



Single-router APS for the Cisco 12000 Series Router

This feature provides 1+1 single-router automatic protection switching (SR-APS) for the Cisco 12000 series ISE ATM line cards (Engine 3) installed in Cisco 12816 or 12810 routers. By installing two identical line cards in physically adjacent slots and bridging traffic across both line cards, the Cisco 12000 Series router SR-APS implementation provides SONET line, ATM interface, and line card redundancy within a single router. This feature supports High Availability and is intended for routers deployed at the service provider multiservice edge.

Feature History for Single-router APS for the Cisco 12000 Series Router

Release	Modification
12.0(31)S	This feature was introduced for the Cisco 12810 and Cisco 12816 routers.

Finding Support Information for Platforms and Cisco IOS Software Images

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.

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Prerequisites for Single-router APS for the Cisco 12000 Series Router

The following hardware is required for operation of SR-APS:

- Cisco 12816 or Cisco 12810 Series router equipped with either the Performance Route Processor 1 or Performance Route Processor 2 (PRP-1 or PRP-2)
- Cisco 12000 Enhanced Clock Scheduler Card
PN: 12816-CSC-B or 12810-CSC-B=

SR-APS supports the following line cards:

- Cisco 12000 Series 4-Port OC-12/STM-4 ATM ISE Multimode Line Card
PN: 4OC12X/ATM-MM-SC
- Cisco 12000 Series 4-Port OC-12/STM-4 ATM ISE Single Mode Line Card
PN: 4OC12X/ATM-IR-SC
- Cisco 12000 Series 4-port OC-3/STM-1 ATM ISE Multimode Line Card
PN: 4OC3X/ATM-MM-SC
- Cisco 12000 Series 4-port OC-3/STM-1 ATM ISE Single Mode Line Card
PN: 4OC3X/ATM-IR-SC

Restrictions for Single-router APS for the Cisco 12000 Series Router

- The Packet-Over-SONET (PoS) CLI for Multirouter APS (MR-APS) is not supported for the Cisco 12000 Series ISE ATM line cards.
- Single-router APS for the Cisco 12000 Series Router does not support the reflector channel currently supported on several PoS interfaces across different Cisco platforms.

ATM interfaces most often connect to an ATM switch or ADM, while PoS interfaces connect to a router. The reflector channel is useful only when connected to a router.
- Configuring working and protection lines of APS redundancy pair on the same line card is not supported.
- Configuring the APS redundancy on the ATM interfaces connected to the core side of the network is not supported.
- Redundancy for IPv6, TE-tunnels and L2TPv3 services on the redundant virtual interface is not supported.
- SDH is not supported.
- In SR-APS, it is recommended to do the APS switchover through CLIs from Protect to Working port before doing online insertion and removal (OIR) of Protect ATM line cards. This avoids extended packet loss and the APS switchover completes within standard switching time which is less than 50 milliseconds.

Information About Single-router APS for the Cisco 12000 Series Router

To implement multirouter APS, you should understand the following concepts:

- [Single-router APS Overview, page 3](#)
- [SR-APS Alarms, Statistics, and SNMP Trap Support, page 5](#)
- [High Availability Support for Single-router APS for the Cisco 12000 Series Router, page 5](#)

Single-router APS Overview

Automatic Protection Switching

This feature allows switchover of ATM circuits in the event of circuit failure due to a line card, interface (port) or SONET line failures. APS refers to the mechanism of configuring a “protection” interface as the backup for a “working” interface. When the working interface fails, the protection interface quickly assumes its traffic load. Single-router APS for the Cisco 12000 Series Router provides one for one (1+1) automatic protection switching for line cards, interfaces and SONET line circuits installed within a single Cisco 12816 or Cisco 12810 router.

1+1 Protection Switching

With 1+1 protection switching, a protect interface (circuit) is paired with each working interface. On a Cisco 12000 Series Router, the protection and working interfaces are connected to an ATM switch or a SONET ADM (Add/Drop Multiplexer) and the working and protection circuits terminate in different line cards in the same router. 1+1 protection switching is described in the Bellcore publication TR-TSY-000253, SONET Transport Systems; Common Generic Criteria, Section 5.3.

On the protection circuit, the K1K2 bytes from the line overhead (LOH) of the SONET frame indicate the current status of the APS connection and convey any requests for action. This signalling channel is used by the two ends of the connection to maintain synchronization.



Note

On a Cisco 12000 Series router, although the Multirouter Automatic Protection Switching (MR-APS) feature supports 1+1 automatic protection switching for SONET line circuits, MR-APS does not conform to 1+1 SONET APS as described in the Bellcore publication TR-TY-000253. (With MR-APS, the working and protect circuits terminate in different line cards in two different routers. As a result, SONET bridging is not supported.)

Bidirectional, Unidirectional, Revertive, and Non-revertive

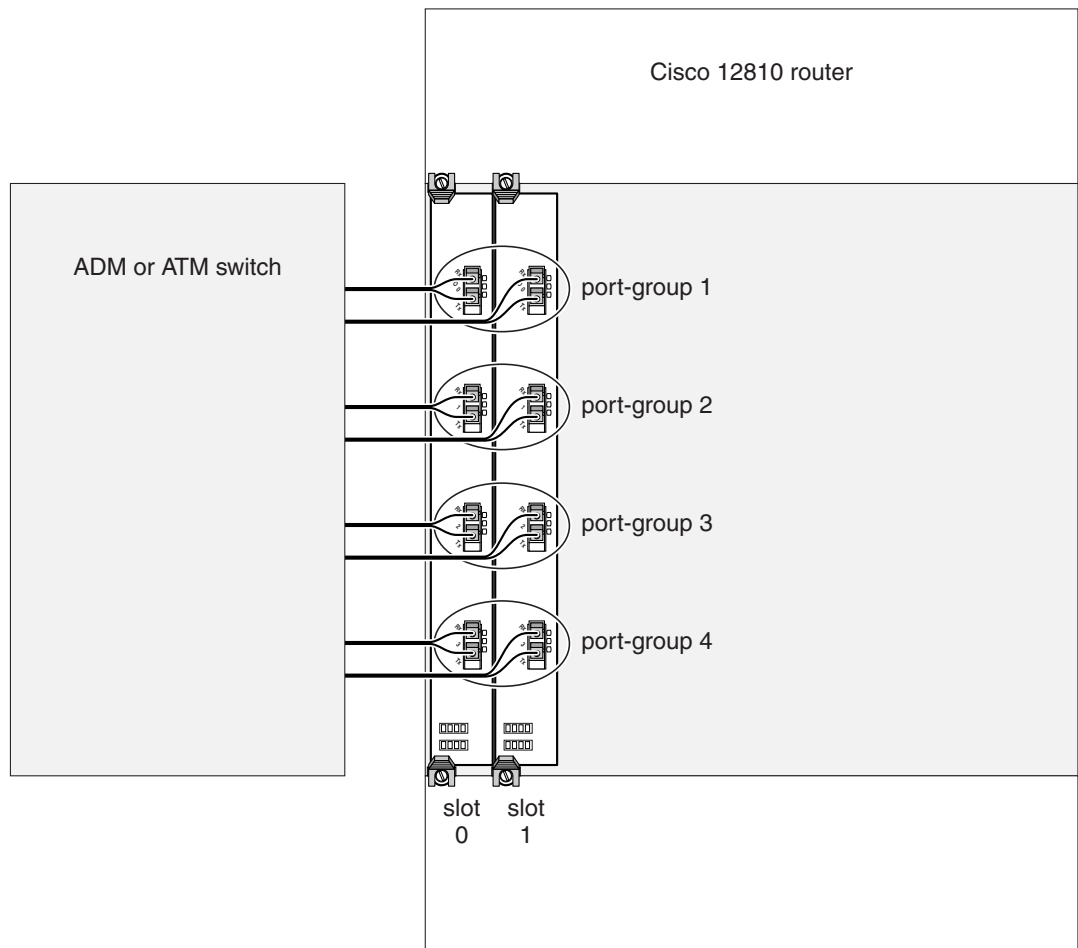
The 1+1 protection switching may be bidirectional or unidirectional, and revertive or non-revertive. In bidirectional mode, the receive and transmit channels are switched as a pair. In unidirectional mode, the transmit and receive channels are switched independently. For example, in bidirectional mode, if the receive channel on the working interface has a loss of channel signal, both the receive and transmit channels are switched. In unidirectional mode, only the failed transmit channel is switched to the protection circuit. The revertive option causes the switched channel to switch back to the original working circuit when the line fault is removed. The default attributes for SR-APS are non-revertive and unidirectional. working and protection circuits can also be switched manually (forced) with the command line interface.

Single-router APS for the Cisco 12000 Series Router

Single-router APS for the Cisco 12000 Series Router implements APS by installing two identical line cards in physically adjacent slots in the same router and bridging traffic across both line cards. One line card is designated primary, the other secondary. A port on the primary line card is configured as the working interface, and the port with same port number on the secondary line card as the protection port. The ports form a single virtual interface, configured with the **atm-redundancy** interface configuration CLI. Ports on the secondary line card cannot be configured with services, they can only be configured as protection ports for the corresponding ports on the primary line card.

Figure 1 shows a basic SR-APS configuration where the working and protection circuits terminate on different line cards installed in physically adjacent slots of the same router.

Figure 1 Single-router APS Configuration



slot-pair 1 = slot 0 (primary), slot 1 (secondary)
 port-group 1 = atm0/0 (working), atm1/0 (protection)
 port-group 2 = atm0/1 (working), atm1/1 (protection)
 port-group 3 = atm0/2 (working), atm1/2 (protection)
 port-group 4 = atm0/3 (working), atm1/3 (protection)

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SR-APS Alarms, Statistics, and SNMP Trap Support

Statistics are maintained for the following APS alarms, and are for bidirectional APS operation only. There are no specific APS alarms for unidirectional APS.

- APS switchover count—Indicates the number of times a line is switched.
- PSBF count—Indicates the number of times the Protection Switching Byte Failure alarm is generated.

When a node receives an invalid K1 byte from the remote node, it reports a PSBF condition. An alarm is generated when the condition persists for 2.5 seconds (plus or minus 0.5 seconds). When the PSBF condition is cleared for 10 seconds (plus or minus 0.5 seconds), the alarm is cleared.

- Channel Mismatch count—Indicates the number of times the Channel Mismatch alarm is generated.

A channel mismatch is when a node receives a channel number in the K2 byte that is different than its transmitted channel number. An alarm is generated when the channel mismatch condition persists for 2.5 seconds (plus or minus 0.5 seconds). When the channel mismatch is cleared for 10 seconds (plus or minus 0.5 seconds), the alarm is cleared.

- Mode Mismatch count—Indicates the number of times the Mode Mismatch alarm is generated.

If the protection switching class of the local node is configured for 1+1 APS and the remote node is configured for 1:n APS, this alarm would be generated. If the received APS architecture differs from the local APS architecture, it would result in mode mismatch alarm. If the mode mismatch persists for 2.5(+/- 0.5)seconds, this alarm will be generated. The alarm is cleared, once the mode mismatch is absent for 10(+/- 0.5)seconds.

- FEPLF count—Indicates the number of times the Far End Protection Line Failure alarm is generated.

The Far End Protection Line Failure alarm is generated when a node receives three consecutive K1 bytes that indicate signal failure (SF) on the protection line.

SNMP Trap Support

The following traps are defined for Single-router APS for the Cisco 12000 Series Router:

- APS switchover
- APS interface add/delete
- Channel mismatch
- FEPLF
- Mode mismatch

High Availability Support for Single-router APS for the Cisco 12000 Series Router

The Route Processor card (RP) provides support for RPR, RPR+ or SSO modes of Route Processor redundancy. The APS redundancy infrastructure supports each of these RP redundancy modes.

How to Configure Single-router APS for the Cisco 12000 Series Router

This section contains the following procedures for implementing SR-APS with the Cisco 12000 Series ISE ATM line cards:

- [Configuring Slot and Port Redundancy, page 6](#)
- [Performing SR-APS Manual Protection Switching, page 12](#)
- [Configuring Bit Error Rate Thresholds, page 14](#)
- [Performing SR-APS Manual Protection Switching, page 12](#)

Configuring Slot and Port Redundancy

To configure Single-router APS for the Cisco 12000 Series Router you must perform the following sequence of procedures:

1. [Reserving Adjacent Slots, page 6](#)
2. [Configuring Primary and Secondary Slot Pairs, page 6](#)
3. [Configuring Working and Protection Ports, page 7](#)
4. [Restrictions, page 7](#)

Reserving Adjacent Slots

Single-router APS for the Cisco 12000 Series Router works with identical line cards installed in physically adjacent slots. To detect and manage line card mismatches, OIR insertions, removals, and system reloads, the **hw-module slot slot type type [reserve] [preconfig]** global configuration command is introduced.

The **type** keyword lists the supported line cards for the specified slot.

The **reserve** keyword reserves the slot for only that line card specified with the **type** keyword. If any other line card is inserted into the reserved slot, that line card is put into a mismatch state, no services are brought up on the line card, and an error message is generated.

The **preconfig** keyword permits a slot to be preconfigured for the specified line card type, even if the slot is empty or currently occupied by a different line card type. When the specified line card is inserted, it acquires the configuration.

Configuring Primary and Secondary Slot Pairs

Single-router APS for the Cisco 12000 Series Router provides 1+1 line card redundancy, where two slots are configured as the members of a slot-pair. Only identical line cards in physically adjacent slots can be slot-paired. One slot is designated as primary and the other as secondary. The configuration of the line card in the primary slot is applied to the secondary slot. Any configuration for the secondary slot is automatically removed. All traffic to the primary slot is automatically bridged to the secondary slot with the Cisco 12000 fabric mirroring feature.

If a slot is not reserved for a card type that supports slot pairing, it cannot be configured as a slot-pair member. Make line cards slot reservations with the **hw-module slot slot type type [reserve] [preconfig]** global configuration command.

Create the slot pair with the **slot-pair *identifier*** redundancy configuration command. Designate which slot is primary and which is secondary with the **member slot *slot/port* {primary | secondary}** redundancy pair configuration command.

Configuring Working and Protection Ports

To configure SR-APS working and protection interfaces, create a port-group, then designate a working interface and a protection interface as members. The working interface is on the primary line card, the protection interface is on the secondary line card. Use the **port-group *portgroupID* aps** redundancy configuration command to create a port-group, then the **member port *slot/port*** redundancy port pair configuration command to designate the working and protection interfaces.

The working and protection pair combine into a single virtual interface. The configuration of the working physical interface is assumed by the virtual interface, and the configuration of the protection interface configuration is removed. Configure the virtual interface with the **interface atm-redundancy *slot/port*** global configuration command. The slot and port number of the virtual interface is the same as the working interface. The configuration of a virtual interface is applied to both of its physical interfaces. Only the protection interface carries the APS control signals.

In a port-group, the working and protection interfaces must have the same port numbers. For example, a 4-port line card in slot one when slot-paired with a line card in slot 2 could have only the following port-group working/protection pairs—1/0 and 2/0, 1/1 and 2/1, 1/2 and 2/2, and 1/3 and 2/3.

The state of the virtual interface is a combined state of both of its physical interfaces, as shown in [Table 1](#).

Table 1 States of SR-APS Interfaces

Working Interface	Protection Interface	Redundant Virtual Interface
Down	Down	Down
Down	Up	Up
Up	Down	Up
Up	Up	Up

When a line card is inserted into a secondary slot while the primary slot is operational, all interfaces on the secondary line card are brought up with the corresponding virtual interface configurations applied to each physical interface.

Use the **show interfaces atm-redundancy *slot/port*** privileged exec command to display the redundancy states of each line card.

Restrictions

- Line cards must have the same part numbers to be configured for SR-APS
- The line cards must be installed in physically adjacent slots
For example, in a Cisco 12816 router, slot 1 and slot 2 are adjacent, slot 6 and slot 7 are not.
- working and protection interfaces must have the same port number.
For example, atm1/0 and atm2/0 can be an SR-APS pair, but atm1/0 and atm2/1 cannot.

SUMMARY STEPS

Reserving Two Adjacent Redundant Slots for the Same Line Card Types

1. **enable**
2. **configure terminal**
3. **hw-module slot *slot-number* type {0x71|0x81} [reserve][preconfig]**
4. **hw-module slot *slot-number* type {0x71|0x81} [reserve][preconfig]**

Adding Slot Redundancy

5. **redundancy**
6. **slot-pair *identifier***
7. **member slot *slot-number* {primary | secondary}**
8. **member slot *slot-number* {primary | secondary}**
9. **end**

Adding Interface (Port) Redundancy

10. **configure terminal**
11. **interface atm *slot/port***
12. **shutdown**
13. **exit**
14. **redundancy**
15. **port-group *portgroupID* aps [multi-router]**
16. **member port *slot/port* working**
17. **member port *slot/port* protection**
18. **end**

Configuring Options—Activation Delay, Direction, Revertiveness and Signalling.

19. **activation-delay *ms***
20. **revertive *seconds***
21. **signalling {sdh | sonet}**
22. **end**

Enabling and Verifying Configuration of SR-APS

23. **configure terminal**
24. **interface atm-redundancy *slot/port***
25. **no shutdown**
26. **show aps group *portgroupID***
27. **show interfaces atm-redundancy *slot/port***
28. **end**

DETAILED STEPS

	Command or Action	Purpose
Reserving Two Adjacent Redundant Slots for the Same Line Card Types		
Step 1	<code>enable</code> Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> Enter your password if prompted.
Step 2	<code>configure terminal</code> Example: Router# configure terminal	Enters global configuration mode.
Step 3	<code>hw-module slot slot-number type {0x71 0x81} [reserve] [preconfig]</code> Example: router(config)# hw-module slot 1 type 0x81 reserve	Specifies one of the two redundant slots and the type of line card to be configured with SR-APS. The reserve option indicates that a mismatch error will be generated when other than the specified line card is installed in the specified slot. The preconfig option allows configuration of the specified line card even if the slot is empty. When the specified line card is installed, it acquires the preconfiguration.
Step 4	<code>hw-module slot slot-number type {0x71 0x81} [reserve] [preconfig]</code> Example: router(config)# hw-module slot 2 type 0x81 reserve	Specifies the other slot and type of line card to be configured with SR-APS. The line card must be the be installed in adjacent slots.
Specifying Slot Redundancy		
Step 5	<code>redundancy</code> Example: Router(config)# redundancy	Enters redundancy configuration mode.
Step 6	<code>slot-pair identifier</code> Example: Router(config-red)# slot-pair 7	Specifies the slot pair to be configured. Enters redundancy slot-pair configuration mode. <ul style="list-style-type: none"> Enter a number in the range of 0–7.
Step 7	<code>member slot slot-number {primary secondary}</code> Example: router(config-red-pair)# member slot 1 primary	Specifies the slots that are members of the specified slot pair. Traffic of one slot pair member is bridged to the other member. The primary slot has the line card with the working interfaces, the secondary slot has the line card with the working interfaces. In this example slot 1 contains the primary line card.
Step 8	<code>member slot slot-number {primary secondary}</code> Example: router(config-red-pair)# member slot 2 secondary	In this example, slot 2 contains the secondary line card.

	Command or Action	Purpose
Step 9	end Example: router(config-red-pair)# end	Exits to privileged EXEC mode.
Adding Interface (Port) Redundancy		
Step 10	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 11	interface atm slot/port Example: router(config)# interface atm 1/0	Specifies the ATM interface to configure. Enters interface configuration mode.
Step 12	shutdown Example: router(config-if)# shutdown	Shuts down the specified physical ATM interface of the primary line card. The physical interface must be shutdown prior to adding redundant port group members.
Step 13	exit Example: router(config-if)# exit	Exits to global configuration mode.
Step 14	redundancy Example: Router(config)# redundancy	Enters redundancy configuration mode.
Step 15	port-group portgroupID aps [multi-router] Example: router(config-red)# port-group 1 aps	Specifies a redundant port group identifier. For SR-APS, include only the aps keyword. Enters redundancy port configuration mode.
Step 16	member port slot/port working Example: router(config-red-port)# member port 1/0 working	Specifies the working interface in the port group.
Step 17	member port slot/port protection Example: router(config-red-port)# member port 2/0 protection	Specifies the protection or standby interface in the port-group. The protection interface in the adjacent slot must be same numbered interface as the working interface. For example, 1/0 and 2/0, or 1/1 and 2/1, etc.
Configuring Options—Activation Delay, Direction, Revertiveness and Signalling		
Step 18	activation-delay ms Example: router(config-red-port)# activation-delay 5	Optional. 5–1,000 milliseconds. Specifies additional delay to incur before switching from the working to the protection interface.

	Command or Action	Purpose
Step 19	direction { <i>bidirectional</i> <i>unidirectional</i> }	(Optional) Unidirectional is default for SR-APS.
	Example: router(config-red-port)# direction bidirectional	
Step 20	revertive <i>timeout</i>	(Optional) Specifies the time interval in which the protection circuit is switched back to the working circuit if the working interface becomes operational. To make the circuit non-revertive, use the no form of the command. SR-APS groups are non-revertive by default. <ul style="list-style-type: none"> Enter 1–86,400 seconds.
	Example: Router(config-red-port)# revertive 200	
Step 21	signalling { <i>sdh</i> <i>sonet</i> }	(Optional) Specifies the signalling for k1k2 framing. The default is the same as the traffic framing.
	Example: router(config-red-port)# signalling sdh	
Step 22	end	Exits Redundancy Port Configuration command mode to Privileged Exec command mode.
	Example: Router2(config-red-port)# end	
Enabling and Verifying Configuration of SR-APS		
Step 23	configure terminal	Enters global configuration mode.
	Example: router# configure terminal	
Step 24	interface atm-redundancy <i>slot/port</i>	Enters interface configuration mode. <ul style="list-style-type: none"> Specify the working interface of a line card pair. In this example, the working interface is atm 1/0.
	Example: router(config)# interface atm-redundancy 1/0	
Step 25	no shutdown	Enables the virtual SR-APS redundancy interface.
	Example: router(config-if)# no shutdown	
Step 26	show aps group <i>portgroupID</i>	Verifies that SR-APS was added as expected. If the other end aps device is configured then APS should be up and alarm free at this point.
	Example: router# show aps group 1	
Step 27	show interfaces atm-redundancy <i>slot/port</i>	Verifies that the virtual interface is recognized and active.
	Example: router# show interfaces atm-redundancy 1/0	
Step 28	end	Exits Redundancy Port Configuration command mode to privileged Exec command mode.
	Example: Router1(config-red-port)# end	

Troubleshooting Tips

- If the interfaces appear to be down, use the **show interfaces** command to check connectivity.
- Check that the ADM is sourcing the SONET clocking.
- Use the **show controllers atm slot/port** command to obtain hardware-related information.
- Use the **show running-config** command to display the configuration parameters of all of the commands that the current user has modified. The **show running-config interface** command is useful when there are multiple interfaces and you want to look at the configuration of a specific interface.
- Use the **show aps** command to check the current APS configuration for each interface.
- Use the **debug aps** command to check specific interface APS activity.

Performing SR-APS Manual Protection Switching

The following commands are used to perform the various switch requests. These commands are again available only on the protection router because that is where the K1K2 processing takes place.

Manual Protection Switching

In SR-APS, you can manually switch working channels and protection channels, or you can lock out a switchover altogether while performing system maintenance. A switchover from the working path to protection path is useful when upgrading or maintaining the system, or in cases where a signal failure caused a switchover. When the SR-APS circuit is configured for non-revertive operation, the system does not automatically revert to the original working circuit when the fault has been corrected. The switchover to the formerly failed interface must be requested through the CLI. The interface originally configured as the working path might be preferred because of its link loss characteristics.



Note

It is recommended to do the APS switchover through CLIs from Protect to Working Port before doing online insertion and removal (OIR) of Protect ATM line cards to avoid extended packet loss and to meet the standard switching time which is less than 50 milliseconds.

There are three types of manual switchover requests:

- Lockout requests—Have the highest priority and take effect regardless of the condition of the protection signal. A lockout prevents the active signal from switching over from the working path to the protection path.
- Forced switchover requests—Have the next highest priority and are only prevented if there is an existing lockout on the protection path, or the signal on the protection path has failed when switching from working to protection.
- Manual switchover requests—Have the lowest priority and only occur if there is no protection path lockout, a forced switchover, or the signal has failed or degraded.

The priority order for switchover are as follows (from higher to lower priority):

1. Lockout
2. Signal failure on the protection path
3. Forced switchover
4. Signal failure on the working path

5. Signal degrade on the working or protection path
6. Manual switchover

If a request or condition of a higher priority is in effect, a lower priority request is rejected.

Use the **clear** option to remove all manual switching requests. For **manual** and **force**, requests, **clear** only eliminates the precedence effect of these commands and does not cause another switchover.



Note

Redundancy port-group *groupID* force and **redundancy port-group *groupID* manual** are privileged exec commands that take effect at the time they are entered. The commands are not written to NVRAM and do not appear when you display the running configuration.

Table 2 *SR-APS Manual Protection Switching Commands*

Manual Protection Switching Task	Command
Force the specified circuit to switch from the protection circuit to the working circuit, unless a request of equal or higher priority is in effect.	redundancy port-group <i>groupID</i> force 0
Force the specified circuit to switch from the working circuit to the protection circuit, unless a request of equal or higher priority is in effect.	redundancy port-group <i>groupID</i> force 1
Manually request the specified circuit to switch from the protection circuit to the working circuit, unless a request of equal or higher priority is in effect.	redundancy port-group <i>groupID</i> manual 0
Manually request the specified circuit to switch from the working circuit to the protection circuit, unless a request of equal or higher priority is in effect.	redundancy port-group <i>groupID</i> manual 1
Prevent a working circuit from switching to a protection circuit.	redundancy port-group <i>groupID</i> lockout
Clear all existing switch requests.	redundancy port-group <i>groupID</i> clear

Examples

This example manually switches traffic from the working interface to the Protect interface.

```
Router# redundancy port-group 10 manual 1
```

This example manually switches traffic from the Protect interface to the working interface.

```
Router# redundancy port-group 10 manual 0
```

The following two commands are used to force switch the traffic.

```
Router# redundancy port-group 10 force 1
Router# redundancy port-group 10 force 0
```

This example prevents a manual switching from a working to a protection interface.

```
Router# redundancy port-group 10 lockout
```

This example clears all existing switch requests.

```
Router# redundancy port-group 10 clear
```

Configuring Bit Error Rate Thresholds

The following commands permit the configuration of threshold values for raising SONET alarms. Exceeding the bit error rate (BER) thresholds will result in a signal degrade (SD) request or a signal failure (SF) request.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface atm *slot/port***
4. **sonet threshold sd-ber *bit-error-rate***
5. **sonet threshold sf-ber *bit-error-rate***
6. **end**

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	interface atm <i>slot/port</i> Example: Router(config)# interface atm 1/0	Enters interface command mode. In this example, port 0 of the ATM line card in slot 1 is being configured.
Step 4	sonet threshold sd-ber <i>bit-error-rate</i> Example: Router(config-if)# sonet-threshold sd-ber 5	Sets the Signal Degrade bit error rate threshold. 5–9 (10 to the minus n)
Step 5	sonet threshold sf-ber <i>bit-error-rate</i> Example: Router(config-if)# sonet-threshold sf-ber 5	Sets the Signal Fail bit error rate threshold. 3–5 (10 to the minus n)
Step 6	end Example: Router1(config-if)# end	Exits Interface Configuration command mode to privileged Exec command mode.

Examples

In the following example, the working router's (router1) atm interface is set to BER values other than the default values. The protection router (router2) is set with the same values.

```
Router1> enable
Router1# configure terminal
Router1(config)# interface atm 1/0
Router1(config-if)# sonet-threshold sd-ber 7
Router1(config-if)# sonet-threshold sf-ber 5
Router1(config-if)# end
Router1#
```

```
Router1> enable
Router2# configure terminal
Router2(config)# interface atm 1/0
Router2(config-if)# sonet-threshold sd-ber 7
Router2(config-if)# sonet-threshold sf-ber 5
Router2(config-if)# end
Router2#
```

Configuration Examples for Single-router APS for the Cisco 12000 Series Router

The following show commands are provided to monitor and verify Single-router APS configurations:

- **show aps**
- **show aps group**
- **show cef interface atm-redundancy**
- **show controllers atm-redundancy**
- **show interfaces atm-redundancy**
- **show ip interface atm-redundancy**
- **show redundancy counters**
- **show redundancy port-group**
- **show redundancy slot-pair**
- **show running-config**
- **show running-config interface atm-redundancy**

Single-router APS Show Command Examples

```

router# show running-config
. . .
redundancy
mode rpr
slot-pair 7
port-group 1 aps
direction unidirectional
activation-delay 10
. . .

router# show aps group 1
ATM1/0 APS Group 1: protect channel 0 (inactive)
Working channel 1 at 127.255.0.0 (Enabled)
unidirectional, non-revertive
PGP timers (default): hello time=1; hold time=3
SONET framing; SONET APS signalling by default
Received K1K2: 0x00 0x04
    No Request (Null)
Transmitted K1K2: 0x00 0x04
    No Request (Null)
Remote APS configuration: (null)

ATM2/0 APS Group 1: working channel 1 (active)
Protect at 127.255.0.0
PGP timers (from protect): hello time=1; hold time=3
SONET framing
Remote APS configuration: (null)

router# show interfaces Atm-redundancy 1/0
Atm-redundancy1/0 is up, line protocol is up
Hardware is Atm-redundancy, address is 0000.0000.0000 (bia 0005.dd34.4dfe)
MTU 4470 bytes, sub MTU 4470, BW 622000 Kbit, DLY 80 usec, rely 255/255, load 1/255
Encapsulation ATM, loopback not set
Carrier delay is 0 msec
Encapsulation(s): AAL5, PVC mode
4095 maximum active VCs, 0 current VCCs
Max vpi bits: 8
VC idle disconnect time: 300 seconds
Last input never, output never, output hang never
Last clearing of "show interface" counters never
Queueing strategy: fifo
Output queue 0/40, 0 drops; input queue 0/75, 0 drops
    Available Bandwidth 622000 kilobits/sec
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
    0 packets input, 0 bytes, 0 no buffer
    Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    0 packets output, 0 bytes, 0 underruns
    0 output errors, 0 collisions, 1 interface resets
    0 output buffer failures, 0 output buffers swapped out

```

Additional References

The following sections provide references related to Single-router APS for the Cisco 12000 Series Router:

Related Documents

Related Topic	Document Title
Multirouter APS Configuration Information	<i>Multi Router APS on ISE ATM Line Cards</i>
APS and SONET commands: complete command syntax, command mode, defaults, usage guidelines, and examples	<i>Cisco IOS Interface Command Reference, Release 12.0</i>
APS for Packet-over-SONET on the Cisco 7500 and Cisco 12000 series routers	<i>Automatic Protection Switching of Packet-over-SONET Circuits feature document, Release 11.2</i>

Standards

Standards	Title
Bellcore SONET linear 1+1 architecture	TR-TSY-000253, SONET Transport Systems; Common Generic Criteria, Section 5.3.

MIBs

MIBs	MIBs Link
<ul style="list-style-type: none"> CISCO-APS-MIB (Also used for APS on POS interfaces. This MIB is a Cisco version of the IETF APS MIB) CISCO-MODULE-REDUNDANCY-MIB CISCO-PORT-REDUNDANCY-MIB 	<p>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL:</p> <p>http://www.cisco.com/go/mibs</p>

RFCs

RFCs	Title
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.	—

Technical Assistance

Description	Link
Technical Assistance Center (TAC) home page, containing 30,000 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/public/support/tac/home.shtml

Command Reference

This section documents new and modified commands only.

- **hw-module slot**
- **interface atm-redundancy**
- **member port**
- **member slot**
- **port-group**
- **redundancy port-group**
- **slot-pair**

hw-module slot

To reserve line card slots for Single-router APS, use the **hw-module slot** command in global configuration mode. To release slots from a reservation, use the **no** form of this command.

hw-module slot *slot* **type** {0x71| 0x81} [**reserve**] [**preconfig**]

no hw-module slot *slot* **type** {0x71| 0x81} [**reserve**] [**preconfig**]

Syntax Description	slot	Indicates that a line card will be configured.
	<i>slot</i>	Specifies the slot number of the line card.
	type	Indicates the slot is to be associated with a specific line card.
	0x71	Specifies that the selected slot is for the Cisco 12000 4-port ISE ATM Over SONET OC-12/STM-4 line card.
	0x81	Specifies that the selected slot is for the Cisco 12000 4-port ISE ATM Over SONET OC-3/STM-1 line card.
	reserve	Reserves the slot for the specified line card.
	preconfig	Permits a preconfiguration of the specified line card.

Command Default None

Command Modes Global configuration

Command History	Release	Modification
	12.0(31)S	This command was introduced for the Cisco 12000 Series router Single-router APS.

Usage Guidelines This command associates a line card type with a specific slot. This association is required for configuring Single-router APS (SR-APS) on the Cisco 12000 Series router where interface, line card, and SONET line redundancy is achieved by installing identical line cards into physically adjacent slots.

The **reserve** keyword indicates that if a line card of a type other than the reserved type is inserted in the slot, the line card is put into a mismatch state, and cannot be configured.

The **preconfig** keyword permits line card configuration for the specified line card type even if the slot is empty. When the specified type of line card is inserted, it acquires the preconfiguration.

Examples The following example reserves slots 2 and 3 for 4-port ISE ATM Over SONET OC-12/STM-4 line cards:

```
router#config terminal
router(config)# hw-module slot 2 type 0x71 reserve
router(config)# hw-module slot 3 type 0x71 reserve
```

Related Commands

Command	Description
hw-module slot	Reserves line card slots for Single-router APS.
interface atm-redundancy	Configures a virtual redundant ATM interface for Single-router APS.
member port	Adds ports as members to a redundancy port group.
member slot	Designates the primary and secondary slots reserved for a Single-router APS line card pair.
port-group	Creates a redundancy port group to which ports are added as members.
redundancy port-group	Manually switch protection and working APS channels.
show aps	Displays status of APS configuration for controllers, groups, and interfaces.
slot-pair	Creates a slot pair and enters into redundancy slot pair configuration mode.

interface atm-redundancy

To configure a virtual redundant ATM interface for Single-router APS, use the **interface atm-redundancy** command in interface configuration mode. To disable the virtual interface, use the **no** form of this command.

atm-redundancy interface *slot/port*

no atm-redundancy interface *slot/port*

Syntax Description	interface	Indicates interface configuration.
	<i>slot/port</i>	Specifies the slot and port number of the working interface in the Single-router APS pair.

Command Default None

Command Modes Interface configuration

Command History	Release	Modification
	12.0(31)S	This command was introduced for the Cisco 12000 Series router Single-router APS.

Usage Guidelines Two ATM interfaces specified in a port group as a working and protection pair for Single-router APS (SR-APS) are configured as a single logical interface with the **interface atm-redundancy** interface configuration command. The slot and port of the atm-redundancy interface is the slot and port of the working interface in the port group. The protection interface receives the same configuration automatically. Any previous configuration of the protection interface is removed.

Examples The following example enables an ATM redundant interface and verifies its operation:

```
cRouter# configure terminal
Router(config)# interface Atm-redundancy2/0
Router(config-if)# no shut
Router(config-if)# end
Router# show interfaces atm-redundancy 2/0
```

Related Commands	Command	Description
	hw-module slot	Reserves line card slots for Single-router APS.
	interface atm-redundancy	Configures a virtual redundant ATM interface for Single-router APS.
	member port	Adds ports as members to a redundancy port group.

Command	Description
member slot	Designates the primary and secondary slots reserved for a Single-router APS line card pair.
port-group	Creates a redundancy port group to which ports are added as members.
redundancy port-group	Manually switch protection and working APS channels.
show aps	Displays status of APS configuration for controllers, groups, and interfaces.
slot-pair	Creates a slot pair and enters into redundancy slot pair configuration mode.

member port

To add ports as members to a redundancy port group, use the **member port** command in redundancy port configuration mode. To remove a port as a member, use the **no** form of this command.

member port *slot/port* {**protection** [*working-ip-address*] | **working**}

no member port *slot/port*

Syntax Description	slot/port	Specifies the slot and port number of a line card.
	protection	Specifies that the port (interface) being configured is a protection port.
	<i>working-ip-address</i>	Specifies the IP address of the working router in a multirouter APS configuration.
	working	Specifies that the port (interface) being configured is a protection port.

Command Default No default behavior or values

Command Modes Redundancy port configuration

Command History	Release	Modification
	12.0(30)S	This command was introduced for the Cisco 12000 Series router Multirouter APS.
	12.0(31)S	This command was extended for the Cisco 12000 Series router Single-router APS.

Usage Guidelines This command adds ports as members to a port group defined by the **port-group** redundancy command. For Multirouter or Single-router APS, there are two ports specified per port group, one designated a working interface, the other as a protection interface. Single-router APS does not use the *working-ip-address* argument. In Multirouter APS, the working IP address is specified only when configuring the port group of the protection interface on the protection router.

Examples The following example adds port 2/0 on router1 as a member of port group 1:

```
Router1# configure terminal
Router1(config)# redundancy
Router1(config-red)# port-group 1 aps multi-router
Router1(config-red-port)# member port 2/0 working
Router1(config-red-port)# end
Router1#
```

The following example deletes port 2/0 as a member of port group 1, then deletes port group 1:

```
Router2> enable
Router2# configure terminal
Router2(config)# redundancy
```

```
Router2(config-red)# port-group 1 aps multi-router
Router2(config-red-port)# no member port 2/0
Router2((config-red-port)# exit
Router2(config-red)# no port-group 1
Router2(config-red)# end
Router2#
```

Related Commands

Command	Description
hw-module slot	Reserves line card slots for Single-router APS.
interface atm-redundancy	Configures a virtual redundant ATM interface for Single-router APS.
member port	Adds ports as members to a redundancy port group.
member slot	Designates the primary and secondary slots reserved for a Single-router APS line card pair.
port-group	Creates a redundancy port group to which ports are added as members.
redundancy port-group	Manually switch protection and working APS channels.
show aps	Displays status of APS configuration for controllers, groups, and interfaces.
slot-pair	Creates a slot pair and enters into redundancy slot pair configuration mode.

member slot

To designate the primary and secondary line card in slot pair, use the **member slot** command in redundancy slot-pair configuration mode. To remove a member from the slot pair, use the **no** form of this command.

```
member slot slot {primary|secondary}
```

```
member slot slot {primary|secondary}
```

Syntax Description	slot	Specifies one slot number in the slot pair.
	primary	Designates that the line card in the specified slot is the primary line card of the slot pair, to be configured with the working interfaces.
	secondary	Designates that the line card in the specified slot is the secondary line card of the slot pair, to be configured with protection interfaces.

Command Default	None
-----------------	------

Command Modes	Redundancy slot pair configuration
---------------	------------------------------------

Command History	Release	Modification
	12.0(31)S	This command was introduced for the Cisco 12000 Series router Single-router APS.

Usage Guidelines	This command designates the primary and secondary line card slots in a slot pair for a Single-router APS configuration. Slots must be physically adjacent and must be previously reserved with the hw-modules slot command.
------------------	--

Examples	The following example designates slot 5 and slot 6 as primary and secondary slots in slot pair 1:
----------	---

```
router# configure terminal
router(config) redundancy
router(config)# redundancy
router(config-red)# slot-pair 1
router(config-red-pair)# member slot 5 primary
router(config-red-pair)# member slot 6 secondary
```

Related Commands	Command	Description
	hw-module slot	Reserves line card slots for Single-router APS.
	interface atm-redundancy	Configures a virtual redundant ATM interface for Single-router APS.

Command	Description
member port	Adds ports as members to a redundancy port group.
member slot	Designates the primary and secondary slots reserved for a Single-router APS line card pair.
port-group	Creates a redundancy port group to which ports are added as members.
redundancy port-group	Manually switch protection and working APS channels.
show aps	Displays status of APS configuration for controllers, groups, and interfaces.
slot-pair	Creates a slot pair and enters into redundancy slot pair configuration mode.

port-group

To create a redundancy port group, use the **port-group** command in redundancy configuration mode. To delete a redundancy port group, use the **no** form of this command.

port-group *groupID* **aps** [**multi-router**]

no port-group *groupID*

Syntax Description	
<i>groupID</i>	1–255. Specifies a unique number to identify the port group to be created.
aps	Specifies that the port group is an APS circuit.
multi-router	Indicates that the working and protection ports in an APS port group are installed in different routers.

Command Default The following defaults apply when a port group is first created:

- APS redundancy class is 1+1.
- APS port redundancy groups are non-revertive.

Command Modes Redundancy configuration

Command History	Release	Modification
	12.0(30)S	This command was introduced for the Cisco 12000 Series router Multirouter APS.
	12.0(31)S	This command was extended for the Cisco 12000 Series router Single-router APS.

Usage Guidelines Use the **port-group** command to create or delete a redundancy port group wherein the members are line card ports. Executing the **port-group** command enters the redundancy port group configuration mode (config-red-port). Use the **no** form of the command to delete the redundancy port group and free the associated group identifier for reuse. Delete all members of a port group before deleting the port group, otherwise, the port group is not deleted and an error message displays.

Examples The following example creates a multirouter APS port group identified as port-group 10:

```
Router1# config terminal
Router1(config)# redundancy
Router1(config-red)# port-group 10 aps multi-router
Router1(config-red-port)#
```

Related Commands

Command	Description
hw-module slot	Reserves line card slots for Single-router APS.
interface atm-redundancy	Configures a virtual redundant ATM interface for Single-router APS.
member port	Adds ports as members to a redundancy port group.
member slot	Designates the primary and secondary slots reserved for a Single-router APS line card pair.
port-group	Creates a redundancy port group to which ports are added as members.
redundancy port-group	Manually switch protection and working APS channels.
show aps	Displays status of APS configuration for controllers, groups, and interfaces.
slot-pair	Creates a slot pair and enters into redundancy slot pair configuration mode.

redundancy port-group

To manually switch protection and working APS channels, use the **redundancy port-group** command in privileged EXEC configuration mode.

redundancy port-group *groupID* {**clear** | **force** {**1** | **0**} | **lockout** | **manual** {**1** | **0**}}

Syntax Description		
	<i>groupID</i>	1–255. Specifies the identifier of the port group.
	clear	Removes all force and manual switching requests.
	force	Requests switch over of working and protection circuits. It is a higher priority request than manual .
	1	Switches the working circuit to the protection circuit.
	0	Switches the protection circuit to the working circuit.
	lockout	Prevents a switchover
	manual	Requests switch over of working and protection circuits. It is a lower priority request than force .

Command Default No default behavior or values

Command Modes Privileged exec command

Command History	Release	Modification
	12.0(30)S	This command was introduced for the Cisco 12000 Series router Multirouter APS.
	12.0(31)S	This command was extended for the Cisco 12000 Series router Single-router APS.

Usage Guidelines In Single-router or Multirouter-APS, you can manually switch a channel signal from one path to another, or you can lock out a switchover altogether while performing system maintenance. A switchover from the working path to protection path is useful when upgrading or maintaining the system, or in cases where a signal failure caused a switchover. When the APS circuit is configured for non-revertive operation, the system does not automatically revert to the original working circuit when the fault has been corrected. The switchover to the formerly failed interface must be requested through the CLI. The interface originally configured as the working path might be preferred because of its link loss characteristics or because of its distance advantage.



Note It is recommended to do the APS switchover through CLIs from Protect to Working Port before doing online insertion and removal (OIR) of Protect ATM line cards to avoid extended packet loss and to meet the standard switching time which is less than 50 milliseconds.

There are three types of manual switchover requests:

- Lockout requests—Have the highest priority and take effect regardless of the condition of the protection signal. A lockout prevents the active signal from switching over from the working path to the protection path.
- Forced switchover requests—Have the next highest priority and are only prevented if there is an existing lockout on the protection path, or the signal on the protection path has failed when switching from working to protection.
- Manual switchover requests—Have the lowest priority and only occur if there is no protection path lockout, a forced switchover, or the signal has failed or degraded.

The priority order for switchover are a follows (from higher to lower priority):

1. Lockout
2. Signal failure on the protection path
3. Forced switchover
4. Signal failure on the working path
5. Signal degrade on the working or protection path
6. Manual switchover

If a request or condition of a higher priority is in effect, a lower priority request is rejected.

Use the **clear** option to remove all manual switching requests. For **manual** and **force**, requests, **clear** only eliminates the precedence effect of these commands and does not cause another switchover.

Examples

This example manually switches traffic from the working interface to the Protect interface.

```
Router2# redundancy port-group 10 manual 1
```

This example manually switches traffic from the Protect interface to the working interface.

```
Router2# redundancy port-group 10 manual 0
```

The following two commands are used to force switch the traffic.

```
Router2# redundancy port-group 10 force 1
Router2# redundancy port-group 10 force 0
```

This example prevents a manual switching from a working to a protection interface.

```
Router2# redundancy port-group 10 lockout
```

This example clears all existing switch requests.

```
Router2# redundancy port-group 10 clear
```

Related Commands

Command	Description
hw-module slot	Reserves line card slots for Single-router APS.
interface atm-redundancy	Configures a virtual redundant ATM interface for Single-router APS.
member port	Adds ports as members to a redundancy port group.
member slot	Designates the primary and secondary slots reserved for a Single-router APS line card pair.

Command	Description
port-group	Creates a redundancy port group to which ports are added as members.
redundancy port-group	Manually switch protection and working APS channels.
show aps	Displays status of APS configuration for controllers, groups, and interfaces.
slot-pair	Creates a slot pair and enters into redundancy slot pair configuration mode.

slot-pair

To create a slot pair group, use the **slot-pair** command in redundancy configuration mode. To remove a slot pair group, use the **no** form of this command.

slot-pair *identifier*

no slot-pair *identifier*

Syntax Description	<i>identifier</i>	Identifies a slot pair group in which two line slots are added as members. 0–7.
---------------------------	-------------------	---

Command Default	None
------------------------	------

Command Modes	Redundancy configuration
----------------------	--------------------------

Command History	Release	Modification
	12.0(31)S	This command was introduced for Cisco 12000 Series router Single-router APS.

Usage Guidelines	This command creates a unique identifier for a group in which two line card slots are added as members. This configuration is required for Single-router APS. See “member slot” section on page 25 for further information.
-------------------------	---

Examples	The following example creates a slot pair designated as 5, and enters redundancy slot pair configuration mode:
-----------------	--

```
router# configure terminal
router(config)# redundancy
router(config-red)# slot-pair 5
router(config-red-pair)#
```

Related Commands	Command	Description
	hw-module slot	Reserves line card slots for Single-router APS.
	interface atm-redundancy	Configures a virtual redundant ATM interface for Single-router APS.
	member port	Adds ports as members to a redundancy port group.
	member slot	Designates the primary and secondary slots reserved for a Single-router APS line card pair.
	port-group	Creates a redundancy port group to which ports are added as members.
	redundancy port-group	Manually switch protection and working APS channels.
	show aps	Displays status of APS configuration for controllers, groups, and interfaces.
	slot-pair	Creates a slot pair and enters into redundancy slot pair configuration mode.

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