Configuring Precision Time Protocol

Precision Time Protocol (PTP) is a protocol that defines a method to distribute time around a network. PTP support is based on the IEEE 1588-2008 standard. This module describes the concepts around this protocol and details the various configurations involved.

This module contains the following topics:

- PTP Overview, on page 1
- ITU-T Telecom Profiles for PTP, on page 16
- PTP Holdover Traceability Suppression, on page 24
- Configuring PTP , on page 25
- Configuration Examples, on page 36

PTP Overview

The Precision Time Protocol (PTP), as defined in the IEEE 1588 standard, synchronizes with nanosecond accuracy the real-time clocks of the devices in a network. The clocks are organized into a master-slave hierarchy. PTP identifies the port that is connected to a device with the most precise clock. This clock is referred to as the master clock. All the other devices on the network synchronize their clocks with the master and are referred to as members. Constantly exchanged timing messages ensure continued synchronization. PTP ensures that the best available clock is selected as the source of time (the grandmaster clock) for the network and that other clocks in the network are synchronized to the grandmaster.

Table 1: PTP Clocks

Network Element	Description
Grandmaster (GM)	A network device physically attached to the primary time source. All clocks are synchronized to the grandmaster clock.

Network Element	Description
Ordinary Clock (OC)	An ordinary clock is a 1588 clock with a single PTP port that can operate in one of the following modes: • Master mode—Distributes timing information over the network to one or more slave clocks, thus allowing the slave to synchronize its clock to the master. • Slave mode—Synchronizes its clock to a master clock. You can enable the slave mode on up to two interfaces simultaneously in order to connect to two different master clocks.
Boundary Clock (BC)	The device participates in selecting the best master clock and can act as the master clock if no better clocks are detected. Boundary clock starts its own PTP session with a number of downstream slaves. The boundary clock mitigates the number of network hops and packet delay variations in the packet network between the Grand Master and Slave.
Transparent Clock (TC)	A transparent clock is a device or a switch that calculates the time it requires to forward traffic and updates the PTP time correction field to account for the delay, making the device transparent in terms of time calculations.

PTP consists of two parts:

- The port State machine and Best Master Clock Algorithm: This provides a method to determine state of the ports in the network that will remain passive (neither master nor slave), run as a master (providing time to other clocks in the network), or run as slaves (receiving time from other clocks in the network).
- Delay-Request/Response mechanism and a Peer-delay mechanism: This provides a mechanisms for slave ports to calculate the difference between the time of their own clocks and the time of their master clock.

Note Transparent Clock (TC) is not supported.

Frequency and Time Selection

The selection of the source to synchronize the device clock frequency is made by frequency synchronization, and is outside of the scope of PTP. The Announce, Sync, and Delay-request frequencies must be the same on the master and slave.

Delay-Response Mechanism

The Delay Request-response mechanism (defined in section 11.3 of IEEE Std 1588-2008) lets a slave port estimate the difference between its own clock-time and the clock-time of its master. The following options are supported:

- One-step mechanism - The timestamp for a Sync message is sent in the Sync message itself.
- Two-step mechanism - The timestamp for a Sync message is sent later in a Follow-up message.

When running a port in Slave state, a router can send Delay-request messages and handle incoming Sync, Follow-up, and Delay-response messages. The timeout periods for both Sync and Delay-response messages are individually configurable.

Hybrid Mode

Your router allows the ability to select separate sources for frequency and time-of-day (ToD). Frequency selection can be between any source of frequency available to the router, such as: BITS, GPS, SyncE or IEEE 1588 PTP. The ToD selection is between the source selected for frequency and PTP, if available (ToD selection is from GPS, or PTP). This is known as hybrid mode, where a physical frequency source (BITS or SyncE) is used to provide frequency synchronization, while PTP is used to provide ToD synchronization.

Frequency selection uses the algorithm described in ITU-T recommendation G.781. The ToD selection is controlled using the time-of-day priority configuration. This configuration is found under the clock interface frequency synchronization configuration mode and under the global PTP configuration mode. It controls the order for which sources are selected for ToD. Values in the range of 1 to 254 are allowed, with lower numbers indicating higher priority.

The steps involved in Configuring PTP Hybrid Mode is described in a subsequent section in this chapter.

Time of Day (ToD) Support

The router receives GPS ToD messages in serial ASCII stream through the RS422 interface in any of the following formats:

- NTP Type 4
- Cisco
- NMEA - GPZDA

Note You can refer to the below support information in context of the current release and see relevant *Release Notes* for more information on supported features and hardware.

Port States

State machine indicates the behavior of each port. The possible states are:

State	Description
INIT	Port is not ready to participate in PTP.

State	Description
LISTENING	First state when a port becomes ready to participate in PTP: In this state, the port listens to PTP masters for a (configurable) period of time.
PRE-MASTER	Port is ready to enter the MASTER state.
MASTER	Port provides timestamps for any Slave or boundary clocks that are listening.
UNCALIBRATED	Port receives timestamps from a Master clock but, the router's clock is not yet synchronized to the Master.
SLAVE	Port receives timestamps from a Master clock and the router's clock is synchronized to the Master.
PASSIVE	Port is aware of a better clock than the one it would advertise if it was in MASTER state and is not a Slave clock to that Master clock.

Restrictions for PTP

The following PTP restrictions apply to the Cisco NCS 5500 Series Router:

- NCS55-RP does not support PTP
- NC55-18H18F line card does not support PTP
- SyncE is not supported on a 1GE copper SFP.
- SyncE is not supported on 25 GE or 100 GE interfaces when they are used in 1G mode.
- Sync2 interface is supported only if 10 MHz, 1 Pulse per Second (PPS) and time-of-day (ToD) ports are configured.
- PTP is not supported with MACSec.
- G.8273.2 Class-A performance is met if CFP2-DCO is configured on either Slave or Master port on the node.
- Transparent Clock is not supported.
- PTP over MPLS is not supported.

Note

- We recommend you to configure, and enable Frequency Synchronization selection input on two interfaces per line card.
- For link aggregation, you must configure and enable Frequency Synchronization selection input on a single bundle member.

PTP Support Information

This table lists different types of support information related to PTP:

Transport Media	• UDP over IPv4 • Ethernet
Messages	• Signaling • Announce • Sync • Follow-up • Delay-request • Delay-response • Management
Transport Modes	• Unicast: This is the default mode. All packets are sent as unicast messages. Unicast is applicable only for PTP over IP profiles. • Multicast: All packets are sent as multicast messages. Multicast is the only mode for PTP over ethernet profiles.

PTP Hardware Support Matrix

Note The table also contains support details of upcoming releases. You can read this table in context of the current release and see relevant *Release Notes* for more information on supported features and hardware.

This table provides a detailed information on the timing features that are supported on the following hardware variants.

Hardware Variant	Features	Cisco IOS XR Release	Comments
NCS-57B1-6D24-SYS NCS-57B1-5DSE-SYS NCS-57D2-18DD-SYS	Default profile	Release 7.11.1	With this release, PTP Class C performance and QSFP-DD optics are now supported on 400G port speed.
	G.8265.1		
	G.8275.1		
	G.8275.2		

Hardware Variant	Features	Cisco IOS XR Release	Comments
NC57-48Q2D-S NC57-48Q2D-SE-S	G8275.1	Release 7.10.1	With this release, SyncE and PTP Class-C, Class-B performance is supported on 1G, 10G, 25G, 40G and 100G port speeds. On 50G and 400G ports speeds, only timing functionality is supported. PTP support is available on compatible mode. PTP with Class-C is not achieved with macsec on any interface speed. **Note** For 1G Class C port speed, only port 32 and 40 are supported. It is not recommended to plug in 1G optics to ports greater than or equal to port 32.
NC57-36H6D-S	G8265.1 G8275.1 G8275.2 Default Profile	Release 7.10.1	With this release, timing support for PTP and SyncE is extended to 4x10G and 4x25G breakout ports of NC57-36H6D-S in native mode. Class B and Class C performances are supported on 4x10G and 4x25G breakout ports in native mode. Route Processor: NC55-RP2-E

Hardware Variant	Features	Cisco IOS XR Release	Comments
NC57-36H-SE	G8265.1	Release 7.10.1	With this release, timing support for PTP and SyncE is extended to 4x10G breakout port of NC57-36H-SE is in native mode. Class B performance is supported on 4x10G breakout port in native mode. Route Processor: NC55-RP2-E
	G8275.1		
	G8275.2		
	Default Profile		
NCS-57C1-48Q6-SYS	G.8265.1	Release 7.10.1	G.8273.2 Class C is supported on 400G interfaces with the following optics modules: • Cisco QSFPDD 400G FR4 Pluggable Optics Module • Cisco QSFPDD 400G LR4 Pluggable Optics Module
	G.8275.1		
	G.8275.2		
	Default Profile		
NCS-57D2-18DD-SYS	G.8265.1	Release 7.8.1	With this release,PTP is supported on 400G, 100G and 40G ports. Class C performance on 100G and 40G ports.
	G.8275.1	Release 7.8.1	
	G.8275.2	Release 7.8.1	
	Default Profile	Release 7.8.1	
NCS-57C3-MODS-SYS NCS-57C3-MODS-SYS	PTP Virtual Port and APTS	Release 7.7.1	
NCS-57B1-6D24-SYS	PTP Virtual Port and APTS	Release 7.7.1	
NCS-57C1-48Q6-SYS	Default profile	Release 7.5.1	
	G.8265.1	Release 7.5.1	
	G.8275.1	Release 7.5.1	
	G.8275.2	Release 7.5.1	

Hardware Variant	Features	Cisco IOS XR Release	Comments
RP:NC57-MOD-RP-2E with NCS573-MODS-SYS and NCS-573-MOD-SYS	G.8275.1	Release 7.4.1	
	G.8273.2	Release 7.4.1	
	GNSS	Release 7.4.1	
NCS-57B1-5DSE-SYS NCS-57B1-6D24-SYS	Default profile	Release 7.3.1	
	G.8265.1	Release 7.3.1	
	G.8275.1	Release 7.3.1	
	G.8275.2	Release 7.3.1	
RP: NC55-RP2-E Line card: NC57-36H6D-S	G.8275.1	Release 7.3.2	• Release 7.3.2 - Supports Compatible Mode only • Release 7.7.1 - Supports both Native and Compatible mode.
	G.8273.2	Release 7.3.2	• Release 7.3.2 - Supports Compatible Mode only • Release 7.7.1 - Supports both Native and Compatible mode.
RP:NC55-RP-E with Line cards: NC55-MOD-A-S and NC55-32T16Q4H-AT	BITS	Release 7.1.1	
	G8275.1	Release 7.1.1	For the profile G8275.1 NC55-32T16Q4H-AT supports only T-BCand does not support T-GM. 25G/100G/40G is supported from IOSXR release 7.2.2 onwards.
	G8273.2	Release 7.1.1	Class B

Hardware Variant	Features	Cisco IOS XR Release	Comments
RP:NC55-RP2-E with Line cards: NC55-MOD-A-S and NC55-32T16Q4H-AT	BITS	Release 7.1.1	
	G.8275.1	Release 7.1.1	For the profile G8275.1 NC55-32T16Q4H-AT supports only T-BC and does not support T-GM. 25G/100G/40G is supported from IOSXR release 7.2.2 onwards.
	G.8273.2	Release 7.1.1	Class B
RP:NC55-RP2-E with Line card:NC55-32T16Q4H-AT	BITS	Release 7.1.1	
	G8275.1	Release 7.1.1	For the profile G8275.1 NC55-32T16Q4H-AT supports only T-BCand does not support T-GM. 25G/100G/40G is supported from IOSXR release 7.2.2 onwards.
	G.8273.2	Release 7.1.1	Class C
NCS-55A1-36H-SE-S	G.8265.1	Release 7.0.1	
	G.8275.1	Release 7.0.1	
	G.8275.2	Release 7.0.1	
	G.8273.2	Release 7.0.1	Class B
NCS-55A1-36H-S	G.8265.1	Release 7.0.1	
	G.8275.1	Release 7.0.1	
	G.8275.2	Release 7.0.1	
	G.8273.2	Release 7.0.1	Class B
NCS-55A1-24Q6H-S NCS-55A1-24Q6H-SS	G.8265.1	Release 6.6.25	
	G.8275.1	Release 6.6.25	
	G.8275.2	Release 6.6.25	From Release 7.7.1, support is available for PTP over IPv6 for ports 10G-25G and 40G-100G
	G.8273.2	Release 6.6.25	Class B

Hardware Variant	Features	Cisco IOS XR Release	Comments
NCS-55A1-48Q6H	G.8265.1	Release 6.6.25	
	G.8275.1	Release 6.6.25	
	G.8275.2	Release 6.6.25	
	G.8273.2	Release 6.6.25	Class B
NCS-55A1-24H	G.8265.1	Release 6.5.2	
	G.8275.1	Release 6.5.2	
	G.8275.2	Release 6.5.2	
	G.8273.2	Release 6.5.2	Class B
NCS55A2-MOD	G.8265.1	Release 6.5.1	
	G.8275.1	Release 6.5.1	
	G.8275.2	Release 6.5.1	
	G.8273.2	Release 6.5.1	Class B
RP:NC55-RP-E Linecard:NC55-MOD-A-S	BITS	Release 6.5.1	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
	G.8265.1	Release 6.5.1	
	G.8275.1	Release 6.5.1	
	G.8275.2	Release 6.5.1	This profile is supported from Release 6.5.1 for Ipv4.
	G.8273.2	Release 6.5.1	Class B
RP:NC55-RP-E Linecard:NC55-36X100G-A-SE	G.8273.2	Release 6.3.2	Class B
	BITS	Release 6.3.2	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
	G.8265.1	Release 6.3.2	
	G.8275.1	Release 6.3.2	
	G.8275.2	NA	
	G.8273.2	Release 6.3.2	Class B

Hardware Variant	Features	Cisco IOS XR Release	Comments
NCS5501-SE	G.8265.1	Release 6.3.2	
	G.8275.1	Release 6.3.2	Class B
	G.8275.2	Release 6.3.2	
	GNSS External	Release 6.3.2	

Hardware Variant-Specific Behaviour

The line card NC55-32T16Q4H-AT displays the following behaviour when configured for PTP:

- The timing features are supported on all ports of the line cards.
- The NC55-RP2-E does not support PTP on the 1588 Port.
- To configure Class C for the profile G.8273.2 when you use NC55-RP2-E with line card NC55-32T16Q4H-AT, follow the example below:

```
RP/0/RP0/CPU0:router# config
RP/0/RP0/CPU0:router(config)#frequency synchronization
RP/0/RP0/CPU0:router(config-freqsync)#timing-accuracy enhanced
RP/0/RP0/CPU0:router(config-freqsync)#commit
```

While configuring PTP on the NCS-57C3-MODS-SYS and NCS-57C3-MOD-SYS, the location must be:

```
0/0/CPU0:router instead of RP/0/RP0/CPU0:router
```

Note Cisco NCS 5500 Series Routers support 64 PTP clients at 64 PPS sync packet rate.

Timing features are supported on the following MPAs:

- NC57-MPA-12L-S
- NC55-MPA-2TH-S
- NC55-MPA-1TH2H-S
- NC55-MPA-1TH2H-HD-S
- NC55-MPA-4H-S
- NC55-MPA-4H-HD-S
- NC55-MPA-12T-S

Table 2: Timing Features Supported on MPAs

Hardware Variant	Features	Cisco IOS XR Release	Comments
NC57-MPA-1FH1D-S	PTP is supported on the following profiles: • G8265.1 • G8275.1 • G8275.2 • Default Profile	Release 7.8.1	Class-C is supported only on QSFP 100G and 40G ports in native mode. Router processor: NC57-MOD-RP2-E with NCS-57C3-MOD-S and NCS-57C3-MOD-SE-S This feature provides only functionality support for PTP on QSFP 400G/200G and CFP2 DCO ports.
NC55-MPA-4H-S	PTP is supported on the following profiles: • G8265.1 • G8275.1 • G8275.2 • Default Profile	Release 7.7.1	Class B
NC55-MPA-2TH-S	PTP is supported on the following profiles: • G8265.1 • G8275.1 • G8275.2 • Default Profile	Release 7.7.1	PTP is supported on 100G and 200G mode. Route Processor:RP2-E
NC55-MPA-1TH2H-S	PTP is supported on the following profiles: • G8265.1 • G8275.1 • G8275.2 • Default Profile	Release 7.7.1	PTP is supported on 100G mode. Route Processor:RP2-E Class C is not supported on 200G port.

Hardware Variant	Features	Cisco IOS XR Release	Comments
NC57-MPA-12L-S	IEEE1588 timestamping on the PHY MPA is supported on the following line cards: • NCS-55A2-MOD-HD-S: Class B. • NCS-57C3-MODS-SYS: Class C • NC57-MOD-S, Line Card (Class B on RPE and Class C on RP2E with enhanced accuracy CLI) • NC55-MOD-A-S (Class B on both RPE and RP2E)	Release 7.6.1	Route Processors: • RP-E: Class B • RP2-E Enhanced: Class C

Breakout Timing Support

PTP Profiles 8275.1 and 8275.2 are supported on breakout ports on the following hardware PIDs:

Table 3: Breakout Timing Support Hardware Matrix

Hardware PID	Client Port	Server Port
NCS-55A1-36H-S	100G	25G Breakout
NCS-55A1-36H-S	100G	10G Breakout
NCS-55A1-48Q6H	10G	25G Breakout
NCS-55A1-48Q6H	100G	25G Breakout
NCS55A1-24Q6H-S	1G	25G Breakout
NCS55A1-24Q6H-S	10G	25G Breakout
NCS55A1-24Q6H-S	100G	25G Breakout
NCS-5501-SE	1G	10G Breakout
NCS-5501-SE	1G	25G Breakout
NCS-5501-SE	10G	10G Breakout
NCS-5501-SE	10G	25G Breakout
NC57-36H6D-S	25G	25G Breakout
NC57-36H6D-S	25G	10G Breakout

Hardware PID	Client Port	Server Port
NC57-36H6D-S	10G	25G Breakout
NC57-36H6D-S	10G	10G Breakout
NC57-36H-SE	10G	10G Breakout
NCS-57D2-18DD-SYS	10G	10G Breakout
NCS-57D2-18DD-SYS	25G Breakout	25G Breakout
NCS-57D2-18DD-SYS	10G Breakout	25G Breakout
NCS-57D2-18DD-SYS	25G Breakout	10G Breakout
NCS-57D2-18DD-SYS	10G Breakout	100G non-breakout
NCS-57D2-18DD-SYS	25G Breakout	100G non-breakout
NCS-57D2-18DD-SYS	10G Breakout	40G non breakout
NCS-57D2-18DD-SYS	25G Breakout	40G non breakout
NCS-57D2-18DD-SYS	100G non-breakout	10G Breakout
NCS-57D2-18DD-SYS	40G non-breakout	25G Breakout
NCS-57D2-18DD-SYS	100G non-breakout	25G Breakout
NCS-57D2-18DD-SYS	40G non-breakout	10G Breakout
NCS-57B1-6D24-SYS	10G Breakout	10G Breakout
NCS-57B1-6D24-SYS	25G Breakout	25G Breakout
NCS-57B1-6D24-SYS	10G Breakout	25G Breakout
NCS-57B1-6D24-SYS	25G Breakout	10G Breakout
NCS-57B1-6D24-SYS	10G Breakout	100G non-breakout
NCS-57B1-6D24-SYS	25G Breakout	100G non-breakout
NCS-57B1-6D24-SYS	10G Breakout	40G non breakout
NCS-57B1-6D24-SYS	25G Breakout	40G non breakout
NCS-57B1-6D24-SYS	100G non-breakout	10G Breakout
NCS-57B1-6D24-SYS	40G non-breakout	25G Breakout
NCS-57B1-6D24-SYS	100G non-breakout	25G Breakout
NCS-57B1-6D24-SYS	40G non-breakout	10G Breakout

Note The server ports 100G and 40G are used as breakout for 4x25G and 4x10G respectively. The client ports are used as direct ports of different port speeds as presented in the table, *Breakout Timing Support Hardware Matrix*.

Slow Tracking

Under normal configured conditions, any change in offset triggers an immediate reaction in the servo. With the Slow Tracking feature enabled, the servo corrects the phase offset based on the configured value. If the phase offset exceeds the acceptable range, servo goes into Holdover state. In such a condition, the Slow Tracking feature becomes inactive and the servo corrects itself to the latest offset and goes into Phase locked state. Slow Tracking becomes active again.

Note

- The supported slow tracking rate range is from 8-894 nanoseconds per second and must be in multiples of 8.
- This feature is active only when servo is in Phase locked mode.

```
Router:# config
ptp
clock
domain 24
profile g.8275.1 clock-type T-BC
!
profile profile1
multicast target-address ethernet 01-1B-19-00-00-00
transport ethernet
sync frequency 16
clock operation one-step
announce frequency 8
delay-request frequency 16
!
physical-layer-frequency
servo-slow-tracking 16
!
```

Double Failure Clock Class Over-ride

Table 4: Feature History Table

Feature Name	Release Information	Feature Description
PTP Double Failure Clock Class	Release 7.7.1	This feature enables you to configure a clock class that will over-ride the existing class during a state of double-failure where PTP and SyncE are lost. This feature introduces the **double-failure-clock-class** command.

ITU-T Telecom Profiles for PTP

Cisco IOS XR software supports ITU-T Telecom Profiles for PTP as defined in the ITU-T recommendations. A profile is a specific selection of PTP configuration options that are selected to meet the requirements of a particular application.

PTP lets you define separate profiles to adapt itself for use in different scenarios. A telecom profile differs in several ways from the default behavior defined in the IEEE 1588-2008 standard and the key differences are mentioned in the subsequent sections.

The following sections describe the ITU-T Telecom Profiles that are supported for PTP.

G.8265.1

G.8265.1 profile fulfills specific frequency-distribution requirements in telecom networks. Features of G.8265.1 profile are:

- Clock advertisement: G.8265.1 profile specifies changes to values used in Announce messages for advertising PTP clocks. The clock class value is used to advertise the quality level of the clock, while the other values are not used.
- Clock Selection: G.8265.1 profile also defines an alternate Best Master Clock Algorithm (BMCA) to select port states and clocks is defined for the profile. This profile also requires to receive Sync messages (and optionally, Delay-Response messages) to qualify a clock for selection.
- Port State Decision: The ports are statically configured to be Master or Slave instead of using state machines to dynamically set port states.
- Packet Rates: The packet rates higher than rates specified in the IEEE 1588-2008 standard are used. They are:
  - Sync/Follow-Up Packets: Rates from 128 packets-per-second to 16 seconds-per-packet.
  - Delay-Request/Delay-Response Packets: Rates from 128 packets-per-second to 16 seconds-per-packet.
  - Announce Packets: Rates from 8 packets-per-second to 64 packets-per-second.

- Transport Mechanism: G.8265.1 profile only supports IPv4 PTP transport mechanism.
- Mode: G.8265.1 profile supports transport of data packets only in unicast mode.
- Clock Type: G.8265.1 profile only supports Ordinary Clock-type (a clock with only one PTP port).
- Domain Numbers: The domain numbers that can be used in a G.8265.1 profile network ranges from 4 to 23. The default domain number is 4.
- Port Numbers: All PTP port numbers can only be one (1) because all clocks in this profile network are Ordinary Clocks.

G.8265.1 profile defines an alternate algorithm to select between different master clocks based on the local priority given to each master clock and their quality levels (QL). This profile also defines Packet Timing Signal Fail (PTSF) conditions to identify the master clocks that do not qualify for selection. They are:

- PTSF-lossSync condition: Raised for master clocks that do not receive a reliable stream of Sync and Delay-Resp messages. Cisco IOS XR software requests Sync and Delay-Resp grants for each configured master clock to track the master clock with this condition.
- PTSF-lossAnnounce condition: Raised for master clocks that do not receive a reliable stream of Announce messages.
- PTSF-unusable condition: Raised for master clocks that receives a reliable stream of Announce, Sync, and Delay-Resp messages, but not usable by slave clocks. Cisco IOS XR software does not use this condition.

G.8275.1

G.8275.1 profile fulfills the time-of-day and phase synchronization requirements in telecom networks with all network devices participating in the PTP protocol. G.8275.1 profile provides better frequency stability for the time-of-day and phase synchronization.

Features of G.8275.1 profile are:

- Synchronization Model: G.8275.1 profile adopts hop-by-hop synchronization model. Each network device in the path from master to slave synchronizes its local clock to upstream devices and provides synchronization to downstream devices.
- Clock Selection: G.8275.1 profile also defines an alternate BMCA that selects a clock for synchronization and port state for the local ports of all devices in the network is defined for the profile. The parameters defined as a part of the BMCA are:
  - Clock Class
  - Clock Accuracy
  - Offset Scaled Log Variance
  - Priority 2
  - Clock Identity
  - Steps Removed
  - Port Identity

- notSlave flag
- Local Priority

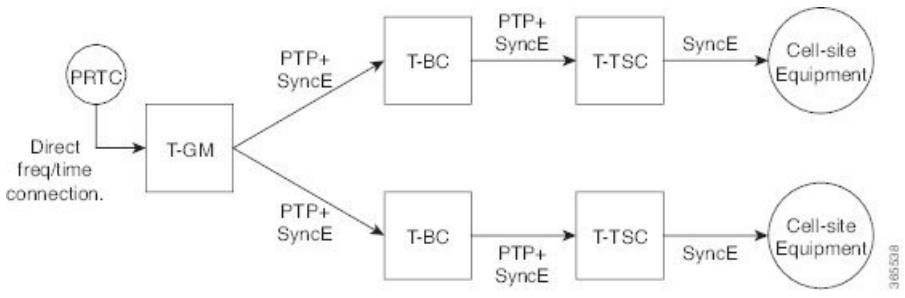
- Port State Decision: The port states are selected based on the alternate BMCA algorithm. A port is configured to a master-only port state to enforce the port to be a master for multicast transport mode.
- Packet Rates: The nominal packet rate for Announce packets is 8 packets-per-second and 16 packets-per-second for Sync/Follow-Up and Delay-Request/Delay-Response packets.
- Transport Mechanism: G.8275.1 profile only supports Ethernet PTP transport mechanism.
- Mode: G.8275.1 profile supports transport of data packets only in multicast mode. The forwarding is done based on forwardable or non-forwardable multicast MAC address.
- Clock Type: G.8275.1 profile supports the following clock types:
  - Telecom Grandmaster (T-GM): Provides timing for other network devices and does not synchronize its local clock to other network devices.
  - Telecom Time Slave Clock (T-TSC): A slave clock synchronizes its local clock to another PTP clock, but does not provide PTP synchronization to any other network devices.
  - Telecom Boundary Clock (T-BC): Synchronizes its local clock to a T-GM or an upstream T-BC clock and provides timing information to downstream T-BC or T-TSC clocks.
- Domain Numbers: The domain numbers that can be used in a G.8275.1 profile network ranges from 24 to 43. The default domain number is 24.

The G.8275.1 supports the following:

- T-GM: The telecom grandmaster (T-GM) provides timing to all other devices on the network. It does not synchronize its local clock with any other network element other than the Primary Reference Time Clock (PRTC).
- T-BC: The telecom boundary clock (T-BC) synchronizes its local clock to a T-GM or an upstream T-BC, and provides timing information to downstream T-BCs or T-TSCs. If at a given point in time there are no higher-quality clocks available to a T-BC to synchronize to, it may act as a grandmaster.
- T-TSC: The telecom time slave clock (T-TSC) synchronizes its local clock to another PTP clock (in most cases, the T-BC), and does not provide synchronization through PTP to any other device.

The following figure describes a sample G.8275.1 topology.

Figure 1: A Sample G.8275.1 Topology



Route Processor Fail Over

The Route processor fail over (RPFO) or stateful switchover (SSO) feature is supported on the Profile G.8275.1 on the Telecom Boundary Clock. Over a switchover, the time error might jump to a high value after losing lock with the T-GM clock. With this feature enabled, the time error will not increase by more than 400 nanoseconds over a switchover.

Note You must wait for a specific time duration to lapse to build holdover.

G.8275.2

Table 5: Feature History Table

Feature Name	Release Information	Description
ITU-T G.8275.2 and Default PTP profiles over IPv6	Release 7.8.1	For ITU-T G.8275.2 and the IEEE 1588 default PTP profiles, the encapsulation type for PTP packet transport is now extended to IPv6. This feature modifies the **transport** command to include the keyword **ipv6**.

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 in unicast mode.

Effective Cisco IOS XR Software Release 7.8.1, the G.8275.2 is capable of using PTP over IPv6 as well. You can now use the **transport ipv6** command to set this encapsulation type.

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 fifth generation (5G) of mobile telecommunications technology.

Note G.8275.2 profile is supported on Cisco NCS 5500 Series Routers. However, the performance standards of this profile is not aligned with any of the ITU-T standards because performance specifications for G.8275.2 profile has not yet been made available by ITU-T.

For more information on hardware that supports G.8275.2 profile configurations, refer to PTP Support Information section in this chapter.

Features of G.8275.2 profile are:

- *Clock Selection*: G.8275.2 profile also defines an alternate BMCA that selects a clock for synchronization and port state for the local ports of all devices in the network is defined for the profile. The parameters defined as a part of the BMCA are:

- Clock Class
- Clock Accuracy
- Offset Scaled Log Variance
- Priority 2
- Clock Identity
- Steps Removed
- Port Identity
- notSlave flag
- Local Priority

Note See ITU-T G.8275.2 document to determine the valid values for Clock Class parameter.

- *Port State Decision*: The port states are selected based on the alternate BMCA algorithm. A port is configured to a **master-only** port state to enforce the port to be a master for unicast transport mode.
- *Packet Rates:*
  - Synchronization/Follow-Up—minimum is one packet-per-second and maximum of 128 packets-per-second.
  - Packet rate for Announce packets—minimum of one packet-per-second and maximum of eight packets-per-second.
  - Delay-Request/Delay-Response packets—minimum is one packet-per-second and maximum of 128 packets-per-second
- *Transport Mechanism*: G.8275.2 profile supports only IPv4 PTP transport mechanism.
- *Mode*: G.8275.2 profile supports transport of data packets only in unicast mode.
- *Clock Type*: G.8275.2 profile supports the following clock types:
  - *Telecom Grandmaster (T-GM)*: Provides timing for other network devices and does not synchronize its local clock to other network devices.
  - *Telecom Time Slave Clock (T-TSC)*: A slave clock synchronizes its local clock to another PTP clock, but does not provide PTP synchronization to any other network devices.
  - *Telecom Boundary Clock (T-BC)*: Synchronizes its local clock to a T-GM or an upstream T-BC clock and provides timing information to downstream T-BC or T-TSC clocks.
- *Domain Numbers*: The domain numbers that can be used in a G.8275.2 profile network ranges from 44 to 63. The default domain number is 44.

Starting from Release 7.2.1, PTP Multi-profile is supported for the below combination of PTP profiles:

- G8275.1

- G8275.2

PTP Virtual Port

Table 6: Feature History Table

Feature Name	Release Information	Feature Description
Use PTP Virtual Port to Select Timing Source	Release 7.7.1	You can now select the best available timing source for your routers by using the PTP Virtual Port (VP) feature. This feature allows you to compare, select, and advertise the best clock source between a PTP server and other local timing sources connected to the routers. PTP Virtual Port is now available on the following routers: • NCS-57C3-MODS-SYS • NCS-57B1-6D24-SYS VP is an external frequency, phase, and time input interface on a Telecom Boundary Clock (T-BC), and thus participates in the timing source selection. Some useful information: • ITU-T Telecom Profiles for PTP

With an increase in diversification in deployment of backhaul networks, there is a need to have the ability to select and advertise the best clock source between a PTP server and other local timing sources connected to the device. ITU-T G.8275 specifies associating a virtual PTP port to an external clock input of the device. This allows the external clock inputs to participate in PTP protocol to select the best clock source between a PTP server and other local timing sources connected to the device.

G.8275.1 introduces the concept of a virtual port on the T-BC. A virtual port is an external frequency, phase,and time input interface on a T-BC, which can participate in the source selection.

Configuration Guidelines and Restrictions

- Virtual port is supported for G8275.1 and G8275.2 in hybrid and non-hybrid modes.
- Virtual port configuration is not allowed under Ordinary Clocks.

Configure Virtual Port

You can configure virtual port on the G8275.1 and G8275.2 profiles in hybrid and non-hybrid modes.

For virtual port configuration to work, GNSS or Sync2 must be configured.

```
Router:# config
virtual-port
offset-scaled-log-variance 20061
priority2 128
clock-class 6
clock-accuracy 33
local-priority 128
!
time-of-day priority 90
```

Verification

To verify the virtual port details, use **show ptp platform servo** command in global PTP configuration mode.

```
RP/0/RP0/CPU0:ios#sh ptp platform
servo
Sun Jan  9 14:51:47.283
UTC
Servo status:
Running
Servo stat_index:
2
Device status:
PHASE_LOCKED
Servo Mode:
Electrical
Servo log level:
0
Phase Alignment Accuracy: 11
ns
Sync timestamp updated:
10092
Sync timestamp discarded:
0
Delay timestamp updated:
10091
Delay timestamp discarded:
0
Previous Received Timestamp T1: 1642091334.238048486  T2: 1642091334.238048504  T3:
1642091334.217949799  T4: 1642091334.217949839
Last Received Timestamp T1: 1642091334.238048486  T2: 1642091334.238048504  T3:
1642091334.281936816  T4: 1642091334.281936855
Offset from master:  0 secs, 0
nsecs
Mean path delay   :  0 secs, 0
nsecs
setTime():0  stepTime():0
adjustFreq():0
Last setTime: 0.000000000 flag:0  Last stepTime:0 Last adjustFreq:0
```

Assisted Partial Timing Support

Table 7: Feature History Table

Feature Name	Release Information	Feature Description
Use APTS to Select Timing Source	Release 7.7.1	Assisted Partial Timing Support (APTS) enables you to select timing and synchronization for mobile backhaul networks. APTS is now available on the following routers: • NCS-57C3-MODS-SYS • NCS-57B1-6D24-SYS APTS allows for proper distribution of phase and time synchronization in the network. Some useful information: • ITU-T Telecom Profiles for PTP

The Assisted Partial Timing Support (APTS) enables you to deliver accurate timing and synchronization in mobile backhaul networks. ITU-T G.8275 specifies the APTS architectures where PTP is used as a backup timing source to a local time reference. The local time reference is generally a GNSS-based PRTC clock.

Configuration Guidelines and Restrictions

- Assisted Partial Timing Support (APTS) is supported only for G8275.2 non-hybrid profiles.

Configure APTS

You can configure APTS on the G8275.2 profile in non-hybrid mode.

```
Router:#
ptp
apts
clock
domain 44
profile g.8275.2 clock-type T-BC
!
profile profile1
transport ipv4
sync frequency 64
clock operation one-step
announce frequency 8
delay-request frequency 64
!
virtual-port
offset-scaled-log-variance 20061
priority2 128
clock-class 6
```

```
clock-accuracy 33
local-priority 127
!
frequency priority 254
time-of-day priority 90
log
```

Verification

To verify the apts details, use **show ptp local-clock** command.

```
RP/0/RP0/CPU0:ios#sh ptp local-clock
Sun Jan  9 14:52:15.211 UTC
Clock ID: 94aef0fffe0b8700
Clock properties:
  Domain: 44, Priority1: 128, Priority2: 128, Class: 165
  Accuracy: 0xfe, Offset scaled log variance: 0xffff
  Time Source: GPS
  Timescale: PTP
  Frequency-traceable, Time-traceable
  Current UTC offset: 37 seconds (valid)
Virtual Port:
  Configured: True, Connected: True
  Clock-class: 6
  Priority1: 128, Priority2: 128, Local Priority: 125
  Accuracy: 0x21, Offset scaled log variance: 0x4e5d
Local clock is grandmaster
APTS: Enabled
```

PTP Holdover Traceability Suppression

Table 8: Feature History Table

Feature Name	Release Information	Feature Description
PTP Holdover Traceability Suppression	Release 7.4.1	When a device which is configured as a Boundary clock (T-BC) loses synchronization with a quality Primary clock, to ensure that the downstream nodes continue to receive the configured clock class for a specified duration, and it's traceable you can configure this feature.

When the device loses synchronization with a quality Primary clock, to ensure that the downstream nodes continue to receive the configured clock class, and it's traceable you can configure this feature.

This feature enables the device which is configured as a boundary clock (T-BC) with PTP Profiles G.8275.1 or G.8275.2 to send out the configured clock-class as holdover clock-class and the time traceability flag to be set as TRUE for the specified duration. This is to ensure the down-stream nodes do not have an impact as this is a deviation from prescribed G.8275.1 ITU-T standards.

Note

- There are PTP flaps during switchovers or ISSU as the PTP holdover timer is running on the active RSP.
- Once the configured holdover override duration has lapsed and the device is unable to receive a quality Primary clock within this duration, the device sends the prescribed default clock class of 165, and the traceability flag will be set as FALSE to advertise loss of clock to downstream nodes.

Configuring PTP Holdover traceability suppression

This section describes how to configure the PTP holdover traceability suppression feature:

```
Router# config
Router(config)# ptp
Router(config-ptp)# holdover-spec-duration 1000
Router(config-ptp)# holdover-spec-clock-class 135
Router(config-ptp)# uncalibrated-traceable-override
Router(config-ptp)# holdover-spec-traceable-override
```

Configuring PTP

Precision Time Protocol (PTP) is a protocol that defines a method to distribute time around a network. PTP support is based on the IEEE 1588-2008 standard.

This module describes the tasks you need to configure PTP on Cisco IOS XR software.

Note When a subinterface is configured with encapsulation default or untag configuration, you must configure PTP on that subinterface, instead of the main interface.

Configuring Global G.8275.1 Profile

This below configuration describes the steps involved to create a global configuration profile for a PTP interface that can then be assigned to any interface as required. It uses G.8275.1 profile as an example:

Note Prior to Cisco IOS XR Software Release 6.3.3, the default PTP timers for G2875.1 were not set to standard values. This could lead to interoperability issues with other routers running the timers with updated values. Hence, to prevent such issues arising due to difference in packet rates, you must explicitly configure the **announce interval** value to 8, **sync frequency** value to 16 and **delay-request frequency** value to 16 while configuring global g.2875.1 profile.

```
RP/0/RP0/CPU0:router# config terminal
RP/0/RP0/CPU0:router(config)# ptp
RP/0/RP0/CPU0:router(config-ptp)# clock
RP/0/RP0/CPU0:router(config-ptp-clock)# domain 24
RP/0/RP0/CPU0:router(config-ptp-clock)# profile g.8275.1 clock-type T-BC
RP/0/RP0/CPU0:router(config-ptp-clock)# exit
RP/0/RP0/CPU0:router(config-ptp)# profile slave
```

```
RP/0/RP0/CPU0:router(config-ptp-profile)# multicast target-address ethernet 01-1B-19-00-00-00
RP/0/RP0/CPU0:router(config-ptp-profile)# transport ethernet
RP/0/RP0/CPU0:router(config-ptp-profile)# sync frequency 16
RP/0/RP0/CPU0:router(config-ptp-profile)# announce frequency 8
RP/0/RP0/CPU0:router(config-ptp-profile)# delay-request frequency 16
RP/0/RP0/CPU0:router(config-ptp-profile)# exit
RP/0/RP0/CPU0:router(config-ptp)# profile master
RP/0/RP0/CPU0:router(config-ptp-profile)# multicast target-address ethernet 01-1B-19-00-00-00
RP/0/RP0/CPU0:router(config-ptp-profile)# transport ethernet
RP/0/RP0/CPU0:router(config-ptp-profile)# sync frequency 16
RP/0/RP0/CPU0:router(config-ptp-profile)# announce frequency 8
RP/0/RP0/CPU0:router(config-ptp-profile)# delay-request frequency 16
RP/0/RP0/CPU0:router(config-ptp-profile)# exit
RP/0/RP0/CPU0:router(config-ptp)# physical-layer-frequency
RP/0/RP0/CPU0:router(config-ptp)# log
RP/0/RP0/CPU0:router(config-ptp-log)# servo events
RP/0/RP0/CPU0:router(config-ptp-log)# commit
```

Verification

To display the configured PTP profile details, use **show run ptp** command.

```
RP/0/RP0/CPU0:router# show run ptp

Wed Feb 28 11:16:05.943 UTC
ptp
 clock
  domain 24
  profile g.8275.1 clock-type T-BC
 !
 profile slave
  multicast target-address ethernet 01-1B-19-00-00-00
  transport ethernet
  sync frequency 16
  announce frequency 8
  delay-request frequency 16
 !
 profile master
  multicast target-address ethernet 01-1B-19-00-00-00
  transport ethernet
  sync frequency 16
  announce frequency 8
  delay-request frequency 16
 !
 physical-layer-frequency
 log
  servo events
!
```

Configuring PTP Master Interface

The below configuration describes the steps involved to configure a PTP interface to be a Master.

```
RP/0/RP0/CPU0:router# configure terminal
RP/0/RP0/CPU0:router(config)# interface HundredGigE0/0/0/0
RP/0/RP0/CPU0:router(config-if)# ptp
RP/0/RP0/CPU0:router(config-if-ptp)# profile master
RP/0/RP0/CPU0:router(config-if-ptp)# port state master-only
RP/0/RP0/CPU0:router(config-if-ptp)# commit
```

Verification

To verify the port state details, use **show run interface** *interface-name* command.

```
RP/0/RP0/CPU0:router# show run interface HundredGigE0/0/0/0
interface HundredGigE0/0/0/0
 ptp
  profile master
  port state master-only
!
```

Configuring PTP Slave Interface

This procedure describes the steps involved to configure a PTP interface to be a Slave.

```
RP/0/RP0/CPU0:router# configure terminal
RP/0/RP0/CPU0:router(config)# interface HundredGigE0/0/0/1
RP/0/RP0/CPU0:router(config-if)# ptp
RP/0/RP0/CPU0:router(config-if-ptp)# profile slave
RP/0/RP0/CPU0:router(config-if-ptp)# port state slave-only
RP/0/RP0/CPU0:router(config-if-ptp)# commit
```

Verification

To verify the port state details, use **show run interface** *interface-name* command.

```
RP/0/RP0/CPU0:router# show run interface HundredGigE0/0/0/1
interface HundredGigE0/0/0/1
 ptp
  profile slave
  port state slave-only
 !
!
```

Configuring PTP Hybrid Mode

This procedure describes the steps involved to configure router in a hybrid mode. You configure hybrid mode by selecting PTP for phase and time-of-day (ToD) and another source for the frequency.

Note

- G.8275.1 PTP profile supports only the hybrid mode. By default, the hybrid mode is used, regardless of the physical-layer-frequency configuration.
- G.8275.2 PTP profile supports both hybrid mode and non-hybrid mode. By default, the non-hybrid mode is used. Hybrid mode is used only when the physical-layer-frequency is configured.

To configure PTP Hybrid mode:

1. Configure Global Frequency Synchronization

```
RP/0/RP0/CPU0:router(config)# frequency synchronization
RP/0/RP0/CPU0:router(config)# commit
```

2. Configure Frequency Synchronization for an Interface. The time-of-day-priority setting specifies that SyncE to be used as a ToD source if there is no source available with a lower priority.

```
RP/0/RP0/CPU0:router(config)# interface GigabitEthernet 0/0/0/0
RP/0/RP0/CPU0:router(config-if)# frequency synchronization
RP/0/RP0/CPU0:router(config-if-freqsync)# selection input
RP/0/RP0/CPU0:router(config-if-freqsync)# time-of-day-priority 100
RP/0/RP0/CPU0:router(config-if-freqsync)# commit
```

3. Configure Global PTP. To configure PTP as source for ToD, use ToD priority values in the range from 1 (highest priority) to 254 (lowest priority). Use frequency from the physical layer.

```
RP/0/RP0/CPU0:router(config)# ptp
RP/0/RP0/CPU0:router(config-ptp)# physical-layer-frequency
RP/0/RP0/CPU0:router(config-ptp)# time-of-day priority 1
RP/0/RP0/CPU0:router(config)# commit
```

4. Configure PTP Interface. To enable this interface as a PTP Master, use **master** command in ptp-interface configuration mode.

```
RP/0/RP0/CPU0:router(config)# interface GigabitEthernet 0/0/0/2
RP/0/RP0/CPU0:router(config-if)# ipv4 address 10.0.0.1/24
RP/0/RP0/CPU0:router(config-if)# ptp
RP/0/RP0/CPU0:router(config-if-ptp)# master ipv4 10.0.0.2
RP/0/RP0/CPU0:router(config-if-ptp)# commit
```

Verifying PTP Hybrid Mode

```
RP/0/RP0/CPU0:router # show frequency synchronization selection

Tue Feb  6 06:34:17.627 UTC
Node 0/0/CPU0:
==============
Selection point: ETH_RXMUX (1 inputs, 1 selected)
  Last programmed 3d23h ago, and selection made 3d23h ago
  Next selection points
    SPA scoped    : None
    Node scoped   : None
    Chassis scoped: T0-SEL-B 1588-SEL
    Router scoped : None
  Uses frequency selection
  S  Input                     Last Selection Point         QL  Pri  Status
  == ========================  ========================  =====  ===  ===========
  1  GigabitEthernet0/0/0/2    n/a    PRC      1  Available
Selection point: LC_TX_SELECT (1 inputs, 1 selected)
  Last programmed 3d23h ago, and selection made 3d23h ago
  Next selection points
    SPA scoped    : None
    Node scoped   : None
    Chassis scoped: None
    Router scoped : None
  Uses frequency selection
  Used for local line interface output
  S  Input                     Last Selection Point         QL  Pri  Status
  == ========================  ========================  =====  ===  ===========
  7  GigabitEthernet0/0/0/2    0/RP0/CPU0 T0-SEL-B 1       PRC    1  Available
Node 0/RP0/CPU0:
==============
Selection point: T0-SEL-B (3 inputs, 1 selected)
  Last programmed 1d00h ago, and selection made 00:36:33 ago
  Next selection points
    SPA scoped    : None
    Node scoped   : CHASSIS-TOD-SEL
```

```
    Chassis scoped: LC_TX_SELECT
    Router scoped : None
  Uses frequency selection
  Used for local line interface output
  S  Input                    Last Selection Point         QL  Pri  Status
  == ======================== ======================== ===== ===  ===========
1  GigabitEthernet0/0/0/2 0/0/CPU0 ETH_RXMUX 1       PRC    1  Locked
   PTP [0/RP0/CPU0]  n/a      SEC  254  Available
   Internal0 [0/RP0/CPU0] n/a      SEC  255  Available

Selection point: 1588-SEL (2 inputs, 1 selected)
  Last programmed 3d23h ago, and selection made 00:36:33 ago
  Next selection points
    SPA scoped    : None
    Node scoped   : None
    Chassis scoped: None
    Router scoped : None
  Uses frequency selection
  S  Input         Last Selection Point      QL     Pri  Status
  == ======================== ======================== ===== ===  ===========
  1  GigabitEthernet0/0/0/2    0/0/CPU0 ETH_RXMUX 1      PRC      1  Locked
     Internal0 [0/RP0/CPU0]    n/a      SEC    255  Available

Selection point: CHASSIS-TOD-SEL (2 inputs, 1 selected)
  Last programmed 1d00h ago, and selection made 1d00h ago
  Next selection points
    SPA scoped    : None
    Node scoped   : None
    Chassis scoped: None
    Router scoped : None
PRC    1  Locked
SEC  255  Available
Last Selection Point
QL Pri Status
Uses time-of-day selection
S  Input       Last Selection Point      Pri  Time  Status
== ======================== ======================== ===  ====  ===========
  1  PTP [0/RP0/CPU0]          n/a         100  Yes   Available
     GigabitEthernet0/0/0/2    0/RP0/CPU0 T0-SEL-B 1   100  No    Available
```

Configuring PTP Telecom Profile Interface

This procedure describes the steps involved to create an interface for PTP ITU-T Telecom Profiles.

Note

- PTP Telecom Profile Interface is not supported on NCS-57C3-MODS-SYS and NCS-57C3-MOD-SYS line cards
- It is also possible to make these definitions within a global PTP profile and attach them to the interface using the profile command in PTP interface configuration mode.

1. To configure an interface, use **interface** *type interface-path-id* command in the configuration mode.

   ```
   RP/0/RP0/CPU0:router(config)# interface gigabitethernet 0/1/0/1
   ```

2. To enter the PTP configuration mode for the given interface, use **ptp** command in the interface configuration mode.

```
RP/0/RP0/CPU0:router(config-if)# ptp
```

3. To configure a PTP profile (or specify a previously defined profile), use **profile** *name* command in the ptp-interface configuration mode.

Note Any additional commands entered in ptp-interface configuration mode overrides the global profile settings.

```
RP/0/RP0/CPU0:router(config-if-ptp)# profile slave
```

4. To configure frequency for Sync or Delay-request messages for the given ptp interface, use **sync frequency** *rate* command or **delay-request frequency** *rate* command appropriately in the ptp-interface configuration mode. The valid configurable values are **2, 4, 8, 16, 32, 64 or 128**.

```
RP/0/RP0/CPU0:router(config-if-ptp)# sync frequency 128
```

```
RP/0/RP0/CPU0:router(config-if-ptp)# delay-request frequency 128
```

5. To configure duration for different PTP messages, use one of the following commands in the ptp-interface configuration mode: **announce grant-duration** *duration*, **sync grant-duration** *duration*, or **delay-response grant-duration** *duration*. The duration value can be between **60 and 1000 seconds**.

Note This duration value represents the length of grant that is requested by a port in Slave state and represents the maximum grant-duration allowed when the port is in Master state.

```
RP/0/RP0/CPU0:router(config-if-ptp)# announce grant-duration 120
```

```
RP/0/RP0/CPU0:router(config-if-ptp)# sync grant-duration 120
```

```
RP/0/RP0/CPU0:router(config-if-ptp)# delay-response grant-duration 120
```

6. To configure a timeout value, length of time by when a PTP message must be received (before PTSF-lossSync is raised), use one of the following commands in the ptp-interface configuration mode: **sync timeout** *timeout* or **delay-response timeout** *timeout*. The timeout value can be between **100 to 10000 micro seconds**.

```
RP/0/RP0/CPU0:router(config-if-ptp)# sync timeout 120
```

```
RP/0/RP0/CPU0:router(config-if-ptp)# delay-response timeout 120
```

7. To configure a response for unicast-grant invalid-request, use **unicast-grant invalid-request {reduce | deny}** command. The response for requests with unacceptable parameters would either be denied or granted with reduced parameters.

```
RP/0/RP0/CPU0:router(config-if-ptp)# unicast-grant
invalid-request reduce
```

8. To configure IPv4 address for a PTP master, use **master ipv4** *ip-address* command in the ptp-interface configuration mode.

```
RP/0/RP0/CPU0:router(config-if-ptp)# master ipv4 1.7.1.2
```

9. To override the clock-class received in Announce messages from the specified Master, use **clock-class** *class* command in the ptp-master-interface configuration mode. The class values can range from **0 to 255**.

```
RP/0/RP0/CPU0:router(config-if-ptp-master)# clock-class 2
```

Verification

To display the PTP interface details, use **show ptp interfaces brief** command.

```
RP/0/RP0/CPU0:router# show ptp interfaces brief
Fri Feb  9 11:16:45.248 UTC
Intf              Port         Port                 Line
Name              Number       State        Encap   State         Mechanism
-------------------------------------------------------------------------------
Gi0/1/0/0         1            Slave        IPv4    up            1-step DRRM
Gi0/0/0/40        2            Master       IPv4    up            1-step DRRM
```

To verify the configured profile details, use **show run interface** *interface-name* command.

```
RP/0/RP0/CPU0:router# show run interface Gi0/0/0/33

Wed Feb 28 11:49:16.940 UTC
interface GigabitEthernet0/0/0/33
ptp
  profile slave
  transport ipv4
  sync frequency 64
  clock operation one-step
  delay-request frequency 64
  !
 physical-layer-frequency
!
ipv4 address 21.1.1.2 255.255.255.0
frequency synchronization
  selection input
  priority 5
  wait-to-restore 0
!
```

Configuring PTP Telecom Profile Clock

This procedure describes the steps involved to configure PTP clock and its settings to be consistent with ITU-T Telecom Profiles for Frequency.

1. To enter the PTP configuration mode, use **ptp** command in the configuration mode.

```
RP/0/RP0/CPU0:router(config)# ptp
```

2. To enter the PTP-clock configuration mode, use **clock** command in the ptp-configuration mode.

```
RP/0/RP0/CPU0:router(config-ptp)# clock
```

3. To configure the domain-number for a PTP profile, use **domain** *number* command in the ptp-configuration mode. The allowed domain number range for G.8265.1 profile is between **4 and 23** and the range for G.8275.1 profile is between **24 and 43**.

```
RP/0/RP0/CPU0:router(config-ptp)# domain 24
```

4. To exit the ptp-clock configuration mode, use **exit** command.

```
RP/0/RP0/CPU0:router(config-ptp-clock)# exit
```

5. To configure the desired telecom profile and the clock type for the profile, use **clock profile {g.8275.1 | g.8275.2} clock-type {T-GM | T-BC | T-TSC}** command in the ptp configuration mode. For **g.8265.1** clock profile, clock type is either master or slave.

Note The **clock-selection telecom-profile** and **clock-advertisement telecom-profile** commands are deprecated from Release 6.1.2. They are replaced by the **clock profile** command.

```
RP/0/RP0/CPU0:router(config-ptp)# clock profile g.8275.1 clock-type T-GM
```

Verification

To display the configured PTP clock profile details, use **show run ptp** command.

```
RP/0/RP0/CPU0:router# show run ptp
ptp
clock
  domain 24
  profile g.8275.1 clock-type T-GM
  timescale PTP
  time-source GPS
  clock-class 6
!
profile master
  transport ethernet
  sync frequency 16
  announce interval 1
  delay-request frequency 16
!
profile master1
  transport ethernet
  sync frequency 64
  announce interval 1
  delay-request frequency 64
!
```

To verify that PTP has been enabled on the router and the device is in LOCKED Phase, use **show ptp platform servo** command.

```
RP/0/RP0/CPU0:router # show ptp platform servo

Fri Feb  9 11:16:54.568 UTC
Servo status: Running
Servo stat_index: 2
Device status: PHASE_LOCKED
```

```
Servo log level: 0
Phase Alignment Accuracy: 1 ns
Sync timestamp updated: 111157
Sync timestamp discarded: 0
Delay timestamp updated: 111157
Delay timestamp discarded: 0
Previous Received Timestamp T1: 1518155252.263409770  T2: 1518155252.263410517  T3:
1518155252.287008362  T4: 1518155252.287009110
Last Received Timestamp T1: 1518155252.325429435  T2: 1518155252.325430194  T3:
1518155252.348938058  T4: 1518155252.348938796
Offset from master:  0 secs, 11 nsecs
Mean path delay   :  0 secs, 748 nsecs
setTime():2  stepTime():1  adjustFreq():10413 adjustFreqTime():0
Last setTime: 1.000000000 flag:1  Last stepTime:-736216, Last adjustFreq:465
```

Configuring PTP Delay Asymmetry

Table 9: Feature History Table

Feature Name	Release Information	Description
PTP Delay Asymmetry	Release 7.3.1	Any delays on Precision Time Protocol (PTP) paths can impact PTP accuracy and in turn impact clock settings for all devices in a network. This feature allows you to configure the static asymmetry such that the delay is accounted for and the PTP synchronization remains accurate. The **delay-symmetry** command is introduced for this feature.
PTP Delay Asymmetry	Release 7.6.1	You can configure static asymmetry such that any delays on Precision Time Protocol (PTP) paths are accounted for, and the PTP synchronization remains accurate, thus avoiding any impact to clock settings for all devices in a network.

Configure PTP delay asymmetry to offset the static delays on a PTP path that occur due to different route selection for forward and reverse PTP traffic. Delays can also be due to any node having different delay for ingress or egress path. These delays can impact PTP accuracy due to the asymmetry in PTP. With this feature, you can enable a higher degree of accuracy in the PTP server performance leading to better synchronization between real-time clocks of the devices in a network.

Configuration of this delay asymmetry provides an option to configure static delays on a client clock for every server clock. You can configure this delay value in microseconds and nanoseconds. Configured PTP delay asymmetry is also synchronized with the Servo algorithm.

Note

- PTP delay asymmetry is not supported on NCS-57C3-MODS-SYS and NCS-57C3-MOD-SYS line cards
- If you configure multiple PTP delay asymmetries for the same PTP profile, the latest PTP delay asymmetry that you configure is applied to the PTP profile.
- For G8275.1 and G8275.2 PTP profiles, PTP delay asymmetry is supported for both, client port and dynamic port that act as a client.
- Fixed delay can be measured by using any test and measurement tool. Fixed delay can be compensated by using the positive or negative values. For example, if the fixed delay is +10 nanoseconds, configure -10 nanoseconds to compensate the fixed delay.

A positive value indicates that the server-to-client propagation time is longer than the client-to-server propagation time, and conversely for negative values.

Supported PTP Profiles

The following PTP profiles support the configuration of PTP delay asymmetry:

- PTP over IP (G8275.2 or default profile)
- PTP over L2 (G8275.1)

Restrictions

- PTP delay asymmetry can be configured only on the PTP port of the grandmaster clock, which can either be a boundary clock or an ordinary clock.
- PTP delay asymmetry is supported for delay compensation of fixed cables and not for variable delay in the network.
- PTP delay asymmetry can be configured within the range of 3 microseconds and -3 microseconds or 3000 nanoseconds and -3000 nanoseconds.

Configuration

To configure PTP delay asymmetry:

1. Configure an interface with PTP.
2. Configure PTP delay asymmetry on the client side.

Configuration Example

```
/* Configure an interface with PTP. */
Router# configure
Router(config)# interface HundredGigE 0/1/0/0
Router(config-if)# ptp

/* Configure PTP delay asymmetry on the client side. */
Router(config-if-ptp)# delay-asymmetry 3 microseconds
Router(config-if-ptp)# commit
```

Running Configuration

```
interface preconfigure HundredGigE 0/1/0/0
 ptp
  delay-asymmetry 3 microseconds
```

Verification

To verify if PTP delay asymmetry is applied, use the **show ptp foreign-masters** command:

```
Router# show ptp foreign-masters
Sun Nov 1 10:19:21.874 UTC
Interface HundredGigE0/1/0/0 (PTP port number 1)
IPv4, Address 209.165.200.225, Unicast
Configured priority: 1
Configured clock class: None
Configured delay asymmetry: 3 microseconds <- configured variable delay asymmetry value
Announce granted: every 2 seconds, 300 seconds
Sync granted: 16 per-second, 300 seconds
Delay-resp granted: 16 per-second, 300 seconds
Qualified for 2 minutes, 45 seconds
Clock ID: 80e01dfffe8ab73f
Received clock properties:
Domain: 0, Priority1: 128, Priority2: 128, Class: 6
Accuracy: 0x22, Offset scaled log variance: 0xcd70
Steps-removed: 1, Time source: GPS, Timescale: PTP
Frequency-traceable, Time-traceable
Current UTC offset: 37 seconds (valid)
Parent properties:
Clock ID: 80e01dfffe8ab73f
Port number: 1
```

To validate the approximate compensated delay value, use the **show ptp platform servo** command:

```
Router# show ptp platform servo
Mon Jun 27 22:32:44.912 UTC
Servo status: Running
Servo stat_index: 2
Device status: PHASE_LOCKED
Servo Mode: Hybrid
Servo log level: 0
Phase Alignment Accuracy: -2 ns
Sync timestamp updated: 18838
Sync timestamp discarded: 0
Delay timestamp updated: 18837
Delay timestamp discarded: 0
Previous Received Timestamp T1: 1657002314.031435081  T2: 1657002314.031436686  T3:
1657002314.026815770  T4: 1657002314.026814372
Last Received Timestamp T1: 1657002314.031435081  T2: 1657002314.031436686  T3:
1657002314.088857790  T4: 1657002314.088856392
Offset from master:  0 secs, 1502 nsecs    <<--compensated value shows 1.5 microseconds
because the asymmetry configured under the interface is
3 microseconds.->>
Mean path delay   :  0 secs, 103 nsecs
setTime():0  stepTime():0 adjustFreq():2
Last setTime: 0.000000000 flag:0  Last stepTime:0 Last adjustFreq:-5093
```

Configuration Examples

Slave Configuration Example

The following example shows a PTP slave configuration:

```
 interface TenGigE 0/1/0/5
 ptp
  profile slave
  transport ipv4
  port state slave-only
  master ipv4 1.7.1.2
  !
  announce interval 1
  !
 ipv4 address 1.7.1.1 255.255.255.0
!
```

Master Configuration Example

This example shows a PTP master configuration:

```
 ptp
  profile master
  transport ipv4
  announce interval 1
 !
 ipv4 address 1.7.1.2 255.255.255.0
 !
```

PTP Hybrid Mode Configuration Example

This example shows the configuration of PTP hybrid mode:

```
ptp
 time-of-day priority 10
 !
interface GigabitEthernet0/1/1/0
 ptp
  transport ipv4
  port state slave-only
  master ipv4 1.7.1.2
  !
  sync frequency 64
  announce interval 1
  delay-request frequency 64
 !
interface GigabitEthernet 0/1/0/1
 ipv4 address 1.7.1.2 255.255.255.0
 speed 100
```

```
 frequency synchronization
  selection input
  priority 10
  wait-to-restore 0
  ssm disable
  time-of-day-priority 100
 !
```

ITU-T Telecom Profile Examples:

G.8265.1 Profile Configuration Examples

Master Global Configuration:

```
ptp
 clock
 domain 4
 profile g.8265.1
 !
  profile master
  transport ipv4
  sync frequency 16
  announce interval 1
  delay-request frequency 16
interface gi 0/2/0/4
 ptp
  profile master
  transport ipv4
  clock operation two-step
 !
 ipv4 address 17.1.1.1/24
```

Slave Global Configuration:

```
ptp
 clock
 domain 4
 profile g.8265.1
 !
  profile slave
  transport ipv4
  sync frequency 16
  announce interval 1
  delay-request frequency 16
interface gi 0/1/0/0
 ptp
  profile slave
  transport ipv4
  Master ipv4 18.1.1.1
  port state slave-only
  !
  clock operation two-step
  !
 ipv4 address 18.1.1.2/24
```

Configuring With Clock Type as T-Boundary Clock (T-BC)

```
ptp
 clock
 domain 4
 profile g.8265.1
 !
  profile master
  transport ipv4
  sync frequency 16
  announce interval 1
  delay-request frequency 16
  exit
  profile slave
  transport ipv4
  sync frequency 16
  announce interval 1
  delay-request frequency 16
  exit
interface gi 0/2/0/4
 ptp
  profile slave
  transport ipv4
  Master ipv4 17.1.1.1
  port state slave-only
  !
  clock operation two-step
  !
ipv4 address 17.1.1.2/24
interface gi 0/2/0/0
 ptp
  profile master
  transport ipv4
  clock operation two-step
  !
 ipv4 address 18.1.1.1/24
```

G.8275.1 Profile Configuration Examples

Master Global Configuration:

```
ptp
 clock
 domain 24
 profile g.8275.1
 !
  profile master
  transport ethernet
  sync frequency 16
  announce frequency 8
  delay-request frequency 16
interface gi 0/2/0/4
 ptp
  profile master
  transport ethernet
  multicast target-address ethernet 01-1B-19-00-00-00
  !
```

Slave Global Configuration:

```
ptp
```

```
 clock
 domain 24
 profile g.8275.1 clock-type T-TSC
 !
  profile slave
  transport ethernet
  sync frequency 16
  announce frequency 8
  delay-request frequency 16
interface gi 0/1/0/0
 ptp
  profile slave
  transport ethernet
  multicast target-address ethernet 01-1B-19-00-00-00
  !
```

Configuring With Clock Type as T-Boundary Clock (T-BC)

```
ptp
 clock
 domain 24
 profile g.8275.1 clock-type T-BC
 !
  profile master
  transport ethernet
  sync frequency 16
  announce frequency 8
  delay-request frequency 16
  exit
  profile slave
  transport ethernet
  sync frequency 16
  announce frequency 8
  delay-request frequency 16
  exit
interface gi 0/2/0/4
 ptp
  profile slave
  transport ethernet
  multicast target-address ethernet 01-1B-19-00-00-00
  !
interface gi 0/2/0/0
 ptp
  profile master
  transport ethernet
  multicast target-address ethernet 01-1B-19-00-00-00
```

G.8275.2 Profile Configuration Examples

Master Global Configuration:

```
ptp
 clock
  domain 44
  profile g.8275.2 clock-type T-GM
 !
 profile master
  transport ipv4
  sync frequency 64
  announce frequency 8
```

```
  unicast-grant invalid-request deny
  delay-request frequency 64
 !
!

interface GigabitEthernet0/2/0/11
 ptp
  profile master
 !
 ipv4 address 17.1.1.1/24
```

Slave Global Configuration:

```
ptp
 clock
  domain 44
  profile g.8275.2 clock-type T-TSC
 !
 profile slave
  transport ipv4
  port state slave-only
  sync frequency 64
  announce frequency 8
  unicast-grant invalid-request deny
  delay-request frequency 64
 !
 log
  servo events
  best-master-clock changes
 !
!
interface GigabitEthernet0/2/0/12
 ptp
  profile slave
  master ipv4 18.1.1.1
   !
 !
 ipv4 address 18.1.1.2/24
!
```

Effective Cisco IOS XR Software Release 7.8.1, the encapsulation type for PTP packet transport is now extended to IPv6; you can now use the **transport ipv6** to set this encapsulation type.

Configuring With Clock Type as T-Boundary Clock (T-BC)

```
ptp
 clock
  domain 44
  profile g.8275.2 clock-type T-BC
 !
 profile slave
  transport ipv4
  port state slave-only
  sync frequency 64
  announce frequency 8
  unicast-grant invalid-request deny
  delay-request frequency 64
 !
 profile master
  transport ipv4
  sync frequency 64
  announce frequency 8
```

```
  unicast-grant invalid-request deny
  delay-request frequency 64
 !
 log
  servo events
  best-master-clock changes
 !
!

interface GigabitEthernet0/2/0/11
 ptp
  profile master
 !
 ipv4 address 18.1.1.1/24
!

interface GigabitEthernet0/2/0/12
 ptp
  profile slave
  master ipv4 17.1.1.1
  !
 !
 ipv4 address 17.1.1.2/24
!
```

Effective Cisco IOS XR Software Release 7.8.1, the encapsulation type for PTP packet transport is now extended to IPv6; you can now use the **transport ipv6** command to set this encapsulation type.

Configure E-SyncE on Primary and Secondary Interface

Primary Interface

The following example shows how you can configure global synce on primary interface:

```
Router#configure terminal
Router(config)#frequency synchronization
Router(config-freqsync)#quality itu-t option 1
Router(config-freqsync)#clock-identity mac-address aaaa.bbbb.cccc
Router(config-freqsync)#clock-interface timing-mode system
Router(config-freqsync)#commit
```

The following example shows how you can configure synce on primary interface:

```
Router#configure terminal
Router(config)# interface HundredGigE0/0/0/11
Router(config-if)# frequency synchronization
Router(config-if)# quality transmit exact itu-t option 1 ePRTC
Router(config-if)# commit
```

Secondary Interface

The following example shows how you can configure global synce on secondary interface:

```
Router#configure terminal
Router(config)#frequency synchronization
Router(config-freqsync)#quality itu-t option 1
Router(config-freqsync)#clock-interface timing-mode system
Router(config-freqsync)#commit
```

The following example shows how you can configure synce on secondary interface:

```
Router#configure terminal
Router(config)# interface HundredGigE0/0/0/10
Router(config-if)# frequency synchronization
Router(config-if-freqsync)# selection input
Router(config-if-freqsync)# priority 10
Router(config-if-freqsync)# wait-to-restore 0
Router(config-if-freqsync)# commit
```

Note If timing mode system is not configured, the major alarm `T4 PLL is in FREERUN mode` is raised. This alarm has no functional impact to the system behavior.

Verification

Use the **show frequency synchronization** command if e-synce is configured.

```
Routerr#show frequency synchronization  interfaces  br
Flags:  > - Up                D - Down              S - Assigned for selection
        d - SSM Disabled      x - Peer timed out    i - Init state
        s - Output squelched
Fl   Interface                 QLrcv QLuse Pri QLsnd Output driven by
==== ======================== ===== ===== === ===== ========================
>S   HundredGigE0/0/0/13      ePRTC ePRTC  31 ePRTC HundredGigE0/0/0/18
>S   HundredGigE0/0/0/18      ePRTC ePRTC  30 DNU   HundredGigE0/0/0/18
RP/0/RP0/CPU0:Shadowtower#sh frequency  synchronization  selection
Node 0/RP0/CPU0:
==============
Selection point: T0-SEL-B (3 inputs, 1 selected)
  Last programmed 02:41:55 ago, and selection made 02:41:04 ago
  Next selection points
    SPA scoped    : None
    Node scoped   : CHASSIS-TOD-SEL
    Chassis scoped: LC_TX_SELECT
    Router scoped : None
  Uses frequency selection
  Used for local line interface output
  Used for local clock interface output
  S  Input                     Last Selection Point         QL  Pri  Status
  == ========================  ========================  =====  ===  ===========
  33 HundredGigE0/0/0/18       0/RP0/CPU0 ETH_RXMUX 33   ePRTC   30  Locked
     HundredGigE0/0/0/13       0/RP0/CPU0 ETH_RXMUX 22   ePRTC   31  Available
     Internal0 [0/RP0/CPU0]    n/a                         SEC  255  Available

Selection point: 1588-SEL (3 inputs, 1 selected)
  Last programmed 02:41:55 ago, and selection made 02:41:04 ago
  Next selection points
    SPA scoped    : None
    Node scoped   : None
    Chassis scoped: None
    Router scoped : None
  Uses frequency selection
  S  Input                     Last Selection Point         QL  Pri  Status
  == ========================  ========================  =====  ===  ===========
  1  Internal0 [0/RP0/CPU0]    n/a                         SEC  255  Freerun
     HundredGigE0/0/0/18       0/RP0/CPU0 ETH_RXMUX 33   ePRTC   30  Available
     HundredGigE0/0/0/13       0/RP0/CPU0 ETH_RXMUX 22   ePRTC   31  Available

Selection point: CHASSIS-TOD-SEL (1 inputs, 1 selected)
  Last programmed 02:41:44 ago, and selection made 02:41:44 ago
  Next selection points
    SPA scoped    : None
```

```
    Node scoped   : None
    Chassis scoped: None
    Router scoped : None
  Uses time-of-day selection
  S  Input                     Last Selection Point      Pri  Time  Status
  == ========================  ========================  ===  ====  ===========
  1  HundredGigE0/0/0/18       0/RP0/CPU0 T0-SEL-B 33    100  No    Available

Selection point: ETH_RXMUX (2 inputs, 2 selected)
  Last programmed 02:41:55 ago, and selection made 02:41:55 ago
  Next selection points
    SPA scoped    : None
    Node scoped   : T0-SEL-B 1588-SEL
    Chassis scoped: None
    Router scoped : None
  Uses frequency selection
  S  Input                     Last Selection Point         QL  Pri  Status
  == ========================  ========================  =====  ===  ===========
  33 HundredGigE0/0/0/18       n/a                       ePRTC   30  Available
  22 HundredGigE0/0/0/13       n/a                       ePRTC   31  Available
```