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CHAPTER 1

Configuring Clocking and Timing

This chapter explains how to configure timing ports on the Route Switch Processor (RSP) modules and includes the following sections:

- Clocking and Timing Restrictions, on page 1
- Clocking and Timing Overview, on page 3
- Configuring Clocking and Timing, on page 15
- Verifying the Configuration, on page 49
- Troubleshooting, on page 50
- Configuration Examples, on page 51

Clocking and Timing Restrictions

The following clocking and timing restrictions apply to the chassis:

- Interfaces carrying PTP traffic must be under the same VPN Routing and Forwarding (VRF). Misconfiguration will cause PTP packet loss. Use the 10 Gigabit Links to configure VRF on two Cisco RSP3 Routers.
- You can configure only a single clocking input source within each group of eight ports (0–7 and 8–15) on the T1/E1 interface module using the `network-clock input-source` command.
- Multicast timing is not supported.
- Out-of-band clocking and the `recovered-clock` command are not supported.
- Precision Time Protocol (PTP) is supported only on loopback interfaces.
- Synchronous Ethernet clock sources are not supported with PTP. Conversely, PTP clock sources are not supported with synchronous Ethernet except when configured as hybrid clock. However, you can use hybrid clocking to allow the chassis to obtain frequency using Synchronous Ethernet, and phase using PTP.
- Time of Day (ToD) and 1 Pulse per Second (1PPS) input is not supported when the chassis is in boundary clock mode.
- Multiple ToD clock sources are not supported.
- PTP redundancy is supported only on unicast negotiation mode; you can configure up to three master clocks in redundancy mode.
• In order to configure time of day input, you must configure both an input 10 Mhz and an input 1 PPS source.

• PTP over IPv6 is not supported.

• SyncE Rx and Tx is supported on uplink interfaces when using 8 x 1 GE Gigabit Ethernet SFP Interface Module.

• When PTP is configured, changing the configuration mode from LAN to WAN or WAN to LAN is not supported for following IMs:
  • 2x10G
  • 8x1G_1x10G_SFP
  • 8x1G_1x10G_CU

• PTP functionality is restricted by license type.

The table below summarizes the PTP functionalities that are available, by license type:

<table>
<thead>
<tr>
<th>License</th>
<th>PTP Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metro Services</td>
<td>Not supported</td>
</tr>
<tr>
<td>Metro IP Service</td>
<td>Ordinary Slave Clock</td>
</tr>
<tr>
<td>Metro Aggregation Service</td>
<td>Ordinary Slave Clock</td>
</tr>
<tr>
<td>Metro IP Service + IEEE 1588-2008 BC/MC</td>
<td>All PTP functionality including boundary and master clock</td>
</tr>
<tr>
<td>Metro Aggregation Service + IEEE 1588-2008 BC/MC</td>
<td>All PTP functionality including boundary and master clock</td>
</tr>
</tbody>
</table>

Note

If you install the IEEE 1588-2008 BC/MC license, you must reload the chassis to use the full PTP functionality.

• End-to-end Transparent Clock is not supported for PTP over Ethernet.

• Transparent clock is not supported on the Cisco RSP3 Module.

• G.8265.1 telecom profiles are not supported with PTP over Ethernet.

• The chassis does not support a mix of IPv4 and Ethernet clock ports when acting as a transparent clock or boundary clock.

The following restrictions apply when configuring synchronous Ethernet SSM and ESMC:

• To use the network-clock synchronization ssm option command, ensure that the chassis configuration does not include the following:
  • Input clock source
• Network clock quality level
• Network clock source quality source (synchronous Ethernet interfaces)

• The `network-clock synchronization ssm option` command must be compatible with the `network-clock eec` command in the configuration.

• To use the `network-clock synchronization ssm option` command, ensure that there is not a network clocking configuration applied to synchronous Ethernet interfaces, BITS interfaces, and timing port interfaces.

• SSM and ESMC are SSO-coexistent, but not SSO-compliant. The chassis goes into hold-over mode during switchover and restarts clock selection when the switchover is complete.

• The chassis does not support ESMC messages on the S1 byte on SONET/SDH and T1/E1 interface modules.

• It is recommended that you do not configure multiple input sources with the same priority as this impacts the TSM (Switching message delay).

• You can configure a maximum of 4 clock sources on interface modules, with a maximum of 2 per interface module. This limitation applies to both synchronous Ethernet and TDM interfaces.

• When you configure the ports using the `synchronous mode` command on a copper interface, the port attempts to auto-negotiate with the peer-node copper port and hence the auto negotiation is incomplete as both the ports try to act as master, which in turn makes the port down. Hence, for a successful clock sync to happen, you should configure the ports using `network-clock input-source interface interface id` command prior to the configuration using the `synchronous mode` command under the interfaces to ensure that one of the ports behaves as a master.

It is not recommended to configure the copper ports using the `synchronous mode` command.

### Restrictions on RSP3 Module

The following clocking and timing restrictions are supported on the RSP3 Module:

• Precision Time Protocol (PTP) is supported only on the routed interfaces.

• Transparent Clock over 1 Gigabit Ethernet port performance is not good.

• PTP is supported for LAN for the following IMs. WAN is not supported.
  - 2x40
  - 1x100 GE
  - 8x10 GE

• To shift from non hybrid clock configuration to hybrid clock configuration, you must first unconfigure PTP, unconfigure netsync, reconfigure netsync and configure hybrid PTP.

### Clocking and Timing Overview

The chassis have the following timing ports:
• 1 PPS Input/Output
• 10 Mhz Input/Output
• ToD
• Building Integrated Timing Supply (BITS)

You can use the timing ports on the chassis to perform the following tasks:
• Provide or receive 1 PPS messages
• Provide or receive time of day (ToD) messages
• Provide output clocking at 10 Mhz, 2.048 Mhz, and 1.544 Mhz
• Receive input clocking at 10 Mhz, 2.048 Mhz, and 1.544 Mhz

Note
Timing input and output is handled by the active RSP.

Note
For timing redundancy, you can use a Y cable to connect a GPS timing source to multiple RSPs. For information, see the Cisco ASR 903 Series Aggregation Services Router Hardware Installation Guide.

SyncE is supported in both LAN and WAN mode on a 10 Gigabit Ethernet interface.

The following sections describe how to configure clocking and timing features on the chassis.

Understanding PTP

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

PTP is particularly useful for industrial automation systems and process control networks, where motion and precision control of instrumentation and test equipment are important.

Table 2: Nodes within a PTP Network

<table>
<thead>
<tr>
<th>Network Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grandmaster (GM)</td>
<td>A network device physically attached to the primary time source. All clocks are synchronized to the grandmaster clock.</td>
</tr>
<tr>
<td>Ordinary Clock (OC)</td>
<td>An ordinary clock is a 1588 clock with a single PTP port that can operate in one of the following modes:</td>
</tr>
<tr>
<td></td>
<td>• Master mode—Distributes timing information over the network to one or more slave clocks, thus allowing the slave to synchronize its clock to the master.</td>
</tr>
<tr>
<td></td>
<td>• Slave mode—Synchronizes its clock to a master clock. You can enable the slave mode on up to two interfaces simultaneously in order to connect to two different master clocks.</td>
</tr>
</tbody>
</table>
### Network Element

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boundary Clock (BC)</td>
</tr>
<tr>
<td>Transparent Clock (TC)</td>
</tr>
</tbody>
</table>

### Telecom Profiles

Release 3.8 introduces support for telecom profiles, which allow you to configure a clock to use the G.8265.1 recommendations for establishing PTP sessions, determining the best master clock, handling SSM, and mapping PTP classes. For information about how to configure telecom profiles, see Configuring Clocking and Timing, on page 15.

Effective Cisco IOS-XE Release 3.18, the G.8275.1 telecom profile is also supported on the Cisco ASR 903 Series Routers with RSP2 module. For more information, see G.8275.1 Telecom Profile.

### PTP Redundancy

PTP redundancy is an implementation on different clock nodes. This helps the PTP slave clock node achieve the following:

- Interact with multiple master ports such as grand master clocks and boundary clock nodes.
- Open PTP sessions.
- Select the best master from the existing list of masters (referred to as the primary PTP master port or primary clock source).
- Switch to the next best master available in case the primary master fails, or the connectivity to the primary master fails.

The Cisco ASR 900 Series chassis supports unicast-based timing as specified in the 1588-2008 standard.

For instructions on how to configure PTP redundancy, see Configuring PTP Redundancy, on page 36.

### PTP Asymmetry Readjustment

Each PTP node can introduce delay asymmetry that affects the adequate time and phase accuracy over the networks. Asymmetry in a network occurs when one-way-delay of forward path (also referred as forward path delay or ingress delay) and reverse path (referred as reverse path delay or egress delay) is different. The magnitude of asymmetry can be either positive or negative depending on the difference of the forward and reverse path delays.

Effective Cisco IOS XE Gibraltar 16.10.1, PTP asymmetry readjustment can be performed on each PTP node to compensate for the delay in the network.
Restriction

In default profile configuration, delay-asymmetry value is provided along with the clock source command. This restricts it to change the delay-asymmetry value with a complete reconfiguration of clock source command. The delay-asymmetry value should be considered as static and cannot be changed at run-time.

PTP Redundancy Using Hop-By-Hop Topology Design

Real world deployments for IEEE-1588v2 for mobile backhaul requires the network elements to provide synchronization and phase accuracy over IP or MPLS networks along with redundancy.

In a ring topology, a ring of PTP boundary clock nodes are provisioned such that each boundary clock node provides synchronization to a number of PTP slaves connected to it. Each such ring includes at least two PTP masters with a PRC traceable clock.

However, with this topology the following issues may occur:

- Node asymmetry and delay variation—In a ring topology, each boundary clock uses the same master, and the PTP traffic is forwarded through intermediate boundary clock nodes. As intermediate nodes do not correct the timestamps, variable delay and asymmetry for PTP are introduced based on the other traffic passing through such nodes, thereby leading to incorrect results.
- Clock redundancy—Clock redundancy provides redundant network path when a node goes down. In a ring topology with PTP, for each unicast PTP solution, the roles of each node is configured. The PTP clock path may not be able to reverse without causing timing loops in the ring.

No On-Path Support Topology

The topology (see Figure 1: Deployment in a Ring - No On-Path Support with IPv4, on page 6) describes a ring with no on-path support. S1 to S5 are the boundary clocks that use the same master clocks. GM1 and GM2 are the grandmaster clocks. In this design, the following issues are observed:

- Timestamps are not corrected by the intermediate nodes.
- Difficult to configure the reverse clocking path for redundancy.
- Formation of timings loops.

Figure 1: Deployment in a Ring - No On-Path Support with IPv4
Table 3: PTP Ring Topology—No On-Path Support

<table>
<thead>
<tr>
<th>Clock Nodes</th>
<th>Behavior in the PTP Ring</th>
</tr>
</thead>
<tbody>
<tr>
<td>GM1</td>
<td>Grandmaster Clock</td>
</tr>
<tr>
<td>GM2</td>
<td>Grandmaster Clock</td>
</tr>
<tr>
<td>S1</td>
<td>Masters: M1 (1st), M2 (2nd)</td>
</tr>
<tr>
<td>S2</td>
<td>Masters: M1 (1st), M2 (2nd)</td>
</tr>
<tr>
<td>S3</td>
<td>Masters: M1 (1st), M2 (2nd)</td>
</tr>
<tr>
<td>S4</td>
<td>Masters: M2 (1st), M1 (2nd)</td>
</tr>
<tr>
<td>S5</td>
<td>Masters: M2 (1st), M1 (2nd)</td>
</tr>
</tbody>
</table>

A solution to the above issue is addressed by using Hop-by-Hop topology configuration.

Hop-By-Hop Topology in a PTP Ring

PTP Ring topology is designed by using Hop-By-Hop configuration of PTP boundary clocks. In this topology, each BC selects its adjacent nodes as PTP masters, instead of using the same GM as the PTP master. These PTP BC masters are traceable to the GM in the network. Timing loops are not formed between adjacent BC nodes. The hot Standby BMCA configuration is used for switching to next the best master during failure.

Prerequisites

- PTP boundary clock configuration is required on all clock nodes in the ring, except the master clock nodes (GM), which provide the clock timing to ring. In the above example (see Figure 5-1) nodes S1 ... S5 must be configured as BC.
- The master clock (GM1 and GM2 in Figure 5-1) nodes in the ring can be either a OC master or BC master.
- Instead of each BC using same the GM as a PTP master, each BC selects its adjacent nodes as PTP masters. These PTP BC-masters are traceable to the GM in the network.
- Boundary clock nodes must be configured with the `single-hop` keyword in the PTP configuration to ensure that a PTP node can communicate with it’s adjacent nodes only.

Restrictions

- Timing loops should not exist in the topology. For example, if for a node there are two paths to get the same clock back, then the topology is not valid. Consider the following topology and configuration.
The paths with double arrows (>>) are the currently active clock paths and paths with single arrow (>) are redundant clock path. This configuration results in a timing loop if the link between the BC-1 and GM fails.

- In a BC configuration, the same loopback interface should never be used for both master and slave port configuration.
- **Single-hop** keyword is not supported for PTP over MPLS with explicit null configuration. The Single-hop keyword is not supported when PTP packets are sent out with a MPLS tag.

**On-Path Support Topology Scenario**

Consider the topology as shown in Figure 5-1.
Now consider there is a failure between BC1 and BC2 (see Figure 5-3). In this case, the BC2 cannot communicate with GM1. Node BC2 receives the clock from BC3, which in turn receives the clock from GM2.
Table 5: PTP Ring Topology—On-Path Support (Failure)

<table>
<thead>
<tr>
<th>Clock Node</th>
<th>Behavior in the PTP Ring¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>GM1</td>
<td>Grandmaster Clock</td>
</tr>
<tr>
<td>GM2</td>
<td>Grandmaster Clock</td>
</tr>
<tr>
<td>BC1</td>
<td>Masters: M1 (1st), BC2 (2nd)</td>
</tr>
<tr>
<td></td>
<td>Slaves: BC2</td>
</tr>
<tr>
<td>BC2</td>
<td>Masters: BC1 (1st), BC3 (2nd)</td>
</tr>
<tr>
<td></td>
<td>Slaves: BC1, BC3</td>
</tr>
<tr>
<td>BC3</td>
<td>Masters: BC2 (1st), BC4 (2nd)</td>
</tr>
<tr>
<td></td>
<td>Slaves: BC2, BC4</td>
</tr>
<tr>
<td>BC4</td>
<td>Masters: BC5 (1st), BC3 (2nd)</td>
</tr>
<tr>
<td></td>
<td>Slaves: BC3, BC5</td>
</tr>
</tbody>
</table>
### Configuration Example

PTP Ring boundary clocks must be configured with **single-hop** keyword in PTP configuration. The PTP node can communicate with its adjacent nodes only. This is required for PTP hop-by-hop ring topology.

```
ptp clock boundary domain 0
  clock-port bcslave1 slave
    transport ipv4 unicast interface Lo0 negotiation single-hop
  clock source 1.1.1.1
  clock source 2.2.2.2 1
  clock-port bcmaster1 master
    transport ipv4 unicast interface Lo1 negotiation single-hop
```

The **single-hop** keyword is not supported for PTP over MPLS with explicit NULL configurations. The **single-hop** keyword is not supported when PTP packets are sent out with a MPLS tag.

For information on configuring PTP redundancy, see [Configuring PTP Redundancy, on page 36](#).

### Best Master Clock Algorithm

Starting Cisco IOS XE Release 3.15, Best Master Clock Algorithm (BMCA) is supported on the chassis.

BMCA is used to select the master clock on each link, and ultimately, select the grandmaster clock for the entire Precision Time Protocol (PTP) domain. BCMA runs locally on each port of the ordinary and boundary clocks, and selects the best clock.

The best master clock is selected based on the following parameters:

- **Priority**—User-configurable value ranging from 0 to 255; lower value takes precedence
- **Clock Class**—Defines the traceability of time or frequency from the grandmaster clock
- **Alarm Status**—Defines the alarm status of a clock; lower value takes precedence

By changing the user-configurable values, network administrators can influence the way the grandmaster clock is selected.

BMCA provides the mechanism that allows all PTP clocks to dynamically select the best master clock (grandmaster) in an administration-free, fault-tolerant way, especially when the grandmaster clocks changes.

For information on configuring BMCA, see [Configuring an Ordinary Clock, on page 15](#) and [Configuring a Boundary Clock, on page 23](#).
Hybrid BMCA

In hybrid BMCA implementation, the phase is derived from a PTP source and frequency is derived from a physical lock source. More than one master clock is configured in this model and the best master is selected. If the physical clock does down, then PTP is impacted.

Configuration Example

**Hybrid BMCA on Ordinary Clock**

```plaintext
ptp clock ordinary domain 0 hybrid
clock-port SLAVE slave
transport ipv4 unicast interface Lo0 negotiation
clock source 133.133.133.133
clock source 144.144.144.144 1
clock source 155.155.155.155 2

Network-clock input-source 10 interface gigabitEthernet 0/4/0
```

**Hybrid BMCA on Boundary Clock**

```plaintext
ptp clock boundary domain 0 hybrid
clock-port SLAVE slave
transport ipv4 unicast interface Lo0 negotiation
clock source 133.133.133.133
clock source 144.144.144.144 1
clock source 155.155.155.155 2
clock-port MASTER master
transport ipv4 unicast interface Lo1 negotiation

Network-clock input-source 10 interface gigabitEthernet 0/4/0
```

**Hybrid Clocking**

The Cisco ASR 900 Series Chassis support a hybrid clocking mode that uses clock frequency obtained from the synchronous Ethernet port while using the phase (ToD or 1 PPS) obtained using PTP. The combination of using physical source for frequency and PTP for time and phase improves the performance as opposed to using only PTP.

---

**Note**

When configuring a hybrid clock, ensure that the frequency and phase sources are traceable to the same master clock.

For more information on how to configure hybrid clocking, see [Configuring a Hybrid Clock, on page 27](#).

**Transparent Clocking**

A transparent clock is a network device such as a switch that calculates the time it requires to forward traffic and updates the PTP time correction field to account for the delay, making the device transparent in terms of timing calculations. The transparent clock ports have no state because the transparent clock does not need to synchronize to the grandmaster clock.

There are two kinds of transparent clocks:

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

Note

The Cisco ASR 900 Series Chassis does not currently support peer-to-peer transparent clock mode.

For information on how to configure the Cisco ASR 900 Series Chassis as a transparent clock, see Configuring a Transparent Clock, on page 26.

Time of Day (TOD)

You can use the time of day (ToD) and 1PPS ports on the Cisco ASR 900 Series Chassis to exchange ToD clocking. In master mode, the chassis can receive time of day (ToD) clocking from an external GPS unit; the chassis requires a ToD, 1PPS, and 10MHZ connection to the GPS unit.

In slave mode, the chassis can recover ToD from a PTP session and repeat the signal on ToD and 1PPS interfaces.

For instructions on how to configure ToD on the Cisco ASR 900 Series Chassis, see the Configuring an Ordinary Clock, on page 15.

Synchronizing the System Clock to Time of Day

You can set the chassis system time to synchronize with the time of day retrieved from an external GPS device. For information on how to configure this feature, see Synchronizing the System Time to a Time-of-Day Source, on page 40.

Timing Port Specifications

The following sections provide specifications for the timing ports on the Cisco ASR 900 Series Chassis.

BITS Framing Support

The following table lists the supported framing modes for a BITS port.

<table>
<thead>
<tr>
<th>BITS or SSU Port Support Matrix</th>
<th>Framing Modes Supported</th>
<th>SSM or QL Support</th>
<th>Tx Port</th>
<th>Rx Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>T1 ESF</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>T1</td>
<td>T1 SF</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>E1</td>
<td>E1 CRC4</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>E1</td>
<td>E1 FAS</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>2048 kHz</td>
<td>2048 kHz</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
The BITS port behaves similarly to the T1/E1 ports on the T1/E1 interface module; for more information about configuring T1/E1 interfaces, see the *Configuring T1/E1 Interfaces* document.

**Understanding Synchronous Ethernet ESMC and SSM**

Synchronous Ethernet incorporates the Synchronization Status Message (SSM) used in Synchronous Optical Networking (SONET) and Synchronous Digital Hierarchy (SDH) networks. While SONET and SDH transmit the SSM in a fixed location within the frame, Ethernet Synchronization Message Channel (ESMC) transmits the SSM using a protocol: the IEEE 802.3 Organization-Specific Slow Protocol (OSSP) standard.

The ESMC carries a Quality Level (QL) value identifying the clock quality of a given synchronous Ethernet timing source. Clock quality values help a synchronous Ethernet node derive timing from the most reliable source and prevent timing loops.

When configured to use synchronous Ethernet, the chassis synchronizes to the best available clock source. If no better clock sources are available, the chassis remains synchronized to the current clock source.

The chassis supports two clock selection modes: QL-enabled and QL-disabled. Each mode uses different criteria to select the best available clock source.

For more information about Ethernet ESMC and SSM, see *Configuring Synchronous Ethernet ESMC and SSM*, on page 43.

---

**Note**
The chassis can only operate in one clock selection mode at a time.

**Note**  
PTP clock sources are not supported with synchronous Ethernet.

**Clock Selection Modes**

The chassis supports two clock selection modes, which are described in the following sections.

**QL-Enabled Mode**

In QL-enabled mode, the chassis considers the following parameters when selecting a clock source:

- Clock quality level (QL)
- Clock availability
- Priority

**QL-Disabled Mode**

In QL-disabled mode, the chassis considers the following parameters when selecting a clock source:

- Clock availability
- Priority

**Note**  
You can use override the default clock selection using the commands described in the *Managing Clock Source Selection*, on page 47.
Managing Clock Selection

You can manage clock selection by changing the priority of the clock sources; you can also influence clock selection by modifying the following clock properties:

- **Hold-Off Time**: If a clock source goes down, the chassis waits for a specific hold-off time before removing the clock source from the clock selection process. By default, the value of hold-off time is 300 ms.
- **Wait to Restore**: The amount of time that the chassis waits before including a newly active synchronous Ethernet clock source in clock selection. The default value is 300 seconds.
- **Force Switch**: Forces a switch to a clock source regardless of clock availability or quality.
- **Manual Switch**: Manually selects a clock source, provided the clock source has a equal or higher quality level than the current source.

For more information about how to use these features, see Managing Clock Source Selection, on page 47.

Configuring Clocking and Timing

The following sections describe how to configure clocking and timing features on the chassis:

**Configuring an Ordinary Clock**

The following sections describe how to configure the chassis as an ordinary clock.

**Configuring a Master Ordinary Clock**

Follow these steps to configure the chassis to act as a master ordinary clock.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `platform ptp master prtc-only-enable`
4. `ptp clock {ordinary | boundary | e2e-transparent} domain domain-number`
5. `priority1 priority-value`
6. `priority2 priority-value`
7. `utc-offset value leap-second “date time” offset {-1 | 1}`
8. `input [1pps] {R0 | R1}`
9. `tod {R0 | R1} {ubx | nmea | cisco | ntp}`
10. `clock-port port-name {master | slave} {profile {g8265.1}}`
11. Do one of the following:
    - `transport ipv4 unicast interface interface-type interface-number [negotiation]`
    - `transport ethernet unicast [negotiation]`
12. `exit`
13. network-clock synchronization automatic
14. network-clock synchronization mode ql-enabled
15. Use one of the following options:
   - network-clock input-source priority controller {SONET | wanphy}
   - network-clock input-source priority external {R0 | R1} [10m | 2m]
   - network-clock input-source priority external {R0 | R1} [2048k | e1 {cas |120ohms | 75ohms | crc4}]
   - network-clock input-source priority external {R0 | R1} [2048k | e1 {crc4 | fas} {120ohms | 75ohms} {linecode {ami | hdb3}}]
   - network-clock input-source priority interface type/slot/port

16. clock destination source-address | mac-address {bridge-domain bridge-domain-id} | interface interface-name
17. sync interval interval
18. announce interval interval
19. end
20. linecode {ami | b8zs | hdb3}

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> platformptp masterprtc-only-enable</td>
<td>(Optional) Enable Master port deletion.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config)# platform ptp master prtc-only-enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> ptp clock {ordinary</td>
<td>boundary</td>
</tr>
<tr>
<td>Example:</td>
<td>• ordinary—A 1588 clock with a single PTP port that can operate in Master or Slave mode.</td>
</tr>
<tr>
<td>Router(config)# ptp clock ordinary domain 0</td>
<td>• boundary—Terminates PTP session from Grandmaster and acts as PTP master to slaves downstream.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-ptp-clk)#</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td>• e2e-transparent—Updates the PTP time correction field to account for the delay in forwarding the traffic. This helps improve the accuracy of 1588 clock at slave.</td>
<td></td>
</tr>
</tbody>
</table>

**Step 5**  
**priority1 priorityvalue**  
**Example:**  
Router(config-tp-clk)# priority1 priorityvalue

Sets the preference level for a clock. Slave devices use the priority1 value when selecting a master clock: a lower priority1 value indicates a preferred clock. The priority1 value is considered above all other clock attributes. Valid values are from 0-255. The default value is 128.

**Step 6**  
**priority2 priorityvalue**  
**Example:**  
Router(config-tp-clk)# priority2 priorityvalue

Sets a secondary preference level for a clock. Slave devices use the priority2 value when selecting a master clock: a lower priority2 value indicates a preferred clock. The priority2 value is considered only when the chassis is unable to use priority1 and other clock attributes to select a clock. Valid values are from 0-255. The default value is 128.

**Step 7**  
**Optional**  
**utc-offset value leap-second “date time” offset {-1 | 1}**  
**Example:**  
Router(config-tp-clk)# utc-offset 45 leap-second “01-01-2017 00:00:00” offset 1

(Optional) Starting with Cisco IOS-XE Release 3.18SP, the new utc-offset CLI is used to set the UTC offset value. Valid values are from 0-255. The default value is 36.  
(Optional) Starting with Cisco IOS-XE Release 3.18.1SP, you can configure the current UTC offset, leap second event date and Offset value (+1 or -1). Leap second configuration will work only when the frequency source is locked and ToD was up before.  
• “date time”—Leap second effective date in dd-mm-yyyy hh:mm:ss format.

**Step 8**  
**input [1pps] {R0 | R1}**  
**Example:**  
Router(config-tp-clk)# input 1pps R0

Enables Precision Time Protocol input 1PPS using a 1PPS input port. Use R0 or R1 to specify the active RSP slot.

**Step 9**  
**tod {R0 | R1} {ubx | nmea | cisco | ntp}**  
**Example:**  
Router(config-tp-clk)# tod R0 ntp

Configures the time of day message format used by the ToD interface.  
**Note**  
It is mandatory that when electrical ToD is used, the utc-offset command is configured before configuring the tod R0, otherwise there will be a time difference of approximately 37 seconds between the master and slave clocks.  
**Note**  
The ToD port acts as an input port in case of Master clock and as an output port in case of Slave clock.
### Configuring a Master Ordinary Clock

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 10</strong></td>
<td><strong>clock-port</strong> <em>port-name</em> `{master</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Defines a new clock port and sets the port to PTP master or slave mode; in master mode, the port exchanges timing packets with PTP slave devices.</td>
</tr>
<tr>
<td>Router(config-ptp-clk)# <strong>clock-port</strong> Master</td>
<td>The <strong>profile</strong> keyword configures the clock to use the G.8265.1 recommendations for establishing PTP sessions, determining the best master clock, handling SSM, and mapping PTP classes.</td>
</tr>
<tr>
<td>Router(config-ptp-port)#</td>
<td><strong>Note</strong> Using a telecom profile requires that the clock have a domain number of 4–23.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Step 11</strong></th>
<th>Do one of the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Specifies the transport mechanism for clocking traffic; you can use IPv4 or Ethernet transport.</td>
</tr>
<tr>
<td>Router(config-ptp-port)# <strong>transport</strong> ipv4 unicast interface loopback 0 negotiation</td>
<td>The <strong>negotiation</strong> keyword configures the chassis to discover a PTP master clock from all available PTP clock sources.</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>PTP redundancy is supported only on unicast negotiation mode.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Step 12</strong></th>
<th><strong>exit</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Exits clock-port configuration.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Step 13</strong></th>
<th><strong>network-clock synchronization automatic</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Enables automatic selection of a clock source.</td>
</tr>
<tr>
<td>Router(config)# <strong>network-clock synchronization automatic</strong></td>
<td><strong>Note</strong> This command must be configured before any input source.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Step 14</strong></th>
<th><strong>network-clock synchronization mode ql-enabled</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Enables automatic selection of a clock source based on quality level (QL).</td>
</tr>
<tr>
<td>Router(config)# <strong>network-clock synchronization mode ql-enabled</strong></td>
<td><strong>Note</strong> This command is disabled by default.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Step 15</strong></th>
<th>Use one of the following options:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td><strong>(Optional)</strong> To nominate SDH or SONET controller as network clock input source.</td>
</tr>
<tr>
<td>Router(config)# <strong>network-clock input-source</strong> priority controller {SONET</td>
<td>wanphy}</td>
</tr>
<tr>
<td><strong>network-clock input-source</strong> priority external `{R0</td>
<td>R1} [10m</td>
</tr>
<tr>
<td><strong>network-clock input-source</strong> priority external `{R0</td>
<td>R1} [2048k</td>
</tr>
<tr>
<td><strong>network-clock input-source</strong> priority external `{R0</td>
<td>R1} [2048k</td>
</tr>
<tr>
<td><strong>network-clock input-source</strong> priority interface type/slot/port</td>
<td><strong>(Optional)</strong> To nominate BITS port as network clock input source in t1 mode.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 16</strong> clock destination source-address</td>
<td>Specifies the IP address or MAC address of a clock destination when the chassis is in PTP master mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 16</strong> sync interval interval</td>
<td>Specifies the interval used to send PTP synchronization messages. The intervals are set using log base 2 values, as follows:</td>
</tr>
</tbody>
</table>
| Example:          | | • 1—1 packet every 2 seconds
|                   | • 0—1 packet every second
|                   | • -1—1 packet every 1/2 second, or 2 packets per second
|                   | • -2—1 packet every 1/4 second, or 4 packets per second
|                   | • -3—1 packet every 1/8 second, or 8 packets per second
|                   | • -4—1 packet every 1/16 seconds, or 16 packets per second.
|                   | • -5—1 packet every 1/32 seconds, or 32 packets per second.
|                   | • -6—1 packet every 1/64 seconds, or 64 packets per second.
|                   | • -7—1 packet every 1/128 seconds, or 128 packets per second. |
| **Step 18** announce interval interval | Specifies the interval for PTP announce messages. The intervals are set using log base 2 values, as follows: |
| Example:          | | • 3—1 packet every 8 seconds
|                   | • 2—1 packet every 4 seconds
|                   | • 1—1 packet every 2 seconds
|                   | • 0—1 packet every second
|                   | • -1—1 packet every 1/2 second, or 2 packets per second |
### Configuring a Slave Ordinary Clock

Follow these steps to configure the chassis to act as a slave ordinary clock.

**SUMMARY STEPS**

1. **enable**
2. **configure terminal**
3. `ptp clock {ordinary | boundary | e2e-transparent} domain domain-number [hybrid]`
4. `output [1pps] {R0 | R1} [offset offset-value] [pulse-width value]`
5. `tod {R0 | R1} {ubx | nmea | cisco | ntp}`
6. `clock-port port-name {master | slave} [profile {g8265.1}]

---

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>end</code></td>
<td>Exit configuration mode.</td>
</tr>
<tr>
<td>`linecode {ami</td>
<td>b8zs</td>
</tr>
</tbody>
</table>

- **ami**—Specifies Alternate Mark Inversion (AMI) as the linecode type. Valid for T1 and E1 controllers.
- **b8zs**—Specifies binary 8-zero substitution (B8ZS) as the linecode type. Valid for sonet controller only. This is the default for T1 lines.
- **hdb3**—Specifies high-density binary 3 (hdb3) as the linecode type. Valid for E1 controller only. This is the default for E1 lines.

---

Example

The following example shows that the utc-offset is configured before configuring the ToD to avoid a delay of 37 seconds between the master and slave clocks:

```
ptp clock ordinary domain 24
local-priority 1
priority2 128
utc-offset 37
tod R0 cisco
clock-port master-port-1 master profile g8275.1 local-priority 1
transport ethernet multicast interface Gig 0/0/1
```
7. Do one of the following:
   - transport ipv4 unicast interface interface-type interface-number [negotiation]
   - transport ethernet unicast [negotiation]

8. clock source source-address | mac-address {bridge-domain bridge-domain-id} | interface interface-name [priority] [delay-asymmetry delay asymmetry value nanoseconds]

9. announce timeout value

10. delay-req interval interval

11. end

12. Router(config-controller)# linecode {ami | b8zs | hdb3}

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
</tr>
</tbody>
</table>

**Step 2**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>configure terminal</td>
<td>Enter configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
</tbody>
</table>

**Step 3**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>`ptp clock {ordinary</td>
<td>boundary</td>
</tr>
<tr>
<td>Example:</td>
<td>• ordinary—A 1588 clock with a single PTP port that can operate in Master or Slave mode.</td>
</tr>
<tr>
<td><code>Router(config)# ptp clock ordinary domain 0</code></td>
<td>• boundary—Terminates PTP session from Grandmaster and acts as PTP master to slaves downstream.</td>
</tr>
<tr>
<td></td>
<td>• e2e-transparent—Updates the PTP time correction field to account for the delay in forwarding the traffic. This helps improve the accuracy of 1588 clock at slave.</td>
</tr>
</tbody>
</table>

**Step 4**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>`output {1pps</td>
<td>{R0</td>
</tr>
<tr>
<td>Example:</td>
<td>Use R0 or R1 to specify the active RSP slot.</td>
</tr>
<tr>
<td><code>Router(config-tp-clk)# output lpps R0 offset 200 pulse-width 20 μsec</code></td>
<td>Note Effective Cisco IOS XE Everest 16.6.1, on the Cisco ASR 900 RSP2 module, the 1pps pulse bandwidth can be changed from the default value of 500 milliseconds to up to 20 microseconds.</td>
</tr>
</tbody>
</table>
### Purpose

**Command or Action**

| Step 5 | tod \{R0 | R1\} \{ubx | nmea | cisco | ntp\} |
|--------|------------------------------------------------|
| **Example:** | Router(config-tp-clk)# tod R0 ntp |
| **Purpose:** | Configures the time of day message format used by the Tod interface. |
| **Note:** | The Tod port acts as an input port in case of Master clock and as an output port in case of Slave clock. |

| Step 6 | clock-port port-name \{master | slave\} \[profile \{g8265.1\}\] |
|--------|--------------------------------------------------|
| **Example:** | Router(config-tp-clk)# clock-port Slave slave |
| **Purpose:** | Sets the clock port to PTP master or slave mode; in slave mode, the port exchanges timing packets with a PTP master clock. |
| **Note:** | Using a telecom profile requires that the clock have a domain number of 4–23. |

<table>
<thead>
<tr>
<th>Step 7</th>
<th>Do one of the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>• transport ipv4 unicast interface interface-type interface-number /negotiation/</strong></td>
<td></td>
</tr>
<tr>
<td><strong>• transport ethernet unicast [negotiation]</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config-tp-port)# transport ipv4 unicast interface loopback 0 negotiation</td>
</tr>
<tr>
<td><strong>Purpose:</strong></td>
<td>Specifies the transport mechanism for clocking traffic; you can use IPv4 or Ethernet transport.</td>
</tr>
<tr>
<td><strong>Note:</strong></td>
<td>The negotiation keyword configures the chassis to discover a PTP master clock from all available PTP clock sources.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 8</th>
<th>clock source source-address</th>
<th>mac-address</th>
<th>bridge-domain bridge-domain-id</th>
<th>interface interface-name</th>
<th>priority</th>
<th>[delay-asymmetry delay asymmetry value nanoseconds]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config-tp-port)# clock-source 8.8.8.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Purpose:</strong></td>
<td>Specifies the IP or MAC address of a PTP master clock.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Note:</strong></td>
<td>PTP redundancy is supported only on unicast negotiation mode.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 9</th>
<th>announce timeout value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config-tp-port)# announce timeout 8</td>
</tr>
<tr>
<td><strong>Purpose:</strong></td>
<td>Specifies the number of PTP announcement intervals before the session times out. Valid values are 1-10.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 10</th>
<th>delay-req interval interval</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config-tp-port)# delay-req interval 1</td>
</tr>
<tr>
<td><strong>Purpose:</strong></td>
<td>Configures the minimum interval allowed between PTP delay-request messages when the port is in the master state.</td>
</tr>
<tr>
<td><strong>Note:</strong></td>
<td>The intervals are set using log base 2 values, as follows:</td>
</tr>
<tr>
<td><strong>• 3—1 packet every 8 seconds</strong></td>
<td></td>
</tr>
<tr>
<td><strong>• 2—1 packet every 4 seconds</strong></td>
<td></td>
</tr>
<tr>
<td><strong>• 1—1 packet every 2 seconds</strong></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td>• 0—1 packet every second</td>
<td></td>
</tr>
<tr>
<td>• -1—1 packet every 1/2 second, or 2 packets per second</td>
<td></td>
</tr>
<tr>
<td>• -2—1 packet every 1/4 second, or 4 packets per second</td>
<td></td>
</tr>
<tr>
<td>• -3—1 packet every 1/8 second, or 8 packets per second</td>
<td></td>
</tr>
<tr>
<td>• -4—1 packet every 1/16 seconds, or 16 packets per second.</td>
<td></td>
</tr>
<tr>
<td>• -5—1 packet every 1/32 seconds, or 32 packets per second.</td>
<td></td>
</tr>
<tr>
<td>• -6—1 packet every 1/64 seconds, or 64 packets per second.</td>
<td></td>
</tr>
<tr>
<td>• -7—1 packet every 1/128 seconds, or 128 packets per second.</td>
<td></td>
</tr>
</tbody>
</table>

**Step 11**

**end**

**Exit configuration mode.**

Example:

```
Router(config-pter-port)# end
```

**Step 12**

`Router(config-controller)# linecode {ami | b8zs | hdb3}`

**Selects the linecode type.**

- **ami**—Specifies Alternate Mark Inversion (AMI) as the linecode type. Valid for T1 and E1 controllers.  
- **b8zs**—Specifies binary 8-zero substitution (B8ZS) as the linecode type. Valid for sonet controller only. This is the default for T1 lines.  
- **hdb3**—Specifies high-density binary 3 (hdb3) as the linecode type. Valid for E1 controller only. This is the default for E1 lines.

---

**Configuring a Boundary Clock**

Follow these steps to configure the chassis to act as a boundary clock.

**SUMMARY STEPS**

1. enable  
2. configure terminal  
3. `Router(config)# ptp clock {ordinary | boundary | e2e-transparent} domain domain-number [hybrid]`  
4. `time-properties persist value`
### Configuring a Boundary Clock

5. `clock-port port-name {master | slave} [profile {g8265.1}]`
6. `transport ipv4 unicast interface interface-type interface-number [negotiation]`
7. `clock-source source-address [priority]`
8. `clock-port port-name {master | slave} [profile {g8265.1}]`
9. `transport ipv4 unicast interface interface-type interface-number [negotiation]`
10. `end`
11. `Router(config-controller)# linecode {ami | b8zs | hdb3}`

### Detailed Steps

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Router&gt; enable</td>
<td>- Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enter configuration mode.</td>
</tr>
<tr>
<td>Example: Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> `Router(config)# ptp clock {ordinary</td>
<td>boundary</td>
</tr>
<tr>
<td>Example: <code>Router(config)# ptp clock boundary domain 0</code></td>
<td>- ordinary—A 1588 clock with a single PTP port that can operate in Master or Slave mode.</td>
</tr>
<tr>
<td></td>
<td>- boundary—Terminates PTP session from Grandmaster and acts as PTP master to slaves downstream.</td>
</tr>
<tr>
<td></td>
<td>- e2e-transparent—Updates the PTP time correction field to account for the delay in forwarding the traffic. This helps improve the accuracy of 1588 clock at slave.</td>
</tr>
<tr>
<td><strong>Step 4</strong> <code>time-properties persist value</code></td>
<td>(Optional) Starting with Cisco IOS-XE Release 3.18.1SP, you can configure time properties holdover time. Valid values are from 0 to 10000 seconds. The default value is 300 seconds.</td>
</tr>
<tr>
<td>Example: <code>Router(config-ptp-clk)# time-properties persist 600</code></td>
<td>When a master clock is lost, the time properties holdover timer starts. During this period, the time properties flags (currentUtcOffset, currentUtcOffsetValid, leap61, leap59) persist for the holdover timeout period. Once the holdover timer expires, currentUtcOffsetValid, leap59, and leap61 flags are set to false and the currentUtcOffset remains unchanged. In case leap second midnight occurs when holdover timer is running, utc-offset value is updated based on leap59 or leap61 flags. This value is used as long as there are no PTP packets being received from the selected master. In case the selected master is sending announce packets, the time-properties advertised by master is used.</td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>------</td>
<td>------------------</td>
</tr>
<tr>
<td>5</td>
<td>`clock-port port-name {master</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>Router(config-ptp-clk)# clock-port SLAVE slave</td>
</tr>
<tr>
<td>6</td>
<td><code>transport ipv4 unicast interface interface-type interface-number [negotiation/</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-ptp-port)# transport ipv4 unicast interface Loopback 0 negotiation</td>
</tr>
<tr>
<td>7</td>
<td><code>clock-source source-address [priority]</code></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>Router(config-ptp-port)# clock source 133.133.133.133</td>
</tr>
<tr>
<td>8</td>
<td>`clock-port port-name {master</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>Router(config-ptp-port)# clock-port Master master</td>
</tr>
<tr>
<td>9</td>
<td><code>transport ipv4 unicast interface interface-type interface-number [negotiation/</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-ptp-port)# transport ipv4 unicast interface Loopback 1 negotiation</td>
</tr>
<tr>
<td>10</td>
<td><code>end</code></td>
</tr>
</tbody>
</table>
### Configuring a Transparent Clock

Follow these steps to configure the chassis as an end-to-end transparent clock.

**Note**
The Cisco ASR 900 Series Chassis does not support peer-to-peer transparent clock mode.

**Note**
The transparent clock ignores the domain number.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `ptp clock {ordinary | boundary | e2e-transparent} domain domain-number [hybrid]`
4. `exit`
5. `Router(config-controller)# linecode {ami | b8zs | hdb3}`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><code>Example:</code> Router&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enter configuration mode.</td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><code>Example:</code></td>
<td></td>
</tr>
</tbody>
</table>
### Configuring a Hybrid Clock

The following sections describe how to configure the chassis to act as a hybrid clock.

#### Configuring a Hybrid Boundary Clock

Follow these steps to configure a hybrid clocking in boundary clock mode.

![Note]

When configuring a hybrid clock, ensure that the frequency and phase sources are traceable to the same master clock.

**SUMMARY STEPS**

1. **enable**
2. **configure terminal**
3. **ptp clock {boundary} domain domain-number [hybrid]**
4. **time-properties persist value**
5. **utc-offset value leap-second "date time" offset {-1 | 1}**
6. **min-clock-class value**
7. **clock-port port-name {master | slave} [profile {g8265.1}]**
8. **transport ipv4 unicast interface interface-type interface-number [negotiationsingle-hop]**

---

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router# configure terminal</td>
<td>Configure chassis as an end-to-end transparent clock.</td>
</tr>
<tr>
<td><strong>Step 3</strong> ptp clock {ordinary</td>
<td>boundary</td>
</tr>
<tr>
<td><strong>Example:</strong> Router(config)# ptp clock e2e-transparent domain 4</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> exit</td>
<td>Exit configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Router(config)# exit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> Router(config-controller)# linecode {ami</td>
<td>b8zs</td>
</tr>
<tr>
<td>• ami—Specifies Alternate Mark Inversion (AMI) as the linecode type. Valid for T1 and E1 controllers.</td>
<td></td>
</tr>
<tr>
<td>• b8zs—Specifies binary 8-zero substitution (B8ZS) as the linecode type. Valid for sonet controller only. This is the default for T1 lines.</td>
<td></td>
</tr>
<tr>
<td>• hdb3—Specifies high-density binary 3 (hdb3) as the linecode type. Valid for E1 controller only. This is the default for E1 lines.</td>
<td></td>
</tr>
</tbody>
</table>
9. `clock-source source-address [priority]`

10. `clock-port port-name {master | slave} [profile {g8265.1}]`

11. `transport ipv4 unicast interface interface-type interface-number [negotiation] [single-hop]`

12. `exit`

13. `network-clock synchronization automatic`

14. `network-clock synchronization mode ql-enabled`

15. Use one of the following options:

   • `network-clock input-source priority controller {SONET | wanphy}`
   • `network-clock input-source priority external {R0 | R1} [10m | 2m]`
   • `network-clock input-source priority external {R0 | R1} [2048k | e1 {cas {120ohms | 75ohms | crc4}}]`
   • `network-clock input-source priority external {R0 | R1} [2048k | e1 {crc4 | fas} {120ohms | 75ohms} {linecode {ami | hdb3}}]`
   • `network-clock input-source priority external {R0 | R1} [t1 {d4 | esf | sf} {linecode {ami | b8zs}}]`
   • `network-clock input-source priority interface type/slot/port`

16. `network-clock synchronization input-threshold ql value`

17. `network-clock hold-off {0 | milliseconds}`

18. `platformptpmasteralways-on`

19. `platformptphybrid-bcdownstream-enable`

20. `end`

21. `Router(config)# linecode {ami | b8zs | hdb3}`

---

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
</tr>
</tbody>
</table>

**Step 2** `configure terminal`

Example:

Router# configure terminal

**Step 3** `ptp clock {boundary} domain domain-number [hybrid]`

Example:

Router(config)# ptp clock boundary domain 0 hybrid

**Configuring a Hybrid Boundary Clock**

**Purpose**

Enables privileged EXEC mode.

Configure the PTP clock. You can create the following clock types:

- **Note** Hybrid mode is only supported with slave clock-ports; master mode is not supported.

- boundary—Terminates PTP session from Grandmaster and acts as PTP master to slaves downstream.
<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td><strong>time-properties persist</strong> 600</td>
<td>(Optional) Starting with Cisco IOS-XE Release 3.18.1SP, you can configure time properties holdover time. Valid values are from 0 to 10000 seconds. The default value is 300 seconds. When a master clock is lost, the time properties holdover timer starts. During this period, the time properties flags (currentUtcOffset, currentUtcOffsetValid, leap61, leap59) persist for the holdover timeout period. Once the holdover timer expires, currentUtcOffsetValid, leap59, and leap61 flags are set to false and the currentUtcOffset remains unchanged. In case leap second midnight occurs when holdover timer is running, utc-offset value is updated based on leap59 or leap61 flags. This value is used as long as there are no PTP packets being received from the selected master. In case the selected master is sending announce packets, the time-properties advertised by master is used.</td>
</tr>
</tbody>
</table>
| 5    | **utc-offset 45 leap-second "01-01-2017 00:00:00" offset 1** | (Optional) Starting with Cisco IOS-XE Release 3.18SP, the new utc-offset CLI is used to set the UTC offset value. Valid values are from 0-255. The default value is 36. (Optional) Starting with Cisco IOS-XE Release 3.18.1SP, you can configure the current UTC offset, leap second event date and Offset value (+1 or -1). Leap second configuration will work only when the frequency source is locked and ToD was up before. 
- "date time"—Leap second effective date in dd-mm-yyyy hh:mm:ss format. |
| 6    | **min-clock-class 157** | Sets the threshold clock-class value. This allows the PTP algorithm to use the time stamps from a upstream master clock, only if the clock-class sent by the master clock is less than or equal to the configured threshold clock-class. Valid values are from 0-255. 
**Note** Min-clock-class value is supported only for PTP with single master source configuration. |
| 7    | **clock-port SLAVE** | Sets the clock port to PTP master or slave mode; in slave mode, the port exchanges timing packets with a PTP master clock. 
**Note** Hybrid mode is only supported with slave clock-ports; master mode is not supported. The profile keyword configures the clock to use the G.8265.1 recommendations for establishing PTP sessions, determining the best master clock, handling SSM, and mapping PTP classes. |
<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td></td>
<td>Using a telecom profile requires that the clock have a domain number of 4–23.</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td></td>
<td>Specifies the transport mechanism for clocking traffic.</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td></td>
<td>PTP redundancy is supported only on unicast negotiation mode.</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td></td>
<td>PTPring topology is used. It ensures that the PTP node communicates only with the adjacent nodes.</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>transport ipv4 unicast interface interface-type interface-number /negotiation single-hop</td>
<td>Specifies the transport mechanism for clocking traffic. negotiation—(Optional) configures the chassis to discover a PTP master clock from all available PTP clock sources. single-hop—(Optional) Must be configured, if Hop-by-Hop PTPring topology is used. It ensures that the PTP node communicates only with the adjacent nodes.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-ptp-port)# transport ipv4 unicast interface Loopback 0 negotiation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>or Router(config-ptp-port)# transport ipv4 unicast interface Loopback 0 negotiation single-hop</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>clock-source source-address [priority]</td>
<td>Specifies the address of a PTP master clock. You can specify a priority value as follows:</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td>• No priority value—Assigns a priority value of 0.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 1—Assigns a priority value of 1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 2—Assigns a priority value of 2, the highest priority.</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>clock-port port-name {master</td>
<td>slave} [profile {g8265.1}]</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-ptp-port)# clock-port MASTER master</td>
<td></td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td>transport ipv4 unicast interface interface-type interface-number /negotiation /single-hop</td>
<td>Specifies the transport mechanism for clocking traffic. negotiation—(Optional) configures the chassis to discover a PTP master clock from all available PTP clock sources. single-hop—(Optional) Must be configured, if Hop-by-Hop PTPring topology is used. It ensures that the PTP node communicates only with the adjacent nodes.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-ptp-port)# transport ipv4 unicast interface Lo1 negotiation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>or Router(config-ptp-port)# transport ipv4 unicast interface Lo1 negotiation single-hop</td>
<td></td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td>exit</td>
<td>Exit clock-port configuration.</td>
</tr>
<tr>
<td><strong>Step 13</strong></td>
<td>network-clock synchronization automatic</td>
<td>Enables automatic selection of a clock source. Note This command must be configured before any input source.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config)# network-clock synchronization automatic</td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>14</td>
<td><strong>network-clock synchronization mode ql-enabled</strong></td>
<td>Enables automatic selection of a clock source based on quality level (QL).</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Router(config)# network-clock synchronization mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ql-enabled</td>
</tr>
<tr>
<td>15</td>
<td>Use one of the following options:</td>
<td>• (Optional) To nominate SDH or SONET controller as network clock input source.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• (Optional) To nominate 10Mhz port as network clock input source.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• (Optional) To nominate BITS port as network clock input source in e1 mode.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• (Optional) To nominate BITS port as network clock input source in t1 mode.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• (Optional) To nominate Ethernet interface as network clock input source.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Router(config)# network-clock input-source priority controller {SONET</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• network-clock input-source <em>priority</em> external {R0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• network-clock input-source <em>priority</em> external {R0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• network-clock input-source <em>priority</em> external {R0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• network-clock input-source <em>priority</em> external {R0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• network-clock input-source <em>priority</em> interface type/slot/port</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Router(config)# network-clock input-source priority controller {SONET</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• network-clock input-source priority external {R0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• network-clock input-source priority external {R0</td>
</tr>
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<td></td>
<td></td>
<td>• network-clock input-source priority external {R0</td>
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<td></td>
<td></td>
<td>• network-clock input-source priority external {R0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• network-clock input-source priority interface type/slot/port</td>
</tr>
<tr>
<td>16</td>
<td><strong>network-clock synchronization input-threshold ql value</strong></td>
<td>(Optional) Starting with Cisco IOS-XE Release 3.18SP, this new CLI is used to set the</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>threshold QL value for the input frequency source. The input frequency source, which is</td>
</tr>
<tr>
<td></td>
<td></td>
<td>better than or equal to the configured threshold QL value, will be selected to recover the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>frequency. Otherwise, internal clock is selected.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Router(config)# network-clock synchronization input-threshold &lt;ql value&gt;</td>
</tr>
<tr>
<td>17</td>
<td><strong>network-clock hold-off</strong> {0</td>
<td>milliseconds}</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>chassis waits when a synchronous Ethernet clock source fails before taking action.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Note: You can also specify a hold-off value for an individual interface using the</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>network-clock hold-off</strong> command in interface mode.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For more information about this command, see Configuring Clocking and Timing, on page 1</td>
</tr>
<tr>
<td>18</td>
<td><strong>platform ptp master always-on</strong></td>
<td>(Optional) Keeps the master port up all the time. So, when the frequency source has</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>acceptable QL, the egress packets are sent to the downstream slaves even when the master</td>
</tr>
<tr>
<td></td>
<td></td>
<td>port is not phase aligned.</td>
</tr>
</tbody>
</table>
Configuring a Hybrid Ordinary Clock

Follow these steps to configure a hybrid clocking in ordinary clock slave mode.

### Note
When configuring a hybrid clock, ensure that the frequency and phase sources are traceable to the same master clock.

#### SUMMARY STEPS

1. enable
2. configure terminal
3. ptp clock {ordinary | boundary | e2e-transparent} domain domain-number [hybrid]
4. output [1pps] {R0 | R1} [offset offset-value] [pulse-width value]
5. tod \{R0 | R1\} \{ubx | nmea | cisco | ntp\}
6. clock-port port-name \{master | slave\} [profile \{g8265.1\}]
7. transport ipv4 unicast interface interface-type interface-number [negotiation]
8. clock-source source-address [priority]
9. exit
10. network-clock synchronization automatic
11. network-clock synchronization mode ql-enabled
12. Use one of the following options:
Configuring Clocking and Timing

### Configuring a Hybrid Ordinary Clock

- `network-clock input-source <priority> controller {SONET | wanphy}`
- `network-clock input-source <priority> external {R0 | R1} [10m | 2m]
- `network-clock input-source <priority> external {R0 | R1} [2048k | e1 {cas {120ohms | 75ohms | crc4}}]
- `network-clock input-source <priority> external {R0 | R1} [2048k | e1 {crc4 | fas} {120ohms | 75ohms} {linecode {ami | hdb3}}]
- `network-clock input-source <priority> external {R0 | R1} [t1 {d4 | esf | sf} {linecode {ami | b8zs}}]
- `network-clock input-source <priority> interface <type/slot/port>`

#### 13. `network-clock hold-off {0 | milliseconds}`

#### 14. `end`

#### 15. Router(config-controller)# linecode {ami | b8zs | hdb3}

### Detailed Steps

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: <code>Router&gt; enable</code></td>
<td>Enter your password if prompted.</td>
</tr>
</tbody>
</table>

| **Step 2** | Enter configuration mode. |
| `configure terminal` | Enter configuration mode. |
| Example: `Router# configure terminal` | Enter configuration mode. |

| **Step 3** | Configures the PTP clock. You can create the following clock types: |
| `ptp clock` | Configures the PTP clock. You can create the following clock types: |
| `{ordinary | boundary | e2e-transparent}` | Configures the PTP clock. You can create the following clock types: |
| `domain domain-number [hybrid]` | Configures the PTP clock. You can create the following clock types: |
| **Example:** `Router(config)# ptp clock ordinary domain 0 hybrid` | Configures the PTP clock. You can create the following clock types: |

| **Step 4** | Enables Precision Time Protocol input 1PPS using a 1PPS input port. |
| `output [1pps] {R0 | R1} [offset offset-value] [pulse-width value]` | Enables Precision Time Protocol input 1PPS using a 1PPS input port. |
| **Example:** `Router(config-protocol)# output 1pps R0 offset 200 pulse-width 20 μsec` | Enables Precision Time Protocol input 1PPS using a 1PPS input port. |

#### Note

- Hybrid mode is only supported with slave clock-ports; master mode is not supported.
- Boundary—Terminates PTP session from Grandmaster and acts as PTP master to slaves downstream.
- e2e-transparent—Updates the PTP time correction field to account for the delay in forwarding the traffic. This helps improve the accuracy of 1588 clock at slave.

#### Effective Cisco IOS XE Everest 16.6.1, on the Cisco ASR 900 RSP2 module, the 1pps pulse bandwidth can be changed from the default value of 500 milliseconds to up to 20 microseconds.
<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>tod {R0</td>
<td>R1} {ubx</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-ptp-clk)# tod R0 ntp</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>clock-port <em>port-name</em> {master</td>
<td>slave} {profile {g8265.1}}</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-ptp-clk)# clock-port SLAVE slave</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>transport ipv4 unicast interface <em>interface-type</em> <em>interface-number</em> /negotiation/</td>
<td>Specifies the transport mechanism for clocking traffic. The <em>negotiation</em> keyword configures the router to discover a PTP master clock from all available PTP clock sources. <strong>Note</strong> PTP redundancy is supported only on unicast negotiation mode.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-ptp-port)# transport ipv4 unicast interface Loopback 0 negotiation</td>
<td></td>
</tr>
</tbody>
</table>
| 8    | clock-source *source-address* [priority] | Specifies the address of a PTP master clock. You can specify a priority value as follows:  
  • No priority value—Assigns a priority value of 0.  
  • 1—Assigns a priority value of 1.  
  • 2—Assigns a priority value of 2, the highest priority. |
|      | **Example:**     |         |
|      | Router(config-ptp-port)# clock source 133.133.133.133 |         |
| 9    | exit             | Exit clock-port configuration. |
|      | **Example:**     |         |
|      | Router(config-ptp-port)# exit |         |
| 10   | network-clock synchronization automatic | Enables automatic selection of a clock source. **Note** This command must be configured before any input source. |
### Command or Action

**Step 11**
**network-clock synchronization mode ql-enabled**

**Example:**

```
Router(config-ptp-clk)# network-clock synchronization mode ql-enabled
```

**Purpose**
Enables automatic selection of a clock source based on quality level (QL).

**Note**
This command is disabled by default.

For more information about this command, see Configuring Clocking and Timing, on page 1

---

**Step 12**
Use one of the following options:

- network-clock input-source <priority> controller {SONET | wanphy}
- network-clock input-source <priority> external {R0 | R1} [10m | 2m]
- network-clock input-source <priority> external {R0 | R1} [2048k | e1 {cas {120ohms | 75ohms | crc4}}]
- network-clock input-source <priority> external {R0 | R1} [2048k | e1 {crc4 | fas} {120ohms | 75ohms} {linecode {ami | hdb3}}]
- network-clock input-source <priority> interface <type/slot/port>

**Example:**

```
Router(config)# network-clock input-source 1 external R0 10m
```

---

**Step 13**
**network-clock hold-off {0 | milliseconds}**

**Example:**

```
Router(config-ptp-clk)# network-clock hold-off 0
```

**Purpose**
(Optional) Configures a global hold-off timer specifying the amount of time that the router waits when a synchronous Ethernet clock source fails before taking action.

**Note**
You can also specify a hold-off value for an individual interface using the `network-clock hold-off` command in interface mode.

For more information about this command, see Configuring Clocking and Timing, on page 1

---

**Step 14**
end

**Example:**

```
Router(config-ptp-clk)# end
```

**Purpose**
Exit configuration mode.

---

**Step 15**
Router(config-controller)# linecode {ami | b8zs | hdb3}

**Purpose**
Selects the linecode type.

- ami—Specifies Alternate Mark Inversion (AMI) as the linecode type. Valid for T1 and E1 controllers.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>• b8zs—Specifies binary 8-zero substitution (B8ZS) as the linecode type. Valid for sonet controller only. This is the default for T1 lines.</td>
<td></td>
</tr>
<tr>
<td>• hdb3—Specifies high-density binary 3 (hdb3) as the linecode type. Valid for E1 controller only. This is the default for E1 lines.</td>
<td></td>
</tr>
</tbody>
</table>

### Configuring PTP Redundancy

The following sections describe how to configure PTP redundancy on the chassis:

#### Configuring PTP Redundancy in Slave Clock Mode

Follow these steps to configure clocking redundancy in slave clock mode:

**SUMMARY STEPS**

1. enable
2. configure terminal
3. ptp clock {ordinary | boundary | e2e-transparent} domain domain-number [hybrid]
4. clock-port port-name {master | slave} [profile {g8265.1}]
5. transport ipv4 unicast interface interface-type interface-number [negotiation] [single-hop]
6. clock-source source-address [priority]
7. clock-source source-address [priority]
8. clock-source source-address [priority]
9. end
10. Router(config-controller)# linecode {ami | b8zs | hdb3}

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>configure terminal</td>
<td>Enter configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>ptp clock {ordinary</td>
<td>boundary</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td>• ordinary—A 1588 clock with a single PTP port that can operate in Master or Slave mode.</td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router(config#) ptp clock ordinary domain 0</td>
<td></td>
</tr>
<tr>
<td>• boundary—Terminates PTP session from Grandmaster and acts as PTP master to slaves downstream.</td>
<td></td>
</tr>
<tr>
<td>• e2e-transparent—Updates the PTP time correction field to account for the delay in forwarding the traffic. This helps improve the accuracy of 1588 clock at slave.</td>
<td></td>
</tr>
</tbody>
</table>

#### Step 4

**clock-port** port-name **{master | slave}** [profile g8265.1]

*Example:*

Router(config-ptp-clk)# clock-port SLAVE slave

Sets the clock port to PTP master or slave mode; in slave mode, the port exchanges timing packets with a PTP master clock.

The **profile** keyword configures the clock to use the G.8265.1 recommendations for establishing PTP sessions, determining the best master clock, handling SSM, and mapping PTP classes.

**Note** Using a telecom profile requires that the clock have a domain number of 4–23.

#### Step 5

**transport ipv4 unicast interface** interface-type interface-number [negotiation] [/single-hop]

*Example:*

Router(config-ptp-port)# transport ipv4 unicast interface Loopback 0 negotiation

Specifies the transport mechanism for clocking traffic.

• **negotiation**—(Optional) Configures the chassis to discover a PTP master clock from all available PTP clock sources.

**Note** PTP redundancy is supported only on unicast negotiation mode.

• **single-hop**—(Optional) **It ensures that the PTP node communicates only with the adjacent nodes.**

#### Step 6

**clock-source** source-address [priority]

*Example:*

Router(config-ptp-port)# clock source 133.133.133.133 1

Specifies the address of a PTP master clock. You can specify a priority value as follows:

• No priority value—Assigns a priority value of 0.
• 1—Assigns a priority value of 1.
• 2—Assigns a priority value of 2, the highest priority.

#### Step 7

**clock-source** source-address [priority]

*Example:*

Router(config-ptp-port)# clock source 133.133.133.134 2

Specifies the address of an additional PTP master clock; repeat this step for each additional master clock. You can configure up to 3 master clocks.

#### Step 8

**clock-source** source-address [priority]

*Example:*

Router(config-ptp-port)# clock source 133.133.133.135

Specifies the address of an additional PTP master clock; repeat this step for each additional master clock. You can configure up to 3 master clocks.

#### Step 9

**end**

*Example:*

Exit configuration mode.
### Purpose

#### Command or Action

```bash
Router(config-pty-port)# end
```

#### Purpose

Selects the line code type.

- **ami**—Specifies Alternate Mark Inversion (AMI) as the line code type. Valid for T1 and E1 controllers.
- **b8zs**—Specifies binary 8-zero substitution (B8ZS) as the line code type. Valid for sonet controller only. This is the default for T1 lines.
- **hdb3**—Specifies high-density binary 3 (hdb3) as the line code type. Valid for E1 controller only. This is the default for E1 lines.

### Configuring PTP Redundancy in Boundary Clock Mode

Follow these steps to configure clocking redundancy in boundary clock mode:

#### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `ptp clock {ordinary | boundary | e2e-transparent} domain domain-number`
4. `clock-port port-name {master | slave} [profile {g8265.1}]`
5. `transport ipv4 unicast interface interface-type interface-number [negotiation] [single-hop]`
6. `clock-source source-address [priority]`
7. `clock-source source-address [priority]`
8. `clock-source source-address [priority]`
9. `clock-port port-name {master | slave} [profile {g8265.1}]`
10. `transport ipv4 unicast interface interface-type interface-number [negotiation] [single-hop]`
11. `end`
12. `Router(config-controller)# linecode {ami | b8zs | hdb3}`

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> <code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Router&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> <code>configure terminal</code></td>
<td>Enter configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Router# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> `ptp clock {ordinary</td>
<td>boundary</td>
</tr>
</tbody>
</table>
### Command or Action

#### Example:

```plaintext
Router(config)# ptp clock boundary domain 0
```

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
</table>
| • ordinary—A 1588 clock with a single PTP port that can operate in Master or Slave mode.  
• boundary—Terminates PTP session from Grandmaster and acts as PTP master to slaves downstream.  
• e2e-transparent—Updates the PTP time correction field to account for the delay in forwarding the traffic. This helps improve the accuracy of 1588 clock at slave. |

#### Step 4

```plaintext
clock-port port-name {master | slave} [profile {g8265.1}]
```

<table>
<thead>
<tr>
<th>Example:</th>
</tr>
</thead>
</table>

```plaintext
Router(config-pte-clk)# clock-port SLAVE slave
```

Sets the clock port to PTP master or slave mode; in slave mode, the port exchanges timing packets with a PTP master clock.

The **profile** keyword configures the clock to use the G.8265.1 recommendations for establishing PTP sessions, determining the best master clock, handling SSM, and mapping PTP classes.

**Note**

Using a telecom profile requires that the clock have a domain number of 4–23.

#### Step 5

```plaintext
transport ipv4 unicast interface interface-type interface-number [negotiation] /single-hop]
```

| Example: |

```plaintext
Router(config-pte-port)# transport ipv4 unicast interface Loopback 0 negotiation
```

Specifies the transport mechanism for clocking traffic.

• **negotiation**—(Optional) Configures the chassis to discover a PTP master clock from all available PTP clock sources.

**Note**

PTP redundancy is supported only on unicast negotiation mode.

• **single-hop**—(Optional) Must be configured, if Hop-by-Hop PTP ring topology is used. It ensures that the PTP node communicates only with the adjacent nodes.

#### Step 6

```plaintext
clock-source source-address [priority]
```

| Example: |

```plaintext
Router(config-pte-port)# clock source 133.133.133.133 1
```

Specifies the address of a PTP master clock. You can specify a priority value as follows:

• No priority value—Assigns a priority value of 0.  
• 1—Assigns a priority value of 1.  
• 2—Assigns a priority value of 2, the highest priority.

#### Step 7

```plaintext
clock-source source-address [priority]
```

| Example: |

```plaintext
Router(config-pte-port)# clock source 133.133.133.134 2
```

Specifies the address of an additional PTP master clock; repeat this step for each additional master clock. You can configure up to 3 master clocks.

#### Step 8

```plaintext
clock-source source-address [priority]
```

| Example: |

```plaintext
Router(config-pte-port)# clock source 133.133.133.135
```

Specifies the address of an additional PTP master clock; repeat this step for each additional master clock. You can configure up to 3 master clocks.
### Command or Action

**Step 9**

`clock-port port-name {master | slave} [profile {g8265.1}]`

**Example:**

```bash
Router(config-ptp-port)# clock-port MASTER master
```

**Purpose**

Specifies the address of a PTP master clock.

The `profile` keyword configures the clock to use the G.8265.1 recommendations for establishing PTP sessions, determining the best master clock, handling SSM, and mapping PTP classes.

**Note**

Using a telecom profile requires that the clock have a domain number of 4–23.

**Step 10**

`transport ipv4 unicast interface interface-type [negotiation] [single-hop]`

**Example:**

```bash
Router(config-ptp-port)# transport ipv4 unicast interface Loopback 1 negotiation single-hop
```

**Purpose**

Specifies the transport mechanism for clocking traffic.

- **negotiation**—(Optional) Configures the chassis to discover a PTP master clock from all available PTP clock sources.

**Note**

PTP redundancy is supported only on unicast negotiation mode.

- **single-hop**—(Optional) Must be configured if Hop-by-Hop PTP ring topology is used. It ensures that the PTP node communicates only with the adjacent nodes.

**Step 11**

`end`

**Example:**

```bash
Router(config-ptp-port)# end
```

**Purpose**

Exit configuration mode.

**Step 12**

`Router(config-controller)# linecode {ami | b8zs | hdb3}`

**Selects the linecode type.**

- **ami**—Specifies Alternate Mark Inversion (AMI) as the linecode type. Valid for T1 and E1 controllers.

- **b8zs**—Specifies binary 8-zero substitution (B8ZS) as the linecode type. Valid for sonet controller only. This is the default for T1 lines.

- **hdb3**—Specifies high-density binary 3 (hdb3) as the linecode type. Valid for E1 controller only. This is the default for E1 lines.

---

### Synchronizing the System Time to a Time-of-Day Source

The following sections describe how to synchronize the system time to a time of day (ToD) clock source.

### Synchronizing the System Time to a Time-of-Day Source (Master Mode)

**Note**

System time to a ToD source (Master Mode) can be configured only when PTP master is configured. See Configuring a Master Ordinary Clock, on page 15. Select any one of the four available ToD format; cisco, nmea, ntp or ubx.10m must be configured as network clock input source.
Follow these steps to configure the system clock to a ToD source in master mode.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. tod-clock input-source priority {gps {R0 | R1} | ptp domain domain}
4. exit
5. Router(config-controller)# linecode {ami | b8zs | hdb3}

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Step 2</td>
<td>configure terminal</td>
<td>Enter configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>tod-clock input-source priority {gps {R0</td>
<td>R1}</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config)# TOD-clock 2 gps R0/R1</td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td>exit</td>
<td>Exit configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config)# exit</td>
<td></td>
</tr>
<tr>
<td>Step 5</td>
<td>Router(config-controller)# linecode {ami</td>
<td>b8zs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• ami—Specifies Alternate Mark Inversion (AMI) as the linecode type. Valid for T1 and E1 controllers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• b8zs—Specifies binary 8-zero substitution (B8ZS) as the linecode type. Valid for sonet controller only. This is the default for T1 lines.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• hdb3—Specifies high-density binary 3 (hdb3) as the linecode type. Valid for E1 controller only. This is the default for E1 lines.</td>
</tr>
</tbody>
</table>
Synchronizing the System Time to a Time-of-Day Source (Slave Mode)

Note
System time to a ToD source (Slave Mode) can be configured only when PTP slave is configured. See Configuring a Slave Ordinary Clock, on page 20.

Follow these steps to configure the system clock to a ToD source in slave mode. In slave mode, specify a PTP domain as a ToD input source.

SUMMARY STEPS

1. enable
2. configure terminal
3. tod-clock input-source priority {gps {R0 | R1} | ptp domain domain}
4. Router(config)# end
5. Router(config-controller)# linecode {ami | b8zs | hdb3}

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Router&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Step 2</td>
<td>configure terminal</td>
<td>Enter configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>tod-clock input-source priority {gps {R0</td>
<td>R1}</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config)# TOD-clock 10 ptp domain 0</td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td>Router(config)# end</td>
<td>Exit configuration mode.</td>
</tr>
<tr>
<td>Step 5</td>
<td>Router(config-controller)# linecode {ami</td>
<td>b8zs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• ami—Specifies Alternate Mark Inversion (AMI) as the linecode type. Valid for T1 and E1 controllers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• b8zs—Specifies binary 8-zero substitution (B8ZS) as the linecode type. Valid for sonet controller only. This is the default for T1 lines.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• hdb3—Specifies high-density binary 3 (hdb3) as the linecode type. Valid for E1 controller only. This is the default for E1 lines.</td>
</tr>
</tbody>
</table>
Configuring Synchronous Ethernet ESMC and SSM

Synchronous Ethernet is an extension of Ethernet designed to provide the reliability found in traditional SONET/SDH and T1/E1 networks to Ethernet packet networks by incorporating clock synchronization features. It supports the Synchronization Status Message (SSM) and Ethernet Synchronization Message Channel (ESMC) for synchronous Ethernet clock synchronization.

The following sections describe ESMC and SSM support on the router.

Configuring Synchronous Ethernet ESMC and SSM

Follow these steps to configure ESMC and SSM on the router.

SUMMARY STEPS

1. enable
2. configure terminal
3. network-clock synchronization automatic
4. network-clock eec {1 | 2}
5. network-clock synchronization ssm option {1 | 2 {GEN1 | GEN2}}
6. Use one of the following options:
   - network-clock input-source priority controller {SONET | wanphy}
   - network-clock input-source priority external {R0 | R1} [10m | 2m]
   - network-clock input-source priority external {R0 | R1} [2048k | e1] {cas {120ohms | 75ohms | crc4}}
   - network-clock input-source priority external {R0 | R1} [2048k | e1] {crc4 | fas} {120ohms | 75ohms} {linecode {ami | hdb3}}
   - network-clock input-source priority external {R0 | R1} [t1 | d4 | esf | sf] {linecode {ami | b8zs}}
   - network-clock input-source priority interface type/slot/port
7. network-clock synchronization mode ql-enabled
8. network-clock hold-off {0 | milliseconds}
9. network-clock wait-to-restore seconds
10. network-clock revertive
11. esmc process
12. network-clock external slot/card/port hold-off {0 | milliseconds}
13. network-clock quality-level {tx | rx} value {controller [E1 | BITS] slot/card/port | external [2m | 10m | 2048k | t1 | e1]}
14. interface type number
15. synchronous mode
16. network-clock source quality-level value {tx | rx}
17. esmc mode {ql-disabled | tx | rx} value
18. network-clock hold-off {0 | milliseconds}
19. network-clock wait-to-restore seconds
20. end
### Detailed Steps

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Step 1 | `enable` | Enables privileged EXEC mode.  
- Enter your password if prompted. |
| | **Example:**  
Router> enable | | |
| Step 2 | `configure terminal` | Enters global configuration mode. |
| | **Example:**  
Router# configure terminal | | |
| Step 3 | `network-clock synchronization automatic` | Enables the network clock selection algorithm. This command disables the Cisco-specific network clock process and turns on the G.781-based automatic clock selection process.  
**Note** This command must be configured before any input source. |
| | **Example:**  
Router(config)# network-clock synchronization automatic | | |
| Step 4 | `network-clock eec {1 | 2}` | Specifies the Ethernet Equipment Clock (EEC) type. Valid values are  
- 1—ITU-T G.8262 option 1 (2048)  
- 2—ITU-T G.8262 option 2 and Telcordia GR-1244 (1544) |
| | **Example:**  
Router(config)# network-clock eec 1 | | |
| Step 5 | `network-clock synchronization ssm option {1 | 2} {GEN1 | GEN2}` | Configures the G.781 synchronization option used to send synchronization messages. The following guidelines apply for this command:  
- Option 1 refers to G.781 synchronization option 1, which is designed for Europe. This is the default value.  
- Option 2 refers to G.781 synchronization option 2, which is designed for the United States.  
- GEN1 specifies option 2 Generation 1 synchronization.  
- GEN2 specifies option 2 Generation 2 synchronization. |
| | **Example:**  
Router(config)# network-clock synchronization ssm option 2 GEN2 | | |
| Step 6 | Use one of the following options:  
- `network-clock input-source priority controller {SONET | wanphy}`  
- `network-clock input-source priority external {R0 | R1} {10m | 2m}`  
- `network-clock input-source priority external {R0 | R1} {2048k | e1 {cas {120ohms | 75ohms | crc4}}}` | (Optional) To nominate SDH or SONET controller as network clock input source.  
(Optional) To nominate 10Mhz port as network clock input source.  
(Optional) To nominate BITS port as network clock input source in e1 mode.  
(Optional) To nominate BITS port as network clock input source in e1 mode. |
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>• network-clock input-source priority external {R0</td>
<td>R1} [2048k</td>
</tr>
<tr>
<td>• network-clock input-source priority external {R0</td>
<td>R1} [t1 {d4</td>
</tr>
<tr>
<td>• network-clock input-source priority interface type/slot/port</td>
<td>(Optional) To nominate PTP as network clock input source.</td>
</tr>
</tbody>
</table>

Example:

Router(config)# network-clock input-source 1 external R0 10m

Step 7

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>network-clock synchronization mode ql-enabled</td>
<td>Enables automatic selection of a clock source based on quality level (QL).</td>
</tr>
<tr>
<td>Example:</td>
<td>Note This command is disabled by default.</td>
</tr>
<tr>
<td>Router(config)# network-clock synchronization mode ql-enabled</td>
<td></td>
</tr>
</tbody>
</table>

Step 8

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>network-clock hold-off {0</td>
<td>milliseconds}</td>
</tr>
<tr>
<td>Example:</td>
<td>Note You can also specify a hold-off value for an individual interface using the network-clock hold-off command in interface mode.</td>
</tr>
<tr>
<td>Router(config)# network-clock hold-off 0</td>
<td></td>
</tr>
</tbody>
</table>

Step 9

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>network-clock wait-to-restore seconds</td>
<td>(Optional) Configures a global wait-to-restore timer for synchronous Ethernet clock sources. The timer specifies how long the router waits before including a restored clock source in the clock selection process.</td>
</tr>
<tr>
<td>Example:</td>
<td>Valid values are 0 to 86400 seconds. The default value is 300 seconds.</td>
</tr>
<tr>
<td>Router(config)# network-clock wait-to-restore 70</td>
<td>Note You can also specify a wait-to-restore value for an individual interface using the network-clock wait-to-restore command in interface mode.</td>
</tr>
</tbody>
</table>

Step 10

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>network-clock revertive</td>
<td>(Optional) Sets the router in revertive switching mode when recovering from a failure. To disable revertive mode, use the no form of this command.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config)# network-clock revertive</td>
<td></td>
</tr>
</tbody>
</table>

Step 11

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>esmc process</td>
<td>Enables the ESMC process globally.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config)# esmc process</td>
<td></td>
</tr>
</tbody>
</table>
## Command or Action

| Step 12 | `network-clock external slot/card/port hold-off \{0 | milliseconds\}` |
|---|---|
| **Example:** | `Router(config)# network-clock external 0/1/0 hold-off 0` |
| Purpose | Overrides the hold-off timer value for the external interface. |

| Step 13 | `network-clock quality-level \{tx | rx\} value \{controller [E1 | BITS] slot/card/port | external [2m | 10m | 2048k | t1 | e1] \}` |
|---|---|
| **Example:** | `Router(config)# network-clock quality-level tx QL-pRC external R0 e1 cas crc4` |
| Purpose | Specifies a quality level for a line or external clock source. The available quality values depend on the G.781 synchronization settings specified by the `network-clock synchronization ssm` option command: |
|  | - Option 1—Available values are QL-PRC, QL-SSU-A, QL-SSU-B, QL-SEC, and QL-DNU. |
|  | - Option 2, GEN1—Available values are QL-PRS, QL-STU, QL-ST2, QL-SMC, QL-ST4, and QL-DUS. |
|  | - Option 2, GEN2—Available values are QL-PRS, QL-STU, QL-ST2, QL-TNC, QL-ST3, QL-SMC, QL-ST4, and QL-DUS. |

<table>
<thead>
<tr>
<th>Step 14</th>
<th><code>interface type number</code></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td><code>Router(config)# interface GigabitEthernet 0/0/1</code></td>
</tr>
<tr>
<td>Purpose</td>
<td>Enters interface configuration mode.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 15</th>
<th><code>synchronous mode</code></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td><code>Router(config-if)# synchronous mode</code></td>
</tr>
<tr>
<td>Purpose</td>
<td>Configures the Ethernet interface to synchronous mode and automatically enables the ESMC and QL process on the interface.</td>
</tr>
</tbody>
</table>

| Step 16 | `network-clock source quality-level value \{tx | rx\}` |
|---|---|
| **Example:** | `Router(config-if)# network-clock source quality-level QL-PrC tx` |
| Purpose | Applies quality level on sync E interface. The available quality values depend on the G.781 synchronization settings specified by the `network-clock synchronization ssm` option command: |
|  | - Option 1—Available values are QL-PRC, QL-SSU-A, QL-SSU-B, QL-SEC, and QL-DNU. |
|  | - Option 2, GEN1—Available values are QL-PRS, QL-STU, QL-ST2, QL-SMC, QL-ST4, and QL-DUS. |
|  | - Option 2, GEN2—Available values are QL-PRS, QL-STU, QL-ST2, QL-TNC, QL-ST3, QL-SMC, QL-ST4, and QL-DUS. |

<p>| Step 17 | <code>esmc mode [ql-disabled | tx | rx] value</code> |
|---|---|
| <strong>Example:</strong> |  |
| Purpose | Enables the ESMC process at the interface level. The <code>no</code> form of the command disables the ESMC process. |</p>
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router(config-if)# esmc mode rx QL-STU</td>
<td></td>
</tr>
<tr>
<td><strong>Step 18</strong></td>
<td>network-clock hold-off `{0</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config-if)# network-clock hold-off 0</td>
</tr>
<tr>
<td><strong>Step 19</strong></td>
<td>network-clock wait-to-restore <code>seconds</code> (Optional) Configures the wait-to-restore timer for an individual synchronous Ethernet interface.</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config-if)# network-clock wait-to-restore 70</td>
</tr>
<tr>
<td><strong>Step 20</strong></td>
<td>end</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config-if)# end</td>
</tr>
<tr>
<td></td>
<td>Exits interface configuration mode and returns to privileged EXEC mode.</td>
</tr>
</tbody>
</table>

**What to do next**

You can use the `show network-clocks` command to verify your configuration.

**Managing Clock Source Selection**

The following sections describe how to manage the selection on the chassis:

**Specifying a Clock Source**

The following sections describe how to specify a synchronous Ethernet clock source during the clock selection process:

**Selecting a Specific Clock Source**

To select a specific interface as a synchronous Ethernet clock source, use the network-clock switch manual command in global configuration mode.

**Note**

The new clock source must be of higher quality than the current clock source; otherwise the chassis does not select the new clock source.
Forcing a Clock Source Selection

To force the chassis to use a specific synchronous Ethernet clock source, use the `network-clock switch force` command in global configuration mode.

**Note**

This command selects the new clock regardless of availability or quality.

**Note**

Forcing a clock source selection overrides a clock selection using the `network-clock switch manual` command.

---

Disabling Clock Source Specification Commands

To disable a `network-clock switch manual` or `network-clock switch force` configuration and revert to the default clock source selection process, use the `network-clock clear switch` command.

---

**Command**

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>`network-clock switch manual external R0</td>
<td>R1 {{E1 {crc4</td>
</tr>
<tr>
<td>Router# network-clock switch manual external r0 e1 crc4</td>
<td></td>
</tr>
<tr>
<td>`network-clock clear switch {t0</td>
<td>external slot/card/port [10m</td>
</tr>
<tr>
<td>Router# network-clock clear switch t0</td>
<td></td>
</tr>
</tbody>
</table>
Disabling a Clock Source

The following sections describe how to manage the synchronous Ethernet clock sources that are available for clock selection:

**Locking Out a Clock Source**

To prevent the chassis from selecting a specific synchronous Ethernet clock source, use the `network-clock set lockout` command in global configuration mode.

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>`network-clock set lockout {interface interface_name slot/card/port</td>
<td>external {R0</td>
</tr>
<tr>
<td>Router# network-clock set lockout interface GigabitEthernet 0/0/0</td>
<td></td>
</tr>
<tr>
<td>`network-clock clear lockout {interface interface_name slot/card/port</td>
<td>external {R0</td>
</tr>
<tr>
<td>Router# network-clock clear lockout interface GigabitEthernet 0/0/0</td>
<td></td>
</tr>
</tbody>
</table>

**Restoring a Clock Source**

To restore a clock in a lockout condition to the pool of available clock sources, use the `network-clock clear lockout` command in global configuration mode.

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>`network-clock clear lockout {interface interface_name slot/card/port</td>
<td>external external {R0</td>
</tr>
<tr>
<td>Router# network-clock clear lockout interface GigabitEthernet 0/0/0</td>
<td></td>
</tr>
</tbody>
</table>

**Verifying the Configuration**

You can use the following commands to verify a clocking configuration:

- `show esmc`—Displays the ESMC configuration.
- `show esmc detail`—Displays the details of the ESMC parameters at the global and interface levels.
- `show network-clock synchronization`—Displays the chassis clock synchronization state.
Troubleshooting

Table 7: SyncE Debug Commands, on page 50 list the debug commands that are available for troubleshooting the SyncE configuration on the chassis:

We recommend that you do not use debug commands without TAC supervision.

Table 7: SyncE Debug Commands

<table>
<thead>
<tr>
<th>Debug Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>debug platform network-clock</td>
<td>Debugs issues related to the network clock including active-standby selection, alarms, and OOR messages.</td>
</tr>
<tr>
<td>debug network-clock</td>
<td>Debugs issues related to network clock selection.</td>
</tr>
<tr>
<td>debug esmc error</td>
<td>These commands verify whether the ESMC packets are transmitted and received with proper quality-level values.</td>
</tr>
<tr>
<td>debug esmc event</td>
<td></td>
</tr>
<tr>
<td>debug esmc packet [interface interface-name]</td>
<td></td>
</tr>
<tr>
<td>debug esmc packet rx [interface interface-name]</td>
<td></td>
</tr>
<tr>
<td>debug esmc packet tx [interface interface-name]</td>
<td></td>
</tr>
</tbody>
</table>

Table 8: Troubleshooting Scenarios, on page 50 provides the information about troubleshooting your configuration

Table 8: Troubleshooting Scenarios

<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clock selection</td>
<td>• Verify that there are no alarms on the interfaces using the show network-clock synchronization detail command.</td>
</tr>
<tr>
<td></td>
<td>• Ensure that the nonrevertive configurations are in place.</td>
</tr>
<tr>
<td></td>
<td>• Reproduce the issue and collect the logs using the debug network-clock errors, debug network-clock event, and debug network-clock sm commands. Contact Cisco Technical Support if the issue persists.</td>
</tr>
<tr>
<td>Problem</td>
<td>Solution</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Incorrect QL values</strong></td>
<td>• Ensure that there is no framing mismatch with the SSM option.</td>
</tr>
<tr>
<td></td>
<td>• Reproduce the issue using the debug network-clock errors and debug</td>
</tr>
<tr>
<td></td>
<td>network-clock event commands.</td>
</tr>
<tr>
<td><strong>Alarms</strong></td>
<td>• Reproduce the issue using the debug platform network-clock command</td>
</tr>
<tr>
<td></td>
<td>enabled in the RSP. Alternatively, enable the debug network-clock event</td>
</tr>
<tr>
<td></td>
<td>and debug network-clock errors commands.</td>
</tr>
<tr>
<td>**Incorrect clock limit set or queue limit</td>
<td>• Verify that there are no alarms on the interfaces using the show</td>
</tr>
<tr>
<td>disabled mode**</td>
<td>network-clock synchronization detail command.</td>
</tr>
<tr>
<td></td>
<td>• Use the <code>show network-clock synchronization</code> command to confirm if</td>
</tr>
<tr>
<td></td>
<td>the system is in revertive mode or non-revertive mode and verify the</td>
</tr>
<tr>
<td></td>
<td>non-revertive configurations.</td>
</tr>
<tr>
<td></td>
<td>• Reproduce the current issue and collect the logs using the debug</td>
</tr>
<tr>
<td></td>
<td>network-clock errors, debug network-clock event, and debug network-</td>
</tr>
<tr>
<td></td>
<td>clock sm RSP commands.</td>
</tr>
<tr>
<td>**Incorrect QL values when you use the <code>show</code></td>
<td>• Use the `network clock synchronization SSM (option 1</td>
</tr>
<tr>
<td>network-clock synchronization detail command.</td>
<td>command to confirm that there is no framing mismatch. Use the `show</td>
</tr>
<tr>
<td></td>
<td>run interface` command to validate the framing for a specific interface.</td>
</tr>
<tr>
<td></td>
<td>For the SSM option 1, framing should be SDH or E1, and for SSM option 2,</td>
</tr>
<tr>
<td></td>
<td>it should be T1.</td>
</tr>
<tr>
<td></td>
<td>• Reproduce the issue using the debug network-clock errors and debug</td>
</tr>
<tr>
<td></td>
<td>network-clock event RSP commands.</td>
</tr>
</tbody>
</table>

**Note**

Effective from Cisco IOS XE Everest 16.6.1, on RSP3 module, alarm notification is enabled on 900 watts DC power supply. There are 2 input feeds for 900 watts DC power supply, if one of the input voltage is lesser than the operating voltage, critical alarm is generated for that particular feed and clears (stops) once the voltage is restored but the power supply state remains in OK state as the other power supply is operationally up.

## Configuration Examples

This section contains sample configurations for clocking features on the chassis.

**Note**

This section contains partial chassis configurations intended to demonstrate a specific feature.
**Ordinary Clock—Slave**

```
ptp clock ordinary domain 0
clock-port Slave slave
transport ipv4 unicast interface loopback 0 negotiation
clock-source 8.8.8.1
announce timeout 7
delay-req interval 100
```

**Ordinary Clock—Slave Mode (Ethernet)**

```
ptp clock ordinary domain 0
clock-port Slave slave
transport ethernet unicast
clock-source 1234.5678.90ab bridge-domain 2 5
```

**Ordinary Clock—Master**

```
ptp clock ordinary domain 0
clock-port Master master
transport ipv4 unicast interface loopback 0 negotiation
```

**Ordinary Clock—Master (Ethernet)**

```
ptp clock ordinary domain 0
clock-port Master master
transport ethernet unicast
clock destination interface GigabitEthernet0/0/1
```

**Unicast Configuration—Slave Mode**

```
ptp clock ordinary domain 0
clock-port Slave slave
transport ipv4 unicast interface loopback 0
clock-source 8.8.8.1
```

**Unicast Configuration—Slave Mode (Ethernet)**

```
ptp clock ordinary domain 0
clock-port Slave slave
transport ethernet unicast
  clock source 1234.5678.90ab bridge-domain 5 2
```

**Unicast Configuration—Master Mode**

```
ptp clock ordinary domain 0
clock-port Master master
transport ipv4 unicast interface loopback 0
clock-destination 8.8.8.2
sync interval 1
announce interval 2
```
Unicast Configuration—Master Mode (Ethernet)

```plaintext
clock-port Master master
transport ethernet unicast
    clock destination 1234.5678.90ab bridge-domain 5
```

Unicast Negotiation—Slave

```plaintext
clock-port Slave slave
transport ipv4 unicast interface loopback 0 negotiation
    clock-source 8.8.8.1
```

Unicast Negotiation—Slave (Ethernet)

```plaintext
clock-port Slave slave
    transport ethernet unicast negotiation
        clock-source 1234.5678.90ab bridge-domain 5 5
        clock-port Slave1 slave
        transport ethernet unicast negotiation
        clock-source 8.8.8.1 interface gigabitethernet 0/0/4 2
```

Unicast Negotiation—Master

```plaintext
clock-port Master master
    transport ipv4 unicast interface loopback 0 negotiation
    sync interval 1
    announce interval 2
```

Unicast Negotiation—Master (Ethernet)

```plaintext
clock-port Master master
    transport ethernet unicast negotiation
```

Boundary Clock

```plaintext
clock-port SLAVE slave
    transport ipv4 unicast interface Loopback 0 negotiation
        clock-source 133.133.133.133
        clock-port MASTER master
        transport ipv4 unicast interface Loopback 1 negotiation
```

Transparent Clock

```plaintext
ptp clock e2e-transparent domain 0
```

Hybrid Clock—Boundary

```plaintext
ptp clock boundary domain 0 hybrid
```
clock-port SLAVE slave
  transport ipv4 unicast interface Loopback0 negotiation
  clock source 133.133.133.133
clock-port MASTER master
  transport ipv4 unicast interface Loopback1 negotiation
Network-clock input-source 10 interface gigabitEthernet 0/4/0

Hybrid Clock—Slave

ptp clock ordinary domain 0 hybrid
  clock-port SLAVE slave
    transport ipv4 unicast interface Loopback0 negotiation
    clock source 133.133.133.133
Network-clock input-source 10 interface gigabitEthernet 0/4/0

PTP Redundancy—Slave

ptp clock ordinary domain 0
  clock-port SLAVE slave
    transport ipv4 unicast interface Loopback0 negotiation
    clock source 133.133.133.133 1
    clock source 55.55.55.55 2
    clock source 5.5.5.5

PTP Redundancy—Boundary

ptp clock boundary domain 0
  clock-port SLAVE slave
    transport ipv4 unicast interface Loopback0 negotiation
    clock source 133.133.133.133 1
    clock source 55.55.55.55 2
    clock source 5.5.5.5
  clock-port MASTER master
    transport ipv4 unicast interface Lo1 negotiation

Hop-By-Hop PTP Redundancy—Slave

ptp clock ordinary domain 0
  clock-port SLAVE slave
    transport ipv4 unicast interface Loopback0 negotiation single-hop
    clock source 133.133.133.133 1
    clock source 55.55.55.55 2
    clock source 5.5.5.5

Hop-By-Hop PTP Redundancy—Boundary

ptp clock boundary domain 0
  clock-port SLAVE slave
    transport ipv4 unicast interface Loopback0 negotiation single-hop
    clock source 133.133.133.133 1
    clock source 55.55.55.55 2
    clock source 5.5.5.5
clock-port MASTER master
transport ipv4 unicast interface Lo1 negotiation single-hop

Time of Day Source—Master

TOD-clock 10 gps R0/R1

Time of Day Source—Slave

TOD-clock 10 ptp domain 0

Clock Selection Parameters

network-clock synchronization automatic
network-clock synchronization mode QL-enabled
network-clock input-source 1 ptp domain 3

ToD/IPPS Configuration—Master

network-clock input-source 1 external R010m
ptp clock ordinary domain 1
tod R0 ntp
input 1pps R0
clock-port master master
transport ipv4 unicast interface loopback 0

ToD/IPPS Configuration—Slave

ptp clock ordinary domain 1
tod R0 ntp
output 1pps R0 offset 200 pulse-width 20 μsec
clock-port SLA slave
transport ipv4 unicast interface loopback 0 negotiation
clock source 33.1.1.

Show Commands

Router# show ptp clock dataset ?
current currentDS dataset
default defaultDS dataset
parent parentDS dataset
time-properties timePropertiesDS dataset
Router# show ptp port dataset ?
foreign-master foreignMasterDS dataset
port portDS dataset
Router# show ptp clock running domain 0

PTP Ordinary Clock [Domain 0]

<table>
<thead>
<tr>
<th>State</th>
<th>Ports</th>
<th>Pkts sent</th>
<th>Pkts rcvd</th>
<th>Redundancy Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACQUIRING</td>
<td>1</td>
<td>98405</td>
<td>296399</td>
<td>Track one</td>
</tr>
</tbody>
</table>

PORT SUMMARY

PTP Master
Name: SLAVE
Addr: 8.8.8.8

Tx Mode: unicast
Role: slave
Transport: Lo0
State: Slave
Sessions: 1

SESSION INFORMATION
<table>
<thead>
<tr>
<th>Peer addr</th>
<th>Pkts in</th>
<th>Pkts out</th>
<th>In Errs</th>
<th>Out Errs</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.8.8.8</td>
<td>296399</td>
<td>98405</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Router# show platform software ptpd stat stream 0
LOCK STATUS : PHASE LOCKED
SYNC Packet Stats
- Time elapsed since last packet: 0.0
- Configured Interval: 0, Acting Interval: 0
- Tx packets: 0, Rx Packets: 169681
- Last Seq Number: 0, Error Packets: 1272

Delay Req Packet Stats
- Time elapsed since last packet: 0.0
- Configured Interval: 0, Acting Interval: 0
- Tx packets: 84595, Rx Packets: 0
- Last Seq Number: 19059, Error Packets: 0

Router# show platform ptp all
Slave info : [Loopback0][0x38A4766C]

Current Data Set
- Offset from master: 0.4230440
- Mean Path Delay: 0.0
- Steps Removed: 1

General Stats about this stream
- Packet rate: 0, Packet Delta (ns): 0
- Clock Stream handle: 0, Index: 0
- Oper State: 6, Sub oper State: 7
- Log mean sync Interval: -5, log mean delay req int: -4

Router# show platform ptp all
Slave info : [Loopback0][0x38A4766C]

ToD/1PPS Info for 0/0

PTP Engine Handle: 0
Master IP: 8.8.8.8
Local Priority: 0
Set Master IP: 8.8.8.8

Router# show ptp clock running domain 0

<table>
<thead>
<tr>
<th>State</th>
<th>Ports</th>
<th>Pkts sent</th>
<th>Pkts rcvd</th>
<th>Redundancy Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHASE_ALIGNED</td>
<td>2</td>
<td>32355</td>
<td>159516</td>
<td>Hot standby</td>
</tr>
</tbody>
</table>

PTP Boundary Clock [Domain 0]

<table>
<thead>
<tr>
<th>Name</th>
<th>Tx Mode</th>
<th>Role</th>
<th>Transport State</th>
<th>Sessions Port Addr</th>
</tr>
</thead>
</table>
Input Synchronous Ethernet Clocking

The following example shows how to configure the chassis to use the BITS interface and two Gigabit Ethernet interfaces as input synchronous Ethernet timing sources. The configuration enables SSM on the BITS port.

```
! Interface GigabitEthernet0/0
   synchronous mode
   network-clock wait-to-restore 720
!
! Interface GigabitEthernet0/1
   synchronous mode
!
!
network-clock synchronization automatic
network-clock input-source 1 External R0 e1 crc4
network-clock input-source 1 gigabitethernet 0/0
network-clock input-source 2 gigabitethernet 0/1
network-clock synchronization mode QL-enabled
no network-clock revertive
```
Configuring Synchronous Ethernet ESMC and SSM

Synchronous Ethernet is an extension of Ethernet designed to provide the reliability found in traditional SONET/SDH and T1/E1 networks to Ethernet packet networks by incorporating clock synchronization features that support the Synchronization Status Message (SSM) and Ethernet Synchronization Message Channel (ESMC) for synchronous Ethernet clock synchronization.

The following sections describe ESMC and SSM support on the Cisco ASR 903 Series Router.

- Understanding Synchronous Ethernet ESMC and SSM, on page 59
- Restrictions and Usage Guidelines, on page 61
- Configuring Synchronous Ethernet ESMC and SSM, on page 61
- Managing Clock Source Selection, on page 65
- Verifying the Configuration, on page 67
- Troubleshooting, on page 67
- Configuration Examples, on page 69
- SSM Support on Cisco ASR 900 Series 4-Port OC3/STM1 or 1-Port OC12/STM4 Interface Module, on page 69
- SSM Support on Cisco 48-Port T3/E3 CEM Interface Module, on page 71

Understanding Synchronous Ethernet ESMC and SSM

Ethernet Synchronization Message Channel (ESMC) incorporates the Synchronization Status Message (SSM) used in Synchronous Optical Networking (SONET) and Synchronous Digital Hierarchy (SDH) networks. While SONET and SDH transmit the SSM in a fixed location within the frame, ESMC transmits the SSM using a protocol: the IEEE 802.3 Organization-Specific Slow Protocol (OSSP) standard.

The ESMC carries a Quality Level (QL) value identifying the clock quality of a given synchronous Ethernet timing source. Clock quality values help a synchronous Ethernet node derive timing from the most reliable source and prevent timing loops.

When configured to use synchronous Ethernet, the Cisco ASR 903 Series Router synchronizes to the best available clock source. If no better clock sources are available, the router remains synchronized to the current clock source.

The router supports two clock selection modes: QL-enabled and QL-disabled. Each mode uses different criteria to select the best available clock source.
Clock Selection Modes

The router can only operate in one clock selection mode at a time.

Conversely, PTP clock sources are not supported with synchronous Ethernet. However, you can use hybrid clocking to allow the router to obtain frequency using Synchronous Ethernet and phase using PTP.

Clock Selection Modes

The Cisco ASR 903 Series Router supports two clock selection modes, which are described in the following sections.

QL-Enabled Mode

In QL-enabled mode, the router considers the following parameters when selecting a clock source:

- Clock quality level (QL)
- Clock availability
- Priority

QL-Disabled Mode

In QL-disabled mode, the router considers the following parameters when selecting a clock source:

- Clock availability
- Priority

You can use override the default clock selection using the commands described in the Managing Clock Source Selection, on page 65.

8275.1 profile does not support QL-disabled mode on RSP3.

Managing Clock Selection

You can manage clock selection by changing the priority of the clock sources; you can also influence clock selection by modifying modify the following clock properties:

- Hold-Off Time: If a clock source goes down, the router waits for a specific hold-off time before removing the clock source from the clock selection process. By default, the value of hold-off time is 300 ms.
- Wait to Restore: The amount of time that the router waits before including a newly active synchronous Ethernet clock source in clock selection. The default value is 300 seconds.
- Force Switch: Forces a switch to a clock source regardless of clock availability or quality.
• Manual Switch: Manually selects a clock source, provided the clock source has an equal or higher quality level than the current source.

For more information about how to use these features, see Managing Clock Source Selection, on page 65.

Restrictions and Usage Guidelines

The following restrictions apply when configuring synchronous Ethernet SSM and ESMC:

• To use the `network-clock synchronization ssm option` command, ensure that the router configuration does not include the following:
  - Input clock source
  - Network clock quality level
  - Network clock source quality source (synchronous Ethernet interfaces)

• The `network-clock synchronization ssm option` command must be compatible with the `network-clock eec` command in the configuration.

• To use the `network-clock synchronization ssm option` command, ensure that there is not a network clocking configuration applied to synchronous Ethernet interfaces, BITS interfaces, and timing port interfaces.

• SSM and ESMC are SSO-coexistent, but not SSO-compliant. The router goes into hold-over mode during switchover and restarts clock selection when the switchover is complete.

• It is recommended that you do not configure multiple input sources with the same priority as this impacts the TSM (Switching message delay).

• You can configure a maximum of 4 clock sources on interface modules, with a maximum of 2 per interface module. This limitation applies to both synchronous Ethernet and TDM interfaces.

• Copper SFP is not supported for SyncE Rx and Tx on the uplink interfaces. SyncE Rx and Tx is supported on the uplink interfaces only for fiber SFP only.

Configuring Synchronous Ethernet ESMC and SSM

Follow these steps to configure ESMC and SSM on the Cisco ASR 903 Series Router.

SUMMARY STEPS

1. enable
2. configure terminal
3. network-clock synchronization automatic
4. network-clock eec {1 | 2}
5. network-clock synchronization ssm option {1 | 2 {GEN1 | GEN2}}
6. network-clock input-source priority {interface interface_name slot/card/port | ptp domain domain_num | [external] {R0 | R1 | { t1 { sf | esf } linecode {ami | b8zs} line-build-out length} | e1 {crc4 | fas} [125ohm | 75ohm] linecode [hdb3 | ami] } | 10m] } ]
7. network-clock synchronization mode ql-enabled
8. network-clock hold-off {0 | milliseconds} global
9. network-clock wait-to-restore seconds global
10. network-clock revertive
11. esmc process
12. network-clock external \{r0 | r1\} hold-off \{0 | milliseconds\}
13. network-clock quality-level \{tx | rx\} value \{interface interface-name slot/card/port | controller [E1 | BITS] slot/card/port | external [2m | 10m] \}
14. interface type number
15. synchronous mode
16. esmc mode [ql-disabled | tx | rx] value
17. network-clock hold-off \{0 | milliseconds\}
18. network-clock wait-to-restore seconds
19. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>enable</td>
</tr>
<tr>
<td>Example:</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>configure terminal</td>
</tr>
<tr>
<td>Example:</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>network-clock synchronization automatic</td>
</tr>
<tr>
<td>Example:</td>
<td>Enables the network clock selection algorithm. This command disables the Cisco-specific network clock process and turns on the G.781-based automatic clock selection process.</td>
</tr>
<tr>
<td>Router(config)# network-clock synchronization automatic</td>
<td></td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>This command must be configured before any input source.</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>network-clock eec {1</td>
</tr>
<tr>
<td>Example:</td>
<td>Specifies the Ethernet Equipment Clock (EEC) type. Valid values are</td>
</tr>
<tr>
<td>Router(config)# network-clock eec 1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>network-clock synchronization ssm option {1</td>
</tr>
<tr>
<td>Example:</td>
<td>Configures the G.781 synchronization option used to send synchronization messages. The following guidelines apply for this command:</td>
</tr>
<tr>
<td>Router(config)# network-clock synchronization ssm option 2 GEN2</td>
<td></td>
</tr>
<tr>
<td>• Option 1 refers to G.781 synchronization option 1, which is designed for Europe. This is the default value.</td>
<td></td>
</tr>
<tr>
<td>• Option 2 refers to G.781 synchronization option 2, which is designed for the United States.</td>
<td></td>
</tr>
<tr>
<td>• GEN1 specifies option 2 Generation 1 synchronization.</td>
<td></td>
</tr>
</tbody>
</table>
### Command or Action

- **network-clock input-source** *priority* {interface *interface_name* slot/card/port | ptp domain domain_num |
  | *external* {R0 | R1 | t1 {sf | esf} | linecode {ami | b8zs | linebuild-out *length*} | e1 {crc4 | fas} [125ohm | 75ohm] | linecode {hdb3 | ami} } | 10m } }

**Example:**

```
Router(config)# network-clock input-source 1
interface GigabitEthernet 0/0/1
```

- **network-clock synchronization mode** *ql-enabled*

**Example:**

```
Router(config)# network-clock synchronization mode ql-enabled
```

- **network-clock hold-off** *{0 | *milliseconds*}* global

**Example:**

```
Router(config)# network-clock hold-off 0 global
```

- **network-clock wait-to-restore** *seconds* global

**Example:**

```
Router(config)# network-clock wait-to-restore 70 global
```

- **network-clock revertive**

**Example:**

```
Router(config)# network-clock revertive
```

- **esmc process**

**Example:**

```
Router(config)# esmc process
```

### Purpose

- **GEN2 specifies option 2 Generation 2 synchronization.**

**Step 6** Enables you to select an interface as an input clock for the router. You can select the BITS, Gigabit Ethernet 0/0, Gigabit Ethernet 0/1 interfaces, or GPS interfaces, or an external interface.

**Note** Before configuring ethernet intreface as clock source, you should configure synchronous mode under interface configuration.

**Step 7** Enables automatic selection of a clock source based on quality level (QL).

**Note** This command is disabled by default.

**Step 8** (Optional) Configures a global hold-off timer specifying the amount of time that the router waits when a synchronous Ethernet clock source fails before taking action.

**Note** You can also specify a hold-off value for an individual interface using the `network-clock hold-off` command in interface mode.

**Step 9** (Optional) Configures a global wait-to-restore timer for synchronous Ethernet clock sources. The timer specifies how long the router waits before including a restored clock source in the clock selection process.

**Note** You can also specify a wait-to-restore value for an individual interface using the `network-clock wait-to-restore` command in interface mode.

**Step 10** (Optional) Sets the router in revertive switching mode when recovering from a failure. To disable revertive mode, use the `no` form of this command.

**Step 11** Enables the ESMC process globally.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 12</strong></td>
<td>network-clock external ([r0\mid r1) hold-off ([0\mid milliseconds]) )</td>
</tr>
<tr>
<td>Example:</td>
<td>Overrides the hold-off timer value for the external interface.</td>
</tr>
<tr>
<td>Router(config)# network-clock external r0 hold-off 0</td>
<td></td>
</tr>
</tbody>
</table>

| **Step 13** | network-clock quality-level \([tx\mid rx\) value \([interface interface-name slot/card/port \mid controller [E1| BITS] slot/card/port \mid external [2m | 10m] \) \)  |
| Example: | Specifies a quality level for a line or external clock source. The available quality values depend on the G.781 synchronization settings specified by the network-clock synchronization ssm option command: |
| Router(config)# network-clock quality-level rx ql-pRC external R0 e1 cas crc4 | • Option 1—Available values are QL-PRC, QL-SSU-A, QL-SSU-B, QL-SEC, and QL-DNU. |
| | • Option 2, GEN1—Available values are QL-PRS, QL-STU, QL-ST2, QL-SCM, QL-ST4, and QL-DUS. |
| | • Option 2, GEN2—Available values are QL-PRS, QL-STU, QL-ST2, QL-TNC, QL-ST3, QL-SCM, QL-ST4, and QL-DUS. |

| **Step 14** | interface type number  |
| Example: | Enters interface configuration mode. |
| Router(config)# interface GigabitEthernet 0/0/1 |  |

| **Step 15** | synchronous mode  |
| Example: | Configures the Ethernet interface to synchronous mode and automatically enables the ESMC and QL process on the interface. |
| Router(config-if)# synchronous mode |  |

| **Step 16** | esmc mode [ql-disabled \mid tx \mid rx\) value  |
| Example: | Enables the ESMC process at the interface level. The no form of the command disables the ESMC process. |
| Router(config-if)# esmc mode rx QL-STU |  |

| **Step 17** | network-clock hold-off \([0\mid milliseconds]\)  |
| Example: | (Optional) Configures an interface-specific hold-off timer specifying the amount of time that the router waits when a synchronous Ethernet clock source fails before taking action. You can configure the hold-off time to either 0 or any value between 50 to 10000 ms. The default value is 300 ms. |
| Router(config-if)# network-clock hold-off 0 |  |
Managing Clock Source Selection

The following sections describe how to manage the selection on the Cisco ASR 903 Series Router:

Specifying a Clock Source

The following sections describe how to specify a synchronous Ethernet clock source during the clock selection process:

Selecting a Specific Clock Source

To select a specific interface as a synchronous Ethernet clock source, use the network-clock switch manual command in global configuration mode.

Note

The new clock source must be of higher quality than the current clock source; otherwise the router does not select the new clock source.

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>network-clock switch manual external R0</td>
<td>R1 {E1</td>
</tr>
<tr>
<td>Router# network-clock switch manual external r0 e1 crc4 120ohms t0</td>
<td></td>
</tr>
<tr>
<td>network-clock clear switch {t0</td>
<td>external slot/card/port [10m</td>
</tr>
<tr>
<td>Router# network-clock clear switch t0</td>
<td></td>
</tr>
</tbody>
</table>
Forcing a Clock Source Selection

To force the router to use a specific synchronous Ethernet clock source, use the `network-clock switch force` command in global configuration mode.

**Note**

This command selects the new clock regardless of availability or quality.

**Note**

Forcing a clock source selection overrides a clock selection using the `network-clock switch manual` command.

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>`network-clock switch force external R0</td>
<td>R1 {</td>
</tr>
<tr>
<td>Router# network-clock switch force r0 e1 crc4 120ohms t0</td>
<td></td>
</tr>
<tr>
<td>`network-clock clear switch {t0</td>
<td>external slot/card/port [10m</td>
</tr>
<tr>
<td>Router# network-clock clear switch t0</td>
<td></td>
</tr>
</tbody>
</table>

Disabling Clock Source Specification Commands

To disable a `network-clock switch manual` or `network-clock switch force` configuration and revert to the default clock source selection process, use the `network-clock clear switch` command.

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>`network-clock clear switch {t0</td>
<td>external slot/card/port [10m</td>
</tr>
<tr>
<td>Router# network-clock clear switch t0</td>
<td></td>
</tr>
</tbody>
</table>

Disabling a Clock Source

The following sections describe how to manage the synchronous Ethernet clock sources that are available for clock selection:

Locking Out a Clock Source

To prevent the router from selecting a specific synchronous Ethernet clock source, use the `network-clock set lockout` command in global configuration mode.
Restoring a Clock Source

To restore a clock in a lockout condition to the pool of available clock sources, use the `network-clock clear lockout` command in global configuration mode.

Verifying the Configuration

You can use the following commands to verify your configuration:

- `show esmc`—Displays the ESMC configuration.
- `show esmc detail`—Displays the details of the ESMC parameters at the global and interface levels.
- `show network-clock synchronization`—Displays the router clock synchronization state.
- `show network-clock synchronization detail`—Displays the details of network clock synchronization parameters at the global and interface levels.

Troubleshooting

Table 9: SyncE Debug Commands, on page 68 list the debug commands that are available for troubleshooting the SyncE configuration on the Cisco ASR 903 Series Router:
We recommend that you do not use `debug` commands without TAC supervision.

<table>
<thead>
<tr>
<th>Debug Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>debug platform network-clock</code></td>
<td>Debugs issues related to the network clock including active-standby selection, alarms, and OOR messages.</td>
</tr>
<tr>
<td><code>debug network-clock</code></td>
<td>Debugs issues related to network clock selection.</td>
</tr>
<tr>
<td><code>debug esmc error</code></td>
<td>These commands verify whether the ESMC packets are transmitted and received with proper quality-level values.</td>
</tr>
<tr>
<td><code>debug esmc event</code></td>
<td>These commands verify whether the ESMC packets are transmitted and received with proper quality-level values.</td>
</tr>
<tr>
<td><code>debug esmc packet [interface interface-name]</code></td>
<td>These commands verify whether the ESMC packets are transmitted and received with proper quality-level values.</td>
</tr>
<tr>
<td><code>debug esmc packet rx [interface interface-name]</code></td>
<td>These commands verify whether the ESMC packets are transmitted and received with proper quality-level values.</td>
</tr>
<tr>
<td><code>debug esmc packet tx [interface interface-name]</code></td>
<td>These commands verify whether the ESMC packets are transmitted and received with proper quality-level values.</td>
</tr>
</tbody>
</table>

Table 10: Troubleshooting Scenarios, on page 68 provides the information about troubleshooting your configuration

<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clock selection</td>
<td>• Verify that there are no alarms on the interfaces using the show network-clock synchronization detail command.</td>
</tr>
<tr>
<td></td>
<td>• Ensure that the nonrevertive configurations are in place.</td>
</tr>
<tr>
<td></td>
<td>• Reproduce the issue and collect the logs using the debug network-clock errors, debug network-clock event, and debug network-clock sm commands. Contact Cisco Technical Support if the issue persists.</td>
</tr>
<tr>
<td>Incorrect QL values</td>
<td>• Ensure that there is no framing mismatch with the SSM option.</td>
</tr>
<tr>
<td></td>
<td>• Reproduce the issue using the debug network-clock errors and debug network-clock event commands.</td>
</tr>
<tr>
<td>Alarms</td>
<td>• Reproduce the issue using the debug platform network-clock command enabled in the RSP. Alternatively, enable the debug network-clock event and debug network-clock errors commands.</td>
</tr>
<tr>
<td>Incorrect clock limit set or queue limit disabled mode</td>
<td>• Verify that there are no alarms on the interfaces using the show network-clock synchronization detail command.</td>
</tr>
<tr>
<td></td>
<td>• Use the <code>show network-clock synchronization</code> command to confirm if the system is in revertive mode or nonrevertive mode and verify the non-revertive configurations.</td>
</tr>
<tr>
<td></td>
<td>• Reproduce the current issue and collect the logs using the debug network-clock errors, debug network-clock event, and debug network-clock sm RSP commands.</td>
</tr>
<tr>
<td>Problem</td>
<td>Solution</td>
</tr>
<tr>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>Incorrect QL values when you use the show network-clock synchronization detail command.</td>
<td>• Use the `network clock synchronization SSM (option 1</td>
</tr>
</tbody>
</table>

### Configuration Examples

#### Example: Input Synchronous Ethernet Clocking

The following example shows how to configure the router to use the BITS interface and two Gigabit Ethernet interfaces as input synchronous Ethernet timing sources. The configuration enables SSM on the BITS port.

```configuration
! Interface GigabitEthernet0/0
  synchronous mode
  network-clock wait-to-restore 720
! Interface GigabitEthernet0/1
  synchronous mode
! network-clock synchronization automatic
  network-clock input-source 1 External R0 e1 crc4
  network-clock input-source 1 gigabitethernet 0/0
  network-clock input-source 2 gigabitethernet 0/1
  network-clock synchronization mode QL-enabled
  no network-clock revertive

SSM is carried over OC-3 and OC-12 optical links. Effective Cisco IOS-XE release 3.18 SP, the SSM is transported in the S1 byte when it is carried over an optical line for SONET and SDH. The SSM messages enable SONET and SDH devices to select the highest quality timing reference automatically and avoid the timing loops.

SSM is supported on Cisco ASR 900 Series 4-Port OC3/STM1 or 1-Port OC12/STM4 Interface Module. It has four ports and the default rate is OC-3. OC-3 rate is supported on all the four ports and OC-12 rate is supported on first port only.
S1 Byte

The SSM is transported in the S1 byte when it is carried over an optical line for SONET and SDH. S1 byte resides in Multiplex Section Overhead (MSOH) in SDH frame. The last four bits (5 to 8) carries SSM information.

Supported Quality Levels

The quality levels supported for SDH framing mode are:

- QL-PRC
- QL-SSU-A
- QL-SSU-B
- QL-SEC (SDH equipment clock)
- QL-DNU

The quality levels supported for SONET framing mode are:

- GEN1—PRS, STU, ST2, ST3, SMC, ST4, and DUS
- GEN2—PRS, STU, ST2, TNC, ST3E, ST3, SMC, ST4, and DUS

Configuring SSM on Cisco ASR 900 Series 4-Port OC3/STM1 or 1-Port OC12/STM4 IM

```plaintext
enable
configure terminal
network-clock synchronization automatic
network-clock eec 1
network-clock synchronization ssm option 2 GEN2
controller SONET 0/0/0
framing sdh
network-clock input-source 10 controller SONET 0/5/1
network-clock synchronization mode ql-enabled
network-clock hold-off 0
network-clock wait-to-restore 70
network-clock revertive
network-clock quality-level tx ql-prC controller SONET 0/0/0
network-clock quality-level rx ql-ssu-a controller SONET 0/5/1
network-clock hold-off 0 global
network-clock wait-to-restore 70
end
```

Configuring Clock Source

```plaintext
enable
configure terminal
controller sonet 0/5/0
clock source line
end
```
Verification of SSM Configuration

Use the `show network-clocks synchronization` command to verify the SSM configuration on Cisco ASR 900 Series 4-Port OC3/STM1 or 1-Port OC12/STM4 IM:

Router#show network-clocks synchronization
Symbols:   En - Enable, Dis - Disable, Adis - Admin Disable
          NA - Not Applicable
          * - Synchronization source selected
          # - Synchronization source force selected
          & - Synchronization source manually switched

Automatic selection process : Enable
Equipment Clock : 2048 (EEC-Option1)
Clock Mode : QL-Enable
ESMC : Enabled
SSM Option : 1
T0 : TenGigabitEthernet0/3/0
Hold-off (global) : 300 ms
Wait-to-restore (global) : 0 sec
Tsm Delay : 180 ms
Revertive : Yes

Nominated Interfaces

<table>
<thead>
<tr>
<th>Interface</th>
<th>SigType</th>
<th>Mode/QL</th>
<th>Prio</th>
<th>QL_IN</th>
<th>ESMC Tx</th>
<th>ESMC Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal</td>
<td>NA</td>
<td>NA/Dis</td>
<td>251</td>
<td>QL-SEC</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>*SONET 0/5/1</td>
<td>NA</td>
<td>NA/En</td>
<td>10</td>
<td>QL-PRC</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

SSM Support on Cisco 48-Port T3/E3 CEM Interface Module

Synchronization Status Message (SSM) is transported over T3 links using proprietary method. SSM enables T3 to select the highest quality timing reference automatically and avoid the timing loops.

SSM is supported on Cisco 48-Port T3/E3 CEM Interface Module.

---

**Note**

Effective IOS XE Everest 16.5.1, E3 mode is not supported.

Supported Quality Levels

The quality levels supported on T3 are:

- GEN1—PRS, STU, ST2, ST3, SMC, ST4, and DUS
- GEN2—PRS, STU, ST2, TNC, ST3E, ST3, SMC, ST4, and DUS

Configuring SSM on Cisco 48-Port T3/E3 CEM Interface Module

```
enable
cconfigure terminal
ccontroller media-type controller 0/5/0
emode t3
ccontroller t3 0/0/0
```
network-clock synchronization automatic
network-clock eec 1
network-clock synchronization ssm option 2 GEN2
network-clock input-source 10 controller t3 0/5/1
network-clock synchronization mode ql-enabled
network-clock hold-off 0
network-clock wait-to-restore 70
network-clock revertive
network-clock quality-level tx ql-prs controller t3 0/0/0
network-clock quality-level rx ql-st2 controller t3 0/5/1
network-clock hold-off 0
network-clock wait-to-restore 70
end

Configuring Clock Source

enable
classify terminal
controller media-type controller 0/5/0
mode t3
classifier t3 0/5/0
clock source line
end

Verification of SSM Configuration

Use the show network-clocks synchronization detail command to verify the SSM configuration on Cisco 48-Port T3/E3 CEM Interface Module:

show network-clock synchronization detail
Symbols: En - Enable, Dis - Disable, Adis - Admin Disable
NA - Not Applicable
* - Synchronization source selected
# - Synchronization source force selected
& - Synchronization source manually switched

Automatic selection process : Enable
Equipment Clock : 1544 (EEC-Option2)
Clock State : Frequency Locked
Clock Mode : QL-Enable
ESMC : Enabled
SSM Option : GEN1
T0 : T3 0/0/21
Hold-off (global) : 300 ms
Wait-to-restore (global) : 0 sec
Tsm Delay : 180 ms
Revertive : No
Force Switch: FALSE
Manual Switch: FALSE
Number of synchronization sources: 1
Squelch Threshold: QL-ST3
sm(netsync NETCLK_QL_ENABLE), running yes, state 1A
Last transition recorded: (begin)-> 2A (ql_mode_enable)-> 1A (src_added)-> 1A (ql_change)-> 1A (sf_change)-> 1A (ql_change)-> 1A

Nominated Interfaces

Interface SigType Mode/QL Prio QL_IN ESMC Tx ESMC Rx
Internal NA NA/Dis 251 QL-ST3 NA NA
*T3 0/0/21 NA NA/En 2 QL-PRS NA NA
Interface:
---------------------------------------------
Local Interface: Internal
Signal Type: NA
Mode: NA(Q1-enabled)
SSM Tx: DISABLED
SSM Rx: DISABLED
Priority: 251
QL Receive: QL-ST3
QL Receive Configured: -
QL Receive Overrided: -
QL Transmit: -
QL Transmit Configured: -
Hold-off: 0
Wait-to-restore: 0
Lock Out: FALSE
Signal Fail: FALSE
Alarms: FALSE
Active Alarms: None
Slot Disabled: FALSE
SNMP input source index: 1
SNMP parent list index: 0
Description: None

Local Interface: T3 0/0/21
Signal Type: NA
Mode: NA(Q1-enabled)
SSM Tx: ENABLED
SSM Rx: ENABLED
Priority: 2
QL Receive: QL-PRS
QL Receive Configured: QL-PRS
QL Receive Overrided: -
QL Transmit: -
QL Transmit Configured: -
Hold-off: 300
Wait-to-restore: 0
Lock Out: FALSE
Signal Fail: FALSE
Alarms: FALSE
Active Alarms: None
Slot Disabled: FALSE
SNMP input source index: 8
SNMP parent list index: 0
Description: None
Verification of SSM Configuration
CHAPTER 3

Configuring the Global Navigation Satellite System

Effective Cisco IOS-XE Release 3.17, the Cisco ASR 903 (with RSP3 module) and Cisco ASR 907 router uses a satellite receiver, also called the global navigation satellite system (GNSS), as a new timing interface.

In typical telecom networks, synchronization works in a hierarchal manner where the core network is connected to a stratum-1 clock and this clock is then distributed along the network in a tree-like structure. However, with a GNSS receiver, clocking is changed to a flat architecture where access networks can directly take clock from satellites in sky using an on-board GPS chips.

This capability simplifies network synchronization planning, provides flexibility and resilience in resolving network synchronization issues in the hierarchical network.

- Information About the GNSS, on page 75
- How to Configure the GNSS, on page 78
- Configuration Example For Configuring GNSS, on page 80
- Additional References, on page 80

Information About the GNSS

Overview of the GNSS Module

The GNSS module is present on the front panel of the RSP3 module and can be ordered separately with PID=. However, there is no license required to enable the GNSS module.

The GNSS LED on the RSP3 front panel indicates the status of the module. The following table explains the different LED status.

<table>
<thead>
<tr>
<th>LED Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>GNSS Normal State. Self survey is complete.</td>
</tr>
<tr>
<td>Amber</td>
<td>All other states</td>
</tr>
</tbody>
</table>

When connected to an external antenna, the module can acquire satellite signals and track up to 32 GNSS satellites, and compute location, speed, heading, and time. GNSS provides an accurate one pulse-per-second
(PPS), a stable 10 MHz frequency output to synchronize broadband wireless, aggregation and pre-aggregation routers, and an accurate time-of-day (ToD).

**Note**

The RSP3 module can also receive 1PPS, 10 MHz, and ToD signals from an external clocking and timing source. However, the timing signals from the GNSS module (when enabled) take precedence over those of the external source.

By default, anti-jamming is enabled on the GNSS module.

**Operation of the GNSS Module**

The GNSS module has the following stages of acquiring and providing timing signals to the Cisco router:

- **Self-Survey Mode**—When the router is reset, the GNSS module comes up in self-survey mode. It tries to lock on to minimum four different satellites and computes approximately 2000 different positions of the satellites to obtain a 3-D location (Latitude, Longitude, and Height) of its current position. This operation takes about 35-to-40 minutes. During this stage also, the module is able to generate accurate timing signals and achieve a Normal or Phase-locked state.

When GNSS moves into Normal state, you can start using the 1PPS, 10 MHz, and ToD inputs from GNSS. The quality of the signal in Self-Survey mode with Normal state is considered good enough to lock to GNSS.

- **Over determined clock mode**—The router switches to over determined (OD) mode when the self-survey mode is complete and the position information is stored in non-volatile memory on the router. In this mode, the module only processes the timing information based on satellite positions captured in self-survey mode.

The router saves the tracking data, which is retained even when the router is reloaded. If you want to change the tracking data, use the `no shutdown` command to set the GNSS interface to its default value.

The GNSS module stays in the OD mode unless one of the following conditions occur:

- A position relocation of the antenna of more than 100 meters is detected. This detection causes an automatic restart of the self-survey mode.
- A manual restart of the self-survey mode or when the stored reference position is deleted.
- A worst-case recovery option after a jamming-detection condition that cannot be resolved with other methods.

You can configure the GNSS module to automatically track any satellite or configure it to explicitly use a specific constellation. However, the module uses configured satellites only in the OD mode.

**Note**

GLONASS and BeiDou satellites cannot be enabled simultaneously. GALILEO is not supported.

When the router is reloaded, it always comes up in the OD mode unless:

- the router is reloaded when the Self-Survey mode is in progress
- the physical location of the router is changed to more than 100 m from its pre-reloaded condition.
When the GNSS self-survey is restarted using the default `gnss slot R0/R1` command in config mode, the 10MHz, 1PPS, and ToD signals are not changed and remain up.

**High Availability for GNSS**

The Cisco ASR 903 and Cisco ASR 907 routers have two GNSS modules, one each on the active and standby RSP3 modules. Each GNSS module must have a separate connection to the antenna in case of an RSP3 switchover.

**Firmware Upgrade**

GNSS firmware is integrated into the Cisco IOS XE Everest 16.5.1 image. When you load this image, the GNSS firmware is copied to the `/usr/binos/bin/` directory.

If the version of the firmware in the software image is greater than the current running version, firmware is automatically upgraded.

**Points to Note During Upgrade**

- During firmware upgrade, the GNSS module status is displayed as *not detected* and lock status as *disabled*.
- SSO during firmware upgrade on standby does not impact firmware upgrade.
- After firmware upgrade is complete or if firmware upgrade is not required, firmware upgrade progress in the show command is displayed as *NA (Not-Applicable)*.
- Syslog messages are displayed to indicate the firmware upgrade start, abort, and finish states.
- While firmware upgrade is in progress, GNSS configuration is not allowed on both, active or standby modules.
- To display the status of the firmware upgrade or downgrade, use the `show platform hardware slot R0/R1 network-clock | sec GNSS` or the `show gnss status` commands.

**Note**

The `show gnss status` command is not applicable on the standby.

**Prerequisites for GNSS**

To use GNSS:

- 1PPS, 10 MHz, and ToD must be configured for netsync and PTP. For more information see the Configuring Clocking and Timing chapter in the *Cisco ASR 903 Router Chassis Software Configuration Guide*.
- The antenna should see as much as possible from the total sky. For proper timing, minimum of four satellites should be locked. For information, see the *Cisco ASR 903 Series Aggregation Services Router Hardware Installation Guide*.
Restrictions for GNSS

The GNSS module is not supported through SNMP; all configurations are performed through commands.

How to Configure the GNSS

To know more about the commands referenced in this document, see the Cisco IOS Master Command List.

Enabling the GNSS on the Cisco Router

```bash
enable
configure terminal
gnss slot r0
no shutdown
exit
```

Note

After the GNSS module is enabled, GNSS will be the source for 1PPS, ToD, and 10MHz clocking functions.

Configuring the Satellite Constellation for GNSS

```bash
enable
configure terminal
gnss slot r0
constellation [auto | gps | galelio | beidou | qzss
exit
```

Configuring Pulse Polarity

```bash
enable
configure terminal
gnss slot r0
1pps polarity negative
exit
```

Note

The no 1pps polarity negative command returns the GNSS to default mode (positive is the default value).

Configuring Cable Delay

```bash
enable
```
configure terminal
gnss slot ro
1pps offset 5
exit

Note
It is recommended to compensate 5 nanosecond per meter of the cable.

The no 1pps offset command sets cable delay offset to zero.

Disabling Anti-Jam Configuration

enable
configure terminal
gnss slot
ro
anti-jam disable
exit

Verifying the Configuration of the GNSS

Use the show gnss status command to display status of GNSS.

Router# show gnss status
GNSS status:

GNSS device: detected
Lock status: Normal
Receiver Status: Auto
Clock Progress: Phase Locking
Survey progress: 100
Satellite count: 22
Holdover Duration: 0
PDOP: 1.04  TDOP: 1.00
HDOP: 0.73  VDOP: 0.74
Minor Alarm: NONE
Major Alarm: None

Use the show gnss satellite command to display the status of all satellite vehicles that are tracked by the GNSS module.

Router# show gnss satellite all
All Satellites Info:

<table>
<thead>
<tr>
<th>SV PRN No</th>
<th>Channel No</th>
<th>Acq Flg</th>
<th>Ephemeris Flg</th>
<th>SV Type</th>
<th>Sig Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>47</td>
</tr>
<tr>
<td>21</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>47</td>
</tr>
<tr>
<td>22</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>46</td>
</tr>
<tr>
<td>18</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>47</td>
</tr>
<tr>
<td>27</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>44</td>
</tr>
<tr>
<td>31</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>49</td>
</tr>
<tr>
<td>24</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>42</td>
</tr>
<tr>
<td>79</td>
<td>12</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>78</td>
<td>13</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>26</td>
</tr>
</tbody>
</table>
Router# show gnss satellite 21
Selected Satellite Info:

  SV PRN No: 21
  Channel No: 2
  Acquisition Flag: 1
  Ephemeris Flag: 1
  SV Type: 0
  Signal Strength: 47

Use the `show gnss time` and `show gnss location` to display the time and location of the Cisco ASR 902 or Cisco ASR907 router.

Router# show gnss time

Current GNSS Time:

  Time: 2015/10/14 12:31:01 UTC Offset: 17

Router# show gnss location

Current GNSS Location:

  LOC: 12:56.184000 N 77:41.768000 E 814.20 m

Use the `show gnss device` to display the hardware information of the active GNSS module.

Router# show gnss device

GNSS device:

  Serial number: FOC2130ND5X
  Firmware version: 1.4
  Firmware update progress: NA
  Authentication: Passed

### Configuration Example For Configuring GNSS

```bash
gnss slot R0
no shutdown
anti-jam disable
constellation glonass
1pps polarity negative
1pps offset 1000 negative
```

### Additional References

#### Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>—</td>
<td>There are no associated standards for this feature,</td>
</tr>
</tbody>
</table>
### MIBs

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>• There are no MIBs for this feature.</td>
<td>To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

### RFCs

<table>
<thead>
<tr>
<th>RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>There are no associated RFCs for this feature.</td>
</tr>
</tbody>
</table>
G.8275.1 Telecom Profile

First Published: March 29, 2016

Precision Time Protocol (PTP) is a protocol for distributing precise time and frequency over packet networks. PTP is defined in the IEEE Standard 1588. It defines an exchange of timed messages. PTP allows for separate profiles to be defined in order to adapt PTP for use in different scenarios. A profile is a specific selection of PTP configuration options that are selected to meet the requirements of a particular application.

Effective Cisco IOS-XE Release 3.18S, Cisco ASR 903 routers with RSP2 module support the G.8275.1 telecom profile. This profile targets accurate time and phase distribution and requires boundary clocks at every node in the network.

Effective Cisco IOS-XE Release 3.18SP, Cisco ASR 903 routers with RSP3 module support the G.8275.1 telecom profile and G.8273.2 telecom recommendation.

This recommendation allows for proper network operation for phase and time synchronization distribution when network equipment embedding a telecom boundary clock (T-BC) and a telecom time slave clock (T-TSC) is timed from another T-BC or a telecom grandmaster clock (T-GM). This recommendation addresses only the distribution of phase and time synchronization with the full timing support architecture as defined in ITU-T G.8275.

- Why G.8275.1?, on page 83
- Configuring the G.8275.1 Profile, on page 88
- Additional References, on page 92
- Feature Information for G.8275.1, on page 93

Why G.8275.1?

The G.8275.1 profile is used in mobile cellular systems that require accurate synchronization of time and phase. For example, the fourth generation (4G) of mobile telecommunications technology.

The G.8275.1 profile is also used in telecom networks where phase or time-of-day synchronization is required and where each network device participates in the PTP protocol.

Because a boundary clock is used at every node in the chain between PTP Grandmaster and PTP Slave, there is reduction in time error accumulation through the network.
More About G.8275.1

The G.8275.1 must meet the following requirements:

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

The following figure describes a sample G.8275.1 topology.

Figure 4: A Sample G.8275.1 Topology

PTP Domain

A PTP domain is a logical grouping of clocks that communicate with each other using the PTP protocol.

A single computer network can have multiple PTP domains operating separately, for example, one set of clocks synchronized to one time scale and another set of clocks synchronized to another time scale. PTP can run over either Ethernet or IP, so a domain can correspond to a local area network or it can extend across a wide area network.

The allowed domain numbers of PTP domains within a G.8275.1 network are between 24 and 43 (both inclusive).

PTP Messages and Transport

The following PTP transport parameters are defined:

- For transmitting PTP packets, either the forwardable multicast MAC address (01-1B-19-00-00-00) or the non-forwardable multicast MAC address (01-80-C2-00-00-0E) must be used as the destination MAC address. The MAC address in use is selected on a per-port basis through the configuration. However, the non-forwardable multicast MAC address (01-80-C2-00-00-0E) will be used if no destination MAC is configured.

The source MAC address is the interface MAC address.
• For receiving PTP packets, both multicast MAC addresses (01-80-C2-00-00-0E and 01-1B-19-00-00-00) are supported.
• The packet rate for Announce messages is 8 packets-per-second. For Sync, Delay-Req, and Delay-Resp messages, the rate is 16 packets-per-second.
• Signaling and management messages are not used.

PTP Modes

Two-Way Operation
To transport phase and time synchronization and to measure propagation delay, PTP operation must be two-way in this profile. Therefore, only two-way operation is allowed in this profile.

One-Step and Two-Step Clock Mode
Both one-step and two-step clock modes are supported in the G.8275.1 profile.
A slave port must be capable of receiving and processing messages from both one-step clocks and two-step clocks, without any particular configuration. However, the master supports only one-step mode.

PTP Clocks

Two types of ordinary clocks and boundary clocks are used in this profile:

Ordinary Clock (OC)
1. OC that can only be a grandmaster clock (T-GM). In this case, one PTP port will be used as a master port. The T-GM uses the frequency, 1PPS, and ToD input from an upstream grandmaster clock.

Note

The T-GM master port is a fixed master port.

Figure 5: Ordinary Clock As T-GM

1. OC that can only be a slave clock (T-TSC). In this case, only one PTP port is used for T-TSC, which in turn will have only one PTP master associated with it.
Boundary Clock (T-BC)

1. T-BC that can only be a grandmaster clock (T-GM).
2. T-BC that can become a master clock and can also be a slave clock to another PTP clock.

If the BMCA selects a port on the T-BC to be a slave port, all other ports are moved into the master role or a passive state.

PTP Ports

A port can be configured to perform either fixed master or slave role or can be configured to change its role dynamically. If no role is assigned to a port, it can dynamically assume a master, passive, or slave role based on the BMCA.

A master port provides the clock to its downstream peers.

A slave port receives clock from an upstream peer.

A dynamic port can work either as a master or a slave based on the BMCA decision.

In Cisco’s implementation of the G.8275.1:

- OC clocks can support only fixed master or slave port.
- One PTP port can communicate with only one PTP peer.
- BC can have a maximum of 64 ports. Fixed slave ports are not supported on the BC.
PTP Asymmetry Readjustment

Each PTP node can introduce delay asymmetry that affects the adequate time and phase accuracy over the networks. Asymmetry in a network occurs when one-way-delay of forward path (also referred as forward path delay or ingress delay) and reverse path (referred as reverse path delay or egress delay) is different. The magnitude of asymmetry can be either positive or negative depending on the difference of the forward and reverse path delays.

Effective Cisco IOS XE Gibraltar 16.10.1, PTP asymmetry readjustment can be performed on each PTP node to compensate for the delay in the network.

Virtual Port Support on T-BC

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

Alternate BMCA

The BMCA implementation in G.8275.1 is different from that in the default PTP profile. The G.8275.1 implementation is called the Alternate BMCA. Each device uses the alternate BMCA to select a clock to synchronize to, and to decide the port states of its local ports.

Benefits

With upcoming technologies like LTE-TDD, LTE-A CoMP, LTE-MBSFN and Location-based services, eNodeBs (base station devices) are required to be accurately synchronized in phase and time. Having GNSS systems at each node is not only expensive, but also introduces vulnerabilities. The G.8275.1 profile meets the synchronization requirements of these new technologies.

Prerequisites for Using the G.8275.1 Profile

- PTP over Multicast Ethernet must be used.
- Every node in the network must be PTP aware.
- It is mandatory to have a stable physical layer frequency whilst using PTP to define the phase.
- Multiple active grandmasters are recommended for redundancy.

Restrictions for Using the G.8275.1 Profile

- PTP Transparent clocks are not permitted in this profile.
- Changing PTP profile under an existing clock configuration is not allowed. Different ports under the same clock cannot have different profiles. You must remove clock configuration before changing the PTP profile. Only removing all the ports under a clock is not sufficient.
- One PTP port is associated with only one physical port in this profile.
- There is no support for BDI and VLAN.
- Signaling and management messages are not used.
- PTP message rates are not configurable.
• Non-hybrid T-TSC and T-BC clock configurations are not supported.

• When the Cisco ASR 900 routers with RSP2 or RSP3 modules are configured with G.8275.1 Hybrid Boundary clock (T-BC) or Hybrid Slave clock (T-TSC), the combination of PTP and SyncE drives all timing outputs except BITS. This implies that clock outputs are compliant to G.8273.2 and track the Hybrid PTP clock. BITS output always tracks only to the input electrical clock and is not influenced by PTP.

• Virtual port is not supported on the Cisco RSP2 Module.

Configuring the G.8275.1 Profile

Note To know more about the commands referenced in this module, see the Cisco IOS Interface and Hardware Component Command Reference or the Cisco IOS Master Command List.

Configuring Physical Frequency Source

For more information, see the Configuring Synchronous Ethernet ESMC and SSM section in the Clocking and Timing chapter of this book.

Creating a Master-Only Ordinary Clock

```
ptp clock ordinary domain 24
local-priority 1
priority2 128
clock-port master-port-1
master profile g8275.1
local-priority 1
transport ethernet multicast interface Gig 0/0/1
clock-port master-port-2
master profile g8275.1
```

Note It is mandatory that when electrical ToD is used, the utc-offset command is configured before configuring the tod R0, otherwise there will be a time difference of approximately 37 seconds between the master and slave clocks.

The following example shows that the utc-offset is configured before configuring the ToD to avoid a delay of 37 seconds between the master and slave clocks:

```
ptp clock ordinary domain 0
utc-offset 37
tod R0 cisco
input 1pps R0
clock-port master master
transport ipv4 unicast interface Loopback0 negotiation
```
**Associated Commands**

- `ptp clock`
- `local-priority`
- `priority2`

**Creating an Ordinary Slave**

```
ptp clock ordinary domain 24
hybrid
clock-port slave-port
slave profile g8275.1
transport ethernet multicast interface Gig 0/0/0
delay-asymmetry 1000
```

**Creating Dynamic Ports**

```
Dynamic ports can be created when you do not specify whether a port is master or slave. In such cases, the BMCA dynamically choses the role of the port.
```

```
ptp clock boundary domain 24 hybrid
time-properties persist 600
utc-offset 45 leap-second "01-01-2017 00:00:00" offset 1
clock-port bc-port-1 profile g8275.1 local-priority 1
transport ethernet multicast interface Gig 0/0/0
delay-asymmetry 500
clock-port bc-port-2 profile g8275.1 local-priority 2
transport ethernet multicast interface Gig 0/0/1
delay-asymmetry -800
```

**Configuring Virtual Ports**

```
ptp clock boundary domain 24 hybrid
utc-offset 45 leap-second "01-01-2017 00:00:00" offset 1
virtual-port virtual-port-1 profile g8275.1 local-priority 1
input 1pps R0
input tod R0 ntp
```

**Note**

It is mandatory that when electrical ToD is used, the `utc-offset` command is configured before configuring the `tod R0`, otherwise there will be a time difference of approximately 37 seconds between the master and slave clocks.

**Restrictions for Configuring Virtual Ports**

- Virtual port configuration is not allowed under Ordinary Clocks.
- Virtual port configuration is not supported under non-hybrid T-BC cases.
Associated Commands

- **input**

**Verifying the Local Priority of the PTP Clock**

Router# `show ptp clock dataset default`
CLOCK [Boundary Clock, domain 24]
  Two Step Flag: No
  Clock Identity: 0x2A:0:0:0:58:67:F3:4
  Number Of Ports: 1
  Priority1: 128
  Priority2: 90
  **Local Priority: 200**
  Domain Number: 24
  Slave Only: No
  Clock Quality:
    Class: 224
    Accuracy: Unknown
    Offset (log variance): 4252

**Verifying the Port Parameters**

Router# `show ptp port dataset port`
PORT [MASTER]
  Clock Identity: 0x49:BD:D1:0:0:0:0:0
  Port Number: 0
  Port State: Unknown
  Min Delay Req Interval (log base 2): 42
  Peer Mean Path Delay: 648518346341351424
  Announce interval (log base 2): 0
  Announce Receipt Timeout: 2
  Sync Interval (log base 2): 0
  Delay Mechanism: End to End
  Peer Delay Request Interval (log base 2): 0
  PTP version: 2
  **Local Priority: 1**
  Not-slave: True

**Verifying the Foreign Master Information**

Router# `show platform software ptp foreign-master domain 24`
PTPd Foreign Master Information:

  Current Master: SLA

  Port: SLA
    Clock Identity: 0x74:A2:E6:FF:FE:5D:CE:3F
    Clock Stream Id: 0
    Priority1: 128
    Priority2: 128
    Local Priority: 128
    Clock Quality:
      Class: 6
      Accuracy: Within 100ns
      Offset (Log Variance): 0x4E5D
Steps Removed: 1
Not-Slave: FALSE

Verifying Current PTP Time

Router# show platform software ptpd tod
PTPd ToD information:

Time: 01/05/70 06:40:59

Verifying the Virtual Port Status

Router# show ptp port virtual domain 24
VIRTUAL PORT [vp]
Status: down
Clock Identity: 0x74:A2:E6:FF:FE:5D:CE:3F
Port Number: 1
Clock Quality:
  Class: 6
  Accuracy: 0x21
  Offset (log variance): 0x4E5D
Steps Removed: 0
Priority1: 128
Priority2: 128
Local Priority: 128
Not-slave: False

G.8275.1 Deployment Scenario

The following example illustrates a possible configuration for a G.8275.1 network with two masters, a boundary clock and a slave. Let’s assume that master A is the primary master and B is the backup master.

*Figure 8: Topology for a Configuration Example*

The configuration on master clock A is:

```
ptp clock ordinary domain 24
  clock-port master-port profile g8275.1
  transport ethernet multicast interface GigabitEthernet 0/0/0
```

The configuration on master clock B is:
The configuration on the boundary clock is:

```
ptp clock boundary domain 24 hybrid
  local-priority 3
  clock-port slave-port-a profile g8275.1 local-priority 1
    transport ethernet multicast interface Gig 0/0/1
  clock-port slave-port-b profile g8275.1 local-priority 2
    transport ethernet multicast interface Gig 0/1/1
  clock-port master-port profile g8275.1
    transport Ethernet multicast interface Gig 0/2/1
```

The configuration on the slave clock is:

```
ptp clock ordinary domain 24 hybrid
  clock-port slave-port slave profile g8275.1
    transport Ethernet multicast interface Gig 0/0/0
```

### Additional References

#### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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<tbody>
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<td>Cisco IOS commands</td>
<td>Cisco IOS Master Commands List, All Releases</td>
</tr>
<tr>
<td>Interface and Hardware Component commands</td>
<td>Cisco IOS Interface and Hardware Component Command Reference</td>
</tr>
<tr>
<td>Clocking and Timing</td>
<td>Clocking and Timing</td>
</tr>
</tbody>
</table>

#### Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
</tr>
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<tbody>
<tr>
<td>G.8275.1/Y.1369.1 (07/14)</td>
<td>SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS</td>
</tr>
<tr>
<td>G.8273.2/Y.1368.2 (05/14)</td>
<td>Packet over Transport aspects – Synchronization, quality and availability targets</td>
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</table>

#### MIBs

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
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<tr>
<td>—</td>
<td>To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

---

Related Documents

- Cisco IOS Master Commands List, All Releases
- Cisco IOS Interface and Hardware Component Command Reference
- Clocking and Timing

Standards

- G.8273.2/Y.1368.2 (05/14): Packet over Transport aspects – Synchronization, quality and availability targets

MIBs

- To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs
RFCs

<table>
<thead>
<tr>
<th>RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>—</td>
<td>There are no new RFCs for this feature.</td>
</tr>
</tbody>
</table>

**Feature Information for G.8275.1**

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to [http://www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

**Note**

Table 11: Feature Information for G.8275.1, on page 93 lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
</table>
| G.8275.1–Support for 1588 profile | XE 3.18 | This PTP telecom profile introduces phase and time synchronization with full timing support from the network. The following commands were introduced:  
  • local-priority  
  
  The following commands were modified:  
  • clock-port  
  • show ptp clock dataset default  
  • show ptp port dataset port  
  
  The following command is deprecated for the G.8275.1 profile clocks:  
  • show ptp port running  
  
  The alternate command is `show platform software ptp foreign-master [domain-number]`.  
  
  **Note** This command is applicable only for the G.8275.1 profile clocks. |
CHAPTER 5

G.8275.2 Telecom Profile

Precision Time Protocol (PTP) is a protocol for distributing precise time and frequency over packet networks. PTP is defined in the IEEE Standard 1588. It define an exchange of timed messages.

PTP allows for separate profiles to be defined in order to adapt PTP for use in different scenarios. A profile is a specific selection of PTP configuration options that are selected to meet the requirements of a particular application.

Effective Cisco IOS XE Everest 16.5.1, Cisco ASR 900 routers with RSP3 module support the ITU-T G.8275.2 telecom profile (PTP telecom profile for Phase/Time-of-day synchronization with partial timing support from the network).

The G.8275.2 is a PTP profile for use in telecom networks where phase or time-of-day synchronization is required. It differs from G.8275.1 in that it is not required that each device in the network participates in the PTP protocol. Also, G.8275.2 uses PTP over IPv4 and IPv6 in unicast mode. However, IPv6 is not supported in Cisco IOS XE Everest 16.5.1.

In this document, G.8275.2 refers to ITU-T G.8275.2 (02/2016).

- Why G.8275.2?, on page 95
- Benefits, on page 99
- Restrictions for Using the G.8275.2 Profile, on page 99
- Configuring the G.8275.2 Profile, on page 99
- G.8275.2 Deployment Scenario, on page 106
- Additional References, on page 107

Why G.8275.2?

The G.8275.2 profile is based on the partial timing support from the network. Hence nodes using G.8275.2 are not required to be directly connected.

The G.8275.2 profile is used in mobile cellular systems that require accurate synchronization of time and phase. For example, the fourth generation (4G) of mobile telecommunications technology.
PTP Clocks

Two types of ordinary clocks and three types of boundary clocks are used in this profile:

**Ordinary Clocks (OCs)**

- **Telecom Grandmaster (T-GM):** A telecom grandmaster provides timing for other devices in the network, and is usually connected to a primary reference time source, such as a GNSS receiver. It does not synchronize its local clock to other network elements.

  Considerations for a T-GM:
  - Only one PTP port can be configured as a master port.
  - One T-GM master port can have multiple slaves associated with it.
  - The T-GM OC Master port is a fixed port; that is, it always acts as a master clock and its role does not change by negotiating with its peer.

- **Partial-Support Telecom Time Slave Clocks (T-TSC-P):** A slave clock synchronizes its local clock to another PTP clock (GM, T-GM or T-BC), and does not provide synchronization through PTP to any other device.

  Considerations for a T-TSC-P:
  - An ordinary clock with single slave port can be configured.
  - Only one peer clock address can be configured as clock source.

**Boundary Clocks (BCs)**

Boundary clocks can assume any of the following roles:

- A BC that can only be a grandmaster (T-GM)

  A master-only boundary clock can have multiple master port configured. The different master ports can be in different VLANs to serve the slaves that need to be served over them.

- A BC that can become a grandmaster and can also be a slave to another PTP clock (T-BC-P).

  Slave-only port configuration is not allowed under boundary clocks. However, one of the dynamic ports (port state negotiated based on BMCA), can assume the role of slave.

- A BC that can only be a slave (T-TSC-P with more than one port).

Fixed master port, dynamic ports and virtual port can be configured under a boundary clock. However, only one clock source (peer address) can be configured with a dynamic port.

**Miscellaneous Notes**

- Any clock that has multiple PTP ports within a PTP domain is termed a boundary clock (BC). Ordinary clocks (OC) always have only one PTP port.

  In G.8275.2 (02/2016), PTP transparent clocks are not permitted.
PTP Domain

A PTP domain is a logical grouping of clocks that communicate with each other using the PTP protocol. A single computer network can have multiple PTP domains operating separately, for example, one set of clocks synchronized to one time scale and another set of clocks synchronized to another time scale. PTP can run over either Ethernet or IP, so a domain can correspond to a local area network or it can extend across a wide area network.

The allowed domain numbers of PTP domains within a G.8275.2 network are in the range of 44 and 63 (both inclusive). The default domain number is 44.

PTP Messages and Transport

The following PTP transport parameters are defined:

- In Cisco IOS XE Everest 16.5.1, PTP over IPv4 in unicast mode must be used.
- Either one-step or two-step clock mode must be used.
- For PTP master clock, both one-way and two-way operation modes are supported. This means PTP master can grant request to a slave's one-way or two-way requests.
- In case of PTP slave clock, two-way PTP operation is required to allow phase/time-of-day delivery. The delay-request-response mechanism is used to propagate delay measurement; the peer-delay mechanism is not used.
- The G.8275.2 profile supports unicast message negotiation.
- Interfaces carrying PTP traffic can be under different VRFs.
- Sync, Delay_Req, Announce, Follow_Up, Delay_Resp, and Signaling messages are used in this profile. See the table below for rates of transmission for these messages.

Table 12: PTP Messages and their Rate of Transmission

<table>
<thead>
<tr>
<th>Message</th>
<th>Default Rate (packets per second)</th>
<th>Minimum Rate (packets per second)</th>
<th>Maximum Rate (packets per second)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sync</td>
<td>32</td>
<td>1</td>
<td>128</td>
</tr>
<tr>
<td>Follow_up (only if sync messages are used)</td>
<td>32</td>
<td>1</td>
<td>128</td>
</tr>
<tr>
<td>Delay_Req</td>
<td>16</td>
<td>1</td>
<td>128</td>
</tr>
<tr>
<td>Delay_Resp</td>
<td>16</td>
<td>1</td>
<td>128</td>
</tr>
<tr>
<td>Announce</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Signaling</td>
<td>Not Specified</td>
<td>1</td>
<td>Not specified</td>
</tr>
</tbody>
</table>
Limitations

- Pdelay_Req, Pdelay_Resp, Pdelay_Resp_Follow_Up and management messages are not used in this profile.

PTP Ports

A port can be configured to perform either fixed master or slave role or can be configured to change its role dynamically. If no role is assigned to a port, it can dynamically assume a master, passive, or slave role based on the BMCA.

In G.8275.2, PTP ports are not tied to any specific physical interfaces, but are tied to a loopback (virtual) interface. Traffic from a PTP port is routed through any physical interface based on the routing decision.

For a Boundary Clock, multiple PTP ports are supported. The maximum number of PTP ports supported on a BC node is 64.

For a dynamic port, only one clock source can be configured.

Virtual Port Support on T-BC

---

**Note**

The virtual port is not supported on the Cisco ASR 900 RSP2 Module.

In G.8275.2 implementation, virtual PTP ports are used to provide electrical frequency and phase inputs to T-BC. With virtual ports, T-BCs are fed with frequency inputs, such as, synchronous Ethernet, 10M, BITS, and phase/time inputs, such as, 1PPS and ToD. Virtual ports participate in the BMCA algorithm of the T-BCs.

If frequency source is of Category-1 (according to G.8275.2) and if 1PPS and ToD inputs are UP, virtual port status is up. Otherwise, virtual port status is down.

A virtual port participates in BMCA only when it is in administratively up state.

A virtual port always has clock class 6, clock accuracy 0x21 (within 100ns), and clock offset Scaled Log Variance of 0x4E5D.

---

**Note**

The virtual port has the attributes set to the above values only when it is in the UP state.

Whenever virtual port is selected as the best master by the BMCA, PTP clock is driven by the electrical inputs. If virtual port is administratively up but not selected by BMCA, 1PPS and ToD inputs do not affect PTP clock.

Alternate BMCA

The BMCA implementation in G.8275.2 is different from that in the default PTP profile. The G.8275.2 implementation specifies an alternate best master clock algorithm (ABMCA), which is used by each device to select a clock to synchronize to, and to decide the port states of its local ports.

The following consideration apply to the G.8275.2 implementation of the BMCA:

- **MasterOnly**: A per port attribute, MasterOnly defines the state of the port. If this attribute is true, the port is never placed in the Slave state.
• **Priority 1**: Priority 1 is always static in this profile and is set to 128. Priority 1 is not used in BMCA.

• **Priority 2**: Priority 2 is a configurable value and its range is from 0 to 255.

• **Local Priority**: Local priority is configured locally on clock ports to set the priority on nominated clocks. The default value is 128 and valid range is from 1 to 255.

**Benefits**

With upcoming technologies like LTE-TDD, LTE-A CoMP, LTE-MBSFN and Location-based services, eNodeBs (base station devices) are required to be accurately synchronized in phase and time. Having GNSS systems at each node is not only expensive, but also introduces vulnerabilities. The G.8275.2 profile meets the synchronization requirements of these new technologies.

**Restrictions for Using the G.8275.2 Profile**

• In G.8275.2, PTP can be used in both hybrid mode and non-hybrid mode. In hybrid mode, PTP is used to provide phase and time-of-day throughout the network synchronization along with PHY layer frequency support (SyncE). In non-hybrid mode, PTP is used without PHY layer frequency support (SyncE).

• The G.8275.2 is not supported on the Cisco ASR 900 Routers with RSP1 module.

• A G.8275.2 PTP clock can have redundant clock sources configured (through multiple PTP ports). However, at any given time, a G.8275.2 PTP clock synchronizes to only one clock source, which is selected by BMCA.

• In Cisco IOS XE Everest 16.5.1, the G.8275.2 does not support assisted partial-support telecom time slave clock (T-TSC-A).

• The G.8275.2 does not provide any recommendations for performance analysis and network limits for the clocks.

• Effective Cisco IOS XE Everest 16.5.1, only one loopback address can be associated with all PTP ports.

• Virtual port is not supported on the Cisco RSP2 Module.

• For the ports configured with G.8275.2 profile, removal of `transport ipv4 unicast interface Loopback 0 negotiation` configuration by using the `no` form of the command is not supported.

**Configuring the G.8275.2 Profile**

---

**Note**

To know more about the commands referenced in this module, see the Cisco IOS Interface and Hardware Component Command Reference or the Cisco IOS Master Command List.
Configuring Physical Frequency Source

For more information, see the Configuring Synchronous Ethernet ESMC and SSM section in the Clocking and Timing chapter of this book.

Creating a Master-Only

T-GM Ordinary Clock

```bash
ptp clock ordinary domain 44
clock-port master1 master profile g8275.2
transport ipv4 unicast interface Loopback0 negotiation
```

Note

It is mandatory that when electrical ToD is used, the `utc-offset` command is configured before configuring the `tod R0`, otherwise there will be a time difference of approximately 37 seconds between the master and slave clocks.

The following example shows that the utc-offset is configured before configuring the ToD to avoid a delay of 37 seconds between the master and slave clocks:

```bash
ptp clock ordinary domain 44
utc-offset 37
tod R0 cisco
input 1pps R0
clock-port master master
transport ipv4 unicast interface Loopback0 negotiation
```

T-GM Boundary Clock

A boundary clock can be configured as a T-GM by configuring the external inputs of 10m, 1pps and ToD. However, external inputs to a boundary clock can be given only through a virtual port.

```bash
ptp clock boundary domain 44 hybrid
virtual-port vp1 profile g8275.2
  input 1pps R0
  input tod R0 ntp
clock-port dp2
  transport ipv4 unicast interface Loopback0 negotiation
clock source 60.60.60.60
ptp clock boundary domain 45
  clock-port d1 profile g8275.2 local-priority 12
  transport ipv4 unicast interface Lo0 negotiation
clock source 1.1.1.1
  clock-port dp2 profile g8275.2 local-priority 13
  transport ipv4 unicast interface Lo0 negotiation
clock source 12.12.12.12
  clock-port dp3 profile g8275.2 local-priority 14
  transport ipv4 unicast interface Lo0 negotiation
clock source 56.56.56.56
  clock-port dp1 profile g8275.2 local-priority 12
  transport ipv4 unicast interface Lo0 negotiation
clock source 2.2.2.2
```
Creating an Ordinary Slave (T-TSC-P)

Creating a Boundary Clock

```plaintext
ptp clock boundary domain 44
    clock-port master-port-1 master profile G.8275.2
    transport ipv4 unicast interface lo 0 negotiation
    clock-port port1 profile G.8275.2
    transport ipv4 unicast interface lo 0 negotiation
    clock source 1.1.1.1
    clock-port port2 profile G.8275.2
    transport ipv4 unicast interface lo 0 negotiation
    clock source 1.1.1.2
```

Creating Dynamic Ports

The following considerations apply to dynamic ports:

- Dynamic ports are created by not specifying whether a port is master or slave. In such cases, the BMCA dynamically chooses the role of the port.
- Dynamic ports do not have a keyword.
- All the dynamic ports configured under a clock must use the same loopback interface.
- For a dynamic port to communicate with a peer, it must have `clock source x.x.x.x` configured with it.

```plaintext
ptp clock boundary domain 44
    clock-port bc-port-1 profile g8275.2 local-priority 1
    transport ipv4 unicast interface Lo0 negotiation
    clock source 1.1.1.1
    clock-port bc-port-2 profile g8275.2 local-priority 2
    transport ipv4 unicast interface Lo0 negotiation
    clock source 2.2.2.2
```

Configuring Virtual Ports

```plaintext
ptp clock boundary domain 44 hybrid
    utc-offset 37 leap-second "01-01-2017 00:00:00" offset 1
    virtual-port virtual-port-1 profile g8275.2 local-priority 1
    input 1pps R0
    input tod R0 ntp
```

**Note**

It is mandatory that when electrical ToD is used, the `utc-offset` command is configured before configuring the `tod R0`, otherwise there will be a time difference of approximately 37 seconds between the master and slave clocks.
Restrictions for Configuring Virtual Ports

- Virtual port configuration is not allowed under Ordinary Clocks.
- Virtual port configuration is not supported under non-hybrid T-BC cases.

Verifying the Default and Parent Datasets

Router# show ptp clock dataset default
CLOCK [Boundary Clock, domain 44]
Two Step Flag: No
Clock Identity: 0x5C:83:8F:FF:FE:1F:27:BF
Number Of Ports: 5
Priority1: 128
Priority2: 128
Local Priority: 128
Domain Number: 44
Slave Only: No
Signal Fail: No
Clock Quality:
Class: 165
Accuracy: Unknown
Offset (log variance): 65535

Router# show ptp clock dataset parent domain 44
CLOCK [Ordinary Clock, domain 44]
Parent Clock Identity: 0x80:E0:1D:FF:FE:E3:F8:BF
Parent Port Number: 1
Parent Stats: No
Observed Parent Offset (log variance): 65535
Observed Parent Clock Phase Change Rate: 2147483647

Grandmaster Clock:
Identity: 0x70:10:5C:FF:FE:50:3A:3F
Priority1: 128
Priority2: 128
Clock Quality:
Class: 6
Accuracy: Within 100ns
Offset (log variance): 20061

Verifying the PTP Clock State

Router# show ptp clock running domain 44
### Verifying the PTP Clock Synchronization State

Router# `show network-clocks synchronization detail`

**Symbols:**
- `En` - Enable, `Dis` - Disable, `Adis` - Admin Disable
- `NA` - Not Applicable
- `*` - Synchronization source selected
- `#` - Synchronization source force selected
- `&` - Synchronization source manually switched

**Automatic selection process:** Enable
**Equipment Clock:** 2048 (EEC-Option1)
**Clock State:** Frequency Locked
**Clock Mode:** QL-Enable
**ESMC:** Enabled
**SSM Option:** 1
**T0:** GigabitEthernet0/0/11
**Hold-off (global):** 300 ms
**Wait-to-restore (global):** 0 sec
**Tsm Delay:** 180 ms
**Revertive:** No
**Force Switch:** FALSE
**Manual Switch:** FALSE

**Number of synchronization sources:** 2

**Squelch Threshold:** QL-SEC

`snnetsync NETCLK_QL_ENABLE`, running yes, state 1A

**Last transition recorded:** (sf_change)-> 1A (sf_change)-> 1A (sf_change)-> 1A (sf_change)-> 1A (sf_change)-> 1A (ql_change)-> 1A

**Nominated Interfaces**

<table>
<thead>
<tr>
<th>Interface</th>
<th>SigType</th>
<th>Mode/QL</th>
<th>Prio</th>
<th>QL_IN</th>
<th>ESMC Tx</th>
<th>ESMC Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal</td>
<td>NA</td>
<td>NA/Dis</td>
<td>251</td>
<td>QL-SEC</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>*Gi0/0/11</td>
<td>NA</td>
<td>Sync/En</td>
<td>1</td>
<td>QL-PRC</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Te0/0/24</td>
<td>NA</td>
<td>Sync/En</td>
<td>2</td>
<td>QL-PRC</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Interface:**

- **Local Interface:** Internal
- **Signal Type:** NA
- **Mode:** NA (QL-enabled)
- **SSM Tx:** DISABLED
- **SSM Rx:** DISABLED
- **Priority:** 251
- **QL Receive:** QL-SEC
- **QL Receive Configured:** -
- **QL Receive Overrided:** -
- **QL Transmit:** -
Verifying the Port Parameters

Router# show ptp port dataset port domain 44

PORT [MASTER-1]
Clock Identity: 0x70:10:5C:FF:FE:50:3A:3F
Port Number: 1  
Port State: Master  
Min Delay Req Interval (log base 2): -4  
Peer Mean Path Delay: 0  
Announce interval (log base 2): 1  
Announce Receipt Timeout: 3  
Sync Interval (log base 2): -5  
Delay Mechanism: End to End  
Peer Delay Request Interval (log base 2): -4  
PTP version: 2  
Local Priority: 128  
Master-only: True  
Signal-fail: False

Verifying the Foreign Master Information

Router# show platform software ptp foreign-master domain 44  
PTPd Foreign Master Information:

Current Master: SLA  
Port: SLA  
GM Clock Identity: 0x70:10:5C:FF:FE:50:3A:3F  
Clock Stream Id: 0  
Priority1: 128  
Priority2: 128  
Local Priority: 10  
Clock Quality:
  Class: 6  
  Accuracy: Within 100ns  
  Offset (Log Variance): 0x4E5D  
Source Port Identity:  
  Clock Identity: 0x70:10:5C:FF:FE:50:3A:3F  
  Port Number: 1  
  Steps Removed: 1  
  masterOnly: FALSE  
  Qualified: TRUE

Verifying Current PTP Time

Router# show platform software ptpd tod  
PTPd ToD information:

Time: 01/05/70 06:40:59

Verifying the Virtual Port Status

Router# show ptp port virtual domain 44  
VIRTUAL PORT [vp1]  
Status: up  
Clock Identity: 0x64:F6:9D:FF:FE:F2:25:3F  
Port Number: 2  
Clock Quality:
  Class: 6  
  Accuracy: 0x21  
  Offset (log variance): 0x4E5D
G.8275.2 Deployment Scenario

The following example illustrates a possible configuration for a G.8275.2 network with two masters, a boundary clock and a slave. Let’s assume that master A is the ordinary clock and B is the backup master with virtual port.

**Figure 9: Topology for a Configuration Example**

The configuration on TGM A (as ordinary clock):

```
ptp clock ordinary domain 44
tod R0 ntp
input 1pps R0
utc-offset 37
clock-port master master profile g8275.2
transport ipv4 unicast interface Lo0 negotiation
```

The configuration on TGM B with Virtual Port:

```
ptp clock boundary domain 44 hybrid
utc-offset 37
clock-port dynamic1 profile g8275.2
transport ipv4 unicast interface Lo0 negotiation
clock source 3.3.3.3
virtual-port virtual1 profile g8275.2
input 1pps R0
input tod R0 ntp
```

The configuration on the boundary clock:

```
ptp clock boundary domain 44 hybrid
clock-port dynamic1 profile g8275.2 local-priority 1
transport ipv4 unicast interface Lo0 negotiation
clock source 1.1.1.1
clock-port dynamic2 profile g8275.2 local-priority 2
transport ipv4 unicast interface Lo0 negotiation
clock source 2.2.2.2
clock-port dynamic3 profile g8275.2
```
transport ipv4 unicast interface Lo0 negotiation
clock source 4.4.4.4

The configuration on the slave clock:

ptp clock ordinary domain 44 hybrid
clock-port slave slave
transport ipv4 unicast interface Lo0 negotiation
clock source 3.3.3.3

Additional References

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