



Any Transport over MPLS Sequencing Support

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The Any Transport over MPLS (AToM) Sequencing Support feature enables the sequencing of packets in an AToM network. When you enable AToM sequencing, each packet entering the imposition provider edge (PE) router is assigned a sequence number. The disposition PE router checks the sequence number of the packet. If the packet is out of order, the packet is dropped. The number of dropped out-of-order packets is recorded. You have the option of resetting the packet sequencing if the number of out-of-order packets exceeds the specified limit.

Finding Feature Information in This Module

Your Cisco IOS software release may not support all of the features documented in this module. To reach links to specific feature documentation in this module and to see a list of the releases in which each feature is supported, use the [“Feature Information for AToM Sequencing Support”](#) section on page 14.

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Restrictions for AToM Sequencing Support

- The sequence number is encapsulated in the control word. The PE routers agree on the use of the control word during Label Distribution Protocol (LDP) label binding. If the control word is disabled, AToM sequencing does not work, even if the feature is enabled.
- Sequencing is not supported with L2VPN Interworking.
- On Cisco 12000 series Engine 3 line cards, AToM Sequencing is supported only without caching.
- This feature is not supported on Cisco 12000 Series Four-Port Gigabit Ethernet line cards.
- When the Cisco 12000 series Engine 5 line card reads the sequence number of a packet arriving in one of its four pipelines, the line card momentarily halts traffic on its other three pipelines in order not to have any outgoing packets be out of sequence. Therefore, all information carried by the three other pipelines is momentarily halted. This reduces the line rate.

Information About AToM Sequencing Support

To configure AToM Sequencing, you need to understand the following concepts:

- [How AToM Sequencing Works, page 2](#)
- [Circumstances That Can Reset AToM Sequencing, page 3](#)
- [Resetting Sequence Numbering When the Disposition PE Router Receives too Many Out-of-Order Packets, page 3](#)

How AToM Sequencing Works

This feature enables the sequencing of packets in an AToM network. When you enable AToM sequencing, each packet entering the imposition PE router is assigned a sequence number, from 1 to 65535. The disposition PE router checks the sequence number of the packet. If the packet is out of order, the packet is dropped. The number of out-of-order packets that are dropped is recorded. You can reset the packet sequencing if the number of out-of-order packets exceeds the specified limit. For example, you can enable a reset of packet sequencing after 1000 out-of-order packets have been received.

On Cisco 12000 series Engine 3 and Engine 5 line cards, sequencing processing is performed only on the hardware switching path. Any sequenced packets punted to the line card exception switching path or to router processing switching paths are processed as non-sequenced packets.

Circumstances That Can Reset AToM Sequencing

The following conditions can cause AToM sequencing to be reset:

- The imposition PE router receives and accepts a new remote VC label.
- The disposition PE router allocates and advertises a new local VC label to its peer. Note however, that AToM sequencing is not reset when a router readvertises the same VC label to update information, such as interface parameters.
- An AToM VC is unprovisioned through the **no xconnect** command.
- The **clear mpls counters** command is entered.
- The line card on which an AToM VC is configured is removed or reset.
- The configuration changes from Cisco Express Forwarding to Distributed Cisco Express Forwarding or from Distributed Cisco Express Forwarding to Cisco Express Forwarding.

When a local router withdraws a VC label or when a remote router releases a VC label, AToM allocates a new VC label. This prevents confusion that could occur if AToM readvertised the same label.

Resetting Sequence Numbering When the Disposition PE Router Receives too Many Out-of-Order Packets

If the disposition PE router receives too many out-of-order packets, it might mean that the imposition and disposition PE routers are hopelessly out of sync. You can use the **clear mpls counters** command to clear the packets. You can also customize the disposition PE router so that it resets sequencing after it receives more than the specified number of out-of-order packets.

How to Configure AToM Sequencing

This section contains the following procedures:

- [Configuring AToM Sequencing, page 3](#)
- [Verifying the AToM Sequencing Configuration, page 6](#)

Configuring AToM Sequencing

This section explains how to enable AToM to sequence packets. You enable sequencing on both the imposition and the disposition PE routers. The command keywords you use depend on which of those routers you are configuring.



Note

You can enable AToM sequencing as part of the pseudowire class configuration or as part of the **xconnect** command. The following configuration steps explain how to configure AToM sequencing as part of the pseudowire class, which is the preferred method.

Prerequisites

Before configuring AToM Sequencing, make sure that all AToM VCs and features have been configured. See the [Any Transport over MPLS](#) documentation for information about configuring AToM.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **pseudowire-class** *name*
4. **encapsulation mpls**
5. **sequencing** {**transmit** | **receive** | **both** | **resync** *number*}
6. **sequencing resync** {*number*}

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	pseudowire-class <i>name</i> Example: Router(config)# pseudowire-class atom	Establishes a pseudowire class with a name that you specify. Enters pseudowire configuration mode.
Step 4	encapsulation mpls Example: Router(config-pw)# encapsulation mpls	Specifies the tunneling encapsulation. For AToM, the encapsulation type is mpls .
Step 5	sequencing { transmit receive both resync <i>number</i> }	Specifies that sequencing should be enabled on the router. For the imposition PE router, use the transmit or both keyword. For the disposition PE router, use the receive or both keyword.
Step 6	sequencing resync <i>number</i> Example: Router(config-pw)# sequencing resync 1000	(Optional) To resync sequencing with the peering PE router after the disposition router receives more than a specified number of out-of-order packets, use the resync keyword.

Resetting Sequence Numbering When the Disposition PE Router Receives too Many Out-of-Order Packets

If the disposition PE router receives too many out-of-order packets, it might mean that the imposition and disposition PE routers are hopelessly out of sync. You can specify the **sequencing resync** command on the disposition PE router so that it resets sequencing after it receives more than the specified number of out-of-order packets.

You can also use the **clear mpls counters** command to clear the packets.

The following example shows how the **clear mpls counters** command works. The **show mpls l2 vc detail** command shows that 15 packets were received and sent, 1656 bytes were received, and 1986 bytes were sent. The **clear mpls counters** command clears the counters. The second **show mpls l2 transport vc detail** command shows that no bytes or packets were received or sent.

```
Router# show mpls l2 vc detail

Local interface: Et0/0.10 up, line protocol up, Eth VLAN 10 up
MPLS VC type is Eth VLAN, interworking type is Ethernet
Destination address: 10.0.0.2, VC ID: 10, VC status: up
Output interface: Et1/0, imposed label stack {16}
Preferred path: not configured
Default path: active
Next hop: 10.0.0.2
Create time: 00:19:35, last status change time: 00:19:09
Signaling protocol: LDP, peer 10.0.0.2:0 up
MPLS VC labels: local 16, remote 16
Group ID: local 0, remote 0
MTU: local 1500, remote 1500
Remote interface description:
Sequencing: receive enabled, send enabled
VC statistics:
packet totals: receive 15, send 15 <---- packet totals
byte totals: receive 1656, send 1986 <---- byte totals
packet drops: receive 0, seq error 0, send 0

Router# clear mpls counters

Clear "show mpls forwarding-table" counters [confirm] mpls forward
counters cleared

Router# show mpls l2 vc detail

Local interface: Et0/0.10 up, line protocol up, Eth VLAN 10 up
MPLS VC type is Eth VLAN, interworking type is Ethernet
Destination address: 10.0.0.2, VC ID: 10, VC status: up
Output interface: Et1/0, imposed label stack {16}
Preferred path: not configured
Default path: active
Next hop: 10.0.0.2
Create time: 00:22:55, last status change time: 00:22:29
Signaling protocol: LDP, peer 10.0.0.2:0 up
MPLS VC labels: local 16, remote 16
Group ID: local 0, remote 0
MTU: local 1500, remote 1500
Remote interface description:
Sequencing: receive enabled, send enabled
VC statistics:
packet totals: receive 0, send 0 <---- packet totals
byte totals: receive 0, send 0 <---- byte totals
packet drops: receive 0, seq error 0, send 0
```

Verifying the AToM Sequencing Configuration

To verify that the PE routers are correctly set up to perform AToM sequencing, issue the **show mpls l2transport vc detail** command. The output shows:

- Sequencing is enabled in both the imposition and disposition directions.
- The transmit and expected receive sequence numbers.
- The number of out-of-order packets (seq error).

```
Router# show mpls l2transport vc 200101110 detail
```

```
Local interface: AT2/0 up, line protocol up, ATM AAL5 101/110 up
Destination address: 10.1.1.1, VC ID: 200101110, VC status: up
  Preferred path: not configured
  Default path: active
  Next hop: point2point
  Output interface: AT1/7.1, imposed label stack {22}
Create time: 00:01:12, last status change time: 00:01:12
Signaling protocol: LDP, peer 10.1.1.1:0 up
  MPLS VC labels: local 21, remote 22
  Group ID: local 0, remote 0
  MTU: local 1500, remote 1500
  Remote interface description:
Sequencing: receive enabled, send enabled
VC statistics:
  packet totals: receive 8290, send 3797
  byte totals:   receive 961416, send 470828
  packet drops: receive 0, seq error 0, send 0
```

Configuration Examples for AToM Sequencing

The following example shows two PE routers set up for AToM sequencing. PE1 is the imposition router and is enabled to transmit sequenced packets. PE2 is the disposition router and is enabled to receive sequenced packets. PE2 is also enabled to reset sequencing if it receives more than 200 out-of-order packets.

PE1	PE2
<pre> ip cef ! mpls ip mpls label protocol ldp tag-switching tdp router-id Loopback0 ! pseudowire-class atom encapsulation mpls sequencing transmit ! interface Loopback0 ip address 10.8.8.8 255.255.255.255 ! interface ATM5/0 no ip address pvc 0/100 l2transport xconnect 10.9.9.9 6 pw-class atom ! ! IGP for MPLS router ospf 10 log-adjacency-changes auto-cost reference-bandwidth 1000 network 10.8.8.8 0.0.0.0 area 0 network 10.17.1.10 0.0.0.255 area 0 </pre>	<pre> ip cef ! mpls ip mpls label protocol ldp tag-switching tdp router-id Loopback0 ! pseudowire-class atom encapsulation mpls sequencing receive sequencing resync 200 ! interface Loopback0 ip address 10.9.9.9 255.255.255.255 ! interface ATM2/0 no ip address pvc 0/100 l2transport xconnect 10.8.8.8 6 pw-class atom ! ! IGP for MPLS router ospf 10 log-adjacency-changes auto-cost reference-bandwidth 1000 network 10.9.9.9 0.0.0.0 area 0 network 10.18.1.10 0.0.0.255 area 0 </pre>

Additional References

The following sections provide references related to this feature.

Related Documents

Related Topic	Document Title
Any Transport over MPLS	<ul style="list-style-type: none"> Data Sheet: Any Transport over MPLS White Paper: Cisco Any Transport over MPLS MPLS AToM White Paper Overview: Cisco Any Transport over MPLS
Layer 2 Tunnel Protocol Version 3 (L2TPv3)	<ul style="list-style-type: none"> Layer 2 Tunnel Protocol Feature Summary Layer 2 Tunneling Protocol: A Feature in Cisco IOS Software Layer 2 Tunnel Protocol Version 3 (L2TPv3) Feature Module

Standards

Standards	Title
draft-martini-l2circuit-trans-mpls-10.txt	Transport of Layer 2 Frames Over MPLS
draft-martini-l2circuit-encap-mpls-01.txt	Encapsulation Methods for Transport of Layer 2 Frames Over MPLS

MIBs

MIBs	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.	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

RFCs

RFCs	Title
RFC 3032	MPLS Label Stack Encoding
RFC 3036	LDP Specification

Technical Assistance

Description	Link
The Cisco Technical Support & Documentation 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

Command Reference

This section documents modified commands.

- [clear mpls counters](#)
- [sequencing](#)

clear mpls counters

To clear the Multiprotocol Label Switching (MPLS) forwarding table disposition counters and the Any Transport over MPLS (AToM) imposition and disposition virtual circuit (VC) counters, use the **clear mpls counters** command in privileged EXEC mode.

clear mpls counters

Syntax Description This command has no arguments or keywords.

Defaults Checkpoint information resides on the active and standby Route Processor.

Command Modes Privileged EXEC

Command History	Release	Modification
	12.2(25)S	This command was introduced.
	12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB and implemented on the Cisco 10000 series routers. This command was updated to clear AToM VC counters.

Examples In the following example, the first **show mpls forwarding-table** command shows that 590 label-switched bytes exist in the forwarding table. The **clear mpls counters** command clears the counters. The second **show mpls forwarding-table** command shows that the number of label-switched bytes is 0.

```
Router# show mpls forwarding-table
```

```
Local   Outgoing   Prefix           Bytes Label   Outgoing   Next Hop
Label   Label or VC or Tunnel Id   Switched     interface
20      30          10.17.17.17     590           Et3/0      172.16.0.2
```

```
Router# clear mpls counters
```

```
Clear "show mpls forwarding-table" counters [confirm]
mpls forward counters cleared
```

```
Router# show mpls forwarding-table
```

```
Local   Outgoing   Prefix           Bytes Label   Outgoing   Next Hop
Label   Label or VC or Tunnel Id   Switched     interface
20      30          10.17.17.17     0             Et3/0      172.16.0.2
```

In the following example, the first **show mpls l2 vc detail** command shows that 15 packets were received and sent, 1656 bytes were received, and 1986 bytes were sent. The **clear mpls counters** command clears the counters. The second **show mpls l2 transport vc detail** command shows that no bytes or packets were received or sent.

```
Router# show mpls l2 vc detail

Local interface: Et0/0.10 up, line protocol up, Eth VLAN 10 up
  MPLS VC type is Eth VLAN, interworking type is Ethernet
  Destination address: 10.0.0.2, VC ID: 10, VC status: up
    Output interface: Et1/0, imposed label stack {16}
    Preferred path: not configured
    Default path: active
    Next hop: 10.0.0.2
  Create time: 00:19:35, last status change time: 00:19:09
  Signaling protocol: LDP, peer 10.0.0.2:0 up
    MPLS VC labels: local 16, remote 16
    Group ID: local 0, remote 0
    MTU: local 1500, remote 1500
    Remote interface description:
  Sequencing: receive enabled, send enabled
  VC statistics:
    packet totals: receive 15, send 15 <---- packet totals
    byte totals:   receive 1656, send 1986 <---- byte totals
    packet drops: receive 0, seq error 0, send 0

Router# clear mpls counters

Clear "show mpls forwarding-table" counters [confirm] mpls forward
counters cleared

Router# show mpls l2 vc detail

Local interface: Et0/0.10 up, line protocol up, Eth VLAN 10 up
  MPLS VC type is Eth VLAN, interworking type is Ethernet
  Destination address: 10.0.0.2, VC ID: 10, VC status: up
    Output interface: Et1/0, imposed label stack {16}
    Preferred path: not configured
    Default path: active
    Next hop: 10.0.0.2
  Create time: 00:22:55, last status change time: 00:22:29
  Signaling protocol: LDP, peer 10.0.0.2:0 up
    MPLS VC labels: local 16, remote 16
    Group ID: local 0, remote 0
    MTU: local 1500, remote 1500
    Remote interface description:
  Sequencing: receive enabled, send enabled
  VC statistics:
    packet totals: receive 0, send 0 <---- packet totals
    byte totals:   receive 0, send 0 <---- byte totals
    packet drops: receive 0, seq error 0, send 0
```

Related Commands

Command	Description
show mpls forwarding-table	Displays the contents of the MPLS forwarding information base.

sequencing

To configure the direction in which sequencing is enabled for data packets in a Layer 2 pseudowire, use the **sequencing** command in pseudowire class configuration mode. To remove the sequencing configuration from the pseudowire class, use the **no** form of this command.

```
sequencing {transmit | receive | both | resync number}
```

```
no sequencing {transmit | receive | both | resync number}
```

Syntax Description

transmit	Updates the Sequence Number field in the headers of data packets sent over the pseudowire according to the data encapsulation method that is used.
receive	Keeps the value in the Sequence Number field in the headers of data packets received over the pseudowire. Out-of-order packets are dropped.
both	Enables both the transmit and receive options.
resync	Enables the reset of packet sequencing after the disposition router receives a specified number of out-of-order packets.
<i>number</i>	The number of out-of-order packets that cause a reset of packet sequencing. The range is 5 to 65535.

Command Default

Sequencing is disabled.

Command Modes

Pseudowire class configuration

Command History

Release	Modification
12.0(23)S	This command was introduced for Layer 2 Tunnel Protocol Version 3 (L2TPv3).
12.3(2)T	This command was integrated into Cisco IOS Release 12.3(2)T.
12.0(29)S	This command was updated to support Any Transport over MPLS (AToM).
12.0(30)S	The resync keyword was added.
12.2(25)S	This command was integrated into Cisco IOS Release 12.2(25)S.
12.2(27)SBC	L2TPv3 support for this command was integrated into Cisco IOS Release 12.2(27)SBC.
12.2(28)SB	AToM support for this command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

When you enable sequencing using any of the available options, the sending of sequence numbers is automatically enabled and the remote provider edge (PE) peer is requested to send sequence numbers. Out-of-order packets received on the pseudowire are dropped only if you use the **sequencing receive** or **sequencing both** command.

If you enable sequencing for Layer 2 pseudowires on the Cisco 7500 series routers and you issue the **ip cef distributed** command, all traffic on the pseudowires is switched through the line cards.

It is useful to specify the **resync** keyword for situations when the disposition router receives many out-of-order packets. It allows the router to recover from situations where too many out-of-order packets are dropped.

Examples

The following example shows how to enable sequencing in data packets in Layer 2 pseudowires that were created from the pseudowire class named “ether-pw” so that the Sequence Number field is updated in tunneled packet headers for data packets that are both sent and received over the pseudowire:

```
Router(config)# pseudowire-class ether-pw
Router(config-pw)# encapsulation mpls
Router(config-pw)# sequencing both
```

The following example shows how to enable the disposition router to reset packet sequencing after it receives 1000 out-of-order packets:

```
Router(config)# pseudowire-class ether-pw
Router(config-pw)# encapsulation mpls
Router(config-pw)# sequencing both
Router(config-pw)# sequencing resync 1000
```

Related Commands

Command	Description
ip cef	Enables Cisco Express Forwarding on the Route Processor card.
pseudowire-class	Specifies the name of an L2TP pseudowire class and enters pseudowire class configuration mode.

Feature Information for AToM Sequencing Support

Table 1 lists the release history for this feature.

Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

Cisco IOS software images are specific to a Cisco IOS software release, a feature set, and a platform. Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at <http://www.cisco.com/go/fn>. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.


Note

Table 1 lists only the Cisco IOS software release that introduced support for a given feature in a given Cisco IOS software release train. Unless noted otherwise, subsequent releases of that Cisco IOS software release train also support that feature.

Table 1 Feature Information for AToM Sequencing Support

Feature Name	Releases	Feature Information
AToM Sequencing Support	12.0(29)S 12.0(30)S 12.0(32)S 12.2(28)SB	<p>In 12.0(29)S, this feature was introduced on the Cisco 7200 and 7500 series routers.</p> <p>In 12.0(30)S, this feature added support for the Cisco 12000 series routers and Engine 3 customer-facing line cards (except for Cisco 12000 Series Four-Port Gigabit Ethernet line cards).</p> <p>In 12.0(32)S, this feature added support for Engine 5 line cards on Cisco 12000 series routers.</p> <p>This feature was integrated into Cisco IOS Release 12.2(28)S for the Cisco 10000 series routers.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> • Information About AToM Sequencing Support, page 2 • How to Configure AToM Sequencing, page 3 • Configuration Examples for AToM Sequencing, page 7

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