Stateful MLPPP with MR-APS

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The Stateful MLPPP with MR-APS feature supports Interchassis Stateful Switchover (IC-SSO) for Multilink PPP (MLPPP) sessions, thereby allowing Multirouter Automatic Protection Switching (MR-APS) from one router to another, while maintaining the MLPPP sessions and avoiding session renegotiation. This feature is available only on Cisco 7600 series routers.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see 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 for Stateful MLPPP with MR-APS, on page 24.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Contents

Prerequisites for Configuring Stateful MLPPP with MR-APS

- To enable Stateful MLPPP with MR-APS across two routers, both routers must be manually configured with similar MR-APS MLPPP configurations.
- SONET controllers must be configured and enabled on the routers before the Stateful MLPPP with MR-APS feature can be configured.

Restrictions for Stateful MLPPP with MR-APS

- In-Service Software Upgrade (ISSU) is not supported.
- Applications running over PPP/MLPPP sessions such as Internet Group Management Protocol (IGMP) and TCP are not synchronized across the chassis. During Automatic Protection Switchover (APS), IGMP joints and TCP sessions need to be reestablished.
- APS session throttling for groups is not supported.
- Broadband sessions such as Point-to-Point Protocol over X (PPPoX) and IP are not supported in this feature.
- Intelligent Services Gateway (ISG) features are not supported on APS groups.
- The Authentication, Authorization, and Accounting (AAA) protocol is not supported on MR-APS.
- Config-sync is not supported.
- To enable Stateful MLPPP with MR-APS across two routers, both routers must be manually configured with similar MR-APS MLPPP configurations.

Information About Stateful MLPPP with MR-APS

Stateful MLPPP with MR-APS Overview

Traditionally, Multirouter Automatic Protection Switching provides Layer 1 (L1) switchover for optical links under 50 milliseconds across two routers. However, if there are MLPPP or PPP sessions on the optical link during an MR-APS switchover, all active MLPPP or PPP sessions need to renegotiate resulting in traffic loss.

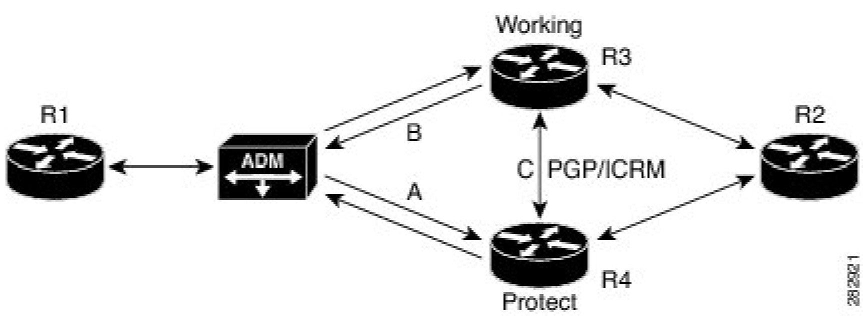
The Stateful MLPPP with MR-APS feature provides IC-SSO for PPP and MLPPP sessions across two routers without renegotiating the session or reprogramming the hardware when the switchover occurs. IC-SSO for MLPPP maintains the control plane state by synchronizing it from the router hosting the MR-APS active interface to the router hosting the MR-APS inactive interface. Using this synchronized information, the second router maintains the forwarding plane in a state of readiness to forward traffic immediately after an MR-APS switchover.

Interchassis MR-APS MLPPP SSO is achieved by leveraging and enhancing the existing functionality of MR-APS, Interchassis Redundancy Manager (ICRM), MLPPP, and Cluster Control Manager (CCM) components and protocols.

MR-APS Deployment

The MR-APS deployment involves multiple cell site routers connected to the provider network using bundled T1/E1 connections. These T1/E1 connections are aggregated into Optical Carrier 3 (OC3) or Optical Carrier 12 (OC12) links using Add-Drop Multiplexers (ADMs). The figure below shows the MR-APS deployment using Cisco 7600 routers. Router 1 (R1) is the cell site router, Router 2 (R2) is the core router, Routers 3 (R3) is the working provider edge (PE) router, and Router 4 (R4) is the protect PE router. To implement the Stateful MLPPP with MR-APS feature, you must configure MR-APS IC-SSO on both the working and the protect Cisco 7600 series routers.

Figure 1: MR-APS Deployment



Unlike the conventional SSO model, where one router is active and the other is in standby mode, in IC-SSO, during an MR-APS deployment, both routers are in the active state with SONET controllers synchronized on both routers. The controllers running on one router are in standby mode on the other router and vice versa. When MR-APS detects a failure in a SONET OC3 or OC12 controller on the working router, it activates the corresponding inactive controller on the protect router. This switchover from the inactive to the active state ensures minimal traffic outage to the end user, and this is achieved by ensuring that the MLPPP/PPP sessions per SONET controller (APS group) are stateful across the routers.

Interchassis Redundancy Manager

The Interchassis Redundancy Manager (ICRM) provides the following capabilities for the implementation of the Stateful MLPPP with MR-APS feature:

Node-health monitoring for complete node/PE/box failure detection. ICRM also detects failures to applications registered with an ICRM group.

Reliable data channeling to transfer state information to the peer.

Active RP failure detection. This failure is detected as a node failure and the controllers are notified.

- On failure of the active Route Processor (RP), ICRM on the standby RP reestablishes the communication channel with the peer node.

Automatic Protection Switching

Automatic Protection Switching (APS), the building block of the MR-APS feature, is responsible for managing the active and standby progression events on APS groups. Each APS group is a logical representation of a physical SONET controller redundancy state.

APS allows the switchover of OC3/OC12 channels in the event of a failure. APS involves a protect interface in the network as the backup for an active (working) interface. When the active interface fails, the protect interface takes care of the traffic load. Depending on the configuration, the two interfaces may be terminated on the same router or different routers. Based on where the interfaces terminate, APS is categorized into two types: single-router APS (SR-APS) and multirouter APS (MR-APS).

CCM Enhancements

The Cluster Control Manager (CCM) acts as a high availability (HA) abstract layer for all types of PPP sessions. The CCM is responsible for collecting all the required information from all clients that are part of a given session and syncing the information to the standby RP, thereby re-creating the session on the standby RP. Traditionally, the CCM is only aware of the RP HA state, which is either standby or active. This means that if the RP is active, the CCM treats all sessions on that RP as active, and if the RP is standby, the CCM treats all sessions on that RP as standby.

However, for the implementation of the Stateful MLPPP with MR-APS feature, the CCM is enhanced to have logical partitions of CCM sessions, also known as CCM groups. These CCM groups provide the capability to logically group broadband sessions and apply redundancy operations to only those set of sessions that belong to a CCM group. This feature enables broadband routers to act as standby for a group of broadband sessions that are active on a remote router, while hosting its own active broadband sessions. Therefore, this enhancement will enable each CCM group to be either active or standby on a given active RP and a given active RP to have multiple active CCM groups and multiple standby CCM groups.

Redundancy Group Facility

A new module called the redundancy group facility (RGF) has been developed to act as an agent between CCM, ICRM, and APS. This module is responsible for propagating redundancy state progressions to the CCM by receiving the redundancy state as active or standby from APS and deriving the CCM group progressions to reach either the active or the standby hot state. RGF also works as a mediator between ICRM and CCM groups for check-pointing session data. It will also accept node failure events from ICRM and propagate them to CCM groups.

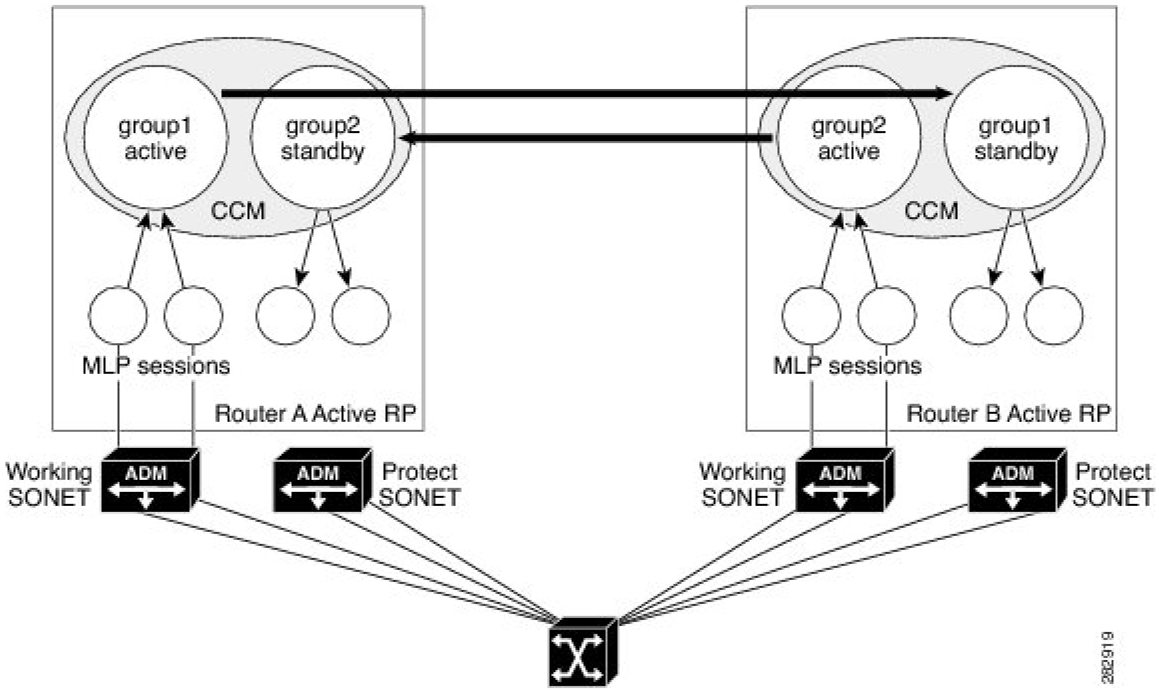
Failure Protection Scenarios

The Stateful MLPPP feature provides network resiliency by protecting against the following scenarios:

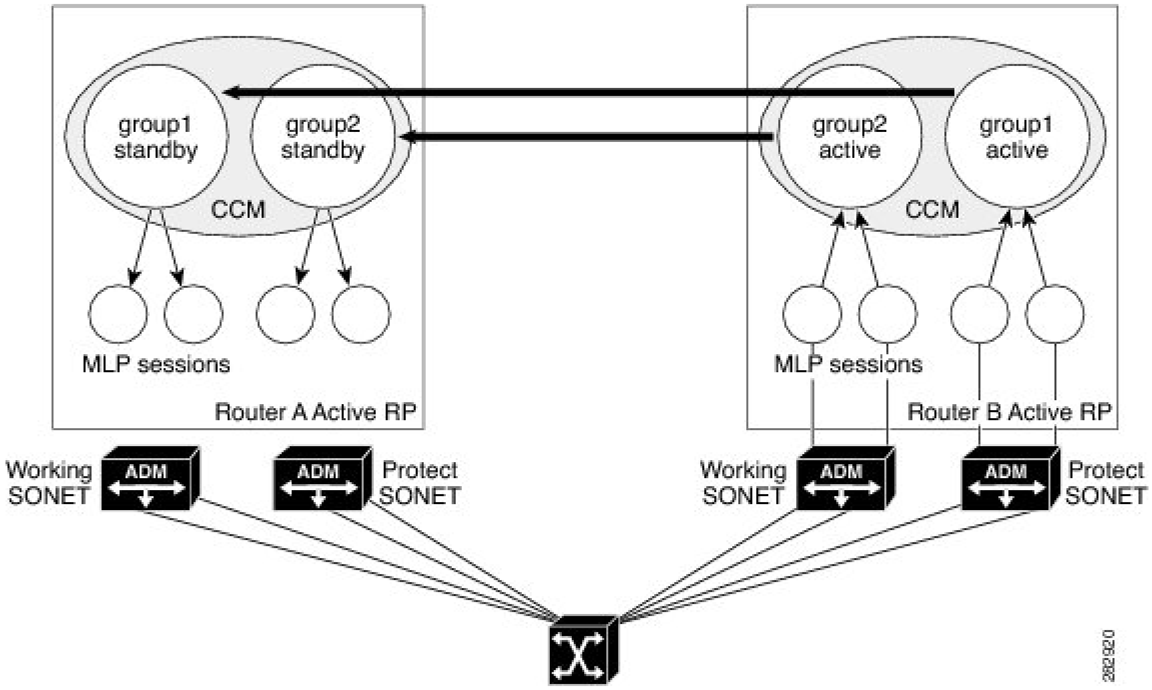
Active APS SONET Controller Failure

The figure below shows MLPPP sessions in an MR-APS configuration before an active APS group fails. On Router A active RP, group1 is CCM group 1 and group2 is CCM group 2. All sessions of group1 are active and all sessions of group2 are standby on Router A. Similarly, on Router B, all sessions of group2 are active and all sessions of group1 are in standby state.

Figure 2: MLPPP Sessions Before an Active APS Group Fails



When an APS group on Router A fails, the APS informs the corresponding standby APS group on Router B to take over as the active APS group. Here APS will be enhanced to inform CCM about the failure to the corresponding CCM group. The CCM group takes over as the active group and all sessions in that group will become active, while the previous active CCM group reinitializes itself before moving into the standby state. The figure below shows how MLPPP sessions switch over after the failure of an active APS group.



The standby group1 on the remote router takes over as the active group and reinitializes itself before going into the standby state.

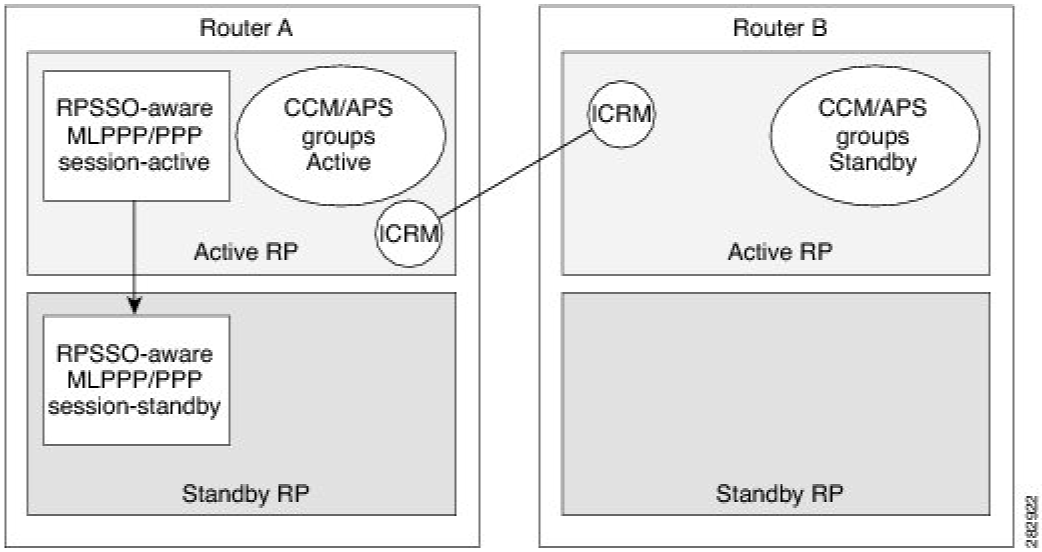
RP Failure and Node Failure

ICRM treats an active RP failure as a complete node failure and sends the go-active event to all standby CCM groups directing them to take over as active. Also, all standby APS groups move to active state on receiving the go-active event message, ensuring that both the APS and CCM groups are in the same state, even though APS can detect node failure on its own. Standby CCM groups take over as active and RGF updates its groups with the "peer not available" status.

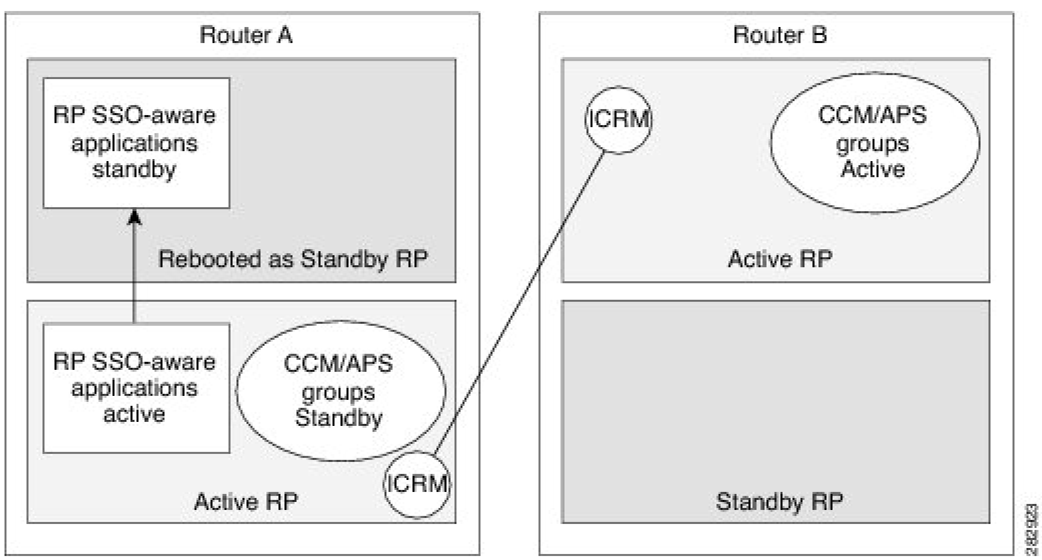
When the failed node comes up, ICRM establishes fresh connectivity and RGF connects to all groups on the remote router that is becoming active. Since peer groups are detected, RGF ensures bulk syncing of active CCM groups. The standby groups on the peer box receive this bulk sync data and automatically move into a hot-standby state.

The figure below shows CCM/APS groups on two peer nodes: Router A and Router B.

Figure 3: APS Groups on Peer Nodes



When the active RP of Router A fails, applications using ICRM should switch over to Router B (remote box). Consequently, all APS/CCM groups should switch over to Router B. Now, Router B has all the active APS/CCM groups. All APS/CCM groups on the standby RP of Router A are set to Init state after the standby RP changes to the active RP on Router A. Applications that are RP SSO aware (non-ICRM clients) switch over to the standby RP on Router A. The figure below shows APS groups after the active RP on Router A fails.



The ICRM establishes fresh connections with the new active RP on Router A and APS synchronizes the group states from Router B to Router A in the standby state. This event triggers all APS groups on Router A to go to the standby state, and the synchronization process is initiated from Router B. On Router A, the failed RP reboots as the new standby RP and RP SSO-aware applications are synchronized to the new standby RP.

How to Configure Stateful MLPPP with MR-APS

Setting Up an ICRM Session

Perform this task on both the working and the protect router to set up ICRM sessions to establish communication between the routers.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **redundancy**
4. **interchassis group** *group-id*
5. **monitor peer bfd**
6. **member ip** *ip-address*
7. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**redundancy** **Example:** `Router(config)# redundancy`	Enters redundancy configuration mode.
Step 4	**interchassis group** *group-id* **Example:** `Router(config-red)# interchassis group 50`	Configures an interchassis group within redundancy configuration mode and enters interchassis redundancy mode.
Step 5	**monitor peer bfd**	Configures the BFD option to monitor the state of the peer.

	Command or Action	Purpose
	Example: `Router(config-r-ic)# monitor peer bfd`	• The default configuration is route-watch.
Step 6	**member ip** *ip-address* **Example:** `Router(config-r-ic)# member ip 10.60.60.1`	Configures a remote redundancy group member by specifying the IP address of the member.
Step 7	**end** **Example:** `Router(config-r-ic)# end`	Exits interchassis redundancy mode and returns to privileged EXEC mode.

Setting Up the BFD Interval

Perform this task on both the working and the protect router to set up the baseline Bidirectional Forwarding Detection (BFD) parameters between the routers.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface gigabitethernet** *slot* / *subplot* / *port*
4. **ip address** *ip-address subnet-mask*
5. **load-interval** *seconds*
6. **negotiation** {**forced**| **auto**}
7. **mpls ip**
8. **mpls label protocol** {**ldp** | **tdp** | **both**}
9. **bfd interval** *milliseconds* **min_rx** *milliseconds* **multiplier** *interval-multiplier*
10. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface gigabitethernet** *slot* / *subplot* / *port* **Example:** `Router(config)# interface GigabitEthernet3/1/0`	Specifies the Gigabit Ethernet interface to be configured, where *slot/subslot/port* specifies the location of the interface.
Step 4	**ip address** *ip-address subnet-mask* **Example:** `Router(config-if)# ip address 10.1.1.1 255.255.255.0`	Configures the IP address for the interface.
Step 5	**load-interval** *seconds* **Example:** `Router(config-if)# load-interval 30`	Sets the length of time for which data is used for load calculations.
Step 6	**negotiation** {**forced**| **auto**} **Example:** `Router(config-if)# negotiation auto`	Enables the negotiation of speed, duplex mode, and flow control on a Gigabit Ethernet interface.
Step 7	**mpls ip** **Example:** `Router(config-if)# mpls ip`	Enables MPLS.
Step 8	**mpls label protocol** {**ldp** | **tdp** | **both**} **Example:** `Router(config-if)# mpls label protocol both`	Configures the label or tag distribution protocol or both on the interface.
Step 9	**bfd interval** *milliseconds* **min_rx** *milliseconds* **multiplier** *interval-multiplier*	Configures the transmit interval between BFD packets.

	Command or Action	Purpose
	Example: `Router(config-if)# bfd interval 50 min_rx 150 multiplier 3`	
Step 10	**end** **Example:** `Router(config-if)# end`	Exits interface configuration mode and returns to privileged EXEC mode.

Configuring the SONET Controller

Perform this task on the working and the protect router to configure SONET controllers on the routers.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **controller sonet** *slot* / *bay* / *port*
4. **no ais-shut**
5. **framing sonet**
6. **clock source** {**line** | **interval**}
7. **sts-1** *sts1-number*
8. **mode vt-15**
9. **vtg** *vtg-number* **t1** *t1-line-number* **channel-group** *channel-number* **timeslots** *list-of-timeslots*
10. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**controller sonet** *slot* / *bay* / *port* **Example:** `Router(config)# controller sonet 3/2/0`	Selects and configures a SONET controller and enters controller configuration mode.
Step 4	**no ais-shut** **Example:** `Router(config-controller)# no ais-shut`	Disables automatic insertion of a line alarm indication signal (LAIS) in the SONET signal.
Step 5	**framing sonet** **Example:** `Router(config-controller)# framing sonet`	Configures the controller for SONET framing; SONET framing is the default configuration.
Step 6	**clock source** {**line** | **interval**} **Example:** `Router(config-controller)# clock source line`	Configures the SONET port transmit clock source, where the **internal** keyword sets the internal clock and **line** keyword sets the clock recovered from the line. • Use the **line** keyword whenever clocking is derived from the network. Use the **internal** keyword when two routers are connected back-to-back or over fiber for which no clocking is available. • The line clock is the default configuration.
Step 7	**sts-1** *sts1-number* **Example:** `Router(config-controller)# sts-1 1`	Specifies the Synchronous Transport Signal (STS) identifier and enters STS configuration mode.
Step 8	**mode vt-15** **Example:** `Router(config-ctrlr-sts1)# mode vt-15`	Specifies VT-15 as the STS-1 mode of operation.
Step 9	**vtg** *vtg-number* **t1** *t1-line-number* **channel-group** *channel-number* **timeslots** *list-of-timeslots*	Creates a Circuit Emulation Services over Packet Switched Network (CESoPSN) circuit emulation CEM group.

	Command or Action	Purpose
	Example: `Router(config-ctrlr-sts1)# vtg 1 t1 1 channel-group 0 timeslots 1-24`	
Step 10	**end**	Exits STS configuration mode and returns to privileged EXEC mode.

Configuring the Serial Interface to Enable MLPPP

Perform this task on both the working and the protect router to configure the serial interface to enable MLPPP sessions on the routers.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface serial** *instance*
4. **no ip address**
5. **encapsulation ppp**
6. **ppp multilink**
7. **ppp multilink group** *group-number*
8. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**interface serial** *instance* **Example:** `Router(config)# interface Serial3/2/0.1/1/1:0`	Configures the serial interface and enters interface configuration mode.
Step 4	**no ip address** **Example:** `Router(config-if)# no ip address`	Removes any configured IP address from the interface.
Step 5	**encapsulation ppp** **Example:** `Router(config-if)# encapsulation ppp`	Enables PPP encapsulation of traffic on the specified interface.
Step 6	**ppp multilink** **Example:** `Router(config-if)# ppp multilink`	Enables MLPPP.
Step 7	**ppp multilink group** *group-number* **Example:** `Router(config-if)# ppp multilink group 1`	Restricts a physical link to be associated only with a designated multilink group interface.
Step 8	**end** **Example:** `Router(config-if)# end`	Exits interface configuration mode and returns to privileged EXEC mode.

Configuring the Multilink Interface

Perform this task on both the working and the protect router to configure the multilink interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface multilink1**
4. **ip address** *ip-address subnet-mask*
5. **carrier-delay msec** *msec*
6. **ppp multilink**
7. **ppp multilink group** *group-number*
8. **ppp multilink endpoint** {**hostname** | **ip** *ip-address* | **mac** *lan-interface* | **none** | **phone** *telephone-number* | **string** *char-string*}
9. **ppp timeout retry** *seconds*
10. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface multilink1** **Example:** `Router(config)# interface multilink1`	Configures a multilink interface and enters multilink interface configuration mode.
Step 4	**ip address** *ip-address subnet-mask* **Example:** `Router(config-if)# ip address 10.0.0.1 255.255.255.0`	Configures the IP address for the interface.
Step 5	**carrier-delay msec** *msec* **Example:** `Router(config-if)# carrier-delay msec 1`	Sets the time to propagate the link status to other modules.

	Command or Action	Purpose
Step 6	**ppp multilink** **Example:** `Router(config-if)# ppp multilink`	Enables MLPPP.
Step 7	**ppp multilink group** *group-number* **Example:** `Router(config-if)# ppp multilink group 1`	Restricts a physical link to be associated only with a designated multilink group interface.
Step 8	**ppp multilink endpoint** {**hostname** | **ip** *ip-address* | **mac** *lan-interface* | **none** | **phone** *telephone-number* | **string** *char-string*} **Example:** `Router(config-if)# ppp multilink endpoint string mlp_aps_1`	Overrides or changes the default endpoint discriminator that the system uses when negotiating the use of MLPPP with the peer system. • **hostname** – Specifies the use of the hostname configured for the router. This is useful when multiple routers use the same username for authentication, but have different hostnames. • **ip** *ip-address* – Specifies the IP address to be used. • **mac** *lan-interface* – Specifies the LAN interface whose MAC address is to be used. • **none** – Causes negotiation of the Link Control Protocol (LCP) without requesting the endpoint discriminator option, which is useful when the router connects to a malfunctioning peer system that does not handle the endpoint discriminator option properly. • **phone** – Specifies the telephone number to be used. Accepts E.164-compliant and full international telephone numbers. • **string** *char-string* – Specifies the specific character string to be used.
Step 9	**ppp timeout retry** *seconds* **Example:** `Router(config-if)# ppp timeout retry 4`	Sets PPP timeout retry parameters. • Specifies the maximum time, in seconds, to wait for a response during PPP negotiation. The range is from 1 to 10 seconds. • The default is 3 seconds.
Step 10	**end** **Example:** `Router(config-if)# end`	Exits interface configuration mode and returns to privileged EXEC mode.

Configuring the APS Group for the SONET Controller

Perform this task on both the working and protect router to configure the APS group for a SONET controller.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **controller sonet** *slot* / *bay* / *port*
4. **shutdown**
5. **aps group** *group-id*
6. **aps** [**working**| **protect**] *aps-group-number*[*ip-address-working-router*]
7. **aps interchassis group** *group-number*
8. **no shutdown**
9. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**controller sonet** *slot* / *bay* / *port* **Example:** `Router(config)# controller sonet 3/2/0`	Selects and configures a SONET controller and enters controller configuration mode.
Step 4	**shutdown** **Example:** `Router(config-controller)# shutdown`	Shuts down the SONET controller.
Step 5	**aps group** *group-id* **Example:** `Router(config-controller)# aps group 1`	Configures an APS group for the SONET controller.

	Command or Action	Purpose
Step 6	**aps** [**working**| **protect**] *aps-group-number*[*ip-address-working-router*] **Example:** `Router(config-controller)# aps working 1 10.2.2.1`	Configures the APS group as the working or protect interface, depending on whether the router is the working router or the protect router. The *ip-address-working-router* attribute is only required while configuring the protect router.
Step 7	**aps interchassis group** *group-number* **Example:** `Router(config-controller)# aps interchassis group 1`	Associates an APS group with an ICRM group number.
Step 8	**no shutdown** **Example:** `Router(config-controller)# no shutdown`	Enables the interface.
Step 9	**end** **Example:** `Router(config-controller)# end`	Exits controller configuration mode and returns to privileged EXEC mode.

Verifying the Functionality of Stateful MLPPP with MR-APS

Perform the following steps to verify the functionality of the Stateful MLPPP with MR-APS feature configured on the working and protect router.

SUMMARY STEPS

1. **show aps**
2. **show rgf groups**

DETAILED STEPS

Step 1 **show aps**
Use this command to display detailed information about the APS configuration on the working or protect router. The following is sample output of the command on the protect router:

Example:

```
Router# show aps
SONET 3/2/0 APS Group 1: protect channel 0 (Inactive) (HA)
Working channel 1 at 10.1.1.2 (Enabled) (HA)
bidirectional, non-revertive
PGP timers (extended for HA): hello time=1; hold time=10
hello fail revert time=120
SONET framing; SONET APS signalling by default
Received K1K2: 0x00 0x05
No Request (Null)
Transmitted K1K2: 0x00 0x05
No Request (Null)
Remote APS configuration: (null)
Protect-Router#
```

The following is sample output of the command on the working router:

Example:

```
Router# show aps
SONET 1/2/0 APS Group 1: working channel 1 (Active) (HA)
Protect at 10.1.1.2
PGP timers (from protect): hello time=1; hold time=10
SONET framing
Remote APS configuration: (null)
```

Step 2 **show rgf groups**

Use this command to get information about the state of the router and the peer. The following is sample output of the command on the protect router:

Example:

```
Router# show rgf groups
Total RGF groups: 1
----------------------------------------------------------
STANDBY RGF GROUP
RGF Group ID : 1
RGF Peer Group ID: 0
ICRM Group ID : 1
APS Group ID : 1
RGF State information:
My State Present : Standby-hot
Previous : Standby-bulk
Peer State Present: Active-fast
Previous: Standby-cold
Misc:
Communication state Up
aps_bulk: 0
aps_stby: 0
peer_stby: 0
-> Driven Peer to [peer Standby Bulk] Progression
-> We sent Bulk Sync start Progression to Active
RGF GET BUF: 366 RGF RET BUF 366
```

The following is sample output of the command on the working router:

Example:

```
Router# show rgf groups
Total RGF groups: 1
----------------------------------------------------------
```

```
ACTIVE RGF GROUP
RGF Group ID : 1
RGF Peer Group ID: 0
ICRM Group ID : 1
APS Group ID : 1
RGF State information:
My State Present : Active-fast
Previous : Standby-cold
Peer State Present: Standby-hot
Previous: Standby-bulk
Misc:
Communication state Up
aps_bulk: 0
aps_stby: 0
peer_stby: 0
-> Driven Peer to [Peer Standby Hot] Progression
-> Standby sent Bulk Sync start Progression
```

RGF GET BUF: 366 RGF RET BUF 366

If the value of “My State Present” is “Standby-hot,” the router is in standby state. If the value of “My State Present” is “Active-fast,” the router is in active state.

Configuration Examples for Stateful MLPPP with MR-APS

This section provides the following configuration examples:

Example Configuring Stateful MLPPP with MR-APS on a Working Router, on page 20

Example Configuring Stateful MLPPP with MR-APS on a Protect Router, on page 21

Example Configuring Stateful MLPPP with MR-APS on a Working Router

This example shows how to configure Stateful MLPPP with MR-APS on a Working Router.

```
Router> enable
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# redundancy
Router(config-red)# interchassis group 1
Router(config-r-ic)# monitor peer bfd
Router(config-r-ic)# member ip 10.1.1.2
Router(config-r-ic)# end
Router#
configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# interface GigabitEthernet3/1/0 <<<<<<< ICRM link >>>>>>>>
Router(config-if)# ip address 10.1.1.1 255.255.255.0
Router(config-if)# load-interval 30
Router(config-if)# negotiation auto
Router(config-if)# mpls ip
Router(config-if)# mpls label protocol both
Router(config-if)# bfd interval 50 min_rx 150 multiplier 3
Router(config-if)# end
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config-if)# interface GigabitEthernet3/1/1 <<<<< PGP Link>>>>>>>
Router(config-if)# ip address 10.1.1.3 255.255.255.0
Router(config-if)# negotiation auto
Router(config-if)# cdp enable
```

```
Router(config-if)# end
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#controller SONET 4/2/0
Router(config-controller)# no ais-shut
Router(config-controller)# framing sonet
Router(config-controller)# clock source line
Router(config-controller)# sts-1 1
Router(config-ctrlr-sts1)# mode vt-15
Router(config-ctrlr-sts1)# vtg 1 t1 1 channel-group 0 timeslots 1-24
Router(config-ctrlr-sts1)# end
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# interface Multilink1
Router(config-if)# ip address 10.1.1.4 255.255.255.0
Router(config-if)# carrier-delay msec 1
Router(config-if)# ppp multilink
Router(config-if)# ppp multilink group 1
Router(config-if)# ppp multilink endpoint string mlp_aps_1
Router(config-if)# ppp timeout retry 0 250
Router(config-if)# end
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# interface Serial4/2/0.1/1/1:0
Router(config-if)# no ip address
Router(config-if)# encapsulation ppp
Router(config-if)# ppp multilink
Router(config-if)# ppp multilink group 1
Router(config-if)# end
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# controller sonet 3/2/0
Router(config-controller)# shutdown
Router(config-controller)# aps group 1
Router(config-controller)# aps working 1
Router(config-controller)# aps interchassis group 1
Router(config-controller)# no shutdown
Router(config-controller)# end
```

Example Configuring Stateful MLPPP with MR-APS on a Protect Router

This example shows how to configure Stateful MLPPP with MR-APS on a Protect router.

```
Protect-Router> enable
Protect-Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# redundancy
Router(config-red)# interchassis group 1
Router(config-r-ic)# monitor peer bfd
Router(config-r-ic)# member ip 10.1.1.7
Router(config-r-ic)# end
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# interface GigabitEthernet2/1/0
Router(config-if)# ip address 10.1.1.8 255.255.255.0
Router(config-if)# load-interval 30
Router(config-if)# negotiation auto
Router(config-if)# mpls ip
Router(config-if)# mpls label protocol both
Router(config-if)# bfd interval 50 min_rx 150 multiplier 3
Router(config-if)# end
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config-if)# interface GigabitEthernet2/1/1
Router(config-if)# ip address 10.1.1.9 255.255.255.0
Router(config-if)# negotiation auto
Router(config-if)# end
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
```

```
Router(config)#controller SONET 3/2/0
Router(config-controller)# no ais-shut
Router(config-controller)# framing sonet
Router(config-controller)# clock source line
Router(config-controller)# sts-1 1
Router(config-ctrlr-sts1)# mode vt-15
Router(config-ctrlr-sts1)# vtg 1 t1 1 channel-group 0 timeslots 1-24
Router(config-ctrlr-sts1)# end
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# interface Multilink1
Router(config-if)# ip address 10.1.1.10 255.255.255.0
Router(config-if)# carrier-delay msec 1
Router(config-if)# ppp multilink
Router(config-if)# ppp multilink group 1
Router(config-if)# ppp multilink endpoint string mlp_aps_1
Router(config-if)# ppp timeout retry 0 250
Router(config-if)# end
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# interface Serial3/2/0.1/1/1:0
Router(config-if)# no ip address
Router(config-if)# encapsulation ppp
Router(config-if)# ppp multilink
Router(config-if)# ppp multilink group 1
Router(config-if)# end
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# controller sonet 3/2/0
Router(config-controller)# shut
Router(config-controller)# aps group 1
Router(config-controller)# aps protect 1 10.1.1.3
Router(config-controller)# aps interchassis group 1
Router(config-controller)# no shutdown
Router(config-controller)# end
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Master Commands List, All Releases
WAN commands: complete command syntax, command mode, defaults, usage guidelines and examples	Wide-Area Networking Command Reference
Layer 2 Tunnel Protocol Version 3	*Layer 2 Tunneling Protocol Version 3*
Any Transport over MPLS	*Any Transport over MPLS*
Cisco 12000 series routers hardware support	*Cross-Platform Release Notes for Cisco IOS Release 12.0S*
Cisco 7600 series routers hardware support	*Cross-Platform Release Notes for Cisco IOS Release 12.2SR*
Cisco 3270 series routers hardware support	*Release Notes for Cisco IOS Software Release 12.2SE*

Standards and RFCs

Standard/RFC	Title
draft-ietf-l2tpext-l2tp-base-03.txt	*Layer Two Tunneling Protocol (Version 3) 'L2TPv3'*
draft-martini-l2circuit-trans-mpls-09.txt	*Transport of Layer 2 Frames Over MPLS*
draft-ietf-pwe3-frame-relay-03.txt.	*Encapsulation Methods for Transport of Frame Relay over MPLS Networks*
draft-martini-l2circuit-encap-mpls-04.txt.	*Encapsulation Methods for Transport of Layer 2 Frames Over IP and MPLS Networks*
draft-ietf-pwe3-ethernet-encap-08.txt.	*Encapsulation Methods for Transport of Ethernet over MPLS Networks*
draft-ietf-pwe3-hdlc-ppp-encap-mpls-03.txt.	*Encapsulation Methods for Transport of PPP/HDLC over MPLS Networks*
draft-ietf-ppvpn-l2vpn-00.txt.	*An Architecture for L2VPNs*

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

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 Stateful MLPPP with MR-APS

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 the Stateful MLPPP with MR-APS feature

Feature Name	Releases	Feature Information
Stateful MLPPP with MR-APS	15.1(3)S	The Stateful MLPPP with MR-APS feature supports IC-SSO for MLPPP sessions, thereby allowing MR-APS from one router to another, while maintaining the MLPPP sessions and avoiding session renegotiation. This feature is available only on Cisco 7600 series routers. In Cisco IOS Release 15.1(3)S, this feature was introduced on the Cisco 7600 series routers. The following commands were introduced or modified: **aps interchassis group**, **debug rgf detail**, **debug rgf error**, **debug rgf event**, **show ccm group all**, **show ccm group id**, **show ccm session id**, **show rgf groups**, **show rgf history**, **show rgf statistics**.