



Configuring Circuit Emulation over Packet on Cisco IOS XR Software

This module describes the configuration of Circuit Emulation over Packet (CEoP) shared port adapters (SPAs) on the Cisco XR 12000 Series Router.

Feature History for Configuring CEoP on Cisco XR 12000 Series Router

Release	Modification
Release 4.2.0	<ul style="list-style-type: none">• Support for Circuit Emulation Service over Packet Switched Network was added in these SPAs:<ul style="list-style-type: none">– Cisco 1-port Channelized OC3/STM-1 Circuit Emulation and Channelized ATM SPA– Cisco 2-Port Channelized T3/E3 Circuit Emulation and Channelized ATM SPA– Cisco 24-Port Channelized T1/E1 Circuit Emulation and Channelized ATM SPA

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Prerequisites for Configuration

You must be in a user group associated with a task group that includes the proper task IDs. The command reference guides include the task IDs required for each command. If you suspect user group assignment is preventing you from using a command, contact your AAA administrator for assistance.

Before configuring the Circuit Emulation over Packet (CEoP) service on your router, ensure that these conditions are met:

- You must have one of these SPAs installed in your chassis:
 - Cisco 1-port Channelized OC3/STM-1 Circuit Emulation and Channelized ATM SPA
 - Cisco 2-Port Channelized T3/E3 Circuit Emulation and Channelized ATM SPA
 - Cisco 24-Port Channelized T1/E1 Circuit Emulation and Channelized ATM SPA
- You should know how to apply and specify the SONET controller name and *interface-path-id* with the generalized notation *rack/slot/module/port*. The SONET controller name and *interface-path-id* are required with the **controller sonet** command.
- You should know how to apply and specify the T3/E3 and T1/E1 controller name and *interface-path-id* with the generalized notation *rack/slot/module/port*. The T3/E3, T1/E1 controller name and *interface-path-id* are required with the **controller {T3|E3|T1|E1}** command.

Overview of Circuit Emulation over Packet Service

Circuit Emulation over Packet (CEoP) is a way to carry TDM circuits over packet switched network. Circuit Emulation over Packet is the imitation of a physical connection. The goal of CEoP is to replace leased lines and legacy TDM networks. This feature allows network administrators to use their existing IP/MPLS network to provide leased-line emulation services or to carry data streams or protocols that do not meet the format requirements of other multiservice platform interfaces. CEoP puts TDM bits into the packets, encapsulates them into appropriate header and then sends through PSN. The receiver side of CEoP restores the TDM bit stream from packets.

CEoP SPAs are half-height (HH) Shared Port Adapters (SPA) and the CEoP SPA family consists of 24xT1/E1/J1, 2xT3/E3, and 1xOC3/STM1 unstructured and structured (NxDS0) quarter rate, half height SPAs. The CEoP SPAs provide bit-transparent data transport that is completely protocol independent.

CEoP has two major modes:

- Unstructured mode is called SAToP (Structure Agnostic TDM over Packet) — SAToP does not look what is inside the incoming data and considers it as a pure bit stream.
- Structured mode is named CESoPSN (Circuit Emulation Service over Packet Switched Network) — CESoPSN is aware of the structure of the incoming TDM bit stream at DS0 level.

CESoPSN and SAToP can use MPLS, UDP/IP, and L2TPv3 for the underlying transport mechanism.



Note

The Cisco IOS XR Release 4.2.0 supports only MPLS transport mechanism.

These SPAs are the first Cisco router interfaces designed to meet the emerging standards for Circuit Emulation Services over Packet Switched Network (CESoPSN) and Structure-Agnostic Transport over Packet (SAToP) transport.

In Cisco IOS XR Release 4.2.0, the CEM functionality is supported on the following CEoP SPAs:

- Cisco 1-port Channelized OC3/STM-1 Circuit Emulation and Channelized ATM SPA

- Cisco 2-Port Channelized T3/E3 Circuit Emulation and Channelized ATM SPA
- Cisco 24-Port Channelized T1/E1 Circuit Emulation and Channelized ATM SPA

In SAToP mode, these SPAs do not assume that data has any predefined format or structure. They simply regard the data as an arbitrary bit stream. All data bits are simply transported to a defined destination encapsulated in IP/MPLS packets. In CESoPSN mode the carrier has defined format. The SPAs support a full range of E1 and T1 framing. CESoPSN applications can save utilized bandwidth by selecting only valid timeslots for transmission. Some primary applications include:

- Transporting 2G and 3G network traffic over packet networks, for mobile operators. Mobile service providers are implementing high-speed data networks with HSDPA to support new revenue-generating services. The SPA is uniquely positioned for multigenerational migration of mobile networks (2G and 3G), simultaneously carrying TDM and ATM traffic over IP/MPLS networks. This technology provides a mechanism to enable IP/MPLS to the cell site, which can eventually be in place to transport the mobile traffic over IP from end to end.
- T3/E3 circuit emulation for leased-line replacement.
- T1/E1 circuit emulation for leased-line replacement.
- PBX to PBX connectivity over PSN.
- High density SS7 backhaul over IP/MPLS.
- Inter-MSC connectivity.
- Preencrypted data for government, defense, or other high-security applications.
- Proprietary synchronous or asynchronous data protocols used in transportation, utilities, and other industries.
- Leased-line emulation service offerings in metropolitan (metro) Ethernet or WAN service provider environments.

For more information on Circuit Emulation service concepts, configuration, and example, see the *Implementing MPLS Layer 2 VPNs* module in the *Cisco IOS XR Virtual Private Network Configuration Guide for the Cisco XR 12000 Series Router*.

Information About Configuring CEoP Channelized SONET/SDH

To configure the Circuit Emulation over Packet Channelized SONET/SDH, you must understand the following concepts:

- [Channelized SONET and SDH Overview, page 311](#)
- [Default Configuration Values for Channelized SONET/SDH, page 316](#)

Channelized SONET and SDH Overview

Synchronous Optical Network (SONET) is an American National Standards Institute (ANSI) specification format used in transporting digital telecommunications services over optical fiber.

Channelized SONET provides the ability to transport SONET frames across multiplexed T3/E3 and virtual tributary group (VTG) channels.

The Cisco 1-port Channelized OC3/STM-1 Circuit Emulation and Channelized ATM SPA does not support the following modes:

- Clear Channel OC3

- Clear Channel E3
- Clear Channel T3

SONET uses Synchronous Transport Signal (STS) framing. An STS is the electrical equivalent to an optical carrier 1 (OC-1).

A channelized SONET interface is a composite of STS streams, which are maintained as independent frames with unique payload pointers. The frames are multiplexed before transmission.

When a line is channelized, it is logically divided into smaller bandwidth channels called *paths*. These paths carry the SONET payload. The sum of the bandwidth on all paths cannot exceed the line bandwidth.

When a line is not channelized, it is called *clear channel*, and the full bandwidth of the line is dedicated to a single channel that carries broadband services.

Channelizing a SONET line consists of two primary processes:

- Configuring the controller
- Configuring the interface into channelized paths

You configure the controller first by setting the mode of the STS path.

When the mode is specified, the respective controller is created, and the remainder of the configuration is applied on that controller. For example, mode T3 creates a T3 controller. The T3 controller can then be configured to a serial channel, or it can be further channelized to carry T1s, and those T1s can be configured to serial interfaces.

The Cisco 1-Port Channelized OC-3/STM-1 Circuit Emulation and Channelized ATM SPA does not support the following modes:

- Clear Channel OC3
- Clear Channel E3
- Clear Channel T3

On a Cisco 1-Port Channelized OC-3/STM-1 SPA, the default configuration consists of the following paths that are already configured when the SONET card is installed.

- STS 1
- STS 2
- STS 3

Each STS path can be independently configured into T3s, E3s, or VTGs, and so on.

Depending on the support for your installed SPA, each STS path can be independently configured into T3s, E3s, or VTGs, and so on. The following level of SONET channelization modes are supported in CEoP SPA:

OC3->STS-1->VTG-> VT1.5 -> Unframed T1

OC3->STS-1->VTG-> VT1.5 -> T1 -> DS0

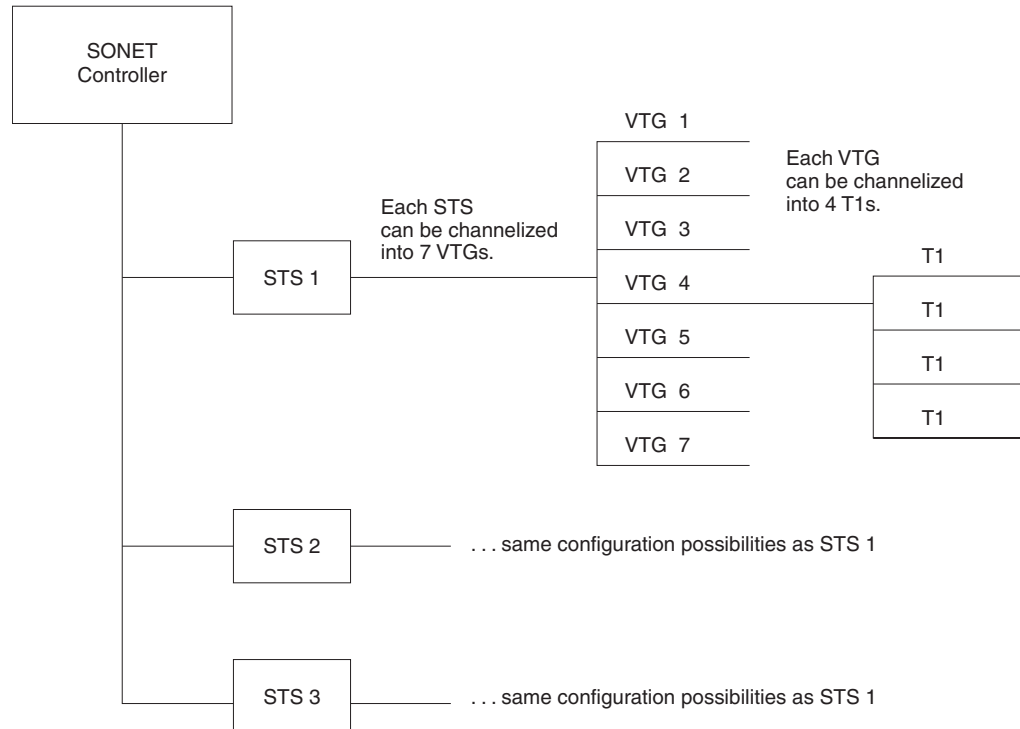
Figure 19 shows the VTG paths that can be configured.



Note

Only VTG paths are supported on the Cisco 1-Port Channelized OC-3/STM-1 SPA on the Cisco XR12000 Series Router.

Figure 19 SONET VTG Channelized Paths



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Synchronous Digital Hierarchy (SDH) is the international equivalent of SONET.

SDH uses Synchronous Transport Mode (STM) framing. An STM-1 is the electrical equivalent to 3 optical carrier 1s (OC-1s). A Synchronous Transport Module (STM) signal is the Synchronous Digital Hierarchy (SDH) equivalent of the SONET STS, but the numbers are different for each bandwidth. In this guide, the STM term refers to both path widths and optical line rates. The paths within an STM signals are called administrative units (AUs).

A summary of the basic terminology differences between SONET and SDH is as follows:

- SONET STS is equivalent to SDH administrative unit (AU)
- SONET VT is equivalent to SDH tributary unit (TU)
- SDH basic building blocks are STM-1 (equivalent to STS-3) and STM-0 (equivalent to STS-1)

An administrative unit (AU) is the information structure that provides adaptation between the higher-order path layer and the multiplex section layer. It consists of an information payload (the higher-order virtual container) and an administrative unit pointer, which indicates the offset of the payload frame start relative to the multiplex section frame start.

An AU can be channelized into tributary units (TUs) and tributary unit groups (TUGs).

An administrative unit 4 (AU-4) consists of three STM-1s or an STM-3.

An administrative unit 3 (AU-3) consists of one STM-1.

An administrative unit group (AUG) consists of one or more administrative units occupying fixed, defined positions in an STM payload.

The [Table 7](#) shows the commonly used notations and terms in SONET standards and their SDH equivalents.

Table 7 SONET and SDH Terminology Equivalencies

SONET Term	SDH Term
SONET	SDH
STS-3c	AU-4
STS-1	AU-3
VT	TU
SPE	VC
Section	Regenerator Section
Line	Multiplex Section
Path	Path

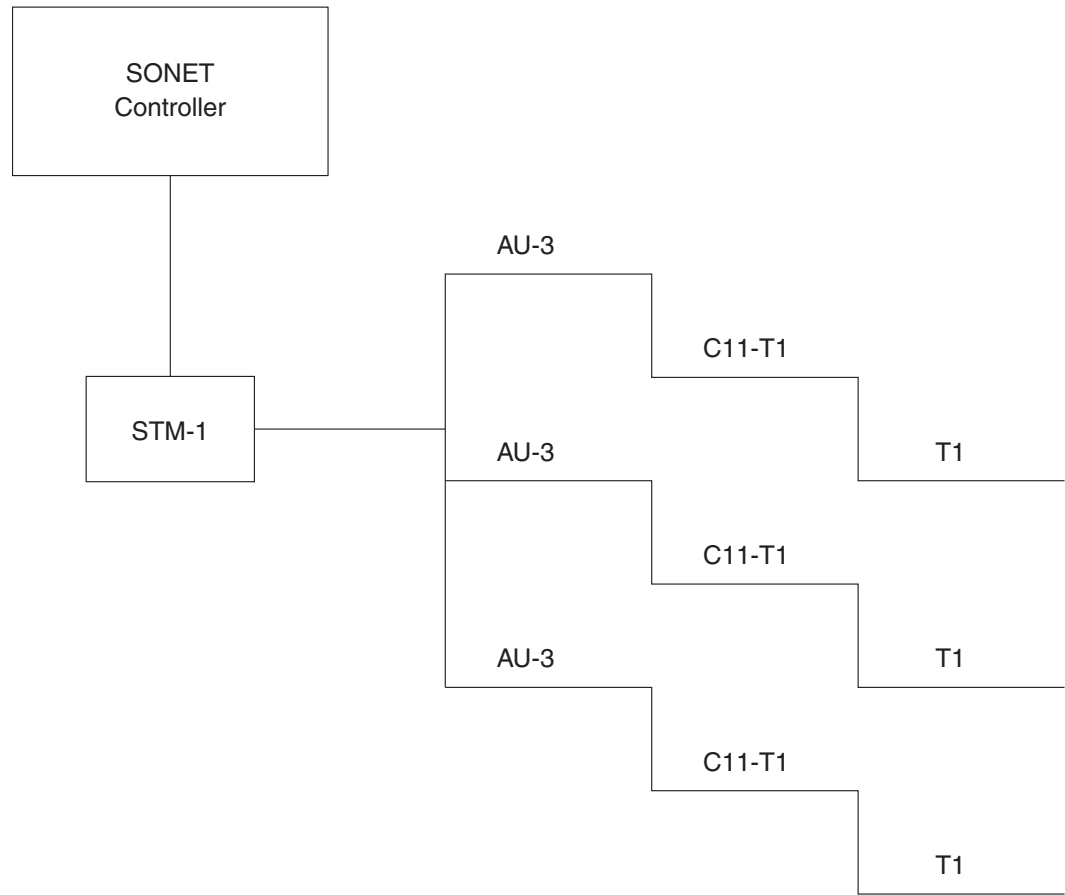
These are the levels of SDH channelization that are supported on the CEoP SPA:

- For E1 :
 - STM1-> AU-4 -> TUG-3 -> TUG-2 ->VC12-> Unframed E1
 - STM1-> AU-4 -> TUG-3 -> TUG-2 ->VC12-> E1 -> DS0

- For T1 :
 - STM1-> AU-3-> TUG-2 -> VC11->Unframed T1
 - STM1-> AU-3-> TUG-2 -> VC11->T1 -> DS0

Figure 20 shows an example of SDH AU-3 paths that can be configured on the CEoP SPA.

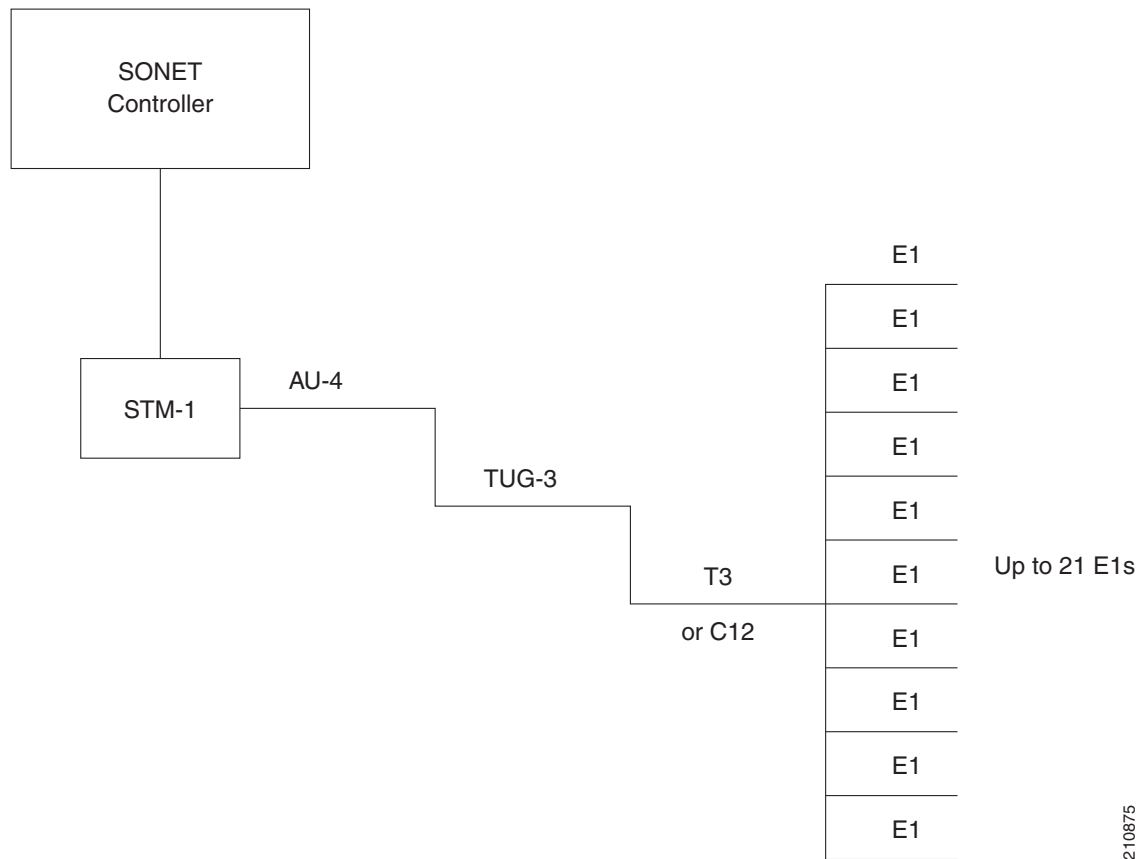
Figure 20 SDH AU3 Paths



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Figure 21 shows the SDH AU4 paths that can be configured on the CEoP SPA.

Figure 21 SDH AU4 Paths



Default Configuration Values for Channelized SONET/SDH

Table 8 describes the default configuration parameters that are present on the Channelized SONET/SDH.

Table 8 SONET/SDH Controller Default Configuration Values

Parameter	Default Value	Configuration File Entry
Clock source	line	clock source {internal line}
SONET framing	sonet	hw-module sub-slot <i>node-id</i> cardtype {sonet sdh}

Clock Distribution

Clocking distribution in the CEoP SPA can be done in these ways:

- Synchronous Clocking — With synchronous clocking, TDM lines on source and destination are synchronized to the same clock delivered by some means of physical clock distribution (SONET/SDH, BITS, GPS, and so on). The clock to the particular TDM line can be delivered from
 - Line: the transmit clock is from the receiver of the same physical line
 - Internal: the transmit clock is taken from line card and can be derived either from an internal free running oscillator or from another physical line
 - Recovered: In-band pseudowire-based activeclock recovery on a CEM interface which is used to drive the transmit clock

The number of recovered clocks that can be configured for CEoP SPA are:

- Cisco 24-Port Channelized T1/E1 Circuit Emulation and Channelized ATM SPA : 24 clocks for each SPA.
- Cisco 2-Port Channelized T3/E3 Circuit Emulation and Channelized ATM SPA : 10 clocks for each SPA in the T1/E1 mode and 2 clocks for each SPA in the T3/E3 mode.
- Cisco 1-port Channelized OC3/STM-1 Circuit Emulation and Channelized ATM SPA : 10 clocks per SPA in the T1/E1 mode.
- Adaptive Clocking — Adaptive clocking is used when the routers do not have a common clock source. See [Figure 22](#). The clock is derived based on packet arrival rates. Two major types of adaptive clock recovery algorithms are:
 - Based on dejitter buffer fill level
 - Based on packet arrival rate

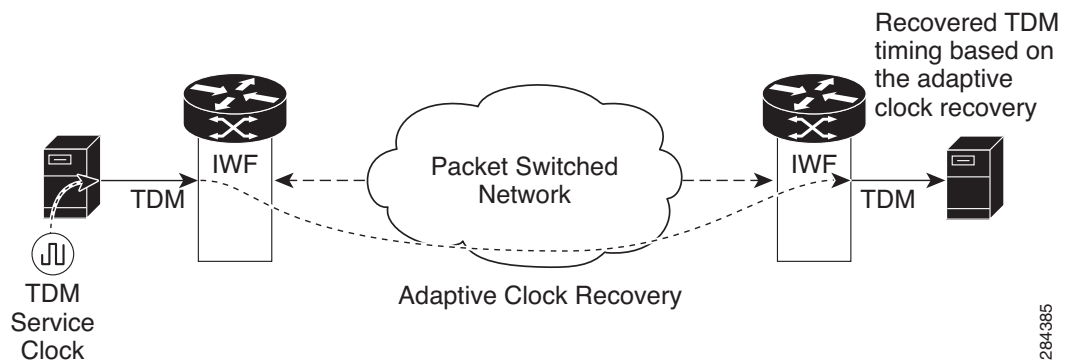
The clock quality depends on packet size, has less tolerance to packet loss/corruption and introduces unnecessary delay in order to have sufficient number of packets in the buffer for clock recovery. The dejitter buffer size determines the ability of the emulated circuit to tolerate network jitter. The dejitter buffer in CEoP software is configurable up to a maximum of 500 milliseconds.



Note

The CEoP SPA hardware supports only the packet arrival rate algorithm.

Figure 22 Adaptive Clock Recovery



**Note**

CEM supports only adaptive clocking in the Cisco XR 12000 Series Router.

For a sample CEM interface configuration, refer [Circuit Emulation Interface Configuration: Examples, page 348](#).

Mode Change for CEoP SPA

This section explains about the command to change the mode of operation of CEoP SPA. At any specific instance, only one of this feature combination is possible on all the CEoP SPAs:

- Combination 1 : ATM + IMA + L3QoS
- Combination 2 : ATM + IMA + CEM

The **hw-module subslot *nodeid* mode CEM** command is introduced in Cisco XR 12000 Series Router to configure the modes. The ATM + IMA + L3QoS is the default mode. These sections describe two scenarios for both the mode combinations.

Host is configured and SPA is running in ATM + IMA + CEM mode

When L3QoS is configured on an ATM / IMA interface and committed, the commit operation fails, as the mode is CEM mode.

When the **hw-module subslot *nodeid* mode CEM** command is executed to switch the mode to ATM + IMA + L3QoS mode, with CEM configuration already present in running configuration, the commit fails with the message that CEM needs to be unconfigured before the change of mode to ATM + IMA + L3QoS. You must manually remove the CEM configuration before the SPA can be reloaded and booted in this new mode.

Host is configured and SPA is running in ATM + IMA + L3QoS mode

When CEM is configured and committed, the commit operation fails, as the mode is L3QoS mode.

When the **hw-module subslot *nodeid* mode CEM** command is executed to switch the mode to ATM + IMA + CEM mode, with L3QoS configuration already present in running configuration, the commit fails with the message that L3QoS needs to be unconfigured before the change of mode to ATM + IMA + CEM. You must manually remove the L3QoS configuration before the SPA can be reloaded and booted in this new mode.

The [Table 9](#) shows the support for L3QoS functionality on the three CEoP SPAs.

Table 9 Support for L3QoS functionality

CEoP SPA Variant	(ATM + IMA + CEM)	(ATM + IMA + L3QoS)
Cisco 24-Port Channelized T1/E1 Circuit Emulation and Channelized ATM SPA	Yes	Yes
Cisco 2-Port Channelized T3/E3 Circuit Emulation and Channelized ATM SPA	Yes	Yes
Cisco 1-port Channelized OC3/STM-1 Circuit Emulation and Channelized ATM SPA	Yes	No

How to implement CEM

This section contains the following procedures:

- [Configuring SONET VT1.5-Mapped T1 Channels and Creating CEM Interface, page 320](#)
- [Configuring SDH AU-3 Mapped to C11-T1 or C12-E1, page 323](#)
- [Configuring the Cisco 24-Port Channelized T1/E1 Circuit Emulation and Channelized ATM SPA and Creating CEM Interface, page 329](#)
- [Configuring the Cisco 2-Port Channelized T3/E3 Circuit Emulation and Channelized ATM SPA and Creating CEM Interface, page 332](#)
- [Configuring CEM Interface, page 337](#)
- [Configuring Clocking, page 345](#)
- [Show Commands for CEM, page 347](#)

Configuring SONET VT1.5-Mapped T1 Channels and Creating CEM Interface

In the case of Cisco 1-port Channelized OC3/STM-1 CEoP SPA, the STS stream can be channelized into the VT1.5 mapped T1 channel.

This task explains how to configure a SONET line into VT-mapped T1 Channels.

Prerequisites

None.

Restrictions

Channelized SONET STS stream with VT1.5-T1 mapping is supported on the following SPA:

- Cisco 1-Port Channelized OC-3/STM-1 SPA

SUMMARY STEPS

1. **configure**
2. **hw-module subslot** *node-id* **cardtype** *type*
3. **hw-module subslot** *node-id* **mode** *CEM*
4. **commit**
5. **controller sonet** *interface-path-id*
6. **sts** *number*
7. **mode** *mode*
8. **root**
9. **controller t1** *interface-path-id*
10. **cem-group unframed**
11. **controller t1** *interface-path-id*
12. **cem-group framed** *group-number* **timeslots** *range1-range2*

13. **no shutdown**
14. **end**
or
commit
15. **show runn interface cem** *interface-path-id*

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	hw-module subslot <i>node-id</i> cardtype {sonet sdh} Example: RP/0/0/CPU0:router(config-sonet)# hw-module subslot 0/3/0 sonet	The hw-module subslot <i>node-id</i> cardtype <i>type</i> command configures the SPA to function in sonet/sdh mode. SONET framing (sonet) is the default. Whenever there is a change in framing mode (sonet/sdh), the SPA will be reloaded automatically. Reload will happen only when all the CEM Interface, T1 Controller and Sonet Controller configurations are removed completely. This is not applicable when you configure the first time because T1 controller and interface configurations would not exist. This configuration is mandatory for CEoP SPA to work normally in one of the framing modes. When you configure for the first time, it will not cause a SPA reload, if the cardtype is set to Sonet.
Step 3	hw-module subslot <i>node-id</i> mode CEM Example: RP/0/0/CPU0:router(config-sonet)# hw-module subslot 0/3/0 mode CEM	The hw-module subslot <i>node-id</i> mode CEM command configures the SPA to function in CEM mode.
Step 4	commit	Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.
Step 5	controller sonet <i>interface-path-id</i>	Enters controller configuration submode and specifies the SONET controller name and instance identifier with the <i>rack/slot/module/port/controllerName</i> notation.
Step 6	sts <i>number</i> Example: RP/0/0/CPU0:router(config-sonet)# sts 1	Configures the STS stream specified by <i>number</i> . The range is from 1 to 3.

	Command or Action	Purpose
Step 7	<p>mode <i>mode</i></p> <p>Example: RP/0/0/CPU0:router(config-stsPath)# mode t1</p>	<p>Sets the mode of interface at the STS level. The possible modes are:</p> <ul style="list-style-type: none"> vt15-t1—SONET path carrying virtual tributary 1.5 T1s (VT15 T1)
Step 8	<p>root</p> <p>Example: RP/0/0/CPU0:router(config-stsPath)# root</p>	<p>Exits to global configuration mode. Go to step 7, if you want to create an structure agnostic CEM interface. Go to step 9, if you want to create a structure aware CEM interface.</p>
Step 9	<p>controller t1 <i>interface-path-id</i></p> <p>Example: RP/0/0/CPU0:router(config)# controller t1 0/0/1/0/1/4/1</p>	<p>Enters T1 controller configuration submode and specifies the T1 controller name and <i>interface-path-id</i> with the <i>rack/slot/module/port/sts-num/vtg-num/T1-num</i> notation.</p>
Step 10	<p>cem-group unframed</p> <p>Example: RP/0/0/CPU0:router(config)# cem-group unframed</p>	<p>Creates an structure agnostic CEM interface.</p>
Step 11	<p>controller t1 <i>interface-path-id</i></p> <p>Example: RP/0/0/CPU0:router(config)# controller t1 0/0/1/0/1/5/1</p>	<p>Enters T1 controller configuration submode and specifies the T1 controller name and <i>interface-path-id</i> with the <i>rack/slot/module/port/sts-num/vtg-num/T1-num</i> notation.</p>
Step 12	<p>cem-group framed <i>group-number timeslots range1-range2</i></p> <p>Example: RP/0/0/CPU0:router(config)# cem-group framed 0 timeslots 1</p>	<p>Creates an structure aware CEM interface. The timeslots keyword specifies the time slots for the interface by range with the <i>range1-range2</i> notation.</p>
Step 13	<p>no shutdown</p> <p>Example: RP/0/0/CPU0:router(config-if)# no shutdown</p>	<p>Removes the shutdown configuration.</p> <p>Note Removal of the shutdown configuration eliminates the forced administrative down on the interface, enabling it to move to an up or down state (assuming that the parent SONET layer is not configured administratively down).</p>

	Command or Action	Purpose
Step 14	<pre>end or commit</pre> <p>Example:</p> <pre>RP/0/00/CPU0:router(config-sonet)# end or RP/0/0/CPU0:router(config-sonet)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.
Step 15	<pre>show runn interface cem interface-path-id</pre> <p>Example:</p> <pre>RP/0/0/CPU0:router# show runn interface cem 0/0/2/0/1/1/1/1:1</pre>	<p>Verifies the CEM interface configuration.</p>

Configuring SDH AU-3 Mapped to C11-T1 or C12-E1

This section includes the following tasks:

- [Configuring SDH AU-3 Mapped to C11-T1 and Creating CEM Interface, page 323](#)
- [Configuring SDH AU-3 Mapped to C12-E1 and Creating CEM Interface, page 326](#)

Configuring SDH AU-3 Mapped to C11-T1 and Creating CEM Interface

This task explains how to configure SDH AU-3 with c11-t1 mapping.

Prerequisites

- You should know how to configure the SONET/SDH controller.

Restrictions

Channelized SDH AU-3 with c11-t1 mapping is supported on the following SPA:

- Cisco 1-Port Channelized OC-3/STM-1 SPA

SUMMARY STEPS

1. **configure**
2. **hw-module subslot** *node-id* **cardtype** *type*
3. **hw-module subslot** *node-id* **mode** *CEM*
4. **commit**
5. **controller sonet** *interface-path-id*
6. **au** *number*
7. **mode** *mode*
8. **root**
9. **controller t1** *interface-path-id*
10. **cem-group unframed**
11. **controller t1** *interface-path-id*
12. **cem-group framed** *group-number* **timeslots** *range1-range2*
13. **no shutdown**
14. **end**
or
commit
15. **show runn interface cem** *interface-path-id*

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	hw-module sub-slot <i>node-id</i> cardtype <i>type</i> Example: RP/0/0/CPU0:router(config-sonet)# hw-module sub-slot <> cardtype sdh	Configures the controller for Synchronous Digital Hierarchy (SDH) framing. The hw-module subslot <i>node-id</i> cardtype <i>type</i> command configures the SPA to function in sonet/sdh mode. This command when committed results in automatic reload of SPA. Reload happens only when all the CEM interface, T1 Controller and Sonet Controller configurations are removed completely. This is not applicable when you configure the first time because T1 controller and interface configurations would not exist. This configuration is mandatory for CEoP SPA to work normally in one of the framing modes. SONET framing (sonet) is the default.
Step 3	hw-module subslot <i>node-id</i> mode <i>CEM</i> Example: RP/0/0/CPU0:router(config-sonet)# hw-module subslot 0/3/0 mode CEM	The hw-module subslot <i>node-id</i> mode <i>CEM</i> command configures the SPA to function in CEM mode.

	Command or Action	Purpose
Step 4	<code>commit</code>	Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.
Step 5	<code>controller sonet interface-path-id</code>	Enters controller configuration submode and specifies the SDH controller name and instance identifier with the <i>rack/slot/module/port/controllerName</i> notation.
Step 6	<code>au number</code> Example: RP/0/0/CPU0:router(config-sonet)# au 1	Specifies the administrative unit (AU) group and enters AU path configuration mode. For AU-3, the valid range is: <ul style="list-style-type: none"> 1 to 3—1-Port Channelized OC-3/STM-1 SPA Note The au command does not specify the AU type. It specifies the number of the AU group for the AU type that you want to configure. The range for the AU command varies based on whether you are configuring AU-3 or AU-4.
Step 7	<code>mode mode</code> Example: RP/0/0/CPU0:router(config-auPath)# mode c11-t1	Sets the mode of interface at the AU level. AU-3 paths can be mapped to c11-t1 on supported SPAs.
Step 8	<code>root</code> Example: RP/0/0/CPU0:router(config-auPath)# root	Exits to global configuration mode.
Step 9	<code>controller t1 interface-path-id</code> Example: RP/0/0/CPU0:router(config)# controller T1 0/0/2/0/1/1/4	Enters T1 controller configuration submode and specifies the T1 controller name and <i>interface-path-id</i> with the <i>rack/slot/module/port/auNum/t1Num</i> notation.
Step 10	<code>cem-group unframed</code> Example: RP/0/0/CPU0:router(config)# cem-group unframed	Creates an structure agnostic CEM interface.
Step 11	<code>controller t1 interface-path-id</code> Example: RP/0/0/CPU0:router(config)# controller t1 0/0/2/0/1/1/7	Enters T1 controller configuration submode and specifies the T1 controller name and <i>interface-path-id</i> with the <i>rack/slot/module/port/auNum/t1Num</i> notation.
Step 12	<code>cem-group framed group-number timeslots range1-range2</code> Example: RP/0/0/CPU0:router(config)# cem-group framed 1 timeslots 2-3	Creates an structure aware CEM interface. The timeslots keyword specifies the time slots for the interface by range with the <i>range1-range2</i> notation.

	Command or Action	Purpose
Step 13	<p>no shutdown</p> <p>Example: RP/0/0/CPU0:router(config-if)# no shutdown</p>	<p>Removes the shutdown configuration.</p> <p>Note Removal of the shutdown configuration eliminates the forced administrative down on the interface, enabling it to move to an up or down state (assuming that the parent SONET layer is not configured administratively down).</p>
Step 14	<p>end OR commit</p> <p>Example: RP/0/0/CPU0:router(config-sonet)# end OR RP/0/0/CPU0:router(config-sonet)# commit</p>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]: <ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.
Step 15	<p>show runn interface cem interface-path-id</p> <p>Example: RP/0/0/CPU0:router# show runn interface cem 0/0/2/0/1/1/1/1:1</p>	<p>Verifies the CEM interface configuration.</p>

Configuring SDH AU-3 Mapped to C12-E1 and Creating CEM Interface

This task explains how to configure SDH AU-3 with c12-e1 mapping.

Prerequisites

- You should know how to configure the SONET/SDH controller.

Restrictions

Channelized SDH AU-3 with c12-e1 mapping is supported on the following SPAs:

- Cisco 1-Port Channelized OC-3/STM-1 SPA

SUMMARY STEPS

- configure**
- hw-module subslot node-id cardtype type**

3. **hw-module subslot** *node-id* **mode** *CEM*
4. **commit**
5. **controller sonet** *interface-path-id*
6. **au** *number*
7. **mode tug3**
8. **width** *number*
9. **tug3** *number*
10. **mode** *mode*
11. **root**
12. **controller e1** *interface-path-id*
13. **cem-group unframed**
14. **controller e1** *interface-path-id*
15. **cem-group framed** *group-number* **timeslots** *range1-range2*
16. **no shutdown**
17. **end**
or
commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	hw-module sub-slot <i>node-id</i> cardtype <i>type</i> Example: RP/0/0/CPU0:router(config-sonet)# hw-module sub-slot <> cardtype sdh	The hw-module subslot <i>node-id</i> cardtype <i>type</i> command configures the SPA to function in sonet/sdh mode. This command when committed results in automatic reload of SPA. Reload happens only when all the CEM interface, E1 Controller and Sonet Controller configurations are removed completely.
Step 3	hw-module subslot <i>node-id</i> mode CEM Example: RP/0/0/CPU0:router(config-sonet)# hw-module subslot 0/3/0 mode CEM	The hw-module subslot <i>node-id</i> mode <i>CEM</i> command configures the SPA to function in CEM mode.
Step 4	commit	Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

	Command or Action	Purpose
Step 5	<code>controller sonet interface-path-id</code>	Enters controller configuration submode and specifies the SDH controller name and instance identifier with the <i>rack/slot/module/port/controllerName</i> notation.
Step 6	<code>au number</code> Example: RP/0/0/CPU0:router(config-sonet)# au 1	Specifies the administrative unit (AU) group and enters AU path configuration mode. For AU-3, the valid range is: <ul style="list-style-type: none"> 1 to 3—1-Port Channelized OC-3/STM-1 SPA Note The <code>au</code> command does not specify the AU type. It specifies the number of the AU group for the AU type that you want to configure. The range for the AU command varies based on whether you are configuring AU-3 or AU-4.
Step 7	<code>mode tug3</code> Example: RP/0/0/CPU0:router(config-auPath)# mode tug3	Sets the mode of interface at the AU level. Currently only TUG3 is supported.
Step 8	<code>width number</code> Example: RP/0/0/CPU0:router(config-auPath)# width 3	Configures the number of the AU streams.
Step 9	<code>tug3 number</code> Example: RP/0/0/CPU0:router(config-auPath)#tug3 1	Specifies the Tributary Unit Group (TUG) <i>number</i> and enters the config-tug3Path mode. The range is 1 to 3.
Step 10	<code>mode mode</code> Example: RP/0/0/CPU0:router(config-tug3Path)# mode c12-e1	Sets the mode of interface at the tug3 level. The modes are: <ul style="list-style-type: none"> c12-e1—TUG-3 path carrying TU-12 to E1
Step 11	<code>root</code> Example: RP/0/0/CPU0:router(config-auPath)# root	Exits to global configuration mode.
Step 12	<code>controller e1 interface-path-id</code> Example: RP/0/0/CPU0:router(config)# controller E1 0/0/2/0/1/1/1	Enters E1 controller configuration submode and specifies the E1 controller name and <i>interface-path-id</i> with the <i>rack/slot/module/port/auNum/tugNum/t1Num</i> notation.
Step 13	<code>cem-group unframed</code> Example: RP/0/0/CPU0:router(config)# cem-group unframed	Creates an structure agnostic CEM interface.

	Command or Action	Purpose
Step 14	<pre>controller e1 interface-path-id</pre> <p>Example: RP/0/0/CPU0:router(config)# controller E1 0/0/2/0/1/1/7 </p>	Enters E1 controller configuration submode and specifies the E1 controller name and <i>interface-path-id</i> with the <i>rack/slot/module/port/auNum/tugNum/t1Num</i> notation.
Step 15	<pre>cem-group framed group-number timeslots range1-range2</pre> <p>Example: RP/0/0/CPU0:router(config)# cem-group framed 0 timeslots 1 </p>	Creates an structure aware CEM interface.
Step 16	<pre>no shutdown</pre> <p>Example: RP/0/0/CPU0:router(config-if)# no shutdown </p>	Removes the shutdown configuration. Note Removal of the shutdown configuration eliminates the forced administrative down on the interface, enabling it to move to an up or down state (assuming that the parent SONET layer is not configured administratively down).
Step 17	<pre>end</pre> <p>OR</p> <pre>commit</pre> <p>Example: RP/0/0/CPU0:router(config-sonet)# end OR RP/0/0/CPU0:router(config-sonet)# commit </p>	Saves configuration changes. <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring the Cisco 24-Port Channelized T1/E1 Circuit Emulation and Channelized ATM SPA and Creating CEM Interface

This task explains how to configure the Cisco 24-Port Channelized T1/E1 Circuit Emulation and Channelized ATM SPA.

SUMMARY STEPS

1. **configure**
2. **hw-module subslot *node-id* cardtype *type***
3. **hw-module subslot *node-id* mode *CEM***
4. **commit**
5. **controller t1 *interface-path-id***
6. **cem-group unframed**
7. **controller t1 *interface-path-id***
8. **cem-group framed *group-number* timeslots *range1-range2***
9. **no shutdown**
10. **end**
or
commit
11. **show runn interface cem *interface-path-id***

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	hw-module subslot <i>node-id</i> cardtype {t1 e1} Example: RP/0/0/CPU0:router(config-t1)# hw-module subslot 0/3/0 cardtype t1	The hw-module subslot <i>node-id</i> cardtype <i>type</i> command configures the SPA to function in t1/e1 mode. Reload will happen only when all the CEM interface, T1 Controller configurations are removed completely. This is not applicable when you configure the first time because T1 controller and interface configurations would not exist.
Step 3	hw-module subslot <i>node-id</i> mode CEM Example: RP/0/0/CPU0:router(config-t1)# hw-module subslot 0/3/0 mode CEM	The hw-module subslot <i>node-id</i> mode <i>CEM</i> command configures the SPA to function in CEM mode.
Step 4	commit	Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

	Command or Action	Purpose
Step 5	<p>controller t1 <i>interface-path-id</i></p> <p>Example: RP/0/0/CPU0:router(config)# controller t1 0/0/1/0/1</p>	Enters T1 controller configuration submode and specifies the T1 controller name and <i>interface-path-id</i> with the <i>rack/slot/module/port/T1num</i> notation.
Step 6	<p>cem-group unframed</p> <p>Example: RP/0/0/CPU0:router(config-t1)# cem-group unframed</p>	Creates an structure agnostic CEM interface.
Step 7	<p>controller t1 <i>interface-path-id</i></p> <p>Example: RP/0/0/CPU0:router(config)# controller t1 0/0/1/0/1</p>	Enters T1 controller configuration submode and specifies the T1 controller name and <i>interface-path-id</i> with the <i>rack/slot/module/port/T1num</i> notation.
Step 8	<p>cem-group framed <i>group-number timeslots</i> <i>range1-range2</i></p> <p>Example: RP/0/0/CPU0:router(config-t1)# cem-group framed 0 timeslots 1</p>	Creates an structure aware CEM interface. The timeslots keyword specifies the time slots for the interface by range with the <i>range1-range2</i> notation.
Step 9	<p>no shutdown</p> <p>Example: RP/0/0/CPU0:router(config-if)# no shutdown</p>	<p>Removes the shutdown configuration.</p> <p>Note Removal of the shutdown configuration eliminates the forced administrative down on the interface, enabling it to move to an up or down state.</p>

	Command or Action	Purpose
Step 10	<pre>end or commit</pre> <p>Example: RP/0/0/CPU0:router(config-t1)# end OR RP/0/0/CPU0:router(config-t1)# commit</p>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.
Step 11	<pre>show runn interface cem interface-path-id</pre> <p>Example: RP/0/0/CPU0:router# show runn interface cem 0/0/2/0/1:1</p>	<p>Verifies the CEM interface configuration.</p>

Configuring the Cisco 2-Port Channelized T3/E3 Circuit Emulation and Channelized ATM SPA and Creating CEM Interface

T3/E3 Channelization Mode

This task explains how to configure the Cisco 2-Port Channelized T3/E3 Circuit Emulation and Channelized ATM SPA using T3/E3 channelization.



Note

The T3/E3 channels can be channelized further into T1s or E1s, and the T1s or E1s can be channelized into time slots (DS0s), on the Cisco 2-Port Channelized T3/E3 Circuit Emulation and Channelized ATM SPA.

SUMMARY STEPS

1. **configure**
2. **hw-module subslot** *node-id* **cardtype** *type*

3. **hw-module subslot** *node-id* **mode** *CEM*
4. **commit**
5. **controller** {**t3** | **e3**} *interface-path-id*
6. **cem-group unframed**
7. **no shutdown**
8. **end**
or
commit
9. **show runn interface cem** *interface-path-id*

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	hw-module subslot <i>node-id</i> cardtype { t3 e3 } Example: RP/0/0/CPU0:router(config-t3)# hw-module subslot 0/3/0 cardtype t3	The hw-module subslot <i>node-id</i> cardtype <i>type</i> command configures the SPA to function in t3/e3 mode. Whenever there is a change in framing mode (t3/e3), the SPA will be reloaded automatically. Reload will happen only when all the CEM Interface, T3 Controller configurations are removed completely. This is not applicable when you configure the first time because T3 controller and interface configurations would not exist.
Step 3	hw-module subslot <i>node-id</i> mode CEM Example: RP/0/0/CPU0:router(config-t3)# hw-module subslot 0/3/0 mode CEM	The hw-module subslot <i>node-id</i> mode <i>CEM</i> command configures the SPA to function in CEM mode.
Step 4	commit	Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.
Step 5	controller { t3 e3 } <i>interface-path-id</i> Example: RP/0/0/CPU0:router(config)# controller t3 0/0/1/0/4	Enters T3/E3 controller configuration submode and specifies the T3/E3 controller name and <i>interface-path-id</i> with the <i>rack/slot/module/port/T3Num</i> notation.

	Command or Action	Purpose
Step 6	cem-group unframed Example: RP/0/0/CPU0:router(config-t3)# cem-group unframed	Creates an structure agnostic CEM interface. Only the unframed CEM interface is supported in this mode.
Step 7	no shutdown Example: RP/0/0/CPU0:router(config-if)# no shutdown	Removes the shutdown configuration. Note Removal of the shutdown configuration eliminates the forced administrative down on the interface, enabling it to move to an up or down state.
Step 8	end OR commit Example: RP/0/0/CPU0:router(config-t3)# end OR RP/0/0/CPU0:router(config-t3)# commit	Saves configuration changes. <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]: <ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.
Step 9	show runn interface cem interface-path-id Example: RP/0/0/CPU0:router# show runn interface cem 0/0/1/0/4:1	Verifies the CEM interface configuration.

T1/E1 Channelization Mode

This task explains how to configure the Cisco 2-Port Channelized T3/E3 Circuit Emulation and Channelized ATM SPA using T1/E1 channelization.

SUMMARY STEPS

1. **configure**
2. **hw-module subslot *node-id* cardtype *type***
3. **hw-module subslot *node-id* mode *CEM***

4. **commit**
5. **controller t3** *interface-path-id*
6. **mode** {t1|e1}
7. **controller t1** *interface-path-id*
8. **cem-group unframed**
9. **controller t1** *interface-path-id*
10. **cem-group framed** *group-number timeslots range1-range2*
11. **no shutdown**
12. **end**
or
commit
13. **show runn interface cem** *interface-path-id*

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	hw-module subslot <i>node-id cardtype</i> {t3 e3} Example: RP/0/0/CPU0:router(config-sonet)# hw-module subslot 0/3/0 t3	The hw-module subslot <i>node-id cardtype type</i> command configures the SPA to function in t3/e3 mode. Whenever there is a change in framing mode (t3/e3), the SPA will be reloaded automatically. Reload will happen only when all the CEM Interface, T3 Controller configurations are removed completely. This is not applicable when you configure the first time because T3 controller and interface configurations would not exist.
Step 3	hw-module subslot <i>node-id mode</i> CEM Example: RP/0/0/CPU0:router(config-t3)# hw-module subslot 0/3/0 mode CEM	The hw-module subslot <i>node-id mode</i> CEM command configures the SPA to function in CEM mode.
Step 4	commit	Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.
Step 5	controller t3 <i>interface-path-id</i> Example: RP/0/0/CPU0:router(config)# controller t3 0/0/1/0/4	Enters T3 controller configuration submode and specifies the T3 controller name and <i>interface-path-id</i> with the <i>rack/slot/module/port/T3Num</i> notation.

	Command or Action	Purpose
Step 6	<code>mode {t1 e1}</code>	Sets the mode of interface. The possible modes are T1 and E1 channelization mode.
Step 7	<code>controller t1 interface-path-id</code> Example: RP/0/0/CPU0:router(config)# controller t1 0/0/1/0/4/1	Enters T1 controller configuration submode and specifies the T1 controller name and <i>interface-path-id</i> with the <i>rack/slot/module/port/T3Num/T1num</i> notation.
Step 8	<code>cem-group unframed</code> Example: RP/0/0/CPU0:router(config-t1)# cem-group unframed	Creates an structure agnostic CEM interface.
Step 9	<code>controller t1 interface-path-id</code> Example: RP/0/0/CPU0:router(config)# controller t1 0/0/1/0/4/1	Enters T1 controller configuration submode and specifies the T1 controller name and <i>interface-path-id</i> with the <i>rack/slot/module/port/T3Num/T1num</i> notation.
Step 10	<code>cem-group framed group-number timeslots range1-range2</code> Example: RP/0/0/CPU0:router(config-t1)# cem-group framed 0 timeslots 1	Creates an structure aware CEM interface. The timeslots keyword specifies the time slots for the interface by range with the <i>range1-range2</i> notation.
Step 11	<code>no shutdown</code> Example: RP/0/0/CPU0:router(config-if)# no shutdown	Removes the shutdown configuration. Note Removal of the shutdown configuration eliminates the forced administrative down on the interface, enabling it to move to an up or down state.

	Command or Action	Purpose
Step 12	<pre>end or commit</pre> <p>Example:</p> <pre>RP/0/0/CPU0:router(config-t1)# end OR RP/0/0/CPU0:router(config-t1)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.
Step 13	<pre>show runn interface cem interface-path-id</pre> <p>Example:</p> <pre>RP/0/0/CPU0:router# show runn interface cem 0/0/2/0/1/1/1/1:1</pre>	<p>Verifies the CEM interface configuration.</p>

Configuring CEM Interface

This section provides information about how to configure CEM. CEM provides a bridge between a time-division multiplexing (TDM) network and a packet network using 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.

The following sections describe how to configure CEM:

- [Configuration Guidelines and Restrictions](#)
- [Configuring a Global CEM Class](#)
- [Attaching a CEM Class](#)
- [Configuring Payload Size](#)
- [Setting the Dejitteer Buffer Size](#)
- [Setting an Idle Pattern](#)
- [Enabling Dummy Mode](#)
- [Setting a Dummy Pattern](#)

Configuration Guidelines and Restrictions

Not all combinations of payload size and dejitter buffer size are supported. If you apply an incompatible payload size or dejitter buffer configuration, the router rejects it and reverts to the previous configuration.

Configuring a Global CEM Class

This task explains how to configure a global CEM class.



Note

Any interface configuration would have higher precedence over configuration applied through attaching a CEM class. Also, CEM class attached to an interface would have higher precedence than CEM class attached to the parent controller. For example, if the dummy pattern value of *0xcf* is applied directly to an interface and then a CEM class which contains dummy pattern value of *0xaa* is attached to the same interface, then the dummy pattern value would be *0xcf*. The new configuration would not be applied until the dummy pattern value applied directly to the interface is removed.

SUMMARY STEPS

1. **configure**
2. **cem class** *class-name*
3. **payload** *value*
4. **dejitter** *value*
5. **idle pattern** *value*
6. **dummy mode** {*last-frame* | *user-defined*}
7. **dummy pattern** *value*
8. **end**
or
commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	cem class <i>class-name</i> Example: RP/0/0/CPU0:router(config)# cem class Default	Creates a new CEM class.

	Command or Action	Purpose
Step 3	<p>payload <i>value</i></p> <p>Example: RP/0/0/CPU0:router(config-cem-class)# payload 512</p>	Enter the payload size for the CEM class.
Step 4	<p>dejitter <i>value</i></p> <p>Example: RP/0/0/CPU0:router(config-cem-class)# dejitter 10</p>	Enter the dejitter buffer size for the CEM class.
Step 5	<p>idle pattern <i>value</i></p> <p>Example: RP/0/0/CPU0:router(config-cem-class)# idle pattern 0x55</p>	Enter the idle pattern value for the CEM class.
Step 6	<p>dummy mode</p> <p>Example: RP/0/0/CPU0:router(config-cem-class)# dummy mode last-frame</p>	Enter the dummy mode for the CEM class. The options are last-frame or user-defined.
Step 7	<p>dummy pattern <i>value</i></p> <p>Example: RP/0/0/CPU0:router(config-cem-class)# dummy pattern</p>	Enter the dummy pattern value for the CEM class. This value is applied only when the dummy mode is user-defined.
Step 8	<p>end OR commit</p> <p>Example: RP/0/0/CPU0:router(config-cem-class)# end OR RP/0/0/CPU0:router(config-cem-class)# commit</p>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Attaching a CEM Class

This task explains how to attach a global CEM class.



Note

You can attach a CEM class either to a CEM interface or to a T1/E1 controller.

SUMMARY STEPS

1. **configure**
2. **interface cem** *interface-path-id* (or) **controller {t1|e1}** *rack/slot/subslot/port*
3. **cem class-attach** *class-name*
4. **end**
or
commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	interface cem <i>interface-path-id</i> (or) controller {t1 e1} <i>interface-path-id</i> Example: RP/0/0/CPU0:router(config)# controller t1 0/0/2/0/1/1	Specifies the CEM interface or the T1/E1 controller.

	Command or Action	Purpose
Step 3	<p>cem class-attach <i>class-name</i></p> <p>Example: RP/0/0/CPU0:router(config)# cem class-attach Default</p>	Attaches the CEM class to an interface or controller.
Step 4	<p>end or commit</p> <p>Example: RP/0/0/CPU0:router(config-cem-class)# end or RP/0/0/CPU0:router(config-cem-class)# commit</p>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring Payload Size

To specify the number of bytes encapsulated into a single IP packet, use the **cem payload** command. The size argument specifies the number of bytes in the payload of each packet. The range is from 32 to 1312 bytes.

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

- E1 = 256 bytes
- T1 = 192 bytes
- E3 = 1024 bytes
- T3 = 1024 bytes

Default payload sizes for a structured CEM channel depend on the number of time slots that constitute the channel. Payload (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 calculated using the packetization latency depending on the number of time slots the cem interface represents. The relationship between the number of time slots and the packetization latency is provided below:

- For $N = 1$, D is 8 milliseconds (with the corresponding packet payloadsize of 64 bytes)
- For $2 \leq N \leq 4$, D is 4 milliseconds (with the corresponding packetpayload size of $32 * N$ bytes)
- For $N \geq 5$, D is 1 millisecond (with the corresponding packet payloadsize of $8 * N$ octets).

Support of 5 ms packetization latency for $N = 1$ is recommended.

Setting the Dejitter Buffer Size

To specify the size of the dejitter buffer used to compensate for the network filter, use the **cem dejitter** 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 following is an example:

```
Router(config-cem)# cem dejitter 5
```

The default dejitter buffer for a CEM channel, irrespective of CESoPSN or SAToP, is as follows:

- E1 = 16 milliseconds
- T1 = 16 milliseconds
- E3 = 5 milliseconds
- T3 = 5 milliseconds



Note

Refer [Table 10](#), [Table 11](#), and [Table 12](#) for the relationship between payload and dejitter buffer on SAToP T1/E1, T3/E3, and CESoPSN lines. Configuration of payload and dejitter should be in accordance with the minimum and maximum values as mentioned in the table.



Note

The maximum and minimum dejitter buffer value, that is the range is fixed for a given payload value.

Setting an Idle Pattern

To specify an idle pattern, use the `[no] cem idle pattern pattern` 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. This is an example:

```
Router(config-cem)# cem idle pattern 0xff
```

If the expected CEM packets are not received for a given CEM interface and are considered as being lost, then the CEoP SPA will play out the idle pattern towards the TDM attachment circuit in the respective timeslots configured in the CEM group.

Enabling Dummy Mode

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

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

When packets are lost due to misordering or where reordering of packets is not successful, the CEoP SPA will play out the Dummy pattern towards the TDM attachment circuit in respective timeslots configured in the CEM group.

Setting a Dummy Pattern

If dummy mode is set to user-defined, you can use the `cem dummy-pattern` command to configure the dummy pattern. The range for pattern is from 0x0 to 0xff. The default dummy pattern is 0xff. This is an example:

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

The [Table 10](#) shows the relationship between payload and dejitter for T1/E1 SAToP lines.

Table 10 T1/E1 SAToP lines: Payload and Jitter Limits

T1/E1	Maximum Payload	Maximum Jitter	Minimum Jitter	Minimum Payload	Maximum Jitter	Minimum Jitter
T1	960	320	10	192	64	2
E1	1280	320	10	256	64	2

The [Table 11](#) shows the relationship between payload and dejitter for T3/E3 SAToP lines.

Table 11 T3/E3 SAToP lines: Payload and Jitter Limits

T3/E3	Maximum Payload	Maximum Jitter	Minimum Jitter	Minimum Payload	Maximum Jitter	Minimum Jitter
T3	1312	8	2	672	8	2
E3	1312	16	2	512	8	2

The [Table 12](#) shows the relationship between payload and dejitter for DS0 lines.

Table 12 *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
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

Configuring Clocking

Each SPA port shall be configured either to use system clock from the host card or loop timed independently. Each SPA also supplies a reference clock to the host which can be selected among the received port clocks. This section provides information about how to configure clocking on the 1xOC3, 24xT1/E1 and 2xT3/E3 SPA.

This section describes the following topics:

- [Configuring Clock Recovery](#)
- [Verifying Clock recovery](#)

Configuring Clock Recovery

When configuring clock recovery, consider the following guidelines:

Adaptive Clock Recovery

- Clock source:
 - In Cisco IOS XR Release 4.2.0 and later, recovered clock from a CEM interface on the 1-Port Channelized OC-3/STM1 CEoP SPA, 24xT1/E1 CEoP SPA and 2xT3/E3 CEoP SPA can be used as a clock source on the SPA itself.
- Number of clock sources allowed:
 - Refer the section [Clock Distribution, page 317](#) for more information.
- The minimum bundle size of CEM pseudowires on the network that delivers robust clock recovery is 4 DS0s.
- The minimum packet size of CEM pseudowires on the network that delivers robust clock recovery is 64 bytes.

To configure clock recovery on the CEoP SPA and to apply the recovered clock to the controller, use the following procedure:

SUMMARY STEPS

1. **configure**
2. **interface cem** *rack/slot/subslot/port:cem-group*
3. **recover-clock** *clock-id* **{adaptive}**
4. **controller** **{t1e1t3e3}** *rack/slot/subslot/port*
5. **clock source recovered** *clock-id*

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	interface cem rack/slot/subslot/port:cem-group Example: RP/0/0/CPU0:router(config)# interface cem 0/1/0/0:2	Specifies the complete CEM interface instance.
Step 3	recover-clock clock-id {adaptive} Example: RP/0/0/CPU0:router(config-if)# recover-clock clock-id <> adaptive	Specifies the recovered clock number and the clock recovery type. This is typically configured at the node acting as Slave that recovers the clock from incoming CEM packets from core.
Step 4	controller name instance Example: RP/0/0/CPU0:router(config)# controller t1 0/1/1/0/0/0	Enters controller configuration submode and specifies the controller name and instance identifier with the <i>rack/slot/module/port/name/instance1/instance2</i> notation.
Step 5	clock source recovered clock-id Example: RP/0/0/CPU0:router(config-t1)# clock source recovered 3	Specifies the recovered clock number. This applies the recovered clock from a CEM interface on a T1/E1 or T3/E3 Controller.

Verifying Clock recovery

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

```
Router# show recovered-clock subslot 0/3/0
Recovered clock status for subslot 0/3/0
-----
Clock   Mode           Port CEM  Status      Frequency Offset(ppb)
1       ADAPTIVE       0    1    HOLDOVER    0
Router# show recovered-clock
Recovered clock status for subslot 3/0
-----
Clock   Mode           Port CEM  Status      Frequency Offset(ppb)
1       ADAPTIVE       0    1    ACQUIRING   -694
```

Show Commands for CEM

You can use the command **show controller cem** *<forward interface instance>* to verify the CEM parameter information. The following example provides a sample output for the command.

Output of show controller cem forward interface instance command

```
RP/0/0/CPU0:Router# show controllers cem 0/4/1/0:0

Interface           : CEM0/4/1/0:0
Admin state         : Up
Driver link state   : Up
Port bandwidth(kbps) : 1984
Dejitter buffer     : 16
Payload size        : 248
Dummy mode          : last-frame
Dummy pattern       : 0xff
Idle pattern        : 0xff
Signalling          : No CAS
RTP                 : Enabled
Ingress packets     : 1638960097, Ingress packets drop : 0
Egress packets      : 1207954294, Egress packets drop  : 287140468
Missing packets     : 160475876, Reordered packets       : 50092
Malformed packets   : 73, Misorder drops                : 7
Jitter buffer underrun : 28, Error seconds                : 79673
Severely error seconds : 25721, Unavailable seconds        : 160361
Failure counts      : 2
```

Configuration Examples for CEM

This section contains the following examples:

- [Circuit Emulation Interface Configuration: Examples, page 348](#)
 - [Channelized Sonet / SDH Configurations and CEM Interface Creation, page 348](#)
 - [SAToP CEM interface creation on T3 / E3 on Cisco 2-Port Channelized T3/E3 Circuit Emulation and Channelized ATM SPA, page 350](#)
 - [SAToP CEM interface creation on T1 / E1 on Cisco 2-Port Channelized T3/E3 Circuit Emulation and Channelized ATM SPA, page 350](#)
 - [CESoPSN CEM interface creation on T1/E1 on Cisco 2-Port Channelized T3/E3 Circuit Emulation and Channelized ATM SPA, page 350](#)
 - [SATO P CEM interface creation on T1 / E1 on Cisco 24-Port Channelized T1/E1 Circuit Emulation and Channelized ATM SPA, page 351](#)
 - [CESoPSN CEM interface creation on T1 / E1 on Cisco 24-Port Channelized T1/E1 Circuit Emulation and Channelized ATM SPA, page 351](#)
- [Clock Recovery : Example, page 351](#)
 - [Adaptive Clock Recovery Configuration:, page 351](#)

Circuit Emulation Interface Configuration: Examples

The following example shows a sample CEM interface configuration on the Cisco 1-port Channelized OC3/STM-1 SPA.

Channelized Sonet / SDH Configurations and CEM Interface Creation

Sonet - T1 Channelization and CEM Interface Creation

```
hw-module subslot <loc> cardtype sonet
controller SONET 0/0/1/0
  sts 1
    mode vt15-t1
  sts 2
    mode vt15-t1
  sts 3
    mode vt15-t1
commit
```

In case of structure agnostic cem interface:

```
controller T1 0/0/1/0/1/4/1
  cem-group unframed
```

In case of structure aware cem interface:

```
controller T1 0/0/1/0/1/5/1
  cem-group framed 0 timeslots 1
  cem-group framed 1 timeslots 2-3
  cem-group framed 2 timeslots 4-6
  cem-group framed 3 timeslots 7-10
  cem-group framed 4 timeslots 11-15
  cem-group framed 5 timeslots 16-21
```



```
cem-group framed 6 timeslots 22-24
```

SDH - T1 Channelization and CEM Interface Creation

```
hw-module subslot <loc> cardtype sdh
controller SONET0/0/2/0
  au 1
    mode c11-t1
  au 2
    mode c11-t1
  au 3
    mode c11-t1
commit
```

In case of structure agnostic cem interface:

```
controller T1 0/0/2/0/1/1/4
cem-group unframed
```

In case of structure aware cem interface:

```
controller T1 0/0/2/0/1/7/1
cem-group framed 0 timeslots 1
cem-group framed 1 timeslots 2-3
cem-group framed 2 timeslots 4-6
cem-group framed 3 timeslots 7-10
cem-group framed 4 timeslots 11-15
cem-group framed 5 timeslots 16-21
cem-group framed 6 timeslots 22-24
```

SDH - E1 Channelization and CEM Interface Creation

```
hw-module subslot <loc> cardtype sdh
controller SONET 0/0/2/0
  au 1
    mode tug3
    width 3
    tug3 1
    mode c12-e1
  tug3 2
    mode c12-e1
  tug3 3
    mode c12-e1
commit
```

In case of structure agnostic cem interface:

```
controller E1 0/0/2/0/1/1/1/1
cem-group unframed
```

In case of structure aware cem interface:

```
controller E1 0/0/2/0/1/1/7/1
cem-group framed 0 timeslots 1
cem-group framed 1 timeslots 2-3
cem-group framed 2 timeslots 4-6
cem-group framed 3 timeslots 7-10
cem-group framed 4 timeslots 11-15
cem-group framed 5 timeslots 16-21
cem-group framed 6 timeslots 22-31
```

CEM Interface Configuration

```
RP/0/RSP0/CPU0:CEOP-01#show runn interface cem 0/0/2/0/1/1/1/1:1

interface CEM0/0/2/0/1/1/1/1:1
  l2transport
  !
CEM Interface Config Options :

RP/0/RSP0/CPU0:CEOP-01(config)#interface cem 0/0/2/0/1/1/1/1:1
RP/0/RSP0/CPU0:CEOP-01(config-if)#cem ?
  class-attach  Attach a CEM class to this interface
  clock         Configure clocks on this CEM interface
  dejitter      Configure dejitter buffer
  dummy         Configure dummy frame parameters
  idle          Configure idle frame parameters
  payload       Configure payload size of CEM frames
```

SAToP CEM interface creation on T3 / E3 on Cisco 2-Port Channelized T3/E3 Circuit Emulation and Channelized ATM SPA

```
RP/0/0/CPU0:router(config)#controller t3 0/4/2/0
RP/0/0/CPU0:router(config-t3)#cem-group ?
  unframed  clear channel carrying CEM
RP/0/0/CPU0:router(config-t3)#cem-group unframed
RP/0/0/CPU0:router(config-t3)#commit
RP/0/0/CPU0:router(config-t3)#
```

SAToP CEM interface creation on T1 / E1 on Cisco 2-Port Channelized T3/E3 Circuit Emulation and Channelized ATM SPA

```
RP/0/0/CPU0:router(config)#controller t3 0/4/2/0
RP/0/0/CPU0:router(config-t3)#mode ?
  atm      clear channel carrying atm
  e1       channelize into 21 E1s
  serial   clear channel carrying hdlc like payload
  t1       channelized into 28 T1s
RP/0/0/CPU0:router(config-t3)#mode e1
RP/0/0/CPU0:router(config-t3)#commit

RP/0/0/CPU0:router(config)#controller e1 0/4/2/0/1
RP/0/0/CPU0:router(config-e1)#cem-group ?
  framed   Configure a framed CEM interface on T1/E1
  unframed Configure a unframed CEM interface on T1/E1
RP/0/0/CPU0:router(config-e1)#cem-group unframed ?
<cr>
RP/0/0/CPU0:router(config-e1)#cem-group unframed
RP/0/0/CPU0:router(config-e1)#commit
```

CESoPSN CEM interface creation on T1/E1 on Cisco 2-Port Channelized T3/E3 Circuit Emulation and Channelized ATM SPA

```
RP/0/0/CPU0:router(config)#controller t3 0/4/2/1
RP/0/0/CPU0:router(config-t3)#mode ?
  atm      clear channel carrying atm
  e1       channelize into 21 E1s
```

```

serial clear channel carrying hdlc like payload
t1      channelized into 28 T1s
RP/0/0/CPU0:router(config-t3)#mode t1
RP/0/0/CPU0:router(config-t3)#commit

RP/0/0/CPU0:router(config)#controller t1 0/4/2/1/1
RP/0/0/CPU0:router(config-t1)#cem-group ?
    framed      Configure a framed CEM interface on T1/E1
    unframed    Configure a unframed CEM interface on T1/E1
RP/0/0/CPU0:router(config-t1)#cem-group framed ?
    <0-23>      CEM group number
RP/0/0/CPU0:router(config-t1)#cem-group framed 0 ?
    timeslots  List of timeslots in the CEM group
RP/0/0/CPU0:router(config-t1)#cem-group framed 0 timeslots ?
    WORD       timeslot string separated by (:) or (-) from 1 to 24. (:) indicates individual
    timeslot and (-) represent range
RP/0/0/CPU0:router(config-t1)#cem-group framed 0 timeslots 1:23
RP/0/0/CPU0:router(config-t1)#commit

```

SAToP CEM interface creation on T1 / E1 on Cisco 24-Port Channelized T1/E1 Circuit Emulation and Channelized ATM SPA

```

RP/0/0/CPU0:router(config)#controller e1 0/4/1/2
RP/0/0/CPU0:router(config-e1)#cem-group ?
    framed      Configure a framed CEM interface on T1/E1
    unframed    Configure a unframed CEM interface on T1/E1
RP/0/0/CPU0:router(config-e1)#cem-group unframed ?
    <cr>
RP/0/0/CPU0:router(config-e1)#cem-group unframed
RP/0/0/CPU0:router(config-e1)#commit

```

CESoPSN CEM interface creation on T1 / E1 on Cisco 24-Port Channelized T1/E1 Circuit Emulation and Channelized ATM SPA

```

RP/0/0/CPU0:router(config)#controller e1 0/4/1/1
RP/0/0/CPU0:router(config-e1)#cem-group framed ?
    <0-30>      CEM group number
RP/0/0/CPU0:router(config-e1)#cem-group framed 1 ?
    timeslots  List of timeslots in the CEM group
RP/0/0/CPU0:router(config-e1)#cem-group framed 1 timeslots ?
    WORD       timeslot string separated by (:) or (-) from 1 to 31. (:) indicates individual
    timeslot and (-) represent range
RP/0/0/CPU0:router(config-e1)#cem-group framed 1 timeslots 1:20
RP/0/0/CPU0:router(config-e1)#commit

```

Clock Recovery : Example

Adaptive Clock Recovery Configuration:

(E1 configurations are similar to T1s given below)

```

CE1
----
Router (config)#controller t1 0/0/2/0/1/1/4
Router (config-t1)#clock source internal

```

PE1 (Acts as source of clock, but no specific configuration under CEM Interface is needed here)

```
-----
Router (config)#controller t1 0/0/2/0/1/1/4
Router (config-t1)#clock source line
```

PE2 (On PE node where clock recovery is done):

To recover the adaptive clock:

```
Router(config)# interface cem 0/0/2/0/1/1/4:0
Router(config-if)#cem clock recover <clock-id> adaptive
```

To apply the recovered clock,

```
Router (config)#controller t1 0/0/2/0/1/1/4
Router (config-t1)#clock source recovered <clock-id>
```

CE2

```
----
Router (config)#controller t1 0/0/2/0/1/1/4
Router (config-t1)#clock source line
```

Additional References

These sections provide references to related documents.

Related Documents

Related Topic	Document Title
Cisco IOS XR master command reference	<i>Cisco IOS XR Master Commands List</i>
Cisco IOS XR interface configuration commands	<i>Cisco IOS XR Interface and Hardware Component Command Reference for the Cisco XR 12000 Series Router</i>
Initial system bootup and configuration information for a router using the Cisco IOS XR software	<i>Cisco IOS XR Getting Started Guide for the Cisco XR 12000 Series Router</i>
Information about user groups and task IDs	<i>Configuring AAA Services on Cisco IOS XR Software module of Cisco IOS XR System Security Configuration Guide</i>

Standards

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

MIBs

MIBs	MIBs Link
There are no applicable MIBs for this module.	To locate and download MIBs for selected platforms using Cisco IOS XR software, use the Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
RFC 5086, RFC 4553, RFC 4197, RFC 5287	<ul style="list-style-type: none"> • <i>Structure-Aware Time Division Multiplexed (TDM) Circuit Emulation Service over Packet Switched Network (CESoPSN)</i> • <i>Structure-Agnostic Time Division Multiplexing (TDM) over Packet (SAtOP)</i> • <i>Requirements for Edge-to-Edge Emulation of Time Division Multiplexed (TDM) Circuits over Packet Switching Networks</i> • <i>Control Protocol Extensions for the Setup of Time-Division Multiplexing (TDM) Pseudowires in MPLS Networks</i>

Technical Assistance

Description	Link
The Cisco Technical Support website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/support

