IP Multicast: LSM Configuration Guide, Cisco IOS XE Amsterdam 17.1.x

Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
http://www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 527-0883

THE SPECIFICATIONS AND INFORMATION REGARDING THE PRODUCTS IN THIS MANUAL ARE SUBJECT TO CHANGE WITHOUT NOTICE. ALL STATEMENTS, INFORMATION, AND RECOMMENDATIONS IN THIS MANUAL ARE BELIEVED TO BE ACCURATE BUT ARE PRESENTED WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED. USERS MUST TAKE FULL RESPONSIBILITY FOR THEIR APPLICATION OF ANY PRODUCTS.

THE SOFTWARE LICENSE AND LIMITED WARRANTY FOR THE ACCOMPANYING PRODUCT ARE SET FORTH IN THE INFORMATION PACKET THAT SHIPPED WITH THE PRODUCT AND ARE INCORPORATED HEREIN BY THIS REFERENCE. IF YOU ARE UNABLE TO LOCATE THE SOFTWARE LICENSE OR LIMITED WARRANTY, CONTACT YOUR CISCO REPRESENTATIVE FOR A COPY.

The Cisco implementation of TCP header compression is an adaptation of a program developed by the University of California, Berkeley (UCB) as part of UCB's public domain version of the UNIX operating system. All rights reserved. Copyright © 1981, Regents of the University of California.

NOTWITHSTANDING ANY OTHER WARRANTY HEREIN, ALL DOCUMENT FILES AND SOFTWARE OF THESE SUPPLIERS ARE PROVIDED “AS IS" WITH ALL FAULTS. CISCO AND THE ABOVE-NAMED SUPPLIERS DISCLAIM ALL WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, WITHOUT LIMITATION, THOSE OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT OR ARISING FROM A COURSE OF DEALING, USAGE, OR TRADE PRACTICE.

IN NO EVENT SHALL CISCO OR ITS SUPPLIERS BE LIABLE FOR ANY INDIRECT, SPECIAL, CONSEQUENTIAL, OR INCIDENTAL DAMAGES, INCLUDING, WITHOUT LIMITATION, LOST PROFITS OR LOSS OR DAMAGE TO DATA ARISING OUT OF THE USE OR INABILITY TO USE THIS MANUAL, EVEN IF CISCO OR ITS SUPPLIERS HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

All printed copies and duplicate soft copies of this document are considered uncontrolled. See the current online version for the latest version.

Cisco has more than 200 offices worldwide. Addresses and phone numbers are listed on the Cisco website at www.cisco.com/go/offices.

Cisco and the Cisco logo are trademarks or registered trademarks of Cisco and/or its affiliates in the U.S. and other countries. To view a list of Cisco trademarks, go to this URL: www.cisco.com go trademarks. Third-party trademarks mentioned are the property of their respective owners. The use of the word partner does not imply a partnership relationship between Cisco and any other company. (1721R)

© 2019 Cisco Systems, Inc. All rights reserved.

CONTENTS

CHAPTER 1 **Read Me First** 1

CHAPTER 2 **MLDP-Based MVPN** 3

- Finding Feature Information 3
- Information About MLDP-Based MVPN 3
  - Overview of MLDP-Based MVPN 3
  - Benefits of MLDP-Based MVPN 5
  - Initial Deployment of an MLDP-Based MVPN 6
    - Default MDT Creation 6
    - Data MDT Scenario 12
- How to Configure MLDP-Based MVPN 13
  - Configuring Initial MLDP Settings 13
  - Configuring an MLDP-Based MVPN 14
  - Verifying the Configuration of an MLDP-Based MVPN 16
- Configuration Examples for MLDP-Based MVPN 18
  - Example Initial Deployment of an MLDP-Based MVPN 18
    - Default MDT Configuration 18
    - Data MDT Configuration 22
  - Example Migration from a PIM with mGRE-Based MVPN to an MLDP-Based MPVN 26
- Additional References 27
- Feature Information for MLDP-Based MVPN 27

CHAPTER 3 **IPv6 Multicast Listener Discovery Protocol** 29

- Finding Feature Information 29
- Information About IPv6 Multicast Listener Discovery Protocol 29
  - IPv6 Multicast Overview 29

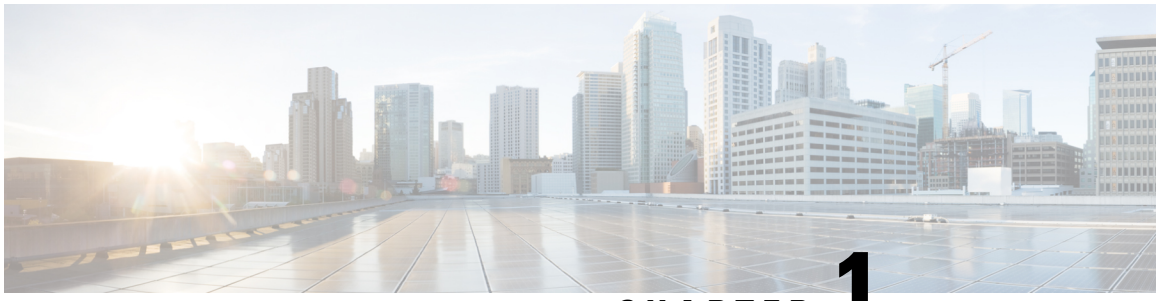
IPv6 Multicast Routing Implementation 30
Multicast Listener Discovery Protocol for IPv6 30
MLD Access Group 32
How to Configure IPv6 Multicast Listener Discovery Protocol 32
Enabling IPv6 Multicast Routing 32
Customizing and Verifying MLD on an Interface 33
Disabling MLD Device-Side Processing 35
Resetting the MLD Traffic Counters 35
Clearing the MLD Interface Counters 36
Configuration Examples for IPv6 Multicast Listener Discovery Protocol 36
Example: Enabling IPv6 Multicast Routing 36
Example: Configuring the MLD Protocol 37
Example: Disabling MLD Router-Side Processing 38
Additional References 38
IPv6 Multicast Listener Discovery Protocol 39

CHAPTER 4 **MLD Group Limits** 41
Finding Feature Information 41
Information About MLD Group Limits 41
Multicast Listener Discovery Protocol for IPv6 41
How to Implement MLD Group Limits 42
Implementing MLD Group Limits Globally 42
Implementing MLD Group Limits per Interface 43
Configuration Examples for MLD Group Limits 44
Example: Implementing MLD Group Limits 44
Additional References 45
Feature Information for MLD Group Limits 46

CHAPTER 5 **MLDP In-Band Signaling/Transit Mode** 47
Finding Feature Information 47
Restrictions for MLDP In-Band Signaling 47
Information About MLDP In-Band Signaling/Transit Mode 48
MLDP In-Band Signaling/Transit Mode 48
How to Configure MLDP In-Band Signaling/Transit Mode 48

Enabling In-Band Signaling on a PE Device 48
Additional References 49
Configuration Examples for MLDP In-Band Signaling/Transit Mode 50
Example: In-Band Signaling on PE1 50
Example: In-Band Signaling on PE2 53
Feature Information for MLDP In-Band Signaling/Transit Mode 57

CHAPTER 6 HA Support for MLDP 59
Finding Feature Information 59
Prerequisites for HA Support for MLDP 59
Restrictions for HA Support for MLDP 60
Information About HA Support for MLDP 60
How to Montior HA Support for MLDP 60
Displaying Check Pointed Information 60
Displaying Data MDT Mappings for MLDP on Standby Device 61
Additional References 62
Feature Information for HA Support for MLDP 63



CHAPTER 1

Read Me First

Important Information about Cisco IOS XE 16

Effective Cisco IOS XE Release 3.7.0E for Catalyst Switching and Cisco IOS XE Release 3.17S (for Access and Edge Routing) the two releases evolve (merge) into a single version of converged release—the Cisco IOS XE 16—providing one release covering the extensive range of access and edge products in the Switching and Routing portfolio.

Feature Information

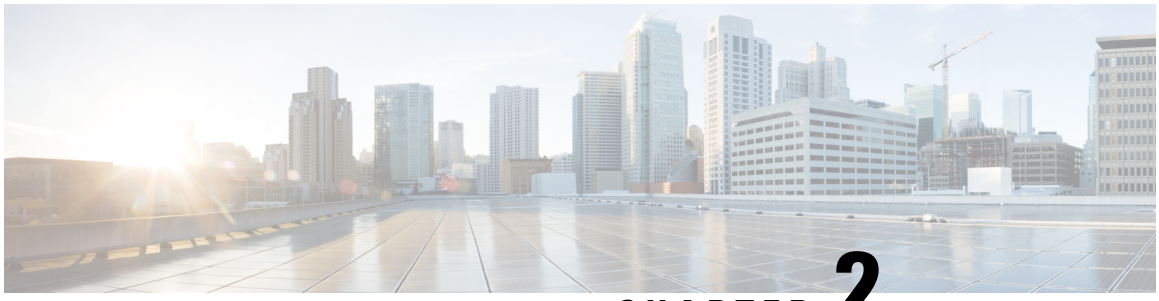
Use Cisco Feature Navigator to find information about feature support, platform support, and Cisco software image support. An account on Cisco.com is not required.

Related References

- Cisco IOS Command References, All Releases

Obtaining Documentation and Submitting a Service Request

- To receive timely, relevant information from Cisco, sign up at Cisco Profile Manager.
- To get the business impact you're looking for with the technologies that matter, visit Cisco Services.
- To submit a service request, visit Cisco Support.
- To discover and browse secure, validated enterprise-class apps, products, solutions and services, visit Cisco Marketplace.
- To obtain general networking, training, and certification titles, visit Cisco Press.
- To find warranty information for a specific product or product family, access Cisco Warranty Finder.



CHAPTER 2

MLDP-Based MVPN

The MLDP-based MVPN feature provides extensions to Label Distribution Protocol (LDP) for the setup of point-to-multipoint (P2MP) and multipoint-to-multipoint (MP2MP) label switched paths (LSPs) for transport in the Multicast Virtual Private Network (MVPN) core network.

- Finding Feature Information, on page 3
- Information About MLDP-Based MVPN, on page 3
- How to Configure MLDP-Based MVPN, on page 13
- Configuration Examples for MLDP-Based MVPN, on page 18
- Additional References, on page 27
- Feature Information for MLDP-Based MVPN, on page 27

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and 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.

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.

Information About MLDP-Based MVPN

Overview of MLDP-Based MVPN

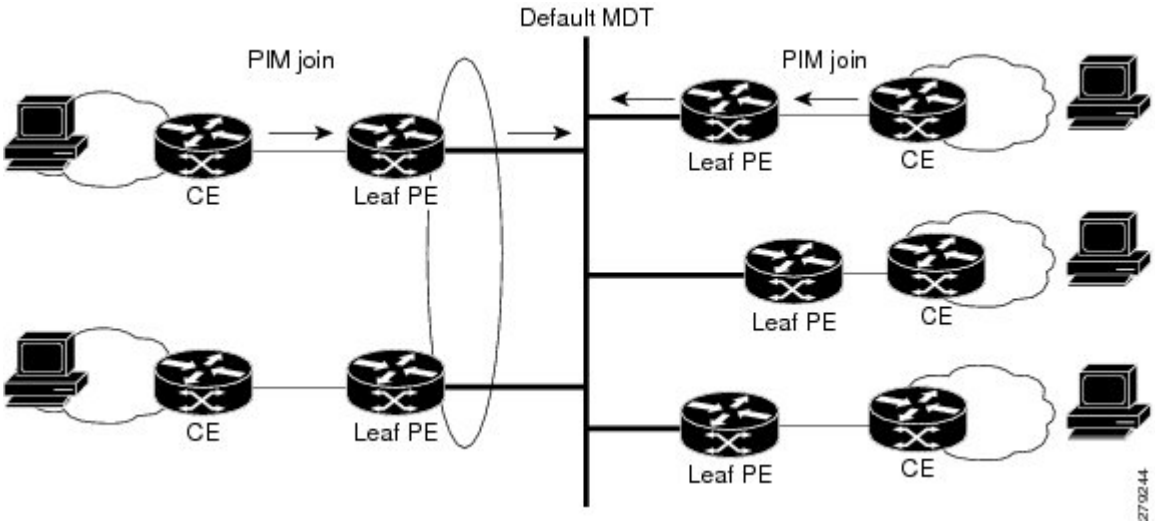
MVPN allows a service provider to configure and support multicast traffic in an MPLS VPN environment. This feature supports routing and forwarding of multicast packets for each individual VPN routing and forwarding (VRF) instance, and it also provides a mechanism to transport VPN multicast packets across the service provider backbone.

A VPN is network connectivity across a shared infrastructure, such as an Internet service provider (ISP). Its function is to provide the same policies and performance as a private network, at a reduced cost of ownership, thus creating many opportunities for cost savings through operations and infrastructure.

An MVPN allows an enterprise to transparently interconnect its private network across the network backbone of a service provider. The use of an MVPN to interconnect an enterprise network in this way does not change the way that the enterprise network is administered, nor does it change general enterprise connectivity.

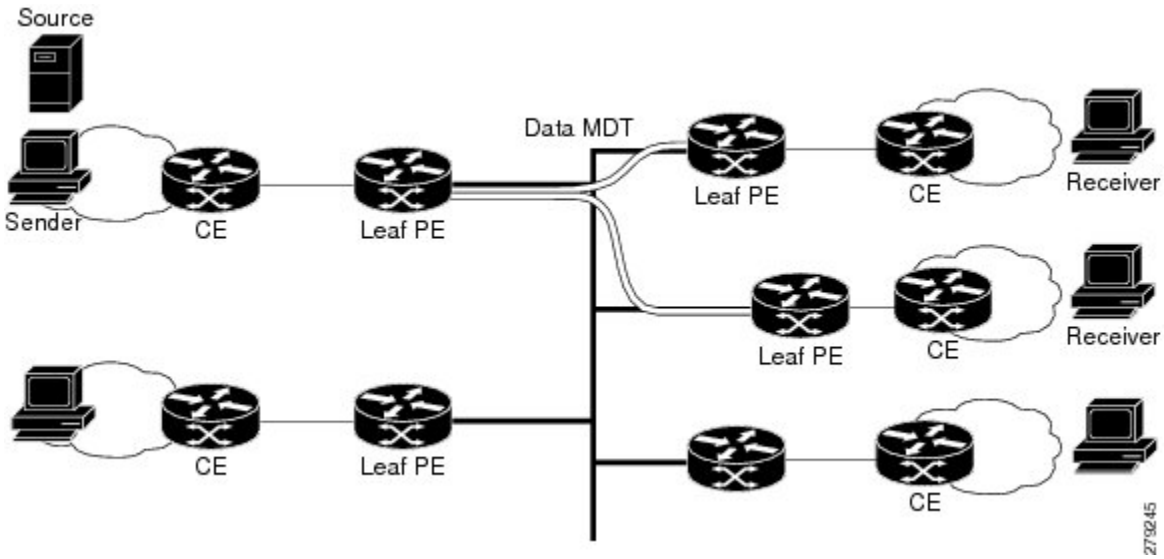
As shown in the figure, in an MLDP-based MVPN, a static default multicast distribution tree (MDT) is established for each multicast domain. The default MDT defines the path used by provider edge (PE) devices to send multicast data and control messages to every other PE device in the multicast domain. A default MDT is created in the core network using a single MP2MP LSP. The default MDT behaves like a virtual LAN.

Figure 1: MLDP with the Default MDT Scenario



As shown in the figure, an MLDP-based MVPN also supports the dynamic creation of data MDTs for high-bandwidth transmission. For high-rate data sources, a data MDT is created using P2MP LSPs to off-load traffic from the default MDT to avoid unnecessary waste of bandwidth to PEs that did not join the stream. The creation of the data MDT is signaled dynamically using MDT Join TLV messages. Data MDTs are a feature unique to Cisco IOS software. Data MDTs are intended for high-bandwidth sources such as full-motion video inside the VPN to ensure optimal traffic forwarding in the MPLS VPN core. The threshold at which the data MDT is created can be configured on a per-device or a per-VRF basis. When the multicast transmission exceeds the defined threshold, the sending PE device creates the data MDT and sends a User Datagram Protocol (UDP) message, which contains information about the data MDT to all devices on the default MDT.

Figure 2: MLDP with the Data MDT Scenario



Data MDTs are created only for (S, G) multicast route entries within the VRF multicast routing table. They are not created for (*, G) entries regardless of the value of the individual source data rate.

The only transport mechanism previously available was Protocol Independent Multicast (PIM) with Multipoint Generic Routing Encapsulation (mGRE) over an IP core network. The introduction of Multicast Label Distribution Protocol (MLDP) provides transport by using MLDP with label encapsulation over an MPLS core network.

MLDP creates the MDTs as follows:

- The default MDT uses MP2MP LSPs.
  - Supports low bandwidth and control traffic between VRFs.
- The data MDT uses P2MP LSPs.
  - Supports a single high-bandwidth source stream from a VRF.

All other operations of MVPN remain the same regardless of the tunneling mechanism:

- PIM neighbors in a VRF are seen across a Label Switched Path virtual interface (LSP-VIF).
- The VPN multicast state is signaled by PIM.

The only other difference when using MLDP is that the MDT group address used in the mGRE solution is replaced with a VPN ID.

Benefits of MLDP-Based MVPN

- Enables the use of a single MPLS forwarding plane for both unicast and multicast traffic.
- Enables existing MPLS protection (for example, MPLS Traffic Engineering/Resource Reservation Protocol (TE/RSVP link protection) and MPLS Operations Administration and Maintenance (OAM) mechanisms to be used for multicast traffic.

- Reduces operational complexity due to the elimination of the need for PIM in the MPLS core network.

Initial Deployment of an MLDP-Based MVPN

Initial deployment of an MLDP-based MVPN involves the configuration of a default MDT and one or more data MDTs.

A static default MDT is established for each multicast domain. The default MDT defines the path used by PE devices to send multicast data and control messages to every other PE device in the multicast domain. A default MDT is created in the core network using a single MP2MP LSP.

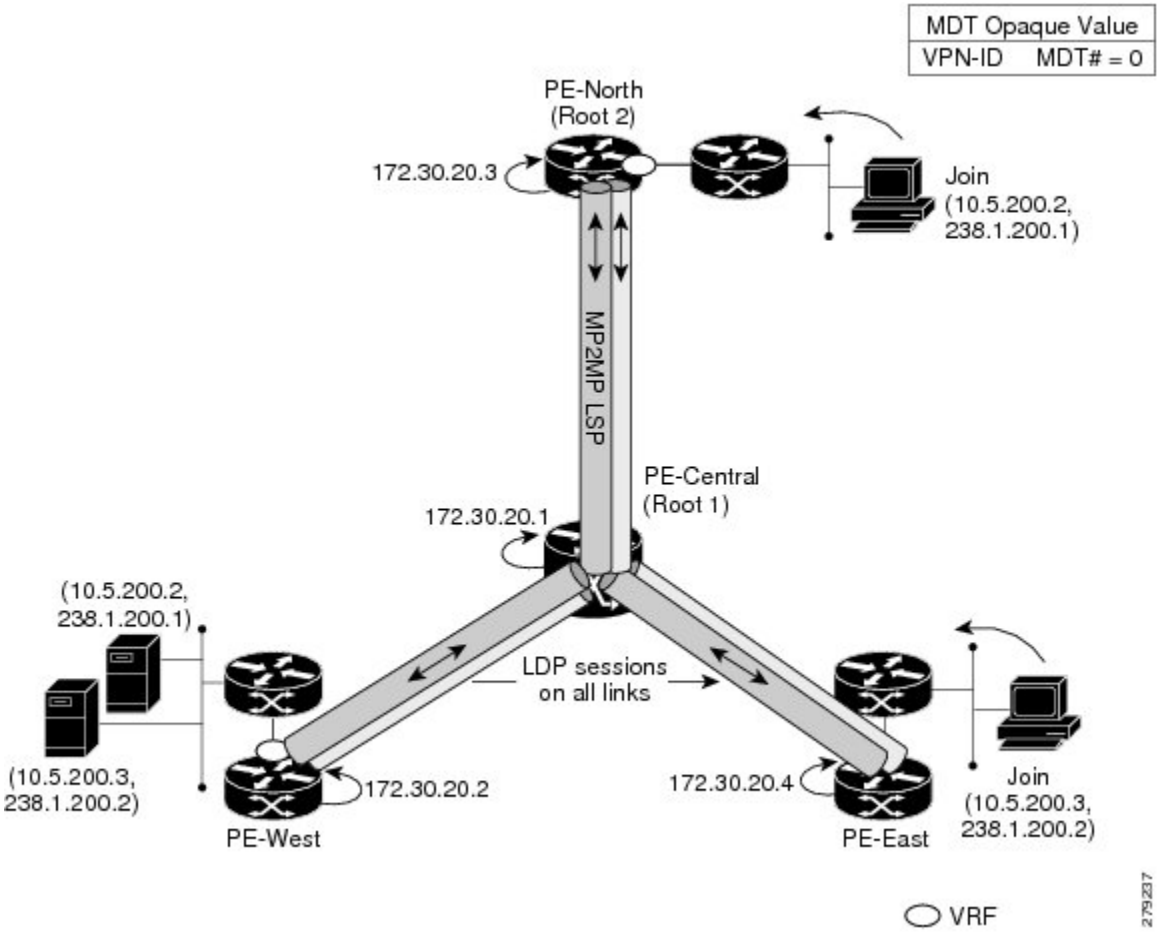
An MLDP-based MVPN also supports the dynamic creation of data MDTs for high-bandwidth transmission.

Default MDT Creation

The figure shows the default MDT scenario. The Opaque value used to signal a default MDT consists of two parameters: the VPN ID and the MDT number for the VPN in the format (vpn-id, 0) where vpn-id is a manually configured 7-byte number that uniquely identifies this VPN. The default MDT is set to zero.

In this scenario, each of the three PE devices belong to the VRF called VRF and they have the same VPN ID. Each PE device with the same VPN ID will join the same MP2MP tree. The PE devices have created a primary MP2MP tree rooted at P-Central (Root 1) and a backup MP2MP tree rooted at PE-North (Root 2). There are two sources at PE-West and interested receivers at both PE-North and PE-East. PE-West will choose one of the MP2MP trees to transmit the customer VPN traffic, but all PE devices can receive traffic on either of the MP2MP trees.

Figure 3: Default MDT Scenario



LSP Downstream Default MDT Creation

The figures show the downstream tree creation for each of the roots. Each PE device configured with VPN ID 100:2 creates the same Forwarding Equivalence Class (FEC) Type Length Value (TLV), but with a different root and downstream labels per MP2MP tree. The FEC type will be MP2MP Down, which prompts the receiving Label Switched Route (LSR) to respond with an upstream label mapping message to create the upstream path.

Figure 4: Default MDT Downstream--Root 1

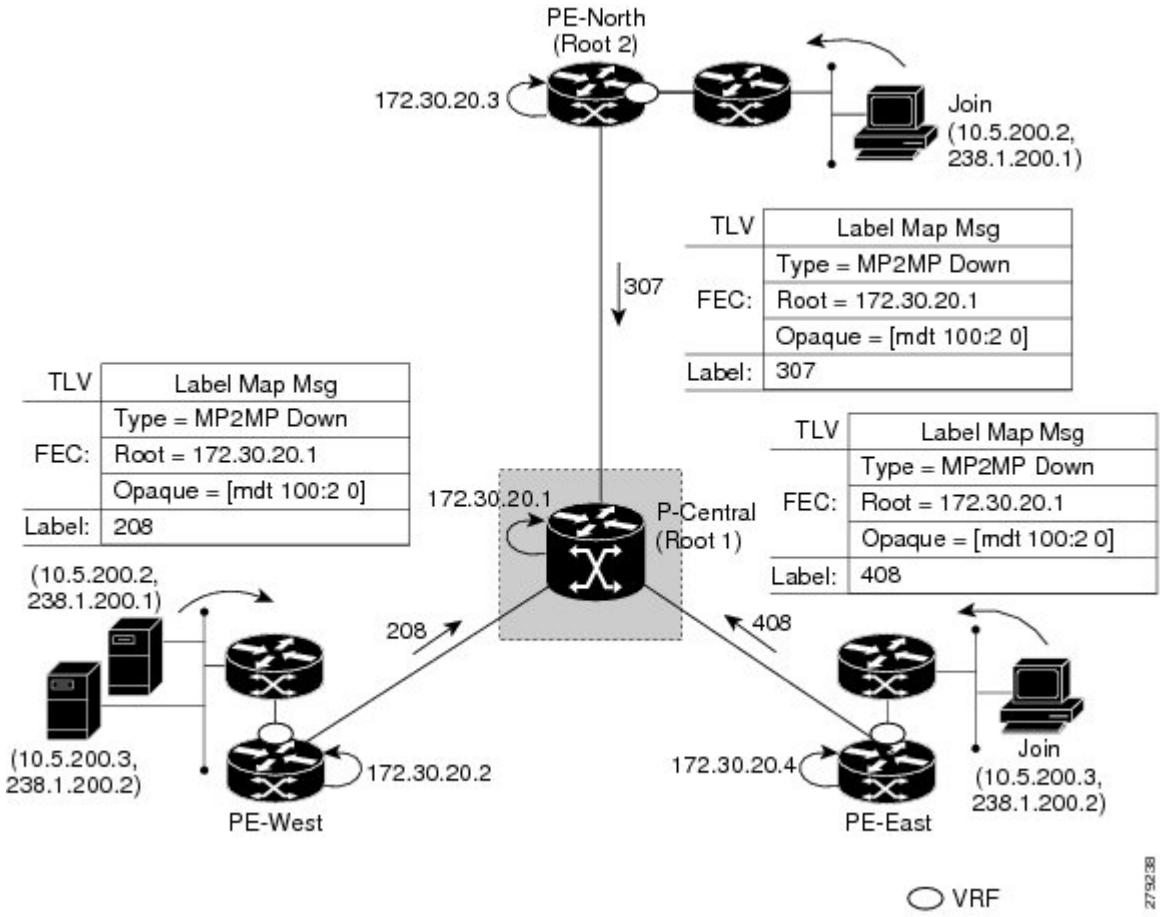
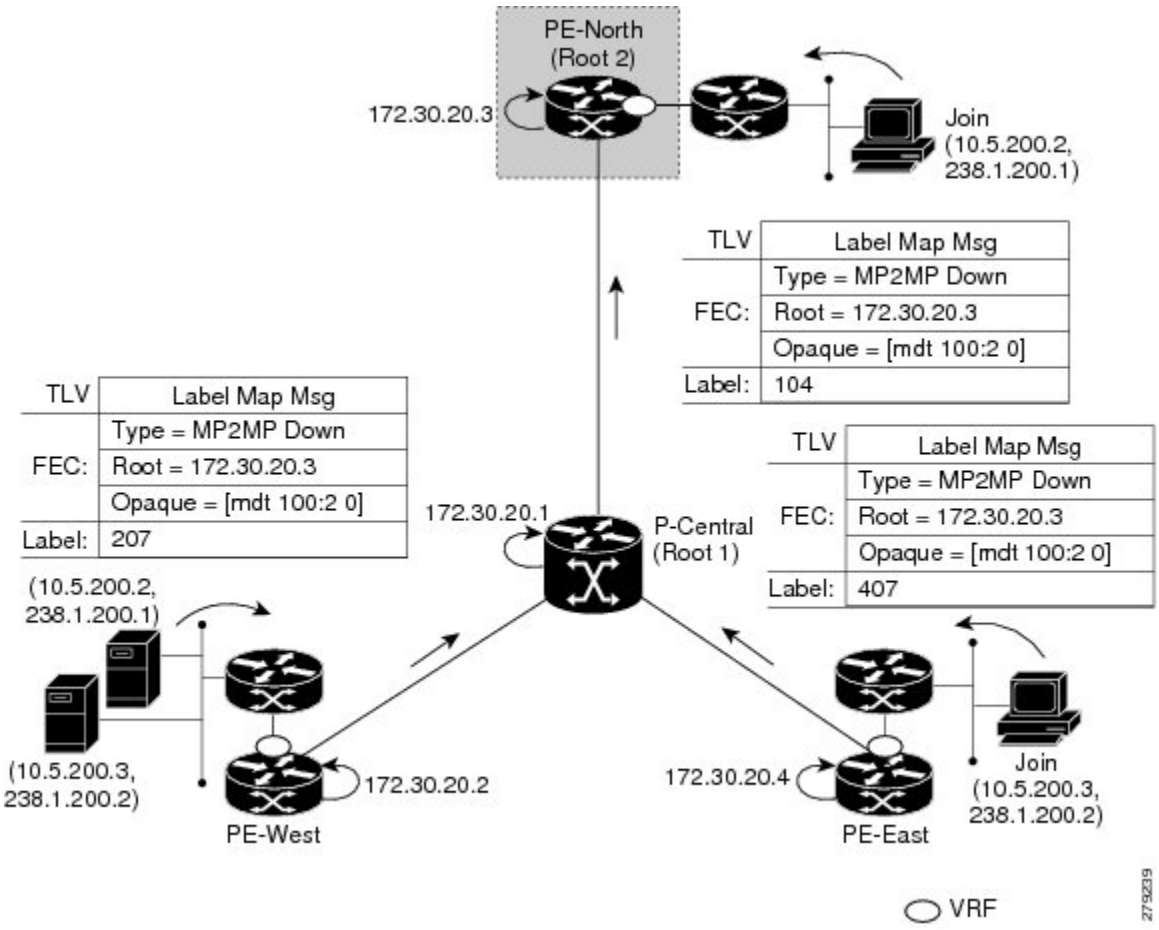


Figure 5: Default MDT Downstream--Root 2



LSP Upstream Default MDT Creation

The figures show the upstream LSP creation for the default MDTs. For each downstream label received, a corresponding upstream label is sent. In the first figure, P-Central sends out three upstream labels (111, 109, and 105) to each downstream directly connected neighbor (downstream is away from the root). The process for PE-North is the same except that it only sends a single upstream label (313) as there is only one directly connected downstream neighbor, as shown in the second figure.

Figure 6: Default MDT Upstream--Root 1

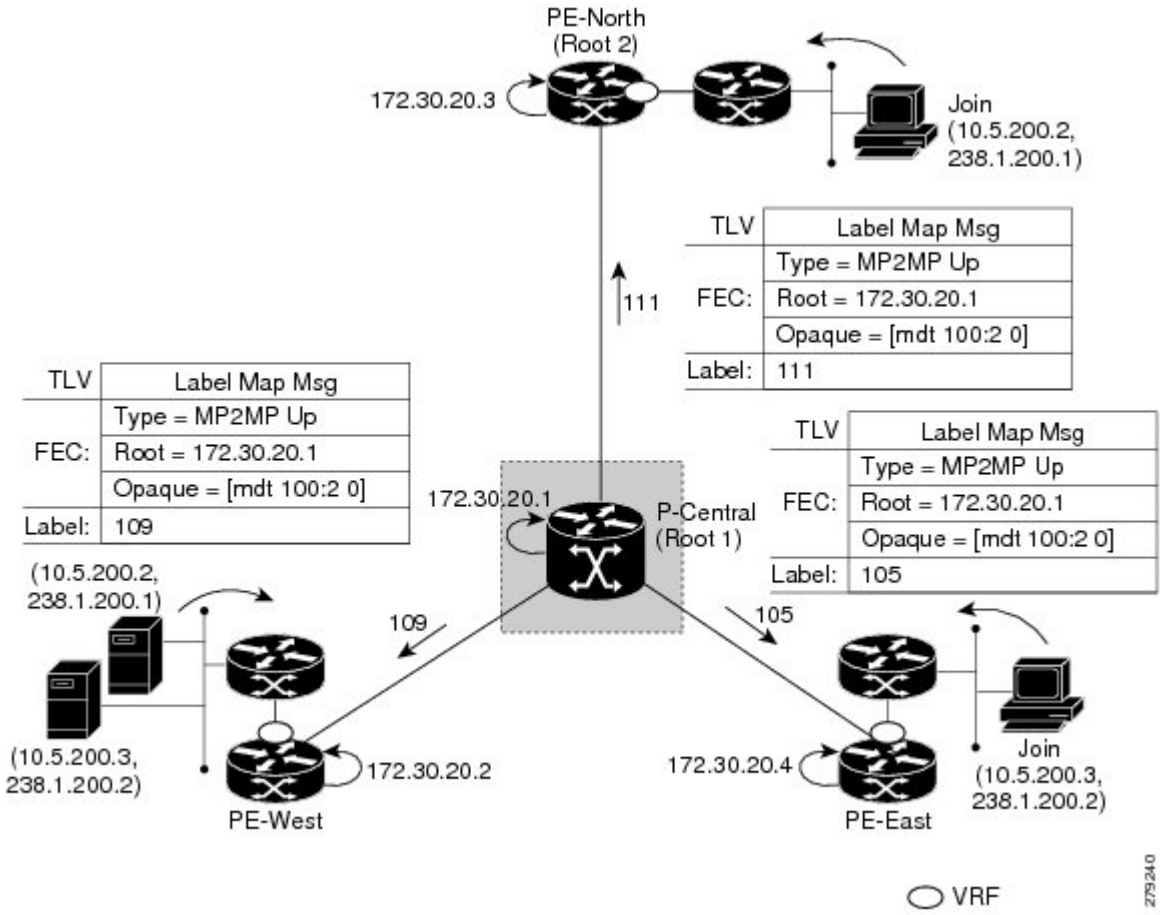
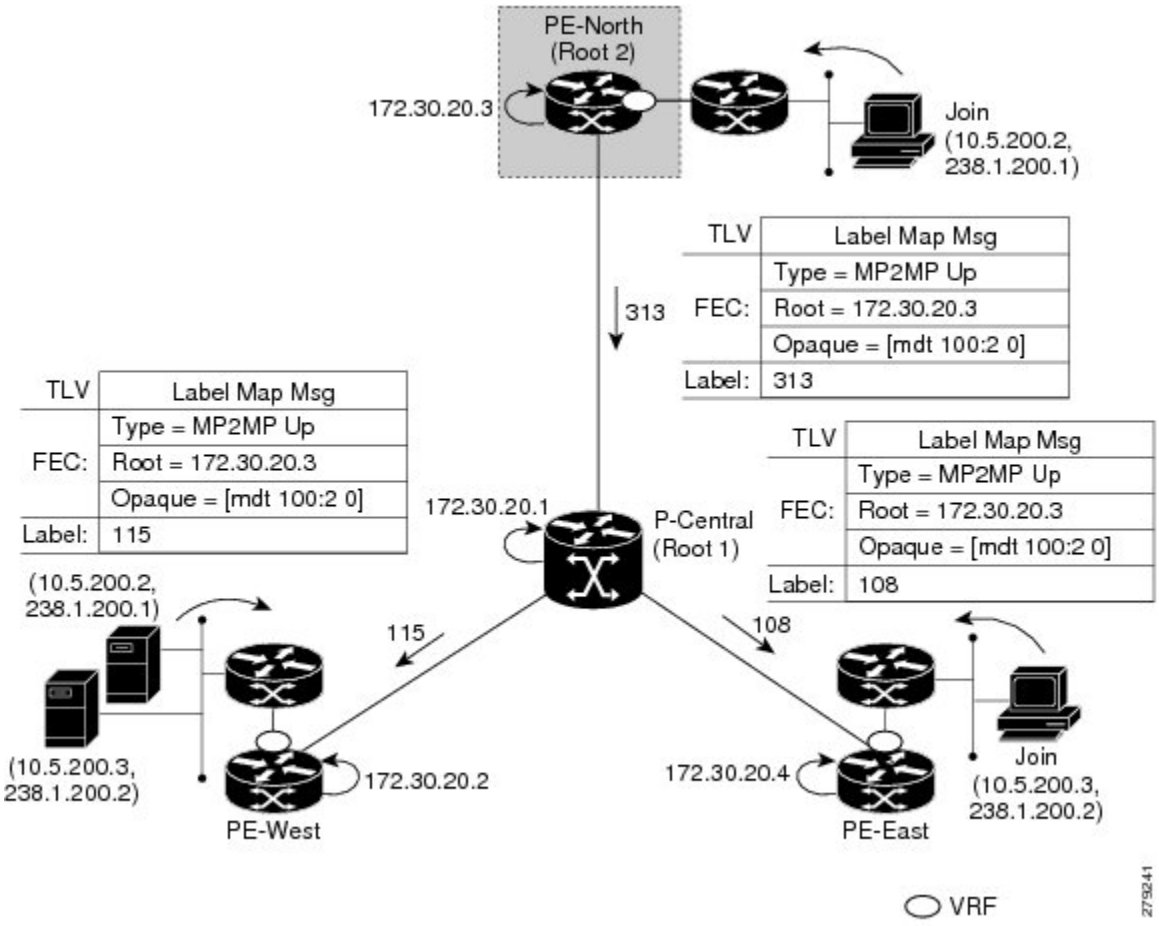


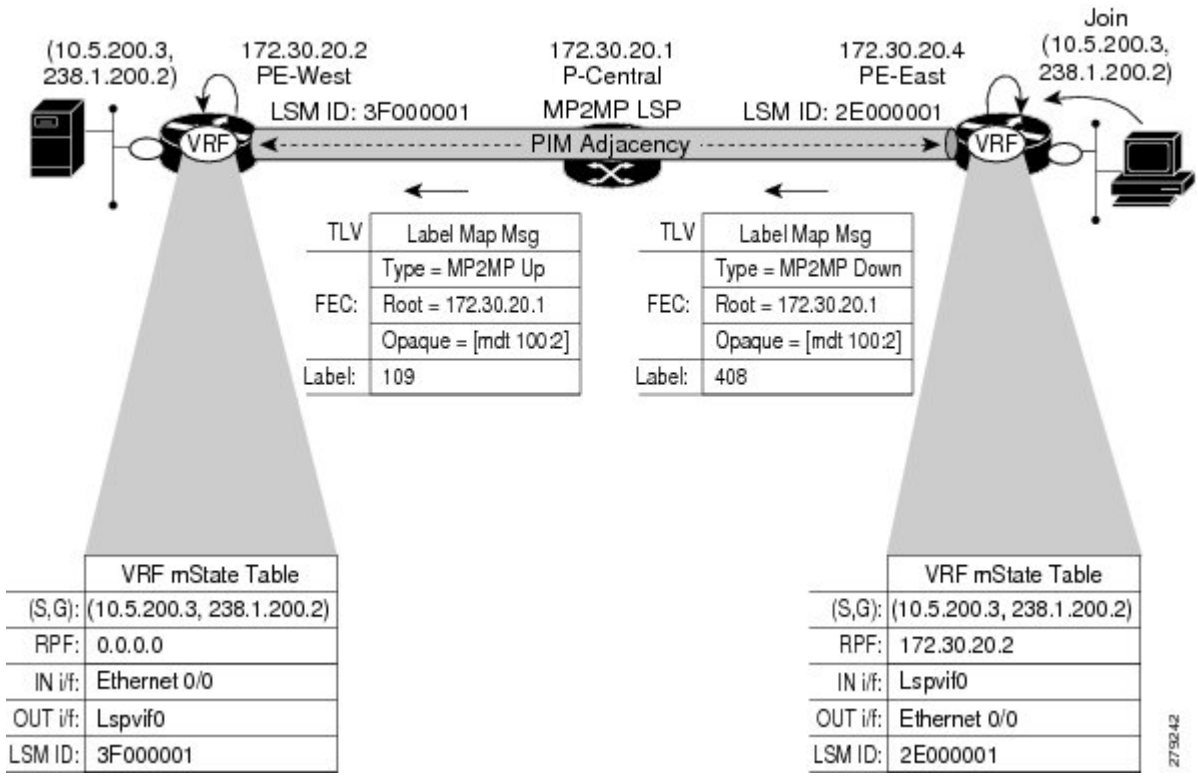
Figure 7: Default MDT Upstream--Root 2



PIM Overlay Signaling of VPN Multicast State

The signaling of the multicast state within a VPN is via PIM. It is called overlay signaling because the PIM session runs over the multipoint LSP and maps the VPN multicast flow to the LSP. In an MVPN, the operation of PIM is independent of the underlying tunnel technology. In the MVPN solution, a PIM adjacency is created between PE devices, and the multicast states within a VRF are populated over the PIM sessions. When using MLDP, the PIM session runs over an LSP-VIF interface. The figure shows PIM signaling running over the default MDT MP2MP LSP. Access to the MP2MP LSP is via the LSP-VIF, which can see all the leaf PE devices at the end of branches, much like a LAN interface. In the figure, PE-East sends a downstream label mapping message to the root, P-Central, which in turn sends an upstream label mapping message to PE-West. These messages result in the creation of the LSP between the two leaf PE devices. A PIM session can then be activated over the top of the LSP allowing the (S, G) states and control messages to be signaled between PE-West and PE-East. In this case, PE-East receives a Join TLV message for (10.5.200.3, 238.1.200.2) within VRF, which it inserts into the mroute table. The Join TLV message is then sent via the PIM session to PE-West (BGP next-hop of 10.5.200.3), which populates its VRF mroute table. This procedure is identical to the procedure using an mGRE tunnel.

Figure 8: PIM Signaling over LSP



Data MDT Scenario

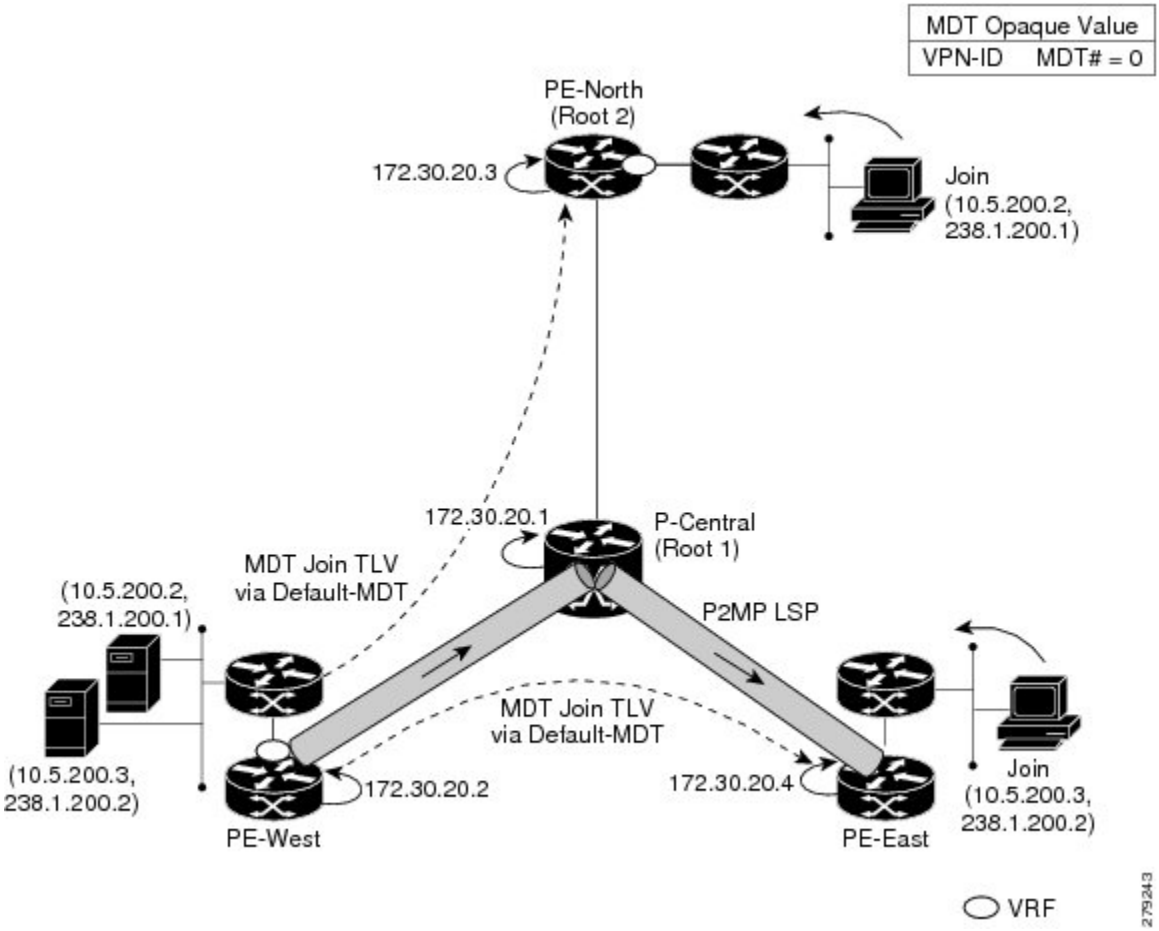
In an MVPN, traffic that exceeds a certain threshold can move off the default MDT onto a data MDT.

The figure shows the data MDT scenario. The Opaque value used to signal a data MDT consists of two parameters: the VPN ID and the MDT number in the format (vpn-id, MDT# > 0) where vpn-id is a manually configured 7-byte number that uniquely identifies this VPN. The second parameter is the unique data MDT number for this VPN, which is a number greater than zero.

In the scenario, two receivers at PE-North and PE-East are interested in two sources at PE-West. If the source 10.5.200.3 exceeds the threshold on the default MDT, PE-West will issue an MDT Join TLV message over the default MDT MP2MP LSP advising all PE devices that a new data MDT is being created.

Because PE-East has an interested receiver in VRF, it will build a multipoint LSP using P2MP back to PE-West, which will be the root of the tree. PE-North does not have a receiver for 10.5.200.3, therefore it will just cache the Join TLV message.

Figure 9: Data MDT Scenario



How to Configure MLDP-Based MVPN

Configuring Initial MLDP Settings

Perform this task to configure the initial MLDP settings.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **mpls mldp logging notifications**
4. **mpls mldp forwarding recursive**
5. **end**

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	**mpls mldp logging notifications** **Example:** `Device(config)# mpls mldp logging notifications`	Enables MLDP logging notifications.
Step 4	**mpls mldp forwarding recursive** **Example:** `Device(config)# mpls mldp forwarding recursive`	Enables MLDP recursive forwarding over a P2MP LSP.
Step 5	**end** **Example:** `Device(config)# end`	Ends the current configuration session and returns to privileged EXEC mode.

Configuring an MLDP-Based MVPN

Perform this task to configure an MLDP-based MVPN.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip multicast-routing**
4. **ip multicast-routing vrf** *vrf-name*
5. **ip vrf** *vrf-name*
6. **rd** *route-distinguisher*
7. **vpn id** *oui* **:** *vpn-index*
8. **route target export** *route-target-ext-community*
9. **route target import** *route-target-ext-community*
10. **mdt preference** *{* **mldp** | **pim** *}*
11. **mdt default mpls mldp** *group-address*
12. **mdt data mpls mldp** *number-of-data-mdt*
13. **mdt data threshold** *kb/s* **list** *access-list*

14. **end**

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	**ip multicast-routing** **Example:** `Device(config)# ip multicast-routing`	Enables IP multicast routing.
Step 4	**ip multicast-routing vrf** *vrf-name* **Example:** `Device(config)# ip multicast-routing vrf VRF`	Enables IP multicast routing for the MVPN VRF specified for the *vrf-name* argument.
Step 5	**ip vrf** *vrf-name* **Example:** `Device(config-vrf)# ip vrf VRF`	Defines a VRF instance and enters VRF configuration mode.
Step 6	**rd** *route-distinguisher* **Example:** `Device(config-vrf)# rd 50:11`	Creates a route distinguisher (RD) (in order to make the VRF functional). Creates the routing and forwarding tables, associates the RD with the VRF instance, and specifies the default RD for a VPN.
Step 7	**vpn id** *oui* **:** *vpn-index* **Example:** `Device(config-vrf)# vpn id 50:10`	Sets or updates the VPN ID on a VRF instance.
Step 8	**route target export** *route-target-ext-community* **Example:** `Device(config-vrf)# route target export 100:100`	Creates an export route target extended community for the specified VRF.
Step 9	**route target import** *route-target-ext-community* **Example:**	Creates an import route target extended community for the specified VRF.

	Command or Action	Purpose
	`Device(config-vrf)# route target import 100:100`	
Step 10	**mdt preference** *{* **mldp** | **pim** *}* **Example:** `Device(config-vrf)# mdt preference mldp`	Specifies a preference for a particular MDT type (MLDP or PIM).
Step 11	**mdt default mpls mldp** *group-address* **Example:** `Device(config-vrf)# mdt default mpls mldp 172.30.20.1`	Configures a default MDT group for a VPN VRF instance.
Step 12	**mdt data mpls mldp** *number-of-data-mdt* **Example:** `Device(config-vrf)# mdt data mpls mldp 255`	Specifies a range of addresses to be used in the data MDT pool.
Step 13	**mdt data threshold** *kb/s* **list** *access-list* **Example:** `Device(config-vrf)# mdt data threshold 40 list 1`	Defines the bandwidth threshold value in kilobits per second.
Step 14	**end** **Example:** `Device(config)# end`	Ends the current configuration session and returns to privileged EXEC mode.

Verifying the Configuration of an MLDP-Based MVPN

Perform this task in privileged EXEC mode to verify the configuration of an MLDP-based MVPN.

SUMMARY STEPS

1. show mpls mldp database
2. **show ip pim neighbor** [**vrf** *vrf-name*] **neighbor** [*interface-type interface-number*]
3. **show ip mroute** [**vrf** *vrf-name*] [[**active** [*kbps*] [**interface** *type number*] | **bidirectional** | **count** [**terse**] | **dense** | **interface** *type number* | **proxy** | **pruned** | **sparse** | **ssm** | **static** | **summary**] | [*group-address* [*source-address*]] [**count** [**terse**] | **interface** *type number* | **proxy** | **pruned** | **summary**] | [*source-address group-address*] [**count** [**terse**] | **interface** *type number* | **proxy** | **pruned** | **summary**] | [*group-address*] **active** [*kbps*] [**interface** *type number* | **verbose**]]
4. **show mpls forwarding-table** [*network* {*mask* | *length*} | **labels** *label* [**-** *label*] | **interface** *interface* | **next-hop** *address* | **lsp-tunnel** [*tunnel-id*]] [**vrf** *vrf-name*] [**detail**]
5. **show adjacency** [*ip-address*] [*interface-type interface-number* | **null** *number* | **port-channel** *number* | **sysclock** *number* | **vlan** *number* | **fcpa** *number* | **serial** *number*] [**connectionid** *number*] [**link** {**ipv4** | **mpls**}] [**detail** | **encapsulation**]

DETAILED STEPS

Step 1 show mpls mldp database

Enter the **show mpls mldp database**command to display information in the MLDP database. It shows the FEC, the Opaque value of the FEC decoded, and the replication clients associated with it:

Example:

```
Device# show mpls mldp database
* Indicates MLDP recursive forwarding is enabled
LSM ID : D3000001 (RNR LSM ID: 8A000002)   Type: MP2MP   Uptime : 00:04:54
  FEC Root           : 172.30.20.1
  Opaque decoded     : [mdt 100:2 0]
  Opaque length      : 11 bytes
  Opaque value       : 07 000B 00000100000000100000000
  RNR active LSP     : (this entry)
  Upstream client(s) :
    172.30.20.1:0    [Active]
      Expires        : Never         Path Set ID  : 99000001
      Out Label (U)  : 32            Interface    : Ethernet1/0*
      Local Label (D): 30            Next Hop     : 10.0.1.7
  Replication client(s):
    MDT  (VRF VRF)
      Uptime         : 00:04:54      Path Set ID  : 5000002
      Interface      : Lspvif0
```

Step 2 **show ip pim neighbor** [**vrf** *vrf-name*] **neighbor** [*interface-type interface-number*]

Enter the **show ip pim neighbor**command to display PIM adjacencies information:

Example:

```
Device# show ip pim vrf VRF neighbor
192.168.10.18     Serial6/0            04:53:19/00:01:18 v2 1 / G
172.30.20.3       Lspvif0              04:52:32/00:01:28 v2 1 / B S P G
172.30.20.2       Lspvif0              04:52:32/00:01:17 v2 1 / B S P G
```

Step 3 **show ip mroute** [**vrf** *vrf-name*] [[**active** [*kbps*] [**interface** *type number*] | **bidirectional** | **count** [**terse**] | **dense** | **interface** *type number* | **proxy** | **pruned** | **sparse** | **ssm** | **static** | **summary**] | [*group-address* [*source-address*]] [**count** [**terse**] | **interface** *type number* | **proxy** | **pruned** | **summary**] | [*source-address group-address*] [**count** [**terse**] | **interface** *type number* | **proxy** | **pruned** | **summary**] | [*group-address*] **active** [*kbps*] [**interface** *type number* | **verbose**]]

Enter the **show ip mroute**command to display the contents of the multicast routing (mroute) table:

Example:

```
Device# show ip mroute vrf VRF 238.1.200.2 10.5.200.3
(10.5.200.3, 238.1.200.2), 04:54:18/00:02:40, flags: sT
Incoming interface: Lspvif0, RPF nbr 172.30.20.2
Outgoing interface list:
Serial6/0, Forward/Sparse-Dense, 04:54:18/00:02:40
```

Step 4 **show mpls forwarding-table** [*network* {*mask* | *length*} | **labels** *label* [**-** *label*] | **interface** *interface* | **next-hop** *address* | **lsp-tunnel** [*tunnel-id*]] [**vrf** *vrf-name*] [**detail**]

Enter the **show mpls forwarding-table**command to display the contents of the MPLS Label Forwarding Information Base (LFIB):

Example:

```
Device# show mpls forwarding-table | inc 1F000001
105    307           mLDP:1F000001     38468         Se5/0      point2point
       208           mLDP:1F000001     38468         Se4/0      point2point
109    307           mLDP:1F000001     34738         Se5/0      point2point
       408           mLDP:1F000001     34738         Se6/0      point2point
111    408           mLDP:1F000001     282           Se6/0      point2point
       208           mLDP:1F000001     282           Se4/0      point2point
```

Step 5 **show adjacency** [*ip-address*] [*interface-type interface-number* | **null** *number* | **port-channel** *number* | **sysclock** *number* | **vlan** *number* | **fcpa** *number* | **serial** *number*] [**connectionid** *number*] [**link** {**ipv4** | **mpls**}] [**detail** | **encapsulation**]

Enter the **show adjacency**command to display adjacency information for the specified LSP-VIF interface:

Example:

```
Device# show adjacency lspvif0
105    307           mLDP:1F000001     38468         Se5/0      point2point
       208           mLDP:1F000001     38468         Se4/0      point2point
109    307           mLDP:1F000001     34738         Se5/0      point2point
       408           mLDP:1F000001     34738         Se6/0      point2point
111    408           mLDP:1F000001     282           Se6/0      point2point
       208           mLDP:1F000001     282           Se4/0      point2point
```

Configuration Examples for MLDP-Based MVPN

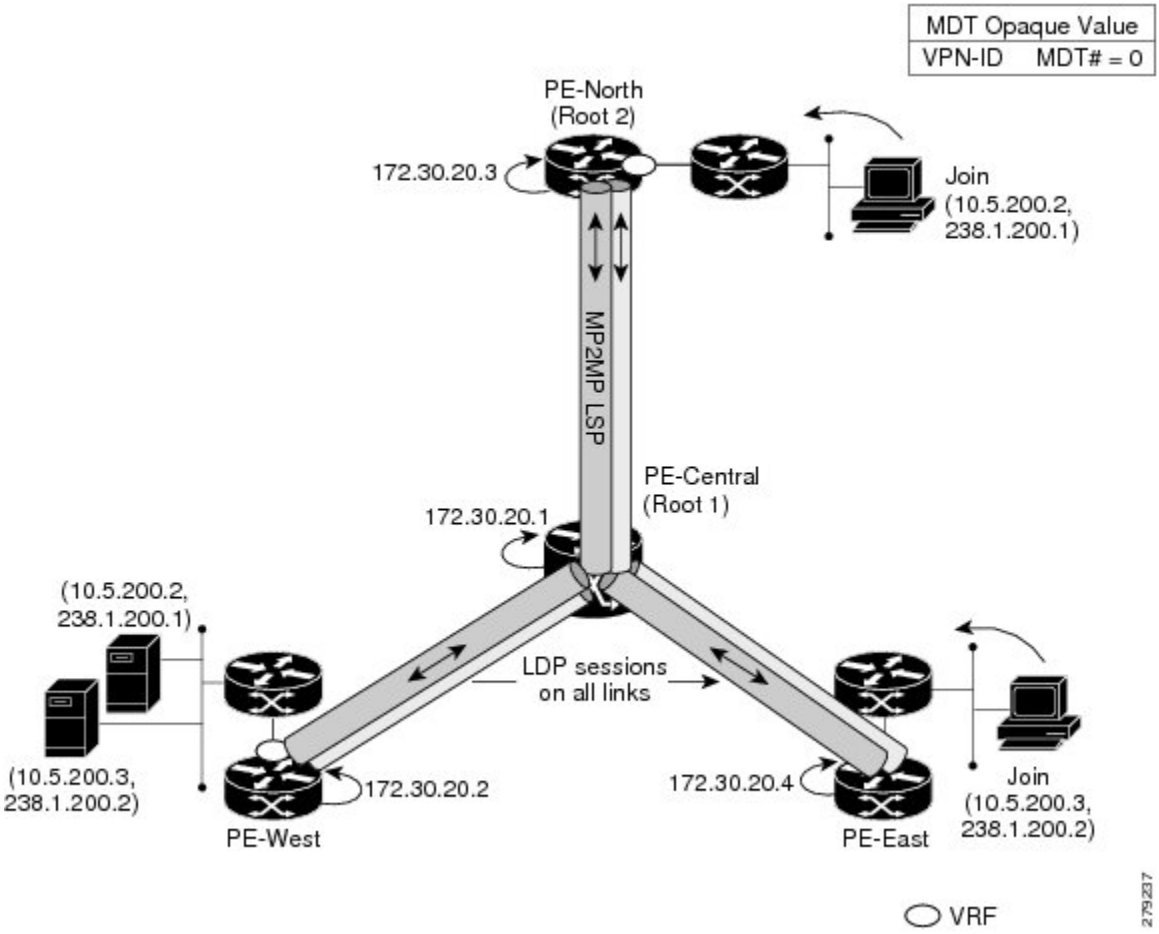
Example Initial Deployment of an MLDP-Based MVPN

Initial deployment of an MLDP-based MVPN involves the configuration of a default MDT and one or more data MDTs.

Default MDT Configuration

The following example shows how to configure the default MDT for an MLDP-based MVPN. This configuration is based on the sample topology illustrated in the figure.

Figure 10: Default MDT Example



This configuration is consistent for every PE device participating in the same VPN ID. The **vpn id 100:2** command replaces the MDT group address used with the mGRE transport method. To provide redundancy, two default MDT trees are statically configured, rooted at P-Central and PE-North. The selection as to which MP2MP tree the default MDT will use at a particular PE device is determined by Interior Gateway Protocol (IGP) metrics. An MP2MP LSP is implicit for the default MDT.

```
ip pim mpls source Loopback0
ip multicast-routing
ip multicast-routing vrf VRF
!
ip vrf VRF
 rd 100:2
 vpn id 100:2
 route-target export 200:2
 route-target import 200:2
 mdt default mpls mldp 172.30.20.1 (P-Central)
 mdt default mpls mldp 172.30.20.3 (PE-North)
```

PIM Adjacencies

PIM operates over the LSP-VIF as if it were a regular tunnel interface. That means PIM hellos are exchanged over the LSP-VIF to establish PIM adjacencies over the default MDT. The sample output in this section

displays the three PIM adjacencies in VRF of PE-East. The first is the adjacency to the receiver network over serial interface 6/0, and the next two are the adjacencies to PE-West and PE-North over the MP2MP LSP via LSP-VIF interface 0.

```
PE-East# show ip pim vrf VRF neighbor
192.168.10.18     Serial6/0           04:53:19/00:01:18 v2 1 / G
172.30.20.3       Lspvif0             04:52:32/00:01:28 v2 1 / B S P G
172.30.20.2       Lspvif0             04:52:32/00:01:17 v2 1 / B S P G
```

The output from the **show ip mroute** command also shows the (S, G) entry for VRF. The stream 238.1.200.2 has the Reverse Path Forwarding (RPF) interface of LSP-VIF interface 0 and the neighbor 172.30.20.2, which is PE-West.

```
PE-East# show ip mroute vrf VRF 238.1.200.2 10.5.200.3
(10.5.200.3, 238.1.200.2), 04:54:18/00:02:40, flags: sT
Incoming interface: Lspvif0, RPF nbr 172.30.20.2
Outgoing interface list:
Serial6/0, Forward/Sparse-Dense, 04:54:18/00:02:40
```

MLDP Database Entry--PE-East

The sample output in this section displays the database entries for the MP2MP trees supporting the default MDT at PE-East. The database is searched by Opaque value MDT 100:2, which results in information for two MP2MP trees (one for each root) being returned. Both trees have different system IDs (2E000001, F2000005) and use the same Opaque value ([mdt 100:2 0]), but with different roots. The last 0 in the Opaque value indicates this tree is a default MDT. Entry 79000004 shows it is the primary MP2MP tree, therefore PE-East will transmit all source multicast traffic on this LSP, and B2000006 will be the backup root. Note that interface LSP-VIF interface 0 represents both MP2MP LSPs. The Local Label (D) is the downstream label allocated by PE-East for this tree. In other words, traffic from the root will be received with either label 408 (Primary Tree) or 407 (Backup Tree). The Out Label (U) is the label that PE-East will use to send traffic into the tree; upstream towards the root, either 105 for the Primary Tree or 108 for the Backup Tree. Both these labels were received from P-Central.

```
PE-East# show mpls mldp database opaque_type mdt 100:2
* Indicates MLDP recursive forwarding is enabled
LSM ID : 79000004 (RNR LSM ID: 8A000002)   Type: MP2MP   Uptime : 00:04:54
  FEC Root           : 172.30.20.1
  Opaque decoded     : [mdt 100:2 0]
  Opaque length      : 11 bytes
  Opaque value       : 07 000B 0000010000000100000000
  RNR active LSP     : (this entry)
  Upstream client(s) :
    172.30.20.1:0    [Active]
      Expires        : Never         Path Set ID  : 99000001
      Out Label (U)  : 32            Interface    : Ethernet1/0*
      Local Label (D): 30            Next Hop     : 10.0.1.7
  Replication client(s):
    MDT  (VRF VRF)
      Uptime         : 00:04:54      Path Set ID  : 5000002
      Interface      : Lspvif0
LSM ID : 79000005 (RNR LSM ID: 8A000003)   Type: MP2MP   Uptime : 00:04:54
  FEC Root           : 172.30.20.3
  Opaque decoded     : [mdt 100:2 0]
  Opaque length      : 11 bytes
  Opaque value       : 07 000B 0000010000000100000001
  RNR active LSP     : (this entry)
  Upstream client(s) :
    172.30.20.1:0    [Active]
```

```
    Expires        : Never         Path Set ID  : 99000002
    Out Label (U)  : 32            Interface    : Ethernet1/0*
    Local Label (D): 30            Next Hop     : 10.0.1.7
  Replication client(s):
    MDT  (VRF VRF)
    Uptime         : 00:04:54      Path Set ID  : 5000003
    Interface      : Lspvif0
```

Label Forwarding Entry--P-Central (Root 1)

The sample output shown in this section displays the VRF (MDT 100:2) MLDP database entry 1F000001 for the primary MP2MP LSP, which is P-Central. Because the local device P-Central is the root, there is no upstream peer ID, therefore no labels are allocated locally. However there are three replication clients, representing each of the three PE devices: PE-North, PE-West, and PE-East. These replication clients are the downstream nodes of the MP2MP LSP. These clients receive multipoint replicated traffic.

In the replication entry looking from the perspective of the root, there are two types of labels:

- Out label (D)--These are labels received from remote peers that are downstream to the root (remember traffic flows downstream away from the root).
- Local label (U)--These are labels provided by P-Central to its neighbors to be used as upstream labels (sending traffic to the root). It is easy to identify these labels as they all start in the 100 range, which we have configured for P-Central to use. P-Central sends these labels out when it receives a FEC with the type as MP2MP Down.

From the labels received and sent in the replication entries, the Label Forwarding Information Base (LFIB) is created. The LFIB has one entry per upstream path and one entry per downstream path. In this case because P-Central is the root, there are only upstream entries in the LFIB that have been merged with the corresponding downstream labels. For example, label 105 is the label P-Central sent to PE-East to send source traffic upstream. Traffic received from PE-East will then be replicated using the downstream labels 307 to PE-West and 208 to PE-North.

```
P-Central# show mpls mldp database opaque_type mdt 100:2
LSM ID : 79000006 (RNR LSM ID: 1F000001)   Type: MP2MP   Uptime : 00:04:54
  FEC Root           : 172.30.20.1
  Opaque decoded     : [mdt 100:2 0]
  Opaque length      : 11 bytes
  Opaque value       : 07 000B 00000100000000100000000
  RNR active LSP     : (this entry)
  Upstream client(s) : None
  Replication client(s):
    172.3.20.2:0
      Uptime         : 01:46:43      Path Set ID  : AC000008
      Out label (D)  : 208            Interface    : Serial4/0
      Local label (U): 109           Next Hop     : 172.30.10.2
    172.3.20.3:0
      Uptime         : 01:42:43      Path Set ID  : E00000C
      Out label (D)  : 307            Interface    : Serial5/0
      Local label (U): 111           Next Hop     : 172.30.10.6
    172.3.20.4:0
      Uptime         : 01:40:43      Path Set ID  : 3D000010
      Out label (D)  : 408            Interface    : Serial6/0
      Local label (U): 105           Next Hop     : 172.30.10.10
P-Central# show mpls forwarding-table | inc 1F000001
105    307           mLDP:1F000001     38468         Se5/0      point2point
       208           mLDP:1F000001     38468         Se4/0      point2point
109    307           mLDP:1F000001     34738         Se5/0      point2point
       408           mLDP:1F000001     34738         Se6/0      point2point
```

```
111     408           mLDP:1F000001     282           Se6/0      point2point
        208           mLDP:1F000001     282           Se4/0      point2point
```

The sample output shown in this section displays the entry on P-Central for the MP2MP LSP rooted at PE-North (backup root). In this tree P-Central is a branch of the tree, not a root, therefore there are some minor differences to note:

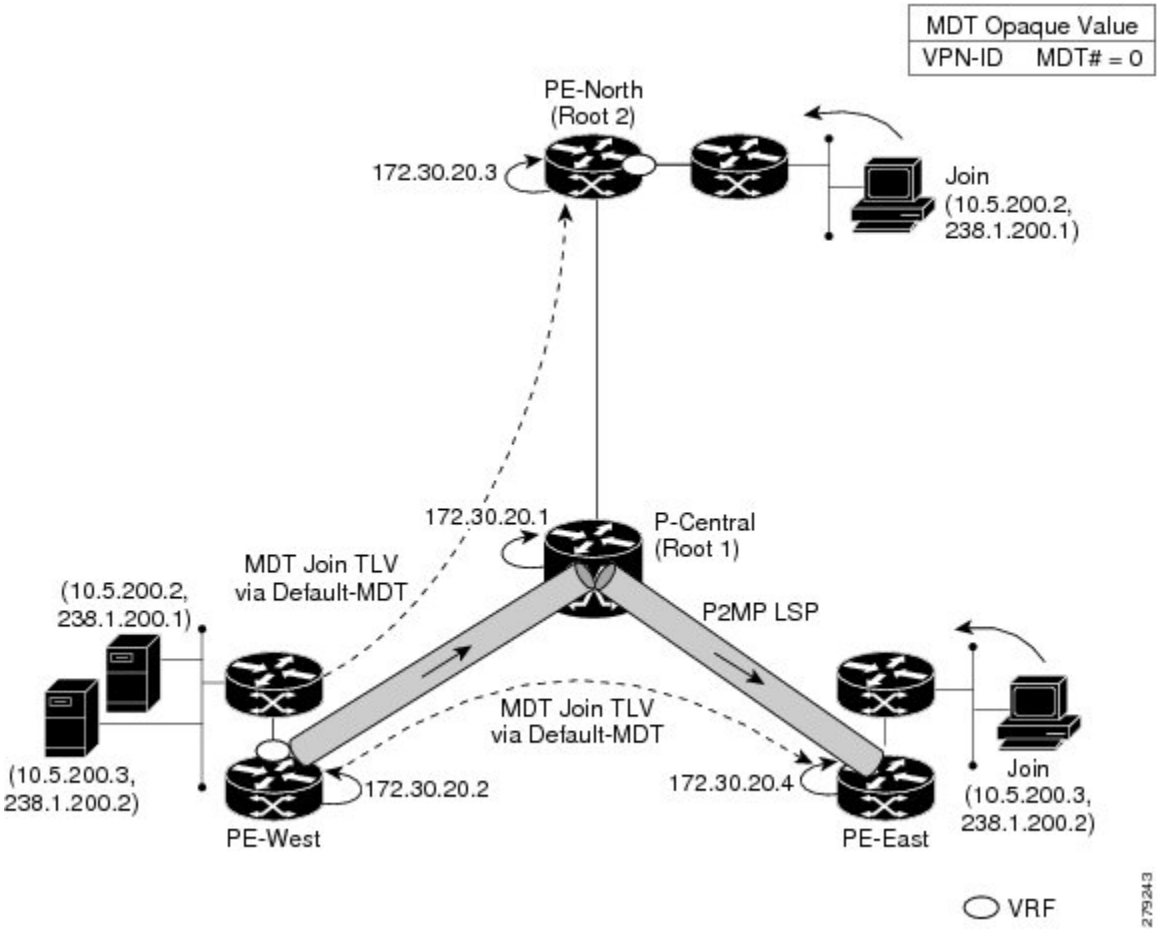
- The upstream peer ID is PE-North, therefore P-Central has allocated label 104 in the downstream direction towards PE-North and subsequently PE-North has responded with an upstream label of 313.
- Two replication entries representing PE-East and PE-West are displayed.
- The merged LFIB shows three entries:
  - One downstream entry label 104 receiving traffic from Root 2 (PE-North), which is then directed further downstream using labels 207 PE-West and 407 PE-East.
  - Two upstream entries 108 and 115 receiving traffic from the leaves and directing it either downstream 207, 407 or upstream using label 313.

```
Central_P# show mpls mldp database opaque_type mdt 100:2
LSM ID             : E6000004
 Uptime             : 00:42:03
 Tree type          : MP2MP
 FEC Root           : 172.30.20.3
 Opaque length      : 14 bytes
 Opaque value       : 07000B00 01000000 00020000 00009C
 Opaque decoded     : [mdt 100:2 0]
 Upstream peer ID   : 172.30.20.3:0, Label local (D): 104  remote (U): 313 active
 Path Set ID        : 48000003
 Replication client(s):
 172.30.20.2:0   uptime: 00:42:03    Path Set ID: CF000004
                 remote label (D): 207  local label (U): 115
                 nhop: 172.30.10.2 intrf: Serial4/0
 172.30.20.4:0   uptime: 00:41:44    Path Set ID: 5800000E
                 remote label (D): 407  local label (U): 108
                 nhop: 172.30.10.10 intrf: Serial6/0
Central_P# show mpls forwarding-table | inc E6000004
104     207           mLDP:E6000004     251228        Se4/0      point2point
        407           mLDP:E6000004     251334        Se6/0      point2point
108     207           mLDP:E6000004     0             Se4/0      point2point
        313           mLDP:E6000004     0             Se5/0      point2point
115     313           mLDP:E6000004     0             Se5/0      point2point
        407           mLDP:E6000004     0             Se6/0      point2point
```

Data MDT Configuration

The following example shows how to configure the data MDT for an MLDP-based MVPN. This configuration is based on the sample topology illustrated in the figure.

Figure 11: Data MDT Example



The sample output in this section displays the data MDT configuration for all the PE devices. The **mdt data** commands are the only additional commands necessary. The first **mdt data**command allows a maximum of 60 data MDTs to be created, and the second **mdt data**command sets the threshold. If the number of data MDTs exceeds 60, then the data MDTs will be reused in the same way as they are for the mGRE tunnel method (the one with the lowest reference count).

```
ip pim vrf VRF mpls source Loopback0
!
ip vrf VRF
 rd 100:2
 vpn id 100:2
 route-target export 200:2
 route-target import 200:2
 mdt default mpls mldp 172.30.20.1 (P-Central)
 mdt default mpls mldp 172.30.20.3 (PE-North)
 mdt data mpls mldp 60
 mdt data threshold 1
```

VRF mroute Table--PE-West

The sample output in this section displays the VRF mroute table on PE-West before the high-bandwidth source exceeds the threshold. At this point there are two streams, representing each of the two VPN sources at

PE-West, on a single MP2MP LSP (System ID D8000000). The LSP represents the default MDT accessed via LSP-VIF interface 0.

```
PE-West# show ip mroute vrf VRF verbose
.
.
.
(10.5.200.2, 238.1.200.1), 00:00:25/00:03:29, flags: sT
  Incoming interface: Serial6/0, RPF nbr 192.168.10.6
  Outgoing interface list:
    Lspvif0, LSM MDT: D8000000 (default),Forward/Sparse-Dense,
.
.
.
(10.5.200.3, 238.1.200.2), 00:11:14/00:02:48, flags: sT
  Incoming interface: Serial6/0, RPF nbr 192.168.10.6
  Outgoing interface list:
    Lspvif0, LSM MDT: D8000000 (default),Forward/Sparse-Dense,
.
.
.
```

The sample output in this section displays the output after the source transmission exceeds the threshold. PE-West sends an MDT Join TLV message to signal the creation of a data MDT. In this case, the data MDT number is 1, therefore PE-East will send a label mapping message back to PE-West with a FEC TLV containing root=PE-West, Opaque value=(mdt vpn-id 1). The System ID is now changed to 4E000003 signaling a different LSP; however, the LSP-VIF is still LSP-VIF interface 0. The (S, G) entry also has the “y” flag set indicating this stream has switched to a data MDT.

```
PE-West# show ip mroute vrf VRF 10.5.200.3 238.1.200.2 verbose
.
.
.
(10.5.200.3, 238.1.200.2), 00:00:08/00:03:27, flags: sTy
  Incoming interface: Serial6/0, RPF nbr 192.168.10.6
    MDT TX nr: 1 LSM-ID 4E000003
  Outgoing interface list:
    Lspvif0, LSM MDT: 4E000003 (data) Forward/Sparse-Dense,
```

LSP-VIF Adjacencies--PE-West

For the interface LSP-VIF, each virtual circuit represents a unique multipoint LSP forwarding instance. The correct adjacency is selected when sending the multicast packet. The sample output in this section displays the application of that concept on PE-West. There is a single LSP-VIF interface 0 interface, but it has three adjacencies as follows:

- 4E000003 is the single data MDT created for (10.5.200.3, 238.1.200.2)
- 58000000 is the default MDT (backup root)
- D8000000 is the default MDT (primary root)

```
PE-West# show adjacency lspvif 0

Protocol Interface                 Address
IP       Lspvif0                   4E000003(5)
IP       Lspvif0                   58000000(4)
IP       Lspvif0                   D8000000(3)
```

MLDP Database Entries

The sample output in this section displays the MLDP entry for the data MDT (4E000003) on the ingress device PE-West. The following points about this entry should be noted:

- The tree type is P2MP with PE-West (172.30.20.2) as the root.
- The Opaque value is [mdt 100:2 1] denoting the first data MDT.
- There are no labels allocated as it is the root.
- There are two replication client entries on this tree.
- Label 112 will be used to send the traffic downstream towards PE-East (via P-Central).
- The MDT entry is an internal construct.

```
PE-West# show mpls mldp database id 4E000003

LSM ID : 4E000003 (RNR LSM ID: 8A000002)   Type: P2MP   Uptime : 00:04:54
  FEC Root           : 172.30.20.2
  Opaque decoded     : [mdt 100:2 1]
  Opaque length      : 11 bytes
  Opaque value       : 07 000B 00000100000000100000000
  RNR active LSP     : (this entry)
  Upstream client(s) : None
  Replication client(s):
    MDT  (VRF VRF)
      Uptime         : 00:04:54      Path Set ID  : 5000002
      Interface      : Lspvif0
  172.30.20.1:0
      Uptime         : 01:41:43      Path Set ID  : D9000007
      Out label (D)  : 27            Interface    : Serial4/0
      Local label (U): 112           Next Hop     : 172.30.10.1
```

The sample output in this section displays the database entry for the data MDT on PE-East, the egress device. Also shown is the MDT Join TLV message that was sent from PE-West over the default MDT. The MDT Join TLV message contains all the necessary information to allow PE-East to create a label mapping message P2MP LSP back to the root of PE-West. Label 414 will be used by P-Central to send traffic to PE-East.

*Feb 19 04:43:24.039: PIM(1): MDT join TLV received for (10.5.200.3,238.1.200.2)

*Feb 19 04:43:24.039: MLDP: LDP root 172.30.20.2 added

*Feb 19 04:43:24.039: MLDP: [mdt 100:2 1] label mapping msg sent to 172.30.20.1:0

```
PE-East# show mpls mldp database opaque_type mdt 100:2 1
LSM ID : 4E000003 (RNR LSM ID: 8A000002)   Type: P2MP   Uptime : 00:04:54
  FEC Root           : 172.30.20.2
  Opaque decoded     : [mdt 100:2 1]
  Opaque length      : 11 bytes
  Opaque value       : 07 000B 00000100000000100000000
  RNR active LSP     : (this entry)
  Upstream client(s) : None
  Replication client(s):
    MDT  (VRF VRF)
      Uptime         : 00:04:54      Path Set ID  : 5000002
      Interface      : Lspvif0
```

LFIB Entry for the Data MDT

The sample output in this section displays the LFIB entry for the data MDT as it passes through P-Central and PE-East. The Tunnel ID used for the LSP is the Opaque value [mdt 100:2 1].

```
P-Central# show mpls for label 112
Local      Outgoing   Prefix           Bytes Label   Outgoing   Next Hop
Label      Label      or Tunnel Id     Switched      interface
111        414        [mdt 100:2 1]    2993584       Se6/0      point2point
PE-East# show mpls for label 400

Local      Outgoing   Prefix           Bytes Label   Outgoing   Next Hop
Label      Label      or Tunnel Id     Switched      interface
414   [T]  No Label   [mdt 100:2 1][V] 3297312       aggregate/green
```

Example Migration from a PIM with mGRE-Based MVPN to an MLDP-Based MPVN

The following example shows an MLDP-based MVPN configuration that has been migrated from a PIM with mGRE based MVPN. The differences in the CLI from the PIM with mGRE-based MVPN are highlighted via comments below. In this example, MLDP derives the FEC from the import route target configured in the VRF.

```
ip vrf VRF
 rd 50:1111
 vpn id 50:10 ! MLDP-based MVPN configuration
 route-target export 100:100
 route-target import 100:100
 mdt preference mldp pim
 mdt default mpls mldp 1.1.1.1 ! MLDP-based MVPN configuration
 mdt default mpls mldp 2.2.2.2 ! MLDP-based MVPN configuration
 mdt data mpls mldp 255 ! MLDP-based MVPN configuration
 mdt data threshold 40 list 1 ! MLDP-based MVPN configuration
!
ip multicast-routing
ip multicast-routing vrf VRF
!
interface Loopback0
 ip address 205.1.0.1 255.255.255.0
 ip router isis
 ip pim sparse-dense-mode
!
interface Ethernet1/0
 ip vrf forwarding green
 ip address 220.0.2.1 255.255.255.0
 ip pim sparse-dense-mode
!
interface Ethernet2/0
 ip address 200.0.0.1 255.255.255.0
 ip pim sparse-dense-mode
 ip router isis
 mpls ip ! MLDP-based MVPN configuration
!
router isis
 net 49.0000.0000.0000.00
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
IP multicast commands	Cisco IOS Multicast Command Reference
Overview of the IP multicast technology area	" IP Multicast Technology Overview " module
Concepts, tasks, and examples for configuring an IP multicast network using PIM	" Configuring a Basic IP Multicast Network " module

MIBs

MIB	MIBs Link
No new or modified MIBs are supported.	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

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

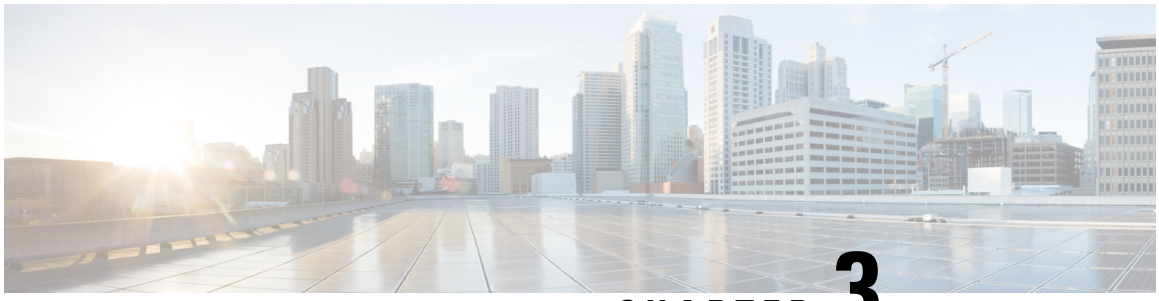
Feature Information for MLDP-Based MVPN

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 MLDP-Based MVPN

Feature Name	Releases	Feature Information
MLDP-Based MVPN	15.0(1)S 15.1(1)SY 15.4(1)T	The MLDP-based MVPN feature provides extensions to Label Distribution Protocol (LDP) for the setup of point-to-multipoint (P2MP) and multipoint-to-multipoint (MP2MP) label switched paths (LSPs) for transport in the Multicast Virtual Private Network (MVPN) core network. The following commands were introduced or modified: **debug mpls mldp all, debug mpls mldp filter opaque type, debug mpls mldp generic, debug mpls mldp gr, debug mpls mldp mfi, debug mpls mldp mrib, debug mpls mldp neighbor, debug mpls mldp packet, mdt data, mdt default, mdt preference, mpls mldp forwarding recursive, mpls logging notifications, mpls mldp path, show ip multicast mpls mrib-client, show ip multicast mpls vif, show mpls ldp discovery detailed, show mpls ldp bindings, show mpls mldp count, show mpls mldp database, show mpls mldp label release, show mpls mldp neighbors, show mpls mldp root.**



CHAPTER 3

IPv6 Multicast Listener Discovery Protocol

- Finding Feature Information, on page 29
- Information About IPv6 Multicast Listener Discovery Protocol, on page 29
- How to Configure IPv6 Multicast Listener Discovery Protocol, on page 32
- Configuration Examples for IPv6 Multicast Listener Discovery Protocol, on page 36
- Additional References, on page 38
- IPv6 Multicast Listener Discovery Protocol, on page 39

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and 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.

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.

Information About IPv6 Multicast Listener Discovery Protocol

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 device. This signaling is achieved with the MLD protocol.

Devices 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.

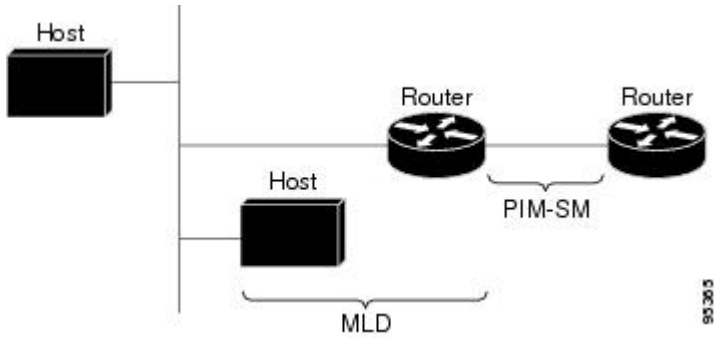
IPv6 Multicast Routing Implementation

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

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

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

Figure 12: 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 devices 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 device, that sends query messages to discover which network devices are members of a given multicast group.
- A host is a receiver, including devices, 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 alert option set. The 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.

An MLD report must be sent with a valid IPv6 link-local source address, or the unspecified address (::), if the sending interface has not yet acquired a valid link-local address. Sending reports with the unspecified address is allowed to support the use of IPv6 multicast in the Neighbor Discovery Protocol.

For stateless autoconfiguration, a node is required to join several IPv6 multicast groups in order to perform duplicate address detection (DAD). Prior to DAD, the only address the reporting node has for the sending interface is a tentative one, which cannot be used for communication. Therefore, the unspecified address must be used.

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.

MLD provides support for source filtering. Source filtering allows a node to report interest in listening to packets only from specific source addresses (as required to support SSM), or from all addresses except specific source addresses sent to a particular multicast address.

When a host using MLD version 1 sends a leave message, the device needs to send query messages to reconfirm that this host was the last MLD version 1 host joined to the group before it can stop forwarding traffic. This function takes about 2 seconds. This "leave latency" is also present in IGMP version 2 for IPv4 multicast.

MLD Access Group

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

How to Configure IPv6 Multicast Listener Discovery Protocol

Enabling IPv6 Multicast Routing

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

Before you begin

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

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 multicast-routing** [**vrf** *vrf-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	**ipv6 multicast-routing** [**vrf** *vrf-name*] **Example:** `Device(config)# ipv6 multicast-routing`	Enables multicast routing on all IPv6-enabled interfaces and enables multicast forwarding for PIM and MLD on all enabled interfaces of the device. • IPv6 multicast routing is disabled by default when IPv6 unicast routing is enabled. IPv6 multicast-routing needs to be enabled for IPv6 multicast routing to function.

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. **end**
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:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface GigabitEthernet 1/0/0`	Specifies an interface type and number, and places the device in interface configuration mode.
Step 4	**ipv6 mld join-group** [*group-address*] [[**include**	**exclude**] {*source-address*	**source-list** [*acl*]} **Example:** `Device(config-if)# ipv6 mld join-group FF04::12 exclude 2001:DB8::10::11`	Configures MLD reporting for a specified group and source.
Step 5	**ipv6 mld access-group** *access-list-name* **Example:**	Allows the user to perform IPv6 multicast receiver access control.

	Command or Action	Purpose
	`Device(config-if)# ipv6 access-list acc-grp-1`	
Step 6	**ipv6 mld static-group** [*group-address*] [[**include**| **exclude**] {*source-address* | **source-list** [*acl*]} **Example:** `Device(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:** `Device(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:** `Device(config-if)# ipv6 mld query-timeout 130`	Configures the timeout value before the device takes over as the querier for the interface.
Step 9	**ipv6 mld query-interval** *seconds* **Example:** `Device(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	**end** **Example:** `Device(config-if)# end`	Exits to privileged EXEC mode.
Step 11	**show ipv6 mld groups** [**link-local**] [*group-name* | *group-address*] [*interface-type interface-number*] [**detail** | **explicit** **Example:** `Device# show ipv6 mld groups GigabitEthernet 2/1/0`	Displays the multicast groups that are directly connected to the device and that were learned through MLD.
Step 12	**show ipv6 mfib summary** **Example:** `Device# 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:** `Device# show ipv6 mld interface GigabitEthernet 2/1/0`	Displays multicast-related information about an interface.

Disabling MLD Device-Side Processing

A user might only want specified interfaces to perform IPv6 multicast and will therefore want to turn off MLD device-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:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface GigabitEthernet 1/0/0`	Specifies an interface type and number, and places the device in interface configuration mode.
Step 4	**no ipv6 mld router** **Example:** `Device(config-if)# no ipv6 mld router`	Disables MLD device-side processing on a specified interface.

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**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Device> enable`	• Enter your password if prompted.
Step 2	**clear ipv6 mld** [**vrf** *vrf-name*] traffic **Example:** `Device# clear ipv6 mld traffic`	Resets all MLD traffic counters.
Step 3	**show ipv6 mld** [**vrf** *vrf-name*] traffic **Example:** `Device# 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:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**clear ipv6 mld** [**vrf** *vrf-name*] **counters** *interface-type* **Example:** `Device# clear ipv6 mld counters GigabitEthernet1/0/0`	Clears the MLD interface counters.

Configuration Examples for IPv6 Multicast Listener Discovery Protocol

Example: Enabling IPv6 Multicast Routing

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

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

Example: Configuring 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:

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

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

Device(config-if)# ipv6 mld query-timeout 130

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

The following example shows how to configure 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:

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

The following example shows information from the **show ipv6 mld interface** command for GigabitEthernet interface 2/1/0:

```
Device# show ipv6 mld interface GigabitEthernet 2/1/1

GigabitEthernet2/1/1 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)
```

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

```
Device# 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
```

Example: Disabling MLD Router-Side Processing

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

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

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

Additional References

Related Documents

Related Topic	Document Title
IPv6 addressing and connectivity	*IPv6 Configuration Guide*
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
IP multicast commands	Cisco IOS IP Multicast Command Reference
IPv6 commands	Cisco IOS IPv6 Command Reference
Cisco IOS IPv6 features	Cisco IOS IPv6 Feature Mapping

Standards and RFCs

Standard/RFC	Title
RFCs for IPv6	*IPv6 RFCs*

MIBs

MIB	MIBs Link
	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

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

IPv6 Multicast Listener Discovery Protocol

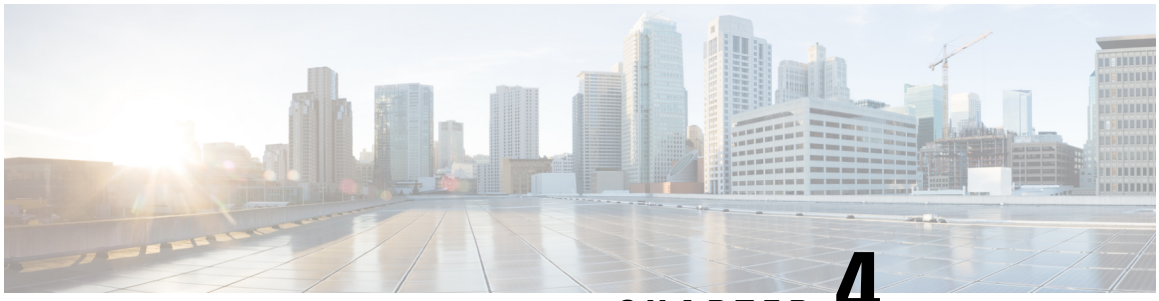
The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train 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 2: Feature Information for IPv6 Multicast Listener Discovery Protocol

Feature Name	Releases	Feature Information
IPv6 Multicast: Multicast Listener Discovery (MLD) Protocol, Versions 1 and 2	12.0(26)S 12.2(18)S 12.2(25)SG 12.2(33)SRA 12.3(2)T 15.0(1)S 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. The following commands were introduced or modified: **debug ipv6 mld**, **ipv6 mld join-group**, **ipv6 mld static-group**, **ipv6 mld query-interval**, **ipv6 mld query-max-response-time**, **ipv6 mld query-timeout**, **ipv6 mld router**, **show ipv6 mld groups**, **show ipv6 mld groups summary**, **show ipv6 mld interface**.

Feature Name	Releases	Feature Information
IPv6 Multicast: MLD Access Group	12.2(33)SRE 12.2(50)SY 12.4(2)T 15.0(1)S Cisco IOS XE Release 2.1	The MLD access group provides receiver access control in Cisco IPv6 multicast routers. The following command was introduced: **ipv6 mld access-group**.



CHAPTER 4

MLD Group Limits

The IPv6 Multicast Listener Discovery (MLD) group limits feature provides global and per-interface MLD join limits.

- Finding Feature Information, on page 41
- Information About MLD Group Limits, on page 41
- How to Implement MLD Group Limits, on page 42
- Configuration Examples for MLD Group Limits, on page 44
- Additional References, on page 45
- Feature Information for MLD Group Limits, on page 46

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and 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.

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.

Information About MLD Group Limits

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 devices 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 device, that sends query messages to discover which network devices are members of a given multicast group.

- A host is a receiver, including devices, 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 alert option set. The 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.

An MLD report must be sent with a valid IPv6 link-local source address, or the unspecified address (::), if the sending interface has not yet acquired a valid link-local address. Sending reports with the unspecified address is allowed to support the use of IPv6 multicast in the Neighbor Discovery Protocol.

For stateless autoconfiguration, a node is required to join several IPv6 multicast groups in order to perform duplicate address detection (DAD). Prior to DAD, the only address the reporting node has for the sending interface is a tentative one, which cannot be used for communication. Therefore, the unspecified address must be used.

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.

MLD provides support for source filtering. Source filtering allows a node to report interest in listening to packets only from specific source addresses (as required to support SSM), or from all addresses except specific source addresses sent to a particular multicast address.

When a host using MLD version 1 sends a leave message, the device needs to send query messages to reconfirm that this host was the last MLD version 1 host joined to the group before it can stop forwarding traffic. This function takes about 2 seconds. This "leave latency" is also present in IGMP version 2 for IPv4 multicast.

How to Implement MLD Group Limits

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:** `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	**ipv6 mld** [**vrf** *vrf-name*] **state-limit** *number* **Example:** `Device(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:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:**	Specifies an interface type and number, and places the device in interface configuration mode.

	Command or Action	Purpose
	`Device(config)# interface FastEthernet 1/0`	
Step 4	**ipv6 mld limit** *number* [**except** *access-list* **Example:** `device(config-if)# ipv6 mld limit 100`	Limits the number of MLD states on a per-interface basis.

Configuration Examples for MLD Group Limits

Example: Implementing MLD Group Limits

This example shows the groups and channels that are being accounted when the MLD group limit function is active:

```
Device# show ipv6 mld groups FF03::1 detail

Interface: FastEthernet5/1
Group:  FF03::1
Uptime:  00:00:05
Router mode: EXCLUDE (Expires: 00:04:14)
Host mode: INCLUDE
Last reporter: FE80::20A:8BFF:FE4D:6039
State accounted
Source list is empty

Interface: FastEthernet5/1
Group:  FF33::1
Uptime:  00:00:03
Router mode: INCLUDE
Host mode: INCLUDE
Last reporter: FE80::20A:8BFF:FE4D:6039
Group source list:
Source Address                          Uptime    Expires   Fwd  Flags
2001:DB8:0::1                                   00:00:03  00:04:16  Yes  Remote Ac 4
```

The following example shows all of the groups joined by Fast Ethernet interface 2/1, including link-local groups used by network protocols.

```
Device# show ipv6 mld groups FastEthernet 2/1

MLD Connected Group Membership
Group Address          Interface           Uptime        Expires
FF02::2                FastEthernet2/1     3d18h         never
FF02::D                FastEthernet2/1     3d18h         never
FF02::16               FastEthernet2/1     3d18h         never
FF02::1:FF00:1         FastEthernet2/1     3d18h         00:00:27
FF02::1:FF00:79        FastEthernet2/1     3d18h         never
FF02::1:FF23:83C2      FastEthernet2/1     3d18h         00:00:22
FF02::1:FFAF:2C39      FastEthernet2/1     3d18h         never
FF06:7777::1           FastEthernet2/1     3d18h         00:00:26
```

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

```
Device# show ipv6 mld groups summary

MLD Route Summary
  No. of (*,G) routes = 5
  No. of (S,G) routes = 0
```

Additional References

Related Documents

Related Topic	Document Title
IPv6 addressing and connectivity	*IPv6 Configuration Guide*
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
IP multicast commands	Cisco IOS IP Multicast Command Reference
IPv6 commands	Cisco IOS IPv6 Command Reference
Cisco IOS IPv6 features	Cisco IOS IPv6 Feature Mapping

Standards and RFCs

Standard/RFC	Title
RFCs for IPv6	*IPv6 RFCs*

MIBs

MIB	MIBs Link
	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

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

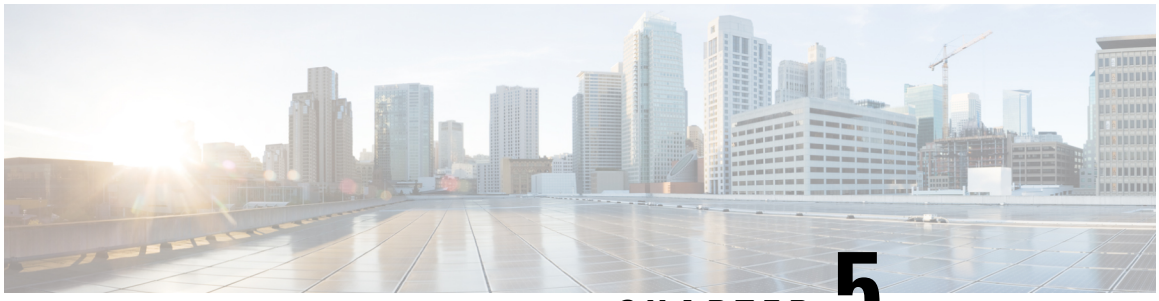
Feature Information for MLD Group Limits

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 3: Feature Information for MLD Group Limits

Feature Name	Releases	Feature Information
MLD Group Limits	12.2(33)SRE 12.2(50)SY 12.4(2)T 15.0(1)S 15.0(1)SY 15.1(1)SY Cisco IOS XE Release 2.6	The IPv6 MLD group limits feature provides global and per-interface MLD join limits. The following commands were introduced or modified: **ipv6 mld limit**, **ipv6 mld state-limit**.



CHAPTER 5

MLDP In-Band Signaling/Transit Mode

This module contains information for configuring Multicast Label Distribution Protocol (MLDP) in-band signaling to enable the MLDP core to create (S,G) or (*,G) state without using out-of-band signaling such as Border Gateway protocol (BGP) or Protocol Independent Multicast (PIM).

- Finding Feature Information, on page 47
- Restrictions for MLDP In-Band Signaling, on page 47
- Information About MLDP In-Band Signaling/Transit Mode, on page 48
- How to Configure MLDP In-Band Signaling/Transit Mode, on page 48
- Additional References, on page 49
- Configuration Examples for MLDP In-Band Signaling/Transit Mode, on page 50
- Feature Information for MLDP In-Band Signaling/Transit Mode, on page 57

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and 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.

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.

Restrictions for MLDP In-Band Signaling

- MLDP in-band signaling supports SOURCE-SPECIFIC MULTICAST (SSM) multicast traffic only.
- MLDP in-band signaling is not supported in the same VRF for which Rosen Model MLDP-based MVPN or GRE-based MVPN is configured.

Information About MLDP In-Band Signaling/Transit Mode

MLDP In-Band Signaling/Transit Mode

Multicast Label Distribution Protocol (MLDP)-supported multicast VPN (MVPN) allows VPN multicast streams to be aggregated over a VPN-specific tree. No customer state is created in the MLDP core;, there is only state for default and data multicast distribution trees (MDTs). In certain scenarios, the state created for VPN streams is limited and does not appear to be a risk or limiting factor. In these scenarios, MLDP can build in-band MDTs that are transit Label Switched Paths (LSPs).

Trees used in a VPN space are MDTs. Trees used in the global table are transit point-to-multipoint (P2MP) or multipoint-to-multipoint (MP2MP) LSPs. In both cases, a single multicast stream (VPN or not) is associated with a single LSP in the MPLS core. The stream information is encoded in the Forwarding Equivalence Class (FEC) of the LSP. This is in-band signaling.

MLDP in-band signaling uses access control lists (ACLs) with the range of the multicast (S, G) to be transported by the MLDP LSP. Each multicast channel (S, G) maps, one-to-one, to each tree in the in-band tree. The (S,G) join is registered in the Multicast Routing Information Base (MRIB), which is a client of MLDP. Each MLDP LSP is identified by the FEC of [(S,G) + RD], where RD is the Route Distinquisher (RD) obtained from BGP. This differs from MLDP-based MVPN, where the identity is in a FEC of [MDT #, VPN ID, Tree #]).

The ingress Provider Edge (PE) device uses the FEC to decode the stream information and associate the multicast stream with the LSP (in the FEC). This service model is only applicable for transporting Protocol Independent Multicast (PIM) source-specific multicast (SSM) traffic. There is no need to run PIM over the LSP because the stream signaling is done in-band.

The MLDP In-Band Signaling/Transit Mode feature is supported on IPv4 networks. MLDP in-band signaling and MLDP-based MVPN cannot be supported in the same VRF.

How to Configure MLDP In-Band Signaling/Transit Mode

Enabling In-Band Signaling on a PE Device

Before you begin

- VRF instances for in-band signaling must be configured.
- Access control lists (ACLs) for controlling streams must be configured.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Use one of the following commands:
   - **ip multicast** [**vrf** *vrf*] **mpls mldp** [**range** *acl*]
   - **ipv6 multicast** [**vrf** *vrf*] **mpls mldp**

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	Use one of the following commands:
	• **ip multicast** [**vrf** *vrf*] **mpls mldp** [**range** *acl*]
	• **ipv6 multicast** [**vrf** *vrf*] **mpls mldp**
	Example:
	`Device (config)# ip multicast vrf vrf1 mpls mldp`
	`Device (config)# ipv6 multicast vrf vrf1 mpls mldp`
		Brings up the MLDP MRIB process and registers MLDP with the MRIB.
		• To enable in-band signaling globally, use this command without the **vrf** *vrf* keyword and argument combination.
		• IPv4 only: To identify streams for in-band signaling, use this command with the **range** keyword on the egress PE.

Additional References

Related Documents

Related Topic	Document Title
IPv6 addressing and connectivity	*IPv6 Configuration Guide*
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
IP multicast commands	Cisco IOS IP Multicast Command Reference
IPv6 commands	Cisco IOS IPv6 Command Reference
Cisco IOS IPv6 features	Cisco IOS IPv6 Feature Mapping

Standards and RFCs

Standard/RFC	Title
RFCs for IPv6	*IPv6 RFCs*

MIBs

MIB	MIBs Link
	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

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

Configuration Examples for MLDP In-Band Signaling/Transit Mode

Example: In-Band Signaling on PE1

```
PE1# show running-config
Building configuration...

Current configuration : 8247 bytes
!
! Last configuration change at 12:44:13 IST Thu Nov 15 2012
!

hostname PE1
!
mls ipv6 vrf
!
vrf definition vrf1
 rd 1:1
 vpn id 1:1
 route-target export 1:1
 route-target import 1:1
 !
 address-family ipv4
  route-target export 1:1
  route-target import 1:1
 exit-address-family
 !
 address-family ipv6
  route-target export 1:1
  route-target import 1:1
```

```
 exit-address-family
!

ip multicast-routing
ip multicast-routing vrf vrf1
ip multicast hardware-switching replication-mode egress
ip multicast mpls mldp
ip multicast vrf vrf1 mpls mldp
!
!
!
ipv6 unicast-routing
ipv6 multicast-routing
ipv6 multicast-routing vrf vrf1
ipv6 multicast rpf use-bgp
ipv6 multicast mpls source Loopback0
ipv6 multicast mpls mldp
ipv6 multicast vrf vrf1 rpf use-bgp
ipv6 multicast vrf vrf1 mpls source Loopback0
ipv6 multicast vrf vrf1 mpls mldp
!
!
vtp domain cisco
vtp mode off
mpls label protocol ldp
mpls ldp graceful-restart
mls flow ip interface-full
no mls flow ipv6
mls rate-limit multicast ipv4 igmp 100 10
mls cef error action reset
mls mpls tunnel-recir
multilink bundle-name authenticated
!
!
!
!
spanning-tree mode pvst
spanning-tree extend system-id
no diagnostic bootup level
!
redundancy
 main-cpu
  auto-sync running-config
 mode sso
!

vlan internal allocation policy ascending
vlan access-log ratelimit 2000
!
interface Loopback0
 ip address 1.1.1.1 255.255.255.255
 ip pim sparse-mode
 ip ospf 100 area 0
 ipv6 address 1::1:1:1/64
 ipv6 enable
!
.
.
.
!
interface GigabitEthernet2/0/0.1
 encapsulation dot1Q 2
 vrf forwarding vrf1
 ip address 192.0.2.1 255.255.255.0
```

```
 ip pim sparse-mode
 ip igmp version 3
 ipv6 address FE80::10:1:1 link-local
 ipv6 address 2001:DB8::/64
 ipv6 enable
!
interface GigabitEthernet2/0/0.2000
 encapsulation dot1Q 2000
 ip address 192.0.2.2 255.255.255.0
 ip pim sparse-mode
 ip igmp version 3
 ipv6 address 2001:DB8:0:1/64
 ipv6 enable
!
.
.
.
interface GigabitEthernet2/0/12
 ip address 192.0.2.3 255.255.255.0
 ip pim sparse-mode
 ip ospf 100 area 0
 ipv6 address 2001:DB8::/64
 ipv6 enable
 mpls ip
 mpls label protocol ldp
 no mls qos trust
!
!
!
router ospf 100
 router-id 1.1.1.1
!
router bgp 100
 bgp log-neighbor-changes
 neighbor 2.2.2.2 remote-as 100
 neighbor 2.2.2.2 update-source Loopback0
 neighbor 3.3.3.3 remote-as 100
 neighbor 3.3.3.3 update-source Loopback0
 neighbor 4.4.4.4 remote-as 100
 neighbor 4.4.4.4 update-source Loopback0
 !
 address-family ipv4
  redistribute static
  redistribute connected
  neighbor 2.2.2.2 activate
  neighbor 2.2.2.2 send-community both
  neighbor 3.3.3.3 activate
  neighbor 3.3.3.3 send-community both
  neighbor 4.4.4.4 activate
  neighbor 4.4.4.4 send-community both
 exit-address-family
 !
 address-family vpnv4
  neighbor 2.2.2.2 activate
  neighbor 2.2.2.2 send-community extended
  neighbor 3.3.3.3 activate
  neighbor 3.3.3.3 send-community extended
  neighbor 4.4.4.4 activate
  neighbor 4.4.4.4 send-community extended
 exit-address-family
 !
 address-family ipv4 mdt
  neighbor 2.2.2.2 activate
  neighbor 2.2.2.2 send-community extended
```

```
 neighbor 3.3.3.3 activate
 neighbor 3.3.3.3 send-community extended
 neighbor 4.4.4.4 activate
 neighbor 4.4.4.4 send-community extended
exit-address-family
!
address-family ipv6
 redistribute connected
 neighbor 2.2.2.2 activate
 neighbor 2.2.2.2 send-community extended
 neighbor 2.2.2.2 send-label
 neighbor 3.3.3.3 activate
 neighbor 3.3.3.3 send-community extended
 neighbor 3.3.3.3 send-label
 neighbor 4.4.4.4 activate
 neighbor 4.4.4.4 send-community extended
 neighbor 4.4.4.4 send-label
exit-address-family
!
address-family vpnv6
 neighbor 2.2.2.2 activate
 neighbor 2.2.2.2 send-community extended
 neighbor 3.3.3.3 activate
 neighbor 3.3.3.3 send-community extended
 neighbor 4.4.4.4 activate
 neighbor 4.4.4.4 send-community extended
exit-address-family
!
address-family ipv4 vrf vrf1
 redistribute connected
exit-address-family
!
address-family ipv6 vrf vrf1
 redistribute connected
exit-address-family
!
no ip forward-protocol nd
!
no ip http server
no ip http secure-server
ip pim ssm default
ip pim mpls source Loopback0
ip pim vrf vrf1 ssm default
ip pim vrf vrf1 mpls source Loopback0
ip route 192.0.2.25 255.255.255.255 7.37.0.1
!
!
mpls ldp router-id Loopback0 force
!
!
!
end
```

Example: In-Band Signaling on PE2

```
PE2# show running-config
Building configuration...

Current configuration : 7609 bytes
!
! Last configuration change at 13:18:45 IST Thu Nov 15 2012
```

```
!
hostname PE2
!
mls ipv6 vrf
!
vrf definition vrf1
 rd 1:1
 vpn id 1:1
 route-target export 1:1
 route-target import 1:1
 !
 address-family ipv4
  route-target export 1:1
  route-target import 1:1
 exit-address-family
 !
 address-family ipv6
  route-target export 1:1
  route-target import 1:1
 exit-address-family
!
.
.
.
!
ip multicast-routing
ip multicast-routing vrf vrf1
ip multicast hardware-switching replication-mode egress
ip multicast mpls mldp
ip multicast vrf vrf1 mpls mldp
!
!
!
ipv6 unicast-routing
ipv6 multicast-routing
ipv6 multicast-routing vrf vrf1
ipv6 multicast rpf use-bgp
ipv6 multicast mpls source Loopback0
ipv6 multicast mpls mldp
ipv6 multicast vrf vrf1 rpf use-bgp
ipv6 multicast vrf vrf1 mpls source Loopback0
ipv6 multicast vrf vrf1 mpls mldp
!
!
vtp domain isbu-devtest
vtp mode off
mpls label protocol ldp
mpls ldp graceful-restart
mls flow ip interface-full
no mls flow ipv6
mls cef error action reset
multilink bundle-name authenticated
!
!
!
!
spanning-tree mode pvst
spanning-tree extend system-id
diagnostic bootup level minimal
!
redundancy
 main-cpu
  auto-sync running-config
 mode sso
```

```
!
!
!
interface Loopback0
 ip address 4.4.4.4 255.255.255.255
 ip pim sparse-mode
 ip ospf 100 area 0
 ipv6 enable
!
.
.
.
!
interface GigabitEthernet3/0/3.1
 encapsulation dot1Q 2
 vrf forwarding vrf1
 ip address 192.0.2.1 255.255.255.0
 ip pim sparse-mode
 ip igmp version 3
 ipv6 address FE80::30:1:1 link-local
 ipv6 address 2001:DB8::/64
 ipv6 enable
!
interface GigabitEthernet3/0/3.2000
 encapsulation dot1Q 2000
 ip address 192.0.2.2 255.255.255.0
 ip pim sparse-mode
 ip igmp static-group 232.1.1.1 source 50.0.0.2
 ip igmp version 3
 ipv6 address 2001:DB8:0:1/64
 ipv6 enable
!
.
.
.
!
interface GigabitEthernet4/15
 ip address 192.0.2.3 255.255.255.0
 ip pim sparse-mode
 ip ospf 100 area 0
 ipv6 address 2001:DB8::/64
 ipv6 enable
 mpls ip
 mpls label protocol ldp
!
.
.
.
!
interface Vlan1
 no ip address
 shutdown
!
router ospf 100
 router-id 4.4.4.4
!
router bgp 100
 bgp log-neighbor-changes
 neighbor 1.1.1.1 remote-as 100
 neighbor 1.1.1.1 update-source Loopback0
 neighbor 2.2.2.2 remote-as 100
 neighbor 2.2.2.2 update-source Loopback0
 neighbor 3.3.3.3 remote-as 100
 neighbor 3.3.3.3 update-source Loopback0
```

```
 !
 address-family ipv4
  redistribute static
  redistribute connected
  neighbor 1.1.1.1 activate
  neighbor 1.1.1.1 send-community both
  neighbor 2.2.2.2 activate
  neighbor 2.2.2.2 send-community both
  neighbor 3.3.3.3 activate
  neighbor 3.3.3.3 send-community both
 exit-address-family
 !
 address-family vpnv4
  neighbor 1.1.1.1 activate
  neighbor 1.1.1.1 send-community extended
  neighbor 2.2.2.2 activate
  neighbor 2.2.2.2 send-community extended
  neighbor 3.3.3.3 activate
  neighbor 3.3.3.3 send-community extended
 exit-address-family
 !
 address-family ipv4 mdt
  neighbor 1.1.1.1 activate
  neighbor 1.1.1.1 send-community extended
  neighbor 2.2.2.2 activate
  neighbor 2.2.2.2 send-community extended
  neighbor 3.3.3.3 activate
  neighbor 3.3.3.3 send-community extended
 exit-address-family
 !
 address-family ipv6
  redistribute connected
  neighbor 1.1.1.1 activate
  neighbor 1.1.1.1 send-community extended
  neighbor 1.1.1.1 send-label
  neighbor 2.2.2.2 activate
  neighbor 2.2.2.2 send-community extended
  neighbor 2.2.2.2 send-label
  neighbor 3.3.3.3 activate
  neighbor 3.3.3.3 send-community extended
  neighbor 3.3.3.3 send-label
 exit-address-family
 !
 address-family vpnv6
  neighbor 1.1.1.1 activate
  neighbor 1.1.1.1 send-community extended
  neighbor 2.2.2.2 activate
  neighbor 2.2.2.2 send-community extended
  neighbor 3.3.3.3 activate
  neighbor 3.3.3.3 send-community extended
 exit-address-family
 !
 address-family ipv4 vrf vrf1
  redistribute connected
 exit-address-family
 !
 address-family ipv6 vrf vrf1
  redistribute connected
 exit-address-family
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
```

```
ip pim ssm default
ip pim mpls source Loopback0
ip pim vrf vrf1 ssm default
ip pim vrf vrf1 mpls source Loopback0
ip route 192.0.2.25 255.255.255.255 7.37.0.1
!
!
mpls ldp router-id Loopback0 force
!
!
.
.
.
!
!
end
```

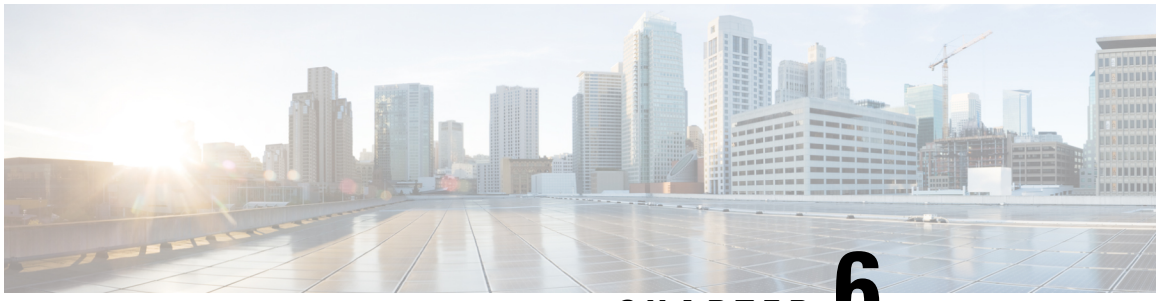
Feature Information for MLDP In-Band Signaling/Transit Mode

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 4: Feature Information for MLDP In-Band Signaling/Transit Mode

Feature Name	Releases	Feature Information
MLDP In-Band Signaling/Transit Mode	15.3(1)S Cisco IOS XE 3.14S	Multicast Label Distribution Protocol (MLDP) in-band signaling supports point-to-multipoint (P2P) and multipoint-to-multipoint (MP2MP) Label Switched Paths (LSPs) and enables the MLDP core to create (S,G) or (*,G) state without using out-of-band signaling such as Border Gateway Protocol (BGP) or Protocol Independent Multicast (PIM). This feature is supported for IPv4 and IPv6 multicast groups. The following commands were introduced or modified: **ip multicast mpls mldp**, **ipv6 multicast mpls mldp**.



CHAPTER 6

HA Support for MLDP

The HA Support for MLDP feature enables Cisco Multicast Label Distribution Protocol (MLDP) to checkpoint sufficient signaling and forwarding information for repopulating the necessary database on a dual Route Processor (RP) platform on which Stateful Switchover/Nonstop Forwarding (SSO/NSF) and Label Distribution Protocol (LDP) Graceful Restart are configured, after a switchover.

- Finding Feature Information, on page 59
- Prerequisites for HA Support for MLDP, on page 59
- Restrictions for HA Support for MLDP, on page 60
- Information About HA Support for MLDP, on page 60
- How to Montior HA Support for MLDP, on page 60
- Additional References, on page 62
- Feature Information for HA Support for MLDP, on page 63

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and 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.

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 HA Support for MLDP

- Stateful Switchover/Nonstop Forwarding (SSO/NSF) and LDP Graceful Restart must be configured on the dual Route Processor (RP) platform.
- LDP Graceful Restart must be configured on the NSF router peers.
- The Cisco IOS release software installed on the active and standby RPs must support MLDP-based MVPN and HA Support for MLDP.

Restrictions for HA Support for MLDP

- If Label Distribution Protocol (LDP) Graceful Restart is not enabled on the dual Route Processor (RP) platform, Nonstop Forwarding (NSF) peers will remove existing forwarding and label information from their Multicast Label Distribution Protocol (MLDP) database entries immediately following a switchover.

Information About HA Support for MLDP

The HA Support for MLDP feature enables MLDP to checkpoint label forwarding or path set information. To support NSF, MLDP uses existing PIM HA architecture to checkpoint the information to the standby RP.

MDT data group creation is a dynamic event triggered by traffic exceeding a specified threshold. When the threshold is exceeded (requiring an MDT data group to be created) or when traffic falls below the threshold (requiring the MDT data group to be deleted), the router detecting the event creates, deletes, or updates an MDT data "send" entry, creates the corresponding (S,G) state, if necessary, and sends a message to PE peers to create, delete, or update a corresponding MDT data "receive" entry and the corresponding (S,G) state.

The active RP will checkpoint the current state of the MLDP peer, paths to peers, root, paths to root, and the database and replication/branch entry onto the standby RP and use this state to recreate the MLDP state after a switchover.

How to Montior HA Support for MLDP

Displaying Check Pointed Information

SUMMARY STEPS

1. **enable**
2. **show mpls mldp ha database**
3. **show mpls mldp ha database summary**
4. **show mpls mldp ha neighbor**
5. **show mpls mldp ha root**
6. **show mpls mldp ha count**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `PE2> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show mpls mldp ha database** **Example:**	Displays checkpoint data information.

	Command or Action	Purpose
	`PE2# show mpls mldp ha database`	
Step 3	**show mpls mldp ha database summary** **Example:** `PE2# show mpls mldp ha database summary`	Displays synched database information only.
Step 4	**show mpls mldp ha neighbor** **Example:** `PE2# show mpls mldp ha neighbor`	Displays information about synched peers.
Step 5	**show mpls mldp ha root** **Example:** `PE2# show mpls mldp ha root`	Displays synched root information.
Step 6	**show mpls mldp ha count** **Example:** `PE2# show mpls mldp ha count`	Displays number of trees.

Displaying Data MDT Mappings for MLDP on Standby Device

SUMMARY STEPS

1. **enable**
2. **show ip pim vrf** *vrf* **mdt send**
3. **show ip pim vrf** *vrf* **mdt recv**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `PE1-standby> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show ip pim vrf** *vrf* **mdt send** **Example:** `PE1-standby# show ip pim vrf blue mdt send`	Displays data MDT mappings for MLDP.

	Command or Action	Purpose
Step 3	**show ip pim vrf** *vrf* **mdt recv** **Example:** `PE1-standby# show ip pim vrf blue mdt recv`	Displays data MDT mappings for MLDP.

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
IP Multicast commands	Cisco IOS IP Multicast Command Reference
Cisco HA	*High Availability Configuration Guide*

Standards and RFCs

Standard/RFC	Title
No new or modified standards are supported, and support for existing standards has not been modified.	--
No new or modified RFCs are supported, and support for existing RFCs has not been modified.	--

MIBs

MIB	MIBs Link
--	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

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 HA Support for MLDP

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 5: Feature Information for HA Support for MLDP

Feature Name	Releases	Feature Information
HA Support for MLDP	15.1(3)S 15.1(1)SY Cisco IOS XE Release 3.8S	The HA Support for MLDP feature enables Cisco Multicast Label Distribution Protocol (MLDP) to checkpoint sufficient signaling and forwarding information for repopulating the necessary database on a dual Route Processor (RP) platform on which Stateful Switchover/Nonstop Forwarding (SSO/NSF) and Label Distribution Protocol (LDP) Graceful Restart are configured, after a switchover. The following commands were introduced or modified: **show ip pim mdt recv**, **show ip pim mdt send**, **show mpls mldp ha database** , **show mpls mldp ha neighbor**, **show mpls mldp ha root**.