CEM 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 CEM Pseudowire

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

Overview of CEM 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. 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.

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

The router supports the pseudowire type that utilizes CEM transport: Structure-Agnostic TDM over Packet (SAToP) and Circuit Emulation Service over Packet-Switched Network (CESoPSN).

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

Note We recommend that you configure the controller in the administratively up mode. Configuration under the administratively down mode is not recommended and it might cause configuration errors.

Note The default behaviour of the CEM pseudowire is always UP irrespective of the controller alarms.

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.

CEM Group

CEM group denotes a CEM channel that you can create for one or more time slots for T1/E1 and T3/E3 lines.

How to Configure 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.

CEM pseudowire Scale

Effective from the 16.12.1 release,

- 21504 CEM pseudowires without protection (with SONET)

- 10752 CEM pseudowires with protection

is supported on the router.

Currently the Cisco A900-IMA3G-IMSG support a maximum of 1344 CEM pseudowires.

Note The 21K CEM pseudowire's can be achieved on the router by using the combination of the Cisco A900-IMA1Z8S-CX and A900-IMA3G-IMSG interface modules in multiple slot combinations.

Restrictions for pseudowire Scale Increase

- CEM pseudowire scale is supported **only** on the SONET mode.

- When configured for scale beyond 21504 CEM pseudowire, a syslog is printed as:

  ```
  Cannot allocate CEM group, maximum CEM group exceeded, but the configurations will not
   be rejected. For example, when a 215xxth CEM pseudowire is configured, the configuration
   fails even though the CLI is not rejected with the mentioned syslog notification.
  ```

- While performing ISSU with 21504 CEM pseudowire, sufficient delay must be provided for each interface module.

- After SSO and successful bulk sync, run the **show platform software tdm-combo cem ha-stray-entries** command. If the output of this command displays no entries, then the next SSO can be performed. You must wait until **show platform software tdm-combo cem ha-stray-entries** has no entries.

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

Dejitter Buffer is a buffering mechanism to account for a delay variation in the CEM packet stream. The buffer size is the amount of time you allocate to compensate for the network filter. The configured dejitter-buffer size is converted from milliseconds to packets and rounded up to the next integral number of packets. To set the size of the dejitter-buffer (in milliseconds), use the **dejitter-buffer** *value* command. The value 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.

- **show cem circuit description**—Displays the CEM interface details with description.

Use the **show cem circuit description** command

```
Router#show cem circuit description
CEM Int.       ID   Ctrlr    Admin    Circuit    Description
 ----------------------------------------------------------------
CEM0/3/16    29   DOWN     UP       Active        cem29_description
Router#show cem circuit interface cem 0/3/16 29 description
CEM Int.       ID   Ctrlr    Admin    Circuit    Description
 ----------------------------------------------------------------
CEM0/3/16    29   DOWN     UP       Active        cem29_description

Router#show cem circuit 29 description
CEM Int.       ID   Ctrlr    Admin    Circuit    Description
 ----------------------------------------------------------------
CEM0/3/16    29   DOWN     UP       Active        cem29_description
```

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

Commands	URL
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

System CESoP NxDS0 BERT

Table 1: Feature History

Feature Name	Release Information	Description
System CESoP NxDS0 BERT	Cisco IOS XE Dublin 17.11.1	You can configure BERT patterns at the DS0 level on the following interface modules for both the system and line directions. • 48-Port T1 or E1 CEM interface module • 48-Port T3 or E3 CEM interface module • 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 You can configure speed with bandwidth of 56 kbps or 64 kbps along with the BERT pattern. With DS0 level BERT configuration, you can verify the end-to-end connectivity.

CESoP NxDS0 BERT enables you to configure BERT patterns at the DS0 level under CEM circuits and verify if the traffic is stable along with the configured BERT pattern.

Ensure that both sides should have the same mode configured along with the same BERT pattern with the same speed. For example, in a network where CE is connected to PE through an OCx line or PE1 is connected PE2, ensure that both CE and PE or PE1 and PE2 should have the same mode configured along with the same BERT pattern and same speed. Ensure that when you configure the DS0 BERT pattern, you should configure the speed with the bandwidth of 56 kbps or 64 kbps.

You can configure BERT in the system and line direction with speed on the following controller modes:

• T1 or E1

- T3 or E3 (channelized T1 or E1)

- SONET—CT3, CT3-E1, or VT-15

- SDH—On AU-3 or AU-4, VC-1x (VC-11 or VC-12), CT3-E1 mode

The following example shows that the line BERT is configured with a speed of 64kbps on the SONET controller:

vtg 1 t1 1 bert timeslots 1 pattern 2^15 interval 100 direction line speed 64kbps

Restrictions for System CESoP NxDS0 BERT

- You should configure CESoP BERT at the DS0 level with timeslots and speed.

- Channel Associated Signaling (CAS) is not supported.

- You can configure a total of 16 BERTs at a time for an interface module.

Configuring System CESoP NxDS0 BERT

Scenario 1 - Configuring System CESoP NxDS0 BERT on PE Side

Consider a scenario, where CE is connected to PE through an OCx line. Network loopback is configured on CE and system CESoP NxDS0 BERT in line direction and speed of 64 kbps is configured on PE. Verify the BERT pattern and speed configured on PE. The BERT should be in sync.

Figure 1: Configuring System CESoP NxDS0 BERT on PE
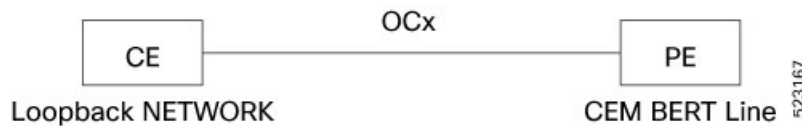
Configuring SONET Controller on CE

```
controller SONET 0/10/1
 no snmp trap link-status
 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 timeslots 1
 !
 sts-1 2
  clock source internal
  !
 sts-1 3
  clock source internal

interface CEM0/10/1
no ip address
```

```
cem 0
end
```

Configuring Network Loopback on CE

```
enable
configure terminal
controller sonet 0/10/1
loopback network
end
```

Configuring SONET Controller on PE

```
controller SONET 0/5/1
 no snmp trap link-status
 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 timeslots 1
 !
 sts-1 2
  clock source internal
  !
 sts-1 3
  clock source internal

interface CEM0/5/1
 no ip address
 cem 0
```
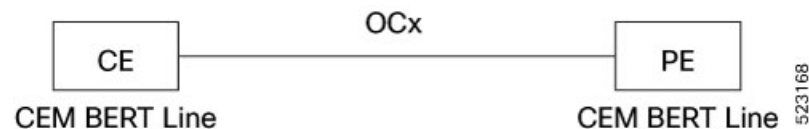
Configuring BERT Pattern with line direction and speed as 64kbps on PE

```
PE(config)#controller sonet 0/5/1
PE(config)#sts-1 1
PE(config-ctrlr-sts1)# vtg 1 t1 1 bert timeslots 1 pattern 2^15 interval 100 direction line
 speed 64kbps
PE(config-ctrlr-sts1)#end
```

Scenario 2 - Configuring Line BERT on CE and PE

Consider a scenario, where CE is connected to PE through an OCx line. BERT with line direction and speed of 64 kbps is configured on both CE and PE. Verify the BERT pattern and speed configured on both CE and PE. The BERT should be in sync.

Figure 2: Configuring Line BERT on CE and PE

Configuring SONET Controller on CE

```
controller SONET 0/10/1
```

```
  no snmp trap link-status
  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 timeslots 1
  !
  sts-1 2
   clock source internal
   !
  sts-1 3
   clock source internal

interface CEM0/10/1
no ip address
cem 0
end
```

Configuring BERT Pattern with line direction and speed as 64 kbps on CE

```
PE(config)#controller sonet 0/5/1
PE(config)#sts-1 1
PE(config-ctrlr-sts1)#vtg 1 t1 1 bert timeslots 1 pattern 2^15 interval 100 direction line
 speed 64kbps
PE(config-ctrlr-sts1)#end
```

Configuring SONET Controller on PE

```
controller SONET 0/5/1
 no snmp trap link-status
 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 timeslots 1
 !
 sts-1 2
  clock source internal
  !
 sts-1 3
  clock source internal

interface CEM0/5/1
 no ip address
 cem 0
```

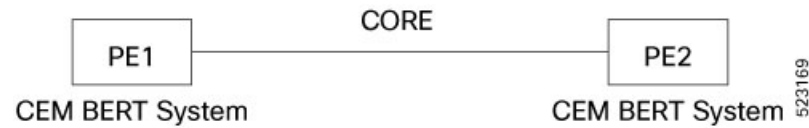### Configuring BERT Pattern with Line Direction and Speed of 64 kbps on PE

```
PE(config)#controller sonet 0/5/1
PE(config)#sts-1 1
PE(config-ctrlr-sts1)#vtg 1 t1 1 bert timeslots 1 pattern 2^15 interval 100 direction line
 speed 64kbps
PE(config-ctrlr-sts1)#end
```

Scenario 3 - Configuring System CESoP NxDS0 BERT with System Direction on PE1 and PE2

Consider a scenario, where PE1 is connected to PE2 through a CORE Gigabit Ethernet line. System CESoP NxDS0 BERT with system direction and speed of 56 kbps is configured on both PE1 and PE2. Verify the BERT pattern and speed configured on both PE1 and PE2. The BERT should be in sync.

Figure 3: Configuring System CESoP NxDS0 BERT with System Direction on PE1 and PE2

Ensure that you perform the following steps:

1. The core should be UP between PEs and the cross connection should be UP.

2. Configure SONET modes on PEs.

3. Configure BERT on PEs.

Configuring SONET Controller on PE1

```
controller SONET 0/10/1
 no snmp trap link-status
 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 timeslots 1
 !
 sts-1 2
  clock source internal
  !
 sts-1 3
  clock source internal

interface CEM0/10/1
no ip address
cem 0
end
```

Configuring BERT Pattern with Line Direction and Speed as 56 kbps on PE1

```
PE(config)#controller sonet 0/5/1
PE(config)#sts-1 1
PE(config-ctrlr-sts1)# vtg 1 t1 1 bert timeslots 1 pattern 2^15 interval 100 direction
system speed 56kbps
PE(config-ctrlr-sts1)#end
```

Configuring SONET Controller on PE2

```
controller SONET 0/5/1
 no snmp trap link-status
 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 timeslots 1
     !
     sts-1 2
      clock source internal
      !
     sts-1 3
      clock source internal

interface CEM0/5/1
 no ip address
 cem 0
```

Configuring BERT Pattern with Line Direction and Speed of 56 kbps on PE2

```
PE(config)#controller sonet 0/5/1
PE(config)#sts-1 1
PE(config-ctrlr-sts1)# vtg 1 t1 1 bert timeslots 1 pattern 2^15 interval 100 direction
system speed 56kbps
PE(config-ctrlr-sts1)#end
```
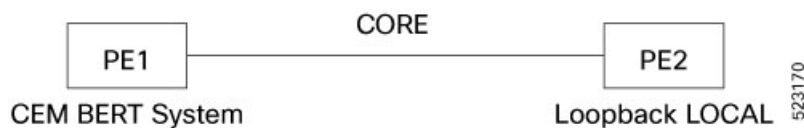
Sample Scenarios

Similarly, the following are sample scenarios where you can configure system CESoP NxDS0 BERT.

Sample Scenario - 1

Figure 4: Configuring System CESoP NxDS0 BERT with System Direction on PE1 and Loopback as Local on PE2

1. The core should be UP between PEs and the cross connection should be UP.

2. Configure SONET modes on PE1 and PE2s.

3. Configure system CESoP NxDS0 BERT with system direction and speed on PE1 and loopback as local on PE2.

Verify the BERT pattern and speed configured on both the PE1 and PE2. The BERT should be in sync.

Sample Scenario - 2

Figure 5: Configuring System CESoP NxDS0 BERT with System Direction and Speed on PE1 and Loopback as Network on CE2

1. The core should be UP between PEs and the cross connection should be UP between PE2 and CE2.

2. Configure SONET modes on PE1 and CE2.

3. Configure system CESoP NxDS0 BERT with system direction and speed on PE1.

4. Configure loopback as network on CE2.

Verify the BERT pattern and speed configured on both the PE1 and CE2. The BERT should be in sync.

Sample Scenario - 3

Figure 6: Configuring System CESoP NxDS0 BERT with System Direction on PE1 and Line BERT CE2

1. The core should be UP between PEs and the cross connection should be UP between PE2 and CE2.

2. Configure SONET modes on PE1 and CE2.

3. Configure system CESoP NxDS0 BERT with system direction and speed on PE1.

4. Configure line BERT on CE2.

Verify the BERT pattern and speed configured on both the PE1 and CE2. The BERT should be in sync.

Verifying System CESoP NxDS0 BERT

The following **show** commands enable you to verify the system CESoP NxDS0 BERT configuration:

- **show controllers t1 bay/slot/port**

- **show controller <controller-type> bay/slot/port | section BERT**

```
PE1#show controller sonet 0/10/1 | sec BERT
  BERT running on timeslots 1,
  BERT test result (running)
    Test Pattern : 2^15, Status : Sync, Sync Detected : 0
    Interval : 100 minute(s), Time Remain : 01:30:52
    Bit Errors (since BERT started): 35 Mbits,
    Bits Received (since BERT started): 2047290 Mbits
    Bit Errors (since last sync): 35 Mbits
    Bits Received (since last sync): 2047290 Kbits
    Direction   : Line
    Speed    : 64kbps


CE#show controller sonet 0/5/1 | sec BERT
  BERT running on timeslots 1,
  BERT test result (running)
    Test Pattern : 2^15, Status : Sync, Sync Detected : 0
    Interval : 100 minute(s), Time Remain : 01:30:52
    Bit Errors (since BERT started): 35 Mbits,
    Bits Received (since BERT started): 2047290 Mbits
    Bit Errors (since last sync): 35 Mbits
    Bits Received (since last sync): 2047290 Kbits
    Direction   : system
    Speed    : 64kbps
```

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