1-Port OC-192 or 8-Port Low Rate CEM Interface Module Configuration Guide, Cisco IOS XE 16 (Cisco ASR 900 Series)

First Published: 2020-07-31

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CHAPTER 1

Feature History

The following table lists the new and modified features supported in the 1-Port OC-192 or 8-Port Low Rate CEM Interface Module Configuration Guide in Cisco IOS XE 16 releases.

Feature Name	Cisco IOS XE Release
Psuedowire Scale Support	16.12.1
8-Port SFP GE and 1-Port 10 GE 20G Interface Module Support	16.12.1a
Transparent Overhead Tunneling Data Communication Channel	16.9.1
Support of DS1 Framed Structure-Agnostic TDM over Packet (SAToP)	16.8.1
Loopback Remote on T1 and T3 Interfaces	16.8.1
Far-end Performance Monitoring Support	16.8.1
CESoPSN	16.7.1
5G Traffic on 1-Port OC192/STM-64 or 8-Port OC3/12/48/STM-1/-4/-16 Interface Module	16.5.1

CHAPTER 2

Configuring CEM

This module describes how to configure Circuit Emulation (CEM).

Overview of Circuit Emulation

Circuit Emulation (CEM) is a technology that provides a protocol-independent transport over IP/MPLS networks. It enables proprietary or legacy applications to be carried transparently to the destination, similar to a leased line.

CEM provides a bridge between a Time-Division Multiplexing (TDM) network and Multiprotocol Label Switching (MPLS) network. The chassis encapsulates the TDM data in the MPLS packets and sends the data over a CEM pseudowire to the remote Provider Edge (PE) chassis. As a result, CEM functions as a physical communication link across the packet network.

The chassis supports the pseudowire type that utilizes CEM transport: Structure-Agnostic TDM over Packet (SAToP).

L2VPN over IP/MPLS is also supported on the interface modules.

The RSP switchover with physical SSO is above 50 ms as follows:

- R0 to R1 is 5 seconds
- R1 to R0 is 10 seconds

Structure-Agnostic TDM over Packet

Structure-Agnostic TDM over Packet (SAToP) encapsulates Time Division Multiplexing (TDM) bit-streams as pseudowires over public switched networks. It disregards any structure that may be imposed on streams, in particular the structure imposed by the standard TDM framing.

The protocol used for emulation of these services does not depend on the method in which attachment circuits are delivered to the Provider Edge (PE) chassis. For example, a T1 attachment circuit is treated the same way for all delivery methods, including copper, multiplex in a T3 circuit, a virtual tributary of a SONET circuit, or unstructured Circuit Emulation Service (CES).

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

Overview of Framed Structure-Agnostic TDM over Packet (SAToP)

Framed Structure-Agnostic TDM over Packet (SAToP) is required to detect an incoming AIS alarm in the DS1 SAToP mode. An AIS alarm indicates a problem with the line that is upstream from the DS1 network element connected to the interface. Framed SAToP further helps in the detection of a packet drop.

In case of unframed mode of SAToP, data received from the Customer Edge (CE) device is transported ove the pseudowire. If the Provider Edge (PE) device receives a Loss of Frame (LOF) signal or Remote Alarm Indication (RAI) signal from a CE, the PE can only transmit the signal that is detected by the CE device. With the introduction of Framed SAToP, when the PE device receives the LOF or RAI signal, the PE device can detect the alarm for SAToP. Thus, the alarm can be detected earlier in the network. This helps in enhanced performance.

Note BERT is *not* supported in system direction for framed SAToP.

Note Framing type should be maintained same in all routers end to end.

Difference between Framed and Unframed SAToP:

1. For unframed SAToP, the incoming signal is transmitted to the far end. This signal is not analyzed by the PE device. Hence, no alarm is reported.
2. For framed SAToP, the incoming signal is analyzed but is not terminated. If a LOF or RAI signal is detected, the remote PE detects the signals and transmits towards the remote CE.

Difference between Framed SAToP and CESoP:

Table 1: Behaviour Difference between Unframed SAToP, Framed SAToP, and CESoP on LOF Alarm

Modes	Alarm Detected at PE	Controller Status at PE	Alarm Detected at CE (Remote)	Framing Bits Generationat PE (Remote)	Framing Bits Terminated at PE (Remote)
Unframed SAToP	None	Up	LOF	No	No
Framed SAToP	LOF	Down (Data path remains up)	LOF[1][2]	Yes	No
CESOP	LOF	Down (Data path remains up)	AIS	Yes	Yes

1 AIS—Support until Cisco IOS XE 16.9.3 Fuji release
2 LOF—Starting from Cisco IOS XE Fuji 16.9.4 or later releases

Table 2: Behaviour Difference between Unframed SAToP, Framed SAToP, and CESoP on RDI Alarm

Modes	Alarm Detected at PE	Controller Status at PE	Alarm Detected at CE (Remote)	Framing Bits Generation at PE (Remote)	Framing Bits Terminated at PE (Remote)
Unframed SAToP	None	Up	RDI	No	No
Framed SAToP	RDI	Down (data path remains up)	RDI	No	No
CESOP	RDI	Down (data path remains up)	RDI	M-bit is set into control word	Yes

Table 3: Behaviour Difference between Unframed SAToP, Framed SAToP, and CESoP on AIS alarm

Modes	Alarm Detected at PE	Controller Status at PE	Alarm Detected at CE (Remote)	Framing Bits Generation at PE (Remote)	Framing Bits Terminated at PE (Remote)
Unframed SAToP	AIS	Down (data path remains up)	AIS	No	No
Framed SAToP	AIS	Down (data path remains up)	AIS	No	No
CESOP	AIS	Down (data path remains up)	AIS	L-bit is set into control word	Yes

Remote Loopback from CE to PE Detection:

Framed SAToP does not detect any loopback.

	Loopback Detected at PE	Controller Status at PE (Remote)	Controller Status at CE (Remote)
Unframed SAToP	No	Not in Loopback	Loopback
Framed SAToP	No	Not in Loopback	Loopback
CESOP	Yes	Loopback	Not in loopback

CEM Pseudowire Scale

Effective from the Cisco IOS XE Gibraltar 16.12.1 release, Cisco router supports the following pseudowire scale numbers:

- 21504 CEM Pseudowire (PWs) without protection (with SONET)
- 10752 CEM PWs with protection

Currently the Cisco A900-IMA3G-IMSG supports a maximum of 1344 CEM PWs.

Currently the Cisco A900-IMA1Z8S-CX supports a maximum of **5376** CEM PWs.

The four Interface Modules can be used on the router to achieve the 21K CEM PWs.

This can be achieved by:

- Configuring CEM circuits on all the 192 STS on the 9th port of the Cisco A900-IMA3G-IMSG which supports OC-192.
- Configuring CEM circuits on all the 4 OC-48 ports of the Cisco A900-IMA3G-IMSG which supports OC-192.

Note The 21K CEM PW's can be achieved on the router by using the combination of the Cisco A900-IMA1Z8S-CX and Cisco A900-IMA3G-IMSG IMs with the Cisco A900-IMA48T-C, and Cisco A900-IMA48D-C in multiple slot combinations.

Restrictions for PW Scale Increase

- CEM PW scale is supported in **only** in the SONET mode.
- When configured for scale beyond 21504 CEM PW, a syslog is printed as: Cannot allocate CEM group, maximum CEM group exceeded, but the configurations will not be rejected. For example, when a 215xxth CEM PW is configured, the configuration fails although the CLI is not rejected with the mentioned syslog notification.
- While performing ISSU with 21504 CEM PW, sufficient interface-module-delay must be provided for each IM. This provision enables all PWs to program after the IM OIR. The minimum 'time for delay' in case of Cisco A900-IMA1Z8S-CX is 1800 seconds.
- To configure CEM circuits (for example, T1 or VT1.5 CEP pseudowire) at a large number (for example, 10,000), we recommend you to configure the CEM circuits in a batch of 2000 CEM circuits. Use the **show platform software tdm-combo cem ha-stray-entries** command to verify that there are no pending

circuits to be programmed before proceeding to the next batch of configuration. The **show platform software tdm-combo cem ha-stray-entries** command can be used only in the standby RSP3 console.

Configuring CEM for SAToP

This section provides information about how to configure CEM. CEM provides a bridge between a Time Division Multiplexing (TDM) network and a packet network, MPLS. The chassis encapsulates the TDM data in the MPLS packets and sends the data over a CEM pseudowire to the remote Provider Edge (PE) chassis.

The following sections describe how to configure CEM.

Configuring CEM Restriction

- Not all combinations of payload size and dejitter buffer size are supported. If you apply an incompatible payload size or dejitter buffer size configuration, the chassis rejects it and reverts to the previous configuration.
- The dummy-pattern command is *not* supported.

Note CEM interface does *not* support idle-cas parameter.

Configuring CEM Classes

A CEM class allows you to create a single configuration template for multiple CEM pseudowires. Follow these steps to configure a CEM class:

Note

- The CEM parameters can be configured either by using CEM class or on CEM interface directly.
- The CEM parameters at the local and remote ends of a CEM circuit must match; otherwise, the pseudowire between the local and remote PE chassis does not come up.

```
enable
configure terminal
class cem mycemclass
payload-size 512
dejitter-buffer 12
exit
interface cem 0/0/1
cem 0
cem class mycemclass
xconnect 10.10.10.10 200 encapsulation mpls
exit
```

Configuring CEM Parameters

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

Configuring Payload Size (Optional)

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

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

- E1 = 256 bytes
- T1 = 192 bytes

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

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

Setting the Dejitter Buffer Size

To specify the size of the dejitter-buffer used to compensate for the network filter, use the **dejitter-buffer** 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 32; the default is 5.

Shutting Down a CEM Channel

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

Configuring DS1 CT3 SAToP Mode

To configure DS1 CT3 SAToP mode, use the following commands:

```
enable
configure terminal
controller MediaType 0/4/11
mode sonet
controller sonet 0/5/0
rate oc12
sts-1 1
mode ct3
t1 1 cem-group 100 unframed
t1 1 framing unframed
interface cem 0/5/0
cem 100
xconnect 2.2.2.2 10 encapsulation mpls
end
```

Configuring VT DS1 SAToP Mode

To configure VT DS1 SAToP mode, use the following commands:

```
enable
configure terminal
controller MediaType 0/5/0
mode sonet
controller sonet 0/5/0
rate oc12
sts-1 1
mode vt-15
vtg 1 t1 1 framing unframed
vtg 1 t1 1 cem-group 0 unframed
end
```

Configuring STS-Nc CEP

To configure STS-Nc CEP, use the following commands:

```
enable
configure terminal
controller MediaType 0/5/0
mode sonet
controller sonet 0/5/0
rate oc12
sts-1 1 - 3 mode sts-3c
cem-group 100 cep
interface cem 0/5/0
cem 100
xconnect 2.2.2.2 10 encapsulation mpls
end
```

Configuring CEP

To configure CEP:

```
enable
configure terminal
controller MediaType 0/5/0
mode sonet
controller sonet 0/5/0
sts-1 1
mode unframed
cem-group 100 cep
end
```

Configuring VT-15 CEP

To configure VT-15 CEP, use the following commands:

```
enable
configure terminal
controller MediaType 0/5/0
mode sonet
controller sonet 0/5/0
rate oc12
sts-1 1
mode vt-15
vtg 1 vt 1 cem-group 100 cep
end
```

Configuring DS3 SAToP

To configure DS3 SAToP, the STS-1 needs to be configured in mode T3. Use the following commands:

```
enable
configure terminal
controller MediaType 0/5/0
mode sonet
controller sonet 0/5/0
rate oc12
sts-1 1
mode t3
cem-group 100 unframed
interface cem 0/5/0
cem 100
xconnect 2.2.2.2 10 encapsulation mpls
end
```

Configuring Bi-directional ACR (SONET Framing) for SAToP

To configure bi-directional ACR (SONET Framing), use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
clock source internal
aps group acr 1
aps working 1
exit
controller sonet 0/4/0
aps group acr 1
aps protect 1 10.7.7.7
end
```

Note To restore the system to its default condition, use the **no** form of the command.

Configuring Unidirectional APS for SAToP

Note When the **aps adm** command is not used, the LOS is detected on active port and the L-AIS is transmitted to the remote-end to force APS switchover. This is similar to bi-directional APS mode.

'When the **aps adm** command is used, the ports are in strict unidirectional mode. When the LOS is detected on active port, the L-AIS is suppressed and behaves in a strict uni-directional mode.

Ensure that the configuration is performed under the protected interface.

To configure unidirectional ACR (SONET Framing), use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
clock source internal
aps group acr 1
```

```
aps working 1
aps unidirectional
exit
controller sonet 0/4/0
aps group acr 1
aps protect 1 10.7.7.7
aps revert 3
aps adm
end
```

Note To restore the system to its default condition, use the **no** form of the command.

Configuring CEM APS

To configure CEM APS, use the following commands:

```
enable
configure terminal
controller MediaType 0/5/0
mode sonet
controller sonet 0/5/0
controller sonet-acr acr_no
sts-1 1
vtg 1 t1 1 cem-group 100 unframed
end
```

Verifying CEM Statistics for SAToP

Use the following commands to verify the pseudowire configuration for SAToP:

- **show cem circuit**—Displays information about the circuit state, administrative state, the CEM ID of the circuit, and the interface on which it is configured. If cross connect is configured under the circuit, the command output also includes information about the attachment circuit status.

```
Router# show cem circuit

  <0-32000>    CEM ID
  detail     Detailed information of cem ckt(s)
  interface  CEM Interface
  summary    Display summary of CEM ckts
  |          Output modifiers
Router# show cem circuit

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

- **show cem circuit** *cem-id* — Displays the detailed information about that particular circuit.

```
Router# show cem circuit 0
```

```
CEM0/1/2, ID: 0, Line: UP, Admin: UP, Ckt: ACTIVE
Controller state: up, T1 state: up
Idle Pattern: 0xFF, Idle CAS: 0x8
Dejitter: 5 (In use: 0)
Payload Size: 192
Framing: Unframed
CEM Defects Set
None

Signalling: No CAS
RTP: No RTP

Ingress Pkts:    11060                Dropped:             0
Egress Pkts:     11061                Dropped:             0

CEM Counter Details
Input Errors:    0                    Output Errors:       0
Pkts Missing:    0                    Pkts Reordered:      0
Misorder Drops:  0                    JitterBuf Underrun:  0
Error Sec:       0                    Severly Errored Sec: 0
Unavailable Sec: 0                    Failure Counts:      0
Pkts Malformed:  0                    JitterBuf Overrun:   0
```

- **show cem circuit summary** — Displays the number of circuits which are up or down per interface basis.

```
Router# show cem circuit summary

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

Configuring CEM Group for SAToP for T1 or DS1 Interfaces for Framed SAToP

To configure a CEM group for Framed SAToP:

```
enable
configure terminal
controller mediatype 0/5/0
mode sonet
controller sonet 0/5/0
rate oc12
sts-1 1
mode vt-15
vtg 1 t1 1 cem-group 0 framed
end
```

Configuring CEM (Uni-directional and Bi-directional) APS for Framed SAToP

Note When the **aps adm** command is not used, the LOS is detected on active port and the L-AIS is transmitted to the remote-end to force APS switchover. This is similar to bi-directional APS mode.

'When the **aps adm** command is used, the ports are in strict unidirectional mode. When the LOS is detected on active port, the L-AIS is suppressed and behaves in a strict uni-directional mode.

To configure unidirectional ACR (SONET Framing), use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
rate OC3
clock source internal
aps group acr 1
aps working 1
exit
controller sonet 0/4/0
rate OC3
aps group acr 1
aps unidirectional
aps protect 1 10.7.7.7
aps revert 3
aps adm
controller sonet-acr 1
sts-1 1
mode vt-15
vtg 1 t1 1 cem-group 0 framed
end
```

To configure bi-directional ACR (SONET Framing), use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
rate OC3
clock source internal
aps group acr 1
aps working 1
exit
controller sonet 0/4/0
rate OC3
aps group acr 1
aps protect 1 10.7.7.7
controller sonet-acr 1
sts-1 1
mode vt-15
vtg 1 t1 1 cem-group 0 framed
end
```

Associated Commands

The following commands are used to configure CEM:

Commands	URL
cem	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2184138077
cem group *cem-group-number* **unframed**	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2440628600
cem-group *cem-group-number* **cep**	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2440628600
class cem	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp7199841750
controller t1	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp1472647421
mode ct3	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html#wp5913349630
mode t3	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html#wp5688885940
mode vt-15	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html#wp1137973905
payload-size dejitter-buffer	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-o1.html#wp3946673156
rate	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-o1.html#wp4442889730
show cem circuit	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-s2.html#wp1086825073
sts-1	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-s6.html#wp2423232697

Commands	URL
t1 t1-line-number cem-group	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t1.html#wp2399838226
t1 t1-line-number framing	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t1.html#wp2623191253
t1 t1-line-number clock source	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t1.html#wp3480850667
vtg *vtg-number* **vt** *vt-line-number* **cem-group** *cem-group-number* **cep**	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t2.html#wp3494199143
xconnect	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t2.html#wp8578094790
show controllers t3	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-s3.html#wp1987423547

Additional References for Configuring CEM

Related Documents

Related Topic	Document Title
Cisco IOS commands	*Cisco IOS Master Commands List, All Releases*

Standards

Standards	Title
—	There are no standards for this feature.

MIBs

MIB	MIBs Link
—	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
—	There are no RFCs for this feature.

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

CHAPTER 3

CEM over MPLS QoS

The QoS EXP matching feature allows you to classify and mark network traffic by modifying the Multiprotocol Label Switching (MPLS) experimental bits (EXP) field in IP packets. This module contains conceptual information and the configuration tasks for classifying and marking network traffic using the MPLS EXP field.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About CEM over MPLS QOS

Classifying and Marking MPLS EXP Overview

The QoS EXP matching feature allows you to organize network traffic by setting values for the MPLS EXP field in MPLS packets. By choosing different values for the MPLS EXP field, you can mark packets so that packets have the priority that they require during periods of congestion. Setting the MPLS EXP value allows you to:

- Classify traffic

  The classification process selects the traffic to be marked. Classification accomplishes this by partitioning traffic into multiple priority levels, or classes of service. Traffic classification is the primary component of class-based QoS provisioning.

- Police and mark traffic

  Policing causes traffic that exceeds the configured rate to be discarded or marked to a different drop level. Marking traffic is a way to identify packet flows to differentiate them. Packet marking allows you to partition your network into multiple priority levels or classes of service.

Prerequisites for CEM over MPLS QoS

The device must be configured as an MPLS provider edge (PE) or provider (P) chassis, which can include the configuration of a valid label protocol and underlying IP routing protocols.

Restrictions for CEM over MPLS QoS

- MPLS classification and marking can only occur in an operational MPLS Network.
- MPLS EXP classification and marking is supported on the main chassis interfaces for MPLS packet switching and imposition (simple IP imposition and Ethernet over MPLS (EoMPLS) imposition) and on Ethernet virtual circuits (EVCs) or Ethernet flow points (EFPs) for EoMPLS imposition.
- MPLS EXP topmost classification is not supported for bridged MPLS packets on Ethernet virtual circuits (EVC) or Ethernet flow points (EFP).
- MPLS EXP marking in the ingress direction only.
- If a packet is classified by IP type of service (ToS) or class of service (CoS) at ingress, it cannot be reclassified by MPLS EXP at egress (imposition case). However, if a packet is classified by MPLS at ingress it can be reclassified by Quality of Service (QoS) group at egress (disposition case).
- If a packet is encapsulated in MPLS, the MPLS payload cannot be checked for other protocols such as IP for classification or marking. Only MPLS EXP marking affects packets encapsulated by MPLS.

How to Classify and Mark MPLS EXP

Classifying MPLS Encapsulated Packets

You can use the **match mpls experimental topmost** command to define traffic classes based on the packet EXP values, inside the MPLS domain. You can use these classes to define services policies to mark the EXP traffic using the **police** command.

```
enable
configure terminal
class-map [match-all | match-any] class-map-name
match mpls experimental topmost mpls-exp-value
end
```

Marking MPLS EXP on Imposed Labels

In typical configurations, marking MPLS packets at imposition is used with ingress classification on IP ToS or CoS fields. However, generic matching with the class default value is supported with other ingress attributes such as **vlan**.

Note For EVC configuration, a policy map that performs matching based on the CoS, and that sets the EXP imposition value, should be used to copy CoS values to the EXP value.

Note The **set mpls experimental imposition** command works only on packets that have new or additional MPLS labels added to them.

```
enable
configure terminal
policy-map policy-map-name
class class-map-name
set mpls experimental imposition mpls-exp-value
end
```

Classifying and Marking MPLS EXP

Note The **set mpls experimental topmost** command works only on packets that are already MPLS encapsulated.

```
enable
configure terminal
policy-map policy-map-name
class class-map-name
set mpls experimental topmost mpls-exp-value
end
```

Configuration Examples

Example: Defining an MPLS EXP Class Map

Example: Defining an MPLS EXP Class Map

The following example defines a class map named exp3 that matches packets that contains MPLS experimental value 3:

```
Router(config)# class-map exp3
Router(config-cmap)# match mpls experimental topmost 3
Router(config-cmap)# exit
```

Example: Defining a Policy Map and Applying the Policy Map to an Ingress Interface

Example: Defining a Policy Map and Applying the Policy Map to an Ingress Interface

The following example uses the class map created in the example above to define a policy map. This example also applies the policy map to a physical interface for ingress traffic.

```
Router(config)# policy-map change-exp-3-to-2
Router(config-pmap)# class exp3
Router(config-pmap-c)# set mpls experimental topmost 2
Router(config-pmap)# exit
Router(config)# interface GigabitEthernet 0/0/0
Router(config-if)# service-policy input change-exp-3-to-2
Router(config-if)# exit
```

Example: Defining a Policy Map and Applying the Policy Map to an Egress Interface

Example: Defining a Policy Map and Applying the Policy Map to an Egress Interface

The following example uses the class map created in the example above to define a policy map. This example also applies the policy map to a physical interface for egress traffic.

```
Router(config)# policy-map WAN-out
Router(config-pmap)# class exp3
Router(config-pmap-c)# shape average 10000000
Router(config-pmap-c)# exit
Router(config-pmap)# exit
Router(config)# interface GigabitEthernet 0/0/0
Router(config-if)# service-policy output WAN-out
Router(config-if)# exit
```

Example: Applying the MPLS EXP Imposition Policy Map to a Main Interface

Example: Applying the MPLS EXP Imposition Policy Map to a Main Interface

The following example applies a policy map to Gigabit Ethernet interface 0/0/0:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# interface GigabitEthernet 0/0/0
Router(config-if)# service-policy input mark-up-exp-2
Router(config-if)# exit
```

Example: Applying the MPLS EXP Imposition Policy Map to an EVC

Example: Applying the MPLS EXP Imposition Policy Map to an EVC

The following example applies a policy map to the Ethernet Virtual Connection specified by the **service instance** command:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# interface GigabitEthernet 0/0/0
Router(config-inf)# service instance 100 ethernet
Router(config-if-srv)# xconnect 100.0.0.1 encapsulation mpls 100
Router(config-if-srv)# service-policy input mark-up-exp-2
Router(config-if-srv)# exit
Router(config-if)# exit
```

Example: Defining an MPLS EXP Label Switched Packets Policy Map

Example: Defining an MPLS EXP Label Switched Packets Policy Map

The following example defines a policy map that sets the MPLS EXP topmost value to 2 according to the MPLS EXP value of the forwarded packet:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# class-map exp012
Router(config-cmap)# match mpls experimental topmost 0 1 2
Router(config-cmap)# exit
Router(config-cmap)# policy-map mark-up-exp-2
Router(config-pmap)# class exp012
Router(config-pmap-c)# set mpls experimental topmost 2
Router(config-pmap-c)# exit
Router(config-pmap)# exit
```

Example: Applying the MPLS EXP Label Switched Packets Policy Map to a Main Interface

Example: Applying the MPLS EXP Label Switched Packets Policy Map to a Main Interface

The following example shows how to apply the policy map to a main interface:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# interface GigabitEthernet 0/0/0
Router(config-if)# service-policy input mark-up-exp-2
Router(config-if)# exit
```

Additional References for CEM over MPLS QoS

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases

Standards

Standards	Title
—	There are no standards for this feature.

MIBs

MIB	MIBs Link
—	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
—	There are no RFCs for this feature.

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

CHAPTER 4

Configuring SONET

This module describes how to configure Synchronous Optical NETwork (SONET). SONET defines optical signals and a synchronous frame structure for multiplexed digital traffic. SONET equipment is generally used in North America.

The transport network using SONET provides much more powerful networking capabilities than existing asynchronous systems.

Overview of SONET

SONET is a set of standards that define the rates and formats for optical networks specified in GR–253–CORE. SONET is based on a structure that has a basic frame format and speed. The frame format used by SONET is the Synchronous Transport Signal (STS), with STS-1 as the base-level signal at 51.84 Mbps. An STS-1 frame can be carried in an OC-1 signal.

SONET has a hierarchy of signaling speeds.

Restrictions for SONET

- Rate combinations are 0-1, 2-3, 4-5, 6-7 and 8. A maximum rate of 4XOC-48 is supported on ports 0-7.

  4XOC-48 can be configured in any one port of a port-group and other port is not used.

- Only 16 BERT Patterns can be configured at a time on 1-Port OC192/STM-64 or 8-Port OC3/12/48/STM-1/-4/-16 Module.
- VT1.5 VT cannot be configured if VT1.5 T1/DS1 is configured with the same KLM value.
- PMON fields are not supported for VT1.5 VT and DS3 or T3.
- PMON Far-end parameters are not supported.

Restrictions on Bandwidth

- Total available bandwidth for 1-Port OC192/STM-64 or 8-Port OC3/12/48/STM-1/-4/-16 Module is 10G.

  The following configuration is blocked and an error message is displayed after the maximum bandwidth is utilized:

  ```
  rate OC3| OC12| OC48| OC192
  ```

  The bandwidth of adjacent ports should not exceed OC-48.

  The following table shows the bandwidth used by different rates:

  Table 4: Bandwidth Used by Different Rates

Rate	Bandwidth
OC-3	155.52 Mbps
OC-12	622.08 Mbps
OC-48	2.4 Gbps
OC-192	9.6 Gbps

Restrictions for Clock Source Configuration

- Only 4 ports can be configured in SONET line for clock source configuration per chassis.

- You should configure the clock source line and network-clock sync together to receive the clock from a remote port that is connected to the SONET port.

SONET Switching

SONET Switching is achieved on optical interface modules by circuit emulation. Circuit Emulation (CEM) is a way to carry TDM circuits over packet switched network. CEM embeds TDM bits into packets, encapsulates them into an appropriate header and then sends that through Packet Switched Network (PSN). The receiver side of CEM restores the TDM bit stream from packets.

Modes of CEM:

- **Structure Agnostic TDM over Packet (SAToP)** (RFC 4553) – Structure-Agnostic TDM over Packet (SAToP) mode is used to encapsulate T1/E1 or T3/E3 unstructured (unchannelized) services over packet switched networks. In SAToP mode, the bytes are sent out as they arrive on the TDM line. Bytes do not have to be aligned with any framing.

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

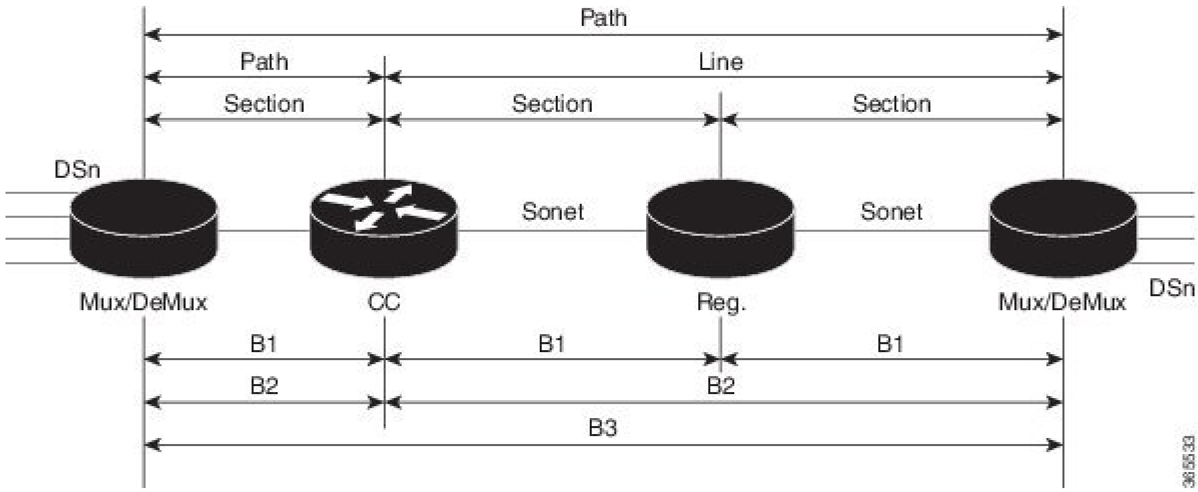
- **Circuit Emulation Service over Packet (CEP)** (RFC 4842) - CEP mode is used to encapsulate SONET payload envelopes (SPEs) like VT1.5 or VT2 or STS-1 or STS-Nc over packet switched networks. In this mode, the bytes from the corresponding SPE are sent out as they arrive on the TDM line. The interface is considered as a continuous framed bit stream. The packetization of the stream is done according to IETF RFC 4842.

Table 5: Modes of CEM

Mode	CEM	Ports
STS-48C	CEP	OC-48, OC-192
STS-12C	CEP	OC-12, OC-48, OC-192
STS-3C	CEP	OC-3, OC-12, OC-48, OC-192
STS-1	CEP	OC-3, OC-12, OC-48, OC-192
DS3	SAToP	OC-3, OC-12, OC-48, OC-192
DS3-T1	SAToP	OC-3, OC-12, OC-48, OC-192
VT 1.5	CEP	OC-3, OC-12, OC-48, OC-192
VT 1.5	CESoPSN	OC-3, OC-12, OC-48, OC-192
CT3-T1	CESoPSN	OC-3, OC-12, OC-48, OC-192

SONET Hierarchy

Figure 1: A SONET Link



Each level of the SONET hierarchy terminates its corresponding fields in the SONET payload, as follows:

Section

A section is a single fiber run that can be terminated by a network element (Line or Path) or an optical regenerator.

The main function of the section layer is to properly format the SONET frames, and to convert the electrical signals to optical signals. Section Terminating Equipment (STE) can originate, access, modify, or terminate the section header overhead.

Line

Line-Terminating Equipment (LTE) originates or terminates one or more sections of a line signal. The LTE does the synchronization and multiplexing of information on SONET frames. Multiple lower-level SONET signals can be mixed together to form higher-level SONET signals. An Add/Drop Multiplexer (ADM) is an example of LTE.

Path

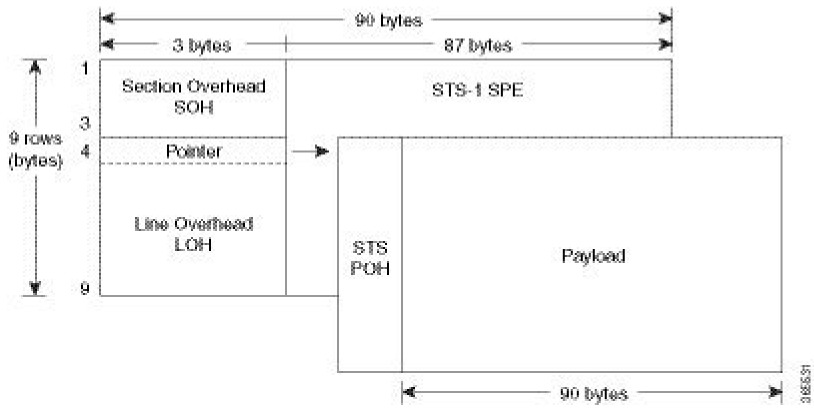
Path-Terminating Equipment (PTE) interfaces non-SONET equipment to the SONET network. At this layer, the payload is mapped and demapped into the SONET frame. For example, an STS PTE can assemble 25 1.544 Mbps DS1 signals and insert path overhead to form an STS-1 signal.

This layer is concerned with end-to-end transport of data.

STS-1 and STS-3 Frames

A standard STS-1 frame is nine rows by 90 bytes. The first three bytes of each row represent the Section and Line overhead. These overhead bits comprise framing bits and pointers to different parts of the SONET frame.

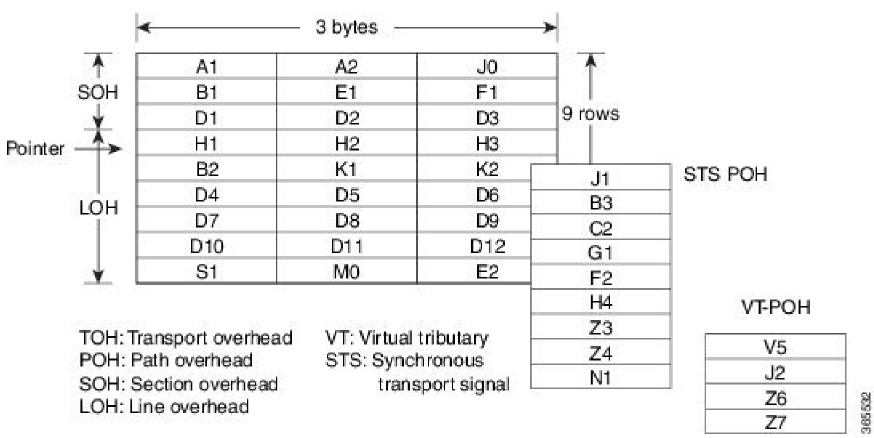
Figure 2: STS-1 Frame Structure



There is one column of bytes in the payload that represents the STS path overhead. This column frequently "floats" throughout the frame. Its location in the frame is determined by a pointer in the Section and Line overhead.

The combination of the Section and Line overhead comprises the transport overhead, and the remainder is the SPE.

Figure 3: STS-1 SONET Overhead



For STS-1, a single SONET frame is transmitted in 125 microseconds, or 8000 frames per second. 8000 fps * 810 B/frame = 51.84 Mbs, of which the payload is roughly 49.5 Mbs, enough to encapsulate 28 DS-1s, a full DS-3, or 21 CEPT-1s.

An STS-3 frame is nine rows by 270 bytes. The first nine columns contain the transport overhead section, and the rest is SPE. For both STS-3 and STS-3c, the transport overhead (Line and Section) is the same.

For an STS-3 frame, the SPE contains three separate payloads and three separate path overhead fields. In essence, it is the SPE of three separate STS-1s packed together, one after another.

For more information on Section Overhead, Line Overhead, and Path Overhead, refer the following:

- http://www.cisco.com/c/en/us/support/docs/optical/synchronous-digital-hierarchy-sdh/5462-sdh-overview.html
- http://www.cisco.com/c/en/us/support/docs/optical/synchronous-optical-network-sonet/13567-sonet-tech-tips.html
- http://www.cisco.com/c/en/us/tech/optical/synchronous-optical-network-sonet/tsd-technology-support-troubleshooting-technotes-list.html

SONET Line and Section Configuration Parameters

The following parameters affect SONET configuration at the line and section levels:

- **Overhead** — Sets the SONET overhead bytes in the frame header to a specific standards requirement, or to ensure interoperability with equipment from another vendors.
  - **J0** — Sets the J0 or C1 byte value in the SONET section overhead.

    Note 1 byte, 16 bytes, and 64 bytes are the supported values for J0.

  - **S1S0** — Sets the SS bits value of the H1 byte in the SONET line overhead.
- **Loopback** — Sets a loopback to test the SONET port.
- **AIS-Shut** — Configures the SONET port to send the Alarm Indication Signal (AIS) at shutdown.
- **Shut** — Disables an interface.
- **Alarm Reporting** — Enables reporting for all or selected alarms.
  - **lias** —Enables line alarm indication signal.
  - **lrdi** — Enables line remote defect indication signal.
  - **pais** — Enables path alarm indication signal.
  - **plop** — Enables loss of pointer failure signal for a path.
  - **pplm** — Enables path payload mismatch indication.
  - **prdi** — Enables path remote defect indication signal.
  - **sd-ber** — Sets Signal Degrade BER threshold.
- **Clock** — Specifies the clock source, where:
  - **line** —The link uses the recovered clock from the line.
  - **internal** — The link uses the internal clock source. This is the default setting.

BERT

Bit-Error Rate Testing (BERT) is used for analyzing quality and for problem resolution of digital transmission equipment. BERT tests the quality of an interface by directly comparing a pseudorandom or repetitive test pattern with an identical locally generated test pattern.

The BERT operation is data-intensive. Regular data cannot flow on the path while the test is in progress. The path is reported to be in alarm state when BERT is in progress and restored to a normal state after BERT has been terminated.

The supported BERT patterns are 2^15, 2^20, 2^23, all 0s.

BERT is supported in the following two directions:

- Line—Supports BERT in TDM direction.
- System—Supports BERT in PSN direction.

The following table shows the SONET level of BERT patterns supported.

Modes	Patterns
SONET Path Level	• 0s—Repeating pattern of zeros. • 2^15-O.151—Pseudo-random O.151 test pattern that is 32,768 bits in length. Error and Jitter measurement of 1544, 2048, 6312, 8448, 32064, 44736 kbps. • 2^20-O.153—Pseudo-random O.153 test pattern that is 1,048,575 bits in length. • 2^20-O.151—Pseudo-random QRSS O.151 test pattern that is 1,048,575 bits in length. Error and Jitter measurement upto 72 kbps. • 2^23-O.151—Pseudo-random 0.151 test pattern that is 8,388,607 bits in length. Error and Jitter measurement of 34368 kbps and 139264 kbps

Modes	Patterns
SONET T3 or E3 or CT3 (T1) or VTG T1 or VT levels	• 0s—Repeating pattern of zeros. • 2^11 2^11-1 test pattern—Pseudo-random test pattern that is 2,048 bits in length. • 2^15-O.151—Pseudo-random O.151 test pattern that is 32,768 bits in length. Error and Jitter measurement of 1544, 2048, 6312, 8448, 32064, 44736 kbps. • 2^20-O.153—Pseudo-random O.153 test pattern that is 1,048,575 bits in length. • 2^20-O.151—Pseudo-random QRSS O.151 test pattern that is 1,048,575 bits in length. Error and Jitter measurement upto 72 kbps. • 2^23-O.151—Pseudo-random 0.151 test pattern that is 8,388,607 bits in length. Error and Jitter measurement of 34368 kbps and 139264 kbps • 2^31 2^31-1 test pattern • 2^9 2^9-1 test pattern

Concatenated SONET Frames

Twenty-eight VTs make up one STS-1. Three STS-1s made up an STS-3 and so on. Any one byte within the STS frame has a direct relationship to a base VT that helps to make up the STS.

A lower-case "c" in the STS rate stands for "concatenated", and indicates that the interface hardware is not channelized. Examples of concatenated interfaces are STS-3c and STS-12c.

The STS-1s may be concatenated into sets of 3 or 12 or 24 or 48 or 192 to form STS-3c, STS-12c, and so on. The STS-1s may be combined only at specific STS-n boundaries within an OC port.

SONET Path Level Configuration Parameters

The following parameters affect SONET configuration at the path level:

- **BERT** — Starts the BERT test.
- **Clock** — Specifies the clock source for a path.
- **Exit** — Exits from SONET path configuration mode.
- **Loopback** — Sets the entire path in the loopback mode.
- **Mode** — Specifies the path operation mode.
- **No** — Negates a command or sets its defaults.

- **Overhead** — Configures SONET path overhead flags.
- **Shutdown** — Disables the SONET path.
- **Threshold** — Sets the path BER threshold values.
- **vtg** — Sets the VT-15 configuration.

Channelized SONET Frames

A channelized SONET interface is a composite of lower-speed STS streams. However, a channelized SONET interface maintains the streams as independent frames with unique payload pointers. The frames are simply multiplexed before transmission to increase the carrying capacity of the physical fiber. This process is similar to multiplexing 24 digital signal level 0 channels into a DS1 or multiplexing 28 DS1 streams into a DS3.

SONET T1 Configuration Parameters

The following parameters affect SONET T1 configuration:

- **BERT** — Starts the BERT test.
- **Clock** — Specifies the clock source for T1 interface.
- **Description** — Specifies the description of the controller.
- **Framing** — Specifies the type of a framing on T1 interface.
- **Loopback** — Sets the T1 interface in the loopback mode.
- **Shutdown** — Disables the T1 interface.

SONET T3 Configuration Parameters

The following parameters affect SONET T3 configuration:

- **Clock** — Specifies the clock source for T3 link.
- **Description** — Specifies the description of the controller.
- **Framing** — Specifies the type of a framing on T3 interface.
- **Loopback** — Sets the T3 link in the loopback mode.
- **Shutdown** — Disables the T3 interface.

SONET VT Configuration Parameters

The following parameters affect SONET VT configuration:

- **BERT** — Starts the BERT test.

CEM Group — Specifies the time slots for CEM group mapping.

- **Clock** — Specifies the clock source for VT.
- **Description** — Specifies the description of the controller.
- **Loopback** — Sets the VT in the loopback mode.
- **Overhead** — Configures VT line path overhead flags.
- **Shutdown** — Disables the VT interface.
- **Threshold** — Configures the VT threshold values.

SONET Protection Switching

Automatic protection switching (APS) is a protection mechanism for SONET networks that enables SONET connections to switch to another SONET circuit when a circuit failure occurs. A protection interface serves as the backup interface for the working interface. When the working interface fails, the protection interface quickly assumes its traffic load.

The SONET protection schemes comply with GR-253 and ITU-T G.783. It allows Optical Interface Module to work seamlessly as SONET Add or Drop Multiplexers (ADMs). The implementation of the above protection schemes allows a pair of SONET lines or paths to be configured for line or path redundancy. In the event of a fiber cut, the active line or path switches automatically to the standby line or path up to 60 milliseconds (2/5/10 millisecond for holdover and 50 millisecond switchovers).

Optical Interface Module supports the following SONET protection switching schemes:

- Linear Bidirectional 1+1 APS
- Linear Unidirectional 1+1 APS
- UPSR Path Protection at STS Level
- UPSR Path Protection at VT Level

1+1 APS

In the 1+1 architecture, there is one working interface (circuit) and one protection interface, and the same payload from the transmitting end is sent to both the receiving ends. The receiving end decides which interface to use. The line overhead (LOH) bytes (K1 and K2) in the SONET frame indicate both status and action.

The protection interfaces need to be configured with an IP address of the chassis that has the working interface, using APS commands. The APS Protect Group Protocol, which runs on top of UDP, provides communication between the process controlling the working interface and the process controlling the protection interface. Using this protocol, interfaces can be switched because of a chassis failure, degradation or loss of channel signal, or manual intervention. In bidirectional mode, the receive and transmit channels are switched as a pair.

Two SONET connections are required to support APS.

The following option is available for linear bidirectional 1+1 APS:

- Revertive option — For any failure on working line, the software switches to protection line and when the working line recovers, it waits based on the revertive timer and reverts back to working line as active link.
- Non-revertive option — When the signal fails, the software switches to the protection line and does not automatically revert back to the working line. This is the default option.

The following features are supported on 1+1 APS:

- SONET PW (SAToP or CEP)
- SONET local connect

Benefits of APS

The following lists the benefits of APS:

- APS performs switchovers with minimal loss of data and time-consuming reroutes are avoided.
- There is no visibility that a failure has occurred beyond the network element in which it is residing; other nodes are not affected by the failure.
- Implementation of APS guards a network against complex restarts and resynchronizations since failures are isolated to a local device.
- With APS, the effect of a failure is greatly minimized and a fast switchover guarantees minimal effect on the network.

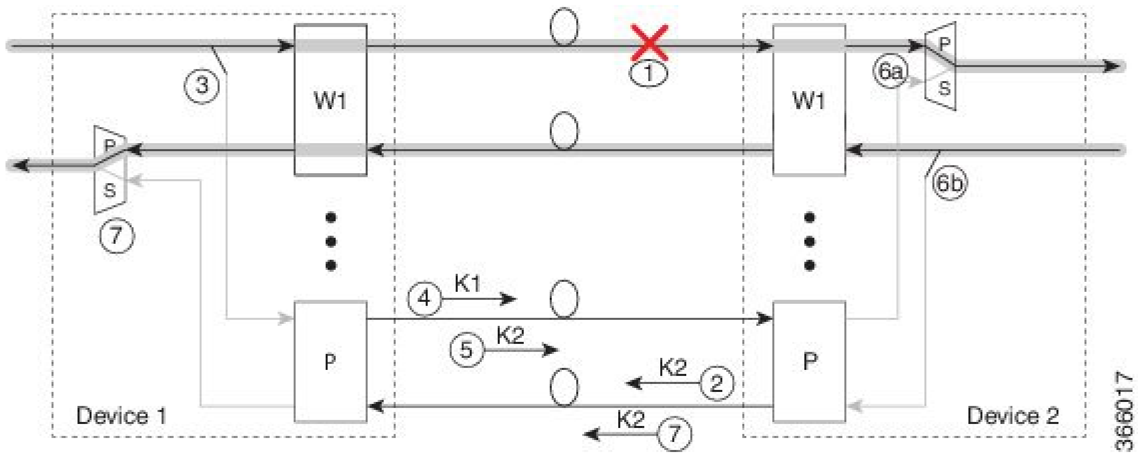
APS 1+1 for SONET Layer 1 traffic

SONET linear APS 1+1 provides protection against both fiber cuts and front card or back card failures. APS 1+1 requires a redundant protection line for every working line. The traffic is simultaneously carried by the working and the protection lines. Hence, the receiver that terminates the APS 1+1 should select the traffic from one of the lines and continue to forward the traffic. APS 1+1 provides protection in unidirectional and bi-directional modes:

- **Uni-directional Protection**: The receiving end can switch from working to protection line without any coordination at the transmit end since both lines transmit the same information.
- **Bi-directional Protection**: The receiving end switches from working to protection line by coordinating at the transmit end.

Scenario for Bidirectional APS 1+1

Figure 4: Bidirectional APS 1+1



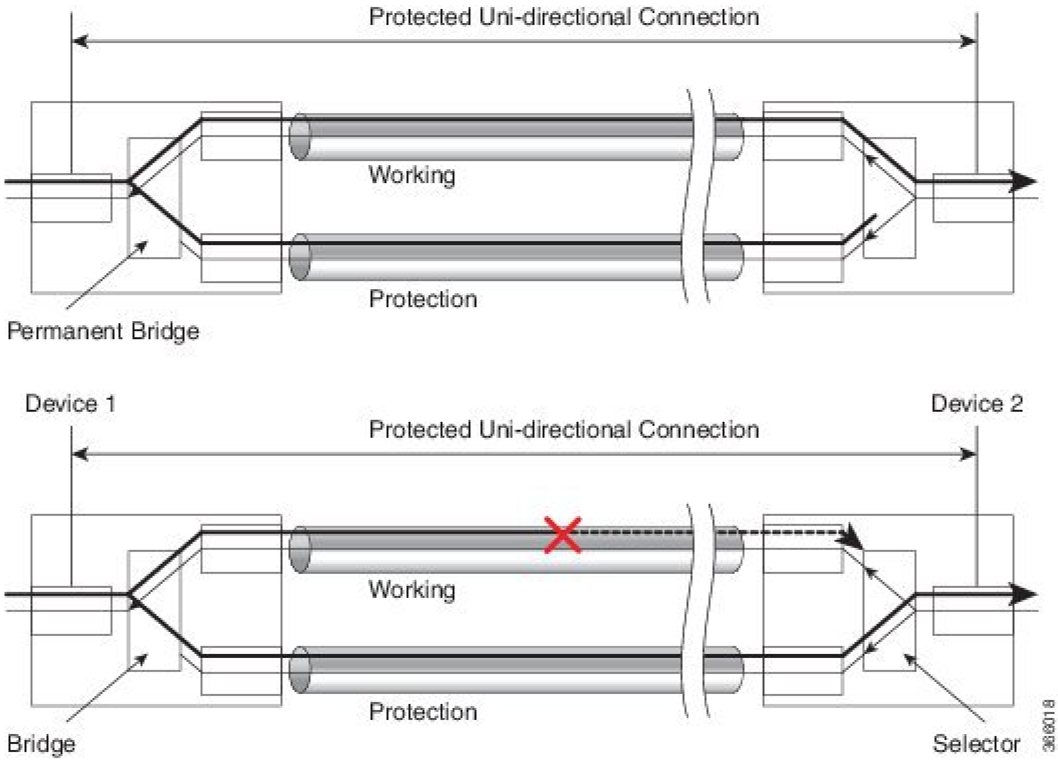
In the above figure, two devices are connected to provide APS 1+1 bi-directional protection. The highlighted one is the working line and the other is the protection line. The traffic is transmitted on both working and protection lines and received only on one line.

In a scenario where you encounter a fiber cut,

1. There is a cable cut in the working line. So, the device 2 receives a Loss of Signal (LOS) on working line.
2. Device 2 starts generating K2 byte and sends it to the Device 1 over the protection line.
3. Device 1 receives the K2 byte and reacts on the receiving K2 byte.
4. Device 1 starts sending K1 byte to the Device 2 on the protection line.
5. Device 1 starts sending K2 byte to Device 2 on the protection line.
6. Device 2 receives the K1/K2 byte and starts receiving the data from protection line. The protection line now acts as the active line.
7. Device 2 sends K2 byte over the new active line to Device 1 . Device 1 receives this signal and starts accepting the data from this new active line.

Scenario for Unidirectional APS 1+1

Figure 5: Unidirectional APS 1+1



In the above figure, two devices are connected to provide APS 1+1 unidirectional protection. The figure shows a working line and a protection line. The traffic is transmitted on both working and protection line and received only on one line.

In a scenario where you encounter a fiber cut,

1. Device 1 receives a LOS on RX working line.
2. Device 2 detects LOS and starts receiving the data from the protection line. The protection line now becomes the active line.
3. Device 1 receives the K2 byte and knows about switching event on device 2.

UPSR Path Protection

A Unidirectional Path Switching Ring (UPSR) is a unidirectional network with two rings, one ring used as the working ring and the other as the protection ring. The same signal flows through both rings, one clockwise and the other counterclockwise. It is called UPSR because monitoring is done at the path layer. A node receives two copies of the electrical signals at the path layer, compares them, and chooses the one with the better quality. If part of a ring between two ADMs fails, the other ring still can guarantee the continuation of data flow. UPSR, like the one-plus-one scheme, has fast failure recovery.

UPSR Path Protection is supported at VT level and STS level.

Once a signal fail condition or a signal degrade condition is detected, the hardware initiates an interrupt to software that switches from the working path to the protection path. Non-revertive options are valid for UPSR path protection.

Note 1X OC-192 and 8X OC-48 interface modules only supports the non-revertive option. The non-revertive option is the default mode.

Note When active link of UPSR and APS is configured on the same interface module and the interface module reloads, the convergence number for UPSR circuits to switch to backup is high ranging from 100 ms to 200 ms. When each circuit is configured separately, the convergence time is always under 50 ms.

The below table gives the maximum number of path level circuits supported in each mode.

Modes	Supported Scale
VT 1.5	84
STS-1	48
STS 3c	16
STS 12c	4
STS 48c	1

The following table illustrates the interface module and the supported release version.

Table 6: Interface Module Supported

Interface Module	48-Port T1/E1 CEM Interface Module (A900-IMA48D-C)	48-Port T3/E3 CEM Interface Module (A900-IMA48T-C)	1-Port OC-192 or 8-Port Low Rate CEM Interface Module (A900-IMA8S1Z-CX)	1 port OC-48/STM-16 or 4 port OC-12/OC-3 / STM-1/STM-4 + 12 port T1/E1 + 4 port T3/E3 CEM Interface Module (A900-IMA3G-IMSG)	ASR 900 Combo 8-Port SFP GE and 1-Port 10 GE 20G Interface Module (A900-IMA1Z8S-CXMS)
Supported Cisco IOS XE Release Version					16.12
Scale Supported					

The following feature is supported on UPSR Path Protection:

- SONET local connect and cross connect are supported at VT15 CEP,STS-1c,STS-3c,STS-12c, andSTS-48c levels. UPSR is also supported on TDM endpoints that are mapped to a pseudowire. T1 SAToP, T3 SAToP, and CT3 are supported on an UPSR ring only with local connect mode. Cross connect of T1, T3, and CT3 circuits to UPSR are not supported.

Configuring UPSR

Protection Group Configuration:

```
enable
configure terminal
protection-group 401 type STS48c
controller protection-group 401
type STS48c
cem-group 19001 cep
end
```

Configuring UPSR Work and Protection Path Configuration

UPSR Work Path Configuration:

```
enable
configure terminal
controller MediaType 0/3/6
mode sonet
controller sonet 0/3/6
rate oc48
sts-1 1 - 48 mode sts-48c
protection-group 401 working
end
```

UPSR Protect Path Configuration:

```
enable
configure terminal
controller MediaType 0/12/6
mode sonet
controller sonet 0/12/6
rate oc48
sts-1 1 - 48 mode sts-48c
protection-group 401 protect
end
```

Verifying UPSR Configuration

Use the **show protection-group** command to verify UPSR configuration:

```
show protection-group
PGN   Type    Working I/f               Protect I/f              Active Status
-------------------------------------------------------------------------------
401   STS48C  SONET0/3/6.1-48           SONET0/12/6.1-48           W         A
-------------------------------------------------------------------------------
Status legend:D=Deleted FO=Force SF=SignalFailure SD=SignalDegrade
                        FL=Fail M=Manual L=Lockout C=Clear A=Auto
 (W)=working, (P)=protect
```

Alarms at SONET Layers

SONET equipment detects events and alarms at each of SONET's three layers — section, line and path. Typically, a SONET chassis sends alarms both upstream and downstream in order to notify other devices of the problem condition.

The interface of active alarm or defect is maintained in a down/down state. The process used to troubleshoot down/down SONET interfaces is similar to that for digital interfaces, such as T1 and T3.

SONET Alarm Surveillance

SONET alarm surveillance uses two terms:

- State—Condition that is reported or detected. A SONET chassis enters a state when the chassis detects the occurrence of an event. A SONET chassis exits that state when the chassis no longer detects the event.
- Indication—Prompted by a change of state. This indicates the presence of a condition. This document discusses the Alarm Indication Signal (AIS), and Remote Defect Indicator (RDI).

The interface of active alarm or defect is maintained in a down/down state. The process used to troubleshoot down/down SONET interfaces is similar to that for digital interfaces, such as T1 and T3.

Section Alarms

The following section alarms are supported:

- LOS — Loss of Signal
- LOF — Loss of Frame
- SEF — Severely Error Frame

Line Alarms

The following line alarms are supported:

- AIS-L — Line AIS
- REI-L — Line Remote Error Indication
- RDI-L — Line Remote Defect Indication
- B2 — Line BIP Error (SF/SD)
- TCA for B2

Path Alarms

The following path alarms are supported:

- AIS-P — STS Path AIS
- LOP-P — STS Path Loss of Pointer
- B3 (SF/SD) — STS Path BIP Error
- UNEQ-P — STS Path unequipped
- REI-P — STS Path Remote Error
- RDI-P — STS Path Remote Defect Indication
- PLM-P — STS path Payload Label Mismatch
- LOM — Loss of MultiFrame

- TCA for B3

VT Alarms

The following VT alarms are supported:

- AIS-V — VT Path AIS
- LOP-V — VT Loss of Pointer
- V-BIP (SF/SD) — VT Path BIP error
- UNEQ-V — VT Path Unequipped
- REI-V — VT Path Remote Error
- RDI-V — VT Path Remote Defect Indication
- PLM-V — VT path Payload Label Mismatch
- TCA for VT Level BIP

T1 Alarms

The following T1 alarms are supported:

- LOS — DS1/E1 Line loss of Signal
- AIS — DS1/E1 Path Alarm Indication Signal
- AIS-CI — DS1/E1 Path Alarm Indication Signal Customer Installation
- LOF — DS1/E1 Path Loss of Frame
- RDI/RAI — Remote Defect Indication or Remote Alarm Indication
- RAI-CI — Remote Alarm Indication Customer Installation
- TCA for Line and Path DS1

T3 Alarms

The following T3 or path alarms are supported:

- LOS — DS3/E3 Line Loss of Signal
- OOF — DS3/E3 Path Loss of Frame
- SEF — DS3/E3 Path Severely Errored Frame
- AIS — DS3/E3 Path Alarm Indication Signal
- SEF/AIS-FE — Far End SEF/AIS
- TCA for Line and Path DS3

Alarm Indicators

Typically, a failure condition detected by a SONET chassis results in one or more error conditions sent both upstream and downstream on the network. An AIS is sent in order to alert downstream chassis of a problem and in order to prevent consequential downstream failures or alarms from being raised.

How to Configure SONET

This section describes how to configure SONET.

Each SFP port (0-7) can be configured as OC-3, OC-12, OC-48, or Gigabit Ethernet. SFP+ port (8) can be configured as OC-192 or 10 Gigabit Ethernet.

Prerequisites for Configuring SONET

You must select the MediaType controller to configure and enter the controller configuration mode.

You must configure the controller as a SONET port.

Configuring MediaType Controller

To configure MediaType Controller, use the following commands:

```
enable
configure terminal
controller MediaType 0/5/0
mode sonet
end
```

Configuring SONET Ports

To configure SONET ports, use the following commands:

```
enable
configure terminal
controller MediaType 0/5/0
mode sonet
controller sonet 0/5/0
rate OC12
end
```

The above example shows how to configure SONET ports in OC-12 mode.

Managing and Monitoring SONET Line

This section describes how to manage and monitor SONET.

Configuring Line and Section Overhead

To configure line and section overhead, use the following commands:

```
enable
configure terminal
```

```
controller MediaType 0/5/0
mode sonet
controller sonet 0/5/0
overhead s1s0 2
overhead j0 tx length 1-byte
end
```

Note To restore the system to its default condition, use the **no** form of the command.

Configuring Line and Section Threshold

To configure line and section threshold, use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
threshold b2-tca 3
end
```

Note To restore the system to its default condition, use the **no** form of the command.

```
enable
configure terminal
controller sonet 0/5/0
threshold b2-tca 3
end
```

Note To restore the system to its default condition, use the **no** form of the command.

Configuring Line Loopback

To configure loopback, use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
loopback local
end
```

Note To restore the system to its default condition, use the **no** form of the command.

Configuring AIS Shut

To configure AIS-Shut, use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
```

```
ais-shut
end
```

Note The **no ais-shut** command will not send AIS.

Configuring Shut

To configure Shut, use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
shutdown
end
```

Note Use the **no shutdown** command to disable the interface.

Configuring Alarm Reporting

To configure alarm reporting, use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
alarm-report b2-tcs
end
```

Note To restore the system to its default condition, use the **no** form of the command.

Configuring Clock

To configure clock, use the following commands:

```
enable
configure terminal
controller MediaType 0/5/0
mode sonet
controller sonet 0/5/0
clock source line
end
```

Note The default mode is internal.

Note To restore the system to its default condition, use the **no** form of the command.

Configuring Network-Clock SONET

To configure network-clock SONET, use the following commands:

```
enable
configure terminal
network-clock input-source 1 controller sonet 0/5/0
end
```

Configuring STS-1 Modes

To configure STS-1 modes, use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
sts-1 1
mode vt-15
end
```

Note There is no default mode. The following modes are supported:

- mode vt-15
- mode ct3
- mode cte-e1
- mode t3
- mode unframed
- mode vt-2

Note To restore the system to its default condition, use the **no** form of the command.

Configuring DS1/T1 CT3 mode of STS-1

To configure DS1/T1 CT3 mode of STS-1, you can configure the T1 link using the following steps:

```
enable
configure terminal
controller sonet 0/5/0
sts-1 1
mode ct3
t1 1 clock source internal
t1 1 framing unframed
end
```

Note To restore the system to its default condition, use the **no** form of the command.

Configuring STS-Nc - Contiguous Concatenation

To configure STS-Nc - contiguous concatenation, use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
sts-1 1-3 mode sts-3c
end
```

Note To restore the system to its default condition, use the **no** form of the command.

Note To configure STS-3c or STS-12c, use the numbers as multiples for 3 or 12, respectively.

Configuring CEM Group for Sonet Mode VT1.5-T1 in CESoPSN

To configure CEM group in VT 1.5 mode of STS-1 for CESoPSN, use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
sts-1 2
mode vt-15
vtg 1 t1 1 cem-group 56 timeslots 1 - 8
end
```

Configuring CEM Group for Sonet Mode CT3-T1 in CESoPSN

To configure CEM group in CT3 mode of STS-1 for CESoPSN, use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
sts-1 1
mode ct3
t1 3 cem-group 28 timeslots 1 - 7
end
```

Configuring APS for SAToP

This section describes the configuration of APS for SAToP.

Configuring Bi-directional ACR (SONET Framing) for SAToP

To configure bi-directional ACR (SONET Framing), use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
clock source internal
aps group acr 1
aps working 1
exit
controller sonet 0/4/0
aps group acr 1
```

```
aps protect 1 10.7.7.7
end
```

Note To restore the system to its default condition, use the **no** form of the command.

Configuring Unidirectional APS for SAToP

Note When the **aps adm** command is not used, the LOS is detected on active port and the L-AIS is transmitted to the remote-end to force APS switchover. This is similar to bi-directional APS mode.

'When the **aps adm** command is used, the ports are in strict unidirectional mode. When the LOS is detected on active port, the L-AIS is suppressed and behaves in a strict uni-directional mode.

Ensure that the configuration is performed under the protected interface.

To configure unidirectional ACR (SONET Framing), use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
clock source internal
aps group acr 1
aps working 1
aps unidirectional
exit
controller sonet 0/4/0
aps group acr 1
aps protect 1 10.7.7.7
aps revert 3
aps adm
end
```

Note To restore the system to its default condition, use the **no** form of the command.

Verifying ACR Configurations for SAToP

This section includes show commands for ACR: The following example shows the ACR groups that have been configured or deleted:

```
Router# show acr group

ACR Group Working I/f Protect I/f Currently Active Status

--------------------------------------------------------------------------

1 SONET 4/1/0 SONET 3/1/0 SONET 4/1/0
```

The following example shows the configured working and protect CEM interfaces under the ACR controller:

```
Router# show acr group 1 detail cem
ACR Group      Working I/f     Protect I/f     Currently Active    Status
--------------------------------------------------------------------------
CE1            CEM0/3/0       CEM0/12/1      CEM0/3/0
```

```
CEM CKT Details
Cktid  State on Working    State on Protect
1         Enable Success      Enable Success
```

The following example shows the configuration under the ACR controller:

```
Router##show running-config | sec ACR
controller SONET-ACR 1
framing sonet
!
sts-1 1
  mode vt-15
  vtg 1 vt 1 cem-group 1 cep
!
sts-1 2
 !
sts-1 3
interface CEM-ACR1
no ip address
cem 1
!
```

The following example shows the loopback IP address for the router:

```
Router# show ip interface brief | i Loopback

Loopback0 22.22.22.22 YES NVRAM up up
```

The following example shows the CEM-ACR circuit status:

```
Router# show cem circuit

CEM Int. ID Ctrlr Admin Circuit AC
--------------------------------------------------------------
CEM-ACR1 1 UP UP Active UP
CEM-ACR1 2 UP UP Active UP
CEM-ACR1 3 UP UP Active UP
CEM-ACR1 4 UP UP Active UP
CEM-ACR1 5 UP UP Active UP
CEM-ACR1 6 UP UP Active UP
CEM-ACR1 7 UP UP Active UP
CEM-ACR1 8 UP UP Active UP
```

The following example shows the CEM-ACR circuit details for CEM group 0 under the CEM-ACR interface:

```
Router# #show cem circuit interface cem-acr 1 1

CEM-ACR1, ID: 1, Line: UP, Admin: UP, Ckt: ACTIVE
Controller state: up, T1/E1 state: up
Idle Pattern: 0xFF, Idle CAS: 0x8
Dejitter: 6 (In use: 0)
Payload Size: 192
Framing: Unframed
CEM Defects Set
None

Signalling: No CAS
RTP: Configured, RTP-HDR Compression: Disabled

Ingress Pkts:    8186065              Dropped:             0
Egress Pkts:     8186065              Dropped:             0

CEM Counter Details
```

```
Input Errors:    0                   Output Errors:       0
Pkts Missing:    0                   Pkts Reordered:      0
Misorder Drops:  0                   JitterBuf Underrun:  0
Error Sec:       0                   Severly Errored Sec: 0
Unavailable Sec: 0                   Failure Counts:      0
Pkts Malformed:  0                   JitterBuf Overrun:   0
Generated Lbits: 0                   Received Lbits:      0
Generated Rbits: 0                   Received Rbits:      0
```

The following example shows the MPLS L2 transport vc details for the specified vc. In this case it is the vc with vc-id = 1001:

```
Router# sh mpls l2 vc 1 det
Local interface: CE1 up, line protocol up, SATOP T1 1 up
  Destination address: 2.2.2.2, VC ID: 1, VC status: up
    Output interface: Te0/8/0, imposed label stack {100}
    Preferred path: not configured
    Default path: active
    Next hop: 31.1.1.2
  Create time: 02:48:15, last status change time: 02:47:26
    Last label FSM state change time: 02:47:26
  Signaling protocol: LDP, peer 2.2.2.2:0 up
    Targeted Hello: 1.1.1.1(LDP Id) -> 2.2.2.2, LDP is UP
    Graceful restart: not configured and not enabled
    Non stop routing: configured and enabled
    Status TLV support (local/remote)   : enabled/supported
      LDP route watch                   : enabled
      Label/status state machine        : established, LruRru
      Last local dataplane   status rcvd: No fault
      Last BFD dataplane     status rcvd: Not sent
      Last BFD peer monitor  status rcvd: No fault
      Last local AC  circuit status rcvd: No fault
      Last local AC  circuit status sent: No fault
      Last local PW i/f circ status rcvd: No fault
      Last local LDP TLV     status sent: No status
      Last remote LDP TLV    status rcvd: No fault
      Last remote LDP ADJ    status rcvd: No fault
    MPLS VC labels: local 16, remote 100
    Group ID: local 38, remote 36
    MTU: local 0, remote 0
    Remote interface description:
  Sequencing: receive disabled, send disabled
  Control Word: On (configured: autosense)
  SSO Descriptor: 2.2.2.2/1, local label: 16
  Dataplane:
    SSM segment/switch IDs: 274581/4096 (used), PWID: 1
  VC statistics:
    transit packet totals: receive 0, send 0
    transit byte totals:   receive 0, send 0
    transit packet drops:  receive 0, seq error 0, send 0
```

The following example shows the currently configured APS groups on the router:

```
Router# show aps

SONET 0/5/2 APS Group 25: protect channel 0 (Inactive) (HA)
Working channel 1 at 1.1.1.1 (Enabled) (HA)
bidirectional, non-revertive
PGP timers (extended for HA): hello time=1; hold time=10
hello fail revert time=120
Received K1K2: 0x00 0x05
No Request (Null)
Transmitted K1K2: 0x00 0x00
```

```
No Request (Null)
Remote APS configuration: (null)
SONET 0/0/2 APS Group 25: working channel 1 (Active) (HA)
Protect at 1.1.1.1
PGP timers (from protect): hello time=1; hold time=10
Remote APS configuration: (null)
```

Configuring APS for CESoPSN

This section describes the configuration of APS for CESoPSN.

Configuring CEM Group for APS CT3-T1 in CESoPSN

To configure CEM group in CT3 mode of STS-1 for CESoPSN, use the following commands:

```
enable
configure terminal
controller sonet-acr 200
sts-1 1
mode ct3
t1 1 cem-group 0 timeslots 1 - 2
end
```

To configure internal clock source for the working controller, use the following commands:

```
enable
configure terminal
controller sonet 0/3/6
sts-1 3
t1 1 clock source internal
t1 1 framing esf
end
```

To configure internal clock source for the protect controller, use the following commands:

```
enable
configure terminal
controller sonet 0/4/6
sts-1 3
vtg 1 t1 1 clock source internal
vtg 1 t1 1 framing esf
end
```

Configuring CEM Group for APS VT1.5-T1 in CESoPSN

To configure CEM group in VT 1.5 mode of STS-1 for CESoPSN, use the following commands:

```
enable
configure terminal
controller sonet-acr 200
sts-1 3
mode vt-15
vtg 1 t1 1 cem-group 37 timeslots 1 - 5
end
```

To configure internal clock source for the working controller, use the following commands:

```
enable
configure terminal
controller sonet 0/3/6
```

```
sts-1 3
vtg 1 t1 1 clock source internal
vtg 1 t1 1 framing esf
end
```

To configure internal clock source for the protect controller, use the following commands:

```
enable
configure terminal
controller sonet 0/4/6
sts-1 3
vtg 1 t1 1 clock source internal
vtg 1 t1 1 framing esf
end
```

Configuring VT 1.5-T1 Loopback

To configure VT 1.5-T1 loopback, use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
rate oc3
no ais shut
alarm- report all
framing sonet
clock source internal
sts-1 1
clock source internal
mode vt-15
vtg 1 t1 1 loopback local
end
```

Configuring VT 1.5-T1 BERT

To configure VT 1.5-T1 BERT, use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
rate oc3
no ais shut
alarm- report all
framing sonet
clock source internal
sts-1 1
clock source internal
mode vt-15
vtg 1 t1 1 bert pattern 2^11 interval 10
end
```

Configuring Path Overhead

This section describes the configuration of path overhead.

C2 Flag

To configure the C2 flag, use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
sts-1 1
```

```
overhead c2 10
end
```

J1 Flag

To configure the J1 flag, use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
sts-1 1
overhead j1 expected length
end
```

Configuring Path Threshold

To configure path threshold, use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
sts-1 1
threshold b3-tca 3
end
```

Verification of SONET Configuration

The following sample output shows the verification of SONET configuration:

```
Router# show controllers sonet 0/3/3
SONET 0/3/3 is up.                                  ======> this is the controller/port
status.
  Hardware is asr900

 Port configured rate: OC3                 =======> this is the rate the port is configured
 on it.
 Applique type is Channelized Sonet / SDH
 Clock Source is Line                          ===> the clocking config
Medium info:
  Type: Sonet, Line Coding: NRZ,
 SECTION:
  LOS = 0          LOF = 0                            =======> the section level alarm
counter (from last clear counters)

SONET/SDH Section Tables
  INTERVAL       CV    ES    SES   SEFS
  05:50-05:58     0     0     0     0                                  ===> PMON for the
 port

LINE:
  AIS = 0          RDI = 0          REI = 0          BIP(B2) = 0    =======> the line level
 alarm counter (from last clear counters)
Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None                                 =========> present active
 alarms on the port.
Alarm reporting enabled for: SLOS SLOF SF B2-TCA
BER thresholds:  SF = 10e-3  SD = 10e-6                   ====> ber thresholds
TCA thresholds:   B2 = 10e-6
Rx: S1S0 = 00
    K1 = 00,   K2 = 00            ===> k1k2 values
    J0 = 00
    RX S1 = 00
Tx: S1S0 = 00
```

```
    K1 = 00,   K2 = 00
    J0 = 00


High Order Path:

PATH 1:
Clock Source is internal              ====> path level clock

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0           ======>   path
 layer alarms counter
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None                                       ======> present alarms
 on the path.
Alarm reporting enabled for: PLOP LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 00                                      =====> rx and tx C2 byte..
Tx: C2 = 02
PATH TRACE BUFFER : UNSTABLE

  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     …………….      ====> path trace of the
path
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................

SONET Path Tables
  INTERVAL       CV    ES   SES   UAS
  05:58-05:58     0     0     0     0

PATH 2:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: PLOP LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 00
Tx: C2 = 00

PATH TRACE BUFFER : UNSTABLE
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................

SONET/SDH Path Tables
  INTERVAL       CV    ES   SES   UAS
  05:58-05:58     0     0     0     0


OC3.STS1 0/3/3.1 is up.    ======> present status of the path
  Hardware is asr 900
```

```
Applique type is VT1.5    =====> mode of the path

STS-1 1, VTG 1, T1 1 (VT1.5 1/1/1) is down   ====> status of the SPE (t1)
VT Receiver has no alarm.
 Receiver is getting AIS.                                ===> alarm of the SPE (t1)
 Framing is unframed, Clock Source is Internal     =====> framing of the T1, clock of the
t1
Data in current interval (230 seconds elapsed):
  Near End
    0 Line Code Violations, 0 Path Code Violations
    0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
    0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 0 Unavailable Secs
    0 Path Failures, 0 SEF/AIS Secs
  Far End
    0 Line Code Violations, 0 Path Code Violations
    0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
    0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 0 Unavailable Secs
    0 Path Failures
 Data in Interval 1:
  Near End
    0 Line Code Violations, 0 Path Code Violations
    0 Slip Secs, 0 Fr Loss Secs, 14 Line Err Secs, 0 Degraded Mins
    0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 15 Unavailable Secs
    1 Path Failures, 0 SEF/AIS Secs
  Far End Data
    0 Line Code Violations, 0 Path Code Violations
    0 Slip Secs, 4 Fr Loss Secs, 2 Line Err Secs, 0 Degraded Mins
    4 Errored Secs, 0 Bursty Err Secs, 4 Severely Err Secs, 0 Unavailable Secs
    0 Path Failures
 Total Data (last 1 15 minute intervals):
  Near End
    0 Line Code Violations, 0 Path Code Violations,
    0 Slip Secs, 0 Fr Loss Secs, 14 Line Err Secs, 0 Degraded Mins,
    0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 15 Unavailable Secs
    1 Path Failures, 0 SEF/AIS Secs
  Far End
    0 Line Code Violations, 0 Path Code Violations,
    0 Slip Secs, 4 Fr Loss Secs, 2 Line Err Secs, 0 Degraded Mins,
    4 Errored Secs, 0 Bursty Err Secs, 4 Severely Err Secs, 0 Unavailable Secs
    0 Path Failures

STS-1 1, VTG 1, T1 2 (VT1.5 1/1/2) is down
VT Receiver has no alarm.
 Receiver is getting AIS.
```

The following table shows each field and its description.

Table 7: Field Description

Field	Description
SONET 0/3/3 is up	Shows that the SONET controller is operating. The controller's state can be up, down, or administratively down.
Port configured rate: OC3	Shows the rate configured on the port.
SECTION: LOS = 0 LOF = 0 BIP = 0	Shows the section level alarm counters.

Field	Description
SONET Section Tables: INTERVAL CV ES SES SEFS 05:50-05:58 0 0 0 0	Shows the PMON for the port.
LINE: AIS = 0 RDI = 0 REI = 0 BIP(B2) = 0	Shows the line level alarm counters.
Asserted/Active Alarms: None	Shows the active alarms on the port.
BER thresholds: SF = 10e-3 SD = 10e-6	Shows BER thresholds.
K1 = 00, K2 = 00	Shows the K1 and K2 values.
PATH 1: Clock Source is internal	Shows the path level clock.
AIS = 0 RDI = 0 REI = 0 BIP(B3) = 0 LOP = 0 PSE = 0 NSE = 0 NEWPTR = 0 LOM = 0 PLM = 0 UNEQ = 0	Shows the path layer alarm counters.
Active Defects: None Detected Alarms: None Asserted/Active Alarms: None Alarm reporting enabled for: PLOP LOM B3-TCA	Shows the alarms on the path.
TCA threshold: B3 = 10e-6 Rx: C2 = 00 =====> rx and tx C2 byte.. Tx: C2 = 02 PATH TRACE BUFFER : UNSTABLE	shows the Rx and Tx C2 bytes.
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 …………….	Shows the path trace.
OC3.STS1 0/3/3.1 is up.	Shows the status of the path.
Applique type is VT1.5	Shows the mode of the path.
STS-1 1, VTG 1, T1 1 (VT1.5 1/1/1) is down	Shows the status of SPE (T1).
Receiver is getting AIS.	Shows the alarm of SPE (T1).
Framing is unframed, Clock Source is Internal	Shows the framing of T1 and clock of the T1.

Performance Monitoring Use Cases or Deployment Scenarios

To view the performance monitoring result that includes statistics or error count, use the **show controller sonet** command:

```
Router# show controller sonet 0/2/0
SONET 0/2/0 is up.
  Hardware is ASR903-1T8S-10CS

 Port configured rate: OC3
 Applique type is Channelized Sonet
 Clock Source is Internal
Medium info:
  Type: Sonet, Line Coding: NRZ,
 Alarm Throttling: OFF
 SECTION:
  LOS = 0          LOF = 0                          BIP(B1) = 0

SONET Section Tables
  INTERVAL       CV    ES   SES  SEFS
  12:00-12:07     0     0     0     0
  11:45-12:00    15     1     0     0
Total of Data in Current and Previous Intervals
  11:45-12:07    15     1     0     0


LINE:
  AIS = 0          RDI = 0          REI = 0          BIP(B2) = 0
Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: SLOS SLOF LAIS SF SD LRDI B1-TCA B2-TCA
BER thresholds:  SF = 10e-3  SD = 10e-6
TCA thresholds:  B1 = 10e-6  B2 = 10e-6
Rx: S1S0 = 00
    K1 = 00,   K2 = 00
    J0 = 00

    RX S1 = 00

Tx: S1S0 = 00
    K1 = 00,   K2 = 00
    J0 = 04

Tx J0 Length : 64
Tx J0 Trace :

  52 6F 75 74 65 72 20 20 20 20 20 20 20 20 20 20     Router
  20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
  20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
  20 20 20 20 20 20 20 20 20 20 20 20 20 20 00 00                  ..

Expected J0 Length : 64
Expected J0 Trace :

  52 6F 75 74 65 72 20 20 20 20 20 20 20 20 20 20     Router
  20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
  20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
  20 20 20 20 20 20 20 20 20 20 20 20 20 20 00 00                  ..

Rx J0 Length : 64
Rx J0 Trace :
```

```
  01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01     ................
  01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01     ................
  01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01     ................
  01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 00     ................

SONET Line Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  12:00-12:07     0     0     0     0     0     0      0      0
  11:45-12:00    48     1     0     0    53     1      0      0
Total of Data in Current and Previous Intervals
  11:45-12:07    48     1     0     0    53     1      0      0


High Order Path:

PATH 1:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 41350871   BIP(B3) = 9
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 1

Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 04
Tx: C2 = 04

Tx J1 Length : 64
Tx J1 Trace

  52 6F 75 74 65 72 20 30 2F 32 2F 30 2E 31 00 00     Router 0/2/0.1..
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................

Expected J1 Length : 64
Expected J1 Trace

  52 6F 75 74 65 72 20 30 2F 32 2F 30 2E 31 00 00     Router 0/2/0.1..
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................

PATH TRACE BUFFER : UNSTABLE

Rx J1 Length : 64
Rx J1 Trace

  BB 43 45 5F 31 5F 31 20 30 2F 34 2F 33 2E 31 00     .CE_1_1 0/4/3.1.
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................

SONET Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  12:00-12:07     0     0     0     0     0     0      0    389
  11:45-12:00     0     1     1     0     0     0      0    900
Total of Data in Current and Previous Intervals
  11:45-12:07     0     1     1     0     0     0      0   1289
```

```
PATH 2:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 1          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 1

Active Defects: None
Detected Alarms: PLOP
Asserted/Active Alarms: PLOP
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 00
Tx: C2 = 04

Tx J1 Length : 64
Tx J1 Trace

  52 6F 75 74 65 72 20 30 2F 32 2F 30 2E 32 00 00     Router 0/2/0.2..
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................

Expected J1 Length : 64
Expected J1 Trace

  52 6F 75 74 65 72 20 30 2F 32 2F 30 2E 32 00 00     Router 0/2/0.2..
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................

PATH TRACE BUFFER : UNSTABLE

Rx J1 Length : 0
Rx J1 Trace


SONET Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  12:00-12:07     0     0     0   389     0     0      0      0
  11:45-12:00     0     0     0   900     0     0      0      0
Total of Data in Current and Previous Intervals
  11:45-12:07     0     0     0  1289     0     0      0      0

PATH 3:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 1          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 1

Active Defects: None
Detected Alarms: PLOP LOM
Asserted/Active Alarms: PLOP
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 00
Tx: C2 = 02

Tx J1 Length : 64
Tx J1 Trace
```

```
  52 6F 75 74 65 72 20 30 2F 32 2F 30 2E 33 00 00     Router 0/2/0.3..
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................

Expected J1 Length : 64
Expected J1 Trace

  52 6F 75 74 65 72 20 30 2F 32 2F 30 2E 33 00 00     Router 0/2/0.3..
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................

PATH TRACE BUFFER : UNSTABLE

Rx J1 Length : 0
Rx J1 Trace


SONET Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  12:00-12:07     0     0     0   389     0     0      0      0
  11:45-12:00     0     0     0   894     0     0      0      0
Total of Data in Current and Previous Intervals
  11:45-12:07     0     0     0  1283     0     0      0      0
```

To view the performance monitoring results in a table format, use the **show controller sonet tabular** command:

```
Router# show controllers sonet 0/2/0 tabular
SONET 0/2/0 is down.
  Hardware is ASR903-1T8S-10CS

 Port configured rate: OC3
 Applique type is Channelized Sonet
 Clock Source is Internal
Medium info:
  Type: Sonet, Line Coding: NRZ,
 Alarm Throttling: OFF
 SECTION:
  LOS = 0          LOF = 0                          BIP(B1) = 0

SONET Section Tables
  INTERVAL       CV    ES   SES  SEFS
  12:00-12:07     0     0     0     0
  11:45-12:00    15     1     0     0
Total of Data in Current and Previous Intervals
  11:45-12:07    15     1     0     0


LINE:
  AIS = 0          RDI = 0          REI = 0          BIP(B2) = 0
Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: SLOS SLOF LAIS SF SD LRDI B1-TCA B2-TCA
BER thresholds:  SF = 10e-3  SD = 10e-6
TCA thresholds:  B1 = 10e-6  B2 = 10e-6
Rx: S1S0 = 00
    K1 = 00,   K2 = 00
    J0 = 00
```

```
    RX S1 = 00

Tx: S1S0 = 00
    K1 = 00,   K2 = 00
    J0 = 04

Tx J0 Length : 64
Tx J0 Trace :

  52 6F 75 74 65 72 20 20 20 20 20 20 20 20 20 20     Router
  20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
  20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
  20 20 20 20 20 20 20 20 20 20 20 20 20 20 00 00                   ..

Expected J0 Length : 64
Expected J0 Trace :

  52 6F 75 74 65 72 20 20 20 20 20 20 20 20 20 20     Router
  20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
  20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
  20 20 20 20 20 20 20 20 20 20 20 20 20 20 00 00                   ..

Rx J0 Length : 64
Rx J0 Trace :

  01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01     ................
  01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01     ................
  01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01     ................
  01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 00     ................

SONET Line Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  12:00-12:07     0     0     0     0     0     0      0      0
  11:45-12:00    48     1     0     0    53     1      0      0
Total of Data in Current and Previous Intervals
  11:45-12:07    48     1     0     0    53     1      0      0


High Order Path:

PATH 2:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 1          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 1

Active Defects: None
Detected Alarms: PLOP
Asserted/Active Alarms: PLOP
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 00
Tx: C2 = 04

Tx J1 Length : 64
Tx J1 Trace

  52 6F 75 74 65 72 20 30 2F 32 2F 30 2E 32 00 00     Router 0/2/0.2..
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
```

```
Expected J1 Length : 64
Expected J1 Trace

  52 6F 75 74 65 72 20 30 2F 32 2F 30 2E 32 00 00     Router 0/2/0.2..
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................

PATH TRACE BUFFER : UNSTABLE

Rx J1 Length : 0
Rx J1 Trace


SONET Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  12:00-12:07     0     0     0   409     0     0      0      0
  11:45-12:00     0     0     0   900     0     0      0      0
Total of Data in Current and Previous Intervals
  11:45-12:07     0     0     0  1309     0     0      0      0

SONET 0/2/0.2 T3 is down.
  Hardware is NCS4200-1T8S-10CS

  Applique type is Channelized T3 to T1
  Receiver is getting AIS.
  MDL transmission is disabled

  FEAC code received: No code is being received
  Framing is C-BIT Parity, Cablelength is 224
  BER thresholds:  SF = 10e-3  SD = 10e-6
  Clock Source is internal
  Equipment customer loopback
  Near End Data
  INTERVAL      LCV   PCV   CCV   PES  PSES  SEFS   UAS   LES   CES  CSES  LSES   PFC  PAIS
  LLOS
  12:00-12:07     0     0     0     0     0     0   419     0     0     0     0     0
0     0
  11:45-12:00     0     0     0     0     0     0   910     0     0     0     0     1
0     0
  Total           0     0     0     0     0     0   910     0     0     0     0     1
0     0
  Far End Data

  INTERVAL      PES  PSES  PUAS  PFC  PCV  PSASC

  12:00-12:07     0     0     0    0    0      0

  11:45-12:00     0     0     0    0    0      0

  Total           0     0     0    0    0      0


 STS-1 2, T1 1 (CT3 2-1) is down
  timeslots:
  FDL per ANSI T1.403 and AT&T 54016 spec.
  Receiver is getting AIS.
  Framing is ESF, Clock Source is Internal
  INTERVAL      LCV   PCV   CSS  SELS   LES    DM    ES   BES   SES   UAS    SS
  12:00-12:07     0     0     0     0     0     0     0     0     0   419     0
  11:45-12:00     0     0     0     0     0     0     0     0     0   900     0
  Total           0     0     0     0     0     0     0     0     0   900     0
  Far End Data
```

```
  INTERVAL      LCV   PCV   CSS  SELS   LES    DM    ES   BES   SES   UAS
  12:00-12:07     0     0     0     0     0     0     0     0     0     0
  11:45-12:00     0     0     0     0     0     0     0     0     0     0
  Total           0     0     0     0     0     0     0     0     0     0

 STS-1 2, T1 2 (CT3 2-2) is down
  timeslots:

Router# sh controller sonet 0/2/0.3/1/1
SONET 0/2/0 is up.
 Path mode VT15

 STS-1 3, VTG 1, VT 1 (VT1.5 3/1/1) is down
 VT Receiver has LP-AIS.
  cep is configured: FALSE cem_id  (0)
  fwd_alarm_ais :0    fwd_alarm_rai :0
  Framing is ESF, Clock Source is Internal
  BIP2-tca:6, BIP2-sf:3, BIP2-sd:6
  Tx V5:1
  Rx V5:7
  Tx J2 Length=64
  TX J2 Trace Buffer:
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................

  Expected J2 Length=64
  Expected J2 Trace Buffer:
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................

  Rx J2 Length=16
  RX J2 Trace Buffer:
  CRC-7: 0x5F ERROR

  5B F4 5E 94 E4 93 F0 18 F7 A7 7C 71 D5 C2 F2 00     [.^.......|q....

 Data in curerent interval (420 seconds elapsed)
   Near End
    0 CodeViolations, 0 ErrorSecs, 0 Severly Err Secs, 419 Unavailable Secs
   Far End
    0 CodeViolations, 0 ErrorSecs, 0 Severly Err Secs, 0 Unavailable Secs
 Data in Interval 1:
   Near End
    0 CodeViolations, 0 ErrorSecs, 0 Severly Err Secs, 893 Unavailable Secs
   Far End
    0 CodeViolations, 0 ErrorSecs, 0 Severly Err Secs, 0 Unavailable Secs
 Total Data (last 1 fifteen minute intervals):
   Near End
    0 CodeViolations, 0 ErrorSecs, 0 Severly Err Secs, 893 Unavailable Secs
   Far End
    0 CodeViolations, 0 ErrorSecs, 0 Severly Err Secs, 0 Unavailable Secs


 STS-1 3, VTG 1, T1 1 (VT1.5 3/1/1) is down
  timeslots:
  FDL per ANSI T1.403 and AT&T 54016 spec.
  Receiver is getting AIS.
  Framing is ESF, Clock Source is Internal
  Data in current interval (430 seconds elapsed):
   Near End
```

```
      0 Line Code Violations, 0 Path Code Violations
      0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
      0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs
      429 Unavailable Secs, 0 Stuffed Secs
    Far End
      0 Line Code Violations, 0 Path Code Violations
      0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
      0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs
      0 Unavailable Secs
   Data in Interval 1:
    Near End
      0 Line Code Violations, 0 Path Code Violations
      0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
      0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs
      893 Unavailable Secs, 0 Stuffed Secs
    Far End
      0 Line Code Violations, 0 Path Code Violations
      0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
      0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs
      0 Unavailable Secs
   Total Data (last 1 15 minute intervals):
    Near End
      0 Line Code Violations,0 Path Code Violations,
      0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins,
      0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs
      893 Unavailable Secs, 0 Stuffed Secs
    Far End
      0 Line Code Violations,0 Path Code Violations
      0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins,
      0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs
      0 Unavailable Secs
Router# sh controller sonet 0/2/0.3/1/1 tabular
SONET 0/2/0 is up.
 Path mode VT15

 STS-1 3, VTG 1, VT 1 (VT1.5 3/1/1) is down
 VT Receiver has LP-AIS.
  cep is configured: FALSE cem_id  (0)
  fwd_alarm_ais :0    fwd_alarm_rai :0
  Framing is ESF, Clock Source is Internal
  BIP2-tca:6, BIP2-sf:3, BIP2-sd:6
  Tx V5:1
  Rx V5:7
  Tx J2 Length=64
  TX J2 Trace Buffer:
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................

  Expected J2 Length=64
  Expected J2 Trace Buffer:
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................

  Rx J2 Length=16
  RX J2 Trace Buffer:
  CRC-7: 0x5F ERROR

  5B F4 5E 94 E4 93 F0 18 F7 A7 7C 71 D5 C2 F2 00     [.^.......|q....

 INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
```

```
12:00-12:08     0     0     0   429     0     0      0      0
11:45-12:00     0     0     0   893     0     0      0      0
Total           0     0     0   893     0     0      0      0


STS-1 3, VTG 1, T1 1 (VT1.5 3/1/1) is down
 timeslots:
 FDL per ANSI T1.403 and AT&T 54016 spec.
 Receiver is getting AIS.
 Framing is ESF, Clock Source is Internal
 INTERVAL      LCV   PCV   CSS  SELS   LES    DM    ES   BES   SES   UAS    SS
 12:00-12:08     0     0     0     0     0     0     0     0     0   429     0
 11:45-12:00     0     0     0     0     0     0     0     0     0   893     0
 Total           0     0     0     0     0     0     0     0     0   893     0
 Far End Data
 INTERVAL      LCV   PCV   CSS  SELS   LES    DM    ES   BES   SES   UAS
 12:00-12:08     0     0     0     0     0     0     0     0     0     0
 11:45-12:00     0     0     0     0     0     0     0     0     0     0
 Total           0     0     0     0     0     0     0     0     0     0
```

ONS Pluggables

A comprehensive range of pluggable optical modules is available. .

Configuring ONS Pluggables

To configure ONS Pluggables, use the following commands:

```
enable
configure terminal
controller mediatype 0/12/0
mode sonet
exit
controller sonet 0/12/0
rate oc3
```

Verifying the Supported Pluggables

Before you configure the ONS pluggables, use the following commands to verify the supported plugables:

show hw-module subslot <slot/bay> transceiver <port> status:

```
The Transceiver in slot 0 subslot 7 port 4 is enabled.
  Module temperature                        = +46.636 C
  Transceiver Tx supply voltage             = 3291.5 mVolts
  Transceiver Tx bias current               = 17264 uAmps
  Transceiver Tx power                      = -2.9 dBm
  Transceiver Rx optical power              = -7.4 dBm
```

Note The **show hw-module subslot <slot/bay> transceiver <port> status** displays as **Enabled** if the pluggables are supported and the command displays as **Disabled** if the pluggables are not supported.

show hw-module subslot <slot/bay> transceiver <port> idprom:

```
show hw-module subslot 0/7 transceiver 6 idprom detail
IDPROM for transceiver SPA-1T8S-10CS_7/6:
  Description                                = SFP or SFP+ optics (type 3)
  Transceiver Type:                          = ONS SE Z1 (406)
  Product Identifier (PID)                   = ONS-SE-Z1
  Vendor Revision                            = A
  Serial Number (SN)                         = FNS19251NPM
  Vendor Name                                = CISCO-FINISAR
  Vendor OUI (IEEE company ID)               = 00.90.65 (36965)
  CLEI code                                  = WMOTCZPAAA
  Cisco part number                          = 10-1971-04
  Device State                               = Enabled.
  Date code (yy/mm/dd)                       = 15/06/19
  Connector type                             = LC.
  Encoding                                   = 8B10B
                                               NRZ
                                               Manchester
  Nominal bitrate                            = OC48/STM16 (2500 Mbits/s)
  Minimum bit rate as % of nominal bit rate = not specified
  Maximum bit rate as % of nominal bit rate = not specified
  The transceiver type is 406
  Link reach for 9u fiber (km)               = IR-1(15km) (15)
  Link reach for 50u fiber (m)               = SR(2km) (0)
                                               IR-1(15km) (0)
                                               IR-2(40km) (0)
                                               LR-1(40km) (0)
                                               LR-2(80km) (0)
                                               LR-3(80km) (0)
                                               DX(40KM) (0)
                                               HX(40km) (0)
                                               ZX(80km) (0)
                                               VX(100km) (0)
                                               1xFC, 2xFC-SM(10km) (0)
                                               ESCON-SM(20km) (0)
  Link reach for 62.5u fiber (m)             = SR(2km) (0)
                                               IR-1(15km) (0)
                                               IR-2(40km) (0)
                                               LR-1(40km) (0)
                                               LR-2(80km) (0)
                                               LR-3(80km) (0)
                                               DX(40KM) (0)
                                               HX(40km) (0)
                                               ZX(80km) (0)
                                               VX(100km) (0)
                                               1xFC, 2xFC-SM(10km) (0)
                                               ESCON-SM(20km) (0)
  Nominal laser wavelength                   = 1310 nm.
  DWDM wavelength fraction                   = 1310.0  nm.
  Supported options                          = Tx disable
                                               Tx fault signal
                                               Loss of signal (standard implementation)
  Supported enhanced options                 = Alarms for monitored parameters
                                               Software Rx LOS monitoring
  Diagnostic monitoring                      = Digital diagnostics supported
                                               Diagnostics are externally calibrated
                                               Rx power measured is "Average power"
  Transceiver temperature operating range   = -40 C to 85 C (industrial)
  Minimum operating temperature              = -40 C
  Maximum operating temperature              = 85 C
  High temperature alarm threshold           = +90.000 C
  High temperature warning threshold         = +85.000 C
  Low temperature warning threshold          =  -40.000 C
  Low temperature alarm threshold            =  -45.000 C
  High voltage alarm threshold               = 3630.0 mVolts
```

```
  High voltage warning threshold           = 3470.0 mVolts
  Low voltage warning threshold            = 3140.0 mVolts
  Low voltage alarm threshold              = 2971.2 mVolts
  High laser bias current alarm threshold   = 85.000 mAmps
  High laser bias current warning threshold = 65.000 mAmps
  Low laser bias current warning threshold  = 4.000 mAmps
  Low laser bias current alarm threshold    = 2.000 mAmps
  High transmit power alarm threshold       =  4.0 dBm
  High transmit power warning threshold     =  2.0 dBm
  Low transmit power warning threshold      = -7.0 dBm
  Low transmit power alarm threshold        = -9.0 dBm
  High receive power alarm threshold        =  1.0 dBm
  Low receive power alarm threshold        = -26.0 dBm
  High receive power warning threshold        = -1.0 dBm
  Low receive power warning threshold        = -24.9 dBm
  External Calibration: bias current slope  = 1.000
  External Calibration: bias current offset = 0
```

show hw-module subslot <slot/bay> transceiver <port> idprom brief:

```
sh hw-module subslot 0/7 transceiver 6 idprom brief
IDPROM for transceiver SPA-1T8S-10CS_7/6:
  Description                               = SFP or SFP+ optics (type 3)
  Transceiver Type:                         = ONS SE Z1 (406)
  Product Identifier (PID)                  = ONS-SE-Z1
  Vendor Revision                           = A
  Serial Number (SN)                        = FNS19251NQ0
  Vendor Name                               = CISCO-FINISAR
  Vendor OUI (IEEE company ID)              = 00.90.65 (36965)
  CLEI code                                 = WMOTCZPAAA
  Cisco part number                         = 10-1971-04
  Device State                              = Enabled.
  Date code (yy/mm/dd)                      = 15/06/19
  Connector type                            = LC.
  Encoding                                  = 8B10B
                                              NRZ
                                              Manchester
  Nominal bitrate                           = OC48/STM16 (2500 Mbits/s)
  Minimum bit rate as % of nominal bit rate = not specified
  Maximum bit rate as % of nominal bit rate = not specified
```

Configuring BERT in Sonet for CESoPSN

Bit-Error Rate Testing (BERT) is used for analyzing quality and for problem resolution of digital transmission equipment. BERT tests the quality of an interface by directly comparing a pseudorandom or repetitive test pattern with an identical locally-generated test pattern.

The supported BERT patterns are 2^11, 2^15, 2^20-O153, and 2^20-QRSS.

BERT is supported in the following two directions:

- Line—Supports BERT in TDM direction.
- System—Supports BERT in PSN direction.

BERT is supported in following controllers:

- T1—NxDS0, DS1
- T3—NxDS0, DS1 (channelised), clear channel DS3.

- OCx—NxDS0, DS1 (channelised), DS3 (channelised), clear channel DS3, STS1, STS-nc, VT-1.5, VT1.5 T1

The following table shows the supported SONET level of BERT patterns.

Modes	Patterns
SONET—AU-3 Mapping—AU3_T1	• 2^11—Pseudo-random test pattern that is 2,048 bits in length. • 2^15—Pseudo-random O.151 test pattern that is 32,768 bits in length. Error and Jitter measurement of 1544, 2048, 6312, 8448, 32064, 44736 kbps. • 2^20-O153—Pseudo-random O.153 test pattern that is 1,048,575 bits in length. • 2^20-QRSS—Pseudo-random QRSS O.151 test pattern that is 1,048,575 bits in length.
SONET—AU-4 Mapping—AU4_E1	• 2^11—Pseudo-random test pattern that is 2,048 bits in length. • 2^15—Pseudo-random O.151 test pattern that is 32,768 bits in length. Error and Jitter measurement of 1544, 2048, 6312, 8448, 32064, 44736 kbps. • 2^20-O153—Pseudo-random O.153 test pattern that is 1,048,575 bits in length. • 2^20-QRSS—Pseudo-random QRSS O.151 test pattern that is 1,048,575 bits in length.

Restrictions for SONET BERT on CESoPSN

- In the system-level BERT for CESoPSN, only the full timeslot is supported and the fractional timeslot is not supported.
- In the BERT timeslot configuration, the timeslot should be same as the one provided in the CEM configuration.
- The BERT is supported either on the NxDS0 or DS1 side but not together.

Configuring VT1.5-T1 BERT for CESoPSN

To configure VT 1.5-T1 BERT, use the following commands:

```
enable
configure terminal
controller sonet 0/5/0
```

```
rate oc3
no ais shut
alarm- report all
clock source internal
sts-1 1
clock source internal
mode vt-15
vtg 1 t1 1 bert timeslots 1 pattern 2^11 interval 10
end
```

Verifying VT1.5-T1 BERT Configuration for CESoPSN

Use **show controller sonet** command to verify BERT configuration in mode VT 1.5:

```
Router# show controller sonet 0/5/0.2/2/3 | sec BERT

  BERT running on timeslots 1,2,3,4,5,6,7,8,
  BERT test result (running)
     Test Pattern : 2^11, Status : Sync, Sync Detected : 1
     Interval : 1 minute(s), Time Remain : 00:00:43
     Bit Errors (since BERT started): 0 bits,
     Bits Received (since BERT started): 8 Mbits
     Bit Errors (since last sync): 0 bits
     Bits Received (since last sync): 8 Mbits
     Direction   : Line
```

Configuring CT3-T1 mode BERT for CESoPSN

To configure T1 CT3 mode BERT, use the following commands:

```
controller mediatype 0/5/0
mode sonet
controller sonet 0/5/0
rate oc3
sts-1 1
mode ct3
t1 4 bert timeslots 1 pattern 2^15 interval 1 direction
```

Verifying CT3-T1 mode BERT for CESoPSN

Use **show controller sonet** command to verify BERT configuration in mode CT3:

```
Router# show controller sonet 0/5/0.1/4 | sec BERT
  BERT running on timeslots 1,
  BERT test result (running)
     Test Pattern : 2^15, Status : Sync, Sync Detected : 1
     Interval : 1 minute(s), Time Remain : 00:00:43
     Bit Errors (since BERT started): 0 bits,
     Bits Received (since BERT started): 1 Mbits
     Bit Errors (since last sync): 0 bits
     Bits Received (since last sync): 1 Mbits
     Direction   : Line
```

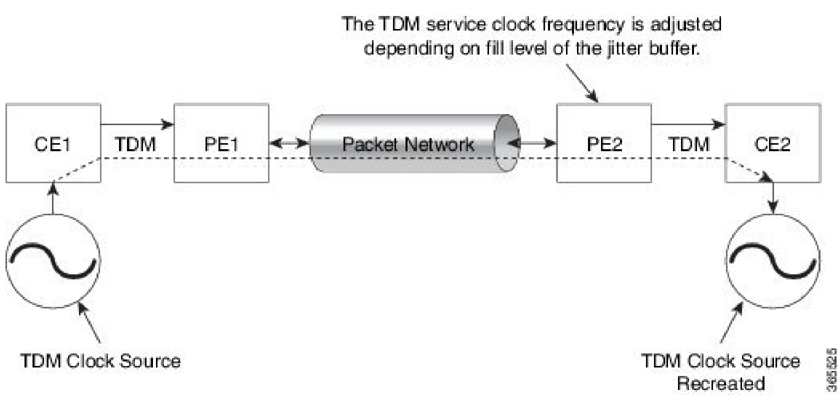
Clock Recovery System in CESoPSN

The Clock Recovery System is able to recover the service clock using two methods, the Adaptive Clock Recovery and Differential Clock Recovery.

Adaptive Clock Recovery in CESoPSN

When emulating TDM over PSNs, the physical layer clock is sometimes not available to both ends. Adaptive Clock Recovery (ACR) is a technique where the clock from the TDM domain is mapped through the packet domain. The sending Inter Working Function (IWF) processes outgoing packets with an internal free-running clock, and the receiving IWF creates a clock based on packet arrival. The service clock frequency is adjusted depending on fill level of the jitter buffer.

- When sending TDM digital signal over PSN, the TDM data is inserted into packets in the master IWF and sent to the desired destination (slave IWF).
- The rate at which the packets are transmitted to the PSN is constant. Due to the nature of the PSN, the packets might arrive to the destination in bursts and with varying rate.
- The long-term average of this rate is equal to the insertion rate at the master IWF. Moreover, the packets in the PSN might switch their order and even be lost.
- The IWF at the far end of the PSN (slave IWF) recovers the service clock (E1/T1) used by the master IWF.
- The recovered clock is used by the slave IWF for the transmission of the data back into the TDM lines.
- The master IWF aggregates the TDM data and creates the PWE packets; these packets are transmitted to the PSN.
- The packets are received by the slave IWF and stored in a jitter buffer designed to absorb the packet delay variation (PDV).
- The packets are extracted from the jitter buffer and the clock recovery algorithm updates the service clock based on the timing information available.

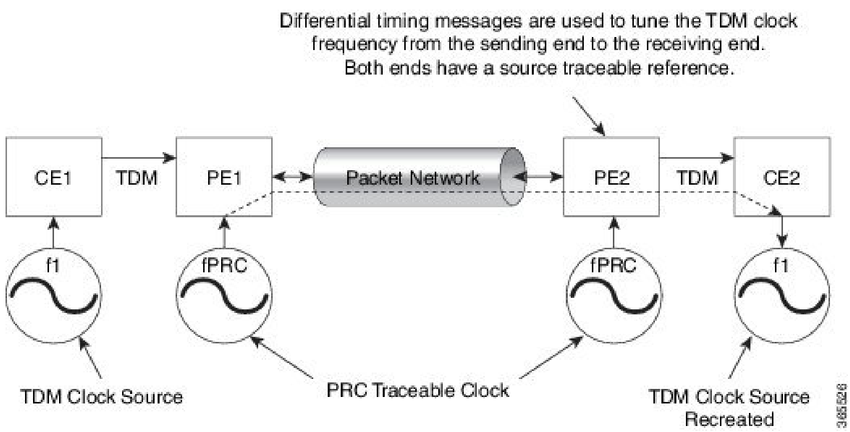


Differential Clock Recovery in CESoPSN

DCR (Differential Clock Recovery) is another technique used for Circuit Emulation (CEM) to recover clocks based on the difference between PE clocks. The clock from the TDM domain is mapped through the packet domain. It differs from ACR in that a PRC traceable clock is used at each end. Differential timing messages are used to tune the TDM clock frequency from the sending end to the receiving end. Both ends have a source traceable reference. Because of this, the recovered clock is not affected by PDV when using DCR.

In contrast with DCR, a PRC traceable clock source is available at each end. ACR is used when a traceable source is not available at both ends of the PSN link.

The recreated service clock accuracy is dependent on the accuracy between the sending and receiving PRC frequencies.



Benefits of Clock Recovery

- Customer-edge devices (CEs) can have different clock from that of the Provide-edge devices (PEs).
- In CESoPSN, a slave clock is supported for clock redundancy.

Scaling Information

IM Card	Pseudowires Supported (Number of Clocks Derived)
48-Port T1/E1 CEM Interface Module	48

Prerequisites for Clock Recovery

- The clock of interface modules must be used as service clock.
- CEM must be configured before configuring the global clock recovery.
- RTP must be enabled for DCR in CEM, as the differential clock information is transferred in the RTP header.

Restrictions for Clock Recovery

- The reference clock source is used and locked to a single clock.
- The clock ID should be unique for a particular interface module for ACR or DCR configuration.
- When CEM group is configured, dynamic change in clock source is not allowed.
- ACR clock configuration under each controller should be performed before configuring CEM group.

Scale Restrictions for ACR and DCR

For the Cisco IOS XE 17.2.1 release, 5376 ACR or DCR session scale is supported on the Cisco A900-IMA1Z8S-CX and the Cisco A900-IMA1Z8S-CXMS IMs.

Configuring ACR in VT 1.5-T1 mode for CESoPSN

To configure the CEM group in the SONET controller:

```
configure terminal
controller sonet <bay>/<slot>/<port>
rate OC3
sts-1 <num>
mode vt-15
vtg <vtg_no> t1 <t1_num> clock source recovered <clock-id>
vtg <vtg_no> t1 <t1_num> cem-group <cem-group-no> timeslots <1-24>
```

To configure the CEM interface for CESoPSN:

```
interface cem <bay>/<slot>/<port>
cem <cem-group-no>
```

To configure recovered clock for CESoPSN:

```
recovered-clock <bay> <slot>
clock recovered <clock-id> adaptive cem <port-no> <cem-group-no> priority <priority no>
```

Verifying ACR in VT 1.5-T1 mode for CESoPSN

Use the **show recovered-clock** command to verify the ACR for CEM groups 58 and 61 configured in VT 1.5 mode on T1 interface:

```
Router#show recovered clock
Recovered clock status for subslot 0/5
----------------------------------------
Clock    Type     Mode        CEM    Status    Frequency Offset(ppb)  Circuit-No
       Priority
19       OCx-T1   ADAPTIVE     58   ACQUIRING  n/a                    0/2/1/1
(Port/path/vtg/t1)     2
20       OCx-T1   ADAPTIVE     61   ACQUIRING  n/a                    0/2/1/2
(Port/path/vtg/t1)     2
```

Configuring DCR in VT 1.5-T1 mode for CESoPSN

To configure the CEM group in the SONET controller:

```
configure terminal
controller sonet <bay>/<slot>/<port>
rate OC3
sts-1 <num>
mode vt-15
vtg <vtg_no> t1 <t1_num> clock source recovered <clock-id>
vtg <vtg_no> t1 <t1_num> cem-group <cem-group-no> timeslots <1-24>
```

To configure the CEM interface for CESoPSN:

```
interface cem <bay>/<slot>/<port>
cem <cem-group-no>
rtp-present
```

To configure recovered clock for CESoPSN:

```
recovered-clock <bay> <slot>
clock recovered <clock-id> differential cem <port-no> <cem-group-no> priority <priority no>
```

Verifying DCR in VT 1.5-T1 mode for CESoPSN

Use the **show recovered-clock** command to verify the DCR for CEM groups 59 and 60 configured in VT 1.5 mode on T1 interface:

```
Router#show recovered clock
Recovered clock status for subslot 0/5
----------------------------------------
Clock    Type      Mode           CEM    Status    Frequency Offset(ppb)  Circuit-No
           Priority
11       OCx-T1   DIFFERENTIAL     59   ACQUIRING  n/a                    0/2/1/1
(Port/path/vtg/t1)     2
12       OCx-T1   DIFFERENTIAL     60   ACQUIRING  n/a                    0/2/1/2
(Port/path/vtg/t1)     2
```

Configuring ACR in CT3-T1 mode for CESoPSN

To configure the CEM group in the SONET controller:

```
configure terminal
controller sonet <bay>/<slot>/<port>
rate OC3
sts-1 <num>
mode ct3
t1 <t1_num> clock source recovered <clock-id>
t1 <t1_num> cem-group <cem-group-no> timeslots <1-24>
```

To configure recovered clock for CESoPSN:

```
recovered-clock <bay> <slot>
clock recovered <clock-id> adaptive cem <port-no> <cem-group-no> priority <priority no>
```

Verifying ACR in CT3-T1 mode for CESoPSN

Use the **show recovered-clock** command to verify the ACR for CEM groups 30 and 34 configured in CT3 mode on T1 interface:

```
Router#show recovered clock
Recovered clock status for subslot 0/5
----------------------------------------
Clock     Type     Mode         CEM    Status    Frequency Offset(ppb)   Circuit-No
  Priority
17        OCx-T1   ADAPTIVE     30   ACQUIRING  n/a                      0/1/3 (Port/t3/t1)
   2
18        OCx-T1   ADAPTIVE     34   ACQUIRED   n/a                      0/1/4 (Port/t3/t1)
   2
```

Configuring DCR in CT3-T1 mode for CESoPSN

To configure the CEM group in the SONET controller:

```
configure terminal
controller sonet <bay>/<slot>/<port>
rate OC3
sts-1 <num>
mode ct3
t1 <t1_num> clock source recovered <clock-id>
t1 <t1_num> cem-group <cem-group-no> timeslots <1-24>
interface cem <bay>/<slot>/<port>
cem < cem-group-no>
rtp-present
```

To configure recovered clock for CESoPSN:

```
recovered-clock <bay> <slot>
clock recovered <clock-id> differential cem <port-no> <cem-group-no> priority <priority no>
```

Verifying DCR in CT3-T1 mode for CESoPSN

Use the **show recovered-clock** command to verify the DCR for CEM groups 31 and 32 configured in CT3 mode on T1 interface:

```
Router#show recovered clock
Recovered clock status for subslot 0/5
----------------------------------------
Clock     Type     Mode             CEM  Status    Frequency Offset(ppb)   Circuit-No
     Priority
17       OCx-T1   DIFFERENTIAL     31   ACQUIRING  n/a                      0/1/3 (Port/t3/t1)
     2
18       OCx-T1   DIFFERENTIAL     32   ACQUIRED   n/a                      0/1/4 (Port/t3/t1)
```

```
2
```

Loopback Remote on T1 and T3 Interfaces

The remote loopback configuration attempts to put the far-end T1 or T3 into a loopback.

The remote loopback setting loops back the far-end at line or payload, using IBOC (inband bit-orientated CDE) or the ESF loopback codes to communicate the request to the far-end.

Restrictions for Loopback Remote

E1 and E3 loopback remote are not supported.

Configuring Loopback Remote in Sonet

To set T1 loopback remote iboc fac1/fac2/csu for OCX sonet, perform the following tasks in global configuration mode:

```
enable
configure terminal
controller sonet 0/0/1
mode ct3
t1 1 loopback remote iboc {fac1 | fac2 | csu}
mode vt-15
vtg 1 t1 1 loopback remote iboc {fac1 | fac2 | csu}
```

To set T1 loopback remote iboc esf line csu/esf payload for OCX sonet, perform the following tasks in global configuration mode:

```
enable
configure terminal
controller sonet 0/0/1
mode ct3
t1 1 loopback remote iboc esf {line csu | payload}
mode vt-15
vtg 1 t1 1 loopback remote esf {line csu | payload}
```

To set T3 loopback remote line/payload for OCX in sonet, perform the following tasks in global configuration mode:

```
enable
configure terminal
controller sonet 0/0/1
mode t3
t3 loopback remote {line | payload}
```

Note **loopback remote esf line niu** is not supported.

Verifying the Loopback Remote Configuration

Use the following command to check the T1 loopback remote configuration:

```
router# show run | sec 0/0/1
controller SONET 0/0/1
rate OC3
no ais-shut
alarm-report all
clock source internal
!
sts-1 1
!
sts-1 2
  clock source internal
  mode ct3
  t3 framing c-bit
  t3 clock source internal
  t1 1 Loopback remote iboc fac1
  t1 1 framing SF
```

Use the following command to verify the T1 loopback remote configuration:

```
Router(config-ctrlr-sts1)# show controller sonet 0/0/1 | b STS-1 2, T1 1
 STS-1 2, T1 1 (CT3 2-1) is up
  timeslots:
  Configured for NIU FAC1 Line Loopback with IBOC
  Currently in Inband Remotely Line Looped
  Receiver has no alarms.
  Framing is SF, Clock Source is Internal
```

Use the following command to check T3 loopback remote configuration:

```
Router# show run | sec 0/0/1
controller SONET 0/0/1
rate OC3
no ais-shut
alarm-report all
clock source internal
!
sts-1 1
!
sts-1 2
!
sts-1 3
  clock source internal
  mode t3
  t3 framing c-bit
  t3 loop remote line
  t3 clock source internal
```

Use the following command to verify T3 loopback remote configuration:

```
Router(config-ctrlr-sts1)# do show controller sonet 0/0/1 | b Path 3
OC3.STS1 0/0/1 Path 3 is up. (Configured for Remotely Looped)
  Currently in Remotely Line Looped
  Hardware is NCS4200-1T8S-10CS

  Applique type is T3
  Receiver has no alarms.
```

```
MDL transmission is disabled
```

Configuring Clocking for ACR and DCR on APS for CESoPSN

Configuring Clocking for ACR on APS CT3-T1 in CESoPSN

For clocking, you need to configure Sonet controllers with prriority.

To configure clock source in CT3 mode of STS-1 for CESoPSN, use the following commands:

```
enable
configure terminal
controller mediatype 0/5/0
mode sonet
controller sonet 0/5/0
rate oc3
sts-1 1
mode ct3
t1 1 clock source recovered 1
end
```

To configure the recovered clock with priority 1, use the following commands:

```
enable
configure terminal
recovered-clock acr 200
clock recovered 1 adaptive cem 1 priority 1
end
```

To configure clock source in CT3 mode of STS-1 for CESoPSN, use the following commands:

```
enable
configure terminal
controller sonet 0/4/6
sts-1 1
mode ct3
t1 1 clock source recovered 1
end
```

To configure the recovered clock with priority 2, use the following commands:

```
enable
configure terminal
recovered-clock acr 200
clock recovered 1 adaptive cem 2 priority 2
end
```

Verifying Clocking for ACR on APS CT3-T1 in CESoPSN

Use the **show recovered-clock** command to verify the ACR on APS in CT3 mode for CESoPSN:

```
Router#show recovered clock

Recovered clock status for SONET-ACR 200
----------------------------------------
```

```
Clock    Type     Mode        CEM    Status        Circuit-No             Working     Protect
   Priority
1     OCx-T1   ADAPTIVE      1    ACQUIRED    200/1/1(acr/t3/t1)          ACQUIRED  ACQUIRED
   1
4     OCx-T1   ADAPTIVE     38   ACQUIRING   200/3/1/1(acr/path/vtg/t1)   ACQUIRIN  ACQUIRING
  1
```

Configuring Clocking for DCR on APS CT3-T1 in CESoPSN

For clocking, you need to configure Sonet controllers with prriority.

To configure clock source in CT3 mode of STS-1 for CESoPSN, use the following commands:

```
enable
configure terminal
controller mediatype 0/3/6
mode sonet
rate oc3
sts-1 1
mode ct3
t1 1 clock source recovered 1
end
```

To configure CEM interface, use the following commands:

```
interface cem <bay>/<slot>/<port>
cem <cem-group-no>
rtp-present
```

To configure the recovered clock with priority 1, use the following commands:

```
enable
configure terminal
recovered-clock dcr 200
clock recovered 1 differential cem 1 priority 1
end
```

To configure clock source in CT3 mode of STS-1 for CESoPSN, use the following commands:

```
enable
configure terminal
controller sonet 0/4/6
sts-1 1
mode ct3
t1 1 clock source recovered 1
end
```

To configure CEM interface, use the following commands:

```
interface cem <bay>/<slot>/<port>
cem <cem-group-no>
rtp-present
```

To configure the recovered clock with priority 2, use the following commands:

```
enable
configure terminal
recovered-clock dcr 200
```

```
clock recovered 1 differential cem 2 priority 2
end
```

Verifying Clocking for DCR on APS CT3-T1 in CESoPSN

Use the **show recovered-clock** command to verify the DCR on APS in CT3 mode for CESoPSN:

```
Router#show recovered clock

Recovered clock status for SONET-DCR 200
----------------------------------------
Clock    Type     Mode        CEM    Status        Circuit-No            Working     Protect
   Priority
2     OCx-T1   DIFFERENTIAL  13   ACQUIRED      200/2/1(dcr/t3/t1)        ACQUIRED  ACQUIRED
   1
5     OCx-T1   DIFFERENTIAL  44   ACQUIRING    200/4/1/1(dcr/path/vtg/t1) ACQUIRIN  ACQUIRING
  1
```

Configuring Clocking for ACR on APS VT 1.5-T1 in CESoPSN

For clocking, you need to configure Sonet controllers with prriority.

To configure clock source in VT 1.5 mode of STS-1 for CESoPSN, use the following commands:

```
enable
configure terminal
controller sonet 0/3/6
sts-1 1
mode vt-15
vtg 1 t1 1 clock source recovered 4
end
```

To configure the recovered clock with priority 1, use the following commands:

```
enable
configure terminal
recovered-clock acr 200
clock recovered 4 adaptive cem 38 priority 1
end
```

To configure clock source in VT1.5 mode of STS-1 for CESoPSN, use the following commands:

```
enable
configure terminal
controller sonet 0/4/6
sts-1 1
mode vt-15
vtg 1 t1 1 clock source recovered 4
end
```

To configure the recovered clock with priority 2, use the following commands:

```
enable
configure terminal
recovered-clock acr 200
clock recovered 4 adaptive cem 39 priority 2
end
```

Verifying Clocking for ACR on APS VT 1.5-T1 in CESoPSN

Use the **show recovered-clock** command to verify the ACR on APS in VT 1.5 mode for CESoPSN:

```
Router#show recovered clock
Recovered clock status for SONET-ACR/SDH-ACR 200
----------------------------------------
Clock    Type     Mode         CEM    Status        Circuit-No          Working     Protect
   Priority
4     OCx-T1   ADAPTIVE      38   ACQUIRING  200/3/1/1(acr/path/vtg/t1) ACQUIRIN  ACQUIRING
  1
```

Configuring Clocking for DCR on APS VT 1.5-T1 in CESoPSN

For clocking, you need to configure Sonet controllers with prriority.

To configure clock source in VT 1.5 mode of STS-1 for CESoPSN, use the following commands:

```
enable
configure terminal
controller sonet 0/3/6
sts-1 1
mode vt-15
vtg 1 t1 1 clock source recovered 4
end
```

To configure CEM interface, use the following commands:

```
interface cem <bay>/<slot>/<port>
cem <cem-group-no>
rtp-present
```

To configure the recovered clock with priority 1, use the following commands:

```
enable
configure terminal
recovered-clock acr 200
clock recovered 4 differential cem 38 priority 1
end
```

To configure clock source in VT1.5 mode of STS-1 for CESoPSN, use the following commands:

```
enable
configure terminal
controller sonet 0/4/6
sts-1 1
mode vt-15
vtg 1 t1 1 clock source recovered 4
end
```

To configure CEM interface, use the following commands:

```
interface cem <bay>/<slot>/<port>
cem <cem-group-no>
rtp-present
```

To configure the recovered clock with priority 2, use the following commands:

```
enable
configure terminal
recovered-clock acr 200
clock recovered 4 differential cem 39 priority 2
end
```

Verifying Clocking for DCR on APS VT 1.5-T1 in CESoPSN

Use the **show recovered-clock** command to verify the DCR on APS in VT 1.5 mode for CESoPSN:

```
Router#show recovered clock
Recovered clock status for SONET-ACR 200
----------------------------------------
Clock    Type     Mode        CEM    Status        Circuit-No          Working     Protect
   Priority
5     OCx-T1   DIFFERENTIAL  44   ACQUIRING  200/4/1/1(acr/path/vtg/t1) ACQUIRIN  ACQUIRING
  1
```

Configuring VT-15 mode of STS-1 for Framed SAToP

To configure VT-15 mode of STS-1 for framed SAToP:

```
enable
configure terminal
controller mediatype 0/5/0
mode sonet
controller sonet 0/5/0
rate oc3
sts-1 1
mode vt-15
vtg 1 t1 1 cem-group 0 framed
end
```

Configuring DS1/T1 CT3 mode of STS-1 for Framed SAToP

To configure DS1 CT3 Framed SAToP mode:

```
enable
configure terminal
controller MediaType 0/5/0
mode sonet
controller sonet 0/5/0
rate oc3
sts-1 2
mode ct3
t3 framing c-bit
t1 1 cem-group 1 framed
end
```

Verifying SONET Configuration for Framed SAToP

To verify SONET configuration for Framed SAToP:

```
Router# show running configuration | sec 0/5/0
platform enable controller mediatype 0/5/0 oc3
controller mediatype 0/5/0
mode sonet
controller sonet 0/5/0
rate oc3
no ais-shut
alarm-report all
clock source internal
!
sts-1 1
clock source internal
mode vt-15
vtg 1 t1 1 cem-group 0 framed
!
sts-1 2
clock source internal
mode ct3
t3 framing c-bit
t3 clock source internal
t1 1 cem-group 1 framed
!
sts-1 3
clock source internal
mode ct3-e1
t3 framing c-bit
t3 clock source internal
e1 1 cem-group 2 framed
interface cem 0/5/0
no ip address
cem 0
!
cem 1
!
cem 2

#Router
```

Associated Commands

The following table shows the Associated Commands for SONET configuration:

Commands	Links
ais-shut	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-a1.html#wp7654966010
alarm-report	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-a1.html#wp2800999060

Commands	Links
aps adm	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-a1.html#wp8015117230
aps group	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-a1.html#wp1674734739
aps protect	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-a1.html#wp2073867702
aps revert	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-a1.html#wp4063780600
aps unidirectional	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-a1.html#wp5340799170
aps working	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-a1.html#wp8949584630
cem-group *cem-group-number* **cep**	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2440628600
controller mediatype	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp1201337639
controller protection-group	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/mcl/allreleasemcl/all-book/all-03.html
controller sonet	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp2020468554
clock source	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp3604380959
loopback	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html#wp2735045490
mode sonet	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html#wp2327088950
mode sts-nc	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html#wp1791424945

Commands	Links
mode vt-15	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html#wp1137973905
overhead c2	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-o1.html#wp1973678817
overhead j0	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-o1.html#wp4338698890
overhead j1	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-o1.html#wp1987243836
overhead s1s0	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-o1.html#wp2779929239
protection-group	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/mcl/allreleasemcl/all-book/all-10.html
protection-group [**working** | **protect**]	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/mcl/allreleasemcl/all-book/all-10.html
rate [**OC3** | **OC12** | **OC48** | **OC192**]	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-o1.html#wp4442889730
shutdown	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-s6.html#wp3364503641
show controllers sonet	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-s3.html#wp1341372847
show hw-module subslot transceiver	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-s4.html#wp6553420000
show protection-group	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/mcl/allreleasemcl/all-book/all-14.html
sts-1	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-s6.html#wp2423232697
t1 *t1-line-number* **framing**	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t1.html#wp2623191253
t1 *t1-line-number* **clock source**	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t1.html#wp3480850667

Commands	Links
threshold	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t1.html#wp2311589330
type sts48c	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/mcl/allreleasemcl/all-book/all-15.html
vtg *vtg-line-number* **t1** *t1-line-number* **loopback**	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t2.html#wp3494199143

Additional References for Configuring SONET on 1-Port OC192/STM-64 or 8-Port OC3/12/48/STM-1/-4/-16 Interface Module

Related Documents

Related Topic	Document Title
Cisco IOS commands	http://www.cisco.com/en/US/docs/ios/mcl/allreleasemcl/all_book.html

Standards

Standards	Title
—	There are no standards for this feature.

MIBs

MIB	MIBs Link
—	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
—	There are no RFCs for this feature.

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

CHAPTER 5

Configuring SDH on 1-Port OC-192/STM-64 or 8-Port OC-3/12/48/STM-1/-4/-16 Module

SDH is a standard that defines optical signals as well as a synchronous frame structure for multiplexed digital traffic. It is is used in Europe by the International Telecommunication Union Telecommunication Standardization Sector (ITU-T). The SDH equipment is used everywhere except North America.

Prior to Cisco IOS XE Everest 16.5.1, only Synchronous Optical NETwork (SONET) was supported on 1-Port OC-192/STM-64 or 8-Port OC-3/12/48/STM-1/-4/-16 Module. SONET equipment is generally used in North America. Previously, 4-Port OC3 STM1 or 1-Port OC12 STM4 Module did not support all possible combinations of the SDH hierarchy.

SDH is supported on 1-Port OC-192/STM-64 or 8-Port OC-3/12/48/STM-1/-4/-16 Module along with SONET. The IM supports the entire SDH hierarchy (except VC-2/C-2).

Overview of SDH

SDH was defined by European Telecommunications Standards Institute (ETSI) and is now being controlled by the ITU-T standards body. SDH standard is prevalently used everywhere outside North America and Japan.

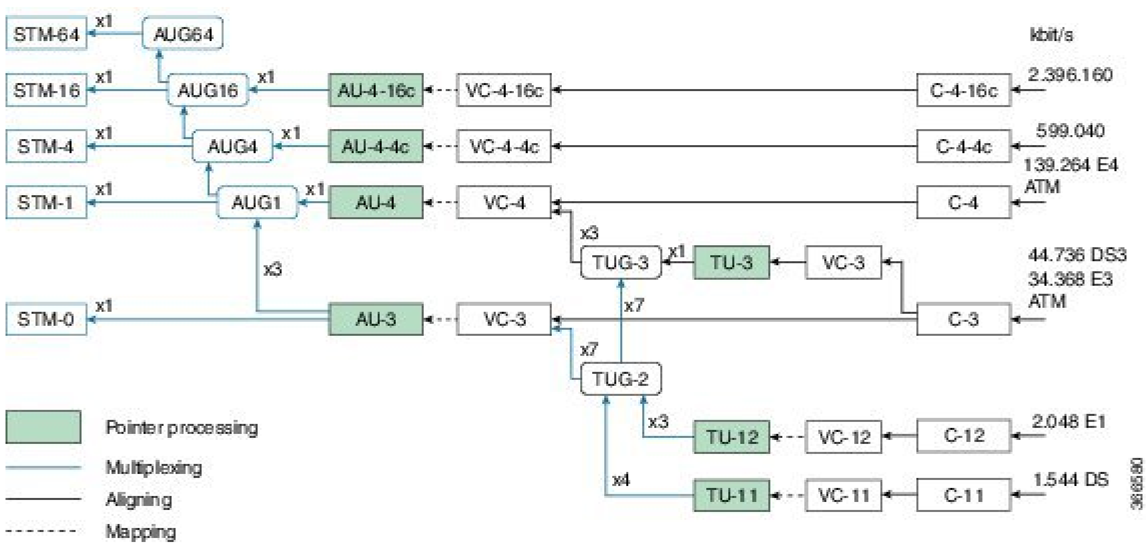
The following are true for SDH:

- Network Node Interface (NNI) defined by CCITT/ITU-TS for worldwide use and partly aompatible with SONET
- One of the two options for the User-Network Interface (UNI) (the customer connection) and formally the U reference point interface for support of BISDN

Basic SDH Signal

The basic format of an SDH signal allows it to carry many different services in its VC because SDH signal is bandwidth-flexible. This capability allows the transmission of high-speed packet-switched services, ATM, contribution video, and distribution video. However, SDH still permits transport and networking at the 2 Mbit/s, 34 Mbit/s, and 140 Mbit/s levels, accommodating the existing digital hierarchy signals. In addition, SDH supports the transport of signals based on the 1.5 Mbit/s hierarchy.

SDH Hierarchy



SDH Frame Structure

The STM-1 frame is the basic transmission format for SDH. The frame lasts for 125 microseconds, therefore, there are 8000 frames per second. The STM-1 frame consists of overhead plus a Virtual Container (VC) capacity.

The SDH frame consists of 270 columns. The first nine columns of each frame make up the Section Overhead, and the last 261 columns make up the VC capacity. The VC plus the pointers (H1, H2, H3 bytes) are called the Administrative Unit (AU). Carried within the VC capacity, which has its own frame structure of nine rows and 261 columns, is the Path Overhead and the Container. The first column is for Path Overhead; it is followed by the payload container, which can itself carry other containers. VCs can have any phase alignment within the Administrative Unit, and this alignment is indicated by the Pointer in row four. Within the Section Overhead, the first three rows are used for the Regenerator Section Overhead, and the last five rows are used for the Multiplex Section Overhead. The STM frame is transmitted in a byte-serial fashion, row-by-row, and is scrambled immediately prior to transmission to ensure adequate clock timing content for downstream regenerators.

Figure 6: STM1 Frame Structure

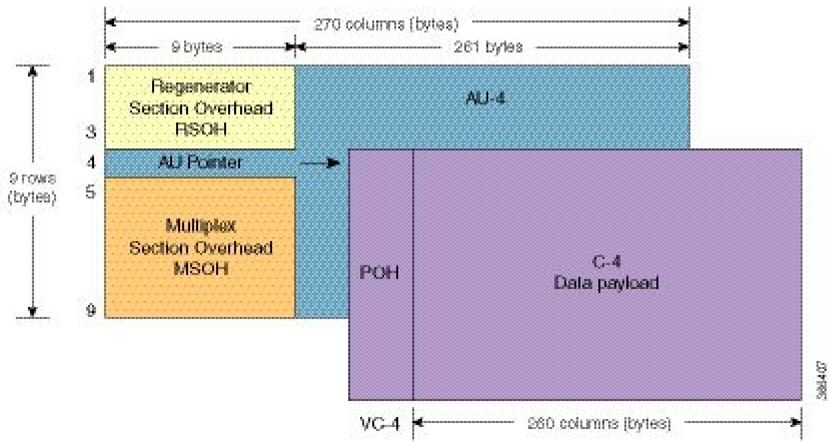
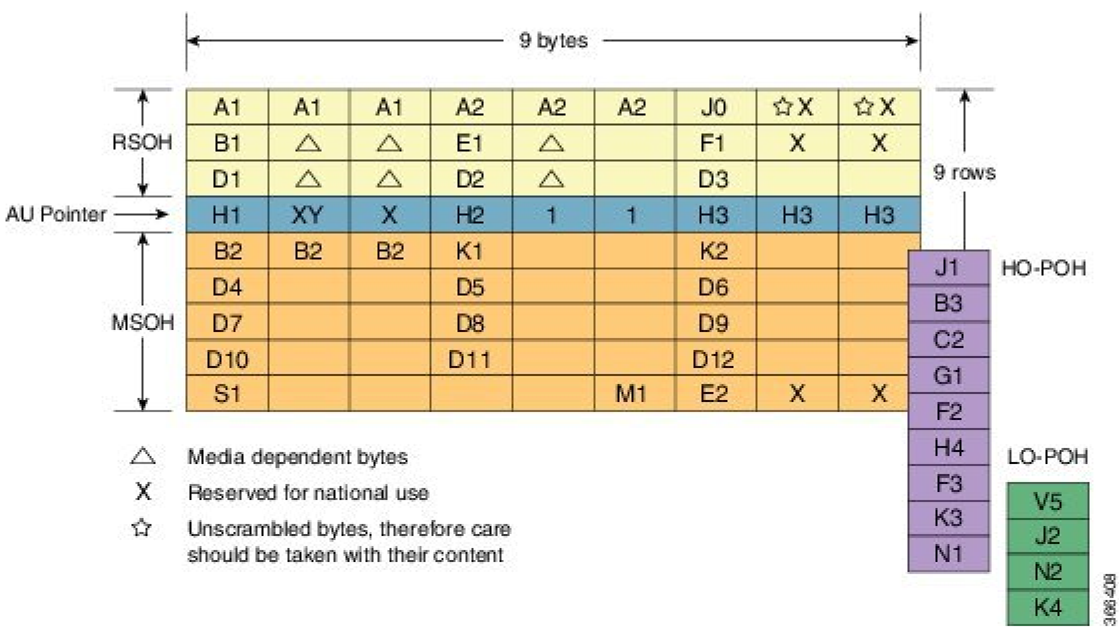


Figure 7: STM1 Section Overhead



VC

SDH supports a concept called VC. Through the use of pointers and offset values, VCs can be carried in the SDH payload as independent data packages. VCs are used to transport lower-speed tributary signals. Note that it can start (indicated by the J1 path overhead byte) at any point within the STM-1 frame. The start location of the J1 byte is indicated by the pointer byte values. VCs can also be concatenated to provide more capacity in a flexible fashion.

CEM Overview

Circuit Emulation (CEM) is a way to carry TDM circuits over packet switched network. CEM embeds the TDM circuits into packets, encapsulates them into an appropriate header, and then sends that through Packet Switched Network. The receiver side of CEM restores the TDM circuits from packets.

Modes of CEM

- **Structure Agnostic TDM over Packet (SAToP)** (RFC 4553) – SAToP mode is used to encapsulate T1/E1 or T3/E3 unstructured (unchannelized) services over packet switched networks. In SAToP mode, the bytes are sent out as they arrive on the TDM line. Bytes do not have to be aligned with any framing.

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

- **Circuit Emulation Service over Packet (CEP)** (RFC 4842) - CEP mode is used to encapsulate SDH payload envelopes (SPEs) like VC11, VC12, VC4, or VC4-Nc over PSN. In this mode, the bytes from the corresponding SPE are sent out as they arrive on the TDM line. The interface is considered as a continuous framed bit stream. The packetization of the stream is done according to IETF RFC 4842.

Table 8: SDH CEM Channelization Modes

SDH Modes	CEM	Ports
VC4-16c	CEP	STM16, STM64
VC4-4c	CEP	STM4, STM16, STM64
VC4	CEP	STM1, STM4, STM16, STM64
TUG-3-E3	SAToP	STM1, STM4, STM16, STM64
TUG-3-T3	SAToP	STM1, STM4, STM16, STM64
TUG-2-VC11	CEP	STM1, STM4, STM16, STM64
TUG-2-VC12	CEP	STM1, STM4, STM16, STM64
TUG-2-T1	SAToP	STM1, STM4, STM16, STM64
TUG-2-E1	SAToP	STM1, STM4, STM16, STM64

Services Provided by SDH Configuration

The following services are provided by SDH Configuration:

SDH Circuits	Configuration Details
Configuring VC4 CEP circuit	• *Configuring Mediatype Controller* • *Configuring Rate on SDH Ports* • *Configurin AU-3 or AU-4 Mapping* • *Configuring Modes under AU-4 Mapping* • *Configuring Mode VC4 CEP*
Configuring VC4-4c circuit or Configuring VC4-16c circuit	• *Configuring Mediatype Controller* • *Configuring Rate on SDH Ports* • *Configuring AU-3 or AU-4 Mapping* • *Configuring Modes under AU-4 Mapping* • *Configuring Mode VC-4 Nc*
Configuring VC4—TUG3—E3 circuit	• *Configuring Mediatype Controller* • *Configuring Rate on SDH Ports* • *Configuring AU-3 or AU-4 Mapping* • *Configuring Mode TUG-3*
Configuring VC4—TUG3—T3 circuit	• *Configuring Mediatype Controller* • *Configuring Rate on SDH Ports* • *Configuring AU-3 or AU-4 Mapping* • *Configuring Mode TUG-3* • *Configuring AU-4—TUG-3—VC-3—DS3*
Configuring VC4—TUG-3—TUG-2—VC-12 circuit	• *Configuring Mediatype Controller* • *Configuring Rate on SDH Ports* • *Configuring AU-3 or AU-4 Mapping* • *Configuring Mode TUG-3* • *Configuring VC4—TUG-3—TUG-2—VC-12—VC*

SDH Circuits	Configuration Details
Configuring VC4 — TUG-3 — TUG-2 — VC-12 — E1 circuit	• *Configuring Mediatype Controller* • *Configuring Rate on SDH Ports* • *Configuring AU-3 or AU-4 Mapping* • *Configuring Mode TUG-3* • *Configuring AU-4—TUG-3—TUG-2—VC-12*
Configuring VC4— TUG-3—TUG-2—VC-11 circuit	• *Configuring Mediatype Controller* • *Configuring Rate on SDH Ports* • *Configuring AU-3 or AU-4 Mapping* • *Configuring Mode TUG-3* • *Configuring AU-4—VC4—TUG-3—TUG-2—VC-11—T1*
Configuring AU-3—VC-3—E3 circuit	• *Configuring Mediatype Controller* • *Configuring Rate on SDH Ports* • *Configuring AU-3 or AU-4 Mapping* • *Configuring AU-3—VC-3—E3*
Configuring AU-3—VC-3—DS3 circuit	• *Configuring Mediatype Controller* • *Configuring Rate on SDH Ports* • *Configuring AU-3 or AU-4 Mapping* • *Configuring AU-3—VC-3—DS3 circuit*
Configuring (AU-3) VC-3—TUG-2—VC-12—T1 circuit	• *Configuring Mediatype Controller* • *Configuring Rate on SDH Ports* • *Configuring AU-3 or AU-4 Mapping* • *Configuring Mode VC-1x* • *Configuring AU-3—TUG-2—VC-11—T1*
Configuring (AU-3) VC-3—TUG-2—VC-12 circuit	• *Configuring Mediatype Controller* • *Configuring Rate on SDH Ports* • *Configuring AU-3 or AU-4 Mapping* • *Configuring Mode VC-1x* • *Configuring AU-3—TUG-2—VC-12—E1*

SDH Circuits	Configuration Details
Configuring (AU-3) VC-3—TUG-2—VC11 circuit	• *Configuring Mediatype Controller* • *Configuring Rate on SDH Ports* • *Configuring AU-3 or AU-4 Mapping* • *Configuring Mode VC-1x* • *Configuring AU-3—TUG-2—VC-11—T1*
Configuring (AU-3) VC-3—TUG-2—VC11—E1 circuit	• *Configuring Mediatype Controller* • *Configuring Rate on SDH Ports* • *Configuring AU-3 or AU-4 Mapping* • *Configuring Mode VC-1x* • *Configuring AU-3—TUG-2—VC-12—E1*

SDH Multiplexing

The terms and definitions of SDH multiplexing principles are:

- **Mapping** – A process used when tributaries are adapted into VCs by adding justification bits and Path Overhead (POH) information.
- **Aligning** – This process takes place when a pointer is included in a Tributary Unit (TU) or an Administrative Unit (AU), to allow the first byte of the VC to be located.
- **Multiplexing** – This process is used when multiple lower-order path layer signals are adapted into a higher-order path signal, or when the higher-order path signals are adapted into a Multiplex Section.
- **Stuffing** – As the tributary signals are multiplexed and aligned, some spare capacity is designed into the SDH frame to provide enough space for all the various tributary rates. Therefore, at certain points in the multiplexing hierarchy, this space capacity is filled with “fixed stuffing” bits that carry no information, but are required to fill up the particular frame.

Modes of SDH

A Synchronous Transport Module (STM) signal is the Synchronous Digital Hierarchy (SDH) equivalent of the SONET STS. In this document, STM term refers to both path widths and optical line rates. The paths within an STM signals are called administrative units (AUs).

An 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 VC) and an AU pointer, which indicates the offset of the payload frame start relative to the multiplex section frame start.

The AU-3 pointer is composed of 3 bytes; the AU-4 pointer is composed of 9 bytes.

The payload of the STM-1 frame consists of one AU-4 unit or three AU-3 units.

Augment Mapping

An administrative unit group (AUG) consists of one or more administrative units occupying fixed, defined positions in an STM payload. Augment mapping is supported at STM1 level.The following types of augment mapping are supported:

- Augment Mapping AU-4

> **Note** This is the default augment mapping mode.

- Augment Mapping AU-3
- Mixed (AU-3 and AU-4) Augment Mapping

The supported modes of SDH are:

- AU-4-16c (VC4-16c)
- AU-4-4c (VC4-4c)
- AU-4 (VC4)
- AU-4 — TUG-3 — VC-3 — DS3
- AU-4 — TUG-3 — VC-3 — E3
- AU-4 — TUG-3 — TUG-2 — VC-11 — T1
- AU-4 — TUG-3 — TUG-2 — VC-12 — E1
- AU-4 — TUG-3 — TUG-2 — VC-11
- AU-4 — TUG-3 — TUG-2 — VC-12
- AU-3 — VC-3 — DS3
- AU-3 — TUG-2 — VC-11 — T1
- AU-3 — TUG-2 — VC-12 — E1
- AU-3 — TUG-2 — VC-11
- AU-3 — TUG-2 — VC-12
- AU-3 — VC-3 — E3

Configuring AUG Mapping

This section describes the configuration of Administration Units Group (AUG) mapping.

Configuring AU-3 or AU-4 Mapping

To configure AU-3 or AU-4 mapping:

```
configure terminal
aug mapping [au-3 | au-4]
end
```

Note The **aug mapping** command is available only when SDH framing is configured.

Note The AUG mapping mode is AU-4 by default. AUG mapping is supported at STM-1 level.

Configuring Mixed AU-3 and AU-4 Mapping

To configure mixed AU-3 and AU-4 mapping:

```
configure terminal
aug mapping [au-3 | au-4] stm [1-1] stm1 number [1-4]
end
```

Note Use the following command to change the AUG mapping of a particular STM-1 to AU-3:

aug mapping *au-3* **stm** [*1-16*] *path number 1-16*

After configuring this command for STM-4 the AUG mapping of path 2, 3, and 4 is AU-4 and for path 1 it is AU-3.

Verifying AUG Mapping Configuration

Use **show running-configuration** command to verify the AUG mapping configuration.

```
show running-config | sec 0/3/4*Apr 20 03:51:28.151 PDT: %SYS-5-CONFIG_I: Configured from
console by console
platform enable
controller MediaType 0/3/4 oc12
controller MediaType 0/3/4
mode sdh
controller SDH 0/3/4
rate STM4
no ais-shut
alarm-report all
threshold sf-ber 3
clock source internal
overhead s1s0 0
aug mapping au-4 stm 1
aug mapping au-3 stm 2
aug mapping au-4 stm 3
aug mapping au-4 stm 4
au-4 1!au-3 4!au-3 5!au-3 6!au-4 3!au-4 4!
```

Configuring Modes under AU-4 Mapping

This section describes the configuration of modes under AU-4 mapping.

Configuring Mode VC4 CEP

To configure mode VC4 CEP:

```
enable
configure terminal
controller sdh 0/5/0
rate stm 4
aug mapping au-4
au-4 1
mode vc4
cem-group 100 cep
end
```

Note Overhead C2 should match with the peer end else it will result in PPLM alarm.

Verifying Mode VC-4 Configuration

Use the **show running-configuration** command to verify the mode VC-4 configuration.

```
#show running-config | sec 0/3/4*
Apr 20 04:44:41.700 PDT: %SYS-5-CONFIG_I: Configured from console by console
platform enable
controller MediaType 0/3/4 oc12
controller MediaType 0/3/4
mode sdh
controller SDH 0/3/4
rate STM4
no ais-shut
alarm-report all
threshold sf-ber 3
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
mode vc4
clock source internal
au-4 2
!
au-4 3
!
au-4 4
```

Configuring Mode TUG-3

To configure mode TUG-3:

```
enable
configure terminal
controller sdh 0/5/0
rate stm4
au-4 1
mode tug-3
end
```

Note Mode TUG-3 creates three TUG-3 paths. TUG-3 range is 1 to 3.

Configuring AU-4 — TUG-3 — VC-3 — DS3

To configure AU-4 — TUG-3 — VC-3 — DS3:

```
enable
configure terminal
controller sdh 0/5/0
rate stm4
au-4 1
mode tug-3
tug-3 1
mode t3
cem-group 100 unframed
end
```

Verifying DS3 Configuration

Use **show running-configuration** command to verify DS3 configuration:

```
#show running-configuration | sec 0/3/4
platform enable controller MediaType 0/3/4 oc12
controller MediaType 0/3/4
mode sdh
controller SDH 0/3/4
rate STM4
no ais-shut
alarm-report all
threshold sf-ber 3
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
mode tug-3
clock source internal
tug-3 1mode T3
t3 clock source internal
t3 framing c-bit
!
tug-3 2
!
tug-3 3
!
au-4 2
!
au-4 3
!
au-4 4
```

Configuring AU-4 — TUG-3 — VC-3 — E3

To configure AU-4 — TUG-3 — VC-3 — E3:

```
enable
configure terminal
controller sdh 0/5/0
rate stm4
au-4 1
mode tug-3
tug-3 1
mode e3
cem-group 100 unframed
end
```

Verifying E3 Configuration

Use **show running-configuration** command to verify E3 configuration.

```
#show running-configuration | sec 0/3/4
platform enable
controller MediaType 0/3/4 oc12
controller MediaType 0/3/4
mode sdh
controller SDH 0/3/4
rate STM4
no ais-shut
alarm-report all
threshold sf-ber 3
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
mode tug-3
clock source internal
tug-3 1
mode E3
e3 clock source internal
e3 framing g751
!
tug-3 2
!
tug-3 3
!
au-4 2
```

Configuring Mode VC-1x

To configure mode VC-1x:

```
enable
configure terminal
controller sdh 0/5/0
rate stm1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
clock source internal
mode tug-3
tug-3 1
mode VC1x
tug-2 1 payload VC11
tug-2 2 payload VC11
tug-2 3 payload VC11
tug-2 4 payload VC11
tug-2 5 payload VC11
tug-2 6 payload VC11
tug-2 7 payload VC11
end
```

Note When you configure mode VC-1x, seven TUG-2 payloads are created. TUG-2 payloads can be of two types, VC-11 and VC-12. Default for TUG-2 payload mode is VC-11.

TUG-2 payload VC-11 can be configured as VC or T1 and the range is 1 to 4.

TUG-2 payload VC-12 can be configured as VC or E1 and the range is 1 to 3.

Configuring AU-4 — TUG-3 — TUG-2 — VC-11 — T1

To configure AU-4 — TUG-3 — TUG-2 — VC-11 — T1:

```
enable
configure terminal
controller sdh 0/5/0
rate stm4
au-4 1
mode tug-3
tug-3 1
mode vc1x
tug-2 1 payload vc11
t1 1 cem-group 10 unframed
vc 1 overhead v5 2
interface cem 0/5/0
cem 100
xconnect 2.2.2.2 10 encapsulation mpls
end
```

Note Overhead v5 has to be matched with the peer end.

Configuring AU-4 — TUG-3 — TUG-2 — VC-12

To configure AU-4 — TUG-3 — TUG-2 — VC-12:

```
enable
configure terminal
controller sdh 0/5/0
rate stm4
au-4 1
mode tug-3
tug-3 1
mode vc1x
tug-2 3 payload vc12
e1 1 cem-group 10 unframed
vc 1 overhead v5 2
end
```

Note Overhead v5 should match with the peer end.

Configuring AU-4 — TUG-3 — TUG-2 — VC-11 — VC

To configure AU-4 — TUG-3 — TUG-2 — VC-11 — VC:

```
enable
configure terminal
controller sdh 0/5/0
rate stm4
au-4 1
mode tug-3
tug-3 1
mode vc1x
tug-2 2 payload vc11
vc 1 cem-group 2 cep
end
```

Configuring AU-4 — TUG-3 — TUG-2 — VC-12 — VC

To configure AU-4 — TUG-3 — TUG-2 — VC-12 — VC:

```
enable
configure terminal
controller sdh 0/5/0
rate stm4
au-4 1
mode tug-3
tug-3 1
mode vc1x
tug-2 4 payload vc12
vc 1 cem-group 10 cep
end
```

Verifying Mode VC-1x Configuration

Use **show running-configuration** command to verify mode VC-1x configuration.

```
#show running-configuration
controller MediaType 0/3/4
mode sdh
controller SDH 0/3/4
rate STM4
no ais-shut
alarm-report all
threshold sf-ber 3
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
clock source internal
mode tug-3
tug-3 1
mode VC1x
tug-2 1 payload VC11
t1 1 cem-group 1 unframed
tug-2 2 payload VC11
vc 1 cem-group 2 cep
tug-2 3 payload VC12
e1 1 cem-group 3 unframed
tug-2 4 payload VC12
vc 1 cem-group 4 cep
tug-2 5 payload VC11
tug-2 6 payload VC11
tug-2 7 payload VC11
!
tug-3 2
!
tug-3 3
!
au-4 2
!
au-4 3
!
au-4 4
```

Configuring Mode VC-4 Nc

To configure mode VC-4 Nc:

```
enable
configure terminal
```

```
controller sdh 0/5/0
au-4 1 - 4 mode vc4-4c
cem-group 100 cep
end
```

Note Overhead C2 should match with the peer end else it will result in PPLM alarm.

Verifying Mode VC-4 Nc Configuration

Use **show running-configuration** command to verify mode VC-4 Nc configuration.

```
#show running-configuration
platform enable
controller MediaType 0/3/6 oc12
controller MediaType 0/3/6
mode sdh
controller SDH 0/3/6
rate STM4
no ais-shut
alarm-report all
threshold sf-ber 3
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1 - 4 mode vc4-4c
clock source internal
cem-group 10 cep
interface CEM0/3/6
no ip address
cem 10
```

Configuring AU-3 — VC-3 — DS3

To configure AU-3 — VC-3 — DS3:

```
enable
configure terminal
controller MediaType 0/5/0
mode sdh
controller sdh 0/5/0
rate stm4
au-3 1
mode t3
cem-group 100 unframed
end
```

Configuring AU-3 — VC-3 — E3

To configure AU-3 — VC-3 — E3:

```
enable
configure terminal
controller sdh 0/5/0
rate stm4
au-3 1
mode e3
```

```
cem-group 100 unframed
end
```

Configuring Modes under AU-3 Mapping

This section describes the configuration of modes under AU-3 mapping.

Configuring Mode VC-1x

To configure mode VC-1x:

```
enable
configure terminal
controller sdh 0/5/0
rate stm4
au-3 1
mode VC1x
tug-2 1 payload VC11
tug-2 2 payload VC11
tug-2 3 payload VC11
tug-2 4 payload VC11
tug-2 5 payload VC11
tug-2 6 payload VC11
tug-2 7 payload VC11
end
end
```

Configuring AU-3 — TUG-2 — VC-11 — VC

To configure AU-3 — TUG-2 — VC-11 — VC:

```
configure terminal
controller MediaType 0/5/0
mode sdh
controller sdh 0/5/0
rate stm4
au-3 1
mode vc1x
tug-2 1 payload vc11
vc 1 cem-group 10 cep
end
```

Configuring AU-3 — TUG-2 — VC-12 — VC

To configure AU-3 — TUG-2 — VC-12 — VC:

```
configure terminal
controller MediaType 0/5/0
mode sdh
controller sdh 0/5/0
rate stm4
au-3 1
mode vc1x
tug-2 1 payload vc12
vc 1 cem-group 10 cep
end
```

Configuring AU-3 — TUG-2 — VC-11 — T1

To configure AU-3 — TUG-2 — VC-11 — T1:

```
configure terminal
controller MediaType 0/5/0
mode sdh
controller sdh 0/5/0
rate stm4
au-3 1
mode vc1x
tug-2 1 payload vc11
t1 1 cem-group 10 unframed
vc 1 overhead v5 2
interface cem 0/5/0
cem 100
xconnect 2.2.2.2 10 encapsulation mpls
end
```

Configuring AU-3 — TUG-2 — VC-12 — E1

To configure AU-3 — TUG-2 — VC-12 — E1:

```
configure terminal
controller MediaType 0/5/0
mode sdh
controller sdh 0/5/0
rate stm4
au-3 1
mode vc1x
tug-2 3 payload vc12
e1 1 cem-group 10 unframed
vc 1 overhead v5 2
end
```

Verifying Mode VC-1x Configuration

Use **show running-configuration** command to verify mode VC-1x configuration.

```
#show running-configuration
controller MediaType 0/3/4
mode sdh
controller SDH 0/3/4
rate STM4
no ais-shut
alarm-report all
threshold sf-ber 3
clock source internal
overhead s1s0 0
aug mapping au-3
au-3 1
clock source internal
mode VC1x
tug-2 1 payload VC11
t1 1 cem-group 1 unframed
tug-2 2 payload VC11
vc 1 cem-group 2 cep
tug-2 3 payload VC12
e1 1 cem-group 3 unframed
tug-2 4 payload VC12
vc 1 cem-group 4 cep
tug-2 5 payload VC11
tug-2 6 payload VC11
tug-2 7 payload VC11
```

Verification of SAToP Configuration for SDH Modes

To verify unframed SAToP configuration for SDH modes:

```
Router#show running configuration
controller MediaType 0/2/0
 mode sdh
controller SDH 0/2/0
 rate STM1
 no ais-shut
 alarm-report all
 clock source internal
 overhead s1s0 0
 aug mapping au-4
 au-4 1
  clock source internal
tug-3 2
   mode VC1x
   tug-2 1 payload VC11
    t1 1 cem-group 3 unframed
    t1 1 framing unframed
   tug-2 2 payload VC12
    e1 1 cem-group 4 unframed
    e1 1 framing unframed
   tug-2 3 payload VC11
   tug-2 4 payload VC11
   tug-2 5 payload VC11
   tug-2 6 payload VC11
   tug-2 7 payload VC11
   !
  tug-3 3
   !
#Router
```

Configuring AU-4 — TUG-3 — TUG-2 — VC-12 for Framed SAToP

Use the following commands to configure AU-4 — TUG-3 — TUG-2 — VC-12 for framed SAToP under mode VC-1x (AU-4 mapping):

```
enable
configure terminal
controller sdh 0/5/0
rate stm4
au-4 1
mode tug-3
tug-3 1
mode vc1x
tug-2 3 payload vc12
e1 1 cem-group 1 framed
vc 1 overhead v5 2
end
```

Configuring AU-3 — TUG-2 — VC-11 — T1 for Framed SAToP

To configure AU-3 — TUG-2 — VC-11 — T1 for framed SAToP under mode VC-1x (AU-3 mapping):

```
configure terminal
controller MediaType 0/5/0
```

```
mode sdh
controller sdh 0/5/0
rate stm4
au-3 1
mode vc1x
tug-2 1 payload vc11
t1 1 cem-group 0 framed
vc 1 overhead v5 2
interface cem 0/5/0
cem 100
xconnect 2.2.2.2 10 encapsulation mpls
end
```

Verifying SDH Configuration for Framed SAToP

Use **show running configuration** command to verify SDH configuration for Framed SAToP:

```
Router#show running configuration | sec 0/5/0
platform enable controller mediatype 0/5/0 oc3
controller mediatype 0/5/0
mode sdh
controller sdh 0/5/0
rate stm1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
clock source internal
mode tug-3
tug-3 1
mode vc1x
tug-2 1 payload vc11
tug-2 2 payload vc12
e1 1 cem-group 1 framed
tug-2 3 payload vc11
tug-2 4 payload vc11
tug-2 5 payload vc11
tug-2 6 payload vc11
tug-2 7 payload vc11
!
interface cem 0/5/0
no ip address
cem 0
!
cem 1!
Router#
```

Restrictions for SDH in SAToP

- If the eighth port is configured as STM-64, you cannot use port 0 to port 7. Similarly, if any one port (0-7) is configured for STM-1, STM-4 or STM-16, you cannot use the eighth port.
- Ports 0 to 7 are divided in four groups, 0-1, 2-3, 4-5, and 6-7. If one port in the group is configured for STM-16, you cannot use the other port.
- This IM does not support CEP on AU-4 — VC-4 — TUG-3 — VC-3.

- This IM does not support CT3, CE3, CT3-E1 under the VC3 container. Only clear channel T3/E3 services are supported.
- This IM does not support the framed SAToP for CESoPSN.
- Eight BERT engines are supported for Higher Order and 16 BERT engines are supported for Lower Order hierarchy.
- If a port is configured as SDH, all ports can only be configured as SDH unless the mode SDH is removed from all the ports on the IM.
- VC-4-64c and VC-2 are not supported.
- AU-4 CT3, AU-4 CE3, AU-4 CT3-E1, AU-3-CT3, AU-3-CE3, and AU-3 CT3-E1 are not supported.

  AU-4 — VC-4 — TUG-3 — VC-3 — DS3 — T1/E1, AU-4 — VC-4 — TUG-3 — VC-3 — E3 — E1, AU-3 — VC-3 — DS3 — T1/E1, and AU-3 — VC-3 — E3 — E1 are not supported.
- Concatenation VC-4-Nc is only supported for augment mapping AU-4.
- E3 MDL is not supported.

Restrictions on Bandwidth

- Total available bandwidth for 1-Port OC192/STM-64 or 8-Port OC3/12/48/STM-1/-4/-16 Module is 10G.

  The following configuration is blocked and an error message is displayed after the maximum bandwidth is utilized:

  ```
  rate stm1 | rate stm4 | rate stm16 | stm64
  ```

Table 9: Bandwidth Used by Different Rates

Rate	Bandwidth (kbit/s)
STM-1	150,336
STM-4	601,344
STM-16	2,405,376
STM-64	9,621,504

Restrictions for Scale PW Circuits

- Only 1000 CEM PW Circuits per OCN Interface modules are supported.

Restrictions for SDH in CESoPSN

- If the eighth port is configured as STM-64, you cannot use port 0 to port 7. Similarly, if any one port (0-7) is configured for STM-1, STM-4 or STM-16, you cannot use the eighth port.

- Ports 0 to 7 are divided in four groups, 0-1, 2-3, 4-5, and 6-7. If one port in the group is configured for STM-16, you cannot use the other port.
- This IM does not support CEP on AU-4 — VC-4 — TUG-3 — VC-3.
- This IM does not support CT3, CE3, CT3-E1 under the VC3 container. Only clear channel T3/E3 services are supported.
- This IM does not support the framed SAToP for CESoPSN.
- Eight BERT engines are supported for Higher Order and 16 BERT engines are supported for Lower Order hierarchy.
- If a port is configured as SDH, all ports can only be configured as SDH unless the mode SDH is removed from all the ports on the IM.
- VC-4-64c and VC-2 are not supported.
- AU-4 CT3, AU-4 CE3, AU-4 CT3-E1, AU-3-CT3, AU-3-CE3, and AU-3 CT3-E1 are not supported.

  AU-4 — VC-4 — TUG-3 — VC-3 — DS3 — T1/E1, AU-4 — VC-4 — TUG-3 — VC-3 — E3 — E1, AU-3 — VC-3 — DS3 — T1/E1, and AU-3 — VC-3 — E3 — E1 are not supported.
- Concatenation VC-4-Nc is only supported for augment mapping AU-4.
- E3 MDL is not supported.

Restrictions on Bandwidth

- Total available bandwidth for 1-Port OC192/STM-64 or 8-Port OC3/12/48/STM-1/-4/-16 Module is 10G.

  The following configuration is blocked and an error message is displayed after the maximum bandwidth is utilized:

  ```
  rate stm1 | rate stm4 | rate stm16 | stm64
  ```

Table 10: Bandwidth Used by Different Rates

Rate	Bandwidth (kbit/s)
STM-1	150,336
STM-4	601,344
STM-16	2,405,376
STM-64	9,621,504

Restrictions for Scale PW Circuits

- Only 1000 CEM PW Circuits per OCN Interface modules are supported.

Configuring Mediatype Controller

Each SFP port (0-7) can be configured as STM-1, STM-4, STM-16, or GigabitEthernet. SFP+ port (8) can be configured as STM-64 or 10 GigabitEthernet.

You must select the MediaType controller to configure and enter the controller configuration mode.

You must configure the controller as a SDH port.

To configure MediaType Controller:

```
enable
configure terminal
controller MediaType 0/5/0
mode sdh
end
```

Configuring Rate on SDH Ports

To configure rate on SDH ports:

```
enable
configure terminal
controller MediaType 0/5/0
mode sdh
controller sdh 0/5/0
rate [stm1 | stm4 | stm16 | stm64]
end
```

Note STM-64 can only be configured only on the last port or port 8.

Note The configuration of **no** form of the command is not suported. To restore to the default condition, use **no mode sdh** command under Mediatype controller after removing all configuration under that port. .

SDH Line and Section Configuration Parameters

The following parameters affect SDH configuration at the line and section levels.

Overhead

Sets the SDH overhead bytes in the frame header to a specific standards requirement, or to ensure interoperability with equipment from another vendors.

- **J0** — Sets the J0 or C1 byte value in the SDH section overhead.

Note The supported values of J0 are 1 byte, 16 bytes, and 64 bytes.

- **S1S0** — Sets the SS bits value of the H1 byte in the SDH line overhead.

Configuring Line and Section Overhead

To configure line and section overhead:

```
enable
configure terminal
controller sdh 0/5/0
overhead s1s0 2
overhead j0 expected length 16-byte
overhead j0 expected tracebuffer rx Message
overhead j0 tx length 1-byte
overhead j0 tx tracebuffer tx Message
end
```

Note To restore the system to its default condition, use the **no** form of the **overhead j0** command.

Threshold

Set the path BER threshold values.

- **b1-tca** — Enables Bit Error Rate (BER) threshold crossing alerts for B1.
- **b2-tca** — Enables BER threshold crossing alerts for B2.
- **sd-ber** — Enables the threshold of the Signal Degrade (SD) BER that is used to trigger a signal degrade alarm.
- **sf-ber** — Configures the threshold of the Signal Failure (SF) BER that is used to trigger a link state change.

Configuring Line and Section Threshold

To configure line and section threshold:

```
enable
configure terminal
mode sdh
controller sdh 0/5/0
threshold b1-tca 5
threshold b2-tca 5
threshold sd-ber 5
threshold sf-ber 5
end
```

Note To restore the system to its default condition, use the **no** form of the threshold command.

Loopback

Sets a loopback to test the SDH port.

- local — Loops the signal from Tx to Rx path. Sends alarm indication signal (AIS) to network.
- network — Loops the signal from Rx to Tx path.

Configuring Line Loopback

To configure loopback:

```
enable
configure terminal
controller sdh 0/5/0
loopback [local | network]
end
```

Note To restore the system to its default condition, use the **no** form of the loopback command.

Note When loopback is configured as network, it is recommended to use the configuration of clock source as line.

AIS-Shut

Enables automatic insertion of a Line Alarm Indication Signal (LAIS) in the sent SDH signal whenever the SDH port enters the administrative shutdown state.

Configuring AIS Shut

To configure AIS-Shut:

```
enable
configure terminal
controller sdh 0/5/0
ais-shut
end
```

Note The **no ais-shut** command does not send AIS.

Shutdown

Disables the interface.

Configuring Shut

To configure Shut:

```
enable
configure terminal
controller sdh 0/5/0
shutdown
end
```

Note Use the **no shutdown** command to disable the interface.

Alarm Reporting

Enables reporting for all or selected alarms.

- **b1-tca** — Enables BER threshold crossing alarm for B1.
- **b2-tca** — Enables BER threshold crossing alarm for B2.
- **b3-tca** — Enables BER threshold crossing alarm for B3.
- **lais** —Enables line alarm indication signal.
- **lom** — Enables loss of multiframe signal.
- **lrdi** — Enables line remote defect indication signal.
- **pais** — Enables path alarm indication signal.
- **plop** — Enables loss of pointer failure signal for a path.
- **pplm** — Enables path payload mismatch indication.
- **prdi** — Enables path remote defect indication signal.
- **puneq** — Enables path unequipped (path label equivalent to zero) signal.
- **sd-ber** — Enables LBIP BER in excess of SD threshold.
- **sf-ber** — Enables LBIP BER in excess of SF threshold.
- **slof** — Enables section loss of frame signal.
- **slos** — Enables section loss of signal.

Configuring Alarm Reporting

To configure alarm reporting:

```
enable
configure terminal
controller sdh 0/5/0
alarm-report [b1-tca | b2-tca | b3-tca | lais | lom | lrdi | pais | plop | pplm | prdi |
puneq | sd-ber | sf-ber | lof | los]
end
```

Note To restore the system to its default condition, use the **no** form of the alarm report command.

Clock Source

Specifies the clock source, where

- **line** —The link uses the recovered clock from the line.
- **internal** — The link uses the internal clock source. This is the default setting.

Configuring Clock

To configure clock, use the following commands:

```
enable
configure terminal
controller sdh 0/5/0
clock source [line | internal]
end
```

Note The default mode is internal.

Note To restore the system to its default condition, use the **no** form of the command.

Configuring Network-Clock SDH

To configure network-clock SDH, use the following commands:

```
enable
configure terminal
network-clock input-source 1 controller sdh 0/5/0
end
```

Verifying SDH Line and Section Parameters Configuration

Use **show controller** command to verify SDH Line and Section Parameters Configuration:

```
Rotuer#show controller sdh 0/7/7
SDH 0/7/7 is up.
Hardware is A900-IMA3G-IMSG
Port configured rate: STM16
 Applique type is Channelized SDH
 Clock Source is Internal, AUG mapping is AU4.
Medium info:
  Type: SDH, Line Coding: NRZ,
 Alarm Throttling: OFF
 Regenerator Section:
  LOS = 0          LOF = 0                          BIP(B1) = 0

SDH Section Tables
  INTERVAL       CV    ES    SES  SEFS
  21:24-21:24     0     0     0     0

Multiplex Section:
  AIS = 0          RDI = 0          REI = 0          BIP(B2) = 0
Active Defects: None
```

```
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: SLOS SLOF LAIS SF SD LRDI B1-TCA B2-TCA
BER thresholds:  SF = 10e-3  SD = 10e-6
TCA thresholds:  B1 = 10e-6  B2 = 10e-6
Rx: S1S0 = 00
    K1 = 00,   K2 = 00
    J0 = 00

    RX S1 = 00

Tx: S1S0 = 00
    K1 = 00,   K2 = 00
    J0 = 04

Tx J0 Length : 16
Tx J0 Trace :

  50 45 31 20 20 20 20 20 20 20 20 20 20 20 20 00     PE1            .

Expected J0 Length : 16
Expected J0 Trace :

  50 45 31 20 20 20 20 20 20 20 20 20 20 20 20 00     PE1            .

Rx J0 Length : 0
Rx J0 Trace :


SDH Line Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  21:24-21:24     0     0     0     0     0     0      0      0


High Order Path:

PATH 1:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
Detected Alarms: PPLM
Asserted/Active Alarms: PPLM
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = FE
Tx: C2 = 01

Tx J1 Length : 16
Tx J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 31 00 00 00 00 00     PE1 0/7/7.1.....

Expected J1 Length : 16
Expected J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 31 00 00 00 00 00     PE1 0/7/7.1.....

PATH TRACE BUFFER : UNSTABLE
```

```
Rx J1 Length : 16
Rx J1 Trace
  CRC-7: 0xBA OK

  4F 4E 54 20 48 4F 2D 54 52 41 43 45 20 20 20 00     ONT HO-TRACE   .

SDH Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  21:24-21:24     0     0     0     0     0     0      0      0

PATH 4:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
Detected Alarms: PPLM LOM
Asserted/Active Alarms: PPLM LOM
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = FE
Tx: C2 = 02

Tx J1 Length : 16
Tx J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 32 00 00 00 00 00     PE1 0/7/7.2.....

Expected J1 Length : 16
Expected J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 32 00 00 00 00 00     PE1 0/7/7.2.....

PATH TRACE BUFFER : UNSTABLE

Rx J1 Length : 16
Rx J1 Trace
  CRC-7: 0xBA OK

  4F 4E 54 20 48 4F 2D 54 52 41 43 45 20 20 20 00     ONT HO-TRACE   .

SDH Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  21:23-21:24     0     0     0   382     0     0      0      0

PATH 7:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 00
Tx: C2 = 00
```

```
Tx J1 Length : 16
Tx J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 33 00 00 00 00 00     PE1 0/7/7.3.....

Expected J1 Length : 16
Expected J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 33 00 00 00 00 00     PE1 0/7/7.3.....

PATH TRACE BUFFER : UNSTABLE

Rx J1 Length : 0
Rx J1 Trace


SDH Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  21:24-21:25     0     0     0     0     0     0      0      0

PATH 10:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 00
Tx: C2 = 00

Tx J1 Length : 16
Tx J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 34 00 00 00 00 00     PE1 0/7/7.4.....

Expected J1 Length : 16
Expected J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 34 00 00 00 00 00     PE1 0/7/7.4.....

PATH TRACE BUFFER : UNSTABLE

Rx J1 Length : 0
Rx J1 Trace


SDH Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  21:25-21:25     0     0     0     0     0     0      0      0

PATH 13:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
```

```
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 00
Tx: C2 = 00

Tx J1 Length : 16
Tx J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 35 00 00 00 00 00     PE1 0/7/7.5.....

Expected J1 Length : 16
Expected J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 35 00 00 00 00 00     PE1 0/7/7.5.....

PATH TRACE BUFFER : UNSTABLE

Rx J1 Length : 0
Rx J1 Trace


SDH Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  21:25-21:25     0     0     0     0     0     0      0      0

PATH 16:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 00
Tx: C2 = 00

Tx J1 Length : 16
Tx J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 36 00 00 00 00 00     PE1 0/7/7.6.....

Expected J1 Length : 16
Expected J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 36 00 00 00 00 00     PE1 0/7/7.6.....

PATH TRACE BUFFER : UNSTABLE

Rx J1 Length : 0
Rx J1 Trace


SDH Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  21:25-21:25     0     0     0     0     0     0      0      0
```

```
PATH 19:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 00
Tx: C2 = 00

Tx J1 Length : 16
Tx J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 37 00 00 00 00 00     PE1 0/7/7.7.....

Expected J1 Length : 16
Expected J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 37 00 00 00 00 00     PE1 0/7/7.7.....

PATH TRACE BUFFER : UNSTABLE

Rx J1 Length : 0
Rx J1 Trace


SDH Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  21:25-21:25     0     0     0     0     0     0      0      0

PATH 22:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 00
Tx: C2 = 00

Tx J1 Length : 16
Tx J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 38 00 00 00 00 00     PE1 0/7/7.8.....

Expected J1 Length : 16
Expected J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 38 00 00 00 00 00     PE1 0/7/7.8.....

PATH TRACE BUFFER : UNSTABLE
```

```
Rx J1 Length : 0
Rx J1 Trace


SDH Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  21:25-21:25     0     0     0     0     0     0      0      0

PATH 25:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 00
Tx: C2 = 00

Tx J1 Length : 16
Tx J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 39 00 00 00 00 00     PE1 0/7/7.9.....

Expected J1 Length : 16
Expected J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 39 00 00 00 00 00     PE1 0/7/7.9.....

PATH TRACE BUFFER : UNSTABLE

Rx J1 Length : 0
Rx J1 Trace


SDH Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  21:25-21:25     0     0     0     0     0     0      0      0

PATH 28:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 00
Tx: C2 = 00

Tx J1 Length : 16
Tx J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 31 30 00 00 00 00     PE1 0/7/7.10....
```

```
Expected J1 Length : 16
Expected J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 31 30 00 00 00 00     PE1 0/7/7.10....

PATH TRACE BUFFER : UNSTABLE

Rx J1 Length : 0
Rx J1 Trace


SDH Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  21:25-21:25     0     0     0     0     0     0      0      0

PATH 31:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 00
Tx: C2 = 00

Tx J1 Length : 16
Tx J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 31 31 00 00 00 00     PE1 0/7/7.11....

Expected J1 Length : 16
Expected J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 31 31 00 00 00 00     PE1 0/7/7.11....

PATH TRACE BUFFER : UNSTABLE

Rx J1 Length : 0
Rx J1 Trace


SDH Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  21:25-21:25     0     0     0     0     0     0      0      0

PATH 34:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA
```

```
TCA threshold:  B3 = 10e-6
Rx: C2 = 00
Tx: C2 = 00

Tx J1 Length : 16
Tx J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 31 32 00 00 00 00     PE1 0/7/7.12....

Expected J1 Length : 16
Expected J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 31 32 00 00 00 00     PE1 0/7/7.12....

PATH TRACE BUFFER : UNSTABLE

Rx J1 Length : 0
Rx J1 Trace


SDH Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  21:25-21:25     0     0     0     0     0     0      0      0

PATH 37:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 00
Tx: C2 = 00

Tx J1 Length : 16
Tx J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 31 33 00 00 00 00     PE1 0/7/7.13....

Expected J1 Length : 16
Expected J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 31 33 00 00 00 00     PE1 0/7/7.13....

PATH TRACE BUFFER : UNSTABLE

Rx J1 Length : 0
Rx J1 Trace


SDH Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  21:25-21:25     0     0     0     0     0     0      0      0

PATH 40:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
```

```
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 00
Tx: C2 = 00

Tx J1 Length : 16
Tx J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 31 34 00 00 00 00     PE1 0/7/7.14....

Expected J1 Length : 16
Expected J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 31 34 00 00 00 00     PE1 0/7/7.14....

PATH TRACE BUFFER : UNSTABLE

Rx J1 Length : 0
Rx J1 Trace


SDH Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  21:26-21:26     0     0     0     0     0     0      0      0

PATH 43:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 00
Tx: C2 = 00

Tx J1 Length : 16
Tx J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 31 35 00 00 00 00     PE1 0/7/7.15....

Expected J1 Length : 16
Expected J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 31 35 00 00 00 00     PE1 0/7/7.15....

PATH TRACE BUFFER : UNSTABLE

Rx J1 Length : 0
Rx J1 Trace
```

```
SDH Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  21:26-21:26     0     0     0     0     0     0      0      0

PATH 46:
Clock Source is internal

  AIS = 0          RDI = 0          REI = 0          BIP(B3) = 0
  LOP = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

TCA threshold:  B3 = 10e-6
Rx: C2 = 00
Tx: C2 = 00

Tx J1 Length : 16
Tx J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 31 36 00 00 00 00     PE1 0/7/7.16....

Expected J1 Length : 16
Expected J1 Trace

  50 45 31 20 30 2F 37 2F 37 2E 31 36 00 00 00 00     PE1 0/7/7.16....

PATH TRACE BUFFER : UNSTABLE

Rx J1 Length : 0
Rx J1 Trace


SDH Path Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  21:26-21:26     0     0     0     0     0     0      0      0


SDH 0/7/7.1 PATH  mode vc4 is down
  cep is configured: TRUE cem_id  :20
  clock source internal

 AU-4 2, TUG-3 1, TUG-2 1, VC12 1 (SDH 0/7/7.2/1/1/1 VC12) is down
 VT Receiver has LP-RDI.
  cep is configured: FALSE cem_id  (0)
  fwd_alarm_ais :0    fwd_alarm_rai :0
  Framing is unframed, Clock Source is Internal
  BIP2-tca:6, BIP2-sf:3, BIP2-sd:6
  Tx V5:1
  Rx V5:6
  Tx J2 Length=16
  TX J2 Trace Buffer:
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................

  Expected J2 Length=16
  Expected J2 Trace Buffer:
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................

  Rx J2 Length=16
  RX J2 Trace Buffer:
  CRC-7: 0x81 OK
```

```
 4F 4E 54 20 4C 4F 2D 54 52 41 43 45 20 20 20 00     ONT LO-TRACE   .

Data in curerent interval (140 seconds elapsed)
  Near End
   0 CodeViolations, 0 ErrorSecs, 0 Severly Err Secs, 269 Unavailable Secs
  Far End
   0 CodeViolations, 0 ErrorSecs, 0 Severly Err Secs, 0 Unavailable Secs

AU-4 2, TUG-3 1, TUG-2 1, E1 1 (SDH 0/7/7.2/1/1/1 E1) is down
 Receiver is getting AIS.
 Framing is unframed, Clock Source is Internal
 Data in current interval (140 seconds elapsed):
  Near End
    0 Line Code Violations, 0 Path Code Violations
    0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
    0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs
    293 Unavail Secs, 0 Stuffed Secs
  Far End
    0 Line Code Violations, 0 Path Code Violations
    0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
    0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs
    0 Unavail Secs

AU-4 2, TUG-3 1, TUG-2 1, VC12 2 (SDH 0/7/7.2/1/1/2 VC12) is down
VT Receiver has LP-RDI.
 cep is configured: FALSE cem_id  (0)
 fwd_alarm_ais :0    fwd_alarm_rai :0
 Framing is unframed, Clock Source is Internal
 BIP2-tca:6, BIP2-sf:3, BIP2-sd:6
 Tx V5:1
 Rx V5:6
 Tx J2 Length=16
 TX J2 Trace Buffer:
 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................

 Expected J2 Length=16
 Expected J2 Trace Buffer:
 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................

 Rx J2 Length=16
 RX J2 Trace Buffer:
 CRC-7: 0x81 OK

 4F 4E 54 20 4C 4F 2D 54 52 41 43 45 20 20 20 00     ONT LO-TRACE   .

Data in curerent interval (150 seconds elapsed)
  Near End
   0 CodeViolations, 0 ErrorSecs, 0 Severly Err Secs, 483 Unavailable Secs
  Far End
   0 CodeViolations, 0 ErrorSecs, 0 Severly Err Secs, 0 Unavailable Secs

AU-4 2, TUG-3 1, TUG-2 1, E1 2 (SDH 0/7/7.2/1/1/2 E1) is down
 Receiver is getting AIS.
 Framing is unframed, Clock Source is Internal
 Data in current interval (150 seconds elapsed):
  Near End
    0 Line Code Violations, 0 Path Code Violations
    0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
    0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs
    90 Unavail Secs, 0 Stuffed Secs
  Far End
    0 Line Code Violations, 0 Path Code Violations
    0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
```

```
0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs
0 Unavail Secs
```

Configuring SDH Path Parameters

This section describes the configuration of SDH path parameters.

Path Overhead

C2 Flag

Sets the message length and the message text of the High Order Path Trace identifier (J1).

J1 Flag

Sets the C2 byte in the Path OverHead (POH) to indicate the contents of the payload inside the frame.

The path overheads, C2 flag and J1 flag can be configured for the following modes:

- AU-4 Mapping
  - Mode VC-4
  - Mode VC-4 Nc
  - Mode TUG-3

  For more information, refer Configuring Modes under AU-4 Mapping, on page 93.

- AU-3 Mapping
  - Mode E3
  - Mode T3

  For more information, refer Configuring Modes under AU-3 Mapping.

C2 Flag

To configure the C2 flag:

```
enable
configure terminal
controller Mediatype 0/5/0
mode sdh
controller sdh 0/5/0
au-4 1
overhead c2 10
end
```

J1 Flag

To configure the J1 flag:

```
enable
configure terminal
controller MediaType 0/5/0
mode sdh
```

```
controller sdh 0/5/0
au-4 1
overhead j1 expected length 16
overhead j1 expected message expectedmessage
overhead j1 tx length 16
overhead j1 tx message testmessage
end
```

Path Threshold

Set the path BER threshold values.

- **b3-tca** — Enables BER threshold crossing alerts for B3.
- **sd-ber** — Enables the threshold of the Signal Degrade (SD) BER that is used to trigger a signal degrade alarm.
- **sf-ber** — Configures the threshold of the Signal Failure (SF) BER that is used to trigger a link state change.

The path threshold can be configured for the following modes:

- AU-4 Mapping
  - Mode VC-4
  - Mode VC-4 Nc
  - Mode TUG-3

    For more information, refer Configuring Modes under AU-4 Mapping, on page 93.
- AU-3 Mapping
  - Mode E3
  - Mode T3

    For more information, refer Configuring Modes under AU-3 Mapping.

Configuring Path Threshold

To configure path threshold:

```
enable
configure terminal
controller MediaType 0/5/0
mode sdh
controller sdh 0/5/0
au-4 1
threshold b3-ber_sd 7
threshold b3-ber_sf 7
end
```

Path Loopback

Sets a loopback to test the SDH port.

- local — Loops the signal from Tx to Rx path. Sends alarm indication signal (AIS) to network.
- network — Loops the signal from Rx to Tx path.

Configuring Path Loopback

To configure path loopback:

```
enable
configure terminal
controller sdh 0/5/0
au-4 1
loopback [local | network]
end
```

Note To restore the system to its default condition, use the **no** form of the command.

Configuring Path BERT

For more information on BERT configuration, see Configuring BERT in SDH for SAToP, on page 124 section.

Verifying Path Parameters Configuration

Use **show running-configuration** command to verify path parameters configuration.

```
router# show running-configuration
controller MediaType 0/5/
mode sdh
controller SDH 0/5/0
rate STM16
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
mode vc4
clock source internal
loopback local
overhead c2 10
threshold b3-ber_sd 7
threshold b3-ber_sf 7
overhead j1 tx message STRING
overhead j1 expected message STRING
threshold b3-tca 5
au-4 2
```

Configuring BERT in SDH for SAToP

Bit-Error Rate Testing (BERT) is used to analyze quality and to resolve problems of digital transmission equipment. BERT tests the quality of an interface by directly comparing a pseudorandom or repetitive test pattern with an identical locally generated test pattern.

The BERT operation is data-intensive. Regular data cannot flow on the path while the test is in progress. The path is reported to be in alarm state when BERT is in progress and restored to a normal state after BERT has terminated.

The supported BERT patterns are 2^15, 2^20, 2^23, all 0s.

BERT is supported in the following two directions:

- Line - Supports BERT in TDM direction.
- System - Supports BERT in PSN direction. CEM must be configured before running BERT towards system direction.

The following table shows the SDH level of BERT patterns supported.

Modes	Patterns
SDH - VC4-4c, VC4-8c, VC4-16c, AU4-VC4, AU4-TUG3-VC3 levels	• 0s - Repeating pattern of zeros • 2^15 - O.151 - Error and Jitter measurement of 1544, 2048, 6312, 8448, 32064, 44736 kbps • 2^20 - O.153 • 2^20 - O.151 - Error and Jitter measurement upto 72 kbps • 2^23 - O.151 - Error and Jitter measurement of 34368 kbps and 139264 kbps
SDH - AU4-TUG3-CT3/CE3/E3 and AU4-TUG3-VC11/VC12 levels	• 0s - Repeating pattern of zeros • 2^11 2^11-1 test pattern • 2^15 - O.151 - Error and Jitter measurement of 1544, 2048, 6312, 8448, 32064, 44736 kbps • 2^20 - O.153 • 2^20 - O.151 - Error and Jitter measurement upto 72 kbps • 2^23 - O.151 - Error and Jitter measurement of 34368 kbps and 139264 kbps

Configuring BERT in Modes VC-4 and VC Nc

To configure BERT in modes VC-4 and VC Nc:

```
configure terminal
controller sdh 0/4/7
rate STM1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
```

```
au-4 1
mode vc4
clock source internal
bert pattern 2^15 internal 10 direction [line | system]
```

Verifying BERT Configuration in Modes VC-4 and VC Nc

Use **show controllers** command to verify BERT Configuration in Modes VC-4 and VC Nc:

```
#show controller sdh 0/4/7 | sec BERT
BERT test result (running)Test Pattern : 2^15,
Status : Sync, Sync Detected : 0Interval : 10 minute(s),
Time Remain : 00:09:47
Bit Errors (since BERT started): 0 Mbits,Bits Received (since BERT started): 0 Mbits
Bit Errors (since last sync): 1943 bits
Bits Received (since last sync): 1943 Kbits
Direction : LineRouter#
```

Configuring T1 Bert

To configure T1 Bert:

```
enable
configure terminal
controller sdh 0/5/0
rate stm4
au-3 1
mode vc1x
tug-2 1 payload vc11
t1 1 bert pattern 2^11 interval 10
end
```

Configuring E1 Bert

To configure E1 Bert:

```
enable
configure terminal
controller MediaType 0/5/0
mode sdh
controller sdh 0/5/0
rate stm4
au-3 1
mode vc1x
tug-2 1 payload vc12
e1 1 bert pattern 2^11 interval 10
end
```

Configuring BERT in Mode T3/E3

To configure BERT in Mode T3/E3 for both AUG mapping AU-3 and AU-4:

```
configure terminal
controller sdh 0/4/7
rate STM1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
```

```
aug mapping au-4
au-4 1
mode tug-3
clock source internal
tug-3 1
mode t3
threshold b3-tca 0
overhead c2 0
t3 clock source internal
t3 bert pattern 2^15 internal 10 direction [line | system]
```

Verifying BERT Configuration in Mode T3/E3

Use **show controllers** command to verify BERT configuration in mode T3/E3:

```
show controller sdh 0/4/7 | sec BERT
BERT test result (running)Test Pattern : 2^15,
Status : Sync, Sync Detected : 0Interval : 10 minute(s),
Time Remain : 00:09:47
Bit Errors (since BERT started): 0 Mbits,
Bits Received (since BERT started): 0 Mbits
Bit Errors (since last sync): 1943 bits
Bits Received (since last sync): 1943 Kbits
Direction : Line
```

Configuring BERT in Mode VC-1x

To configure BERT in mode VC-1x for both AUG mapping AU-3 and AU-4:

```
configure terminal
controller sdh 0/4/7
rate STM1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
mode tug-3
clock source internal
tug-3 1
mode vc-1x
tug-2 1 payload VC11
t3 bert pattern 2^15 internal 10 direction [line | system]
```

Verifying BERT Configuration in Mode VC-1x

Use **show controllers** command to verify BERT configuration in mode VC-1x:

```
#show controller sdh 0/4/7 | sec BERT
BERT test result (running)Test Pattern : 2^15,
Status : Sync, Sync Detected : 0Interval : 10 minute(s),
Time Remain : 00:09:47Bit Errors (since BERT started): 0 Mbits,Bits Received (since BERT
started): 0 Mbits
Bit Errors (since last sync): 1943 bits
Bits Received (since last sync): 1943 Kbits
Direction : Line
```

Configuring BERT in SDH for CESoPSN

Bit-Error Rate Testing (BERT) is used for analyzing quality and for problem resolution of digital transmission equipment. BERT tests the quality of an interface by directly comparing a pseudorandom or repetitive test pattern with an identical locally generated test pattern.

The BERT operation is data-intensive. Regular data cannot flow on the path while the test is in progress. The path is reported to be in alarm state when BERT is in progress and restored to a normal state after BERT has been terminated.

The supported BERT patterns are 2^11, 2^15, 2^20-O153, and 2^20-QRSS.

BERT is supported in the following two directions:

- Line - Supports BERT in TDM direction.
- System - Supports BERT in PSN direction.

The following table shows the SDH level of BERT patterns supported.

Modes	Patterns
SDH - AU-3 Mapping - AU3_T1	• 2^11 - • 2^15- Error and Jitter measurement of 1544, 2048, 6312, 8448, 32064, 44736 kbps • 2^20 - O.153 • 2^20-QRSS
SDH - AU-4 Mapping - AU4_E1	• 2^11 - • 2^15- Error and Jitter measurement of 1544, 2048, 6312, 8448, 32064, 44736 kbps • 2^20 - O.153 • 2^20-QRSS

Restrictions for SDH BERT on CESoPSN

- In the system-level BERT for CESoPSN, only the full timeslot is supported and the fractional timeslot is not supported.
- In the BERT timeslot configuration, the timeslot should be same as the one provided in the CEM configuration.

Configuring BERT in AUG mapping AU-3 VC1x T1 for CESoPSN

To configure BERT in AUG Mapping AU-3 VC1x T1 for CESoPSN:

```
router#configure terminal
router(config)#controller mediatype 0/5/0
router(config)#mode sdh
router(config)#controller sdh 0/5/0
router(config)#rate stm1
router(config)#controller sdh 0/5/0
router(config-controller)#aug mapping au-3
router(config-controller)#au-3 1
router(config-ctrlr-au3)#mode vc1x
router(config-ctrlr-au3)#!
router(config-ctrlr-au3)#Tug-2 1 payload vc11
router(config-ctrlr-tug2-vcx)#T1 1 bert timeslots 1 - 7 pattern 2^11 interval 1 direction
line
router(config-ctrlr-tug2-vcx)#end
```

Configuring BERT in AUG mapping AU-4 VC1x E1 for CESoPSN

To configure BERT in AUG mapping AU-4 VC1x E1:

```
router#configure terminal
router(config)#controller mediatype 0/5/0
router(config)#mode sdh
router(config)#controller sdh 0/5/0
router(config)#rate stm1
router(config)#controller sdh 0/5/0
router(config-controller)#aug mapping au-4
router(config-controller)#au-4 1
router(config-ctrlr-au4)#tug-3 1
router(config-ctrlr-tug3)#mode vc1x
router(config-ctrlr-tug3)#Tug-2 1 payload vc12
router(config-ctrlr-tug2-vcx)#e1 1 bert timeslots 1 - 7 pattern 2^11 interval 1 direction
line
router(config-ctrlr-tug2-vcx)#end
```

Verifying BERT Configuration in AUG mapping AU-3 VC1x T1 or AU-4 VC1x E1 for CESoPSN

Use **show controller** command to verify BERT configuration in mode VC-1x:

```
Router# show controller sdh 0/5/0.1/1/1 | sec BERT

  BERT running on timeslots 1,2,3,4,5,6,7,
  BERT test result (running)
     Test Pattern : 2^11, Status : Sync, Sync Detected : 1
     Interval : 1 minute(s), Time Remain : 00:00:52
     Bit Errors (since BERT started): 0 bits,
     Bits Received (since BERT started): 3 Mbits
     Bit Errors (since last sync): 0 bits
     Bits Received (since last sync): 3 Mbits
     Direction   : Line
```

SDH T1/E1 Configuration Parameters for SAToP

The following parameters affect SDH T1/E1 configuration:

- **BERT** — Starts the BERT test.
- **MDL** — Sets the Maintenance Data Link.
- **CEM Group** — Creates a circuit emulation (CEM) channel from one or more time slots of a T1 or E1 line of an NM-CEM-4TE1 network module,
- **Clock** — Specifies the clock source for T1 or E1 interface.
- **Description** — Specifies the description of the controller.
- **Loopback** — Sets the T1 or E1 interface in the loopback mode.

Configuring T1/E1 Parameters

To configure T1/E1 parameters:

```
enable
configure terminal
controller sdh 0/5/0
rate stm4
au-3 1
mode vc1x
tug-2 1 payload vc11
t1 1 loopback [local | network line]
t1 1 clock source [line | internal | recovered]
end
```

Note Loopback network payload is not supported. This is applicable for AU-4 Vc-1x and AU-3 Vc-1x modes.

Note If T1/E1 is enabled on a particular J/K/L/M, you can only configure overhead and threshold for that J/K/L/M value.

Verifying T1 or E1 Parameters Configuration

Use **show running-configuration** command to verify T1 or E1 parameters configuration:

```
# show running-configuration
controller SDH 0/4/0
rate STM1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
clock source internal
```

```
mode tug-3
tug-3 2
mode VC1x
tug-2 1 payload VC11
t1 1 loopback network line
t1 1 clock source line
```

SDH T3/E3 Configuration Parameters for SAToP

The following parameters affect SDH T3/E3 configuration:

- **Clock** — Specifies the clock source for T3 or E3 link.
- **Loopback** — Sets the T3 or E3 link in the loopback mode.
- **CEM Group** — Creates a circuit emulation (CEM) channel from one or more time slots of a T1 or E1 line of an NM-CEM-4TE1 network module.
- **MDL** — Sets the Maintenance Data Link. This is only supported for T3.
- **BERT** — Bit-Error Rate Testing (BERT) is used for analyzing quality and for problem resolution of digital transmission equipment.

Configuring SDH T3/E3 Parameters Configuration

To configure SDH T3/E3 parameters configuration:

```
enable
configure terminal
controller sdh 0/5/0
rate stm4
au-4 1
mode tug 3
tug-3 1
mode e3
e3 clock source [line | internal | recovered]
e3 framing  [g751 | g832 ] (applicable to mode e3)
e3 loopback [local | network line ]
e3 bert pattern 0s interval 2
tug-3 2
mode t3
t3 1 clock source [line | internal | recovered]
t3 framing [m13 | c-bit ] (applicable to for mode t3)
t3 1 loopback [local | network line]
t3 bert pattern 0s interval 2
end
```

Note This is applicable to AUG mappaing AU-4 mode T3/E3 and AU-3 mode T3/E3.

Verifying SDH T3 or E3 Parameters Configurations

Use **show running-configuration** command to verify SDH T3 or E3 parameters configurations:

```
router# show running-configuration
controller sdh
rate stm1
au-4 2
mode tug-3
clock source internal
tug-3 1
mode E3
threshold b3-tca 0
overhead c2 0
e3 clock source internal
e3 framing g751
!tug-3 2mode T3
threshold b3-tca 0
overhead c2 0
t3 clock source internal
t3 framing c-bit!
```

SDH VC Configuration Parameters for SAToP

The following parameters affect SDH VC configuration:

- **BERT** — Starts the BERT test.
- **CEM Group** — Specifies the time slots for CEM group mapping.
- **Clock** — Specifies the clock source for VC.
- **Loopback** — Sets the VC in the loopback mode.
- **Overhead** — Configures VC line path overhead flags.
- **Shutdown** — Disables the VC interface.

Configuring VC Parameters

To configure VC parameters:

```
enable
configure terminal
controller sdh 0/5/0
rate stm4
au-3 1
mode vc1x
tug-2 1 payload vc11
vc 1 loopback [local | network]
vc 1 clock source internal
vc 1 overhead j2 expected [16  | 64]
vc 1 overhead j2 expected message STRING
vc 1 overhead j2 tx [16  | 64]
vc 1 overhead j2 tx message STRING
vc 1 overhead v5 [0 - 7]
vc 1 [threshold bip2-sd 4 | threshold bip2-sf  4 | threshold bip2-tca 9]
end
```

Note v5 overhead should match with the far end tx v5.

Verifying VC Configuration Parameters Configurations

Use **show running-configuration** command to verify VC configuration parameters configuration:

```
# show running-configuration
controller SDH 0/4/0
rate STM1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
clock source internal
mode tug-3
tug-3 1
mode VC1x
tug-2 1 payload VC11
vc 1 overhead j2 tx message STRING
vc 1 overhead j2 expected message STRING
vc 1 threshold bip2-sd 4
vc 1 threshold bip2-sf 4
vc 1 threshold bip2-tca 9
```

Configuring CEM Group for CESoPSN

Configuring CEM Group for AU3-T1 on SDH for CESoPSN

To configure MediaType controller and rate on SDH port, use the following commands:

```
enable
configure terminal
controller mediatype 0/5/0
mode sdh
controller sdh 0/5/0
rate stm1
end
```

To configure CEM group for AU3-T1 on SDH for CESoPSN, use the following commands:

```
enable
configure terminal
controller sdh 0/5/0
aug mapping au-3
au-3 1
mode vc1x
Tug-2 1 payload vc11
T1 1 cem-group 0 timeslots 1 - 7
T1 1 framing esf
vc 1 overhead v5 2
end
```

Verifying CEM Group for AU3-T1 on SDH for CESoPSN

This section includes show command to verify CEM Group for AU3-T1 on SDH for CESoPSN:

```
Router# show cem circuit interface cem 0/5/0

sdh0/5/0, ID: 0, Line: UP, Admin: UP, Ckt: ACTIVE
Path Mode : VC1X,Payload:VC11, AU3: 1, TUG-2: 1, T1: 1,CEM Mode: sdh-CESoP
Controller state: up, T1/E1 state: up
Idle Pattern: 0xFF, Idle CAS: 0x8
Dejitter: 6 (In use: 0)
Payload Size: 56
Framing: Framed (DS0 channels: 1-7)
CEM Defects Set
None

Signalling: No CAS
RTP: No RTP

Ingress Pkts:    54113124             Dropped:             0
Egress Pkts:     54112259             Dropped:             0

CEM Counter Details
Input Errors:    0                    Output Errors:       0
Pkts Missing:    868                  Pkts Reordered:      0
Misorder Drops:  0                    JitterBuf Underrun:  869
Error Sec:       0                    Severly Errored Sec: 0
Unavailable Sec: 0                    Failure Counts:      28
Pkts Malformed:  0                    JitterBuf Overrun:   0
Generated Lbits: 0                    Received Lbits:      0
Generated Rbits: 868                  Received Rbits:      1830
Generated Mbits: 146392               Received Mbits:      232588
```

Configuring CEM Group for AU4-E1 on SDH for CESoPSN

To configure MediaType controller and rate on SDH port, use the following commands:

```
enable
configure terminal
controller mediatype 0/5/0
mode sdh
controller sdh 0/5/0
rate stm1
end
```

To configure CEM group for AU4-E1 on SDH for CESoPSN, use the following commands:

```
enable
configure terminal
controller sdh 0/5/0
aug mapping au-4
au-4 1
mode tug-3
tug-3 1
mode vc1x
Tug-2 1 payload vc12
e1 1 cem-group 0 timeslots 1 - 7
vc 1 overhead v5 2
end
```

Verifying CEM Group for AU4-E1 on SDH for CESoPSN

This section includes show command to verify CEM Group for AU4-E1 on SDH for CESoPSN:

```
Router# show cem circuit interface cem 0/5/0

sdh0/5/0, ID: 0, Line: UP, Admin: UP, Ckt: ACTIVE
Path Mode : VC1X,Payload:VC12, AU4: 1, TUG-3: 1, E1: 1,CEM Mode: sdh-CESoP
Controller state: up, T1/E1 state: up
Idle Pattern: 0xFF, Idle CAS: 0x8
Dejitter: 6 (In use: 0)
Payload Size: 56
Framing: Framed (DS0 channels: 1-7)
CEM Defects Set
None

Signalling: No CAS
RTP: No RTP

Ingress Pkts:    54113124             Dropped:             0
Egress Pkts:     54112259             Dropped:             0

CEM Counter Details
Input Errors:    0                    Output Errors:       0
Pkts Missing:    868                  Pkts Reordered:      0
Misorder Drops:  0                    JitterBuf Underrun:  869
Error Sec:       0                    Severly Errored Sec: 0
Unavailable Sec: 0                    Failure Counts:      28
Pkts Malformed:  0                    JitterBuf Overrun:   0
Generated Lbits: 0                    Received Lbits:      0
Generated Rbits: 868                  Received Rbits:      1830
Generated Mbits: 146392               Received Mbits:      232588
```

Loopback Remote on T1 and T3 Interfaces

The remote loopback configuration attempts to put the far-end T1 or T3 into a loopback.

The remote loopback setting loops back the far-end at line or payload, using IBOC (inband bit-orientated CDE) or the ESF loopback codes to communicate the request to the far-end.

Restrictions for Loopback Remote

E1 and E3 loopback remote are not supported.

Configuring Loopback Remote in SDH

To set T1 loopback remote iboc fac1/fac2/csu for OCX in SDH, perform the following tasks in global configuration mode:

```
enable
configure terminal
controller sdh 0/2/0
mode vc1x
tug-2 1 payload vc1x
```

```
t1 1 loopback remote iboc {fac1 | fac2 | csu}
```

To set T1 loopback remote iboc esf line csu/esf payload for OCX in SDH, perform the following tasks in global configuration mode:

```
enable
configure terminal
controller sdh 0/2/0
mode vc1x
tug-2 1 payload vc1x
t1 1 loopback remote esf {line csu | payload}
```

To set T3 loopback remote line/payload for OCX in SDH, perform the following tasks in global configuration mode:

```
enable
configure terminal
controller sdh 0/2/0
mode t3
t3 loopback remote {line | payload}
```

Note **loopback remote esf line niu** is not supported.

Verifying the Loopback Remote Configuration

Use the following command to check the T1 loopback remote configuration:

```
router# show run | sec 0/2/0
controller SDH 0/2/0
rate STM1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
  clock source internal
 mode tug-3
  tug-3 1
   mode VC1x
   tug-2 1 payload VC11
    t1 1 Loopback remote iboc fac1
```

Use the following command to verify the T1 loopback remote configuration:

```
Router(config-ctrlr-tug2-vcx)#do show controller sdh 0/2/0 | be T1 1
AU-4 1, TUG-3 1, TUG-2 1, T1 1 (C-11 1/1/1/1) is up
  timeslots:
  Configured for NIU FAC1 Line Loopback with IBOC
  Currently in Inband Remotely Line Looped
  Receiver has no alarms.
  Framing is SF, Clock Source is Internal
  Data in current interval (250 seconds elapsed):
   Near End
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
```

```
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs
     0 Unavailable Secs, 0 Stuffed Secs
     0 Path Failures, 0 SEF/AIS Secs
   Far End
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs
     0 Unavailable Secs 0 Path Failures
  Data in Interval 1:
   Near End
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 2 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     2 Errored Secs, 0 Bursty Err Secs, 2 Severely Err Secs
     0 Unavailable Secs, 0 Stuffed Secs
     1 Path Failures, 2 SEF/AIS Secs
   Far End
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 2 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     3 Errored Secs, 0 Bursty Err Secs, 3 Severely Err Secs
     0 Unavailable Secs 0 Path Failures
  Total Data (last 1 15 minute intervals):
   Near End
     0 Line Code Violations,0 Path Code Violations,
     0 Slip Secs, 2 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins,
     2 Errored Secs, 0 Bursty Err Secs, 2 Severely Err Secs
     0 Unavailable Secs, 0 Stuffed Secs
     1 Path Failures, 2 SEF/AIS Secs
   Far End
     0 Line Code Violations,0 Path Code Violations
     0 Slip Secs, 2 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins,
     3 Errored Secs, 0 Bursty Err Secs, 3 Severely Err Secs
     0 Unavailable Secs, 0 Path Failures
```

Use the following command to check the T3 loopback remote configuration:

```
Router#show run | sec 0/4/7
platform enable controller MediaType 0/4/7 oc3
controller MediaType 0/4/7
mode sdh
controller SDH 0/4/7
rate STM1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
  clock source internal
  mode tug-3
  tug-3 1
   mode T3
   t3 clock source internal
   t3 framing c-bit
   t3 loopback remote line
```

Use the following command to verify the T3 loopback remote configuration:

```
Router#show controll sdh 0/4/7 | be T3
SDH 0/4/7.1/1 T3 is up. (Configured for Remotely Looped)
  Hardware is NCS4200-1T8S-10CS
  Applique type is T3
```

```
  Receiver has no alarms.
  Data in current interval (240 seconds elapsed):
   Near End
     0 Line Code Violations, 0 P-bit Coding Violations
     0 C-bit Coding Violations, 0 P-bit Err Secs
     0 P-bit Severely Err Secs, 0 Severely Err Framing Secs
     0 Unavailable Secs, 0 Line Errored Secs
     0 C-bit Errored Secs, 0 C-bit Severely Errored Secs
     0 Severely Errored Line Secs, 0 Path Failures
     0 AIS Defect Secs, 0 LOS Defect Secs
   Far End
     0 Errored Secs, 0 Severely Errored Secs
     0 C-bit Unavailable Secs, 0 Path Failures
     0 Code Violations, 0 Service Affecting Secs
  Data in Interval 1:
   Near End
     0 Line Code Violations, 0 P-bit Coding Violations
     0 C-bit Coding Violations, 0 P-bit Err Secs
     0 P-bit Severely Err Secs, 0 Severely Err Framing Secs
     20 Unavailable Secs, 20 Line Errored Secs
     0 C-bit Errored Secs, 0 C-bit Severely Errored Secs
     20 Severely Errored Line Secs, 1 Path Failures
     0 AIS Defect Secs, 20 LOS Defect Secs
   Far End
     0 Errored Secs, 0 Severely Errored Secs
     0 C-bit Unavailable Secs, 0 Path Failures
     0 Code Violations, 0 Service Affecting Secs
  Total Data (last 1 15 minute intervals):
   Near End
     0 Line Code Violations, 0 P-bit Coding Violations,
     0 C-bit Coding Violations, 0 P-bit Err Secs,
     0 P-bit Severely Err Secs, 0 Severely Err Framing Secs,
     20 Unavailable Secs, 20 Line Errored Secs,
     0 C-bit Errored Secs, 0 C-bit Severely Errored Secs
     20 Severely Errored Line Secs, 1 path failures
     0 AIS Defect Secs, 20 LOS Defect Secs
   Far End
     0 Errored Secs, 0 Severely Errored Secs
     0 C-bit Unavailable Secs, 0 Path Failures
     0 Code Violations, 0 Service Affecting Secs

T1 1 is up
  timeslots:
  FDL per AT&T 54016 spec.
  No alarms detected.
  Framing is ESF, Clock Source is Internal
  Data in current interval (250 seconds elapsed):
   Near End
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs
     0 Unavailable Secs, 0 Stuffed Secs
     0 Path Failures, 0 SEF/AIS Secs
   Far End
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs
     0 Unavailable Secs 0 Path Failures
  Data in Interval 1:
   Near End
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 2 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     2 Errored Secs, 0 Bursty Err Secs, 2 Severely Err Secs
     0 Unavailable Secs, 0 Stuffed Secs
```

```
      1 Path Failures, 2 SEF/AIS Secs
    Far End
      0 Line Code Violations, 0 Path Code Violations
      0 Slip Secs, 2 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
      3 Errored Secs, 0 Bursty Err Secs, 3 Severely Err Secs
      0 Unavailable Secs 0 Path Failures
   Total Data (last 1 15 minute intervals):
    Near End
      0 Line Code Violations,0 Path Code Violations,
      0 Slip Secs, 2 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins,
      2 Errored Secs, 0 Bursty Err Secs, 2 Severely Err Secs
      0 Unavailable Secs, 0 Stuffed Secs
      1 Path Failures, 2 SEF/AIS Secs
    Far End
      0 Line Code Violations,0 Path Code Violations
      0 Slip Secs, 2 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins,
      3 Errored Secs, 0 Bursty Err Secs, 3 Severely Err Secs
      0 Unavailable Secs, 0 Path Failures
```

Configuring ACR and DCR for SAToP

Configuring ACR for SAToP

Adaptive Clock Recovery (ACR) is an averaging process that negates the effect of random packet delay variation and captures the average rate of transmission of the original bit stream. ACR recovers the original clock for a synchronous data stream from the actual payload of the data stream. In other words, a synchronous clock is derived from an asynchronous packet stream. ACR is a technique where the clock from the TDM domain is mapped through the packet domain, but is commonly used for SAToP.

To configure E1 ACR:

```
enable
configure terminal
controller sdh 0/4/0
rate STM1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
clock source internal
mode tug-3
tug-3 1
mode vc1x
tug-2 1 payload vc12
e1 1 cem-group 1 unframed
e1 1 clock source recovered 1
tug-2 2 payload vc11
tug-2 3 payload vc11
tug-2 4 payload vc11
end
```

To configure E3 ACR:

```
enable
configure terminal
controller sdh 0/4/0
```

```
rate STM1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
clock source internal
mode tug-3
tug-3 1
mode e3
overhead c2 0
cem-group 1 unframed
e3 clock source recovered 1
```

ACR Global Configuration

```
enable
configure terminal
recovered-clock 0 4
clock recovered 1 adaptive cem 0 1
end
```

Verifying ACR Configuration

Use **show recovered clock** command to verify E1 ACR configuration:

```
#show recovered clock
Recovered clock status for subslot 0/4
----------------------------------------
Clock    Type     Mode        CEM    Status    Frequency Offset(ppb)  Circuit-No
1        STMx-E1  ADAPTIVE     1    ACQUIRED   n/a                    0/1/1/1/1
(Port/au-4/tug3/tug2/e1)
```

Use **show recovered clock** command to verify E3 ACR configuration:

```
#show recovered clock
Recovered clock status for subslot 0/4
----------------------------------------
Clock    Type     Mode        CEM    Status    Frequency Offset(ppb)  Circuit-No
1       STMx-E3  ADAPTIVE     1    ACQUIRED   n/a                   0/1/1 (Port/au-4/tug3)
```

Configuring DCR for SAToP

Differential Clock Recovery (DCR) is another technique used for Circuit Emulation (CEM) to recover clocks based on the difference between PE clocks. TDM clock frequency are tuned to receive differential timing messages from the sending end to the receiving end. A traceable clock is used at each end, which ensures the recovered clock is not affected by packet transfer.

To configure E1 DCR:

```
enable
configure terminal
controller sdh 0/4/0
rate STM1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
```

```
clock source internal
mode tug-3
tug-3 1
mode vc1x
tug-2 1 payload vc12
e1 1 cem-group 1 unframed
e1 1 clock source recovered 1
tug-2 2 payload vc11
tug-2 3 payload vc11
tug-2 4 payload vc11
end
```

To configure E3 DCR:

```
enable
configure terminal
controller sdh 0/4/0
rate STM1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
clock source internal
mode tug-3
tug-3 1
mode e3
overhead c2 0
cem-group 1 unframed
e3 clock source recovered 1
```

DCR Global Configuration

```
enable
configure terminal
recovered-clock 0 4
clock recovered 1 differential cem 0 1
end
```

Verifying DCR Configuration

Use **show recovered clock** command to verify E1 DCR configuration:

```
#show recovered clockRecovered clock status for subslot 0/4
----------------------------------------
Clock     Type      Mode           CEM    Status    Frequency Offset(ppb)  Circuit-No
1         STMx-E1   DIFFERENTIAL     1    ACQUIRED   n/a                     0/1/1/1/1
(Port/au-4/tug3/tug2/e1)
```

Use **show recovered clock** command to verify E3 DCR configuration:

```
#show recovered clock
Recovered clock status for subslot 0/4
----------------------------------------
Clock     Type      Mode          CEM    Status    Frequency Offset(ppb)  Circuit-No
1         STMx-E3   DIFFERENTIAL     1    ACQUIRED   n/a                     0/1/1
(Port/au-4/tug3)
```

Configuring ACR and DCR for CESoPSN

Configuring ACR for CESoPSN

To configure CEM for CESoPSN:

```
router#configure terminal
router(config)#controller sdh 0/5/0
router(config-controller)#au-3 1
router(config-ctrlr-au3)#tug-2 1 payload vc11
router(config-ctrlr-tug2-vcx)#t1 1 clock source recovered 1
router(config-ctrlr-tug2-vcx)#end
```

To configure CEM for CESoPSN:

```
router#configure terminal
router(config)#controller sdh 0/5/0
router(config-controller)#au-3 1
router(config-ctrlr-au3)#tug-2 1 payload vc11
router(config-ctrlr-tug2-vcx)#t1 2 clock source recovered 1
router(config-ctrlr-tug2-vcx)#end
```

To configure recovered clock for CESoPSN:

```
router#configure terminal
router(config)#recovered-clock 0 5
router(config-clock)#clock recovered 1 adaptive cem 0 1 priority 1
router(config-clock)#end
```

To configure recovered clock for CESoPSN:

```
router#configure terminal
router(config)#recovered-clock 0 5
router(config-clock)#clock recovered 1 adaptive cem 0 2 priority 2
router(config-clock)#end
```

Note Ensure that you configure ACR with two priorities, priority 1 and priority 2, on different cem IDs.

Verifying ACR Configuration for CESoPSN

Use the **show recovered clock command** to verify ACR configuration:

```
Router# show recovered clock
Recovered clock status for SDH-ACR 200
----------------------------------------
Clock    Type     Mode        CEM    Status        Circuit-No          Working     Protect
   Priority
4     OCx-T1   ADAPTIVE      38   ACQUIRING  200/3/1/1(acr/path/vtg/t1) ACQUIRIN  ACQUIRING
  1
```

Configuring DCR for CESoPSN

To configure CEM for CESoPSN:

```
router#configure terminal
router(config)#controller sdh 0/5/0
router(config-controller)#au-3 1
router(config-ctrlr-au3)#tug-2 1 payload vc11
router(config-ctrlr-tug2-vcx)#t1 1 clock source recovered 1
router(config-ctrlr-tug2-vcx)#end
```

To configure CEM for CESoPSN:

```
router#configure terminal
router(config)#controller sdh 0/5/0
router(config-controller)#au-3 1
router(config-ctrlr-au3)#tug-2 1 payload vc11
router(config-ctrlr-tug2-vcx)#t1 2 clock source recovered 1
router(config-ctrlr-tug2-vcx)#end
```

To configure recovered clock for CESoPSN:

```
router#configure terminal
router(config)#recovered-clock 0 5
router(config-clock)#clock recovered 1 differential cem 0 1 priority 1
router(config-clock)#end
```

To configure recovered clock for CESoPSN:

```
router#configure terminal
router(config)#recovered-clock 0 5
router(config-clock)#clock recovered 1 differential cem 0 2 priority 2
router(config-clock)#end
```

Ensure that you configure DCR with two priorities, priority 1 and priority 2, on different cem IDs.

Verifying DCR Configuration for CESoPSN

Use the **show recovered clock command** to verify DCR configuration:

```
Router# show recovered clock
Recovered clock status for SSDH-DCR 200
----------------------------------------
Clock    Type     Mode         CEM    Status        Circuit-No          Working     Protect
   Priority
5     OCx-T1   DIFFERENTIAL  44   ACQUIRING  200/4/1/1(acr/path/vtg/t1) ACQUIRIN  ACQUIRING
  1
```

CHAPTER 6

Configuring MSP on 1-Port OC192/STM-64 or 8-Port OC3/12/48/STM-1/-4/-16 Module

Multiplex Section Protection (MSP) is a protection mechanism for SDH networks that enables SDH connections to switch to another SDH circuit when a port failure occurs. A protection interface serves as the backup interface for the working interface. When the working interface fails, the protection interface quickly assumes its traffic load.

The SDH protection schemes comply with GR-253 and ITU-T G.783. It allows Optical Interface Module to work seamlessly as SDH Add or Drop Multiplexers (ADMs). The implementation of the above protection schemes allows a pair of SDH lines or paths to be configured for line or path redundancy. In the event of a fiber cut, the active line or path switches automatically to the standby line or path up to 60 milliseconds (2/5/10 millisecond for holdover and 50 millisecond switchovers).

Optical Interface Module supports the following SDH protection switching schemes:

- Linear Bidirectional 1+1 MSP
- Linear Unidirectional 1+1 MSP

1+1 MSP

In the 1+1 architecture, there is one working interface (circuit) and one protection interface, and the same payload from the transmitting end is sent to both the receiving ends. The receiving end decides which interface to use. The line overhead (LOH) bytes (K1 and K2) in the SDH frame indicate both status and action.

The protection interfaces need to be configured with an IP address of the chassis that has the working interface, using MSP commands. The MSP Protect Group Protocol, which runs on top of UDP, provides communication between the process controlling the working interface and the process controlling the protection interface.

Using this protocol, interfaces can be switched because of a chassis failure, degradation or loss of channel signal, or manual intervention. In bidirectional mode, the receive and transmit channels are switched as a pair.

Two SDH connections are required to support MSP.

The following option is available for linear bidirectional 1+1 MSP:

- Revertive option — For any failure on working line, the software switches to protection line and when the working line recovers, it waits based on the revertive timer and reverts back to working line as active link.
- Non-revertive option — When the signal fails, the software switches to the protection line and does not automatically revert back to the working line. This is the default option.

The following features are supported on 1+1 MSP:

- SDH PW (SAToP or CEP)
- SDH local connect

Benefits of MSP

The following lists the benefits of MSP:

- MSP performs switchovers with minimal loss of data, and time-consuming reroutes are avoided.
- There is no visibility that a failure has occurred beyond the network element in which it is residing; other nodes are not affected by the failure.
- Implementation of MSP guards a network against complex restarts and resynchronizations since failures are isolated to a local device.
- With MSP, the effect of a failure is greatly minimized, and a fast switchover guarantees minimal effect on the network.

Restrictions for MSP

- MSP is supported on all the ports except on the 8th port with STM-64.
- Loopback, BERT, ACR and DCR, and Clocking should be configured on physical member controllers.

MSP 1+1 for SDH Layer 1 traffic

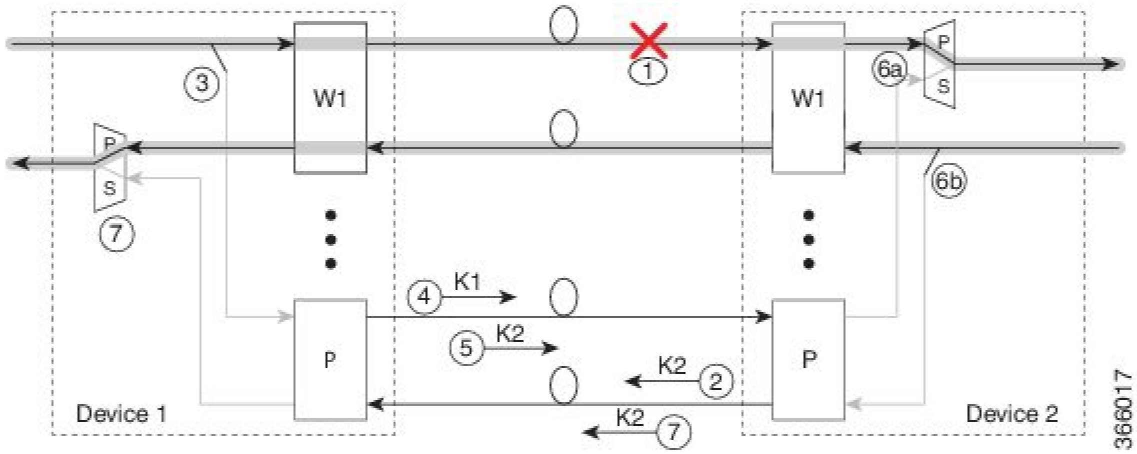
SDH linear MSP 1+1 provides protection against both fiber cuts and front card or back card failures. MSP 1+1 requires a redundant protection line for every working line. The traffic is simultaneously carried by the working and the protection lines. Hence, the receiver that terminates the MSP 1+1 should select the traffic from one of the line and continue to forward the traffic. MSP 1+1 provides protection in unidirectional and bi-directional modes:

- **Uni-directional Protection**: The receiving end can switch from working to protection line without any coordination at the transmit end since both lines transmit the same information.

- **Bi-directional Protection**: The receiving end switches from working to protection line by coordinating at the transmit end.

Scenario for Bidirectional MSP 1+1

Figure 8: Bidirectional MSP 1+1



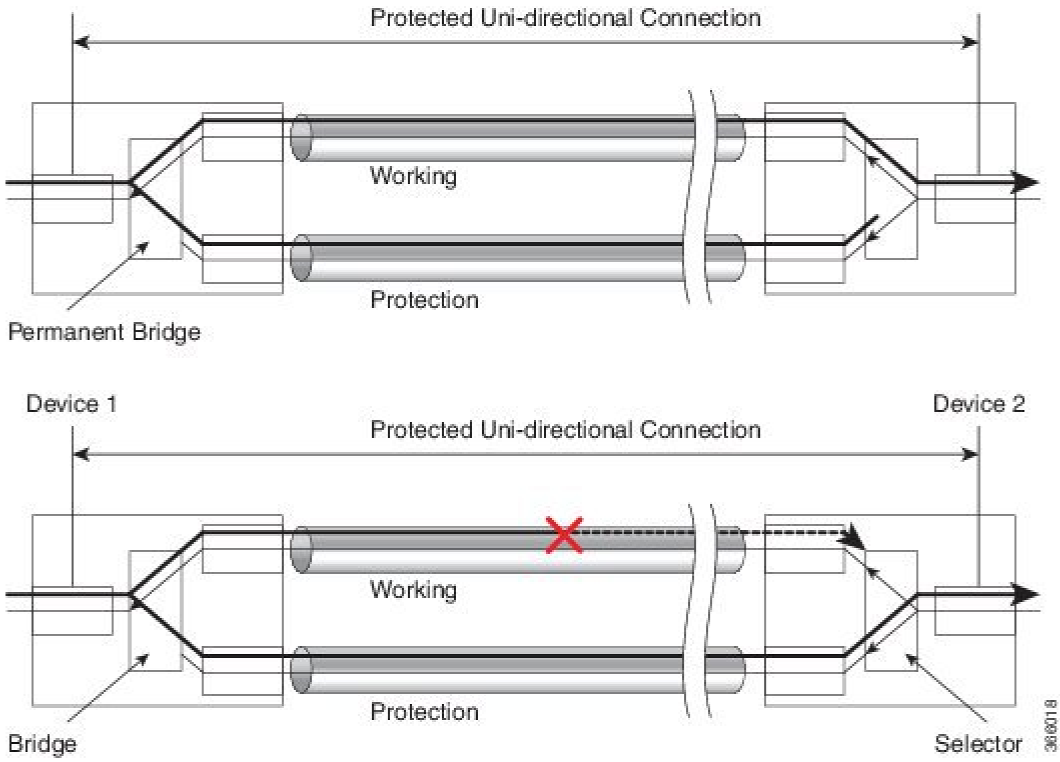
In the above figure, two devices are connected to provide MSP 1+1 bi-directional protection. The highlighted one is the working line and the other is the protection line. The traffic is transmitted on both working and protection lines and received only on one line.

In a scenario where you encounter a fiber cut,

1. There is a cable cut in the working line. So, the device 2 receives a Loss of Signal (LOS) on working line.
2. Device 2 starts generating K2 byte and sends it to the Device 1 over the protection line.
3. Device 1 receives the K2 byte and reacts on the receiving K2 byte.
4. Device 1 starts sending K1 byte to the Device 2 on the protection line.
5. Device 1 starts sending K2 byte to Device 2 on the protection line.
6. Device 2 receives the K1/K2 byte and starts receiving the data from protection line. The protection line now acts as the active line.
7. Device 2 sends K2 byte over the new active line to Device 1 . Device 1 receives this signal and starts accepting the data from this new active line.

Scenario for Unidirectional MSP 1+1

Figure 9: Unidirectional MSP 1+1



In the above figure, two devices are connected to provide MSP 1+1 unidirectional protection. The figure shows a working line and a protection line. The traffic is transmitted on both working and protection line and received only on one line.

In a scenario where you encounter a fiber cut,

1. Device 1 receives a LOS on RX working line.
2. Device 2 detects LOS and starts receiving the data from the protection line. The protection line now becomes the active line.
3. Device 1 receives the K2 byte and knows about switching event on device 2.

Configuring MSP for SAToP

This section describes the configuration of MSP.

Configuring Bi-directional MSP (SDH Framing)

To configure bi-directional MSP (SDH Framing):

```
enable
configure terminal
```

```
controller MediaType 0/5/0
mode sdh
controller sdh 0/4/0
clock source internal
aps group acr 1
aps working 1
exit
controller sdh 0/5/0
aps group acr 1
aps protect 1 10.7.7.7
end
```

Note To restore the system to its default condition, use the **no** form of the command.

Note '10.7.7.7' is the loopback interface IP address on the same router.

Configuring Revertive Mode

To configure revertive mode:

```
enable
configure terminal
controller MediaType 0/5/0
mode sdh
controller sdh 0/5/0
clock source internal
aps group acr 1
aps working 1
exit
controller sdh 0/5/0
aps group acr 1
aps protect 1 10.7.7.7
aps revert 3
aps adm
end
```

Note 3 is the time in minutes for reverting back to the working port after it becomes available.

Configuring Unidirectional MSP (SDH Framing)

To configure unidirectional MSP (SDH Framing):

```
enable
configure terminal
controller MediaType 0/5/0
mode sdh
controller sdh 0/5/0
clock source internal
aps group acr 1
aps working 1
exit
controller sdh 0/5/0
aps group acr 1
aps protect 1 10.7.7.7
```

```
aps unidirectional
aps adm
end
```

Note To restore the system to its default condition, use the **no** form of the command.

APS operational commands are supported only on protect controller. The following are the operational commands for MSP with APS.

- **aps lockout**:

  This command locks the switch to protect port so that APS does not switch to protect controller for any failure on working port or IM.

- **aps force** *1*:

  This command forces the traffic to switch from active working controller to switch to protect controller.

- **aps force** *0*:

  This command forces the traffic to switch from active protect controller to switch to working controller.

- **aps manual** *1*:

  This command switches the traffic from active protect controller to work controller in the absence of **aps force** and **aps lockout** commands.

- **aps manual** *0*:

  This command switches the traffic from active protect controller to work controller in the absence of **aps force** and **aps lockout** commands.

Verifying MSP Configuration for SAToP

Use **show aps** and **show cem circuit** commands to verify MSP configuration:

```
Device#show aps
SDH 0/4/6 APS Group 1: protect channel 0 (Active)
 Working channel 1 at 1.1.1.1 (Disabled)
  bidirectional, non-revertive
  PGP timers (default): hello time=1; hold time=3
  hello fail revert time=120
 SDH framing; SDH MSP signalling by default
 Received K1K2: 0x21 0x15
  Reverse Request (working); Bridging working
 Transmitted K1K2: 0x11 0x10
  Do Not Revert (working); Bridging working
 Remote APS configuration: (null)
SDH 0/3/6 APS Group 1: working channel 1 (Inactive)
 Protect at 1.1.1.1
 PGP timers (from protect): hello time=1; hold time=3
 SDH framing
 Remote APS configuration: (null)
Device#
```

```
Device#show cem circuit int cem-acr 1 1
CEM-ACR1, ID: 1, Line: UP, Admin: UP, Ckt: ACTIVE
Controller state: up, CEP state: up
Idle Pattern: 0xFF, Idle CAS: 0x8
```

```
Dejitter: 6 (In use: 0
)Payload Size: 783
Framing: Not-Applicable
CEM Defects Set
None
Signalling: No CAS
RTP: No RTP
Ingress Pkts:    111851780            Dropped:             0
Egress Pkts:     111851778            Dropped:             0
CEM Counter Details
Input Errors:    0                    Output Errors:       0
Pkts Missing:    0                    Pkts Reordered:      0
 Misorder Drops:  0                    JitterBuf Underrun:  0
Error Sec:       0                    Severly Errored Sec: 0
Unavailable Sec: 0                    Failure Counts:      0
Pkts Malformed:  0                    JitterBuf Overrun:   0
Generated Lbits: 0                    Received Lbits:      0
Generated Rbits: 0                    Received Rbits:      0
Generated Nbits: 10950                Received Nbits:      9093
Generated Pbits: 0                    Received Pbits:      0
Device#
```

Configuring MSP for CESoPSN

This section describes the configuration of MSP for CESoPSN.

Configuring CEM Group for MSP on Virtual ACR AU3-T1 in CESoPSN

To configure CEM group on MSP, use the following commands:

```
enable
configure terminal
controller sdh-acr 200
aug mapping au-3
au-3 1
mode vc1x
Tug-2 1 payload vc11
T1 1 cem-group 0 timeslots 1 - 7
```

To configure the working controller, use the following commands:

```
enable
configure terminal
controller sdh 0/3/6
au-3 1
Tug-2 1 payload vc11
vc 1 overhead v5 2
```

To configure the protect controller, use the following commands:

```
enable
configure terminal
controller sdh 0/4/6
au-3 1
Tug-2 1 payload vc11
vc 1 overhead v5 2
```

Verifying CEM Group for MSP on Virtual ACR AU3-T1 in CESoPSN

This section includes show command to verify CEM Group for MSP on Virtual ACR AU3-T1 in CESoPSN:

```
Router# show cem circuit interface cem-acr 1

CEM-ACR1, ID: 0, Line: UP, Admin: UP, Ckt: ACTIVE
Path Mode : VC1X,Payload:VC11, AU3: 1, TUG-2: 1, T1: 1,CEM Mode: T1-CESoP
Controller state: up, T1/E1 state: up
Idle Pattern: 0xFF, Idle CAS: 0x8
Dejitter: 6 (In use: 0)
Payload Size: 192
Framing: Framed (DS0 channels: 1-24)
CEM Defects Set
None

Signalling: No CAS
RTP: No RTP

Ingress Pkts:    54113124             Dropped:             0
Egress Pkts:     54112259             Dropped:             0

CEM Counter Details
Input Errors:    0                    Output Errors:       0
Pkts Missing:    0                    Pkts Reordered:      0
Misorder Drops:  0                    JitterBuf Underrun:  869
Error Sec:       0                    Severly Errored Sec: 0
Unavailable Sec: 0                    Failure Counts:      28
Pkts Malformed:  0                    JitterBuf Overrun:   0
Generated Lbits: 0                    Received Lbits:      0
Generated Rbits: 868                  Received Rbits:      1830
Generated Mbits: 146392               Received Mbits:      232588
```

Configuring CEM Group for MSP on Virtual ACR AU4-E1 in CESoPSN

To configure CEM group on MSP, use the following commands:

```
enable
configure terminal
controller sdh-acr 200
aug mapping au-4
au-4 1
mode tug-3
tug-3 1
mode vc1x
Tug-2 1 payload vc12
e1 1 cem-group 0 timeslots 1 - 7
```

To configure the working controller, use the following commands:

```
enable
configure terminal
controller sdh 0/3/6
au-4 1
tug-3 1
Tug-2 1 payload vc12
vc 1 overhead v5 2
```

To configure the protect controller, use the following commands:

```
enable
configure terminal
controller sdh 0/4/6
au-4 1
tug-3 1
Tug-2 1 payload vc12
vc 1 overhead v5 2
```

Verifying CEM Group for MSP on Virtual ACR AU4-E1 in CESoPSN

This section includes show command to verify CEM group for MSP on Virtual ACR AU4-E1 in CESoPSN:

```
Router# show cem circuit interface cem-acr 1

CEM-ACR1, ID: 0, Line: UP, Admin: UP, Ckt: ACTIVE
Path Mode : VC1X,Payload:VC11, AU4: 1, TUG-3: 1, E1: 1,CEM Mode: E1-CESoP
Controller state: up, T1/E1 state: up
Idle Pattern: 0xFF, Idle CAS: 0x8
Dejitter: 6 (In use: 0)
Payload Size: 56
Framing: Framed (DS0 channels: 1-7)
CEM Defects Set
None

Signalling: No CAS
RTP: No RTP

Ingress Pkts:    54113124             Dropped:             0
Egress Pkts:     54112259             Dropped:             0

CEM Counter Details
Input Errors:    0                    Output Errors:       0
Pkts Missing:    0                    Pkts Reordered:      0
Misorder Drops:  0                    JitterBuf Underrun:  869
Error Sec:       0                    Severly Errored Sec: 0
Unavailable Sec: 0                    Failure Counts:      28
Pkts Malformed:  0                    JitterBuf Overrun:   0
Generated Lbits: 0                    Received Lbits:      0
Generated Rbits: 868                  Received Rbits:      1830
Generated Mbits: 146392               Received Mbits:      232588
```

Configuring Clocking ACR for MSP AU3-T1 in CESoPSN

To configure clock source on MSP for the working controller, use the following commands:

```
enable
configure terminal
controller sdh 0/3/6
au-3 1
tug-2 1 payload vc11
t1 1 clock source recovered 1
end
```

To configure the recovered clock, use the following commands:

```
enable
configure terminal
```

```
recovered-clock acr 200
clock recovered 1 adaptive cem 1 priority 1
end
```

To configure clock source on MSP for the protect controller, use the following commands:

```
enable
configure terminal
controller sdh 0/4/6
au-3 1
tug-2 1 payload vc11
t1 1 clock source recovered 1
end
```

To configure the recovered clock, use the following commands:

```
enable
configure terminal
recovered-clock acr 200
clock recovered 1 adaptive cem 2 priority 2
end
```

Verifying Clocking ACR for MSP AU3-T1 in CESoPSN

Use the show recovered-clock command to verify the ACR for AU3-T1 in CESoPSN:

```
Router# show recovered-clock

Recovered clock status for MSP-ACR 200
----------------------------------------
Clock    Type     Mode        CEM    Status        Circuit-No          Working     Protect
   Priority
4      OCx-T1   ADAPTIVE     38   ACQUIRING  200/3/1/1(acr/path/vtg/t1) ACQUIRING  ACQUIRING
  1
```

Configuring Clocking DCR for MSP AU3-T1 in CESoPSN

To configure clock source on MSP for the working controller, use the following commands:

```
enable
configure terminal
controller sdh 0/3/6
au-3 1
tug-2 1 payload vc11
t1 1 clock source recovered 1
end
```

To configure CEM interface, use the following commands:

```
interface cem <bay>/<slot>/<port>
cem <cem-group-no>
rtp-present
```

To configure the recovered clock with priority 1, use the following commands:

```
enable
configure terminal
recovered-clock acr 200
```

```
clock recovered 1 differential cem 1 priority 1
end
```

To configure clock source on MSP for the protect controller, use the following commands:

```
enable
configure terminal
controller sdh 0/4/6
au-3 1
tug-2 1 payload vc11
t1 1 clock source recovered 1
end
```

To configure CEM interface, use the following commands:

```
interface cem <bay>/<slot>/<port>
cem <cem-group-no>
rtp-present
```

To configure the recovered clock with priority 1, use the following commands:

```
enable
configure terminal
recovered-clock acr 200
clock recovered 1 differential cem 2 priority 2
end
```

Verifying Clocking DCR for MSP AU3-T1 in CESoPSN

Use the show recovered-clock command to verify the DCR for AU3-T1 in CESoPSN:

```
Router# show recovered-clock

Recovered clock status for MSP-DCR 200
----------------------------------------
Clock    Type     Mode         CEM    Status        Circuit-No          Working     Protect
   Priority
5     OCx-T1   DIFFERENTIAL  44   ACQUIRING  200/4/1/1(acr/path/vtg/t1) ACQUIRING  ACQUIRING
  1
```

Configuring Clocking ACR for MSP AU4-E1 in CESoPSN

To configure clock source on MSP for the working controller, use the following commands:

```
enable
configure terminal
controller sdh 0/3/6
au-4 1
tug-3 1
tug-2 1 payload vc12
e1 1 clock source recovered 5
end
```

To configure the recovered clock, use the following commands:

```
enable
configure terminal
```

```
recovered-clock acr 200
clock recovered 5 adaptive cem 1 priority 1
end
```

To configure clock source on MSP for the protect controller, use the following commands:

```
enable
configure terminal
controller sdh 0/4/6
au-4 1
tug-3 1
tug-2 1 payload vc12
e1 1 clock source recovered 5
end
```

To configure the recovered clock, use the following commands:

```
enable
configure terminal
recovered-clock acr 200
clock recovered 5 adaptive cem 2 priority 2
end
```

Verifying Clocking ACR for MSP AU4-E1 in CESoPSN

Use the show recovered-clock command to verify the ACR for AU4-E1 in CESoPSN:

```
Router# show recovered-clock
Recovered clock status for MSP-ACR 200
----------------------------------------
Clock    Type     Mode        CEM    Status        Circuit-No          Working     Protect
   Priority
4     OCx-T1   ADAPTIVE     38   ACQUIRING  200/3/1/1(acr/path/vtg/t1) ACQUIRING  ACQUIRING
  1
```

Configuring Clocking DCR for MSP AU4-E1 in CESoPSN

To configure clock source on MSP for the working controller, use the following commands:

```
enable
configure terminal
controller sdh 0/3/6
au-4 1
tug-3 1
tug-2 1 payload vc12
e1 1 clock source recovered 5
end
```

To configure CEM interface, use the following commands:

```
interface cem <bay>/<slot>/<port>
cem <cem-group-no>
rtp-present
```

To configure the recovered clock with priority 1, use the following commands:

```
enable
```

```
configure terminal
recovered-clock acr 200
clock recovered 5 differential cem 1 priority 1
end
```

To configure clock source on MSP for the protect controller, use the following commands:

```
enable
configure terminal
controller sdh 0/4/6
au-4 1
tug-3 1
tug-2 1 payload vc12
e1 1 clock source recovered 5
end
```

To configure CEM interface, use the following commands:

```
interface cem <bay>/<slot>/<port>
cem <cem-group-no>
rtp-present
```

To configure the recovered clock with priority 1, use the following commands:

```
enable
configure terminal
recovered-clock acr 200
clock recovered 5 differential cem 2 priority 2
end
```

Verifying Clocking DCR for MSP AU4-E1 in CESoPSN

Use the show recovered-clock command to verify the DCR for AU4-E1 in CESoPSN:

```
Router# show recovered-clock
Recovered clock status for MSP-DCR 200
----------------------------------------
Clock    Type     Mode         CEM    Status        Circuit-No          Working     Protect
   Priority
5     OCx-T1   DIFFERENTIAL  44   ACQUIRING  200/4/1/1(acr/path/vtg/t1) ACQUIRING  ACQUIRING
  1
```

CHAPTER 7

Configuring SNCP on 1-Port OC192/STM-64 or 8-Port OC3/12/48/STM-1/-4/-16 Module

SNCP is a protection mechanism for SDH networks that enables SDH connections to switch to another SDH circuit when a circuit failure occurs. A protection interface serves as the backup interface for the working interface. When the working interface fails, the protection interface quickly assumes its traffic load.

The SDH protection schemes comply with GR-253 and ITU-T G.783. It allows Optical Interface Module to work seamlessly as SDH Add or Drop Multiplexers (ADMs). The implementation of the above protection schemes allows a pair of SDH lines or paths to be configured for line or path redundancy. In the event of a fiber cut, the active line or path switches automatically to the standby line or path up to 60 milliseconds (2/5/10 millisecond for holdover and 50 millisecond switchovers).

Optical Interface Module supports the following SDH protection switching schemes:

- SNCP Path Protection at STS Level
- SNCP Path Protection at VT Level

Restrictions for SNCP

- SNCP is not supported on port 8 of the IM with STM-64 rate configured.
- SNCP is supported on AU-3 —VC-3 SDH mode and not supported on AU-4 —VC-3 mode.

SNCP Path Protection

SNCP is a unidirectional network with two rings, one ring used as the working ring and the other as the protection ring. The same signal flows through both rings, one clockwise and the other counterclockwise. It is called SNCP because monitoring is done at the path layer. A node receives two copies of the electrical signals at the path layer, compares them, and chooses the one with the better quality. If part of a ring between two ADMs fails, the other ring still can guarantee the continuation of data flow. SNCP, like the one-plus-one scheme, has fast failure recovery.

SNCP Path Protection is supported at VC level and STM level.

Once a signal fail condition or a signal degrade condition is detected, the hardware initiates an interrupt to software that switches from the working path to the protection path. Non-revertive options are valid for SNCP path protection.

Note 1X OC-192 and 8X OC-48 interface modules only supports the non-revertive option. The non-revertive option is the default mode.

The following table shows the scales of SNCP supported on different modes:

Modes	Supported Scales
AU4-VC12	252
AU4-VC11	336
AU4-VC4	16
AU3-VC12	252
AU3-VC11	336
VC4-4c	4
VC4-16c	1

Configuring SNCP

Protection Group Controller Configuration

```
enable
configure terminal
protection group 1 type vc4-16c
controller protection group 1
type vc4-16c
cem-group 16001 cep
end
```

Working Path Configuration

```
enable
configure terminal
controller sdh 0/3/6
au-4 1-16 mode vc4-16c
protection group 1 working
end
```

Protect Path Configuration

```
enable
configure terminal
```

```
controller sdh 0/12/6
au-4 1-16 mode vc4-16c
protection group 1 protect
end
```

CEM Group Configuration

```
enable
configure terminal
controller sdh 0/4/1
au-4 1-16 mode vc4-16c
cem-group 1 cep
end
```

Local Connect Configuration

```
enable
configure terminal
connect lc cem 0/4/1 1 cem-pg 1 16001
end
```

Verification of SNCP Configuration

Use **show protection-group** command to verify SNCP configuration:

```
#show protection-group
PGN   Type    Working I/f                Protect I/f               Active Status
--------------------------------------------------------------------------------
1     VC4-16C SDH0/3/6.1-48              SDH0/12/6.1-48              P         A
--------------------------------------------------------------------------------
Status legend:D=Deleted FO=Force SF=SignalFailure SD=SignalDegrade
                         FL=Fail M=Manual L=Lockout C=Clear A=Auto
 (W)=working, (P)=protect
```

CHAPTER 8

Clock Recovery System for SAToP

The Clock Recovery System recovers the service clock using Adaptive Clock Recovery (ACR) and Differential Clock Recovery (DCR).

Prerequisites for Clock Recovery

- The clock of interface modules must be used as service clock.
- CEM must be configured before configuring the global clock recovery.
- RTP must be enabled for DCR in CEM, as the differential clock information is transferred in the RTP header.

Restrictions for Clock Recovery

- The reference clock source is used and locked to a single clock.
- The clock ID should be unique for a particular interface module for ACR or DCR configuration.
- When CEM group is configured, dynamic change in clock source is not allowed.
- ACR clock configuration under each controller should be performed before configuring CEM group.

Scale Restrictions for ACR and DCR

For the Cisco IOS XE 17.2.1 release, 5376 ACR or DCR session scale is supported on the Cisco A900-IMA1Z8S-CX and the Cisco A900-IMA1Z8S-CXMS IMs.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

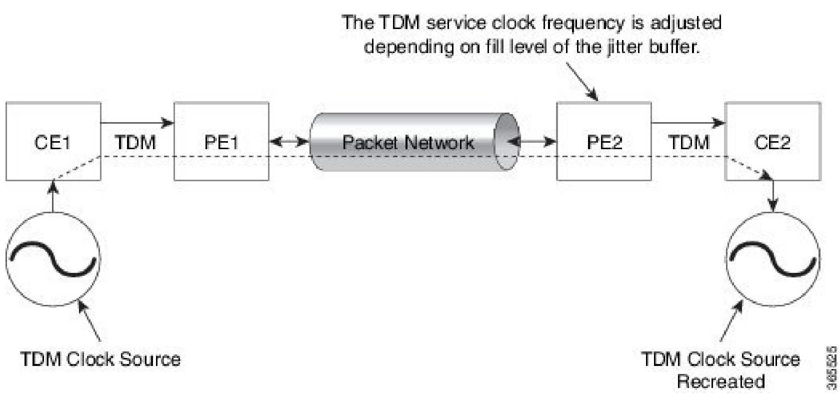
Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Adaptive Clock Recovery (ACR)

Adaptive Clock Recovery (ACR) is an averaging process that negates the effect of random packet delay variation and captures the average rate of transmission of the original bit stream. ACR recovers the original clock for a synchronous data stream from the actual payload of the data stream. In other words, a synchronous clock is derived from an asynchronous packet stream. ACR is a technique where the clock from the TDM domain is mapped through the packet domain, but is most commonly used for Circuit Emulation (CEM). ACR is supported on unframed and framed modes of SAToP.

Note Framing type should be maintained same in all routers end to end.

Effective Cisco IOS XE Everest 16.5.1, ACR is supported on the 8-port T1/E1 interface module.



Benefits of ACR for 8 T1/E1 Interface Module

- Customer-edge devices (CEs) can have different clocks from that of the Provide-edge devices (PEs). Every T1/E1 interface module supports eight pseudowires (or the derived clocks).

Restrictions for ACR on 8 T1/E1 Interface Module

- ACR is supported only on the 8-port T1/E1 interface module (A900-IMA8D). It is not supported on the 16-port T1/E1 interface module (A900-IMA16D), the 32-port T1/E1 interface module (A900-IMA32D), or the 4-port OC3 interface module (A900-IMA4OS).

- ACR is supported only for unframed and framed CEM (SAToP) and for fully-framed CEM (CESoPSN). Fully-framed refers to all the timeslots of T1 (1-24) or E1 (1-31) interfaces.
- ACR is supported only for CEM circuits with MPLS PW encapsulation. ACR is not supported for CEM circuits with UDP or IP PW encapsulation.
- The clock recovered by an ACR clock for a CEM circuit is local to that CEM circuit. The recovered clock cannot be introduced to another circuit and also cannot be introduced to the system clock as a frequency input source.
- The clock ID should be unique for the entire device.
- When a CEM group is configured, dynamic change in clock source is not allowed.
- Physical or soft IM OIR causes the APS switchover time to be higher (500 to 600 ms). Shut or no shut of the port and removal of the active working or protect also cause the APS switchover time to be high.

  To overcome these issues, force the APS switchover.

Prerequisites for ACR Configuration in 8 T1/E1 Interface Module

- Ensure that CEM is configured before configuring the adaptive clock recovery.
- The following must be configured before configuring the ACR:
  - The remote Customer Equipment and the remote Provider Edge device. These can be configured by using the clock source internal and the clock source line commands under the T1/E1 controller.
  - The controller on the local Customer Equipment connected to the ACR router by using the **clock source line**command.
  - PRC or PRS reference clock from a GPS reference to the remote Customer Equipment or remote CEM Provider Edge device.

Configuring ACR for T1 Interfaces for SAToP

To configure the clock on T1/E1 interfaces for SAToP in controller mode:

```
enable
configure terminal
controller t1 0/4/3
clock source recovered 15
cem-group 20 unframed
exit
```

To configure the clock recovery on T1/E1 interfaces in global configuration mode:

```
recovered-clock 0 4
clock recovered 15 adaptive cem 3 20
exit
```

Note The clock source recovered configuration on the controller must be completed before configuring the clock recovery in global configuration mode.

Note On the controller, the clock source should be configured before CEM group is configured.

Note Follow a similar procedure to configure to configure CEM ACR for E1 Interfaces for SAToP. Also, follow a similar procedure to configure CEM ACR for T1 and E1 Interfaces for CESoPSN. Use **cem-group** *circuit-id* **timeslots** *<1-24>* | *<1-31>* command instead of **cem-group** *circuit-id unframed* command for the configuration depending on T1 or E1 controller.

To remove the clock configuration in ACR, you must remove the recovery clock configuration in global configuration mode, then remove the CEM circuit, and finally remove the clock source recovered configuration under the controller.

Verifying the ACR Configuration of T1 Interfaces for SAToP

Important Notes

- When multiple ACR clocks are provisioned and if the core network or PSN traffic load primarily has fixed packet rate and fixed size packets, the states of one or more ACR clocks might flap between Acquiring and Acquired states and might not be stable in Acquired state.

  This happens because of the "beating" phenomenon and is documented in *ITU-T G.8261 - Timing and synchronization aspects in packet networks*.

  This is an expected behavior.

- After an ACR clock is provisioned and starts recovering the clock, a waiting period of 15-20 minutes is mandatory before measuring MTIE for the recovered clock.

  This behavior is documented in *ITU-T G.8261 Timing and synchronization aspects in packet networks Appendix 2*.

- When the input stream of CEM packets from the core network or PSN traffic is lost or has many errors, the ACR clock enters the HOLDOVER state. In this state, the ACR clock fails to provide an output clock on the E1/T1 controller. Hence, during the HOLDOVER state, MTIE measurement fails.

  This is an expected behavior.

- When the clock output from the clock master or GPS reference flaps or fails, the difference in the characteristics between the holdover clock at the source device and the original GPS clock may result in the ACR algorithm failing to recover clock for a transient period. The MTIE measurement for the ACR clock fails during this time. After this transient period, a fresh MTIE measurement is performed. Similarly, when the GPS clock recovers, for the same difference in characteristics, ACR fails to recover clock and MTIE fails for a transient period.

  This is an expected behavior.

- When large-sized packets are received along with the CEM packets by the devices in the core network or PSN traffic, CEM packets may incur delay with variance in delay. As ACR is susceptible to delay and variance in delay, MTIE measurement may fail. This behavior is documented in *ITU-T G.8261 section 10*.

  This is an expected behavior.

- For a provisioned ACR clock that is in Acquired state, if the ACR clock configuration under the recovered-clock global configuration mode is removed and then reconfigured, the status of the ACR clock may initially be ACQUIRED and not FREERUN and then move to Acquiring. This happens because the ACR clock is not fully unprovisioned until the CEM circuit and the controller clock source recovered configuration are removed. Hence, the clock starts from the old state and then re-attempts to recover the clock.

  This is an expected behavior.

Use the **show recovered-clock** command to verify the ACR of T1 interfaces for SAToP:

```
Router#show recovered-clock
Recovered clock status for subslot 0/1
----------------------------------------
Clock Type Mode Port CEM Status Frequency Offset(ppb)
1 T1/E1 ADAPTIVE 3 1 ACQUIRED 100
```

Use the **show running-config** command to verify the recovery of adaptive clock of T1 interfaces:

```
Router#show running-config
controller T1 0/1/2
clock source recovered 1
cem-group 1 unframed
interface CEM0/1/3
cem 1
no ip address
xconnect 2.2.2.2 10
encapsulation mpls
```

Associated Commands

Commands	Links
cem-group	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2440628600
clock source	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp3848511150
clock recovered adaptive cem	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp8894393830
controller t1	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp1472647421
recovered-clock	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html

Configuring ACR for OCn

Configuring ACR in Mode VT15 for SAToP

You must configure ACR for virtual tributary groups (VTG) mode. In this mode, a single STS-1 is divided into seven VTGs. Each VTG is then divided into four VT1.5, each carrying a T1.

To configure ACR in mode VT15 for Structure-Agnostic TDM over Packet (SAToP):

```
enable
configure terminal
controller sonet <bay>/<slot>/<port>
rate OC3
sts-1 <number>
mode vt-15
vtg 1 t1 cem 0 unframed
vtg 1 t1 1 clock source recovered 1
vtg <vtg_number> t1 <t1_number> cem-group < cem-group-no> unframed
vtg <vtg_number> t1 <t1_number> clock source recovered <clock-id>
exit
recovered-clock 0 <0-15> Subslot number
end
```

Verifying ACR in Mode VT15 for SAToP

Verifying ACR Configuration

```
Router# show running-config | section 0/4/0

controller MediaType 0/4/0
 mode sonet
controller SONET 0/4/0
 rate OC48
 no ais-shut
 framing sonet
 clock source internal
 !
 sts-1 1
  clock source internal
  mode vt-15
  vtg 1 t1 1 clock source Recovered 0
  vtg 1 t1 1 framing unframed
  vtg 1 t1 1 cem-group 0 unframed

interface CEM0/4/0
 no ip address
 cem 0
!
```

Verifying Recovered Clock

```
Router# show recovered-clock

Recovered clock status for subslot 0/3
----------------------------------------
Clock    Type     Mode        CEM    Status         Frequency Offset(ppb)  Circuit-No
0        OCx-ds1  ADAPTIVE     0    ACQUIRED   n/a                              0/1/1/1
(Port/path/vtg/t1)
```

```
Router# show running-config | section recovered-clock 0 4
```

```
recovered-clock 0 4
 clock recovered 0 adaptive cem 0 0
```

Configuring ACR in mode T3 for SAToP

You must configure ACR in mode T3. Mode T3 is STS-1 or AU-4/TUG3 carrying an unchannelized (clear channel) T3.

```
enable
configure terminal
recovered-clock  <bay> <slot>
clock recovered <clock-id> adaptive cem <port-no> <cem-group-no>
controller sonet <bay>/<slot>/<port>
rate OC3
sts-1 <number>
mode t3
cem-group < cem-group-no> unframed
t3 clock source recovered <clock-id>

end
```

Verifying ACR in Mode T3 for SAToP

Verifying ACR Configuration

```
Router# show run | sec recovered
recovered-clock bay/slot
clock recovered clock_id adaptive cem cem-group-no port-no
!
```

```
Router# show running-config | section 0/4/6

controller SONET 0/4/6
 rate OC3
 no ais-shut
 framing sonet
 clock source internal
 !
 sts-1 1
  clock source internal
  mode t3
  t3 clock source line
  cem-group 0 unframed
  clock source recovered 20

interface CEM0/4/6
 no ip address
 cem 0
!
```

Verifying Recovered Clock

```
Router# show recovered-clock

Recovered clock status for subslot 0/3
----------------------------------------
Clock    Type         Mode        CEM    Status        Frequency Offset(ppb)  Circuit-No
0         OCx-ds3  ADAPTIVE     0    ACQUIRED   n/a                                 0/1
(Port/t3)
```

```
Router# show run | sec recovered

recovered-clock 0 4
```

```
clock recovered 20 adaptive cem 6 0
!
```

Configuring ACR in Mode CT3 for SAToP

You must configure ACR in mode CT3. Mode CT3 is an STS-1 carrying a DS3 signal that is divided into 28 T1s (PDH).

```
enable
configure terminal
recovered-clock  <bay> <slot>
clock recovered <clock-id> adaptive cem <port-no> <cem-group-no>
controller sonet <bay>/<slot>/<port>
rate OC3
sts-1 <number>
mode ct3
t1 <t1_number> cem-group < cem-group-no> unframed
t1 <t1_number> clock source recovered <clock-id>
enable
```

Verifying ACR in Mode CT3 for SAToP

Verifying ACR Configuration

```
Router# show running-config | section 0/4/0

controller MediaType 0/4/0
 mode sonet
controller SONET 0/4/0
 rate OC48
 no ais-shut
 framing sonet
 clock source internal
 !
 sts-1 1
  clock source internal
  mode ct3
  t3 framing c-bit
  t1 1 clock source Recovered 10
  t1 1 framing unframed
  t1 1 cem-group 1 unframed

interface CEM0/4/0
 no ip address
 cem 1
!
```

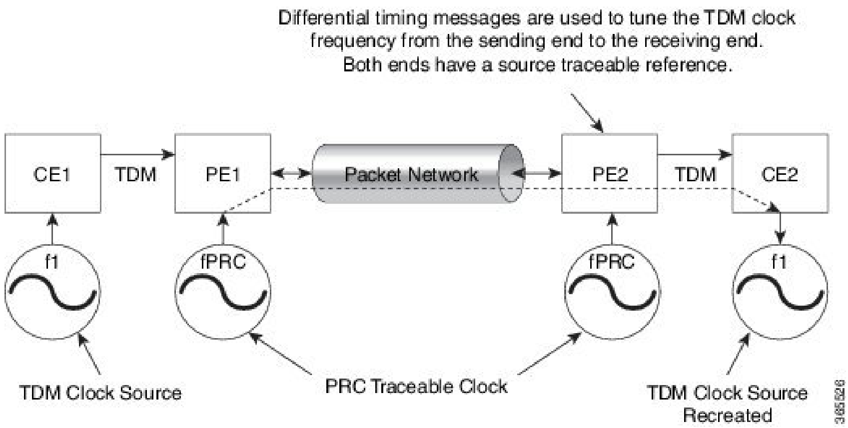
Verifying Recovered Clock

```
show recovered-clock

Recovered clock status for subslot 0/3
----------------------------------------
Clock    Type     Mode        CEM    Status        Frequency Offset(ppb)  Circuit-No
0        OCx-ds1  ADAPTIVE     0    ACQUIRED  n/a                             0/1/1
(Port/t3/t1)

show running-config | section recovered-clock 0 4
recovered-clock 0 4
 clock recovered 10 adaptive cem 1 0
```

Differential Clock Recovery (DCR)

Differential Clock Recovery (DCR) is another technique used for Circuit Emulation (CEM) to recover clocks based on the difference between PE clocks. TDM clock frequency are tuned to receive differential timing messages from the sending end to the receiving end. A traceable clock is used at each end, which ensures the recovered clock is not affected by packet transfer. DCR is supported on unframed and framed modes of SAToP.

Note Framing type should be maintained same in all routers end to end.

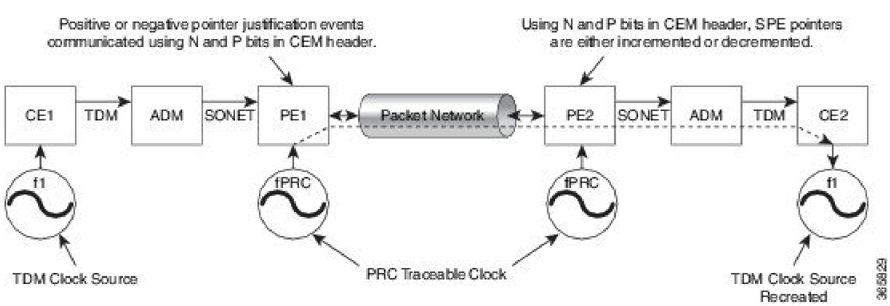


Explicit Pointer Adjustment Relay (EPAR)

A pointer management system is defined as part of the definition of SONET. If there is a frequency offset between the frame rate of the transport overhead and that of the SONET Synchronous Payload Envelope (SPE), the alignment of the SPE slips back periodically or advances in time through positive or negative stuffing. Similarly, if there is a frequency offset between the SPE rate and the VT rate it carries, the alignment of the VT slips back periodically or advances in time through positive or negative stuffing within the SPE. The emulation of this aspect of SONET network in pseudowire emulation network may be accomplished using EPAR feature.

EPAR uses N and P bits in CEP header to signal negative or positive pointer justification event. EPAR is supported on STS-1, STS-3C, STS-12C, STS-48C and VT-1.5 levels. N and P counters are added to communicate the signaling of the pointer events over CEP pseudowire.

Figure 10: EPAR



Effective Cisco IOS-XE Release 3.18 SP, EPAR is enabled by default.

Restrictions for EPAR

- EPAR is applicable only for circuit emulation for SONET LO & HO paths and is not applicable for PDH.
- EPAR is effective only when both ends of the pseudowire have access to a common timing reference.

Benefits of Clock Recovery

- Customer-edge devices (CEs) can have different clock from that of the Provide-edge devices (PEs).

Scaling Information

IM Card	Pseudowires Supported (Number of Clocks Derived)
DS1	48
DS3	1344
1-Port OC192/STM-64 or 8-Port OC3/12/48/STM-1/-4/-16 Interface Module	2000

Configuring DCR for OCn

Configuring DCR in Mode VT15 for SAToP

```
enable
configure terminal
recovered-clock  <bay> <slot>
clock recovered <clock-id> differential cem <port-no> <cem-group-no>
controller sonet <bay>/<slot>/<port>
rate OC3
sts-1 <number>
mode vt-15
vtg <vtg_no> t1 <t1_number> cem-group <cem-group-no> unframed
vtg <vtg_no> t1 <t1_number> clock source recovered <clock-id>
interface cem <bay>/<slot>/<port>
cem <cem-group-number>
rtp-present
end
```

Verifying DCR in Mode VT15 for SAToP

Verifying DCR Configuration

```
Router# show running-config | section 0/4/0

controller MediaType 0/4/0
 mode sonet
controller SONET 0/4/0
 rate OC48
 no ais-shut
 framing sonet
 clock source internal
```

```
 !
 sts-1 1
  clock source internal
  mode vt-15
  vtg 1 t1 1 clock source Recovered 0
  vtg 1 t1 1 framing unframed
  vtg 1 t1 1 cem-group 0 unframed


interface CEM0/4/0
 no ip address
 cem 0
  rtp-present
 !
```

Verifying Recovered Clock

```
Router# show recovered-clock

Recovered clock status for subslot 0/4
----------------------------------------
Clock    Type     Mode         CEM    Status         Frequency Offset(ppb)  Circuit-No
0        OCx-ds1  Differential     0    ACQUIRED   n/a                             0/1/1/1
 (Port/path/vtg/t1)
```

```
Router# show running-config | section recovered-clock 0 4

recovered-clock 0 4
 clock recovered 0 differential cem 0 0
```

Configuring DCR in Mode CT3 for SAToP

```
enable
configure terminal
recovered-clock  <bay> <slot>
clock recovered <clock-id> differential cem <port-no> <cem-group-no>
controller sonet <bay>/<slot>/<port>
rate OC3
sts-1 <number>
mode ct3
t1 <t1_number> cem-group < cem-group-no> unframed
t1 <t1_number> clock source recovered <clock-id>
interface cem <bay>/<slot>/<port>
cem <cem-group-number>
rtp-present
end
```

Verifying DCR in Mode CT3 for SAToP

Verifying DCR Configuration

```
Router# show running-config | section 0/4/0

controller MediaType 0/4/0
 mode sonet
controller SONET 0/4/0
 rate OC48
 no ais-shut
 framing sonet
 clock source internal
 !
```

```
 sts-1 1
  clock source internal
  mode ct3
  t3 framing c-bit
  t1 1 clock source Recovered 10
  t1 1 framing unframed
  t1 1 cem-group 1 unframed


interface CEM0/4/0
 no ip address
 cem 1
  rtp-present
 !
```

Verifying Recovered Clock

```
Router# show recovered-clock

Recovered clock status for subslot 0/4
----------------------------------------
Clock    Type     Mode         CEM    Status         Frequency Offset(ppb)  Circuit-No
0        OCx-ds1  Differential     0    ACQUIRED   n/a                              0/1/1
(Port/t3/t1)
```

```
Router# show running-config | section recovered-clock 0 4
recovered-clock 0 4
 clock recovered 10 differential cem 1 0
```

Configuring DCR in Mode T3 for SAToP

```
enable
configure terminal
recovered-clock  <bay> <slot>
clock recovered <clock-id> differential cem <port-no> <cem-group-no>
controller sonet <bay>/<slot>/<port>
rate OC3
sts-1 <number>
mode t3
cem-group <cem-group-number> unframed
t3 clock source recovered <clock-id>
interface cem <bay>/<slot>/<port>
cem <cem-group-nber>
rtp-present
end
```

Verifying DCR in Mode T3 for SAToP

Verifying DCR Configuration

```
Router# show running-config | section 0/4/6

controller SONET 0/4/6
 rate OC3
 no ais-shut
 framing sonet
 clock source internal
 !
 sts-1 1
  clock source internal
  mode t3
```

```
  cem-group 0 unframed
  clock source recovered 20

interface CEM0/4/6
 no ip address
 cem 0
  rtp-present
 !
```

Verifying Recovered Clock

```
Router# show recovered-clock

Recovered clock status for subslot 0/4
----------------------------------------
Clock    Type     Mode         CEM    Status         Frequency Offset(ppb)  Circuit-No
0        OCx-ds3  Differential     0    ACQUIRED   n/a                              0/1
(Port/t3)

Router# show running-config | section recovered-clock 0 4

recovered-clock 0 4
clock recovered 20 differential cem 6 0
```

Configuring ACR in Mode CT3 for CESoPSN

You must configure ACR in mode CT3. Mode CT3 is an STS-1 carrying a DS3 signal that is divided into 28 T1s (PDH).

```
enable
configure terminal
controller sonet <bay>/<slot>/<port>
rate OC3
sts-1 <num>
mode ct3
t1 <t1_num> clock source recovered <clock-id>
t1 <t1_num> cem-group < cem-group-no> timeslots <1-24>

recovered-clock  <bay> <slot>
clock recovered <clock-id> adaptive cem <port-no> <cem-group-no>
```

Verification of EPAR Configuration

The following example shows the configuration of EPAR for STS-3c with negative pointer adjustment events signaled using N-bits.

```
Router#show cem circuit interface cem 0/4/4 104

CEM0/4/4, ID: 104, Line: UP, Admin: UP, Ckt: ACTIVE
Controller state: up, CEP state: up
Idle Pattern: 0xFF, Idle CAS: 0x8
Dejitter: 6 (In use: 0)
Payload Size: 783
Framing: Not-Applicable
CEM Defects Set
None

Signalling: No CAS
RTP: No RTP
```

```
Ingress Pkts:    8507028158          Dropped:             0
Egress Pkts:     8507028151          Dropped:             0

CEM Counter Details
Input Errors:    0                   Output Errors:       0
Pkts Missing:    0                   Pkts Reordered:      0
Misorder Drops:  0                   JitterBuf Underrun:  0
Error Sec:       0                   Severly Errored Sec: 0
Unavailable Sec: 0                   Failure Counts:      0
Pkts Malformed:  0                   JitterBuf Overrun:   0
Generated Lbits: 0                   Received Lbits:      0
Generated Rbits: 0                   Received Rbits:      0
Generated Nbits: 81794328            Received Nbits:      81794328
Generated Pbits: 0                   Received Pbits:      0
```

Recovering a Clock

Recovering an ACR Clock

```
enable
configure terminal
recovered-clock  <bay> <slot>
clock recovered <clock-id> adaptive cem <port-no> <cem-group-no>
end
```

Recovering a DCR Clock

```
enable
configure terminal
recovered-clock  <bay> <slot>
clock recovered <clock-id> differential cem <port-no> <cem-group-no>
end
```

Example: Adaptive Clock Recovery (ACR) for SAToP

Example: Adaptive Clock Recovery (ACR) Mode VT15 for SAToP

```
enable
configure terminal
recovered-clock  0 4
clock recovered 0 adaptive cem 0 0
controller SONET 0/4/0
rate OC48
sts-1 1
mode vt-15
vtg 1 t1 1 cem-group 0 unframed
vtg 1 t1 1 clock source Recovered 0
end
```

Example: Adaptive Clock Recovery (ACR) Mode CT3 for SAToP

```
enable
configure terminal
recovered-clock  0 4
clock recovered 10 adaptive cem 1 0
controller SONET 0/4/0
```

```
rate OC48
sts-1 1
mode ct-3
t1 1 cem-group 1 unframed
t1 1 clock source Recovered 10
end
```

Example: Adaptive Clock Recovery (ACR) Mode T3 for SAToP

```
enable
configure terminal
recovered-clock  0 4
clock recovered 20 adaptive cem 6 0
controller SONET 0/4/6
rate OC48
sts-1 1
mode t3
cem-group 0 unframed
t3 clock source recovered 20
end
```

Example: Differential Clock Recovery (DCR) for SAToP

Example: Differential Clock Recovery (DCR) Mode VT15 for SAToP

```
enable
configure terminal
recovered-clock 0 4
clock recovered 0 differential cem 0 0
controller SONET 0/4/0
rate OC48
sts-1 1
mode vt-15
vtg 1 t1 1 cem-group 0 unframed
vtg 1 t1 1 clock source Recovered 0
interface CEM 0/4/0
cem 1
rtp-present
end
```

Example: Differential Clock Recovery (DCR) Mode CT3 for SAToP

```
enable
configure terminal
recovered-clock 0 4
clock recovered 10 differential cem 1 0
controller SONET 0/4/0
rate OC48
sts-1 1
mode ct3
t1 1 cem-group 1 unframed
t1 1 clock source Recovered 10
interface CEM 0/4/0
cem 1
rtp-present
end
```

Example: Differential Clock Recovery (DCR) Mode T3 for SAToP

```
enable
configure terminal
controller SONET 0/4/0
rate OC48
sts-1 1
mode ct3
t1 1 cem-group 1 unframed
t1 1 clock source Recovered 10
recovered-clock 0 4
clock recovered 10 differential cem 0 1
interface CEM 0/4/0
cem 1
rtp-present
end
```

Additional References for Clock Recovery

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases

Standards and RFCs

Standard/RFC	Title
ITU -T G.8261	*Timing and synchronization aspects in packet networks*

MIBs

MIB	MIBs Link
—	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

CHAPTER 9

Configuring 5G Mode on 1-Port OC-192/STM-64 or 8-Port OC-3/12/48/STM-1/-4/-16 Interface Module

Effective Cisco IOS XE Everest 16.5.1, 5G mode is supported on 1-Port OC-192/STM-64 or 8-Port OC-3/12/48/STM-1/-4/-16 Interface Module. Previously, only 10G mode was supported. 5G mode is supported on those interface module slots that do not support 10G mode.

On the ASR 907 Routers, if the interface module is inserted in the slots 3, 4, 7, 8, 11, or 12, the interface module comes up in 10G mode by default. Use the mode conversion command to use the interface module in 5G mode. If the interface module is inserted in the slots 2, 5, 6, 9, 10, 13, 14, and 15, the interface module comes up in 5G mode by default. Hence, there is no need to apply the mode conversion command.

On the ASR 903 Routers, all interface module slots support 10G mode. Use the mode conversion command to change the interface module slots to 5G mode.

On the ASR 907 Routers, 10G mode is supported on slots 3,4,7,8, 11, 12 interface module slots. Use the mode conversion command to change the interface module slots to 5G mode. Other interface module slots support 5G traffic mode by default.

Note Slot 1 on the ASR 907 Router is supported for the 5G mode for 1-Port OC-192/STM-64 or 8-Port OC-3/12/48/STM-1/-4/-16 Interface module on the chassis.

Note OC-192/STM-64 port is disabled in 5G mode.

Table 11: Default 5G Slots on ASR 903 Routers

Bays	Interface Module Support	Default Mode	5G Mode Command Support
0	No	No	No
1	No	No	No

Bays	Interface Module Support	Default Mode	5G Mode Command Support
2	Yes	10G_CEM	Yes
3	Yes	10G_CEM	Yes
4	Yes	10G_CEM	Yes
5	Yes	10G_CEM	Yes

Table 12: Default 10G Slots on ASR 907 Routers

Bays	Interface Module Support	Default Mode	5G Mode Command Support
0	No	No	No
1	No	No	No
2	Yes	5G_CEM	No need to use the command as the interface module is in 5G mode by default
3	Yes	10G_CEM	Yes
4	Yes	10G_CEM	Yes
5	Yes	5G_CEM	No need to use the command as the interface module is in 5G mode by default
6	Yes	5G_CEM	No need to use the command as the interface module is in 5G mode by default
7	Yes	10G_CEM	Yes
8	Yes	10G_CEM	Yes
9	Yes	5G_CEM	No need to use the command as the interface module is in 5G mode by default
10	Yes	5G_CEM	No need to use the command as the interface module is in 5G mode by default
11	Yes	10G_CEM	Yes

Bays	Interface Module Support	Default Mode	5G Mode Command Support
12	Yes	10G_CEM	Yes
13	Yes	5G_CEM	No need to use the command as the interface module is in 5G mode by default
14	Yes	5G_CEM	No need to use the command as the interface module is in 5G mode by default
15	Yes	5G_CEM	No need to use the command as the interface module is in 5G mode by default

Features of the Interface Module:

- This IM supports 8 ports with 5G CEM traffic.
- This IM supports a maximum of 5Gbps traffic throughput with the following services:
  - 5G HO CEP
  - 5G LO CES/CEP

Supported Traffic Combinations

The following traffic combination is supported:

- **CEM Traffic - SONET**:

  Ports 0-7 are available as OC-48/OC-12/OC-3/1GE ports. To achieve 5G traffic on the card, four ports are grouped. For example, 0-3 and 4-7 can provide a maximum traffic of 2.5G. For example, OC-48 port is allocated in each group. Hence, if one of the ports is configured as OC-48, the other ports in the group cannot be configured. If OC-12 or OC-3 rate is configured in any of the port groups, OC-48 cannot be configured.

- **CEM Traffic - SDH**:

Ports 0-7 are available as STM-16, STM-4, and STM-1 ports. To achieve 5G traffic on the card, four ports are grouped. For example, 0-3 and 4-7 can provide a maximum traffic of 2.5G. For example, STM-16 port is allocated in each group. Hence, if one of the ports is configured as STM-16, the other ports in the group cannot be configured. If STM-4 or STM-1 rate is configured in any of the port groups, STM-16 cannot be configured.

Restrictions for Configuring 1-Port OC-192/STM-64 or 8-Port OC-3/12/48/STM-1/-4/-16 Interface Module

- There should not be any configuration before the mode conversion command is used.
- The IM reloads and becomes active only about 5 minutes after a mode conversion is complete.
- When the mode changing command is applied by copying from a file (from TFTP server), the IM reloads and as a result all subsequent configurations fail for that interface module. You must change the mode of the interface module to 5G mode or 10G before copying the configurations from the TFTP file.
- For 10G mode, port 8 is used to configure OC-192 or STM-64 rate. You cannot use port 8 in 5G mode.

Important Notes on Configuration

- There should not be any of the following configurations before the **mode conversion** command is used:
  - CEM configurations
  - Path configurations
  - Mode SONET configuration under controller Mediatype
  - Mode SDH configuration under controller Mediatype
- When the **mode conversion** command is applied, the interface module reloads and becomes active after 5 minutes after a mode conversion is complete.
- When mode changing command is applied by copying from a file (from TFTP server), the IM reloads and as a result subsequent configurations fail for that IM. hence, you should change the mode of the interface module to 5G mode or vice versa before copying the configurations from the TFTP file.
- The interface module must be in shutdown state while upgrading from XLAUI mode to XFI passthrough mode.

Configuring 5G Mode from 10G Mode

To configure 5G mode from 10G mode:

```
enable
configure terminal
platform hw-module configuration
```

```
hw-module <slot> / <subslot> <PID> mode 5G_CEM
end
```

Configuring 10G Mode from 5G Mode

To configure 10G mode from 5G mode:

```
enable
configure terminal
platform hw-module configuration
hw-module <slot> / <subslot> <PID>
end
```

Verification of 5G Traffic Configuration

Use the **show running configuration** command to verify 5G traffic configuration:

```
Router#show running-config  | include mode
hw-module 0/bay PID mode 5G_CEM
Router#
```

Associated Commands

The following table shows the associated commands for 5G traffic configuration:

Commands	Links
hw-module mode	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/mcl/allreleasemcl/all-book/all-06.html
platform hw-module configuration	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/mcl/allreleasemcl/all-book/all-10.html
show running configuration | include mode	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/mcl/allreleasemcl/all-book/all-14.html

CHAPTER 10

Configuring Data Communication Channel

The Data Communication Channel (DCC) feature uses the SONET or SDH Operation Administration and Maintenance (OAM) channel to manage devices that support SONET or SDH interfaces. SONET or SDH standards support extensive operations, administration, management, and provisioning (OAM&P) capabilities.

The following overhead bytes are specified in the standards as the OAM channels that carry management information, alarms, and management commands:

- D1 to D3 bytes of the Section overhead
- D4 to D12 bytes of the Line overhead

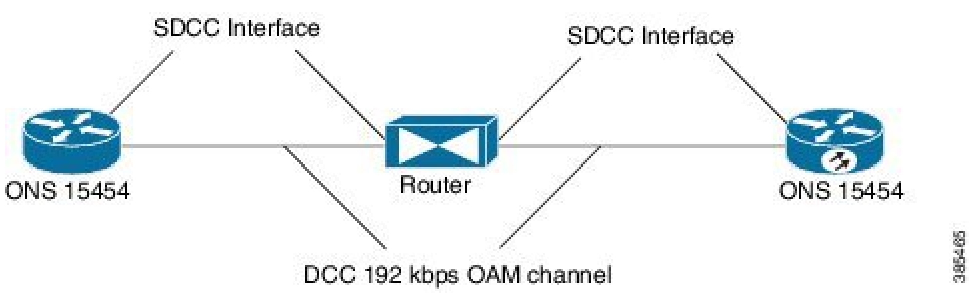
These overhead bytes are referred to as the Data Communication Channel (DCC). The Line-level DCC is a 576 kbps OAM channel; the Section-level DCC is a 192 kbps OAM channel. DCC feature uses the data communications channel to access network devices that are connected through SONET/SDH interfaces for management access.

ITU-G.7712 has defined the following three DCC network domains:

- OSI DCC network
- IP DCC network
- OSI+IP DCC network

Effective Cisco IOS XE Everest 16.6.1 release, only OSI DCC network and IP DCC network are supported, which implies that same type of network resides on either side of the router.

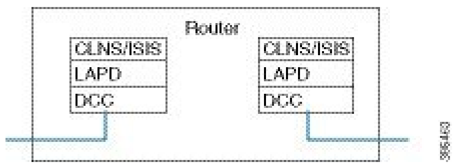
Figure 11: Implementation of DCC



As shown in the figure above, the logical interface for DCC channels is called a SONET Data Communications Channel (SDCC). Each SDCC interface is assigned an IP address. The Routing Information Protocol (RIP) is used as the routing protocol for the IP DCC network.

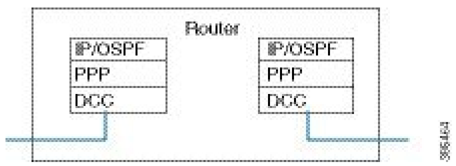
For OSI network, CLNS or ISIS protocol is used for routing and node discovery. The data layer encapsulation is LAPD.

Figure 12: DCC for OSI Network



For IP netwok, IP or OSPF protocol is used for routing and node discovery. The data layer encapsulation is PPP.

Figure 13: DCC for IP Network



Static IP configuration and PPP authentication are also supported. DCC also works with APS 1+1 protection infrastructure.

- Restrictions of DCC, on page 188
- Configuring PPP, on page 189
- Configuring CLNS or LAPD, on page 189
- Verification of DCC Configiration, on page 190

Restrictions of DCC

- Only routing IP and OSI domains are supported; layers 4–7 of OSI model is not supported.
- Interworking of OSPI and IP domains is not supported.
- CLNS MTU supported is 1489 on routers.
- CLNS interoperability with ONS is not supported.
- IS-IS packet bigger than LAPD MTU is not dropped.
- 1+1 APS with CLNS mode is not supported.
- During a CRC mismatch, the interface reaches **Up** state under the LAPD UITS mode after SSO.
- Under LAPD encapsulation mode, the default LAPD role and modes are not displayed in the running configuration.
- DCC termination on APS controllers is not supported.

Configuring PPP

To configure PPP:

```
enable
configure terminal
controller mediatype 0/3/4
mode sonet
controller sonet 0/3/4
rate oc48
dcc enable [section | line]
interface [sdcc | ldcc] 0/3/4
ip unnumbered loopback 1
encapsulation ppp
crc 16 | 32
exit
interface loopback 1
ip address 2.2.2.2 255.255.255.255
router ospf 1
network 2.2.2.0 0.0.0.255 area 0
end
```

Note CRC 32 is for SDCC and CRC 16 is for LDCC.

Configuring CLNS or LAPD

To configure CLNS or LAPD:

```
enable
configure terminal
controller mediatype 0/3/4
mode sonet
controller sonet 0/3/4
rate oc48
dcc enable [section | line]
interface [sdcc | ldcc] 0/3/4
encapsulation lapd
clns mtu 1489
lapd role user
clns router isis R1_R2
router isis R1_R2
network 47.0039.3333.3333.3333.00
end
```

Note When you configure LAPD role user on router, you should not configure the other router as LADP role user. It should be network and not user.

Verification of DCC Configiration

Use **show clns neighbors**, **show ip ospf neighbor**, **show ip int br | I DCC**, and **show interface SDCC** commands to verify DCC configuration.

```
#show clns neighbors
Tag R1_R2:

Tag null:
System Id       Interface     SNPA                State  Holdtime  Type Protocol
NCS4216_2       LD0/3/4       *LAPD*              Up     9         L1L2 IS-IS

Tag ethernet:
System Id       Interface     SNPA                State  Holdtime  Type Protocol
NCS4216_1       Te0/1/8       5006.ab62.6062      Up     54        L1   IS-IS
#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
3.3.3.4           1   FULL/BDR        00:00:35    3.3.3.4         TenGigabitEthernet0/1/8
6.6.6.2           0   FULL/  -        00:00:37    2.2.2.1         SDCC0/3/4
#show ip int br | i DCC
LDCC0/3/4              5.5.5.2         YES NVRAM  up                    up
SDCC0/3/6              2.2.2.1         YES TFTP   up                    down
SDCC0/3/7              2.2.2.1         YES TFTP   up                    up
SDCC0/4/7              8.8.8.8         YES TFTP   down                  down
```

CHAPTER 11

Transparent Overhead Tunneling Data Communication Channel

This chapter provides information about the transparent overhead tunneling data communication channel.

Transparent Overhead Tunneling Data Communication Channel Overview

SONET or SDH frame provides data communications channel (DCC) bytes for network element operations such as administration, maintenance, and provisioning.

Each SONET or SDH frame includes two DCCs—Section DCC (SDCC or RS-DCC) and Line DCC (LDCC or MS-DCC). The section and line DCCs are used for transporting management messages between Network Elements (NEs) and between NEs and Network Management System (NMS).

Each SONET or SDH frame uses these DCC bytes in overhead of the frame to carry management information for SONET or SDH networks, or Add or Drop multiplexers (ADMs). These DCC bytes traverse through hop-by-hop between ADMs and perform a path discovery and end-to-end provisioning in SONET or SDH network.

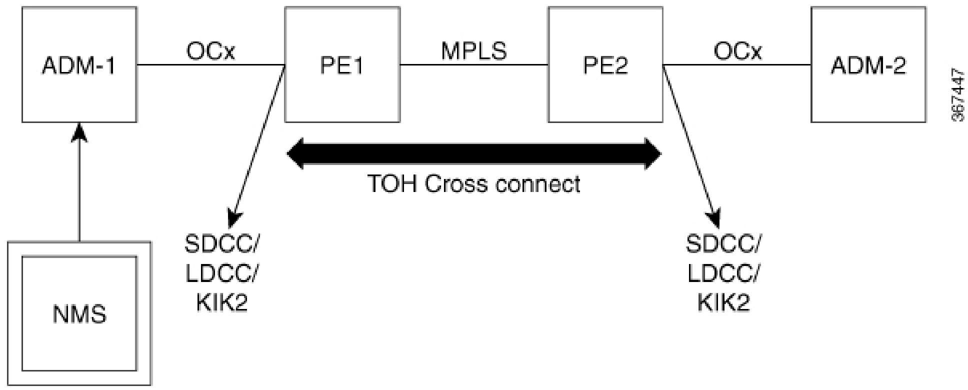
The behavior without DCC tunneling is that the NMS discovers the connected ADM but could not reach the ADM at the remote end of the TDM circuit.

With the introduction of DCC tunneling, the NMS discovers the existing topology and the insertion of ASR nodes are transparent to the DCC bytes. These ASR nodes help to tunnel DCC bytes and the NMS connectivity remains intact.

In the following diagram, the ADM-1 reaches the ADM-2 through transparent overhead (TOH) tunnel that is established between provider edges (PE1 and PE2).

The DCC bytes from ADM-1 reach ADM-2 through the TOH tunnel. Therefore, the NMS could reach the ADM-2 and the topology across ADMs remains intact.

Figure 14: Transparent Overhead Tunneling-SONET



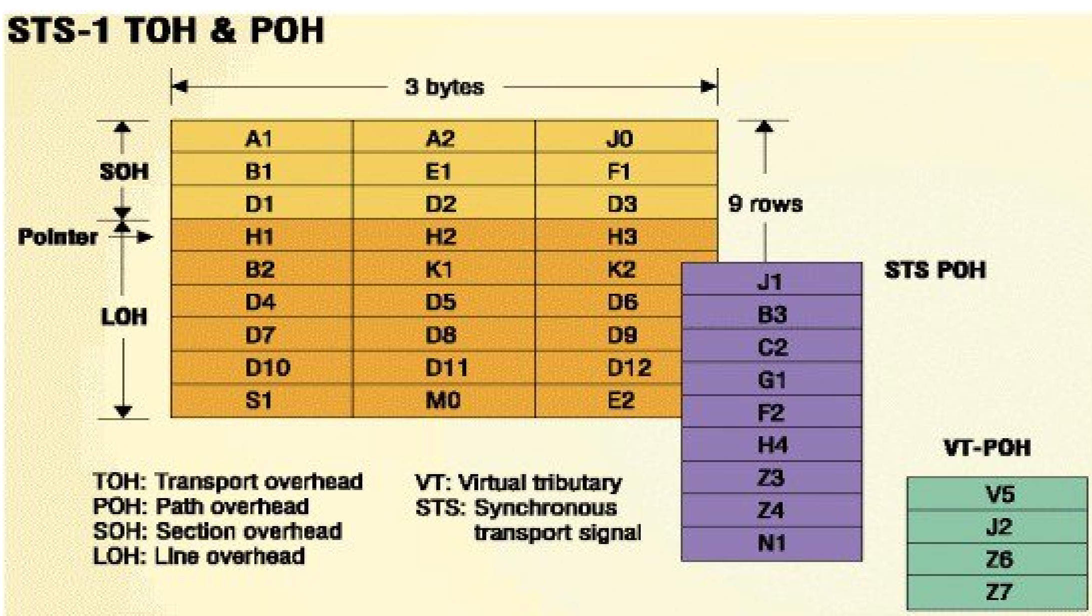
Transparent Overhead Tunnel DCC Types

The transparent overhead tunnel supports the following DCC types that are embedded in the transport overhead of STS-1 frame:

- Section DCC—Supports 3 bytes, D1, D2, and D3 responsible for message-based administration, monitoring, alarm maintenance, and other communication requirements. The section DCC provides a bandwidth of 192 Kbit/s between each pair of SONET section termination equipment. Any SONET equipment that can extract these 3 bytes from the STS-1 frame overhead and process them is considered to support a DCC interface.
- Line DCC—Supports D4 to D12 bytes with bandwidth of 576 Kbit/s.

In the following diagram, STS-1 Transport and Path Overhead are displayed.

Figure 15: STS-1 Frame Structure



The following table describes the transparent overhead tunnel segments with the supported tunnel types and the respective tunnel header bytes.

Table 13: Tunnel Segments with Tunnel Types and Supported Header Bytes

Tunnel Segment	Tunnel Type	Header Bytes
Section Header	SDCC for SONET RS-DCC for SDH	D1, D2, D3
Section Header	SOH	E1, F1, D1, D2, D3
Line Header	K1K2	K1K2
Line Header	LDCC for SONET MS-DCC for SDH	D4 to D12
Line Header	LOH	K1, K2, D4 to D12, E2
Section and Line Header	ALL	E1, F1, D1, D2, D3, K1, K2, D4 to D12, M0, E2

Prerequisites for Transparent Overhead Tunnel

Before creating transparent overhead tunnel, ensure that you perform the following steps:

- Set mode under the STS path for SONET before enabling the overhead tunnel.

  The following example details on how to set STS-1 mode on SONET.

```
platform enable controller MediaType 0/3/2 oc3
controller MediaType 0/3/2
 mode sonet
controller SONET 0/3/2
 rate OC3
 no ais-shut
 alarm-report all
 clock source internal
 !
 sts-1 1
  clock source internal
  mode vt-15
```

- Set mode under the AU-4 path on SDH before enabling the overhead tunnel.

  The following example details on how to set AU-4 mode on SDH.

```
platform enable controller MediaType 0/3/2 stm1
controller MediaType 0/3/2
 mode sdh
controller SDH 0/3/2
 rate STM1
 no ais-shut
 alarm-report all
 clock source internal
 aug mapping au-4
 au-4 1
```

```
clock source internal
channel-group 0
mode vc4
```

- Mode and TOH type must be same on both PEs in an end-to-end setup.

  For example, if the PE-1 device has mode that is configured as VT-15 and TOH type as SDCC, then the same mode and TOH type must be configured on the PE-2 device.

  If the mode and TOH type configurations differ, then the TOH tunneling does not work.

Limitations of Transparent Overhead Tunnel

The following limitations apply to the transparent overhead tunnel:

- Ensure that mode is set under the path level of SONET or SDH interface before configuring the tunnel.
- If the DCC interface is configured, then DCC tunneling cannot be configured. You can configure either one of them at a time.
- TOH tunnel configuration is supported only at the port level.
- QoS is not supported for TOH channels.
- Each interface module in IO-FPGA supports only 9 TOH channels.
- When a TOH tunnel is configured with a specific CEM group and CEM identifier on an interface, then to modify the CEM group, you must perform the following steps:
  1. First remove the TOH tunnel that is configured on that interface using the **no overhead tunnel** *tunnel-type cem-group cem-id* command.
  2. Then add with a new CEM group and CEM identifier.
- When DCC tunneling is set, you cannot configure payload and dejitter buffer under the CEM interface.
- The K1 and K2 bytes are not transparent over APS-enabled channels.

How to Configure Transparent Overhead Tunnel

This section provides information about configuring the transparent overhead tunnel.

Configuring Mode for Controller

Configuring Mode for SONET Controller

Before configuring transparent overhead tunnel, ensure that mode for the controller is configured.

To configure mode for the SONET controller, use the following commands:

```
controller sonet interface
sts-1 1
  mode vt-15
end
```

Configuring Mode for SDH Controller

To configure mode for the SDH controller, use the following commands:

```
controller sdh interface
aug mapping au-4
au-4 1
clock source internal
channel-group 0
mode vc4
end
```

Note Any path-level mode can be set for SONET or SDH.

Creating Transparent Overhead Tunnel

To configure a transparent overhead tunnel, specify the tunnel type of the line or section header and CEM group with identifier.

To configure the transparent overhead tunnel on the SONET interface, use the following commands:

```
router(config)#controller sonet interface-name
router(config-controller)#overhead tunnel <All | SDCC | LDCC | K1K2 | LOH | SOH> cem-group
 cem-id unframed
router(config-controller)#end
```

To configure the transparent overhead tunnel on the SDH interface, use the following commands:

```
router(config)#controller sdh interface-name
router(config-controller)#overhead tunnel <All | RS-DCC | MS-DCC | K1K2 | LOH | SOH> cem-group
 cem-id unframed
router(config-controller)#end
```

Creating Transparent Overhead Tunnel Pseudowire

To configure a transparent overhead tunnel pseudowire, first configure the CEM interface and then perform cross connect to a peer device with a remote IP address and specific virtual circuit identifier using MPLS encapsulation. The pseudowire carry forward specific TOH types as configured.

To configure the transparent overhead tunnel pseudowire, use the following commands:

```
router(config)#interface cem 0/3/4
router(config-if)#cem cem-id
router(config-if)#xconnect  remote-ip-address  virtual-connect-ID  encapsulation MPLS
router(config-controller)#end
```

```
router(config)#interface cem 0/3/4
router(config-if)#cem 1
router(config-if)#xconnect   192.2.0.2  2  encapsulation MPLS
router(config-controller)#end
```

Verifying Transparent Overhead Tunnel and Pseudowire Configuration

The following **show cem circuit interface cem** *interface-name* command displays that CEM interface is configured for a transparent overhead tunnel.

```
Router# show cem circuit interface cem 0/7/7
CEM0/7/7, ID: 100, Line: UP, Admin: UP, Ckt: ACTIVE,   TOH Type: LOH
Controller state: up
Idle Pattern: 0xFF, Idle CAS: 0x8
Dejitter: 6 (In use: 0)
Payload Size: 8
Framing: Unframed
CEM Defects Set
None

Signalling: No CAS
RTP: No RTP

Ingress Pkts:    3001                 Dropped:            0
Egress Pkts:     3001                 Dropped:            0

CEM Counter Details
Input Errors:    0                    Output Errors:      0
Pkts Missing:    0                    Pkts Reordered:     0
Misorder Drops:  0                    JitterBuf Underrun:  0
Error Sec:       0                    Severly Errored Sec: 0
Unavailable Sec: 0                    Failure Counts:     0
Pkts Malformed:  0                    JitterBuf Overrun:   0
Generated Lbits: 0                    Received Lbits:     0
Generated Rbits: 0                    Received Rbits:     0
```

CHAPTER 12

Target Identifier Address Resolution Protocol

Some applications running on SONET devices identify these devices by a Target Identifier (TID). Therefore, it is necessary for the router to cache TID-to-network address mappings. As these devices usually run over OSI, the network addresses involved in the mapping are OSI Network Service Access Points (NSAP).

When a device sends a packet to another device, the device needs a way to request this information directly from the device, or from an intermediate device in the network. This functionality is provided by an address resolution protocol called TID Address Resolution Protocol (TARP).

Service providers need a dynamic method to map TIDS to NSAPs, and TARP serves this purpose. TARP runs over the Connectionless Network Protocol (CLNP) as a router must support CLN Service Routing to support TARP.

Prerequisites for TARP Support

If the router is configured as an IS, the router must be running IS-IS.

If the router is configured as an ED, then the router must be running ES-IS.

Restrictions and Limitations

- The commands “tarp allow caching” and “no tarp allow caching” may result in tarp resolution failures.
- Configuring multiple NSAP addresses are not supported.
- Avoid multiple configuring or changing tid and NSAP.

Types of TARP PDU's

- Type 1—Sent when a device has a TID for which it has no matching NSAP. Type 1 PDUs are sent to all Level 1 (IS-IS and ES-IS) neighbors. If no response is received within the specified time limit, a Type 2 PDU is sent. To prevent packet looping, a loop detection buffer is maintained on the router. A Type 1 PDU is sent when you use the **tarp resolve** command.

  A Type 1 PDU is sent when a device has a TID for which it has no matching NET information and is sent to all L1 neighbors. When a device receives a Type 1 PDU, it checks if the PDU matches the target TID of the device. When they match, a type 3 PDU is created and unicasted directly to the sender of the TARP PDU. In addition, if the update remote cache is set in the incoming PDU, the receiver updates (or creates) the cache entry for the originator. If the target TID does not match, the device propagates this PDU to all its L1 neighbors (except the originator of this PDU). If no response is received within the timeout period (15 seconds), a Type 2 PDU is originated.

  To prevent packet looping, a Loop Detection Buffer (LDB) is maintained. This consists of system ID - sequence number mappings. A packet is discarded if its sequence number is less than or equal to that found in the LDB for this system ID. If no entry is present, the LDB is updated, and the packet is processed. A sequence number of zero is treated specially, and will cause the entry in the cache to be superseded.

- Type 2—Sent when a device has a TID for which it has no matching NSAP and no response was received from a Type 1 PDU. Type 2 PDUs are sent to all Level 1 and Level 2 neighbors. A time limit for Type 2 PDUs can also be specified. A Type 2 PDU is sent when you use the **tarp resolve** command and specify the option 2.

  A Type 2 PDU is same as a Type 1, except that this PDU is sent to all (L1 and L2) neighbors. The default timeout is 25 seconds.

- Type 3—Sent as a response to a Type 1, Type 2, or Type 5 PDU. Type 3 PDUs are sent directly to the originator of the request.

- Type 4—Sent as a notification when a change occurs locally (for example, a TID or NSAP change). A Type 4 PDU usually occurs when a device is powered up or brought online.

- Type 5—Sent when a device needs a TID that corresponds to a specific NSAP. Unlike Type 1 and Type 2 PDUs that are sent to all Level 1 and Level 2 neighbors, a Type 5 PDU is sent only to a particular router. In addition to the type, TARP PDUs contain the sender NSAP, the sender TID, and the target TID (if the PDU is a Type 1 or Type 2). A Type 5 PDU is sent when you use the **tarp query** command.

TARP Features

The following are the features of TARP:

TARP Caching

TID - Network addresses mappings are stored in a cache, implemented as a hash table. A cache entry can be created dynamically when a router hears from another TARP device (e.g. as a result of a query addressed to the router), or statically via TARP "map" commands. All dynamically created TARP cache entries (i.e. those that are not static or flagged as "LOCAL") are aged out. The time out value is configurable.

TARP Timers

Configure the amount of time that the router waits to receive a response from a Type 1 PDU, a Type 2 PDU, and a Type 5 PDU and also configure the lifetime of the PDU based on the number of hops.

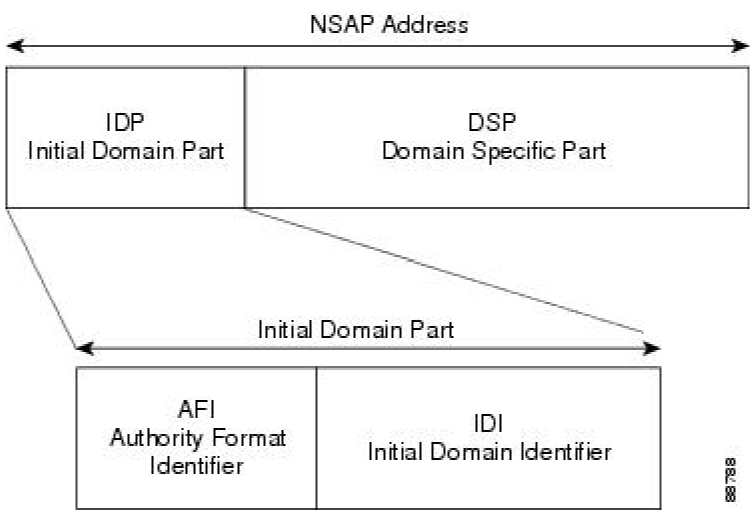
Set timers that control how long dynamically created TARP entries remain in the TID cache, and how long the system ID-to-sequence number mapping entry remains in the loop detection buffer table. The loop detection buffer table prevents TARP PDUs from looping.

TARP Counters

TARP will maintain a list of useful counters, and will increment the relevant counter. There will also be extensive debugging support that will facilitate troubleshooting

NSAP Address Format

The OSI network address is referred to as a network service access point (NSAP). The NSAP is assigned to the end system (ES) or intermediate system (IS) device. Unlike in IP, which has an address for every network interface, the OSI network device receives only one address, the NSAP address. The NSAP address has two parts, the Initial Domain Part (IDP) and Domain Specific Part (DSP).



IDP		DSP						
AFI	IDI	DFI						
39	840	128	org	res	rd	area	system	sel
1	2	1	3	2	2	2	6	1

88787

Number of Octets

Determining TIDs and NSAPs

To determine an NSAP address for a TID or a TID for an NSAP address, use the following commands in EXEC mode:

Command	Purpose
Router # **tarp query** *nsap*	Gets the TID associated with a specific NSAP.
Router # **tarp resolve** *neighbour tid*	Gets the NSAP associated with a specific TID.

To determine the TID, the router first checks the local TID cache. If there is a TID entry in the local TID cache, the requested information is displayed. If there is no TID entry in the local TID cache, a TARP Type 5 PDU is sent out to the specified NSAP address.

To determine the NSAP address, the router first checks the local TID cache. If there is an NSAP entry in the local TID cache, the requested information is displayed. If there is no NSAP entry in the local TID cache, a TARP Type 1 or Type 2 PDU is sent out. By default, a Type 1 PDU is sent to all Level 1 (IS-IS and ES-IS) neighbors. If a response is received, the requested information is displayed. If a response is not received within the response time, a Type 2 PDU is sent to all Level 1 and Level 2 neighbors. Specifying the **tarp resolve** *tid 2* EXEC command causes only a Type 2 PDU to be sent.

You can configure the length of time that the router will wait for a response (in the form of a Type 3 PDU).

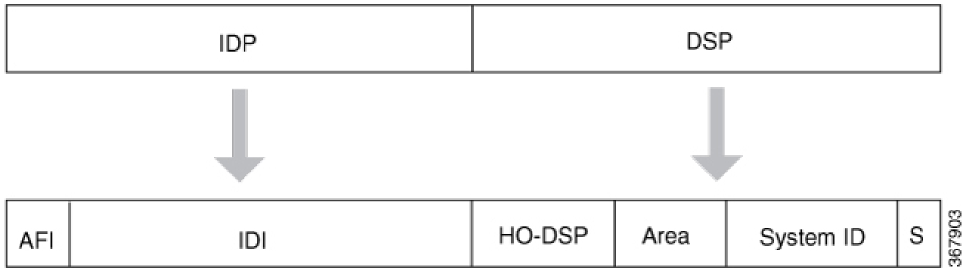
Understanding NSAP

Addresses in the ISO network architecture are referred to as network service access point (NSAP)addresses and network entity titles (NETs). Each node in an OSI network has one or more NETs. In addition, each node has many NSAP addresses. Each NSAP address differs from one of the NETs for that node in only the last byte. This byte is called the N-selector. Its function is similar to the port number in other protocol suites.

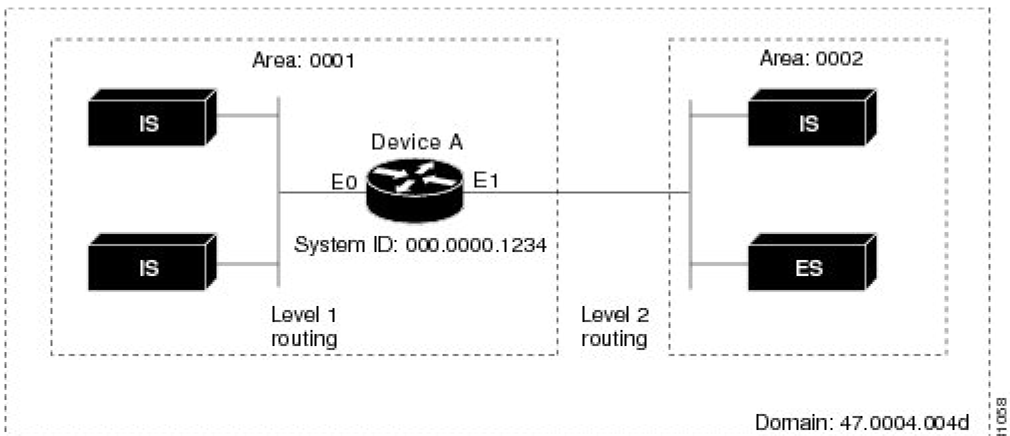
Our implementation supports all NSAP address formats that are defined by ISO 8348/Ad2; however, Cisco provides ISO Interior Gateway Routing Protocol (IGRP) or Intermediate System-to-Intermediate System (IS-IS) dynamic routing only for NSAP addresses that conform to the address constraints defined in the ISO standard for IS-IS (ISO 10589).

An NSAP address consists of the following two major fields, as shown in Figure 1:

- The initial domain part (IDP) is made up of 1-byte authority and format identifier (AFI) and a variable-length initial domain identifier (IDI). The length of the IDI and the encoding format for the domain specific part (DSP) are based on the value of the AFI.
- The DSP is made up of a High Order DSP (HO-DSP), an area identifier, a system identifier, and a 1-byte N-selector (labeled S).



Assign addresses or NETs for your domains and areas. The domain address uniquely identifies the routing domain. All routers within a given domain are given the same domain address. Within each routing domain, you can set up one or more areas, as shown in Figure 2. Determine which routers are to be assigned to which areas. The area address uniquely identifies the routing area and the system ID identifies each node.



The key difference between the ISO IGRP and IS-IS NSAP addressing schemes is in the definition of area addresses. Both use the system ID for Level 1 routing (routing within an area). However, they differ in the way addresses are specified for area routing. An ISO IGRP NSAP address includes three separate fields for routing: the domain, area, and system ID. An IS-IS address includes two fields: a single continuous area field (comprising the domain and area fields) and the system *ID*.

How To Configure TARP

To configure TARP on the router, perform the tasks in the following sections:

Enabling TARP and Configuring a TARP TID

TARP must be explicitly enabled before the TARP functionality becomes available, and the router must have a TID assigned. Also, before TARP packets can be sent out on an interface, each interface must have TARP enabled and the interface must be able to propagate TARP PDUs.

The router will use the CLNS capability to send and receive TARP PDUs. If the router is configured as an IS, the router must be running IS-IS. If the router is configured as an ES, the router must be running ES-IS.

To turn on the TARP functionality, use the following commands in global configuration mode:

Command	Purpose
Router(config)# **tarp run**	Turns on the TARP functionality.
Router(config)# **tarp tid** *tid*	Assigns a TID to the router.

To enable TARP on one or more interfaces, use the following command in interface configuration mode

Table 14:

Command	Purpose
Router(config-if)# **tarp enable**	Enables TARP on the interface.

TARP on Gigabit Ethernet Interface

The following example shows how to enable TARP on the router and Ethernet interface 0. The router is assigned the TID name.

```
interface GigabitEthernet0/2/5
ip address 60.1.1.2 255.255.255.0 àip address for gig
ip router isis 1 -- to enable the isis configured under gig
negotiation auto
clns router isis 1 --- to assign it to clns
isis circuit-type level-1 --- isis level type
tarp enable
```

TARP on SDCC

The following example shows how to enable TARP on the SDCC interface. The router is assigned the TID name.

```
interface SDCC0/3/3
ip address 192.168.10.7 255.255.255.0
encapsulation lapd
lapd t200 200
lapd role user
‘lapd role network’ by default
clns mtu 512
clns router isis 1
isis circuit-type level-1
no isis hello padding
isis retransmit-interval 10
isis lsp-interval 512
tarp enable

tunnel source GigabitEthernet0/4/7
interface GigabitEthernet0/4/7
ip address 60.1.1.1 255.255.255.0
negotiation auto

Router#sh run | sec Tunnel1
interface Tunnel1
ip address 80.1.1.2 255.255.255.0
ip router isis 1
```

```
tunnel source GigabitEthernet0/4/7
tunnel destination 60.1.1.2
clns router isis 1
isis circuit-type level-1
tarp enable
```

For more information on SDCC, Configuring Data Communication Channel

How to Configure TARP

TARP must be explicitly enabled before the TARP functionality becomes available, and the router must have a TID assigned. Also, before TARP packets can be sent out on an interface, each interface must have TARP enabled and the interface must be able to propagate TARP PDUs.

The router uses the CLNS capability to transfer and receive TARP PDUs. If the router is configured as an IS, the router must be running IS-IS. If the router is configured as an ES, the router must be running ES-IS.

TARP feature can be optionally enabled or disabled through CLI. Furthermore, all interfaces over which TARP packets that need to be sent must have TARP configured. Propagation of TARP packets can be disabled on an interface basis, on an adjacency basis, or on a global basis. Origination of TARP packets can be disabled on a global basis.

To configure TARP on a Gigabit Ethernet Interface, use the following commands:

Step 1 **configure terminal**

Enter global configuration mode.

Step 2 **tarp run**

```
Router (config)# tarp run
```

Enable TARP functionality.

Step 3 **tarp tid** *id*

```
Router (config)# tarp tid 500
```

Assign TID to the router.

Step 4 **tarp enable** *interface name*

```
Router (config)#tarp enable Te0/12/0
```

Enables TARP on an interface.

TARP Configuration Examples

The following example shows how to enable TARP on the router and Ethernet interface 0. The router is assigned the TID myname.

```
clns routing
 tarp run
 tarp tid myname

 interface ethernet 0
  tarp enable
```

Configuring TARP Features

To configure TARP features on the router, perform the tasks in the following sections.

Configuring Static TARP Adjacency and Blacklist Adjacency

In addition to all its IS-IS/ES-IS adjacencies, a TARP router propagates PDUs to all its static TARP adjacencies. If a router is not running TARP, the router discards TARP PDUs rather than propagating the PDUs to all its adjacencies. To allow TARP to bypass routers en route that may not have TARP running, TARP provides a static TARP adjacency capability. Static adjacencies are maintained in a special queue.

To create a static TARP adjacency, use the following command in global configuration mode:

Command	Purpose
Router(config)# **tarp route-static** *nsap* **[all | message-type {unknowns** | type-number} [type-number] [type-number]]	Enters a static TARP adjacency.

To stop TARP from propagating PDUs to an IS-IS/ES-IS adjacency that may not have TARP running, TARP provides a blacklist adjacency capability. The router will not propagate TARP PDUs to blacklisted routers. To blacklist a router, use the following command in global configuration mode:

To blacklist a router, use the following command in global configuration mode:

Command	Purpose
Router(config)# **tarp blacklist-adjacency** *nsap*	Bypasses a router not running TARP.

Configuring TARP Timers

TARP timers provide default values and typically need not be changed.

You can configure the amount of time that the router waits to receive a response from a Type 1 PDU, a Type 2 PDU, and a Type 5 PDU. You can also configure the lifetime of the PDU based on the number of hops.

You can also set timers that control how long dynamically created TARP entries remain in the TID cache, and how long the system ID-to-sequence number mapping entry remains in the loop detection buffer table. The loop detection buffer table prevents TARP PDUs from looping.

To configure TARP PDU timers, control PDU lifetime, and set how long entries remain in cache, use the following commands in global configuration mode:

Command	Purpose
Router(config)# **tarp t1-response-timer** *seconds*	Configures the number of seconds that the router will wait for a response from a TARP Type 1 PDU.
Router(config)# **tarp t2-response-timer** *seconds*	Configures the number of seconds that the router will wait for a response from a TARP Type 2 PDU.

Command	Purpose
Router(config)# **tarp post-t2-response-timer** *seconds*	Configures the number of seconds that the router will wait for a response from a TARP Type 2 PDU after the default timer has expired.
Router(config)# **tarp arp-request-timer** *seconds*	Configures the number of seconds that the router will wait for a response from a TARP Type 5 PDU.
Router(config)# **tarp lifetime** *hops*	Configures the number of routers that a TARP PDU can traverse before it is discarded.
Router(config)# **tarp cache-timer** *seconds*	Configures the number of seconds a dynamically created TARP entry remains in the TID cache.
Router(config)# **tarp ldb-timer** *seconds*	Configures the number of seconds that a system ID-to-sequence number mapping entry remains in the loop detection buffer table.

Configuring Miscellaneous TARP PDU Information

TARP default PDU values typically need not be changed.

You can configure the sequence number of the TARP PDU, set the update remote cache bit used to control whether the remote router updates its cache, specify the N-selector used in the PDU to indicate a TARP PDU, and specify the network protocol type used in outgoing PDUs.

To configure miscellaneous PDU information, use the following commands in global configuration mode:

Table 15:

Command	Purpose
Router(config)# **tarp sequence-number** *number*	Changes the sequence number in the next outgoing TARP PDU.
Router(config)# **tarp urc [0 | 1]**	Sets the update remote cache bit in all subsequent outgoing TARP PDUs so that the remote router does or does not update the cache.
Router(config)# **tarp nselector-type** *hex-digit*	Specifies the N-selector used to identify TARP PDUs.
Router(config)# **tarp protocol-type***hex-digit*	Specifies the protocol type used in outgoing TARP PDUs. Only the hexadecimal value 0xFE (to indicate the CLNP) is supported.

TARP Configuration Task List

To configure TARP on the router, perform the tasks in the following sections. Only the first task is required; all other tasks are optional.

Disabling TARP Caching

By default, TID-to-NSAP address mappings are stored in the TID cache. Disabling this capability clears the TID cache. Reenabling this capability restores any previously cleared local entry and all static entries.

To disable TID-to-NSAP address mapping in the TID cache, use the following command in global configuration mode:

Command	Purpose
Router(config)# **no tarp allow-caching**	Disables TARP TID-to-NSAP address mapping.

Disabling TARP PDU Origination and Propagation

By default, the router originates TARP PDUs and propagates TARP PDUs to its neighbors, and the interface propagates TARP PDUs to its neighbor. Disabling these capabilities means that the router no longer originates TARP PDUs, and the router and the specific interface no longer propagate TARP PDUs received from other routers.

To disable origination and propagation of TARP PDUs, use the following commands in global configuration mode:

Command	Purpose
Router(config)# **no tarp originate**	Disables TARP PDU origination.
Router(config)# **no tarp global-propagate**	Disables global propagation of TARP PDUs.

To disable propagation of TARP PDUs on a specific interface, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **no tarp propagateall | message-type {unknowns***type-number} [type-number] [type-number]]*	Disables propagation of TARP PDUs on the interface.

CHAPTER 13

Configuring Support for ASR 900 Combo 8-Port SFP GE and 1-Port 10 GE 20G Interface Module (A900-IMA1Z8S-CXMS)

The ASR 900 combo 8-port SFP GE and 1-port 10 GE 20G interface Module (A900-IMA1Z8S-CXMS) Interface Module is supported on the RSP3 module and has the capability for SONET or SDH termination with SAToP, CESoP, and CEP traffic types.

Note The Ethernet and Multiservice Gateway features are not supported on this IM for the Cisco IOS XE 16.12.1 Release.

The IM is capable of processing a maximum of 20G with different types of traffic such as 10G CEM, 2.5G iMSG, 2.5G Ethernet, and 6.9Mbps DCC. However for the Cisco IOS XE Release 16.12.1, only the 10G CEM traffic is supported. In the 10G mode, 7.5G CEM traffic is supported.

In this IM, all the eight 1G ports can be configured as OC-48 and you can utilize a maximum of 192 STS-1.

ASR 900 Combo 8-Port SFP GE and 1-Port 10 GE 20G Interface Module (A900-IMA1Z8S-CXMS)

The interface module operates in following two modes:

- Single XFI or 10 G mode
- Dual XFI or 20 G mode

Single XFI or 10 G mode

Consider the following requirement while working on the 10 G mode:

- OC-192 or SFP+ port is supported on the 10G GE port. In the 10G mode, 7.5G for CEM traffic is supported.
- If bandwidth is available to accommodate a particular circuit or Ethernet port, then configuration is allowed, and it can be performed. Otherwise, the configuration is rejected due to bandwidth limitation.
- When there is a change in the payload size, the required bandwidth gets modified accordingly. This in turn checks for the bandwidth and if the sufficient bandwidth is not available, the configuration is rejected.
- You can remove or delete the existing configuration from the port and perform new configuration on the port.

Dual XFI or 20 G mode

You can convert the IM into dual mode. In 20G mode of operation, channelized (xfi0) and non-channelized (xfi1) bandwidth are available.

Enter the following commands to convert into dual mode and then reload the IM:

```
router (config)# platform hw-module configuration
PE1(conf-plat-hw-conf)# hw-module <slot/subslot> A900-IMA1Z8S-CXMS mode 10G_CEM
```

Consider the following requirements while working on the 20-G mode:

- For configuring CEM group, the software performs bandwidth check. If the required bandwidth is not available, you cannot configure the CEM group.
- If a maximum capacity configuration is already performed on the IM and you update the payload size, then the update is not accepted on the same channel (xfi). You need to remove some configurations on circuits and then update the payload again.

For slot compatibility, refer Supported RSP and Slots in the Cisco ASR 900 Series Routers and Cisco ASR 920 Series Routers, and Cisco Interface Module Hardware Installation Guide.

Restrictions for ASR 900 Combo 8-Port SFP GE and 1-Port 10 GE 20G Interface Module (A900-IMA1Z8S-CXMS)

Feature Restrictions

The following features are not supported:

- Ethernet
- EOS L1 or L2
- MS features
- DCC is not supported for the Cisco IOS XE 16.12.1 release.
- iMSG is not supported for the Cisco IOS XE 16.12.1 release. .
- STS-192c or VC-4-64c concatenation
- Low order path concatenation (VCAT)

- Fractional CEP
- BLSR for SONET or MSSP ring for SDH
- SyncE and PTP Support on EoS (L1 or L2/L3 Terminated)
- Card level protection
- Non-standard concatenation such as STS-6c, STS-9c, STS-15c, STS-18c, and so on.
- APS or MSP 1:N, where N is greater than 1
- TSOP support
- Auto detection support
- SONET to SDH and SDH to SONET Translation
- CAS Signaling
- HSPW

Management Restrictions

The following are some management restrictions to consider while configuring the module:

- The ports can be configured and used regardless of available backplane bandwidth or HO Path resources.
- Provisioning a new CEM circuit and payload size change to the new CEM circuit is allowed as long as bandwidth is available.
- Gigabit Ethernet configuration is allowed if required bandwidth is available. Bandwidth reallocation can be performed based on some following scenarios:
    - The required bandwidth is not available on channelized xfi, but sufficient bandwidth is available on non-channelized xfi. In such cases, you should remove some configuration from circuits on the channelized xfi and then provision Gigabit Ethernet followed by CEM circuit provision.

Scale Restrictions

- The maximum number of supported VT1.5 CESoP circuits are 672 per interface module for Cisco IOS XE 16.12.x release.

Table 16: Dual Mode Restrictions for Gigabit Ethernet port

Circuit Type	Scale Supported
DS1 SAToP	2800
VT 1.5 CEP Pseudowire	2800
Gigabit Ethernet	1 x 10 G and 8 x 1 G
ACR or DCR	2000 per interface module
DS1 CESoP Pseudowire	672 per interface module

Configuring ASR 900 Combo 8-Port SFP GE and 1-Port 10 GE 20G Interface Module (A900-IMA1Z8S-CXMS)

The ASR 900 combo 8-port SFP GE and 1-port 10 GE 20G interface module functions similar to the 1-port OC-192/STM-64 or 8-Port OC-3/12/48/STM-1/-4/-16 interface module. The configurations remain the same. For more information, refer the 1-Port OC-192 or 8-Port Low Rate CEM Interface Module Configuration Guide, Cisco IOS XE Gibraltar 16.11.x (Cisco ASR 900 Series).

The following TDM features are supported:

- SNMP
- Local, network, or remote loopback
- BERT (both system and line). The system side BERT is not supported in the framed SAToP mode.
- OH config
- Network synchronization
- SSM
- Shut at port and CEM-group level

The CEM features such as SAToP, CESoP, and CEP are supported in the following modes:

- Unprotected CEM with ACR or DCR are supported in the following modes:
  - T1, T3, E1, E3, DS0, DS1, and DS3
  - CEM Payload size configurable.

  APS CEM with ACR or DCR are supported in the following modes
  - DS0, DS1, DS3, T1, T3, E1, E3, AU-3, and AU-4
  - CEM payload size configurable.
- UPSR at VT or STS mode.
- DS1 (with VT Protection) or DS3 (STS Protection) with ACR or DCR
- CEM Class with configurable payload size or jitter buffer

Note For more information, see the Cisco ASR 900 Series Routers and Cisco ASR 920 Series Routers, and Cisco Interface Module Hardware Installation Guide.