

Configuring PTP

This chapter describes how to configure the Precision Time Protocol (PTP) on Cisco NX-OS devices.

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About PTP

PTP is a time synchronization protocol for nodes distributed across a network. Its hardware timestamp feature provides greater accuracy than other time synchronization protocols such as the Network Time Protocol (NTP).

A PTP system can consist of a combination of PTP and non-PTP devices. PTP devices include ordinary clocks, boundary clocks, and transparent clocks. Non-PTP devices include ordinary network switches, routers, and other infrastructure devices.

PTP is a distributed protocol that specifies how real-time PTP clocks in the system synchronize with each other. These clocks are organized into a master-slave synchronization hierarchy with the grandmaster clock, which is the clock at the top of the hierarchy, determining the reference time for the entire system. Synchronization is achieved by exchanging PTP timing messages, with the members using the timing information to adjust their clocks to the time of their master in the hierarchy. PTP operates within a logical scope called a PTP domain.

PTP Device Types

The following clocks are common PTP devices:

Ordinary clock

Communicates with the network based on a single physical port, similar to an end host. An ordinary clock can function as a grandmaster clock.

Boundary clock

Typically has several physical ports, with each port behaving like a port of an ordinary clock. However, each port shares the local clock, and the clock data sets are common to all ports. Each port decides its individual state, either master (synchronizing other ports connected to it) or slave (synchronizing to a downstream port), based on the best clock available to it through all of the other ports on the boundary clock. Messages that are related to synchronization and establishing the master-slave hierarchy terminate in the protocol engine of a boundary clock and are not forwarded.

Transparent clock

Forwards all PTP messages like an ordinary switch or router but measures the residence time of a packet in the switch (the time that the packet takes to traverse the transparent clock) and in some cases the link delay of the ingress port for the packet. The ports have no state because the transparent clock does not need to synchronize to the grandmaster clock.

There are two kinds of transparent clocks:

End-to-end transparent clock

Measures the residence time of a PTP message and accumulates the times in the correction field of the PTP message or an associated follow-up message.

Peer-to-peer transparent clock

Measures the residence time of a PTP message and computes the link delay between each port and a similarly equipped port on another node that shares the link. For a packet, this incoming link delay is added to the residence time in the correction field of the PTP message or an associated follow-up message.



Note PTP operates only in boundary clock mode. We recommend that you deploy a Grand Master Clock (10 MHz) upstream. The servers contain clocks that require synchronization and are connected to the switch.

End-to-end transparent clock and peer-to-peer transparent clock modes are not supported.

PTP Time Distribution Hold

In a properly synchronized PTP network, when any PTP node goes down and comes up, the PTP clock is synchronized to its primary time source (GM). During this process, the local node has significant correction and it tries to correct its local clock. At that time, the node can send incorrect time to the downstream nodes and cause issues for all downstream nodes. The Time Distribution (TD) hold feature, introduced in Cisco NX-OS Release 10.5(1)F, resolves this issue by ensuring that the node is properly synchronized to its primary source and distributes time to the downstream nodes during boot up.

The TD hold feature holds the time distribution until a Boundary Clock (BC) node locks to the primary time source and settles down to the target correction value. The TD hold enabled node receives all PTP packets, does the normal state change, and synchronizes time, but it does not send any PTP packets out.



Note If all nodes reboot at the same time (with a difference of few seconds), each node will be in active hold time, which sometimes results in no nodes having secondary port. This leads to the BMC taking a long time to find the best clock. Hence, the user needs to take this into account when enabling this feature.

PTP Process

The PTP process consists of two phases: establishing the master-slave hierarchy and synchronizing the clocks.

Within a PTP domain, each port of an ordinary or boundary clock follows this process to determine its state:

- Examines the contents of all received announce messages (issued by ports in the master state)
- Compares the data sets of the foreign master (in the announce message) and the local clock for priority, clock class, accuracy, and so on
- Determines its own state as either master or slave

After the master-slave hierarchy has been established, the clocks are synchronized as follows:

- The master sends a synchronization message to the slave and notes the time it was sent.
- The slave receives the synchronization message and notes the time that it was received. For every synchronization message, there is a follow-up message. The number of sync messages should be equal to the number of follow-up messages.
- The slave sends a delay-request message to the master and notes the time it was sent.
- The master receives the delay-request message and notes the time it was received.
- The master sends a delay-response message to the slave. The number of delay request messages should be equal to the number of delay response messages.
- The slave uses these timestamps to adjust its clock to the time of its master.

High Availability for PTP

Stateful restarts are not supported for PTP.

Guidelines and Limitations for PTP

- For Cisco Nexus 3600 Series switches, PTP clock correction is expected to be in the 3-digit range, from 100 to 999 nanoseconds.
- PTP operates only in boundary clock mode. End-to-end transparent clock and peer-to-peer transparent clock modes are not supported.
- PTP supports transport over User Datagram Protocol (UDP). Transport over Ethernet is not supported.
- PTP supports only multicast communication. Negotiated unicast communication is not supported.
- PTP is limited to a single domain per network.
- Forwarding PTP management packets is not supported.
- PTP-capable ports do not identify PTP packets and do not time-stamp or redirect those packets unless you enable PTP on those ports.

- 1 pulse per second (1 PPS) input is not supported.
- PTP over IPv6 is not supported.
- Cisco Nexus switches should be synchronized from the neighboring master using a synchronization log interval that ranges from –2 to –5.
- Beginning with Cisco NX-OS Release 10.5(1)F, the following attributes are added to the PTP high-correction notification:
  - lastHighCorrectionMPD
  - maxHighCorrectionTime
  - maxHighCorrectionValue
  - maxHighCorrectionMPD
- Beginning with Cisco NX-OS Release 10.5(1)F, the PTP Time Distribution (TD) hold feature is introduced. This feature allows for holding the time distribution until a Boundary Clock node locks to the primary time source and settles down to the target correction value.

Default Settings for PTP

The following table lists the default settings for PTP parameters.

Table 1: Default PTP Parameters

Parameters	Default
PTP	Disabled
PTP version	2
PTP domain	0
PTP priority 1 value when advertising the clock	255
PTP priority 2 value when advertising the clock	255
PTP announce interval	1 log second
PTP sync interval	– 2 log seconds
PTP announce timeout	3 announce intervals
PTP minimum delay request interval	0 log seconds
PTP VLAN	1

Configuring PTP

Configuring PTP Globally

You can enable or disable PTP globally on a device. You can also configure various PTP clock parameters to help determine which clock in the network has the highest priority to be selected as the grandmaster.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config) # [**no**] **feature ptp**
3. switch(config) # [**no**] **ptp source** *ip-address* [**vrf** *vrf*]
4. (Optional) switch(config) # [**no**] **ptp domain** *number*
5. (Optional) switch(config) # [**no**] **ptp priority1** *value*
6. (Optional) switch(config) # [**no**] **ptp priority2** *value*
7. (Optional) switch(config) # **show ptp brief**
8. (Optional) switch(config) # **show ptp clock**
9. (Optional) [**no**] **ptp time distribution-hold** [**correction-threshold** <corr_limit>] [**delay-threshold** <max_delay_time>]
10. (Optional) switch(config)# **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config) # [**no**] **feature ptp**	Enables or disables PTP on the device. **Note** Enabling PTP on the switch does not enable PTP on each interface.
Step 3	switch(config) # [**no**] **ptp source** *ip-address* [**vrf** *vrf*]	Configures the source IP address for all PTP packets. The *ip-address* can be in IPv4 format.
Step 4	(Optional) switch(config) # [**no**] **ptp domain** *number*	Configures the domain number to use for this clock. PTP domains allow you to use multiple independent PTP clocking subdomains on a single network. The range for the *number* is from 0 to 128.
Step 5	(Optional) switch(config) # [**no**] **ptp priority1** *value*	Configures the priority1 value to use when advertising this clock. This value overrides the default criteria (clock quality, clock class, and so on) for the best master clock selection. Lower values take precedence.

	Command or Action	Purpose
		The range for the *value* is from 0 to 255.
Step 6	(Optional) switch(config) # [**no**] **ptp priority2** *value*	Configures the priority2 value to use when advertising this clock. This value is used to decide between two devices that are otherwise equally matched in the default criteria. For example, you can use the priority2 value to give a specific switch priority over other identical switches. The range for the *value* is from 0 to 255.
Step 7	(Optional) switch(config) # **show ptp brief**	Displays the PTP status.
Step 8	(Optional) switch(config) # **show ptp clock**	Displays the properties of the local clock.
Step 9	(Optional) [**no**] **ptp time distribution-hold** [**correction-threshold** <corr_limit>] [**delay-threshold** <max_delay_time>] **Example:** `switch(config)# ptp time distribution-hold correction-threshold 90000ns delay threshold 4000s`	Enables the PTP time distribution hold feature. **correction-threshold** - Holds the time distribution until the correction settles down to the given specified correction value provided in nanoseconds. **delay-threshold** - Sets the maximum time limit in seconds to hold the time-distribution. However, if correction threshold is met before the delay threshold, time distribution resumes. Default correction threshold is 300 nanoseconds, and default delay threshold is 300 seconds for TOR and 900 seconds for modular chassis. The maximum correction threshold is 100000 nanoseconds, and the maximum delay threshold is 5000 seconds.
Step 10	(Optional) switch(config)# **copy running-config startup-config**	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.

Example

The following example shows how to configure PTP globally on the device, specify the source IP address for PTP communications, and configure a preference level for the clock:

```
switch# configure terminal
switch(config)# feature ptp
switch(config)# ptp source 10.10.10.1
switch(config)# ptp priority1 1
switch(config)# ptp priority2 1
switch(config)# show ptp brief
PTP port status
-----------------------
Port State
------- --------------
switch(config)# show ptp clock
PTP Device Type: Boundary clock
Clock Identity : 0:22:55:ff:ff:79:a4:c1
Clock Domain: 0
```

```
Number of PTP ports: 0
Priority1 : 1
Priority2 : 1
Clock Quality:
Class : 248
Accuracy : 254
Offset (log variance) : 65535
Offset From Master : 0
Mean Path Delay : 0
Steps removed : 0
Local clock time:Sun Jul 3 14:13:24 2011
switch(config)#
```

Configuring PTP on an Interface

After you globally enable PTP, it is not enabled on all supported interfaces by default. You must enable PTP interfaces individually.

Before you begin

Make sure that you have globally enabled PTP on the switch and configured the source IP address for PTP communication.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config) # **interface ethernet** *slot/port*
3. switch(config-if) # [**no**] **feature ptp**
4. (Optional) switch(config-if) # [**no**] **ptp announce** {**interval** *log seconds* | **timeout** *count*}
5. (Optional) switch(config-if) # [**no**] **ptp delay request minimum interval** *log seconds*
6. (Optional) switch(config-if) # [**no**] **ptp sync interval** *log seconds*
7. (Optional) switch(config-if) # [**no**] **ptp vlan** *vlan-id*
8. (Optional) switch(config-if) # **show ptp brief**
9. (Optional) switch(config-if) # **show ptp port interface** *interface slot/port*
10. (Optional) switch(config-if)# **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config) # **interface ethernet** *slot/port*	Specifies the interface on which you are enabling PTP and enters interface configuration mode.
Step 3	switch(config-if) # [**no**] **feature ptp**	Enables or disables PTP on an interface.
Step 4	(Optional) switch(config-if) # [**no**] **ptp announce** {**interval** *log seconds* | **timeout** *count*}	Configures the interval between PTP announce messages on an interface or the number of PTP intervals before a timeout occurs on an interface.

	Command or Action	Purpose
		The range for the PTP announcement interval is from 0 to 4 seconds, and the range for the interval timeout is from 2 to 10.
Step 5	(Optional) switch(config-if) # [**no**] **ptp delay request minimum interval** *log seconds*	Configures the minimum interval allowed between PTP delay-request messages when the port is in the master state. The range is from -1 to -6 log seconds. Where, log (-2) = 4 frames per second.
Step 6	(Optional) switch(config-if) # [**no**] **ptp sync interval** *log seconds*	Configures the interval between PTP synchronization messages on an interface. The range for the PTP synchronization interval is from -6 log second to 1 second.
Step 7	(Optional) switch(config-if) # [**no**] **ptp vlan** *vlan-id*	Specifies the VLAN for the interface where PTP is being enabled. You can only enable PTP on one VLAN on an interface. The range is from 1 to 4094.
Step 8	(Optional) switch(config-if) # **show ptp brief**	Displays the PTP status.
Step 9	(Optional) switch(config-if) # **show ptp port interface** *interface slot/port*	Displays the status of the PTP port.
Step 10	(Optional) switch(config-if)# **copy running-config startup-config**	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.

Example

This example shows how to configure PTP on an interface and configure the intervals for the announce, delay-request, and synchronization messages:

```
switch# configure terminal
switch(config)# interface ethernet 2/1
switch(config-if)# ptp
switch(config-if)# ptp announce interval 3
switch(config-if)# ptp announce timeout 2
switch(config-if)# ptp delay-request minimum interval 4
switch(config-if)# ptp sync interval -1
switch(config-if)# show ptp brief
PTP port status
-----------------------
Port State
------- --------------
Eth2/1 Master
switch(config-if)# show ptp port interface ethernet 2/1
PTP Port Dataset: Eth2/1
Port identity: clock identity: 0:22:55:ff:ff:79:a4:c1
Port identity: port number: 1028
PTP version: 2
Port state: Master
Delay request interval(log mean): 4
```

```
Announce receipt time out: 2
Peer mean path delay: 0
Announce interval(log mean): 3
Sync interval(log mean): -1
Delay Mechanism: End to End
Peer delay request interval(log mean): 0
switch(config-if)#
```

Verifying the PTP Configuration

Use one of the following commands to verify the configuration:

Table 2: PTP Show Commands

Command	Purpose
show ptp brief	Displays the PTP status.
show ptp clock	Displays the properties of the local clock, including the clock identity.
show ptp clock foreign-masters-record	Displays the state of foreign masters known to the PTP process. For each foreign master, the output displays the clock identity, basic clock properties, and whether the clock is being used as a grandmaster.
show ptp corrections	Displays the last few PTP corrections.
show ptp parent	Displays the properties of the PTP parent.
show ptp port interface ethernet *slot/port*	Displays the status of the PTP port on the switch.