MPLS High Availability Configuration Guide, Cisco IOS Release 15MT

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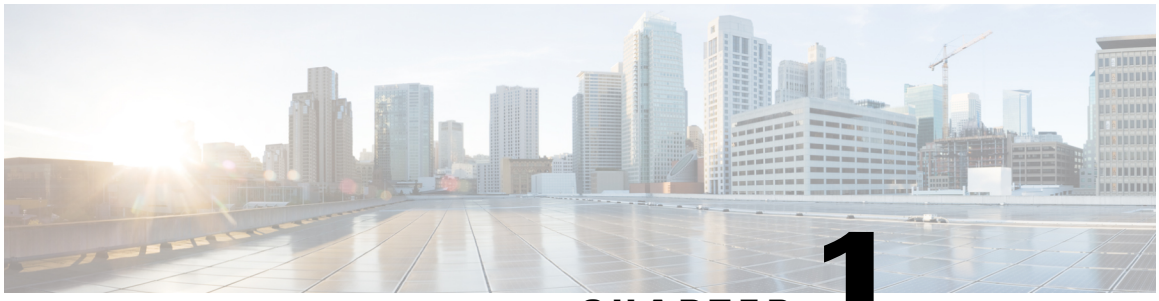


CHAPTER 1

MPLS LDP Graceful Restart

When a device is configured with Multiprotocol Label Switching (MPLS) Label Distribution Protocol (LDP) Graceful Restart (GR), it assists a neighboring device that has MPLS LDP Stateful Switchover/Nonstop Forwarding (SSO/NSF) Support and Graceful Restart to recover gracefully from an interruption in service. In this Cisco software release, MPLS LDP GR functions strictly in helper mode, which means it can only help other devices that are enabled with MPLS SSO/NSF and GR to recover. If the device with LDP GR fails, its peer devices cannot help it recover.

Notes:

- MPLS LDP SSO/NSF Support and Graceful Restart feature is called LDP SSO/NSF in this document.
- The MPLS LDP GR feature described in this document refers to helper mode.

When you enable MPLS LDP GR on a device that peers with an MPLS LDP SSO/NSF-enabled device, the SSO/NSF-enabled device can maintain its forwarding state when the LDP session between them is interrupted. While the SSO/NSF-enabled device recovers, the peer device forwards packets using stale information. This enables the SSO/NSF-enabled device to become operational more quickly.

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.

Restrictions for MPLS LDP Graceful Restart

- Multiprotocol Label Switching (MPLS) Label Distribution Protocol (LDP) Graceful Restart (GR) is supported in strict helper mode.
- Tag Distribution Protocol (TDP) sessions are not supported. Only LDP sessions are supported.
- MPLS LDP GR cannot be configured on label-controlled ATM (LC-ATM) interfaces.
- MPLS LDP SSO/NSF is supported in Cisco IOS Release 12.2(25)S. It is not supported in this release.

Information About MPLS LDP Graceful Restart

How MPLS LDP Graceful Restart Works

Multiprotocol Label Switching (MPLS) Label Distribution Protocol (LDP) Graceful Restart (GR) works in strict helper mode, which means it helps a neighboring route processor that has MPLS LDP SSO/NSF to recover from disruption in service without losing its MPLS forwarding state. The disruption in service could be the result of a TCP or UDP event or the stateful switchover of a route processor. When the neighboring device establishes a new session, the LDP bindings and MPLS forwarding states are recovered.

In the topology shown in the figure below, the following elements have been configured:

- LDP sessions are established between Device 1 and Device 2, as well as between Device 2 and Device 3.
- Device 2 has been configured with MPLS LDP SSO/NSF. Devices 1 and 3 have been configured with MPLS LDP GR.
- A label switched path (LSP) has been established between Device 1 and Device 3.

Figure 1: Example of a Network Using LDP Graceful Restart

The following process shows how Devices 1 and 3, which have been configured with LDP GR help Device 2, which has been configured with LDP SSO/NSF recover from a disruption in service:

1. Device 1 notices an interruption in service with Device 2. (Device 3 also performs the same actions in this process.)
2. Device 1 marks all the label bindings from Device 2 as stale, but it continues to use the bindings for MPLS forwarding.

Device 1 reestablishes an LDP session with Device 2, but keeps its stale label bindings. If you issue a **show mpls ldp neighbor graceful-restart** command, the output displays the recovering LDP sessions.

1 Both devices readvertise their label binding information. If Device 1 relearns a label from Device 2 after the session has been established, the stale flags are removed. The **show mpls forwarding-table** command displays the information in the MPLS forwarding table, including the local label, outgoing label or VC, prefix, label-switched bytes, outgoing interface, and next hop.

You can set various graceful restart timers. See the following commands for more information:

- **mpls ldp graceful-restart timers neighbor-liveness**
- **mpls ldp graceful-restart timers max-recovery**

How a Route Processor Advertises That It Supports MPLS LDP Graceful Restart

A route processor that is configured to perform Multiprotocol Label Switching (MPLS) Label Distribution Protocol (LDP) Graceful Restart (GR) includes the Fault Tolerant (FT) Type Length Value (TLV) in the LDP initialization message. The route processor sends the LDP initialization message to a neighbor to establish an LDP session.

The FT session TLV includes the following information:

- The Learn from Network (L) flag is set to 1, which indicates that the route processor is configured to perform MPLS LDP GR.
- The Reconnect Timeout field shows the time (in milliseconds) that the neighbor should wait for a reconnection if the LDP session is lost. In this release, the timer is set to 0, which indicates that if the local device fails, its peers should not wait for it to recover. The timer setting indicates that the local device is working in helper mode.
- The Recovery Time field shows the time (in milliseconds) that the neighbor should retain the MPLS forwarding state during a recovery. If a neighbor did not preserve the MPLS forwarding state before the restart of the control plane, the neighbor sets the recovery time to 0.

What Happens If a Route Processor Does Not Have LDP Graceful Restart

If two route processors establish a Label Distribution Protocol (LDP) session and one route processor is not configured for Multiprotocol Label Switching (MPLS) LDP Graceful Restart (GR), the two route processors create a normal LDP session but do not have the ability to perform MPLS LDP GR. Both route processors must be configured for MPLS LDP GR.

How to Configure MPLS LDP Graceful Restart

Configuring MPLS LDP Graceful Restart

You must enable Multiprotocol Label Switching (MPLS) Label Distribution Protocol (LDP) Graceful Restart (GR) on all route processors for an LDP session to be preserved during an interruption in service.

MPLS LDP GR is enabled globally. When you enable MPLS LDP GR, it has no effect on existing LDP sessions. New LDP sessions that are established can perform MPLS LDP GR.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip cef** [**distributed**]
4. **mpls ldp graceful-restart**
5. **interface** *type number*
6. **mpls ip**
7. **mpls label protocol** {**ldp** | **tdp** | **both**}

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 cef** [**distributed**] **Example:** `Device(config)# ip cef distributed`	Enables Cisco Express Forwarding (CEF).
Step 4	**mpls ldp graceful-restart** **Example:** `Device(config)# mpls ldp graceful-restart`	Enables the device to protect the LDP bindings and MPLS forwarding state during a disruption in service.
Step 5	**interface** *type number* **Example:** `Device(config)# interface pos 3/0`	Specifies an interface and enters interface configuration mode.
Step 6	**mpls ip** **Example:** `Device(config-if)# mpls ip`	Configures MPLS hop-by-hop forwarding for an interface.

	Command or Action	Purpose
Step 7	**mpls label protocol** {**ldp** | **tdp** | **both**} **Example:** `Device(config-if)# mpls label protocol ldp`	Configures the use of LDP for an interface. You must use LDP.

What to Do Next

Note You can also issue the **mpls label protocol ldp** command in global configuration mode, which enables LDP on all interfaces configured for MPLS.

Verifying the MPLS LDP Graceful Restart Configuration

The following commands help verify that Multiprotocol Label Switching (MPLS) Label Distribution Protocol (LDP) Graceful Restart (GR) has been configured correctly:

show mpls ldp neighbor with the **graceful-restart** keyword	Displays the Graceful Restart information for LDP sessions.
show mpls ldp graceful-restart	Displays Graceful Restart sessions and session parameters.

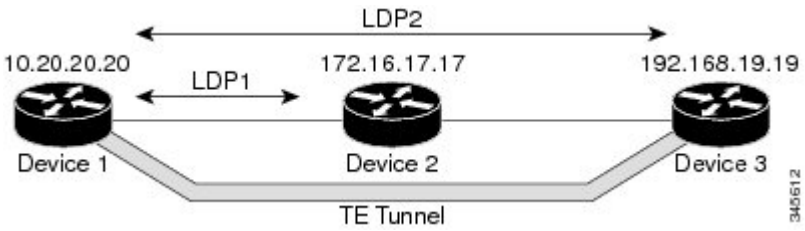
Configuration Example for MPLS LDP Graceful Restart

Example: MPLS LDP Graceful Restart Configuration

The figure below shows a configuration where MPLS LDP GR is enabled on Device 1 and MPLS LDP SSO/NSF is enabled on Devices 2 and 3. In this configuration example, Device 1 creates an LDP session with

Device 2. Device 1 also creates a targeted session with Device 3 through a traffic engineering tunnel using Device 2.

Figure 2: MPLS LDP Graceful Restart Configuration Example



Device 1 configured with LDP GR:

```
boot system slot0:rsp-pv-mz
hw-module slot 2 image slot0:rsp-pv-mz
hw-module slot 3 image slot0:rsp-pv-mz
!
ip subnet-zero
ip cef
mpls label range 16 10000 static 10001 1048575
mpls label protocol ldp
mpls ldp logging neighbor-changes
mpls ldp graceful-restart
mpls traffic-eng tunnels
no mpls traffic-eng auto-bw timers frequency 0
mpls ldp router-id Loopback0 force
!
interface Loopback0
 ip address 20.20.20.20 255.255.255.255
 no ip directed-broadcast
 no ip mroute-cache
!
interface Tunnel1
 ip unnumbered Loopback0
 no ip directed-broadcast
 mpls label protocol ldp
 mpls ip
 tunnel destination 19.19.19.19
 tunnel mode mpls traffic-eng
 tunnel mpls traffic-eng autoroute announce
 tunnel mpls traffic-eng priority 7 7
 tunnel mpls traffic-eng bandwidth  500
 tunnel mpls traffic-eng path-option 1 dynamic
!
interface ATM5/1/0
 no ip address
 no ip directed-broadcast
 atm clock INTERNAL
 no atm enable-ilmi-trap
 no atm ilmi-keepalive
!
interface ATM5/1/0.5 point-to-point
 ip address 12.0.0.2 255.0.0.0
 no ip directed-broadcast
 no atm enable-ilmi-trap
 pvc 6/100
  encapsulation aal5snap
mpls label protocol ldp
mpls traffic-eng tunnels
mpls ip
ip rsvp bandwidth 1000
!
router ospf 100
```

```
 log-adjacency-changes
 redistribute connected
     network 12.0.0.0 0.255.255.255 area 100
 network 20.20.20.20 0.0.0.0 area 100
 mpls traffic-eng router-id Loopback0
 mpls traffic-eng area 100
```

Device 2 configured with LDP SSO/NSF:

```
boot system slot0:rsp-pv-mz
hw-module slot 2 image slot0:rsp-pv-mz
hw-module slot 3 image slot0:rsp-pv-mz
redundancy
  mode sso
!
ip cef
no ip domain-lookup
mpls label range 17 10000 static 10001 1048575
mpls label protocol ldp
mpls ldp logging neighbor-changes
mpls ldp graceful-restart
mpls traffic-eng tunnels
no mpls traffic-eng auto-bw timers frequency 0
no mpls advertise-labels
mpls ldp router-id Loopback0 force
!
interface Loopback0
 ip address 17.17.17.17 255.255.255.255
 no ip directed-broadcast
!
interface ATM4/0/0
 no ip address
 no ip directed-broadcast
 no ip mroute-cache
 atm clock INTERNAL
 atm sonet stm-1
 no atm enable-ilmi-trap
 no atm ilmi-keepalive
!
interface ATM4/0/0.5 point-to-point
 ip address 12.0.0.1 255.0.0.0
 no ip directed-broadcast
 no atm enable-ilmi-trap
 pvc 6/100
  encapsulation aal5snap
mpls label protocol ldp
mpls traffic-eng tunnels
mpls ip
ip rsvp bandwidth 1000
!
interface POS5/1/0
 ip address 11.0.0.1 255.0.0.0
 no ip directed-broadcast
 encapsulation ppp
 mpls label protocol ldp
 mpls traffic-eng tunnels
 mpls ip
 no peer neighbor-route
 clock source internal
 ip rsvp bandwidth 1000
!
router ospf 100
 log-adjacency-changes
 redistribute connected
 nsf enforce global
 network 11.0.0.0 0.255.255.255 area 100
 network 12.0.0.0 0.255.255.255 area 100
 network 17.17.17.17 0.0.0.0 area 100
 mpls traffic-eng router-id Loopback0
 mpls traffic-eng area 100
```

```
!
ip classless
```

Device 3 configured with LDP SSO/NSF:

```
boot system slot0:rsp-pv-mz
hw-module slot 2 image slot0:rsp-pv-mz
hw-module slot 3 image slot0:rsp-pv-mz
redundancy
  mode sso
!
ip subnet-zero
ip cef
!
no ip finger
no ip domain-lookup
mpls label protocol ldp
mpls ldp neighbor 11.11.11.11 targeted ldp
mpls ldp logging neighbor-changes
mpls ldp graceful-restart
mpls traffic-eng tunnels
no mpls traffic-eng auto-bw timers frequency 0
mpls ldp discovery directed-hello interval 12
mpls ldp discovery directed-hello holdtime 130
mpls ldp discovery directed-hello accept
mpls ldp router-id Loopback0 force
!
interface Loopback0
 ip address 19.19.19.19 255.255.255.255
 no ip directed-broadcast
!
interface POS1/0
 ip address 11.0.0.2 255.0.0.0
 no ip directed-broadcast
 encapsulation ppp
 mpls label protocol ldp
 mpls traffic-eng tunnels
 mpls ip
 no peer neighbor-route
 clock source internal
 ip rsvp bandwidth 1000
!
router ospf 100
 log-adjacency-changes
 redistribute connected
 nsf enforce global
network 11.0.0.0 0.255.255.255 area 100
network 19.19.19.19 0.0.0.0 area 100
mpls traffic-eng router-id Loopback0
 mpls traffic-eng area 100
!
ip classless
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Command List, All Releases
MPLS commands	Cisco IOS Multiprotocol Label Switching Command Reference

Related Topic	Document Title
MPLS Label Distribution Protocol	"MPLS Label Distribution Protocol" module in the *MPLS Label Distribution Protocol Configuration Guide*

MIBs

MIBs	MIBs Link
• MPLS Label Distribution Protocol MIB Version 8 Upgrade	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
RFC 3036	*LDP Specification*
RFC 3478	*Graceful Restart Mechanism for Label Distribution*

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

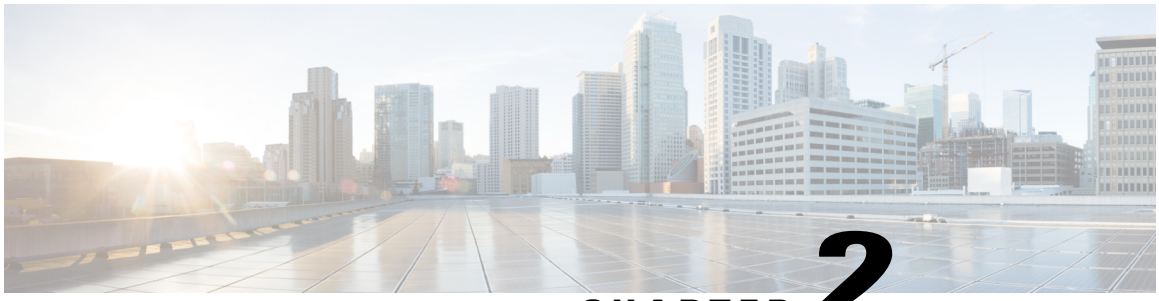
Feature Information for MPLS LDP Graceful Restart

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 LDP Graceful Restart

Feature Name	Releases	Feature Information
MPLS LDP Graceful Restart	12.0(29)S 12.3(14)T 12.2(33)SRA	The MPLS LDP Graceful Restart feature assists a neighboring device that has MPLS LDP Stateful Switchover/Nonstop Forwarding (SSO/NSF) Support and Graceful Restart to recover gracefully from an interruption in service. In Cisco IOS Release 12.0(29)S, this feature was introduced. This feature was integrated into Cisco IOS Release 12.3(14)T. This feature was integrated into Cisco IOS Release 12.2(33)SRA. The following commands were introduced or modified: **debug mpls ldp graceful-restart**, **mpls ldp graceful-restart**, **mpls ldp graceful-restart timers max-recovery**, **mpls ldp graceful-restart timers neighbor-liveness**, **show mpls ip binding**, **show mpls ldp bindings**, **show mpls ldp graceful-restart**, **show mpls ldp neighbor**.



CHAPTER 2

AToM Graceful Restart

The AToM Graceful Restart feature assists neighboring devices that have nonstop forwarding (NSF), stateful switchover (SSO), and graceful restart (GR) for Any Transport over Multiprotocol Label Switching (AToM) to recover gracefully from an interruption in service. AToM GR functions strictly in helper mode, which means it helps other devices that are enabled with the NSF/SSO—Any Transport over MPLS and AToM Graceful Restart feature to recover. If the device with AToM GR fails, its peers cannot help it recover. AToM GR is based on the MPLS Label Distribution Protocol (LDP) Graceful Restart feature.

Keep the following points in mind when reading this document:

- The AToM GR feature described in this document refers to helper mode.
- For brevity, the NSF/SSO—Any Transport over MPLS and AToM Graceful Restart feature is called AToM SSO/NSF in this document.

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.

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Prerequisites for AToM Graceful Restart

Any Transport over Multiprotocol Label Switching (AToM) must be configured.

Restrictions for AToM Graceful Restart

- Any Transport over Multiprotocol Label Switching (AToM) graceful restart (GR) is supported in strict helper mode.
- MPLS Label Distribution Protocol (LDP) GR cannot be configured on label-controlled ATM (LC-ATM) interfaces.
- On some hardware platforms, Tag Distribution Protocol (TDP) sessions are not supported. Only LDP sessions are supported.

Information About AToM Graceful Restart

How AToM Graceful Restart Works

Any Transport over Multiprotocol Label Switching Graceful Restart (AToM GR) works in strict helper mode, which means it helps a neighboring Route Processor (RP) that has AToM nonstop forwarding (NSF) and stateful switchover (SSO) to recover from a disruption in service without losing its MPLS forwarding state. The disruption in service could result from a TCP or User Datagram Protocol (UDP) event or the SSO of an RP. AToM GR is based on the MPLS Label Distribution Protocol (LDP) Graceful Restart feature, which preserves forwarding information for AToM circuits during an LDP session interruption. When the neighboring device establishes a new session, the LDP bindings and MPLS forwarding state are recovered.

How to Configure AToM Graceful Restart

Configuring AToM Graceful Restart

There is no Any Transport over Multiprotocol Label Switching (AToM)-specific configuration for AToM Graceful Restart (GR). You enable the Label Distribution Protocol (LDP) GR to assist a neighboring device configured with AToM nonstop forwarding (NSF) and stateful switchover (SSO) to maintain its forwarding state while the LDP session is disrupted.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip cef distributed**
4. **mpls ldp graceful-restart**
5. **exit**
6. **show mpls l2transport vc detail**

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 cef distributed** **Example:** `Device(config)# ip cef distributed`	Enables distributed Cisco Express Forwarding.
Step 4	**mpls ldp graceful-restart** **Example:** `Device(config)# mpls ldp graceful-restart`	Enables the device to protect the LDP bindings and MPLS forwarding state during a disruption in service. • AToM GR is enabled globally. When you enable AToM GR, it has no effect on existing LDP sessions. New LDP sessions that are established can perform AToM GR.
Step 5	**exit** **Example:** `Device(config)# exit`	Exits to privileged EXEC mode.
Step 6	**show mpls l2transport vc detail** **Example:** `Device# show mpls l2transport vc detail`	Displays detailed information about AToM virtual circuits (VCs).

Configuration Examples for AToM Graceful Restart

Example: Configuring AToM Graceful Restart

The following example shows a Fast Ethernet VLAN over Multiprotocol Label Switching (MPLS) configuration. PE1 is configured with Any Transport over MPLS Graceful Restart (AToM GR). PE2 is configured with AToM nonstop forwarding (NSF) and stateful switchover (SSO). The commands for configuring AToM GR and NSF/SSO are shown in bold.

PE1 with AToM GR	PE2 with AToM NSF/SSO
ip cef distributed ! mpls label protocol ldp **mpls ldp graceful-restart** mpls ldp router-id Loopback0 ! pseudowire-class atom encapsulation mpls ! interface Loopback0 ip address 10.1.1.2 255.255.255.255 ! interface FastEthernet2/1/1 no ip address ! interface FastEthernet2/1/1.2 description “xconnect to PE2” encapsulation dot1Q 2 native xconnect 10.2.2.2 1002 pw-class mpls ! ! IGP for MPLS router ospf 10 log-adjacency-changes auto-cost reference-bandwidth 1000 network 10.1.1.2 10.0.0.0 area 0 network 10.1.1.0 10.0.0.255 area 0	**redundancy** **mode sso** ip cef distributed ! mpls label protocol ldp **mpls ldp graceful-restart** mpls ldp router-id Loopback0 ! pseudowire-class atom encapsulation mpls ! interface Loopback0 ip address 10.2.2.2 255.255.255.255 ! interface FastEthernet0/3/2 no ip address ! interface FastEthernet0/3/2.2 description “xconnect to PE1” encapsulation dot1Q 2 xconnect 10.1.1.2 1002 pw-class mpls ! ! IGP for MPLS router ospf 10 log-adjacency-changes **nsf cisco enforce global** auto-cost reference-bandwidth 1000 network 10.2.2.2 10.0.0.0 area 0 network 10.1.1.0 10.0.0.255 area 0

Examples: Verifying AToM Graceful Restart Recovery from an LDP Session Disruption

The following examples show the output of the **show mpls l2transport vc** command during normal operation and when a Label Distribution Protocol (LDP) session is recovering from a disruption.

The following example shows the status of the virtual circuit (VC) on PE1 with Any Transport over Multiprotocol Label Switching Graceful Restart (AToM GR) during normal operation:

```
Device# show mpls l2transport vc

Local intf     Local circuit        Dest address    VC ID      Status
-------------  -------------------- --------------- ---------- ----------
Fa2/1/1.2      Eth VLAN 2           10.2.2.2         1002       UP
```

The following example shows the status of the VC on PE1 with AToM GR while the VC is recovering from an LDP session disruption. The forwarding state for the circuit remains as it was before the disruption.

```
Device# show mpls l2transport vc

Local intf     Local circuit        Dest address    VC ID      Status
-------------  -------------------- --------------- ---------- ----------
Fa2/1/1.2      Eth VLAN 2           10.2.2.2         1002       RECOVERING
```

The following example shows the status of the VC on PE1 with AToM GR after the LDP session disruption was cleared. The AToM label bindings were advertised within the allotted time and the status returned to UP.

```
Device# show mpls l2transport vc

Local intf     Local circuit        Dest address    VC ID      Status
-------------  -------------------- --------------- ---------- ----------
Fa2/1/1.2      Eth VLAN 2           10.2.2.2         1002       UP
```

The following example shows the detailed status of the VC on PE1 with AToM GR during normal operation:

```
Device# show mpls l2transport vc detail

Local interface: Fa2/1/1.2 up, line protocol up, Eth VLAN 2 up
  Destination address: 10.2.2.2, VC ID: 1002, VC status: up
    Preferred path: not configured
    Default path: active
    Tunnel label: imp-null, next hop point2point
    Output interface: Se2/0/2, imposed label stack {16}
  Create time: 1d00h, last status change time: 1d00h
  Signaling protocol: LDP, peer 10.2.2.2:0 up
    MPLS VC labels: local 21, remote 16
    Group ID: local 0, remote 0
    MTU: local 1500, remote 1500
    Remote interface description: "xconnect to PE2"
  Sequencing: receive disabled, send disabled
  VC statistics:
    packet totals: receive 3466, send 12286
    byte totals:   receive 4322368, send 5040220
    packet drops:  receive 0, send 0
```

The following example shows the detailed status of the VC on PE1 with AToM GR while the VC is recovering.

```
Device# show mpls l2transport vc detail

Local interface: Fa2/1/1.2 up, line protocol up, Eth VLAN 2 up
  Destination address: 10.2.2.2, VC ID: 1002, VC status: recovering
    Preferred path: not configured
    Default path: active
    Tunnel label: imp-null, next hop point2point
    Output interface: Se2/0/2, imposed label stack {16}
  Create time: 1d00h, last status change time: 00:00:03
  Signaling protocol: LDP, peer 10.2.2.2:0 down
    MPLS VC labels: local 21, remote 16
    Group ID: local 0, remote 0
    MTU: local 1500, remote 1500
    Remote interface description: "xconnect to PE2"
  Sequencing: receive disabled, send disabled
  VC statistics:
    packet totals: receive 20040, send 28879
    byte totals:   receive 25073016, send 25992388
    packet drops:  receive 0, send 0
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Command List, All Releases
MPLS AToM and LDP commands	Cisco IOS Multiprotocol Label Switching Command Reference
MPLS LDP graceful restart	"MPLS LDP Graceful Restart" module in the *MPLS: High Availability Configuration Guide* (part of the *Multiprotocol Label Switching Configuration Guide Library*)
Configuring AToM	"Any Transport over MPLS" module in the *MPLS: Layer 2 VPNs Configuration Guide* (part of the *Multiprotocol Label Switching Configuration Guide Library*)
Nonstop forwarding and stateful switchover for AToM	"NSF SSO Any Transport over MPLS and AToM Graceful Restart" module in the *MPLS: High Availability Configuration Guide* (part of the *Multiprotocol Label Switching Configuration Guide Library*)
High availability commands	*Cisco IOS High Availability Command Reference*

MIBs

MIBs	MIBs Link
MPLS Label Distribution Protocol MIB Version 8 Upgrade	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/mib

RFCs

RFCs	Title
RFC 3036	*LDP Specification*
RFC 3478	*Graceful Restart Mechanism for Label Distribution*

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 AToM Graceful Restart

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 AToM Graceful Restart

Feature Name	Releases	Feature Information
AToM Graceful Restart	12.0(29)S 12.2(33)SRA 12.2(33)SXH 12.4(11)T Cisco IOS XE Release 2.3	The AToM Graceful Restart feature assists neighboring devices that have nonstop forwarding (NSF), stateful switchover (SSO), and graceful restart (GR) for Any Transport over Multiprotocol Label Switching (AToM) to recover gracefully from an interruption in service. AToM GR functions strictly in helper mode, which means it helps other devices that are enabled with the NSF/SSO—Any Transport over MPLS and AToM Graceful Restart feature to recover. If the device with AToM GR fails, its peers cannot help it recover. AToM GR is based on the MPLS Label Distribution Protocol (LDP) Graceful Restart feature. In Cisco IOS Release 12.0(29)S, this feature was introduced. In Cisco IOS Release 12.2(33)SRA, support was added for the Cisco 7600 series routers. In Cisco IOS Release 12.2(33)SXH, this feature was integrated into the release. In Cisco IOS Release 12.4(11)T, this feature was integrated into the release. In Cisco IOS Release XE 2.3, this feature was implemented on the Cisco ASR 1000 Series Aggregation Services Routers. This feature uses no new or modified commands.