Clock Recovery

Table 1: Feature History

Feature Name	Release Information	Description
ACR and DCR Scale Support	Cisco IOS XE Amsterdam 17.3.1	Adaptive Clock Recovery (ACR) and Differential Clock Recovery (DCR) are techniques used for Circuit Emulation (CEM) to recover clocks on the following Cisco RSP3 module: • NCS 4200 Combo 8-Port SFP GE and 1-Port 10 GE 20G Interface Module (NCS4200-1T8S-20CS)

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

- Adaptive Clock Recovery (ACR), on page 1
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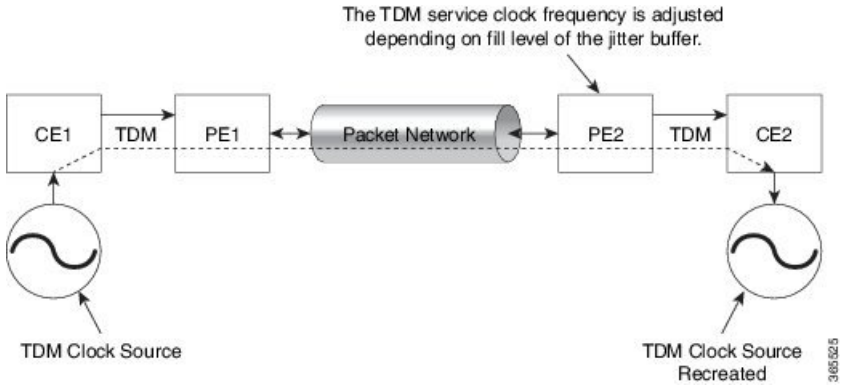
Adaptive Clock Recovery (ACR)

Adaptive Clock Recovery (ACR) is an averaging process that negates the effect of random packet delay variation and captures the average rate of transmission of the original bit stream. ACR recovers the original clock for a synchronous data stream from the actual payload of the data stream. In other words, a synchronous clock is derived from an asynchronous packet stream. ACR is a technique where the clock from the TDM domain is mapped through the packet domain, but is most commonly used for Circuit Emulation (CEM). ACR is supported on unframed and framed modes of SAToP.

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

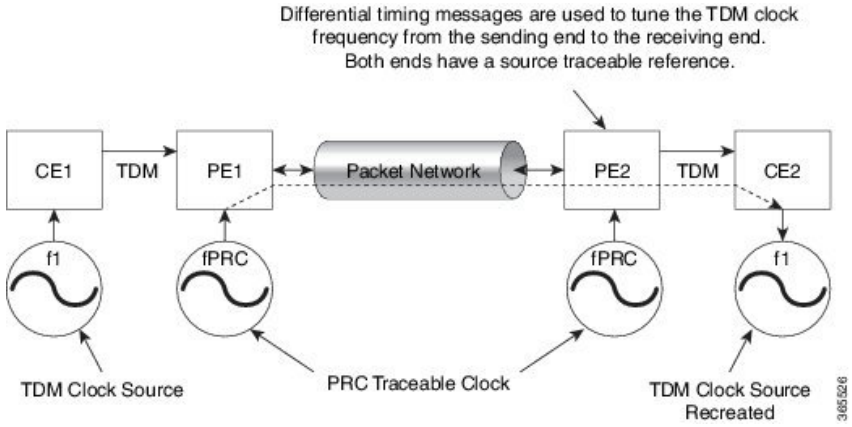
Effective Cisco IOS XE Everest 16.5.1, ACR is supported on the 8-port T1/E1 interface module.



Differential Clock Recovery (DCR)

Differential Clock Recovery (DCR) is another technique used for Circuit Emulation (CEM) to recover clocks based on the difference between PE clocks. TDM clock frequency are tuned to receive differential timing messages from the sending end to the receiving end. A traceable clock is used at each end, which ensures the recovered clock is not affected by packet transfer. DCR is supported on unframed and framed modes of SAToP.

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



Benefits of Clock Recovery

- Customer-edge devices (CEs) can have different clock from that of the Provide-edge devices (PEs).

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

Scaling Information

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

Prerequisites for Clock Recovery

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

Restrictions for Clock Recovery

- The reference clock source is used and locked to a single clock.
- The clock ID should be unique for a particular interface module for ACR or DCR configuration.
- When CEM group is configured, dynamic change in clock source is not allowed.
- ACR clock configuration under each controller should be performed before configuring CEM group.
- When ACR or DCR is configured and loopback network is applied on the same PDH (T1/E1), then the ACR or DCR mode configuration is removed to enable the loopback. The ACR or DCR should be configured again after the loopback maintenance activity.

Scale Restrictions

- For the Cisco IOS XE Amsterdam 17.3.x release, a maximum of **5376** ACR and DCR session scale is supported on the Cisco 1-port OC-192 Interface module or 8-port Low Rate Interface Module (8-port SFP GE and 1-port 10GE IM with CEM, 10G). For releases before the Cisco IOS XE Amsterdam 17.3.1 release, only 2000 session are supported.

How to Configure Clock Recovery

Configuring Clock Recovery for SONET

Configuring ACR of T1/E1 Interfaces for SAToP

Before You Begin

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

- The node (chassis) on which the DS1 is configured for ACR, must have its own clock derived from BITS/GPS/Stratum clock.
- The minimum packet size of CEM pseudowires on the network that delivers robust clock recovery is 64 bytes.

Configure the CEM Interface

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

Perform Global Configuration for Clock Recovery

To configure the clock recovery in the global configuration mode, use the following commands:

```
recovered-clock 0 0
clock recovered 1 adaptive cem 1 0
exit
```

Configure the Clock under Controller

To configure the clock recovery on T1/E1 interfaces, use the following commands:

```
enable
configure terminal
controller t1 0/0/1
clock source recovered 1
```

Note The global clock configuration must be performed before configuring the clock recovery under the controller. From the Cisco IOS XE Cupertino 17.9.1 release onwards, the above config sequence is restricted only from CLI.

To remove the clock configuration in ACR and DCR, you must remove the recovery clock configuration in global configuration mode and then remove the controller configuration.

Verifying the ACR Configuration of T1/E1 Interfaces for SAToP

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

```
Router# show recovered-clock

Recovered clock status for subslot 0/4
---------------------------------------
Clock    Type     Mode         CEM    Status       Frequency Offset(ppb)  Circuit-No

0        DS1      ADAPTIVE      0     ACQUIRED     n/a                    0 (Port)
```

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

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

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

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

Configuring ACR of T3/E3 Interfaces for SAToP

Before You Begin

- The node (router) on which the 48-Port T3/E3 interface module is configured for ACR, must have its own clock derived from BITS/GPS/Stratum clock.
- The minimum packet size of CEM pseudowires on the network that delivers robust clock recovery is 256 bytes.

Configure the CEM Interface

```
enable
configure terminal
controller t3 0/0/1
cem-group 0 unframed
exit
```

Perform Global Configuration for Clock Recovery

To configure the clock recovery in the global configuration mode, use the following commands:

```
recovered-clock 0 0
clock recovered 1 adaptive cem 1 0
exit
```

Configure the Clock under Controller

To configure the clock recovery on T3/E3 interfaces, use the following commands:

```
enable
configure terminal
controller t3 0/0/1
clock source recovered 1
```

Note The global clock configuration must be performed before configuring the clock recovery under the controller. From the Cisco IOS XE Cupertino 17.9.1 release onwards, the above config sequence is restricted only from CLI.

Verifying Adaptive Clock Recovery Configuration of T3/E3 Interfaces for SAToP

Use the **show recovered-clock** command to verify the ACR on T3/E3 interfaces for SAToP:

```
Router# show recovered-clock

Recovered clock status for subslot 0/4
---------------------------------------
Clock    Type     Mode        CEM    Status       Frequency Offset(ppb)  Circuit-No

0        DS3      ADAPTIVE     0     ACQUIRED     n/a                    0 (Port)
```

Use the **show running-config | section** command to verify the configuration of adaptive clock of T3/E3 interfaces:

```
Router# show running-config | section 0/0/1
controller MediaType 0/0/1
 mode t3
controller T3 0/0/1
  cem-group 0 unframed
 clock source recovered 1
 cablelength 224
interface CEM0/0/1
 no ip address
 cem 0
```

Use the **show running-config | section recovered-clock** command to verify the recovery of adaptive clock of T3/E3 interfaces:

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

Configuring ACR of Channelized T3/T1 or E3/E1 Interfaces for SAToP

Before You Begin

- The node (chassis) on which the T3/T1 or E3/E1 is configured for ACR, has to have its own clock derived from BITS/GPS/Stratum clock.
- The minimum packet size of CEM pseudowires on the network that delivers robust clock recovery is 256 bytes.

Configure the CEM Interface

```
enable
configure terminal
controller t3 0/0/1
t1 1 cem-group 0 unframed
exit
```

Perform Global Configuration for Clock Recovery

```
recovered-clock 0 0
clock recovered 1 adaptive cem 1 0
exit
```

Configure the Clock under Controller

```
enable
configure terminal
controller t3 0/0/1
clock source recovered 1
```

Note The global clock configuration must be performed before configuring the clock recovery under the controller. From the Cisco IOS XE Cupertino 17.9.1 release onwards, the above config sequence is restricted only from CLI.

To remove the clock configuration in ACR and DCR, you must remove the recovery clock configuration in global configuration mode and then remove the controller configuration.

Verifying the ACR Configuration of Channelized T3/T1 or E3/E1 Interfaces for SAToP

Use the **show recovered-clock** command to verify the ACR of T3/T1 or E3/E1 interfaces for SAToP:

```
Router# show recovered-clock

Recovered clock status for subslot 0/4
---------------------------------------

Clock    Type      Mode         CEM    Status      Frequency Offset(ppb)  Circuit-No
0        DS3-ds1   ADAPTIVE      0     ACQUIRED    n/a                    0/1 (Port/t1)
```

Use the **show running-config | section** command to verify the configuration of adaptive clock of channelized T3/T1 or E3/E1 interfaces:

```
Router# show running-config | section 0/0/1
controller MediaType 0/0/1
 mode t3
controller T3 0/0/1
 framing c-bit
 cablelength 224
 t1 1 cem-group 0 unframed
 t1 1 clock source recovered 1
interface CEM0/0/1
 no ip address
 cem 0
```

Use the **show running-config | section recovered-clock** command to verify the recovery of adaptive clock of channelized T3/T1 or E3/E1 interfaces:

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

Configuring ACR in Mode CT3 for SAToP

You must configure ACR in mode CT3. Mode CT3 is an STS-1 carrying a DS3 signal that is divided into 28 T1s (PDH).

Configure the CEM Interface

```
controller MediaType 0/4/0
mode sonet
controller SONET 0/4/0
rate OC48
no ais-shut
framing sonet
clock source internal
!
sts-1 1

clock source internal
mode ct3
t3 framing c-bit

t1 1 framing unframed
t1 1 cem-group 1 unframed
interface CEM0/4/0
no ip address
cem 1
```

Perform Global Configuration for Clock Recovery

```
recovered-clock 0 4
clock recovered 1 adaptive cem 1 0
exit
```

Configure the Clock under Controller

```
enable
configure terminal
controller t3 0/4/0
clock source recovered 1
```

Note The global clock configuration must be performed before configuring the clock recovery under the controller. From the Cisco IOS XE Cupertino 17.9.1 release onwards, the above config sequence is restricted only from CLI.

Verifying ACR in Mode CT3 for SAToP

Verifying ACR Configuration

```
Router# show running-config | section 0/4/0

controller MediaType 0/4/0
 mode sonet
controller SONET 0/4/0
 rate OC48
 no ais-shut
 framing sonet
 clock source internal
 !
 sts-1 1
  clock source internal
  mode ct3
  t3 framing c-bit
  t1 1 clock source Recovered 10
  t1 1 framing unframed
  t1 1 cem-group 1 unframed

interface CEM0/4/0
 no ip address
 cem 1
!
```

Verifying Recovered Clock

```
show recovered-clock

Recovered clock status for subslot 0/3
---------------------------------------
Clock    Type     Mode        CEM    Status        Frequency Offset(ppb)  Circuit-No
0        OCx-ds1  ADAPTIVE     0    ACQUIRED  n/a                              0/1/1
(Port/t3/t1)

show running-config | section recovered-clock 0 4
recovered-clock 0 4
 clock recovered 10 adaptive cem 1 0
```

Configuring ACR in mode T3 for SAToP

You must configure ACR in mode T3. Mode T3 is STS-1 or AU-4/TUG3 carrying an unchannelized (clear channel) T3.

```
enable
configure terminal
recovered-clock  <bay> <slot>
clock recovered <clock-id> adaptive cem <port-no> <cem-group-no>
controller sonet <bay>/<slot>/<port>
rate OC3
sts-1 <number>
mode t3
cem-group < cem-group-no> unframed
t3 clock source recovered <clock-id>

end
```

Verifying ACR in Mode T3 for SAToP

Verifying ACR Configuration

```
Router# show run | sec recovered
recovered-clock bay/slot
clock recovered clock_id adaptive cem cem-group-no port-no
!
```

```
Router# show running-config | section 0/4/6

controller SONET 0/4/6
 rate OC3
 no ais-shut
 framing sonet
 clock source internal
 !
 sts-1 1
  clock source internal
  mode t3
  t3 clock source line
  cem-group 0 unframed
  clock source recovered 20

interface CEM0/4/6
 no ip address
 cem 0
!
```

Verifying Recovered Clock

```
Router# show recovered-clock

Recovered clock status for subslot 0/3
---------------------------------------
Clock    Type          Mode         CEM    Status         Frequency Offset(ppb)  Circuit-No
0         OCx-ds3  ADAPTIVE     0    ACQUIRED   n/a                                    0/1
(Port/t3)
```

```
Router# show run | sec recovered

recovered-clock 0 4
clock recovered 20 adaptive cem 6 0
!
```

Configuring ACR in Mode VT15 for SAToP

You must configure ACR for virtual tributary groups (VTG) mode. In this mode, a single STS-1 is divided into seven VTGs. Each VTG is then divided into four VT1.5, each carrying a T1.

To configure ACR in mode VT15 for Structure-Agnostic TDM over Packet (SAToP):

```
enable
configure terminal
controller sonet <bay>/<slot>/<port>
rate OC3
sts-1 <number>
mode vt-15
vtg 1 t1 cem 0 unframed
vtg 1 t1 1 clock source recovered 1
vtg <vtg_number> t1 <t1_number> cem-group < cem-group-no> unframed
vtg <vtg_number> t1 <t1_number> clock source recovered <clock-id>
exit
```

```
recovered-clock 0 <0-15> Subslot number
end
```

Verifying ACR in Mode VT15 for SAToP

Verifying ACR Configuration

```
Router# show running-config | section 0/4/0

controller MediaType 0/4/0
 mode sonet
controller SONET 0/4/0
 rate OC48
 no ais-shut
 framing sonet
 clock source internal
 !
 sts-1 1
  clock source internal
  mode vt-15
  vtg 1 t1 1 clock source Recovered 0
  vtg 1 t1 1 framing unframed
  vtg 1 t1 1 cem-group 0 unframed

interface CEM0/4/0
 no ip address
 cem 0
!
```

Verifying Recovered Clock

```
Router# show recovered-clock

Recovered clock status for subslot 0/3
---------------------------------------
Clock    Type     Mode        CEM    Status          Frequency Offset(ppb)  Circuit-No
0        OCx-ds1  ADAPTIVE     0    ACQUIRED   n/a                                0/1/1/1
(Port/path/vtg/t1)
```

```
Router# show running-config | section recovered-clock 0 4

recovered-clock 0 4
 clock recovered 0 adaptive cem 0 0
```

Configuring ACR of T3/E3 Interfaces for CESoPSN

Before You Begin

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

- The node (chassis) on which the DS1 is configured for ACR, must have its own clock derived from BITS/GPS/Stratum clock.
- The minimum packet size of CEM pseudowires on the network that delivers robust clock recovery is 64 bytes.

To configure the clock on T3/E3 interfaces for CESoPSN in controller mode, use the following commands:

```
enable
configure terminal
```

```
controller t3 <slot>/<bay>/<port>
t1 <t1_num>  clock source recovered <clock-id>
t1 <t1_num> cem-group < cem-group-no > timeslots <1-24>
exit
```

To configure the clock recovery on T3/E3 interfaces in global configuration mode, use the following commands:

```
recovered-clock <slot> <bay>
clock recovered <clock-id> adaptive cem <port-no> <cem-group-no>
exit
```

To remove the clock configuration in ACR and DCR, you must remove the recovery clock configuration in global configuration mode and then remove the controller configuration.

Recovering a Clock

Recovering an ACR Clock

```
enable
configure terminal
recovered-clock  <bay> <slot>
clock recovered <clock-id> adaptive cem <port-no> <cem-group-no>
end
```

Recovering a DCR Clock

```
enable
configure terminal
recovered-clock  <bay> <slot>
clock recovered <clock-id> differential cem <port-no> <cem-group-no>
end
```

Configuring DCR of T1/E1 Interfaces for SAToP

Before You Begin

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

- Before you start configuring DCR, RTP must be enabled on the CEM interface. The RTP is used to carry the differential time.
- The minimum packet size of CEM pseudowires on the network that delivers robust clock recovery is 64 bytes.

Configure the CEM Interface

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

Perform Global Configuration for Clock Recovery

To configure the clock recovery in the global configuration mode, use the following commands:

```
recovered-clock 0 0
clock recovered 1 differential cem 1 0
exit
```

Configure the Clock under Controller

To configure the clock recovery on T1/E1 interfaces, use the following commands:

```
enable
configure terminal
controller t1 0/0/1
clock source recovered 1
```

Note The global clock configuration must be performed before configuring the clock recovery under the controller. From the Cisco IOS XE Cupertino 17.9.1 release onwards, the above config sequence is restricted only from CLI.

To remove the clock configuration in ACR and DCR, you must remove the recovery clock configuration in global configuration mode and then remove the controller configuration.

Verifying the DCR Configuration of T1/E1 Interfaces for SAToP

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

```
Router# show recovered-clock

Recovered clock status for subslot 0/4
---------------------------------------
Clock    Type     Mode            CEM    Status       Frequency Offset(ppb)  Circuit-No

0        DS1      DIFFERENTIAL     0     ACQUIRED     n/a                    0 (Port)
```

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

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

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

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

Configuring DCR of T3/E3 Interfaces for SAToP

Before You Begin

- Before you start configuring DCR, RTP must be enabled on the CEM interface. The RTP is used to carry the differential time.
- The minimum packet size of CEM pseudowires on the network that delivers robust clock recovery is 256 bytes.

Configure the CEM Interface

```
enable
configure terminal
controller t3 0/0/1
cem-group 0 unframed
exit
```

Perform Global Configuration for Clock Recovery

To configure the clock recovery in the global configuration mode, use the following commands:

```
recovered-clock 0 0
clock recovered 1 differential cem 1 0
exit
```

Configure the Clock under Controller

To configure the clock recovery on T3/E3 interfaces, use the following commands:

```
enable
configure terminal
controller t3 0/0/1
clock source recovered 1
```

Note The global clock configuration must be performed before configuring the clock recovery under the controller. From the Cisco IOS XE Cupertino 17.9.1 release onwards, the above config sequence is restricted only from CLI.

To remove the clock configuration in ACR and DCR, you must remove the recovery clock configuration in global configuration mode and then remove the controller configuration.

Verifying the DCR Configuration of T3/E3 Interfaces for SAToP

Use the **show recovered-clock** command to verify the DCR of T3/E3 interfaces for SAToP:

```
Router# show recovered-clock

Recovered clock status for subslot 0/4
---------------------------------------
Clock    Type     Mode            CEM    Status       Frequency Offset(ppb)  Circuit-No

0        DS3      DIFFERENTIAL     0     ACQUIRED     n/a                    0 (Port)
```

Use the **show running-config | section** command to verify the configuration of differential clock of T3/E3 interfaces for SAToP:

```
Router# show running-config | section 0/0/1
controller MediaType 0/0/1
 mode t3
controller T3 0/0/1
  cem-group 0 unframed
 clock source recovered 1
 cablelength 224
interface CEM0/0/1
 no ip address
 cem 0
  rtp-present
```

Use the **show running-config | section recovered-clock** command to verify the recovery of differential clock of T3/E3 interfaces:

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

Configuring DCR of Channelized T3/T1 or E3/E1 Interfaces for SAToP

Before You Begin

- Before you start configuring DCR, RTP must be enabled on the CEM interface. The RTP is used to carry the differential time.
- The minimum packet size of CEM pseudowires on the network that delivers robust clock recovery is 256 bytes.

To configure differential clock on a channelized T3/T1 or E3/E1 interfaces under controller in controller mode, use the following commands:

```
enable
configure terminal
controller t3 0/0/1
t1 1 clock source recovered 1
t1 1 cem-group 0 unframed
exit
```

To configure RTP header under channelized T3/T1 or E3/E1 interfaces, use the following commands:

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

To configure recovery of differential clock of channelized T3/T1 or E3/E1 interfaces in global configuration mode, use the following commands:

```
recovered-clock 0 0
clock recovered 1 differential cem 1 0
exit
```

Note The clock configuration on controller must be done before configuring the clock recovery on global configuration mode.

Verifying the DCR Configuration of Channelized T3/T1 or E3/E1 Interfaces for SAToP

Use the **show recovered-clock** command to verify the DCR of T3/T1 or E3/E1 interfaces for SAToP:

```
Router# show recovered-clock

Recovered clock status for subslot 0/4
---------------------------------------

Clock    Type         Mode           CEM     Status     Frequency Offset(ppb) Circuit-No

0        DS3-ds1      DIFFERENTIAL   0       ACQUIRED    n/a                   0/1 (Port/t1)
```

Use the **show running-config | section** command to verify the configuration of differential clock of channelized T3/T1 or E3/E1 interfaces:

```
Router# show running-config | section 0/0/1
controller MediaType 0/0/1
 mode t3
controller T3 0/0/1
 framing c-bit
 cablelength 224
 t1 1 cem-group 0 unframed
 t1 1 clock source recovered 1
interface CEM0/0/1
 no ip address
 cem 0
  rtp-present
```

Use the **show running-config | section recovered-clock** command to verify the recovery of differential clock of channelized T3/T1 or E3/E1 interfaces:

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

Configuring Clock Recovery for SONET

To configure MediaType Controller, use the following commands:

```
enable
configure terminal
controller MediaType 0/5/0
mode sonet
controller sonet 0/5/0
rate OC12
```

To configure a CEM group, use the following commands:

```
enable
configure terminal
controller sonet 0/2/1
```

```
sts-1 1
mode vt-15
vtg 1 t1 1 cem-group 0 timeslots 1
vtg 1 t1 1 cem-group 1 timeslots 2
```

To configure the clock recovery for SONET in global configuration mode, use the following commands

```
recovered-clock 0 2
clock recovered 100 adaptive cem 1 0 priority 1
clock recovered 100 adaptive cem 1 1 priority 2
exit
```

Configuring Clock Recovery on STS-1e Controller for Framed SAToP

Table 2: Feature History

Feature Name	Release Information	Description
STS1E Framed SAToP Support on IMA3G	Cisco IOS XE Bengaluru 17.4.1	Support on clock recovery on STS-1e controller for framed SAToP on the following modes: • T3 • CT3 • VT-15

Starting from Cisco IOS XE Bengaluru 17.4.1, ACR and DCR are supported on STS-1e controller for framed SAToP.

To configure the clock on STS-1e controller for framed SAToP on the T3 mode, enter the following commands:

```
enable
configure terminal
controller STS-1e slot/bay/port
sts-1 1
mode t3
t3 framing c-bit
cem-group 0 framed
t3 clock source recovered 1
```

To configure the clock on STS-1e controller for framed SAToP on the CT3 mode, enter the following commands:

```
enable
configure terminal
controller STS-1e slot/bay/port
sts-1 1
clock source internal
mode ct3
t3 framing c-bit
t1 1 cem-group 0 framed
t1 1 clock source recovered 1
```

To configure the clock on STS-1e controller for framed SAToP on the VT-15 mode, enter the following commands:

```
enable
configure terminal
controller STS-1e slot/bay/port
sts-1 1
mode vt-15
vtg 1 t1 1 cem-group 0 framed
vtg  1 t1 1 clock source recovered 2
```

The following example shows how to configure the clock on STS-1e controller for framed SAToP on the T3 mode:

```
enable
configure terminal
controller STS-1e 0/8/12
sts-1 1
mode t3
t3 framing c-bit
cem-group 0 framed
t3 clock source recovered 1
```

The following example shows how to configure the clock on STS-1e controller for framed SAToP on the CT3 mode:

```
enable
configure terminal
controller STS-1e 0/8/12
sts-1 1
clock source internal
mode ct3
t3 framing c-bit
t1 1 cem-group 0 framed
t1 1 clock source recovered 1
```

The following example shows how to configure the clock on STS-1e controller for framed SAToP on the VT-15 mode:

```
enable
configure terminal
controller STS-1e 0/8/12
sts-1 1
mode vt-15
vtg 1 t1 1 cem-group 0 framed
vtg 1t1 1 clock source recovered 2
```

Configuring DCR in Mode T3 for SAToP

```
enable
configure terminal
recovered-clock  <bay> <slot>
clock recovered <clock-id> differential cem <port-no> <cem-group-no>
controller sonet <bay>/<slot>/<port>
rate OC3
sts-1 <number>
mode t3
```

```
cem-group <cem-group-number> unframed
t3 clock source recovered <clock-id>
interface cem <bay>/<slot>/<port>
cem <cem-group-nber>
rtp-present
end
```

Verifying DCR in Mode T3 for SAToP

Verifying DCR Configuration

```
Router# show running-config | section 0/4/6

controller SONET 0/4/6
 rate OC3
 no ais-shut
 framing sonet
 clock source internal
 !
 sts-1 1
  clock source internal
  mode t3
  cem-group 0 unframed
  clock source recovered 20

interface CEM0/4/6
 no ip address
 cem 0
  rtp-present
 !
```

Verifying Recovered Clock

```
Router# show recovered-clock

Recovered clock status for subslot 0/4
---------------------------------------
Clock    Type     Mode         CEM    Status         Frequency Offset(ppb)  Circuit-No
0        OCx-ds3  Differential     0    ACQUIRED   n/a                              0/1
(Port/t3)
```

```
Router# show running-config | section recovered-clock 0 4

recovered-clock 0 4
clock recovered 20 differential cem 6 0
```

Configuring DCR in Mode CT3 for SAToP

```
enable
configure terminal
recovered-clock  <bay> <slot>
clock recovered <clock-id> differential cem <port-no> <cem-group-no>
controller sonet <bay>/<slot>/<port>
rate OC3
sts-1 <number>
mode ct3
t1 <t1_number> cem-group < cem-group-no> unframed
t1 <t1_number> clock source recovered <clock-id>
interface cem <bay>/<slot>/<port>
cem <cem-group-number>
rtp-present
end
```

Verifying DCR in Mode CT3 for SAToP

Verifying DCR Configuration

```
Router# show running-config | section 0/4/0

controller MediaType 0/4/0
 mode sonet
controller SONET 0/4/0
 rate OC48
 no ais-shut
 framing sonet
 clock source internal
 !
 sts-1 1
  clock source internal
  mode ct3
  t3 framing c-bit
  t1 1 clock source Recovered 10
  t1 1 framing unframed
  t1 1 cem-group 1 unframed


interface CEM0/4/0
 no ip address
 cem 1
  rtp-present
 !
```

Verifying Recovered Clock

```
Router# show recovered-clock

Recovered clock status for subslot 0/4
---------------------------------------
Clock    Type     Mode        CEM    Status         Frequency Offset(ppb)  Circuit-No
0        OCx-ds1  Differential     0    ACQUIRED   n/a                              0/1/1
(Port/t3/t1)

Router# show running-config | section recovered-clock 0 4
recovered-clock 0 4
 clock recovered 10 differential cem 1 0
```

Configuring DCR in Mode VT15 for SAToP

```
enable
configure terminal
recovered-clock  <bay> <slot>
clock recovered <clock-id> differential cem <port-no> <cem-group-no>
controller sonet <bay>/<slot>/<port>
rate OC3
sts-1 <number>
mode vt-15
vtg <vtg_no> t1 <t1_number> cem-group <cem-group-no> unframed
vtg <vtg_no> t1 <t1_number> clock source recovered <clock-id>
interface cem <bay>/<slot>/<port>
cem <cem-group-number>
rtp-present
end
```

Verifying DCR in Mode VT15 for SAToP

Verifying DCR Configuration

```
Router# show running-config | section 0/4/0

controller MediaType 0/4/0
 mode sonet
controller SONET 0/4/0
 rate OC48
 no ais-shut
 framing sonet
 clock source internal
 !
 sts-1 1
  clock source internal
  mode vt-15
  vtg 1 t1 1 clock source Recovered 0
  vtg 1 t1 1 framing unframed
  vtg 1 t1 1 cem-group 0 unframed


interface CEM0/4/0
 no ip address
 cem 0
  rtp-present
 !
```

Verifying Recovered Clock

```
Router# show recovered-clock

Recovered clock status for subslot 0/4
---------------------------------------
Clock    Type     Mode         CEM    Status          Frequency Offset(ppb)  Circuit-No
0        OCx-ds1  Differential     0    ACQUIRED   n/a                              0/1/1/1
 (Port/path/vtg/t1)
```

```
Router# show running-config | section recovered-clock 0 4

recovered-clock 0 4
 clock recovered 0 differential cem 0 0
```

Clock Recovery System in CESoPSN

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

Configuring ACR of T1/E1 Interfaces for CESoP

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

```
enable
configure terminal
controller t1 <slot>/<bay>/<port>
t1 <t1_num>  clock source recovered <clock-id>
t1 <t1_num> cem-group < cem-group-no > timeslots <1-24>
exit
```

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

```
recovered-clock <slot> <bay>
clock recovered <clock-id> adaptive cem <port-no> <cem-group-no> prioroty <1 | 2>
exit
```

Configuring ACR of T3/E3 Interfaces for CESoP

To configure the clock on T3/E3 interfaces for CESoPSN in controller mode, use the following commands:

```
enable
configure terminal
controller t3 <slot>/<bay>/<port>
t1 <t1_num>  clock source recovered <clock-id>
t1 <t1_num> cem-group < cem-group-no > timeslots <1-24>
exit
```

To configure the clock recovery on T3/E3 interfaces in global configuration mode, use the following commands:

```
recovered-clock <slot> <bay>
clock recovered <clock-id> adaptive cem <port-no> <cem-group-no> prioroty <1 | 2>
exit
```

Configuring DCR of T1/E1 Interfaces for CESoP

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

```
enable
configure terminal
controller t1 <slot>/<bay>/<port>
t1 <t1_num> clock source recovered <clock-id>
t1 <t1_num> cem-group < cem-group-no > timeslots <1-24>
exit
```

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

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

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

```
recovered-clock <slot> <bay>
clock recovered <clock-id> differential cem <port-no> <cem-group-no> prioroty <1 | 2>
exit
```

Configuring DCR of T3/E3 Interfaces for CESoP

Before You Begin

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

- The node (chassis) on which the DS1 is configured for DCR, must have its own clock derived from BITS/GPS/Stratum clock.
- The minimum packet size of CEM pseudowires on the network that delivers robust clock recovery is 64 bytes.

To configure the clock on T3/E3 interfaces for CESoP in controller mode, use the following commands:

```
enable
configure terminal
controller t3 <slot>/<bay>/<port>
t1 <t1_num>  clock source recovered <clock-id>
t1 <t1_num> cem-group < cem-group-no > timeslots <1-24>
exit


interface cem <slot>/<bay>/<port>
cem < cem-group-no>
rtp-present
```

To configure the clock recovery on T3/E3 interfaces in global configuration mode, use the following commands:

```
recovered-clock <slot> <bay>
clock recovered <clock-id> differential cem <port-no> <cem-group-no> prioroty <1 | 2>
exit
```

Note To remove the clock configuration in ACR and DCR, perform the following steps:

- Use the **no clock source recovered** command.
- Remove the global clock.
- Remove CEM configuration, if required.

Configuring Clock Recovery for SDH

Configuring ACR on SDH

To configure E1 ACR:

```
enable
configure terminal
controller sdh 0/0/16
rate STM1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
clock source internal
mode tug-3
tug-3 1
mode vc1x
tug-2 1 payload vc12
e1 1 cem-group 1 unframed
e1 1 clock source recovered 1
tug-2 2 payload vc11
tug-2 3 payload vc11
tug-2 4 payload vc11
end
```

To configure E3 ACR:

```
enable
configure terminal
controller sdh 0/0/16
rate STM1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
clock source internal
mode tug-3
tug-3 1
mode e3
overhead c2 0
cem-group 1 unframed
e3 clock source recovered 1
```

ACR Global Configuration

```
enable
configure terminal
recovered-clock 0 4
clock recovered 1 adaptive cem 0 1
end
```

Verifying ACR Configuration on SDH

Use **show recovered clock** command to verify E1 ACR configuration:

```
#show recovered clock
Recovered clock status for subslot 0/16
---------------------------------------
Clock    Type     Mode        CEM    Status    Frequency Offset(ppb)  Circuit-No
1        STMx-E1  ADAPTIVE     1    ACQUIRED   n/a                    0/1/1/1/1
(Port/au-4/tug3/tug2/e1)
```

Use **show recovered clock** command to verify T3 ACR configuration:

```
#show recovered clock
Recovered clock status for subslot 0/16
---------------------------------------
Clock    Type     Mode        CEM    Status    Frequency Offset(ppb)  Circuit-No
1       STMx-E3  ADAPTIVE     1    ACQUIRED   n/a                  0/1/1 (Port/au-4/tug3)
```

Configuring DCR on SDH

To configure E1 DCR:

```
enable
configure terminal
controller sdh 0/0/16
rate STM1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
clock source internal
mode tug-3
```

```
tug-3 1
mode vc1x
tug-2 1 payload vc12
e1 1 cem-group 1 unframed
e1 1 clock source recovered 1
tug-2 2 payload vc11
tug-2 3 payload vc11
tug-2 4 payload vc11
end
```

To configure E3 DCR:

```
enable
configure terminal
controller sdh 0/0/16
rate STM1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
clock source internal
mode tug-3
tug-3 1
mode e3
overhead c2 0
cem-group 1 unframed
e3 clock source recovered 1
```

DCR Global Configuration

```
enable
configure terminal
recovered-clock 0 4
clock recovered 1 differential cem 0 1
end
```

Verifying DCR Configuration on SDH

Use **show recovered clock** command to verify E1 DCR configuration:

```
#show recovered clockRecovered clock status for subslot 0/16
----------------------------------------
Clock    Type     Mode          CEM    Status    Frequency Offset(ppb)  Circuit-No
1        STMx-E1  DIFFERENTIAL     1    ACQUIRED   n/a                    0/1/1/1/1
(Port/au-4/tug3/tug2/e1)
```

Use **show recovered clock** command to verify T3 DCR configuration:

```
#show recovered clock
Recovered clock status for subslot 0/16
----------------------------------------
Clock    Type     Mode         CEM    Status    Frequency Offset(ppb)  Circuit-No
1        STMx-E3  DIFFERENTIAL     1    ACQUIRED   n/a                    0/1/1
(Port/au-4/tug3)
```

Configuring Network Clock

To configure a network clock, use the following commands:

```
enable
configure terminal
```

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

Verifying Network Clocking Configuration

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

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

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

Nominated Interfaces

Interface            SigType     Mode/QL      Prio  QL_IN  ESMC Tx  ESMC Rx
Internal             NA          NA/Dis       251   QL-SEC    NA        NA
*E1 0/1/0             NA          NA/Dis        1     QL-SEC    NA        NA
rtr1#
```