

# Multi-Chassis APS and Pseudowire Redundancy Interworking

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## In This Chapter

This section describes multi-chassis APS and pseudowire redundancy interworking.

Topics in this section include:

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## Applicability

Multi-chassis Automatic Protection Switching (MC-APS) is supported on 7x50 platforms including 7710. The configuration in this chapter was tested on release 6.0R2 and includes the use of the ATM ports. Refer to the Release Notes for information about support of ATM (and other) MDAs on various platforms as well as MC-APS restrictions.

## Overview

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### MC-APS

MC-APS is an extension to the APS feature to provide not only link redundancy but also node level redundancy. It can protect against nodal failure by configuring the working circuit of an APS group on one node while configuring the protect circuit of the same APS group on a different node.

The two nodes connect to each other with an IP link that is used to establish a signaling path between them. The relevant APS groups in both the working and protection routers must have same group ID and working circuit, and the protect circuit must have compatible configurations (such as the same speed, framing, and port-type). Signaling is provided using the direct connection between the two service routers. A heartbeat protocol can be used to add robustness to the interaction between the two routers.

Signaling functionality includes support for:

- APS group matching between service routers.
- Verification that one side is configured as a working circuit and the other side is configured as the protect circuit. In case of a mismatch, a trap (incompatible-neighbor) is generated.
- Change in working circuit status is sent from the working router to keep the protection router in sync.
- Protection router, based on K1/K2 byte data, member circuit status, and external request, selects the active circuit and informs the working router to activate or de-activate the working circuit.

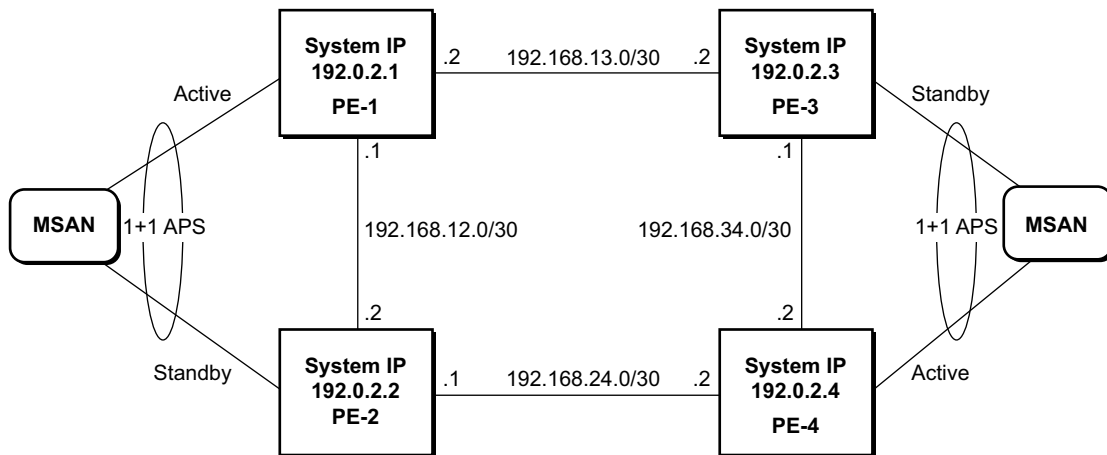
## Pseudowire Redundancy

Pseudowire (PW) redundancy provides the ability to protect a pseudowire with a pre-provisioned pseudowire and to switch traffic over to the secondary standby pseudowire in case of a SAP and/or network failure condition. Normally, pseudowires are redundant by the virtue of the SDP redundancy mechanism. For instance, if the SDP is an RSVP LSP and is protected by a secondary standby path and/or by Fast-Reroute paths, the pseudowire is also protected.

However, there are a few of applications in which SDP redundancy does not protect the end-to-end pseudowire path when there are two different destination 7x50 PE nodes for the same VLL service. The main use case is the provisioning of dual-homing of a CPE or access node to two 7x50 PE nodes located in different POPs. The other use case is the provisioning of a pair of active and standby BRAS nodes, or active and standby links to the same BRAS node, to provide service resiliency to broadband service subscribers.

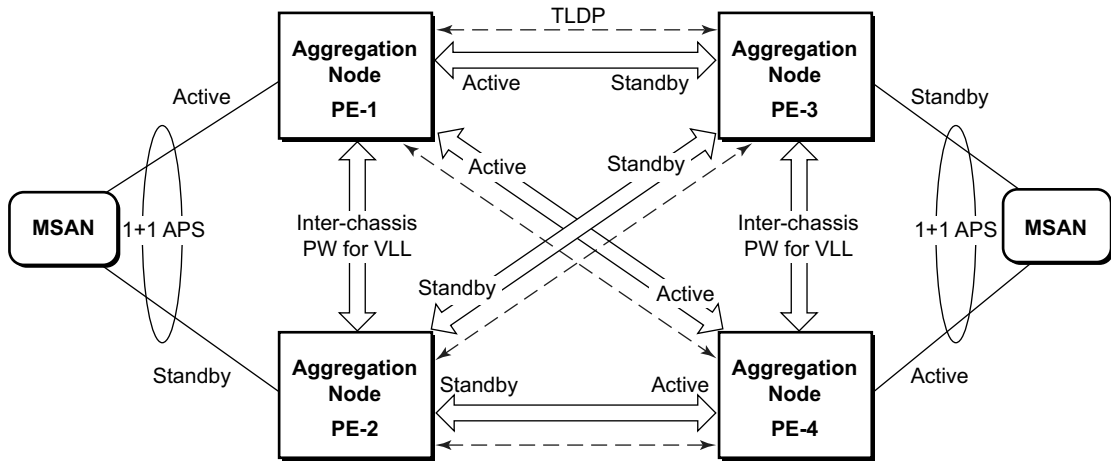
## Network Topology

The setup in this section contains two access nodes and 4 PE nodes. The access nodes can be any ATM switches that support 1+1 bi-directional APS. Figure 18 shows the physical topology of the setup. Figure 19 shows the use of both MC-APS in the access network and pseudowire redundancy in the core network to provide a resilient end-to-end VLL service.

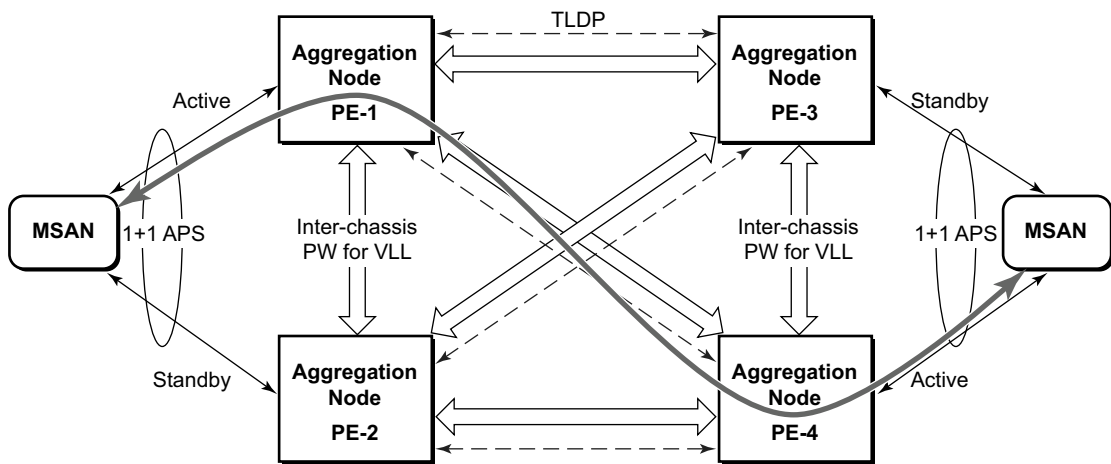


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Figure 18: MC-APS Network Topology



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Figure 19: Access Node and Network Resilience

# Configuration

The following configuration should be completed on the PEs before configuring MC-APS:

- Cards, MDAs and ports
- Interfaces
- IGP configured and converged
- MPLS
- SDPs configured between all PE routers

For the IGP, OSPF or IS-IS can be used. MPLS or GRE can be used for the transport tunnels. For MPLS, LDP or RSVP protocols can be used for signaling MPLS labels. In this example OSPF and LDP are used. The following commands can be used to check if OSPF has converged and to make sure the SDPs are up (for example, on PE-1):

```
A:PE-1# show router route-table
=====
Route Table (Router: Base)
=====
Dest Prefix                               Type  Proto  Age           Pref
  Next Hop[Interface Name]                Metric
-----
192.0.2.1/32                               Local  Local  00h40m53s    0
  system                                   0
192.0.2.2/32                               Remote OSPF    00h41m57s   10
  192.168.12.2                             100
192.0.2.3/32                               Remote OSPF    00h40m12s   10
  192.168.13.2                             100
192.0.2.4/32                               Remote OSPF    00h42m53s   10
  192.168.12.2                             100
192.168.12.0/30                           Local  Local  00h43m15s    0
  int-pe1-pe2                               0
192.168.13.0/30                           Local  Local  00h42m10s    0
  int-pe1-pe3                               0
192.168.24.0/30                           Remote OSPF    00h43m50s   10
  192.168.12.2                             200
192.168.34.0/30                           Remote OSPF    00h42m51s   10
  192.168.13.2                             200
-----
No. of Routes: 8
=====
*A:PE-1#
A:PE-1# show service sdp
=====
Services: Service Destination Points
=====
SdpId   Adm MTU  Opr MTU  IP address      Adm  Opr      Deliver  Signal
-----
12      0       1556    192.0.2.2      Up   Up       LDP      TLDP
13      0       1556    192.0.2.3      Up   Up       LDP      TLDP
14      0       1556    192.0.2.4      Up   Up       LDP      TLDP
-----
```

```
Number of SDPs : 3
```

```
-----
=====
*A:PE-1#
```

### Step 1. APS configuration on MSANs

The access nodes can be any ATM switches that support 1+1 bi-directional APS. Here is an example on 7670RSP (Routing Switching Platform).

```
Alcatel[RW]> configure
Alcatel[RW]> port 1-6-1-1
Alcatel[RW]> options protection type 1+1
Alcatel[RW]> options protection switching bidirect
Alcatel[RW]> options protection
```

#	Type	Status	Name	(Standby)
1-6-1-1	STM1_IR8	OK		

```
Protection Group Contains:
  Protection Port      : 1-6-1-1      (Standby)
  Working Port         : 1-5-1-1
Protection Type       : 1+1
Switching Type        : Non-Revertive
Switching Mode        : Bi-directional
Wait-To-Restore Timer : 5 minute(s)
```

### Step 2. MC-APS configuration on PE-1 and PE-2

Assuming the link between MSAN and PE-1 is working circuit and the link between MSAN and PE-2 is protection circuit.

Configure APS on the PE-1 port. Specify the system IP address of neighbor node (PE-2) and working-circuit.

```
*A:PE-1>config>port 2/1/1# info
```

```
-----
sonet-sdh
exit
no shutdown-----
```

```
*A:PE-1>config>port 2/1/1#
```

```
*A:PE-1>config>port aps-1# info
```

```
-----
aps
  neighbor 192.0.2.2
  working-circuit 2/1/1
exit
sonet-sdh
  path
    atm
    exit
    no shutdown
  exit
exit
no shutdown
```

## Configuration

```
-----  
*A:PE-1>config>port aps-1#
```

Configure APS on the PE-2 port. Specify the system IP address of neighbor node (PE-1) and protect-circuit instead of working-circuit.

```
*A:PE-2>config>port 2/1/1# info  
-----  
sonet-sdh  
exit  
no shutdown-----  
*A:PE-2>config>port 2/1/1#  
  
*A:PE-2>config>port aps-1# info  
-----  
aps  
neighbor 192.0.2.1  
protect-circuit 2/1/1  
exit  
sonet-sdh  
path  
atm  
exit  
no shutdown  
exit  
exit  
no shutdown  
-----  
*A:PE-2>config>port aps-1#
```

The following parameters can be configured under APS optionally.

- advertise-interval — This command specifies the time interval, in 100s of milliseconds, between 'I am operational' messages sent by both protect and working circuits to their neighbor for multi-chassis APS.
- hold-time — This command specifies how much time can pass, in 100s of milliseconds, without receiving an advertise packet from the neighbor before the multi-chassis signaling link is considered not operational.
- revert-time — This command configures the revert-time timer to determine how long to wait before switching back to the working circuit after that circuit has been restored into service.
- switching-mode — This command configures the switching mode for the APS port including bi-directional and uni-directional modes.



**Step 3.** Verify the APS status on PE-1.

```
*A:PE-1# show port aps-1
=====
SONET/SDH Interface
=====
Description      : APS Group
Interface        : aps-1                Speed           : oc3
Admin Status    : up                    Oper Status     : up
Physical Link   : Yes                   Loopback Mode   : none
Single Fiber Mode : No
Clock Source    : node                  Framing         : sonet
Last State Change : 09/08/2010 12:37:42    Port IfIndex    : 1358987264
Last Cleared Time : N/A
J0 String       : 0x01                  Section Trace Mode : byte
Rx S1 Byte     : 0x00                    Rx K1/K2 Byte   : 0x00/0x00
Rx J0 String (Hex) : 81 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Cfg Alarm       : loc lais lrldi ss1f lb2er-sd lb2er-sf sl0f sl0s lrei
Alarm Status    :
Hold time up    : 500 milliseconds
Hold time down  : 200 milliseconds

=====
Port Statistics
=====
                                     Input           Output
-----
Packets                               8671498         4814981
Discards                               0                0
Unknown Proto Discards                 0
=====
*A:PE-1#
```

**Step 4.** Verify the MC-APS status and parameters on PE-1 and PE-2

```
*A:PE-1# show aps detail
=====
APS Group: aps-1
=====
Description      : APS Group
Group Id         : 1                    Active Circuit   : 2/1/1
Admin Status    : Up                    Oper Status     : Up
Working Circuit  : 2/1/1                 Protection Circuit : N/A
Switching-mode  : Bi-directional        Switching-arch  : 1+1
Revertive-mode  : Non-revertive         Revert-time (min) :
Rx K1/K2 byte   : N/A
Tx K1/K2 byte   : N/A
Current APS Status : OK
Multi-Chassis APS : Yes
Neighbor        : 192.0.2.2
Control link state : Up
Advertise Interval : 1000 msec           Hold time       : 3000 msec
Mode mismatch Cnt : 0                   Channel mismatch Cnt : 0
PSB failure Cnt  : 0                     FEPL failure Cnt  : 0

-----
APS Working Circuit - 2/1/1
-----
Admin Status      : Up                    Oper Status      : Up
Current APS Status : OK                    No. of Switchovers : 0
Last Switchover   : None                   Switchover seconds : 0
```

## Configuration

```
Signal Degrade Cnt : 1                Signal Failure Cnt : 0
Last Switch Cmd   : N/A              Last Exercise Result : N/A
Tx L-AIS         : None
```

```
=====
*A:PE-1#
```

Detailed parameters of the APS configuration on PE-1 can be verified, shown above. The admin/oper status of APS group 1 shows up/up. K1/K2 byte shows N/A as APS 1+1 exchanges that information through protection circuit.

The admin/oper status of the working circuit (the link between MSAN and PE-1) is up/up.

```
*A:PE-2# show aps detail
```

```
=====
APS Group: aps-1
```

```
=====
Description      : APS Group
Group Id         : 1
Admin Status     : Up
Working Circuit  : N/A
Switching-mode   : Bi-directional
Revertive-mode   : Non-revertive
Rx K1/K2 byte    : 0x00/0x05 (No-Req on Protect)
Tx K1/K2 byte    : 0x00/0x05 (No-Req on Protect)
Current APS Status : OK
Multi-Chassis APS : Yes
Neighbor        : 192.0.2.1
Control link state : Up
Advertise Interval : 1000 msec
Mode mismatch Cnt : 0
PSB failure Cnt  : 0
Active Circuit   : N/A
Oper Status     : Up
Protection Circuit : 1/2/1
Switching-arch  : 1+1
Revert-time (min) :
Hold time       : 3000 msec
Channel mismatch Cnt : 0
FEPL failure Cnt : 1
```

```
-----
APS Working Circuit - Neighbor
```

```
-----
Admin Status     : N/A
Current APS Status : OK
Last Switchover  : None
Signal Degrade Cnt : 1
Last Switch Cmd  : No Cmd
Tx L-AIS        : None
Oper Status     : N/A
No. of Switchovers : 0
Switchover seconds : 0
Signal Failure Cnt : 1
Last Exercise Result : Unknown
```

```
-----
APS Protection Circuit - 1/2/1
```

```
-----
Admin Status     : Up
Current APS Status : OK
Last Switchover  : None
Signal Degrade Cnt : 1
Last Switch Cmd  : No Cmd
Tx L-AIS        : None
Oper Status     : Up
No. of Switchovers : 0
Switchover seconds : 0
Signal Failure Cnt : 0
Last Exercise Result : Unknown
```

```
=====
*A:PE-2
```

Detailed parameters of the APS configuration on PE-2 can be verified, as above. The admin/oper status of APS group 1 shows up/up. Both Rx and Tx of the K1/K2 byte are in the status of 0x00/0x05 (No-Req on Protect) as there is no failure or force-switchover request.

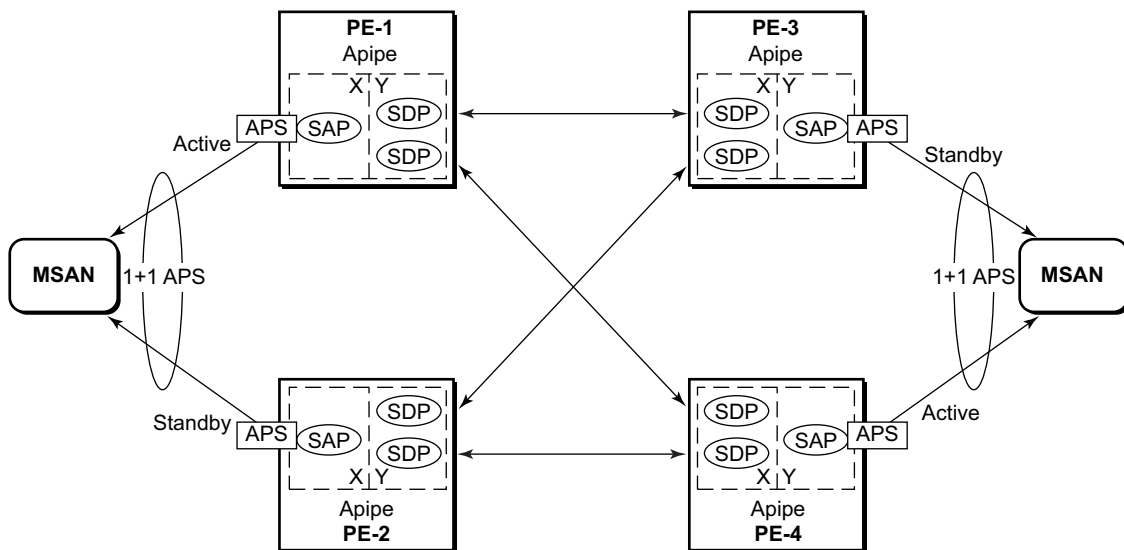
The admin/oper status of the protection circuit (the link between MSAN and PE-2) is up/up.

**Step 5.** MC-APS configuration on PE-3 and PE-4

The MC-APS configuration on PE-3 and PE-4 is similar to the configuration on PE-1 and PE-2. Configure the working circuit on PE-4 and the protection circuit on PE-3.

**Step 6.** Pseudowire configuration

Configure an Apipe service on every PE and create endpoints x and y. Associate the SAPs and spoke SDPs with the endpoints, as shown in Figure 20.



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**Figure 20: Association of SAPs/SDPs and Endpoints**

```
*A:PE-1>config>service>apipe# info
-----
endpoint "x" create
exit
endpoint "y" create
exit
sap aps-1:0/32 endpoint "x" create
exit
spoke-sdp 13:1 endpoint "y" create
```

## Configuration

```
exit
spoke-sdp 14:1 endpoint "y" create
exit
no shutdown
```

```
-----
*A:PE-1>config>service>apipe#
```

Syntax ps-1:0/32 above specifies the APS group and VPI/VCI of the ATM circuit (aps-id:vpi/vci).

Likewise, an Apipe service, endpoints, SAPs and spoke SDPs must be configured on the other PE routers.

### Step 7. Pseudowire verification

```
*A:PE-1# show service service-using
```

```
=====
Services
```

```
=====
ServiceId   Type      Adm  Opr    CustomerId  Last Mgmt Change
-----
1000        Apipe    Up   Up      1            08/09/2010 09:55:23
```

```
-----
Matching Services : 1
-----
```

```
=====
*A:PE-1#
```

```
*A:PE-2# show service service-using
```

```
=====
Services
```

```
=====
ServiceId   Type      Adm  Opr    CustomerId  Last Mgmt Change
-----
1000        Apipe    Up   Down    1            08/09/2010 09:55:55
```

```
-----
Matching Services : 1
-----
```

```
=====
*A:PE-2#
```

```
*A:PE-3# show service service-using
```

```
=====
Services
```

```
=====
ServiceId   Type      Adm  Opr    CustomerId  Last Mgmt Change
-----
1000        Apipe    Up   Down    1            08/09/2010 09:56:12
```

```
-----
Matching Services : 1
-----
```

```
=====
*A:PE-3#
```

```
*A:PE-4# show service service-using
```

```

=====
Services
=====
ServiceId      Type      Adm  Opr      CustomerId    Last Mgmt Change
-----
1000           Apipe    Up   Up        1              08/09/2010 09:56:45
-----
Matching Services : 1
=====
*A:PE-4#

```

Note that only the Apipe services on PE-1 and PE-4 show as up but they are down on PE-2 and PE-3 as the APS configuration on these nodes is in protection status.

### Step 8. Verify SDP status

An example on PE-2:

```

*A:PE-2# show service id 1 sdp 23:1 detail
=====
Service Destination Point (Sdp Id : 23:1) Details
=====
Sdp Id 23:1 -(192.0.2.3)
-----
Description      : (Not Specified)
SDP Id           : 23:1                               Type           : Spoke
Split Horiz Grp  : (Not Specified)
VC Type          : Ether                               VC Tag         : n/a
Admin Path MTU   : 0                                 Oper Path MTU   : 1556
Far End          : 192.0.2.3                          Delivery        : LDP

Admin State      : Up                               Oper State      : Up
Acct. Pol        : None                             Collect Stats   : Disabled
Ingress Label    : 131070                            Egress Label    : 131070
Ingr Mac Fltr    : n/a                               Egr Mac Fltr    : n/a
Ingr ip Fltr     : n/a                               Egr ip Fltr     : n/a
Ingr ipv6 Fltr   : n/a                               Egr ipv6 Fltr   : n/a
Admin ControlWord : Not Preferred                               Oper ControlWord : False
Admin BW(Kbps)   : 0                                 Oper BW(Kbps)   : 0
Last Status Change : 08/09/2010 15:13:15                       Signaling       : TLDP
Last Mgmt Change  : 08/07/2010 09:41:08                       Force Vlan-Vc   : Disabled
Endpoint         : y                                       Precedence      : 4
Class Fwding State : Down
Flags            : None
Peer Pw Bits     : lacIngressFault lacEgressFault pwFwdingStandby
Peer Fault Ip    : None
Peer Vccv CV Bits : lspPing
Peer Vccv CC Bits : mplsRouterAlertLabel

KeepAlive Information :
Admin State       : Disabled                               Oper State      : Disabled
Hello Time        : 10                                    Hello Msg Len    : 0
Max Drop Count    : 3                                       Hold Down Time   : 10

Statistics        :

```

## Configuration

```
I. Fwd. Pkts.      : 0                I. Dro. Pkts.      : 0
E. Fwd. Pkts.      : 0                E. Fwd. Octets     : 0
-----
Number of SDPs : 1
-----
=====
*A:PE-2#
```

Peer Pw Bits shows the status of the pseudowire on peer node. In this example, the remote node (PE-3) is sending lacIngressFault lacEgressFault pwFwdingStandby flags. This is because the Apipe service on PE-3 is down because the MC-APS is in protection status.

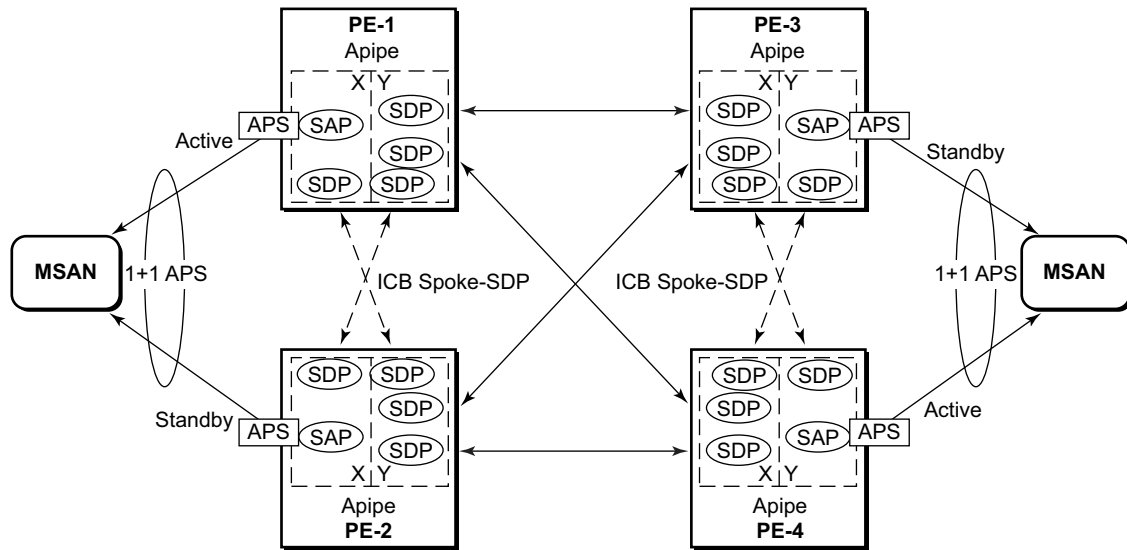
In case of failure, the access link can be protected by MC-APS. An MPLS network failure can be protected by pseudowire redundancy. Node failure can be protected by the combination of MC-APS and pseudowire redundancy.

### **Step 9.** Inter-Chassis Backup (ICB) pseudowire configuration.

Configuring Inter-Chassis Backup (ICB) is optional. It can reduce traffic impact by forwarding traffic on ICB spoke SDPs during MC-APS switchover. The ICB spoke SDP cannot be added to the endpoint if the SAP is not part of an MC-APS (or MC-LAG) instance. Conversely, a SAP which is not part of a MC-APS (or MC-LAG) instance cannot be added to an endpoint which already has an ICB spoke SDP. Forwarding between ICBs is blocked on the same node. The user has to explicitly indicate the spoke SDP is actually an ICB at creation time. Figure 5 shows some setup examples where ICBs are required.

Note that after configuring ICB spoke SDPs the Apipe will be in admin/oper up/up status on all PE routers.

Configure ICB SDPs and associate them to endpoints is shown in [Figure 21](#).



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**Figure 21: ICB Spoke SDPs and Association with the Endpoints**

Two ICB spoke SDPs must be configured in the Apipe service on each PE router, one in each endpoint. The same SDP IDs can be used for the ICBs since the far-end will be the same. However, the vc-id must be different. The ICB spoke SDPs must cross, i.e. one end should be associated with endpoint x and the other end (on the other PE) should be associated with endpoint y.

An ICB is always the last forwarding resort. Only one spoke SDPs will be forwarding. If there is an ICB and a MC-APS SAP in an endpoint, the ICB will only forward if the SAP goes down. If an ICB resides in an endpoint together with other spoke SDPs the ICB will only forward if there is no other active spoke SDP.

The following shows the configuration with ICB on each PE:

```
*A:PE-1>config>service>apipe# info
-----
endpoint "x" create
exit
endpoint "y" create
exit
sap aps-1:0/32 endpoint "x" create
exit
spoke-sdp 13:1 endpoint "y" create
exit
spoke-sdp 14:1 endpoint "y" create
exit
spoke-sdp 12:1 endpoint "x" icb create
exit
spoke-sdp 12:2 endpoint "y" icb create
exit
```

## Configuration

```
no shutdown
-----
*A:PE-1>config>service>apipe

*A:PE-2>config>service>apipe# info
-----
endpoint "x" create
exit
endpoint "y" create
exit
sap aps-1:0/32 endpoint "x" create
exit
spoke-sdp 23:1 endpoint "y" create
exit
spoke-sdp 24:1 endpoint "y" create
exit
spoke-sdp 21:1 endpoint "y" icb create
exit
spoke-sdp 21:2 endpoint "x" icb create
exit
no shutdown
-----
*A:PE-2>config>service>apipe#

*A:PE-3>config>service>apipe# info
-----
endpoint "x" create
exit
endpoint "y" create
exit
sap aps-1:0/32 endpoint "y" create
exit
spoke-sdp 31:1 endpoint "x" create
exit
spoke-sdp 32:1 endpoint "x" create
exit
spoke-sdp 34:1 endpoint "x" icb create
exit
spoke-sdp 34:2 endpoint "y" icb create
exit
no shutdown
-----
*A:PE-3>config>service>apipe#

*A:PE-4>config>service>apipe# info
-----
endpoint "x" create
exit
endpoint "y" create
exit
sap aps-1:0/32 endpoint "y" create
exit
spoke-sdp 41:1 endpoint "x" create
exit
spoke-sdp 42:1 endpoint "x" create
exit
```



```
spoke-sdp 43:1 endpoint "y" icb create
exit
spoke-sdp 43:2 endpoint "x" icb create
exit
no shutdown
```

```
-----
*A:PE-4>config>service>apipe#
```

### Step 10. Verification of active objects for each endpoint

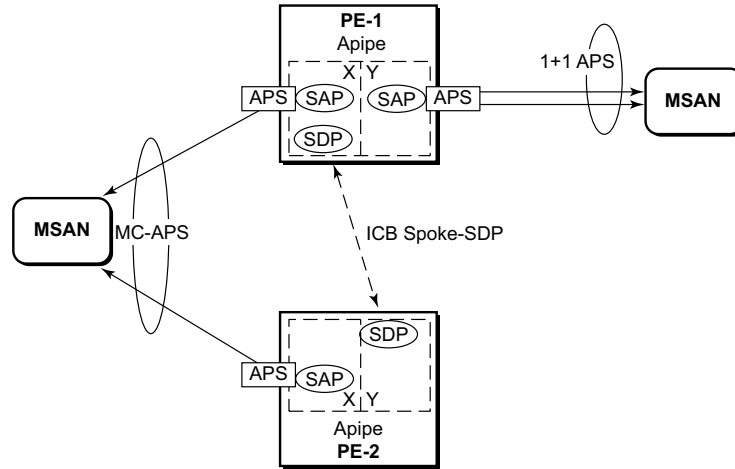
The following command shows which objects are configured for each endpoint and which is the active object at this moment:

```
*A:PE-1# show service id 1000 endpoint
-----
Service Endpoints
-----
Endpoint name          : x
Revert time            : 0
Act Hold Delay         : 0
Ignore Standby Signaling : false
Suppress Standby Signaling : true
Tx Active              : aps-1:0/32
Tx Active Up Time      : 0d 02:01:19
Revert Time Count Down : N/A
Tx Active Change Count : 8
Last Tx Active Change  : 08/09/2010 02:24:18
-----
Members
-----
SAP                    : aps-1:0/32
Spoke-sdp              : 12:1 Precedence:4 (icb)
=====
Endpoint name          : y
Revert time            : 0
Act Hold Delay         : 0
Ignore Standby Signaling : false
Suppress Standby Signaling : true
Tx Active              : 14:1
Tx Active Up Time      : 0d 03:16:08
Revert Time Count Down : N/A
Tx Active Change Count : 1
Last Tx Active Change  : 08/09/2010 02:23:18
-----
Members
-----
Spoke-sdp              : 12:2 Precedence:4 (icb)
Spoke-sdp              : 13:1 Precedence:4
Spoke-sdp              : 14:1 Precedence:4
=====
*A:PE-1#
```

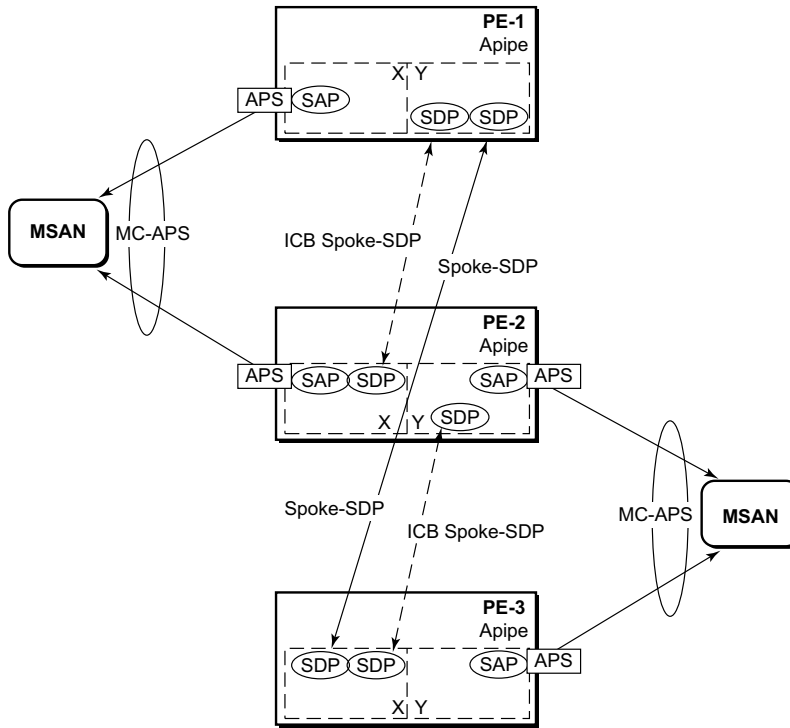
Note that on PE-1 both the SAP and the spoke SDP 14:1 are active. The other objects do not forward traffic.

**Step 11.** Other types of setups

The following figures show other setups that combine MC-APS and pseudowire redundancy.

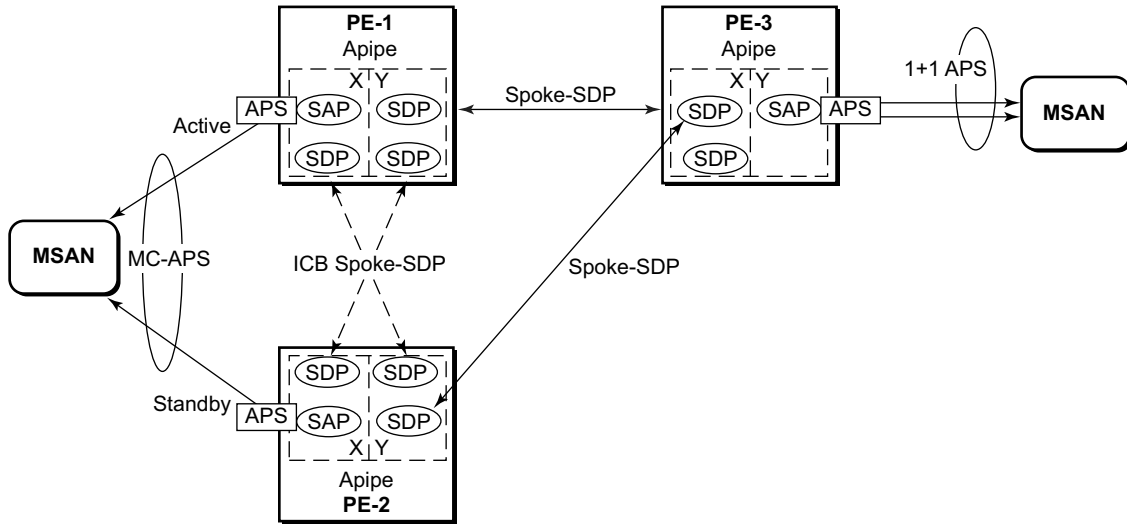


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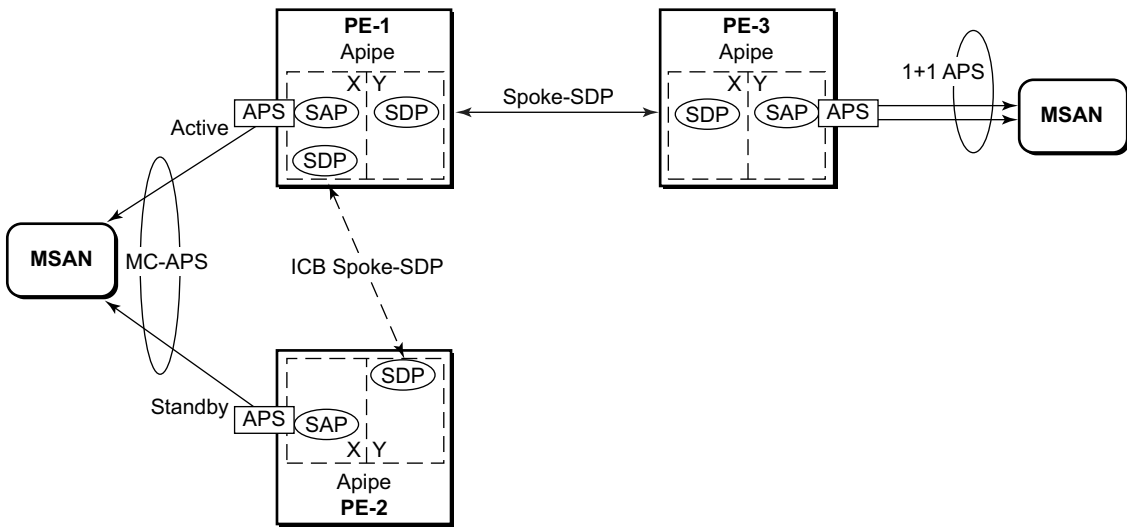


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**Figure 22: Additional Setup Example 1**

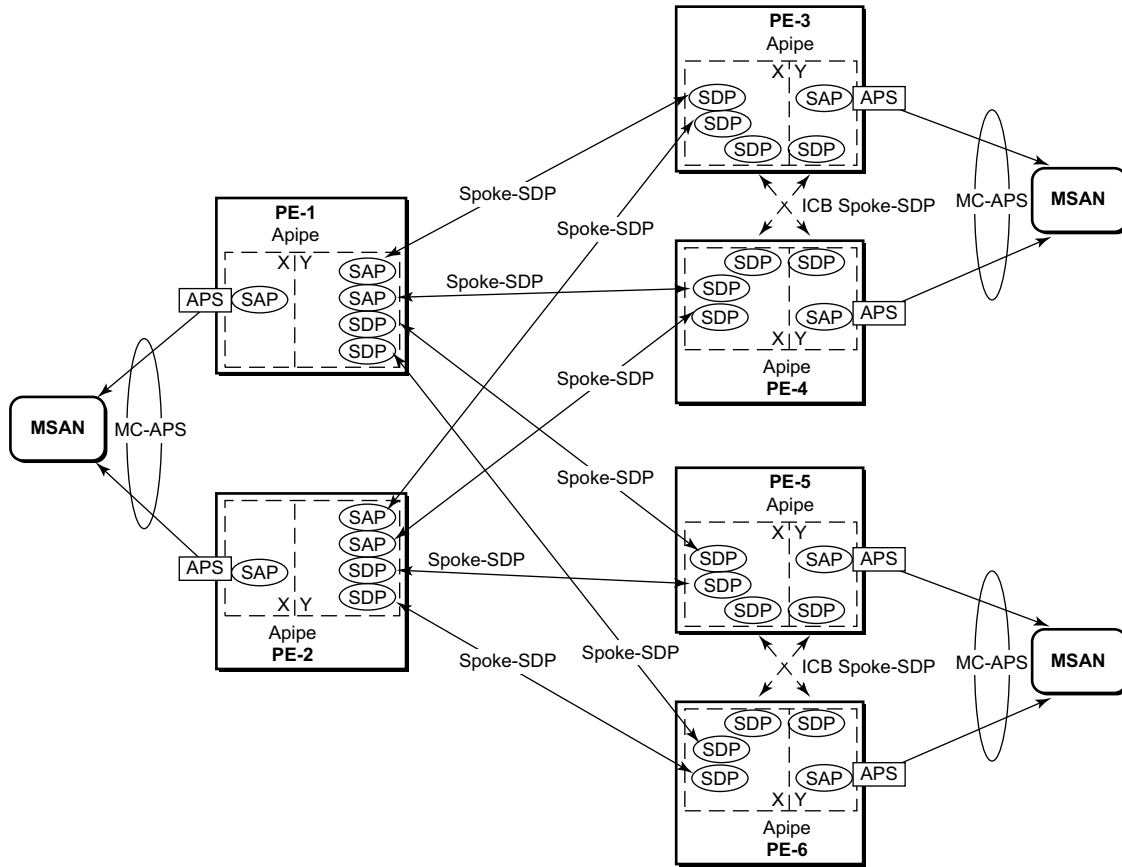


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Figure 23: Additional Setup Example 2 (Part 1)



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Figure 24: Additional Setup Example 2 (Part 2)

## Forced Switchover

MC-APS convergence can be forced with the **tools perform aps** command:

```
*A:PE-1# tools perform aps force
  - force <aps-id> {protect|working}

<aps-id>          : aps-<group-id>
                   aps          - keyword
                   group-id     - [1..64]
<protect|working> : keyword
```

After the forced switchover it is important to clear the forced switchover:

```
*A:PE1# tools perform aps clear
  - clear <aps-id> {protect|working}

<aps-id>          : aps-<group-id>
                   aps          - keyword
                   group-id     - [1..64]
<protect|working> : protect|working
```

## Conclusion

In addition to Multi-Chassis LAG, Multi-Chassis APS provides a solution for both network redundancy and access node redundancy. It supports ATM VLL and Ethernet VLL with ATM SAP. Access links and PE nodes are protected by APS and the MPLS network is protected by pseudowire redundancy/FRR. With this feature, Alcatel-Lucent can provide resilient end-to-end solutions.