Routing Updates Over APS on POS Interfaces

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Contents

Introduction
Background
Sample Configuration
Known Issues
Related Information

Introduction

This document clarifies how routing protocols operate over Packet Over SONET (POS) interfaces configured as working or protective members of Automatic Protection Switching (APS) setups.

Background

Telecordia specification GR−253 and ITU−T G.841 (replaces G.783) define "strict" SONET APS, which defines the protocol between the Add−Drop Multiplexer (ADM) and the Line Terminating Equipment (LTE), in this case a Cisco router or switch port. GR−253 defines two SONET APS models:

- **SONET APS 1:1** requires that, for every working (W) line, a protection (P) line exists. Traffic protected by the redundancy is carried on the protection line only when a failure occurs on the working line. The protection line is not guaranteed to carry real traffic until the transmit end is informed of the failure and subsequent switchover.
- **SONET Linear APS 1+1** requires that, for every working line, a redundant protection line exists. Traffic is carried simultaneously by the working and the protection lines.

The Cisco 12000 series implements 1+1. In a 1+1 model, GR−253 and ITU−T G.783 require bridging to be done at the electrical level, and the ADM transmits the same payload to the W and P interfaces.

The Cisco 12000 series APS implementation supports unidirectional and bidirectional APS modes. Use the `aps unidirectional` command to select a mode. The default operational mode is bidirectional, which means that either W or P is active at any moment. The two network elements (NEs) must agree on which circuit to receive. Whether the W or P circuit is to be active is negotiated between the two NEs over the P circuit using a protocol defined in the SONET frame's K1K2 bytes. Unidirectional mode means that the two NEs choose independently which circuit to receive, without negotiation.

In either mode, the W and P interfaces receive the same payload from the ADM − but only one is selected, or currently active. Only the selected interface actually processes the payload. The deselected interface is held in a "line protocol is down" state and cannot participate in routes or adjacencies. That is, the currently−deselected interface is completely removed from the layer 3 picture.

One consequence of the definition of unidirectional mode is that the one NE can choose to listen to W, while the other NE listens to P. This works because the 1+1 architecture requires full transmit bridging. That is, all payload is transmitted simultaneously by the W and P interfaces via electrical bridging. This is not feasible for two independent IP NEs that can even be housed in separate routers. The Cisco 12000 Series POS APS implementation therefore does not comply with this transmit bridging requirement. In order to support unidirectional mode, the Cisco 12000 Series asserts the Line Alarm Indication Signal (L−AIS) on the currently deselected interface. Since the L−AIS signal is an APS trigger condition, this forces the ADM to...
switch to the other, currently selected interface.

On the Cisco 12000, 7200 and 7500 series, this implementation means that a protection switch forces the APS routers to remove adjacencies and routes involving the now−deselected interface, and form new adjacencies over the now−selected interface. In other words, IP traffic begins to flow on the new W interface only after routing−protocol convergence, which typically extends over seconds depending on the scale of the network. Thus, although the APS switch itself requires less than 50 ms to complete, as required, all this means is that the choice of which interface is to be selected is changed, which affects at most two routers (W and P). Full restoration of IP traffic via the newly−selected interface requires that new adjacencies be formed between the newly−selected interface and the remote router, and that the resulting routes be disseminated to all the routers directly connected to either W or P.

Note: When the 12000 series POS interfaces are used at both ends of the SONET path, Layer 3 convergence is enhanced by the APS reflector channel feature, in which the adjacency at both ends is torn down without waiting for the hello timeout interval to expire.

Note: Unlike the 12000 and 7x00 series, the 10000 series supports a protection switch between a W and P on the same router without a change to routing adjacencies. Special switching circuitry in the backplane enables this transparent cutover.

Why implement APS when routing convergence times span several seconds? POS APS (APS over IP) is designed to protect against a router reload or hardware fault on the line card. Connection−oriented voice environments need millisecond switchover times to maintain TDM calls. However, millisecond switchover times in the connectionless world of IP data transport have much less bearing.

Sample Configuration

This is an example of protection switching on the Cisco 12000 series. This configuration uses Open Shortest Path First (OSPF) and a shared, per−router IP address on the W and P interfaces.

<table>
<thead>
<tr>
<th>Configuration</th>
</tr>
</thead>
</table>
| interface Loopback0
  ip address 192.168.100.100 255.255.255.255 |
|   !
| interface POS1/0
  ip address 192.168.1.2 255.255.255.252
  crc 32
  clock source internal
  aps working 1
  pos ais−shut
  no keepalive
  |
|   !
| interface POS2/0
  description GSR_A Protect to GSR_B Protect
  ip address 192.168.1.2 255.255.255.252
  crc 32  clock source internal
  aps protect 1 192.168.100.100
  pos ais−shut  no keepalive
  |
|   !
| router ospf 1
|  log−adjacency−changes
|  network 192.168.1.0 0.0.0.3 area 1
|  network 192.168.100.100 0.0.0.0 area 1
| |
| GSR_A#show interface pos1/0
| POS1/0 is up, line protocol is up
|  (APS working − active)
| Hardware is Packet over SONET
Description: GSR_A Working to GSR_B Working
Internet address is 192.168.1.2/30
MTU 4470 bytes, BW 622000 Kbit, DLY 100 usec,
rely 255/255, load 1/255
Encapsulation HDLC, crc 32, loopback not set
Keepalive set (10 sec)
Scramble disabled
[output omitted]

!--- The deselected interface is held in a protocol down state,
!--- and is unavailable for Layer 3 routing.

In addition, use the **show aps** command to view the current state of interfaces configured to run APS.

These log messages were captured after the removal of the fiber cabling from the W circuit:

```
*Sep  5 17:41:46: %SONET-4-ALARM: POS1/0: SLOS
*Sep  5 17:41:46: %SONET-4-ALARM: POS2/0: APS enabling channel
*Sep  5 17:41:46: %SONET-6-APSREMSWI: POS2/0: Remote APS status now Protect

!--- Indicates that the circuit uses APS reflector channel.

*Sep  5 17:41:46: %SONET-4-ALARM: POS1/0: APS disabling channel
*Sep  5 17:41:46: %LINEPROTO-5-UPDOWN: Line protocol on Interface POS2/0, changed state to up
*Sep  5 17:41:46: %LINEPROTO-5-UPDOWN: Line protocol on Interface POS1/0, changed state to down
*Sep  5 17:41:48: %LINK-3-UPDOWN: Interface POS1/0, changed state to down
*Sep  5 17:41:48: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.100.100 on POS1/0 from FULL to DOWN, Neighbor Down: Interface down or detached
*Sep  5 17:41:56: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.100.100 on POS2/0 from LOADING to FULL, Loading Done

!--- OSPF neighbor states change on both interfaces.
```

**Known Issues**

This table lists rare reports of a P or deselected APS interface processing input packets.

<table>
<thead>
<tr>
<th>Cisco Bug ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCdr61413</td>
<td>Under rare conditions, Cisco 12000 series line cards configured with APS can see input traffic on the deselected or protect interface. As a workaround, enter the <strong>shutdown</strong> and <strong>no shutdown</strong> commands on the deselected APS</td>
</tr>
</tbody>
</table>
interface.

CSCdj84628

An interface on a Cisco 7500 series POS Interface Processor (POSIP) can receive and switch packets when in an administratively shutdown state and connected to a protect circuit. (Duplicated by CSCdj84669.)

CSCdw03179

A Cisco 12000 series 8xOC3 Line Card that runs APS can accept input traffic even while it is deselected by APS. This condition causes duplicated packets. As a workaround, when the error condition occurs, enter the **shutdown** and **no shutdown** commands on the deselected APS interface.

If your router experiences this condition, capture output from these commands on both the W and P interfaces when you contact Cisco TAC:

- **show version** Displays basic hardware and firmware version information.
- **show gsr** Displays hardware information on the GSR.
- **show running-configuration** Displays the list of configuration commands that modify the default configuration of the system.
- **show ip interface brief** Displays a brief summary of IP status and configuration.
- **show aps** Displays information about the current automatic protection switching (APS) feature.
- **show interface pos x/x** Displays information about the Packet OC-3 interface in Cisco routers.
- **debug aps** Debugs APS operation

Take the action that precedes the problem and, again, capture the output displayed by this set of commands:

- **show aps**
- **show ip interface brief**
- **show interface pos x/x**
- **no debug aps**

**Related Information**

- Optical Technology Support Pages
- Technical Support & Documentation – Cisco Systems

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