

PIM Sparse Mode for IPv6 (PIM-SMv6)

FEATURE OVERVIEW AND CONFIGURATION GUIDE

Introduction

This guide provides information about Protocol Independent Multicast-Sparse Mode for IPv6 (PIM-SMv6).

Products and software version that apply to this guide

This guide applies to AlliedWare Plus™ products that support PIM-SMv6, running version **5.4.4** or later.

To see whether your product supports PIM-SMv6, see the following documents:

- The [product's Datasheet](#)
- The [AlliedWare Plus Datasheet](#)
- The product's [Command Reference](#)

These documents are available from the above links on our website at alliedtelesis.com.

Feature support may change in later software versions. For the latest information, see the above documents.

Related Documents

The following documents give more information about the IPv6 multicasting features on AlliedWare Plus products:

- the [Multicasting Feature Overview and Configuration Guide](#)
- the [MLD Feature Overview and Configuration Guide](#)
- the [Command Reference](#) for each product

These documents are available from the links above or on our website at alliedtelesis.com.

Content

Introduction.....	1
Products and software version that apply to this guide	1
Related Documents.....	2
PIM-SMv6	3
Characteristics of PIM-SMv6.....	4
PIM-SMv6 Embedded RP, RP and BSR Candidate Configurations	4
Embedded RP configuration.....	4
Verify embedded RP configuration.....	6
RP and BSR candidate configuration	7
Verify RP and RP candidate configuration	10
PIM-SMv6 Static RP, DR, BSR Configurations.....	12
Static Rendezvous Point configuration.....	13
Verify static Rendezvous Point configuration.....	14
Dynamic Rendezvous Point configuration.....	16
Verify PIM group-to-RP mappings.....	17
Verify RP details	17
Boot Strap Router configuration	18
Verify Boot Strap Router configuration	19

PIM-SMv6

Protocol Independent Multicast-Sparse Mode for IPv6 (PIM-SMv6) provides efficient communication between members of sparsely distributed groups—the type of groups that are most common in wide-area internetworks.

PIM-SMv6 helps geographically dispersed network nodes to conserve bandwidth and reduce traffic by simultaneously delivering a single stream of information to multiple locations. PIM-SMv6 uses the IPv6 multicast model of receiver-initiated membership, supporting both shared and shortest-path trees and uses mechanisms to adapt to changing network conditions. PIM-SMv6 uses a topology gathering approach to populate a multicast routing table with routes.

Note: IPv6 must be enabled on an interface with the **ipv6 enable** command, IPv6 forwarding must be enabled globally for routing IPv6 with the **ipv6 forwarding** command, and IPv6 multicasting must be enabled globally with the **ipv6 multicast-routing** command before using PIM-SMv6 commands.

Static IPv6 multicast routes take priority over dynamic IPv6 multicast routes. Use the **clear ipv6 mroute** command to clear static IPv6 multicast routes and ensure dynamic IPv6 multicast routes can take over from previous static IPv6 multicast routes.

Note: The IPv6 Multicast addresses shown can be derived from IPv6 unicast prefixes as per RFC 3306. The IPv6 unicast prefix reserved for documentation is 2001:0db8::/32 as per RFC 3849. Using the base /32 prefix the IPv6 multicast prefix for 2001:0db8::/32 is ff3x:20:2001:0db8::/64. Where an RP address is 2001:0db8::1 the embedded RP multicast prefix is ff7x:120:2001:0db8::/96. For ASM (Any-Source Multicast) the IPv6 multicast addresses allocated for documentation purposes are ff0x::0db8:0:0/96 as per RFC 6676. This is a /96 prefix so that it can be used with group IDs as per RFC 3307. These addresses should not be used for practical networks (other than for testing purposes), nor should they appear in any public network.

Note: The IPv6 addresses shown use the address space 2001:0db8::/32, defined in RFC 3849 for documentation purposes. These addresses should not be used for practical networks (other than for testing purposes) nor should they appear on any public network.

Characteristics of PIM-SMv6

PIM Sparse Mode for IPv6 (PIM-SMv6) is defined by standards that are almost identical to those that define PIM for IPv4. For a description of the protocol, refer to the [PIM-SM Feature Overview and Configuration Guide](#).

PIM-SMv6 Embedded RP, RP and BSR Candidate Configurations

This section provides two PIM-SMv6 configuration examples:

- **Embedded RP configuration**
- **RP and BSR candidate configuration**

Embedded RP configuration

RFC 3956 describes a multicast address allocation policy, in which the address of the Rendezvous Point (RP) is encoded in the IPv6 multicast group address, and specifies a PIM-SMv6 group-to-RP mapping to use the encoding, leveraging and extending unicast-prefix-based addressing.

Embedded RP multicast group address format

RFC 3956 specifies a modification to the unicast-prefix-based address format by specifying the second high-order bit (R-bit) as follows:

Table 1: RFC3956 modification to the unicast-prefix-based IPv6 address format

IIIIIIII	flgs	scop	rsvd	RIID	plen	network prefix	group ID
8 bits	4 bits	4 bits	4 bits	4 bits	8 bits	64 bits	32 bits

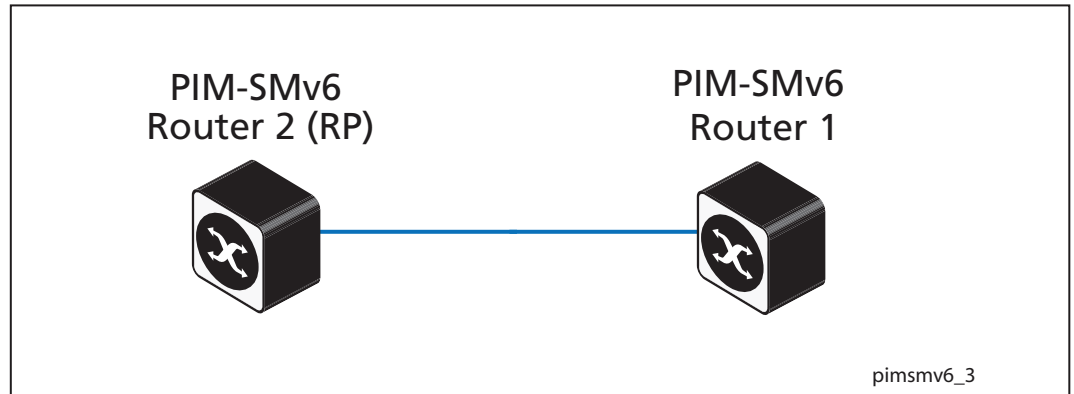
Note: Note: **flgs** is a set of four flags - **0 - R - P - T**

flgs the highest-order bit is 0, flag R is 1. This indicates a multicast address that embeds the address on the RP. In this case, the P flag must be set to 1 and the T flag must be set to 1. In effect, this implies the prefix **ff70::/12**. This means that the last 4 bits of the previously reserved field are interpreted as the embedded RP interface ID.

RP address in embedded RP multicast address

The address of the RP can only be embedded in unicast-prefix-based Any Source Multicast (ASM) addresses. To identify whether it is an embedded RP multicast address, and to be processed any further, an IPv6 address must satisfy all of the following criteria:

- It must be an IPv6 multicast address with **flgs** set to **0111** to be of the prefix **ff70::/12**, or with **flgs** set to **1111** to be of the prefix **fff0::/12**
- **plen** must not be set to 0 and **plen** must not be set to greater than 64.



Enable embedded RP

Enter the following commands to enable embedded-RP to group mapping (**ipv6 pim rp embedded**) then configure an access-list to permit a multicast group (ipv6 access-list) and use this access-list to limit valid groups with a configured static RP (ipv6 pim rp-address):

```
awplus# configure terminal
awplus(config)# ipv6 forwarding
awplus(config)# ipv6 multicast-routing
awplus(config)# ipv6 pim rp embedded
awplus(config)# ipv6 access-list embedrp1 permit
ff70:2:2001:0db8:12::2::/96
awplus(config)# ipv6 pim rp-address ff70:2001:0db8:12::2/12
embedrp1
awplus(config)# exit
```

Disable embedded RP

Enter the following commands to disable embedded-RP to group mapping (**no ipv6 pim rp embedded**) after enabling embedded RP (as shown in the previous example above):

```
awplus# configure terminal
awplus(config)# no ipv6 pim rp embedded
awplus(config)# exit
```

PIM-SMv6 commands used

```
ipv6 pim rp-address
ipv6 pim rp embedded
```

Verify embedded RP configuration

Use the following commands to verify the embedded-RP configuration. Note that the group-to-RP mapping for embedded-RP addresses is created when the group is first seen at a PIM-SMv6 router. This can be due to the MLD local receiver report, Join/Prune and Register message processing.

Verify RP-mapping in RP

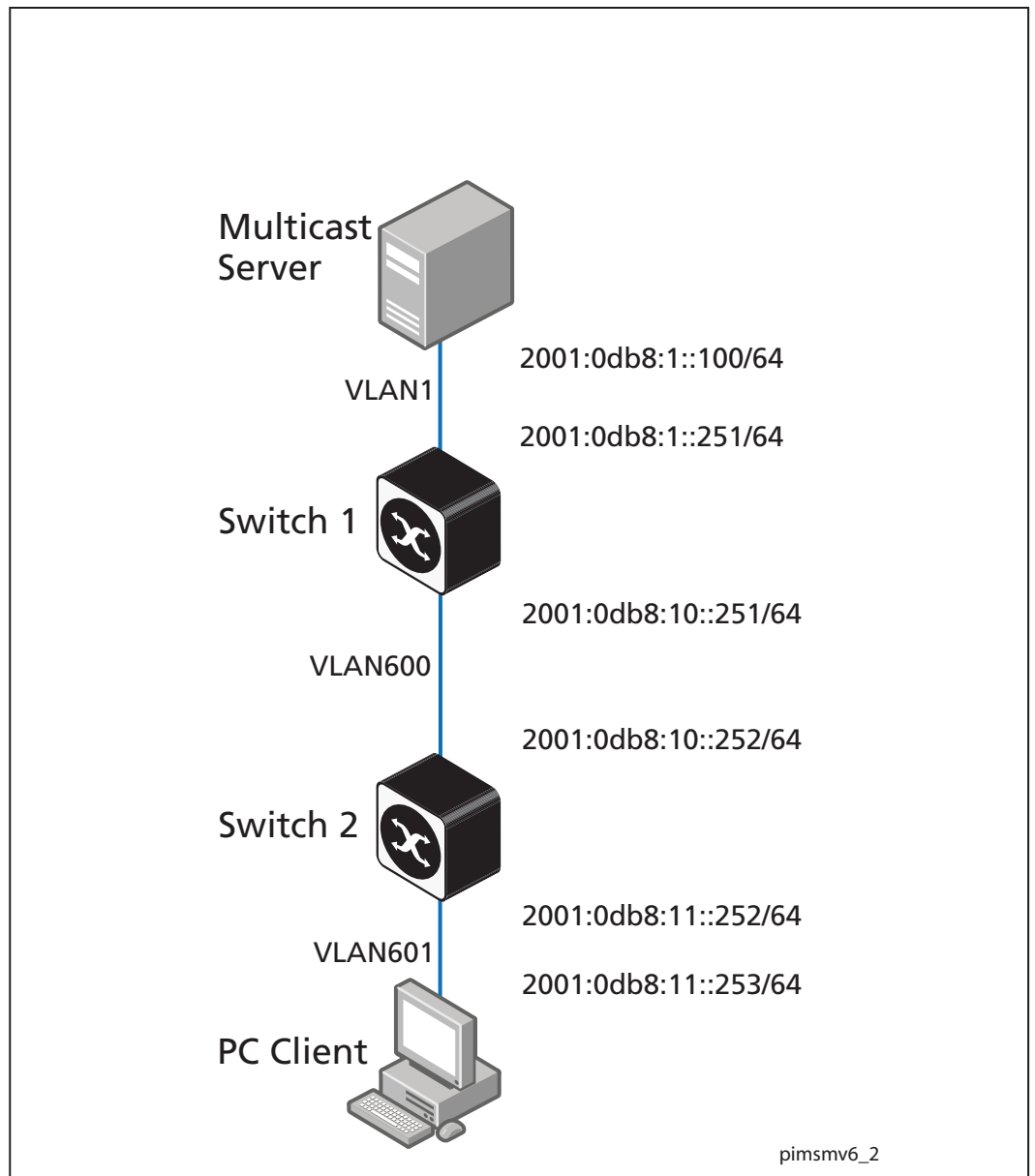
```
awplus#show ipv6 pim sparse-mode rp mapping
PIM Group-to-RP Mappings
Group(s): ff7e:240:3ffe:172:31:12::/96, Static
        RP: 3ffe:172:31:12::2
           Uptime: 00:04:12
Embedded RP Groups:
Group(s): ff7e:240:3ffe:172:31:12::/96
        RP: 3ffe:172:31:12::2, Uptime: 00:00:33
```

Verify RP-mapping in non-RP

```
mv66#show ipv6 pim sparse-mode rp mapping
PIM Group-to-RP Mappings
Embedded RP Groups:
Group(s): ff7e:240:3ffe:172:31:12::/96
        RP: 3ffe:172:31:12::2, Uptime: 00:00:27
```

RP and BSR candidate configuration

Apply the configurations for Switch 1 and Switch 2 shown following the topology to configure Switch 1 and Switch 2 as RP and BSR candidates.



Note the Multicast Server serves multiple streams on addresses `ff0e:1:1::3` and `ff0e:3:1::4`. Also note Switch 1 and Switch 2 are configured as BSR Candidates with Switch 2 elected.

Switch I Enter this configuration to configure Switch I as an RP candidate and a BSR candidate.

```
!
no ip multicast-routing
!
ipv6 multicast-routing
!
vlan database
  vlan 600 state enable
!
ipv6 pim bsr-candidate vlan600
ipv6 pim rp-candidate vlan600
!
!
interface port1.0.17
  switchport
  switchport mode access
  switchport access vlan 1
!
interface port1.0.24
  switchport
  switchport mode access
  switchport access vlan 600
!
interface vlan1
  ip address 192.168.1.101/24
  ipv6 address 2001:0db8:1::251/64
  ipv6 enable
  ipv6 router rip
  ipv6 pim sparse-mode passive
!
interface vlan600
  ipv6 address 2001:0db8:10::251/64
  ipv6 enable
  ipv6 router rip
  ipv6 pim sparse-mode
!
ipv6 forwarding
!
```


Switch 2 Enter this configuration to configure Switch 2 as an RP candidate and a BSR candidate:

```

!
ipv6 access-list standard testacl permit ff0e:1::3/128
!
no ip multicast-routing
!
ipv6 multicast-routing
!
vlan database
  vlan 600-601 state enable
!
ipv6 pim bsr-candidate vlan600
ipv6 pim rp-candidate vlan601 group-list testacl
!
interface port1.0.11
  switchport
  switchport mode access
  switchport access vlan 600
!
interface port1.0.13-1.0.14
  switchport
  switchport mode access
  switchport access vlan 603
!
interface port1.0.15-1.0.19
  switchport
  switchport mode access
!
interface port1.0.20
  switchport
  switchport mode access
  switchport access vlan 601
!
interface port1.0.21-1.0.24
  switchport
  switchport mode access
!
interface vlan600
  ipv6 address 2001:0db8:10::252/64
  ipv6 enable
  ipv6 router rip
  ipv6 pim sparse-mode
!
interface vlan601
  ipv6 address 2001:0db8:11::252/64
  ipv6 enable
  ipv6 mld
  ipv6 router rip
  ipv6 pim sparse-mode
!
ipv6 forwarding
!

```

Verify RP and RP candidate configuration

Use the following commands to verify the RP candidate configuration for Switch 1 and Switch 2. Note both Switch 1 and Switch 2 are BSR candidates and Switch 2 is elected.

Also note Switch 1 is a candidate RP for all multicast groups, while Switch 2 is a candidate for only the multicast group ff0e:1::3/128. Therefore, Switch 1 and Switch 2 overlap and Switch 1 has become the RP for ff0e:1::4 while Switch 2 is now the RP for ff0e:1::3.

Verify Switch 1 configuration

```
awplus#show ipv6 pim sparse-mode bsr-router
PIM6v2 Bootstrap information
  BSR address: 2001:0db8:10::252 (?)
  Uptime:      01:09:46, BSR Priority: 64, Hash mask length: 126
  Expires:     00:01:44
  Role:        Candidate BSR
  State:       Candidate BSR

Candidate RP: 2001:0db8:10::251(vlan600)
  Advertisement interval 60 seconds
  Next C-RP advertisement in 00:00:21
```

```
awplus#show ipv6 pim sparse-mode rp mapping
PIM Group-to-RP Mappings
Group(s): ff00::/8
  RP: 2001:0db8:10::251
    Info source: 2001:0db8:10::252, via bootstrap, priority 192
    Uptime: 01:24:33, expires: 00:02:24
Group(s): ff0e:1::3/128
  RP: 2001:11::252
    Info source: 2001:0db8:10::252, via bootstrap, priority 192
    Uptime: 00:34:06, expires: 00:02:24
Embedded RP Groups:
```

```
awplus#show ipv6 pim sparse-mode rp-hash ff0e:1::3
RP: 2001:0db8:11::252
Info source: 2001:0db8:10::252, via bootstrap
```

Verify Switch 2 configuration (Switch 2 is the elected BSR)

```
awplus#show ipv6 pim sparse-mode bsr-router
PIM6v2 Bootstrap information
This system is the Bootstrap Router (BSR)
  BSR address: 2001:0db8:10::252 (?)
  Uptime:      01:08:31, BSR Priority: 64, Hash mask length: 126
  Next bootstrap message in 00:00:49
  Role: Candidate BSR
  State: Elected BSR

Candidate RP: 2001:0db8:11::252(vlan601)
  Advertisement interval 60 seconds
  Next C-RP advertisement in 00:00:44
```

```
awplus#show ipv6 pim sparse-mode rp mapping
PIM Group-to-RP Mappings
This system is the Bootstrap Router (v2)
Group(s): ff00::/8
  RP: 2001:0db8:10::251
    Info source: 2001:0db8:10::251, via bootstrap, priority 192
    Uptime: 01:17:06, expires: 00:01:46
Group(s): ff0e:1::3/128
  RP: 2001:11::252
    Info source: 2001:0db8:10::252, via bootstrap, priority 192
    Uptime: 00:37:41, expires: 00:01:54
Embedded RP Groups:
```

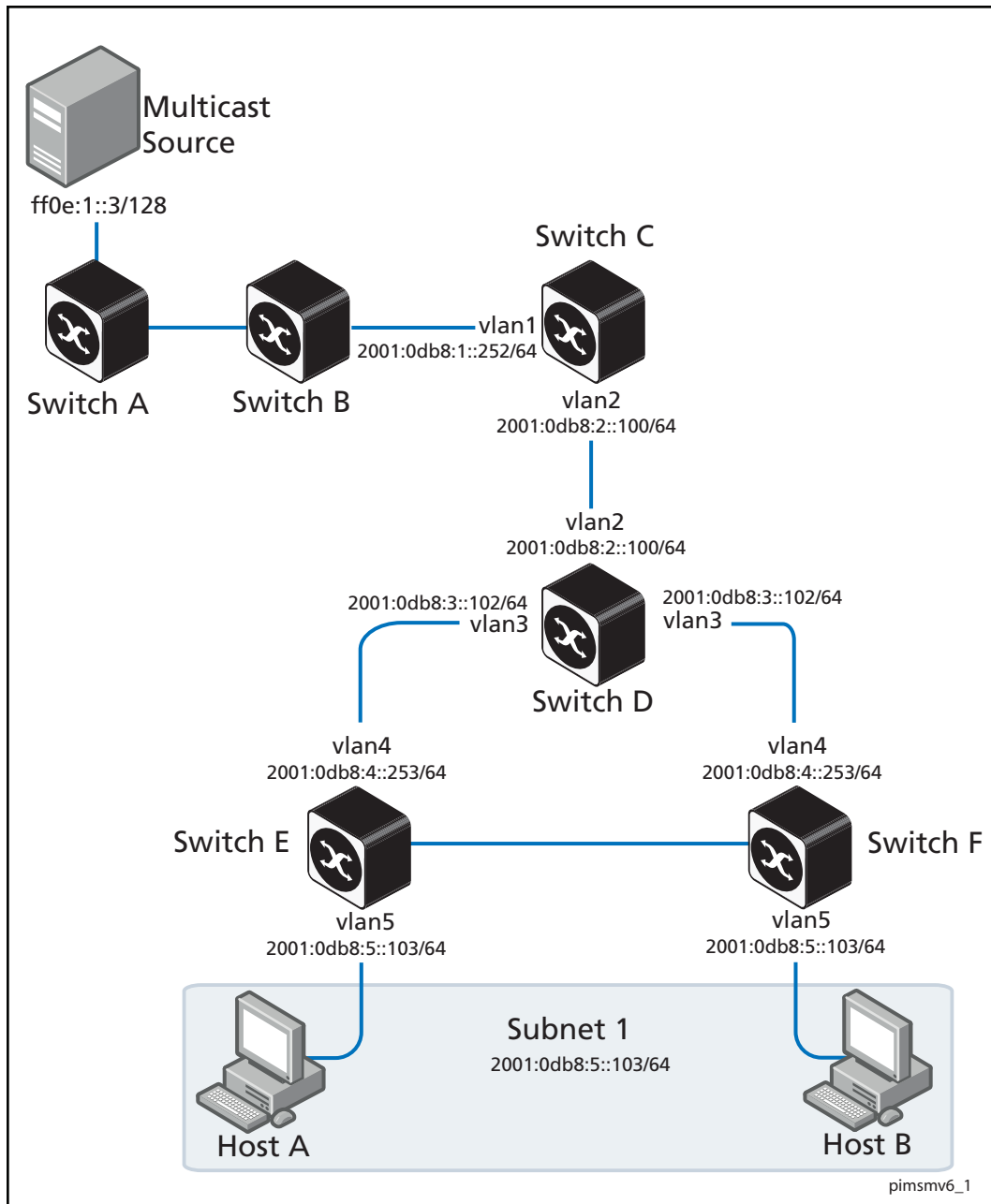
```
awplus#show ipv6 pim sparse-mode rp-hash ff0e:1::4
RP: 2001:0db8:10::251
Info source: 2001:0db8:10::252, via bootstrap
```

PIM-SMv6 Static RP, DR, BSR Configurations

This section provides three PIM-SMv6 configuration examples:

- **Static Rendezvous Point configuration**
- **Dynamic Rendezvous Point configuration**
- **Boot Strap Router configuration**

Both Rendezvous Point (RP) configuration examples refer to the network topology in the following figure and use Allied Telesis managed Layer 3 Switches as the PIM routers.



Static Rendezvous Point configuration

In this example using the above network topology, Switch C is the Rendezvous Point (RP) and all switches are statically configured with RP information. Host A and Host B join group **ff0e:1::3/128** for all the sources. They send the MLD membership report to Subnet 1. Two switches are attached to Subnet 1, Switch E and Switch F. Both of these switches have default Designated Router (DR) priority on **vlan1**. Because Switch E has a higher IP address on **vlan1**, Switch E becomes the DR and is responsible for sending Join messages to the RP (Switch C).

While configuring the RP, ensure that:

- Every switch includes the **ipv6 pim rp-address 2001:0db8:1::100/64** statement, even if it does not have any source or group member attached to it.
- There is only one RP address for the whole multicast group.
- All interfaces running PIM-SMv6 must have sparse-mode enabled. In the configuration sample output below, both **vlan1** and **vlan2** are pim sparse-mode enabled.

See the following configuration output for Switch D:

```
hostname Switch D
!
interface vlan2
  ipv6 enable
  ipv6 pim sparse-mode
  ipv6 address 2001:0db8:2::100/64
!
interface vlan3
  ipv6 enable
  ipv6 pim sparse-mode
  ipv6 address 2001:0db8:3::102/64
!
ipv6 multicast-routing
ipv6 pim rp-address 2001:0db8:1::100/64
!
ipv6 forwarding
!
```

Configure all the switches with the same **ipv6 pim rp-address 2001:0db8:1::100/64** statement as shown above.

Verify static Rendezvous Point configuration

Use the following commands to verify the RP configuration, interface details, and the multicast routing table.

RP details For Switch D, the **show ipv6 pim sparse-mode rp mapping** command shows that **2001:0db8:1::100/64** is the RP for all multicast groups **ff0e:1::3/128**, and is statically configured. All other switches will have a similar output.

```
awplus#show ipv6 pim sparse-mode rp mapping
PIM Group-to-RP Mappings
Group(s): ff0e:1::3/128, Static
  RP: 2001:0db8:1::100/64
  Uptime: 5d02h15m
```

For Switch D, the **show ipv6 pim sparse-mode rp-hash** command displays the selected RP for the specified group, in this example **ff0e:1::3/128**.

```
awplus#show ipv6 pim sparse-mode rp-hash ff0e:1::3/128
RP: 2001:0db8:1::100/64
```

Interface details For Switch E, the **show ipv6 pim sparse-mode interface** command displays the interface details and shows that Switch E is the DR on Subnet 1.

```
awplus#show ipv6 pim sparse-mode interface
Total configured interfaces: 16   Maximum allowed: 31
Total active interfaces:      12

Address                Interface VIFindex Ver/  Nbr    DR    DR
                    Mode     Count   Mode  Count  Prior
2001:0db8:1::251      vlan2    0       v2/S   1      1     2001:0db8:1::100
```

IP multicast routing table Note that the multicast routing table displayed for an RP switch is different to that displayed for other switches. For Switch C, because this switch is the RP and the root of this multicast tree, the **show ipv6 pim sparse-mode mroute** command shows **RPF nbr** (next-hop to reach RP) as **0.0.0.0** and **RPF idx** (incoming interface for this (*, G) state) as **None**.

```

awplus#show ipv6 pim sparse-mode mroute
IP Multicast Routing Table

(*,*,RP) Entries: 0
(*,G) Entries: 1
(S,G) Entries: 0
(S,G,rpt) Entries: 0
(*, ff0e:1::3/128)
RP: 2001:0db8:1::100/64
RPF nbr: 0.0.0.0
RPF idx: None
Upstream State: JOINED
  Local      .....
  Joined     j.....
  Asserted   .....
  Outgoing   o.....

```

For Switch E, the **show ipv6 pim sparse-mode mroute** command displays the IP multicast routing table.

```

awplus#show ipv6 pim sparse-mode mroute
IP Multicast Routing Table

(*,*,RP) Entries: 0
(*,G) Entries: 1
(S,G) Entries: 0
(S,G,rpt) Entries: 0
(*, ff0e:1::3/128)
RP: 2001:0db8:1::100/64
RPF nbr: 2001:0db8:1::100/64
RPF idx: port1.0.2
Upstream State: JOINED
  Local      .....
  Joined     j.....
  Asserted   .....
  Outgoing   o.....

```

On Switch E, **port1.0.2** is the incoming interface of the (*, G) entry, and **port1.0.1** is on the outgoing interface list of the (*, G) entry. This means that there is a group member through **port1.0.1**, and RP is reachable through **port1.0.2**.

Dynamic Rendezvous Point configuration

A static RP configuration works for a small, stable PIM domain. However, it is not practical for a large and not so stable internetwork. In such a network, if the RP fails, the network administrator may have to change the static configurations on all PIM switches. An additional reason for choosing dynamic configuration is high routing traffic leading to a change in the RP.

The Bootstrap Router (BSR) mechanism is used to dynamically maintain the RP information. To configure the RP dynamically in the above network topology, Switch C on **port I.0.I** and Switch D on **vlan I** are configured as RP candidates using the **ipv6 pim rp-candidate** command. Switch D on **vlan I** is also configured as the BSR candidate.

Since no other device has been configured as a BSR candidate, Switch D becomes the BSR router and is responsible for sending group-to-RP mapping information to all other PIM switches in this PIM domain.

The following output displays the complete configuration at Switch C.

```
awplus#show run
!
interface vlan1
  ipv6 enable
  ipv6 pim sparse-mode
  ipv6 address 2001:0db8:1::252/64
!
interface vlan2
  ipv6 enable
  ipv6 pim sparse-mode
  ipv6 address 2001:0db8:2::100/64
!
ipv6 multicast-routing
ipv6 pim rp-candidate vlan1
!
```

The following output displays the complete configuration at Switch D.

```
awplus#show run
!
interface vlan2
  ipv6 enable
  ipv6 pim sparse-mode
  ipv6 address 2001:0db8:2::100/64
!
interface vlan3
  ipv6 enable
  ipv6 pim sparse-mode
  ipv6 address 2001:0db8:3::102/64
!
ipv6 multicast-routing
ipv6 pim bsr-candidate vlan1
ipv6 pim rp-candidate vlan1 priority 2
!
```


The highest priority switch is chosen as the RP. If two or more switches have the same priority, a hash function in the BSR mechanism is used to choose the RP to make sure that all devices in the PIM domain have the same RP for the same multicast group.

Use the `<interface> priority <priority>` parameters of the `ipv6 pim rp-candidate` command to change the default priority of any RP candidate.

Verify PIM group-to-RP mappings

The `show ipv6 pim sparse-mode rp mapping` command displays the group-to-RP mapping details. The output shows information about RP candidates. There are two RP candidates for the group range `ff0e:1::3/128`. RP candidate `2001:1::100/64` has a default priority of **192**, whereas RP candidate `2001:1::251/64` has been configured to have a priority of **2**. Since RP candidate `2001:1::251/64` has a higher priority, it is selected as the RP for the multicast group `ff0e:1::3/128`.

See the following configuration output for Switch D.

```
awplus#show ipv6 pim sparse-mode rp mapping
This system is the Bootstrap Router (v2)
Group(s): ff0e:1::3/128
  RP: 2001:0db8:1::100/64
      Info source: 2001:0db8:1::251/64, via bootstrap, priority 192
      Uptime: 00:00:13, expires: 00:02:29
```

Verify RP details

The `show ipv6 pim sparse-mode rp-hash` command displays information about the RP router for a particular group. See the following configuration output for Switch D. This output shows that `2001:0db8:1::251/64` has been chosen as the RP for the multicast group `ff0e:1::3/128`.

```
awplus#show ipv6 pim sparse-mode rp-hash ff0e:1::3/128
Group(s): ff0e:1::3/128
  RP: 2001:0db8:1::251/64
      Info source: 2001:0db8:1::251/64, via bootstrap
```

After RP information reaches all PIM switches in the domain, various state machines maintain all routing states as the result of Join/Prune messages from members of the multicast group.

Boot Strap Router configuration

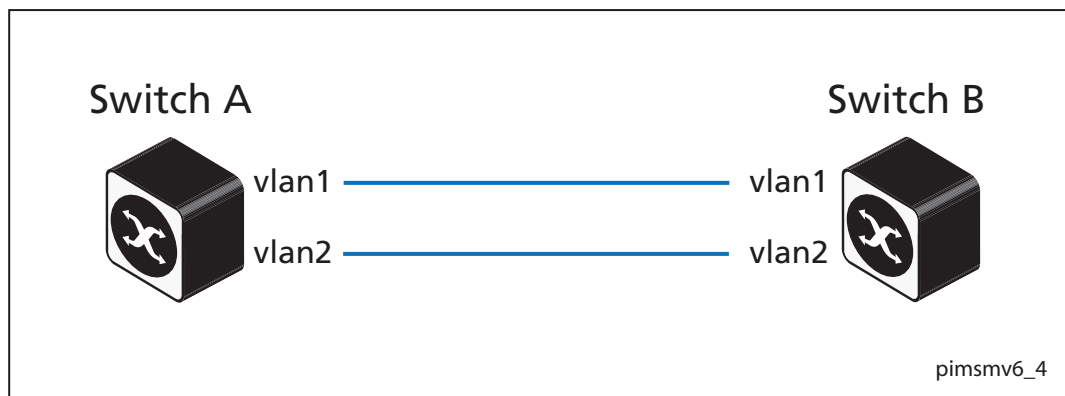
Every PIM multicast group needs to be associated with the IP address of a Rendezvous Point (RP). This address is used as the root of a group-specific distribution tree, whose branches extend to all nodes in the domain that want to receive traffic sent to the group. For all senders to reach all receivers, all devices in the domain use the same mappings of group addresses to RP addresses. In order to determine the RP for a multicast group, a PIM device maintains a collection of group-to-RP mappings, called the RP-Set.

The BSR mechanism is one way that a multicast router can learn the set of group-to-RP mappings required in order to function.

Some of the PIM devices within a PIM domain are configured as RP candidates. A subset of the RP candidates will eventually be used as the actual RPs for the domain. An RP configured with a lower value in the priority field has higher a priority.

Some of the PIM devices in the domain are configured to be BSR candidates. One of these BSR candidates is elected to be the BSR for the domain, and all PIM devices in the domain learn the result of this election through Bootstrap messages (BSM). The BSR candidate with highest value in the priority field is the elected BSR.

The RP candidates then report their candidacy to the elected BSR, which chooses a subset of the RP candidates, and distributes corresponding group-to-RP mappings to all the devices in the domain through Bootstrap messages.



Switch A Enter the following commands to configure **vlan 1** on Switch A as the BSR candidate. The default priority is 64.

```
awplus# configure terminal
awplus(config)# ipv6 forwarding
awplus(config)# ipv6 multicast-routing
awplus(config)# ipv6 pim bsr-candidate vlan1
awplus(config)# exit
```

Switch B Enter the following commands to configure **vlan 1** on Switch B as the BSR candidate with a hash mask length of 10 and a priority of 25 and to configure **vlan 1** as the RP candidate with a priority of 0.

```
awplus# configure terminal
awplus(config)# ipv6 forwarding
awplus(config)# ipv6 multicast-routing
awplus(config)# ipv6 pim bsr-candidate vlan1 10 25
awplus(config)# ipv6 pim rp-candidate vlan1 priority 0
awplus(config)# exit
```

Verify Boot Strap Router configuration

Use the **show ipv6 pim sparse-mode bsr-router** command to verify the BSR candidate state on Switch A.

```
awplus#show ipv6 pim sparse-mode bsr-router
PIMv2 Bootstrap information
This system is the Bootstrap Router (BSR)
  BSR address: 2001:0db8:1::251/64
  Uptime:      00:37:12, BSR Priority: 64, Hash mask length: 10
  Expires:     00:01:32
  Role:        Candidate BSR
  State:       Elected BSR
```

Use the **show ipv6 pim sparse-mode bsr-router** command to verify the BSR candidate state on Switch B. The initial state of the BSR candidate is pending before transitioning to BSR candidate.

```
awplus#show ipv6 pim sparse-mode bsr-router
PIMv2 Bootstrap information
  BSR address: 2001:0db8:1::251/64
  Uptime:      00:02:39, BSR Priority: 64, Hash mask length: 10
  Expires:     00:00:03
  Role:        Candidate BSR
  State:       Pending BSR
```

```
awplus#show ipv6 pim sparse-mode bsr-router
PIMv2 Bootstrap information
  BSR address: 2001:0db8:1::251/64
  Uptime:      00:40:20, BSR Priority: 64, Hash mask length: 10
  Expires:     00:02:07
  Role:        Candidate BSR
  State:       Candidate BSR
```

Use the **show ipv6 pim sparse-mode rp mapping** command to verify RP-set information on Switch A.

```
awplus#show ipv6 pim sparse-mode rp mapping
PIM Group-to-RP Mappings
This system is the Bootstrap Router (v2)
Group(s): ff0e:1::3/128
  RP: 2001:db8:1::251/64
    Info source: 2001:db8:1::251/64, via bootstrap, priority 0
    Uptime: 00:00:30, expires: 00:02:04
```

Use the **show ipv6 pim sparse-mode rp mapping** command to verify RP-set information on Switch B.

```
awplus#show ipv6 pim sparse-mode rp mapping
PIM Group-to-RP Mappings
Group(s) : ff0e:1::3/128
  RP: 2001:db8:1::251/64
    Info source: 2001:db8:1::251/64, via bootstrap, priority 0
    Uptime: 00:00:12, expires: 00:02:18
```