



MPLS Embedded Management—LSP Ping Support for MLDP

The MPLS Embedded Management—LSP Ping Support for MLDP feature allows you to check connectivity and isolate failure points to provide a Multiprotocol Label Switching (MPLS) Operation, Administration, and Maintenance (OAM) solution. MPLS OAM helps service providers monitor label-switched paths (LSPs) and quickly isolate MPLS forwarding problems to assist with fault detection and troubleshooting in an MPLS network.

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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 at the end of this module.

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 MPLS Embedded Management—LSP Ping Support for MLDP

Enable MPLS OAM using the `mpls oam` command on all devices in the MPLS network.

Information About MPLS Embedded Management—LSP Ping Support for MLDP

MPLS Network Management with MLDP LSP Ping

Label Switched Multicast (LSM) can be summarized as Multiprotocol Label Switching (MPLS) technology extensions to support new point-to-multipoint and multipoint-to-multipoint connectivity requirements in a MPLS-enabled network infrastructure. In short, LSM provides scalable and reliable multicast tree building services in an MPLS network, which includes signaling and setup of label-switched multicast distribution trees (MDTs). A focus of LSM is the mapping of ingress multicast traffic onto MDTs and tree optimization mechanisms to minimize LSM traffic loss and reroute capabilities around network failures.

To manage an MPLS network, you must have the ability to monitor label-switched paths (LSPs) and quickly isolate MPLS forwarding problems. You need ways to reliably detect when an LSP fails to deliver user traffic. You can use MPLS LSP ping to verify the LSP that is used to transport packets.

An MPLS echo request is sent through an LSP to validate it. A Time to Live (TTL) expiration or LSP breakage causes the transit device to process the echo request before it gets to the intended destination. The device returns an MPLS echo reply that contains an explanatory reply code to the originator of the echo request.

The successful echo request is processed at the egress of the LSP. The echo reply is sent through an IP path, an MPLS path, or a combination of both back to the originator of the echo request.

The MPLS Embedded Management—LSP Ping Support for MLDP feature extends this diagnostic and troubleshooting ability to the MPLS network and aids in the identification of inconsistencies between the IP and MPLS forwarding tables, inconsistencies in the MPLS control and data plane, and problems with the reply path.

MLDP Overview

For Multicast Label Distribution Protocol (MLDP), a forwarding equivalence class (FEC) is defined by a root node address, a tree type, and an opaque type or value. The root node is a single point of failure for a Multiprotocol Label Switching (MPLS) label-switched path (LSP), whether the MPLS LSP is point-to-multipoint or multipoint-to-multipoint. The definition of an opaque type or value allows MLDP to remain separate from the applications that define the FECs, hence allowing the MLDP FEC protocol element to be reused to build point-to-multipoint and multipoint-to-multipoint trees for many applications. The application type is identified by the opaque type field.

In order to use MLDP, it is recommended to provide some Operation, Administration, and Maintenance (OAM) functionality. The `ping mpls mldp` command is one of the basic OAM functions for MLDP to detect failures and isolate a failure point.

MLDP supports injecting LSP ping packets starting from MLDP point-to-multipoint and multipoint-to-multipoint root, midpoint, bud, or leaf nodes. The midpoint device where the sub-LSP signaling is processed and this can be a branch point also. The bud node is a midpoint and tail-end device at the same time. A label switch router (LSR) that is an egress LSR, has one or more directly connected downstream LSRs. In a scenario where the ping is sent from a bud node, the sending device will not receive a copy of the echo request and act as a responder. When an LSP ping is sent from a midpoint in a multipoint-to-multipoint case, there is no existing forwarding entry that replicates to all MPLS neighbors. MLDP builds a forwarding state for a multipoint-to-multipoint tree containing number of neighbors (n) as n point-to-multipoint forwarding entries each with n-1 neighbors. Since there is no equivalent forward entry to reach all leaves, LSP needs to craft and send an MPLS echo request packet to any active upstream neighbors and all downstream neighbors.

Point-to-Multipoint Ping

The point-to-multipoint ping feature is used to check the connectivity between an ingress label switch router (LSR) and egress LSR along a point-to-multipoint label-switched path (LSP). The ingress LSR sends the point-to-multipoint echo request message along the specified point-to-multipoint LSP. All egress LSRs that receive the point-to-multipoint echo request message from the ingress LSR must send a point-to-multipoint echo reply message to the ingress LSR, according to the reply mode specified in the point-to-multipoint echo request message.

The point-to-multipoint Label Distribution Protocol (LDP) uses LDP to establish multicast LSPs. These LSPs distribute data from a single source (ingress) to one or more destinations (egress) across the network according to the next hops indicated by the routing protocols. Each LSP is identified by a Multiprotocol Label Switching (MPLS) multicast forwarding equivalence class (FEC).

An MPLS echo request packet is sent to a target device through the use of an appropriate label stack associated with the LSP to be validated. Use of the label stack causes the packet to be forwarded over the LSP itself.

An MPLS echo reply is sent in response to an MPLS echo request. The reply is sent as an IP packet and it is forwarded using IP, MPLS, or a combination of both types of switching. The source address of the MPLS echo reply packet is an address obtained from the device generating an echo reply. The destination address is the source address of the device that originated the MPLS echo request packet. The MPLS echo reply destination port is set to the echo request source port.

Multipoint-to-Multipoint Ping

A multipoint-to-multipoint label-switched path (LSP) allows traffic from multiple leaf (ingress) nodes to be delivered to multiple egress nodes. Only a single copy of the packet will be sent on any link traversed by the multipoint LSP.

A multipoint-to-multipoint LSP is much like a point-to-multipoint LSP in that it consists of a single root node, zero or more transit nodes, and one or more leaf label switch routers (LSRs) acting equally as an ingress or egress LSR. A leaf node participates in the setup of a multipoint-to-multipoint LSP by establishing both a downstream LSP, which is like a point-to-multipoint LSP from the root, and an upstream LSP, which is used to send traffic towards the root and other leaf nodes. Transit nodes support the setup by propagating the upstream and downstream LSP setup towards the root node and installing the necessary Multiprotocol Label Switching (MPLS) forwarding state. The transmission of packets from the root node of a multipoint-to-multipoint LSP to the receivers is identical to that for a point-to-multipoint LSP. Traffic from a leaf node follows the upstream LSP towards the root node and branches downward along the downstream LSP as required to reach other leaf nodes. Mapping traffic to the multipoint-to-multipoint LSP happens at any leaf node.

Jitter

Jitter is used to reduce the load on the label switch router (LSR) where the ping is performed. By adding a jitter, the replying devices will space their reply time based on a random number between one and the jitter value. Jitter value must be smaller than jitter type, length, value (TLV) received in an echo request or locally configured jitter value.

The jitter field specifies an upper limit for the jitter period that must be applied by a responding node to determine how long to wait before sending an echo reply. You can configure the jitter value to allow the echo replies to be spread out uniformly over the jitter duration. An echo request originator is needed to extend the timeout by the jitter value to account for jittered replies. The responder needs to either limit the maximum number of outstanding jitter waits that can be present or set an upper limit on the maximum jitter time. The jitter value is specified in milliseconds. The range is from 1 to 2147483647, and the default is 200.

The configured jitter value is also used by the responder node. If the configured jitter value is smaller than the received jitter TLV, then a reply is generated after a random time between a configured jitter value. If the configured jitter value is larger than the received jitter TLV, then the reply is generated after a random time between one and the received jitter TLV.



Note

An echo jitter TLV is only applicable on an echo request message. If it is present on an echo reply message, it is ignored.

How to Verify MPLS Embedded Management—LSP Ping Support for MLDP

Configuring Echo Jitter

SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `mpls oam`
4. `echo jitter jitter-value`
5. `end`

DETAILED STEPS

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

	Command or Action	Purpose
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	mpls oam Example: Device(config)# mpls oam	Enters MPLS OAM configuration mode for customizing the default behavior of echo packets.
Step 4	echo jitter jitter-value Example: Device(config-mpls)# echo jitter 100	Configures the jitter value, in milliseconds, that is used in the jitter type, length, values (TLVs) and sent as part of the echo request packets. <ul style="list-style-type: none"> • The range is from 1 to 2147483647. The default is 200.
Step 5	end Example: Device(config-mpls)# end	Exits MPLS OAM configuration mode and enters privileged EXEC mode.

Configuration Examples for Verifying MPLS Embedded Management—LSP Ping Support for MLDP

Example: Configuring Echo Jitter

```
Device(config)# mpls oam
Device(config-mpls)# echo jitter 100
Device(config-mpls)# end
Device#
```

Example: Verifying MLDP LSP Ping

The following example shows the sample output for the `ping mpls mldp p2mp` command:

```
Device# ping mpls mldp p2mp 10.0.0.5 vpnv4 100:100 38.0.0.8 232.1.1.2
verbose size 200 interval 100 exp 4 timeout 2 repeat 3 jitter 140 ddmapp ttl 1

p2mp Root node addr 10.0.0.5
Opaque type VPNv4, source 38.0.0.8, group 232.1.1.2
Sending 3, 200-byte MPLS Echos to Target FEC Stack TLV descriptor,
    timeout is 2.1 seconds, send interval is 100 msec, jitter value is 140 msec:

Codes: '!' - success, 'Q' - request not sent, '.' - timeout,
       'L' - labeled output interface, 'B' - unlabeled output interface,
       'D' - DS Map mismatch, 'F' - no FEC mapping, 'f' - FEC mismatch,
       'M' - malformed request, 'm' - unsupported tlvs, 'N' - no label entry,
       'P' - no rx intf label prot, 'p' - premature termination of LSP,
       'R' - transit router, 'I' - unknown upstream index,
```

Example: Verifying MLDP LSP Ping

```

'l' - Label switched with FEC change, 'd' - see DDMAP for return code,
'X' - unknown return code, 'x' - return code 0

Type escape sequence to abort.

Request #1
L   size 200, reply addr 30.0.0.2, return code 8
Echo Reply received from 30.0.0.2
  DDMAP 0, DS Router Addr 33.0.0.3, DS Intf Addr 33.0.0.3
    RC L, RSC 0, MRU 1500 [Labels: 26 Exp: 4]

  DDMAP 1, DS Router Addr 34.0.0.6, DS Intf Addr 34.0.0.6
    RC L, RSC 0, MRU 1500 [Labels: 26 Exp: 4]

Received 0 replies

Request #2
L   size 200, reply addr 30.0.0.2, return code 8
Echo Reply received from 30.0.0.2
  DDMAP 0, DS Router Addr 33.0.0.3, DS Intf Addr 33.0.0.3
    RC L, RSC 0, MRU 1500 [Labels: 26 Exp: 4]

  DDMAP 1, DS Router Addr 34.0.0.6, DS Intf Addr 34.0.0.6
    RC L, RSC 0, MRU 1500 [Labels: 26 Exp: 4]

Received 0 replies

Request #3
L   size 200, reply addr 30.0.0.2, return code 8
Echo Reply received from 30.0.0.2
  DDMAP 0, DS Router Addr 33.0.0.3, DS Intf Addr 33.0.0.3
    RC L, RSC 0, MRU 1500 [Labels: 26 Exp: 4]

  DDMAP 1, DS Router Addr 34.0.0.6, DS Intf Addr 34.0.0.6
    RC L, RSC 0, MRU 1500 [Labels: 26 Exp: 4]

Received 0 replies

Total Time Elapsed 6120 ms

```

The following example shows the sample output for the **ping mpls mldp mp2mp** command:

```

Device# ping mpls mldp mp2mp 10.0.0.1 mdt 100:100 0
verbose size 200 interval 100 exp 4 timeout 2 repeat 3 jitter 230

mp2mp Root node addr 10.0.0.1
Opaque type MDT, oui:index 0x100:0100, mdtnum 0
Sending 3, 200-byte MPLS Echos to Target FEC Stack TLV descriptor,
  timeout is 2.2 seconds, send interval is 100 msec, jitter value is 230 msec:

Codes: '!' - success, 'Q' - request not sent, '.' - timeout,
'L' - labeled output interface, 'B' - unlabeled output interface,
'D' - DS Map mismatch, 'F' - no FEC mapping, 'f' - FEC mismatch,
'M' - malformed request, 'm' - unsupported tlvs, 'N' - no label entry,
'P' - no rx intf label prot, 'p' - premature termination of LSP,
'R' - transit router, 'I' - unknown upstream index,
'l' - Label switched with FEC change, 'd' - see DDMAP for return code,
'X' - unknown return code, 'x' - return code 0

```

Type escape sequence to abort.

```

Request #1
!   size 200, reply addr 35.0.0.4, return code 3
!   size 200, reply addr 34.0.0.6, return code 3
!   size 200, reply addr 36.0.0.7, return code 3

Round-trip min/avg/max = 52/92/118 ms
Received 3 replies

Request #2
!   size 200, reply addr 34.0.0.6, return code 3
!   size 200, reply addr 36.0.0.7, return code 3
!   size 200, reply addr 35.0.0.4, return code 3

```

```

Round-trip min/avg/max = 118/158/196 ms
Received 3 replies

Request #3
!   size 200, reply addr 36.0.0.7, return code 3
!   size 200, reply addr 34.0.0.6, return code 3
!   size 200, reply addr 35.0.0.4, return code 3

Round-trip min/avg/max = 80/116/155 ms
Received 3 replies

Total Time Elapsed 6409 ms

```

Additional References for MPLS Embedded Management—LSP Ping Support for MLDP

Related Documents

Related Topic	Document Title
ping and traceroute commands	<i>Understanding the Ping and Traceroute Commands</i>
Cisco IOS commands	Cisco IOS Master Command List, All Releases
Switching services commands	Cisco IOS Multiprotocol Label Switching Command Reference

RFCs

RFC	Title
RFC 4379	<i>Detecting Multi-Protocol Label Switched (MPLS) Data Plane Failures</i>
RFC 6388	<i>Label Distribution Protocol Extensions for Point-to-Multipoint and Multipoint-to-Multipoint Label Switched Paths</i>
RFC 6424	<i>Mechanism for Performing Label Switched Path Ping (LSP Ping) over MPLS Tunnels</i>
RFC 6425	<i>Detecting Data-Plane Failures in Point-to-Multipoint MPLS - Extensions to LSP Ping</i>

Technical Assistance

Description	Link
The Cisco Technical Support website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/techsupport

Feature Information for MPLS Embedded Management—LSP Ping 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 1: Feature Information for MPLS Embedded Management—LSP Ping Support for MLDP

Feature Name	Releases	Feature Information
MPLS Embedded Management—LSP Ping Support for MLDP	15.3(3)S	<p>The MPLS Embedded Management—LSP Ping Support for MLDP feature allows you to check connectivity and isolate failure points to provide a Multiprotocol Label Switching (MPLS) Operation, Administration, and Maintenance (OAM) solution.</p> <p>The following command was introduced or modified: echo.</p>