



# **Precision Time Protocol Software Configuration Guide for IE 2000U and Connected Grid Switches**

**Configuring PTP 2**

## Configuring PTP

This document describes Precision Time Protocol (PTP) and how to configure it on the Cisco Industrial Ethernet 2000U Series Switch, CGS 2520 Switch, and CG Ethernet Switch Module (ESM). This document uses the term *switch* to refer to any of these platforms.

### Information About Precision Time Protocol

Precision Time Protocol (PTP) is defined in IEEE 1588 as Precision Clock Synchronization for Networked Measurements and Control Systems, and was developed to synchronize the clocks in packet-based networks that include distributed device clocks of varying precision and stability. PTP is designed specifically for industrial, networked measurement and control systems, and is optimal for use in distributed systems because it requires minimal bandwidth and little processing overhead.

#### Why PTP?

Smart grid power automation applications such as peak-hour billing, virtual power generators, and outage monitoring and management, require extremely precise time accuracy and stability. Timing precision improves network monitoring accuracy and troubleshooting ability.

In addition to providing time accuracy and synchronization, the PTP message-based protocol can be implemented on packet-based networks, such as Ethernet networks. The benefits of using PTP in an Ethernet network include:

- Low cost and easy setup in existing Ethernet networks
- Limited bandwidth is required for PTP data packets

#### Ethernet Switches and Delays

In an Ethernet network, switches provide a full-duplex communication path between network devices. Switches send data packets to packet destinations using address information contained in the packets. When the switch attempts to send multiple packets simultaneously, some of the packets are buffered by the switch so that they are not lost before they are sent. When the buffer is full, the switch delays sending packets. This delay can cause device clocks on the network to lose synchronization with one another.

Additional delays can occur when packets entering a switch are stored in local memory while the switch searches the MAC address table to verify packet CRC fields. This process causes variations in packet forwarding time latency, and these variations can result in asymmetrical packet delay times.

Adding PTP to a network can compensate for these latency and delay problems by correctly adjusting device clocks so that they stay synchronized with one another. PTP enables network switches to function as PTP devices, including boundary clocks (BCs) and transparent clocks (TCs).



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**Note** To learn more about PTP clock devices and their role in a PTP network, refer to [PTP Clocks, on page 7](#).

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#### Message-Based Synchronization

To ensure clock synchronization, PTP requires an accurate measurement of the communication path delay between the time source (*master*) and the receiver (*slave*). PTP sends messages between the master and slave device to determine the delay measurement. Then, PTP measures the exact message transmit and receive times and uses these times to calculate the communication path delay.

PTP then adjusts current time information contained in network data for the calculated delay, resulting in more accurate time information.

This delay measurement principle determines path delay between devices on the network, and the local clocks are adjusted for this delay using a series of messages sent between masters and slaves. The one-way delay time is calculated by averaging the path delay of the transmit and receive messages. This calculation assumes a symmetrical communication path; however, switched networks do not necessarily have symmetrical communication paths, due to the buffering process.

PTP provides a method, using transparent clocks, to measure and account for the delay in a time-interval field in network timing packets, making the switches temporarily transparent to the master and slave nodes on the network. An end-to-end transparent clock forwards all messages on the network in the same way that a switch does.

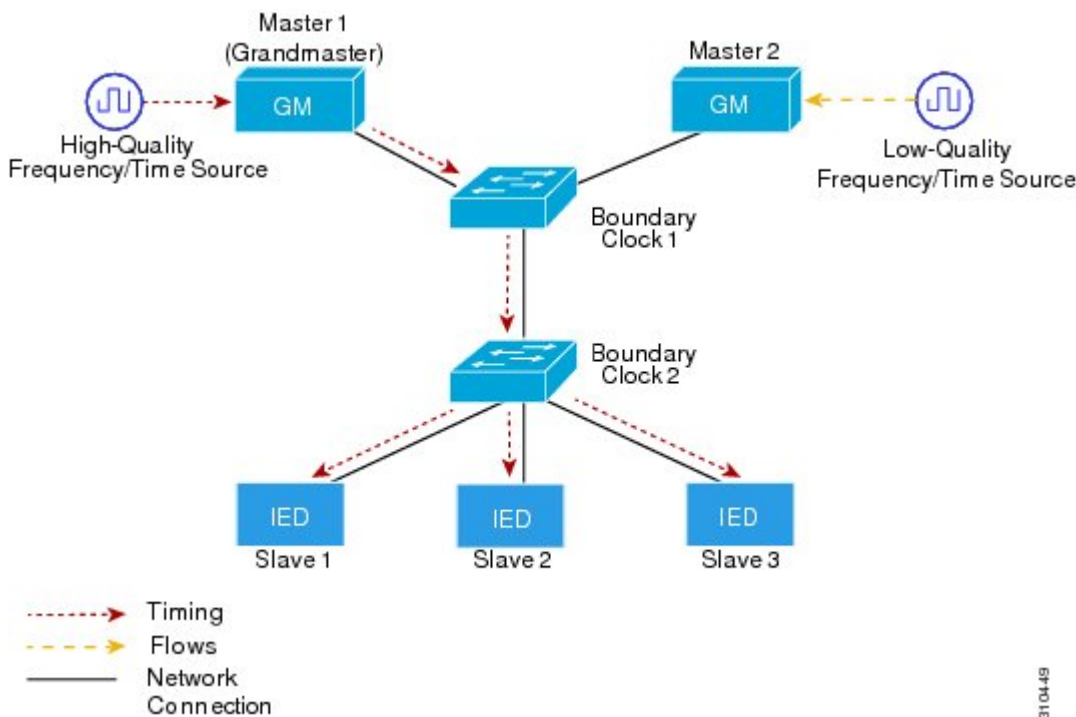


**Note** Cisco PTP supports multicast PTP messages only.

To read a detailed description of synchronization messages, refer to [PTP Event Message Sequences, on page 3](#). To learn more about how transparent clocks calculate network delays, refer to [Transparent Clock, on page 7](#).

The following figure shows a typical 1588 PTP network that includes grandmaster clocks, switches in boundary clock mode, and Intelligent Electronic Device (IEDs) such as a digital relays or protection devices. In this diagram, Master 1 is the grandmaster clock. If Master 1 becomes unavailable, the boundary clock slaves switch to Master 2 for synchronization.

**Figure 1: PTP Network**



### PTP Event Message Sequences

This section describes the PTP event message sequences that occur during synchronization.

## Synchronizing with Boundary Clocks

The ordinary and boundary clocks configured for the delay request-response mechanism use the following event messages to generate and communicate timing information:

- Sync
- Delay\_Req
- Follow\_Up
- Delay\_Resp

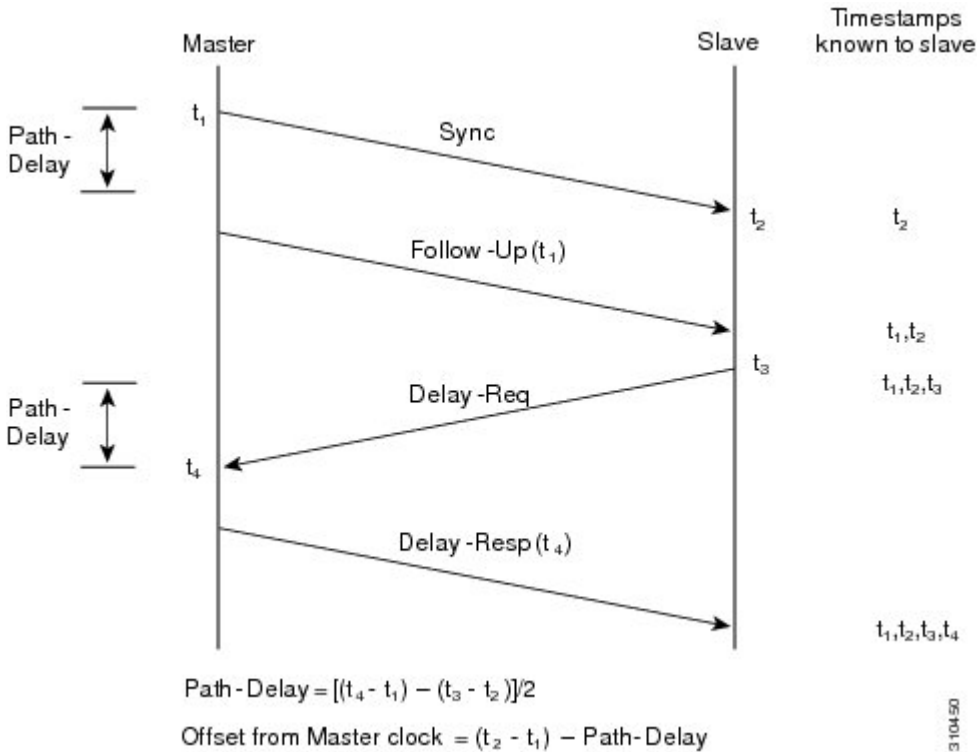
These messages are sent in the following sequence:

1. The master sends a Sync message to the slave and notes the time ( $t_1$ ) at which it was sent.
2. The slave receives the Sync message and notes the time of reception ( $t_2$ ).
3. The master conveys to the slave the timestamp  $t_1$  by embedding the timestamp  $t_1$  in a Follow\_Up message.
4. The slave sends a Delay\_Req message to the master and notes the time ( $t_3$ ) at which it was sent.
5. The master receives the Delay\_Req message and notes the time of reception ( $t_4$ ).
6. The master conveys to the slave the timestamp  $t_4$  by embedding it in a Delay\_Resp message.

After this sequence, the slave possesses all four timestamps. These timestamps can be used to compute the offset of the slave clock relative to the master, and the mean propagation time of messages between the two clocks.

The offset calculation is based on the assumption that the time for the message to propagate from master to slave is the same as the time required from slave to master. This assumption is not always valid on an Ethernet network due to asymmetrical packet delay times.

Figure 2: Detailed Steps—Boundary Clock Synchronization



### Synchronizing with Peer-to-Peer Transparent Clocks

When the network includes multiple levels of boundary clocks in the hierarchy, with non-PTP enabled devices between them, synchronization accuracy decreases.

The round-trip time is assumed to be equal to  $\text{mean\_path\_delay}/2$ , however this is not always valid for Ethernet networks. To improve accuracy, the resident time of each intermediary clock is added to the offset in the end-to-end transparent clock. Resident time, however, does not take into consideration the link delay between peers, which is handled by peer-to-peer transparent clocks.

Peer-to-peer transparent clocks measure the link delay between two clock ports implementing the peer delay mechanism. The link delay is used to correct timing information in Sync and Follow\_Up messages.

Peer-to-peer transparent clocks use the following event messages:

- Pdelay\_Req
- Pdelay\_Resp
- Pdelay\_Resp\_Follow\_Up

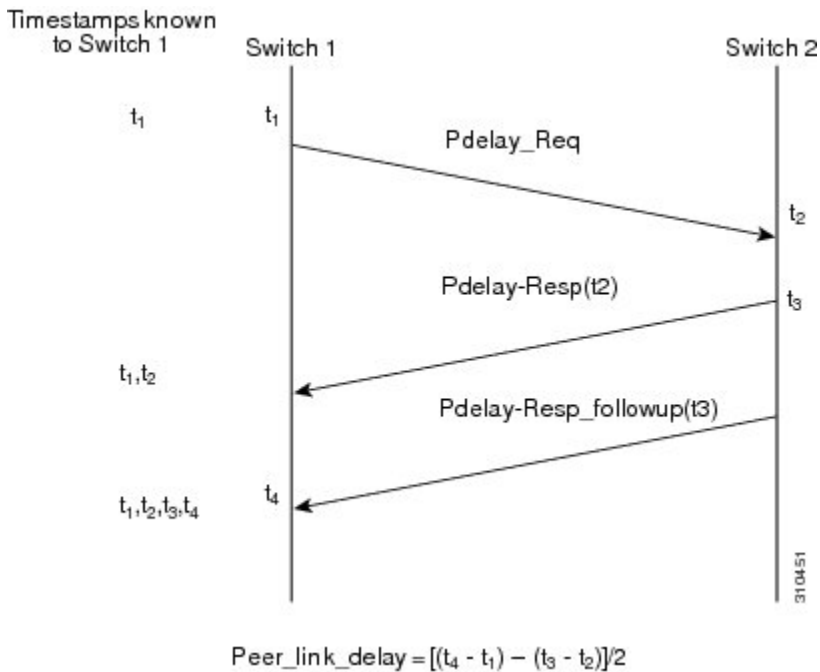
These messages are sent in the following sequence:

1. Port 1 generates timestamp  $t_1$  for a Pdelay\_Req message.
2. Port 2 receives and generates timestamp  $t_2$  for this message.
3. Port 2 returns and generates timestamp  $t_3$  for a Pdelay\_Resp message.

To minimize errors due to any frequency offset between the two ports, Port 2 returns the Pdelay\_Resp message as quickly as possible after the receipt of the Pdelay\_Req message.

4. Port 2 returns timestamps  $t_2$  and  $t_3$  in the `Pdelay_Resp` and `Pdelay_Resp_Follow_Up` messages respectively.
5. Port 1 generates timestamp  $t_4$  after receiving the `Pdelay_Resp` message. Port 1 then uses the four timestamps ( $t_1$ ,  $t_2$ ,  $t_3$ , and  $t_4$ ) to calculate the mean link delay.

**Figure 3: Detailed Steps—Peer-to-Peer Transparent Clock Synchronization**



### Synchronizing the Local Clock

In an ideal PTP network, the master and slave clock operate at the same frequency. However, *drift* can occur on the network. Drift is the frequency difference between the master and slave clock. You can compensate for drift by using the time stamp information in the device hardware and follow-up messages (intercepted by the switch) to adjust the frequency of the local clock to match the frequency of the master clock.

### Best Master Clock Algorithm

The Best Master Clock Algorithm (BMCA) is the basis of PTP functionality. The BMCA specifies how each clock on the network determines the best master clock in its subdomain of all the clocks it can see, including itself. The BMCA runs on the network continuously and quickly adjusts for changes in network configuration.

The BMCA uses the following criteria to determine the best master clock in the subdomain:

- Clock quality (for example, GPS is considered the highest quality)
- Clock accuracy of the clock's time base
- Stability of the local oscillator
- Closest clock to the grandmaster

In addition to identifying the best master clock, the BMCA also ensures that clock conflicts do not occur on the PTP network by ensuring that:

- Clocks do not have to negotiate with one another
- There is no misconfiguration, such as two master clocks or no master clocks, as a result of the master clock identification process

## PTP Clocks

A PTP network is made up of PTP-enabled devices and devices that are not using PTP. The PTP-enabled devices typically consist of the following clock types.

### Grandmaster Clock

Within a PTP domain, the grandmaster clock is the primary source of time for clock synchronization using PTP. The grandmaster clock usually has a very precise time source, such as a GPS or atomic clock. When the network does not require any external time reference and only needs to be synchronized internally, the grandmaster clock can free run.

### Ordinary Clock

An ordinary clock is a PTP clock with a single PTP port. It functions as a node in a PTP network and can be selected by the BMCA as a master or slave within a subdomain. Ordinary clocks are the most common clock type on a PTP network because they are used as end nodes on a network that is connected to devices requiring synchronization. Ordinary clocks have various interface to external devices.

### Boundary Clock

A boundary clock in a PTP network operates in place of a standard network switch or router. Boundary clocks have more than one PTP port, and each port provides access to a separate PTP communication path. Boundary clocks provide an interface between PTP domains. They intercept and process all PTP messages, and pass all other network traffic. The boundary clock uses the BMCA to select the best clock seen by any port. The selected port is then set as a slave. The master port synchronizes the clocks connected downstream, while the slave port synchronizes with the upstream master clock.

### Transparent Clock

The role of transparent clocks in a PTP network is to update the time-interval field that is part of the PTP event message. This update compensates for switch delay and has an accuracy of within one picosecond.

There are two types of transparent clocks:

**End-to-end (E2E) transparent clocks** measure the PTP event message transit time (also known as *resident time*) for SYNC and DELAY\_REQUEST messages. This measured transit time is added to a data field (correction field) in the corresponding messages:

- The measured transit time of a SYNC message is added to the correction field of the corresponding SYNC or the FOLLOW\_UP message.
- The measured transit time of a DELAY\_REQUEST message is added to the correction field of the corresponding DELAY\_RESPONSE message.

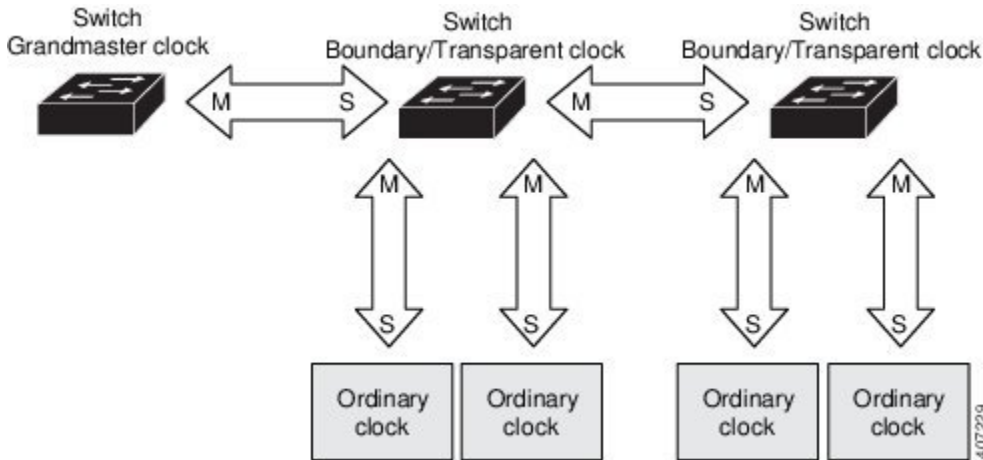
The slave uses this information when determining the offset between the slave's and the master's time. E2E transparent clocks do not provide correction for the propagation delay of the link itself.

**Peer-to-peer (P2P) transparent clocks** measure PTP event message transit time in the same way E2E transparent clocks do, as described above. In addition, P2P transparent clocks measure the upstream link delay. The upstream link delay is the estimated packet propagation delay between the upstream neighbor P2P transparent clock and the P2P transparent clock under consideration.

These two times (message transit time and upstream link delay time) are both added to the correction field of the PTP event message, and the correction field of the message received by the slave contains the sum of all link delays. In theory, this is the total end-to-end delay (from master to slave) of the SYNC packet.

The following figure illustrates PTP clocks in a master-slave hierarchy within a PTP network.

**Figure 4: PTP Clock Hierarchy**



## PTP Profiles

This section describes the following PTP profiles available on the switch:

- Power Profile
- Default Profile
- 802.1AS Profile (IE 4000 only)

The Power Profile is defined in PC37.238 - IEEE Draft Standard Profile for Use of IEEE 1588 Precision Time Protocol in Power System Applications. This switch documentation uses the terms Power Profile mode and Default Profile mode when referring to this IEEE 1588 profile and its associated configuration values.

The IEEE 1588 definition of a PTP profile is *the set of allowed PTP features applicable to a device*. A PTP profile is usually specific to a particular type of application or environment and defines the following values:

- Best master clock algorithm options
- Configuration management options
- Path delay mechanisms (peer delay or delay request-response)
- Range and default values of all PTP configurable attributes and data set members
- Transport mechanisms that are required, permitted, or prohibited
- Node types that are required, permitted, or prohibited
- Options that are required, permitted, or prohibited

## Default Profile Mode

The default PTP profile mode on the switch is Default Profile mode. In this mode:



- The PTP mode of transport is Layer 3.
- The supported transparent clock mode is end-to-end (E2E).

Table 1: Configuration Values for the IEEE PTP Power Profile and Switch Modes , on page 9 lists the configuration values for the switch in Default Profile mode.

### Power Profile Mode

The IEEE Power Profile defines specific or allowed values for PTP networks used in power substations. The defined values include the optimum physical layer, the higher level protocol for PTP messages, and the preferred best master clock algorithm. The Power Profile values ensure consistent and reliable network time distribution within substations, between substations, and across wide geographic areas.

The switch is optimized for PTP in these ways:

- Hardware—The switch uses FPGA and PHY for the PTP function. The PHY time stamps the Fast Ethernet and Gigabit Ethernet ports.
- Software—In Power Profile mode, the switch uses the configuration values defined in the IEEE 1588 Power Profile standard.

The following table lists the configuration values defined by the IEEE 1588 Power Profile and the values that the switch uses for each PTP profile mode.

Table 1: Configuration Values for the IEEE PTP Power Profile and Switch Modes

PTP Field	Power Profile Value	Switch Configuration Value	
		Power Profile Mode	Default Profile Mode
Message transmission	Ethernet 802.3 with Ethertype 0X88F7. PTP messages are sent as 802.1Q tagged Ethernet frames with a default VLAN 0 and default priority 4.	<b>Access Ports</b> —Untagged Layer 2 packets. <b>Trunk Ports</b> —802.1Q tagged Layer 2 packets with native VLAN on the port and default priority value of 4.	Layer 3 packets. By default, 802.1q tagging is disabled.
<b>MAC address</b> —Non-peer delay messages	01-1B-19-00-00-00.	01-1B-19-00-00-00.	01-1B-19-00-00-00.
<b>MAC address</b> —Peer delay messages	01-80-C2-00-00-0E.	01-80-C2-00-00-0E.	Not applicable to this mode.
Domain number	0.	0.	0.
Path delay calculation	Peer-to-peer transparent clocks.	Peer-to-peer transparent clocks using the peer_delay mechanism.	End-to-end transparent clocks using the delay_request mechanism.
BMCA	Enabled.	Enabled.	Enabled.
Clock type	Two-step clocks are supported.	Two-step.	Two-step.
Time scale	Epoch. <sup>1</sup>	Epoch.	Epoch.

PTP Field	Power Profile Value	Switch Configuration Value	
		Power Profile Mode	Default Profile Mode
Grandmaster ID and local time determination	PTP-specific TLV (type, length, value) to indicate Grandmaster ID.	PTP-specific TLV to indicate Grandmaster ID.	PTP-specific type, length, and value to indicate Grandmaster ID.
Time accuracy over network hops	Over 16 hops, slave device synchronization accuracy is within 1 usec (1 microsecond).	Over 16 hops, slave device synchronization accuracy is within 1 usec (1 microsecond).	Not applicable in this mode.

<sup>1</sup> Epoch = Elapsed time since epoch start.

## Tagging Behavior for PTP Packets

The following table describes the switch tagging behavior in Power Profile and Default Profile modes.

**Table 2: Tagging Behavior for PTP Packets**

Switch Port Mode	Configuration	Power Profile Mode		Default Profile Mode	
		Behavior	Priority	Behavior	Priority
Trunk Port	<b>vlan dot1q tag native</b> enabled	Switch tags packets	7	Switch tags packets	7
Trunk Port	<b>vlan dot1q tag native</b> disabled	PTP software tags packets	4	Untagged	None
Access Port	N/A	Untagged	None	Untagged	None

## PTP Clock Modes Supported on the Switch

PTP synchronization behavior depends on the PTP clock mode that you configure on the switch. You can configure the switch for one of the following global modes.

See [Guidelines and Limitations, on page 11](#) for guidelines for configuring each of the clock modes.

### Boundary Clock Mode

A switch configured for boundary clock mode participates in selecting the best master clock on the subdomain, selecting from all clocks it can see, including itself. If the switch does not detect a more accurate clock than itself, then the switch becomes the master clock. If a more accurate clock is detected, then the switch synchronizes to that clock and becomes a slave clock.

After initial synchronization, the switch and the connected devices exchange PTP timing messages to correct the changes caused by clock offsets and network delays.

### Forward Mode

A switch configured for forward mode passes incoming PTP packets as normal multicast traffic.

## E2E Transparent Clock Mode

A switch configured for end-to-end transparent clock mode does not synchronize its clock with the master clock. A switch in this mode does not participate in master clock selection and uses the default PTP clock mode on all ports.

## P2P Transparent Clock Mode

A switch configured for peer-to-peer transparent clock mode does not synchronize its clock with the master clock. A switch in this mode does not participate in master clock selection and uses the default PTP clock mode on all ports.

## Configurable Boundary Clock Synchronization Algorithm

You can configure the BC synchronization algorithm to accommodate various PTP use cases, depending on whether you need to prioritize filtering of input time errors or faster convergence. A PTP algorithm that filters packet delay variation (PDV) converges more slowly than a PTP algorithm that does not.

By default, the BC uses a linear feedback controller (that is, a servo) to set the BC's time output to the next clock. The linear servo provides a small amount of PDV filtering and converges in an average amount of time. For improved convergence time, BCs can use the TC feedforward algorithm to measure the delay added by the network elements forwarding plane (the disturbance) and use that measured delay to control the time output.

While the feedforward BC dramatically speeds up the boundary clock, the feedforward BC does not filter any PDV. The adaptive PDV filter provides high quality time synchronization in the presence of PDV over wireless access points (APs) and enterprise switches that do not support PTP and that add significant PDV.

Three options are available for BC synchronization (all are compliant with IEEE 1588-2008):

- Feedforward—For very fast and accurate convergence; no PDV filtering.
- Adaptive—Filters as much PDV as possible, given a set of assumptions about the PDV characteristics, the hardware configuration, and the environmental conditions.



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**Note** With the adaptive filter, the switch does not meet the time performance requirements specified in ITU-T G.8261.

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- Linear—Provides simple linear filtering (the default).

Adaptive mode (**ptp transfer filter adaptive**) is not available in Power Profile mode.

For configuration information, see [Configuring PTP on the Switch, on page 14](#).

## Prerequisites

Review [Information About Precision Time Protocol](#), on page 2 and [Guidelines and Limitations](#), on page 11.

## Guidelines and Limitations

### PTP Messages

- The Cisco PTP implementation supports only the two-step clock and not the one-step clock. If the switch receives a one-step message from the Grand Master Clock, it will convert it into a two-step message.
- Cisco PTP supports multicast PTP messages only.

## PTP Mode and Profile

- The switch and the grandmaster clock must be in the same PTP domain.
- When Power Profile mode is enabled, the switch drops the PTP announce messages that do not include these two Type, Length, Value (TLV) message extensions: *Organization\_extension* and *Alternate\_timescale*.

If the grandmaster clock is not compliant with PTP and sends announce messages without these TLVs, configure the switch to process the announce message by entering the **ptp allow-without-tlv** command.

Refer to [Configuring PTP Power Profile Mode on the Switch, on page 14](#) for a complete description of this command.

- When the switch is in Power Profile mode, only the peer\_delay mechanism is supported.  
To change to [Boundary Clock Mode, on page 10](#) and the peer\_delay mechanism, enter the **ptp mode boundary pdelay-req** command.
- To disable Power Profile mode and return the switch to [E2E Transparent Clock Mode, on page 11](#), enter the **no ptp profile power** command.  
Refer to [Configuring Default Profile Mode on the Switch, on page 17](#) for a complete description of this command.
- In Default Profile mode, only the delay\_request mechanism is supported.  
To change to [Boundary Clock Mode, on page 10](#) with the delay\_request mechanism, enter the **ptp mode boundary delay-req** command.

## Packet Format

- The packet format for PTP messages can be 802.1q tagged packets or untagged packets.
- The switch does not support 802.1q QinQ tunneling.
- In switch Power Profile mode:
  - When the PTP interface is configured as an access port, PTP messages are sent as untagged, Layer 2 packets.
  - When the PTP interface is configured as a trunk port, PTP packets are sent as 802.1q tagged Layer 2 packets over the port native VLAN.
- Slave IEDs must support tagged and untagged packets.
- When PTP packets are sent on the native VLAN in [E2E Transparent Clock Mode, on page 11](#), they are sent as untagged packets. To configure the switch to send them as tagged packets, enter the global **vlan dot1q tag native** command.

## VLAN Configuration

- Sets the PTP VLAN on a trunk port. The range is from 1 to 4094. The default is the native VLAN of the trunk port.
- In boundary mode, only PTP packets in PTP VLAN will be processed, PTP packets from other VLANs will be dropped.
- Before configuring the PTP VLAN on an interface, the PTP VLAN must be created and allowed on the trunk port.
- Most grandmaster clocks use the default VLAN 0. In Power Profile mode, the switch default VLAN is VLAN 1 and VLAN 0 is reserved. When you change the default grandmaster clock VLAN, it must be changed to a VLAN other than 0.
- When VLAN is disabled on the grandmaster clock, the PTP interface must be configured as an access port.

## Clock Configuration

- All PHY PTP clocks are synchronized to the grandmaster clock. The switch system clock is not synchronized as part of PTP configuration and processes.
- When VLAN is enabled on the grandmaster clock, it must be in the same VLAN as the native VLAN of the PTP port on the switch.
- Grandmaster clocks can drop untagged PTP messages when a VLAN is configured on the grandmaster clock. To force the switch to send tagged packets to the grandmaster clock, enter the global **vlan dot1q tag native** command.

## Clock Modes



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**Note** The 802.1AS profile does not have a clock mode setting.

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- Boundary Clock Mode
  - You can enable this mode when the switch is in [Power Profile Mode, on page 9](#) (Layer 2) or in [Default Profile Mode, on page 8](#) (Layer 3).
- Forward Mode
  - You can enable this mode when the switch is in [Power Profile Mode, on page 9](#) (Layer 2) or in [Default Profile Mode, on page 8](#) (Layer 3).
  - When the switch is in Forward mode, the only global configuration available is the CLI command to switch to a different PTP mode (that is, boundary, e2transparent, or p2transparent).
- E2E Transparent Clock Mode
  - You can enable this mode only when the switch is in [Default Profile Mode, on page 8](#) (Layer 3).
  - When the switch is in E2E Transparent mode, the only global configuration available is the CLI command to switch to a different PTP mode (that is, boundary, p2transparent, or forward).
- P2P Transparent Clock Mode
  - You can enable this mode only when the switch is in [Power Profile Mode, on page 9](#) (Layer 2).
  - When the switch is in P2P Transparent mode, the only global configuration available is the CLI command to switch to a different PTP mode (that is, boundary, e2transparent, or forward).

## PDV Filtering

Adaptive mode (**ptp transfer filter adaptive**) is not available in Power Profile mode.

## PTP Interaction with Other Features

- The following PTP clock modes do not support EtherChannels:
  - e2transparent
  - p2transparent

- boundary
- The following PTP clock modes only operate on a single VLAN:
  - e2transparent
  - p2pttransparent

## Default Settings

- PTP is enabled on the switch by default.
- By default, the switch uses configuration values defined in the PTP Power Profile (Power Profile mode is enabled).
- The switch default PTP clock mode is [P2P Transparent Clock Mode, on page 11](#)
- The default BC synchronization algorithm is linear filter.

## Configuring PTP on the Switch

Use one of the following procedures in this section to configure the switch for PTP.

### Configuring PTP Power Profile Mode on the Switch

This section describes how to configure the switch to use the PTP Power Profile and operate in Power Profile mode.

#### Before you begin

These are some guidelines for configuring the Power Profile on the switch:

- When you enter **no** with PTP port configuration commands, the specified port property is set to the default value.
- To determine the value in seconds for the ptp global command *interval* variable, use a logarithmic scale. Below are examples of the *interval* variable value converted to seconds with a logarithmic scale:

Value Entered	Logarithmic Calculation	Value in Seconds
-1	$2^{-1}$	1/2
0	$2^0$	1

#### Procedure

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- Step 1** Enter global configuration mode:  
**configure terminal**
- Step 2** Set the Power Profile:  
**ptp profile power**

**Step 3** Specify the synchronization clock mode:

**ptp mode {boundary pdelay-req | p2pttransparent | forward}**

- **mode boundary pdelay-req**—Configures the switch for boundary clock mode using the delay-request mechanism. In this mode, the switch participates in the selection of the most accurate master clock. Use this mode when overload or heavy load conditions produce significant delay jitter.
- **mode p2pttransparent**—Configures the switch for peer-to-peer transparent clock mode and synchronizes all switch ports with the master clock. The link delay time between the participating PTP ports and the message transit time is added to the resident time. Use this mode to reduce jitter and error accumulation. This is the default in Power Profile mode.
- **mode forward**—Configures the switch to pass incoming PTP packets as normal multicast traffic.

**Step 4** (Optional, BC and TC mode) Specify TLV settings:

**ptp allow-without-tlv**

**Step 5** (Optional, BC and TC mode) Specify the PTP clock domain:

**ptp domain domain-number**

*domain-number* —A number from 0 to 255.

The participating grandmaster clock, switches, and slave devices should be in the same domain.

**Step 6** (Optional, BC and TC mode) Specify the packet priority:

**ptp packet priority**

The PTP packets have a default priority of 4. Lower values take precedence.

**Step 7** (Optional, BC mode only) Specify the BMCA priority:

**ptp priority1 priority priority2 priority**

- **priority1 priority**—Overrides the default criteria (such as clock quality and clock class) for the most accurate master clock selection.
- **priority2 priority**—Breaks the tie between two switches that match the default criteria. For example, enter 2 to give a switch priority over identical switches. *priority* —A priority number from 0 to 255. The default is 128.

**Step 8** (Optional, BC mode only) Specify time-property preservation:

**ptp time-property persist {value | infinite}**

- *value*—Time duration, in seconds, from 0-100000. The default is 300.
- **infinite**—Time properties are preserved indefinitely.

Preserving the time properties prevents slave clocks from detecting a variance in the time values when the redundant GMC comes out of standby.

**Step 9** (Optional, BC mode only) Specify the BC synchronization algorithm:

**ptp transfer {feedforward | filter linear}**

- **feedforward**—Very fast and accurate. No PDV filtering.
- **filter linear**—Provides a simple linear filter (default).

**Step 10** (Optional) Enter interface configuration mode:

```
interface interface-id
```

**Step 11** (Optional) Specify port settings:

Boundary pdelay-req mode:

```
ptp {announce {interval value | timeout value} | pdelay-req interval value | enable | sync {interval value | limit value}}
```

p2ptransparent mode:

```
ptp {pdelay-req interval value | enable}
```

- **announce interval value**—Sets the logarithmic mean interval in seconds to send announce messages. The range is 0 to 4. The default is 1 (2 seconds).
- **announce timeout value**—Sets the logarithmic mean interval in seconds to announce timeout messages. The range is 2 to 10. The default is 3 (8 seconds).
- **pdelay-req interval value**—Sets the logarithmic mean interval in seconds for slave devices to send pdelay request messages when the port is in the master clock state. The range is -3 to 5. The default is 0 (1 second).
- **enable**—Enables PTP on the port base module.
- **sync interval value**—Sets the logarithmic mean interval in seconds to send synchronization messages. The range is -2 to 1. The default is 1 second.
- **sync limit value**—Sets the maximum clock offset value before PTP attempts to resynchronize. The range is from 50 to 500000000 nanoseconds. The default is 500000000 nanoseconds.

**Step 12** Return to privileged EXEC mode:

```
end
```

**Step 13** Verify your entries:

```
show running-config
```

**Step 14** (Optional) Save your entries in the configuration file:

```
copy running-config startup-config
```

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## Example

The following example configures the switch for P2P transparent mode, specifies **allow-without-tlv** PTP message processing, and uses default values for all PTP interval settings:

```
switch(config)# ptp allow-without-tlv
```

The following example configures the switch for boundary clock mode using the peer delay request (pdelay-req) mechanism and uses default values for all PTP interval settings:

```
switch(config)# ptp mode boundary pdelay-req
```



## Configuring Default Profile Mode on the Switch

This section describes how to configure the switch to operate in Default Profile mode.

### Before you begin

The switch sends untagged PTP packets on the native VLAN when the switch port connected to the grandmaster clock is configured as follows:

- Switch is in Default Profile mode.
- Switch is in trunk mode.
- VLAN X is configured as the native VLAN.

When the grandmaster clock requires tagged packets, make one of the following configuration changes:

- Force the switch to send tagged frames by entering the global **vlan dot1q tag native** command.
- Configure the grandmaster clock to send and receive untagged packets. If you make this configuration change on the grandmaster clock, you can configure the switch port as an access port.

These are some guidelines for configuring the Default Profile on the switch:

- When you enter **no** with PTP port configuration commands, the specified port property is set to the default value.
- To determine the value in seconds for the ptp global command *interval* variable, use a logarithmic scale. Below are examples of the *interval* variable value converted to seconds with a logarithmic scale:

Value Entered	Logarithmic Calculation	Value in Seconds
-1	$2^{-1}$	1/2
0	$2^0$	1

### Procedure

---

- Step 1** Enter global configuration mode:  
**configure terminal**
- Step 2** Configure the switch for Default Profile mode when the switch is in Power Profile mode. If the switch is already in Default Profile mode, this command has no effect.  
**no ptp profile power**
- Step 3** Specify the synchronization clock mode:  
**ptp {mode boundary delay-req | e2transparent | forward}**
- **mode boundary delay-req**—Configures the switch for boundary clock mode using the delay-request mechanism. In this mode, the switch participates in the selection of the most accurate master clock. Use this mode when overload or heavy load conditions produce significant delay jitter.

- **mode e2transparent**—Configures the switch for end-to-end transparent clock mode. A switch clock in this mode synchronizes all switch ports with the master clock. This switch does not participate in master clock selection and uses the default PTP clock mode on all ports. This is the default clock mode. The message transit time is added to the resident time. Use this mode to reduce jitter and error accumulation.
- **mode forward**—Configures the switch to pass incoming PTP packets as normal multicast traffic.

**Step 4** (Optional, BC and TC mode) Specify the PTP clock domain:

**ptp domain** *domain-number*

*domain-number*—A number from 0 to 255.

The participating grandmaster clock, switches, and slave devices should be in the same domain.

**Step 5** (Optional, BC mode only) Specify the BMCA priority:

**ptp priority1** *priority* **priority2** *priority*

- **priority1** *priority*—Overrides the default criteria (such as clock quality and clock class) for the most accurate master clock selection.
- **priority2** *priority*—Breaks the tie between two switches that match the default criteria. For example, enter 2 to give a switch priority over identical switches.

*priority*—A priority number from 0 to 255. The default is 128.

**Step 6** (Optional, BC mode only) Specify time-property preservation:

**ptp time-property persist** {*value* | infinite}

- *value*—Time duration, in seconds, from 0-100000. The default is 300.
- infinite—Time properties are preserved indefinitely.

Preserving the time properties prevents slave clocks from detecting a variance in the time values when the redundant GMC comes out of standby.

**Step 7** (Optional, BC mode only) Specify the BC synchronization algorithm:

**ptp transfer** {**feedforward** | **filter** {**adaptive** | **linear**}}

- **feedforward**—Very fast and accurate. No PDV filtering.
- **filter adaptive**—Automatically filters as much PDV as possible.
- **filter linear**—Provides a simple linear filter (default).

**Step 8** (Optional) Enter interface configuration mode:

**interface** *interface-id*

**Step 9** (Optional) Specify port settings:

Boundary delay-req mode:

**ptp** {**announce** {**interval** *value* | **timeout** *value*} | **delay-req interval** *value* | **enable** | **sync** {**interval** *value* | **limit** *value*} | **vlan** *value*}

e2transparent mode:

**ptp** {**enable** | **sync** {**interval** *value* | **limit** *value*}}

- **announce interval** *value*—Sets the logarithmic mean interval in seconds to send announce messages. The range is 0 to 4. The default is 1 (2 seconds).
- **announce timeout** *value*— Sets the logarithmic mean interval in seconds to announce timeout messages. The range is 2 to 10. The default is 3 (8 seconds).
- **delay-req interval** *value*—Sets the logarithmic mean interval in seconds for slave devices to send delay request messages when the port is in the master clock state. The range is -2 to 6. The default is -5 (1 packet every 1/32 seconds, or 32 packets per second).
- **enable**—Enables PTP on the port base module.
- **sync interval** *value*—Sets the logarithmic mean interval in seconds to send synchronization messages. The range is -2 to 1. The default is 1 second.
- **sync limit** *value*—Sets the maximum clock offset value before PTP attempts to resynchronize. The range is from 50 to 500000000 nanoseconds. The default is 500000000 nanoseconds.
- **vlan** *value*—Sets the PTP VLAN on a trunk port. The range is from 1 to 4094. The default is the native VLAN of the trunk port. In boundary mode, only PTP packets in PTP VLAN will be processed, PTP packets from other VLANs will be dropped. Before configuring the PTP VLAN on an interface, the PTP VLAN must be created and allowed on the trunk port.

**Step 10** Return to privileged EXEC mode:

**end**

**Step 11** Verify your entries:

**show running-config**

**Step 12** (Optional) Save your entries in the configuration file:

**copy running-config startup-config**

---

## Example

The following example configures the switch to operate in Default Profile mode and end-to-end transparent mode and uses default values for all PTP interval settings:

```
switch(config)# no ptp profile
switch(config)# ptp mode e2etransparent
```

The following example configures the switch for Default Profile mode and boundary clock mode with the delay\_request mechanism, and uses default values for all PTP interval settings:

```
switch(config)# no ptp profile
switch(config)# ptp mode boundary delay-req
```

## Verifying Configuration

Command	Purpose
<b>show ptp {clock   foreign-master-records   parent   port {FastEthernet   GigabitEthernet}   time-property}</b>	Specifies the PTP information to display. <ul style="list-style-type: none"> <li>• <b>clock</b>—Displays PTP clock information.</li> <li>• <b>foreign-master-records</b>—Displays PTP foreign-master-records.</li> <li>• <b>parent</b>—Displays PTP parent properties.</li> <li>• <b>port FastEthernet</b>—Displays PTP properties for the FastEthernet IEEE 802.3 interfaces.</li> <li>• <b>port GigabitEthernet</b>—Displays PTP properties for the GigabitEthernet IEEE 802.3z interfaces.</li> <li>• <b>time-property</b>—Displays PTP clock-time properties.</li> </ul>

```
switch# show ptp parent
PTP PARENT PROPERTIES
Parent Clock:
Parent Clock Identity: 0xA4:C:C3:FF:FE:BF:B4:0
Parent Port Number: 23
Observed Parent Offset (log variance): N/A
Observed Parent Clock Phase Change Rate: N/A
Grandmaster Clock:
Grandmaster Clock Identity: 0xA4:C:C3:FF:FE:BF:2B:0
Grandmaster Clock Quality:
Class: 248
Accuracy: Unknown
Offset (log variance): N/A
Priority1: 128
Priority2: 128
```

```
switch# show ptp clock
PTP CLOCK INFO
PTP Device Type: Boundary clock
PTP Device Profile: Power Profile
Clock Identity: 0xA4:C:C3:FF:FE:BF:E0:80
Clock Domain: 0
Number of PTP ports: 26
PTP Packet priority: 4
Priority1: 128
Priority2: 128
Clock Quality:
Class: 248
Accuracy: Unknown
Offset (log variance): N/A
Offset From Master(ns): 25
Mean Path Delay(ns): 705
Steps Removed: 4
Local clock time: 14:23:56 PST Apr 5 2013
```

```
switch# show ptp foreign-master-record
PTP FOREIGN MASTER RECORDS
Interface FastEthernet0/1
Empty
Interface FastEthernet0/2
Empty
Interface FastEthernet0/3
```

```

Empty
Interface FastEthernet0/4
  Empty
Interface FastEthernet0/5
  Empty
Interface FastEthernet0/6
  Empty
Interface FastEthernet0/7
  Empty
Interface FastEthernet0/8
  Empty
Interface FastEthernet0/9
  Empty
Interface FastEthernet0/10
  Empty
Interface FastEthernet0/11
  Empty
Interface FastEthernet0/12
  Empty
Interface FastEthernet0/13
  Empty
Interface FastEthernet0/14
  Empty
Interface FastEthernet0/15
  Empty
Interface FastEthernet0/16
  Empty
Interface FastEthernet0/17
  Empty
Interface FastEthernet0/18
  Empty
Interface FastEthernet0/19
  Empty
Interface FastEthernet0/20
  Empty
Interface FastEthernet0/21
  Empty
Interface FastEthernet0/22
  Empty
Interface FastEthernet0/23
  Empty
Interface FastEthernet0/24
  Foreign master port identity: clock id: 0xA4:C3:FF:FE:BF:B4:0
  Foreign master port identity: port num: 23
  Number of Announce messages: 4
  Message received port: 24
  Time stamps: 2718923059, 2717917723
Interface GigabitEthernet0/1
  Empty
Interface GigabitEthernet0/2
  Empty
switch#
switch# show ptp ?
  clock                show ptp clock information
  foreign-master-record show PTP foreign master records
  parent               show PTP parent properties
  port                 show PTP port properties
  time-property        show PTP clock time property
switch# show ptp time-property
PTP CLOCK TIME PROPERTY
Current UTC offset valid: 0
Current UTC offset: 35
Leap 59: 0
Leap 61: 0

```

```

Time Traceable: 16
Frequency Traceable: 32
PTP Timescale: 1
Time Source: Internal Oscillator
Time Property Persistence: 300 seconds
switch# show ptp port FastEthernet 0/23
PTP PORT DATASET: FastEthernet0/23
Port identity: clock identity: 0xA4:C:C3:FF:FE:BF:E0:80
Port identity: port number: 23
PTP version: 2
Port state: MASTER
Delay request interval(log mean): 5
Announce receipt time out: 3
Peer mean path delay(ns): 507
Announce interval(log mean): 0
Sync interval(log mean): 0
Delay Mechanism: Peer to Peer
Peer delay request interval(log mean): 0
Sync fault limit: 500000000
switch# show ptp port FastEthernet 0/24
PTP PORT DATASET: FastEthernet0/24
Port identity: clock identity: 0xA4:C:C3:FF:FE:BF:E0:80
Port identity: port number: 24
PTP version: 2
Port state: SLAVE
Delay request interval(log mean): 5
Announce receipt time out: 3
Peer mean path delay(ns): 745
Announce interval(log mean): 0
Sync interval(log mean): 0
Delay Mechanism: Peer to Peer
Peer delay request interval(log mean): 0
Sync fault limit: 500000000
switch#

```

## Configuration Example

The following example configures the switch for P2P transparent mode, specifies **allow-without-tlv** PTP message processing, and uses default values for all PTP interval settings:

```
switch(config)# ptp allow-without-tlv
```

The following example configures the switch for boundary clock mode using the peer delay request (pdelay-req) mechanism and uses default values for all PTP interval settings:

```
switch(config)# ptp mode boundary pdelay-req
```

The following example configures the switch to operate in Default Profile mode and end-to-end transparent mode and uses default values for all PTP interval settings:

```
switch(config)# no ptp profile
switch(config)# ptp mode e2transparent
```

The following example configures the switch for Default Profile mode and boundary clock mode with the delay\_request mechanism, and uses default values for all PTP interval settings:

```
switch(config)# no ptp profile
switch(config)# ptp mode boundary delay-req
```

## PTP Serviceability

PTP Serviceability refers to the ability to troubleshoot and monitor PTP performance on a network with a Cisco IE Switch. This section describes how to display the following PTP Serviceability statistics and information:

- PTP message counters
- PTP error counters
- Timestamp offset and mean path delay maximum and minimum values
- Histogram of the offset and mean path delay values

### Displaying PTP Message Counters

To display counter information for PTP messages sent and received on all interfaces, use the **show ptp port counters messages** command. To display counters for a specific interface, enter **show ptp port counters messages <interface>**. For example:

```
Switch#show ptp port counters messages gigabitEthernet 1/4
  Ingress  Announce      Sync  Followup   DelReq  DelResp  PdelReq  PdelResp  PdelFwUp
  -----  -
  Gi1/4    117492    234629  234629      0       7216     0         0         0
  Egress   Announce      Sync  Followup   DelReq  DelResp  PdelReq  PdelResp  PdelFwUp
  -----  -
  Gi1/4     7         13     13       7216     0         0         0         0
```

The command output is described in the table below.

Enter **clear ptp port counters messages** to clear the message counters for all interfaces.

Ingress, Egress	The direction of the data displayed in the table: Ingress (input) or Egress (output).
Port	The port type and number (for example, Gi1/3).
Announce	General message (not tagged with a timestamp) used to establish a master-slave hierarchy.
Sync	Event message tagged with a timestamp when data packets reach or leave a port and used to synchronize ordinary and boundary clocks.
Followup	General message (not tagged with a timestamp) used to used to synchronize ordinary and boundary clocks.
DelReq	Delay request—Event message tagged with a timestamp when data packets reach or leave a port and used to synchronize ordinary and boundary clocks.
DelResp	Delay response—General message used to synchronize ordinary and boundary clocks. The master conveys the timestamp t4 to the slave by embedding it in a Delay_Resp message.
PdelReq	Peer delay request—Event message tagged with a timestamp when data packets reach or leave a port and used to measure the link delay in transparent clocks.

PdelResp	Peer delay response—Event message tagged with a timestamp when data packets reach or leave a port and used to measure the link delay in transparent clocks.
PdelFwUp	Peer delay follow up—General message (not tagged with a timestamp) used to measure the link delay in transparent clocks.

## Displaying PTP Error Message Counters

PTP errors are categorized as field mismatch errors, unexpected messages, duplicate messages, and generic errors. To display counter information for PTP errors that occurred on all interfaces, use the **show ptp port counters errors** command. To display counters for a specific interface, enter **show ptp port counters errors <interface>**. For example:

```
Switch#show ptp port counters errors gigabitEthernet 1/4
  Port          Sanity          Blkd          Vlan          Domain          Timestamp
  Parent-Id
  Gi1/4         0               0             0             0               0
  0

  Port          Gmc-Id          Seq-Id        Sync-Fault    Unmatched-FwUp  Unmatched-DelResp
  Duplicate-Sync
  Gi1/4         0               0             0             0               0
  0

  Port          Unmatched-PdelFwUp Duplicate-Announce Unmatched-PdelResp Send-Error      Misc-Error
  Gi1/4         0               0             0             0               0
  0
```

The command output is described in the table below.

Enter **clear ptp port counters errors** to clear the error counters for all interfaces.

Port	The port type and number.
<b>Field Mismatch Errors</b>	
Sanity	Sanity Check—The PTP message header field(s) of ingress PTP packets are invalid.
Blkd	Blocked—The PTP messages (except Peer-Delay messages) are received on REP/STP blocked ports.
Vlan	VLAN Mismatch—The VLAN ID of ingress PTP messages is different from the VLAN ID configured in the <b>ptp vlan</b> command.
Domain	(Applicable only in Boundary Clock mode) Domain Mismatch—The domain number field of ingress PTP messages is different from the configured PTP clock domain (the PTP domain number configured in the <b>ptp domain</b> command).



Timestamp	The timestamp for PTP messages is generated by the hardware. The timestamp error counter is incremented when the software is unable to fetch the timestamp for a given PTP message. The PTP messages that have a timestamp are Sync, Delay_Req, Pdelay_Req, and Pdelay_Resp.
Parent-Id	(Applicable only in Boundary Clock mode) Invalid Parent ID—The source port identity of ingress PTP messages is different from parent port identity of the local PTP clock.
GMC-Id	(Applicable only in Boundary Clock mode) Invalid GMC ID—The grandmaster clock identity of ingress announce messages has an invalid value (the grandmaster clock identity of ingress announce messages is the same as the clock identity of the local PTP clock).
Seq-Id	(Applicable only in Boundary Clock mode) Invalid Sequence ID—The sequence ID field of ingress PTP messages has an invalid value (the sequence ID of the follow-up message is different from the sequence ID of the preceding sync message).
Sync-Fault	Sync Fault—The PTP clock offset value has exceeded the “sync limit” value configured on the PTP slave port (the value configured for <b>ptp sync limit</b> on the interface, which is in the PTP SLAVE state).
<b>Unexpected Messages</b>	
Unmatched-FwUp	Unmatched Follow Up—The switch received a Follow up message when there was no outstanding SYNC message for which it expected a Follow up.
Unmatched-DelResp	Unmatched Delay Response—The switch received a Delay Response without sending a Delay Request.
Unmatched-PdelFwUp	Unmatched Peer Delay Response Follow up—The switch received a Peer Delay Response Follow up message without sending a Peer Delay Request.
Unmatched-PdelResp	Unmatched Peer Delay Response—The switch received a Peer Delay Response message without sending a Peer Delay Request.
<b>Duplicate Messages</b>	
Duplicate-Sync	Duplicate Sync—This counter indicates the number of duplicate PTP Sync messages received by the switch. (Duplicates are identified by checking the PTP sequence number on received messages.)

Duplicate-Announce	Duplicate Announce—This counter indicates the number of duplicate PTP Announce messages received by the switch. (Duplicates are identified by checking the PTP sequence number on received messages.)
<b>Generic Errors</b>	
Send-Error	Send Error—This counter indicates the number of PTP messages that could not be sent due to failures. PTP software might fail to send PTP messages due to reasons such as memory allocation failure, failure to obtain the correct outgoing interface information, etc.
Misc-Error	Miscellaneous Error—This counter indicates the number of miscellaneous errors that have occurred in the PTP protocol. Any error other than the ones listed above is classified as a miscellaneous error.

## Displaying PTP Offset and Delay

The PTP offset value is the measured offset of the clock from the master clock, in nanoseconds. The mean path delay is the average time, in nanoseconds, taken by PTP frames to travel between master and slave. You can display the historical maximum and minimum values for the offset from master and mean path delay when the switch is operating in GMC-BC (Grandmaster Boundary Clock) or BC (Boundary Clock) modes. You can also display a histogram of offset, delay, and time errors, where the historical values of the field specified are divided into bins to show the data distribution.

High offset and delay values can indicate a problem, for example, when a device goes down in the network and the link to the master is available but not viable. Ideally, offset and delay values should be as small as possible. Some PTP modes or profiles might cause higher offset values. Offsets can be negative.

Offset and delay values are shown for the last day and the past 5 seconds, 15 seconds, 1 minute, 5 minutes, 15 minutes, 1 hour, 5 hours, 15 hours, 1 day (same as last day), 5 days, 15 days, and more than fifteen days.

If the switch is the master or grandmaster clock these values are zero.

### Offset

To display PTP offset, enter the **show ptp internal-info offset** command, for example:

```
Switch#show ptp internal-info offset
           5 seconds  15 seconds  1 minute   5 minutes
Max Offset From Master(ns): 2          4          7          7
Min Offset From Master(ns): -1         -3         -8         -8
           15 minutes 1 hour     5 hours   15 hours
Max Offset From Master(ns): 7          7          7          8
Min Offset From Master(ns): -8         -8         -8         -9
           1 day     5 days    15 days   >15 days
Max Offset From Master(ns): 8          10         0          0
Min Offset From Master(ns): -9         -10        0          0
```

## Delay

To display the mean path delay, enter **show ptp internal-info delay**, as shown in this example:

```
Switch#show ptp internal-info delay
          5 seconds  15 seconds  1 minute  5 minutes
Max Mean Path Delay(ns): 123      123      123      123
Min Mean Path Delay(ns): 122      122      122      121
          15 minutes 1 hour     5 hours  15 hours
Max Mean Path Delay(ns): 123      123      123      123
Min Mean Path Delay(ns): 121      121      121      121
          1 day     5 days    15 days  >15 days
Max Mean Path Delay(ns): 123      123      0        0
Min Mean Path Delay(ns): 121      121      0        0
```

## Histogram

To display a histogram of PTP offset, delay, or time-error data, enter the **show ptp histogram [offset|delay|time-error]** command. Data is shown for the last 60 seconds, the last hour, and the last 24 hours. Values are divided into ranges of 0 to 20 nanoseconds, 20 to 50 nanoseconds, 50 to 100 nanoseconds, 100 to 250 nanoseconds, 250 to 500 nanoseconds, 500 to 1000 nanoseconds, 1000 to 10,000 nanoseconds, and greater than 10,000 nanoseconds. Offset and time-error values are further classified as negative or positive.

- Offset—Available when the clock mode is boundary; displays histogram for offset from master.
- Delay—Available when the clock mode is boundary or gmc-boundary; displays histogram of mean path delay data.
- Time-error—Available when the clock mode is p2transparent or e2transparent; displays histogram of data for time-error (frequency error \* residence time).

The following example shows the histogram for PTP offset and delay.

```
Switch#show ptp histogram offset
Offset data history

Last 60 seconds:
0          5          5          2          -6          1          0          4
-3         -5          2          -4          0          -1         2          4
3          -3         -4          -2          3          3          2          -3
0          -8          4          4          -2          6          -5          -6
4          0          2          -1          -4          1          -6          2
2          -3         -1          4          -1          1          0          3
-4         -6          0          5          0          7          5          0
-6         2          4          1

Offset range      Positive  Negative
0-20ns            38        22
20-50ns           0         0
50-100ns          0         0
100-250ns         0         0
250-500ns         0         0
500-1us           0         0
1-10us            0         0
>10us             0         0
```

Last 60 mins:

-6	2	-2	-6	0	0	0	1
-6	3	-2	3	-6	-1	4	3
-4	3	-6	-2	3	-2	-1	-4
-1	-7	2	0	-6	3	1	-5
5	-6	3	-1	-4	-1	2	1
-2	1	2	-2	4	2	0	4
0	-2	3	-2	-5	-4	-3	-5
-1	-1	-4	-1				

Offset range	Positive	Negative
0-20ns	27	33
20-50ns	0	0
50-100ns	0	0
100-250ns	0	0
250-500ns	0	0
500-1us	0	0
1-10us	0	0
>10us	0	0

Last 24hr:

0	-4	-3	4	7	0	6	1
-6	3	3	-3	4	0	1	-9
1	-3	-2	0	2	-5	-1	-4

Offset range	Positive	Negative
0-20ns	14	10
20-50ns	0	0
50-100ns	0	0
100-250ns	0	0
250-500ns	0	0
500-1us	0	0
1-10us	0	0
>10us	0	0

Switch#show ptp histogram delay

Mean path delay data history

Last 60 seconds:

122	122	122	122	122	122	122	122
122	122	122	122	122	122	122	122
122	122	122	122	122	122	122	122
122	122	122	122	122	122	122	122
122	122	122	122	122	122	122	122
122	122	122	122	122	122	122	122
122	122	122	122	122	122	122	122
122	122	122	122	122	122	123	123
123	123	123	123				

Delay range

0-20ns	0
20-50ns	0
50-100ns	0
100-250ns	60
250-500ns	0
500-1us	0
1-10us	0
>10us	0

Last 60 minutes:

122	122	123	123	123	123	122	122
122	122	122	122	122	122	122	122
122	122	122	122	122	122	122	122
121	121	122	121	122	122	122	122

```

122      122      122      122      122      122      122      122
122      122      122      122      122      121      121      121
121      122      122      122      122      121      121      122
122      122      122      122

```

```

Delay range
0-20ns      0
20-50ns     0
50-100ns    0
100-250ns   60
250-500ns   0
500-1us     0
1-10us      0
>10us       0

```

```

Last 24 hours:
121      122      121      122      122      122      122      122
121      122      121      122      121      121      122      121
121      122      122      122      122      122      122      122

```

```

Delay range
0-20ns      0
20-50ns     0
50-100ns    0
100-250ns   24
250-500ns   0
500-1us     0
1-10us      0
>10us       0

```

## Debugging PTP

Commands that you can use to debug PTP are listed in the following table.

<pre>debug ptp messages [<i>message-type</i>]</pre>	<p>Enables debugging of PTP messages.</p> <p>You can specify <i>message-type</i> to filter out the logs based on the PTP message type:</p> <ul style="list-style-type: none"> <li>• announce</li> <li>• delayreq</li> <li>• delayresp</li> <li>• followup</li> <li>• peerdelayfollowup</li> <li>• peerdelayreq</li> <li>• peerdelayresp</li> <li>• sync</li> </ul>
<pre>debug ptp error</pre>	<p>Enables debugging of PTP errors.</p>
<pre>debug ptp bmc</pre>	<p>Enables debugging of the PTP Best Master Clock Algorithm.</p>
<pre>debug ptp event</pre>	<p>Enables debugging of PTP state event.</p>

## Related Documents

- Cisco CGS 2520 switch product documentation:  
[www.cisco.com/go/cgs2520](http://www.cisco.com/go/cgs2520)
- [Cisco Connected Grid Ethernet Switch Module Interface Card Software Configuration Guide](#)
- Cisco IE 2000U switch product documentation:  
[Cisco Industrial Ethernet 2000U Series Switches](#)

## Feature History

Feature Name	Release	Feature Information
PTP Serviceability	15.2(7)E1a	Initial support of the feature on the IE 2000U.
Time Service Enhancements	15.2(4)EA	Addition of support for Feedforward BC and PDV Filtering.
Precision Time Protocol	15.0(2)EK	Addition of support for Default Profile Mode and End-to-End Transparent Clock Mode on the IE 2000U.
	15.0(2)EH	Initial support of the feature on the IE 2000U.
	15.0(2)ED	Initial support of the feature on the CG Ethernet Switch Module.
	12.2(58)Y and 15.0(2)SE	Initial support of the feature on the CGS 2520.

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**Americas Headquarters**  
Cisco Systems, Inc.  
San Jose, CA 95134-1706  
USA

**Asia Pacific Headquarters**  
CiscoSystems(USA)Pte.Ltd.  
Singapore

**Europe Headquarters**  
CiscoSystemsInternationalBV  
Amsterdam,TheNetherlands

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