Chapter 33

IPv6 Multicasting

Introduction

This chapter describes IPv6 multicasting and support for IPv6 multicasting on the router.

Any IPv6 host or router can send packets to an IPv6 multicast group's address. The packets are received by nodes that have joined that group. A node can join or leave a group at any time.

IPv6 "broadcast" traffic is a subset of multicast traffic. It is sent to one of a reserved subset of multicast addresses, and is received by all hosts or routers to which the address applies. Some reserved addresses and IPv6 multicast prefixes are shown in Table 33-1 on page 33-3. For more reserved addresses, see RFC 2375 "IPv6 Multicast Address Assignments".

Table 33-1: Some IPv6 multicast addresses

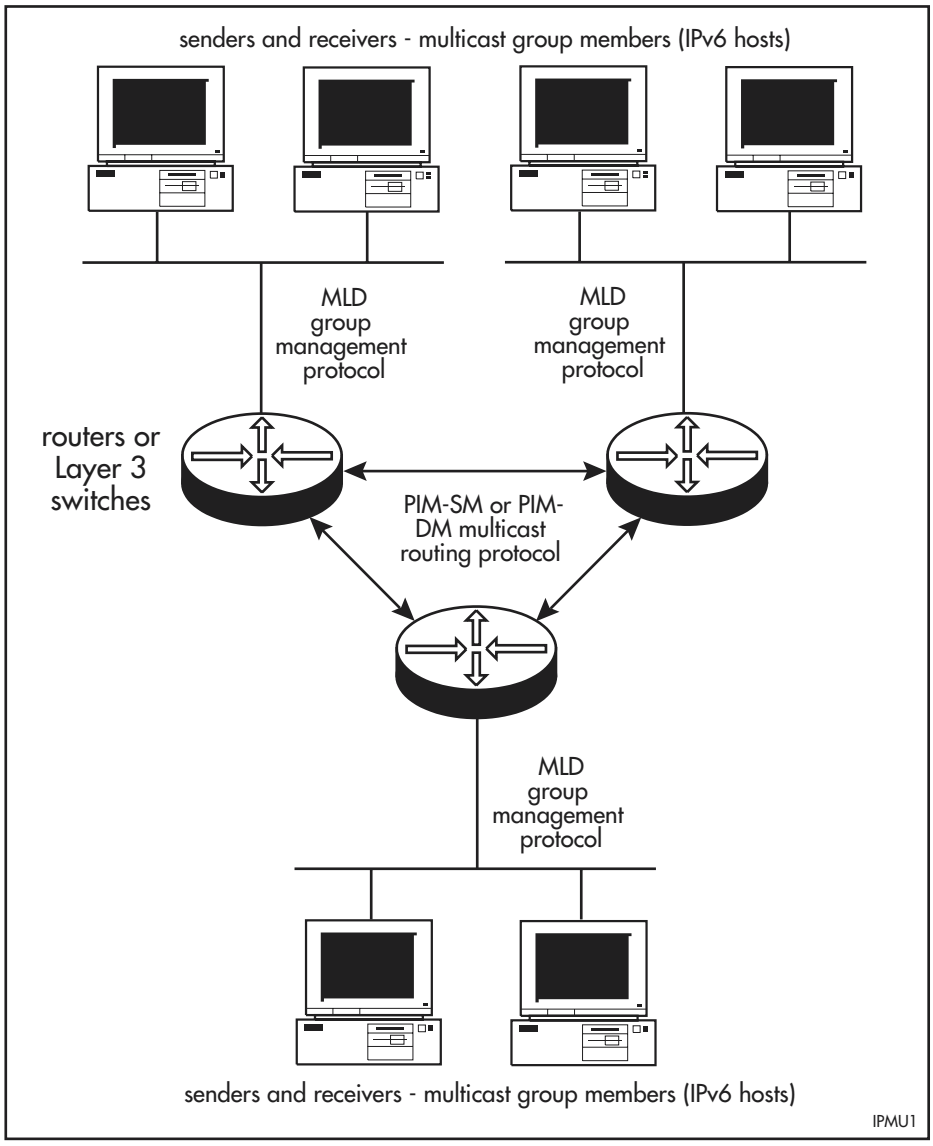
Address	Meaning
ff05:group	A site scope multicast group
ff0e:group	A global scope multicast group
ff02::1	The link-scope all-nodes multicast address (listened to by all systems on the local link).

IPv6 requires a special feature licence, which can be purchased from an Allied Telesis authorised distributor or reseller.

Overview of IPv6 Multicast Routing

For multicasting to succeed, the router needs to know which of its interfaces are directly connected to members of each multicast group. To establish this, the router uses Multicast Listener Discovery for multicast group management (see "Multicast Listener Discovery (MLD)" on page 33-5). The router also needs to know which other routers to route multicast traffic to. The router uses Protocol Independent Multicast Sparse Mode or Dense Mode to maintain a routing table for multicast traffic (see "Protocol Independent Multicast Sparse Mode (PIM-SM)" on page 33-7 and "Protocol Independent Multicast Dense Mode (PIM-DM)" on page 33-11). The protocols IPv6, MLD and at least one of PIM-SM and PIM-DM must all be configured before the router can forward IPv6 multicast packets. The relationship between IPv6 hosts, routers and the multicasting protocols is shown in Figure 33-1 on page 33-4.

Figure 33-1: IPv6 multicast environment



Interoperability between Multicast Routing Protocols

The router can be configured as a Multicast Border Router (MBR), as specified in RFC 2715, *Interoperability Rules for Multicast Routing Protocols*. A Multicast Border Router forms the border between two or more multicasting domains that are running different multicast routing protocols (PIM-SM or PIM-DM). The MBR forwards multicast packets across the different domains so that receivers in one domain can receive packets from sources in another domain. Therefore different IPv6 interfaces on the router can be configured as PIM-SM or PIM-DM interfaces.

The router treats sources that are reached via another multicasting domain as if they were directly connected sources.

Multicast Listener Discovery (MLD)

Version 2 of the Multicast Listener Discovery Protocol (MLDv2) allows an IPv6 router to determine the following for each of its directly-attached links:

- which IPv6 nodes are interested in receiving multicast traffic,
- which groups each node wishes to receive traffic from, and
- which sources a node wishes to receive traffic from, or wishes not to receive traffic from, if the node specifies a list of such sources.

MLDv2 supplies PIM-SM (Protocol Independent Multicasting—Sparse Mode) with information about group membership so that PIM-SM can forward the multicast traffic appropriately to all links in the network.

The router supports MLDv2 as specified in RFC 3810, *Multicast Listener Discovery Version 2 (MLDv2) for IPv6.* MLDv2 is interoperable with MLDv1. Only the router-router part of the protocol has been implemented; the router cannot act as an MLD host.

Queries and Reports

MLD determines the links that have interested hosts on them by sending query messages. Each subnet elects the router with the lowest IPv6 address to be the Querier. If the Querier receives a query from another router with a lower IPv6 address, it resets its Other Querier Present timer, and stops sending query messages until the timer expires. If the timer expires, the router sends query messages again until another query is received from a router with a lower IPv6 address.

There are three different kinds of query messages, and two different host report types. Three different types of exchange occur, depending on the information held by the Querier and whether group membership changes. Each of the three exchanges can occur at any time. These messages and exchanges are illustrated in Figure 33-2 on page 33-6.

The first type of exchange is initiated by the Querier, which periodically sends General Queries to the link-scope all-nodes multicast address (ff02::1). All nodes on the link listen to this address. Hosts that are running the host part of MLD respond with a Multicast Listener Report. The report contains a Current State Multicast Address Record, which informs the Querier of the groups and sources that the host wishes to receive traffic from (steps 1a and 2a of Figure 33-2 on page 33-6).

The second type of exchange is initiated by the host. If a host leaves or joins a multicast group, it sends the Querier a Multicast Listener Report containing a State Change Record (step 1b). The Querier responds by sending all hosts on the link (step 2b) either:

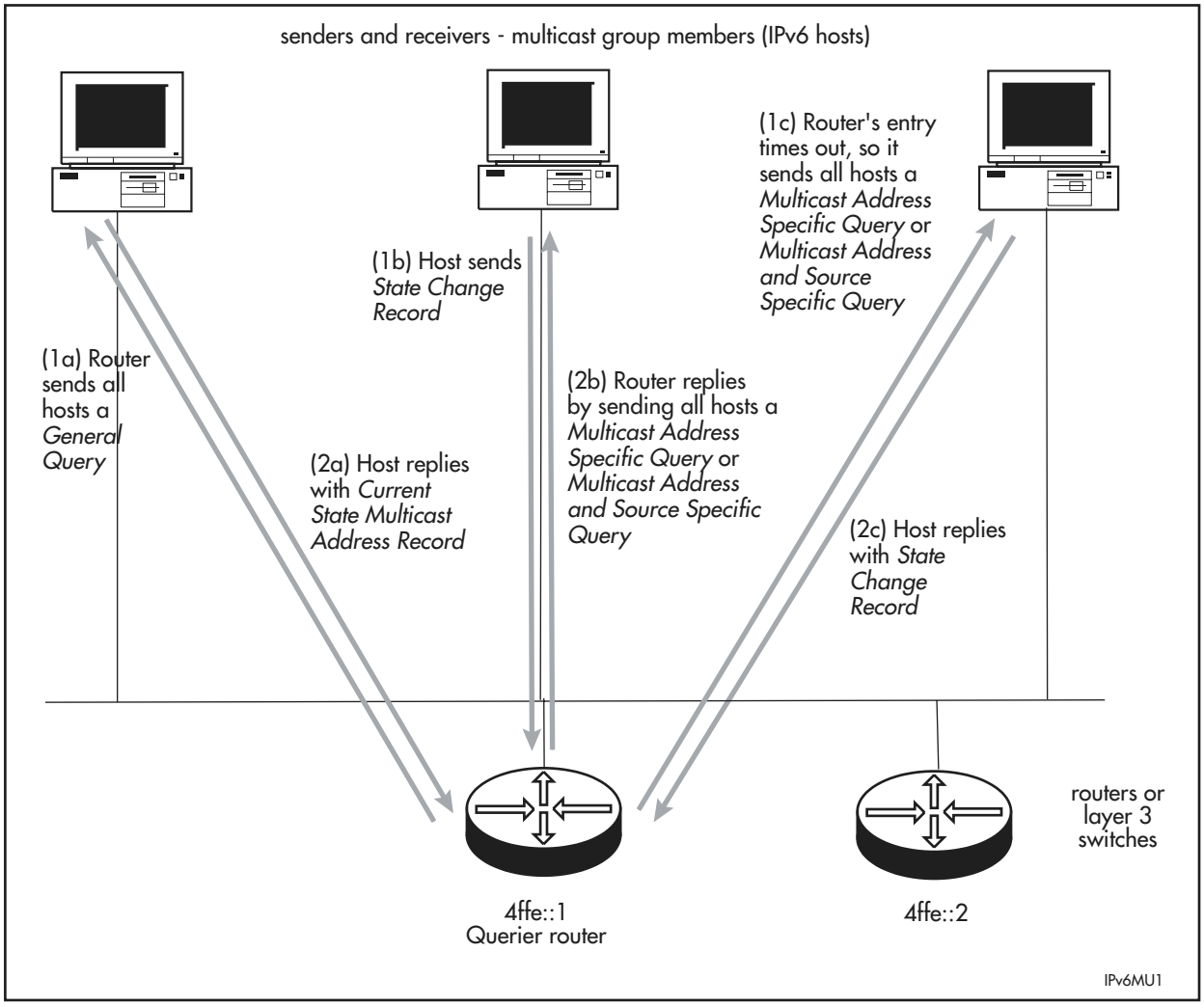
- a Multicast Address Specific Query, to determine whether any hosts are listening to a particular multicast address, or
- a Multicast Address and Source Specific Query, to determine whether any hosts are listening to a traffic from a particular source to a particular multicast address.

The third type of exchange is initiated by the Querier. When the Current State Records or State Change Records sent by the hosts stops referring to a particular multicast group or source, the relevant entry in the Querier's group

membership table times out. The Querier then sends all hosts a Multicast Address Specific Query or a Multicast Address and Source Specific Query to confirm that no hosts are interested in the group or source (steps 1c and 2c).

Current State Multicast Address Records normally refresh the Querier's existing state because they are the host's response to a query from the Querier. When the interface state changes, the node sends an unsolicited State Change Record. State Change Records indicate to the Querier that changes are required. Distinguishing the two record types reduces package processing.

Figure 33-2: MLD queries and responses



Configuring MLD

To enable an interface to listen for and respond to MLD traffic, first enable IPv6 and configure IPv6 for that interface. Then enable MLD by using the command:

```
enable ipv6 mld
```

Enable MLD on the desired interface by using the command:

```
enable ipv6 mld interface=interface
```

If MLD is enabled on an interface before MLD is globally enabled, the interface begins processing traffic as soon as MLD is enabled globally.

Disable MLD globally by using the command:

```
disable ipv6 mld
```

Disable a single interface by using the command:

```
disable ipv6 mld interface=interface
```

Protocol Independent Multicast Sparse Mode (PIM-SM)

PIM Sparse Mode (PIM-SM) provides efficient communication between members of sparsely distributed groups - the type of groups that are most common in wide-area internetworks. It is designed on the principle that several hosts wishing to participate in a multicast conference does not justify flooding the entire internetwork with periodic multicast traffic. PIM-SM is designed to limit multicast traffic so that only routers interested in receiving traffic for a particular group receive the traffic. For both IPv4 and IPv6, the router supports PIM Sparse Mode as specified in Internet Draft *Protocol Independent Multicast - Sparse Mode (PIM-SM): Protocol Specification (Revised)*, Internet Engineering Task Force, PIM WG, 1 March 2002 (draft-ietf-pim-sm-v2-new-05).

PIM-SM uses the same mechanism to process traffic in IPv4 and IPv6. The principles of PIM-SM are described in "PIM Sparse Mode" on page 24-10 of Chapter 24, IP Multicasting.

Configuring PIM Sparse Mode

PIM-SM is dependent on the router's underlying unicast routing protocols. Before multicasting can function, IPv6 must be enabled and interfaces and routing must be configured on the router.

PIM6 multicasting routing is disabled by default and must be enabled router before any PIM6 configuration takes effect. However, we recommend that the PIM6 configuration be completely set up on the router before PIM6 is enabled. To enable or disable PIM6, use the commands:

```
enable pim6
```

```
disable pim6
```

For PIM Sparse Mode multicast routing to operate on the router, each interface over which it is to send and receive multicast routing messages and multicast packets must be assigned to PIM-SM. Each subnetwork must also have at least one *Designated Router* candidate, each network must have at least one *Bootstrap Router* candidate, and each multicast group must have at least one *Rendezvous Point* candidate.

PIM-SM Interfaces

By default PIM interfaces are set to use Sparse Mode when they are added. To add a PIM-SM interface, use the command:

```
add pim6 interface=interface [drpriority=0..4294967295]
   [electby={drpriority|ipaddress}] [mode=sparse]
   [other-options...]
```

Each PIM-SM interface has a priority for becoming the *designated router* (DR) for its subnetwork. The higher the number, the higher the priority. The default designated router priority is 1. If the multicast group must choose a DR from interfaces with the same priority, or no priority, the interface with the highest IP address number is chosen. The **electby** parameter determines how the router elects the designated router for this interface. If **drpriority** is specified, the interface transmits its DR priority in its hello messages. If all routers in the subnetwork transmit their DR priorities, routers in the subnetwork are able to elect the DR by priority. If **ipaddress** is specified, the router does not transmit its DR priority, which forces the routers in the subnetwork to elect the DR by IP address. The default is **drpriority**.

To delete an interface, use the command:

```
delete pim6 interface=interface
```

To modify the mode, designated router priority, or method by which the designated router is elected for a PIM interface, use the command:

```
set pim6 interface=interface mode={dense|sparse}
   [drpriority=0..4294967295] [electby={drpriority|
   ipaddress}] [other-options...]
```

To restart all PIM processes on an interface, resetting the PIM timers, route information and counters for the interface, use the command:

```
reset pim6 interface=interface
```

To display information about PIM interfaces, use the command:

```
show pim6 interface
```

Bootstrap Router Candidates

Each network of PIM–SM routers must have a Bootstrap Router (BSR). PIM-SM chooses as the Bootstrap Router the candidate with the highest preference value from all the Bootstrap Router candidates available. Each PIM–SM connected network must have at least one Bootstrap Router candidate. The candidate with the highest preference value becomes the Bootstrap Router. The default preference is 1. The Bootstrap Router sends a *bootstrap message* to the other PIM–SM routers, containing a list of the RP candidates for multicast groups at BSMINTERVAL seconds. To make the router a Bootstrap Router candidate, use the command:

```
add pim6 bsrcandidate [preference=0..255]
   [scope=site|global|all]
```

To change the router's Bootstrap Router candidate preference or the scope zone for which it is a BSR candidate, use the command:

```
set pim6 bsrcandidate [preference=0..255]
   [scope=site|global|all]
```

To stop the router acting as a Bootstrap Router candidate, use the command:

```
delete pim6 bsrcandidate
```

To display information about the router's Bootstrap Router configuration, use the command:

```
show pim6 bsrcandidate
```

Rendezvous Point Candidates

Each multicast group must have a *Rendezvous Point* (RP), which is either chosen dynamically from the list of Rendezvous Point candidates available, or statically configured on each router that processes traffic for that group. For dynamic RP selection, there must be at least one RP candidate in the PIM-SM connected network, but generally there should be several. PIM-SM chooses the RP candidate with lowest preference value to be the RP for the multicast group. The lower the number, the higher its priority. The default priority is 192. The dynamically-chosen RP advertises itself to the current Bootstrap Router at an interval specified by the **advinterval** parameter in the **set ipm6** command. The default **advinterval** is 60 seconds.

When an IP host joins a multicast group on a router, the router sends a *Join* message to the active Rendezvous Point. The Rendezvous Point then knows to send multicast packets for the group to this router. When the last IP host leaves a group, the router sends a *Prune* message to the RP, telling it that it no longer needs to receive multicast packets for the group.

To configure the router to be a dynamic RP candidate, use the command:

```
add pim6 rpcandidate group=ipv6address[/prefixlength]
   [priority=0..255]
```

To modify the router's RP candidate priority, use the command:

```
set pim6 rpcandidate group=ipv6address[/prefixlength]
   priority=0..255
```

The router has the same values for **priority** for all multicast groups for which it is a rendezvous point candidate, so changing the priority for one group changes it for all groups.

To stop the router from acting as an RP candidate, use the command:

```
delete pim6 rpcandidate group=ipv6address[/prefixlength]
```

Static RP mappings can be configured instead of using the bootstrap mechanism. To configure a static Rendezvous Point on the router for a multicast group, specify the IP address of the Rendezvous Point, using the command:

```
add pim6 rpcandidate=rp-address group=ipv6address
   [/prefixlength]
```

where *rp-address* is the IP address of the router that is to be the Rendezvous Point for the multicast group(s) specified. An RP can be statically configured as the RP for multiple groups, but each group can have only one statically-configured RP. Each router in the PIM-SM domain must be configured with the same static RP to group mapping. If the bootstrap mechanism is also running, a static RP mapping takes precedence.

To delete a static RP, use the command:

```
delete pim6 rpcandidate=rp-address group=ipv6address
   [/prefixlength]
```

To display information about multicast groups for which the router is a Rendezvous Point candidate, use the command:

```
show pim6 rpcandidate
```

To display the static group-to-RP mapping, followed by the elected bootstrap router's current set of RP candidates and the groups they are configured for, use the command:

```
show pim6 rpset
```

Displaying Other PIM-SM Information

The following commands display general PIM-SM information:

- **show pim6 config**, which lists the CLI commands that make up the router's PIM6 configuration
- **show pim6 counters**, which displays the number of PIM messages that the router has received and sent, and the number of bad messages it has received
- **show pim6 neighbour**, which gives information about the neighbouring routerss that PIM is aware of
- **show pim6 route**, which displays the internal PIM routing table

PIM-SM Timers

Timers for PIM-SM operations have defaults that suit most networks and should not generally be modified. If they need to be modified, use the command:

```
set pim6 [advinterval={10..15000|default}]
   [bsminterval={10..15000|default}] [jpinterval={1..65535|
   default}] [keepalivetime={10..65535|default}]
   [probetime={1..65535|default}]
   [suppressiontime={1..65535|default}] [other-options...]
```

Caution Changing these timers to inappropriate values can cause PIM to function in undesirable ways. System administrators should only change these timer values based on a sound understanding of their interaction with other devices in the network.

To list the values of the global PIM timers, use the command:

```
show pim6 timer
```

PIM-SM Debugging

To display debugging information about PIM-SM, use the command:

```
enable pim6 debug={all|assert|bsr|c-rp-adv|hello|join|
   register}[,...]
```

Debugging options are listed in a table with the command. To see which options are enabled, use the command:

```
show pim6 debug
```

Protocol Independent Multicast Dense Mode (PIM-DM)

Unlike PIM Sparse Mode, PIM Dense Mode (PIM-DM) does not use a designated router, bootstrap router or Rendezvous Points. PIM-DM assumes that when a source starts sending, all downstream systems want to receive multicast datagrams. Initially, multicast datagrams are flooded to all areas of the network. If some areas of the network do not have group members, dense-mode PIM prunes the forwarding branch by setting up prune state. When a new member appears in a pruned area, a router can "graft" toward the source for the group, turning the pruned branch into a forwarding branch.

For both IPv4 and IPv6, the router supports PIM Dense Mode as specified in Internet Draft "*Protocol Independent Multicast - Dense Mode (PIM-DM): Protocol Specification (Revised)*", Internet Engineering Task Force, PIM WG, 15 February 2002 (draft-ietf-pim-dm-new-v2-01).

PIM-DM uses the same mechanism to process traffic in IPv4 and IPv6. The principles of PIM-DM are described in more detail in "PIM Dense Mode" on page 24-8 of Chapter 24, IP Multicasting.

Configuring PIM Dense Mode

Like PIM-SM, PIM-DM is dependent on the router's underlying unicast routing protocols. Before multicasting can function, IPv6 must be enabled and interfaces and routing must be configured on the router.

PIM6 multicasting routing is disabled by default and must be enabled before any PIM6 configuration takes effect. However, we recommend that the PIM6 configuration be completely set up on the router before PIM6 is enabled. To enable or disable PIM6, use the commands:

```
enable pim6
disable pim6
```

For PIM Dense Mode multicast routing to operate on the router, each interface over which it is to send and receive multicast routing messages and multicast packets must be assigned to PIM-DM.

By default PIM interfaces are set to use Sparse Mode when they are added. To add a PIM-DM interface, use the command:

```
add pim6 interface=interface mode=dense [other-options...]
```

To delete an interface, use the command:

```
delete pim6 interface=interface
```

To modify a PIM interface, use the command:

```
set pim6 interface=interface [mode={dense|sparse}]
   [other-options...]
```

State Refresh messages can be used in a PIM-DM domain to reduce unnecessary multicast traffic. Instead of a source repeatedly flooding downstream routers with multicast packets and repeatedly receiving prune messages, a State Refresh message maintains an existing prune. By default the router cannot initiate or process State Refresh messages. To enable this functionality on an interface, use one of the commands:

```
add pim6 interface=interface mode=dense srcapable=yes
   [other-options...]
set pim6 interface=interface srcapable=yes [other-options...]
```

To restart all PIM processes on an interface, resetting the PIM timers, route information and counters for the interface, use the command:

```
reset pim6 interface=interface
```

To display information about PIM interfaces, use the command:

```
show pim6 interface
```

Displaying More PIM-DM Information

The following commands display general PIM-DM information:

- **show pim6 config**, which lists the CLI commands that make up the router's PIM6 configuration
- **show pim6 counters**, which displays the number of PIM messages that the router has received and sent, and the number of bad messages it has received
- **show pim6 neighbour**, which gives information about the neighbouring routers that PIM is aware of
- **show pim6 route**, which displays the internal PIM routing table
- **show pim6 staterefresh**, which displays the internal State Refresh table

PIM-DM Timers

Timers for PIM-DM operations have defaults that suit most networks and should not generally be modified.

Caution Changing these timers to inappropriate values can cause PIM to function in undesirable ways. System administrators should change these timer values based on a sound understanding of their interaction with other devices in the network.

If the timers need to be modified, use the command:

```
set pim6 [jpinterval={1..65535|default}]
   [keepalivetime={10..65535|default}]
   [pruneholdtime={1..65535|default}]
   [sourcealivetime={10..65535|default}]
   [srinterval={10..255|default}] [other-options...]
```

To list the values of the global PIM timers, use the command:

```
show pim6 timer
```

PIM-DM Debugging

To display debugging information about PIM-DM, use the command:

```
enable pim6 debug={all|assert|bsr|c-rp-adv|graft|hello|join|
   register|staterefresh}[,...]
```

Debugging options are listed in the description of the command.

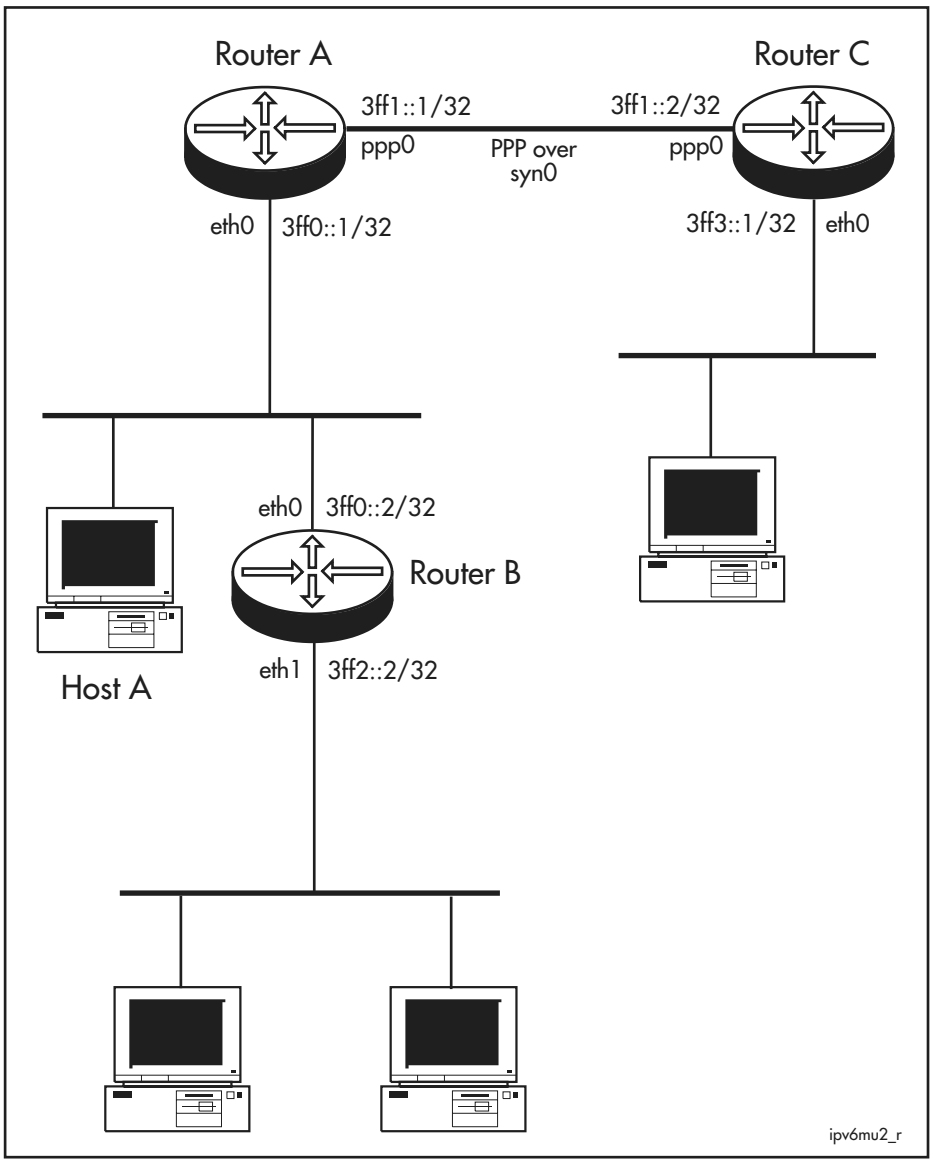
To see which options are enabled, use the command:

```
show pim6 debug
```

Configuration Examples

These examples use PIM-SM or PIM-DM for multicast routing between three routers. The network topology is the same for each example (Figure 33-3 on page 33-13). Multicast group management uses MLD. The examples assume that each router starts from the default configuration.

Figure 33-3: Multicast configuration topology using PIM6 Sparse or Dense Mode.



PIM6 Sparse Mode

This example allows IPv6 hosts to send data to and receive data from the multicast groups ff0e::1230 to ff0e::1233. The configuration of Routers A, B, and C are very similar, but Router A is the only router that is configured as a PIM6 Bootstrap Router Candidate and a PIM6 Rendezvous Point Candidate.

Some interface and port types mentioned in this example may not be supported on your router. The interface and port types that are available vary depending on your product's model, and whether an expansion unit (PIC, NSM) is installed. For more information, see the *AR400 Series Router Hardware Reference*.

To configure A

1. Set the system name for the router.

```
set sys name=a-pim6-rp
```

2. Create a PPP interface.

Create a PPP interface 0 over synchronous port 0.

```
create PPP=0 over=syn0
```

3. Configure IPv6

Enable IPv6 on the router.

```
enable ipv6
```

Assign IPv6 addresses to the PPP and Ethernet interfaces.

```
add ipv6 interface=eth0 ipaddress=3ff0::1/32
add ipv6 interface=ppp0 ipaddress=3ff1::1/32
```

4. Configure IPv6 Routing

Enable routing of IPv6 packets using RIPv6.

```
enable ipv6 rip
```

Enable RIPv6 on the interfaces.

```
add ipv6 rip interface=eth0
add ipv6 rip interface=ppp0
```

5. Configure MLD.

Enable MLD on the router for group management.

```
enable ipv6 mld
```

Enable MLD on each interface, so that MLD can find out which multicast groups have hosts connected to this interface.

```
enable ipv6 mld interface=eth0
enable ipv6 mld interface=ppp0
```

6. Configure PIM6.

Define PIM6 interfaces for the Ethernet and PPP interfaces.

```
add pim6 interface=eth0
add pim6 interface=ppp0
```

The network must have a PIM6 bootstrap router, so at least one router in the network must be configured as a Bootstrap Router Candidate. Set this router to be a Bootstrap Router Candidate.

```
add pim6 bsrcandidate
```

At least one router in each multicast group must be a PIM6 Rendezvous Point (RP) for the multicast group, so at least one router in each group must be configured as a Rendezvous Point Candidate. Set this router to be an RP Candidate.

```
add pim6 rpcandidate group=ff0e::1230/126 priority=100
```

Enable PIM6 multicast routing.

```
enable pim6
```

To configure Router B

1. Set the system name.

Set a unique system name on the router.

```
set sys name=b-pim6
```

2. Configure IPv6

Enable IPv6 on the router.

```
enable ipv6
```

Assign IPv6 addresses to the Ethernet interfaces.

```
add ipv6 interface=eth0 ipaddress=3ff0::2/32
add ipv6 interface=eth1 ipaddress=3ff2::1/32
```

3. Configure IPv6 Routing

Enable routing of IPv6 packets using RIPv6.

```
enable ipv6 rip
```

Enable RIPv6 on the interfaces.

```
add ipv6 rip interface=eth0
add ipv6 rip interface=eth1
```

4. Configure MLD.

Enable MLD on the router for group management.

```
enable ipv6 mld
```

Enable MLD on the Ethernet interfaces, so that MLD can find out which multicast groups have hosts connected to each interface.

```
enable ipv6 mld interface=eth0
enable ipv6 mld interface=eth1
```

Note that Router A becomes the Querier for Host A because Router A has a lower IP address than Router B. Router B becomes the Querier when Router A becomes unavailable because MLD is also enabled on Router B's interface to Host A (eth0).

5. Configure PIM6.

Define PIM6 interfaces for the Ethernet interfaces.

```
add pim6 interface=eth0
add pim6 interface=eth1
```

Enable PIM6 multicast routing.

```
enable pim6
```

To configure Router C

1. Set the system name.

Set a unique system name on the router.

```
set sys name=c-pim6
```

2. Create a PPP interface.

Create a PPP interface 0 over synchronous port 0.

```
create ppp=0 over=syn0
```

3. **Configure IPV6**

   Enable IPv6 on the router.

   ```
   enable ipv6
   ```

   Assign IPv6 addresses to PPP and Ethernet interfaces.

   ```
   add ipv6 interface=ppp0 ipaddress=3ff1::2/32
   add ipv6 interface=eth0 ipaddress=3ff3::1/32
   ```

4. **Configure IPV6 routing.**

   Enable routing of IPv6 packets using RIPv6.

   ```
   enable IPV6 RIP
   ```

   Enable RIPv6 on interfaces.

   ```
   add ipv6 rip interface=ppp0
   add ipv6 rip interface=eth0
   ```

5. **Configure MLD.**

   Enable MLD on the router for group management.

   ```
   enable ipv6 mld
   ```

   Enable MLD on each interface, so that MLD can find out which multicast groups have hosts connected to this interface.

   ```
   enable ipv6 mld interface=ppp0
   enable ipv6 mld interface=eth0
   ```

6. **Configure PIM6.**

   Define PIM6 interfaces for the Ethernet and PPP interfaces.

   ```
   add pim6 interface=eth0
   add pim6 interface=ppp0
   ```

   Enable PIM6 multicast routing.

   ```
   enable pim6
   ```

To confirm multicasting

When the three routers have been configured, RIP takes a few seconds to distribute the unicast routing information to all routers. Then the IP hosts connected to these interfaces can send and receive multicasts.

1. **Test multicasting.**

   Test whether IP multicasting is successful by sending IP multicast data between hosts connected to each of the routers. Check that MLD messages are correctly processed by having hosts leave and join groups.

2. **Check the multicast state.**

   To check each router, use the commands:

   ```
   show pim6
   show ipv6 mld
   show ipv6 mld counters
   show ipv6 mld config
   show ipv6 route multicast
   ```

The final configurations are:

Router A

```
set sys name=a-pim6-rp
create ppp=0 over=syn0
enable ipv6
add ipv6 interface=eth0 ipaddress=3ff0::1/32
add ipv6 interface=ppp0 ipaddress=3ff1::1/32
enable ipv6 rip
add ipv6 rip interface=eth0
add ipv6 rip interface=ppp0
enable ipv6 mld
enable ipv6 mld interface=eth0
enable ipv6 mld interface=ppp0
add pim6 interface=eth0
add pim6 interface=ppp0
add pim6 bsrcandidate
add pim6 rpcandidate group=ff0e::1230/126 priority=100
enable pim6
```

Router B

```
set sys name=b-pim6
enable ipv6
add ipv6 interface=eth0 ipaddress=3ff0::2/32
add ipv6 interface=eth1 ipaddress=3ff2::1/32
enable ipv6 rip
add ipv6 rip interface=eth0
add ipv6 rip interface=eth1
enable ipv6 mld
enable ipv6 mld interface=eth0
enable ipv6 mld interface=eth1
add pim6 interface=eth0
add pim6 interface=eth1
enable pim6
```

Router C

```
set sys name=c-pim6
create ppp=0 over=syn0
enable ipv6
add ipv6 interface=ppp0 ipaddress=3ff1::2/32
add ipv6 interface=eth0 ipaddress=3ff3::1/32
enable ipv6 rip
add ipv6 rip interface=ppp0
add ipv6 rip interface=eth0
enable ipv6 mld
enable ipv6 mld interface=ppp0
enable ipv6 mld interface=eth0
add pim6 interface=eth0
add pim6 interface=ppp0
enable pim6
```

PIM6 Dense Mode

This example uses PIM Dense Mode for multicast routing between routers in the same topology as the PIM Sparse Mode example (Figure 33-3 on page 33-13). Multicast group management uses MLD. The example assumes that each router starts from the default configuration.

The configurations of Switches A, B and C are identical except for names and interfaces.

To configure Router A

1. **Set the system name for the router.**

   ```
   set sys name=a-pim6-dm
   ```

2. **Create a PPP interface.**

   Create a PPP interface 0 over synchronous port 0.

   ```
   create ppp=0 over=syn0
   ```

3. **Configure IPv6**

   Enable IPv6 on the router.

   ```
   enable ipv6
   ```

   Assign IPv6 addresses to the PPP and Ethernet interfaces.

   ```
   add ipv6 interface=eth0 ipaddress=3ff0::1/32
   add ipv6 interface=ppp0 ipaddress=3ff1::1/32
   ```

4. **Configure IPv6 Routing**

   Enable routing of IPv6 packets using RIPv6.

   ```
   enable ipv6 rip
   ```

   Enable RIPv6 on the interfaces.

   ```
   add ipv6 rip interface=eth0
   add ipv6 rip interface=ppp0
   ```

5. **Configure MLD.**

   Enable MLD on the router for group management.

   ```
   enable ipv6 mld
   ```

   Enable MLD on each interface, so that MLD can find out which multicast groups have hosts connected to this interface.

   ```
   enable ipv6 MLD interface=eth0
   enable ipv6 MLD interface=ppp0
   ```

6. **Configure PIM6.**

   Define PIM6 interfaces for the Ethernet and PPP interfaces.

   ```
   add pim6 interface=eth0 mode=dense
   add pim6 interface=ppp0 mode=dense
   ```

   Enable PIM6 multicast routing.

   ```
   enable pim6
   ```

To configure Router B

1. **Set the system name.**

   Set a unique system name on the router.

   ```
   set sys name=b-pim6
   ```

2. **Configure IPv6**

   Enable IPv6 on the router.

   ```
   enable ipv6
   ```

   Assign IPv6 addresses to the Ethernet interfaces.

   ```
   add ipv6 interface=eth0 ipaddress=3ff0::2/32
   add ipv6 interface=eth1 ipaddress=3ff2::1/32
   ```

3. **Configure IPv6 Routing**

   Enable routing of IPv6 packets using RIPv6.

   ```
   enable ipv6 rip
   ```

   Enable RIPv6 on the interfaces.

   ```
   add ipv6 rip interface=eth0
   add ipv6 rip interface=eth1
   ```

4. **Configure MLD.**

   Enable MLD on the router for group management.

   ```
   enable ipv6 mld
   ```

   Enable MLD on the Ethernet interfaces, so that MLD can find out which multicast groups have hosts connected to each interface.

   ```
   enable ipv6 mld interface=eth0
   enable ipv6 mld interface=eth1
   ```

   Note that Router A becomes the Querier for Host A because Router A has a lower IP address than Router B. Router B becomes the Querier when Router A becomes unavailable because MLD is also enabled on Router B's interface to Host A (eth0).

5. Configure PIM6.

Define PIM6 interfaces for the Ethernet interfaces.

```
add pim6 interface=eth0 mode=dense
add pim6 interface=eth1 mode=dense
```

Enable PIM6 multicast routing.

```
enable pim6
```

To configure Router C

1. Set the system name.

Set a unique system name on the router.

```
set sys name=c-pim6
```

2. Create a PPP interface.

Create a PPP interface 0 over synchronous port 0.

```
create ppp=0 over=syn0
```

3. Configure IPV6

Enable IPv6 on the router.

```
enable ipv6
```

Assign IPv6 addresses to PPP and Ethernet interfaces.

```
add ipv6 interface=ppp0 ipaddress=3ff1::2/32
add ipv6 interface=eth0 ipaddress=3ff3::1/32
```

4. Configure IPV6 routing.

Enable routing of IPv6 packets using RIPv6.

```
enable ipv6 rip
```

Enable RIPv6 on interfaces.

```
add ipv6 rip interface=ppp0
add ipv6 rip interface=eth0
```

5. Configure MLD.

Enable MLD on the router for group management.

```
enable ipv6 mld
```

Enable MLD on each interface, so that MLD can find out which multicast groups have hosts connected to this interface.

```
enable ipv6 mld interface=ppp0
enable ipv6 mld interface=eth0
```

6. Configure PIM6.

Define PIM6 interfaces for the Ethernet and PPP interfaces.

```
add pim6 interface=eth0 mode=dense
add pim6 interface=ppp0 mode=dense
```

Enable PIM6 multicast routing.

```
enable pim6
```

To confirm multicasting

When the three routers have been configured, RIP takes a few seconds to distribute the unicast routing information to all routers. Then the IP hosts connected to these interfaces can send and receive multicasts.

1. **Test multicasting.**

   Test whether IP multicasting is successful by sending IP multicast data between hosts connected to each of the routers. Check that MLD messages are correctly processed by having hosts leave and join groups.

2. **Check the multicast state.**

   To check each router, use the commands:

```
show pim6
show ipv6 mld
show ipv6 mld counters
show ipv6 mld config
show ipv6 route multicast
```

The final configurations are:

Router A

```
set sys name=a-pim6-dm
create ppp=0 over=syn0
enable ipv6
add ipv6 interface=eth0 ipaddress=3ff0::1/32
add ipv6 interface=ppp0 ipaddress=3ff1::1/32
enable ipv6 rip
add ipv6 rip interface=eth0
add ipv6 rip interface=ppp0
enable ipv6 mld
enable ipv6 mld interface=eth0
enable ipv6 mld interface=ppp0
add pim6 interface=eth0 mode=dense
add pim6 interface=ppp0 mode=dense
enable pim6
```

Router B

```
set sys name=b-pim6
enable ipv6
add ipv6 interface=eth0 ipaddress=3ff0::2/32
add ipv6 interface=eth1 ipaddress=3ff2::1/32
enable ipv6 rip
add ipv6 rip interface=eth0
add ipv6 rip interface=eth1
enable ipv6 mld
enable ipv6 mld interface=eth0
enable ipv6 mld interface=eth1
add pim6 interface=eth0 mode=dense
add pim6 interface=eth1 mode=dense
enable pim6
```

Router C

```
set sys name=c-pim6
create ppp=0 over=syn0
enable ipv6
add ipv6 interface=ppp0 ipaddress=3ff1::2/32
add ipv6 interface=eth0 ipaddress=3ff3::1/32
enable ipv6 rip
add ipv6 rip interface=ppp0
add ipv6 rip interface=eth0
enable ipv6 mld
enable ipv6 mld interface=ppp0
enable ipv6 mld interface=eth0
add pim6 interface=eth0 mode=dense
add pim6 interface=ppp0 mode=dense
enable pim6
```

Command Reference

This section describes the commands available on the router to configure MLD for IPv6 multicast group management, and the IPv6 multicast routing protocols PIM-SM (Protocol Independent Multicast - Sparse Mode) and PIM-DM (Protocol Independent Multicast - Dense Mode).

The shortest valid command is denoted by capital letters in the Syntax section. See "Conventions" on page lxv of About this Software Reference in the front of this manual for details of the conventions used to describe command syntax. See Appendix A, Messages for a complete list of error messages and their meanings.

add pim6 bsrcandidate

Syntax

```
ADD PIM6 BSRCandidate [SCOpe=SITe|GLobal|ALL]
   [PREFerence=0...255]
```

Description

This command configures the router to be a Bootstrap Router Candidate.

The **scope** parameter specifies the scope zone for which this router can be a BSR candidate. The default is **all**.

The **preference** parameter specifies the preference for this router to become the bootstrap router. A higher number indicates a higher priority. The default is 1.

Examples

To add the router as a Bootstrap Router Candidate to a PIM6 domain, for all scopes, with a preference of 10 to become the bootstrap router in the domain, use the command:

```
add pim6 bsrc pref=10
```

Related Commands

delete pim6 bsrcandidate
enable pim6
set pim6 bsrcandidate
show pim6 bsrcandidate

add pim6 interface

Syntax

```
ADD PIM6 INTerface=interface [DRPriority=0..4294967295]
   [ELectby={DRPriority|IPaddress}]
   [HEllointerval={10..15000|DEFault|65535}] [MODe={Dense|
   Sparse}] [SRCapable={Yes|No}]
```

where *interface* is a valid interface

Description

This command adds the specified IPv6 interface to the PIM6 interface list so that PIM6 multicast routing can operate on this interface.

The **interface** parameter specifies the IPv6 interface over which PIM6 operates. The interface must already exist. Valid interfaces are:

- eth (such as eth0)
- PPP (such as ppp0)
- VLAN (such as vlan1)
- virtual tunnel (such as virt9)

To see a list of current valid interfaces, use the **show interface** command on page 9-72 of Chapter 9, Interfaces.

The **drpriority** parameter specifies the preference for the router to become the designated router (DR) on this interface. A higher value indicates a greater preference. The default is 1.

The **electby** parameter determines how the router elects the designated router for this interface. If **drpriority** is specified, the interface transmits its DR priority in its hello messages, which allows DR election by priority. If **ipaddress** is specified, the router does not transmit its DR priority, which causes election by IP address. The default is **drpriority**. Note that a router with **electby**=**drpriority** may still elect by IP address when it does not receive DR priority in any one of its neighbours' hello messages. Election by DR priority is possible only when all routers on the interface supply their DR priority.

The **hellointerval** parameter specifies the interval at which the router sends Hello messages from this interface. Setting the **hellointerval** parameter to 65535 results in a Hello message being sent with a hold time of 65535, which means "infinity". A router receiving this router's Hello never expires this router as a PIM neighbour. This can be useful on point-to-point links. The default is 30 seconds.

The **mode** parameter specifies the PIM operating mode for the interface. The default is **sparse**. All interfaces should have the same mode setting unless the router is being configured as a Multicast Border Router.

The **srcapable** parameter indicates whether this interface originates or processes State Refresh messages. The default is **no**. This parameter applies to dense mode interfaces only.

Examples

To configure the IPv6 interface eth0 to be a PIM6 sparse mode interface, with a designated router priority of 100, use the command:

```
add pim6 int=eth0 drp=100
```

Related Commands

delete pim6 interface
enable pim6
reset pim6 interface
set pim6 interface
show pim6 interface

add pim6 rpcandidate

Syntax

```
ADD PIM6 RPCandidate[=rp-address] GROup=ipv6address [/
   prefixlength] [PRIOrity=0...255]
```

where:

- *ipv6address* is a valid IPv6 multicast address, with its prefix length optionally indicated by a slash and the *prefixlength*.
- *prefixlength* is an integer between 16 and 128.
- *rp-address* is a valid IPv6 multicast address.

Description

This command configures the router to announce that it is willing to be a Rendezvous Point for the specified multicast group or groups.

The **rpcandidate** parameter, if specified with a value, is the IP address of the Rendezvous Point for the multicast group(s). This option can be used to create static RP mappings for networks in which the bootstrap mechanism cannot be used.

If the bootstrap mechanism is also running, a static RP mapping takes precedence.

The **group** parameter specifies the multicast group or groups to which the router is a rendezvous point candidate. Specifying a prefix length may be useful to configure multiple multicast groups with a common Rendezvous Point (RP). The default prefix length is 128.

The **priority** parameter specifies the preference for the router to become the Rendezvous Point for the multicast group. A lower value indicates a higher priority. The default is 192. This parameter does not apply to static RP mappings.

The router's **priority** is the same for all multicast groups of the same scope, for which it is a rendezvous point candidate, so changing this router's priority to be the RP for one group changes it for all groups.

Examples

To configure the router to advertise its willingness to be RP candidate for the multicast group of ff05::1230 to ff05::1233, with a priority of 100, use the command:

```
add pim6 rpc gro=ff05::1230/126 prio=100
```

Related Commands

delete pim6 rpcandidate
enable pim6
set pim6 rpcandidate
show pim6 rpcandidate
show pim6 rpset

delete pim6 bsrcandidate

Syntax `DELete PIM6 BSRCandidate [SCOpe=SITe|GLobal|ALL]`

Description This command stops the router from acting as a bootstrap router (BSR) candidate in the PIM domain.

The **scope** parameter specifies the scope zone for which this router stops being a BSR candidate. The default is **all**.

Examples To stop the router from being a BSR candidate for all scopes, use the command:

```
del pim6 bsrc
```

Related Commands
add pim6 bsrcandidate
disable pim6
purge pim6
set pim6 bsrcandidate
show pim6 bsrcandidate

delete pim6 interface

Syntax `DELete PIM6 INTerface=`*`interface`*

where *interface* is a valid interface

Description This command deletes the specified interface from the PIM6 interface list on the router, stops all PIM6 processes on the interface, and deletes all routing information generated by the interface. The interface must already be assigned and configured. Valid interfaces are:

- eth (such as eth0)
- PPP (such as ppp0)
- VLAN (such as vlan1)
- virtual tunnel (such as virt9)

To see a list of current valid interfaces, use the **show interface** command on page 9-72 of Chapter 9, Interfaces, or the **show pim6 interface** command on page 33-52.

Examples To delete interface eth0 from PIM6 interface list, use the command:

```
del pim6 int=eth0
```

Related Commands
add pim6 interface
disable pim6
purge pim6
reset pim6 interface
set pim6 interface
show pim6 interface

delete pim6 rpcandidate

Syntax `DELete PIM6 RPCandidate[=`*`rp-address`*`] GROup=`*`ipv6address`*`[/`*`prefixlength`*`]`

where:

- *rp-address* is an IP address in dotted decimal notation.
- *ipv6address* is a valid IPv6 multicast address, with its prefix length optionally indicated by a slash and the *prefixlength*.
- *prefixlength* is an integer between 16 and 128.

Description This command deconfigures the router from acting as a Rendezvous Point candidate for the specified multicast group(s).

The **rpcandidate** parameter, if specified with a value, is the IP address of the Rendezvous Point for the multicast group(s). This option can be used to remove a static RP mapping.

The **group** parameter specifies the multicast group(s) for which the router stops being a rendezvous point candidate. The default prefix length is 128.

Examples To stop the router from advertising itself as an RP candidate for multicast groups ff05::1230 to ff05::1233, use the command:

```
del pim6 rpc gro=ff05::1230/126
```

Related Commands
add pim6 rpcandidate
disable pim6
purge pim6
set pim6 rpcandidate
show pim6 rpcandidate
show pim6 rpset

disable ipv6 mld

Syntax `DISable IPV6 MLD`

Description This command disables MLD processing on the router. MLD is disabled by default.

Examples To disable MLD, use the command:

```
dis ipv6 mld
```

Related Commands
disable ipv6 mld interface
enable ipv6 mld
enable ipv6 mld interface
show ipv6 mld

disable ipv6 mld debug

Syntax `DISable IPV6 MLD DEBug`

Description This command disables the debug option for MLD.

Examples To disable MLD debugging, use the command:

```
dis ipv6 mld deb
```

Related Commands
enable ipv6 mld debug
show ipv6 mld
show ipv6 mld debug

disable ipv6 mld interface

Syntax `DISable IPV6 MLD INTerface=`*`interface`*

where *interface* is a valid interface

Description This command disables the MLD protocol on the specified interface. The interface must already be assigned and configured. Valid interfaces are:

- eth (such as eth0)
- PPP (such as ppp0)
- VLAN (such as vlan1)
- virtual tunnel (such as virt9)

To see a list of current valid interfaces, use the **show interface** command on page 9-72 of Chapter 9, Interfaces, or the **show ipv6 mld** command on page 33-40.

Examples To disable MLD on the eth0 interface, use the command:

```
dis mld int=eth0
```

Related Commands
disable ipv6 mld
enable ipv6 mld
enable ipv6 mld interface
show ipv6 mld

disable pim6

Syntax

```
DISable PIM6
```

Description

This command disables PIM6 on the router. PIM6 multicast routing stops, and PIM6 configurations are left intact. PIM6 is disabled by default.

Examples

To disable PIM6 on the router, use the command:

```
dis PIM6
```

Related Commands

delete pim6 bsrcandidate
delete pim6 interface
delete pim6 rpcandidate
enable pim6
purge pim6

disable pim6 debug

Syntax

```
DISable PIM6 DEBug={ALL|ASSERT|BSR|C-RP-ADV|GRAFT|HEllo|
   JOIN|REGISTER|STATerefresh}[,...]
```

Description

This command disables the debugging option. The option must currently be enabled. All PIM6 debugging is disabled by default.

The **debug** parameter specifies which debugging options are to be disabled. The value of this parameter is a single option or a comma-separated list of options. See the **enable pim6 debug** command for available options.

Related Commands

enable pim6 debug
purge pim6
show pim6 debug

enable ipv6 mld

Syntax `ENAble IPV6 MLD`

Description This command enables MLD processing on the router. MLD is disabled by default. IPv6 must also be enabled before configuring MLD.

Once MLD has been enabled, it must also be enabled on the required IPv6 interfaces before the interfaces can start receiving and sending multicast packets (see the **enable ipv6 mld interface** command on page 33-31).

Examples To enable MLD, use the command:

```
ena ipv6 mld
```

Related Commands
disable ipv6 mld
enable ipv6 mld interface
set ipv6 mld
show ipv6 mld

enable ipv6 mld debug

Syntax `ENAble IPV6 MLD DEBug`

Description This command enables MLD debugging.

Examples To enable MLD debugging, use the command:

```
ena ipv6 mld deb
```

Related Commands
disable ipv6 mld debug
show ipv6 mld
show ipv6 mld debug

enable ipv6 mld interface

Syntax

```
ENAble IPV6 MLD INTerface=interface [QUERYversion={1|2}]
   [V2Draftcompat={No|Yes}]
```

where *interface* is a valid interface

Description

This command enables the MLD protocol to run on a specific interface. The interface must already exist, and IPv6 must be enabled.

The **interface** parameter specifies the interface on which MLD is to be enabled. The interface must already be assigned and configured. Valid interfaces are:

- eth (such as eth0)
- PPP (such as ppp0)
- VLAN (such as vlan1)
- virtual tunnel (such as virt9)

To see a list of current valid interfaces, use the **show interface** command on page 9-72 of Chapter 9, Interfaces, or the **show ipv6 mld** command on page 33-40.

The **queryversion** parameter specifies the version of MLD Query to use on the interface. The default is 2.

The **v2draftcompat** parameter determines the ICMP type of MLDv2 reports. If you specify **yes**, the interface can process MLDv2 reports that have an ICMP type of 255. This is compatible with early implementations of MLD on the router. If you specify **no**, the interface can only process MLD Report messages that have an ICMP type of 143, as specified by RFC 3810. The default is **no**.

Examples

To enable MLD on the eth0 interface, use the command:

```
ena ipv6 mld int=eth0
```

Related Commands

add ipv6 interface
create ipv6 interface
disable ipv6 mld
disable ipv6 mld interface
enable ipv6 mld
set ipv6 mld
set ipv6 mld interface
show ipv6 interface
show ipv6 mld

enable pim6

Syntax

```
ENAble PIM6
```

Description

This command enables PIM6 routing on the router. PIM6 is disabled by default. An existing PIM configuration is activated when this command has been entered. IPv6 must also be enabled before configuring PIM6.

Related Commands

add pim6 bsrcandidate
add pim6 interface
add pim6 rpcandidate
disable pim6

enable pim6 debug

Syntax

```
ENAble PIM6 DEBug={ALL|ASSERT|BSR|C-RP-ADV|GRAFT|HEllo|
   JOIN|REGISTER|STATErefresh}[,...]
```

Description

This command enables debugging options. Debugging may or may not be enabled already. Debugging information is sent to the port or Telnet session from which the command was entered. All PIM6 debugging is disabled by default.

The **debug** parameter specifies which debugging options are to be enabled. The value of this parameter is a single option or a comma-separated list of options. The options and the debugging that results from specifying the item are shown in following table.

Parameter	Meaning
ALL	All debug options.
ASSERT	PIM6 Assert packets
BSR	PIM6 Bootstrap packets (Sparse Mode only)
C-RP-ADV	PIM6 Candidate-RP-Advertisement (Sparse Mode only)
GRAFT	PIM Graft packets (Dense Mode only)
HELLO	PIM6 Hello packets
JOIN	PIM6 Join/Prune packets
REGISTER	PIM6 Register and Register Stop packets (Sparse Mode only)
STATEREFRESH	PIM State Refresh packets (Dense Mode only)

Examples

To enable debugging of PIM6 Hello and Join/Prune messages, use the command:

```
ena pim6 deb=he,join
```

Related Commands

disable pim6 debug
purge pim6
show pim6 debug

purge pim6

Syntax `PURge PIM6`

Description This command purges all configuration information relating to the PIM6 multicast routing module, and reinitialises the data structures used by the module. It also stops the current PIM6 operation. It should be used when first setting up the PIM6 module or when a major change is required.

Caution All current PIM6 configuration information will be lost.

Related Commands
delete pim6 bsrcandidate
delete pim6 interface
delete pim6 rpcandidate
disable pim6
disable pim6 debug
reset pim6 interface

reset pim6 interface

Syntax `RESET PIM6 INTerface=`*`interface`*

where *interface* is a valid interface

Description This command resets all timers, route information, and counters associated with the specified interface, and restarts all PIM6 processes for this interface as if this interface has just been added to PIM6 interface list. It also disables any enabled PIM debugging on the interface. The interface must already be assigned and configured. Valid interfaces are:

- eth (such as eth0)
- PPP (such as ppp0)
- VLAN (such as vlan1)
- virtual tunnel (such as virt9)

To see a list of current valid interfaces, use the **show interface** command on page 9-72 of Chapter 9, Interfaces, or the **show pim6 interface** command on page 33-52.

Examples To reset the ppp0 interface, use the command:

```
reset pim6 int=ppp0
```

Related Commands
add pim6 interface
delete pim6 interface
enable pim6
purge pim6
set pim6
set pim6 interface
show pim6 interface

set ipv6 mld

Syntax

```
SET IPV6 MLD [ROBustness={2..65535|DEFault}]
   [QINterval={1..65535|DEFault}] [QRInterval={1..8387|
   DEFault}] [SQInterval={1..65535|DEFault}]
   [SQCount={1..65535|DEFault}] [LLQInterval={1..65535|
   DEFault}] [LLQCount={1..65535|DEFault}]
```

Description This command sets global parameters for Multicast Listener Discovery (MLD).

Caution The defaults for these parameters suit most networks. Changing them can cause MLD to function in undesirable ways. System administrators should change them based on a sound understanding of their interaction with other devices in the network. The values must be internally consistent and consistent among all nodes on a link.

The **robustness** parameter allows fine-tuning for the expected packet loss on a link. The default is 2. If the link is very lossy, increase this value.

The **qinterval** parameter specifies the query interval in seconds. The query interval is the period between General Queries sent by the router when it is a querier. The default is 125. To reduce the number of MLD messages on the link, increase this value. The **qinterval** must be equal to or longer than the **qrinterval**.

The **qrinterval** parameter specifies the query response interval in seconds. Responses to queries are spread over this time period. The default is 10. The bandwidth used by MLD is inversely proportional to **qrinterval**, so increasing this value reduces traffic peaks. However, increasing **qrinterval** means that when the router receives a Leave message from the last member of a multicast group, the router waits longer for possible responses to the query. Therefore it takes longer for the router to stop sending streams that no longer have any members. The **qrinterval** must be equal to or shorter than the **qinterval**.

If the router is acting as an MLDv1 querier and **qrinterval** is set to more than 65 seconds, then 65535ms is put into the Maximum Response Code in the MLDv1 query packet. This is the maximum number allowed.

The **sqinterval** parameter specifies the startup query interval in seconds. The startup query interval is the interval between each the General Queries that the router sends on startup when it is a querier. This timer should be one quarter of a **qinterval**. The default is 31.

The **sqcount** parameter specifies the startup query count, which is the number of queries that the router sends out on startup. Each query is separated by the **sqinterval**. This counter should be the same as the **robustness**. The default is 2.

The **llqinterval** parameter specifies the last listener query interval in seconds. The last listener query interval determines how long the router takes to detect the departure of the last listener for a multicast address or source and stop the traffic flow. The default is 1.

The **llqcount** parameter specifies the last listener query count, which is the number of Multicast Address Specific Queries that the router sends before it assumes there are no local listeners (and the number of Multicast Address and Source Specific Queries that the router sends before it assumes there are no

listeners for that source). This counter should be the same as the **robustness**. The default is 2.

Examples To set the MLD robustness to 3, use the command:

```
set ipv6 mld rob=3
```

Related Commands
disable ipv6 mld
enable ipv6 mld
set ipv6 mld interface
show ipv6 mld

set ipv6 mld interface

Syntax `SET IPV6 MLD INTerface=`*`interface`* `QUERYversion={1|2}`

where *interface* is a valid interface

Description This command sets the MLD compatibility mode on the specified interface.

The **interface** parameter specifies an interface on which MLD is enabled. The interface must already be assigned and configured. Valid interfaces are:

- eth (such as eth0)
- PPP (such as ppp0)
- VLAN (such as vlan1)
- virtual tunnel (such as virt9)

To see a list of current valid interfaces, use the **show interface** command on page 9-72 of Chapter 9, Interfaces, or the **show ipv6 mld** command on page 33-40.

The **queryversion** parameter specifies the version of MLD Query to use on the interface. The default is 2.

Examples To set the eth0 interface to use MLDv1 Query, use the command:

```
set ipv6 mld int=eth0 query=1
```

Related Commands
add ipv6 interface
create ipv6 interface
disable ipv6 mld
disable ipv6 mld interface
enable ipv6 mld
enable ipv6 mld interface
set ipv6 interface
set ipv6 mld
show ipv6 interface
show ipv6 mld

set pim6

Syntax

```
SET PIM6 [ADVinterval={10..15000|DEFault}]
   [BSMinterval={10..15000|DEFault}]
   [JPInterval={1..65535|DEFault}]
   [KEEPalivetime={10..65535|DEFault}]
   [PRObetime={1..65535|DEFault}]
   [PRUNEholdtime={1..65535|DEFault}]
   [SOURCealivetime={10..65535|DEFault}]
   [SRINterval={10..255|DEFault}]
   [SUPPressiontime={1..65535|DEFault}]
```

Description This command sets PIM6 timers to coordinate PIM6 operation.

Caution The defaults for these timers suit most networks. Changing them may cause PIM6 to function in undesirable ways. System administrators should change timer values based on a sound understanding of their interaction with other devices in the network.

The **advinterval** parameter specifies the interval, in seconds, at which the router sends C-RP-Advertisements. The default is 60 seconds. This timer applies to PIM-SM only.

The **bsminterval** parameter specifies the time interval, in seconds, at which the router sends bootstrap messages when it is the bootstrap router in the domain. The default is 60 seconds. This timer applies to PIM-SM only.

The **jpinterval** parameter specifies the Upstream Join Timer, in seconds. This is the interval at which the router sends PIM6 Join/Prune messages. The default is 60 seconds.

The **keepalivetime** parameter specifies how long, in seconds, the Join state for a particular Source and Group pair is maintained in the absence of data for that pair. The default for **keepalivetime** is 210 seconds.

The **probetime** interval specifies the Register Probe Time, in seconds. This is the time that the DR waits for another Register Stop message after sending a Null Register message to the RP. If it does not receive a Register Stop message in this time, it resumes registering data packets to the RP. The default is 5 seconds. This timer applies to PIM-SM only.

The **pruneholdtime** parameter specifies the interval, in seconds, for which the prune state is maintained. This time is used in Prune messages to let upstream neighbours know how long to hold the prune state. It is also used as the Prune Limit Timer for suppressing prunes if a Prune message has already been sent. The default is 210 seconds. This timer applies to PIM-DM only.

The **sourcealivetime** parameter specifies the interval, in seconds, for which a router acting as a State Refresh Originator is active in the absence of data packets from the source. The default is 210 seconds. This timer applies to PIM-DM only.

The **srinterval** parameter specifies the time interval, in seconds, at which this router sends State Refresh Messages when it is configured to be State Refresh Capable and becomes a State Refresh Originator (in general, this means having a directly connected source). The default is 60 seconds. This timer applies to PIM-DM only.

The **suppressiontime** parameter specifies the Register Suppression Time in seconds. This determines the interval at which the sender's DR sends Null Register messages to the group's RP to tell it to send another Register Stop message if it still does not need the data to be registered and sent to it. The default is 60 seconds. This timer applies to PIM-SM only.

Examples To set the Join/Prune Message interval to 90 seconds, use the command:

```
set pim6 jpi=90
```

Related Commands
set pim6 interface
show pim6 timer

set pim6 bsrcandidate

Syntax

```
SET PIM6 BSRCandidate [SCOpe=SITe|GLobal|ALL]
   [PREFerence=0...255]
```

Description This command sets the router's Bootstrap Router Candidate parameters.

The **scope** parameter specifies the scope zone for which this router can be a BSR candidate.

The **preference** parameter specifies the preference for this router to become the bootstrap router. A higher value indicates a greater preference.

Examples To change the router's candidate BSR preference to 100 for global scope, use the command:

```
set pim6 bsrc sco=global pref=100
```

Related Commands
add pim6 bsrcandidate
delete pim6 bsrcandidate
enable pim6
show pim6 bsrcandidate

set pim6 interface

Syntax

```
SET PIM6 INTerface=interface [DRPriority=0..4294967295]
   [ELectby={DRPriority|IPaddress}]
   [HEllointerval={10..15000|DEFault|65535}] [MODe={Dense|
   Sparse}] [SRCapable={Yes|No}]
```

where *interface* is a valid interface

Description

This command sets parameters for the specified PIM6 interface. The interface must already be assigned and configured. Valid interfaces are:

- eth (such as eth0)
- PPP (such as ppp0)
- VLAN (such as vlan1)
- virtual tunnel (such as virt9)

To see a list of current valid interfaces, use the **show interface** command on page 9-72 of Chapter 9, Interfaces, or the **show pim6 interface** command on page 33-52.

The **drpriority** parameter specifies the preference for the router to become the designated router (DR) on this interface. A higher value indicates a greater preference. The default is 1.

The **electby** parameter determines how the router elects the designated router for this interface. If **drpriority** is specified, the interface transmits its DR priority in its hello messages, which allows DR election by priority. If **ipaddress** is specified, the router does not transmit its DR priority, which causes election by IP address. The default is **drpriority**. Note that a router with **electby**=**drpriority** may still elect by IP address when it does not receive DR priority in any one of its neighbours' hello messages. Election by DR priority is possible when all routers on the interface supply their DR priority.

The **hellointerval** parameter specifies the interval at which the router sends Hello messages from this interface. Setting the **hellointerval** parameter to 65535 results in a Hello message being sent with a hold time of 65535, which means "infinity". A router receiving this router's Hello never expires this router as a PIM6 neighbour. This can be useful on point to point links. The default is 30 seconds.

The **mode** parameter specifies the PIM6 operating mode for the interface. The default is **sparse**. All interfaces should have the same mode setting unless the router is being configured as a Multicast Border Router.

The **srcapable** parameter indicates whether this interface originates or processes State Refresh messages. The default is **no**. This parameter applies to Dense Mode interfaces only.

Examples

To set the designated router priority for the interface vlan1 to 100, use the command:

```
set pim6 int=vlan1 drp=100
```

Related Commands

add pim6 interface
delete pim6 interface
purge pim6
reset pim6 interface
show pim6 interface

set pim6 rpcandidate

Syntax

```
SET PIM6 RPCandidate GROup=ipv6address[/prefixlength]
   [PRIOrity=0..255]
```

where:

- *ipv6address* is a valid IPv6 multicast address, with its prefix length optionally indicated by a slash and the *prefixlength*.
- *prefixlength* is an integer between 16 and 128.

Description

This command sets the Rendezvous Point Candidate parameters for the specified multicast group(s).

The **group** parameter specifies the multicast group or groups to which the router is a rendezvous point candidate. Specifying a prefix length may be useful to configure multiple multicast groups with a common Rendezvous Point (RP).

The **priority** parameter specifies the preference for the router to become the Rendezvous Point for the multicast group. A lower value indicates a higher priority.

The router's **priority** is the same for all multicast groups of the same scope, for which it is a rendezvous point candidate, so changing this router's priority to be the RP for one group changes it for all groups.

Examples

To change the router's RP priority to 10 for the multicast group of ff05::1230 to ff05::1233, and consequently all groups of site scope, use the command:

```
set pim6 rpc gro=ff05::1230/126 prio=10
```

Related Commands

add pim6 rpcandidate
delete pim6 rpcandidate
show pim6 rpcandidate
show pim6 rpset

show ipv6 mld

Syntax `SHow IPV6 MLD INTerface=`*`interface`*

where *interface* is a valid interface name

Description This command displays information about MLD and the multicast state of IPv6 interfaces. If an interface is specified then information for the specified interface is displayed, otherwise information for all IPv6 interfaces is displayed (Figure 33-4, Table 33-2 on page 33-41). The interface must already be assigned and configured. Valid interfaces are:

- eth (such as eth0)
- PPP (such as ppp0)
- VLAN (such as vlan1)
- virtual tunnel (such as virt9)

To see a list of current valid interfaces, use the **show interface** command on page 9-72 of Chapter 9, Interfaces, or the **show pim6 interface** command on page 33-52.

Figure 33-4: Example output from the **show ipv6 mld** command

```
MLD Protocol
------------------------------------------------------------------------------
Status ............................ ENABLED
Robustness ........................ 2
Query Interval ..................... 125 secs
Query Response Interval ............ 10 secs
Startup Query Interval ............. 31 secs
Startup Query Count ................ 2
Last Listener Query Interval ....... 1 secs
Last Listener Query Count .......... 2

Interface: eth0
------------------------------------------------------------------------------
  Version ......................... 2
  V2 Draft Compatible ............. NO
  Is querier ...................... YES
  Link local address .............. fe80::0200:cdff:fe01:66fd
  Multicast Address ............... ff05:2222:3333:4444:5555:6666:7777:1111
    Filter Mode ................... Exclude
    MA Timer ...................... 200
    Version ....................... 2
    Source ........................ 1111:2222:3333:4444:5555:6666:7777:8888
      Source Timer ................ 120

Interface: eth1
------------------------------------------------------------------------------
  Version ......................... 2
  Is querier ...................... YES
  Link local address .............. fe80::0200:cdff:fe00:a148
```

Table 33-2: Parameters in output of the **show ipv6 mld** command

Parameter	Meaning
Status	The status of MLD; one of "Enabled" or "Disabled".
Robustness	An integer that allows tuning for the expected packet loss on a link. Higher values are used for more lossy links.
Query Interval	The interval between General Queries sent by the querier.
Query Response Interval	The time period that responses to General Queries are spread over.
Startup Query Interval	The interval between Queries sent by the querier at startup.
Startup Query Count	The number of Queries the router sends at startup.
Last Listener Query Interval	The maximum response delay, used to calculate the time the router takes to detect the departure of the last listener.
Last Listener Query Count	The number of Multicast Address Specific Queries the router sends before it assumes there are no local listeners, and the number of Multicast Address and Source Specific Queries the router sends before it assumes there are no local listeners for the specified source.
Interface	The interface to the attached link.
Version [Interface]	The version of MLD that is running on the interface; one of "1" or "2". The interface may change to version 1, to operate with another router that is running MLDv1.
V2 Draft Compatible	Whether MLD can process MLDv2 reports that have an ICMP type of 255 (YES), or reports that have an ICMP type of 143, as specified by RFC 3810 (NO).
IsQuerier	Whether the router is a querier on this interface.
Link local address	The interface's link-local IPv6 address.
Multicast Address	The IPv6 multicast address.
Filter Mode	The filter mode; one of "include" or "exclude". See the Internet Draft "Multicast Listener Discovery Version 2 (MLDv2) for IPv6" (draft-vida-mld-v2-01) for more information.
MA Timer	The MA Timer, in seconds. See the Internet Draft "Multicast Listener Discovery Version 2 (MLDv2) for IPv6" (draft-vida-mld-v2-01) for more information.
Version [Multicast Address]	The version that the source is running of the listener part of the MLD protocol.
Source	The source of the multicast package.
Source Timer	The Source Timer, in seconds. See the Internet Draft "Multicast Listener Discovery Version 2 (MLDv2) for IPv6" (draft-vida-mld-v2-01) for more information.

Examples To display information about MLD, use the command:

```
sh ipv6 mld
```

Related Commands
disable ipv6 mld
disable ipv6 mld interface
enable ipv6 mld
enable ipv6 mld interface
set ipv6 mld
set ipv6 mld interface

show ipv6 mld config

Syntax `SHOW IPV6 MLD CONFig`

Description This command lists the command line interface commands that make up the MLD configuration (Figure 33-5).

Figure 33-5: Example output from the **show ipv6 mld config** command.

```
enable ipv6 mld
enable ipv6 mld interface=eth1
enable ipv6 mld interface=eth0
```

Examples To display the MLD configuration, use the command:

```
sh ipv6 mld conf
```

Related Commands
disable ipv6 mld
disable ipv6 mld interface
enable ipv6 mld
enable ipv6 mld interface
set ipv6 mld interface

show ipv6 mld counters

Syntax `SHow IPV6 MLD COUnters`

Description This command displays the MLD counters (Figure 33-6, Table 33-3).

Figure 33-6: Example output from the **show ipv6 mld counters** command

```
MLD counters
------------------------------------------------------------
eth0:

  inQueryV1 ............ 0     outQueryTotal ........... 2
  inReportV1 ........... 0
  inDoneV1 ............. 0
  inQueryV2 ............ 0
  inReportV2 ........... 0

eth1:

  inQueryV1 ............ 0     outQueryTotal ........... 2
  inReportV1 ........... 0
  inDoneV1 ............. 0
  inQueryV2 ............ 0
  inReportV2 ........... 0

------------------------------------------------------------
```

Table 33-3: Parameters in output of the **show ipv6 mld counters** command

Parameter	Meaning
inQueryV1	Number of MLDv1 Queries received by the interface.
inReportV1	Number of MLDv1 Reports received by the interface.
inDoneV1	Number of MLDv1 Done messages received by the interface. Done messages indicate that the sender is no longer interested in a multicast address.
inQueryV2	Number of MLDv2 Queries received by the interface.
inReportV2	Number of MLDv2 Reports received by the interface.
outQueryTotal	Total number of queries sent by the interface.

Examples To display MLD counters, use the command:

```
sh ipv6 mld cou
```

Related Commands

disable ipv6 mld debug
enable ipv6 mld debug
show ipv6 mld

show ipv6 mld debug

Syntax `SHow IPV6 MLD DEBug`

Description This command displays information about the MLD debug state (Figure 33-7).

Figure 33-7: Example output from the **show ipv6 mld debug** command

```
MLD debug ENABLED
```

Examples To display the MLD debug state, use the command:

```
sh ipv6 mld deb
```

Related Commands **disable ipv6 mld debug**
enable ipv6 mld debug

show pim6

Syntax

```
SHow PIM6
```

Description

This command displays detailed information about the PIM6 routing status on the router, and is equivalent to specifying all of the following commands in this order:

```
show pim6 interface
show pim6 route
show pim6 neighbour
show pim6 counters
show pim6 debug
show pim6 rpcandidate
show pim6 bsrcandidate
show pim6 rpset
show pim6 timer
show pim6 config
```

Examples

To display detailed PIM6 routing status information, use the command:

```
sh pim6
```

Related Commands

add pim6 bsrcandidate
add pim6 interface
add pim6 rpcandidate
delete pim6 bsrcandidate
delete pim6 interface
delete pim6 rpcandidate
disable pim6
disable pim6 debug
enable pim6
enable pim6 debug
reset pim6 interface
set pim6
set pim6 bsrcandidate
set pim6 interface
set pim6 rpcandidate
show ipv6 in Chapter 31, Internet Protocol version 6 (IPv6)
show ipv6 multicast in Chapter 31, Internet Protocol version 6 (IPv6)

show pim6 bsrcandidate

Syntax `SHow PIM6 BSRCandidate`

Description This command displays information about the router as a BSR candidate for PIM6-SM (Figure 33-8, Figure 33-9, Table 33-4 on page 33-47).

Figure 33-8: Example output from the **show pim6 bsrcandidate** command for an elected BSR

```
PIM6 BSR Candidate
-----------------------------------------------------------

Scope ............................. Site
  Preference ...................... 1
  BSR State ....................... Elected BSR
    Elected BSR IP address ......... fec0:0057::0002
    Elected BSR preference ......... 1

Scope ............................. Global
  Preference ...................... 1
  BSR State ....................... Elected BSR
    Elected BSR IP address ......... 4ffe:0057::0002
    Elected BSR preference ......... 1
```

Figure 33-9: Example output from the **show pim6 bsrcandidate** command for an unelected BSR candidate .

```
PIM6 BSR Candidate
-------------------------------------------------------------

Scope ............................. Site
  BSR State ....................... Accepts Preferred BSM
    Elected BSR IP address ......... fec0:0057::0002
    Elected BSR preference ......... 1

Scope ............................. Global
  BSR State ....................... Accepts Preferred BSM
    Elected BSR IP address ......... 4ffe:0057::0002
    Elected BSR preference ......... 1
```

Table 33-4: Parameters in output of the **show pim6 bsrcandidate** command

Parameter	Meaning
Scope	The scope zone for which the router is a BSR candidate.
Preference	The preference value for the router to be a candidate bootstrap router. The higher the number, the higher the priority. This parameter is present when the router is the elected BSR.
BSR State	The current status of the BSR; one of "Accepts Preferred BSM" (the router is available to become the BSR), or "Elected BSR" (the router is the BSR).
Elected BSR IP address	The IPv6 address of the BSR. When the router is the BSR, this address is one of the router's addresses for the given scope.
Elected BSR preference	The preference of the BSR. When the router is the BSR, this is its preference.

Examples To display BSR candidate information, use the command:

```
sh pim6 bsrc
```

Related Commands
add pim6 bsrcandidate
delete pim6 bsrcandidate
set pim6 bsrcandidate

show pim6 config

Syntax `SHow PIM6 CONFig`

Description This command lists the command line interface commands that make up the PIM6 configuration (Figure 33-10).

Figure 33-10: Example output from the **show pim6 config** command

```
#PIM6 configuration
#
add pim6 interface=eth0
add pim6 interface=eth1 drpriority=100
enable pim6
```

Examples To display the PIM6 configuration, use the command:

```
sh pim6 conf
```

Related Commands
show ipv6 mld config
show config

show pim6 counters

Syntax `SHow PIM6 COUnters`

Description This command displays PIM6 counters (Figure 33-11, Figure 33-12, Table 33-5 on page 33-49).

Figure 33-11: Example output from the **show pim6 counters** command for PIM Sparse Mode

```
PIM6 Counters
-------------------------------------------------------------
Sparse Mode
-------------------------------------------------------------
eth0:
  inHello ............. 14       outHello ............. 15
  inRegister ........... 0       outRegister ........... 0
  inRegisterStop ....... 0       outRegisterStop ....... 0
  inJP ................. 0       outJP ................. 0
  inAssert ............. 0       outAssert ............. 0
  inBSM ................ 8       outBSM ................ 3
  inCRPAdv ............. 0       outCRPAdv ............. 0
  inTotal .............. 22      outTotal .............. 18

eth0 Bad:
  badHello ............. 0
  badRegister .......... 0
  badRegisterStop ...... 0
  badJP ................ 0
  badAssert ............ 0
  badBSM ............... 0
  badCRPAdv ............ 0
  badTotal ............. 0

-------------------------------------------------------------
Dense Mode
-------------------------------------------------------------
eth0:

  inHello ............. 25       outHello ............. 26
  inGraft .............. 0       outGraft .............. 0
  inGraftAck ........... 0       outGraftAck ........... 0
  inJP ................. 0       outJP ................. 0
  inAssert ............. 0       outAssert ............. 0
  inSRM ................ 0       outSRM ................ 0
  inTotal .............. 25      outTotal .............. 26

eth0 Bad:
    badHello ........... 0
    badGraft ........... 0
    badGraftAck ........ 0
    badJP .............. 0
    badAssert .......... 0
    badTotal ........... 0
```

Figure 33-12: Example output from the **show pim6 counters** command for PIM Dense Mode.

```
PIM6 Counters
-------------------------------------------------------------
Dense Mode
-------------------------------------------------------------
eth0:

  inHello ............. 25       outHello ............. 26
  inGraft ............. 0        outGraft ............. 0
  inGraftAck ........... 0        outGraftAck .......... 0
  inJP ................ 0        outJP ................ 0
  inAssert ............ 0        outAssert ............ 0
  inSRM ............... 0        outSRM ............... 0
  inTotal ............. 25       outTotal ............. 26

eth0 Bad:
    badHello ........... 0
    badGraft ........... 0
    badGraftAck ........ 0
    badJP .............. 0
    badAssert .......... 0
    badTotal ........... 0
```

Table 33-5: Parameters in output of the **show pim6 counters** command

Parameter	Meaning
inHello	Number of PIM6 Hello messages received by the interface.
inRegister	Number of PIM6 Register messages received by the interface. This parameter is displayed for PIM-SM interfaces only.
inRegisterStop	Number of PIM6 Register Stop messages received by the interface. This parameter is displayed for PIM-SM interfaces only.
inGraft	Number of PIM6 Graft messages received by the interface. This parameter is displayed for PIM-DM interfaces only.
inGrackAck	Number of PIM6 Graft acknowledgement messages received by the interface. This parameter is displayed for PIM-DM interfaces only.
inJP	Number of PIM6 Join and Prune messages received by the interface.
inAssert	Number of PIM6 Assert messages received by the interface.
inBSM	Number of PIM6 BootStrap messages received by the interface. This parameter is displayed for PIM-SM interfaces only.
inCRPAdv	Number of PIM6 Candidate RP Advertisement messages received by the interface. This parameter is displayed for PIM-SM interfaces only.
inSRM	Number of PIM6 State Refresh messages received by the interface. This parameter is displayed for PIM-DM interfaces only.
inTotal	Total number of PIM6 messages received by the interface.
outHello	Number of PIM6 Hello messages transmitted by the interface.
outRegister	Number of PIM6 Register messages transmitted by the interface. This parameter is displayed for PIM-SM interfaces only.
outRegisterStop	Number of PIM6 Register Stop messages transmitted by the interface. This parameter is displayed for PIM-SM interfaces only.
outGraft	Number of PIM6 Graft messages transmitted by the interface. This parameter is displayed for PIM-DM interfaces only.

Table 33-5: Parameters in output of the **show pim6 counters** command (cont.)

Parameter (cont.)	**Meaning** (cont.)
outGrackAck	Number of PIM6 Graft acknowledgement messages transmitted by the interface. This parameter is displayed for PIM-DM interfaces only.
outJP	Number of PIM6 Join and Prune messages transmitted by the interface.
outAssert	Number of PIM6 Assert messages transmitted by the interface.
outBSM	Number of PIM6 BootStrap messages transmitted by the interface. This parameter is displayed for PIM-SM interfaces only.
outCRPAdv	Number of PIM6 Candidate RP Advertisement messages transmitted by the interface. This parameter is displayed for PIM-SM interfaces only.
outSRM	Number of PIM6 State Refresh messages that were transmitted by the interface. This parameter is displayed for PIM-DM interfaces only.
outTotal	Total number of PIM6 messages transmitted by the interface.
badHello	Number of PIM6 Hello messages with errors received by the interface.
badRegister	Number of PIM6 Register messages with errors received by the interface. This parameter is displayed for PIM-SM interfaces only.
badRegisterStop	Number of PIM6 Register Stop messages with errors received by the interface. This parameter is displayed for PIM-SM interfaces only.
badGraft	Number of PIM6 Graft messages with errors received by the interface. This parameter is displayed for PIM-DM interfaces only.
badGrackAck	Number of PIM6 Graft acknowledgement messages with errors received by the interface. This parameter is displayed for PIM-DM interfaces only.
badJP	Number of PIM6 Join and Prune messages received by the router.
badAssert	Number of PIM6 Assert messages with errors received by the interface.
badBSM	Number of PIM6 BootStrap messages with errors received by the interface. This parameter is displayed for PIM-SM interfaces only.
badCRPAdv	Number of PIM6 Candidate RP Advertisement messages with errors received by the interface. This parameter is displayed for PIM-SM interfaces only.
badSRM	Number of PIM6 State Refresh messages with errors received by the interface. This parameter is displayed for PIM-DM interfaces only.
badTotal	Total number of PIM6 messages with errors received by the interface.

Examples To display PIM6 counters, use the command:

```
sh pim6 cou
```

Related Commands **show ipv6 counter** in Chapter 31, Internet Protocol version 6 (IPv6)
show pim6 bsrcandidate
show pim6 interface
show pim6 rpcandidate

show pim6 debug

Syntax `SHow PIM6 DEBug`

Description This command displays the comma-separated list of enabled PIM6 debugging options that are enabled, if any (Figure 33-13). See the **enable pim6 debug** command for available options.

Figure 33-13: Example output from the **show pim6 debug** command

```
PIM6 Debug Options
-----------------------------------------------

Debug Options Enabled: Join, Assert
```

Examples To display a list of enabled PIM6 interface debugging options, use the command:

```
sh pim6 deb
```

Related Commands
disable pim6 debug
enable pim6 debug
show pim6 counters

show pim6 interface

Syntax `SHow PIM6 INTerface`

Description This command displays information about all PIM interfaces and their designated router status (Figure 33-14, Figure 33-15, Table 33-6).

Figure 33-14: Example output from the **show pim6 interface** command for PIM Sparse Mode

```
PIM6 Sparse mode Interface Table
--------------------------------------------------
Interface ................ eth0
  IP address ............. fe80::0200:cdff:fe01:66fd
    DR election by ....... DR priority
    DR priority .......... 1
    DR winner ............ fe80::0200:cdff:fe03:dc70
  Hello interval ......... 30

Interface ................ eth1
  IP address ............. fe80::0200:cdff:fe00:a148
    DR election by ....... DR priority
    DR priority .......... 100
    DR winner ............ Me
  Hello interval ......... 30
```

Figure 33-15: Example output from the **show pim6 interface** command for PIM Dense Mode

```
PIM4 Dense mode Interface Table
---------------------------------------------------
Interface ................ eth0
  IP address ............. fe80::0200:cdff:fe01:fef8
  State refresh capable ... No
  Hello interval .......... 30
```

Table 33-6: Parameters in the output of the **show pim6 interface** command

Parameter	Meaning
Interface	IP interfaces running PIM6 processes.
IP Address	The link-local IPv6 address of this interface.
DR election by	How this interface elects a DR; one of "DR priority "(the DR priority is transmitted in Hello messages and election is by priority), or "IP address" (the DR priority is not transmitted in Hello messages so election is by IP address).
DR priority	The priority for the DR candidate to become the PIM6 designated router. A candidate with a higher priority is more likely to become the DR.
DR winner	The link-local IPv6 address of the PIM6 designated router for the interface, or "Me" if this router is the designated router.
State refresh capable	Whether this interface originates and processes State Refresh messages for PIM-DM.
Hello interval	The interval in seconds at which the router sends PIM Hello messages out this interface. The value 65535 indicates that the Hello message never expires.

Examples To display information about PIM6 interfaces, use the command:

```
sh pim6 int
```

Related Commands

add pim6 interface
delete pim6 interface
enable pim6
reset pim6 interface
set pim6 interface

show pim6 neighbour

Syntax `SHow PIM6 NEIghbour`

Description This command displays the PIM6 Neighbour Table (Figure 33-16, Figure 33-17, Table 33-7).

Figure 33-16: Example output from the **show pim6 neighbour** command for PIM Sparse Mode

```
PIM6 Sparse mode Neighbour Table
------------------------------------------------------------
Interface ..................... eth0
  IP Address .................. fe80::0200:cdff:fe03:dc70
    DR Priority ............... 1
    Neighbour Liveness Timer .. 82
```

Figure 33-17: Example output from the **show pim6 neighbour** command for PIM Dense Mode

```
PIM6 Dense mode Neighbour Table
------------------------------------------------------------
Interface ..................... eth1
  IP Address .................. fe80::0200:cdff:fe03:f206
    Neighbour Liveness Timer .. 105
    Is state refresh capable .. No
```

Table 33-7: Parameters in the output of the **show pim6 neighbour** command

Parameter	Meaning
Interface	The interface to which the PIM neighbour is connected.
IP Address	The link-local IPv6 address of the neighbour.
DR Priority	The priority for this neighbour to become the designated router for the subnetwork.
Neighbour Liveness Timer	The time in seconds until the neighbour is removed from the neighbour table.
Is state refresh capable	Whether the neighbour originates and processes State Refresh messages for PIM-DM.

Examples To display information about the router's PIM6 neighbours, use the command:

```
sh pim6 nei
```

Related Commands

add pim6 interface
delete pim6 interface
set pim6 interface

show pim6 route

Syntax `SHow PIM6 ROUte`

Description This command displays the internal PIM6 routing table for:

- PIM Sparse Mode (Figure 33-18, Table 33-8 on page 33-56)
- PIM Dense Mode (Figure 33-19 on page 33-56, Table 33-9 on page 33-59)

Most timers decrement in 10 second steps.

Figure 33-18: Example output from the **show pim6 route** command for PIM Sparse Mode when the router is the RP.

```
PIM6 Sparse Mode Tree Information Base
------------------------------------------------------------

Group ............................ ff0e:0057::0057
  Type ............................ (*,G)
    RP Address .................... I am the RP
    Expiry time ................... 630
    Join/prune time ............... 0
    Immediate output interfaces .. eth2

  Type ............................ (S,G)
    Source ........................ 5ffe::0065:0001:0001
    RPF Neighbour to Src ......... fe80::0200:cdff:fe01:66fd
    RPF Interface to Src ......... eth0
    Expiry time ................... 180
    Keepalive time ................ 160
    Join/prune time ............... 0
    Register time ................. 0
    SPT bit ....................... Unset
    Inherited output interfaces .. eth2
    Immediate output interfaces .. None

  Type ............................ (S,G,rpt)
    Source ........................ 5ffe::0065:0001:0001
    RP Address .................... I am the RP
    Expiry time ................... 180
    Override time ................. 0
    Inherited output interfaces .. eth2

  Type ............................ (*,*,RP)
    RP Address .................... I am the RP
    Expiry time ................... 210
    Join/prune time ............... 0
    Immediate output interfaces .. None
```

Figure 33-19: Example output from the **show pim6 route** command for PIM Sparse Mode when the router is not the RP

```
PIM6 Sparse Mode Tree Information Base
--------------------------------------------------------------

Group ............................ ff0e:0057::0057
  Type ............................ (*,G)
    RP Address .................... 4ffe:0057::0002
    RPF Neighbour to RP ........... fe80::0200:cdff:fe03:dc70
    RPF Interface to RP ........... eth0
    Expiry time ................... 630
    Join/prune time ............... 0
    Immediate output interfaces .. eth2

  Type ............................ (S,G)
    Source ........................ 5ffe::0065:0001:0001
    RPF Neighbour to Src .......... Directly connected
    RPF Interface to Src .......... eth1
    Expiry time ................... 230
    Keepalive time ................ 210
    Join/prune time ............... 0
    Register time ................. 21
    SPT bit ....................... Unset
    Inherited output interfaces .. eth2
    Immediate output interfaces .. eth2

  Type ............................ (S,G,rpt)
    Source ........................ 5ffe::0065:0001:0001
    RP Address .................... 4ffe:0057::0002
    Expiry time ................... 230
    Override time ................. 0
    Inherited output interfaces .. eth2

 Type ............................ (*,*,RP)
    RP Address .................... 4ffe:0057::0002
    Next hop to RP ................ fe80::0200:cdff:fe03:dc70
    RPF Interface to RP ........... eth0
    Expiry time ................... 210
    Join/prune time ............... 0
    Immediate output interfaces .. None
```

Table 33-8: Parameters in output of the **show pim6 route** command for PIM Sparse Mode

Parameter	Entry Type	Parameter for Entry Type	Meaning
Group			The IPv6 address of the multicast group.
Type			The type of entry in the Tree Information Base.
	(*,G)		The entry for traffic from any source to a particular group.
		RP Address	The IPv6 address of the Rendezvous Point for the group.
		RPF Neighbour to RP	The link-local address of the PIM neighbour to the RP, taking into account any PIM assert messages. Packets from the RP would be received from this neighbour.
		RPF Interface to RP	The interface on which packets from the RP would be received.
		Expiry time	The time remaining until this entry is deleted, in seconds. A value of "0" indicates that the timer is not running. This timer decrements when there are no (S,G) entries.

Table 33-8: Parameters in output of the **show pim6 route** command for PIM Sparse Mode (cont.)

Parameter	Entry Type	Parameter for Entry Type	Meaning
		Join/prune time	The Join/prune timer, in seconds. If the router sees a Prune message on the correct upstream interface, and it still needs to receive traffic via that rp tree, it sends a Join message when this timer expires. A value of "0" indicates that the timer is not running.
		Immediate output interfaces	The interfaces with downstream routers or MLD hosts that are interested in this (*,G) entry.
	(S,G)		The entry for traffic from a particular source to a particular group.
		Source	The IPv6 address of the multicast sender.
		RPF Neighbour to Src	The link-local address of the PIM neighbour to the source, taking into account any PIM assert messages. Packets from the source would be received from this neighbour. "Directly connected" indicates that the source is directly connected to the router.
		RPF Interface to Src	The interface on which packets from the source would be received if the source is in this multicasting domain.
		Expiry time	The time remaining until this entry is deleted, in seconds. A value of "0" indicates that the timer is not running. The expiry time is 20 seconds longer than the Keepalive time.
		Keepalive time	The Keepalive timer, in seconds. A value of "0" indicates that the timer is not running because no data is being received. The timer is reset when data is received.
		Join/prune time	The Join/prune timer, in seconds. If the router sees a Prune message on the correct upstream interface, and it still needs to receive traffic via that sp tree, it sends a Join message when this timer expires. A value of "0" indicates that the timer is not running.
		Register time	The Register suppression time, in seconds. When this timer reaches the Register Probe Time, a Null Register message is sent to the RP.
		SPT bit	Whether forwarding is on the Shortest Path Tree ("set") or not ("unset").
		Inherited output interfaces	The interfaces to forward (S,G) data to.
		Immediate output interfaces	The interfaces with downstream routers or MLD hosts that are interested in this (S,G) data.
	(S,G, rpt)		The entry that is used for suppressing traffic on the RP tree from a particular source to a particular group. This entry applies when the traffic is known to be flowing down the shortest path tree, so the traffic is no longer needed via the RP tree.
		Source	The IPv6 address of the multicast sender.
		RP Address	The IPv6 address of the Rendezvous Point for the group.
		Expiry time	The time remaining until this entry is deleted, in seconds. The expiry time is 20 seconds longer than the (S,G) Keepalive time.

Table 33-8: Parameters in output of the **show pim6 route** command for PIM Sparse Mode (cont.)

Parameter	Entry Type	Parameter for Entry Type	Meaning
		Override time	The Override timer, in seconds. If the router sees a Prune message on the correct upstream interface, and it still needs to receive traffic via that rp tree, it sends a Join message when this timer expires. A value of "0" indicates that the timer is not running.
		Inherited output interfaces	The interfaces that still require (S,G) data via the RP tree.
	(*,*,RP)		The entry for handling multicast traffic to and from a network that is running a different multicast protocol. This entry applies when the router is a PIM multicast border router (PMBR).
		RP Address	The IPv6 address of the Rendezvous Point for the group.
		Next hop to RP	The link-local IPv6 address of the next routing device on the best unicast routing path to the RP.
		RPF Interface to RP	The interface on which packets from the RP would be received.
		Expiry time	The time remaining until this entry is deleted, in seconds.
		Join/Prune time	The Join/prune timer, in seconds. If the router sees a Prune message on the correct upstream interface, and it still needs to receive traffic via that rp tree, it sends a Join message when this timer expires. A value of "0" indicates that the timer is not running.
		Immediate output interfaces	The interfaces with downstream routers that are interested in this (*,*,RP) entry.

Figure 33-20: Example output from the **show pim6 route** command for PIM Dense Mode

```
PIM6 Dense Mode Tree Information Base
-------------------------------------------------------

  Source ......................... 3ffe::1
  Group .......................... ff0e:0057::0057
    RPF Neighbour to Src ......... Directly connected
    RPF Interface to Src ......... eth0
    Source Alive time ............ 200
    Expiry time .................. 220
    Prune override time .......... 0
    Prune limit time ............. 0
    Immediate output interfaces .. eth1

  Source ......................... 3ffe::2
  Group .......................... ff0e:0057::0057
    RPF Neighbour to Src ......... 3ff0::1
    RPF Interface to Src ......... eth1
    Keep Alive time .............. 200
    Expiry time .................. 220
    Prune override time .......... 0
    Prune limit time ............. 50
    Immediate output interfaces .. eth1
```

Table 33-9: Parameters in output of the **show pim6 route** command for PIM Dense Mode

Parameter	Meaning
Source	The IPv6 address of the multicast sender.
Group	The IPv6 address of the multicast group.
RPF Neighbour to Src	The address of the PIM neighbour to the source, taking into account any PIM assert messages. Packets from the source would be received from this neighbour. "Directly connected" indicates that the source is directly connected to the router.
RPF Interface to Src	The interface on which the router expects to receive traffic from the source.
Keep Alive time	The Keepalive timer, in seconds. A value of "0" indicates that the timer is not running because no data is being received. The timer is reset when data is received.
Source Alive time	An alive timer, in seconds, that is the equivalent of the Keepalive timer but applies to directly connected sources. A value of "0" indicates that the timer is not running because no data is being received. The timer is reset when data is received.
Expiry time	The time remaining until this entry is deleted, in seconds. The expiry time is 20 seconds longer than the (S,G) Keepalive or Sourcealive time.
Prune override time	The Prune override timer, in seconds. If the router sees a Prune message on the correct upstream interface, and it still needs to receive traffic, it sends a Join message when this timer expires. A value of "0" indicates that the timer is not running.
Prune limit time	The Prune limit, in seconds. A value of "0" indicates that the timer is not running. The router cannot send a data-triggered prune until this timer expires.
Immediate output interfaces	The interfaces with routers or MLD hosts that are interested in this (S,G) data.

Examples

To display the internal PIM6 routing table, use the command:

```
sh pim6 rou
```

Related Commands

set pim6
show ipv6 in Chapter 31, Internet Protocol version 6 (IPv6)
show ipv6 route in Chapter 31, Internet Protocol version 6 (IPv6)

show pim6 rpcandidate

Syntax `SHow PIM6 RPCandidate`

Description This command displays information about multicast groups for which the router is a PIM Sparse Mode Rendezvous Point candidate (Figure 33-21, Table 33-10).

Figure 33-21: Example output from the **show pim6 rpcandidate** command

```
PIM6 RP Candidate
-------------------------------------------------------------------------------

Scope ................................ Site

Info (1105058): No RP Candidate groups currently available or configured.

Scope ................................ Global
  Priority ........................... 192
    Group address/Prefix ............. ff0e:0057::/32
```

Table 33-10: Parameters in the output of the **show pim6 rpcandidate** command

Parameter	Meaning
Scope	The scope zone for which the router is an RP candidate.
Info	A message indicating that no RP candidate groups have been configured for this scope.
Priority	The priority for the router to become the Rendezvous Point for the multicast group. A candidate with a lower priority is more likely to become the RP.
Group Address/Prefix	The addresses and prefixes of the multicast groups associated with the specified Rendezvous Point.

Examples To display a list of multicast groups for which the router is a Rendezvous Point candidate, use the command:

```
sh pim6 rpc
```

Related Commands

add pim6 rpcandidate
delete pim6 rpcandidate
set pim6 rpcandidate
show pim6 rpset

show pim6 rpset

Syntax `SHow PIM6 RPSet`

Description This command displays the static group-to-RP mapping (Figure 33-22, Table 33-11), followed by the elected bootstrap router's current set of RP candidates and the groups they are configured for (Figure 33-23, Table 33-12 on page 33-62). It applies for PIM-SM only.

Figure 33-22: Example output from the **show pim6 rpset** command when the RP is statically configured

```
PIM6 Static RP Mapping
------------------------------------------------------

Scope ............................ Global
  RP address ..................... 4ffe:0057::0002
     Group address/prefix ........ ff0e:0057::/32
```

Table 33-11: Parameters in the output of the **show pim6 rpset** command when the RP is statically configured

Parameter	Meaning
Scope	The scope zone to which this RP information applies.
RP address	The IPv6 address of the router that is statically configured as the RP for the following group(s).
Group address/Prefix	The IPv6 address and prefix of the multicast group.

Figure 33-23: Example output from the **show pim6 rpset** command when the RP is determined using the bootstrap mechanism

```
PIM6 RP Set Information
-------------------------------------------------

Scope ................................ Site

Info (1105060): Nothing to display.

Scope ......................... Global
  Group address/prefix ........ ff0e:0057::/32
    RP Candidate address ...... 4ffe:0057::0002
      Priority ................ 192
      Holdtime ................ 120
    RP Candidate address ...... 4ffe:8923::1111
      Priority ................ 180
      Holdtime ................ 120
```

Table 33-12: Parameters in the output of the **show pim6 rpset** command when the RP is determined using the bootstrap mechanism

Parameter	Meaning
Scope	The scope zone to which this RP information applies.
Info	A statement indicating that no RP information has been received from the BSR for the given scope.
Group address/Prefix	IPv6 address and prefix of the multicast group.
RP Candidate address	IPv6 address of the RP Candidate for the multicast group.
Priority	Priority for the RP candidate to become the RP. A candidate with a lower priority is more likely to become the RP.
Holdtime	The time in seconds for which this RP candidate is valid. Unless the RP advertisement is refreshed, the RP candidate is deleted when this time has elapsed.

Examples

To display information about RP candidates for multicast groups, use the command:

```
sh pim6 rps
```

Related Commands

add pim6 rpcandidate
delete pim6 rpcandidate
set pim6 rpcandidate
show pim6 rpcandidate

show pim6 staterefresh

Syntax `SHow PIM6 STATerefresh`

Description This command displays the internal State Refresh table for PIM-DM (Figure 33-24, Table 33-13).

Figure 33-24: Example output from the **show pim6 staterefresh** command

```
PIM6 Dense Mode State Refresh
-----------------------------------------------------

  Source ........................... 3ffe::1
  Group ............................ ff0e::1234:5678
    Originator state ............... Orginator
      Direct Connect to source on ... eth1
      Source alive timer ............ 200
      State refresh timer ........... 50


  Source ........................... 4ffe::1
  Group ............................ ff0e::1234:5678
    Originator state ............... Not Originator
```

Table 33-13: Parameters in the output of the **show pim6 staterefresh** command

Parameter	Meaning
Source	IPv6 address of the multicast sender.
Group	IPv6 address of the multicast group.
Originator state	Whether the router can act a state refresh message originator. A router can act as an originator only when the source is directly connected.
Direct Connect to source on	Interface the source is connected to.
Source alive timer	An alive timer, in seconds, for directly connected sources. A "0" value indicates that the timer is not running because no data is being received. The timer is reset when data is received.
State refresh timer	Time in seconds before the next state refresh message is sent.

Examples To display the internal State Refresh table, use the command:

```
sh pim6 stat
```

Related Commands

add pim6 interface
delete pim6 interface
set pim6 interface

show pim6 timer

Syntax `SHow PIM6 TIMer`

Description This command displays timer intervals for PIM6 operations (Figure 33-25, Table 33-14).

Figure 33-25: Example output from the **show pim6 timer** command

```
PIM6 Timers
-----------------------------------------------
Join/Prune interval ................... 60
Register probe time ................... 5
Register suppression time ............. 60
Keep Alive time ....................... 210
BSM interval .......................... 60
RP adv interval ....................... 60
Prune hold time ....................... 210
Source Alive time ..................... 210
State refresh interval ................ 60
```

Table 33-14: Parameters in the output of the **show pim6 timer** command

Parameter	Meaning
Join/Prune Interval	Time in seconds when the router sends Join/Prune messages.
Register Probe time	Time in seconds that the DR waits for another Register Stop message after sending a Null Register message to the RP.
Register Suppression time	Time in seconds when the sender's DR sends Null Register messages to the group's RP.
Keep Alive time	Time in seconds that the Join state for a particular Source and Group pair is maintained in the absence of data for that pair.
BSM interval	Time in seconds when the router sends bootstrap messages when it is the bootstrap router in the domain.
RP adv interval	Time in seconds when the router sends C-RP-Advertisements.
Prune hold time	Time in seconds that upstream routers maintain in the Prune state.
Source Alive time	Time in seconds when a router acting as a State Refresh Originator is active in the absence of data packets from the source.
State refresh time	Time in seconds when the router sends State Refresh messages.

Examples To display PIM6 timer intervals, use the command:

```
sh pim6 tim
```

Related Commands **set pim6**