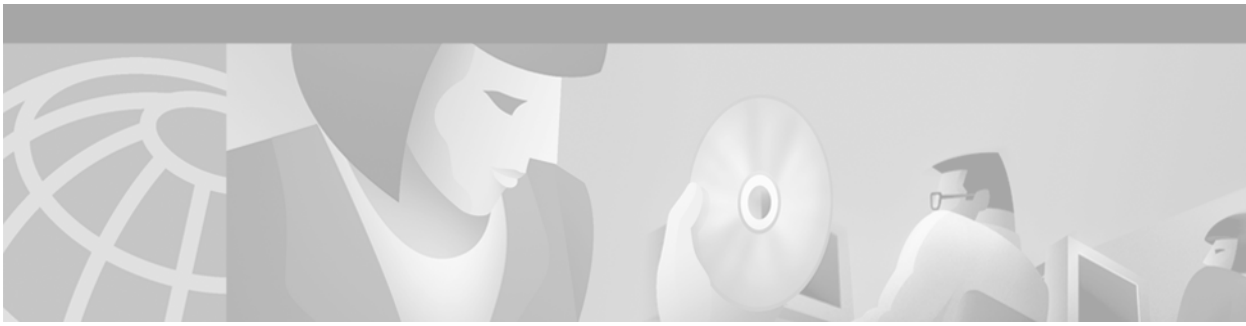


Configuring IP Multicast Multilayer Switching

This chapter describes how to configure your network to perform IP multicast Multilayer Switching (MLS). For a complete description of the Multilayer Switching commands, see the chapter "IP Multicast MLS Commands" in the *Cisco IOS Switching Services Command Reference*. For documentation of other commands that appear in this chapter, you can use the command reference master index or search online.

This chapter contains these sections:

- Prerequisites
- Restrictions
- Configuring and Monitoring IP Multicast MLS
- IP Multicast MLS Configuration Examples

Note The information in this chapter is a brief summary of the information contained in the *Catalyst 5000 Series Multilayer Switching User Guide*. The commands and configurations described in this guide apply only to the devices that provide routing services. Commands and configurations for Catalyst 5000 series switches are documented in the *Catalyst 5000 Series Multilayer Switching User Guide*.

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 procedures on this, refer to the "Configuring IP Multicast Routing" chapter in the *Cisco IOS IP and IP Routing Configuration Guide*.
- IP multicast routing and PIM must be enabled on the router. The minimal steps to configure them are described in the "Configuring and Monitoring IP Multicast MLS" section later in this document. For detailed information on configuring IP multicast routing and PIM, refer to the *Cisco IOS IP and IP Routing Configuration Guide*.

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

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

The following 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
```

Configuring and Monitoring IP Multicast MLS

Perform the tasks in this section to configure your Cisco router for IP multicast MLS. To ensure a successful multicast MLS configuration, you must also configure the Catalyst Switches in your network. For a full description, see the *Catalyst 5000 Series Multilayer Switching User Guide*. Only configuration tasks and commands for routers are described in this chapter.

- Enabling IP Multicast Routing (Required)
- Enabling IP PIM (Required)
- Enabling IP Multicast MLS (Optional, this is a required task if you disabled it.)
- Specifying a Management Interface (Optional)

For examples of IP multicast MLS configurations, see the "IP Multicast MLS 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 in router configuration mode:

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 "Configuring IP Multicast Routing" chapter in the *Cisco IOS IP and IP Routing Configuration Guide*.

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 in interface configuration mode:

	Command	Purpose
Step 1	`Router(config)# interface` *type number*	Configures an interface.
Step 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 "Configuring IP Multicast Routing" chapter in the *Cisco IOS IP and IP Routing Configuration Guide*.

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 in interface configuration mode:

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 in interface configuration mode:

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

To monitor and maintain an IP multicast MLS network, use the following show commands:

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.

IP Multicast MLS Configuration Examples

The following 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 Example
- Complex IP Multicast MLS Network Example

Basic IP Multicast MLS Network Example

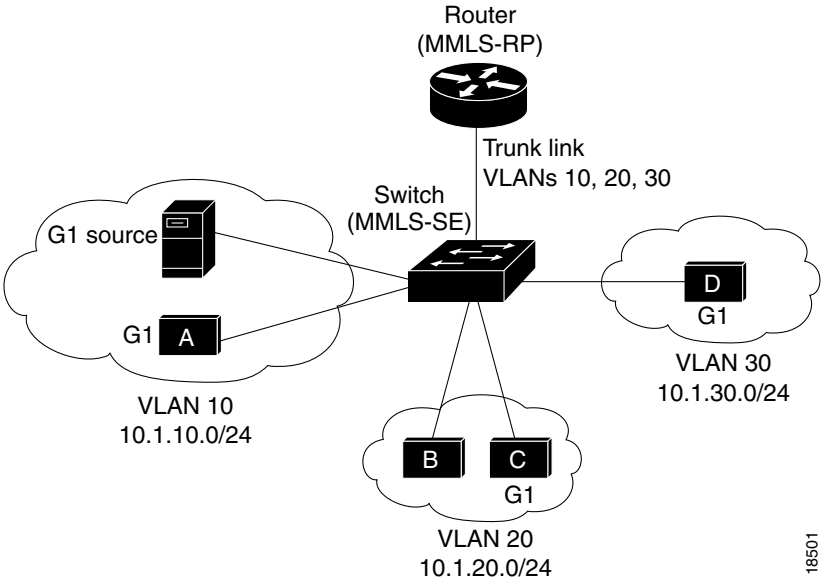
This example consists of the following sections:

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

Example Network Topology

Figure 32 shows a basic IP multicast MLS example network topology.

Figure 32 Example Network: Basic IP Multicast MLS



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 Example

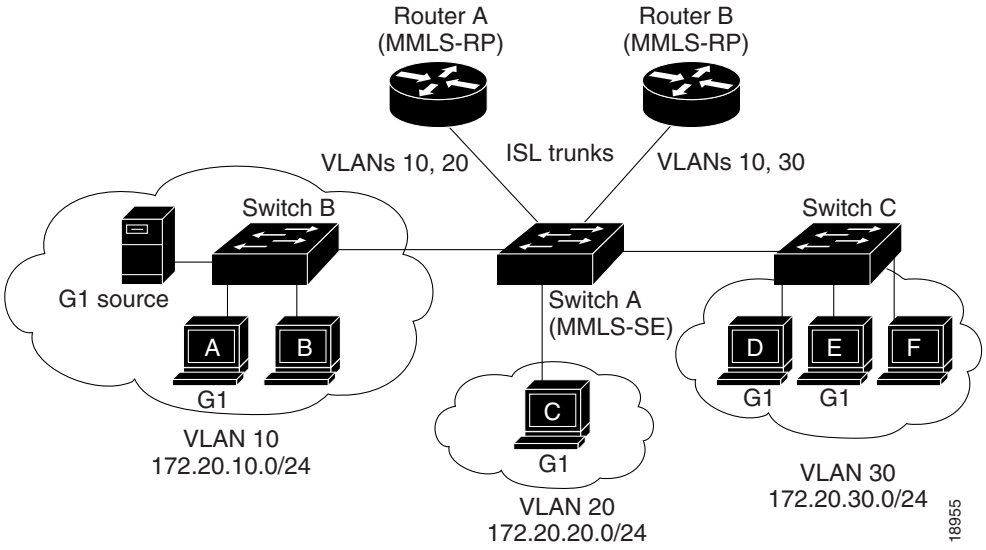
This example consists of the following sections:

- 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 33 shows a more complex IP multicast MLS example network topology.

Figure 33 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)
```