



48-Port T1/E1 CEM Interface Module Configuration Guide, Cisco IOS XE 16 (Cisco ASR 900 Series)

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CHAPTER 1

Feature History



CHAPTER 2

Configuring T1/E1 Interfaces on 48-Port T1/E1 Interface Module

This chapter provides information about configuring the T1/E1 interfaces on the 48-Port T1/E1 interface module:



Note Effective Cisco IOS XE Release 16.5.1S, E1 interface is supported.

T1/E1 is supported only on Cisco ASR 900 RSP3 Module.

- [Information About T1/E1 Interfaces, on page 3](#)
- [How to Configure T1/E1 Interfaces, on page 4](#)
- [Circuit Emulation Service over Packet-Switched Network, on page 11](#)
- [Troubleshooting T1/E1 Controllers, on page 13](#)
- [Associated Commands, on page 21](#)
- [Additional References for Configuring 48-Port T1/E1 CEM Interface Module , on page 23](#)

Information About T1/E1 Interfaces

The following sections provide information about T1/E1 interfaces.

Overview of T1/E1 Interfaces

The 48-Port T1/E1 interface module on CEM line card supports generic single or dual-port T1/E1 trunk interfaces for voice, data, and integrated voice or data applications.

Restrictions for Configuring T1/E1 Interfaces

- You can configure CEM to support serial interface configuration.
- The supported BERT patterns are 2¹¹, 2¹⁵, 2²⁰-O153, 2²⁰-QRSS, and 2²³.
- The card can be configured either in the T1 or E1 mode only but the combination of T1 and E1 ports is not supported.

How to Configure T1/E1 Interfaces

This section provides information about configuring T1/E1 interfaces on the 48-Port T1/E1 interface module.

Recommended Pattern for Linecode

The following pattern for linecode configuration is supported for T1 or E1.

Table 1: Linecode Configuration and Pattern Supported on T1 or E1 Controllers

Part Number	Linecode Configuration	T1 or E1	Random Pattern
XRT83VSH316 LIU	B8ZS/AMI	T1	QRSS
	HDB3/AMI	E1	PRBS15

Configuration Using AMI Linecodes at Both Ends (UUT (AMI) and TESTER (AMI))

When both sides are configured as AMI, the linecodes match and the T1 or E1 controller is always UP with a smooth traffic flow.

Configuration Using Different Linecodes at Both Ends (UUT (AMI) and TESTER (B8ZS or HDB3))

- The line codes do not match when one side is configured with AMI and other side is configured with non-AMI codes such as B8ZS or HDB3. Based on the pattern that is inserted, there is change in the behavior.
- For 511 QRSS pattern, although the line codes do not match, the controller is UP. The controllers go DOWN for other patterns.
- Each pattern is unique and contains a combination of ones and zeros. Only the pattern 511 QRSS is supported. If patterns other than 511 QRSS are used, then LOS is generated, and controller goes to the DOWN state.

The following table details the configuration using same and different linecodes at both ends and the pattern that is supported on T1 (UUT mode) controller:

Table 2: Configuration Using Linecodes for T1 Controllers

Pattern Mode (ANSI)	Pattern with UUT (AMI) and TESTER (B8zS)	UUT(AMI) and TESTER (AMI)
511 QRSS	Controller is UP. Linecodes do not match.	T1 controller is UP on UUT. Linecodes match.
QRSS	UUT controller is DOWN.	T1 controller is UP on UUT. Linecodes match.
2047 QRSS	UUT controller is DOWN.	T1 controller is UP on UUT. Linecodes match.

The following table details configuration using same and different linecodes at both ends and the pattern that is supported on E1 (UUT mode) controller:

Table 3: Configuration Using Linecodes for E1 Controllers

Pattern Mode (ANSI)	Pattern with UUT (AMI) and TESTER (B8zS)	UUT(AMI) and TESTER (AMI)
2^15- 1	Controller is DOWN.	E1 controller is UP on UUT. Linecodes match.
2^15- 1 INV	Controller is DOWN.	E1 controller is UP on UUT. Linecodes match.

Setting the Card Type

To set the card type for the T1/E1 interfaces, complete these steps:

```
enable
configure terminal
card type t1 0 0
exit
```

Configuring the Controller

To configure T1 interface, use the following commands:

```
enable
configure terminal
controller t1 0/3/0
clock source internal
framing esf
cablelength short 110
linecode b8zs
no shut
exit
```



Note For T1 interface, the default frame mode is Extended Super Frame (ESF).

To configure E1 interface, use the following commands:

```
enable
configure terminal
controller e1 0/3/0
clock source internal
framing crc4
linecode hdb3
no shut
exit
```



Note For E1 interface, the default frame mode is Cyclic Redundancy Check 4 (CRC4).

Verifying the Controller Configuration

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

```
Router# show controller e1 0/2/0
E1 0/2/0 is up.
Applique type is ASR903-48T1E1-CE

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/E1 Interfaces

To configure Structure-Agnostic TDM over Packet (SAToP), use the following commands:

```
enable
```

```

configure terminal
controller t10/0/0
cem-group 0 unframed
exit

```



Note To configure SAToP, the framing mode for the port is set to unframed.

Verifying CEM Configuration for SAToP

Use the following command to verify the CEM configuration for T1/E1 interfaces:

```

Router# show cem circuit interface CEM 0/0/0

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

Signalling: No CAS
RTP: No RTP

Ingress Pkts:    475471          Dropped:          0
Egress Pkts:    475471          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

```

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 over 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 4: 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 Generation at PE (Remote)	Framing Bits Terminated at PE (Remote)
Unframed SAToP	None	Up	LOF	No	No
Framed SAToP	LOF	Down (Data path remains up)	LOF ¹²	Yes	No
CESOP	LOF	Down (Data path remains up)	AIS	Yes	Yes

¹ AIS—Support until Cisco IOS XE 16.9.3 Fuji release

² LOF—Starting from Cisco IOS XE Fuji 16.9.4 or later releases

Table 5: 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 6: 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 SAToP:

```
enable
configure terminal
controller t1 0/0/0
framing esf
cem-group 0 framed
exit
```

Verifying Framed SAToP Configuration

Use the following command to verify the CEM configuration for T1/E1 interfaces:

```
Router# show cem circuit interface cem 0/0/0

CEM0/0/0, 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: 5 (In use: 0)
Payload Size: 192
Framing: Framed SAToP
```

```

CEM Defects Set
None

Signalling: No CAS
RTP: No RTP

Ingress Pkts: 7836 Dropped: 0
Egress Pkts: 7836 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

```

Performance Monitoring

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

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

```

Router# show controllers t1 0/2/1

T1 0/2/1 is down.
  Applique type is ASR900-48T1E1-CE
  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

Router# show controllers e1 0/2/1

E1 0/2/1 is down.
Applique type is ASR900-48T1E1-CE
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

```

Circuit Emulation Service over Packet-Switched Network

CESoPSN is a method for encapsulating structured (NxDS0) TDM signals as pseudowires over packet switching networks.

Restrictions for CESoPSN on T1 Interface

- The maximum number of CEM interface supported is 192.

- DS0 loopback is not supported on the T1 interface.
- Alarm forwarding is not supported on the T1 interface.
- Card protection is not supported on the T1 interface.

Configuring CEM Group for CESoPSN on T1 Interface

The following section describes how to configure a CEM group for CESoPSN.

To configure xconnect over MPLS, use the following commands:

```
enable
configure terminal
controller t1 0/4/32
cem-group 0 timeslots 1-10
```

Configure cross-connect:

```
enable
configure terminal
interface cem 0/4/32
cem 0
xconnect 2.2.2.2 10 encapsulation mpls
```

Perform a similar configuration on the other end of the pseudowire.

```
show running-config | sec 0/8/16
controller T1 0/8/16
 framing esf
 linecode b8zs
 cablelength short 110
  cem-group 0 timeslots 1-10
interface CEM0/8/16
 no ip address
 cem 0
  xconnect 2.2.2.2 10 encapsulation mpls
```

Check for cross-connect configuration using the following command:

```
Router#show xconnect all | i 0/4/32
UP pri ac CE0/4/32:0(CESoPSN Basic) UP mpls 2.2.2.2:10 UP

Router#sh controllers t1 0/4/32
T1 0/4/32 is up
Applique type is NCS4200-48T1E1-CE
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, Line Code is B8ZS, Clock Source is Line.
```

Verifying CEM for CESoPSN on T1 Interface

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

- show cem circuit—Displays information about the circuit state, administrative state, the CEM ID of the circuit, and the interface on which it is configured. If cross connect is configured under the circuit, the command output also includes information about the attachment circuit status.
- show mpls l2 vc—Displays information about the MPLS VC.
- show mpls l2 vc detail—Displays detailed information about the MPLS VC.

```
PE1#show mpls l2 vc 10
```

Local intf	Local circuit	Dest address	VC ID	Status
CE0/4/32	CESoPSN Basic 0	2.2.2.2	10	UP

```
PE1#sh mpls l2 vc 10 detail
```

```
Local interface: CE0/4/32 up, line protocol up, CESoPSN Basic 0 up
  Destination address: 2.2.2.2, VC ID: 10, VC status: up
  Output interface: Te0/0/0, imposed label stack {650}
  Preferred path: not configured
  Default path: active
  Next hop: 123.123.123.2
Create time: 00:21:25, last status change time: 00:21:25
  Last label FSM state change time: 00:21:25
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: 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 577, remote 650
Group ID: local 238, remote 276
MTU: local 0, remote 0
Remote interface description:
Sequencing: receive disabled, send disabled
Control Word: On (configured: autosense)
SSO Descriptor: 2.2.2.2/10, local label: 577
Dataplane:
  SSM segment/switch IDs: 6893171/4140658 (used), PWID: 674
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
```

Troubleshooting T1/E1 Controllers

You can use the following methods to troubleshoot the T1/E1 controllers:

Running Bit Error Rate Testing for SAToP

Bit error rate testing (BERT) is supported on T1/E1 interfaces. You can run BERTs on 16 controllers out of 48 T1/E1 controllers at a time.

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. BERT is supported for both unframed and framed modes. BERT in system side direction is not supported for framed SAToP.



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

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 7: 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 O.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.

Configuring BERT for SAToP

Before You Begin

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

To run a BERT on T1/E1 interface, perform the following tasks in global configuration mode.

```
enable
configure terminal
controller t10/1/1
bert pattern 2^11 interval 5 direction line/system
exit
```



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

Verifying BERT Configuration for SAToP

Use the following command to verify the BERT configuration for T1/E1 interfaces:

```
Router# show controllers t1 0/1/1

T1 0/1/1 is up.
  Applique type is ASR903-48T1E1-CE
  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 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

```

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

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

Bit Error Rate Testing for CESoPSN

Bit-Error Rate Testing (BERT) is used for analyzing quality and 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. BERT is supported at the TDM side and pseudowire side. BERT can be used either at NxDS0 or DS1 but not together.

BERT is supported on following controllers:

- T1NxDS0, DS1
- T3NxDS0, DS1 (channelised), clear channel DS3.
- OCXNxDS0, DS1 (channelised), DS3(channelised), clear channel DS3, STS1, STS-nc, VT-1.5, VT1.5 T1

Restrictions for BERT in CESoPSN

- The BERT patterns supported are 2¹¹, 2¹⁵, 2²⁰-O153, and 2²⁰-QRSS.
- For the line side BERT to be configured at timeslot level, the first CEM should be configured and it should be present at the same timeslot level where the BERT is configured.
- The system side BERT is not supported on partial timeslots. For the system side BERT, use full timeslots.

Configuring BERT for CESoPSN

Before You Begin

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

To run a BERT on T1/E1 interface for CESoPSN, perform the following tasks in global configuration mode.

```
enable
configure terminal
controller t10/1/1
bert pattern 2^11 interval 5 direction line/system timeslots value speed
exit
```



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

Verifying BERT Configuration for CESoPSN

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

```
Router# show controllers t1 0/4/32
T1 0/4/32 is up
  Applique type is NCS4200-48T1E1-CE
  Cablelength is short 110
  DS0 Bert enabled on the following timeslots : 1-2
  Speed : 64 kpbs
  DSX1 BERT test result: (running)
  DSX1 BERT pattern      : 2^15
  DSX1 BERT direction   : Line
  DSX1 BERT sync        : sync
  DSX1 BERT sync count  : 1
  DSX1 BERT interval    : 1
  DSX1 BERT time remain : 00:00:55
  DSX1 BERT total errs  : 0
  DSX1 BERT total k bits: 512
  DSX1 BERT errors (last): 0
  DSX1 BERT k bits (last): 512
  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 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

```

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

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

Loopback on T1 or E1 Interfaces

You can use the following loopback on the T1 or E1 interfaces. Loopback is supported on both unframed and framed modes.

Restrictions

- Framing type should be maintained same in all routers end to end.
- AIS alarm is not transmitted to the connected peer port with **loopback local line** configuration.

Loopback	Description
loopback local line	Loops the outgoing transmit signal back to the receive signal. This is done using the diagnostic loopback feature in the interface module's framer. Set the clock source command to internal for this loopback mode.
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. Loopback network line is supported on E1 interface.



Note Starting Cisco IOS Release 16.8.1, the following loopback commands are not supported.

- loopback diag
- loopback local
- loopback local payload

Configuring Loopback

Before You Begin

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 0/0/1
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 0/0/1
loopbackdiag
exit
```

To set a loopback local on the E1 interface, perform the following tasks in global configuration mode:

```
enable
configure terminal
controller e1 0/0/1
loopback local
exit
```

To set a loopback network on the E1 interface, perform the following tasks in global configuration mode:

```
enable
configure terminal
controller e1 0/0/1
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.

Loopback Remote on T1 Interfaces

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

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

For releases later than Cisco IOS XE Fuji 16.8.x, we recommend that you use ESF loopback codes with ESF framing and IBOC loopback codes with SF framing.

Restrictions for Loopback Remote

- E1 loopback remote is not supported.
- Loopback remote is not supported when cem-group is configured under T1.

Configuring Loopback Remote on a T1 Interface Module

To set T1 loopback remote iboc fac1/fac2/csu for DS1, perform the following tasks in global configuration mode:

```
enable
configure terminal
controller t1 0/0/1
loopback remote iboc {fac1 | fac2 | csu}
exit
```

To set T1 loopback remote esf line csu/payload on the DS1 interface, perform the following tasks in global configuration mode:

```
enable
configure terminal
controller t1 0/0/1
loopback remote esf {line csu | payload}
exit
```



Note loopback remote esf line niu is not supported.

Verifying the Loopback Remote Configuration

Use the following command to check the loopback remote configuration:

```
router# show running-config | sec 0/0/1
controller T1 0/2/10
  threshold sd-ber 6
  threshold sf-ber 3
  framing sf
  linecode b8zs
  cablelength short 110
  loopback remote iboc fac1
```

Use the following command to verify the loopback remote configuration:

```
router# show controller t1 0/0/1
T1 0/0/1 is up (NIU FAC1 Line Loopback with IBOC)
  Currently in Inband Remotely Line Looped
  Applique type is ASR900-48T1E1-CE
  Cablelength is short 110
  Receiver has no alarms.
  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

```

Associated Commands

The commands used to configure the Interfaces.

Commands	URL
card type	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-cl.html#wp2336574570
cem-group	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-cl.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-cl.html#wp2169323859

Commands	URL
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
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
show controller e1	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-s2.html#wp1632676058

Additional References for Configuring 48-Port T1/E1 CEM Interface Module

Related Documents

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

Standards and RFCs

Standard/RFC	Title
—	<i>There are no standards and RFCs for this feature.</i>

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
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>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.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	http://www.cisco.com/cisco/web/support/index.html



CHAPTER 3

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
- [Configuring Pseudowire, on page 25](#)

Configuring Pseudowire

Cisco Pseudowire Emulation Edge-to-Edge (PWE3) allows you to transport traffic by using traditional services such as T1/E1 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/E1 or T3/E3 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.

How to Configure Pseudowire

The following sections describe how to configure pseudowire.

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 for SAToP

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

The following sections describe how to configure CEM.

Configuring CEM Restriction

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



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

Configuring CEM 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
```



Note You need metroaggrservice license to configure CEM group on the Interface Module.

Configuring CEM Classes

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



Note

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

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

Configuring CEM Parameters

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

Configuring Payload Size

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
- E1 = 256 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.

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 0/0/1
cem 0
payload-size 512 dejitter-buffer 12
xconnect 10.10.10.10 200 encapsulation mpls
exit
```

Verifying CEM Statistics for SAToP

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

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

```
Router# show cem circuit

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

```
Router# show cem circuit
```

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

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

```
Router# show cem circuit 0

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

Signalling: No CAS
```

```

RTP: No RTP

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

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

```

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

```

Router# show cem circuit summary

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

```

Configuring Framed SAToP



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

To configure framed SAToP:

```

enable
configure terminal
controller t1 0/0/0
framing esf
cem-group 0 framed
exit

```

Verifying CEM Statistics for Framed SAToP

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

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

```

Router# show cem circuit

<0-4294967295>      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  Ctrlr  Admin  Circuit  AC
-----
CEM0/1/0  1   UP     UP     Active  UP
CEM0/1/1  2   UP     UP     Active  UP
CEM0/1/2  3   UP     UP     Active  UP

```

```
CEM0/1/3 4   UP   UP   Active UP
CEM0/1/4 5   UP   UP   Active UP
```

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

```
Router# show cem circuit 0
CEM0/1/2, ID: 0, Line: UP, Admin: UP, Ckt: ACTIVE
Mode :T1, CEM Mode: T1-SAToP
Controller state: up, T1 state: up
Idle Pattern: 0xFF, Idle CAS: 0x8
Dejitter: 5 (In use: 0)
Payload Size: 192
Framing: Framed SAToP
CEM Defects Set
None

Signalling: No CAS
RTP: No RTP

Ingress Pkts: 167027103 Dropped: 0
Egress Pkts: 167027102 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
```

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

```
Router# show cem circuit summary

CEM Int. Total Active Inactive
-----
CEM0/1/0 1 1 0
CEM0/1/1 1 1 0
CEM0/1/2 1 1 0
CEM0/1/3 1 1 0
CEM0/1/4 1 1 0
```

Circuit Emulation Service over Packet-Switched Network

CESoPSN is a method for encapsulating structured (NxDS0) TDM signals as pseudowires over packet switching networks.

Restrictions for CESoPSN on T1 Interface

- The maximum number of CEM interface supported is 192.
- DS0 loopback is not supported on the T1 interface.
- Alarm forwarding is not supported on the T1 interface.
- Card protection is not supported on the T1 interface.

Configuring CEM Group for CESoPSN on T1 Interface

The following section describes how to configure a CEM group for CESoPSN.

To configure xconnect over MPLS, use the following commands:

```
enable
configure terminal
controller t1 0/4/32
cem-group 0 timeslots 1-10
```

Configure cross-connect:

```
enable
configure terminal
interface cem 0/4/32
cem 0
xconnect 2.2.2.2 10 encapsulation mpls
```

Perform a similar configuration on the other end of the pseudowire.

```
show running-config | sec 0/8/16
controller T1 0/8/16
 framing esf
 linecode b8zs
 cablelength short 110
  cem-group 0 timeslots 1-10
interface CEM0/8/16
 no ip address
 cem 0
  xconnect 2.2.2.2 10 encapsulation mpls
```

Check for cross-connect configuration using the following command:

```
Router#show xconnect all | i 0/4/32
UP pri ac CE0/4/32:0(CESoPSN Basic) UP mpls 2.2.2.2:10 UP

Router#sh controllers t1 0/4/32
T1 0/4/32 is up
Applique type is NCS4200-48T1E1-CE
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, Line Code is B8ZS, Clock Source is Line.
```

Verifying CEM for CESoPSN on T1 Interface

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

- show cem circuit—Displays information about the circuit state, administrative state, the CEM ID of the circuit, and the interface on which it is configured. If cross connect is configured under the circuit, the command output also includes information about the attachment circuit status.
- show mpls l2 vc—Displays information about the MPLS VC.
- show mpls l2 vc detail—Displays detailed information about the MPLS VC.

```
PE1#show mpls l2 vc 10
```

Local intf	Local circuit	Dest address	VC ID	Status
CE0/4/32	CESoPSN Basic 0	2.2.2.2	10	UP

```
PE1#sh mpls l2 vc 10 detail
```

```
Local interface: CE0/4/32 up, line protocol up, CESoPSN Basic 0 up
Destination address: 2.2.2.2, VC ID: 10, VC status: up
Output interface: Te0/0/0, imposed label stack {650}
Preferred path: not configured
Default path: active
Next hop: 123.123.123.2
Create time: 00:21:25, last status change time: 00:21:25
Last label FSM state change time: 00:21:25
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: 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 577, remote 650
Group ID: local 238, remote 276
MTU: local 0, remote 0
Remote interface description:
Sequencing: receive disabled, send disabled
Control Word: On (configured: autosense)
SSO Descriptor: 2.2.2.2/10, local label: 577
Dataplane:
SSM segment/switch IDs: 6893171/4140658 (used), PWID: 674
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
```

Configuring DS1 Local Connet

The following section describes how to configure first segment for DS1 local connection:

```
enable
configure terminal
controller T1 0/5/0
framing unframed
clock source internal
linecode b8zs
cablelength short 110
cem-group 0 unframed
description TO_CE1_0/1/0
```

The following section describes how to configure second segment for DS1 local connection:

```
enable
```

```

configure terminal
controller T1 0/5/3
framing unframed
clock source recovered 0
linecode b8zs
cablelength short 110
cem-group 0 unframed
description TO_CE1_0/1/1

```

The following section describes how to create a DS1 local connection:

```

enable
configure terminal
connect ds1_connect CEM0/5/0 0 CEM0/5/3 0

```

Verifying DS1 Local Connect

Use the following commands to verify the DS1 local connection:

- **show connection name**—Displays information about the connection state and segment state.

```

Router#show connection name ds1_connect

Connection: 673 - ds1_connect
Current State: UP
Segment 1: CEM0/5/0 SATOP T1 0 up
Segment 2: CEM0/5/3 SATOP T1 0 up

```

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

Commands	URL
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
—	<i>There are no standards and RFCs for this feature.</i>

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
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>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.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	http://www.cisco.com/cisco/web/support/index.html



CHAPTER 4

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, on page 35](#)
- [Information About Clock Recovery, on page 35](#)
- [Prerequisites for Clock Recovery, on page 37](#)
- [Restrictions for Clock Recovery, on page 37](#)
- [How to Configure ACR and DCR, on page 37](#)
- [Associated Commands, on page 43](#)
- [Additional References for Clock Recovery, on page 43](#)

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

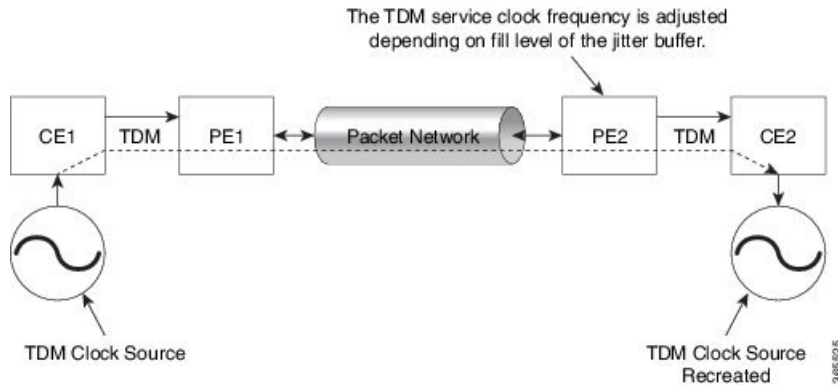
Adaptive Clock Recovery (ACR)

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.

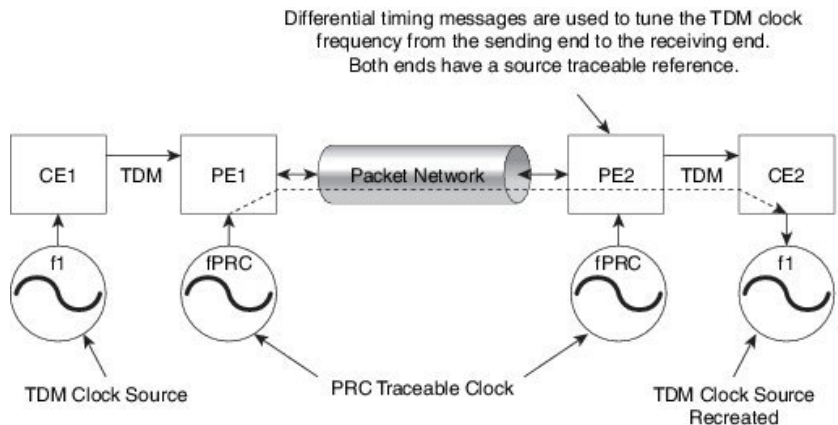


Differential Clock Recovery (DCR)

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).
- In CESoPSN, a slave clock is supported for clock redundancy.

Scaling Information

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

Prerequisites for Clock Recovery

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

Restrictions for Clock Recovery

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

How to Configure ACR and DCR

Configuring ACR for T1/E1

Configuring Adaptive Clock Recovery of T1/E1 Interfaces for SAToP

Before You Begin

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/E1 interfaces for SAToP in controller mode, use the following commands:

```
enable
configure terminal
controller t1 0/0/1
```

```
clock source recovered 1
cem-group 0 unframed
exit
```

To configure the clock recovery on T1/E1 interfaces in global configuration mode, use the following commands:

```
recovered-clock 0 0
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 the Adaptive Clock Recovery Configuration of T1/E1 Interfaces for SAToP

Use the **show recovered-clock** command to verify the adaptive clock recovery of T1/E1 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          DS1       ADAPTIVE  0        ACQUIRED    n/a              0 (Port)
```

Use the **show running-config** command to verify the configuration of adaptive clock of T1/E1 interfaces:

```
Router# show running-config | section 0/0/1
controller T1 0/0/1
 framing unframed
 clock source recovered 1
 linecode b8zs
 cablelength long 0db
  cem-group 0 unframed
interface CEM0/0/1
 no ip address
 cem 0
```

Use the **show running-config | section recovered-clock** command to verify the recovery of adaptive clock of T1/E1 interfaces:

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

Configuring Adaptive Clock Recovery for Framed SAToP

To configure ACR for Framed SAToP:

```
enable
configure terminal
```

```

controller t1 0/0/1
framing esf
clock source recovered 1
cem-group 0 framed
exit

```

To configure ACR in global configuration mode:

```

recovered-clock 0 0
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 for Framed SAToP

Use the **show recovered-clock** command to verify the adaptive clock recovery of T1/E1 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          DS1       ADAPTIVE  0        ACQUIRED    n/a                0 (Port)

```

Use the **show running-config** command to verify the configuration of adaptive clock of T1/E1 interfaces:

```

Router# show running-config | section 0/0/1
controller T1 0/0/1
threshold sd-ber 6
threshold sf-ber 3
framing esf
clock source recovered 1
linecode b8zs
cablelength short 110
cem-group 0 framed
interface CEM 0/0/1
no ip address
cem 0
!

```

Use the **show running-config | section recovered-clock** command to verify the recovery of adaptive clock of T1/E1 interfaces:

```

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

```

Configuring DCR for T1/E1

Configuring Differential Clock Recovery of T1/E1 Interfaces for SAToP

Before You Begin

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

- 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 64 bytes.

To configure the clock on T1/E1 interfaces for SAToP in controller mode, use the following commands:

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

To configure RTP header on T1/E1 interfaces in global configuration mode, use the following commands:

```
interface cem 0/0/1
cem 0
rtp-present
```

To configure Differential clock recovery of T1/E1 interfaces, use the following commands in global configuration mode:

```
recovered-clock 0 0
clock recovered 1 differential cem 1 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 T1/E1 Interfaces for SAToP

Use the **show recovered-clock** command to verify the differential clock recovery of T1/E1 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          DS1       DIFFERENTIAL  0        ACQUIRED    n/a          0 (Port)
```

Use the **show running-config | section** command to verify the configuration of differential clock of T1/E1 interfaces for SAToP:

```
Router# show running-config | section 0/0/1
controller T1 0/0/1
  framing unframed
  clock source recovered 1
  linecode b8zs
  cablelength long 0db
  cem-group 0 unframed
interface CEM 0/0/1
  no ip address
  cem 0
  rtp-present
```

Use the **show running-config | section recovered-clock** command to verify the recovery of differential clock of T1/E1 interfaces:

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

Configuring Differential Clock Recovery for Framed SAToP

To configure DCR for framed SAToP:

```
enable
configure terminal
controller t1 0/0/1
  framing esf
  clock source recovered 1
  cem-group 0 framed
exit
```

Verifying Differential Clock Recovery Configuration for Framed SAToP

Use the **show recovered-clock** command to verify the differential clock recovery of T1/E1 interfaces for framed SAToP:

```
Router# show recovered-clock

Recovered clock status for subslot 0/4
-----
Clock      Type      Mode           CEM      Status      Frequency Offset (ppb)  Circuit-No
-----
0          DS1       DIFFERENTIAL   0        ACQUIRED   n/a          0 (Port)
```

Use the **show running-config | section** command to verify the configuration of differential clock for Framed SAToP:

```
Router# show running-config | section 0/0/1
controller T1 0/0/1
  threshold sd-ber 6
  threshold sf-ber 3
  framing esf
  clock source recovered 1
  linecode b8zs
```

```

cablelength short 110
cem-group 0 framed
interface CEM0/0/1
no ip address
cem 0
rtp-present
!

```

Use the **show running-config | section recovered-clock** command to verify the recovery of differential clock of T1/E1 interfaces:

```

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

```

Configuring Network Clock

To configure a network clock, use the following commands:

```

enable
configure terminal
controller T1 0/5/0
clock source line
cem-group 0 unframed
exit
enable
configure terminal
network-clock input-source 1 controller T1 0/5/0
exit

```

Verifying Network Clocking Configuration

Use **show run | sec network-cl** command to verify the network clocking configuration.

```

network-clock synchronization automatic
network-clock synchronization mode QL-enabled
network-clock input-source 1 controller E1 0/1/0
network-clock wait-to-restore 10 global
rtr1#sh netw synchronization
Symbols:      En - Enable, Dis - Disable, Adis - Admin Disable
              NA - Not Applicable
              * - Synchronization source selected
              # - Synchronization source force selected
              & - Synchronization source manually switched

```

```

Automatic selection process : Enable
Equipment Clock : 2048 (EEC-Option1)
Clock Mode : QL-Enable
ESMC : Enabled
SSM Option : 1
T0 : E1 0/1/0
Hold-off (global) : 300 ms
Wait-to-restore (global) : 10 sec
Tsm Delay : 180 ms
Revertive : No

```

Nominated Interfaces

Interface	SigType	Mode/QL	Prio	QL_IN	ESMC Tx	ESMC Rx
Internal	NA	NA/Dis	251	QL-SEC	NA	NA
*E1 0/1/0	NA	NA/Dis	1	QL-SEC	NA	NA
rtrl#						

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
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	<i>Timing and synchronization aspects in packet networks</i>

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
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>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.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	http://www.cisco.com/cisco/web/support/index.html



CHAPTER 5

Clock Recovery System for CESoPSN

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

- [Finding Feature Information, on page 45](#)
- [Information About Clock Recovery, on page 45](#)
- [Prerequisites for Clock Recovery, on page 47](#)
- [Restrictions for Clock Recovery, on page 47](#)
- [How to Configure ACR and DCR, on page 48](#)
- [Associated Commands, on page 51](#)
- [Additional References for Clock Recovery, on page 52](#)

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.

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Information About Clock Recovery

Clock Recovery System in CESoPSN

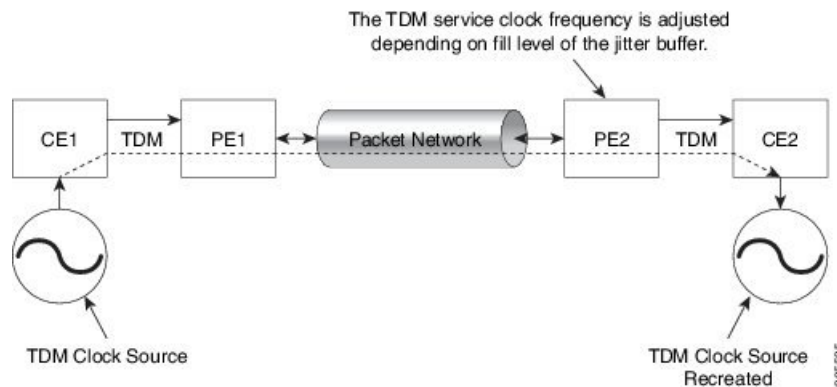
The Clock Recovery System is able to recover the service clock using two methods, the Adaptive Clock Recovery and Differential Clock Recovery.

Adaptive Clock Recovery in CESoPSN

When emulating TDM over PSNs, the physical layer clock is sometimes not available to both ends. Adaptive Clock Recovery (ACR) is a technique where the clock from the TDM domain is mapped through the packet domain. The sending Inter Working Function (IWF) processes outgoing packets with an internal free-running

clock, and the receiving IWF creates a clock based on packet arrival. The service clock frequency is adjusted depending on fill level of the jitter buffer.

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

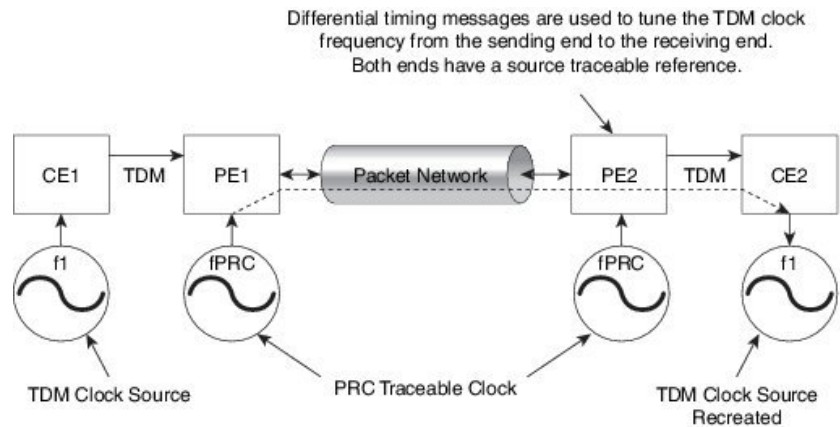


Differential Clock Recovery in CESoPSN

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

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

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



Benefits of Clock Recovery

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

Scaling Information

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

Prerequisites for Clock Recovery

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

Restrictions for Clock Recovery

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

How to Configure ACR and DCR

Configuring ACR for T1/E1

Configuring Adaptive Clock Recovery of T1/E1 Interfaces for SAToP

Before You Begin

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/E1 interfaces for SAToP in controller mode, use the following commands:

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

To configure the clock recovery on T1/E1 interfaces in global configuration mode, use the following commands:

```
recovered-clock 0 0
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 the Adaptive Clock Recovery Configuration of T1/E1 Interfaces for SAToP

Use the **show recovered-clock** command to verify the adaptive clock recovery of T1/E1 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          DS1       ADAPTIVE  0        ACQUIRED    n/a                    0 (Port)
```

Use the **show running-config** command to verify the configuration of adaptive clock of T1/E1 interfaces:

```
Router# show running-config | section 0/0/1
controller T1 0/0/1
  framing unframed
  clock source recovered 1
  linecode b8zs
  cablelength long 0db
  cem-group 0 unframed
interface CEM0/0/1
  no ip address
  cem 0
```

Use the **show running-config | section recovered-clock** command to verify the recovery of adaptive clock of T1/E1 interfaces:

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

Configuring DCR for T1/E1

Configuring Differential Clock Recovery of T1/E1 Interfaces for SAToP

Before You Begin

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

- 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 64 bytes.

To configure the clock on T1/E1 interfaces for SAToP in controller mode, use the following commands:

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

To configure RTP header on T1/E1 interfaces in global configuration mode, use the following commands:

```
interface cem 0/0/1
cem 0
rtp-present
```

To configure Differential clock recovery of T1/E1 interfaces, use the following commands in global configuration mode:

```
recovered-clock 0 0
```

```
clock recovered 1 differential cem 1 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 T1/E1 Interfaces for SAToP

Use the **show recovered-clock** command to verify the differential clock recovery of T1/E1 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	DS1	DIFFERENTIAL	0	ACQUIRED	n/a	0 (Port)

Use the **show running-config | section** command to verify the configuration of differential clock of T1/E1 interfaces for SAToP:

```
Router# show running-config | section 0/0/1
controller T1 0/0/1
 framing unframed
 clock source recovered 1
 linecode b8zs
 cablelength long 0db
 cem-group 0 unframed
interface CEM 0/0/1
 no ip address
 cem 0
 rtp-present
```

Use the **show running-config | section recovered-clock** command to verify the recovery of differential clock of T1/E1 interfaces:

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

Configuring Network Clock

To configure a network clock, use the following commands:

```
enable
configure terminal
controller T1 0/5/0
 clock source line
 cem-group 0 unframed
exit
enable
configure terminal
```



```
network-clock input-source 1 controller T1 0/5/0
exit
```

Verifying Network Clocking Configuration

Use **show run | sec network-cl** command to verify the network clocking configuration.

```
network-clock synchronization automatic
network-clock synchronization mode QL-enabled
network-clock input-source 1 controller E1 0/1/0
network-clock wait-to-restore 10 global
rtrl#sh netw synchronization
Symbols:      En - Enable, Dis - Disable, Adis - Admin Disable
              NA - Not Applicable
              * - Synchronization source selected
              # - Synchronization source force selected
              & - Synchronization source manually switched
```

```
Automatic selection process : Enable
Equipment Clock : 2048 (EEC-Option1)
Clock Mode : QL-Enable
ESMC : Enabled
SSM Option : 1
T0 : E1 0/1/0
Hold-off (global) : 300 ms
Wait-to-restore (global) : 10 sec
Tsm Delay : 180 ms
Revertive : No
```

Nominated Interfaces

Interface	SigType	Mode/QL	Prio	QL_IN	ESMC Tx	ESMC Rx
Internal	NA	NA/Dis	251	QL-SEC	NA	NA
*E1 0/1/0	NA	NA/Dis	1	QL-SEC	NA	NA

rtrl#

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	<i>Timing and synchronization aspects in packet networks</i>

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
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>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.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	<p>http://www.cisco.com/cisco/web/support/index.html</p>

