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 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.

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 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.

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.

Structure-Agnostic TDM over Packet

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

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

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

Configuring CEM

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

The following sections describe how to configure CEM.

Configuring CEM Restriction

- Not all combinations of payload size and dejitter buffer size are supported. If you apply an incompatible payload size or dejitter buffer size configuration, the chassis rejects it and reverts to the previous configuration.
- 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 is a single step configuration of CEM parameters such as payload size and dejitter buffer that you can perform at the global configuration mode and apply this CEM class on an individual CEM interfaces.

Thus the 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
```

Note Removing the global CEM class that is associated with CEM interface/CEM group will remove the configuration from all the associated CEM.

Configuring CEM Parameters

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

Calculating Payload Sizes for T1 and E1 Interfaces

Payload size for a CEM class denotes the number of bytes encapsulated into a single IP packet and you configure the payload size using 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

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

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 0/0/1
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 0/1/0
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 0/1/32
cem-group 0  timeslots 1-10
```

Configure cross-connect:

```
enable
configure terminal
interface cem 0/1/32
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 0/1/16
controller t1 0/1/16
 framing esf
 linecode b8zs
 cablelength short 110
  cem-group 0 timeslots 1-10
interface CEM0/1/16
 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 0/1/32
UP pri   ac CE0/1/32:0(CESoPSN Basic)    UP mpls 2.2.2.2:10       UP

Router#sh controllers  t1 0/1/32
T1 0/1/32 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
-------------  -------------------------- --------------- ---------- ----------
CE0/1/32       CESoPSN Basic 0            2.2.2.2         10         UP

PE1#sh mpls l2 vc 10 detail
Local interface: CE0/1/32 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 0/1/0
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 0/1/3
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 CEM0/1/0 0 CEM0/1/3 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: CEM0/1/0 SATOP T1 0 up
 Segment 2: CEM0/1/3 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

Commands	URL
payload-size dejitter-buffer	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-o1.html#wp3946673156
class cem	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2169323859
controller t1	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp1472647421
xconnect	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t2.html#wp8578094790
show controllers t3	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-s3.html#wp1987423547

Additional References for Configuring Pseudowire

Related Documents

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

Standards and RFCs

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

MIBs

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

Technical Assistance

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