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 Configuration Guide, Cisco IOS XE 16 (Cisco NCS 4200 Series)

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CHAPTER 1

Configuring Support of 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

The 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 has 12XDS1, 4XDS3, electrical interfaces, and 4XSFP ports that can provide multiple functions such as 1XOC-48/12/3 and 3XOC-12/3. The maximum speed supported on OCx ports is OC-48. The interface module supports a maximum of 3G CEM traffic.

Note In addition to support on RSP2 module, the IM is supported on RSP3 from the Cisco IOS XE 16.9.x release.

Restrictions of Feature Support on 4 Port OC48/OC12/OC3 + 12 Port T1/E1 + 4 Port T3/E3 CEM Interface Module

- Mixed mode support, for example, DS1 and E1 or DS3 and E3 or SONET and SDH simultaneously on different ports is not available.
- E1/E3, Unidirectional Path Switching Ring (UPSR), and Data Communication Channel (DCC) are not supported.
- Multiservice functionality: MLPPP, FR, and MLFR are not supported.
- EoS and EoPDH are not supported.
- The **configure replace** command is *not* supported.

- A combination of T1/T3/SONET with E1/E3/SDH modes are not supported.
- When IM is used with RSP3 module, then it is not allowed in slots 0 and 1 on NCS42xx chassis.
- Synchronization Status Message (SSM) is not supported on T3 ports.

Enabling T1 Controller

Note T1/T3 or E1/E3 does not require any license.

To enable T1 controller:

```
enable
configure terminal
controller mediatype 0/4/0
mode t1
end
```

Configuring the Controller

To configure T1 interface, use the following commands:

```
enable
configure terminal
controller mediatype 0/4/0
mode t1
exit
controller t1 0/4/0
clock source internal
framing esf
cablelength short 110
linecode b8zs
no shutdown
exit
```

Enabling T3 Controller

To enable T3 controller:

```
enable
configure terminal
controller mediatype 0/4/12
mode t3
end
```

Enabling SONET Controller

To enable SONET controller:

```
enable
configure terminal
controller mediatype 0/0/16
mode sonet
end
```

Associated Commands

The following table shows the commands for the IM configuration:

Command	Link
platform enable controller Mediatype *<slot/bay/port> <port rate>*	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-o1.html#wp3145726977

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Compact-SFP	Cisco SFP Modules for Gigabit Ethernet Applications Data Sheet

Standards and RFCs

Standard/RFC	Title
—	*There are no standards and RFCs for this feature.*

MIBs

MIB	MIBs Link
—	*There are no MIBs for this feature.* 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 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

Restrictions for CEM

The **framed** command is not supported.

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.

Configuring CEM

This section provides information about how to configure CEM. CEM provides a bridge between a Time Division Multiplexing (TDM) network and a packet network, 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.

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 0/4/0
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:

- 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 on OCx Ports

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

```
enable
configure terminal
controller MediaType 0/4/16
mode sonet
controller sonet 0/4/16
rate oc12
sts-1 1
mode ct3
t1 1 cem-group 100 unframed
t1 1 framing unframed
interface cem 0/4/16
cem 100
xconnect 2.2.2.2 10 encapsulation mpls
end
```

Configuring DS1 CT3 Framed SAToP Mode on OCx Ports

To configure DS1 CT3 Framed SAToP mode on OCx ports:

```
enable
configure terminal
controller MediaType 0/4/16
mode sonet
controller sonet 0/4/16
rate oc12
sts-1 1
mode ct3
t3 framing c-bit
t1 1 cem-group 100 framed
interface cem 0/4/16
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 0/4/16
mode sonet
controller sonet 0/4/16
rate oc12
sts-1 1
mode vt-15
vtg 1 t1 1 framing unframed
vtg 1 t1 1 cem-group 0 unframed
end
```

Configuring VT DS1 Framed SAToP Mode

To configure VT DS1 Framed SAToP mode:

```
enable
configure terminal
controller MediaType 0/4/16
mode sonet
controller sonet 0/4/16
rate oc12
sts-1 1
mode vt-15
vtg 1 t1 1 cem-group 0 framed
end
```

Configuring STS-Nc CEP

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

```
enable
configure terminal
controller MediaType 0/4/16
mode sonet
controller sonet 0/4/16
rate oc12
sts-1 1 - 3 mode sts-3c
cem-group 100 cep
```

```
interface cem 0/4/16
cem 100
xconnect 2.2.2.2 10 encapsulation mpls
end
```

Configuring CEP

To configure CEP, use the following commands:

```
enable
configure terminal
controller MediaType 0/4/16
mode sonet
controller sonet 0/4/16
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 0/4/16
mode sonet
controller sonet 0/4/16
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::

```
enable
configure terminal
controller MediaType 0/4/16
mode sonet
controller sonet 0/4/16
rate oc12
sts-1 1
mode t3
cem-group 100 unframed
interface cem 0/4/16
cem 100
xconnect 2.2.2.2 10 encapsulation mpls
end
```

Configuring CEM APS

To configure CEM APS:

```
enable
configure terminal
controller MediaType 0/4/16
mode sonet
controller sonet 0/4/16
controller sonet-acr acr_no
```

```
sts-1 1
vtg 1 t1 1 cem-group 100 unframed
end
```

Configuring Unidirectional APS

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

```
enable
configure terminal
controller sonet 0/4/16
clock source internal
aps group acr 1
aps working 1
aps unidirectional
exit
controller sonet 0/4/16
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 Bi-directional ACR (SONET Framing)

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

```
enable
configure terminal
controller sonet 0/4/16
clock source internal
aps group acr 1
aps working 1
exit
controller sonet 0/4/16
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 CEM APS

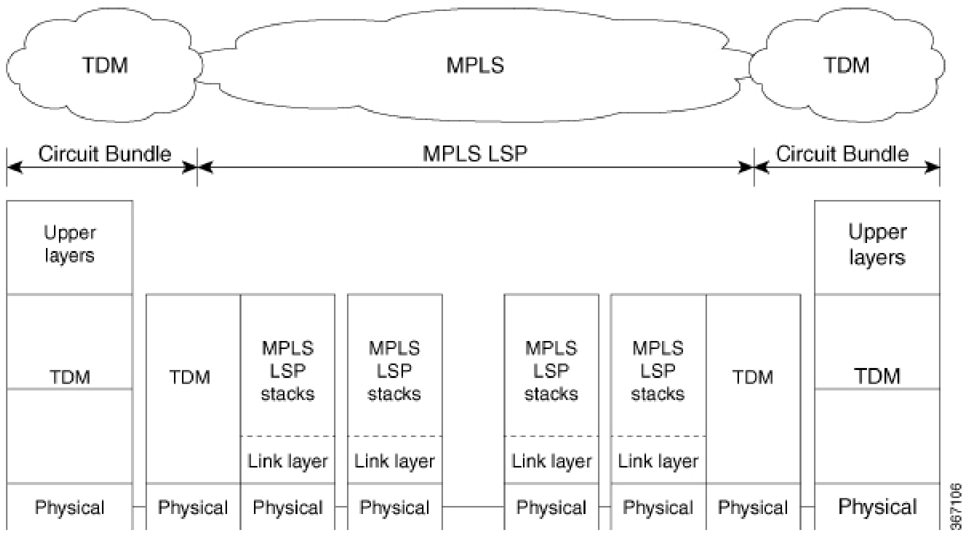
To configure CEM APS, use the following commands:

```
enable
configure terminal
controller MediaType 0/4/16
mode sonet
controller sonet 0/4/16
controller sonet-acr acr_no
sts-1 1
vtg 1 t1 1 cem-group 100 unframed
end
```

Overview of DS3 CEP

Effective Cisco IOS XE Fuji 16.8.1, DS3 CEP feature is introduced to achieve CEP configuration on DS3 ports of the interface module. Here, T3 or E3 is mapped to STS-1 or VC4 that is emulated on a packet network.

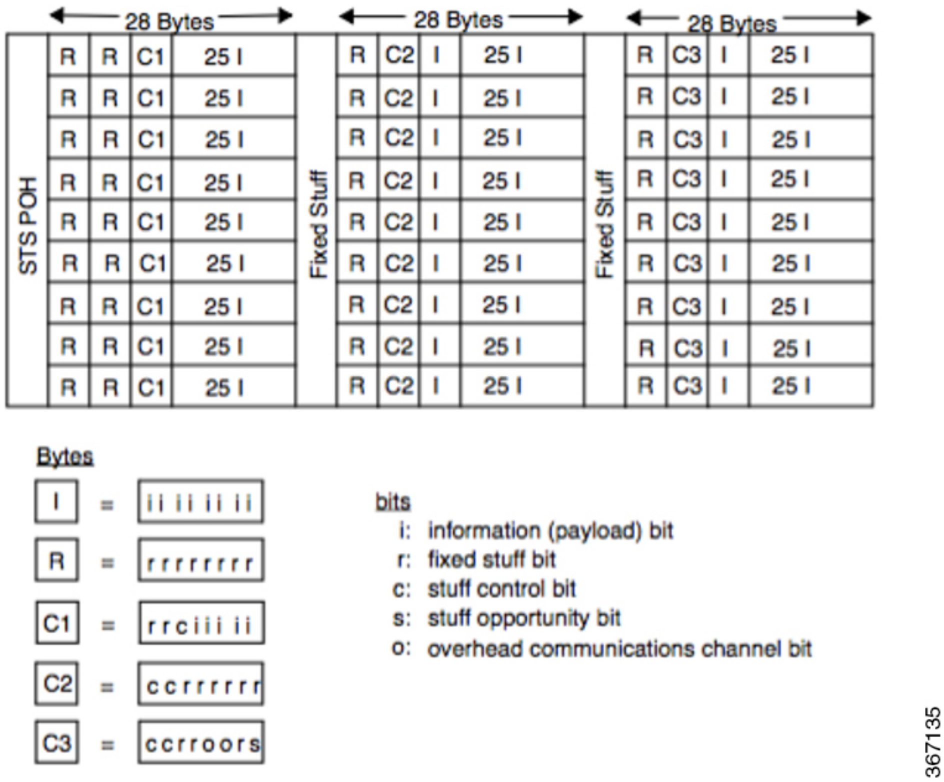
Figure 1: Network Reference Model and Protocol Layers for TDM-MPLS User Plane Interworking



Asynchronous Mapping for DS3 CEP

An asynchronous mapping for a DS3 in the payload capacity of an STS-1 signal is defined for clear-channel transport of DS3 signals that meet the DS3 requirements in GR-499-CORE. The asynchronous DS3 mapping consists of nine subframes each of 125 μs. Each subframe contains 621 information (I) bits, a set of five stuff control (C) bits, one stuff opportunity (S) bit, and two overhead communication channel (O) bits. The remaining bits of the STS-1 payload capacity are fixed stuff (R) bits. The O-bits are reserved for future overhead communication purposes. The values of the R and O bits are undefined. In each subframe, the set of five C-bits are used to control the S-bit. CCCCC = 00000 is used to indicate that the S-bit is an information bit, while CCCCC = 11111 is used to indicate that the S-bit is a stuff bit. The value of the S-bit (if it is stuff bit) is undefined.

Figure 2: Asynchronous Mapping for DS3 CEP



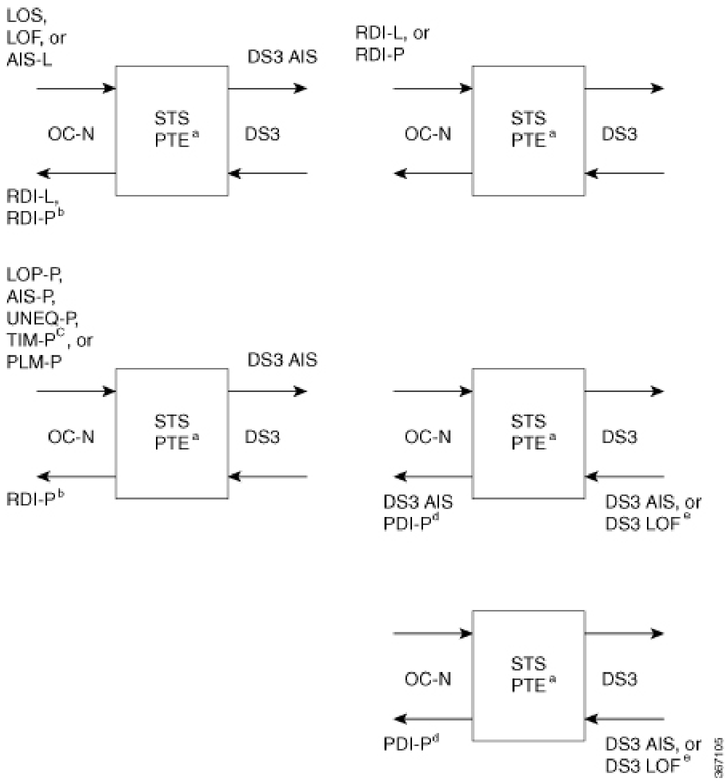
Restrictions

- BERT for both line and system directions is *not* supported.
- Card Protection is *not* supported.
- E3 CEP is not supported on optical or SDH controller.

Alarms

If an alarm is detected in the DS3 end, the C2 bytes are used to inform the remote Provider Edge (PE). For this, the alarm mapping table has to be followed as shown in the figure below.

Figure 3: Alarm Mapping Table



Configuring DS3 CEP

Pre-requisites:

The default mode is channelized mode. Use **no channelized** command to change to non-channelized mode.

To configure DS3 CEP for mode T3:

```
enable
controller MediaType 0/4/15
mode t3
controller t3 0/4/15
no channelized
cem-group 0 cep
```

To configure DS3 CEP for mode E3:

```
enable
controller MediaType 0/4/15
mode e3
controller e3 0/4/15
no channelized
cem-group 0 cep
```

Configuration of Overhead C2 and J1 Bytes:

You can configure overhead C2 and J1 bytes after you configure DS3 CEP.

```
enable
controller MediaType 0/4/15
```

```
mode e3
controller e3 0/4/15
threshold sd-ber 6
threshold sf-ber 3
no channelized
framing g751
cablelength short
cem group 0 cep
overhead j1 tx length 16
overhead j1 expected length 16
```

For loopback configuration, see *Loopback on T3/E3 Interfaces* section.

Verification of DS3 CEP Configuration

Use **show controller t3** *0/4/15 path* to verify DS3 CEP configuration:

```
router#show controller t3 0/4/15 path

T3 0/1/20 PATH 1.

Asynchronous Mapping for DS3 into STS-1

TX : TDM to PSN direction
RX : PSN to TDM direction

Clock Source is internal

  AIS = 0           RDI = 0           REI = 349         BIP(B3) = 22
  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: None

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

Tx J1 Length : 64
Tx J1 Trace

  72 74 72 32 20 30 2F 31 2F 32 30 2E 31 00 00 00     rtr2 0/1/20.1...
  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

  72 74 72 32 20 30 2F 31 2F 32 30 2E 31 00 00 00     rtr2 0/1/20.1...
  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

  72 73 70 32 20 30 2F 35 2F 31 32 2E 31 00 00 00     rsp2 0/5/12.1...
  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     ................

router#
```

Note The verification output does not provide the details for alarms.

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

Commands	URL
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
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

Configuring T1 Interfaces

This chapter provides information about configuring the T1 interfaces:

Information About T1 Interfaces

The following sections provide information about T1 interfaces.

Overview of T1 Interfaces

The 12-port T1 interface module on CEM line card supports generic single or dual-port T1 trunk interfaces for voice, data, and integrated voice or data applications.

Configuring the Controller

To configure T1 interface, use the following commands:

```
enable
configure terminal
controller mediatype 0/4/0
mode t1
exit
controller t1 0/4/0
clock source internal
framing esf
cablelength short 110
linecode b8zs
no shutdown
exit
```

Verifying Controller Configuration

Use **show controllers** command to verify the controller configuration:

```
#show controller t1 0/4/0
T1 0/4/0 is up
  Applique type is
  Cablelength is short 110
  No alarms detected.
  alarm-trigger is not set
  Soaking time: 3, Clearance time: 10
  AIS State:Clear  LOS State:Clear  LOF State:Clear
  Framing is ESF, FDL is ansi, Line Code is B8ZS, Clock Source is Line.
  BER thresholds:  SF = 10e-3  SD = 10e-6
  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
```

Performance Monitoring

The performance monitoring result displays the statistics or error count generated on the TDM lines for DS1.

To view the performance monitoring error details, use the **show controller t1** command:

```
PE2#show controller t1 0/4/0
T1 0/4/0 is up
  Applique type is
  Cablelength is short 110
  No alarms detected.
  alarm-trigger is not set
  Soaking time: 3, Clearance time: 10
  AIS State:Clear  LOS State:Clear  LOF State:Clear
  Framing is ESF, FDL is ansi, Line Code is B8ZS, Clock Source is Line.
  BER thresholds:  SF = 10e-3  SD = 10e-6
  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
```

Configuring Structure-Agnostic TDM over Packet - T1 Interfaces

To configure Structure-Agnostic TDM over Packet (SAToP):

```
enable
configure terminal
controller t1 0/4/0
cem-group 0 unframed
exit
interface cem 0/4/0
cem 0
xconnect 2.2.2.2 10000 encapsulation mpls
exit
```

Verifying CEM Configuration for SAToP

Use the following command to verify the CEM configuration for T1 interfaces:

```
#show cem ci interface cem 0/4/0

CEM 0/4/0, ID: 0, Line: UP, Admin: UP, Ckt: ACTIVE
Mode :T1, CEM Mode: T1-SAToP
Controller state: up, T1 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: No RTP

Ingress Pkts:    6463477             Dropped:             0
Egress Pkts:     5132190             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
```

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 remians up)	LOF[1][2]	Yes	No
CESOP	LOF	Down (Data path remians 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

Configuring Framed SAToP

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

To configure Framed Structure-Agnostic TDM over Packet (SAToP):

```
enable
configure terminal
controller t1 0/4/0
framing esf
cem-group 0 framed
exit
interface cem 0/4/0
cem 0
xconnect 2.2.2.2 10000 encapsulation mpls
exit
```

Verifying CEM Configuration for Framed SAToP

Use **show cem ci interface** to verify CEM configuration for Framed SAToP:

```
#show cem ci interface cem 0/4/0

CEM 0/4/0, ID: 0, Line: UP, Admin: UP, Ckt: ACTIVE
Mode :T1, CEM Mode: T1-SAToP
Controller state: up, T1 state: up
Idle Pattern: 0xFF, Idle CAS: 0x8
Dejitter: 6 (In use: 0)
Payload Size: 192
Framing: Framed SAToP
CEM Defects Set
None

Signalling: No CAS
RTP: No RTP

Ingress Pkts:    6463477              Dropped:             0
Egress Pkts:     6463477              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
```

Troubleshooting T1 Controllers

You can use the following methods to troubleshoot the T1 controllers:

Running Bit Error Rate Testing

Bit error rate testing (BERT) is supported on T1 interfaces.

The interface module contains onboard BERT circuitry. With this, the interface module software can send and detect a programmable pattern that is compliant with CCITT/ITU O.151, O.152, O.153 pseudo-random and repetitive test patterns. BERT allows you to test cables and signal problems in the field.

When running a BERT test, your system expects to receive the same pattern that it is transmitting. To help ensure this, two common options are available:

- Use a loopback somewhere in the link or network
- Configure remote testing equipment to transmit the same BERT test pattern at the same time

The following keywords list different BERT keywords and their descriptions.

Table 4: BERT Pattern Descriptions

Keyword	Description
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.
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.
2^23	Pseudo-random 0.151 test pattern that is 8,388,607 bits in length.

The total number of error bits received, and the total number of bits received are available for analysis. You can select the testing period from 1 minute to 24 hours, and you can also retrieve the error statistics anytime during the BERT test.

BERT is supported in two directions:

- Line - supports BERT in TDM direction
- System - supports BERT in PSN direction

Note Before starting system side BERT, you must configure CEM. When the BERT is configured towards system direction, it internally loopbacks the TDM side. BERT in system direction is *not* supported for framed SAToP.

Configuring BERT

Before you run BERT test, you must configure card type and controller.

To run a BERT on T1 interface, perform the following tasks in global configuration mode.

```
enable
configure terminal
controller t1 0/4/0
bert pattern 2^11 interval 5 direction [line | system]
exit
```

Verifying BERT Configuration for SAToP

Use the following command to verify the BERT configuration for T1 interfaces:

```
Router# show controllers t1 0/4/0
T1 0/4/0 is up.
Applique type is
Cablelength is short 110
DSX1 BERT pattern : 2^11
DSX1 BERT direction : Line
DSX1 BERT sync : no sync
DSX1 BERT sync count : 0
DSX1 BERT interval : 5
DSX1 BERT time remain : 2
DSX1 BERT total errs : 0
DSX1 BERT total k bits: 0
DSX1 BERT errors (last): 0
DSX1 BERT k bits (last): 0
Last clearing of BERT counters never
No alarms detected.
alarm-trigger is not set
Soaking time: 3, Clearance time: 10
AIS State:Clear LOS State:Clear LOF State:Clear
Framing is unframed, Line Code is B8ZS, Clock Source is Internal.
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
```

Loopback on T1 Interfaces

Loopback is supported on both unframed and framed modes. You can use the following loopback on the T1 interfaces.

Loopback	Description
loopback diag	Loops the outgoing transmit signal back to the receive signal. This is done using the diagnostic loopback feature in the interface module's framer. The interface transmits AIS in this mode. Set the **clock source** command to internal for this loopback mode.
loopback local	Loops the incoming receive signal back out to the transmitter. You can specify whether to use the line or payload.
loopback local line	The incoming signal is looped back in the interface using the framer's line loopback mode. The framer does not reclock or reframe the incoming data. All incoming data is received by the interface driver.
loopback local payload	Loops the incoming signal back in the interface using the payload loopback mode of the framer. The framer reclocks and reframes the incoming data before sending it back out to the network. **Note** Loopback Local Payload support is available only when framing is ESF.
loopback network line	Loops the incoming signal back in the interface module using the line loopback mode of the framer. The framer does not reclock or reframe the incoming data. All incoming data is received by the interface module driver.

Configuring Loopback

Before you configure loopback, you must configure the controller and the CEM.

To set a loopback local on the T1 interface, perform the following tasks in global configuration mode:

```
enable
```

```
configure terminal
controller t1 0/4/0
loopback local line
exit
```

To set a loopback diag on the T1 interface, perform the following tasks in global configuration mode:

```
enable
configure terminal
controller t1 0/4/0
loopbackdiag
exit
```

Note To remove a loopback, use the **no loopback** command.

Note Network payload configuration is not supported on SAToP. To configure loopback network payload when SAToP is configured, you need to remove the CEM configuration and then configure the loopback.

Associated Commands

The commands used to configure the Interfaces.

Commands	URL
cem-group	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2440628600
payload-size dejitter-buffer	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-o1.html#wp3946673156
class cem	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2169323859
controller t1/e1	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp1472647421
xconnect	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t2.html#wp8578094790
linecode	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l1.html#wp2312535965

Commands	URL
framing	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-f1.html#wp2853515177
clock source	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp6081785140
cable length	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2492964151
bert pattern	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-a1.html#wp3620978929
channelized	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp7026926390
loopback	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l1.html#wp1033903426
show controller t1	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-s3.html#wp2149471094

CHAPTER 4

Configuring T3 Interfaces

T3 interface supports 4 ports. The channels on the T3 interface can be configured as either clear channel mode or channelized mode.

Information About T3 Interfaces

The following sections provide information about T3 interfaces.

Overview of T3 Interfaces

The T3 interface supports two modes, clear channel mode and channelized mode.

Benefits of T3 Interfaces

The following are the benefits of T3 interfaces:

- Higher bandwidth
- Flexibility by channelization

Enabling T3 Controller

To enable T3 controller:

```
enable
configure terminal
controller mediatype 0/4/12
mode t3
end
```

Configuring the Controller of Clear Channel T3 Interfaces

When the clear channel T3 interface is used for the first time, the running configuration does not show the T3 controller. You can use the **show platform** command to check whether the chassis recognizes the T3 port and initializes the card correctly. After the port is configured for the slot, the respective controller appears in the running configuration and you can configure the clear channel T3 interface.

Perform this task to configure clear channel controller as T3.

```
enable
configure terminal
controller t3 0/4/12
no channelized
clock source line
no shut
exit
```

Note By default, the T3 controller is in C-Bit framing mode. To configure CEM, the framing mode must be set to unframed.

Verifying Controller Configuration of Clear Channel T3 Interfaces

Use the **show controllers** command to verify the controller configuration of clear channel T3 interface:

```
# show controllers t3 0/4/12
T3 0/4/12 is up.
Hardware is
Applique type is Clear Channel T3
No alarms detected.
Framing is Unframed, Line Code is B3ZS, Cablelength is 224
Clock Source is internal
Equipment customer loopback
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 the Controller of Channelized T3/T1 Interfaces

When the channelized T3/T1 interface is used for the first time, the running configuration does not show the T3 controller. You can use the show platform command to check if the chassis recognizes the T3 port and initializes the card properly. After the port is configured for the slot, the respective controller appears in the running configuration and you can configure the channelized T3/T1 interface.

Perform this task to configure channelized controller as T3/T1.

```
enable
configure terminal
controller t3 0/4/12
channelized
clock source line
no shut
exit
```

Note The channelized mode is the default mode for T3 interface.

Verifying the Controller Configuration of Channelized T3/T1 Interfaces

Use the **show controllers** command to verify the controller configuration of channelized T3/T1 interfaces:

```
# show controllers t3 0/4/12
T3 0/4/12 is down.
Hardware is
Applique type is Channelized T3/T1
Receiver has loss of signal.
MDL transmission is disabled
FEAC code received: No code is being received
Framing is C-BIT Parity, Line Code is B3ZS, Cablelength Short less than 225ft
BER thresholds: SF = 10e-10 SD = 10e-10
Clock Source is line
Equipment customer loopback
 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 Sec

T1 1 is down
  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 SAToP - Clear Channel T3 Interfaces

Before Structure-Agnostic TDM over Packet (SAToP) is configured, the controller of clear channel T3 interface must be configured.

```
enable
configure terminal
controller t3 0/4/12
no channelized
cem-group 0 unframed
interface CEM 0/4/12
cem 0
```

```
xconnect 10.10.2.2 204 encapsulation mpls
exit
```

Verifying CEM Configuration of Clear Channel T3 Interfaces for SAToP

Use the **show run interface** command to verify the configuration of xconnect:

```
# show run interface cem 0/4/12
Current configuration : 96 bytes
!
interface CEM 0/4/12
no ip address
cem 0
xconnect 10.10.2.2 204 encapsulation mpls
!
end
```

Use the **show cem circuit interface cem** command to verify the CEM interface configuration of clear channel T3 interface for SAToP:

```
# show cem circuit interface cem 0/4/12
CEM 0/4/12, ID: 0, Line: UP, Admin: UP, Ckt: ACTIVE
Controller state: down, T3 state: up
Configuring SAToP - Clear Channel T3 Interfaces
Idle Pattern: 0xFF, Idle CAS: 0x8
Dejitter: 5 (In use: 0)
Payload Size: 1024
Framing: Unframed
CEM Defects Set
None
Signalling: No CAS
RTP: No RTP
Ingress Pkts: 1321577 Dropped: 0
Egress Pkts: 1321577 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
```

Configuring SAToP - Channelized T3/T1 Interfaces

Before SAToP is configured, the controller of channelized T3/T1 interface must be configured.

```
enable
configure terminal
controller t3 0/4/12
channelized
t1 1 cem-group 0 unframed
interface CEM 0/4/12
no shut
cem 0
xconnect 10.10.2.2 204 encapsulation mpls
exit
```

Verifying the CEM Configuration of Channelized T3 or T1 Interfaces

Use the **show run controller** command to verify the CEM configuration of channelized T3 or T1 interface:

```
# show run controller t3 0/4/12
Current configuration : 109 bytes
!
Controller T3 0/4/12
framing c-bit
cablelength short
t1 1 cem-group 0 unframed
end
```

Use the **show cem circuit interface cem** command to verify the CEM configuration of channelized T3 or T1 interface:

```
# show cem circuit interface cem 0/4/12
CEM0/4/12, ID: 1, 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: 105043259 Dropped: 0
Egress Pkts: 105043387 Dropped: 0
CEM Counter Details
Input Errors: 0 Output Errors: 0
Pkts Missing: 0 Pkts Reordered: 0
Misorder Drops: 0 JitterBuf Underrun: 32
Error Sec: 0 Severly Errored Sec: 0
Unavailable Sec: 0 Failure Counts: 0
Pkts Malformed: 0 JitterBuf Overrun: 0
---
CEM0/4/12, ID: 28, 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: 136303 Dropped: 0
Egress Pkts: 0 Dropped: 0
CEM Counter Details
Input Errors: 0 Output Errors: 0
Pkts Missing: 135682 Pkts Reordered: 0
Misorder Drops: 0 JitterBuf Underrun: 137649
Error Sec: 0 Severly Errored Sec: 0
Unavailable Sec: 0 Failure Counts: 135
Pkts Malformed: 0 JitterBuf Overrun: 0
```

Configuring Framed SAToP - Channelized T3/T1 Interfaces

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

To configure the controller of channelized T3/T1 interface for framed SAToP:

```
enable
configure terminal
controller t3 0/4/12
channelized mode
framing c-bit
t1 1 cem-group 0 framed
interface CEM 0/4/12
cem 0
xconnect 10.10.2.2 204 encapsulation mpls
exit
```

Verifying the CEM Configuration of Channelized T3/T1 Interfaces for Framed SAToP

Use the **show run controller** command to verify the CEM configuration of channelized T3/T1 interface for Framed SAToP:

```
# show run controller t3 0/4/12
Current configuration : 109 bytes
!
Controller T3 0/4/12
framing c-bit
cablelength short
t1 1 cem-group 0 framed
end
```

Use the **show cem circuit interface cem** command to verify the CEM configuration of channelized T3/T1 interface for Framed SAToP:

```
# show cem circuit interface cem 0/4/12
CEM0/0/0, ID: 1, Line: UP, Admin: UP, Ckt: ACTIVE
Mode :Channelized-T1, T1: 1, CEM Mode: T1-SAToP
Controller state: down, T1 state: up
Idle Pattern: 0xFF, Idle CAS: 0x8
Dejitter: 5 (In use: 0)
Payload Size: 192
Framing: Framed SAToP
CEM Defects Set
None
```

Performance Monitoring

You can view the statistics or error count generated on the TDM lines for T3 interfaces.

```
enable
configure terminal
controller MediaType 0/4/12
mode t3
controller t3 0/4/12
framing c-bit
cablelength
long 224-450 ft
short 0-224 ft
controller MediaType 0/4/12
mode t3
controller T3 0/4/12
```

```
framing c-bit
cablelength short
```

To view the performance monitoring result, use the **show controller t3** command:

```
Router# show controller t3 0/4/12

T3 0/4/12 is up.
Hardware is
Applique type is Channelized T3/T1
  No alarms detected.
  MDL transmission is disabled
  FEAC code received: No code is being received
  Framing is C-BIT Parity, Line Code is B3ZS, Cablelength Short less than 225ft
  BER thresholds:  SF = 10e-10  SD = 10e-10
  Clock Source is internal
  Equipment customer loopback
  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
```

Use Case 1

If your configuration is as follows:

- T1 is up
- No alarms
- Framing is unframed
- Clock Source is Internal

, then the following performance monitoring result is displayed:

```
Router# show controller t3 0/4/12
T3 0/4/12 is up.
Hardware is
Applique type is Channelized T3/T1
  No alarms detected.
  MDL transmission is disabled
  FEAC code received: No code is being received
  Framing is unframedt
  Clock Source is internal
  Equipment customer loopback
  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 unframed, 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 Case 2

If your configuration is as follows:

- T1 28 is up
- No alarm received
- Framing is unframed
- Clock Source is Internal

, then the following performance monitoring result is displayed:

```
Router# show controller t3 0/4/12
T3 0/4/12 is up.
Hardware is
Applique type is Channelized T3/T1
  No alarms detected.
  MDL transmission is disabled
  FEAC code received: No code is being received
  Framing is unframedt
  Clock Source is internal
  Equipment customer loopback
  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 28 is up
  timeslots:
  FDL per AT&T 54016 spec.
  No alarms detected.
  Framing is unframed, 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
```

The complete output for the T3 **show controller** command is:

```
# show controllers t3 0/4/12
T3 0/4/12 is down.
Hardware is
 Applique type is Channelized T3/T1
  No alarms detected.
  MDL transmission is disabled
  FEAC code received: No code is being received
  Framing is C-BIT Parity, Line Code is B3ZS, Cablelength Short less than 225ft
  BER thresholds:  SF = 10e-10  SD = 10e-10
  Clock Source is internal
```

```
  Equipment customer loopback
  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 28 is up
  timeslots:
  FDL per AT&T 54016 spec.
  No alarms detected.
  Framing is unframed, 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
```

Troubleshooting T3 Controllers

You can use the following methods to troubleshoot the T3 controllers on the chassis:

Running Bit Error Rate Testing

Bit error rate testing (BERT) is supported on T3 interfaces. You can run 16 BERTs at a time. The test can be either of the T1 or the T3 interface.

The interface contains on board BERT circuitry. With this, the interface software can send and detect a programmable pattern that is compliant with CCITT/ITU O.151, O.152, O.153 pseudo-random, and repetitive test patterns. BERTs allow you to test cables and signal problems in the field.

When running a BERT test, your system must receive the same pattern that it is transmitting. So, ensure the two common options are available:

- Use of a loopback somewhere in the link or network
- Configuration of a remote testing equipment to transmit the same BERT test pattern at the same time

Table 1 lists different BERT keywords and their descriptions.

Table 5: BERT Pattern Descriptions

Keyword	Description
0s	Not supported
1s	Not supported
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.

Keyword	Description
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.
2^23	Pseudo-random 0.151 test pattern that is 8,388,607 bits in length.

Both the total number of bits and the error bits received are available for analysis. You can select the testing period from 1 minute to 24 hours and you can also retrieve the error statistics anytime during the BERT test.

BERT is supported in two directions:

- Line - supports BERT in TDM direction
- System - supports BERT in PSN direction

Note When the BERT is configured towards the system direction, it internally loopbacks the TDM side.

Note 0s and 1s keywords are not supported for T1, T3, and OCx controllers.

Configuring BERT for Clear and Channelized T3 Interfaces

Before you configure BERT for clear channel T3 interfaces, ensure that controller and CEM are configured.

To run a BERT on clear channel T3 interface, perform the following tasks in global configuration mode.

```
enable
configure terminal
controller t3 0/4/12
no channelized
bert pattern 0s interval 30 direction line
exit
```

Note To terminate a BERT test during the specified test period, use the **no bert** command.

You can view the results of a BERT test at the following points of time:

- After you terminate the test using the **no bert** command
- After the test runs completely
- Anytime during the test (in real time)

Verifying the BERT Configuration for T3 Interfaces

Use the **show controller** command to verify the BERT configuration for clear channel T3 interfaces:

```
# show controllers t3 0/4/12 | sec BERT
BERT test result (running)
Running Bit Error Rate Testing
Test Pattern : 2^15, Status : Not Sync, Sync Detected : 0
DSX3 BERT direction : Line
Interval : 5 minute(s), Time Remain : 3 minute(s)
Bit Errors (since BERT started): 0 bits,
Bits Received (since BERT started): 0 Kbits
Bit Errors (since last sync): 0 bits
Bits Received (since last sync): 0 Kbits
```

Use the **show controller** command to verify the BERT configuration of channelized T3/T1 interfaces interfaces:

```
# show controllers t3 0/4/12

Hardware is
 Applique type is Channelized T3/T1
  No alarms detected.
  MDL transmission is disabled
  FEAC code received: No code is being received
  Framing is C-BIT Parity, Line Code is B3ZS, Cablelength Short less than 225ft
  BER thresholds:  SF = 10e-10  SD = 10e-10
  Clock Source is internal
  Equipment customer loopback
  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 28 is up
  timeslots:
  FDL per AT&T 54016 spec.
  No alarms detected.
  Framing is unframed, Clock Source is Internal
  BERT test result (running)
  Test Pattern : 2^23, Status : Not Sync, Sync Detected : 0
  DSX1 BERT direction : Line
  Interval : 5 minute(s), Time Remain : 4 minute(s)
  Bit Errors (since BERT started): 0 bits,
  Bits Received (since BERT started): 0 Kbits
  Bit Errors (since last sync): 0 bits
  Bits Received (since last sync): 0 Kbits
  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
```

Loopback on T1/T3 Interfaces

You can use the following loopback on the clear and channelized T3/T1 interfaces.

Loopback	Description
loopback local	Loops the transmitting signal back to the receiver.

Loopback	Description
loopback network line	Loops the incoming signal back to the interface using the line loopback mode of the framer. The framer does not reclock or reframe the incoming data. All incoming data is received by the interface driver.

Configuring Loopback for T3 Interfaces

To set a loopback local on the clear channel T3 interface, perform the following tasks in global configuration mode:

```
enable
configure terminal
controller t3 0/4/12
loopback local
exit
```

To set a loopback network on the clear channel T3 interface, perform the following tasks in global configuration mode:

```
enable
configure terminal
controller t3 0/4/12
loopback network line
exit
```

To set a loopback local on the channelized channel T3/T1 interface, perform the following tasks in global configuration mode:

```
enable
configure terminal
controller t3 0/4/12
channelized
t1 1 loopback local
exit
```

To set a loopback network on the channelized channel T3/T1 interface, perform the following tasks in global configuration mode:

```
enable
configure terminal
controller t3 0/4/12
channelized
t1 1 loopback network line
exit
```

Note To remove a loopback, use the **no loopback** command.

Note Network payload configuration is not supported on SAToP. To configure loopback network payload when SAToP is configured, you need to remove the CEM configuration and then configure the loopback.

Associated Commands

The commands used to configure the interfaces.

Commands	URL
controller mediatype	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp3512725718
mode t3/e3	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html#wp5688885940
controller t1	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp1472647421
controller t3	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp1921350260
controller e3	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp4240965734
clock source	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp6081785140
channelized	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp7026926390
cem	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2184138077
cem-group	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2440628600
xconnect	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t2.html#wp8578094790
t1/e1 cem-group	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t1.html#wp8472041760

Commands	URL
payload-size dejitter-buffer	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-o1.html#wp3946673156
bert pattern	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-a1.html#wp3620978929
loopback	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html#wp2513399572
t1/e1 loopback	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t1.html#wp3852360411
show controllers t3	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-s3.html#wp1987423547

CHAPTER 5

Configuring Pseudowire

Cisco Pseudowire Emulation Edge-to-Edge (PWE3) allows you to transport traffic by using traditional services such as T1 over a packet-based backhaul technology such as MPLS or IP. A pseudowire (PW) consists of a connection between two provider edge (PE) chassis that connects two attachment circuits (ACs), such as T1 or T3 links.

Information About Pseudowire

The following sections describe how to configure pseudowire on the interface module of the chassis.

Overview of Pseudowire

Pseudowires manage encapsulation, timing, order, and other operations in order to make it transparent to users. The pseudowire tunnel acts as an unshared link or circuit of the emulated service.

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.

How to Configure Pseudowire

The following sections describe how to configure pseudowire.

Configuring CEM

This section provides information about how to configure CEM. CEM provides a bridge between a Time Division Multiplexing (TDM) network and a packet network, 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.

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

CEM PW Scale

Effective from the 16.12.1 release,

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

will be supported on the Cisco router.

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

4 Interface Modules can be used on the ASR 903 and NCS 4206 routers 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 OC192.
- Configuring CEM circuits on all the 4 OC48 ports of the Cisco A900-IMA3G-IMSG which supports OC192.

Note The 21K CEM PW's can be achieved on the ASR 907/921 and NCS 4216 by using the combination of the Cisco A900-IMA1Z8S-CX and A900-IMA3G-IMSG IMs in multiple slot combinations.

Restrictions for PW Scale Increase

- When you configure the 21505th T1 PW command, your configuration may fail even though no error message is prompted

Configuring CEM Group for SAToP for T1 Interfaces

To configure a CEM group for SAToP:

```
enable
configure terminal
controller t1 0/4/0
cem-group 0 unframed
end
```

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 0/4/0
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

To specify the number of bytes encapsulated into a single IP packet, use the **payload-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:

- T1 = 192 bytes

- DS0 = 32 bytes

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

Note Both payload-size and dejitter-buffer must be configured simultaneously.

Configuring Payload Size for T3 Interfaces

To specify the number of bytes encapsulated into a single IP packet, use the payload-size command. The size argument specifies the number of bytes in the payload of each packet.

Default payload sizes are as follows:

- T3 clear channel= 1024 bytes
- T3 channelized = 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.

Note Both payload-size and dejitter-buffer must be configured simultaneously.

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 CEM Parameter on CEM Interface

The CEM parameters can be configured directly on CEM interface. Follow these steps to configure CEM parameters:

```
enable
configure terminal
interface cem 0/4/0
cem 0
payload-size 512 dejitter-buffer 12
```

```
xconnect 10.10.10.10 200 encapsulation mpls
exit
```

Verifying the Interface Configuration

Use the following commands to verify the pseudowire configuration:

- **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 **xconnect** is configured under the circuit, the command output also includes information about the attachment circuit status.

```
Router# show cem circuit
 ?

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

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

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

```
Router# show cem circuit 0

CEM 0/4/0, ID: 0, Line: UP, Admin: UP, Ckt: ACTIVE
Controller state: down, T3 state: up
Idle Pattern: 0x55, Idle CAS: 0x8
Dejitter: 10 (In use: 0)
Payload Size: 1024
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 for each interface.

```
Router# show cem circuit summary

CEM Int.       Total Active  Inactive
```

```
-------------------------------------
CEM 0/4/0        1      1       0
```

- **show running configuration**—The **show running configuration** command shows detail on each CEM group.

Associated Commands

The following commands are used to configure pseudowire:

Commands	URL
cem-group	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2440628600
payload-size dejitter-buffer	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-o1.html#wp3946673156
class cem	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2169323859
controller t1	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp1472647421
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 Pseudowire

Related Documents

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

Standards and RFCs

Standard/RFC	Title
—	*There are no standards and RFCs 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

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 6

Clock Recovery System for SAToP

The Clock Recovery System recovers the service clock using Adaptive Clock Recovery (ACR) and Differential Clock Recovery (DCR).

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.

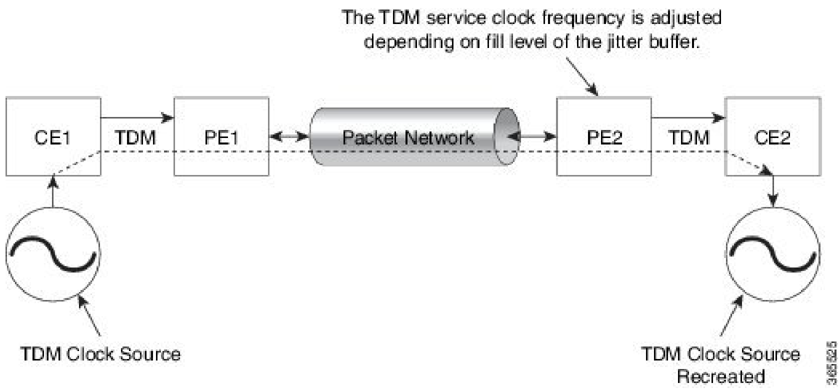
Information About Clock Recovery

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.

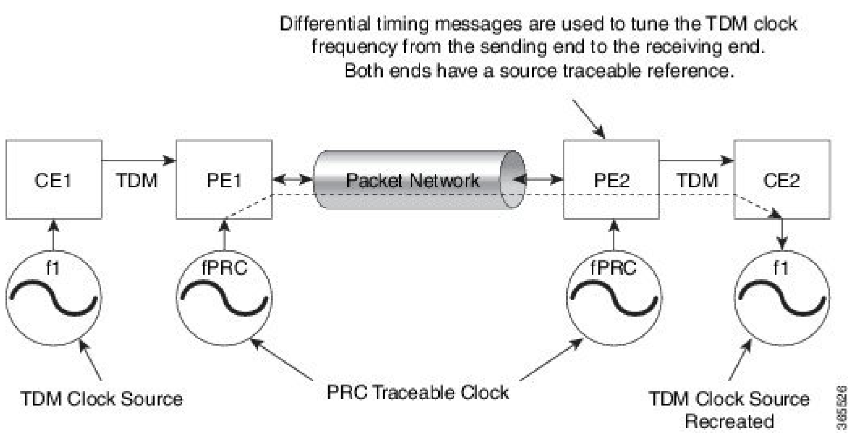
Effective Cisco IOS XE Everest 16.5.1, ACR is supported on the 8-port T1/E1 interface module.



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.



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)
T1 CEM Interface Module	1476

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.
- ACR clock configuration under each controller should be performed before configuring CEM group.

How to Configure ACR and DCR

Configuring Adaptive Clock Recovery of T1 Interfaces for SAToP

Before configuring Adaptive Clock Recovery, CEM must be configured. Below are the guidelines to configure clock recovery:

- The node (chassis) on which the DS1 is configured for ACR, must have its own clock derived from BITS/GPS/Stratum clock.
- The minimum packet size of CEM pseudowires on the network that delivers robust clock recovery is 64 bytes.

To configure the clock on T1 interfaces for SAToP in controller mode:

```
enable
configure terminal
controller t1 0/4/0
cem-group 0 unframed
clock source recovered 1
exit
```

To configure the clock recovery on T1 interfaces in global configuration mode, use the following commands:

```
recovered-clock 0 1
```

```
clock recovered 1 adaptive cem 1 0
exit
```

Note The clock configuration on controller must be done before configuring the clock recovery on global configuration mode.

To remove the clock configuration in ACR and DCR, you must remove the recovery clock configuration in global configuration mode and then remove the controller configuration.

Configuring Adaptive Clock Recovery of T3 Interfaces for SAToP

Before configuring Adaptive Clock Recovery, CEM must be configured. Below are the guidelines to configure clock recovery:

- The node (router) on which the interface module is configured for ACR, must have its own clock derived from BITS/GPS/Stratum clock.
- The minimum packet size of CEM pseudowires on the network that delivers robust clock recovery is 256 bytes.

To configure the clock on T3 interfaces for SAToP in controller mode:

```
enable
configure terminal
controller t3 0/4/12
cem-group 0 unframed
clock source recovered 1
exit
```

To configure the clock recovery on T3 interfaces in global configuration mode, use the following commands:

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

Note The clock configuration on controller must be done before configuring the clock recovery on global configuration mode.

To remove the clock configuration in ACR and DCR, you must remove the recovery clock configuration in global configuration mode and then remove the controller configuration.

Verifying Adaptive Clock Recovery Configuration of T3 Interfaces for SAToP

Use the **show recovered-clock** command to verify the adaptive clock recovery of T3 interfaces for SAToP:

```
Router# show recovered-clock
Recovered clock status for subslot 0/1
---------------------------------------
Clock     Type   Mode         CEM    Status    Frequency Offset(ppb)  Circuit-No
0          DS3    ADAPTIVE      0    ACQUIRED      n/a                  12 (Port)
```

Use the **show running-config | section** command to verify the configuration of adaptive clock of T3 interfaces:

```
Router# show running-config | section 0/4/12
controller MediaType 0/4/12
mode t3
controller T3 0/4/12
cem-group 0 unframed
clock source recovered 1
cablelength 224
interface CEM 0/4/12
no ip address
cem 0
```

Use the **show running-config | section recovered-clock** command to verify the recovery of adaptive clock of T3 interfaces:

```
Router# show running-config | section recovered-clock
recovered-clock 0 0
clock recovered 1 adaptive cem 12 0
```

Configuring Differential Clock Recovery of T3 Interfaces for SAToP

- Before you start configuring DCR, RTP must be enabled on the CEM interface. The RTP is used to carry the differential time.
- The minimum packet size of CEM pseudowires on the network that delivers robust clock recovery is 256 bytes.

To configure differential clock recovery on T3 interface for SAToP in controller mode:

```
enable
configure terminal
controller t3 0/4/12
cem-group 0 unframed
clock source recovered 1
exit
```

To configure RTP header under interface, use the following commands:

```
interface cem 0/4/12
cem 0
rtp-present
```

To configure differential clock recovery of T3 interface in global configuration mode, use the following commands:

```
recovered-clock 0 1
clock recovered 1 differential cem 12 0
exit
```

Note The clock configuration on controller must be done before configuring the clock recovery on global configuration mode.

Verifying the Differential Clock Recovery Configuration of Channelized T3/T1 Interfaces for SAToP

Use the **show recovered-clock** command to verify the differential clock recovery of T3/T1 interfaces for SAToP:

```
Router# show recovered-clock
Recovered clock status for subslot 0/4
----------------------------------------
Clock  Type      Mode           CEM   Status      Frequency Offset(ppb) Circuit-No
0      DS3-ds1    DIFFERENTIAL   0     ACQUIRED        n/a              12/1 (Port/t1)
```

Use the **show running-config | section** command to verify the configuration of differential clock of channelized T3/T1 interfaces:

```
Router# show running-config | section 0/4/12
controller MediaType 0/4/12
mode t3
controller T3 0/4/12
framing c-bit
cablelength 224
t1 1 cem-group 0 unframed
t1 1 clock source recovered 1
interface CEM 0/4/12
no ip address
cem 0
rtp-present
```

Use the **show running-config | section recovered-clock** command to verify the recovery of differential clock of channelized T3/T1 interfaces:

```
Router# show running-config | section recovered-clock
recovered-clock 0 0
clock recovered 1 differential cem 1 0
```

Associated Commands

The commands used to configure adaptive clock recovery and differential clock recovery are:

Commands	URL
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
clock recovered differential cem	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp8894393830
cem-group	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2440628600
recovered-clock	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-o1.html#wp8262293900

Commands	URL
controller t1/e1	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp1472647421
clock-source	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp6081785140
network-clock input-source	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html

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 7

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: Defining an MPLS EXP Imposition Policy Map

Example: Defining an MPLS EXP Imposition Policy Map

The following example defines a policy map that sets the MPLS EXP imposition value to 2 based on the IP precedence value of the forwarded packet.

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# class-map prec012
Router(config-cmap)# match ip prec 0 1 2
Router(config-cmap)# exit
Router(config)# policy-map mark-up-exp-2
Router(config-pmap)# class prec012
Router(config-pmap-c)# set qos-group 3
Router(config-pmap-c)# exit
Router(config-pmap)# 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: 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 8

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 1 port of OC-48 or 4 ports of OC-12 or OC-3.
- Only 16 BERT Patterns can be configured at a time.
- 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 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 6: Bandwidth Used by Different Rates

Rate	Bandwidth
OC-3	155.52 Mbps
OC-12	622.08 Mbps
OC-48	2.4 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 or T3 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.

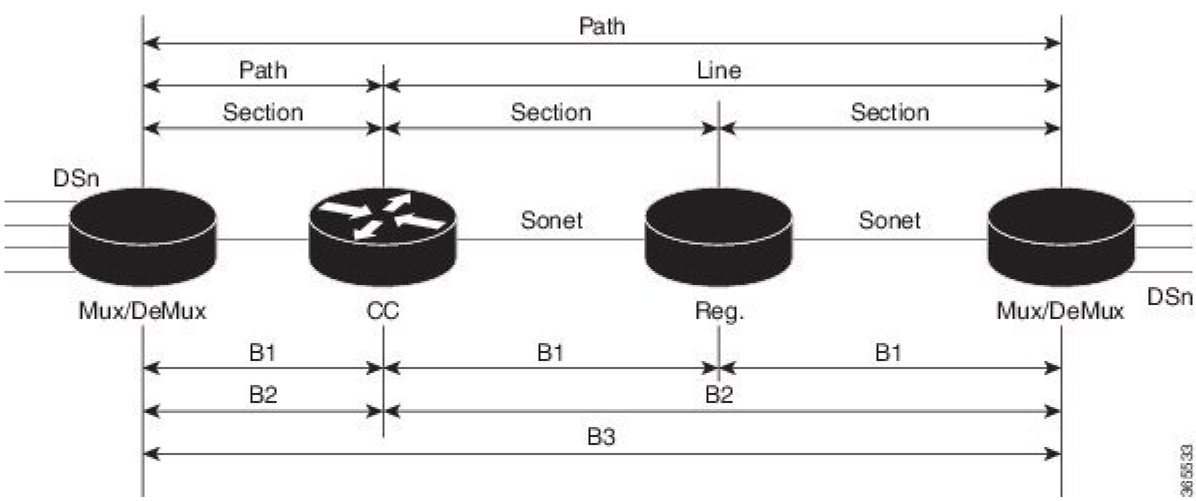
- **Circuit Emulation Service over Packet (CEP)** (RFC 4842) - CEP mode is used to encapsulate SONET payload envelopes (SPEs) like VT1.5 or VT2 or STS-1 or STS-Nc over packet switched networks. In this mode, the bytes from the corresponding SPE are sent out as they arrive on the TDM line. The interface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

Table 7: 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 DS1	SAToP	OC-3, OC-12, OC-48, OC-192

SONET Hierarchy

Figure 4: 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

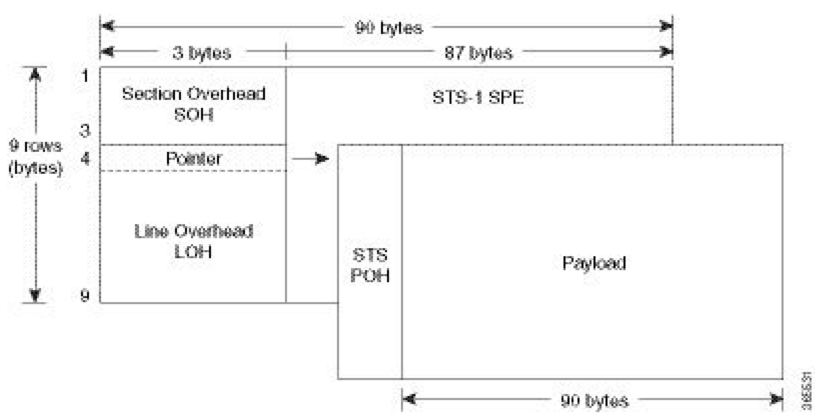
Path-Terminating Equipment (PTE) interfaces non-SONET equipment to the SONET network. At this layer, the payload is mapped and demapped into the SONET frame. For example, an STS PTE can assemble 25 1.544 Mbps DS1 signals and insert path overhead to form an STS-1 signal.

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.

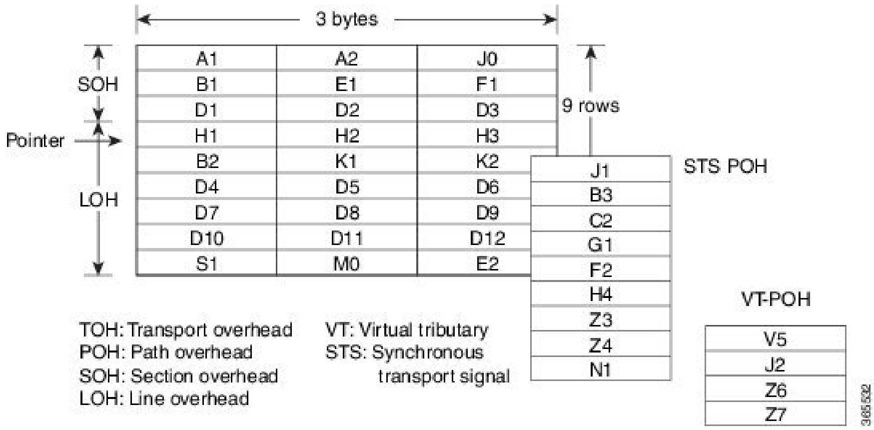
Figure 5: STS-1 Frame Structure



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 6: 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 - 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

Modes	Patterns
SONET T3 or CT3 (T1) or VTG T1 or VT 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 • 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

In the above figure, two 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 receives a Loss of Signal (LOS) on working line.
2. starts generating K2 byte and sends it to the over the protection line.
3. receives the K2 byte and reacts on the receiving K2 byte.
4. starts sending K1 byte to the on the protection line.
5. starts sending K2 byte to on the protection line.
6. receives the K1/K2 byte and starts receiving the data from protection line. The protection line now acts as the active line.
7. sends K2 byte over the new active line to . receives this signal and starts accepting the data from this new active line.

Scenario for Unidirectional APS 1+1

In the above figure, two 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. receives a LOS on RX working line.
2. detects LOS and starts receiving the data from the protection line. The protection line now becomes the active line.
3. 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.

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. Nonrevertive options are valid for UPSR path protection.

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

Note When an 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 100–200 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 that are supported in each mode.

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

The UPSR path protection supports the following feature:

- SONET local connect and cross connect are supported at VT-15 CEP, STS-1c, STS-3c, STS-12c, and STS-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 until Cisco IOS XE Fuji 16.8.x.

  Starting with Cisco IOS XE Fuji 16.9.x, the cross connect of T1, T3, and CT3 circuits to UPSR is supported. For xconnect with the CT3 mode, the CEM protection group interface only supports the VT-15 mode. For cross-connect configuration, see *Configuring UPSR*.

Configuring UPSR

Protection Group Configuration

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

Cross-connect Configuration with the CT3 mode

For cross connect with the CT3 mode, the CEM protection group interface supports only the VT-15 mode.

```
protection-group 2 type vt1.5
controller protection-group 2
type vt1.5
cem-group 16002 unframed

controller sonet 0/4/0
sts-1 1
mode vt-15
vtg 1 t1 2 protection-group 2 working

controller sonet 0/5/0
sts-1 1
mode vt-15
vtg 1 t1 2 protection-group 2 protect
```

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.

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 Line loss of Signal
- AIS — DS1 Path Alarm Indication Signal
- AIS-CI — DS1 Path Alarm Indication Signal Customer Installation
- LOF — DS1 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 Line Loss of Signal
- OOF — DS3 Path Loss of Frame
- SEF — DS3 Path Severely Errored Frame
- AIS — DS3 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 0/0/16
mode sonet
end
```

Configuring SONET Ports

To configure SONET ports, use the following commands:

```
enable
configure terminal
controller MediaType 0/0/16
mode sonet
controller sonet 0/0/16
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 0/0/16
mode sonet
controller sonet 0/0/16
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 Loopback

To configure loopback, use the following commands:

```
enable
configure terminal
controller sonet 0/0/16
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 0/0/16
```

```
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 0/0/16
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 0/0/16
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 0/0/16
mode sonet
controller sonet 0/0/16
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 0/0/16
end
```

Configuring STS-1 Modes

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

```
enable
configure terminal
controller sonet 0/0/16
sts-1 1
mode vt-15
end
```

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

- mode vt-15
- mode ct3
- mode t3
- mode unframed

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 0/0/16
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 0/0/16
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 APS for SAToP

This section describes the configuration of APS for SAToP.

Configuring Bi-directional ACR (SONET Framing)

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

```
enable
configure terminal
controller sonet 0/0/16
clock source internal
aps group acr 1
aps working 1
exit
controller sonet 0/0/16
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

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

```
enable
configure terminal
controller sonet 0/0/16
clock source internal
aps group acr 1
aps working 1
aps unidirectional
exit
controller sonet 0/0/17
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.

> **Note** Ensure that you use same interface modules for both work and protect links.

Verifying ACR Configurations

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 0/0/16 SONET 0/0/16 SONET 0/0/16
```

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            CEM 0/0/16       CEM 0/0/16      CEM 0/0/16

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 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: Te 0/0/16, 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 0/0/16 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 VT 1.5-T1 Loopback

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

```
enable
configure terminal
controller sonet 0/0/16
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 0/0/16
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 0/0/16
sts-1 1
overhead c2 10
end
```

J1 Flag

To configure the J1 flag, use the following commands:

```
enable
configure terminal
controller sonet 0/0/16
sts-1 1
overhead j1 expected length
end
```

Configuring Path Threshold

To configure path threshold, use the following commands:

```
enable
configure terminal
controller sonet 0/0/16
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 0/0/16
SONET 0/0/16 is up.                                ======> this is the controller/port
status.
  Hardware is

 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 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                                        ===> 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

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               ====> 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: PAIS PRDI PUNEQ PLOP PPLM 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  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 = 0          PSE = 0          NSE = 0          NEWPTR = 0
  LOM = 0          PLM = 0          UNEQ = 0

Active Defects: None
Detected Alarms: None
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
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

OC3.STS1 0/0/16 is up.    ======> present status of the path
  Hardware is

 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 8: Field Description

Field	Description
SONET 0/0/16 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.
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.

Field	Description
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 …………….	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.

Configuring CEM Group for Framed SAToP

To configure a CEM group for Framed SAToP:

```
enable
configure terminal
controller mediatype 0/4/16
mode sonet
controller sonet 0/4/16
rate oc12
sts-1 1
mode vt-15
vtg 1 t1 1 cem-group 0 framed
end
```

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 0/0/16
mode sonet
controller sonet 0/0/16
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/T1 CT3 mode of STS-1 for framed SAToP:

```
enable
configure terminal
controller mediatype 0/0/16
mode sonet
controller sonet 0/0/16
rate oc3
sts-1 2
mode ct3
t3 framing c-bit
t1 1 cem-group 1 framed
end
```

Configuring CEM APS for Framed SAToP

To configure unidirectional ACR (SONET Framing) for framed SAToP:

```
enable
configure terminal
controller sonet 0/4/16
rate OC3
clock source internal
aps group acr 1
aps working 1
exit
controller sonet 0/4/16
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) for Framed SAToP:

```
enable
configure terminal
```

```
controller sonet 0/4/16
rate OC3
clock source internal
aps group acr 1
aps working 1
exit
controller sonet 0/4/16
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
```

Verifying SONET Configuration for Framed SAToP

To verify SONET configuration for Framed SAToP:

```
Router# show running configuration | sec 0/0/16
platform enable controller mediatype 0/0/16 oc3
controller mediatype 0/0/16
mode sonet
controller sonet 0/0/16
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 0/0/16
no ip address
cem 0
!
cem 1
!
cem 2

#Router
```

Provisioning APS 1+1

Note Ensure to follow the steps only in the order provided.

Perform the following generic steps to provision APS 1+1.

Step 1 Provision a physical controller with mode and rate.
Step 2 Put controllers into the APS group and define as working or protect.
Step 3 Setup STS1s on the sonet-acr controller. Cem-group placement is done on the logical port.
Step 4 Setup ACR or DCR clocking on the physical controllers.
Step 5 Provision clock recovered configuration under the recovered-clock section.
Step 6 Apply xconnect under the cem-acr interface.

Deprovisioning APS 1+1

Note Ensure to follow the steps only in the order provided.

Perform the following generic steps to deprovision APS 1+1.

Step 1 Remove all xconnect under the cem-acr interface.
Step 2 Remove clock source for all ACR or DCR services under the physical controllers.
Step 3 Remove the clock recovered lines under the recovered-clock ACR section.
Step 4 Remove all provisioning under the sonet-acr controller. This includes cem-group information and mode settings.
Step 5 Shutdown the physical controller setup for Protect, remove aps provisioning and apply no shut controller.
Step 6 Shutdown the physical controller setup for Working, remove aps provisioning and apply no shut controller.
Step 7 Remove the *acr XX type* line in the config.
Step 8 Remove the mode sonet from each physical controller media type to restore the controller to its default setup.

Performance Monitoring Use Cases or Deployment Scenarios

You can view the statistics or error count generated on the TDM lines.

To view the statistics or error count generated, use the **show controller sonet** command:

```
Router# show controller sonet 0/2/0
SONET 0/2/0 is up.
  Hardware is NCS4200-1T8S-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


SONET 0/2/0.1 T3 is down.
  NCS4200-1T8S-10CS

  Applique type is T3
  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
  Data in current interval (390 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
     389 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
     910 Unavailable Secs, 0 Line Errored Secs
     0 C-bit Errored Secs, 0 C-bit Severely Errored Secs
     0 Severely Errored Line Secs, 1 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
  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,
     910 Unavailable Secs, 0 Line Errored Secs,
     0 C-bit Errored Secs, 0 C-bit Severely Errored Secs
     0 Severely Errored Line Secs, 1 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

     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

   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
     Data in current interval (400 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
```

```
    399 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
    910 Unavailable Secs, 0 Line Errored Secs
    0 C-bit Errored Secs, 0 C-bit Severely Errored Secs
    0 Severely Errored Line Secs, 1 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
 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,
    910 Unavailable Secs, 0 Line Errored Secs,
    0 C-bit Errored Secs, 0 C-bit Severely Errored Secs
    0 Severely Errored Line Secs, 1 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
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
  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
   Data in current interval (390 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
      389 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
      900 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
      900 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
```

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 0/0/16
mode sonet
exit
controller sonet 0/0/16
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
```

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
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

Commands	Links
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
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

Commands	Links
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
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

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 NCS4200-3GMS

  Applique type is T3
  Receiver has no alarms.
  MDL transmission is disabled
```

CHAPTER 9

Configuring SDH

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. 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.

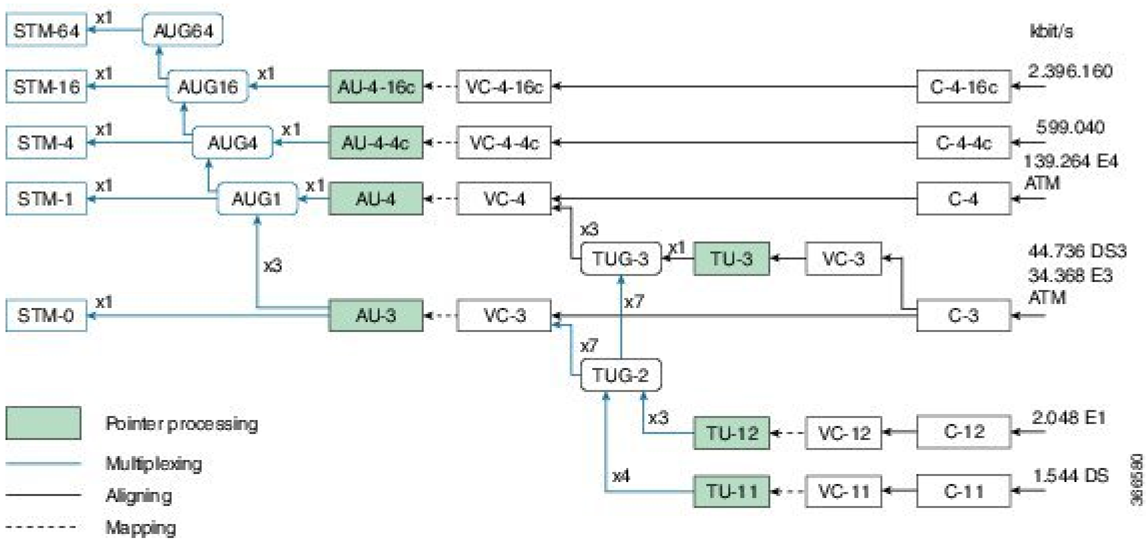
The following are true for SDH:

- 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 7: STM1 Frame Structure

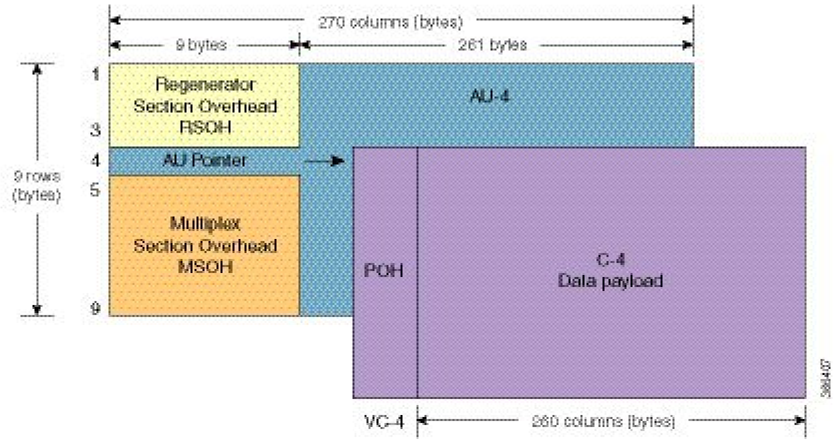
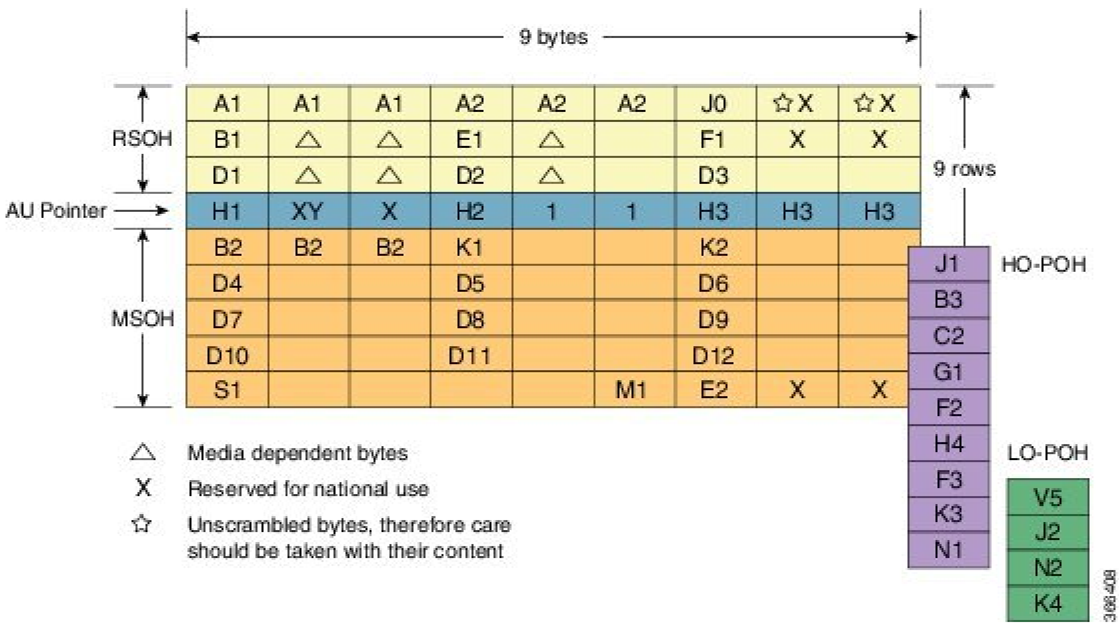


Figure 8: STM1 Section Overhead



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 9: SDH CEM Channelization Modes

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

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*

SDH Circuits	Configuration Details
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*
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*

SDH Circuits	Configuration Details
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*
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*

SDH Circuits	Configuration Details
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
PDT: %SYS-5-CONFIG_I: Configured from console by console
controller MediaType 0/0/16
mode sdh
controller SDH 0/0/16
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 VC-4 CEP

To configure mode VC-4 CEP:

```
enable
configure terminal
controller sdh 0/0/16
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
PDT: %SYS-5-CONFIG_I: Configured from console by console
platform enable
controller MediaType 0/0/16 oc12
controller MediaType 0/0/16
mode sdh
controller SDH 0/0/16
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 0/0/16
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 0/0/16
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 0/0/16 oc12
controller MediaType 0/0/16
mode sdh
controller SDH 0/0/16
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 0/0/16
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 0/0/16
platform enable
controller MediaType 0/0/16 oc12
controller MediaType 0/0/16
mode sdh
controller SDH 0/0/16
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 0/0/16
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 0/0/16
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 0/0/16
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

Use the following commands to configure AU-4 — TUG-3 — TUG-2 — VC-12:

```
enable
configure terminal
controller sdh 0/0/16
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 0/0/16
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 0/0/16
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 0/0/16
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 0/0/16 oc12
controller MediaType 0/0/16
mode sdh
controller SDH 0/0/16
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 CEM 0/0/16
no ip address
cem 10
```

Configuring AU-3 — VC-3 — DS3

To configure AU-3 — VC-3 — DS3:

```
enable
configure terminal
controller MediaType 0/0/16
mode sdh
controller sdh 0/0/16
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 0/0/16
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 0/0/16
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 0/0/16
mode sdh
controller sdh 0/0/16
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 0/0/16
mode sdh
controller sdh 0/0/16
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 0/0/16
mode sdh
controller sdh 0/0/16
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 0/0/16
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 0/0/16
mode sdh
controller sdh 0/0/16
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 0/0/16
mode sdh
controller SDH 0/0/16
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
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
```

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 0/0/16
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 0/0/16
mode sdh
controller sdh 0/0/16
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 0/0/16
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 0/0/16
platform enable controller mediatype 0/0/16 oc3
controller mediatype 0/0/16
mode sdh
controller sdh 0/0/16
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 0/0/16
no ip address
cem 0
!
cem 1
!
cem 2
!
cem 3
!
Router#
```

Restrictions for SDH

- The maximum supported bandwidth is STM-16.
- Any Port (16-19) is configurable for STM-1, STM-4 or STM-16.
- The IM has 4 X STM-4 ports. You can configure STM-1 or STM-4 on all four ports. If you configure rate STM-16 on any of the four ports, others ports will not be available.
- 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 services are supported.
- This IM does not support the framed SAToP 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.

- MDL is not supported.
- SNCP is not supported.

Restrictions on Bandwidth

- Total available bandwidth is 2.5G.

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

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

Table 10: Bandwidth Used by Different Rates

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

Restrictions for Scale PW Circuits

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

Configuring Mediatype Controller

Each SFP port (16-19) can be configured as STM-1, STM-4, STM-16.

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 0/0/16
mode sdh
end
```

Configuring Rate on SDH Ports

To configure rate on SDH ports:

```
enable
configure terminal
controller MediaType 0/0/16
mode sdh
controller sdh 0/0/16
rate [stm1 | stm4 | stm16]
end
```

> **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 0/0/16
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 0/0/16
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 0/0/16
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 0/0/16
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 0/0/16
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 0/0/16
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 0/0/16
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
controller sdh 0/0/16
```

```
clock source line
end
enable
configure terminal
network-clock input-source 1 controller sdh 0/0/16
end
```

Verifying SDH Line and Section Parameters Configuration

Use **show controllers** 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 NCS4200-1T8S-10CS
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

J1 Flag

Sets the message length and the message text of the High Order Path Trace identifier (J1).

C2 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 129.

- AU-3 Mapping

- Mode E3
- Mode T3

For more information, refer Configuring Modes under AU-3 Mapping.

Configuring C2 Flag

To configure the C2 flag:

```
enable
configure terminal
controller Mediatype 0/0/16
mode sdh
controller sdh 0/0/16
au-4 1
overhead c2 10
end
```

J1 Flag

To configure the J1 flag:

```
enable
configure terminal
controller MediaType 0/0/16
mode sdh
controller sdh 0/0/16
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 129.

- AU-3 Mapping

- For more information, refer Configuring Modes under AU-3 Mapping.

Configuring Path Threshold

To configure path threshold:

```
enable
configure terminal
controller MediaType 0/0/16
mode sdh
controller sdh 0/0/16
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 0/0/16
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 159 section.

Verifying Path Parameters Configuration

Use **show running-configuration** command to verify path parameters configuration.

```
#show running-configuration
controller MediaType 0/0/16
mode sdh
controller SDH 0/0/16
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

Modes	Patterns
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 0/0/16
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 0/0/16 | 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 E1 Bert

To configure E1 Bert:

```
enable
configure terminal
controller MediaType 0/0/16
mode sdh
controller sdh 0/0/16
rate stm4
```

```
au-3 1
mode vc1x
tug-2 1 payload vc12
e1 1 bert pattern 2^11 interval 10
end
```

Configuring T1 Bert

To configure T1 Bert:

```
enable
configure terminal
controller sdh 0/0/16
rate stm4
au-3 1
mode vc1x
tug-2 1 payload vc11
t1 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 0/0/16
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 or E3

Use **show controllers** command to verify BERT configuration in mode T3 or E3:

```
show controller sdh 0/0/16 | 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 0/0/16
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
vc 1 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 0/0/16 | 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
```

SDH T1/E1 Configuration Parameters

The following parameters affect SDH T1/E1 configuration:

- **BERT** — Starts the BERT test.
- **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 0/0/16
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 0/0/16
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

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.
- **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 0/0/16
rate stm4
au-4 1
mode tug 3
tug-3 1
mode e3
e3 1 clock source [line | internal | recovered]
e3 framing [m13 | c-bit ] (applicable to for mode e3)
e3 1 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 and AU-3 mode T3.

Verifying SDH T3 or E3 Parameters Configurations

Use **show running-configuration** command to verify SDH T3 or E3 parameters configurations:

```
# show running-configuration
controller sdh 0/0/16
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 0/0/16
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 0/0/16
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 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 commonly used for SAToP. Both unframed and framed SAToP modes are supported.

To configure E1 ACR:

```
enable
configure terminal
controller sdh 0/0/16
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 0/0/16
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 0/16
```

```
----------------------------------------
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 T3 ACR configuration:

```
#show recovered clock
Recovered clock status for subslot 0/16
----------------------------------------
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

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. Both unframed and framed SAToP modes are supported.

To configure E1 DCR:

```
enable
configure terminal
controller sdh 0/0/16
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 0/0/16
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 0/16
----------------------------------------
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 T3 DCR configuration:

```
#show recovered clock
Recovered clock status for subslot 0/16
----------------------------------------
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)
```

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 NCS4200-3GMS
  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
```

Associated Commands

The following commands are used to configure SDH:

Commands	URL
aug mapping	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-a1.html#wp4691616330
aug mapping [*au-3* | *au-4*] **stm** [*stm number*] **stm1 number** [*number*]	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-a1.html#wp4691616330
aug mapping *au-3* **stm** *1-16* **path number** *1-16*	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-a1.html#wp4691616330
controller sdh	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html
rate	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-o1.html
mode vc-4	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html
mode tug-3	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html
tug-3	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t1.html
mode e3	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html
mode vc-1x	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html
tug-2	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t1.html

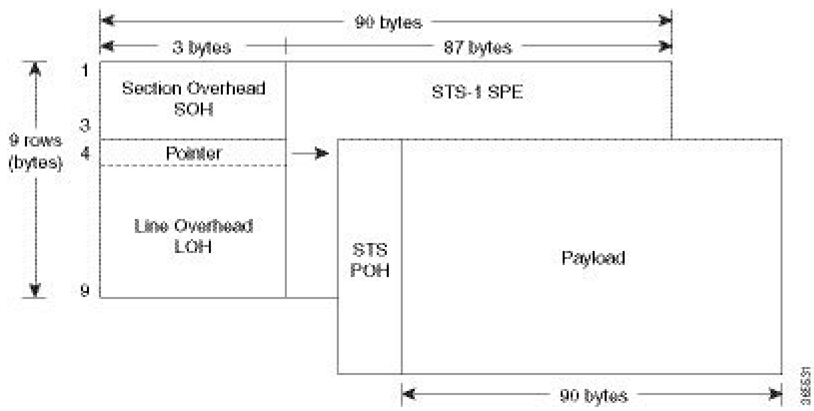
Commands	URL
mode vc4-Nc	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html
au-3	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-a1.html#wp3402412891
au-4	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-a1.html#wp3402412891
mode t3	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html

CHAPTER 10

STS-1 Electricals

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 STS-1 frame.

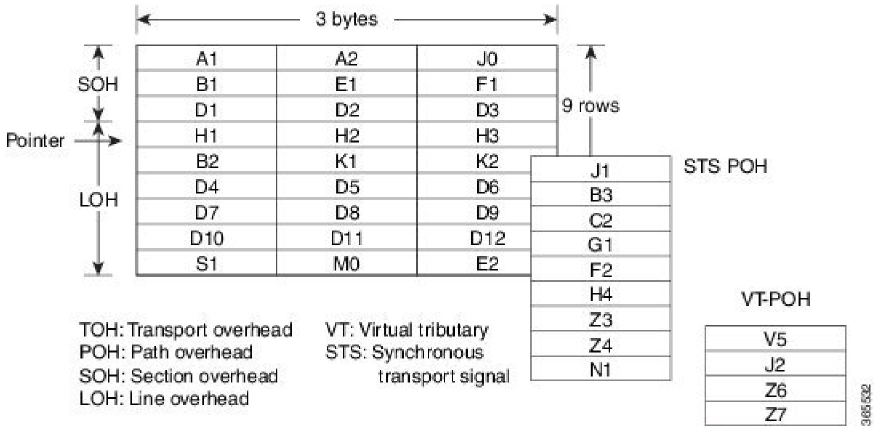
Figure 9: STS-1 Frame Structure



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 10: STS-1 Overhead



For STS-1, a single 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.

STS-1electrical ports are also supported. 4 Telcordia-compliant, GR-253 STS-1 electrical ports are supported per card. Each port operates at 51.840 Mbps over a single 75-ohm, 728A or equivalent coaxial span. Ports range from 12 to 15 are supported.

Restrictions for STS-1e

- Only 16 BERT Patterns can be configured at a time.
- PMON fields are not supported for VT1.5 VT and DS3 or T3.
- PMON Far-end parameters are not supported.
- APS and card-protection are not supported for STS-1e port.
- In unframed mode, ACR and DCR are not supported.
- CESoPSN is not supported.
- Framed SAToP is not supported.

Restrictions for Clock Source Configuration

- Only 4 ports can be configured in STS-1e 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 STS-1e port.

Prerequisites for Configuring STS-1e

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

You must configure the controller as a STS-1e port.

Configuring MediaType Controller

To configure MediaType Controller, use the following commands:

```
enable
configure terminal
controller MediaType 0/0/16
mode STS-1e
end
```

Configuring STS-1e Modes

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

```
enable
configure terminal
controller sts-1e 0/0/16
sts-1 1
mode vt-15
end
```

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

- mode vt-15
- mode ct3
- mode t3
- mode unframed

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

Configuring VT-15 Mode of STS-1e

```
enable
configure terminal
controller STS1E 0/3/14
no ais-shut
alarm-report all
clock source internal
!
sts-1 1
clock source internal
mode vt-15
vtg 1 t1 1 framing unframed
vtg 1 t1 1 cem-group 0 unframed
```

Configuring DS1/T1 CT3 mode of STS-1e

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

```
enable
configure terminal
controller sts-1e 0/0/16
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 T3 mode of STS-1e

```
controller STS1E 0/3/14
no ais-shut
alarm-report all
clock source internal
!
sts-1 1
clock source internal
mode t3
cem-group 0 unframed
t3 clock source internal
```

Configuring Unframed Mode of STS-1e

```
controller STS1E 0/3/14
no ais-shut
alarm-report all
clock source internal
!
sts-1 1
clock source internal
mode unframed
cem-group 0 cep
```

Configuring Line and Section Overhead

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

```
enable
configure terminal
controller MediaType 0/0/16
mode sts-1e
controller sts-1e 0/0/16
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 Loopback

To configure loopback, use the following commands:

```
enable
configure terminal
controller sts-1e 0/0/16
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 sts-1e 0/0/16
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 sts-1e 0/0/16
shutdown
end
```

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

Configuring Clock

To configure clock, use the following commands:

```
enable
configure terminal
controller MediaType 0/0/16
mode sts-1e
controller sts-1e 0/0/16
clock source line
end
```

Note The default mode is internal.

Note ACR and DCR clock recovery are also supported. Refer to Clock Recovery System for SAToP, on page 61 for more information.

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

Configuring Network-Clock STS-1e

To configure network-clock STS-1e, use the following commands:

```
enable
configure terminal
network-clock input-source 1 controller STS-1e 0/0/16
end
```

Verification of STS-1e Configuration

The following sample output shows the verification of STS-1e configuration in unframed mode:

```
router#show controllers sts1e 0/3/14
STS1E 0/3/14 is up.                            ======> this is the controller/port status.

  Hardware is A900-IMA3G-IMSG
```

```
 Port configured rate: OC1                       =======> this is the rate the port is
configured on it.
 Applique type is Channelized STS1E
 Clock Source is Internal                         ===> the clocking config
Medium info:
  Type: STS1E, Line Coding: NRZ,
 Alarm Throttling: OFF
 SECTION:
  LOS = 0          LOF = 0                     BIP(B1) = 0      =======> the section level
 alarm counter (from last clear counters)

STS1E Section Tables
  INTERVAL       CV    ES   SES  SEFS
  05:26-05:28     0    49    49    49

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 LAIS SF SD LRDI B1-TCA B2-TCA
BER thresholds:  SF = 10e-3  SD = 10e-6                        ====> ber thresholds
TCA thresholds:  B1 = 10e-6  B2 = 10e-6
Rx: S1S0 = 00
    J0 = 00

    RX S1 = 00

Tx: S1S0 = 00
    J0 = 04

Tx J0 Length : 64
Tx J0 Trace :

  52 53 50 32 20 20 20 20 20 20 20 20 20 20 20 20     RSP2
  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 53 50 32 20 20 20 20 20 20 20 20 20 20 20 20     RSP2
  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 : 16
Rx J0 Trace :
  CRC-7: 0xD8 ERROR

  BC 4B 69 CC 79 24 1B 01 E8 EB 9C 36 FC 29 A9 00     .Ki.y$.....6.)..

STS1E Line Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  05:26-05:28     0     0     0    50     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: 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 = 01

Tx J1 Length : 64
Tx J1 Trace

  52 53 50 32 20 30 2F 33 2F 31 34 2E 31 00 00 00     RSP2 0/3/14.1...
  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 53 50 32 20 30 2F 33 2F 31 34 2E 31 00 00 00     RSP2 0/3/14.1...
  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

  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 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
  05:26-05:28     0     0     0    48     0     0      0      0


STS1E 0/3/14.1 PATH  mode UNFRAMED is up
  cep is configured: TRUE cem_id  :0
  clock source internal
```

The following sample output shows the verification of STS-1e configuration in VT-15 mode:

```
router#show controllers sts1e 0/3/14
STS1E 0/3/14 is up.
  Hardware is A900-IMA3G-IMSG

 Port configured rate: OC1
 Applique type is Channelized STS1E
 Clock Source is Internal
Medium info:
  Type: STS1E, Line Coding: NRZ,
 Alarm Throttling: OFF
 SECTION:
  LOS = 0          LOF = 0                          BIP(B1) = 0

STS1E Section Tables
```

```
  INTERVAL       CV    ES   SES  SEFS
  05:33-05:33     0     0     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
    J0 = 00

    RX S1 = 00

Tx: S1S0 = 00
    J0 = 04

Tx J0 Length : 64
Tx J0 Trace :

  52 53 50 32 20 20 20 20 20 20 20 20 20 20 20 20     RSP2
  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 53 50 32 20 20 20 20 20 20 20 20 20 20 20 20     RSP2
  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 : 16
Rx J0 Trace :
  CRC-7: 0xD8 ERROR

  BC 4B 69 CC 79 24 1B 01 E8 EB 9C 36 FC 29 A9 00     .Ki.y$.....6.)..

STS1E Line Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  05:33-05:33     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: None
Asserted/Active Alarms: None
Alarm reporting enabled for: PAIS PRDI PUNEQ PLOP PPLM LOM B3-TCA

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

```
Tx J1 Length : 64
Tx J1 Trace

  52 53 50 32 20 30 2F 33 2F 31 34 2E 31 00 00 00     RSP2 0/3/14.1...
  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 53 50 32 20 30 2F 33 2F 31 34 2E 31 00 00 00     RSP2 0/3/14.1...
  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

  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 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
  05:33-05:33     0     0     0     0     0     0      0      0


STS1E 0/3/14.1 PATH  is up.
  Hardware is A900-IMA3G-IMSG

 Applique type is VT1.5

 STS-1 1, VTG 1, VT 1 (STS1E 0/3/14.1/1/1 VT) is up
 No VT alarms detected.
  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 V5:2
  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: 0x80 OK

  4A 44 53 55 00 00 00 00 00 00 00 00 00 00 00 00     JDSU............
```

```
 Data in curerent interval (1 seconds elapsed)
   Near End
    0 CodeViolations, 0 ErrorSecs, 0 Severly Err Secs, 0 Unavailable Secs
   Far End
    0 CodeViolations, 0 ErrorSecs, 0 Severly Err Secs, 0 Unavailable Secs

 STS-1 1, VTG 1, T1 1 (STS1E 0/3/14.1/1/1 T1) is up
  No alarms detected.
  Framing is unframed, Clock Source is Internal
  Data in current interval (0 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 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
```

The following sample output shows the verification of STS-1e configuration in T3 mode:

```
router#show controllers sts1e 0/3/14
STS1E 0/3/14 is up.
  Hardware is A900-IMA3G-IMSG

 Port configured rate: OC1
 Applique type is Channelized STS1E
 Clock Source is Internal
Medium info:
  Type: STS1E, Line Coding: NRZ,
 Alarm Throttling: OFF
 SECTION:
  LOS = 0          LOF = 0                          BIP(B1) = 0

STS1E Section Tables
  INTERVAL       CV    ES   SES  SEFS
  05:35-05:35     0     0     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
    J0 = 00

    RX S1 = 00

Tx: S1S0 = 00
    J0 = 04

Tx J0 Length : 64
Tx J0 Trace :

  52 53 50 32 20 20 20 20 20 20 20 20 20 20 20 20     RSP2
  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 53 50 32 20 20 20 20 20 20 20 20 20 20 20 20     RSP2
  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 : 16
Rx J0 Trace :
  CRC-7: 0xD8 ERROR

  BC 4B 69 CC 79 24 1B 01 E8 EB 9C 36 FC 29 A9 00     .Ki.y$.....6.)..

STS1E Line Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  05:35-05:35     0     0     0    73     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: 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 53 50 32 20 30 2F 33 2F 31 34 2E 31 00 00 00     RSP2 0/3/14.1...
  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 53 50 32 20 30 2F 33 2F 31 34 2E 31 00 00 00     RSP2 0/3/14.1...
  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

  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 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
```

```
  05:26-05:36     0      0      0    12      0      0       0       0


STS1E 0/3/14.1 T3 is up.
  Hardware is A900-IMA3G-IMSG

  Applique type is T3
  No alarms detected.
  Framing is Unframed, Cablelength is 224
  BER thresholds:  SF = 10e-3  SD = 10e-6
  Clock Source is internal
  Equipment customer loopback
  Data in current interval (560 seconds elapsed):
   Near End
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation, 0 P-bit Err Secs
     0 P-bit Severely Err Secs, 0 Severely Err Framing Secs
     275 Unavailable Secs, 0 Line Errored Secs
     0 C-bit Errored Secs, 0 C-bit Severely Errored Secs
     0 Severely Errored Line Secs, 3 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
```

The following sample output shows the verification of STS-1e configuration in CT3 mode:

```
router#show controllers sts1e 0/3/14
STS1E 0/3/14 is up.
  Hardware is A900-IMA3G-IMSG

 Port configured rate: OC1
 Applique type is Channelized STS1E
 Clock Source is Internal
Medium info:
  Type: STS1E, Line Coding: NRZ,
 Alarm Throttling: OFF
 SECTION:
  LOS = 0          LOF = 0                           BIP(B1) = 0

STS1E Section Tables
  INTERVAL       CV    ES   SES  SEFS
  05:41-05:42     0    10    10    10

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
    J0 = 00

    RX S1 = 00

Tx: S1S0 = 00
    J0 = 04

Tx J0 Length : 64
Tx J0 Trace :

  52 53 50 32 20 20 20 20 20 20 20 20 20 20 20 20     RSP2
```

```
  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 53 50 32 20 20 20 20 20 20 20 20 20 20 20 20     RSP2
  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 : 16
Rx J0 Trace :
  CRC-7: 0xD8 ERROR

  BC 4B 69 CC 79 24 1B 01 E8 EB 9C 36 FC 29 A9 00     .Ki.y$.....6.)..

STS1E Line Tables
  INTERVAL       CV    ES   SES   UAS  CVFE  ESFE  SESFE  UASFE
  05:41-05:42     0     0     0    10     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: 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 53 50 32 20 30 2F 33 2F 31 34 2E 31 00 00 00     RSP2 0/3/14.1...
  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 53 50 32 20 30 2F 33 2F 31 34 2E 31 00 00 00     RSP2 0/3/14.1...
  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

  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00     ................
```

```
  00 00 00 00 00 00 00 00 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
  05:42-05:42     0     0     0     0     0     0      0      0

STS1E 0/3/14.1 T3 is up.
  Hardware is A900-IMA3G-IMSG

  Applique type is Channelized T3 to T1
  No alarms detected.
  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
  Data in current interval (60 seconds elapsed):
   Near End
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation, 0 P-bit Err Secs
     0 P-bit Severely Err Secs, 0 Severely Err Framing Secs
     25 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

 STS-1 1, T1 1 (STS1E 0/3/14.1/1 T1) is up
  No alarms detected.
  Framing is unframed, Clock Source is Internal
  Data in current interval (60 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
     25 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

 STS-1 1, T1 2 (STS1E 0/3/14.1/2 T1) is up
  timeslots:
  FDL per AT&T 54016 spec.
  No alarms detected.
  Framing is ESF, Clock Source is Internal
  Data in current interval (60 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
     26 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
```

controller sts-1e

To configure a STS-1e controller and enter controller configuration mode, use the **controller sts-1e** command in global configuration mode.

controller sts-1e *slot*/*subslot*/*port*

slot	Physical slot number. The slot is always 0.
/*subslot*	Physical sub-slot number. The range for sub-slot is 0-5.
/*port*	STS-1e port number. The range of port number for 3GMS is 12-15 and for 48 T3E3 CE is 0-47.

Command Default

port : 0

Command Modes

Global configuration

Command History

Release	Modification
XE Fuji 16.9.1	This command was integrated into the Cisco ASR 900 Series, Cisco ASR 920 Sesries, and Cisco NCS 4200 Series Routers.

Usage Guidelines

This command can be enabled only after configuring the **mode sts1e** command under **controller mediatype** *slot/subslot/port*command, as shown below:

```
Router(config)#controller mediaType 0/3/13
Router(config-controller)#mode
Router(config-controller)#mode sts1e
```

Example

```
enable
configure terminal
controller sts-1e 0/0/16
sts-1 1
mode sts-1e
t1 1 clock source internal
t1 1 framing unframed
end
```

mode sts-1e

Use this command to configure the sts-1e mode.

None.

Command Default

None.

Command Modes

Controller configuration.

Command History

Release	Modification
IOS XE Fuji 16.9.1	This command was integrated into the Cisco ASR 900 Series, Cisco ASR 920 Series, and the Cisco NCS 4200 Series.

Usage Guidelines

You can change the mode of a controller only when there are no subinterfaces defined for the controller.

Example

```
enable
configure terminal
controller MediaType 0/0/16
mode STS-1e
end
```

CHAPTER 11

Unidirectional Path Switching Ring Over HDLC

Unidirectional Path Switching Ring Over HDLC Overview

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 traffic on a working ring or path is always in one direction (clockwise) and on a protection path is in the opposite direction (counterclockwise). The same signal flows through both working and protection rings using a selector switch.

The UPSR monitoring is performed 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. When a signal fail condition is detected, the hardware initiates an interrupt to software which switches from the working path to the protection path or the opposite way.

In an access network, the UPSR serial traffic is processed with an HDLC encapsulation protocol. The termination CE end may be Ethernet traffic. Between the access routers, the network can be a SONET network, where the data path in the network is protected by UPSR. The data terminating router in the network selects the working or protection path.

UPSR is supported on modes such as VT 1.5, STS 3c, and T3.

Limitations for HDLC UPSR

- HDLC UPSR is supported only on the 1 port OC-48/ 4 port OC-12/OC-3 + 12 port T1/E1 + 4 port T3/E3 CEM interface module.
- HDLC UPSR is applicable only for the OCx ports of the 1 port OC-48/ 4 port OC-12/OC-3 + 12 port T1/E1 + 4 port T3/E3 CEM interface module.
- Work path and protection path should be in the different interface modules.
- The modes supported for configuring HDLC UPSR are VT 1.5, T3, and STS-3c.
- The HDLC UPSR is supported only on RSP2 module.

- HDLC UPSR switching does not happen when there is any alarm at PDH level, for example T1 or T3. The switching happens at VT or STS path alarm.

How to Configure UPSR over HDLC

You can configure HDLC UPSR in anyone of the following ways:

- Create protection group first and then add working or protect member under physical controller. The channel group can be configured under protection group controller once the protection group is created.
- Add working or protect member under physical controller which creates the protection group controller. The channel group can be added under the protection group controller once protection group is created.

Configuring Protection Group

You need to create protection group serial interface.

You can create protection group for anyone of the following types: T3, VT 1.5 T1, and STS-3c.

```
enable
configure terminal
controller protection-group 401 type STS3c
channel-group chan-num timeslots 1-24
end
```

Configuring Channel Group

You can configure channel group under protection controller to create a protection group (PG) serial interface.

Creating Protection Group Serial Interface for VT 1.5 T1 Mode

Once the protection group is created, you can configure the controller using the protection group name and mode. You need to specify the channel group number with timeslots to create a PG serial interface.

To configure the channel group under the controller for VT 1.5 T1 mode, enter the following commands:

```
enable
configure terminal
controller protection-group pg_grp_num type vt1.5
channel-group chan_num timeslots 1-24
end
```

Creating Protection Group Serial Interface for T3 or STS-3c Mode

You can configure protection group for the controller mode types T3 or STS-3c using specific channel group.

To configure channel group under protection controller for mode T3, enter the following commands:

```
enable
configure terminal
protection-group pg_grp_num type sts1
controller sonet x/y/z
sts-1 3
mode t3
```

```
protection-grouppg_grp_numworking
end
```

To configure channel group under protection controller for mode types STS-3c, enter the following commands:

```
enable
configure terminal
protection-group pg_grp_num type sts1
controller sonet x/y/z
sts-3c
mode t3
protection-grouppg_grp_numworking
end
```

The following example details on how to create protection group serial interface for T3 mode:

```
Router(config)#protection-group 6 type stS1
Router(config-ctrlr-sts1)#controller sonet 0/5/17
Router(config-controller)#sts-1 3
Router(config-ctrlr-sts1)#mode t3
Router(config-ctrlr-sts1)#protection-group 6 working
```

Creating Protection Group Serial Interface for VT 1.5 T1 Mode

Once the protection group is created, you can configure the controller using the protection group name and mode. You need to specify the channel group number with timeslots to create a PG serial interface.

To configure the channel group under the controller for VT 1.5 T1 mode, enter the following commands:

```
enable
configure terminal
controller protection-group pg_grp_num type vt1.5
channel-group chan_num timeslots 1-24
end
```

Creating Protection Group Serial Interface for T3 or STS-3c Mode

You can configure protection group for the controller mode types T3 or STS-3c using specific channel group.

To configure channel group under protection controller for mode T3, enter the following commands:

```
enable
configure terminal
protection-group pg_grp_num type sts1
controller sonet x/y/z
sts-1 3
mode t3
protection-grouppg_grp_numworking
end
```

To configure channel group under protection controller for mode types STS-3c, enter the following commands:

```
enable
configure terminal
protection-group pg_grp_num type sts1
controller sonet x/y/z
sts-3c
mode t3
protection-grouppg_grp_numworking
end
```

The following example details on how to create protection group serial interface for T3 mode:

```
Router(config)#protection-group 6 type stS1
Router(config-ctrlr-sts1)#controller sonet 0/5/17
Router(config-controller)#sts-1 3
Router(config-ctrlr-sts1)#mode t3
Router(config-ctrlr-sts1)#protection-group 6 working
```

Adding Protection Group to Controller Under VT 1.5 Mode

You can add protection group as working or protect under specific SONET controller mode on the SONET controller interface.

To add protection group to SONET controller under VT 1.5 mode, enter the following commands:

```
enable
configure terminal
controller sonet <x/y/z>
sts-1 1
mode vt-15
vtg 1 t1 1
protection-group pg_grp_num type {working | protect}
end
```

Adding Protection Group to Controller Under T3 Mode

You can add protection group for T3 framing type such as M13, c-bit.

To add protection group to SONET controller under T3 mode, enter the following commands:

```
enable
configure terminal
controller sonet <x/y/z>
sts-1 1
mode t3
protection-group pg_grp_num type {working | protect}
end
```

Adding Protection Group to Controller Under STS-3c Mode

To add protection group to SONET controller under STS-3c mode, enter the following commands:

```
enable
configure terminal
controller sonet <x/y/z>
sts-1 1 - 3
mode sts-3c
protection-group pg_grp_num type {working | protect}
end
```

ConfiguringCross-ConnectUnderProtectionGroupSerialInterfacePseudowire

The **xconnect** command binds the attachment circuit to a pseudowire for cross connect service. The identifier creates the binding between a pseudowire that is configured on a PE router and an attachment circuit in a CE device.

To perform cross connection between a pseudowire and attachment circuit, use the following commands:

```
router(config)#interface serial-pg <pg-group-name>.<chan_num>
router(config-if)#xconnect ip-address id encapsulation type pw-class pw-class
```

Verifying UPSR Over HDLC Configuration

Use the following **show** commands to verify the UPSR over HDLC configuration:

```
Router#show ip int br | sec PG
Serial-PG1.0           unassigned      YES unset  up                     up
Serial-PG2.0           unassigned      YES unset  up                     up
Router#sh protection-group
PGN   Type    Working I/f               Protect I/f             Active Status
-------------------------------------------------------------------------------
1     VT15    SONET0/5/17.1/1/1                                   W         A
2     VT15    SONET0/5/17.2/2/2                                   W         A


Router#show xconnect all | sec PG
DN pri   ac Se-PG1.0(HDLC)               UP mpls 10.10.10.10:2                DN

Router#sh controller sonet 0/5/17 | sec prot
  Working member of protection-group: 1
  Working member of protection-group: 2


Router#show run | sec 0/5/17
platform enable controller MediaType 0/5/17 oc3
controller MediaType 0/5/17
mode sonet
controller SONET 0/5/17
rate OC3
no ais-shut
alarm-report all
clock source internal
!
sts-1 1
  clock source internal
  mode vt-15
  vtg 1 t1 1 protection-group 1 working
!
sts-1 2
  clock source internal
  mode vt-15
  vtg 2 t1 2 protection-group 2 working
```

Configuration Examples for HDLC UPSR

This section provides examples to configure HDLC UPSR:

Use Case 1

The following example details on how UPSR is configured over HDLC:

- Protection group of 3 configured under VT 1.5 T1 mode.

- Channel group of zero with timeslot configured under the protection group created.
- SONET controller is configured for mode VT 1.5 T1 on interface 0/5/17.
- Protection group of 3 added as working ring under SONET controller mode VT 1.5 T1.
- Perform cross connection under attachment circuit

```
Router(config)#protection-group 3 type vt1.5
Router(config)#controller protection-group 3
Router(config-controller)#type vt1.5
Router(config-ctrlr-sts1)#channel-group 0 timeslots 1-24
Router(config-ctrlr-sts1)#controller sonet 0/5/17
Router(config-controller)#sts-1 1
Router(config-ctrlr-sts1)#mode vt-15
Router(config-ctrlr-sts1)#vtg 1 t1 1 protection-group 3 working
```

Verify the configuration using the following **show** commands:

```
Router#show protection-group
PGN   Type    Working I/f                Protect I/f              Active Status
--------------------------------------------------------------------------------
1     VT15                                                          -         A
2     VT15                                                          -         A
3     VT15    SONET0/5/17.1/1/1                                     W         A

Router#show controller sonet 0/5/17 | sec protection
  Working member of protection-group: 3


Router#show ip int br | sec PG
Serial-PG3.0           unassigned      YES unset  up                    up


Router(config)#interface Serial-PG3.0
Router(config-if)#xconnect 10.10.10.10 1 encapsulation mpls pw-
Router(config-if)#$.10.10.10 1 encapsulation mpls pw-class serial_pg
```

If you want to remove the configuration performed, use the following commands:

```
Router(config-if-xconn)#int Serial-PG3.0
Router(config-if)#no xconnect

Router(config)#controller sonet 0/5/17
Router(config-controller)#sts-1 1
Router(config-ctrlr-sts1)#no vtg 1 t1 1 protection-group 3 working

Router(config)#controller protection-group 3
Router(config-controller)#type vt1.5
Router(config-ctrlr-sts1)#no channel-group 0
Router(config-ctrlr-sts1)#no protection-group 3
```

Use Case 2

The following example details on how UPSR is configured over HDLC:

- SONET controller is configured for mode VT 1.5 T1 on interface 0/5/17.
- Protection group of 3 added as working ring under SONET controller mode VT 1.5 T1.

- Protection group of 3 configured under VT 1.5 T1 mode.
- Channel group of zero with timeslot configured under the protection group created.
- Perform cross connection under attachment circuit

```
Router(config)#controller sonet 0/5/17
Router(config-controller)#sts-1 1
Router(config-ctrlr-sts1)#mode vt-15
Router(config-ctrlr-sts1)#vtg 1 t1 1 protection-group 3 working
Router(config-ctrlr-sts1)#exit
Router(config-controller)#exit
Router(config)#controller protection-group 3
Router(config-controller)#type vt1.5
Router(config-ctrlr-sts1)#channel-group 0 timeslots 1-24
```

Verify the configuration using the following **show** commands:

```
Router#show protection-group
PGN   Type    Working I/f                Protect I/f            Active Status
-------------------------------------------------------------------------------
1     VT15                                                        -         A
2     VT15                                                        -         A
3     VT15    SONET0/5/17.1/1/1                                   W         A

Router#show controller sonet 0/5/17 | sec protection
  Working member of protection-group: 3


Router#show ip int br | sec PG
Serial-PG3.0           unassigned      YES unset  up                    up


Router(config)#int Serial-PG3.0
Router(config-if)#xconnect 10.10.10.10 1 encapsulation mpls pw-
Router(config-if)#$.10.10.10 1 encapsulation mpls pw-class serial_pg
```

CHAPTER 12

Interworking Multiservice Gateway Access Circuit Redundancy

Interworking Multiservice Gateway Access Circuit Redundancy (iMSG ACR) enables local switching for serial interfaces by creating a virtual serial-ACR interface. All configuration changes made on the virtual serial-ACR interface are applied automatically on both the working and protect interfaces. Switching from working to protect or protect to working interface occurs within 250 milliseconds at different scaled levels with line rate traffic. For more information, see Serial ACR.

SONET Supported Modes

Table 11: SONET Supported Modes for iMSG ACR

Mode	Ports
STS-3C	OC-3, OC-12, OC-48
DS3	OC-3, OC-12, OC-48
DS3-T1	OC-3, OC-12, OC-48
VT 1.5	OC-3, OC-12, OC-48

Table 12: SONET Supported Modes for iMSG non-ACR

Mode	Ports
STS-3C	OC-3, OC-12, OC-48
STS-12C	OC-12, OC-48
STS-48C	OC-48

Mode	Ports
DS3	OC-3, OC-12, OC-48
DS3-T1	OC-3, OC-12, OC-48
VT 1.5	OC-3, OC-12, OC-48

SDH Supported Modes

Table 13: SDH Supported Modes for iMSG ACR

Mode	Ports
VC4	STM1, STM4, STM16
TUG-3-E3	STM1, STM4, STM16
TUG-3-T3	STM1, STM4, STM16
TUG-2-E1	STM1, STM4, STM16
TUG-2-T1	STM1, STM4, STM16

Table 14: SDH Supported Modes for iMSG non-ACR

Mode	Ports
VC4	STM1, STM4, STM16
VC4-4c	STM4, STM16
VC4-16c	STM16

Modes not supported on SDH for iMSG ACR

- VC4—TUG-3—TUG-2—VC-12
- VC4— TUG-3—TUG-2—VC-11
- (AU-3) VC-3—TUG-2—VC-12
- (AU-3) VC-3—TUG-2—VC11
- SDH—AU3—VC12—E1

Restrictions for iMSG ACR

- A maximum number of 336 circuits are supported on ACR interface.

- Quality of Service (QoS) and default experimental bits (EXP) marking for MPLS pseudowires is not supported on the iMSG-ACR interface.
- The iMSG ACR is supported only on NCS4200-3GMS card.

How to Configure iMSG ACR

Creating ACR Group

You can create virtual ACR groups with the following SONET ACR types:

- OC3
- OC12
- OC48

You can create virtual ACR groups with the following SDH ACR types:

- STM1
- STM4
- STM16

To create ACR group, enter the following commands:

```
rotuer(config)#ACR <id> type <type-id>
```

Configuring ACR Group on APS

You can configure ACR group on APS. The ACR group supported range is from 1 to 96. Any group number exceeding the range is not supported. You can configure the interface as working using the circuit number. The circuit number identies a particular channel in the APS pair. Since the interface only supports 1 + 1 redundancy, the only valid and the default value for working interface is 1.

The APS group created can be active or inactive:

- Active—The interface that is currently sending and receiving data.
- Inactive—The interface that is currently standing by to take over when the active fails.

Note APS is supported in revertive and non-revertive mode and can be configured as undirectional and bidirectional.

To configure ACR group on APS with SONET interface as a working interface, enter the following commands:

```
configure terminal
controller sonet slot/subslot/port
aps group acr-id
aps working circuit-number
```

```
 aps group acr <acr_id>
```

To configure ACR group on APS with SDH interface as a working interface, enter the following commands:

```
configure terminal
controller sdh slot/subslot/port
aps group acr-id
aps working circuit-number
 aps group acr <acr_id>
```

You can configure an interface to be protect interface in the APS pair. Because only 1+1 redundancy is supported, the only valid value is 1, and the protect interface defaults to 1.

While specifying ACR ID, you need to specify an IP address for the loopback interface. The protect interface uses this IP address to communicate with the working interface.

To configure ACR group on APS with SONET interface as a protect interface, enter the following commands:

```
configure terminal
controller sonet slot/subslot/port
aps group acr-id
aps protect <acr_id> <any-loopback-ip-address>
 aps group acr <acr_id>
```

To configure ACR group on APS with SDH interface as a protect interface, enter the following commands:

```
configure terminal
controller sdh slot/subslot/port
aps group acr-id
aps protect <acr_id> <any-loopback-ip-address>
 aps group acr <acr_id>
```

The following example explains how to configure ACR group on APS with SONET interface as working interface:

```
Router# configure  terminal
Router (config)# controller sonet  0/1/0
Router(config-controller)# aps  group  1
Router (config-controller)# aps  working  1
Router (config-controller)# aps group acr 1
```

The following example explains how to configure ACR group on APS with SONET interface as protect interface:

```
Router# configure  terminal
Router (config)# controller  sonet  0/2/0
Router(config-controller)# aps  group  1
Router (config-controller)# aps protect  1 4.1.1.1
Router (config-controller)# aps group acr 1
```

The following example explains how to configure ACR group on APS with SDH interface as working interface:

```
Router# configure  terminal
Router (config)# controller sdh  0/3/0
Router(config-controller)# aps  group  1
Router (config-controller)# aps  working  1
Router (config-controller)# aps group acr 1
```

The following example explains how to configure ACR group on APS with SDH interface as protect interface:

```
Router# configure  terminal
Router (config)# controller  sdh  0/4/0
Router(config-controller)# aps  group  1
Router (config-controller)# aps protect  1 4.1.1.1
Router (config-controller)# aps group acr 1
```

Creating Serial Interface for SONET ACR

You can create serial interface for SONET ACR on VT 1.5, CT-3, and T3 modes.

Creating Serial Interface for SONET ACR on VT 1.5 Mode

To create serial interface for SONET ACR on VT 1.5 mode, enter the following commands:

```
controller SONET-ACR <ACR-ID>
 sts-1 1
 mode vt-15
 vtg <vtg_num> t1 <t1_num> channel-group <channel_num> timeslots 1-24
```

The following example describes how to create serial interface on VT 1.5 mode for SONET controller:

```
controller SONET-ACR 100
 sts-1 2
  mode vt-15
  vtg 1 t1 1 channel-group 0 timeslots 1-24
```

Creating Serial Interface for SONET ACR on CT3 Mode

To create serial interface for SONET ACR on CT-3 mode, enter the following commands:

```
controller SONET-ACR <ACR-ID>
 sts-1 1
 mode ct3
 t3 framing c-bit
 t1 <t1_num> channel-group <channel_num> timeslots 1-24
```

The following example describes how to create serial interface on CT-3 mode for SONET controller:

```
controller SONET-ACR 100
  sts-1 1
  mode ct3
  t3 framing c-bit
  t1 1 channel-group 0 timeslots 1-24
```

Creating Serial Interface for SONET ACR on T3 Mode

To create serial interface for SONET ACR on T3 mode, enter the following commands:

```
controller SONET-ACR <ACR-ID>
```

```
 sts-1 3
 mode t3
 t3 framing c-bit
 t3 channel-group 0
```

The following example describes how to create serial interface on T3 mode for SONET controller:

```
controller SONET-ACR 100
 sts-1 3
  mode t3
  t3 framing c-bit
  t3 channel-group 0
 !
```

Creating Serial Interface for SONET ACR on PoS Mode

To create serial interface for SONET ACR on PoS mode, enter the following commands

```
controller SONET-ACR 50
 sts-1 1 - 3 mode sts-3c
  channel-group 0
```

Creating Serial Interface for SONET non-ACR on PoS Mode

To create serial interface for SONET non-ACR on STS-12c mode, enter the following commands:

```
configure terminal
controller SONET <slot>/<subslot>/<port>
   rate OC12
   sts-1 1 – 12 mode sts-12c
   channel-group 0
```

To create serial interface for SONET non-ACR on STS-48c mode, enter the following commands:

```
configure terminal
controller SONET <slot>/<subslot>/<port>
  rate OC48
  sts-1 1 – 48 mode sts-48c
  channel-group 0
```

Creating Serial Interface for SDH ACR

To create serial interface for SDH ACR on T1, enter the following commands:

```
configure terminal
controller sdh-acr <acr-ID>
aug mapping au-4
au-4 1
mode tug-3
tug-3 1
mode vc1x
Tug-2 1 payload vc12
t1 1 channel-group 0 timeslots 1 - 24
```

To create serial interface for SDH ACR on E1, enter 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 channel-group 0 timeslots 1 - 31
```

The following example explains how to create serial interface for SDH ACR on T1:

```
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
t1 1 channel-group 0 timeslots 1 - 24
```

The following example explains how to create serial interface for SDH ACR on E1:

```
enable
configure terminal
controller sdh-acr 300
aug mapping au-4
au-4 1
mode tug-3
tug-3 1
mode vc1x
Tug-2 1 payload vc12
e1 1 channel-group 0 timeslots 1 - 31
```

Creating Serial Interface for SDH ACR on PoS Mode

To create serial interface for SDH ACR on PoS mode, enter the following commands

```
controller SDH-ACR 50
 aug mapping au-4
 au-4 1
  mode vc4
  Channel-group 0
```

Creating Serial Interface for SDH non-ACR on PoS Mode

To create serial interface for SDH non-ACR on VC4-4c Mode, enter following commands under physical controller:

```
configure terminal
controller SDH <slot>/<subslot>/<port>
  rate STM
```

```
  au-4 1 - 4 mode vc4-4c
   channel-group 0
```

To create serial interface for SDH non-ACR on VC4-16c Mode, enter following commands under physical controller:

```
configure terminal
controller SDH <slot>/<subslot>/<port>
  rate STM16
  au-4 1 - 16 mode vc4-16c
  channel-group 0
```

Modifying Encapsulation to PPP

By default the encapsulation is HDLC, and you can change the encapsulation to PPP.

To modify encapsulation to PPP, enter the following commands:

```
router(config)#interface SERIAL-ACR148.1
router(config-if)#no ip address
router(config-if)# encapsulation ppp
```

Configuring Pseudowire Class

The following example describes how to configure pseudowire class:

```
pseudowire-class PW_class_name
 encapsulation mpls
 interworking ip
 control-word
```

Note If the interop node requires control word to be enabled, then you need to use the control word.

The following example describes how to configure pseudowire class:

```
pseudowire-class PW_class_name
 encapsulation mpls
 interworking ip
 control-word
```

Configuring Cross-Connect on Serial Interface

The **xconnect** command binds the attachment circuit to a pseudowire for cross connect service. The identifier creates the binding between a pseudowire that is configured on a PE router and an attachment circuit in a CE device.

To perform cross connection between a pseudowire and attachment circuit, use the following commands:

```
router(config)#interface serial-ACR1.29
router(config-if)#xconnect ip-address vc_num pw-class  class-name
```

Verifying iMSG ACR

Verifying iMSG ACR with HDLC Encapsulation

Use the following **show aps group** and **show interface SERIAL-ACR** commands to verify iMSG ACR with HDLC encapsulation on the SONET or SDH controller:

```
router# show aps group 100
SONET 0/1/16 APS Group 100: protect channel 0 (Inactive) (HA)
        Working channel 1 at 11.1.1.3 (Enabled)  (HA)
        unidirectional, ADM, non-revertive
        PGP timers (extended for HA): hello time=1; hold time=10
                hello fail revert time=120
        SONET framing; SONET APS signalling by default
        Received K1K2: 0x11 0x04
                Do Not Revert (working)
        Transmitted K1K2: 0x00 0x04
                No Request (Null)
        Remote APS configuration: (null)

SONET 0/4/16 APS Group 100: working channel 1 (Active) (HA)
        Protect at 11.1.1.3 (unidirectional, non-revertive)
        PGP timers (from protect): hello time=1; hold time=10
        SONET framing
        Remote APS configuration: (null)


router# show aps group 300
SDH 0/3/0 APS Group 300: protect channel 0 (Inactive) (HA)
        Working channel 1 at 11.1.1.3 (Enabled)  (HA)
        unidirectional, ADM, non-revertive
        PGP timers (extended for HA): hello time=1; hold time=10
                hello fail revert time=120
        SDH framing; SDH APS signalling by default
        Received K1K2: 0x11 0x04
                Do Not Revert (working)
        Transmitted K1K2: 0x00 0x04
                No Request (Null)
        Remote APS configuration: (null)

SDH 0/3/1 APS Group 300: working channel 1 (Active) (HA)
        Protect at 11.1.1.3 (unidirectional, non-revertive)
        PGP timers (from protect): hello time=1; hold time=10
        SDH framing
        Remote APS configuration: (null)


router#show interface SERIAL-ACR100.1
SERIAL-ACR100.1 is up, line protocol is up
  Hardware is N/A
  MTU 1500 bytes, BW 1536 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, crc 16, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:05, output 00:00:02, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     70 packets input, 10902 bytes, 0 no buffer
```

```
     Received 0 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     57 packets output, 2508 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     20 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
     7 carrier transitions no alarm present
  VC 1: timeslot(s): 1-24, Transmitter delay 0, non-inverted data
```

Use the following **show interface SERIAL-ACR** commands to verify HDLC ACR configuration on the SDH controller:

```
router#show int SERIAL-ACR148.1
SERIAL-ACR148.1 is up, line protocol is up
  Hardware is N/A
  MTU 1500 bytes, BW 44210 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, crc 16, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:07, output 00:00:06, output hang never
  Last clearing of "show interface" counters 01:16:15
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     122925 packets input, 16492939 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     744239 packets output, 41162791 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     85 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions alarm present
  DSU mode 0, bandwidth 0 Kbit, scramble 0, VC 1, non-inverted data
```

Verifying iMSG ACR with PPP Encapsulation

Use the following **show interface SERIAL-ACR** command to verify iMSG ACR with PPP encapsulation on the SONET or SDH controller:

```
router#show interface SERIAL-ACR100.1
SERIAL-ACR100.1 is up, line protocol is up
  Hardware is N/A
  MTU 1500 bytes, BW 1536 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 2/255, rxload 2/255
  Encapsulation PPP, LCP Open
  Stopped: TAGCP
  Open: IPCP, crc 16, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:00, output 00:00:00, output hang never
  Last clearing of "show interface" counters 03:28:29
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 14000 bits/sec, 1185 packets/sec
  5 minute output rate 14000 bits/sec, 1185 packets/sec
     14628274 packets input, 25965577 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicasts)
```

```
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     14628402 packets output, 26013374 bytes, 0 underruns
     0 output errors, 0 collisions, 1 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
     2 carrier transitions
 PW stats
 14625804 input packets ,14625930 output packets,
 1872102912 input bytes, 1872119040 output bytes, 0 input packet drop
 no alarm present
  VC 1: timeslot(s): 1-24, Transmitter delay 0, non-inverted data
```

Verifying iMSG ACR with HDLC Encapsulation on PoS Mode

Use the following **show interfaces SERIAL-ACR<*acr-id*>.<*path-number*>** command to verify iMSG ACR with HDLC encapsulation on PoS mode for SONET or SDH controller.

```
Router#show interfaces serial-acr50.1
SERIAL-ACR50.1 is up, line protocol is up
  Hardware is N/A
  MTU 1500 bytes, BW 155000 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, crc 16, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:09, output 00:00:05, output hang never
  Last clearing of "show interface" counters 00:00:27
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     102 packets input, 10688 bytes
     Received 0 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     103 packets output, 10732 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
PW stats
100 input packets ,100 output packets,
10000 input bytes, 10000 output bytes, 0 input packet drop
no alarm present
  VC:1, Non-inverted data
```

Verifying iMSG ACR with PPP Encapsulation on PoS Mode

Use the following **show interfaces SERIAL-ACR<*acr-id*>.<*path-number*>** command to verify iMSG ACR with PPP encapsulation on PoS mode for SONET or SDH controller.

```
Router#show interfaces serial-acr50.85
SERIAL-ACR50.85 is up, line protocol is up
  Hardware is N/A
  MTU 1500 bytes, BW 155000 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, LCP Open
  Stopped: TAGCP
```

```
  Open: IPCP, crc 16, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:01, output 00:00:01, output hang never
  Last clearing of "show interface" counters 00:00:11
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     104 packets input, 10776 bytes
     Received 0 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     104 packets output, 10776 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
PW stats
100 input packets ,100 output packets,
10000 input bytes, 10000 output bytes, 0 input packet drop
no alarm present
  VC:85, Non-inverted data
```

CHAPTER 13

Serial Interfaces

You can create the serial interface on T1 or E1, T3 or E3, SDH, or SONET interface. Each serial interface configuration differs based on the interface mode.

The channel identifier configuration differs based on the interface mode. For more information, refer serial interface supported modes.

Serial Interface Supported Modes

The serial interface name is specified as **`interface serial`***`0/bay/port`*. The zero specifies the slot number, bay specifies the bay number in the slot, and port specifies the port number in the bay.

The channel identifier varies depending on port type and supported port modes.

The following table details the values for the channel ID depending on the port modes:

Table 15: Channel Identifier Supported on T1 or E1 Interface

Mode	Interface	Serial Interface with supported Channel Identifier
T1 or E1	T1 or E1	Serial0/bay/port.1 The port value ranges from 0 to 11.

Table 16: Channel Identifier Supported on T3 or E3 Interface

Mode	Interface	Serial Interface with supported Channel Identifier
T3 or E3	T3 or E3	Serial0/bay/port.1 The port value ranges from 12 to 15.
CT3 or CE3	Channelized T3 or E3	Serial0/bay/port.<t1 number> Serial0/bay/port.<e1 number> T1 or E1 number specifies the VTG number with TUG number and T1 channels. The T1 or E1 number that is supported are as follows: • VTG 1/TUG2 1: T1 {1,8,15,22} • VTG 2/TUG2 2: T1 {2,9,16,23} • VTG 3/TUG2 3: T1 {3,10,17,24} • VTG 4/TUG2 4: T1 {4,11,18,25} • VTG 5/TUG2 5: T1 {5,12,19,26} • VTG 6/TUG2 6: T1 {6,13,20,27} • VTG 7/TUG2 7: T1 {7,14,21,28

Table 17: Channel Identifier Supported on SDH or SONET Interface

Mode	Interface Mode	Serial Interface with supported Channel Identifier
SONET or SDH	STS-3c or VC-4	Serial0/bay/port.<channel-id> For SONET, the <channel-id> is calculated based on the following formula: Channel-id = (start_sts_number − 1) x 28 + 1 For SDH, the <channel-id> is calculated based on the following formula: Channel-id = (start_aug4 − 1) x 28 x 3 + 1
SONET or SDH	T3 or E3	Serial0/bay/port.<channel-id> For SONET, the <channel-id> is calculated based on the following formula: Channel-id = (start_sts_number − 1) x 28 + 1 For SDH AU-4 mapping in TUG3 mode, the <channel-id> is calculated based on the following formula: Channel-id = (AUG 4 − 1) x 28 x 3 + (TUG 3 − 1) x 28 + (e1 − 1) x 7 + TUG 2 For SDH AU-3 mapping, the <channel-id> is calculated based on the following formula: Channel-id = (AUG 3 − 1) x 28 + (e1 − 1) x 7 + TUG 2

<table>
<tr><th>Mode</th><th>Interface Mode</th><th>Serial Interface with supported Channel Identifier</th></tr>
<tr><td>SONET or SDH</td><td>Concatenated Mode</td><td>For SONET, the <channel-id> is calculated based on the following formula:

Channel-id = (start_sts_number − 1) x 28 + 1

For SDH, the <channel-id> is calculated based on the following formula:

Channel-id = (start_aug4 −1) x 28 x 3 + 1</td></tr>
<tr><td>SONET</td><td>VT1.5</td><td>Serial0/bay/port.<channel-id>

<channel-id> is the channel ID calculated based on the following formula:

Channel-id = (sts_number − 1) x 28 + (T1/E1 − 1) x 7 + VTG

The following example describes how the channel ID is calculated for a given configuration.

<code>sts-1 2</code>
<code>mode vt-15</code>
<code>vtg 2 t1 3 channel-group 0 timeslots 1-24</code>

Inter serial interface channel-id = (2 − 1) x 28 + (3 − 1) x 7 + 2 = 44

• VTG 1 1: T1 {1,8,15,22}
• VTG 2 2: T1 {2,9,16,23}
• VTG 3 3: T1 {3,10,17,24}
• VTG 4 4: T1 {4,11,18,25}
• VTG 5 5: T1 {5,12,19,26}
• VTG 6 6: T1 {6,13,20,27}
• VTG 7 7: T1 {7,14,21,28</td></tr>
</table>

Mode	Interface Mode	Serial Interface with supported Channel Identifier
SDH	Vc11 and Vc12	T1 number with Vc11 supported: • TUG2 1: T1 {1,8,15,22} • TUG2 2: T1 {2,9,16,23} • TUG2 3: T1 {3,10,17,24} • TUG2 4: T1 {4,11,18,25} • TUG2 5: T1 {5,12,19,26} • TUG2 6: T1 {6,13,20,27} • TUG2 7: T1 {7,14,21,28 E1 number with Vc12 supported: • TUG2 1: E1 {1,8,15} • TUG2 2: E1 {2,9,16} • TUG2 3: E1 {3,10,17} • TUG2 4: E1 {4,11,18} • TUG2 5: E1 {5,12,19} • TUG2 6: E1 {6,13,20} • TUG2 7: E1 {7,14,21} **Note** Depending on the mode selected, the number of E1 changes.

Creating T1 or E1 Serial Interfaces on T1 or E1 Ports

Creating T1 Serial Interface

To create a channel group on a T1 interface, use the following commands:

```
router(config)#controller t1 0/2/0
router(config-controller)#channel-group 0  timeslots 1-24
```

Note For T1, the channel-group ID ranges from 0 to 23.

Creating E1 Serial Interface

To create a channel group on an E1 interface, use the following commands:

```
router(config)#controller e1 0/2/0
router(config-controller)#channel-group 0  timeslots 1-31
```

Note For E1, the channel-group ID ranges from 0 to 30.

The following example explains a channel group of number 2 with time slot 1-24 is configured on the T1 interface of the controller. The default encapsulation of HDLC is used.

```
router(config)#controller t1 0/2/0
router(config-controller)#channel-group  2 timeslots  1-24
router(config-controller)#end
```

Note While specifying time slot, use the complete range, for example, 1-24 for T1 and 1-31 for E1.

The following example explains a channel group of number 10 with time slot 1-31 is configured on the E1 interface of the controller. The default encapsulation of HDLC is used.

```
router(config)#controller e1 0/3/2
router(config-controller)#channel-group 2 timeslots 1-31
router(config-controller)#end
```

Creating T3 or E3 Serial Interfaces on T3 or E3 Ports

Configuring Mode to T3 or E3

To configure T3 mode, use the following commands:

```
router(config)#controller mediatype 0/2/12
router(config-controller)#mode t3
router(config-controller)#exit
```

To configure E3 mode, use the following commands:

```
router(config)#controller mediatype 0/2/12
router(config-controller)#mode e3
router(config-controller)#exit
```

Creating T3 Serial Interface

To create a T3 interface, use the following commands:

```
router(config)#controller t3 0/2/12
router(config-controller)#no channelized
router(config-controller)#channel-group 0
router(config-controller)#exit
```

Note Use **no channel group** command to clear configured T3 channels.

Creating E3 Serial Interface

To create an E3 interface, use the following commands:

```
router(config)#controller e3 0/2/12
router(config-controller)#no channelized
router(config-controller)#channel-group 0
router(config-controller)#exit
```

Creating CT3 Serial Interface

To create a CT3 interface, use the following commands:

```
router(config)#controller t3 0/2/12
router(config-controller)#channelized
router(config-controller)#T1 1 channel-group 0 timeslots 1-24
router(config-controller)#T1 2 channel-group 0 timeslots 1-24
router(config-controller)#exit
```

Note While specifying time slot, ensure that you provide the complete time slot, for example 1-24 for T1 interface.

The following example explains a channel group of 0 is configured on the E3 interface of the controller. The default encapsulation of HDLC is used.

```
router(config)#controller e3 0/2/12
router(config-controller)#no channelized
router(config-controller)#channel-group 0
router(config-controller)#end
```

The following example explains a channel group of number 0 is configured on the CT3 interface of the controller. The default encapsulation of HDLC is used.

```
router(config)#controller t3 0/2/12
router(config-controller)#no channelized
router(config-controller)#channel-group 0
router(config-controller)#end
```

Creating Serial Interfaces on SDH

Configuring Mode to SDH

To enter into SDH mode, use the following commands:

```
router(config)#controller mediatype 0/bay/port
router(config-controller)#mode sdh
router(config-controller)#exit
```

Creating SDH T3 Interface

To create an SDH T3 interface, use the following commands:

```
router(config)#controller sdh 0/bay/port
router(config-controller)#rate {stm1 | stm4 | stm16}
router(config-controller)#aug mapping au-4
router(config-controller)#au-4 1
router(config-ctrlr-au4)#mode tug-3
router(config-ctrlr-au4)#tug-3 1
router(config-ctrlr-tug3)#[no]mode t3
router(config-ctrlr-tug3)#[no]t3 channel-group 0
router(config-ctrlr-tug3)#exit
```

Creating SDH E3 Interface

To create an SDH E3 interface, use the following commands:

```
router(config)#controller sdh 0/bay/port
router(config-controller)#rate {stm1 | stm4 | stm16}
router(config-controller)#aug mapping au-4
router(config-controller)#au-4 1
router(config-ctrlr-au4)#mode tug-3
router(config-ctrlr-au4)#tug-3 1
router(config-ctrlr-tug3)#[no]mode e3
router(config-ctrlr-tug3)#[no]e3  channel-group 0
router(config-ctrlr-tug3)#exit
```

Creating SDH VC11 Interface

To create an SDH VC11 interface, use the following commands:

```
router(config)#controller sdh 0/bay/port
router(config-controller)#rate {stm1 | stm4 | stm16}
router(config-controller)#aug mapping au-4
router(config-controller)#au-4 1
router(config-ctrlr-au4)#[no]mode tug-3
router(config-ctrlr-au4)#tug-3 1
router(config-ctrlr-tug3)#[no]mode vc1x
router(config-ctrlr-tug3)#tug-2 1 payload vc11
router(config-ctrlr-tug2-vcx)#[no]t1 1  channel-group 0 timeslots 1-24
router(config-ctrlr-tug3)#exit
```

Creating SDH VC12 Interface

To create an SDH VC12 interface, use the following commands:

```
router(config)#controller sdh 0/bay/port
router(config-controller)#rate {stm1 | stm4 | stm16}
router(config-controller)#aug mapping au-4
router(config-controller)#au-4 1
router(config-ctrlr-au4)#[no]mode tug-3
router(config-ctrlr-au4)#tug-3 1
router(config-ctrlr-tug3)#[no]mode vc1x
router(config-ctrlr-tug3)#tug-2 1 payload vc12
router(config-ctrlr-tug2-vcx)#[no]e1 1  channel-group 0 timeslots 1-31
router(config-ctrlr-tug3)#exit
```

Creating SDH VC4-nc Interface

To create an SDH VC4-nc concatenated interface, use the following commands:

```
router(config)#controller sdh 0/bay/port
router(config-controller)#rate {stm1 | stm4 | stm16}
router(config-controller)#aug mapping au-4
router(config-controller)#au-4 1
router(config-ctrlr-au4)#[no]mode vc4
router(config-ctrlr-au4)#[no]channel-group 0
router(config-ctrlr-tug3)#exit
```

Creating SDH T3 Interface with AUG-3 Mapping

To create an SDH T3 interface with AUG-3 AUG mapping, use the following commands:

```
router(config)#controller sdh 0/bay/port
router(config-controller)#aug mapping au-3
router(config-controller)#au-3 1
router(config-ctrlr-au3)#[no]mode t3
router(config-ctrlr-au3)#[no]t3 channel-group 0
router(config-ctrlr-au3)#exit
```

Creating SDH VC11 Interface with AUG-3 Mapping

To create an SDH VC11 interface with AUG-3 AUG mapping, use the following commands:

```
router(config)#controller sdh 0/bay/port
router(config-controller)#au-3 1
router(config-ctrlr-au3)#[no]mode vc1x
router(config-ctrlr-au3)#tug-2 1 payload vc11
router(config-ctrlr-tug2-vcx)#[no] t1 1 channel-group 0 timeslots 1-24
router(config-ctrlr-tug3)#exit
```

Creating SDH VC12 Interface with AUG-3 Mapping

To create an SDH VC12 interface with AUG-3 AUG mapping, use the following commands:

```
router(config)#controller sdh 0/bay/port
router(config-controller)#au-3 1
router(config-ctrlr-au3)#[no]mode vc1x
router(config-ctrlr-au3)#tug-2 1 payload vc12
router(config-ctrlr-tug2-vcx)#[no]e1 1 channel-group 0 timeslots 1-31
router(config-ctrlr-tug3)#exit
```

The following example explains SDH serial interface is configured with rate STM1 with AU-4 mapping and TUG-3 and T3 mode:

```
router(config)#controller sdh 0/3/4
router(config-controller)#rate stm1
router(config-controller)#aug mapping au-4
router(config-controller)#au-4 1
router(config-ctrlr-au4)#mode tug-3
router(config-ctrlr-au4)#tug-3 1
router(config-ctrlr-tug3)#mode t3
router(config-ctrlr-tug3)#t3  channel-group 0
router(config-ctrlr-tug3)#exit
```

Creating Serial Interfaces on SONET

Setting Controller Mode to SONET

To enter into SONET mode, use the following commands:

```
router(config)#controller mediatype 0/bay/port
router(config-controller)#mode sonet
router(config-controller)#exit
```

Creating T3 Serial Interface

To create a channel group on the T3 interface, use the following commands:

```
router(config)#controller sonet 0/bay/port
router(config-controller)#rate {oc3 | oc12 | oc48}
router(config-controller)#sts-1  1
router(config-controller)#[no]mode t3
router(config-controller)#[no]t3 channel-group 0
router(config-controller)#exit
```

Creating VT1.5 Serial Interface

To create a channel group on the VT1.5 interface, use the following commands:

```
router(config)#controller sonet 0/bay/port
router(config-controller)#rate oc3
router(config-controller)#sts-1  1
router(config-controller)#[no]mode vt-15
router(config-controller)#[no]vtg 1 t1 1 channel-group 0 timeslots  1-24
router(config-controller)#exit
```

Creating CT3 Serial Interface

To create a channel group on the CT3 interface, use the following commands:

```
router(config)#controller sonet 0/bay/port
router(config-controller)#rate oc3
router(config-controller)#sts-1  1
router(config-controller)#[no]mode ct3
router(config-controller)#[no]t1  1 channel-group 0  timeslots 1-24
router(config-controller)#exit
```

Note While specifying time slot, ensure that you specify the complete time slot.

Creating Concatenated Mode Serial Interface

To create a channel group on the concatenated mode serial interface, use the following commands:

```
router(config)#controller sonet 0/bay/port
router(config-controller)#rate oc3
router(config-controller)#sts-1  1 - 3 mode sts-3c
router(config-controller)#channel-group 0
router(config-controller)#exit
```

The following example explains SONET interface that is configured with OC-3 rate, STS-1 as 1, and mode as T3.The serial interface is modified for PPP encapsulation.

```
router(config)#controller sonet 0/3/4
router(config-controller)#rate oc3
router(config-controller)#sts-1  1
router(config-controller)#mode t3
router(config-controller)#t3  channel-group 0
router(config-controller)#end
router(config)#interface serial 0/3/4 .1
router(config-if)#no ip address
router(config-if)# encapsulation ppp
```

Modifying Encapsulation to PPP

By default, HDLC is used for encapsulation. You can modify encapsulation to PPP on a serial interface using the **encapsulation ppp** command.

The ***channel-id*** varies based on the mode set and the circuit type. For more information, see the Serial Interface Supported Modes section.

To modify encapsulation on the serial interface, use the following commands:

```
router(config)#interface serial 0/bay/port.channel-id
router(config-if)#no ip address
router(config-if)# encapsulation ppp
```

IPv4 Interworking Pseudowire over HDLC or PPP

L2VPN Interworking

Layer 2 transport over MPLS and IP already exists for like-to-like attachment circuits, such as Ethernet-to-Ethernet or PPP-to-PPP. Layer 2 Virtual Private Network (L2VPN) Interworking builds on this functionality by allowing disparate attachment circuits to be connected. An interworking function facilitates the translation between the different Layer 2 encapsulations.

- L2VPN Interworking Mode, on page 223
- IPv4 Interworking Pseudowire Supported Modes, on page 224

L2VPN Interworking Mode

L2VPN Interworking works in IP (routed) mode that facilitates transport of IPv4 payload in HDLC or PPP frames to Ethernet, over an MPLS network. The configuration is supported on NCS4200-3GMS. You specify the mode by issuing the **interworking ip** command in pseudowire-class configuration mode.

The interworking command causes the attachment circuits to be terminated locally. The **ip** keyword causes IP packets to be extracted from the attachment circuit and sent over the pseudowire. Packets with IPv4 payload only are transported over pseudowire.

IP Interworking Mode

The CE routers encapsulate the IP on the link between the CE router and PE router. A new VC type is used to signal the IP pseudowire in MPLS. Translation between the L2 and IP encapsulations across the pseudowire is required. Special consideration is given to the address resolution and routing protocol operation, because these operations are handled differently on different L2 encapsulations.

In routed interworking, IP packets that are extracted from the ACs are sent over the pseudowire. The pseudowire works in the IP Layer 2 transport (VC type 0x000B) like-to-like mode. The interworking function at the network service provider's (NSP) end performs the required adaptation that is based on the AC technology. Non-IPv4 packets are not forwarded on pseudowire. Only packets with the IPv4 payload are transported over the pseudowire.

The following table details on the packets that are terminated locally:

Table 18: List of Packets Locally Terminated

Protocol	Packets (Locally Terminated)	PID Number
Cisco HDLC	SLARP, LCP, or RARP	0x8035
Cisco HDLC	NCP or ARP	0x0806
PPP	LCP	0xCxxx to 0xFxxx
PPP	NCP	0x8xxx to 0xBxxx

HDLC or PPP to Ethernet IPv4 Interworking Pseudowire

Starting with Cisco IOS XE 16.9.1 release, the L2VPN interworking allows you to connect disparate attachment circuits, for example, TDM and Ethernet attachment circuits. The L2VPN interworking operates in IP (routed) mode that facilitates transport of IPv4 payload in HDLC or PPP frames to Ethernet, over MPLS network translation. The configuration is supported on an NCS4200-3GMS.

For pseudowires operated in the IP (routed) mode, the IP packets are extracted from the attachment circuit and sent over the pseudowire.

Once IPv4 interworking is configured, create a serial interface with specific channel identifier.

When a serial interface is UP, an internal label is allocated and LDP negotiation with a peer is performed for a remote label. A pseudowire is created and bound to HDLC or PPP channel. Based on the pseudowire configuration, you can permit IPv4 payload traffic with an allocated internal MPLS label.

The default encapsulation for all serial interfaces is HDLC. You can change the encapsulation to PPP. You can cross connect the attachment circuit segment with specific VC identifier and the pseudowire segment.

IPv4 Interworking Pseudowire Supported Modes

IPv4 interworking pseudowire is supported on the following modes:

- T1 or E1
- T3 or E3
- Channelized T3 or E3 (channelized to T1 or E1)

- SDH
- SONET

Limitations of IPv4 Interworking Pseudowire on HDLC or PPP Serial Interfaces

The following limitations apply to IPv4 interworking pseudowire on HDLC or PPP serial interfaces:

- IPv4 interworking pseudowire with HDLC or PPP attachment circuit is supported only on the NCS4200-3GMS.
- IPv4 interworking is supported only for HDLC or PPP to Ethernet and not supported on MLPPP.
- L3 termination, bridging, and local switching on serial interfaces are not supported.
- Access circuit redundancy, Unidirectional Path Switched Ring (UPSR), and card protection with serial interfaces are not supported.
- IPv4 over HDLC or PPP is not supported on Nx DS0 serial interfaces.
- T1 framing SF is not supported.
- HDLC or PPP is not supported for STS-12C or VC4-4C, and STS48C or VC4-16C modes.
- HDLC or PPP is not supported for CE3 modes.

How to Configure IPv4 Interworking Pseudowire on HLDC or PPP Interface

This section provides the following information about configuring an IPv4 interworking pseudowire on an HLDC or PPP interface:

- Configuring L2VPN Interworking, on page 225
- Configuring Cross-Connect Under Attachment Circuit, on page 226

Configuring L2VPN Interworking

To configure L2VPN interworking, create a pseudowire class with the tunneling encapsulation as MPLS. The **interworking** command specifies the type of payload traffic that flows across the pseudowire tunnel. Configure pseudowire class only once on a device.

You can also configure **control-word** as an optional command.

To configure L2VPN interworking, use the following commands:

```
router>enable
router#configure terminal
router(config)#pseudowire-class pw-class-name
router(config-pw)#encapsulation mpls
router(config-pw)# interworking ip
router(config-pw)# control-word
```

Configuring Cross-Connect Under Attachment Circuit

The **xconnect** command binds the attachment circuit to an L2VPN pseudowire for cross connect service. The virtual circuit identifier creates the binding between a pseudowire that is configured on a PE router and an attachment circuit in a CE device.

To perform cross connection between an AToM routed pseudowire and attachment circuit, use the following commands:

```
router(config)#interface serial 0/bay/port.channel-id
router(config-if)#xconnect ip-address vc-id pw-class atom-iw-routed
```

Verifying IPv4 Interworking Pseudowire over HDLC or PPP Configuration

The following **show interface serial** *0/bay/port.vc-number* command displays information about encapsulation and statistics of a serial interface.

To display configuration information on the serial interface, use the **show interface serial** command:

```
Router# show interface serial 0/5/19.8
 Serial0/5/19.8 is up, line protocol is up
  Hardware is NCS4200-3GMS
  MTU 1500 bytes, BW 1536 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, LCP Open
  Stopped: TAGCP
  Open: IPCP, crc 16, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:04, output 00:00:04, output hang never
  Last clearing of "show interface" counters 23:52:46
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     16201 packets input, 712844 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     16205 packets output, 696835 bytes, 0 underruns
     0 output errors, 0 collisions, 1 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
     1 carrier transitions
 PW stats

 0 input packets ,0 output packets,
 0 input bytes, 0 output bytes, 0 input packet drop
 no alarm present
  VC 2: timeslot(s): 1-24, Transmitter delay 0, non-inverted data
```

The **`show platform software tdm-combo vc info`** command helps you to identify the bay, port, STS path, T1, and channel group associated with a serial interface:

```
router#show platform software tdm-combo vc info
BAY  PORT PATH  T1      CHANNEL          VC          HWIDB
spa in bay:0 is NULL
spa in bay:1 is NULL
5    19   1      1          0        Serial0/5/19.1  1
5    19   1      8          0        Serial0/5/19.8  2
TOTAL ENTRIES :2
```

The **show running-config interface serial 0/5/19.8** command provides information on cross connect status, and local or remote label bindings:

```
router#show running-config interface serial 0/5/19.8
Building configuration...

Current configuration : 147 bytes
!
interface Serial0/5/19.8
 no ip address
 encapsulation ppp
 ppp authentication chap
 xconnect 192.0.2.6 207 encapsulation mpls pw-class ip-iw
end

BYOS-RSP3#sh xconnect all
Legend:    XC ST=Xconnect State  S1=Segment1 State  S2=Segment2 State
  UP=Up       DN=Down            AD=Admin Down      IA=Inactive
  SB=Standby  HS=Hot Standby     RV=Recovering      NH=No Hardware

XC ST  Segment 1                         S1 Segment 2                         S2
------+---------------------------------+--+---------------------------------+--
UP pri   ac Se0/5/19.8(PPP)              UP mpls 192.0.2.6:207                  UP
```

The **show mpls l2transport vc 207 detail** command provides information on pseudowire corresponding to VC ID 207:

```
Local interface: Se0/5/19.8 up, line protocol up, PPP up
  Interworking type is IP
  Destination address: 192.0.2.6, VC ID: 207, VC status: up
    Output interface: Gi0/3/7, imposed label stack {16}
    Preferred path: not configured
    Default path: active
    Next hop: 40.40.40.1
  Create time: 23:31:56, last status change time: 23:31:54
    Last label FSM state change time: 23:31:56
  Signaling protocol: LDP, peer 192.0.2.6:0 up
    Targeted Hello: 192.0.2.10(LDP Id) -> 192.0.2.6, LDP is UP
    Graceful restart: configured and not enabled
    Non stop routing: not configured and not 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 fault
      Last remote LDP TLV    status rcvd: No fault
      Last remote LDP ADJ    status rcvd: No fault
    MPLS VC labels: local 512, remote 16
    Group ID: local n/a, remote 0
    MTU: local 1500, remote 1500
    Remote interface description:
  Sequencing: receive disabled, send disabled
  Control Word: On
  SSO Descriptor: 192.0.2.6/207, local label: 512
  Dataplane:
    SSM segment/switch IDs: 8219/8218 (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
```

IPv4 Layer 3 Termination on HDLC or PPP Serial Interfaces

IPv4 Layer 3 Termination on HDLC or PPP Serial Interfaces

IPv4 routing can be performed using standard routing protocols such as OSPF, BGP, IS-IS, EIGRP, and RIP.

A maximum of 1020 serial interfaces are supported on the Cisco RSP3 module.

This feature supports MPLS IP.

Restrictions for IP4 Layer 3 Termination on HDLC or PPP Serial Interfaces

- IPv6 routing is not supported.
- ACR or UPSR protection on serial interfaces is not supported.
- Multicast and QoS features are not supported.
- Frame-relay or MLPPP is not supported.
- BFD is not supported on serial interfaces.

How to Configure IP4 Layer 3 Termination on HDLC or PPP Serial Interfaces

Configuring Protocols

Configuring Routing Protocol

You should configure routing protocols such as OSPF, BGP, IS-IS, EIGRP, and RIP.

For more information on configuring IP Routing protocols, refer the respective Guides:

https://www.cisco.com/c/en/us/support/ios-nx-os-software/ios-xe-3s/products-installation-and-configuration-guides-list.html

Configuring L3 VPN

To configure L3 VPN, refer the MPLS Virtual Private Networks chapter in the MPLS: Layer 3 VPNs Configuration Guide.

Configuring VRF

Before configuring IPv4 Layer 3 flow on a serial interface, ensure that you have configured VRF forwarding. For more information, refer Configuring VFR.

VRF-lite is a feature that enables a service provider to support two or more VPNs, where IP addresses can be overlapped among the VPNs. VRF-lite uses input interfaces to distinguish routes for different VPNs and forms virtual packet-forwarding tables by associating one or more Layer 3 interfaces with each VRF.

With the VRF-lite feature, the router supports multiple VPN routing or forwarding instances in customer edge devices. VRF-lite allows a service provider to support two or more VPNs with overlapping IP addresses using one interface.

To configure VRF, enter the following commands:

```
router#configure terminal
router(config)#vrf definition vrf_test
router(config-vrf)#rd 1:1
router(config-vrf)#address-family ipv4
```

Once VRF is configured, ensure that you specify the Layer 3 interface to be associated with the VRF and then associate the VRF with the Layer 3 interface using the **`vrf forwarding vrf-name`** command. The interface can be a routed port or SVI.

To configure VRF forwarding, enter the following commands:

```
router#configure terminal
router (config-vrf)# interface interface-id
router (config-if)#vrf forwarding vrf-name
```

Configuring IPv4 Unicast Layer 3 Termination on HDLC or PPP Interfaces

You can enable or disable IPv4 Layer 3 flow on HDLC or PPP serial interfaces. You can use the **vrf forwarding <vrf name>** command optionally on the serial interface.

You can also modify the default MTU 1500 bytes optionallyusing the **mtu** command.

To enable IPv4 Layer 3 flow on a serial interface, enter the following commands:

```
router(config)#interface serial x/y/z.channel-id
router(config-if)#vrf forwarding <vrf name> (optional)
router(config-if)#ip address <ipv4 address> <mask>
router(config-if)#mtu <bytes>
```

To disable IPv4 Layer 3 flow on a serial interface, enter the no form of the command:

```
router(config)#interface serial x/y/z.channel-id
router(config-if)#vrf forwarding <vrf name>
router(config-if)#no ip address <ipv4 address> <mask>

router(config)#interface serial x/y/z.channel-id
router(config-if)#no vrf forwarding <vrf name>
```

Verifying IPv4 Layer 3 Termination on HDLC or PPP

The following **show interface serial** *0/bay/port.vc-number* command displays information about PPP encapsulation and statistics of a serial interface.

To display configuration information on the serial interface, use the **show interface serial** command:

```
Router# show interface serial 0/5/16.1
 Serial0/5/16.1 is up, line protocol is up
  Hardware is NCS4200-3GMS
  Internet address is 41.41.41.1/24
  MTU 1500 bytes, BW 44210 Kbit/sec, DLY 20000 usec,
```

```
   reliability 255/255, txload 1/255, rxload 1/255
Encapsulation HDLC, crc 16, loopback not set
Keepalive set (10 sec)
Last input 00:00:03, output 00:00:02, output hang never
Last clearing of "show interface" counters never
Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: fifo
Output queue: 0/40 (size/max)
5 minute input rate 76000 bits/sec, 298 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
   99332 packets input, 983489 bytes, 0 no buffer
   Received 0 broadcasts (0 IP multicasts)
   0 runts, 0 giants, 0 throttles
   0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
   62 packets output, 4832 bytes, 0 underruns
   0 output errors, 0 collisions, 3 interface resets
   0 unknown protocol drops
   0 output buffer failures, 0 output buffers swapped out
   0 carrier transitions
no alarm present
DSU mode 0, bandwidth 0 Kbit, scramble 0, VC 3, non-inverted data
```