Implementing IPv6 Multicast

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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.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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.

Prerequisites for Implementing IPv6 Multicast

- In order to enable IPv6 multicast routing on a router, you must first enable IPv6 unicast routing on the router. For information on how to enable IPv6 unicast routing on a router, refer to Implementing IPv6 Addressing and Basic Connectivity.
- You must enable IPv6 unicast routing on all interfaces.
- This module assumes that you are familiar with IPv6 addressing and basic configuration. Refer to the Implementing IPv6 Addressing and Basic Connectivity module for more information.

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Restrictions for Implementing IPv6 Multicast

- IPv6 multicast for Cisco IOS XE software uses Multicast Listener Discovery (MLD) version 2. This version of MLD is fully backward-compatible with MLD version 1 (described in RFC 2710). Hosts that support only MLD version 1 will interoperate with a router running MLD version 2. Mixed LANs with both MLD version 1 and MLD version 2 hosts are likewise supported.
- When using bidirectional (bidir) range in a network, all routers in that network must be able to understand the bidirectional range in the bootstrap message (BSM).
- IPv6 multicast routing is disabled by default when the **ipv6 unicast-routing** command is configured.

Information About Implementing IPv6 Multicast

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 router. This signaling is achieved with the MLD protocol.

Routers 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 the members of a group 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.

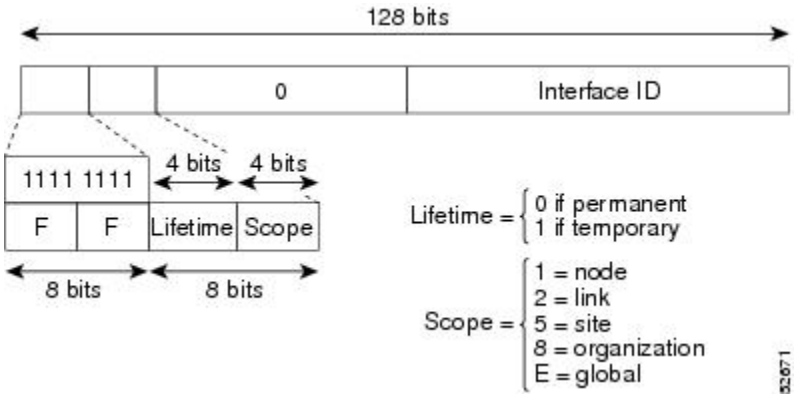
Membership in a multicast group is dynamic; hosts can join and leave at any time. There is no restriction on the location or number of members in a multicast group. A host can be a member of more than one multicast group at a time.

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.

IPv6 Multicast Addressing

An IPv6 multicast address is an IPv6 address that has a prefix of FF00::/8 (1111 1111). An IPv6 multicast address is an identifier for a set of interfaces that typically belong to different nodes. A packet sent to a multicast address is delivered to all interfaces identified by the multicast address. The second octet following the prefix defines the lifetime and scope of the multicast address. A permanent multicast address has a lifetime parameter equal to 0; a temporary multicast address has a lifetime parameter equal to 1. A multicast address that has the scope of a node, link, site, or organization, or a global scope has a scope parameter of 1, 2, 5, 8, or E, respectively. For example, a multicast address with the prefix FF02::/16 is a permanent multicast address with a link scope. The figure below shows the format of the IPv6 multicast address.

Figure 1 IPv6 Multicast Address Format



IPv6 nodes (hosts and routers) are required to join (receive packets destined for) the following multicast groups:

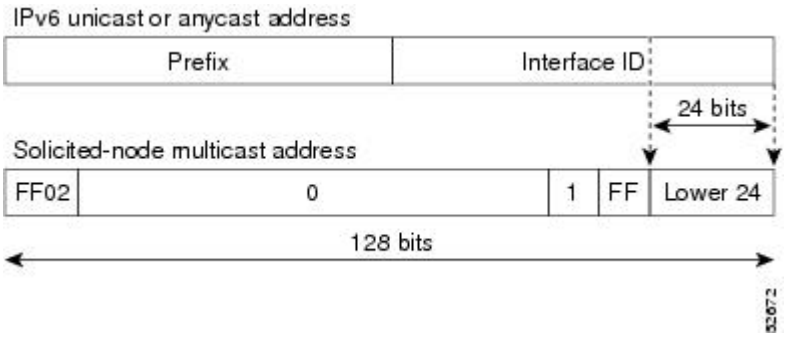
- All-nodes multicast group FF02:0:0:0:0:0:0:1 (scope is link-local)
- Solicited-node multicast group FF02:0:0:0:0:1:FF00:0000/104 for each of its assigned unicast and anycast addresses

IPv6 routers must also join the all-routers multicast group FF02:0:0:0:0:0:0:2 (scope is link-local).

The solicited-node multicast address is a multicast group that corresponds to an IPv6 unicast or anycast address. IPv6 nodes must join the associated solicited-node multicast group for every unicast and anycast address to which it is assigned. The IPv6 solicited-node multicast address has the prefix FF02:0:0:0:0:1:FF00:0000/104 concatenated with the 24 low-order bits of a corresponding IPv6 unicast or anycast address (see the figure below). For example, the solicited-node multicast address corresponding to

the IPv6 address 2037::01:800:200E:8C6C is FF02::1:FF0E:8C6C. Solicited-node addresses are used in neighbor solicitation messages.

Figure 2 IPv6 Solicited-Node Multicast Address Format



Note There are no broadcast addresses in IPv6. IPv6 multicast addresses are used instead of broadcast addresses.

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IPv6 Multicast Groups

An IPv6 address must be configured on an interface before the interface can forward IPv6 traffic. Configuring a site-local or global IPv6 address on an interface automatically configures a link-local address and activates IPv6 for that interface. Additionally, the configured interface automatically joins the following required multicast groups for that link:

- Solicited-node multicast group FF02:0:0:0:0:1:FF00::/104 for each unicast and anycast address assigned to the interface

  Note The solicited-node multicast address is used in the neighbor discovery process.

- All-nodes link-local multicast group FF02::1
- All-routers link-local multicast group FF02::2

IPv6 Multicast Routing Implementation

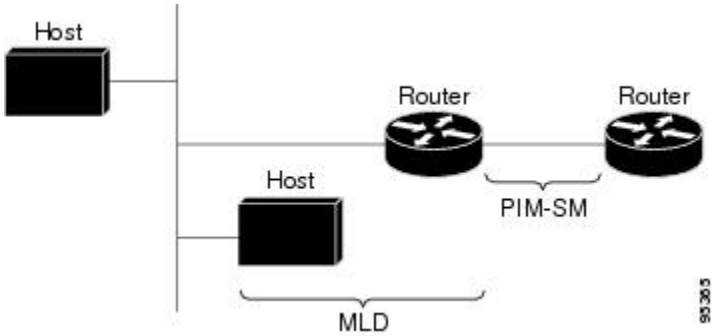
Cisco software supports the following protocols to implement IPv6 multicast routing:

- MLD for IPv6. MLD is used by IPv6 routers 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 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 router running MLD version 2. Mixed LANs with both MLD version 1 and MLD version 2 hosts are likewise supported.

- PIM-SM is used between routers so that they can track which multicast packets to forward to each other and to their directly connected LANs.
- PIM in Source Specific Multicast (PIM-SSM) is similar to PIM-SM with the additional ability to report interest in receiving packets from specific source addresses (or from all but the specific source addresses) to an IP multicast address.

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

Figure 3 IPv6 Multicast Routing Protocols Supported for IPv6



Multicast Listener Discovery Protocol for IPv6

To start implementing multicasting in the campus network, users must first define who receives the multicast. The MLD protocol is used by IPv6 routers 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.

The difference between multicast queriers and hosts is as follows:

- A querier is a network device, such as a router, that sends query messages to discover which network devices are members of a given multicast group.
- A host is a receiver, including routers, that send report messages to inform the querier of a host membership.

A set of queriers and hosts that receive multicast data streams from the same source 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 router alert option set. The router alert option implies an implementation of the hop-by-hop option header.

MLD has three types of messages:

- Query--General, group-specific, and multicast-address-specific. In a query message, the multicast address field is set to 0 when MLD sends a general query. The general query learns which multicast addresses have listeners on an attached link.

Group-specific and multicast-address-specific queries are the same. A group address is a multicast address.

- Report--In a report message, the multicast address field is that of the specific IPv6 multicast address to which the sender is listening.
- Done--In a done message, the multicast address field is that of the specific IPv6 multicast address to which the source of the MLD message is no longer listening.

MLD states that result from MLD version 2 or MLD version 1 membership reports can be limited globally or by interface. The MLD group limits feature provides protection against denial of service (DoS) attacks caused by MLD packets. Membership reports in excess of the configured limits will not be entered in the MLD cache, and traffic for those excess membership reports will not be forwarded.

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MLD Access Group

The MLD access group provides receiver access control in Cisco IOS XE IPv6 multicast routers. 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 router 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 routers 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 XE 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.

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

Requests are accomplished via PIM joins, which are sent hop by hop toward the root node of the tree. The root node of a tree in PIM-SM is the RP in the case of a shared tree or the first-hop router 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 router.

As a PIM join travels up the tree, routers 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 router 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 router updates its forwarding state appropriately. Ultimately, the forwarding state associated with a multicast group or source is removed.

A multicast data sender sends data destined for a multicast group. The designated router (DR) of the sender takes those data packets, unicast-encapsulates them, and sends them directly to the RP. The RP receives these encapsulated data packets, de-encapsulates them, and forwards them onto the shared tree. The packets then follow the (*, G) multicast tree state in the routers 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.

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Designated Router

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

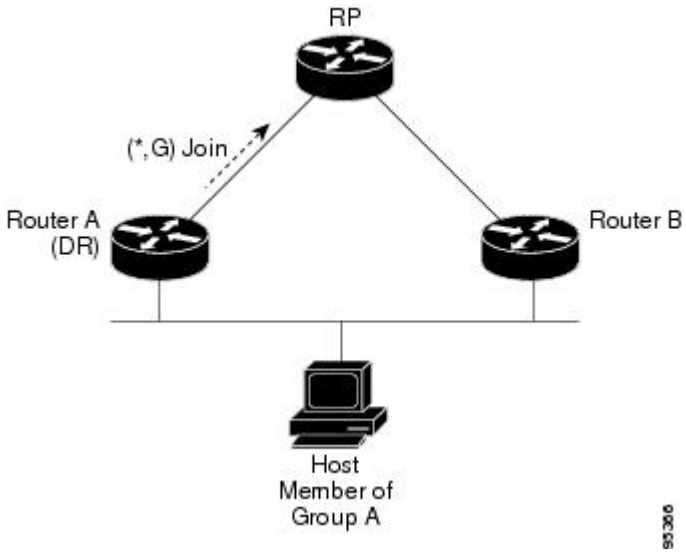
The designated router is responsible for sending PIM register and PIM join and prune messages toward the RP to inform it about host group membership.

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

The figure below illustrates what happens on a multiaccess segment. Router A and Router B are connected to a common multiaccess Gigabit Ethernet segment with Host A as an active receiver for Group A. Only Router A, operating as the DR, sends joins to the RP to construct the shared tree for Group A. If Router B was also permitted to send (*, G) joins to the RP, parallel paths would be created and Host A would receive duplicate multicast traffic. Once Host A begins to source multicast traffic to the group, the DR's

responsibility is to send register messages to the RP. If both routers were assigned the responsibility, the RP would receive duplicate multicast packets.

Figure 4 Designated Router Election on a Multiaccess Segment



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

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

Note DR election process is required only on multiaccess LANs. The last-hop router directly connected to the host is the DR.

Rendezvous Point

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

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

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

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

- Data is encapsulated in register packets and unicast directly to the RP by the first-hop router 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 routers 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 routers to send PIM join and prune messages to the RP to inform it about group membership. You must configure the RP address on all routers (including the RP router).

A PIM router 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 router 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.

IPv6 BSR

PIM routers in a domain must be able to map each multicast group to the correct RP address. The 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 router sends a (*, G) join message, the PIM router needs to know which is the next router toward the RP so that the router can direct its (*, G) join message toward it. Also, when a PIM router is forwarding data packets using (*, G) state, the PIM router 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 routers from a domain are configured as candidate bootstrap routers (C-BSRs) and a single BSR is selected for that domain. A set of routers within a domain are also configured as candidate RPs (C-RPs); typically, these routers are the same routers 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.

The IPv6 BSR ability to configure RP mapping allows IPv6 multicast routers to be statically configured to announce scope-to-RP mappings directly from the BSR instead of learning them from candidate-RP messages. Announcing RP mappings from the BSR is useful in several situations:

- When an RP address never changes because there is only a single RP or the group range uses an anycast RP, it may be less complex to configure the RP address announcement statically on the candidate BSRs.
- When an RP address is a virtual RP address (such as when bidirectional PIM is used), it cannot be learned by the BSR from a candidate-RP. Instead, the virtual RP address must be configured as an announced RP on the candidate BSRs.

Cisco IOS XE IPv6 routers provide support for the RPF flooding of BSR packets so that a Cisco IOS XE IPv6 router will not disrupt the flow of BSMs. The router will recognize and parse enough of the BSM to identify the BSR address. The router performs an RPF check for this BSR address and forwards the packet only if it is received on the RPF interface. The router also creates a BSR entry containing RPF information to use for future BSMs from the same BSR. When BSMs from a given BSR are no longer received, the BSR entry is timed out.

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

BSR provides scoped zone support by distributing group-to-RP mappings in networks using administratively scoped multicast. The user can configure candidate BSRs and a set of candidate RPs for each administratively scoped region in the user’s domain.

For BSR to function correctly with administrative scoping, a BSR and at least one C-RP must be within every administratively scoped region. Administratively scoped zone boundaries must be configured at the zone border routers (ZBRs), because they need to filter PIM join messages that might inadvertently cross the border due to error conditions. In addition, at least one C-BSR within the administratively scoped zone must be configured to be a C-BSR for the administratively scoped zone’s address range.

A separate BSR election will then take place (using BSMs) for every administratively scoped range, plus one for the global range. Administratively scoped ranges are identified in the BSM because the group range is marked to indicate that this is an administrative scope range, not just a range that a particular set of RPs is configured to handle.

Unless the C-RP is configured with a scope, it discovers the existence of the administratively scoped zone and its group range through reception of a BSM from the scope zone’s elected BSR containing the scope zone’s group range. A C-RP stores each elected BSR's address and the administratively scoped range contained in its BSM. It separately unicasts C-RP-Adv messages to the appropriate BSR for every administratively scoped range within which it is willing to serve as an RP.

All PIM routers within a PIM bootstrap domain where administratively scoped ranges are in use must be able to receive BSMs and store the winning BSR and RP set for all administratively scoped zones that apply.

PIM-Source Specific Multicast

PIM-SSM is the routing protocol that supports the implementation of SSM and is derived from PIM-SM. However, unlike PIM-SM where data from all multicast sources are sent when there is a PIM join, the SSM feature forwards datagram traffic to receivers from only those multicast sources that the receivers have explicitly joined, thus optimizing bandwidth utilization and denying unwanted Internet broadcast traffic. Further, instead of the use of RP and shared trees, SSM uses information found on source addresses for a multicast group. This information is provided by receivers through the source addresses relayed to the last-hop routers by MLD membership reports, resulting in shortest-path trees directly to the sources.

In SSM, delivery of datagrams is based on (S, G) channels. Traffic for one (S, G) channel consists of datagrams with an IPv6 unicast source address S and the multicast group address G as the IPv6 destination address. Systems will receive this traffic by becoming members of the (S, G) channel. Signaling is not

required, but receivers must subscribe or unsubscribe to (S, G) channels to receive or not receive traffic from specific sources.

MLD version 2 is required for SSM to operate. MLD allows the host to provide source information. Before SSM will run with MLD, SSM must be supported in the Cisco IPv6 router, the host where the application is running, and the application itself.

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- PIM Shared Tree and Source Tree (Shortest-Path Tree), page 11
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SSM Mapping for IPv6

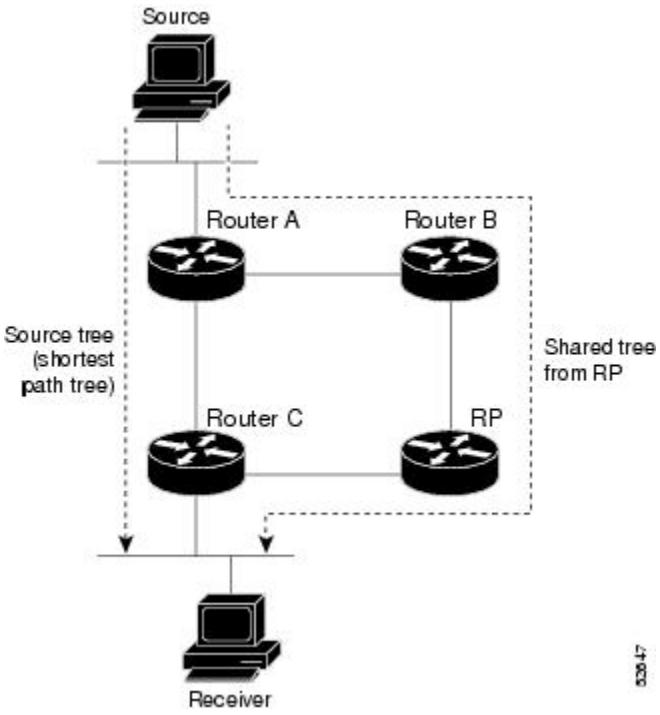
SSM mapping for IPv6 supports both static and dynamic Domain Name System (DNS) mapping for MLD version 1 receivers. This feature allows deployment of IPv6 SSM with hosts that are incapable of providing MLD version 2 support in their TCP/IP host stack and their IP multicast receiving application.

SSM mapping allows the router to look up the source of a multicast MLD version 1 report either in the running configuration of the router or from a DNS server. The router can then initiate an (S, G) join toward the source.

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

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

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



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

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

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

Join and prune messages are sent for sources and RPs. They are sent hop-by-hop and are processed by each PIM router 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.

Reverse Path Forwarding

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

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

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

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

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

Routable Address Hello Option

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

Two typical situations can lead to this situation for IPv6. The first situation can occur when the unicast routing table is not built by an IPv6 interior gateway protocol such as multicast BGP. The second situation

occurs when the address of an RP shares a subnet prefix with downstream routers (note that the RP router 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 router finds an upstream router 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 router on that link, it always includes the RPF calculation result if it refers to the PIM router 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.

Bidirectional PIM

Bidirectional PIM allows multicast routers to keep reduced state information, as compared with unidirectional shared trees in PIM-SM. Bidirectional shared trees convey data from sources to the RPA and distribute them from the RPA to the receivers. Unlike PIM-SM, bidirectional PIM does not switch over to the source tree, and there is no register encapsulation of data from the source to the RP.

A single designated forwarder (DF) exists for each RPA on every link within a bidirectional PIM domain (including multiaccess and point-to-point links). The only exception is the RPL on which no DF exists. The DF is the router on the link with the best route to the RPA, which is determined by comparing MRIB-provided metrics. A DF for a given RPA forwards downstream traffic onto its link and forwards upstream traffic from its link toward the rendezvous point link (RPL). The DF performs this function for all bidirectional groups that map to the RPA. The DF on a link is also responsible for processing Join messages from downstream routers on the link as well as ensuring that packets are forwarded to local receivers discovered through a local membership mechanism such as MLD.

Bidirectional PIM offers advantages when there are many moderate or low-rate sources. However, the bidirectional shared trees may have worse delay characteristics than do the source trees built in PIM-SM (depending on the topology).

Only static configuration of bidirectional RPs is supported in IPv6.

PIM Passive Mode

A router configured with PIM will always send out PIM hello messages to all interfaces enabled for IPv6 multicast routing, even if the router is configured not to accept PIM messages from any neighbor on the LAN. The IPv6 PIM passive mode feature allows PIM passive mode to be enabled on an interface so that a PIM passive interface cannot send and receive PIM control messages, but it can act as RPF interface for multicast route entries, and it can accept and forward multicast data packets.

Static Mroutes

IPv6 static mroutes behave much in the same way as IPv6 static routes. IPv6 static mroutes share the same database as IPv6 static routes and are implemented by extending static route support. 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 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.

- Distributed MFIB, page 14

Distributed MFIB

Distributed Multicast Forwarding Information Base (MFIB) is used to switch multicast IPv6 packets on distributed platforms. Distributed 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.

dMFIB implements the following functions:

- Distributes a copy of the MFIB to the line cards.
- 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.
- Provides hooks to allow clients residing on the RP to read traffic statistics on demand. Distributed MFIB does not periodically upload these statistics to the RP.

The combination of distributed MFIB and MRIB subsystems allows the device 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 VRF Lite

The IPv6 Multicast VRF Lite feature provides IPv6 multicast support for multiple virtual routing/forwarding contexts (VRFs). The scope of these VRFs is limited to the router in which the VRFs are defined.

This feature provides separation between routing and forwarding, providing an additional level of security because no communication between devices belonging to different VRFs is allowed unless it is explicitly configured. The IPv6 Multicast VRF Lite feature simplifies the management and troubleshooting of traffic belonging to a specific VRF.

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 must examine, rewrite, and forward each packet. The packet is first received and copied into the system memory. The router 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 also computes the cyclic redundancy check (CRC). This switching method is the least scalable method for switching IPv6 packets.

IPv6 multicast fast switching allows routers 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 router 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.

Multiprotocol BGP for the IPv6 Multicast Address Family

The multiprotocol BGP for the IPv6 multicast address family feature provides multicast BGP extensions for IPv6 and supports the same features and functionality as IPv4 BGP. IPv6 enhancements to multicast BGP include support for an IPv6 multicast address family and network layer reachability information (NLRI) and next hop (the next router in the path to the destination) attributes that use IPv6 addresses.

Multicast BGP is an enhanced BGP that allows the deployment of interdomain IPv6 multicast. Multiprotocol BGP carries routing information for multiple network layer protocol address families; for example, IPv6 address family and for IPv6 multicast routes. The IPv6 multicast address family contains routes used for RPF lookup by the IPv6 PIM protocol, and multicast BGP IPv6 provides for interdomain transport of the same. Users must use multiprotocol BGP for IPv6 multicast when using IPv6 multicast with BGP because the unicast BGP learned routes will not be used for IPv6 multicast.

Multicast BGP functionality is provided through a separate address family context. A subsequent address family identifier (SAFI) provides information about the type of the network layer reachability information

that is carried in the attribute. Multiprotocol BGP unicast uses SAFI 1 messages, and multiprotocol BGP multicast uses SAFI 2 messages. SAFI 1 messages indicate that the routes are usable only for IP unicast, not IP multicast. Because of this functionality, BGP routes in the IPv6 unicast RIB must be ignored in the IPv6 multicast RPF lookup.

A separate BGP routing table is maintained to configure incongruent policies and topologies (for example, IPv6 unicast and multicast) by using IPv6 multicast RPF lookup. Multicast RPF lookup is very similar to the IP unicast route lookup.

No MRIB is associated with the IPv6 multicast BGP table. However, IPv6 multicast BGP operates on the unicast IPv6 RIB when needed. Multicast BGP does not insert or update routes into the IPv6 unicast RIB.

Bandwidth-Based CAC for IPv6 Multicast

The bandwidth-based call admission control (CAC) for IPv6 multicast feature implements a way to count per-interface mroute state limiters using cost multipliers. This feature can be used to provide bandwidth-based CAC on a per-interface basis in network environments where the multicast flows use different amounts of bandwidth.

This feature limits and accounts for IPv6 multicast state in detail. When this feature is configured, interfaces can be limited to the number of times they may be used as incoming or outgoing interfaces in the IPv6 multicast PIM topology.

With this feature, router administrators can configure global limit cost commands for state matching access lists and specify which cost multiplier to use when accounting such state against the interface limits. This feature provides the required flexibility to implement bandwidth-based local CAC policy by tuning appropriate cost multipliers for different bandwidth requirements.

- Threshold Notification for mCAC Limit, page 16

Threshold Notification for mCAC Limit

The threshold notification for mCAC limit feature notifies the user when actual simultaneous multicast channel numbers exceeds or fall below a specified threshold percentage. For example, if the mCAC rate limit is set to 50,000,000 and the configured threshold percentage is 80 percent, then the user is notified if the limit exceeds 10,000,000.

How to Implement IPv6 Multicast

Enabling IPv6 Multicast Routing

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 multicast-routing**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 multicast-routing** **Example:** `Router(config)# ipv6 multicast-routing`	Enables multicast routing on all IPv6-enabled interfaces and enables multicast forwarding for PIM and MLD on all enabled interfaces of the router.

Customizing and Verifying the MLD Protocol

Customizing and Verifying MLD on an Interface

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ipv6 mld join-group** [*group-address*] [[**include** | **exclude**] {*source-address* | **source-list** [*acl*]}
5. **ipv6 mld access-group** *access-list-name*
6. **ipv6 mld static-group** [*group-address*] [[**include**| **exclude**] {*source-address* | **source-list** [*acl*]}
7. **ipv6 mld query-max-response-time** *seconds*
8. **ipv6 mld query-timeout** *seconds*
9. **ipv6 mld query-interval** *seconds*
10. **exit**
11. **show ipv6 mld groups** [**link-local**] [*group-name* | *group-address*] [*interface-type interface-number*] [**detail** | **explicit**
12. **show ipv6 mfib summary**
13. **show ipv6 mld interface** [*type number*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface GigabitEthernet 1/0/0`	Specifies an interface type and number, and places the router in interface configuration mode.
Step 4	**ipv6 mld join-group** [*group-address*] [[**include**	**exclude**] {*source-address*	**source-list** [*acl*]} **Example:** `Router(config-if)# ipv6 mld join-group FF04::12 exclude 2001:DB8::10::11`	Configures MLD reporting for a specified group and source.

	Command or Action	Purpose
Step 5	**ipv6 mld access-group** *access-list-name* **Example:** `Router(config-if)# ipv6 access-list acc-grp-1`	Allows the user to perform IPv6 multicast receiver access control.
Step 6	**ipv6 mld static-group** [*group-address*] [[**include**| **exclude**] {*source-address* | **source-list** [*acl*]} **Example:** `Router(config-if)# ipv6 mld static-group ff04::10 include 100::1`	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** *seconds* **Example:** `Router(config-if)# ipv6 mld query-max-response-time 20`	Configures the maximum response time advertised in MLD queries.
Step 8	**ipv6 mld query-timeout** *seconds* **Example:** `Router(config-if)# ipv6 mld query-timeout 130`	Configures the timeout value before the router takes over as the querier for the interface.
Step 9	**ipv6 mld query-interval** *seconds* **Example:** `Router(config-if)# ipv6 mld query-interval 60`	Configures the frequency at which the Cisco IOS XE software sends MLD host-query messages. **Caution** Changing this value may severely impact multicast forwarding.
Step 10	**exit** **Example:** `Router(config-if)# exit`	Enter this command twice to exit interface configuration mode and enter privileged EXEC mode.
Step 11	**show ipv6 mld groups** [**link-local**] [*group-name* | *group-address*] [*interface-type interface-number*] [**detail** | **explicit** **Example:** `Router# show ipv6 mld groups GigabitEthernet 2/1/0`	Displays the multicast groups that are directly connected to the router and that were learned through MLD.

	Command or Action	Purpose
Step 12	**show ipv6 mfib summary** **Example:** `Router# show ipv6 mfib summary`	Displays summary information about the number of IPv6 Multicast Forwarding Information Base (MFIB) entries (including link-local groups) and interfaces.
Step 13	**show ipv6 mld interface** [*type number* **Example:** `Router# show ipv6 mld interface GigabitEthernet 2/1/0`	Displays multicast-related information about an interface.

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 router. 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, page 20
- Implementing MLD Group Limits per Interface, page 21

Implementing MLD Group Limits Globally

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 mld** [**vrf** *vrf-name*] **state-limit** *number*

DETAILED STEPS

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

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 mld** [**vrf** *vrf-name*] **state-limit** *number* **Example:** `Router(config)# ipv6 mld state-limit 300`	Limits the number of MLD states globally.

Implementing MLD Group Limits per Interface

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ipv6 mld limit** *number* [**except** *access-list*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface GigabitEthernet 1/0/0`	Specifies an interface type and number, and places the router in interface configuration mode.

	Command or Action	Purpose
Step 4	**ipv6 mld limit** *number* [**except** *access-list*] **Example:** `Router(config-if)# ipv6 mld limit 100`	Limits the number of MLD states on a per-interface basis.

Configuring Explicit Tracking of Receivers to Track Host Behavior

The explicit tracking feature allows a router 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.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ipv6 mld explicit-tracking** *access-list-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface GigabitEthernet 1/0/0`	Specifies an interface type and number, and places the router in interface configuration mode.
Step 4	**ipv6 mld explicit-tracking** *access-list-name* **Example:** `Router(config-if)# ipv6 mld explicit-tracking list1`	Enables explicit tracking of hosts.

Disabling the Router from Receiving Unauthenticated Multicast Traffic

In some situations, access control may be needed to prevent multicast traffic from being received unless the subscriber is authenticated and the channels are authorized as per access control profiles. That is, there should be no traffic at all unless specified otherwise by access control profiles.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 multicast group-range** [*access-list-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 multicast group-range** [*access-list-name* **Example:** `Router(config)# ipv6 multicast group-range`	Disables multicast protocol actions and traffic forwarding for unauthorized groups or channels on all the interfaces in a router.

Resetting the MLD Traffic Counters

SUMMARY STEPS

1. **enable**
2. **clear ipv6 mld** [**vrf** *vrf-name*] traffic
3. **show ipv6 mld** [**vrf** *vrf-name*] traffic

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**clear ipv6 mld** [**vrf** *vrf-name*] traffic **Example:** `Router# clear ipv6 mld traffic`	Resets all MLD traffic counters.
Step 3	**show ipv6 mld** [**vrf** *vrf-name*] traffic **Example:** `Router# show ipv6 mld traffic`	Displays the MLD traffic counters.

Clearing the MLD Interface Counters

SUMMARY STEPS

1. **enable**
2. **clear ipv6 mld** [**vrf** *vrf-name*] **counters** *interface-type*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**clear ipv6 mld** [**vrf** *vrf-name*] **counters** *interface-type* **Example:** `Router# clear ipv6 mld counters GigabitEthernet1/0/0`	Clears the MLD interface counters.

Configuring PIM

Configuring PIM Options

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 pim** [**vrf** *vrf-name*] **spt-threshold infinity** [**group-list** *access-list-name*]
4. **interface** *type number*
5. **ipv6 pim dr-priority** *value*
6. **ipv6 pim hello-interval** *seconds*
7. **ipv6 pim join-prune-interval** *seconds*
8. **exit**
9. **show ipv6 pim** [**vrf** *vrf-name*] **join-prune statistic** [*interface-type*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 pim** [**vrf** *vrf-name*] **spt-threshold infinity** [**group-list** *access-list-name*] **Example:** `Router(config)# ipv6 pim spt-threshold infinity group-list acc-grp-1`	Configures when a PIM leaf router joins the SPT for the specified groups.

	Command or Action	Purpose
Step 4	**interface** *type number* **Example:** `Router(config)# interface GigabitEthernet 1/0/0`	Specifies an interface type and number, and places the router in interface configuration mode.
Step 5	**ipv6 pim dr-priority** *value* **Example:** `Router(config-if)# ipv6 pim dr-priority 3`	Configures the DR priority on a PIM router.
Step 6	**ipv6 pim hello-interval** *seconds* **Example:** `Router(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:** `Router(config-if)# ipv6 pim join-prune-interval 75`	Configures periodic join and prune announcement intervals for a specified interface.
Step 8	**exit** **Example:** `Router(config-if)# exit`	Enter this command twice to exit interface configuration mode and enter privileged EXEC mode.
Step 9	**show ipv6 pim** [**vrf** *vrf-name*] **join-prune statistic** [*interface-type*] **Example:** `Router# show ipv6 pim join-prune statistic`	Displays the average join-prune aggregation for the most recently aggregated 1000, 10,000, and 50,000 packets for each interface.

Configuring Bidirectional PIM and Displaying Bidirectional PIM Information

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 pim** [**vrf** *vrf-name*] **rp-address** *ipv6-address* [*group-access-list*] [**bidir**]
4. **exit**
5. **show ipv6 pim df** [*interface-type interface-number*] [*rp-address*]
6. **show ipv6 pim** [**vrf** *vrf-name*] **df winner**[*interface-type interface-number*] [*rp-address*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 pim** [**vrf** *vrf-name*] **rp-address** *ipv6-address* [*group-access-list*] [**bidir**] **Example:** `Router(config)# ipv6 pim rp-address 2001:DB8::01:800:200E:8C6C bidir`	Configures the address of a PIM RP for a particular group range. Use of the **bidir** keyword means that the group range will be used for bidirectional shared-tree forwarding.
Step 4	**exit** **Example:** `Router(config-if)# exit`	Exits global configuration mode, and returns the router to privileged EXEC mode.
Step 5	**show ipv6 pim df** [*interface-type interface-number*] [*rp-address*] **Example:** `Router# show ipv6 pim df`	Displays the designated forwarder (DF)-election state of each interface for RP.

	Command or Action	Purpose
Step 6	**show ipv6 pim** [**vrf** *vrf-name*] **df winner**[*interface-type interface-number*] [*rp-address*] **Example:** `Router# show ipv6 pim df winner GigabitEthernet 1/0/0 200::1`	Displays the DF-election winner on each interface for each RP.

Configuring IPv6 PIM Passive Mode

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 multicast pim-passive-enable**
4. **interface** *type number*
5. **ipv6 pim passive**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 multicast pim-passive-enable** **Example:** `Router(config)# ipv6 multicast pim-passive-enable`	Enables the PIM passive feature on an IPv6 router.

	Command or Action	Purpose
Step 4	**interface** *type number* **Example:** `Router(config)# interface GigabitEthernet 1/0/0`	Specifies an interface type and number, and places the router in interface configuration mode.
Step 5	**ipv6 pim passive** **Example:** `Router(config-if)# ipv6 pim passive`	Enables the PIM passive feature on a specific interface.

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.

SUMMARY STEPS

1. **enable**
2. **clear ipv6 pim** [**vrf** *vrf-name*] **traffic**
3. **show ipv6 pim** [**vrf** *vrf-name*] **traffic**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**clear ipv6 pim** [**vrf** *vrf-name*] **traffic** **Example:** `Router# clear ipv6 pim traffic`	Resets the PIM traffic counters.

	Command or Action	Purpose
Step 3	**show ipv6 pim** [**vrf** *vrf-name*] **traffic** **Example:** `Router# show ipv6 pim traffic`	Displays the PIM traffic counters.

Clearing the PIM Topology Table to Reset the MRIB Connection

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

SUMMARY STEPS

1. **enable**
2. **clear ipv6 pim topology** [*group-name* | *group-address*
3. **show ipv6 mrib client filter**] [**name** {*client-name* | *client-name* **:** *client-id*}]
4. **show ipv6 mrib route** [**link-local** | **summary** | *source-address* | *source-name* | *****] [*group-name* | *group-address* [*prefix-length*]]
5. **show ipv6 pim topology** [**link-local** | **route-count** | *group-name* | *group-address*] [*source-address* | *source-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**clear ipv6 pim topology** [*group-name*	*group-address* **Example:** `Router# clear ipv6 pim topology FF04::10`	Clears the PIM topology table.
Step 3	**show ipv6 mrib client filter**] [**name** {*client-name*	*client-name* **:** *client-id*}] **Example:** `Router# show ipv6 mrib client`	Displays multicast-related information about an interface.

	Command or Action	Purpose
Step 4	**show ipv6 mrib route** [**link-local** | **summary** | *source-address* | *source-name* | *****] [*group-name* | *group-address* [*prefix-length*]] **Example:** `Router# show ipv6 mrib route`	Displays the MRIB route information.
Step 5	**show ipv6 pim topology** [**link-local** | **route-count** | *group-name* | *group-address*] [*source-address* | *source-name* **Example:** `Router# show ipv6 pim topology`	Displays PIM topology table information for a specific group or all groups.

Configuring a BSR

Configuring a BSR and Verifying BSR Information

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 pim** [**vrf** *vrf-name*] **bsr candidate bsr** *ipv6-address*[*hash-mask-length*] [**priority** *priority-value*]
4. **interface** *type number*
5. **ipv6 pim bsr border**
6. **exit**
7. **show ipv6 pim** [**vrf** *vrf-name*] **bsr** {**election** | **rp-cache** | **candidate-rp**}

DETAILED STEPS

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

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 pim** [**vrf** *vrf-name*] **bsr candidate bsr** *ipv6-address*[*hash-mask-length*] [**priority** *priority-value*] **Example:** `Router(config)# ipv6 pim bsr candidate bsr 2001:DB8:3000:3000::42 124 priority 10`	Configures a router to be a candidate BSR.
Step 4	**interface** *type number* **Example:** `Router(config)# interface GigabitEthernet 1/0/0`	Specifies an interface type and number, and places the router in interface configuration mode.
Step 5	**ipv6 pim bsr border** **Example:** `Router(config-if)# ipv6 pim bsr border`	Configures a border for all BSMs of any scope on a specified interface.
Step 6	**exit** **Example:** `Router(config-if)# exit`	Enter this command twice to exit interface configuration mode and enter privileged EXEC mode.
Step 7	**show ipv6 pim** [**vrf** *vrf-name*] **bsr** {**election** | **rp-cache** | **candidate-rp**} **Example:** `Router# show ipv6 pim bsr election`	Displays information related to PIM BSR protocol processing.

Sending PIM RP Advertisements to the BSR

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 pim** [**vrf** *vrf-name*] **bsr candidate rp** *ipv6-address* [**group-list** *access-list-name*] [**priority** *priority-value*] [**interval** *seconds*] [**scope** *scope-value*] [**bidir**]
4. **interface** *type number*
5. **ipv6 pim bsr border**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 pim** [**vrf** *vrf-name*] **bsr candidate rp** *ipv6-address* [**group-list** *access-list-name*] [**priority** *priority-value*] [**interval** *seconds*] [**scope** *scope-value*] [**bidir**] **Example:** `Router(config)# ipv6 pim bsr candidate rp 2001:DB8:3000:3000::42 priority 0`	Sends PIM RP advertisements to the BSR.
Step 4	**interface** *type number* **Example:** `Router(config)# interface GigabitEthernet 1/0/0`	Specifies an interface type and number, and places the router in interface configuration mode.
Step 5	**ipv6 pim bsr border** **Example:** `Router(config-if)# ipv6 pim bsr border`	Configures a border for all BSMs of any scope on a specified interface.

• Disabling the Router from Receiving Unauthenticated Multicast Traffic, page 34

Disabling the Router from Receiving Unauthenticated Multicast Traffic

In some situations, access control may be needed to prevent multicast traffic from being received unless the subscriber is authenticated and the channels are authorized as per access control profiles. That is, there should be no traffic at all unless specified otherwise by access control profiles.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 multicast group-range** [*access-list-name*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 multicast group-range** [*access-list-name*] **Example:** `Router(config)# ipv6 multicast group-range`	Disables multicast protocol actions and traffic forwarding for unauthorized groups or channels on all the interfaces in a router.

Configuring SSM Mapping

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

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

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

>

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 mld** [**vrf** *vrf-name*] **ssm-map enable**
4. **no ipv6 mld** [**vrf** *vrf-name*] **ssm-map query dns**
5. **ipv6 mld** [**vrf** *vrf-name*] **ssm-map static** *access-list source-address*
6. **exit**
7. **show ipv6 mld** [**vrf** *vrf-name*] **ssm-map** [*source-address*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 mld** [**vrf** *vrf-name*] **ssm-map enable** **Example:** `Router(config)# ipv6 mld ssm-map enable`	Enables the SSM mapping feature for groups in the configured SSM range.
Step 4	**no ipv6 mld** [**vrf** *vrf-name*] **ssm-map query dns** **Example:** `Router(config)# no ipv6 mld ssm-map query dns`	Disables DNS-based SSM mapping.
Step 5	**ipv6 mld** [**vrf** *vrf-name*] **ssm-map static** *access-list source-address* **Example:** `Router(config)# ipv6 mld ssm-map static SSM_MAP_ACL_2 2001:DB8:1::1`	Configures static SSM mappings.

	Command or Action	Purpose
Step 6	**exit** **Example:** `Router(config-if)# exit`	Exits global configuration mode, and returns the router to privileged EXEC mode.
Step 7	**show ipv6 mld** [**vrf** *vrf-name*] **ssm-map** [*source-address*] **Example:** `Router# show ipv6 mld ssm-map`	Displays SSM mapping information.

Configuring Static Mroutes

Static multicast routes (mroutes) in IPv6 can be implemented as an extension of IPv6 static routes. You can configure your router 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.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 route** *ipv6-prefix / prefix-length ipv6-address* | *interface-type interface-number ipv6-address*]} [*administrative-distance*] [*administrative-multicast-distance* | **unicast**| **multicast**] [**tag** *tag*
4. **exit**
5. **show ipv6 mroute** [**vrf** *vrf-name*] [**link-local** | [*group-name* | *group-address* [*source-address* | *source-name*]] [**summary**] [**count**]
6. **show ipv6 mroute** [**vrf** *vrf-name*] [**link-local** | *group-name* | *group-address*] **active**[*kbps*]
7. **show ipv6 rpf** [**vrf** *vrf-name*] *ipv6-prefix*

DETAILED STEPS

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

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 route** *ipv6-prefix / prefix-length ipv6-address* | *interface-type interface-number ipv6-address*]} [*administrative-distance*] [*administrative-multicast-distance* | **unicast**| **multicast**] [**tag** *tag* **Example:** `Router(config)# ipv6 route 2001:DB8::/64 6::6 100`	Establishes static IPv6 routes. The example shows a static route used for both unicast routing and multicast RPF selection.
Step 4	**exit** **Example:** `Router(config-if)# exit`	Exits global configuration mode, and returns the router to privileged EXEC mode.
Step 5	**show ipv6 mroute** [**vrf** *vrf-name*] [**link-local** | [*group-name* | *group-address* [*source-address* | *source-name*]] [**summary**] [**count**] **Example:** `Router# show ipv6 mroute ff07::1`	Displays the contents of the IPv6 multicast routing table.
Step 6	**show ipv6 mroute** [**vrf** *vrf-name*] [**link-local** | *group-name* | *group-address*] **active**[*kbps*] **Example:** `Router# show ipv6 mroute active`	Displays the active multicast streams on the router.
Step 7	**show ipv6 rpf** [**vrf** *vrf-name*] *ipv6-prefix* **Example:** `Router# show ipv6 rpf 2001:DB8::1:1:2`	Checks RPF information for a given unicast host address and prefix.

Configuring IPv6 Multiprotocol BGP

Configuring an IPv6 Peer Group to Perform Multicast BGP Routing

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** *as-number*
4. **neighbor** *peer-group-name* **peer-group**
5. **neighbor** {*ip-address* | *ipv6-address* | *peer-group-name*} **remote-as** *as-number*
6. **address-family ipv6** [**unicast** | **multicast**]
7. **neighbor** {*ip-address* | *peer-group-name* | *ipv6-address*} **activate**
8. **neighbor** {*ip-address* | *ipv6-address*} **peer-group** *peer-group-name*

DETAILED STEPS

	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	**router bgp** *as-number* **Example:** `Device(config)# router bgp 65000`	Enters router configuration mode for the specified BGP routing process.

Command or Action	Purpose
Step 4 **neighbor** *peer-group-name* **peer-group** **Example:** `Device(config-router)# neighbor group1 peer-group`	Creates a BGP peer group.
Step 5 **neighbor** {*ip-address* | *ipv6-address* | *peer-group-name*} **remote-as** *as-number* **Example:** `Device(config-router)# neighbor 2001:DB8:0:CC00::1 remote-as 64600`	Adds the IPv6 address of the neighbor in the specified autonomous system to the IPv6 multicast BGP neighbor table of the local router. • The *ipv6-address* argument in the **neighbor remote-as** command must be in the form documented in RFC 2373 where the address is specified in hexadecimal using 16-bit values between colons.
Step 6 **address-family ipv6** [**unicast** | **multicast**] **Example:** `Device(config-router)# address-family ipv6 multicast`	Specifies the IPv6 address family, and enters address family configuration mode. • The **unicast** keyword specifies the IPv6 unicast address family. By default, the router is placed in configuration mode for the IPv6 unicast address family if a keyword is not specified in the **address-family ipv6** command. • The **multicast** keyword specifies IPv6 multicast address prefixes.
Step 7 **neighbor** {*ip-address* | *peer-group-name* | *ipv6-address*} **activate** **Example:** `Device(config-router-af)# neighbor 2001:DB8:0:CC00::1 activate`	Enables the neighbor to exchange prefixes for the specified family type with the neighbor and the local router. • To avoid extra configuration steps for each neighbor, use the **neighbor activate** command with the *peer-group-name* argument as an alternative in this step.
Step 8 **neighbor** {*ip-address* | *ipv6-address*} **peer-group** *peer-group-name* **Example:** `Device(config-router-af)# neighbor 2001:DB8:0:CC00::1 peer-group group1`	Assigns the IPv6 address of a BGP neighbor to a peer group.

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What to Do Next

Refer to the section "Configuring an IPv6 Multiprotocol BGP Peer Group" in the Implementing Multiprotocol BGP for IPv6 module and the "Configure BGP Peer Groups" section of the "Configuring

BGP" chapter in the *Cisco IOS XE IP Routing Configuration Guide* , for more information on assigning options to peer groups and making a BGP or multicast BGP neighbor a member of a peer group.

Advertising Routes into IPv6 Multiprotocol BGP

By default, networks that are defined in router configuration mode using the **network** command are injected into the IPv4 unicast database. To inject a network into another database, such as the IPv6 BGP database, you must define the network using the **network** command in address family configuration mode for the other database, as shown for the IPv6 BGP database.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** *as-number*
4. **address-family ipv6** [**vrf** *vrf-name*] [**unicast** | **multicast** | **vpnv6**]
5. **network** {*network-number* [**mask** *network-mask*] | *nsap-prefix*} [**route-map** *map-tag*]
6. **exit**

DETAILED STEPS

	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	**router bgp** *as-number* **Example:** `Device(config)# router bgp 65000`	Enters router configuration mode for the specified BGP routing process.
Step 4	**address-family ipv6** [**vrf** *vrf-name*] [**unicast** | **multicast** | **vpnv6**] **Example:** `Device(config-router)# address-family ipv6 unicast`	Specifies the IPv6 address family, and enters address family configuration mode. • The **unicast** keyword specifies the IPv6 unicast address family. By default, the router is placed in configuration mode for the IPv6 unicast address family if a keyword is not specified with the **address-family ipv6** command. • The **multicast** keyword specifies IPv6 multicast address prefixes.

	Command or Action	Purpose
Step 5	**network** {*network-number* [**mask** *network-mask*] | *nsap-prefix*} [**route-map** *map-tag*] **Example:** `Device(config-router-af)# network 2001:DB8::/24`	Advertises (injects) the specified prefix into the IPv6 BGP database. (The routes must first be found in the IPv6 unicast routing table.) • Specifically, the prefix is injected into the database for the address family specified in the previous step. • Routes are tagged from the specified prefix as "local origin." • The *ipv6-prefix*argument in the **network** command must be in the form documented in RFC 2373 where the address is specified in hexadecimal using 16-bit values between colons. • The *prefix-length* argument is a decimal value that indicates how many of the high-order contiguous bits of the address comprise the prefix (the network portion of the address). A slash mark must precede the decimal value.
Step 6	**exit** **Example:** `Device(config-router-af)# exit`	Exits address family configuration mode, and returns the router to router configuration mode. • Repeat this step to exit router configuration mode and return the router to global configuration mode.

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What to Do Next

Refer to the section "Advertising Routes into IPv6 Multiprotocol BGP" in the Implementing Multiprotocol BGP for IPv6 module for more information on assigning options to peer groups and making a BGP or multicast BGP neighbor a member of a peer group.

Redistributing Prefixes into IPv6 Multiprotocol BGP

Redistribution is the process of redistributing, or injecting, prefixes from one routing protocol into another routing protocol. This task explains how to inject prefixes from a routing protocol into IPv6 multiprotocol BGP. Specifically, prefixes that are redistributed into IPv6 multiprotocol BGP using the **redistribute** router configuration command are injected into the IPv6 unicast database.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** *as-number*
4. **address-family ipv6** [**vrf** *vrf-name*] [**unicast** | **multicast** | **vpnv6**]
5. **redistribute bgp** [*process-id*] [**metric** *metric-value*] [**route-map** *map-name*] [*source-protocol-options*]
6. **exit**

DETAILED STEPS

	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	**router bgp** *as-number* **Example:** `Device(config)# router bgp 65000`	Enters router configuration mode for the specified BGP routing process.
Step 4	**address-family ipv6** [**vrf** *vrf-name*] [**unicast** | **multicast** | **vpnv6**] **Example:** `Device(config-router)# address-family ipv6`	Specifies the IPv6 address family, and enters address family configuration mode. • The **unicast** keyword specifies the IPv6 unicast address family. By default, the router is placed in configuration mode for the IPv6 unicast address family if a keyword is not specified with the **address-family ipv6** command. • The **multicast** keyword specifies IPv6 multicast address prefixes.
Step 5	**redistribute bgp** [*process-id*] [**metric** *metric-value*] [**route-map** *map-name*] [*source-protocol-options*] **Example:** `Device(config-router-af)# redistribute bgp 64500 metric 5 metric-type external`	Redistributes IPv6 routes from one routing domain into another routing domain.
Step 6	**exit** **Example:** `Device(config-router-af)# exit`	Exits address family configuration mode, and returns the router to router configuration mode. • Repeat this step to exit router configuration mode and return the router to global configuration mode.

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What to Do Next

Refer to the section "Redistributing Prefixes into IPv6 Multiprotocol BGP" in the Implementing Multiprotocol BGP for IPv6 module for more information on assigning options to peer groups and making a BGP or multicast BGP neighbor a member of a peer group.

To configure aggregate addresses for Multicast BGP, refer to the "Configuring Aggregate Addresses" section of the "Configuring BGP" chapter in the *Cisco IOS XE IP Routing Configuration Guide* .

Assigning a BGP Administrative Distance

Caution Changing the administrative distance of BGP internal routes is not recommended. One problem that can occur is the accumulation of routing table inconsistencies, which can break routing.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** *as-number*
4. **address-family ipv6** [**unicast** | **multicast**}
5. **distance bgp** *external-distance internal-distance local-distance*

DETAILED STEPS

	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	**router bgp** *as-number* **Example:** `Device(config)# router bgp 100`	Enters router configuration mode for the specified routing process.
Step 4	**address-family ipv6** [**unicast**	**multicast**} **Example:** `Device(config-router)# address-family ipv6 multicast`	Enters address family configuration mode for configuring routing sessions such as BGP that use standard IPv6 address prefixes.

	Command or Action	Purpose
Step 5	**distance bgp** *external-distance internal-distance local-distance* **Example:** `Device(config-router)# distance bgp 20 20 200`	Assigns a BGP administrative distance.

Generating Translate Updates for IPv6 Multicast BGP

The multicast BGP translate-update feature generally is used in a multicast BGP-capable router that peers with a customer site that has only a BGP-capable router; the customer site has not or cannot upgrade its router to a multicast BGP-capable image. Because the customer site cannot originate multicast BGP advertisements, the router with which it peers will translate the BGP prefixes into multicast BGP prefixes, which are used for multicast-source RPF lookup.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** *as-number*
4. **address-family ipv6** [**unicast** | **multicast**}
5. **neighbor** *ipv6-address* **translate-update ipv6 multicast** [**unicast**]

DETAILED STEPS

	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	**router bgp** *as-number* **Example:** `Device(config)# router bgp 100`	Enters router configuration mode for the specified routing process.

	Command or Action	Purpose
Step 4	**address-family ipv6** [**unicast** | **multicast**] **Example:** `Device(config-router)# address-family ipv6 multicast`	Enters address family configuration mode for configuring routing sessions such as BGP that use standard IPv6 address prefixes.
Step 5	**neighbor** *ipv6-address* **translate-update ipv6 multicast** [**unicast**] **Example:** `Device(config-router)# neighbor 2001:DB8:7000::2 translate-update ipv6 multicast`	Generates multiprotocol IPv6 BGP updates that correspond to unicast IPv6 updates received from a peer.

Resetting IPv6 BGP Sessions

SUMMARY STEPS

1. **enable**
2. **clear bgp ipv6** {**unicast** | **multicast**} {***** | *autonomous-system-number* | *ip-address* | *ipv6-address* | **peer-group** *peer-group-name*} [**soft**] [**in** | **out**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**clear bgp ipv6** {**unicast** | **multicast**} {***** | *autonomous-system-number* | *ip-address* | *ipv6-address* | **peer-group** *peer-group-name*} [**soft**] [**in** | **out**] **Example:** `Device# clear bgp ipv6 unicast peer-group marketing soft out`	Resets IPv6 BGP sessions.

Clearing External BGP Peers

SUMMARY STEPS

1. **enable**
2. **clear bgp ipv6** {**unicast** | **multicast**} **external** [**soft**] [**in** | **out**]
3. **clear bgp ipv6** {**unicast** | **multicast**} **peer-group** *name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**clear bgp ipv6** {**unicast**	**multicast**} **external** [**soft**] [**in**	**out**] **Example:** `Device# clear bgp ipv6 unicast external soft in`	Clears external IPv6 BGP peers.
Step 3	**clear bgp ipv6** {**unicast**	**multicast**} **peer-group** *name* **Example:** `Device# clear bgp ipv6 unicast peer-group marketing`	Clears all members of an IPv6 BGP peer group.

Clearing IPv6 BGP Route Dampening Information

SUMMARY STEPS

1. **enable**
2. **clear bgp ipv6** {**unicast** | **multicast**} **dampening** [*ipv6-prefix prefix-length*]

DETAILED STEPS

	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	**clear bgp ipv6** {**unicast** | **multicast**} **dampening** [*ipv6-prefix prefix-length*] **Example:** `Device# clear bgp ipv6 unicast dampening 2001:DB8::/64`	Clears IPv6 BGP route dampening information and unsuppresses the suppressed routes.

Clearing IPv6 BGP Flap Statistics

SUMMARY STEPS

1. **enable**
2. **clear bgp ipv6** {**unicast** | **multicast**} **flap-statistics** [*ipv6-prefix*/*prefix-length* | **regexp** *regexp* | **filter-list** *list*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**clear bgp ipv6** {**unicast** | **multicast**} **flap-statistics** [*ipv6-prefix*/*prefix-length* | **regexp** *regexp* | **filter-list** *list*] **Example:** `Device# clear bgp ipv6 unicast flap-statistics filter-list 3`	Clears IPv6 BGP flap statistics.

Configuring Bandwidth-Based CAC for IPv6

Configuring the Interface Limit for Bandwidth-Based CAC in IPv6

Bandwidth-based CAC for IPv6 counts per-interface IPv6 mroute states using cost multipliers. With this feature, router administrators can specify which cost multiplier to use when accounting such state against the interface limits.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ipv6 address** {*ipv6-address* / *prefix-length* | *prefix-name sub-bits*/*prefix-length*
5. **ipv6 multicast limit** [**connected** | **rpf** | **out**] *limit-acl max* [**threshold** *threshold-value*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface GigabitEthernet 1/3/1`	Specifies an interface type and number, and places the router in interface configuration mode.
Step 4	**ipv6 address** {*ipv6-address* / *prefix-length* | *prefix-name sub-bits*/ *prefix-length* **Example:** `Router(config-if)# ipv6 address FE80::40:1:3 link-local`	Configures an IPv6 address based on an IPv6 general prefix.
Step 5	**ipv6 multicast limit** [**connected** | **rpf** | **out**] *limit-acl max* [**threshold** *threshold-value*] **Example:** `Router (config-if)# ipv6 multicast limit out acl1 10`	Configures per-interface mroute state limiters in IPv6.

Configuring an Access List for Bandwidth-Based CAC in IPv6

In bandwidth-based CAC for IPv6, router administrators can configure global limit cost commands for state matching access lists. Perform this task to configure an access list to configure a state matching access list.

or

deny

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 access-list** *access-list-name*
4. **permit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 access-list** *access-list-name* **Example:** `Router(config)# ipv6 access-list costlist1`	Defines an IPv6 access list and places the router in IPv6 access list configuration mode.

	Command or Action	Purpose
Step 4	**permit** **Example:** **Example:** or **Example:** **Example:** **deny** **Example:** `Router(config-ipv6-acl)# permit any ff03::1/64`	Use the **permit** or **deny** command to set conditions for an IPv6 access list.

Configuring the Global Limit for Bandwidth-Based CAC in IPv6

Router administrators can configure global limit cost commands for state matching access lists.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 multicast** [**vrf** *vrf-name*] **limit cost** *access-list cost-multiplier*

DETAILED STEPS

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

Command or Action	Purpose
Step 2 **configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3 **ipv6 multicast** [**vrf** *vrf-name*] **limit cost** *access-list cost-multiplier* **Example:** `Router (config)# ipv6 multicast limit cost costlist1 2`	Applies a cost to mroutes that match per-interface mroute state limiters in IPv6.

Configuring the Threshold Notification for the mCAC Limit in IPv6

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 multicast limit rate** *rate-value*
4. **interface** *type number*
5. **ipv6 multicast limit** [**connected** | **rpf** | **out**] *limit-acl max* [**threshold** *threshold-value*]

DETAILED STEPS

Command or Action	Purpose
Step 1 **enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2 **configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3 **ipv6 multicast limit rate** *rate-value* **Example:** `Router(config)# ipv6 multicast limit rate 2`	Configures the maximum allowed state on the source router.

	Command or Action	Purpose
Step 4	**interface** *type number* **Example:** `Router(config)# interface GigabitEthernet 1/3/1`	Specifies an interface type and number, and places the router in interface configuration mode.
Step 5	**ipv6 multicast limit** [**connected** | **rpf** | **out**] *limit-acl max* [**threshold** *threshold-value*] **Example:** `Router (config-if)# ipv6 multicast limit out acl1 10 threshold 20`	Configures per-interface mroute state limiters in IPv6.

Using MFIB in IPv6 Multicast

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

- Verifying MFIB Operation in IPv6 Multicast, page 52
- Resetting MFIB Traffic Counters, page 54

Verifying MFIB Operation in IPv6 Multicast

SUMMARY STEPS

1. **enable**
2. **show ipv6 mfib** [**vrf** *vrf-name*] [**link-local** | **verbose** | *group-address-name* | *ipv6-prefix* / *prefix-length* | *source-address-name*| **active** | **count** | **interface** | **status** | **summary**]
3. **show ipv6 mfib** [**vrf** *vrf-name*] [**link-local**| *group-name* | *group-address*] **active** [*kbps*]
4. **show ipv6 mfib** [**vrf** *vrf-name*] [**all** | **linkscope**| *group-name* | *group-address* [*source-name* | *source-address*]] **count**
5. **show ipv6 mfib interface**
6. **show ipv6 mfib status**
7. **show ipv6 mfib** [**vrf** *vrf-name*] **summary**
8. **debug ipv6 mfib** [**vrf** *vrf-name*] [*group-name*| *group-address*] [**adjacency** | **db** | **fs** | **init** | **interface** | **mrib** [**detail**] | **nat** | **pak** | **platform** | **ppr** | **ps** | **signal** | **table**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show ipv6 mfib** [**vrf** *vrf-name*] [**link-local** | **verbose** | *group-address-name* | *ipv6-prefix* / *prefix-length* | *source-address-name*| **active** | **count** | **interface** | **status** | **summary**] **Example:** `Router# show ipv6 mfib`	Displays the forwarding entries and interfaces in the IPv6 MFIB.
Step 3	**show ipv6 mfib** [**vrf** *vrf-name*] [**link-local**| *group-name* | *group-address*] **active** [*kbps*] **Example:** `Router# show ipv6 mfib active`	Displays the rate at which active sources are sending to multicast groups.
Step 4	**show ipv6 mfib** [**vrf** *vrf-name*] [**all** | **linkscope**| *group-name* | *group-address* [*source-name* | *source-address*]] **count** **Example:** `Router# show ipv6 mfib count`	Displays summary traffic statistics from the MFIB about the group and source.
Step 5	**show ipv6 mfib interface** **Example:** `Router# show ipv6 mfib interface`	Displays information about IPv6 multicast-enabled interfaces and their forwarding status.
Step 6	**show ipv6 mfib status** **Example:** `Router# show ipv6 mfib status`	Displays general MFIB configuration and operational status.

	Command or Action	Purpose
Step 7	**show ipv6 mfib** [**vrf** *vrf-name*] **summary** **Example:** `Router# show ipv6 mfib summary`	Displays summary information about the number of IPv6 MFIB entries and interfaces.
Step 8	**debug ipv6 mfib** [**vrf** *vrf-name*] [*group-name*| *group-address*] [**adjacency** | **db** | **fs** | **init** | **interface** | **mrib** [**detail**] | **nat** | **pak** | **platform** | **ppr** | **ps** | **signal** | **table**] **Example:** `Router# debug ipv6 mfib FF04::10 pak`	Enables debugging output on the IPv6 MFIB.

Resetting MFIB Traffic Counters

SUMMARY STEPS

1. **enable**
2. **clear ipv6 mfib** [**vrf** *vrf-name*] **counters** [*group-name* | *group-address* [*source-address* | *source-name*]]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**clear ipv6 mfib** [**vrf** *vrf-name*] **counters** [*group-name* | *group-address* [*source-address* | *source-name*]] **Example:** `Router# clear ipv6 mfib counters FF04::10`	Resets all active MFIB traffic counters.

Disabling Default Features in IPv6 Multicast

Several features are automatically enabled when IPv6 multicast is used. However, a user may want to disable certain features in response to certain situations.

- Disabling Embedded RP Support in IPv6 PIM, page 55
- Turning Off IPv6 PIM on a Specified Interface, page 56
- Disabling MLD Router-Side Processing, page 57

- Disabling MFIB on the Router, page 57
- Disabling MFIB Interrupt-Level IPv6 Multicast Forwarding, page 58

Disabling Embedded RP Support in IPv6 PIM

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

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

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **no ipv6 pim** [**vrf** *vrf-name*] **rp embedded**
4. **interface** *type number*
5. **no ipv6 pim**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**no ipv6 pim** [**vrf** *vrf-name*] **rp embedded** **Example:** `Router(config)# no ipv6 pim rp embedded`	Disables embedded RP support in IPv6 PIM.
Step 4	**interface** *type number* **Example:** `Router(config)# interface GigabitEthernet 1/0/0`	Specifies an interface type and number, and places the router in interface configuration mode.

	Command or Action	Purpose
Step 5	**no ipv6 pim** **Example:** `Router(config-if)# no ipv6 pim`	Turns off IPv6 PIM on a specified interface.

Turning Off IPv6 PIM on a Specified Interface

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

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **no ipv6 pim**

DETAILED STEPS

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

Disabling MLD Router-Side Processing

A user might only want specified interfaces to perform IPv6 multicast and will therefore want to turn off MLD router-side processing on a specified interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **no ipv6 mld router**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface GigabitEthernet 1/0/0`	Specifies an interface type and number, and places the router in interface configuration mode.
Step 4	**no ipv6 mld router** **Example:** `Router(config-if)# no ipv6 mld router`	Disables MLD router-side processing on a specified interface.

Disabling MFIB on the Router

Multicast forwarding is automatically enabled when IPv6 multicast routing is enabled. However, a user may want to disable multicast forwarding on the router.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **no ipv6 mfib**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**no ipv6 mfib** **Example:** `Router(config)# no ipv6 mfib`	Disables IPv6 multicast forwarding on the router.

Disabling MFIB Interrupt-Level IPv6 Multicast Forwarding

MFIB interrupt-level IPv6 multicast forwarding of outgoing packets on a specific interface is enabled on interfaces that support Cisco Express Forwarding. However, a user may want to disable MFIB interrupt-level forwarding on a specified interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **no ipv6 mfib cef output**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface GigabitEthernet 1/0/0`	Specifies an interface type and number, and places the router in interface configuration mode.
Step 4	**no ipv6 mfib cef output** **Example:** `Router(config-if)# no ipv6 mfib cef output`	Disables MFIB interrupt-level IPv6 multicast forwarding of outgoing packets on a specific interface.

Troubleshooting IPv6 Multicast

SUMMARY STEPS

1. **enable**
2. **debug ipv6 mfib** *group-name* | *group-address*] [**adjacency** | **signal** | **db** | **init** | **mrib** | **pak** | **ps**
3. debug ipv6 mld [group-name | group-address | interface-type]
4. **debug ipv6 mld explicit** [*group-name* | *group-address*
5. **debug ipv6 pim** [*group-name* | *group-address* | *interface-type* | **neighbor** | **bsr**
6. **debug bgp ipv6** {**unicast** | **multicast**} **dampening** [**prefix-list** *prefix-list-name*
7. **debug bgp ipv6** {**unicast** | **multicast**} **updates** [*ipv6-address*] [**prefix-list** *prefix-list-name*] [**in** | **out**
8. **debug ipv6 mrib client**
9. **debug ipv6 mrib io**
10. **debug ipv6 mrib issu**
11. **debug ipv6 mrib proxy**
12. **debug ipv6 mrib route** [*group-name* | *group-address*
13. **debug ipv6 mrib table**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**debug ipv6 mfib** *group-name* | *group-address*] [**adjacency** | **signal** | **db** | **init** | **mrib** | **pak** | **ps** **Example:** `Router# debug ipv6 mfib pak FF04::10`	Enables debugging output on the IPv6 MFIB.
Step 3	debug ipv6 mld [group-name | group-address | interface-type] **Example:** `Router# debug ipv6 mld`	Enables debugging on MLD protocol activity.
Step 4	**debug ipv6 mld explicit** [*group-name* | *group-address* **Example:** `Router# debug ipv6 mld explicit`	Displays information related to the explicit tracking of hosts.
Step 5	**debug ipv6 pim** [*group-name* | *group-address* | *interface-type* | **neighbor** | **bsr** **Example:** `Router# debug ipv6 pim`	Enables debugging on PIM protocol activity.
Step 6	**debug bgp ipv6** {**unicast** | **multicast**} **dampening** [**prefix-list** *prefix-list-name* **Example:** `Router# debug bgp ipv6 multicast`	Displays debugging messages for IPv6 BGP dampening.

	Command or Action	Purpose
Step 7	**debug bgp ipv6** {**unicast** | **multicast**} **updates** [*ipv6-address*] [**prefix-list** *prefix-list-name*] [**in** | **out** **Example:** `Router# debug bgp ipv6 multicast updates`	Displays debugging messages for IPv6 BGP update packets.
Step 8	**debug ipv6 mrib client** **Example:** `Router# debug ipv6 mrib client`	Enables debugging on MRIB client management activity.
Step 9	**debug ipv6 mrib io** **Example:** `Router# debug ipv6 mrib io`	Enables debugging on MRIB I/O events.
Step 10	**debug ipv6 mrib issu** **Example:** `Router# debug ipv6 mrib issu`	Enables debugging on MRIB in service software update.
Step 11	**debug ipv6 mrib proxy** **Example:** `Router# debug ipv6 mrib proxy`	Enables debugging on MRIB proxy activity between the route processor and line cards on distributed router platforms.
Step 12	**debug ipv6 mrib route** [*group-name* | *group-address* **Example:** `Router# debug ipv6 mrib route`	Displays information about MRIB routing entry-related activity.
Step 13	**debug ipv6 mrib table** **Example:** `Router# debug ipv6 mrib table`	Enables debugging on MRIB table management activity.

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Examples

Sample Output from the show ipv6 mfib Command

The following example displays the forwarding entries and interfaces in the MFIB. The router is configured for fast switching, and it has a receiver joined to FF05::1 on GigabitEthernet 1/1/0 and a source (2001:DB8:1:1:20) sending on GigabitEthernet 1/2/0:

```
Router# show ipv6 mfib
IP Multicast Forwarding Information Base
Entry Flags: C - Directly Connected, S - Signal, IA - Inherit A flag,
             AR - Activity Required, D - Drop
Forwarding Counts: Pkt Count/Pkts per second/Avg Pkt Size/Kbits per second
Other counts: Total/RPF failed/Other drops
Interface Flags: A - Accept, F - Forward, NS - Negate Signalling
             IC - Internal Copy, NP - Not platform switched
             SP - Signal Present
Interface Counts: FS Pkt Count/PS Pkt Count
(*,FF00::/8) Flags: C
   Forwarding: 0/0/0/0, Other: 0/0/0
   Tunnel0 Flags: NS
(*,FF00::/15) Flags: D
   Forwarding: 0/0/0/0, Other: 0/0/0
(*,FF05::1) Flags: C
   Forwarding: 2/0/100/0, Other: 0/0/0
   Tunnel0 Flags: A NS
   GigabitEthernet1/1/0 Flags: F NS
     Pkts: 0/2
(2001:DB8:1:1:200,FF05::1) Flags:
   Forwarding: 5/0/100/0, Other: 0/0/0
   GigabitEthernet1/2/0 Flags: A
   GigabitEthernet1/1/0 Flags: F NS
     Pkts: 3/2
(*,FF10::/15) Flags: D
   Forwarding: 0/0/0/0, Other: 0/0/0
```

Sample Output from the show ipv6 mfib active Command

The following example displays statistics on the rate at which active IP multicast sources are sending information. The router is switching traffic from 2001:DB8:1:1:200 to FF05::1:

```
Router# show ipv6 mfib active
Active IPv6 Multicast Sources - sending >= 4 kbps
Group: FF05::1
  Source: 2001:DB8:1:1:200
    Rate: 20 pps/16 kbps(1sec), 0 kbps(last 128 sec)
```

Sample Output from the show ipv6 mfib count Command

The following example displays statistics from the MFIB about the group and source. The router is switching traffic from 2001:DB8:1:1:200 to FF05::1:

```
Router# show ipv6 mfib count

IP Multicast Statistics
54 routes, 7 groups, 0.14 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: FF00::/8
  RP-tree:    Forwarding: 0/0/0/0, Other: 0/0/0
Group: FF00::/15
  RP-tree:    Forwarding: 0/0/0/0, Other: 0/0/0
Group: FF05::1
  RP-tree:    Forwarding: 2/0/100/0, Other: 0/0/0
```

```
  Source: 10::1:1:200,   Forwarding: 367/10/100/7, Other: 0/0/0
  Tot. shown: Source count: 1, pkt count: 369
Group: FF10::/15
  RP-tree:    Forwarding: 0/0/0/0, Other: 0/0/0
Group: FF20::/15
  RP-tree:    Forwarding: 0/0/0/0, Other: 0/0/0
```

Sample Output from the show ipv6 mfib interface Command

The following example displays information about IPv6 multicast-enabled interfaces and their forwarding status. The router is configured for fast switching:

```
Router# show ipv6 mfib interface
IPv6 Multicast Forwarding (MFIB) status:
    Configuration Status: enabled
    Operational Status: running
MFIB interface       status    CEF-based output
                               [configured,available]
GigabitEthernet1/1/0 up     [yes       ,yes      ]
GigabitEthernet1/2/0 up     [yes       ,?        ]
Tunnel0              up     [yes       ,?        ]
Tunnel1              up     [yes       ,?        ]
```

Sample Output from the show ipv6 mfib summary Command

The following example displays summary information about the number of IPv6 MFIB entries and interfaces:

```
Router# show ipv6 mfib summary

IPv6 MFIB summary:
  54     total entries [1 (S,G), 7 (*,G), 46 (*,G/m)]
  17     total MFIB interfaces
```

Sample Output from the show ipv6 mld groups Command

The following is sample output from the **show ipv6 mld groups** command. It shows all of the groups joined by Gigabit Ethernet interface 2/1/0, including link-local groups used by network protocols.

```
Router# show ipv6 mld groups GigabitEthernet 2/1/0
MLD Connected Group Membership
Group Address          Interface           Uptime        Expires
FF02::2                GigabitEthernet2/1/0     3d18h         never
FF02::D                GigabitEthernet2/1/0     3d18h         never
FF02::16               GigabitEthernet2/1/0     3d18h         never
FF02::1:FF00:1         GigabitEthernet2/1/0     3d18h         00:00:27
FF02::1:FF00:79        GigabitEthernet2/1/0     3d18h         never
FF02::1:FF23:83C2      GigabitEthernet2/1/0     3d18h         00:00:22
FF02::1:FFAF:2C39      GigabitEthernet2/1/0     3d18h         never
FF06:7777::1           GigabitEthernet2/1/0     3d18h         00:00:26
```

Sample Output from the show ipv6 mld groups summary Command

The following is sample output from the **show ipv6 mld groups summary**command:

```
Router# show ipv6 mld groups summary
MLD Route Summary
  No. of (*,G) routes = 5
  No. of (S,G) routes = 0
```

Sample Output from the show ipv6 mld interface Command

The following is sample output from the **show ipv6 mld interface** command for Gigabit Ethernet interface 2/1/0:

```
Router# show ipv6 mld interface GigabitEthernet 2/1/0
GigabitEthernet2/1/0 is up, line protocol is up
Internet address is FE80::205:5FFF:FEAF:2C39/10
MLD is enabled in interface
Current MLD version is 2
MLD query interval is 125 seconds
MLD querier timeout is 255 seconds
MLD max query response time is 10 seconds
Last member query response interval is 1 seconds
MLD activity: 25 joins, 17 leaves
MLD querying router is FE80::205:5FFF:FEAF:2C39 (this system)
```

Sample Output from the show ipv6 mld ssm-map Command

The following examples show SSM mapping for the source address 2001:DB8::1:

```
Router# show ipv6 mld ssm-map 2001:DB8::1
 Group address  : 2001:DB8::1
 Group mode ssm : TRUE
 Database       : STATIC
 Source list    : 2001:DB8::2
                  2001:DB8::3
Router# show ipv6 mld ssm-map 2001:DB8::2
 Group address  : 2001:DB8::2
 Group mode ssm : TRUE
 Database       : DNS
 Source list    : 2001:DB8::3
                  2001:DB8::1
```

Sample Output from the show ipv6 mld traffic Command

The following example displays the MLD protocol messages received and sent.

```
Router# show ipv6 mld traffic

MLD Traffic Counters
Elapsed time since counters cleared:00:00:21
                              Received     Sent
Valid MLD Packets               3           1
Queries                         1           0
Reports                         2           1
Leaves                          0           0
Mtrace packets                  0           0
Errors:
Malformed Packets                           0
Bad Checksums                               0
Martian source                              0
Packets Received on MLD-disabled Interface  0
```

Sample Output from the show ipv6 mrib client Command

The following is sample output from the **show ipv6 mrib client**command:

```
Router# show ipv6 mrib client
IP MRIB client-connections
igmp:145        (connection id 0)
pim:146 (connection id 1)
mfib ipv6:3     (connection id 2)
slot 3  mfib ipv6 rp agent:16   (connection id 3)
slot 1  mfib ipv6 rp agent:16   (connection id 4)
slot 0  mfib ipv6 rp agent:16   (connection id 5)
```

```
slot 4  mfib ipv6 rp agent:16   (connection id 6)
slot 2  mfib ipv6 rp agent:16   (connection id 7)
```

Sample Output from the show ipv6 mrib route Command

The following is sample output from the **show ipv6 mrib route**command using the **summary** keyword:

```
Router# show ipv6 mrib route summary
MRIB Route-DB Summary
  No. of (*,G) routes = 52
  No. of (S,G) routes = 0
  No. of Route x Interfaces (RxI) = 10
```

Sample Output from the show ipv6 mroute Command

Using the **show ipv6 mroute** command is a good way to dynamically verify that multicast IPv6 data is flowing. The following is sample output from the **show ipv6 mroute**command:

```
Router# show ipv6 mroute ff07::1
Multicast Routing Table
Flags:D - Dense, S - Sparse, B - Bidir Group, s - SSM Group,
       C - Connected, L - Local, I - Received Source Specific Host Report,
       P - Pruned, R - RP-bit set, F - Register flag, T - SPT-bit set,
       J - Join SPT
Timers:Uptime/Expires
Interface state:Interface, State
(*, FF07::1), 00:04:45/00:02:47, RP 2001:DB8:6::6, flags:S
  Incoming interface:Tunnel5
  RPF nbr:6:6:6::6
  Outgoing interface list:
    POS4/0, Forward, 00:04:45/00:02:47
(2001:DB8:999::99, FF07::1), 00:02:06/00:01:23, flags:SFT
  Incoming interface:POS1/0
  RPF nbr:2001:DB8:999::99
  Outgoing interface list:
    POS4/0, Forward, 00:02:06/00:03:27
```

Sample Output from the show ipv6 mroute active Command

The following is sample output from the **show ipv6 mroute active**command:

```
Router# show ipv6 mroute active
Active IPv6 Multicast Sources - sending >= 4 kbps
Group:FF05::1
 Source:2001:DB8:1:1:1
   Rate:11 pps/8 kbps(1sec), 8 kbps(last 8 sec)
```

Sample Output from the show ipv6 pim group-map Command

The following is sample output from the **show ipv6 pim group-map**command:

```
Router# show ipv6 pim group-map
FF33::/32*
      SSM
      Info source:Static
      Uptime:00:08:32, Groups:0
  FF34::/32*
      SSM
      Info source:Static
      Uptime:00:09:42, Groups:0
```

Sample Output from the show ipv6 pim interface Command

The following is sample output from the **show ipv6 pim interface** command using the **state-on** keyword:

```
Router# show ipv6 pim interface state-on
Interface          PIM  Nbr   Hello  DR
                        Count Intvl  Prior
GigabitEthernet0/0/0 on   0     30     1
    Address:FE80::208:20FF:FE08:D7FF
    DR     :this system
POS1/0             on   0     30     1
    Address:FE80::208:20FF:FE08:D554
    DR     :this system
POS4/0             on   1     30   1
    Address:FE80::208:20FF:FE08:D554
    DR     :FE80::250:E2FF:FE8B:4C80
POS4/1             on   0     30   1
    Address:FE80::208:20FF:FE08:D554
    DR     :this system
Loopback0          on   0     30     1
    Address:FE80::208:20FF:FE08:D554
    DR     :this system
```

Sample Output from the show ipv6 pim join-prune statistic Command

The following example provides the join/prune aggregation on GigabitEthernet interface 0/0/0:

```
Router# show ipv6 pim join-prune statistic GigabitEthernet0/0/0
PIM Average Join/Prune Aggregation for last (1K/10K/50K) packets
Interface             Transmitted             Received
GigabitEthernet0/0/0      0    / 0    / 0         1    / 0    / 0
```

Sample Output from the show ipv6 pim range-list Command

The following is sample output from the **show ipv6 pim range-list**command:

```
Router# show ipv6 pim range-list
config SSM Exp:never Learnt from :::
 FF33::/32 Up:00:26:33
 FF34::/32 Up:00:26:33
 FF35::/32 Up:00:26:33
 FF36::/32 Up:00:26:33
 FF37::/32 Up:00:26:33
 FF38::/32 Up:00:26:33
 FF39::/32 Up:00:26:33
 FF3A::/32 Up:00:26:33
 FF3B::/32 Up:00:26:33
 FF3C::/32 Up:00:26:33
 FF3D::/32 Up:00:26:33
 FF3E::/32 Up:00:26:33
 FF3F::/32 Up:00:26:33
config SM RP:40::1:1:1 Exp:never Learnt from :::
 FF13::/64 Up:00:03:50
config SM RP:40::1:1:3 Exp:never Learnt from :::
 FF09::/64 Up:00:03:50
```

Sample Output from the show ipv6 pim topology Command

The following is sample output from the **show ipv6 pim topology** command:

```
Router# show ipv6 pim topology
IP PIM Multicast Topology Table
Entry state:(*/S,G)[RPT/SPT] Protocol Uptime Info
Entry flags:KAT - Keep Alive Timer, AA - Assume Alive, PA - Probe Alive,
    RA - Really Alive, LH - Last Hop, DSS - Don't Signal Sources,
    RR - Register Received, SR - Sending Registers, E - MSDP External,
    DCC - Don't Check Connected
```

```
Interface state:Name, Uptime, Fwd, Info
Interface flags:LI - Local Interest, LD - Local Dissinterest,
II - Internal Interest, ID - Internal Dissinterest,
LH - Last Hop, AS - Assert, AB - Admin Boundary
(*,FF05::1)
SM UP:02:26:56 JP:Join(now) Flags:LH
RP:2001:DB8:1:1:2
RPF:GigabitEthernet1/1/0,FE81::1
  GigabitEthernet0/1/0 02:26:56  fwd LI LH
(2001:DB8:1:1:200,FF05::1)
SM UP:00:00:07 JP:Null(never) Flags:
RPF:GigabitEthernet1/1/0,FE80::30:1:4
  GigabitEthernet1/1/0         00:00:07  off LI
```

Sample Output from the show ipv6 pim traffic Command

The following example shows the number of PIM protocol messages received and sent.

```
Router# show ipv6 pim traffic

PIM Traffic Counters
Elapsed time since counters cleared:00:05:29
                              Received     Sent
Valid PIM Packets               22          22
Hello                           22          22
Join-Prune                      0           0
Register                        0           0
Register Stop                   0           0
Assert                          0           0
Bidir DF Election               0           0
Errors:
Malformed Packets                           0
Bad Checksums                               0
Send Errors                                 0
Packet Sent on Loopback Errors              0
Packets Received on PIM-disabled Interface  0
Packets Received with Unknown PIM Version   0
```

Sample Output from the show ipv6 pim tunnel Command

The following is sample output from the **show ipv6 pim tunnel**command on the RP:

```
Router# show ipv6 pim tunnel
Tunnel0*
 Type  :PIM Encap
 RP    :100::1
 Source:100::1
Tunnel0*
 Type  :PIM Decap
 RP    :100::1
 Source: -
```

The following is sample output from the **show ipv6 pim tunnel**command on a non-RP:

```
Router# show ipv6 pim tunnel
Tunnel0*
 Type  :PIM Encap
 RP    :100::1
 Source:2001::1:1:1
```

Sample Output from the show ipv6 rpf Command

The following example displays RPF information for the unicast host with the IPv6 address of 2001:DB8:1:1:2:

```
Router# show ipv6 rpf 2001:DB8:1:1:2
RPF information for 2001:DB8:1:1:2
```

```
RPF interface:GigabitEthernet3/2/0
RPF neighbor:FE80::40:1:3
RPF route/mask:20::/64
RPF type:Unicast
RPF recursion count:0
Metric preference:110
Metric:30
```

Configuration Examples for IPv6 Multicast

Example: Enabling IPv6 Multicast Routing

The following example enables multicast routing on all interfaces. Entering this command also enables multicast forwarding for PIM and MLD on all enabled interfaces of the router.

```
Router> enable
Router# configure terminal

Router(config)# ipv6 multicast-routing
```

Examples Configuring the MLD Protocol

The following example shows how to configure the query maximum response time, the query timeout, and the query interval on GigabitEthernet interface 1/0/0:

```
Router> enable
Router# configure terminal
Router(config)# interface GigabitEthernet 1/0/0

Router(config-if)# ipv6 mld query-max-response-time  20

Router(config-if)# i pv6 mld query-timeout 130

Router(config-if)# ipv6 mld query-interval 60
```

The following example configures MLD reporting for a specified group and source, allows the user to perform IPv6 multicast receiver access control, and statically forwards traffic for the multicast group onto GigabitEthernet interface 1/0/0:

```
Router> enable
Router# configure terminal
Router(config)# interface GigabitEthernet 1/0/0
Router(config)# ipv6 mld join-group FF04::10
Router(config)# ipv6 mld static-group FF04::10 100::1
Router(config)# ipv6 mld access-group acc-grp-1
```

Example Configuring Explicit Tracking of Receivers

```
Router> enable
Router# configure terminal
Router(config)# interface GigabitEthernet 1/0/0
Router(config-if)# ipv6 mld explicit-tracking list1
```

Example Configuring PIM

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

```
Router(config)# ipv6 multicast-routing
Router(config)# ipv6 pim rp-address 2001:DB8::1
Router(config)# ipv6 pim spt-threshold infinity
```

Example Configuring PIM Options

The following example sets the DR priority, the PIM hello interval, and the periodic join and prune announcement interval on GigabitEthernet interface 0/0/0.

```
Router(config)# interface GigabitEthernet0/0/0
Router(config)# ipv6 pim hello-interval 60
Router(config)# ipv6 pim dr-priority 3
Router(config)# ipv6 pim join-prune-interval 75
```

Example Configuring Mroutes

The following example shows how to configure a static multicast route to be used for multicast RPF selection only:

```
Router> enable
Router# configure terminal
Router(config)# ipv6 route 2001:DB8::/64 7::7 100 multicast
```

Example Configuring an IPv6 Multiprotocol BGP Peer Group

The following example configures the IPv6 multiprotocol BGP peer group named group1:

```
router bgp 65000
no bgp default ipv4-unicast
neighbor group1 peer-group
neighbor 2001:DB8:0:CC00::1 remote-as 64600
address-family ipv6 multicast
 neighbor 3FFE:C00:0:1:A8BB:CCFF:FE00:8200 activate
```

```
 no auto-summary
 no synchronization
 exit-address-family
```

Example Redistributing Prefixes into IPv6 Multiprotocol BGP

The following example redistributes BGP routes into the IPv6 multicast database of the local router:

```
router bgp 64900
 no bgp default ipv4-unicast
address-family ipv6 multicast
 redistribute BGP
```

Example: Generating Translate Updates for IPv6 Multicast BGP

The following example shows how to generate IPv6 multicast BGP updates that correspond to unicast IPv6 updates:

```
router bgp 64900
 no bgp default ipv4-unicast
address-family ipv6 multicast
 neighbor 2001:DB8:7000::2 translate-update ipv6 multicast
```

Example: Configuring Bandwidth-Based CAC for IPv6

Example: Configuring the Interface Limit for Bandwidth-Based CAC in IPv6

The following example configures the interface limit on the source router's outgoing interface GigabitEthernet 1/1/3.

```
interface GigabitEthernet 1/3/1
ipv6 address FE80::40:1:3 link-local
 ipv6 address 2001:DB8:1:1:3/64
 ipv6 multicast limit out acl1 10
```

Example: Configuring an Access List for Bandwidth-Based CAC in IPv6

The following example shows how to configure an access list to use for bandwidth-based CAC:

```
ipv6 access-list cost-list
   permit any ff03::1/64
```

Example: Configuring the Global Limit for Bandwidth-Based CAC

The following example configures the global limit on the source router.

```
ipv6 multicast limit cost cost-list 2
```

Example Turning Off IPv6 PIM on a Specified Interface

The following example turns off IPv6 PIM on GigabitEthernet interface 1/0/0:

```
Router(config)# ipv6 multicast-routing
Router(config)# interface GigabitEthernet 1/0/0
Router(config)# no ipv6 pim
```

Example Disabling MLD Router-Side Processing

The following example turns off MLD router-side processing on GigabitEthernet interface 1/0/0:

```
Router> enable
Router# configure terminal
Router(config)# interface GigabitEthernet 1/0/0

Router(config-if)# no ipv6 mld router
```

Additional References

Related Documents

Related Topic	Document Title
IPv6 multicast addresses	Implementing IPv6 Addressing and Basic Connectivity , *Cisco IOS XE IPv6 Configuration Guide*
Multicast BGP for IPv6	Implementing Multiprotocol BGP for IPv6 , *Cisco IOS XE IPv6 Configuration Guide*
IPv6 static routes	Implementing Static Routes for IPv6 , *Cisco IOS XE IPv6 Configuration Guide*
IPv6 tunnels	Implementing Tunneling for IPv6 , *Cisco IOS XE IPv6 Configuration Guide*

Standards and Drafts

Standards	Title
draft-ietf-pim-sm-v2-new	*Protocol Independent Multicast - Sparse Mode PIM-SM): Protocol Specification (Revised)* , March 6, 2003
draft-savola-mboned-mcast-rpaddr	*Embedding the Address of RP in IPv6 Multicast Address* , May 23, 2003
draft-suz-pim-upstream-detection	*PIM Upstream Detection Among Multiple Addresses* , February 2003

Standards	Title
draft-ietf-pim-bidir-05	*Bi-directional Protocol Independent Multicast (BIDIR-PIM)* , June 20, 2003

MIBs

MIBs	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
RFC 2373	*IP Version 6 Addressing Architecture*
RFC 2375	*IPv6 Multicast Address Assignments*
RFC 2460	*Internet Protocol, Version 6 (IPv6) Specification*
RFC 2461	*Neighbor Discovery for IP version 6 (IPv6)*
RFC 2462	*IPv6 Stateless Address Autoconfiguration*
RFC 3576	*Change of Authorization*
RFC 3590	*Source Address Selection for the Multicast Listener Discovery (MLD) Protocol*
RFC 3810	*Multicast Listener Discovery Version 2 (MLDv2) for IPv6*
RFC 4007	*IPv6 Scoped Address Architecture*
RFC 4610	*Anycast-RP Using Protocol Independent Multicast (PIM)*

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for Implementing IPv6 Multicast

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 1 Feature Information for Implementing IPv6 Multicast

Feature Name	Releases	Feature Information
Distributed MFIB (dMFIB)	Cisco IOS XE Release 2.1	Distributed MFIB is used to switch multicast IPv6 packets on distributed platforms.
IPv6 Multicast	Cisco IOS XE Release 2.1	IPv6 multicast allows a host to send a single data stream to a subset of all hosts simultaneously.
IPv6--Multicast Address Group Range Support	Cisco IOS XE Release 2.6 Cisco IOS XE Release 3.3SG	This feature allows the router to keep from receiving multicast traffic to be received from unauthenticated groups or unauthorized channels. The following command was modified by this feature: **ipv6 multicast group-range**.
IPv6 Multicast--Address Family Support for Multiprotocol BGP	Cisco IOS XE Release 2.1	This feature provides multicast BGP extensions for IPv6 and supports the same features and functionality as IPv4 BGP.

Feature Name	Releases	Feature Information
IPv6 Multicast--Bandwidth-Based Call Admission Control (CAC)	Cisco IOS XE Release 2.6	The bandwidth-based call admission control (CAC) for IPv6 multicast feature implements a method to monitor bandwidth per interface and multicast group avoiding oversubscription due to multicast services. The following commands were modified by this feature: ipv6 multicast group-range, ipv6 multicast limit, ipv6 multicast limit cost.
IPv6 Multicast--Bootstrap Router (BSR)	Cisco IOS XE Release 2.1 Cisco IOS XE Release 2.4	If an RP becomes unreachable, this feature allows the RP to be detected and the mapping tables modified so that the unreachable RP is no longer used, and the new tables will be rapidly distributed throughout the domain.
IPv6 Multicast--Explicit Tracking of Receivers	Cisco IOS XE Release 2.1	This feature allows a router to track the behavior of the hosts within its IPv6 network. The following command was modified by this feature: **ipv6 mld explicit-tracking**
IPv6 Multicast--IPv6 Bidirectional PIM	Cisco IOS XE Release 2.3	Bidirectional PIM allows multicast routers to keep reduced state information. Bidirectional shared trees convey data from sources to the RP and distribute them from the RP to the receivers. The following commands were modified by this feature: **ipv6 pim rp-address**, **show ipv6 pim df**, **show ipv6 pim df winner**
IPv6 Multicast--IPv6 BSR--Ability to Configure RP Mapping	Cisco IOS XE Release 2.4 Cisco IOS XE Release 3.3SG	This feature allows IPv6 multicast routers to be statically configured to announce scope-to-RP mappings directly from the BSR instead of learning them from candidate-RP messages.

Feature Name	Releases	Feature Information
IPv6 Multicast--IPv6 BSR Bidirectional Support	Cisco IOS XE Release 2.4	Bidirectional BSR support allows bidirectional RPs to be advertised in C-RP messages and bidirectional ranges in the BSM.
IPv6 Multicast--MLD Access Group	Cisco IOS XE Release 2.1	The MLD access group provides receiver access control in Cisco IOS XE IPv6 multicast routers. The following command was modified by this feature: **ipv6 mld access-group**
IPv6 Multicast--MLD Group Limits	Cisco IOS XE Release 2.6 Cisco IOS XE Release 3.3SG	The MLD group limits feature provides protection against denial of service (DoS) attacks caused by MLD packets. The following commands were modified by this feature: **ipv6 mld limit**, **ipv6 mld state-limit**

Feature Name	Releases	Feature Information
IPv6 Multicast--Multicast Listener Discovery (MLD) Protocol, Versions 1 and 2	Cisco IOS XE Release 2.1	MLD is used by IPv6 routers 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 IGMP for IPv4, and MLD version 2 is based on version 3 of the IGMP for IPv4. IPv6 multicast for Cisco IOS XE software uses both MLD version 2 and MLD version 1. The following commands were modified by this feature: **clear ipv6 mld counters**, **clear ipv6 mld traffic**, **debug ipv6 mld**, **debug ipv6 mld explicit**, **debug ipv6 mld ssm-map**, **ipv6 mld join-group**, **ipv6 mld query-interval**, **ipv6 mld query-max-response-time**, **ipv6 mld query-timeout**, **ipv6 mld router**, **ipv6 mld static-group**, **ipv6 multicast-routing**, **show ipv6 mld interface**, **show ipv6 mld groups**, **show ipv6 mld groups summary**, **show ipv6 mld traffic**
IPv6 Multicast--MRIB	Cisco IOS XE Release 2.1	The MRIB is a protocol-independent repository of multicast routing entries instantiated by multicast routing protocols (routing clients). The following commands were modified by this feature: **clear ipv6 pim topology**, **debug ipv6 mrib client, debug ipv6 mrib io, debug ipv6 mrib proxy, debug ipv6 mrib route, debug ipv6 mrib table, show ipv6 mrib client**, **show ipv6 mrib route**, **show ipv6 pim topology**

Feature Name	Releases	Feature Information
IPv6 Multicast--PIM Source Specific Multicast (PIM-SSM)	Cisco IOS XE Release 2.1	PIM-SSM supports the implementation of SSM and is derived from PIM-SM. The SSM feature forwards datagram traffic to receivers from only those multicast sources that the receivers have explicitly joined, optimizing bandwidth utilization and denying unwanted Internet broadcast traffic. The following commands were modified by this feature: **clear ipv6 pim counters**, **clear ipv6 pim topology**, **debug ipv6 pim**, **debug ipv6 pim df-election**, **ipv6 pim**, **ipv6 pim dr-priority**, **ipv6 pim hello-interval**, **ipv6 pim join-prune-interval**, **ipv6 pim spt-threshold infinity**, **show ipv6 mrib client**, **show ipv6 mrib route**, **show ipv6 pim group-map**, **show ipv6 pim interface**, **show ipv6 pim join-prune statistic**, **show ipv6 pim range-list**, **show ipv6 pim traffic**, **show ipv6 pim topology**
IPv6 Multicast--PIM Sparse Mode (PIM-SM)	Cisco IOS XE Release 2.1 Cisco IOS XE Release 2.4	PIM-SM uses unicast routing to provide reverse-path information for multicast tree building. PIM-SM is used in a multicast network when relatively few routers are involved in each multicast and these routers do not forward multicast packets for a group, unless there is an explicit request for the traffic.
IPv6 Multicast--Routable Address Hello Option	Cisco IOS XE Release 2.4	The routable address hello option adds a PIM hello message option that includes all the addresses on the interface on which the PIM hello message is advertised.

Feature Name	Releases	Feature Information
IPv6 Multicast--SSM Mapping for MLDv1 SSM	Cisco IOS XE Release 2.1 Cisco IOS XE Release 2.4 Cisco IOS XE Release 3.3SG	This feature allows deployment of IPv6 SSM with hosts that are incapable of providing MLD version 2 support in their TCP/IP host stack and their IP multicast receiving application. The following commands were modified by this feature: **ipv6 mld ssm-map enable**, **ipv6 mld ssm-map query dns**, **ipv6 mld ssm-map static**, **show ipv6 mld ssm-map**
IPv6 Multicast--Static Multicast Routing (mroute)	Cisco IOS XE Release 2.1	IPv6 static mroutes share the same database as IPv6 static routes and are implemented by extending static route support. The following commands were modified by this feature: **ipv6 route**, **show ipv6 mroute**, **show ipv6 mroute active**, **show ipv6 rpf**
IPv6 Multicast--VRF Lite	XE 3.4S	The IPv6 Multicast VRF Lite feature provides IPv6 multicast support for multiple virtual routing/forwarding contexts (VRFs). The scope of these VRFs is limited to the router in which the VRFs are defined.
PIM Passive Mode	Cisco IOS XE Release 2.6	This feature allows PIM passive mode to be enabled on an interface so that a PIM passive interface cannot send and receive PIM control messages, but it can act as RPF interface for multicast route entries, and it can accept and forward multicast data packets. The following command were introduced or modified by this feature: **ipv6 multicast pim-passive-enable**, **ipv6 pim passive**.

Feature Name	Releases	Feature Information
Threshold Notification for mCAC Limit	Cisco IOS XE Release 2.6	Support for this feature is provided in Cisco IOS XE Release 2.6 The following command were introduced or modified by this feature: ipv6 multicast limit, ipv6 multicast limit rate.
PIMv6: Anycast RP Solution	Cisco IOS XE Release 3.4S	The anycast RP solution in IPv6 PIM allows an IPv6 network to support anycast services for the PIM-SM RP. It allows anycast RP to be used inside a domain that runs PIM only. This feature is useful when interdomain connection is not required.