Configuring Circuit Emulation over Packet on the Cisco ASR 9000 Series Router

This module describes the configuration of Circuit Emulation over Packet (CEoP) shared port adapters (SPAs) on the Cisco ASR 9000 Series Aggregation Services Routers.

Feature History for Configuring CEoP on Cisco ASR 9000 Series Router

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 4.2.0</td>
<td>• Support for Circuit Emulation Service over Packet Switched Network was added in the following SPA:</td>
</tr>
<tr>
<td></td>
<td>• Cisco 1-port Channelized OC3/STM-1 SPA</td>
</tr>
<tr>
<td></td>
<td>(SPA-1CHOC3-CE-ATM)</td>
</tr>
</tbody>
</table>

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- Overview of Circuit Emulation over Packet Service, page 364
- Information About Configuring CEoP Channelized SONET/SDH, page 365
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- How to implement CEM, page 371
- Configuring Clocking, page 389
- Configuration Examples for CEM, page 392
- Additional References, page 395

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 this SPA installed in your chassis:
  - Cisco 1-port Channelized OC3/STM-1 Circuit Emulation and ATM SPA
- You should know how to apply and specify the SONET controller name and \textit{interface-path-id} with the generalized notation \textit{rack/slot/module/port}. The SONET controller name and \textit{interface-path-id} are required with the \texttt{controller sonet} 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.

\textbf{Note}

The Cisco IOS XR Release 4.2.x 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.

The Cisco IOS XR Release 4.2.x supports CEM functionality only on this SPA:

1-port Channelized OC3 SPA [SPA-1xOC3-CE-ATM]

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.
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 365
- Default Configuration Values for Channelized SONET/SDH, page 369

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.

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.

The T3/E3 channels can be channelized into T1s, and the T1s can be channelized further into DS0 time slots.

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.

- 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 Point to Point Layer 2 Services module in the Cisco ASR 9000 Series Aggregation Services Router L2VPN and Ethernet Services Configuration Guide.
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.

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 28 shows the VTG paths that can be configured.

Only VTG paths are supported on the Cisco 1-Port Channelized OC-3/STM-1 SPA on the Cisco ASR 9000 Series Router.

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 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 4 shows the commonly used notations and terms in SONET standards and their SDH equivalents.

### Table 4 SONET and SDH Terminology Equivalencies

<table>
<thead>
<tr>
<th>SONET Term</th>
<th>SDH Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>SONET</td>
<td>SDH</td>
</tr>
<tr>
<td>STS-3c</td>
<td>AU-4</td>
</tr>
<tr>
<td>STS-1</td>
<td>AU-3</td>
</tr>
<tr>
<td>VT</td>
<td>TU</td>
</tr>
<tr>
<td>SPE</td>
<td>VC</td>
</tr>
<tr>
<td>Section</td>
<td>Regenerator Section</td>
</tr>
<tr>
<td>Line</td>
<td>Multiplex Section</td>
</tr>
<tr>
<td>Path</td>
<td>Path</td>
</tr>
</tbody>
</table>

The following levels of SDH channelization are supported on the CEoP SPA in Cisco IOS XR Release 4.2.0:

- 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 29 shows an example of SDH AU-3 paths that can be configured on the CEoP SPA.
Figure 30 shows the SDH AU4 paths that can be configured on the CEoP SPA.

**Figure 30  SDH AU4 Paths**

![Diagram of SDH AU4 Paths]

**Default Configuration Values for Channelized SONET/SDH**

Table 5 describes the default configuration parameters that are present on the Channelized SONET/SDH.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Default Value</th>
<th>Configuration File Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clock source</td>
<td>line</td>
<td>clock source {internal</td>
</tr>
<tr>
<td>SONET framing</td>
<td>sonet</td>
<td>hw-module sub-slot node-id cardtype {sonet</td>
</tr>
</tbody>
</table>

Table 5  SONET/SDH Controller Default Configuration Values
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 active clock 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 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 31. 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 31 Adaptive Clock Recovery**

- **Differential clocking** — Differential clocking is used when the cell site and aggregation routers have a common clock source but TDM lines are clocked by a different source. The TDM clocks are derived from differential information in the RTP header of the packet with respect to the common clock. Differential clock recovery is based on time stamps received in RTP header. On the master side, the difference of TDM clock and network clock is recorded into RTP header. On the slave side, these timestamps are read from RTP header, the clock recovery is done and this clock is used for
synchronization. See Figure 32.

**Note**

The Cisco 1-port Channelized OC3/STM-1 CEoP SPA hardware can recover only a maximum of ten unique clocks in as many CEM interfaces. The CEM interfaces where clock recovery is configured must be on unique T1s.

**Figure 32**  Differential Clock Recovery

For information on CEM configuration and commands, see *Implementing Point to Point Layer 2 Services module* in the Cisco ASR 9000 Series Aggregation Services Router L2VPN and Ethernet Services Configuration Guide and Cisco ASR 9000 Series Aggregation Services Router L2VPN and Ethernet Services Command Reference.

For a sample CEM interface configuration, refer Circuit Emulation Interface Configuration: Examples, page 392.

**How to implement CEM**

This section contains the following procedures:

- Configuring SONET VT1.5-Mapped T1 Channels and Creating CEM Interface, page 372
- Configuring SDH AU-3 Mapped to C11-T1 or C12-E1, page 375
- Configuring CEM Interface, page 381
- Configuring Clocking, page 389
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 sublot node-id cardtype type
3. commit
4. controller sonet interface-path-id
5. sts number
6. mode mode
7. root
8. controller t1 interface-path-id
9. cem-group unframed
10. controller t1 interface-path-id
11. cem-group framed group-number timeslots range1-range2
12. no shutdown
13. end
   or
   commit
14. show runn interface cem interface-path-id
# Configuring Circuit Emulation over Packet on the Cisco ASR 9000 Series Router

## How to implement CEM

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><code>configure</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router# <code>configure</code></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>`hw-module subslot node-id cardtype {sonet</td>
<td>sdh}`</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-sonet)# <code>hw-module subslot 0/3/0 sonet</code></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><code>commit</code></td>
<td>Use the <code>commit</code> command to save the configuration changes to the running configuration file and remain within the configuration session.</td>
</tr>
<tr>
<td>4</td>
<td><code>controller sonet interface-path-id</code></td>
<td>Enters controller configuration submode and specifies the SONET controller name and instance identifier with the <code>rack/slot/module/port/controllerName</code> notation.</td>
</tr>
<tr>
<td>5</td>
<td><code>sts number</code></td>
<td>Configures the STS stream specified by <code>number</code>. The range is from 1 to 3.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-sonet)# <code>sts 1</code></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td><code>mode mode</code></td>
<td>Sets the mode of interface at the STS level. The possible modes are:</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-stsPath)# <code>mode t1</code></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td><code>root</code></td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-stsPath)# <code>root</code></td>
<td></td>
</tr>
</tbody>
</table>
### How to implement CEM

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td><code>controller t1 interface-path-id</code></td>
<td>Enters T1 controller configuration submode and specifies the T1 controller name and <code>interface-path-id</code> with the rack/slot/module/port/sts-num/vtg-num/T1-num notation.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config)# controller t1 0/0/1/0/1/4/1</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td><code>cem-group unframed</code></td>
<td>Creates an structure agnostic CEM interface.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config)# cem-group unframed</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td><code>controller t1 interface-path-id</code></td>
<td>Enters T1 controller configuration submode and specifies the T1 controller name and <code>interface-path-id</code> with the rack/slot/module/port/sts-num/vtg-num/T1-num notation.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config)# controller t1 0/0/1/0/1/5/1</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td><code>cem-group framed group-number timeslots</code></td>
<td>Creates an structure aware CEM interface. The <code>timeslots</code> keyword specifies the time slots for the interface by range with the <code>range1-range2</code> notation.</td>
</tr>
<tr>
<td></td>
<td><code>range1-range2</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config)# cem-group framed 0 timeslots 1</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td><code>no shutdown</code></td>
<td>Removes the shutdown configuration.</td>
</tr>
<tr>
<td></td>
<td><strong>Note</strong></td>
<td>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).</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-if)# no shutdown</td>
<td></td>
</tr>
</tbody>
</table>
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 375
- Configuring SDH AU-3 Mapped to C12-E1 and Creating CEM Interface, page 378

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

**Command or Action**  **Purpose**

<table>
<thead>
<tr>
<th>Step 13</th>
<th>end or commit</th>
</tr>
</thead>
</table>

**Example:**

```
RP/0/RSP0/CPU0:router(config-sonet)# end or commit
```

This saves configuration changes.

- When you issue the `end` command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:
```

  - 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.

<table>
<thead>
<tr>
<th>Step 14</th>
<th>show runn interface cem interface-path-id</th>
</tr>
</thead>
</table>

**Example:**

```
RP/0/RSP0/CPU0:router# show runn interface cem 0/0/2/0/1/1/1/1:1
```

Verifies the CEM interface configuration.
### SUMMARY STEPS

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

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router# configure</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> hw-module sub-slot node-id cardtype type</td>
<td>Configures the controller for Synchronous Digital Hierarchy (SDH) framing. The <code>hw-module subslot node-id cardtype type</code> 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.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-sonet)# hw-module sub-slot &lt;&gt; cardtype sdh</td>
<td>This configuration is mandatory for CEoP SPA to work normally in one of the framing modes. SONET framing (sonet) is the default.</td>
</tr>
<tr>
<td><strong>Step 3</strong> commit</td>
<td>Use the <code>commit</code> command to save the configuration changes to the running configuration file and remain within the configuration session.</td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Step 4</th>
<th>controller sonet interface-path-id</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>Enters controller configuration submode and specifies the SDH controller name and instance identifier with the <code>rack/slot/module/port/controllerName</code> notation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 5</th>
<th>au number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-sonet)# au 1</td>
</tr>
<tr>
<td>Purpose</td>
<td>Specifies the administrative unit (AU) group and enters AU path configuration mode. For AU-3, the valid range is:</td>
</tr>
<tr>
<td>Note</td>
<td>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.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 6</th>
<th>mode mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-auPath)# mode c11-t1</td>
</tr>
<tr>
<td>Purpose</td>
<td>Sets the mode of interface at the AU level. AU-3 paths can be mapped to c11-t1 on supported SPAs.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 7</th>
<th>root</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-auPath)# root</td>
</tr>
<tr>
<td>Purpose</td>
<td>Exits to global configuration mode.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 8</th>
<th>controller t1 interface-path-id</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config)# controller T1 0/0/2/0/1/1/4</td>
</tr>
<tr>
<td>Purpose</td>
<td>Enters T1 controller configuration submode and specifies the T1 controller name and <code>interface-path-id</code> with the <code>rack/slot/module/port/auNum/t1Num</code> notation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 9</th>
<th>cem-group unframed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config)# cem-group unframed</td>
</tr>
<tr>
<td>Purpose</td>
<td>Creates an structure agnostic CEM interface.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 10</th>
<th>controller t1 interface-path-id</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config)# controller T1 0/0/2/0/1/1/7</td>
</tr>
<tr>
<td>Purpose</td>
<td>Enters T1 controller configuration submode and specifies the T1 controller name and <code>interface-path-id</code> with the <code>rack/slot/module/port/auNum/t1Num</code> notation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 11</th>
<th>cem-group framed group-number timeslots range1-range2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config)# cem-group framed 1 timeslots 2-3</td>
</tr>
<tr>
<td>Purpose</td>
<td>Creates an structure aware CEM interface. The <code>timeslots</code> keyword specifies the time slots for the interface by range with the <code>range1-range2</code> notation.</td>
</tr>
</tbody>
</table>
Configuring Circuit Emulation over Packet on the Cisco ASR 9000 Series Router

How to implement CEM

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

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

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router# configure</td>
</tr>
<tr>
<td>Step 2 hw-module sub-slot node-id cardtype type</td>
<td>Configures the controller framing for Synchronous Digital Hierarchy (SDH) framing. The <code>hw-module subslot node-id cardtype type</code> 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.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-sonet)# hw-module sub-slot &lt;&gt; cardtype sdh</td>
</tr>
<tr>
<td>Step 3 commit</td>
<td>Use the <code>commit</code> command to save the configuration changes to the running configuration file and remain within the configuration session.</td>
</tr>
<tr>
<td>Step 4 controller sonet interface-path-id</td>
<td>Enters controller configuration submode and specifies the SDH controller name and instance identifier with the <code>rack/slot/module/port/controllerName</code> notation.</td>
</tr>
</tbody>
</table>
## Configuring Circuit Emulation over Packet on the Cisco ASR 9000 Series Router

### Command or Action

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| 5    | `au number`       | Specifies the administrative unit (AU) group and enters AU path configuration mode. For AU-3, the valid range is:  
  - 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. |
| 6    | `mode tug3`       | Sets the mode of interface at the AU level. Currently only TUG3 is supported. |
| 7    | `width number`    | Configures the number of the AU streams. |
| 8    | `tug3 number`     | Specifies the Tributary Unit Group (TUG) `number` and enters the config-tug3Path mode. The range is 1 to 3. |
| 9    | `mode mode`       | Sets the mode of interface at the tug3 level. The modes are:  
  - **c12-e1**—TUG-3 path carrying TU-12 to E1  
**Example:**  
RP/0/RSP0/CPU0:router(config-auPath)# mode tug3  
Step 10 root  
**Example:**  
RP/0/RSP0/CPU0:router(config-auPath)# root  
**Step 11 controller e1 interface-path-id**  
**Example:**  
RP/0/RSP0/CPU0:router(config)# controller E1 0/0/0/0/1/1/1  
**Step 12 cem-group unframed**  
**Example:**  
RP/0/RSP0/CPU0:router(config)# cem-group unframed  
**Example:**  
RP/0/RSP0/CPU0:router(config-sonet)# au 1

**Example:**  
RP/0/RSP0/CPU0:router(config-auPath)# mode tug3  
Step 7 width number  
**Example:**  
RP/0/RSP0/CPU0:router(config-auPath)# width 3  
Step 8 tug3 number  
**Example:**  
RP/0/RSP0/CPU0:router(config-auPath)# tug3 1  
Step 9 mode mode  
**Example:**  
RP/0/RSP0/CPU0:router(config-tug3Path)# mode c12-e1  
Step 10 root  
**Example:**  
RP/0/RSP0/CPU0:router(config-auPath)# root  
**Step 11 controller e1 interface-path-id**  
**Example:**  
RP/0/RSP0/CPU0:router(config)# controller E1 0/0/0/0/1/1/1  
**Step 12 cem-group unframed**  
**Example:**  
RP/0/RSP0/CPU0:router(config)# cem-group unframed  
**Example:**  
RP/0/RSP0/CPU0:router(config-sonet)# au 1

**Command or Action**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| 5    | `au number`       | Specifies the administrative unit (AU) group and enters AU path configuration mode. For AU-3, the valid range is:  
  - 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. |
| 6    | `mode tug3`       | Sets the mode of interface at the AU level. Currently only TUG3 is supported. |
| 7    | `width number`    | Configures the number of the AU streams. |
| 8    | `tug3 number`     | Specifies the Tributary Unit Group (TUG) `number` and enters the config-tug3Path mode. The range is 1 to 3. |
| 9    | `mode mode`       | Sets the mode of interface at the tug3 level. The modes are:  
  - **c12-e1**—TUG-3 path carrying TU-12 to E1  
**Example:**  
RP/0/RSP0/CPU0:router(config-auPath)# mode tug3  
Step 7 width number  
**Example:**  
RP/0/RSP0/CPU0:router(config-auPath)# width 3  
Step 8 tug3 number  
**Example:**  
RP/0/RSP0/CPU0:router(config-auPath)# tug3 1  
Step 9 mode mode  
**Example:**  
RP/0/RSP0/CPU0:router(config-tug3Path)# mode c12-e1  
Step 10 root  
**Example:**  
RP/0/RSP0/CPU0:router(config-auPath)# root  
**Step 11 controller e1 interface-path-id**  
**Example:**  
RP/0/RSP0/CPU0:router(config)# controller E1 0/0/0/0/1/1/1  
**Step 12 cem-group unframed**  
**Example:**  
RP/0/RSP0/CPU0:router(config)# cem-group unframed  
**Example:**  
RP/0/RSP0/CPU0:router(config-sonet)# au 1

**Command or Action**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| 5    | `au number`       | Specifies the administrative unit (AU) group and enters AU path configuration mode. For AU-3, the valid range is:  
  - 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. |
| 6    | `mode tug3`       | Sets the mode of interface at the AU level. Currently only TUG3 is supported. |
| 7    | `width number`    | Configures the number of the AU streams. |
| 8    | `tug3 number`     | Specifies the Tributary Unit Group (TUG) `number` and enters the config-tug3Path mode. The range is 1 to 3. |
| 9    | `mode mode`       | Sets the mode of interface at the tug3 level. The modes are:  
  - **c12-e1**—TUG-3 path carrying TU-12 to E1  
**Example:**  
RP/0/RSP0/CPU0:router(config-auPath)# mode tug3  
Step 7 width number  
**Example:**  
RP/0/RSP0/CPU0:router(config-auPath)# width 3  
Step 8 tug3 number  
**Example:**  
RP/0/RSP0/CPU0:router(config-auPath)# tug3 1  
Step 9 mode mode  
**Example:**  
RP/0/RSP0/CPU0:router(config-tug3Path)# mode c12-e1  
Step 10 root  
**Example:**  
RP/0/RSP0/CPU0:router(config-auPath)# root  
**Step 11 controller e1 interface-path-id**  
**Example:**  
RP/0/RSP0/CPU0:router(config)# controller E1 0/0/0/0/1/1/1  
**Step 12 cem-group unframed**  
**Example:**  
RP/0/RSP0/CPU0:router(config)# cem-group unframed  
**Example:**  
RP/0/RSP0/CPU0:router(config-sonet)# au 1
Configuring Circuit Emulation over Packet on the Cisco ASR 9000 Series Router

How to implement CEM

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

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 13</strong></td>
<td><strong>controller e1 interface-path-id</strong></td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config)# controller E1 0/0/2/0/1/1/7</td>
</tr>
<tr>
<td><strong>Step 14</strong></td>
<td><strong>cem-group framed group-number timeslots range1-range2</strong></td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config)# cem-group framed 0 timeslots 1</td>
</tr>
<tr>
<td><strong>Step 15</strong></td>
<td><strong>no shutdown</strong></td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-if)# no shutdown</td>
</tr>
<tr>
<td><strong>Step 16</strong></td>
<td><strong>end</strong> or <strong>commit</strong></td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-sonet)# end or RP/0/RSP0/CPU0:router(config-sonet)# commit</td>
</tr>
</tbody>
</table>

### Configuring CEM Interface

Enters E1 controller configuration submode and specifies the E1 controller name and interface-path-id with the rack/slot/module/port/auNum/tugNum/t1Num notation.

Creates a structure aware CEM interface.

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).

Saves configuration changes.

- When you issue the *end* command, the system prompts you to commit changes:
  
  Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:

  - 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.
How to implement CEM

- Configuring a Global CEM Class
- Attaching a CEM Class
- Configuring Payload Size
- Setting the Dejitter 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

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router# configure</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> cem class class-name</td>
<td>Creates a new CEM class.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config)# cem class Default</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> payload value</td>
<td>Enter the payload size for the CEM class.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-cem-class)# payload 512</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> dejitter value</td>
<td>Enter the dejitter buffer size for the CEM class.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-cem-class)# dejitter 10</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> idle pattern value</td>
<td>Enter the idle pattern value for the CEM class.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-cem-class)# idle pattern 0x55</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> dummy mode</td>
<td>Enter the dummy mode for the CEM class. The options are last-frame or user-defined.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-cem-class)# dummy mode last-frame</td>
<td></td>
</tr>
</tbody>
</table>
How to implement CEM

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 {t1e1} rack/slot/subslot/port
3. cem class-attach class-name
4. end
   or
   commit

Step 7

dummy pattern value

Example:
RP/0/RSP0/CPU0:router(config-cem-class)#
dummy pattern

Step 8

dummy pattern value

Example:
RP/0/RSP0/CPU0:router(config-cem-class)#
dummy pattern

SUMMARY STEPS

1. configure
2. interface cem interface-path-id (or) controller {t1e1} rack/slot/subslot/port
3. cem class-attach class-name
4. end
   or
   commit

Enter the dummy pattern value for the CEM class. This value is applied only when the dummy mode is user-defined.

Saves configuration changes.

- When you issue the end command, the system prompts you to commit changes:
  Uncommitted changes found, commit them before exiting(yes/no/cancel)?
  [cancel]:
  - 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.
**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1**
| `configure`       | Enters global configuration mode. |
| Example:
| `RP/0/RSP0/CPU0:router# configure` |
| **Step 2**
| `interface cem interface-path-id`
| `(or)`
| `controller (t1|e1) interface-path-id` | Specifies the CEM interface or the T1/E1 controller. |
| Example:
| `RP/0/RSP0/CPU0:router(config)# controller t1 0/0/2/0/1/1` |
| **Step 3**
| `cem class-attach class-name` | Attaches the CEM class to an interface or controller. |
| Example:
| `RP/0/RSP0/CPU0:router(config)# cem class-attach Default` |
| **Step 4**
| `end`
| `commit` | Saves configuration changes. |
| Example:
| `RP/0/RSP0/CPU0:router(config-cem-class)# end`
| `or`
| `RP/0/RSP0/CPU0:router(config-cem-class)# commit` |

- When you issue the `end` command, the system prompts you to commit changes:
  - Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:
    - 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 payload size of 64 bytes)
- For \( 2 \leq N \leq 4 \), D is 4 milliseconds (with the corresponding packet payload size of 32*N bytes)
- For \( N \geq 5 \), D is 1 millisecond (with the corresponding packet payload size 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 6, Table 7, and Table 8 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 6 shows the relationship between payload and dejitter for T1/E1 SAToP lines.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>960</td>
<td>320</td>
<td>10</td>
<td>192</td>
<td>64</td>
<td>2</td>
</tr>
<tr>
<td>E1</td>
<td>1280</td>
<td>320</td>
<td>10</td>
<td>256</td>
<td>64</td>
<td>2</td>
</tr>
</tbody>
</table>

The Table 7 shows the relationship between payload and dejitter for T3/E3 SAToP lines.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T3</td>
<td>1312</td>
<td>8</td>
<td>2</td>
<td>672</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>E3</td>
<td>1312</td>
<td>16</td>
<td>2</td>
<td>512</td>
<td>8</td>
<td>2</td>
</tr>
</tbody>
</table>
The Table 8 shows the relationship between payload and dejitter for DS0 lines.

<table>
<thead>
<tr>
<th>DS0</th>
<th>Maximum Payload</th>
<th>Maximum Jitter</th>
<th>Minimum Jitter</th>
<th>Minimum Payload</th>
<th>Maximum Jitter</th>
<th>Minimum Jitter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40</td>
<td>320</td>
<td>10</td>
<td>32</td>
<td>256</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>80</td>
<td>320</td>
<td>10</td>
<td>32</td>
<td>128</td>
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</table>
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 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 can be used as a clock source on the SPA itself.
- Number of clock sources allowed:
  - Refer the section Clock Distribution, page 370 for more information.
- The clock must be the same as used by the router as the network clock. Any pseudowire in this case can carry the clock.
- 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.

Differential Clocking

- The maximum number of differential clocks sourced from a 1-Port Channelized OC-3/STM1 CEoP SPA is 10.
- The 1-Port Channelized OC-3/STM1 CEoP SPA can recover up to 10 T1/E1 clocks.
- There are several bundles sent from the same port. The bundle that is used for carrying the clock of the port is the first created bundle of the port. Only pseudowires that include the first DS0 of a port can carry differential clock.
- You must have a Stratum-1 clock, a common clock going to both PE routers. If not, the recovery will not work as expected.

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. transmit-clock differential
4. **recover-clock** `clock-id {adaptive | differential}`

5. **controller** `{t1|e1|t3|e3} rack/slot/subslot/port`

6. **clock source recovered** `clock-id`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><strong>configure</strong></td>
</tr>
<tr>
<td>Example:</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><strong>interface cem</strong></td>
</tr>
<tr>
<td>Example:</td>
<td>Specifies the complete CEM interface instance.</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><strong>transmit-clock</strong> <code>{differential}</code></td>
</tr>
<tr>
<td>Example:</td>
<td>Configures the CEM port transmit clock source. This is typically configured at the node acting as Master to send the clock. This command is not required for Adaptive Clock Recovery.</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td><strong>recover-clock</strong> `clock-id {adaptive</td>
</tr>
<tr>
<td>Example:</td>
<td>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.</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td><strong>controller</strong> <code>name instance</code></td>
</tr>
<tr>
<td>Example:</td>
<td>Enters controller configuration submode and specifies the controller name and instance identifier with the <code>rack/slot/module/port/name/instance1/instance2</code> notation.</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td><strong>clock source recovered</strong> <code>clock-id</code></td>
</tr>
<tr>
<td>Example:</td>
<td>Specifies the recovered clock number. This applies the recovered clock from a CEM interface on a T1/E1 Controller.</td>
</tr>
</tbody>
</table>
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
Configuration Examples for CEM

This section contains the following examples:

- Circuit Emulation Interface Configuration: Examples, page 392
  - Channelized Sonet / SDH Configurations and CEM Interface Creation, page 392

- Clock Recovery : Example, page 394
  - Adaptive Clock Recovery Configuration;, page 394
  - Differential Clock Recovery Configuration;, page 394

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

```plaintext
hw-module subslot <loc> cardtype sonet
controller SONET 0/0/1/0
  st 1
    mode vt15-t1
  st 2
    mode vt15-t1
  st 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

```plaintext
hw-module subslot <loc> cardtype sdh
controller SONET0/0/2/0
  au 1
    mode c11-t1
  au 2
    mode c11-t1
```
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/CP0:CE0P-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/CP0:CE0P-01(config)#interface cem 0/0/2/0/1/1/1/1/1
RP/0/RSP0/CP0:CE0P-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

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

Differential Clock Recovery Configuration:

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

PE1 (Acts as source of clock)
-----------------------------
Router (config)#controller t1 0/0/2/0/1/1/4
Router (config-t1)#clock source line
Router(config)# interface cem 0/0/2/0/1/1/4:0
Router(config-if)#cem clock transmit differential

PE2 (To recover the differential clock):
-----------------------------
Router (config)#interface cem 0/0/2/0/1/1/4:0
Router (config-t1)#cem clock recover <clock-id> differential
To apply the recovered clock:

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

CE2

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

Additional References

The following sections provide references to related documents.

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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<tbody>
<tr>
<td>Cisco IOS XR master command reference</td>
<td>Cisco IOS XR Master Commands List</td>
</tr>
<tr>
<td>Cisco IOS XR interface configuration commands</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Interface and Hardware Component Command Reference</td>
</tr>
<tr>
<td>Initial system bootup and configuration information for a router using the Cisco IOS XR software</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide</td>
</tr>
<tr>
<td>Information about user groups and task IDs</td>
<td>Configuring AAA Services on Cisco IOS XR Software module of Cisco IOS XR System Security Configuration Guide</td>
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Standards

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<td>No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.</td>
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MIBs

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<tr>
<td>• CISCO-SONET-MIB</td>
<td>To locate and download MIBs for selected platforms using Cisco IOS XR software, use the Cisco MIB Locator found at the following URL: <a href="http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml">http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml</a></td>
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<td>• ENTITY-MIB</td>
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<tr>
<td>• SONET-MIB (RFC 3592)</td>
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The following additional MIBs are supported on the Cisco 1-Port Channelized OC-3/STM-1 SPA on the Cisco ASR 9000 Series Router:

<table>
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<th>MIBs</th>
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<tr>
<td>• CISCO-IF-EXTENSION-MIB</td>
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<td>• DS1-MIB</td>
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<td>• DS3-MIB</td>
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<td>• IF-MIB</td>
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RFCs

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<tr>
<td>RFC 5086, RFC 4553, RFC 4197, RFC 5287</td>
<td>• Structure-Aware Time Division Multiplexed (TDM) Circuit Emulation Service over Packet Switched Network (CESoPSN)</td>
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<td>• Structure-Agnostic Time Division Multiplexing (TDM) over Packet (SAToP)</td>
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<td>• Requirements for Edge-to-Edge Emulation of Time Division Multiplexed (TDM) Circuits over Packet Switching Networks</td>
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<td>• Control Protocol Extensions for the Setup of Time-Division Multiplexing (TDM) Pseudowires in MPLS Networks</td>
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Technical Assistance

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<td><a href="http://www.cisco.com/techsupport">http://www.cisco.com/techsupport</a></td>
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