



Cisco Connected Grid Switch Software Configuration Guide, Cisco IOS Release 15.0(2)SE

Last revised: October 10, 2012
Part number: OL-27721-02

This guide provides configuration information about the software features released in Cisco IOS Release 15.0(2)SE. This software release is supported on the Connected Grid switch devices listed in the section [Supported Hardware, page 1](#). This document should be used in conjunction with the related software documentation for the supported devices.

For details on the software release, please refer to the Release Notes for Cisco IOS Release 15.0(2)SE: http://www.cisco.com/en/US/partner/docs/switches/lan/catalyst3750/software/release/15.0_2_se/release/notes/OL25301.html

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Supported Hardware

Supported Hardware	Hardware Minimum Software Release	Related Software Documentation
Cisco CGS 2520 Switch	Cisco IOS Release 15.0(2)SE	Cisco 2500 Series Connected Grid Switches Configuration Guides



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Cisco IOS Release 15.0(2)SE Features

This guide describes the following software features:

- [IEEE 1588 Precision Time Protocol, page 2](#)
- [Temperature and Voltage Monitoring, page 18](#)

IEEE 1588 Precision Time Protocol

This section describes Precision Time Protocol (PTP) and how to configure it on the switch. This section includes following topics:

- [About Precision Time Protocol, page 2](#)
- [Configuring PTP on the Switch, page 10](#)

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 overhead processing.



Note

The section [About Precision Time Protocol, page 2](#), is a general discussion of PTP and PTP profiles. If you are familiar with PTP and PTP profiles, you can skip to the section [Configuring PTP on the Switch, page 10](#), which describes the switch default PTP configuration and how to configure the switch PTP options.

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
- Very little network bandwidth is needed 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 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 and transparent clocks.

**Note**

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

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 time 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.

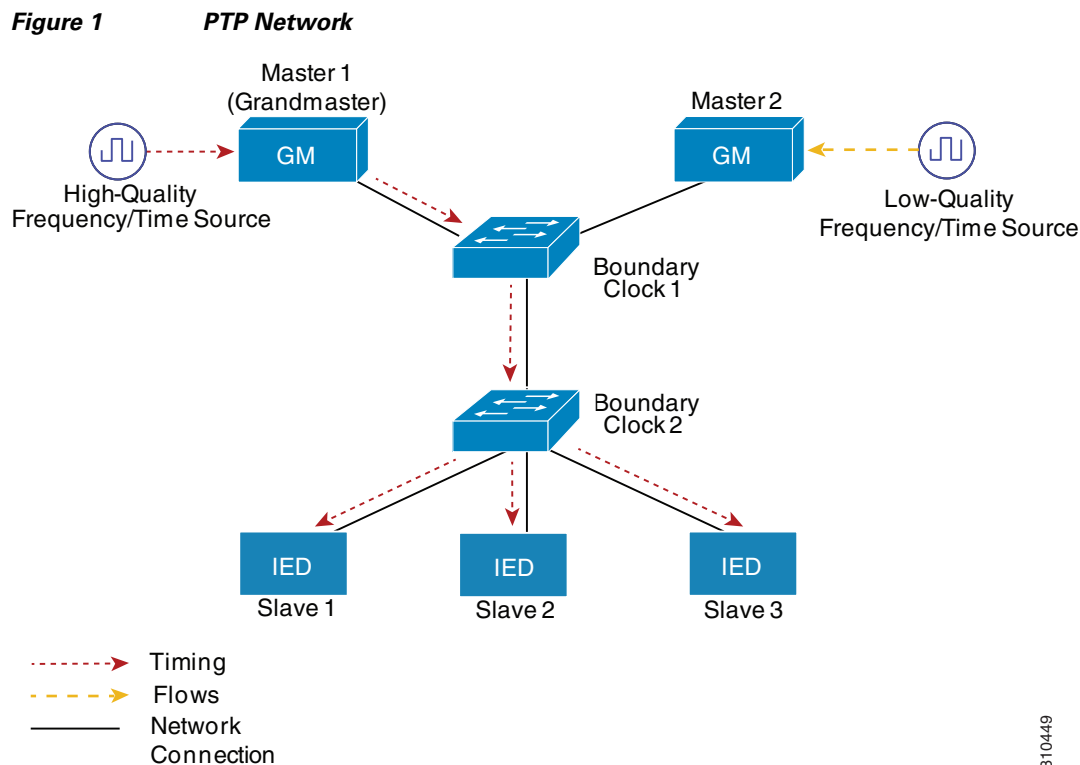
This delay measurement principle determines path delay between devices on the network and the local clocks are adjusted for this delay using a series of messages sent between masters and slaves. The one-way delay time is calculated by averaging the path delay of the transmit and receive messages. This 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.

More Information

- To read a detailed description of synchronization messages, refer to the section [PTP Event Message Sequences, page 4](#).
- To learn more about how transparent clocks calculate network delays, refer to the section [Transparent Clock, page 7](#)

Figure 1 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.



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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:

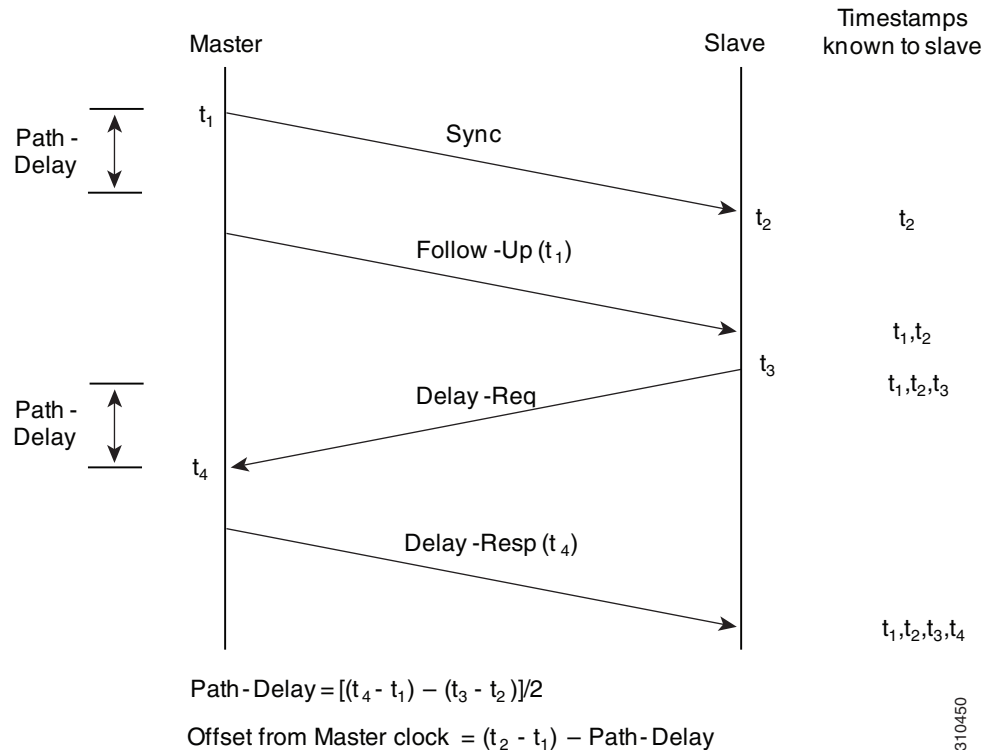
1. The master sends a Sync message to the slave and notes the time (t_1) at which it was sent.
2. The slave receives the Sync message and notes the time of reception (t_2).
3. The master conveys to the slave the timestamp t_1 by embedding the timestamp t_1 in a Follow_Up message.
4. The slave sends a 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.

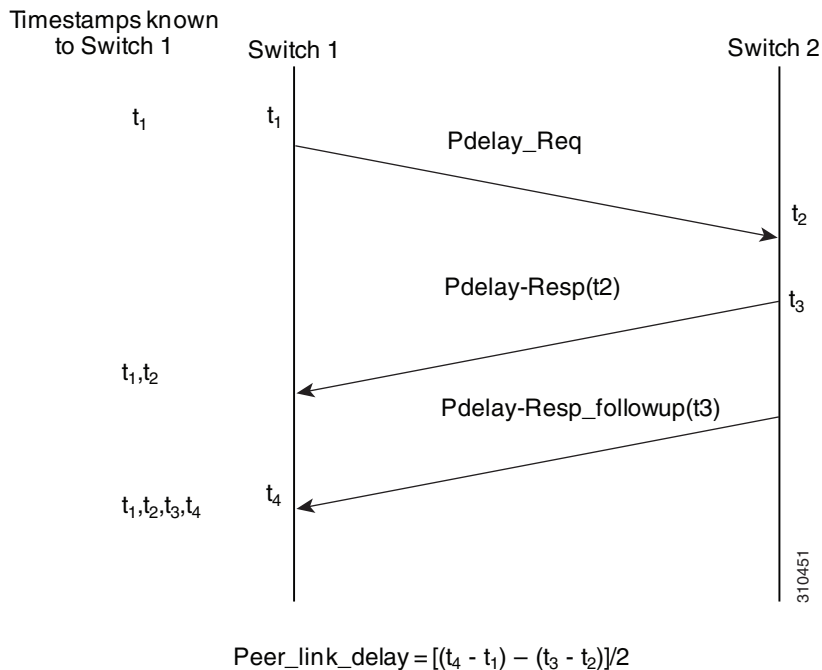
Peer-to-peer transparent clocks use the following event messages:

- 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 (BMC) algorithm is the basis of PTP functionality. BMC 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 BMC algorithm runs on the network continuously and quickly adjusts for changes in network configuration.

BMC 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, BMC 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, which are described in this section:

- [Grandmaster Clock, page 7](#)
- [Ordinary Clock, page 7](#)
- [Boundary Clock, page 7](#)
- [Transparent Clock, page 7](#)

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 BMC 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 BMC algorithm 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.

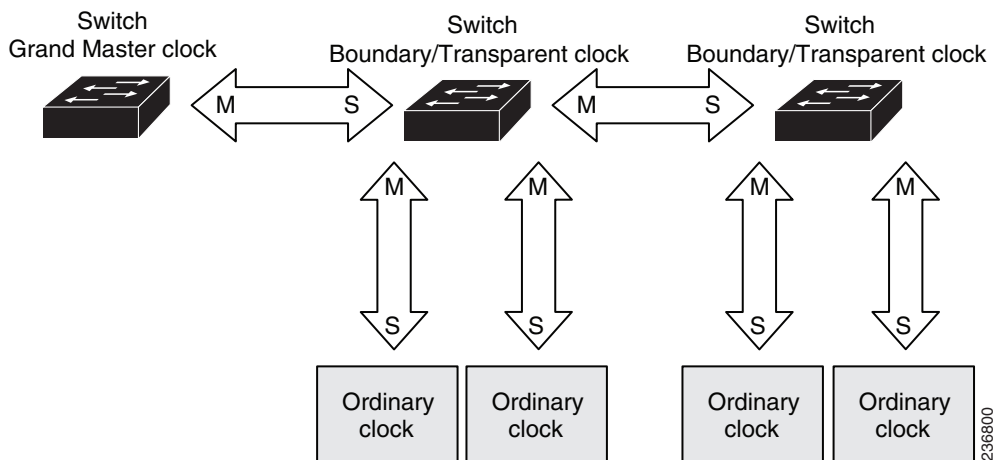
The slave uses this information when determining the offset between the slave's and the master's time. E2E transparent clocks do not provide correction for the propagation delay of the link itself.

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.

Figure 4 illustrates PTP clocks in a master-slave hierarchy within a PTP network.

Figure 4 PTP Clock Hierarchy



About the PTP Power Profile

This section describes PTP profiles and specifically the PC37.238 IEEE-1588 standard, Power Profile, which is also known as the Profile for Protection Applications.



Note

The switch documentation and CLI use the terms Power Profile, power profile mode, and non-power profile mode when referring to this IEEE-1588 profile and its associated configuration values.

What are PTP Profiles?

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

Power Profile Description

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 a Sprite FPGA, which time stamps the Fast Ethernet and Gigabit Ethernet ports.
- **Software**—The switch default configuration is power profile mode. In this mode, the switch uses the configuration values defined in the IEEE-1588 Power Profile standard.

[Table 1](#) lists the configuration values defined by the IEEE-1588 Power Profile.

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

PTP Field	Power Profile Value	Switch Configuration Value	
		Power Profile Mode	Non-Power 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.	Access Ports —Untagged Layer 2 packets, Trunk Ports —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.
MAC address —Non-peer delay messages	01-1B-19-00-00-00.	01-1B-19-00-00-00.	01-1B-19-00-00-00.
MAC address —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.
BMC	Enabled.	Enabled.	Enabled.

PTP Field	Power Profile Value	Switch Configuration Value	
		Power Profile Mode	Non-Power Profile Mode
Clock type	Two-step and one-step clocks are supported. Two-step is preferred for Ethernet.	Two-step.	Two-step.
Time scale	Epoch. ¹	Epoch.	Epoch.
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.

1. Epoch = Elapsed time since epoch start.

Configuring PTP on the Switch

This section describes how to configure the switch for PTP applications.

Power Profile Modes on the Switch

This section describes the two PTP modes that the switch uses.



Note

For detailed information about the IEEE-1588 Power Profile, refer to [About the PTP Power Profile, page 8](#).

Power Profile Mode

By default, the switch PTP configuration uses the values defined by the IEEE-1588 Power Profile and the switch is in power profile mode. In this mode:

- The PTP mode of transport is Layer 2.
- The supported transparent clock mode is peer-to-peer (P2P).

[Table 1 on page 9](#) lists the configuration values for the switch in power profile mode.

Non-Power Profile Mode

When power profile mode is disabled on the switch with the **no ptp profile power** command, the switch is in non-power 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 on page 9](#) lists the configuration values for the switch in non-power profile mode.

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:

- [Boundary Clock Mode](#)
- [Forward Mode](#)
- [E2E Transparent Clock Mode](#)
- [P2P Transparent Clock Mode](#)

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. These are some guidelines for this mode:

- You can enable this mode when the switch is in [Power Profile Mode](#) (Layer 2) or in [Non-Power Profile Mode](#) (Layer 3).
- The switch must be in this mode to configure PTP on individual switch ports.

Forward Mode

A switch configured for forward mode passes incoming PTP packets as normal multicast traffic. These are some guidelines for this mode:

- You can enable this mode when the switch is in [Power Profile Mode](#) (Layer 2) or in [Non-Power Profile Mode](#) (Layer 3).
- When the switch is in this mode, the only PTP configuration available is PTP mode.
- The switch must be in [Boundary Clock Mode](#) to configure PTP on individual switch ports.

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. These are some guidelines for this mode:

- You can enable this mode only when the switch is in [Non-Power Profile Mode](#) (Layer 3).
- When the switch is in this mode, the only PTP configuration available is PTP mode.
- The switch must be in [Boundary Clock Mode](#) to configure PTP on individual switch 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. These are some guidelines for this mode:

- You can enable this mode only when the switch is in [Power Profile Mode](#) (Layer 2).
- When the switch is in this mode, the only PTP configuration available is PTP mode.
- The switch must be in [Boundary Clock Mode](#) to configure PTP on individual switch ports.

Switch Configuration Guidelines for PTP

Be aware of the guidelines in this section when you configure PTP on the switch.

PTP Mode and Profile Guidelines

- 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](#).
- 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 the section [Configuring PTP Power Profile Mode on the Switch, page 13](#), 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](#) 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](#), enter the **no ptp profile power** command.
Refer to the section [Configuring Non-Power Profile Mode on the Switch, page 15](#), for a complete description of this command.
- In non-power profile mode, only the delay_request mechanism is supported.
To change to [Boundary Clock Mode](#) with the delay_request mechanism, enter the **ptp mode boundary delay-req** command.

Packet Format Guidelines

- 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](#), 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 Guidelines

- 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 Guidelines

- The switch FPGA PTP clock only is 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.

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.

- For complete information about PTP profiles and the Power Profile, refer to the section [About the PTP Power Profile, page 8](#).
- For details about switch power profile mode, refer to the section [Power Profile Mode, page 10](#).

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

To configure the switch for power profile mode, follow these steps:

	Command	Description
Step 1	configure terminal	Enters global configuration mode.
Step 2	ptp profile power	Enables the PTP Power Profile on the switch and configures the switch for power profile mode (if the switch is in non-power profile mode). The switch default configuration is power profile enabled. If the switch is already in power profile mode, then this command has no effect.
Step 3	ptp { allow-without-tlv domain mode { boundary pdelay-req p2ptransparent forward } packet priority1 <i>priority</i> priority2 <i>priority</i> }	<p>Specifies the synchronization clock mode.</p> <ul style="list-style-type: none"> • allow-without-tlv—Enables PTP message processing for announce messages that do not include the <i>Organization_extension</i> and <i>Alternate_Timescale_Offset_Indicator</i> TLVs. • domain—Sets the PTP clock domain. The participating grandmaster clock, switches, and slave devices should be in the same domain. • mode boundary pdelay-req—Configures the switch for boundary clock mode using the peer delay request (pdelay-req) mechanism. A switch in boundary clock mode participates in the selection of the most accurate master clock. The peer_link delay between PTP ports is included in the offset calculation. Use this mode when heavy network conditions produce significant delay jitter. • mode p2ptransparent—Default clock mode. 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. • mode forward—Configures the switch to pass incoming PTP packets as normal multicast traffic. <p>The following options specify the clock priority properties when the switch port is in boundary mode.</p> <ul style="list-style-type: none"> • packet—Changes the PTP packet priority. The default is priority 4. Lower values take precedence. • priority1—Overrides the default criteria (such as clock quality and clock class) for the most accurate master clock selection. • priority2—Breaks the tie between two switches that match the default criteria. For example, enter 2 to give a switch priority over identical switches. • <i>priority</i> —A priority number from 0 to 255. The default is 128.
Step 4	interface <i>interface-id</i>	Enters interface configuration mode.

	Command	Description
Step 5	ptp { announce interval <i>interval</i> } timeout { <i>timeout-in-secs</i> } delay-req { interval <i>interval</i> } enable pdelay-req { interval <i>interval</i> } sync { interval <i>interval</i> } limit { <i>offset-in-nanosecs</i> }	<p>Specifies the settings for PTP timing messages. These options are available only when the switch is in boundary mode.</p> <ul style="list-style-type: none"> interval—Interval time. You can calculate interval seconds from the value you enter using a logarithmic scale as described in the section Configuring PTP Power Profile Mode on the Switch, page 13. announce interval <i>interval</i>—Sets the time to send announce messages. The range is 0 to 4 seconds. The default is 0 seconds (entered value: 0). announce timeout <i>timeout-in-secs</i>— Sets the time to announce timeout messages. The range is 2 to 10 seconds. The default is 8 seconds (entered value is 3). delay-req interval <i>interval</i>—Sets the time interval for slave devices to send delay request messages when the port is in the master clock state. The range is -1 to 6 seconds. The default is 32 seconds (entered value is 5). enable—Enables PTP on the port base module. pdelay-req interval <i>interval</i>—Sets the time interval for PTP devices to send peer_delay request messages when the peer_delay mechanism is enabled. The range is -3 to 5. The default is 0 (0 seconds). sync interval <i>interval</i>—Sets the time interval to send synchronization messages. The range is -1 to 1 second. The default is 1 second. sync limit <i>offset-in-nanosecs</i>—Sets the maximum clock offset value before PTP attempts to resynchronize. The range is 50 to 500000000 nanoseconds. The default is 500000000 nanoseconds.
Step 6	end	Returns to privileged EXEC mode.
Step 7	show running-config	Verifies your entries.
Step 8	copy running-config startup-config	(Optional) Saves your entries in the configuration file.

Configuring Non-Power Profile Mode on the Switch

This section describes how to configure the switch to operate in non-power profile mode.

- For complete information about PTP profiles and the Power Profile, refer to the section [About the PTP Power Profile](#), page 8.
- For details about switch non-power profile mode, refer to the section [Non-Power Profile Mode](#), page 10.

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 non-power 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.

To configure the switch for non-power profile mode, follow these steps:

	Command	Description
Step 1	configure terminal	Enters global configuration mode.
Step 2	no ptp profile power	Configures the switch for non-power profile mode when the switch is in power profile mode. If the switch is already in non-power profile mode, this command has no effect.
Step 3	ptp { domain mode boundary delay-req e2transparent forward } packet priority1 priority priority2 priority }	<p>Specifies the synchronization clock.</p> <ul style="list-style-type: none"> • domain—Sets the PTP clock domain. The participating grandmaster clock, switches, and slave devices should be in the same domain. • 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 times 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. <p>These options specify the clock priority properties when the switch port is in boundary mode:</p> <ul style="list-style-type: none"> • packet—Changes the PTP packet priority. The PTP packets have a default priority of 4. Lower values take precedence. • 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 4	interface interface-id	Enters interface configuration mode.

	Command	Description
Step 5	ptp { announce { interval <i>interval</i> timeout <i>interval</i> } delay-req interval <i>interval</i> enable sync { interval <i>interval</i> limit <i>offset-in-nanosecs</i> }}	<p>Specifies the settings for the timing messages. These options are available only when the switch is in boundary mode.</p> <ul style="list-style-type: none"> interval—Interval time. You can calculate interval seconds from the value you enter using a logarithmic scale as described in the section Configuring PTP Power Profile Mode on the Switch, page 13. announce interval <i>interval</i>—Sets the time to send announce messages. The range is 0 to 4 seconds. The default is 0 (0 seconds). announce timeout <i>interval</i>— Sets the time to announce timeout messages. The range is 2 to 10 seconds. The default is 8 seconds (entered value is 3). delay-req interval <i>interval</i>—Sets the time for slave devices to send delay request messages when the port is in the master clock state. The range is -1 second to 6 seconds. The default is 32 seconds (entered value is 5). enable—Enables PTP on the port base module. sync interval <i>interval</i>—Sets the time to send synchronization messages. The range is -1 to 1 second. The default is 1 second. sync limit <i>offset-in-nanosecs</i>—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 6	end	Returns to privileged EXEC mode.
Step 7	show running-config	Verifies your entries.
Step 8	copy running-config startup-config	(Optional) Saves your entries in the configuration file.

PTP Show Commands

This section describes the PTP **show** command options.

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

Tagging Behavior for PTP Packets

Table 2 describes the switch tagging behavior in power profile and non-power profile modes.

Table 2 Tagging Behavior for PTP Packets

Switch Port Mode	Configuration	Power Profile Mode		Non-Power Profile Mode	
		Behavior	Priority	Behavior	Priority
Trunk Port	vlan dot1q tag native enabled	Switch tags packets.	7	Switch tags packets.	7
Trunk Port	vlan dot1q tag native disabled	PTP software tags packets.	4	Untagged	None
Access Port	N/A	Untagged	None	Untagged	None

Temperature and Voltage Monitoring

This release includes enhancements to features that support monitoring of the switch operating temperature and power supply voltage. This section describes how to configure this feature on the switch, and includes the following topics:

- [Power Supply Voltage Monitoring, page 18](#)
- [Historical Data Collection, page 18](#)
- [Configuring Temperature and Voltage Monitoring Options, page 20](#)
- [Temperature and Voltage Monitoring Show Commands, page 23](#)
- [MIB Support for TVM, page 24](#)

Power Supply Voltage Monitoring

Earlier software releases for the switch supported user configurable alarm thresholds (maximum and minimum) for the switch operating temperature. You can configure operating temperature ranges (primary and secondary) for the switch, and then configure alarm options to trigger an event message when the switch operating temperature is out of the defined range.

Cisco IOS Release 15.0(2)SE includes a similar feature for the switch power supply. You can configure power supply voltage ranges and then configure alarm options for when the voltage is out of range. These features include:

- User configurable thresholds for the power supply voltage.
- Support for SNMP traps and SYSLOG messages (alarms) when the power supply voltage exceeds or falls below the configured thresholds.

Historical Data Collection

Cisco IOS Release 15.0(2)SE includes new features to support switch historical data collection and storage. Use these features to configure the switch to save historical data about switch operating temperature and power supply voltage. New features include:

- Historical data collection and storage for temperature and voltage information.

- A **show** command that displays the configuration and historical data for temperature and voltage.
- An enhanced MIB enables historical data retrieval so that network management systems can collect report data from the switch.
- Commands for monitoring redundant power supplies.

Monitoring and Storing Temperature and Voltage Data

This section describes how often the switch monitors and stores temperature and voltage data.

Monitoring Interval

The switch checks the operating temperature and power supply voltage once per minute.

Storage Interval

The switch stores temperature and voltage data as follows:

- Every 60 seconds, the switch stores the actual, measured temperature and voltage.
- Every 60 minutes, the switch stores the average of the 60 measurements taken during the previous hour.

You must enter the **alarm facility history** command to enable the switch to store the data that it collects at the monitoring intervals. Refer to these sections for details about how to use these commands:

- The **alarm facility temperature history** command is described in the section [Configure Temperature Monitoring Features, page 20](#)
- The **alarm facility power-supply voltage history** command is described in the section [Configure Power Supply Monitoring Features, page 21](#)

Maximum Storage Period

The switch stores temperature and voltage data for a maximum of 72 hours. After 72 hours, the oldest data is purged as the switch adds the most recent data.

Alarms

At each monitoring interval, the switch checks the operating temperature and power supply voltage. If the switch detects that either is out of range of the thresholds defined with the **alarm facility** command, then it generates an event message (alarm). The message type is SYSLOG or SNMP trap. Refer to these sections for details about how to use these commands:

- The **alarm facility temperature** command is described in the section [Configure Temperature Monitoring Features, page 20](#)
- The **alarm facility power-supply voltage** command is described in the section [Configure Power Supply Monitoring Features, page 21](#)
- The **alarm facility power-supply rps** command is described in the section [Configure RPS Monitoring Features, page 23](#)

Configuring Temperature and Voltage Monitoring Options

This section describes the temperature and voltage monitoring configuration commands supported in Cisco IOS Release 15.0(2)SE and later.

Configure Temperature Monitoring Features

Use the **alarm facility temperature** global configuration command to configure temperature thresholds for the purpose of generating event messages (alarms). You can configure an alarm for both of these threshold types.

You can also use this command to:

- Configure the alarm options to use when operating temperature is outside the configured threshold ranges.
- Enable historical data collection for operating temperature ranges.
- Use the **no** form of the command to disable the specified setting
- To reset the high or low parameter to the default value, use the **no** form of the command with the previously entered value, for example:

```
Switch)# no alarm facility temperature primary low 220
```

Command Syntax	Description
alarm facility temperature { <i>history</i> primary { <i>low celsius</i> <i>high celsius</i> <i>notifies</i> relay major <i>syslog</i> } secondary { <i>low celsius</i> <i>high celsius</i> <i>notifies</i> <i>syslog</i> }	<p>The alarm facility temperature global command configures the operating temperature thresholds, alarm settings, and historical data settings for the switch.</p> <ul style="list-style-type: none"> • history—Enables historical data collection for the switch operating temperature. The default setting is disabled. • primary—Configures the primary temperature thresholds. • secondary—Configures the secondary temperature thresholds. • high celsius—Maximum temperature in degrees celsius that, when exceeded, triggers an alarm event on the switch. The range is -150 to 300. The default value is 110. • low celsius—Minimum temperature in degrees celsius that, when not met, triggers an alarm event on the switch. The range is -200 to 250. The default value is -25. • notifies—Generates an SNMP trap when the switch operating temperature is out of range of the configured threshold values. The default setting is disabled. • relay major—Sends alarms across the major relay circuits. This is the default configuration and it cannot be changed. • syslog—Generates a SYSLOG message when the switch operating temperature is out of range of the configured threshold values. The default setting is enabled.

Configure Power Supply Monitoring Features

Supported Power Supplies

The switch supports the power supply models described below. The **alarm facility power-supply voltage** command options and alarm threshold ranges are different for each model.

For detailed information about these power supplies, refer to the switch hardware installation guide.

Power Supply Model	Description	set threshold Command Option	Threshold Ranges
PWR-RGD-AC-DC	High-voltage AC or DC.	threshold ac-dc	<ul style="list-style-type: none"> High: 275 to 300 volts Low: 75 to 80 volts
PWR-RGD-LOW-DC	Low-voltage DC.	threshold low-dc	<ul style="list-style-type: none"> High: 75 to 80 volts Low: 16 to 20 volts

Use the **alarm facility power-supply voltage** global configuration command to configure voltage thresholds for the purpose of generating event messages (alarms). You can also use this command to:

- Configure the event notification options to use when power supply voltage is outside the configured threshold ranges.
- Enable historical data collection of power supply voltage.
- Use the **no** form of the command to disable the specified setting
- Use the **no** form of the command to reset a parameter to the default value.

Command Syntax	Description
<p>alarm facility power-supply voltage { disable history notifies relay major } syslog threshold ac-dc { high volts low volts } threshold low-dc { high volts low volts }</p>	<p>The alarm facility power-supply voltage global configuration command configures the power supply thresholds, alarm settings, and historical data settings for the switch power supplies.</p> <ul style="list-style-type: none"> • disable—Disables threshold alarms for the power supply. • history—Enables historical data collection for the power supplies. The default setting is disabled. • notifies—Generates an SNMP trap when the power supply voltage exceeds the high value or falls below the low value. The default setting is disabled. • relay major—Sends alarms across the major relay circuits. This is the default setting and it cannot be changed. • syslog—Generates a SYSLOG message when the power supply voltage exceeds the high value or falls below the low value. The default setting is enabled. • threshold ac-dc—Configures the maximum and minimum threshold values for the PWR-RGD-AC-DC power supply. • threshold low-dc—Configures the maximum and minimum threshold values for the PWR-RGD-LOW-DC power supply. • high volts—Maximum power supply voltage that, when exceeded, triggers an alarm event on the switch. The range is: <ul style="list-style-type: none"> – threshold ac-dc: 275 to 300 – threshold low-dc: 75 to 80 The default values are: <ul style="list-style-type: none"> – ac-dc high: 275 – low-dc high: 80 • low volts—Minimum power supply voltage that, when not met, triggers an alarm event on the switch. The range is: <ul style="list-style-type: none"> – threshold ac-dc: 75 to 85 – threshold low-dc: 16 to 20 The default values are: <ul style="list-style-type: none"> – ac-dc low: 80 – low-dc low: 17

Configure RPS Monitoring Features

Use the **alarm facility power-supply rps** global configuration command to configure event messages (alarms) for the switch redundant power supply (RPS). Use this command to:

- Configure the relay circuits on which RPS alarms are sent.
- Configure the alarm settings to use for RPS alarms.
- Disable alarms for the RPS.
- Use the **no** form of the command to disable the specified RPS setting.

Command Syntax	Description
alarm facility power-supply rps {disable relay major syslog notifies}	<p>The alarm facility power-supply rps global configuration command configures the event message options for the RPS.</p> <ul style="list-style-type: none"> • disable—Disables alarms for the redundant power supply. • notifies—Generates an SNMP when the switch operating temperature is out of range of the configured threshold values. • relay major—Sends alarms across the major relay circuits. This is the default setting and it cannot be changed. • syslog—Generates a SYSLOG message when the switch operating temperature is out of range of the configured threshold values.

Temperature and Voltage Monitoring Show Commands

This section describes the temperature and voltage monitoring **show** commands supported in Cisco IOS Release 15.0(2)SE and later.

Command Syntax	Description
show {alarm settings env {all temperature history power-supply history}}	<p>The show command displays configuration information and historical data for the switch operating temperature and power supply voltage.</p> <ul style="list-style-type: none"> • alarm settings—Displays the power supply temperature configuration. • env—Displays historical data for the selected option. • all—Displays historical data for the switch operating temperature and the power supply voltage. • temperature history—Displays historical data for the switch operating temperature. • power-supply history—Displays historical data for the switch power supply voltage.

MIB Support for TVM

This section describes the MIBs that are supported by the TVM feature:

- CISCO-ENTITY-SENSOR-MIB—Collects history information about temperature and power-supply monitoring on the router.
- CISCO-ENTITY-SENSOR-HISTORY-MIB—Provides five objects that support read-write operations:
 - entSensorThresholdSeverity
 - entSensorThresholdRelation
 - entSensorThresholdValue
 - entSensorThresholdNotificationEnable
 - entSensorThreshNotifGlobalEnable

**Note**

TVM supports read operations (get operations) only, including for objects that support read and write operations.

Enable Entity Sensor Threshold Notifications

To enable entity sensor threshold notifications, enter the **snmp-server enable traps entity-sensor threshold** global configuration command. To disable entity sensor threshold notifications, enter the **no** form of this command.

Specify SNMP Notification Recipients

To specify the recipient of an SNMP notification operation for entity sensor threshold, enter the **snmp-server host** global configuration command. To remove the specified host, enter the **no** form of this command.

Related Documents

- Cisco CGS 2520 Software Configuration Guides:
http://www.cisco.com/en/US/products/ps10978/products_installation_and_configuration_guides_list.html
- Cisco CGS 2520 Release Notes:
http://www.cisco.com/en/US/products/ps10978/prod_release_notes_list.html

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