G.8275.2 Telecom Profile

This document provides information on the support for G.8275.2 telecom profile and how to configure Cisco cBR series routers to avail the support.

Your software release may not support all the features that are documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. The Feature Information Table at the end of this document provides information about the documented features and lists the releases in which each feature is supported.

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G.8275.2 Telecom Profile

Information About G.8275.2 Telecom Profile

Precision Time Protocol (PTP) is a protocol for distributing precise time and frequency over packet networks. PTP is defined in the IEEE Standard 1588. It defines an exchange of timed messages.

PTP allows for separate profiles to be defined in order to adapt PTP for use in different scenarios. A profile is a specific selection of PTP configuration options that are selected to meet the requirements of a particular application.

Effective Cisco IOS XE Fuji 16.8.1, Cisco cBR Converged Broadband routers support the ITU- T G.8275.2 telecom profile (PTP telecom profile for Phase/Time-of-day synchronization with partial timing support from the network).

The G.8275.2 is a PTP profile for use in telecom networks where phase or time-of-day synchronization is required. It differs from G.8275.1 in that it is not required that each device in the network participates in the PTP protocol. Also, G.8275.2 uses PTP over IPv4 and IPv6 in unicast mode.

Why G.8275.2 Telecom Profile?

The G.8275.2 profile is based on the partial timing support from the network. Hence nodes using G.8275.2 are not required to be directly connected.

The G.8275.2 profile is used in mobile cellular systems that require accurate synchronization of time and phase. For example, the fourth generation (4G) of mobile telecommunications technology.

PTP Clocks

Two types of ordinary clocks are used in this profile:

Ordinary Clocks (OCs)

- Telecom Grandmaster (T-GM)—A telecom grandmaster provides timing for other devices in the network, and is usually connected to a primary reference time source, such as a GNSS receiver. It does not synchronize its local clock to other network elements. Considerations for a T-GM:
  - Only one PTP port can be configured as a primary port.
  - One T-GM primary port can have multiple subordinates associated with it.
  - The T-GM OC primary port is a fixed port; that is, it always acts as a primary clock and its role does not change by negotiating with its peer.
- Partial-Support Telecom Time Subordinate Clocks (T-TSC-P and T-TSC-A)—A subordinate clock synchronizes its local clock to another PTP clock (GM, T-GM or T-BC), and does not provide synchronization through PTP to any other device. Considerations for a T-TSC-P:
  - An ordinary clock with single subordinate port can be configured.
  - Only one peer clock address can be configured as clock source.

Note

- Ordinary clocks (OC) always have only one PTP port.
- In G.8275.2 (02/2016), PTP transparent clocks are not permitted.

PTP Domain

A PTP domain is a logical grouping of clocks that communicate with each other using the PTP protocol.

A single computer network can have multiple PTP domains operating separately, for example, one set of clocks synchronized to one time scale and another set of clocks synchronized to another time scale. PTP can run over either Ethernet or IP, so a domain can correspond to a local area network or it can extend across a wide area network.

The allowed domain numbers of PTP domains within a G.8275.2 network are in the range of 44 and 63 (both inclusive). The default domain number is 44.

PTP Messages and Transport

The following PTP transport parameters are defined:

- In Cisco IOS XE Fuji 16.8.1, PTP over IPv4 in unicast mode must be used.
- One-step clock mode must be used.
- The G.8275.2 profile supports unicast message negotiation.

PTP Ports

A port can be configured to perform either fixed primary or subordinate role or can be configured to change its role dynamically. If no role is assigned to a port, it can dynamically assume a primary, passive, or subordinate role based on the BMCA.

In G.8275.2, PTP ports are not tied to any specific physical interfaces, but are tied to a loopback (virtual) interface. Traffic from a PTP port is routed through any physical interface based on the routing decision.

For a dynamic port, only one clock source can be configured.

Alternate BPCA

The BPCA (Best Primary Clock Algorithm, which is also known as Best Master Clock Algorithm (BMCA [RFCÂ 7273]) implementation in G.8275.2 is different from that in the default PTP profile. The G.8275.2 implementation specifies an alternate best primary clock algorithm (ABPCA), which is used by each device to select a clock to synchronize to, and to decide the port states of its local ports.

The following consideration apply to the G.8275.2 implementation of the BPCA:

- PrimaryOnly—A per port attribute, PrimaryOnly defines the state of the port. If this attribute is true, the port is never placed in the subordinate state.
- Priority 1—Priority 1 is always static in this profile and is set to 128. Priority 1 is not used in BPCA.
- Priority 2—Priority 2 is a configurable value and its range if from 0 to 255.
- Local Priority—Local priority is configured locally on clock ports to set the priority on nominated clocks. The default value is 128 and valid range is from 1 to 255.

Benefits

With upcoming technologies like LTE-TDD, LTE-A CoMP, LTE MBSFN and Location-based services, eNodeBs (base station devices) are required to be accurately synchronized in phase and time. Having GNSS systems at each node is not only expensive, but also introduces vulnerabilities. The G.8275.2 profile meets the synchronization requirements of these new technologies.

Restrictions for Using the G.8275.2 Profile

- In G.8275.2, PTP can be used in both hybrid mode and non-hybrid mode. In hybrid mode, PTP is used to provide phase and time-of-day throughout the network synchronization along with PHY layer frequency support (SyncE). In non hybrid mode, PTP is used without PHY layer frequency support (SyncE).

- A G.8275.2 PTP clock can have redundant clock sources configured (through multiple PTP ports). However, at any given time, a G.8275.2 PTP clock synchronizes to only one clock source, which is selected by BMCA.
- The G.8275.2 does not provide any recommendations for performance analysis and network limits for the clocks.

How to Configure the G.8275.2 Profile

Creating an Ordinary Subordinate (T-TSC-P)

Cisco cBR-8 supports PTP ordinary clock subordinate mode with G8275.2 profile. In this mode, PTP ports are either on the Supervisor PIC cards or on the 10GE Ethernet ports on the DPIC cards.

To create an ordinary subordinate, run the following steps:

```
ptp clock Ordinary domain 44
            clock-port slave-port slave profile G.8275.2
              transport ipv4 unicast interface lo 0 negotiation
              clock source 10.1.1.1
```

Configuring Dual PTP Primary Clocks

Dual PTP primary clocks must connect to the same grandmaster. Both PTP primary clocks and the grandmaster must be set to Priority 2 configuration. You must set the minimum Priority 2 value for the grandmaster to keep the highest priority. The PTP primary clocks connected to the grandmaster must have a Priority 2 value.

The following example shows a grandmaster in the Dual PTP primary clocks configuration:

```
Router# show run | se ptp
license feature ptp
ptp clock ordinary domain 44
  priority2 2
  clock-port master-to-two903 master profile g8275.2
   sync interval -5
   sync one-step
   transport ipv4 unicast interface Lo1588 negotiation
```

Configuring the G.8275.2 Profiles

To configure G.8275.2 Profiles, run the following steps:

```
Router# config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# ptp clock ordinary domain 55
Router(config-ptp-clk)#servo tracking-type R-DTI
Router(config-ptp-clk)#clock-port slave-port slave profile g8275.2
Router(config-ptp-port)# delay-req interval -4
Router(config-ptp-port)# sync interval -4
Router(config-ptp-port)# sync one-step
Router(config-ptp-port)# transport ipv6 unicast interface Lo1588 negotiation
Router(config-ptp-port)# clock source ipv6 2001:158:158:158::158
```

Configuring an IPv4 Single Clock Source

To configure IPv4 single clock source, run the following steps:

```
ptp clock ordinary domain <domain id>
  servo tracking-type R-DTI
  clock-port <name> slave profile g8275.2
   delay-req interval < Interval>
   sync interval < Interval>
   sync one-step
   transport ipv4 unicast interface <loopback name> negotiation
   clock source <clock ip>
```

Configuring an IPv6 Single Clock Source

To configure IPv6 single clock source, run the following steps:

```
ptp clock ordinary domain <domain id>
  servo tracking-type R-DTI
  clock-port <name> slave profile g8275.2
   delay-req interval < Interval>
   sync interval < Interval>
   sync one-step
   transport ipv6 unicast interface <loopback name> negotiation
   clock source ipv6 <clock ip>
```

Verifying the G.8275.2 Profile

To verify the G.8275.2 profile, run the following command:

```
Router# show run | se ptp
ptp clock ordinary domain 55
servo tracking-type R-DTI
clock-port slave-port slave profile g8275.2
   delay-req interval -4
sync interval -4
   sync one-step
   transport ipv6 unicast interface Lo1588
negotiation
   clock source ipv6 2001:158:158:158::158
```

Configuration Examples

The following example shows IPv4 single clock source configuration:

```
ptp clock ordinary domain 55
  servo tracking-type R-DTI
  clock-port slave-from-903 slave profile g8275.2
   delay-req interval -4
   sync interval -5
   sync one-step
   transport ipv4 unicast interface Lo1588 negotiation
   clock source 10.90.3.93
```

The following example shows IPv6 single clock source configuration:

```
ptp clock ordinary domain 55 profile g8275.2
  servo tracking-type R-DTI
  clock-port slave-from-903 slave profile g8275.2
```

```
delay-req interval -4
sync interval -5
sync one-step
transport ipv6 unicast interface Lo1588 negotiation
clock source ipv6 2001:10:90:3::93
```

DPIC PTP Primary

Effective Cisco IOS XE Fuji 16.12.1y, Cisco cBR Converged Broadband router provides support for Digital Physical Interface Card (DPIC) Precision Time Protocol (PTP) Primary. With the DPIC PTP Primary feature, RPD syncs to the PTP primary with some switch between them.

Note The DPIC PTP Primary feature is only supported on DPIC40, and not supported on DPIC100.

The DPIC PTP Primary feature has the following capabilities:

- PTP primary works as ordinary clock (OC mode) when using default profile.
- PTP primary works as Boundary clock (BC mode limited) only when using G8275.2 Profile.
- Supports PTP One-step mode
- Supports IPv4/IPv6 UDP PTP packets
- Supports up to 200 RPDs, 100 RPDs when ptp redundancy is configured.
- Supports G8275.2 Profile
- Supports SUPHA and LCHA configurations

Note The following scenarios are not supported:

- PTP packets that are sent and received through SUPPIC or DPIC100.
- Boundary clock mode with both primary and subordinate clock port.
- Two-step mode.
- Dual Stack (IPv4/v6).

Configuring DPIC PTP Primary

The DPIC PTP Primary configuration involves the following steps in sequence:

1. Basic setup
   a. Configure cBR as PTP Primary with its loopback interface.

      Ensure that the IP address of cBR loopback interface and RPD core interface should be in global or same VPN Routing/Forwarding (VRF).

b. In RPD, configure cBR loopback as its PTP Primary IP.

c. Ensure that the RPD uses its core interface IP as its PTP Gateway.

Note The PTP traffic between cBR loopback interface and RPD are routed through the RPD core interface. Therefore, IP address of the cBR loopback interface and RPD core interface should be in global or same VRF.

2. PTP setup redundancy

If Line Card High Availability (LCHA) is configured, RPD uses the corresponding DPIC interface on standby LC as it is an alternate clock source and gateway. Use the following snippet to configure the LCHA for PTP redundancy:

```
ptp r-dti <id>
ptp-domain <domain id>
 clock-port <port id>
   clock source <ip address> gateway ip <ip address >
   clock source <ip address> gateway ip <ip address >alternate
```

3. Configure using either of the following formats:

- With Default Profile
  - For cBR PTP configuration:

```
ptp clock ordinary domain <domain id>
 servo tracking-type R-DTI
 clock-port <port_name0> master
  sync interval <interval>
  sync one-step
  transport <ipv4/ipv6> unicast interface <loopback0> negotiation
 clock-port <port_name1> master
  sync interval <interval>
  sync one-step
  transport <ipv4/ipv6> unicast interface <loopback1> negotiation
  clock-port <port_name2> master
  sync interval <interval>
  sync one-step
  transport <ipv4/ipv6> unicast interface <loopback2> negotiation
.
.
.
 clock-port <port_name63> master
  sync interval <interval>
  sync one-step
  transport <ipv4/ipv6> unicast interface <loopback63> negotiation
```

Note cBR supports up to 64 clock-ports.

  - For RPD PTP configuration:

```
ptp r-dti <id>
 ptp-domain <domain id>
```

```
 clock-port <port id>
   ethernet x
   [transport ipv6]
   clock source [ipv6] <ip address> gateway ip <ip address >
   clock source [ipv6] <ip address> gateway ip <ip address >alternate
```

Note The gateway ip is the active and standby core interface

- With G8275.2 Profile
  - For cBR PTP configuration:

```
ptp clock boundary domain <domain id>
 servo tracking-type R-DTI
 clock-port <port_name0> master  profile G8275.2
  sync interval <interval>
  sync one-step
  transport <ipv4/ipv6> unicast interface <loopback0> negotiation
 clock-port <port_name1> master  profile G8275.2
  sync interval <interval>
  sync one-step
  transport <ipv4/ipv6> unicast interface <loopback1> negotiation
  clock-port <port_name2> master profile G8275.2
  sync interval <interval>
  sync one-step
  transport <ipv4/ipv6> unicast interface <loopback2> negotiation
.
.
.
 clock-port <port_name63> master profile G8275.2
  sync interval <interval>
  sync one-step
  transport <ipv4/ipv6> unicast interface <loopback63> negotiation
```

Note By the ITU G8275.2 Profile specification, the ordinary clock supports only one clock-port with G8275.2 Profile. You need to use the boundary clock if you have scenarios where multiple clock-ports are required.

  - For RPD PTP configuration:

```
ptp r-dti <id>
 profile G.8275.2
 ptp-domain <domain id>
 clock-port <port id>
   ethernet x
   [transport ipv6]
   clock source [ipv6]  <ip address> gateway ip <ip address >
   clock source [ipv6]  <ip address> gateway ip <ip address >alternate
```

Note The gateway IP is the active and standby core interface.

Verifying the DPIC PTP Primary

Use the following options to verify your DPIC PTP Primary configuration:

- To check the cBR and RPD PTP configuration, use the **show run | se ptp** command. The syntax is as follows:

```
show run | se ptp

ptp clock boundary domain <domain id>
 servo tracking-type R-DTI
 clock-port <port_name0> master  profile G8275.2
  sync interval <interval>
  sync one-step
  transport <ipv4/ipv6> unicast interface <loopback0> negotiation
 clock-port <port_name1> master  profile G8275.2
  sync interval <interval>
  sync one-step
  transport <ipv4/ipv6> unicast interface <loopback1> negotiation
  clock-port <port_name2> master profile G8275.2
  sync interval <interval>
  sync one-step
  transport <ipv4/ipv6> unicast interface <loopback2> negotiation
.
.
.
 clock-port <port_name63> master profile G8275.2
  sync interval <interval>
  sync one-step
  transport <ipv4/ipv6> unicast interface <loopback63> negotiation
```

- To check the PTP Primary state, you can use the **show ptp clock running domain <id>** command. See the following example:

```
Router# show ptp clock running domain 55
Load for five secs: 4%/0%; one minute: 4%; five minutes: 4%
Time source is NTP, 04:34:17.164 CST Tue Dec 19 2017



                    PTP Boundary Clock [Domain 55]

        State          Ports          Pkts sent      Pkts rcvd      Redundancy Mode

        FREQ_LOCKED    2              2005322        971815         Hot standby

                              PORT SUMMARY
                                                                    PTP Master
Name  Tx Mode      Role         Transport    State        Sessions     Port Addr

22    unicast      master       Lo1588       Master       2            -
33    unicast      master       Lo1589       Master       2            -


                             SESSION INFORMATION

22 [Lo1588] [Sessions 2]

Peer addr                              Pkts in    Pkts out   In Errs    Out Errs
```

```
2001:120:101:16:A94F:61DB:D324:76B4     240839     497336     0          0
2001:120:101:16:2827:F9A6:4332:81AF     245193     505541     0          0

33 [Lo1589] [Sessions 2]

Peer addr                               Pkts in    Pkts out   In Errs    Out Errs

2001:120:101:16:A94F:61DB:D324:76B4     240582     496880     0          0
2001:120:101:16:2827:F9A6:4332:81AF     245201     505565     0          0
Router#
```

- To check detailed stream statistics, use the **show platform software ptpd stat stream <id|ip>** command. For example:

```
Router# show platform software ptpd stat stream 2001:120:101:16:A94F:61DB:D324:76B4
Load for five secs: 5%/0%; one minute: 4%; five minutes: 4%
Time source is NTP, 04:40:43.466 CST Tue Dec 19 2017
IP-Address : 2001:120:101:16:a94f:61db:d324:76b4 Stream-Number: 0
SYNC Contract
Remaining Duration : 105 (secs),  State : ACTIVE
Tx packets : 247592, Rx Packets : 0 Error Packets : 0
Announce Contract
Remaining Duration : 105 (secs),  State : ACTIVE
Tx packets : 15490, Rx Packets : 0 Error Packets : 0
Delay-Response Contract
Remaining Duration : 101 (secs),  State : ACTIVE
Tx packets : 246878, Rx Packets : 0 Error Packets : 0

Router# show platform software ptpd stat stream 0
Load for five secs: 3%/0%; one minute: 4%; five minutes: 4%
Time source is NTP, 04:40:26.810 CST Tue Dec 19 2017
LOCK STATUS : FREERUN
SYNC Packet Stats
Time elapsed since last packet: 0.0
Configured Interval : -4, Acting Interval -4
Tx packets : 247325,  Rx Packets : 0
Last Seq Number : 0,  Error Packets : 0
Delay Req Packet Stats
Time elapsed since last packet: 0.0
Configured Interval : 0, Acting Interval : -4
Tx packets : 0, Rx Packets : 246612
Last Seq Number : 26116, Error Packets : 0
Delay Response Packet Stats
Time elapsed since last packet: 0.0
Configured Interval : -4, Acting Interval : -4
Tx packets : 246612, Rx Packets : 0
Last Seq Number : 0, Error Packets : 0
Announce Packet Stats
Time elapsed since last packet: 0.0
Configured Interval : 0, Acting Interval : 0
Tx packets : 15474, Rx Packets :  0
Last Seq Number 0 Error Packets 0
Signalling Packet Stats
Time elapsed since last packet: 0.0
Configured Interval : 0, Acting Interval : 0
Tx packets : 162, Rx Packets : 162
Last Seq Number : 0, Error Packets : 0
Current Data Set
Offset from master :  +0.000000000
Mean Path Delay    :  +0.000000000
Forward Path Delay :  +0.000000000
Reverse Path Delay :  +0.000000000
```

```
Steps Removed 0
General Stats about this stream
Packet rate : 0, Packet Delta (ns) : 0
Clock Stream handle : 0, Index : 0
Oper State : 3, Sub oper State : 6
Log mean sync Interval : 0, log mean delay req int : 0
```

- To check the RPD PTP state, you can use the following commands:
  - **show ptp clock 0 state** command is used to check the PTP state on RPD. For example:

```
Router# show ptp clock 0 state
apr state       : PHASE_LOCK
clock state     : SUB_SYNC
current tod     : 1423125872   Thu Feb  5 08:44:32 2015
active stream   : 0
==stream    0   :
port id       :                0
master ip     : 2001:158:158:158::158
stream state  :       PHASE_LOCK
Master offset :             -110
Path    delay :              957
Forward delay :              888
Reverse delay :             1026
Freq offset   :          -418299
1Hz  offset   :               40
==stream    1   :
port id       :                0
master ip     : 2001:158:158:158::159
stream state  :       PHASE_LOCK
Master offset :              -15
Path    delay :              969
Forward delay :              916
Reverse delay :             1023
Freq offset   :          -418526
1Hz  offset   :               47
Router#
```

  - The **show ptp clock 0 statistics** command is used to check PTP packets statistics on RPD. See the following example usage:

```
Router# show ptp clock 0 statistics
AprState    4  :
           2@0-00:11:41.897          1@0-00:11:32.266          0@0-00:09:37.062
           4@0-00:09:17.861
ClockState  5  :
           5@0-00:12:02.947          4@0-00:11:59.305          3@0-00:11:55.663
           2@0-00:11:42.664          1@0-00:11:41.866
BstPktStrm  1  :
           0@0-00:09:10.010
StepTime    1  :
   773016962@0-00:11:01.145
AdjustTime  3  :
          12@0-00:13:57.520       -280@0-00:13:33.895      -1137@0-00:11:27.895
fwdFltr     0  :
           Total: 4828                        Drop: 513
            MEAN: 973                       stdDev: 974
       Threshold:     -299027 ~ 300973      shrink: 85714
revFltr     0  :
           Total: 4827                        Drop: 513
            MEAN: 950                       stdDev: 951
       Threshold:     -299050 ~ 300950      shrink: 85714
```

```
fwdFltr     1  :
           Total: 1507                       Drop: 256
            MEAN: 974                      stdDev: 975
       Threshold:     -299026 ~ 1373       shrink: 42914
revFltr     1  :
           Total: 1505                       Drop: 257
            MEAN: 947                      stdDev: 947
       Threshold:         619 ~ 300947      shrink: 42904
streamId  msgType           rx          rxProcessed     lost        tx
0        SYNC              4828        4828            0           0
0        DELAY REQUEST     0           0               0           4827
0        P-DELAY REQUEST   0           0               0           0
0        P-DELAY RESPONSE  0           0               0           0
0        FOLLOW UP         0           0               0           0
0        DELAY RESPONSE    4827        4827            3           0
0        P-DELAY FOLLOWUP  0           0               0           0
0        ANNOUNCE          314         314             0           0
0        SIGNALING         5           5               0           5
0        MANAGEMENT        0           0               0           0
   TOTAL                    9974        9974            3           4832
1        SYNC              1507        1507            0           0
1        DELAY REQUEST     0           0               0           1505
1        P-DELAY REQUEST   0           0               0           0
1        P-DELAY RESPONSE  0           0               0           0
1        FOLLOW UP         0           0               0           0
1        DELAY RESPONSE    1505        1505            2           0
1        P-DELAY FOLLOWUP  0           0               0           0
1        ANNOUNCE          103         103             0           0
1        SIGNALING         2           2               0           7
1        MANAGEMENT        0           0               0           0
   TOTAL                    3117        3117            2           1512
Router#
```

Feature Information for G.8275.2 Profile

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 1: Feature Information for G.8275.2 Profile

Feature Name	Releases	Feature Information
G.8275.2 Profile	Cisco IOS XE Fuji 16.8.1	This feature was introduced in Cisco IOS XE Fuji 16.8.1 on Cisco cBR Series Converged Broadband Router.
DPIC PTP Primary	Cisco IOS XE Gibraltar 16.12.1y	This feature was introduced in Cisco IOS XE Gibraltar 16.12.1y on Cisco cBR Series Converged Broadband Router.