

Configuring CESoPSN Pseudowires

SYSTEM ADMINISTRATOR GUIDE

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1 Overview

Circuit Emulation Service (CES) transparently carries time-division-multiplexing (TDM) circuits over a packet-switched network (PSN). At the source endpoint, TDM frames are converted to packets, which are then transported across the PSN core. At the destination endpoint, the packets are converted back to TDM frames.

Structure-aware TDM CES over PSN (CESoPSN, as defined in RFC5086) encapsulates structured (NxDS0) TDM signals as pseudowires over a PSN, preserving the standard TDM framing structure.

CESoPSN is supported on Channelized 8-port OC-3/STM-1 and Channelized 2-port OC-12/STM-4 line cards and as well as Cross-Connect Route Processor Version 4 (XCRP4) Controller cards on all chassis. Packet Processing ASIC first generation (PPA1) cards are not supported.

CESoPSN requires an all-ports license and a ces license. For information about all-ports and ces licenses, see *Configuring Channelized Ports, 8/10948-CRA 119 1170/1*.

This document applies to both the Ericsson SmartEdge® and SM family routers. However, the software that applies to the SM family of systems is a subset of the SmartEdge OS; some of the functionality described in this document may not apply to SM family routers.

For information specific to the SM family chassis, including line cards, refer to the SM family chassis documentation.

For specific information about the differences between the SmartEdge and SM family routers, refer to the Technical Product Description *SM Family of Systems* (part number 5/221 02-CRA 119 1170/1) in the **Product Overview** folder of this Customer Product Information library.

1.1 Components in the CESoPSN Model

A CESoPSN pseudowire consists of the following components.

T1 or E1 trunk

A T1 trunk has 24 time slots. An E1 trunk has 31 time slots.

Attachment Circuit (AC)

On CESoPSN, the AC is a digital signal level 0 (DS-0) channel group, that is, a set of DS-0s on a T1 or E1 trunk. Each DS-0 channel group has 64 kbps of bandwidth available at all times.



Interworking function (IWF)

In the ingress direction, a CESoPSN IWF packetizes the framed AC data onto a pseudowire.

In the egress direction, the IWF places out the payload from the pseudowire onto the AC.

Cross connect (XC)

The XC joins the AC to the PSN, either User Datagram Protocol (UDP/IP) or Multiprotocol Label Switching (MPLS).

Pseudowire (PW)

The PW carries the framed AC data between CESoPSN IWFs.

CESoPSN circuits are created and managed using CLI commands. Simple Network Management Protocol (SNMP) support is limited to get, getnext, and walk functions. SNMP set functions are not supported.

CESoPSN requires an "all-ports" license to be used. For more details about the "all-ports" license, see *Configuring Channelized Ports*, 8/10948-CRA 119 1170/1.

2 Creating a CESoPSN Circuit

To create a CESoPSN circuit, perform the following on each end of the circuit:

1. Configure the AC.
2. Configure the XC to form the PW.
3. (Optional) Configure the clock source.
4. Bind the AC to the XC.

2.1 Configuring the AC

Configuring the AC involves configuring the AC port for CES use and configuring the corresponding IWF.

When a DS-0 channel group is configured on a port, and the port has been configured for CES, the DS-0 channel group is automatically attached to the port's IWF. To configure an IWF, set the CESoPSN parameters in the DS-0 channel group.



An IWF can be bound to only one DS-0 channel group. The following syntax is used to specify which channel group the IWF is attached to:

- *slot/port: [ds3-channel:] ds1-channel:ds0-channel-group*

To configure an AC, perform the tasks described in Table 1.

Table 1 Configure the Attachment Circuit

| Task | Root Command | Notes |
|--|-------------------------|--|
| Configure the DS-0 channel group of the AC. | <i>port ds0s</i> | Enter this command in global configuration mode or in DS-3 or DS-1 configuration mode. |
| Configure the timeslots to be added to a CESoPSN interworking function (IWF). | <i>timeslot</i> | Enter this command in DS0 channel configuration mode. |
| Create a new L2VPN profile or select an existing L2VPN profile and enter L2VPN profile configuration mode. | <i>l2vpn local</i> | Enter this command in global configuration mode. |
| Enable CESoPSN configuration mode on an attachment circuit. | <i>cesopsn</i> | Enter this command in DS0 channel configuration mode. |
| Configure the end-to-end delay settings of a CESoPSN IWF. | <i>end-to-end-delay</i> | Enter this command in CESoPSN configuration mode. |
| Configure the idle-pattern settings of a CESoPSN IWF. | <i>idle_pattern</i> | Enter this command in CESoPSN configuration mode. |
| Enable control of the state of the T1/E1 trunk on a CESoPSN interworking function (IWF). | <i>trunk-control</i> | Enter this command in CESoPSN configuration mode. |
| Display CESoPSN channel attributes. | <i>show ces</i> | Enter this command in any mode. |
| Displays the medium access control (MAC) address and other lower-layer settings of a single port, all ports on a card, or all ports in the system. | <i>show port detail</i> | Enter this command in any mode. |

For guidelines on configuring the AC, see *AC Guidelines* and *IWFGuidelines*.

See *Configuration Examples* and *Monitoring and Diagnostic Examples* for CLI examples.

2.2 Configuring the XC to Form the Pseudowire

For information on configuring a pseudowire, see *Pseudowire Guidelines*.



To configure the XC, perform the tasks described in Table 2.

Table 2 *Configure the Cross Connect to Form the Pseudowire*

| Task | Root Command | Notes |
|---|--|--|
| Configure the global pseudowire settings for CESoPSN connections. | <i>pseudowire router-id</i> | Enter this command in global configuration mode. |
| Create a new Layer 2 Virtual Private Network (L2VPN) profile or select an existing L2VPN profile and enter L2VPN profile configuration mode. | <i>l2vpn profile</i> | Enter this command in global configuration mode. |
| Configure the remote endpoint of the PW. The remote ip address can be an IPv4 address. | <i>peer ip-address</i> | Enter this command in L2VPN profile peer configuration mode. |
| Specify the EXP bits configuration in an L2VPN profile. | <i>exp-bits</i> | Enter this command in L2VPN profile peer configuration mode. |
| Specify a particular Resource Reservation Protocol (RSVP) or Label Distribution Protocol (LDP) tunnel for carrying traffic exiting an L2VPN cross-connect (XC). | RSVP: <i>tunnel lsp</i> LDP: <i>tunnel ldp-path</i> | Enter this command in L2VPN profile peer configuration mode. |
| Configure the diffserver code for the CES PW. | <i>dscp</i> | Enter this command in L2VPN profile peer configuration mode. |
| Display the PW global configuration. | <i>show pseudowire</i> | Enter this command in any mode. |

See *Configuration Examples* and *Monitoring and Diagnostic Examples* for CLI examples.

2.3 Configuring the Clock Source

CESoPSN supports the following methods for clock recovery on DS1 or E1 channels and sub-channels:

- Adaptive
- Synchronous
- Loop-timed

For more information about these methods, see *Clock Source Guidelines*.

To configure the clock source on a channel or sub-channel, perform the tasks described in Table 3.



Table 3 Configure the Clock Source

| Task | Root Command | Notes |
|---|---|--|
| Enter configuration mode for a DS1 channel in a channelized OC-3 or OC-12 port or in a channelized DS3 channel. | <code>port {ds1 / channelized-ds1}</code> | Enter this command in global configuration mode or in OC-3, OC-12, or DS-3 configuration mode. |
| Enter configuration mode for a DS3 channel in a channelized STM-1, STM-4, OC-3, or OC-12 port. | <code>port {ds3 / channelized-ds3}</code> | Enter this command in global configuration mode or in OC-3, OC-12, STM-1, or STM-4 configuration mode. |
| Enter configuration mode for an E1 channel in a channelized STM-1 or STM-4 port, or in a channelized DS3 channel. | <code>port {e1 / channelized-e1}</code> | Enter this command in global configuration mode or in STM-1, STM-4, or DS-3 configuration mode. |
| Configure the clock source settings of a CESoPSN circuit. | <code>clock-source ces-domain</code> | Enter this Show command to display CES timing domain. in global configuration mode. |
| Display the CES timing domain. | <code>show ces domain</code> | Enter this command in any mode. |

For more information about these methods, see *Clock Source Guidelines*.

See *Configuration Examples* and *Monitoring and Diagnostic Examples* for CLI examples.

2.4 Binding the AC to the XC

An AC can be bound to only one PW, using the `xc` command.

For information on binding the pseudowire to the IWF, see *Pseudowire Guidelines* and *IWFGuidelines*.

To bind the AC to the XC, perform the tasks described in Table 4.

Table 4 Bind the Attachment Channel to the Cross Connect

| Task | Root Command | Notes |
|---|----------------------------|---|
| Enter local context configuration mode. | <code>context local</code> | Enter this command in global configuration mode. |
| Enter L2VPN configuration mode. | <code>l2vpn</code> | Enter this command in context configuration mode. |
| Create a Layer 2 Virtual Private Network (L2VPN) cross-connection group and enters L2VPN XC group configuration mode. | <code>xc-group</code> | Enter this command in L2VPN configuration mode. |

**Table 4** *Bind the Attachment Channel to the Cross Connect*

| Task | Root Command | Notes |
|---|-----------------------------------|--|
| Configure the pseudowire cross connect for the CESoPSN circuit. | <code>xc ds0s</code> | Enter this command in L2VPN XC group configuration mode. Use the <code>udp</code> keyword to create a CES Over UDP pseudowire. Use the <code>vpn-label</code> keyword to create a CES Over MPLS pseudowire. |
| Display L2VPN cross-connect information. | <code>show xc l2vpn static</code> | Enter this command in any mode. |

See *Configuration Examples* and *Monitoring and Diagnostic Examples* for CLI examples.

3 Monitoring CESoPSN Circuits

On an existing CESoPSN circuit, you can:

- Configure excess packet loss thresholds
- Enable outage and excess packet loss traps for managing service level agreements (SLAs)
- Monitor port and circuit counters

3.1 Monitoring Excess Packet Loss Information

For information on configuring the excess packet loss rate, see *Excess Packet Loss Measurement*.

To display and monitor excess packet loss information, perform the tasks described in Table 5.

Table 5 *Monitoring Excess Packet Loss Information*

| Task | Root Command | Notes |
|---|--|--|
| Configure the excessive packet loss settings of CESoPSN circuits. | <code>ces excessive-packet-loss</code> | Enter this command in global configuration mode. |



Table 5 Monitoring Excess Packet Loss Information

| Task | Root Command | Notes |
|--|--|--|
| Clear all excessive packet loss counters or only the counters of a specific CESoPSN circuit. | <code>clear ces excessive -packet-loss</code> | Enter this command in global configuration mode. |
| Display CES excessive packet loss rate on CESoPSN circuits. | <code>show ces excessiv e-packet-loss-rate [detail]</code> | Enter this command in any mode. |

See *Configuration Examples* and *Monitoring and Diagnostic Examples* for CLI examples.

3.2 Trapping Outage Information

Trapping SLA information can be enabled on a per-PW basis for the life of the PW channel.

For information on configuring SNMP traps and alarms for CES outage or excessive packet loss rate, see *Outage Monitoring*.

To trap outage information, perform the tasks described in Table 6.

Table 6 Trapping Outage Information

| Task | Root Command | Notes |
|---|---|--|
| Enables and disables the CES outage or excessive-packet-loss-rate trap. | <code>trap cesmib outage / excessive-packet-l oss-rate</code> | Enter this command in SNMP server configuration mode. |
| Clears all outage counters or only the counters of a specific CESoPSN. circuit. | <code>clear ces outage</code> | Enter this command in SNMP server configuration mode. |
| Display CESoPSN channel attributes. | <code>show ces</code> | Enter this command in any mode. Use the normal keyword to display attributes for normal circuits. Use the outage keyword to display attributes for circuits with outages. |

See *Configuration Examples* and *Monitoring and Diagnostic Examples* for CLI examples.

3.3 Monitoring Statistics

CESoPSN statistics are monitored using port counters and circuit counters.



To monitor statistics, perform the tasks described in Table 7.

Table 7 Monitoring Statistics

| Task | Root Command | Notes |
|--|-------------------------------|---------------------------------|
| Display output for CES port counters on CESoPSN circuits. | <i>show port counters</i> | Enter this command in any mode. |
| Clears the CES port counters on all or selected CESoPSN circuits. | <i>clear port counters</i> | Enter this command in any mode. |
| Display CES circuit counters for all or specified CESoPSN circuits. | <i>show circuit counters</i> | Enter this command in any mode. |
| Clears the CES circuit counters on all or selected CESoPSN circuits. | <i>clear circuit counters</i> | Enter this command in any mode. |

See *Monitoring and Diagnostic Examples* for CLI examples.

4 CESoPSN Configuration Guidelines

4.1 AC Guidelines

The access port is an OC3/OC12/STM1/STM4, supporting channelized SONET/SDH interfaces

The Channelized 8-port OC-3/STM-1 or Channelized 2-port OC-12/STM-4 line card operates in two service modes on a given port: Packet over SONET/SDH (POS) mode or CES mode. The line card can never operate in mixed mode on a given port.

If a port is configured for CES mode, the system rejects attempts to change the mode to POS. To change the mode of a port, enter the **no port** command before switching modes, even if no channels are configured on it.

Full or fractional channels E1/T1 channels are supported. A fractional E1/T1 channel is always on a DS-0 channel group.

The CES DS-0 channel group is represented with the syntax *slot/port: [ds3-channel:] ds1-channel:ds0-channel-group*. To specify a range of timeslots for a DS-0 channel group, use the **through** keyword.



SAToP and CESoPSN can be configured on the same port without impacting scale or Automatic Protection Switching (APS) support (see *Clock Source Guidelines* for timing-domain constraints).

A DS-0 channel group can have a single time slot, so up to 31 DS-0 channel groups could be configured for an E1 channel, and each DS-0 channel group could be cross-connected. Up to 31 PWs can be configured per E1 channel, and up to 24 PWs per T1 channel, subject to the scalability limits. The system supports a maximum of 8,000 static CES PWs. A line card supports up to 2,000 member links (1,000 member links per port group).

4.2 IWF Guidelines

4.2.1 IWF Egress States

The CESoPSN IWF can be in one of two possible states: normal or packet loss. The IWF begins in normal state when it is created. You can view the state of the IWF using the `show ces` command.

The IWF begins in normal state when it is created.

4.2.1.1 Normal State

The normal state indicates that all the following are occurring:

- Packets are being received.
- The received control words are being processed.
- Adaptive clock recovery (if configured) is taking place.
- The DS-0 channel group payload is being played out according to the PW packet payload.

The IWF enters the normal state when it exits the packet loss state.

The IWF transitions to the packet loss state when the entry criteria for that state are met. Outage criteria are set using the `end-to-end-delay` command.

While in the normal state:

- The IWF sets the value of **R** to 0 in its transmitted PW control word.
- The IWF sets the value of **L** in its transmitted PW control word according to the T1 or E1 trunk state in the received direction.
- Incoming packets are added to the jitter buffer, processed and counted.



4.2.1.2 Packet Loss State

The packet loss state indicates that packet loss has occurred in the PSN or the jitter buffer has an underrun. This state is entered if either of the following is true:

- The number of consecutive missing packets is greater than or equal to the *enter* value configured with the **end-to-end-delay** command.
- The jitter buffer has underrun.

The IWF transitions to the normal state when both of the following have occurred:

- If a jitter buffer underrun occurred, the jitter buffer has filled to half of its depth.
- The number of consecutive packets received is greater than or equal to the *exit* value configured with the **end-to-end-delay** command.

While in the packet loss state:

- The IWF sets the value of **R** to 1 in its transmitted PW control word.
- The IWF sets the value of **L** in its transmitted control word according to the T1 or E1 trunk state in the received direction.
- The configured idle pattern is played out on every DS-0 of the IWF's DS-0 channel group.
- Incoming packets are added to the jitter buffer, but are not processed or counted.

Note: Underrun can occur due to lost packets on the PW or if the DS-0 channel group's TDM trunk has a transmit clock frequency that is too high relative to the sustained packet arrival rate on the PW.

4.2.2 IWF Egress Behavior

The IWF can optionally control the AC data and the E1 or T1 trunk state, according to the control word it receives. At most, one IWF can control the state—alarm indication signal (AIS) or remote defect indication (RDI)—on the outgoing trunk.

Egress control (if configured) is based on the **L-R-M** control word bits in the packet received from its peer IWF.

Table 8 illustrates the IWF behavior on egress, based on the E1 or T1 trunk state or the IWF state.



Table 8 Egress (PSN to TDM) IWF Behavior

| Control Event (Received CW Bits) | | | Egress T1 or E1 Trunk Control (If Configured) | Counter | Effect on Egress AC Data |
|-------------------------------------|---|------------|--|------------------------|--|
| L | R | M | | | |
| 0 | 0 | 00 | | | Data played out as received. |
| 0 | 1 | 00 | RDI | Remote packet loss | Packet is played as received on the TDM channel. |
| 0 | 0 | 01 | | Malformed packets | Packet is discarded and replaced with the user-configurable idle pattern. |
| 0 | 1 | 01 | | Malformed packets | Packet is discarded and replaced with the user-configurable idle pattern. |
| 0 | 0 | 10 | RDI | | TDM payload is played as received, except SF-framed T1s when RDI is evoked. |
| 0 | 1 | 10 | RDI | Remote end packet loss | TDM payload is played out as received, except SF-framed T1s when RDI is evoked. |
| 0 | 0 | 11 | | Malformed packet | Packet is discarded and replaced with the user-configurable idle pattern. |
| 0 | 1 | 11 | | Malformed packet | Packet is discarded and replaced with the user-configurable idle pattern. |
| 1 | 0 | 00 | AIS | Far end AC down | Packet is discarded and replaced with the user-configurable idle pattern unless AIS is evoked, in which case, an unframed "all 1s" is transmitted on the AC. |
| 1 | 1 | 00 | AIS | Far end AC down | Packet is discarded and replaced with the user-configurable idle pattern unless AIS is evoked, in which case, an unframed "all 1s" is transmitted on the AC. |
| 1 | X | 01 /10 /11 | | Malformed packet | Packet is discarded and replaced with the user-configured idle pattern. |

4.2.3 IWF Ingress Behavior

Table 9 illustrates the IWF behavior on ingress, based on the E1/T1 trunk state or IWF state.



Table 9 Ingress (TDM to PSN) CES IWF Behavior

| Control Event (T1 or E1 Trunk State / IWF State) | Transmitted CW | | | Effect on TDM Data in PW Payload |
|---|-------------------|---|----|--|
| | L | R | M | |
| OK | 0 | 0 | 00 | None. This is the normal error-free case. |
| T1 or E1 Trunk LOS T1 or E1 Trunk LOF T1 or E1 Trunk AIS | 1 | 0 | 00 | TDM data present in the packet is considered invalid. <i>Note:</i> Because of the software latency on setting the L bit in the CW for the affected PWs, if a large number of PWs needs to be updated, some packets sent in the PSN might have an invalid payload and the L bit cleared. |
| T1 or E1 Trunk RDI | 0 | 0 | 10 | None |
| IWF Loss of Packet State or Underrun | 0 | 1 | 00 | None |

4.2.4 Idle Pattern

The CES IWF propagates the idle pattern for the following jitter buffer conditions:

- The current packet in the IWF's jitter buffer has not been received (lost packet).
- The current packet in the IWF's jitter buffer was dropped because it was malformed (malformed packet).
- The jitter buffer has underrun, and the jitter buffer has not yet been filled to half its size when a frame is to be played out.

4.3 Clock Source Guidelines

4.3.1 Adaptive Clock Recovery

CES timing domains are created automatically for the Channelized 8-port OC-3/STM-1 or Channelized 2-port OC-12/STM-4 line card and are not configurable.

CESoPSN supports 16 timing domains per card (8 timing domains per port group) for CES adaptive clock recovery. All trunks in a timing domain are in the same 4-port group on the card.



You assign a DS-1 or E1 trunk to a timing domain for that trunk's port group.

Timing domains for SAToP and CESoPSN are independent of each other. If an existing timing domain for CESoPSN is changed to SAToP (or vice versa), the change is rejected.

Software on the Channelized 8-port OC-3/STM-1 or Channelized 2-port OC-12/STM-4 line card automatically selects a master IWF for each timing domain on the associated DS-0 group within the DS-1 or E1 trunk. The master IWF provides the timing domain with its reference clock based on packet arrival times.

If the source IWF experiences an error (loss-of-packet, underrun, or overrun state), the timing domain enters the holdover state. If the master IWF goes into loss-of-packet state or is deleted, the software on the card changes to a new master IWF (one that is not in loss-of-packet, underrun, or overrun state) within the same timing clock recovery domain group. If the master IWF is in underrun state, no change occurs.

If all IWFs within a domain are in loss-of-packet state, the master is not changed, and it remains in holdover state.

When in holdover state, the configured card reference clock is used. This results in 20ppm accuracy if the card reference clock is derived from the card's local clock.

A CES timing domain that is not in holdover is active.

4.3.2 Synchronous Clock Recovery

The clock source is the local clock source on the Channelized 8-port OC-3/STM-1 or Channelized 2-port OC-12/STM-4 line card or is global, referenced from the XCRP card.

4.3.3 Loop-Timed Clock Recovery

The transmit clock source for the DS-1 or E1 trunk is derived from that trunk's recovered receive clock.

4.4 Pseudowire Guidelines

4.4.1 Pseudowire Payload

The order of the payload octets corresponds to their order on the TDM trunk.

Consecutive bits coming from the TDM trunk fill each payload octet, starting from the most significant bit to the least significant bit.



All CESoPSN packets *must* carry the same amount of valid TDM data in both directions on the PW. The time that is required to fill a CESoPSN packet with the TDM data must be constant.

The egress (CE-bound) CESoPSN IWF reorders misordered packets. Misordered packets that cannot be reordered are discarded and treated as lost.

Loss-of-packet state is declared immediately on underrun. Use of a timer to declare the loss-of-packet state after an underrun is not supported.

After the PW is set up, TDM data is packetized using the configured number of payload bytes per packet.

The egress CESoPSN IWF includes a jitter buffer in which the payload of the received CESoPSN packets is stored prior to play-out to the local TDM AC.

4.4.1.1 CES Control Word

The CES control word format, as described in RFC 5086, is supported.

| | |
|--------------|---|
| L bit | <ul style="list-style-type: none">• The L bit flag in a normal packet set to zero.• L (local failure): If the L bit flag is set, it indicates some abnormal condition on the far-end T1 or E1 trunk. The behavior of the L bit is as described in Table 8 and Table 9.• On egress, if the payload is omitted (such as under an error condition to save bandwidth), the length is 4 (equal to the control word). In such a case, the system plays the packet as received over the TDM channel. |
| M bit | The behavior of the M bit flag is as described in Table 8 and Table 9. |
| R bit | The behavior of the R bit flag is as described in Table 8 and Table 9. |
| FRG | <p>The FRG bits are not supported.</p> <ul style="list-style-type: none">• On the PW ingress, the FRG bits are always set to 00b.• On the PW egress, if the FRG bits are greater than 00b, the system ignores the FRG bits and processes the packet. A remote configuration that generates FRG bits greater than 00b is considered as invalid. |



| | |
|------------|--|
| LEN | The LEN field is set to zero if the packet length (SAToP header + the payload size) is greater than or equal to 64 bytes; otherwise, it is set to the packet length. |
| SN | <p>The control word sequence number (SN) provides the common PW sequencing function, as well as detection of lost packets.</p> <ul style="list-style-type: none"> • Its space is a 16-bit unsigned circular space. • Its initial value is random (unpredictable). • It is incremented with each SAToP data packet sent over a given PW. |

4.4.2 Pseudowire Initialization and Shutdown

Before a PW has been set up and after a PW has been torn down, the IWF must play out the “all 1s” pattern to its TDM AC.

After the PW has been set up, the egress IWF begins to receive CESoPSN packets and to store their payload in the jitter buffer but continues to play out the “all 1s” pattern to its TDM AC. This intermediate state persists until a preconfigured amount of TDM data (usually half of the jitter buffer) has been received in consecutive CESoPSN packets. This amount is set with the `end-to-end-delay` command.

When the preconfigured amount of TDM data has been received, the PW enters its normal operation state in which it receives CESoPSN packets and stores their payload in the jitter buffer while playing out the contents of the jitter buffer in accordance with the required clock.

There is no intermediate timer involved. When the jitter buffer is half full, in the egress direction, the IWF starts transmitting data. The intermediate state depends *only* on the jitter buffer size and packetization latency.

CESoPSN PW monitoring is performed after the egress IWF has exited its intermediate state.

4.4.3 Pseudowire State

The PW is operationally UP when both of the following conditions are met:

- The destination peer is reachable.
- The PW state meets any of the UP conditions in Table 10.

Otherwise, the PW state is DOWN.

*Table 10 CES AC and Pseudowire States*

| Local Physical Port Events | AC Admin Status | Port Link Status | AC Operational Status | CES PW State |
|--------------------------------------|-----------------|------------------|-----------------------|--------------|
| LOS | UP | DOWN | UP | UP |
| AIS | UP | DOWN | UP | UP |
| RDE (At Sonet or DS-3 or DS-1 level) | UP | UP | UP | UP |
| Loopback | UP | UP | UP | UP |
| Administrative Shutdown | DOWN | DOWN | DOWN | DOWN |

Port link status is the final stable port state at the end of the link-dampening process.

AC operational status represents the final state on AC operational status.

4.4.4 CES Over MPLS Pseudowire

- To provision CES over an MPLS pseudowire, use Layer 2 Virtual Private Network (L2VPN) MPLS static labels.
- Exp Bits support is per MPLS pseudowire.
- MPLS pseudowire using LDP signaling is not supported.
- Virtual circuit connectivity verification (VCCV) ping is not supported.
- If all the following conditions are met, the PW state is operationally UP; otherwise, the PW state is DOWN.
 - The destination peer is reachable through LSP.
 - The PW state UP conditions are as listed in Table 10.

4.4.5 CES over UDP Pseudowire

4.4.5.1 Endpoints

In a CES over UDP pseudowire connection, the PW destination endpoints are determined by the destination UDP and destination IP address. The source endpoints are determined by the source IP address, which is the loopback IP address in the local context.



4.4.5.2 UDP Ports

The port range for a UDP pseudowire is 1024–65535 for the source UDP port, and 1–65535 for the destination UDP port.

UDP ports 1–1024 are reserved ports on the system. The PW source UDP port should not overlap the system's reserved ports.

The UDP port of the source endpoint is the destination port at the peer, and vice versa.

4.4.5.3 Other UDP Considerations

Pseudowire UDP header checksum verification and generation are not supported. The UDP header checksum is always zero.

Differentiated Services Code Point (DSCP) marking is per PW. IP traffic marking is toward the ingress. If there is IP Security (IPSec) traffic, the PW DSCP present at the inner IP header is copied to the outer IP header.

A Layer 2 transport of the PW endpoints is either Ethernet or multilink Point-to-Point Protocol (MLPPP). MLPPP fragmentation is independent of CES PW traffic.

A Layer 3 PSN to the PW endpoint is either IP or IPSec.

- IPv4 datagrams are marked as “Don’t Fragment”.
- The cross-connect of the UDP PW is on the local context, and the destination peer address is routed through the local context.
- Intercontext routing of the destination peer address for unmapped UDP PW is supported.

IPSec services are provided by the Advanced Services Engine (ASE) card using tunnel mode.

- PW over manual (static) IPSec tunnel is supported.
- The PW IP address is the inner IP address of the IPSec tunnel.
- The outer IP address is the tunnel IP address.
- The source IP address configured for CES UDP PW is the loopback IP address on the local context.

The PW state is operationally UP if all the following conditions are met; otherwise, the PW state is DOWN.

- The destination peer is reachable through IP or IPSec, depending on the user configuration.
- The source IP address is a loopback IP address in the local context.



- The PW state UP conditions are as listed in Table 10.

4.4.6 Pseudowire and Equal-Cost Multipath

The CES PW endpoint is reachable through the equal-cost multipath (ECMP) next hops. The SE implements different hashing techniques for MPLS and UDP PWs. Selection of the next hop is based on the configured hashing scheme: either two tuple or five tuple

The hashing scheme makes sure that the flows are uniquely distributed for different PWs.

UDP PW hashing is based on the source IP address, destination IP address, UDP source port, and UDP destination port.

4.4.7 CES with APS

An APS configuration for CES is always provided on an APS working port. The system rejects any CES configuration on the APS port.

The ingress and egress CES functions are supported on APS-enabled ports.

After APS switchover recovery, the CES function has additional predictable packet loss, because the new switched-over CES IWF must meet the loss of packet state exit criteria.

4.5 Monitoring Guidelines

4.5.1 Excess Packet Loss Monitoring

Packet loss rate can be measured on a per PW basis.

Packet loss rate (PLR) is defined as the ratio of lost packets / transmitted packets, where lost packets = dummy packet count – error packet count, and transmitted packets = valid packet count – lost packets.

The average packet loss rate (APLR) is the PLR over a given amount of time (T), equal to 2.5 seconds.

A fault declaration time (FDT) is when an excessive packet loss fault is declared if a specified number of defect samples (N) in successive periods of duration $N \times T$ experience an excessive packet loss defect and exceed the user-configured threshold (L), that is, $FDT = PLR > L$.

The current snapshot entry is maintained per CES channel. The time information presented is in seconds. The snapshot entry contains the following elements:

**Entry**

- The time stamped on entering into excessive packet loss state.
- Total packet loss on entry is the sum of the packet loss measured at the entry point since the up time of the channel. For example, if deltaX1 and deltaX2 are the last packet loss on the entry of the current excessive packet loss, total packet loss = deltaX1 + deltaX2.

Exit

- Packet loss on exit is the loss at duration X on the channel. If the channel is already in progress of excessive packet loss, packet loss = user query timestamp – entry timestamp.
- Total packet loss on exit is the sum of the packet loss measured since the up time of the channel: total packet loss = total packet loss on entry + packet loss. If you reset the excessive packet loss statistics, total packet loss is calculated from the time the DS-1 channel stats were reset.

Total times in packet loss

Number of times the channel entered into the excessive packet loss condition.

Total circuit time

Total time elapsed since the CES channel is up, plus total packet loss time on exit. If you reset the excessive packet loss statistics, total circuit time is calculated from the time the DS-0 channel group stats were reset.

Total failure rate

Total time the PW is in excessive packet loss / total circuit time. If you reset the excessive packet loss statistics, then total failure rate is calculated from the time the DS-0 channel group stats were reset.

DS-0 channel group ID**DS-0 channel group timeslots****4.5.2****Outage Monitoring**

SLA current snapshot entries are per DS-0 channel group as listed in Page 20.



Table 11 SLA Current Snapshot Entries

| SLA Parameter | Description |
|-------------------------------|--|
| Latest Outage Time | Delta time where the IWF enters the packet-loss / underrun state and the exit time (latest outage exit timestamp – latest outage entry timestamp). |
| Latest Outage Exit Timestamp | <p>Latest exit from the defective state timestamp in the format, Month/Day/Year, Hour:Min:Sec.</p> <p>If you query the snapshot entry and the IWF is in packet-loss / underrun state, latest outage exit timestamp is the query time.</p> <p>If you query the snapshot entry and the IWF is in normal state, the latest outage exit timestamp is the time when the IWF exited from the packet loss / underrun state to normal state.</p> |
| Latest Outage Entry Timestamp | The latest entry to the defective state timestamp in the format, Month/Day/Year, Hour:Min:Sec. |
| Last Outage Time | Delta time of the outage prior to the latest outage time. |
| Last UP Time | Delta time when the channel was UP prior to the latest outage time (the time elapsed between the entry of the latest outage time and the exit of the last outage time). |
| Cumulative Outage Time | Sum of the outage since the CES channel was created. |
| UP Time | Total UP time since the CES channel was created, minus the cumulative outage time. |
| Number of Outages | Counts the number of outage times. |

An outage SNMP trap is supported per card.

- The SNMP trap is raised when at least one SAToP PW is in the outage state (packet loss / underrun state).
- The SNMP trap is cleared whenever all the SAToP PWs are in normal state.

Time information in snapshot entries is in seconds.

5 Configuration Examples

5.1 IWF Binding

The following example configures the IWF on a CESoPSN circuit:



```
[local]Redback(config)#port ds0s 1/1:1:1:1
[local]Redback(config-ds0-ces)#timeslot 16
[local]Redback(config-ds0-ces)#l2vpn local
[local]Redback(config-ds0-ces)#cesopsn
[local]Redback(config-ds0-cesopsn)#end-to-end-delay latency 4 jitter 160 outage-criteria 1 10
[local]Redback(config-ds0-cesopsn)#idle-pattern 0x3f
[local]Redback(config-ds0-cesopsn)#trunk control
```

5.2 Pseudowire

The following example configures the global settings for a CESoPSN PW:

```
[local]Redback(config)#pseudowire router-id ipaddress xxx.xxx.xxx.xxx context local
```

The following example configures the profile settings of a CESoPSN PW:

```
[local]Redback(config)#l2vpn profile name1
[local]Redback(config-l2vpn-xc-profile)#peer xxx.xxx.xxx.xxx
[local]Redback(config-l2vpn-xc-profile)#exp-bits 3
[local]Redback(config-l2vpn-xc-profile)#tunnel lsp name2
[local]Redback(config-l2vpn-xc-profile)#dscp af13
```

5.3 Clock Source

The following example configures the clock source on a CESoPSN circuit:

```
[local]Redback(config)#port 2/1:1:3
[local]Redback(config-ces-chan-dsl)#clock-source ces-domain 1.3
```

5.4 Cross-connect

The following example configures various types of CESoPSN cross-connects:

```
[local]Redback(config)#context local
[local]Redback(config-ctx)#l2vpn
[local]Redback(config-l2vpn)#xc-group name
[local]Redback(config-l2vpn-xc-group)#xc ds0s 3/4:1:1:1 ces udp 3:4 profile name1
[local]Redback(config-l2vpn-xc-group)#xc ds0s 3/4:1:1:3 through 8 ces udp 5:6 profile name
[local]Redback(config-l2vpn-xc-group)#xc ds0s 3/4:3:1:1 ces vpn-label 556 profile name1
[local]Redback(config-l2vpn-xc-group)#xc ds0s 3/4:3:2:1 through 8 ces vpn-label 556 profile name1
```

5.5 Excessive Packet Loss Settings

The following example configures settings for excessive packet loss:

```
[local]Redback(config)#ces excessive-packet-loss threshold 45 set 5 clear 20
```

The following example clears the excessive packet loss counters on a specific circuit:

```
[local]Redback(config)#clear ces excessive-packet-loss 3/2:3:1:1
```



5.6 Outage Settings

The following example enables the outage trap and disables the excessive-packet-loss-rate trap:

```
[local]Redback(config-snmp-server)#trap cesmib outage
[local]Redback(config-snmp-server)#no trap cesmib excessive-packet-loss-rate
```

The following example shows how to clear excessive packet loss counters on a specific circuit.:

```
[local]Redback(config)#clear ces outage 3/2:3:1:1
```

6 Monitoring and Diagnostic Examples

6.1 CES Operation

```
[local]Redback#show ces 3/2:1:1:1
```

| Circuit | Time Slots | CES Type | IWF State | L2vpn |
|-----------|------------|----------|-----------|---------|
| 3/2:1:1:1 | 1-10 | CESoPSN | Normal | enabled |

```
[local]Redback#show ces all
```

| Circuit | Time Slots | CES Type | IWF State | L2vpn |
|------------|------------|----------|--------------------------|----------|
| 3/2:1:1:1 | 1-10 | CESoPSN | Normal | disabled |
| 3/2:1:1:11 | 11 | CESoPSN | Loss of Packet/under-run | enabled |
| 3/2:1:1:12 | 12-15 | CESoPSN | Normal | enabled |

6.2 Clock Source

The following example displays information about timing domain 1.3 on slot 2. There are 5 member trunks (three from port 1 and two from port 3). The current master IWF is associated with DS-0 group 4 on DS-1 2/3:1:14, indicating that the timing domain state is active.



```
[local]Redback#show ces domain 2/1.3
```

```
Slot 2 Timing Domain: 1.3
Current Master      : 2/3:1:14:4
```

Members:

Port/Channel Type

```
-----
2/1:1      ds1
2/1:2      ds1
2/1:121    ds1
2/3:1:14   ds1
2/3:1:21   ds1
```

6.3 Pseudowire

The following example displays the PW global configuration on a CESoPSN circuit:

```
[local]Redback#show pseudowire
multi-path disabled
PW MTU matching enabled
PW Router id enabled
=====
Router id           : 4.4.4.4
Router id Context   : 0x40080001
Router id if Grid    : 0x10000004
Router id Nexthop Grid : 0x31d00003
Router id State      : UP
```

6.4 Excessive Packet Loss Information

```
[local]Redback#show ces excessive-packet-loss-rate
```

```
Circuit      Time Slots CES Type Total Loss Time (dd:hh:mm:ss)
=====
3/2:1:1:1    1-10      cesopsn           00:00:20:00
3/2:1:1:11   11-12     cesopsn           00:00:20:00
```

Total Channels in Packet Loss : 2



```
[local]Redback#show ces excessive-packet-loss-rate detail
```

```
Threshold (%)           : 40
Clearing time           : 10 seconds
Declaration Time        : 2.5 seconds
```

```
-----
```

```
Circuit                 : 3/2:1:1:1
Time Slot               : 1-10
CES Type                : CESoPSN
```

Current Excessive packet loss snapshot

Entry

```
Time Stamp              : Tue Apr 20 00:00:01 2010 GMT
Total Packet Loss Time  : 0 days 0 hours 1 minutes 0 seconds
```

Exit

```
Packet Loss Time        : 0 days 0 hours 0 minutes 10 seconds
Total Packet Loss Time  : 0 days 0 hours 1 minutes 10 seconds
Total Failure Rate (%)   : 10
Total Circuit Time:      : 00 days 00 hours 10 minutes 10 seconds
```

Total number of times the channel in packet loss: 2

```
-----
```

```
Circuit                 : 3/2:1:1:11
Time Slot               : 11-12
CES Type                : CESoPSN
```

Current Excessive packet loss snapshot

Entry

```
Time Stamp              : Tue Apr 20 01:00:00 2010 GMT
Total Packet Loss Time  : 0 days 0 hours 2 minutes 0 seconds
```

Exit

```
Packet Loss Time        : 0 days 0 hours 0 minutes 20 seconds
Total Packet Loss Time  : 0 days 0 hours 2 minutes 20 second
Total Failure Rate (%)   : 20
Total Circuit Time:      : 00 days 00 hours 10 minutes 20 seconds
Total number of times the channel in packet loss: 3
```

Total Channels in Packet Loss : 2

6.5 Outage Information

```
[local]Redback#show ces outage
```

| Circuit | CES Type | Cumulative Outage Time (dd:hh:mm:ss) |
|------------|----------|--------------------------------------|
| 3/2:1:1:11 | CESoPSN | 00:00:12:01 |
| 3/3:1:2:1 | CESoPSN | 00:00:20:01 |



```
[local]Redback#show ces outage 3/2:1:1:11
```

```
Circuit: 3/2:1:1:11 Service Type: CESoPSN
```

```
-----
Latest Outage Time      - 0 days 0 hours 5 minutes 0 second
                        (Tue Apr 20 18:25:01 2010 GMT) - (Tue Apr 20 18:20:01 2010 GMT)
Last Outage Time        - 0 days 0 hours 4 minutes 1 second
Last UP Time            - 0 days 0 hours 5 minutes 1 second
Cumulative Outage Time  - 0 days 0 hours 12 minutes 1 second
UP Time                 - 0 days 1 hours 4 minutes 1 second
Number of Outage (s)    - 3
```

```
[Local]Redback# show ces outage
```

```
Circuit: 3/2:1:1:11 Service Type: CESoPSN
```

```
-----
Latest Outage Time      - 0 days 0 hours 5 minutes 0 second
                        (Tue Apr 20 01:25:01 2010 GMT) - (Tue Apr 20 01:20:01 2010 GMT)
Last Outage Time        - 0 days 0 hours 4 minutes 0 second
Last UP Time            - 0 days 0 hours 5 minutes 0 second
Cumulative Outage Time  - 0 days 0 hours 12 minutes 0 second
UP Time                 - 0 days 1 hours 0 minutes 0 second
Number of Outage (s)    - 3
```

```
Circuit: 3/3:1:2:1 Service Type: CESoPSN
```

```
-----
Latest Outage Time      - 0 days 0 hours 5 minutes 0 second
                        (Tue Apr 20 02:25:01 2010 GMT) - (Tue Apr 20 02:10:01 2010 GMT)
Last Outage Time        - 0 days 0 hours 5 minutes 1 second
Last UP Time            - 0 days 0 hours 6 minutes 1 second
Cumulative Outage Time  - 0 days 0 hours 20 minutes 1 second
UP Time                 - 1 days 2 hours 4 minutes 1 second
Number of Outage (s)    - 2
```

6.6 Statistics

```
[local]Redback#show port counters 6/1:1:1:1
```

| Port | Type | | |
|------------------------------------|--------|---------------|---------|
| 6/1:1:1:1 | ds0s | | |
| packets sent | : 1061 | bytes sent | : 27586 |
| packets recvd | : 1061 | bytes recvd | : 23342 |
| send packet rate | : 0.10 | send bit rate | : 20.80 |
| recv packet rate | : 0.10 | recv bit rate | : 17.60 |
| rate refresh interval : 60 seconds | | | |



```
[local]Redback#show port counters 6/1:1:1:1 detail

Counters for port ds0s 6/1:1:1:1 - Interval: 1d 00:49:27

PPA Port Counters
packets sent      : 1061          bytes sent      : 27586
packets recvd    : 1061          bytes recvd     : 23342
send packet rate  : 0.10          send bit rate   : 20.80
recv packet rate  : 0.10          recv bit rate   : 17.60
IP mcast pkts rcv : 0             IP mcast bytes rcv : 0
IP mcast pkts sent : 0            IP mcast bytes snt : 0
rate refresh interval : 60 seconds

PPA Input Counters
idc other errors  : 0             crc port errors  : 0
idc overrun errors : 0           idc abort errors : 0
no cct packets    : 0             no cct bytes     : 0
cct down pkts     : 0             cct down bytes   : 0
unknown encap pkts : 0           unknown encap byte : 0
unreach pkts      : 0             unreach bytes    : 0
media filter pkts : 0             media filter bytes : 0

PPA Output Counters
WRED drop pkts    : 0             tail drop pkts   : 0
adj drop pkts     : 0             adj drop bytes    : 0

Packet Drop Counters
not IPv4 drop pkts : 0           bad IP checksum   : 0
unhandled IP optns : 0           link layer bcst   : 0
bad IP length      : 0

Policing Counters
conform pkts      : 0             conform bytes     : 0
conform drop pkts : 0             conform drop bytes : 0
exceed pkts       : 0             exceed bytes      : 0
exceed drop pkts  : 0             exceed drop bytes  : 0
violate pkts      : 0             violate bytes     : 0
violate drop pkts : 0             violate drop bytes : 0

[local]Redback#show circuit counters ces
Circuit          Packets/Bytes Sent Packets/Bytes Received
2/1:1:1:1        0 0
2/4:1:1:1        0 0
2/6:1:1:2        640736 66438
                  52488402 5548482
10/12:1:2:3      0 0
                  0 0

[local]Redback#show circuit counters 2/1:1:2:3 ces
Circuit          Packets/Bytes Sent Packets/Bytes Received
2/1:1:2:3        0 0
                  0 0
```