Configuring the Circuit Emulation over Packet Shared Port Adapter

This chapter provides information about configuring the Circuit Emulation over Packet (CEoP) shared port adapters (SPAs) on the Cisco ASR 1000 Series Routers.

Release History

Release	Modification
Cisco IOS XE Release 3.10S	Added information about support for ATM on the SPA-24CHT1-CE-ATM.
Cisco IOS XE Release 3.6S	Added information about support for the Circuit Emulation (CEM) mode for the 2-Port Channelized T3/E3 ATM CEoP SPA.
Cisco IOS XE Release 3.5S	Added information about support for the SPA-2CHT3-CE-ATM in clear-channel E3 mode.
Cisco IOS XE Release 3.4S	Information added for the following SPAs: • 2-Port Channelized T3/E3 ATM CEoP SPA • 24-Port Channelized T1/E1 ATM CEoP SPA
Cisco IOS XE Release 3.3S	Support for the 1-Port Channelized OC3/STM-1 ATM and Circuit Emulation SPA was introduced in the Cisco ASR 1000 Series Aggregation Services Routers.

Note For more information pertaining to the restrictions about the Circuit Emulation SPAs, see the " SIP and SPA Product Overview" chapter in the Cisco ASR 1000 Series Hardware Installation Guide .

Configuration Tasks

This section describes the most common configurations for the SPA-1CHOC3-CE-ATM on the Cisco ASR 1000 Series Routers. For information about managing your system images and configuration files, see the following documents:

- Cisco ASR 1000 SIP and SPA Hardware Installation Guide
- Cisco ASR 1000 Series Aggregation Services Routers Software Configuration Guide
- Cisco IOS Configuration Fundamentals Configuration Guide
- Cisco IOS Configuration Fundamentals Command Reference

Referring an Interface on a SPA

Four CEoP SPAs can be installed in a SPA interface processor (SIP). Ports are numbered from left to right, beginning with 0. Single-port SPAs use only the port number 0. To configure or monitor SPA interfaces, you

must specify the physical location of the SIP, SPA, and interface in the command line interface (CLI). The interface address format is *slot*/*subslot*/*port* , where:

- *slot* —Specifies the chassis slot number in the Cisco ASR 1000 Series Router in which the SIP is installed
- *subslot* —Specifies the secondary slot of the SIP in which the SPA is installed
- *port* —Specifies the number of the individual interface port on a SPA

The following example shows how to specify the first interface (0) on a SPA that is installed in subslot 1 of the SIP in chassis slot 0:

```
Router(config)# interface cem 0/1/0
```

Configuring Port Usage: An Overview

The SPA-1CHOC3-CE-ATM can be configured to run only in the CEM mode. The 2-Port Channelized T3/E3 ATM CEoP SPA, introduced in Cisco IOS XE Release 3.4.0S, can be configured to run only in the ATM mode. Effective from Cisco IOS XE Release 3.6.0S, the 2-Port Channelized T3/E3 ATM CEoP SPA supports the CEM mode, but does not support the IMA mode. Effective from Cisco IOS XE Release 3.10.0S, The 24-port channelized T1E1 SPA supported ATM mode on the SPA-24CHT1-CE-ATM.

The following sections show how to configure each of the SPAs for the CEM mode.

Configuring SPA-1CHOC3-CE-ATM for SONET VT1.5

To configure SPA-1CHOC3-CE-ATM for SONET VT 1.5, perform the following procedure:

SUMMARY STEPS

1. Router(config)# **controller sonet** *slot/subslot/interface-id*
2. Router(config-controller)# **framing sonet**
3. Router(config-controller)# **sts-1** *2*
4. Router(config-ctrlr-sts1)# **mode vt-15**
5. Do one of the following:
   - Router(config-ctrlr-sts1)# **vtg** *2* **t1** *1* **cem-group** *1* unframed
   -
   -
   -

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **controller sonet** *slot/subslot/interface-id*	Selects the controller to be configured.
Step 2	Router(config-controller)# **framing sonet**	Specifies SONET framing.

	Command or Action	Purpose
Step 3	Router(config-controller)# **sts-1** *2*	Specifies the STS identifier.
Step 4	Router(config-ctrlr-sts1)# **mode vt-15**	Specifies VT-15 as the STS-1 mode of operation.
Step 5	Do one of the following: • Router(config-ctrlr-sts1)# **vtg** *2* **t1** *1* **cem-group** *1* unframed • • • **Example:** `Router(config-ctrlr-sts1)#` **vtg** *2* **t1** *4* **cem-group** *2* **timeslots** *list-of-timeslots*	Creates a single Structure-Agnostic TDM over Packet (SAToP) CEM group. or Creates a Circuit Emulation Services over Packet Switched Network (CESoPSN) CEM group.

Configuring SPA-1CHOC3-CE-ATM for SDH AU-4 C-12

To configure SPA-1CHOC3-CE-ATM for SDH AU-4 C-12, perform the following procedure:

SUMMARY STEPS

1. Router(config)# **controller sonet** *slot/subslot/interface-id*
2. Router(config-controller)# **framing sdh**
3. Router(config-controller)# **aug mapping au-4**
4. Router(config-controller)# **au-4** *1* **tug-3** *2*
5. Router(config-ctrlr-tug3)# **mode c-12**
6. Do one of the following:
   - Router(config-ctrlr-tug3)# **tug-2** *1* **e1** *1* **cem-group** *1* **unframed**
   - Router(config-ctrlr-tug3)# **tug-2** *1* **e1** *1* **cem-group** *1* **timeslots** *list-of-timeslots*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **controller sonet** *slot/subslot/interface-id*	Selects the controller to be configured.
Step 2	Router(config-controller)# **framing sdh**	Specifies SDH as the framing mode.

	Command or Action	Purpose
Step 3	Router(config-controller)# **aug mapping au-4**	Specifies AUG mapping.
Step 4	Router(config-controller)# **au-4** *1* **tug-3** *2*	Selects the AU-4 and TUG-3 to be configured.
Step 5	Router(config-ctrlr-tug3)# **mode c-12**	Specifies the channelization mode for TUG-3.
Step 6	Do one of the following: • Router(config-ctrlr-tug3)# **tug-2** *1* **e1** *1* **cem-group** *1* **unframed** • Router(config-ctrlr-tug3)# **tug-2** *1* **e1** *1* **cem-group** *1* **timeslots** *list-of-timeslots*	Creates an SAToP CEM group or a CESoPSN CEM group.

Configuring SPA-1CHOC3-CE-ATM for SDH AU-3 C-11

To configure SPA-1CHOC3-CE-ATM for SDH AU-3 C-11, perform the following procedure:

SUMMARY STEPS

1. Router(config)# **controller sonet** *slot/subslot/interface-id*
2. Router(config-controller)# **framing sdh**
3. Router(config-controller)# **aug mapping au-3**
4. Router(config-controller)# **au-3** *3*
5. Router(config-ctrlr-au3)# **mode c-11**
6. Do one of the following:
   - Router(config-ctrlr-au3)# **tug-2** *1* **t1** *2* **cem-group** *1* **unframed**
   - Router(config-ctrlr-au3)# **tug-2** *1* **t1** *2* **cem-group** *2015* **timeslots** *list-of-timeslots*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **controller sonet** *slot/subslot/interface-id*	Selects the controller to be configured.
Step 2	Router(config-controller)# **framing sdh**	Specifies the framing mode.
Step 3	Router(config-controller)# **aug mapping au-3**	Specifies AUG mapping.
Step 4	Router(config-controller)# **au-3** *3*	Selects the AU-3 to be configured.
Step 5	Router(config-ctrlr-au3)# **mode c-11**	Specifies the channelization mode for the link.

	Command or Action	Purpose
Step 6	Do one of the following: • Router(config-ctrlr-au3)# **tug-2** *1* **t1** *2* **cem-group** *1* **unframed** • Router(config-ctrlr-au3)# **tug-2** *1* **t1** *2* **cem-group** *2015* **timeslots** *list-of-timeslots*	Creates an SAToP CEM group or a CESoPSN CEM group.

Configuring the Card Type and CEM Group for the 24-Port Channelized T1/E1 ATM CEoP SPA

To configure the card type and CEM group for the 24-Port Channelized T1/E1 ATM CEoP SPA, perform the following steps:

SUMMARY STEPS

1. Router(config)# **card type {t1** | **e1**} *slot subslot*
2. Router(config)# **controller** {**t1** | **e1**} *slot/subslot/port*
3. Router(config-controller)# **cem-group** *group* **unframed**
4. Router(config-controller)# **cem-group** *group* **timeslots** *list-of-timeslots*
5. Router(config-controller)# **atm**
6. Router (config-controller)# exit

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **card type {t1**	**e1**} *slot subslot*	Selects the card type as T1 or E1.
Step 2	Router(config)# **controller** {**t1**	**e1**} *slot/subslot/port*	Selects the controller for the SPA port to be configured as T1 or E1.
Step 3	Router(config-controller)# **cem-group** *group* **unframed**	Creates a SAToP CEM group and configures the port for the clear-channel CEM mode.
Step 4	Router(config-controller)# **cem-group** *group* **timeslots** *list-of-timeslots*	Creates a CESoPSN CEM group and configures the port for the channelized CEM mode.
Step 5	Router(config-controller)# **atm**	Configures the port to run in the clear-channel ATM mode and creates an ATM interface to represent the port. or Removes the ATM interface.
Step 6	Router (config-controller)# exit	Exits the controller configuration mode.

Configuring the Card Type for the 2-Port Channelized T3/E3 ATM CEoP SPA

SUMMARY STEPS

1. Router # enable
2. Router# configure terminal
3. Router(config)# **card type {t3 | e3}** *slot subslot*
4. Router(config)# **controller** {**t3** | **e3**} *slot/subslot/port*
5. Router(config-controller)# **channelized mode {t1 | e1}**
6. Router(config-controller)# **cem-group** *group* **unframed**
7. Do one of the following:
   - Router(config-controller)# **{t1}** *1-28* **cem-group** *group* **timeslots** *1-24*
   - Router(config-controller)# **{e1}** *1-21* **cem-group** *group* **timeslots** *1-31*
8. Router(config-controller)# **atm**
9. Router (config-if)# exit

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router # enable	Enables privileged EXEC mode.
Step 2	Router# configure terminal	Enters global configuration mode.
Step 3	Router(config)# **card type {t3 | e3}** *slot subslot*	Selects a card type. or Use the **no** form of the command to remove the card type.
Step 4	Router(config)# **controller** {**t3** | **e3**} *slot/subslot/port*	Selects the controller to configure the SPA port. **Note** Effective from Cisco IOS XE Release 3.6.0S, T3 and E3 card types are supported.
Step 5	Router(config-controller)# **channelized mode {t1 | e1}**	Swaps between the CT3-T1 and CT3-E1 modes. This is applicable only if the card type is T3.
Step 6	Router(config-controller)# **cem-group** *group* **unframed**	Creates a SAToP CEM group and configures the port for clear-channel CEM mode. or To delete the CEM circuit and release the time slots, use the **no cem-group group-number** command.

	Command or Action	Purpose
Step 7	Do one of the following: • Router(config-controller)# **{t1}** *1-28* **cem-group** *group* **timeslots** *1-24* • Router(config-controller)# **{e1}** *1-21* **cem-group** *group* **timeslots** *1-31*	Creates a CESoPSN CEM group and configures the port for channelized CEM mode. Group number range is from 0 to 671.
Step 8	Router(config-controller)# **atm**	Configures the port to run in clear-channel ATM mode and creates an ATM interface to represent the port. or Use the **no** form of the command to remove the link from the ATM.
Step 9	Router (config-if)# exit	Exits the interface configuration mode and returns to the privileged EXEC mode.

Restrictions and Usage Guidelines for Configuring the 2-Port Channelized T3/E3 CEoP SPA

Following are the restrictions and usage guidelines pertaining to the configuration of the 2-Port Channelized T3/E3 CEoP SPA:

- PVC configuration is not supported on the ATM main interface.
- SPA-2CHT3-CE-ATM does not support the Control-Bit PLCP (Physical Layer Convergence Protocol) framing.
- Bridging features, such as Bridging Routed Encapsulations (BRE), Multipoint Bridging (MPB), and multi-VLAN are not supported on CEoP.
- CEoP SPAs do not support Layer 3 Quality of Service (QoS).
- E3 Channelization to E1 is not supported.
- CEoP SPAs simultaneously support multiple interface types.
- Adaptive clock recovery is supported on the 2-Port Channelized T3/E3 CEoP SPA.
- Out-of-Band (OOB) clock recovery for CEM is not supported.
- Maintenance Digital Link (MDL) is supported only for Digital Signal Cross Connect (DSX3-C) framing.
- In Cisco IOS XE Release 3.4.0S, ATM on clear-channel E3 is not supported.
- Effective from Cisco IOS XE Release 3.5.0S, ATM on clear-channel E3 is supported.

Note Mixed configuration of the T3 mode and the E3 mode simultaneously on the SPA-2CHT3-CE-ATM is not supported in Cisco IOS XE Release 3.5.0S.

Sample Configurations of the 2-Port Channelized T3/E3 CEoP SPA in the Clear-Channel T3 Mode

Configure the SPA in the T3 mode as follows:

```
Router(config)# card type T3 5 0
<SPA Reloads itself after the card type is configured. Only after SPA is UP, configure the
 controller as T3 or E3>
Router(config)# controller T3 5/0/0
```

Create a T3 ATM interface as follows:

```
Router(config-controller)# atm
```

Create a CEM group as follows:

```
Router(config-controller)# cem-group 0 unframed
```

Sample Configurations of the 2-Port Channelized T3/E3 CEoP SPA in the Clear-Channel E3 Mode

Configure the SPA in the E3 mode as follows:

```
Router(config)# card type E3 5 0
Router(config)# controller E3 5/0/0
```

Create an E3 ATM interface as follows:

```
Router(config-controller)# atm
```

Create a CEM group as follows:

```
Router(config-controller)# cem-group 0 unframed
```

Sample Configurations of the 2-Port Channelized T3/E3 CEoP SPA in the CT3-T1 Channelization Mode

Configure the SPA in the T3 mode as follows:

```
Router(config)# card type T3 5 0
Router(config)# controller T3 5/0/0
```

Create an NxDS0 T1 CEM group as follows:

```
Router(config-controller)# t1 2 cem-group 0 timeslots 1-12
```

Sample Configurations of the 2-Port Channelized T3/E3 CEoP SPA in the CT3-E1 Channelization Mode

Configure the SPA in the T3 mode as follows:

```
Router(config)# card type T3 5 0
Router(config)# controller T3 5/0/0
```

Change the channelization to the E1 mode as follows:

```
Router(config)# controller T3 5/0/0
router(config-controller)# channelized mode e1
```

Create an NxDS0 E1 CEM group as follows:

```
Router(config-controller)# e1 2 cem-group 0 timeslots 1-12
```

Verifying the 2-Port Channelized T3/E3 CEoP SPA Configuration

The following example shows how to verify the configuration for the 2-Port Channelized T3/E3 CEoP SPA:

```
Router# show controller t3 0/1/0
T3 0/1/0 is up.
  Hardware is SPA-2CHT3-CE-ATM
Applique type is Clear-channel T3 ATM
  No alarms detected.
  Framing is M23, Line Code is B3ZS, Cablelength is 224
  Clock Source is internal
  Equipment customer loopback
  Data in current interval (97 seconds elapsed):
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation, 0 P-bit Err Secs
     0 P-bit Severely Err Secs, 0 Severely Err Framing Secs
     0 Unavailable Secs, 0 Line Errored Secs
     0 C-bit Errored Secs, 0 C-bit Severely Errored Secs
     0 Severely Errored Line Secs
     0 Far-End Errored Secs, 0 Far-End Severely Errored Secs
     0 CP-bit Far-end Unavailable Secs
     0 Near-end path failures, 0 Far-end path failures
     0 Far-end code violations, 0 FERF Defect Secs
     0 AIS Defect Secs, 0 LOS Defect Secs
Router# show controller e3 0/1/0
E3 0/1/0 is up.
  Hardware is SPA-2CHT3-CE-ATM
Applique type is Clear-channel E3 ATM
  Receiver has loss of signal.
  Framing is E3 G751, Line Code is HDB3
  Clock Source is internal, National Bit 0
  Equipment customer loopback
  Data in current interval (363 seconds elapsed):
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation, 0 P-bit Err Secs
     0 P-bit Severely Err Secs, 0 Severely Err Framing Secs
     101 Unavailable Secs, 0 Line Errored Secs
     0 C-bit Errored Secs, 0 C-bit Severely Errored Secs
Router# show ip interface brief
Interface              IP-Address        OK?  Method    Status                Protocol
ATM0/1/0               Unassigned        YES  manual    up                    up
ATM0/1/1               Unassigned        YES  manual    up                    up
```

The following section displays the command outputs for the E3 mode:

```
Router# show interfaces ATM 0/1/0.1
ATM0/1/0.1 is up, line protocol is up
  Hardware is SPA-2CHT3-CE-ATM, address is 0026.cb0c.f410 (bia 0026.cb0c.f410)
  MTU 4470 bytes, BW 33791 Kbit/sec, DLY 0 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ATM
  Keepalive not supported
     0 packets input, 0 bytes
     0 packets output, 0 bytes
     0 OAM cells input, 0 OAM cells output
  AAL5 CRC errors : 0
  AAL5 SAR Timeouts : 0
  AAL5 Oversized SDUs : 0
  AAL5 length violation : 0
  Last clearing of "show interface" counters never
Router# show interfaces atm 0/1/0
ATM0/1/0 is up, line protocol is up
  Hardware is SPA-2CHT3-CE-ATM, address is 0026.cb0c.f410 (bia 0026.cb0c.f410)
  MTU 4470 bytes, sub MTU 4470, BW 33791 Kbit/sec, DLY 0 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ATM, loopback not set
  Keepalive not supported
  Encapsulation(s): AAL5 AAL0
  2047 maximum active VCs, 1 current VCCs
  VC Auto Creation Disabled.
```

```
  VC idle disconnect time: 300 seconds
  2 carrier transitions
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  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 IP multicasts)
     0 runs, 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 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
Router# show atm pvc interface atm 0/1/0.1
          VCD /                                              Peak Av/Min Burst
Interface  Name         VPI   VCI Type    Encaps     SC     Kbps   Kbps Cells St
0/1/0.1    1            100    32 PVC     SNAP       UBR   33791      UP
Router# show atm interface atm 0/1/0
Interface ATM0/1/0:
AAL enabled:  AAL5, AAL0, Maximum VCs: 2047, Current VCCs: 1
Max. Datagram Size: 4528
PLIM Type: E3 - 34000Kbps, Framing is G.751 ADM, TX clocking: LINE
0 input, 0 output, 0 IN fast, 0 OUT fast
 Avail bw = 34368
Config. is ACTIVE
Router# show atm interface atm 0/1/0.1
Interface ATM0/1/0.1:
AAL enabled:  AAL5, AAL0, Maximum VCs: 2047, Current VCCs: 1
Max. Datagram Size: 4528
PLIM Type: E3 - 34000Kbps, Framing is G.751 ADM, TX clocking: LINE
0 input, 0 output, 0 IN fast, 0 OUT fast
 Avail bw = 34368
Config. is ACTIVE
Router# show atm pvc
VCD /                                             Peak Av/Min Burst
Interface  Name         VPI   VCI Type    Encaps     SC     Kbps   Kbps Cells St
0/1/0.1    1            100    32 PVC     SNAP       UBR   33791      UP
```

The following section displays the command outputs for the T3 mode:

```
Router# show atm interface atm 5/1/0
Interface ATM5/1/0:
AAL enabled: AAL5, AAL0, Maximum VCs: 2047, Current VCCs: 0
Max. Datagram Size: 4528
PLIM Type: DS3 - 45000Kbps, Framing is C-bit ADM,
DS3 lbo: short, TX clocking: LINE
Cell-payload scrambling: OFF
0 input, 0 output, 0 IN fast, 0 OUT fast
 Avail bw = 44209
New Config. not yet ACTIVE
Router# show atm pvc interface atm 5/1/1.1
VCD /                                             Peak Av/Min Burst
Interface  Name         VPI   VCI Type    Encaps     SC     Kbps   Kbps Cells St
5/1/1.1    1            100    34 PVC     SNAP       UBR   44209              UP
Router# show atm interface atm 5/1/1.1
Interface ATM5/1/1.1:
AAL enabled:  AAL5, AAL0, Maximum VCs: 2047, Current VCCs: 1
Max. Datagram Size: 4528
PLIM Type: DS3 - 45000Kbps, Framing is C-bit ADM,
DS3 lbo: short, TX clocking: LINE
Cell-payload scrambling: OFF
0 input, 0 output, 0 IN fast, 0 OUT fast
 Avail bw = 44209
Config. is ACTIVE
Router# show interfaces atm 5/1/1.1
ATM5/1/1.1 is up, line protocol is up
  Hardware is SPA-2CHT3-CE-ATM, address is e804.6227.3851 (bia e804.6227.3851)
  MTU 4470 bytes, BW 44209 Kbit/sec, DLY 0 usec,
     reliability 255/255, txload 1/255, rxload 1/255
```

```
  Encapsulation ATM
  Keepalive not supported
     0 packets input, 0 bytes
     0 packets output, 0 bytes
     0 OAM cells input, 0 OAM cells output
  AAL5 CRC errors : 0
  AAL5 SAR Timeouts : 0
  AAL5 Oversized SDUs : 0
  AAL5 length violation : 0
  Last clearing of "show interface" counters never
Router# show interfaces atm 5/1/1
ATM5/1/1 is up, line protocol is up
  Hardware is SPA-2CHT3-CE-ATM, address is e804.6227.3851 (bia e804.6227.3851)
  MTU 4470 bytes, sub MTU 4470, BW 44209 Kbit/sec, DLY 0 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ATM, loopback not set
  Keepalive not supported
  Encapsulation(s): AAL5 AAL0
  2047 maximum active VCs, 1 current VCCs
  VC Auto Creation Disabled.
  VC idle disconnect time: 300 seconds
  2 carrier transitions
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  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 IP multicasts)
     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 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
```

The following section displays the command output for the CEM mode:

```
Router# show interfaces cem 0/3/0
CEM0/3/0 is up, line protocol is up
  Hardware is Circuit Emulation Interface
  MTU 1500 bytes, BW 45000 Kbit/sec, DLY 0 usec,
     reliability 255/255, txload 2/255, rxload 8/255
  Encapsulation CEM, loopback not set
  Keepalive not supported
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/0 (size/max)
  5 minute input rate 1536000 bits/sec, 1000 packets/sec
  5 minute output rate 425000 bits/sec, 278 packets/sec
     4708356 packets input, 904004352 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     100747 packets output, 19343424 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
```

Configuring the ATM Connection on a SPA

The following ATM SPAs are supported on the Cisco ASR 1000 Series Aggregation Services Routers:

SPA-2CHT3-CE-ATM

From Cisco IOS XE Release 3.4S, ATM support for the SPA-2CHT3-CE-ATM is introduced. When configured to operate in the ATM mode, CEoP SPAs support the ATM features.

The SPA-2CHT3-CE-ATM CEoP supports ATM operation only in the clear-channel mode. In this mode, each SPA port provides a single high-speed ATM connection operating at the line rate of the port.

Guideline for Configuring ATM Connections on a SPA

Consider the following guideline before configuring the ATM connections on a SPA:

In the clear-channel mode, each port in the 2-Port Channelized T3/E3 ATM CEoP SPA provides a single ATM connection operating at the T3line rate.

Configuring a Port on a CEoP SPA for ATM Operations

To configure a port on a CEoP SPA for ATM operations, you must:

1. Set the port to the ATM mode.
2. Configure an ATM permanent virtual circuit (PVC) for the port.
3. Configure a pseudowire for the ATM interface.

Configuring an ATM Interface

The router creates an ATM interface for each T3port that is configured for the ATM. The interface is in the **atm** *slot* /*subslot* /*port* format, where *slot* /*subslot* identifies the SPA slot and subslot, and /*port* identifies the port, for example, **atm** *2/1/0*.

SPA-24CHT1-CE-ATM

In Cisco IOS XE Release 3.10S, ATM support for the SPA-24CHT1-CE-ATM is introduced. When configured to operate in the ATM mode, CEoP SPAs support the ATM feature.

The SPA-24CHT1-CE-ATM CEoP is supported only in the clear-channel mode. In the clear-channel mode, each SPA port provides a single high-speed ATM connection operating at the line rate of the port.

Guidelines for Configuring ATM Connections on a SPA

Consider the following guideline before configuring the ATM connections on a SPA:

In the clear-channel mode, each port in the 24-Port Channelized T1/E1 ATM CEoP SPA provides a single ATM connection operating at the T1/E1 line rate.

Configuring a Port on a CEoP SPA for ATM Operations

To configure a port on a CEoP SPA for the ATM operations, you must:

1. Set the port to the ATM mode.
2. Configure an ATM permanent virtual circuit (PVC) for the port.
3. Configure a pseudowire for the ATM interface.

Configuring an ATM Interface

A Cisco ASR 1000 Series Aggregation Services Router creates an ATM interface for each T1/E1port that is configured for the ATM. The interface is in the **atm** *slot* /*subslot* /*port* format, where *slot* /*subslot* identifies the SPA slot and subslot, and /*port* identifies the port, for example, **atm** *2/1/0*.

The ATM configuration for SPA-24CHT1-CE-ATM is the same as the ATM configuration for SPA-2CHT3-CE-ATM. For more information about the ATM configuration for SPA-2CHT3-CE-ATM, see the Configuring the Card Type for the 2-Port Channelized T3/E3 ATM CEoP SPA, on page 7.

Note The SPA-24CHT1-CE-ATM is supported both T1 and E1 modes.

VC QoS on VP-PWRestriction

The VC QoS on VP-PW feature works only with single-cell relay and does not work with the packet-cell relay function.

Configuring a Pseudowire for an ATM Connection

To configure a pseudowire for an ATM connection, perform the procedure described in the following sections. The pseudowire carries ATM data across the MPLS network.

Configuring the T3E3 ATM and T1E1 ATM SPAs in the Layer 2 Permanent Virtual Circuit (L2 PVC) Mode

Perform the following steps to configure the T3E3 ATM and T1E1 ATM SPAs with ATM Cell Relay over Multiprotocol Label Switching (ACRoMPLS) in the L2 PVC mode:

SUMMARY STEPS

1. Router(config)# **interface atm** *slot* /*subslot* /*port.subinterface* point-to-point
2. Router(config-subif)# **pvc** *vpi* /*vci* l2transport
3. Router(cfg-if-atm-l2trans-pvc)# **encapsulation** {**aalo** | **aal5**}
4. Router(cfg-if-atm-l2trans-pvc)# **xconnect** *peer-router-id vcid* {**encapsulation mpls** | **pseudowire-class** *name* }
5. Router(config-if)# **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **interface atm** *slot* /*subslot* /*port.subinterface* point-to-point	Selects the ATM interface on which the pseudowire has to be configured, where *slot*/*subslot* is the SPA slot and subslot, and /*port* is the SPA port on which the interface exists.

	Command or Action	Purpose
Step 2	Router(config-subif)# **pvc** *vpi* /*vci* l2transport	Creates a permanent virtual circuit for the ATM interface and assigns the PVC with a VPI and VCI: • *vpi*—Specifies the virtual path identifier (0 to 255). • *vci*—Specifies the virtual channel identifier. Valid values are 32 to 1 less than the value specified using the **atm vc-per-vp** command. **Note** Do not specify 0 for both the VPI and VCI.
Step 3	Router(cfg-if-atm-l2trans-pvc)# **encapsulation** {**aalo** | **aal5**}	Specifies the ATM adaptation layer (AAL) for the PVC (only like-to-like Xconnects and LS): • **aal0**—Cell mode • **aal5**—Packet mode
Step 4	Router(cfg-if-atm-l2trans-pvc)# **xconnect** *peer-router-id vcid* {**encapsulation mpls** | **pseudowire-class** *name* }	Configures a pseudowire to transport data from the ATM interface across the MPLS network. • *peer-router-id* is the IP address of the remote PE peer router. • *vcid* is a 32-bit identifier that is to be assigned to the pseudowire. The same *vcid* must be used at both the ends of the pseudowire. • **encapsulation mpls** sets MPLS in tunneling mode. • **pseudowire-class** *name* specifies a pseudowire class that includes the **encapsulation mpls** command. **Note** The *peer-router-id* and *vcid* combination must be unique on the router.
Step 5	Router(config-if)# **exit**	Exits the interface configuration mode.

Configuring the T3E3 ATM and T1E1 ATM SPAs in the Layer 2 Permanent Virtual Path (L2 PVP) Mode

Perform the following steps to configure the T3E3 ATM and T1E1 ATM SPAs with ATM Cell Relay over MPLS in the L2 PVP mode:

SUMMARY STEPS

1. Router(config)# **interface atm** *slot* /*subslot* /*port.subinterface* multi-point
2. Router(config-subif)# **atm pvp** *vpi* l2transport
3. Router(cfg-if-atm-l2trans-pvp)# **xconnect** *peer-router-id vcid* {**encapsulation mpls** | **pseudowire-class** *name* }
4. Router(cfg-if-atm-l2trans-pvp)# **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **interface atm** *slot* /*subslot* /*port.subinterface* multi-point	Selects the ATM interface on which the pseudowire has to be configured, where *slot*/*subslot* is the SPA slot and subslot, and /*port* is the SPA port on which the interface exists.
Step 2	Router(config-subif)# **atm pvp** *vpi* l2transport	Creates an ATM permanent virtual path for the ATM interface and assigns a VPI to the PVP: • *vpi* specifies the virtual path identifier (0 to 255).
Step 3	Router(cfg-if-atm-l2trans-pvp)# **xconnect** *peer-router-id vcid* {**encapsulation mpls** | **pseudowire-class** *name* }	Configures a pseudowire to transport data from the ATM interface across the MPLS network. • *peer-router-id* is the IP address of the remote PE peer router. • *vcid* is a 32-bit identifier that is to be assigned to the pseudowire. The same *vcid* must be used at both ends of the pseudowire. • **encapsulation mpls** sets MPLS in the tunneling mode. • **pseudowire-class** *name* specifies a pseudowire class that includes the **encapsulation mpls** command. **Note** The *peer-router-id* and *vcid* combination must be unique on the router.
Step 4	Router(cfg-if-atm-l2trans-pvp)# **exit**	Exits the interface configuration mode.

Configuring the T3E3 ATM and T1E1 ATM SPAs in the Layer 3 Permanent Virtual Path (L3 PVP) Mode

Perform the following steps to configure the T3E3 ATM and T1E1 ATM SPAs in the ATM L3 PVP mode:

SUMMARY STEPS

1. Router(config)# **interface atm** *slot* /*subslot* /*port.subinterface* multi-point
2. Router(config-subif)# **ip address ip-address subnetmask**
3. Router(config-subif)# **atm pvp vpi-id**
4. Router(config-subif)# **pvc vpi-id/vci-id**
5. Router(config-if-atm-vc)# **protocol ip ip-address**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **interface atm** *slot* /*subslot* /*port.subinterface* multi-point **Example:** **Example:**	Selects the ATM interface on which to configure an ATM Multipoint L3 PVP configuration, where *slot*/*subslot* is the SPA slot and subslot, and /*port* is the SPA port on which the interface exists.
Step 2	Router(config-subif)# **ip address ip-address subnetmask**	Configures the IP address and subnetmask of the subinterface.
Step 3	Router(config-subif)# **atm pvp vpi-id**	Creates an ATM permanent virtual path for the ATM interface and assigns a VPI to the PVP: *vpi* id specifies the virtual path identifier (0 to 255).
Step 4	Router(config-subif)# **pvc vpi-id/vci-id**	Configures a permanent virtual circuit with the specified VPI ID and VCI ID.
Step 5	Router(config-if-atm-vc)# **protocol ip ip-address**	Maps the protocol type and IP address to the connection type.

Configuring the Layer 3 Permanent Virtual Circuit (L3 PVC) for the Point-to-Point (P2P) Connection

Perform the following steps to configure the T3E3 ATM and T1E1 ATM SPAs in the ATM L3 PVC for the P2P connection:

SUMMARY STEPS

1. Router(config)# **interface atm** *slot* /*subslot* /*port.subinterface* point-to-point
2. Router(config-subif)# **ip address ip-address subnetmask**
3. Router(config-subif)# **pvc vpi-id/vci-id**
4. Router(config-if-atm-vc)# **encapsulation {aal5mux | aal5snap}**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **interface atm** *slot* /*subslot* /*port.subinterface* point-to-point	Selects the ATM interface on which to configure ATM Point-to-Point (P2P) L3 PVC, where *slot*/*subslot* is the SPA slot and subslot, and /*port* is the SPA port where the interface exists.

	Command or Action	Purpose
Step 2	Router(config-subif)# **ip address ip-address subnetmask**	Configures the IP address and subnetmask of the subinterface.
Step 3	Router(config-subif)# **pvc vpi-id/vci-id**	Configures a permanent virtual circuit with the specified VPI ID and VCI ID.
Step 4	Router(config-if-atm-vc)# **encapsulation {aal5mux | aal5snap}**	Specifies the AAL for the PVC. • aal5mux—AAL5+MUX encapsulation • aal5snap—AAL5+LLC/SNAP encapsulation

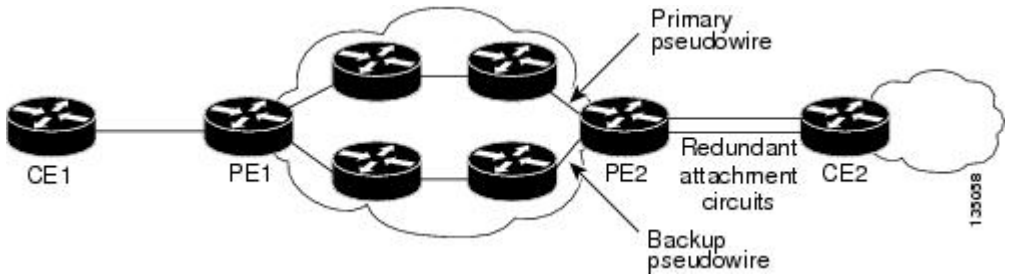
Configuring Pseudowire Redundancy

CEoP SPAs support the L2VPN Pseudowire Redundancy feature, which provides backup service for the ATM and CEM pseudowires. Configuring a Pseudowire Redundancy is an optional task. The L2VPN Pseudowire Redundancy feature enables the network to detect a failure and reroute the Layer 2 (L2) service to another endpoint that can continue to provide the service. This feature provides the ability to recover from a failure of either the remote PE router or the link between the PE and CE routers.

Configure pseudowire redundancy by configuring two pseudowires for an ATM interface, a primary pseudowire and a backup (standby) pseudowire. If the primary pseudowire fails, the router uses the backup pseudowire in its place. When the primary pseudowire becomes operational again, the backup pseudowire is stopped and the router resumes the use of the primary pseudowire.

The following figure shows an example of pseudowire redundancy.

Figure 1: Pseudowire Redundancy



The following is a summary of the steps to configure pseudowire redundancy on the SPA-2CHT3-CE-ATM.

Note You must configure the backup pseudowire such that it connects to a router that is different from the one the primary pseudowire connects to.

SUMMARY STEPS

1. Router# **enable**
2. Router# **configure terminal**
3. Router(config)# **interface atm** *slot/subslot/port.subinterface point-to-point*
4. Router(config-subif)# **pvc** *vpi /vci* l2transport
5. Router(cfg-if-atm-l2trans-pvc)# **encapsulation** {**aalo** | **aal5**}
6. Router(cfg-if-atm-l2trans-pvc)# **xconnect** *peer-router-id vcid* {**encapsulation mpls** | **pseudowire-class** *name* }
7. Router(config-if-atm-l2trans-pvc-xconn)# **backup peer** *peer-router-id peer-vcid* {**priority peer-priority** | **pw-class** *name* }
8. Router(config-if-atm-l2trans-pvc-xconn)# **backup delay** *enable-delay* {**disable delay** | **never**}

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router# **enable**	Enables the privilege exec mode.
Step 2	Router# **configure terminal**	Enters the global configuration mode.
Step 3	Router(config)# **interface atm** *slot/subslot/port.subinterface point-to-point*	Enters the subinterface configuration mode pertaining to the specified slot and port number to establish a P2P connection in which the SPA-2CHT3-CE-ATM is installed.
Step 4	Router(config-subif)# **pvc** *vpi /vci* l2transport	Creates a permanent virtual circuit for the ATM interface and assigns the PVC a VPI ID and VCI ID: • *vpi* specifies the virtual path identifier (0 to 255). • *vci* specifies the virtual channel identifier. Valid values are 32 to 1 less than the value specified using the **atm vc-per-vp** command. **Note** Do not specify 0 for both the VPI and VCI.
Step 5	Router(cfg-if-atm-l2trans-pvc)# **encapsulation** {**aalo**	**aal5**}	Specifies the ATM adaptation layer (AAL) for the PVC: • **aal0—**Cell mode • **aal5—**Packet mode
Step 6	Router(cfg-if-atm-l2trans-pvc)# **xconnect** *peer-router-id vcid* {**encapsulation mpls**	**pseudowire-class** *name* }	Configures a pseudowire to transport data from the ATM interface across the MPLS network. • *peer-router-id* is the IP address of the remote PE peer router. • *vcid* is a 32-bit identifier that is to be assigned to the pseudowire. The same *vcid* must be used for both ends of the pseudowire. • **encapsulation mpls** sets MPLS for the tunneling mode.

	Command or Action	Purpose
		• **pseudowire-class** *name* specifies a pseudowire class that includes the **encapsulation mpls** command. **Note** The *peer-router-id* and *vcid* combination must be unique on the router.
Step 7	Router(config-if-atm-l2trans-pvc-xconn)# **backup peer** *peer-router-id peer-vcid* {**priority peer-priority** | **pw-class** *name* }	Configures a backup peer router for providing ATM service if a failover occurs.
Step 8	Router(config-if-atm-l2trans-pvc-xconn)# **backup delay** *enable-delay* {**disable delay** | **never**}	Configures the backup delay parameters. • *enable-delay* is the time after which the backup route starts to work as the primary route. The valid range for the enable-delay is 0 to 180 seconds. • *disable delay* is the time after which the backup route will be disabled. The valid range is 0 to 180 seconds. • **never** enables the delay and sets it to never expire.

Configuring the 2-Port Channelized T3/E3 ATM CEoP SPA for the T3 Mode and the E3 Mode

This section describes how to configure the 2-Port Channelized T3/E3 ATM CEoP SPA. This SPA can be configured to operate in the ATM mode and the CEM mode. The router creates a logical interface to represent the mode that the SPA port is configured to run in. An ATM interface or a CEM interface is created for each T3 port that is configured for the ATM mode or the CEM mode. The interface has the format **atm** *slot* /*subslot* /*port* or **cem** *slot* /*subslot* /*port,* where *slot* /*subslot* identifies the SPA slot and subslot, and *port* identifies the port. The same port can be configured either in the CEM mode or in the ATM mode.

The following sections provide instructions for configuring the 2-Port Channelized T3/E3 ATM CEoP SPA:

Note Up to 1000 PVCs and 255 PVPs are supported per SPA for the ATM mode. Up to 576 CEM groups are supported per SPA for the CEM mode.

Configuring a SPA Port for the T3 Mode

To configure a SPA port for the T3 mode, perform the following steps:

SUMMARY STEPS

1. Router(config)# **controller t3** *slot*/*subslot*/*port*
2. Router(config-controller)# [**no**] framing {auto-detect | c-bit | m23}
3. Router(config-controller)# cablelength *feet*
4. Router(config-controller)# [**no**] **loopback** {**local** | **network** | **remote** {**line** | **payload**}}
5. Router(config-controller)# [**no**] **bert pattern** [**2^11** | **2^15** | **2^20 O.153** | **2^20 QRSS** | **2^23** | **0s** | **1s** | **alt-0-1**] **interval** [**1-1440**]
6. Router(config-controller)# *mdl {string {eic* | *fic* | *generator* | *lic* | *pfi* | *port* | *unit*} *string}* | {*transmit {idle-signal* | *path* | *test-signal}}*
7. Router(config-controller)# **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **controller t3** *slot*/*subslot*/*port*	Selects the T3 controller for the port you are configuring, where *slot* /*subslot* identifies the SPA slot and subslot, and *port* identifies the port.
Step 2	Router(config-controller)# [**no**] framing {auto-detect | c-bit | m23} **Example:**	For the clear channel ATM, configure framing as: • auto-detect—Detects the framing type at the device at the end of the line and switches to that framing type. If both devices are set to auto-detect, c-bit framing is used. • c-bit—Specifies C-bit parity framing. • m23—Specifies M23 framing.
Step 3	Router(config-controller)# cablelength *feet*	(Optional) Specifies the length of the cable attached to the port (in feet). Valid values are 0 to 450 ft. The default is 224 ft.
Step 4	Router(config-controller)# [**no**] **loopback** {**local** | **network** | **remote** {**line** | **payload**}} **Example:**	(Optional) Runs a loopback test, which is useful for troubleshooting problems. The **no** form of the command stops the test. The default is no loopback. • **local—**Loops the signal from Tx to Rx path. Sends alarm indication signal (AIS) to network. • **network—**Loops the signal from Rx to Tx path. • **remote** {**line** | **payload**}**—**(C-bit framing only) Sends a loopback request to the remote end. The **line** parameter loops back the unframed signal and the **payload** parameter loops back the framed signal.
Step 5	Router(config-controller)# [**no**] **bert pattern** [**2^11** | **2^15** | **2^20 O.153** | **2^20 QRSS** | **2^23** | **0s** | **1s** | **alt-0-1**] **interval** [**1-1440**]	(Optional) Configures bit error rate (BER) testing.

	Command or Action	Purpose
Step 6	Router(config-controller)# *mdl {string {eic | fic | generator | lic | pfi | port | unit} string} | {transmit {idle-signal | path | test-signal}}*	(Optional) Configures maintenance data link (MDL) messages, that communicate information between the local and remote ports. MDL configuration is valid only with C-bit framing. • **mdl string** specifies the type of identification information to be included in the MDL messages: ◦ eic *string* specifies the Equipment Identification Code, up to 10 characters. ◦ fic *string* specifies the Frame Identification Code, up to 10 characters. ◦ generator *string* specifies the Generator Number for test-signal messages, up to 38 characters. ◦ lic *string* is the Location Identification Code, up to 11 characters. ◦ pfi *string* specifies the Path Facility Identification Code for path messages, up to 38 characters. ◦ port *string* is the port number for idle-signal messages, up to 38 characters. ◦ unit *string* specifies the Unit Identification Code, up to 6 characters. • **mdl transmit** specifies the type of MDL messages to transmit: ◦ idle-signal—Enables idle-signal messages. ◦ path—Enables path messages. ◦ test-signal—Enables test-signal messages.
Step 7	Router(config-controller)# **exit**	Returns to the global configuration mode.

Configuring a SPA Port for the T3 Mode

To configure a SPA port for the E3 mode, perform the following steps:

Note The E3 mode is not supported in Cisco IOS XE Release 3.4.0S. Effective from Cisco IOS XE Release 3.5.0S, support for ATM on the clear-channel E3 mode has been introduced. Mixed configuration of both the T3 mode and the E3 mode simultaneously is not supported on the SPA-2CHT3-CE-ATM.

SUMMARY STEPS

1. Router(config)# **controller e3** *slot*/*subslot*/*port*
2. Router(config-controller)# [**no**] framing **g751**
3. Router(config-controller)# cablelength *feet*
4. Router(config-controller)# [**no**] **loopback** {**local** | **network** {**line** | **payload**}
5. Router(config-controller)# [**no**] **bert pattern** [**2^15** | **2^20** | **2^23** | **0s** | **1s** | **alt-0-1**] **interval** [**1-1440**]
6. Router(config-controller)# **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **controller e3** *slot*/*subslot*/*port*	Selects the E3 controller for the port you are configuring, where *slot* /*subslot* identifies the SPA slot and subslot, and /*port* identifies the port.
Step 2	Router(config-controller)# [**no**] framing **g751** **Example:**	(Optional) For the clear-channel ATM, configure framing as g751, which is the only framing that is supported.
Step 3	Router(config-controller)# cablelength *feet*	(Optional) Specifies the length (in feet) of the cable attached to the port. The valid values are 0 to 450 feet. The default value is 224 feet.
Step 4	Router(config-controller)# [**no**] **loopback** {**local**	**network** {**line**	**payload**} **Example:**	(Optional) Runs a loopback test that is useful for troubleshooting problems. The **no** form of the command stops the test. The default command is no loopback. • **local—**Loops the signal from the Tx path to the Rx path. Sends an Alarm Indication Signal (AIS) to the network. • **network** {**line**	**payload**}**—**Loops the signal from the Rx path to the Tx path. The line parameter loops back the unframed signal and the payload parameter loops back the framed signal.
Step 5	Router(config-controller)# [**no**] **bert pattern** [**2^15**	**2^20**	**2^23**	**0s**	**1s**	**alt-0-1**] **interval** [**1-1440**]	(Optional) Configures bit error rate (BER) testing.
Step 6	Router(config-controller)# **exit**	Returns to the global configuration mode.

Configuring the T3/E3 SPA Port for the Clear-Channel ATM Mode

To configure a T3/E3 SPA port for the clear-channel ATM mode, perform the following steps:

SUMMARY STEPS

1. Router(config)# **controller** {**t3**} *slot*/*subslot*/*port*
2. Router(config-controller)# **atm**
3. Router(config-controller)# **exit**
4. Router(config)# interface atm 0/1/2.10 point-to-point
5. Router(config-if)# **pvc** *vpi* /*vci*
6. Router(config-if)# **xconnect** *peer-router-id vcid* {**encapsulation mpls** | **pseudowire-class** *name* }
7. Router(config-if)# **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **controller** {**t3**} *slot*/*subslot*/*port*	Selects the T3controller for the port you are configuring, where *slot* /*subslot* identifies the SPA location and *port* identifies the port.
Step 2	Router(config-controller)# **atm**	Configures the port (interface) for the clear-channel ATM. The router creates an ATM interface whose format is atm /*slot* /*subslot* /*port* , where *slot* /*subslot* identifies the SPA slot and subslot, and *port* identifies the SPA port.
Step 3	Router(config-controller)# **exit**	Returns to the global configuration mode.
Step 4	Router(config)# interface atm 0/1/2.10 point-to-point	Selects the ATM interface for the SPA port.
Step 5	Router(config-if)# **pvc** *vpi* /*vci*	Configures a PVC for the interface and assigns the PVC a VPI and VCI. Do not specify 0 for both the VPI and VCI. See the *Configuring a Pseudowire for an ATM Connection* section for details about this command.
Step 6	Router(config-if)# **xconnect** *peer-router-id vcid* {**encapsulation mpls** | **pseudowire-class** *name* }	Configures a pseudowire to carry data from the clear-channel ATM interface over the MPLS network. See the *Configuring a Pseudowire for an ATM Connection* section for details about this command.
Step 7	Router(config-if)# **end**	Exits the interface configuration (config-if) mode.

Configuring the Scrambling Payload Feature on T3/E3 SPA Port

To configure the Scrambling Payload feature on a T3/E3 SPA port, perform the following steps:

Note The **scrambling** command is supported on SPA-2CHT3-CE-ATM from Cisco IOS XE Release 3.16.4S and Cisco IOS XE Everest 16.4.1 onwards.

SUMMARY STEPS

1. Router(config)# **controller t3** *slot*/*subslot*/*port*
2. Router(config-controller)# **atm**
3. Router(config-controller)# **scrambling cell-payload**
4. Router(config-controller)# **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **controller t3** *slot*/*subslot*/*port*	Selects the T3controller for the port you are configuring, where *slot*/*subslot* identifies the SPA location and *port* identifies the port.
Step 2	Router(config-controller)# **atm**	Configures the port (interface) for the clear-channel ATM. The router creates an ATM interface whose format is atm /*slot* /*subslot* /*port* , where *slot* /*subslot* identifies the SPA slot and subslot, and *port* identifies the SPA port.
Step 3	Router(config-controller)# **scrambling cell-payload**	Enables the Scrambling Payload feature on the SPA port.
Step 4	Router(config-controller)# **exit**	Returns to the global configuration mode.

Configuring CEM

This section provides information about how to configure CEM on the SPA-1CHOC3-CE-ATM, SPA-2CHT3-CE-ATM, and SPA-24CHT1-CE-ATM. The CEM provides a bridge between a time-division multiplexing (TDM) network and a packet network, such as Multiprotocol Label Switching (MPLS). The router encapsulates the TDM data in the MPLS packets and sends the data over a CEM pseudowire to the remote provider edge (PE) router. Thus, functions as a physical communication link across the packet network.

Prerequisites

Prior to configuring CEM on the SPA-1CHOC3-CE-ATM port, SPA-2CHT3-CE-ATM port, and SPA-24CHT1-CE-ATM port, perform the following steps:

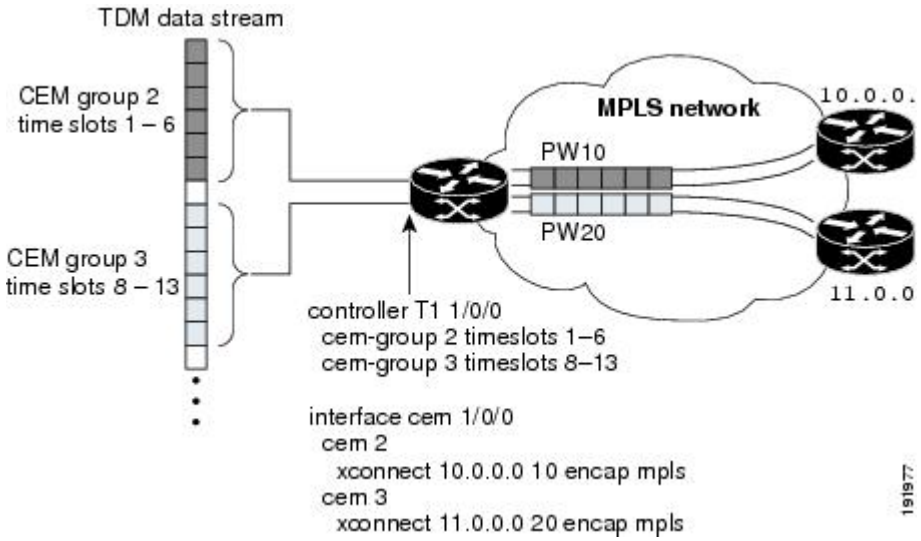
1 Configure one or more CEM groups on the port. Each CEM group represents a set of time slots from the TDM circuit attached to the port. When you configure a CEM group on the port, the router creates an interface that has the same slot/subslot/port number as the port (for example, **cem** *0/1/0*).

2 Configure a pseudowire for each CEM group. The router maps the data from the time slots in each group to its pseudowire and sends the data over the MPLS network to the remote PE router. Use the **xconnect** command with **encap mpls** to create a pseudowire for each CEM group.

The following figure shows the following sample configurations for the SPA-1CHOC3-CE-ATM, SPA-2CHT3-CE-ATM, and SPA-24CHT1-CE-ATM:

- A TDM circuit is connected to port 0 on a SPA installed in slot 1, subslot 0 (T1 controller 1/0/0).
- Two pseudowires (PW10 and PW20) are configured to carry TDM data across the MPLS network.
- Two CEM groups (2 and 3) are configured for the data in the TDM time slots:
  - Time slots 1 through 6 are sent over pseudowire 10 to the remote PE router at 10.0.0.0.
  - Time slots 8 through 13 are sent to the PE router 11.0.0.0 over pseudowire 20.

Figure 2: TDM Time Slots-to-Pseudowire Mappings



The following table lists the number of CEM groups you can configure for each CEM SPA.

Table 1: Number of CEM Groups Supported for Each Circuit Emulation SPA

CEoP SPA	Number of Supported CEM Groups
1-Port Channelized OC-3 STM1 ATM CEoP SPA	576
2-Port Channelized T3/E3 ATM CEoP SPA	576
24-Port Channelized T1/E1 ATM CEoP SPA	191

Configuration Guidelines and Restrictions

Not all combinations of payload size and dejitter buffer size are supported. Payload size, or dejitter configurations are rejected at the CLI level in the CEM circuit mode on the SPA, if they are not compatible. Incompatible parameter modifications (if any), will be rejected, and the configuration will fall back to the old dejitter and payload parameters if the parameters are being applied through the CEM class template.

Configuring a CEM Group

To configure a CEM group to represent a CEM circuit on a SPA port, perform the following steps:

Note The first **cem-group** command under the controller creates a CEM interface that has the same *slot* /*subslot* /*port* information as the controller. The CEM interface is removed when all of the CEM groups under the interface is deleted.

- The CEM interface is always up, even if the controller state is down. This allows the CEM pseudowire to carry alarm information to the remote end.

SUMMARY STEPS

1. Router(config)# **controller** *type slot*/*subslot*/*port*
2. Router(config-controller)# [**no**] **cem-group** *group-number* {**unframed** | **timeslots** *timeslot*}
3. Router(config-controller)# **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **controller** *type slot*/*subslot*/*port* **Example:** `Router(config)# controller t1 3/1/Router(config)# controller sonet 2/0/1`	Selects the controller for the port that is being configured: • *type* identifies the port type. Depending on the card type, the valid values are **t1**, **e1**, **t3**, **e3**, or **sonet**. For additional information about the card types, see the Setting the Card Type, page 15-2 section. • *slot* /*subslot* /*port* identifies the SPA slot, subslot, and the port.
Step 2	Router(config-controller)# [**no**] **cem-group** *group-number* {**unframed** | **timeslots** *timeslot*} **Example:** `Router(config)# controller t1 3/2/0Router(config-controller)# cem-group 1 unframedRouter(config)# controller t1 3/2/1Router(config-controller)# cem-group 1 timeslots 1,3,5-11Router(config-controller)# cem-group 2 timeslots 12-24Router(config)#` **`controller t3 3/2/0`** **Example:** `Router(config-controller)#` **`t1 1 cem-group 1 timeslots 1`**	Creates a CEM circuit (group) from one or more time slots of the line connected to this port. To delete the CEM circuit and release the time slots, use the **no cem-group** *group-number* command. • *group-number* assigns a CEM circuit number: ◦ For 24 T1/E1 Channelized ATM CEoP SPA, you can configure up to 191 CEM groups. ◦ For 2-Port Channelized T3/E3 ATM CEoP SPA, you can configure up to 576 CEM groups. ◦ For 1-Port Channelized OC-3 STM1 ATM CEoP SPA, you can configure up to 576 CEM groups. • **unframed** creates a single CEM circuit from all the time slots, and uses the framing on the line. Use this keyword for the SAToP mode.

	Command or Action	Purpose
	Example: `Router(config)#` **controller t3 3/2/1** **Example:** `Router(config-controller)#` **e1 1 cem-group 1 unframed**	• **timeslots** *timeslots* specifies the time slots to be included in the CEM circuit. Use this keyword for the CESoPSN mode. The list of time slots can include commas and hyphens with no spaces between the numbers, commas, and hyphens. **Note** Each time slot operates at 64 kbps.
Step 3	Router(config-controller)# **exit**	Exits the controller configuration mode.

Configuring a CEM Class (Optional)

To assign CEM parameters to one or more CEM interfaces, create a CEM class (template) that defines the parameters, and then apply the class to the interfaces.

CEM class parameters can be configured directly on the CEM circuit. The inheritance is as follows:

- CEM circuit (highest level)
- Class attached to CEM circuit
- Class attached to the CEM interface

If the same parameter is configured on the CEM interface and the CEM circuit, the value on the CEM circuit takes precedence.

To configure a CEM class, perform the following steps:

SUMMARY STEPS

1. Router# configure terminal
2. Router(config)# **class cem** *name*
3. Router(config-cem-class)# **command**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router# configure terminal	Enters the global configuration mode.
Step 2	Router(config)# **class cem** *name*	Creates a CEM class to configure the parameters in a template and apply the parameters at the CEM interface level. • *The name* argument is a string of up to 80 characters that identifies the CEM class. Note that the name is truncated to the first 15 characters.

	Command or Action	Purpose
Step 3	Router(config-cem-class)# **command**	Configures the CEM parameters by issuing the appropriate commands. See the Configuring CEM Parameters, on page 61 for information about the commands.

What to Do Next

In the following example, a CEM class (TDM-Class-A) is configured to set the payload size and dejitter buffer parameters:

```
class cem TDM-Class-A
  payload-size 512
  dejitter-buffer 80
exit
```

In the following example, the CEM parameter settings from TDM-Class-A are applied to CEM interface 0/1/0. Any CEM circuits created under this interface inherit these parameter settings.

```
int cem 0/1/0
  class int TDM-Class-A
  cem 6
      xconnect 10.10.10.10 2 encap mpls
  exit
```

Configuring a CEM Pseudowire

To configure a pseudowire to transport a CEM circuit across the MPLS network, perform the following steps:

SUMMARY STEPS

1. Router(config)# **interface cem** *slot /subslot /port*
2. Router(config-if)# **cem** *group-number*
3. Router(config-if-cem)# *command*
4. Router(config-if)# **xconnect** *peer-router-id vcid* {**encapsulation mpls** | **pw-class** *name* }
5. Router(config-if)# **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **interface cem** *slot /subslot /port*	Selects the CEM interface in which the CEM circuit (group) is located, where *slot*/*subslot* is the SIP slot and SPA subslot, and *port* is the SPA port in which the interface exists.
Step 2	Router(config-if)# **cem** *group-number*	Selects the CEM circuit (group) to configure a pseudowire.

	Command or Action	Purpose
Step 3	Router(config-if-cem)# *command*	(Optional) Defines the operating characteristics for the CEM circuit. For command details, see the Configuring CEM Parameters, on page 61.
Step 4	Router(config-if)# **xconnect** *peer-router-id vcid* {**encapsulation mpls** | **pw-class** *name* }	Configures a pseudowire to transport TDM data from the CEM circuit across the MPLS network. • *peer-router-id* is the IP address of the remote PE peer router. • *vcid* is a 32-bit identifier, which is assigned to the pseudowire. The same *vcid* must be used for both ends of the pseudowire. • **encapsulation mpls** sets MPLS for the tunneling mode. • **pseudowire-class** *name* specifies a pseudowire class that includes the **encapsulation mpls** command. **Note** The *peer-router-id* and *vcid* combination must be unique on the router.
Step 5	Router(config-if)# **exit**	Exits interface configuration mode.

What to Do Next

Example

The following sample configuration shows a T1 port on which two CEM circuits (groups) are configured. Each CEM circuit carries data from the time slots of the TDM circuit attached to the port.

The two **xconnect** commands create pseudowires to carry the TDM data across the MPLS network. Pseudowire 2 carries the data from time slots 1, 2, 3, 4, 9, and 10 to the remote PE router at 10.10.10.10. Pseudowire 5 carries the data from time slots 5, 6, 7, 8, and 11 to the remote PE router at 10.10.10.11.

```
controller SONET 0/1/0
 description This is SONET controller
 framing sonet
 clock source internal
 loopback network
 !
 sts-1 1
  mode vt-15
  vtg 1 t1 1 description T1 line to 3rd floor PBX
  vtg 1 t1 1 clock source Recovered 6
  vtg 1 t1 1 cem-group 6 timeslots 1-4,9,10
  vtg 1 t1 1 cem-group 7 timeslots 5-8,11
 !
 sts-1 2
  mode vt-15
 !
 sts-1 3
  mode vt-15
int cem0/1/0
  cem 6
    xconnect 10.10.10.10 2 encap mpls
  cem 7
    xconnect 10.10.10.11 5 encap mpls
```

Configuring TDM Local Switching

TDM Local Switching allows switching of Layer 2 data between two CEM interfaces on the same router. The two CEM groups can be on the same physical interface or different physical interfaces; they can be on the same SPA, the same line card, or different line cards.

Consider the following guidelines before configuring CEM Phase 2 TDM Local Switching:

- Autoprovisioning is not supported.
- Out-of-band signaling is not supported.
- Port mode local switching is not supported on the CEM interface.
- Interworking with other interface types is not supported.
- The same CEM circuit cannot be used for both local switching and Xconnect.
- You can use CEM local switching between two CEM circuits on the same CEM interface.
- CEM local switching can be across a 24-Port Channelized T1/E1 ATM CEoP SPA, a 2-Port Channelized T3/E3 ATM CEoP SPA, or a 1-Port Channelized OC-3 STM1 ATM CEoP SPA.

To configure the CEoPS Phase 2 TDM Local Switching, perform the following steps:

SUMMARY STEPS

1. Router# configure terminal
2. Router(config)# [no] connect name cem x/y/z circuit-id cem a/b/c circuit-id

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router# configure terminal	Enters the global configuration mode.
Step 2	Router(config)# [no] connect name cem x/y/z circuit-id cem a/b/c circuit-id **Example:** `Router(config)#` **connect** `cem` **cem** *0/1/0 cemckt1* **cem** *0/2/0 cemckt2* **Example:** `Router(config)#` **no connect** `cem` **cem** *0/1/0 cemckt1* **cem** *0/2/0 cemckt2*	Configures a local switching connection between cemckt1 of CEM interface x/y/z and cemckt2 of CEM interface a/b/c. The no form of this command unconfigures a local switching connection between cemckt1 of the CEM interface x/y/z and cemckt2 of the CEM interface a/b/c.

Verifying Switching Connections

Use the show connection, show connection **all**, show connection id conn id, and show connection conn name commands to verify the current switching connections.

Local Switching Redundancy

Local Switching Redundancy provides a backup attachment circuit (AC) when the primary attachment circuit fails. All the ACs must be on the same Cisco ASR 1000 Series Aggregation Services Router.

The following combinations of CEM ACs are supported:

- CEM ACs on different SPAs on the same SIP
- CEM ACs on different SIPs on the same Cisco ASR 1000 Series Aggregation Services Router

Guidelines for Local Switching Redundancy

Local Switching Redundancy guidelines are as follows:

- Autoconfiguration of CEM interfaces is not supported.
- Only the tail-end AC can be backed up. If head end fails, there is no protection.
- The circuit type of the primary and backup AC must be identical (failover operation will not switch between different types of interfaces or different CEM circuit types).
- Backs up a local switching connection to cem-ckt3 of CEM interface cem3. Only one backup AC is allowed for each connection.
- Auto configuration of backup CEM circuits is not allowed.
- The CEM circuit that is used as a backup in a local switching connection cannot be used for Xconnect configurations.
- Dynamic modification of parameters in a local switching connection is not supported in a scenario where the tail-end segment is backed up to a segment using the backup command. If you want to modify the parameters in any of the three segments (head-end, tail-end, or backup), you must first unconfigure with the backup command, make the changes in the individual segments, and then reconfigure the backup with the backup command.

Configuring a Backup Switched Connection

To configure a backup switched connection, when the primary connection fails, perform the following procedure:

SUMMARY STEPS

1. Router# **configure terminal**
2. Router(config)# [no] connect name cem x/y/z circuit-id cem a/b/c circuit-id
3. Router(config-connection)# backup interface cemx/y/z circuit-id

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router# **configure terminal**	Enters the global configuration mode.
Step 2	Router(config)# [no] connect name cem x/y/z circuit-id cem a/b/c circuit-id **Example:** `Router(config)# connect cem cem 0/1/0 cemckt1 cem 0/2/0 cemckt2`	Configures a local switching connection between cemckt1 of CEM interface x/y/z and cemckt2 of CEM interface a/b/c. The no form of this command unconfigures a local switching connection between cemckt1 of CEM interface x/y/z and cemckt2 of CEM interface a/b/c.
Step 3	Router(config-connection)# backup interface cemx/y/z circuit-id **Example:** `Router(config-connection)# backup interface cem 0/3/0 3`	Backs up a locally switched CEM connection.

Verifying Backup and Primary Circuits

Use the show xconnect all command to check the status of the backup and primary circuits.

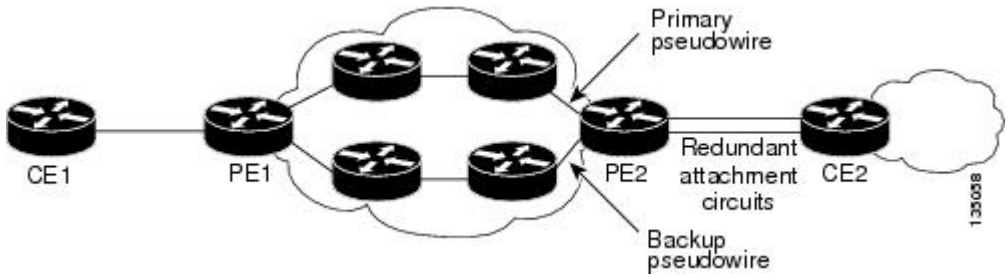
Configuring Pseudowire Redundancy

The SPA-1CHOC3-CE-ATM, SPA-2CHT3-CE-ATM, and SPA-24CHT1-CE-ATM support the L2VPN Pseudowire Redundancy feature that provides backup service for CEM pseudowires. Configuring a Pseudowire Redundancy is an optional task.The L2VPN Pseudowire Redundancy feature enables the network to detect a failure and reroute the Layer 2 (L2) service to another endpoint that can continue to provide service. This feature provides the ability to recover from a failure of either the remote PE router or the link between the PE router and the CE router.

Configure pseudowire redundancy by configuring two pseudowires for a CEM interface, a primary pseudowire and a backup (standby) pseudowire. If the primary pseudowire goes down, the router uses the backup pseudowire in its place. When the primary pseudowire becomes functional again, the backup pseudowire is brought down and the router resumes the use of the primary pseudowire.

The following figure shows an example of pseudowire redundancy.

Figure 3: Pseudowire Redundancy



To configure pseudowire redundancy on a SPA-1CHOC3-CE-ATM, SPA-2CHT3-CE-ATM, or SPA-24CHT1-CE-ATM perform the following steps.

Note You must configure the backup pseudowire to connect to a router that is different from the primary pseudowire.

SUMMARY STEPS

1. Router# **enable**
2. Router# **configure terminal**
3. Router(config)# **interface cem** *slot/subslot/port*
4. Router(config-if)# **cem** *group-number*
5. Router(config-if-cem)# **xconnect** *peer-router-id vcid* {**encapsulation mpls** | **pw-class** *pw-class-name*}
6. Router(config-if-cem-xconn)# **backup peer** *peer-router-ip-addr vcid* [**pw-class** *pw-class-name*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router# **enable**	Enters the Privileged EXEC mode.
Step 2	Router# **configure terminal**	Enters the global configuration mode.
Step 3	Router(config)# **interface cem** *slot/subslot/port*	Selects the CEM interface where the CEM circuit (group) is located (where *slot*/*subslot* is the SIP slot and SPA subslot and *port* is the SPA port where the interface exists).
Step 4	Router(config-if)# **cem** *group-number*	Selects the CEM circuit (group) to configure a pseudowire.
Step 5	Router(config-if-cem)# **xconnect** *peer-router-id vcid* {**encapsulation mpls** | **pw-class** *pw-class-name*}	Configures a pseudowire to transport TDM data from the CEM circuit across the MPLS network. • *peer-router-id* is the IP address of the remote PE peer router. • *vcid* is a 32-bit identifier assigned to the pseudowire. The same *vcid* must be used for both ends of the pseudowire.

	Command or Action	Purpose
		• **encapsulation mpls** sets MPLS for tunneling mode. • **pw-class** *name* specifies a pseudowire class that includes the **encapsulation mpls** command. **Note** The *peer-router-id* and *vcid* combination must be unique on the router.
Step 6	Router(config-if-cem-xconn)# **backup peer** *peer-router-ip-addr vcid* [**pw-class** *pw-class-name*]	Configures a backup pseudowire link for failover mechanism if the link between PE router and CE router fails or the remote PE router fails.

Example

The following example shows pseudowire redundancy configured for a CEM circuit (group). In the following example, the **xconnect** command configures a primary pseudowire for CEM group 0. The **backup peer** command creates a redundant pseudowire for a CEM circuit (group).

```
int cem0/1/0
  no ip address
  cem 0
    xconnect 10.10.10.1 1 encap mpls
    backup peer 10.10.10.2 200
  exit
```

Configuring T1 on a 24-Port Channelized T1/E1 ATM CEoP SPA

When configuring T1 on a 24-Port Channelized T1/E1 ATM CEoP SPA, follow these guidelines:

- There can be 0 to 23 channels under a T1 controller, one for each T1 time slot.
- Each channel can be configured as a CEM group.
- Maximum channels under a single CEM group are 24.
- Each CEM group number under a controller must be unique.
- A maximum of 191 CEM circuits can be configured.

To configure T1 on a 24-Port Channelized T1/E1 ATM CEoP SPA, perform the following steps:

SUMMARY STEPS

1. Router(config)# **controller t1** *slot*/*subslot*/*port*
2. Router(config-controller)# [**no**] **cem-group** *group-number* {**unframed** | **timeslots** *timeslot*}
3. Router(config-controller)# **framing** {**sf** | **esf**}
4. Router(config-controller)# **exit**
5. Router(config)# **interface cem** *slot*/*subslot*/*port*
6. Router(config-controller)# **cem** *group-number*
7. Router(config-controller)# **xconnect** *peer-ip-address* **encap mpls**
8. Router(config-controller)# **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **controller t1** *slot*/*subslot*/*port*	Selects the T1 controller.
Step 2	Router(config-controller)# [**no**] **cem-group** *group-number* {**unframed** | **timeslots** *timeslot*}	Creates a CEM interface and assigns it to a CEM group number.
Step 3	Router(config-controller)# **framing** {**sf** | **esf**}	Selects the T1 framing type.
Step 4	Router(config-controller)# **exit**	Exits the controller configuration (config-controller) mode and returns to the global configuration (config) mode.
Step 5	Router(config)# **interface cem** *slot*/*subslot*/*port*	Selects the CEM interface.
Step 6	Router(config-controller)# **cem** *group-number*	Selects the specified CEM group.
Step 7	Router(config-controller)# **xconnect** *peer-ip-address* **encap mpls**	Configures a pseudowire for the T1 timeslot identified by the CEM group.
Step 8	Router(config-controller)# **exit**	Exits the controller configuration (config-controller) mode.

Configuring E1 on a 24-Port Channelized T1/E1 ATM CEoP SPA

To configure E1 on a 24-Port Channelized T1/E1 ATM CEoP SPA, perform the following steps:

SUMMARY STEPS

1. Router(config)# **controller e1** *slot*/*subslot*/*port*
2. Router(config-controller)# [**no**] **cem-group** *group-number* {**unframed** | **timeslots** *timeslot*}
3. Router(config-controller)# **framing** {**crc4** | **no-crc4**}
4. Router(config-controller)# **exit**
5. Router(config)# **interface cem** *slot*/*subslot*/*port*
6. Router(config-controller)# **cem** *group-number*
7. Router(config-controller)# **xconnect** *peer-ip-address* **encap mpls**
8. Router(config-controller)# **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **controller e1** *slot*/*subslot*/*port*	Selects the controller for the E1 port being configured.
Step 2	Router(config-controller)# [**no**] **cem-group** *group-number* {**unframed** | **timeslots** *timeslot*}	Creates a CEM interface and assigns a CEM group number.
Step 3	Router(config-controller)# **framing** {**crc4** | **no-crc4**}	Selects the framing type.
Step 4	Router(config-controller)# **exit**	Exits the controller configuration mode and returns to the global configuration mode.
Step 5	Router(config)# **interface cem** *slot*/*subslot*/*port*	Selects the CEM interface.
Step 6	Router(config-controller)# **cem** *group-number*	Selects the specified CEM group.
Step 7	Router(config-controller)# **xconnect** *peer-ip-address* **encap mpls**	Configures a pseudowire for the E1 time slots identified by the CEM group.
Step 8	Router(config-controller)# **exit**	Exits the controller configuration mode.

Configuring a 24-Port Channelized T1/E1 ATM CEoP SPA in the Clear-Channel ATM Mode

To configure a T1/E1 SPA port in the clear-channel ATM mode, perform the following steps:

SUMMARY STEPS

1. **enable**
2. configure terminal
3. controller{ t1 | e1 } slot/subslot/port
4. atm
5. exit
6. **interface atm slot/subslot/port.subinterface number point-to-point**
7. pvc vpi | vci
8. xconnect peer-router-id vcid {encapsulation mpls | pseudowire-class name}
9. end

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** **Router> enable**	**Enables the privileged EXEC mode.** **Enter your password, if prompted.**
Step 2	configure terminal **Example:** `Router#` **configure terminal**	Enters the global configuration mode.
Step 3	controller{ t1 | e1 } slot/subslot/port **Example:** `Router(config)# controller t1 0/0/2`	Selects the T1 or E1 controller for the slot, the subslot, or the port on the SPA.
Step 4	atm **Example:** `Router(config-controller)# atm`	Configures the port or the slot for the clear-channel ATM.
Step 5	exit **Example:** `Router(config-controller)# exit`	Returns to the global configuration mode.
Step 6	**interface atm slot/subslot/port.subinterface number point-to-point** **Example:** `Router(config)# interface atm 0/1/2.10 point-to-point`	Specifies the ATM interface for the SPA port mentioned in Step 1.

	Command or Action	Purpose
Step 7	pvc vpi | vci **Example:** `Router(config-if)# pvc 10/11`	Configures a PVC for the interface and assigns the PVC a VPI or VCI. Do not specify 0 for the VPI or the VCI. See the"Configuring a Pseudowire for an ATM Connection, on page 14" section for more details.
Step 8	xconnect peer-router-id vcid {encapsulation mpls | pseudowire-class name} **Example:** `Router(config-if)# xconnect 10.0.0.8 2 encapsulation mpls`	Configures a pseudowire to carry data from the clear-channel ATM interface over the MPLS network. See the "Configuring a Pseudowire for an ATM Connection, on page 14" section for more details.
Step 9	end **Example:** `Router(config-if)# end`	Exits the interface configuration mode.

Examples for Configuring a 24-Port Channelized T1/E1 ATM CEoP SPA in the Clear-Channel ATM Mode

The following example shows how to verify the configuration of the 24-Port channelized T1/E1 CEoP SPA:

```
Router# show controllers T1 1/1/14
T1 1/1/14 is up.
  Applique type is SPA-24CHT1-CE-ATM
  Cablelength is short 133
  No alarms detected.
  alarm-trigger is not set
  Soaking time: 3, Clearance time: 10
  AIS State:Clear  LOS State:Clear  LOF State:Clear
  Framing is ESF, Line Code is B8ZS, Clock Source is Line.
  Data in current interval (87 seconds elapsed):
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 0 Unavail Secs
     0 Near-end path failures, 0 Far-end path failures, 0 SEF/AIS Secs
  Data in Interval 1:
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 0 Unavail Secs
     0 Near-end path failures, 0 Far-end path failures, 0 SEF/AIS Secs
  Data in Interval 2:
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 0 Unavail Secs
     0 Near-end path failures, 0 Far-end path failures, 0 SEF/AIS Secs
  Data in Interval 3:
     0 Line Code Violations, 3 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     1 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 1 Unavail Secs
     0 Near-end path failures, 0 Far-end path failures, 0 SEF/AIS Secs
  Total Data (last 3 15 minute intervals):
     0 Line Code Violations, 3 Path Code Violations,
```

```
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins,
     1 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 1 Unavail Secs
     0 Near-end path failures, 0 Far-end path failures, 0 SEF/AIS Secs
Router# show ip int brief | inc ATM1/1
ATM1/1/6               unassigned      YES unset  up                    up
ATM1/1/14              unassigned      YES unset  up                    up
ATM1/1/14.10           unassigned      YES unset  up                    up
Router# show interfaces ATM1/1/14
ATM1/1/14 is up, line protocol is up
  Hardware is SPA-24CHT1-CE-ATM, address is 0000.0000.0000 (bia 0000.0000.0000)
  MTU 4470 bytes, sub MTU 4470, BW 1536 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ATM, loopback not set
  Keepalive not supported
  Encapsulation(s): AAL5 AAL0
  2047 maximum active VCs, 1 current VCCs
  VC Auto Creation Disabled.
  VC idle disconnect time: 300 seconds
  1 carrier transitions
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  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 IP multicasts)
     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 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
Router# show interfaces ATM1/1/14.10
ATM1/1/14.10 is up, line protocol is up
  Hardware is SPA-24CHT1-CE-ATM, address is 0000.0000.0000 (bia 0000.0000.0000)
  MTU 4470 bytes, BW 1536 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ATM
  Keepalive not supported
     0 packets input, 0 bytes
     0 packets output, 0 bytes
     0 OAM cells input, 0 OAM cells output
  AAL5 CRC errors : 0
  AAL5 SAR Timeouts : 0
  AAL5 Oversized SDUs : 0
  AAL5 length violation : 0
  Last clearing of "show interface" counters never
Router#show interfaces ATM1/1/14.10
ATM1/1/14.10 is up, line protocol is up
  Hardware is SPA-24CHT1-CE-ATM, address is 0000.0000.0000 (bia 0000.0000.0000)
  MTU 4470 bytes, BW 1536 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ATM
  Keepalive not supported
     0 packets input, 0 bytes
     0 packets output, 0 bytes
     0 OAM cells input, 0 OAM cells output
  AAL5 CRC errors : 0
  AAL5 SAR Timeouts : 0
  AAL5 Oversized SDUs : 0
  AAL5 length violation : 0
  Last clearing of "show interface" counters never
Router# show atm interface ATM1/1/14
Interface ATM1/1/14:
AAL enabled:  AAL5, AAL0, Maximum VCs: 2047, Current VCCs: 1
Max. Datagram Size: 4528
PLIM Type: DS1, TX clocking: LINE
Cell-payload scrambling: OFF
0 input, 0 output, 0 IN fast, 0 OUT fast
 Avail bw = 1536
Config. is ACTIVE
```

```
Router#
Router#show atm interface ATM1/1/14.10
Interface ATM1/1/14.10:
AAL enabled:  AAL5, AAL0, Maximum VCs: 2047, Current VCCs: 1
Max. Datagram Size: 4528
PLIM Type: DS1, TX clocking: LINE
Cell-payload scrambling: OFF
0 input, 0 output, 0 IN fast, 0 OUT fast
 Avail bw = 1536
Config. is ACTIVE
```

The following example displays the output of the show commands in the E1 mode:

```
Router# show controllers e1 1/1/14
E1 1/1/14 is up.
  Applique type is SPA-24CHT1-CE-ATM
  Cablelength is Unknown
  No alarms detected.
  alarm-trigger is not set
  Framing is crc4, Line Code is HDB3, Clock Source is Line.
  International Bit: 1, National Bits: 11111
  Data in current interval (599 seconds elapsed):
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 0 Unavail Secs
     0 Near-end path failures, 0 Far-end path failures, 0 SEF/AIS Secs
Router# show interfaces ATM1/1/14
ATM1/1/14 is up, line protocol is up
  Hardware is SPA-24CHT1-CE-ATM, address is 0000.0000.0000 (bia 0000.0000.0000)
  MTU 4470 bytes, sub MTU 4470, BW 1920 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ATM, loopback not set
  Keepalive not supported
  Encapsulation(s): AAL5 AAL0
  2047 maximum active VCs, 0 current VCCs
  VC Auto Creation Disabled.
  VC idle disconnect time: 300 seconds
  1 carrier transitions
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  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 IP multicasts)
     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 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
Router# show interfaces ATM1/1/14
*May 24 00:41:57.886: %SYS-5-CONFIG_I: Configured from console by console.10
ATM1/1/14.10 is up, line protocol is up
  Hardware is SPA-24CHT1-CE-ATM, address is 0000.0000.0000 (bia 0000.0000.0000)
  MTU 4470 bytes, BW 1920 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ATM
  Keepalive not supported
     0 packets input, 0 bytes
     0 packets output, 0 bytes
     0 OAM cells input, 0 OAM cells output
  AAL5 CRC errors : 0
  AAL5 SAR Timeouts : 0
  AAL5 Oversized SDUs : 0
  AAL5 length violation : 0
  Last clearing of "show interface" counters never
Router# show atm interface ATM1/1/14
Interface ATM1/1/14:
AAL enabled:  AAL5, AAL0, Maximum VCs: 2047, Current VCCs: 1
Max. Datagram Size: 4528
```

```
PLIM Type: E1, TX clocking: LINE
Cell-payload scrambling: OFF
0 input, 0 output, 0 IN fast, 0 OUT fast
 Avail bw = 1920
Config. is ACTIVE
Router#show atm interface ATM1/1/14.10
Interface ATM1/1/14.10:
AAL enabled:  AAL5, AAL0, Maximum VCs: 2047, Current VCCs: 1
Max. Datagram Size: 4528
PLIM Type: E1, TX clocking: LINE
Cell-payload scrambling: OFF
0 input, 0 output, 0 IN fast, 0 OUT fast
 Avail bw = 1920
Config. is ACTIVE
Router# show atm pvc
           VCD /                                              Peak Av/Min Burst
Interface  Name         VPI   VCI Type    Encaps     SC     Kbps   Kbps Cells St
1/1/14.10  1             10    11 PVC     SNAP       UBR    1920              UP
```

Configuring SONET (OC-3)

Use the following guidelines to configure SONET (OC-3) on the1-Port Channelized OC-3 STM1 ATM CEoP SPA:

- Each T1 can be configured to operate in the CEM mode.
- CEM groups can be directly configured on a T1.
- CEM groups can be channelized to DS0s.
- A maximum of 2016 DS0s can be configured.
- A maximum of 575 CEM circuits can be configured.

Configuring the SONET Controller

To configure the SONET controller, perform the following steps:

SUMMARY STEPS

1. Router(config)# **controller sonet** *0/1/0*
2. Router(config-controller)# **framing sonet**
3. Router(config-controller)# **sts-1** *2*
4. Router(config-ctrlr-sts1)# **mode vt-15**
5. Router(config-controller-stsl)# **vtg** *5* **t1** *1* **cem-group** *15* **timeslots** *1-5,20-23*
6. Router(config-controller-sts1)# exit

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **controller sonet** *0/1/0*	Selects the controller to be configured.

	Command or Action	Purpose
Step 2	Router(config-controller)# **framing sonet**	Configures the controller framing for SONET framing (default).
Step 3	Router(config-controller)# **sts-1** *2*	Specifies the STS identifier.
Step 4	Router(config-ctrlr-sts1)# **mode vt-15**	Specifies VT-15 as the STS-1 mode of operation.
Step 5	Router(config-controller-stsl)# **vtg** *5* **t1** *1* **cem-group** *15* **timeslots** *1-5,20-23*	Creates a virtual tributary group carrying a T1.
Step 6	Router(config-controller-sts1)# exit	Exits the controller configuration mode.

Configuring SDH for AU-4 C-12

To enable an interface under SDH framing with AU-4 mapping after configuring the SONET controller, perform the following steps:

SUMMARY STEPS

1. Router(config)# **controller sonet** *0/1/0*
2. Router(config-controller)# **framing sdh**
3. Router(config-controller)# **aug mapping au-4**
4. Router(config-controller)# **au-4** *1* **tug-3** *2*
5. Router(config-ctrlr-tug3)# **mode c-12**
6. Router(config-ctrlr-tug3)# **tug-2** *1* **e1** *1* **cem-group** *1* **unframedor**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **controller sonet** *0/1/0*	Selects the controller to be configured.
Step 2	Router(config-controller)# **framing sdh**	Specifies SDH as the framing mode.
Step 3	Router(config-controller)# **aug mapping au-4**	Specifies AUG mapping.
Step 4	Router(config-controller)# **au-4** *1* **tug-3** *2*	Selects the AU-4 and TUG-3 to be configured.
Step 5	Router(config-ctrlr-tug3)# **mode c-12**	Specifies the channelization mode for the TUG-3.
Step 6	Router(config-ctrlr-tug3)# **tug-2** *1* **e1** *1* **cem-group** *1* **unframedor**	Creates a SAToP CEM group. orCreates a CESoPSN CEM group.

	Command or Action	Purpose
	Example: `Router(config-ctrlr-tug3)#` **tug-2** *1* **e1** *1* **cem-group** *1* **timeslots** *1-31*	

Configuring SDH for AU-3 C-11

To enable an interface under SDH framing with AU-3 mapping after configuring the SONET controller, perform the following steps:

SUMMARY STEPS

1. Router(config)# **controller sonet** *0/1/0*
2. Router(config-controller)# **framing sdh**
3. Router(config-controller)# **aug mapping au-3**
4. Router(config-controller)# **au-3** *3*
5. Router(config-ctrlr-au3)# **mode c-11**
6. Router(config-ctrlr-au3)# **tug-2** *1* **t1** *2* **cem-group** *1* **unframedor**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **controller sonet** *0/1/0*	Selects the controller to be configured.
Step 2	Router(config-controller)# **framing sdh**	Specifies the framing mode.
Step 3	Router(config-controller)# **aug mapping au-3**	Specifies AUG mapping.
Step 4	Router(config-controller)# **au-3** *3*	Selects the AU-3 to be configured.
Step 5	Router(config-ctrlr-au3)# **mode c-11**	Specifies the channelization mode for the link.
Step 6	Router(config-ctrlr-au3)# **tug-2** *1* **t1** *2* **cem-group** *1* **unframedor** **Example:** `Router(config-ctrlr-au3)#` **tug-2** *1* **t1** *2* **cem-group** *2015* **timeslots** *1-12*	Creates a SAToP CEM group. or Creates a CESoPSN CEM group.

Configuring Clocking

This section provides information about how to configure clocking on the SPA-24CHT1-CE-ATM or the SPA-1CHOC3-CE-ATM, and contains the following topics:

BITS Clock Support Receive and Distribute CEM SPA

You can use the BITS Clock Support—Receive and Distribute—CEM SPA feature to select and configure a clock and distribute it across the chassis to be used as the Transmit reference on all SPA ports.

The line card operates in three different modes, depending on the configuration and the configured source state.

- Free-running—A line card that is not participating in network clocking or a line card that is actively sourcing the clock operates in the free-running mode. In this mode, the internal oscillator of the line card generates the reference clock to the backplane.
- Normal—In the normal mode, the module synchronizes with an externally supplied network timing reference sourced from one of the chassis BITS inputs or recovered from a network interface. In this mode, the accuracy and stability of the output signal is determined by the accuracy and stability of the input reference.
- Holdover—In the holdover mode, the network timing module generates a timing signal based on the stored timing reference used when operating in the normal mode. The holdover mode is automatically selected when the recovered reference is lost or has drifted excessively.

Note All the line cards operate in the free-running mode until the network clock is configured.

Guidelines for Configuring the Network Clock

To configure the network clock, consider the following guidelines:

- The Cisco ASR 1000 Series Aggregation Services Routers operate in the free-running mode until the network clock is configured.
- When the network clocking configuration is present in the startup configuration, the clocking configuration is not applied until five minutes after the configuration has been parsed. This prevents clocking instability on the backplane when the interfaces or controllers come up out of order.
- Network clocking is enabled by default for the Cisco ASR 1000 Series Aggregation Services Routers.
- If there is a source flap, an interval of 180 seconds exists before the source becomes valid and active.
- In the event of an Out-of-Range (OOR) switchover (revertive mode), the source switchover occurs when the clock offset crosses the -9.2 ppm or +9.2 ppm threshold. If OOR switchover occurs, you must reconfigure the source.

Configuring the Network Clock

To configure the network clock for a Cisco ASR 1000 Series Aggregation Services Router, perform the following procedure:

Note Network clocking is not supported on the SPA-2CHT3-CE-ATM.

SUMMARY STEPS

1. Router(config)# **[no] network-clock select** *priority* **{interface | controller | slot | system** type *interface name* [**global**][**local**]}
2. Router(config)# **[no] network-clock revertive**
3. Router(config)# **controller sonet** *slot/subslot/port*
4. Router(config-controller)# clock source {line | internal}
5. Router(config-controller)# exit
6. Router(config)# exit
7. Router# show network-clocks
8. Router# debug network-clock
9. Router# debug network-clock redundancy

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **[no] network-clock select** *priority* **{interface | controller | slot | system** type *interface name* [**global**][**local**]}	Selects an interface or controller and configures it as a network clock source with a particular priority. • **system—**Required for platforms that have an internal clock generator. Not applicable to the Cisco ASR 1000 Series Aggregation Services Routers. • *priority*—Configures the priority of the network clock source. Values range from 1 to 6. • type—Interface type that needs to be configured like Gigabitethernet, POS, CEM and so on. • *interface name*—Configures the network clock source to the selected interface. • **global—**Configures the network clock such that it uses a global configuration. • **local—**Configures the network clock such that it uses a local configuration. **Note** Only one source can be configured at a time.
Step 2	Router(config)# **[no] network-clock revertive**	Configures the revertive mode on the network clock.

	Command or Action	Purpose
		When the revertive mode is configured and a previously unavailable higher-priority source comes up, this source becomes the active clock and the previous active source becomes the standby clock. The revertive mode is the default mode and is applicable for all types of interface failures. The alternate source is selected only if there is an interface failure; the alternate source is not selected when a source is supplying a bad clock. The no form of this command configures the nonrevertive mode.
Step 3	Router(config)# **controller sonet** *slot/subslot/port*	Enters the Controller configuration (config-controller) mode.
Step 4	Router(config-controller)# clock source {line | internal}	Enables network clocking and configures clocking on the interface. • **line—Specifies the clock that has been recovered from the line.** • internal—Specifies the SPA internal clock or the clock from the host.
Step 5	Router(config-controller)# exit	Exits Controller configuration mode and enters the global configuration mode.
Step 6	Router(config)# exit	Exits global configuration mode and enters the Privileged EXEC mode.
Step 7	Router# show network-clocks	Displays details about the configured clocks and the current operational clocks, and provides status information.
Step 8	Router# debug network-clock	Helps in debugging the network clocking feature operation.
Step 9	Router# debug network-clock redundancy	Enables high availability-related debugging.

Verifying the Network Clock Configuration

Use the **show network-clocks** command to verify the output on the RP:

```
Router# show network-clocks
 Active source = SONET 0/1/0
 Active source backplane reference line = Primary Backplane Clock
 All Network Clock Configuration
--------------------------------
 Priority    Clock Source             State                          Reason
 1           SONET 0/1/0              Valid
 Current operating mode is Revertive
 Current OOR Switchover mode is Switchover
There are no slots disabled from participating in network clocking
```

Configuring Clock Recovery

When configuring clock recovery, consider the following guidelines:

Adaptive Clocking

- SPA-1CHOC3-CE-ATM, SPA-2CHT3-CE-ATM, or SPA-24CHT1-CE-ATM can be used as the clock source.
- The clock must be the same as that used by the router as the network clock. Any pseudowire can carry the clock.
- The minimum bundle size of the CEM pseudowires on the network that delivers robust clock recovery is 4 DS0s.
- The minimum packet size of the CEM pseudowires on the network that delivers robust clock recovery is 64 bytes.
- Effective from Cisco IOS XE Release 3.6.0S, the SPA-2CHT3-CE-ATM supports adaptive clocking for the CEM mode. The SPA-2CHT3-CE-ATM does not support Out-of-Band (OOB) clocking in the CEM mode due to lack of hardware support.

Differential Clock Recovery

- The SPA-2CHT3-CE-ATM does not support differential clock recovery.
- The maximum number of differential clocks sourced from a 24-Port Channelized T1/E1 ATM CEoP SPA are 24.
- The 24-Port Channelized T1/E1 ATM CEoP SPA can recover up to 24 T1 or E1 clocks.
- Several bundles are sent from the same port. The bundle that is used for carrying the clock of the port is the bundle that is created for the port. Only pseudowires that include the first DS0 of a port, can carry differential clocks.

To configure clock recovery on a 24-Port Channelized T1/E1 ATM CEoP SPA, a 2-Port Channelized T3/E3 ATM CEoP SPA, or a 1-Port Channelized OC-3 STM1 ATM CEoP SPA, perform the following procedure:

SUMMARY STEPS

1. Router(config)# **recovered-clock** *slot subslot*
2. Router(config-clock)# **clock recovered** *clock-id* {**adaptive** | **differential**} **cem** *port cem-group*
3. Router(config-clock)# **clock reference** {**enhanced** | **internal**}
4. Router(config-clock)# **clock master**
5. Router(config-clock)# **clock slave**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **recovered-clock** *slot subslot*	Specifies the slot and subslot for the recovered clock.
Step 2	Router(config-clock)# **clock recovered** *clock-id* {**adaptive** | **differential**} **cem** *port cem-group*	Specifies the recovered clock number and the clock recovery type.
Step 3	Router(config-clock)# **clock reference** {**enhanced** | **internal**}	Specifies the clock reference.
Step 4	Router(config-clock)# **clock master**	Configures the clock master.

	Command or Action	Purpose
Step 5	Router(config-clock)# **clock slave**	Configures the clock slave.

Applying the Recovered Clock to the Controller

To apply the recovered clock to the controller, perform the following steps:

SUMMARY STEPS

1. Router(config)# **controller** {**e1** | **t1**} *slot*/*subslot*/*port*
2. Router(config-controller)# **vtg** *2* **t1** *1* **clock source recovered** *number*
3. Router(config-controller)# **vtg** *2* **t1** *1* **cem-group** *number* **timeslots** *number*
4. Router(config-controller)# **recovered-clock** *slot*/*subslot*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **controller** {**e1**	**t1**} *slot*/*subslot*/*port*	Selects the controller.
Step 2	Router(config-controller)# **vtg** *2* **t1** *1* **clock source recovered** *number*	Assigns a number to the recovered clock.
Step 3	Router(config-controller)# **vtg** *2* **t1** *1* **cem-group** *number* **timeslots** *number*	Creates a CEM channel from one or more time slots of a T1 or E1.
Step 4	Router(config-controller)# **recovered-clock** *slot*/*subslot*	Applies the recovered clock to the interface.

Example for Configuring Clock Recovery

The following example shows how to configure clock recovery:

Configuration on CE1

```
controller t3 1/0/1
cablelength 224
t1 1 channel-group 1 timeslots 1-24
clock source internal
```

Note The clock configuration is not shown as the internal clock by default.

Configuration on PE1

```
controller T3 0/3/0
 clock source line
 cablelength 224
```

configuration on CE2

```
controller T3 1/0/1
 clock source line
 cablelength 224
 t1 1 channel-group 1 timeslots 1-24
```

Configuration on PE2

recovered-clock configuration:

```
recovered-clock 0 3
 clock recovered 1 adaptive cem 0 1
```

configuration for applying recovered clock to controller:

```
controller T3 0/3/0
 cablelength 224
 t1 1 cem-group 1 timeslots 1-24
 t1 1 clock source Recovered 1
```

Verifying Clock Recovery

To verify clock recovery, use the **show recovered-clock** command.

```
Router# show recovered-clock

Recovered clock status for subslot 1/0
---------------------------------------
Clock    Mode         Port CEM  Status     Frequency Offset(ppb)
1        ADAPTIVE     0    1    HOLDOVER   0
Router# show recovered-clock

Recovered clock status for subslot 1/0
---------------------------------------
Clock    Mode         Port CEM  Status     Frequency Offset(ppb)
1        ADAPTIVE     0    1    ACQUIRING  -694
```

Configuring Out-of-Band Clocking

A TDM network requires a synchronized clock at each end of the connection (source and destination). This means that the source and destination clock signals must be synchronized with each other in order to maintain data integrity on the communication link.

On the other hand, a packet-switched network (PSN) does not use a clocking strategy, which means that the PSN does not provide frequency synchronization between the source and the destination routers. Therefore, to transmit TDM data across a PSN (such as an MPLS network), we need a way to deliver the clocking signal between the source and the destination routers.

Out-of-band clocking provides a way to deliver a clock signal between two SPAs. This allows TDM devices connected to the SPAs to communicate with each other. Dedicated pseudowires (called out-of-band clock channels) carry the timing signal between the sending and the receiving SPAs. When a TDM device sends data to a destination TDM device, the receiving SPA uses the out-of-band clock channel to recover the clock signal that was used to send the data.

By keeping the timing packets separate from data packets, out-of-band clocking delivers an extremely accurate timing signal. This timing accuracy is important for mobile wireless applications and other specialized applications that have very low tolerances for such things as packet delay variation (PDV), jitter, and latency in the network. In-band clocking (where timing information is derived from the data stream) does not provide a clock that is accurate enough for these applications.

To set up out-of-band clock channels, you must configure a master clock interface and a slave clock interface on the SPAs and configure pseudowires to connect the master and slave clocks. Instructions for performing these steps are provided later in this section.

Note The SPA-2CHT3-CE-ATM does not support Out-of-Band (OOB) clocking in the CEM mode due to lack of hardware support.

Benefits of Out-Of-Bank Clocking

Out-of-band clocking provides the following benefits:

- Enables mobile wireless providers to migrate from TDM networks to PSNs in order to save on costs and improve scalability.
- CEM SPA equipment can ignore the contents of the timing packets that are sent over the out-of-band clock channel because the packets do not contain data.
- Uses the CEM SPA for applications that use something other than constant bit rate (CBR) data. For example, out-of-band clocking uses the SPA for 3G (data) wireless applications, which use AAL2 in variable bit rate (VBR) mode. In addition, out-of-band clocking uses the SPA for 2G (voice) applications.
- Provides recovered clock accuracy that complies with ITU-T G.823 and G.824 specifications, which enables the CEM SPA to be used in mobile and wireless applications (including voice) that require extreme synchronization accuracy.
- Provides an alternative clock-recovery mechanism when adaptive clocking cannot be deployed.
- Enables the CEM SPA to be the master clock in a PSN.
- Makes it possible to have two master clocks. Previously, only one master clock was possible.

Guidelines for Configuring Out-Of-Band Clocking

The following guidelines apply to out-of-band clocking on CEM SPA:

- The default packet size for out-of-band clock channels (CEM circuits) is 910 bytes.
- Out-of-band clocking can co-exist with Stateful SwitchOver (SSO), but it is not SSO compliant. Therefore, if a switchover occurs, the out-of-band clocking functionality is not available for a brief period of time while the feature is brought back online.

- A CEM SPA cannot be configured as both a master and slave clock. To reconfigure a SPA's clock type, you must first remove the existing clock configuration (master or slave).
- Pseudowires for out-of-band clocking are configured under the virtual CEM interface that represents the recovered clock interface. This process differs from normal CEM pseudowires, which are configured under the port (controller interface). When no network clock is available, the virtual CEM interface goes down and the pseudowire is disabled. This process is reversed when a valid network clock becomes available again. Normal CEM interfaces never go down, even if the associated physical link is down.
- The master clock pseudowire and slave clock pseudowire should be on different CEM SPAs.

Router Sending Clock (Master Clock)

- You must select the common telecom 19.44MHz clock as the recovered clock to use for the master clock.
- A maximum of 64 out-of-band clock channels can be configured from the CEM SPAs that provides the master clock signal.
- The out-of-band clock channel (pseudowire) is configured under the virtual CEM interface that represents the SPA from which the master clock is recovered. The **xconnect** command used to create the clock channel must specify the destination for the clock signal.
- The out-of-band clock stream is sent in SAToP (unframed) format.

Router Recovering Clock (Slave Clock)

- The out-of-band clock signal is always recovered in adaptive mode. The clock signal can then be used to drive all of the ports on the CEM SPA.
- Two CEM circuits (a primary and a secondary out-of-band channel) can be configured under a slave clock interface, one for each of two master clock signals. This way, the SPA can receive a master clock signal from two separate sources (that is, two master clocks).
- Under the slave clock interface, the **xconnect** command (used to create the out-of-band clock channel) must specify the router from which the master clock is recovered.

Overview of Configuring Out-of-band Clocking Between Two CEM SPAs

The following section provides a high-level overview of the procedure for configuring out-of-band clocking between two CEM SPAs. Detailed steps are provided in the sections that follow.

Before you begin, determine which CEM SPAs have TDM devices connected to them. You must configure an out-of-band clock channel to deliver the clock signal from each SPA that sends TDM data to every destination SPA that receives the data.

1. Use the **recovered clock** command to identify the CEM SPA that is to send TDM data across the MPLS network. This SPA's clock is used as the master clock for out-of-band clocking.
2. Configure the master and slave clock interfaces to represent the source (clock master) and destination (clock slave) for the out-of-band clock signal. The master and slave clock interfaces (and pseudowires) should be configured on different SPAs.

a Configure the master clock interfac. This interface represents the master clock, which is distributed to all the destination CEM SPAs that receive data from the source TDM device connected to this SPA. (See the Creating the Master Clock Interface , on page 53 for instructions.)

b Configure a slave clock interface on each of the SPAs connected to the TDM devices that can receive data from the source TDM device. (See the Configuring the Slave Clock Interface, on page 55 for detailed instructions.)

Note When you configure a master or slave clock interface, the router creates a virtual CEM interface to represent this out-of-band clock. The virtual CEM interface has the same slot and subslot information as the CEM SPA from which the master clock is recovered. The port number is always 24. For example, if the clock signal is recovered from the SPA in slot 0, subslot 1 (**recovered-clock 0 1**), the virtual CEM interface is virtual-cem0/1/24.

1 Under both the master and slave clock interfaces, use the **cem** *circuit-id* command to configure CEM circuits to represent the out-of-band channels that will distribute the clock signal over the MPLS network. Each CEM circuit represents a separate out-of-band channel for delivering the clock signal from the source (master clock) to a destination TDM device (slave clock). The out-of-band clock channel is created when you issue the **xconnect** command in the next step.

- Under the master clock interface, you can configure up to 64 CEM circuits, one for each of the destination TDM devices that will use this clock signal as its master clock.
- Under the slave clock interface (on the destination TDM device), you can configure one or two CEM circuits. Two CEM circuits are allowed because the clock slave can receive a clock signal from two master clocks.

Note Each out-of-band clock channel requires two CEM circuits (one on the master clock interface and one on the slave clock interface). Each CEM circuit represents the CEM attachment circuit at one end of the out-of-band clock channel.

1 Create the out-of-band channel for the clock signal by using the **xconnect** command to configure two pseudowires between the CEM circuit on the master clock interface and the CEM circuit on the slave clock interface. The master clock pseudowire and slave clock pseudowire should be on different SPAs; however, you should use the same VCID for both pseudowires.

a Under the master clock interface, configure a pseudowire to the destination device (slave clock).

b Under the slave clock interface (on the SPA that connects to the destination TDM device), configure a pseudowire to the router that contains the master clock interface.

Creating the Master Clock Interface

To create the master clock interface for out-of-band clocking, perform the following procedure.

SUMMARY STEPS

1. Router(config)# **recovered-clock** *slot subslot*
2. Router(config-clock)# **clock master**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **recovered-clock** *slot subslot*	Specifies the slot and subslot of the CEoP SPA to recover the master clock signal from. This is the SPA from which the TDM data will be sent. Enters the Clock configuration mode. **Note** You must specify the 19.44MHz clock as the recovered clock to use as the clock master.
Step 2	Router(config-clock)# **clock master**	Specifies that the recovered clock is to be used as the master clock signal for out-of-band clocking. The router creates a virtual CEM interface for the master clock. Go to the following procedures to configure an out-of-band channel to use for the master clock.

Configuring an Out-Of-Band Channel

To configure an out-of-band channel to use the master clock signal, perform the following steps:

SUMMARY STEPS

1. Router(config)# **interface virtual-cem** *slot*/*subslot*/*port*
2. Router(config-if)# **cem** *circuit-id*
3. Router(config-if-cem)# **xconnect** *peer-router-id vcid* **encapsulation mpls**
4. Router(config-if-cem-xconn)# **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **interface virtual-cem** *slot*/*subslot*/*port*	Selects the virtual CEM interface for the master clock and enters interface configuration mode. The interface has the same slot and subslot as the SPA from which the master clock was recovered (Step 1 in the preceding task), and the port number is always 24.
Step 2	Router(config-if)# **cem** *circuit-id*	Creates a CEM attachment circuit for the master clock signal. Valid values for *circuit-id* are 0 to 63. **Note** You can configure up to 64 CEM circuits under the master clock interface.

	Command or Action	Purpose
Step 3	Router(config-if-cem)# **xconnect** *peer-router-id vcid* **encapsulation mpls**	Configures an out-of-band channel (pseudowire) to carry the master clock signal. • *peer-router-id* is the IP address of the router that is connected to the destination TDM device. • *vcid* is a 32-bit identifier for the pseudowire. • **encapsulation mpls** sets MPLS for the tunneling mode. **Note** Use the same vcid for the master and slave clock pseudowires; otherwise, the clock channel does not come up.
Step 4	Router(config-if-cem-xconn)# **end**	Exits CEM interface configuration mode and returns you to privileged EXEC mode.

What to Do Next

Note A CEM SPA cannot be configured as both master and slave at the same time. To reconfigure a SPA's clock type, you must first remove the existing clock configuration.

Configuring the Slave Clock Interface

To configure the slave clock interface and out-of-band channel to use for out-of-band clocking, perform the following steps.

Note Configure a slave clock interface on every CEM SPA that receives TDM data from the SPA configured as the master clock in the preceding section.

SUMMARY STEPS

1. Router(config)# **recovered-clock** *slot*/*subslot*
2. Router(config-clock)# **clock slave**
3. Router(config)# **exit**
4. Router(config)# **int virtual-cem** *slot*/*subslot*/*port*
5. Router(config-if)# **cem** *circuit-id*
6. Router(config-if-cem)# **xconnect** *peer-router-id vcid* **encapsulation mpls**
7. Router(config-if-cem-xconn)# **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **recovered-clock** *slot*/*subslot*	Specifies the slot and subslot of the CEM SPA from which the master clock is recovered.
Step 2	Router(config-clock)# **clock slave**	Creates a virtual CEM interface to represent the clock slave for out-of-band clocking.
Step 3	Router(config)# **exit**	Exits from the Clock configuration mode and enters the global configuration mode.
Step 4	Router(config)# **int virtual-cem** *slot*/*subslot*/*port*	Enters configuration mode for the virtual CEM interface that represents the clock slave. • *slot* /*subslot* is the slot and subslot of the SPA from which the master clock was recovered (Step 1 above). • *port* is always 24.
Step 5	Router(config-if)# **cem** *circuit-id*	Creates a CEM attachment circuit for the clock slave. The *circuit-id* value can be: • 0—The primary clock source. • 1—The secondary clock source. **Note** You can configure up to two CEM circuits, one for each of two master clock signals.
Step 6	Router(config-if-cem)# **xconnect** *peer-router-id vcid* **encapsulation mpls**	Configures an out-of-band channel (pseudowire) to carry the clock signal. • *peer-router-id* is the IP address of the router that is connected to the source TDM device. • *vcid* is a 32-bit identifier for the pseudowire. • **encapsulation mpls** sets MPLS for the tunneling mode. **Note** Use the same VCID for the master and slave clock pseudowires; otherwise, the clock channel does not come up.
Step 7	Router(config-if-cem-xconn)# **end**	Exits CEM interface configuration mode and returns you to privileged EXEC mode.

Verifying Out-of-Band Clocking

This section lists the **show** commands that you can use to verify the out-of-band clocking configuration.

- Use the **show ip interface brief**command to display the virtual CEM interfaces that the router created to represent master and slave clock interfaces. The output in the following example shows only the virtual CEM interface. Information for all other interfaces is omitted from the display.

```
Router# show ip int brief

. . .
Virtual-cem0/1/24 unassigned      YES unset  up                    up
. . .
```

- Use the **show cem circuit**command to display a list of CEM circuits configured on the SPA. The command displays both normal and out-of-band clocking CEM circuits.

```
Router# show cem circuit

CEM Int.        ID   Line      Admin     Circuit          AC
--------------------------------------------------------------
CEM0/1/0 1    DOWN      DOWN      Active          --/--
Virtual-cem0/1/24 DOWN      UP        Active           UP
```

- Use the **show cem interface virtual-cem** *slot*/*subslot*/*port* command to display information about a particular virtual CEM interface:

```
Router# show cem interface virtual-cem 0/1/24

(Virtual-cem0/1/24) State: CONFIG COMPLETE
Virtual CEM Slave Clock Interface
Slot 0, Slot Unit 88, VC -1
Total cem circuits:    1
Cem circuits up   :    1
Cem circuits down :    0
```

- Use the **show run interface virtual-cem** *slot*/*subslot*/*port* command to display the current running configuration pertaining to the specified interface:

```
Router# show run int virtual-cem 0/1/24

Building configuration...
Current configuration : 117 bytes
!
interface Virtual-cem0/1/24
 no ip address
 cem 1
xconnect 20.0.0.1 300 encapsulation mpls
 !
end
```

- Use the **show run | begin recovered** command to display the recovered clock used for out-of-band clocking:

```
Router# show run | begin recovered

recovered-clock 0 1
 clock master
```

- On the clock slave, you can use the **show recovered-clock** command to display the status of the out-of-band clock:

```
Router# show recovered-clock
```

```
Recovered clock status for subslot 0/1
---------------------------------------
Clock    Mode         Port CEM  Status     Frequency Offset(ppb)
ENHANCED PRIMARY           0    HOLDOVER   0
```

Removing the Out-of-Band Clocking Configuration

Use the following commands to delete the various components used for out-of-band clocking:

- To remove a CEM circuit, use the **no cem** *circuit-id* command (where *circuit-id* is the number assigned to the circuit). Issue the command under the virtual CEM interface where the circuit exists.

```
Router# conf t

Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# int virtual-cem 0/1/24

Router(config-if)# no cem 1

Router(config-if)# end
```

- To remove a virtual CEM interface, use the **no clock master** or **no clock slave** command in recovered-clock configuration mode, as shown in the following examples. Note that the virtual CEM interface is not deleted when you remove the last CEM circuit under the interface.

```
Router# conf t

Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# recovered-clock 0 1

Router(config-clock)# no clock master

Router(config-clock)# end

Router#
```

In the following example, the **no clock slave** command deletes the slave clock interface for the recovered clock (which is 0/1):

```
Router# config t

Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# recovered-clock 0 1

Router(config-clock)# no clock slave

Router(config-clock)# end

Router#
```

Example: Out-of-Band Clocking Configuration

This section provides an example of how to configure out-of-band clocking between two CEM SPAs. It is divided into several different configuration sections.

Configuring the Master Clock Interface

The following example shows how to configure a CEM SPA as a master clock and verify the configuration:

```
Router# config t

Enter configuration commands, one per line. End with CNTL/Z.
Router (config)# recovered-clock ?

  <0-14>  Slot number
Router (config)# recovered-clock 0 1

Router(config-clock)# clock ?

  master     Configure clock master on the card
  recovered  Configure recovered clock on the card
  reference  Configure reference clock on the card
  slave      Configure clock slave on the card
Router(config-clock)# clock master

Router(config-clock)# end

Router# show run | begin recovered

recovered-clock 0 1
 clock master
```

Configuring the Slave Clock Interface

The following example shows how to configure a CEM SPA as a slave clock and verify the configuration:

```
Router# config t

Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# recovered-clock 0 1

Router(config-clock)# clock slave

Router(config-clock)# end

Router#
Router# show run | begin recovered-clock

recovered-clock 0 1
 clock slave
```

Verifying the Virtual CEM Interface Configuration

The router creates a virtual CEM interface when you configure either the master or slave clock interface. You can view the interface using the **show ip interface brief** command:

```
Router# show ip int br

...
Virtual-cem0/1/24 unassigned      YES unset  up                    up
...
Router# sh run int Virtual-cem 0/1/24
Building configuration...
Current configuration : 50 bytes
!
interface Virtual-cem0/1/24
 no ip address
end
```

Example: Configuring CEM Circuits for Out-of-Band Clocking

This section provides an example of how to configure CEM circuits and pseudowires for out-of-band clocking. The sample configuration shows the circuits and pseudowires configured on a CEM SPA in PE1, which sends TDM data to another CEM SPA in PE2.

You configure CEM circuits for the master and slave clocks under the virtual CEM interface that represents the recovered clock that is being used for out-of-band clocking. This differs from normal CEM circuits, which are configured under the SPA controller through the **cem-group** command.

Issuing the **xconnect** command under the master and slave CEM circuits, configures an out-of-band clock channel to send the clock signal from the sending SPA to the receiving SPA. Note that normal CEM pseudowires are configured under the SPA controller interface.

Out-of-Band Clocking (PE1)

```
PE1# config t

PE1(config)# int virtual-cem 0/1/24

PE1(config-if)# cem 1

PE1(config-if-cem)# xconnect 20.0.0.1 200 encap mpls

PE1(cfg-if-cem-xconn)# end

PE1# show run int Virtual-CEM 0/1/24

Building configuration...
Current configuration : 117 bytes
!
interface Virtual-cem0/1/24
 no ip address
 cem 1
xconnect 20.0.0.1 200 encapsulation mpls
 !
end
```

Out-of-Band Clocking (PE2)

```
PE2# conf t

PE2(config)# int virtual-cem 0/1/24

PE2(config-if)# cem 1

PE2(config-if-cem)# xconnect 10.0.0.1 200 encap mpls

PE2(cfg-if-cem-xconn)# end

PE2# show run int Virtual-CEM 0/1/24

Building configuration...
Current configuration : 117 bytes
!
interface Virtual-cem0/1/24
 no ip address
 cem 1
xconnect 10.0.0.1 200 encapsulation mpls
 !
end
```

Configuring CEM Parameters

The following sections describe the parameters you can configure for CEM circuits.

Note The CEM parameters at the local and remote ends of a CEM circuit must match; otherwise, the pseudowire between the local and remote PE routers will not come up.

Configuring Payload Size (Optional)

To specify the number of bytes encapsulated into a single IP packet, use the **pay-load** *size* command. The *size* argument specifies the number of bytes in the payload of each packet. The range is from 32 to 1313 bytes.

Default payload sizes for an unstructured CEM channel are as follows:

- E1 = 248 bytes
- T1 = 192 bytes
- DS0 = 32 bytes
- T3/E3 = 1024 bytes

Default payload sizes for a structured CEM channel depend on the number of time slots that constitute the channel. Payload size (L in bytes), number of time slots (N), and packetization delay (D in milliseconds) have the following relationship: L = 8*N*D. The default payload size is selected in such a way that the packetization delay is always 1 millisecond. For example, a structured CEM channel of 16xDS0 has a default payload size of 128 bytes.

The payload size must be an integer of the multiple of the number of time slots for structured CEM channels.

Setting the Dejitter Buffer Size

To specify the size of the dejitter buffer used to compensate for the network filter, use the **dejitter-buffer** *size* command. The configured dejitter buffer size is converted from milliseconds to packets and rounded up to the next integral number of packets. Use the *size* argument to specify the size of the buffer, in milliseconds. The range is from 1 to 500 ms; the default is 5 ms.

Setting the Idle Pattern (Optional)

To specify the idle pattern, use the [**no**] **idle-pattern** *pattern1* command. The payload of each lost CESoPSN data packet must be replaced with the equivalent amount of the replacement data. The range for *pattern* is from 0x0 to 0xFF; the default idle pattern is 0xFF.

Enabling the Dummy Mode

The dummy mode enables a bit pattern for filling in for lost or corrupted frames. To enable dummy mode, use the **dummy-mode** [**last-frame** | **user-defined**] command. The default is **last-frame**. The following is an example:

```
Router(config-cem)# dummy-mode last-frame
```

Setting the Dummy Pattern

If dummy mode is set to user defined, you must use the **dummy-pattern** *pattern* command to configure the dummy pattern. The range for *pattern* is from 0x0 to 0xFF. The default dummy pattern is 0xFF. The following is an example:

```
Router(config-cem)# dummy-pattern 0x55
```

Shutting Down a CEM Channel

To shut down a CEM channel, use the **shutdown** command in CEM configuration mode. The **shutdown** command is supported only under CEM mode and not under the CEM class.

Configuring Layer 3 QoS on CEoP SPAs

Restrictions

The following restriction exists when configuring a Layer 3 QoS on the CEoP SPA:

- The VC QoS on VP-PW feature works only with the single-cell relay function and not with the packed-cell relay function.

Supported Interface

The following interfaces are supported for the :

- P2P and multipoint permanent virtual circuit (PVC) under the main interface.
- P2P and multipoint PVC under the subinterface.
- P2P and multipoint L2 PVC under the main interface—AAL5 and AAL0 (sustainable cell rate (SCR) and peak cell rate (PCR)).
- P2P and Multipoint L2PVC under the subinterface—AAL5 and AAL0 (SCR and PCR).

Configuring the QoS Features on the 2-Port Channelized T3/E3 ATM CEoP SPA

To configure the , perform the following steps:

SUMMARY STEPS

1. Router> enable
2. Router# configure terminal
3. Router(config)# **interface atm** *slot* /*subslot* /*port.subinterface* **point-to-point**
4. **Router(config-if)# ip address** *address mask* [**secondary**]
5. **Router(config-if)#** pvc vpi/vci
6. Router(config-if-atm-vc)# service-policy in *policy-map-name*
7. Router(config-if-atm-vc)# service-policy out *policy-map-name*
8. Router(config-if-atm-vc)# end

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router> enable	Enables the privileged EXEC mode. Enter your password if prompted.
Step 2	Router# configure terminal	Enters the global configuration mode.
Step 3	Router(config)# **interface atm** *slot* /*subslot* /*port.subinterface* **point-to-point**	Specifies or creates a subinterface and enters the subinterface configuration mode. The parameters are as follows: • *slot*—Specifies the chassis slot number where the SIP is installed. • *subslot*—Specifies the secondary slot number on a SIP where a SPA is installed. • *port*—Specifies the number of the interface port on the SPA. • *subinterface*—Specifies the number of the subinterface on the interface port. • **point-to-point**—Specifies a point-to-point subinterface.
Step 4	**Router(config-if)# ip address** *address mask* [**secondary**]	(Optional) Assigns the specified IP address and subnet mask to the interface. Repeat the command with the optional **secondary** keyword to assign additional, secondary IP addresses to the port.
Step 5	**Router(config-if)#** pvc vpi/vci	Assigns a virtual path identifier (VPI) and a virtual circuit identifier (VCI).
Step 6	Router(config-if-atm-vc)# service-policy in *policy-map-name*	Attaches ingress QoS to the configuration.
Step 7	Router(config-if-atm-vc)# service-policy out *policy-map-name*	Attaches egress QoS to the configuration.

	Command or Action	Purpose
Step 8	Router(config-if-atm-vc)# end	Exits the ATM VC interface configuration mode and returns to the privileged EXEC mode.

Sample Configuration

The following example shows how to configure a Layer 3 QOS on the CEoP SPA:

```
Router# configure terminal
Router(config)# interface atm 3/0/0.1 point-to-point
Router(config-if)# ip address 24.0.0.1 255.255.255.0
Router(config-if)# pvc 1/40
Router(config-if-atm-vc)# service-policy in omni_flat_ingress10
Router(config-if-atm-vc)# service-policy out flat_brr10
Router(config-if-atm-vc)# end
```

Verifying the Configuration

The following example shows how to verify the configuration:

```
Router# show policy-map interface cem3/0/0.1/1/1
CEM3/0/0.1/1/1: VC 1/40 -
Service-policy input: omni_flat_ingress10
Counters last updated 00:00:03 ago
    Class-map: prec4 (match-all)
      0 packets, 0 bytes
      30 second offered rate 0000 bps, drop rate 0000 bps
      Match:  precedence 4 police:
      cir 52500 bps, bc 4470 bytes
      conformed 0 packets, 0 bytes; actions:
      transmit
      exceeded 0 packets, 0 bytes; actions:
      drop
      conformed 0000 bps, exceeded 0000 bps
    Class-map: prec5 (match-all)
      0 packets, 0 bytes
      30 second offered rate 0000 bps, drop rate 0000 bps
      Match:  precedence 5
      police:
      cir 54000 bps, bc 4470 bytes
      conformed 0 packets, 0 bytes; actions:
      transmit
      exceeded 0 packets, 0 bytes; actions:
      drop
      conformed 0000 bps, exceeded 0000 bps
    Class-map: prec6 (match-all)
      391 packets, 29584 bytes
      30 second offered rate 0000 bps, drop rate 0000 bps
      Match:  precedence 6
      police:
      cir 56000 bps, bc 4470 bytes
      conformed 391 packets, 29584 bytes; actions:
      transmit
      exceeded 0 packets, 0 bytes; actions:
      drop
      conformed 0000 bps, exceeded 0000 bps
     Class-map: class-default (match-any)
      255775 packets, 194214265 bytes
```

```
    30 second offered rate 1325000 bps, drop rate 1275000 bps
    Match: any
    police:
    cir 51000 bps, bc 4470 bytes
    conformed 30423 packets, 7439395 bytes; actions:
    transmit
    exceeded 225352 packets, 186774870 bytes; actions:
    drop
    conformed 51000 bps, exceeded 1275000 bps
Service-policy output: omni_flat10
Counters last updated 00:00:03 ago
  queue stats for all priority classes:
  Queueing
  priority level 1
  queue limit 12 packets
  (queue depth/total drops/no-buffer drops) 0/0/0
  (pkts output/bytes output) 43602/7460616
  queue stats for all priority classes:
  Queueing
  priority level 2
  queue limit 14 packets
  (queue depth/total drops/no-buffer drops) 0/0/0
  (pkts output/bytes output) 0/0
  Class-map: prec4 (match-all)
    0 packets, 0 bytes
    30 second offered rate 0000 bps, drop rate 0000 bps
    Match:  precedence 4
    Queueing
    queue limit 13 packets
    (queue depth/total drops/no-buffer drops) 0/0/0
    (pkts output/bytes output) 0/0
    bandwidth 52 kbps
```

Configuring AIS and RAI Alarm Forwarding in the CESoPSN Mode on the CEoP SPAs

This feature allows grooming of traffic from several different cell-site fractional T1/E1s via CEM, through an MPLS cloud, on to a single aggregate T1/E1 going to the BSC.

This feature provides the following functionalities:

- By default, AIS and RAI alarms are not forwarded on T1/E1s having the CESoPSN mode configured on the SPA-1CHOC3-CE-ATM, SPA-2CHT3-CE-ATM, and SPA-24CHT1-CE-ATM even if one or all of the CESoPSN groups terminating on the T1/E1 receives AIS or RAI notification from the corresponding remote CESoPSN peers across the PSN.
- AIS forwarding can be enabled on a per-T1/E1 basis on the SPA-1CHOC3-CE-ATM, SPA-2CHT3-CE-ATM, and SPA-24CHT1-CE-ATM. This ensures that the PE transmits AIS on the T1/E1 whenever one or more CESoPSN groups configured on it receives AIS notification from the remote CESoPSN peers across the PSN.
- RAI forwarding can be enabled on a per-T1/E1 basis on the SPA-1CHOC3-CE-ATM, the SPA-2CHT3-CE-ATM, and the SPA-24CHT1-CE-ATM. This ensures that the PE transmits RAI on the T1/E1 whenever one or more CESoPSN groups configured on it receives RAI notification from the remote CESoPSN peers across the PSN.

Restrictions

The following restrictions are applicable while configuring AIS and RAI alarm forwarding:

- Alarms cannot be suppressed in the unframed CEM mode (SAToP). Alarms received from the remote SAToP peer across the PSN always pass over the attachment circuit.
- The forward-alarm -ais/rai- command is a hidden command and is not available in the option list. You must type the full command.

Configuring AIS and RAI Alarm Forwarding for T1 on the CEoP SPA

To enable AIS and RAI alarm forwarding on the SPA-24CHT1-CE-ATM and the SPA-2CHT3-CE-ATM for T1 mode, perform the following procedure:

SUMMARY STEPS

1. Router> enable
2. Router# configure terminal
3. Do one of the following:
   - Router(config)# controller t1 slot/subslot/port
   -
   - Router(config)# controller t3 slot/subslot/port
4. Do one of the following:
   - Router(config-controller)# forward-alarm ais/rai
   -
   - Router(config-controller)# t1 1-28 forward-alarm ais/rai

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router> enable	Enables the privileged EXEC mode. Enter your password if prompted.
Step 2	Router# configure terminal	Enters the global configuration (config) mode.
Step 3	Do one of the following: • Router(config)# controller t1 slot/subslot/port • • Router(config)# controller t3 slot/subslot/port	Enters the controller configuration mode pertaining to the specified slot, subslot, and port. or Selects the controller for the SPA port that is to be configured.
Step 4	Do one of the following: • Router(config-controller)# forward-alarm ais/rai	Enables AIS or RAI alarm forwarding on the selected T1 controller interface for the 24-Port Channelized T1/E1 ATM CEoP SPA. or

	Command or Action	Purpose
	• • Router(config-controller)# t1 1-28 forward-alarm ais/rai	Enables AIS or RAI alarm forwarding on the selected T1 controller interface for the 2-Port Channelized T3/E3 ATM CEoP SPA.

Configuring AIS and RAI Alarm Forwarding for E1 on the CEoP SPA

To enable AIS and RAI forwarding on the SPA-24CHT1-CE-ATM and the SPA-2CHT3-CE-ATM for E1 mode, perform the following procedure:

SUMMARY STEPS

1. Router> enable
2. Router# configure terminal
3. Do one of the following:
   - Router(config)# controller e1 slot/subslot/port
   -
   - Router(config)# controller t3 slot/subslot/port
4. Do one of the following:
   - Router(config-controller)# forward-alarm ais/rai
   -
   - Router(config-controller)# e1 1-21 forward-alarm ais/rai

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router> enable	Enables the privileged EXEC mode. Enter your password if prompted.
Step 2	Router# configure terminal	Enters the global configuration (config) mode.
Step 3	Do one of the following: • Router(config)# controller e1 slot/subslot/port • • Router(config)# controller t3 slot/subslot/port	Enters the controller configuration mode pertaining to the specified slot, subslot, and port. or Selects the controller for the SPA port that is to be configured.

	Command or Action	Purpose
Step 4	Do one of the following: • Router(config-controller)# forward-alarm ais/rai • • Router(config-controller)# e1 1-21 forward-alarm ais/rai	Enables AIS or RAI alarm forwarding on the selected E1 controller interface for the 24-Port Channelized T1/E1 ATM CEoP SPA. or Enables AIS or RAI alarm forwarding on the selected E1 controller interface for the 2-Port Channelized T3/E3 ATM CEoP SPA.

Configuring the SONET Mode

To enable AIS/RAI forwarding on the CEoP SPAs for SONET mode, perform the following steps:

SUMMARY STEPS

1. Router(config)# controller sonet slot/bay/port
2. Router(config-controller)# sts-1 id
3. Router(config-controller-sts)# vtg identifier t1 identifier forward-alarm {ais|rai}

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# controller sonet slot/bay/port **Example:** `orRouter(config)# controller sonet 0/1/0`	Enters the Controller configuration mode. or Selects the controller to be configured.
Step 2	Router(config-controller)# sts-1 id **Example:** **Example:** `Router(config-controller)# sts-1 1`	Specifies the STS identifier.
Step 3	Router(config-controller-sts)# vtg identifier t1 identifier forward-alarm {ais|rai} **Example:**	Enables AIS or RAI alarm forwarding on the selected interface for the SONET mode.

	Command or Action	Purpose
	Example: `Router(config-ctrlr-sts1)# vtg 1 t1 1 forward-alarm ais`	

Configuring the SDH AU-4 Mode

To enable AIS or RAI forwarding on the CEoP SPAs for SDH AU-4 mode, perform the following steps:

SUMMARY STEPS

1. Router(config)# **controller sonet** *0/1/0*
2. Router(config-controller)# **framing sdh**
3. Router(config-controller)# **aug mapping au-4**
4. Router(config-controller)# **au-4** *id* **tug-3** *id*
5. Router(config-ctrlr-tug3)# **mode c-12**
6. tug-2 id e1 id forward-alarm ais | rai

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **controller sonet** *0/1/0*	Enters the controller configuration mode and selects the controller to be configured.
Step 2	Router(config-controller)# **framing sdh**	Specifies SDH as the framing mode.
Step 3	Router(config-controller)# **aug mapping au-4**	Specifies AUG mapping.
Step 4	Router(config-controller)# **au-4** *id* **tug-3** *id*	Selects the AU-4, TUG-3 to configure.
Step 5	Router(config-ctrlr-tug3)# **mode c-12**	Specifies the channelization mode for the TUG-3.
Step 6	tug-2 id e1 id forward-alarm ais | rai **Example:** **Example:** `Router(config-ctrlr-tug3)# tug-2 1 e1 1 forward-alarm rai`	Enables AIS and RAI alarm forwarding on the selected SDH mode for the AU-4 mode.

Configuring the SDH AU-3 Mode

To enable AIS or RAI forwarding on the CEoP SPAs for SDH AU-3 mode, perform the following steps:

SUMMARY STEPS

1. Router(config)# **controller sonet** *0/1/0*
2. Router(config-controller)# **framing sdh**
3. Router(config-controller)# **aug mapping au-3**
4. Router(config-controller)# **au-3** *3*
5. Router(config-ctrlr-au3)# **mode c-11**
6. Router(config-ctrlr-au3)# **tug-2** *tug-2 number* **t1** *t1-line-number* **forward-alarm** *{ais | rai}*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **controller sonet** *0/1/0*	Enters the controller configuration mode and selects the controller to be configured.
Step 2	Router(config-controller)# **framing sdh**	Specifies the framing mode.
Step 3	Router(config-controller)# **aug mapping au-3**	Specifies AUG mapping.
Step 4	Router(config-controller)# **au-3** *3*	Selects the AU-3 to configure.
Step 5	Router(config-ctrlr-au3)# **mode c-11**	Specifies the channelization mode for the link.
Step 6	Router(config-ctrlr-au3)# **tug-2** *tug-2 number* **t1** *t1-line-number* **forward-alarm** *{ais | rai}* **Example:** **Example:** `Router(config-ctrlr-au3)#` **tug-2** *1* **t1** *2* **forward-alarm ais** **Example:** `Router(config-ctrlr-au3)# tug-2 1 t1 1 forward-alarm` **rai**	Enables AIS and RAI alarm forwarding on the selected SDH mode for the AU-3 mode.

Restrictions

The following restrictions apply while configuring AIS or RAI alarm forwarding:

- Alarms cannot be suppressed in unframed CEM mode (SAToP). Alarms received from the remote SAToP peer across the PSN will always be propagated over the attachment circuit.
- The **forward-alarm** {**ais**/**rai**} is a hidden command and is not available in the option list. You must type the full command.

Verifying the Interface Configuration

The **show cem circuit** command shows information about the circuit state, administrative state, the CEM ID of the circuit, and the interface on which it is configured. If **xconnect** is configured under the circuit, the command output also includes information about the attached circuit.

```
Router# show cem circuit
 ?

  <0-504>    CEM ID
  detail     Detailed information of cem ckt(s)
  interface  CEM Interface
  summary    Display summary of CEM ckts
  |          Output modifiers
Router# show cem circuit

CEM Int.       ID   Line      Admin     Circuit         AC
---------------------------------------------------------------
CEM0/1/0       1    UP        UP        ACTIVE          --/--
CEM0/1/0       2    UP        UP        ACTIVE          --/--
CEM0/1/0       3    UP        UP        ACTIVE          --/--
CEM0/1/0       4    UP        UP        ACTIVE          --/--
CEM0/1/0       5    UP        UP        ACTIVE          --/--
```

The **show cem circuit** *0-504* command displays the detailed information about that particular circuit.

```
Router# show cem circuit 1

CEM0/1/0, ID: 1, Line State: UP, Admin State: UP, Ckt State: ACTIVE
Idle Pattern: 0xFF, Idle cas: 0x8, Dummy Pattern: 0xFF
Dejitter: 5, Payload Size: 40
Framing: Framed, (DS0 channels: 1-5)
Channel speed: 56
CEM Defects Set
Excessive Pkt Loss RatePacket Loss
Signalling: No CAS
Ingress Pkts:    25929               Dropped:             0
Egress Pkts:     0                   Dropped:             0
CEM Counter Details
Input Errors:    0                   Output Errors:       0
Pkts Missing:    25927               Pkts Reordered:      0
Misorder Drops:  0                   JitterBuf Underrun:  1
Error Sec:       26                  Severly Errored Sec: 26
Unavailable Sec: 5                   Failure Counts:      1
Pkts Malformed:  0
```

The **show cem circuit summary** command displays the number of circuits which are up or down per interface basis.

```
Router# show cem circuit summary

CEM Int.       Total Active  Inactive
--------------------------------------
CEM0/1/0       5     5       0
```

The **show running configuration** command shows detail on each CEM group:

```
Router# show running configuration
```

```
Building configuration...
Current configuration : 1720 bytes
!
! Last configuration change at 17:22:39 UTC Wed Jan 5 2011
!
version 15.1
service timestamps debug datetime msec
service timestamps log datetime msec
no platform punt-keepalive disable-kernel-core
!
hostname Router
!
boot-start-marker
boot-end-marker
!
!
vrf definition Mgmt-intf
 !
 address-family ipv4
 exit-address-family
 !
 address-family ipv6
 exit-address-family
!
!
no aaa new-model
ip source-route
!
!
multilink bundle-name authenticated
!
redundancy
 mode none
!
!
!
controller SONET 0/1/0
 framing sonet
 clock source line
 !
 sts-1 1
  mode vt-15
  vtg 1 t1 1 cem-group 1 timeslots 1
  vtg 2 t1 1 cem-group 6 timeslots 1-24
  vtg 3 t1 2 cem-group 7 timeslots 1-24
 !
 sts-1 2
  mode vt-15
 !
 sts-1 3
  mode vt-15
!
!
recovered-clock 0 1
 clock master
!
ip tftp source-interface GigabitEthernet0
!
class cem cemqos
 payload-size 256
 dejitter-buffer 20
 dummy-mode last-frame
!
!
interface GigabitEthernet0/0/0
 no ip address
 negotiation auto
!
interface GigabitEthernet0/0/1
 no ip address
 negotiation auto
!
interface GigabitEthernet0/0/2
```

```
 no ip address
 negotiation auto
!
interface GigabitEthernet0/0/3
 no ip address
 negotiation auto
!
interface GigabitEthernet0
 vrf forwarding Mgmt-intf
 no ip address
 negotiation auto
!
interface CEM0/1/0
 no ip address
 cem 1
  cem class cemqos
 !
 cem 6
  xconnect 10.10.10.10 3 encapsulation mpls
 !
 cem 7
  xconnect 10.10.10.11 2 encapsulation mpls
 !
!
interface Virtual-cem0/1/24
 no ip address
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
logging esm config
!
!
!
control-plane
!
!
!
!
!
line con 0
 stopbits 1
line vty 0 4
 login
!
exception data-corruption buffer truncate
end
Router# show int cem 0/1/0

CEM0/1/0 is up, line protocol is up
  Hardware is Circuit Emulation Interface
  MTU 1500 bytes, BW 155520 Kbit/sec, DLY 0 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation CEM, loopback not set
  Keepalive not supported
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/0 (size/max)
  5 minute input rate 64000 bits/sec, 250 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     1779066 packets input, 56930112 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicasts)
     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, 0 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
Router# show class cem cemqos
```

```
Class: cemqos         , Dummy mode: last-frame
Dejitter: 20, Payload Size: 256
Router# show class cem detail
Class: cemqos         , Dummy mode: last-frame
Dejitter: 20, Payload Size: 256
Circuits inheriting this Class:
CEM0/1/0: Circuit 1
Interfaces inheriting this Class:
None
```