile or a parameter to the interface takes precedence over the interface-group configuration. By default, all the interfaces belong to a default interface-group.

To view the configuration of the default interface-group, use the **show interface-group-config gigabitethernet default** command. When you create non-default interface-groups, the excluded interfaces continue to belong to the default interface-group.

NOTE

Interface-group and port-channel are not the same. Interface group assigns the configuration to individual interfaces whereas the port-channel makes a group of interfaces to work as a single logical interface.

NOTE

You cannot have overlapping ranges of interfaces when you have multiple interface-groups. For more information about the scope of an interface and interface-group profiles, see Scope of the Profiles and Parameters on page 41.

Using the CLI

```
(host)(config)# interface-group gigabitethernet {default|<group-name>}
   aaa-profile <profile_name>
   apply-to <interface range> add | remove
   clone <source>
   enet-link-profile <profile_name>
   igmp-snooping mrouter-vlan {add | delete} <vlan-id>
   ip access-group in <in>
   lacp-profile <profile_name>
   lldp-profile <profile_name>
   mac-limit <limit>
   mirroring-in-profile <profile_name>
   mirroring-out-profile <profile_name>
   mld-snooping mrouter-vlan {add | delete} <vlan-list>
   mstp-profile <profile_name>
   mtu <64-9216>
   tunneled-node-profile <profile-name>
   no {...}
   poe-profile <profile_name>
   policer-profile <profile_name>
   qos trust
   qos-profile <profile_name>
   shutdown
   switching-profile <profile_name>
   trusted port
   voip-profile <profile_name>
```

Sample Interface Group Configuration

```
(host)(config)# interface-group gigabitethernet FINANCE
   apply-to 0/0/0-0/0/20,0/0/32
```

NOTE

Ensure that you do not add blank spaces between the ranges or multiple interfaces, and there must be three tuples in the individual, starting, and ending ranges. Also, the interface numbers should be in ascending order from start to finish of the range value. For example, 0/0, 0/1/0-1/1 is not a valid range because there is a space and the interface number format is not of slot/module/port in all the occurrences.

Verifying the Interface Group Configuration

You can use the following commands to view details about an interface-group.

```
(host)# show interface-group-config gigabitethernet default
gigabitethernet "default"
-------------------------
Parameter                                    Value
---------                                    -----
Interface group members                      ALL
Interface MSTP profile                       default
```

```
Interface Tunneled Node profile             N/A
Interface VOIP profile                      N/A
Interface LLDP profile                      lldp-factory-initial
Interface PoE profile                       poe-factory-initial
Interface Ethernet link profile             default
Interface LACP profile                      N/A
QoS Profile                                 N/A
Policer Profile                             N/A
Interface AAA profile                       N/A
Interface Ingress Mirroring profile         N/A
Interface Egress Mirroring profile          N/A
Interface shutdown                          Disabled
mtu                                         1514
Ingress ACL                                 N/A
QoS Trust                                   Disabled
Interface switching profile                 default
Static IGMP Multicast Router port for VLANs N/A
Static MLD Multicast Router port for VLANs  N/A
Interface Trusted/Untrusted                 Trusted
MAC-Limit (Action)                          N/A

(host)# show interface-group-config gigabitethernet FINANCE
gigabitethernet "FINANCE"
----------------------------
Parameter                                   Value
---------                                   -----
Interface group members                     0/0/0-0/0/20,0/0/32
Interface MSTP profile                      default
Interface Tunneled Node profile             N/A
Interface VOIP profile                      N/A
Interface LLDP profile                      default
Interface PoE profile                       default
Interface Ethernet link profile             default
Interface LACP profile                      N/A
QoS Profile                                 N/A
Policer Profile                             N/A
Interface AAA profile                       N/A
Interface Ingress Mirroring profile         N/A
Interface Egress Mirroring profile          N/A
Interface shutdown                          Disabled
mtu                                         1514
Ingress ACL                                 N/A
QoS Trust                                   Disabled
Interface switching profile                 default
Static Multicast Router port for the VLANs  N/A
Interface Trusted/Untrusted                 Trusted
MAC-Limit (Action)                          N/A

(host)# show interface-group-config gigabitethernet
gigabitethernet List
--------------------
Name         References  Profile Status
----         ----------  --------------
default      0
FirstFloor   0
SecondFloor  0
Total:3
```

NOTE

In the case of LLDP and PoE profiles, the default interface-group has lldp-factory-initial and poe-factory-initial profiles applied, whereas a non-default interface-group that you create has the LLDP and PoE default profiles applied. The default LLDP and PoE profiles have LLDP and PoE disabled, while they are enabled in the factory-initial profiles.

You can view the differences in the LLDP and PoE factory-initial and default profiles using the following commands:

```
(host)# show interface-profile poe-profile poe-factory-initial
Power over Ethernet profile "poe-factory-initial"
-------------------------------------------------
Parameter                                 Value
---------                                 -----
Enable PoE interface                      Enabled
Max Power on PoE port milliwatts          30000
PoE port priority                         low
time-range-profile                        N/A

(host)# show interface-profile poe-profile default
Power over Ethernet profile "default"
-------------------------------------
Parameter                                 Value
---------                                 -----
Enable PoE interface                      Disabled
Max Power on PoE port milliwatts          30000
PoE port priority                         low
time-range-profile                        N/A


(host)# show interface-profile lldp-profile lldp-factory-initial
LLDP Profile "lldp-factory-initial"
-----------------------------------
Parameter                          Value
---------                          -----
LLDP pdu transmit                  Enabled
LLDP protocol receive processing   Enabled
LLDP transmit interval (Secs)      30
LLDP transmit hold multiplier      4
LLDP-MED protocol                  Enabled

(host)# show interface-profile lldp-profile default
LLDP Profile "default"
----------------------
Parameter                          Value
---------                          -----
LLDP pdu transmit                  Disabled
LLDP protocol receive processing   Disabled
LLDP transmit interval (Secs)      30
LLDP transmit hold multiplier      4
LLDP-MED protocol                  Disabled
```

Creating and Applying an Ethernet Link Profile to an Interface

You can use the ethernet link profile to configure the gigabit ethernet switching and uplink ports. The ethernet interfaces support auto negotiation from 10BaseT to 1000BaseT as per IEEE 802.3u/z standards. When you enable auto negotiation, the device that is connected to the port is automatically configured to the highest speed supported by the device in the following order (highest to lowest):

- 10000 Mbps full duplex (supported only on the S2500/S3500 uplink interfaces)
- 1000 Mbps full duplex
- 100 Mbps full duplex
- 100 Mbps half duplex
- 10 Mbps full duplex
- 10 Mbps half duplex

NOTE

The 10000 Mbps ports (10 gigabit uplink interfaces) cannot scale down to less than 1000 Mbps (1 gigabit speed).

Auto negotiation also supports the pause capabilities, automatic Media Detection Interface (MDI), and Media Detection Interface Crossover (MDIX) cable detection. The devices exchange information using the Fast link Pulse (FLP) bursts. The auto negotiation on the link is performed when you perform any of the following activities:

- Connect the device.
- Power on or reset the device at either end of the link.
- Make a negotiation request.

You can configure the ethernet link profile either using the CLI or the WebUI.

Using the WebUI

1. Navigate to the **Configuration > Ports > Ethernet** page.
2. Click **New** under the Profiles list, and enter a name for the Ethernet profile.
3. Click on the **Speed/Duplex** column and select the Speed and Duplex from the popup window.
4. Select a **Flow Control** option from the next column.
5. Select whether you need **Autonegotiation** enabled or disabled.
6. Click on the **Association** column and move the ports to the **Selected** list to apply this profile to selected ports.
7. Click **Apply**.

Using the CLI

```
(host)(config)# interface-profile enet-link-profile <profile-name>
   autonegotiation
   duplex {auto|full|half}
   speed {auto|10|100|10m_100m|1000|10000}
   flowcontrol {auto|on|off}
   no {...}
   exit
(host)(config)# interface gigabitethernet <slot/module/port>
   enet-link-profile <profile-name>
```

NOTE

When the port speed is explicitly configured, the autonegotiation is disabled.

Ethernet Link Default Profile

```
(host)# show interface-profile enet-link-profile default
Ethernet Link "default"
-----------------------
Parameter        Value
---------        -----
Speed            auto
Duplex           auto
Autonegotiation  Enabled
Flowcontrol      off
```

Sample Ethernet Link Profile Configuration

```
(host)(config)# interface-profile enet-link-profile intspd
   duplex full
   speed 1000
(host)(config)# interface gigabitethernet0/0/0
```

```
enet-link-profile intspd
```

Verifying Ethernet Link Profile Configuration

```
(host)# show interface gigabitethernet 0/0/0
GE0/0/0 is administratively Up, Link is Down, Line protocol is Down
Hardware is Gigabit Ethernet, Address is 00:0b:86:6a:42:02
Encapsulation ARPA, Loopback not set
Configured: duplex (Auto), Speed (Auto), FC (Off), Autoneg (On)
Auto negotiation in progress
Interface index: 1
MTU 1514 bytes
Flags: Access, Trusted
Link status last changed:      0d 00:00:00 ago
Last update of counters:       0d 00:00:00 ago
Last clearing of counters:     0d 00:00:00 ago
Statistics:
   Received 0 frames, 0 octets
   0 broadcasts, 0 runts, 0 giants, 0 throttles
   0 error octets, 0 CRC frames
   0 multicast, 0 unicast
   Transmitted 0 frames, 0 octets
   0 broadcasts, 0 throttles
   0 errors octets, 0 deferred
   0 collisions, 0 late collisions
PoE Information:
   Interface: GE0/0/0, Administratively Disable, Port status: On
   Maximum power: 30000 mW, Power consumption: 0 mW
   Port voltage: 0 mV, Port current: 0 mA
   PD class: Class-0, Priority: Low, PSE port status: On
```

Ethernet Flow Control

Ethernet flow control prevents loss of frames by providing a back pressure. When an ethernet port receives frames faster than it can handle, it sends a PAUSE frame to stop the transmission from the sender for a specific period of time. The PAUSE frame has a destination group address of 01-80-c2-00-00-01.

Use the following command in the ethernet link profile to configure flow control for an ethernet port:

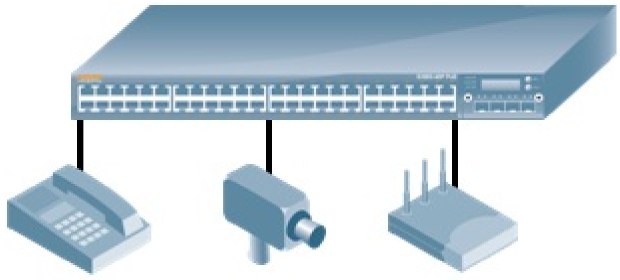
```
(host)(config)# [no] flow-control {on|off|auto}
```

NOTE

When flow control frames are received, only pausing the transmit is supported. Sending flow control frames are not supported. This means that the system can only respond to PAUSE frames and cannot generate them. The flow-control can be enabled or disabled to respond to incoming PAUSE frames.

Power Over Ethernet

Power over Ethernet (PoE) as per IEEE 802.3at is a technology for wired Ethernet LANs to carry the electric-power required for the device in the data cables. You can use this technology to power IP phones, wireless LAN access points, cameras, embedded computers, thin clients, and LCDs.



The IEEE standard defined in IEEE 802.3af allows network equipment (power sourcing equipment) to provide up to 15.4 Watts of power at the output for powered devices (PDs). In addition, the IEEE 802.3at (PoE+) standard provides more power to PDs where up to 30.0 Watts of power on output is delivered on the standard copper cable. The Mobility Access Switch supports both PoE standards.

Power Management Modes

The Mobility Access Switch supports three PoE power management modes:

- Static Mode–The power deducted from the total power pool is the maximum power for that interface. This mode ensures that the maximum power specified by you for the interface is always reserved and cannot be shared by other PDs.
- Dynamic Mode–The power allocated from the total power pool for each port is the actual power consumed at that port. You can allocate any unused portion of power to the other PDs. This is the default mode.
- Class-based Mode–The power allocated for each port from the total power pool is the maximum power available for the class of PD connected to that port.

Power Pools

The Mobility Access Switch family use a variety of power supply units (PSUs), some are integrated and some are modular depending on the platform

- Integrated 150W PSU–This power supply is used in the S1500-12P and provides 120W for PoE.
- Integrated 180W PSU–This power supply is used in the non-PoE models of the S2500.
- Integrated 580W PSU–This power supply is used in the 24 and 48 port PoE models of the S1500 and S2500 and provides 400W for PoE.
- Modular 350W PSU–This power supply is used in the non-PoE models of the S3500. You can also install two 350W PSUs for system redundancy.
- Modular 600W PSU–This power supply is used in the 24 and 48 port PoE models of the S3500 and provides 400W for PoE. You can also install two 600W PSUs for system redundancy and an increased PoE budget.
- Modular 1050W PSU–This power supply is used in the 48 port PoE model of the S3500 and provides 850W for PoE. You can also install two 1050W PSUs for system redundancy and an increased PoE budget.

Table 16: *Power Supply Pools*

Power Supply Capacity	System Power Redundancy	Power Available for PoE and PoE+Pool
350W	No	–
350W+350W	Yes	–
600W	No	400W
600W+600W	Yes	689W
1050W	No	850W
1050W+1050W	Yes	1465W

Mixed Mode PSUs

You can mix and match PSU models. The Table 17 describes the various mixed mode PSU models.

Table 17: *Mixed Mode PSUs*

	350W	600W	1050W
350W	No PoE	PoE with 400W budget Not redundant for PoE	PoE with 850W budget Not redundant for PoE
600W	PoE with 400W budget Not redundant for PoE	PoE with 666W budget	PoE with 666W budget
1050W	PoE with 850W budget Not redundant for PoE	PoE with 666W budget	PoE with 1440W budget

PoE Priority

When you have power shortage in the PoE pool, you can configure PoE port priority to define which PoE ports should be provided with power while disabling power on other ports until enough power is available for all the PoE ports. Priority can be either low (default), high, or critical. When there is a power shortage, the Mobility Access Switch stops power to the low priority ports, then high priority ports, until there is enough PoE power available in the pool. If the ports have the same priority, PoE is stopped for ports with higher interface numbers and then the lower interface numbers. For example, when there is an interface 0/0/4 and an interface 0/0/10 with the same priority, the Mobility Access Switch will stop power to the interface 0/0/10 before stopping power to the interface 0/0/4.

PoE Guard-Band

The PoE guard-band can provide protection when there is a sudden spike in the consumed power of PDs that could potentially impact other PoE enabled ports. When the guard-band is configured, the Mobility Access Switch reserves the specified amount of power to prevent other PoE enabled ports from powering off and then on again. The default value for guard-band is 11,000mW. You can specify the guard-band value in steps of 1000 starting from 1000 to 30,000 milliwatts.

PoE Compatibility with CISCO Legacy Devices

The Mobility Access Switch supports the IEEE 802.3af and 802.3at Power over Ethernet detection standards by default. Certain older CISCO PoE devices require a pre-standard Power over Ethernet detection method to be recognized and powered up. The Mobility Access Switch can power these devices in addition to standards based devices by enabling **cisco-compatibility** mode.

Execute the following commands to enable this functionality under the PoE management profile:

```
(host) (config)# poe-management-profile slot <slot_number 0-7>
cisco-compatibility
clone <source>
no {...}
poe-guardband <1000-30000 milliwatts>
poe-powermanagement {class|dynamic|static}
```

Execute the following command to disable this functionality:

```
(host) (poe-management profile "<slot number 0-7>") #no cisco-compatibility
```

Limitations

- The **cisco-compatibility** option is per stack member (slot) and not per port, i.e. if you configure this option it applies to the entire slot.
- When **cisco-compatibility** is disabled, the Mobility Access Switch continues to provide power to the CISCO legacy devices until that device is unplugged or the Mobility Access Switch is reloaded.
- When cisco-compatibility is enabled, Mobility Access Switch may provide PoE to any detected CISCO legacy switch with pre-standard PoE. It is recommended not to connect a CISCO legacy phone and legacy switch on the same slot.

Configuring Power Over Ethernet

PoE/PoE+ is enabled on the Mobility Access Switch by default. It supports plug-and-play capability for 802.3af/802.3at capable devices. You can configure PoE either using the CLI or the WebUI.

Using the WebUI

1. Navigate to the **Configuration > Ports > PoE** page.
2. Select a mode from the **Power Management Mode** drop-down list.
3. Click **Apply** and **Save Configuration**.

NOTE

You can configure only one PoE management mode for the stack.

Using the CLI

```
(host)(config)# poe-management-profile slot <slot_num>
  clone<source>
  poe-powermanagement {class|dynamic|static}
  poe-guardband <1000-30000 milliwats>
  no {...}
```

NOTE

You can configure different PoE management modes (class/dynamic/static) on each stack member.

Sample PoE Configuration

```
(host)(config)# poe-management-profile slot 0
```

```
poe-powermanagement static
poe-guardband 15000
```

Creating and Applying a PoE Profile to an Interface

You can configure the PoE profile either using the CLI or the WebUI.

Using the WebUI

1. Navigate to the **Configuration > Ports > PoE** page.
2. Click **New** under the Profiles list, and enter a name for the PoE profile.
3. Click on the **Priority** column and select the priority from the drop-down list.
4. Enter the power in milliwatts in the **Power(/mW) Port** column.
5. Select whether the PoE state is enabled or disabled in the **State** column.
6. Click on the **Association** column and move the ports to the **Selected** list to apply this profile to the selected ports.
7. Click **Apply** and **Save Configuration**.

Using the CLI

```
(host) (config)# interface-profile poe-profile <profile-name>
   close <source>
   enable
   poe-maxpower <milliwatts>
   poe-priority {critical|high|low}
   time-range-profile <name>
(host)(config)# interface gigabitethernet <slot/module/port>
   poe-profile <profile-name>
```

Sample PoE Profile Configuration

```
(host)(config)# interface-profile poe-profile CAMERAS
   poe-priority high
   poe-maxpower 15000
   enable
(host)(config)# interface gigabitethernet 0/0/15
   poe-profile CAMERAS
```

Time Range Support for PoE

The PoE supports time range for controlling the mode of the PoE power (enable/disable) to the PoE port. The PoE port mode is enabled by the administrator.

NOTE

By default, the time range profile is disabled in the poe-profile.

The PoE time range can be configured in two modes: **absolute** and **periodic**. In absolute mode, the time parameters correspond to a specific time range: start date, start time, end date, and the end time. The PoE port is enabled if the current system time is within this range. In periodic mode, the user can specify start day, start time, end day, and end time. The start day or end day can be daily, weekend, weekday, or any day of the week. The PoE port is enabled if the current day and time falls within the range.

The following are the invalid combinations for start and end values for the time range parameters in the periodic mode:

- **start-day**: daily, **end-day**: any other day other than daily

- **start-day**: weekend, **end-day**: any other day other than than weekend. (Here weekend refers to Saturday or Sunday)
- **start-day**: weekday, **end-day**: any other day other than weekday

NOTE

Both the **start-time** and the **end- time** should not have identical time values if the **start-day** and the **end-day** are same.

You can configure the PoE time-range-profile using the following CLI :

```
(host)(config)# time-range-profile <profile_name>
```

CAUTION

As a best practice, avoid configuring the PoE time-of-day when the connected devices are in the process of being upgraded or when a power loss has rendered the connected device inoperable. In the case of an Aruba wireless Access Point, the PoE time-of-day should not be configured when an AP flash memory upgrade is in progress as it may result in potential corruption of the flash.

PoE Factory-Initial and Default Profiles

When the Mobility Access Switch is booted as factory-default and when it is booted for the first time, the poe-factory-initial profile is associated to all the ports.

```
(host)# show interface-profile poe-profile poe-factory-initial
Power over Ethernet profile "poe-factory-initial"
-------------------------------------------------
Parameter                                 Value
---------                                 -----
Enable PoE interface                      Enabled
Max Power on PoE port milliwatts          30000
PoE port priority                         low
time-range-profile                        N/A
(host)# show interface-profile poe-profile default
Power over Ethernet profile "default"
-------------------------------------
Parameter                                 Value
---------                                 -----
Disable PoE interface                     Disabled
Max Power on PoE port milliwatts          30000
PoE port priority                         low
time-range-profile                        N/A
```

Monitoring Power-over-Ethernet

You can use the following commands to verify the PoE configuration and monitor the PoE usage:

```
(host)# show poe interface gigabitethernet 0/0/5

GE0/0/5: Administratively Enable, Port status: On
Maximum power: 30000 mW, Power consumption: 4400 mW
Port voltage: 56000 mV, Port current: 80 mA
PD class: Class-0, Priority: Low, PSE port status: On
Time-range: Periodic
Start: daily, 18:00:00 PST
End: daily, 09:00:00 PST

(host) #show poe interface brief
PoE Interface Brief
-------------------
Interface  Admin   Consumption(mW)  Port Priority  Port Status
---------  -----   ---------------  -------------  -----------
GE0/0/0    Enable  4100             High           On
GE0/0/1    Enable  0                Low            Off
```

```
GE0/0/2    Enable  2700            Low           On
GE0/0/3    Enable  0               Low           Off
GE0/0/4    Enable  0               Low           Off
GE0/0/5    Enable  4400            Low           On
<Intentionally Truncated>
```

(host) #show poe interface

```
GE0/0/0
-------
GE0/0/0: Administratively Enable, Port status: On
Maximum power: 30000 mW, Power consumption: 4100 mW
Port voltage: 55500 mV, Port current: 74 mA
PD class: Class-3, Priority: High, PSE port status: On
GE0/0/1
-------
GE0/0/1: Administratively Enable, Port status: Off
Maximum power: 30000 mW, Power consumption: 0 mW
Port voltage: 0 mV, Port current: 0 mA
PD class: Class-0, Priority: Low, PSE port status: Off, PD detection in progress
GE0/0/2
-------
GE0/0/2: Administratively Enable, Port status: On
Maximum power: 30000 mW, Power consumption: 2700 mW
Port voltage: 55800 mV, Port current: 48 mA
PD class: Class-0, Priority: Low, PSE port status: On
<Intentionally Truncated>
```

(host) # show poe

```
Port      Status  Voltage(mV)  Current(mA)  Power (mW)
----      ------  -----------  -----------  ----------
GE0/0/0   On      55500        74           4100
GE0/0/1   Off     N/A          N/A          N/A
GE0/0/2   On      55800        50           2700
GE0/0/3   Off     N/A          N/A          N/A
GE0/0/4   Off     N/A          N/A          N/A
GE0/0/5   On      55900        80           4400
<Intentionally Truncated>
```

(host) # show poe controller

```
Linecard  PowerBudget(W)  Power Consumption(W)  GuardBand(mW)  PoE Management
--------  --------------  --------------------  -------------  --------------
0         689             7                     11000          Dynamic
```

(host) #show inventory

```
Show Inventory
--------------
System Card Slot                : 0
SC Serial #                     : AW0000428 (Date: 06/19/11)
SC Model Name                   : ArubaS3500-48P
Mgmt Port HW MAC Addr           : 00:0b:86:6b:82:81
HW MAC Addr                     : 00:0b:86:6b:82:80 to 00:0b:86:6b:82:bf
CPLD Version                    : (Rev: 11)
PoE Firmware Version            : 4.1.5 (Build: 1)
CPU Assembly #                  : 2010095E (Rev: 02.B0)
CPU Serial #                    : AB24019190 (Date: 06/15/11)
Fantray                         : Present (Version: 1)
Module 1                        : Online
Module 1 Assembly #             : 2010140B (Rev: 01.00)
Module 1 Serial #               : UB33000099 (Date: 08/17/11)
Power Supply 0                  : Present (600W)
                                : 12V System Voltage Ok
                                : 56V PoE Voltage Ok
```

```
Power Supply 0 Serial #         : QCS111900Y0 (Date: 05/13/11)
Power Supply 0 Model No         : 2510056
Power Supply 0 Vendor Model No  : DCJ6002-02P (Rev: 66.0)
Power Supply 1                  : Present (600W)
                                : 12V System Voltage Ok
                                : 56V PoE Voltage Ok
Power Supply 1 Serial #         : QCS112900JH (Date: 07/20/11)
Power Supply 1 Model No         : 2510056
Power Supply 1 Vendor Model No  : DCJ6002-02P (Rev: 66.0)
<Intentionally Truncated>
```

```
(host) #show port status
Interface  Admin   Line Protocol  Link  PoE      Trusted  Mode
---------  -----   -------------  ----  ---      -------  ----
GE0/0/0    Enable  Up             Up    Enable   No       Access
GE0/0/1    Enable  Down           Down  Enable   No       Access
GE0/0/2    Enable  Up             Up    Enable   No       Access
GE0/0/3    Enable  Down           Down  Enable   No       Access
GE0/0/4    Enable  Down           Down  Enable   No       Access
GE0/0/5    Enable  Up             Up    Enable   No       Access
<Intentionally Truncated>
```

Time-Domain Reflectometer

Time-Domain Reflectometer (TDR) is a measurement technique used to characterize and locate faults in metallic cables such as twisted pair. TDR transmits a short rise electric pulse across the conducting cable and if the cable is properly terminated, the entire electric pulse is absorbed on the other end. If any faults exist in the cable, some of the incident signal is sent back towards the source. TDR also:

- Locates the position of faults within meters
- Detects and reports open circuits, short circuits, and impedance mismatches in a cable
- Detects pair swap (straight/crossover) on each pair of cable in twisted pair cable
- Detects pair polarity (positive/negative) on each channel pairs in a cable

NOTE

TDR is not supported over management interfaces, Direct Attach Cables (DAC) or Fiber interfaces.

Use this command to execute a TDR diagnostic test on a specific gigabitethernet interface.

```
(host) (config)# run diagnostics interface gigabitethernet <slot/module/port> cable
```

Use the following command to view the test results for the Time-Domain Reflectometer (TDR) cable diagnostics:

```
(host)# show diagnostics interface gigabitethernet
```

A port-channel is a bundle of multiple physical interfaces that form a single logical interface. You can use port-channels to provide additional bandwidth or link redundancy between two devices. This chapter describes how to configure port-channels using the static Link Aggregation Group (LAG) and the dynamic Link Aggregation Control Protocol (LACP) methods.

This chapter includes the following topics:

Important Points to Remember

- A port-channel is always trusted. Any network that extends beyond the port-channel on the Mobility Access Switch must be a trusted network.
- The maximum port-channels supported per system is 8 groups for the S1500s and 64 groups for the S2500/S3500s; each group can be created statically or dynamically (via LACP).
- Each port-channel can have up to 8 member ports.
- The port-channel group identification (ID) range is 0 to 7 (S1500) or 0 to 63 (S2500/S3500s) for both static and dynamic port-channels.
- The static and dynamic methods must use different group IDs and different port-channel members.
- When a port is added to a port-channel, it inherits the port-channel's properties such as VLAN membership and trunk status.
- Ports that are already assigned a feature profile cannot be part of a static or dynamic port-channel.
- Aruba recommends that all the port-channel members have the same port speed and duplex for proper operation. Configuring dissimilar speed and duplex on the port-channel members will result in a syslog error message.
- There is no default LACP profile.
- For port-channel members, apart from the following profiles and parameters, all the other profiles and parameters are inherited from the port-channel configuration:
  - shutdown
  - lacp-profile
  - lldp-profile

Creating a Port-Channel

You can create port channels using the static method or the dynamic method.

- In the static method, you must first create the port-channel interface, and then add the physical interfaces to the port-channel.
- In the dynamic method, you must first create the lacp-profile and then apply the lacp-profile to the member interfaces.

Using the WebUI

1. Navigate to the **Configuration > Ports > Port Channel** page.

2. Select the **Group ID** for the port channel.
3. Select Static or LACP from the **Type** popup window and click **OK**.
4. Click on the **Membership** column and move the ports to the **Selected** list to include the selected ports to the port channel.
5. Click **Apply** and **Save Configuration**.

Using the CLI

```
(host) (config) #interface port-channel <0-63>
  backup [gigabitethernet <slot/module/port> | port-channel <0-63>]
  clone <source>
  description <description>
  enet-link-profile <profile-name>
  gvrp-profile <profile-name>
  igmp-snooping [ mrouter-vlan [ <vlan-list> | add <vlan-list> | delete <vlan-list>]]
  ip [access-group [in <ingress-acl> | out <egress-acl>]]
  mirroring-in-profile <profile-name>
  mirroring-out-profile <profile-name>
  mld-snooping [mrouter-vlan [<vlan-list> | add <vlan-list> | delete <vlan-list>]]
  mstp-profile <profile-name>
  mtu <64-9216>
  no
  policer-profile <profile-name>
  port-channel-members [<interface-list> | [add | delete] gigabitethernet <slot/module/port>]
  port-security-profile <profile-name>
  preemption [delay <10-300s> | mode [forced | off]]
  pvst-port-profile <profile-name>
  qos [trust [auto | dot1p | dscp | none]
  qos-profile <profile-name>
  shutdown
  switching-profile <profile-name>
```

NOTE

For all Mobility Access Switches except the S1500 Mobility Access Switch, you can configure up to 64 (0-63) port channels. For the S1500 Mobility Access Switch, you can configure only up to 8 (0-7) port channels.

Default Enet-Link Profile for Port-Channels

If you do not assign any enet-link-profile to the static or dynamic port-channel, the hidden **pc_default** profile is applied by default:

```
(show)# show interface-profile enet-link-profile pc_default
Ethernet Link "pc_default" (Predefined (editable))
--------------------------------------------------
Parameter        Value
---------        -----
Speed            1000
Duplex           full
Autonegotiation  Enabled
Flowcontrol      off
```

Sample Static Port-Channel Configuration

```
(host)(config)# interface port-channel 1
  port-channel-members gigabitethernet0/0/4,gigabitethernet0/0/5
  [or]
  port-channel-members add gigabitethernet 0/0/4
  port-channel-members add gigabitethernet 0/0/5
  exit
```

Verifying the Port-Channel Configuration

You can use the following command to verify the port-channel configuration:

```
(host) (config) #show interface port-channel 1
port-channel 1 is administratively Up, Link is Up, Line protocol is Up
Hardware is Port-Channel, Address is 00:0b:86:6a:70:c0
Description: Link Aggregate
Member port(s):
   GE0/0/4 is administratively Up, Link is Up, Line protocol is Up
   GE0/0/5 is administratively Up, Link is Up, Line protocol is Up
Speed: 2 Gbps
Interface index: 1445
MTU 1514 bytes
Flags: Access, Trusted
Link status last changed: 0d 02h:25m:57s ago
Last clearing of counters: 0d 02h:25m:57s ago
Statistics:
   Received 4973595 frames, 1272848056 octets
   668 pps, 1.383 Mbps
   32 broadcasts, 0 runts, 0 giants, 0 throttles
   0 error octets, 0 CRC frames
   13602 multicast, 4959961 unicast
   Transmitted 23674 frames, 6226872 octets
   0 pps, 0 bps
   39 broadcasts, 0 throttles
```

Creating and Applying a Dynamic Port-Channel Profile to an Interface

Using the WebUI

1. Navigate to the **Configuration > Ports > Port Channel** page.
2. Select the **Group ID** for the port channel.
3. Select LACP from the **Type** popup window.
4. Choose whether you want to select the LACP profile from a list of existing LACP profiles or you want to specify a new profile.
5. Select the LACP Profile name from the drop-down list or enter the name for the new LACP profile in the **Profile Name** text box.
6. Select the mode as passive or active from the **Mode** drop-down list.
7. Enter the priority in the **Priority** text box.
8. Select the timeout as long or short from the **Timeout** drop-down list.
9. Click on the **Membership** column and move the ports to the **Selected** list to include the selected ports to the port channel.
10. Click **Apply** and **Save Configuration**.

Using the CLI

```
(host)(config)# interface-profile lacp-profile <profile-name>
   group-id <0-63>
   mode {active|passive}
   port-priority <1-65535>
   timeout {long|short}
   no {...}
   exit
(host)(config)# interface gigabitethernet <slot/module/port>
   lacp-profile <profile-name>
```

NOTE

For all Mobility Access Switches except the S1500 Mobility Access Switch, you can configure up to 64 (0-63) port channel group-ids. For the S1500 Mobility Access Switch, you can configure only up to 8 (0-7) port channel group ids.

Sample Dynamic Port-Channel Configuration

```
(host)(config)# interface-profile lacp-profile LACP_2
   group-id 2
   mode active
   exit
(host)(config)# interface gigabitethernet 0/0/0
   lacp-profile LACP_2
   exit
(host)(config)# interface gigabitethernet 0/0/1
   lacp-profile LACP_2
   exit
```

Verifying Port-Channel Configuration

```
(host)# show interface port-channel 2
port-channel 0 is administratively Up, Link is Down, Line protocol is Down
Hardware is Port-Channel, LACP enabled, Address is 00:0b:86:6a:25:40
Description: Link Aggregate
Member port(s):
   GE0/0/0 is administratively Up, Link is Down, Line protocol is Down
   GE0/0/1 is administratively Up, Link is Down, Line protocol is Down
Speed: 0 Mbps
Interface index: 1443
MTU 1514 bytes
Flags: Access, Trusted
Link status last changed: 0d 04h:10m:27s ago
Last clearing of counters: 0d 00h:00m:02s ago
Statistics:
   Received 0 frames, 0 octets
   0 broadcasts, 0 runts, 0 giants, 0 throttles
   0 error octets, 0 CRC frames
   0 multicast, 0 unicast
   Transmitted 0 frames, 0 octets
   0 broadcasts, 0 throttles
   0 errors octets, 0 deferred
   0 collisions, 0 late collisions
```

Verifying Port-Channel Neighbor Information

```
(host) #show lacp 2 neighbor
Flags: S - Device is requesting slow LACPDUs
       F - Device is requesting fast LACPDUs
       A - Device is in Active mode P - Device is in Passive mode
LACP Neighbor Table
-------------------
Port     Flags  Pri  OperKey  State  Num  Dev Id
----     -----  ---  -------  -----  ---  ------
GE0/0/0  SP     0    0x0      0x0    0x0  00:00:00:00:00:00
GE0/0/1  SP     0    0x0      0x0    0x0  00:00:00:00:00:00
```

Verifying Port-Channel Internal (Local) Information

```
(host) #show lacp 2 internal

Flags: S - Device is requesting slow LACPDUs
       F - Device is requesting fast LACPDUs
       A - Device is in Active mode P - Device is in Passive mode
LACP Internal Table
```

```
-------------------
Port      Flags  Pri  AdminKey  OperKey  State  Num  Status
----      -----  ---  --------  -------  -----  ---  ------
GE0/0/0   SA     255  0x3       0x3      0x5    0x7  down
GE0/0/1   SA     255  0x3       0x3      0x5    0x8  down
```

Verifying Port-Channel Counters Information

```
(host) #show lacp 2 counters

LACP Counter Table
------------------
Port      LACPDUTx  LACPDURx  MrkrTx  MrkrRx  MrkrRspTx  MrkrRspRx  ErrPktRx
----      --------  --------  ------  ------  ---------  ---------  --------
GE0/0/0   0         0         0       0       0          0          0
GE0/0/1   0         0         0       0       0          0          0
```

Link Aggregation Control Protocol

The Mobility Access Switch supports Link Aggregation Control Protocol (LACP) based on the IEEE 802.3ad standard. LACP provides a standardized means for exchanging information with partner systems, to form a dynamic link aggregation group. LACP avoids port channel misconfiguration. You can define the LACP parameters in a `lacp-profile`, and then reference the profile in the ports to form a dynamic port-channel. A port-channel will be operationally down if all the ports in the port-channel are down.

LACP Port Modes

There are two modes in which the dynamic port-channel member interfaces can operate.

- Active mode—the interface is in active negotiating state. LACP runs on any link that is configured to be in the active state. The port in an active mode automatically initiates negotiations with other ports by initiating LACP packets.
- Passive mode—the interface is *not* in an active negotiating state and does not initiate negotiations. LACP runs on any link that is configured in a passive state. The port in a passive mode only responds to negotiations requests from other ports that are in an active state. .

NOTE

A port in a passive state cannot set up a port-channel with another port in a passive state. Hence, to form a port-channel group between two ports, one port must be an active participant.

LACP Session Timeout and Port Priority

You can set the timeout for a LACP session. The timeout value is the amount of time that a port-channel interface waits for a LACPDU from the remote system before terminating the LACP session. The default time out value is long (90 seconds); short is 3 seconds. You can also set the port priority. The higher the value the lower the priority. The priority range is 1 to 65535 and the default is 255.

When a port in a port-channel is misconfigured (that is, the partner port is different from the other ports) or if the neighbor experiences time out or if it cannot exchange LACPDUs with the partner, then the port operational status is displayed as DOWN.

NOTE

The port priority is used to dynamically select the ports that have the highest priority to form the port-channel when there are unspecified number of ports. As Mobility Access Switch provides support for a maximum of only 8 ports per port-channel, configuring the port priority does not have any effect.

Operations, Administration, and Maintenance (OAM) refers to the tools and utilities to install, monitor, and troubleshoot a network. This implementation of OAM complies with the IEEE 802.3ah standard and is able to report layer-2 network behavior. This helps network administrators monitor troubleshoot a network without sending technicians into the field to diagnose problems on location. OAM provides mechanisms to monitor link operation and health, and improve fault isolation.

The Mobility Access Switch OAM supports the following Link Fault Management Functionalities:

- Discovery - OAM-enabled local interface discovers remote interface enabled with OAM and notifies each other of own capabilities. After discovery, both sides send OAM PDUs periodically to monitor the link.
- Remote fault detection - Detection and handling of faulty link such as not receiving OAM PDU from the other peer within configured time-out or OAM PDU with “link-fault” flag.
- Remote loopback - Link segment testing controlled remotely using test frames. Usually remote loopback used during installation or for troubleshooting.

OAM is disabled by default. To enable OAM, you must create an OAM profile and apply it to a physical interface.

Creating an OAM Profile

OAM parameters are set by creating an OAM profile, which is a new type of interface profile.

```
(host) (config) # interface-profile oam-profile <oam-profile-name>
(host) (OAM profile "<oam-profile-name>") # ?
allow-loopback          Support OAM local loopback
clone                   Copy data from another OAM profile
discovery-mode          OAM discovery mode
link-fault-action       Action taken on link-fault detection
link-timeout            Timeout in seconds to declare link fault
no                      Delete Command
pdu-rate                Maximum OAM PDUs sent per second
remote-loopback         Put remote device into loopback mode
```

Table 18: *OAM Profile Parameters Default Values*

Parameter	Possible Values	Default Value
discovery-mode	Active, Passive	Active
remote-loopback	Enable, Disable	Disable
allow-loopback	Enable, Disable	Disable
pdu-rate	1 to10	5
link-timeout	2 to10	5
link-fault-action	Syslog, Error-disable	Error-disable

Sample Configuration

```
(host) (OAM profile "oam1") #allow-loopback
(host) (OAM profile "oam1") #link-fault-action syslog
```

```
(host) (OAM profile "oam1") #link-timeout 3
(host) (OAM profile "oam1") #pdu-rate 8

(host) (OAM profile "oam1") #show interface-profile oam-profile oam1

OAM profile "oam1"
------------------
Parameter                         Value
---------                         -----
OAM discovery mode                active
OAM remote-loopback               Disabled
OAM local-loopback                Enabled
OAM PDU rate (PDU per second)     8
OAM link-fault timeout (seconds)  3
OAM link-fault action             syslog
```

Applying an OAM Profile

Once you've created an OAM profile, you must apply it to physical interfaces.

```
(host) (config) #interface gigabitethernet 0/0/1
(host) (gigabitethernet "0/0/1") #oam-profile <oam-profile-name>
(host) (config) #interface gigabitethernet 0/0/2
(host) (gigabitethernet "0/0/2") #oam-profile <oam-profile-name>
```

NOTE

You cannot simultaneously apply both OAM and tunneled node settings to an interface.

NOTE

An OAM profile must be applied to each port channel member interface.

Applying OAM to each Port Channel Member

In this first example, the output of the **show interface port channel** command identifies **GE0/0/12** and **GE0/0/13** as member ports of port channel 4:

```
(host) (config) #show interface port-channel 4
port-channel 4 is administratively Up, Link is Up, Line protocol is Up
Hardware is Port-Channel, LACP enabled, Address is 00:0b:86:6a:70:c0
Description: Link Aggregate
Member port(s):
   GE0/0/12 is administratively Up, Link is Up, Line protocol is Up
   GE0/0/13 is administratively Up, Link is Up, Line protocol is Up
Speed: 2 Gbps
Interface index: 1445
MTU 1514 bytes
Flags: Access, Trusted
Link status last changed: 0d 02h:25m:57s ago
Last clearing of counters: 0d 02h:25m:57s ago
Statistics:
   Received 4973595 frames, 1272848056 octets
   668 pps, 1.383 Mbps
   32 broadcasts, 0 runts, 0 giants, 0 throttles
   0 error octets, 0 CRC frames
   13602 multicast, 4959961 unicast
   Transmitted 23674 frames, 6226872 octets
   0 pps, 0 bps
```

```
   39 broadcasts, 0 throttles
   0 errors octets, 0 deferred
   0 collisions, 0 late collisions
```

The commands in the example below below apply an OAM profile to Port Channel Members **GE0/0/12** and **GE0/0/13**:

```
(host) (config) #interface gigabitethernet 0/0/12
(host) (gigabitethernet "0/0/12") #oam-profile oam1
(host) (gigabitethernet "0/0/12") #interface gigabitethernet 0/0/13
(host) (gigabitethernet "0/0/13") #oam-profile oam1
(host) (gigabitethernet "0/0/13") #
```

Related Show Commands

The following show commands display the status of OAM on your Mobility Access Switches.

The **show oam brief** command displays a quick overview of the ports on which OAM is enabled.

```
OAM      Link-fault     Loopback     Link  Oper
Interface Mode    Action      Local   Remote  State State Remote MAC
--------- ------- ----------- ------- ------- ----- ----- -----------------
GE0/0/1   Active  Syslog      Enable  Disable Up    Up    00:0b:86:6a:4f:04
GE0/0/2   Active  Syslog      Enable  Disable Up    Up    00:0b:86:6a:4f:03
```

The **show oam counters** command displays the total PDUs received and transmitted, as well as the number of errors, on OAM-enabled ports.

```
Total PDU   Error PDU   Unknown PDU Total PDU   Transmit
Interface Received    Received    Received    Transmitted Discarded
--------- ----------- ----------- ----------- ----------- -----------
GE0/0/1           295           0           0         295           0
GE0/0/2           295           0           0         295           0
```

Use the **clear counters oam** command to clear any OAM counters:

```
(host) #clear counters oam
```

The **show oam interface gigabitethernet** command displays the OAM profile and status on a specific port:

```
show oam interface gigabitethernet <slot/port/module>
GE0/0/1 is operationally Up, Link is Up
   OAM link-fault action is syslog
   Local loopback is Enable, Remote loopback is Disable
   OAM PDU rate is 8, Link timeout is 3
Local:
   MAC address is 00:0b:86:6a:4f:03, PDU size is 64
   MUX state is Forward, Parser state is Forward
   Discovery mode is Active, Discovery state Completed
   Local is stable, Locat is satisified
Remote:
   MAC address is 00:0b:86:6a:4f:04, PDU size is 64
   MUX state is Forward, Parser state is Forward
   Discovery mode is Active
   Remote is stable, Remote is valid
```

The Mobility Access Switch supports IEEE 802.1Q VLANs. It supports MAC-based VLANs, tag-based VLANs, port-based VLANs, and voice VLANs.You can optionally configure an IP address and netmask for a VLAN for inband management.

This chapter includes the following topics:

VLANs Overview

The Mobility Access Switch supports the following types of VLANs:

- MAC-based VLANs–In the case of untrusted interfaces, you can associate a client to a VLAN based on the source MAC of the packet. Based on the MAC, you can assign a role to the user after authentication. For more information about how to assign MAC-based VLANs, see MAC-Based Authentication on page 304.
- Port-based VLANs–In the case of trusted interfaces, all untagged traffic is assigned a VLAN based on the incoming port.
- Tag-based VLANs–In the case of trusted interfaces, all tagged traffic is assigned a VLAN based on the incoming tag.
- Voice VLANs–You can use the voice VLANs to separate voice traffic from data traffic when the voice and data traffic are carried over the same ethernet link. For more information on Voice VLANs, see Voice VLANs on page 152.

Creating VLANs

By default, all the ports in the Mobility Access Switch are assigned to VLAN 1. You can create VLANs and assign ports to them.

Using the WebUI

1. Navigate to the **Configuration > VLANs** page.
2. Click **New** under the VLANs list.
3. Enter the VLAN **ID**.
4. Enter a Description for the VLAN.
5. Click **Apply** and **Save Configuration**.

Using the CLI

```
(host)(config)# vlan <id>
  aaa-profile <profile-name>
  clone <source>
  description <name>
  igmp-snooping-profile <profile-name>
  mac-address-table static <mac-address> gigabitethernet <slot/module/port>
  mac-aging-time <minutes>
```

```
   mld-snooping-profile <profile-name>
   no {...}
   pvst-profile <profile-name>
   exit
```

Sample VLAN Configuration

```
(host)(config)# vlan 100
   description Faculty
   exit
(host)(config)# vlan 200
   description Students
   exit
```

Verifying VLAN Configuration

You can verify the VLANs created and the ports assigned to the VLANs using the following commands:

```
(host)# show vlan
VLAN CONFIGURATION
------------------
VLAN  Description        Ports
----  -----------        -----
1     All                GE0/0/0-1 GE0/0/7 GE0/0/9-29 GE0/0/33
                         GE0/0/35-41 GE0/0/44-47
100   Faculty            GE0/0/0
101   Student            GE0/0/0
102   Admin              GE0/0/0
103   Finance            GE0/0/0
104   HR                 GE0/0/0
105   Engineering        GE0/0/0
106   QA                 GE0/0/0
107   Support            GE0/0/0
108   Marketing          GE0/0/0
109   Management         GE0/0/0

(host)# show vlan detail
U - Untagged member, T - Tagged member
* - Active interface
Dot1q tag: 1, Description: VLAN0001
Number of interfaces: 36, Active: 5
VLAN membership:
Access:
   GE0/0/1(U) GE0/0/7(U) GE0/0/9*(U) GE0/0/10*(U)
   GE0/0/11(U) GE0/0/12(U) GE0/0/13(U) GE0/0/14(U)
   GE0/0/15(U) GE0/0/16(U) GE0/0/17(U) GE0/0/18(U)
   GE0/0/19(U) GE0/0/20(U) GE0/0/21(U) GE0/0/22(U)
   GE0/0/23(U) GE0/0/24(U) GE0/0/25(U) GE0/0/26(U)
   GE0/0/27(U) GE0/0/28(U) GE0/0/29(U) GE0/0/33(U)
   GE0/0/35(U) GE0/0/36(U) GE0/0/37(U) GE0/0/38(U)
   GE0/0/39(U) GE0/0/40(U) GE0/0/41(U) GE0/0/44(U)
   GE0/0/45*(U) GE0/0/46*(U) GE0/0/47*(U)
Trunk:
   GE0/0/0(U) GE0/0/0(T)
Dot1q tag: 100, Description: Faculty
Number of interfaces: 1, Active: 0
VLAN membership:
Trunk:
   GE0/0/0(T)

(host)# show vlan extensive
Dot1q tag: 1, Description: VLAN0001
IGMP-snooping profile name: igmp-snooping-factory-initial
```

```
IGMP-snooping: Enabled
IGMP-snooping proxy: Disabled
MSTP instance: 0
MAC aging time: 5 minutes
Number of interfaces: 36, Active: 5
VLAN membership:
   GE0/0/0    Trunk  Trusted   Untagged
   GE0/0/0    Trunk  Trusted   Tagged
   GE0/0/1    Access Trusted   Untagged
   GE0/0/7    Access Trusted   Untagged
   GE0/0/9*   Access Trusted   Untagged
   ....
Dot1q tag: 100, Description: Faculty
MSTP instance: 0
MAC aging time: 300
Number of interfaces: 1, Active: 0
VLAN membership:
   GE0/0/0    Trunk  Trusted   Tagged

(host)#show vlan summary
Number of tunneled-node VLANs                    :2
Number of operational VLANs                      :10
```

Creating and Applying a Switching Profile to an Interface

You can assign VLAN membership to the interface using the switching profile. The switching profile has the following types of configurations for a port:

- Switch-Port Mode—Specifies whether the port is an access port connected to an end device or a trunk port for uplink connectivity.
- Access VLAN—Specifies the VLAN ID for the port, when the switch-port mode is access.
- Native VLAN—Specifies the VLAN for incoming untagged packets, when the switch-port mode is trunk. When a packet goes out of a trunk interface in native VLAN, it will be untagged. By default, VLAN 1 is the native VLAN. The native VLAN should be part of the trunk allowed VLANs.
- Trunk Allowed VLANs—Identifies the VLAN IDs for which the trunk carries the traffic.

Using the WebUI

1. Navigate to the **Configuration > Ports > Switching** tab.
2. Under the profiles list, click **New**.
3. Enter a name for the new switching profile under the **Name** column.
4. Select a mode from the drop-down list. It can be either trunk or access.
5. If you selected the mode as access, select the Access VLAN from the drop-down list. Only the VLANs created already are listed.
6. If you selected the mode as trunk, select the Native VLAN from the drop-down list. Only the VLANs created already are listed.
7. If you selected the mode as Trunk, select the trunk allowed VLANs from the Allowed VLAN column.
8. Select the interfaces that are part of this VLAN in the Association column.
9. Click **Apply** and **Save Configuration**.

Using the CLI

```
(host)(config)# interface-profile switching-profile <profile-name>
   access-vlan <VLAN-ID>
   clone <source>
```

```
   native-vlan <VLAN-ID>
   switchport-mode {access|trunk}
   trunk allowed vlan [add|all|except|remove] <VLANs-List>
   storm-control-bandwidth <50-100>
   storm-control-broadcast
   storm-control-multicast
   storm-control-unknown-unicast
   no {...}
   exit
(host)(config)# interface gigabitethernet <slot/module/port>
   switching-profile <profile-name>
```

NOTE

If you do not specify a switch-port mode, the port will be in switch-port mode access implicitly. In the case of switchport-mode trunk, the native vlan has to be in the allowed vlan list if you want the port to receive and transmit on the native vlan.

Default Switching Profile

```
(host)# show interface-profile switching-profile default
switching profile "default"
---------------------------
Parameter                                           Value
---------                                           -----
Switchport mode                                     access
Access mode VLAN                                    1
Trunk mode native VLAN                              1
Enable broadcast traffic rate limiting              Enabled
Enable multicast traffic rate limiting              Disabled
Enable unknown unicast traffic rate limiting        Enabled
Max allowed rate limit traffic on port in percentage  50
Trunk mode allowed VLANs                            1-4094
```

Sample Access Port Configuration

You can use the following steps to configure an interface as an access port that belongs to a particular VLAN:

1. Create a switching profile.
2. Apply the switching profile to the interface.

To configure a switching profile with access VLAN 200, use the following commands:

```
interface-profile switching-profile Student
   access-vlan 200
```

To apply the switching-profile to the interface (gigabitethernet 0/0/10), use the following commands:

```
interface gigabitethernet 0/0/10
   switching-profile Student
   exit
```

Verifying the Switching Profile Configuration for the Interface

To verify the configuration, use one of the following commands:

```
(host) #show vlan
VLAN CONFIGURATION
------------------
VLAN Description Ports
---- ----------- ------------------------------------
1    VLAN0001    GE 0/0/0 GE 0/0/1 GE 0/0/11 GE 0/0/12
                 GE 0/0/13 GE 0/0/14 GE 0/0/15 GE 0/0/16
                 GE 0/0/17 GE 0/0/18 GE 0/0/19 GE 0/0/2
100  Faculty
200  Student GE 0/0/10
```

```
(host) #show interface gigabitethernet 0/0/0 switchport extensive
GE0/0/0
Link is Up
Flags: Access, Trusted

VLAN membership:

VLAN tag  Tagness   STP-State
--------  --------  ---------
1         Untagged  FWD
```

Sample Trunk Port Configuration

To configure a trunk port, the switch-port mode should be set as trunk. To define the switching profile, use the following commands:

```
interface-profile switching-profile Upstream
   switchport-mode trunk
```

To apply the switching profile to the trunk ports, use the following commands:

```
interface gigabitethernet 0/0/11
   switching-profile Upstream
```

For trunk ports, there are times when the other side of the link requires traffic to be sent without any tags. This functionality is commonly referred as native VLAN. For this purpose, you can use the native-vlan parameter in the switching-profile:

```
interface-profile switching-profile Upstream
   native-vlan 100
```

By default, a trunk port allows all VLANs to be transported. You can change the allowed VLANs using the `trunk allowed vlan` parameter in the switching profile:

```
interface-profile switching-profile Upstream
   trunk allowed vlan all
```

Verifying the Trunk Configuration

You can use the following command to view the trunk configuration:

```
(host)# show trunk
Trunk Port Table
----------------
Port      Vlans Allowed  Vlans Active    Native Vlan
----      -------------  ------------    -----------
GE 0/0/11 ALL            1,100,200       100
GE 0/0/12 2-45           2,30            45
```

Managing the MAC Address Table

The Mobility Access Switch populates the MAC address table as a result of dynamic learning, static addition, Sticky MAC, and authentication process. These MACs are referred to as learnt, static, sticky, and auth MACs respectively. You can manage the MAC address table using the following tasks:

- Adding Static MAC Addresses on page 133
- Displaying the MAC Address Table on page 133
- Displaying Sticky MAC Addresses on page 134
- Deleting the Static MACs on page 134
- Clearing the Learnt MACs on page 135

- Clearing Sticky MAC Addresses on page 135
- Configuring the MAC Aging Time on page 135

Adding Static MAC Addresses

You can add static MAC addresses to a VLAN and thus to the MAC address table.

```
(host)(config)# vlan <vlan-id>
  mac-address-table static <mac-address> gigabitethernet <slot/module/port>
```

Example Configuration

```
(host)(config)# vlan 700
  description “vlan 700”
  aaa-profile default
  mac-aging-time 10
  mac-address-table static 00:01:02:03:04:05 gigabitethernet 0/0/14
  mac-address-table static 0a:0b:0c:0d:4e:0f gigabitethernet 0/0/16
(host)(config)# show vlan-config 700
  VLAN "700"
  ----------
  Parameter                Value
  ---------                -----
  Description              vlan 700
  aaa-profile              default
  igmp-snooping-profile    N/A
  mld-snooping-profile     N/A
  pvst-bridge-profile      predefinedprofile
  MAC Aging time(Minutes)  10
  Static mac address       00:01:02:03:04:05 gigabitethernet 0/0/14
  Static mac address       0a:0b:0c:0d:4e:0f gigabitethernet 0/0/16
```

Displaying the MAC Address Table

```
(host)# show mac-address-table
Total MAC address: 3
Learnt: 1, Static: 1, Auth: 0, sticky: 1
MAC Address Table
-----------------
Destination Address  Address Type  VLAN  Destination Port
-------------------  ------------  ----  ----------------
00:0b:86:0f:0a:80    Learnt        0226  GE0/0/42
00:10:db:00:00:11    Static        0201  GE0/0/0
00:00:cc:aa:1c:00    Sticky        0001  GE0/0/12

(host)# show mac-address-table interface gigabitethernet 0/0/19
Total MAC address: 1
Learnt: 1, Static: 0, Auth: 0
MAC Address Table
-----------------
Destination Address  Address Type  VLAN  Destination Port
-------------------  ------------  ----  ----------------
00:0c:34:46:f2:52    Learnt        0100  GE0/0/19

(host)#show mac-address-table summary
Total MAC address: 3
Learnt: 3, Static: 0, Auth: 0, sticky: 0

(host)# show mac-address-table vlan 700
Total MAC address: 5
Learnt: 0, Static: 5, Auth: 0, sticky: 0
MAC Address Table
```

```
-----------------
Destination Address  Address Type  VLAN  Destination Port
-------------------  ------------  ----  ----------------
00:01:02:03:04:05    static        700   GE0/0/14
00:01:02:03:44:05    static        700   GE0/0/16
00:00:02:03:44:05    static        700   GE0/0/16
00:00:00:03:44:05    static        700   GE0/0/16
00:00:00:03:54:05    static        700   GE0/0/16
```

Displaying Sticky MAC Addresses

The following example displays Sticky MAC addresses on a switch:

```
(host) #show mac-address-table sticky
Total MAC address: 5
MAC Address Table
-----------------
Destination Address  Address Type  VLAN  Destination Port
-------------------  ------------  ----  ----------------
00:00:cc:aa:1c:00    Sticky        0001  GE0/0/12
00:00:cc:aa:1c:01    Sticky        0001  GE0/0/12
00:00:cc:aa:1c:02    Sticky        0001  GE0/0/12
00:00:cc:aa:1c:03    Sticky        0001  GE0/0/12
00:00:cc:aa:1c:04    Sticky        0001  GE0/0/12
```

The following example displays Sticky MAC addresses on a VLAN

```
(host) #show mac-address-table vlan 2 sticky

Total MAC address: 5
MAC Address Table
-----------------
Destination Address  Address Type  VLAN  Destination Port
-------------------  ------------  ----  ----------------
00:00:cc:aa:1c:00    Sticky        0002  GE0/0/12
00:00:cc:aa:1c:01    Sticky        0002  GE0/0/12
00:00:cc:aa:1c:02    Sticky        0002  GE0/0/12
00:00:cc:aa:1c:03    Sticky        0002  GE0/0/12
00:00:cc:aa:1c:04    Sticky        0002  GE0/0/12
```

The following example displays Sticky MAC addresses on an interface:

```
(host) #show mac-address-table interface gigabitethernet 0/0/12 sticky
Total MAC address: 5
MAC Address Table
-----------------
Destination Address  Address Type  VLAN  Destination Port
-------------------  ------------  ----  ----------------
00:00:cc:aa:1c:00    Sticky        0001  GE0/0/12
00:00:cc:aa:1c:01    Sticky        0001  GE0/0/12
00:00:cc:aa:1c:02    Sticky        0001  GE0/0/12
00:00:cc:aa:1c:03    Sticky        0001  GE0/0/12
00:00:cc:aa:1c:04    Sticky        0001  GE0/0/12
```

Deleting the Static MACs

You can use the following command to delete the static MAC addresses from the MAC address table:

```
(host)(config)# vlan <vlan-id>
  no mac-address-table static <mac-address>
```

Clearing the Learnt MACs

You can use the following commands to clear the learnt MACs from the MAC address table:

```
(host)(config)# clear mac-address-table
(host)(config)# clear mac-address-table interface gigabitethernet 0/0/5
(host)(config)# clear mac-address-table vlan 20
(host)(config)# clear mac-address-table vlan 20 interface gigabitethernet 0/0/0
```

Clearing Sticky MAC Addresses

You can use the following commands to clear the Sticky MAC addresses from the MAC address table:

```
(host)(config)# clear mac-address-table sticky
(host)(config)# clear mac-address-table vlan <id> sticky
(host)(config)# clear mac-address-table interface <interface-name> sticky
(host)(config)# clear mac-address-table vlan <id> mac <mac-address> sticky
(host)(config)# clear mac-address-table interface <interface-name> mac <mac address> sticky
(host)(config)# clear mac-address-table vlan <id> interface <interface name> sticky
```

Configuring the MAC Aging Time

In the case of learnt MACs, you can configure the system to prune the MAC address if it does not get refreshed within the specified MAC aging time. The default value is 5 minutes. Use the following command to specify the MAC aging interval per VLAN:

```
(host)(config)# vlan <vlan-id>
  mac-aging-time <minutes>
```

VLAN Profile

A VLAN Profile (as opposed to interface profile) can be created to enable/modify IGMP-Snooping, MLD-Snooping and PVST settings. You can use the vlan-profile command followed by the particular feature.

```
(host) (config) #vlan-profile
  dhcp-snooping-profile
  igmp-snooping-profile
  mld-snooping-profile
  pvst-profile
```

For more information on configuring and applying DHCP Snooping profile to a VLAN, see Configuring DHCP Snooping on page 242.

For more information on configuring and applying IGMP Snooping profile to a VLAN, see Creating and Applying an IGMP Snooping Profile to a VLAN on page 228.

For more information on configuring and applying MLD Snooping profile to a VLAN, see Configuring MLD Snooping on page 232

For more information on configuring and applying PVST profile to a VLAN, see Configuring PVST+ on page 174.

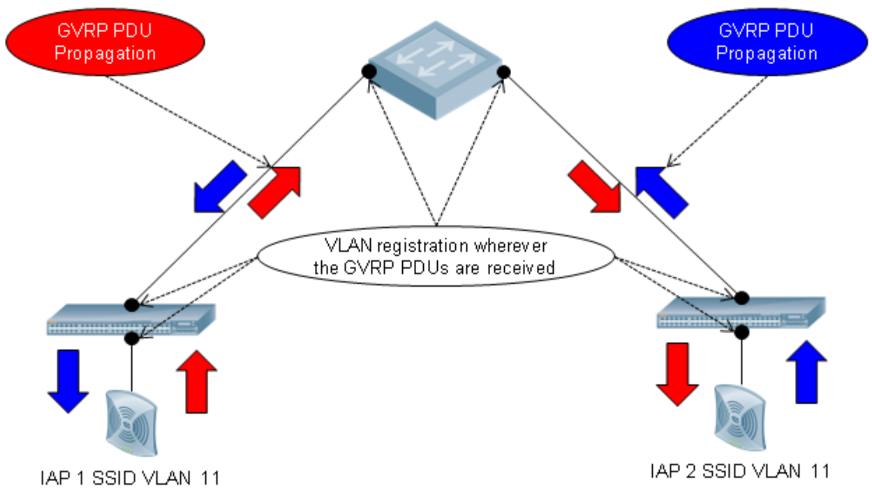
The GARP (Generic Attribute Registration Protocol) VLAN Registration Protocol (GVRP) is an application defined in the IEEE 802.1Q standard that allows for the control of 802.1Q VLANs.

This chapter includes the following topics:

GVRP Overview

Configuring GVRP in the Mobility Access Switch enables the switch to register/de-register the dynamic VLAN information received from a GVRP applicant such as an IAP in the network. GVRP support also enables the switch to propagate the registered VLAN information to the neighboring bridges in the network.

Figure 9 *GVRP Overview*



Enabling and Configuring GVRP Functionality

To enable GVRP in the Mobility Access Switch, you must configure the following two profiles and attach them to a trunk port:

- gvrp–To enable GVRP globally.
- gvrp-profile–To enable GVRP on an interface.

NOTE

You can enable GVRP only on trunk ports.

You can use the following CLI commands to define the GVRP global profile settings.

```
(host)(config)# gvrp
(host)(Global GVRP configuration)# enable
(host)(Global GVRP configuration)# join-time <milliseconds>
```

The join period timer controls the interval between the transmit PDU events that are applied to the applicant state machine. Default is 200 milliseconds.

```
(host)(Global GVRP configuration)# leave-time <milliseconds>
```

The leave period timer controls the period of time that the registrar state machine waits in the leaving state before transmitting to the empty state. Default is 600 milliseconds.

```
(host)(Global GVRP configuration)# leave-all-time <milliseconds>
```

The leave all period timer controls the frequency with which the leave all state machine generates LeaveAll PDUs. Default is 10000 milliseconds.

You can use the following CLI commands to define the interface specific gvrp-profile:

```
(host)(config)# interface-profile gvrp-profile <profile_name>
(host)(Interface GVRP profile <profile_name)# registrar-mode [normal|forbidden]
```

In normal registrar mode, the Mobility Access Switch registers and de-registers VLANs to or from its connected switches and IAPs. In forbidden registrar mode, the Mobility Access Switch cannot register nor de-register VLANs to or from its connected switches and IAPs. Default is `registrar-mode normal`.

Sample Configurations

To enable and configure GVRP globally:

```
(host)(config)# gvrp
(host)(Global GVRP configuration)# enable
(host)(Global GVRP configuration)# join-time 200
(host)(Global GVRP configuration)# leave-time 600
(host)(Global GVRP configuration)# leave-all-time 10000
```

To enable and configure GVRP profile on an interface:

```
(host)(config)# interface-profile gvrp-profile Enable-GVRP
(host)(Interface GVRP profile “Enable-GVRP”)# enable
(host)(Interface GVRP profile “Enable-GVRP”)# registrar-mode normal
```

To attach GVRP profile to the interface:

```
(host) (config) # interface gigiabitethernet 0/0/10
(host) (gigabitethernet "0/0/10") # gvrp-profile gvrp
```

The following example displays global GVRP status and current timer values:

```
(host) (config) #show gvrp-global-profile

Global GVRP configuration
-------------------------
Parameter        Value
---------        -----
GVRP status      Enabled
Join Time        200
Leave Time       600
Leave-all Time   10000
```

The following example displays the interfaces in which gvrp is enabled:

```
(host) (config) #show gvrp interfaces

Interface GVRP info
-------------------
Interface              State     Registrar Mode
```

```
---------              -----     --------------
gigabitethernet0/0/10  Enabled   Normal
gigabitethernet0/0/20  Disabled  N/A
port-channel1          Disabled  N/A
```

The Mobility Access Switch supports Link Layer Discovery Protocol (LLDP) to advertise identity information and capabilities to other nodes on the network, and store the information discovered about the neighbors. LLDP is also used to implement Voice VLAN configurations. For more information on Voice VLAN configuration, see VoIP on page 152.

This chapter contains the following major sections:

Important Points to Remember

- Inventory-management, and Location TLVs are not currently supported.
- LLDP-MED must be enabled to advertise a VOIP VLAN.

LLDP

This section contains the following sections:

Understanding LLDP

Link Layer Discovery Protocol (LLDP), defined in the IEEE 802.1AB standard, is a Layer 2 protocol that allows network devices to advertise their identity and capabilities on a LAN. The Mobility Access Switch supports a simple one-way neighbor discovery protocol with periodic transmissions of LLDP PDU.

- LLDP frames are constrained to a local link.
- LLDP frames are TLV (Type-Length-Value) form.
- LLDP Multicast address is 01-80-C2-00-00-0E.

LLDP provides support for a set of attributes used to discover neighbor devices. These attributes are referred as TLVs which contain type, length, and value descriptions. LLDP supported devices use TLVs to receive and send information such as configuration information, device capabilities, and device identity to their neighbors.

The Mobility Access Switch supports the following optional basic management TLVs which are enabled by default:

- Aggregation status TLV
- MAC Phy configuration TLV
- Management address TLV
- Maximum frame size TLV
- Port-description TLV
- Port VLAN ID TLV
- Power management TLV

- System capabilities TLV
- System description TLV
- System name TLV
- VLAN name TLV

LLDP Factory Initial and Default Profiles

This section contains the following sections:

LLDP Factory Initial Profile

When the Mobility Access Switch is booted as factory-default for the first time, the "lldp-factory-initial" profile is associated to all the ports.

To display this information, use the following command:

```
(host)# show interface-profile lldp-profile lldp-factory-initial
LLDP Profile "lldp-factory-initial"
-----------------------------------
Parameter                               Value
---------                               -----
LLDP pdu transmit                       Enabled
LLDP protocol receive processing        Enabled
Port Description TLV                    Enabled
System Name TLV                         Enabled
System Description TLV                  Enabled
System Capabilities TLV                 Enabled
Management Address TLV                  Enabled
Port VlanID TLV                         Enabled
Vlan Name TLV                           Enabled
Aggregation Status TLV                  Enabled
MAC/PHY configuration TLV               Enabled
Maximum Frame Size TLV                  Enabled
Power Via MDI TLV                       Enabled
Network Policy TLV                      Enabled
Extended Power Via MDI TLV              Enabled
LLDP transmit interval (Secs)           30
LLDP transmit hold multiplier           4
LLDP fast transmit interval (Secs)      1
LLDP fast transmit counter              4
LLDP-MED protocol                       Enabled
Control proprietary neighbor discovery  Disabled
```

Default LLDP Profile

To display the default lldp profile information, use the following command:

```
(host)# show interface-profile lldp-profile default

LLDP Profile "default"
----------------------
Parameter                               Value
---------                               -----
LLDP pdu transmit                       Disabled
LLDP protocol receive processing        Disabled
Port Description TLV                    Enabled
System Name TLV                         Enabled
System Description TLV                  Enabled
System Capabilities TLV                 Enabled
Management Address TLV                  Enabled
```

```
Port VlanID TLV                     Enabled
Vlan Name TLV                       Enabled
Aggregation Status TLV              Enabled
MAC/PHY configuration TLV           Enabled
Maximum Frame Size TLV              Enabled
Power Via MDI TLV                   Enabled
Network Policy TLV                  Enabled
Extended Power Via MDI TLV          Enabled
LLDP transmit interval (Secs)       30
LLDP transmit hold multiplier       4
LLDP fast transmit interval (Secs)  1
LLDP fast transmit counter          4
LLDP-MED protocol                   Disabled
Control proprietary neighbor discovery  Disabled
```

NOTE

When you use the default LLDP profile, the RX and TX parameters are disabled. You have to explicitly enable them for LLDP to work.

Configuring LLDP

- Configuring an LLDP Profile on page 142
- Applying LLDP Profile to an Interface on page 142

Configuring an LLDP Profile

To configure an LLDP profile, use the following command:

```
(host)(config)# interface-profile lldp-profile <profile-name>
   clone <source>
   lldp fast-transmit-counter <1-8>
   lldp fast-transmit-interval <1-3600>
   lldp med-tlv-select
   lldp receive
   lldp tlv-select
   lldp transmit
   lldp transmit-hold <1-100>
   lldp transmit-interval <1-3600>}
   no {...}
   exit
```

Applying LLDP Profile to an Interface

To apply an LLDP profile to an interface, use the following command:

```
(host)(config)# interface gigabitethernet <slot/module/port>
   lldp-profile <profile-name>.
```

NOTE

In the case of static and dynamic port-channels, the LLDP profile must be applied to the member interfaces.

Verifying LLDP Profile Configuration

```
   (host)# show interface-profile lldp-profile <profile-name>
LLDP Profile "<profile-name>"
-------------------
Parameter                           Value
---------                           -----
LLDP pdu transmit                   Disabled
LLDP protocol receive processing    Disabled
Port Description TLV                Enabled
System Name TLV                     Enabled
```

```
System Description TLV                   Enabled
System Capabilities TLV                  Enabled
Management Address TLV                   Enabled
Port VlanID TLV                          Enabled
Vlan Name TLV                            Enabled
Aggregation Status TLV                   Enabled
MAC/PHY configuration TLV                Enabled
Maximum Frame Size TLV                   Enabled
Power Via MDI TLV                        Enabled
Network Policy TLV                       Enabled
Extended Power Via MDI TLV               Enabled
LLDP transmit interval (Secs)            30
LLDP transmit hold multiplier            4
LLDP fast transmit interval (Secs)       1
LLDP fast transmit counter               4
LLDP-MED protocol                        Disabled
Control proprietary neighbor discovery   Disabled
```

Monitoring LLDP

This section describes commands for monitoring LLDP. It contains the following sections:

- Display LLDP Interface on page 143
- Display LLDP Interface <interface> on page 143
- Display LLDP Neighbor on page 144
- Display LLDP Neighbor Interface Detail on page 144
- Display LLDP Statistics on page 145
- Display LLDP Statistics Interface on page 145

Display LLDP Interface

To display all LLDP information for all interfaces, use the following command:

```
(host)# show lldp interface
LLDP Interfaces Information
---------------------------
Interface  LLDP TX  LLDP RX  LLDP-MED  TX interval  Hold Timer
---------  -------  -------  --------  -----------  ----------
GE0/0/0    Enabled  Enabled  Enabled   30           120
GE0/0/1    Enabled  Enabled  Enabled   30           120
GE0/0/2    Enabled  Enabled  Enabled   30           120
GE0/0/3    Enabled  Enabled  Enabled   30           120
GE0/0/4    Enabled  Enabled  Enabled   30           120
GE0/0/5    Enabled  Enabled  Enabled   30           120
GE0/0/6    Enabled  Enabled  Enabled   30           120
GE0/0/7    Enabled  Enabled  Enabled   30           120
GE0/0/8    Enabled  Enabled  Enabled   30           120
GE0/0/9    Enabled  Enabled  Enabled   30           120
GE0/0/10   Enabled  Enabled  Enabled   30           120
<output truncated>
```

Display LLDP Interface <interface>

To display LLDP information for a specific interface, use the following command:

```
(host) #show lldp interface gigabitethernet 0/0/1

Interface: gigabitethernet0/0/1
LLDP Tx: Enabled, LLDP Rx: Enabled
Proprietary Neighbor Discovery: Disabled
LLDP-MED: Enabled
```

```
Fast Transmit interval: 1, Fast Transmit message counter: 4
Transmit interval: 30, Hold timer: 120
```

Display LLDP Neighbor

```
(host)#show lldp neighbor
Capability codes: (R)Router, (B)Bridge, (A)Access Point, (P)Phone, (O)Other
LLDP Neighbor Information
-------------------------
Local Intf Chassis ID        Capability  Remote Intf  Expiry-Time (Secs)
---------  -----------       ----------  -----------  ------------------
GE4/0/1    00:0b:86:6a:25:40  B:R         GE0/0/17     105
GE4/0/2    00:0b:86:6a:25:40  B:R         GE0/0/18     105

System name
-----------
ArubaS3500
ArubaS3500

Number of neighbors: 2
```

NOTE

To view proprietary neighbors, use the **show neighbor-devices** command.

Display LLDP Neighbor Interface Detail

```
(host) (gigabitethernet "0/0/2") #show lldp neighbor interface gigabitethernet 0/0/1 detail
Interface: gigabitethernet0/0/1, Number of neighbors: 1
------------------------------------------------------------
Chassis id: 24.1.1.253, Management address: 24.1.1.253
Interface description: SW PORT, ID: 04C5A44C3485:P1
Device MAC: 04:c5:a4:4c:34:85
Last Update: Thu Oct  3 17:01:41 2013
Time to live: 180, Expires in: 179 Secs
System capabilities : Bridge,Phone
Enabled capabilities: Bridge,Phone
System name: SEP04C5A44C3485
System description:
Cisco IP Phone 7962G,V10, SCCP42.9-2-1S
Auto negotiation: Supported, Enabled
Autoneg capability:
100Base-X, HD: no, FD: yes
1000Base-T, HD: yes, FD: yes
Media attached unit type: 100BaseTXFD - 2 pair category 5 UTP, full duplex mode (16)
802.3 Power:
PortID:       local 04C5A44C3485:P1
PortDescr:    SW PORT
LLDP-MED:
Device Type:  Communication Device Endpoint (Class III)
Capability:   LLDP-MED capabilities, Network policy, Extended power via MDI/PD, Inventory
LLDP-MED Network Policy for: AppType: 1, Defined: yes
Descr:        Voice
VLAN:         204
Layer 2 Priority: 5
DSCP Value:   46
LLDP-MED Network Policy for: AppType: 2, Defined: yes
Descr:        Voice Signaling
VLAN:         204
Layer 2 Priority: 4
DSCP Value:   32
Extended Power-over-Ethernet:
Power Type & Source: PD Device
```

```
Power Source: unknown
Power Priority: unknown
Power Value:  6300
Inventory:
Hardware Revision: 10
Software Revision: SCCP42.9-2-1S
Firmware Revision: tnp62.8-3-1-21a.bin
Serial Number: FCH1529F57D
Manufacturer: Cisco Systems, Inc.
Model:        CP-7962G
```

Display LLDP Statistics

```
(host)# show lldp statistics
LLDP Statistics
---------------
Interface  Received  Unknow TLVs  Malformed  Transmitted
---------  --------  -----------  ---------  -----------
GE0/0/0    0         0            0          0
GE0/0/1    0         0            0          0
GE0/0/2    0         0            0          0
GE0/0/3    0         0            0          0
GE0/0/4    0         0            0          0
GE0/0/5    4         2            0          4
GE0/0/6    0         0            0          0
GE0/0/7    0         0            0          0
GE0/0/8    0         0            0          0
GE0/0/9    0         0            0          0
GE0/0/10   0         0            0          0
<output truncated>
```

Display LLDP Statistics Interface

```
(host)# show lldp statistics interface gigabitethernet 0/0/0
LLDP Statistics
---------------
Interface              Received  Unknow TLVs  Malformed  Transmitted
---------              --------  -----------  ---------  -----------
gigabitethernet0/0/0   0         0            0          0
```

LLDP-MED

This section contains the following sections:

- Understanding LLDP-MED
- Configuring LLDP-MED
- Verifying LLDP-MED

Understanding LLDP-MED

LLDP-MED (media endpoint devices) is an extension to LLDP developed by TIA (ANSI/TIA-1057) to support interoperability between VoIP end-point devices and other networking end-devices. LLDP-MED is focused mainly on discovery running between network devices and end-points such as IP phones.

LLDP MED supports the following optional TLVs which are enabled by default:

- Network policy TLV
- Power management TLV

Configuring LLDP-MED

LLDP-MED network policy discovery lets end-points and network devices advertise their VLAN IDs (e.g. voice VLAN), IEEE 802.1p, and DSCP values. The Mobility Access Switch can instruct end-devices to modify their settings to match VoIP requirements.

To configure the LLDP profile to enable LLDP-MED, use the following command:

```
(host)(config)# interface-profile lldp-profile <profile-name>
   lldp transmit
   lldp receive
   med enable
   med-tlv-select
(host)(config)# interface gigabitethernet 0/0/18
   lldp-profile <profile-name>
```

NOTE

If the end devices connected to the Mobility Access Switch sends LLDP MED packets, then the Mobility Access Switch automatically responds with the LLDP MED packets irrespective of the LLDP MED configuration.

LLDP-MED Usage

In a converged network, LLDP-MED provides the following benefits:

- **Interoperability**

  LLDP-MED offers vendor-independent management capabilities, enabling different convergence endpoints to inter-operate on one network.

- **Automatic deployment of network policies**

  With LLDP-MED, administrators can automatically deploy voice VLAN.

NOTE

The default transmit interval time is 30 seconds and the default transmit hold timer is 120 seconds. You can change the transmit-interval and transmit-hold timer in the lldp-profile.

- **Location services**

  LLDP-MED allows deploying location services.

- **Detailed inventory management capabilities**

  For each converged device, LLDP-MED can supply model, manufacturer, firmware and asset information.

- **Advanced PoE**

  LLDP-MED enables advanced Power over Ethernet capabilities.

- **IP telephony network troubleshooting**

  LLDP-MED enables detection of speed and duplex mismatches, and of improper static voice policy configurations.

- **More security**

  LLDP-MED runs after 802.1X to prevent unauthenticated devices from gaining access to the network.

- **Hardware Information**

  For each converged device, LLDP-MED can supply model, manufacturer and firmware.

- **IP Telephony Network Troubleshooting**

  The information from the device attached and information from our own device is available for the user to take corrective action.

Verifying the LLDP Profile Configuration to Check LLDP-MED Status

To verify the LLDP profile configuration check LLDP-Med. status, use the following command:

```
(host) (config) #show interface-profile lldp-profile <profile-name>

LLDP Profile "<profile-name>"
-------------------
Parameter                               Value
---------                               -----
LLDP pdu transmit                       Disabled
LLDP protocol receive processing        Disabled
Port Description TLV                    Enabled
System Name TLV                         Enabled
System Description TLV                  Enabled
System Capabilities TLV                 Enabled
Management Address TLV                  Enabled
Port VlanID TLV                         Enabled
Vlan Name TLV                           Enabled
Aggregation Status TLV                  Enabled
MAC/PHY configuration TLV               Enabled
Maximum Frame Size TLV                  Enabled
Power Via MDI TLV                       Enabled
Network Policy TLV                      Enabled
Extended Power Via MDI TLV              Enabled
LLDP transmit interval (Secs)           30
LLDP transmit hold multiplier           4
LLDP fast transmit interval (Secs)      1
LLDP fast transmit counter              4
LLDP-MED protocol                       Disabled
Control proprietary neighbor discovery  Disabled
```

PoE Negotiation over LLDP

Mobility Access Switch supports Power over Ethernet (PoE) negotiation over LLDP. By default, PoE negotiation is enabled on all the PoE interfaces of the Mobility Access Switch. The PoE negotiation happens either through LLDP or via LLDP MED packets.

To enable this feature on an interface not using default settings, you must configure the power management TLVs on both LLDP and LLDP MED packets.

NOTE

Ensure that the LLDP transmit and receive processing is enabled on the LLDP profile.

Enabling PoE Negotiation on LLDP

You can use the following CLI commands to enable PoE negotiation on an LLDP profile:

```
(host) (config) # interface-profile lldp-profile PoE
(host) (LLDP Profile "PoE") #lldp transmit
(host) (LLDP Profile "PoE") #lldp receive
(host) (LLDP Profile "PoE") #lldp tlv-select power-management
(host) (LLDP Profile "PoE") #lldp med-tlv-select power-management
(host) (LLDP Profile "PoE") #interface gigabitethernet 0/0/26
(host) (gigabitethernet "0/0/26") #lldp-profile PoE
```

Verifying the Configuration

To verify if the PoE is enabled on the LLDP Profile, execute the following command:

```
(host) #show interface-profile lldp-profile PoE
LLDP Profile "PoE"
-------------------
Parameter                               Value
---------                               -----
```

```
LLDP pdu transmit                        Enabled
LLDP protocol receive processing         Enabled
Port Description TLV                     Enabled
System Name TLV                          Enabled
System Description TLV                   Enabled
System Capabilities TLV                  Enabled
Management Address TLV                   Enabled
Port VlanID TLV                          Enabled
Vlan Name TLV                            Enabled
Aggregation Status TLV                   Enabled
MAC/PHY configuration TLV                Enabled
Maximum Frame Size TLV                   Enabled
Power Via MDI TLV                        Enabled
Network Policy TLV                       Enabled
Extended Power Via MDI TLV               Enabled
LLDP transmit interval (Secs)            30
LLDP transmit hold multiplier            4
LLDP fast transmit interval (Secs)       1
LLDP fast transmit counter               4
LLDP-MED protocol                        Disabled
Control proprietary neighbor discovery   Disabled
```

Viewing PoE negotiation on a device

Use the following commands to view the power negotiated on a device through LLDP or LLDP MED:

```
(host) #show lldp neighbor interface gigabitethernet 0/0/26 detail
...
100Base-X, HD: no, FD: yes
1000Base-T, HD: yes, FD: yes
Media attached unit type: 100BaseTXFD - 2 pair category 5 UTP, full duplex mode (16)
802.3 Power:
PortID:       local D0574CF7E2FB:P1
PortDescr:    SW PORT
MDI Power:    supported: no, enabled: no
Power Port Class: PD
Port Power Classification: class 4
Power type:   2
Power Source: Primary power source
Power Priority: unknown
PD requested power Value: 10600
PSE allocated power Value: 20000
LLDP-MED:
Device Type:  Communication Device Endpoint (Class III)
Capability:   LLDP-MED capabilities, Network policy, Extended power via MDI/PD, Inventory
LLDP-MED Network Policy for: AppType: 1, Defined: no
Descr:        Voice
Layer 2 Priority: 5
DSCP Value:   46
...

(host) # show neighbor-devices interface gigabitethernet 0/0/26 detail
Interface: gigabitethernet0/0/26, Number of neighbors: 1
------------------------------------------------------------
...
MDI Power:    supported: no, enabled: no
Power Port Class: PD
Port Power Classification: class 4
Power type:   2
Power Source: Primary power source
Power Priority: unknown
PD requested power Value: 10600
```

```
PSE allocated power Value: 20000
LLDP-MED:
Device Type:  Communication Device Endpoint (Class III)
Capability:   LLDP-MED capabilities, Network policy, Extended power via MDI/PD, Inventory
LLDP-MED Network Policy for: AppType: 1, Defined: no
Descr:        Voice
Layer 2 Priority: 5
DSCP Value:   46
LLDP-MED Network Policy for: AppType: 2, Defined: no
Descr:        Voice Signaling
Layer 2 Priority: 4
DSCP Value:   32
Extended Power-over-Ethernet:
Power Type & Source: PD Device
Power Source: PSE
Power Priority: unknown
Power Value:  2000
Inventory:
Hardware Revision: 1
Software Revision: sip9971.9-2-1
Firmware Revision: sboot9971.031610R1-9-2-1.sebn
Serial Number: FCH142990H9
...
```

Proprietary Link Layer Discovery Protocols

This section contains the following sections:

Understanding Proprietary Link Layer Discovery Protocol

Network companies can also define their proprietary data link layer discovery protocol. For instance, Cisco Discovery Protocol (CDP) is a proprietary data link layer discovery protocol. CDP is similar to LLDP and is used to share information about other directly connected vendor-specific equipment. CDP runs on many of vendor-specific devices including routers, switches, and VoIP phones.

When there are devices in the network that do not support LLDP, you can use the `proprietary-neighbor-discovery` knob in the LLDP interface profile to turn on the ability to receive proprietary discovery protocol packets and identify the neighbors. Mobility Access Switch supports only CDP (Cisco Discovery Protocol) under proprietary protocols. You can use the show neighbor-devices command to display the neighbors identified using LLDP and CDP protocols.

CDP Receive Processing

The Mobility Access Switch processes CDP frames that are received from CDP-supported devices. However, the Mobility Access Switch only receives CDP frames and does not forward CDP frames to other connected neighbors/devices. When new CDP information is received from an existing neighbor, the Mobility Access Switch updates the information and discards the existing information.

CDP Frame Information

The CDP frame contains the following information:

- Device ID

- IP Address
- Port ID
- Capabilities
- Software Version
- Platform
- Native VLAN

Configuring Proprietary LLDP Receive Processing

Priority LLDP receive processing is configured under LLDP profile:

```
(host) (config) #interface-profile lldp-profile CDP-PROC
(host) (LLDP Profile "CDP-PROC") #proprietary-neighbor-discovery
(host) (LLDP Profile "CDP-PROC") #exit
```

The configured LLDP/CDP-PROC profile needs to be applied to the interface:

```
(host) (config) #interface gigabitethernet 2/0/23
(host) (gigabitethernet "2/0/23") #lldp-profile CDP-PROC
(host) (gigabitethernet "2/0/23") #exit
```

Verifying Proprietary LLDP Receive Processing

Propriety LLDP receive processing configuration profile can be verified with the following command:

```
(host) #show interface-profile lldp-profile CDP-PROC
LLDP Profile "CDP-PROC"
------------------------
Parameter                               Value
---------                               -----
LLDP pdu transmit                       Disabled
LLDP protocol receive processing        Disabled
LLDP transmit interval (Secs)           30
LLDP transmit hold multiplier           4
LLDP fast transmit interval (Secs)      30
LLDP fast transmit counter              1
LLDP-MED protocol                       Disabled
Control proprietary neighbor discovery Enabled
```

CDP-enabled neighboring devices can be viewed by following CLI command:

```
(host) #show neighbor-devices
Neighbor Devices Information
----------------------------
Local Intf  Chassis ID        Protocol  Remote Intf          Expiry-Time (Secs)
----------  -----------       --------  -----------          ------------------
GE2/0/22    SEP002414B211B3  CDPv2     GigabitEthernet0/22  44
GE2/0/23    SEP00254593BFD8  CDPv2     Port 1               166

System name
-----------
SEP002414B211B3.cisco.com
SEP00254593BFD8.cisco.com

Number of neighbors: 2
(host) #show neighbor-devices interface gigabitethernet 2/0/23
Neighbor Devices Information
----------------------------
Local Intf  Chassis ID        Protocol  Remote Intf  Expiry-Time (Secs)
----------  -----------       --------  -----------  ------------------
GE2/0/23    SEP00254593BFD8  CDPv2     Port 1       137
```

```
System name
-----------
SEP00254593BFD8.cisco.com

Number of neighbors: 1
(host) #show neighbor-devices interface gigabitethernet 2/0/23 detail

Interface: GE2/0/23, Number of neighbors: 1
------------------------------------------------------------
Chassis id: SEP00254593BFD8, Protocol: CDPv2
Management address: 5.5.5.21
Interface description: Port 1, ID: Port 1
Last Update: Sat Oct  1 14:24:43 2011
Time to live: 180, Expires in: 170 Secs
System capabilities :
Enabled capabilities:
System name: SEP00254593BFD8
System description:
  SCCP41.8-4-4S
Duplex: full
```

Monitoring the Proprietary Neighbor Discovery

You can use the following commands to display the neighbors discovered using the proprietary protocols such as CDP:

```
(host)# show neighbor-devices
(host)# show neighbor-devices interface gigabitethernet 0/0/1
(host)# show neighbor-devices interface gigabitethernet 0/0/1 detail
```

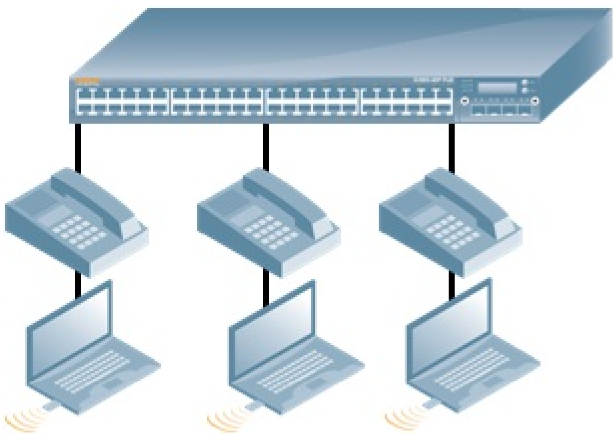
The Mobility Access Switch supports certain Voice functionalities.

This chapter includes the following topics:

Voice VLANs

The VoIP VLAN feature enables access ports to accept both untagged (data) and tagged (voice) traffic from IP phones connected directly to the Mobility Access Switch and separate these traffic into different VLANs (namely data VLAN and voice VLAN). You can configure a voice VLAN using the `voip-profile`.

The dot1p and DSCP values in the VoIP profile are communicated to the phone using LLDP. VoIP profile does not affect the QoS behavior on the switch. The QoS behavior depends on the QoS configuration on the port.



The following guidelines and limitations must be considered before creating a VoIP profile:

- If the port is configured as QoS trusted then the phone is expected to mark the DSCP and dot1p fields accordingly.
- To enable separate QoS treatment for the voice traffic ingressing an interface, you can either enable QoS Trust on the interface or apply the QoS-profile to the interface/access-list/user-role. For more information, see Quality of Service on page 258.
- Voice VLAN can be applied only to the access ports.
- Trunk ports and port-channels are not allowed to be part of a voice VLAN.
- You cannot assign a VoIP profile to untrusted interfaces. In the case of untrusted interfaces, the phone derives the voip-vlan from the role that is assigned to the phone after authentication.
- LLDP-MED instructs the attached VoIP phones to use the specified voice VLAN ID, 802.1p, and DSCP values. For details about configuring an LLDP profile, refer to Link Layer Discovery Protocols on page 140.

Creating and Applying VoIP Profile to an Interface

You can create and apply a VoIP profile to an interface using the following set of commands:

```
(host)(config)# interface-profile voip-profile <profile-name>
   clone <source>
   no{...}
   voip-dot1p <priority>
   voip-dscp <value>
   voip-vlan <VLAN-ID>
(host)(config)# interface gigabitethernet <slot/module/port>
   voip-profile <profile-name>
```

VoIP Auto-Discovery on Trusted Ports

ArubaOS provides support for VoIP Auto-discovery (also referred as CDP Fingerprinting) to discover the VoIP phones using neighbor discovery protocols (such as LLDP-MED and CDP) and assign Voice VLAN to the traffic originating from the phone. For more information on LLDP-MED, see Link Layer Discovery Protocols on page 140.

You can configure VoIP either in static mode or auto-discover mode. By default, VoIP is configured in static mode. When VoIP operates in static mode, the phone is expected to know the Voice VLAN to be used and send the Voice traffic with the Voice VLAN tag. This is achieved, only if the Voice VLAN is configured statically on the phone or propagated to the phone using LLDP-MED.

In auto-discover mode, when LLDP-MED or CDP discovers a phone, the switch creates a rule to associate all the traffic originating from the phone to the Voice VLAN. Hence, the Voice VLAN need not be configured statically on the phone. The Voice VLAN can be tagged or untagged depending on the LLDP-MED configuration.

VoIP configured in auto-discover mode applies the Voice VLAN only to the first neighbor discovered in an interface. If both LLDP-MED and CDP neighbors are discovered, the preference is always given to the first LLDP-MED neighbor even if a CDP neighbor is already associated.

Enabling VoIP Auto-Discovery

You can use the following CLI command to enable VoIP in auto-discover mode:

```
(host) (config) #interface-profile voip-profile VOIP-1
(host) (VOIP profile "VOIP-1") #voip-mode auto-discover
(host) (VOIP profile "VOIP-1") #voip-vlan 5
```

NOTE

You must enable the LLDP-profile with proprietary-neighbor-discovery/LLDP on the respective interface to identify the CDP/LLDP enabled phones.

You can enable proprietary-neighbor-discovery on an LLDP profile:

```
(host) (config) #interface-profile lldp-profile LLDP-1
(host) (LLDP Profile "LLDP-1") #lldp transmit
(host) (LLDP Profile "LLDP-1") #lldp receive
(host) (LLDP Profile "LLDP-1") #med enable
(host) (LLDP Profile "LLDP-1") #proprietary-neighbor-discovery
```

You can apply the configured LLDP-1 profile to an interface:

```
(host) (config) #interface gigabitethernet 0/0/0
(host) (gigabitethernet "0/0/0") #lldp-profile LLDP-1
(host) (gigabitethernet "0/0/0") # voip-profile VOIP-1
```

Verifying VoIP Mode Configuration

You can use the following command to verify the VoIP mode configuration on a VoIP profile:

```
(host) (config) #show interface-profile voip-profile VOIP-1

VOIP profile "VOIP-1"
--------------------
Parameter  Value
---------  -----
VOIP VLAN  5
DSCP       46
802.1 UP   6
VOIP Mode  auto-discover
```

Viewing Neighboring Phones

You can use the following command to view the neighboring phones in the network and the Voice VLAN associated with the phones:

```
(host) #show neighbor-devices phones
Neighbor Phones
---------------
Interface  Protocol  Phone MAC          Voice VLAN
---------  --------  ---------          ----------
GE0/0/6    CDPv2     00:1b:54:c9:e9:fd  -
GE0/0/47   CDPv2     00:1b:54:c9:e9:fd  5
```

In the above output, "-" under the Voice VLAN column denotes that either Voice VLAN is not available or VoIP is not configured to run in auto-discover mode.

VoIP Auto-Discovery on Untrusted Ports

Mobility Access Switch automatically discovers the Cisco Discovery Protocol (CDP) phones on an untrusted interface and assigns a VoIP VLAN to the phone.

Complete the following steps to place a non-802.1x CDP phone in a VoIP VLAN by using a user derivation rule (UDR) to match **device-type**:

1. Create an LLDP profile.
   ```
   (host) (config) #interface-profile lldp-profile ciscophones
   (host) (LLDP Profile "ciscophones") #proprietary-neighbor-discovery
   ```
2. Create a VoIP profile.
   ```
   (host) (config) #interface-profile voip-profile phone
   (host) (VOIP profile "phone") #voip-vlan 100
   ```
3. Create a user-role and add thepreviously created VoIP profile to that role.
   ```
   (host) (config-role) #user-role phonerole
   (host) (config-role) #access-list stateless allowall-stateless
   (host) (config-role) #voip-profile phone
   ```
4. Create a UDR and add the phone role.
   ```
   (host) (config) #aaa derivation-rules user phoneudr
   (host) (user-rule) #set role condition device-type equals "phone" set-value phonerole
   ```
5. Add the UDR to a AAA profile.
   ```
   (host) (config) #aaa profile phone_client
   (host) (AAA Profile "phone_client") #user-derivation-rules phoneudr
   ```
6. Attach the LLDP profile and AAA profile to a port.
   ```
   (host) (config) #interface gigabitethernet 0/0/2
   ```

```
(host) (gigabitethernet "0/0/2") #lldp-profile ciscophones
(host) (gigabitethernet "0/0/2") #aaa-profile phone_client
```

Alternatively, you can define the UDR for a VLAN assignment using the following command:

```
(host) (config) #aaa derivation-rules user <rule-name>
(host) (user-rule) #set vlan condition device-type equals phone set-value <vlan-id> [positi
on <priority> | description <descr>]
```

NOTE

It is recommended to configure the UDR for the CDP phones that do not support LLDP or 802.1x authentication on an untrusted interface.

Chapter 13 MSTP

The implementation of Multiple Spanning Tree Protocol (MSTP) is based on the IEEE Standard 802.1D-2004 and 802.1Q-2005. In addition, MSTP supports the loopguard, rootguard, bpduguard, and portfast features.

NOTE

To enable MSTP, use the spanning tree mode command.

MSTP maps a group of Virtual Local Area Networks (VLANs) to a reduced number of spanning tree instances. This allows VLAN bridges to use multiple spanning trees. This protocol enables network traffic from different VLANs to flow through different potential paths within a bridged VLAN. Because most networks do not need more than a few logical topologies, MSTP provides design flexibility as well as better overall network resource utilization.

Layer 2 networks typically use multiple paths and link redundancies to handle node and link failures. By definition, spanning tree uses a subset of the available physical links in its active logical topology to provide complete connectivity between any pair of end hosts. This chapter covers:

- Important Points to Remember on page 156
- Example MSTP Configuration on page 156
- Loopguard and Rootguard on page 159
- Bridge Protocol Data Unit (BPDU) Guard on page 161
- Sample Topology and Configuration on page 163

Important Points to Remember

- Configure MSTP using the command line only.
- Portfast, Loopguard, BPDUguard, and Rootguard are disabled by default.
- MSTP allows users to map a set of VLANs to a MSTP instance.
- MSTP allows formation of multiple spanning tree regions and each region can run multiple instances.
- For two switches to be in the same MSTP region, they must share the same name, the same version, and the same VLAN instance mapping.
- If a Mobility Access Switch receives RSTP/STP control packets from a neighbor, the neighbor is considered to be in a different region. For the RSTP/STP neighbor, the entire MSTP region looks like a single bridge.
- You can perform proper load balancing across redundant links using MSTP instances. The ability to configure the port cost and port priority values also provides you with the flexibility to determine the links that are chosen to carry the traffic.
- State machines (SM), as defined by the IEEE, get the port and instance information as input. As output, SMs provide the port-state for each port in every instance.

Example MSTP Configuration

Basic MSTP configuration includes setting the spanning tree mode to MSTP, entering the global MSTP mode, and assigning a region name.

1. Set the spanning tree mode:

```
(host)(config) #spanning-tree mode mstp
```

2. Verify the spanning tree mode:

```
(host)(config) #show spanning-tree-profile
```

```
spanning-tree
-------------
Parameter           Value
---------           -----
spanning-tree-mode  mstp
```

3. Assign a region name:

```
(host) (Global MSTP) #region-name mstptechpubs
```

There are, of course, other MSTP options you can configure (such as forward delay, hello time). You can view the current MSTP configuration values using the **show mstp-global-profile** command.

```
(host) # show mstp-global-profile

Global MSTP
-----------
Parameter                 Value
---------                 -----
MSTP region name          mstptechpubs
MSTP revision             0
Instance bridge priority  1 4096
Instance vlan mapping     1 801-802
MSTP hello time           2
MSTP forward delay        15
MSTP maximum age          20
MSTP max hops             20
```

To view the interface MSTP configuration values, use the **show interface-profile mstp-profile** command:

```
(host) (config) #show interface-profile mstp-profile

Interface MSTP List
-------------------
Name               References  Profile Status
----               ----------  --------------
default            14
mstp_cost          3
techpubs           2
Total:4
```

To view the interface-profile named ‘mstp_cost’, use the **show interface-profile mstp_cost** command:

```
(config) #show interface-profile mstp-profile mstp_cost

Interface MSTP "mstp_cost"
--------------------------
Parameter               Value
---------               -----
Instance port cost      0 100
Instance port cost      1 200
Instance port cost      2 300
Instance port priority  N/A
Enable point-to-point   Disabled
Enable portfast         Disabled
Enable rootguard        Disabled
Enable loopguard        Disabled
```

Viewing Operational Information

To view MSTP operational information, use the **show spanning-tree interface all detail** command (the following is a partial output)

```
(host) #show spanning-tree mstp interface all detail
```

```
(GE0/0/23) of MST 0 is designated forwarding
Port path cost 20000, Port priority 128, Port identifier 128.24
Designated Root ID priority: 32768,  Address: 000b.866a.f240
Designated Bridge ID priority: 32768,  Address: 000b.866a.f240
Number of transitions to forwarding state: 1
Link type is point-to-point by default, Internal
BPDU sent: 108, Received: 9
Edge mode: Disabled
Root guard: Disabled
Loop guard: Disabled
(GE0/0/23) of MST 4 is designated forwarding
Port path cost 20000, Port priority 128, Port identifier 128.24
Designated Root ID priority: 32768,  Address: 000b.866a.f240
Designated Bridge ID priority: 32768,  Address: 000b.866a.f240
Number of transitions to forwarding state: 1
Link type is point-to-point by default, Internal
BPDU sent: 104, Received: 5

(GE1/0/22) of MST 0 is designated forwarding
Port path cost 20000, Port priority 128, Port identifier 128.167
Designated Root ID priority: 32768,  Address: 000b.866a.f240
Designated Bridge ID priority: 32768,  Address: 000b.866a.f240
Number of transitions to forwarding state: 1
Link type is point-to-point by default, Internal
BPDU sent: 107, Received: 8
Edge mode: Disabled
Root guard: Disabled
Loop guard: Disabled
(GE1/0/22) of MST 4 is designated forwarding
Port path cost 20000, Port priority 128, Port identifier 128.167
Designated Root ID priority: 32768,  Address: 000b.866a.f240
Designated Bridge ID priority: 32768,  Address: 000b.866a.f240
Number of transitions to forwarding state: 1
Link type is point-to-point by default, Internal
BPDU sent: 104, Received: 4
...
```

Or use the **show spanning-tree msti all detail** command (partial).

```
(host) #show spanning-tree mstp msti all detail

MST 0

vlans mapped         : 3,7
Configuration Digest : 0xED285086D33012C7D2B283FB89730D4D


Root ID            Address: 000b.866a.f240,  Priority: 32768
Regional Root ID   Address: 000b.866a.f240,  Priority: 32768
Bridge ID          Address: 000b.866a.f240,  Priority: 32768
External root path cost 0, Internal root path cost 0

Interface  Role  State  Port Id  Cost   Type
---------  ----  -----  -------  ----   ----
GE0/0/23   Desg  FWD    128.24   20000  P2p
GE1/0/22   Desg  FWD    128.167  20000  P2p
GE1/0/23   Bkup  BLK    128.168  20000  P2p
GE2/0/23   Bkup  BLK    128.312  20000  P2p

MST 4

vlans mapped         : 1
Root ID            Address: 000b.866a.f240,  Priority: 32768
```

```
Bridge ID          Address: 000b.866a.f240,  Priority: 32768
root path cost 0, remaining hops 20

Interface  Role  State  Port Id  Cost   Type
---------  ----  -----  -------  ----   ----
GE0/0/23   Desg  FWD    128.24   20000  P2p
GE1/0/22   Desg  FWD    128.167  20000  P2p
GE1/0/23   Bkup  BLK    128.168  20000  P2p
GE2/0/23   Bkup  BLK    128.312  20000  P2p
```

For a more complete listing of MSTP commands, see the *Command Line Reference Guide*.

Loopguard and Rootguard

Loopguard provides additional protection against Layer 2 forwarding loops (spanning tree loops). A spanning tree loop is created when a spanning tree blocking port, in a redundant topology, erroneously transitions to the forwarding state. This usually happens because one of the ports of a physically redundant topology (not necessarily the spanning tree blocking port) is no longer receiving spanning tree BPDUs (Bridge Protocol Data Units).

NOTE

Loopguard configuration is mutually exclusive with Rootguard configuration.

If loopguard is enabled on a non-designated port and it stops receiving BPDUs, then that non-designated port is moved into the spanning tree loop-inconsistent blocking state.

NOTE

Best practices is that loopguard be used on non-designated ports.

Configuring Loopguard

Below is a basic configuration for loopguard using the profile name *techpubs*.

```
(host) (config) #interface-profile mstp-profile techpubs
(host) (Interface MSTP "techpubs") #loopguard
(host) (Interface MSTP "techpubs") #
```

Associate the above mstp-profile to the interface:

```
(host) (config) #interface gigabitethernet 0/0/2
(host) (gigabitethernet "0/0/2") #mstp-profile techpubs
(host) (gigabitethernet "0/0/2") #
```

Verify the loopguard configuration:

```
(host) #show spanning-tree

MST 0
Root ID            Address: 0019.0655.3a80,  Priority: 4097
Regional Root ID   Address: 000b.866c.3200,  Priority: 16384
Bridge ID          Address: 000b.866c.3200,  Priority: 16384
External root path cost 40000, Internal root path cost 0

Interface  Role      State  Port Id  Cost   Type
---------  ----      -----  -------  ----   ----
GE0/0/1    Desg      FWD    128.2    20000  P2p
GE0/0/2    Loop-Inc  BLK    128.3    20000  P2p Bound    <-- loopguard on GE0/0/2
GE0/0/22   Root      FWD    128.23   20000  P2p
```

Verify that loopgurard is applied to the interface:

```
(host) #show spanning-tree mstp interface gigabitethernet 0/0/2 detail
```

```
(GE0/0/2) of MST 0 is loop inconsistent blocking
Port path cost 20000, Port priority 128, Port identifier 128.3
Designated Root ID priority: 4097,  Address: 0019.0655.3a80
Designated Bridge ID priority: 16384,  Address: 000b.866c.3200
Number of transitions to forwarding state: 1
Link type is point-to-point by default, Boundary
BPDU sent: 15, Received: 36
Edge mode: Disabled
Root guard: Disabled
Loop guard: Enabled     <-- loopguard enabled
```

Configuring Rootguard

Rootguard provides a way to enforce the root bridge placement in the network. The rootguard feature guarantees that a port will not be selected as Root Port for the CIST or any MSTI. If a bridge receives superior spanning tree BPDUs on a rootguard-enabled port, the port is selected as an Alternate Port instead of Root Port and no traffic is forwarded across this port.

By selecting the port as an Alternate Port, the rootguard configuration prevents bridges, external to the region, from becoming the root bridge and influencing the active spanning tree topology.

NOTE

Best practices is that rootguard be used on designated ports.

Below is a basic configuration for rootguard using the profile name **techpubs**.

```
(host) (config) #interface-profile mstp-profile techpubs
(host) (Interface MSTP "techpubs") #rootguard
(host) (Interface MSTP "techpubs") #
```

Associate the above mstp-profile to the interface:

```
(host) (config) #interface gigabitethernet 0/0/1
(host) (gigabitethernet "0/0/1") #mstp-profile techpubs
(host) (gigabitethernet "0/0/1") #
```

If a downstream bridge starts advertising itself as root without rootguard enabled, MSTP will accept that bridge as root. With rootguard enabled, it guards the root and prevents bridges from neighboring networks from becoming the root.

Verify the rootguard configuration:

```
(host) #show spanning-tree

MST 0
Root ID             Address: 0019.0655.3a80,  Priority: 4097
Regional Root ID    Address: 000b.866c.3200,  Priority: 16384
Bridge ID           Address: 000b.866c.3200,  Priority: 16384
External root path cost 40000, Internal root path cost 0

Interface  Role            State  Port Id   Cost   Type
---------  ----            -----  -------   ----   ----
GE0/0/1    Altn(Root-Inc)  BLK    128.22    20000  P2p    <---rootguard on GE0/0/1
GE0/0/2    Desg            FWD    128.301   20000  P2p
GE0/0/22   Root            FWD    128.23    20000  P2p
```

Use the **show interface-profile mstp-profile** command to view the status of loopguard and rootguard.

```
(host) #show interface-profile mstp-profile techpubs
Interface MSTP "techpubs"
------------------------
Parameter               Value
---------               -----
```

```
Instance port cost       N/A
Instance port priority  N/A
Enable point-to-point   Disabled
Enable portfast         Disabled
Enable rootguard        Enabled
Enable loopguard        Disabled
```

Bridge Protocol Data Unit (BPDU) Guard

BPDU guard functionality prevents malicious attacks on edge ports. When the malicious attacker sends a BPDU on the edge port, it triggers unnecessary STP calculation. To avoid this attack, use the BPDU guard on that edge port. The BPDU guard enabled port shuts down as soon as a BPDU is received.

Enabling and Configuring BPDU Guard Functionality

BPDU guard can be enabled or disabled at an interface level. By default, the BPDU is disabled. The BPDU guard functionality is configured as part of the `mstp-profile` configuration.

You can use the following command to configure the BPDU guard by using the MSTP profile:

```
(host) (config) #interface-profile mstp-profile <profile-name>
   bpduguard
   auto-recovery-time <recovery-time>
```

The following example shows how to enable and configure BPDU guard :

```
(host)(config)# interface-profile mst-profile BPDU-Guard1
   bpduguard auto-recovery-time 60
```

NOTE

You can configure BPDU guard with or without the **auto-recovery-time** option.

You can disable BPDU guard by using the following command:

```
(host) (config) #interface-profile <profile-name> no bpduguard
```

You can disable the auto recovery time by using the following command:

```
(host) (Interface MST “profile-name”) #bpduguard no auto-recovery-time
```

Verifying the BPDU Guard Configuration

```
(host) (config) #show interface-profile mstp-profile bpdu-guard

Interface MSTP "bpdu-guard"
---------------------------
Parameter                            Value
---------                            -----
Instance port cost                   N/A
Instance port priority               N/A
Enable point-to-point                Disabled
Enable portfast                      Disabled
Enable rootguard                     Enabled
Enable loopguard                     Disabled
Enable bpduguard                     Enabled <———BPDU guard is enabled
Enable bpduguard auto recovery time N/A
```

Sample Configuration

To enable and configure BPDU guard using the MSTP profile:

```
(host)(config)# interface-profile mst-profile BPDU-Guard1
   bpduguard auto-recovery-time 60
```

To attach the MSTP profile to the interface:

```
(host) (config)# interface gigabitethernet <0/0/6>
  mstp-profile BPDU-Guard1
```

Portfast

When the link on a bridge port goes up, MSTP runs its algorithm on that port. If the port is connected to a host that does not "speak" MSTP, it takes approximately 30 seconds for the port to transition to the forwarding state. During this time, no user data passes through this bridge port and some user applications may timeout.

NOTE

The portfast is mutually exclusively with the Loopguard feature.

Configuring Portfast

To immediately transition the bridge port into the forwarding state upon linkup, enable the MSTP Portfast feature.

```
(host) (config) #interface-profile mstp-profile portfast_techpubs
(host) (Interface MSTP "portfast_techpubs") #portfast
```

The bridge port still participates in MSTP; if a BPDU is received, it becomes a normal port.

NOTE

The portfast is operational on both access ports and trunk ports.

Associate the above mstp-profile to the interface:

```
(host) (config) #interface gigabitethernet 0/0/1
(host) (gigabitethernet "0/0/1") #mstp-profile portfast_techpubs
(host) (gigabitethernet "0/0/1")
```

Use the following command to enable the portfast support on a trunk port:

```
(host) (config) #interface-profile mstp-profile portfast_techpubs
(host) (Interface MSTP "portfast_techpubs") #portfast trunk
```

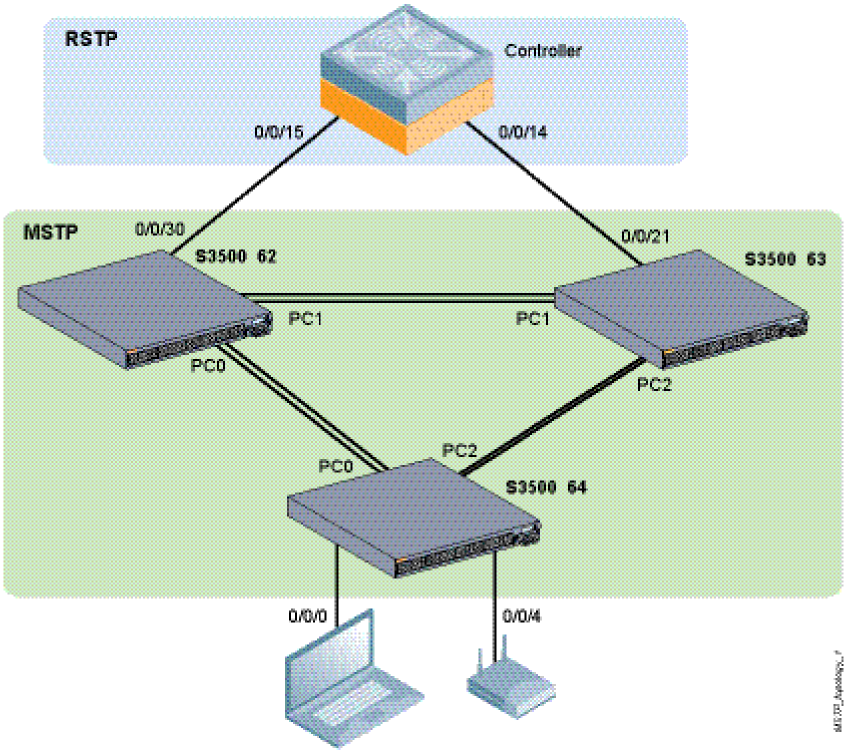
Use the **show interface-profile** command to view the status of Portfast.

```
(host) (config) #show interface-profile mstp-profile portfast_techpubs

Interface MSTP "portfast_techpubs"
----------------------------------
Parameter                Value
---------                -----
Instance port cost       N/A
Instance port priority   N/A
Enable point-to-point    Disabled
Enable portfast          Enabled
Enable rootguard         Disabled
Enable loopguard         Disabled
```

Sample Topology and Configuration

Figure 10 *MSTP Topology*



Below is a the configuration for the topology in Figure 10.

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```
!
interface-profile switching-profile "access-port-509"
   access-vlan 509
!
interface-profile switching-profile "access-port-865"
   access-vlan 865
!
interface-profile switching-profile "access-vlan-2"
   access-vlan 2
!
interface-profile switching-profile "accessPortVlan100"
   access-vlan 100
!
interface-profile switching-profile "accessPortVlan120"
   access-vlan 120
!
interface-profile switching-profile "accessPortVlan150"
   access-vlan 150
!
interface-profile switching-profile "accessPortVlan200"
   access-vlan 200
!
interface-profile switching-profile "accessPortVlan40"
   access-vlan 40
!
interface-profile switching-profile "accessVlan12"
   access-vlan 12
!
interface-profile switching-profile "accessVlan6"
```

```
   access-vlan 6
!
interface-profile switching-profile "accessVlan9"
   access-vlan 9
!
interface-profile switching-profile "default"
!
interface-profile switching-profile "trunk-profile"
   switchport-mode trunk
!
interface-profile poe-profile "default"
!
interface-profile enet-link-profile "default"
!
interface-profile lacp-profile "pc0"
   group-id 0
   mode active
!
interface-profile lacp-profile "pc1"
   group-id 1
   mode active
!
interface-profile lldp-profile "default"
!
interface-profile lldp-profile "lldp-factory-initial"
   lldp transmit
   lldp receive
   med enable
!
interface-profile mstp-profile "default"
!
interface-profile mstp-profile "mstpPortfast"
   portfast
!
interface-profile mstp-profile "pathCost2000"
   instance 0 cost 2000
!
interface-profile mirroring-profile "toPort28"
!
spanning-tree
   mode mstp
!
mstp
   region-name "region1"
   instance 2 bridge-priority 4096
   instance 1 vlan 50-100
   instance 2 vlan 101-151
   instance 3 vlan 152-202
   instance 4 vlan 203-253
   instance 5 vlan 254-304
   instance 6 vlan 305-355
   instance 7 vlan 356-406
   instance 8 vlan 407-457
   instance 9 vlan 458-508
   instance 10 vlan 509-559
   instance 11 vlan 560-610
   instance 12 vlan 611-661
   instance 13 vlan 662-712
   instance 14 vlan 713-763
   instance 15 vlan 764-814
   instance 16 vlan 815-865
!
```

```
lacp
!
igmp-snooping-profile "default"
!
igmp-snooping-profile "igmp-snooping-factory-initial"
!
poemanagement member-id "default"
!
vlan "10"
!
vlan "100"
!
vlan "1000"
!
vlan "101"
!
vlan "102"
!
vlan "103"
!
vlan "104"
!
vlan "105"
!
vlan "106"
!
vlan "107"
!
vlan "108"
!
vlan "109"
!
vlan "11"
!
!
vlan "995"
!
vlan "996"
!
vlan "997"
!
vlan "998"
!
vlan "999"
!
interface gigabitethernet "0/0/0"
  switching-profile "trunk-profile"
!
interface gigabitethernet "0/0/12"
  switching-profile "trunk-profile"
!
interface gigabitethernet "0/0/2"
  lacp-profile "pc1"
!
interface gigabitethernet "0/0/20"
  mstp-profile "mstpPortfast"
!
interface gigabitethernet "0/0/24"
  shutdown
  switching-profile "trunk-profile"
!
interface gigabitethernet "0/0/28"
```

```
  mstp-profile "mstpPortfast"
!
interface gigabitethernet "0/0/3"
  lacp-profile "pc1"
!
interface gigabitethernet "0/0/30"
  switching-profile "trunk-profile"
!
interface gigabitethernet "0/0/36"
  shutdown
  switching-profile "trunk-profile"
!
interface gigabitethernet "0/0/42"
  lacp-profile "pc0"
!
interface gigabitethernet "0/0/43"
  lacp-profile "pc0"
!
interface gigabitethernet "0/0/46"
  shutdown
  switching-profile "trunk-profile"
!
interface gigabitethernet "0/0/47"
  shutdown
  switching-profile "trunk-profile"
!
interface vlan "4093"
!
interface mgmt
  ip address 10.16.56.62 netmask 255.255.255.0
!
interface port-channel "0"
  switching-profile "trunk-profile"
!
interface port-channel "1"
  switching-profile "trunk-profile"
!

snmp-server enable trap
end
```

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```
!
interface-profile switching-profile "access-poer-10"
  access-vlan 10
!
interface-profile switching-profile "access-port-1000"
  access-vlan 1000
!
interface-profile switching-profile "access-port-287"
  access-vlan 287
!
interface-profile switching-profile "access-port-509"
  access-vlan 509
!
interface-profile switching-profile "accessPortVlan100"
  access-vlan 100
!
interface-profile switching-profile "accessPortVlan120"
  access-vlan 120
```

```
!
interface-profile switching-profile "accessPortVlan150"
   access-vlan 150
!
interface-profile switching-profile "accessPortVlan200"
   access-vlan 200
!
interface-profile switching-profile "accessPortVlan40"
   access-vlan 40
!
interface-profile switching-profile "accessVlan12"
   access-vlan 12
!
interface-profile switching-profile "accessVlan6"
   access-vlan 6
!
interface-profile switching-profile "accessVlan9"
   access-vlan 9
!
interface-profile switching-profile "default"
!
interface-profile switching-profile "trunk-profile"
   switchport-mode trunk
!
interface-profile switching-profile "vlan-13-mgmt"
   access-vlan 13
!
interface-profile tunneled-node-profile "tunnuel-ip-10.10.1"
   controller-ip 10.10.10.2
   keepalive 5
!
interface-profile poe-profile "default"
!
interface-profile enet-link-profile "default"
!
interface-profile lacp-profile "pc1"
   group-id 1
   mode active
!
interface-profile lacp-profile "pc2"
   group-id 2
!
interface-profile lldp-profile "default"
!
interface-profile lldp-profile "lldp-factory-initial"
   lldp transmit
   lldp receive
   med enable
!
interface-profile mstp-profile "default"
!
interface-profile mstp-profile "mstpPortfast"
   portfast
!
interface-profile mirroring-profile "toPort31"
!
spanning-tree
   mode mstp
!
mstp
   region-name "region1"
   instance 3 bridge-priority 4096
```

```
   instance 0 bridge-priority 20480
   instance 1 vlan 50-100
   instance 2 vlan 101-151
   instance 3 vlan 152-202
   instance 4 vlan 203-253
   instance 5 vlan 254-304
   instance 6 vlan 305-355
   instance 7 vlan 356-406
   instance 8 vlan 407-457
   instance 9 vlan 458-508
   instance 10 vlan 509-559
   instance 11 vlan 560-610
   instance 12 vlan 611-661
   instance 13 vlan 662-712
   instance 14 vlan 713-763
   instance 15 vlan 764-814
   instance 16 vlan 815-865
!
lacp
!
igmp-snooping-profile "default"
!
igmp-snooping-profile "igmp-snooping-factory-initial"
!
poemanagement member-id "default"
!
vlan "10"
!
vlan "100"
!
vlan "1000"
!
vlan "101"
!
vlan "102"
!
vlan "103"
!
vlan "104"
!
vlan "105"
!
vlan "106"
!
vlan "107"
!
vlan "998"
!
vlan "999"
!
interface gigabitethernet "0/0/0"
   shutdown
!
interface gigabitethernet "0/0/12"
   lacp-profile "pc1"
!
interface gigabitethernet "0/0/13"
   lacp-profile "pc1"
!
interface gigabitethernet "0/0/16"
   switching-profile "trunk-profile"
!
```

```
interface gigabitethernet "0/0/17"
   shutdown
   switching-profile "trunk-profile"
!
interface gigabitethernet "0/0/31"
   mstp-profile "mstpPortfast"
   tunneled-node-profile "tunnuel-ip-10.10.1"
!
interface gigabitethernet "0/0/34"
   switching-profile "trunk-profile"
!
interface gigabitethernet "0/0/36"
   switching-profile "trunk-profile"
!
interface gigabitethernet "0/0/42"
   lacp-profile "pc2"
!
interface gigabitethernet "0/0/43"
   lacp-profile "pc2"
!
interface gigabitethernet "0/0/44"
   switching-profile "trunk-profile"
!
interface gigabitethernet "0/0/45"
   switching-profile "vlan-13-mgmt"
!
interface gigabitethernet "0/0/46"
   switching-profile "trunk-profile"
!
interface gigabitethernet "0/0/47"
   mstp-profile "mstpPortfast"
!
interface gigabitethernet "0/0/6"
!
interface gigabitethernet "0/0/7"
!
interface mgmt
   ip address 10.16.56.63 netmask 255.255.255.0
!
interface port-channel "1"
   switching-profile "trunk-profile"
!
interface port-channel "2"
   switching-profile "trunk-profile"
```

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```
!
interface-profile switching-profile "access-port-509"
   access-vlan 509
!
interface-profile switching-profile "access-port-865"
   access-vlan 865
!
interface-profile switching-profile "access-vlan-2"
   access-vlan 2
!
interface-profile switching-profile "accessPortVlan100"
   access-vlan 100
!
interface-profile switching-profile "accessPortVlan120"
```

```
   access-vlan 120
!
interface-profile switching-profile "accessPortVlan150"
   access-vlan 150
!
interface-profile switching-profile "accessPortVlan200"
   access-vlan 200
!
interface-profile switching-profile "accessPortVlan40"
   access-vlan 40
!
interface-profile switching-profile "accessVlan12"
   access-vlan 12
!
interface-profile switching-profile "accessVlan6"
   access-vlan 6
!
interface-profile switching-profile "accessVlan9"
   access-vlan 9
!
interface-profile switching-profile "default"
!
interface-profile switching-profile "trunk-profile"
   switchport-mode trunk
!
interface-profile poe-profile "default"
!
interface-profile enet-link-profile "default"
!
interface-profile lacp-profile "pc0"
   group-id 0
   mode active
!
interface-profile lacp-profile "pc2"
   group-id 1
   mode active
!
interface-profile lacp-profile "pc2"
   group-id 2
!
interface-profile lldp-profile "default"
!
interface-profile lldp-profile "lldp-factory-initial"
   lldp transmit
   lldp receive
   med enable
!
interface-profile mstp-profile "default"
!
interface-profile mstp-profile "mstpPortfast"
   portfast
!
interface-profile mstp-profile "pathCost2000"
   instance 0 cost 2000
!
interface-profile mirroring-profile "toPort28"
!
spanning-tree
   mode mstp
!
mstp
   region-name "region1"
```

```
   instance 2 bridge-priority 4096
   instance 0 bridge-priority 16384
   instance 1 vlan 50-100
   instance 2 vlan 101-151
   instance 3 vlan 152-202
   instance 4 vlan 203-253
   instance 5 vlan 254-304
   instance 6 vlan 305-355
   instance 7 vlan 356-406
   instance 8 vlan 407-457
   instance 9 vlan 458-508
   instance 10 vlan 509-559
   instance 11 vlan 560-610
   instance 12 vlan 611-661
   instance 13 vlan 662-712
   instance 14 vlan 713-763
   instance 15 vlan 764-814
   instance 16 vlan 815-865
!
lacp
!
igmp-snooping-profile "default"
!
igmp-snooping-profile "igmp-snooping-factory-initial"
!
poemanagement member-id "default"
!
vlan "10"
!
vlan "100"
!
vlan "1000"
!
vlan "101"
!
vlan "102"
!
vlan "103"
!
vlan "104"
!
vlan "105"
!
vlan "106"
!
vlan "107"
!
vlan "108"
!
vlan "109"
!
vlan "11"
!
vlan "110"
!

interface gigabitethernet "0/0/0"
   switching-profile "trunk-profile"
!
interface gigabitethernet "0/0/12"
   switching-profile "trunk-profile"
!
```

```
interface gigabitethernet "0/0/2"
   lacp-profile "pc0"
!
interface gigabitethernet "0/0/20"
   mstp-profile "mstpPortfast"
!
interface gigabitethernet "0/0/24"
   switching-profile "trunk-profile"
!
interface gigabitethernet "0/0/28"
   mstp-profile "mstpPortfast"
!
interface gigabitethernet "0/0/3"
   lacp-profile "pc0"
!
interface gigabitethernet "0/0/36"
   switching-profile "trunk-profile"
!
interface gigabitethernet "0/0/42"
   lacp-profile "pc2"
!
interface gigabitethernet "0/0/43"
   lacp-profile "pc2"
!
interface gigabitethernet "0/0/46"
   shutdown
   switching-profile "trunk-profile"
!
interface gigabitethernet "0/0/47"
   shutdown
   switching-profile "trunk-profile"
!
interface vlan "4093"
!
interface mgmt
   ip address 10.16.56.62 netmask 255.255.255.0
!
interface port-channel "0"
   switching-profile "trunk-profile"
!
interface port-channel "2"
   switching-profile "trunk-profile"
!
```

The implementation of Rapid PVST+ (Per-VLAN Spanning Tree Plus) is based on the IEEE Standards 802.1D-2004 and 802.1Q-2005 ensuring interoperability with industry accepted PVST+ protocols. In addition, Rapid PVST+ supports the loopguard, rootguard, bpduguard, and portfast features.

NOTE

To enable PVST+ , use the spanning tree mode command.

Rapid PVST+ runs a separate spanning tree instance for each Virtual Local Area Network (VLAN). This allows the port to forward some VLANs while blocking other VLANs. PVST+ provides for load balancing of VLANs across multiple ports resulting in optimal usage of network resources.

Convergence occurs rapidly with Rapid PVST+. By default, each designated port in the spanning tree protocol sends out a BPDUs (Bridge Protocol Data Units) every 2 seconds. On a designated port in the topology, if hello messages are missed three consecutive times, or if the maximum age expires, the port immediately flushes all protocol information from the table. A port considers that it loses connectivity to its direct neighbor designated port when it misses three BPDUs or if the maximum age expires. This rapid aging of the protocol information allows for quick failure detection.

Rapid PVST+ provides for rapid recovery of connectivity following the failure of a device, a device port, or a LAN. It provides rapid convergence for edge ports, new root ports, and ports connected through point-to-point links.

This chapter covers:

Important Points to Remember

- Configure Rapid PVST+ using the command line only.
- If your Mobility Access Switch is terminated on a router/switch spanning tree environment running PVST+, your Mobility Access Switch must be in PVST mode (**spanning-tree mode pvst** command).
- Once in Rapid PVST+ mode, a predefined non-editable PVST profile automatically associates all configured VLANs (including default VLAN 1) and PVST+ starts running on all configured VLANs.
- Rapid PVST+ inter-operates seamlessly with IEEE and PVST bridges when the Mobility Access Switch is placed in a network.

Configuring PVST+

You configure Rapid PVST+ via two profiles; the VLAN profile that enables you to configure the Rapid PVST+ properties and the interface-based profile that enables you to configure your Rapid PVST+ port properties.

Configuring using the VLAN Profile

Set the spanning tree mode to PVST+, assign a profile name, attach the profile to a VLAN, then configure PVST+ properties.

1. Set the spanning tree mode to PVST+.

```
(host)(config) #spanning-tree mode pvst
```

Verify the spanning treee mode:

```
(host)(config) #show spanning-tree-profile

spanning-tree
-------------
Parameter           Value
---------           -----
spanning-tree-mode  pvst
```

2. Assign a PVST+ profile name; in the example below the profile name is “techpubs”:

```
(host)(config) #vlan-profile pvst-profile techpubs
(host)(pvst-profile "techpubs") #
```

3. Attach the named profile to a VLAN; in the example below the profile name “techpubs” is attached to VLAN 1:

```
(host)(config) #vlan 1#
(host)(VLAN "1") #pvst-profile techpubs
```

4. View the other PVST+ options settings (such as forward delay, hello time and maximum age).

```
(host)(pvst-profile "techpubs") # ?
bridge-priority        Bridge-priority [0-61440 in steps of 4096]. Default:
                       32768
clone                  Copy data from another pvst-profile
enable                 Enable or disable PVST+ bridge.
forward-delay          Forward-delay in seconds [4-30]. Default: 15 seconds
hello-time             Hello-time in seconds [1-10]. Default: 2 seconds
max-age                Maximum age in seconds [6-40]. Default: 20 seconds
no                     Delete Command
```

5. To change one of the value, for example bridge hello time, execute the following command:

```
(host)(pvst-profile "techpubs") #hello-time 5
```

6. Then verify your change:

```
(host)(pvst-profile "techpubs") #show vlan-profile pvst-profile techpubs

pvst-profile "TechPubs"
----------------------
Parameter             Value
---------             -----
Enable PVST+ bridge   Enabled
bridge priority       32768
bridge hello time     5                <——forward delay changed from 2 to 5 seconds
bridge forward delay  15
bridge maximum age    20
```

Disable PVST+ on a VLAN

The following example disables the PVST+ profile “techpubs” and then removes the PVST profile from VLAN 1.

```
(host)(config) #vlan-profile pvst-profile techpubs
(host)(pvst-profile "techpubs") #no enable
(host)(pvst-profile "techpubs") #exit
(host)(config) #vlan 1
(host)(VLAN "1") #pvst-profile techpubs
(host)(VLAN "1") #
```

Configuring using the Interface-based Profile

The interface-based Rapid PVST+ profile allows you to configure PVST+ port parameters.

1. Name the interface and view the configuration options.

```
(host) (config) #interface-profile pvst-port-profile techpubs
(host) (Interface PVST bridge "techpubs") #?
```

```
bpduguard              Enable or disable bpduguard
clone                  Copy data from another Interface PVST bridge
loopguard              Enable or disable loopguard
no                     Delete Command
point-to-point         Enable or disable point-to-point
portfast               Enable or disable portfast
rootguard              Enable or disable rootguard
vlan                   spanning tree [1-4094]
```

2. Use any of the command options to further configure your interface-based profile.

```
(host)(Interface PVST bridge "techpubs") #vlan 3 cost 8
(host)(Interface PVST bridge "techpubs") #vlan 3 priority 240
```

Then verify your configuration. Notice that the cost and priority values include the original default value and the current value.

```
(host)(Interface PVST bridge "techpubs") #show interface-profile pvst-port-profile techpubs

Interface PVST bridge "techpubs"
-------------------------------
Parameter                    Value
---------                    -----
spanning tree port cost      3 8 <——new value is displayed
spanning tree port priority  3 240 <——new value is displayed
Enable point-to-point        Enabled
Enable portfast              Disabled
Enable rootguard             Disabled
Enable loopguard             Disabled
```

Loopguard and Rootguard

Rapid PVST+ supports the loopguard and rootguard features.

Configuring Loopguard

Loopguard provides additional protection against Layer 2 forwarding loops (spanning tree loops). A spanning tree loop is created when a spanning tree blocking port, in a redundant topology, erroneously transitions to the forwarding state. This usually happens because one of the ports of a physically redundant topology (not necessarily the spanning tree blocking port) is no longer receiving spanning tree BPDUs (Bridge Protocol Data Units).

If loopguard is enabled on a non-designated port receiving BPDUs, then that non-designated port is moved into the spanning tree loop-inconsistent blocking state.

Enable loopguard:

```
(host)(Interface PVST bridge "techpubs") #loopguard
```

Associate to the interface:

```
(host)(config) #interface gigabitethernet 0/0/2
(host)(gigabitethernet "0/0/2") #pvst-port-profile techpubs
```

Configuring Rootguard

Rootguard provides a way to enforce the root bridge placement in the network. The rootguard feature guarantees that a port will not be selected as Root Port. If a bridge receives superior spanning tree BPDUs on a rootguard-enabled port, the port is selected as an Alternate Port instead of Root Port and no traffic is forwarded across this port.

By selecting the port as an Alternate Port, the rootguard configuration prevents bridges, external to the region, from becoming the root bridge and influencing the active spanning tree topology.

Enable rootguard:

```
(host)(Interface PVST bridge "techpubs") #rootguard
```

Associate to the interface:

```
(host)(config) #interface gigabitethernet 0/0/2
(host)(gigabitethernet "0/0/2") #pvst-port-profile techpubs
```

Verifying the Configuration

Use the show interface-profile command to view the status of loopguard and rootguard.

```
(host) #show interface-profile pvst-port-profile techpubs

Interface PVST bridge "techpubs"
--------------------------------
Parameter                           Value
---------                           -----
Instance port cost                  3 8
Instance port priority              3 240
Enable point-to-point               Enabled
Enable portfast                     Enabled
Enable rootguard                    Enabled <———rootguard is enabled
Enable loopguard                    Disabled
Enable bpduguard                    Enabled
Enable bpduguard auto recovery time  60
```

Bridge Protocol Data Unit (BPDU) Guard

The BPDU guard functionality prevents malicious attacks on edge ports. When the malicious attacker sends a BPDU on the edge port, it triggers unnecessary STP calculation. To avoid this attack, use the BPDU guard on that edge port. The BPDU guard enabled port shuts down as soon as a BPDU is received.

Enabling and Configuring BPDU Guard Functionality

The BPDU Guard functionality can be enabled or disabled at an interface level. By default, the BPDU is disabled. The BPDU guard functionality can now be configured as part of the `pvst-port-profile` configuration.

You can use the following command to configure the BPDU guard by using the PVST profile:

```
(host) (config) #interface-profile pvst-port-profile <profile-name>
   bpduguard
   auto-recovery-time <recovery-time>
```

The following example shows how to enable and configure the BPDU guard functionality:

```
(host)(config)# interface-profile pvst-port-profile BPDU-Guard1
   bpduguard auto-recovery-time 60
```

NOTE

You can configure BPDU guard with or without the **auto-recovery-time** option.

You can disable the BPDU guard functionality by using the following command:

```
(host) (config) #interface-profile <profile-name> no bpduguard
```

You can disable the auto recovery time by using the following command:

```
(host) (Interface PVST bribge “profile-name”) #bpduguard no auto-recovery-time
```

Verifying the BPDU Guard Configuration:

```
(host) (config) #show interface-profile pvst-port-profile bpdu

Interface PVST bridge "bpdu"
----------------------------
Parameter                            Value
---------                            -----
Instance port cost                   N/A
Instance port priority               N/A
Enable point-to-point                Disabled
Enable portfast                      Disabled
Enable rootguard                     Enabled
Enable loopguard                     Disabled
Enable bpduguard                     Enabled <——BPDU guard is enabled
Enable bpduguard auto recovery time  N/A
```

Sample Configuration

To enable and configure BPDU guard using the PVST profile:

```
(host)(config)# interface-profile pvst-port-profile BPDU-Guard1
  bpduguard auto-recovery-time 60
```

To attach the PVST profile to the interface:

```
(host) (config)# interface gigabitethernet <0/0/6>
  pvst-port-profile BPDU-Guard1
```

Portfast

When the link on a bridge port goes up, PVST+ runs its algorithm on that port. If the port is connected to a host that does not “speak” PVST+, it takes approximately 30 seconds for the port to transition to the forwarding state. During this time, no user data passes through this bridge port and some user applications may time out.

NOTE

The portfast is mutually exclusively with the Loopguard feature.

Configuring Portfast

To immediately transition the bridge port into the forwarding state upon linkup, enable the PVST+ portfast feature.

```
(host)(config) #interface-profile pvst-port-profile techpubs
(host)(Interface PVST bridge "techpubs") #portfast
```

The bridge port still participates in PVST+; if a BPDU is received, it becomes a normal port.

NOTE

Portfast is operational on both access ports and trunk ports.

Use the following command to enable the portfast support on a trunk port:

```
(host) (config) #interface-profile mstp-profile portfast_techpubs
(host) (Interface "portfast_techpubs") #portfast trunk
```

Verify the Configuration

Use the show interface-profile command to view the status of the portfast.

```
(host) (config) #show interface-profile pvst-port-profile bpdu

Interface PVST bridge "bpdu"
```

```
----------------------------
Parameter                           Value
---------                           -----
Instance port cost                  N/A
Instance port priority              N/A
Enable point-to-point               Disabled
Enable portfast                     Enabled <——portfast is enabled
Enable rootguard                    Disabled
Enable loopguard                    Disabled
Enable bpduguard                    Enabled
Enable bpduguard auto recovery time N/A
```

The Hot-Standby Link (HSL) feature is a simplified failover mechanism. HSL enables a Layer 2 interface (or port-channel) to back-up another Layer 2 interface (or port-channel) so that these interfaces become mutual backups.

HSL consists of a pair of redundant links. One is the *primary* for traversing traffic, and the other is the *backup*. When the primary fails, a rapid traffic failover occurs to the awaiting backup.

One of the primary use cases for HSL is in an enterprise topology where each access switch is dual-homed to two distribution/core switches for redundancy purpose.

Important Point to Remember

- Spanning tree (MSTP and PVST+) must be disabled before configuring HSL. HSL and spanning tree can not be configured on the same system at the same time.
- HSL is a 1:1 ratio for primary and backup pairs. One backup interface can not be the backup of multiple primary interfaces. An interface can be part of only one HSL pair.
- HSL links are always trusted.
- Primary and backup interfaces must have the same switching profiles.
- Primary and backup interfaces cannot be members of the same port-channel.
- The interfaces cannot be Tunneled Node interfaces.

Configuration Steps

When a primary link goes down, the backup link becomes active. By default, when the link comes up it goes into the standby mode as the other interface is activated. You can force the primary interface to become active by enabling preemption.

Configure HSL directly in the interface. First, on the primary interface (for example 0/0/10), then specify the back-up interface (for example 0/0/11). Use the following steps, from the command line, to configure and verify HSL.

1. Configure the primary and backup interfaces.
```
(host) (config) #interface gigabitethernet 0/0/10
(host) (gigabitethernet "0/0/10") #backup interface gigabitethernet 0/0/11
```
2. Configure pre-emption if necessary (it is off by default).
```
(host) (gigabitethernet "0/0/10") #preemption mode forced
```
3. If pre-emption is configured, best practices recommends configuring *delay*. The range is 10 seconds to 5 minutes (300 seconds); default is 100 seconds.
```
(host) (gigabitethernet "0/0/10") #preemption delay 10
```
4. Verify the HSL configuration. The following show command is a partial output.
```
(host) #show interface-config gigabitethernet 0/0/10

gigabitethernet "0/0/10"
------------------------
Parameter                                    Value
---------                                    -----
Interface MSTP Profile                       disabled
...
Interface Trusted Mode                       Enabled
HSL backup interface                         gigabitethernet0/0/11
HSL preemption mode                          Forced
HSL preemption delay                         10
```

```
...
```

To view details of HSL on an interface, use the following show commands.

```
(host) #show hot-standby-link gigabitethernet 0/0/10

HSL Interface Info
------------------
Primary Interface: GE-0/0/10 (Active)  Backup Interface:  GE-0/0/11 (Standby)
Preemption Mode: forced                Preemption Delay: 10
Last Switchover Time: NEVER            Flap Count: 0
```

To view details of all HSL links, use the following show command.

```
(host) #show hot-standby-link

HSL Interfaces Info
-------------------
Primary    State   Backup      State      Last Switchover Time
--------   ------  -------     ------     --------------------
GE-0/0/10  Active  GE-0/0/11   Standby    Never
GE-0/0/3   Down    PC-4        Down       Never
PC-1       Down    GE-0/0/0    Active     Never
PC-2       Down    PC-3        Down       Never
```

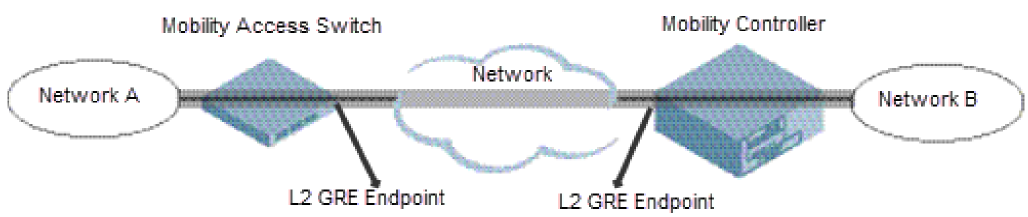
Generic Routing Encapsulation (GRE) is an Aruba proprietary tunnel across Mobility Access Switches, Aruba Controllers, and Aruba APs. This chapter describes the following topics related to GRE:

- L2 GRE on page 182
- L3 GRE on page 184

L2 GRE

ArubaOS Mobility Access Switch supports L2 connectivity through GRE tunnel. L2-GRE tunnel extends VLANs across Mobility Access Switches and Aruba controllers. GRE encapsulates Layer-2 frames with a GRE header and transmit through an IP tunnel over the cloud. Following figure shows how L2-GRE tunnel fits into network operations.

Figure 11 *L2-GRE Tunnel Network Topology*



Configuring an L2-GRE Tunnel

To configure an L2-GRE tunnel, see the following procedure.

```
(host) (config) #interface tunnel ethernet <tunnel-id>
(host) (Tunnel “tunnel-id”) #description <interface-description>
(host) (Tunnel “tunnel-id”) #source-ip <source-tunnel-ip>
(host) (Tunnel “tunnel-id”) #destination-ip <destination-tunnel-ip>
(host) (Tunnel “tunnel-id”) #switching-profile <profile-name>
(host) (Tunnel “tunnel-id”) #keepalive <Tunnel heartbeat interval in seconds (1-86400)> <Tunne
l Heartbeat Retries (1-1024)>
```

Inter-tunnel flooding

There can be multiple L2-GRE tunnels terminating on the same device, either ArubaOS Mobility Access Switch or Mobility Controller. If the tunnels carry same VLANs, this may cause inter-tunnel flooding resulting in loops within the network. To avoid this scenario, disable inter-tunnel flooding in the switch and the controller.

```
(host) (config) #interface tunnel ethernet <tunnel-id>
(host) (Tunnel “tunnel-id”) #no inter-tunnel-flooding
```

For additional parameters, see *ArubaOS 7.2 Command Line Interface* guide.

Understanding the VLAN Membership of Existing L2 GRE Tunnel

You can use the following commands to understand the VLAN membership of L2 GRE tunnel which is already configured.

Use the following command to check the VLAN membership of the existing L2 GRE tunnel:

```
(host) #show interface tunnel <tunnel-id>
```

```
tunnel 10 is administratively Up, Line protocol is Down
Description: GRE Interface
Internet address is unassigned
Source  <source_IP>
Destination <destination_IP>
Protocol number  0
Tunnel mtu is set to 1100
Tunnel is an L2 GRE Tunnel
Tunnel is Trusted
Inter Tunnel Flooding is enabled
Tunnel keepalive is enabled
Tunnel keepalive interval is 3 seconds, retries 3
   Heartbeats sent 51347, Heartbeats lost 51346
   Tunnel is down 4 times
Switching-profile "100"

(host) #show interface-config tunnel <tunnel-id>

Tunnel "10"
-----------
Parameter                 Value
---------                 -----
Tunnel Description        N/A
Tunnel Source IP          <source_IP>
Tunnel Destination IP     <destination_IP>
Inter-Tunnel-Flooding     Enabled
Tunnel Mode               L2
Tunnel Protocol           0
Tunnel Keepalive          3/3
Tunnel MTU                1100
Tunnel Shutdown           Disabled
Tunnel Switching Profile  100
Tunnel Trusted            Enabled
```

This shows that Switching-Profile “100” is applied in L2 GRE tunnel interface. You can use the **show interface-profile switching-profile 100** command to view the VLAN configuration.

```
(host) #show interface-profile switching-profile 100

switching profile "100"
-----------------------
Parameter                                             Value
---------                                             -----
Switchport mode                                       access
Access mode VLAN                                      100
Trunk mode native VLAN                                1
Enable broadcast traffic rate limiting                Enabled
Enable multicast traffic rate limiting                Disabled
Enable unknown unicast traffic rate limiting          Enabled
Max allowed rate limit traffic on port in percentage  50
Trunk mode allowed VLANs                              1-4094
```

You can use the **show vlan** command to view the port associated with the vlan:

```
(host) #show vlan

VLAN CONFIGURATION
------------------
VLAN  Description  Ports
----  -----------  -----
1     VLAN0001     GE0/0/1-19 GE0/0/21-26 GE0/0/28-33 GE0/0/35-36
                   GE0/0/38-47 GE0/1/0-3 GRE-TUN30
10    VLAN0010     GE0/0/34 Pc1
```

```
11    VLAN0011     GE0/0/34
20    VLAN0020     GE0/0/20
100   VLAN0100     GE0/0/0 GE0/0/27 GRE-TUN10 GRE-TUN20
```

NOTE

MAC address learned on L2 GRE tunnel does not honor `mac-aging-timer` configuration , and ages out at 270 seconds.

Sample Configuration

To configure an L2-GRE tunnel and apply the switching profile:

```
(host) (config) #interface tunnel ethernet 1
(host) (Tunnel "1") #description L2-GRE_Interface
(host) (tunnel "1") #source-ip 10.0.0.1
(host) (tunnel "1") #destination-ip 10.0.1.2
(host) (tunnel "1") #switching-profile mDNS_vlan_200
(host) (tunnel "1") #keepalive 30 5
```

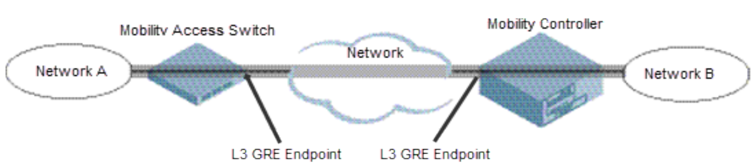
NOTE

In the above example, **mDNS_vlan_200** was previously defined.

L3 GRE

ArubaOS Mobility Access Switch supports L3 connectivity through GRE tunnel. L3 GRE tunnel extends VLANs across Mobility Access Switches and Aruba controllers. GRE encapsulates Layer-3 frames with a GRE header and transmits through an IP tunnel over the cloud. Following figure shows how L3-GRE tunnel fits into network operations.

Figure 12 *L3-GRE Tunnel Network Topology*



Configuring an L3 GRE Tunnel

To configure an L3-GRE tunnel, see the following procedure.

```
(host) (config) #interface tunnel ip <tunnel-id>
(host) (Tunnel "tunnel-id") #description <interface-description>
(host) (Tunnel "tunnel-id") #source-ip <source-tunnel-ip>
(host) (Tunnel "tunnel-id") #destination-ip <destination-tunnel-ip>
(host) (Tunnel "tunnel-id") #keepalive <Tunnel heartbeat interval in seconds (1-86400)>
<Tunnel Heartbeat Retries (1-1024)>
(host) (Tunnel "tunnel-id") #mtu <Set MTU between 1024 and 1500 (Default 1100)>
(host) (Tunnel "tunnel-id") #ip address <addr> <mask>
(host) (Tunnel "tunnel-id") #ospf-profile <profile-name>"
```

Sample Configuration

To configure an L3 GRE tunnel:

```
(host) (config) #interface tunnel ip 1
(host) (Tunnel "1") #description L3-GRE_Interface
(host) (tunnel "1") #source-ip 192.0.2.10
(host) (tunnel "1") #destination-ip 192.0.2.12
(host) (tunnel "1") #keepalive 30 5
(host) (tunnel "1") #mtu 1100
(host) (Tunnel "1") #ip address 192.0.2.1 255.255.255.0
```

```
(host) (Tunnel "1") #ospf-profile TechPubs
```

Verification

Use the following command to verify the L3 GRE tunnel configuration:

```
(host) #show interface tunnel <tunnel-id>
```

The following example shows L3 GRE tunnel configuration on tunnel 1:

```
(host) #show interface tunnel 1
tunnel 1 is administratively Up, Line protocol is Up
Description: L3-GRE_Interface
Source  192.0.2.10
Destination 192.0.2.12
Tunnel mtu is set to 1100
Tunnel keepalive is enabled
Tunnel keepalive interval is 30 seconds, retries 5
Heartbeats sent 4, Heartbeats lost 3
Tunnel is down 0 times
Tunnel is an L3 GRE Tunnel
Internet address is 192.0.2.1, Netmask is 255.255.255.0
```

Chapter 17 Layer 3 Routing

This chapter describes the Layer 3 Routing features available on the Mobility Access Switch. It contains the following sections:

Understanding Routed VLAN Interfaces

Routed VLAN Interfaces (RVI) are logical interfaces that enable routing and bridging between VLANs. You can route and bridge a protocol on the same interface. The traffic that remains in the bridge group (the bridged traffic) will be bridged among the bridged interfaces, and the traffic that needs to go out to another network (the routed traffic) will be routed internally to the appropriate output routed interface.

There can be an IPv4 address to each VLAN interface. You can also configure IGMP and PIM interface profiles to the VLAN interfaces. You can configure up to 4094 routed VLAN interfaces. VLAN interface 1 is configured by default.

Important Points to Remember

- The maximum number of VLAN interfaces supported are 4094.
- The Layer 2 VLAN must be configured before configuring the corresponding RVIs.
- The protocol status of a RVI is in up state only when the protocol status of at least one member port in the corresponding VLAN is in up state.

To assign member ports to a VLAN, create a switching profile with the corresponding VLAN, and assign the switching profile to the member interfaces.

Configuring Routed VLAN Interfaces

You can configure routed VLAN interfaces using the CLI.

Using the CLI

To configure routed VLAN interfaces, follow these steps:

1. Create the required VLANs.

```
(host)(config)# vlan <vlan-id>
```

2. Create the switching profiles and reference the existing VLANs.

```
(host)(config)# interface-profile switching-profile <profile-name>
        switchport-mode {access|trunk}
        access-vlan <vlan-id>
        trunk allowed vlan <vlan-list>
        native-vlan <vlan-id>
        exit
```

3. Apply the swtiching profiles to the physical interfaces.

```
(host)(config)# interface gigabitethernet <slot/module/port>
        switching-profile <profile-name>
        exit
```

4. Create the VLAN interfaces.

```
(host)(config)# interface vlan <vlan-id>
        description <vlan-interface-description>
        dhcp-relay-profile <profile-name>
        igmp-profile <profile-name>
        ip {address {{<ip-address> netmask <subnet-mask>}| dhcp-client} | directed- broadcast | na
t {inside}}
        ipv6 address {{<prefix> netmask <subnet-mask>}| link-local <link-local>}
        mtu <64-9216>
        shutdown
        no {...}
        ospf-profile <profile-name>
        pim-profile <profile-name>
        exit
```

Multinetting

ArubaOS supports multiple IP addresses per VLAN and loopback interface. This allows the user to specify any number of secondary IP addresses. Secondary IP address can be used in a variety of situations, such as the following:

- If an insufficient number of host addresses are available on a particular network segment. Using secondary IP addresses on the routers or access devices allows you to have two logical subnets using one physical subnet
- If the an older network is built using Layer 2 bridges and has no subnetting. Secondary addresses can aid in the transition to a subnetted, router-based network.
- Two subnets of a single network might be otherwise separated by another network. You can create a single network from subnets that are physically separated by another network using a secondary address.

Important Points to Remember

- OSPF advertises the secondary IP address in the router LSA but it does not form adjacency on the secondary IP address.
- PIM will not send hello packets on the secondary IP address.
- DHCP servers identify the subnets associated with secondary IP addresses used for allocation.

Configuring Secondary IP

To configure a secondary IP address, use the following command:

```
(host) (vlan "1") #ip address 1.1.1.1 255.255.255.0 ?
secondary               Make this IP address a secondary address
```

Sample Configuration

```
(host) (config) #interface vlan  2
(host) (vlan "2") #ip address 1.1.1.1 255.255.255.0 secondary

(host) (vlan "2") #show interface vlan  2

VLAN2 is administratively Up, Line protocol is Up
Hardware is CPU Interface, Address is 00:0b:86:6a:1c:c0
Description: 802.1Q VLAN
Internet address is 20.20.20.1, Netmask is 255.255.255.0
```

```
Internet address is 1.1.1.1, Netmask is 255.255.255.0 secondary
IPV6 link-local address is fe80::b:8600:26a:1cc0
Global Unicast address(es):
Routing interface is enable, Forwarding mode is enable
Directed broadcast is disabled, BCMC Optimization disabled
```

Loopback Interfaces

The Mobility Access Switch supports a maximum of 64 (0 to 63) loopback interfaces. You can configure the loopback interfaces using the CLI. Additionally, you can assign a secondary IP address to a loopback interface by using the **secondary** parameter.

Using the CLI

```
(host)(config)# interface loopback <0-63>
   clone <source>
   description <description>
   ip address <address> [secondary]
   no {...}
   ospf-profile
   exit
```

Sample Loopback Interface Configuration

```
(host)(config)# interface loopback 1
   description loopback01
   ip address 1.1.1.1
   exit
```

Network Address Translation

Aruba Mobility Access Switches support source Network Address Translation (NAT) with Port Address Translation (PAT) on VLAN interfaces. When source NAT is enabled on a VLAN interface, the IP address of the egress VLAN interface as determined by the routing table will be used as the source IP. For example, if "ip nat inside" is enabled on interface VLAN X and traffic will be routed out interface vlan Y, the IP address of interface VLAN Y will be used as the source IP for traffic from VLAN X

```
(host) (config) #interface vlan <vlan_id>
(host) (vlan "vlan_id") #ip nat inside
```

NOTE

No packet fragmentation is supported by NATing.

To verify source NAT is enabled on a VLAN interface, use **show interface vlan <vlan-id>**. In the following example, source NAT has been enabled on interface VLAN 6. As a result, the output of **show interface vlan <vlan-id>** will included the bolded section below. If the bolded section is not displayed, source NAT has not been enabled.

```
(host) # show interface vlan 6

VLAN6 is administratively Up, Line protocol is Up
Hardware is CPU Interface, Address is 00:0b:86:6a:5d:c0
Description: 802.1Q VLAN
Internet address is 6.1.1.1, Netmask is 255.255.255.0
IPV6 link-local address is fe80::b:8600:66a:5dc0
Global Unicast address(es):
Routing interface is enabled, Forwarding mode is enabled
Interface is source NAT'ed
Directed broadcast is disabled, BCMC Optimization disabled
```

```
Encapsulation 802, Loopback not set
Interface index: 50331654
MTU 1700 bytes
```

Additionally, you can use the **show datapath vlan** command to verify that source NAT has been enabled.

```
(host) #show datapath vlan

Datapath VLAN Table Entries
---------------------------
Flags:  N - Nat Inside, M - Route Multicast, R - Routing
       S - Snoop MLD, G - Snoop IGMP, P - Proxy IGMP
       B - BCMC Optimization, A - Proxy ARP, U - Suppress ARP
       1(cert-id) - 8021X Term-PEAP, 2(cert-id) - 8021X Term-TLS
VLAN  Flags         Ports
----  ------------  -----
6     NRU        1/0/14
100   RU         0/0/14
```

The **show datapath session** command can be used to to verify the packet flows that are being NAT'ed. This output however will not indicate the interface VLAN the flow(s) are using. To determine that information use the **show ip interface brief** command.

```
(host) #show datapath session
Datapath Session Table Entries
------------------------------
Flags: F - fast age, S - src NAT, N - dest NAT
       D - deny, R - redirect, Y - no syn
       H - high prio, P - set prio, T - set ToS
       C - client, M - mirror, V - VOIP
       Q - Real-Time Quality analysis
       I - Deep inspect, U - Locally destined
       E - Media Deep Inspect, G - media signal
       u - User Index
  Source IP     Destination IP  Prot SPort DPort  Cntr Prio ToS Age Destination TAge UsrIdx Us
rVer Flags
--------------  --------------  ---- ----- -----  ---- ---- --- --- ----------- ---- ------ --
---- -----
6.1.1.5         100.1.1.6       61   0     0      0/0     0 0   0   1/0/14      1    0      0
    FSC
100.1.1.6       100.1.1.7       61   0     0      0/0     0 0   0   1/0/14      1    0      0
    FNY

(host) #show ip interface brief

Interface                    IP Address / IP Netmask        Admin   Protocol
vlan 100                      100.1.1.7 / 255.255.255.0     Up      Up
vlan 6                          6.1.1.1 / 255.255.255.0     Up      Up
```

IP Directed Broadcast

An IP directed broadcast is typically used by network management systems (NMS) for features like Wake On LAN to broadcast packets on a local subnet even though the source of that broadcast is located on a remote subnet. When the source device initiates this broadcast packet, it is routed through the network as a unicast packet until it reaches the target subnet. Other than the router directly attached to the target subnet, all routers across the network view it as a unicast packet. The router directly attached to the target subnet identifies the packet as a directed broadcast, converts it to a link-layer broadcast packet and propagates it across the target subnet.

This feature is disabled by default. When disabled, the directed broadcast packets are dropped unconditionally without generating an ICMP error packet. Due to the nature of propagating broadcast, Aruba does not recommend enabling this parameter as it can result in Denial of Service (DoS) attacks, if not used correctly. When absolutely necessary, you can enable this feature on a subnet by subnet basis. You can enable this feature on the Routed VLAN Interfaces (RVI) in the CLI.

Configuring IP Directed Broadcast

```
(host)(config) #interface vlan <id>
(host)(vlan) #ip directed-broadcast
```

Sample Configuration

The following example shows how to configure a routed VLAN interface and enable IP directed broadcast:

```
(host)(config) #interface vlan 10
(host)(vlan "10") #ip address 10.10.10.10 netmask 255.255.255.0
(host)(vlan "10") #ip directed-broadcast
(host)(vlan "10") #description layer 3
(host)(vlan "10") #mtu 1500
(host)(vlan "10") #exit
```

You can verify the preceding configuration using the following command:

```
(host)#show interface vlan 10
VLAN10 is administratively Up, Line protocol is Up
Hardware is CPU Interface, Address is 00:0b:86:6a:f2:40
Description: layer3
Internet address is 10.10.10.10, Netmask is 255.255.255.0
IPV6 link-local address not assigned
Global Unicast address(es):
Routing interface is enable, Forwarding mode is enable
Directed broadcast is enabled, BCMC Optimization disabled
Encapsulation 802, Loopback not set
Interface index: 50331658
MTU 1500 bytes
```

Static Routes

The Mobility Access Switch supports static routes configuration. You can configure a default gateway and multiple static routes within the global IP-profile to route packets outside the local network. The static routes are active or added to the routing table only when the next hop is reachable, and can be removed from the static routes list only by using the `no` command.

Important Points to Remember

- You can have only one default gateway. However, you can have multiple static routes.
- You can have both an IPv4 and an IPv6 default gateway simultaneously.
- Static routes become active only when the nexthop is reachable.
- Nexthops have to be within the local network.

Default Gateway

Default gateway is a special case of static route where the destination mask and prefix is 0/0. The next hop in a default gateway can be any valid IP address which can be reached through a routable or the management interface.

Configuring the Default Gateways and the Static Routes

You can configure the static routes within the global IP-profile. Each static route needs a destination, netmask and nexthop addresses.

The static routes are inserted in to the Forwarding Information Base (FIB), only when the nexthop matches the subnet of any of the RVI interfaces or the management interface. If the nexthop becomes unreachable, the Routing Information Base (RIB) gets purged but the static route is still retained. The static route can be completely removed from the system only by using the `no` command within the IP-profile.

You can configure the default gateways and the static routes using the CLI. You can also configure static routes using the WebUI.

Using the WebUI

1. Navigate to the **Configuration > Routing** page.
2. Click **New** under the static routes list.
3. Click on the **Destination IP** column and enter the destination IP address.
4. Click on the **Destination Mask** column and enter the destination netmask address.
5. Click on the **Next Hop** column and enter the nexthop IP address.
6. Click on the **Metric** column and enter the metric.
7. Press **Enter**.

Using the CLI

```
(host)(config) #ip-profile
controller-ip           Configure controller IP
default-gateway         Specify default gateway
no                      Delete Command
prefix-list             Configure prefix list
route                   Configure static route A.B.C.D
```

Sample Configuration

```
(host)(config) #ip-profile
(host)(ip-profile) #default-gateway 2.2.2.2
(host)(ip-profile) #no default gateway
(host)(ip-profile) #default-gateway import dhcp
(host)(ip-profile) #route 20.20.31.0 255.255.255.0 10.10.10.31
(host)(ip-profile) #route 20.20.32.0 255.255.255.0 10.10.10.32
(host)(ip-profile) #route 20.20.33.0 255.255.255.0 10.10.10.33
(host)(ip-profile) #no route 20.20.34.0 255.255.255.0 10.10.10.20
```

Verifying the IP Routes

```
(host) #show ip route
Codes: C - connected, O - OSPF, R - RIP, S - static
       M - mgmt, U - route usable, * - candidate default
Gateway of last resort is 10.18.7.254 to network 0.0.0.0 at cost 39
S    0.0.0.0/0 [39/0] via 10.18.7.254
C    10.10.10.0 is directly connected: vlan1
C    10.10.10.1 is directly connected: vlan1
C    10.10.10.20 is directly connected: vlan1
C    10.10.10.31 is directly connected: vlan1
C    10.10.10.32 is directly connected: vlan1
C    10.10.10.33 is directly connected: vlan1
M    10.18.7.0 is connected mgmt-intf: 10.18.7.125
M    10.18.7.125 is connected mgmt-intf: 10.18.7.125
M    10.18.7.254 is connected mgmt-intf: 10.18.7.125
S    20.20.31.0 [0] via 10.10.10.31
```

```
S    20.20.32.0 [0] via 10.10.10.32
S    20.20.33.0 [0] via 10.10.10.33

(host) #show ip route summary

Route Source  Total
------------  -----
connected     6
static        5
ospf-intra    0
ospf-inter    0
ospf-ext1     0
ospf-ext2     0
ospf-nssa     0

(host) #show arp
IPV4 ARP Table
--------------
Protocol  IP Address    Hardware Address   Interface
--------  ----------    ----------------   ---------
Internet  40.40.40.252  00:0b:86:64:a8:c0  vlan40
```

Clearing the ARP Table

```
(host) #clear arp {<all>|<ip-address>}
```

Route Configuration Limits

The following table specifies the maximum number of routes and nexthops you can have in a Mobility Access Switch:

Table 19: *Route Configuration Limits*

Type of Route/Nexthop	Maximum Routes Supported
IPv4 Unicast + IPv4 Multicast Groups	6912
IPv4 Multicast Sources	1024
IPv6 Unicast + IPv6 Multicast Groups + IPv6 Multicast Sources	320
Address Resolution Protocol	4096 (3k distinct MACs)
Multicast downstream interface table	4096

Route Metrics

The Mobility Access Switch includes support for route metrics. For a given route destination, there can be multiple nexthops. A route metric enables the Mobility Access Switch to prefer one route over another or load balance when the metric is the same. For more details on load balancing across multiple nexthops, see Equal Cost Multipath on page 193.

A route destination with a lower metric is added to the route manager. The higher metric routes are added only when the lower metric routes are removed.

The following example shows how to add a metric of 10 to a static route:

```
(host) (ip-profile) # route 192.168.1.0 255.255.255.0 192.168.2.1 10
```

Equal Cost Multipath

NOTE

No commands are necessary to enable ECMP.

Equal Cost Multipath (ECMP) enables Mobility Access Switch to forward the data packets to any of the multiple nexthops of a routing destination. The route manager identifies the best routing destination based on the priority of the protocol. After the route manager identifies the best route, all the nexthops of that route are used for datapath forwarding. ECMP is auto-enabled and does not require any command to enable it.

ECMP provides flow-based load balancing for the chosen routing destination. For a given flow same nexthop is used to forward all the packets. For multiple flows, load balancing happens across multiple nexthops. ECMP uses the source IP and destination IP to define a flow. For TCP/UDP packets, it also uses the source and destination ports to define the flow. ECMP automatically load balances the traffic when multiple nexthops with equal cost exist

Apart from multiple nexthops, ECMP also enables addition of metric for a route. ECMP nexthops are per metric basis. For a given metric, there can be multiple nexthops (up to 4). A route with a lower metric is added to the route manager. The higher metric routes are added only when the lower metric routes are deleted.

NOTE

ECMP is not supported across different nexthop-types.

IP Prefix List

The ip prefix-list command is used to configure IP prefix filtering. Prefix lists are used to either permit or deny the configured prefix based on the matching condition. The prefix list consists of an IP address and a bit mask. The IP address can be classful network, a subnet, or a single host route.

NOTE

Any traffic that does not match any prefix-list entry is denied.

```
(host) (config) #ip-profile
(host) (ip-profile) #prefix-list <prefix-list-name>
   seq <sequence-number>
   deny|permit
   <network prefix A.B.C.D>
   <network mask A.B.C.D>
   ge <bit-length>|le <bit-length>
(host) (ip-profile) #prefix-list test seq 1 permit 5.5.5.0 255.255.255.0 ge 32
```

Parameter	Description
`prefix-list`	Prefix list name.
`seq <sequence-number>`	Sequence number. Prefix lists are evaluated starting with the lowest sequence number and continue down the list until a match is made. Once a match is made, the permit or deny statement is applied to that network and the rest of the list is ignored.
`deny <network-prefix> <network mask>`	Specify IPv4 packets to reject.

Parameter	Description
`permit <network-prefix> <network mask>`	Specify IPv4 packets to forward.
`ge <bit-length>`	Minimum prefix length to be matched.
`le <bit-length>`	Maximum prefix length to be matched.

If only a ge value is entered, the range is the value entered for ge-length argument to a full 32-bit length. If only the le value is entered, the range is from the value entered for network-length argument to le-length argument. If a ge or le value is not used, the prefix list is processed using an exact match. If both ge and le values are entered, the range falls between the values between the values used for the ge-length and le-length arguments. The behavior can described as follows:

network/length < ge-length <= le-length <= 32

NOTE

The ge and le values are optional parameters.

Once you have configured the desired prefix-list entries, you apply them to the global OSPF profile using the following command.

```
(host) (Global OSPF profile) #distribute-list prefix-list <prefix-list name>
```

The following is a sample configuration:

```
(host) (ip-profile) #prefix-list test seq 1 permit 5.5.5.0 255.255.255.0 ge 32
(host) (ip-profile) #prefix-list test seq 2 deny 6.6.6.0 255.255.255.0 ge 32
(host) (ip-profile) #prefix-list test seq 3 permit 10.10.0.0 255.255.255.0 ge 24 le 32
(host) (Global OSPF profile) #distribute-list test
```

Verify the IP Prefix List configuration by using the **show ip-profile** command.

```
(host) (ip-profile) #show ip-profile

ip-profile "default"
--------------------
Parameter            Value
---------            -----
Default Gateway      10.18.7.254
Import DHCP Gateway  Disabled
controller-ip        N/A
prefix-list test seq 1 permit 5.5.5.0 255.255.255.0 ge 32
prefix-list test seq 2 deny 6.6.6.0 255.255.255.0 ge 32
prefix-list test seq 3 permit 10.10.0.0 ge 24 le 32
```

Virtual Router Redundancy Protocol (VRRP) enables a group of layer 3 configured Mobility Access Switches to form a single virtual router. LAN clients may be configured with the virtual router IP as the default gateway.

This chapter includes the following topics:

VRRP Definitions

Table 20: *Common VRRP Terms*

Term	Definition
VRRP Router	A Mobility Access Switch running the Virtual Router Redundancy Protocol. It may participate in one or more virtual routers.
Virtual Router	An abstract object managed by VRRP that acts as a default router for hosts on a shared LAN. It consists of a Virtual Router Identifier and a set of associated IP address(es) across a common LAN. A VRRP Router may backup one or more virtual routers.
Primary IP Address	In an active-standby scenario, the IP address of the master Mobility Access Switch is the primary IP address.
Virtual Router Master	The VRRP router that is assuming the responsibility of forwarding packets sent to the IP address(es) associated with the virtual router, and answering ARP requests for these IP addresses.

VRRP Overview

The underlying mechanism for the Aruba redundancy solution is the Virtual Router Redundancy Protocol (VRRP). VRRP is used to create various redundancy solutions, including:

- pairs of Mobility Access Switches acting in an active-active mode or a hot-standby mode.
- a master Mobility Access Switch backing up a set of backup Mobility Access Switches.
- a pair of Mobility Access Switches acting as a redundant pair of master Mobility Access Switches in a hot-standby mode.

VRRP eliminates a single point of failure by providing an election mechanism, among the Mobility Access Switches, to elect a VRRP master Mobility Access Switch. If VRRP preemption is disabled and all Mobility Access Switches share the same priority, the first Mobility Access Switch that comes up becomes the master. However, if VRRP preemption is enabled (the default setting) and all the Mobility Access Switches share the same priority, the Mobility Access Switch with the highest IP address becomes the master. This helps in achieving high-availability in Mobility Access Switch.

The master Mobility Access Switch owns the configured virtual IP address for the VRRP instance. When the master Mobility Access Switch becomes unavailable, a backup Mobility Access Switch steps in as the master and takes ownership of the virtual IP address. All network elements (APs and controllers) can be configured to access the virtual IP address, thereby providing a transparent redundant solution to your network.

Following are the advantages of enabling VRRP:

- Redundancy on a cluster of virtual-interfaces: Alternate paths can be configured for the hosts in the network without any explicit configuration by creating redundancy. This eliminates single point of failure.
- Load sharing in a cluster of virtual interfaces: To eliminate under-utilization of a backup Mobility Access Switch in a cluster, you can configure an active-active VRRP deployment, This way the hosts can share the traffic amongst the Mobility Access Switches in the cluster.

Important Points to Remember

- The Mobility Access Switch implementation of VRRP adheres to RFC 2338.
- VRRP is disabled by default and should be enabled manually on a layer-3 VLAN interface.
- For VRRP to be operational, you should have at least one IP address configured on a layer-3 VLAN interface.
- You can configure a maximum of two VRRP profiles on a layer-3 VLAN interface.

VRRP Deployment Scenarios

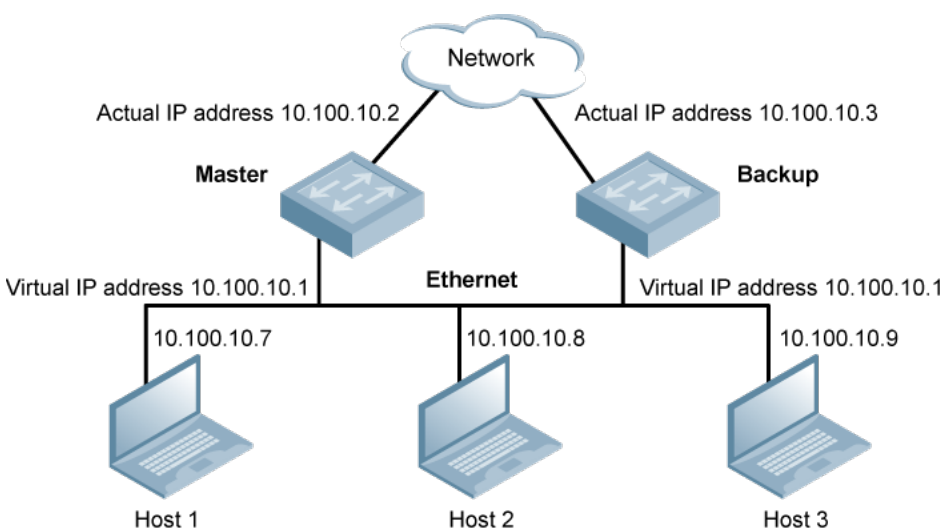
The following VRRP deployment scenarios are described in this section:

- Active-Standby Deployment
- Active-Active Deployment

Active-Standby Deployment

In an active-standby deployment, one Mobility Access Switch is configured as the active or master and the other as standby or backup. If the master Mobility Access Switch fails or should become unavailable at any point of time, the backup Mobility Access Switch takes over from the master Mobility Access Switch by the use of dynamic fail-over and the network state is maintained. Figure 13 shows a simple active-standby deployment.

Figure 13 *Active-Standby Deployment*



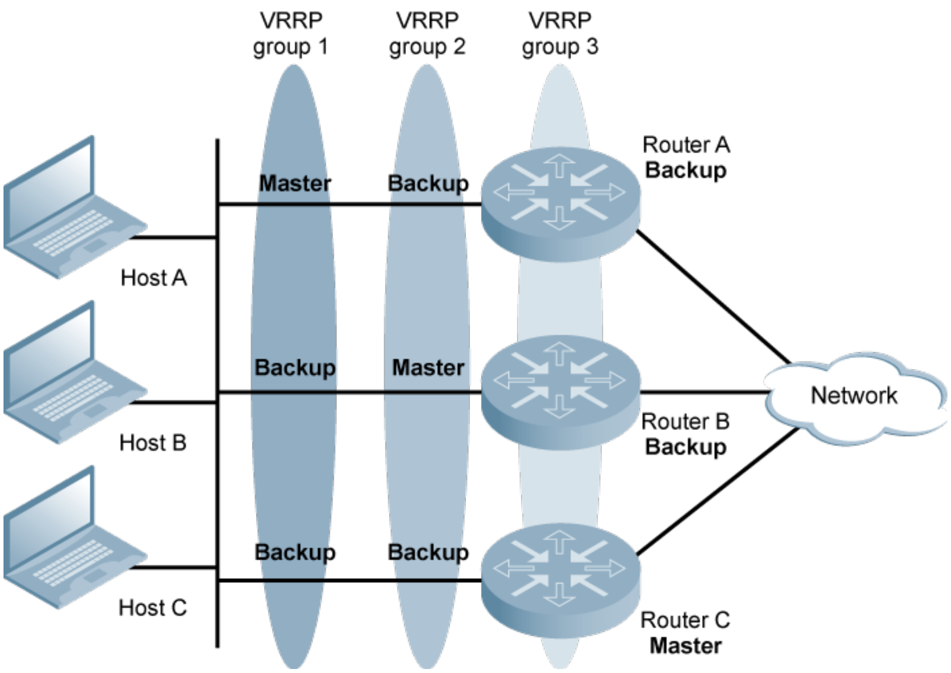
In Figure 13, the active (master) Mobility Access Switch and standby (backup) Mobility Access Switch are participating in VRRP. The VRRP protocol creates a virtual router with 10.100.10.1 as the Virtual IP address . This

IP address serves as the default gateway for IP clients connected to the master and backup Mobility Access Switches. Host 1, 2, and 3 now have the default gateway address as 10.100.10.1. If the master Mobility Access Switch fails or should become unavailable at any point of time, the backup Mobility Access Switch takes over from the master Mobility Access Switch. Due to the loss of availability of a route in the master Mobility Access Switch, traffic continues to flow from the host to the network.

Active-Active Deployment

In the active-standby deployment, the backup Mobility Access Switch remains under-utilized as no traffic is routed through this Mobility Access Switch. Active-active deployment does load-balancing and is the most common and preferred deployment model. Figure 14 shows a typical active-active deployment.

Figure 14 *Active-Active Deployment*



A Mobility Access Switch can be a part of multiple VRRP groups and can hold a different priority in a different group. In Figure 14, there are three VRRP groups.

- VRRP group 1: Router A is the master; Router B and Router C are the backups.
- VRRP group 2: Router B is the master; Router A and Router C are the backups.
- VRRP group 3: Router C is the master; Router A and Router B are the backups.

For load-balancing between Router, A, B, and C, hosts on the LAN is configured to use VRRP group 1, 2, and 3 as the default gateway respectively. The VRRP priorities are configured in such a way, that each router takes the expected role in the group. The Mobility Access Switch with the highest priority wins the election for the role of master in a pre-emptive mode of operation. For more information on VRRP priorities, see Enabling and Configuring VRRP on page 198.

Enabling and Configuring VRRP

This section describes the VRRP configuration on Mobility Access Switch.

VRRP Profile Configuration

The following CLI commands enable and configure VRRP on the Mobility Access Switch.

```
(host) (config) #vrrp <id>
   advertise <interval>
```

```
clone <source>
ip <address>
no
preempt
preemption delay <seconds>
priority <level>
shutdown
tracking vlan <vlanId>
```

Table 21: *VRRP Parameter Definition*

Parameter	Description
`vrrp <id>`	Unique virtual router ID of the VRRP profile.
`advertise <interval>`	Specifies the VRRP advertisement interval (in seconds) after which the master Mobility Access Switch sends VRRP advertisement packets to the peers in the group.
`clone <source>`	Copy configuration from another VRRP instance.
`ip <address>`	Virtual router IP address of the master and backup Mobility Access Switch. This IP address must be different from the VLAN interface IP address on which the virtual router is configured.
`no`	Deletes or negates previously entered VRRP configuration or parameter.
`preempt`	Enables preemption for the VRRP profile. This is the default setting. If you enable preemption, VRRP determines the state of the backup Mobility Access Switch when it becomes the master. For example, if Switch A is the master and fails, VRRP selects Switch B (next in the order of priority). If Switch C comes online with a higher priority than Switch B, VRRP selects Switch C as the new master, although Switch B has not failed. When disabled, VRRP switches only if the original master recovers or the new master fails.
`preemption delay <seconds>`	Delay in seconds, the backup should wait for before transitioning to master.
`priority <level>`	Sets the VRRP router priority level. A priority of 255 indicates that the Mobility Access Switch has stopped participating in the VRRP group. The switch with highest configured priority always wins the election for master in preemptive mode of operation. For example, a switch with a priority level of 254 wins the election, but a switch with priority level 255 stops participating in the VRRP group.
`shutdown`	Terminates the participation of the master Mobility Access Switch in the VRRP group. The priority of the switch is set to 255 indicating that the switch has stopped participating in the VRRP group.
`tracking vlan <vlanId>`	Tracks the up-link layer-3 VLAN interface transitions. When the up-link layer-3 VLAN interface of the master Mobility Access Switch fails, the role of the master is transitioned to the backup Mobility Access Switch.

You can view the VRRP interface profile state and statistics by using the following CLI command:

```
(host) #show vrrp [<id> statistics]
```

You can verify the VRRP interface profile configuration by using the following CLI command:

```
(host) #show vrrp-config [<id>]
```

Once you configure the VRRP profile, apply this profile to the layer-3 VLAN interface. The CLI commands are as follows:

```
(host) (config) #interface vlan <id>
   vrrp-profile <id>
```

Load-Balancing using VRRP

To achieve load-balancing in a Mobility Access Switch, you can apply a maximum of 2 VRRP profiles with different Virtual Router ID to a layer-3 VLAN interface of the Mobility Access Switch. Sample example follows:

```
(host) (config) #interface vlan 1
(host) (vlan "1") #vrrp-profile 1
(host) (vlan "1") #vrrp-profile 2
```

You can verify the configuration by using the following CLI command:

```
(host) #show interface-config vlan <id>
```

Clear VRRP statistics

You can clear the VRRP operational statistics from the running configuration of the Mobility Access Switch by using the following CLI command:

```
(host) #clear vrrp <id> statistics
```

Sample Configuration

This section describes a sample example of configuring VRRP on the Mobility Access Switch.

The following example configures a VRRP profile on the Mobility Access Switch.

```
(host) (config) #vrrp 1
(host) (Interface VRRP profile "1") #advertise 10
(host) (Interface VRRP profile "1") #ip 192.0.2.2
(host) (Interface VRRP profile "1") #preempt
(host) (Interface VRRP profile "1") #preemption delay 10
(host) (Interface VRRP profile "1") #priority 200
```

Apply the newly configured VRRP profile to the VLAN interface. The CLI commands are as follows:

```
(host) (config) #interface vlan 1
(host) (vlan "1") #vrrp-profile 1
```

You can view the VRRP interface profile state and statistics by using the following CLI command:

```
(host) #show vrrp 1

VRRP Instance Information
-------------------------
Virutal RouterId  Admin State  Vrrp State  Interface  VIP        Primary IP  Local IP
----------------  -----------  ----------  ---------  ---        ----------  --------
1                 UP           Master      vlan1      192.0.2.2  192.0.2.1   192.0.2.1
```

You can verify the VRRP interface profile configuration by using the following CLI command:

```
(host) #show vrrp-config 1

Interface VRRP profile "1"
--------------------------
Parameter                    Value
---------                    -----
Master advertise interval    1
Router priority level        100
Virtual router IP address    192.0.2.2
Shutdown the VRRP instance   Disabled
Enable pre-emption           Enabled
pre-emption delay            10
Enable vlan Tracking         0
```

You can verify the VLAN configuration by using the following CLI commands:

```
(host) #show interface-config vlan 1

vlan "1"
--------
Parameter                  Value
---------                  -----
Interface OSPF profile     N/A
Interface PIM profile      N/A
Interface IGMP profile     N/A
Interface VRRP profile     1
Directed Broadcast Enabled Disabled
Interface shutdown         Disabled
Session-processing         Disabled
mtu                        1500
IP Address                 192.0.2.1
IP NAT Inside              Disabled
IPv6 Address               N/A
IPv6 link local Address    N/A
DHCP client                Disabled
DHCP relay profile         N/A
Ingress ACL                N/A
Interface description      N/A
```

This chapter describes the following topics:

Policy Based Routing Overview

Policy-based routing (PBR) provides a flexible mechanism for forwarding data packets based on polices configured by a network administrator. By default, PBR is disabled. When enabled, you can implement policies that selectively cause packets to take different paths. PBR is used to route IP unicast packets based on a policy. Unlike the traditional destination IP based route lookups, the switch uses ACLs to determine how to forward a packet. This could be beneficial in the branch deployments where traffic could be sent on different uplinks based on packet characteristics. For example, if a branch has two ISPs, traffic matching a certain criteria as determined by an ACL could be send to ISP1 and traffic matching different criteria could be send to ISP2.

Important Points to Remember

- Only IPv4 unicast packets can be policy routed.
- Next hop IP address must be same as that of the L3 router that is adjacent/directly connected.
- PBR can be applied only to VLAN interfaces.
- PBR would take precedence over IPsec routing.
- ACLs that have next hop/L3 GRE tunnel/IPsec map cannot be applied to port or user and ACLs applied to ports/users cannot be modified to have new ACE entries with next hop/L3 GRE tunnel/IPsec.
- MAS supports 32 unique nexthops for PBR.
- Stateless ACLs have an implicit deny at the end of the ACL. So a permit statement without nexthop/redirect option must be configured to allow traffic that needs to be permitted, but not subjected to policy routing.
- Traffic destined to the switch will also get policy routed if it matches any of the entries configured for policy routing. Permit statement without nexthop/redirect option must be configured before policy routing statements for traffic destined to the switch.

Configuring Policy-Based Routing

PBR is configured as extensions to stateless ACLs, with next hop as part of the ACE entry in permit or redirect for redirection over a tunnel/IPsec interface. Once a stateless ACL has been configured, it can be applied to a VLAN interface, that need to be policy routed.

Configuring Nexthop IP as part of ACE Entry

Use the following command to enter stateless ACL configuration mode:

```
(host) (config) #ip access-list stateless st
(host) (config-stateless-st)#?
alias                    Match a IPv4 network resource
any                      Match any IPv4 source traffic
host                     Match a single IPv4 host address
network                  Match IPv4 subnet
no                       Delete Command
```

The following example configures the Nexthop IP:

```
(host) (config) #ip access-list stateless abc
(host) (config-stateless-abc) # any any tcp <port-number><port-number> permit nexthop <ip-add
r>
```

Configuring Redirect to Tunnel as part of ACE Entry

```
(host) (config-stateless-st)#any any udp 10 100 ?
deny                    Specify packets to reject
permit                  Specify packets to forward
redirect                Redirect packets
(host) (config-stateless-st)#any any udp 10 100 redirect ?
ipsec                   Redirect based on IPSec map
tunnel                  Redirect packets to tunnel
(host) (config-stateless-st)#any any udp 10 100 redirect tunnel ?
<1-50>                  Tunnel ID
(host) (config-stateless-st)#any any udp 10 100 redirect tunnel 10
```

The following example configures redirect to tunnel:

```
(host) (config-stateless-abc) #any any udp <port-number><port-number> redirect tunnel <id>
```

NOTE

Ensure that the tunnel ID that is used in the redirect keyword for PBR is a Layer 3 GRE tunnel.

Configuring IPsec Map as part of ACE Entry

```
(host) (config-stateless-st)#any any udp 200 500 redirect ?
ipsec                   Redirect based on IPSec map
tunnel                  Redirect packets to tunnel
(host) (config-stateless-st)#any any udp 200 500 redirect ipsec ?
<mapname>               ipsec map name [1..30]
(host) (config-stateless-st)#any any udp 200 500 redirect ipsec ipsec1
(host) (config-stateless-st)#end
```

The following example configures an IPsec map:

```
(host) (config-stateless-st)# any any udp <port-number><port-number> redirect ipsec <mapname>
```

Configuring a Deny Entry

```
(host) (config-stateless-st)#any any ?
<0-255>                 IP protocol number
STRING                  Name of network service
any                     Match any traffic
arp                     Match ARP traffic
tcp                     Match TCP traffic
udp                     Match UDP traffic
(host) (config-stateless-st)#any any tcp 400 50 ?
deny                    Specify packets to reject
permit                  Specify packets to forward
redirect                Redirect packets
(host) (config-stateless-st)#any any tcp 400 500 ?
deny                    Specify packets to reject
permit                  Specify packets to forward
redirect                Redirect packets
(host) (config-stateless-st)#any any tcp 400 500 deny
```

You can use the following command to configure a deny entry:

```
(host) (config-stateless-abc) # any any tcp <port-number> <port-number> deny
```

Applying Stateless ACL on VLAN Interface

```
(host) (config) #interface vlan <number>
(host) (vlan "number") #ip access-group in abc
```

Sample Configurations

To configure the policy based routing:

```
(host) (config) #ip access-list stateless st
(host) (config-stateless-st) # any any tcp 10 100 permit nexthop 200.0.0.5
(host) (config-stateless-st) # any any udp 10 100 redirect tunnel 10
(host) (config-stateless-st)# any any udp 10 101 redirect ipsec ipsec1
(host) (config) #interface vlan 100
(host) (vlan 100) #ip access-group in st
```

To apply stateless ACL on VLAN interface:

```
(host) (config) #interface vlan 100
(host) (vlan 100) #ip access-group in st
```

Verifying Configuration

```
(host) #show interface-config vlan 100
vlan "100"
----------
Parameter                    Value
---------                    -----
Interface OSPF profile       N/A
Interface PIM profile        N/A
Interface IGMP profile       N/A
Directed Broadcast Enabled   Disabled
Interface shutdown           Disabled
mtu                          1500
IP Address                   100.0.0.1/255.255.255.0
IP NAT Inside                Disabled
IPv6 Address                 N/A
IPv6 link local Address      N/A
DHCP client                  Disabled
DHCP relay profile           N/A
Ingress ACL                  st
Interface description        N/A
```

This chapter describes the DHCP server and relay support on the Mobility Access Switch. It contains the following sections:

- Understanding DHCP Server and DHCP Relay on page 206
- Configuring DHCP Server and DHCP Relay on page 206
- Verifying DHCP Server and DHCP Relay on page 209

Understanding DHCP Server and DHCP Relay

Dynamic Host Configuration Protocol automates network-parameter assignment to network devices from one or more DHCP servers. Even in small networks, DHCP is useful because it makes it easy to add new machines to the network.

When a DHCP-configured client connects to a network, the DHCP client sends a broadcast query requesting necessary information from a DHCP server. The DHCP server manages a pool of IP addresses and information about client configuration parameters such as default gateway, domain name, the name servers, other servers such as time servers, and so forth.

On receiving a valid request, the server assigns the computer an IP address, a lease (length of time the allocation is valid), and other IP configuration parameters, such as the subnet mask and the default gateway. The query is typically initiated immediately after booting, and must complete before the client can initiate IP-based communication with other hosts.

During initialization, network clients try to dynamically obtain their IP addresses. In small networks, where all the systems are in the same IP subnet, the client and the server can communicate directly.

Clients on subnets that are not directly connected to a DHCP server must go through a "relay agent."

If DHCP relay is not enabled on the VLAN on which the request is received, but a pool is configured for that subnet, the IP is assigned from the internal DHCP server.

DHCP relay is enabled when a DHCP relay profile is attached to a VLAN interface. At this point, the relay agent receives the DHCP broadcast packets from the client and unicast them to one or more of the DHCP servers that are configured on the VLAN interface.

NOTE

Mobility Access Switch does not support DHCP server identifier override sub-option.

Configuring DHCP Server and DHCP Relay

This section contains the following sections:

- Configuring DHCP Server on page 206
- Configuring DHCP Relay on page 207
- Applying DHCP Relay Profile to VLAN on page 208

Configuring DHCP Server

DHCP server configuration is profile based. To configure the DHCP server, follow these steps:

1. Enable DHCP server configuration.

```
(host)(config) #service dhcp
```

2. Configure a DHCP server profile.

```
(host)(config) #ip dhcp pool pool-1
(host)(dhcp server profile "pool-1") #
```

3. Configure the domain name in the pool profile.

```
(host)(dhcp server profile "pool-1") #domain-name doc-domain
```

4. Configure the DNS servers. You can configure up to 8 DNS servers in a DHCP pool one by one.

```
(host)(dhcp server profile "pool-1") #dns-server 192.168.1.2
```

5. Configure the default router. Up to 8 routers can be configured.

```
(host)(dhcp server profile "pool-1") #default-router 192.168.1.1
```

6. Configure the Netbios name server. Up to 8 Netbios name servers can be configured.

```
(host)(dhcp server profile "pool-1") #netbios-name-server 192.168.1.3
```

7. Configure the lease time in days, hours, minutes, and seconds.

```
(host)(dhcp server profile "pool-1") #lease 30 24 60 60
```

8. Configure the network.

```
(host)(dhcp server profile "pool-1") #network 192.168.1.0 255.255.255.0
```

9. Configure the range between two IP addresses to be excluded.

```
(host)(dhcp server profile "pool-1") #exclude-address 192.168.1.1 192.168.1.3
```

10. Configure a vendor-class-identifier.

```
(host)(dhcp server profile "pool-1") #vendor-class-identifier testVendor
```

11. Configure server options.

```
(host)(dhcp server profile "pool-1") #option 50 ip 192.168.1.1
(host)(dhcp server profile "pool-1") #option 54 text server1
```

Configuring DHCP Relay

DHCP-Relay is supported with DHCP Option 82. DHCP Option 82 allows a DHCP relay agent to insert circuit specific information into a request that is being forwarded to a DHCP server.

DHCP Option 82 works by setting two sub-options:

- Circuit ID

  The circuit ID includes information specific to the circuit on which the request arrives. Circuit identifier parameters can be interface-name, VLAN ID, or both.

- Remote ID

  The remote ID carries information relating to the remote host end of the circuit. Remote identifier parameters can be the MAC address, the hostname of the relay agent, or a user defined string.

DHCP Relay Option 82 can be configured using DHCP Relay profile. To configure a DHCP Relay profile, follow these steps:

1. Configure a DHCP Relay profile under an interface profile.

```
(host)(config) #interface-profile dhcp-relay-profile relay1
```

2. Configure a helper address.

```
(host)(dhcp relay profile "relay1") #helper-address 172.16.30.1
```

3. Configure Option 82 circuit-identifier a VLAN only, an interface-name only or both VLAN and interface-name:

```
(host)(dhcp relay profile "relay1") #option82 circuit-identifier vlan
(host)(dhcp relay profile "relay1") #option82 circuit-identifier interface-name
(host)(dhcp relay profile "relay1") #option82 circuit-identifier interface-name vlan
```

4. Configure Option 82 remote-identifier with the host-name option.

```
(host)(dhcp relay profile "relay1") #option82 remote-identifier host-name
```

5. Configure Option 82 remote-identifier as MAC.

```
(host)(dhcp relay profile "relay1") #option82 remote-identifier mac
```

6. Configure Option 82 with the user defined option “myOwnString.”

```
(host)(dhcp relay profile "relay1") #option82 remote-identifier myOwnString
```

Applying DHCP Relay Profile to VLAN

The DHCP relay profile must be applied to the VLAN where DHCP clients connect. To configure a DHCP Relay profile to a VLAN, follow these steps:

1. Configure a VLAN interface.

```
(host)(config) #interface vlan 11
```

2. Configure an IP address on the VLAN interface.

```
(host)(vlan "11") #ip address 172.16.4.1 netmask 255.255.255.0
```

3. Configure DHCP Relay profile on the VLAN interface.

```
(host)(vlan "11") #dhcp-relay-profile relay1
```

Configuring a VLAN with a Relay Profile as DHCP Client

Keep the following points in mind before you configure a VLAN with a relay profile as DHCP client.

Points to Remember

- You can configure both static default gateway and default gateway import from DHCP.
- Static and OSPF routes have preference over DHCP and DHCP has preference over OSPF AS External routes.
- The DHCP routes will be installed only if **default gateway import dhcp** is specified in the ip-profile.
- If multiple VLANs act as DHCP clients with the **default-gw import dhcp** option, then the first valid DHCP gateway received in the response will be installed in the routing table.

Configuration Steps

1. Configure a VLAN.

```
(host)(config) #interface vlan 4
```

2. Configure a DHCP relay profile.

```
(host)(vlan "4") #dhcp-relay-profile relay1
```

3. Set the IP address of an interface and use DHCP to obtain an IP address.

```
(host)(vlan "4") #ip address dhcp-client
(host)(vlan "4") #end
```

4. Display the VLAN Interface

```
(host)#show interface-config vlan 4

vlan "4"
--------
Parameter                Value
---------                -----
Interface OSPF profile   N/A
Interface PIM profile    N/A
Interface IGMP profile   N/A
Interface shutdown       Disabled
mtu                      1500
IP Address               N/A
IPv6 Address             2012::12/64
IPv6 link local Address  fe80::b:8600:a6a:3300
DHCP client              Enabled
DHCP relay profile       relay1
```

```
Interface description    N/A
```

Verifying DHCP Server and DHCP Relay

This section contains the following sections:

Verifying DHCP Relay Option 82 Logs

The debug level can be configured to log the DHCP relay messages. It can be configured in network or system logs.

Network Log

```
(host)(config) #logging level debugging network process dhcpd subcat dhcp
```

System Log

```
(host)(config) #logging level debugging system process dhcpd subcat all
```

The DHCP relay functionality can be verified by checking network or system logs as has been configured:

```
Sep 27 07:30:43  dhcpdwrap[1497]: <202523> <DBUG> |dhcpdwrap| |dhcp| dhcprelay: dev=eth1, leng
th=341, from_port=67, op=2, giaddr=172.16.4.1
Sep 27 07:30:43  dhcpdwrap[1497]: <202527> <DBUG> |dhcpdwrap| |dhcp| RelayToClient: OFFER dest
=172.16.4.2 client yiaddr=172.16.4.1 MAC=1c:75:08:9e:60:c8
Sep 27 07:30:43  dhcpdwrap[1497]: <202541> <DBUG> |dhcpdwrap| |dhcp| Received DHCP packet from
Datpath, sos msg hdr flags 0x42 opcode 0x5a ingress 0x0 vlan 11 egress 0xb src mac 00:0b:86:6a
:41:40
Sep 27 07:30:43  dhcpdwrap[1497]: <202544> <DBUG> |dhcpdwrap| |dhcp| Datapath vlan11: ACK 1c:7
5:08:9e:60:c8 clientIP=172.16.4.2
```

Show Commands for IP DHCP

This section describes the following commands:

show interface-profile dhcp-relay-profile

To display an IP DHCP Relay profile, use the following command:

```
(host)#show interface-profile dhcp-relay-profile relay1

dhcp relay profile "relay1"
---------------------------
Parameter                  Value
---------                  -----
DHCP helper address        172.16.30.1
Option82 Circuit-Id option vlan interface-name
Option82 Remote-Id option  myOwnString
Giaddr as Source IP        Disabled
```

show ip dhcp database

To display the complete IP DHCP database, use the following command:

```
(host)#show ip dhcp database
DHCP enabled
```

```
# pool-1
subnet 172.16.1.0 netmask 255.255.255.0 {
default-lease-time 43200;
max-lease-time 43200;
option domain-name "www.test.com";
option vendor-class-identifier "testStr";
option vendor-encapsulated-options "172.16.0.254";
option routers 172.16.1.254;
option user-option-43 code 43 = ip-address;
option user-option-43 172.16.1.254;
range 172.16.1.1 172.16.1.254;
authoritative;
```

show ip dhcp binding

To display the DHCP binding table, use the following command:

```
(host) #show ip dhcp binding

lease 172.16.1.251 {
  starts Fri Oct 21 08:10:29 2011
  ends Fri Oct 21 20:10:29 2011
  binding state active;
  next binding state free;
  hardware ethernet 00:25:90:0a:95:e1;
  uid "\001\000%\220\012\225\341";
}
lease 172.16.1.254 {
  starts Fri Oct 21 09:21:30 2011
  ends Fri Oct 21 21:21:30 2011
  binding state active;
  next binding state free;
  hardware ethernet 00:25:90:0a:95:d2;
  uid "\001\000%\220\012\225\322";
}
lease 172.16.1.253 {
  starts Fri Oct 21 13:09:32 2011
  ends Sat Oct 22 01:09:32 2011
  binding state active;
  next binding state free;
  hardware ethernet 00:25:90:0a:96:42;
  uid "\001\000%\220\012\226B";
}
```

NOTE

The DHCP server assigns the abandoned leases only after all the free entries are exhausted.

show ip dhcp statistics

Displays the statistics in the pools stating the number of active leases, free leases etc

```
(host)#show ip dhcp statistics

Network Name 172.16.1.0/24
    Free leases        249
    Active leases      3
    Expired leases     0
    Abandoned leases   0
```

show ip dhcp pool

Displays the list of the dhcp pools configured and information about their references:

```
(host)#show ip dhcp pool

dhcp server profile List
------------------------
Name       References  Profile Status
----       ----------  --------------
pool-1     0
pool-2     0
pool-3     0
pool-4     0
Total:4
```

show ip dhcp pool

```
(host)#show ip dhcp pool <pool_name>
This command displays the details of the pool
(host)#show ip dhcp pool pool-1

dhcp server profile "pool-1"
----------------------------
Parameter                       Value
---------                       -----
Domain name for the pool        www.test.com
DHCP server pool                192.168.1.0/255.255.255.0
DHCP pool lease time            0 12 0 0
Vendor Class Identifier         testStr
DHCP default router address     192.168.1.253
Configure DNS servers           N/A
Configure netbios name servers  N/A
DHCP Option                     43 ip 192.168.1.254
Exclude address                 192.168.1.254
Exclude address                 192.168.1.253
```

This chapter contains the following sections:

OSPF Feature Overview

Open shortest path first (OSPFv2) is a dynamic interior gateway routing protocol (IGP) based on IETF RFC 2328. Aruba's implementation of OSPFv2 allows the Mobility Access Switch to be effectively deployed in a Layer 3 topology.

Key Features Supported by Mobility Access Switch

- All stub area types
- Area border router (ABR)
- OSPF on VLAN and loopback interfaces
- OSPF MD5 authentication
- One OSPF instance
- Redistribute VLANs
- OSPF interface can belong to only one area

LSAs Originated by Mobility Access Switch

With current implementation, the following Link State Advertisement (LSA) types are generated by Mobility Access Switch:

- Type 1 Router LSA
- Type 2 Network LSA
- Type 3 Summary LSA
- Type 4 ASBR Summary LSA

Notes:

- Routes learned from VLAN-based access interfaces are distributed to OSPF as Router LSAs (Type 1).
- Mobility Access Switch can process Type 5 AS External LSA.
- Mobility Access Switch can process Type 7 NSSA External LSA.

Configuring OSPF

This section contains the following sections:

- Enabling OSPF with L3 GRE Tunnel Interface on page 217

Configuring OSPF

NOTE: The **router ospf** command must be configured to start the OSPF process.

To configure OSPF, follow these steps:

1. Enter the global OSPF configuration mode.

```
(host) (config) #router ospf
(host) (Global OSPF profile)
```

2. Assign the router identification.

```
(host) (Global OSPF profile) router-id 5.5.5.5
```

3. Assign areas.

```
(host) (Global OSPF profile)area 0.0.2.0
(host) (Global OSPF profile)area 0.0.0.1 stub
```

4. Create the interface OSPF profile “techpubs.”

```
(host) (config) #interface-profile ospf-profile techpubs
(host) (Interface OSPF profile "techpubs") #
```

5. Assign an area and cost to the profile “techpubs.”

```
(host) (Interface OSPF profile "techpubs") #area 0.0.2.0
(host) (Interface OSPF profile "techpubs") #cost 10
```

6. Attach the OSPF profile “techpubs” to a VLAN.

```
(host) (config) #interface vlan 2
(host) (vlan "2") #ospf-profile techpubs
(host) (vlan "2") #ip address 172.0.10.254 255.255.255.0
```

Configuring OSPF Area Types

ArubaOS Mobility Access Switch supports all Open Shortest Path First (OSPF) area types including Totally Stubby Area (TSA) and Not-So-Stubby-Area (NSSA). The following new commands are added to the Command Line Interface (CLI).

In the configuration mode, type **router ospf** to enter global OSPF profile mode.

To set an area as NSSA:

```
(host)(Global OSPF profile) #area <areaid> nssa
```

To set an area as Totally NSSA:

```
(host)(Global OSPF profile) #area <areaid> nssa no-summary
```

To set an area as TSA:

```
(host)(Global OSPF profile) #area <areaid> stub no-summary
```

To enable sending default route in NSSA:

```
(host)(Global OSPF profile) #area <areaid> nssa default-info-originate metric <cost> metric-ty
pe <mtype>
```

To generate default Link State Advertisement (LSA) in normal area:

```
(host)(Global OSPF profile) #default-info-originate [always]|[metric <cost> metric-type <mtyp
e>]
```

For additional parameters, see *ArubaOS Command Line Interface* guide.

Sample Configuration

```
(host)(config) #router ospf
```

```
(host)(Global OSPF profile) #area 0.0.0.1 nssa
(host)(Global OSPF profile) #area 0.0.0.2 nssa no-summary
(host)(Global OSPF profile) #area 0.0.1.0 stub no-summary
(host)(Global OSPF profile) #area 0.0.2.0 nssa default-info-originate metric 1 metric-type 1
(host)(Global OSPF profile) #default-info-originate always
```

Configuring prefix-list with OSPF

You can filter networks received from LSA updates. The **prefix-list** command is used to configure IP prefix filtering. Prefix lists are used to either permit or deny the configured prefix based on a matching condition.

NOTE

For a detailed description of the IP Prefix-list feature, see IP Prefix List on page 193.

The **distribute-list** command filter networks received in updates. This command references to the user-defined prefix-list.

```
(host) (config) #router ospf
(host) (Global OSPF profile) #distribute-list <prefix-list name>
```

The **show router ospf** command verifies the distribute-list configuration.

```
(host) (config) #show router ospf
```

For **show router ospf** sample configuration, see Verifying the Configuration on page 214.

Sample Configuration

NOTE

This example assumes that a prefix-list called **aruba** has already been created.

```
(host) (config) #router ospf
(host) (Global OSPF profile) #distribute-list aruba
```

Verifying the Configuration

View the global OSPF profile values.

```
(host) (config) #show router ospf

Global OSPF profile "default"
-----------------------------
Parameter           Value
---------           -----
State               Enabled
Area                0.0.0.0
Area                0.0.1.0 (stub)
Area                0.0.0.1 (nssa)
Area                0.0.0.2 (nssa)
Area                0.0.2.0 (nssa)
Area                0.0.0.4 (totally-stubby)
Router-id           10.10.10.10
Redistribute vlan   2
Distribute-list     aruba
```

View the parameters and values for the interface OSPF profile “techpubs”.

```
(host) (vlan "2") #show interface-profile ospf-profile techpubs

Interface OSPF profile "techpubs"
---------------------------------
Parameter             Value
---------             -----
```

```
Area                 0.0.2.0
Cost                 10
Dead-interval        Auto
Hello-interval       10
Retransmit-interval  5
Transmit-delay       1
Priority             1
State                Enabled
```

View the interface configuration for VLAN 2.

```
(host) (vlan "2") #show interface-config vlan 2

vlan "2"
--------
Parameter                Value
---------                -----
Interface OSPF profile   techpubs
Interface PIM profile    N/A
Interface IGMP profile   N/A
Interface shutdown       Disabled
mtu                      1500
IP Address               172.0.10.254/255.255.255.0
IPv6 Address             N/A
IPv6 link local Address  N/A
DHCP client              Disabled
DHCP relay profile       N/A
Interface description    N/A
```

Verify that the OSPF interface is running on VLAN 2.

```
(host) #show ip ospf interface vlan 2

Interface is vlan2, line protocol is up
Internet Address 172.0.10.254, Mask 255.255.255.0, Area 0.0.2.0
Router ID 5.5.5.5, Network Type BROADCAST, Cost: 10
Transmit Delay is 1 sec, State DR, Priority 1
Designated Router id 0.0.0.0, Interface Address 0.0.0.0
Backup designated Router id 0.0.0.0, Interface Address 0.0.0.0
Timer intervals configured, Hello 10, Dead 40, Retransmit 5
Neighbor Count is 0
Tx Stat: Hellos 0 DbDescr 0 LsReq 0 LsUpdate 0 LsAck 0 Pkts 0
Rx Stat: Hellos 0 DbDescr 0 LsReq 0 LsUpdate 0 LsAck 0 Pkts 0
         BadCksum 0 BadVer 0 BadNet 0 BadArea 0 BadDstAdr 0 BadAuType 0
         BadAuth 0 BadNeigh 0 BadMTU 0 BadVirtLink 0
```

Verify the IP Routes

```
(host) #show ip route

Codes: C - connected, R - RIP
       O - OSPF, O(IA) - Ospf inter Area
       O(E1) - OSPF Ext  Type 1, O(E2) - Ospf Ext  Type 2
       M - mgmt, S - static, * - candidate default
       D - DHCP

Gateway of last resort is 10.232.10.1 to network 0.0.0.0 at cost 17
O(IA)   * 0.0.0.0  /0 [17] via 10.232.10.1
O(IA)    1.0.0.99 /32 [2] via 10.232.10.1
O(IA)    1.0.0.103/32 [2] via 10.232.20.1
O(IA)    1.0.0.104/32 [3] via 10.232.10.1
O(IA)    1.0.0.105/32 [3] via 10.232.10.1
```

```
O(IA)    1.0.0.106/32 [3] via 10.232.10.1
O(IA)    1.0.0.108/32 [3] via 10.232.10.1
S        10.0.0.0 /8 [0] via 10.4.135.254
M        10.4.135.0/24 is directly connected: mgmt
M        10.4.135.91/32 is directly connected: mgmt
C        10.64.8.0/24 is directly connected: vlan66
C        10.64.8.1/32 is directly connected: vlan66
C        10.65.8.0/24 is directly connected: vlan21
C        10.65.8.1/32 is directly connected: vlan21
C        10.69.8.0/24 is directly connected: vlan61
C        10.69.8.1/32 is directly connected: vlan61
C        10.70.8.0/24 is directly connected: vlan81
C        10.70.8.1/32 is directly connected: vlan81
C        10.128.63.1/32 is directly connected: loopback0
C        10.128.64.0/24 is directly connected: vlan64
<omitted>

 (host) #show ip route summary

Route Source  Total
------------  -----
connected     419
static        1
ospf-intra    400
ospf-inter    820
ospf-ext1     0
ospf-ext2     0
ospf-nssa     0
```

Enabling OSPF on a Loopback Interface

1. Create the loopback interface (3 in the example).

```
(host) (config) #interface loopback 3
(host) (loopback "3") #
```

2. Configure an IP address and Mask for the loopback.

```
(host) (loopback "3") #ip address 172.0.25.254
```

3. Attach the ospf-profile “techpubs” to the loopback interface.

```
(host) (loopback "3") #ospf-profile techpubs
```

4. Verify the loopback configuration:

```
(host) (loopback "3") #show interface loopback 3

loopback3 is administratively Up, Line protocol is Up
Hardware is Ethernet, Address is 00:0b:86:6a:f2:40
Description: Loopback
Internet address is 172.0.25.254, Netmask is 255.255.255.255
Interface index: 100663299
MTU 1514 bytes
```

5. Verify the interface configuration:

```
(host) (config) #show interface-config loopback 3

loopback "3"
------------
Parameter                Value
---------                -----
Interface OSPF profile   techpubs
IP Address               172.0.25.254
Interface description    N/A
```

6. Verify that the OSPF is enabled on a Loopback interface:

```
(host) #show ip ospf interface loopback 3

Interface is loopback3, line protocol is up
Internet Address 172.0.25.254, Mask 255.255.255.255, Area 0.0.2.0
Router ID 5.5.5.5, Network Type LOOPBACK, Cost: 10
Transmit Delay is 1 sec, State LOOP, Priority 1
Timer intervals configured, Hello 10, Dead 40, Retransmit 5
Neighbor Count is 0
Tx Stat: Hellos 0 DbDescr 0 LsReq 0 LsUpdate 0 LsAck 0 Pkts 0
Rx Stat: Hellos 0 DbDescr 0 LsReq 0 LsUpdate 0 LsAck 0 Pkts 0
         BadCksum 0 BadVer 0 BadNet 0 BadArea 0 BadDstAdr 0 BadAuType 0
         BadAuth 0 BadNeigh 0 BadMTU 0 BadVirtLink 0
```

Enabling OSPF with L3 GRE Tunnel Interface

1. Create L3 GRE tunnel interface. See Configuring an L3 GRE Tunnel on page 184.
2. Create OSPF profile.
   a. Create the interface OSPF profile “techpubs.”

```
(host) (config) #interface-profile ospf-profile techpubs
(host) (Interface OSPF profile "techpubs") #
```

   b. Assign an area and cost to the profile “techpubs.”

```
(host) (Interface OSPF profile "techpubs") #area 0.0.2.0
(host) (Interface OSPF profile "techpubs") #cost 10
```

3. Attach the ospf-profile “techpubs” to the L3 GRE interface.

```
host) (config) #interface tunnel ip 1
host) (config) (Tunnel “1”) # ospf-profile techpubs
```

4. Verify OSPF-profile interface.

```
(host) (config) #show ip ospf interface
```

OSPF MD5 Authentication

This section contains the following sections:

Important Points to Remember

- Mobility Access Switch supports only OSPF MD5 authentication on a per-interface basis.
- Mobility Access Switch supports only OSPF MD5 authentication key and does not support simple OSPF authentication.

Understanding OSPF MD5 Authentication

To protect Open Shortest Path First (OSPF) connections from spoofing attacks, the Mobility Access Switch supports MD5 authentication. MD5 is a message-digest algorithm that is specified in RFC 1321 and considered to be the most secure OSPF authentication mode.

Without MD5 authentication, a remote attacker can spoof an OSPF packet so that it appears to come from a trusted source, but can then change the routing tables of the unprotected device or exploit other vulnerabilities in the AOS OSPF network.

Note that you must configure the same MD5 key and password on both OSPF neighbors. The neighbor-ship only forms when both devices have the matching key and password.

Mobility Access Switch supports only MD5 OSPF authentication and not simple OSPF authentication. With simple authentication, the password traverses the network in clear-text. With MD5 OSPF authentication, the password does not traverse the network.

Configuring OSPF MD5 Authentication

To configure OSPF MDF authentication, follow these steps:

1. Configure an OSPF profile in an interface profile:

```
(host)(config) #interface-profile ospf-profile ospf1
```

2. Configure an MD5 key and password.

```
(host)(Interface OSPF profile "ospf1") #message-digest-key 1 md5-passwd Aruba
```

3. Attach the interface OSPF profile to the vlan interface:

```
(host) (config) #interface vlan 1
(host) (vlan "1") #ospf-profile ospf1
```

Verifying OSPF MD5 Authentication

This section contains the following sections:

- Verifying OSPF MD5 Authentication Configuration from the Interface Profile on page 218
- Verifying the OSPF MD5 Authentication Configuration on page 218
- Verifying OSPF MD5 Authentication on page 219

Verifying OSPF MD5 Authentication Configuration from the Interface Profile

To verify the OSPF MD5 Authentication configuration from the Interface Profile, use the following show command:

```
(host)(config) #show interface-profile ospf-profile ospf1

Interface OSPF profile "ospf1"
------------------------------
Parameter            Value
---------            -----
Area                 0.0.0.0
Cost                 1
Dead-interval        Auto
Hello-interval       10
Retransmit-interval  5
Transmit-delay       1
Priority             1
md5-key              1
md5-passwd           ********
State                Enabled
```

Verifying the OSPF MD5 Authentication Configuration

To verify the OSPF MD5 Authentication configuration, use the following show command:

```
(host)(config) #show running-config

Building Configuration...
router ospf
   area 0.0.0.0
```

```
interface-profile ospf-profile "ospf1"
   message-digest-key 1 md5-passwd 2aa9fdf39271f7779771543efd658fd0
   area 0.0.0.0
```

Verifying OSPF MD5 Authentication

To verify the OSPF MD5 Authentication, use the following show command:

```
(host)(config) #show ip ospf interface vlan 1

Interface is vlan1, line protocol is up
Internet Address 10.10.10.2, Mask 255.255.255.0, Area 0.0.0.0
Router ID 10.10.10.2, Network Type BROADCAST, Cost: 1
Transmit Delay is 1 sec, State DR, Priority 1
Designated Router id 10.10.10.2, Interface Address 10.10.10.2
Backup designated Router id 0.0.0.0, Interface Address 0.0.0.0
Timer intervals configured, Hello 10, Dead 40, Retransmit 5
Message digest authentication enabled key id:1
Neighbor Count is 0
Tx Stat: Hellos 19 DbDescr 0 LsReq 0 LsUpdate 0 LsAck 0 Pkts 19
Rx Stat: Hellos 0 DbDescr 0 LsReq 0 LsUpdate 0 LsAck 0 Pkts 0
   BadCksum 0 BadVer 0 BadNet 0 BadArea 0 BadDstAdr 0 BadAuType 0
   BadAuth 0 BadNeigh 0 BadMTU 0 BadVirtLink 0
```

The IPv6 protocol enables the next generation of large-scale IP networks by supporting addresses that are 128 bits long. This allows 2^{128} possible addresses (versus 2^{32} possible IPv4 addresses).

IPv6 addresses are represented as eight colon-separated fields of up to four hexadecimal digits each. The following are examples of IPv6 addresses:

```
FEDC:BA98:7654:3210:FEDC:BA98:7654:3210
1080:0:0:0:0:800:200C:417A
```

The use of the "::" symbol is a special syntax that you can use to compress one or more 16-bit groups of zeros or to compress leading or trailing zeros in an address. The "::" can appear only once in an address. For example, the address, `1080:0:0:0:0:800:200C:417A` can also be represented as `1080::800:200C:417A`.

IPv6 uses subnet identifiers to identify subnetworks to which nodes are attached. The subnet mask is a bitmask that specifies the prefix length. For example, `1080::800:200C:417A ffff:ffff:ffff:ffff::` represents all IPv6 addresses with the subnet identifier `1080:0:0:0`.

IPv6 Support for Mobility Access Switch

ArubaOS provides IPv6 support on the Mobility Access Switch.

NOTE

IPv6 support is currently limited to management functionality.

Following are the IPv6 functionalities supported on the Mobility Access Switch:

- Default IPv6 support on all RVI interfaces and Management interface.
- Auto-configured link local address on all IPv6 interfaces based on the MAC address and VLAN Id combination.
- Ability to override the auto configured link local address with another link local address.
- Ability to configure multiple global unicast addresses.
- Ability to ping other IPv6 hosts.
- Telnet support.
- Default gateway configuration support.

You can perform the following IPv6 operations on the Mobility Access Switch:

- Configure an IPv6 Interface Address
- Configure IPv6 Default Gateway
- Debug IPv6 Mobility Access Switch

You can also view the IPv6 related information on the Mobility Access Switch using the following commands:

- **show interface <intf name>**: View the IPv6 auto configured link local address and global unicast address of a VLAN interface
- **show ipv6 neighbors**: View the IPv6 neighbors
- **show ipv6 route**: View the IPv6 routes
- **show ipv6 interface brief**: View the list of IPv6 interfaces on the Mobility Access Switch
- **show ipv6 interface**: View detailed information about IPv6 interfaces

Configure an IPv6 Interface Address

You can configure an IPv6 address for the management interface and VLAN interface of the Mobility Access Switch. The Mobility Access Switch can have multiple IPv6 addresses for each VLAN interface. You can configure IPv6 interface addresses using the following CLI commands.

To modify the auto-configured link local address of the VLAN interface, execute the following commands:

```
(host)(config) #interface vlan <vlan#>
(host)(vlan “#”) #ipv6 address link-local <link_local>
```

To configure the global unicast address, execute the following commands:

```
(host)(config) #interface vlan <vlan#>
(host)(vlan "#") #ipv6 address <prefix> prefix_len <prefix_length>
```

To configure global unicast address on the management interface, execute the following commands:

```
(host)(config) #interface mgmt
(host)(mgmt) #ipv6 address <prefix> prefix_len <prefix_length>
```

To modify the auto-configured link local address of the management interface, execute the following commands:

```
(host)(config) #interface mgmt
(host)(mgmt) #ipv6 address link-local <link_local>
```

Configure IPv6 Default Gateway

You can configure IPv6 default gateway using the following CLI command:

```
(host)(config) #ipv6-profile
(host)(ipv6-profile) #default-gateway <nexthop>
```

Debug IPv6 Mobility Access Switch

You can now use the Ping command to debug IPv6 hosts.

To ping the global unicast address execute the following command:

```
(host) #ping ipv6 <global-address>
```

To ping the link-local address of the host connected to the VLAN interface execute the following command:

```
(host) #ping ipv6 interface vlan <vlad-id> <linklocal-address>
```

To ping the link-local address of the host connected to the management interface execute the following command:

```
(host) #ping ipv6 interface mgmt <linklocal-address>
```

This chapter contains the following major sections:

Important Points to Remember

- PIM-SM runs on top of IGMP and needs an IGMP profile for the VLAN interface.
- IGMP must be enabled to run PIM-SM.
- IGMP is enabled by default and cannot be disabled.

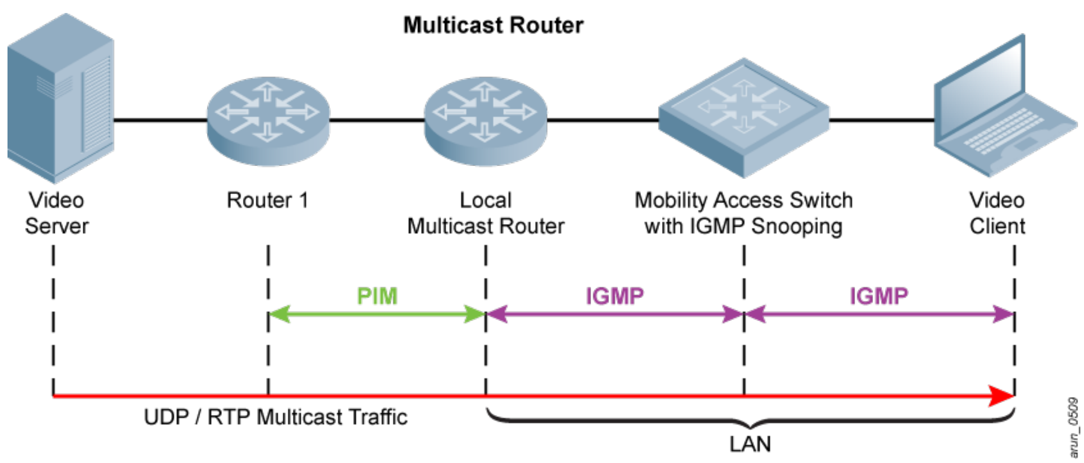
Understanding IGMP and PIM-SM

This section contains the following sections:

IGMP

The Mobility Access Switch supports Internet Group Management Protocol (IGMP) as defined in IETF RFC 1112 (IGMPv1) and RFC 2236 (IGMPv2). IGMP allows hosts and adjacent routers on IP networks to establish multicast group memberships.

Basic IGMP Network Architecture



PIM

Protocol-Independent Multicast (PIM) is a family of multicast routing protocols for Internet Protocol (IP) networks that provide one-to-many and many-to-many distribution of data over a LAN, WAN or the Internet. It is termed protocol-independent because PIM does not include its own topology discovery mechanism, but instead uses routing information supplied by other traditional routing protocols such as the Border Gateway Protocol (BGP).

There are four variants of PIM, of which the Mobility Access Switch supports PIM Sparse Mode (PIM-SM).

PIM Sparse Mode

PIM-SM explicitly builds unidirectional shared trees rooted at a rendezvous point (RP) per group, and optionally creates shortest-path trees per source. PIM-SM generally scales fairly well for wide-area usage. PIM-SM is useful for routing multicast streams between VLANs, subnets, or local area networks (LANs) in applications such as IPTV.

Configuring IGMP

To configure an IGMP profile, follow these steps:

1. Configure an IGMP profile under an interface profile.
```
(host) (config) #interface-profile igmp-profile igmp1
(host) (Interface IGMP profile "igmp1") #
```
2. Enable IGMP profile (default is enabled).
```
(host) (Interface IGMP profile "igmp1") #no disable
```
3. Assign IGMP profile to a VLAN interface.
```
(host) (Interface IGMP profile "igmp1") #interface vlan 2
(host) (vlan "2") #igmp-profile igmp1
```
4. Verify the VLAN interface.
```
(host) (vlan "2") #show interface-config vlan 2

vlan "2"
--------
Parameter                 Value
---------                 -----
Interface OSPF profile    ospf-a0
Interface PIM profile     default
Interface IGMP profile    igmp1
Interface shutdown        Disabled
mtu                       1500
IP Address                20.1.1.4/255.255.255.0
IPv6 Address              N/A
IPv6 link local Address   N/A
DHCP client               Disabled
DHCP relay profile        N/A
Interface description     N/A
```

Configuring PIM Sparse Mode

This section contains the following sections:

- Configuring PIM-SM End to End on page 223
- Verifying PIM Sparse Mode on page 224

Configuring PIM-SM End to End

To configure PIM-SIM end to end, follow these steps:

1. Create a VLAN.

```
(host)(config) #vlan 7
(host)(VLAN "7") #exit
```

2. Create an interface-profile switching-profile profile to associate with a physical interface.

```
(host)(config) #interface-profile switching-profile ip-sp-profile
```

3. Add an access-vlan to set the VLAN when interface is in access mode.

```
(host)(switching profile "ip-sp-profile") #access-vlan 7
(host)(switching profile "ip-sp-profile") #exit
```

4. Associate the interface-profile switching-profile with a physical interface profile.

```
(host)(config) #interface gigabitethernet 0/0/0
(host)(gigabitethernet "0/0/0") #switching-profile ip-sp-profile
(host)(gigabitethernet "0/0/0") #exit
```

5. Create the routed VLAN interface (RVI).

```
(host)(config) #interface vlan 7
(host)(vlan "7") #
```

6. Assign an IP address to the routed VLAN interface (RVI).

```
(host)(vlan "7") #ip address 20.2.1.1 netmask 255.255.255.0
```

7. Associate the "default" PIM profile with the routed VLAN interface (RVI).

```
(host)(vlan "7") #pim-profile default
(host)(vlan "7") #exit
```

8. Use the router pim command to enter Global PIM profile mode and define the RP address and group range.

```
(host)(config) #router pim
(host)(Global PIM profile) #rp-address 224.0.0.1 group-range 225.0.0.0 255.0.0.0
```

CAUTION

When configuring static RP, please ensure the RP is active and reachable. If the RP is not reachable, multicast traffic fails.

Verifying PIM Sparse Mode

This section contains the following sections:

- Displaying PIM RPF Information on page 224
- Displaying PIM Neighbor Information on page 224
- Displaying PIM RP Information on page 225
- Displaying PIM Mroute Information on page 225
- Displaying PIM Statistical Information on page 225

Displaying PIM RPF Information

```
(host) #show ip pim rpf 10.10.10.10
PIM RPF Information
-------------------
Address      Nexthop    RPF Interface
-------      -------    -------------
10.10.10.10  20.20.1.9  vlan20
```

Displaying PIM Neighbor Information

To display PIM neighbor information, use the following command:

```
(host)# show ip pim neighbor
PIM Neighbor Information
------------------------
Interface  Neighbor IP  UpTime    Expiry
---------  -----------  ------    ------
vlan11     11.11.22.22  07:58:51  08:00:20
```

Displaying PIM RP Information

To display PIM RP information, use the following command:

```
(host)# show ip pim rp
PIM RP-Group Mapping
--------------------
Group/Prefix  RP
------------  --
224.0.0.0/4   11.11.22.22
```

Displaying PIM Mroute Information

To display PIM Mroute information, use the following command:

```
(host)# show ip pim mroute
IP Multicast Route Table
Flags:  D - Dense, S - Sparse, C - Connected, L - Local,
        P - Pruned, R - RP-bit set, T - SPT bit set, F - Register Flag
        J - Join SPT, A - Assert Winner
(*,224.1.1.6) 14:20:11 RP 11.11.22.22 flags:
        Incoming Interface: vlan11 RPF nbr: 11.11.22.22
        Outgoing Interface List:
                vlan22, 14:20:11
(22.22.99.99,230.1.1.1) 14:17:20 RP 11.11.22.22 flags: T
        Incoming Interface: vlan22 RPF nbr: 22.22.99.99
        Outgoing Interface List:
                vlan11, 14:17:20
```

Displaying PIM Statistical Information

To display PIM statistical information, use the following command:

```
(host)# show ip pim stats
PIM Statistics
--------------
Interface  Counter                Value
---------  -------                -----
vlan11 Rx  Hellos                 0056
           Rx Join/Prune          0000
           Rx Join                0000
           Rx Prune               0000
           Rx Register-Stop       0000
           Tx Hellos              0057
           Tx Join/Prune          0016
           Tx Join                0000
           Tx Prunes              0000
           Tx Register            0000
           Invalid Hellos         0000
           Invalid Join/Prune     0000
           Invalid Join           0000
           Invalid Prune          0000
           Invalid Register       0000
           Invalid Register-Stop  0000
```

Chapter 24 IGMP Snooping

You can enable multicast support on the Mobility Access Switch with IGMP snooping. You can enable the Mobility Access Switch to listen in on the IGMP conversation between hosts and network devices, and create a mapping table of which links need which IP multicast streams and which multicasts can be filtered from the links which do not need them.

This chapter includes the following topics:

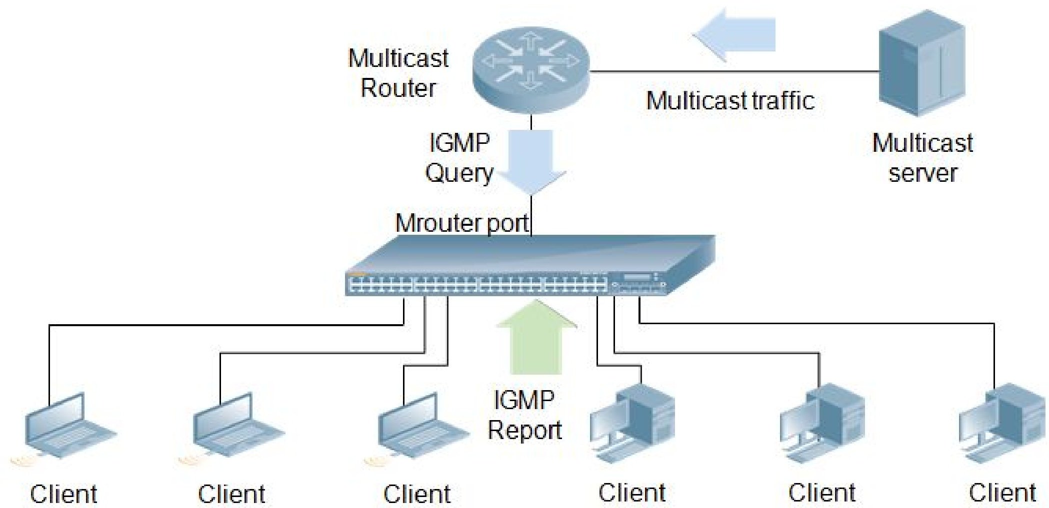
Important Points to Remember

- IGMP snooping is enabled by default.
- IGMP snooping is enabled on per-VLAN basis.
- IGMP snooping profile must be referenced in the VLAN and not on the interface.
- IGMP versions 1 and 2 are supported for snooping.

Multicast Support with IGMP Snooping

The Mobility Access Switch supports IGMP snooping, which prevents multicast flooding on Layer 2 network treating multicast traffic as broadcast traffic. All streams could be flooded to all ports on that VLAN. When multicast flooding occurs, end-hosts that happen to be in the same VLAN would be receiving all the streams only to be discarded without snooping.

When you enable IGMP snooping, the switch becomes IGMP-aware and processes the IGMP control messages as received. You must do this to correctly process all IGMP membership reports and IGMP leave messages. IGMP snooping is handled by the hardware for performance. Multicast routers and multicast receivers associated with each IP multicast group are learnt dynamically.



Snooping Report and Query Support

The Mobility Access Switch relays IGMP report from all receiver per group to the multicast router. In IGMP snooping proxy mode, reports to multicast router ports are suppressed. Query from multicast router is relayed to all ports in the VLAN. When snooping proxy is enabled, the switch queries hosts for interested receivers and it floods the query message received from a multicast router. When IGMP query message is seen, it becomes a mrouter port in IGMP snooping table. This port is used for forwarding multicast frames that are sourced from a VLAN to a multicast router for further processing.

Mrouter

VLANs in a Layer 2 switch needs to know the path to the PIM router that connects Layer 2 domain to the Layer 3 Network. When the multicast source is present on the Layer 2 switch, the traffic that originates from the Layer 2 switches need to know a port through which multicast traffic can reach the Layer 3 PIM router. For this reason, the VLAN in the Layer 2 switch on which IGMP snooping is enabled will designate a port as Mrouter port. The mrouter port can be detected dynamically or statically. The dynamic detection is based on IGMP query message or PIM hello messages. You can also configure static mrouter ports.

When multicast receivers are present on the VLAN in a Layer 2 switch, the IGMP report message from the host is forwarded out of the mrouter port towards the PIM router to let the PIM router know that there are receivers interested in receiving multicast traffic, so that, PIM routers can add the VLAN interface to the outgoing list in the multicast route on a multicast router.

Configuring a Static Mrouter Port

To configure a static mrouter port, follow these steps:

```
(host)(config)# interface gigabitethernet <slot/module/port>
   igmp-snooping mrouter-vlan <vlan-id|vlan-list>
   igmp-snooping mrouter-vlan {add | delete} <vlan-id>
```

Example Configuration

```
(host)(config)# interface gigabitethernet 0/0/9
   igmp-snooping mrouter-vlan 1
(host)# show igmp-snooping mrouter vlan 1

Flags: D - Dynamic, S - Static, P - PIM, M - IGMP/MLD query

IGMP Snooping Multicast Router Ports
------------------------------------
```

```
VLAN  Elected-Querier  Ports (Flags)  Expiry    UpTime    Src-Ip
----  ---------------  -------------  ------    ------    ------
0001  10.10.10.6       GE0/0/9 (DM)   00:03:25  04:35:30  10.10.10.6
                       GE0/0/9 (DP)   00:04:14  04:35:09  10.10.10.6

(host)# show igmp-snooping mrouter vlan 1 detail
Flags: D - Dynamic, S - Static, P - PIM, M - IGMP/MLD query

Vlan:0001 Elected-Querier:10.10.10.6
  GE0/0/9    (DM)  Expiry Time: 00:03:45  Uptime: 04:36:10
                Router IP: 10.10.10.6
                Router MAC: 00:19:06:55:15:40
  GE0/0/9    (DP)  Expiry Time: 00:04:04  Uptime: 04:35:49
                Router IP: 10.10.10.6
                Router MAC: 00:19:06:55:15:40
```

Creating and Applying an IGMP Snooping Profile to a VLAN

Using the CLI

```
(host)(config)# vlan-profile igmp-snooping-profile <profile-name>
   clone <source>
   fast-leave
   last-member-query-count <1-5>
   last-member-query-interval <1-25 seconds>
   no {...}
   query-interval <1-18000 seconds>
   query-response-interval <1-25 seconds>
   robustness-variable <1-7>
   snooping
   snooping-proxy
   startup-query-count <1-10>
   startup-query-interval <1-18000 seconds>
(host)(config)# vlan <vlan-id>
   vlan-profile igmp-snooping-profile <profile-name>
```

Sample Configuration

```
(host)(config)# vlan-profile igmp-snooping-profile IGMP_SNOOP
   fast-leave
   last-member-query-count 2
   last-member-query-interval 15
   query-interval 6000
   query-response-interval 5
   robustness-variable 2
   snooping
   snooping-proxy
   startup-query-count 5
   startup-query-interval 6000
(host)(config)# vlan 200
   vlan-profile igmp-snooping-profile IGMP_SNOOP
```

IGMP Snooping Factory Initial and the Default Profiles

```
(host)# show vlan-profile igmp-snooping-profile igmp-snooping-factory-initial
igmp-snooping-profile "igmp-snooping-factory-initial"
-----------------------------------------------------
Parameter                         Value
---------                         -----
```

```
Enable igmp snooping                Enabled
Enable igmp snooping proxy          Disabled
Enable fast leave                   Disabled
startup-query-count                 2
startup-query-interval(secs)        31
query-interval(secs)                125
query-response-interval(secs)       10
last-member-query-count             2
last-member-query-interval(secs)    1
robustness-variable                 2

(host)# show vlan-profile igmp-snooping-profile default
igmp-snooping-profile "default"
-------------------------------
Parameter                   Value
---------                   -----
Enable igmp snooping        Enabled
Enable igmp snooping proxy  Disabled
Enable fast leave           Disabled
startup-query-count         2
startup-query-interval      31
query-interval              125
query-response-interval     10
last-member-query-count     2
last-member-query-interval  1
robustness-variable         2
```

Verifying IGMP Snooping Configuration

```
(host)# show vlan-profile igmp-snooping-profile IGMP_SNOOP
igmp-snooping-profile "IGMP_SNOOP"
----------------------------------
Parameter                   Value
---------                   -----
Enable igmp snooping        Enabled
Enable igmp snooping proxy  Disabled
Enable fast leave           Disabled
startup-query-count         2
startup-query-interval      31
query-interval              125
query-response-interval     10
<output truncated>
```

Monitoring IGMP Snooping

```
(host)# show igmp-snooping counters vlan 2
IGMP Snooping Multicast Counters
--------------------------------
Name                    Value
----                    -----
received-total          0000
received-queries        0000
received-v1-reports     0000
received-v2-reports     0000
received-v3-reports     0000
received-pimv1-hello    0000
received-pimv2-hello    0000
received-leaves         0000
received-unknown-types  0000
len-errors              0000
checksum-errors         0000
```

```
transmitted-queries     0000
transmitted-joins       0000
transmitted-leaves      0000
transmitted-errors      0000
forwarded-queries       0000
forwarded-joins         0000
forwarded-leaves        0000

(host)# show igmp-snooping groups
IGMP Snooping Multicast Route Table
-----------------------------------
VLAN  Group             Port List
----  -----             ---------
0100  224.0.1.40        GE 0/0/11
0100  239.255.255.250   GE 0/0/11

(host)# show igmp-snooping membership

IGMP Snooping Multicast Membership
----------------------------------
VLAN  Group       Port      Expiry    UpTime
----  -----       ----      ------    ------
0001  224.0.1.40  GE0/0/9   00:03:36  04:47:27
0001  225.0.1.1   GE0/0/9   00:00:00  00:01:25
1900  225.0.1.1   GE0/0/3   00:03:49  04:47:32
0003  225.0.1.1   GE0/0/9   00:00:00  04:46:30
0003  239.0.0.1   GE0/0/9   00:00:00  04:44:42

(host)# show igmp-snooping mrouter

Flags: D - Dynamic, S - Static, P - PIM, M - IGMP/MLD query

IGMP Snooping Multicast Router Ports
------------------------------------
VLAN  Elected-Querier  Ports (Flags)  Expiry    UpTime    Src-Ip
----  ---------------  -------------  ------    ------    ------
0001  10.10.10.6       GE0/0/9 (DM)   00:04:07  04:45:55  10.10.10.6
                       GE0/0/9 (DP)   00:04:09  04:45:34  10.10.10.6
0003  3.3.3.10         GE0/0/9 (DM)   00:04:15  04:45:25  3.3.3.10
                       GE0/0/9 (DP)   00:04:06  04:44:56  3.3.3.10
0300  20.20.20.1       GE0/0/9 (DM)   00:04:15  04:45:25  20.20.20.1
                       GE0/0/9 (DP)   00:04:05  04:45:13  20.20.20.1
```

You can also use the following commands:

```
(host)# show igmp-snooping counters vlan <vlan-id>
(host)# show igmp-snooping groups vlan <vlan-id>
(host)# show igmp-snooping membership vlan <vlan-id> | detail
(host)# show igmp-snooping mrouter vlan <vlan-id> | detail
```

Clearing IGMP Counters and Membership

```
(host)(config)# clear igmp-snooping counters
(host)(config)# clear igmp-snooping counters vlan <vlan-id>
(host)(config)# clear igmp-snooping membership
(host)(config)# clear igmp-snooping membership vlan <vlan-id>
(host)(config)# clear igmp-snooping mrouter
(host)(config)# clear igmp-snooping mrouter vlan <vlan-id>
```

Enabling IGMP Snooping Trace Options

```
(host)(config)# traceoptions
```

```
igmp-snooping flags {all|config|errors|receive|transmit}
```

This chapter contains the following major sections:

Important Points to Remember

- Mobility Access Switch supports only MLDv1 (RFC 2710) and hence does not process the MLDv2 specific packets.
- MLD snooping prevents multicast flooding on an Ethernet link, but it requires complex processing for each of the interfaces on switches that were not initially designed for this kind of task.
- MLD is embedded in ICMPv6, unlike IGMP, which uses a separate protocol. MLDv1 is similar to IGMPv2 and MLDv2 is similar to IGMPv3.

Understanding MLD Snooping

Multicast Listener Discovery (MLD) is a component of the Internet Protocol Version 6 (IPv6) suite. It is used by IPv6 routers for discovering multicast listeners on a directly attached link. When multicast is supported at the IPv6 level, it often broadcasts at lower levels. So, for example, an Ethernet switch broadcasts multicast traffic on all ports, even if only one host wants to receive it.

To prevent entire Ethernet segments from being flooded, MLD snooping can be implemented on Ethernet switches. The MLD snooping solution is similar to the IGMP snooping solution for IPv4. When MLD snooping is implemented on a switch, it detects all MLD version 1 messages that are exchanged on the link. It also maintains a table that indicates which IPv6 multicast groups should be forwarded for each of the interfaces.

Configuring MLD Snooping

This section contains the following sections:

Configuring MLD Snooping

To configure MLD snooping, follow these steps:

1. Configure an MLD snooping profile in a VLAN profile.

```
(host) (config) #vlan-profile mld-snooping-profile MLD_Doc
(host) (mld-snooping-profile "MLD_Doc") #snooping
(host) (mld-snooping-profile "MLD_Doc") #
```

2. Apply the MLD snooping profile to the VLAN.

```
(host) (config) #vlan 10
(host) (VLAN "10") #mld-snooping-profile MLD_Doc
(host) (VLAN "10") #
```

3. Configure a static mrouter port.

```
(host) (config) #interface gigabitethernet 0/0/46
```

```
(host) (gigabitethernet "0/0/46") #mld-snooping mrouter-vlan 10
```

Deleting an Mrouter Port on a VLAN

To delete an mrouter port on a VLAN, use the following command:

```
(host) (gigabitethernet "0/0/4") #mld-snooping mrouter-vlan delete 2
```

Verifying MLD Snooping

This section contains the following sections:

Verifying the MLD Snooping Profile

To verify an MLD snooping profile, use the following command:

```
(host) #show vlan-profile mld-snooping-profile MLD_Doc

mld-snooping-profile "MLD_Doc"
----------------------------
Parameter                         Value
---------                         -----
robustness-variable               2
last-member-query-interval(secs)  1
query-interval(secs)              125
query-response-interval(secs)     10
Enable fast leave                 Disabled
Enable mld snooping               Enabled
```

Verifying the Static and Dynamic Mrouter Port for MLD Snooping

To verify the static and dynamic mrouter port for MLD snooping, use the following command:

```
(host) #show mld-snooping mrouter vlan 1

Flags: D - Dnyamic, S - Static, P - PIM, M - IGMP/MLD

MLD Snooping Multicast Router Ports
-----------------------------------
VLAN  Elected-Querier                          Ports (Flags)  Expiry    UpTime
----  ---------------                          -------------  ------    ------
0001  3555:5555:6666:6666:7777:7777:8888:8888  GE0/0/0 (S)    00:00:00  00:10:35
                                               GE0/0/3 (DM)   00:04:20  00:10:33
                                               GE0/0/3 (DP)   00:04:19  00:10:33
```

Verifying the MLD Snooping Mrouter Detail

To verify the mld-snooping mrouter detail and show identifiers for each field, use the following command:

```
(host) (VLAN "1") #show mld-snooping mrouter detail

Flags: D - Dnyamic, S - Static, P - PIM, M - IGMP/MLD
```

```
Vlan:0001 Elected-Querier:3555:5555:6666:6666:7777:7777:8888:8888
  GE0/0/0    (S)  Expiry Time: 00:00:00  Uptime: 00:03:54
                Router IP: N/A
                Router MAC: 00:00:00:00:00:00
  GE0/0/3    (DM)  Expiry Time: 00:01:32  Uptime: 00:03:52
                Router IP: 3555:5555:6666:6666:7777:7777:8888:8888
                Router MAC: 00:00:00:00:02:00
  GE0/0/3    (DP)  Expiry Time: 00:01:31  Uptime: 00:03:52
                Router IP: fe80::200:24ff:fef9:7ccd
                Router MAC: 00:00:24:f9:7c:cd
(host) (VLAN "1") #show igmp-snooping mrouter detail

Flags: D - Dynamic, S - Static, P - PIM, M - IGMP/MLD

Vlan:0001 Elected-Querier:111.1.0.12
  GE0/0/0    (DM)  Expiry Time: 00:04:12  Uptime: 00:00:08
                Router IP: 111.1.0.12
                Router MAC: 00:00:33:00:05:00
Vlan:0004 Elected-Querier:11.11.11.3
  GE0/0/4    (S)  Expiry Time: 00:00:00  Uptime: 00:19:54
                Router IP: N/A
                Router MAC: 00:00:00:00:00:00
  GE0/0/4    (DM)  Expiry Time: 00:04:09  Uptime: 00:00:11
                Router IP: 11.11.11.3
                Router MAC: 00:00:09:0b:91:6d
```

Verifying the Two Mrouter Entries with the Same IP Address

Two mrouter entries with the same router IP address can be created if the PIM router is also the IGMP querier based on both protocol packets. To distinguish between the two IP addresses, flags are displayed in the commands **show igmp-snooping mrouter** and **show mld-snooping mrouter**.

```
(host) (VLAN "1") #show igmp-snooping mrouter

Flags: D - Dnyamic, S - Static, P - PIM, M - IGMP/MLD

IGMP Snooping Multicast Router Ports
------------------------------------
VLAN  Elected-Querier  Ports (Flags)  Expiry    UpTime    Src-Ip
----  ---------------  -------------  ------    ------    ------
0004  11.11.11.3       GE0/0/4 (S)    00:00:00  00:26:26  -
                       GE0/0/4 (DM)   00:03:52  00:06:43  11.11.11.3
                       GE0/0/4 (DP)   00:04:19  00:00:02  11.11.11.3
                       GE0/0/3 (DM)   00:03:52  00:06:43  11.11.11.11
```

If the 80 column limit is exceeded when displaying the **src-ip** and the elected querier in the same row of the **show mld-snooping mrouter** output, the **src-ip** is not shown. To find the **src-ip**, use the **show mld-snooping mrouter detail** command.

```
(host) (VLAN "1") #show mld-snooping mrouter

Flags: D - Dnyamic, S - Static, P - PIM, M - IGMP/MLD

MLD Snooping Multicast Router Ports
-----------------------------------
VLAN  Elected-Querier                           Ports (Flags)  Expiry    UpTime
----  ---------------                           -------------  ------    ------
0001  3555:5555:6666:6666:7777:7777:8888:8888   GE0/0/0 (S)    00:00:00  00:10:35
                                                GE0/0/3 (DM)   00:04:20  00:10:33
                                                GE0/0/3 (DP)   00:04:19  00:10:33
```

Similar to the output of **show mld-snooping mrouter detail**, the output the **show mld-snooping membership detail** now includes labels for each field to enhance readability.

```
(host) (VLAN "1") #show igmp-snooping membership detail

Flags: H - IGMP/MLD listener, M - Multicast Router

Group:225.0.0.9 Vlan:0001
  Port: GE0/0/2    Expiry: 00:00:00 Uptime: 00:01:21
        (M)  IP: 0.0.0.0          MAC: 00:0b:86:6a:20:80
  Port: GE0/0/4    Expiry: 00:02:59 Uptime: 00:01:21
        (H)  IP: 11.11.11.1       MAC: 00:00:09:0b:91:6c
Group:225.0.0.10 Vlan:0001
  Port: GE0/0/2    Expiry: 00:00:00 Uptime: 00:01:21
        (M)  IP: 0.0.0.0          MAC: 00:0b:86:6a:20:80
  Port: GE0/0/4    Expiry: 00:02:59 Uptime: 00:01:21
        (H)  IP: 11.11.11.1       MAC: 00:00:09:0b:91:6c

(host) #show mld-snooping membership detail

Flags: H - IGMP/MLD listener, M - Multicast Router

Group:ff03::3 Vlan:0001
  Port: GE0/0/0    Expiry: 00:04:08 Uptime: 00:00:12
        (H)  IP: fe80::5001       MAC: 00:00:02:00:05:00
  Port: GE0/0/4    Expiry: 00:00:00 Uptime: 00:00:12
        (M)  IP: fe80::5002       MAC: 00:00:00:00:03:00
```

Verifying MLD Snooping Member Ports

To verify the MLD snooping member ports, use the following command:

```
(host) #show mld-snooping membership vlan 10

MLD Snooping Multicast Membership
---------------------------------
VLAN  Group     Port       Expiry    UpTime
----  -----     ----       ------    ------
0010  ff03::1  GE0/0/22   00:04:11  00:00:15
               GE0/0/47   00:00:00  00:00:15
0010  ff03::2  GE0/0/22   00:04:11  00:00:15
               GE0/0/47   00:00:00  00:00:15
0010  ff03::3  GE0/0/22   00:04:11  00:00:15
               GE0/0/47   00:00:00  00:00:15
0010  ff03::4  GE0/0/22   00:04:11  00:00:15
               GE0/0/47   00:00:00  00:00:15
0010  ff03::5  GE0/0/22   00:04:11  00:00:15
               GE0/0/47   00:00:00  00:00:15
0010  ff03::6  GE0/0/22   00:04:11  00:00:15
               GE0/0/47   00:00:00  00:00:15
0010  ff03::7  GE0/0/22   00:04:11  00:00:15
               GE0/0/47   00:00:00  00:00:15
0010  ff03::8  GE0/0/22   00:04:11  00:00:15
               GE0/0/47   00:00:00  00:00:15
0010  ff03::9  GE0/0/22   00:04:11  00:00:15
               GE0/0/47   00:00:00  00:00:15
0010  ff03::a  GE0/0/22   00:04:11  00:00:15

MLD Snooping Multicast Membership
---------------------------------
VLAN  Group  Port       Expiry    UpTime
----  -----  ----       ------    ------
             GE0/0/47   00:00:00  00:00:15
```

Verifying the MLD Group

To verify the MLD group, use the following command:

```
(host) # show mld-snooping groups vlan 10

MLD Snooping Multicast Route Table
----------------------------------
VLAN  Group    Port List
----  -----    ---------
0010  ff03::1  GE0/0/47 GE0/0/22
0010  ff03::2  GE0/0/47 GE0/0/22
0010  ff03::3  GE0/0/47 GE0/0/22
0010  ff03::4  GE0/0/47 GE0/0/22
0010  ff03::5  GE0/0/47 GE0/0/22
0010  ff03::6  GE0/0/47 GE0/0/22
0010  ff03::7  GE0/0/47 GE0/0/22
0010  ff03::8  GE0/0/47 GE0/0/22
0010  ff03::9  GE0/0/47 GE0/0/22
0010  ff03::a  GE0/0/47 GE0/0/22
```

Verifying the MLD Snooping Group Count

To verify the MLD snooping group count, use the following command:

```
(host) # show mld-snooping groups vlan 10 count

MLD Snooping Multicast Route Count
----------------------------------
VLAN  Count
----  -----
0010  0010
```

Verifying the MLD Snooping Statistics

To verify the MLD snooping statistics, use the following command:

```
(host) #show mld-snooping counters vlan 10

MLD Snooping Counters
---------------------
Name                    Value
----                    -----
received-total          1110
received-queries        0036
received-v1-reports     1074
received-leaves         0000
received-unknown-types  0000
len-errors              0000
checksum-errors         0000
forwarded               0930
```

List of MLD Snooping Commands and Sample Outputs

This section contains the following commands:

- Show MLD Snooping Counters on page 237
- Show MLD Snooping Counters per VLAN on page 237
- Show MLD Mrouter Ports on page 237
- Show MLD Mrouter Ports Detail on page 237
- Show MLD Router Ports Per VLAN on page 238
- Show Detected MLD Multicast Addresses on page 238

Show MLD Snooping Counters

```
(host) #show mld-snooping counters
MLD Snooping Counters
---------------------
Name                    Value
----                    -----
received-total          0005
received-queries        0001
received-v1-reports     0004
received-leaves         0000
received-pim-v6         0000
received-unknown-types  0000
len-errors              0000
checksum-errors         0000
forwarded               0000
```

Show MLD Snooping Counters per VLAN

```
(host) #show mld-snooping counters vlan 1
MLD Snooping Counters
---------------------
Name                    Value
----                    -----
received-total          0005
received-queries        0001
received-v1-reports     0004
received-leaves         0000
received-pim-v6         0000
received-unknown-types  0000
len-errors              0000
checksum-errors         0000
forwarded               0000
```

Show MLD Mrouter Ports

```
(host) #show mld-snooping mrouter
Flags: D - Dynamic, S - Static, P - PIM, M - IGMP/MLD query

MLD Snooping Multicast Router Ports
-----------------------------------
VLAN  Elected-Querier  Ports (Flags)  Expiry    UpTime
----  ---------------  -------------  ------    ------
0001  fef1::d0d0       GE0/0/4 (DM)   00:04:12  00:00:08
```

Show MLD Mrouter Ports Detail

```
(host) #show mld-snooping mrouter detail

Flags: D - Dynamic, S - Static, P - PIM, M - IGMP/MLD query

Vlan:0001 Elected-Querier:fef1::d0d0
  GE0/0/4    (DM)  Expiry Time: 00:04:06  Uptime: 00:00:14
```

```
                Router IP: fef1::d0d0
                Router MAC: 00:00:00:00:03:00
```

Show MLD Router Ports Per VLAN

```
(host) #show mld-snooping mrouter vlan 1

Flags: D - Dynamic, S - Static, P - PIM, M - IGMP/MLD query

MLD Snooping Multicast Router Ports
-----------------------------------
VLAN  Elected-Querier  Ports (Flags)  Expiry    UpTime
----  ---------------  -------------  ------    ------
0001  fef1::d0d0       GE0/0/4 (DM)   00:04:11  00:00:09
```

Show Detected MLD Multicast Addresses

```
(host) #show mld-snooping groups

MLD Snooping Multicast Route Table
----------------------------------
VLAN  Group    Port List
----  -----    ---------
0001  ff03::1  GE0/0/0 GE0/0/4
0001  ff03::2  GE0/0/0 GE0/0/4
0001  ff03::3  GE0/0/0 GE0/0/4
0001  ff03::4  GE0/0/0 GE0/0/4
```

Show Detected MLD Multicast Addresses Per VLAN

```
(host) #show mld-snooping groups vlan 1

MLD Snooping Multicast Route Table
----------------------------------
VLAN  Group    Port List
----  -----    ---------
0001  ff03::1  GE0/0/0 GE0/0/4
0001  ff03::2  GE0/0/0 GE0/0/4
0001  ff03::3  GE0/0/0 GE0/0/4
0001  ff03::4  GE0/0/0 GE0/0/4
0001  ff03::5  GE0/0/0 GE0/0/4
```

Show Detected MLD Multicast Membership Information

```
(host) #show mld-snooping membership

MLD Snooping Multicast Membership
---------------------------------
VLAN  Group    Port      Expiry    UpTime
----  -----    ----      ------    ------
0001  ff03::1  GE0/0/0   00:02:12  00:02:08
0001  ff03::2  GE0/0/0   00:02:13  00:02:07
0001  ff03::3  GE0/0/0   00:02:14  00:02:06
0001  ff03::4  GE0/0/0   00:02:15  00:02:05
0001  ff03::5  GE0/0/0   00:02:16  00:02:04
```

Show Detected MLD Multicast Membership Information (Detailed Version)

```
(host) #show mld-snooping membership detail

Flags: H - IGMP/MLD listener, M - Multicast Router

Group:ff03::1 Vlan:0001
  Port: GE0/0/0    Expiry: 00:00:30 Uptime: 00:03:50
```

```
        (H)  IP: fe80::200:24ff:fef9:7ccf MAC: 00:00:24:f9:7c:cf
Group:ff03::2 Vlan:0001
  Port: GE0/0/0    Expiry: 00:00:31 Uptime: 00:03:49
        (H)  IP: fe80::200:24ff:fef9:7ccf MAC: 00:00:24:f9:7c:cf
Group:ff03::3 Vlan:0001
  Port: GE0/0/0    Expiry: 00:00:32 Uptime: 00:03:48
        (H)  IP: fe80::200:24ff:fef9:7ccf MAC: 00:00:24:f9:7c:cf
Group:ff03::4 Vlan:0001
  Port: GE0/0/0    Expiry: 00:00:33 Uptime: 00:03:47
        (H)  IP: fe80::200:24ff:fef9:7ccf MAC: 00:00:24:f9:7c:cf
Group:ff03::5 Vlan:0001
  Port: GE0/0/0    Expiry: 00:00:34 Uptime: 00:03:46
        (H)  IP: fe80::200:24ff:fef9:7ccf MAC: 00:00:24:f9:7c:cf
```

Show Detected MLD Multicast Membership Information Per VLAN

```
(host) #show mld-snooping membership vlan 1

MLD Snooping Multicast Membership
---------------------------------
VLAN  Group    Port     Expiry    UpTime
----  -----    ----     ------    ------
0001  ff03::1  GE0/0/0  00:02:12  00:02:08
0001  ff03::2  GE0/0/0  00:02:13  00:02:07
0001  ff03::3  GE0/0/0  00:02:14  00:02:06
0001  ff03::4  GE0/0/0  00:02:15  00:02:05
0001  ff03::5  GE0/0/0  00:02:16  00:02:04
```

Show MLD-Snooping Profile

```
(host) #show VLAN-profile mld-snooping-profile default

mld-snooping-profile "default"
------------------------------
Parameter                          Value
---------                          -----
robustness-variable                2
last-member-query-interval(secs)   10
query-interval(secs)               125
query-response-interval(secs)      10
Enable fast leave                  Enabled
Enable mld snooping                Enabled
```

Show List of MLD-Snooping Profiles

```
(host) #show VLAN-profile mld-snooping-profile

mld-snooping-profile List
-------------------------
Name     References  Profile Status
----     ----------  --------------
default  2
Total:1
```

Show List of References for MLD-Snooping Profile

```
(host) #show references  vlan-profile mld-snooping-profile default

References to mld-snooping-profile "default"
--------------------------------------------
Referrer                           Count
--------                           -----
vlan "1" mld-snooping-profile      1
vlan "1111" mld-snooping-profile   1
```

```
Total References:2
```

This chapter contains the following major sections:

DHCP Snooping Overview

When DHCP snooping is enabled, the system snoops the DHCP messages to view DHCP lease information and build and maintain a database of valid IP address to MAC address bindings called the DHCP snooping database.

DHCP snooping helps to build the binding database to support the security features like IP Source Guard (IPSG) and Dynamic ARP Inspection (DAI).

Important Points to Remember

- By default, DHCP Snooping is disabled on the VLAN.
- When DHCP Snooping is enabled on the VLAN, the IP to MAC binding is created in the system.

Configuring DHCP Snooping

The following command adds a static binding on a VLAN:

```
(host) ("vlan id") #dhcp-snooping-database <mac> gigabitethernet <slot/module/port> <ip_addres
s>
```

The following command deletes a static binding on a VLAN:

```
(host) ("vlan id") #no dhcp-snooping-database <mac> gigabitethernet <slot/module/port> <ip_add
ress>
```

The following command enables and configures DHCP snooping and static binding on a VLAN:

```
(host) (“vlan id”)# vlan-profile dhcp-snooping-profile <profile-name>
(host) (dhcp-snooping-profile “profile-name”)# enable
```

The following command attaches DHCP Snooping profile on the VLAN:

```
(host) (“vlan id”)# dhcp-snooping-profile <profile name>
```

Sample Configuration

The following example enables and configures DHCP Snooping on a VLAN:

```
(host) (“vlan 6”)# vlan-proifile dhcp-snooping-profile DHCP
(host) (dhcp-snooping-profile “DHCP”)# enable
```

The following example attaches DHCP Snooping profile on the VLAN:

```
(host) (“vlan 6”)# dhcp-snooping-profile DHCP
```

Verifying Configuration

The following command displays the DHCP Snooping configuration details:

```
(host) (config) #show vlan-profile dhcp-snooping-profile DHCP
dhcp-snooping-profile "DHCP"
----------------------------
Parameter Value
```

```
--------- -----
DHCP Snooping Enabled
```

The following command displays the DHCP Snooping database details:

```
(host) (config) #show  dhcp-snooping-database  vlan 6
Total DHCP Snoop Entries : 3
Learnt Entries : 1, Static Entries : 2

DHCP Snoop Table
----------------
MAC                IP        BINDING-STATE  LEASE-TIME                 VLAN-ID  INTERFACE
---                --        -------------  ----------                 -------  ---------
00:00:00:60:4a:69  6.6.6.10  Dynamic entry  2013-09-06 10:50:05 (PST)  6        gigabitetherne
t1/0/2
00:00:11:22:44:55  4.4.4.4   Static entry   No lease time              6        gigabitetherne
t1/0/2
00:00:11:33:66:77  7.7.7.7   Static entry   No lease time              6        gigabitetherne
t1/0/11
```

The following command displays static entries of DHCP Snooping database:

```
(host) (config) #show  dhcp-snooping-database
Total DHCP Snoop Entries : 4
Learnt Entries : 0, Static Entries : 4
DHCP Snoop Table
----------------
MAC                IP       BINDING-STATE  LEASE-TIME     VLAN-ID  INTERFACE
---                --       -------------  ----------     -------  ---------
00:00:11:33:66:77  7.7.7.7  Static entry   No lease time  6        gigabitethernet1/0/11
00:00:11:51:77:11  7.7.7.7  Static entry   No lease time  3        gigabitethernet0/0/4
```

00:00:77:11:66:33 6.6.6.6 Static entry No lease time 3 gigabitethernet0/0/4

00:11:77:22:88:22 9.9.9.9 Static entry No lease time 6 gigabitethernet1/0/4

This chapter describes the following topics:

Port Security Overview

ArubaOS Mobility Access Switchsupports for Port Security functionality to provide network security at Layer 2. You can now filter the unauthorized devices to send the control packets, restrict the number of MACs allowed on the interface, and detect unwanted loops in the network when not running spanning-tree protocol.

You can enable or disable this functionality at an interface level.

Router Advertisement Guard

The Router Advertisement (RA) Guard functionality analyzes the RAs and filters out RA packets sent by unauthorized devices. The RA guard feature is disabled by default. By enabling, the RA packets received on the interface are dropped and the port can be shutdown based on the interface configuration. The port can be re-activated after the configured time by configuring the **auto-recovery** option.

Points to remember

- The following RA messages are filtered by enabling the RA guard:
  - RA message with no extension header
  - RA message with multiple extension headers
  - RA message fragmented
- The following Unicast RA messages are not filtered by enabling the RA guard:
  - Unicast RA messages with multiple extension headers.
  - Unicast RA messages fragmented

DHCP Trust

The DHCP trust functionality provides support to filter the IPv4 DHCP packets from the unauthorized devices. The following IPv4 DHCP messages are filtered on an interface configured not to trust DHCP.

- DHCP offer messages
- DHCP Ack messages

You can enable DHCP trust on any interface. By default, the DHCP Trust setting in a port-security-profile is to filter (block) these OFFER and ACK messages. You must explicitly enable DHCP Trust (trust dhcp) in the port-security-profile (if applied to a port) to allow these DHCP messages from valid devices.

Loop Protect

The Loop Protect functionality detects the unwanted physical loops in your network. You can enable or disable this functionality at an interface level. A proprietary protocol data unit (PDU) is used to detect the physical loops in the network. When the system detects a loop, it disables the port that sends the PDU. You can re-enable the port automatically or manually.

Points to Remember

- It is recommended that you enable Loop Protect on all the Layer 2 interfaces when the spanning tree is disabled on the Mobility Access Switch.
- The Loop Protect functionality will not detect any loops when MSTP or PVST (on any VLAN) is enabled on the Mobility Access Switch.
- The Loop Protect functionality will work only on non-HSL interfaces. An error will be displayed when you try to enable this functionality on HSL interfaces.

MAC Limit

The MAC limit feature restricts the maximum number of MACs that can be learnt on the interface. When the MAC limit is enabled, it provides support to log the excess MACs or drop the new MAC learning requests or shuts down the port.

Sticky MAC

Sticky MAC is a port security feature that dynamically learns MAC addresses on an interface and retains the MAC information in case the Mobility Access Switch reboots.

Sticky MAC is an alternative to the tedious and manual configuration of static MAC addresses on a port or to allow the port to continuously learn new MAC addresses after interface-down events. Allowing the port to continuously learn MAC addresses is a security risk. Sticky MAC prevents traffic losses for trusted workstations and servers because the interface does not have to relearn the addresses from ingress traffic after a restart.

Enable Sticky MAC in conjunction with MAC limit to restrict the number of MAC addresses learning.

Sticky MAC with MAC limit prevents Layer 2 denial of service (DoS) attacks, overflow attacks on the Ethernet switching table, and DHCP starvation attacks by limiting the MAC addresses allowed while still allowing the interface to dynamically learn a specified number of MAC addresses. The interface is secured because after the limit has been reached, additional devices cannot connect to the port.

By enabling Sticky MAC learning along with MAC limiting, interfaces can be allowed to learn MAC addresses of trusted workstations and servers during the period from when the interface are connected to the network until the limit for MAC addresses is reached. This ensures that after this initial period with the limit reached, new devices will not be allowed even if the Mobility Access Switch restarts.

Sticky MAC is disabled by default.

Points to Remember

- Sticky MAC is not supported on untrusted interfaces.
- Sticky MAC is not supported on HSL interfaces.
- No global configuration to enable or disable Sticky MAC address learning. The Sticky MAC feature will be enabled at interface level as part of port-security profile.
- Though the feature is enabled at the interface level, the MAC addresses are learned at the VLAN level.
- Configure on access or edge ports. However, there is no restriction for configuring Sticky MAC on trunk ports.
- Once a MAC address is learned on one interface, it will not be learned on any other interface in the same VLAN (no MAC move).
- Clear command with Sticky keyword can be used to remove Sticky MAC Addresses. All sticky MAC addresses will be removed when the VLAN is removed or the port-security profile is removed from the interface.
- Sticky MAC address can be learned on interfaces in other VLANs.
- Sticky MAC addresses, Phone MAC addresses and Dynamic addresses are considered as a part of MAC limit. Static addresses are not included in MAC limit.

- Sticky MAC feature does not influence the packet forwarding. Packet forwarding is only driven by the MAC limit. Packets from a Sticky MAC address received on other interfaces will be forwarded but will not be learnt on the new interface. Ensure to clear the sticky MAC address before it is learnt again on other interfaces.
- Shutting down a Sticky MAC enabled interface, linkdown, and STP TCN of an interface will not remove Sticky MAC entries learned on that interface.
- Sticky MAC entries are retained in case of a Mobility Access Switch reboot.

IP Source Guard

IP Source Guard (IPSG) functionality permits IP traffic from certain IP addresses, while denying the rest of IP traffic or manually configured IP source bindings and prevents IP spoofing attacks. When IPSG is enabled on an interface, the Mobility Access Switch blocks all IP traffic received on the interface, except for DHCP packets allowed by DHCP snooping. The port allows only IP traffic with a source IP address in the IP source binding table and denies all other traffic.

Important Points to Remember

- IPSG is disabled by default
- IPSG can be enabled for source IP and MAC address filtering
- If IPSG is enabled on the trusted interfaces, the number of users supported on untrusted interfaces will be reduced
- IPSG drops only IP traffic, Layer 2 traffic is not validated by IPSG

Dynamic ARP Inspection (DAI)

DAI is a security feature that validates ARP packets in a network. DAI intercepts, logs, and discards ARP packets with invalid IP-to-MAC address bindings.

DAI determines the validity of an ARP packet based on valid IP-to-MAC address bindings stored in a trusted database. This database is built by DHCP snooping, if DHCP snooping is enabled on the VLANs. The Mobility Access Switch forwards the ARP packets received on trusted and untrusted ports only if the validations on the ARP packets are successful. If the validation is not successful, the ARP packet is dropped and a log is generated.

Important Points to Remember

- DAI is disabled by default on all the interfaces.

Configuring Port Security Functionality

The port security functionality will be configured as part of the port level security configuration. This profile can be attached to the interface.

Configuring RA Guard Functionality

RA Guard functionality can be enabled at the port level. Configure the RA guard as part of the port level security configuration and attach to the interface.

```
(host)(config)# interface-profile port-security-profile <profile-name>
   ipv6-ra-guard action {drop|shutdown}auto-recovery-time <recovery-time>
```

The following example shows how to enable the RA Guard functionality:

```
(host)(config)# interface-profile port-security-profile RA-Guard1
   ipv6-ra-guard action shutdown auto-recovery-time 60
```

Configuring DHCP Trust Functionality

The DHCP trust functionality will be configured as part of the port level security configuration. This profile can be attached to the interface.

DHCP Trust can be enabled on any interface. By default, the DHCP Trust setting in a port-security-profile is to filter (block) these OFFER and ACK messages. You must explicitly enable DHCP Trust (trust dhcp) in the port-security-profile (if applied to a port) to allow these DHCP messages from valid devices.

```
(host)(config)# interface-profile port-security-profile <profile-name>
   trust dhcp
```

When **no trust dhcp** is configured the DHCP packets are dropped and a message is logged.

The following example shows how to enable the DHCP Trust functionality:

```
(host)(config)# interface-profile port-security-profile ps1
   trust dhcp
```

Configuring Loop Protect Functionality

Port Loop Protect functionality is configured as part of the port level security configuration. You can attach the port-security profile to any Layer 2 interface. Enabling Loop Protect will disable a port when it detects a loop. You can automatically re-enable the port by setting the auto-recovery option. Otherwise, you can recover the port manually using the **clear** command.

Use the following CLI commands to enable Loop Protect and the auto-recovery option:

```
(host) (config) #interface-profile port-security-profile <profile-name>
(host) (Port security profile "<profile-name>") #loop-protect auto-recovery-time <time in seco
nds>
```

Set a value for **auto-recovery-time** to enable the auto-recovery option. The port automatically re-enables and recovers from the error after the specified time. By default, auto-recovery is disabled. Auto-recovery remains disabled, if you enable **loop-protect** without setting the **auto-recovery-time** option or by setting the value to 0.

Use the following command to disable the auto-recovery option:

```
(host) (Port security profile "<profile-name>") #no loop-protect auto-recovery-time
```

Use the following command to disable the Loop Protect functionality:

```
(host) (Port security profile "<profile-name>") #no loop-protect
```

NOTE

It is recommended that you disable Spanning Tree using the following command before enabling Loop Protect on an interface:

```
(host) (config) #spanning-tree no mode
```

Otherwise, you will see the following warning message:

Warning: Port Loop Protect configured in the port-security-profile, will be inactive. It becomes active when MSTP/PVST is disabled.

Configuring MAC Limit Functionality

The MAC Limit functionality will be configured as part of the port level security configuration. You can attach this profile to an interface.

Use the following command to configure the MAC Limit:

```
(host)(config)# interface-profile port-security-profile <profile-name>
   mac-limit <limit> action {drop|log|shutdown}
   auto-recovery-time <time in seconds>
```

The following example shows how to enable the MAC Limit functionality:

```
(host)(config)# interface-profile port-security-profile MAC_Limit
```

```
mac-limit 30 action drop
auto-recovery-time 50
```

NOTE

The maximum value for **auto-recovery-time** for all the port security functionalities is 65535 seconds. You can apply `auto-recovery-time` option only if the action is `shutdown`.

Configuring Sticky MAC

The Sticky MAC learning is configured as part of the port level security configuration. You can attach this profile to an interface.

Enabling Sticky MAC

Use the following command to enable Sticky MAC:

```
(host)(config)# interface-profile port-security-profile <profile-name> sticky-mac
```

The following example shows how to enable Sticky MAC:

```
(host)(config)# interface-profile port-security-profile PSP sticky-mac
```

Use the following command to disable Sticky MAC:

```
(host)(config)# interface-profile port-security-profile <profile-name> no sticky-mac
```

The following example shows how to enable Sticky MAC:

```
(host)(config)# interface-profile port-security-profile PSP no sticky-mac
```

Viewing Sticky MAC

Execute the following command to view the Sticky MAC addresses on a Mobility Access Switch:

```
(host) show mac-address-table sticky
```

Execute the following command to view the Sticky MAC addresses on a VLAN:

```
(host) show mac-address-table vlan <id> sticky
```

Execute the following command to view the Sticky MAC addresses on an interface:

```
(host) show mac-address-table interface <interface-name> sticky
```

Clearing Sticky MAC Addresses

Execute the following command to remove the Sticky MAC addresses on a Mobility Access Switch:

```
(host) clear mac-address-table sticky
```

Execute the following command to remove the Sticky MAC addresses on a VLAN:

```
(host) clear mac-address-table vlan <id> sticky
```

Execute the following command to remove the Sticky MAC addresses on an interface:

```
(host) clear mac-address-table interface <interface-name> sticky
```

Execute the following command to remove a specific Sticky MAC address on a VLAN:

```
(host) clear mac-address-table vlan <id> mac <mac-address> sticky
```

Execute the following command to remove a specific Sticky MAC address on an interface:

```
(host) clear mac-address-table interface <interface-name> mac <mac address> sticky
```

Execute the following command to remove a specific Sticky MAC address on a VLAN port:

```
(host) clear mac-address-table vlan <id> interface <interface name> sticky
```

Configuring IP Source Guard

The IPSG functionality can be configured as part of the port level security configuration. This profile can be attached to the interface.

Use the following command to configure the IPSG:

```
(host)(config)# interface-profile port-security-profile <profile-name>
  ip-src-guard
```

Verifying IP Source Guard

You can use the following command to display all the interface on which IPSG is enabled, and the type of IPSG filter:

```
(host) #show ip source-guard
IPSG interface Info
-------------------
Interface   IPSG
----------  ----
GE0/0/12    Enabled
GE0/0/20    Enabled
GE1/0/20    Enabled
GE1/0/24    Enabled
GE2/0/16    Enabled
GE2/0/20    Enabled
GE3/0/8     Enabled
GE3/0/20    Enabled
```

You can use the following command to display if IPSG is enabled on a specific interface, along with type of filter:

```
(host) #show ip source-guard interface gigabitethernet 0/0/12 ← Shows if ipsg is enabled on sp
ecific interface, along with type of filter
IPSG interface Info
-------------------
Interface   IPSG     MAC Binding
----------  ----     -----------
GE0/0/12    Enabled  Disabled
```

You can use the following command to display details about the IP and MAC combination:

```
(host) #show ip source-guard interface gigabitethernet 0/0/12 detail
IPSG allowed users on the interface
-----------------------------------
IP Address   Mac Address  VLAN
----------   -----------  ----
172.2.1.255  NA           2
```

You can use the following command to verify the IPSG configuration:

```
(host) #show interface-profile port-security-profile techpubs
Port security profile "techpubs"
---------------------------
Parameter                           Value
---------                           -----
IPV6 RA Guard Action                N/A
IPV6 RA Guard Auto Recovery Time    N/A
MAC Limit                           N/A
MAC Limit Action                    N/A
MAC Limit Auto Recovery Time        N/A
Trust DHCP                          No
Port Loop Protect                   N/A
Port Loop Protect Auto Recovery Time  N/A
Sticky MAC                          N/A
IP Source Guard                     Enabled
IP Source Guard with MAC binding    N/A
Dynamic Arp Inspection              N/A
```

Configuring DAI

The DAI functionality can be configured as part of the port level security configuration. This profile can be attached to the interface.

You can use the following command to configure the DIA:

```
(host)(config)# interface-profile port-security-profile <profile-name>
  dynamic-arp-inspection
```

Verifying DAI

You can use the following command to verify the DAI configuration:

```
(host) #show  interface-profile port-security-profile abc
Port security profile "abc"
---------------------------
Parameter                              Value
---------                              -----
IPV6 RA Guard Action                   N/A
IPV6 RA Guard Auto Recovery Time       N/A
MAC Limit                              N/A
MAC Limit Action                       N/A
MAC Limit Auto Recovery Time           N/A
Trust DHCP                             No
Port Loop Protect                      N/A
Port Loop Protect Auto Recovery Time   N/A
Sticky MAC                             N/A
Dynamic Arp Inspection                 Enabled
```

Attaching Port Security Profile to Interface

To enable the Port Security functionality on an interface, you must attach a port-security profile to it. Use the following commands to associate a port-security profile with an interface:

For Gigabitethernet:

```
(host) (config) #interface gigabitethernet <slot/mod/port>
(host) (gigabitethernet "<slot/mod/port>") #port-security-profile <profile-name>
```

For Port-channel:

```
(host) (config) #interface port-channel <id>
(host) (port-channel "<id>") #port-security-profile <profile-name>
```

Viewing Port Errors

Use the following command to view the list of ports that are detected with port errors and the time at which they will be recovered automatically, if auto-recovery is enabled:

```
(host) #show port-error-recovery

Layer-2 Interface Error Information
-----------------------------------
Interface      Error                          Recovery Time
---------      -----                          -------------
Pc5            Shutdown (Loop Detected)       2012-02-08 16:42:45 (PST)
GE0/0/42       Shutdown (Loop Detected)       No Auto recovery
Pc1            Shutdown (Loop Detected)       2012-02-07 16:45:40 (PST)
Pc2            Shutdown (RA Guard)            2012-02-08 16:42:45 (PST)
GE0/0/14       Log      (Mac Limit Exceeded)  No Auto recovery
GE0/0/2        Drop     (DHCP Trust Error)    2012-02-07 16:45:40 (PST)
GE0/0/5        Log      (MAC Limit exceed)    No Auto recovery
                         Drop (RA guard)      No Auto recovery
GE1/0/24       Shutdown (BPDU received)       2012-10-18 11:25:17 (PST)
                                              No Auto Recovery
```

Recovering Ports Manually

Use the CLI to manually recover the port errors. To recover the ports on a specific interface execute the following command:

```
(host) #clear port-error-recovery interface <interface-name>
```

The following command clears the errors on gigabitethernet 0/0/42:

```
(host) #clear port-error-recovery interface gigabitethernet 0/0/42
```

To clear the port errors on all interfaces execute the following command:

```
(host) #clear port-error-recovery
```

Sample Configurations

To configure the port security profile:

```
(host) (config) # interface-profile port-security-profile port-security-1
(host (port security profile port-security-1)#
   ipv6-ra-guard action drop auto-recovery-time 60
   no trust dhcp
   loop-protect auto-recovery-time 10
   mac-limit 30 action drop auto-recovery-time 50
   ip-src-guard include-mac-binding
   dynamic-arp-inspection
```

To attach the port security profile to the interface:

```
(host)(config)# interface gigabitethernet 0/0/6
   port-security-profile port-security-1
(host) (config) #interface port-channel 3
   port-security-profile port-security-1
```

Storm Control

Some protocols or features prevents bridge loops in a Layer 2 network, rogue switches, or end hosts can degrade the network by creating and propagating traffic storms.

Storm control prevents interfaces from disruptions by providing protection against excessive ingress rates of unknown-unicast, multicast, and broadcast traffic.

Important Points to Remember

- The configured storm control bandwidth percentage applies to all types of traffic.
- If the rate is 100%, no traffic is rate limited. If the rate is 50% then 50% of configured traffic is rate limited.
- Individual levels of storm control per traffic type is not supported. All types are set to single percentage.
- By default, storm control is enabled for unknown-unicast and broadcast traffic.
- Storm Control is configured from the command line only. You configure it under the switching-profile.

Configuration Steps

Use the following steps, from the command line, to configure and verify Storm Control.

1. Define the level of storm-control based on percentage of interface speed. Range is 50 to100%.
```
(host) (config) #interface-profile switching-profile STORM_CONTROL
(host) (switching profile "STORM_CONTROL") #storm-control-bandwidth 80
```
2. Enable the type(s) of traffic you want controlled.
```
(host) (switching profile "STORM_CONTROL") #storm-control-unknown-unicast
(host) (switching profile "STORM_CONTROL") #storm-control-multicast
(host) (switching profile "STORM_CONTROL") #storm-control-broadcast
```
3. Apply the configured switching-profile to the interface.
```
(host) (config) #interface gigabitethernet 0/0/20
(host) (gigabitethernet "0/0/20") #switching-profile STORM_CONTROL
```
4. Verify the configuration.
```
(host) #show interface-profile switching-profile STORM_CONTROL

switching profile "STORM_CONTROL"
---------------------------------
Parameter                                             Value
---------                                             -----
Switchport mode                                       access
Access mode VLAN                                      1
Trunk mode native VLAN                                1
Enable broadcast traffic rate limiting                Enabled
Enable multicast traffic rate limiting                Enabled
Enable unknown unicast traffic rate limiting          Enabled
Max allowed rate limit traffic on port in percentage  80
Trunk mode allowed VLANs                              1-4094
```

Access control lists (ACLs) are a common way of restricting certain types of traffic on a physical port. The Mobility Access Switch supports multiple types of access control lists to provide flexibility to control the traffic. This chapter describes the different types of ACLs supported and how to configure them on the Mobility Access Switch.

This chapter includes the following topics:

Types of ACLs

- Ethertype ACLs are used to filter based on the Ethertype field in the frame header. Ethertype ACLs can be either named or numbered, with valid numbers in the range of 200-299. These ACLs can be used to permit IP while blocking other non-IP protocols, such as IPX or AppleTalk.
- MAC ACLs are used to filter traffic on a specific source MAC address or range of MAC addresses. MAC ACLs can be either named or numbered, with valid numbers in the range of 700-799 and 1200-1299.
- Standard ACLs permit or deny traffic based on the source IP address of the packet. Standard ACLS can be either named or numbered, with valid numbers in the range of 1-99 and 1300-1399. Standard ACLs use a bitwise mask to specify the portion of the source IP address to be matched.
- Extended ACLs permit or deny traffic based on source or destination IP address, or IP protocol. Extended ACLs can be named or numbered, with valid numbers in the range 100-199 and 2000-2699.
- Stateless ACLs are used to define stateless packet filtering and quality of service (QoS). A stateless ACL statically evaluates packet contents. The traffic in the reverse direction will be allowed unconditionally. Statless ACLs are named ACLs.

Mobility Access Switch provides both standard and extended ACLs for compatibility with router software from popular vendors, however firewall policies provide equivalent and greater function than standard and extended ACLs and should be used instead.

You can apply MAC and Ethertype ACLs to a user role, however these ACLs apply only to non-IP traffic from the user.

Router ACLs (RACLs)

Router ACLs perform access control on all traffic entering the specified Routed VLAN Interface. Roter ACLs provide access control based on the Layer 3 addresses or Layer 4 port information and ranges. RACLs can only be applied to ingress traffic.

Port ACLs (PACLs)

ACLs provide the ability to filter ingress traffic based on conditions specified in the ACL. Port ACLs perform access control on all traffic entering or leaving the specified Layer 2 port. PACLs provides access control based on the Layer 3 addresses (for IP protocols), Layer 2 MAC addresses (for non-IP protocols), or Layer 4 port information and ranges. A Layer 2 port is a physical LAN or trunk port that belongs to a VLAN. The PACLs are applied on both the ingress and egress traffic with the following exceptions for egress traffic:

- Egress ACLs are applied only on interfaces and not on user roles.

- When QoS-profile is applied on egress ACL, only the dot1p and dscp values are applicable. The trafficclass, drop-precedence are not applicable.

NOTE

You can apply all the types of ACLs to a port and only the MAC, Ethertype and Stateless ACLs can be applied to a user role. The MAC and Ethertype ACLs only apply to non-IP traffic and the Stateless ACL to IP traffic from the user.

User ACLs (UACLs)

User ACLs perform access control on all traffic received from a specified user. User ACLs provide access control based on the Layer 3 addresses (for IP protocols), Layer 2 MAC addresses (for non-IP protocols), or Layer 4 port information and ranges. UACLs are only applied to ingress traffic.

Configuring the ACLs

ACL is order dependent. ACLs are executed in the sequential order in which access control entries (ACE) are defined. The Mobility Access Switch process the ACEs in the order in which it is configured. Usually the deny ACEs are configured before permit ACEs. There is an implicit deny at the end of every ACL. Therefore, if there are no matching ACEs for a given packet, then that packet will be dropped.

This section describes the CLIs to configure the different ACLs:

Ethertype ACL

The below command configures an Ethertype access control list (ACL).

```
(host)(config) #ip access-list eth ETHER_TYPE
(host)(config-eth-ETHER_TYPE) #deny 0x880
(host)(config-eth-ETHER_TYPE) #permit any
(host)(config-stateless-ETHER_TYPE) #exit
```

To configure the ACL when a particular access control entry(ACE) is changed in a particular ACL:

```
(host)(config) #ip access-list eth ETHER_TYPE
(host)(config-eth-ETHER_TYPE) #deny 0x0806
(host)(config-eth-ETHER_TYPE) #permit any
(host)(config-eth-ETHER_TYPE) #exit
```

MAC ACL

A range of MAC address can be matched by using a wildcard mask or a particular host using the `host` keyword:

```
(host)(config) #ip access-list mac MAC_LIST
(host)(config-mac-MAC_LIST) #deny 00:11:22:00:00:00 00:00:00:FF:FF:FF
(host)(config-mac-MAC_LIST) #deny host 00:66:77:88:99:AA
(host)(config-mac-MAC_LIST) #permit any
(host)(config-mac-MAC_LIST) #exit
```

Standard ACL

The Standard ACL match the source IP address of the packet. The IP address to be matched can be either a range of IP Addresses using wildcard mask or a particular host:

```
(host)(config) #ip access-list standard STANDARD
(host)(config-standard-STANDARD) #deny 1.1.1.0 0.0.0.255
(host)(config-standard-STANDARD) #deny host 192.168.10.100
(host)(config-standard-STANDARD) #permit any
(host)(config-standard-STANDARD) #exit
```

Extended ACL

The Extended ACL extends the standard ACL by matching IP address of the source and destination, port number of the source and destination, and the protocol:

```
(host)(config) #ip access-list extended EXTENDED
(host)(config-extended-EXTENDED) #deny icmp 1.1.1.0 0.0.0.255 2.2.2.0 0.0.0.255 echo-reply
(host)(config-extended-EXTENDED) #deny tcp host 192.168.1.1 eq 53 host 20.1.1.1 range 20 30 es
tablished
(host)(config-extended-EXTENDED) #permit any any any
(host)(config-extended-EXTENDED) #exit
```

Stateless ACL

Stateless ACL provides userlevel access control on statically configured ACL.

```
(host)(config) #ip access-list stateless STATELESS
(host)(config-stateless-STATELESS) #network 10.100.100.0 255.255.255.0 any tcp 8888 deny log
(host)(config-stateless-STATELESS) #any host 10.100.100.200 any deny log
(host)(config-stateless-STATELESS) #any any any permit
(host)(config-stateless-STATELESS) #exit
```

Stateless ACL provides additional options that can be specified on matching the traffic. Table 22 describes the parameters you configure for a stateless ACL.

Table 22: *Stateless ACL Configuration Parameters*

Parameter	Description
blacklist	Configure the ACL blacklist user when the ACL rule is matched. If the ACE entry is matched, the traffic from that particular user is denied and the user is blacklisted for 3600 seconds
log	Configure to display the log information when the ACL is applied.
policer-profile	To attach the policer-profile to the ACL
position	Defines or redefines the position of an ACE in an ACL.
qos-profile	QoS profile can be configured to assign specific TC/DP, DSCP, and 802.1p values. This option attaches the qos-profile to the ACL
time-range	Associate a time-range to an ACL. This configures the ACL to filter traffic during the specified time-range

The following ACL actions are not supported for Egress ACLs (For Stateless ACL applied in egress direction):

- Blacklist
- Log

For the policer profile attached to the egress ACL, only the following are permitted:

- Action: drop/permit
- counters

To apply ACL to a port in ingress direction, use the following CLI:

```
(host)(config) #interface  gigabitethernet 0/0/0
(host)(gigabitethernet "0/0/0") #ip access-group in <acl_name>
(host)(gigabitethernet "0/0/0") #exit
```

To apply ACL to a port in egress direction, use the following CLI:

```
(host)(config) #interface gigabitethernet 0/0/0
```

```
(host)(gigabitethernet "0/0/0") #ip access-group out <acl_name>
(host)(gigabitethernet "0/0/0") #exit
```

Verifying the ACL configuration

Use the following commands to verify the ACL configuration:

```
(host) #show ip access-list ETHER_TYPE
ETHER_TYPE
----------
Priority Action EtherType Mirror
-------- ------ --------- ------
1        deny   0x8800
2        permit any
```

You can use the same command to verify the ACL configuration after changing the ACE:

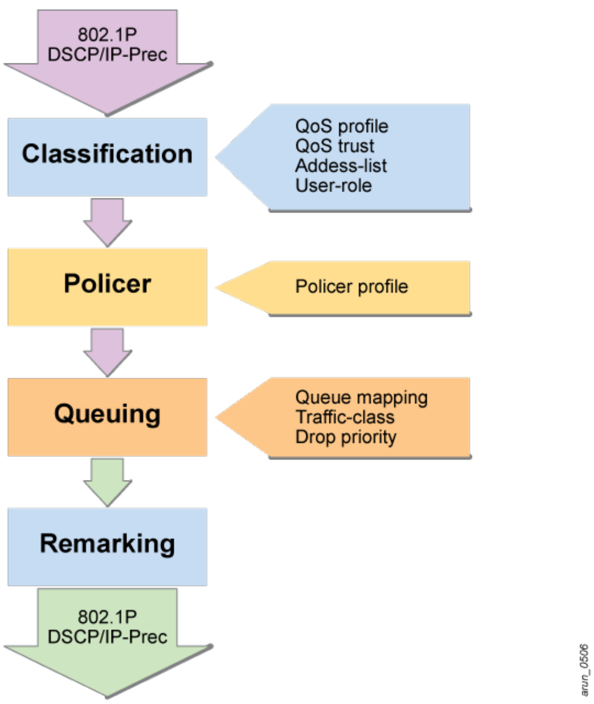
```
(host) #show ip access-list ETHER_TYPE
ip access-list eth ETHER_TYPE
ETHER_TYPE
----------
Priority  Action   EtherType  Mirror
--------  ------   ---------  ------
1         deny     0x880
2         permit   any
3         deny     0x806
(host) #show ip access-list MAC_LIST
ip access-list mac MAC_LIST
deny 00:11:22:00:00:00 00:00:00:ff:ff:ff
deny host 00:66:77:88:99:aa
permit any
(host) #show ip access-list STANDARD
ip access-list standard STANDARD
deny 1.1.1.0 0.0.0.255
deny host 192.168.10.100
permit any
(host) #show ip access-list EXTENDED
ip access-list extended EXTENDED
deny icmp 1.1.1.0 0.0.0.255 2.2.2.0 0.0.0.255 echo-reply
deny tcp host 192.168.1.1 eq 53 host 20.1.1.1 range 20 30
permit any any any
(host) #show ip access-list STATELESS
ip access-list stateless STATELESS
STATELESS
---------
Priority  Source                      Destination     Service   Action  TimeRange  Log
--------  ------                      -----------     -------   ------  ---------  ---
1         10.100.100.0 255.255.255.0  any             tcp 8888  deny               Yes
2         any                         10.100.100.200  any       deny               Yes
3         any                         any             any       permit
Expired  QoS  Policer  Blacklist  Mirror  IPv4  Nexthop
-------  ---  -------  ---------  ------  ----  -------
                                            4
                                            4
                                            4
```

This chapter describes how to configure quality of service (QoS) on the Mobility Access Switch. This chapter contains the following major sections:

QoS Concepts

This section contains the following sections:

Overview



Profiles and Queues

The Mobility Access Switch supports:

- A QoS profile that can be applied to an interface, user role, and traffic flow.
- Eight queues per interface in hardware.
- Eight traffic classes (TC), which map to the corresponding queue (0 - 7).
- Drop-precedence for controlling tail-drop.

Classification

This section contains the following sections:

- Trust Mode on page 259
- Untrusted Mode on page 259

Trust Mode

When the QoS mode on a port is set to be trusted, the received 802.1P/DSCP is considered trustworthy and the frame is allowed to exit with those values intact. The received DSCP or 802.1P value is used to index predefined QoS profiles to determine traffic class and drop precedence. These QoS profiles cannot be edited at this time.

The Mobility Access Switch supports several modes:

- Layer 2 QoS Trust Mode - Port is configured to trust the IEEE 802.1P user priority. This is relevant for 802.1Q packets
- Layer 3 Qos Trust Mode - Port is configured to trust the received DSCP value of the frame.
- Auto (L2+L3) trust mode prioritizes DSCP over 802.1P. If the received frame is IP, the DSCP value is used for indexing the QoS profile. If the received tagged frame is non-IP, then the 802.1P value is used for indexing the QoS profile.

The following table shows DSCP-Queue mapping:

Table 23: *DSCP-Queue Mapping*

DSCP	802.1p	Queue
0-7	0	0
8-15	1	1
16-23	2	2
24-31	3	3
32-39	4	4
40-47	5	5
48-55	6	6
56-63	7	7

- DP is defined as low for first 4 values (0-3) and high for last 4 values (4-7) for each DSCP range.
- For 802.1p, DP is defined low for all values.

Untrusted Mode

- The default is “untrust” for all interfaces where all incoming traffic are mapped to TC “0” and are then subsequently mapped to egress queue 0.

Profile

- QoS profile can be configured to assign specific TC/DP, DSCP, and 802.1p values.
- The QoS profile can be then applied to:
  - Interface (interface-profile)
  - Stateless access-list

- User-role
- Policer profile

Policing

- Limits inbound transmission rate of a class of traffic on the basis of user-defined criteria.
- Policer can be applied to stateless ACL, interface, and user-role.
- 1-rate 3-color policer is supported.
  - Traffic rate below CIR or burst below CBS limit is considered “conforming” and is allowed to pass through the policer.
  - Traffic rate exceeding CIR, and bursting below EBS limit is considered “exceeding” and is allowed to pass through the policer by default.
  - Traffic rate exceeding CIR, and bursting above EBS limit is considered “violating” and is dropped at the policer by default.

Configuring QoS

This section contains the following sections:

- Configuring QoS Trust Mode on page 260
- Configuring QoS-Profile under an Interface on page 261
- Configuring QoS-Profile under a Stateless ACL on page 261
- Configuring QoS-Profile under a User-Role on page 261
- Configuring Policer under Policer-Profile on page 261
- Configuring Policer-Profile under an Interface on page 261
- Configuring Policer-Profile under a Stateless ACL on page 261
- Configuring QoS-Profile under a User-Role on page 261

Configuring QoS Trust Mode

To configure QoS trust mode, follow these steps:

1. In the configuration mode, configure the appropriate interface:
```
(host)(config) #interface gigabitethernet 0/0/6
```
2. In the interface mode, you can configure the following options:

   To configure QoS trust aruba-device, use the following command:
```
(host)(gigabitethernet "0/0/6") #qos trust aruba-device
```
   To configure QoS trust auto, use the following command:
```
(host)(gigabitethernet "0/0/6") #qos trust auto
```
   To disable QoS trust, use the following command:
```
(host)(gigabitethernet "0/0/6") #qos trust disable
```
   To configure QoS trust dot1p, use the following command:
```
(host)(gigabitethernet "0/0/6") #qos trust dot1p
```
   To configure QoS trust dscp, use the following command:
```
(host)(gigabitethernet "0/0/6") #qos trust dscp
```
   To configure QoS trust pass-through, use the following command:
```
(host)(gigabitethernet "0/0/6") #qos trust pass-through
```
   To display the predefined QoS profiles, use the following command.
```
(host)(config#show qos-profile trusted
```

When configuring QoS trust, note the following guidelines:

- qos-profile configured is mutually exclusive with dscp, dot1p and auto modes.
- qos-profile configured takes priority in Disable and Passthrough mode.
- qos-profile config is allowed even with aruba-vevice option. But will take effect only if no aruba-device is detected.

Configuring QoS-Profile

To configure a QoS under a QoS profile, use the following commands:

```
(host) (config) #qos-profile QOS1
(host) (QoS Profile "QOS1") #dot1p <value>
(host) (QoS Profile "QOS1") #drop-precedence <low/high>
(host) (QoS Profile "QOS1") #dscp <value>
(host) (QoS Profile "QOS1") #traffic-class <value>
```

Configuring QoS-Profile under an Interface

To configure a QoS profile on an Interface, use the following commands:

```
(host) (config) #interface gigabitethernet 0/0/19
(host) (gigabitethernet "0/0/19") #qos-profile QOS1
```

Configuring QoS-Profile under a Stateless ACL

To configure QoS Profile under a Stateless ACL, use the following commands:

```
(host) (config) #ip access-list stateless STATELESS
(host) (config-stateless-STATELESS)#any any any permit qos-profile QOS1
```

Configuring QoS-Profile under a User-Role

To configure QoS Profile under a user-role, use the following commands:

```
(host) (config) #user-role EMPLOYEE_1
(host) (config-role) #qos-profile QOS1
```

Configuring Policer under Policer-Profile

To configure Policer under a Policer profile, use the following commands:

```
(host) (config) #policer-profile 100MBPS
(host) (Policer Profile "100MBPS") #cir 100000 (100m)
(host) (Policer Profile "100MBPS") #cbs 100000 (100m)
(host) (Policer Profile "100MBPS") #ebs 110000 (110m)
(host) (Policer Profile "100MBPS") #exceed-action <permit | remark | drop>
(host) (Policer Profile "100MBPS") #exceed-profile <QoS profile for remark>
(host) (Policer Profile "100MBPS") #violate-action <permit | remark | drop>
```

NOTE

When remark action is configured, a corresponding QoS profile must be configured also.

Configuring Policer-Profile under an Interface

To configure a policer profile on an interface, use the following commands:

```
(host) (config) #interface gigabitethernet 0/0/19
(host) (gigabitethernet "0/0/19") #policer-profile 100MBPS
```

Configuring Policer-Profile under a Stateless ACL

To configure a policer profile on an interface, use the following commands:

```
(host) (config) #ip access-list stateless STATELESS
(host) (config-stateless-STATELESS)#any any any permit policer-profile 100MBPS
```

Configuring Policer-Profile under a User-role

```
(host) (config) #user-role EMPLOYEE_1
(host) (config-role) #policer-profile 100MBPS
```

Chapter 31
Authentication Servers

This chapter describes how to configure authentication servers. It contains the following sections:

Important Points to Remember

The Mobility Access Switch allows you to use an external authentication server or the internal user database to authenticate clients who need to access the wired network.

For an external authentication server to process requests from the Mobility Access Switch, you must configure the server to recognize the switch. Refer to the vendor documentation for information on configuring the authentication server.

Server and Server Group Concepts

The Mobility Access Switch supports the following external authentication servers:

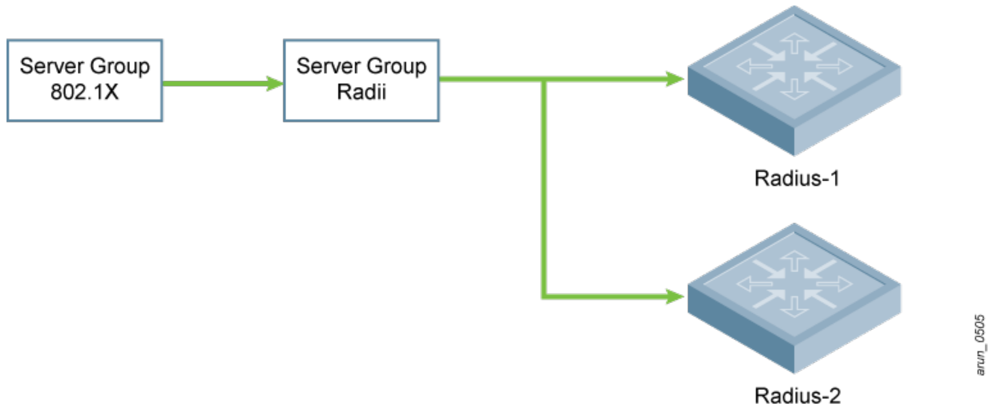
- RADIUS (Remote Authentication Dial-In User Service)
- LDAP (Lightweight Directory Access Protocol)
- TACACS+ (Terminal Access Mobility Access Switch Access Control System)

Additionally, you can use the Mobility Access Switch's internal database to authenticate users. You create entries in the database for users and their passwords and default role.

You can create groups of servers for specific types of authentication. For example, you can specify one or more RADIUS servers to be used for 802.1x authentication. The list of servers in a server group is an ordered list. This means that the first server in the list is always used unless it is unavailable, in which case the next server in the list is used. You can configure servers of different types in one group – for example, you can include the internal database as a backup to a RADIUS server.

Figure 15 shows a server group named Radii that contains two RADIUS servers, Radius-1 and Radius-2. The Radii server group is assigned to the server group for 802.1x authentication.

Figure 15 *Server Group*



Server names must be unique. You can configure the same server in multiple server groups, and you must configure the server before you can add it to a server group.

NOTE

If you are using the Mobility Access Switch's internal database for user authentication, use the predefined "Internal" server group.

You can also include conditions for server-derived user roles or VLANs in the server group configuration. The server derivation rules apply to all servers in the group.

Configuring Authentication Servers

This section describes how to configure authentication servers on the Mobility Access Switch. It contains the following sections:

- RADIUS Server Username/Password Authentication
- RADIUS Server Authentication with VSA
- RADIUS Server Authentication with Server-Derivation Rule
- Configuring Authentication Servers
- Verifying the configuration
- Configuring a RADIUS Server on page 267
- Configuring an LDAP Server on page 268
- Configuring a TACACS+ Server on page 270

RADIUS Server Username/Password Authentication

In this example, an external RADIUS server is used to authenticate management users. Upon authentication, users are assigned the default role root.

In the CLI

```
aaa authentication-server radius rad1
   host <ipaddr>
   key <string>
aaa server-group corp_rad
   auth-server rad1
aaa authentication mgmt
   default-role root
   enable
   server-group corp_rad
```

RADIUS Server Authentication with VSA

In this scenario, an external RADIUS server authenticates management users and returns to the Mobility Access Switch the Aruba vendor-specific attribute (VSA) called Aruba-Admin-Role that contains the name of the management role for the user. The authenticated user is placed into the management role specified by the VSA.

The Mobility Access Switch configuration is identical to the RADIUS Server Username/Password Authentication on page 265. The only difference is the configuration of the VSA on the RADIUS server. Ensure that the value of the VSA returned by the RADIUS server is one of the predefined management roles. Otherwise, the user will have *no* access to the Mobility Access Switch.

RADIUS Server Authentication with Server-Derivation Rule

A RADIUS server can return to the Mobility Access Switch a standard RADIUS attribute that contains one of the following values:

- The name of the management role for the user
- A value from which a management role can be derived

For either situation, configure a server-derivation rule for the server group.

In the following example, the RADIUS server returns the attribute Class to the Mobility Access Switch. The value of the attribute can be either "root" or "network-operations" depending upon the user; the returned value is the role granted to the user.

NOTE

Ensure that the value of the attribute returned by the RADIUS server is one of the predefined management roles. Otherwise, the management user will not be granted access to the Mobility Access Switch.

In the CLI

```
aaa authentication-server radius rad1
   host <ipaddr>
   key <string>
aaa server-group corp_rad
   auth-server rad1
   set role condition Class value-of
aaa authentication mgmt
   default-role read-only
   enable
   server-group corp_rad
```

Disabling Authentication of Local Management User Accounts

You can disable authentication of management user accounts in local switches if the configured authentication server(s) (RADIUS or TACACS+) are not available.

You can disable authentication of management users based on the results returned by the authentication server. When configured, locally-defined management accounts (for example, admin) are not allowed to log in if the server(s) are reachable and the user entry is not found in the authentication server. In this situation, if the RADIUS or TACACS+ server is unreachable, meaning it does not receive a response during authentication, or fails to authenticate a user because of a timeout, local authentication is used and you can log in with a locally-defined management account.

In the CLI

```
mgmt-user localauth-disable
```

Verifying the configuration

To verify if authentication of local management user accounts is enabled or disabled, use the following command:

```
show mgmt-user local-authentication-mode
```

Configuring a RADIUS Server

Table 24 describes the parameters you configure for a RADIUS server.

Table 24: *RADIUS Server Configuration Parameters*

Parameter	Description
Host	IP address of the authentication server. Default: N/A
Key	Shared secret between the Mobility Access Switch and the authentication server. The maximum length is 128 characters. Default: N/A
Authentication Port	Authentication port on the server. Default: 1812
Accounting Port	Accounting port on the server Default: 1813
Retransmits	Maximum number of retries sent to the server by the Mobility Access Switch before the server is marked as down. Default: 3
Timeout	Maximum time, in seconds, that the Mobility Access Switch waits before timing out the request and resending it. Default: 5 seconds
NAS ID	Network Access Server (NAS) identifier to use in RADIUS packets. Default: N/A
NAS IP	NAS IP address to send in RADIUS packets. You can configure a "global" NAS IP address that the Mobility Access Switch uses for communications with all RADIUS servers. If you do not configure a server-specific NAS IP, the global NAS IP is used. To set the global NAS IP in the CLI, enter the **ip radius nas-ip <ipaddr>** command. Default: N/A
Source Interface	Enter a VLAN number ID. Allows you to use source IP addresses to differentiate RADIUS requests. Associates a VLAN interface with the RADIUS server to allow the group-specific source interface to override the global configuration. • If you associate a Source Interface (by entering a VLAN number) with a configured server, then the source IP address of the packet will be that interface's IP address. • If you do not associate the Source Interface with a configured server (leave the field blank), then the IP address of the global Source Interface will be used.
Use MD5	Use MD5 hash of cleartext password. Default: disabled
Mode	Enables or disables the server. Default: enabled

Using the CLI

```
aaa authentication-server radius <name>
   host <ipaddr>
   key <key>
```

```
  enable
```

RADIUS Server Authentication Codes

A configured RADIUS server will return the following standard response codes.

Table 25: *RADIUS Authentication Response Codes*

Code	Description
0	Authentication OK.
1	Authentication failed–user/password combination not correct.
2	Authentication request timed out–No response from server.
3	Internal authentication error.
4	Bad Response from RADIUS server. Verify shared secret is correct.
5	No RADIUS authentication server is configured.
6	Challenge from server. (This does not necessarily indicate an error condition.)

RADIUS Change of Authorization

The following command configures a RADIUS server that can send user disconnect and change-of-authorization messages, as described in RFC 3576, "Dynamic Authorization Extensions to Remote Dial In User Service (RADIUS)".

```
aaa rfc-3576-server <server-ip-addr>
  key <psk>
  no
```

The following command configures an RFC 3576 server:

```
(host) #aaa rfc-3576-server 10.1.1.245
(host) #key asdfjkl;
```

Configuring an LDAP Server

Table 26 describes the parameters you configure for an LDAP server.

Table 26: *LDAP Server Configuration Parameters*

Parameter	Description
Host	IP address of the LDAP server. Default: N/A
Admin-DN	Distinguished name for the admin user who has read/search privileges across all the entries in the LDAP database (the user need not have write privileges but the user should be able to search the database, and read attributes of other users in the database).
Admin Password	Password for the admin user. Default: N/A
Allow Clear-Text	Allows clear-text (unencrypted) communication with the LDAP server. Default: disabled

Parameter	Description
Authentication Port	Port number used for authentication. Default: 389
Base-DN	Distinguished Name of the node which contains the entire user database to use. Default: N/A
Filter	Filter that should be applied to search of the user in the LDAP database: Default: (objectclass=*)
Key Attribute	Attribute that should be used as a key in search for the LDAP server. For Active Directory, the value is sAMAccountName. Default: sAMAccountName
Timeout	Timeout period of a LDAP request, in seconds. Default: 20 seconds
Mode	Enables or disables the server. Default: enabled
Preferred Connection Type	Preferred type of connection between the Mobility Access Switch and the LDAP server.The default order of connection type is: 1. ldap-s 2. start-tls 3. clear-text The Mobility Access Switch will first try to contact the LDAP server using the preferred connection type, and will only attempt to use a lower-priority connection type if the first attempt is not successful. **NOTE:** If you select **clear-text** as the preferred connection type, you must also enable the **allow-cleartext** option.

Using the CLI

```
aaa authentication-server ldap <name>
admin-dn                The Distinguished Name for the Admin user who can
                        search for the LDAP user. E.g.
                        (cn=Admin-Name,cn=Users,dc=department-name,dc=domain-
                        name,dc=com)
admin-passwd            The password for the Admin user who can search for
                        the LDAP user
allow-cleartext         Allow unencrypted communication with LDAP server
authport                Specify port number used for authentication. Range:
                        1-65535. Default : 389. Port 636 will be attempted
                        for LDAP over SSL - LDAPS, 389 will be attempted for
                        SSL over LDAP - Start TLS and for clear text.
base-dn                 The Base Distinguished Name of search for the LDAP
                        server. E.g. (cn=Users,dc=qa,dc=domain,dc=com)
clone                   Copy data from another LDAP Server
enable                  Enable LDAP server
filter                  The filter that should be used as a key in a search
                        for the LDAP server
host                    IP address of LDAP server
key-attribute           The attribute that should be used as a key in search
                        for the LDAP server. For PAP, the value is
                        sAMAccountName. For EAP-TLS termination the value is
                        userPrincipalName.
no                      Delete Command
preferred-conn-type     Preferred connection type
timeout                 Timeout period for LDAP request. Range: 1-30.
                        Default: 20.
```

Configuring a TACACS+ Server

Table 27 defines the TACACS+ server parameters.

Table 27: *TACACS+ Server Configuration Parameters*

Parameter	Description
Host	IP address of the server. Default: N/A
Key	Shared secret to authenticate communication between the TACACS+ client and server. Default: N/A
TCP Port	TCP port used by server. Default: 49
Retransmits	Maximum number of times a request is retried. Default: 3
Timeout	Timeout period for TACACS+ requests, in seconds. Default: 20 seconds
Mode	Enables or disables the server. Default: enabled
Session Authorization	Enables or disables session authorization.Session authorization turns on the optional authorization session for admin users. Default: disabled

Using the CLI

The following command configures, enables a TACACS+ server and enables session authorization:

```
aaa authentication-server tacacs <name>
   clone default
   host <ipaddr>
   key <key>
   enable
   session-authorization
```

Internal Database Concepts

You can create entries, in the Mobility Access Switch's internal database, to use to authenticate clients. The internal database contains a list of clients along with the password and default role for each client. When you configure the internal database as an authentication server, client information in incoming authentication requests is checked against the internal database.

Configuring the Internal Database

The default server-group (aaa server-group "default") has the internal user database defined as the first authentication server by default. You must first add users if you want to effectively use the internal user database in the Mobility Access Switch.

Table 28 defines the required and optional parameters used in the internal database.

Table 28: *Internal Database Configuration Parameters*

Parameters	Description
User Name	(Required) Enter a user name or select **Generate** to automatically generate a user name. An entered username can be up to 64 characters in length.
Password	(Required) Enter a password or select **Generate** to automatically generate a password string. An entered password must be a minimum of 6 characters and can be up to 128 characters in length.
Role	Role for the client. In order for this role to be assigned to a client, you need to configure a server derivation rule, as described in Configuring Server-Derivation Rules on page 274. (A user role assigned through a server-derivation rule takes precedence over the default role configured for an authentication method.)
E-mail	(Optional) E-mail address of the client.
Enabled	Select this checkbox to enable the user as soon as the user entry is created.
Expiration	Select one of the following options: • Entry does not expire: No expiration on user entry • Set Expiry time (mins): Enter the number of minutes the user will be authenticated before their user entry expires. • Set Expiry Date (mm/dd/yyyy) Expiry Time (hh:mm): To select a specific expiration date and time, enter the expiration date in mm/dd/yyyy format, and the expiration time in hh:mm format.

Using the CLI

```
local-userdb add {generate-username|username <name>} {generate-password|password
<password>} {remote-ip<remote-ip>}
local-userdb modify {username < name>} {remote-ip<remote-ip>}
```

The output of **show local-userdb** command:

```
User Summary
------------
Name                Password            Role               E-Mail  Enabled  Expiry  Status  Spon
sor-Name  Remote-IP  Grantor-Name
----                --------            ----               ------  -------  ------  ------  ----
--------  ---------  ------------
68:b5:99:d7:ff:bc   68:b5:99:d7:ff:bc   mac-authenticated  Yes              Active
 0.0.0.0    admin
00:1a:1e:01:11:0d   00:1a:1e:01:11:0d   mac-auth-101       Yes              Active
 0.0.0.0    admin
00:1a:1e:01:11:0e   00:1a:1e:01:11:0e   mac-auth-102       Yes              Active
 0.0.0.0    admin
wireless1            ******              authenticated      Yes              Active
  0.0.0.0    admin
```

Managing Internal Database Files

ArubaOS allows you to import and export tables of user information to and from the internal database. These files should not be edited once they are exported. ArubaOS only supports the importing of database files that were created during the export process. Note that importing a file into the internal database overwrite and removes all existing entries.

Using the CLI

Enter the following command in enable mode:

```
local-userdb export <filename>
```

```
local-userdb import <filename>
```

Internal Database Utilities

The local internal database also includes utilities to clear all users from the database and to restart the internal database to repair internal errors. Under normal circumstances, neither of these utilities are necessary.

Server Group Concepts

You can create groups of servers for specific types of authentication – for example, you can specify one or more RADIUS servers to be used for 802.1x authentication. You can configure servers of different types in one group – for example, you can include the internal database as a backup to a RADIUS server.

Configuring Server Groups

Server names are unique. You can configure the same server in more than one server group. The server must be configured before you can include it in a server group.

Using the CLI

```
aaa server-group <name>
auth-server <name>
```

Configuring Server List Order and Fail-Through

The list of servers in a server group is an ordered list. By default, the first server in the list is always used unless it is unavailable, in which case the next server in the list is used. You can configure the order of servers in the server group. In the CLI, use the **position** parameter to specify the relative order of servers in the list (the lowest value denotes the first server in the list).

As mentioned previously, the first available server in the list is used for authentication. If the server responds with an authentication failure, there is no further processing for the user or client for which the authentication request failed. You can optionally enable *fail-through* authentication for the server group so that if the first server in the list returns an authentication deny, the Mobility Access Switch attempts authentication with the next server in the ordered list. The Mobility Access Switch attempts authentication with each server in the list until either there is a successful authentication or the list of servers in the group is exhausted. This feature is useful in environments where there are multiple, independent authentication servers; users may fail authentication on one server but can be authenticated on another server.

Before enabling fail-through authentication, note the following:

- This feature is not supported for 802.1x authentication with a server group that consists of external EAP-compliant RADIUS servers. You can, however, use fail-through authentication when the 802.1x authentication is terminated on the Mobility Access Switch (AAA FastConnect).
- Enabling this feature for a large server group list may cause excess processing load on the Mobility Access Switch. Aruba recommends that you use server selection based on domain matching whenever possible (see Configuring Dynamic Server Selection on page 273).
- Certain servers, such as the RSA RADIUS server, lock out the Mobility Access Switch if there are multiple authentication failures. Therefore you should not enable fail-through authentication with these servers.

In the following example, you create a server group 'corp-serv' with two LDAP servers (ldap-1 and ldap-2), each of which contains a subset of the usernames and passwords used in the network. When fail-through authentication is enabled, users that fail authentication on the first server in the server list should be authenticated with the second server.

Using the CLI

```
aaa authentication-server ldap ldap-1
```

```
   host 10.1.1.234
aaa authentication-server ldap ldap-2
   host 10.2.2.234
aaa server-group corp-serv
   auth-server ldap-1 position 1
   auth-server ldap-2 position 2
   allow-fail-through
```

Configuring Dynamic Server Selection

The Mobility Access Switch can dynamically select an authentication server from a server group based on the user information sent by the client in an authentication request. For example, an authentication request can include client or user information in one of the following formats:

- <domain>\<user> – for example, corpnet.com\darwin
- <user>@<domain> – for example, darwin@corpnet.com
- host/<pc-name>.<domain> – for example, host/darwin-g.finance.corpnet.com (this format is used with 802.1x machine authentication in Windows environments)

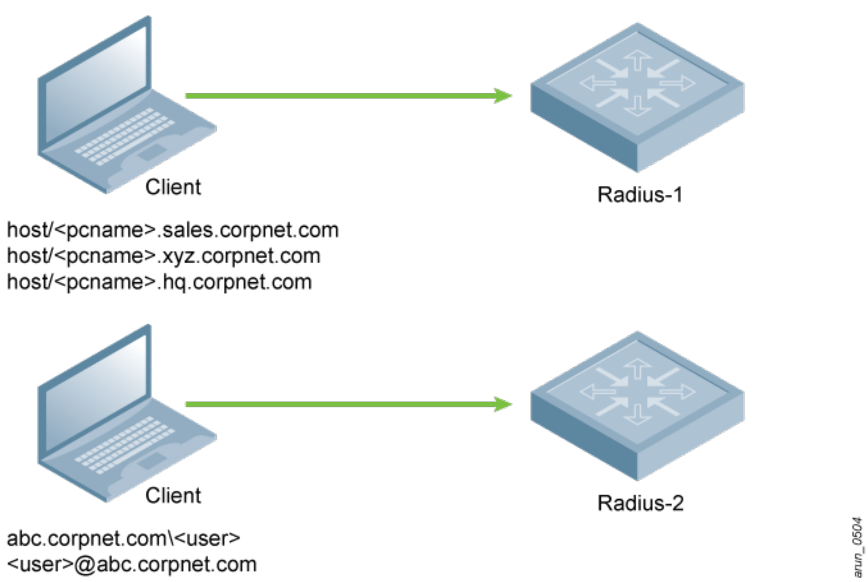
When you configure a server in a server group, you can optionally associate the server with one or more match rules. A match rule for a server can be one of the following:

- The server is selected if the client/user information contains a specified string.
- The server is selected if the client/user information begins with a specified string.
- The server is selected if the client/user information exactly matches a specified string.

You can configure multiple match rules for the same server. The Mobility Access Switch compares the client/user information with the match rules configured for each server, starting with the first server in the server group. If a match is found, the Mobility Access Switch sends the authentication request to the server with the matching rule. If no match is found before the end of the server list is reached, an error is returned and no authentication request for the client/user is sent.

For example, Figure 16 depicts a network consisting of several subdomains in corpnet.com. The server radius-1 provides 802.1x machine authentication to PC clients in xyz.corpnet.com, sales.corpnet.com, and hq.corpnet.com. The server radius-2 provides authentication for users in abc.corpnet.com.

Figure 16 *Domain-Based Server Selection Example*



You configure the following rules for servers in the corp-serv server group:

- radius-1 will be selected if the client information starts with “host/”.
- radius-2 will be selected if the client information contains “abc.corpnet.com”.

Using the CLI

```
aaa server-group corp-serv
   auth-server radius-1 match-authstring starts-with host/ position 1
   auth-server radius-2 match-authstring contains abc.corpnet.com position 2
```

Trimming Domain Information from Requests

Before the Mobility Access Switch forwards an authentication request to a specified server, it can truncate the domain-specific portion of the user information. This is useful when user entries on the authenticating server do not include domain information. You can specify this option with any server match rule. This option is only applicable when the user information is sent to the Mobility Access Switch in the following formats:

- <domain>\<user> – the <domain>\ portion is truncated
- <user>@<domain> – the @<domain> portion is truncated

This option does not support client information sent in the format host/<pc-name>.<domain>

Using the CLI

```
aaa server-group corp-serv
   auth-server radius-2 match-authstring contains abc.corpnet.com trim-fqdn
```

Configuring Server-Derivation Rules

When you configure a server group, you can set the VLAN or role for clients based on attributes returned for the client by the server during authentication. The server derivation rules apply to all servers in the group. The user role or VLAN assigned through server derivation rules takes precedence over the default role and VLAN configured for the authentication method.

The authentication servers must be configured to return the attributes for the clients during authentication. For instructions on configuring the authentication attributes in a Windows environment using IAS, refer to the documentation at http://technet2.microsoft.com/windowsserver/en/technologies/ias.mspx

The server rules are applied based on the first match principle. The first rule that is applicable for the server and the attribute returned is applied to the client and would be the only rule applied from the server rules. These rules are applied uniformly across all servers in the server group.

Table 29 describes the server rule parameters you can configure.

Table 29: *Server Rule Configuration Parameters*

Parameter	Description
Role or VLAN	The server derivation rules can be for either user role or VLAN assignment. With Role assignment, a client can be assigned a specific role based on the attributes returned. In case of VLAN assignment, the client can be placed in a specific VLAN based on the attributes returned.
Attribute	This is the attribute returned by the authentication server that is examined for *Operation* and *Operand* match.
Operation	This is the match method by which the string in *Operand* is matched with the attribute value returned by the authentication server. ● contains - The rule is applied if and only if the attribute value contains the string in parameter *Operand.* ● starts-with - The rule is applied if and only if the attribute value returned starts with the string in parameter *Operand.* ● ends-with - The rule is applied if and only if the attribute value returned ends with the string in parameter *Operand.* ● equals - The rule is applied if and only if the attribute value returned equals the string in parameter *Operand.* ● not-equals - The rule is applied if and only if the attribute value returned is not equal to the string in parameter *Operand.* ● value-of - This is a special condition. What this implies is that the role or VLAN is set to the value of the attribute returned. For this to be successful, the role and the VLAN ID returned as the value of the attribute selected must be already configured on the Mobility Access Switch when the rule is applied.
Operand	This is the string to which the value of the returned attribute is matched.
Value	The user role or the VLAN applied to the client when the rule is matched.
position	Position of the condition rule. Rules are applied based on the first match principle. 1 is the top. Default: bottom

Using the CLI

```
aaa server-group <name>
   auth-server <name>
   set {role|vlan} condition <condition> set-value {<role>|<vlan>}
   [position number]
```

Configuring a Role Derivation Rule for the Internal Database

When you add a user entry in the Mobility Access Switch's internal database, you can optionally specify a user role (see Internal Database Concepts on page 270). In order for the role specified in the internal database entry to be assigned to the authenticated client, you must configure a server derivation rule as shown in the following sections:

Using the CLI

```
aaa server-group internal
   set role condition Role value-of
```

Assigning Server Groups

You can create server groups for the following purposes:

- user authentication
- management authentication

- accounting

You can configure all types of servers for user and management authentication. However, TACACS+ is not supported for 802.1x authentication. For Accounting only RADIUS and TACACS+ servers are supported (see Table 30).

Table 30: *Server Types and Purposes*

	RADIUS	TACACS+	LDAP	Internal Database
User authentication	Yes	Yes (for MAC Authenticatio n only)	Yes	Yes
Management authentication	Yes	Yes	Yes	Yes
Accounting	Yes	Yes	No	No

User Authentication

For information about assigning a server group for user authentication, see the configuration chapter for the authentication method.

Management Authentication

Users who need to access the Mobility Access Switch to monitor, manage, or configure the Aruba user-centric network can be authenticated with RADIUS, TACACS+, or LDAP servers or the internal database.

NOTE

Only user record attributes are returned upon a successful authentication. Therefore, to derive a different management role other than the default mgmt auth role, set the server derivation rule based on the user attributes.

Using the CLI

```
aaa authentication mgmt
   server-group <group>
```

Radius Accounting

This section describes how user statistics are maintained and made available for RADIUS accounting. It contains the following scetions:

- Understanding Radius Accounting on page 276
- Configuring RADIUS Accounting on page 278

Understanding Radius Accounting

RADIUS accounting supports sending user statistics in radius accounting stop and interim records. This document describes how user statistics are maintained and made available for RADIUS accounting.

When RADIUS accounting is enabled in the AAA profile, RADIUS accounting start and stop records are sent to the server. RADIUS accounting stop records contain received bytes and packet counters. The accounting start record is sent when a user authenticates. The stop record is sent when a user logs out or is deleted from the system. If interim accounting is enabled, updates are sent out at a fixed interval. Each interim record includes cumulative user statistics.

Currently, only received packets and bytes in accounting records are transmitted.to the radius server.

User Activity and Statistics

RADIUS accounting allows user activity and statistics to be reported from the Mobility Access Switch to RADIUS servers. RADIUS accounting works as follows:

- The Mobility Access Switch generates an Accounting Start packet when a user logs in. The code field of transmitted RADIUS packet is set to 4 (Accounting-Request). Note that sensitive information, such user passwords, are not sent to the accounting server. The RADIUS server sends an acknowledgement of the packet.
- The Mobility Access Switch sends an Accounting Stop packet when a user logs off; the packet information includes various statistics such as elapsed time, input and output bytes and packets. The RADIUS server sends an acknowledgement of the packet.The following is the list of attributes that the Mobility Access Switch can send to a RADIUS accounting server:
- Acct-Status-Type:

  This attribute marks the beginning or end of accounting record for a user. Currently, possible values include Start and Stop.
- User-Name:

  Name of user.
- Acct-Session-Id:

  A unique identifier to facilitate matching of accounting records for a user. It is derived from the user name, IP address and MAC address. This is set in all accounting packets.
- Acct-Authentic:

  This indicates how the user was authenticated. Current values are 1 (RADIUS), 2 (Local) and 3 (LDAP).
- Acct-Session-Time:

  The elapsed time, in seconds, that the client was logged in to the Mobility Access Switch. This is only sent in Accounting-Request records where the Acct-Status-Type is Stop.
- Acct-Terminate-Cause:

  Indicates how the session was terminated and is sent in Accounting-Request records where the Acct-Status-Type is Stop. Possible values are:

  1: User logged off

  4: Idle Timeout

  5: Session Timeout. Maximum session length timer expired.

  7: Admin Reboot: Administrator is ending service, for example prior to rebooting the Mobility Access Switch.
- NAS-Identifier:

  This is set in the RADIUS server configuration.

  NAS-IP-Address: IP address of the master Mobility Access Switch. You can configure a “global” NAS IP address: in the WebUI, navigate to the Configuration > Security > Authentication > Advanced page; in the CLI, use the ip radius nas-ip command.
- NAS-Port:

  Physical or virtual port (tunnel) number through which the user traffic is entering the Mobility Access Switch.
- NAS-Port-Type:

  Type of port used in the connection. This is set to one of the following:

  5: admin login

  15: wired user type

  19: wireless user
- Framed-IP-Address: IP address of the user.

- Calling-Station-ID: MAC address of the user.
- Called-station-ID: MAC address of the Mobility Access Switch.

The following attributes are sent in Accounting-Request packets when Acct-Status-Type value is Start:

- Acct-Status-Type
- User-Name
- NAS-IP-Address
- NAS-Port
- NAS-Port-Type
- NAS-Identifier
- Framed-IP-Address
- Calling-Station-ID
- Called-station-ID
- Acct-Session-Id
- Acct-Authentic

The following attributes are sent in Accounting-Request packets when Acct-Status-Type value is Stop:

- Acct-Status-Type
- User-Name
- NAS-IP-Address
- NAS-Port
- NAS-Port-Type
- NAS-Identifier
- Framed-IP-Address
- Calling-Station-ID
- Called-station-ID
- Acct-Session-Id
- Acct-Authentic
- Terminate-Cause
- Acct-Session-Time

The following attributes are sent only in Accounting Stop packets (they are not sent in Accounting Start packets):

- Acct-Input-Octets
- Acct-Output-Octets
- Acct-Input-Packets
- Acct-Output-Packets

Configuring RADIUS Accounting

Radius accounting support is enabled and disabled in the AAA profile. By default, it is disabled.

To enable radius-accounting, use the command radius-accounting:

```
(host) #configure terminal
(host) (config)#aaa profile default
(host) (AAA Profile "default") #radius-accounting foobar
(host) (AAA Profile "default") #show aaa profile test

AAA Profile "TEST"
------------------
```

```
Parameter                             Value
---------                             -----
Initial role                          logon
MAC Authentication Profile            N/A
MAC Authentication Default Role       guest
MAC Authentication Server Group       default
802.1X Authentication Profile         N/A
802.1X Authentication Default Role    guest
802.1X Authentication Server Group    N/A
Download Role from ClearPass          Enabled
L2 Authentication Fail Through        Enabled
RADIUS Accounting Server Group        foobar
RADIUS Interim Accounting             Disabled
XML API server                        N/A
RFC 3576 server                       N/A
User derivation rules                 N/A
SIP authentication role               N/A
Enforce DHCP                          Disabled
Authentication Failure Blacklist Time  3600 sec
```

To disable the feature, use the command no radius-accounting:

```
(host) (AAA Profile "default") #no radius-accounting
```

TACACS+ Accounting

TACACS+ accounting allows commands issued on the Mobility Access Switch to be reported to TACACS+ servers. You can specify the types of commands that are reported (action, configuration, or show commands) or have all commands reported.

Using the CLI

```
aaa tacacs-accounting server-group <group> command {action|all|configuration|show} mode {enabl
e|disable}
```

Authentication Timers

Table 31 describes the timers you can configure that apply to all clients and servers. These timers can be left at their default values for most implementations.

Table 31: *Authentication Timers*

Timer	Description
User Idle Timeout	Maximum period after which a client is considered idle if there is no user traffic from the client. The timeout period is reset if there is a user traffic. If Mobility Access Switch does not see traffic from the user for more than the timeout period, then that user entry will be deleted from the system. If the keyword **seconds** is not specified, the value defaults to minutes at the command line. Range: 1 to 255 minutes (30 to 15300 seconds) Default: 5 minutes (300 seconds)
Authentication Server Dead Time	Maximum period, in minutes, that the Mobility Access Switch considers an unresponsive authentication server to be “out of service”. This timer is only applicable if there are two or more authentication servers configured on the Mobility Access Switch. If there is only one authentication server configured, the server is never considered out of service and all requests are sent to the server. If one or more backup servers are configured and a server is unresponsive, it is marked as out of service for the dead time; subsequent requests are sent to the next server on the priority list for the duration of the dead time. If the server is responsive after the dead time has elapsed, it can take over servicing requests from a lower-priority server; if the server continues to be unresponsive, it is marked as down for the dead time. Range: 0-50 Default: 10 minutes
Logon User Lifetime	Maximum time, in minutes, unauthenticated clients are allowed to remain logged on. Range: 0-255 Default: 5 minutes

Using the CLI

To set an authentication timer, use the following command:

```
aaa timers {dead-time <minutes>|idle-timeout <number>|logon-lifetime <minutes>}
```

This chapter describes AAA authentication. It contains the following major sections:

AAA Authentication Profile

Authentication Profile Concepts

The AAA profile can be applied on a global or per port or per VLAN basis, but only if the port is marked as un-trusted. If no AAA profile is configured on a port or a VLAN that the port is part of, the AAA profile configured under the wired authentication profile (aaa authentication wired) is applied globally by default.

AAA profile cannot be attached to an interface that is configured with a Tunneled Node profile.

If the port is marked as trusted, no authentication can be applied to traffic to the port.

The global AAA profile has limited ability to perform granular access control. The ability to apply an AAA profile on a per port/VLAN basis provides the administrator with greater flexibility and more granular access control. With per-port AAA profile, users can specify a unique AAA profile for each un-trusted port.

The AAA profile can be configured with the following parameters:

Initial Role

- The Initial Role is applied to all packets before a Layer 3 user entry is created.

MAC Auth Profile

- The MAC Auth Profile contains the MAC authentication profile parameters.

MAC Default Role

- The MAC Default Role is the default role a user receives upon successful MAC authentication.

802.1x Auth Profile

- The 802.1x Auth Profile contains the 802.1x authentication profile parameters.

802.1x Default Role

- The 802.1x Default Role is the default role a user receives upon successful 802.1x authentication.

User Derivation Rules

- The User Derivation Rules provide the means to derive a new VLAN or role, based on user attributes.

Authentication Schemes

The Mobility Access Switch supports the following authentication schemes:

- MAC Based Authentication
- 802.1X Authentication
- Layer2 Authentication Fail-through

MAC-Based Authentication

MAC-Based Authentication is a simple authentication method that is used more often as a filtering mechanism than as an actual authentication method. MAC-Based Authentication is frequently used when devices such as phones, printers, and scanners do not support 802.1x. It is also used in conjunction with 802.1x, so that the 802.1x authenticator and the back-end authentication server do not have to handle the load of authenticating users or devices that are not part of the back end database.

802.1x Authentication

802.1x authentication is a sophisticated method of network authentication that is widely supported across client OS and networking devices. This scheme provides a number of authentication methods, including PEAP and TLS. Both of these methods rely on TLS protocol to establish a secure tunnel to exchange user credentials, and authenticate the user. User validation can be done using a password or a certificate. The Mobility Access Switch supports using 802.1x authentications in the following modes:

- Authenticator Mode
- Authentication (EAP-Termination) Mode

Authenticator Mode

The authenticator mode is a generic method where the EAP frames from the user are packaged and sent to a RADIUS server. In the authentication server mode, also known as eap-termination mode, the controller can terminate the EAP frames to provide crypto hardware acceleration support to terminate the TLS tunnel. The controller dataplane terminates the phase 1 of the 802.1x authentication and provides with the TLS keys to the control plane to terminate the TLS tunnel. The phase 2 continues in the control plane with the user validation done using MSChapV2, PAP or Certification verification depending on the EAP mode the user was configured.

Authentication Server (EAP-Termination) Mode

In the authentication server mode, or eap-termination mode, the controller can terminate the EAP frames to provide crypto hardware acceleration support to terminate the TLS tunnel.

802.1x also supports key exchange in data encryption for wireless users. For wired users that are deployed today there is no key exchange and the security is limited to authenticating the user.

Layer2 Authentication Fail-through

Layer2 Authentication Fail-through is used to perform mixed authentication which includes both MAC and 802.1x authentication. This feature automatically switches to 802.1x authentication when MAC authentication fails.

NOTE

By default, the Layer2 Authentication Fail-through option is enabled.

Role/VLAN Derivation

A user can be assigned a role/VLAN at different stages in its life cycle and the derivation can be done on various parameters. The precedence of the assignment is from 1 to 5 with 1 being the lowest and 5 being the highest. A user can be assigned a different role/VLAN in the following stages:

1. Initial Role/VLAN

This role is applied to the ingress on which the user traffic arrives. For wireless and tunneled-mode users, the ingress is a GRE tunnel and for wired users it is a port or VLAN. This role provides the means to control what kind of initial traffic is allowed, which is predominantly determined based on the allowed modes of authentication. There are cases where initial role is configured to deny all DHCP traffic so that the creation of the user happens after MAC based or 802.1x authentication is completed.

2. User Derived Role/VLAN

   This role is only assigned based on the user MAC address. For this role derivation, user-derivation-rules must be defined and applied under the AAA profile.

3. Default Authentication Role/VLAN

   This role is assigned when a user successfully completes a specific authentication type. Each authentication type can have a different role and this provision is defined in the AAA profile for Layer 2 authentication types. A VLAN can be configured under the default authentication role. This VLAN is assigned to the user after successful authentication. If a VLAN is not present under the user role, the client gets a default port based VLAN or VLAN derived via user derivation rule, server derivation rule or Vendor Specific Attribute.

4. Server Derived Role/VLAN

   This role is derived from the attributes sent by the back-end authentication server. For this role to be applied, a set of "server derivation rules" must be defined under the server-group. The server group contains both the server definitions and the rules that are applied to the attributes returned from the list of servers.

5. Aruba VSA

   Aruba Vendor Specific Attributes (VSA) override any of the above rules and derivations. If the back-end authentication server sends an VSA like Aruba-User-Role or Aruba-User-VLAN, the value of these attributes are sent to the user.

   There are no rules that must be configured for this derivation to happen.

NOTE

Roles and VLANs can be derived using VSA, but neither user role nor VLAN derivation is possible using two separate entries of VSA attributes under an IAS profile of the Windows authentication server.

Role Assignment Precedence

The precedence of role assignment in reducing order is as follows:

1. Vendor specific attribute (VSA) derived via Captive Portal authentication
2. Server derived via Captive Portal authentication
3. Default Captive Portal authentication
4. VSA derived via 802.1x authentication
5. Server derived via 802.1x authentication
6. Default 802.1x authentication
   - 802.1X authentication Default Role—Users get this role after successful machine (if it is enabled) and user authentication (username/password or certificates).
   - Machine authentication-Default User Role—Users get this role after a successful user authentication (username/password or certificates) and a failed machine authentication.
   - Machine Authentication-Default Machine Role—Users get this role after a successful machine authentication and a failed user authentication.
7. MAC authentication default role
8. Role derived via UDR matching the MAC address
9. AAA Profile Initial Role

NOTE

If the “dhcp-option” based UDR or a device-type based UDR is configured to derive a role and if the rule matches, it overrides all the above precedence. The client will get a VLAN configured under the respective UDR. If a VLAN is not configured, then the client will either stay in current VLAN or follow the VLAN assignment precedence. For more details, see VLAN Assignment Precedence: on page 285.

VLAN Assignment Precedence:

The precedence of VLAN assignment in reducing order is given below:

NOTE

No VLAN will be derived if Captive Portal authentication is successful. Any VLAN derived will be ignored after a successful Captive Portal authentication.

1. Explicit VSA derived via 802.1x authentication
2. VLAN configured under VSA derived 802.1x authentication role
3. Explicit server derived via 802.1x authentication
4. VLAN configured under server derived 802.1x authentication role
5. VLAN defined under the respective default authentication role
   - 802.1X authentication default role
   - Machine authentication–default user role
   - Machine authentication–default machine role
   - MAC authentication default role
6. Explicit UDR based on MAC address match to derive a VLAN
7. VLAN defined under UDR based on matching MAC address
8. VLAN defined under AAA profile initial role
9. Default VLAN assigned to the port

NOTE

If the dhcp-option based UDR or a device-type based UDR is configured to derive a VLAN and if the rule matches, it overrides all the above precedence.

Current Limitations

- If the MAC authenticated client has received a VLAN via SDR or VSA and going further for successful 802.1x authentication, its VLAN is overwritten and client is assigned a new VLAN (precedence is based on points 1 to 9 above).
- SDR and VSA are not available for machine authentication.

Layer 2 Entry

Layer 2 user entry is created when the wired station connects to the network or when a Layer 2 “miss trigger” is sent to the control plane for a wired user. The Layer 2 user entry with 0.0.0.0 and MAC address is created both in the control plane and dataplane. The user entry inherits the initial role or the user derived role from the AAA profile. This user entry controls the Layer 2 traffic the user can send prior to getting an IP address. It also maintains the statistics for a given MAC address, assuming a user can potentially get multiple IP addresses. Location based ACLs are applied using the Layer 2 user entry.

Layer 3 Entry

After getting an IP address, the user entry shows up in the user table as “Layer 3 Entry.”

User Roles

User roles are a key component for role based policy enforcement.

Fully authenticated Layer 2 roles are assigned when a user has successfully completed all configured Layer 2 authentication methods.

The following authentication command is available in all roles:

```
reauthentication-interval <minutes>
  policer-profile <policer profile name>
  qos-profile <qos profile name>
  voip-profile <voip profile name>
```

NOTE

For more detail, see Roles and Policies on page 294.

Authentication Roles

After authentication, the station or user is given a role that defines the behavior of the user. The role can be defined with the following:

- Access List
- VLAN
- Reauthentication Interval

Access List

This ACL is applied to the user. Three types of ACLs can be applied:

- Ether ACL

  These access rules can be applied to specific Ether types.
- MAC ACL

  These access rules are applied based on MAC address
- Layer 2 - 4

  These access rules are applied based on Layer 3 and Layer 4 information such as IP-Address, protocol, and port.

VLAN

The VLAN attribute is set on initial roles or Layer 2 authenticated roles, so that the user ends on a new VLAN.

- Reauthentication Interval

This is defined in terms of minutes and is sometimes used to re-trigger authentication after a specified interval.

User Derivation Rules

This section contains the following sections:

- Configuring User Derivation Rules on page 286
- Displaying User Derivation Rules on page 287

NOTE

DHCP Signature (DHCP-Option) is supported in addition to MAC Address-based UDRs.

Configuring User Derivation Rules

To configure user derivation rules, use the following command:

```
aaa derivation-rules user student
   set role condition macaddr equals "00:25:90:0a:95:d2" set-value student-role
   set vlan condition macaddr equals "00:25:90:0a:95:d2" set-value 202
```

Displaying User Derivation Rules

To display user derivation rules, use the following command:

```
(host)(config) #show aaa derivation-rules user udr_rule1

User Rule Table
---------------                                                   Total   New
Pr  Attribute  Operation  Operand            Action    Value      Hits    Hits   Desc
--  ---------  ---------  -------            ------    -----      -----  -----  -----
1   macaddr    equals     00:aa:bb:cc:dd:e1  set role  authentic   0       0
2   macaddr    equals     00:aa:bb:cc:dd:e2  set vlan  3912        0       0

Rule Entries: 2
```

RADIUS Fail-Open

When wired users try to access a network where AAA servers are unreachable, they will be unable to authenticate and will continue to stay in the configured initial role. As a result, a user may effectively be blocked off the network due to a restrictive initial-role. To overcome this problem, ArubaOS provides support for RADIUS Fail-open. This feature enables the IT administrators to provide an alternate user-role (unreachable-role) to the users for network connectivity during a AAA server outage. When AAA servers are unreachable, the RADIUS Fail-open feature assigns the unreachable-role to the users trying to authenticate. The users will stay in the unreachable-role until at least one of the AAA servers is back in service.

Enabling RADIUS Fail-Open

RADIUS Fail-open is an optional configuration. It is enabled only if:

- the unreachable-role is configured under the AAA profile, and
- the AAA server dead time expiry feature is enabled (i.e. the dead time value is set above 0)

Configuring Unreachable Role

Use the following command to configure the unreachable-role:

```
(host) (config) #aaa profile profile1
(host) (AAA Profile "profile1") # unreachable-role <user-role>
```

The following is a sample configuration:

```
(host) (config) #aaa profile profile1
(host) (AAA Profile "profile1") # unreachable-role new-role
```

Verifying Unreachable Role Configuration

You can use the following commands to verify the unreachable-role configuration:

```
(host) #show aaa profile profile1


AAA Profile "profile1"
-------------------
Parameter                       Value
---------                       -----
Initial role                    logon
MAC Authentication Profile      N/A
MAC Authentication Default Role guest
MAC Authentication Server Group N/A
```

```
802.1X Authentication Profile         dot1x-auth-profile
802.1X Authentication Default Role    default-role
802.1X Authentication Server Group    server-group
Download Role from ClearPass          Enabled
L2 Authentication Fail Through        Disabled
RADIUS Accounting Server Group        N/A
RADIUS Interim Accounting             Disabled
XML API server                        N/A
AAA unreachable role                  new-role
RFC 3576 server                       N/A
User derivation rules                 N/A
SIP authentication role               N/A
Enforce DHCP                          Disabled
Authentication Failure Blacklist Time  3600 sec

(host)# show running-config
...
...
...
aaa profile "profile1"
authentication-dot1x "dot1x-auth-profile"
dot1x-default-role "default-role"
dot1x-server-group "server-group"
unreachable-role "new-role"
...
...
...
```

Key Points to Remember

- A client remains in the initial role until all the AAA servers in the server group are processed. The unreachable-role is assigned to a user only when:
  - no intermediate role (such as UDR, MAC auth, and 802.1x machine-auth-machine-role) has been derived i.e. the user is still in initial role, and
  - the last AAA server in the AAA server group has been processed, and
  - if one or more AAA servers have timed out and the rest have failed the authentication, or if all the servers have timed out.

NOTE

A role derived after authenticating UDR or MAC auth will have more privileges than the initial or unreachable-role.

- A client will transition from the switch profile VLAN to AAA unreachable-role-based-VLAN only if:
  - AAA unreachable-role is assigned to that MAC, and
  - no intermediate VLAN has been derived.

NOTE

AAA unreachable-role-based-VLAN (high priority) takes precedence over the switching profile's VLAN (low priority).

- Clients that attempted AAA authentication and got timed out are added to the mac-in-unreachable-list table. This list also includes the clients that have derived an intermediate role (such as UDR and MAC auth) but failed AAA authentication due to time-out.

  You can use the following command to view the list of clients in the unreachable-role:

```
(host) #show aaa mac-in-unreachable-list
Station Entry
-------------
MAC         AAA profile Name  AAA server Group          Port
```

```
-----------------  ----------------  ----------------  --------------------
00:60:6e:00:f1:7d  dot1x             mac               gigabitethernet0/0/7
Entries: 1
```

- When the dead timer has expired (default 10 minutes), the Mobility Access Switch sends a dummy authentication request to the AAA server (username: DummyArubaUser). When the AAA server comes back in service, all the clients corresponding to that server group are cleared from the mac-in-unreachable-list table. The clients then re-attempt authentication.
- When a client is removed from the mac-in-unreachable-list table, the port to which it is connected is administratively disabled (shutdown) and then re-enabled (in 5 seconds). This is to ensure that the client initiates the DHCP process again when it re-attempts authentication. The port is administratively disabled and then re-enabled in the following scenarios:
  - When all the clients on the same port are removed from the mac-in-unreachable-list table, if there are more than one client on the same port.
  - When aaa user delete command is executed to delete a client entry that is in the mac-in-unreachable-list table.

NOTE

The port does not get shut when the client entry that is in the unreachable-role ages out due to AAA timer expiry..

- If the AAA server dead time expiry is set to 0, the clients that are in the unreachable-role are rolled back to initial role and are removed from the mac-in-unreachable-list table. No clients will be assigned the unreachable-role as RADIUS Fail-open gets disabled.
- If a system switch over happens (the secondary switch becomes the new primary and the primary switch becomes the new secondary) in the network while RADIUS Fail-Open is active, the following process takes place:
  - The servers that were marked out of service in the old primary are marked as in-service in the new primary.
  - The user table entries for the clients that were in mac-in-unreachable-list table are deleted and their respective interfaces are administratively disabled and then re-enabled. These clients re-attempt authentication and derive a role based on the authentication outcome.
  - If the servers are still out of service during the authentication re-attempt, they will be marked as out of service.
- When more than one server is configured under a server group and when server-group fail-through option is disabled, then the unreachable-role is assigned to the user only if:
  - all the servers are out of service, or
  - when all the servers except the last one in the server group are out of service and the last one fails authentication.

Limitations

- RADIUS Fail-Open is not supported when re-authentication timer is enabled.
- RADIUS Fail-Open is not supported when EAP-Termination is enabled under 802.1x authentication profile.
- When the unreachable-role is assigned to a captive portal user, the user may be misled to the welcome screen indicating that the authentication has succeeded. It is recommended to configure the Captive Portal Authentication Profile under the unreachable-role to avoid such misleading scenarios.

Configuring Authentication End to End

This section describes how to configure authentication end-to-end using the command-line interface. This section contains the following sections:

  - Configuring Authentication Server on page 290

- Configuring Management Authentication on page 291
- Configuring AAA Timers on page 291

Configuring Authentication Server

Prior to configuring authentication, an authentication server must be defined. The Mobility Access Switch supports the following authentication server types: RADIUS, TACACS+, LDAP, and the Internal Database.

NOTE

TACACS+ is not supported for 802.1X authentication.

Configuring a RADIUS Authentication Server

To configure a RADIUS authentication server, use the following commands:

```
(host)(config) #aaa authentication-server radius RADIUS1
(host)(RADIUS Server "RADIUS1") #host 10.20.20.200
(host)(RADIUS Server "RADIUS1") #key <shared-secret>
(host)(RADIUS Server "RADIUS1") #exit
```

Displaying the Authentication Server Configuration

To display the authentication server configuration for verification, use the following command:

```
(host) #show aaa authentication-server all

Auth Server Table
-----------------
Name      Type    IP addr       AuthPort  AcctPort  Status   Requests
----      ----    ------------  --------  --------  -------  --------
Internal  Local   172.16.0.254  n/a       n/a       Enabled  0
RADIUS1   Radius  10.20.20.200  1812      1813      Enabled  0
```

Configuring an Authentication Server Group

NOTE

Authentication servers are referenced in server groups.

To configure the server in a server group, use the following commands:

```
(host) (config) #aaa server-group AUTH_SERVER
(host) (Server Group "AUTH_SERVER") #auth-server RADIUS1
(host) (Server Group "AUTH_SERVER") #exit
```

Configuring a Server for Fail-Over with the Internal Database

You can define multiple authentication servers for fail-over purposes. When you define multiple authentication servers, reference the servers in a single server-group.

```
(host) (config) #aaa server-group AUTH_SERVER
(host) (Server Group "AUTH_SERVER") #auth-server Internal
(host) (Server Group "AUTH_SERVER") #auth-server RADIUS2
```

Configuring Internal Server Under a Server-Group

To configure the internal database server, use the Internal keyword for the authentication-server, and the following commands:

```
(host) (config) #aaa server-group INTERNAL_SERVER
(host) (Server Group "INTERNAL_SERVER") #auth-server Internal
(host) (Server Group "INTERNAL_SERVER") #exit
```

Configuring a User Account with the Internal Database

To use the Internal Server, create a user account with the following command:

```
(host) #local-userdb add username <username> password <password> role dot1x-authenticated
```

Displaying the Internal Database

To display the user database, use the following commands:

```
(host) # show local-userdb

User Summary
------------
Name   Password Role   E-Mail Enabled Expiry Status Sponsor-Name Remote-IP Grantor-Name
----   -------- ----   ------ ------- ------ ------ ------------ --------- ------------
USER1 ******** guest         Yes            Active              0.0.0.0   admin


User Entries: 1
```

Maintaining Existing Accounts with the Internal Database

To add an existing user account, use the following command:

```
(host) #local-userdb add username labuser1 password abcdef
```

To modify an existing user account, use the following command:

```
(host) #local-userdb modify username USER1 role <ROLE>
```

To delete an existing user account, use the following command:

```
(host) #local-userdb del username USER1
```

To delete all existing user accounts, use the following command:

```
(host) #local-userdb del-all
```

Configuring Management Authentication

Similar to user/port authentication, management user can also be authenticated by using the AAA profile, such as using central authentication server for authenticating access to the network devices.

Authentication server can be the same server used for user authentication, or a separate server can be created for management authentication purpose. Similar to AAA authentication server configuration, the server needs to be defined first, then referenced on the server-group:

```
(host) (config) #aaa authentication-server tacacs TACACS1
(host) (TACACS Server "TACACS1") #host 10.20.20.202
(host) (TACACS Server "TACACS1") #key <shared-secret>
(host) (TACACS Server "TACACS1") #exit

(host) (config) #aaa server-group MGMT_AUTH_SERVER
(host) (Server Group "MGMT_AUTH_SERVER") #auth-server TACACS1
(host) (Server Group "MGMT_AUTH_SERVER") #exit
```

Once the server-group is defined (or used existing server-group), the AAA profile for management can be configured:

```
(host) (config) #aaa authentication mgmt
(host) (Management Authentication Profile) #enable
(host) (Management Authentication Profile) #server-group MGMT_AUTH_SERVER
(host) (Management Authentication Profile) #exit
```

Configuring AAA Timers

AAA timers such as dead-time, timeout for idle, as well as logon-lifetime can be defined at global level:

```
(host) (config) #aaa timers dead-time 10
```

```
(host) (config) #aaa timers idle-timeout 300
(host) (config) #aaa timers logon-lifetime 5
(host) (config) #aaa timers stats-timeout 300 seconds
```

NOTE

Logon-lifetime is not applicable for 802.1x and MAC authentication as the user entry is deleted and the session is terminated when the idle-timeout hits.

Timers can be viewed using the following CLI command:

```
(host) #show aaa timers
User idle timeout = 300 seconds
Auth Server dead time = 10 minutes
Logon user lifetime = 5 minutes
User Interim stats frequency = 300 seconds
```

The idle-timeout is set to 5 minutes, which is the default.

Every client is associated with a user role, which determines the client's network privileges and how often it must re-authenticate. A *policy* is a set of rules that applies to traffic that passes through the ArubaOS Mobility Access Switch. You specify one or more policies for a user role. Finally, you can assign a user role to clients before or after they authenticate to the system.

This chapter describes assigning and creating roles and policies using the ArubaOS command line. This chapter describes the following topics:

Firewall Policies

A firewall policy identifies specific characteristics about a data packet passing through the Mobility Access Switch and takes some action based on that identification. In a Mobility Access Switch, that action can be a firewall-type action such as permitting or denying the packet, an administrative action such as logging the packet, or a quality of service (QoS) action such as setting 802.1p bits or placing the packet into a priority queue. You can apply firewall policies to user roles to give differential treatment to different users on the same network to apply the same policy to all traffic through the port.

Firewall policies are categorized as follows on the Mobility Access Switch:

- Stateful
- Stateless

NOTE

Stateful and stateless firewall policies are mutually exclusive and cannot co-exist on the same user-role.

The following table compares the stateful and stateless firewall policies.

Table 32: *Comparison of Stateful and Stateless Firewall Policies*

Stateful Firewall Policies	Stateless Firewall Policies
Stateful–Recognize flows in a network and keep track of the state of sessions. For example, if a firewall policy permits telnet traffic from a client, the policy also recognizes that inbound traffic associated with that session should be allowed.	Stateless–Statically evaluate the packet contents. The traffic in the reverse direction will be allowed unconditionally.
Bidirectional– Keep track of data connections traveling into or out of the network. ACLs are applied to either an inbound traffic or an outbound traffic.	Uni-directional–Keep track of data connections traveling into or out of the network. ACLs are applied to inbound traffic.
Dynamic– The address information in the policy rules can change as the policies are applied to the users. For example, the alias user in a policy automatically applies to the IP address assigned to a particular user.	Static– The address information in the policy rules is static

Stateful Firewall Policy (Session ACL)

A session ACL is a stateful firewall which keeps track of the state of network connections such as TCP streams and UDP communication that hit the firewall. The firewall distinguishes the legitimate packets for different types of connections and allows only those packets that match a known active connection.

Mobility Access Switch provides supports for stateful firewall using the session ACLs which can be applied on user-roles. Mobility Access Switch enforces the stateful firewall policy exclusively on the traffic routed through a firewall-enabled VLAN interface (up-link VLAN) and forwards the internal traffic in a stateless manner.

Configuring a Stateful Firewall Policy

This section describes how to configure a stateful firewall policy using session ACLs. To configure a stateful firewall policy, you must

1. Create a session ACL and apply it to a user-role.
2. Enable firewall on the up-link VLAN interface.

NOTE

If you Modify a session ACL in the middle of an ongoing session, the policy is not enforced on the session until it is terminated.

Creating a Session ACL

Execute the following command to create a session ACL:

```
(host)(config) #ip access-list session <acl-name>
(host)(config-sess-<acl-name>)# <source> <dest> <service> <action> [<extended action>]
```

NOTE

To choose source NAT as an extended action under the redirect option,ensure that it is the last option configured in the access control entry (ACE) .

Execute the following command to apply the session ACL to a user-role:

```
(host)(config) #user-role <user>
(host)(config-role) #access-list session <acl-name>
```

Enabling Firewall on an Up-link VLAN Interface

Execute the following command to enable firewall on a specific VLAN.

```
(host) (config) #interface vlan <id>
(host) (vlan "id") #session-processing
```

NOTE

You can enable **session-processing** on multiple VLAN interfaces.

Sample Configuration

The following example creates a policy, web-only that allows web (HTTP and HTTPS) access.

```
(host)(config) #ip access-list session web-only
  any any svc-http permit
  any any svc-https permit
```

The following command applies the session ACL, web-only to the user-role user2

```
(host)(config) #user-role user2
(host)(config-role) #access-list session web-only
```

The following example enables firewall on VLAN 5:

```
(host) (config) #interface vlan 5
(host) (vlan "5") #session-processing
```

Verifying the Configuration

Execute the following command to verify the session ACL configuration:

```
(host) #show ip access-list web-only
ip access-list session web-only
web-only
--------
Priority  Source  Destination  Service    Action  TimeRange  Log  Expired  Queue
                                                                                    TOS  8021P
 Blacklist  Mirror  DisScan  ClassifyMedia  IPv4/6
--------  ------  -----------  -------    ------  ---------  ---  -------  -----
                                                                                    ---  -----
 ---------  ------  -------  -------------  ------
1         any     any          svc-http   permit                           Low

                                            4
2         any     any          svc-https  permit                           Low

                                            4
```

> **NOTE:** You can use the command **show ip access-list hardware** to view the ACL equivalent .of the session ACL used to forward the internal traffic.

Execute the following command to verify if the session ACL is applied to the user-role, user2:

```
(host) #show rights user2
Derived Role = 'user2'
Up BW:No Limit   Down BW:No Limit
L2TP Pool = default-l2tp-pool
PPTP Pool = default-pptp-pool
Periodic reauthentication: Disabled
ACL Number = 54/0
Max Sessions = 65535
access-list List
----------------
Position  Name      Type     Location
--------  ----      ----     --------
1         web-only  session
web-only
--------
Priority  Source  Destination  Service    Action  TimeRange  Log  Expired  Queue
                                                                                    TOS  8021P
 Blacklist  Mirror  DisScan  ClassifyMedia  IPv4/6
--------  ------  -----------  -------    ------  ---------  ---  -------  -----
                                                                                    ---  -----
 ---------  ------  -------  -------------  ------
1         any     any          svc-http   permit                           Low
                                          4
2         any     any          svc-https  permit                           Low
                                          4
Expired Policies (due to time constraints) = 0
```

Execute the following command to verify if the specified VLAN interface is firewall-enabled:

```
(host) (config) #show interface-config vlan 5
vlan "5"
--------
Parameter                        Value
---------                        -----
Interface OSPF profile           N/A
Interface PIM profile            N/A
Interface IGMP profile           N/A
Directed Broadcast Enabled       Disabled
```

```
Interface shutdown              Disabled
session-processing             Enabled

mtu                             1500
IP Address                      5.5.5.2/255.255.255.0
IP NAT Inside                   Disabled
IPv6 Address                    N/A
IPv6 link local Address         N/A
DHCP client                     Disabled
DHCP relay profile              N/A
Ingress ACL                     pbr_acl
Interface description           N/A
```

Understanding Application-Level Gateways (ALG) Support on Mobility Access Switch

An application-level gateway (ALG) is a firewall proxy that provides security to networks by filtering the incoming application data such as File Transfer Protocol (FTP) and Real Time Streaming Protocol (RTSP) based on respective protocol specifications.

ArubaOS provides support for the following types of ALGs on the Mobility Access Switch:

- **Data ALGs**: FTP, RTSP, DNS, and DHCP.
- **Voice ALGs**: SIP and SCCP (Skinny)

The following are the limitations on the ALG support for Mobility Access Switch:

- No support for SIP initiated voice calls that use an IP other than the one used for the call initiation
- No support for VoIP over NAT
- No Support for RTSP over NAT
- No support for Multicast
- Maximum pause time limit of 300 seconds for streaming in RTSP ALG

You can configure data ALGs on the Mobility Access Switch for services running on both standard and non-standard ports.

NOTE

Aruba recommends that the VoIP ALGs are configured only for services running on standard ports.

By default, all the ALGs are enabled on the Mobility Access Switch. You can enable or disable the VoIP ALGs using the **firewall** command.

NOTE

You cannot disable the Data ALGs on the Mobility Access Switch.

Configuring Application-Level Gateways (ALG)

You can configure ALG for a service by creating an alias for the network service using the **netservice** command and applying it to a session ACL.

NOTE

ALGs are functional only if Stateful firewall is enabled.

Sample ALG Configuration for FTP Running on a Non-Standard Port

For configuring ALGs on non-standard ports, create an alias and specify the port(s) on which the service is running and apply it for ip access-list.

```
(host)(config) #netservice ftp1 tcp 10000 ALG ftp
(host)(config) #ip access-list session ftp_session
```

```
(host)(config-sess-ftp_session) #host 20.20.20.20 any ftp1 permit
```

NOTE

ftp1 is the alias defined for FTP service running on a non-standard port (10000).

Sample ALG Configuration for FTP Running on Standard Port

```
(host)(config) #netservice ftp2 tcp 21 ALG ftp
(host)(config) #ip access-list session ftp_session
(host)(config-sess-ftp_session) #host 20.20.20.20 any ftp2 permit
```

Enable **session-processing** on the up-link port to enable ALG processing. The following sample enables **session-processing** on VLAN 100:

```
(host) (config) #interface vlan 100
(host) (vlan "5") #session-processing
```

Enabling/Disabling VoIP ALG

Executing the following command disables the SIP ALG on the Mobility Access Switch:

```
(host)(config) #firewall disable-stateful-sip-processing
```

You can verify the firewall configuration using the following command:

```
(host) #show firewall
Global firewall policies
------------------------
Policy                                      Action    Rate      Port
------                                      ------    ----      ----
...
Stateful SIP Processing                     Disabled
Stateful SCCP Processing                    Enabled
...
```

Stateless Firewall Policy (Stateless ACL)

Stateless ACL does not store information on the connection state. It filters the packets based only on the information contained in the packet such as the source and destination address of the packet, its protocol, and the port number for TCP and UDP traffic.

Stateless ACLs are applicable to the network and physical layers, and sometimes the transport layer to find out the source and destination port numbers. When a packet originates from the sender and filters through a firewall, the device checks for matches to any of the ACL rules that are configured in the firewall and drops or rejects the packet accordingly. When the packet passes through the firewall, it filters the packet on a protocol/port number basis. For example, if a rule in the firewall exists to block telnet access, then the firewall will block the TCP protocol for port number 23.

Creating a Stateless Firewall Policy

This section describes how to configure the rules that constitute a stateless firewall policy(stateless ACL). A stateless ACL can then be applied to a user role (until the policy is applied to a user role, it does not have any effect).

The following command is used to create a stateless ACL:

```
(host) (config) #ip access-list stateless <acl-name>
(host) (config-sess-<acl-name>)# <source> <dest> <service> <action> [<extended action>]
```

The following command is used to apply the stateless ACL to a user-role:

```
(host) (config) #user-role <user>
(host) (config-role) #access-list stateless <acl-name>
```

Sample Configuration

The following example creates a policy, STATELESS:

```
(host)(config) #ip access-list stateless STATELESS
(host)(config-stateless-STATELESS) #network 10.100.100.0 255.255.255.0 any tcp 8888 deny log
(host)(config-stateless-STATELESS) #any host 1.100.100.200 any deny log
(host)(config-stateless-STATELESS) #any any any permit
```

The following command applies the stateless ACL, STATELESS to the user-role user1:

```
(host) (config) #user-role user1
(host) (config-role) #access-list session STATELESS
```

Verifying the Configuration

Execute the following command to verify the stateless ACL configuration:

```
(host) #show ip access-list STATELESS
ip access-list stateless STATELESS
STATELESS
---------
Priority  Source                      Destination    Service   Action  TimeRange
                                                                                    Log  Expir
ed  QoS  Policer  Blacklist  Mirror  IPv4  Nexthop
--------  ------                      -----------    -------   ------  ---------
                                                                                    ---  -----
--  ---  -------  ---------  ------  ----  -------
1         10.100.100.0 255.255.255.0  any            tcp 8888  deny
                                                                                    Yes
                                    4
2         any                         1.100.100.200  any       deny
                                                                                    Yes
                                    4
3         any                         any            any       permit

                                    4
```

Execute the following command to verify if the stateless ACL is applied to the user-role, user1:

```
(host)  #show rights user1
Derived Role = 'user1'
Periodic reauthentication: Disabled
ACL Number = 55/0/56
access-list List
----------------
Position  Name       Type       Location
--------  ----       ----       --------
1         STATELESS  stateless
STATELESS
---------
Priority  Source                      Destination    Service   Action  TimeRange
                                                                                    Log  Expir
ed  QoS  Policer  Blacklist  Mirror  IPv4  Nexthop
--------  ------                      -----------    -------   ------  ---------
                                                                                    ---  -----
--  ---  -------  ---------  ------  ----  -------
1         10.100.100.0 255.255.255.0  any            tcp 8888  deny
                                                                                    Yes
                                    4
2         any                         1.100.100.200  any       deny
                                                                                    Yes
                                    4
3         any                         any            any       permit

                                    4
Expired Policies (due to time constraints) = 0
```

Global Firewall Policies

You can set the following optional firewall parameters on the Mobility Access Switch using the **firewall** command in the CLI:

- **disable-stateful-sccp-processing**–Disables stateful SCCP processing. Default option is enabled.
- **disable-stateful-sip-processing**–Disables stateful SIP processing. Default option is enabled.
- **drop-ip-fragments**– Drops all IP fragments.
- **enable-per-packet-logging**–Enables per-packet logging. Default is per-session logging.
- **enforce-tcp-handshake**–Enforces TCP handshake before allowing data.
- **enforce-tcp-sequence**–Enforces TCP sequence numbers for all packets.
- **log-icmp-error**–Logs all received ICMP errors.
- **prohibit-arp-spoofing**–Prohibits ARP spoofing.
- **prohibit-ip-spoofing**–Prohibits IP spoofing.
- **prohibit-rst-replay**–Prohibits TCP RST replay attack.
- **session-idle-timeout**–Sets idle or closed session timeout in seconds.
- **session-mirror-destination**–Configures destination for a mirrored session.
- **session-mirror-ipsec**–Configures session mirror of all frames that are processed by IPSec.
- **session-voip-timeout**–Sets VoIP session idle timeout in seconds.

Creating a Network Service Alias

A network service alias defines a TCP, UDP or IP protocol and a list or range of ports supported by that service. When you create a network service alias, you can use that alias when specifying the network service for multiple session ACLs.

To define a service alias via the command-line interface, access the CLI in config mode and issue the following command:

(host) (config) #`netservice <name> <protocol>|tcp|udp {list <port>,<port>}|{<port> [<port>]}[ALG <service>]`

User Roles

This section describes how to create a new user role. When you create a user role, you specify one or more policies for the role. Table 33 lists the parameters you can configure for the user role.

Table 33: *User Role Parameters*

Field	Description
Access Policies (required)	One or more policies that define the privileges of a wired client in this role. There are three ways to add a access policy to a user role: ● Use an existing policy via CLI ● Edit and use the existing policy via CLI ● Create a new policy CLI **NOTE:** For more information, see Configuring the ACLs on page 255.
Re-authentication Interval (optional)	Time, in minutes, after which the client is required to reauthenticate. Enter a value between 0-4096. 0 disables reauthentication. Default: 0 (disabled)
Role VLAN ID (optional)	By default, a client is assigned a VLAN on the basis of the ingress VLAN for the client to the Mobility Access Switch. You can override this assignment and configure the VLAN ID that is to be assigned to the user role. You configure a VLAN by navigating to the **Configuration > VLANs** page.
policer-profile (optional)	Specifies the policer activities configuration parameters for the user under this role.
qos-profile (optional)	Specifies the QoS configuration parameters for the user under this role.
voip-profile (optional)	Specifies the VOIP configuration parameters for an user connected to the interface (VOIP devices and/or PCs and Laptops).

Creating a User Role

The following example creates the user role 'web-guest' and assigns the previously-configured 'web-only' policy to this user role.

NOTE

You cannot delete a user-role that is referenced in a **aaa-profile**. Remove all references to the role and then perform the delete operation. Deleting user-roles used by external authentication servers is also inadvisable without first modifying the external authentication server not to reference that role.

In the CLI

```
user-role web-guest
  access-list stateless web-only position 1
```

After assigning the user role, you can use the **show reference user-role <role>** command to see the profiles that reference this user role.

User Role Assignments

A client is assigned a user role by one of several methods. A role assigned by one method may take precedence over one assigned by a different method. The methods of assigning user roles are, from lowest to highest precedence:

1. The user role can be derived from user attributes upon the client's association with an interface (this is known as a user-derived role). You can configure rules that assign a user role to clients that match the mac address. For example, you can configure a rule to assign the role "VoIP-Phone" to any client that has a MAC address that starts with bytes xx:yy:zz. User-derivation rules are executed before client authentication.
2. The user role can be the default user role configured for an authentication method, such as 802.1x or MAC authentication. For each authentication method, you can configure a default role for clients who are successfully authenticated using that method.

3. The user role can be derived from attributes returned by the authentication server (this is known as a server-derived role). If the client is authenticated via an authentication server, the user role for the client can be based on the attribute returned by the server during authentication. In case the attribute is not returned by the server, the client gets the default authentication role defined under aaa profile. Server-derivation rules are executed after client authentication.
4. The user role can be derived from Aruba Vendor-Specific Attributes (VSA) for RADIUS server authentication. A role derived from an Aruba VSA takes precedence over any other user roles.

The following sections describe the methods of assigning user roles.

User Role in AAA Profile

An AAA profile defines the user role for unauthenticated clients (initial role) as well as the default user role for MAC and 802.1x authentication. To configure user roles in the AAA profile:

In the CLI

```
aaa profile <profile>
   initial-role <role>
   dot1x-default-role <role>
   mac-default-role <role>
```

User-Derived Roles or VLANs

Attributes derived from the client's can be used to assign the client to a specific role or VLAN, as user-derivation rules are executed before the client is authenticated.

You configure the user role or VLAN to be assigned to the client by specifying condition rules; when a condition is met, the specified user role or VLAN is assigned to the client. You can specify more than one condition rule; the order of rules is important as the first matching condition is applied. You can optionally add a description of the user rule.

Table 34 describes the conditions for which you can specify a user role or VLAN.

Table 34: *Conditions for a User-Derived Role or VLAN*

Rule Type	Condition	Value
DHCP-Option	One of the following: • equals • starts with	DHCP signature ID. **NOTE:** This string is not case sensitive.
MAC address of the client	One of the following: • contains • ends with • equals • does not equal • starts with	MAC address (xx:xx:xx:xx:xx:xx)

Configure a User-derived Role or VLAN in the CLI

```
aaa derivation-rules user <name>
   set role|vlan
   condition macaddr
   contains|ends-with|equals|not-equals|starts-with <string>
   set-value <role>
   position <number>
```

NOTE

There are many online tools available for converting ASCII text to a hexadecimal string.

Default Role for Authentication Method

For each authentication method, you can configure a default role for clients who are successfully authenticated using that method. To configure a default role for an authentication method:

In the CLI

To configure the default user role for MAC or 802.1x authentication:

```
aaa profile <profile>
   mac-default-role <role>
   dot1x-default-role <role>
```

Server-Derived Role

If the client is authenticated via an authentication server, the user role for the client can be based on one or more attributes returned by the server during authentication. You configure the user role to be derived by specifying condition rules; when a condition is met, the specified user role is assigned to the client. You can specify more than one condition rule; the order of rules is important as the first matching condition is applied. You can also define server rules based on client MAC address, even though the MAC address is not returned by the server as an attribute.

NOTE

The roles and VLANs in the sample below are defined under the **aaa server-group <server-group-name>** configuration.

Sample configuration

```
set role|vlan
   condition <attribute name>
   contains|ends-with|equals|not-equals|starts-with <attribute value>
   set-value <role> | <vlan>
   position <number>
```

VSA-Derived Role

Many Network Address Server (NAS) vendors, including Aruba, use VSAs to provide features not supported in standard RADIUS attributes. For Aruba systems, VSAs can be employed to provide the user role and VLAN for RADIUS-authenticated clients, however the VSAs must be present on your RADIUS server. This involves defining the vendor (Aruba) and/or the vendor-specific code (14823), vendor-assigned attribute number, attribute format (such as string or integer), and attribute value in the RADIUS dictionary file. VSAs supported on Mobility Access Switches conform to the format recommended in RFC 2865, “Remote Authentication Dial In User Service (RADIUS)”.

This chapter describes the following topics:

- MAC-Based Authentication Concepts on page 304
- Configuring MAC-Based Authentication on page 304
- Configuring Clients on page 305

MAC-Based Authentication Concepts

MAC-based authentication is used to authenticate devices based on their physical media access control (MAC) address. While not the most secure and scalable method, MAC-based authentication implicitly provides an addition layer of security authentication devices. MAC-based authentication is often used to authenticate and allow network access through certain devices while denying access to the rest. For example, if clients are allowed access to the network via station A, then one method of authenticating station A is MAC-based. Clients may be required to authenticate themselves using other methods depending on the network privileges required.

Configuring MAC-Based Authentication

This section describes how to configure MAC-based authentication on the Mobility Access Switch. Before configuring MAC-based authentication, you must configure*:*

- The user role that will be assigned as the default role for the MAC-based authenticated clients.
- You configure the default user role for MAC-based authentication in the AAA profile. If derivation rules exist or if the client configuration in the internal database has a role assignment, these values take precedence over the default user role.
- The authentication server group that the Mobility Access Switch uses to validate the clients. The internal database can be used to define clients for MAC-based authentication.

Configuring the MAC Authentication Profile

Table 35 describes the MAC-based authentication parameters.

Table 35: *MAC Authentication Profile Configuration Parameters*

Parameter	Description
Delimiter	Delimiter used in the MAC string: ● colon specifies the format xx:xx:xx:xx:xx:xx ● dash specifies the format xx-xx-xx-xx-xx-xx ● none specifies the format xxxxxxxxxxxx ● oui-nic specifes the format xxxxxx-xxxxxx Default: none
Case	The case (upper or lower) used in the MAC string. Default: lower
Max Authentication failures	Number of times a station can fail to authenticate before it is blacklisted. A value of 0 disables blacklisting. Default: 0

Using the CLI

```
aaa authentication mac <profile>
   case {lower|upper}
   delimiter {colon|dash|none|oui-nic}
   max-authentication-failures <number>
```

Configuring Clients

You can create entries in the Mobility Access Switch's internal database that can be used to authenticate client MAC addresses. The internal database contains a list of clients along with the password and default role for each client. To configure entries in the internal database for MAC authentication, you enter the MAC address for both the user name and password for each client.

NOTE: You must enter the MAC address using the delimiter format configured in the MAC authentication profile. The default delimiter is none, which means that MAC addresses should be in the format xxxxxxxxxxxx. If you specify colons for the delimiter, you can enter MAC addresses in the format xx:xx:xx:xx:xx:xx.

Using the CLI to configure clients in the internal database

Enter the following command in enable mode:

```
local-userdb add username <macaddr> password <macaddr>
```

Chapter 35 802.1x Authentication

This chapter describes the following topics:

802.1x Authentication Concepts

IEEE 802.1x is an IEEE Standard for Port-based Network Access Control (PNAC). It is part of the IEEE 802.1x group of networking protocols. It provides an authentication mechanism to devices wishing to attach to a LAN or WLAN.

802.1x authentication involves three parties:

- The *supplicant*, or client, is the device attempting to gain access to the network. You can configure the Aruba user-centric network to support 802.1x authentication for wired users.
- The *authenticator* is the gatekeeper to the network and permits or denies access to the supplicants. The Aruba Mobility Access Switch acts as the authenticator, relaying information between the authentication server and supplicant. The EAP type must be consistent between the authentication server and supplicant and is transparent to the Mobility Access Switch.
- The *authentication server* provides a database of information required for authentication and informs the authenticator to deny or permit access to the supplicant.

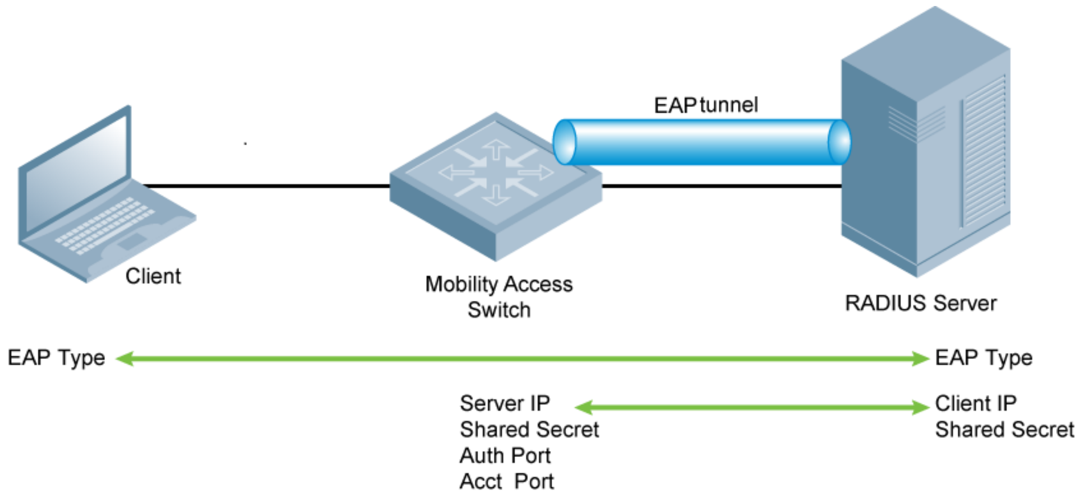
  The 802.1x authentication server is typically an EAP-compliant Remote Access Dial-In User Service (RADIUS) server which can authenticate either users (through passwords or certificates) or the client computer.

  In Aruba user-centric networks, you can terminate the 802.1x authentication on the Mobility Access Switch. The Mobility Access Switch passes user authentication to its internal database or to a “backend” non-802.1x server. This feature is useful for deployments where an 802.1x EAP-compliant RADIUS server is not available or required for authentication.

Authentication with a RADIUS Server

See Table 36 below for an overview of the parameters that you need to configure on authentication components when the authentication server is an 802.1x EAP-compliant RADIUS server.

Figure 17 *802.1x Authentication with RADIUS Server*



The supplicant and authentication server must be configured to use the same EAP type. The Mobility Access Switch does not need to know the EAP type used between the supplicant and authentication server.

For the Mobility Access Switch to communicate with the authentication server, you must configure the IP address, authentication port, and accounting port of the server on the Mobility Access Switch. The authentication server must be configured with the IP address of the RADIUS client, which is the Mobility Access Switch in this case. Both the Mobility Access Switch and the authentication server must be configured to use the same shared secret.

NOTE

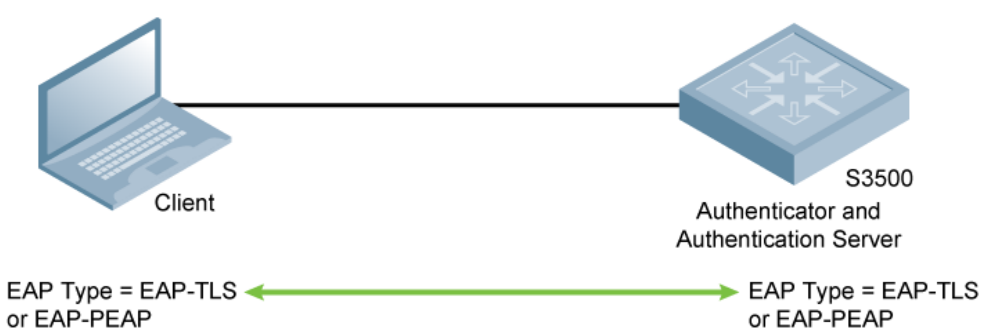
Additional information on EAP types supported in a Windows environment, Microsoft supplicants, and authentication server, is available at http://technet.microsoft.com/en-us/library/cc782851(WS.10).aspx.

The client communicates with the Mobility Access Switch through an EAP tunnel in order to authenticate to the network. Therefore, the network authentication and encryption configured must be the same on both the client and the Mobility Access Switch.

Authentication Terminated on the Mobility Access Switch

User authentication is performed either via the Mobility Access Switch's internal database or a non-802.1x server.

Figure 18 *802.1x Authentication with Termination on Mobility Access Switch*



In this scenario, the supplicant is configured for EAP-Transport Layer Security (TLS) or EAP-Protected EAP (PEAP).

- EAP-TLS is used with smart card user authentication. A smart card holds a digital certificate which, with the user-entered personal identification number (PIN), allows the user to be authenticated on the network. EAP-TLS relies on digital certificates to verify the identities of both the client and server.

  EAP-TLS requires that you import server and certification authority (CA) certificates onto the Mobility Access Switch. The client certificate is verified on the Mobility Access Switch (the client certificate must be signed by a known CA) before the user name is checked on the authentication server.
- EAP-PEAP uses TLS to create an encrypted tunnel. Within the tunnel, one of the following “inner EAP” methods is used:
  - EAP-Generic Token Card (GTC): Described in RFC 2284, this EAP method permits the transfer of unencrypted usernames and passwords from client to server. The main uses for EAP-GTC are one-time token cards such as SecureID and the use of an LDAP or RADIUS server as the user authentication server. You can also enable caching of user credentials on the Mobility Access Switch as a backup to an external authentication server.
  - EAP-Microsoft Challenge Handshake Authentication Protocol version 2 (MS-CHAPv2): Described in RFC 2759, this EAP method is widely supported by Microsoft clients. A RADIUS server must be used as the backend authentication server.

If you are using the Mobility Access Switch’s internal database for user authentication, you need to add the names and passwords of the users to be authenticated. If you are using an LDAP server for user authentication, you need to configure the LDAP server on the Mobility Access Switch, and configure user IDs and passwords. If you are using a RADIUS server for user authentication, you need to configure the RADIUS server on the Mobility Access Switch.

Configuring 802.1x Authentication

The Mobility Access Switch supports 802.1x (dot1x) authentication including **termination**. For example, the list of termination options for the profile name *techpubsAuth* is shown below.

```
(host) (802.1X Authentication Profile "techpubsAuth") # termination ?
eap-type                Configure the EAP method.Default method is EAP-PEAP
enable                  Enable Dot1x Termination.Default is disabled
enable-token-caching    Enable Token Caching.Default is disabled
inner-eap-type          Configure the inner EAP method.Default method is
                        EAP-MSCHAPV2
token-caching-period    Configure the Token Caching Period
```

The following example configures various options for the 802.1x Authentication profile *techpubsAuth.*

```
(host) (802.1X Authentication Profile "techpubsAuth") #termination enable
(host) (802.1X Authentication Profile "techpubsAuth") #termination eap-type eap-peap
(host) (802.1X Authentication Profile "techpubsAuth") #max-authentication-failures 2
(host) (802.1X Authentication Profile "techpubsAuth") #timer reauth-period 3600
(host) (802.1X Authentication Profile "techpubsAuth") #framed-mtu 1500
(host) (802.1X Authentication Profile "techpubsAuth") #reauth-max 2
(host) (802.1X Authentication Profile "techpubsAuth") #reauthentication
```

To verify the above configurations, execute the show command below:

```
(host) (config) #show aaa authentication dot1x techpubsAuth

802.1X Authentication Profile "techpubsAuth"
--------------------------------------------
Parameter                                                     Value
---------                                                     -----
Max authentication failures                                   2           <--
Enforce Machine Authentication                                Disabled
Machine Authentication: Default Machine Role                  guest
Machine Authentication Cache Timeout                          24 hr(s)
Blacklist on Machine Authentication Failure                   Disabled
Machine Authentication: Default User Role                     guest
```

```
Interval between Identity Requests                          30 sec
Quiet Period after Failed Authentication                    30 sec
Reauthentication Interval                                   3600 sec    <--
Use Server provided Reauthentication Interval               Disabled
Authentication Server Retry Interval                        30 sec
Authentication Server Retry Count                           2
Framed MTU                                                  1500 bytes  <--
Number of times ID-Requests are retried                     3
Maximum Number of Reauthentication Attempts                 2           <--
Maximum number of times Held State can be bypassed          0
Reauthentication                                            Enabled     <--
Termination                                                 Enabled     <--
Termination EAP-Type                                        eap-peap    <--
Termination Inner EAP-Type                                  N/A
Enforce Suite-B 128 bit or more security level Authentication  Disabled
Enforce Suite-B 192 bit security level Authentication       Disabled
Token Caching                                               Disabled
Token Caching Period                                        24 hr(s)
CA-Certificate                                              N/A
Server-Certificate                                          N/A
TLS Guest Access                                            Disabled
TLS Guest Role                                              guest
Ignore EAPOL-START after authentication                     Disabled
Handle EAPOL-Logoff                                         Disabled
Ignore EAP ID during negotiation.                           Disabled
Check certificate common name against AAA server            Enabled
```

NOTE

Use the privileged mode in the CLI to configure users in the Mobility Access Switch's internal database.

To add users to the local database, use the following command:

```
local-userdb add username <user> password <password> role <user_role>
```

Configuring a Server Rule Using the CLI

```
aaa server-group dot1x_internal
set role condition Role value-of
```

LDAP Servers

If you are using a LDAP server for authentication, the following variables should be set.

- termination enabled
- EAP type of TLS or PEAP (with inner-EAP-type set to GTC)

Below is an example configuration for the profile *techpubsAuth* for an LDAP server:

```
(host) (802.1X Authentication Profile "techpubsAuth") #termination enable
(host) (802.1X Authentication Profile "techpubsAuth") #termination eap-type eap-peap
(host) (802.1X Authentication Profile "techpubsAuth") # termination inner-eap-type eap-gtc
```

To verify the configuration, execute the **show aaa authentication dot1x <profile_name>** command.

Configuring Certificates with Auth Termination

The Mobility Access Switch supports 802.1x authentication using digital certificates for auth termination.

- Server Certificate–A server certificate installed in the Mobility Access Switch verifies the authenticity of the Mobility Access Switch for 802.1x authentication. Aruba Mobility Access Switches ship with a demonstration digital certificate. Until you install a customer-specific server certificate in the Mobility Access Switch, this demonstration certificate is used by default for all secure HTTP connections and auth termination. This certificate is included primarily for the purposes of feature demonstration and convenience and is not intended for long-term use in production networks. Users in a production environment are urged to obtain and install a certificate issued for their site or domain by a well-known certificate authority (CA). You can generate a Certificate Signing Request (CSR) on the Mobility Access Switch to submit to a CA. For information on how to generate a CSR and how to import the CA-signed certificate into the Mobility Access Switch, see Managing Certificates on page 64.

- Client Certificates–Client certificates are verified on the Mobility Access Switch (the client certificate must be signed by a known CA) before the user name is checked on the authentication server. To use client certificate authentication for auth termination you need to import the following certificates into the Mobility Access Switch (see Importing Certificates on page 66):
  - Mobility Access Switch's server certificate
  - CA certificate for the CA that signed the client certificates

Using the CLI

```
aaa authentication dot1x <profile>
   termination enable
   server-cert <certificate>
   ca-cert <certificate>
```

Configuring 802.1x Authentication with Machine Authentication

When a Windows device boots, it logs onto the network domain using a machine account. Within the domain, the device is authenticated before computer group policies and software settings can be executed; this process is known as *machine authentication*. Machine authentication ensures that only authorized devices are allowed on the network.

You can configure 802.1x for both user and machine authentication (select the **Enforce Machine Authentication** option described in Table 36). This tightens the authentication process further since both the device and user need to be authenticated.

Role Assignment with Machine Authentication Enabled

When you enable machine authentication, there are two additional roles you can define in the 802.1x authentication profile:

- Machine authentication default machine role
- Machine authentication default user role

While you can select the same role for both options, you should define the roles as per the polices that need to be enforced. Also, these roles can be different from the 802.1x authentication default role configured in the AAA profile.

With machine authentication enabled, the assigned role depends upon the success or failure of the machine and user authentications. In certain cases, the role that is ultimately assigned to a client can also depend upon attributes returned by the authentication server or server derivation rules configured on the Mobility Access Switch.

Table 36 describes role assignment based on the results of the machine and user authentications.

Table 36: *Role Assignment for User and Machine Authentication*

Machine Auth Status	User Auth Status	Description	Role Assigned
Failed	Failed	Both machine authentication and user authentication failed. L2 authentication failed.	Initial role defined in the AAA profile will be assigned. If no initial role is explicitly defined, the default initial role (logon role) is assigned.
Failed	Passed	Machine authentication fails (for example, the machine information is not present on the server) and user authentication succeeds. Server-derived roles do not apply.	Machine authentication default user role configured in the 802.1x authentication profile.
Passed	Failed	Machine authentication succeeds and user authentication has not been initiated. Server-derived roles do not apply.	Machine authentication default machine role configured in the 802.1x authentication profile.
Passed	Passed	Both machine and user are successfully authenticated. If there are server-derived roles, the role assigned via the derivation take precedence. This is the *only* case where server-derived roles are applied.	A role derived from the authentication server takes precedence. Otherwise, the 802.1x authentication default role configured in the AAA profile is assigned.

For example, if the following roles are configured:

- 802.1x authentication default role (in AAA profile): dot1x_user
- Machine authentication default machine role (in 802.1x authentication profile): dot1x_mc
- Machine authentication default user role (in 802.1x authentication profile): guest

Role assignments would be as follows:

- If both machine and user authentication succeed, the role is dot1x_user. If there is a server-derived role, the server-derived role takes precedence.
- If only machine authentication succeeds, the role is dot1x_mc.
- If only user authentication succeeds, the role is guest.
- On failure of both machine and user authentication, the initial role defined in the AAA profile is assigned.

With machine authentication enabled, the VLAN to which a client is assigned (and from which the client obtains its IP address) depends upon the success or failure of the machine and user authentications. The VLAN that is ultimately assigned to a client can also depend upon attributes returned by the authentication server or server derivation rules configured on the Mobility Access Switch. If machine authentication is successful, the client is associated to the VLAN configured on the interface. However, the client can be assigned a derived VLAN upon successful user authentication.

NOTE

You can optionally assign a VLAN as part of a user role configuration. It is recommended not to use VLAN derivation if user roles are configured with VLAN assignments.

Table 37 describes VLAN assignment based on the results of the machine and user authentications when VLAN derivation is used.

Table 37: *VLAN Assignment for User and Machine Authentication*

Machine Auth Status	User Auth Status	Description	VLAN Assigned
Failed	Failed	Both machine authentication and user authentication failed. L2 authentication failed.	VLAN configured on the interface or, VLAN configured under initial role
Failed	Passed	Machine authentication fails (for example, the machine information is not present on the server) and user authentication succeeds.	VLAN configured on the interface or, VLAN configured under Machine authentication default user role
Passed	Failed	Machine authentication succeeds and user authentication has not been initiated.	VLAN configured on the interface or, VLAN configured under Machine authentication default machine role
Passed	Passed	Both machine and user are successfully authenticated.	Derived VLAN or, VLAN configured on the interface

Authentication with an 802.1x RADIUS Server

- An EAP-compliant RADIUS server provides the 802.1x authentication. The RADIUS server administrator must configure the server to support this authentication. The administrator must also configure the server to all communications with the Aruba Mobility Access Switch.
- 802.1x authentication based on PEAP with MS-CHAPv2 provides both computer and user authentication. If a user attempts to log in without the computer being authenticated first, the user is placed into a more limited "guest" user role.

  Windows domain credentials are used for computer authentication, and the user's Windows login and password are used for user authentication. A single user sign-on facilitates both authentication to the network and access to the Windows server resources.

You can create the following policies and user roles for:

- Student
- Faculty
- Guest
- Sysadmin
- Computer

Creating an Alias for the Internal Network

Using the CLI

```
netdestination "Internal Network"
   network 10.0.0.0 255.0.0.0
   network 172.16.0.0 255.255.0.0
```

Creating the Student Role and Policy

The **student** policy prevents students from using telnet, POP3, FTP, SMTP, SNMP, or SSH to the wired portion of the network. The **student** policy is mapped to the **student** user role.

Using the CLI

```
ip access-list stateless student
   any alias "Internal Network" svc-telnet deny
   any alias "Internal Network" svc-pop3 deny
   any alias "Internal Network" svc-ftp deny
   any alias "Internal Network" svc-smtp deny
   any alias "Internal Network" svc-snmp deny
   any alias "Internal Network" svc-ssh deny
user-role student
access-list stateless student
access-list stateless allowall
```

Creating the Faculty Role and Policy

The **faculty** policy is similar to the **student** policy. However, the faculty members are allowed to use POP3 and SMTP. The **faculty** policy is mapped to the **faculty** user role.

Using the CLI

```
ip access-list stateless faculty
   any alias "Internal Network" svc-telnet deny
   any alias "Internal Network" svc-ftp deny
   any alias "Internal Network" svc-snmp deny
   any alias "Internal Network" svc-ssh deny
user-role faculty
access-list stateless faculty
access-list stateless allowall
```

Creating the Guest Role and Policy

The **guest** policy permits only access to the Internet (via HTTP or HTTPS) and only during daytime working hours. The **guest** policy is mapped to the **guest** user role.

Using the CLI

```
time-range working-hours periodic
   weekday 07:30 to 17:00
ip access-list stateless guest
   any host 10.1.1.25 svc-dhcp permit time-range working-hours
   any host 10.1.1.25 svc-dns permit time-range working-hours
   any alias "Internal Network" any deny
   any any svc-http permit time-range working-hours
   any any svc-https permit time-range working-hours
   any any any deny
user-role guest
access-list stateless guest
```

Configuring the RADIUS Authentication Server

You can set the role condition to identify the user's group. The Mobility Access Switch uses the literal value of this attribute to determine the role name. The following example uses the RADIUS server name *radiusTechPubs* to configure the Radius server.

```
(host) (config) #aaa authentication-server radius radiusTechPubs
(host) (RADIUS Server "radiusTechPubs") #host 10.41.255.30
(host) (RADIUS Server "radiusTechPubs") #key hometown
```

```
(host) (RADIUS Server "radiusTechPubs") #exit

(host) (config) #aaa server-group radiusTechpubs
(host) (Server Group "radiusTechpubs") #auth-server radiusTechpubs
(host) (Server Group "radiusTechpubs") #set role condition Class Value-of
```

Configuring 802.1x Authentication Profile

In the 802.1x authentication profile, configure enforcement of machine authentication before user authentication. If a user attempts to log in without machine authentication taking place first, the user is placed in the limited guest role.

Using the CLI

```
aaa authentication dot1x dot1x
   machine-authentication enable
   machine-authentication machine-default-role student
   machine-authentication user-default-role guest
```

Configuring AAA Profile

A AAA profile specifies the 802.1x authentication profile and 802.1x server group to be used for authenticating clients. The AAA profile also specifies the default user roles for 802.1x authentication.

Using the CLI

```
aaa profile aaa_dot1x
   dot1x-default-role faculty
   authentication-dot1x dot1x
   dot1x-server-group radiusTechpubs
```

Captive portal is an L3 authentication method supported by Mobility Access Switch. A captive portal presents a web page which requires user action before network access is granted. The required action can be simply viewing and agreeing to an acceptable use policy, entering Email ID, or entering a user ID and password which must be validated against a database of authorized users. The Mobility Access Switch supports both internal and external captive portals.

This chapter describes the following topics:

Captive Portal Overview

You can configure captive portal for guest users where no authentication is required, or for registered users who must be authenticated against an external authentication server or the Mobility Access Switch's internal user database.

NOTE

Captive portal is most often used for guest access, access to open systems (such as public hot spots), or as a way to connect to a VPN.

You can use captive portal for guest and registered users at the same time. The default captive portal web page provided with ArubaOS Mobility Access Switch displays login prompts only for registered users. The Mobility Access Switch supports the creation of 16 different customer login pages. The login page displayed is based on the AAA Profile applied to the port that the user is connected.

Configuring Captive Portal Authentication

This section describes how to configure Captive Portal authentication on the Mobility Access Switch. Before configuring Captive Portal authentication, you must configure the following:

- The user role that will be assigned as the initial role. This initial role does not require any Captive Portal specific ACLs because once Captive Portal is added to the user-role, the necessary ACLs will automatically be added.
- The authentication server group that the Mobility Access Switch uses to validate the guest or registered users. The internal user database or an external authentication server may be used.

NOTE

A read-only ACL using the same name defined in **captive-portal <name>** is automatically generated upon adding **captive-portal <name>** to a user-role. This ACL is configured to redirect http/https traffic and permit DNS and DHCP traffic. You can use the **show rights <user-role>** command to verify this ACL.

Captive Portal Configuration Parameters

Table 38 describes configuration parameters for Captive Portal Authentication profile page in the WebUI. In the CLI, you configure these options with the **aaa authentication captive-portal** commands.

Table 38: *Captive Portal Authentication Profile Parameters*

Parameter	Description
`default-guest-role`	Role assigned to guest. Default: guest
`default-role`	Role assigned to the Captive Portal user upon login. When both user and guest logon are enabled, the default role applies to the user logon; users logging in using the guest interface are assigned the guest role. Default: guest
`enable-welcome-page`	Displays the configured welcome page before the user is redirected to their original URL. If this option is disabled, redirection to the web URL happens immediately after the user logs in. Default: Enabled
`guest-logon`	Enables Captive Portal logon without authentication. Default: Disabled
`ip-addr-in-redirection-url`	Sends IP address of one of the interface in the redirection URL when external captive portal servers are used. Default: Disabled
`login-page`	URL of the page that appears for the user logon. This can be set to any URL. Default: /auth/index.html
`logon-wait`	Configure parameters for the logon wait interval Default: 10 seconds
`Logon wait CPU utilization threshold`	CPU utilization percentage above which the Logon wait interval is applied when presenting the user with the logon page. Default: 60%
`Logon wait minimum wait`	Minimum time, in seconds, the user will have to wait for the logon page to pop up if the CPU load is high. This works in conjunction with the Logon wait CPU utilization threshold parameter. Default: 5 seconds
`logout-popup-window`	Enables a pop-up window with the Logout link for the user to logout after logon. If this is disabled, the user remains logged in until the user timeout period has elapsed or the station reloads. Default: Enabled
`max-authentication-failures`	The number of authentication failures before the user is blacklisted. Default : 0, Range: 0-10
`protocol-http`	Use HTTP protocol on redirection to the Captive Portal page. If you use this option, modify the captive portal policy to allow HTTP traffic. Default: disabled (HTTPS is used)
`redirect-pause`	Time, in seconds, that the system remains in the initial welcome page before redirecting the user to the final web URL. If set to 0, the welcome page displays until the user clicks on the indicated link. Default: 10 seconds
`server-group`	Name of the group of servers used to authenticate Captive Portal users.

Parameter	Description
`show-fqdn`	Allows the user to see and select the fully-qualified domain name (FQDN) on the login page. The FQDNs shown are specified when configuring individual servers for the server group used with captive portal authentication. Default: Disabled
`show-acceptable-use-policy`	Show the acceptable use policy page before the logon page. Default: Disabled
`single-session`	Allows only one active user session at a time. Default: Disabled
`switchip-in-redirection-url`	Sends the Mobility Access Switch's IP address in the redirection URL when external captive portal servers are used. An external captive portal server can determine the Mobility Access Switch from which a request originated by parsing the 'switchip' variable in the URL. Default: Disabled
`use-chap`	Use CHAP protocol. You should not use this option unless instructed to do so by an Aruba representative. Default: Disabled
`user-logon`	Enables Captive Portal with authentication of user credentials. Default: Enabled
`user-vlan-in-redirection-url`	Sends VLAN ID of the user in the redirection URL when external captive portal servers are used.
`welcome-page`	URL of the page that appears after logon and before redirection to the web URL. This can be set to any URL. Default: /auth/welcome.html
`white-list`	Name of an existing white list on an IPv4 or IPv6 network destination. The white list contains authenticated websites that a guest can access.
White List	To add a netdestination to the captive portal whitelist, enter the destination host or subnet, then click **Add**. The netdestination will be added to the whitelist. To remove a netdestination from the whitelist, select it in the whitelist field, then click **Delete**. If you have not yet defined a netdestination, use the CLI command **netdestination** to define a destination host or subnet before you add it to the whitelist. This parameter requires the Public Access license.
Black List	To add a netdestination to the captive portal blacklist, enter the destination host or subnet, then click **Add**. The netdestination will be added to the blacklist. To remove a netdestination from the blacklist, select it in the blacklist field, then click **Delete**. If you have not yet defined a netdestination, use the CLI command **netdestination** to define a destination host or subnet before you add it to the blacklist. This parameter requires the Public Access license.

Captive Portal Configuration Example

You can configure Captive Portal either using the WebUI or using the CLI.

Configuring Captive Portal via the CLI

To configure Captive Portal via the command-line interface, access the CLI configuration mode and issue the following commands:

1. Create a Captive Portal profile

```
(host)(config)#aaa authentication captive-portal cp-profile
(host)(Captive Portal Authentication Profile "cp-profile") #default-role guest
(host)(Captive Portal Authentication Profile "cp-profile") #server-group cp-srv
```

NOTE

It is assumed that a AAA server-group named "cp-srv" was previously created. To create a AAA server-group, refer the procedure mentioned in Configuring Server Groups on page 272.

You can use the following URL to configure an external captive portal authentication on an external server:

```
(host)(config)#aaa authentication captive-portal cp-profile
(host) (Captive Portal Authentication Profile "cp-profile") #login-page https://<external_server_IP>/<login_page_path>
```

You can use the following URLs to configure an external captive portal authentication on CPPM:

For pre-6.0 ClearPass Policy Manager (Onboard, Legacy Captive Portal Capability):

```
(host)(Captive Portal Authentication Profile "cp-profile") #login-page https://<clearpass-server>/agent/portal/
```

For pre-6.0 ClearPass Guest:

```
(host)(Captive Portal Authentication Profile "cp-profile") #login-page https://<clearpass-guest-server>/<admin-defined-name>.php
```

For 6.0 ClearPass Policy Manager and ClearPass Guest (Integrated Platform):

```
(host)(Captive Portal Authentication Profile "cp-profile") #login-page https://<clearpass-server>/agent/portal/ (Onboard, Legacy Captive Portal Capability)
(host)(Captive Portal Authentication Profile "cp-profile") #login-page https://<clearpass-server>/guest/ (ClearPass Guest)
```

Please refer to ClearPass Policy Manager and ClearPass Guest documentation for more details.

2. Attach a Captive Portal profile to a user role

```
(host)(config) #user-role cp-first
(host)(config-role) #captive-portal cp-profile
```

3. Designate the **cp-first** user-role as the initial role of the AAA profile **cp_aaa**

```
(host)(config) #aaa profile cp_aaa
(host)(AAA Profile "cp_aaa") #initial-role cp-first
```

4. Apply the configured AAA profile to the interface

```
(host)(config) #interface gigabitethernet 0/0/0
aaa-profile cp_aaa
no trusted port
```

NOTE

By default, the authenticated Captive Portal users will be assigned the **guest** user-role.

Configuring Captive Portal via the WebUI

NOTE

You can create the user role using the CLI. For more information, see Creating a User Role on page 301 .

1. Navigate to the **Configuration>Authentication** page.
2. Select initial role as **cp-first** from the **Initial-Role** drop-down list.
3. Click the **New** button to create a new AAA profile, enter the name of the profile (for example, **profile1**) in the **Name** textbox.
4. Select the authentication method as **captive-portal** from the **Authentication Method** drop-down list.
5. Select the **specify new profile** radio button and enter the captive portal profile name (for example, **c-portal**) in the **Profile Name** textbox.
6. Select the server-group as **cp-srv** from the **Auth Server** drop-down list.

NOTE

It is assumed that a AAA server-group named "cp-srv" was previously created. To create a AAA server-group, refer the procedure mentioned in Configuring Server Groups on page 272.

7. Click **Ok** and **Apply**.
8. To assign AAA profile to the port, select the port from the **Ports Assign** list.
9. Click **Ok** and **Apply**.
10. To make the port untrusted, navigate to **Configuration>Ports** page and select the port from the **Ports** list.
11. Select the **Disabled** radio button from the **Trusted** list.
12. Click **Ok** and **Apply**.

NOTE

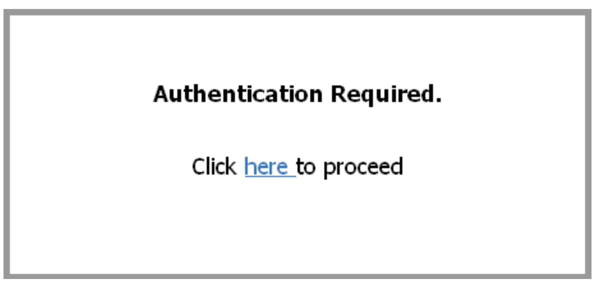
By default, authenticated Captive Portal users will be assigned the **guest** user-role.

Personalizing the Captive Portal Page

The first screen displayed before the captive portal login page informs the user about the authentication requirement and a link (here) is provided . By clicking on this link, the user can access the captive portal login page.

Figure 19 displays the screen that appears before the captive portal login page.

Figure 19 *Authentication Request Page*



The following can be personalized on the default captive portal page:

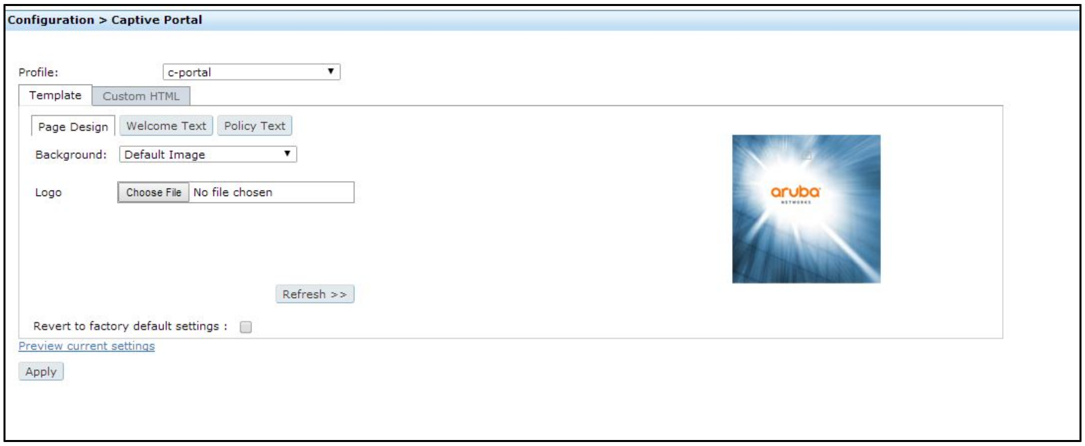
- Captive portal background
- Page text

The background image and text should be visible to users with a browser window on a 1024 by 768 pixel screen. The background should not clash if viewed on a much larger monitor. A good option is to have the background image at 800 by 600 pixels, and set the background color to be compatible. The maximum image size for the background can be around 960 by 720 pixels, as long as the image can be cropped at the bottom and right edges. Leave space on the left side for the login box.

1. Navigate to the **Configuration > Captive Portal** page.
2. Select the captive portal profile that you want to customize from the **Profile** drop-down list.
3. Select the image that you want to customize from the **Background** drop-down list.

   The default page design is as shown below:

Figure 20 *Personalizing the Captive Portal - Default Image*



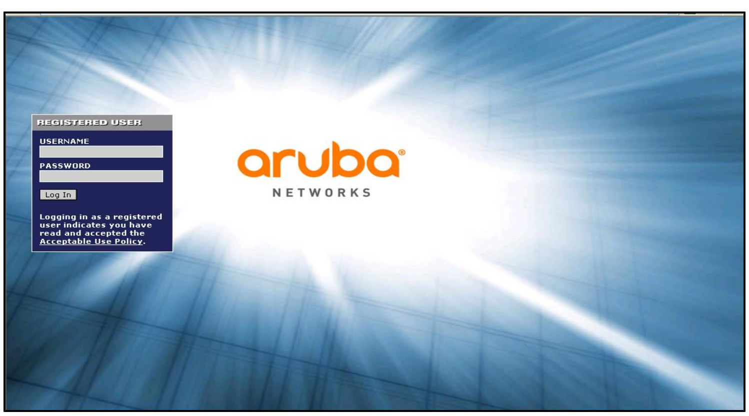
4. To add the policy text:
   a. Click on the **policy text** tab and enter the acceptable use policy for guests in HTML format.
   b. Click **Apply**.
   c. To view the changes, click on the **Preview current settings** link which displays the Captive Portal page as it will be seen by users.

NOTE

You can configure policy text from the WebUI. To enable it from the CLI, use `show-acceptable-use-policy` command.

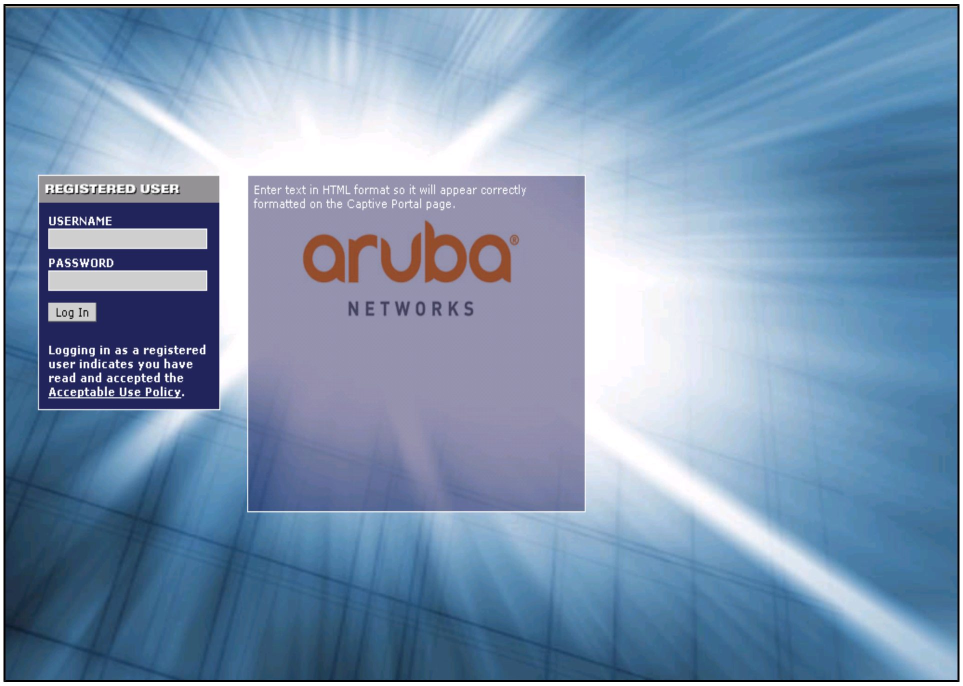
5. To customize the page background:
   a. Select the **CUSTOM Image** from the **Background** drop-down list.
   b. Set the background color in the custom page background color field. The color code must a hexadecimal value in the format #hhhhhh.
   c. To view the page background changes, click on the **Preview current settings** link. This displays the Captive Portal page as seen by the users.

Figure 21 *Customizing the Captive Portal Background Page*



6. To customize the captive portal background text:
   a. Enter the text that needs to be displayed in the **Welcome Text (in HTML format)** message box.
   b. To view the background text changes, click **Preview current settings link** at the bottom on the page. This displays the Captive Portal page as it will be seen by users.

Figure 22 *Customizing the Captive Portal Background Text*



Creating Walled Garden Access

On the Internet, a walled garden typically controls a user's access to web content and services. The walled garden directs the user's navigation within particular areas to allow access to a selection of websites or prevent access to other websites.

Creating Walled Garden Access

Walled garden access is needed when an external or internal captive portal is used. A common example could be a hotel environment where unauthenticated users are allowed to navigate to a designated login page (for example, a hotel website) and all its contents.

Users who do not sign up for Internet service can view "allowed" websites (typically hotel property websites). The website names must be DNS-based (not IP address based) and support the option to define wildcards. This works for client devices with or without HTTP proxy settings.

When a user attempts to navigate to other websites not configured in the white list walled garden profile, the user is redirected back to the login page. In addition, the black listed walled garden profile is configured to explicitly block navigation to websites from unauthenticated users.

Using the CLI to create walled garden access

This example configures a destination named Mywhite-list and adds the domain names, google.com and cnn.com to that destination. It then adds the destination name Mywhite-list (which contains the allowed domain names google.com and cnn.com) to the white list.

```
(host)(config)#netdestination "Mywhite-list"
(host)(config)#name www.google.com
(host)(config)#name www.cnn.com

(host)(config) #aaa authentication captive-portal default
(host)(Captive Portal Authentication Profile "default")#white-list Mywhite-list
```

Ensure not to prefix named netdestination with “http://” or “https://”.

Mobility Access Switch Server Certificate

The Mobility Access Switch is designed to provide secure services through the use of digital certificates. A server certificate installed in the Mobility Access Switch verifies the authenticity of the Mobility Access Switch for captive portal.

ArubaOS Mobility Access Switch ships with a demonstration digital certificate. Until you install a customer-specific server certificate in the Mobility Access Switch, this demonstration certificate is used by default for all secure HTTP connections such as captive portal. This certificate is included primarily for the purposes of feature demonstration and convenience and is not intended for long-term use in production networks. Users in a production environment are urged to obtain and install a certificate issued for their site or domain by a well-known certificate authority (CA). You can generate a Certificate Signing Request (CSR) on the Mobility Access Switch to submit to a CA.

You can use the following command to assign a customized captive portal certificate:

```
(host)(config) #web-server
(host)(Web Server Configuration) #captive-portal-cert
(host)(Web Server Configuration) #captive-portal-cert <captive-portal-cert-name>
```

For information on how to generate a CSR and to import a certificate into the Mobility Access Switch, see Obtaining a Server Certificate on page 65.

Chapter 37 Tunneled Nodes

Tunneled Node (previously known as Mux) provides the ability to tunnel the ingress packets (via GRE) from an interface on the Mobility Access Switch (Tunneled Node port) to an Mobility Controller (Tunneled Node server). You can use the Tunneled Nodes to allow the Mobility Controller to provide centralized security policy, authentication, and access-control.

This chapter includes the following topics:

Important Points to Remember

- The minimum required version of Mobility Controller ArubaOS is 6.1.2.4.
- Multiple VLAN interfaces are supported in ArubaOS and the GRE tunnel is sourced with the “Switch IP” of the switch.
- Only the following Aruba Mobility Controllers support Tunneled Nodes:
  - 7200 Series Controllers
  - 6000 Series Chassis (M3 module).
  - 3000 Series Controllers
  - 600 Series Controllers
- Ensure that there is an IP reachability between the Mobility Access Switch and the Mobility Controller.
- The Tunneled Node is configured on per-port basis.
- The Tunneled Node is not supported on port-channels. However, Tunneled Node traffic can traverse port-channels.
- The GRE tunnel is created when the interface state transitions to *up* state and the controller is reachable.
- If the interface is up but the Mobility Controller is not reachable, the Mobility Access Switch will retry at every 60 seconds to form a GRE tunnel.
- The Mobility Access Switch allocates an internal VLAN for every Tunneled Node interface. This VLAN is used only for Tunneled Node internal processing. An available internal VLAN ID with the highest number (starting with 4094) is used by default. If you create a new VLAN with the ID that is already assigned to a Tunneled Node, then that VLAN ID is released and then the system allocates the next available VLAN ID. There can be traffic disruption in the mean time.
- Ensure that the VLANs specified in the switching profile and assigned to the Tunneled Node interface is present on the Mobility Controller.
- Only one Tunneled Node profile is supported on the Mobility Access Switch and hence only one Mobility Controller can be used as the Tunneled Node server.
- Spanning tree processing does not take place on the Tunneled Node interface.
- A policer-profile and qos-profile may be applied to a Tunneled Node interface.

- To support Tunneled Node, the Mobility Controller must have an AP and Security bundle license per Mobility Access Switch or ArubaStack.

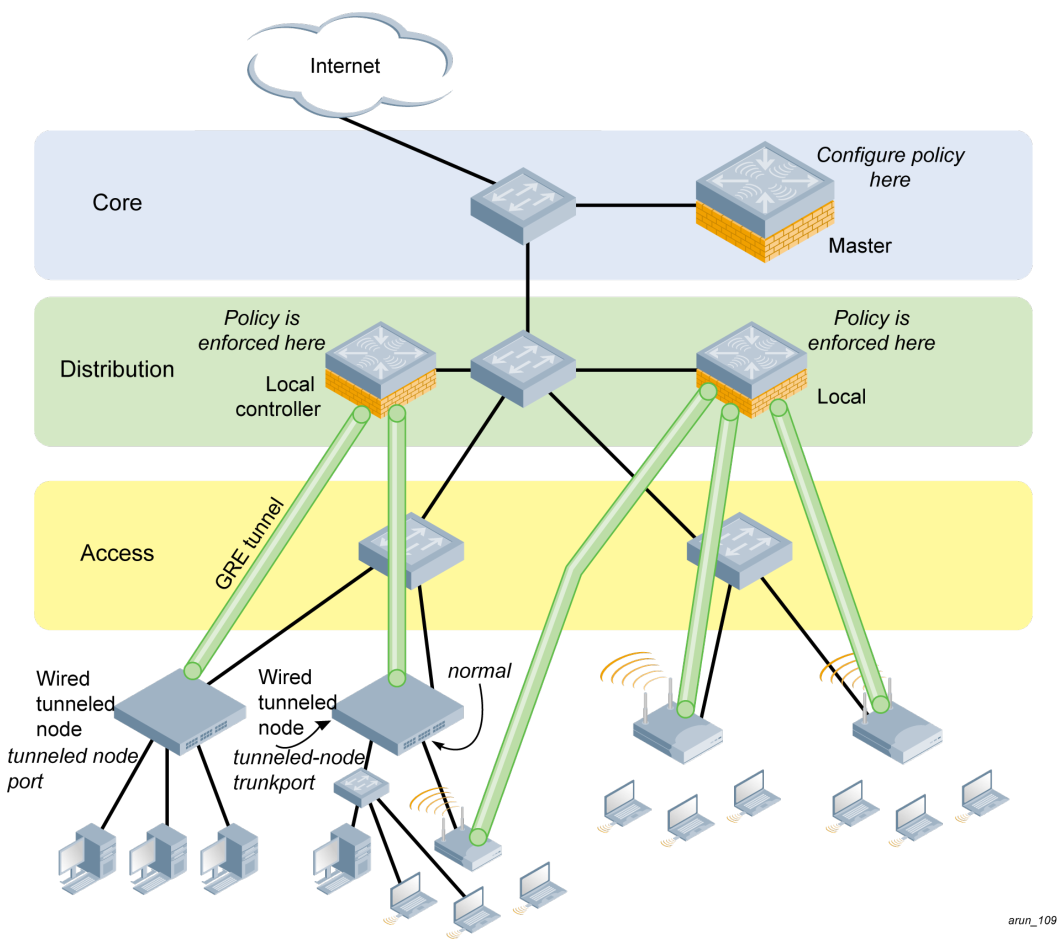
Tunneled Nodes Overview

This section provides detailed information on the Tunneled Node, also known as a wired Tunneled Node. The Tunneled Node provides access and security using an overlay architecture.

The Tunneled Node connects to one or more client devices at the edge of the network and then establishes a GRE tunnel to the controller. This approach allows the controller to support all the centralized security features, such as IEEE 802.1x authentication, captive-portal authentication, and stateful firewall.

To configure the Tunneled Node, you must specify the IP address of the controller and identify the ports that are to be used as Tunneled Node ports. A tunnel is established between the controller and the Mobility Access Switch for each active Tunneled Node port. Figure 23 shows how the Tunneled Node fits into network operations. Traffic moves through GRE tunnels between the active Tunneled Node ports and the controller. Policies are configured and enforced on the controller. On the controller, you can assign the same policy to Tunneled Node user traffic as you would to any untrusted wired traffic.

Figure 23 *Tunneled Node configuration operation*



NOTE

The Tunneled Node port can also be configured as a trunk port. This allows you to have multiple clients on different VLANs on the trunk port.

Support for Tunneled Node Back-up Server

ArubaOS provides support for Tunneled Node back-up server by allowing you to configure primary and back-up controllers in the Tunneled Node profile. The Mobility Access Switch keeps checking for the reachability of both primary and the back-up servers configured on the Tunneled Node profile. When the primary controller goes down and if the back-up controller is reachable, the Mobility Access Switch automatically establishes a Tunneled Node between the back-up controller. This ensures that the ports on the Mobility Access Switch do not lose connectivity at any point. The Mobility Access Switch switches back to the primary controller as soon as it finds the primary controller reachable.

Creating and Configuring Tunneled Node Profile

You can create, configure, view, and apply a Tunneled Node profile to an interface using the following commands:

To create a Tunneled Node Profile:

```
(host)(config)# interface-profile tunneled-node-profile <profile-name>
```

To configure the primary and the back-up server for a Tunneled Node:

```
(host)(config)(Tunneled Node Server profile "<profile-name>")#
  backup-controller-ip <IP-address>
  clone <source>
  controller-ip <IP-address>
  keepalive <1-40>
  mtu <1024-1500>
  no {...}
```

To view a Tunneled Node profile configuration, execute the following command:

```
(host)# show interface-profile tunneled-node-profile tunnel1
Tunneled Node Server profile "tunnel1"
Parameter                     Value
---------                     -----
Controller IP Address         1.1.1.1
Backup Controller IP Address  2.2.2.1
Keepalive timeout in seconds  10
MTU on path to controller     1400
```

To apply the Tunneled Node profile to an interface:

```
(host)(config)# interface gigabitethernet <slot/module/port>
  tunneled-node-profile <profile-name>
```

NOTE

Tunneled Node profile must be applied to the interface along with the switching profile.

NOTE

For information about how to configure the Tunneled Node server (controller) to use the appropriate Tunneled Node clients, see the appropriate version of the controller User Guide.

Path MTU Discovery

The MTU specified in the Tunneled Node profile must match the path MTU on your network. To determine the correct path MTU between the Tunneled Node client and the controller, use the **ping <ip-address> mtu discovery do size <size>** command. For example, see the following output:

```
(host)# ping 10.13.6.44 mtu_discovery do size 16508
Press 'q' to abort.
PING 10.13.6.44 (10.13.6.44)
```

```
From 10.16.48.21 icmp_seq=1 Frag needed and DF set (mtu = 1500)
From 10.16.48.21 icmp_seq=1 Frag needed and DF set (mtu = 1500)
From 10.16.48.21 icmp_seq=1 Frag needed and DF set (mtu = 1500)
From 10.16.48.21 icmp_seq=1 Frag needed and DF set (mtu = 1500)
From 10.16.48.21 icmp_seq=1 Frag needed and DF set (mtu = 1500)
```

Verifying and Monitoring Tunneled Nodes

```
(host)# show tunneled-node state
Tunneled Node State
-------------------
IP           MAC                Port state     vlan  tunnel  inactive-time
--           ---                ---- -----     ----  ------  -------------
172.16.30.2  00:0b:86:6a:23:80  GE0/0/11  complete  0400  4088    0000
172.16.30.2  00:0b:86:6a:23:80  GE0/0/34  complete  0400  4091    0000

(host)# show tunneled-node config
Tunneled Node Client: Enabled
Tunneled Node Server: 172.16.30.2
Tunneled Node Loop Prevention: Disabled
```

NOTE

The **show tunneled-node config** command displays the Tunneled Node server IP address of the controller to which Mobility Access Switch is connected at that moment.

```
(host)# show vlan
VLAN CONFIGURATION
------------------
VLAN  Description        Ports
----  -----------        -----
4088  MUX Internal VLAN  GE 0/0/11 TUNNEL-0
<output truncated>
```

Verifying and Monitoring the Tunneled Nodes on the Controller

```
(host)# show tunneled-node state
Tunneled Node State
-------------------
IP           MAC                s/p state     vlan  tunnel  inactive-time
--           ---                --- -----     ----  ------  -------------
172.16.50.2  00:0b:86:6a:23:80 gigabitethernet0/0/34  complete  400   9      1
172.16.50.2  00:0b:86:6a:23:80 gigabitethernet0/0/11  complete  400   10     1

(host)# show user-table
Users
-----
    IP              MAC            Name     Role           Age(d:h:m)  Auth  VPN link  AP nam
e    Roaming  Essid/Bssid/Phy   Profile          Forward mode  Type
----------     ------------       ------   ----           ----------  ----  --------  ------
-   -------  --------------    -------          ------------  ----
172.16.100.25   00:25:90:0c:5b:6e          authenticated  00:00:02                    tunnel
10  Wired    172.16.50.2:2/24  wired-aaa-profile  tunnel       Win XP
172.16.100.252  00:25:90:0c:59:bc          authenticated  00:00:02                    tunnel
10  Wired    172.16.50.2:2/24  wired-aaa-profile  tunnel       Win XP
<output truncated>
```

This chapter describes the following topics:

Aruba Instant Overview

Aruba Instant virtualizes Aruba Mobility Controller capabilities on 802.11n access points (APs), creating a feature-rich enterprise-grade wireless LAN (WLAN) that combines affordability and configuration simplicity.

Aruba Instant is a simple, easy to deploy turn-key WLAN solution consisting of one or more access points. An Ethernet port with routable connectivity to the Internet or a self-enclosed network, is used to deploy an Instant Wireless Network. An Instant Access Point (IAP) can be installed at a single site or deployed across multiple geographically-dispersed locations. Designed specifically for easy deployment, and proactive management of networks, Instant is ideal for small customers or remote locations without any on-site IT administrator.

Aruba Instant consists of an Instant Access Point (IAP) and a Virtual Controller (VC). The Virtual Controller resides within one of the access points. In an Aruba Instant deployment only the first IAP needs to be configured. After the first IAP is deployed, the subsequent IAPs will inherit all the required information from the Virtual Controller.

Supported Devices

The following is a list of Instant devices supported by Aruba:

- IAP-92
- IAP-93
- IAP-104
- IAP-105
- IAP-134
- IAP-135
- IAP-175P/175AC
- RAP-3WN/3WN-US/3WNP/3WNP-US

NOTE

IAP-104, IAP-105, IAP-134, IAP-135, and IAP-175 support an unlimited number of IAPs on Layer 2 networks. IAP -92/93 supports 16 IAPs.

For more information on IAP, see the *Instant Access Point 6.2.0.0-3.2 User Guide*.

Aruba AP Integration with the MAS

ArubaOS Mobility Access Switch includes new integration features with Aruba Instant AP (IAP) 3.1 software.

Aruba AP Integration Features

The Aruba AP integration features saves the wastage of power and bandwidth consumed by the rouge APs on the wired network.

Following features are supported only on IAP:

- Rogue AP containment
- GVRP Integration

Following features are supported on both IAP and CAP:

- PoE prioritization
- Auto QoS Trust

NOTE

Ensure that LLDP is enabled on ports where IAPs are connected.

Rogue AP Containment

When a rogue AP is detected by IAP, the IAP sends out the MAC Address of the rogue AP to the MAS using the Aruba's proprietary LLDP TLV protocol (MAC information TLV with action as Blacklist). The MAS blacklists the MAC address of the rogue AP and turns off the PoE on the port or the MAS installs a bridge entry with the source MAC command as `DROP` to discard the packets originating from or carried to the Rouge AP.

NOTE

To enable the rogue AP containment feature, connect the IAPs to the LLDP enabled MAS ports.

The rogue AP containment functionality is supported only on trusted ports.

GVRP Integration

Configuring GVRP in Mobility Access Switch enables the switch to register/de-register the dynamic VLAN information received from a GVRP applicant such as an IAP in the network. GVRP support also enables the switch to propagate the registered VLAN information to the neighboring bridges in the network.

NOTE

When VLANs are added on WLAN or wired profiles, the VLANs are advertised to the upstream switch using GVRP messages.

For information on enabling and configuring GVRP on Mobility Access Switch, see Enabling and Configuring GVRP Functionality on page 136.

PoE Prioritization

When an IAP is plugged into a PoE enabled port on the Mobility Access Switch, the Mobility Access Switch automatically increases the PoE priority from low (default) to high. This only occurs if the **poe-profile** associated with the given port is using the **poe-factory-initial** profile and the default **poe-priorty** has not been manually changed.

For information on PoE and configuring the PoE on MAS, see Power Over Ethernet on page 110.

Auto QoS Trust

A new option, `aruba-device` is introduced in ArubaOS under the `qos trust` command to automatically trust Aruba IAPs.

```
(host) (gigabitethernet "0/0/0") #qos trust ?
aruba-device            Trust DSCP/802.1p for Aruba-Device otherwise
pass-through
auto                    Trust DSCP for IP packets; 802.1p for non-IP packets
disable                 Disable QoS trust (reset DSCP/802.1p to 0)
dot1p                   Trust 802.1p
dscp                    Trust DSCP
pass-through            Pass-through DSCP/802.1p
```

If an Aruba device is detected using Aruba LLDP TLV, then DSCP is preserved for IP packets and 802.1p for non-IP packets. To use **qos-profile trusted** command for queuing mapping. If **`aruba-device`** is not detected, then the detected Aruba device falls back to pass-through and preserve sDSCP/802.1p markings.

Viewing the Blacklisted MAC Address of the Rogue APs

You can use the following command to view details on the blacklisted MAC addresses received from the IAPs:

```
(host) #show lldp neighbor interface  gigabitethernet 1/0/40 detail

Interface: gigabitethernet1/0/40, Number of neighbors: 1
------------------------------------------------------------
Chassis id: d8:c7:c8:ce:0d:63, Management address: 192.168.0.252
Interface description: bond0, ID: d8:c7:c8:ce:0d:63, MTU: 1522
Device MAC: d8:c7:c8:ce:0d:63
Last Update: Thu Sep 27 10:59:37 2012
Time to live: 120, Expires in: 103 Secs
System capabilities : Bridge,Access point
Enabled capabilities: Access point
System name: d8:c7:c8:ce:0d:63
System description:
   ArubaOS (MODEL: 105), Version 6.1.3.4-3.1.0.0 (35380)
Auto negotiation: Supported, Enabled
Autoneg capability:
   10Base-T, HD: yes, FD: yes
   100Base-T, HD: yes, FD: yes
   1000Base-T, HD: no, FD: yes
Media attached unit type: 1000BaseTFD - Four-pair Category 5 UTP, full duplex mode (30)
MAC:          7c:d1:c3:c7:e9:72: Blacklist
MAC:          9c:b7:0d:7d:0b:72: Blacklist
MAC:          7c:d1:c3:d1:02:c8: Blacklist
```

Viewing Port Errors

The following command displays the state of the interface due to the detection of the blacklisted rogue AP by the MAS:

```
(host) # show port-error-recovery

Layer-2 Interface Error Information
-----------------------------------
Interface  Error                        Error seen time          Recovery time
---------  -----                        ---------------          -------------
GE0/0/47   Blacklisted device detected  2012-05-09 20:37:10 (PST)  2012-05-09 20:42:10 (PST)
```

Recovering Ports Manually

You can use the following command to manually recover the state of the interface:

```
(host) (config) #clear port-error-recovery interface <interface-name>
```

The following command clears the errors on gigabitethernet 0/0/42:

```
(host) (config) #clear port-error-recovery interface gigabitethernet 0/0/42
```

To clear the port errors on all interfaces execute the following command:

```
(host) (config) #clear port-error-recovery
```

NOTE

The interface recovers from the port error state automatically after five minutes and can be re-activated.

This chapter describes the following topics:

Overview

Aruba AirGroup is a unique enterprise-class capability that leverages zero configuration networking to allow mobile devices to use services like the Apple AirPrint wireless printer service and the Apple AirPlay streaming service. These services use multicast DNS (mDNS) packets to locate devices and the services that those devices offer.

To ensure Wired and Wireless AirPrint/AirPlay devices can communicate with one another previously required all devices to be on the same Layer-2 network which may not be desirable. Airgroup, which was introduced in ArubaOS 7.2 for the Mobility Access Switch and ArubaOS 6.1.3.4-AirGroup for the Mobility Controller, avoids that need by enabling the ability to just redirect mDNS traffic to a Mobility Controller regardless of VLAN. A simple rule on the MAS is used to redirect all incoming mDNS packets on a port to an L2-GRE tunnel which is then terminated on a Mobility Controller. This allows the Mobility Controller to handle the rest of the AirGroup functionality.

Aruba AirGroup is available in two deployment models; Integrated and Overlay. The location of the mDNS proxy function primarily differentiates the two deployment models. The Mobility Access Switch can interoperate in either deployment model but uses the same underlying features like L2-GRE tunnels used in the Overlay Deployment Model between Mobility Controller.

For more information about Aruba AirGroup, Overlay Deployment Model, and configuration, see the *Aruba AirGroup Deployment Guide*.

Configuring mDNS packet forwarding

To configure mDNS packet forwarding to an AirGroup Mobility Controller, see the following procedures.

1. Create a switching profile and add VLAN for mDNS traffic.

```
(host) (config) #interface-profile switching-profile  <profile-name>
(host) (switching profile) #switchport-mode trunk
(host) (switching profile) #trunk allowed vlan <vlan-list>
```

NOTE

Both ends of an L2-GRE tunnel must carry the same user VLANs.

2. Configure an L2-GRE tunnel and apply the switching profile.

   ArubaOS Mobility Access Switch supports L2 connectivity through GRE tunnel. L2-GRE tunnel extends VLANs across switches and Aruba controllers.

NOTE

If the MAS and AirGroup controller are on the same L2 network, L2-GRE tunnel is not required.

```
(host) (config) #interface tunnel ethernet <tunnel-id>
(host) (Tunnel “tunnel-id”) #description <interface-description>
(host) (Tunnel “tunnel-id”) #source-ip <source-tunnel-ip>
(host) (Tunnel “tunnel-id”) #destination-ip <destination-tunnel-ip>
(host) (Tunnel “tunnel-id”) #switching-profile <profile-name>
```

```
(host) (Tunnel "tunnel-id") #keepalive <Tunnel heartbeat interval in seconds (1-86400)> <Tu
nnel Heartbeat Retries (1-1024)>
```

3. Configure a stateless ACL with mDNS UDP port 5353 redirect rule.

```
(host) (config) #ip access-list stateless <name of the access-list>
(host) (config-stateless)#any any udp 5353 redirect tunnel <L2-GRE-tunnel-ID>
```

NOTE

The Extended-action options appearing in a stateless ACL after `redirect tunnel <ID>` are unsupported.

4. Apply redirect ACL to either a port or user role.
   a. Apply redirect ACL to a port.

NOTE

Before you apply redirect ACL to a port, you must create explicit allow rules while configuring mDNS redirect ACL to permit non-mDNS traffic.

```
(host) (config) #interface gigabitethernet <slot/module/port>
(host) (gigabitethernet) #ip access-group in <ingress-access-control-list>
```

   b. Apply redirect ACL to a user role.

NOTE

Add the mDNS redirect ACL to position one of the user-role.

```
(host) (config) #user-role <role-name>
(host) (config-role) #access-list stateless <name-of-access-list> position 1
```

Inter-tunnel flooding

There can be multiple switches from the same L2 network having L2-GRE tunnel terminating at a single controller. This may generate inter-tunnel flooding resulting in loops within the switch network. To avoid this scenario, disable inter-tunnel flooding in the switch and the controller.

```
(host) (config) #interface tunnel ethernet <tunnel-id>
(host) (Tunnel "tunnel-id") #no inter-tunnel-flooding
```

Sample Configuration

To create a switching profile and add VLAN for mDNS traffic:

```
(host) (config) #interface-profile switching-profile  mDNS_vlan_200
(host) (switching profile "mDNS_vlan_200") #switchport-mode trunk
(host) (switching profile "mDNS_vlan_200") #trunk allowed vlan 200
```

To configure an L2-GRE tunnel and apply the switching profile:

```
(host) (config) #interface tunnel ethernet 1
(host) (Tunnel "1") #description L2-GRE_Interface
(host) (tunnel "1") #source-ip 10.0.0.1
(host) (tunnel "1") #destination-ip 10.0.1.2
(host) (tunnel "1") #switching-profile mDNS_vlan_200
(host) (tunnel "1") #keepalive 30 5
```

To configure stateless ACL with mDNS redirect rule:

```
(host) (config) #ip access-list stateless mDNS_redirect
(host) (config-stateless-mDNS_redirect)#any any udp 5353 redirect tunnel 1
```

To apply redirect ACL to a port:

```
(host) (config) #interface gigabitethernet 0/0/1
(host) (gigabitethernet "0/0/1") #ip access-group in mDNS_redirect
```

To apply redirect ACL to a user role:

```
(host) (config) #user-role employee
(host) (config-role) #access-list stateless mDNS_redirect position 1
```

ArubaOS for the Mobility Access Switch and ClearPass Policy Manager (CPPM) include support for centralized policy definition and distribution. ArubaOS Mobility Access Switch introduces downloadable roles. By using this feature, when CPPM successfully authenticates a user, the user is assigned a role by CPPM and if the role is not defined on the Mobility Access Switch, the role attributes can also be automatically downloaded.

This chapter contains the following sections:

Introduction

In order to provide highly granular per-user level access, user roles can be created when a user has been successfully authenticated. During the configuration of a policy enforcement profile at CPPM, the administrator can define a role that should be assigned to the user after successful authentication. In RADIUS authentication, when CPPM successfully authenticates a user, the user is assigned a role by CPPM and if the role is not defined on the Mobility Access Switch, the role attributes can also be automatically downloaded.

Important Points to Remember

- Under **Advanced** mode, CPPM does not perform any error checking to confirm accuracy of the role definition. Therefore, it is recommended that you review the role defined in CPPM prior to enabling this feature.
- Attributes that are listed below, herein referred to as whitelist role attributes, can be defined in CPPM. The VLAN attribute under user-role may be referenced, but cannot be defined in CPPM.
  - **netdestination**
  - **netservice**
  - **ip access-list stateless**
  - **ip access-list eth**
  - **ip access-list mac**
  - **ip access-list session**
  - **user-role**
    - **re-authentication interval**
  - **time-range**
    - **periodic**
    - **absolute**
  - **aaa authentication captive-portal**

NOTE: Under **aaa authentication captive-portal** profile, **server-group** parameter can be referenced, but cannot be defined in CPPM.

  - **qos-profile**
  - **policer-profile**
  - **interface-profile voip-profile**

- The above attributes that are referred to by a role definition must either be defined within the role definition itself or configured on the Mobility Access Switch before the policy is downloaded.
- In CPPM, two or more attributes (as listed above) should not have the same name. Example below is considered invalid as both the attributes have **test** as the profile/net destination name.

  ```
  qos-profile test
  netdestination test
  ```
- An instance name (name of a whitelist role attribute as stated above) is case-sensitive. Attributes must adhere to the following rules:
  - Should not match any CLI option nested under a command from the whitelist.
  - Should not contain a number or a combination of numbers.
  - Should not contain any periods '.'.
  - Should not contain any spaces.

  Example below are considered as invalid configurations and will fail CPPM role download on Mobility Access Switch:

  ```
  netservice 'tcp' tcp 443
  ```

  The first instance of **tcp** is a user-defined field while the second is an operator of the **netservice** command. This violates the first rule.

  ```
  netdestination 'alias'
  ```

  The user-defined name **alias** is also a valid operator of the **netdestination** command. This violates the first rule.

  ```
  netdestination '10.1.5'
  ```

  This user-defined name uses both numbers and periods. This violates the second and third rule.

  ```
  ip access-list stateless '100'
  ```

  This user-defined name uses numbers. This violates the second rule.

  ```
  qos-profile emp role
  ```

  This profile name **emp role** contains spaces. This violates the fourth rule.

It is recommended that some naming convention similar to the CamelCase (mixture of upper and lower case letters in a single word) be used to avoid collisions with the CLI options in the role description.

Enabling Downloadable Role on Mobility Access Switch

You can enable role download using the CLI or WebUI.

Using the WebUI

1. Navigate to the **Configuration > Authentication > Profiles** tab.
2. Select an AAA profile.
3. Select **Enabled** from the **Role Download** drop-down list.

Using the CLI

```
(host) (config) #aaa profile <profile-name>
(host) (AAA profile) #download-role
```

Sample Configuration

The following example shows the configuration details to integrate CPPM server with Mobility Access Switch to automatically download roles.

CPPM Server Configuration

Adding a Device

1. From the **Configuration > Network > Devices** page, click the **Add Device** link.
2. On the **Device** tab, enter the **Name**, **IP or Subnet Address**, and **RADIUS Shared Secret** fields.

   Keep the rest of the fields as default.
3. Click **Add**.

The fields are described in Figure 24 and Table 39.

Figure 24 *Device Tab*

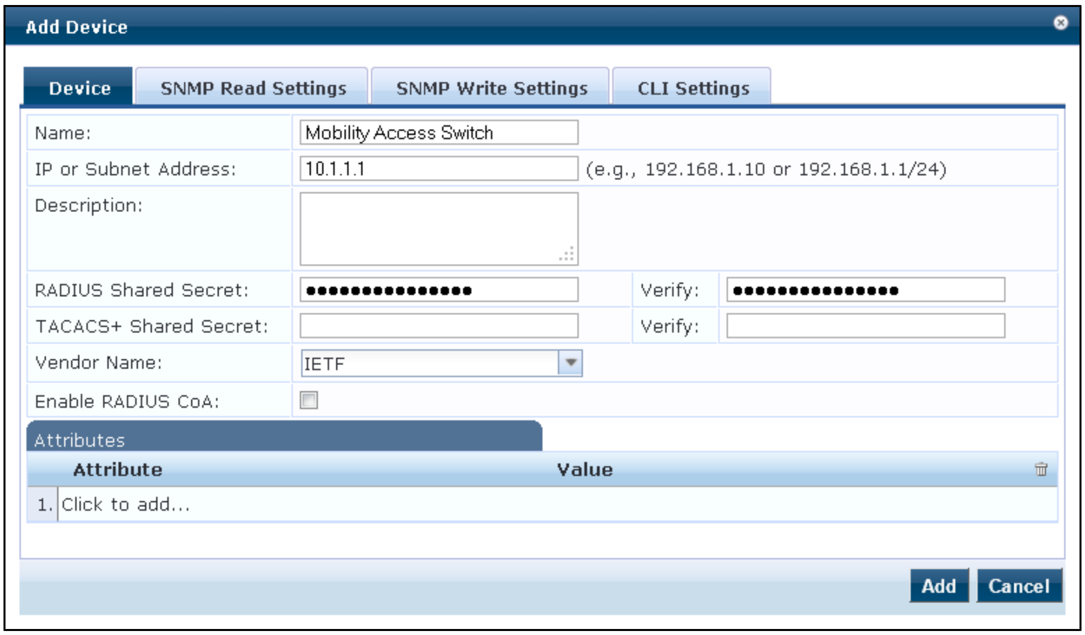


Table 39: *Device Tab*

Container	Description
Name	Specify the name or identity of the device.
IP or Subnet Address	Specify the IP address or subnet (example 10.1.1.1/24) of the device.
RADIUS Shared Secret	Enter and confirm a Shared Secret for each of the two supported request protocols.

Adding Enforcement Profile

1. From **Configuration > Enforcement > Profiles** page, click **Add Enforcement Profile**.
2. On the **Profile** tab, select **Aruba Downloadable Role Enforcement** from the **Template** drop-down list.
3. Enter the **Name** of the enforcement profile.
4. From the **Role Configuration Mode**, select **Standard** or **Advanced**.

   Keep the rest of the fields as default.
5. Click **Next**.

   For the rest of the configuration, see Standard Role Configuration Mode or Advanced Role Configuration Mode.

The fields are described in Figure 25 and Table 40.

Figure 25 *Enforcement Profiles Page*

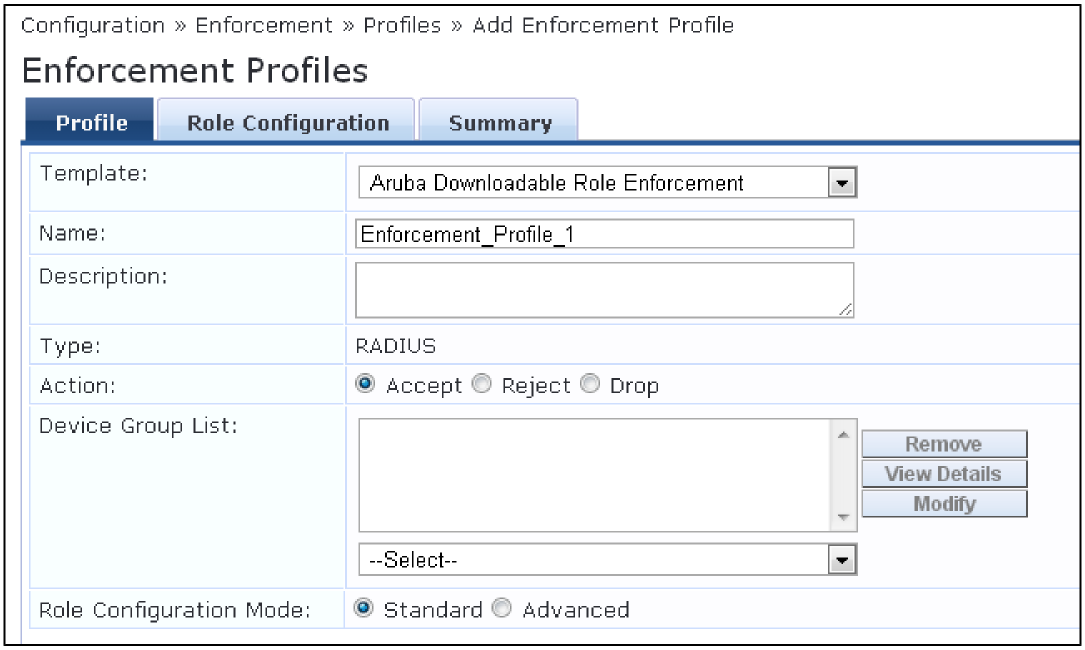


Table 40: *Enforcement Profiles Page*

Container	Description
Template	Policy Manager comes pre-packaged with several enforcement profile templates. In this example, select **Aruba Downloadable Role Enforcement** - RADIUS template that can be filled with user role definition to create roles that can be assigned to users after successful authentication.
Name	Specify the name of the enforcement profile.
Role Configuration Mode	Standard–Configure enforcement profile role using standard mode. Advanced–Configure enforcement profile role using advanced mode.

Standard Role Configuration Mode

1. Under **Role Configuration** tab, enter the parameters based on Table 41.
2. Click **Save**.

The fields are described in Figure 26 and Table 41.

Figure 26 *Enforcement Profiles Role Configuration Tab*

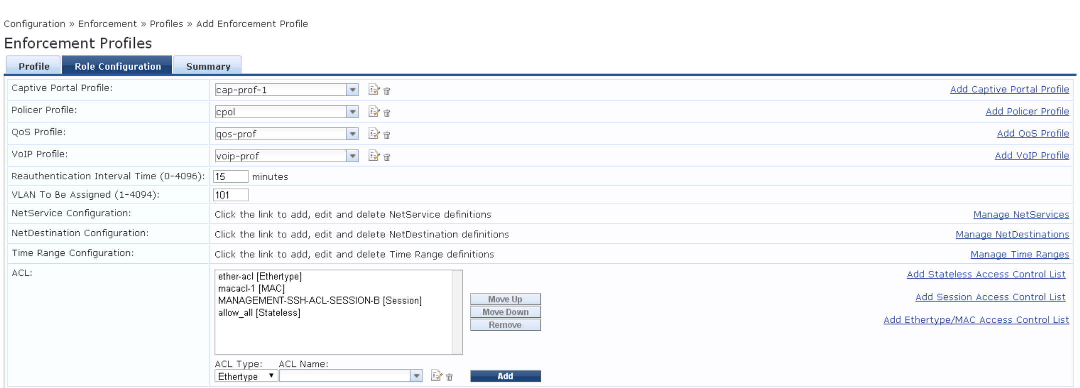


Table 41: *Enforcement Profiles Role Configuration Tab*

Container	Description
Captive Portal Profile	This parameter defines a Captive Portal authentication profile.
Policer Profile	This parameter defines a policer profile to manage the transmission rate of a class of traffic based on user-defined criteria.
QoS Profile	This parameter defines a QoS profile to assign Traffic-Class/Drop-Precedence, Differentiated Services Code Point (DSCP), and 802.1p values to an interface or policer profile of a Mobility Access Switch.
VoIP Profile	This parameter defines a VoIP profile that can be applied to any interface, interface group, or a port-channel of a Mobility Access Switch.
Reauthentication Interval Time (0–4096)	Time interval in minutes after which the client is required to reauthenticate.
VLAN To Be Assigned (0–4094)	Identifies the VLAN ID to which the user role is mapped.
NetService Configuration	Defines an alias for network protocols. Aliases can simplify configuration of session ACLs, as you can use an alias when specifying the network service. Once you configure an alias, you can use it in multiple session ACLs.
NetDestination Configuration	Defines an alias for an IPv4 network host, subnet mask, or a range of addresses. Aliases can simplify configuration of session ACLs, as you can use an alias when specifying the traffic source and/or destination IP in multiple session ACLs.
Time Range Configuration	The following time-range can be defined: **Periodic**–Specifies a recurring time range. Specify the start and end time and Daily, Weekday, Weekend, or the day of the week. **Absolute**–Specifies an absolute time range, with a specific start and/or end time and date.
ACL	Adds the following Access Control List (ACL): **Ethertype**–Defines an Ethertype ACL. The Ethertype field in an Ethernet frame indicates the protocol being transported in the frame. This type of ACL filters on the Ethertype field in the Ethernet frame header, and is useful when filtering non-IP traffic on a physical port. This ACL can be used to permit IP frames while blocking other non-IP protocols such as IPX or Appletalk. **MAC**–Defines a MAC ACL. MAC ACLs allow filtering of non-IP traffic. This ACL filters on a specific source MAC address or range of MAC addresses. **Session**–Defines a session ACL. Session ACLs define traffic and firewall policies on the Mobility Access Switch. You can configure multiple rules for each policy, with rules evaluated from top (1 is first) to bottom. The first match terminates further evaluation. Generally, you should order more specific rules at the top of the list and place less specific rules at the bottom of the list. **Stateless**–Defines a stateless ACL. A stateless ACL statically evaluates packet contents. The traffic in the reverse direction is allowed unconditionally. **NOTE:** In CPPM, do not configure the **Next Hop** parameter under Stateless ACL configuration.
User Role Configuration	See the **Summary** tab for auto-generated Role Configuration.

Advanced Role Configuration Mode

1. On the **Attributes** tab, select **Radius:Aruba** from the **Type** drop-down list.
2. From the **Name** drop-down list, select **Aruba-CPPM-Role**.
3. In the **Value** field, enter the attribute for the downloadable-role.
4. Click the save icon to save the attribute.
5. Click **Save** to save the enforcement profile.

The fields are described in Figure 27 and Table 42.

Figure 27 *Enforcement Profiles Attributes Tab*

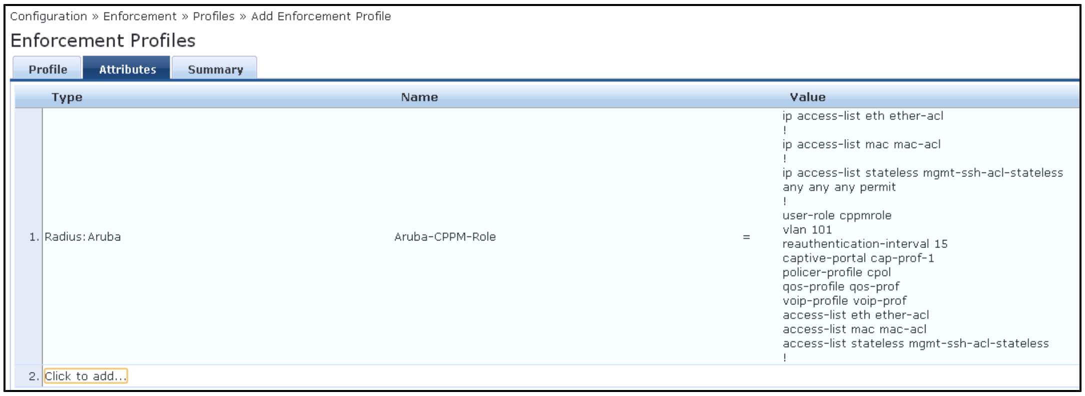


Table 42: *Enforcement Profiles Attributes Tab*

Container	Description
Type	Type is any RADIUS vendor dictionary that is pre-packaged with Policy Manager, or imported by the Administrator. This field is pre-populated with the dictionary names.
Name	Name is the name of the attribute from the dictionary selected in the Type field. The attribute names are pre-populated from the dictionary.
Value	Value is attribute for the downloadable role. You can enter free-form text to define the role and policy. **NOTE:** The maximum limit for free form text is 16,000 bytes.

Adding Enforcement Policy

1. From **Configuration > Enforcement > Policies** page, click **Add Enforcement Policy**.
2. On the **Enforcement** tab, enter the name of the enforcement policy.
3. From the **Default Profile** drop-down list, select **[Deny Access Profile]**.

   Keep the rest of the fields as default.
4. Click **Next**.

The fields are described in Figure 28 and Table 43.

Figure 28 *Enforcement Policies Enforcement Tab*

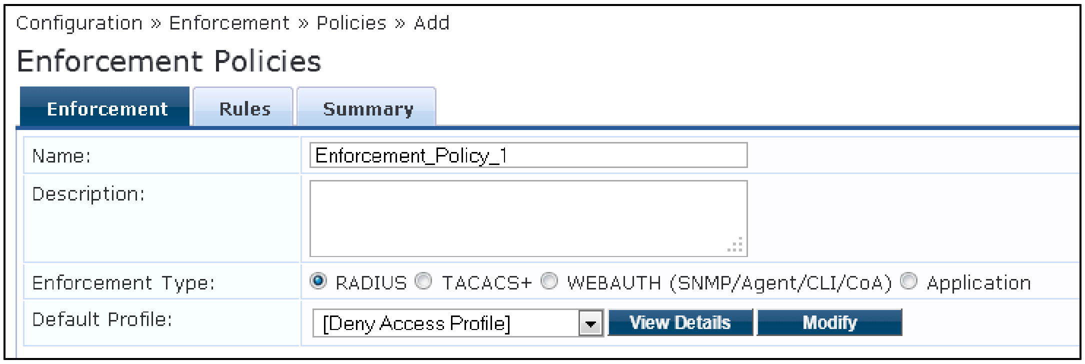


Table 43: *Enforcement Policies Enforcement Tab*

Container	Description
Name	Specify the name of the enforcement policy.
Default Profile	An Enforcement Policy applies Conditions (roles, health, and time attributes) against specific values associated with those attributes to determine the Enforcement Profile. If none of the rules matches, Policy Manager applies the Default Profile. See Adding Enforcement Profile on page 338 to add a new profile.

5. On the **Rules** tab, click **Add Rule**.
6. On the **Rules Editor** pop-up, select the appropriate values in the **Conditions** section and click the save icon.
7. In the **Enforcement Profiles** section, select the RADIUS enforcement profile that you created in step Adding Enforcement Profile on page 338 from the **Profile Names** drop-down list.
8. Click **Save**.

The fields are described in Figure 29 and Table 44.

Figure 29 *Enforcement Policies Rules Editor*

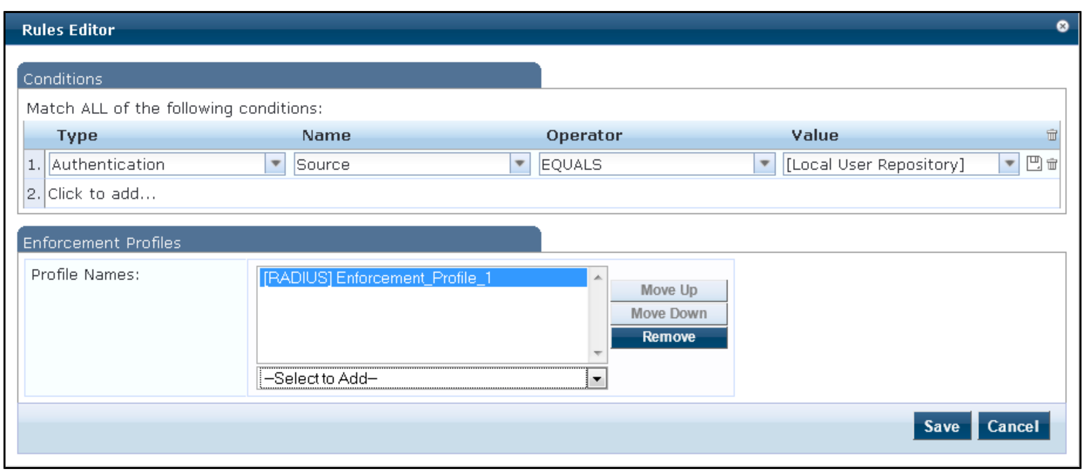


Table 44: *Enforcement Policies Rules Editor*

Container	Description
Type	The rules editor appears throughout the Policy Manager interface. It exposes different namespace dictionaries depending on Service type. When working with service rules, you can select **Authentication** namespace dictionary
Name	Drop-down list of attributes present in the selected namespace. In this example, select **Source**.
Operator	Drop-down list of context-appropriate (with respect to the attribute) operators. In this example, select **EQUALS**.
Value	Drop-down list of the Authentication source database. In this example, select **[Local User Repository]**.
Profile Names	Name of the RADIUS enforcement profile.

Adding Services

1. From the **Configuration > Services** page, click the **Add Service** link.
2. On the **Service** tab, select **802.1X Wired** from the **Type** drop-down-list.
3. In the **Name** field, enter the name of the service.

   Keep the rest of the fields as default.
4. Click **Next**.

The fields are described in Figure 30 and Table 45.

Figure 30 *Service Tab*

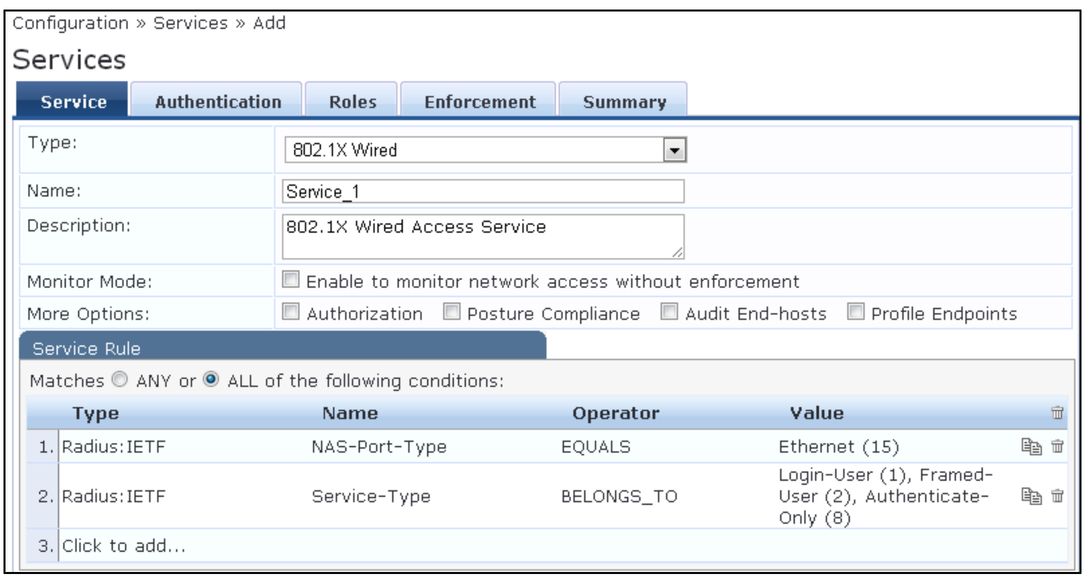


Table 45: *Service Tab*

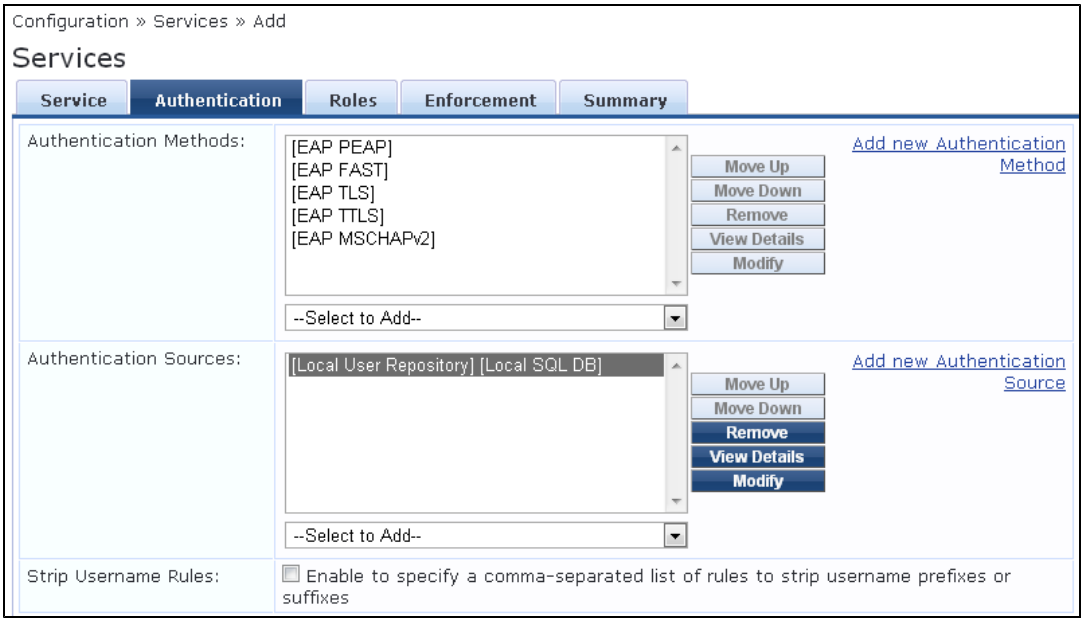
Container	Description
Type	Select the desired service type from the drop down menu. In this example, select **802.1X Wired**.
Name	Specify the name of the service.

5. On the **Authentication** tab, select **[Local User Repository] [Local SQL DB]** from the **Authentication Sources** drop-down list.

   Keep the rest of the fields as default.
6. Click **Next** twice.

The fields are displayed in Figure 31.

Figure 31 *Authentication Tab*

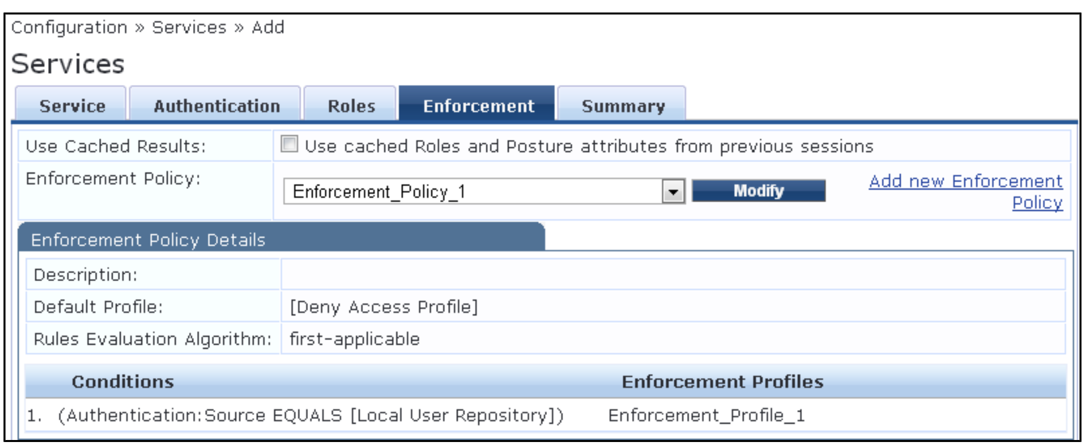


7. On the **Enforcement** tab, select the enforcement policy that you created in step Adding Enforcement Policy on page 341 from the **Enforcement Policy** drop-down list.

   Keep the rest of the fields as default.
8. Click **Save**.

The fields are displayed in Figure 32.

Figure 32 *Enforcement Tab*



For more configuration details on CPPM, see the *ClearPass Policy Manager 6.2 User Guide.*

Mobility Access Switch Configuration

Configuring CPPM Server on Mobility Access Switch

```
(host) (config) #aaa authentication-server radius cppm_server
(host) (RADIUS Server "cppm_server") #host <ip_address_of_cppm_server>
(host) (RADIUS Server "cppm_server") #key <shared_secret>
```

Configuring Server Group to include CPPM Server

```
(host) (config) #aaa server-group cppm_grp
(host) (Server Group "cppm_grp") #auth-server cppm_server
```

Configuring 802.1X Profile

```
(host) (config) #aaa authentication dot1x cppm_dot1x_prof
```

Configuring AAA Profile

```
(host) (config) #aaa profile cppm_aaa_prof
(host) (AAA Profile "cppm_aaa_prof") #authentication-dot1x cppm_dot1x_prof
(host) (AAA Profile "cppm_aaa_prof") #dot1x-server-group cppm_grp
(host) (AAA Profile "cppm_aaa_prof") #download-role
```

Show AAA Profile

```
(host) #show aaa profile cppm_aaa_prof

AAA Profile "cppm_aaa_prof"
---------------------------
Parameter                              Value
---------                              -----
Initial role                           logon
MAC Authentication Profile             N/A
MAC Authentication Default Role        guest
MAC Authentication Server Group        default
802.1X Authentication Profile          cppm_dot1x_prof
802.1X Authentication Default Role     guest
802.1X Authentication Server Group     cppm_grp
Download Role from ClearPass           Enabled
L2 Authentication Fail Through         Enabled
RADIUS Accounting Server Group         N/A
RADIUS Interim Accounting              Disabled
XML API server                         N/A
AAA unreachable role                   N/A
RFC 3576 server                        N/A
User derivation rules                  N/A
SIP authentication role                N/A
Enforce DHCP                           Disabled
Authentication Failure Blacklist Time  3600 sec
```

Wireless networks can use virtual private network (VPN) connections to further secure wireless data from attackers.

NOTE: The Mobility Access Switch supports only Site-to-Site VPN configurations in tunnel mode and does not support IPSec transport mode.

NOTE: There is no Equal Cost Multiple Path (ECMP) support over VPN.

Planning a Site-to-Site VPN Configuration

Site-to-site VPNs allow networks (for example, a branch office network) to connect to other networks (for example, a corporate network). Unlike a remote access VPN, hosts in a site-to-site VPN do not run VPN client software. All traffic for the other network is sent and received through a VPN gateway which encapsulates and encrypts the traffic.

The following IKE authentication methods are supported for site-to-site VPNs:

- Preshared Key authentication
- Certificate authentication. You can configure a RSA server certificate and a CA certificate for each site-to-site VPN IPsec map configuration. If you are using certificate-based authentication, the peer must be identified by its certificate subject-name distinguished name (for deployments using IKEv2) or by the peer's IP address (for IKEv1).

NOTE: Certificate-based authentication is supported for site-to-site VPN between two Aruba devices with static IP addresses. Additionally, Certificate-based authentication is also supported with dynamic IP addresses when IKEv2 is used.

Selecting an IKE protocol

Mobility Access Switches running ArubaOS 7.2 and later support both IKEv1 and the newer IKEv2 protocol to establish IPsec tunnels. IKEv2 is simpler, faster, and a more reliable protocol than IKEv1.

If your IKE policy uses IKEv2, you should be aware of the following caveats when you configure your VPN:

- ArubaOS does not support separate pre-shared keys for both directions of an exchange; the same pre-shared key must be used by both peers. ArubaOS does not support mixed authentication with both pre-shared keys and certificates; each authentication exchange requires a single authentication type. (For example, if a Site-to-Site peer authenticates with a pre-shared key, the other peer must also authenticate with a pre-shared key.)
- ArubaOS does not support IKEv2 mobility (MOBIKE), Authentication Headers (AH) or IP Payload Compression Protocol (IPComp).

NOTE: In this relase of Mobility Access Switch, site-to-site tunnels are not coming up using Internet Key Exchange (IKEv1) protocol when SHA1-96 is used as the hash algorithm. As a workaround, use (SHA1-160) as the hash algorithm.

Supported IKE Modes

ArubaOS supports site-to-site VPNs using IKEv2 or IKEv1 Main-mode/Aggressive-mode. By default, site-to-site VPN uses IKEv1 Main-mode with Pre-Shared-Keys to authenticate the IKE security association (SA). This method requires static IP addresses between the peers and therefore will not work for dynamically addressed peers.

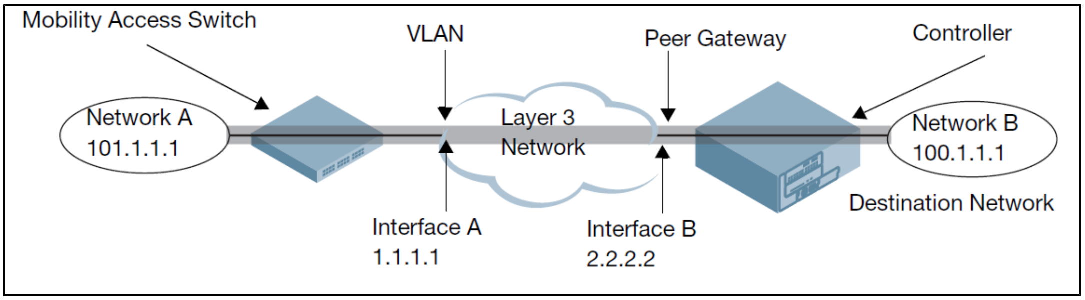
To support site-site VPN with dynamically addressed devices, you must use IKEv1 Aggressive-mode or IKEv2 with certificates. The VPN endpoint with a dynamic IP address must be configured to be the initiator and the endpoint with the static IP address must be configured as the responder.

Aruba Mobility Access Switch and Mobility Controllers can use IKEv1 or IKEv2 to establish a site-to-site VPN between another Mobility Access Switch or Mobility Controller or between that Mobility Access Switch and third party device. Note, however, that only Aruba devices (Mobility Access Switches or Mobility Controllers) and devices running Windows 2008 Server or Strongswan 4.3 support IKEv2 authentication.

VPN Topologies

You must configure VPN settings on the devices at both the local and remote sites. In the following figure, a VPN tunnel connects Network A to Network B across the Internet.

Figure 33 *Site-to-Site VPN Configuration Components*



To configure the VPN tunnel on Mobility Access Switch, you need to configure the following:

- The source network (Network A).
- The destination network (Network B).
- The VLAN or loopback interface on the Mobility Access Switch connected to the Layer-3 network (Interface A in the Figure 33).
- The peer gateway address, which is the IP address of the Mobility Controller's interface connected to the Layer-3 network (Interface B in the Figure 33).

Configuring VPN

To configure a site-to-site VPN with a static IP Mobility Access Switch device and static IP Mobility Controller using IKEv1, issue the following commands:

```
(host) (config) #crypto-local ipsec-map <name> <priority>
   (host) (config-ipsec-map) #src-net <ipaddr> <mask>
   (host) (config-ipsec-map) #dst-net <ipaddr> <mask>
   (host) (config-ipsec-map) #peer-ip <ipaddr>
   (host) (config-ipsec-map) #interface [loopback <loopback-number>|vlan <vlan-id>]
   (host) (config-ipsec-map) #version v1
   (host) (config-ipsec-map) #pre-connect enable|disable
```

For certificate authentication:

```
(host) (config) #set ca-certificate <cacert-name>
(host) (config) #set server-certificate <cert-name>
(host) (config) #crypto isakmp policy <priority>
   (host) (config-isakmp) #encryption {3des|aes128|aes192|aes256|des}
   (host) (config-isakmp) #version v1
   (host) (config-isakmp) #authentication rsa-sig
   (host) (config-isakmp) #group 1|2
   (host) (config-isakmp) #hash {md5|sha|sha1-96}
```

```
   (host) (config-isakmp) #lifetime <seconds>
```

For preshared key authentication:

```
(host) (config) #crypto-local isakmp key <key> address <ipaddr> netmask <mask>

(host) (config) #crypto isakmp policy <priority>
   (host) (config-isakmp) #encryption {3des|aes128|aes192|aes256|des}
   (host) (config-isakmp) #version v1
   (host) (config-isakmp) #authentication pre-share
   (host) (config-isakmp) #group {1|2}
   (host) (config-isakmp) #hash {md5|sha|sha1-96}
   (host) (config-isakmp) #lifetime <seconds>
```

To configure site-to-site VPN with a static Mobility Access Switch and a dynamically addressed Mobility Controller that initiates IKE Aggressive-mode for Site-Site VPN:

```
(host) (config) #crypto-local ipsec-map <name> <priority>
   (host) (config-ipsec-map) #src-net <ipaddr> <mask>
   (host) (config-ipsec-map) #dst-net <ipaddr> <mask>
   (host) (config-ipsec-map) #peer-ip <ipaddr>
   (host) (config-ipsec-map) #local-fqdn <local_id_fqdn>
   (host) (config-ipsec-map) #interface [loopback <loopback-number>|vlan <vlan-id>]
   (host) (config-ipsec-map) #pre-connect [enable|disable]
```

For the Pre-shared-key:

```
crypto-local isakmp key <key> address <ipaddr> netmask 255.255.255.255
```

For a static IP Mobility Controller that responds to IKE Aggressive-mode for Site-Site VPN:

```
(host) (config) #crypto-local ipsec-map <name2> <priority>
   (host) (config-ipsec-map) #src-net <ipaddr> <mask>
   (host) (config-ipsec-map) #dst-net <ipaddr> <mask>
   (host) (config-ipsec-map) #peer-ip 0.0.0.0
   (host) (config-ipsec-map) #peer-fqdn fqdn-id <peer_id_fqdn>
   (host) (config-ipsec-map) #vlan <id>
```

For the Pre-shared-key:

```
(host) (config) #crypto-local isakmp key <key> fqdn <fqdn-id>
```

For a static IP Mobility Access Switch that responds to IKE Aggressive-mode for Site-Site VPN with One PSK for All FQDNs:

```
(host) (config) #crypto-local ipsec-map <name2> <priority>
   (host) (config-ipsec-map) #src-net <ipaddr> <mask>
   (host) (config-ipsec-map) #peer-ip 0.0.0.0
   (host) (config-ipsec-map) #peer-fqdn any-fqdn
   (host) (config-ipsec-map) #vlan <id>
```

For the Pre-shared-key for All FQDNs:

```
(host) (config) #crypto-local isakmp key <key> fqdn-any
```

Configuration Examples

Main-Mode

The following example shows a Mobility Access Switch with static IP address and Mobility Controller with a static IP address.

Mobility Access Switch:

```
(host) (config) #crypto-local ipsec-map Test1 1
(host) (config-ipsec-map) #src-net 1.1.1.1 255.255.255.0
(host) (config-ipsec-map) #dst-net 2.2.2.2 255.255.255.0
(host) (config-ipsec-map) #peer-ip 159.116.110.10
(host) (config-ipsec-map) #local-fqdn sample@arubanetworks.com
```

```
(host) (config-ipsec-map) #interface vlan 62
(host) (config-ipsec-map) #version v2
(host) (config-ipsec-map) #pre-connect enable
(host) (config-ipsec-map) #exit
(host) (config) #cryto-local isakmp key 12345678 159.116.110.10 netmask 255.255.255.255
```

Controller:

```
(host) (config) #crypto-local ipsec-map Test2 1
(host) (config-ipsec-map) #src-net 2.2.2.0 255.255.255.0
(host) (config-ipsec-map) #dst-net 1.1.1.0 255.255.255.0
(host) (config-ipsec-map) #peer-ip 0.0.0.0
(host) (config-ipsec-map) #peer-fqdn fqdn-id sample@arubanetworks.com
(host) (config-ipsec-map) #vlan 1
(host) (config-ipsec-map) #version v2
(host) (config-ipsec-map) #trusted enabled
(host) (config-ipsec-map) #exit
(host) (config) #crypto-local isakmp key 12345678 fqdn sample@arubanetworks.com
```

Verifying VPN Tunnel Configuration

You can use the following CLI commands to verify the VPN configuration.

- `show datapath session`
- `show datapath tunnel`
- `show crypto ipsec sa`
- `show crypto isakmp sa`

Use the following command to verify if the VPN is established :

```
(host) # show datapath  session

Datapath Session Table Entries
------------------------------
Flags: F - fast age, S - src NAT, N - dest NAT
D - deny, R - redirect, Y - no syn
H - high prio, P - set prio, T - set ToS
C - client, M - mirror, V - VOIP
Q - Real-Time Quality analysis
I - Deep inspect, U - Locally destined
E - Media Deep Inspect, G - media signal
u - User Index
Source IP/     Destination IP  Prot SPort DPort  Cntr Prio ToS Age Destination TAge UsrIdx Usr
Ver Flags
Destination MAC
--------------  --------------  ---- ----- -----  ---- ---- --- --- ----------- ---- ------ --
---- -----
62.62.62.10     159.116.110.10  17   500   500    0/0     0 0    1   local       16d  2      2
    FC
159.116.110.10  62.62.62.10     17   500   500    0/0     0 0    2   local       16d  0      0
    F
```

Use the following command to verify the incoming and outgoing packets over the VPN tunnel:

```
(host) # show datapath tunnel

Datapath Tunnel Table Statistics
--------------------------------
Current Entries      6
Pending Deletes      0
High Water Mark      6
Maximum Entries      8191
Total Entries        6
Allocation Failures  0
Max link length      1
```

```
Datapath Tunnel Table Entries
-----------------------------
Flags: E - Ether encap,  I - Wi-Fi encap,  R - Wired tunnel,  F - IP fragment OK
W - WEP,  K - TKIP,  A - AESCCM,  G - AESGCM,  M - no mcast src filtering
S - Single encrypt,  U - Untagged,  X - Tunneled node,  1(cert-id) - 802.1X Term-PEAP
2(cert-id) - 802.1X Term-TLS,  T - Trusted,  L - No looping, d - Drop Bcast/Mcast,
D - Decrypt tunnel,  a - Reduce ARP packets in the air, e - EAPOL only
C - Prohibit new calls, P - Permanent, m - Convert multicast
n - Don't convert IPv6 Mcast RA to Ucast, s - Split tunnel
#       Source        Destination    Prt  Type  MTU   VLAN       Acls                BSSID
    Decaps     Encaps   Heartbeats Cpu QSz Flags
---  --------------  --------------  ---  ----  ----  ---- -------------------  --------------
--- ---------- ---------- ---------- --- --- -----
67   SPIFAED5E00out  159.116.110.10  50   IPSE  1500  0                    routeDest 0000
      0          0
68   SPIE8812300 in  62.62.62.10     50   IPSE  1500  0                    routeDest 0000
          0          0
```

To view the ISAKMP information, use the following command:

```
(host) #show crypto isakmp sa

ISAKMP SA Active Session Information
------------------------------------
Initiator IP     Responder IP   Flags       Start Time      Private IP
------------     ------------   -----     ---------------   ----------
62.62.62.10      159.116.110.10 i-v2-p    Aug  1 05:04:55     -
Flags: i = Initiator; r = Responder
m = Main Mode; a = Agressive Mode v2 = IKEv2
p = Pre-shared key; c = Certificate/RSA Signature; e =  ECDSA Signature
x = XAuth Enabled; y = Mode-Config Enabled; E = EAP Enabled
3 = 3rd party AP; C = Campus AP; R = RAP, A = Aruba VPN
V = VIA; S = VIA over TCP
Total ISAKMP SAs: 1
```

To view the IPSec information, use the following command:

```
(host) #show crypto ipsec sa

IPSEC SA (V2) Active Session Information
-----------------------------------
Initiator IP     Responder IP     SPI(IN/OUT)        Flags Start Time        Inner IP
------------     ------------     ----------------   ----- ---------------   --------
62.62.62.10      159.116.110.10   e8812300/faed5e00  T2    Aug  1 05:04:55     -
Flags: T = Tunnel Mode; E = Transport Mode; U = UDP Encap
L = L2TP Tunnel; N = Nortel Client; C = Client; 2 = IKEv2
Total IPSEC SAs: 1
```

Aggressive-Mode with Tunneled Node over VPN

ArubaOS Mobility Access Switch also adds support for Tunneled Node over VPN. This allows you to provide all the centralized security policy, authentication, and access-control from a tunneled node over a VPN connection.

The following example shows site-to-site VPN configured between Mobility Access Switch with a dynamic IP address and Mobility Controller with a static IP address. In this example, the Mobility Access Switch is configured to be the initiator of IKE Aggressive-mode and the Mobility Controller is the responder of IKE Aggressive-mode.

1. Establish a VPN connection between the Mobility Access Switch and the Mobility Controller.

   Mobility Access Switch:

   ```
   (host) (config) #crypto-local ipsec-map here-there-vpn 100
   (host) (config-ipsec-map) #src-net 101.1.1.1 255.255.255.0
   (host) (config-ipsec-map) #dst-net 100.1.1.1 255.255.255.0
   (host) (config-ipsec-map) #peer-ip 2.2.2.2
   ```

```
(host) (config-ipsec-map) #local-fqdn test@abc.com
(host) (config-ipsec-map) #interface vlan 2
(host) (config) #cryto-local isakmp key secret address 2.2.2.2 netmask 255.255.255.255
```

Mobility Controller:

```
(host) (config) #crypto-local ipsec-map there-here-vpn 100
(host) (config-ipsec-map) #src-net 100.1.1.0 255.255.255.0
(host) (config-ipsec-map) #dst-net 101.1.1.0 255.255.255.0
(host) (config-ipsec-map) #peer-ip 0.0.0.0
(host) (config-ipsec-map) #peer-fqdn fqdn-id test@abc.com
(host) (config-ipsec-map) #vlan 2
(host) (config) #crypto-local isakmp key secret fqdn test@abc.com
```

2. Establish a Tunneled Node connection between the Mobility Access Switch and Mobility Controller. Ensure that the Mobility Access Switch's switch IP is in the IPSec source network and the Mobility Controller's IP address is in the IPSec destination network.

```
(host)(config)(Tunneled Node Server profile "tunnel1")#
(host) (config) #controller-ip 100.1.1.1

(host)# show interface-profile tunneled-node-profile tunnel1
Tunneled Node Server profile "tunnel1"
Parameter                     Value
---------                     -----
Controller IP Address         100.1.1.1
Keepalive timeout in seconds  10
MTU on path to controller     1400
```

3. Apply the tunneled node profile to an interface.

Static Route Support for VPN

You can also configure a static route to be used with VPN to and from your Mobility Access Switch. Use the following command to configure a static route using an IPSec map.

```
(host) (config) #ip-profile
(host) (ip-profile) #route <destip> <netmask> ipsec <mapname> metric <metric>
```

The value **metric** is used to enable IPSec route redundancy. **Metric** is cost assigned to the IPSec map that determines which map should be used first and which map should be used if the first map is unavailable.

```
(host) (ip-profile) #route 5.5.5.0 255.255.255.0 ipsec map1 metric 10
(host) (ip-profile) #route 5.5.5.0 255.255.255.0 ipsec map2 metric 20
```

In the above example, map1 would be used over map2. However, if map1 was unavailable, map2 would be used.

NOTE

Pre-connect must be enabled on the IPSec maps for IPSec route redundancy.

The static route to IPSec map can be configured before or after the crypto map. If the static route is configured before the IPSec map, the static route is kept in the configuration; however, the route is not pushed to the routing table.

Troubleshooting

You can use the following commands to troubleshoot VPN related issues:

- `show log security all | include ike`–View the logs.
- `show datapath tunnel`–Verify the encapsulation/decapsulation information.

You can also use the following commands to clear the crypto information:

- `clear crypto dp`– Clears crypto latest DP packets.

- `clear crypto ipsec`– Clears crypto IPSec state.
- `clear crypto isakmp`– Clears crypto ISAKMP state.

Chapter 42 Port Mirroring

You can use port mirroring to send copies of all or sampled packets seen on specific port(s) or port-channel to a destination. You can use this method for appliances such as sniffers that monitor network traffic for further analysis.

This chapter includes the following topics:

Important Points to Remember

- The destination port must be a local interface.
- A VLAN cannot be configured as the destination.
- The Mobility Access Switch mirroring session limit is one.

The Source Port

You can use port mirroring to take a copy of the ingress and egress packets on one or more ports. Packets are sent to the destination without modification at Layer 2. Any number of network ports can be configured for monitoring. Port-channel can also be the source for mirroring. If the bandwidth for source is greater than the destination, packets loss can occur. The Mobility Access Switch does not distinguish whether the source port is a Layer 2 access or trunk interface.

The Destination Port

One port can be the destination interface; Port-channels and VLANs cannot be a destination. Normal traffic forwarding will not be performed on the destination port. Only the mirrored packets can be received on the destination port. A destination port cannot be a port mirroring source port at the same time. The destination port does not participate in any Layer 2 protocol, including Spanning-tree. Switching profile such as access or trunk profile cannot be applied on the destination port.

Mirroring Sampled Ratio

You can configure the Mobility Access Switch to mirror at a ratio of one out of X packets (1:X) to the destination. The value of X can be between 0 and 2,047.

Table 46: *Sampled Ratio Values*

Ratio (X value)	Description
0	Does not mirror any packet to the destination.
1	Mirrors all packets to the destination (1:1). This is the default.
100	Mirrors 1 out of 100 packets to the destination.
...	...
2047	Mirrors 1 out of 2,047 packets to the destination.

Creating and Applying a Mirroring Profile to an Interface

Using the CLI

```
(host)(config)# interface-profile mirroring-profile <profile-name>
   destination gigabitethernet <slot/module/port>
   ratio <0-2047>
   clone <source>
   no {...}
(host)(config)# interface gigabitethernet <slot/module/port>
   mirroring-in-profile <profile-name>
   mirroring-out-profile <profile-name>
```

The **mirroring-in-profile** is used for ingress traffic and the **mirroring-out-profile** is used for egress traffic.

Sample Configuration

```
(host)(config)# interface-profile mirroring-profile MIRROR
   destination gigabitethernet 0/0/40
   ratio 10
   exit
(host)(config)# interface gigabitethernet 0/0/30
   mirroring-in-profile MIRROR
   mirroring-out-profile MIRROR
```

Verifying Port Mirroring Configuration

```
(host) (config) #show mirroring

Mirroring Profile Name : MIRROR
Mirroring Ratio        : 10
Mirroring Destination  : GE0/0/40
Ingress mirrored ports : GE0/0/30
Egress mirrored ports  : GE0/0/30

(host)# show  interface-config gigabitethernet 0/0/30
gigabitethernet "0/0/30"
------------------------
Parameter                         Value
---------                         -----
<output truncated>
Ingress Port Mirroring Profile    MIRROR
Egress Port Mirroring Profile     MIRROR
<output truncated>
```

```
(host)# show interface-profile mirroring-profile MIRROR
Mirroring profile "MIRROR"
--------------------------
Parameter             Value
---------             -----
gigabitethernet       0/0/30
Port mirroring ratio  10
```

This chapter describes the following topics:

Remote Monitoring (RMON) Overview

ArubaOS Mobility Access Switch supports RMON, which provides standard information that a network administrator can use to monitor, analyze, and troubleshoot a group of distributed local area networks (LANs). Monitoring devices (commonly called "probes") contain RMON software agents that collect information and analyze packets. These probes act as servers and the Network Management applications that communicate with them act as clients. While both agent configuration and data collection use SNMP, RMON is designed to operate differently than other SNMP-based systems:

- Probes have more responsibility for data collection and processing, which reduces SNMP traffic and the processing load of the clients.
- Information is only transmitted to the management application when required, instead of continuous polling.

ArubaOS supports the following RMON groups:

- ethernet statistics
- history control
- ethernet history
- alarm
- event

Enabling RMON Service

You can use the following command to enable RMON service on the Mobility Access Switch:

```
(host)(config)# service rmon
```

The **service rmon** command is disabled by default. When the **service rmon** command is disabled, the rmon data is not populated in the CLI display command but all the other configurations can be done. When the **service rmon** command is enabled, all the configurations done before would be applied.

Configuring RMON Parameters

Configuring the Alarm

Table 47 describes the alarm parameters

Table 47: *Alarm Configuration Parameters*

Parameter	Description
alarm-profile	To associate an alarm profile.
monitor	Configures an OID to monitor.
owner	Configures an owner of this alarm entry.

You can use the following command to associate the alarm profile with the alarm entry:

```
(host)(config)#rmon alarm <alarm_index>
(host)(alarm_index)#alarm-profile <alarm-profile-name>
```

You can use the following command to monitor an interface or OID:

```
(host)(alarm_index)#monitor <oid>
```

You can use the following command to monitor OID on gigabitethernet interface:

```
(host)(alarm_index)#monitor gigabitethernet <slot/module/port> oid-type <oid_types>
```

You can use the following command to monitor OID on port-channel interface:

```
(host)(alarm_index)#monitor port-channel <port-channel id> oid-type <oid_types>
```

Configuring the Alarm Profile

Table 48 describes the alarm-profile parameters.

Table 48: *Alarm Profile Configuration Parameters*

Parameter	Description
falling-event	Associate an event index or profile to the falling event.
falling-threshold-value	Specifies the value at which the event is generated.
rising-event	Associate an event profile or index to the rising event.
rising-threshold-value	Specifies the value at which the event is generated.
sample-type	Specifies whether the sample type is either delta or absolute • When the sample-type is delta, the value of the selected variable at the last sample will be subtracted from the current value, and the difference is compared with the thresholds. • When the sample-type is absolute, the value of the selected variable will be compared directly with the thresholds at the end of the sampling interval.
startup-alarm	Configures initial alarm (rising, falling, or either)

To configure the alarm variable, first you have to create an alarm profile. You can use the following command to create the alarm profile:

```
(host)(config)#rmon alarm-profile <profile-name>
   falling-event<event-index>
   falling-threshold-value <value>
   interval<interval>
   rising-event <event-index>
   rising-threshold-value <value>
   sample-type <absolute|delta>
   startup-alarm {falling|rising|rising-or-falling}
```

Configuring Ethernet Statistics Index

Table 49 describes the ethernet statistics index parameters.

Table 49: *Ethernet Statistics Index Configuration Parameters*

Parameter	Description
monitor	Configures an OID to monitor.
owner	Configure the owner of the etherstat entry.

You can use the following command to configure ethernet statistics collection on an interface:

```
(host)(config)# rmon etherstat <etherstat-index>
```

You can use the following command to monitor an OID:

```
(host) (etherstat_index)#monitor <oid>
```

You can use the following command to monitor OID on gigabitethernet interface:

```
(host) (etherstat_index)#monitor gigabitethernet <slot/module/port>
```

You can use the following command to monitor OID on port-channel interface:

```
(host) (etherstat_index)#monitor port-channel <port-channel id>
```

Configuring History Group

Table 50 describes the history group parameters.

Table 50: *History Group Configuration Parameters*

Parameter	Description
monitor	Configures the OID to monitor.
owner	Configures the owner of the history entry.
samples	Number of samples
sampling-interval	Interval of each sample

You can use the following command to create the history group profile:

```
(host)(config)#rmon history <history-index>
   samples <number>
   sampling-interval <interval
   owner <owner>
```

You can use the following command to monitor an OID:

```
(host) (history_index)#monitor <oid>
```

You can use the following command to monitor OID on gigabitethernet interface:

```
(host) (history_index)#monitor gigabitethernet <slot/module/port>
```

You can use the following command to monitor OID on port-channel interface:

```
(host) (history_index)#monitor port-channel <port-channel id>
```

Configuring Event Entry

Table 51 describes the event entry parameters.

Table 51: *Event Entry Configuration Parameters*

Parameter	Description
description	Configures description of the event.
owner	Configures owner of the event.
Type	Specifies whether to send SNMPtrap or create log entry when the event occurs. ● When type is log or log-and-trap, an RMON log entry is created when the event is triggered and sets the eventType in the RMON MIB to log or log-and-trap. ● When type is trap or log-and-trap, SNMP trap is generated. ● When type is none, no action is taken for this event.

You can use the following command to configure the event entry:

```
(host)(config)#rmon event <event-index>
```

You can use the following command to configure the event type:

```
(host)(event-index)#type
```

You can use the following command to clear the RMON log entries:

```
(host)# clear rmon log-table
```

Viewing RMON Active Configuration

You can use the following command to list the alarm-oids supported on device to use it as an alarm variable.

```
(host)#show rmon alarm-oid

Supported OID List
------------------
Object Name                     Object Identifier
-----------                     -----------------
ifOutOctets                     1.3.6.1.2.1.2.2.1.16
ifInUcastPkts                   1.3.6.1.2.1.2.2.1.11
ifOutUcastPkts                  1.3.6.1.2.1.2.2.1.17
ifOutBroadcastPkts              1.3.6.1.2.1.31.1.1.1.5
ifInErrors                      1.3.6.1.2.1.2.2.1.14
ifHCInOctets                    1.3.6.1.2.1.31.1.1.1.6
ifHCInUcastPkts                 1.3.6.1.2.1.31.1.1.1.7
ifHCInMulticastPkts             1.3.6.1.2.1.31.1.1.1.8
ifHCOutMulticastPkts            1.3.6.1.2.1.31.1.1.1.12
ifHCOutBroadcastPkts            1.3.6.1.2.1.31.1.1.1.13
```

You can use the following command to display the RMON event table information:

```
(host)#show rmon event-table
RMON Event Table:
-----------------
Event Index   Type           Last Seen           Description  Owner
-----------   ----           ---------           -----------  -----
1             log and Trap   10-25-2011@19-28-16 desc_log_1   admin
4             log            -                   desc_log_2   guest
```

You can use the following command to display the log table information. The latest log entry will be displayed as the first one:

```
(host) #show rmon log-table

RMON Log Table:
```

```
---------------
Log Id  Event Id  Creation Time       Description
------  --------  -------------       -----------
1       3         3-22-2012@23-39-43  Rising threshold log: ifHCInOctets.455
```

You can use the following command to display the log table based on an event index:

```
(host)#show rmon log-table event <event-id> log <log-id>
```

You can use the following command to display the alarms on the device either briefly or detailed on alarm entry index basis:

```
(host)# show rmon alarms {brief | entry <index>}
```

The following command displays the details on the alarm on the device:

```
(host)#show rmon alarms brief

Total: 1 entry

RMON Alarm Table:
-----------------
RMON Alarm Table
----------------
Alarm Index  Variable      Rising Threshold Value  Falling Threshold Value  Owner
-----------  --------      ----------------------  -----------------------  -----
1            ifInErrors.8  10                      0                        config

(host) #show rmon alarms entry 1

Alarm 1 is active, owned by config
    Monitors ifHCInMulticastPkts.1 every 10 seconds
    Taking delta sample, last value was 0
    Rising threshold value is 300, assigned to event 1

 Falling threshold value is 100, assigned to event 1
```

You can use the following command to display the history table either briefly or detailed on history entry index basis:

```
(host)# show rmon history {brief | entry <index>}
```

The following example displays the history table information:

```
(host)#show rmon history brief

Total: 1 entry

RMON History Table
------------------
History Index  Interface              Octets   Pkts   Bcast Pkts  MCast Pkts  Utilization
-------------  ---------              ------   ----   ----------  ----------  -----------
1              gigabitethernet0/0/1  1323196  19594  0           19554       17

(host) #show rmon history entry 1

Entry 1 is active, and owned by config
    Monitors gigabitethernet0/0/0 every 1800 seconds
    Buckets requested 50, Buckets granted 50
    0 sample(s) created
```

Viewing RMON Configuration

You can use the following list of commands to display the RMON configurations which may or may not get applied. For active configuration, see Viewing RMON Active Configuration on page 361.

You can use the following command to display the configuration done for a specific alarm-profile:

```
(host)#show rmon-config alarm-profile [profile-name]
```

You can use the following command to display the configuration for a specific alarm entry:

```
(host)#show rmon-config alarm [index]
```

You can use the following command to display the configuration done for a specific etherstat index:

```
(host)#show rmon-config etherstat [index]
```

You can use the following command to display the configuration done for a specific event index.

```
(host)#show rmon-config event [index]
```

You can use the following command to display the configuration done for a specific history index:

```
(host)#show rmon-config history [index]
```

This chapter describes the following topics:

MIB and SNMP

ArubaOS Mobility Access Switch supports versions 1, 2c, and 3 of Simple Network Management Protocol (SNMP) for reporting purposes only. In other words, SNMP cannot be used for setting values in an Aruba system in the current Mobility Access Switch.

NOTE

Aruba-specific management information bases (MIBs) describe the objects that can be managed using SNMP.

SNMP Parameters for Mobility Access Switch

You can configure the following SNMP parameters for the Mobility Access Switch.

Table 52: *SNMP Parameters for the Mobility Access Switch*

Parameter	Description
Read Community Strings	Community strings used to authenticate requests for SNMP versions lower than version 3.
Enable Trap Generation	Activates the SNMP trap generation functionality. The configured SNMP trap receivers will receive the generated traps when this option is enabled.
Trap/Inform receivers	Host information about a trap receiver. This host needs to be running a trap receiver to receive and interpret the traps sent by the Mobility Access Switch. Configure the following for each host/trap receiver: • IP address • SNMP version: can be 1, 2c, or 3. • Community string • UDP port on which the trap receiver is listening for traps. The default is the UDP port number 162. This is optional, and will use the default port number if not modified by the user.
If you are using SNMPv3 to obtain values from the ArubaOS Mobility Access Switch, you can configure the following parameters:	
User name	Name of the user.
Authentication protocol	An indication of whether messages sent on behalf of this user can be authenticated, and if so, the type of authentication protocol used. This can take one of the two values: • MD5: HMAC-MD5-96 Digest Authentication Protocol • SHA: HMAC-SHA-96 Digest Authentication Protocol

Parameter	Description
Authentication protocol password	The (private) authentication key for use with the authentication protocol, if messages sent on behalf of this user can be authenticated. This is a string password for MD5 or SHA depending on the choice above.
Privacy protocol	An indication of whether messages sent on behalf of this user can be protected from disclosure, and if so, the type of privacy protocol which is used. This can take one of the following values: ● DES (Data Encryption Standard) ● AES (Advanced Encryption Standard) **NOTE:** Under DES, only CBC-DES Symmetric Encryption Protocol is supported.
Privacy protocol password	The (private) privacy key for use with the privacy protocol, if messages sent on behalf of this user can be encrypted/decrypted with AES or DES based on the privacy protocol selected.
Context	SNMPv3 context information used in SNMP agent.
Engine ID	Agent engine ID for SNMPv3.
SNMP Server Group	View access group entry for SNMPv3
View	SNMP view can be used to give restricted access to the MIB for the users. You can include or exclude the OIDs that are accessible to the users.

Configuring SNMPv1/v2c Parameters

Execute the following command to configure the basic SNMP v1/v2c parameters:

```
(host)(config) #snmp-server community <string>
```

Example

The following is a sample SNMP v1/v2c configuration:

```
(host)(config) #snmp-server community public
```

Configuring SNMPv3 Parameters

You can use the SNMPv3 for advanced security options, such as authenticated or authenticated and encrypted security settings. You can also choose the unauthenticated settings.

Use one of the following system-defined groups for configuring v3 users with various security level settings or create a new group:

- ALLPRIV—Use this group for unauthenticated security settings.
- AUTHNOPRIV—Use this group for authenticated security settings.
- AUTHPRIV—Use this group for authenticated and encrypted security settings.

Execute the following commands to configure the basic SNMPv3 parameters:

```
(host)(config) #snmp-server group <group-name> {v1 | v2c | (v3 [auth|noauth|priv])}
(host)(config) #snmp-server user <user-name> group <name> {v1 | v2c | {v3[auth-prot {md5|sha}
<password>] [priv-prot {AES|DES} <password>]}}
```

Example

You can use the following sample commands to configure SNMPv3:

```
(host) (config) #snmp-server group V3-Group v3 auth
(host) (config) # snmp-server user V3-User group V3-Group v3 auth-prot md5 abcd1234
```

For unauthenticated user configuration using the system-defined group, use the following command:

```
(host) (config) #snmp-server user V3-User1 group ALLPRIV v3
```

For authenticated user configuration using the system-defined group, use the following command:

```
(host) (config) #snmp-server user V3-User2 group AUTHNOPRIV v3 auth-prot md5 abc123
```

For authenticated and encrypted user configuration using the system-defined group, use the following command:

```
(host) (config) #snmp-server user V3-User3 group AUTHPRIV v3 auth-prot md5 password priv-prot
aes abc123
```

Configuring SNMP Traps

Use the following commands to configure SNMP v1/v2c or v3 traps on the Mobility Access Switch:

```
(host)(config) #snmp-server enable trap
(host)(config) #snmp-server host <ipaddr> version {1 <community-string>} | {2c <community-stri
ng>} | {3 <user-name>}
(host)(config) #snmp-server trap source <ipaddr>
```

To additionally configure informs, use the following command:

```
(host)(config) #snmp-server inform queue-length <size>
```

Examples

To enable SNMP traps globally, use the following command:

```
(host)(config) #snmp-server enable trap
```

To configure SNMP v1 traps, use the following sample:

```
(host)(config) #snmp-server host 10.13.6.60 version 1 public
```

To configure SNMP v2c traps, use the following sample:

```
(host)(config) #snmp-server host 10.13.6.70 version 2c public
```

To configure SNMPv3 straps, use the following sample:

```
(host)(config) #snmp-server host 10.13.6.66 version 3 V3-User
```

To configure a trap source IP, use the following command:

```
(host)(config) #snmp-server trap source 10.13.7.80
```

To configure informs, use the following command:

```
(host)(config) #snmp-server inform queue-length 250
```

Viewing SNMP Configuration Parameters

You can use the following show commands to view the SNMP configuration details on the Mobility Access Switch:

- **show snmp group-snmp**: View the SNMP Group information populated from the snmpd process.
- **show snmp group-trap**: View the SNMP Group trap information populated from the trapd process.
- **show snmp view**: View the View information with the included and excluded OID details.
- **show snmp context**: View the list of context names configured on the Mobility Access Switch.
- **show snmp community**: View the SNMP community table.
- **show snmp user-table**: View the user-table entries.
- **show snmp trap-hosts**: View the target trap host entries.
- **show snmp trap-group**: View the list of trap filter groups that can be applied while configuring trap hosts. You can also view the traps associated with a specific trap filter.
- **show snmp notify filter profile-name**: View the SNMP Target profile names.
- **show snmp engine-id**: View the SNMP engine ID.

- **show snmp inform stats**: View the SNMP inform statistics.
- **show snmp trap-list**: View the list of SNMP traps supported and their status.
- **show snmp trap-queue**: View the list of SNMP traps in queue.

Supported Standard MIBs

The following table gives the list of supported standard MIBs, supported tables in each MIB, and the scalars that are not supported in each MIB:

Table 53: *Supported MIBs*

MIB Name	Supported Tables	Scalars Not Supported
RFC1213-MIB	• ipNetToMediaTable • tcp Globals • tcpConnTable • udp Globals • udpConnTable • sysinfo	–
IF-MIB(RFC 1213, ifXTable RFC 2233, RFC 2863)	• ifTable • ifXtable • ifTableLastChange	• ifOutDiscards • ifOutErrors • ifInUnknownProtos • ifInNUcastPkts • ifOutNUcastPkts
EtherLike-MIB(RFC 3635)	• dot3StatsTable	• dot3StatsSQETestErrors • dot3StatsSymbolErrors • dot3StatsEtherChipSet • dot3StatsCarrierSenseErrors • dot3StatsInternalMacTransmitErrors • dot3StatsRateControlAbility • dot3StatsRateControlStatus • dot3StatsAlignmentErrors • dot3StatsSingleCollisionFrames
ALARM-MIB-1(RFC 3877)	• alarmModelTable • alarmActiveStatsTable • alarmClearTable	–
NOTIFICATION-LOG (RFC3014()	• Notification MIB(Globals) • nlmConfigLogTable	–
SNMP-MPD-MIB(RFC 2572)		–
SNMP-FRAMEWORK-MIB (RFC 2571)	• snmpEngine	–
SNMPv2-MIB(RFC 1907)	–	• snmpInTooBigs • snmpInNoSuchNames • snmpInBadValues • snmpInReadOnlys • snmpInGenErrs • snmpInTotalReqVars • snmpInTotalSetVars • snmpInGetRequests • snmpInGetNexts • snmpInSetRequests

MIB Name	Supported Tables	Scalars Not Supported
		• snmpInGetResponses • snmpInTraps • snmpOutTooBigs • snmpOutNoSuchNames • snmpOutBadValues • snmpOutGenErrs • snmpOutGetRequests • snmpOutGetNexts • snmpOutSetRequests • snmpOutGetResponses • snmpOutTraps
SNMP-TARGET-MIB(RFC 2573)	• snmpTargetObjects • snmpTargetAddrTable • snmpTargetParamsTable	–
SNMP-NOTIFICATION-MIB(RFC 2573)	• snmpNotifyTable • snmpNotifyFilterProfileTable • snmpNotifyFilterTable	–
Q-BRIDGE-MIB(RFC 4363)	• dot1qBase • dot1qFdbTable • dot1qTpFdbTable • dot1qStaticUnicastTable • dot1qVlanStaticTable	–
BRIDGE-MIB(RFC 4188)	• dot1dBase • dot1dTpFdbTable • dot1dStaticTable • dot1dBasePortTable	–
PTOPO-MIB(RFC 2922)	• ptopoConnTable	–
LLDP-MIB	• lldpPortConfigTable • lldpConfigManAddrTable • lldpStatsTxPortTable • lldpStatsRxPortTable • lldpLocPortTable • lldpLocManAddrTable • lldpRemTable • lldpRemManAddrTable	–
RMON-MIB(RFC 2819)	• etherStatsTable • historyControlTable • etherHistoryTable • alarmTable • eventTable • logTable	–
RMON2-MIB (RFC 4502)	• probeConfig	–
HC-RMON-MIB (RFC 3273)	• etherStatsHighCapacityGroup	• etherStatsHighCapacityOverflowPkts64Octets • etherStatsHighCapacityPkts64Octets

MIB Name	Supported Tables	Scalars Not Supported
	• etherHistoryHighCapacityGroup	• etherStatsHighCapacityOverflowPkts65to127Octets • etherStatsHighCapacityPkts65to127Octets • etherStatsHighCapacityOverflowPkts128to255Octets • etherStatsHighCapacityPkts128to255Octets • etherStatsHighCapacityOverflowPkts256to511Octets • etherStatsHighCapacityPkts256to511Octets • etherStatsHighCapacityOverflowPkts512to1023Octets • etherStatsHighCapacityPkts512to1023Octets • etherStatsHighCapacityOverflowPkts1024to1518Octets • etherStatsHighCapacityPkts1024to1518Octets
OSPF-MIB	• ospfGeneralGroup • ospfAreaTable • ospfStubAreaTable • ospfIfTable • ospfNbrTable • ospfLsdbTable • ospfExtLsdbTable	• ospfDemandExtensions • ospfIfDemand • ospfNbmaNbrPermanence • ospfNbrHelloSuppressed • ospfStubMetric • ospfImportAsExtern • ospfNbmaNbrPermanence • ospfNbrHelloSuppressed • ospfIfAuthKey • ospfExtLsdbAdvertisement • ospfLsdbAdvertisement
ENTITY-MIB	• entityGeneral • entPhysicalTable • entLogicalTable • entAliasMappingTable • entPhysicalContainsTable	• entPhysicalMfgName • entPhysicalAssetID • entPhysicalUris • entPhysicalHardwareRev • entPhysicalAlias • entPhysicalMfgDate • entLPMappingTable

NOTE

To get OID for ENTITY-MIB, a new MIB called ARUBA-VENDORTYPE has been added.

Supported Enterprise MIBs

The following table gives the list of supported enterprise MIBs, supported tables in each MIB, and the scalars that are not supported in each MIB:

Table 54: *Supported Enterprise MIBs*

MIB Name	Supported Tables	Scalars Not Supported
ARUBA-SYSTEMEXT	• wlsxSysExtProcessorTable • wlsxSysExtStorageTable • wlsxSysExtMemoryTable • wlsxSysExtCardTable • wlsxSysExtFanTable • wlsxSysExtPowerSupplyTable	• wlsxSysExtSwitchMasterIp • wlsxSysExtSwitchRole
ARUBA-SWITCH	• wlsxSysXProcessorTable • wlsxSysXStorageTable • wlsxSysXMemoryTable	• wlsxSwitchMasterIP • wlsxSwitchRole
ARUBA-USER	• wlsxUserTable • wlsxUserSessionTimeTable	–
ARUBA-IFEXT	• wlsxIfExtNPortTable	–
ARUBA-POE	• wlsxPsePortTable • wlsxPseSlotTable	–
ARUBA-STACKING	• wlsxStackMemberTable • wlsxStackProtoIfTable • wlsxStackTopoTable	–

Supported Standard Traps

The following table gives the list of supported standard traps:

Table 55: *Standard Traps*

Supported Traps
• authenticationFailure • coldStart • linkDown • linkUp • warmStart • ptopoConfigChange • lldpRemTablesChange • risingAlarm • fallingAlarm • ospfIfStateChange • ospfNbrStateChange • entConfigChange

Supported Enterprise Traps

The following table gives the list of supported enterprise traps:

Table 56: *Supported Enterprise Traps*

Supported Traps
• wlsxAuthMaxAclEntries • wlsxAuthServerReqTimedOut • wlsxColdStart • wlsxFanFailure • wlsxFanOK • wlsxFanTrayInsertedTrap • wlsxFanTrayRemovedTrap • wlsxFlashSpaceOK • wlsxInRangeVoltage • wlsxInformQueueOverFlow • wlsxLowMemory • wlsxLowOnFlashSpace • wlsxMemoryUsageOK • wlsxNAuthMaxAclEntries • wlsxNAuthServerIsDown • wlsxNAuthServerIsUp • wlsxNAuthServerReqTimedOut • wlsxNFanFailure • wlsxNGBICInserted • wlsxNLowMemory • wlsxNLowOnFlashSpace • wlsxNOutOfRangeTemperature • wlsxNOutOfRangeVoltage • wlsxNProcessDied • wlsxNUserEntryAuthenticated • wlsxNUserEntryCreated • wlsxNUserEntryDeAuthenticated • wlsxNUserEntryDeleted • wlsxNormalTemperature
• wlsxOutOfRangeTemperature • wlsxOutOfRangeVoltage • wlsxPowerSupplyFailureTrap • wlsxPowerSupplyMissingTrap • wlsxPowerSupplyOK • wlsxPowerSupplyOKTrap • wlsxProcessDied • wlsxProcessRestart • wlsxStackIfStateChangeTrap • wlsxStackTopologyChangeTrap • wlsxUserAuthenticationFailed • wlsxUserEntryAuthenticated • wlsxUserEntryChanged • wlsxUserEntryCreated • wlsxUserEntryDeAuthenticated • wlsxUserEntryDeleted • wlsxVlanLinkDown • wlsxVlanLinkUp • wlsxWarmStart • wlsxIfStateChangeTrap (Enhanced for BPDU guard feature)

Logging

For each category or subcategory of message, you can set the logging level or severity level of the messages to be logged. Table 57 lists the logging levels.

Table 57: *Logging Levels*

Logging Level	Description
Emergency	System is unusable
Alerts	Immediate action is needed.
Critical	Any critical conditions.
Errors	Error conditions.
Warning	Warning messages.
Notifications	Normal but signification conditions.
Informational	Messages of general interest to system users.
Debug	Messages containing information useful for debugging.

The default logging level for all categories is Warning. Within each logging level are several log types you can select.

- network
- security
- system
- user
- user debug