

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. For information on PTP commands, see *System Management Command Reference for Cisco ASR 9000 Series Routers*.

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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 server-client hierarchy. PTP identifies the port that is connected to a device with the most precise clock. This clock is referred to as the server clock. All the other devices on the network synchronize their clocks with the server 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: • server mode—Distributes timing information over the network to one or more client clocks, thus allowing the client to synchronize its clock to the server. • client mode—Synchronizes its clock to a server clock. You can enable the client mode on up to two interfaces simultaneously in order to connect to two different server clocks.
Boundary Clock (BC)	The device participates in selecting the best server clock and can act as the server clock if no better clocks are detected. Boundary clock starts its own PTP session with a number of downstream clients. The boundary clock mitigates the number of network hops and results in packet delay variations in the packet network between the Grandmaster and client.
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 the ports in the network that will remain passive (neither server nor client), run as a server (providing time to other clocks in the network), or run as clients (receiving time from other clocks in the network).
- Delay-Request/Response mechanism and a Peer-delay mechanism: This provides a mechanisms for client ports to calculate the difference between the time of their own clocks and the time of their server clock.

Note Cisco ASR 9000 Series routers do not support Peer-delay mechanism.

The implementation of PTP on Cisco IOS XR software is designed to operate effectively in Telecommunication networks, which are different from the networks for which PTP was originally designed.

PTP is supported on Gigabit Ethernet interfaces and subinterfaces (1G, 10G, 40G, and 100G), and Bundle Ethernet main interfaces. PTP is not supported on Bundle Ethernet subinterfaces.

Frequency and Time Selection

The selection of the source to synchronize the backplane 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 server and client.

Delay-Response Mechanism

The Delay Request-response mechanism (defined in section 11.3 of IEEE Std 1588-2008) lets a client port estimate the difference between its own clock-time and the clock-time of its server. 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 client 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, DTI 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.871, and is described in the *Configuring Frequency Synchronization* module in this document. The ToD selection is controlled using the time-of-day priority configuration. This configuration is found under the source 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.

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.
LISTENING	First state when a port becomes ready to participate in PTP: In this state, the port listens to PTP servers for a (configurable) period of time.
PRE-MASTER	Port is ready to enter the Server state.
MASTER	Port provides timestamps for any client or boundary clocks that are listening.
UNCALIBRATED	Port receives timestamps from a server clock but, the router’s clock is not yet synchronized to the server.

State	Description
SLAVE	Port receives timestamps from a server clock and the router's clock is synchronized to the server.
PASSIVE	Port is aware of a better clock than the one it would advertise if it was in server state and is not a client clock to that server clock.

Leap Seconds

In prior releases, IOS-XR only offered a static and time-consuming solution to manage leap seconds. For every upcoming leap second inclusion, the number of leap seconds had to be hard-coded into a Software Maintenance Update (SMU) and also installed on the router for the same. It is a prolonged and tedious process to provide and install a SMU each time a new leap second is announced.

From Release 6.4.1 onward, Cisco IOS-XR supports leap-second configuration instead of SMU installations or reloads.

Time is measured using a common timescale. Leap second factor is used to adjust the current time to compensate for any drift from the common timescale. Leap seconds are introduced to dynamically adjust the UTC offset in response to leap second events. The two most relevant timescales are:

- **TAI - International Atomic Time** : This is a notional passage of time determined by weighted average of readings across a large number of atomic clocks.
- **UTC - Universal Coordinated Time** : This differs from TAI by an integer number of seconds to remain in synchronization with mean solar time. UTC is related to a notion of time called **UT1**, which represents the mean solar time at 0° longitude. Leap seconds are periodically inserted to ensure UTC and UT1 are never more than 0.9 seconds apart.

PTP uses TAI timescale. UTC time is derived using UTC offset. UTC offset and the number of seconds in the last minute of the current UTC day are sent in the PTP header of Announce messages.

UTC is calculated as: **UTC = TAI - offset**.

IOS-XR PTP implementation uses the following sources (in order of decreasing precedence) to determine the current UTC offset value:

- The current grandmaster clock, if present.
- UTC offset configuration, if present.
- The previous grandmaster clock, if one exists.
- The hardware (e.g. a locally connected GPS receiver), if available.
- Zero, indicating that no UTC offset information is available.

If any upcoming leap second (being advertised at the time synchronization with a grandmaster) is lost, that too will be applied at the appropriate time while in holdover

Note

- Leap seconds are generally added by including an extra second (23:59:60), either on June 30th or on December 31st.
- UTC offset is + 37 seconds, as of 01 Jan 2017.

Multiple PTP Profile Interoperability

Communication between two different profiles was not possible previously due to various factors like, incompatible domain numbers, BMCA, or clock-class leading to drop in packets. Also, you cannot compare devices running different profiles in such configurations. For example, the domain number for G.8275.1 profile (24) is incompatible with the domain number for G.8275.2 profile (44).

Multiple PTP Profile Interoperability feature lets you develop a configuration to communicate with a peer device running a different PTP profile than the profile that is configured on the source router. This means that multiple profiles can interoperate on a single device in this implementation.

Interoperation is achieved by converting packets on ingress/egress so that it is acceptable to the profile configured on the receiving device. This prevents packet loss and allows comparison of different profiles. You can configure the interoperation using the **interop** command. Configuration details are described in a later section in this chapter. For command details, refer to Precision Time Protocol (PTP) Commands chapter in the *System Management Command Reference for Cisco ASR 9000 Series Routers* guide.

Note

- Multiple ingress conversions are performed for interfaces configured with multiple servers.
- Only G.8275.1 and G.8275.2 profiles can be configured to interoperate.

Class C Timing Mode

Table 2: Feature History Table

Feature Name	Release Information	Feature Description
Class C Timing Mode	Release 7.6.2	We now support the enhanced timing mode, Class C, as per the revised version of G.8273.2 by ITU-T. You can now switch to this Class C mode to avail high-accuracy clocks in the telecom networks having precise timing requirements, such as 5G networks. Class C mode reduces the Maximum Absolute Time Error (Max|TE|) and enhances synchronization of Telecom Boundary Clock (T-BC) and Telecom Time Secondary Clock (T-TSC). Class C timing support is available for both PTP and Frequency Synchronization. Class C timing mode is supported only on the routers with the combination of following Route Switch Processors (RSPs) and Fifth generation of the ASR 9000 Series Ethernet line cards except A99-32X100GE-X-TR/SE: • A9K-RSP5-X-TR/SE • A99-RP3-X-TR/SE This feature introduces the timing-accuracy enhanced command.

The advent of 5G technology demands strict timing requirements. To satisfy the strict timing requirements, ITU-T has introduced Class C or Enhanced timing accuracy mode under G8273.2 profile. Class B or Legacy mode is the default mode. The Max|TE| for Class B is 70 ns, whereas for Class C it is 40 ns. Reduced Max|TE| error indicates reduced noise transfer and improved timing accuracy between T-BC and T-SC.

Restrictions

- Class C timing support is not available on A99-32X100GE-X-TR/SE Lightspeed-plus-based line card.
- Class C is not supported on the following line cards:
  - Third generation of the ASR 9000 Series Ethernet Line Cards

- BITS-output clock does not work with Cisco IOS XR Software Release 7.6.2 image. You must install Software Maintenance Updates (SMU) for the same.
- If the **timing-accuracy enhanced** command is applied on the router with unsupported line cards, the timing functionality stops working on those line cards.

  The following system log appears on the router console when Class C configuration is applied on the routers containing unsupported hardware that does not support Class C mode.

```
LC/0/1/CPU0:Sep 2 15:51:50.791 UTC: sync_agent[325]:
%PLATFORM-FSYNC-4-CLOCK_ACCURACY_UNSUPPORTED : This line card does not support enhanced
 accuracy mode
```

To configure Class C mode, see Configuring Class C Timing Mode, on page 41.

PTP Support Information

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

Transport Media	• UDP over IPv4 • Ethernet • IPv6
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. • Mixed: Announce and Sync messages are sent as multicast messages. Signaling, Delay-request, and Delay-response messages are sent as unicast messages. • Multicast: All packets are sent as multicast messages.

PTP hardware support matrix

Table 3: Feature History Table

Feature Name	Release Information	Feature Description
Precision time protocol on ASR 9000 5th generation 400G Ethernet line card	Release 25.2.1	Support for IEEE-1588 PTP is extended to the following line card: • A99-4HG-FLEX-X-SE Class B performance is supported on all ports 1G, 10G, 25G, 40G and 100G. Route processors: • A9K-RSP5-SE/TR • A99-RP3-SE/TR Class C performance is supported on all ports 1G, 10G, 25G, 40G and 100G. Route processors: • A9K-RSP5-X-SE/TR • A99-RP3-X-SE/TR
Precision time protocol on ASR 9000 5th generation 400G Ethernet line card	Release 25.1.1	Support for IEEE-1588 PTP is extended to the following line card: • A9K-4HG-FLEX-X-SE Class C performance is supported on all ports 1G, 10G, 25G, 40G and 100G. Route Processor: • A9K-RSP5-X-SE • A9K-RSP5-X-TR

Feature Name	Release Information	Feature Description
Precision time protocol on 12-port 100 Gigabit Ethernet line cards, ASR 9000 5th generation 400G line cards, ASR 9902 Series Routers, and 0.8T PEC	Release 7.4.1	Support for IEEE-1588 PTP is extended to the following routers and line cards: • A99-12X100GE • A9K-4X100GE • ASR-9902 • A9K-8HG-FLEX-SE/TR • A9K-4HG-FLEX-SE • A9K-4HG-FLEX-TR • A99-4HG-FLEX-SE • A99-4HG-FLEX-TR
PTP support on 5th generation 10-Port 400 Gigabit Ethernet line cards: • A99-10X400GE-X-SE • A99-10X400GE-X-TR	Release 7.3.2	Support for IEEE-1588 PTP is extended to the following line cards: • A99-10X400GE-X-SE • A99-10X400GE-X-TR

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 supported hardware:

Hardware Variant	1588/PTP	Cisco IOS XR	Cisco IOS XR 64 bit	Comments
A9K-8X100GE-L-SE/TR (10GE and 100GE)	Default & G.8265.1	5.3.3	6.3.2 6.4.1	PTP over Ethernet does not work on 100G ports on Cisco IOS XR until 6.4.1. Support was introduced in 6.4.1.
	G.8275.1 & G.8275.2	6.2.1	6.3.2 6.4.1	
	G.8273.2	6.2.1	6.3.2	
	PTP Multiprofile	6.5.1	6.5.1	

Hardware Variant	1588/PTP	Cisco IOS XR	Cisco IOS XR 64 bit	Comments
A9K-RSP880-SE/TR	1588/PTP Default & G.8265.1	5.3.3	6.3.2 6.4.1	-
	1588/PTP G.8275.1 & G.8275.2	6.2.1	6.3.2 6.4.1	
	1588/PTP G.8273.2	6.2.1	6.3.2 6.4.1	
	PTP Multiprofile	6.5.1	6.5.1	
A9K-8X100GE-L-SE/TR (40-GE)	1588/PTP Default & G.8265.1	6.0.1	6.3.2 6.4.1	-
	1588/PTP G.8275.1 & G.8275.2	6.2.1	6.3.2 6.4.1	
	1588/PTP G.8273.2	NA	NA	
	PTP Multiprofile	6.5.1	6.5.1	
A9K-4X100GE-SE/TR A9K-8X100GE-SE/TR	1588/PTP Default & G.8265.1	6.2.1	6.4.1	PTP over Ethernet does not work on 100G ports on Cisco IOS XR until 6.4.1. Support was introduced in 6.4.1. In 6.2.1, only G.8275.1 PTP profile is supported on the cards; No support for G.8273.2 PTP profile.
	1588/PTP G.8275.1 & G.8275.2	6.2.1	6.4.1	
	1588/PTP G.8273.2	6.4.1	6.4.1	
	PTP Multiprofile	6.5.1	6.5.1	

Hardware Variant	1588/PTP	Cisco IOS XR	Cisco IOS XR 64 bit	Comments
A9K-MOD400-SE/TR & A9K-MOD200-SE/TR with Legacy MPAs	1588/PTP Default & G.8265.1	6.1.3	6.4.1	-
	1588/PTP G.8275.1 & G.8275.2	6.2.2	6.4.1	-
	1588/PTP G.8273.2	-	-	-
	PTP Multiprofile	6.5.1	6.5.1	-
A9K-MOD400-SE/TR & A9K-MOD200-SE/TR with MPA 20x10GE , A9K-MPA-1X100GE and A9K-MPA-2X100GE	1588/PTP Default & G.8265.1	6.1.3	6.4.1	PTP over Ethernet does not work on 100G ports on Cisco IOS XR until 6.4.1. Support was introduced in 6.4.1. In 6.2.2, only G.8275.1 PTP profile is supported on the cards. No support for G.8273.2 PTP profile until 6.5.1.
	1588/PTP G.8275.1 & G.8275.2	6.2.2	6.4.1	
	1588/PTP G.8273.2	6.5.1	6.5.1	
	PTP Multiprofile	6.5.1	6.5.1	
A9K-24X10GE-1G-SE/TR A9K-48X10GE-1G-SE/TR	1588/PTP Default & G.8265.1	6.2.2 6.3.1	6.3.2	You cannot use one-step PTP clock operation on the PTP master interface of A9K-48X10GE-1G-SE line cards.
	1588/PTP G.8275.1 & G.8275.2	6.2.2 6.3.1	6.3.2	
	1588/PTP G.8273.2	6.3.1	6.3.2	
	PTP Multiprofile	6.5.1	6.5.1	

Hardware Variant	1588/PTP	Cisco IOS XR	Cisco IOS XR 64 bit	Comments
A99-RSP-SE/TR (Cisco ASR 9910 Series Routers)	1588/PTP Default & G.8265.1	6.3.1	6.3.2	-
	1588/PTP G.8275.1 & G.8275.2	6.3.1	6.3.2	
	1588/PTP G.8273.2	6.4.1	6.3.2	
	PTP Multiprofile	6.5.1	6.5.1	
A9K-RSP880-LT-SE/TR	1588/PTP Default & G.8265.1	6.2.2	6.4.1	-
	1588/PTP G.8275.1 & G.8275.2	6.2.2	6.4.1	
	1588/PTP G.8273.2	6.4.1	6.4.1	
	PTP Multiprofile	6.5.1	6.5.1	
A9K-RSP440-TR/SE A99-RP-SE Enhanced Ethernet Linecards	1588/PTP Default & G.8265.1	4.3.4	NA	Enhanced Ethernet linecards do not support G.8273.2 with G.8275.1 PTP profile. .
	1588/PTP G.8275.1 & G.8275.2	NA	NA	
	1588/PTP G.8273.2	NA	NA	
A99-RP2-TR/SE	1588/PTP Default & G.8265.1	5.3.3	6.3.2 6.4.1	-
	1588/PTP G.8275.1 & G.8275.2	6.2.1	6.3.2 6.4.1	
	1588/PTP G.8273.2	NA	NA	

Hardware Variant	1588/PTP	Cisco IOS XR	Cisco IOS XR 64 bit	Comments
Cisco ASR 9001 Series Routers	1588/PTP Default & G.8265.1	4.3.4	NA	Enhanced Ethernet based hardware does not support G.8273.2 with G.8275.1 PTP profile.
	1588/PTP G.8275.1 & G.8275.2	NA	NA	
	1588/PTP G.8273.2	NA	NA	
Cisco ASR 9901 Series Routers	1588/PTP Default & G.8265.1	NA	6.4.1	-
	1588/PTP G.8275.1 & G.8275.2	NA	6.4.1	
	1588/PTP G.8273.2	NA	6.6.1	
	PTP Multiprofile	NA	6.5.1	
A99-RSP-SE/TR (Cisco ASR 9906 Series Routers)	1588/PTP Default & G.8265.1	6.3.1	6.3.2	-
	1588/PTP G.8275.1 & G.8275.2	6.3.1	6.3.2	
	1588/PTP G.8273.2	6.4.1	6.3.2	
	PTP Multiprofile	6.5.1	6.5.1	
A9K-RSP5-SE	1588/PTP Default & G.8265.1	NA	6.5.15	-
	1588/PTP G.8275.2	NA	6.5.15	
	1588/PTP G.8275.1 & G.8273.2	NA	6.6.1	
	PTP Multiprofile	NA	6.5.15	

Hardware Variant	1588/PTP	Cisco IOS XR	Cisco IOS XR 64 bit	Comments
A9K-RSP5-TR	1588/PTP Default & G.8265.1	NA	6.5.15	-
	1588/PTP G.8275.2	NA	6.5.15	
	1588/PTP G.8275.1 & G.8273.2	NA	6.6.1	
	PTP Multiprofile	NA	6.5.15	
A99-RP3-SE	1588/PTP Default & G.8265.1	NA	6.5.15	-
	1588/PTP G.8275.2	NA	6.5.15	
	1588/PTP G.8275.1 & G.8273.2	NA	6.6.1	
	PTP Multiprofile	NA	6.5.15	
A99-RP3-TR	1588/PTP Default & G.8265.1	NA	6.5.15	-
	1588/PTP G.8275.2	NA	6.5.15	
	1588/PTP G.8275.1 & G.8273.2	NA	6.6.1	
	PTP Multiprofile	NA	6.5.15	
A9K-8X100GE-X-TR	1588/PTP Default & G.8265.1	NA	6.5.15	-
	1588/PTP G.8275.2	NA	6.5.15	
	1588/PTP G.8275.1 & G.8273.2	NA	6.6.1	
	PTP Multiprofile	NA	6.5.15	
A9K-16X100GE-TR	1588/PTP Default & G.8265.1	NA	6.5.15	NA
	1588/PTP G.8275.2	NA	6.5.15	
	1588/PTP G.8275.1 & G.8273.2	NA	6.6.1	
	PTP Multiprofile	NA	6.5.15	

Hardware Variant	1588/PTP	Cisco IOS XR	Cisco IOS XR 64 bit	Comments
A99-16X100GE-X-SE A99-32X100GE-TR/CM	1588/PTP Default & G.8265.1	NA	6.6.1	NA
	1588/PTP G.8275.2	NA	6.6.1	
	1588/PTP G.8275.1 & G.8273.2	NA	6.6.1	
	PTP Multiprofile	NA	6.6.1	
A9K-32X100GE-TR	1588/PTP Default & G.8265.1	NA	6.5.15	-
	1588/PTP G.8275.2	NA	6.5.15	
	1588/PTP G.8275.1 & G.8273.2	NA	6.6.1	
	PTP Multiprofile	NA	6.5.15	
Cisco ASR 9903 Series Routers	1588/PTP Default & G.8265.1	NA	7.1.3	Card supports 'one-step' clock operation only and must have one-step configuration on PTP master interface to operate.
	1588/PTP G.8275.2	NA	7.1.3	
	1588/PTP G.8275.1 & G.8273.2	NA	7.1.3	
	PTP Multiprofile	NA	7.1.3	
A9903-20HG-PEC	1588/PTP Default & G.8265.1	NA	7.1.3	
	1588/PTP G.8275.2	NA	7.1.3	
	1588/PTP G.8275.1 & G.8273.2	NA	7.1.3	
	PTP Multiprofile	NA	7.1.3	
A99-32X100GE-X-SE/TR	1588/PTP Default & G.8265.1	NA	7.1.15	
	1588/PTP G.8275.2	NA	7.1.15	
	1588/PTP G.8275.1 & G.8273.2	NA	7.1.15	
	PTP Multiprofile	NA	7.1.15	

Hardware Variant	1588/PTP	Cisco IOS XR	Cisco IOS XR 64 bit	Comments
A9K-8HG-FLEX-SE/TR	1588/PTP Default & G.8265.1	NA	7.1.15	Card supports 'one-step' clock operation only and must have one-step configuration on PTP master interface to operate.
	1588/PTP G.8275.2	NA	7.1.15	
	1588/PTP G.8275.1 & G.8273.2	NA	7.1.15	
	PTP Multiprofile	NA	7.1.15	
A9K-20HG-FLEX-SE/TR	1588/PTP Default & G.8265.1	NA	7.1.15	Card supports 'one-step' clock operation only and must have one-step configuration on PTP master interface to operate.
	1588/PTP G.8275.2	NA	7.1.15	
	1588/PTP G.8275.1 & G.8273.2	NA	7.1.15	
	PTP Multiprofile	NA	7.1.15	
A99-10X400GE-X-SE/TR	1588/PTP Default & G.8265.1	NA	7.3.2	Card supports 'one-step' clock operation only and must have one-step configuration on PTP master interface to operate. Class B Performance (Applicable to 1588/PTP G.8275.1 & G.8273.2)
	1588/PTP G.8275.2	NA	7.3.2	
	1588/PTP G.8275.1 & G.8273.2	NA	7.3.2	
	PTP Multiprofile	NA	7.3.2	
A99-12x100GE A99-12X100GE-CM	1588/PTP Default & G.8265.1	NA	7.4.1	
	1588/PTP G.8275.2	NA	7.4.1	
	1588/PTP G.8275.1 & G.8273.2	NA	7.4.1	Class B Performance
	PTP Multiprofile	NA	7.4.1	
A99-8X100GE-SE/TR/CM A9K-8X100GE-CM A9K-8X100G-LB-SE/TR A9K-400G-DWDM-TR A99-48X10GE-1G-SE/TR	1588/PTP Default & G.8265.1	6.2.2	6.2.2	
	1588/PTP G.8275.2	6.2.2	6.2.2	
	1588/PTP G.8275.1 & G.8273.2	6.2.2	6.2.2	
	PTP Multiprofile	6.2.2	6.2.2	

Hardware Variant	1588/PTP	Cisco IOS XR	Cisco IOS XR 64 bit	Comments
A9K-4X100GE	1588/PTP Default & G.8265.1	NA	7.4.1	
	1588/PTP G.8275.2	NA	7.4.1	
	1588/PTP G.8275.1 & G.8273.2	NA	7.4.1	Class B Performance
	PTP Multiprofile	NA	7.4.1	
A9K-400GE-SE/TR	1588/PTP Default & G.8265.1	NA	7.4.1	
	1588/PTP G.8275.2	NA	7.4.1	
	1588/PTP G.8275.1 & G.8273.2	NA	7.4.1	Class B Performance
	PTP Multiprofile	NA	7.4.1	
A99-400GE-SE/TR	1588/PTP Default & G.8265.1	NA	7.4.1	
	1588/PTP G.8275.2	NA	7.4.1	
	1588/PTP G.8275.1 & G.8273.2	NA	7.4.1	Class B Performance
	PTP Multiprofile	NA	7.4.1	
ASR 9902	1588/PTP Default & G.8265.1	NA	7.4.1	Port 12 to Port 35 provides Class B Performance and requires two-step clock operation on PTP master interface Port 0 to port 11 and port 36 to port 47 provide Class C performance and requires one-step clock operation on PTP master interface.
	1588/PTP G.8275.2	NA	7.4.1	
	1588/PTP G.8275.1 & G.8273.2	NA	7.4.1	
	PTP Multiprofile	NA	7.4.1	

Hardware Variant	1588/PTP	Cisco IOS XR	Cisco IOS XR 64 bit	Comments
ASR-9903	1588/PTP Default & G.8265.1	NA	7.4.1	Card supports 'one-step' clock operation only and must have one-step configuration on PTP master interface to operate.
	1588/PTP G.8275.2	NA	7.4.1	
	1588/PTP G.8275.1 & G.8273.2	NA	7.4.1	
	PTP Multiprofile	NA	7.4.1	
A9K-4HG-FLEX-SE/TR	1588/PTP Default & G.8265.1	NA	7.4.1	Card supports 'one-step' clock operation only and must have one-step configuration on PTP master interface to operate.
	1588/PTP G.8275.2	NA	7.4.1	
	1588/PTP G.8275.1 & G.8273.2	NA	7.4.1	
	PTP Multiprofile	NA	7.4.1	
A99-4HG-FLEX-SE/TR	1588/PTP Default & G.8265.1	NA	7.4.1	Card supports 'one-step' clock operation only and must have one-step configuration on PTP master interface to operate.
	1588/PTP G.8275.2	NA	7.4.1	
	1588/PTP G.8275.1 & G.8273.2	NA	7.4.1	
	PTP Multiprofile	NA	7.4.1	
A9K-4HG-FLEX-X-SE	1588/PTP Default & G.8265.1	NA	25.1.1	Card supports 'one-step' clock operation only and must have one-step configuration on PTP master interface to operate. Class C performance is supported on all ports 1G, 10G, 25G, 40G and 100G. Route Processor: • A9K-RSP5-X-SE • A9K-RSP5-X-TR
	1588/PTP G.8275.2	NA	25.1.1	
	1588/PTP G.8275.1 & G.8273.2	NA	25.1.1	
	PTP Multiprofile	NA	25.1.1	

Hardware Variant	1588/PTP	Cisco IOS XR	Cisco IOS XR 64 bit	Comments
A99-4HG-FLEX-X-SE	1588/PTP Default & G.8265.1	NA	25.2.1	Card supports 'one-step' clock operation only and must have one-step configuration on PTP master interface to operate. Class B performance is supported on all ports 1G, 10G, 25G, 40G and 100G. Route processors: • A9K-RSP5-SE/TR • A99-RP3-SE/TR Class C performance is supported on all ports 1G, 10G, 25G, 40G and 100G. Route processors: • A9K-RSP5-X-SE/TR • A99-RP3-X-SE/TR
	1588/PTP G.8275.2	NA	25.2.1	
	1588/PTP G.8275.1 & G.8273.2	NA	25.2.1	
	PTP Multiprofile	NA	25.2.1	

Note The following 2nd generation line cards support all IEEE-1588 PTP telecom profiles (Default, G.8265.1, G.8275.2, G.8275.1, G.8273.2, and PTP Multiprofile) in Cisco IOS XR 32 bit:

Table 4: 2nd Generation Line Cards Supporting IEEE-1588 PTP

Hardware Variant	Hardware Variant	Hardware Variant
A9K-2X100GE-SE/TR	A9K-40GE-SE/TR	A9K-40GE-SE/TR
A9K-1X100GE-SE/TR	A9K-MOD160-SE/TR	A9K-VSM-500
A9K-36X10GE-SE/TR	A9K-MOD80-SE/TR	A9K-SIP-700
A9K-4T16GE-SE/TR	A9K-4T16GE-SE/TR	

Restrictions

- PTP Grandmaster (GM) is not supported with all the PTP profiles.

- RSP IEEE 1588 port on RSP/RP is not supported.
- If PTP clock operation CLI is not configured, the default clock operation is two-step on all ASR9000 hardware variants.
- Due to the difference in PTP timestamp unit, which involves the PHY injecting the timestamp instead of the NPU, you must configure PTP clock operation **one-step** on the PTP master interface of the line cards which are explicitly specified in the PTP hardware support matrix, on page 8. Rest of the line cards only support PTP clock operation **two-step** on the PTP master interface.
- PTP clock operation one-step or two-step restriction is only for PTP master interface. PTP slave interface can operate in either one-step or two-step.
- Cisco ASR 9000 Series Routers do not support Class B 1 Pulse Per Second (PPS) performance with Forward Error Correction (FEC) enabled optics.
- The upgrade of TimingIC-*X* firmware impacts timing functionality on the ASR 9902 and ASR 9903 Routers, and 5th Generation Line Cards. You must reload the linecard after upgrade of timing firmware for proper functioning of SyncE and PTP features. Interface flapping and traffic drops are expected during this process.
- G.8275.1 and G.8275.2 profiles are not supported on Cisco ASR 9001 chassis, Cisco ASR 9000 Ethernet line cards, Cisco ASR 9000 Enhanced Ethernet line cards, and A9K-400G-DWDM-SE/TR line cards.
- As recommended in Appendix VI of ITU-T G.8275.1 document, G.8275.1 profile is supported only on Bundle Link Aggregation (LAG) member links and not supported on a bundle interface.
- G.8273.2 Telecom Boundary Clock (T-BC) performance is not supported on 40G interfaces.
- The G.8273.2 Class B performance is observed when the same type of line card is used for both PTP server and PTP client ports. Class A performance is observed when different types of line cards are used for PTP server and PTP client on T-BC.
- G.8275.2 profile is supported on Cisco ASR 9000 Series Routers. However, the performance standards of this profile are 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.
- Transparent Clock (TC) is not supported.
- PTP Multiprofile is not supported for G.8273.2 Class B performance.
- Platform Fault Manager (PFM) alarms for the 10MHz port are not supported on A9K-RSP5-SE, A9K-RSP5-TR, A99-RP3-SE, and A99-RP3-TR.
- Select 5th generation line cards (A9K-20HG-FLEX-xx and A9K-8HG-FLEX-xx) will support PTP Telecom Profile G.8275.2 in combination with transit G.8265.1/G.8275.2 packets, in a future version of these cards.



Note Forwarding PTP packets as IP or MPLS isn't possible without the redirecting device not being PTP-aware. If each node across the PTP path isn't performing the T-BC function, timing accuracy can't be maintained.

ITU-T Telecom Profiles for PTP

Cisco IOS XR software supports ITU-T Telecom Profiles for PTP as defined in the ITU-T recommendation. A profile consists of PTP configuration options applicable only to a specific application.

Separate profiles can be defined to incorporate PTP in different scenarios based on the IEEE 1588-2008 standard. 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 Profile

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 FSM 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 1 because all clocks in a 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.

Hardware variant-specific behavior

The profile G8265.1 displays the following behavior on these hardware variants A9K-RSP5-SE, A9K-RSP5-TR, A99-RP3-SE, and A99-RP3-TR:

- Configuring either a master or slave clock type is mandatory.
- G.8265.1 is only a frequency synchronization profile and the servo state is displayed as FREQ_LOCKED and the PTP slave interface remains as slave. Phase synchronization is not supported.
- G.8265.1 profile supports only PTP pure mode and not PTP hybrid mode.

G.8273.2 Profile

The G.8273.2 profile allows distribution of time and phase synchronization across packet-based networks. Cisco's implementation supports the enhanced Class C timing mode.

Class C mode enables highly accurate clock synchronization crucial for telecom networks with stringent timing requirements, including 5G networks. This mode significantly reduces the Maximum Absolute Time Error (Max|TE|) and improves the synchronization of Telecom Boundary Clocks (T-BC) and Telecom Time Secondary Clocks (T-TSC).

Class C timing support is available for both PTP and Frequency Synchronization, ensuring comprehensive synchronization capabilities for your network.

For information on how to configure PTP, see Configuring PTP.

G.8275.1 Profile

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 with SyncE 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.

Hardware variant-specific behavior

The profile G8275.1 displays the following behavior on these hardware variants A9K-RSP5-SE, A9K-RSP5-TR, A99-RP3-SE, and A99-RP3-TR:

- SyncE input is mandatory as only PTP hybrid mode is supported.
- The frequency is derived from the SyncE interface and phase adjustments are based on PTP.
- If you configure SyncE before you configure PTP, the Servo state is set to FREQ_LOCKED by default.
- After the Servo is in PHASE_LOCKED state, if the SyncE input is lost or removed, the Servo transitions to HOLDOVER state.
- After the Servo is in PHASE_LOCKED state, if the PTP input is lost or removed, the Servo transitions to FREQ_LOCKED state.

Note For the hardware variants A9K-8X100GE-X-TR, A9K-16X100GE-TR and A9K-32X100GE-TR you are not required to shut the 100 GE link to configure this profile.

G.8275.2 Profile

G.8275.2 profile fulfills the time-of-day and phase synchronization requirements in telecom networks with partial timing support from the network. 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 and IPv6 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.

Hardware variant-specific behavior

The profile G8275.2 displays the following behavior on these hardware variants A9K-RSP5-SE, A9K-RSP5-TR, A99-RP3-SE, and A99-RP3-TR:

- Hybrid PTP and pure PTP are supported on this profile.
- The physical-layer-frequency command must be used to configure Hybrid PTP.
- To switch from Hybrid PTP to Pure PTP, you must remove the physical-layer-frequency configuration and frequency synchronization configuration to remove SyncE inputs from line card interfaces and RSP clock-interfaces.

Configuring PTP

Prerequisite

You must be in a user group associated with a task group that includes the proper task IDs. The command reference guides include the task IDs required for each command. If you suspect user group assignment is preventing you from using a command, contact your AAA administrator for assistance.

PTP Interface and Profile Configuration

When a global PTP profile is attached to an interface, its values are used as default settings for that interface. When additional settings are configured under an interface itself, these settings override the defaults in that profile. When no profile is attached to an interface, the configuration on the interface is used to determine the PTP settings for that interface.

When configuring PTP, use one of the following approaches:

- Create a profile (or multiple profiles) containing all the default settings to use on all PTP interfaces. Override any settings that differ for particular interfaces by using the interface configuration under the interfaces themselves.
- Configure all settings separately for each interface, without using any global profiles. Use this approach if the interfaces do not have consistent settings, or if you are configuring only a small number of PTP interfaces.

Configuring Frequency Synchronization and Quality Settings for PTP

This procedure describes the steps involved to configure frequecy and quality settings for PTP on a router.

1. To enable frequency synchronization on the router, use **frequency synchronization** command in the configuration mode.

```
RP/0/RSP0/CPU0:router(config)# frequency synchronization
```

2. To configure ITU-T quality parameters, use **quality itu-t option** *option* **generation** *number* command in the frequency synchronization configuration mode.
   - **option 1**: Includes PRC, SSU-A, SSU-B, SEC, and DNU. This is the default option.
   - **option 2 generation 1**: Includes PRS, STU, ST2, ST3, SMC, and DUS.
   - **option 2 generation 2**: Includes PRS, STU, ST2, ST3, TNC, ST3E, SMC, and DUS.



Note The **quality option** configured here must match the **quality option** specified in the **quality receive** and **quality transmit** commands.

```
RP/0/RSP0/CPU0:router(config-freqsync)# quality itu-t
option 2 generation 2
```

Verification

To display the frequency synchronization selection, use **show frequency synchronization selection** command.

```
RP/0/RSP0/CPU0:router# show frequency synchronization selection
Node 0/RSP1/CPU0:
==============
Selection point: T0-SEL-B (3 inputs, 1 selected)
  Last programmed 06:49:27 ago, and selection made 06:49:15 ago
  Next selection points
    SPA scoped    : None
    Node scoped   : T4-SEL-C 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  Sync1 [0/RSP1/CPU0]       n/a                         PRC    1  Locked
     HundredGigE0/5/0/2        0/5/CPU0 ETH_RXMUX 1        PRC    1  Available
     Internal0 [0/RSP1/CPU0]   n/a                         SEC  255  Available

Selection point: T4-SEL-A (1 inputs, 1 selected)
  Last programmed 06:49:27 ago, and selection made 06:49:15 ago
  Next selection points
    SPA scoped    : None
    Node scoped   : T4-SEL-C
    Chassis scoped: None
    Router scoped : None
  Uses frequency selection
  S  Input                     Last Selection Point         QL  Pri  Status
```

```
  == ========================  ========================  =====  ===  ===========
  1  HundredGigE0/5/0/2        0/5/CPU0 ETH_RXMUX 1        PRC    1  Available

Selection point: T4-SEL-C (2 inputs, 1 selected)
  Last programmed 06:49:15 ago, and selection made 06:49:15 ago
  Next selection points
    SPA scoped    : None
    Node scoped   : None
    Chassis scoped: None
    Router scoped : None
  Uses frequency selection
  Used for local clock interface output
  S  Input                     Last Selection Point         QL  Pri  Status
  == ========================  ========================  =====  ===  ===========
  1  Sync1 [0/RSP1/CPU0]       0/RSP1/CPU0 T0-SEL-B 1      PRC    1  Locked
     HundredGigE0/5/0/2        0/RSP1/CPU0 T4-SEL-A 1      PRC    1  Available

Selection point: CHASSIS-TOD-SEL (1 inputs, 1 selected)
  Last programmed 6d04h ago, and selection made 6d04h 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  Sync1 [0/RSP1/CPU0]       0/RSP1/CPU0 T0-SEL-B 1    100  Yes   Available

Node 0/3/CPU0:
==============
Selection point: ETH_RXMUX (0 inputs, 0 selected)
  Last programmed 9w6d ago, and selection made 9w6d ago
  Next selection points
    SPA scoped    : None
    Node scoped   : None
    Chassis scoped: T0-SEL-B T4-SEL-A
    Router scoped : None
  Uses frequency selection

Selection point: LC_TX_SELECT (1 inputs, 1 selected)
  Last programmed 9w6d ago, and selection made 9w6d 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
  == ========================  ========================  =====  ===  ===========
  24 Sync1 [0/RSP1/CPU0]       0/RSP1/CPU0 T0-SEL-B 1      PRC    1  Available

Node 0/5/CPU0:
==============
Selection point: ETH_RXMUX (1 inputs, 1 selected)
  Last programmed 06:49:27 ago, and selection made 06:49:27 ago
  Next selection points
    SPA scoped    : None
    Node scoped   : None
    Chassis scoped: T0-SEL-B T4-SEL-A
    Router scoped : None
  Uses frequency selection
  S  Input                     Last Selection Point         QL  Pri  Status
```

```
  == ========================  ========================  =====  ===  ===========
  1  HundredGigE0/5/0/2        n/a                         PRC    1  Available

Selection point: LC_TX_SELECT (1 inputs, 1 selected)
  Last programmed 6d04h ago, and selection made 6d04h 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
  == ========================  ========================  =====  ===  ===========
  24 Sync1 [0/RSP1/CPU0]       0/RSP1/CPU0 T0-SEL-B 1      PRC    1  Available
```

Configuring Global Profile

This procedure describes the steps involved to create a global configuration profile for a PTP interface that can then be assigned to any interface as required.

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.

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

   ```
   RP/0/RSP0/CPU0:router(config)# ptp
   ```

2. To configure a PTP profile, use **profile** command in the ptp configuration mode.

   ```
   RP/0/RSP0/CPU0:router(config-ptp)# profile tp64
   ```

3. To configure frequency for a Sync message for the given PTP profile, use **sync frequency** *rate* command in the ptp-profile configuration mode.

   ```
   RP/0/RSP0/CPU0:router(config-ptp-profile)# sync frequency 16
   ```

4. To configure delay-request frequency for the given PTP profile, use **delay-request frequency** *rate* command in the ptp-profile configuration mode.

   ```
   RP/0/RSP0/CPU0:router(config-ptp-profile)# delay-request frequency 16
   ```

Verification

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

```
RP/0/RSP0/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
  transport ethernet
  sync frequency 16
  announce interval 1
  delay-request frequency 16
!
profile master
  transport ethernet
  sync frequency 16
  announce interval 1
  delay-request frequency 16
!
profile slave1
  transport ethernet
  sync frequency 64
  announce interval 1
  delay-request frequency 64
!
```

Configuring PTP Slave Interface

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

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

   ```
   RP/0/RSP0/CPU0:router(config)# interface TenGigE 0/1/0/5
   ```

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

   ```
   RP/0/RSP0/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/RSP0/CPU0:router(config-if-ptp)# profile tp64
   ```

4. To configure the transport mode for all PTP messages in the given PTP profile, use **transport** *mode_type* command in the ptp interface configuration mode.

   ```
   RP/0/RSP0/CPU0:router(config-if-ptp)# transport ipv4
   ```

5. To configure timeout for PTP announce messages in the given PTP profile, use **announce interval** *interval-value* command in the ptp interface configuration mode.

```
RP/0/RSP0/CPU0:router(config-if-ptp)# announce interval 1
```

6. To configure the port state, use **port state** command in the ptp interface configuration mode.

```
RP/0/RSP0/CPU0:router(config-if-ptp)# port state slave-only
```

7. To configure IPv4 or IPv6 address for PTP master, use **master ipv4|ipv6** *address* command in the ptp interface configuration mode.

```
RP/0/RSP0/CPU0:router(config-if-ptp)# master ipv4 192.168.2.1
```

```
RP/0/RSP0/CPU0:router(config-if-ptp)# master ipv6 2001:DB8::1
```

8. To return to the interface configuration mode, use **exit** command.

```
RP/0/RSP0/CPU0:router(config-if-ptp)# exit
```

9. To configure a gateway for the given interface, use **ipv4 address** *address mask* command in the interface configuration mode.

```
RP/0/RSP0/CPU0:router(config-if)# ipv4 address 1.7.1.2 255.255.255.0
```

Verification

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

```
RP/0/RSP0/CPU0:router# show run interface TenGigE 0/1/0/5

Fri Aug  3 19:57:14.184 UTC
interface TenGigE 0/1/0/5
 ptp
  profile tp64
  transport ipv4
  port state slave-only
  master ipv4 192.168.2.1
  !
  announce interval 1
  !
 ipv4 address 1.7.1.1 255.255.255.0
!
```

Configuring PTP Master Interface

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

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

```
RP/0/RSP0/CPU0:router(config)# interface TenGigE 0/1/0/5
```

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

```
RP/0/RSP0/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 override settings in this profile.

```
RP/0/RSP0/CPU0:router(config-if-ptp)# profile tp64
```

4. To configure the transport mode for all PTP messages in the given PTP profile, use **transport** *mode_type* command in the ptp interface configuration mode.

```
RP/0/RSP0/CPU0:router(config-if-ptp)# transport ipv4
```

5. To configure timeout for PTP announce messages in the given PTP profile, use **announce interval** *interval-value* command in the ptp interface configuration mode.

```
RP/0/RSP0/CPU0:router(config-if-ptp)# announce interval 1
```

6. To return to the interface configuration mode, use **exit** command.

```
RP/0/RSP0/CPU0:router(config-if-ptp)# exit
```

7. To configure a gateway for the given interface, use **ipv4 address** *address mask* command in the interface configuration mode.

```
RP/0/RSP0/CPU0:router(config-if)# ipv4 address 1.7.1.2 255.255.255.0
```

Verification

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

```
RP/0/RSP0/CPU0:router# show run interface TenGigE 0/1/0/5

Fri Aug  3 13:57:44.366 PST
interface TenGigE 0/1/0/5
 ptp
  profile tp64
  transport ipv4
  !
  announce interval 1
  !
  ipv4 address 1.7.1.2 255.255.255.0
 !
```

Configuring PTP Hybrid Mode

This procedure describes the steps involved to configure router in a hybrid mode. You can do this by selecting PTP for Time-of-Day (ToD) and another source for frequency.

Note Configure appropriate clock priorities when using synchronous Ethernet for frequency synchronization. This ensures the system selects the frequency source from the same interface as the PTP source. Aligning both frequency and time synchronization to the same interface helps maintain consistency and reduces configuration complexity.

1. To enable frequency synchronization on the router, use **frequency synchronization** command in the configuration mode.

```
RP/0/RSP0/CPU0:router(config)# frequency synchronization
```

2. To configure a SyncE source, create an interface to be a SyncE input. This can be configured using **interface** command in the configuration mode.

Note 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/RSP0/CPU0:router(config)# interface GigabitEthernet 0/1/0/0
RP/0/RSP0/CPU0:router(config-if)# frequency synchronization
RP/0/RSP0/CPU0:router(config-if-freqsync)# selection input
RP/0/RSP0/CPU0:router(config-if-freqsync)# time-of-day-priority 100
RP/0/RSP0/CPU0:router(config-if-freqsync)# commit
```

3. To configure PTP as the source for ToD, enable PTP on the router using **ptp** command in command in the configuration mode. ToD priority values can range from 1 (highest priority) to 254 (lowest priority).

```
RP/0/RSP0/CPU0:router(config)# ptp
RP/0/RSP0/CPU0:router(config-ptp)# time-of-day-priority 1
RP/0/RSP0/CPU0:router(config)# commit
```

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

```
RP/0/RSP0/CPU0:router(config)# interface gigabitEthernet 0/1/0/1
RP/0/RSP0/CPU0:router(config-if)# ipv4 address 10.0.0.1/24
RP/0/RSP0/CPU0:router(config-if)# ptp
RP/0/RSP0/CPU0:router(config-if-ptp)# master ipv4 10.0.0.2
RP/0/RSP0/CPU0:router(config-if-ptp)# commit
```

Verification

To display the frequency synchronization selection, use **show frequency synchronization selection** command.

```
RP/0/RSP0/CPU0:router# show frequency synchronization selection
Node 0/RSP1/CPU0:
==============
Selection point: T0-SEL-B (3 inputs, 1 selected)
  Last programmed 06:49:27 ago, and selection made 06:49:15 ago
```

```
  Next selection points
    SPA scoped    : None
    Node scoped   : T4-SEL-C 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  Sync1 [0/RSP1/CPU0]       n/a                         PRC    1  Locked
     HundredGigE0/5/0/2        0/5/CPU0 ETH_RXMUX 1        PRC    1  Available
     Internal0 [0/RSP1/CPU0]   n/a                         SEC  255  Available

Selection point: T4-SEL-A (1 inputs, 1 selected)
  Last programmed 06:49:27 ago, and selection made 06:49:15 ago
  Next selection points
    SPA scoped    : None
    Node scoped   : T4-SEL-C
    Chassis scoped: None
    Router scoped : None
  Uses frequency selection
  S  Input                     Last Selection Point         QL  Pri  Status
  == ========================  ========================  =====  ===  ===========
  1  HundredGigE0/5/0/2        0/5/CPU0 ETH_RXMUX 1        PRC    1  Available

Selection point: T4-SEL-C (2 inputs, 1 selected)
  Last programmed 06:49:15 ago, and selection made 06:49:15 ago
  Next selection points
    SPA scoped    : None
    Node scoped   : None
    Chassis scoped: None
    Router scoped : None
  Uses frequency selection
  Used for local clock interface output
  S  Input                     Last Selection Point         QL  Pri  Status
  == ========================  ========================  =====  ===  ===========
  1  Sync1 [0/RSP1/CPU0]       0/RSP1/CPU0 T0-SEL-B 1      PRC    1  Locked
     HundredGigE0/5/0/2        0/RSP1/CPU0 T4-SEL-A 1      PRC    1  Available

Selection point: CHASSIS-TOD-SEL (1 inputs, 1 selected)
  Last programmed 6d04h ago, and selection made 6d04h 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  Sync1 [0/RSP1/CPU0]       0/RSP1/CPU0 T0-SEL-B 1    100  Yes   Available

Node 0/3/CPU0:
==============
Selection point: ETH_RXMUX (0 inputs, 0 selected)
  Last programmed 9w6d ago, and selection made 9w6d ago
  Next selection points
    SPA scoped    : None
    Node scoped   : None
    Chassis scoped: T0-SEL-B T4-SEL-A
    Router scoped : None
  Uses frequency selection

Selection point: LC_TX_SELECT (1 inputs, 1 selected)
  Last programmed 9w6d ago, and selection made 9w6d 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
  == ========================  ========================  =====  ===  ===========
  24 Sync1 [0/RSP1/CPU0]       0/RSP1/CPU0 T0-SEL-B 1      PRC    1  Available

Node 0/5/CPU0:
==============
Selection point: ETH_RXMUX (1 inputs, 1 selected)
  Last programmed 06:49:27 ago, and selection made 06:49:27 ago
  Next selection points
    SPA scoped    : None
    Node scoped   : None
    Chassis scoped: T0-SEL-B T4-SEL-A
    Router scoped : None
  Uses frequency selection
  S  Input                     Last Selection Point         QL  Pri  Status
  == ========================  ========================  =====  ===  ===========
  1  HundredGigE0/5/0/2        n/a                         PRC    1  Available

Selection point: LC_TX_SELECT (1 inputs, 1 selected)
  Last programmed 6d04h ago, and selection made 6d04h 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
  == ========================  ========================  =====  ===  ===========
  24 Sync1 [0/RSP1/CPU0]       0/RSP1/CPU0 T0-SEL-B 1      PRC    1  Available
```

Configuring Leap Seconds

This procedure describes the steps involved in leap second configuration. The configuration can be executed in two ways:

- By directly providing the **UTC offset value** in the command.
- By providing the path to a **file** in the command, where the UTC offset information is stored (or available).

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

   ```
   RP/0/RSP0/CPU0:router(config)# ptp
   ```

2. To configure the UTC offset information by providing the offset value directly, use { **utc-offset** {**baseline** | *date* } { *offset-value* } } command in the ptp configuration mode.
   - Using the **baseline** keyword, enter a positive number for the *offset-value* (it is assumed that a negative UTC offset will not be required).

- **OR** provide a date (in YYYY-MM-DD format) and the *offset-value* . UTC offset used by PTP will be updated on this date. If you do not specify a date, the configuration is applied for the current day, at midnight.



Note In both cases, providing the UTC *offset-value* directly in the command is mandatory.

```
RP/0/RSP0/CPU0:router(config-ptp)# utc-offset baseline 37

RP/0/RSP0/CPU0:router(config-ptp)# utc-offset 2018-07-01 38
```

3. To configure UTC offset information by providing the path to a file containing the UTC offset information, use { **utc-offset leap-second-file** { *file-path* } } [**poll-frequency** *days*] command in the ptp configuration mode. Optionally, you can provide a polling frequency in days, at which to poll the file for changes. If a frequency for polling is not specified, the file will polled on the day the file is set to expire.



Note The format of this file must be based on the canonical list present at http://www.ietf.org/timezones/data/leap-seconds.list.

```
RP/0/RSP0/CPU0:router(config-ptp)# utc-offset leap-second-file http://<remote-url>

RP/0/RSP0/CPU0:router(config-ptp)# utc-offset leap-second-file file://<local-path>
poll-frequency 7
```

Verification

To display the current UTC offset value, use **show ptp utc-offset** command.

```
RP/0/RSP0/CPU0:router# show ptp utc-offset

Current offset: +36 seconds (not valid)
Pending leap seconds:
 From 2017-01-01 offset will be +37 seconds
 From 2018-07-01 offset will be +38 second
 From 2019-07-01 offset will be +39 seconds
Source: User-configured
```

To display the current UTC offset value and related details, use **show ptp utc-offset detail** command.

```
RP/0/RSP0/CPU0:router# show ptp utc-offset detail

Current offset: +36 seconds (valid)
Known leap seconds:
From 1996-01-01 offset was +30 seconds
From 1997-07-01 offset was +31 seconds
From 1999-01-01 offset was +32 seconds
From 2006-01-01 offset was +33 seconds
From 2009-01-01 offset was +34 seconds
From 2012-07-01 offset was +35 seconds
```

```
From 2015-07-01 offset was +36 seconds
From 2017-01-01 offset will be +37 seconds
Source: file:///test/xxxuser/leapsec/test/list-leap-seconds.list
Expiry date: 2017-12-28
```

Configuring Multiple PTP Profile Interoperability

This procedure describes the steps involved in configuring interoperability for PTP profiles.

1. To configure an interface and then enter the PTP configuration mode, use **interface** and **ptp** commands respectively.

```
RP/0/RSP0/CPU0:router(config)# interface tenGigE 0/0/0/9

RP/0/RSP0/CPU0:router(config-if)# ptp
```

2. To configure PTP profile, use **profile** command in the interface-ptp configuration mode.

```
RP/0/RSP0/CPU0:router(config-if-ptp)# profile interop-slave
```

3. To configure interoperability, use **interop** command in the interface-ptp configuration mode.

```
RP/0/RSP0/CPU0:router(config-if-ptp)# interop
```

4. To configure the Telecom profile and domain number to interoperate with, use **profile {profile-type}** and **domain** *domain-number* commands in the interface-ptp-interop configuration mode.

```
RP/0/RSP0/CPU0:router(config-if-ptp-interop)# profile g.8275.2

RP/0/RSP0/CPU0:router(config-if-ptp-interop)# domain 44
```

5. To enable conversion of packets on ingress, use **ingress-conversion** command in the interface-ptp-interop configuration mode. The **ingress-conversion** command, converts the packets received from the incoming Announce messages.

```
RP/0/RSP0/CPU0:router(config-if-ptp-interop)#
ingress-conversion
```

6. To explicitly configure the other related parameters, use the respective commands in the interop-ingress submode.

Note Default values are used for parameters that are not explicitly configured during ingress-conversion. For example, default values will be used for parameters like **ClockAccuracy** or **OffsetScaledLogVariance** if they are not explicitly configured.

```
RP/0/RSP0/CPU0:router(config-if-ptp-interop-ingress)#
priority1 10
priority2 10
```

7. To enable conversion of packets on egress, use **egress-conversion** command in the interface-ptp-interop configuration mode. The **egress-conversion** command converts the packets sent through the outgoing Announce messages. The configuration is the same as for ingress conversion.

```
RP/0/RSP0/CPU0:router(config-if-ptp-interop)#
egress-conversion
```

Verification

To display the interop conversions, use **show ptp interop** command.

```
RP/0/RSP0/CPU0:router# show ptp interop tenGigE 0/0/0/9
Egress Conversions:
    Profile:                    Default -> G.8275.2
    Domain:                           0 -> 10
    Priority1:                        1 -> 128
    Priority2:                      100 -> 100
    ClockClass:                      52 -> 140
    ClockAccuracy:                    0 -> 0x21
    OffsetScaledLogVariance:          0 -> 0x4e5d

  Ingress Conversions:
    Profile:                  G.8275.2 -> Default
    Domain:                         10 -> 0
    Master 51.51.51.51:
      Priority1:                      1 -> 100
      Priority2:                      2 -> 254
      ClockClass:                     3 -> 13
      ClockAccuracy:               0x20 -> 0x20
      OffsetScaledLogVariance:   0x4e5d -> 0x4e5d
```

Configuring PTP Telecom Profile Interface

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



Note 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/RSP0/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/RSP0/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/RSP0/CPU0:router(config-if-ptp)# profile tele64
```

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/RSP0/CPU0:router(config-if-ptp)# sync frequency 128
```

```
RP/0/RSP0/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 for a port in Slave state and represents the maximum grant-duration allowed when the port is in Master state.

```
RP/0/RSP0/CPU0:router(config-if-ptp)# announce grant-duration 120
```

```
RP/0/RSP0/CPU0:router(config-if-ptp)# sync grant-duration 120
```

```
RP/0/RSP0/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/RSP0/CPU0:router(config-if-ptp)# sync timeout 120
```

```
RP/0/RSP0/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/RSP0/CPU0:router(config-if-ptp)# unicast-grant
invalid-request reduce
```

8. To configure IPv4 or IPv6 address for a PTP master, use **master {ipv4 | ipv6}** *ip-address* command in the ptp-interface configuration mode.

```
RP/0/RSP0/CPU0:router(config-if-ptp)# master ipv4 192.168.2.1
```

```
RP/0/RSP0/CPU0:router(config-if-ptp)# master ipv6 2001:DB8::1
```

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/RSP0/CPU0:router(config-if-ptp-master)# clock-class 2
```

Verification

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

```
RP/0/RSP0/CPU0:router# show ptp interfaces brief
Fri Feb  9 11:16:45.248 UTC
Intf              Port         Port                 Line
Name              Number       State        Encap   State         Mechanism
-------------------------------------------------------------------------------
BE1               1            Slave        IPv4    up            2-step DRRM
Gi0/0/0/40        2            Master       IPv4    up            2-step DRRM
```

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

```
RP/0/RSP0/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
  multicast target-address ethernet 01-1B-19-00-00-00
  transport ethernet
  port state slave-only
  clock operation two-step
!
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/RSP0/CPU0:router(config)# ptp
```

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

```
RP/0/RSP0/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/RSP0/CPU0:router(config-ptp)# domain 24
```

4. To configure timescale, use **timescale** *source* command in the ptp-clock configuration mode.

```
RP/0/RSP0/CPU0:router(config-ptp-clock)# timescale PTP
```

5. To configure the time-source that will be advertised in Announce messages, use **time-source** *source* command in the ptp-clock configuration mode. The allowed options are: atomic-clock, GPS, hand-set, internal-oscillator, NTP, other, PTP, and terrestrial-radio.

```
RP/0/RSP0/CPU0:router(config-ptp-clock)# time-source GPS
```

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

```
RP/0/RSP0/CPU0:router(config-ptp-clock)# exit
```

7. To configure the desired telecom profile and the clock type for the profile, use **clock profile { g.8265.1 | g.8275.1 | g.8275.2} clock-type {T-GM | T-BC | T-TSC}** command in the ptp configuration mode.

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/RSP0/CPU0:router(config-ptp)# clock profile g.8275.1 clock-type T-BC
```

Verification

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

```
RP/0/RSP0/CPU0:router# show run ptp !
ptp
clock
  domain 24
  profile g.8275.1 clock-type T-BC
!
profile slave
  sync frequency 16
  announce frequency 8
  delay-request frequency 16
!
profile master
  sync frequency 16
  announce frequency 8
  delay-request frequency 16
!
log
  servo events
  best-master-clock changes
!
!
```

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/RSP0/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 Class C Timing Mode

Configuration Example

Use the **timing-accuracy enhanced** command to switch to Class C from Class B mode.

```
Router#configure
Router(config)#frequency synchronization
Router(config-freqsync)#timing-accuracy enhanced
Router(config-freqsync)#commit
```

Verification

Use the **show running-config frequency synchronization** command to verify that you have enhanced to Class C mode from Class B mode.

```
Router#show running-config frequency synchronization
frequency synchronization
 quality itu-t option 1
 clock-interface timing-mode system
 timing-accuracy enhanced
 !
```

System Log

The following system log informs you about the successful mode change from Class B to Class C:

```
RP/0/RSP0/CPU0:Sep 2 15:51:50.784 UTC: dao_tmp[119]:
%PLATFORM-CLKCTRL-5-CLOCK_ACCURACY_ENHANCED : System timing switching to enhanced accuracy
 mode
```

PTP Phase Difference Threshold Between Passive and Secondary Ports

Table 5: Feature History Table

Feature Name	Release Information	Feature Description
PTP Phase Difference Threshold Between Passive and Secondary Ports	Release 26.3.1	Passive ports can now be included in the Delay Request-Response Mechanism (DRRM), which allows for the monitoring of PTP phase differences between a passive port and a secondary port. If these PTP phase differences surpass a predefined limit, system logs are triggered. This feature enables you to detect potential errors such as fiber asymmetry or a clock failure in the PTP network. This feature introduces these changes: CLI: • **phase-difference-threshold-breach** • The **show ptp foreign-masters** command output is enhanced to include phase difference values and servo status. This feature is enabled on these routers and route processor cards: • Cisco ASR 9903 • Cisco ASR 9902 • A9K-RSP5-X-SE • A9K-RSP5-X-TR • A99-RP3-X-SE • A99-RP3-X-TR YANG Data Models: The following data models are enhanced: • `Cisco-IOS-XR-ptp-cfg.yang` • `Cisco-IOS-XR-um-ptp-cfg.yang`

The Precision Time Protocol (PTP), as defined in the IEEE 1588 standard, is designed for precise time synchronization across networked devices. It operates by having Foreign Masters (FMs) broadcast timing information to interfaces within the network. The selection of the Grandmaster (GM), the primary reference clock, is determined by the Best Master Clock Algorithm (BMCA). Devices synchronize their clocks to the GM through a process known as the Delay Request-Response Mechanism (DRRM), wherein ports that are directly synchronizing with the GM enter a secondary state.

Historically, ports in a passive state—those that receive timing messages from FMs but aren't actively syncing to the GM—didn't participate in DRRM, which meant they didn't synchronize their clocks.

Starting Cisco IOS XR Software Release 26.3.1, DRRM has been extended to include passive ports, enabling them to engage in the exchange of delay request and response packets. This enhancement allows for the calculation of PTP phase differences between the clocks on passive ports and the GM.

This calculated PTP phase difference provides a valuable insight into the timing characteristics of other foreign masters in the network by using the grandmaster as a reference point. It can be utilized on any boundary clock or slave clock that has connections to at least one other foreign master.

You can access these measurements and the calculated PTP phase differences using show commands through the router's CLI. Also, the information can be retrieved programmatically through operational data models in YANG, providing flexibility in how you can access and utilize this synchronization data.

Phase Difference Alarm

PTP phase difference can also be used to monitor the timing properties of the network. You can configure a value at which a bistate alarm is triggered when the PTP phase difference of a FM exceeds the threshold. The PTP phase difference can have a negative or positive value, but the threshold can only be the absolute value. You can configure the PTP phase difference threshold using the **phase-difference-threshold-breach** command.

System Log for PTP Phase Difference

When the configured threshold is reached, system logs (syslogs) are displayed. The following syslog is triggered if the configured PTP phase difference threshold is passed through by any master.

```
Raising phase difference alarm for clock ACDE48FFFE234567, steps removed 1, receiving-port
 1, received on interface GigabitEthernet0/2/0/3. Phase difference is 40ns, configured
threshold is 30ns.
```

Configure PTP Phase Difference Alarm Threshold

Procedure

Step 1 Configure threshold for triggering PTP phase difference alarms using the **phase-difference-threshold-breach** command.

Example:

```
Router#configure terminal
Router(config)#ptp
Router(config-ptp)#phase-difference-threshold-breach 300
Router(config-ptp)#commit
```

Step 2 Verify that PTP phase difference threshold value is configured using the **show running configuration** command.

Example:

```
ptp
 phase-difference-threshold-breach 300
!
```

Step 3 Display the current operational value using the **show ptp foreign-masters** command. This command displays the **Phase difference** and **Servo status** values.

Example:

```
Router#show ptp foreign-masters

Interface TenGigE0/0/0/13 (PTP port number 2)
Ethernet, Address e41f.7bcf.6d11, Multicast
Configured priority: None (128)
Configured clock class: None
Configured delay asymmetry: None
Is alternateMaster: False
Qualified for 1 hour, 0 minutes, 13 seconds
Clock ID: e41f7bfffecf6d00
Phase difference: 300ns
Servo status: PTSF-unusable
Received clock properties:
Domain: 24, Priority1: 128, Priority2: 128, Class: 6
Accuracy: 0x21, Offset scaled log variance: 0x4e5d
Steps-removed: 1, Time source: GPS, Timescale: PTP
Frequency-traceable, Time-traceable
Current UTC offset: 0 seconds
Parent properties:
Clock ID: e41f7bfffecf6d00
Port number: 3
```

Foreign masters causing packet timing signal fail

Foreign masters causing packet timing signal fail are PTP clock sources that

- have timestamps indicating unstable or unusable timing quality,
- are automatically excluded from time source selection by the Best Master Clock Algorithm (BMCA), and
- continue to be monitored for timing stability and possible reintegration if conditions improve.

Table 6: Feature History Table

Feature Name	Release Information	Feature Description
Isolate Foreign Masters Causing Packet Timing Signal Fail	Release 26.3.1	This feature permits the flexible selection of timing sources by filtering out Foreign Master (FM) clocks that exhibit unstable timing. This filtering causes the secondary clocks to produce a signal deemed Packet Timing Signal Fail (PTSF)-unusable, from consideration within the Best Master Clock Algorithm (BMCA). The system continuously monitors these clocks for timing stabilization, and upon detecting enhanced stability, it may reevaluate and possibly reintegrate them as suitable time sources. This feature introduces these changes: CLI: • **detect-ptsf-unusable** • **show ptp foreign-masters** command output is enhanced to include phase difference values and servo status. This feature is enabled on these routers and route processor cards: • Cisco ASR 9903 • Cisco ASR 9902 • A9K-RSP5-X-SE • A9K-RSP5-X-TR • A99-RP3-X-SE • A99-RP3-X-TR YANG Data Models: The following data models are enhanced: • `Cisco-IOS-XR-ptp-cfg.yang` • `Cisco-IOS-XR-um-ptp-cfg.yang`

Syslogs for foreign masters causing packet timing signal fail

When the master becomes PTSF-unusable, and if its the current Grandmaster, the following system log (syslogs) is displayed:

```
Foreign master with clock ID ACDE48FFFE234567, steps removed 1, receiving-port 1, received
 on interface GigabitEthernet0/2/0/4 is now PTSF-unusable and disqualified from selection.
```

Configure PTSF-unusable

Procedure

Step 1 Exclude the FM with unstable timing from selection in the BMCA and declare it as unusable using the **detect-ptsf-unusable** command.

Example:

```
Router#configure terminal
Router(config)#ptp
Router(config-ptp)#detect-ptsf-unusable
Router(config-ptp)#commit
```

Step 2 Check if the master clock is PTSF-unuable using the **show ptp foreign-masters** command.

Example:

```
Router#show ptp foreign-masters
Interface TenGigE0/0/0/13 (PTP port number 2)
Ethernet, Address e41f.7bcf.6d11, Multicast
Configured priority: None (128)
Configured clock class: None
Configured delay asymmetry: None
Is alternateMaster: False
Qualified for 1 hour, 0 minutes, 13 seconds
Clock ID: e41f7bfffecf6d00
Phase difference: 111ns
Servo status: PTSF-unusable
Received clock properties:
Domain: 24, Priority1: 128, Priority2: 128, Class: 6
Accuracy: 0x21, Offset scaled log variance: 0x4e5d
Steps-removed: 1, Time source: GPS, Timescale: PTP
Frequency-traceable, Time-traceable
Current UTC offset: 0 seconds
Parent properties:
Clock ID: e41f7bfffecf6d00
Port number: 3
```

Step 3 Use **show ptp platform servo sessions** command to to display detailed information about the Precision Time Protocol (PTP) servo sessions. This command provides insight into the status and performance of the PTP servo, responsible for synchronizing the device's clock to a PTP master clock.

Example:

```
Router#show ptp platform servo sessions
Interface TenGigE0_0_0_0:
  Primary session: TRUE
  Clock-id: 0xe41f7bfffecf6d00, Receiving port:1, Steps-removed:1
  Servo-running: TRUE
  Has frequency: TRUE, Has time: TRUE
  Source-type: 0
```

```
  Timescale: 0, asymmetry:0
  Phase-offset from PTP source: 2
  Previous Received Timestamp T1: 21391762.558738932  T2: 21391762.558738939  T3: 21391762.572261171
  T4: 21391762.572261178
  Last Received Timestamp T1: 21391762.618757564  T2: 21391762.618757577  T3: 21391762.634337689
T4: 21391762.634337698
  Clock-offset: -0.070136            ppb

Interface TenGigE0_0_0_13:
  Primary session: FALSE
  Clock-id: 0xe41f7bfffecf6d00, Receiving port:2, Steps-removed:1
  Servo-running: TRUE
  Has frequency: TRUE, Has time: TRUE
  Source-type: 0
  Timescale: 0, asymmetry:0
  Phase-offset from PTP source: 3
  Previous Received Timestamp T1: 21391762.558750340  T2: 21391762.558750472  T3: 21391762.572265313
  T4: 21391762.572265446
  Last Received Timestamp T1: 21391762.618770244  T2: 21391762.618770376  T3: 21391762.634339044
T4: 21391762.634339170
  Clock-offset: 0.116531             ppb

Interface TenGigE0_0_0_25:
  Primary session: FALSE
  Clock-id: 0xe41f7bfffecf6d00, Receiving port:3, Steps-removed:1
  Servo-running: TRUE
  Has frequency: TRUE, Has time: TRUE
  Source-type: 0
  Timescale: 0, asymmetry:0
  Phase-offset from PTP source: 6
  Previous Received Timestamp T1: 21391762.558758780  T2: 21391762.558758938  T3: 21391762.572266088
  T4: 21391762.572266234
  Last Received Timestamp T1: 21391762.618782868  T2: 21391762.618783028  T3: 21391762.634340934
T4: 21391762.634341082
  Clock-offset: 0.049578             ppb
```

Step 4 Use **show ptp platform servo sessions brief** command to provide a summary of the Precision Time Protocol (PTP) servo sessions on the device interfaces.

Example:

```
Router#show ptp platform servo sessions brief


Interface         Type           State          Phase-offset      Clock-offset(ppb)
=============     =====       =============     ===============    =================
TenGigE0_0_0_0   Primary         Running          00000002          0.508343
TenGigE0_0_0_13  Monitored       Running          00000002          0.433685
TenGigE0_0_0_25  Monitored       Running          00000006          -0.957407
```

Configuring PTP Delay Asymmetry

Table 7: 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.

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. Better synchronization between the clocks of different devices in a network leads to a network that performs efficiently.

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

Note 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.

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.

- For G875.1 and G875.2 PTP profiles, PTP delay asymmetry is supported for both, client port and dynamic port that act as a client.
- PTP delay asymmetry is supported for fixed cable delay compensation 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.
- 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.

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-master)# delay-asymmetry 3 microseconds
Router(config-if-ptp-master)# commit
```

Running Configuration

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

Verification

To verify if PTP delay asymmetry delay 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
Sat Nov 1 15:17:14.611 UTC
Servo status: Running
Servo stat_index: 2
Device status: PHASE_LOCKED
Servo Mode: Non Hybrid
Servo log level: 0
Phase Alignment Accuracy: -3 ns
Sync timestamp updated: 54754
Sync timestamp discarded: 0
Delay timestamp updated: 55196
Delay timestamp discarded: 0
Previous Received Timestamp T1: 1563984472.036333938 T2: 1563984472.036334935 T3:
1563984472.077066895 T4: 1563984472.077067478
Last Received Timestamp T1: 1563984472.100355188 T2: 1563984472.100356182 T3:
1563984472.139059682 T4: 1563984472.139060266
Offset from master: 0 secs, 6 microsecs <--------------- compensated value, showing 6
microseconds because actual fixed delay is 3 microseconds, we configured 3 microseconds and
 router detected it as fixed delay and tries to compensate.
Mean path delay : 0 secs, 771 nsecs
setTime():1 stepTime():0 adjustFreq():4278
Last setTime: 1563981048.000000000 flag:0 Last stepTime:0 Last adjustFreq:51511
```

Double Failure Clock Class Over-ride

Table 8: 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.

PTP Holdover Traceability suppression

Table 9: Feature History Table

Feature Name	Release Information	Feature Description
PTP Holdover Traceability Suppression	Release 7.3.1	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 the downstream nodes continue to receive the configured clock class, and it is 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 downstream nodes do not have an impact as this is a deviation from prescribed G.8275.1 ITU-T standards.

Note

- There will be 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 quality Primary clock within this duration, the device will send 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
```

Configuration Examples

Slave Configuration Example

The following example shows a PTP slave configuration:

```
 interface TenGigE 0/1/0/5
 ptp
  profile tp64
  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 tp64
  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 192.168.52.38
  !
  sync frequency 64
  announce interval 1
  delay-request frequency 64
 !
interface GigabitEthernet 0/1/0/1
 ipv4 address 192.168.52.41 255.255.255.0
 speed 100
```

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

ITU-T Telecom Profiles Configuration Examples

Master global configuration for the telecom profile:

```
-- For G.8265.1 profile --

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

-- For G.8275.1 profile --

ptp
 clock
 domain 24
 profile g.8275.1
 !
  profile master
  transport ethernet
  sync frequency 16
  announce interval 1
  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
  clock operation two-step
 !
 ipv4 address 17.1.1.1/24
```

Slave global configuration for the telecom profile:

```
-- For G.8265.1 profile --
```

```
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
```

```
-- For G.8275.1 profile --
```

```
ptp
 clock
 domain 24
 profile g.8275.1 clock-type T-TSC
 !
  profile slave
  transport ethernet
  sync frequency 16
  announce interval 1
  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
  !
  clock operation two-step
  !
 ipv4 address 18.1.1.2/24
```

```
-*- For G.8275.2 profile -*-
```

```
ptp
 clock
  domain 44
  profile g.8275.2 clock-type T-TSC
 !
 profile slave
  transport ipv6
  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 ipv6 30::2
  !
 !
 ipv6 address 30::1/64
!
```

Global configuration with clock type as T-Boundary Clock (**T-BC**) for the telecom profile:

```
-- For G.8275.1 profile --

ptp
 clock
 domain 24
 profile g.8275.1 clock-type T-BC
 !
  profile master
  transport ethernet
  sync frequency 16
  announce interval 1
  delay-request frequency 16
  exit
  profile slave
  transport ethernet
  sync frequency 16
  announce interval 1
  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
  !
  clock operation two-step
  !
 ipv4 address 17.1.1.2/24
interface gi 0/2/0/0
 ptp
  profile master
  transport ethernet
  multicast target-address ethernet 01-1B-19-00-00-00
  clock operation two-step
  !
 ipv4 address 18.1.1.1/24
```

Note When G.8275.1 profile is configured on a 100G interface, keywords **commit replace** and **rollback config last 1** does not work and the router configuration rollback fails entirely. Use **rollback config last 1 best-effort** instead.

```
-*- For G.8275.2 profile -*-
ptp
```

```
 clock
  domain 44
  profile g.8275.2 clock-type T-BC
 !
 profile slave
  transport ipv6
  port state slave-only
  sync frequency 64
  announce frequency 8
  unicast-grant invalid-request deny
  delay-request frequency 64
 !
 profile master
  transport ipv6
  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
 !
 ipv6 address 30::1/64
!

interface GigabitEthernet0/2/0/12
 ptp
  profile slave
  master ipv6 40::2
   !
 !
 ipv6 address 40::1/64
!
```