Transparent PDH over Packet (TPoP) and Channelized SDH over Packet (CSoP)

Table 1: Feature History Table

Feature Name	Release Information	Feature Description
Transparent PDH over Packet (TPoP) and Channelized SDH over Packet (CSoP) Smart SFPs	Release 7.5.2	Cisco TPoP (Transparent PDH over Packet) and Cisco CSoP (Channelized SDH over Packet) Smart SFPs now support transparent forwarding of Synchronous Digital Hierarchy (SDH) signals on the following line card: • A99-48X10GE-1G-SE

Starting with Cisco IOS XR 7.5.2 release, TPoP (E1) and CSoP (CH-STM-1) smart SFP types are supported on the following line card(s):

• A99-48X10GE-1G-SE

Transparent PDH over Packet (TPoP) Smart SFP converts E1 traffic to a packet stream using RFC4553 SAToP TDM over packet pseudo-wire technology. TPoP Smart SFP can be used on selected SFP slots in a router to transport PDH traffic across a packet network. TPoP Smart SFP is a plug-and-play device which can be used without any provisioning and simplifies configuration and service turn-up of E1 connections across a packet network. The integration of TPoP into an SFP greatly reduces system and network complexity, offers lower carbon footprint, and results in savings.

Channelized SDH over Packet (CSoP) Smart SFP converts a fully channelized SDH signal to a packet stream using RFC4553 SAToP TDM over packet pseudo-wire technology. CSoP Smart SFP can replace an existing SFP in a router or a switch and transport E1 traffic across a packet network. CSoP Smart SFP aggregates single E1 and enables each E1 channel to be processed individually to provide a high-density gateway between an SDH network and a TDM over packet ethernet or IP or MPLS network.

Following are the supported E1 and STM1 optical SFPs:

• Framed STM1-ch E1 type: SFP-CH-OC3STM1-I

• Framed PDH E1 type: SFP-E1F-SATOP-I

Configuring TPoP and CSoP

Consider a deployment scenario with the TDM circuits from a base transceiver station is connected to access router and must be transported to the base station controller through an aggregation router over an MPLS network through pseudowire.

During aggregation from transceiver to controller, the TDM circuits protect the data by using smart SFPs. For the E1 lines coming from transceiver, you must use TPoP SFPs and for the STM-1 lines coming from transceiver or controller, you must use CSoP SFPs.

Also consider a case, with Automatic Protection Switching (APS) protection being enabled on the controller, then the protect link coming from a single node or from multiple nodes with standby pseudowire is supported in the MPLS core.

Configuring Controller for PDH E1

To configure PDH E1 on a controller, ensure Gigabit Ethernet port is up and enter the following commands:

```
enable
configure terminal
    controller e1  0/0/0/7
    vlan 100 ecid 1
end
```

You must mention unique VLAN ID which is specific to that port and ecid number to identify E1.

Verifying Controller for PDH E1

Use the **show controller e1 x/y/z** command to verify the controller configuration on E1 for TPoP smart SFP.

```
Router# show controller e1 0/0/0/7
Controller State: Up
Transport Admin State: In Service
Framing: Unframed
Linecoding: High Density Bipolar Order 3
Loopback: None
Clock: Adaptive Clock Recovery (ACR)
Clock State: Locked
VLAN ID: 100
ecid:1
```

Configuring Controller for STM1

To configure STM1 on a controller, ensure Gigabit Ethernet port is up and enter the following commands:

```
controller STM1 0/0/0/18
 aug-mapping au4 au-4 1
  mode tug3
   tug-3 1
    mode tug2
     tug-2 1 payload vc12
```

```
        vc12 1 mapping e1

/*Configure STM1-ch E1 */
```

Verifying Controller for STM1

Use the **show controller stm1 x/y/z** command to verify the controller configuration on STM1 for CSoP smart SFP.

```
Router# show controller STM1 0/0/0/18
Port STM 10/0/0/18

Status:
Primary State: Up
Configured Sec admin State: Normal
Inherited Sec admin State: Normal
Derived State: In Service
performance_monitoring_enabled
Loopback: None
```

Configuring Controller for STM1-ch E1

To configure each E1 on STM1 port, enter the following commands:

```
Config terminal
    controller E1 0/0/0/18/1/1/1/1
    vlan 200 ecid 1
```

You can configure same VLAN ID for all the E1 under same STM1 port or a different VLAN ID for each E1 under that STM1 port.

Verifying Controller for STM1-ch E1

Use the **show controller e1 x/y/z** command to verify the controller configuration on STM1.

```
Router# show controller e1 0/0/0/18/1/1/1/1
Controller State: Up
Transport Admin State: In Service
Framing: Unframed
Linecoding: None
Loopback: None
Clock: Internal

VLAN ID: 200
ecid:1
```

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. ACR is supported on only framed Smart SFP.

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 only framed Smart SFP.

Configure ACR and DCR

To configure ACR or DCR clocking under E1 controller, ensure Gigabit Ethernet port is up and enter the following commands:

```
enable
configure terminal
controller E1 0/0/0/7
    clock source recovered acr     //* configures acr *
end

enable
configure terminal
controller E1 0/0/0/7
    clock source recovered dcr     //* configures dcr *
end
```

> **Note**   ACR and DCR clocking is supported only on framed Smart SFPs.

Verification for ACR

```
Router:abc1#show controller e1 0/0/0/18
Thu Apr 28 11:00:34.118 UTC

 Controller State: Up

 Transport Admin State: Maintenance

 Framing: Unframed

 Linecoding: High Density Bipolar Order 3

 Loopback: None

 Clock : Adaptive Clock Recovery (ACR)

 Clock State: Locked

 vlan id:100
 ecid:1

         Alarm Status :
         -------------
         Detected Alarms : None
         -------------
         Root Alarm Status :
         -------------
         Detected Alarms : None
         -------------
```

```
        CEM stats:
 Ingress Pkts:5000
 Ingress Drop Pkts:0
 Egress Pkts:5000
 Egress Drop Pkts :0
 Input Error :0
 Output Error :0
 Pkt Missing :0
 Pkt Reordered :0
 Missorder Drops:0
 Jitter Buffer Underrun:0
 Pkts Malformed:0
 JitterBuffer Overrun :0
Router:abc1#
```

Verification for DCR

```
Router:abc1#show controller e1 0/0/0/18
Thu Apr 28 11:13:15.979 UTC

 Controller State: Up

 Transport Admin State: Maintenance

 Framing: Unframed

 Linecoding: High Density Bipolar Order 3

 Loopback: None

 Clock : Differential Clock Recovery (DCR)

 Clock State: Locked

 vlan id:100
 ecid:1

        Alarm Status :
        -------------
        Detected Alarms : None
        -------------
        Root Alarm Status :
        -------------
        Detected Alarms : None
        -------------

        CEM stats:
 Ingress Pkts:247999
 Ingress Drop Pkts:0
 Egress Pkts:247999
 Egress Drop Pkts :0
 Input Error :0
 Output Error :0
 Pkt Missing :0
 Pkt Reordered :0
 Missorder Drops:0
 Jitter Buffer Underrun:0
 Pkts Malformed:0
 JitterBuffer Overrun :0
Router:abc1#
```

Pseudo Random Binary Sequence (PRBS)

Pseudo Random Binary Sequence (PRBS) feature allows users to perform data integrity checks on their encapsulated packet data payloads using a pseudo-random bit stream pattern. PRBS generates a bit pattern and sends it to the peer router that uses this feature to detect if the sent bit pattern is intact or not.

Configure PRBS

Following are some of the configuration guidelines for PRBS:

- You can start PRBS test on E1 controller either from line side or system side.

- Only PN15 pattern is supported for PRBS test.

- At a time, you can start either line or system. To stop the test, you need to negate the command and commit.

Use the following steps to configure PRBS test on line and system:

```
Config terminal
controller e1 0/0/0/18
    prbs mode source-sink pattern PN15 direction line    /* configures prbs on line side
*/
end

Config terminal
controller e1 0/0/0/18
    prbs mode source-sink pattern PN15 direction system    /* configures prbs on system
side */
end
```

Verification

```
Router:#show controller e1 0/0/0/18 | begin PRBS Details
Mon Mar 21 10:45:33.920 UTC
        PRBS Details:
 PRBS Mode: Source-Sink
 Test Pattern: PN15(2^15)
 Sync Status: Sync
 Direction: Line
 Sync Detected: 1
 Bit Recieved((since last sync): 184320000
 PRBS Duration: 137 (Seconds)
 Timeunits since last-syn: 9
```

VPWS with Smart SFP

The TDM circuits flows through the VPWS with smart SFP packetizing the incoming TDM frames. Packetizing happens with the following process:

- All frames from the TDM lines are channelized until E1 and then packetized.

- The packetization is done by adding:

    - RTP header – For DCR clocking support

    - VLAN header – For uniquely identifying the E1 channel

- ENET header – The Ethernet DMAC and SMAC

- CW – control word for communicating the sequence number, faults in the access side

- Payload – the incoming TDM frames are chopped into 193Bytes frames and added into the payload.

- The packets mentioned previously sent to the NPU.

- The E1 channel is mapped into a sub-interface (with specific VLAN).

- The packets received into the NPU with that specific VLAN number go through the VPWS logic and gets pseudowired (xconnected) with the configuration in a specific sub-interface.

- QOS configured under the sub-interface gets applied to this PW.

Multi Router Automatic Protection Switching

The Multi Router Automatic Protection Switching (MR-APS) integration with hot standby pseudowire (HSPW) feature is a protection mechanism for SDH to switch to another circuit during failure.

Consider a deployment scenario with the MR-APS circuits from a base transceiver station is connected to access router and must be transported to the base station controller through an aggregation router over an MPLS network through pseudowire. When the pseudowire reaches the router with MR-APS, data is depacketized on the smart SFP and the raw TDM frames are sent towards the base station controller. The controller is connected to routers via two links, one as working link from router-A and other as protect link towards the router-B.

Configuring Xconnect on Sub-Interface

To configure E1 port based on the VLAN ID, create sub-interface Gigabit Ethernet port.

✎

Note   The **propagate-tdm-alarm** command enables the forwarding of port level alarms to Gigabit Ethernet port in which Smart SFP resides.

```
Config terminal
controller STM1 0/0/0/0
   propagate-tdm-alarm
!
interface GigabitEthernet0/0/0/18.200 l2transport
 encapsulation dot1q 200
!


interface GigabitEthernet0/0/0/7.100 l2transport
 encapsulation dot1q 100

l2vpn
 pw-class tdm_pw
  encapsulation mpls
  !
 !
 xconnect group tdm_csop
  p2p pw200
    interface GigabitEthernet0/0/0/18.200
```

```
        neighbor ipv4 2.2.2.2 pw-id 200
         pw-class tdm_pw
         !
       !
     !
  xconnect group tdm_tpop
   p2p pw100
     interface GigabitEthernet0/0/0/7.100
     neighbor ipv4 2.2.2.2 pw-id 100
      pw-class tdm_pw
      !
     !
   !
  !
```

For more information on the standby pseudowire, see *Configure Pseudowire Redundancy* in chapter *Configure Point-to-Point Layer 2 Services* of the *L2VPN and Ethernet Services Configuration Guide*.

Restrictions for Smart SFP

- CEM interface configuration is not supported.

- E1 emulation is supported only on Ethernet pseudowire (VPWS).

- CSoP does not support E1-AIS alarm.

- No support to Single Router-Automatic Protection Switching (SR-APS).

- The Standby PW is not programmed in the NPU, so when the active PW goes down, the router must be informed to program the NPU for the standby pseudowire support.

- CLI configuration for the E1 controller on a VLAN needs to be mapped to an Ethernet sub-interface (by configuring same VLAN dot1q under the sub-interface). Any xconnect, also must be configured with this ethernet sub-interface.

- MR-APS is supported only by using the VLAN PW. Traffic convergence time over MR-APS link failure-based switchover is nearly 100 ms.

- Ensure to have a backup MPLS path for the MPLS path to converge during a core failure.

- Only 8 smart SFPs are supported per router.