



IP Multicast Routing Configuration Guide, Cisco Catalyst IE3x00 Rugged, IE3400 Heavy Duty, and ESS3300 Series Switches

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CHAPTER 1

Configuring Basic Multicast Routing

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Prerequisites for Basic IP Multicast Routing

The following are the prerequisites for configuring basic IP multicast routing:

- You must configure the multicast routing protocols like Protocol Independent Multicast (PIM) in order to perform IP multicast routing. The switch populates its multicast routing table and forwards multicast packets it receives from its directly connected LANs according to the mode setting. You can configure an interface to be in the PIM dense mode, or sparse mode.
- Enabling PIM on an interface also enables IGMP operation on that interface. (To participate in IP multicasting, the multicast hosts, routers, and multilayer device must have IGMP operating.)

If you enable PIM on multiple interfaces, when most of these interfaces are not on the outgoing interface list, and IGMP snooping is disabled, the outgoing interface might not be able to sustain line rate for multicast traffic because of the extra replication.



Note

This feature is supported on the Cisco Catalyst IE3x00 Rugged, IE3400 Heavy Duty, and ESS3300 Series Switches.

Restrictions for Basic IP Multicast Routing

The following are the restrictions for IP multicast routing:

- PIM enabled interface scale limit is 26 targets (Routed port + SVIs).

- PIM sparse-dense mode is not supported.
- IPv6 PIM dense mode is not supported.

Information About Basic IP Multicast Routing

IP multicasting is an efficient way to use network resources, especially for bandwidth-intensive services such as audio and video. IP multicast routing enables a host (source) to send packets to a group of hosts (receivers) anywhere within the IP network by using a special form of IP address called the IP multicast group address.

The sending host inserts the multicast group address into the IP destination address field of the packet, and IP multicast routers and multilayer forward incoming IP multicast packets out all interfaces that lead to members of the multicast group. Any host, regardless of whether it is a member of a group, can send to a group. However, only the members of a group receive the message.

Starting from the IOS XE 17.17.1 release, multicast is supported over port channels or EtherChannels. This ensures that multicast traffic is efficiently distributed across multiple physical links within a port channel while maintaining redundancy and preventing duplicate traffic.

Multicast Forwarding Information Base Overview

The switch controller device uses the Multicast Forwarding Information Base (MFIB) architecture and the Multicast Routing Information Base (MRIB) for IP multicast.

The MFIB architecture provides both modularity and separation between the multicast control plane (Protocol Independent Multicast [PIM] and Internet Group Management Protocol [IGMP]) and the multicast forwarding plane (MFIB). This architecture is used in Cisco IOS IPv6 multicast implementations.

MFIB itself is a multicast routing protocol independent forwarding engine; that is, it does not depend on PIM or any other multicast routing protocol. It is responsible for:

- Forwarding multicast packets
- Registering with the MRIB to learn the entry and interface flags set by the control plane
- Handling data-driven events that must be sent to the control plane
- Maintaining counts, rates, and bytes of received, dropped, and forwarded multicast packets

The MRIB is the communication channel between MRIB clients. Examples of MRIB clients are PIM, IGMP, the multicast routing (mroutd) table, and the MFIB.

Default IP Multicast Routing Configuration

This table displays the default IP multicast routing configuration.

Table 1: Default IP Multicast Routing Configuration

Feature	Default Setting
Multicast routing	Disabled on all interfaces.
PIM version	Version 2.

Feature	Default Setting
PIM mode	No mode is defined.
PIM RP address	None configured.
PIM domain border	Disabled.
PIM multicast boundary	None.
Candidate BSRs	Disabled.
Candidate RPs	Disabled.
Shortest-path tree threshold rate	0 kb/s.
PIM router query message interval	30 seconds.

How to Configure Basic IP Multicast Routing

This section provides information about configuring basic IP multicast routing.

Configuring Basic IP Multicast Routing

By default, multicast routing is disabled, and there is no default mode setting.

This procedure is required.

Before you begin

You must configure the PIM version and the PIM mode. The switch populates its multicast routing table and forwards multicast packets it receives from its directly connected LANs according to the mode setting.

In populating the multicast routing table, dense-mode interfaces are always added to the table. If the multicast traffic from a specific source is sufficient, the receiver's first-hop router might send join messages toward the source to build a source-based distribution tree.

Procedure

	Command or Action	Purpose
Step 1	enable Example: <code>> enable</code>	Enables privileged EXEC mode. Enter your password, if prompted.
Step 2	configure terminal Example:	Enters global configuration mode.

	Command or Action	Purpose
	<code># configure terminal</code>	
Step 3	interface <i>interface-id</i> Example: <pre>(config)# interface gigabitethernet 1/3</pre>	<p>Specifies the Layer 3 interface on which you want to enable multicast routing, and enters interface configuration mode.</p> <p>The specified interface must be one of the following:</p> <ul style="list-style-type: none"> • A routed port—A physical port that has been configured as a Layer 3 port by entering the no switchport interface configuration command. You will also need to enable IP PIM mode on the interface, and join the interface as a statically connected member to an IGMP static group. • An SVI—A VLAN interface created by using the interface vlan <i>vlan-id</i> global configuration command. You will also need to enable IP PIM mode on the VLAN, join the VLAN as a statically connected member to an IGMP static group, and then enable IGMP snooping on the VLAN, the IGMP static group, and physical interface. <p>These interfaces must have IP addresses assigned to them.</p>
Step 4	ip pim { dense-mode sparse-mode } Example: <pre>(config-if)# ip pim sparse-mode</pre>	<p>Enables a PIM mode on the interface.</p> <p>By default, no mode is configured.</p> <p>The keywords have these meanings:</p> <ul style="list-style-type: none"> • dense-mode—Enables dense mode of operation. • sparse-mode—Enables sparse mode of operation. If you configure sparse mode, you must also configure an RP. <p>Note To disable PIM on an interface, use the no ip pim interface configuration command.</p>
Step 5	end Example:	Returns to privileged EXEC mode.

	Command or Action	Purpose
	<code>(config-if)# end</code>	
Step 6	show running-config Example: <code># show running-config</code>	Verifies your entries.
Step 7	copy running-config startup-config Example: <code># copy running-config startup-config</code>	(Optional) Saves your entries in the configuration file.

Configuring IP Multicast Forwarding

You can use the following procedure to configure IPv4 Multicast Forwarding Information Base (MFIB) interrupt-level IP multicast forwarding of incoming packets or outgoing packets on the device.



Note After you have enabled IP multicast routing by using the **ip multicast-routing** command, IPv4 multicast forwarding is enabled. To disable IPv4 multicast forwarding, use the **no** form of the **ip mfib** command.

Procedure

	Command or Action	Purpose
Step 1	enable Example: <code>Device> enable</code>	Enables privileged EXEC mode. Enter your password, if prompted.
Step 2	configure terminal Example: <code>Device# configure terminal</code>	Enters global configuration mode.
Step 3	ip mfib Example: <code>Device(config)# ip mfib</code>	Enables IP multicast forwarding.
Step 4	exit Example: <code>Device(config)# exit</code>	Returns to privileged EXEC mode.

	Command or Action	Purpose
Step 5	show running-config Example: Device# <code>show running-config</code>	Verifies your entries.
Step 6	copy running-config startup-config Example: Device# <code>copy running-config startup-config</code>	(Optional) Saves your entries in the configuration file.

Configuring Optional IP Multicast Routing Features

This section provides information about configuring optional IP multicast routing features.

Defining the IP Multicast Boundary



Note Support for this feature on ipv6 was introduced in IOS XE Release 17.3.1. It is not supported on ipv4.

You define a multicast boundary to prevent Auto-RP messages from entering the PIM domain. You create an access list to deny packets destined for 224.0.1.39 and 224.0.1.40, which carry Auto-RP information.

This procedure is optional.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> <code>enable</code>	Enables privileged EXEC mode. <ul style="list-style-type: none">• Enter your password if prompted.
Step 2	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 3	access-list access-list-number deny source [<i>source-wildcard</i>] Example: Device(config)# <code>access-list 12 deny 224.0.1.39</code> <code>access-list 12 deny 224.0.1.40</code>	Creates a standard access list, repeating the command as many times as necessary. <ul style="list-style-type: none">• For <i>access-list-number</i>, the range is 1 to 99.• The deny keyword denies access if the conditions are matched.• For <i>source</i>, enter multicast addresses 224.0.1.39 and 224.0.1.40, which carry Auto-RP information.

	Command or Action	Purpose
		<ul style="list-style-type: none"> • (Optional) For <i>source-wildcard</i>, enter the wildcard bits in dotted decimal notation to be applied to the source. Place ones in the bit positions that you want to ignore. <p>The access list is always terminated by an implicit deny statement for everything.</p>
Step 4	interface <i>interface-id</i> Example: Device(config)# interface gigabitethernet 1/3	Specifies the interface to be configured, and enters interface configuration mode.
Step 5	ip multicast boundary <i>access-list-number</i> Example: Device(config-if)# ip multicast boundary 12	Configures the boundary, specifying the access list you created in Step 2.
Step 6	end Example: Device(config)# end	Returns to privileged EXEC mode.
Step 7	show running-config Example: Device# show running-config	Verifies your entries.
Step 8	copy running-config startup-config Example: Device# copy running-config startup-config	(Optional) Saves your entries in the configuration file.

Monitoring and Maintaining Basic IP Multicast Routing

Clearing Caches, Tables, and Databases

You can remove all contents of a particular cache, table, or database. Clearing a cache, table, or database might be necessary when the contents of the particular structure are or suspected to be invalid.

You can use any of the privileged EXEC commands in the following table to clear IP multicast caches, tables, and databases.

Table 2: Commands for Clearing Caches, Tables, and Databases

Command	Purpose
clear ip igmp group {group [hostname IP address] vrf name group [hostname IP address] }	Deletes entries from the IGMP cache.
clear ip mroute { * [hostname IP address] vrf name group [hostname IP address] }	Deletes entries from the IP multicast routing table.
clear ip sap [group-address “session-name”]	Deletes the Session Directory Protocol Version 2 cache or an sdr cache entry.

Displaying System and Network Statistics

You can display specific statistics, such as the contents of IP routing tables, caches, and databases.



Note This release does not support per-route statistics.

You can display information to learn resource usage and solve network problems. You can also display information about node reachability and discover the routing path that packets of your device are taking through the network.

You can use any of the privileged EXEC commands in the following table to display various routing statistics.

Table 3: Commands for Displaying System and Network Statistics

Command	Purpose
ping [group-name group-address]	Sends an ICMP Echo Request to a multicast group address.
show ip igmp filter	Displays IGMP filter information.
show ip igmp groups [group-name group-address type-number]	Displays the multicast groups that are directly connected to the device and that were learned through IGMP.
show ip igmp interface [type number]	Displays multicast-related information about an interface.
show ip igmp profile [profile_number]	Displays IGMP profile information.
show ip igmp ssm-mapping [hostname/IP address]	Displays IGMP SSM mapping information.
show ip igmp static-group {class-map [interface [type]]	Displays static group information.

Command	Purpose
show ip igmp membership [<i>name/group address</i> all tracked]	Displays IGMP membership information for forwarding.
show ip igmp vrf	Displays the selected VPN Routing/Forwarding instance by name.
show ip mfib [<i>type number</i>]	Displays the IP multicast forwarding information base.
show ip mrrib { client route vrf }	Displays the multicast routing information base.
show ip mrm { interface manager status-report }	Displays the IP multicast routing monitor information.
show ip mroute [<i>group-name</i> <i>group-address</i>] [<i>source</i>] [count interface proxy pruned summary verbose]	Displays the contents of the IP multicast routing table.
show ip msdp { count peer rpf-peer sa-cache summary vrf }	Displays the Multicast Source Discovery Protocol (MSDP) information.
show ip multicast [interface limit mpls redundancy vrf]	Displays global multicast information.
show ip pim autorp	Display global auto-RP information.
show ip pim bsr-router	Display bootstrap router information (version 2).
show ip pim interface [<i>type number</i>] [count detail df stats]	Displays information about interfaces configured for PIM. This command is available in all software images.
show ip pim neighbor [<i>type number</i>]	Lists the PIM neighbors discovered by the device. This command is available in all software images.
show ip pim rp [<i>group-name</i> <i>group-address</i>]	Displays the RP routers associated with a sparse-mode multicast group. This command is available in all software images.
show ip pim tunnel [<i>tunnel</i> <i>verbose</i>]	Displays the registered tunnels.
show ip pim vrf <i>name</i>	Displays VPN routing and forwarding instances.
show ip rpf { <i>source-address</i> <i>name</i> }	<p>Displays how the device is doing Reverse-Path Forwarding (that is, from the unicast routing table, DVMRP routing table, or static mroutes).</p> <p>Command parameters include:</p> <ul style="list-style-type: none"> • <i>Host name</i> or <i>IP address</i>—IP name or group address. • Select—Group-based VRF select information. • vrf—Selects VPN Routing/Forwarding instance.

Command	Purpose
<code>show ip sap [group "session-name" detail]</code>	<p>Displays the Session Announcement Protocol (SAP) Version 2 cache.</p> <p>Command parameters include:</p> <ul style="list-style-type: none"> • <i>A.B.C.D</i>—IP group address. • <i>WORD</i>—Session name (in double quotes). • detail—Session details.

Configuration Examples for Basic IP Multicast Routing

This section provides configuration examples for Basic IP Multicast Routing.

Example: Configuring an IP Multicast Boundary (ipv6 only)

This example shows how to set up a boundary for all administratively-scoped addresses:

```
(config)# access-list 1 deny 239.0.0.0 0.255.255.255
(config)# access-list 1 permit 224.0.0.0 15.255.255.255
(config)# interface gigabitethernet 1/3
(config-if)# ip multicast boundary 1
```

Feature Information for Basic IP Multicast Routing

Table 4: Feature Information for Basic IP Multicast Routing

Feature Name	Releases	Feature Information
IP Multicast Support Over Port Channel	Cisco IOS XE 17.17.1	This feature is supported on the Cisco Catalyst IE3x00 Rugged, IE3400 Heavy Duty, and ESS3300 Series Switches.
Basic IP Multicast Routing	Cisco IOS XE 17.3.1	IP Multicast is an efficient way to use network resources, especially for bandwidth-intensive services such as audio and video. IP multicast routing enables a host (source) to send packets to a group of hosts (receivers) anywhere within the IP network by using a special form of IP address called the IP multicast group address.



CHAPTER 2

Configuring MSDP

- [Prerequisites for Using MSDP to Interconnect Multiple PIM-SM Domains, on page 11](#)
- [Information About Using MSDP to Interconnect Multiple PIM-SM Domains, on page 11](#)
- [How to Use MSDP to Interconnect Multiple PIM-SM Domains, on page 25](#)
- [Configuration Examples for Using MSDP to Interconnect Multiple PIM-SM Domains, on page 43](#)
- [Troubleshooting Tips, on page 46](#)

Prerequisites for Using MSDP to Interconnect Multiple PIM-SM Domains

Before you configure MSDP, the addresses of all MSDP peers must be known in Border Gateway Protocol (BGP).

Information About Using MSDP to Interconnect Multiple PIM-SM Domains

This section provides information about using MSDP to interconnect multiple PIM-SM domains.

Benefits of Using MSDP to Interconnect Multiple PIM-SM Domains

- Allows a rendezvous point (RP) to dynamically discover active sources outside of its domain.
- Introduces a more manageable approach for building multicast distribution trees between multiple domains.

Use of MSDP to Interconnect Multiple PIM-SM Domains

MSDP is a mechanism to connect multiple PIM-SM domains. The purpose of MSDP is to discover multicast sources in other PIM domains. The main advantage of MSDP is that it reduces the complexity of interconnecting multiple PIM-SM domains by allowing PIM-SM domains to use an interdomain source tree (rather than a common shared tree). When MSDP is configured in a network, RPs exchange source information with RPs in other domains. An RP can join the interdomain source tree for sources that are sending to groups for which

it has receivers. The RP can do that because it is the root of the shared tree within its domain, which has branches to all points in the domain where there are active receivers. When a last-hop device learns of a new source outside the PIM-SM domain (through the arrival of a multicast packet from the source down the shared tree), it then can send a join toward the source and join the interdomain source tree.



Note If the RP either has no shared tree for a particular group or a shared tree whose outgoing interface list is null, it does not send a join to the source in another domain.

When MSDP is enabled, an RP in a PIM-SM domain maintains MSDP peering relationships with MSDP-enabled devices in other domains. This peering relationship occurs over a TCP connection, where primarily a list of sources sending to multicast groups is exchanged. MSDP uses TCP (port 639) for its peering connections. As with BGP, using point-to-point TCP peering means that each peer must be explicitly configured. The TCP connections between RPs, moreover, are achieved by the underlying routing system. The receiving RP uses the source lists to establish a source path. If the multicast sources are of interest to a domain that has receivers, multicast data is delivered over the normal, source-tree building mechanism provided by PIM-SM. MSDP is also used to announce sources sending to a group. These announcements must originate at the RP of the domain.



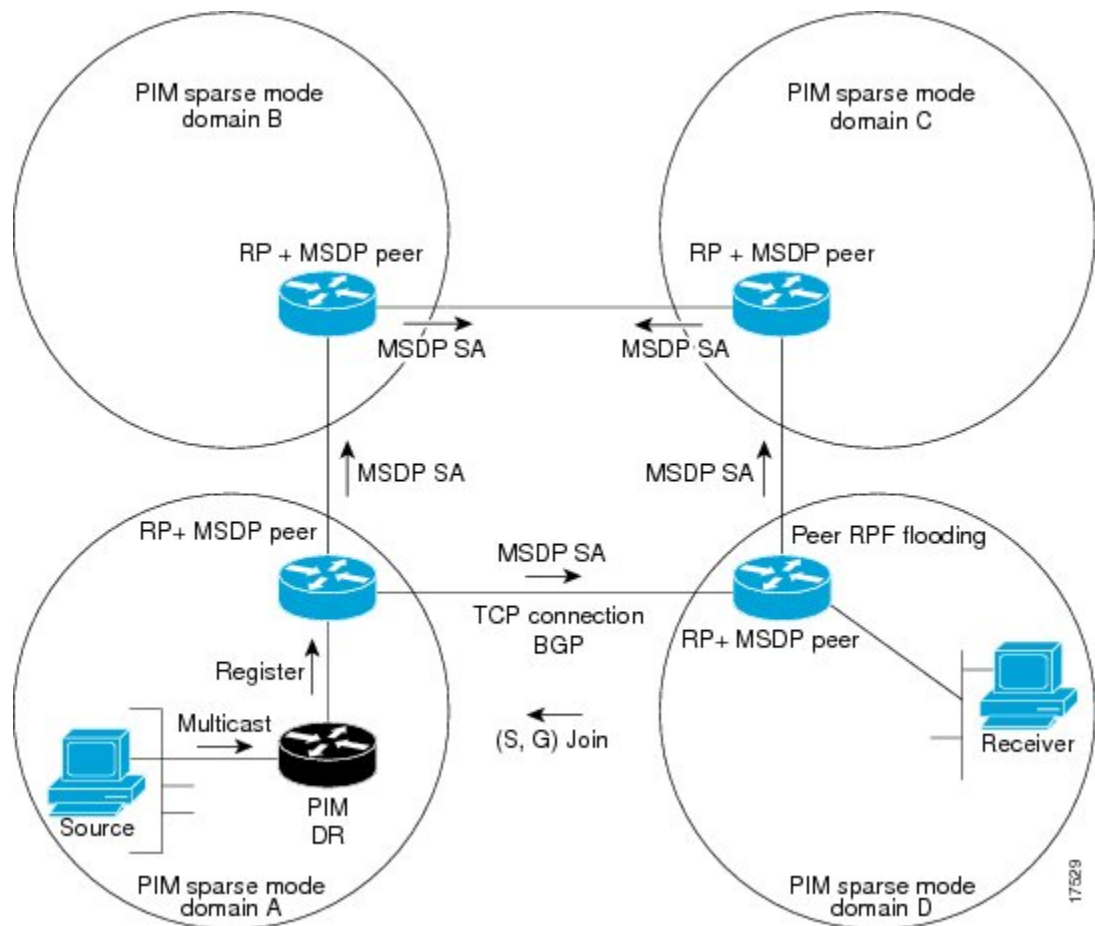
Note MSDP depends on BGP for interdomain operation. We recommended that you run MSDP on RPs sending to global multicast groups.

The figure illustrates MSDP operating between two MSDP peers. PIM uses MSDP as the standard mechanism to register a source with the RP of a domain.



Note Although the following illustration and example uses routers in the configuration, any device (router or switch) can be used.

Figure 1: MSDP Running Between RP Peers



When MSDP is implemented, the following sequence of events occurs:

1. When a PIM designated device (DR) registers a source with its RP as illustrated in the figure, the RP sends a Source-Active (SA) message to all of its MSDP peers.



Note The DR sends the encapsulated data to the RP only once per source (when the source goes active). If the source times out, this process happens again when it goes active again. This situation is different from the periodic SA message that contains all sources that are registered to the originating RP. Those SA messages are MSDP control packets, and, thus, do not contain encapsulated data from active sources.

1. The SA message identifies the source address, the group that the source is sending to, and the address or the originator ID of the RP, if configured.
2. Each MSDP peer that receives the SA message floods the SA message to all of its peers downstream from the originator. In some cases (such as the case with the RPs in PIM-SM domains B and C in the figure), an RP may receive a copy of an SA message from more than one MSDP peer. To prevent looping, the RP consults the BGP next-hop database to determine the next hop toward the originator of the SA message. That next-hop neighbor is the RPF-peer for the originator. SA messages that are received from the originator on any interface other than the interface to the RPF peer are dropped. The SA message flooding process,

therefore, is referred to as peer-RPF flooding. Because of the peer-RPF flooding mechanism, BGP must be running in conjunction with MSDP.

**Note**

- (M)BGP is not required in MSDP mesh group scenarios. For more information about MSDP mesh groups, see the [Configuring an MSDP Mesh Group, on page 32](#) section.
- (M)BGP is not required in default MSDP peer scenarios or in scenarios where only one MSDP peer is configured. For more information, see the [Configuring a Default MSDP Peer, on page 31](#) section.

1. When an RP receives an SA message, it checks to see whether there are any members of the advertised groups in its domain by checking to see whether there are interfaces on the group's (*, G) outgoing interface list. If there are no group members, the RP does nothing. If there are group members, the RP sends an (S, G) join toward the source. As a result, a branch of the interdomain source tree is constructed across autonomous system boundaries to the RP. As multicast packets arrive at the RP, they are then forwarded down its own shared tree to the group members in the RP's domain. The members' DRs then have the option of joining the rendezvous point tree (RPT) to the source using standard PIM-SM procedures.
2. The originating RP continues to send periodic SA messages for the (S, G) state every 60 seconds for as long as the source is sending packets to the group. When an RP receives an SA message, it caches the SA message. Suppose, for example, that an RP receives an SA message for (172.16.5.4, 228.1.2.3) from originating RP 10.5.4.3. The RP consults its mroute table and finds that there are no active members for group 228.1.2.3, so it passes the SA message to its peers downstream of 10.5.4.3. If a host in the domain then sends a join to the RP for group 228.1.2.3, the RP adds the interface toward the host to the outgoing interface list of its (*, 228.1.2.3) entry. Because the RP caches SA messages, the device will have an entry for (172.16.5.4, 228.1.2.3) and can join the source tree as soon as a host requests a join.

**Note**

In all current and supported software releases, caching of MSDP SA messages is mandatory and cannot be manually enabled or disabled. By default, when an MSDP peer is configured, the **ip multicast cache-sa-state** command will automatically be added to the running configuration.

MSDP Message Types

There are four basic MSDP message types, each encoded in their own Type, Length, and Value (TLV) data format.

SA Messages

SA messages are used to advertise active sources in a domain. In addition, these SA messages may contain the initial multicast data packet that was sent by the source.

SA messages contain the IP address of the originating RP and one or more (S, G) pairs being advertised. In addition, the SA message may contain an encapsulated data packet.

**Note**

For more information about SA messages, see the [SA Message Origination Receipt and Processing, on page 15](#) section.

SA Request Messages

SA request messages are used to request a list of active sources for a specific group. These messages are sent to an MSDP SA cache that maintains a list of active (S, G) pairs in its SA cache. Join latency can be reduced by using SA request messages to request the list of active sources for a group instead of having to wait up to 60 seconds for all active sources in the group to be readvertised by originating RPs.



Note For more information about SA request messages, see the [Requesting Source Information from MSDP Peers, on page 36](#) section.

SA Response Messages

SA response messages are sent by the MSDP peer in response to an SA request message. SA response messages contain the IP address of the originating RP and one or more (S, G) pairs of the active sources in the originating RP's domain that are stored in the cache.



Note For more information about SA response messages, see the [Controlling the Response to Outgoing SA Request Messages from MSDP Peers Using SA Request Filters, on page 37](#) section.

Keepalive Messages

Keepalive messages are sent every 60 seconds in order to keep the MSDP session active. If no keepalive messages or SA messages are received for 75 seconds, the MSDP session is reset.



Note For more information about keepalive messages, see the [Adjusting the MSDP Keepalive and Hold-Time Intervals, on page 30](#) section.

SA Message Origination Receipt and Processing

The section describes SA message origination, receipt, and processing in detail.

SA Message Origination

SA messages are triggered by an RP (assuming MSDP is configured) when any new source goes active within a local PIM-SM domain. A local source is a source that is directly connected to the RP or is the first-hop DR that has registered with it. An RP originates SA messages only for local sources in its PIM-SM domain; that is, for local sources that register with it.



Note A local source is denoted by the A flag being set in the (S, G) mroute entry on the RP (which can be viewed in the output of the **show ip mroute** command). This flag indicates that the source is a candidate for advertisement by the RP to other MSDP peers.

When a source is in the local PIM-SM domain, it causes the creation of (S, G) state in the RP. New sources are detected by the RP either by the receipt of a register message or the arrival of the first (S, G) packet from a directly connected source. The initial multicast packet sent by the source (either encapsulated in the register message or received from a directly connected source) is encapsulated in the initial SA message.

SA Message Receipt

SA messages are only accepted from the MSDP RPF peer that is in the best path back toward the originator. The same SA message arriving from other MSDP peers must be ignored or SA loops can occur. Deterministically selecting the MSDP RPF peer for an arriving SA message requires knowledge of the MSDP topology. However, MSDP does not distribute topology information in the form of routing updates. MSDP infers this information by using (M)BGP routing data as the best approximation of the MSDP topology for the SA RPF check mechanism. An MSDP topology, therefore, must follow the same general topology as the BGP peer topology. Besides a few exceptions (such as default MSDP peers and MSDP peers in MSDP mesh groups), MSDP peers, in general should also be (M)BGP peers.

How RPF Check Rules Are Applied to SA Messages

The rules that apply to RPF checks for SA messages are dependent on the BGP peerings between the MSDP peers:

- Rule 1: Applied when the sending MSDP peer is also an interior (M)BGP peer.
- Rule 2: Applied when the sending MSDP peer is also an exterior (M)BGP peer.
- Rule 3: Applied when the sending MSDP peer is not an (M)BGP peer.

RPF checks are not performed in the following cases:

- If the sending MSDP peer is the only MSDP peer, which would be the case if only a single MSDP peer or a default MSDP peer is configured.
- If the sending MSDP peer is a member of a mesh group.
- If the sending MSDP peer address is the RP address contained in the SA message.

How the Software Determines the Rule to Apply to RPF Checks

The software uses the following logic to determine which RPF rule to apply to RPF checks:

- Find the (M)BGP neighbor that has the same IP address as the sending MSDP peer.
 - If the matching (M)BGP neighbor is an internal BGP (iBGP) peer, apply Rule 1.
 - If the matching (M)BGP neighbor is an external BGP (eBGP) peer, apply Rule 2.
 - If no match is found, apply Rule 3.

The implication of the RPF check rule selection is as follows: The IP address used to configure an MSDP peer on a device must match the IP address used to configure the (M)BGP peer on the same device.

Rule 1 of RPF Checking of SA Messages in MSDP

Rule 1 of RPF checking in MSDP is applied when the sending MSDP peer is also an i(M)BGP peer. When Rule 1 is applied, the RPF check proceeds as follows:

1. The peer searches the BGP Multicast Routing Information Base (MRIB) for the best path to the RP that originated the SA message. If a path is not found in the MRIB, the peer then searches the Unicast Routing Information Base (URIB). If a path is still not found, the RPF check fails.
2. If the previous search succeeds (that is, the best path is found), the peer then determines the address of the BGP neighbor for this best path, which will be the address of the BGP neighbor that sent the peer the path in BGP update messages.



Note The BGP neighbor address is not the same as the next-hop address in the path. Because i(M)BGP peers do not update the next-hop attribute of a path, the next-hop address usually is not the same as the address of the BGP peer that sent us the path.

The BGP neighbor address is not necessarily the same as the BGP ID of the peer that sent the peer the path.

1. If the IP address of the sending MSDP peer is the same as the BGP neighbor address (that is, the address of the BGP peer that sent the peer the path), then the RPF check succeeds; otherwise it fails.

Implications of Rule 1 of RPF Checking on MSDP

The MSDP topology must mirror the (M)BGP topology. In general, wherever there is an i(M)BGP peer connection between two devices, an MSDP peer connection should be configured. More specifically, the IP address of the far-end MSDP peer connection must be the same as the far-end i(M)BGP peer connection. The addresses must be the same because the BGP topology between i(M)BGP peers inside an autonomous system is not described by the AS path. If it were always the case that i(M)BGP peers updated the next-hop address in the path when sending an update to another i(M)BGP peer, then the peer could rely on the next-hop address to describe the i(M)BGP topology (and hence the MSDP topology). However, because the default behavior for i(M)BGP peers is to not update the next-hop address, the peer cannot rely on the next-hop address to describe the (M)BGP topology (MSDP topology). Instead, the i(M)BGP peer uses the address of the i(M)BGP peer that sent the path to describe the i(M)BGP topology (MSDP topology) inside the autonomous system.



Tip Care should be taken when configuring the MSDP peer addresses to make sure that the same address is used for both i(M)BGP and MSDP peer addresses.

Rule 2 of RPF Checking of SA Messages in MSDP

Rule 2 of RPF checking in MSDP is applied when the sending MSDP peer is also an e(M)BGP peer. When Rule 2 is applied, the RPF check proceeds as follows:

1. The peer searches the BGP MRIB for the best path to the RP that originated the SA message. If a path is not found in the MRIB, the peer then searches the URIB. If a path is still not found, the RPF check fails.
2. If the previous search succeeds (that is, the best path is found), the peer then examines the path. If the first autonomous system in the best path to the RP is the same as the autonomous system of the e(M)BGP peer (which is also the sending MSDP peer), then the RPF check succeeds; otherwise it fails.

Implications of Rule 2 of RPF Checking on MSDP

The MSDP topology must mirror the (M)BGP topology. In general, wherever there is an e(M)BGP peer connection between two devices, an MSDP peer connection should be configured. As opposed to Rule 1, the

IP address of the far-end MSDP peer connection does not have to be the same as the far-end e(M)BGP peer connection. The reason that the addresses do not have to be identical is that BGP topology between two e(M)BGP peers is not described by the AS path.

Rule 3 of RPF Checking of SA Messages in MSDP

Rule 3 of RPF checking is applied when the sending MSDP peer is not a (M)BGP peer at all. When Rule 3 is applied, the RPF check proceeds as follows:

1. The peer searches the BGP MRIB for the best path to the RP that originated the SA message. If a path is not found in the MRIB, the peer then searches the URIB. If a path is still not found, the RPF check fails.
2. If the previous search succeeds (that is, the best path to the RP that originated the SA message is found), the peer then searches the BGP MRIB for the best path to the MSDP peer that sent the SA message. If a path is not found in the MRIB, the peer then searches the URIB. If a path is still not found, the RPF check fails.



Note The autonomous system of the MSDP peer that sent the SA is the origin autonomous system, which is the last autonomous system in the AS path to the MSDP peer.

1. If the first autonomous system in the best path to the RP is the same as the autonomous system of the sending MSDP peer, then the RPF check succeeds; otherwise it fails.

SA Message Processing

The following steps are taken by an MSDP peer whenever it processes an SA message:

1. Using the group address G of the (S, G) pair in the SA message, the peer locates the associated (*, G) entry in the mroute table. If the (*, G) entry is found and its outgoing interface list is not null, then there are active receivers in the PIM-SM domain for the source advertised in the SA message.
2. The MSDP peer then creates an (S, G) entry for the advertised source.
3. If the (S, G) entry did not already exist, the MSDP peer immediately triggers an (S, G) join toward the source in order to join the source tree.
4. The peer then floods the SA message to all other MSDP peers with the exception of:
 - The MSDP peer from which the SA message was received.
 - Any MSDP peers that are in the same MSDP mesh group as this device (if the peer is a member of a mesh group).



Note SA messages are stored locally in the device's SA cache.

MSDP Peers

Like BGP, MSDP establishes neighbor relationships with other MSDP peers. MSDP peers connect using TCP port 639. The lower IP address peer takes the active role of opening the TCP connection. The higher IP address

peer waits in LISTEN state for the other to make the connection. MSDP peers send keepalive messages every 60 seconds. The arrival of data performs the same function as the keepalive message and keeps the session from timing out. If no keepalive messages or data is received for 75 seconds, the TCP connection is reset.

MSDP MD5 Password Authentication

The MSDP MD5 password authentication feature is an enhancement to support Message Digest 5 (MD5) signature protection on a TCP connection between two MSDP peers. This feature provides added security by protecting MSDP against the threat of spoofed TCP segments being introduced into the TCP connection stream.

How MSDP MD5 Password Authentication Works

Developed in accordance with RFC 2385, the MSDP MD5 password authentication feature is used to verify each segment sent on the TCP connection between MSDP peers. The **ip msdp password peer** command is used to enable MD5 authentication for TCP connections between two MSDP peers. When MD5 authentication is enabled between two MSDP peers, each segment sent on the TCP connection between the peers is verified. MD5 authentication must be configured with the same password on both MSDP peers; otherwise, the connection between them will not be made. Configuring MD5 authentication causes the Cisco IOS software to generate and verify the MD5 digest of every segment sent on the TCP connection.

Benefits of MSDP MD5 Password Authentication

- Protects MSDP against the threat of spoofed TCP segments being introduced into the TCP connection stream.
- Uses the industry-standard MD5 algorithm for improved reliability and security.

SA Message Limits

The **ip msdp sa-limit** command is used to limit the overall number of SA messages that a device can accept from specified MSDP peers. When the **ip msdp sa-limit** command is configured, the device maintains a per-peer count of SA messages stored in the SA cache and will ignore new messages from a peer if the configured SA message limit for that peer has been reached.

The **ip msdp sa-limit** command was introduced as a means to protect an MSDP-enabled device from denial of service (DoS) attacks. We recommend that you configure SA message limits for all MSDP peerings on the device. An appropriately low SA limit should be configured on peerings with a stub MSDP region (for example, a peer that may have some further downstream peers but that will not act as a transit for SA messages across the rest of the Internet). A high SA limit should be configured for all MSDP peerings that act as transits for SA messages across the Internet.

MSDP Keepalive and Hold-Time Intervals

The **ip msdp keepalive** command is used to adjust the interval at which an MSDP peer will send keepalive messages and the interval at which the MSDP peer will wait for keepalive messages from other peers before declaring them down.

Once an MSDP peering session is established, each side of the connection sends a keepalive message and sets a keepalive timer. If the keepalive timer expires, the local MSDP peer sends a keepalive message and restarts its keepalive timer; this interval is referred to as the keepalive interval. The *keepalive-interval* argument

is used to adjust the interval for which keepalive messages will be sent. The keepalive timer is set to the value specified for the *keepalive-interval* argument when the peer comes up. The keepalive timer is reset to the value of the *keepalive-interval* argument whenever an MSDP keepalive message is sent to the peer and reset when the timer expires. The keepalive timer is deleted when an MSDP peering session is closed. By default, the keepalive timer is set to 60 seconds.



Note The value specified for the *keepalive-interval* argument must be less than the value specified for the *holdtime-interval* argument and must be at least one second.

The hold-time timer is initialized to the value of the *hold-time-interval* argument whenever an MSDP peering connection is established, and is reset to the value of the *hold-time-interval* argument whenever an MSDP keepalive message is received. The hold-time timer is deleted whenever an MSDP peering connection is closed. By default, the hold-time interval is set to 75 seconds.

Use the *hold-time-interval* argument to adjust the interval at which the MSDP peer will wait for keepalive messages from other peers before declaring them down.

MSDP Connection-Retry Interval

You can adjust the interval at which all MSDP peers will wait after peering sessions are reset before attempting to reestablish the peering sessions. This interval is referred to as the connection-retry interval. By default, MSDP peers will wait 30 seconds after the session is reset before attempting to reestablish sessions with other peers. The modified configured connection-retry interval applies to all MSDP peering sessions on the device.

Default MSDP Peers

In most scenarios, an MSDP peer is also a BGP peer. If an autonomous system is a stub or nontransit autonomous system, and particularly if the autonomous system is not multihomed, there is little or no reason to run BGP to its transit autonomous system. A static default route at the stub autonomous system, and a static route pointing to the stub prefixes at the transit autonomous system, is generally sufficient. But if the stub autonomous system is also a multicast domain and its RP must peer with an RP in the neighboring domain, MSDP depends on the BGP next-hop database for its peer-RPF checks. You can disable this dependency on BGP by defining a default peer from which to accept all SA messages without performing the peer-RPF check. A default MSDP peer must be a previously configured MSDP peer.

If your switch does not support BGP, you cannot configure an MSDP peer on the local switch by using the **ip msdp peer** global configuration command. Instead, you define a default MSDP peer (by using the **ip msdp default-peer** global configuration command) which can accept all SA messages for the switch. The default MSDP peer must be a previously configured MSDP peer. Configure a default MSDP peer when the switch is not BGP-peering with an MSDP peer. If a single MSDP peer is configured, the switch always accepts all SA messages from that peer.

A stub autonomous system also might want to have MSDP peerings with more than one RP for the sake of redundancy. For example, SA messages cannot just be accepted from multiple default peers, because there is no RPF check mechanism. Instead, SA messages are accepted from only one peer. If that peer fails, SA messages are then accepted from the other peer. The underlying assumption here, of course, is that both default peers are sending the same SA messages.

The figure illustrates a scenario where default MSDP peers might be used. In the figure, a customer that owns Device B is connected to the Internet through two Internet service providers (ISPs), one that owns Device A

and the other that owns Device C. They are not running BGP between them. In order for the customer to learn about sources in the ISP domain or in other domains, Device B identifies Device A as its default MSDP peer. Device B advertises SA messages to both Device A and Device C, but accepts SA messages either from Device A only or Device C only. If Device A is the first default peer in the configuration, it will be used if it is up and running. Only if Device A is not running will Device B accept SA messages from Device C.

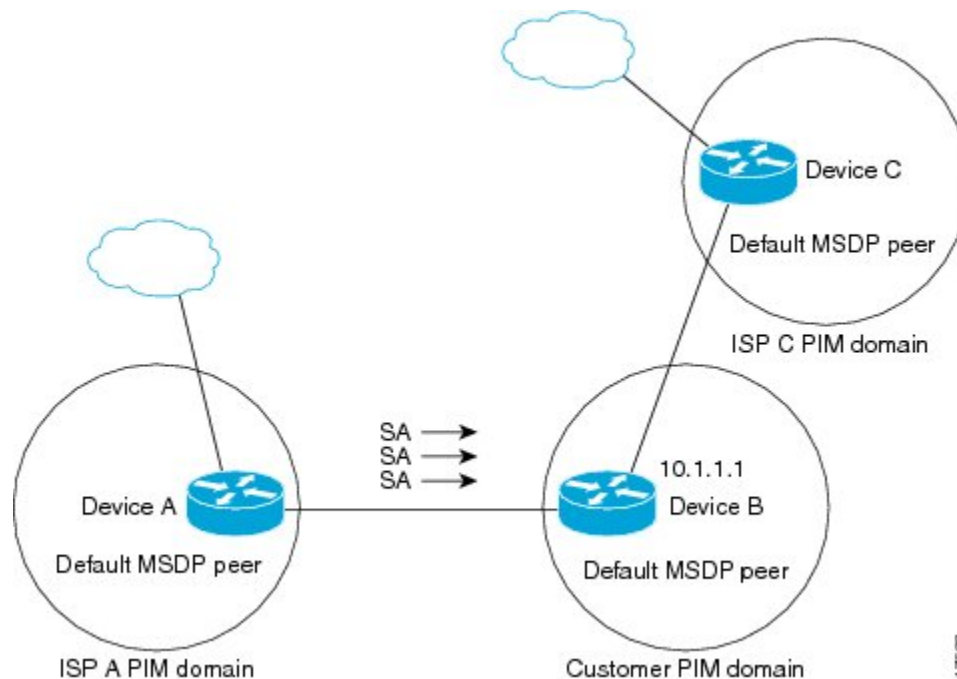
The ISP will also likely use a prefix list to define which prefixes it will accept from the customer device. The customer will define multiple default peers, each having one or more prefixes associated with it.

The customer has two ISPs to use. The customer defines both ISPs as default peers. As long as the first default peer identified in the configuration is up and running, it will be the default peer and the customer will accept all SA messages it receives from that peer.



Note Although the following illustration and example uses routers in the configuration, any device (router or switch) can be used.

Figure 2: Default MSDP Peer Scenario



Device B advertises SAs to Device A and Device C, but uses only Device A or Device C to accept SA messages. If Device A is first in the configuration, it will be used if it is up and running. Only when Device A is not running will Device B accept SAs from Device C. This is the behavior without a prefix list.

If you specify a prefix list, the peer will be a default peer only for the prefixes in the list. You can have multiple active default peers when you have a prefix list associated with each. When you do not have any prefix lists, you can configure multiple default peers, but only the first one is the active default peer as long as the device has connectivity to this peer and the peer is alive. If the first configured peer goes down or the connectivity to this peer goes down, the second configured peer becomes the active default, and so on.

MSDP Mesh Groups

An MSDP mesh group is a group of MSDP speakers that have fully meshed MSDP connectivity between one another. In other words, each of the MSDP peers in the group must have an MSDP peering relationship (MSDP connection) to every other MSDP peer in the group. When an MSDP mesh group is configured between a group of MSDP peers, SA message flooding is reduced. Because when an MSDP peer in the group receives an SA message from another MSDP peer in the group, it assumes that this SA message was sent to all the other MSDP peers in the group. As a result, it is not necessary for the receiving MSDP peer to flood the SA message to the other MSDP peers in the group.

Benefits of MSDP Mesh Groups

- Optimizes SA flooding--MSDP mesh groups are particularly useful for optimizing SA flooding when two or more peers are in a group.
- Reduces the amount of SA traffic across the Internet--When MSDP mesh groups are used, SA messages are not flooded to other mesh group peers.
- Eliminates RPF checks on arriving SA messages--When an MSDP mesh group is configured, SA messages are always accepted from mesh group peers.

SA Origination Filters

By default, an RP that is configured to run MSDP will originate SA messages for all local sources for which it is the RP. Local sources that register with an RP, therefore, will be advertised in SA messages, which in some cases is not desirable. For example, if sources inside a PIM-SM domain are using private addresses (for example, network 10.0.0.0/8), you should configure an SA origination filter to restrict those addresses from being advertised to other MSDP peers across the Internet.

To control what sources are advertised in SA messages, you can configure SA origination filters on an RP. By creating SA origination filters, you can control the sources advertised in SA messages as follows:

- You can configure an RP to prevent the device from advertising local sources in SA messages. The device will still forward SA messages from other MSDP peers in the normal fashion; it will just not originate any SA messages for local sources.
- You can configure the device to only originate SA messages for local sources sending to specific groups that match (S, G) pairs defined in the extended access list. All other local sources will not be advertised in SA messages.
- You can configure the device to only originate SA messages for local sources sending to specific groups that match AS paths defined in an AS-path access list. All other local sources will not be advertised in SA messages.
- You can configure the device to only originate SA messages for local sources that match the criteria defined in the route map. All other local sources will not be advertised in SA messages.
- You configure an SA origination filter that includes an extended access list, an AS-path access list, and route map, or a combination thereof. In this case, all conditions must be true before any local sources are advertised in SA messages.

Use of Outgoing Filter Lists in MSDP

By default, an MSDP-enabled device forwards all SA messages it receives to all of its MSDP peers. However, you can prevent SA messages from being forwarded to MSDP peers by creating outgoing filter lists. Outgoing filter lists apply to all SA messages, whether locally originated or received from another MSDP peer, whereas SA origination filters apply only to locally originated SA messages. For more information about enabling a filter for MSDP SA messages originated by the local device, see the [Controlling SA Messages Originated by an RP for Local Sources, on page 33](#) section.

By creating an outgoing filter list, you can control the SA messages that a device forwards to a peer as follows:

- You can filter all outgoing SA messages forwarded to a specified MSDP peer by configuring the device to stop forwarding its SA messages to the MSDP peer.
- You can filter a subset of outgoing SA messages forwarded to a specified MSDP peer based on (S, G) pairs defined in an extended access list by configuring the device to only forward SA messages to the MSDP peer that match the (S, G) pairs permitted in an extended access list. The forwarding of all other SA messages to the MSDP peer will be stopped.
- You can filter a subset of outgoing SA messages forwarded to a specified MSDP peer based on match criteria defined in a route map by configuring the device to only forward SA messages that match the criteria defined in the route map. The forwarding of all other SA messages to the MSDP peer will be stopped.
- You can filter a subset of outgoing SA messages from a specified peer based on the announcing RP address contained in the SA message by configuring the device to filter outgoing SA messages based on their origin, even after an SA message has been transmitted across one or more MSDP peers. The forwarding of all other SA messages to the MSDP peer will be stopped.
- You can configure an outgoing filter list that includes an extended access list, a route map, and either an RP access list or an RP route map. In this case, all conditions must be true for the MSDP peer to forward the outgoing SA message.

**Caution**

Arbitrary filtering of SA messages can result in downstream MSDP peers being starved of SA messages for legitimate active sources. Care, therefore, should be taken when using these sorts of filters. Normally, outgoing filter lists are used only to reject undesirable sources, such as sources using private addresses.

Use of Incoming Filter Lists in MSDP

By default, an MSDP-enabled device receives all SA messages sent to it from its MSDP peers. However, you can control the source information that a device receives from its MSDP peers by creating incoming filter lists.

By creating incoming filter lists, you can control the incoming SA messages that a device receives from its peers as follows:

- You can filter all incoming SA messages from a specified MSDP peer by configuring the device to ignore all SA messages sent to it from the specified MSDP peer.
- You can filter a subset of incoming SA messages from a specified peer based on (S, G) pairs defined in an extended access list by configuring the device to only receive SA messages from the MSDP peer that

match the (S, G) pairs defined in the extended access list. All other incoming SA messages from the MSDP peer will be ignored.

- You can filter a subset of incoming SA request messages from a specified peer based on match criteria defined in a route map by configuring the device to only receive SA messages that match the criteria defined in the route map. All other incoming SA messages from the MSDP peer will be ignored.
- You can filter a subset of incoming SA messages from a specified peer based on both (S, G) pairs defined in an extended access list and on match criteria defined in a route map by configuring the device to only receive incoming SA messages that both match the (S, G) pairs defined in the extended access list and match the criteria defined in the route map. All other incoming SA messages from the MSDP peer will be ignored.
- You can filter a subset of incoming SA messages from a specified peer based on the announcing RP address contained in the SA message by configuring the device to filter incoming SA messages based on their origin, even after the SA message may have already been transmitted across one or more MSDP peers.
- You can configure an incoming filter list that includes an extended access list, a route map, and either an RP access list or an RP route map. In this case, all conditions must be true for the MSDP peer to receive the incoming SA message.



Caution

Arbitrary filtering of SA messages can result in downstream MSDP peers being starved of SA messages for legitimate active sources. Care, therefore, should be taken when using these sorts of filters. Normally, incoming filter lists are used only to reject undesirable sources, such as sources using private addresses.

TTL Thresholds in MSDP

The time-to-live (TTL) value provides a means to limit the number of hops a packet can take before being dropped. The **ip multicast ttl-threshold** command is used to specify a TTL for data-encapsulated SA messages sent to specified MSDP peers. By default, multicast data packets in SA messages are sent to an MSDP peer, provided the TTL value of the packet is greater than 0, which is standard TTL behavior.

In general, a TTL-threshold problem can be introduced by the encapsulation of a source's initial multicast packet in an SA message. Because the multicast packet is encapsulated inside of the unicast SA message (whose TTL is 255), its TTL is not decremented as the SA message travels to the MSDP peer. Furthermore, the total number of hops that the SA message traverses can be drastically different than a normal multicast packet because multicast and unicast traffic may follow completely different paths to the MSDP peer and hence the remote PIM-SM domain. As a result, encapsulated packets can end up violating TTL thresholds. The solution to this problem is to configure a TTL threshold that is associated with any multicast packet that is encapsulated in an SA message sent to a particular MSDP peer using the **ip multicast ttl-threshold** command. The **ip msdp ttl-threshold** command prevents any multicast packet whose TTL in the IP header is less than the TTL value specified for the *ttl-value* argument from being encapsulated in SA messages sent to that peer.

SA Request Messages

You can configure a noncaching device to send SA request messages to one or more specified MSDP peers. If a noncaching RP has an MSDP peer that is caching SAs, you can reduce the join latency for a noncaching peer by enabling the noncaching peer to send SA request messages. When a host requests a join to a particular group, the noncaching RP sends an SA request message to its caching peers. If a peer has cached source

information for the group in question, it sends the information to the requesting RP with an SA response message. The requesting RP uses the information in the SA response but does not forward the message to any other peers. If a noncaching RP receives an SA request, it sends an error message back to the requestor.



Note In all current and supported software releases, caching of MSDP SA messages is mandatory and cannot be manually enabled or disabled. By default, when an MSDP peer is configured, the configured commands are automatically added to the running configuration.

SA Request Filters

By default, a device honors all outgoing SA request messages from its MSDP peers; that is, it sends cached source information to requesting MSDP peers in SA response messages. You can control the outgoing SA request messages that a device will honor from specified peers by creating an SA request filter. An SA request filter controls the outgoing SA requests that the device will honor from MSDP peers as follows:

- You can filter all SA request messages from a specified peer by configuring the device to ignore all SA requests from the specified MSDP peer.
- You can filter a subset of SA request messages from a specified peer based on groups defined in a standard access list by configuring the device to honor only SA request messages from the MSDP peer that match the groups defined in a standard access list. SA request messages from the specified peer for other groups will be ignored.

How to Use MSDP to Interconnect Multiple PIM-SM Domains

The first task is required; all other tasks are optional.

Configuring an MSDP Peer



Note By enabling an MSDP peer, you implicitly enable MSDP.

Before you begin

- IP multicast routing must be enabled and PIM-SM must be configured.
- With the exception of a single MSDP peer, default MSDP peer, and MSDP mesh group scenarios, all MSDP peers must be configured to run BGP prior to being configured for MSDP.

Procedure

	Command or Action	Purpose
Step 1	<code>enable</code>	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: Device> enable	<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	ip msdp peer <i>{peer-name peer-address}</i> [<i>connect-source type number</i>] [remote-as <i>as-number</i>] Example: Device(config)# ip msdp peer 192.168.1.2 connect-source loopback0	Enables MSDP and configures an MSDP peer as specified by the DNS name or IP address. Note The device that is selected to be configured as an MSDP peer is also usually a BGP neighbor. If it is not, see the Configuring a Default MSDP Peer, on page 31 section or the Configuring an MSDP Mesh Group, on page 32 section. <ul style="list-style-type: none"> If you specify the connect-source keyword, the primary address of the specified local interface <i>type</i> and <i>number</i> values are used as the source IP address for the TCP connection. The connect-source keyword is recommended, especially for MSDP peers on a border that peer with a device inside of a remote domain.
Step 4	ip msdp description <i>{peer-name peer-address}</i> <i>text</i> Example: Device(config)# ip msdp description 192.168.1.2 router at customer a	(Optional) Configures a description for a specified peer to make it easier to identify in a configuration or in show command output.
Step 5	end Example: Device(config)# end	Exits global configuration mode and returns to privileged EXEC mode.

Shutting Down an MSDP Peer

Perform this optional task to shut down an MSDP peer.

If you are configuring several MSDP peers and you do not want any of the peers to go active until you have finished configuring all of them, you can shut down each peer, configure each peer, and later bring each peer up. You might also want to shut down an MSDP session without losing the configuration for that MSDP peer.



Note When an MSDP peer is shut down, the TCP connection is terminated and not restarted until the peer is brought back up using the **no ip msdp shutdown** command (for the specified peer).

Before you begin

MSDP is running and the MSDP peers must be configured.

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	ip msdp shutdown { <i>peer-name</i> <i>peer-address</i> } Example: Device(config)# ip msdp shutdown 192.168.1.3	Administratively shuts down the specified MSDP peer.
Step 4	Repeat Step 3 to shut down additional MSDP peers.	--
Step 5	end Example: Device(config)# end	Exits global configuration mode and returns to privileged EXEC mode.

Configuring MSDP MD5 Password Authentication Between MSDP Peers

Perform this optional task to configure MSDP MD5 password authentication between MSDP peers.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	ip msdp password peer {peer-name peer-address} [encryption-type] string Example: <pre>Device(config)# ip msdp password peer 10.32.43.144 0 test</pre>	Enables MD5 password encryption for a TCP connection between two MSDP peers. Note MD5 authentication must be configured with the same password on both MSDP peers; otherwise, the connection between them will not be made. <ul style="list-style-type: none"> • If you configure or change the password or key, which is used for MD5 authentication between two MSDP peers, the local device does not disconnect the existing session after you configure the password. You must manually disconnect the session to activate the new or changed password.
Step 4	exit Example: <pre>Device(config)# exit</pre>	Exits global configuration mode and returns to privileged EXEC mode.
Step 5	show ip msdp peer [peer-address peer-name] Example: <pre>Device# show ip msdp peer</pre>	(Optional) Displays detailed information about MSDP peers. Note Use this command to verify whether MD5 password authentication is enabled on an MSDP peer.

Troubleshooting Tips

If a device has a password configured for an MSDP peer but the MSDP peer does not, a message such as the following will appear on the console while the devices attempt to establish an MSDP session between them:

```
%TCP-6-BADAUTH: No MD5 digest from [peer's IP address]:11003 to [local router's IP address]:179
```

Similarly, if the two devices have different passwords configured, a message such as the following will appear on the console:

```
%TCP-6-BADAUTH: Invalid MD5 digest from [peer's IP address]:11004 to [local router's IP address]:179
```

The **debug ip tcp transactions** command is used to display information on significant TCP transactions such as state changes, retransmissions, and duplicate packets. In the context of monitoring or troubleshooting MSDP MD5 password authentication, use the **debug ip tcp transactions** command to verify that the MD5 password is enabled and that the keepalive message is received by the MSDP peer.

Preventing DoS Attacks by Limiting the Number of SA Messages Allowed in the SA Cache from Specified MSDP Peers

Perform this optional (but highly recommended) task to limit the overall number of SA messages that the device can accept from specified MSDP peers. Performing this task protects an MSDP-enabled device from distributed denial-of-service (DoS) attacks.



Note We recommend that you perform this task for all MSDP peerings on the device.

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	ip msdp sa-limit <i>{peer-address peer-name}</i> <i>sa-limit</i> Example: <pre>Device(config)# ip msdp sa-limit 192.168.10.1 100</pre>	Limits the number of SA messages allowed in the SA cache from the specified MSDP.
Step 4	Repeat Step 3 to configure SA limits for additional MSDP peers.	--
Step 5	exit Example: <pre>Device(config)# exit</pre>	Exits global configuration mode and returns to privileged EXEC mode.
Step 6	show ip msdp count <i>[as-number]</i> Example: <pre>Device# show ip msdp count</pre>	(Optional) Displays the number of sources and groups originated in MSDP SA messages and the number of SA messages from an MSDP peer in the SA cache.

	Command or Action	Purpose
Step 7	show ip msdp peer [<i>peer-address</i> <i>peer-name</i>] Example: <pre>Device# show ip msdp peer</pre>	(Optional) Displays detailed information about MSDP peers. Note The output of this command displays the number of SA messages received from MSDP peers that are stored in the cache.
Step 8	show ip msdp summary Example: <pre>Device# show ip msdp summary</pre>	(Optional) Displays MSDP peer status. Note The output of this command displays a per-peer “SA Count” field that displays the number of SAs stored in the cache.

Adjusting the MSDP Keepalive and Hold-Time Intervals

Perform this optional task to adjust the interval at which an MSDP peer will send keepalive messages and the interval at which the MSDP peer will wait for keepalive messages from other peers before declaring them down. By default, it may take as long as 75 seconds for an MSDP peer to detect that a peering session with another MSDP peer has gone down. In network environments with redundant MSDP peers, decreasing the hold-time interval can expedite the reconvergence time of MSDP peers in the event that an MSDP peer fails.



Note We recommend that you do not change the command defaults for the **ip msdp keepalive** command, because the command defaults are in accordance with RFC 3618, *Multicast Source Discovery Protocol*. If your network environment requires that you modify the defaults, you must configure the same time values for the *keepalive-interval* and *hold-time-interval* arguments on both ends of the MSDP peering session.

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	ip msdp keepalive { <i>peer-address</i> <i>peer-name</i> } <i>keepalive-interval hold-time-interval</i> Example:	Configures the interval at which an MSDP peer will send keepalive messages and the interval at which the MSDP peer will wait for keepalive

	Command or Action	Purpose
	Device(config)# ip msdp keepalive 10.1.1.3 40 55	messages from other peers before declaring them down.
Step 4	Repeat Step 3 to adjust the keepalive message interval for additional MSDP peers.	--
Step 5	exit Example: Device(config)# exit	Exits global configuration mode and returns to privileged EXEC mode.

Adjusting the MSDP Connection-Retry Interval

Perform this optional task to adjust the interval at which MSDP peers will wait after peering sessions are reset before attempting to reestablish the peering sessions. In network environments where fast recovery of SA messages is required, such as in trading floor network environments, you may want to decrease the connection-retry interval to a time value less than the default value of 30 seconds.

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	ip msdp timer connection-retry-interval Example: Device# ip msdp timer 45	Configures the interval at which MSDP peers will wait after peering sessions are reset before attempting to reestablish the peering sessions.
Step 4	exit Example: Device(config)# exit	Exits global configuration mode and returns to privileged EXEC mode.

Configuring a Default MSDP Peer

Perform this optional task to configure a default MSDP peer.

Before you begin

An MSDP default peer must be a previously configured MSDP peer. Before configuring a default MSDP peer, you must first configure an MSDP peer.

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	ip msdp default-peer <i>{peer-address peer-name}</i> [prefix-list <i>list</i>] Example: <pre>Device(config)# ip msdp default-peer 192.168.1.3</pre>	Configures a default peer from which to accept all MSDP SA messages
Step 4	exit Example: <pre>Device(config)# exit</pre>	Exits global configuration mode and returns to privileged EXEC mode.

Configuring an MSDP Mesh Group

Perform this optional task to configure an MSDP mesh group.



Note You can configure multiple mesh groups per device.

Procedure

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

	Command or Action	Purpose
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	ip msdp mesh-group <i>mesh-name</i> <i>{peer-address peer-name}</i> Example: Device(config)# ip msdp mesh-group peermesh	Configures an MSDP mesh group and indicates that an MSDP peer belongs to that mesh group. Note All MSDP peers on a device that participate in a mesh group must be fully meshed with all other MSDP peers in the group. Each MSDP peer on each device must be configured as a peer using the ip msdp peer command and also as a member of the mesh group using the ip msdp mesh-group command.
Step 4	Repeat Step 3 to add MSDP peers as members of the mesh group.	--
Step 5	exit Example: Device(config)# exit	Exits global configuration mode and returns to privileged EXEC mode.

Controlling SA Messages Originated by an RP for Local Sources

Perform this task to control SA messages originated by an RP by enabling a filter to restrict which registered sources are advertised in SA messages.



Note For best practice information related to configuring MSDP SA message filters, see the [Multicast Source Discovery Protocol SA Filter Recommendations](#) tech note.

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:	Enters global configuration mode.

	Command or Action	Purpose
	Device# <code>configure terminal</code>	
Step 3	ip msdp redistribute [<i>list access-list</i>] [<i>asn as-access-list</i>] [<i>route-map map-name</i>] Example: Device(config)# <code>ip msdp redistribute route-map customer-sources</code>	Enables a filter for MSDP SA messages originated by the local device. Note The ip msdp redistribute command can also be used to advertise sources that are known to the RP but not registered. However, it is strongly recommended that you not originate advertisements for sources that have not registered with the RP.
Step 4	exit Example: Device(config)# <code>exit</code>	Exits global configuration mode and returns to privileged EXEC mode.

Controlling the Forwarding of SA Messages to MSDP Peers Using Outgoing Filter Lists

Perform this optional task to control the forwarding of SA messages to MSDP peers by configuring outgoing filter lists.



Note For best practice information related to configuring MSDP SA message filters, see the [Multicast Source Discovery Protocol SA Filter Recommendations](#) tech note.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> <code>enable</code>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 3	ip msdp sa-filter out { <i>peer-address</i> <i>peer-name</i> } [<i>list access-list</i>] [<i>route-map</i>	Enables a filter for outgoing MSDP messages.

	Command or Action	Purpose
	<code>map-name] [rp-list access-list rp-route-map map-name]</code> Example: <pre>Device(config)# ip msdp sa-filter out 192.168.1.5 peerone</pre>	
Step 4	Repeat Step 3 to configure outgoing filter lists for additional MSDP peers.	--
Step 5	exit Example: <pre>Device(config)# exit</pre>	Exits global configuration mode and returns to privileged EXEC mode.

Controlling the Receipt of SA Messages from MSDP Peers Using Incoming Filter Lists

Perform this optional task to control the receipt of incoming SA messages from MSDP peers.



Note For best practice information related to configuring MSDP SA message filters, see the [Multicast Source Discovery Protocol SA Filter Recommendations](#) tech note.

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	ip msdp sa-filter in <i>{peer-address peer-name}</i> [list access-list] [route-map map-name] [rp-list access-list rp-route-map map-name] Example: <pre>Device(config)# ip msdp sa-filter in 192.168.1.3</pre>	Enables a filter for incoming MSDP SA messages.

	Command or Action	Purpose
Step 4	Repeat Step 3 to configure incoming filter lists for additional MSDP peers.	--
Step 5	exit Example: <pre>Device(config)# exit</pre>	Exits global configuration mode and returns to privileged EXEC mode.

Using TTL Thresholds to Limit the Multicast Data Sent in SA Messages

Perform this optional task to establish a time to live (TTL) threshold to limit the multicast data sent in SA messages.

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	ip msdp ttl-threshold <i>{peer-address peer-name} ttl-value</i> Example: <pre>Device(config)# ip msdp ttl-threshold 192.168.1.5 8</pre>	Sets a TTL value for MSDP messages originated by the local device. <ul style="list-style-type: none"> • By default, multicast data packets in SA messages are sent to an MSDP peer, provided the TTL value of the packet is greater than 0, which is standard TTL behavior.
Step 4	exit Example: <pre>Device(config)# exit</pre>	Exits global configuration mode and returns to privileged EXEC mode.

Requesting Source Information from MSDP Peers

Perform this optional task to enable a device to request source information from MSDP peers.



Note Because SA caching is enabled by default and cannot be explicitly enabled or disabled in earlier Cisco software releases, performing this task is seldom needed.

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	ip msdp sa-request <i>{peer-address peer-name}</i> Example: <pre>Device(config)# ip msdp sa-request 192.168.10.1</pre>	Specifies that the device send SA request messages to the specified MSDP peer.
Step 4	Repeat Step 3 to specify that the device send SA request messages to additional MSDP caching peers.	--
Step 5	exit Example: <pre>Device(config)# exit</pre>	Exits global configuration mode and returns to privileged EXEC mode.

Controlling the Response to Outgoing SA Request Messages from MSDP Peers Using SA Request Filters

Perform this optional task to control the outgoing SA request messages that the device will honor from MSDP peers.

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	ip msdp filter-sa-request {peer-address peer-name} [list access-list] Example: Device(config)# ip msdp filter sa-request 172.31.2.2 list 1	Enables a filter for outgoing SA request messages. Note Only one SA request filter can be configured per MSDP peer.
Step 4	Repeat Step 3 to configure SA request filters for additional MSDP peers.	--
Step 5	exit Example: Device(config)# exit	Exits global configuration mode and returns to privileged EXEC mode.

Configuring an Originating Address Other Than the RP Address

Perform this optional task to allow an MSDP speaker that originates an SA message to use the IP address of its interface as the RP address in the SA message.

You can also change the originator ID for any one of the following reasons:

- If you configure multiple devices in an MSDP mesh group for Anycast RP.
- If you have a device that borders a PIM-SM domain and a PIM-DM domain. If a device borders a PIM-SM domain and a PIM-DM domain and you want to advertise active sources within the PIM-DM domain, configure the RP address in SA messages to be the address of the originating device's interface.

Before you begin

MSDP is enabled and the MSDP peers are configured. For more information about configuring MSDP peers, see the [Configuring an MSDP Peer, on page 25](#) section.

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.

	Command or Action	Purpose
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	ip msdp originator-id <i>type number</i> Example: Device(config)# ip msdp originator-id ethernet 1	Configures the RP address in SA messages to be the address of the originating device's interface.
Step 4	exit Example: Device(config)# exit	Exits global configuration mode and returns to privileged EXEC mode.

Monitoring MSDP

Perform this optional task to monitor MSDP SA messages, peers, state, and peer status.

Procedure

Step 1 enable

Example:

```
Device# enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 debug ip msdp [*peer-address* | *peer-name*] [**detail**] [**routes**]

Use this command to debug MSDP activity.

Use the optional *peer-address* or *peer-name* argument to specify for which peer debug events are logged.

The following is sample output from the **debug ip msdp** command:

Example:

```
Device# debug ip msdp
MSDP debugging is on
Device#
MSDP: 224.150.44.254: Received 1388-byte message from peer
MSDP: 224.150.44.254: SA TLV, len: 1388, ec: 115, RP: 172.31.3.92
MSDP: 224.150.44.254: Peer RPF check passed for 172.31.3.92, used EMBGP peer
MSDP: 224.150.44.250: Forward 1388-byte SA to peer
MSDP: 224.150.44.254: Received 1028-byte message from peer
MSDP: 224.150.44.254: SA TLV, len: 1028, ec: 85, RP: 172.31.3.92
```

```

MSDP: 224.150.44.254: Peer RPF check passed for 172.31.3.92, used EMBGP peer
MSDP: 224.150.44.250: Forward 1028-byte SA to peer
MSDP: 224.150.44.254: Received 1388-byte message from peer
MSDP: 224.150.44.254: SA TLV, len: 1388, ec: 115, RP: 172.31.3.111
MSDP: 224.150.44.254: Peer RPF check passed for 172.31.3.111, used EMBGP peer
MSDP: 224.150.44.250: Forward 1388-byte SA to peer
MSDP: 224.150.44.250: Received 56-byte message from peer
MSDP: 224.150.44.250: SA TLV, len: 56, ec: 4, RP: 192.168.76.241
MSDP: 224.150.44.250: Peer RPF check passed for 192.168.76.241, used EMBGP peer
MSDP: 224.150.44.254: Forward 56-byte SA to peer
MSDP: 224.150.44.254: Received 116-byte message from peer
MSDP: 224.150.44.254: SA TLV, len: 116, ec: 9, RP: 172.31.3.111
MSDP: 224.150.44.254: Peer RPF check passed for 172.31.3.111, used EMBGP peer
MSDP: 224.150.44.250: Forward 116-byte SA to peer
MSDP: 224.150.44.254: Received 32-byte message from peer
MSDP: 224.150.44.254: SA TLV, len: 32, ec: 2, RP: 172.31.3.78
MSDP: 224.150.44.254: Peer RPF check passed for 172.31.3.78, used EMBGP peer
MSDP: 224.150.44.250: Forward 32-byte SA to peer

```

Step 3 debug ip msdp resets

Use this command to debug MSDP peer reset reasons.

Example:

```
Device# debug ip msdp resets
```

Step 4 show ip msdp count [as-number]

Use this command to display the number of sources and groups originated in MSDP SA messages and the number of SA messages from an MSDP peer in the SA cache. The **ip msdp cache-sa-state** command must be configured for this command to produce any output.

The following is sample output from the **show ip msdp count** command:

Example:

```

Device# show ip msdp count
SA State per Peer Counters, <Peer>: <# SA learned>
    192.168.4.4: 8
SA State per ASN Counters, <asn>: <# sources>/<# groups>
    Total entries: 8
    ?: 8/8

```

Step 5 show ip msdp peer [peer-address | peer-name]

Use this command to display detailed information about MSDP peers.

Use the optional *peer-address* or *peer-name* argument to display information about a particular peer.

The following is sample output from the **show ip msdp peer** command:

Example:

```

Device# show ip msdp peer 192.168.4.4
MSDP Peer 192.168.4.4 (?), AS 64512 (configured AS)
Connection status:
    State: Up, Resets: 0, Connection source: Loopback0 (2.2.2.2)
    Uptime(Downtime): 00:07:55, Messages sent/received: 8/18
    Output messages discarded: 0
    Connection and counters cleared 00:08:55 ago
SA Filtering:
    Input (S,G) filter: none, route-map: none

```

```

Input RP filter: none, route-map: none
Output (S,G) filter: none, route-map: none
Output RP filter: none, route-map: none
SA-Requests:
  Input filter: none
Peer ttl threshold: 0
SAs learned from this peer: 8
Input queue size: 0, Output queue size: 0
MD5 signature protection on MSDP TCP connection: not enabled

```

Step 6 **show ip msdp sa-cache** [*group-address* | *source-address* | *group-name* | *source-name*] [*as-number*]

Use this command to display the (S, G) state learned from MSDP peers.

The following is sample output from the **show ip msdp sa-cache** command:

Example:

```

Device# show ip msdp sa-cache
MSDP Source-Active Cache - 8 entries
(10.44.44.5, 239.232.1.0), RP 192.168.4.4, BGP/AS 64512, 00:01:20/00:05:32, Peer 192.168.4.4
(10.44.44.5, 239.232.1.1), RP 192.168.4.4, BGP/AS 64512, 00:01:20/00:05:32, Peer 192.168.4.4
(10.44.44.5, 239.232.1.2), RP 192.168.4.4, BGP/AS 64512, 00:01:19/00:05:32, Peer 192.168.4.4
(10.44.44.5, 239.232.1.3), RP 192.168.4.4, BGP/AS 64512, 00:01:19/00:05:32, Peer 192.168.4.4
(10.44.44.5, 239.232.1.4), RP 192.168.4.4, BGP/AS 64512, 00:01:19/00:05:32, Peer 192.168.4.4
(10.44.44.5, 239.232.1.5), RP 192.168.4.4, BGP/AS 64512, 00:01:19/00:05:32, Peer 192.168.4.4
(10.44.44.5, 239.232.1.6), RP 192.168.4.4, BGP/AS 64512, 00:01:19/00:05:32, Peer 192.168.4.4
(10.44.44.5, 239.232.1.7), RP 192.168.4.4, BGP/AS 64512, 00:01:19/00:05:32, Peer 192.168.4.4

```

Step 7 **show ip msdp summary**

Use this command to display MSDP peer status.

The following is sample output from the **show ip msdp summary** command:

Example:

```

Device# show ip msdp summary
MSDP Peer Status Summary
Peer Address      AS      State      Uptime/   Reset SA      Peer Name
                  AS      State      Downtime Count Count
192.168.4.4       4       Up         00:08:05 0        8        ?

```

Clearing MSDP Connections Statistics and SA Cache Entries

Perform this optional task to clear MSDP connections, statistics, and SA cache entries.

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.

	Command or Action	Purpose
Step 2	clear ip msdp peer [<i>peer-address</i> <i>peer-name</i>] Example: Device# clear ip msdp peer	Clears the TCP connection to the specified MSDP peer and resets all MSDP message counters.
Step 3	clear ip msdp statistics [<i>peer-address</i> <i>peer-name</i>] Example: Device# clear ip msdp statistics	Clears the statistics counters for the specified MSDP peer and resets all MSDP message counters.
Step 4	clear ip msdp sa-cache [<i>group-address</i>] Example: Device# clear ip msdp sa-cache	Clears SA cache entries. <ul style="list-style-type: none"> • If the clear ip msdp sa-cache is specified with the optional <i>group-address</i> argument or <i>source-address</i> argument, all SA cache entries are cleared. • Use the optional <i>group-address</i> argument to clear all SA cache entries associated with a specific group.

Enabling SNMP Monitoring of MSDP

Perform this optional task to enable Simple Network Management Protocol (SNMP) monitoring of MSDP.

Before you begin

- SNMP and MSDP is configured on your devices.
- In each PIM-SM domain there should be a device that is configured as the MSDP speaker. This device must have SNMP and the MSDP MIB enabled.



Note

- All MSDP-MIB objects are implemented as read-only.
- The Requests table is not supported in Cisco's implementation of the MSDP MIB.
- The MSDP Established notification is not supported in Cisco's implementation of the MSDP MIB.

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	snmp-server enable traps msdp Example: Device# snmp-server enable traps msdp	Enables the sending of MSDP notifications for use with SNMP. Note The snmp-server enable traps msdp command enables both traps and informs.
Step 3	snmp-server host <i>host</i> [traps informs] [version { 1 2c 3 [auth priv noauth]}] <i>community-string</i> [udp-port <i>port-number</i>] msdp Example: Device# snmp-server host examplehost msdp	Specifies the recipient (host) for MSDP traps or informs.
Step 4	exit Example: Device(config)# exit	Exits global configuration mode and returns to privileged EXEC mode.

Troubleshooting Tips

You can compare the results of MSDP MIB notifications to the output from the software by using the **show ip msdp summary** and **show ip msdp peer** commands on the appropriate device. You can also compare the results of these commands to the results from SNMP Get operations. You can verify SA cache table entries using the **show ip msdp sa-cache** command. Additional troubleshooting information, such as the local address of the connection, the local port, and the remote port, can be obtained using the output from the **debug ip msdp** command.

Configuration Examples for Using MSDP to Interconnect Multiple PIM-SM Domains

This section provides configuration examples of using MSDP to interconnect multiple PIM-SM domains.

Example: Configuring an MSDP Peer

The following example shows how to establish MSDP peering connections between three MSDP peers:

Device A

```
!
interface Loopback 0
 ip address 10.220.8.1 255.255.255.255
!
```

```
ip msdp peer 10.220.16.1 connect-source Loopback0
ip msdp peer 10.220.32.1 connect-source Loopback0
!
```

Device B

```
!
interface Loopback 0
 ip address 10.220.16.1 255.255.255.255
!
ip msdp peer 10.220.8.1 connect connect-source Loopback0
ip msdp peer 10.220.32.1 connect connect-source Loopback0
!
```

Device C

```
!
interface Loopback 0
 ip address 10.220.32.1 255.255.255.255
!
ip msdp peer 10.220.8.1 connect 10.220.8.1 connect-source Loopback0
ip msdp peer 10.220.16.1 connect 10.220.16.1 connect-source Loopback0
!
```

Example: Configuring MSDP MD5 Password Authentication

The following example shows how to enable MD5 password authentication for TCP connections between two MSDP peers:

Device A

```
!
ip msdp peer 10.3.32.154
ip msdp password peer 10.3.32.154 0 test
!
```

Device B

```
!
ip msdp peer 10.3.32.153
ip msdp password peer 10.3.32.153 0 test
!
```

Example: Configuring a Default MSDP Peer

The figure illustrates a scenario where default MSDP peers might be used. In the figure, a customer that owns Device B is connected to the internet through two ISPs, one that owns Device A and the other that owns Device C. They are not running (M)BGP between them. In order for the customer to learn about sources in the ISP domain or in other domains, Device B identifies Device A as its default MSDP peer. Device B advertises SA messages to both Device A and Device C, but accepts SA messages either from Device A only or Device C only. If Device A is the first default peer in the configuration, it will be used if it is up and running. Only if Device A is not running will Device B accept SA messages from Device C.

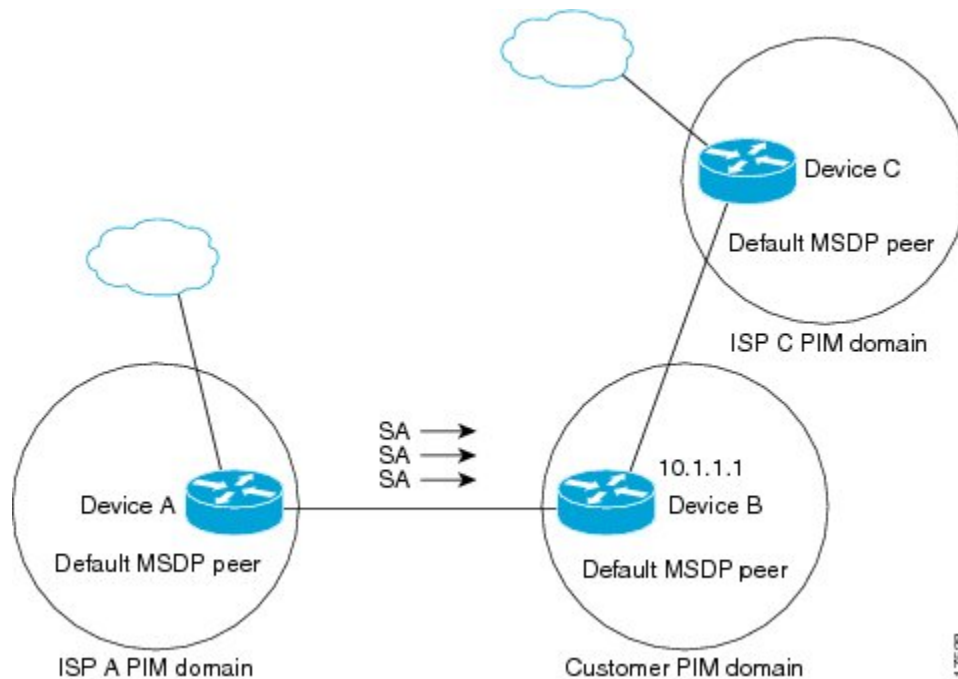
The ISP will also likely use a prefix list to define which prefixes it will accept from the customer device. The customer will define multiple default peers, each having one or more prefixes associated with it.

The customer has two ISPs to use. The customer defines both ISPs as default peers. As long as the first default peer identified in the configuration is up and running, it will be the default peer and the customer will accept all SA messages it receives from that peer.



Note Although the following illustration and example uses routers in the configuration, any device (router or switch) can be used.

Figure 3: Default MSDP Peer Scenario



Device B advertises SAs to Device A and Device C, but uses only Device A or Device C to accept SA messages. If Device A is first in the configuration file, it will be used if it is up and running. Only when Device A is not running will Device B accept SAs from Device C. This is the behavior without a prefix list.

If you specify a prefix list, the peer will be a default peer only for the prefixes in the list. You can have multiple active default peers when you have a prefix list associated with each. When you do not have any prefix lists, you can configure multiple default peers, but only the first one is the active default peer as long as the device has connectivity to this peer and the peer is alive. If the first configured peer goes down or the connectivity to this peer goes down, the second configured peer becomes the active default, and so on.

The following example shows a partial configuration of Device A and Device C in the figure. Each of these ISPs may have more than one customer using default peering, like the customer in the figure. In that case, they may have similar configurations. That is, they will only accept SAs from a default peer if the SA is permitted by the corresponding prefix list.

Device A Configuration

```
ip msdp default-peer 10.1.1.1
ip msdp default-peer 10.1.1.1 prefix-list site-b ge 32
ip prefix-list site-b permit 10.0.0.0/8
```

Device C Configuration

```
ip msdp default-peer 10.1.1.1 prefix-list site-b ge 32
ip prefix-list site-b permit 10.0.0.0/8
```

Example: Configuring MSDP Mesh Groups

The following example shows how to configure three devices to be fully meshed members of an MSDP mesh group:

Device A Configuration

```
ip msdp peer 10.2.2.2
ip msdp peer 10.3.3.3
ip msdp mesh-group test-mesh-group 10.2.2.2
ip msdp mesh-group test-mesh-group 10.3.3.3
```

Device B Configuration

```
ip msdp peer 10.1.1.1
ip msdp peer 10.3.3.3
ip msdp mesh-group test-mesh-group 10.1.1.1
ip msdp mesh-group test-mesh-group 10.3.3.3
```

Device C Configuration

```
ip msdp peer 10.1.1.1
ip msdp peer 10.2.2.2
ip msdp mesh-group test-mesh-group 10.1.1.1
ip msdp mesh-group test-mesh-group 10.2.2.2
```

Troubleshooting Tips

You can gather diagnostic data on the Multicast configurations with the **show tech-support ipmulticast** command. You can also verify the configurations and the IGMP snooping information with the **show tech-support igmp-snooping** command.

For further troubleshooting and debugging, you can use these commands:

Debug Commands	Purpose
debug mrouting	Enables debugging on Multicast Routing
debug ip multicast	Enables debugging on IP Multicast activiti
debug mpacket	Enables debugging on Multicast packets

debug ip igmp	Enables debugging IP IGMP protocol
debug mfib	Enables debugging MFIB routing and



CHAPTER 3

Configuring PIM

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- [Restrictions for PIM, on page 49](#)
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Prerequisites for PIM

Before you begin the PIM configuration process, decide which PIM mode to use. This is based on the applications you intend to support on your network. Use the following guidelines:

- In general, if the application is one-to-many or many-to-many in nature, then PIM-SM can be used successfully.
- For optimal one-to-many application performance, SSM is appropriate but requires IGMP version 3 support.

Restrictions for PIM

The following are the restrictions for configuring PIM:

- Use ACLs to designate a specified port only as a multicast host port and not as a multicast router port. Multicast router control-packets received on this port are dropped.
- PIM nonbroadcast multiaccess (NBMA) mode is not supported on an ethernet interface.
- Hot Standby Router Protocol-aware (HSRP-aware) PIM is not supported.

PIMv1 and PIMv2 Interoperability

To avoid misconfiguring multicast routing, review the information in this section.

The Cisco PIMv2 implementation provides interoperability and transition between Version 1 and Version 2, although there might be some minor problems.

You can upgrade to PIMv2 incrementally. PIM Versions 1 and 2 can be configured on different routers and multilayer switches within one network. Internally, all routers and multilayer switches on a shared media network must run the same PIM version. Therefore, if a PIMv2 device detects a PIMv1 device, the Version 2 device downgrades itself to Version 1 until all Version 1 devices have been shut down or upgraded.

PIMv2 uses the BSR to discover and announce RP-set information for each group prefix to all the routers and multilayer switches in a PIM domain. PIMv1, together with the Auto-RP feature, can perform the same tasks as the PIMv2 BSR. However, Auto-RP is a standalone protocol, separate from PIMv1, and is a proprietary Cisco protocol. PIMv2 is a standards track protocol in the IETF.



Note We recommend that you use PIMv2. The BSR function interoperates with Auto-RP on Cisco routers and multilayer switches.

When PIMv2 devices interoperate with PIMv1 devices, Auto-RP should have already been deployed. A PIMv2 BSR that is also an Auto-RP mapping agent automatically advertises the RP elected by Auto-RP. That is, Auto-RP sets its single RP on every router or multilayer switch in the group. Not all routers and switches in the domain use the PIMv2 hash function to select multiple RPs.

Sparse-mode groups in a mixed PIMv1 and PIMv2 region are possible because the Auto-RP feature in PIMv1 interoperates with the PIMv2 RP feature. Although all PIMv2 devices can also use PIMv1, we recommend that the RPs be upgraded to PIMv2. To ease the transition to PIMv2, we recommend:

- Using Auto-RP throughout the region.

If Auto-RP is not already configured in the PIMv1 regions, configure Auto-RP.

Restrictions for Configuring Auto-RP and BSR

Take into consideration your network configuration, and the following restrictions when configuring Auto-RP and BSR:

Restrictions for Configuring Auto-RP

The following are restrictions for configuring Auto-RP (if used in your network configuration):

- If routed interfaces are configured in sparse mode, Auto-RP can still be used if all devices are configured with a manual RP address for the Auto-RP groups.
- If routed interfaces are configured in sparse mode and you enter the **ip pim autorp listener** global configuration command, Auto-RP can still be used even if all devices are not configured with a manual RP address for the Auto-RP groups.

Restrictions for Configuring BSR

The following are the restrictions for configuring BSR (if used in your network configuration):

- Configure the candidate BSRs as the RP-mapping agents for Auto-RP.
- For group prefixes advertised through Auto-RP, the PIMv2 BSR mechanism should not advertise a subrange of these group prefixes served by a different set of RPs. In a mixed PIMv1 and PIMv2 domain,

have backup RPs serve the same group prefixes. This prevents the PIMv2 DRs from selecting a different RP from those PIMv1 DRs, due to the longest match lookup in the RP-mapping database.

Restrictions and Guidelines for Configuring Auto-RP and BSR

The following are restrictions for configuring Auto-RP and BSR (if used in your network configuration):

- If your network is all Cisco routers and multilayer switches, you can use either Auto-RP or BSR.
- If you have non-Cisco routers in your network, you must use BSR.
- If you have Cisco PIMv1 and PIMv2 routers and multilayer switches and non-Cisco routers, you must use both Auto-RP and BSR. If your network includes routers from other vendors, configure the Auto-RP mapping agent and the BSR on a Cisco PIMv2 device. Ensure that no PIMv1 device is located in the path a between the BSR and a non-Cisco PIMv2 device.



Note There are two approaches to using PIMv2. You can use Version 2 exclusively in your network or migrate to Version 2 by employing a mixed PIM version environment.

- Because bootstrap messages are sent hop-by-hop, a PIMv1 device prevents these messages from reaching all routers and multilayer switches in your network. Therefore, if your network has a PIMv1 device in it and only Cisco routers and multilayer switches, it is best to use Auto-RP.
- If you have a network that includes non-Cisco routers, configure the Auto-RP mapping agent and the BSR on a Cisco PIMv2 router or multilayer switch. Ensure that no PIMv1 device is on the path between the BSR and a non-Cisco PIMv2 router.
- If you have non-Cisco PIMv2 routers that need to interoperate with Cisco PIMv1 routers and multilayer switches, both Auto-RP and a BSR are required. We recommend that a Cisco PIMv2 device be both the Auto-RP mapping agent and the BSR.

Restrictions for Auto-RP Enhancement

The simultaneous deployment of Auto-RP and bootstrap router (BSR) is not supported.

Information about PIM

Protocol Independent Multicast Overview

The Protocol Independent Multicast (PIM) protocol maintains the current IP multicast service mode of receiver-initiated membership. PIM is not dependent on a specific unicast routing protocol; it is IP routing protocol independent and can leverage whichever unicast routing protocols are used to populate the unicast routing table, including Enhanced Interior Gateway Routing Protocol (EIGRP), Open Shortest Path First (OSPF), Border Gateway Protocol (BGP), and static routes. PIM uses unicast routing information to perform the multicast forwarding function.

Although PIM is called a multicast routing protocol, it actually uses the unicast routing table to perform the reverse path forwarding (RPF) check function instead of building up a completely independent multicast routing table. Unlike other routing protocols, PIM does not send and receive routing updates between routers.

PIM is defined in RFC 4601, Protocol Independent Multicast - Sparse Mode (PIM-SM)

PIM Versions

PIMv2 includes these improvements over PIMv1:

- A single, active rendezvous point (RP) exists per multicast group, with multiple backup RPs. This single RP compares to multiple active RPs for the same group in PIMv1.
- A bootstrap router (BSR) provides a fault-tolerant, automated RP discovery and distribution function that enables routers and multilayer switches to dynamically learn the group-to-RP mappings.
- PIM join and prune messages have more flexible encoding for multiple address families.
- A more flexible hello packet format replaces the query packet to encode current and future capability options.
- Register messages sent to an RP specify whether they are sent by a border router or a designated router.
- PIM packets are no longer inside IGMP packets; they are standalone packets.

Multicast Source Discovery Protocol (MSDP)

Multicast Source Discovery Protocol (MSDP) is used for inter-domain source discovery when PIM SM is used. Each PIM administrative domain has its own RP. In order for the RP in one domain to signal new sources to the RP in the other domain, MSDP is used.

When RP in a domain receives a PIM register message for a new source, with MSDP configured it sends a new source-active (SA) message to all its MSDP peers in other domains. Each intermediate MSDP peer floods this SA message away from the originating RP. The MSDP peers install this SA message in their MSDP sa-cache. If the RPs in other domains have any join requests for the group in the SA message (indicated by the presence of a (*,G) entry with non empty outgoing interface list), the domain is interested in the group, and the RP triggers an (S,G) join toward the source.

PIM Sparse Mode

PIM sparse mode (PIM-SM) uses a pull model to deliver multicast traffic. Only network segments with active receivers that have explicitly requested the data will receive the traffic.

Sparse mode interfaces are added to the multicast routing table only when periodic Join messages are received from downstream routers, or when a directly connected member is on the interface. When forwarding from a LAN, sparse mode operation occurs if an RP is known for the group. If so, the packets are encapsulated and sent toward the RP. If the multicast traffic from a specific source is sufficient, the first hop router of the receiver may send Join messages toward the source to build a source-based distribution tree.

PIM-SM distributes information about active sources by forwarding data packets on the shared tree. Because PIM-SM uses shared trees (at least, initially), it requires the use of a rendezvous point (RP). The RP must be administratively configured in the network.

In sparse mode, a router assumes that other routers do not want to forward multicast packets for a group, unless there is an explicit request for the traffic. When hosts join a multicast group, the directly connected routers send PIM Join messages toward the RP. The RP keeps track of multicast groups. Hosts that send

multicast packets are registered with the RP by the first hop router of that host. The RP then sends Join messages toward the source. At this point, packets are forwarded on a shared distribution tree. If the multicast traffic from a specific source is sufficient, the first hop router of the host may send Join messages toward the source to build a source-based distribution tree.

Sources register with the RP and then data is forwarded down the shared tree to the receivers. The edge routers learn about a particular source when they receive data packets on the shared tree from that source through the RP. The edge router then sends PIM (S,G) Join messages toward that source. Each router along the reverse path compares the unicast routing metric of the RP address to the metric of the source address. If the metric for the source address is better, it will forward a PIM (S,G) Join message toward the source. If the metric for the RP is the same or better, then the PIM (S,G) Join message will be sent in the same direction as the RP. In this case, the shared tree and the source tree would be considered congruent.

If the shared tree is not an optimal path between the source and the receiver, the routers dynamically create a source tree and stop traffic from flowing down the shared tree. This behavior is the default behavior in software. Network administrators can force traffic to stay on the shared tree by using the **ip pim spt-threshold infinity** command, which is a global configuration level command.

PIM-SM scales well to a network of any size, including those with WAN links. The explicit join mechanism prevents unwanted traffic from flooding the WAN links.

Rendezvous Points

A rendezvous point (RP) is a role that a device performs when operating in Protocol Independent Multicast (PIM) Sparse Mode (SM). An RP is required only in networks running PIM SM. In the PIM-SM model, only network segments with active receivers that have explicitly requested multicast data will be forwarded the traffic.

An RP acts as the meeting place for sources and receivers of multicast data. In a PIM-SM network, sources must send their traffic to the RP. This traffic is then forwarded to receivers down a shared distribution tree. By default, when the first hop device of the receiver learns about the source, it will send a Join message directly to the source, creating a source-based distribution tree from the source to the receiver. This source tree does not include the RP unless the RP is located within the shortest path between the source and receiver.

In most cases, the placement of the RP in the network is not a complex decision. By default, the RP is needed only to start new sessions with sources and receivers. Consequently, the RP experiences little overhead from traffic flow or processing. In PIM version 2, the RP performs less processing than in PIM version 1 because sources must only periodically register with the RP to create state.

Auto-RP

In the first version of PIM-SM, all leaf routers (routers directly connected to sources or receivers) were required to be manually configured with the IP address of the RP. This type of configuration is also known as static RP configuration. Configuring static RPs is relatively easy in a small network, but it can be laborious in a large, complex network.

Following the introduction of PIM-SM version 1, Cisco implemented a version of PIM-SM with the Auto-RP feature. Auto-RP automates the distribution of group-to-RP mappings in a PIM network. Auto-RP has the following benefits:

- Configuring the use of multiple RPs within a network to serve different groups is easy.
- Auto-RP allows load splitting among different RPs and arrangement of RPs according to the location of group participants.

- Auto-RP avoids inconsistent, manual RP configurations that can cause connectivity problems.

Multiple RPs can be used to serve different group ranges or serve as backups to each other. For Auto-RP to work, a router must be designated as an RP-mapping agent, which receives the RP-announcement messages from the RPs and arbitrates conflicts. The RP-mapping agent then sends the consistent group-to-RP mappings to all other routers. Thus, all routers automatically discover which RP to use for the groups they support.



Note If router interfaces are configured in sparse mode, Auto-RP can still be used if all routers are configured with a static RP address for the Auto-RP groups.

To make Auto-RP work, a router must be designated as an RP mapping agent, which receives the RP announcement messages from the RPs and arbitrates conflicts. Thus, all routers automatically discover which RP to use for the groups they support. The Internet Assigned Numbers Authority (IANA) has assigned two group addresses, 224.0.1.39 and 224.0.1.40, for Auto-RP. One advantage of Auto-RP is that any change to the RP designation must be configured only on the routers that are RPs and not on the leaf routers. Another advantage of Auto-RP is that it offers the ability to scope the RP address within a domain. Scoping can be achieved by defining the time-to-live (TTL) value allowed for the Auto-RP advertisements.

Each method for configuring an RP has its own strengths, weaknesses, and level of complexity. In conventional IP multicast network scenarios, we recommend using Auto-RP to configure RPs because it is easy to configure, well-tested, and stable. The alternative ways to configure an RP are static RP, Auto-RP, and bootstrap router.

The Role of Auto-RP in a PIM Network

Auto-RP automates the distribution of group-to-rendezvous point (RP) mappings in a PIM network. To make Auto-RP work, a device must be designated as an RP mapping agent, which receives the RP announcement messages from the RPs and arbitrates conflicts.

Thus, all routers automatically discover which RP to use for the groups they support. The Internet Assigned Numbers Authority (IANA) has assigned two group addresses, 224.0.1.39 and 224.0.1.40, for Auto-RP.

The mapping agent receives announcements of intention to become the RP from Candidate-RPs. The mapping agent then announces the winner of the RP election. This announcement is made independently of the decisions by the other mapping agents.

Multicast Boundaries

Administratively-scoped boundaries can be used to limit the forwarding of multicast traffic outside of a domain or subdomain. This approach uses a special range of multicast addresses, called administratively-scoped addresses, as the boundary mechanism. If you configure an administratively-scoped boundary on a routed interface, multicast traffic whose multicast group addresses fall in this range cannot enter or exit this interface, which provides a firewall for multicast traffic in this address range.



Note Multicast boundaries and TTL thresholds control the scoping of multicast domains; however, TTL thresholds are not supported by the device. You should use multicast boundaries instead of TTL thresholds to limit the forwarding of multicast traffic outside of a domain or a subdomain.

You can define an administratively-scoped boundary on a routed interface for multicast group addresses. A standard access list defines the range of addresses affected. When a boundary is defined, no multicast data

packets are allowed to flow across the boundary from either direction. The boundary allows the same multicast group address to be reused in different administrative domains.

The IANA has designated the multicast address range 239.0.0.0 to 239.255.255.255 as the administratively-scoped addresses. This range of addresses can then be reused in domains administered by different organizations. The addresses would be considered local, not globally unique.

You can configure the **filter-autorp** keyword to examine and filter Auto-RP discovery and announcement messages at the administratively scoped boundary. Any Auto-RP group range announcements from the Auto-RP packets that are denied by the boundary access control list (ACL) are removed. An Auto-RP group range announcement is permitted and passed by the boundary only if all addresses in the Auto-RP group range are permitted by the boundary ACL. If any address is not permitted, the entire group range is filtered and removed from the Auto-RP message before the Auto-RP message is forwarded.

Auto RP Benefits

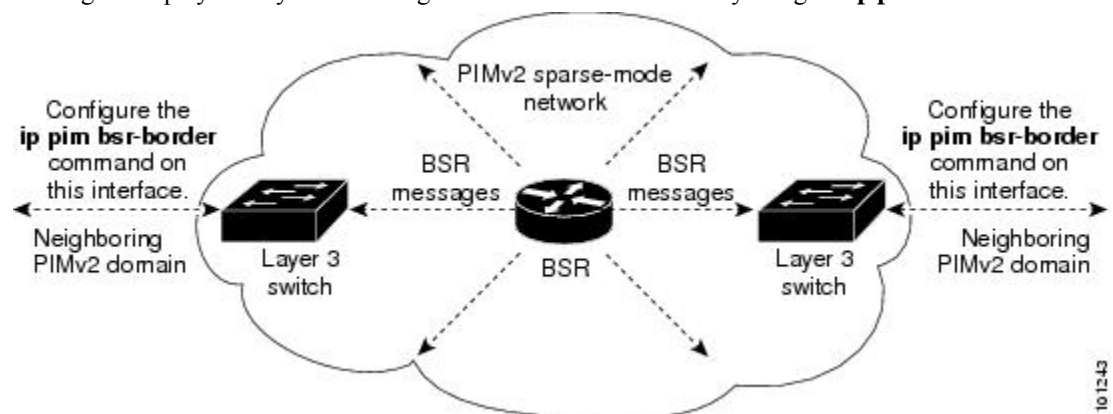
Benefits of Auto-RP in a PIM Network

- Auto-RP allows any change to the RP designation to be configured only on the devices that are RPs, not on the leaf routers.
- Auto-RP offers the ability to scope the RP address within a domain.

PIM Domain Border

As IP multicast becomes more widespread, the chance of one PIMv2 domain bordering another PIMv2 domain increases. Because two domains probably do not share the same set of RPs, BSR, candidate RPs, and candidate BSRs, you need to constrain PIMv2 BSR messages from flowing into or out of the domain. Allowing messages to leak across the domain borders could adversely affect the normal BSR election mechanism and elect a single BSR across all bordering domains and comingle candidate RP advertisements, resulting in the election of RPs in the wrong domain.

This figure displays how you can configure the PIM domain border by using the **ip pim bsr-border** command.



PIMv2 Bootstrap Router

PIMv2 Bootstrap Router (BSR) is another method to distribute group-to-RP mapping information to all PIM routers and multilayer devices in the network. It eliminates the need to manually configure RP information in every router and switch in the network. However, instead of using IP multicast to distribute group-to-RP

mapping information, BSR uses hop-by-hop flooding of special BSR messages to distribute the mapping information.

The BSR is elected from a set of candidate routers and switches in the domain that have been configured to function as BSRs. The election mechanism is similar to the root-bridge election mechanism used in bridged LANs. The BSR election is based on the BSR priority of the device contained in the BSR messages that are sent hop-by-hop through the network. Each BSR device examines the message and forwards out all interfaces only the message that has either a higher BSR priority than its BSR priority or the same BSR priority, but with a higher BSR IP address. Using this method, the BSR is elected.

The elected BSR sends BSR messages with a TTL of 1. Neighboring PIMv2 routers or multilayer devices receive the BSR message and multicast it out all other interfaces (except the one on which it was received) with a TTL of 1. In this way, BSR messages travel hop-by-hop throughout the PIM domain. Because BSR messages contain the IP address of the current BSR, the flooding mechanism enables candidate RPs to automatically learn which device is the elected BSR.

Candidate RPs send candidate RP advertisements showing the group range for which they are responsible to the BSR, which stores this information in its local candidate-RP cache. The BSR periodically advertises the contents of this cache in BSR messages to all other PIM devices in the domain. These messages travel hop-by-hop through the network to all routers and switches, which store the RP information in the BSR message in their local RP cache. The routers and switches select the same RP for a given group because they all use a common RP hashing algorithm.

Multicast Forwarding

Forwarding of multicast traffic is accomplished by multicast-capable routers. These routers create distribution trees that control the path that IP multicast traffic takes through the network in order to deliver traffic to all receivers.

Multicast traffic flows from the source to the multicast group over a distribution tree that connects all of the sources to all of the receivers in the group. This tree may be shared by all sources (a shared tree) or a separate distribution tree can be built for each source (a source tree). The shared tree may be one-way or bidirectional.

Before describing the structure of source and shared trees, it is helpful to explain the notations that are used in multicast routing tables. These notations include the following:

- (S,G) = (unicast source for the multicast group G, multicast group G)
- (*,G) = (any source for the multicast group G, multicast group G)

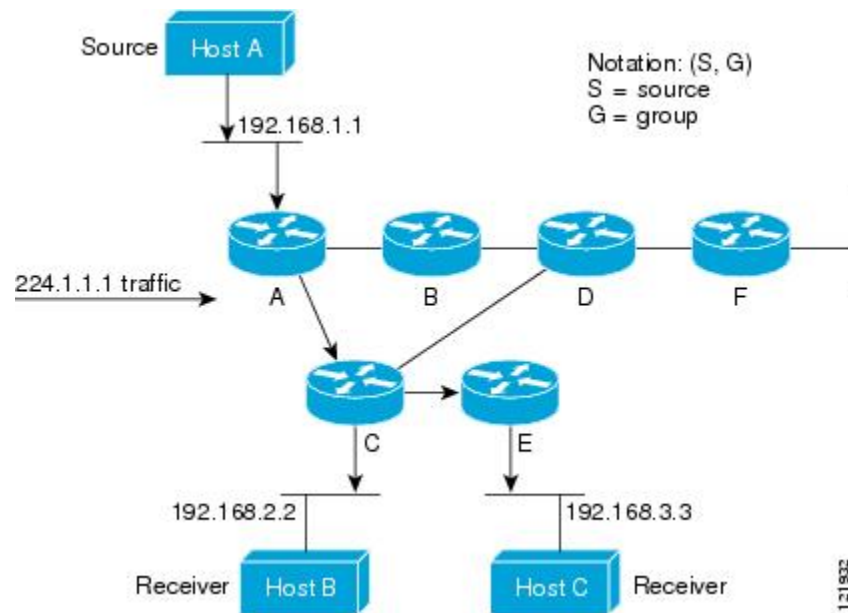
The notation of (S,G), pronounced “S comma G,” enumerates a shortest path tree where S is the IP address of the source and G is the multicast group address.

Shared trees are (*,G) and the source trees are (S,G) and always routed at the sources.

Multicast Distribution Source Tree

The simplest form of a multicast distribution tree is a source tree. A source tree has its root at the source host and has branches forming a spanning tree through the network to the receivers. Because this tree uses the shortest path through the network, it is also referred to as a shortest path tree (SPT).

The figure shows an example of an SPT for group 224.1.1.1 rooted at the source, Host A, and connecting two receivers, Hosts B and C.



Using standard notation, the SPT for the example shown in the figure would be (192.168.1.1, 224.1.1.1).

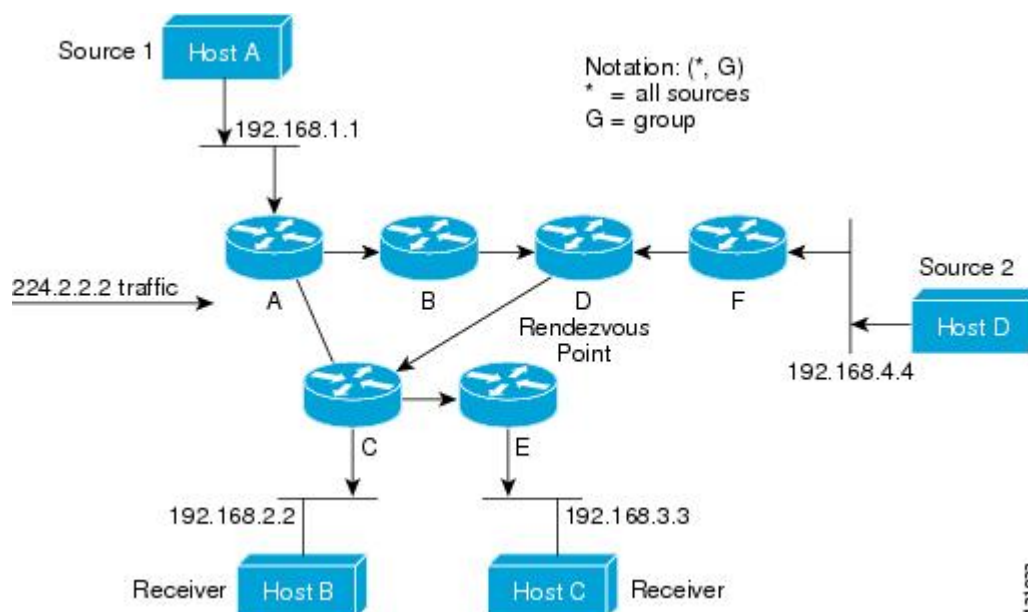
The (S,G) notation implies that a separate SPT exists for each individual source sending to each group--which is correct.

Multicast Distribution Shared Tree

Unlike source trees that have their root at the source, shared trees use a single common root placed at some chosen point in the network. This shared root is called a rendezvous point (RP).

The following figure shows a shared tree for the group 224.2.2.2 with the root located at Router D. This shared tree is unidirectional. Source traffic is sent towards the RP on a source tree. The traffic is then forwarded down the shared tree from the RP to reach all of the receivers (unless the receiver is located between the source and the RP, in which case it will be serviced directly).

Figure 4: Shared Tree



In this example, multicast traffic from the sources, Hosts A and D, travels to the root (Router D) and then down the shared tree to the two receivers, Hosts B and C. Because all sources in the multicast group use a common shared tree, a wildcard notation written as (*, G), pronounced "star comma G", represents the tree. In this case, * means all sources, and G represents the multicast group. Therefore, the shared tree shown in the figure would be written as (*, 224.2.2.2).

Both source trees and shared trees are loop-free. Messages are replicated only where the tree branches. Members of multicast groups can join or leave at any time; therefore the distribution trees must be dynamically updated. When all the active receivers on a particular branch stop requesting the traffic for a particular multicast group, the routers prune that branch from the distribution tree and stop forwarding traffic down that branch. If one receiver on that branch becomes active and requests the multicast traffic, the router will dynamically modify the distribution tree and start forwarding traffic again.

Source Tree Advantage

Source trees have the advantage of creating the optimal path between the source and the receivers. This advantage guarantees the minimum amount of network latency for forwarding multicast traffic. However, this optimization comes at a cost. The routers must maintain path information for each source. In a network that has thousands of sources and thousands of groups, this overhead can quickly become a resource issue on the routers. Memory consumption from the size of the multicast routing table is a factor that network designers must take into consideration.

Shared Tree Advantage

Shared trees have the advantage of requiring the minimum amount of state in each router. This advantage lowers the overall memory requirements for a network that only allows shared trees. The disadvantage of shared trees is that under certain circumstances the paths between the source and receivers might not be the optimal paths, which might introduce some latency in packet delivery. For example, in the figure above the shortest path between Host A (source 1) and Host B (a receiver) would be Router A and Router C. Because we are using Router D as the root for a shared tree, the traffic must traverse Routers A, B, D and then C.

Network designers must carefully consider the placement of the rendezvous point (RP) when implementing a shared tree-only environment.

In unicast routing, traffic is routed through the network along a single path from the source to the destination host. A unicast router does not consider the source address; it considers only the destination address and how to forward the traffic toward that destination. The router scans through its routing table for the destination address and then forwards a single copy of the unicast packet out the correct interface in the direction of the destination.

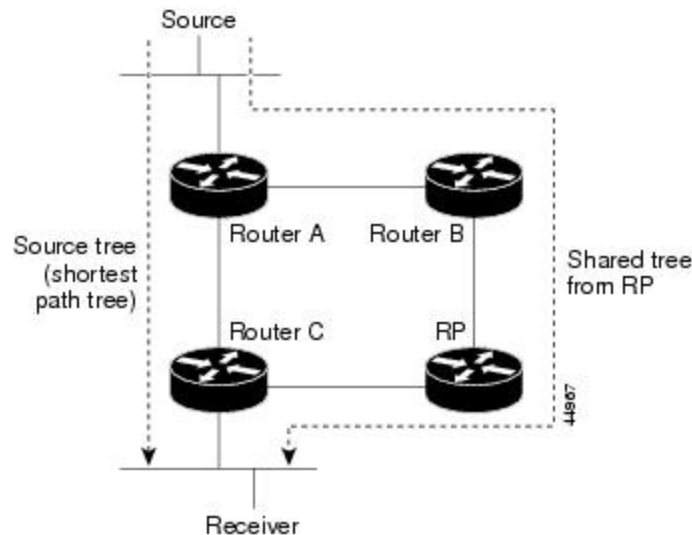
In multicast forwarding, the source is sending traffic to an arbitrary group of hosts that are represented by a multicast group address. The multicast router must determine which direction is the upstream direction (toward the source) and which one is the downstream direction (or directions) toward the receivers. If there are multiple downstream paths, the router replicates the packet and forwards it down the appropriate downstream paths (best unicast route metric)--which is not necessarily all paths. Forwarding multicast traffic away from the source, rather than to the receiver, is called Reverse Path Forwarding (RPF). RPF is described in the following section.

PIM Shared Tree and Source Tree

By default, members of a group receive data from senders to the group across a single data-distribution tree rooted at the RP.

Figure 5: Shared Tree and Source Tree (Shortest-Path Tree)

The following figure shows this type of shared-distribution tree. Data from senders is delivered to the RP for distribution to group members joined to the shared tree.



If the data rate warrants, leaf routers (routers without any downstream connections) on the shared tree can use 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 device to a source tree upon receiving the first data packet from a source.

This process describes the move from a shared tree to a source tree:

1. A receiver joins a group; leaf Router C sends a join message toward the RP.
2. The RP puts a link to Router C in its outgoing interface list.
3. A source sends data; Router A encapsulates the data in a register message and sends it to the RP.

4. The RP forwards the data down the shared tree to Router C and sends a join message toward the source. At this point, data might arrive twice at Router C, once encapsulated and once natively.
5. When data arrives natively (unencapsulated) at the RP, it sends a register-stop message to Router A.
6. By default, reception of the first data packet prompts Router C to send a join message toward the source.
7. When Router C receives data on (S, G), it sends a prune message for the source up the shared tree.
8. The RP deletes the link to Router C from the outgoing interface of (S, G). The 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 that is directly connected to a source and are received by the RP for the group.

Multiple sources sending to groups use the shared tree. You can configure the PIM device to stay on the shared tree.

The change from shared to source tree happens when the first data packet arrives at the last-hop router. This change depends upon the threshold that is configured by using the **ip pim spt-threshold** global configuration command.

The shortest-path tree requires more memory than the shared tree but reduces delay. You may want to postpone its use. Instead of allowing the leaf router to immediately move to the shortest-path tree, you can specify that the traffic must first reach a threshold.

You can configure when a PIM leaf router should join the shortest-path tree for a specified group. If a source sends at a rate greater than or equal to the specified kbps rate, the multilayer switch triggers a PIM join message toward the source to construct a source tree (shortest-path tree). If the traffic rate from the source drops below the threshold value, the leaf router switches back to the shared tree and sends a prune message toward the source.

You can specify to which groups the shortest-path tree threshold applies by using a group list (a standard access list). If a value of 0 is specified or if the group list is not used, the threshold applies to all groups.

Reverse Path Forwarding

In unicast routing, traffic is routed through the network along a single path from the source to the destination host. A unicast router does not consider the source address; it considers only the destination address and how to forward the traffic toward that destination. The router scans through its routing table for the destination network and then forwards a single copy of the unicast packet out the correct interface in the direction of the destination.

In multicast forwarding, the source is sending traffic to an arbitrary group of hosts that are represented by a multicast group address. The multicast router must determine which direction is the upstream direction (toward the source) and which one is the downstream direction (or directions) toward the receivers. If there are multiple downstream paths, the router replicates the packet and forwards it down the appropriate downstream paths (best unicast route metric)--which is not necessarily all paths. Forwarding multicast traffic away from the source, rather than to the receiver, is called Reverse Path Forwarding (RPF). RPF is an algorithm used for forwarding multicast datagrams.

Protocol Independent Multicast (PIM) uses the unicast routing information to create a distribution tree along the reverse path from the receivers towards the source. The multicast routers then forward packets along the distribution tree from the source to the receivers. RPF is a key concept in multicast forwarding. It enables

routers to correctly forward multicast traffic down the distribution tree. RPF makes use of the existing unicast routing table to determine the upstream and downstream neighbors. A router will forward a multicast packet only if it is received on the upstream interface. This RPF check helps to guarantee that the distribution tree will be loop-free.

RPF Check

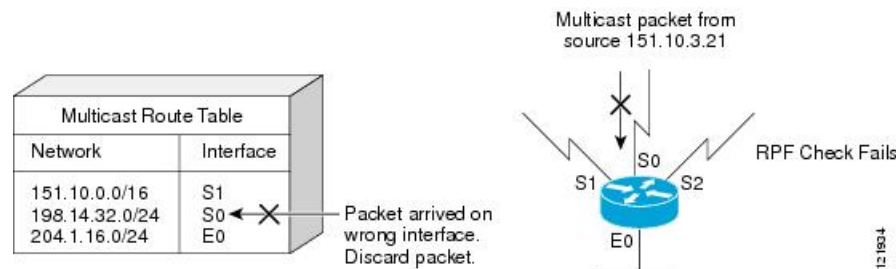
When a multicast packet arrives at a router, the router performs an RPF check on the packet. If the RPF check succeeds, the packet is forwarded. Otherwise, it is dropped.

For traffic flowing down a source tree, the RPF check procedure works as follows:

1. The router looks up the source address in the unicast routing table to determine if the packet has arrived on the interface that is on the reverse path back to the source.
2. If the packet has arrived on the interface leading back to the source, the RPF check succeeds and the packet is forwarded out the interfaces present in the outgoing interface list of a multicast routing table entry.
3. If the RPF check in Step 2 fails, the packet is dropped.

The figure shows an example of an unsuccessful RPF check.

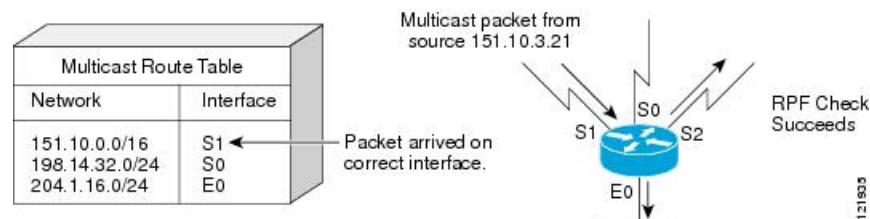
Figure 6: RPF Check Fails



As the figure illustrates, a multicast packet from source 151.10.3.21 is received on serial interface 0 (S0). A check of the unicast route table shows that S1 is the interface this router would use to forward unicast data to 151.10.3.21. Because the packet has arrived on interface S0, the packet is discarded.

The figure shows an example of a successful RPF check.

Figure 7: RPF Check Succeeds



In this example, the multicast packet has arrived on interface S1. The router refers to the unicast routing table and finds that S1 is the correct interface. The RPF check passes, and the packet is forwarded.

PIM uses both source trees and RP-rooted shared trees to forward datagrams. The RPF check is performed differently for each:

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



Note DVMRP is not supported on the switch.

Sparse-mode PIM uses the RPF lookup function to decide 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.

Default PIM Routing Configuration

This table displays the default PIM routing configuration for the device.

Table 5: Default Multicast Routing Configuration

Feature	Default Setting
Multicast routing	Disabled on all interfaces.
PIM version	Version 2.
PIM mode	No mode is defined.
PIM RP address	None configured.
PIM domain border	Disabled.
PIM multicast boundary	None.
Candidate BSRs	Disabled.
Candidate RPs	Disabled.
Shortest-path tree threshold rate	0 kb/s.
PIM router query message interval	30 seconds.

How to Configure PIM

Configuring a Rendezvous Point

You must have a rendezvous point (RP), if you want to handle the group as a sparse group. You can use these methods:

- By manually assigning an RP to multicast groups.
- As a standalone, which includes Cisco-proprietary protocol separate from PIMv1.
- By using a standards track protocol in the Internet Engineering Task Force (IETF), which includes configuring PIMv2 BSR .



Note You can use Auto-RP, BSR, or a combination of both, depending on the PIM version that you are running and the types of routers in your network.

Manually Assigning an RP to Multicast Groups

If the rendezvous point (RP) for a group is learned through a dynamic mechanism (such as Auto-RP or BSR), you need not perform this task for that RP.

Senders of multicast traffic announce their existence through register messages received from the source first-hop router (designated router) and forwarded to the RP. Receivers of multicast packets use RPs to join a multicast group by using explicit join messages.



Note RPs are not members of the multicast group; they serve as a *meeting place* for multicast sources and group members.

You can configure a single RP for multiple groups defined by an access list. If there is no RP configured for a group, the multilayer switch responds to the group as dense and uses the dense-mode PIM techniques.

This procedure is optional.

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.

	Command or Action	Purpose
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	ip pim rp-address <i>ip-address</i> [<i>access-list-number</i>] [<i>override</i>] Example: Device(config)# ip pim rp-address 10.1.1.1 20 override	<p>Configures the address of a PIM RP.</p> <p>By default, no PIM RP address is configured. You must configure the IP address of RPs on all routers and multilayer switches (including the RP).</p> <p>Note If there is no RP configured for a group, the device treats the group as dense, using the dense-mode PIM techniques.</p> <p>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. The access list conditions specify for which groups the device is an RP.</p> <ul style="list-style-type: none"> • For <i>ip-address</i>, enter the unicast address of the RP in dotted-decimal notation. • (Optional) For <i>access-list-number</i>, enter an IP standard access list number from 1 to 99. If no access list is configured, the RP is used for all groups. • (Optional) The override keyword indicates that if there is a conflict between the RP configured with this command and one learned by Auto-RP or BSR, the RP configured with this command prevails.
Step 4	access-list <i>access-list-number</i> {deny permit} <i>source</i> [<i>source-wildcard</i>] Example: Device(config)# access-list 25 permit 10.5.0.1 255.224.0.0	<p>Creates a standard access list, repeating the command as many times as necessary.</p> <ul style="list-style-type: none"> • For <i>access-list-number</i>, enter the access list number specified in Step 2. • The deny keyword denies access if the conditions are matched. • The permit keyword permits access if the conditions are matched. • For <i>source</i>, enter the multicast group address for which the RP should be used.

	Command or Action	Purpose
		<ul style="list-style-type: none"> • (Optional) For <i>source-wildcard</i>, enter the wildcard bits in dotted decimal notation to be applied to the source. Place ones in the bit positions that you want to ignore. <p>The access list is always terminated by an implicit deny statement for everything.</p>
Step 5	end Example: <pre>Device(config)# end</pre>	Returns to privileged EXEC mode.
Step 6	show running-config Example: <pre>Device# show running-config</pre>	Verifies your entries.
Step 7	copy running-config startup-config Example: <pre>Device# copy running-config startup-config</pre>	(Optional) Saves your entries in the configuration file.

Setting Up Auto-RP in a New Internetwork



Note Omit Step 3 in the following procedure, if you want to configure a PIM router as the RP for the local group.

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	show running-config Example: <pre>Device# show running-config</pre>	Verifies that a default RP is already configured on all PIM devices and the RP in the sparse-mode network. It was previously configured with the ip pim rp-address global configuration command.

	Command or Action	Purpose
		<p>Note This step is not required for sparse-dense-mode environments.</p> <p>The selected RP should have good connectivity and be available across the network. Use this RP for the global groups (for example, 224.x.x.x and other global groups). Do not reconfigure the group address range that this RP serves. RPs dynamically discovered through Auto-RP take precedence over statically configured RPs. Assume that it is desirable to use a second RP for the local groups.</p>
Step 3	<p>configure terminal</p> <p>Example:</p> <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 4	<p>ip pim send-rp-announce interface-id scope ttl group-list access-list-number interval seconds</p> <p>Example:</p> <pre>Device(config)# ip pim send-rp-announce gigabitethernet 1/5 scope 20 group-list 10 interval 120</pre>	<p>Configures another PIM device to be the candidate RP for local groups.</p> <ul style="list-style-type: none"> For <i>interface-id</i>, enter the interface type and number that identifies the RP address. Valid interfaces include physical ports, port channels, and VLANs. For scope <i>ttl</i>, specify the time-to-live value in hops. Enter a hop count that is high enough so that the RP-announce messages reach all mapping agents in the network. There is no default setting. The range is 1 to 255. For group-list <i>access-list-number</i>, enter an IP standard access list number from 1 to 99. If no access list is configured, the RP is used for all groups. For interval <i>seconds</i>, specify how often the announcement messages must be sent. The default is 60 seconds. The range is 1 to 16383.
Step 5	<p>access-list access-list-number {deny permit} source [source-wildcard]</p> <p>Example:</p> <pre>Device(config)# access-list 10 permit</pre>	<p>Creates a standard access list, repeating the command as many times as necessary.</p> <ul style="list-style-type: none"> For <i>access-list-number</i>, enter the access list number specified in Step 3.

	Command or Action	Purpose
	10.10.0.0	<ul style="list-style-type: none"> The deny keyword denies access if the conditions are matched. The permit keyword permits access if the conditions are matched. For <i>source</i>, enter the multicast group address range for which the RP should be used. (Optional) For <i>source-wildcard</i>, enter the wildcard bits in dotted decimal notation to be applied to the source. Place ones in the bit positions that you want to ignore. <p>Note Recall that the access list is always terminated by an implicit deny statement for everything.</p>
Step 6	ip pim send-rp-discovery scope <i>tvl</i> Example: <pre>Device(config)# ip pim send-rp-discovery scope 50</pre>	<p>Finds a device whose connectivity is not likely to be interrupted, and assign it the role of RP-mapping agent.</p> <p>For scope <i>tvl</i>, specify the time-to-live value in hops to limit the RP discovery packets. All devices within the hop count from the source device receive the Auto-RP discovery messages. These messages tell other devices which group-to-RP mapping to use to avoid conflicts (such as overlapping group-to-RP ranges). There is no default setting. The range is 1 to 255.</p>
Step 7	end Example: <pre>Device(config)# end</pre>	Returns to privileged EXEC mode.
Step 8	show running-config Example: <pre>Device# show running-config</pre>	Verifies your entries.
Step 9	show ip pim rp mapping Example: <pre>Device# show ip pim rp mapping</pre>	Displays active RPs that are cached with associated multicast routing entries.

	Command or Action	Purpose
Step 10	show ip pim rp Example: <pre>Device# show ip pim rp</pre>	Displays the information cached in the routing table.
Step 11	copy running-config startup-config Example: <pre>Device# copy running-config startup-config</pre>	(Optional) Saves your entries in the configuration file.

Adding Auto-RP to an Existing Sparse-Mode Cloud

This section contains suggestions for the initial deployment of Auto-RP into an existing sparse-mode cloud to minimize disruption of the existing multicast infrastructure.

This procedure is optional.

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	show running-config Example: <pre>Device# show running-config</pre>	Verifies that a default RP is already configured on all PIM devices and the RP in the sparse-mode network. It was previously configured with the ip pim rp-address global configuration command. Note This step is not required for sparse-dense-mode environments. The selected RP should have good connectivity and be available across the network. Use this RP for the global groups (for example, 224.x.x.x and other global groups). Do not reconfigure the group address range that this RP serves. RPs dynamically discovered through Auto-RP take precedence over statically configured RPs. Assume that it is desirable to use a second RP for the local groups.

	Command or Action	Purpose
Step 3	configure terminal Example: <pre>Device # configure terminal</pre>	Enters global configuration mode.
Step 4	ip pim send-rp-announce <i>interface-id</i> scope <i>ttl</i> group-list <i>access-list-number</i> interval <i>seconds</i> Example: <pre>Device(config)# ip pim send-rp-announce gigabitethernet 1/5 scope 20 group-list 10 interval 120</pre>	<p>Configures another PIM device to be the candidate RP for local groups.</p> <ul style="list-style-type: none"> For <i>interface-id</i>, enter the interface type and number that identifies the RP address. Valid interfaces include physical ports, port channels, and VLANs. For scope <i>ttl</i>, specify the time-to-live value in hops. Enter a hop count that is high enough so that the RP-announce messages reach all mapping agents in the network. There is no default setting. The range is 1 to 255. For group-list <i>access-list-number</i>, enter an IP standard access list number from 1 to 99. If no access list is configured, the RP is used for all groups. For interval <i>seconds</i>, specify how often the announcement messages must be sent. The default is 60 seconds. The range is 1 to 16383.
Step 5	access-list <i>access-list-number</i> {deny permit} <i>source</i> [<i>source-wildcard</i>] Example: <pre>Device(config)# access-list 10 permit 224.0.0.0 15.255.255.255</pre>	<p>Creates a standard access list, repeating the command as many times as necessary.</p> <ul style="list-style-type: none"> For <i>access-list-number</i>, enter the access list number specified in Step 3. The deny keyword denies access if the conditions are matched. The permit keyword permits access if the conditions are matched. For <i>source</i>, enter the multicast group address range for which the RP should be used. (Optional) For <i>source-wildcard</i>, enter the wildcard bits in dotted decimal notation to be applied to the source. Place ones in the bit positions that you want to ignore.

	Command or Action	Purpose
		Recall that the access list is always terminated by an implicit deny statement for everything.
Step 6	ip pim send-rp-discovery scope ttl Example: <pre>Device(config)# ip pim send-rp-discovery scope 50</pre>	<p>Finds a device whose connectivity is not likely to be interrupted, and assigns it the role of RP-mapping agent.</p> <p>For scope ttl, specify the time-to-live value in hops to limit the RP discovery packets. All devices within the hop count from the source device receive the Auto-RP discovery messages. These messages tell other devices which group-to-RP mapping to use to avoid conflicts (such as overlapping group-to-RP ranges). There is no default setting. The range is 1 to 255.</p> <p>Note To remove the device as the RP-mapping agent, use the no ip pim send-rp-discovery global configuration command.</p>
Step 7	end Example: <pre>Device(config)# end</pre>	Returns to privileged EXEC mode.
Step 8	show running-config Example: <pre>Device# show running-config</pre>	Verifies your entries.
Step 9	show ip pim rp mapping Example: <pre>Device# show ip pim rp mapping</pre>	Displays active RPs that are cached with associated multicast routing entries.
Step 10	show ip pim rp Example: <pre>Device# show ip pim rp</pre>	Displays the information cached in the routing table.
Step 11	copy running-config startup-config Example: <pre>Device# copy running-config</pre>	(Optional) Saves your entries in the configuration file.

	Command or Action	Purpose
	<code>startup-config</code>	

Preventing Join Messages to False RPs

Determine whether the **ip pim accept-rp** command was previously configured throughout the network by using the **show running-config** privileged EXEC command. If the **ip pim accept-rp** command is not configured on any device, this problem can be addressed later. In those routers or multilayer switches already configured with the **ip pim accept-rp** command, you must enter the command again to accept the newly advertised RP.

Filtering Incoming RP Announcement Messages

You can add configuration commands to the mapping agents to prevent a maliciously configured router from masquerading as a candidate RP and causing problems.

This procedure is optional.

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	ip pim rp-announce-filter rp-list access-list-number group-list access-list-number Example: Device(config)# ip pim rp-announce-filter rp-list 10 group-list 14	Filters incoming RP announcement messages. Enter this command on each mapping agent in the network. Without this command, all incoming RP-announce messages are accepted by default. For rp-list access-list-number , configure an access list of candidate RP addresses that, if permitted, is accepted for the group ranges supplied in the group-list access-list-number variable. If this variable is omitted, the filter applies to all multicast groups. If more than one mapping agent is used, the filters must be consistent across all mapping agents to ensure that no conflicts occur in the group-to-RP mapping information.

	Command or Action	Purpose
Step 4	<p>access-list <i>access-list-number</i> {deny permit} <i>source</i> [<i>source-wildcard</i>]</p> <p>Example:</p> <pre>Device(config)# access-list 10 permit 10.8.1.0 255.255.224.0</pre>	<p>Creates a standard access list, repeating the command as many times as necessary.</p> <ul style="list-style-type: none"> For <i>access-list-number</i>, enter the access list number specified in Step 2. The deny keyword denies access if the conditions are matched. The permit keyword permits access if the conditions are matched. Create an access list that specifies from which routers and multilayer switches the mapping agent accepts candidate RP announcements (rp-list ACL). Create an access list that specifies the range of multicast groups from which to accept or deny (group-list ACL). For <i>source</i>, enter the multicast group address range for which the RP should be used. (Optional) For <i>source-wildcard</i>, enter the wildcard bits in dotted decimal notation to be applied to the source. Place ones in the bit positions that you want to ignore. <p>The access list is always terminated by an implicit deny statement for everything.</p>
Step 5	<p>end</p> <p>Example:</p> <pre>Device(config)# end</pre>	Returns to privileged EXEC mode.
Step 6	<p>show running-config</p> <p>Example:</p> <pre>Device# show running-config</pre>	Verifies your entries.
Step 7	<p>copy running-config startup-config</p> <p>Example:</p> <pre>Device# copy running-config startup-config</pre>	(Optional) Saves your entries in the configuration file.

Configuring PIMv2 BSR

The process for configuring PIMv2 BSR may involve the following optional tasks:

- Defining the PIM domain border
- Defining the IP multicast boundary
- Configuring candidate BSRs
- Configuring candidate RPs

Defining the PIM Domain Border

Perform the following steps to configure the PIM domain border. This procedure is optional.

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	interface <i>interface-id</i> Example: <pre>Device(config)# interface gigabitethernet 1/3</pre>	Specifies the interface to be configured, and enters interface configuration mode.
Step 4	ip pim bsr-border Example: <pre>Device(config-if)# ip pim bsr-border</pre>	Defines a PIM bootstrap message boundary for the PIM domain. Enter this command on each interface that connects to other bordering PIM domains. This command instructs the device to neither send nor receive PIMv2 BSR messages on this interface. Note To remove the PIM border, use the no ip pim bsr-border interface configuration command.

	Command or Action	Purpose
Step 5	end Example: <pre>Device(config)# end</pre>	Returns to privileged EXEC mode.
Step 6	show running-config Example: <pre>Device# show running-config</pre>	Verifies your entries.
Step 7	copy running-config startup-config Example: <pre>Device# copy running-config startup-config</pre>	(Optional) Saves your entries in the configuration file.

Defining the IP Multicast Boundary

You define a multicast boundary to prevent Auto-RP messages from entering the PIM domain. You create an access list to deny packets destined for 224.0.1.39 and 224.0.1.40, which carry Auto-RP information.

This procedure is optional.

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: <pre>Device # configure terminal</pre>	Enters global configuration mode.
Step 3	access-list access-list-number deny source [source-wildcard] Example: <pre>Device(config)# access-list 12 deny 224.0.1.39 access-list 12 deny 224.0.1.40</pre>	Creates a standard access list, repeating the command as many times as necessary. <ul style="list-style-type: none"> • For <i>access-list-number</i>, the range is 1 to 99. • The deny keyword denies access if the conditions are matched.

	Command or Action	Purpose
		<ul style="list-style-type: none"> For <i>source</i>, enter multicast addresses 224.0.1.39 and 224.0.1.40, which carry Auto-RP information. (Optional) For <i>source-wildcard</i>, enter the wildcard bits in dotted decimal notation to be applied to the source. Place ones in the bit positions that you want to ignore. <p>The access list is always terminated by an implicit deny statement for everything.</p>
Step 4	interface <i>interface-id</i> Example: <pre>Device(config)# interface gigabitethernet 1/3</pre>	Specifies the interface to be configured, and enters interface configuration mode.
Step 5	ip multicast boundary <i>access-list-number</i> Example: <pre>Device(config-if)# ip multicast boundary 12</pre>	Configures the boundary, specifying the access list you created in Step 2.
Step 6	end Example: <pre>Device(config)# end</pre>	Returns to privileged EXEC mode.
Step 7	show running-config Example: <pre>Device# show running-config</pre>	Verifies your entries.
Step 8	copy running-config startup-config Example: <pre>Device# copy running-config startup-config</pre>	(Optional) Saves your entries in the configuration file.

Configuring Candidate BSRs

You can configure one or more candidate BSRs. The devices serving as candidate BSRs should have good connectivity to other devices and be in the backbone portion of the network.

This procedure is optional.

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	ip pim bsr-candidate interface-id hash-mask-length [priority] Example: Device(config)# ip pim bsr-candidate gigabitethernet 1/3 28 100	Configures your device to be a candidate BSR. <ul style="list-style-type: none"> • For <i>interface-id</i>, enter the interface on this device from which the BSR address is derived to make it a candidate. This interface must be enabled with PIM. Valid interfaces include physical ports, port channels, and VLANs. • For <i>hash-mask-length</i>, specify the mask length (32 bits maximum) that is to be ANDed with the group address before the hash function is called. All groups with the same seed hash correspond to the same RP. For example, if this value is 24, only the first 24 bits of the group addresses matter. • (Optional) For <i>priority</i>, enter a number from 0 to 255. The BSR with the larger priority is preferred. If the priority values are the same, the device with the highest IP address is selected as the BSR. The default is 0.
Step 4	end Example: Device(config-if) # end	Returns to privileged EXEC mode.
Step 5	show running-config Example:	Verifies your entries.

	Command or Action	Purpose
	Device# show running-config	
Step 6	copy running-config startup-config Example: Device# copy running-config startup-config	(Optional) Saves your entries in the configuration file.

Configuring the Candidate RPs

You can configure one or more candidate RPs. Similar to BSRs, the RPs should also have good connectivity to other devices and be in the backbone portion of the network. An RP can serve the entire IP multicast address space or a portion of it. Candidate RPs send candidate RP advertisements to the BSR.

This procedure is optional.

Before you begin

When deciding which devices should be RPs, consider these options:

- In a network of Cisco routers and multilayer switches where only Auto-RP is used, any device can be configured as an RP.
- In a network that includes only Cisco PIMv2 routers and multilayer switches and with routers from other vendors, any device can be used as an RP.
- In a network of Cisco PIMv1 routers, Cisco PIMv2 routers, and routers from other vendors, configure only Cisco PIMv2 routers and multilayer switches as RPs.

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	ip pim rp-candidate interface-id [group-list access-list-number] Example:	Configures your device to be a candidate RP. <ul style="list-style-type: none"> • For <i>interface-id</i>, specify the interface whose associated IP address is advertised

	Command or Action	Purpose
	<pre>Device(config)# ip pim rp-candidate gigabitethernet 1/5 group-list 10</pre>	<p>as a candidate RP address. Valid interfaces include physical ports, port channels, and VLANs.</p> <ul style="list-style-type: none"> • (Optional) For group-list <i>access-list-number</i>, enter an IP standard access list number from 1 to 99. If no group-list is specified, the device is a candidate RP for all groups.
Step 4	<p>access-list <i>access-list-number</i> {deny permit} <i>source</i> [<i>source-wildcard</i>]</p> <p>Example:</p> <pre>Device(config)# access-list 10 permit 239.0.0.0 0.255.255.255</pre>	<p>Creates a standard access list, repeating the command as many times as necessary.</p> <ul style="list-style-type: none"> • For <i>access-list-number</i>, enter the access list number specified in Step 2. • The deny keyword denies access if the conditions are matched. The permit keyword permits access if the conditions are matched. • For <i>source</i>, enter the number of the network or host from which the packet is being sent. • (Optional) For <i>source-wildcard</i>, enter the wildcard bits in dotted decimal notation to be applied to the source. Place ones in the bit positions that you want to ignore. <p>The access list is always terminated by an implicit deny statement for everything.</p>
Step 5	<p>end</p> <p>Example:</p> <pre>Device(config)# end</pre>	Returns to privileged EXEC mode.
Step 6	<p>show running-config</p> <p>Example:</p> <pre>Device# show running-config</pre>	Verifies your entries.
Step 7	<p>copy running-config startup-config</p> <p>Example:</p> <pre>Device# copy running-config startup-config</pre>	(Optional) Saves your entries in the configuration file.

Configuring Sparse Mode with Auto-RP

Before you begin

- All access lists that are needed when Auto-RP is configured should be configured prior to beginning the configuration task.



Note

- When configuring Auto-RP, you must either configure the Auto-RP listener feature (Step 5) and specify sparse mode (Step 7).

Follow this procedure to configure auto-rendezvous point (Auto-RP). Auto-RP can also be optionally used with anycast RP.

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	ip multicast-routing Example: Device(config)# ip multicast-routing	Enables IP multicast routing.
Step 4	Either perform Steps 5 through 7 or perform Steps 6 and 8.	--
Step 5	interface <i>type number</i> Example: Device(config)# interface Gigabitethernet 1/0	Selects an interface that is connected to hosts on which PIM can be enabled.
Step 6	ip pim sparse-mode Example: Device(config-if)# ip pim sparse-mode	Enables PIM sparse mode on an interface. When configuring Auto-RP in sparse mode, you must also configure the Auto-RP listener in the next step.

	Command or Action	Purpose
Step 7	exit Example: Device(config-if)# exit	Exits interface configuration mode and returns to global configuration mode.
Step 8	Repeat Steps 1 through 9 on all PIM interfaces.	--
Step 9	ip pim send-rp-announce { <i>interface-type</i> <i>interface-number</i> <i>ip-address</i> } scope <i>ttl-value</i> [group-list <i>access-list</i>] [interval <i>seconds</i>] [bidir]	Sends RP announcements out all PIM-enabled interfaces. <ul style="list-style-type: none"> • Perform this step on the RP device only. • Use the <i>interface-type</i> and <i>interface-number</i> arguments to define which IP address is to be used as the RP address. • Use the <i>ip-address</i> argument to specify a directly connected IP address as the RP address. <p>Note If the <i>ip-address</i> argument is configured for this command, the RP-announce message will be sourced by the interface to which this IP address is connected (that is, the source address in the IP header of the RP-announce message is the IP address of that interface).</p> <ul style="list-style-type: none"> • This example shows that the interface is enabled with a maximum of 31 hops. The IP address by which the device wants to be identified as RP is the IP address associated with loopback interface 0. Access list 5 describes the groups for which this device serves as RP.
Step 10	ip pim send-rp-discovery [<i>interface-type</i> <i>interface-number</i>] scope <i>ttl-value</i> [interval <i>seconds</i>]	Configures the device to be an RP mapping agent. <ul style="list-style-type: none"> • Perform this step on RP mapping agent devices or on combined RP/RP mapping agent devices. <p>Note Auto-RP allows the RP function to run separately on one device and the RP mapping agent to run on one or multiple devices. It is possible to deploy the RP and the RP mapping agent on a combined RP/RP mapping agent device.</p>

	Command or Action	Purpose
		<ul style="list-style-type: none"> • Use the optional <i>interface-type</i> and <i>interface-number</i> arguments to define which IP address is to be used as the source address of the RP mapping agent. • Use the scope keyword and <i>tvl-value</i> argument to specify the Time-to-Live (TTL) value in the IP header of Auto-RP discovery messages. • Use the optional interval keyword and <i>seconds</i> argument to specify the interval at which Auto-RP discovery messages are sent. <p>Note Lowering the interval at which Auto-RP discovery messages are sent from the default value of 60 seconds results in more frequent floodings of the group-to-RP mappings. In some network environments, the disadvantages of lowering the interval (more control packet overhead) may outweigh the advantages (more frequent group-to-RP mapping updates).</p> <ul style="list-style-type: none"> • The example shows limiting the Auto-RP discovery messages to 31 hops on loopback interface 1.
Step 11	ip pim rp-announce-filter rp-list <i>access-list</i> group-list <i>access-list</i> Example: <pre>Device(config)# ip pim rp-announce-filter rp-list 1 group-list 2</pre>	Filters incoming RP announcement messages sent from candidate RPs (C-RPs) to the RP mapping agent. <ul style="list-style-type: none"> • Perform this step on the RP mapping agent only.
Step 12	interface <i>type number</i> Example: <pre>Device(config)# interface gigabitethernet 1/0</pre>	Selects an interface that is connected to hosts on which PIM can be enabled.
Step 13	ip multicast boundary <i>access-list</i> [filter-autorp]	Configures an administratively scoped boundary. <ul style="list-style-type: none"> • Perform this step on the interfaces that are boundaries to other devices. • The access list is not shown in this task.

	Command or Action	Purpose
		<ul style="list-style-type: none"> An access list entry that uses the deny keyword creates a multicast boundary for packets that match that entry.
Step 14	end Example: <pre>Device(config-if)# end</pre>	Returns to global configuration mode.
Step 15	show ip pim autorp Example: <pre>Device# show ip pim autorp</pre>	(Optional) Displays the Auto-RP information.
Step 16	show ip pim rp [mapping] [rp-address] Example: <pre>Device# show ip pim rp mapping</pre>	(Optional) Displays RPs known in the network and shows how the device learned about each RP.
Step 17	show ip igmp groups [group-name group-address interface-type interface-number] [detail] Example: <pre>Device# show ip igmp groups</pre>	(Optional) Displays the multicast groups having receivers that are directly connected to the device and that were learned through Internet Group Management Protocol (IGMP). <ul style="list-style-type: none"> A receiver must be active on the network at the time that this command is issued in order for receiver information to be present on the resulting display.
Step 18	show ip mroute [group-address group-name] [source-address source-name] [interface-type interface-number] [summary] [count] [active kbps] Example: <pre>Device# show ip mroute cbone-audio</pre>	(Optional) Displays the contents of the IP multicast routing (mroute) table.

Delaying the Use of PIM Shortest-Path Tree

Perform these steps to configure a traffic rate threshold that must be reached before multicast routing is switched from the source tree to the shortest-path tree.

This procedure is optional.

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	access-list <i>access-list-number</i> {deny permit} <i>source</i> [<i>source-wildcard</i>] Example: <pre>Device(config)# access-list 16 permit 225.0.0.0 0.255.255.255</pre>	Creates a standard access list. <ul style="list-style-type: none"> • For <i>access-list-number</i>, the range is 1 to 99. • The deny keyword denies access if the conditions are matched. • The permit keyword permits access if the conditions are matched. • For <i>source</i>, specify the multicast group to which the threshold will apply. • (Optional) For <i>source-wildcard</i>, enter the wildcard bits in dotted decimal notation to be applied to the source. Place ones in the bit positions that you want to ignore. <p>The access list is always terminated by an implicit deny statement for everything.</p>
Step 4	ip pim spt-threshold {<i>kbits</i> infinity} [<i>group-list access-list-number</i>] Example: <pre>Device(config)# ip pim spt-threshold infinity group-list 16</pre>	Specifies the threshold that must be reached before moving to shortest-path tree (spt). <ul style="list-style-type: none"> • For <i>kbits</i>, specify the traffic rate in kilobits per second. The default is 0 kbps. <p>Note Because of device hardware limitations, 0 kbps is the only valid entry even though the range is 0 to 4294967.</p> <ul style="list-style-type: none"> • Specify infinity if you want all sources for the specified group to use the shared tree, never switching to the source tree.

	Command or Action	Purpose
		<ul style="list-style-type: none"> (Optional) For group-list <i>access-list-number</i>, specify the access list created in Step 2. If the value is 0 or if the group list is not used, the threshold applies to all groups.
Step 5	end Example: Device(config)# end	Returns to privileged EXEC mode.
Step 6	show running-config Example: Device# show running-config	Verifies your entries.
Step 7	copy running-config startup-config Example: Device# copy running-config startup-config	(Optional) Saves your entries in the configuration file.

Modifying the PIM Router-Query Message Interval

PIM routers and multilayer switches send PIM router-query messages to find which device will be the designated router (DR) for each LAN segment (subnet). The DR is responsible for sending IGMP host-query messages to all hosts on the directly connected LAN.

With PIM DM operation, the DR has meaning only if IGMPv1 is in use. IGMPv1 does not have an IGMP querier election process, so the elected DR functions as the IGMP querier. With PIM-SM operation, the DR is the device that is directly connected to the multicast source. It sends PIM register messages to notify the RP that multicast traffic from a source needs to be forwarded down the shared tree. In this case, the DR is the device with the highest IP address.

This procedure is optional.

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.

	Command or Action	Purpose
Step 2	configure terminal Example: <pre>Device # configure terminal</pre>	Enters global configuration mode.
Step 3	interface <i>interface-id</i> Example: <pre>Device(config)# interface gigabitethernet 1/3</pre>	Specifies the interface to be configured, and enters interface configuration mode.
Step 4	ip pim query-interval <i>seconds</i> Example: <pre>Device(config-if)# ip pim query-interval 45</pre>	Configures the frequency at which the device sends PIM router-query messages. The default is 30 seconds. The range is 1 to 65535.
Step 5	end Example: <pre>Device(config-if)# end</pre>	Returns to privileged EXEC mode.
Step 6	show ip igmp interface [<i>interface-id</i>] Example: <pre>Device# show ip igmp interface</pre>	Verifies your entries.
Step 7	copy running-config startup-config Example: <pre>Device# copy running-config startup-config</pre>	(Optional) Saves your entries in the configuration file.

Verifying PIM Operations

Verifying IP Multicast Operation in a PIM-SM or a PIM-SSM Network

When you verify the operation of IP multicast in a PIM-SM network environment or in a PIM-SSM network environment, a useful approach is to begin the verification process on the last hop router, and then continue the verification process on the routers along the SPT until the first hop router has been reached. The goal of the verification is to ensure that IP multicast traffic is being routed properly through an IP multicast network.

Perform the following optional tasks to verify IP multicast operation in a PIM-SM or a PIM-SSM network. The steps in these tasks help to locate a faulty hop when sources and receivers are not operating as expected.



Note If packets are not reaching their expected destinations, you might want consider disabling IP multicast fast switching, which would place the router in process switching mode. If packets begin reaching their proper destinations after IP multicast fast switching has been disabled, then the issue most likely was related to IP multicast fast switching.

Verifying IP Multicast on the First Hop Router

Enter these commands on the first hop router to verify IP multicast operations on the first hop router:

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	show ip mroute [group-address] Example: Device# show ip mroute 239.1.2.3 (*, 239.1.2.3), 00:18:10/stopped, RP 172.16.0.1, flags: SPF Incoming interface: Serial1/0, RPF nbr 172.31.200.2 Outgoing interface list: Null (10.0.0.1, 239.1.2.3), 00:18:10/00:03:22, flags: FT Incoming interface: GigabitEthernet0/0, RPF nbr 0.0.0.0 Outgoing interface list: Serial1/0, Forward/Sparse, 00:18:10/00:03:19	Confirms that the F flag has been set for mroutes on the first hop router.
Step 3	show ip mroute active [kb/s] Example: Device# show ip mroute active Active IP Multicast Sources - sending >= 4 kbps Group: 239.1.2.3, (?) Source: 10.0.0.1 (?) Rate: 20 pps/4 kbps(1sec), 4 kbps(last 30 secs), 4 kbps(life avg)	Displays information about active multicast sources sending to groups. The output of this command provides information about the multicast packet rate for active sources. Note By default, the output of the show ip mroute command with the active keyword displays information about active sources sending traffic to groups at a rate greater than or equal to 4 kb/s. To display information about active

	Command or Action	Purpose
		sources sending low-rate traffic to groups (that is, traffic less than 4 kb/s), specify a value of 1 for the <i>kb/s</i> argument. Specifying a value of 1 for this argument displays information about active sources sending traffic to groups at a rate equal to or greater than 1 kb/s, which effectively displays information about all possible active source traffic.

Verifying IP Multicast on Routers Along the SPT

Enter these commands on routers along the SPT to verify IP multicast operations on routers along the SPT in a PIM-SM or PIM-SSM network:

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	show ip mroute [<i>group-address</i>] Example: Device# show ip mroute 239.1.2.3 (*, 239.1.2.3), 00:17:56/00:03:02, RP 172.16.0.1, flags: S Incoming interface: Null, RPF nbr 0.0.0.0 Outgoing interface list: GigabitEthernet0/0, Forward/Sparse, 00:17:56/00:03:02 (10.0.0.1, 239.1.2.3), 00:15:34/00:03:28, flags: T Incoming interface: Serial1/0, RPF nbr 172.31.200.1 Outgoing interface list: GigabitEthernet0/0, Forward/Sparse, 00:15:34/00:03:02	Confirms the RPF neighbor towards the source for a particular group or groups.
Step 3	show ip mroute active Example: Device# show ip mroute active Active IP Multicast Sources - sending >= 4 kbps Group: 239.1.2.3, (?) Source: 10.0.0.1 (?)	Displays information about active multicast sources sending to groups. The output of this command provides information about the multicast packet rate for active sources. Note By default, the output of the show ip mroute command with the active keyword displays

	Command or Action	Purpose
	Rate: 20 pps/4 kbps(1sec), 4 kbps(last 30 secs), 4 kbps(life avg)	information about active sources sending traffic to groups at a rate greater than or equal to 4 kb/s. To display information about active sources sending low-rate traffic to groups (that is, traffic less than 4 kb/s), specify a value of 1 for the <i>kb/s</i> argument. Specifying a value of 1 for this argument displays information about active sources sending traffic to groups at a rate equal to or greater than 1 kb/s, which effectively displays information about all possible active source traffic.

Verifying IP Multicast Operation on the Last Hop Router

Enter these commands on the last hop router to verify IP multicast operations on the last hop router:

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	show ip igmp groups Example: Device# show ip igmp groups IGMP Connected Group Membership Group Address Interface Uptime Expires Last Reporter 239.1.2.3 GigabitEthernet1/0 00:05:14 00:02:14 10.1.0.6 224.0.1.39 GigabitEthernet0/0 00:09:11 00:02:08 172.31.100.1	Verifies IGMP memberships on the last hop router. This information will confirm the multicast groups with receivers that are directly connected to the last hop router and that are learned through IGMP.
Step 3	show ip pim rp mapping Example: Device# show ip pim rp mapping PIM Group-to-RP Mappings Group(s) 224.0.0.0/4 RP 172.16.0.1 (?), v2v1 Info source: 172.16.0.1 (?), elected via Auto-RP Uptime: 00:09:11, expires: 00:02:47	Confirms that the group-to-RP mappings are being populated correctly on the last hop router. Note Ignore this step if you are verifying a last hop router in a PIM-SSM network. The show ip pim rp mapping command does not work with routers in a PIM-SSM network because PIM-SSM does not use RPs. In addition, if configured correctly, PIM-SSM groups do not appear in the output of the show ip pim rp mapping command.

	Command or Action	Purpose
Step 4	show ip mroute Example: <pre> Device# show ip mroute (*, 239.1.2.3), 00:05:14/00:03:04, RP 172.16.0.1, flags: SJC Incoming interface: GigabitEthernet0/0, RPF nbr 172.31.100.1 Outgoing interface list: GigabitEthernet1/0, Forward/Sparse, 00:05:10/00:03:04 (10.0.0.1, 239.1.2.3), 00:02:49/00:03:29, flags: T Incoming interface: GigabitEthernet0/0, RPF nbr 172.31.100.1 Outgoing interface list: GigabitEthernet1/0, Forward/Sparse, 00:02:49/00:03:04 (*, 224.0.1.39), 00:10:05/stopped, RP 0.0.0.0, flags: DC Incoming interface: Null, RPF nbr 0.0.0.0 Outgoing interface list: GigabitEthernet1/0, Forward/Sparse, 00:05:15/00:00:00 GigabitEthernet0/0, Forward/Sparse, 00:10:05/00:00:00 (172.16.0.1, 224.0.1.39), 00:02:00/00:01:33, flags: PTX Incoming interface: GigabitEthernet0/0, RPF nbr 172.31.100.1 </pre>	Verifies that the mroute table is being populated properly on the last hop router.
Step 5	show ip interface [type number] Example: <pre> Device# show ip interface GigabitEthernet 0/0/0 GigabitEthernet0/0/0 is up, line protocol is up Internet address is 172.31.100.2/24 Broadcast address is 255.255.255.255 Address determined by setup command MTU is 1500 bytes Helper address is not set Directed broadcast forwarding is disabled Multicast reserved groups joined: 224.0.0.1 224.0.0.22 224.0.0.13 224.0.0.5 224.0.0.6 Outgoing access list is not set Inbound access list is not set Proxy ARP is enabled Local Proxy ARP is disabled Security level is default Split horizon is enabled ICMP redirects are always sent ICMP unreachable are always sent ICMP mask replies are never sent </pre>	Verifies that multicast fast switching is enabled for optimal performance on the outgoing interface on the last hop router. Note Using the no ip mroute-cache interface command disables IP multicast fast-switching. When IP multicast fast switching is disabled, packets are forwarded through the process-switched path.

	Command or Action	Purpose
	<pre> IP fast switching is enabled IP fast switching on the same interface is disabled IP Flow switching is disabled IP CEF switching is disabled IP Fast switching turbo vector IP multicast fast switching is enabled IP route-cache flags are Fast Router Discovery is disabled IP output packet accounting is disabled IP access violation accounting is disabled TCP/IP header compression is disabled RTP/IP header compression is disabled Policy routing is disabled Network address translation is disabled WCCP Redirect outbound is disabled WCCP Redirect inbound is disabled WCCP Redirect exclude is disabled BGP Policy Mapping is disabled </pre>	
Step 6	show ip mfib Example: Device# show ip mfib	Displays the forwarding entries and interfaces in the IP Multicast Forwarding Information Base (MFIB).
Step 7	show ip pim interface count Example: Device# show ip pim interface count State: * - Fast Switched, H - Hardware Switching Enabled Address Interface FS Mpackets In/Out 172.31.100.2 GigabitEthernet0/0 * 4122/0 10.1.0.1 GigabitEthernet1/0 * 0/3193	Confirms that multicast traffic is being forwarded on the last hop router.
Step 8	show ip mroute count Example: Device# show ip mroute count IP Multicast Statistics 6 routes using 4008 bytes of memory 3 groups, 1.00 average sources per group Forwarding Counts: Pkt Count/Pkts per second/Avg Pkt Size/Kilobits per second Other counts: Total/RPF failed/Other drops(OIF-null, rate-limit etc) Group: 239.1.2.3, Source count: 1, Packets forwarded: 3165, Packets received: 3165 RP-tree: Forwarding: 0/0/0/0, Other: 0/0/0 Source: 10.0.0.1/32, Forwarding:	Confirms that multicast traffic is being forwarded on the last hop router.

	Command or Action	Purpose
	<pre>3165/20/28/4, Other: 0/0/0 Group: 224.0.1.39, Source count: 1, Packets forwarded: 21, Packets received: 120 Source: 172.16.0.1/32, Forwarding: 21/1/48/0, Other: 120/0/99 Group: 224.0.1.40, Source count: 1, Packets forwarded: 10, Packets received: 10 Source: 172.16.0.1/32, Forwarding: 10/1/48/0, Other: 10/0/0</pre>	
Step 9	<p>show ip mroute active [kb/s]</p> <p>Example:</p> <pre>Device# show ip mroute active Active IP Multicast Sources - sending >= 4 kbps Group: 239.1.2.3, (?) Source: 10.0.0.1 (?) Rate: 20 pps/4 kbps(1sec), 4 kbps(last 50 secs), 4 kbps(life avg)</pre>	<p>Displays information about active multicast sources sending traffic to groups on the last hop router. The output of this command provides information about the multicast packet rate for active sources.</p> <p>Note By default, the output of the show ip mroute command with the active keyword displays information about active sources sending traffic to groups at a rate greater than or equal to 4 kb/s. To display information about active sources sending low-rate traffic to groups (that is, traffic less than 4 kb/s), specify a value of 1 for the <i>kb/s</i> argument. Specifying a value of 1 for this argument displays information about active sources sending traffic to groups at a rate equal to or greater than 1 kb/s, which effectively displays information about all possible active source traffic.</p>

Using PIM-Enabled Routers to Test IP Multicast Reachability

If all the PIM-enabled routers and access servers that you administer are members of a multicast group, pinging that group causes all routers to respond, which can be a useful administrative and debugging tool.

To use PIM-enabled routers to test IP multicast reachability, perform the following tasks:

Configuring Routers to Respond to Multicast Pings

Follow these steps to configure a router to respond to multicast pings. Perform the task on all the interfaces of a router and on all the routers participating in the multicast network:

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 1/0	Enters interface configuration mode. For the <i>type</i> and <i>number</i> arguments, specify an interface that is directly connected to hosts or is facing hosts.
Step 4	ip igmp join-group <i>group-address</i> Example: Device(config-if)# ip igmp join-group 225.2.2.2	(Optional) Configures an interface on the router to join the specified group. For the purpose of this task, configure the same group address for the <i>group-address</i> argument on all interfaces on the router participating in the multicast network. Note With this method, the router accepts the multicast packets in addition to forwarding them. Accepting the multicast packets prevents the router from fast switching.
Step 5	Repeat Step 3 and Step 4 for each interface on the router participating in the multicast network.	--
Step 6	end Example: Device(config-if)# end	Ends the current configuration session and returns to privileged EXEC mode.

Pinging Routers Configured to Respond to Multicast Pings

Follow these steps on a router to initiate a ping test to the routers configured to respond to multicast pings. This task is used to test IP multicast reachability in a network.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	ping <i>group-address</i> Example: Device# ping 225.2.2.2	Pings an IP multicast group address. A successful response indicates that the group address is functioning.

Monitoring and Troubleshooting PIM

Monitoring PIM Information

Use the privileged EXEC commands in the following table to monitor your PIM configurations.

Table 6: PIM Monitoring Commands

Command	Purpose
show ip pim autorp	Displays global auto-RP information.
show ip pim interface	Displays information about interfaces configured for Protocol Independent Multicast (PIM).
show ip pim neighbor	Displays the PIM neighbor information.
show ip pim rp [<i>group-name</i> <i>group-address</i>]	Displays RP routers associated with a sparse-mode multicast group. This command is available in all software images.
show ip pim tunnel [<i>tunnel</i> <i>verbose</i>]	Displays information about Protocol Independent Multicast (PIM) tunnel interfaces
show ip pim vrf { <i>word</i> { <i>all-vrfs</i> <i>autorp</i> <i>boundary</i> <i>bsr-router</i> <i>interface</i> <i>mdt</i> <i>neighbor</i> <i>rp</i> <i>rp-hash</i> <i>tunnel</i> } }	Displays the VPN routing/forwarding instance.
show ip igmp groups detail	Displays the interested clients that have joined the specific multicast source group.

Monitoring the RP Mapping and BSR Information

Use the privileged EXEC mode in the following table to verify the consistency of group-to-RP mappings:

Table 7: RP Mapping Monitoring Commands

Command	Purpose
show ip pim rp [<i>hostname</i> or <i>IP address</i> mapping [<i>hostname</i> or <i>IP address</i> elected in-use] metric [<i>hostname</i> or <i>IP address</i>]]	<p>Displays all available RP mappings and metrics. This tells you how the device learns of the RP (through the BSR or the Auto-RP mechanism).</p> <ul style="list-style-type: none"> • (Optional) For the <i>hostname</i>, specify the IP name of the group about which to display RPs. • (Optional) For the <i>IP address</i>, specify the IP address of the group about which to display RPs. • (Optional) Use the mapping keyword to display all group-to-RP mappings of which the Cisco device is aware (either configured or learned from Auto-RP). • (Optional) Use the metric keyword to display the RP RPF metric.

Use the privileged EXEC commands in the following table to monitor BSR information:

Table 8: BSR Monitoring Commands

Command	Purpose
show ip pim bsr	Displays information about the elected BSR.
show ip pim bsr-router	Displays information about the BSRv2.

Troubleshooting PIMv1 and PIMv2 Interoperability Problems

When debugging interoperability problems between PIMv1 and PIMv2, check these in the order shown:

1. Verify interoperability between different versions of DRs and RPs. Make sure that the RPs are interacting with the DRs properly (by responding with register-stops and forwarding decapsulated data packets from registers).

Monitoring the RP Mapping and BSR Information

Use the privileged EXEC mode in the following table to verify the consistency of group-to-RP mappings:

Table 9: RP Mapping Monitoring Commands

Command	Purpose
show ip pim rp [<i>hostname</i> or <i>IP address</i> mapping [<i>hostname</i> or <i>IP address</i> elected in-use] metric [<i>hostname</i> or <i>IP address</i>]]	<p>Displays all available RP mappings and metrics. This tells you how the device learns of the RP (through the BSR or the Auto-RP mechanism).</p> <ul style="list-style-type: none"> • (Optional) For the <i>hostname</i>, specify the IP name of the group about which to display RPs. • (Optional) For the <i>IP address</i>, specify the IP address of the group about which to display RPs. • (Optional) Use the mapping keyword to display all group-to-RP mappings of which the Cisco device is aware (either configured or learned from Auto-RP). • (Optional) Use the metric keyword to display the RP RPF metric.

Use the privileged EXEC commands in the following table to monitor BSR information:

Table 10: BSR Monitoring Commands

Command	Purpose
show ip pim bsr	Displays information about the elected BSR.
show ip pim bsr-router	Displays information about the BSRv2.

Configuration Examples for PIM

Example: Manually Assigning an RP to Multicast Groups

This example shows how to configure the address of the RP to 147.106.6.22 for multicast group 225.2.2.2 only:

```
(config)# access-list 1 permit 225.2.2.2 0.0.0.0
(config)# ip pim rp-address 147.106.6.22 1
```

Example: Configuring Auto-RP

This example shows how to send RP announcements out all PIM-enabled interfaces for a maximum of 31 hops. The IP address of port 1 is the RP. Access list 5 describes the group for which this serves as RP:

```
(config)# ip pim send-rp-announce gigabitethernet1/0/1 scope 31 group-list 5
(config)# access-list 5 permit 224.0.0.0 15.255.255.255
```

Example: Sparse Mode with Auto-RP

The following example configures sparse mode with Auto-RP:

```
ip multicast-routing
ip pim autorp listener
access-list 1 permit 239.254.2.0 0.0.0.255
access-list 1 permit 239.254.3.0 0.0.0.255
access-list 10 permit 224.0.1.39
access-list 10 permit 224.0.1.40
access-list 10 permit 239.254.2.0 0.0.0.255
access-list 10 permit 239.254.3.0 0.0.0.255
```

Example: Defining the IP Multicast Boundary to Deny Auto-RP Information

This example shows a portion of an IP multicast boundary configuration that denies Auto-RP information:

```
(config)# access-list 1 deny 224.0.1.39
(config)# access-list 1 deny 224.0.1.40
(config)# access-list 1 permit all
(config)# interface gigabitethernet1/0/1
```

Example: Filtering Incoming RP Announcement Messages

This example shows a sample configuration on an Auto-RP mapping agent that is used to prevent candidate RP announcements from being accepted from unauthorized candidate RPs:

```
(config)# ip pim rp-announce-filter rp-list 10 group-list 20
(config)# access-list 10 permit host 172.16.5.1
(config)# access-list 10 permit host 172.16.2.1
(config)# access-list 20 deny 239.0.0.0 0.0.255.255
(config)# access-list 20 permit 224.0.0.0 15.255.255.255
```

The mapping agent accepts candidate RP announcements from only two devices, 172.16.5.1 and 172.16.2.1. The mapping agent accepts candidate RP announcements from these two devices only for multicast groups that fall in the group range of 224.0.0.0 to 239.255.255.255. The mapping agent does not accept candidate RP announcements from any other devices in the network. Furthermore, the mapping agent does not accept candidate RP announcements from 172.16.5.1 or 172.16.2.1 if the announcements are for any groups in the 239.0.0.0 through 239.255.255.255 range. This range is the administratively scoped address range.

Example: Preventing Join Messages to False RPs

If all interfaces are in sparse mode, use a default-configured RP to support the two well-known groups 224.0.1.39 and 224.0.1.40. Auto-RP uses these two well-known groups to collect and distribute

RP-mapping information. When this is the case and the **ip pim accept-rp auto-rp** command is configured, another **ip pim accept-rp** command accepting the RP must be configured as follows:

```
(config)# access-list 1 permit 224.0.1.39
(config)# access-list 1 permit 224.0.1.40
```

Example: Configuring Candidate BSRs

This example shows how to configure a candidate BSR, which uses the IP address 172.21.24.18 on a port as the advertised BSR address, uses 30 bits as the hash-mask-length, and has a priority of 10.

```
(config)# interface gigabitethernet 1/2
(config-if)# ip address 172.21.24.18 255.255.255.0
```

Example: Configuring Candidate RPs

This example shows how to configure the to advertise itself as a candidate RP to the BSR in its PIM domain. Standard access list number 4 specifies the group prefix associated with the RP that has the address identified by a port. That RP is responsible for the groups with the prefix 239.

```
(config)# ip pim rp-candidate gigabitethernet1/2 group-list 4
(config)# access-list 4 permit 239.0.0.0 0.255.255.255
```




CHAPTER 4

Configuring SSM

- [Prerequisites for Configuring SSM, on page 99](#)
- [Restrictions for Configuring SSM, on page 99](#)
- [Information About SSM, on page 101](#)
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Prerequisites for Configuring SSM

The following are the prerequisites for configuring source-specific multicast (SSM) and SSM mapping:

- Before you configure SSM mapping, you must perform the following tasks:
 - Enable IP multicast routing.
 - Enable PIM sparse mode.
 - Configure SSM.
- Before you configure static SSM mapping, you must configure access control lists (ACLs) that define the group ranges to be mapped to source addresses.
- Before you can configure and use SSM mapping with DNS lookups, you need to add records to a running DNS server. If you do not already have a DNS server running, you need to install one.



Note

You can use a product such as *Cisco Network Registrar* to add records to a running DNS server.

Restrictions for Configuring SSM

The following are the restrictions for configuring SSM:

- To run SSM with IGMPv3, SSM must be supported in the Cisco IOS router, the host where the application is running, and the application itself.
- Existing applications in a network predating SSM will not work within the SSM range unless they are modified to support (S, G) channel subscriptions. Therefore, enabling SSM in a network may cause problems for existing applications if they use addresses within the designated SSM range.
- IGMP Snooping—IGMPv3 uses new membership report messages that might not be correctly recognized by older IGMP snooping devices.
- Address management is still necessary to some degree when SSM is used with Layer 2 switching mechanisms. Cisco Group Management Protocol (CGMP), IGMP snooping, or Router-Port Group Management Protocol (RGMP) support only group-specific filtering, not (S, G) channel-specific filtering. If different receivers in a switched network request different (S, G) channels sharing the same group, they do not benefit from these existing mechanisms. Instead, both receivers receive all (S, G) channel traffic and filter out the unwanted traffic on input. Because SSM can re-use the group addresses in the SSM range for many independent applications, this situation can lead to decreased traffic filtering in a switched network. For this reason, it is important to use random IP addresses from the SSM range for an application to minimize the chance for re-use of a single address within the SSM range between different applications. For example, an application service providing a set of television channels should, even with SSM, use a different group for each television (S, G) channel. This setup guarantees that multiple receivers to different channels within the same application service never experience traffic aliasing in networks that include Layer 2 devices.
- In PIM-SSM, the last hop router will continue to periodically send (S, G) join messages if appropriate (S, G) subscriptions are on the interfaces. Therefore, as long as receivers send (S, G) subscriptions, the shortest path tree (SPT) state from the receivers to the source will be maintained, even if the source is not sending traffic for longer periods of time (or even never).

The opposite situation occurs with PIM-SM, where (S, G) state is maintained only if the source is sending traffic and receivers are joining the group. If a source stops sending traffic for more than 3 minutes in PIM-SM, the (S, G) state is deleted and only reestablished after packets from the source arrive again through the RPT (rendezvous point tree). Because no mechanism in PIM-SSM notifies a receiver that a source is active, the network must maintain the (S, G) state in PIM-SSM as long as receivers are requesting receipt of that channel.

The following are the restrictions for configuring SSM mapping:

- The SSM Mapping feature does not share the benefit of full SSM. SSM mapping takes a group G join from a host and identifies this group with an application associated with one or more sources, therefore, it can only support one such application per group G. Nevertheless, full SSM applications may still share the same group also used in SSM mapping.
- Enable IGMPv3 with care on the last hop router when you rely solely on SSM mapping as a transition solution for full SSM. When you enable both SSM mapping and IGMPv3 and the hosts already support IGMPv3 (but not SSM), the hosts send IGMPv3 group reports. SSM mapping does not support these IGMPv3 group reports, and the router does not correctly associate sources with these reports.

Information About SSM

The source-specific multicast (SSM) feature is an extension of IP multicast in which datagram traffic is forwarded to receivers from only those multicast sources that the receivers have explicitly joined. For multicast groups configured for SSM, only SSM distribution trees (no shared trees) are created.

This section describes how to configure source-specific multicast (SSM). For a complete description of the SSM commands in this section, refer to the *IP Multicast Command Reference*. To locate documentation for other commands that appear in this chapter, use the command reference master index, or search online.

SSM Components Overview

SSM is a datagram delivery model that best supports one-to-many applications, also known as broadcast applications. SSM is a core networking technology for the Cisco implementation of IP multicast solutions targeted for audio and video broadcast application environments. The device supports the following components that support SSM implementation:

- Protocol independent multicast source-specific mode (PIM-SSM)

PIM-SSM is the routing protocol that supports the implementation of SSM and is derived from PIM sparse mode (PIM-SM).

- Internet Group Management Protocol version 3 (IGMPv3)

SSM and Internet Standard Multicast (ISM)

The current IP multicast infrastructure in the Internet and many enterprise intranets is based on the PIM-SM protocol and Multicast Source Discovery Protocol (MSDP). These protocols have the limitations of the Internet Standard Multicast (ISM) service model. For example, with ISM, the network must maintain knowledge about which hosts in the network are actively sending multicast traffic.

The ISM service consists of the delivery of IP datagrams from any source to a group of receivers called the multicast host group. The datagram traffic for the multicast host group consists of datagrams with an arbitrary IP unicast source address (S) and the multicast group address (G) as the IP destination address. Systems receive this traffic by becoming members of the host group. Membership in a host group simply requires signaling the host group through IGMP version 1, 2, or 3.

In SSM, delivery of datagrams is based on (S, G) channels. In both SSM and ISM, no signaling is required to become a source. However, in SSM, receivers must subscribe or unsubscribe to (S, G) channels to receive or not receive traffic from specific sources. In other words, receivers can receive traffic only from (S, G) channels to which they are subscribed, whereas in ISM, receivers need not know the IP addresses of sources from which they receive their traffic. The proposed standard approach for channel subscription signaling uses IGMP and includes modes membership reports, which are supported only in IGMP version 3.

SSM IP Address Range

SSM can coexist with the ISM service by applying the SSM delivery model to a configured subset of the IP multicast group address range. Cisco IOS software allows SSM configuration for the IP multicast address range of 224.0.0.0 through 239.255.255.255. When an SSM range is defined, existing IP multicast receiver

applications do not receive any traffic when they try to use an address in the SSM range (unless the application is modified to use an explicit (S, G) channel subscription).

SSM Operations

An established network, in which IP multicast service is based on PIM-SM, can support SSM services. SSM can also be deployed alone in a network without the full range of protocols required for interdomain PIM-SM (for example, MSDP, Auto-RP, or bootstrap router [BSR]) if only SSM service is needed.

If SSM is deployed in a network already configured for PIM-SM, only the last-hop routers support SSM. Routers that are not directly connected to receivers do not require support for SSM. In general, these not-last-hop routers must only run PIM-SM in the SSM range and might need additional access control configuration to suppress MSDP signalling, registering, or PIM-SM shared tree operations from occurring within the SSM range.

Use the **ip pim ssm** global configuration command to configure the SSM range and to enable SSM. This configuration has the following effects:

- For groups within the SSM range, (S, G) channel subscriptions are accepted through IGMPv3 include-mode membership reports.
- PIM operations within the SSM range of addresses change to PIM-SSM, a mode derived from PIM-SM. In this mode, only PIM (S, G) join and prune messages are generated by the router, and no (S, G) rendezvous point tree (RPT) or (*, G) RPT messages are generated. Incoming messages related to RPT operations are ignored or rejected, and incoming PIM register messages are immediately answered with register-stop messages. PIM-SSM is backward-compatible with PIM-SM unless a router is a last-hop router. Therefore, routers that are not last-hop routers can run PIM-SM for SSM groups (for example, if they do not yet support SSM).
- No MSDP source-active (SA) messages within the SSM range are accepted, generated, or forwarded.

SSM Mapping

In a typical set-top box (STB) deployment, each TV channel uses one separate IP multicast group and has one active server host sending the TV channel. A single server can send multiple TV channels, but each to a different group. In this network environment, if a router receives an IGMPv1 or IGMPv2 membership report for a particular group, the report addresses the well-known TV server for the TV channel associated with the multicast group.

When SSM mapping is configured, if a router receives an IGMPv1 or IGMPv2 membership report for a particular group, the router translates this report into one or more channel memberships for the well-known sources associated with this group.

When the router receives an IGMPv1 or IGMPv2 membership report for a group, the router uses SSM mapping to determine one or more source IP addresses for the group. SSM mapping then translates the membership report as an IGMPv3 report and continues as if it had received an IGMPv3 report. The router then sends PIM joins and continues to be joined to these groups as long as it continues to receive the IGMPv1 or IGMPv2 membership reports, and the SSM mapping for the group remains the same.

SSM mapping enables the last hop router to determine the source addresses either by a statically configured table on the router or through a DNS server. When the statically configured table or the DNS mapping changes, the router leaves the current sources associated with the joined groups.

Static SSM Mapping

With static SSM mapping, you can configure the last hop router to use a static map to determine the sources that are sending to groups. Static SSM mapping requires that you configure ACLs to define group ranges. After configuring the ACLs to define group ranges, you can then map the groups permitted by those ACLs to sources by using the **ip igmp ssm-map static** global configuration command.

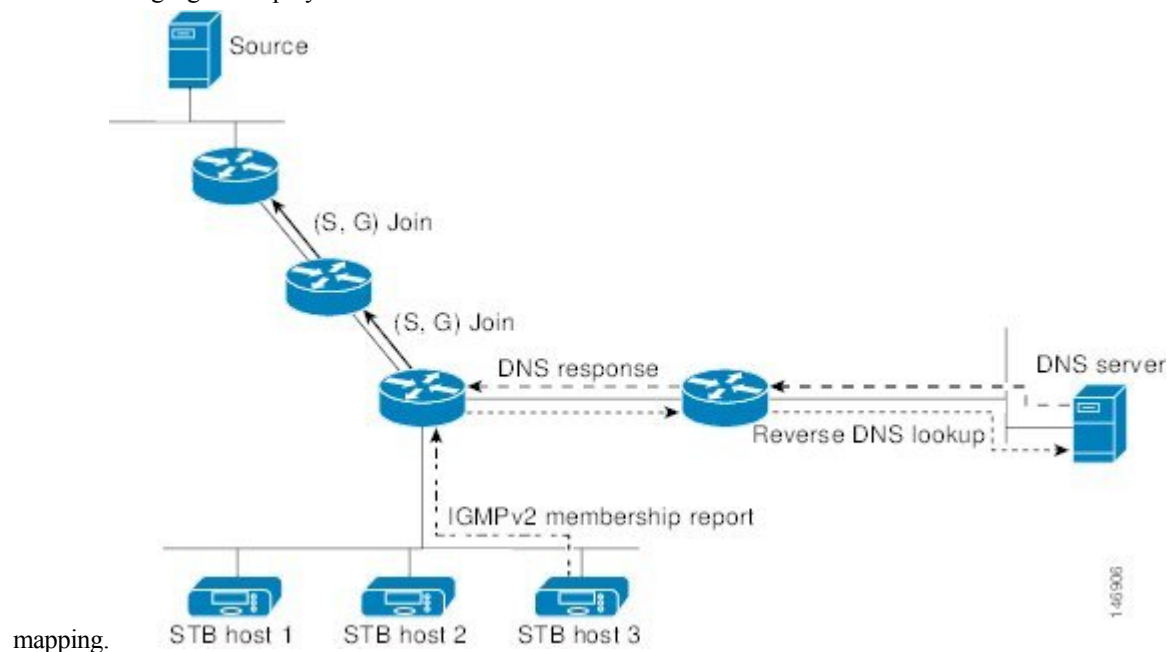
You can configure static SSM mapping in smaller networks when a DNS is not needed or to locally override DNS mappings. When configured, static SSM mappings take precedence over DNS mappings.

DNS-Based SSM Mapping

You can use DNS-based SSM mapping to configure the last hop router to perform a reverse DNS lookup to determine sources sending to groups. When DNS-based SSM mapping is configured, the router constructs a domain name that includes the group address and performs a reverse lookup into the DNS. The router looks up IP address resource records and uses them as the source addresses associated with this group. SSM mapping supports up to 20 sources for each group. The router joins all sources configured for a group.

Figure 8: DNS-Based SSM Mapping

The following figure displays DNS-based SSM



The SSM mapping mechanism that enables the last hop router to join multiple sources for a group can provide source redundancy for a TV broadcast. In this context, the last hop router provides redundancy using SSM mapping to simultaneously join two video sources for the same TV channel. However, to prevent the last hop router from duplicating the video traffic, the video sources must use a server-side switchover mechanism. One video source is active, and the other backup video source is passive. The passive source waits until an active source failure is detected before sending the video traffic for the TV channel. Thus, the server-side switchover mechanism ensures that only one of the servers is actively sending video traffic for the TV channel.

To look up one or more source addresses for a group that includes G1, G2, G3, and G4, you must configure these DNS records on the DNS server:

```
G4.G3.G2.G1 [multicast-domain] [timeout] IN A source-address-1
```

```
IN A source-address-2
IN A source-address-n
```

See your DNS server documentation for more information about configuring DNS resource records.

How to Configure SSM

Configuring SSM

Follow these steps to configure SSM:

This procedure is optional.

Before you begin

If you want to use an access list to define the Source Specific Multicast (SSM) range, configure the access list before you reference the access list in the **ip pim ssm** command.

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> Enter your password if prompted.
Step 2	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	ip pim ssm [default range <i>access-list</i>] Example: <pre>Device(config)# ip pim ssm range 20</pre>	Defines the SSM range of IP multicast addresses.
Step 4	interface <i>type number</i> Example: <pre>Device(config)# interface gigabitethernet 1/3</pre>	Selects an interface that is connected to hosts on which IGMPv3 can be enabled, and enters the interface configuration mode.
Step 5	ip pim {sparse-mode } Example:	Enables PIM on an interface.

	Command or Action	Purpose
	Device(config-if) # ip pim sparse-mode	
Step 6	ip igmp version 3 Example: Device(config-if) # ip igmp version 3	Enables IGMPv3 on this interface. The default version of IGMP is set to Version 2.
Step 7	end Example: Device(config-if) # end	Returns to privileged EXEC mode.
Step 8	show running-config Example: Device# show running-config	Verifies your entries.
Step 9	copy running-config startup-config Example: Device# copy running-config startup-config	(Optional) Saves your entries in the configuration file.

Configuring Source Specific Multicast Mapping

The Source Specific Multicast (SSM) mapping feature supports SSM transition when supporting SSM on the end system is impossible or unwanted due to administrative or technical reasons. You can use SSM mapping to leverage SSM for video delivery to legacy STBs that do not support IGMPv3 or for applications that do not use the IGMPv3 host stack.

Configuring Static SSM Mapping

Follow these steps to configure static SSM Mapping:

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.

	Command or Action	Purpose
Step 2	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	ip igmp ssm-map enable Example: <pre>Device(config)# ip igmp ssm-map enable</pre>	Enables SSM mapping for groups in the configured SSM range. Note By default, this command enables DNS-based SSM mapping.
Step 4	no ip igmp ssm-map query dns Example: <pre>Device(config)# no ip igmp ssm-map query dns</pre>	(Optional) Disables DNS-based SSM mapping. Note Disable DNS-based SSM mapping if you only want to rely on static SSM mapping. By default, the ip igmp ssm-map command enables DNS-based SSM mapping.
Step 5	ip igmp ssm-map static <i>access-list source-address</i> Example: <pre>Device(config)# ip igmp ssm-map static 11 172.16.8.11</pre>	Configures static SSM mapping. <ul style="list-style-type: none"> The ACL supplied for the <i>access-list</i> argument defines the groups to be mapped to the source IP address entered for the <i>source-address</i> argument. Note You can configure additional static SSM mappings. If additional SSM mappings are configured and the router receives an IGMPv1 or IGMPv2 membership report for a group in the SSM range, the device determines the source addresses associated with the group by walking each configured ip igmp ssm-map static command. The device associates up to 20 sources per group. Repeat Step to configure additional static SSM mappings, if required.
Step 6	end Example: <pre>Device(config)# end</pre>	Returns to privileged EXEC mode.
Step 7	show running-config Example:	Verifies your entries.

	Command or Action	Purpose
	Device# show running-config	
Step 8	copy running-config startup-config Example: Device# copy running-config startup-config	(Optional) Saves your entries in the configuration file.

Configuring DNS-Based SSM Mapping

To configure DNS-based SSM mapping, you need to create a DNS server zone or add records to an existing zone. If the routers that are using DNS-based SSM mapping are also using DNS for other purposes, you should use a normally configured DNS server. If DNS-based SSM mapping is the only DNS implementation being used on the router, you can configure a false DNS setup with an empty root zone or a root zone that points back to itself.

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	ip igmp ssm-map enable Example: Device(config)# ip igmp ssm-map enable	Enables SSM mapping for groups in a configured SSM range.
Step 4	ip igmp ssm-map query dns Example: Device(config)# ip igmp ssm-map query dns	(Optional) Enables DNS-based SSM mapping. <ul style="list-style-type: none"> • By default, the ip igmp ssm-map command enables DNS-based SSM mapping. Only the no form of this command is saved to the running configuration. <p>Note</p>

	Command or Action	Purpose
		Use this command to reenable DNS-based SSM mapping if DNS-based SSM mapping is disabled.
Step 5	ip domain multicast <i>domain-prefix</i> Example: <pre>Device(config)# ip domain multicast ssm-map.cisco.com</pre>	(Optional) Changes the domain prefix used for DNS-based SSM mapping. <ul style="list-style-type: none"> • By default, the software uses the ip-addr.arpa domain prefix.
Step 6	ip name-server <i>server-address1</i> [<i>server-address2...server-address6</i>] Example: <pre>Device(config)# ip name-server 10.48.81.21</pre>	Specifies the address of one or more name servers to use for name and address resolution.
Step 7	Repeat Step 6 to configure additional DNS servers for redundancy, if required.	
Step 8	end Example: <pre>Device(config)# end</pre>	Returns to privileged EXEC mode.
Step 9	show running-config Example: <pre>Device# show running-config</pre>	Verifies your entries.
Step 10	copy running-config startup-config Example: <pre>Device# copy running-config startup-config</pre>	(Optional) Saves your entries in the configuration file.

Configuring Static Traffic Forwarding with SSM Mapping

Follow these steps to configure static traffic forwarding with SSM mapping on the last hop router:

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	interface <i>interface-id</i> Example: Device(config)# interface gigabitethernet 1/3	Selects an interface on which to statically forward traffic for a multicast group using SSM mapping, and enters interface configuration mode. Note Static forwarding of traffic with SSM mapping works with either DNS-based SSM mapping or statically configured SSM mapping.
Step 4	ip igmp static-group <i>group-address</i> source ssm-map Example: Device(config-if)# ip igmp static-group 239.1.2.1 source ssm-map	Configures SSM mapping to statically forward a (S, G) channel from the interface. Use this command if you want to statically forward SSM traffic for certain groups. Use DNS-based SSM mapping to determine the source addresses of the channels.
Step 5	end Example: Device(config-if)# end	Returns to privileged EXEC mode.
Step 6	show running-config Example: Device# show running-config	Verifies your entries.
Step 7	copy running-config startup-config Example: Device# copy running-config startup-config	(Optional) Saves your entries in the configuration file.

Monitoring SSM

Use the privileged EXEC commands in the following table to monitor SSM.

Table 11: Commands for Monitoring SSM

Command	Purpose
show ip igmp groups detail	Displays the (S, G) channel subscription through IGMPv3.
show ip mroute	Displays whether a multicast group supports SSM service or whether a source-specific host report was received.

Monitoring SSM Mapping

Use the privileged EXEC commands in the following table to monitor SSM mapping.

Table 12: SSM Mapping Monitoring Commands

Command	Purpose
show ip igmp ssm-mapping	Displays information about SSM mapping.
show ip igmp ssm-mapping group-address	Displays the sources that SSM mapping uses for group.
show ip igmp groups [<i>group-name</i> <i>group-address</i> <i>interface-type interface-number</i>] [detail]	Displays the multicast groups with receivers that are connected to the router and that were learned through SSM mapping.
show host	Displays the default domain name, the style of name service, a list of name server hosts, and the cache of hostnames and addresses.
debug ip igmp group-address	Displays the IGMP packets received and sent and host-related events.

Where to Go Next for SSM

You can configure the following:

- IGMP
- PIM
- IP Multicast Routing
- Service Discovery Gateway

Feature Information for SSM

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 13: Feature Information for SSM

Feature Name	Releases	Feature Information
SSM		The source-specific multicast (SSM) feature is an extension of IP multicast in which datagram traffic is forwarded to receivers from only those multicast sources that the receivers have explicitly joined. For multicast groups configured for SSM, only SSM distribution trees (no shared trees) are created.



CHAPTER 5

Implementing IPv6 Multicast

- [Information About Implementing IPv6 Multicast Routing, on page 113](#)
- [Implementing IPv6 Multicast, on page 123](#)

Information About Implementing IPv6 Multicast Routing

This chapter describes how to implement IPv6 multicast routing on the switch.

Traditional IP communication allows a host to send packets to a single host (unicast transmission) or to all hosts (broadcast transmission). IPv6 multicast provides a third scheme, allowing a host to send a single data stream to a subset of all hosts (group transmission) simultaneously.

IPv6 Multicast Overview

An IPv6 multicast group is an arbitrary group of receivers that want to receive a particular data stream. This group has no physical or geographical boundaries—receivers can be located anywhere on the Internet or in any private network. Receivers that are interested in receiving data flowing to a particular group must join the group by signaling their local switch. This signaling is achieved with the Multicast Listener Discovery (MLD) protocol.

Switches use the MLD protocol to learn whether members of a group are present on their directly attached subnets. Hosts join multicast groups by sending MLD report messages. The network then delivers data to a potentially unlimited number of receivers, using only one copy of the multicast data on each subnet. IPv6 hosts that wish to receive the traffic are known as group members.

Packets delivered to group members are identified by a single multicast group address. Multicast packets are delivered to a group using best-effort reliability, just like IPv6 unicast packets.

The multicast environment consists of senders and receivers. Any host, regardless of whether it is a member of a group, can send to a group. However, only members of a group can listen to and receive the message.

A multicast address is chosen for the receivers in a multicast group. Senders use that address as the destination address of a datagram to reach all members of the group.

Membership in a multicast group is dynamic; hosts can join and leave at any time. There is no restriction on the location or number of members in a multicast group. A host can be a member of more than one multicast group at a time.

How active a multicast group is, its duration, and its membership can vary from group to group and from time to time. A group that has members may have no activity.



Note Multicast is not supported on port-channels.

IPv6 Multicast Routing Implementation

The Cisco IOS-XE software supports the following protocols to implement IPv6 multicast routing:

- MLD is used by IPv6 switches 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, and MLD version 2 is based on version 3 of the IGMP for IPv4. IPv6 multicast for Cisco IOS 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 switch running MLD version 2. Mixed LANs with both MLD version 1 and MLD version 2 hosts are likewise supported.



Note MLDv2 is not fully supported as part of this release. MLDv2 Join/Report alone, is supported as part of the V6 SSM feature.

- PIM-SM is used between switches 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.

IPv6 Multicast Listener Discovery Protocol

To start implementing multicasting in the campus network, users must first define who receives the multicast. The MLD protocol is used by IPv6 switches to discover the presence of multicast listeners (for example, nodes that want to receive multicast packets) on their directly attached links, and to discover specifically which multicast addresses are of interest to those neighboring nodes. It is used for discovering local group and source-specific group membership.

The MLD protocol provides a means to automatically control and limit the flow of multicast traffic throughout your network with the use of special multicast queriers and hosts.

Multicast Queriers and Hosts

A multicast querier is a network device, such as a switch, that sends query messages to discover which network devices are members of a given multicast group.

A multicast host is a receiver which reports host memberships.

A set of queriers and hosts is called a multicast group. Queriers and hosts use MLD reports to join and leave multicast groups and to begin receiving group traffic.

MLD uses the Internet Control Message Protocol (ICMP) to carry its messages. All MLD messages are link-local with a hop limit of 1, and they all have the switch alert option set. The switch alert option implies an implementation of the hop-by-hop option header.

MLD Access Group

The MLD access group provides receiver access control in IPv6 multicast switches. This feature limits the list of groups a receiver can join, and it allows or denies sources used to join SSM channels.

Explicit Tracking of Receivers

The explicit tracking feature allows a switch to track the behavior of the hosts within its IPv6 network. This feature also enables the fast leave mechanism to be used with MLD version 2 host reports.

Protocol Independent Multicast

Protocol Independent Multicast (PIM) is used between switches 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 PIM-SM operation.

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 switches are involved in each multicast and these switches 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 Rendezvous Point (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 switch 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 switch.

As a PIM join travels up the tree, switches 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 switch 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 switch 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 switch (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 switches 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.

IPv6 BSR: Configure RP Mapping

PIM switches in a domain must be able to map each multicast group to the correct RP address. The Bootstrap Router (BSR) protocol for PIM-SM provides a dynamic, adaptive mechanism to distribute group-to-RP

mapping information rapidly throughout a domain. With the IPv6 BSR feature, if an RP becomes unreachable, it will be detected and the mapping tables will be modified so that the unreachable RP is no longer used, and the new tables will be rapidly distributed throughout the domain.

Every PIM-SM multicast group needs to be associated with the IP or IPv6 address of an RP. When a new multicast sender starts sending, its local DR will encapsulate these data packets in a PIM register message and send them to the RP for that multicast group. When a new multicast receiver joins, its local DR will send a PIM join message to the RP for that multicast group. When any PIM switch sends a (*, G) join message, the PIM switch needs to know which is the next switch toward the RP so that G (Group) can send a message to that switch. Also, when a PIM switch is forwarding data packets using (*, G) state, the PIM switch needs to know which is the correct incoming interface for packets destined for G, because it needs to reject any packets that arrive on other interfaces.

A small set of switches from a domain are configured as candidate bootstrap switches (C-BSRs) and a single BSR is selected for that domain. A set of switches within a domain is also configured as candidate RPs (C-RPs). Typically, these switches are the same switches that are configured as C-BSRs. Candidate RPs periodically unicast candidate-RP-advertisement (C-RP-Adv) messages to the BSR of that domain, advertising their willingness to be an RP. A C-RP-Adv message includes the address of the advertising C-RP, and an optional list of group addresses and mask length fields, indicating the group prefixes for which the candidacy is advertised. The BSR then includes a set of these C-RPs, along with their corresponding group prefixes, in bootstrap messages (BSMs) it periodically originates. BSMs are distributed hop-by-hop throughout the domain.

Bidirectional BSR support allows bidirectional RPs to be advertised in C-RP messages and bidirectional ranges in the BSM. All switches in a system must be able to use the bidirectional range in the BSM; otherwise, the bidirectional RP feature will not function.

Routable Address Hello Option

When an IPv6 interior gateway protocol is used to build the unicast routing table, the procedure to detect the upstream switch address assumes the address of a PIM neighbor is always same as the address of the next-hop switch, as long as they refer to the same switch. However, it may not be the case when a switch has multiple addresses on a link.

A typical situation which can lead to this is when the address of an RP shares a subnet prefix with downstream switches (note that the RP switch address has to be domain-wide and therefore cannot be a link-local address).

The routable address hello option allows the PIM protocol to avoid such situations by adding a PIM hello message option that includes all the addresses on the interface on which the PIM hello message is advertised. When a PIM switch finds an upstream switch for some address, the result of RPF calculation is compared with the addresses in this option, in addition to the PIM neighbor's address itself. Because this option includes all the possible addresses of a PIM switch on that link, it always includes the RPF calculation result if it refers to the PIM switch supporting this option.

Because of size restrictions on PIM messages and the requirement that a routable address hello option fits within a single PIM hello message, a limit of 16 addresses can be configured on the interface.

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 and 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.



Note The **ipv6 pim rp embedded** command is enabled by default.

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.



Note Dynamic RPs have higher preference over Static RP's

Configuring a BSR

Follow these steps to configure the Bootstrap Router (BSR). The BSR distributes group-to-RP mapping information rapidly throughout a domain.

Configuring a BSR and Verifying BSR Information

To configure and verify BSR information, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: <code>> enable</code>	Enter your password if prompted.
Step 2	configure terminal Example: <code># configure terminal</code>	Enters global configuration mode.
Step 3	ipv6 pim bsr candidate bsr <i>ipv6-address[hash-mask-length] [priority</i> <i>priority-value]</i> Example: <code>(config)# ipv6 pim bsr candidate bsr</code> <code>2001:DB8:3000:3000::42 124 priority 10</code>	Configures a switch to be a candidate BSR.
Step 4	interface type number Example: <code>(config)# interface GigabitEthernet 1/0/1</code>	Specifies an interface type and number, and places the switch in interface configuration mode.
Step 5	ipv6 pim bsr border Example: <code>(config-if)# ipv6 pim bsr border</code>	Configures a border for all bootstrap message (BSMs) of any scope on a specified interface.
Step 6	exit Example: <code>(config-if)# exit</code>	Enter this command twice to exit interface configuration mode and enter privileged EXEC mode.
Step 7	show ipv6 pim bsr {election rp-cache candidate-rp} Example: <code>(config-if)# show ipv6 pim bsr election</code>	Displays information related to PIM BSR protocol processing.
Step 8	copy running-config startup-config	(Optional) Save your entries in the configuration file.

Sending PIM RP Advertisements to the BSR

To sending PIM RP advertisements to the BSR, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>> enable</pre>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: <pre># configure terminal</pre>	Enters global configuration mode.
Step 3	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 4	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 5	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 6	copy running-config startup-config	(Optional) Save your entries in the configuration file.

Configuring BSR for Use Within Scoped Zones

To configure BSR for use within scoped zones, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>> enable</pre>	Enables privileged EXEC mode. Enter your password if prompted.

	Command or Action	Purpose
Step 2	configure terminal Example: <code># configure terminal</code>	Enters global configuration mode.
Step 3	ipv6 pim bsr candidate rp <i>ipv6-address</i> [<i>hash-mask-length</i>] [priority <i>priority-value</i>] Example: <code>(config)# ipv6 pim bsr candidate bsr 2001:DB8:1:1:4</code>	Configures a switch to be a candidate BSR.
Step 4	ipv6 pim bsr candidate rp <i>ipv6-address</i> [group-list <i>access-list-name</i>] [priority <i>priority-value</i>] [interval <i>seconds</i>] Example: <code>(config)# ipv6 pim bsr candidate rp 2001:DB8:1:1:1 group-list list scope 6</code>	Configures the candidate RP to send PIM RP advertisements to the BSR.
Step 5	interface <i>type number</i> Example: <code>(config-if)# interface GigabitEthernet 1/0/1</code>	Specifies an interface type and number, and places the switch in interface configuration mode.
Step 6	ipv6 multicast boundary scope <i>scope-value</i> Example: <code>(config-if)# ipv6 multicast boundary scope 6</code>	Configures a multicast boundary on the interface for a specified scope.
Step 7	copy running-config startup-config	(Optional) Save your entries in the configuration file.

Configuring BSR Switches to Announce Scope-to-RP Mappings

IPv6 BSR switches can be statically configured to announce scope-to-RP mappings directly instead of learning them from candidate-RP messages. A user might want to configure a BSR switch to announce scope-to-RP mappings so that an RP that does not support BSR is imported into the BSR. Enabling this feature also allows an RP positioned outside the enterprise's BSR domain to be learned by the known remote RP on the local candidate BSR switch.

To configure BSR switches to announce Scope-to-RP mappings, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <code>> enable</code>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: <code># configure terminal</code>	Enters global configuration mode.
Step 3	ipv6 pim bsr announced rp <i>ipv6-address</i> [group-list <i>access-list-name</i>] [priority <i>priority-value</i>] Example: <code>(config)# ipv6 pim bsr announced rp 2001:DB8:3000:3000::42 priority 0</code>	Announces scope-to-RP mappings directly from the BSR for the specified candidate RP.
Step 4	copy running-config startup-config	(Optional) Save your entries in the configuration file.

Static Mroutes

IPv6 static mroutes behave much in the same way as IPv4 static mroutes used to influence the RPF check. IPv6 static mroutes share the same database as IPv6 static routes and are implemented by extending static route support for RPF checks. Static mroutes support equal-cost multipath mroutes, and they also support unicast-only static routes.

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-XE 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.



Note V6 PIM register tunnels MTU created by MFIB are limited to a max of 1452 bytes. Therefore, jumbo frames over V6 PIM tunnel are not supported.

Distributed MFIB

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 Route Processor IOS daemon 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 RP IOSd 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.

Implementing IPv6 Multicast

Enabling IPv6 Multicast Routing

To enable IPv6 multicast routing, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <code>> enable</code>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal	Enter global configuration mode.
Step 3	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 4	copy running-config startup-config	(Optional) Save your entries in the configuration file.

Customizing and Verifying the MLD Protocol

Customizing and Verifying MLD on an Interface

To customize and verify MLD on an interface, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>> enable</pre>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal	Enters global configuration mode.
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 mld join-group [<i>group-address</i>] [include exclude] { <i>source-address</i> source-list [<i>acl</i>]} Example: <pre>(config-if) # ipv6 mld join-group FF04::10</pre>	Configures MLD reporting for a specified group and source. Note join-group and static-group should be used only in a debugging environment, as the packets matching this group will reach CPU for processing.
Step 5	ipv6 mld access-group <i>access-list-name</i> Example: <pre>(config-if) # ipv6 access-list acc-grp-1</pre>	Allows the user to perform IPv6 multicast receiver access control.
Step 6	ipv6 mld static-group [<i>group-address</i>] [include exclude] { <i>source-address</i> <i>source-list</i> [<i>acl</i>]} Example: <pre>(config-if) # ipv6 mld static-group ff04::10 include 100::1</pre>	Statically forwards traffic for the multicast group onto a specified interface and cause the interface to behave as if a MLD joiner were present on the interface.
Step 7	ipv6 mld query-max-response-time <i>seconds</i> Example: <pre>(config-if) # ipv6 mld query-timeout 130</pre>	Configures the timeout value before the switch takes over as the querier for the interface.
Step 8	exit Example: <pre>(config-if) # exit</pre>	Enter this command twice to exit interface configuration mode and enter privileged EXEC mode.

	Command or Action	Purpose
Step 9	show ipv6 mld groups [link-local] [<i>group-name</i> <i>group-address</i>] [<i>interface-type</i> <i>interface-number</i>] [detail explicit] Example: <pre># show ipv6 mld groups GigabitEthernet 1/0/1</pre>	Displays the multicast groups that are directly connected to the switch and that were learned through MLD.
Step 10	show ipv6 mld groups summary Example: <pre># show ipv6 mld groups summary</pre>	Displays the number of (*, G) and (S, G) membership reports present in the MLD cache.
Step 11	show ipv6 mld interface [<i>type number</i>] Example: <pre># show ipv6 mld interface GigabitEthernet 1/0/1</pre>	Displays multicast-related information about an interface.
Step 12	debug ipv6 mld [<i>group-name</i> <i>group-address</i> <i>interface-type</i>] Example: <pre># debug ipv6 mld</pre>	Enables debugging on MLD protocol activity.
Step 13	debug ipv6 mld explicit [<i>group-name</i> <i>group-address</i>] Example: <pre># debug ipv6 mld explicit</pre>	Displays information related to the explicit tracking of hosts.
Step 14	copy running-config startup-config	(Optional) Save your entries in the configuration file.

Implementing MLD Group Limits

Per-interface and global MLD limits operate independently of each other. Both per-interface and global MLD limits can be configured on the same switch. The number of MLD limits, globally or per interface, is not configured by default; the limits must be configured by the user. A membership report that exceeds either the per-interface or the global state limit is ignored.

Implementing MLD Group Limits Globally

To implement MLD group limits globally, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Switch Controller Device> enable</pre>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: <pre>Switch Controller Device# configure terminal</pre>	Enters global configuration mode.
Step 3	ipv6 mld state-limit <i>number</i> Example: <pre>Switch Controller Device(config)# ipv6 mld state-limit 300</pre>	Limits the number of MLD states globally.
Step 4	copy running-config startup-config	(Optional) Save your entries in the configuration file.

Implementing MLD Group Limits per Interface

To implement MLD group limits per interface, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>> enable</pre>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: <pre># configure terminal</pre>	Enters global configuration mode.
Step 3	interface type <i>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.

	Command or Action	Purpose
Step 4	ipv6 mld limit <i>number</i> [except] <i>access-list</i> Example: (config-if) # ipv6 mld limit 100	Limits the number of MLD states on a per-interface basis.
Step 5	copy running-config startup-config	(Optional) Save your entries in the configuration file.

Configuring Explicit Tracking of Receivers to Track Host Behavior

The explicit tracking feature allows a switch to track the behavior of the hosts within its IPv6 network and enables the fast leave mechanism to be used with MLD version 2 host reports.

To configuring explicit tracking of receivers to track host behavior, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable Example: > enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal	Enter global configuration mode.
Step 3	interface <i>type number</i> Example: (config) # interface GigabitEthernet 1/0/1	Specifies an interface type and number, and places the switch in interface configuration mode.
Step 4	ipv6 mld explicit-tracking <i>access-list-name</i> Example: (config-if) # ipv6 mld explicit-tracking list1	Enables explicit tracking of hosts.
Step 5	copy running-config startup-config	(Optional) Save your entries in the configuration file.

Resetting the MLD Traffic Counters

To reset the MLD traffic counters, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <code>> enable</code>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: <code># configure terminal</code>	Enters global configuration mode.
Step 3	clear ipv6 mld traffic Example: <code># clear ipv6 mld traffic</code>	Resets all MLD traffic counters.
Step 4	show ipv6 mld traffic Example: <code># show ipv6 mld traffic</code>	Displays the MLD traffic counters.
Step 5	copy running-config startup-config	(Optional) Save your entries in the configuration file.

Clearing the MLD Interface Counters

To clearing the MLD interface counters, perform this procedure

Procedure

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

	Command or Action	Purpose
Step 3	clear ipv6 mld counters <i>interface-type</i> Example: <code># clear ipv6 mld counters Ethernet1/0</code>	Clears the MLD interface counters.
Step 4	copy running-config startup-config	(Optional) Save your entries in the configuration file.

Configuring PIM

This section explains how to configure PIM.

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

To configuring PIM-SM and view PIM-SM information for a group range, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <code>> enable</code>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: <code># configure terminal</code>	Enters global configuration mode.
Step 3	ipv6 pim rp-address <i>ipv6-address[group-access-list]</i> Example: <code>(config)# ipv6 pim rp-address 2001:DB8::01:800:200E:8C6C acc-grp-1</code>	Configures the address of a PIM RP for a particular group range.
Step 4	exit Example: <code>(config)# exit</code>	Exits global configuration mode, and returns the switch to privileged EXEC mode.
Step 5	show ipv6 pim interface [state-on] [state-off] [type-number] Example:	Displays information about interfaces configured for PIM.

	Command or Action	Purpose
	# show ipv6 pim interface	
Step 6	show ipv6 pim group-map [<i>group-name</i> <i>group-address</i>] [<i>group-range</i> <i>group-mask</i>] [<i>info-source</i> { <i>bsr</i> default embedded-rp static }] Example: # show ipv6 pim group-map	Displays an IPv6 multicast group mapping table.
Step 7	show ipv6 pim neighbor [<i>detail</i>] [<i>interface-type interface-number</i> count] Example: # show ipv6 pim neighbor	Displays the PIM neighbors discovered by the Cisco IOS software.
Step 8	show ipv6 pim range-list [<i>config</i>] [<i>rp-address</i> <i>rp-name</i>] Example: # show ipv6 pim range-list	Displays information about IPv6 multicast range lists.
Step 9	show ipv6 pim tunnel [<i>interface-type interface-number</i>] Example: # 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: # debug ipv6 pim	Enables debugging on PIM protocol activity.
Step 11	copy running-config startup-config	(Optional) Save your entries in the configuration file.

Configuring PIM Options

To configure PIM options, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: Switch Controller Device > enable	Enter your password if prompted.
Step 2	configure terminal Example: Switch Controller Device # configure terminal	Enters global configuration mode.
Step 3	ipv6 pim spt-threshold infinity [group-list access-list-name] Example: Switch Controller Device (config)# ipv6 pim spt-threshold infinity group-list acc-grp-1	Configures when a PIM leaf switch joins the SPT for the specified groups.
Step 4	interface type number Example: Switch Controller Device (config)# interface GigabitEthernet 1/0/1	Specifies an interface type and number, and places the switch in interface configuration mode.
Step 5	ipv6 pim dr-priority value Example: Switch Controller Device (config-if)# ipv6 pim dr-priority 3	Configures the DR priority on a PIM switch.
Step 6	ipv6 pim hello-interval seconds Example: Switch Controller Device (config-if)# ipv6 pim hello-interval 45	Configures the frequency of PIM hello messages on an interface.
Step 7	ipv6 pim join-prune-interval seconds Example: Switch Controller Device (config-if)# ipv6 pim join-prune-interval 75	Configures periodic join and prune announcement intervals for a specified interface.
Step 8	exit Example: Switch Controller Device (config-if)# exit	Enter this command twice to exit interface configuration mode and enter privileged EXEC mode.

	Command or Action	Purpose
Step 9	ipv6 pim join-prune statistic [<i>interface-type</i>] Example: <pre>Switch Controller Device (config-if)# show ipv6 pim join-prune statistic</pre>	Displays the average join-prune aggregation for the most recently aggregated packets for each interface.
Step 10	copy running-config startup-config	(Optional) Save your entries in the configuration file.

Resetting the PIM Traffic Counters

If PIM malfunctions or in order to verify that the expected number of PIM packets are received and sent, the user can clear PIM traffic counters. Once the traffic counters are cleared, the user can enter the `show ipv6 pim traffic` command to verify that PIM is functioning correctly and that PIM packets are being received and sent correctly.

To resetting the PIM traffic counters, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>> enable</pre>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: <pre># configure terminal</pre>	Enters global configuration mode.
Step 3	clear ipv6 pim traffic Example: <pre># clear ipv6 pim traffic</pre>	Resets the PIM traffic counters.
Step 4	show ipv6 pim traffic Example: <pre># show ipv6 pim traffic</pre>	Displays the PIM traffic counters.
Step 5	copy running-config startup-config	(Optional) Save your entries in the configuration file.

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.

To clear the PIM topology table to reset the MRIB connection, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <code>> enable</code>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: <code># configure terminal</code>	Enters global configuration mode.
Step 3	clear ipv6 pim [<i>vrf vrfname</i>] topology [<i>group-name</i> <i>group-address</i>] Example: <code># clear ipv6 pim topology FF04::10</code>	Clears the PIM topology table.
Step 4	show ipv6 mrib [<i>vrf vrfname</i>] client [filter] [name { <i>client-name</i> <i>client-name</i> : <i>client-id</i> }] Example: <code># show ipv6 mrib client</code>	Displays multicast-related information about an interface.
Step 5	show ipv6 mrib [<i>vrf vrfname</i>] route { link-local summary [<i>sourceaddress-or-name</i> *] [<i>groupname-or-address</i> [<i>prefix-length</i>]]] Example: <code># show ipv6 mrib route</code>	Displays the MRIB route information.
Step 6	show ipv6 pim [<i>vrf vrfname</i>] topology [<i>groupname-or-address</i> [<i>sourceaddress-or-name</i>] link-local route-count [detail]] Example: <code># show ipv6 pim topology</code>	Displays PIM topology table information for a specific group or all groups.

	Command or Action	Purpose
Step 7	debug ipv6 mrib [<i>vrf vrfname</i>] io Example: <code># debug ipv6 mrib io</code>	Enables debugging on MRIB I/O events.
Step 8	debug ipv6 mrib [<i>vrf vrfname</i>] route [<i>group-name</i> <i>group-address</i>] Example: <code># debug ipv6 mrib route</code>	Displays information about MRIB routing entry-related activity.
Step 9	debug ipv6 mrib [<i>vrf vrfname</i>] table Example: <code># debug ipv6 mrib table</code>	Enables debugging on MRIB table management activity.
Step 10	copy running-config startup-config	(Optional) Save your entries in the configuration file.

Configuring Static Mroutes

Static multicast routes (mroutes) in IPv6 can be implemented as an extension of IPv6 static routes. You can configure your switch to use a static route for unicast routing only, to use a static multicast route for multicast RPF selection only, or to use a static route for both unicast routing and multicast RPF selection.

To configure static mroutes, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <code>> enable</code>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: <code># configure terminal</code>	Enters global configuration mode.
Step 3	ipv6 route { <i>ipv6-prefix</i> / <i>prefix-length</i> <i>ipv6-address</i> <i>interface-type</i> <i>interface-number</i> <i>ipv6-address</i> } [<i>administrative-distance</i>] [<i>administrative-multicast-distance</i> <i>unicast</i> <i>multicast</i>] [<i>tag tag</i>]	Establishes static IPv6 routes. The example shows a static route used for both unicast routing and multicast RPF selection.

	Command or Action	Purpose
	Example: <pre>(config)# ipv6 route 2001:DB8::/64 6::6 100</pre>	
Step 4	exit Example: <pre># exit</pre>	Exits global configuration mode, and returns the switch to privileged EXEC mode.
Step 5	show ipv6 mroute [<i>link-local</i> [<i>group-name</i> <i>group-address</i> [<i>source-address</i> <i>source-name</i>]] [<i>summary</i>] [<i>count</i>] Example: <pre># show ipv6 mroute ff07::1</pre>	Displays the contents of the IPv6 multicast routing table.
Step 6	show ipv6 mroute [<i>link-local</i> <i>group-name</i> <i>group-address</i>] active [<i>kbps</i>] Example: <pre>(config-if)# show ipv6 mroute active</pre>	Displays the active multicast streams on the switch.
Step 7	show ipv6 rpf [<i>ipv6-prefix</i>] Example: <pre>(config-if)# show ipv6 rpf 2001::1:1:2</pre>	Checks RPF information for a given unicast host address and prefix.
Step 8	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

To verify MFIB operation in IPv6 multicast

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>> enable</pre>	Enables privileged EXEC mode. Enter your password if prompted.

	Command or Action	Purpose
Step 2	show ipv6 mfib [verbose <i>vrf vrfname</i> <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 3	show ipv6 mfib [all linkscope <i>vrf vrfname</i> <i>group-name</i> <i>group-address</i> [<i>source-name</i> <i>source-address</i>]] count Example: <pre># show ipv6 mfib ff07::1</pre>	Displays the contents of the IPv6 multicast routing table.
Step 4	show ipv6 mfib interface Example: <pre># show ipv6 mfib interface</pre>	Displays information about IPv6 multicast-enabled interfaces and their forwarding status.
Step 5	show ipv6 mfib status Example: <pre># show ipv6 mfib status</pre>	Displays general MFIB configuration and operational status.
Step 6	show ipv6 mfib summary Example: <pre># show ipv6 mfib summary</pre>	Displays summary information about the number of IPv6 MFIB entries and interfaces.
Step 7	debug ipv6 mfib [<i>vrf vrfname</i> <i>group-name</i> <i>group-address</i>] [adjacency db fs init interface mrrib [detail] nat pak platform ppr ps signal table] Example: <pre># debug ipv6 mfib FF04::10 pak</pre>	Enables debugging output on the IPv6 MFIB.

Resetting MFIB Traffic Counters

To reset MFIB traffic counters, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: <code>> enable</code>	Enter your password if prompted.
Step 2	clear ipv6 mfib counters [<i>group-name</i> <i>group-address</i> [<i>source-address</i> <i>source-name</i>]] Example: <code># clear ipv6 mfib counters FF04::10</code>	Resets all active MFIB traffic counters.

