



IPv6 Multicast PIM

This module describes how to configure IPv6 Multicast PIM features.

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Prerequisites for IPv6 Multicast

The following are the prerequisites for IPv6 PIM source-specific multicast (SSM):

- Multicast Listener Discovery (MLD) version 2 is required for source-specific multicast (SSM) to operate.
- Before configuring SSM with MLD, SSM must be supported by the Cisco IPv6 device, the host where the application is running, and the application itself.

Restrictions for IPv6 Multicast

The supported IPV6 scale for the default templates for multicast routes are available in <http://www.cisco.com/c/en/us/products/routers/asr-903-series-aggregation-services-routers/models-comparison.html>.

The router does *not* support :

- IPv6 Multicast Listener Discovery (MLD) snooping
- Multiprotocol BGP Extensions for multicast
- Equal Cost Multipath (ECMP) for multicast
- Multicast Virtual Private Network (MVPN)
- Multicast QoS for IPv6
- Dynamic Domain Name System (DNS) PIM Source Specific Multicast (SSM) mapping for multicast
- Multicast Source Discovery Protocol (MSDP)

- Embedded RP is not supported on RSP3 module.



Note The Multicast control packets are *not* processed when the system memory utilization is more than 90%. The following message is displayed on the console.

```
*Sep 18 18:21:07.287: %SYS-2-NOMEMORY: No memory available for multicast control packets,
dropping multicast control packets.
Memory usage percentage: 91
```

The system memory utilization may increase when the number of multicast sources and MLD reports join rate is increased. When 90% of the system memory is used, the MLD reports are *not* processed and multicast may not function as expected. For the multicast reports to be processed again, decrease the join rate.

Information About IPv6 Multicast

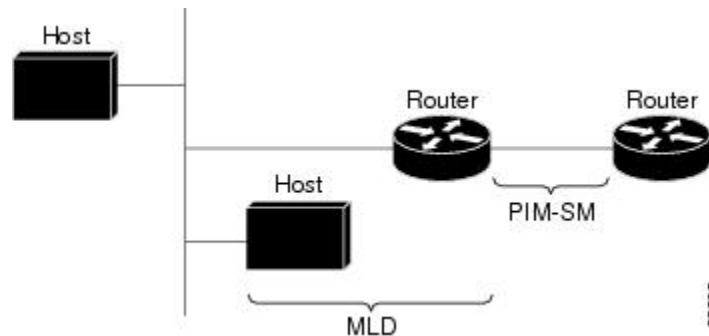
IPv6 Multicast Routing Implementation

Cisco software supports the following protocols to implement IPv6 multicast routing:

- MLD is used by IPv6 devices to discover multicast listeners (nodes that want to receive multicast packets destined for specific multicast addresses) on directly attached links. There are two versions of MLD:
 - MLD version 1 is based on version 2 of the Internet Group Management Protocol (IGMP) for IPv4.
 - MLD version 2 is based on version 3 of the IGMP for IPv4.
- IPv6 multicast for Cisco software uses both MLD version 2 and MLD version 1. MLD version 2 is fully backward-compatible with MLD version 1 (described in RFC 2710). Hosts that support only MLD version 1 will interoperate with a device running MLD version 2. Mixed LANs with both MLD version 1 and MLD version 2 hosts are likewise supported.
- PIM-SM is used between devices so that they can track which multicast packets to forward to each other and to their directly connected LANs.
- PIM in Source Specific Multicast (PIM-SSM) is similar to PIM-SM with the additional ability to report interest in receiving packets from specific source addresses (or from all but the specific source addresses) to an IP multicast address.

The figure below shows where MLD and PIM-SM operate within the IPv6 multicast environment.

Figure 1: IPv6 Multicast Routing Protocols Supported for IPv6



Protocol Independent Multicast

Protocol Independent Multicast (PIM) is used between devices so that they can track which multicast packets to forward to each other and to their directly connected LANs. PIM works independently of the unicast routing protocol to perform send or receive multicast route updates like other protocols. Regardless of which unicast routing protocols are being used in the LAN to populate the unicast routing table, Cisco IOS PIM uses the existing unicast table content to perform the Reverse Path Forwarding (RPF) check instead of building and maintaining its own separate routing table.

You can configure IPv6 multicast to use either a PIM- Sparse Mode (SM) or PIM-Source Specific Multicast (SSM) operation, or you can use both PIM-SM and PIM-SSM together in your network.

PIM-Sparse Mode

IPv6 multicast provides support for intradomain multicast routing using PIM-SM. PIM-SM uses unicast routing to provide reverse-path information for multicast tree building, but it is not dependent on any particular unicast routing protocol.

PIM-SM is used in a multicast network when relatively few devices are involved in each multicast and these devices do not forward multicast packets for a group, unless there is an explicit request for the traffic. PIM-SM distributes information about active sources by forwarding data packets on the shared tree. PIM-SM initially uses shared trees, which requires the use of an RP.

Requests are accomplished via PIM joins, which are sent hop by hop toward the root node of the tree. The root node of a tree in PIM-SM is the RP in the case of a shared tree or the first-hop device that is directly connected to the multicast source in the case of a shortest path tree (SPT). The RP keeps track of multicast groups and the hosts that send multicast packets are registered with the RP by that host's first-hop device.

As a PIM join travels up the tree, devices along the path set up multicast forwarding state so that the requested multicast traffic will be forwarded back down the tree. When multicast traffic is no longer needed, a device sends a PIM prune up the tree toward the root node to prune (or remove) the unnecessary traffic. As this PIM prune travels hop by hop up the tree, each device updates its forwarding state appropriately. Ultimately, the forwarding state associated with a multicast group or source is removed.

A multicast data sender sends data destined for a multicast group. The designated router (DR) of the sender takes those data packets, unicast-encapsulates them, and sends them directly to the RP. The RP receives these encapsulated data packets, de-encapsulates them, and forwards them onto the shared tree. The packets then follow the (*, G) multicast tree state in the devices on the RP tree, being replicated wherever the RP tree branches, and eventually reaching all the receivers for that multicast group. The process of encapsulating data packets to the RP is called registering, and the encapsulation packets are called PIM register packets.

Designated Router

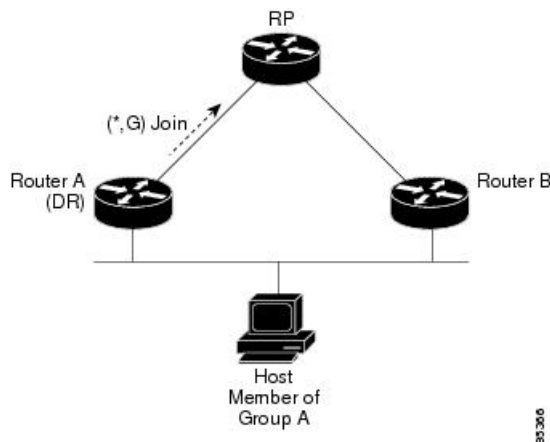
Cisco devices use PIM-SM to forward multicast traffic and follow an election process to select a designated device when there is more than one device on a LAN segment.

The designated router (DR) is responsible for sending PIM register and PIM join and prune messages toward the RP to inform it about active sources and host group membership.

If there are multiple PIM-SM devices on a LAN, a DR must be elected to avoid duplicating multicast traffic for connected hosts. The PIM device with the highest IPv6 address becomes the DR for the LAN unless you choose to force the DR election by use of the **ipv6 pim dr-priority** command. This command allows you to specify the DR priority of each device on the LAN segment (default priority = 1) so that the device with the highest priority will be elected as the DR. If all devices on the LAN segment have the same priority, then the highest IPv6 address is again used as the tiebreaker.

The figure below illustrates what happens on a multiaccess segment. Device A and Device B are connected to a common multiaccess Ethernet segment with Host A as an active receiver for Group A. Only Device A, operating as the DR, sends joins to the RP to construct the shared tree for Group A. If Device B was also permitted to send (*, G) joins to the RP, parallel paths would be created and Host A would receive duplicate multicast traffic. Once Host A begins to source multicast traffic to the group, the DR's responsibility is to send register messages to the RP. If both devices were assigned the responsibility, the RP would receive duplicate multicast packets and result in wastage of bandwidth.

Figure 2: Designated Router Election on a Multiaccess Segment



If the DR should fail, the PIM-SM provides a way to detect the failure of Device A and elect a failover DR. If the DR (Device A) became inoperable, Device B would detect this situation when its neighbor adjacency with Device A timed out. Because Device B has been hearing MLD membership reports from Host A, it already has MLD state for Group A on this interface and would immediately send a join to the RP when it became the new DR. This step reestablishes traffic flow down a new branch of the shared tree via Device B. Additionally, if Host A were sourcing traffic, Device B would initiate a new register process immediately after receiving the next multicast packet from Host A. This action would trigger the RP to join the SPT to Host A via a new branch through Device B.



Tip Two PIM devices are neighbors if there is a direct connection between them. To display your PIM neighbors, use the **show ipv6 pim neighbor** command in privileged EXEC mode.



Note The DR election process is required only on multiaccess LANs.

Rendezvous Point

IPv6 PIM provides embedded RP support. Embedded RP support allows the device to learn RP information using the multicast group destination address instead of the statically configured RP. For devices that are the RP, the device must be statically configured as the RP.

The device searches for embedded RP group addresses in MLD reports or PIM messages and data packets. On finding such an address, the device learns the RP for the group from the address itself. It then uses this learned RP for all protocol activity for the group. For devices that are the RP, the device is advertised as an embedded RP must be configured as the RP.

To select a static RP over an embedded RP, the specific embedded RP group range or mask must be configured in the access list of the static RP. When PIM is configured in sparse mode, you must also choose one or more devices to operate as an RP. An RP is a single common root placed at a chosen point of a shared distribution tree and is configured statically in each box.

PIM DRs forward data from directly connected multicast sources to the RP for distribution down the shared tree. Data is forwarded to the RP in one of two ways:

- Data is encapsulated in register packets and unicast directly to the RP by the first-hop device operating as the DR.
- If the RP has itself joined the source tree, it is multicast-forwarded per the RPF forwarding algorithm described in the PIM-Sparse Mode section.

The RP address is used by first-hop devices to send PIM register messages on behalf of a host sending a packet to the group. The RP address is also used by last-hop devices to send PIM join and prune messages to the RP to inform it about group membership. You must configure the RP address on all devices (including the RP device).

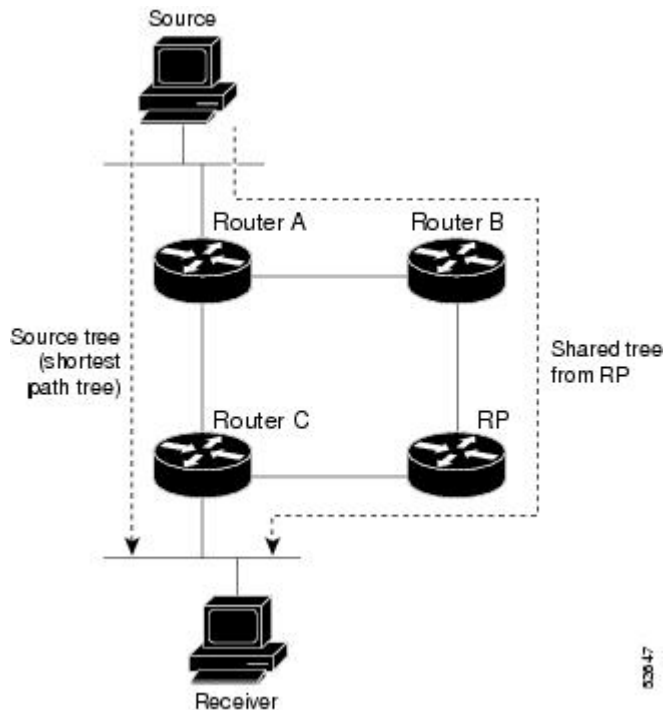
A PIM device can be an RP for more than one group. Only one RP address can be used at a time within a PIM domain for a certain group. The conditions specified by the access list determine for which groups the device is an RP.

IPv6 multicast supports the PIM accept register feature, which is the ability to perform PIM-SM register message filtering at the RP. The user can match an access list or compare the AS path for the registered source with the AS path specified in a route map.

PIM Shared Tree and Source Tree (Shortest-Path Tree)

By default, members of a group receive data from senders to the group across a single data distribution tree rooted at the RP. This type of distribution tree is called shared tree or rendezvous point tree (RPT), as illustrated in the figure below. Data from senders is delivered to the RP for distribution to group members joined to the shared tree.

Figure 3: Shared Tree and Source Tree (Shortest Path Tree)



If the data threshold warrants, leaf devices on the shared tree may initiate a switch to the data distribution tree rooted at the source. This type of distribution tree is called a shortest path tree or source tree. By default, the software switches to a source tree upon receiving the first data packet from a source.

The following process details the move from shared tree to source tree:

1. Receiver joins a group; leaf Device C sends a join message toward the RP.
2. RP puts the link to Device C in its outgoing interface list.
3. Source sends the data; Device A encapsulates the data in the register and sends it to the RP.
4. RP forwards the data down the shared tree to Device C and sends a join message toward the source. At this point, data may arrive twice at Device C, once encapsulated and once natively.
5. When data arrives natively (unencapsulated) at the RP, the RP sends a register-stop message to Device A.
6. By default, receipt of the first data packet prompts Device C to send a join message toward the source.
7. When Device C receives data on (S, G), it sends a prune message for the source up the shared tree.
8. RP deletes the link to Device C from the outgoing interface of (S, G).
9. RP triggers a prune message toward the source.

Join and prune messages are sent for sources and RPs. They are sent hop-by-hop and are processed by each PIM device along the path to the source or RP. Register and register-stop messages are not sent hop-by-hop. They are sent by the designated router (DR) that is directly connected to a source and are received by the RP for the group.

Reverse Path Forwarding

Reverse-path forwarding is used for forwarding multicast datagrams. It functions as follows:

- If a device receives a datagram on an interface it uses to send unicast packets to the source, the packet has arrived on the RPF interface.
- If the packet arrives on the RPF interface, a device forwards the packet out the interfaces present in the outgoing interface list of a multicast routing table entry.
- If the packet does not arrive on the RPF interface, the packet is silently discarded to prevent loops.

PIM uses both source trees and RP-rooted shared trees to forward datagrams; the RPF check is performed differently for each, as follows:

- If a PIM device has source-tree state (that is, an (S, G) entry is present in the multicast routing table), the device performs the RPF check against the IPv6 address of the source of the multicast packet.
- If a PIM device has shared-tree state (and no explicit source-tree state), it performs the RPF check on the RP's address (which is known when members join the group).

Sparse-mode PIM uses the RPF lookup function to determine where it needs to send joins and prunes. (S, G) joins (which are source-tree states) are sent toward the source. (*, G) joins (which are shared-tree states) are sent toward the RP.



Note To do a RPF check, use the **show ipv6 rpf hostname** or **show ipv6 rpf vrf vrf_name hostname** command.

PIM IPv6 Stub Routing

The PIM stub routing feature reduces resource usage by moving routed traffic closer to the end user.

In a network using PIM stub routing, the only allowable route for IPv6 traffic to the user is through a switch that is configured with PIM stub routing. PIM passive interfaces are connected to Layer 2 access domains, such as VLANs, or to interfaces that are connected to other Layer 2 devices. Only directly connected multicast receivers and sources are allowed in the Layer 2 access domains. The PIM passive interfaces do not send or process any received PIM control packets.

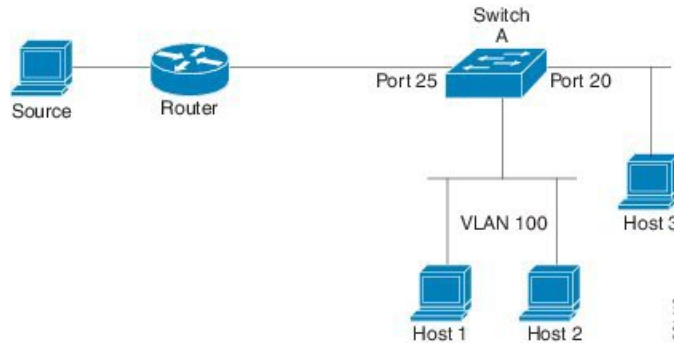
When using PIM stub routing, you should configure the distribution and remote routers to use IPv6 multicast routing and configure only the switch as a PIM stub router. The switch does not route transit traffic between distribution routers. You also need to configure a routed uplink port on the switch. The switch uplink port cannot be used with SVIs.

You must also configure EIGRP stub routing when configuring PIM stub routing on the switch.

The redundant PIM stub router topology is not supported. The redundant topology exists when there is more than one PIM router forwarding multicast traffic to a single access domain. PIM messages are blocked, and the PIM assert and designated router election mechanisms are not supported on the PIM passive interfaces. Only the non-redundant access router topology is supported by the PIM stub feature. By using a non-redundant topology, the PIM passive interface assumes that it is the only interface and designated router on that access domain.

In the figure shown below, Switch A routed uplink port 25 is connected to the router and PIM stub routing is enabled on the VLAN 100 interfaces and on Host 3. This configuration allows the directly connected hosts to receive traffic from multicast source.

Figure 4: PIM Stub Router Configuration



MRIB

The Multicast Routing Information Base (MRIB) is a protocol-independent repository of multicast routing entries instantiated by multicast routing protocols (routing clients). Its main function is to provide independence between routing protocols and the Multicast Forwarding Information Base (MFIB). It also acts as a coordination and communication point among its clients.

Routing clients use the services provided by the MRIB to instantiate routing entries and retrieve changes made to routing entries by other clients. Besides routing clients, MRIB also has forwarding clients (MFIB instances) and special clients such as MLD. MFIB retrieves its forwarding entries from MRIB and notifies the MRIB of any events related to packet reception. These notifications can either be explicitly requested by routing clients or spontaneously generated by the MFIB.

Another important function of the MRIB is to allow for the coordination of multiple routing clients in establishing multicast connectivity within the same multicast session. MRIB also allows for the coordination between MLD and routing protocols.

MFIB

The MFIB is a platform-independent and routing-protocol-independent library for IPv6 software. Its main purpose is to provide a Cisco IOS platform with an interface with which to read the IPv6 multicast forwarding table and notifications when the forwarding table changes. The information provided by the MFIB has clearly defined forwarding semantics and is designed to make it easy for the platform to translate to its specific hardware or software forwarding mechanisms.

When routing or topology changes occur in the network, the IPv6 routing table is updated, and those changes are reflected in the MFIB. The MFIB maintains next-hop address information based on the information in the IPv6 routing table. Because there is a one-to-one correlation between MFIB entries and routing table entries, the MFIB contains all known routes and eliminates the need for route cache maintenance that is associated with switching paths such as fast switching and optimum switching.

MFIB



Note Distributed MFIB has its significance only in a stacked environment where the Master distributes the MFIB information to the other stack members. In the following section the line cards are nothing but the member switches in the stack.

MFIB (MFIB) is used to switch multicast IPv6 packets on distributed platforms. MFIB may also contain platform-specific information on replication across line cards. The basic MFIB routines that implement the core of the forwarding logic are common to all forwarding environments.

MFIB implements the following functions:

- Relays data-driven protocol events generated in the line cards to PIM.
- Provides an MFIB platform application program interface (API) to propagate MFIB changes to platform-specific code responsible for programming the hardware acceleration engine. This API also includes entry points to switch a packet in software (necessary if the packet is triggering a data-driven event) and to upload traffic statistics to the software.

The combination of MFIB and MRIB subsystems also allows the switch to have a "customized" copy of the MFIB database in each line card and to transport MFIB-related platform-specific information from the RP to the line cards.

IPv6 Multicast Process Switching and Fast Switching

A unified MFIB is used to provide both fast switching and process switching support for PIM-SM and PIM-SSM in IPv6 multicast. In process switching, the switch must examine, rewrite, and forward each packet. The packet is first received and copied into the system memory. The switch then looks up the Layer 3 network address in the routing table. The Layer 2 frame is then rewritten with the next-hop destination address and sent to the outgoing interface. The switch also computes the cyclic redundancy check (CRC). This switching method is the least scalable method for switching IPv6 packets.

IPv6 multicast fast switching allows switches to provide better packet forwarding performance than process switching. Information conventionally stored in a route cache is stored in several data structures for IPv6 multicast switching. The data structures provide optimized lookup for efficient packet forwarding.

In IPv6 multicast forwarding, the first packet is fast-switched if the PIM protocol logic allows it. In IPv6 multicast fast switching, the MAC encapsulation header is precomputed. IPv6 multicast fast switching uses the MFIB to make IPv6 destination prefix-based switching decisions. In addition to the MFIB, IPv6 multicast fast switching uses adjacency tables to prepend Layer 2 addressing information. The adjacency table maintains Layer 2 next-hop addresses for all MFIB entries.

The adjacency table is populated as adjacencies are discovered. Each time an adjacency entry is created (such as through ARP), a link-layer header for that adjacent node is precomputed and stored in the adjacency table. Once a route is determined, it points to a next hop and corresponding adjacency entry. It is subsequently used for encapsulation during switching of packets.

A route might have several paths to a destination prefix, such as when a switch is configured for simultaneous load balancing and redundancy. For each resolved path, a pointer is added for the adjacency corresponding to the next-hop interface for that path. This mechanism is used for load balancing across several paths.

Enabling IPv6 Multicast Routing

Beginning in privileged EXEC mode, follow these steps:

Procedure

	Command or Action	Purpose
Step 1	configure terminal	Enter global configuration mode.
Step 2	ipv6 multicast-routing Example: <code>(config)# ipv6 multicast-routing</code>	Enables multicast routing on all IPv6-enabled interfaces and enables multicast forwarding for PIM and MLD on all enabled interfaces of the switch.
Step 3	copy running-config startup-config	(Optional) Save your entries in the configuration file.

IPv6 Multicast: PIM Sparse Mode

IPv6 multicast provides support for intradomain multicast routing using PIM sparse mode (PIM-SM). PIM-SM uses unicast routing to provide reverse-path information for multicast tree building, but it is not dependent on any particular unicast routing protocol.

IPv6 PIM Passive Mode

A device configured with PIM will always send out PIM hello messages to all interfaces enabled for IPv6 multicast routing, even if the device is configured not to accept PIM messages from any neighbor on the LAN.

IPv6 Multicast: PIM Source-Specific Multicast

The PIM source-specific multicast (SSM) routing protocol supports SSM implementation and is derived from PIM-SM. However, unlike PIM-SM data from all multicast sources are sent when there is a PIM join, the SSM feature forwards datagram traffic to receivers from only those multicast sources that the receivers have explicitly joined, thus optimizing bandwidth utilization and denying unwanted Internet broadcast traffic.

IPv6 Source Specific Multicast Mapping

SSM mapping for IPv6 supports both static and dynamic Domain Name System (DNS) mapping for MLD version 1 receivers. This feature allows deployment of IPv6 SSM with hosts that are incapable of providing MLD version 2 support in their TCP/IP host stack and their IP multicast receiving application. SSM mapping allows the device to look up the source of a multicast MLD version 1 report either in the running configuration of the device or from a DNS server. The device can then initiate an (S, G) join toward the source.

How to Configure IPv6 Multicast

Enabling IPv6 Multicast Routing

IPv6 multicast uses MLD version 2. This version of MLD is fully backward-compatible with MLD version 1 (described in *RFC 2710*). Hosts that support only MLD version 1 will interoperate with a device running MLD version 2. Mixed LANs with both MLD version 1 and MLD version 2 hosts are likewise supported.

Before you begin

You must first enable IPv6 unicast routing on all interfaces of the device on which you want to enable IPv6 multicast routing .

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	ipv6 multicast-routing [vrf vrf-name] Example: Device(config)# ipv6 multicast-routing	Enables multicast routing on all IPv6-enabled interfaces and enables multicast forwarding for PIM and MLD on all enabled interfaces of the device. <ul style="list-style-type: none"> • IPv6 multicast routing is disabled by default when IPv6 unicast routing is enabled. IPv6 multicast-routing needs to be enabled for IPv6 multicast routing to function.

Configuring PIM Options

Procedure

	Command or Action	Purpose
Step 1	enable Example:	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.

	Command or Action	Purpose
	Device> enable	
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	ipv6 pim [vrf vrf-name] spt-threshold infinity [group-list access-list-name] Example: Device(config)# ipv6 pim spt-threshold infinity group-list acc-grp-1	Configures when a PIM leaf device joins the SPT for the specified groups.
Step 4	ipv6 pim [vrf vrf-name] accept-register {list access-list route-map map-name} Example: Device(config)# ipv6 pim accept-register route-map reg-filter	Accepts or rejects registers at the RP.
Step 5	interface type number Example: Device(config)# interface gigabitethernet 0/1/0	Specifies an interface type and number, and places the device in interface configuration mode.
Step 6	ipv6 pim dr-priority value Example: Device(config-if)# ipv6 pim dr-priority 3	Configures the DR priority on a PIM device.
Step 7	ipv6 pim hello-interval seconds Example: Device(config-if)# ipv6 pim hello-interval 45	Configures the frequency of PIM hello messages on an interface.
Step 8	ipv6 pim join-prune-interval seconds Example: Device(config-if)# ipv6 pim join-prune-interval 75	Configures periodic join and prune announcement intervals for a specified interface.

	Command or Action	Purpose
Step 9	exit Example: Device(config-if)# exit	Enter this command twice to exit interface configuration mode and enter privileged EXEC mode.
Step 10	show ipv6 pim [vrf vrf-name] join-prune statistic [interface-type] Example: Device# show ipv6 pim join-prune statistic	Displays the average join-prune aggregation for the most recently aggregated packets for each interface.

Configuring PIM-SM and Displaying PIM-SM Information for a Group Range

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	ipv6 pim [vrf vrf-name] rp-address ipv6-address [group-access-list] [bidir] Example: Device(config)# ipv6 pim rp-address 2001:DB8::01:800:200E:8C6C acc-grp-1	Configures the address of a PIM RP for a particular group range.
Step 4	end Example: Device(config-if)# end	Returns to privileged EXEC mode.
Step 5	show ipv6 pim [vrf vrf-name] interface [state-on] [state-off] [type number] Example: Device# show ipv6 pim interface	Displays information about interfaces configured for PIM.

	Command or Action	Purpose
Step 6	show ipv6 pim [<i>vrf vrf-name</i>] group-map [<i>group-name</i> <i>group-address</i>] [<i>group-range</i> <i>group-mask</i>] [info-source { <i>bsr</i> default embedded-rp static }] Example: Device# show ipv6 pim group-map	Displays an IPv6 multicast group mapping table.
Step 7	show ipv6 pim [<i>vrf vrf-name</i>] neighbor [detail] [<i>interface-type interface-number</i> count] Example: Device# show ipv6 pim neighbor	Displays the PIM neighbors discovered by the Cisco IOS software.
Step 8	show ipv6 pim [<i>vrf vrf-name</i>] range-list [config] [<i>rp-address</i> <i>rp-name</i>] Example: Device# show ipv6 pim range-list	Displays information about IPv6 multicast range lists.
Step 9	show ipv6 pim [<i>vrf vrf-name</i>] tunnel [<i>interface-type interface-number</i>] Example: Device# show ipv6 pim tunnel	Displays information about the PIM register encapsulation and de-encapsulation tunnels on an interface.
Step 10	debug ipv6 pim [<i>group-name</i> <i>group-address</i> interface <i>interface-type</i> bsr group mvpn neighbor] Example: Device# debug ipv6 pim	Enables debugging on PIM protocol activity.

Resetting the PIM Traffic Counters

If PIM malfunctions, or in order to verify that the expected number of PIM packets are received and sent, clear PIM traffic counters. Once the traffic counters are cleared, you can verify that PIM is functioning correctly and that PIM packets are being received and sent correctly.

Procedure

	Command or Action	Purpose
Step 1	enable Example:	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.

	Command or Action	Purpose
	Device> enable	
Step 2	clear ipv6 pim [vrf vrf-name] traffic Example: Device# clear ipv6 pim traffic	Resets the PIM traffic counters.
Step 3	show ipv6 pim [vrf vrf-name] traffic Example: Device# show ipv6 pim traffic	Displays the PIM traffic counters.

Clearing the PIM Topology Table to Reset the MRIB Connection

No configuration is necessary to use the MRIB. However, users may in certain situations want to clear the PIM topology table in order to reset the MRIB connection and verify MRIB information.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	clear ipv6 pim [vrf vrf-name] topology [group-name group-address] Example: Device# clear ipv6 pim topology FF04::10	Clears the PIM topology table.
Step 3	show ipv6 mrib [vrf vrf-name] client [filter] [name {client-name client-name : client-id}] Example: Device# show ipv6 mrib client	Displays multicast-related information about an interface.
Step 4	show ipv6 mrib [vrf vrf-name] route [link-local summary [sourceaddress-or-name *] [groupname-or-address [prefix-length]]] Example: Device# show ipv6 mrib route	Displays the MRIB route information.

	Command or Action	Purpose
Step 5	show ipv6 pim [vrf vrf-name] topology [groupname-or-address [sourcename-or-address] link-local route-count [detail]] Example: Device# show ipv6 pim topology	Displays PIM topology table information for a specific group or all groups.
Step 6	debug ipv6 mrib [vrf vrf-name] client Example: Device# debug ipv6 mrib client	Enables debugging on MRIB client management activity.
Step 7	debug ipv6 mrib [vrf vrf-name] io Example: Device# debug ipv6 mrib io	Enables debugging on MRIB I/O events.
Step 8	debug ipv6 mrib proxy Example: Device# debug ipv6 mrib proxy	Enables debugging on MRIB proxy activity between the route processor and line cards on distributed router platforms.
Step 9	debug ipv6 mrib [vrf vrf-name] route [group-name group-address] Example: Device# debug ipv6 mrib route	Displays information about MRIB routing entry-related activity.
Step 10	debug ipv6 mrib [vrf vrf-name] table Example: Device# debug ipv6 mrib table	Enables debugging on MRIB table management activity.

Turning Off IPv6 PIM on a Specified Interface

A user might want only specified interfaces to perform IPv6 multicast and will therefore want to turn off PIM on a specified interface.



Note Though IOS supports disabling PIM on an interface, this is not possible on RSP3 platform due to caveat. Ipv6 multicast packets will still get punted to CPU even if PIM is turned off on the interface.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	interface <i>type number</i> Example: Device(config)# interface gigabitethernet 0/1/0	Specifies an interface type and number, and places the device in interface configuration mode.
Step 4	no ipv6 pim Example: Device(config-if)# no ipv6 pim	Turns off IPv6 PIM on a specified interface.

Disabling Embedded RP Support in IPv6 PIM

A user might want to disable embedded RP support on an interface if all of the devices in the domain do not support embedded RP.



Note This task disables PIM completely, not just embedded RP support in IPv6 PIM.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 3	no ipv6 pim [vrf vrf-name] rp embedded Example: Device(config)# no ipv6 pim rp embedded	Disables embedded RP support in IPv6 PIM.
Step 4	interface type number Example: Device(config)# interface gigabitethernet 0/1/0	Specifies an interface type and number, and places the device in interface configuration mode.
Step 5	no ipv6 pim Example: Device(config-if)# no ipv6 pim	Turns off IPv6 PIM on a specified interface.

Configuring IPv6 SSM

When the SSM mapping feature is enabled, DNS-based SSM mapping is automatically enabled, which means that the device will look up the source of a multicast MLD version 1 report from a DNS server.

You can configure either DNS-based or static SSM mapping, depending on your device configuration. If you choose to use static SSM mapping, you can configure multiple static SSM mappings. If multiple static SSM mappings are configured, the source addresses of all matching access lists will be used.

Before you begin



Note To use DNS-based SSM mapping, the device needs to find at least one correctly configured DNS server to which the device can be directly attached.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 3	ipv6 mld [vrf vrf-name] ssm-map enable Example: Device(config)# ipv6 mld ssm-map enable	Enables the SSM mapping feature for groups in the configured SSM range.
Step 4	no ipv6 mld [vrf vrf-name] ssm-map query dns Example: Device(config)# no ipv6 mld ssm-map query dns	Disables DNS-based SSM mapping.
Step 5	ipv6 mld [vrf vrf-name] ssm-map static access-list source-address Example: Device(config)# ipv6 mld ssm-map static SSM_MAP_ACL_2 2001:DB8:1::1	Configures static SSM mappings.
Step 6	end Example: Device(config-if)# end	Returns to privileged EXEC mode.
Step 7	show ipv6 mld [vrf vrf-name] ssm-map [source-address] Example: Device# show ipv6 mld ssm-map	Displays SSM mapping information.

Configuring PIM Passive/MLD State Limit

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 3	ipv6 multicast pim-passive-enable Example: Device(config)# ipv6 multicast pim-passive-enable	Enables the PIM passive feature on an IPv6 device.
Step 4	ipv6 mld state-limit <i>number</i> Example: Device(config)# ipv6 mld state-limit 100	(Optional) Specifies maximum number of dynamic MLD groups allowed on a router.
Step 5	interface <i>type number</i> Example: Device(config)# interface GigabitEthernet 1/0/0	Specifies an interface type and number, and places the device in interface configuration mode.
Step 6	ipv6 pim passive Example: Device(config-if)# ipv6 pim passive	Enables the PIM passive feature on a specific interface.
Step 7	ipv6 mld limit <i>number</i> Example: Device(config-if)# ipv6 mld limit 300	(Optional) Configure the per-interface MLD state limit. You can use this command to limit the dynamic MLD groups joined.
Step 8	no ipv6 mld router Example: Device(config-if)# no ipv6 mld router	(Optional) Prevents the interface from processing MLD v1/v2 joins sent through it or to prune from a group it has already joined. To enable the interface to start receiving MLD reports again, use ipv6 mld router command.
Step 9	show ipv6 mld <i>interface</i> Example: Device(config-if)# show ipv6 mld interface 1/0/0	(Optional) Displays MLD information about the interface. You can use this command to determine which interface acts as a querier.

Configuring a BSR

The tasks included here are described below.

Configuring a BSR and Verifying BSR Information

Beginning in privileged EXEC mode, follow these steps:

Procedure

	Command or Action	Purpose
Step 1	configure terminal	Enter global configuration mode.
Step 2	ipv6 pim bsr candidate bsr <i>ipv6-address[hash-mask-length] [priority</i> <i>priority-value]</i> Example: <pre>(config) # ipv6 pim bsr candidate bsr 2001:DB8:3000:3000::42 124 priority 10</pre>	Configures a switch to be a candidate BSR.
Step 3	interface <i>type number</i> Example: <pre>(config) # interface GigabitEthernet 1/0/1</pre>	Specifies an interface type and number, and places the switch in interface configuration mode.
Step 4	ipv6 pim bsr border Example: <pre>(config-if) # ipv6 pim bsr border</pre>	Specifies an interface type and number, and places the switch in interface configuration mode.
Step 5	exit Example: <pre>(config-if) # exit</pre>	Enter this command twice to exit interface configuration mode and enter privileged EXEC mode.
Step 6	show ipv6 pim bsr {election rp-cache candidate-rp} Example: <pre>(config-if) # show ipv6 pim bsr election</pre>	Displays information related to PIM BSR protocol processing.
Step 7	copy running-config startup-config	(Optional) Save your entries in the configuration file.

Sending PIM RP Advertisements to the BSR

Beginning in privileged EXEC mode, follow these steps:

Procedure

	Command or Action	Purpose
Step 1	configure terminal	Enter global configuration mode.

	Command or Action	Purpose
Step 2	ipv6 pim bsr candidate rp <i>ipv6-address</i> [group-list <i>access-list-name</i>] [priority <i>priority-value</i>] [interval seconds] Example: <pre>(config) # ipv6 pim bsr candidate rp 2001:DB8:3000:3000::42 priority 0</pre>	Sends PIM RP advertisements to the BSR.
Step 3	interface <i>type number</i> Example: <pre>(config) # interface GigabitEthernet 1/0/1</pre>	Specifies an interface type and number, and places the switch in interface configuration mode.
Step 4	ipv6 pim bsr border Example: <pre>(config-if) # ipv6 pim bsr border</pre>	Configures a border for all BSMs of any scope on a specified interface.
Step 5	copy running-config startup-config	(Optional) Save your entries in the configuration file.

Using MFIB in IPv6 Multicast

Multicast forwarding is automatically enabled when IPv6 multicast routing is enabled.

Verifying MFIB Operation in IPv6 Multicast

Beginning in privileged EXEC mode, follow these steps:

Procedure

	Command or Action	Purpose
Step 1	show ipv6 mfib [verbose <i>group-address-name</i> <i>ipv6-prefix/prefix-length</i> <i>source-address-name</i> count interface status summary] Example: <pre># show ipv6 mfib</pre>	Displays the forwarding entries and interfaces in the IPv6 MFIB.
Step 2	show ipv6 mfib [all linkscope group-name group-address [source-name source-address]] count Example:	Displays the contents of the IPv6 multicast routing table.

	Command or Action	Purpose
	<pre># show ipv6 mfib ff07::1</pre>	
Step 3	show ipv6 mfib interface Example: <pre># show ipv6 mfib interface</pre>	Displays information about IPv6 multicast-enabled interfaces and their forwarding status.
Step 4	show ipv6 mfib status Example: <pre># show ipv6 mfib status</pre>	Displays general MFIB configuration and operational status.
Step 5	show ipv6 mfib summary Example: <pre># show ipv6 mfib summary</pre>	Displays summary information about the number of IPv6 MFIB entries and interfaces.
Step 6	debug ipv6 mfib [<i>group-name</i> <i>group-address</i>] [<i>adjacency</i> <i>db</i> <i>fs</i> <i>init</i> <i>interface</i> <i>mrrib</i> [<i>detail</i>] <i>nat</i> <i>pak</i> <i>platform</i> <i>ppr</i> <i>ps</i> <i>signal</i> <i>table</i>] Example: <pre># debug ipv6 mfib FF04::10 pak</pre>	Enables debugging output on the IPv6 MFIB.

Resetting MFIB Traffic Counters

Beginning in privileged EXEC mode, follow these steps:

Procedure

	Command or Action	Purpose
Step 1	clear ipv6 mfib counters [<i>group-name</i> <i>group-address</i> [<i>source-address</i> <i>source-name</i>]] Example: <pre># clear ipv6 mfib counters FF04::10</pre>	Resets all active MFIB traffic counters.

Configuration Examples for IPv6 Multicast

Example: Enabling IPv6 Multicast Routing

The following example enables multicast routing on all interfaces and also enables multicast forwarding for PIM and MLD on all enabled interfaces of the device.

```
Device> enable
Device# configure terminal
Device(config)# ipv6 multicast-routing
```

Example: Configuring PIM Options

The following example sets the DR priority, the PIM hello interval, and the periodic join on the interface.

```
Device(config)# interface gigabitethernet 1/0/0
Device(config)# ipv6 pim hello-interval 60
Device(config)# ipv6 pim dr-priority 3
```

Example: Configuring PIM

The following example shows how to configure a device to use PIM-SM using 2001:DB8::1 as the RP. It sets the SPT threshold to infinity to prevent switchover to the source tree when a source starts sending traffic and sets a filter on all sources that do not have a local multicast BGP prefix.

```
Device(config)# ipv6 multicast-routing
Device(config)# ipv6 pim rp-address 2001:DB8::1
Device(config)# ipv6 pim spt-threshold infinity
Device(config)# ipv6 pim accept-register route-map reg-filter
```

Example: Displaying PIM-SM Information for a Group Range

This example displays information about interfaces configured for PIM:

```
Device# show ipv6 pim interface state-on
```

Interface	PIM	Nbr	Hello	DR
		Count	Intvl	Prior
Gi0/1/2	on	0	30	1
Address:	FE80::D2C2:82FF:FE17:F392			
DR	: this system			
Gi0/1/5	on	1	30	1
Address:	FE80::D2C2:82FF:FE17:F395			
DR	: FE80::D2C2:82FF:FE17:FAA5			
Loopback0	on	0	30	1
Address:	FE80::D2C2:82FF:FE17:F380			
DR	: this system			

This example displays an IPv6 multicast group mapping table:

```
Device# show ipv6 pim group-map
```

```
FF33::/32*
  SSM
  Info source:Static
  Uptime:00:08:32, Groups:0
FF34::/32*
  SSM
  Info source:Static
  Uptime:00:09:42, Groups:0
```

This example displays information about IPv6 multicast range lists:


```
Device# show ipv6 pim range-list

config SSM Exp:never Learnt from :::
FF33::/32 Up:00:26:33
FF34::/32 Up:00:26:33
FF35::/32 Up:00:26:33
FF36::/32 Up:00:26:33
FF37::/32 Up:00:26:33
FF38::/32 Up:00:26:33
FF39::/32 Up:00:26:33
FF3A::/32 Up:00:26:33
FF3B::/32 Up:00:26:33
FF3C::/32 Up:00:26:33
FF3D::/32 Up:00:26:33
FF3E::/32 Up:00:26:33
FF3F::/32 Up:00:26:33
config SM RP:40::1:1:1 Exp:never Learnt from :::
FF13::/64 Up:00:03:50
config SM RP:40::1:1:3 Exp:never Learnt from :::
FF09::/64 Up:00:03:50
```

Example: Displaying IPv6 PIM Topology Information

```
Device# show ipv6 pim topology

IP PIM Multicast Topology Table
Entry state: (*S,G)[RPT/SPT] Protocol Uptime Info Upstream Mode
Entry flags: KAT - Keep Alive Timer, AA - Assume Alive, PA - Probe Alive,
             RA - Really Alive, LH - Last Hop, DSS - Don't Signal Sources,
             RR - Register Received, SR - Sending Registers, E - MSDP External,
             DCC - Don't Check Connected, Y - Joined MDT-data group,
             y - Sending to MDT-data group
             BGS - BGP Signal Sent, !BGS - BGP signal suppressed
             SAS - BGP Src-Act Sent, SAR - BGP Src-Act Received
Interface state: Name, Uptime, Fwd, Info
Interface flags: LI - Local Interest, LD - Local Disinterest,
                II - Internal Interest, ID - Internal Disinterest,
                LH - Last Hop, AS - Assert, AB - Admin Boundary, BS - BGP Signal,
                BP - BGP Shared-Tree Prune, BPT - BGP Prune Time

(*,FF08::1)
SM UP: 00:04:36 JP: Join(00:00:28) Flags:
RP: 8001::1*
RPF: Tunnel1,8001::1*
   Gi0/1/5          00:04:36 fwd      Join(00:03:01)

(3001::5,FF08::1)
SM SPT UP: 00:04:57 JP: Join(never) Flags: KAT(00:02:12) RA
RPF: GigabitEthernet0/1/2,3001::5*
   Gi0/1/5          00:04:36 fwd      Join(00:03:01)
```

Example: Displaying Information About PIM Traffic

```
Device# show ipv6 pim traffic

PIM Traffic Counters
Elapsed time since counters cleared:00:05:29
```

	Received	Sent
Valid PIM Packets	22	22
Hello	22	22
Join-Prune	0	0
Register	0	0
Register Stop	0	0
Assert	0	0
Bidir DF Election	0	0
Errors:		
Malformed Packets		0
Bad Checksums		0
Send Errors		0
Packet Sent on Loopback Errors		0
Packets Received on PIM-disabled Interface		0
Packets Received with Unknown PIM Version		0

Example: Disabling Embedded RP Support in IPv6 PIM

The following example disables embedded RP support on IPv6 PIM:

```
Device(config)# ipv6 multicast-routing
Device(config)# no ipv6 pim rp embedded
```

Example: IPv6 SSM Mapping

```
Device# show ipv6 mld ssm-map 2001:DB8::1

Group address   : 2001:DB8::1
Group mode ssm  : TRUE
Database        : STATIC
Source list     : 2001:DB8::2
                  2001:DB8::3

Device# show ipv6 mld ssm-map 2001:DB8::2

Group address   : 2001:DB8::2
Group mode ssm  : TRUE
Database        : DNS
Source list     : 2001:DB8::3
                  2001:DB8::1
```