Configuring Multi Router Automatic Protection Switching

Note Multi Router Automatic Protection Switching is *not* supported on the Cisco ASR 900 RSP3 module.

The Multi Router Automatic Protection Switching (MR-APS) integration with hot standby pseudowire (HSPW) feature is a protection mechanism for Synchronous Optical Network (SONET) networks that enables SONET connections to switch to another SONET circuit when a circuit failure occurs. A protect interface serves as the backup interface for the working interface. When the working interface fails, the protect interface quickly assumes its traffic load.

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 MR-APS

- Asynchronous Transfer Mode (ATM) port mode is not supported.
- An APS group number must be greater than zero.
- Revertive APS mode on the Circuit Emulation (CEM) interface is not supported.

- Starrting with Cisco IOS XE Release 3.15, CEM MR-APS switvchover does not occur on an RP SSO.
- HSPW *group number* other than the redundancy interchassis *group number* is not supported.
- Do not configure the **backup delay** *value* command if the MR-APS integration with HSPW feature is configured.
- Unconfiguring the **mpls ip** command on the core interface is not supported.
- The **hspw force switch** command is not supported.
- When you enable MRAPS 1+1 unidirectional mode, the PW status does not change for ASR 903 routers. But, the same behavior is not seen for ASR 901 routers. To overcome this issue, reload the ASR 901 router.
- Ensure to have both ASR 903 and ASR 901 routers configured with unidirectional configuration mode for MRAPS 1+1, else it results in a traffic drop.

Information About MR-APS

This feature enables interface connections to switch from one circuit to another if a circuit fails. Interfaces can be switched in response to a router failure, degradation or loss of channel signal, or manual intervention. In a multi router environment, the MR-APS allows the protected SONET interface to reside in a different router from the working SONET interface.

Service providers are migrating to ethernet networks from their existing SONET or SDH equipment to reduce cost. Any transport over MPLS (AToM) PWs help service providers to maintain their investment in time division multiplexing (TDM) network and change only the core from SONET or SDH to ethernet. When the service providers move from SONET or SDH to ethernet, network availability is always a concern. Therefore, to enhance the network availability, service providers use PWs.

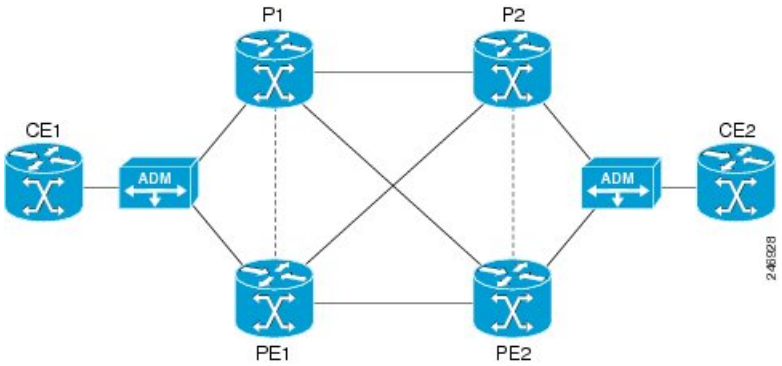
The HSPW support for TDM access circuits (ACs) allow the backup PW to be in a hot- standby state, so that it can immediately take over if the primary PW fails. The present HSPW solution does not support ACs as part of the APS group. The PWs which are configured over the protected interface, remain in the standby state. MR-APS integration with an HSPW is an integration of APS with CEM TDM HSPW and improves the switchover time.

For more information on APS, see the Automatic Protection Switching Configuration.

In the example below, routers P1 and PE1 are in the same APS group G1, and routers P2 and PE2 are in the same APS group G2. In group G1, P1 is the working router and PE1 is the protected router. Similarly in group G2, P2 is the working router and PE2 is the protected router.

The MR-APS integration with HSPW deployment involves cell sites connected to the provider network using bundled T1/E1 connections. These T1/E1 connections are aggregated into the optical carrier 3 (OC3) link using the add-drop multiplexers (ADMs).

Figure 1: MR-APS Integration with HSPW Implementation

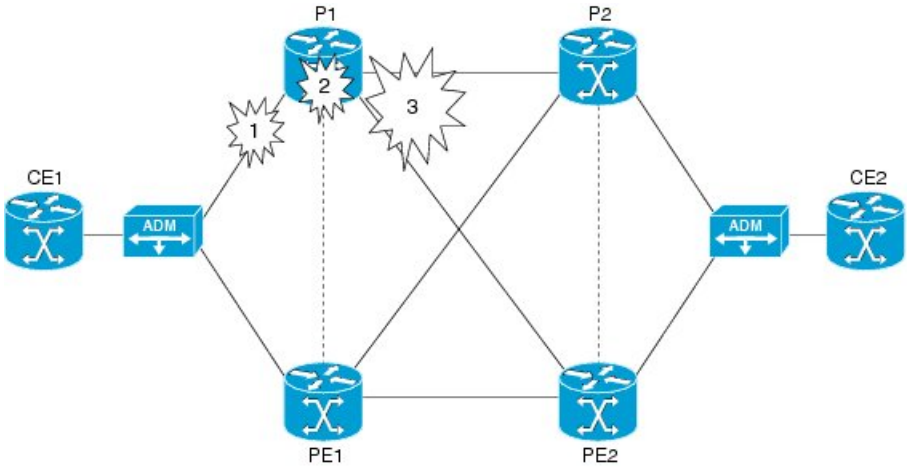


Failover Operations

MR-APS integration with HSPW feature handles the following failures:

- Failure 1, where the link between ADM and P1 goes down, or the connecting ports at ADM or P1 go down.
- Failure 2, where the router P1 fails.
- Failure 3, where the router P1 is isolated from the core.

Figure 2: Failure Points in the Network

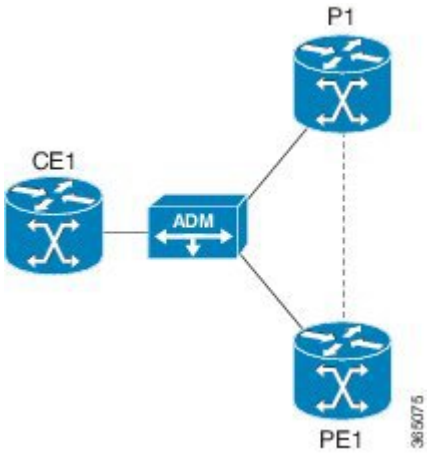


In case of failure 1, where either port at the ADM goes down, or the port at the router goes down, or the link between ADM and router fails, the APS switchover triggers the pseudowires at the protect interface to become active. The same applies to failure 2 as well where the complete router fails over.

In case of failure 3, where all the links carrying primary and backup traffic lose the connection, a new client is added to the inter chassis redundancy manager (ICRM) infrastructure to handle the core isolation. The client listens to the events from the ICRM. Upon receiving the core isolation event from the ICRM, the client either initiates the APS switchover, or initiates the alarm based on the peer core isolation state. If APS switchover occurs, it changes the APS inactive interface to active and hence activates the PWs at the interface. Similarly, when core connectivity goes up based upon the peer core isolation state, it clears the alarms or triggers the

APS switchover. The ICRM monitors the directly connected interfaces only. Hence only those failures in the directly connected interfaces can cause a core isolation event.

Figure 3: MR-APS Integration on a POS interface



Configuring MR-APS with HSPW-ICRM on a CEM interface

To configure MR-APS integration with HSPW-ICRM on a CEM interface, complete the following steps:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **pseudowire-class** *pw-class-name*
4. **encapsulation mpls**
5. **status peer topology dual-homed**
6. **exit**
7. **redundancy**
8. **interchassis group** *group-id*
9. **member ip** *ip-address*
10. **backbone interface** *slot/bay/port*
11. **exit**
12. **controller SONET** *slot/bay/port*
13. **framing** [**SDH** | **SONET**]
14. **clock source line**
15. **sts-1** *sts1-number*
16. **mode vt-15**
17. **vtg** *vtg_number* **t1** *t1_line_number* **cem-group** *group-number* **timeslots** *time-slot-range*
18. **exit**
19. **aps group** *group_id*
20. **aps** [**working** | **protect**] *aps-group-number*
21. **aps hspw-icrm-grp** *group-number*

22. **exit**
23. **interface cem** *slot/bay/port*
24. **cem** *group-number*
25. **xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name*
26. **backup peer** *peer-id vc-id* **pw-class** *pw-class-name*
27. **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	**pseudowire-class** *pw-class-name* **Example:** `Router(config)# pseudowire-class hspw_aps`	Specifies the name of a PW class and enters PW class configuration mode.
Step 4	**encapsulation mpls** **Example:** `Router(config-pw-class)# encapsulation mpls`	Specifies that MPLS is used as the data encapsulation method for tunneling Layer 2 traffic over the PW.
Step 5	**status peer topology dual-homed** **Example:** `Router(config-pw-class)# status peer topology dual-homed`	Enables the reflection of the attachment circuit status on both the primary and secondary PWs. This configuration is necessary if the peer PEs are connected to a dual-homed device.
Step 6	**exit** **Example:** `Router(config-pw-class)# exit`	Exits PW class configuration mode.
Step 7	**redundancy** **Example:** `Router(config)# redundancy`	Enters the redundancy configuration mode.
Step 8	**interchassis group** *group-id* **Example:** `Router(config-red)# interchassis group 50`	Configures an interchassis group within the redundancy configuration mode and enters the interchassis redundancy mode.
Step 9	**member ip** *ip-address* **Example:** `Router(config-r-ic)# member ip 60.60.60.2`	Configures the IP address of the peer member group.

	Command or Action	Purpose
Step 10	**backbone interface** *slot/bay/port* **Example:** `Router(config-r-ic)# backbone interface GigabitEthernet 0/2/3`	Specifies the backbone interface. • *slot*—Chassis slot number, which is always 0. • *bay*—Card interface bay number in a slot. The range is from 0 to 5. • *port*—Port or interface number. The range is from 0 to 7 for Gigabit Ethernet.
Step 11	**exit** **Example:** `Router(config-r-ic)# exit`	Exits the redundancy mode.
Step 12	**controller SONET** *slot/bay/port* **Example:** `Router(config)# controller SONET 0/5/2`	Selects and configures a SONET controller and enters controller configuration mode. • *slot*—Chassis slot number, which is always 0. • *bay*—Card interface bay number in a slot. The range is from 0 to 5. • *port*—Port or interface number. The range is from 0 to 7 for Gigabit Ethernet.
Step 13	**framing** [**SDH** | **SONET**] **Example:** `Router(config-controller)# framing SONET`	Configures the controller with framing type. SONET framing is the default option.
Step 14	**clock source line** **Example:** `Router(config-controller)# clock source line`	Sets the clocking for individual T1 or E1 links.
Step 15	**sts-1** *sts1-number* **Example:** `Router(config-controller)# sts-1 1`	Specifies the STS identifier.
Step 16	**mode vt-15** **Example:** `Router(config-ctrlr-sts1)# mode vt-15`	Specifies the STS-1 mode of operation.
Step 17	**vtg** *vtg_number* **t1** *t1_line_number* **cem-group** *group-number* **timeslots** *time-slot-range* **Example:** `Router(config-ctrlr-sts1)# vtg 1 t1 1 cem-group 0 timeslots 1-24`	Creates a Circuit Emulation Services over Packet Switched Network circuit emulation (CESoPSN) CEM group. • **vtg**—Specifies the VTG number from 1-7. • **t1**—Specifies the T1 line. • *t1_line_number*—Specifies the T1 line number.

	Command or Action	Purpose
		• **cem-group**—Creates a circuit emulation (CEM) channel from one or more time slots of a T1 line. • *group-number*—CEM identifier to be used for this group of time slots. For T1 ports, the range is from 0 to 23. • **timeslots**—Specifies that a list of time slots is to be used as specified by the *time-slot-range* argument. • *time-slot-range*—Specifies the time slots to be included in the CEM channel. The list of time slots may include commas and hyphens with no spaces between the numbers.
Step 18	**exit** **Example:** `Router(config-ctrlr-sts1)# exit`	Exits from the STS configuration mode.
Step 19	**aps group** *group_id* **Example:** `Router(config-controller)# aps group 1`	Configures the APS group for CEM.
Step 20	**aps** [**working** | **protect**] *aps-group-number* **Example:** `Router(config-controller)# aps working 1`	Configures the APS group as working or protect interface. **Note** For MR-APS, one router must be configured as aps working 1 and the other router must be configured as aps protect 1.
Step 21	**aps hspw-icrm-grp** *group-number* **Example:** `Router(config-controller)# aps hspw-icrm-group 1`	Associates the APS group to an ICRM group number.
Step 22	**exit** **Example:** `Router(config-controller)# exit`	Ends the controller session and returns to the configuration mode.
Step 23	**interface cem** *slot/bay/port* **Example:** `Router(config)# interface cem 0/5/2`	Configures a serial interface and enters the interface configuration mode • *slot*—Chassis slot number, which is always 0. • *bay*—Card interface bay number in a slot. The range is from 0 to 5. • *port*—Port or interface number. The range is from 0 to 7 for Gigabit Ethernet.

	Command or Action	Purpose
Step 24	**cem** *group-number* **Example:** `Router(config-if)# cem 0`	Selects the CEM circuit (group) to configure a PW for.
Step 25	**xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name* **Example:** `Router(config-if-srv)# xconnect 3.3.3.3 1 pw-class hspw_aps`	Specifies the IP address of the peer PE router and the 32-bit virtual circuit identifier shared between the PEs at each end of the control channel. • *peer-ip-address*—IP address of the remote provider edge (PE) peer. The remote router ID can be any IP address, as long as it is reachable. • *vcid* —32-bit identifier of the virtual circuit (VC) between the PE routers. • **pw-class**—Specifies the PW class. • *pw-class-name*—Specifies the name of the PW class. **Note** The peer router IP address and virtual circuit ID must be a unique combination on the router.
Step 26	**backup peer** *peer-id vc-id* **pw-class** *pw-class-name* **Example:** `Router(config-if-srv)# backup peer 4.3.3.3 90 pw-class vpws`	Specifies a redundant peer for a PW virtual circuit. • *peer-id vc-id*—Specifies IP address of the remote peer. • **pw-class**—Specifies the PW class. • *pw-class-name*—Specifies the name of the PW class.
Step 27	**end** **Example:** `Router(config-if-srv)# end`	Returns to privileged EXEC mode.

Verifying MR-APS

- Use the **show cem circuit** [*cem-group-id* | **interface** {**CEM** | **Virtual-CEM**} *slot /subslot /port cem-group-id* | **detail** | **summary**] command to display CEM statistics for the configured CEM circuits. If **xconnect** is configured under the circuit, the command output also includes information about the attached circuit.

  Following is a sample output of the **show cem circuit** command to display the detailed information about CEM circuits configured on the router:

```
Router# show cem circuit

CEM Int.        ID   Ctrlr     Admin     Circuit          AC
---------------------------------------------------------------
CEM0/5/2        1    UP        UP        Active            UP
CEM0/5/2        2    UP        UP        Active            UP
```

```
CEM0/5/2       3    UP         UP         Active           UP

!
.
.
.

CEM0/5/2       83   UP         UP         Active           UP
CEM0/5/2       84   UP         UP         Active           UP
!
```

Following is a sample output of the **show cem circuit***0-504* command to display the detailed information about that particular circuit:

```
Router# show cem circuit 1
```

```
CEM0/5/2 , ID: 1, Line: UP, Admin: UP, Ckt: ACTIVE Controller state: up, T1/E1
 state: up Idle Pattern: 0xFF, Idle CAS: 0x8
Dejitter: 5 (In use: 0)
Payload Size: 192
Framing: Unframed
CEM Defects Set
None

Signalling: No CAS
RTP: No RTP

Ingress Pkts:    151066              Dropped:             0

Egress Pkts:     151066              Dropped:             0


CEM Counter Details
Input Errors:    0                   Output Errors:       0

Pkts Missing:    0                   Pkts Reordered:      0

Misorder Drops:  0                   JitterBuf Underrun:  0

Error Sec:       0                   Severly Errored Sec: 0

Unavailable Sec: 0                   Failure Counts:      0

Pkts Malformed:  0                   JitterBuf Overrun:   0
```

- Use the **show mpls ldp neighbor** command to display the status of Label Distribution Protocol (LDP) sessions:

```
Router# show mpls ldp neighbor
```

```
 Peer LDP Ident: 17.3.3.3:0; Local LDP Ident 17.1.1.1:0
        TCP connection: 17.3.3.3.13282 - 17.1.1.1.646
        State: Oper; Msgs sent/rcvd: 466/209; Downstream
        Up time: 00:23:50
        LDP discovery sources:
          GigabitEthernet0/4/0 , Src IP addr: 11.11.11.2
          Targeted Hello 17.1.1.1 -> 17.3.3.3, active, passive
        Addresses bound to peer LDP Ident:
          70.70.70.1      22.22.22.2      17.3.3.3        11.11.11.2
    Peer LDP Ident: 17.4.4.4:0; Local LDP Ident 17.1.1.1:0
        TCP connection: 17.4.4.4.24248 - 17.1.1.1.646
```

```
        State: Oper; Msgs sent/rcvd: 209/205; Downstream
        Up time: 00:23:40
        LDP discovery sources:
          GigabitEthernet0/4/2, Src IP addr: 33.33.33.2
          Targeted Hello 17.1.1.1 -> 17.4.4.4, active, passive
        Addresses bound to peer LDP Ident:
          70.70.70.2      44.44.44.2      17.4.4.4        33.33.33.2
    Peer LDP Ident: 17.2.2.2:0; Local LDP Ident 17.1.1.1:0
        TCP connection: 17.2.2.2.32112 - 17.1.1.1.646
        State: Oper; Msgs sent/rcvd: 45/44; Downstream
        Up time: 00:23:38
        LDP discovery sources:
          GigabitEthernet0/4/4 , Src IP addr: 60.60.60.2
        Addresses bound to peer LDP Ident:
          22.22.22.1      44.44.44.1      17.2.2.2        60.60.60.2
```

- Use the **show mpls l2 vc** command to display information related to a VC:

```
Router# show mpls l2 vc
```

```
Local intf     Local circuit              Dest address    VC ID      Status
-------------  -------------------------- --------------- ----------
----------
CEM0/5/2           SATOP T1 1                 17.3.3.3        1001       UP

CEM0/5/2           SATOP T1 2                 17.3.3.3        1002       UP

CEM0/5/2           SATOP T1 3                 17.3.3.3        1003       UP
!
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.
.

CEM0/5/2           SATOP T1 19                17.3.3.3        1019       UP

CEM0/5/2           SATOP T1 20                17.3.3.3        1020       UP
!


Local intf     Local circuit              Dest address    VC ID      Status
-------------  -------------------------- --------------- ----------
----------
CEM0/5/2           SATOP T1 21                17.3.3.3        1021       UP

CEM0/5/2           SATOP T1 22                17.3.3.3        1022       UP

CEM0/5/2           SATOP T1 23                17.3.3.3        1023       UP

!
.
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.

CEM0/5/2           SATOP T1 25                17.3.3.3        1025       UP

CEM0/5/2           SATOP T1 43                17.3.3.3        1043       UP
!


Local intf     Local circuit              Dest address    VC ID      Status
-------------  -------------------------- --------------- ----------
----------
CEM0/5/2           SATOP T1 44                17.3.3.3        1044       UP
```

```
CEM0/5/2           SATOP T1 45               17.3.3.3        1045       UP

CEM0/5/2           SATOP T1 46               17.3.3.3        1046       UP

!
.
.

CEM0/5/2           SATOP T1 65               17.3.3.3        1065       UP

CEM0/5/2           SATOP T1 66               17.3.3.3        1066       UP
!

Local intf     Local circuit              Dest address    VC ID      Status
-------------  -------------------------- --------------- ----------
----------
CEM0/5/2           SATOP T1 67               17.3.3.3        1067       UP

CEM0/5/2           SATOP T1 68               17.3.3.3        1068       UP

CEM0/5/2           SATOP T1 69               17.3.3.3        1069       UP

!
.
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.

CEM0/5/2           SATOP T1 83               17.3.3.3        1083       UP

CEM0/5/2           SATOP T1 84               17.3.3.3        1084       UP

CEM0/5/2           SATOP T1 1                17.4.4.4        4001
STANDBY
CEM0/5/2           SATOP T1 2                17.4.4.4        4002
STANDBY
CEM0/5/2           SATOP T1 3                17.4.4.4        4003
STANDBY
CEM0/5/2           SATOP T1 4                17.4.4.4        4004
STANDBY
CEM0/5/2           SATOP T1 5                17.4.4.4        4005
STANDBY

!

Local intf     Local circuit              Dest address    VC ID      Status
-------------  -------------------------- --------------- ----------
----------
CEM0/5/2           SATOP T1 6                17.4.4.4        4006
STANDBY
CEM0/5/2           SATOP T1 7                17.4.4.4        4007
STANDBY
CEM0/5/2           SATOP T1 8                17.4.4.4        4008
STANDBY

!
.
.
.

CEM0/5/2           SATOP T1 27               17.4.4.4        4027
STANDBY
CEM0/5/2           SATOP T1 28               17.4.4.4        4028
STANDBY
```

```
!
Local intf     Local circuit              Dest address    VC ID      Status
-------------  -------------------------- --------------- ----------
----------
CEM0/5/2           SATOP T1 29                17.4.4.4        4029
STANDBY
CEM0/5/2           SATOP T1 30                17.4.4.4        4030
STANDBY
CEM0/5/2           SATOP T1 31                17.4.4.4        4031
STANDBY

!
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.

CEM0/5/2           SATOP T1 50                17.4.4.4        4050
STANDBY
CEM0/5/2           SATOP T1 51                17.4.4.4        4051
STANDBY

!

Local intf     Local circuit              Dest address    VC ID      Status
-------------  -------------------------- --------------- ----------
----------
CEM0/5/2           SATOP T1 52                17.4.4.4        4052
STANDBY
CEM0/5/2           SATOP T1 53                17.4.4.4        4053
STANDBY
CEM0/5/2           SATOP T1 54                17.4.4.4        4054
STANDBY

!
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.

CEM0/5/2           SATOP T1 73                17.4.4.4        4073
STANDBY
CEM0/5/2           SATOP T1 74                17.4.4.4        4074
STANDBY

!

Local intf     Local circuit              Dest address    VC ID      Status
-------------  -------------------------- --------------- ----------
----------
CEM0/5/2           SATOP T1 75                17.4.4.4        4075
STANDBY
CEM0/5/2           SATOP T1 76                17.4.4.4        4076
STANDBY
CEM0/5/2           SATOP T1 77                17.4.4.4        4077
STANDBY

!
.
.
.

CEM0/5/2           SATOP T1 83                17.4.4.4        4083
STANDBY
```

```
CEM0/5/2           SATOP T1 84                17.4.4.4        4084
STANDBY

!

R-96-2011#sh cem circuit
CEM Int.       ID   Ctrlr     Admin     Circuit         AC
---------------------------------------------------------------
CEM0/5/2          1    UP        UP        Active          UP
CEM0/5/2          2    UP        UP        Active          UP
CEM0/5/2          3    UP        UP        Active          UP

!
.
.
.

CEM0/5/2          83   UP        UP        Active          UP
CEM0/5/2          84   UP        UP        Active          UP

!
```

- Use the **show mpls l2 vc** *vc-id* **detail** command to display detailed information related to the VC:

```
Router# show mpls l2 vc 1001 detail
```

```
Local interface: CEM0/5/2    up, line protocol up, SATOP T1 1 up
  Destination address: 17.3.3.3, VC ID: 1001, VC status: up
    Output interface: Gi0/4/0 , imposed label stack {42}
    Preferred path: not configured
    Default path: active
    Next hop: 11.11.11.2
  Create time: 00:26:04, last status change time: 00:03:36
    Last label FSM state change time: 00:23:00
  Signaling protocol: LDP, peer 17.3.3.3:0 up
    Targeted Hello: 17.1.1.1(LDP Id) -> 17.3.3.3, LDP is UP
    Graceful restart: configured and enabled
    Non stop routing: not configured and not enabled
    Status TLV support (local/remote)   : enabled/supported
      LDP route watch                   : enabled
      Label/status state machine        : established, LruRru
      Last local dataplane   status rcvd: No fault
      Last BFD dataplane     status rcvd: Not sent
      Last BFD peer monitor  status rcvd: No fault
      Last local AC  circuit status rcvd: No fault
      Last local AC  circuit status sent: No fault
      Last local PW i/f circ status rcvd: No fault
      Last local LDP TLV     status sent: No fault
      Last remote LDP TLV    status rcvd: No fault
      Last remote LDP ADJ    status rcvd: No fault
    MPLS VC labels: local 182, remote 42
    Group ID: local 0, remote 0
    MTU: local 0, remote 0
    Remote interface description:
  Sequencing: receive disabled, send disabled
  Control Word: On (configured: autosense)
  SSO Descriptor: 17.3.3.3/1001, local label: 182
  Dataplane:
    SSM segment/switch IDs: 1278679/4262 (used), PWID: 1
  VC statistics:
    transit packet totals: receive 201616, send 201617
    transit byte totals:   receive 41129664, send 40323400
    transit packet drops:  receive 0, seq error 0, send 0
```

- Use the **show hspw-aps-icrm group** *group-id* command to display information about a specified HSPW APS group:

```
Router# show hspw-aps-icrm group 100
```

```
ICRM group id 100, Flags : My core isolated No,Peer core isolated No, State
Connect
         APS Group id 1 hw_if_index 33 APS valid:Yes
        Total aps grp attached to ICRM group 100 is 1
```

- Use the **show hspw-aps-icrm all** command to display information about all HSPW APS and ICRM groups:

```
Router# show hspw-aps-icrm all
```

```
ICRM group id 100, Flags : My core isolated No,Peer core isolated No, State
Connect
         APS Group id 1 hw_if_index 33 APS valid:Yes
       Total aps grp attached to ICRM group 100 is 1 ICRM group count attached
 to MR-APS HSPW feature is 1
```

- Use the **show redundancy interchassis** command to display information about interchassis redundancy group configuration:

```
Router# show redundancy interchassis
```

```
Redundancy Group 100 (0x64)
  Applications connected: MR-APS with HSPW
  Monitor mode: RW
  member ip: 60.60.60.2 "R-222-2028", CONNECTED
    Route-watch for 60.60.60.2 is UP
    MR-APS with HSPW state: CONNECTED
  backbone int GigabitEthernet0/4/0 : UP (IP)
  backbone int GigabitEthernet0/4/2 : UP (IP)

ICRM fast-failure detection neighbor table
  IP Address       Status Type Next-hop IP      Interface
  ==========       ====== ==== ===========      =========
  60.60.60.2       UP     RW
```

- Use the **show aps** command to display information about the current APS feature:

```
Router# show aps
```

```
 SONET 0/5/2    APS Group 1: working channel 1 (Active) (HA)
        Protect at 60.60.60.2
        PGP timers (from protect): hello time=1; hold time=10
        SONET framing
        Remote APS configuration: (null)
```

- Use the **show xconnect all** command to display information about all Cross–Connect attachment circuits and PWs:

```
Router# show xconnect all
```

```
Legend:    XC ST=Xconnect State  S1=Segment1 State  S2=Segment2 State
  UP=Up       DN=Down            AD=Admin Down      IA=Inactive
  SB=Standby  HS=Hot Standby     RV=Recovering      NH=No Hardware
```

```
XC ST  Segment 1                          S1 Segment 2
   S2
------+----------------------------------+--+----------------------------
------+----------------------------------+--+---
--+--
UP pri   ac CEM0/5/2 :1(SATOP T1)          UP mpls 17.3.3.3:1001
   UP
IA sec   ac CEM0/5/2 :1(SATOP T1)          UP mpls 17.4.4.4:4001
   SB
UP pri   ac CEM0/5/2 :10(SATOP T1)         UP mpls 17.3.3.3:1010
   UP
IA sec   ac CEM0/5/2 :10(SATOP T1)         UP mpls 17.4.4.4:4010
   SB

!
.
.
.

UP pri   ac CEM0/5/2 :9(SATOP T1)          UP mpls 17.3.3.3:1009

   UP
IA sec   ac CEM0/5/2 :9(SATOP T1)          UP mpls 17.4.4.4:4009

   SB

!
```

Configuration Examples for MR-APS

The following example shows how to configure the MR-APS integration with HSPW on a CEM interface on the working router with framing mode as SONET on router P1:

```
RouterP1> enable
RouterP1# configure terminal
RouterP1(config)# pseudowire-class hspw_aps
RouterP1(config-pw-class)# encapsulation mpls
RouterP1(config-pw-class)# status peer topology dual-homed
RouterP1(config-pw-class)# exit
RouterP1(config)# redundancy
RouterP1(config-red)# interchassis group 1
RouterP1(config-r-ic)# member ip 14.2.0.2
RouterP1(config-r-ic)# backbone interface GigabitEthernet 0/1/0
RouterP1(config-r-ic)# backbone interface GigabitEthernet 0/1/1
RouterP1(config-r-ic)# exit
RouterP1(config)# controller SONET 0/1/0
RouterP1(config-controller)# framing sonet
RouterP1(config-controller)# clock source line
RouterP1(config-controller)# sts-1 1
RouterP1(config-ctrlr-sts1)# mode vt-15
RouterP1(config-ctrlr-sts1)# vtg 1 t1 1 cem-group 0 timeslots 1-24
RouterP1(config-ctrlr-sts1)# exit
RouterP1(config-controller)# aps group 3
RouterP1(config-controller)# aps working 1
RouterP1(config-controller)# aps hspw-icrm-grp 1
RouterP1(config-controller)# exit
RouterP1(config)# interface cem 0/1/0
RouterP1(config-if)# cem 0
RouterP1(config-if)# xconnect 3.3.3.3 1 encapsulation mpls pw-class hspw_aps
RouterP1(config-if)# backup peer 4.4.4.4 2 pw-class hspw_aps
```

```
RouterP1(config-if)# exit
RouterP1(config)# end
```

The following example shows how to configure the MR-APS integration with HSPW on a CEM interface on the protect router with framing mode as SONET on router PE1:

```
RouterPE1> enable
RouterPE1# configure terminal
RouterPE1(config)# pseudowire-class hspw_aps
RouterPE1(config-pw-class)# encapsulation mpls
RouterPE1(config-pw-class)# status peer topology dual-homed
RouterPE1(config-pw-class)# exit
RouterPE1(config)# redundancy
RouterPE1(config-red)# interchassis group 1
RouterPE1(config-r-ic)# member ip 14.2.0.1
RouterPE1(config-r-ic)# backbone interface GigabitEthernet 0/1/0
RouterPE1(config-r-ic)# backbone interface GigabitEthernet 0/1/1
RouterPE1(config-r-ic)# exit
RouterPE1(config)# controller SONET 0/2/0
RouterPE1(config-controller)# framing sonet
RouterPE1(config-controller)# clock source line
RouterPE1(config-controller)# sts-1 1
RouterPE1(config-ctrlr-sts1)# mode vt-15
RouterPE1(config-ctrlr-sts1)# vtg 1 t1 1 cem-group 0 timeslots 1-24
RouterPE1(config-ctrlr-sts1)# exit
RouterPE1(config-controller)# aps group 3
RouterPE1(config-controller)# aps protect 1 14.2.0.2
RouterPE1(config-controller)# aps hspw-icrm-grp 1
RouterPE1(config-controller)# exit
RouterPE1(config)# interface cem 0/2/0
RouterPE1(config-if)# cem 0
RouterPE1(config-if)# xconnect 3.3.3.3 3 pw-class hspw_aps
RouterPE1(config-if)# backup peer 4.4.4.4 4 pw-class hspw_aps
RouterPE1(config-if)# exit
RouterPE1(config)# end
```

The following example shows how to configure the MR-APS integration with HSPW on a CEM interface on the working router with framing mode as SONET on router P2:

```
RouterP2> enable
RouterP2# configure terminal
RouterP2(config)# pseudowire-class hspw_aps
RouterP2(config-pw-class)# encapsulation mpls
RouterP2(config-pw-class)# status peer topology dual-homed
RouterP2(config-pw-class)# exit
RouterP2(config)# redundancy
RouterP2(config-red)# interchassis group 1
RouterP2(config-r-ic)# member ip 14.6.0.2
RouterP2(config-r-ic)# backbone interface GigabitEthernet 0/2/0
RouterP2(config-r-ic)# backbone interface GigabitEthernet 0/2/1
RouterP2(config-r-ic)# exit
RouterP2(config)# controller SONET 0/1/0
RouterP2(config-controller)# framing sonet
RouterP2(config-controller)# clock source line
RouterP2(config-controller)# sts-1 1
RouterP2(config-ctrlr-sts1)# mode vt-15
RouterP2(config-ctrlr-sts1)# vtg 1 t1 1 cem-group 0 timeslots 1-24
RouterP2(config-ctrlr-sts1)# exit
RouterP2(config-controller)# aps group 3
RouterP2(config-controller)# aps working 1
RouterP2(config-controller)# aps hspw-icrm-grp 1
RouterP2(config-controller)# exit
RouterP2(config)# interface cem 0/1/0
RouterP2(config-if)# cem 0
RouterP2(config-if)# xconnect 1.1.1.1 1 encapsulation mpls pw-class hspw_aps
```

```
RouterP2(config-if)# backup peer 2.2.2.2 3 pw-class hspw_aps
RouterP2(config-if)# exit
RouterP2(config)# end
```

The following example shows how to configure the MR-APS Integration with HSPW on a CEM interface on the protect router with framing mode as SONET on router PE2:

```
RouterPE2> enable
RouterPE2# configure terminal
RouterPE2(config)# pseudowire-class hspw_aps
RouterPE2(config-pw-class)# encapsulation mpls
RouterPE2(config-pw-class)# status peer topology dual-homed
RouterPE2(config-pw-class)# exit
RouterPE2(config)# redundancy
RouterPE2(config-red)# interchassis group 1
RouterPE2(config-r-ic)# member ip 14.6.0.1
RouterPE2(config-r-ic)# backbone interface GigabitEthernet 0/2/0
RouterPE2(config-r-ic)# backbone interface GigabitEthernet 0/2/1
RouterPE2(config-r-ic)# exit
RouterPE2(config)# controller SONET 0/2/0
RouterPE2(config-controller)# framing sonet
RouterPE2(config-controller)# clock source line
RouterPE2(config-controller)# sts-1 1
RouterPE2(config-ctrlr-sts1)# mode vt-15
RouterPE2(config-ctrlr-sts1)# vtg 1 t1 1 cem-group 0 timeslots 1-24
RouterPE2(config-ctrlr-sts1)# exit
RouterPE2(config-controller)# aps group 2
RouterPE2(config-controller)# aps protect 1 14.6.0.2
RouterPE2(config-controller)# aps hspw-icrm-grp 1
RouterPE2(config-controller)# exit
RouterPE2(config)# interface cem 0/2/0
RouterPE2(config-if)# cem 0
RouterPE2(config-if)# xconnect 1.1.1.1 2 pw-class hspw_aps
RouterPE2(config-if)# backup peer 2.2.2.2 4 pw-class hspw_aps
RouterPE2(config-if)# exit
RouterPE2(config)# end
```

Configuring MR-APS on a POS interface

The following section shows how to configure the MR-APS integration on a POS interface on the working node and protect node.

Configuring working node for POS MR-APS

To configure MR-APS working node for POS interface, complete the following steps:

SUMMARY STEPS

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

9. **controller SONET** *slot/bay/port*
10. **framing** [**SDH** | **SONET**]
11. **clock source internal**
12. **sts-1** *1-3POS*
13. **exit**
14. **controller SONET** *slot/bay/port*
15. **Shutdown**
16. **aps group** *group_id*
17. **aps working** *aps-group-number*
18. **aps interchassis group** *group-id*
19. **no shut**
20. **exit**
21. **interface POS** *slot/bay/port*
22. **ip address** *ip-address*
23. **encapsulation** *ppp*
24. **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	**exit** **Example:** `Router(config-pw-class)# exit`	Exits PW class configuration mode.
Step 4	**redundancy** **Example:** `Router(config)# redundancy`	Enters the redundancy configuration mode.
Step 5	**interchassis group** *group-id* **Example:** `Router(config-red)# interchassis group 50`	Configures an interchassis group within the redundancy configuration mode and enters the interchassis redundancy mode.
Step 6	**member ip** *ip-address* **Example:** `Router(config-r-ic)# member ip 60.60.60.2`	Configures the IP address of the peer member group.

	Command or Action	Purpose
Step 7	**monitor peer** *bfd* **Example:** `Router(config-red)# monitor peer bfd`	Enables BFD on the POS link.
Step 8	**exit** **Example:** `Router(config-r-ic)# exit`	Exits the redundancy mode.
Step 9	**controller SONET** *slot/bay/port* **Example:** `Router(config)# controller SONET 0/5/2`	Selects and configures a SONET controller and enters controller configuration mode. • *slot*—Chassis slot number, which is always 0. • *bay*—Card interface bay number in a slot. The range is from 0 to 5. • *port*—Port or interface number. The range is from 0 to 7 for Gigabit Ethernet.
Step 10	**framing** [**SDH** | **SONET**] **Example:** `Router(config-controller)# framing SONET`	Configures the controller with framing type. SONET framing is the default option.
Step 11	**clock source internal** **Example:** `Router(config-controller)# clock source internal`	Sets the clocking for individual E1 links.
Step 12	**sts-1** *1-3POS* **Example:** `Router(config-controller)# sts-1 1-3`	Specifies the STS identifier.
Step 13	**exit** **Example:** `Router(config-ctrlr-sts1)# exit`	Exits from the STS configuration mode.
Step 14	**controller SONET** *slot/bay/port* **Example:** `Router(config)# controller SONET 0/5/2`	Selects and configures a SONET controller and enters controller configuration mode.
Step 15	**Shutdown** **Example:** `Router(config)# Shutdown`	Shut down the controller before APS configuration.
Step 16	**aps group** *group_id* **Example:** `Router(config-controller)# aps group 1`	Configures the APS group for POS.

	Command or Action	Purpose
Step 17	**aps working** *aps-group-number* **Example:** `Router(config-controller)# aps working 1`	Configures the APS group as working or protect interface. **Note** For MR-APS, one router must be configured as aps working 1 and the other router must be configured as aps protect 1.
Step 18	**aps interchassis group** *group-id* **Example:** `Router(config-red)# aps interchassis group 50`	Configures an aps inter chassis group.
Step 19	**no shut** **Example:** `Router(config-controller)# no shut`	Shut down the controller.
Step 20	**exit** **Example:** `Router(config-controller)# exit`	Ends the controller session and returns to the configuration mode.
Step 21	**interface POS** *slot/bay/port* **Example:** `Router(config)# interface POS 0/5/2`	Configures a serial interface and enters the interface configuration mode • *slot*—Chassis slot number, which is always 0. • *bay*—Card interface bay number in a slot. The range is from 0 to 5. • *port*—Port or interface number. The range can be 0-3.
Step 22	**ip address** *ip-address* **Example:** `Router(config-if)# ip address 45.1.1.2 255.255.255.0`	Assigns the ip address to POS interface
Step 23	**encapsulation** *ppp* **Example:** `Router(config-if-srv)# encapsulation ppp`	Specifies the ppp encapsulation over POS interface.
Step 24	**end** **Example:** `Router(config-if-srv)# end`	Returns to privileged EXEC mode.

Configuring protect node for POS MR-APS

To configure MR-APS protect node for POS interface, complete the following steps:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **exit**
4. **redundancy**
5. **interchassis group** *group-id*
6. **member ip** *ip-address*
7. **monitor peer** *bfd*
8. **exit**
9. **controller SONET** *slot/bay/port*
10. **framing** [**SDH** | **SONET**]
11. **clock source internal**
12. **sts-1** *1-3POS*
13. **exit**
14. **controller SONET** *slot/bay/port*
15. **Shutdown**
16. **aps group** *group_id*
17. **aps protect 1** *remote loopback ip*
18. **aps interchasis group** *interchasis group-id*
19. **no shut**
20. **exit**
21. **interface POS** *slot/bay/port*
22. **ip address** *ip-address*
23. **encapsulation** *ppp*
24. **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	**exit** **Example:** `Router(config-pw-class)# exit`	Exits PW class configuration mode.
Step 4	**redundancy** **Example:** `Router(config)# redundancy`	Enters the redundancy configuration mode.

	Command or Action	Purpose
Step 5	**interchassis group** *group-id* **Example:** `Router(config-red)# interchassis group 50`	Configures an interchassis group within the redundancy configuration mode and enters the interchassis redundancy mode.
Step 6	**member ip** *ip-address* **Example:** `Router(config-r-ic)# member ip 60.60.60.2`	Configures the IP address of the peer member group.
Step 7	**monitor peer** *bfd* **Example:** `Router(config-red)# monitor peer bfd`	Enables BFD on the POS link.
Step 8	**exit** **Example:** `Router(config-r-ic)# exit`	Exits the redundancy mode.
Step 9	**controller SONET** *slot/bay/port* **Example:** `Router(config)# controller SONET 0/5/2`	Selects and configures a SONET controller and enters controller configuration mode. • *slot*—Chassis slot number, which is always 0. • *bay*—Card interface bay number in a slot. The range is from 0 to 5. • *port*—Port or interface number. The range is from 0 to 7 for Gigabit Ethernet.
Step 10	**framing** [**SDH** | **SONET**] **Example:** `Router(config-controller)# framing SONET`	Configures the controller with framing type. SONET framing is the default option.
Step 11	**clock source internal** **Example:** `Router(config-controller)# clock source internal`	Sets the clocking for individual E1 links.
Step 12	**sts-1** *1-3POS* **Example:** `Router(config-controller)# sts-1 1-3`	Specifies the STS identifier.
Step 13	**exit** **Example:** `Router(config-ctrlr-sts1)# exit`	Exits from the STS configuration mode.
Step 14	**controller SONET** *slot/bay/port* **Example:** `Router(config)# controller SONET 0/5/2`	Selects and configures a SONET controller and enters controller configuration mode.

	Command or Action	Purpose
Step 15	**Shutdown** **Example:** `Router(config)# Shutdown`	Shut down the controller before APS configuration.
Step 16	**aps group** *group_id* **Example:** `Router(config-controller)# aps group 1`	Configures the APS group for POS.
Step 17	**aps protect 1** *remote loopback ip* **Example:** `Router(config-controller)# aps protect 1 192.168.1.1`	Enable the protect node.
Step 18	**aps interchasis group** *interchasis group-id* **Example:** `Router(config-controller)# aps interchasis group 1`	Enable the inter chasis.
Step 19	**no shut** **Example:** `Router(config-controller)# no shut`	Unshut the controller.
Step 20	**exit** **Example:** `Router(config-controller)# exit`	Ends the controller session and returns to the configuration mode.
Step 21	**interface POS** *slot/bay/port* **Example:** `Router(config)# interface POS 0/5/2`	Configures a serial interface and enters the interface configuration mode • *slot*—Chassis slot number, which is always 0. • *bay*—Card interface bay number in a slot. The range is from 0 to 5. • *port*—Port or interface number. The range can be 0-3.
Step 22	**ip address** *ip-address* **Example:** `Router(config-if)# ip address 45.1.1.2 255.255.255.0`	Assigns the ip address to POS interface
Step 23	**encapsulation** *ppp* **Example:** `Router(config-if-srv)# encapsulation ppp`	Specifies the ppp encapsulation over POS interface.
Step 24	**end** **Example:**	Returns to privileged EXEC mode.

	Command or Action	Purpose
	`Router(config-if-srv)# end`	

Verifying MR-APS on POS interface

- Use the **show rgf groups** command to display POS statistics for the configured POS circuits.

  Following is a sample output of the **show rgf groups** command to display the detailed information about POS interface configured on the router:

```
Router# show rgf groups
```

```
Router# sh rgf groups

 Total RGF groups: 2
------------------------------------------------------------
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     <<<<<<<<<<Chk this status
         Previous  : Standby-hot
 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:    66       RGF RET BUF    66
```

  Following is a sample output of the **show ppp interface***POS*

```
Router# show  ppp interface 0/5/2
```

```
PPP Serial Context Info
-------------------
Interface        : PO0/4/2.1
PPP Serial Handle: 0xE9000006
PPP Handle       : 0xBF000006
SSS Handle       : 0x8000006
AAA ID           : 14
Access IE        : 0xA000006
SHDB Handle      : 0xA3000006
State            : Up
Last State       : Binding
Last Event       : LocalTerm
```

- Use the **show ccm group id** *grioup-id number* command to check CCM status

```
Router# show ccm group id
```

```
 CCM Group 1 Details
----------------------------------------

CCM Group ID              : 1
Infra Group ID            : 2
Infra Type                : Redundancy Group Facility (RGF)  <<<<Chk this
HA State                  : CCM HA Active
Redundancy State          : Dynamic Sync
Group Initialized/cleaned : FASLE

ASR903_PE2#
```

- Following is a sample output of the **show aps gr 1** command:

```
Router#  show aps gr 1
```

```
SONET 0/4/2 APS Group 1: working channel 1 (Inactive) (HA)
        Protect at 33.1.1.1
        PGP timers (from protect): hello time=1; hold time=10
        SDH framing
        Remote APS configuration: (null)
```

- Following is a sample output of the **show redundancy interchassis** command to display information about interchassis redundancy group configuration:

```
Router# show redundancy interchassis
```

```
Redundancy Group 1 (0x1)
  Applications connected: MSR
  Monitor mode: BFD
  member ip: 10.17.255.163 "ASR903_PE2", CONNECTED
    BFD neighbor: GigabitEthernet0/1/2, next hop 33.1.1.2, DOWN
    MSR state: CONNECTED

ICRM fast-failure detection neighbor table
  IP Address       Status Type Next-hop IP      Interface
  ==========       ====== ==== ============     =========
  10.17.255.163    DOWN   BFD  33.1.1.2         GigabitEthernet0/1/2
```

Configuration Examples for MR-APS on POS interface

The following example shows how to configure the MR-APS integration on a POS interface on the working router PE1 working node:

```
RouterPE1> enable
RouterPE1(config)#cont so 0/4/2
RouterPE1(config-controller)#au-4 1 pos
RouterPE1(config-controller)#aps gr 1
RouterPE1(config-controller)#aps working 1
RouterPE1(config-controller)#aps interchassis group 1
RouterPE1(config-controller)#exit
RouterPE1(config)#interface POS0/4/2.1
RouterPE1(config-interface)#ip address 45.1.1.2
RouterPE1(config-interface)#encapsulation ppp
RouterPE1(config)# redundancy
RouterPE1(config-red)# interchassis group 1
RouterPE1(config-r-ic)# member ip 14.2.0.2
RouterPE1(config-r-ic)# backbone interface gig 0/0/1
```

```
RouterPE1(config-r-ic)# exit
```

The following example shows how to configure the MR-APS integration on a POS interface on the Protect router PE2 Protect node:

```
RouterPE2> enable
RouterPE2(config)#cont so 0/4/2
RouterPE2(config-controller)#framing sdh
RouterPE2(config-controller)#clock source line
RouterPE2(config-controller)#aug mapping au-4
RouterPE2(config-controller)#au-4 1 pos
RouterPE2(config-controller)#aps group 1
RouterPE2(config-controller)#aps protect 1 1.1.1.1
RouterPE2(config-controller)#aps interchassis group 1
RouterPE1(config-controller)#exit
RouterPE2(config)#interface POS0/4/2.1
RouterPE2(config-interface)#ip address 45.1.1.1 255.255.255.0
RouterPE2(config-interface)#encapsulation ppp
RouterPE2(config-controller)#network-clock input-source 1 controller SONET 0/4/2
RouterPE2(config)# redundancy
RouterPE2(config)#mode sso
RouterPE2(config-red)#interchassis group 1
RouterPE2(config-r-ic)#monitor peer bfd
RouterPE2(config-r-ic)#member ip 52.1.1.1
RouterPE2(config-r-ic)# exit
```

The following example shows how to configure the MR-APS integration on a POS interface on the router CE1 working node:

```
RouterPE3> enable
RouterPE3(config)#cont SONET 0/3/1
RouterPE3(config-controller)#framing sdh
RouterPE3(config-controller)#clock source line
RouterPE3(config-controller)#aug mapping au-4
RouterPE3(config-controller)#au-4 1 pos
RouterPE3(config)#interface POS0/4/2.1
RouterPE3(config-interface)#ip address 45.1.1.1
RouterPE3(config-interface)#encapsulation ppp
RouterPE3(config-controller)#network-clock input-source 1 controller SONET 0/4/2
RouterPE1(config-controller)#exit
```