



# CHAPTER 9

## Overview of the CEoP and Channelized ATM SPAs

This chapter provides an overview of the release history, features, and MIB support for the Circuit Emulation over Packet (CEoP) shared port adapters (SPAs) that are available for Cisco 7600 series routers. This chapter includes the following sections:

- [Release History, page 9-1](#)
- [Overview, page 9-2](#)
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### Release History

Release	Modification
12.2(33) SRE3	Added new CLI options for configuring hardware timer to bring up the controller.
15.0(1)S	Support was added for the following features: <ul style="list-style-type: none"><li>• Network Clocking and SSM functionality support was added</li><li>• VC QoS on VP-PW</li></ul>
12.2(33)SRE	Support was added for VP and VC mode on CeOP and 1-Port OC-48c/STM-16 ATM SPA
12.2(33)SRC	Support was added for the following features: <ul style="list-style-type: none"><li>• Support was introduced for the 2-Port Channelized T3/E3 ATM CEoP SPA.</li><li>• Support was added for Inverse multiplexing over ATM (IMA).</li><li>• KEOPS Phase 2 Local Switching Redundancy</li><li>• KEOPS Phase 2 TDM Local Switching</li></ul>

12.2(33)SRB1	Support was added for the following new features: <ul style="list-style-type: none"> <li>• ATM pseudowire redundancy.</li> <li>• Out-of-band clocking.</li> </ul>
12.2(33)SRB	Support was introduced for the 1-Port Channelized OC-3 STM1 ATM CEoP SPA and 24-Port Channelized T1/E1 ATM CEoP SPA.

## Overview

The CEoP SPAs are single-width, single-height, cross-platform Circuit Emulation over Packet (CEoP) shared port adapters (SPAs) for Cisco 7600 series routers. CEoP SPAs come in the following models:

- 24-Port Channelized T1/E1 ATM CEoP SPA (SPA-24CHT1-CE-ATM=)
- 2-Port Channelized T3/E3 ATM CEoP SPA (SPA-2CHT3-CE-ATM=)
- 1-Port Channelized OC-3 STM1 ATM CEoP SPA (SPA-1CHOC3-CE-ATM=)

The 24-Port Channelized T1/E1 ATM CEoP SPA and 1-Port Channelized OC-3 STM1 ATM CEoP SPA must be installed in a Cisco 7600 SIP-400 SPA interface processor (SIP) before they can be used in the Cisco 7600 series router. A maximum of four CEoP SPAs can be installed in each SIP, and these SPAs can be different models. You can install the SPA in the SIP before or after you insert the SIP into the router chassis. This allows you to perform online insertion and removal (OIR) operations either by removing individual SPAs from the SIP, or by removing the entire SIP (and its contained SPAs) from the router chassis.

Pseudowire Emulation over Packet (PWEoP) is one of the key components to migrate customers to a packet-based multi-service network. Circuit Emulation over Packet (CEoP) is a subset of PWEoP and is a technology to migrate to all-packet networks from legacy TDM networks, yet providing transport for legacy applications transparently over a packet network. CEoP is the imitation of a physical connection. Many service providers and enterprises operate both packet switched networks and time division multiplexed (TDM) networks. These service providers and enterprises have moved many of their data services from the TDM network to their packet network for scalability and efficiency. Cisco provides routing and switching solutions capable of transporting Layer 2 and Layer 3 protocols such as Ethernet, IP, and Frame Relay. While most applications and services have been migrated to the packet-based network, some, including voice and legacy applications, still rely on a circuit or leased line for transport. CEoP SPAs implement Circuit Emulation over Packet by transporting circuits over a packet-based network. CEoP SPAs help service providers and enterprises migrate to one packet network capable of efficiently delivering both data and circuit services. CEoP SPAs also support ATM and ATM pseudowire. For an overview of ATM, see the [“ATM Overview” section on page 6-4](#).



### Note

In Cisco IOS Release 12.2(33)SRC, the 2-Port Channelized T3/E3 ATM CEoP SPA does not support Circuit Emulation (CEM) mode. The SPA supports ATM mode only.

## CEoP Frame Formats

The CEoP SPAs support the structured or Circuit Emulation Service over Packet Switched Networks (CESoPSN) and the Structure-Agnostic TDM over Packet (SAToP) encapsulations.

## Circuit Emulation Services over Packet Switched Network (CESoPSN) mode

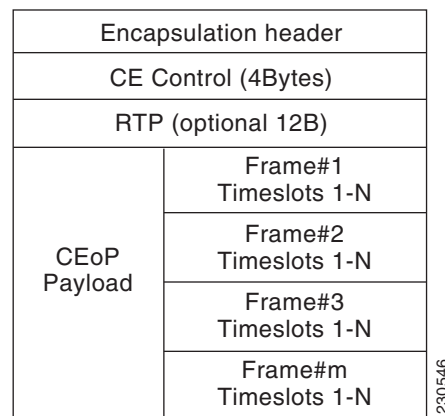
Circuit Emulation Services over Packet Switched Network (CESoPSN) mode is used to encapsulate T1/E1 structured (channelized) services over PSN. Structured mode (CESoPSN) identifies framing and sends only payload, which can be channelized T1s within DS3 and DS0s within T1. DS0s can be bundled to the same packet. This mode is based on IETF RFC 5086.

SPAs can aggregate individual interfaces and flexibly bundle them together. They can be configured to support either structured or unstructured CES modes of operation per each T1/E1/J1 as well as clear channel DS3 interfaces. Note that DS3 does not support CESoPSN/SAToP currently. It is only supported on 1-Port Channelized OC-3 STM1 ATM CEoP SPA channelized to T1/E1, or on 24-Port Channelized T1/E1 ATM CEoP SPA.

Each supported interface can be configured individually to any supported mode. The supported services comply with IETF and ITU drafts and standards.

Figure 9-1 shows the frame format in CESoPSN mode.

**Figure 9-1 Structured Mode Frame Format**



"For CESoPSN, Table 9-1 shows the payload and jitter for DS0 lines.

**Table 9-1 CESoPSN DS0 Lines: Payload and Jitter Limits**

DS0	Maximum Payload	Maximum Jitter	Minimum Jitter	Minimum Payload	Maximum Jitter	Minimum Jitter
1	40	320	10	32	256	8
2	80	320	10	32	128	4
3	120	320	10	33	128	4
4	160	320	10	32	64	2
5	200	320	10	40	64	2
6	240	320	10	48	64	2
7	280	320	10	56	64	2

DSO	Maximum Payload	Maximum Jitter	Minimum Jitter	Minimum Payload	Maximum Jitter	Minimum Jitter
8	320	320	10	64	64	2
9	360	320	10	72	64	2
10	400	320	10	80	64	2
11	440	320	10	88	64	2
12	480	320	10	96	64	2
13	520	320	10	104	64	2
14	560	320	10	112	64	2
15	600	320	10	120	64	2
16	640	320	10	128	64	2
17	680	320	10	136	64	2
18	720	320	10	144	64	2
19	760	320	10	152	64	2
20	800	320	10	160	64	2
21	840	320	10	168	64	2
22	880	320	10	176	64	2
23	920	320	10	184	64	2
24	960	320	10	192	64	2
25	1000	320	10	200	64	2
26	1040	320	10	208	64	2
27	1080	320	10	216	64	2
28	1120	320	10	224	64	2
29	1160	320	10	232	64	2
30	1200	320	10	240	64	2
31	1240	320	10	248	64	2
32	1280	320	10	256	64	2

## Circuit Emulation Services over Packet Switched Network (CESoPSN) over UDP

Circuit Emulation Services over Packet Switched Network (CESoPSN) provides the infrastructure for the emulation of TDM circuits like T1/E1 unstructured and structured over Packet Switched Network (PSN) infrastructure. Existing Pseudowire Emulation over Packet (PWE) solution on the Cisco 7600 series router only supports MPLS as the transport for circuit emulation whereas Circuit Emulation Services over Packet Switched Network over User Datagram Protocol (CESoUDP) extends the support adding UDP over Internet Protocol (IP) as the transport mechanism for circuit emulation over PSN.

## Restrictions and Usage Guidelines

- CESoUDP supports all the existing modes of HA (RPR and SSO).
- CESoUDP is supported on 24-Port Channelized T1/E1 ATM CEoP SPA, 2-Port Channelized T3/E3 ATM CEoP SPA, and 1-Port Channelized OC-3 STM1 ATM CEoP SPA.
- CESoPSN on Cisco 7600 series router is supported only with SIP400 on the CE facing side. Both the decapsulation and the encapsulation are done by the CE facing line card.
- The Cisco 7600 series router supports up to 8192 CESoUDP pseudowires. But a SIP400 supports only maximum of 2304 pseudowires.
- Since CLI on RP is used to install the Access Control List (ACL) entry, the ACL programming is decoupled from the L2VPN control plane update. As a result, when a pseudowire circuit goes down, the ACL is still present. Any traffic coming in from the core which matches the ACL is redirected to the egress line card, where it is dropped due to the absence of appropriate entries in the disposition table.
- Pseudowires redundancy is not supported.
- Fragmentation of IP packets is not supported. The DF bit is set when the IP header is inserted.
- Path MTU is not supported.
- Differential synchronization mode is not supported.
- The supported pseudowires, payload size ranges from 40 to 1312 Bytes.
- The Time To Live (TTL) value in the IP header is configurable under the pseudowire class. The default value is 255.
- Only the basic CESoPSN over UDP/IP encapsulation without the optional Real-Time Protocol (RTP) header is supported.

## Configuring CESoPSN with UDP Encapsulation

Complete the following steps to configure CESoPSN with UDP encapsulation on the Cisco 7600 series router.


### SUMMARY STEPS

- 
- Step 1** `enable`
  - Step 2** `configure terminal`
  - Step 3** `interface loopback interface-number`
  - Step 4** `ip address ip-address mask [secondary]`
  - Step 5** `mls cemoudp reserve slot <slot no>`
  - Step 6** `pseudowire-class pseudowire-class-name`
  - Step 7** `encapsulation udp`
  - Step 8** `ip local interface loopback interface-number`
  - Step 9** `ip tos value value number`
  - Step 10** `ip ttl number`
  - Step 11** `exit`

- Step 12 **controller** {e1|t1} slot/subslot/port
- Step 13 **clock source** {internal | line| loop}
- Step 14 **cem-group** number timeslots number
- Step 15 **exit**
- Step 16 **interface cem** slot/subslot/port
- Step 17 **cem** group-number
- Step 18 **xconnect** peer-router-id vcid {pseudowire-class name}
- Step 19 **udp port local** <local\_udp\_port> **remote** <remote\_udp\_port>
- Step 20 **exit**

## DETAILED STEPS

	Command	Purpose
Step 1	<b>enable</b>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>interface loopback</b> interface-number	Creates a loopback interface and enters interface configuration mode: <i>interface-number</i> : An arbitrary value from 0 to 2,147,483,647 that uniquely identifies this loopback interface.
Step 4	<b>ip address</b> ip-address mask [secondary]	Specifies the IP address and subnet mask for this loopback interface.
Step 5	<b>mls cemudp reserve slot</b> <slot no>	Used to reserve a loopback interface used as source for the CESoPSN circuit for a particular line card.  Slot number refers to the module number of the line card where the CEoP SPA resides.
Step 6	<b>pseudowire-class</b> pseudowire-class-name	Creates a new pseudowire class.
Step 7	<b>encapsulation udp</b>	Specifies the UDP transport protocol.
Step 8	<b>ip local interface loopback</b> interface-number	Configures the IP address of the provider edge (PE) router interface as the source IP address for sending tunneled packets.
Step 9	<b>ip tos value</b> value number	Specifies the type of service (ToS) level for IP traffic in the pseudowire.
Step 10	<b>ip ttl</b> number	Specifies a value for the time-to-live (TTL) byte in the IP headers of Layer 2 tunneled packets.
Step 11	<b>exit</b>	Exits pseudowire-class configuration mode.
Step 12	<b>controller</b> {e1 t1} slot/subslot/port	Enters E1/T1 controller configuration mode.

	Command	Purpose
Step 13	<code>clock source {internal   line   loop}</code>	<p>Sets the clock source on the interface to:</p> <ul style="list-style-type: none"> <li>• Internal: The system clock selection process does not select clock source as the interface but it uses the system clock for TX.</li> <li>• Line: The system clock selection process selects the clock source line as the interface and uses the system clock for TX.</li> <li>• Loop: The system clock selection process selects the clock source line as the interface. For TX clock the interface uses the clock source received on the same interface.</li> </ul> <p> <b>Note</b> By default, the clock source on the interface is set to internal.</p>
Step 14	<code>cem-group number timeslots number</code>	Assigns channels on the T1/E1 circuit to the circuit emulation (CEM) channel. This example uses the <b>timeslots</b> parameter to assign specific timeslots to the CEM channel.
Step 15	<code>exit</code>	Exits controller configuration.
Step 16	<code>interface cem slot/subslot/port</code>	Selects the CEM interface where the CEM circuit (group) is located (where slot/subslot is the SPA slot and subslot and port is the SPA port where the interface exists).
Step 17	<code>cem group-number</code>	Defines a CEM channel.
Step 18	<code>xconnect peer-router-id vcid {pseudowire-class name}</code>	<p>Binds an attachment circuit to the CEM interface to create a pseudowire. This example creates a pseudowire by binding the CEM circuit 5 to the remote peer 30.30.30.2.</p> <p><b>Note</b> When creating IP routes for a pseudowire configuration, we recommend that you build a route from the cross-connect address (LDP router-ID or loopback address) to the next hop IP address, such as <b>ip route 30.30.30.2 255.255.255.255 1.2.3.4</b>.</p>
Step 19	<code>udp port local &lt;local_udp_port&gt; remote &lt;remote_udp_port&gt;</code>	Specifies a local and remote UDP port for the connection. Valid port values for CESoPSN pseudowires using UDP are from 49152–57343.
Step 20	<code>exit</code>	Exits the CEM interface.

## Configuration Examples

This is an example for configuring CESoPSN with UDP encapsulation on the Cisco 7600 series router:

```
Router> enable
Router# configure terminal
Router(config)# interface loopback 0
Router(config-if)# ip address 2.2.2.8 255.255.255.255
Router(config-if)# mls cemoudp reserve slot 2
Router(config)# pseudowire-class udpClass
Router(config-pw-class)# encapsulation udp
Router(config-pw-class)# ip local interface loopback 0
Router(config-pw-class)# ip tos value 100
Router(config-pw-class)# ip ttl 100
Router(config-pw-class)# exit
Router(config)# controller e1 2/0/0
Router(config-controller)# clock source internal
Router(config-controller)# cem-group 5 timeslots 1-24
Router(config-controller)# exit
```

```

Router(config)# interface cem 2/0/0
Router(config-if)# cem 5
Router(config-if-cem)# xconnect 30.30.30.2 305 pw-class udpClass
Router(config-if-cem)# udp port local 50000 remote 55000
Router(config-if-cem)# exit

```

## Verifying the Configuration

This section provides the commands to verify the configuration of CESoPSN with UDP encapsulation on the Cisco 7600 series router:

```
Router# show xcon all
```

```

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

```

XC	ST	Segment 1	S1	Segment 2	S2
UP	ac	CE3/0/0:1 (CESoPSN Basic)	UP	udp 66.66.66.66:180	UP
UP	ac	CE3/0/0:6 (CESoPSN Basic)	UP	udp 66.66.66.66:181	UP

```
Router# show pw vc
```

Local intf	Local circuit	VC ID	Status
CE3/0/0	CESoPSN Basic	180	established
	LAddr: 55.55.55.55 LPort: 50002		
	RAddr: 66.66.66.66 RPort: 50002		
CE3/0/0	CESoPSN Basic	181	established
	LAddr: 55.55.55.55 LPort: 50004		
	RAddr: 66.66.66.66 RPort: 50004		

## Troubleshooting the CESoPSN with UDP Encapsulation Configuration

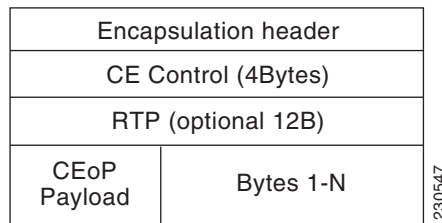
Use these debug commands to troubleshoot CESoPSN with UDP encapsulation when the pseudowire is down:

- **debug pw-udp event:** Provides details on all events occurring on the pseudowire UDP.
- **debug pw-udp error:** Provides debugging information on pseudowire UDP error.
- **debug pw-udp fsm:** Debugs the pseudowire UDP finite state machine (FSM).

## Structure-Agnostic TDM over Packet (SAToP) mode

Structure-Agnostic TDM over Packet (SAToP) mode is used to encapsulate T1/E1 or T3/E3 unstructured (unchannelized) services over packet switched networks. In unstructured (SAToP) mode, bytes are sent out as they arrive on the TDM line. Bytes do not have to be aligned with any framing.

In this mode the interface is considered as a continuous framed bit stream. The packetization of the stream is done according to IETF RFC 4553. All signaling is carried transparently as a part of a bit stream.

**Figure 9-2 Unstructured Mode Frame Format**

For SAToP frame format the following table shows the payload and jitter limits for the T1 lines.

**Table 9-2 SAToP T1 Frame: Payload and Jitter Limits**

Maximum Payload	Maximum Jitter	Minimum Jitter	Minimum Payload	Maximum Jitter	Minimum Jitter
960	320	10	192	64	2

For SAToP frame format the following table shows the payload and jitter limits for the E1 lines.

**Table 9-3 SAToP E1 Frame: Payload and Jitter Limits**

Maximum Payload	Maximum Jitter	Minimum Jitter	Minimum Payload	Maximum Jitter	Minimum Jitter
1280	320	10	256	64	2

## Supported Features

This section provides a list of some of the primary features supported by the CEoP hardware and software:

- [Basic Features, page 9-9](#)
- [SONET/SDH Error, Alarm, and Performance Monitoring, page 9-11](#)
- [Layer 2 Features, page 9-13](#)
- [Layer 3 Features, page 9-14](#)
- [High Availability Features, page 9-15](#)

## Basic Features

- Circuit emulation compliant with IETF standards for CESoPSN and SAToP
- The 24-Port Channelized T1/E1 ATM CEoP SPA supports T1 or E1, which can be channelized to DS0 for circuit emulation (CEM).

- The 2-Port Channelized T3/E3 ATM CEoP SPA is supported in Cisco IOS Release 12.2(33)SRC and later releases.
- The 1-Port Channelized OC-3 STM1 ATM CEoP SPA supports VT1.5 SONET channelization, and VC-11 and VC-12 SDH channelizations. ATM can be configured on T1s, while CEM can be configured down to DS0.
- Maintenance Digital Link (MDL) and Far End Alarm Control (FEAC) features (T3/E3)
- Facility Data Link (FDL) support (T1/E1)
- Adaptive clock recovery compliant with G.823 and G.824 Traffic interface ITU specification
- Compliant with Y.1411 ATM-MPLS network interworking—cell mode user plane interworking
- Compliant with Y.1413 TDM-MPLS network interworking—user plane interworking
- Compliant with Y.1453 TDM-IP network interworking—user plane interworking
- ATM MPLS encapsulation IETF RFC and drafts
- ATM over channelized T1 lines
- Full channelization down to DS0 (CEM only)
- Simultaneous multiple interface support (for example, ATM and circuit emulation)
- Bellcore GR-253-CORE SONET/SDH compliance (ITU-T G.707, G.783, G.957, G.958)
- Supports both permanent virtual circuits (PVCs) and switched virtual circuits (SVCs)
- The absolute maximum for the sum of VPs at VCs is 2048 per CEoP SPA. Each interface can have a maximum of 2047 VCs with the following recommended limitations:
  - On a Cisco 7600 SIP-400, 8000 PVCs are supported on multipoint subinterfaces.
  - A recommended maximum number of 2048 PVCs on all point-to-point subinterfaces for all CEoP SPAs in a SIP.
  - A recommended maximum number of 16,380 PVCs on all multipoint subinterfaces for all CEoP SPAs in a SIP, and a recommended maximum number of 200 PVCs per each individual multipoint subinterface.
  - A recommended maximum number of 400 SVCs for all CEoP SPAs in a SIP.
  - A recommended maximum number of 1024 PVCs or 400 SVCs using service policies for all CEoP SPAs in a SIP.
- Up to 4096 simultaneous segmentations and reassemblies (SARs) per interface
- Supports a maximum number of 200 PVCs or SVCs using Link Fragmentation and Interleaving (LFI) for all CEoP ATM SPAs (or other ATM modules) in a Cisco 7600 series router
- Up to 1000 maximum virtual templates per router
- ATM adaptation layer 5 (AAL5) for data traffic
- Hardware switching of multicast packets for point-to-point subinterfaces
- The 1-Port Channelized OC-3 STM1 ATM CEoP SPA uses small form-factor pluggable (SFP) optical transceivers, allowing the same CEoP SPA hardware to support multimode (MM), short reach (SR), intermediate reach (IR1), and long reach (LR1 and LR2) fiber, depending on the capabilities of the SPA.
- ATM section, line, and path alarm indication signal (AIS) cells, including support for F4 and F5 flows, loopback, and remote defect indication (RDI)
- Operation, Administration, and Maintenance (OAM) cells

- Online insertion and removal (OIR) of individual CEoP SPAs from the SIP, as well as OIR of the SIPs with CEoP SPAs installed

Cisco IOS Release 12.2SRC adds support for the following new features:

- 2-Port Channelized T3/E3 ATM CEoP SPA (supports clear-channel T3 ATM mode only)
- Inverse multiplexing over ATM (IMA)
- CEM local switching and local switching redundancy
- ATM cell packing (VC and VP modes) (both SCR and PCR) on 2-Port and 4-Port OC-3c/STM-1 ATM SPA on both SIP-200 and SIP-400, and for SCR on CEoP SPAs (24xT1/E1-CE, 2xT3/E3-CE and 1xCHOC3-CE) on SIP-400.
- ATM local switching and local switching redundancy

In Cisco IOS Release 12.2(33)SRD support was added for PMCRoMPLS-single or packed-cell relay for the 2-Port and 4-Port OC-3c/STM-1 ATM SPA on SIP-200 and SIP-400, and single cell relay for the CEoP SPAs (24xT1/E1-CE, 2xT3/E3-CE, 1xCHOC3-CE) on the SIP400.

In Cisco IOS Release 12.2(33)SRE support was added for VP and VC mode on CeOP and 1-Port OC-48c/STM-16 ATM SPA.

- Cisco IOS Release 15.0(1)S adds support for Network Clocking and Synchronization Status Message(SSM) functionality for the CEoP SPAs in a Cisco 7600 SIP-400 only. The supported CEoP SPAs are:
  - -SPA-1CHOC3-CE-ATM
  - -SPA-24CHT1-CE-ATM

For more information on configuring the network clock see, [Configuring Boundary Clock for 2-Port Gigabit Synchronous Ethernet SPA on Cisco 7600 SIP-400, page 12-29](#)

Beginning in Cisco IOS Release 12.2(33)SRE support is added for:

- Modular QoS CLI (MQC) policy support existing on ATM VC is extended to the ATM PVP on 2-Port and 4-Port OC-3c/STM-1 ATM SPA and the below three flavors of CEoP SPA:
  - SPA-24XT1E1-CE
  - SPA-1XOC3-CE
  - SPA-2XT3E3-CE
- ATM VCI (match atm-vci command)—Input ATM PVP Interface is added to the ATM VP.

## SONET/SDH Error, Alarm, and Performance Monitoring

- To configure variable soak period for line, use delay alarm triggers line.
- To configure path alarm reporting, use path msec command.
- To configure clearing on 1Port Channelized OC-3 STM1 ATM CEoP SPA, use delay alarm clear line/path msec.
- Fiber removed and reinserted
- Signal failure bit error rate (SF-BER)
- Signal degrade bit error rate (SD-BER)
- Signal label payload construction (C2)
- Path trace byte (J1)

- Section Diagnostics:
  - Loss of signal (SLOS)
  - Loss of frame (SLOF)
  - Error counts for B1
  - Threshold crossing alarms (TCA) for B1 (B1-TCA)
- Line Diagnostics:
  - Line alarm indication signal (LAIS)
  - Line remote defect indication (LRDI)
  - Line remote error indication (LREI)
  - Error counts for B2
  - Threshold crossing alarms for B2 (B2-TCA)
- Path Diagnostics:
  - Path alarm indication signal (PAIS)
  - Path remote defect indication (PRDI)
  - Path remote error indication (PREI)
  - Error counts for B3
  - Threshold crossing alarms for B3 (B3-TCA)
  - Loss of pointer (PLOP)
  - New pointer events (NEWPTR)
  - Positive stuffing event (PSE)
  - Negative stuffing event (NSE)
- The following loopback tests are supported:
  - Network (line) loopback
  - Internal (diagnostic) loopback
- Supported SONET/SDH synchronization:
  - Local (internal) timing (for inter-router connections over dark fiber or wave division multiplexing [WDM] equipment)
  - Loop (line) timing (for connecting to SONET/SDH equipment)
  - +/- 4.6 ppm clock accuracy over full operating temperature

### T1/E1 Errors and Alarms

The 24-Port Channelized T1/E1 ATM CEoP SPA reports the following types of T1/E1 errors and alarms:

- Cyclic redundancy check (CRC) errors
- Far end block error (FEBE)
- Alarm indication signal (AIS)
- Remote alarm indication (RAI)
- Loss of signal (LOS)
- Out of frame (OOF)

- Failed seconds
- Bursty seconds
- Bipolar violations
- Error events
- Failed signal rate
- Line and Path Diagnostics:
  - Errored Second–Line (ES-L)
  - Severely Errored Second–Line (SES-L)
  - Coding violation–Line (CV-L)
  - Failure Count–Path (FC-P)
  - Errored Second–Path (ES-P)
  - Severely Errored Second–Path (SES-P)
  - Unavailable Seconds–Path (UAS-P)

### T3/E3 Errors and Alarms

The 2-Port Channelized T3/E3 ATM CEoP SPA reports the following errors and alarms:

- AIS (Alarm Indication Signal)
- Far end bit error (FEBE)
- Far end receive failure (FERF)
- Frame error
- Out of frame (OOF)
- Path parity error
- Parity bit (P-bit) disagreements
- Receive Alarm Indication Signal (RAIS)
- Yellow alarm bit (X-bits) disagreements

## Layer 2 Features

- Supports the following encapsulation types:
  - AAL5SNAP (LLC/SNAP)
  - LLC encapsulated bridged protocol
  - AAL5MUX (VC multiplexing)
  - AAL5CISCOPPP
- Supports the following ATM traffic classes and per-VC traffic shaping modes:
  - Constant bit rate (CBR) with peak rate
  - Unspecified bit rate (UBR) with peak cell rate (PCR)
  - Non-real-time variable bit rate (VBR-nrt)
  - Variable bit rate real-time (VBR-rt)




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**Note** ATM shaping is supported, but class queue-based shaping is not.

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- ATM point-to-point and multipoint connections
- Explicit Forward Congestion Indication (EFCI) bit in the ATM cell header
- Integrated Local Management Interface (ILMI) operation, including keepalive, PVC discovery, and address registration and deregistration
- Link Fragmentation and Interleaving (LFI) performed in hardware
- VC-to-VC local switching and cell relay
- VP-to-VP local switching and cell relay
- AToM VP Mode Cell Relay support
- RFC 1755, *ATM Signaling Support for IP over ATM*
- ATM User-Network Interface (UNI) signalling V3.0, V3.1, and V4.0 only
- RFC 2225, *Classical IP and ARP over ATM* (obsoletes RFC 1577)
- Unspecified bit rate plus (UBR+) traffic service class on SVCs and PVCs

## Layer 3 Features

- ATM VC Access Trunk Emulation (multi-VLAN to VC)
- ATM over MPLS (AToM) in AAL5 mode (except for AToM cell packing)
- ATM over MPLS (AToM) in AAL5/AAL0 VC mode
- Distributed Link Fragmentation and Interleaving (dLFI) for ATM (dLFI packet counters are supported, but dLFI byte counters are not supported)
- 2047 is the maximum number of VCs per interface (assuming no VPs). Each AToM L2transport PVP reduces the total number of VCs by 3 per CEoP SPA.
- OAM flow connectivity using OAM ping for segment or end-to-end loopback
- Multicast SVCs are supported if there is only one VC on the subinterface
- PVC multicast (Protocol Independent Multicast [PIM] dense and sparse modes)
- Quality of Service (QoS):
  - Policing
  - IP-to-ATM class of service (IP precedence and DSCP)
  - ATM CLP bits matching for ingress and set ATM CLP bits for egress through MQC for PVC
- [RFC 1483](#), *Multiprotocol Encapsulation over ATM Adaptation Layer 5*:
  - PVC bridging (full-bridging)
- Routing protocols:
  - Border Gateway Protocol (BGP)
  - Enhanced Interior Gateway Routing Protocol (EIGRP)
  - Interior Gateway Routing Protocol (IGRP)
  - Integrated Intermediate System-to-Intermediate System (IS-IS)

- Open Shortest Path First (OSPF)
- Routing Information Protocol version 1 and version 2 (RIPv1 and RIPv2)

## High Availability Features

- 1+1 Automatic Protection Switching (APS) redundancy (PVC circuits only)
- Route Processor Redundancy (RPR)
- RPR Plus (RPR+)
- OSPF Nonstop Forwarding (NSF)

Cisco IOS Release 12.2SRC adds support for the following high-availability feature:

- NonStop Forwarding and Stateful switchover (NSF/SSO) support for CEM and ATM pseudowires

## Unsupported Features

- MLPPP and MLFR are not supported
- Primary surge protection for the 24-Port Channelized T1/E1 ATM CEoP SPA
- The following High Availability features are not supported:
  - APS 1:N redundancy is not supported.
  - APS redundancy is not supported on SVCs.
  - APS reflector mode (**aps reflector** interface configuration command) is not supported.
- PVC autoprovisioning (**create on-demand** VC class configuration command) is not supported.
- Creating SVCs with UNI signalling version 4.1 is not supported (UNI signalling v 3.0, v 3.1, and v 4.0 are supported).
- Enhanced Remote Defect Indication–Path (ERDI-P) is not supported.
- Fast Re-Route (FRR) over ATM is not supported.
- LAN Emulation (LANE) is not supported.
- Available Bit Rate (ABR) traffic service class is not supported.
- Oversubscription of the Cisco 7600 SIP-400 is not supported (in either CEM or ATM mode).

## Prerequisites

- The Cisco 7600 SIP-400 requires a Cisco 7600 series router using either of the following processors running the Cisco IOS Release 12.2(33)SRB or a later release:
  - Supervisor Engine 720 (SUP-720) processor, or
  - Route Switch Processor 720 (RSP720-GE and RSP720-10GE), or
  - Supervisor Engine 32 (SUP-32) processor

**Note**

Before configuring the CEoP SPA, have the following information available:  
IP addresses for all ports on the new interfaces, including subinterfaces.

## Restrictions

- The 1-Port Channelized OC-3 STM1 ATM CEoP SPA and 24-Port Channelized T1/E1 ATM CEoP SPA do not support mixed line modes (for example, T1 or E1, or T3). A reset of the SPA is required to change modes.
- The 1-Port Channelized OC-3 STM1 ATM CEoP SPA, the 2-Port Channelized T3/E3 ATM CEoP SPA, and the 24-Port Channelized T1/E1 ATM CEoP SPA do not support the following features: BRE, LFI, RBE, or bridging.
- The 2-Port Channelized T3/E3 ATM CEoP SPA can receive data over distances of up to 1350 ft (411.5 meters).
- When a pseudowire is configured on an interface, APS for the interface is useful only in conjunction with pseudowire redundancy.
- VC QoS on VP-PW feature works only with Single Cell Relay and does not work with Packed Cell Relay.

## Supported MIBs

The following MIBs are supported in Cisco IOS Release 12.2(33)SRB and later releases for the CEoP SPAs on the Cisco 7600 series router.

### Common MIBs

- ENTITY-MIB
- IF-MIB
- MIB-II
- MPLS-CEM-MIB

### Cisco-Specific MPLS MIBs

- CISCO-IETF-PW-MIB
- CISCO-IETF-PW-MPLS-MIB

### Cisco-Specific Common MIBs

- CISCO-ENTITY-EXT-MIB
- OLD-CISCO-CHASSIS-MIB
- CISCO-CLASS-BASED-QOS-MIB
- CISCO-ENTITY-FRU-CONTROL-MIB
- CISCO-ENTITY-ASSET-MIB
- CISCO-ENTITY-SENSOR-MIB
- CISCO-MQC-MIB

For more information about MIB support on a Cisco 7600 series router, refer to the Cisco 7600 Series Internet Router MIB Specifications Guide at the following URL:

[http://www.cisco.com/en/US/docs/routers/7600/technical\\_references/7600\\_mib\\_guides/MIB\\_Guide\\_ver\\_6/7600mib2.html](http://www.cisco.com/en/US/docs/routers/7600/technical_references/7600_mib_guides/MIB_Guide_ver_6/7600mib2.html)

To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator at the following URL:

<http://tools.cisco.com/ITDIT/MIBS/servlet/index>

If Cisco MIB Locator does not support the MIB information that you need, you can also obtain a list of supported MIBs and download MIBs from the Cisco MIBs page at the following URL:

<http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml>

To access Cisco MIB Locator, you must have an account on Cisco.com. If you have forgotten or lost your account information, send a blank e-mail to [cco-locksmith@cisco.com](mailto:cco-locksmith@cisco.com). An automatic check will verify that your e-mail address is registered with Cisco.com. If the check is successful, account details with a new random password will be e-mailed to you.

## Displaying the SPA Hardware Type

To verify the SPA hardware type that is installed in your Cisco 7600 series router, use the **show interfaces** or **show diag** commands. A number of other **show** commands also provide information about the SPA hardware.

Table 9-4 shows the hardware description that appears in the **show** command output for each type of CEoP SPA that is supported on the Cisco 7600 series router:

**Table 9-4** CEoP SPA Hardware Descriptions in show Commands

SPA	Description in show interfaces Command
SPA-24CHT1-CE-ATM	"Hardware is SPA-24CHT1-CE-ATM"
SPA-1CHOC3-CE-ATM	"Hardware is SPA-1CHOC3-CE-ATM"
SPA-2CHT3-CE-ATM	"Hardware is SPA-2CHT3-CE-ATM"

## Example of the show interfaces cem Command

The following example shows output from the **show interfaces cem** command on a Cisco 7600 series router with an CEoP SPA installed in the first subslot of a SIP that is installed in slot 2:

```
Router# show interfaces cem 2/1/3
CEM2/1/3 is up, line protocol is up
  Hardware is Circuit Emulation Interface
  MTU 1500 bytes, BW 10000000 Kbit, DLY 0 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation CEM, loopback not set
  Keepalive set (10 sec)
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/0 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
```

## ■ Displaying the SPA Hardware Type

```
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, 0 interface resets
  0 output buffer failures, 0 output buffers swapped out
```