

Multicast PIM Dense Mode

IMPORTANT! THIS GUIDE ASSUMES THAT THE AOS-CX OVA HAS BEEN INSTALLED AND WORKS IN GNS3 OR EVE-NG. PLEASE REFER TO GNS3/EVE-NG INITIAL SETUP LABS IF REQUIRED.

<https://www.eve-ng.net/index.php/documentation/howtos/howto-add-aruba-cx-switch/>

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Lab Objective

This guide will enable the reader to gain hands on experience with multicast Protocol Independent Multicast (PIM) dense mode (DM). It implicitly builds shortest-path trees by flooding multicast traffic domain wide, and then pruning back branches of the tree where no receivers are present.

PIM DM is straightforward to implement but generally has poor scaling properties.

Lab Overview

This lab as shown in Figure 1 will allow you to generate multicast traffic from a multicast source over a L3 routed PIM DM multicast network. FHR refers to First Hop Router and LHR refers to Last Hop Router.

Simulating a multicast source on a AOS-CX VM doesn't work at this time, that's why a source VPCS (Virtual PC Simulator) is used.

In addition, no configuration is required on the receiver VPCS, you just need to power it up to simulate a receiver on LHR.

Lab Network Layout

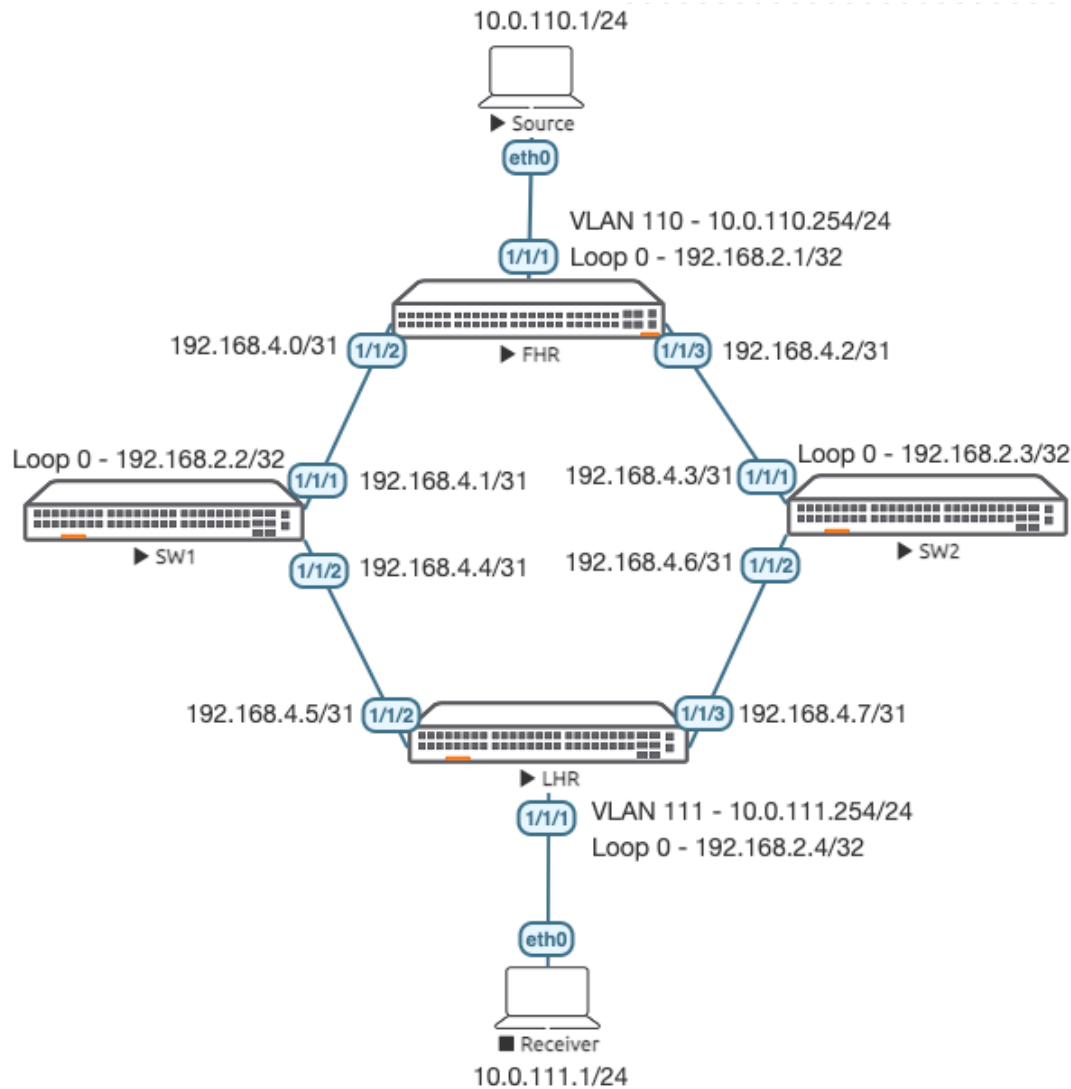


Figure 1. Lab topology and addresses

Lab Tasks

Task 1 – Lab setup

For this lab refer to Figure 1 for topology and IP address details.

- Start all the devices, including source and receiver
- Open each switch console and log in with user “admin” and hit enter, so that no password is applied
- Change all hostnames as shown in the topology:
configure
hostname ...
- On all devices, bring up required ports:
int 1/1/1-1/1/6
no shutdown
use “exit” to go back a level

- Validate LLDP neighbors appear as expected on each switch
show lldp neighbor

FHR

```
FHR(config)# show lldp neighbor-info
```

```
LLDP Neighbor Information
=====
```

```
Total Neighbor Entries      : 2
Total Neighbor Entries Deleted : 0
Total Neighbor Entries Dropped : 0
Total Neighbor Entries Aged-Out : 0
```

LOCAL-PORT	CHASSIS-ID	PORT-ID	PORT-DESC	TTL	SYS-NAME
1/1/2	08:00:09:8a:14:fa	1/1/1	1/1/1	120	SW1
1/1/3	08:00:09:12:8e:9e	1/1/1	1/1/1	120	SW2

Task 2 – Configure FHR, SW1, SW2, LHR Interfaces

- Configure interfaces, IPs and required VLANs on these 4 switches

FHR

```
FHR(config)# int 1/1/2
FHR(config-if)# ip add 192.168.4.0/31
FHR(config-if)# int 1/1/3
FHR(config-if)# ip add 192.168.4.2/31
FHR(config-if)# int lo 0
FHR(config-loopback-if)# ip add 192.168.2.1/32
FHR(config-loopback-if)# vlan 110
FHR(config-vlan-110)# int vlan 110
FHR(config-if-vlan)# ip add 10.0.110.254/24
FHR(config-if-vlan)# int 1/1/1
FHR(config-if)# no routing
FHR(config-if)# vlan access 110
```

SW1

```
SW1(config)# int 1/1/1
SW1(config-if)# ip add 192.168.4.1/31
SW1(config-if)# int 1/1/2
SW1(config-if)# ip add 192.168.4.4/31
SW1(config-if)# int lo 0
SW1(config-loopback-if)# ip add 192.168.2.2/32
```

SW2

```
SW2(config)# int 1/1/1
SW2(config-if)# ip add 192.168.4.3/31
SW2(config-if)# int 1/1/2
SW2(config-if)# ip add 192.168.4.6/31
SW2(config-if)# int lo 0
SW2(config-loopback-if)# ip add 192.168.2.3/32
```

LHR

```
LHR(config)# int 1/1/2
LHR(config-if)# ip add 192.168.4.5/31
LHR(config-if)# int 1/1/3
LHR(config-if)# ip add 192.168.4.7/31
LHR(config-if)# int lo 0
LHR(config-loopback-if)# ip add 192.168.2.4/32
LHR(config-loopback-if)# vlan 111
LHR(config-vlan-111)# int vlan 111
LHR(config-if-vlan)# ip add 10.0.111.254/24
LHR(config-loopback-if)# int 1/1/1
LHR(config-if)# no routing
LHR(config-if)# vlan access 111
```

Task 3 – Configure FHR, SW1, SW2, LHR with Unicast Routing

- Multicast depends heavily on unicast, you need to ensure unicast connectivity works as expected before moving onto multicast

FHR

```
FHR(config-if)# int lo 0
FHR(config-loopback-if)# ip ospf 1 area 0
OSPF process does not exist.
Do you want to create (y/n)? y
OSPF Area is not configured.
Do you want to create (y/n)? y

FHR(config-loopback-if)# router ospf 1
FHR(config-ospf-1)# router-id 192.168.2.1
FHR(config-ospf-1)# int 1/1/2
FHR(config-if)# ip ospf 1 area 0
FHR(config-if)# ip ospf network point-to-point
FHR(config-if)# int 1/1/3
FHR(config-if)# ip ospf 1 area 0
FHR(config-if)# ip ospf network point-to-point
FHR(config-if)# int vlan 110
FHR(config-if-vlan)# ip ospf 1 area 0
```

SW1

```
SW1(config-loopback-if)# int lo 0
SW1(config-loopback-if)# ip ospf 1 area 0
OSPF process does not exist.
Do you want to create (y/n)? y
OSPF Area is not configured.
Do you want to create (y/n)? y

SW1(config-if)# router ospf 1
SW1(config-ospf-1)# router-id 192.168.2.2

SW1(config-loopback-if)# int 1/1/1
SW1(config-if)# ip ospf 1 area 0
SW1(config-if)# ip ospf network point-to-point
SW1(config-if)# int 1/1/2
SW1(config-if)# ip ospf 1 area 0
SW1(config-if)# ip ospf network point-to-point
```

SW2

```
SW2(config-loopback-if)# int lo 0
SW2(config-loopback-if)# ip ospf 1 area 0
OSPF process does not exist.
Do you want to create (y/n)? y
OSPF Area is not configured.
Do you want to create (y/n)? y

SW2(config-loopback-if)# router ospf 1
SW2(config-ospf-1)# router-id 192.168.2.3

SW2(config-loopback-if)# int 1/1/1
SW2(config-if)# ip ospf 1 area 0
SW2(config-if)# ip ospf network point-to-point
SW2(config-if)# int 1/1/2
SW2(config-if)# ip ospf 1 area 0
SW2(config-if)# ip ospf network point-to-point
```

LHR

```
LHR(config-if)# int lo 0
LHR(config-loopback-if)# ip ospf 1 area 0
OSPF process does not exist.
Do you want to create (y/n)? y
OSPF Area is not configured.
Do you want to create (y/n)? y

LHR(config-loopback-if)# router ospf 1
LHR(config-ospf-1)# router-id 192.168.2.4
LHR(config-ospf-1)# int 1/1/2
LHR(config-if)# ip ospf 1 area 0
LHR(config-if)# ip ospf network point-to-point
LHR(config-if)# int 1/1/3
LHR(config-if)# ip ospf 1 area 0
LHR(config-if)# ip ospf network point-to-point
LHR(config-if)# int vlan 111
LHR(config-if-vlan)# ip ospf 1 area 0
```

- Verify OSPF neighbors appear as expected between the switches, check all switches

```
FHR# sh ip ospf nei
OSPF Process ID 1 VRF default
=====
```

Total Number of Neighbors: 2

Neighbor ID	Priority	State	Nbr Address	Interface
192.168.2.2	n/a	FULL	192.168.4.1	1/1/2
192.168.2.3	n/a	FULL	192.168.4.3	1/1/3

- Verify OSPF routes are learnt as expected on LHR/FHR, you should see routes for C-RP/BSR Lo0/Lo1, and source/receiver subnets, check your configs if routes are missing
- Equal Cost Multi Pathing (ECMP) does not currently work in AOS-CX VMs, it may show up in the routing table but does not forward across equal paths

```
FHR# sh ip ro ospf
```

Displaying ipv4 routes selected for forwarding

'[x/y]' denotes [distance/metric]

```
10.0.111.0/24, vrf default
    via 192.168.4.1, [110/300], ospf
    via 192.168.4.3, [110/300], ospf
192.168.2.2/32, vrf default
    via 192.168.4.1, [110/100], ospf
192.168.2.3/32, vrf default
    via 192.168.4.3, [110/100], ospf
192.168.2.4/32, vrf default
    via 192.168.4.1, [110/200], ospf
    via 192.168.4.3, [110/200], ospf
192.168.4.4/31, vrf default
    via 192.168.4.1, [110/200], ospf
192.168.4.6/31, vrf default
    via 192.168.4.3, [110/200], ospf
```

Task 4 – Configure FHR, SW1, SW2, LHR with PIM Dense Mode

- Configure PIM-DM and IGMP on the SVIs (VLAN 110 exists on FHR, VLAN 111 exists on LHR).

FHR

```
FHR(config)# router pim
FHR(config-pim)# enable
FHR(config-pim)# int 1/1/2
FHR(config-if)# ip pim-dense enable
FHR(config-if)# int 1/1/3
FHR(config-if)# ip pim-dense enable
FHR(config-if)# int vlan 110
FHR(config-if-vlan)# ip pim-dense enable
FHR(config-if-vlan)# ip igmp enable
```

SW1

```
SW1(config-loopback-if)# int 1/1/1
SW1(config-if)# ip pim-dense enable
SW1(config-if)# int 1/1/2
SW1(config-if)# ip pim-dense enable
SW1(config-if)# router pim
SW1(config-pim)# enable
```

SW2

```
SW2(config-loopback-if)# int 1/1/1
SW2(config-if)# ip pim-dense enable
SW2(config-if)# int 1/1/2
SW2(config-if)# ip pim-dense enable
SW2(config-if)# router pim
SW2(config-pim)# enable
```


LHR

```
LHR(config)# router pim
LHR(config-pim)# enable
LHR(config-pim)# int 1/1/2
LHR(config-if)# ip pim-dense enable
LHR(config-if)# int 1/1/3
LHR(config-if)# ip pim-dense enable
LHR(config-if)# int vlan 111
LHR(config-if-vlan)# ip pim-dense enable
LHR(config-if-vlan)# ip igmp enable
```

Task 5 – Configure Multicast Source

- Configure the Source VPCS with your desired IP and default gateway

```
VPCS> ip 10.0.110.1/24 10.0.110.254
Checking for duplicate address...
PC1 : 10.0.110.1 255.255.255.0 gateway 10.0.110.254
```

- Ensure unicast connectivity works

```
VPCS> ping 10.0.110.254

84 bytes from 10.0.110.254 icmp_seq=1 ttl=64 time=1.363 ms
84 bytes from 10.0.110.254 icmp_seq=2 ttl=64 time=1.281 ms
84 bytes from 10.0.110.254 icmp_seq=3 ttl=64 time=1.032 ms
84 bytes from 10.0.110.254 icmp_seq=4 ttl=64 time=0.848 ms
84 bytes from 10.0.110.254 icmp_seq=5 ttl=64 time=1.045 ms
^C
```

```
VPCS> ping 10.0.111.254

84 bytes from 10.0.111.254 icmp_seq=1 ttl=62 time=3.560 ms
84 bytes from 10.0.111.254 icmp_seq=2 ttl=62 time=2.848 ms
84 bytes from 10.0.111.254 icmp_seq=3 ttl=62 time=2.656 ms
84 bytes from 10.0.111.254 icmp_seq=4 ttl=62 time=2.868 ms
^C
```

Task 6 – Final Validation

- Generate multicast traffic on the source VPCS and leave it running (it has to be running to validate mroute later on)

```
VPCS> ping 239.10.10.10 -c 10000

239.10.10.10 icmp_seq=1 timeout
239.10.10.10 icmp_seq=2 timeout
239.10.10.10 icmp_seq=3 timeout
239.10.10.10 icmp_seq=4 timeout
239.10.10.10 icmp_seq=5 timeout
239.10.10.10 icmp_seq=6 timeout
239.10.10.10 icmp_seq=7 timeout
239.10.10.10 icmp_seq=8 timeout
239.10.10.10 icmp_seq=9 timeout
```

- Take note, the receiver VPCS is not actually receiving multicast traffic, but you will be able to view the incoming interface and outgoing interface list of the multicast tree on the AOS-CX switches
- Since the receiver is not able to send a multicast join, you will need to force a static IGMP join from the LHR SVI

```
LHR(config)#interface vlan111
LHR(config-if-vlan)# ip igmp static-group 239.10.10.10
```

- Validate mroute on FHR

```
FHR# show ip mroute
IP Multicast Route Entries
```

```
VRF : default
Total number of entries : 1
```

```
Group Address      : 239.10.10.10
Source Address     : 10.0.110.1
Incoming interface : vlan110
Outgoing Interface List :
Interface          State
-----
1/1/2              forwarding
```

- Validate mroute on SW1

```
SW1# sh ip mr
IP Multicast Route Entries
```

```
VRF : default
Total number of entries : 1
```

```
Group Address      : 239.10.10.10
Source Address     : 10.0.110.1
Neighbor           : 192.168.4.0
Incoming interface : 1/1/1
Outgoing Interface List :
Interface          State
-----
1/1/2              forwarding
```

- Validate mroute on SW2, this is expected as multicast traffic is flooded from FHR 1/1/2 towards SW1 1/1/1

```
SW2# sh ip mroute
SW2#
```

- Validate mroute on LHR.

```
LHR# sh ip mrou
IP Multicast Route Entries
```

```
VRF : default
Total number of entries : 1
```

```
Group Address      : 239.10.10.10
Source Address     : 10.0.110.1
```



```
Neighbor                : 192.168.4.4
Incoming interface      : 1/1/2
Outgoing Interface List :
Interface              State
-----
vlan111                forwarding
```

- If you shut the uplink on SW1, you will notice that multicast traffic now fails over to the redundant RP-BSR.

```
SW1(config)# int 1/1/1
SW1(config-if)# shut
```

```
SW2# sh ip mroute
IP Multicast Route Entries
```

```
VRF : default
Total number of entries : 1
```

```
Group Address          : 239.10.10.10
Source Address         : 10.0.110.1
Neighbor               : 192.168.4.2
Incoming interface     : 1/1/1
Outgoing Interface List :
Interface              State
-----
1/1/2                  forwarding
```

- The change to the multicast tree will also be seen on LHR

```
LHR# sh ip mroute
IP Multicast Route Entries
```

```
VRF : default
Total number of entries : 1
```

```
Group Address          : 239.10.10.10
Source Address         : 10.0.110.1
Neighbor               : 192.168.4.6
Incoming interface     : 1/1/3
Outgoing Interface List :
Interface              State
-----
vlan111                forwarding
```

Appendix – Complete Configurations

- If you face issues during your lab, you can verify your configs with the configs listed in this section
- If configs are the same, try powering off/powering on the switches to reboot them

Source

```
VPCS> show ip
```

```
NAME       : VPCS[1]
IP/MASK    : 10.0.110.1/24
GATEWAY    : 10.0.110.254
DNS        :
MAC        : 00:50:79:66:68:07
LPORT     : 20000
RHOST:PORT : 127.0.0.1:30000
MTU        : 1500
```

FHR

```
FHR# sh run
Current configuration:
!
!Version ArubaOS-CX Virtual.10.05.0001
!export-password: default
hostname FHR
user admin group administrators password ciphertext
AQBapQCihf6iT4vThV+NzijklZt54Sz+q6RXr9YVfsEwiTWaYgAAAJsRozmZt1wlgK3xVOeEzcyzUS6Oj3QltiMKU+6Yj+V
C7oaU4v
jbd33BwEP5jNvtQbrWaB/UCSqPcet0SXWVkke8emagoz9b50eVylFVWHVvQCHlCKuktnRn/HVR64ZO6OkT
led locator on
!
!
!
!
ssh server vrf mgmt
vlan 1,110
interface mgmt
    no shutdown
    ip dhcp
interface 1/1/1
    no shutdown
    no routing
    vlan access 110
interface 1/1/2
    no shutdown
    ip address 192.168.4.0/31
    ip ospf 1 area 0.0.0.0
    ip ospf network point-to-point
    ip pim-dense enable
interface 1/1/3
    no shutdown
    ip address 192.168.4.2/31
    ip ospf 1 area 0.0.0.0
    ip ospf network point-to-point
    ip pim-dense enable
interface 1/1/4
    no shutdown
interface 1/1/5
    no shutdown
interface 1/1/6
    no shutdown
```

```
interface loopback 0
  ip address 192.168.2.1/32
  ip ospf 1 area 0.0.0.0
interface vlan 110
  ip address 10.0.110.254/24
  ip ospf 1 area 0.0.0.0
  ip igmp enable
  ip pim-dense enable
!
!
!
!
!
router ospf 1
  router-id 192.168.2.1
  area 0.0.0.0
router pim
  enable
https-server vrf mgmt
```

SW1

```
SW1# sh run
Current configuration:
!
!Version ArubaOS-CX Virtual.10.05.0001
!export-password: default
hostname SW1
user admin group administrators password ciphertext
AQBapav/XJ3HbHUCxaIIpFcvAPN6c/hgdm3/jcYPsN5/rgzdYgAAAJk+6KaHENCQgPnjxq+ZDokxMFeacYh3+rrpcktMKnJ
JM84Wce
cmgASpYGSkWzJaR2/uDjLvn4t44QXN0dh0/jAVPXakvQekaXF1l7pwpghCXNG3kQFfXkLdITG30GESr4un
led locator on
!
!
!
!
ssh server vrf mgmt
vlan 1
interface mgmt
  no shutdown
  ip dhcp
interface 1/1/1
  ip address 192.168.4.1/31
  ip ospf 1 area 0.0.0.0
  ip ospf network point-to-point
  ip pim-dense enable
interface 1/1/2
  no shutdown
  ip address 192.168.4.4/31
  ip ospf 1 area 0.0.0.0
  ip ospf network point-to-point
  ip pim-dense enable
interface 1/1/3
  no shutdown
interface 1/1/4
  no shutdown
interface 1/1/5
  no shutdown
interface 1/1/6
  no shutdown
interface loopback 0
  ip address 192.168.2.2/32
  ip ospf 1 area 0.0.0.0
!
```

```
!
!
!
!
router ospf 1
  router-id 192.168.2.2
  area 0.0.0.0
router pim
  enable
https-server vrf mgmt
```

SW2

```
SW2# sh run
Current configuration:
!
!Version ArubaOS-CX Virtual.10.05.0001
!export-password: default
hostname SW2
user admin group administrators password ciphertext
AQBapS7Fd3NqkQjPvMqPKrX6D9uA8n2sWl0ChTu4m3qMjjyxYgAAAIbgl5240J0fCqIodMxCrHrq8uGWxePbE+Z+OV70e2w
lhMzdVC
GMrrP4rCSI84x+vRKSe3+FkUOkEektSu01Z9NVLF484xz083An/dcTOK0SXbw6daELPJWtMLrkh1Bm6WC1
led locator on
!
!
!
!
ssh server vrf mgmt
vlan 1
interface mgmt
  no shutdown
  ip dhcp
interface 1/1/1
  no shutdown
  ip address 192.168.4.3/31
  ip ospf 1 area 0.0.0.0
  ip ospf network point-to-point
  ip pim-dense enable
interface 1/1/2
  no shutdown
  ip address 192.168.4.6/31
  ip ospf 1 area 0.0.0.0
  ip ospf network point-to-point
  ip pim-dense enable
interface 1/1/3
  no shutdown
interface 1/1/4
  no shutdown
interface 1/1/5
  no shutdown
interface 1/1/6
  no shutdown
interface loopback 0
  ip address 192.168.2.3/32
  ip ospf 1 area 0.0.0.0
!
!
!
!
!
router ospf 1
  router-id 192.168.2.3
  area 0.0.0.0
router pim
```

```
enable
https-server vrf mgmt
SW2#
```

LHR

```
LHR# sh run
Current configuration:
!
!Version ArubaOS-CX Virtual.10.05.0001
!export-password: default
hostname LHR
led locator on
!
!
!
ssh server vrf mgmt
vlan 1,111
interface mgmt
    no shutdown
    ip dhcp
interface 1/1/1
    no shutdown
    no routing
    vlan access 111
interface 1/1/2
    no shutdown
    ip address 192.168.4.5/31
    ip ospf 1 area 0.0.0.0
    ip ospf network point-to-point
    ip pim-dense enable
interface 1/1/3
    no shutdown
    ip address 192.168.4.7/31
    ip ospf 1 area 0.0.0.0
    ip ospf network point-to-point
    ip pim-dense enable
interface 1/1/4
    no shutdown
interface 1/1/5
    no shutdown
interface 1/1/6
    no shutdown
interface loopback 0
    ip address 192.168.2.4/32
    ip ospf 1 area 0.0.0.0
interface vlan 111
    ip address 10.0.111.254/24
    ip ospf 1 area 0.0.0.0
    ip igmp enable
    ip igmp static-group 239.10.10.10
    ip pim-dense enable
!
!
!
!
router ospf 1
    router-id 192.168.2.4
    area 0.0.0.0
router pim
    enable
```

```
https-server vrf mgmt
```




www.arubanetworks.com

3333 Scott Blvd. Santa Clara, CA 95054
1.844.472.2782 | T: 1.408.227.4500 | FAX: 1.408.227.4550 | info@arubanetworks.com