IP Multicast Multilayer Switching

This feature module describes the IP multicast Multilayer Switching (MLS) feature. It includes the following sections:

Feature Overview

The IP multicast MLS feature provides high-performance, hardware-based, Layer 3 switching of IP multicast traffic for routers connected to Catalyst 5000 series LAN switches.

An IP multicast flow is a unidirectional sequence of packets between a multicast source and the members of a destination multicast group. Flows are based on the IP address of the source device and the destination IP multicast group address.

IP multicast MLS switches IP multicast data packet flows between IP subnets using advanced, application-specific integrated circuit (ASIC) switching hardware, thereby off-loading processor-intensive, multicast packet routing from network routers.

The packet forwarding function is moved onto the connected Layer 3 switch whenever a supported path exists between a source and members of a multicast group. Packets that do not have a supported path to reach their destinations are still forwarded in software by routers. Protocol Independent Multicast (PIM) is used for route determination.

IP Multicast MLS Components

An IP multicast MLS network topology has two components:

- Multicast MLS-Switching Engine (MMLS-SE)—Catalyst 5000 series switch with hardware that supports IP multicast MLS. The MMLS-SE provides Layer 3 LAN-switching services.

- Multicast MLS-Route Processor (MMLS-RP)—Routing platform running Cisco IOS software that supports IP multicast MLS. The MMLS-RP interacts with the IP multicast routing software and updates the MLS cache in the MMLS-SE. When you enable IP multicast MLS, the MMLS-RP continues to handle all non-IP-multicast traffic while off-loading IP multicast traffic forwarding to the MMLS-SE.

Layer 2 Multicast Forwarding Table

The MMLS-SE uses the Layer 2 multicast forwarding table to determine on which ports Layer 2 multicast traffic should be forwarded (if any). The Layer 2 multicast forwarding table is populated by enabling CGMP, IGMP snooping, or GMRP on the switch. These entries map the destination multicast MAC address to outgoing switch ports for a given VLAN.

Layer 3 Multicast MLS Cache

The MMLS-SE maintains the Layer 3 MLS cache to identify individual IP multicast flows. Each entry is of the form {source IP, destination group IP, source VLAN}. The maximum MLS cache size is 128K and is shared by all MLS processes on the switch (such as IP unicast MLS and IPX MLS). However, if the total of cache entries exceeds 32K, there is increased probability that a flow will not be switched by the MMLS-SE and will get forwarded to the router.

The MMLS-SE populates the MLS cache using information learned from the routers participating in IP multicast MLS. The router and switch exchange information using the multicast Multilayer Switching Protocol (multicast MLSP).

Whenever the router receives traffic for a new flow, it updates its multicast routing table and forwards the new information to the MMLS-SE using multicast MLSP. In addition, if an entry in the multicast routing table is aged out, the router deletes the entry and forwards the updated information to the MMLS-SE.

The MLS cache contains flow information for all active multilayer switched flows. After the MLS cache is populated, multicast packets identified as belonging to an existing flow can be Layer 3-switched based on the cache entry for that flow. For each cache entry, the MMLS-SE maintains a list of outgoing interfaces for the destination IP multicast group. The MMLS-SE uses this list to determine on which VLANs traffic to a given multicast flow should be replicated.

IP Multicast MLS Flow Mask

IP multicast MLS supports a single flow mask, source-destination-vlan. The MMLS-SE maintains one multicast MLS cache entry for each {source IP, destination group IP, source VLAN}. The multicast source-destination-vlan flow mask differs from the IP unicast MLS source-destination-ip flow mask in that, for IP multicast MLS, the source VLAN is included as part of the entry. The source VLAN is the multicast Reverse Path Forwarding (RPF) interface for the multicast flow.

Layer 3-Switched Multicast Packet Rewrite

When a multicast packet is Layer 3-switched from a multicast source to a destination multicast group, the MMLS-SE performs a packet rewrite based on information learned from the MMLS-RP and stored in the multicast MLS cache.

For example, if Server A sends a multicast packet addressed to IP multicast group G1 and members of group G1 are on VLANs other than the source VLAN, the MMLS-SE must perform a packet rewrite when it replicates the traffic to the other VLANs (the switch also bridges the packet in the source VLAN).

When the MMLS-SE receives the multicast packet, it is formatted similarly to the sample that follows (only the important fields are shown):

Frame Header		**IP Header**				**Payload**	
Destination	Source	Destination	Source	TTL	Checksum	Data	Checksum
Group G1 MAC	*Server A MAC*	*Group G1 IP*	*Server A IP*	*n*	*calculation1*		

The MMLS-SE rewrites the packet as follows:

- Changes the source MAC address in the Layer 2 frame header from the MAC address of the server to the MAC address of the MMLS-RP (this MAC address is stored in the multicast MLS cache entry for the flow)
- Decrements the IP header Time to Live (TTL) by one and recalculates the IP header checksum

The result is a rewritten IP multicast packet that appears to have been routed by the router. The MMLS-SE replicates the rewritten packet onto the appropriate destination VLANs, where it is forwarded to members of IP multicast group G1.

After the MMLS-SE performs the packet rewrite, the packet is formatted as follows:

Frame Header		**IP Header**				**Payload**	
Destination	Source	Destination	Source	TTL	Checksum	Data	Checksum
Group G1 MAC	*MMLS-RP MAC*	*Group G1 IP*	*Server A IP*	*n – 1*	*calculation2*		

Partially and Completely Switched Flows

When at least one outgoing router interface for a given flow is multilayer switched, and at least one outgoing interface is not multilayer switched, that flow is considered partially switched. When a partially switched flow is created, all multicast traffic belonging to that flow still reaches the router and is software forwarded on those outgoing interfaces that are not multilayer switched.

A flow might be partially switched instead of completely switched in these situations:

- Some multicast group destinations are located across the router (not all multicast traffic is received and sent on subinterfaces of the same trunk link).
- The router is configured as a member of the IP multicast group (using the **ip igmp join-group** command) on the RPF interface of the multicast source.
- The router is the first-hop router to the source in PIM sparse mode (in this case, the router must send PIM-register messages to the rendezvous point [RP]).
- Multicast TTL threshold or multicast boundary is configured on an outgoing interface for the flow.
- Multicast helper is configured on the RPF interface for the flow and multicast to broadcast translation is required.

- Access list restrictions are configured on an outgoing interface (see the "Access List Restrictions and Guidelines" section later in this document).
- Integrated routing and bridging (IRB) is configured on the ingress interface.
- An output rate limit is configured on an outgoing interface.
- Multicast tag switching is configured on an outgoing interface.

When all the outgoing router interfaces for a given flow are multilayer switched, and none of the above situations apply to the flow, that flow is considered completely switched. When a completely switched flow is created, the MMLS-SE prevents multicast traffic bridged on the source VLAN for that flow from reaching the MMLS-RP interface in that VLAN, reducing the load on the router.

One consequence of a completely switched flow is that the router cannot record multicast statistics for that flow. Therefore, the MMLS-SE periodically sends multicast packet and byte count statistics for all completely switched flows to the router using multicast MLSP. The router updates the corresponding multicast routing table entry and resets the expiration timer for that multicast route.

IP Multicast MLS Network Topology

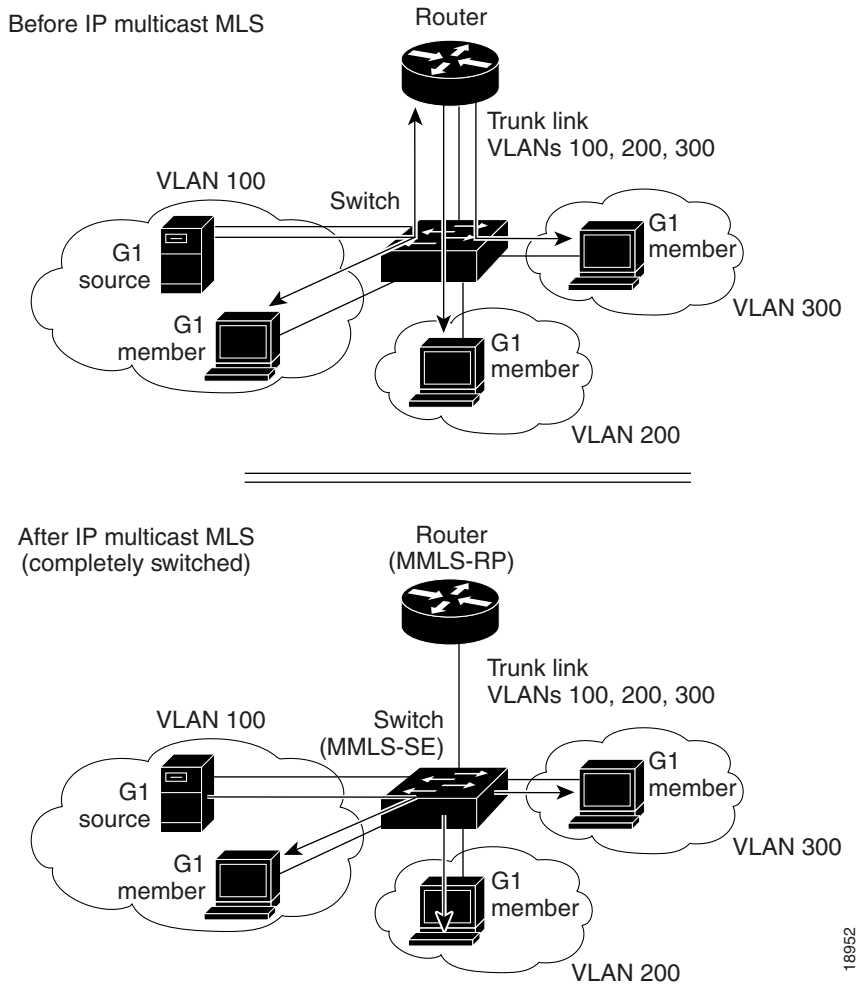
IP multicast MLS requires specific network topologies to function correctly. In each of these topologies, the source traffic is received on the switch, traverses a trunk link to the router, and returns to the switch over the same trunk link to reach the destination group members. The basic topology consists of a switch and an internal or external router connected through an ISL or 802.1Q trunk link.

Figure 1 shows this basic configuration before and after IP multicast MLS is deployed (assuming a completely switched flow). The topology consists of a switch, a directly connected external router, and multiple IP subnetworks (VLANs).

The network in the upper diagram in Figure 1 does not have the IP multicast MLS feature enabled. Note the arrows from the router to each multicast group in each VLAN. In this case, the router must replicate the multicast data packets to the multiple VLANs. The router can be easily overwhelmed with forwarding and replicated multicast traffic if the input rate or the number of outgoing interfaces increases.

As shown in the lower diagram in Figure 1, this potential problem is prevented by having the switch hardware forward the multicast data traffic. (Multicast control packets are still moving between the router and switch.)

Figure 1 Basic IP Multicast MLS Network Topology



Benefits

Improves Throughput

This feature improves the router's multicast Layer 3 forwarding and replication throughput.

Reduces Load on Router

If the router must replicate many multicast packets to many VLANs, it can be overwhelmed as the input rate and number of outgoing interfaces increase. Configuring the switch to replicate and forward the multicast flow reduces the demand on the router.

Provides IP Multicast Scalability

If you need high throughput of multicast traffic, install a Catalyst 5000 series switch and configure this feature. By reducing the load on your router, you can accommodate more multicast flows.

Provides Meaningful Flow Statistics

IP multicast MLS provides flow statistics that can be used to administer, plan, and troubleshoot networks.

Restrictions

You must also configure the Catalyst 5000 series switch in order for IP multicast MLS to function on the router.

The restrictions in the following sections apply to IP multicast MLS on the router:

- Router Configuration Restrictions
- External Router Guidelines
- Access List Restrictions and Guidelines
- Unsupported Features

Router Configuration Restrictions

IP multicast MLS does not work on internal or external routers in the following situations:

- If IP multicast MLS is disabled on the RPF interface for the flow (using the **no mls rp ip multicast** interface configuration command).
- For IP multicast groups that fall into these ranges (where * is in the range 0 to 255):
  - 224.0.0.* through 239.0.0.*
  - 224.128.0.* through 239.128.0.*

Note Groups in the 224.0.0.* range are reserved for routing control packets and must be flooded to all forwarding ports of the VLAN. These addresses map to the multicast MAC address range 01-00-5E-00-00-*xx,* where *xx* is in the range 0 to 0xFF.

- For PIM auto-RP multicast groups (IP multicast group addresses 224.0.1.39 and 224.0.1.40).
- For flows that are forwarded on the multicast shared tree (that is, {*,G,*} forwarding) when the interface or group is running PIM sparse mode.
- If the shortest path tree (SPT) bit for the flow is cleared when running PIM sparse mode for the interface or group.
- When an input rate limit is applied on an RPF interface.
- For any RPF interface with access lists applied (for detailed information, see the “Access List Restrictions and Guidelines” section later in this document).
- For any RPF interface with multicast boundary configured.
- For packets that require fragmentation and packets with IP options. However, packets in the flow that are not fragmented or that do not specify IP options are multilayer switched.
- On external routers, for source traffic received at the router on non-ISL or non-802.1Q interfaces.
- For source traffic received on tunnel interfaces (such as MBONE traffic).
- For any RPF interface with multicast tag switching enabled.

External Router Guidelines

Follow these guidelines when using an external router:

- The connection to the external router must be over a single ISL or 802.1Q trunk link with subinterfaces (using appropriate encapsulation type) configured.
- A single external router can serve as the MMLS-RP for multiple switches, provided each switch connects to the router through a separate ISL or 802.1Q trunk link.
- If the switch connects to a single router through multiple trunk links, IP multicast MLS is supported on one of the links only. You must disable IP multicast MLS on the redundant links using the **no mls rp ip multicast** interface configuration command.
- You can connect end hosts (source or multicast destination devices) through any media (Ethernet, Fast Ethernet, ATM, and Fiber Distributed Data Interface [FDDI]), but the connection between external routers and the switch must be through Fast Ethernet or Gigabit Ethernet interfaces.

Access List Restrictions and Guidelines

These restrictions apply when using access lists on interfaces participating in IP multicast MLS:

- All standard access lists are supported on any interface. The flow is multilayer switched on all interfaces on which the traffic for the flow is allowed by the access list.
- Layer 4 port-based extended IP input access lists are not supported. For interfaces with these access lists applied, no flows are multilayer switched.
- Extended access lists on the RPF interface that specify conditions other than Layer 3 source, Layer 3 destination, and **ip** protocol are not multilayer switched.

  For example, if the following input access list is applied to the RPF interface for a group of flows, no flows will be multilayer switched even though the second entry permits all IP traffic (because the protocol specified in the first entry is not **ip**):

  ```
  Router(config)# access-list 101 permit udp any any
  Router(config)# access-list 101 permit ip any any
  ```

  If the following input access list is applied to the RPF interface for a group of flows, all flows except the {s1,g1} flow are multilayer switched (because the protocol specified in the entry for {s1, g1} is not **ip)**:

  ```
  Router(config)# access-list 101 permit udp s1 g1
  Router(config)# access-list 101 permit ip any any
  ```

Unsupported Features

If IP multicast MLS is enabled, IP accounting for the interface will not reflect accurate values.

Related Features and Technologies

- Switching
- IP multicast routing

Related Documents

- *Catalyst 5000 Software Configuration Guide*, Release 5.1 (You need this document to configure the switch. It also contains additional supported topologies you might want to consider.)
- *Catalyst 5000 Command Reference*, Release 5.1
- Cisco IOS Release 12.0 *Network Protocols Configuration Guide, Part 1*
- Cisco IOS Release 12.0 *Network Protocols Command Reference, Part 1*
- *Cisco IOS Switching Services Configuration Guide*, Release 12.0
- *Cisco IOS Switching Services Command Reference*, Release 12.0

Supported Platforms

The first five platforms listed are external routers; the last two platforms have internal routers:

- Cisco 3600 series
- Cisco 4500 series
- Cisco 7200 series
- Cisco 7500 series
- Catalyst 8500 Campus Switch Router (CSR)
- Catalyst 5000 series Route Switch Module (RSM)
- Catalyst 5000 series Route Switch Feature Card (RSFC)

Supported Standards, MIBs, and RFCs

MIBs

No new or modified MIBs are supported by this feature.

For descriptions of supported MIBs and how to use MIBs, see the Cisco MIB web site on CCO at http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml.

RFCs

None

Standards

None

Prerequisites

The following prerequisites are necessary before MLS can function:

- A VLAN interface must be configured on both the switch and the router. For information on configuring interVLAN routing on the RSM or an external router, refer to the *Catalyst 5000 Software Configuration Guide*.
- IP multicast MLS must be configured on the switch. For information on this, refer to the *Catalyst 5000 Software Configuration Guide*.

- IP multicast routing and PIM must be enabled on the router. The minimal steps to configure them are described in the "Configuration Tasks" section later in this document. For detailed information on configuring IP multicast routing and PIM, refer to the Cisco IOS Release 12.0 *Network Protocols Configuration Guide, Part 1*.

Configuration Tasks

See the following sections for configuration tasks for IP multicast MLS. Each task in the list indicates whether it is optional or required.

- Enabling IP Multicast Routing (Required)
- Enabling IP PIM (Required)
- Enabling IP Multicast MLS (Optional unless you disabled it)
- Specifying a Management Interface (Optional)

For examples of IP multicast MLS configurations, see the "Configuration Examples" section later in this document.

Enabling IP Multicast Routing

You must enable IP multicast routing globally on the MMLS-RPs before you can enable IP multicast MLS on router interfaces. To enable IP multicast routing on the router, use the following command:

Command	Purpose
Router(config)# **ip multicast-routing**	Enables IP multicast routing globally.

Note This section describes only how to enable IP multicast routing on the router. For detailed IP multicast configuration information, refer to the Cisco IOS Release 12.0 *Network Protocols Configuration Guide, Part 1*.

Enabling IP PIM

You must enable Protocol Independent Multicast (PIM) on the router interfaces connected to the switch before IP multicast MLS will function on those router interfaces. To do so, use the following commands:

Step	Command	Purpose
1	Router(config)# **interface** *type number*	Configures an interface.
2	Router(config-if)# **ip pim** {**dense-mode** | **sparse-mode** | **sparse-dense-mode**}	Enables PIM on the interface.

Note This section describes only how to enable PIM on router interfaces. For detailed PIM configuration information, refer to the documentation for your Cisco IOS software release.

Enabling IP Multicast MLS

IP multicast MLS is enabled by default when you enable PIM on the interface. Perform this task only if you disabled IP multicast MLS and you want to reenable it. To enable IP multicast MLS on an interface, use the following command:

Command	Purpose
Router(config-if)# **mls rp ip multicast**	Enables IP multicast MLS on an interface.

Specifying a Management Interface

When you enable IP multicast MLS, the subinterface (or VLAN interface) that has the lowest VLAN ID and is active (in the "up" state) is automatically selected as the *management interface*. The one-hop protocol Multilayer Switching Protocol (MLSP) is used between a router and a switch to pass messages about hardware-switched flows. MLSP packets are sent and received on the management interface. Typically, the interface in VLAN 1 is chosen (if that interface exists). Only one management interface is allowed on a single trunk link.

In most cases, we recommend that the management interface be determined by default. However, you can optionally specify a different router interface or subinterface as the management interface. We recommend using a subinterface with minimal data traffic so that multicast MLSP packets can be sent and received more quickly.

If the user-configured management interface goes down, the router uses the default interface (the active interface with the lowest VLAN ID) until the user-configured interface comes up again.

To change the default IP multicast MLS management interface, use the following command:

Command	Purpose
Router(config-if)# **mls rp ip multicast management-interface**	Configures an interface as the IP multicast MLS management interface.

Monitoring and Maintaining IP Multicast MLS

Command	Purpose
Router# **show ip mroute** [*group-name* | *group-address* [*source*]]	Displays hardware switching state for outgoing interfaces.
Router# **show ip pim interface** [*type number*] [**count**]	Displays PIM interface information.
Router# **show mls rp ip multicast** [**locate**] [*group* [*source*] [*vlan-id*]] | [**statistics**] | [**summary**]	Displays Layer 3 switching information.

Configuration Examples

These sections contain example IP multicast MLS implementations. These examples include the switch configurations, although switch commands are not documented in this router publication. Refer to the *Catalyst 5000 Command Reference* for that information.

- Basic IP Multicast MLS Network
- Complex IP Multicast MLS Network

Basic IP Multicast MLS Network

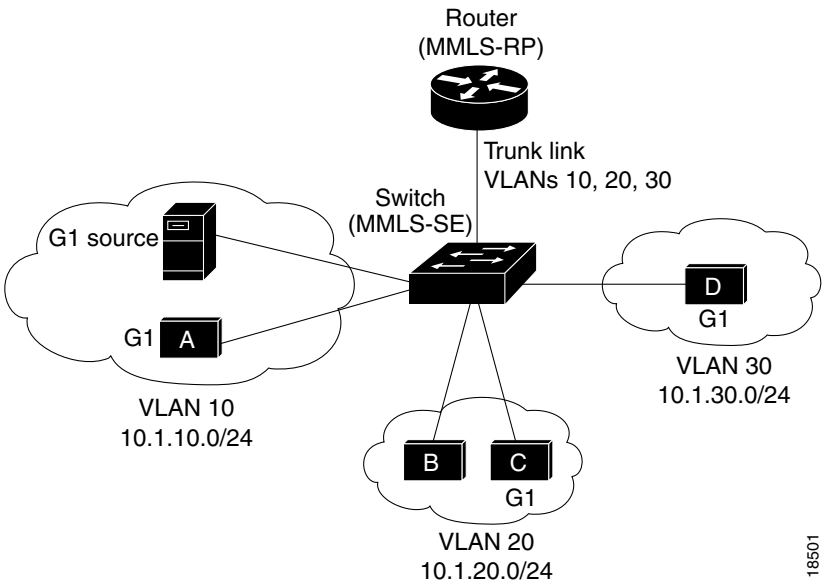
This example consists of these sections:

- Example Network Topology
- Operation Before IP Multicast MLS
- Operation After IP Multicast MLS
- Router Configuration
- Switch Configuration

Example Network Topology

Figure 2 shows a basic IP multicast MLS example network topology.

Figure 2 Basic IP Multicast MLS Example Network



The network is configured as follows:

- There are three VLANs (IP subnetworks): VLANs 10, 20, and 30.
- The multicast source for group G1 belongs to VLAN 10.
- Hosts A, C, and D have joined IP multicast group G1.
- Port 1/2 on the MMLS-SE is connected to interface fastethernet2/0 on the MMLS-RP.
- The link between the MMLS-SE and the MMLS-RP is configured as an ISL trunk.
- The subinterfaces on the router interface have these IP addresses:
  - fastethernet2/0.10: 10.1.10.1 255.255.255.0 (VLAN 10)
  - fastethernet2/0.20: 10.1.20.1 255.255.255.0 (VLAN 20)
  - fastethernet2/0.30: 10.1.30.1 255.255.255.0 (VLAN 30)

Operation Before IP Multicast MLS

Without IP multicast MLS, when the G1 source (on VLAN 10) sends traffic destined for IP multicast group G1, the switch forwards the traffic (based on the Layer 2 multicast forwarding table entry generated by the IGMP snooping, CGMP, or GMRP multicast service) to Host A on VLAN 10 and to the router subinterface in VLAN 10.

The router receives the multicast traffic on its incoming subinterface for VLAN 10, checks the multicast routing table, and replicates the traffic to the outgoing subinterfaces for VLANs 20 and 30. The switch receives the traffic on VLANs 20 and 30 and forwards the traffic received on these VLANs to the appropriate switch ports, again based on the contents of the Layer 2 multicast forwarding table.

Operation After IP Multicast MLS

After IP multicast MLS is implemented, when the G1 source sends traffic destined for multicast group G1, the MMLS-SE checks its Layer 3 multicast MLS cache and recognizes that the traffic belongs to a multicast MLS flow. The MMLS-SE forwards the traffic to Host A on VLAN 10 based on the multicast forwarding table, but does not forward the traffic to the router subinterface in VLAN 10 (assuming a completely switched flow).

For each multicast MLS cache entry, the switch maintains a list of outgoing interfaces for the destination IP multicast group. The switch replicates the traffic on the appropriate outgoing interfaces (VLANs 20 and 30) and then forwards the traffic on each VLAN to the destination hosts (using the Layer 2 multicast forwarding table). The switch performs a packet rewrite for the replicated traffic so that the packets appear to have been routed by the appropriate router subinterface.

If not all the router subinterfaces are eligible to participate in IP multicast MLS, the switch must forward the multicast traffic to the router subinterface in the source VLAN (in this case, VLAN 10). In this situation, on those subinterfaces that are ineligible, the router performs multicast forwarding and replication in software, in the usual manner. On those subinterfaces that are eligible, the switch performs multilayer switching.

Note On the MMLS-RP, the IP multicast MLS management interface is user-configured to the VLAN 30 subinterface. If this interface goes down, the system will revert to the default management interface (in this case, the VLAN 10 subinterface).

Router Configuration

The following is an example configuration of IP multicast MLS on the router:

```
ip multicast-routing
interface fastethernet2/0.10
 encapsulation isl 10
 ip address 10.1.10.1 255.255.255.0
 ip pim dense-mode
interface fastethernet2/0.20
 encapsulation isl 20
 ip address 10.1.20.1 255.255.255.0
 ip pim dense-mode
interface fastethernet2/0.30
 encapsulation isl 30
 ip address 10.1.30.1 255.255.255.0
 ip pim dense-mode
 mls rp ip multicast management-interface
```

You will receive the following message informing you that you changed the management interface:

```
Warning: MLS Multicast management interface is now Fa2/0.30
```

Switch Configuration

The following example shows how to configure the switch (MMLS-SE):

```
Console> (enable) set trunk 1/2 on isl
Port(s) 1/2 trunk mode set to on.
Port(s) 1/2 trunk type set to isl.
Console> (enable) set igmp enable
IGMP feature for IP multicast enabled
Console> (enable) set mls multicast enable
Multilayer Switching for Multicast is enabled for this device.
Console> (enable) set mls multicast include 10.1.10.1
Multilayer switching for multicast is enabled for router 10.1.10.1.
```

Complex IP Multicast MLS Network

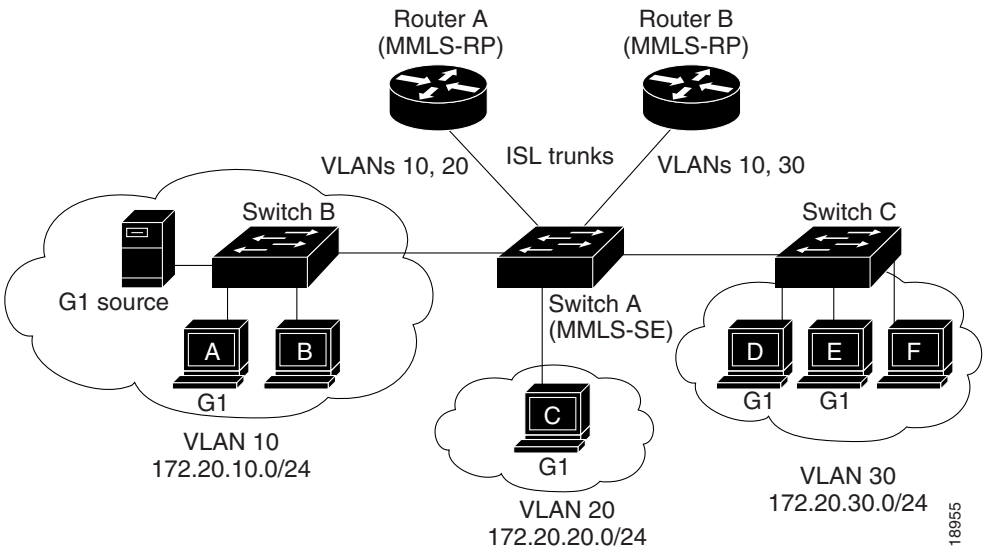
This example consists of these sections:

- Example Network Topology
- Operation Before IP Multicast MLS
- Operation After IP Multicast MLS
- Router A (MMLS-RP) Configuration
- Router B (MMLS-RP) Configuration
- Switch A (MMLS-SE) Configuration
- Switch B Configuration
- Switch C Configuration

Example Network Topology

Figure 3 shows a more complex IP multicast MLS example network topology.

Figure 3 Complex IP Multicast MLS Example Network



The network is configured as follows:

- There are four VLANs (IP subnetworks): VLANs 1, 10, 20, and 30 (VLAN 1 is used only for management traffic, not multicast data traffic).
- The G1 multicast source belongs to VLAN 10.
- Hosts A, C, D, and E have joined IP multicast group G1.
- Switch A is the MMLS-SE.
- Router A and Router B are both operating as MMLS-RPs.
- Port 1/1 on the MMLS-SE is connected to interface fastethernet1/0 on Router A.
- Port 1/2 on the MMLS-SE is connected to interface fastethernet2/0 on Router B.
- The MMLS-SE is connected to the MMLS-RPs through ISL trunk links.
- The trunk link to Router A carries VLANs 1, 10, and 20.
- The trunk link to Router B carries VLANs 1, 10, and 30.
- The subinterfaces on the Router A interface have these IP addresses:
  - fastethernet1/0.1: 172.20.1.1 255.255.255.0 (VLAN 1)
  - fastethernet1/0.10: 172.20.10.1 255.255.255.0 (VLAN 10)
  - fastethernet1/0.20: 172.20.20.1 255.255.255.0 (VLAN 20)
- The subinterfaces on the Router B interface have these IP addresses:
  - fastethernet1/0.1: 172.20.1.2 255.255.255.0 (VLAN 1)
  - fastethernet2/0.10: 172.20.10.100 255.255.255.0 (VLAN 10)
  - fastethernet2/0.30: 172.20.30.100 255.255.255.0 (VLAN 30)
- The default IP multicast MLS management interface is used on both MMLS-RPs (VLAN 1).
- Port 1/3 on the MMLS-SE is connected to Switch B through an ISL trunk link carrying all VLANs.

- Port 1/4 on the MMLS-SE is connected to Switch C through an ISL trunk link carrying all VLANs.
- Switch B and Switch C perform Layer 2 switching functions only.

Operation Before IP Multicast MLS

Without IP multicast MLS, when Server A (on VLAN 10) sends traffic destined for IP multicast group G1, Switch B forwards the traffic (based on the Layer 2 multicast forwarding table entry) to Host A on VLAN 10 and to Switch A. Switch A forwards the traffic to the Router A and Router B subinterfaces in VLAN 10.

Router A receives the multicast traffic on its incoming subinterface for VLAN 10, checks the multicast routing table, and replicates the traffic to the outgoing subinterface for VLAN 20. Router B receives the multicast traffic on its incoming interface for VLAN 10, checks the multicast routing table, and replicates the traffic to the outgoing subinterface for VLAN 30.

Switch A receives the traffic on VLANs 20 and 30. Switch A forwards VLAN 20 traffic to the appropriate switch ports (in this case, to Host C), based on the contents of the Layer 2 multicast forwarding table. Switch A forwards the VLAN 30 traffic to Switch C.

Switch C receives the VLAN 30 traffic and forwards it to the appropriate switch ports (in this case, Hosts D and E) using the multicast forwarding table.

Operation After IP Multicast MLS

After IP multicast MLS is implemented, when Server A sends traffic destined for multicast group G1, Switch B forwards the traffic (based on the Layer 2 multicast forwarding table entry) to Host A on VLAN 10 and to Switch A.

Switch A checks its Layer 3 multicast MLS cache and recognizes that the traffic belongs to a multicast MLS flow. Switch A does not forward the traffic to the router subinterfaces in VLAN 10 (assuming a completely switched flow). Instead, Switch A replicates the traffic on the appropriate outgoing interfaces (VLANs 20 and 30).

VLAN 20 traffic is forwarded to Host C and VLAN 30 traffic is forwarded to Switch C (based on the contents of the Layer 2 multicast forwarding table). The switch performs a packet rewrite for the replicated traffic so that the packets appear to have been routed by the appropriate router subinterface.

Switch C receives the VLAN 30 traffic and forwards it to the appropriate switch ports (in this case, Hosts D and E) using the multicast forwarding table.

If not all the router subinterfaces are eligible to participate in IP multicast MLS, the switch must forward the multicast traffic to the router subinterfaces in the source VLAN (in this case, VLAN 10). In this situation, on those subinterfaces that are ineligible, the routers perform multicast forwarding and replication in software in the usual manner. On those subinterfaces that are eligible, the switch performs multilayer switching.

Note On both MMLS-RPs, no user-configured IP multicast MLS management interface is specified. Therefore, the VLAN 1 subinterface is used by default.

Router A (MMLS-RP) Configuration

```
ip multicast-routing
interface fastethernet1/0.1
 encapsulation isl 1
 ip address 172.20.1.1 255.255.255.0
interface fastethernet1/0.10
 encapsulation isl 10
 ip address 172.20.10.1 255.255.255.0
 ip pim dense-mode
interface fastethernet1/0.20
 encapsulation isl 20
 ip address 172.20.20.1 255.255.255.0
 ip pim dense-mode
```

Router B (MMLS-RP) Configuration

```
ip multicast-routing
interface fastethernet1/0.1
 encapsulation isl 1
 ip address 172.20.1.2 255.255.255.0
interface fastethernet2/0.10
 encapsulation isl 10
 ip address 172.20.10.100 255.255.255.0
 ip pim dense-mode
interface fastethernet2/0.30
 encapsulation isl 30
 ip address 172.20.30.100 255.255.255.0
 ip pim dense-mode
```

Switch A (MMLS-SE) Configuration

```
Console> (enable) set vlan 10
Vlan 10 configuration successful
Console> (enable) set vlan 20
Vlan 20 configuration successful
Console> (enable) set vlan 30
Vlan 30 configuration successful
Console> (enable) set trunk 1/1 on isl
Port(s) 1/1 trunk mode set to on.
Port(s) 1/1 trunk type set to isl.
Console> (enable) set trunk 1/2 on isl
Port(s) 1/2 trunk mode set to on.
Port(s) 1/2 trunk type set to isl.
Console> (enable) set trunk 1/3 desirable isl
Port(s) 1/3 trunk mode set to desirable.
Port(s) 1/3 trunk type set to isl.
Console> (enable) set trunk 1/4 desirable isl
Port(s) 1/4 trunk mode set to desirable.
Port(s) 1/4 trunk type set to isl.
Console> (enable) set igmp enable
IGMP feature for IP multicast enabled
Console> (enable) set mls multicast enable
Multilayer Switching for Multicast is enabled for this device.
Console> (enable) set mls multicast include 172.20.10.1
Multilayer switching for multicast is enabled for router 172.20.10.1.
Console> (enable) set mls multicast include 172.20.10.100
Multilayer switching for multicast is enabled for router 172.20.10.100.
Console> (enable)
```

Switch B Configuration

The following example shows how to configure Switch B (assuming VLAN Trunking Protocol [VTP] is used for VLAN management):

```
Console> (enable) set igmp enable
IGMP feature for IP multicast enabled
Console> (enable)
```

Switch C Configuration

The following example shows how to configure Switch C (assuming VTP is used for VLAN management):

```
Console> (enable) set igmp enable
IGMP feature for IP multicast enabled
Console> (enable)
```

Command Reference

This section documents new or modified commands. All other commands used with this feature are documented in the Cisco IOS Release 12.0 command reference publications and the *Catalyst 5000 Software Configuration Guide* and *Catalyst 5000 Command Reference,* Release 5.1.

- **clear ip mroute**
- **ip multicast-routing**
- **mls rp ip multicast**
- **mls rp ip multicast management-interface**
- **show ip mroute**
- **show ip pim interface**
- **show mls rp ip multicast**

In Cisco IOS Release 12.0(1)T or later, you can search and filter the output for **show** and **more** commands. This functionality is useful when you need to sort through large amounts of output, or if you want to exclude output that you do not need to see.

To use this functionality, enter a **show** or **more** command followed by the "pipe" character (|), one of the keywords **begin**, **include**, or **exclude**, and an expression that you want to search or filter on:

command | {**begin | include | exclude**} *regular-expression*

Following is an example of the **show atm vc** command in which you want the command output to begin with the first line where the expression "PeakRate" appears:

show atm vc | begin PeakRate

For more information on the search and filter functionality, refer to the Cisco IOS Release 12.0(1)T feature module entitled *CLI String Search*.

clear ip mroute

To delete entries from the IP multicast routing table, use the **clear ip mroute** EXEC command.

clear ip mroute {***** | *group* [*source*]}

Syntax Description

*****	Deletes all entries from the IP multicast routing table.
group	Can be either one of the following: • Name of the multicast group, as defined in the DNS hosts table or with the **ip host** command. • IP address of the multicast group. This is a multicast IP address in four-part, dotted notation.
source	(Optional) If you specify a group name or address, you can also specify a name or address of a multicast source that is sending to the group. A source need not be a member of the group.

Command Modes

EXEC

Command History

Release	Modification
10.0	This command was introduced.
12.0(5)T	The effect of this command was modified. If IP multicast Multilayer Switching (MLS) is enabled, using this command now clears both the multicast routing table on the MMLS-RP and all multicast MLS cache entries for all MMLS-SEs that are performing multicast MLS for the MMLS-RP. That is, the original clearing occurs, and the derived hardware switching table is also cleared.

Examples

The following example deletes all entries from the IP multicast routing table:

```
clear ip mroute *
```

The following example deletes from the IP multicast routing table all sources on the 10.3.0.0 subnet that are sending to the multicast group 224.2.205.42. Note that this example deletes all sources on network 10.3, not individual sources.

```
clear ip mroute 224.2.205.42 10.3.0.0
```

Related Commands

Command	Description
ip host	Statically maps a host name to an IP address.
mls rp ip multicast	Enables IP multicast MLS.
show ip mroute	Displays the contents of the IP multicast routing table.

ip multicast-routing

To enable IP multicast routing, use the **ip multicast-routing** global configuration command. To disable IP multicast routing, use the **no** form of this command.

ip multicast-routing
no ip multicast-routing

Syntax Description

This command has no arguments or keywords.

Defaults

Disabled

Command Modes

Global configuration

Command History

Release	Modification
10.0	This command was introduced.
12.0(5)T	The effect of this command was modified. If IP multicast Multilayer Switching (MLS) is enabled, using the **no** form of this command now disables IP multicast routing on the MMLS-RP and purges all multicast MLS cache entries on the MMLS-SE.

Usage Guidelines

When IP multicast routing is disabled, the Cisco IOS software does not forward any multicast packets.

Examples

The following example enables IP multicast routing:

```
ip multicast-routing
```

Related Commands

Command	Description
ip pim	Enables PIM and IGMP on an interface.

mls rp ip multicast

To enable IP multicast Multilayer Switching (hardware switching) on an external or internal router in conjunction with Layer 3 switching hardware for the Catalyst 5000, use the **mls rp ip multicast** interface configuration command. Use the **no** form of the command to disable IP multicast Multilayer Switching (MLS) on the interface or VLAN.

mls rp ip multicast
no mls rp ip multicast

Syntax Description

This command has no arguments or keywords.

Defaults

Enabled

Command Modes

Interface configuration

Command History

Release	Modification
12.0(5)T	This command was introduced.

Usage Guidelines

This feature is available only on specific router platforms connected to a Catalyst 5000 switch. Use this feature to reduce multicast load on the router. The switch will perform the multicast packet replication and forwarding.

IP multicast MLS is enabled by default on an interface once IP multicast routing and PIM are enabled.

Examples

The following example disables IP multicast MLS:

```
interface fastethernet1/0.1
 no mls rp ip multicast
```

Related Commands

Command	Description
mls rp ip multicast management-interface	Assigns a management interface other than the default.
show ip mroute	Enables complete flows for IP multicast MLS.
show mls rp ip multicast	Displays hardware-switched multicast flow information about IP multicast MLS.

mls rp ip multicast management-interface

To assign a different interface (other than the default) to act as the management interface for Multilayer Switching Protocol (MLSP) , use the **mls rp ip multicast management-interface** interface configuration command. Use the **no** form of the command to restore the default interface as the management interface.

mls rp ip multicast management-interface
no mls rp ip multicast management-interface

Syntax Description

This command has no arguments or keywords.

Defaults

When IP multicast MLS is enabled, the subinterface (or VLAN interface) that has the lowest VLAN ID and is active (in the "up" state) is automatically selected as the management interface.

Command Modes

Interface configuration

Command History

Release	Modification
12.0(5)T	This command was introduced.

Usage Guidelines

When you enable IP multicast MLS, the subinterface (or VLAN interface) that has the lowest VLAN ID and is active (in the "up" state) is automatically selected as the *management interface*. The one-hop protocol Multilayer Switching Protocol (MLSP) is used between a router and a switch to pass messages about hardware-switched flows. MLSP packets are sent and received on the management interface. Typically, the interface in VLAN 1 is chosen (if that interface exists). Only one management interface is allowed on a single trunk link.

In most cases, we recommend that the management interface be determined by default. However, you can optionally use this command to specify a different router interface or subinterface as the management interface. We recommend using a subinterface with minimal data traffic so that multicast MLSP packets can be transmitted and received more quickly.

If the user-configured management interface goes down, the router uses the default interface (the active interface with the lowest VLAN ID) until the user-configured interface comes up again.

Examples

The following example configures the Fast Ethernet interface as the management interface:

```
interface fastethernet1/0.1
 mls rp ip multicast management-interface
```

Related Commands

Command	Description
mls rp ip multicast	Enables IP multicast MLS.

show ip mroute

To display the contents of the IP multicast routing table, use the **show ip mroute** EXEC command.

show ip mroute [*group-name* | *group-address*] [*source*] [**summary**] [**count**] [**active** *kbps*]

Syntax Description

group-name | *group-address*	(Optional) IP address, name, or interface of the multicast group as defined in the DNS hosts table.
source	(Optional) IP address or name of a multicast source.
summary	(Optional) Displays a one-line, abbreviated summary of each entry in the IP multicast routing table.
count	(Optional) Displays statistics about the group and source, including number of packets, packets per second, average packet size, and bits per second.
active *kbps*	(Optional) Displays the rate that active sources are sending to multicast groups. Active sources are those sending at a rate of *kbps* or higher. The *kbps* argument defaults to 4 kilobits per second (kbps).

Default

The **show ip mroute** command displays all groups and sources.
The **show ip mroute active** command displays all sources sending at a rate greater than or equal to 4 kbps.

Command Modes

EXEC

Command History

Release	Modification
10.0	This command was introduced.
12.0(5)T	The flag "H" was added in the output display to indicate that an outgoing interface is hardware switched in the case of IP multicast Multilayer Switching (MLS).

Usage Guidelines

If you omit all optional arguments and keywords, the **show ip mroute** command displays all entries in the IP multicast routing table.

The Cisco IOS software populates the multicast routing table by creating source, group (S,G) entries from star, group (*,G) entries. The star refers to all source addresses, the "S" refers to a single source address, and the "G" is the destination multicast group address. In creating (S,G) entries, the software uses the best path to that destination group found in the unicast routing table (that is, through Reverse Path Forwarding [RPF]).

Examples

The following is sample output from the **show ip mroute** command for a router operating in dense mode. This command displays the contents of the IP multicast routing table for the multicast group named *cbone-audio*.

```
Router# show ip mroute cbone-audio

IP Multicast Routing Table
Flags: D - Dense, S - Sparse, C - Connected, L - Local, P - Pruned
       R - RP-bit set, F - Register flag, T - SPT-bit set
Timers: Uptime/Expires
Interface state: Interface, Next-Hop, State/Mode

(*, 224.0.255.1), uptime 0:57:31, expires 0:02:59, RP is 0.0.0.0, flags: DC
  Incoming interface: Null, RPF neighbor 0.0.0.0, Dvmrp
  Outgoing interface list:
    Ethernet0, Forward/Dense, 0:57:31/0:02:52
    Tunnel0, Forward/Dense, 0:56:55/0:01:28

(198.92.37.100/32, 224.0.255.1), uptime 20:20:00, expires 0:02:55, flags: C
  Incoming interface: Tunnel0, RPF neighbor 10.20.37.33, Dvmrp
  Outgoing interface list:
    Ethernet0, Forward/Dense, 20:20:00/0:02:52
```

The following is sample output from the **show ip mroute** command for a router operating in sparse mode:

```
Router# show ip mroute

IP Multicast Routing Table
Flags: D - Dense, S - Sparse, C - Connected, L - Local, P - Pruned
       R - RP-bit set, F - Register flag, T - SPT-bit set
Timers: Uptime/Expires
Interface state: Interface, Next-Hop, State/Mode

(*, 224.0.255.3), uptime 5:29:15, RP is 198.92.37.2, flags: SC
  Incoming interface: Tunnel0, RPF neighbor 10.3.35.1, Dvmrp
  Outgoing interface list:
    Ethernet0, Forward/Sparse, 5:29:15/0:02:57

(198.92.46.0/24, 224.0.255.3), uptime 5:29:15, expires 0:02:59, flags: C
  Incoming interface: Tunnel0, RPF neighbor 10.3.35.1
  Outgoing interface list:
    Ethernet0, Forward/Sparse, 5:29:15/0:02:57
```

The following is sample output from the **show ip mroute** command that shows the VCD value, because an ATM interface with PIM multipoint signalling is enabled:

```
Router# show ip mroute 224.1.1.1

IP Multicast Routing Table
Flags: D - Dense, S - Sparse, C - Connected, L - Local, P - Pruned
       R - RP-bit set, F - Register flag, T - SPT-bit set, J - Join SPT
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode

(*, 224.1.1.1), 00:03:57/00:02:54, RP 130.4.101.1, flags: SJ
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    ATM0/0, VCD 14, Forward/Sparse, 00:03:57/00:02:53
```

The following is sample output from the **show ip mroute** command with the **summary** keyword:

```
Router# show ip mroute summary

IP Multicast Routing Table
Flags: D - Dense, S - Sparse, C - Connected, L - Local, P - Pruned
       R - RP-bit set, F - Register flag, T - SPT-bit set, J - Join SPT
Timers: Uptime/Expires
Interface state: Interface, Next-Hop, State/Mode

(*, 224.255.255.255), 2d16h/00:02:30, RP 171.69.10.13, flags: SJPC

(*, 224.2.127.253), 00:58:18/00:02:00, RP 171.69.10.13, flags: SJC

(*, 224.1.127.255), 00:58:21/00:02:03, RP 171.69.10.13, flags: SJC

(*, 224.2.127.254), 2d16h/00:00:00, RP 171.69.10.13, flags: SJCL
  (128.9.160.67/32, 224.2.127.254), 00:02:46/00:00:12, flags: CLJT
  (129.48.244.217/32, 224.2.127.254), 00:02:15/00:00:40, flags: CLJT
  (130.207.8.33/32, 224.2.127.254), 00:00:25/00:02:32, flags: CLJT
  (131.243.2.62/32, 224.2.127.254), 00:00:51/00:02:03, flags: CLJT
  (140.173.8.3/32, 224.2.127.254), 00:00:26/00:02:33, flags: CLJT
  (171.69.60.189/32, 224.2.127.254), 00:03:47/00:00:46, flags: CLJT
```

The following is sample output from the **show ip mroute** command with the **active** keyword:

```
Router# show ip mroute active

Active IP Multicast Sources - sending >= 4 kbps

Group: 224.2.127.254, (sdr.cisco.com)
   Source: 146.137.28.69 (mbone.ipd.anl.gov)
     Rate: 1 pps/4 kbps(1sec), 4 kbps(last 1 secs), 4 kbps(life avg)

Group: 224.2.201.241, ACM 97
   Source: 130.129.52.160 (webcast3-e1.acm97.interop.net)
     Rate: 9 pps/93 kbps(1sec), 145 kbps(last 20 secs), 85 kbps(life avg)

Group: 224.2.207.215, ACM 97
   Source: 130.129.52.160 (webcast3-e1.acm97.interop.net)
     Rate: 3 pps/31 kbps(1sec), 63 kbps(last 19 secs), 65 kbps(life avg)
```

The following is sample output from the **show ip mroute** command with the **count** keyword:

```
Router# show ip mroute count

IP Multicast Statistics - Group count: 8, Average sources per group: 9.87
Counts: Pkt Count/Pkts per second/Avg Pkt Size/Kilobits per second

Group: 224.255.255.255, Source count: 0, Group pkt count: 0
  RP-tree: 0/0/0/0

Group: 224.2.127.253, Source count: 0, Group pkt count: 0
  RP-tree: 0/0/0/0

Group: 224.1.127.255, Source count: 0, Group pkt count: 0
  RP-tree: 0/0/0/0

Group: 224.2.127.254, Source count: 9, Group pkt count: 14
  RP-tree: 0/0/0/0
  Source: 128.2.6.9/32, 2/0/796/0
  Source: 128.32.131.87/32, 1/0/616/0
  Source: 128.125.51.58/32, 1/0/412/0
  Source: 130.207.8.33/32, 1/0/936/0
  Source: 131.243.2.62/32, 1/0/750/0
```

```
  Source: 140.173.8.3/32, 1/0/660/0
  Source: 146.137.28.69/32, 1/0/584/0
  Source: 171.69.60.189/32, 4/0/447/0
  Source: 204.162.119.8/32, 2/0/834/0

Group: 224.0.1.40, Source count: 1, Group pkt count: 3606
  RP-tree: 0/0/0/0
  Source: 171.69.214.50/32, 3606/0/48/0, RPF Failed: 1203

Group: 224.2.201.241, Source count: 36, Group pkt count: 54152
  RP-tree: 7/0/108/0
  Source: 13.242.36.83/32, 99/0/123/0
  Source: 36.29.1.3/32, 71/0/110/0
  Source: 128.9.160.96/32, 505/1/106/0
  Source: 128.32.163.170/32, 661/1/88/0
  Source: 128.115.31.26/32, 192/0/118/0
  Source: 128.146.111.45/32, 500/0/87/0
  Source: 128.183.33.134/32, 248/0/119/0
  Source: 128.195.7.62/32, 527/0/118/0
  Source: 128.223.32.25/32, 554/0/105/0
  Source: 128.223.32.151/32, 551/1/125/0
  Source: 128.223.156.117/32, 535/1/114/0
  Source: 128.223.225.21/32, 582/0/114/0
  Source: 129.89.142.50/32, 78/0/127/0
  Source: 129.99.50.14/32, 526/0/118/0
  Source: 130.129.0.13/32, 522/0/95/0
  Source: 130.129.52.160/32, 40839/16/920/161
  Source: 130.129.52.161/32, 476/0/97/0
  Source: 130.221.224.10/32, 456/0/113/0
  Source: 132.146.32.108/32, 9/1/112/0
```

The following example of **show ip mroute** is displayed when IP multicast MLS is configured. Note that the "H" indicates hardware switched.

```
Router# show ip mroute
IP Multicast Routing Table
Flags: D - Dense, S - Sparse, C - Connected, L - Local, P - Pruned
       R - RP-bit set, F - Register flag, T - SPT-bit set, J - Join SPT, H - Hardware
switched
Timers: Uptime/Expires

(*, 229.10.0.1), 00:04:35/00:02:59, RP 0.0.0.0, flags: DJC
Incoming interface: Null, RPF nbr 0.0.0.0
Outgoing interface list:
 Vlan6, Forward/Dense, 00:00:30/00:02:30
    Vlan5, Forward/Dense, 00:04:35/00:02:30
    Vlan2, Forward/Dense, 00:01:28/00:00:00

(192.0.2.20, 229.10.0.1), 00:04:35/00:02:27, flags: CT
Incoming interface: Vlan2, RPF nbr 0.0.0.0
Outgoing interface list:
    Vlan5, Forward/Dense, 00:03:25/00:00:00, H
    Vlan6, Forward/Dense, 00:00:10/00:00:00, H
```

Table 1 describes the fields shown in the displays.

Table 1 show ip mroute Field Descriptions

Field	Description
Flags:	Provides information about the entry.
D - Dense	Entry is operating in dense mode.

Table 1 show ip mroute Field Descriptions (continued)

Field	Description
S - Sparse	Entry is operating in sparse mode.
C - Connected	A member of the multicast group is present on the directly connected interface.
L - Local	The router itself is a member of the multicast group.
P - Pruned	Route has been pruned. The Cisco IOS software keeps this information in case a downstream member wants to join the source.
R - Rp-bit set	Indicates that the (S,G) entry is pointing toward the rendezvous point (RP). This is typically prune state along the shared tree for a particular source.
F - Register flag	Indicates that the software is registering for a multicast source.
T - SPT-bit set	Indicates that packets have been received on the shortest path source tree.
J - Join SPT	
H - Hardware switched	Indicates the outgoing interface is hardware switched because IP multicast MLS is enabled.
Timers:	Uptime/Expires.
Interface state:	Interface, Next-Hop or VCD, State/Mode.
(*, 224.0.255.1) (198.92.37.100/32, 224.0.255.1)	Entry in the IP multicast routing table. The entry consists of the IP address of the source router followed by the IP address of the multicast group. An asterisk (*) in place of the source router indicates all sources. Entries in the first format are referred to as (*,G) or "star comma G" entries. Entries in the second format are referred to as (S,G) or "S comma G" entries. (*,G) entries are used to build (S,G) entries.
uptime	How long in hours, minutes, and seconds the entry has been in the IP multicast routing table.
expires	How long in hours, minutes, and seconds until the entry will be removed from the IP multicast routing table on the outgoing interface.
RP	Address of the rendezvous point (RP) router. For routers and access servers operating in sparse mode, this address is always 0.0.0.0.
flags:	Information about the entry.
Incoming interface:	Expected interface for a multicast packet from the source. If the packet is not received on this interface, it is discarded.
RPF neighbor	IP address of the upstream router to the source. "Tunneling" indicates that this router is sending data to the RP encapsulated in Register packets. The hexadecimal number in parentheses indicates to which RP it is registering. Each bit indicates a different RP if multiple RPs per group are used.
Dvmrp or Mroute	Indicates if the RPF information is obtained from the DVMRP routing table or the static mroutes configuration.
Outgoing interface list:	Interfaces through which packets will be forwarded. When the **ip pim nbma-mode** command is enabled on the interface, the IP address of the PIM neighbor is also displayed.
Ethernet0	Name and number of the outgoing interface.

Table 1 show ip mroute Field Descriptions (continued)

Field	Description
Next hop or VCD	Next hop specifies downstream neighbor's IP address. VCD is the virtual circuit descriptor number. VCD0 means the group is using the static-map virtual circuit.
Forward/Dense	Indicates that packets will be forwarded on the interface if there are no restrictions due to access lists or TTL threshold. Following the slash (/) is the mode in which the interface is operating (dense or sparse).
Forward/Sparse	Sparse mode interface is in forward mode.
time/time (uptime/expiration time)	Per interface, how long in hours, minutes, and seconds the entry has been in the IP multicast routing table. Following the slash (/) is how long in hours, minutes, and seconds until the entry will be removed from the IP multicast routing table.

Related Commands

Command	Description
ip multicast routing	Enables IP multicast routing.
ip pim	Enables PIM and IGMP on an interface.

show ip pim interface

To display information about interfaces configured for Protocol Independent Multicast (PIM), use the **show ip pim interface** EXEC command.

show ip pim interface [*type number*] [**count**]

Syntax Description

type	(Optional) Interface type.
number	(Optional) Interface number.
count	(Optional) Number of packets received and sent out the interface.

Command Modes

EXEC

Command History

Release	Modification
10.0	This command was introduced.
12.0(5)T	The flag "H" was added in the output display to indicate that an outgoing interface is hardware switched in the case of IP multicast Multilayer Switching (MLS).

Usage Guidelines

This command works only on interfaces that are configured for PIM.

Examples

The following is sample output from the **show ip pim interface** command:

```
Router# show ip pim interface

Address          Interface          Mode    Neighbor  Query     DR
                                            Count     Interval
198.92.37.6      Ethernet0          Dense   2         30        198.92.37.33
198.92.36.129    Ethernet1          Dense   2         30        198.92.36.131
10.1.37.2        Tunnel0            Dense   1         30        0.0.0.0
```

The following is sample output from the **show ip pim interface** command with a **count**:

```
Router# show ip pim interface count

Address          Interface          FS  Mpackets In/Out
171.69.121.35    Ethernet0          *   548305239/13744856
171.69.121.35    Serial0.33         *   8256/67052912
198.92.12.73     Serial0.1719       *   219444/862191
```

The following is sample output from the **show ip pim interface** command with a **count** when IP multicast MLS is enabled. The examples lists the PIM interfaces that are fast switched and process switched, and the packet counts for these. The "H" is added to interfaces where IP multicast MLS is enabled.

```
Router# show ip pim interface count

States: FS - Fast Switched, H - Hardware Switched
Address          Interface          FS  Mpackets In/Out
192.1.10.2       Vlan10             * H 40886/0
192.1.11.2       Vlan11             * H 0/40554
192.1.12.2       Vlan12             * H 0/40554
192.1.23.2       Vlan23             *   0/0
192.1.24.2       Vlan24             *   0/0
```

Table 2 describes the fields shown in the displays.

Table 2 show ip pim interface Field Descriptions

Field	Description
Address	IP address of the next-hop router.
Interface	Interface type and number that is configured to run PIM.
Mode	Multicast mode in which the Cisco IOS software is operating. This can be dense mode or sparse mode. DVMRP indicates a DVMRP tunnel is configured.
Neighbor Count	Number of PIM neighbors that have been discovered through this interface. If the neighbor count is 1 for a DVMRP tunnel, the neighbor is active (receiving probes and reports).
Query Interval	Frequency, in seconds, of PIM router-query messages, as set by the **ip pim query-interval** interface configuration command. The default is 30 seconds.
DR	IP address of the designated router on the LAN. Note that serial lines do not have designated routers, so the IP address is shown as 0.0.0.0.
FS	An asterisk (*) in this column indicates fast switching is enabled.
Mpackets In/Out	Number of packets into and out of the interface since the box has been up.

Related Commands

Command	Description
ip pim	Enables PIM on an interface.
show ip pim neighbor	Lists the PIM neighbors discovered by the Cisco IOS software.

show mls rp ip multicast

To display hardware-switched multicast flow information about IP multicast Multilayer Switching (MLS), use the **show mls rp ip multicast** EXEC command.

show mls rp ip multicast [**locate**] [*group* [*source*] [*vlan-id*]] | [**statistics**] | [**summary**]

Syntax Description

locate	(Optional) Displays flow information associated with the switch. This keyword applies only to a single router and multiple switches.
group	(Optional) Address of the IP multicast group about which to display information.
source	(Optional) IP multicast source sending to the specified multicast *group* about which to display information.
vlan-id	(Optional) Source VLAN about which to display information.
statistics	(Optional) Displays MLS statistics.
summary	(Optional) Displays MLS summary.

Command Modes

EXEC

Command History

Release	Modification
12.0(5)T	This command was introduced.

Examples

The following is sample output of the **show mls rp ip multicast** command using the **locate** keyword:

```
Router# show mls rp ip multicast locate

Source           Group            Vlan  SwitchIP         SwitchMAC
------           -----            ----  --------         ---------
192.1.10.6       239.255.158.197  10    1.2.10.199       0010.a60b.b4ff
```

The following is sample output of the **show mls rp ip multicast** command for a specific IP multicast *group*:

```
Router# show mls rp ip multicast 224.1.1.1
Multicast hardware switched flows:
(1.1.13.1, 224.1.1.1) Incoming interface: Vlan13, Packets switched: 61590
Hardware switched outgoing interfaces: Vlan20 Vlan9
MFD installed: Vlan13

(1.1.9.3, 224.1.1.1) Incoming interface: Vlan9, Packets switched: 0
Hardware switched outgoing interfaces: Vlan20
MFD installed: Vlan9

(1.1.12.1, 224.1.1.1) Incoming interface: Vlan12, Packets switched: 62010
Hardware switched outgoing interfaces: Vlan20 Vlan9
```

```
MFD installed: Vlan12

(1.1.12.3, 224.1.1.1) Incoming interface: Vlan12, Packets switched: 61980
Hardware switched outgoing interfaces: Vlan20 Vlan9
MFD installed: Vlan12

(1.1.11.1, 224.1.1.1) Incoming interface: Vlan11, Packets switched: 62430
Hardware switched outgoing interfaces: Vlan20 Vlan9
MFD installed: Vlan11

(1.1.11.3, 224.1.1.1) Incoming interface: Vlan11, Packets switched: 62430
Hardware switched outgoing interfaces: Vlan20 Vlan9
MFD installed: Vlan11

Total shortcut installed: 6
```

The following is sample output of the **show mls rp ip multicast** command using the **statistics** keyword:

```
Router# show mls rp ip multicast statistics
MLS Multicast Operation Status:
MLS Multicast configuration and state:
    Router Mac: 0010.298f.0009
    Switch Mac: 0010.0d70.a3ff      Switch IP: 1.2.10.195
    MLS Multicast Operating state: ACTIVE
    Active management vlan: Vlan1, 192.1.4.1
    User configured management vlan: None, 0.0.0.0
    Include-List: IP1 = 192.1.28.2, IP2 = 0.0.0.0
    Router IP used in MLS Multicast messages: 192.1.28.2

MLS Multicast statistics:
    Keepalive sent: 90
    Keepalive ACK received: 90
    Open request sent: 3
    Open request ACK received: 3
    Delete notifications received: 3
    Flow statistics messages received: 181
    Flow message sent: 14
    Flow message Ack received: 14
    Flow message Nack received: 0

    Flow install Ack: 2
    Flow install Nack: 0
    Flow update Ack: 7
    Flow update Nack: 0
    Flow delete Ack: 0
    Complete flow install Ack: 3
    Complete flow install Nack: 0
    Complete flow delete Ack: 1
    Input vlan delete Ack: 0
    Output vlan delete Ack: 0
    Global delete sent: 1

    L2 entry not found error: 0
    LTL entry not found error: 0
    MET entry not found error: 0
    L3 entry not found error: 0
    L3 entry exists error : 0
    Hash collision error : 0
    Sequence number error : 0
    None-supported error : 0
    Generic error : 0
```

The following is sample output of the **show mls rp ip multicast** command using the **summary** keyword:

```
Router# show mls rp ip multicast summary
Switch IP:0.0.0.0  Switch MAC:0000.0000.0000
Number of complete flows: 0
Total hardware-switched flows: 0

Switch IP:1.2.10.199  Switch MAC:0010.a60b.b4ff
Number of complete flows: 1
Total hardware-switched flows: 1
```

Related Commands

Command	Description
mls rp ip multicast	Enables IP multicast MLS.

Debug Commands

This section documents new **debug** commands. All other commands used with this feature are documented in this feature module or the Cisco IOS Release 12.0 command reference publications.

- **debug mdss**
- **debug mls rp ip multicast**

debug mdss

To display the run-time errors and sequence of events for the multicast distributed switching services (MDSS), use the **debug mdss** privileged EXEC command. Use the **no** form of the command to disable debugging output.

[**no**] **debug mdss** {**all** | **error** | **event**}

Syntax Description

all	Displays both errors and sequence of events for MDSS.
error	Displays the run-time errors for MDSS.
event	Displays the run-time sequence of events for MDSS.

Defaults

Debugging is not enabled.

Command History

Release	Modification
12.0(5)T	This command was introduced.

Examples

The following example shows output using the **debug mdss** command:

```
Router# debug mdss all
mdss all debugging is on
Router# clear ip mroute *
Router#
01:31:03: MDSS: got MDFS_CLEARALL
01:31:03: MDSS: --> mdss_flush_all_sc
01:31:03: MDSS: enqueue a FE_GLOBAL_DELETE
01:31:03: MDSS: got MDFS_MROUTE_ADD for (0.0.0.0, 224.0.1.40)
01:31:03: MDSS: --> mdss_free_scmdb_cache
01:31:03: MDSS: got MDFS_MROUTE_ADD for (0.0.0.0, 239.255.158.197)
01:31:03: MDSS: got MDFS_MROUTE_ADD for (192.1.21.6, 239.255.158.197)
01:31:03: MDSS: got a MDFS_MIDB_ADD for (192.1.21.6, 239.255.158.197,
Vlan21) +Vlan22
01:31:03: MDSS: -- mdss_add_oif
01:31:03: MDSS: enqueue a FE_OIF_ADD (192.1.21.6, 239.255.158.197,
Vlan21) +Vlan22
01:31:03: MDSS: mdb (192.1.21.6, 239.255.158.197) fast_flags |
MCACHE_MTU
01:31:03: MDSS: got a MDFS_MIDB_ADD for (192.1.21.6, 239.255.158.197,
Vlan21) +Vlan23
01:31:03: MDSS: -- mdss_add_oif
01:31:03: MDSS: enqueue a FE_OIF_ADD (192.1.21.6, 239.255.158.197,
Vlan21) +Vlan
23
01:31:03: MDSS: mdb (192.1.21.6, 239.255.158.197) fast_flags |
MCACHE_MTU
01:31:03: MDSS: got a MDFS_MIDB_ADD for (192.1.21.6, 239.255.158.197,
Vlan21) +Vlan24
01:31:03: MDSS: -- mdss_add_oif
01:31:03: MDSS: enqueue a FE_OIF_ADD (192.1.21.6, 239.255.158.197,
```

```
Vlan21) +Vlan24
01:31:03: MDSS: mdb (192.1.21.6, 239.255.158.197) fast_flags |
MCACHE_MTU
01:31:03: MDSS: got a MDFS_MIDB_ADD for (192.1.21.6, 239.255.158.197,
Vlan21) +Vlan25
01:31:03: MDSS: -- mdss_add_oif
01:31:03: MDSS: enqueue a FE_OIF_ADD (192.1.21.6, 239.255.158.197,
Vlan21) +Vlan25
01:31:03: MDSS: mdb (192.1.21.6, 239.255.158.197) fast_flags |
MCACHE_MTU
01:31:03: MDSS: got a MDFS_MIDB_ADD for (192.1.21.6, 239.255.158.197,
Vlan21) +Vlan26
01:31:03: MDSS: -- mdss_add_oif

01:31:03: MDSS: enqueue a FE_OIF_ADD (192.1.21.6, 239.255.158.197,
Vlan21) +Vlan26
01:31:03: MDSS: mdb (192.1.21.6, 239.255.158.197) fast_flags |
MCACHE_MTU
01:31:03: MDSS: got a MDFS_MIDB_ADD for (192.1.21.6, 239.255.158.197,u
Vlan21) +Vlan27
```

Related Commands

Command	Description
debug mls rp ip multicast	Displays information relating to Multilayer Switching Protocol (MLSP).

debug mls rp ip multicast

To display information about Multilayer Switching Protocol (MLSP), use the **debug mls rp ip multicast** privileged EXEC command. Use the **no** form of the command to disable debugging output.

[**no**] **debug mls rp ip multicast** {**all** | **error** | **event** | **packet**}

Syntax Description

all	Displays all multicast MLSP debugging information, including errors, events, and packets.
error	Displays error messages related to multicast MLSP.
event	Displays the run-time sequence of events for multicast MLSP.
packet	Displays the contents of MLSP packets.

Defaults

Debugging is not enabled.

Command History

Release	Modification
12.0(5)T	This command was introduced.

Usage Guidelines

One and only one of the keywords is required.

Examples

The following example shows output from the **debug mls rp ip multicast** command using the **error** keyword:

```
Router# debug mls rp ip multicast error
mlsm error debugging is on
chtang-7200#
06:06:45: MLSMERR: scb is INACTIVE, free INSTALL_FE
06:06:46: MLSM: --> mlsm_proc_sc_ins_req(10.0.0.1, 224.2.2.3, 10)
```

The following example shows output from the **debug mls rp ip multicast** command using the **event** keyword:

```
Router# debug mls rp ip multicast event
mlsm events debugging is on
Router#
3d23h: MSCP: incoming shortcut flow statistic  from Fa2/0.11
3d23h: MLSM: Flow_stat: (192.1.10.6, 239.255.158.197), byte :537792
packet:8403
3d23h: MLSM: byte delta:7680 packet delta:120, time delta: 10
3d23h: MSCP: incoming shortcut flow statistic  from Fa2/0.11
3d23h: MLSM: Flow_stat: (192.1.10.6, 239.255.158.197), byte :545472
packet:8523
3d23h: MLSM: byte delta:7680 packet delta:120, time delta: 10
3d23h: MSCP: Router transmits keepalive_msg on Fa2/0.11
```

```
3d23h: MSCP: incoming shortcut keepalive ACK  from Fa2/0.11
3d23h: MLSM: Include-list: (192.1.2.1  ->  0.0.0.0)
3d23h: MSCP: incoming shortcut flow statistic  from Fa2/0.11
3d23h: MLSM: Flow_stat: (192.1.10.6, 239.255.158.197), byte :553152
packet:8643
```

The following example shows output from the **debug mls rp ip multicast** command using the **packet** keyword:

```
Router# debug mls rp ip multicast packet
mlsm packets debugging is on
Router#
Router#
Router#
Router#
**23h: MSCP(I): 01 00 0c cc cc cc 00 e0 1e 7c fe 5f 00 30 aa aa
...LLL.`.|~_.0
..23h: MSCP(I): 03 00 00 0c 01 07 01 05 00 28 01 02 0a c7 00 10
.........(...G
 ..23h: MSCP(I): a6 0b b4 ff 00 00 c0 01 0a 06 ef ff 9e c5 00 00
&.4...@...o..E
3d23h: MSCP(I): 00 00 00 09 42 c0 00 00 00 00 00 00 25 0b
....B@......%.
3d23h:
**23h: MSCP(O): 01 00 0c 00 00 00 aa 00 04 00 01 04 00 00 aa aa
......*.......
LL23h: MSCP(O): 03 00 00 0c 00 16 00 00 00 00 01 00 0c cc cc cc
.............L
..23h: MSCP(O): aa 00 04 00 01 04 00 24 aa aa 03 00 00 0c 01 07
*......$**....
..23h: MSCP(O): 01 06 00 1c c0 01 02 01 aa 00 04 00 01 04 00 00
....@...*.....
3d23h: MSCP(O): 00 0b 00 00 00 00 00 00 01 01 0a 62                ...........b

3d23h:
**23h: MSCP(I): 01 00 0c cc cc cc 00 e0 1e 7c fe 5f 00 24 aa aa
...LLL.`.|~_.$
..23h: MSCP(I): 03 00 00 0c 01 07 01 86 00 1c 01 02 0a c7 00 10
.............G
..23h: MSCP(I): a6 0b b4 ff 00 00 00 0b 00 00 c0 01 02 01 00 00
..4.......@...
3d23h: MSCP(I): 00 00
3d23h:
```

Related Commands

Command	Description
debug mdss	Displays information about MDSS.