Junos® OS

Timing and Synchronization Guide

Published
2025-01-10

Juniper Networks, Inc.
1133 Innovation Way
Sunnyvale, California 94089
USA
408-745-2000
www.juniper.net

The information in this document is current as of the date on the title page.

YEAR 2000 NOTICE

Juniper Networks hardware and software products are Year 2000 compliant. Junos OS has no known time-related limitations through the year 2038. However, the NTP application is known to have some difficulty in the year 2036.

END USER LICENSE AGREEMENT

Table of Contents

About This Guide | xi

1 **Overview**

Timing and Synchronization Overview | 2

Configure Date and Time Locally | 3

Modify Default Time Zone | 4

Internet Assigned Numbers Authority (IANA) Time Zone | 5

Import and Install Time Zone Files | **6**

Configure Custom Time Zone | **7**

2 **Precision Time Protocol**

Precision Time Protocol Overview | 10

Precision Time Protocol (PTP) Overview | **10**

Configure Precision Time Protocol (PTP) Clocking | **12**

Example: Configure Precision Time Protocol | **14**

- Overview | **14**
  - Requirements for PTP Configuration | **15**
  - Configuration | **15**
  - Verification | **18**

Precision Time Protocol Clocks | 21

PTP Boundary Clock Overview | **21**

Example: Configure PTP Boundary Clock | **25**

- Requirements | **26**
- Overview | **26**
- Configuration | **26**

Example: Configure PTP Boundary Clock With Unicast Negotiation | **29**

- Requirements | **30**
- Overview | **30**

Configuration | 31

Configure PTP TimeTransmitter Clock | 35

Configure PTP TimeTransmitter Boundary Clock Parameters | 35

Configure a PTP TimeTransmitter Clock Interface | 37

Configure PTP TimeReceiver Clock | 39

Configure the PTP TimeReceiver Clock Parameters | 40

Configure the PTP TimeReceiver Clock Interface | 42

Example: Configure Ordinary TimeReceiver Clock With Unicast-Negotiation | 44

Requirements | 44

Overview | 44

Configuration | 45

Example: Configure Ordinary TimeReceiver Clock Without Unicast-Negotiation | 48

Requirements | 48

Overview | 48

Configuration | 49

PTP Transparent Clocks | 51

Configure PTP Transparent Clock | 53

Precision Time Protocol Profiles | 56

Configure PTP Default Profile | 56

Configure PTP and its Options | 57

Configure PTP Options | 57

Configure TimeReceiver Clock Options | 58

Configure TimeTransmitter Clock Options | 59

G.8275.1 Telecom Profile | 61

Configure G.8275.1 Profile | 63

Configure G.8275.1 PTP profile | 63

Configure G.8275.1 PTPoLAG profile | 65

G.8275.2 Enhanced Profile | 65

Configure G.8275.2 Enhanced Profile | 68

Configure PTP and Its Options | 68

Configure PTP Options | 69

Configure TimeReceiver Clock Options | 70

Configure TimeTransmitter Clock Options | 72

PTP Enterprise Profile | 73

Configure PTP Enterprise Profile | 75

Configure PTP and its Options | 75

Configure PTP Options | 76

Configure TimeReceiver Clock Options | 77

Configure TimeTransmitter Clock Options | 78

PTP over IRB for Broadcast Profiles | 79

PTP Media Profile | 83

Configure PTP Media Profiles | 85

Configure AES67, SMPTE, and AES67+SMPTE Profiles | 86

Optional and Required Parameters for SMPTE ST-2059-2, AES67, and AES67+SMPTE ST-2059-2 Profiles | 86

Configure PTP Media Profile | 87

PHY Timestamping | 93

PHY Timestamping | 93

Configure PHY Timestamping | 94

Configure PHY Timestamping on ACX500 and ACX2K Routers | 95

Enable PHY Timestamping for Boundary Clock | 95

Precision Time Protocol over Ethernet | 97

PTP over Ethernet Overview | 97

Guidelines to Configure PTP over Ethernet | 99

Configure PTP Dynamic Ports for Ethernet Encapsulation | 102

Configure PTP Multicast TimeTransmitter and TimeReceiver Ports for Ethernet Encapsulation | 103

Configure the PTP over Ethernet TimeTransmitter Boundary Clock Parameters | 104

Configure the PTP over Ethernet TimeTransmitter Boundary Clock Interface | 106

Configure the PTP over Ethernet TimeReceiver Clock Parameters | 107

Configure PTP over Ethernet TimeReceiver Clock Interface | 108

Example: Configure PTP over Ethernet for Multicast TimeTransmitter, TimeReceiver, and Dynamic Ports | **109**

Requirements | **110**

Overview | **110**

Configuration | **111**

Verify PTP over Ethernet Multicast Dynamic, TimeTransmitter, and TimeReceiver Settings | **117**

Precision Time Protocol Additional Features | 121

Precision Time Protocol (PTP) over Link Aggregation Group (LAG) | **121**

Precision Time Protocol (PTP) Trace Overview | **122**

Line Card Redundancy for PTP | **126**

Timing Defects and Event Management on Routing Platforms | **127**

SNMP MIB for Timing on Routing Platforms | **132**

PTP Passive Port Performance Monitoring on PTX10004 and PTX10008 Devices | **137**

3 **Global Navigation Satellite System (GNSS)**

GPS Systems on Routing Platforms | 144

Global Positioning System (GPS) on Routing Platforms | **144**

Integrated GNSS on Routing Platforms | 145

Integrated Global Navigation Satellite System (GNSS) on Routing Platforms | **145**

GNSS Configuration for Routers Using External GNSS Receiver | 154

GNSS Configuration for Routers | **154**

Configure GNSS Receiver for Telecom Grandmaster (T-GM) | **156**

Troubleshoot GNSS Receiver | **160**

Configuration Statements to Enable T-GM Functionality | **160**

clock-mode | **161**

profile-type | **162**

Administrative Commands to Enable T-GM Functionality | **163**

ptp-mode | **163**

gnss-receiver | **164**

transport-ieee-802.3 | **167**

Monitoring Commands to Enable T-GM Functionality | **168**

show chassis synchronization extensive | 168
show ptp lock-status detail | 170
show chassis synchronization gnss-receiver extensive | 173
Assisted Partial Timing Support (APTS) on Routing Platforms | 178
Assisted Partial Timing Support on ACX500 Routers | 178
4 **Network Time Protocol**
NTP Concepts | 182
Network Time Protocol | 182
NTP Overview | 182
NTP Time Servers | 184
NTP Authentication Keys | 188
Network Time Security (NTS) Support for NTP | 190
Synchronize and Coordinate Time Distribution Using NTP | 193
Configure Devices to Listen to Broadcast Messages Using NTP | 196
Configure Devices to Listen to Multicast Messages Using NTP | 196
NTP Configuration Examples | 198
NTP Configuration | 198
Example: Configure NTP | 202
Requirements | 202
Overview | 202
Configuration | 203
Verification | 204
Example: Configure NTP as a Single Time Source for Router and Switch Clock Synchronization | 207
5 **Synchronous Ethernet**
Synchronous Ethernet Overview | 209
Synchronous Ethernet | 209
Synchronous Ethernet Overview | 209
Ethernet Synchronization Message Channel (ESMC) | 213
Ethernet Synchronization Message Channel Overview | 213

Ethernet Synchronization Message Channel Quality Level Mapping | 215

Example: Configure Synchronous Ethernet | 219

Example Prerequisites | 220

Overview | 220

Configuration | 220

Verification | 222

Synchronous Ethernet on 10-Gigabit Ethernet MIC | 226

Synchronous Ethernet on 10-Gigabit Ethernet MIC | 226

Overview | 226

Example: Configure Framing Mode for Synchronous Ethernet with 10-Gigabit Ethernet MIC | 230

Requirements | 230

Overview | 231

Configuration | 231

6 **Clock Synchronization**

Clock Synchronization Concepts | 236

Clock Synchronization | 236

Clock Synchronization Overview | 236

Clocking Modes, External Clock Synchronization, and Configuration Parameters | 238

Automatic Clock Selection | 257

Interface and Router Clock Sources | 260

Clock Synchronization for ACX Series Routers | 264

Configure External Clock Synchronization for ACX Series Routers | 264

Clock Synchronization for MX Series Routers | 272

Configure External Clock Synchronization for MX Series Routers | 272

Configure Clock Synchronization Options | 273

Display the External Clock Synchronization Configuration for SCB | 282

Display the External Clock Synchronization Configuration for SCBE | 283

Display the External Clock Synchronization Configuration for SCBE2 | 285

Display the External Clock Synchronization Configuration for MX2020 Control Board | 287

Clock Synchronization for PTX Series Routers | 290

Clock Sources for PTX Series Routers | 290

Synchronize Internal Stratum 3 Clock to External Clock Sources on PTX Series Routers | 293

Configure a Recovered Clock for an FPC | 293

Configure External Clock Synchronization Options | 293

Centralized Clocking | 297

Centralized Clocking | 297

Centralized Clocking Overview | 297

Example: Configure Centralized Clocking on MX2020 | 303

Requirements | 303

Overview | 304

Configuration | 305

Verification | 313

Example: Configure Centralized Clocking on the Enhanced MX Switch Control Board | 317

Requirements | 317

Overview | 318

Configuration | 319

Verification | 326

7 **Hybrid Mode**

Hybrid Mode Overview | 332

Hybrid Mode | 332

Hybrid Mode Overview | 332

Hybrid Mode Support on Junos OS and Junos OS Evolved Devices | 334

Guidelines to Configure Hybrid Mode on ACX Series Routers | 335

Hybrid Mode and ESMC Quality-Level Mapping | 337

Configure Hybrid Mode and ESMC Quality-Level Mapping Overview | 337

Configure the Router in Hybrid Mode | 338

Configure Hybrid Mode with Mapping of the PTP Clock Class to the ESMC Quality-Level | 338

Configure Hybrid Mode with a User-Defined Mapping of the PTP Clock Class to the ESMC Quality-Level | 340

Example: Configure Hybrid Mode and ESMC Quality-Level Mapping on ACX Series Router | 343

Requirements for Hybrid Mode Configuration | **343**

Overview | **343**

Configuration | **344**

Verification | **347**

Example: Configure Hybrid Mode and ESMC Quality-Level Mapping on MX240 Router | **351**

Requirements for Hybrid Mode Configuration | **351**

Overview | **351**

Configuration | **353**

Verification | **356**

8 **Configuration Statements and Operational Commands**

Junos CLI Reference Overview | 361

9 **Appendix**

Appendix - Inclusive Terms | 363

About This Guide

Use this guide to configure time-based protocols for your network devices running Junos OS and Junos OS Evolved.

RELATED DOCUMENTATION

Day One: Deploying Junos Timing and Synchronization

1

PART

Overview

Timing and Synchronization Overview | 2

Configure Date and Time Locally | 3

Modify Default Time Zone | 4

Internet Assigned Numbers Authority (IANA) Time Zone | 5

Timing and Synchronization Overview

IN THIS SECTION

- Benefits of time management and clock synchronization | 2

In network operations, support for time management and clock synchronization ensures that devices on your network display the correct date and time. Accurate and reliable synchronization of network devices helps in managing security, availability, and efficiency of the network devices. You can configure and synchronize the clocks on the devices so that all devices on the network display accurate time.

Time-based protocols and methods to configure and synchronize the network devices include:

- Synchronous Ethernet—A physical layer technology that functions regardless of the network load and supports hop-by-hop frequency transfer, where all interfaces on the trail must support Synchronous Ethernet. It enables you to deliver synchronization services that meet the requirements of the present-day mobile network, as well as future Long Term Evolution (LTE)–based infrastructures.

- Precision Time Protocol (PTP)—Provides time synchronization service over precise time and frequency on packet-based networks. In time synchronization, packets are transmitted and received in a session between a timeTransmitter clock and a timeReceiver clock.

  NOTE: Juniper documentation adheres to the inclusive terms adopted by IEEE 1588. See, "Appendix - Inclusive Terms" on page 363 for more information.

- Network Time Protocol (NTP)—Provides time synchronizes to all devices on a network. The primary NTP servers are synchronized to a reference clock, such as GPS receivers and telephone modem services. An NTP server receives the time service from a time source, a clock that is attached to a time server, and then distributes and synchronizes the time across all devices on a network.

Benefits of time management and clock synchronization

- Detects security breaches on the network devices using log data with accurate time stamps
- Reduces Ethernet latency and jitter with time stamping

- Avoids manual errors with full automation time services
- Improves accuracy and minimizes operation cost to setup Ethernet networks

Configure Date and Time Locally

You can set the date and time on a device running Junos OS by using the `set date` operational mode command:

To enter the date and time locally:

1. From operational mode, manually set the date and time.

   Because this is an operational-mode command, there is no need to perform a commit operation.

   ```
   user@host> set date YYYYMMDDhhmm.ss
   ```

   For example:

   ```
   user@host> set date 201307251632
   Thu Jul 25 16:32:00 PDT 2013
   ```

2. Verify the time.

   The `show system uptime` command provides the following information: current time, last boot time, protocols start time, last configuration commit time.

   ```
   user@host> show system uptime
   Current time: 2013-07-25 16:33:38 PDT
   System booted: 2013-07-11 17:14:25 PDT (1w6d 23:19 ago)
   Protocols started: 2013-07-11 17:16:35 PDT (1w6d 23:17 ago)
   Last configured: 2013-07-23 12:32:42 PDT (2d 04:00 ago) by user
    4:33PM  up 13 days, 23:19, 1 user, load averages: 0.00, 0.01, 0.00
   ```

You can use the `set date` command from operational mode to instruct the device to retrieve the date and time from a configured NTP server. For example:

- From operational mode, issue the `set date` command and specify `ntp` to retrieve the date and time from a configured NTP server, or specify `ntp` *`ntp-server`* to retrieve the date and time from the given NTP server.

```
user@host> set date ntp ntp-server
```

For example:

```
user@host> set date ntp
 25 Jun 16:38:28 ntpdate[2314]: step time server 192.0.2.1 offset -0.004182 sec
```

Modify Default Time Zone

The default local time zone on a router or a switching device is UTC (Coordinated Universal Time, formerly known as Greenwich Mean Time, or GMT).

To modify the local time zone, include the `time-zone` statement at the `[edit system]` hierarchy level:

```
[edit system]
time-zone (GMThour-offset | time-zone);
```

You can use the `GMT` *`hour-offset`* option to set the time zone relative to UTC (GMT) time. By default, *`hour-offset`* is 0. You can configure this to be a value in the range from −14 to +12.

You can also specify *`time-zone`* as a string such as PDT (Pacific Daylight Time) or WET (Western European Time), or specify the continent and major city.

NOTE: Junos OS complies with the POSIX time-zone standard, which is counter-intuitive to the way time zones are generally indicated relative to UTC. A time zone ahead of UTC (east of the Greenwich meridian) is commonly indicated as GMT +*n*; for example, the Central European Time (CET) zone is indicated as GMT +1. However, this is not true for POSIX time zone designations. POSIX indicates CET as GMT-1. If you include the `set system time-zone GMT+1` statement for a router or a switch in the CET zone, your device time will be set to one hour behind GMT, or two hours behind the actual CET time. For this reason, you might find it easier to use the POSIX time-zone strings, which you can list by entering `set system time-zone ?`.

For the time zone change to take effect for all processes running on the router or switch, you must reboot the router or switch.

The following example shows how to change the current time zone to `America/New_York`:

```
[edit]
user@host# set system time-zone America/New_York
[edit]
user@host# show
system {
    time-zone America/New_York;
}
```

Starting in Junos OS Release 15.1F6, for the routers with the RE-MX-X6, RE-MX-X8, and RE-PTX-X8 Routing Engines, the date and time zones are synchronized from the admin guest Junos OS to the host OS. Thus, the guest OS and the host OS use the same time zone and there is no difference in the timestamps in system log files of Junos OS and the host OS. This time zone and date synchronization changes the time zone of the host from the default UTC to the configured time zone. However, for the time zone change to take effect for all processes running on the router, reboot the router by using the `request vmhost reboot` command.

Internet Assigned Numbers Authority (IANA) Time Zone

IN THIS SECTION

- Import and Install Time Zone Files | 6
- Configure Custom Time Zone | 7

Junos OS devices use the tz database, also known as the IANA Time Zone Database to manage time zones. This database is periodically updated by IANA to reflect political and time changes. As such, you may need from time to time to update this file to ensure the Junos devices continue to accurately reflect worldwide time zones and daylight savings time intervals.

To update the IANA Time Zone Database, perform the following steps:

Import and Install Time Zone Files

The IANA Time Zone Database is maintained by the Internet Assigned Numbers Authority (IANA), which is a department of the Internet Corporation for Assigned Names and Numbers (ICANN). You can download the latest IANA Time Zone Database file from the following URL: http://www.iana.org/time-zones.

The following steps will guide you through one method of installing the file to your device. However, depending on your network access and other preferences, you may need to modify these steps.

1. Log into the Junos device.
2. If you are in the CLI interface, open the shell interface.

```
device@user# start shell
```

3. Create a `tz` directory in the `/var/tmp` and navigate to that directory.

```
# mkdir /var/tmp/tz
# cd /var/tmp/tz
```

4. Using FTP, download the time zone files archive.

NOTE: FTP must be enabled on your device before you can use FTP. FTP is enabled by adding the `ftp` statement into the `[edit system services]` hierarchy.

```
# ftp ftp.iana.org/tz
# bin
# get tzdata-latest.tar.gz
```

NOTE: If needed, you can edit the above untarred files to create or modify the time zones.

5. Select the names of time zone files to compile and feed them to the following script. For example, to generate **northamerica** and **asia** tz files:

```
# /usr/libexec/ui/compile-tz northamerica asia
```

6. Enable the use of the generated tz files using the CLI:

```
[edit]
# set system use-imported-time-zones

[edit]
# set system time-zone ?
```

   This should show the newly generated tz files in **/var/db/zoneinfo/**.

7. Set the time zone and commit the configuration:

```
[edit]
# set system time-zone <your-time-zone>
# commit
```

8. Verify that the time zone change has taken effect:

```
[edit]
# run show system uptime
```

Configure Custom Time Zone

To use a custom time zone, follow these steps:

1. Download a time zones archive (from a known or designated source) to the router or switch. Compile the time zone archive using the *zic* time zone compiler, which generates *tz* files.
2. Using the CLI, configure the router or switch to enable the use of the generated tz files as follows:

```
[edit]
user@host# set system use-imported-time-zones
```

3. Display the imported time zones (saved in the directory **/var/db/zoneinfo/**):

```
[edit]
user@host# set system time-zone ?
```

If you do not configure the router to use imported time zones, the Junos OS default time zones are shown (saved in the directory **/usr/share/zoneinfo/**).

2
PART

Precision Time Protocol

Precision Time Protocol Overview | 10

Precision Time Protocol Clocks | 21

Precision Time Protocol Profiles | 56

PHY Timestamping | 93

Precision Time Protocol over Ethernet | 97

Precision Time Protocol Additional Features | 121

CHAPTER 1

Precision Time Protocol Overview

IN THIS CHAPTER

- Precision Time Protocol (PTP) Overview | 10
- Configure Precision Time Protocol (PTP) Clocking | 12
- Example: Configure Precision Time Protocol | 14

Precision Time Protocol (PTP) Overview

SUMMARY

Precision Time Protocol (PTP) is a time-based protocol, designed to distribute precise time and frequency over packet-switched Ethernet networks.

PTP, also known as IEEE 1588v2, is a packet-based technology that enables the operator to deliver synchronization services on packet-based mobile backhaul networks. IEEE 1588 PTP (Version 2) clock synchronization standard is a highly precise protocol for time synchronization that synchronizes clocks in a distributed system. The time synchronization is achieved through packets that are transmitted and received in a session between a timeTransmitter clock and a timeReceiver clock. When a clocks serves as a source of time, it is known as a timeTransmitter clock. When a clock may synchronize to another clock, it is called a timeReceiver clock. The following list explains these clocks in detail:

- TimeTransmitter clock—The timeTransmitter clock transmits the messages to the PTP timeReceiver clocks (also called timeReceiver node or boundary node). This allows the timeReceiver clocks to establish their relative time distance and offset from the timeTransmitter clock (which is the reference point) for phase synchronization. Delivery mechanism to the timeReceiver clocks is either unicast or multicast packets over Ethernet or UDP.

- TimeReceiver clock—located in the PTP timeReceiver (also called timeReceiver node), the timeReceiver clock performs clock and time recovery operations based on the received and requested timestamps from the timeTransmitter clock.

> **NOTE**: Juniper documentation adheres to the inclusive terms adopted by IEEE 1588. See, "Appendix - Inclusive Terms" on page 363 for more information.

The system clocks can be categorized based on the role of the node in the network. They are broadly categorized into ordinary clock, boundary clock, grandmaster clock and transparent clock. The following list explains these clocks in detail:

- Boundary clock—The boundary clock has multiple PTP ports in a domain and maintains the timescale used in the domain. The boundary clock operates as a combination of the timeTransmitter and timeReceiver clocks. The boundary clock endpoint acts as a timeReceiver clock to the timeTransmitter clock, and also acts as the timeTransmitter to all the timeReceiver clocks reporting to the boundary endpoint.

- Ordinary clock—The ordinary clock has a single PTP port in a domain and maintains the timescale used in the domain. It operates either as a timeTransmitter or timeReceiver clock.

- Transparent clock—Transparent clocks measure and adjust for packet delay. The transparent clock computes the variable delay as the PTP packets pass through the switch or the router.

- Grandmaster clock—Grandmaster clock is the primary source of time and provides root time reference in PTP. It is connected to a reliable time source such as GPS. All other clocks directly or indirectly synchronize with the grandmaster clock. The grandmaster clock is always configured as a timeTransmitter clock.

See the Feature Explorer page to confirm platform and release support for specific features.

> **NOTE**:
>
> - Unified in-service software upgrade (unified ISSU) is currently not supported when clock synchronization is configured for PTP and Synchronous Ethernet on the MICs and Enhanced MPCEs on MX240, MX480, MX960, MX2010, and MX2020 routers.
>
> - To switch between the PTP and Synchronous Ethernet modes, you must first deactivate the configuration for the current mode and then commit the configuration. Wait for a short period of 30 seconds, configure the new mode and its related parameters, and then commit the configuration.

- PTP configuration might not work properly when MX10008 Router with JNP10K-LC2101 Line card and Hypermode Enabled. Hypermode can be enabled by default when MX10008 Router has Switch Fabric Board 2 (SFB2), or by using the command `set forwarding-options hyper mode`. Hence, such PTP interfaces (timeReceiver, timeTransmitter, stateful) are unsupported.

Configure Precision Time Protocol (PTP) Clocking

SUMMARY

In a distributed network, you can configure Precision Time Protocol (PTP) timeTransmitter clocks and timeReceiver clocks to help synchronize the timing across the network. The synchronization is achieved through packets that are transmitted and received in a session between the timeTransmitter clock and the timeReceiver clock or clock client.

To configure Precision Time Protocol (PTP) options:

1. In configuration mode, go to the `[edit protocols ptp]` hierarchy level.

```
[edit]
user@host# edit protocols ptp
```

2. Specify the clock as a boundary or ordinary clock. The `boundary` option signifies that the clock can be both a timeTransmitter clock and a timeReceiver clock. The `ordinary` option signifies that the clock is a timeReceiver clock.

```
[edit protocols ptp]
user@host# set clock-mode (boundary | ordinary)
```

3. (Optional) Enable PHY Timestamping. The PHY timestamping is disabled by default.

```
[edit protocols ptp]
user@host# set e2e-transparent
```

4. (Optional) Configure the PTP domain with values from 0 through 127. The default value is 0.

```
[edit protocols ptp]
user@host# set domain domain-value
```

5. (Optional) Specify the DiffServ code point (DSCP) value (0 through 63) for all PTP IPv4 packets originated by the router. The default value is 56.

```
[edit protocols ptp]
user@host# set ipv4-dscp number
```

6. Specify the timeTransmitter clock parameters.

```
[edit protocols ptp]
user@host# set master
```

For details about configuring the timeTransmitter clock parameters, see .

7. (Optional) Configure the priority value of the clock (0 through 255). This value is used in selecting the best timeTransmitter clock. The *priority1-value* is advertised in the timeTransmitter clock's announce message to clock clients. The default value is 128.

```
[edit protocols ptp]
user@host# set priority1 priority1-value
```

8. (Optional) Configure the tie-breaker in selecting the best timeTransmitter clock (0 through 255). The `priority2` value differentiates and prioritizes the timeTransmitter clock to avoid confusion when the *priority1-value* is the same for different timeTransmitter clocks in a network. The default value is 128.

```
[edit protocols ptp]
user@host# set priority2 priority2-value
```

9. Specify the PTP timeReceiver clock parameters.

```
[edit protocols ptp]
user@host# set slave
```

For information about configuring the timeReceiver clock options, see

10. (Optional) Enable unicast negotiation. Unicast negotiation is a method by which the announce, synchronization, and delay response packet rates are negotiated between the timeTransmitter clock and the clock client before a PTP session is established.

```
[edit protocols ptp]
user@host# set unicast-negotiation
```

NOTE: Unicast negotiation, when enabled, does not allow you to commit packet rate–related configurations.

Example: Configure Precision Time Protocol

SUMMARY

You can configure the timeTransmitter clock and the timeReceiver clock for Precision Time Protocol (PTP) to help synchronize clocks in a distributed system. The time synchronization is achieved through packets that are transmitted and received in a session between the timeTransmitter clock and the timeReceiver clock.

IN THIS SECTION

- Overview | 14

Overview

IN THIS SECTION

- Requirements for PTP Configuration | 15
- Configuration | 15
- Verification | 18

This example shows the configuration of Precision Time Protocol (PTP) on all Ethernet Modular Interface Cards (MICs) on the enhanced Module Port Concentrator (MPCE) MX-MPC2E-3D-P on MX240, MX480, and MX960 routers and on the MX80 Universal Routing Platforms with precision timing support (MX80-P).

PTP synchronizes clocks between nodes in a network, thereby enabling the distribution of an accurate clock over a packet switched network. This synchronization is achieved through packets that are transmitted and received in a session between the timeTransmitter clock and the timeReceiver clock. PTP also supports boundary clock.

NOTE: You can set the values for each parameter according to your requirement. The values given in this example are for illustration purposes only.

Requirements for PTP Configuration

This example uses the following hardware and software components:

- One MX80, MX240, MX480, or MX960 router
- Junos OS Release 12.2 or later

Configuration

IN THIS SECTION

- CLI Quick Configuration | 15
- Step-by-Step Procedure | 16
- Result | 17

CLI Quick Configuration

To quickly configure PTP on an interface, copy the following commands, paste them in a text file, remove any line breaks, and then copy and paste the commands into the CLI.

```
[edit]
set interfaces ge-0/1/0 unit 0 family inet address 192.0.2.5/24
set interfaces ge-0/1/5 unit 0 family inet address 198.51.100.5/24
set protocols ptp clock-mode boundary priority1 1 priority2 2 domain 0 unicast-negotiation
set protocols ptp slave interface ge-0/1/0.0 unicast-mode transport ipv4
set protocols ptp slave announce-timeout 2 delay-request -4 frequency-only
```

```
set protocols ptp slave interface ge-0/1/0.0 unicast-mode clock-source 192.0.2.3 local-ip-
address 192.0.2.5
set protocols ptp master interface ge-0/1/5.0 unicast-mode transport ipv4
set protocols ptp master announce-interval 0 clock-step one-step sync-interval 0
set protocols ptp master interface ge-0/1/5.0 unicast-mode clock-client 198.51.100.3 local-ip-
address 198.51.100.5
```

Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see Using the CLI Editor in Configuration Mode in the CLI User Guide.

To configure PTP, perform the following tasks:

1. Configure two interfaces and assign IP addresses to it.

   ```
   [edit]
   user@host# set interfaces ge-0/1/0 unit 0 family inet address 192.0.2.5/24
   user@host# set interfaces ge-0/1/5 unit 0 family inet address 198.51.100.5/24
   ```

2. Configure the clock mode, priorities, domain, and unicast negotiation options for PTP.

   ```
   [edit protocols ptp]
   user@host# set clock-mode boundary priority1 1 priority2 2 domain 0 unicast-negotiation
   ```

3. Configure the timeReceiver interface

   ```
   [edit protocols ptp slave]
   user@host# set interface ge-0/1/0.0 unicast-mode transport ipv4
   ```

4. Configure the announce timeout, delay request, and frequency synchronization parameters for the timeReceiver.

   ```
   [edit protocols ptp slave]
   user@host# set announce-timeout 2 delay-request -4 frequency-only
   ```

5. Assign the IP address of the remote timeTransmitter using the `clock-source` option and the IP address of the local interface acting as the timeReceiver.

```
[edit protocols ptp slave interface ge-0/1/0.0 unicast-mode]
user@host# set clock-source 192.0.2.3 local-ip-address 192.0.2.5
```

6. Configure the timeTransmitter interface

```
[edit protocols ptp master]
user@host# set interface ge-0/1/5.0 unicast-mode transport ipv4
```

7. Configure the announce interval, clock step, and synchronous interval parameters for the timeTransmitter.

```
[edit protocols ptp master]
user@host# set announce-interval 0 clock-step one-step sync-interval 0
```

8. Configure the remote PTP host that will receive time from the PTP timeTransmitter using the clock-client option and the IP address of the local interface acting as timeTransmitter.

```
[edit protocols ptp master interface ge-0/1/5.0 unicast-mode]
user@host# set clock-client 198.51.100.3 local-ip-address 198.51.100.5
```

Result

Display the results of the configuration:

```
[edit protocols ptp]
user@host# show
clock-mode boundary;
priority1 1;
priority2 2;
domain 0;
unicast-negotiation;
slave {
    frequency-only;
    delay-request -4;
```

```
    announce-timeout 2;
    interface ge-0/1/0.0 {
        unicast-mode {
            transport ipv4;
            clock-source 192.0.2.3 local-ip-address 192.0.2.5;
        }
    }
}
master {
    announce-interval 0;
    sync-interval 0;
    clock-step one-step;
    interface ge-0/1/5.0 {
        unicast-mode {
            transport ipv4;
            clock-client 198.51.100.3 local-ip-address 198.51.100.5;
        }
    }
}
```

Verification

IN THIS SECTION

- Verify PTP Clock Details | 18
- Verify the Lock Status of the Member | 19
- Verify the PTP Options on the Member | 19
- Verify the PTP Options and the Current Status of the Primary | 20
- Verify the Number and Status of the PTP Ports | 20

Confirm that the configuration is working properly.

Verify PTP Clock Details

Purpose

Verify that the PTP clock is working as expected.

Action

In operational mode, enter the `run show ptp clock` command to display the clock details.

Meaning

The output displays the clock details, which include the parameters configured on the node. For more information about the `run show ptp clock` operational command, see *show ptp clock*.

Verify the Lock Status of the Member

Purpose

Verify that the timeReceiver clock is aligned to the timeTransmitter clock by checking the lock status of the timeReceiver.

Action

In operational mode, enter the `run show ptp lock-status` command to display the lock status of the timeReceiver.

Meaning

The output displays information about the lock status of the timeReceiver. The output shows whether the timeReceiver is aligned to the timeTransmitter clock or not. For more information about the `run show ptp lock-status` operational command, see *show ptp lock status*.

Verify the PTP Options on the Member

Purpose

Verify the PTP options that are set on the timeReceiver and its current status.

Action

In operational mode, enter the `run show ptp slave` command to display the configured timeReceiver.

Meaning

The output displays information about the configured timeReceiver and the status of the timeReceiver. For more information about the `run show ptp slave` operational command, see *show ptp slave*.

Verify the PTP Options and the Current Status of the Primary

Purpose

Verify the PTP options that are set for the ` and its current status.

Action

In operational mode, enter the `run show ptp master` command to display the configured options for the timeTransmitter.

Meaning

The output displays information about the configured timeTransmitter and the current status of the timeTransmitter. For more information about the `run show ptp master` operational command, see *show ptp master*.

Verify the Number and Status of the PTP Ports

Purpose

Verify the number of PTP ports and their current status.

Action

In operational mode, enter the `run show ptp port` command to display the configured ports.

Meaning

The output displays information about the number of ports created according to the configuration and their current status. For each unique local IP address, one PTP port is created. For more information about the `run show ptp port` operational command, see *show ptp port*.

CHAPTER 2

Precision Time Protocol Clocks

IN THIS CHAPTER

- PTP Boundary Clock Overview | **21**
- Example: Configure PTP Boundary Clock | **25**
- Example: Configure PTP Boundary Clock With Unicast Negotiation | **29**
- Configure PTP TimeTransmitter Clock | **35**
- Configure PTP TimeReceiver Clock | **39**
- Example: Configure Ordinary TimeReceiver Clock With Unicast-Negotiation | **44**
- Example: Configure Ordinary TimeReceiver Clock Without Unicast-Negotiation | **48**
- PTP Transparent Clocks | **51**
- Configure PTP Transparent Clock | **53**

PTP Boundary Clock Overview

IN THIS SECTION

- PTP Boundary Clock | **22**
- Clock Clients | **24**

An IEEE 1588v2 boundary clock has multiple network connections and can act as a source (timeTransmitter) and a destination (timeReceiver) for synchronization messages. It synchronizes itself to a best *timeTransmitter clock* through a timeReceiver port and supports synchronization of remote clock clients to it on timeTransmitter ports.

PTP Boundary Clock

Boundary clocks can improve the accuracy of clock synchronization by reducing the number of 1588v2-unaware hops between the timeTransmitter and the timeReceiver. Boundary clocks can also be deployed to deliver better scale because they reduce the number of sessions and the number of packets per second on the timeTransmitter.

The boundary clock intercepts and processes all PTP messages and passes all other traffic. The best timeTransmitter clock algorithm (BTCA) is used by the boundary clock to select the best configured acceptable timeTransmitter clock that a boundary timeReceiver port can see. To configure a boundary clock, include the `boundary` statement at the [`edit protocols ptp clock-mode`] hierarchy level and at least one timeTransmitter with the `master` statement and at least one timeReceiver with the `slave` statement at the [`edit protocols ptp`] hierarchy level.

ACX5448 router supports PTP boundary clocks for phase and time synchronization using IEEE-1588 Precision Timing Protocol (PTP). The ACX5448 router supports the following features:

- PTP over IPv4 (IEEE-1588v2)
- PTP ordinary and boundary clocks
- One step clock mode operation for PTP TimeTransmitter
- 10Mhz and 1PPS output for measurement purpose

All PTP packets uses the best-effort queue instead of network control queue.

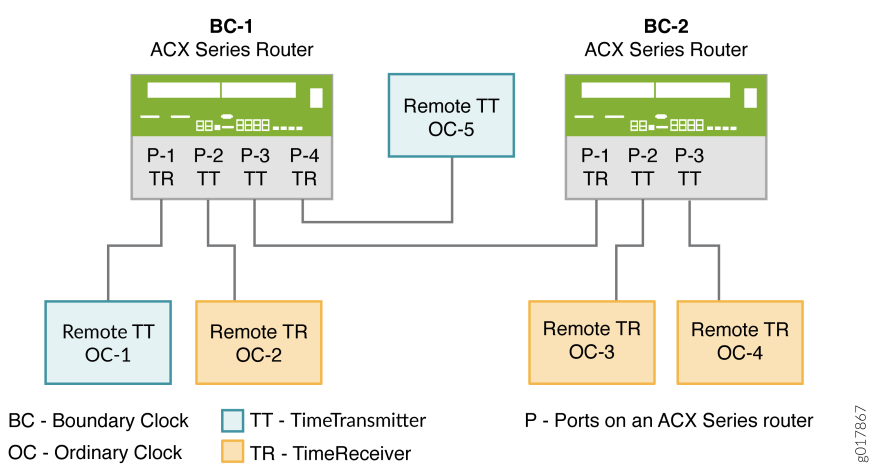
If `clksyncd-service` restart is initiated, then the `show ptp lock status detail` CLI command output of **Clock reference state** and **1pps reference state** fields shows incorrect information. The following is a sample of output for `show ptp lock status detail`:

```
user@host> show ptp lock-status detail
Lock Status:

Lock State    : 5 (PHASE ALIGNED)
Phase offset  : 0.000000010 sec
State since   : 2018-11-22 00:38:56 PST (00:10:18 ago)

Selected Master Details:
Upstream Master address    : 12.0.0.1
Slave interface            : xe-0/0/20.0
Clock reference state      : Clock locked
1pps reference state       : Clock qualified
```

> **NOTE**:
>
> - On MX240, MX480, MX960, MX2010, and MX2020 platforms when the boundary clock is switched from one MPC slot to another, PTP may go into a re-acquiring state irrespective of the PTP lock state. The clock state will transition from `Initializing/Free run` to `Acquiring` and then to `Phase-Aligned` upon the switchover from one slot to the other. On these platforms, while the clock recovery is in progress, the downstream nodes are notified of the change through the downgrading of the clock class. The clock class 248 is transmitted to downstream nodes. The downstream nodes can take appropriate action such as to go to the holdover state or to switch to an alternate clock path.
>
> - On MX304, PTX10004, PTX10008, and PTX10016, if the time of day (TOD) counter of the timestamping units (PHY or ASIC) in the system are not synced with the global TOD counter for more than 3 seconds due to any reason, then the downstream clock class of the boundary clock is degraded to 248. Once the timestamping units are in sync with the global ToD counter, the clock class value is restored to the old valid value based on its active timeTransmitter's clock class.

Figure 1 on page 23 illustrates two boundary clocks in a network in which the clock flow is from the upstream node (BC-1) to the downstream node (BC-2). This figure also applies to MX Series routers and QFX Series switches.

Figure 1: Boundary Clocks in a Network



The first boundary clock—BC-1—has four ports. Each port is configured as follows:

- BC-1 P-1 and BC-1 P-4 are boundary timeReceiver ports connected to two grandmaster clocks—OC-1 and OC-5. The grandmaster clocks are included as the clock sources in the timeReceiver port configurations. From the packets received on the timeReceiver ports, BC-1 selects the best timeTransmitter, synchronizes its clock, and generates PTP packets, which are sent over the timeTransmitter ports—BC-1 P-2 and BC-1 P-3—to the downstream timeReceiver clocks.

- BC-1 P-2, a timeTransmitter port, is connected to OC-2, an ordinary remote timeReceiver. OC-2 is included as a clock client in BC-1 P-2's timeTransmitter configuration, and so receives PTP packets from BC-1 P-2.

- BC-1 P-3, a timeTransmitter port, is connected to BC-2 P-1, a remote boundary timeReceiver port. In this situation, the timeTransmitter port—BC-1 P-3—is included as a clock source in the configuration of the boundary timeReceiver port—BC-2 P-1. In addition, the boundary timeReceiver port—BC-2 P-1—is included as a clock client in the configuration of the timeTransmitter port—BC-1 P-3. With this configuration, the boundary timeReceiver—BC-2 P1—receives PTP packets from BC-1 P3.

The second boundary clock—BC-2—has three ports. Each port is configured as follows:

- BC-2 P-1 is a boundary timeReceiver port connected to the upstream timeTransmitter port—BC-1 P3. As described previously, BC-2 P-1 receives PTP packets from BC-1 P3. The timeTransmitter ports—BC-2 P-2 and BC-2 P-3—synchronize their time from the packets received from BC-2 P1.

- BC-2 P-2 and BC-2 P-3, boundary timeTransmitter ports, are connected to ordinary remote timeReceiver clocks—OC-3 and OC-4. OC-3 and OC-4 are included as clock clients in the configuration of the timeTransmitter ports—BC-2 P2 and BC-2 P-3. Both timeReceiver clocks receive PTP packets from the timeTransmitter boundary port to which they are connected.

In this example, the boundary clock synchronizes its clock from the packets received on its timeReceiver ports from the upstream timeTransmitter. The boundary clock then generates PTP packets, which are sent over the timeTransmitter port to downstream timeReceiver clocks. These packets are timestamped by the boundary clock by using its own time, which is synchronized to the selected upstream timeTransmitter.

Clock Clients

A clock client is the remote PTP host, which receives time from the PTP timeTransmitter and is in a timeReceiver relationship to the timeTransmitter.

> **NOTE**: The term *timeReceiver* is sometimes used to refer to the clock client.

A device acting as a timeTransmitter boundary clock supports the following types of downstream timeReceiver clocks:

- Automatic timeReceiver—An automatic timeReceiver is configured with an IP address, which includes the subnet mask, indicating that any remote PTP host belonging to that subnet can join the timeTransmitter clock through a unicast negotiation. To configure an automatic timeReceiver, include the subnet mask in the `clock-client` *`ip-address`* statement at the [`edit protocols ptp master interface` *`interface-name`* `unicast-mode`] hierarchy level.

- Manual timeReceiver—A manual timeReceiver is configured with the `manual` statement at the [`edit protocols ptp master interface` *`interface-name`* `unicast-mode clock-client ip-address local-ip-address` *`local-ip-address`*] hierarchy level. A manual timeReceiver does *not* use unicast negotiation to join the timeTransmitter clock. The `manual` statement overrides the `unicast negotiation` statement configured at the [`edit protocols ptp`] hierarchy level. As soon as you configure a manual timeReceiver, it starts receiving announce and synchronization packets.

- Secure timeReceiver—A secure timeReceiver is configured with an exact IP address of the remote PTP host, after which it joins a timeTransmitter clock through unicast negotiation. To configure a secure timeReceiver, include the exact IP address in the `clock-client` *`ip-address`* statement at the [`edit protocols ptp master interface` *`interface-name`* `unicast-mode`] hierarchy level.

NOTE:

- You can configure the maximum number of timeReceiver clocks (512) in the following combination:
  - 256 Automatic timeReceiver clocks
  - 256 Manual and secure timeReceiver clocks—Any combination of manual and secure timeReceiver clocks is allowed as long as the combined total amounts to 256.
- You can configure a maximum of 512 timeReceiver clocks in any combination of automatic, manual, and secure timeReceiver clocks for ACX7100 devices on Junos OS Evolved.

Example: Configure PTP Boundary Clock

IN THIS SECTION

- Requirements | 26
- Overview | 26

● Configuration | 26

This example shows how to configure a Precision Timing Protocol (PTP) boundary clock. A boundary clock must include the configuration of at least one timeTransmitter and at least one timeReceiver. The boundary timeTransmitter receives time from a remote timeTransmitter through the timeReceiver, and in turn passes that time on to the timeReceiver clocks, which are in a timeReceiver relationship to the boundary timeTransmitter. In this example, you configure a timeTransmitter, timeReceiver, clock source, and clock client.

NOTE: ACX5048 and ACX5096 routers do not support boundary clock.

Requirements

This example uses the following hardware and software components:

NOTE: This example also applies to QFX Series switches. QFX Series switches do not support Gigabit Ethernet interfaces. Instead, configure PTP boundary clock parameters on 10-Gigabit Ethernet interfaces.

- An ACX Series router
- Junos OS Release 12.3 or later

Overview

In this example, the timeReceiver clock or clock client immediately receives announce and synchronization packets after completion of the configuration.

Configuration

IN THIS SECTION

● Procedure | 27

Procedure

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them in a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the [edit] hierarchy level:

```
set protocols ptp clock-mode boundary
set protocols ptp slave interface ge-1/3/9.0 unicast-mode transport ipv4
set protocols ptp slave interface ge-1/3/9.0 unicast-mode clock-source 192.1.1.2 local-ip-
address 192.1.1.1
set protocols ptp master interface ge-1/0/0.0 unicast-mode transport ipv4
set protocols ptp master interface ge-1/0/0.0 unicast-mode clock-client 20.20.20.2/32 local-ip-
address 20.20.20.1
```

Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy.

To configure a boundary clock without unicast negotiation:

1. Configure the clock mode.

   ```
   [edit protocols ptp]
   user@host# set clock-mode boundary
   ```

2. Configure the timeReceiver interface.

   ```
   [edit protocols ptp]
   user@host# edit slave interface ge-1/3/9.0
   ```

3. Configure the upstream unicast PTP timeTransmitter clock source parameters.

   ```
   [edit protocols ptp slave interface ge-1/3/9.0]
   user@host# edit unicast-mode
   ```

4. Configure the encapsulation type for PTP packet transport.

```
[edit protocols ptp slave interface ge-1/3/9.0 unicast-mode ]
user@host# set transport ipv4
```

5. Configure the IP address of the timeTransmitter interface.

```
[edit protocols ptp]
user@host# edit master interface ge-1/0/0.0
```

6. Specify the IP address and subnet of the remote PTP host, and the IP address of the local PTP timeTransmitter interface.

```
[edit protocols ptp master interface ge-1/0/0.0 ]
user@host# edit unicast-mode
user@host# set protocols ptp master interface ge-1/0/0.0 unicast-mode clock-client
20.20.20.2/32 local-ip-address 20.20.20.1
```

> **NOTE**: For the configuration to work, the timeTransmitter interface you specify must be configured with this IP address at the [`edit interfaces` *`interface-name`*] hierarchy level.

7. Configure the encapsulation type for PTP packet transport.

```
[edit protocols ptp master interface ge-1/0/0.0 unicast-mode]
user@host# set transport ipv4
```

Results

From configuration mode, confirm your configuration by entering the `show` command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit protocols ptp]
user@host# show
clock-mode boundary;
slave {
    interface ge-1/3/9.0 {
```

```
        unicast-mode {
            transport ipv4;
            clock-source 192.1.1.2 local-ip-address 192.1.1.1;
        }
    }
}
master {
    interface ge-1/0/0.0 {
        unicast-mode {
            transport ipv4;
            clock-client 20.20.20.2/32 local-ip-address 20.20.20.1;
        }
    }
}
```

After you have configured the device, enter the **commit** command from configuration mode.

Example: Configure PTP Boundary Clock With Unicast Negotiation

IN THIS SECTION

- Requirements | **30**
- Overview | **30**
- Configuration | **31**

This example shows how to configure a boundary clock with unicast negotiation turned on and a mixture of manual, secure and automatic clock clients, which have a timeReceiver relationship to the timeTransmitter boundary clock. The unicast negotiation applies to clock sources, which are configured on the timeReceiver or clock client. Clock clients, configured on the timeTransmitter, are not affected by unicast negotiation.

NOTE: ACX5048 and ACX5096 routers do not support boundary clock.

In this example, unicast-negotiation is applicable only to clock-sources. For clock clients, the statement `unicast-negotiation` at the [`edit protocols ptp`] hierarchy level is not effective.

Requirements

This example uses the following hardware and software components:

> **NOTE**: This example also applies to QFX Series switches. QFX Series switches do not support Gigabit Ethernet interfaces. Instead, configure PTP boundary clock parameters on 10-Gigabit Ethernet interfaces.

- An ACX Series router
- Junos OS Release 12.3 or later

Overview

A PTP timeReceiver clock or clock client can join a timeTransmitter clock with and without unicast negotiation. With unicast negotiation, the announce, synchronization, and delay response packet rates are negotiated between the timeTransmitter and the timeReceiver before a PTP session is established. Without unicast negotiation and after it is configured, the timeReceiver or the clock client immediately receives announce and synchronization packets.

A clock client is the remote PTP host, which receives time from the PTP timeTransmitter. The following clock clients are configured in this example:

- Secure timeReceiver—A secure timeReceiver is configured with an exact IP address, after which, it joins a timeTransmitter clock through unicast negotiation. In this example, the clock client `clock-client 117.117.117.117/32 local-ip-address 109.109.109.53` is a secure timeReceiver, which means that only this specific host from the subnet can join the timeTransmitter clock through a unicast negotiation .
- Automatic timeReceiver—An automatic timeReceiver is configured with an IP address, which includes a subnet mask, indicating that any PTP host belonging to that subnet, can join the timeTransmitter clock through a unicast negotiation. In this example, the clock client `clock-client 109.109.109.0/24 local-ip-address 109.109.109.53` is an automatic timeReceiver. Additionally, this automatic timeReceiver is configured on the same timeTransmitter clock interface—`109.109.109.53`—as the secure timeReceiver.
- Manual timeReceiver—A manual timeReceiver does *not* use unicast negotiation to join the timeTransmitter clock. The `manual` statement overrides the `unicast-negotiation` statement configured at the `[edit protocols ptp]` hierarchy level. As soon as you configure a manual timeReceiver, it starts receiving announce and synchronization packets. In this example, the clock client `clock-client 7.7.7.7 local-ip-address 7.7.7.53 manual` is the manual timeReceiver and is configured on a second timeTransmitter clock interface.

Configuration

IN THIS SECTION

- Procedure | 31

A boundary clock must include the configuration of at least one timeTransmitter and at least one timeReceiver. The boundary timeTransmitter receives time from a remote timeTransmitter through the timeReceiver, and in turn passes that time on to clock clients, which are in a timeReceiver relationship to the boundary timeTransmitter. In this example, you configure a boundary timeReceiver, two Precision Time Protocol (PTP) boundary timeTransmitters with three different kinds of clock clients—automatic, manual, and secure. Two of the clock clients are configured on the same boundary timeTransmitter.

Procedure

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them in a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the [edit] hierarchy level:

```
set protocols ptp clock-mode boundary
set protocols ptp unicast-negotiation
set protocols ptp slave interface ge-0/1/0.0 unicast-mode transport ipv4
set protocols ptp slave interface ge-0/1/0.0 unicast-mode clock-source 10.10.10.50 local-ip-
address 10.10.10.53
set protocols ptp master interface ge-0/1/3.0 unicast-mode transport ipv4
set protocols ptp master interface ge-0/1/3.0 unicast-mode clock-client 117.117.117.117/32 local-
ip-address 109.109.109.53
set protocols ptp master interface ge-0/1/3.0 unicast-mode clock-client 109.109.109.0/24 local-
ip-address 109.109.109.53
set protocols ptp master interface ge-0/1/5.0 unicast-mode transport ipv4
 set protocols ptp master interface ge-0/1/5.0 unicast-mode clock-client 7.7.7.7/32 local-ip-
address 7.7.7.53 manual
```

Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For information about navigating the CLI, see *Using the CLI Editor in Configuration Mode* in the CLI User Guide.

To configure a boundary clock with unicast negotiation:

1. Configure the clock mode.

```
[edit protocols ptp]
user@host# set clock-mode boundary
```

2. Enable unicast negotiation.

```
[edit protocols ptp]
user@host# set unicast-negotiation
```

3. Configure the local timeReceiver interface from which the boundary timeTransmitter receives time and passes it on to the configured clock timeReceiver clocks.

```
[edit protocols ptp]
user@host# edit slave interface ge-0/1/0.0
```

4. Configure the upstream unicast PTP timeTransmitter clock source parameters.

```
[edit protocols ptp slave interface ge-0/1/0.0]
user@host# edit unicast-mode
```

5. Configure the encapsulation type for PTP packet transport.

```
[edit protocols ptp slave interface  ge-0/1/0.0 unicast-mode ]
user@host# set transport ipv4
```

6. Configure the PTP timeTransmitter parameters by specifying the IP address of the PTP timeTransmitter clock and the IP address of the local interface.

```
[edit protocols ptp slave interface ge-0/1/0.0 unicast-mode ]
user@host# set clock-source 10.10.10.50 local-ip-address 10.10.10.53
```

7. Configure the first timeTransmitter interface in this example.

```
[edit protocols ptp]
user@host# edit master interface ge-0/1/3.0
```

8. On the first timeTransmitter interface, configure the downstream PTP clock clients.

```
[edit protocols ptp master interface ge-0/1/3.0 ]
user@host# edit unicast-mode
```

9. On the first timeTransmitter interface, configure the encapsulation type for PTP packet transport.

```
[edit protocols ptp master interface ge-0/1/3.0  unicast-mode]
user@host# set transport ipv4
```

10. On the first timeTransmitter interface, configure the PTP timeTransmitter parameters by specifying the exact IP address of the remote PTP host and the IP address of the local PTP timeTransmitter interface.

```
[edit protocols ptp master interface ge-0/1/3.0 unicast-mode]
user@host# set clock-client 117.117.117.117 local-ip-address 109.109.109.53
```

11. On the first timeTransmitter interface, configure a second PTP timeTransmitter by specifying the IP address and subnet of the second remote PTP host and the IP address of the local PTP timeTransmitter interface.

```
[edit protocols ptp master interface ge-0/1/3.0 unicast-mode]
user@host# set clock-client 109.109.109.0/24 local-ip-address 109.109.109.53
```

12. Configure the second timeTransmitter interface with the following parameters: the encapsulation type, the downstream PTP host, the IP address of the local PTP timeTransmitter interface, and the `manual` statement so that this clock client does not use unicast negotiation.

```
[edit protocols ptp master]
user@host# set interface ge-0/1/5.0 unicast-mode transport ipv4
user@host# set interface ge-0/1/5.0 unicast-mode clock-client 7.7.7.7 local-ip-address
7.7.7.53 manual
```

Results

From configuration mode, confirm your configuration by entering the `show` command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit protocols ptp]
user@host# show
clock-mode boundary;
unicast-negotiation;
slave {
    interface ge-0/1/0.0 {
        unicast-mode {
            transport ipv4;
            clock-source 10.10.10.50 local-ip-address 10.10.10.53;
        }
    }
}
master {
    interface ge-0/1/3.0 {
        unicast-mode {
            transport ipv4;
            clock-client 117.117.117.117/32 local-ip-address 109.109.109.53;
            clock-client 109.109.109.0/24 local-ip-address 109.109.109.53;
        }
    }
    interface ge-0/1/5.0 {
        unicast-mode {
            transport ipv4;
            clock-client 7.7.7.7/32 local-ip-address 7.7.7.53 {
                manual;
```

```
            }
        }
    }
}
```

After you have configured the device, enter the `commit` command from configuration mode.

Configure PTP TimeTransmitter Clock

SUMMARY

This topic talks about configuring PTP timeTransmitter boundary clock interface and parameters.

IN THIS SECTION

- Configure PTP TimeTransmitter Boundary Clock Parameters | 35
- Configure a PTP TimeTransmitter Clock Interface | 37

A Precision Time Protocol (PTP) timeTransmitter clock in either boundary or ordinary clock mode sends PTP messages to the timeReceiver clocks so that they can establish their relative time offset from this timeTransmitter's clock or clock reference. You cannot configure an ordinary timeTransmitter clock on a device. The timeTransmitter boundary clock synchronizes time through a boundary timeReceiver port. To configure a timeTransmitter boundary clock, you must include the `boundary` statement at the `[edit protocols ptp clock-mode]` hierarchy level and at least one timeTransmitter with the `master` statement and at least one timeReceiver with the `slave` statement at the `[edit protocols ptp]` hierarchy level. ACX5048 and ACX5096 routers do not support ordinary and boundary clock.

To configure a PTP timeTransmitter clock, complete the following tasks:

Configure PTP TimeTransmitter Boundary Clock Parameters

To configure the parameters of a PTP timeTransmitter boundary clock:

1. Configure the clock mode.

   ```
   [edit protocols ptp]
   user@host# set clock-mode (boundary | ordinary)
   ```

2. Configure the timeTransmitter clock.

```
[edit protocols ptp]
user@host# edit master
```

3. (Optional) Specify the log mean interval between announce messages—from `0` through `4`. By default, one announce message is sent every two seconds. This configuration is used for manual clock clients. The timeTransmitter boundary clock sends announce messages to manual clock clients as specified in the announce-interval value.

```
[edit protocols ptp master]
user@host# set announce-interval announce-interval-value
```

4. Configure the interface on which to respond to downstream clock clients and timeReceiver clocks.

```
[edit protocols ptp master]
user@host# edit interface interface-name
```

5. (Optional) Specify the maximum log mean interval between announce messages—from `0` through `4`. The default value is 4.

```
[edit protocols ptp master]
user@host# set max-announce-interval max-announce-interval-value
```

6. (Optional) Specify the maximum log mean interval between delay-response messages—from `-7` through `4`. The default value is `4`.

```
[edit protocols ptp master]
user@host# set max-delay-response-interval max-delay-response-interval-value
```

7. (Optional) Specify the maximum log mean interval between synchronization messages—from `-7` through `4`. The default value is `4`.

```
[edit protocols ptp master]
user@host# set max-sync-interval max-sync-interval-value
```

8. (Optional) Specify the minimum log mean interval between announce messages—from `-0` through `4`. The default value is `0`.

```
[edit protocols ptp master]
user@host# set min-announce-interval min-announce-interval
```

9. (Optional) Specify the minimum log mean interval between delay-response messages—from `-7` through `4`. The default value is `-7`.

```
[edit protocols ptp master]
user@host# set min-delay-response-interval min-delay-response-interval
```

10. (Optional) Specify the minimum log mean interval between synchronization messages—from `-7` through `4`. The default value is `-7`.

```
[edit protocols ptp master]
user@host# set min-sync-interval min-sync-interval-value
```

11. (Optional) Specify the log mean interval between synchronization messages—from `-7` through `4`. The default value is `-6`. This configuration is used for manual clock clients. The timeTransmitter boundary clock sends synchronization messages to manual clock clients as specified in the `syn-interval-value` statement.

```
[edit protocols ptp master]
user@host# set sync-interval sync-interval-value
```

After you have configured the PTP timeTransmitter clock parameters, enter the **commit** command from configuration mode.

Configure a PTP TimeTransmitter Clock Interface

After you have configured the timeTransmitter clock parameters, complete the configuration of the timeTransmitter clock by configuring an interface to act in the role of the timeTransmitter clock.

To configure a PTP timeTransmitter clock interface:

1. Configure the interface on which to respond to downstream PTP timeReceiver clocks or clock clients.

```
[edit protocols ptp master]
user@host# edit interface interface-name
```

> **NOTE**: For the configuration to work, the interface you specify must be configured at the [edit interfaces *interface-name*] hierarchy level.

2. On this interface, configure downstream PTP timeReceiver clocks.

```
[edit protocols ptp master interface interface-name]
user@host# edit unicast-mode
```

3. Configure the IP address of the remote PTP host, or configure a subnet mask so that any host belonging to that subnet can join the timeTransmitter clock. You can configure up to 512 timeReceiver clocks for each timeTransmitter boundary clock.

```
[edit protocols ptp master interface interface-name unicast-mode]
user@host# edit clock-client ip-address
```

> **NOTE**:
>
> - You can configure the maximum number of timeReceiver clocks (512) in the following combination:
>   - Automatic timeReceiver clocks 256.
>   - Manual and secure timeReceiver clocks 256—Any combination of manual and secure timeReceiver clocks is allowed as long as the combined total amounts to 256.
> - You can configure a maximum of 512 timeReceiver clocks in any combination of automatic, manual, and secure timeReceiver clocks for ACX7100 devices on Junos OS Evolved.

> **NOTE**: If you need to add a new PTP configuration when you toggle from a secure timeReceiver to an automatic timeReceiver or from an automatic timeReceiver to a secure timeReceiver in the PTP configuration of a boundary clock, then you should delete the existing PTP configuration and issue the commit command. After which, you can add a new PTP configuration and issue the commit command.

4. Configure the IP address of the interface acting as the local PTP timeTransmitter.

```
[edit protocols ptp master interface interface-name unicast-mode clock-client ip-address]
user@host# set local-ip-address local-ip-address
```

5. (Optional) When the `unicast-negotiation` statement is configured at the `[edit protocols ptp]` hierarchy level, configure a clock client to immediately receive announce and synchronization messages from the timeTransmitter boundary clock without unicast negotiation.

```
[edit protocols ptp master interface interface-name unicast-mode clock-client ip-address
local-ip-address local-ip-address]
user@host# set manual
```

6. Specify the encapsulation type for PTP packet transport—IPv4. This statement is mandatory.

```
[edit protocols ptp master interface interface-name unicast-mode]
user@host# set transport ipv4
```

After you have configured the PTP timeTransmitter clock interface, enter the `commit` command from configuration mode.

Configure PTP TimeReceiver Clock

SUMMARY

This topic talks about configuring interface and parameters for the PTP timeReceiver clock.

IN THIS SECTION

- Configure the PTP TimeReceiver Clock Parameters | **40**
- Configure the PTP TimeReceiver Clock Interface | **42**

The timeReceiver port that you configure can be a Precision Time Protocol (PTP) boundary or ordinary clock, depending on the configuration of the `clock-mode` statement at the `[edit protocols ptp]` hierarchy level. An ordinary or boundary client clock performs frequency and phase recovery based on received and requested timestamps from a timeTransmitter clock—a grandmaster clcok or a boundary clock timeTransmitter.

NOTE: In ACX Series routers, the grandmaster clock functionality is supported only on ACX500 router.

To configure a PTP timeReceiver clock, complete the following tasks:

Configure the PTP TimeReceiver Clock Parameters

To configure a PTP timeReceiver clock parameters:

NOTE: The `clock-class-to-quality-level-mapping quality-level`, `convert-clock-class-to-quality-level`, and `grant-duration` statements are not supported on the QFX10002 switch.

1. Configure the clock mode:

```
[edit protocols ptp]
user@host# set clock-mode (boundary | ordinary)
```

2. Configure the timeReceiver clock.

```
[edit protocols ptp]
user@host# edit slave
```

3. (Optional) Specify the rate of announce messages that a PTP timeReceiver requests from the timeTransmitter during a unicast-negotiation session—from 0 through 4. The default value is 1.

```
[edit protocols ptp slave]
user@host# set announce-interval announce-interval-value
```

NOTE: The configuration of the `announce-interval` statement is effective only when the `unicast-negotiation` statement is also configured at the [**edit protocols ptp**] hierarchy level.

4. (Optional) Specify the number of announce messages that a timeReceiver—configured on an ACX Series router—must miss before an announce timeout is declared—from 2 through 10. The default value is 3.

```
[edit protocols ptp slave]
user@host# set announce-timeout announce-timeout-value
```

5. (Optional) Override the default PTP clock class to Ethernet Synchronization Message Channel (ESMC) mapping and specify the quality level for the PTP timing source.

```
[edit protocols ptp slave]
user@host# set clock-class-to-quality-level-mapping quality-level (prc | prs |sec | smc |
ssu-a | ssu-b | st2 | st3 | st3e | st4 | stu | tnc)
```

6. (Optional) Enable retrieval of ESMC information from the PTP clock class.

```
[edit protocols ptp slave]
user@host# set convert-clock-class-to-quality-level
```

7. (Optional) Specify the logarithmic mean interval in seconds between the delay request messages sent by the timeReceiver to the timeTransmitter—from –6 through 3. The default value is 0.

```
[edit protocols ptp slave]
user@host# set delay-request delay-request-value
```

8. (Optional) Specify the grant duration value. When unicast negotiation is enabled, the local PTP timeReceiver requests announce, synchronization, and delay-response messages from the timeTransmitter. In each request, the timeReceiver asks for the packets to be sent at a specified rate and the timeReceiver provides a duration for which the rate is valid. The grant-duration value is specified in seconds. The default grant duration is 300 seconds.

```
[edit protocols ptp slave]
user@host# set grant-duration interval
```

9. Configure the interface for the timeReceiver.

```
[edit protocols ptp slave]
user@host# edit interface interface-name
```

For details about configuring the timeReceiver clock interface, see "Configure the PTP TimeReceiver Clock Interface" on page 42.

10. (Optional) Configure the log mean interval between synchronization messages—from -6 through -3. The default value is –6 or 64 synchronous interval messages sent per second

```
[edit protocols ptp slave]
user@host# set sync-interval sync-interval-value
```

After you have configured the PTP timeReceiver clock parameters, enter the **commit** command from configuration mode. To complete the configuration of the timeReceiver clock, complete "Configure the PTP TimeReceiver Clock Interface" on page 42.

Configure the PTP TimeReceiver Clock Interface

The timeReceiver clock interface responds to the upstream PTP timeTransmitter clock.

To configure the PTP timeReceiver clock interface:

1. Configure the interface for the timeReceiver clock.

```
[edit protocols ptp slave]
user@host# edit interface interface-name
```

> **NOTE**: On the QFX Series, you can configure an aggregated Ethernet interface and its configured IP address for PTP streams acting as timeReceiver clocks or timeTransmitters.

For example, to configure a timeReceiver using an aggregated Ethernet interface:

```
user@switch# set protocols ptp slave interface ae0.0
```

> **NOTE**: On the QFX Series, you can configure a loopback interface (there is only one loopback interface, and it is lo0.0) and its corresponding IP addresses for PTP streams acting as timeReceiver clocks or timeTransmitters. Although the loopback interface is the same for both timeTransmitters and timeReceiver clocks, the IP addresses must be unique.

For example, to configure a timeReceiver using the loopback interface:

```
user@switch# set protocols ptp slave interface lo0.0
```

2. Configure the upstream unicast PTP timeTransmitter clock source parameters.

```
[edit protocols ptp slave interface interface-name]
user@host# edit unicast-mode
```

3. Configure the IP address of the timeTransmitter, which acts as a source of time for this timeReceiver.

```
[edit protocols ptp slave interface interface-name unicast-mode]
user@host# edit clock-source ip-address
```

NOTE: To configure additional timeTransmitter clock sources for the timeReceiver, include the `clock-source` statement up to four times. However, synchronization is to only one timeTransmitter clock.

4. Specify the IP address of the interface acting as the local PTP timeReceiver port.

```
[edit protocols ptp slave interface interface-name unicast-mode clock-source ip-address]
user@host# set local-ip-address local-ip-address
```

NOTE: For the configuration to work, the interface you specify must be configured with this IP address at the [`edit interfaces` *`interface-name`*] hierarchy level.

5. Configure the encapsulation type for PTP packet transport. This statement is mandatory.

```
[edit protocols ptp slave interface interface-name unicast-mode]
user@host# set transport (ipv4 | ipv6)
```

After you have configured the PTP timeReceiver clock interface, enter the **commit** command from configuration mode.

Example: Configure Ordinary TimeReceiver Clock With Unicast-Negotiation

IN THIS SECTION

- Requirements | 44
- Overview | 44
- Configuration | 45

This example shows the base configuration of a Precision Time Protocol (PTP) ordinary timeReceiver clock *with* unicast-negotiation on an ACX Series router.

NOTE: ACX5048 and ACX5096 routers do not support ordinary clock.

Requirements

This example uses the following hardware and software components:

NOTE: This example also applies to QFX Series switches. QFX Series switches do not support Gigabit Ethernet interfaces. Instead, configure PTP boundary clock parameters on 10-Gigabit Ethernet interfaces.

- One ACX Series router
- Junos OS Release 12.2 or later

Overview

In this configuration, the ordinary timeReceiver clock uses unicast-negotiation and compensates for some network asymmetry.

NOTE: The values in this example are for illustration purposes only. You can set the values for each parameter according to your requirements.

Configuration

IN THIS SECTION

- CLI Quick Configuration | 45
- Configuring an ordinary client clock with unicast-negotiation | 45
- Results | 47

To configure an ordinary timeReceiver clock with unicast-negotiation, perform these tasks:

CLI Quick Configuration

```
set ptp clock-mode ordinary
set ptp domain 110
set ptp unicast-negotiation
set ptp slave delay-request -6
set ptp slave announce-timeout 2
set ptp slave announce-interval 3
set ptp slave sync-interval -5
set ptp slave grant-duration 7200
set ptp slave interface ge-0/1/0.0 unicast-mode transport ipv4
set ptp slave interface ge-0/1/0.0 unicast-mode clock-source 10.10.10.50 local-ip-address
10.10.10.75 asymmetry -4500
```

Configuring an ordinary client clock with unicast-negotiation

Step-by-Step Procedure

1. Configure the clock mode, domain, and unicast-negotiation:

```
[edit protocols ptp]
user@host# set clock-mode ordinary domain 110 unicast-negotiation
```

2. Configure the announce timeout and the announce interval:

```
[edit protocols ptp]
user@host# set slave announce-timeout 2 announce-interval 3
```

3. Configure the synchronization interval and the grant duration:

```
[edit protocols ptp]
user@host#  set slave sync-interval -5 grant-duration 7200
```

4. Configure the timeReceiver interface:

```
[edit protocols ptp]
user@host# edit slave interface ge-0/1/0.0
```

5. Configure the unicast transport mode:

```
[edit protocols ptp slave interface ge-0/1/0.0]
user@host# set unicast-mode transport ipv4
```

6. Configure the clock source:

```
[edit protocols ptp slave interface ge-0/1/0.0]
user@host# edit unicast-mode clock-source 10.10.10.50 local-ip-address 10.10.10.75
```

7. Configure the asymmetric path:

```
 [edit protocols ptp slave interface ge-0/1/0.0 unicast-mode clock-source 10.10.10.50 local-
ip-address 10.10.10.75]
user@host# set asymmetry -4500
```

8. Verify the configuration:

```
 [edit protocols ptp slave interface ge-0/1/0.0 unicast-mode clock-source 10.10.10.50 local-
ip-address 10.10.10.75]
user@host# top
```

```
 [edit]
user@host# edit protocols
 [edit protocols]
user@host# show
```

See the output for the show command in the Results section.

Results

The following output shows the configuration of unicast-negotiation and compensation for some network asymmetry. The unicast-negotiation statement includes the parameters for the delay request, announce interval, synchronization interval, and grant duration values. Interface **ge-0/1/0.0** is configured to compensate for an asymmetric path to the PTP timeTransmitter by subtracting 4.5 microseconds from the timeReceiver-to-timeTransmitter direction delay calculations.

```
[edit protocols]
user@host# show
ptp {
    clock-mode ordinary;
    domain 110;
    unicast-negotiation;
    slave {
        delay-request -6;
        announce-timeout 2;
        announce-interval 3;
        sync-interval -5;
        grant-duration 7200;
        interface ge-0/1/0.0 {
            unicast-mode {
                transport ipv4;
                clock-source 10.10.10.50 local-ip-address 10.10.10.75 {
                    asymmetry -4500;
                }
            }
        }
    }
}
```

Example: Configure Ordinary TimeReceiver Clock Without Unicast-Negotiation

IN THIS SECTION

- Requirements | 48
- Overview | 48
- Configuration | 49

This example shows the base configuration of a Precision Time Protocol (PTP) ordinary timeReceiver clock *without* unicast-negotiation on an ACX Series router.

> **NOTE**: ACX5048 and ACX5096 routers do not support ordinary clock.

Requirements

This example uses the following hardware and software components:

> **NOTE**: This example also applies to QFX Series switches. QFX Series switches do not support Gigabit Ethernet interfaces. Instead, configure PTP boundary clock parameters on 10-Gigabit Ethernet interfaces.

- One ACX Series router
- Junos OS Release 12.2 or later

Overview

In this configuration, unicast-negotiation is *not* configured, so the PTP timeReceiver has no control over the rate of the negotiation. The PTP timeTransmitter (a primary reference clock) must be configured with the parameters of the PTP timeReceiver, such as announce, synchronization, and delay-response packets to control the rate of the negotiation.

> **NOTE**: The values in this example are for illustration purposes only. You can set the values for each parameter according to your requirements.

Configuration

IN THIS SECTION

- CLI Quick Configuration | 49
- Configuring an ordinary client clock without unicast-negotiation | 49
- Results | 51

To configure an ordinary timeReceiver clock without unicast-negotiation, perform these tasks:

NOTE: The `ipv4-dscp` statement is not supported on the QFX10002 switch.

CLI Quick Configuration

```
set protocols ptp clock-mode ordinary
set protocols ptp ipv4-dscp 46
set protocols ptp slave interface ge-0/2/0.0 unicast-mode transport ipv4
set protocols ptp slave interface ge-0/2/0.0 unicast-mode clock-source 12.1.1.4 local-ip-address
12.1.1.5
```

Configuring an ordinary client clock without unicast-negotiation

Step-by-Step Procedure

1. Configure the clock mode:

   ```
   [edit protocols ptp]
   user@host# set clock-mode ordinary
   ```

2. Configure the Differentiated Services code point (DSCP) value for all PTP IPv4 packets originated by the device:

NOTE: The `ipv4-dscp 46` statement is not supported on QFX Series switches.

```
[edit protocols ptp]
user@host# set ipv4-dscp 46
```

3. Configure the timeReceiver interface:

```
[edit protocols ptp]
user@host# edit slave interface ge-0/2/0.0
```

4. Configure the unicast transport mode:

```
[edit protocols ptp slave interface ge-0/2/0.0]
user@host# set unicast-mode transport ipv4
```

5. Configure the clock source:

```
[edit protocols ptp slave interface ge-0/2/0.0]
user@host# unicast-mode clock-source 12.1.1.4 local-ip-address 12.1.1.5
```

6. Verify the configuration:

```
[edit protocols ptp slave interface ge-0/2/0.0]
user@host# top
 [edit]
user@host# edit protocols
 [edit protocols]
user@host# show
```

See the output for the `show` command in the Results section.

Results

In this example, the PTP timeReceiver on the local interface **ge-0/2/0** is assigned a local IP address of **12.1.1.5**. Unicast-negotiation is not configured so the PTP timeTransmitter must be explicitly configured with the details of the PTP timeReceiver (**12.1.1.5**).

```
[edit protocols]
user@host# show
ptp {
    clock-mode ordinary;
    ipv4-dscp 46;
    slave {
        interface ge-0/2/0.0 {
            unicast-mode {
                transport ipv4;
                clock-source 12.1.1.4 local-ip-address 12.1.1.5;
            }
        }
    }
}
```

PTP Transparent Clocks

The Precision Time Protocol (PTP) standardized by IEEE 1588 improves the current methods of synchronization used within a distributed network. You can use PTP across packet-based networks including, but not limited to, Ethernet networks. Queuing and buffering delays in the switch can cause variable delay to packets, which affects path delay measurements. Queuing delays vary based on the network load and also depend on the architecture of the switch or the router.

Transparent clocks measure and adjust for packet delay. The transparent clock computes the variable delay as the PTP packets pass through the switch or the router.

The QFX5100, EX4600, ACX5048, ACX5096, ACX6360-OR, and PTX10001-20C devices act as transparent clocks only and operate between the timeTransmitter and the timeReceiver clocks in a distributed network. Transparent clocks improve synchronization between the timeTransmitter and timeReceiver clocks and ensure that the timeTransmitter and timeReceiver clocks are not impacted by the effects of packet delay variation. The transparent clock measures the residence time (the time that the packet spends passing through the switch or the router), and adds the residence time into the correction field of the PTP packet. The timeReceiver clock accounts for the packet delay by using both the timestamp of when it started and the information in the correction field.

ACX5048 , ACX5096, ACX6360-OR, and PTX10001-20C devices support end-to-end transparent clocks. With an end-to-end transparent clock, only the residence time is included in the correction field of the PTP packets. The residence timestamps are sent in one packet as a one-step process. In a two-step process, which is not supported on ACX6360-OR, and PTX10001-20C devices, estimated timestamps are sent in one packet, and additional packets contain updated timestamps.

NOTE: ACX5048 , ACX5096, ACX6360-OR, and PTX10001-20C devices support only the one-step process, which means that the timestamps are sent in one packet.

You can enable or disable a transparent clock globally for the switch or router. With a global configuration, the same configuration is applied to each interface. If the transparent clock is disabled, PTP packet correction fields are not updated. If the transparent clock is enabled, the PTP packet correction fields are updated.

On QFX5100, EX4600, and EX4400 switches, PTP over Ethernet, IPv4, IPv6, unicast, and multicast for transparent clocks are supported. EX4400 switches also support IRB and LAG. EX4300 and EX4300-MP switches do not support PTP transparent clock on virtual chassis mode.

You can configure the syntonized-end-to-end (E2E) transparent clock for Precision Time Protocol (PTP). In syntonized transparent clock, the transparent clock requires physical layer frequency based on the ITU-T G.8262/.1 standard. To set syntonized transparent clock, you can enable Synchronous Ethernet configuration with Ethernet Synchronization Message Channel (ESMC) along with PTP transparent clock configuration. Syntonization supports frequency synchronization but does not support phase or time synchronization.

NOTE: ACX5048 and ACX5096 routers do not support PTP over IPv6 for transparent clocks.

NOTE: PTP Transparent Clock is not supported on QFX5120-48YM device 1G ports.

NOTE: ACX6360-OR, PTX10001-20C, and PTX10001-36MR devices support PTP over IPv6 for transparent clocks.

ACX5048 and ACX5096 routers do not support the following:

- Boundary clock
- Ordinary clock
- Transparent clock over MPLS switched path

- Transparent clock with more than two VLAN tags

ACX6360-OR and PTX10001-20C devices do not support the following:

- Boundary, ordinary, timeTransmitter, and timeReceiver clocks
- Transparent clock over MPLS switched path
- Transparent clock with more than two VLAN tags
- PTP over Ethernet
- PTP over IPv4
- PTP multicast mode
- Configuration of unicast and broadcast modes.

  Unicast mode is enabled by default.
- Transparent clock in transponder mode
- PTP while MACSec is enabled
- Two-step process

> **NOTE**: You might notice higher latency when you use copper SFP ports instead of fiber SFP ports. In this case, you must compensate the latency introduced by the copper SFP ports for the accurate CF (correction factor) measurement.

Configure PTP Transparent Clock

SUMMARY

ACX Series routers supports transparent clock functionality. A Precision Time Protocol (PTP) Transparent clock measures the residence time of PTP packets as they pass through router. This residence time is added to the Correction Field of the PTP packet.

> **NOTE**: Starting in Junos OS Release 17.1 onwards, to configure transparent clock, include the `e2e-transparent` CLI command at the `[edit protocols ptp]` hierarchy level. Prior to Junos OS Release 17.1, to configure transparent clock, include the `transparent-clock` CLI command at the `[edit protocols ptp]` hierarchy level.

In a distributed network, you can configure transparent clock for Precision Time Protocol (PTP) for synchronizing the timing across the network. Junos OS supports the `e2e-transparent` CLI statement at the `[edit protocols ptp]` hierarchy level to configure `transparent clock` for Precision Time Protocol (PTP).

The following points need to be considered while configuring a PTP transparent clock in ACX routers:

- Domain numbers—Transparent clock functionality would compute the residence time for PTP packets belonging to all domains.
- PTP-over-MPLS—Transparent clock functionality do not support PTP carried over MPLS in ACX routers.

The PTP transparent clock functionality is supported on PTP-over-IP and PTP-over-Ethernet (PTPoE).

> **NOTE**:
>
> - ACX routers do not support PTPoE over VLANs when it works in ordinary clock or boundary clock mode.
> - When the IGMP snooping-enabled routers and switches that are configured with PTP Transparent clock fail to perform the IGMP snooping, use the static IGMP configuration to forward the PTP traffic.

To configure a PTP transparent clock:

1. Configure the clock mode:

```
[edit protocols ptp]
user@host# set clock-mode (boundary | ordinary)
```

2. Configure the transparent clock:

```
[edit protocols ptp]
user@host# set e2e-transparent
```

3. (Optional) To configure the syntonized-end-to-end (E2E) transparent clock for Precision Time Protocol (PTP) use the command provided below. Please note that SyncE must be enabled before enabling syntonized transparent clock.

```
[edit protocols ptp]
user@host# set syntonized-e2e-transparent
```

CHAPTER 3

Precision Time Protocol Profiles

IN THIS CHAPTER

- Configure PTP Default Profile | 56
- G.8275.1 Telecom Profile | 61
- Configure G.8275.1 Profile | 63
- G.8275.2 Enhanced Profile | 65
- Configure G.8275.2 Enhanced Profile | 68
- PTP Enterprise Profile | 73
- Configure PTP Enterprise Profile | 75
- PTP over IRB for Broadcast Profiles | 79
- PTP Media Profile | 83
- Configure PTP Media Profiles | 85

Configure PTP Default Profile

IN THIS SECTION

- Configure PTP and its Options | 57

You can configure the timeTransmitter clock and the timeReceiver clock for Precision Time Protocol (PTP) to help synchronize clocks in a distributed system. This time synchronization is achieved through packets that are transmitted and received in a session between the timeTransmitter clock and the timeReceiver clock. The default profile is enabled by default. You do not need to enable the `profile-type` statement to use the default profile.

Configure PTP and its Options

IN THIS SECTION

- Configure PTP Options | 57
- Configure TimeReceiver Clock Options | 58
- Configure TimeTransmitter Clock Options | 59

This topic includes the following tasks:

Configure PTP Options

To configure PTP options:

1. In configuration mode, go to the `[edit protocols ptp]` hierarchy level:

```
[edit]
user@host# edit protocols ptp
```

2. Configure the clock mode as either boundary or ordinary. This attribute is mandatory and has no default value.

   The `boundary` option signifies that the clock can be both a timeTransmitter clock and a timeReceiver clock. The `ordinary` option signifies that the clock is either a timeTransmitter clock or a timeReceiver clock.

```
[edit protocols ptp]
user@host# set clock-mode (boundary | ordinary)
```

3. Configure the PTP domain option with values from 0 through 127. The default value is 0.

```
[edit protocols ptp]
user@host# set domain domain-value
```

4. Configure the `priority1` option with values from 0 through 255. The default value is 128.

The `priority1` value determines the best timeTransmitter clock. The *priority1-value* is also advertised in the timeTransmitter clock's announce message to other timeReceiver clocks.

```
[edit protocols ptp]
user@host# set priority1 priority1-value
```

5. Configure the `priority2` option with values from 0 through 255. The default value is 128.

   The `priority2` value differentiates and prioritizes the timeTransmitter clock to avoid confusion when *priority1-value* is the same for different timeTransmitter clocks in a network.

```
[edit protocols ptp]
user@host# set priority2 priority2-value
```

6. Configure the `multicast-mode` option to enable multicast transport.

```
[edit protocols ptp]
user@host# set multicast-mode
```

Configure TimeReceiver Clock Options

Configure the following options after the aforementioned PTP options have been set.

1. Configure the timeReceiver clock.

```
[edit protocols ptp]
user@host# edit slave
```

2. (Optional) Configure the `delay-request` option in the timeReceiver node with values from –7 through 7. The default value is 0.

   The delay request value is the logarithmic mean interval in seconds between the delay request messages sent by the timeReceiver to the timeTransmitter.

```
[edit protocols ptp slave]
user@host# set delay-request delay-request-value
```

3. Configure the interface for the timeReceiver.

```
[edit protocols ptp slave]
user@host# set interface interface-name
```

NOTE: PTP interfaces are unsupported and raise a Chassis Alarm, when PTP is configured on: MX10004 or MX10008 with JNP10K-LC2101 line cards and JNP10008-SF2 Switch Fabric Board.MX10008/MX100016 with JNP10K-LC2101 Line cards and JNP10008-SF Switch Fabric Board and Hypermode is enabled by config [set forwarding-options hyper-mode]

4. Configure the `multicast-mode` option for the timeReceiver. You can set this option when PTP multicast mode of messaging is needed.

```
[edit protocols ptp slave interface interface-name]
user@host# set multicast-mode
```

5. Configure the `transport` option in multicast mode as IPv4.

   The encapsulation type for PTP packet transport is IPv4.

```
[edit protocols ptp slave interface interface-name multicast-mode]
user@host# set transport ipv4
```

6. Configure the IP address of the local logical interface.

```
[edit protocols ptp slave interface interface-name multicast-mode]
user@host# set local-ip-address IP address
```

Configure TimeTransmitter Clock Options

Configure the following options after the aforementioned PTP options and timeReceiver clock options have been set.

1. Configure the timeTransmitter clock.

```
[edit protocols ptp]
user@host# edit master
```

2. Configure the `delay-req-timeout` option for the timeTransmitter.

   The maximum timeout for delay request messages is between 30 and 300 seconds. We recommend 30 seconds.

   ```
   [edit protocols ptp master]
   user@host# set delay-req-timeout seconds
   ```

3. Configure the interface for the timeTransmitter.

   ```
   [edit protocols ptp master]
   user@host# set interface interface-name
   ```

4. Configure the `multicast-mode` option for the timeTransmitter. You can set this option when PTP multicast mode of messaging is needed.

   ```
   [edit protocols ptp master interface interface-name]
   user@host# set multicast-mode
   ```

5. Configure the `transport` option in multicast mode as IPv4.

   The encapsulation type for PTP packet transport is IPv4.

   ```
   [edit protocols ptp master interface interface-name multicast-mode]
   user@host# set transport ipv4
   ```

6. Configure the IP address of the interface acting as the local PTP timeTransmitter port.

   ```
   [edit protocols ptp master interface interface-name multicast-mode clock-client ip-address]
   user@host# set local-ip-address local-ip-address
   ```

7. Configure the interface to be used to connect with the PTP grandmaster clock.

   ```
   [edit protocols ptp master]
   user@host# set interface interface-name
   ```

   If the timeTransmitter clock connection is through a 1-Gigabit Ethernet interface, configure the `ptp0` interface.

This interface is named `ptp0` by default.

```
[edit protocols ptp master]
user@host# set interface ptp0
```

8. Configure the `multicast-mode` option for the PTP grandmaster clock interface. You can set this option when PTP multicast mode of messaging is needed.

```
[edit protocols ptp master interface]
user@host# set interface-name multicast-mode
```

9. Configure the `transport` option in multicast mode as IPv4.

   The encapsulation type for PTP packet transport is IPv4.

```
[edit protocols ptp master interface interface-name multicast-mode]
user@host# set transport ipv4
```

G.8275.1 Telecom Profile

IN THIS SECTION

- Types of Clocks Supported in the G.8275.1 Profile | **62**
- Alternate BTCA | **62**

G.8275.1 is a PTP profile for applications that require accurate phase and time synchronization. It supports the architecture defined in ITU-T G.8275 to enable the distribution of phase and time with full timing support and is based on the second version of PTP defined in IEEE 1588. You can configure the G.8275.1 profile by including the profile-type G.8275.1 statement at the `[edit protocols ptp]` hierarchy level.

NOTE: If you don't configure a profile, the device operates in IEEE1588v2 profile which is the default profile.

The following sections give a brief overview about the types of clocks supported in the G.8275.1 profile and about the alternate Best TimeTransmitter Clock Algorithm (BTCA):

Types of Clocks Supported in the G.8275.1 Profile

There are two types of clocks supported in this profile—ordinary clock and the boundary clock.

There are two types of ordinary clocks:

- One that can be only a grandmaster clock (Telecom grandmaster or T-GM)
- One that can be only a timeReceiver clock (a timeReceiver-only ordinary clock or T-TSC)

There are two types of boundary clocks:

- One that can be only a grandmaster clock (T-GM)
- One that can become a timeTransmitter clock and a timeReceiver clock to another PTP clock (T-BC)

NOTE: MX Series routers support the T-TSC and T-BC clock types.

Alternate BTCA

The G.8275.1 profile uses an alternate Best TimeTransmitter Clock Algorithm (BTCA). The alternate BTCA allows:

- A new per-port attribute named `notSlave`. The `notSlave` port attribute is implemented using the `protocols ptp master` stanza configuration.
- Multiple active grandmaster clocks. If there are multiple active grandmasters, every clock that is not a grandmaster is synchronized by a single grandmaster in the PTP domain.
- Per-port attribute `local-priority` to be used as a tie-breaker in the dataset comparison algorithm.

Configure G.8275.1 Profile

SUMMARY

This topic details the steps to configure SyncE, PTP, and PTPoLAG on G.8275.1 profile.

IN THIS SECTION

- Configure G.8275.1 PTP profile | 63
- Configure G.8275.1 PTPoLAG profile | 65

You can configure the G.8275.1 PTP profile for applications requiring accurate phase and time synchronization. It supports the architecture defined in ITU-T G.8275 to enable the distribution of phase and time with full timing support and is based on the second version of PTP defined in [IEEE 1588].

Configure G.8275.1 PTP profile

1. In configuration mode, go to the `[edit protocols ptp]` hierarchy level:

```
[edit]
user@host# edit protocols ptp
```

2. Configure the G.8275.1 profile.

```
[edit protocols ptp]
user@host# set profile-type g.8275.1
```

3. Configure the clock mode as either boundary or ordinary.

   The `boundary` option signifies that the clock can be both a timeTransmitter clock and a timeReceiver clock. The `ordinary` option signifies that the clock is either a timeTransmitter clock or a timeReceiver clock.

```
[edit protocols ptp]
user@host# set clock-mode (boundary | ordinary)
```

4. Configure the PTP domain option with values from 24 through 43. The default value is 24.

```
[edit protocols ptp]
user@host# set domain domain-value
```

5. Configure the `priority2` option with values from 0 through 255. The default value is 128.

The priority2 value differentiates and prioritizes the timeTransmitter clock to avoid confusion when *priority1-value* is the same for different timeTransmitter clocks in a network.

```
[edit protocols ptp]
user@host# set priority2 priority2-value
```

6. Configure stateful interface for boundary clock mode of operation.

```
[edit protocols ptp stateful]
user@host# edit interface interface-name
```

> **NOTE**: For the configuration to work, the interface you specify must be configured at the [edit interfaces *interface-name*] hierarchy level.

7. Configure multicast transmission of Precision Time Protocol (PTP) packets.

```
[edit protocols ptp stateful interface interface-name]
user@host# set multicast-mode
```

8. Configure the local-priority option. This attribute to be used as a tie-breaker in the dataset comparison algorithm, in the event that all other previous attributes of the datasets being compared are equal.

```
[edit protocols ptp stateful interface interface-name multicast-mode]
user@host# set local-priority local priority-value
```

9. Specify the encapsulation type for PTP packet transport as Ethernet or IEEE 802.3.

```
[edit protocols ptp stateful interface interface-name multicast-mode]
user@host# set transport ieee-802.3
```

10. Specify the asymmetry value.

```
[edit protocols ptp stateful interface interface-name multicast-mode]
user@host# set asymmetry asymmetry value
```

Configure G.8275.1 PTPoLAG profile

1. In the configuration mode, configure the aggregate interface:

```
set interfaces ae0 aggregated-ether-options link-speed mixed
set interfaces ae0 unit 0 family inet address 2.2.0.1/24
set interfaces et-0/0/2 ether-options 802.3ad ae0
set interfaces et-0/0/4 ether-options 802.3ad ae0
```

2. In configuration mode, go to the `[edit protocols ptp]` hierarchy level to configure PTP with G.8275.1 profile. The timeReceiver clock is configured on an aggregate interface:

```
set protocols ptp clock-mode boundary
set protocols ptp profile-type g.8275.1
set protocols ptp slave interface ae0.0 multicast-mode transport ieee-802.3
set protocols ptp slave interface ae0.0 primary et-0/0/2
set protocols ptp slave interface ae0.0 secondary et-0/0/4
set protocols ptp slave hybrid
set protocols ptp master interface et-0/0/0.0 multicast-mode transport ieee-802.3
```

3. Optionally, configure non-revertive switchover for LAG. If configured, it enables non-revertive switchover for LAG, that is if primary link goes down, the secondary link continues to stay as active link, even when the primary link comes back up. If not configured, the AE link shall switchover to primary from secondary as soon as the primary link becomes available.

```
set protocols ptp disable-lag-revertive-switchover
```

G.8275.2 Enhanced Profile

SUMMARY

Thi topic talks about the G.8275.2 enhamced profile.

The Precision Time Protocol (PTP) G.8275.2 enhanced profile supports telecom applications that require accurate phase and time synchronization for phase alignment and time of day synchronization over a wide area network. This profile supports partial timing support (PTS) using PTP over IPv4 and IPv6 unicast, ordinary and boundary clocks, and unicast negotiation with single and multiple TLVs support on the timeTransmitter port.

With the G.8275.2 enhanced profile, you can use either boundary or ordinary clocks. Up to 512 downstream timeReceiver clocks are supported. TimeReceiver clock ports can recover clocks from one-step or two-step timeTransmitter clocks, but timeTransmitter clocks only support one-step PTP.

The G.8275.2 enhanced profile includes the following functionality:

- Support for both ordinary clocks and boundary clocks.
- Support for timeTransmitter-only and timeReceiver-only ports.
- Support for node types T-BC-P (BC) and T-TSC-P (OC/BC).
- Support for the alternate best timeTransmitter clock algorithm.
- Support for PTP with or without VLAN encapsulation. Unicast PTP over IPv4 and IPv6 transport is supported.
- Unicast negotiation with single and multiple TLVs support on the timeTransmitter port. The timeTransmitter accepts single and multiple TLV messages from the remote timeReceiver for request, cancel, and ack messages. The timeTransmitter responds with single or multiple TLV messages as appropriate. The “rate” TLV is ignored.
- Reception and transmission of unicast Announce and Sync PTP packets.
- Support for full domain and packet-rate ranges.
- Support for manual mode, rather than unicast negotiation.
- Support for aggregated Ethernet interfaces.

  You can configure an aggregated Ethernet interface and its configured IP address for PTP streams acting as timeReceiver clocks or timeTransmitter clocks. IP hashing determines which physical link to use for the PTP traffic flows. Both IPv4 unicast and IPv6 unicast transport are supported.

  Note that the QFX5120-48T switch does not support G.8275.2.enh profile over aggregated Ethernet interfaces.
- Support for loopback interface.

  You can configure a loopback interface (there is only one loopback interface, and it is lo0.0) and its corresponding IP addresses for PTP streams acting as timeReceiver clocks or timetransmitter clocks. The IP address configured on lo0.0 is used as the local IP address in the PTP configuration statements, and the remote timeTransmitter or timeReceiver IP address is used to identify the destination forwarding direction. You can configure multiple IP addresses on lo0.0, which allows different unique PTP streams to co-exist on lo0.0. Although, the loopback interface is the same for both timeTransmitter clocks and timeReceiver clocks, the IP addresses must be unique. Both IPv4 unicast and IPv6 unicast transport are supported.

Note that the QFX5120-48T switch does not support G.8275.2.enh profile over loopback interface.

- Support for automatic or subnet-based timeReceiver clocks over the loopback interface. Any IPv4 or IPv6 PTP timeReceiver clock belonging to the subnet can join the timeTransmitter clock through unicast negotiation.

With the G.8275.2 enhanced profile enabled, the following parameters can apply:

- Priority1

  The allowed (and default) value is 128. (Not user-configurable.)

- Priority2

  The range is from 0 to 255, and the default value is 128.

- Domain number

  The range is from 44 to 63, and the default value is 44.

- Clock mode

  The clock mode can be ordinary or boundary.

- Duration of negotiated rates

  The range is 60 to 1000 seconds, and the default value is 300 seconds.

- clockAccuracy

  0xFE

- offsetScaledLogVariance

  0xFFFF

- slaveOnly

  The allowed values are True and False; the default value is False. (Not user-configurable; the value is set according to the setting of the clock mode: boundary or ordinary.)

- localPriority

  The range is 1 to 255; the default value is 128.

- **Table 1: Announce, Sync, and Delay Request/ Response Rate Parameters**

Parameter	Default Value	Allowed Range of Values
Announce rate	0	• TimeTransmitter: -3 to 4 • TimeReceiver: -3 to 0
Delay request/response rate	-6	• TimeReceiver: -7 to -3
Sync rate	-6	• TimeTransmitter: -7 to 4 • TimeReceiver: -7 to -3

Configure G.8275.2 Enhanced Profile

IN THIS SECTION

- Configure PTP and Its Options | 68

NOTE: When you enable the G.8275.2 enhanced profile, you cannot enable any other profile.

Configure PTP and Its Options

IN THIS SECTION

- Configure PTP Options | 69
- Configure TimeReceiver Clock Options | 70
- Configure TimeTransmitter Clock Options | 72

This topic includes the following tasks:

Configure PTP Options

To configure PTP options:

1. In configuration mode, go to the `[edit protocols ptp]` hierarchy level:

```
[edit]
user@host# edit protocols ptp
```

2. Configure the clock mode as either boundary or ordinary. This attribute is mandatory and has no default value.

   The `boundary` option signifies that both timeTransmitter and timeReceiver must be configured. The `ordinary` option signifies that only the timeTransmitter, or only the timeReceiver, must be configured.

```
[edit protocols ptp]
user@host# set clock-mode (boundary | ordinary)
```

3. Configure the profile type as g.8275.2.enh (the G.8275.2.enh profile type provides the telecom profile). This attribute is mandatory.

```
[edit protocols ptp]
user@host# set profile-type g.8275.2.enh
```

4. (Optional) Configure the PTP domain option with a value from 44 through 63. The default value is 44.

```
[edit protocols ptp]
user@host# set domain domain-value
```

5. (Optional) Configure the `priority2` option with values from 0 through 255. The default value is 128.

   The `priority2` value differentiates and prioritizes the timeTransmitter clock to avoid confusion when *`priority1-value`* is the same for different timeTransmitter clocks in a network.

```
[edit protocols ptp]
user@host# set priority2 priority2-value
```

6. (Optional) Configure the `unicast-negotiation` option.

Unicast negotiation is a method by which the announce, sync, and delay response packet rates are negotiated between the timeTransmitter clock and the timeReceiver clock before a PTP session is established.

```
[edit protocols ptp]
user@host# set unicast-negotiation
```

NOTE: Unicast negotiation, when enabled, does not allow you to commit any packet rate–related configuration.

Configure TimeReceiver Clock Options

Configure the following options after the aforementioned PTP options have been set.

1. Configure the timeReceiver clock.

```
[edit protocols ptp]
user@host# edit slave
```

2. (Optional) Configure the `delay-request` option in the timeReceiver node. The range is -7 to -3 seconds, and the default values are -6 for the timeTransmitter and -7 for the timeReceiver.

   The delay request value is the logarithmic mean interval in seconds between the delay request messages sent by the timeReceiver to the timeTransmitter.

```
[edit protocols ptp slave]
user@host# set delay-request delay-request-value
```

3. Configure the interface for the timeReceiver.

```
[edit protocols ptp slave]
user@host# set interface interface-name
```

NOTE: You can configure an aggregated Ethernet interface and its configured IP address for PTP streams acting as timeReceiver clocks or timeTransmitter clocks.

For example, to configure a timeReceiver using an aggregated Ethernet interface:

```
user@switch# set protocols ptp slave interface ae0.0
```

NOTE: You can configure a loopback interface (there is only one loopback interface, and it is lo0.0) and its corresponding IP addresses for PTP streams acting as timeReceiver clocks or timeTransmitter clocks. Although the loopback interface is the same for both timeTransmitter clocks and timeReceiver clocks, the IP addresses must be unique.

For example, to configure a timeReceiver using the loopback interface:

```
user@switch# set protocols ptp slave interface lo0.0
```

4. Configure the `unicast-mode` option for the timeReceiver.

```
[edit protocols ptp slave interface interface-name]
user@host# set unicast-mode
```

5. Configure the `transport` option in unicast mode as IPv4 or IPv6.

```
[edit protocols ptp slave interface interface-name unicast-mode]
user@host# set transport (ipv4 | ipv6)
```

6. Configure the clock source and the IP address of the interface acting as the local PTP timeReceiver port. Optionally, configure the global asymmetry, timeTransmitter-asymmetry or secondary-asymmetry value. Primary and secondary asymmetry values take precedence, if defined.

```
[edit protocols ptp slave interface interface-name unicast-mode]
user@host# set clock-source ip-address local-ip-address local-ip-address (asymmetry asymmetry-value | primary-asymmetry asymmetry-value | secondary-asymmetry asymmetry-value)
```

NOTE: You must configure this IP address at the `[edit interfaces interface-name]` hierarchy level.

7. (Optional) Configure the priority assigned to the interface acting as the local PTP timeReceiver port.

```
[edit protocols ptp slave interface interface-name unicast-mode]
user@host# set local-priority number
```

Configure TimeTransmitter Clock Options

Configure the following options after the aforementioned PTP options and timeReceiver clock options have been set.

1. Configure the timeTransmitter clock.

```
[edit protocols ptp]
user@host# edit master
```

2. Configure the interface for the timeTransmitter.

```
[edit protocols ptp master]
user@host# set interface interface-name
```

> **NOTE**: You can configure an aggregated Ethernet interface and its configured IP address for PTP streams acting as timeReceiver clocks or timeTransmitter clocks.

For example, to configure a timeTransmitter using an aggregated Ethernet interface:

```
user@switch# set protocols ptp master interface ae0.0
```

> **NOTE**: You can configure a loopback interface (there is only one loopback interface, and it is lo0.0) and its corresponding IP addresses for PTP streams acting as timeReceiver clocks or timeTransmitter clocks. Although the loopback interface is the same for both timeTransmitter clocks and timeReceiver clocks, the IP addresses must be unique.

For example, to configure a timeTransmitter using the loopback interface:

```
user@switch# set protocols ptp master interface lo0.0
```

3. Configure the unicast mode option for the timeTransmitter.

```
[edit protocols ptp master interface interface-name]
user@host# edit unicast-mode
```

4. Configure the `transport` option in unicast mode as IPv4 or IPv6.

```
[edit protocols ptp master interface interface-name unicast-mode]
user@host# set transport (ipv4 | ipv6)
```

5. Configure the remote clock source and the IP address of the interface acting as the timeTransmitter.

```
[edit protocols ptp master interface interface-name unicast-mode transport type]
user@host# set clock-client ip-address local-ip-address ip-address
```

PTP Enterprise Profile

The enterprise profile is based on Precision Time Protocol (PTPv1) as defined in IEEE 1588-2002. This profile was designed to distribute system time of day (TOD) and clock frequency from a grand timeTransmitter clock to timeReceiver clocks within the same network and clock domain, and to use multicast communications. The enterprise profile PTPv2 is not backwards compatible with PTPv1.

With the enterprise profile, you can use either boundary or ordinary clocks. Up to 512 downstream timeReceiver clocks are supported. TimeReceiver clock ports can recover clocks from one-step or two-step timeTransmitter clocks, but timeTransmitter clocks only support one-step PTP.

The enterprise profile supports PTP over IPv4 and UDP encapsulation, which includes the following functionality:

- Reception and transmission of Multicast Announce and Sync PTP packets.
- Reception of multicast or unicast Delay Request packets for the timeTransmitter clock interfaces.

  The Delay Response is sent with the same multicast or unicast transmission to match the request.
- Transmission of unicast Delay Request packets for the timeReceiver clock interfaces.

  The switch will not transmit Multicast Delay Request packets.
- IPv4 Multicast address of 224.0.1.129 for PTP.

- PTP Interfaces can be trunk or access ports, so the traffic might or might not be part of a VLAN.

The enterprise profile supports dynamic timeTransmitter clock interface and timeReceiver clock interface detection as Announce and Delay Request packets are received and supports the following functionality:

- Streams are identified by the clock identity, rather than the IP address.
- Up to four remote timeTransmitter clocks that use the best timeTransmitter clock algorithm (BTCA) to select the clock source.
- Up to 512 remote timeReceiver clocks with up to 64 logical interfaces.
- Remote devices are ignored when the number of timeTransmitter and timeReceiver clocks reach the limit.

  If messages are no longer being received from a remote device; a timeout mechanism is used. Streams are removed if they are no longer receiving packets after a default value of 30 seconds.

To support a 1-Gigabit Ethernet connection to a grandmaster clock, you can use a special interface that is labeled **PTP** on the faceplate of the QFX10002 switch. This interface is named `ptp0` in the Junos OS CLI. This interface only supports encapsulated PTP, ARP, and PING packets to support the grandmaster clock connection. Non-PTP traffic is not supported. You can configure this interface as a timeReceiver clock interface to connect to a reference but not as a tagged interface. You can, however, configure 10-, 40-, and 100-Gigabit Ethernet interfaces as timeTransmitter clock, timeReceiver clock, and in tagged and untagged configurations.

With the enterprise profile enabled, there are restrictions on which parameters you can configure or cannot configure.

With the enterprise profile enabled, you can configure the following parameters:

- Priority1

  The range is from 0 to 255, and the default value is 128.

- Priority2

  The range is from 0 to 255, and the default value is 128.

- Domain number

  The range is from 0 to 127, and the default value is 0.

- Clock mode

  Clock mode can be ordinary or boundary.

- Delay request

The Range -7 to +7 seconds, and the default value is 0 (1pps).

- Sync interval

  The range is -7 to +4 seconds, and the default value is 0 (1pps).

With the enterprise profile enabled, you cannot configure the following parameters:

- Announce interval

  Default value is 0 (1pps).

- Announce timeout

  The announce receipt timeout interval is set for three announce intervals for preferred timeTransmitter clocks, and four announce intervals for all other timeTransmitter clocks. All timeTransmitter clocks will be treated as preferred timeTransmitter clocks, so the announce receipt timeout interval is set to three announce intervals.

- Unicast negotiation

Configure PTP Enterprise Profile

IN THIS SECTION

- Configure PTP and its Options | 75

NOTE: When you enable the enterprise profile, you cannot enable any other profile. Also, unicast negotiation is disabled when you enable the enterprise profile.

Configure PTP and its Options

IN THIS SECTION

- Configure PTP Options | 76
- Configure TimeReceiver Clock Options | 77

- Configure TimeTransmitter Clock Options | 78

This topic includes the following tasks:

Configure PTP Options

To configure PTP options:

1. In configuration mode, go to the `[edit protocols ptp]` hierarchy level:

```
[edit]
user@host# edit protocols ptp
```

2. Configure the clock mode as either boundary or ordinary. This attribute is mandatory and has no default value.

   The `boundary` option signifies that the clock can be both a timeTransmitter clock and a timeReceiver clock. The `ordinary` option signifies that the clock is either a timeTransmitter clock or a timeReceiver clock.

```
[edit protocols ptp]
user@host# set clock-mode (boundary | ordinary)
```

3. Configure the profile type as enterprise. This attribute is mandatory.

```
[edit protocols ptp]
user@host# set profile-type enterprise-profile
```

4. (Optional) Configure the PTP domain option with values from 0 through 127. The default value is 0.

```
[edit protocols ptp]
user@host# set domain domain-value
```

5. (Optional) Configure the `priority1` option with values from 0 through 255. The default value is 128.

The `priority1` value determines the best timeTransmitter clock. The *priority1-value* is also advertised in the timeTransmitter clock's announce message to other timeReceiver clocks.

```
[edit protocols ptp]
user@host# set priority1 priority1-value
```

6. (Optional) Configure the `priority2` option with values from 0 through 255. The default value is 128.

   The `priority2` value differentiates and prioritizes the timeTransmitter clock to avoid confusion when *`priority1-value`* is the same for different timeTransmitter clocks in a network.

```
[edit protocols ptp]
user@host# set priority2 priority2-value
```

Configure TimeReceiver Clock Options

Configure the following options after the aforementioned PTP options have been set.

1. Configure the timeReceiver clock.

```
[edit protocols ptp]
user@host# edit slave
```

2. (Optional) Configure the `delay-request` option in the timeReceiver node with values from –7 through 7. The default value is 0.

   The delay request value is the logarithmic mean interval in seconds between the delay request messages sent by the timeReceiver to the timeTransmitter.

```
[edit protocols ptp slave]
user@host# set delay-request delay-request-value
```

3. Configure the interface for the timeReceiver.

```
[edit protocols ptp slave]
user@host# set interface interface-name
```

4. Configure the `multicast-mode` option for the timeReceiver. You can set this option when PTP multicast mode of messaging is needed.

```
[edit protocols ptp slave interface interface-name]
user@host# set multicast-mode
```

5. Configure the `transport` option in multicast mode as IPv4.

   The encapsulation type for PTP packet transport is IPv4.

```
[edit protocols ptp slave interface interface-name multicast-mode]
user@host# set transport ipv4
```

6. Configure the IP address of the local logical interface.

```
[edit protocols ptp slave interface interface-name multicast-mode]
user@host# set local-ip-address IP address
```

Configure TimeTransmitter Clock Options

Configure the following options after the aforementioned PTP options and timeReceiver clock options have been set.

1. Configure the timeTransmitter clock.

```
[edit protocols ptp]
user@host# edit master
```

2. (Optional) Configure the `delay-req-timeout` option for the timeTransmitter.

   The maximum timeout for delay request messages is between 30 and 300 seconds. We recommend 30 seconds.

```
[edit protocols ptp master]
user@host# set delay-req-timeout seconds
```

3. Configure the interface for the timeTransmitter.

```
[edit protocols ptp master]
user@host# set interface interface-name
```

4. Configure the `multicast-mode` option for the timeTransmitter. You can set this option when PTP multicast mode of messaging is needed.

```
[edit protocols ptp master interface interface-name]
user@host# set multicast-mode
```

5. Configure the `transport` option in multicast mode as IPv4.

   The encapsulation type for PTP packet transport is IPv4.

```
[edit protocols ptp master interface interface-name multicast-mode]
user@host# set transport ipv4
```

6. Configure the IP address of the interface acting as the local PTP timeTransmitter port.

```
[edit protocols ptp master interface interface-name multicast-mode clock-client ip-address]
user@host# set local-ip-address local-ip-address
```

   If the timeTransmitter clock connection is through a 1-Gigabit Ethernet interface, configure the interface named `ptp0` interface.

   This interface is named `ptp0` by default.

PTP over IRB for Broadcast Profiles

IN THIS SECTION

- CLI Configuration | **80**
- CLI Commands | **81**

The IEEE 1588 PTP boundary clock (BC) applications for broadcast media often requires many PTP streams to use a common local IP address. These packets are forwarded through L2 switching. In these use cases, there are no physical interface IFLs created for each PTP physical interface, as would be usually expected for PTP configurations on physical interfaces. Configuration over integrated routing and bridging (IRB) interfaces allows you to meet this requirement. Currently, there is an existing feature that supports multicast-mode with physical interfaces. PTP over IRB for broadcast profiles will extend this support for physical interfaces on IRB interfaces. PTP BC over IRB for broadcast profiles will support SMPTE/AES67/AES67-SMPTE profiles (multicast PTP over IP). This new interface type is added to the multicast profiles. The PTP multicast-mode supports IRB interfaces using the IPv4 transport type that is used with physical interfaces.

The QFX5K switches use the IRB ethernet interface and its configured IP address for the multicast PTP streams. The interface acts either as a timeReceiver or timeTransmitter in the configuration statements. Since a single IRB cannot connect to many physical interfaces, the forwarding interface is specified with the IRB, so that the PTP packets are sent only to the intended receiver. This specification identifies the egress packet interface for the stream, which can be configured for L2 forwarding.

NOTE: PTP BC features developed for QFX5110 and QFX5200 are still available. Support is extended to IRB interfaces for PTP BC over multicast for broadcast profiles.

CLI Configuration

A new CLI configuration is added to this feature for multicast mode to identify the L2 interface that needs to be transported. This new interface type is supported in the example configuration statements below.

IPv4 Configuration Example

```
set protocols ptp clock-mode boundary
set protocols ptp profile-type smpte

set protocols ptp slave interface irb.100 multicast-mode transport ipv4
set protocols ptp slave interface irb.100 multicast-mode
                        local-ip-address 170.1.0.5 l2-ifl xe-0/0/2:0.0

set protocols ptp master interface irb.200 multicast-mode transport ipv4
set protocols ptp master interface irb.200 multicast-mode
                        local-ip-address 180.3.5.2 l2-ifl xe-0/0/8:2.0
```

Multiple IRB IPv4 Configuration Example

```
set interfaces xe-0/0/2:0 unit 0 family ethernet-switching vlan members V100
set interfaces xe-0/0/8:2 unit 0 family ethernet-switching vlan members V200
set interfaces et-0/0/20 unit 0 family ethernet-switching vlan members V100
set interfaces et-0/0/28 unit 0 family ethernet-switching vlan members V200
set interfaces irb unit 100 family inet address 170.1.0.5/24
set interfaces irb unit 200 family inet address 180.3.5.2/24
```

```
set protocols ptp clock-mode boundary
set protocols ptp profile-type smpte
set protocols ptp slave interface irb.100 multicast-mode transport ipv4
set protocols ptp slave interface irb.100 multicast-mode
                        local-ip-address 170.1.0.5 l2-ifl xe-0/0/2:0.0
set protocols ptp slave interface irb.100 multicast-mode
                        local-ip-address 170.1.0.5 l2-ifl et-0/0/20.0

set protocols ptp master interface irb.200 multicast-mode transport ipv4
set protocols ptp master interface irb.200 multicast-mode
                        local-ip-address 180.3.5.2 l2-ifl xe-0/0/8:0.0
set protocols ptp master interface irb.200 multicast-mode
                        local-ip-address 180.3.5.2 l2-ifl et-0/0/28.0
```

CLI Commands

There are no new operational commands being added. Areas in the display output that show an interface name will show the appropriate name for the IRB interface and will be expanded to include the L2 IFL name for IRB interfaces.

NOTE: Available `vty` commands that are used to help diagnose the operation of the `clksyncd` and PTP protocol stack will not change, but will support the new interface types and information.

show ptp lock-status detail

```
{master:0}
regress@imax> show ptp lock-status detail
Lock Status:

Lock State    : 5 (PHASE ALIGNED)
Phase offset  : 0.000000180 sec
State since   : 2020-08-02 05:29:06 PDT (00:13:06 ago)

Selected Master Details:
Upstream Master address    : 224.0.1.129
Slave interface            : irb.5 (xe-0/0/29:1.0)
```

```
Parent Id                 : aa:00:00:00:00:00:11:11
GMC Id                    : aa:00:00:00:00:00:11:11
```

show ptp timeTransmitter detail

```
{master:0}
regress@imax> show ptp master detail

PTP Master Interface Details:
Interface  : irb.10
Status     : Master, Active
Clock Info :
    Local Address: 20.0.0.1           Status: Configured, Master, Active
      l2-ifl: xe-0/0/29:0.0
        Remote Address: 20.0.0.2           Status: Learned, Slave, Active
        Remote Address: 224.0.1.129        Status: Configured, Slave, Active
    Total Remote Slaves: 2
```

show ptp timeReceiver detail

```
{master:0}
regress@imax> show ptp slave detail
PTP Slave Interface Details:

Interface        : irb.5
Status           : Slave, Active
Clock Info
    Local Address : 12.0.0.2                Status: Configured, Slave, Active
      l2-ifl: xe-0/0/29:1.0
        Remote Master: 224.0.1.129      Status: Configured, Master, Active
    Total Remote Masters: 1
```

show ptp statistics

```
{master:0}
regress@imax> show ptp statistics
Local Clock      Remote Clock       Role  Stream      Received  Transmitted
irb.5            224.0.1.129       Slave       0         18255         7449
xe-0/0/29:1.0

irb.10           20.0.0.2         Master       5          7554         7554
```

```
xe-0/0/29:0.0

irb.10          224.0.1.129      Master       4             0        11682
xe-0/0/29:0.0
```

show ptp statistics detail

```
{master:0}
regress@imax> show ptp statistics detail
Local Clock      Remote Clock       Role  Stream      Received  Transmitted
irb.5           224.0.1.129       Slave       0         18255         7449
xe-0/0/29:1.0

         Signalling    Announce        Sync       Delay       Error
   Rx:            0        3725        7428        7102          27
   Tx:            0           0           0        7449           0
Local Clock      Remote Clock       Role  Stream      Received  Transmitted
irb.10          20.0.0.2         Master       5          7554         7554
xe-0/0/29:0.0

         Signalling    Announce        Sync       Delay       Error
   Rx:            0           0           0        7554           0
   Tx:            0           0           0        7554           0
Local Clock      Remote Clock       Role  Stream      Received  Transmitted
irb.10          224.0.1.129      Master       4             0        11682
xe-0/0/29:0.0

         Signalling    Announce        Sync       Delay       Error
   Rx:            0           0           0           0           0
   Tx:            0        3805        7877           0           0
```

PTP Media Profile

IN THIS SECTION

- Benefits of the PTP Media Profiles | 84
- Functionality Common to the SMPTE ST-2059-2, AES67, and the AES67+SMPTE ST-2059-2 Profiles | 84

- SMPTE Profile | 85
- AES67 Profile | 85
- AES67+SMPTE ST-2059-2 Profile | 85

The PTP media profiles comprise three profiles: SMPTE ST-2059-2, AES67, and AES67+SMPTE ST-2059-2. These profiles support video and audio applications for capture (for example, cameras) to be used in professional broadcast environments. These profiles supports PTP over IPv4 multicast and ordinary and boundary clocks.

Benefits of the PTP Media Profiles

- The PTP media profiles enable multiple video and audio sources to stay in synchronization across multiple devices.

Functionality Common to the SMPTE ST-2059-2, AES67, and the AES67+SMPTE ST-2059-2 Profiles

These profiles include the following functionality:

> **NOTE**: These profiles do not use an alternate timeTransmitter clock, path trace, unicast message negotiation, alternate time scales, or acceptable timeTransmitter table.

- Support for both ordinary clocks and boundary clocks as part of the IEEE 1588 PTP specification.
- Support for encapsulating PTP over IPv4/UDP.

  Multicast is required for both PTP over IPv4 and PTP over UDP.
- Support for IEEE 1588 delay request and response method for the path delay measurement.
- Support for the default IEEE 1588 BTCA algorithm.
- Support for standard management packets.
- Support for IGMPv2.

  IGMPv3 is optional.

SMPTE Profile

The SMPTE profile is based on the SMPTE ST-2059-2 standard and was created specifically to synchronize video equipment in a professional broadcast environment. The standard allows multiple video sources to stay in synchronization across various equipment by providing time and frequency synchronization to all devices. This standard is used with other SMPTE standards such as SMPTE ST 2059-1, which defines a point in time (the SMPTE Epoch) used for aligning real-time signals, and formula for ongoing signal alignment. Alignment is considered met when two clocks are within 1 microsecond of each other. This implies that each timeReceiver should be accurate with +/- .5 microseconds of the central clock.

AES67 Profile

The AES67 profile is based on the AES67 standard and supports professional quality audio applications for high performance streaming over IPv4 multicast transport in media networks with low latencies. This profile enables audio streams to be combined at a receiver and maintain stream synchronization. The standard uses IPv4 multicast and IGMP, plus the DiffServ and DSCP fields, to select packet quality of service. Audio devices transmit their content using RTP (Real Time Protocol).

AES67+SMPTE ST-2059-2 Profile

The AES67+SMPTE ST-2059-2 profile is based on both the AES67 and SMPTE ST-2059-2 standards and is used in professional audio and video media applications. This profile enables the two standards to operate together over the same network.

Configure PTP Media Profiles

IN THIS SECTION

- Configure AES67, SMPTE, and AES67+SMPTE Profiles | **86**

NOTE: When you enable any of the PTP media profiles (AES67, AES67+SMPTE, or SMPTE), you cannot enable any other profile.

Configure AES67, SMPTE, and AES67+SMPTE Profiles

IN THIS SECTION

- Optional and Required Parameters for SMPTE ST-2059-2, AES67, and AES67+SMPTE ST-2059-2 Profiles | **86**
- Configure PTP Media Profile | **87**

This topic provides the configuration necessary to enable any of the three media profiles (AES67, SMPTE, and AES67+SMPTE), and includes the following sections.

Optional and Required Parameters for SMPTE ST-2059-2, AES67, and AES67+SMPTE ST-2059-2 Profiles

Table 2 on page 86 and Table 3 on page 87 provide default values and ranges for optional and required PTP parameters:

Table 2: Defaults and Ranges for PTP Parameters

Profile	SM (Synchronization Metadata) TLV	Domain	Priority1	Priority2
SMPTE	Yes	• Default: 127 • Range: 0 through 127	• Default: 128 • Range: 0 through 255	• Default: 128 • Range: 0 through 255
AES67	No	• Default: 0 • Range: 0 through 127	• Default: 128 • Range: 0 through 255	• Default: 128 • Range: 0 through 255

Table 2: Defaults and Ranges for PTP Parameters *(Continued)*

Profile	SM (Synchronization Metadata) TLV	Domain	Priority1	Priority2
AES67+SMPTE	Yes	• Default: 0 • Range: 0 through 127	• Default: 128 • Range: 0 through 255	• Default: 128 • Range: 0 through 255

Table 3: Defaults and Ranges for PTP Parameters

Profile	Announce	Announce Timeout	Sync	Delay-Req
SMPTE	• Default: -2 • Range: -3 through 1	• Default: 3 • Range: 2 through 10	• Default: -3 • Range: -7 through -1	• Default: -3 • Range: -7 through -3
AES67	• Default: 1 • Range: 0 through 4	• Default: 3 • Range: 2 through 10	• Default: -3 • Range: -4 through 1	• Default: -3 • Range: -7 through -3
AES67+SMPTE	• Default: 0 • Range: 0 through 1	• Default: 3 • Range: 2 through 10	• Default: -3 • Range: -4 through -1	• Default: -3 • Range: -7 through -3

Configure PTP Media Profile

To configure the any of the media profiles:

NOTE: On the QFX Series, when you configure either a timeTransmitter or timeReceiver port, it must be on the same subnet as the remote device to which it is connected.

NOTE: When either the enterprise or any of the media profiles are enabled, the timeTransmitter and timeReceiver ports must be configured in multicast-mode. The timeTransmitter sends the announce and sync packets as multicast IP packets, but the QFX Series timeReceiver will send the delay-req packets as unicast IP packets.

1. In configuration mode, go to the `[edit protocols ptp]` hierarchy level:

```
[edit]
user@host# edit protocols ptp
```

2. Configure the clock mode as either boundary or ordinary. This attribute is mandatory and has no default value.

   The `boundary` option signifies that both timeTransmitter and timeReceiver must be configured. The `ordinary` option signifies that only the timeTransmitter, or only the timeReceiver, must be configured.

   For example:

```
[edit protocols ptp]
user@host# set clock-mode (boundary | ordinary)
```

3. Configure the profile type.

   Configuring the profile type is mandatory.

```
[edit protocols ptp]
user@host# set profile-type (aes67 | smpte | aes67-smpte)
```

4. Configure the clock mode.

```
[edit protocols ptp]
user@host# set clock-mode (boundary | ordinary)
```

5. Configure the interface for the timeReceiver.

```
[edit protocols ptp ]
user@host# set slave interface interface-name
```

6. Configure the `multicast-mode` option for the timeReceiver.

```
[edit protocols ptp slave interface interface-name]
user@host# set multicast-mode
```

7. Configure the `transport` option in multicast-mode as IPv4.

```
[edit protocols ptp slave interface interface-name multicast--mode]
user@host# set transport ipv4
```

8. Configure the IP address of the interface acting as the local PTP timeReceiver port.

```
[edit protocols ptp slave interface interface-name multicast-mode]
user@host# set local-ip-address local-ip-address
```

NOTE: You must also configure this IP address at the `[edit interfaces interface-name]` hierarchy level.

9. Configure the interface for the timeTransmitter.

```
[edit protocols ptp master]
user@host# set interface interface-name
```

10. Configure the multicast-mode option for the timeTransmitter.

```
[edit protocols ptp master interface interface-name]
user@host# set multicast-mode
```

11. Configure the `transport` option in multicast-mode as IPv4.

```
[edit protocols ptp master interface interface-name multicast-mode]
user@host# set transport ipv4
```

12. Configure the local IP address for the timeTransmitter.

NOTE: You must also configure this IP address at the [edit interfaces *interface-name*] hierarchy level.

```
[edit protocols ptp master interface interface-name multicast-mode]
user@host# set local-ip-address local IP address
```

13. (Optional) Configure the PTP domain option.

```
[edit protocols ptp]
user@host# set domain domain-value
```

14. (Optional) Configure the priority1 option.

    The priority1 value determines the best timeTransmitter clock. The *priority1-value* is also advertised in the timeTransmitter clock's announce message to other timeReceiver clocks.

```
[edit protocols ptp]
user@host# set priority1 priority1-value
```

15. (Optional) Configure the priority2 option.

    The priority2 value differentiates and prioritizes the timeTransmitter clock to avoid confusion when *priority1-value* is the same for different timeTransmitter clocks in a network.

```
[edit protocols ptp]
user@host# set priority2 priority2-value
```

16. (Optional) Configure the announce-timeout option in the timeReceiver node.

    The announce timeout value signifies the number of times an announce interval message has to pass through the timeReceiver without receiving the announce message—that is, the timeout period for announce messages.

```
[edit protocols ptp slave]
user@host# set announce-timeout announce-timeout-value
```

17. (Optional) Specify the log mean interval between announce messages.

The timeTransmitter boundary clock sends announce messages to manual timeReceiver clocks as specified in the announce-interval value.

```
[edit protocols ptp master]
user@host# set announce-interval announce-interval-value
```

18. (Optional) Configure the `sync interval` option for the timeTransmitter clock.

    The sync interval is the logarithmic mean interval between synchronous messages that is sent by the timeTransmitter.

```
[edit protocols ptp master]
user@host# set sync-interval sync-interval-value
```

19. (Optional) Configure the `delay-request` option in the timeReceiver node.

    The delay request value is the logarithmic mean interval in seconds between the delay request messages sent by the timeReceiver to the timeTransmitter.

```
[edit protocols ptp slave]
user@host# set delay-request delay-request-value
```

20. Verify the lock status of the timeReceiver.

> **NOTE**: On the QFX Series, the timeReceiver will not lock to the timeTransmitter unless at least eight sync packets per second are received from the timeTransmitter.

For example:

```
user@switch> show ptp lock-status detail
Lock Status:

Lock State    : 5 (PHASE ALIGNED)
Phase offset  : -0.000000202 sec

```

The output shows that the lock state is aligned.

21. Verify the status of the timeTransmitter.

For example:

```
user@switch> show ptp master detail
PTP Master Interface Details:
Interface  : et-0/0/0:31.0
Status     : Master, Active
Clock Info :
Local Address: 192.168.99.42  Status: Configured, Master, Active
Remote Address: 192.168.1.12    Status: Configured, Slave, Active
Total Remote Slaves: 1
```

The output shows that the timeTransmitter is active.

CHAPTER 4

PHY Timestamping

IN THIS CHAPTER

- PHY Timestamping | 93
- Configure PHY Timestamping | 94
- Configure PHY Timestamping on ACX500 and ACX2K Routers | 95

PHY Timestamping

SUMMARY

The PHY timestamping refers to the timestamping of the IEEE 1588 event packets at the 1-Gigabit Ethernet and 10-Gigabit Ethernet PHY. Timestamping the packet in the PHY results in higher stability of recovered clock.

Juniper Networks recommends that you configure timestamping at the physical layer if the port supports IEEE 1588 timestamping.

The PHY timestamping on ACX updates the correction field of the packet. ACX supports PHY timestamping in ordinary clock and boundary clock modes.

On 10-Gigabit Ethernet ports, PHY timestamping and WAN-PHY framing are mutually exclusive—that is, you cannot configure PHY timestamping on a 10-Gigabit Ethernet port if you have configured WAN-PHY framing mode on that port. This is applicable only for MPC5E and MPC6E with 24x10XGE MIC. PHY timestamping is *not* supported on the enhanced MPCs MPC1E, MPC2E, and MPC4E. Only hardware timestamping is supported on these MPCs. Therefore, a packet delay variation (also known as jitter) of up to 1 microsecond is observed on these MPCs for a very small percentage of packets occasionally. Hardware timestamping is typically timestamping either at FPGA or similar device.

On Junos Evo platforms, PHY timestamping is enabled by default and the `phy-timestamping` configuration option is unavailable.

Configure PHY Timestamping

You can configure timestamping either at the physical layer or at the nonphysical layer on the 10-Gigabit Ethernet and 100-Gigabit Ethernet ports. The PHY timestamping updates the correction field of the packet. PHY timestamping is supported in ordinary clock and boundary clock modes.

The following points need to be considered while configuring PHY timestamping:

- PHY timestamping is enabled or disabled on all the PHYs. You cannot selectively enable or disable PHY timestamping on a particular interface.

NOTE: The PHYs on ACX do not support PHY timestamping functionality for PTP-over-MPLS. You should not enable PHY timestamping if PTP is transported over MPLS.

To enable PHY timestamping, configure `clock-mode` (ordinary clock or boundary clock) along with the `phy-timestamping` CLI statement at the `[edit protocols ptp]` hierarchy.

```
[edit protocols ptp]
user@host# set clock-mode (boundary | ordinary)
```

```
[edit protocols ptp]
user@host# set phy-timestamping
```

NOTE: Starting in Junos OS Release 17.1 onwards, to configure transparent clock, include the `e2e-transparent` CLI command at the `[edit protocols ptp]` hierarchy level. Prior to Junos OS Release 17.1, to configure transparent clock, include the `transparent-clock` CLI command at the `[edit protocols ptp]` hierarchy level.

On Junos Evo platforms, PHY timestamping is enabled by default and the `phy-timestamping` configuration option is unavailable.

RELATED DOCUMENTATION

https://www.juniper.net/documentation/us/en/software/junos/cli-reference/topics/ref/statement/phy-timestamping-edit-protocols-ptp.html

Configure PHY Timestamping on ACX500 and ACX2K Routers

IN THIS SECTION

- Enable PHY Timestamping for Boundary Clock | 95

The PHY timestamping refers to the timestamping of the IEEE 1588 event packets at the 1-Gigabit Ethernet and 10-Gigabit Ethernet PHY. Timestamping the packet in the PHY results in higher stability of recovered clock. The PHY timestamping on ACX updates the correction field of the packet. ACX2200 supports PHY timestamping in boundary clock mode.

The following points need to be considered while configuring PHY timestamping in ACX routers:

- PHY timestamping is enabled or disabled on all the PHYs. You cannot selectively enable or disable PHY timestamping on a particular interface.
- When PHY timestamping is enabled, the transparent clock functionality is also enabled.

> **NOTE**: The PHYs on ACX do not support transparent clock functionality for PTP-over-MPLS. You should not enable transparent clock or PHY timestamping if PTP is transported over MPLS.

To enable PHY timestamping on ACX500, ACX2100 and ACX2200 routers, configure boundary clock along with `e2e-transparent` CLI statement at the `[edit protocols ptp]` hierarchy.

```
[edit protocols ptp]
user@host# set e2e-transparent
```

Enable PHY Timestamping for Boundary Clock

The following procedure enables you to configure PHY timestamping for boundary clock in ACX2200 routers:

1. Configure the clock mode as boundary.

```
[edit protocols ptp]
user@host# set boundary
```

2. Enable Phy timestamping on boundary clock.

```
[edit protocols ptp]
user@host# set e2e-transparent
```

3. Configure the interface for timeReceiver clock. For information on configuring PTP timeReceiver clock interface, see "Configure PTP TimeReceiver Clock" on page 39.

```
[edit protocols ptp]
user@host# set slave interface interface-name...
```

4. Configure the interface for timeTransmitter clock. For information on configuring PTP timeTransmitter clock, see "Configure PTP TimeTransmitter Clock" on page 35.

```
[edit protocols ptp]
user@host# set master interface interface-name...
```

CHAPTER 5

Precision Time Protocol over Ethernet

IN THIS CHAPTER

- PTP over Ethernet Overview | 97
- Guidelines to Configure PTP over Ethernet | 99
- Configure PTP Dynamic Ports for Ethernet Encapsulation | 102
- Configure PTP Multicast TimeTransmitter and TimeReceiver Ports for Ethernet Encapsulation | 103
- Example: Configure PTP over Ethernet for Multicast TimeTransmitter, TimeReceiver, and Dynamic Ports | 109

PTP over Ethernet Overview

SUMMARY

PTP over Ethernet provides effective implementation of packet-based technology that enables the operator to deliver synchronization services on packet- based mobile backhaul networks that are configured in Ethernet rings.

Precision Time Protocol (PTP) is supported over IEEE 802.3 or Ethernet links on ACX Series routers. This functionality is supported in compliance with the IEEE 1588-2008 specification. Deployment of PTP at every hop in an Ethernet ring by using the Ethernet encapsulation method enables robust, redundant, and high-performance topologies to be created that enables a highly precise time and phase synchronization to be obtained.

The ACX Series routers can be directly connected to different types of base stations (for example, base transceiver station (BTS) in 2G, NodeB in 3G, and eNodeB in 4G networks) and different types of routers that hand off time- division multiplexing (TDM), ATM, and Ethernet traffic to the base station controller. ACX Series routers must extract the network clock from these sources and pass on synchronization information to the base stations to help the routers synchronize with the base station controller.

Most of the network deployments that use Ethernet contain a minimum of two Ethernet rings, while some of the network topologies might also contain up to three Ethernet rings. Consider a scenario in which the first ring contains aggregation routers (MX Series routers) and the second ring contains access routers (ACX Series routers). In such a network, about 10 or 12 nodes of MX Series routers and ACX Series routers are present in the aggregation and access Ethernet rings.

Some of the 4G base stations that are connected to ACX Series routers need to receive the timing and synchronization information in a packet-based form. Such base station vendors support only packet interfaces that use Ethernet encapsulation for PTP packets for time and phase synchronization. Therefore, any node (an ACX Series router) that is directly connected to a 4G base station must be able to use the Ethernet encapsulation method for PTP on a timeTransmitter port to support a packet-based timing capability.

PTP over Ethernet encapsulation also facilitates an easier, optimal network deployment model than PTP over IPv4. Using IPv4, the nodes (timeTransmitter and timeReceiver devices) participate in unicast negotiation in which the timeReceiver node is provisioned with the IP address of the timeTransmitter node and requests unicast messages to be sent to it from the timeTransmitter node. A timeTransmitter node is the router that functions as the PTP server where the timeTransmitter clock is located and a timeReceiver node is the router that functions as the PTP timeReceiver where the timeReceiver clock is located. Because PTP over Ethernet uses multicast addresses, the timeReceiver node automatically learns about the timeTransmitter nodes in the network. Also, the timeReceiver node is able to immediately receive the multicast messages from the timeTransmitter node and can begin sending messages to the timeTransmitter node without the need for any provisioning configuration.

An interface on which the timeTransmitter clock is configured is called a timeTransmitter interface and an interface on which the timeReceiver clock is configured is called a timeReceiver interface. A timeTransmitter interface functions as the timeTransmitter port and a timeReceiver interface functions as the timeReceiver port. For PTP over Ethernet, apart from configuring a port or a logical interface to operate as a timeTransmitter clock or a timeReceiver clock, you can also configure a port or a logical interface to function as both a timeTransmitter clock and a timeReceiver clock. This type of port is called a *stateful port*, or a *bidirectional port*. Such a stateful port enables the network to more efficiently adapt to the introduction and failure of timing sources by forming the shortest synchronization trees from a particular source. This behavior is implemented as defined by the best timeTransmitter clock algorithm (BTCA) in the *ITU-T G.8265.1 Precision time protocol telecom profile for frequency synchronization* specification.

On both MX Series and ACX Series routers, you can achieve the highest quality performance if you configure every node in a synchronization chain as a PTP boundary clock. In Ethernet ring-based topologies, you can configure a port or a logical interface to function either as a timeTransmitter port or as a timeReceiver port to enable redundancy when a node or link failure occurs. This stateful port or dual-port functionality is in accordance with the IEEE 1588-2008 standard and enables the implementation of PTP in data center or financial applications.

Apart from enabling every node to be available for configuration as a PTP boundary clock, it is also necessary to enable a logical interface to be configured either as a timeTransmitter port or a timeReceiver port. When you configure a logical interface or even a shared IP address to be a timeTransmitter port or a timeReceiver port, a PTP protocol stack can represent dynamic ports and the PTP application selects the correct state (timeTransmitter or timeReceiver) for any specific port in the system based on the output of the default PTP BTCA and the states of other ports in the system.

While an ACX Series router supports the PTP over Ethernet functionality, a TimeTransmitter such as an MX Series router or a TCA Series Timing TimeReceiver does not support PTP over Ethernet. In such a scenario, the ACX Series router functions as a boundary clock with a PTP timeReceiver port using IPv4 as the encapsulation mode and timeTransmitter ports using Ethernet as the encapsulation mode for PTP traffic. For example, consider an ACX Series router named ACX1 to have two potential timeReceiver interfaces, one that is fixed as a timeReceiver-only port using IPv4 on the link toward an MX Series router named MX1, and a stateful port that functions as a timeReceiver port using PTP over Ethernet on the link toward another ACX Series router named ACX2. In addition, ACX1 also contains a port that is a timeTransmitter-only port using PTP over Ethernet and connects to the base station.

Because PTP over Ethernet uses multicast addresses, a timeReceiver port can automatically start receiving the multicast announce messages transmitted by the timeTransmitter ports on a network and can also start communication with the timeTransmitter node with minimal or no configuration. Unlike PTP over IPv4 where IP addresses are used to identify the timeTransmitter and timeReceiver ports, with PTP over Ethernet, multicast MAC addresses are used in the forwarding of PTP traffic. The IEEE 1588 standard defines two types of multicast MAC addresses 01-80-C2-00-00-0E (link local multicast) and 01-1B-19-00-00-00 (standard Ethernet multicast) for PTP over Ethernet operations.

Guidelines to Configure PTP over Ethernet

Keep the following points in mind when you configure PTP over Ethernet for multicast mode of transmission of PTP traffic:

- You can configure a port or a logical interface to be a timeTransmitter clock for PTP over Ethernet to provide packet-based synchronization to base stations that support time and phase alignment; this configuration is compliant with Annexure F of the IEEE 1588-2008 specification.
- Two multicast MAC addresses are used for PTP over Ethernet: 01-1B-19-00-00-00 and 01-80-C2-00-00-0E. The first address is a more standard Ethernet MAC address that is expected to be flooded by all types of Ethernet bridges and switches and also by a large number of base station vendors. A node with this MAC address can be a node that does not process PTP packets. The second address is a reserved address in the IEEE 802.1Q standard for Ethernet encapsulation that is required to be filtered and not forwarded. This MAC address is used to ensure complete end-to-end support of PTP, instead of transmission of packets through any network element that does not support PTP. This address is the default address for G.8275.1 (PTP Profile for time or phase distribution) and a node with this MAC address is a node that supports processing of PTP packets.

- Both of the MAC addresses, 01-1B-19-00-00-00 and 01-80-C2-00-00-0E, are supported on multiple ports simultaneously to enable maximum flexibility and extension of existing networks for future deployments. A single PTP port is configured for one of the MAC addresses at a time.
- PTP packets are sent with the unique MAC address assigned to each port as the MAC source address. In the PTP packet, the Ethernet frame portion of the packet contains the Destination MAC field. This field contains either of the two MAC addresses, 01-1B-19-00-00-00 or 01-80-C2-00-00-0E. Also, the Ethernet frame portion contains the Source MAC field that contains the MAC address of the source port and the Ethertype field that contains the PTP Ethertype value of 0x88F7. Apart from the Ethernet frame, the PTP packet contains the PTP payload.
- When you configure a port for PTP over Ethernet to be a timeReceiver port, a timeTransmitter port, or both by having a stateful port that can be either a timeTransmitter port or a timeReceiver port depending on the states of the other ports in the PTP application, it is possible to build an easily provisioned, redundant PTP service in an Ethernet ring where every node is configured as a boundary clock.
- A boundary clock can function as a timeReceiver clock to a device using IP (such as a TCA Series Timing TimeReceiver or an MX Series router) on one port and can also function as a timeReceiver clock, a timeTransmitter clock, or both on other ports using Ethernet as the encapsulation method. This behavior occurs within a single PTP domain number.
- Best TimeTransmitter Clock Algorithm (BTCA) and the port state machine are supported to determine the states of all the ports in a system and the correct state (timeTransmitter or timeReceiver) for a certain port to process PTP packets.
- PTP over Ethernet supports fully redundant and resilient ring-based configurations of up to 10 nodes for a form of fourth-generation (4G) evolution known as Long-Term Evolution-Time Division Duplex (LTE-TDD). ACX Series routers support a single node or link failure and all nodes maintain a phase accuracy of plus or minus 1.5 microseconds matching a common source.
- You can configure the asymmetry value between the timeTransmitter port and the timeReceiver port, which indicates a value to be added to the path delay value to make the delay symmetric and equal to the path from the timeTransmitter port to the timeReceiver port, on either a dynamic-state port or a timeReceiver-only port.
- You cannot enable PTP over Ethernet on Ethernet interfaces that are configured with 802.1Q VLAN tags or contain a user-configured MAC address.
- While you can configure unique PTP timeReceiver interfaces or timeReceiver ports with different encapsulation mechanisms (such as IPv4 and Ethernet), the boundary clock can use only a single encapsulation method for all of the timeTransmitter ports. Therefore, you must define either IPv4 or Ethernet encapsulation for all the ports or logical interfaces that can possibly function as boundary clock primaries. TimeTransmitter ports select the link-local flag based on each port.

- You can configure a maximum of 128 PTP over Ethernet ports, where up to 4 ports can be configured as timeReceiver and the remaining can be configured as timeTransmitter.

- In PTP over IPv4 deployment, it is necessary to configure certain basic settings on a PTP timeTransmitter port before the PTP timeReceiver ports to connect to the timeTransmitter port. PTP over Ethernet offers a plug-and-play service because any PTP timeReceiver starts receiving packets and can request delay-response packets from the timeTransmitter port after you configure an interface to be a timeTransmitter.

- PTP over Ethernet is compatible with Junos OS releases earlier than Release 12.3X51. When you perform an upgrade to Release 12.3X51 and later from a previous release on an ACX Series router, you can modify the timeReceiver and timeTransmitter ports previously configured for IPv4 to enable PTP over Ethernet based on your network needs.

- You cannot configure a fully redundant PTP ring using IP. A fully redundant PTP ring is supported only when Ethernet encapsulation is used.

- Configuration of dynamic ports in conjunction with Synchronous Ethernet to enable hybrid mode is not supported.

- Multiple PTP timing domains are not supported for PTP over Ethernet, similar to PTP over IPv4. Although a single node can contain interfaces configured for PTP over IPv4 and PTP over Ethernet, both of these interfaces must be part of the same PTP domain.

- SONET/SDH networks define the ability to configure a local priority to a synchronization source in the ITU G.781 standard. Addition of such locally configured priorities to PTP sources to influence BTCA to determine a particular path for PTP packets is not supported.

- Although you can configure a timeReceiver port to use either IP or Ethernet simultaneously, a single timeReceiver port is selected based on the announce messages it receives from the timeTransmitter port and the PTP event packets are exchanged only with a single timeTransmitter port.

- The IPv4 unicast implementation of PTP enables you to limit the number of timeReceiver ports that can be supported simultaneously in the system. With multicast Ethernet-based implementation, in which the timeTransmitter port is not provisioned with the timeReceiver port information, the timeTransmitter port cannot limit the number of timeReceiver ports that it services. This control must be exercised with proper networking planning and design.

- PTP works well with Media Access Control Security (MACsec) encryption enabled on the same port at the same time on supported routers. The following limitations are applicable:

  - The maximum limit for MACsec-enabled logical interfaces (IFL) is 200 per system.

  - The maximum limit for MACsec-enabled ports with physical interfaces (IFDs) and IFLs where MACsec and PTP are enabled together on different ports is 200 per system.

  - The maximum number of IFLs that can be supported on both 1G and 10G ports is 128.

- PTP in clear text mode is not supported.

Configure PTP Dynamic Ports for Ethernet Encapsulation

For PTP over Ethernet, you can also configure a port to function as both a timeReceiver port and a timeTransmitter port. This type of port is called a stateful port, or a bidirectional port. Such a stateful port enables the transfer of frequency for synchronization services, in addition to time and phase alignment, when PTP functionality is not hop-by-hop and you have provisioned timeTransmitter and timeReceiver roles or interfaces.

To configure PTP over Ethernet with dynamic or bidirectional ports for multicast mode of transmission, you must include the `multicast-mode` statement at the `[edit protocols ptp stateful interface` *`interface-name`*`]` hierarchy level.

To enable a node to function as both a timeTransmitter and a timeReceiver port in PTP over Ethernet networks:

1. Configure the interface on which to respond to downstream PTP timeReceiver ports or timeReceiver clocks.

   ```
   [edit protocols ptp stateful]
   user@host# edit interface interface-name
   ```

   > **NOTE**: For the configuration to work, the interface you specify must be configured at the `[edit interfaces` *`interface-name`*`]` hierarchy level.

2. Configure the upstream multicast PTP dynamic clock source parameters.

   ```
   [edit protocols ptp stateful interface interface-name]
   user@host# edit multicast-mode
   ```

3. Specify the encapsulation type for PTP packet transport as Ethernet or IEEE 802.3. This statement is mandatory.

   ```
   [edit protocols ptp stateful interface interface-name multicast-mode]
   user@host# set transport ieee-802.3
   ```

   Alternatively, specify the encapsulation type as Ethernet with the link-local multicast address to be used in the sending of PTP messages. If you specify the link-local attribute, the timeTransmitter clock chooses either of the two MAC addresses defined in the IEEE 1588-2008 standard. When you configure this option, the system attempts to use the 01 -80-C2-00-00-0E MAC address (link-local multicast MAC address) for multicast transmission. If this MAC address is not available, the 01-1B-19-00-00-00 address (standard Ethernet multicast address) is used as the second priority. The standard Ethernet multicast address is used by default. You need to explicitly configure the link-local multicast address.

```
[edit protocols ptp stateful interface interface-name multicast-mode]
user@host# set transport ieee-802.3 link-local
```

After you have configured the PTP over Ethernet timeReceiver clock interface, enter the `commit` command from configuration mode.

Configure PTP Multicast TimeTransmitter and TimeReceiver Ports for Ethernet Encapsulation

IN THIS SECTION

- Configure the PTP over Ethernet TimeTransmitter Boundary Clock Parameters | 104
- Configure the PTP over Ethernet TimeTransmitter Boundary Clock Interface | 106
- Configure the PTP over Ethernet TimeReceiver Clock Parameters | 107
- Configure PTP over Ethernet TimeReceiver Clock Interface | 108

On an ACX Series router, you can configure a Precision Time Protocol (PTP) timeTransmitter boundary clock with IEEE 802.3 or Ethernet encapsulation of PTP messages to the timeReceiver clocks (ordinary and boundary) so that they can establish their relative time offset from this timeTransmitter's clock or clock reference. PTP over Ethernet uses multicast addresses for communication of PTP messages between the timeReceiver clock and the timeTransmitter clock. The timeReceiver clock automatically learns of timeTransmitter clocks in the network, is immediately able to receive the multicast messages from the timeTransmitter clock, and can begin sending messages to the timeTransmitter clock without any pre-provisioning. The timeTransmitter boundary clock synchronizes time through a timeReceiver boundary port.

To configure PTP over Ethernet with multicast timeTransmitter and timeReceiver ports, you must include the `multicast-mode transport ieee-802.3` statement at the `[edit protocols ptp master interface interface-name]` and `[edit protocols ptp slave interface interface-name]` hierarchy levels, respectively.

To configure a PTP over Ethernet timeTransmitter boundary clock and timeReceiver boundary clock for multicast transmission, complete the following tasks:

Configure the PTP over Ethernet TimeTransmitter Boundary Clock Parameters

To configure the parameters of a PTP over Ethernet timeTransmitter boundary clock:

1. Configure the clock mode.

```
[edit protocols ptp]
user@host# set clock-mode boundary
```

2. Configure the timeTransmitter clock.

```
[edit protocols ptp]
user@host# edit master
```

3. (Optional) Specify the log mean interval between announce messages—from 0 through 4. By default, one announce message is sent every two seconds. This configuration is used for manual timeReceiver clocks. The timeTransmitter boundary clock sends announce messages to manual timeReceiver clocks as specified in the announce-interval value.

```
[edit protocols ptp master]
user@host# set announce-interval announce-interval-value
```

4. Configure the interface on which to respond to downstream PTP timeReceiver clocks or timeReceiver ports.

```
[edit protocols ptp master]
user@host# edit interface interface-name
```

For details about configuring the parameters for the timeTransmitter boundary clock interface, see "Configure the PTP over Ethernet TimeTransmitter Boundary Clock Interface" on page 106.

5. (Optional) Specify the maximum log mean interval between announce messages—from 0 through 4. The default value is 4.

```
[edit protocols ptp master]
user@host# set max-announce-interval max-announce-interval-value
```

6. (Optional) Specify the maximum log mean interval between delay-response messages—from –7 through 4. The default value is 4.

```
[edit protocols ptp master]
user@host# set max-delay-response-interval max-delay-response-interval-value
```

7. (Optional) Specify the maximum log mean interval between synchronization messages—from –7 through 4. The default value is 4.

```
[edit protocols ptp master]
user@host# set max-sync-interval max-sync-interval-value
```

8. (Optional) Specify the minimum log mean interval between announce messages—from 0 through 4. The default value is `0`.

```
[edit protocols ptp master]
user@host# set min-announce-interval min-announce-interval
```

9. (Optional) Specify the minimum log mean interval between delay-response messages—from –7 through 4. The default value is –7.

```
[edit protocols ptp master]
user@host# set min-delay-response-interval min-delay-response-interval
```

10. (Optional) Specify the minimum log mean interval between synchronization messages—from –7 through 4. The default value is –7.

```
[edit protocols ptp master]
user@host# set min-sync-interval min-sync-interval-value
```

11. (Optional) Specify the log mean interval between synchronization messages—from –7 through 4. The default value is –6. This configuration is used for manual timeReceiver clocks. The

timeTransmitter boundary clock sends synchronization messages to manual timeReceiver clocks as specified in the `syn-interval-value` statement.

```
[edit protocols ptp master]
user@host# set sync-interval sync-interval-value
```

After you have configured the PTP timeTransmitter boundary clock parameters, enter the `commit` command from configuration mode. To complete the configuration of the timeTransmitter boundary clock, complete "Configure the PTP over Ethernet TimeTransmitter Boundary Clock Interface" on page 106.

Configure the PTP over Ethernet TimeTransmitter Boundary Clock Interface

After you configured the timeTransmitter boundary clock parameters for PTP over Ethernet with multicast transmission of PTP traffic, complete the configuration of the timeTransmitter boundary clock by configuring an interface to act in the role of the timeTransmitter clock.

To configure a PTP over Ethernet timeTransmitter boundary clock interface:

1. Configure the interface on which to respond to downstream PTP timeReceiver ports or timeReceiver clocks.

   ```
   [edit protocols ptp master]
   user@host# edit interface interface-name
   ```

   NOTE: For the configuration to work, the interface you specify must be configured at the [`edit interfaces` *`interface-name`*] hierarchy level.

2. On this interface, configure multicast as the transmission mode of traffic for PTP timeReceiver clocks.

   ```
   [edit protocols ptp master interface interface-name]
   user@host# edit multicast-mode
   ```

3. Specify the encapsulation type for PTP packet transport as Ethernet or IEEE 802.3. This statement is mandatory.

   ```
   [edit protocols ptp master interface interface-name multicast-mode]
   user@host# set transport ieee-802.3
   ```

Alternatively, specify the encapsulation type as Ethernet with the link-local multicast address to be used in the sending of PTP messages. If you specify the `link-local` attribute, the timeTransmitter clock chooses either of the two MAC addresses defined in the IEEE 1588-2008 standard. When you configure this option, the system attempts to use the 01 -80-C2-00-00-0E MAC address (link-local multicast MAC address) for multicast transmission. If this MAC address is not available, the 01-1B-19-00-00-00 address (standard Ethernet multicast address) is used as the second priority. The standard Ethernet multicast address is used by default. You need to explicitly configure the link-local multicast address.

```
[edit protocols ptp master interface interface-name multicast-mode]
user@host# set transport ieee-802.3 link-local
```

After you have configured the PTP over Ethernet timeTransmitter clock interface, enter the `commit` command from configuration mode.

Configure the PTP over Ethernet TimeReceiver Clock Parameters

An interface on which the timeTransmitter clock is configured is called a timeTransmitter interface and an interface on which the timeReceiver clock is configured is called a timeReceiver interface. A timeTransmitter interface functions as the timeTransmitter port and a timeReceiver interface functions as the timeReceiver port. Because PTP over Ethernet uses multicast addresses, a timeReceiver port can automatically start receiving the multicast announce messages transmitted by the timeTransmitter ports on a network and can also start communication with the timeTransmitter port with minimal or no configuration. You can optionally configure these settings for a timeReceiver port that communicates with the timeTransmitter ports using PTP over Ethernet.

To configure a PTP over Ethernet timeReceiver clock.

1. Configure the clock mode:

```
[edit protocols ptp]
user@host# set clock-mode boundary
```

2. Configure the timeReceiver clock.

```
[edit protocols ptp]
user@host# edit slave
```

3. (Optional) Specify the number of announce messages that a timeReceiver clock or port—configured on an ACX Series router—must miss before an announce timeout is declared—from 2 through 10. The default value is 3.

```
[edit protocols ptp slave]
user@host# set announce-timeout announce-timeout-value
```

4. (Optional) Specify the logarithmic mean interval in seconds between the delay request messages sent by the timeReceiver port to the timeTransmitter port—from –6 through 3. The default value is 0.

```
[edit protocols ptp slave]
user@host# set delay-request delay-request-value
```

5. Configure the interface for the timeReceiver clock.

```
[edit protocols ptp slave]
user@host# edit interface interface-name
```

6. (Optional) Configure the log mean interval between synchronization messages—from `-6` through `-3`. The default value is –6, which means by default, 64 synchronous interval messages sent per second.

```
[edit protocols ptp slave]
user@host# set sync-interval sync-interval-value
```

After you have configured the PTP timeReceiver clock parameters, enter the `commit` command in configuration mode. To complete the configuration of the timeReceiver clock, complete "Configure PTP over Ethernet TimeReceiver Clock Interface" on page 108.

Configure PTP over Ethernet TimeReceiver Clock Interface

The timeReceiver clock interface responds to the upstream PTP timeTransmitter clock.

To configure the PTP timeReceiver clock interface:

1. Configure the interface for the timeReceiver clock.

```
[edit protocols ptp slave]
user@host# edit interface interface-name
```

2. Configure the upstream multicast PTP timeTransmitter clock source parameters.

```
[edit protocols ptp slave interface interface-name]
user@host# edit multicast-mode
```

3. Specify the encapsulation type for PTP packet transport as Ethernet or IEEE 802.3. This statement is mandatory.

```
[edit protocols ptp slave interface interface-name multicast-mode]
user@host# set transport ieee-802.3
```

   Alternatively, specify the encapsulation type as Ethernet with the link-local multicast address to be used in the sending of PTP messages. If you specify the `link-local` attribute, the timeTransmitter clock chooses either of the two MAC addresses defined in the IEEE 1588-2008 standard. When you configure this option, the system attempts to use the 01 -80-C2-00-00-0E MAC address (link-local multicast MAC address) for multicast transmission. If this MAC address is not available, the 01-1B-19-00-00-00 address (standard Ethernet multicast address) is used as the second priority. The standard Ethernet multicast address is used by default. You need to explicitly configure the link-local multicast address.

```
[edit protocols ptp slave interface interface-name multicast-mode]
user@host# set transport ieee-802.3 link-local
```

After you have configured the PTP over Ethernet timeReceiver clock interface, enter the `commit` command in configuration mode.

Example: Configure PTP over Ethernet for Multicast TimeTransmitter, TimeReceiver, and Dynamic Ports

IN THIS SECTION

- Requirements | 110
- Overview | 110
- Configuration | 111

In PTP over Ethernet networks, the timeTransmitter sends the announce, synchronization, and delay-response packets using the multicast method. If any unicast delay-request message is received, the timeTransmitter disregards the message and does not send delay-response messages to the timeReceiver. A PTP timeReceiver receives the multicast announce packets from the timeTransmitter or multiple primaries and determines the best timeTransmitter using Best TimeTransmitter Clock Algorithm (BTCA). A timeReceiver receives and processes the synchronization from the selected timeTransmitter clock. The timeReceiver sends delay-request messages to this timeTransmitter using the multicast method and processes the delay-response messages from the timeTransmitter to establish synchronization.

Both the link-local MAC address and the standard 802.3 multicast MAC address can be present in a system. However, a PTP interface supports only one of the following at a point in time:

- Layer 2 multicast with link-local MAC address
- Layer 2 multicast with standard multicast MAC address
- PTP over IPv4

When you configure both IPv4 and Ethernet encapsulation, the unicast-negotiation configuration applies only to IPv4 encapsulation. It is not effective for PTP over Ethernet operation.

When you configure a logical interface by using the `stateful` statement at the `[edit protocols ptp]` hierarchy level, each interface that you configure as a stateful is considered to be both a timeTransmitter and a timeReceiver port. Although an ACX Series router supports up to 32 timeTransmitter ports and 4 timeReceiver ports, you can configure only 4 unique logical interfaces as potential PTP masters by using the `stateful` statement because the interface is treated as both a timeReceiver and a timeTransmitter interface. You cannot configure the interface that you specify to be a stateful with the `master` or `slave` statements.

This example shows how to configure a timeTransmitter port, timeReceiver port, and a stateful port for PTP over Ethernet and PTP over IPv4 encapsulation, and how to configure unicast and multicast mode of transmission of PTP traffic among the timeTransmitter and timeReceiver nodes.

Requirements

This example uses the following hardware and software components:

- An ACX Series router
- Junos OS Release 12.3X51 or later

Overview

While an ACX Series router supports the PTP over Ethernet functionality, a grandmaster clock such as an MX Series router or a TCA Series Timing TimeReceiver does not support PTP over Ethernet. Consider a sample deployment in which an ACX Series router named ACX1 functions as a boundary clock with a

PTP timeReceiver port using IPv4 as the encapsulation mode and timeTransmitter ports using Ethernet as the encapsulation mode for PTP traffic. ACX1 contains two potential timeReceiver interfaces, one that is fixed as a timeReceiver-only port using IPv4 on the link toward an MX Series router named MX2, and a stateful port that functions as a timeReceiver using PTP over Ethernet on the link toward another ACX Series router named ACX2. In addition, ACX1 also contains a port that is a timeTransmitter-only port using PTP over Ethernet and connects to the base station.

In this example, the router uses either interface ge-0/2/0.0 or ge-0/2/1.0 as the selected timeReceiver interface based on the announce messages received from the timeTransmitter and the port that was selected using the Best TimeTransmitter Clock Algorithm (BTCA). The interface ge-0/1/4.0 is always in the timeTransmitter state. According to the IEEE 1588 specification, if port ge-0/2/0.0 is selected as the timeReceiver interface, interface ge-0/2/1.0 transitions to the timeTransmitter state. If interface ge-0/2/1.0is selected as the timeReceiver port, interface ge-0/2/0.0 transitions to the listening state. You can also configure the interface ge-0/1/4.0 as a timeReceiver only interface for PTP over Ethernet, if necessary, for completeness of the configuration.

Configuration

IN THIS SECTION

- Verify PTP over Ethernet Multicast Dynamic, TimeTransmitter, and TimeReceiver Settings | **117**

In this example, you configure a timeTransmitter port, a timeReceiver port, and a stateful port for PTP over Ethernet and PTP over IPv4 encapsulation. You can also configure unicast and multicast modes of transmission of PTP traffic among the timeTransmitter and timeReceiver nodes.

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them in a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the `[edit]` hierarchy level:

```
set interfaces ge-0/1/4 description “to base-station”
set interfaces ge-0/1/4 unit 0 family inet address 7.1.1.37/24
set interfaces ge-0/2/0 description “to MX2”
set interfaces ge-0/2/0 unit 0 family inet address 110.1.1.2/24
set interfaces ge-0/1/4 description “to ACX2”
set interfaces ge-0/1/4 unit 0 family inet address 110.1.1.2/24
set protocols ptp clock-mode boundary
```

```
set protocols ptp domain 110
set protocols ptp slave interface ge-0/2/0.0 unicast-mode transport ipv4
set protocols ptp slave interface ge-0/2/0.0 unicast-mode clock-source 110.1.1.250 local-ip-
address 110.1.1.2
set protocols ptp master interface ge-0/1/4.0 multicast-mode transport ieee-802.3
set protocols ptp stateful interface ge-0/2/1.0 multicast-mode transport ieee-802.3
```

Configure PTP over Ethernet for Multicast Master, Slave, and Dynamic Ports

Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy.

To configure the timeTransmitter, timeReceiver, and dynamic interfaces, and a boundary clock with unicast and multicast mode of transmission of PTP packets in PTP over IPv4 and PTP over Ethernet topologies:

1. Configure the timeTransmitter interface, and enter edit mode for the interface.

```
[edit interfaces]
user@host#edit ge-0/1/4
```

2. Configure a description for the interface.

```
[edit interfaces ge-0/1/4]
user@host#set description to base-station
```

3. Configure a logical unit and specify the protocol family.

```
[edit interfaces ge-0/1/4]
 user@host#set unit 0 family inet
```

4. Specify the address for the logical interface

```
[edit interfaces ge-0/1/4 unit 0 family inet]
user@host#set address 7.1.1.37/24
```

5. Configure the timeReceiver interface, and enter edit mode for the interface.

```
[edit interfaces]
user@host#edit ge-0/2/0
```

6. Configure a description for the interface.

```
[edit interfaces ge-0/2/0]
user@host#set description to-MX2
```

7. Configure a logical unit and specify the protocol family.

```
[edit interfaces ge-0/2/0]
user@host#set unit 0 family inet
```

8. Specify the address for the logical interface

```
[edit interfaces ge-0/2/0 unit 0 family inet]
user@host#set address 110.1.1.2/24
```

9. Configure the stateful interface, and enter edit mode for the interface.

```
[edit interfaces]
user@host#edit ge-0/2/1
```

10. Configure a description for the interface.

```
[edit interfaces ge-0/2/1]
user@host#set description to-ACX2
```

11. Configure a logical unit and specify the protocol family.

```
[edit interfaces ge-0/2/1]
user@host#set unit 0 family inet
```

12. Specify the address for the logical interface

```
[edit interfaces ge-0/2/1 unit 0 family inet]
user@host#set address 110.2.1.1/24
```

13. Configure the clock mode as boundary clock.

```
[edit protocols ptp]
user@host# set clock-mode boundary
```

14. Specify the PTP domain value.

```
[edit protocols ptp]
user@host# set domain 110
```

15. Configure the local timeReceiver interface from which the boundary timeTransmitter receives time and passes it on to the configured timeReceiver clocks.

```
[edit protocols ptp]
user@host# edit slave interface ge-0/2/0.0
```

16. Configure the upstream unicast PTP timeTransmitter clock source parameters.

```
[edit protocols ptp slave interface ge-0/2/0.0]
user@host# edit unicast-mode
```

17. Configure the encapsulation type for PTP packet transport.

```
[edit protocols ptp slave interface ge-0/2/0.0 unicast-mode]
user@host# set transport ipv4
```

18. Configure the PTP timeTransmitter parameters by specifying the IP address of the PTP timeTransmitter clock and the IP address of the local interface.

```
[edit protocols ptp slave interface ge-0/1/0.0 unicast-mode]
user@host# set clock-source 110.1.1.250 local-ip-address 110.1.1.2
```

19. Configure the timeTransmitter interface in this example.

```
[edit protocols ptp]
user@host# edit master interface ge-0/1/4.0
```

20. On the timeTransmitter interface, configure multicast transmission for downstream PTP timeReceiver clocks.

```
[edit protocols ptp master interface ge-0/1/4.0]
user@host# edit multicast-mode
```

21. On the timeTransmitter interface, configure the encapsulation type as Ethernet for PTP packet transport.

```
[edit protocols ptp master interface ge-0/2/1.0  multicast-mode]
user@host# set transport ieee-802.3
```

22. Configure the dynamic or stateful interface in this example.

```
[edit protocols ptp]
user@host# edit stateful interface ge-0/2/1.0
```

23. On the dynamic interface, configure multicast transmission for downstream PTP timeReceiver clocks.

```
[edit protocols ptp stateful interface ge-0/2/1.0 ]
user@host# edit multicast-mode
```

24. On the dynamic interface, configure the encapsulation type as Ethernet for PTP packet transport and the link-local multicast address to be used.

```
[edit protocols ptp stateful interface ge-0/2/1.0  multicast-mode]
user@host# set transport ieee-802.3 link-local
```

Results

In configuration mode, confirm your configuration by entering the `show` command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit protocols ptp]
user@host# show
clock-mode boundary;
        domain 110;
        slave {
            interface ge-0/2/0.0 {
                unicast-mode {
                    transport ipv4;
                    clock-source 110.1.1.250 local-ip-address 110.1.1.2;
                }
            }
        }
        master {
            interface ge-0/1/4.0 {
                multicast-mode {
                    transport ieee-802.3;
                }
            }
        }
        stateful {
            interface ge-0/2/1.0 {
                multicast-mode {
                    transport ieee-802.3 link-local;
                }
            }
        }
```

After you have configured the device, enter the `commit` command in configuration mode.

Verify PTP over Ethernet Multicast Dynamic, TimeTransmitter, and TimeReceiver Settings

IN THIS SECTION

- Verifying the PTP Clock Details | 117
- Verify the Lock Status of the Slave | 118
- Verify the PTP Options on the Slave | 118
- Verify the PTP Options and the Current Status of the Master | 118
- Verify the Number and Status of the PTP Ports | 119
- Verify PTP Statistics | 119

Confirm that the configuration is working properly.

Verifying the PTP Clock Details

Purpose

Verify that the PTP clock is working as expected.

Action

In operational mode, enter the `run show ptp clock` command to display comprehensive, globally configured clock details.

Meaning

The output displays the clock details, such as the encapsulation method used for transmission of PTP traffic and the number of configured stateful or dynamic ports. Although a stateful port functions as either a timeReceiver or a timeTransmitter port, the value displayed in the `Stateful Ports` field denotes the dynamic ports that you explicitly configured. The number of dynamic ports is not computed and displayed in the fields that display the explicitly configured timeTransmitter and timeReceiver ports. For more information about the `run show ptp clock`, see *show ptp clock* in the CLI explorer.

Verify the Lock Status of the Slave

Purpose

Verify that the timeReceiver clock is aligned to the timeTransmitter clock by checking the lock status of the timeReceiver.

Action

In operational mode, enter the `run show ptp lock-status` command to display the lock status of the timeReceiver.

Meaning

The output displays information about the lock status of the timeReceiver. The output shows whether the timeReceiver is aligned to the timeTransmitter clock or not, and the interface name configured for PTP on the timeReceiver. The `Master Source Port` field displays the address of the timeTransmitter clock when PTP over IPv4 is configured and the multicast MAC address of the source when PTP over Ethernet is configured. For more information about the `run show ptp lock-status` operational command, see in the *show ptp lock status*.

Verify the PTP Options on the Slave

Purpose

Verify the PTP options that are set on the timeReceiver and the current status of the timeTransmitter.

Action

In operational mode, enter the `run show ptp slave` command to display the configured timeReceiver.

Meaning

The output displays information about the configured timeReceiver and the status of the timeReceiver. For more information about the `show ptp slave` operational command, see in the *show ptp slave*.

Verify the PTP Options and the Current Status of the Master

Purpose

Verify the PTP options that are set for the timeTransmitter and its current status.

Action

In operational mode, enter the `run show ptp master` command to display the configured options for the timeTransmitter.

Meaning

The output displays information about the configured timeTransmitter and the current status of the timeTransmitter. For more information about the `run show ptp master` operational command, see in the *show ptp master*.

Verify the Number and Status of the PTP Ports

Purpose

Verify the number of PTP ports and their current status.

Action

In operational mode, enter the `run show ptp port` command to display the configured ports.

Meaning

The output displays information about the number of ports created according to the configuration and their current status. The name of the interface configured for PTP and the number of times a stateful port transitioned from the timeReceiver to the timeTransmitter state and vice versa is displayed. For more information about the `run show ptp port` operational command, see in the *show ptp port*.

Verify PTP Statistics

Purpose

Verify the statistical details of the PTP configuration.

Action

In operational mode, enter the `run show ptp statistics` command to display the statistical information regarding the configured PTP clocks.

Meaning

The output displays brief or detailed information about the operation of configured PTP clocks. Statistical parameters include information such as the total number of PTP packets transmitted or received by a timeTransmitter or timeReceiver interface and the number of various messages (such as announce and synchronization messages) that are sent between a timeTransmitter and a timeReceiver. For more information about the `show ptp statistics` operational command, see *show ptp statistics* .

CHAPTER 6

Precision Time Protocol Additional Features

IN THIS CHAPTER

- Precision Time Protocol (PTP) over Link Aggregation Group (LAG) | **121**
- Precision Time Protocol (PTP) Trace Overview | **122**
- Line Card Redundancy for PTP | **126**
- Timing Defects and Event Management on Routing Platforms | **127**
- SNMP MIB for Timing on Routing Platforms | **132**
- PTP Passive Port Performance Monitoring on PTX10004 and PTX10008 Devices | **137**

Precision Time Protocol (PTP) over Link Aggregation Group (LAG)

SUMMARY

Link Aggregation is a mechanism of combining multiple physical links into a single virtual link to achieve linear increase in bandwidth and to provide redundancy in case one of the links fails.

Link Aggregation is a mechanism of combining multiple physical links into a single virtual link to achieve linear increase in bandwidth and to provide redundancy in case one of the links fails. The virtual link is referred as Aggregated Ethernet (AE) interface or Link Aggregation Group (LAG). Junos OS supports PTP (IPv4 and Ethernet) over LAG based on the recommendation in ITU-T-G.8275.1.

For each aggregated Ethernet link configured as PTP timeTransmitter or timeReceiver, you can specify one member link of the aggregated Ethernet bundle as primary and another as secondary. PTP switches over to the secondary member in the aggregated Ethernet bundle when the primary aggregated Ethernet link is down. For providing both link-level and FPC-level redundancy, the primary and secondary interfaces of the aggregated Ethernet bundle must be configured on separate line cards. If both primary and secondary are configured on the same line card, it would provide only link-level redundancy.

PTP timeTransmitter streams are created on the FPC on which the timeTransmitter interface is present. Announce and sync packets are transmitted on this active PTP aggregated Ethernet link. The line card on the PTP timeReceiver containing this active PTP aggregated Ethernet link will receive announce and sync packets from the remote timeTransmitter.

Junos OS also supports Hybrid over LAG. When primary and backup SyncE Interfaces are present on same line card, hybrid over LAG is supported.

See the Feature Explorer page to confirm platform and release support for specific features.

NOTE: PTP might not function correctly if an aggregated Ethernet (AE) interface is configured on MX10008 Router with JNP10K-LC2101 Line card. If either the timeTransmitter or secondary links on the AE do not support PTP with Hypermode, then the whole AE is marked as unsupported.

Precision Time Protocol (PTP) Trace Overview

SUMMARY

You can implement a path trace mechanism to detect PTP loops that circulate endlessly within a PTP ring of boundary clocks over an IPv4 network. The PTP ring topology implementation uses the 1588v2 path trace mechanism to prevent PTP loops and to provide PTP convergence in the event of any single-point failure.

IN THIS SECTION

- PTP Ring Topology | 122
- Path Trace Mechanism for Handling PTP Failures | 123
- Steady State | 124
- Failure Handling | 125
- PTP Ring Topology Without Path Trace Mechanism | 125

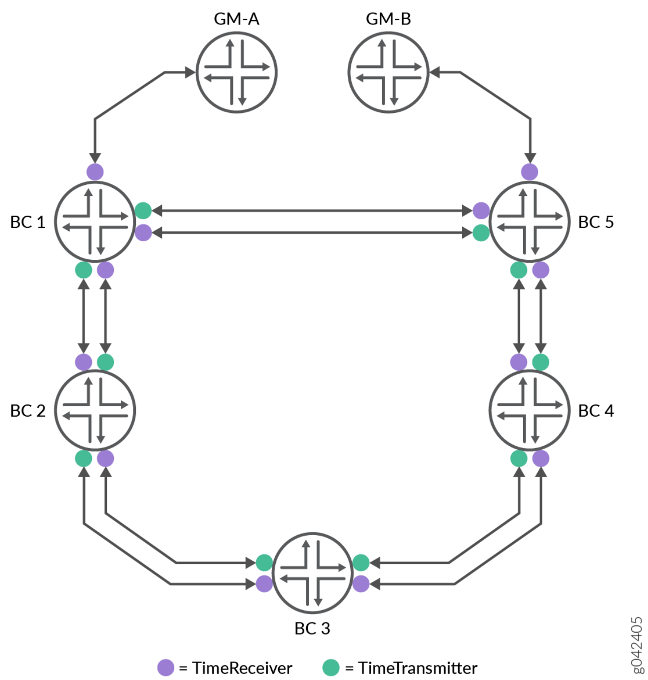
The following sections explain the path trace mechanism and how it is implemented in a multiple-grandmaster clock PTP ring topology over an IPv4 network. The sections also explain steady state and failure handling in a PTP ring topology:

PTP Ring Topology

A PTP ring topology is a ring topology that consists of one or more grandmaster clocks and several boundary clocks.

Consider a simple ring topology of boundary clocks—BC1 through BC5—driven by one primary PTP grandmaster clock and one backup PTP grandmaster clock—GM-A and GM-B, respectively—as illustrated in Figure 2 on page 123. Assume that GM-A is superior to GM-B—that is, the quality level of GM-A's clock is higher than that of GM-B's clock.

Figure 2: Multiple-reference Clock PTP Ring Topology



Each boundary clock in the PTP ring is configured as both timeReceiver and timeTransmitter to its immediate neighbor to provide seamless PTP grandmaster clock switchover in case of reference or boundary clock failure. For example, in Figure 2 on page 123 BC2 is both timeTransmitter and timeReceiver to both BC1 and BC3, BC3 is both timeTransmitter and timeReceiver to BC2 and BC4, and so on.

Path Trace Mechanism for Handling PTP Failures

During the process of synchronization in a PTP ring topology, certain announce messages—timing information messages that are sent from timeTransmitter to timeReceiver—might form in an infinite loop (also called *PTP loop*) in a network trail of boundary clocks. These PTP loops create issues such as a boundary clock potentially synchronizing its local clock with its own timing information, thereby compromising the quality of the recovered clock. The path trace mechanism is used to detect such loops.

A *path trace* is the route that a PTP announce message takes through the network trail of boundary clocks and is tracked through the path trace TLV in the announce message. A path trace TLV (type, length, and value) is a set of octets in an announce message that includes the TLV type, the length field, and the path sequence. The path trace sequence contains the clock ID of each boundary clock that an announce message traverses through the PTP ring.

One of the principal uses of the path trace mechanism is to detect the so-called *rogue announce messages* that circulate endlessly in loops in the PTP ring of boundary clocks. A boundary clock detects a PTP loop when it finds its own clock ID in the path trace of the received announce message. When such a loop is detected, the router discards the received announce message.

To view the trail of the announce message or path trace, use the `show ptp path-trace detail` operational mode command.

NOTE:

- During GRES, the path trace and the best timeTransmitter clock algorithm information are pushed to the kernel. Therefore, this information is available on the backup Routing Engine as well.
- When the number of boundary clocks in a topology exceeds 20, the path trace TLV is dropped.
- Currently, the PTP ring topology is supported only for PTP over IPv4 networks.

Steady State

The PTP ring is considered to be in steady state or operating normally when a router, say BC1, is locked—that is, is connected and synchronized—to a grandmaster clock that has a higher quality level value—higher than the quality level of other grandmaster clocks in the network—and all the other routers in the PTP ring are locked to the grandmaster clock through this router BC1. For example in Figure 2 on page 123, during steady state, BC1 is locked to GM-A, BC2 and BC5 are locked to BC1, BC3 is locked to BC2, and BC4 is locked to BC5. When the path trace mechanism is implemented in this ring topology, a clock ID is assigned to each boundary clock that, in turn, is included in the path trace TLV within the announce message. Therefore, the path trace TLV in the announce message originating from BC1 has its own clock ID—CID1. Similarly, the announce message from BC2 has its own clock ID—CID2—and BC1's clock ID–CID1—and so on.

As router BC2 is timeTransmitter to BC1, BC1 constantly receives BC2's announce messages. The announce messages from BC2 received on BC1 contains BC1's own clock ID—CID1—along with BC2's clock ID—CID2. Because BC1 receives its own clock ID—CID1—in the announce message, BC1 drops BC2's announce messages. Similarly, BC2 drops BC3's announce messages as the messages contain BC2's clock ID—CID2—along with other clock IDs—CID1 and CID3. Note that this behavior is intentional and by design, as is explained in "Failure Handling" on page 125.

Failure Handling

Consider a scenario where the router BC1 crashes in the PTP ring illustrated in Figure 2 on page 123. This failure is handled in the following way:

1. The router BC2 stops receiving announce messages from BC1.
2. The announce messages now received by BC2 are only those sent by BC3. BC2 drops these announce messages because these messages contain BC2's own clock ID—CID2.
3. Because BC2 does not receive any valid announce messages, it goes into holdover mode and lowers the value of its announce parameters, such as clock class, which results in BC2 announce messages carrying an inferior clock class.
4. When BC3 receives these announce messages with inferior clock class from BC2, it in turn announces this inferior clock class to all the downstream routers.
5. When BC5 eventually receives this announce message with the inferior quality level value from BC4, the best timeTransmitter clock algorithm running on the BC5 router switches BC5 to GM-B automatically and the BC5 router sends announce messages corresponding to the parameters as set by GM-B.
6. When BC4 receives this announce message—carrying superior clock class information as compared to that carried by BC3's announce message—the BC4 router switches to BC5. Similarly, BC3 locks to BC4 and then BC2 locks to BC3. In other words, the ring topology shown in Figure 2 on page 123 converges to a clockwise hierarchy of boundary clocks. This entire process takes a few tens of seconds.

Note that each PTP best timeTransmitter clock algorithm switchover at each boundary clock is seamless and thereby ensures that the performance of the PTP ring does not degrade. However, when there are multiple simultaneous failures in the ring topology—for example, simultaneous link failures between GM-A and BC1 and between BC4 and BC5—the short-term absolute maximum time interval error (MTIE) might go up to 650ns—for example, between routers BC2 to BC4. Note that this type of multiple failures in a ring topology is rare.

MTIE is a maximum phase variation error that is measured over a period of time, where the error is calculated between the phase variation of a signal with the perfect signal.

PTP Ring Topology Without Path Trace Mechanism

When the PTP path trace mechanism is not implemented, the BC2 router cannot detect announce messages from BC3 that are actually BC2's looped announce messages. This, in turn, results in BC2 attempting to lock to BC3 (while BC3 is already locked to BC2) and a PTP deadlock is created. Because of the PTP deadlock, there is a significant clock drift over a period of time on both BC2 and BC3 and potentially on all the boundary clocks that can be traced to BC3.

Note that when the crashed router BC1 comes up, it chooses GM-A as its timeTransmitter, and it sends out announce messages that carry superior clock class information compared to those carried by announce messages sent out by GM-B. The BC2 router's best timeTransmitter clock algorithm determines that the BC1's announce messages carry superior clock class information as compared to BC3's, resulting in BC2 switching back to BC1. Similarly, BC3 switches back to BC2. This way, the ring topology is restored to the pre-crash topology.

Line Card Redundancy for PTP

SUMMARY

Line card redundancy is one the PTP redundancy scenarios possible in a mobile backhaul solution. Multiple timeReceiver streams are configured across line cards and if the currently active timeReceiver line card crashes or all streams on that line card lose their timing packets another timeReceiver line card can take over if it has been primed to do so.

When you configure line card redundancy, timeReceiver streams are created on appropriate line cards. At this time all of the line cards are in DPLL mode. All of the timeReceiver streams are primed to receive and process announce messages.

Each line card executes the BTCA algorithm and identifies the best timeTransmitter and the stream serving the best timeTransmitter. The line card sends the best timeTransmitter information to the RE. After receiving best timeTransmitter information from individual line cards, the RE selects the best timeTransmitter to serve the BC node. This information is propagated to all of the line cards. Once the best timeTransmitter is selected by the RE, the regular PTP state machine will be executed.

If the BTCA algorithm results in a stream switchover and the new stream falls on a different line card, a hitless switchover will be triggered. The new timeReceiver card may be configured in pure PTP or Hybrid mode. The old timeReceiver card may in pure PTP timeReceiver or Hybrid timeReceiver mode. The line cards need to go through following steps:

- A timeReceiver line card transition needs to happen via holdover state on the timeTransmitter line card.
- FSM needs to convert the old timeReceiver line card to pure PTP timeTransmitter mode.
- On the new timeReceiver card, FSM needs to be triggered based on pure PTP or hybrid mode of operation. All these transitions need to be hitless.

NOTE:

- Limited Line card redundancy is supported on NG-MPCE2, 3, MPCE5, MPCE6, MPCE7, MPCE8, MPCE9, and MPCE10 line cards.
- BTCA switchover from a port on one line card to another line card is not hitless.
- Stateful or timeReceiver port configuration on more than two-line cards is not supported on MX960, MX480, MX240, MX2020, MX2010, MX10003 and MX2008 universal routing platforms. This limitation is not applicable to MX10K (MX10008, MX10016 and MX10004 platforms.

Timing Defects and Event Management on Routing Platforms

SUMMARY

Junos OS supports defect and event management capabilities for timing features. Defects and events are notified in the form of SNMP traps. These SNMP traps are logged into the system log-file (var/log/snmpd).

Junos OS for ACX Universal Metro Routers supports defect and event management capabilities for timing features. Defects and events are notified in the form of SNMP traps and these SNMP traps are logged into the system log-file (var/log/snmpd). For each of the SNMP traps (timing defects and timing events) that are generated, a message is logged in the clksyncd file (var/log/clksyncd).

Starting Junos Evolved release version 24.2R1, ACX7332 and ACX7348 devices support additional defect management capability for the SYNCE, PTP MIB (SNMP traps) and display error messages for timing features. For details, see *SNMP MIB for Timing on Routing Platforms.*

Table 4 on page 128 shows the list of SNMP trap notifications for timing defects and events supported in ACX Universal Metro Routers.

Table 4: SNMP trap notifications for timing defects and events

SNMP Trap	Notification Type	Description
jnxTimingFaultLOS	Defects (Set, Clear)	Set denotes loss of signal Clear denotes loss of signal is cleared
jnxTimingFaultEFD	Defects (Set, Clear)	Denotes exceeded frequency deviation
jnxTimingFaultLOESMC	Defects (Set, Clear)	Denotes loss of Ethernet Synchronization Message Channel (ESMC)
jnxTimingFaultQLFail	Defects (Set, Clear)	Denotes failure in quality level
jnxTimingFaultLTI	Defects (Set, Clear)	Denotes loss of timing information
jnxTimingFaultPriSrcFailed	Defects	Denotes the failure of timeTransmitter source
jnxTimingFaultSecSrcFailed	Defects	Denotes the failure of secondary source
jnxTimingFaultPtpUniNegRateReject	Defects	When acting as timeTransmitter, this SNMP trap denotes failure or rejects timeReceivers for signaling messages. When acting as a timeReceiver, this SNMP trap denotes failure or timeReceiver stops receiving signaling messages
jnxTimingEventPriSrcRecovered	Events	Denotes the recovery of timeTransmitter source
jnxTimingEventSecSrcRecovered	Events	Denotes the recovery of secondary source

Table 4: SNMP trap notifications for timing defects and events *(Continued)*

SNMP Trap	Notification Type	Description
jnxTimingEventPriRefChanged	Events	Denotes a change in timeTransmitter reference such as a change in logical interface or a change from SyncE to BITS/external interface)
jnxTimingEventSecRefChanged	Events	Denotes a change in secondary reference such as a change in logical interface
jnxTimingEventQLChangedRx (ACX7332, ACX7348)	Events	Denotes a change in quality level at Receiver SSM/ESMC
jnxTimingEventQLChangedTx (ACX7332, ACX7348)	Events	Denotes a change in quality level at Transmitter SSM/ESMC
jnxTimingEventDpllStatus	Events	Denotes the DPLL status (SyncE, BITS, Hybrid)
jnxTimingEventSynceDpllStatus (ACX7332, ACX7348)	Events	Denotes the following SyncE DPLL states: jnxClksyncIfIndex: Frequency is derived from this interface index. jnxClksyncIntfName: Frequency is derived from this interface name. jnxClksyncDpllState: DPLL status. jnxClksyncDpllStateStr: DPLL status in string format.

Table 4: SNMP trap notifications for timing defects and events *(Continued)*

SNMP Trap	Notification Type	Description
jnxTimingEventPtpServoStatus	Events	Denotes the following PTP Servo states: • INITIALIZING • ACQUIRING (TimeTransmitter is elected and servo starts acquiring lock) • PHASE ALIGNED (Locked to TimeTransmitter) • FREERUN (no PTP source available) • HOLDOVER (Member locked to PTP for more than 12 hours and then loses all the PTP sources)
jnxTimingEventPtpClockClassChange	Events	Denotes a change in PTP clock class
jnxTimingEventPtpClockAccuracyChange	Events	Denotes a change in PTP accuracy
jnxTimingEventPtpGMChange	Events	Denotes a change in PTP grandmaster clock
jnxTimingEventHybridStatus	Events	Denotes the following hybrid states: • INITIALIZING • ACQUIRING (TimeTransmitter is elected and servo starts acquiring lock) • FREQUENCY LOCKED (Frequency locked but acquiring phase) • PHASE ALIGNED (Frequency and phase locked)

To configure and generate timing defects and events trap notifications, include the `timing-events` statement at the `[edit snmp trap-group *trap-group-name* categories]` hierarchy level as shown below:

```
[edit]
snmp {
    trap-group <group-name> {
       categories {
          timing-events;
        }
    }
}
```

The following is a sample configuration for SNMP timing in ACX Series routers:

```
snmp {
    trap-options {
        source-address 10.216.66.139;
    }
    trap-group timingGroup {
        version v2;
        destination-port 8999;
        categories {
            timing-events;
        }
        targets {
            192.168.120.129;
        }
    }
    traceoptions {
        flag all;
    }
}
```

SNMP MIB for Timing on Routing Platforms

SUMMARY

This topic talks about theJunos OS support for SNMP get, get-next, and walk management capabilities for timing features.

Junos OS for ACX Universal Metro Routers supports SNMP get, get-next, and walk management capabilities for timing features. These capabilities are enabled through the PTP MIB, SyncE MIB and GPS MIB timing objects.

> **NOTE**: The PTP MIB and SyncE MIB timing objects are grouped under the **jnxTimingNotfObjects** SNMP MIB object.

Table 5 on page 132 shows the list of SNMP MIB objects supported for SNMP get, get-next, and walk management on ACX Universal Metro Routers.

Table 5: SNMP MIB Objects for get, get-next, and walk management

SNMP MIB	Object	Description
PTP MIB	jnxPtpServoState	Denotes the following PTP Servo states: • INITIALIZING • ACQUIRING • PHASE ALIGNED • FREERUN • HOLDOVER • FREQUENCY LOCKED

Table 5: SNMP MIB Objects for get, get-next, and walk management *(Continued)*

SNMP MIB	Object	Description
	jnxPtpServoStateStr	Denotes the PTP Servo state string: • INITIALIZING • ACQUIRING (TimeTransmitter is elected and servo starts acquiring lock) • PHASE ALIGNED (Locked to TimeTransmitter) • FREERUN (no PTP source available) • HOLDOVER (Member locked to PTP for more than 12 hours and then loses all the PTP sources)
	jnxPtpClass	Denotes the class of the PTP grandmaster clock.
	jnxPtpGmId	Denotes the PTP grandmaster clock identifier.
	(ACX7332, ACX7348)	
	jnxPtpPhaseOffset	Denotes the PTP phase offset.
	jnxPtpUtcOffset	Denotes the PTP UTC offset.
	jnxPtpAdvClockClass	Denotes the PTP Advertised clock class.
	jnxTimingFrequencyTraceability	Denotes the frequency traceability indicator.
	jnxTimingTimeTraceability	Denotes the time traceability indicator.
	jnxClksyncPtpOperationalMasters	Denotes the PTP operational masters.
	jnxClksyncPtpOperationalSlaves	Denotes the PTP operational timeReceiver clocks.
SyncE MIB	jnxClksyncQualityCode	Denotes the SSM/ESMC quality level of the locked source in decimal format.

Table 5: SNMP MIB Objects for get, get-next, and walk management *(Continued)*

SNMP MIB	Object	Description
	jnxClksyncQualityCodeStr	Denotes the SSM/ESMC quality level of the locked source in string format
	jnxClksyncIfIndex	Denotes the interface index of the locked source in decimal format.
	jnxClksyncIntfName	Denotes the interface name of the locked source in string format.
	(ACX7332, ACX7348)	
	jnxClksyncSynceQualityTable	Denotes the SyncE table to get quality metrics for all configured sources.
	jnxClksyncSynceQualityEntry	Denotes the SyncE table entry to get quality metrics for all configured sources.
	jnxClksyncSynceQualityIntfName	Denotes the interface name of the configured source.
	jnxClksyncSynceQualityValue	Denotes the quality level of the configured source.
	jnxClksyncSynceLockedIfIndex	Denotes the locked SNMP ifIndex of member interface.
	jnxClksyncSynceLockedIntfName	Denotes the SyncE interface name.
	jnxClksyncDpllState	Denotes the SyncE DPLL states.
	jnxClksyncDpllStateStr	Denotes the DPLL state in string format.
GPS MIB	jnxGpsRecvStatus	Displays the status of the GPS receiver.

NOTE:

- The SNMP get and walk management are supported only for scalar objects.

  Use the `show snmp mib get>` and `show snmp mib walk <oid>` commands to view the configured SNMP MIB objects.

- For SyncE objects, the jnxClksyncQualityCode, jnxClksyncQualityCodeStr, jnxClksyncIfIndex, and jnxClksyncIntfName objects displays only for locked source.

- For additional details, see Timing MIBs and Notifications.

You can use the `show chassis synchronization extensive`, `show ptp lock-status detail`, `show snmp mib get <MIB-timing-objects>`, and `show snmp mib walk jnxTimingNotfObjects` show commands for monitoring and troubleshooting purposes.

The following are the sample show command outputs for reference:

show chassis synchronization extensive

```
user@host> show chassis synchronization extensive

Current clock status  : Locked
Clock locked to       : Primary
SNMP trap status : Enabled

Configured sources:

Interface           : ge-0/0/7
Status              : Secondary     Index        : 136
Clock source state  : Clk qualified Priority     : Default(8)
Configured QL       : SEC           ESMC QL      : PRC
Clock source type   : ifd           Clock Event : Clock qualified
Interface State     : Up,sec,ESMC Rx(SSM 0x2),ESMC TX(QL SEC/SSM 0xb),

Interface           : ge-0/1/1
Status              : Primary       Index        : 138
Clock source state  : Clk qualified Priority     : Default(8)
Configured QL       : PRC           ESMC QL      : PRC
Clock source type   : ifd           Clock Event : Clock locked
Interface State     : Up,pri,ESMC Rx(SSM 0x2),ESMC TX(QL DNU/SSM 0xf)
```

show chassis synchronization extensive

```
user@host> show chassis synchronization extensive

Configured ports:

Name                : auxiliary
Rx status           : active
Rx message          : TL000001433759011353
Current ToD         : Mon Jun  8 10:23:31 2015
Last ToD update     : Mon Jun  8 10:23:30 2015
GPS receiver status : Lost Sync
UTC Pending         : FALSE
UTC Offset          : 35

One PPS status : Active

Configured sources:

Interface           : gps
Status              : Primary       Index       : 1
Clock source state  : Clk failed    Priority    : Default(6)
Configured QL       : PRC           ESMC QL     : DNU
Clock source type   : extern        Clock Event : Clock failed
Interface State     : Up,pri
```

show ptp lock-status detail

```
user@host> show ptp lock-status detail

Lock Status:

Lock State    : 1 (FREERUN)
Phase offset  : 0.000000000 sec
State since   : 2015-05-04 03:13:49 PDT (00:01:45 ago)

Selected Master Details:
Upstream Master address    : 61.1.1.2
Slave interface            : ge-0/1/1.0
Parent Id                  : 40:b4:f0:ff:fe:42:f5:00
```

```
GMC Id                    : 40:b4:f0:ff:fe:42:d5:00
```

show snmp mib get <MIB-timing-objects>

```
user@host> show snmp mib get jnxGpsRecvStatus.0

jnxGpsRecvStatus.0 = Lost Sync
```

show snmp mib walk jnxTimingNotfObjects

```
user@host> show snmp mib walk jnxTimingNotfObjects

jnxClksyncIfIndex.0 = 138
jnxClksyncIntfName.0 = ge-0/1/1
jnxClksyncQualityCode.0 = 2
jnxPtpServoState.0 = 1
jnxPtpClass.0 = 6
jnxPtpGmId.0  = 40:b4:f0:ff:fe:42:d5:00
jnxClksyncQualityCodeStr.0 = PRC
jnxPtpServoStateStr.0 = FREERUN
```

PTP Passive Port Performance Monitoring on PTX10004 and PTX10008 Devices

IN THIS SECTION

- Limitations: | 138
- Configuring PTP Passive Port Performance Monitoring | 139
- Results | 140

The Precision Time Protocol (PTP) passive port performance monitoring feature can be enabled on stateful ports (as per G.8275.1 Annex G) for PTX10004 and PTX10008 platform with LC1201 and LC1202 line-cards.

The PTP passive port performance monitoring feature:

- is used to monitor the PTP performance at a passive port. The passive port state is defined in ITU-T-G.8275.1 specifications.
- supports `not-master` and `measure-only` per PTP port attributes for stateful ports.
- can be configured on a maximum of four ports (including one active member port).
- supports configurable delay request rates of passive ports.
- supports PTP passive port minor alarms when performance metrics exceed the configured thresholds.
- is supported on LAG interfaces on PTP selected active interface. The source port is same for the primary or secondary links because the port-numbers belong to the aggregated Ethernet (AE) interface.

The following alarm is supported for PTP performance monitoring:

Alarms	Reason	Type	Raise Condition	Clear Condition
ALARM_REASON _PTP_PHASE_ DIFFERENCE_TH RESHOLD_ EXCEEDED_PTP	PTP phase difference measurement exceeds configured threshold for the monitored port	Minor Interface Alarm	Alarm is raised when the measured phase-difference of the monitored interface exceeds configured threshold over 15 minutes interval and the configuration `set protocols ptp performance-monitor passive-port` is enabled.	Alarm is cleared when the measured phase difference at the monitored interface is below the configured threshold over 15 minutes interval and the configuration `set protocols ptp performance-monitor passive-port` is deativated.

Limitations:

- Two-step clock in master mode is not supported in PTP FPGA mode.
- PTP with MACSec encryption is not supported.

Configuring PTP Passive Port Performance Monitoring

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the [edit] hierarchy level.

1. Configure `set protocols ptp performance-monitor passive-port` to enable the PTP passive port performance monitoring feature.

```
user@root> set protocols ptp performance-monitor passive-port
```

2. Configure `set protocols ptp performance-monitor passive-port delay-request-rate` *<delay-request-value>* to set the delay request rate for port monitoring.

   This configuration is used for raising PTP performance alarm when the measured phase error exceeds the threshold over 15 minutes interval.

   The default value is -4 and the value ranges from `-4` to `+4`. For example,

```
user@root> set protocols ptp performance-monitor passive-port delay-request-rate -4
```

3. To configure PTP passive port performance monitoring for stateful interfaces, use `set protocols ptp stateful interface` *<interface-number>* `passive-port-monitor` command. It sets the interface port to monitor-mode. The port is now monitored when it moves to passive state. This command is supported only for multicast mode.

   For example,

```
user@root> set protocols ptp stateful interface 1 passive-port-monitor
```

4. Use `set protocols ptp stateful interface` *interface-name* `passive-port-monitor maximum-phase-offset-threshold` *<offset-threshold-value>* to set the interface PTP passive port performance monitoring maximum phase offset threshold. This configuration is used for raising PTP performance alarm when the measured phase error exceeds the threshold over 15 minutes interval. The value is defined in nano seconds and range from 0 to 100000000. The default value is 100ms.

   For example,

```
user@root> set protocols stateful interface et-0/0/34 passive-port-monitor maximum-phase-
offset-threshold 10000
```

5. Use `set protocols ptp stateful interface` *`interface--name`* `not-master` to configure `not-master` per PTP port attribute for stateful ports. This ensures the port is never placed in timeTransmitter state but can be placed in passive or member state. This configuration is independent of passive-port-monitoring feature and is supported only for multicast mode. For example:

```
user@root> set protocols stateful interface et-0/0/34 not-master
```

6. Use `set protocols ptp stateful interface` *`interface--name`* `passive-port-monitor measure-only` to configure the stateful port as `measure-only`. This ensures the port is never placed in timeTransmitter or member state but can be placed in passive state. This configuration is independent of the `not-master` configuration and supported only for multicast mode.

```
user@root> set protocols stateful interface et-0/0/34 passive-port-monitor measure-only
```

Results

Check the results of the configuration using the `show ptp global-information`, `show ptp passive-port-monitor-status` and `show ptp port` commands. For example:

- `show ptp global-information` output with PTP passive port performance monitoring enabled:

```
user@root> show ptp global-information
PTP Global Configuration:
Domain number            : 24
Clock mode               : Boundary
Profile type             : G.8275.1
Priority Level1          : 128
Priority Level2          : 128
Local Priority           : 128
Path Trace               : Disabled
Unicast Negotiation      : Disabled
ESMC QL From Clock Class: Disabled
Clock Class/ESMC QL      :  -
SNMP Trap Status         : Disabled
PHY Time Stamping        : Enabled
UTC Leap Seconds         : 37
Transparent-clock-config : DISABLED
Transparent-clock-status : N/A
PPM Status               : ENABLED
PPM Delay Request Interval : -4 (16 packets per second)
```

```
Slave Parameters:
  Sync Interval         : <not applicable>
  Delay Request Interval: -4 (16 packets per second)
  Announce Interval     : <not applicable>
  Announce Timeout      : 3
  Grant Duration        : <not applicable>
Master Parameters:
  Sync Interval               : -4 (16 packets per second)
  Announce Interval           : -3 (8 packets per second)
  Delay Request Timeout       : <not applicable>
  Clock Step                  : one-step
  Arbitrary Mode              : FALSE

Number of Slaves       : 0
Number of Masters      : 1
Number of Stateful     : 1
```

- `show ptp passive-port-monitor status` command output with PTP passive port performance monitoring enabled and configured as not-master.

```
user@root> show ptp passive-port-monitor-status
PPM Status              : ENABLED
PPM Delay Request Interval : -4 (16 packets per second)

Actively Monitored-PTP ports data:

Local Interface          : ae0.4094 (et-4/0/0, primary)
Clock Stream             : 5
Source-Port-ID           : 00:cc:34:ff:fe:77:c4:57  Port : 5
Destination-Port-ID      : 00:cc:34:ff:fe:77:c8:de  Port : 1
Port State               : Passive
Operating Mode           : Stateful
PhaseOffsetThreshold(ns) : 100000
Configured role          : Not-master
Measurement-status       : Valid
Latest measurement data  :
Timestamp                : Aug 20 22:26:16
PhaseOffsetFromMaster(ns): 15       / 17       / 791       (min/mean/max)
Master->slave delay(ns)  : 0        / 1575     / 1584      (min/mean/max)
```

```
Slave->master delay(ns)  : 0         / 1540     / 1582      (min/mean/max)
Mean-path-delay(ns)      : 1557      (mean)
```

- `show ptp port` command output with `measure-only` and `not-master` configured on the stateful port with PTP passive port performance monitoring enabled.

```
user@root> show ptp port
PTP port-data:

Local Interface   : et-0/0/16:1.0
Local Address     : e4:5d:37:4e:c8:19
Remote Address    : 01:1b:19:00:00:00
Clock Stream      : 5              Clock Identity    : e4:5d:37:ff:fe:4e:d7:76
Port State        : Passive        Delay Req Interval: -4
Announce Interval : -3             Announce Timeout  : 3
Sync Interval     : -4             Delay Mechanism   : End-to-end
Port Number       : 2              Operating Mode    : Stateful, Not-master, Measure-only
Local Priority    : 128
```

RELATED DOCUMENTATION

ptp

show ptp global-information

3

PART

Global Navigation Satellite System (GNSS)

GPS Systems on Routing Platforms | 144

Integrated GNSS on Routing Platforms | 145

GNSS Configuration for Routers Using External GNSS Receiver | 154

Assisted Partial Timing Support (APTS) on Routing Platforms | 178

CHAPTER 7

GPS Systems on Routing Platforms

IN THIS CHAPTER

- Global Positioning System (GPS) on Routing Platforms | **144**

Global Positioning System (GPS) on Routing Platforms

SUMMARY

GPS is a navigation aid system that uses signals from satellites to calculate the actual position of a GPS-capable receiver. Some Juniper routers support GPS.

Global Positioning System (GPS) is a navigation aid system that uses signals from satellites to calculate the actual position of a GPS-capable receiver. These signals are not only used for determining the position of the receiver on Earth but also as a very accurate time base. There are GPS receivers with 10-MHz clock frequency output synchronized to a GPS satellite. The ACX Series router has a SubMiniature version B (SMB) connector that can take 10-MHz sine-wave input from a GPS receiver. To configure this 10-MHz clock from a GPS receiver as a candidate clock source for chassis synchronization, include the `gps` statement and options at the [**edit chassis synchronization source**] hierarchy level.

NOTE: ACX500 routers do not require an external GPS receiver because the GPS receiver is integrated into the system.

CHAPTER 8

Integrated GNSS on Routing Platforms

IN THIS CHAPTER

- Integrated Global Navigation Satellite System (GNSS) on Routing Platforms | 145

Integrated Global Navigation Satellite System (GNSS) on Routing Platforms

SUMMARY

GNSS is a navigation aid system that uses signals from satellites to calculate the actual position of a GPS-capable receiver. These signals are not only used for determining the position of the receiver on Earth but also as a very accurate time base. Juniper provides routers that have the GNSS receiver integrated within the system. These routers support Telecom Grandmaster (T-GM) functionality.

IN THIS SECTION

- Configuration | 146

Global Navigation Satellite System (GNSS) is a navigation aid system that uses signals from satellites to calculate the actual position of a GPS-capable receiver. These signals are not only used for determining the position of the receiver on Earth but also as a very accurate time base.

Juniper provides routers with the GNSS receiver integrated within the platform. This eliminates the need to have an external GPS receiver. Routers integrated with the GNSS receivers support the Telecom Grandmaster (T-GM) functionality. The T-GM acts as a G8275.1 T-GM (ordinary clock) by synchronizing itself to an internal/external GNSS receiver and drives time and frequency to the downstream PTP slaves via timestamps in PTP packets.

The inbuilt GPS receiver can be hooked to a GPS antenna to be able to receive GPS time. It then uses PTP to distribute this time to other network devices. The router enables GNSS input through SubMiniature version A (SMA) connector.

The ACX500, ACX7332, and ACX7348 routers support integrated GNSS receivers. Review the platform's hardware guide for more details.

Configuration

To enable T-GM feature you must configure the GNSS port and its associated parameters at the [edit chassis synchronization] hierarchy level. You must also configure the PTP settings under the [edit protocols ptp] hierarchy.

Configuring T-GM for ACX7332 and ACX7348 Routers

1. Configure the GNSS settings under the [set chassis synchronization] hierarchy. You must specify at least one constellation option. A sample configuration snippet for mandatory GNSS configuration is provided below:

```
set chassis synchronization gnss-receiver 0 receiver-type internal
set chassis synchronization gnss-receiver 0 interface
set chassis synchronization gnss-receiver 0 constellation gps l1ca
```

2. Optionally, you can also configure the following GNSS options:

```
set chassis synchronization gnss-receiver 0 position mode survey-mode survey-length 5
set chassis synchronization gnss-receiver 0 position-mode position-fix-mode latitude 90
longitude 180 altitude 0
set chassis synchronization gnss-receiver 0 cable-delay-compensation 100000
set chassis synchronization gnss-receiver 0 snr-threshold 10
set chassis synchronization gnss-receiver 0 disable-log
set chassis synchronization network-option option-1
set chassis synchronization esmc-transmit interfaces ge-0/0/0
set chassis synchronization enable-extended-ql-tlv
```

3. Configure PTP T-GM configuration under the [set protocols ptp] hierarchy. A sample configuration snippet is provided below:

```
set protocols ptp clock-mode ordinary
set protocols ptp profile-type g.8275.1
set protocols ptp master interface et-0/0/0.0 multicast-mode transport ieee-802.3
```

4. Verify GNSS configuration:

```
user@host> show chassis synchronization gnss-receiver time
Current ToD                        : 00:00:00 00/00/0
UTC Pending                        : FALSE
UTC offset (TAI-UTC)               : 0
Future leap sec & schedule         : 00  00:00:00 00/00/0
```

```
user@host> show chassis synchronization gnss-receiver version
Product Name                       : GF8801 OPUS7_SFLASH_MP_64P
Product Rev/version                : ENP708C2109100T
Additional Information             : None
```

```
user@host> show chassis synchronization gnss-receiver

Lock status                      : Fine lock
Receiver-type                    : Internal
Serial Number                    : 751700984
Port Status                      : Up
Port Details                     : UART 9600 bps / USB
Current ToD                      : 23:46:30 05/01/2024
UTC Pending                      : FALSE
UTC offset (TAI-UTC)             : 37
Future leap sec & schedule       : 38  00:00:00 01/01/2024
1PPS STATUS                      : Available
10mhz status                     : Available
Time source                      : UTC (USNO)
Alarms                           : NONE
Antenna port status              : Open
Constellation                    : GPS L1CA
Position mode                    : Position-fix-mode
Self Survey Length               : 0 mins
Cable Delay Compensation         : 0 ns
SNR-threshold                    : 0 dBHz
Latitude                         : 0 0' 0.006000'' N
Longitude                        : 0 0' 0.000000'' W
```

```
Altitude                       : -18 m
No. of Satellites Used         : 12
```

```
user@host> show chassis synchronization gnss-receiver extensive

Lock status                    : Fine lock
Receiver-type                  : Internal
Serial Number                  : 751700984
Port Status                    : Up
Port Details                   : UART 9600 bps / USB
Current ToD                    : 23:48:06 05/01/2024
UTC Pending                    : FALSE
UTC offset (TAI-UTC)           : 37
Future leap sec & schedule     : 38  00:00:00 01/01/2024
1PPS STATUS                    : Available
10mhz status                   : Available
Time source                    : UTC (USNO)
Alarms                         : NONE
Antenna port status            : Open
Constellation                  : GPS L1CA
Position mode                  : Position-fix-mode
Self Survey Length             : 0 mins
Cable Delay Compensation       : 0 ns
SNR-threshold                  : 0 dBHz
Latitude                       : 0 0' 0.006000'' N
Longitude                      : 0 0' 0.000000'' W
Altitude                       : -18 m
No. of Satellites Used         : 12
Visible Satellite List:

Sat-Num   Signal-level     Status        Type
20        43    dBHz       Acquired      GPS
1         43    dBHz       Acquired      GPS
7         42    dBHz       Acquired      GPS
23        42    dBHz       Acquired      GPS
25        42    dBHz       Acquired      GPS
19        42    dBHz       Acquired      GPS
8         42    dBHz       Acquired      GPS
13        42    dBHz       Acquired      GPS
11        42    dBHz       Acquired      GPS
28        42    dBHz       Acquired      GPS
```

```
3          42    dBHz       Acquired      GPS
4          41    dBHz       Acquired      GPS
```

```
user@host> show chassis synchronization extensive

Current clock status  : LOCKED
Clock locked to       : Primary
SNMP trap status      : Disabled

Configured ports:

Name                 : gnss-rx-0
Current ToD          : Fri Jan 05 15:48:54 2024 PST
Last ToD update      : Fri Jan 05 15:48:53 2024 PST
GPS receiver status : Synchronized
UTC Pending          : FALSE
UTC Offset           : 37

One PPS status : Active

{master}
```

5. Verify PTP T-GM configuration:

```
user@host> show ptp lock-status detail

Lock Status:

Lock State     : 5 (PHASE ALIGNED)
State since    : 2024-07-25 23:53:29 PDT (4d 10:07 ago)

Source: GNSS
```

Configuring T-GM for ACX500 Routers

1. Configure the GNSS settings under the [`set chassis synchronization`] hierarchy. If you do not specify a `constellation` option, then the *gps* constellation option is considered by default. A sample configuration snippet is provided below:

```
set chassis synchronization network-option option-1
set chassis synchronization selection-mode received-quality
set chassis synchronization clock-mode auto-select
set chassis synchronization quality-mode-enable
set chassis synchronization port gnss client cable-length-compensation 20
set chassis synchronization port gnss client constellation gps-qzss
set chassis synchronization port gnss client anti-jamming
set chassis synchronization esmc-transmit interfaces ge-0/0/0
set chassis synchronization esmc-transmit interfaces ge-0/0/1
set chassis synchronization esmc-transmit interfaces ge-0/1/0
```

2. Configure PTP T-GM configuration under the [`set protocols ptp`] hierarchy. A sample configuration snippet is provided below:

```
set protocols ptp clock-mode ordinary
set protocols ptp profile-type g.8275.1
set protocols ptp transparent-clock
set protocols ptp priority1 128
set protocols ptp priority2 128
set protocols ptp domain 12
set protocols ptp unicast-negotiation
set protocols ptp master pseudo-holdover-time 1920
set protocols ptp master pseudo-holdover-cooldown-time 300
set protocols ptp master holdover-in-specification-time 3600
set protocols ptp master interface ge-0/0/0.0 unicast-mode transport ipv4
set protocols ptp master interface ge-0/0/0.0 unicast-mode clock-client 192.168.0.2/32 local-
ip-address 192.168.0.10
set protocols ptp master interface ge-0/0/1.0 unicast-mode transport ipv4
set protocols ptp master interface ge-0/0/1.0 unicast-mode clock-client 10.0.0.2/32 local-ip-
address 10.0.0.10
```

3. Verify the GNSS configuration:

```
user@host> show chassis synchronization extensive
Aug 22 16:27:05
Configured ports:
Name                : gnss
Current ToD         : Wed Aug 22 16:27:05 2018
Last ToD update     : Wed Aug 22 16:27:04 2018
GPS receiver status : Synchronized
UTC Pending         : FALSE
UTC Offset          : 37
One PPS status      : Active
```

```
user@host> show chassis synchronization gnss extensive
Aug 22 16:25:15
Receiver Status          : Good
Constellation            : GPS + QZSS
Cable delay compensation : 20
Antenna Status           : GPS Antenna Good
Position                 : 35 39' 1.708827'' N   : 139 45' 21.107670'' E
Altitude                 : 78 meters
Number of satellites     : 9
Satellite List:
Sat No     Signal Level     Status        Type          Mode(T=Timing/P=Position)
13         41    dBHZ       Acquired      GPS           T,P
2          43    dBHZ       Acquired      GPS           T,P
195        41    dBHZ       Acquired      QZSS          T,P
6          46    dBHZ       Acquired      GPS           T,P
5          46    dBHZ       Acquired      GPS           T,P
9          22    dBHZ       Acquired      GPS           T,P
19         39    dBHZ       Acquired      GPS           T,P
193        42    dBHZ       Acquired      QZSS          T,P
```

4. Verify the PTP T-GM configuration:

```
user@host> show ptp lock-status detail
Aug 28 10:05:52
Lock Status:
Lock State    : 5 (PHASE ALIGNED)
```

```
State since   : 2017-09-19 12:45:47 JST (48w6d 21:20 ago)
Source: External GPS/GNSS
```

```
user@host> show ptp global-information
Aug 28 10:07:22
PTP Global Configuration:
Domain number            : 12
Clock mode               : Ordinary
PTP Profile Type         : ITU-G.8275.1
Priority Level1          : 128
Priority Level2          : 128
Unicast Negotiation      : Enabled
ESMC QL From Clock Class : Disabled
Clock Class/ESMC QL      :  -
SNMP Trap Status         : Enabled
Transparent-clock-config : ENABLED
Transparent-clock-status : ACTIVE
Slave Parameters:
  Sync Interval          : -4 (16 packets per second - unicast request)
  Delay Request Interval: -6 (64 packets per second - unicast request)
  Announce Interval      : -3 (8 packets per second - unicast request)
  Announce Timeout       : 3
  Grant Duration         : 300
```

```
user@host> show ptp clock detail
Aug 28 15:44:46
Clock Details:
Slot Number            : 0
Default Data:
Two-step Clock         : FALSE                        Clock Identity : 30:7c:5e:ff:fe:3f:65:00
Total Ports on Device : 32                            Clock Class    : 248
Clock Accuracy         : 254                          Log Variance   : 20061
Clock Priority1        : 128                          Clock Priority2: 128
UTC Offset             : 37                           Leap59         : FALSE
Leap61                 : FALSE                        Time Tracable  : FALSE
Frequency Tracable     : FALSE                        Time Source    : 0
Delay Req Sending Time: 0                             Steps Removed  : 0
Slave-only             : NA
Parent Data:
Parent Id              : 30:7c:5e:ff:fe:3f:65:00
```

```
GMC Id                 : 30:7c:5e:ff:fe:3f:65:00  GMC Class        : 6
GMC Accuracy           : 33                       GMC Variance     : 20061
GMC Priority1          : 128                      GMC Priority2    : 128
Global Data:
UTC Offset             : 37                       Leap-59          : FALSE
Leap-61                : FALSE                    Time tracable    : TRUE
Freq Traceable         : TRUE                     Time Scale       : TRUE
```

NOTE:

- The range for `cable-length-compensation` is from *0* to *50000000* nanoseconds.
- The integrated GNSS receiver in the ACX500 series routers do not support 10-MHz frequency input and output.
- PTP is not supported on 1G ports across all platforms. Refer PTP Features and Supported Platforms for information on PTP platforms and supported PTP features.

CHAPTER 9

GNSS Configuration for Routers Using External GNSS Receiver

IN THIS CHAPTER

- GNSS Configuration for Routers | 154
- Configuration Statements to Enable T-GM Functionality | 160
- Administrative Commands to Enable T-GM Functionality | 163
- Monitoring Commands to Enable T-GM Functionality | 168

GNSS Configuration for Routers

SUMMARY

This topic describes how to configure a GNSS receiver on routers.

IN THIS SECTION

- Configure GNSS Receiver for Telecom Grandmaster (T-GM) | 156
- Troubleshoot GNSS Receiver | 160

Some Juniper routers support the G.8275.1 profile—Telecom Grandmaster (T-GM) functionality using an external TB-1 GNSS receiver. There are several benefits of the TB-1 receiver with the T-GM functionality which include:

- Compliance to ITU-T G.8272 (Unified functional architecture for transport networks) PRTC Class A.
- Support for multiple constellations such as GPS, GLONAS, QZSS and Galileo.
- Support for multipath spoofing, jamming, interference detection and isolation mechanisms.
- Supported on 10G and 25G ports for all devices in the network.

Commands to Configure the T-GM Functionality

Use the following commands to configure the T-GM functionality:

- `set chassis synchronization gnss-receiver <(0|1)> receiver-type <name>`
- `set chassis synchronization gnss-receiver <(0|1)> interface`

Commands to Enable GM Functionality

Use the following commands to enable GM functionality:

- `set protocols ptp clock-mode ordinary`
- `set protocols ptp profile-type g.8275.1`
- `set protocols ptp master interface <interface-name> multicast-mode transport ieee-802.3`
- `ptp-mode`
- `gnss-receiver`
- `show chassis synchronization gnss-receiver extensive`
- `show chassis synchronization extensive`
- `show ptp lock-status detail`

In T-GM mode the router functions as an ordinary clock and all the PTP configured ports are in "TimeTransmitter only" state. Up to 512 timeTransmitter ports are supported on the routers.

NOTE:

- ACX7024 and ACX7024X routers support this functionality.
- A synchronous Ethernet (SyncE) input is not allowed when system is functioning as a T-GM. Use the following command to configure a wait-to-restore check for SyncE input:

  ```
  set chassis synchronization source interfaces et-0/0/4 quality-level prc wait-to-restore 0
  ```

- Ensure that at least one of configured timeTransmitter port link is up, else the `show ptp lock-status` command will keep displaying the status as `Initializing` and `show chassis synchronization extensive` command will keep displaying the current clock status as `Freerun`.

Configure GNSS Receiver for Telecom Grandmaster (T-GM)

The TB-1 GNSS receiver is designed to operate with multiple constellations. When connected to an external GNSS antenna, the receiver contains all the circuitry necessary to automatically acquire GNSS satellite signals, track GNSS satellites, and acquire precise position and timing solutions. It provides 1 pulse-per-second (PPS) precision timing and stable 10-MHz frequency output.

To optimize the GNSS capability, establish a common time scale and coordinated system between all the systems. This coordinated system simplifies network synchronization, and provides flexibility and resiliency.

Table 1 describes the steps to configure GNSS receiver on the supported routers.

Table 6: GNSS Receiver Configuration

Configuration Step	Command

Step 1: (Mandatory) Enable GNSS receiver and grandmaster clock functionality.
 	
Enable the GNSS receiver by using the `gnss-receiver 0 interface` statement at the `edit chassis synchronization` hierarchy level. By enabling the GNSS receiver, you establish communication between the router with the GNSS receiver.
 	
Configure the satellite constellation by using the `gnss-receiver 0 constellation` statement at the `edit chassis synchronization` hierarchy level. Various constellations are available. Through this configuration, you can configure the GNSS receiver to explicitly use a specific constellation or combination of constellations.
 	
For more information, see "clock-mode" on page 161, "profile-type" on page 162, "transport-ieee-802.3" on page 167, "gnss-receiver" on page 164, and "ptp-mode" on page 163.
 	
NOTE: When `ptp-mode` is enabled, port 27 is no longer available for use.
	1. Set clock mode.
	
	`[edit protocols ptp]`
	`user@host# ` **`set clock-mode ordinary`**
	
	2. Set G.8275.1 profile type.
	
	`[edit protocols ptp]`
	`user@host# ` **`set profile-type g.8275.1`**
	
	3. Set transport protocol as IEEE 802.3.
	
	`[edit protocols ptp master interface` *`interface name`*
	`multicast-mode]`
	`user@host# ` **`set transport ieee-802.3`**
	
	4. Set the GNSS receiver interface.
	
	`[edit chassis synchronization gnss-receiver` *`number`*`]`
	`user@host# ` **`set interface`**
	
	5. Configure the GNSS receiver type as TB-1.
	
	`[edit chassis synchronization gnss-receiver` *`number`*`]`
	`user@host# ` **`set receiver-type`** ***`tb-1`***
	
	6. Set the GNSS receiver constellation.
	
	`[edit chassis synchronization gnss-receiver` *`number`*`]`
	`user@host# ` **`set constellation`**
	
	7. Set PTP mode for FPC and PIC.

Table 6: GNSS Receiver Configuration *(Continued)*

Configuration Step	Command
	`[edit chassis fpc 0 pic 0]` `user@host#` **`set ptp-mode`**
Step 2: (Optional) Specify the position mode. TB-1 as timing receiver has two different position modes— position-fix-mode and survey-mode. The default position mode is survey-mode if no specific mode is configured. • **position-fix-mode**: Use this mode when you know the accurate antenna location. • **survey-mode**: Use this mode when you do not know the fixed location of the antenna. For more information about position mode, see "gnss-receiver" on page 164.	`[edit chassis synchronization gnss-receiver` *`number`*`]` `user@host#` **`set position-mode`**
Step 3: (Optional) Specify the antenna cable delay compensation value. This configuration is used to compensate the delay introduced due to RF cable which is routed from antenna to TB-1 RF input. You can also use this command to compensate the PPS cable delay by adding both RF cable and PPS cable delays. For long cable runs, this delay can be significant. The range is from -1000000 to 1000000 nanoseconds. For more information about cable delay compensation, see "gnss-receiver" on page 164.	`[edit chassis synchronization gnss-receiver` *`number`*`]` `user@host#` **`set cable-delay-compensation`** ***`value`*** **NOTE**: Refer https://timesmicrowave.com/calculator/ to calculate the antenna cable delay compensation value and mention it in the command. For example, if the antenna cable delay compensation is *1000* nanoseconds, then the command should be **set cable-delay-compensation *-1000***. Note the negative value for the delay.

Table 6: GNSS Receiver Configuration *(Continued)*

Configuration Step	Command
Step 4: (Optional) Specify the Signal-to-Noise Ratio (SNR) threshold value. The SNR is the ratio of the signal power to the noise power. GNSS receiver measures SNR value to indicate the signal strength of the received satellite signal and the noise density. You can configure the SNR threshold value. Satellites with the signal level equal to or above the threshold value can only be used for positioning. • range: 0 - 99 dBHz For more information about SNR threshold, see "gnss-receiver" on page 164.	`[edit chassis synchronization gnss-receiver number]` `user@host# set snr-threshold value`
Step 5: Commit the configuration.	`[edit]` `user@host# commit`

Step 6: Verify the configuration.
 	
For more information about the operational commands, see "show chassis synchronization gnss-receiver extensive" on page 173, "show chassis synchronization extensive" on page 168, and "show ptp lock-status detail" on page 170.
 	
NOTE: Ensure that at least one of configured timeTransmitter port link is up, else the `show ptp lock-status` command will keep displaying the status as `Initializing` and `show chassis synchronization extensive` command will keep displaying the current clock status as `Freerun`.
	`[edit]`
	`user@host# run show chassis synchronization gnss-receiver extensive`
	
	`[edit]`
	`user@host# run show chassis synchronization extensive`
	
	`[edit]`
	`user@host# run show ptp lock-status detail`
	
	`[edit]`
	`user@host# run show ptp clock detail`

Troubleshoot GNSS Receiver

IN THIS SECTION

- Alarms | 160

Alarms

In case of any issues, run the `show chassis alarms` command to verify the following:

- TB-1 is not detected or not connected in the USB port.
- 1PPS is not detected or connected.
- 10 MHz is not detected or connected.

Sample Output

```
root@abc> show chassis alarms
3 alarms currently active

2024-05-29 23:14:58 PDT  Major  GNSS dongle removed
2024-05-29 23:14:59 PDT  Minor  GNSS 1 PPS link LOS set
2024-05-29 23:14:59 PDT  Minor  GNSS 10 MHz link LOS set
```

Configuration Statements to Enable T-GM Functionality

SUMMARY

This topic describes the various configuration statements required to enable the T-GM functionality on supported routers.

IN THIS SECTION

- clock-mode | 161
- profile-type | 162

clock-mode

IN THIS SECTION

- Syntax | 161
- Hierarchy Level | 161
- Description | 161
- Options | 161
- Required Privilege Level | 161

Syntax

```
clock-mode (ordinary);
```

Hierarchy Level

```
[edit protocols ptp]
```

Description

Configure the clock mode as ordinary clock with GNSS configuration. The clock mode determines whether the node behaves as a timeReceiver or timeTransmitter node. This attribute is mandatory and has no default value.

Options

`ordinary`—The clock mode of the node is a system clock that acts either as a timeTransmitter node or as a timeReceiver node.

Required Privilege Level

routing—To view this statement in the configuration.

routing-control—To add this statement to the configuration.

profile-type

IN THIS SECTION

- Syntax | 162
- Hierarchy Level | 162
- Description | 162
- Options | 162
- Required Privilege Level | 162

Syntax

```
profile-type (g.8275.1);
```

Hierarchy Level

```
[edit protocols ptp]
```

Description

On Telecom Grandmaster (T-GM) supported routers, configure the G.8275.1 profile for GNSS receiver that requires accurate phase and time synchronization. This profile supports the architecture defined in ITU-T G.8271.1 specification to enable the distribution of phase and time with full timing support. This profile requires all devices in the network to operate in combined or hybrid modes. To fulfill this requirement, you must enable Precision Time Protocol (PTP) and Synchronous Ethernet on all devices.

Options

`g.8275.1`—Enable the G.8275.1 PTP profile.

Required Privilege Level

routing—To view this statement in the configuration.

routing-control—To add this statement to the configuration.

Administrative Commands to Enable T-GM Functionality

SUMMARY

This topic describes the administrative commands required to enable the T-GM functionality on the supported routers.

IN THIS SECTION

- ptp-mode | 163
- gnss-receiver | 164
- transport-ieee-802.3 | 167

ptp-mode

IN THIS SECTION

- Syntax | 163
- Hierarchy Level | 163
- Description | 163
- Required Privilege Level | 164

Syntax

```
ptp-mode;
```

Hierarchy Level

```
[edit chassis fpc name pic name]
```

Description

The PTP mode configuration is mandatory to enable the PTP ordinary clock feature in the Telecom Grandmaster (T-GM) supported routers.

When you enable PTP mode on the supported routers, port 27 is no longer available for use.

For more information about valid port configurations on the supported routers, see Port Speed Overview.

Required Privilege Level

interface—To view this statement in the configuration.

interface-control—To add this statement to the configuration.

gnss-receiver

IN THIS SECTION

- Syntax | 164
- Hierarchy Level | 165
- Description | 165
- Options | 165
- Required Privilege Level | 166

Syntax

```
gnss-receiver {
      cable-delay-compensation;
      constellation {
            galileo (e1);
            glonass (l1of);
            gps (l1ca);
            qzss (l1ca);
      }
      interface;
      position-mode {
            position-fix-mode (latitude | longitude | altitude);
            survey-mode (survey-length);
      }
      receiver-type;
      snr-threshold
}
```

Hierarchy Level

```
[edit chassis synchronization]
```

Description

Configure GNSS receiver on the supported routers. The GNSS receiver receives signals from a navigation satellite constellation. The receiver gains precise phase and time information by processing these signals and delivers the information across the packet network.

Options

`cable-delay-compensation`—GNSS receiver unit to router RF cable delay compensation in nanoseconds. You can specify a value in nanoseconds to compensate the delay that the cable introduces.

- Range: -1000000 through 1000000 nanoseconds

`constellation`—Various constellations are available. You can configure the GNSS receiver to explicitly use a specific constellation or combination of constellations.

The following constellations are available:

- `gps`: Enables detection and locking to the GPS constellation.

  GPS signals enable you to determine the position of the receiver on earth and maintain a high level of time accuracy. The GPS L1CA receiver with 10MHz clock frequency output synchronized to a GPS satellite.

  > **NOTE**: You can use only GPS L1CA to configure the GNSS receiver.

- `galileo`: Enables detection and locking to the GALILEO constellation.
- `glonass`: Enables detection and locking to the GLONASS constellation.
- `qzss`: Enables detection and locking to the QZSS constellation.

`interface`—Enable/Disable GNSS port/slot communication.

> **NOTE**: For ACX7024 and ACX7024X routers, only one port of the GNSS receiver is supported.

`position-mode`—GNSS receiver's position modes. You can configure two position modes of GNSS receiver—`position-fix-mode` and `survey-mode`.

- `position-fix-mode`: Use this mode when you know the accurate antenna location.
  - `Latitude`— Latitude in degrees.
    - Range: -90.0000000 to 90.0000000 degrees
  - `Longitude`— Longitude in degrees.
    - Range: -180.0000000 to 180.0000000 degrees
  - `Altitude`— Altitude in meters.
    - Range: -1000 to 18000 meters

  NOTE: Be cautious when you use this mode. Ensure that you configure the correct position. Configuring the wrong position might cause erroneous receiver function and faulty grandmaster clock performance.

- `survey-mode`: Use this mode when you do not know the fixed location of the antenna.

  GNSS receiver does a self survey of its own position for a period mentioned in survey length and then moves to position fix mode. This is the default mode and the default survey length is 120 minutes.

`receiver-type`— Only TB-1 is supported as the GNSS receiver.

`snr-threshold`— GNSS receiver measures the Signal-to-Noise Ratio (SNR) value to indicate the signal strength of the received satellite signal and the noise density. You can configure the SNR threshold value. You can perform positioning by using only those satellites that have signal level equal to or above the threshold value with a range of 0 to 99 dBHz.

Required Privilege Level

interface—To view this statement in the configuration.

interface-control—To add this statement to the configuration.

transport-ieee-802.3

IN THIS SECTION

- Syntax | 167
- Hierarchy Level | 167
- Description | 167
- Options | 167
- Required Privilege Level | 168

Syntax

```
transport ieee-802.3;
```

Hierarchy Level

```
[edit protocols ptp master interface <interface-name> multicast-mode]
```

Description

Configure Ethernet as the encapsulation type for transport of Precision Time Protocol (PTP) packets. Ethernet encapsulation type is supported for transmission of PTP packets in multicast mode.

> **NOTE**: The `transport` statement is mandatory in the configuration of a timeTransmitter clock.

Options

`802.3`—Enable encapsulation for PTP packet transport in multicast mode.

`link-local`—Enable timeTransmitter or timeReceiver to choose either of the two MAC addresses defined in the IEEE 1588-2008 standard. When you configure this option, the system attempts to use the MAC address (link-local multicast address) for multicast transmission.

If the link-local multicast address is not available, the system uses the standard Ethernet multicast address as a second priority. The link-local multicast MAC address ensures complete end-to-end support of PTP and eliminate the chance of packet transmission through any network element that does not support PTP. The address is the default address for G.8275.1 (PTP profile for time or phase distribution), and a node with this MAC address is a node that supports processing of PTP packets.

Required Privilege Level

routing—To view this statement in the configuration.

routing-control—To add this statement to the configuration.

Monitoring Commands to Enable T-GM Functionality

SUMMARY

This topic describes the monitoring commands to view and troubleshoot the T-GM configuration on the supported routers.

IN THIS SECTION

- show chassis synchronization extensive | 168
- show ptp lock-status detail | 170
- show chassis synchronization gnss-receiver extensive | 173

show chassis synchronization extensive

IN THIS SECTION

- Syntax | 169
- Description | 169
- Options | 169
- Required Privilege Level | 169
- Output Fields | 169
- Sample Output | 170

Syntax

```
show chassis synchronization extensive
<interface interface-name>
<no-forwarding>
```

Description

Display detailed clock synchronization information.

Options

interface *interface-name*	(Optional) Display clock synchronization information for the specified interface.
no-forwarding	(Optional) Display clock synchronization information for interfaces configured with `no-forwarding` option.

Required Privilege Level

maintenance

Output Fields

Table 1 lists the output fields for the `show chassis synchronization extensive` command. Output fields are listed in the approximate order in which they appear.

Table 7: show chassis synchronization extensive Output Fields

Field Name	Field Description
`Current clock status`	Indicates the current status of chassis synchronization: • `Locked`—Clock is operational. • `Holdover`—Clock is not operational. • `Freerun`—Clock is locked to the free-run local oscillator. • `Acquiring`—Clock is attempting to acquire a lock on the specified clock source.

Table 7: show chassis synchronization extensive Output Fields *(Continued)*

Field Name	Field Description
`Clock locked to`	The source to which the clock is locked. The clock can be locked to either the `primary` source or the `secondary` source.
`SNMP trap status`	Indicates whether the SNMP trap generation status is `Enabled` or `Disabled` on the router.

Sample Output

show chassis synchronization extensive

```
user@host> show chassis synchronization extensive
Current clock status  : LOCKED
Clock locked to       : Primary
SNMP trap status      : Disabled

Configured ports:

Name                : gnss-rx-0
Current ToD         : Sat Nov 12 14:14:19 2022 PST
Last ToD update     : Sat Nov 12 14:14:18 2022 PST
GPS receiver status : Synchronized
UTC Pending         : FALSE
UTC Offset          : 37

One PPS status : Active
```

show ptp lock-status detail

IN THIS SECTION

- Syntax | 171
- Description | 171
- Options | 171

- Required Privilege Level | 171
- Output Fields | 171
- Sample Output | 172

Syntax

```
show ptp lock-status detail
```

Description

Display information about the lock status of the timeReceiver. The output verifies whether the router is locked to GNSS receiver.

Options

This command has no options.

Required Privilege Level

view

Output Fields

Table 1 lists the output fields for the `show ptp lock-status detail` command. Output fields are listed in the approximate order in which they appear.

Table 8: show ptp lock-status detail Output Fields

Field Name	Field Description
`Lock State`	State of the timeReceiver clock with respect to its timeTransmitter clock: • `Freerun` • `Holdover` • `Phase Aligned` • `Acquiring` • `Initializing`
`State since`	Date, time, and how long ago the lock status of the PTP timeReceiver or timeReceiver clock changed. The format is `State since: year-month-day hour:minute:second:timezone (hour:minute:second ago)`. For example, `2022-11-10 04:18:40 PST (00:47:10 ago)`.
`Source`	Information about external clock sources.

Sample Output

show ptp lock-status detail

```
user@host> show ptp lock-status detail
Lock Status:

Lock State    : 5 (PHASE ALIGNED)
State since   : 2022-11-10 04:18:40 PST (00:47:10 ago)

Source: GNSS
```

show chassis synchronization gnss-receiver extensive

IN THIS SECTION

- Syntax | 173
- Description | 173
- Options | 173
- Output Fields | 173
- Sample Output | 177

Syntax

```
show chassis synchronization gnss-receiver extensive
<time>
```

Description

Display information about the status of the GNSS receiver.

Options

time (Optional) Display GNSS receiver time information in detail.

Output Fields

Table 1 lists the output fields for the `show chassis synchronization gnss-receiver extensive` command. Output fields are listed in the approximate order in which they appear.

Table 9: show chassis synchronization gnss-receiver extensive Output Fields

Field Name	Field Description
`Lock status`	Indicates the lock status of the GNSS receiver: • `Warmup`—In this state the GNSS receiver waits for internal clock synchronization after you turn on the power supply. • `Pull-in`—In this state the receiver receives the signal from a satellite constellation. • `Coarse-lock`—In this state the receiver is locked to a satellite constellation but requires further synchronization. • `Fine-lock`—In this state the receiver is locked accurately to the satellite constellation and starts synchronizing. • `Holdover`—In this state the GNSS RF signals are lost or not strong enough to enable locking. • `Out of Holdover`—In this state 10-MHz frequency and 1-PPS signal are beyond holdover specification.
`Receiver-type`	Indicates the type of the receiver. **NOTE**: Only TB-1 is supported.
`Port Status`	Indicates the status of the configured port. • `Up`— TB-1 is connected tothe supported router (as applicable) and can communicate over channel. • `Down`— TB-1 is not connected.
`Port Details`	GNSS receiver port details, type of interface, and speed.
`Current TOD`	The current time of the day indicated by the receiver.
`UTC Pending`	The status of UTC leap collection by the receiver. • `True`— UTC parameters are not available. • `False`— UTC parameters are available.

Table 9: show chassis synchronization gnss-receiver extensive Output Fields *(Continued)*

Field Name	Field Description
`UTC offset (TAI-UTC)`	UTC offset between International Atomic Time (TAI) scale and Coordinated Universal Time (UTC) scale.
`Future leap sec & schedule`	Indicates the schedule and leap second correction values. A leap second is a one-second adjustment that is occasionally applied to Coordinated Universal Time (UTC) in order to keep its time of day close to the solar time.
`1PPS STATUS`	Indicates PPS signal received on the GPS interface of the supported router (as applicable). • `Available`— 1PPS from TB-1 is received on the GPS interface. • `Not available`—1PPS from TB-1 is not received on the GPS interface.
`10mhz status`	Indicates frequency output status of 10-MHz availability from receiver. • `Available`—10-MHz frequency from TB-1 is received on the GPS interface. • `Not available`—10-MHz frequency from TB-1 is not received on the GPS interface.
`Time source`	The standard time source to which the receiver current time is aligned.
`Alarms`	Alarm signals or messages. Possible messages are: • `Spoofing detected` • `Jamming detected` • `Antenna short circuit` • `Receiver oscillator error` • `Receiver data errors` • `No PPS` • `No 10MHz`

Table 9: show chassis synchronization gnss-receiver extensive Output Fields *(Continued)*

Field Name	Field Description
Antenna port status	Status of the configured antenna. • Open— No antenna is connected. • Good— Antenna is connected and detected. • Bad— Antenna is connected but failed to detect due to less antenna power circuitry within receiver.
Constellation	Satellite constellation that GNSS detects and locks to.
Position mode	Position modes of the GNSS receiver.
Self Survey Length	Duration for which the GNSS receiver can survey its own position before moving to position-fix-mode. The Self-survey length is specified in minutes.
Cable Delay Compensation	Indicates the time duration to compensate the delay introduced due to RF cable which is routed from the antenna to TB1 RF input. Cable delay compensation is specified in nanoseconds.
Latitude	GNSS receiver's latitude in degree minutes.
Longitude	GNSS receiver's longitude in degree minutes.
Altitude	GNSS receiver's altitude in meters.
No. of Satellites Used	Number of satellites are used for position and time solutions.
Visible Satellite List	The current tracking satellite number, its signal strength in dBHz, and the constellation to which the satellite belongs.

Sample Output

show chassis synchronization gnss-receiver extensive

```
user@host> show chassis synchronization gnss-receiver extensive

Lock status                  : warmup / pull-in / coarse-lock / fine-lock / holdover / out of
holdover
Receiver-type                : TB-1
Port Status                  : Up / Down
Port Details                 : UART 9600 bps / USB
Current ToD                  : 05:02:15 29/11/2019
UTC Pending                  : FALSE
UTC offset (TAI-UTC)         : 37
Future leap sec & schedule   : -99/+99 date and Time
1PPS STATUS                  : Available /Not available
10MHz status                 : Available /Not available
Time source                  : GPS/UTC/USNO/SU/Eu/NCIT
Alarms                       : NONE
Antenna port status:         : Open/Good(connected)/Bad
Constellation                : GPS L1CA
Position mode                : Position-fix-mode/survey-mode
Self Survey Length           : 120 mins
Cable Delay Compensation     : 0 ns
Snr-threshold                : 0 dBHz
Latitude                     : 37 33' 0.036000'' N
Longitude                    : 126 58' 23.483999'' E
Altitude                     : 976 m
No. of Satellites Used       : 13
Visible Satellite List:
Sat-Num   Signal-level     Status        Type
222       41    dBHz       Acquired      GPS
216       40    dBHz       Acquired      GPS
213       40    dBHz       Acquired      GPS
209       39    dBHz       Acquired      GPS
202       39    dBHz       Acquired      GPS
221       38    dBHz       Acquired      GLONASS
205       37    dBHz       Acquired      Galileo
```

CHAPTER 10

Assisted Partial Timing Support (APTS) on Routing Platforms

IN THIS CHAPTER

- Assisted Partial Timing Support on ACX500 Routers | 178

Assisted Partial Timing Support on ACX500 Routers

SUMMARY

APTS which is a GNSS backed by PTP delivers accurate timing and synchronization in mobile backhaul networks. This topic talks about the APTS support on ACX500 routers.

On the ACX500 router, the APTS feature helps you to configure PTP timeReceiver ports on a GNSS grandmaster clock serving as the PTP timeTransmitter. APTS uses GNSS as the timeTransmitter time reference at cell site locations, or at an aggregation point close to the cell sites. APTS uses network-based timing distribution to assist and maintain the timing during holdover periods when GNSS is unavailable.

To support this feature on ACX500, you need an APTS node with GNSS source configured at the `[edit chassis synchronization]` hierarchy level and PTP boundary clock configured at the `[edit protocols ptp]` hierarchy level as shown below:

GNSS configuration

```
[edit chassis]
  synchronization {
            network-option <option-1 | option-2>;
            port gnss {
```

```
                    client {
                         constellation <constellation-type>;
                        anti-jamming;
                     }
             }
            esmc-transmit {
                  interface <interfaces-name>;
            }
      }
```

PTPoE Configuration

```
[edit protocols]
 ptp {
            clock-mode boundary;
            slave {
                      interface <slave-ptp-ifl> {
                      multicast-mode {
                             transport ieee-802.3 [ link-local ] ;
                      }
                  }
           }
          master {
                interface <master-ptp-ifl> {
                    multicast-mode {
                    transport ieee-802.3 [ link-local ] ;
                  }
               }
        }
```

PTPoIP Configuration

```
[edit protocols]
clock-mode boundary;
    slave {
            interface <logical-interface-name> {
            unicast-mode {
                transport ipv4;
                clock-source <remote-master-ip-address> local-ip-address <local-slave-ip-
address>;
            }
```

```
        }
    }
    master {
        interface <logical-interface-name>{
            unicast-mode {
                transport ipv4;
                clock-client <remote-slave-ip> local-ip-address  <local-master-ip>;
            }
        }
    }
   }
```

The priority of clock source would be GNSS first and then PTP.

You can use the `show ptp lock-status detail`, `show chassis synchronization extensive`, and `show chassis synchronization gnss extensive` show commands to monitor and troubleshoot the configurations.

4

PART

Network Time Protocol

NTP Concepts | 182

NTP Configuration Examples | 198

CHAPTER 11

NTP Concepts

IN THIS CHAPTER

- Network Time Protocol | 182
- NTP Time Servers | 184
- NTP Authentication Keys | 188
- Network Time Security (NTS) Support for NTP | 190
- Synchronize and Coordinate Time Distribution Using NTP | 193
- Configure Devices to Listen to Broadcast Messages Using NTP | 196
- Configure Devices to Listen to Multicast Messages Using NTP | 196

Network Time Protocol

SUMMARY

Network Time Protocol (NTP) is a protocol used to synchronize time on all the devices in a network.

IN THIS SECTION

- NTP Overview | 182

NTP Overview

Network Time Protocol (NTP) is a widely used protocol used to synchronize the clocks of routers and other hardware devices on the Internet. Primary NTP servers are synchronized to a reference clock directly traceable to Coordinated Universal Time (UTC). Reference clocks include GPS receivers and telephone modem services, NTP accuracy expectations depend on the environment application requirements. However, NTP can generally maintain time to within tens of milliseconds over the public internet.

NTP is defined in the RFC 5905: Network Time Protocol Version 4: Protocol and Algorithms Specification

Devices running Junos OS can be configured to act as an NTP client, a secondary NTP server, or a primary NTP server. These variations are as follows:

- Primary NTP Server—Primary NTP servers are synchronized to a reference clock that is directly traceable to UTC. These servers then re-distribute this time data downstream to other Secondary NTP servers or NTP clients.
- Secondary NTP Server—Secondary NTP servers are synchronized to a primary or secondary NTP server. These servers then re-distribute this data downstream to other Secondary NTP servers or NTP clients.
- NTP Client—NTP clients are synchronized to a primary or secondary NTP server. Clients do not re-distribute this time data to other devices.

NOTE: The NTP subnet includes a number of widely accessible public primary time servers that can be used as a network's primary NTP server. Juniper Networks strongly recommends that you authenticate any primary servers you use.

Each device on your network can be configured to run in one or more of the following NTP modes:

- Broadcast Mode—One or more devices is set up to transmit time information to a specified broadcast or multicast address. Other devices listen for time sync packets on these addresses. This mode is less accurate than the client/server mode.
- Client/Server Mode—Devices are organized hierarchically across the network in client/server relationships.
- Symmetric Active (peer) Mode—Two or more devices are configured as NTP server peers to provide redundancy.

By default, if an NTP client time drifts so that the difference in time from the NTP server exceeds 128 milliseconds, the NTP client is automatically stepped back into synchronization. The NTP client will still synchronize with the server even if the offset between the NTP client and server exceeds the 1000-second threshold. You can manually request that a device synchronize with an NTP server by using the `set date ntp` operational command on the router. On devices running Junos OS that have dual Routing Engines, the backup Routing Engine synchronizes directly with the primary Routing Engine.

All Juniper platforms that run Junos OS support the leap second adjustment. By default, if the NTP server is aware of the leap second calculations, then the Junos device will automatically add the 1 second delay. PTP (Precision Time Protocol) is used to detect and propagate leap second synchronization changes throughout all nodes in a network. NTP is also required for Common Criteria compliance.

For more details about the Network Time Protocol, go to the Network Time Foundation website at http://www.ntp.org.

NTP supports IPv4 VPN and IPv6 routing and forwarding (VRF) requests on Junos OS. VRF request is also supported on Junos OS Evolved Release 20.2R1 onwards. This enables an NTP server running on a provider edge (PE) router to respond to NTP requests from a customer edge (CE) router. As a result, a PE router can process any NTP request packet coming from different routing instances.

NTP Time Servers

SUMMARY

The IETF defined the Network Time Protocol (NTP) to synchronize the clocks of computer systems connected to each other over a network. Most large networks have an NTP server that ensures that time on all devices is synchronized, regardless of the device location. If you use one or more NTP servers on your network, ensure you include the NTS server addresses in your Junos OS configuration.

IN THIS SECTION

- Configure NTP Time Server and Time Services | **185**

When configuring the NTP, you can specify which system on the network is the authoritative time source, or time server, and how time is synchronized between systems on the network. To do this, you configure the router, switch, or security device to operate in one of the following modes:

- Client mode—In this mode, the local router or switch can be synchronized with the remote system, but the remote system can never be synchronized with the local router or switch.
- Symmetric active mode—In this mode, the local router or switch and the remote system can synchronize with each other. You use this mode in a network in which either the local router or switch or the remote system might be a better source of time.

  Symmetric active mode can be initiated by either the local or the remote system. Only one system needs to be configured to do so. This means that the local system can synchronize with any system that offers symmetric active mode without any configuration whatsoever. However, we strongly encourage you to configure authentication to ensure that the local system synchronizes only with known time servers.
- Broadcast mode—In this mode, the local router or switch sends periodic broadcast messages to a client population at the specified broadcast or multicast address. Normally, you include this statement only when the local router or switch is operating as a transmitter.
- Server mode—In this mode, the local router or switch operates as an NTP server.

  In NTP server mode, the Junos OS supports authentication as follows:

- If the NTP request from the client comes with an authentication key (such as a key ID and message digest sent with the packet), the request is processed and answered based on the authentication key match.
- If the NTP request from the client comes without any authentication key, the request is processed and answered without authentication.

Configure NTP Time Server and Time Services

When you use NTP, configure the router or switch to operate in one of the following modes:

- Client mode—"Configure the Router or Switch to Operate in Client Mode" on page 185
- Symmetric active mode—"Configure the Router or Switch to Operate in Symmetric Active Mode" on page 186
- Broadcast mode—"Configure the Router or Switch to Operate in Broadcast Mode" on page 186
- Server mode—"Configure the Router or Switch to Operate in Server Mode" on page 187

Configure the Router or Switch to Operate in Client Mode

To configure the local router or switch to operate in client mode, include the `server` statement and other optional statements at the `[edit system ntp]` hierarchy level:

```
[edit system ntp]
server address <key key-number> <version value> <prefer>;
authentication-key key-number type type value password;
trusted-key[key-numbers];
```

Specify the address of the system acting as the time server. You must specify an address, not a hostname.

To include an authentication key in all messages sent to the time server, include the **key** option. The key corresponds to the key number you specify in the `authentication-key` statement, as described in .

By default, the router or switch sends NTP version 4 packets to the time server. To set the NTP version level to 1, 2, or 3, include the **version** option.

If you configure more than one time server, you can mark one server preferred by including the **prefer** option.

The following example shows how to configure the router or switch to operate in client mode:

```
[edit system ntp]
authentication-key 1 type md5 value "$ABC123";
server 10.1.1.1 key 1 prefer;
trusted-key 1;
```

Configure the Router or Switch to Operate in Symmetric Active Mode

To configure the local router or switch to operate in symmetric active mode, include the `peer` statement at the `[edit system ntp]` hierarchy level:

```
[edit system ntp]
peer address <key key-number> <version value> <prefer>;
```

Specify the address of the remote system. You must specify an address, not a hostname.

To include an authentication key in all messages sent to the remote system, include the **key** option. The key corresponds to the key number you specify in the `authentication-key` statement.

By default, the router or switch sends NTP version 4 packets to the remote system. To set the NTP version level to 1, 2 or 3, include the **version** option.

If you configure more than one remote system, you can mark one system preferred by including the **prefer** option:

```
peer address <key key-number> <version value> prefer;
```

Configure the Router or Switch to Operate in Broadcast Mode

To configure the local router or switch to operate in broadcast mode, include the `broadcast` statement at the `[edit system ntp]` hierarchy level:

```
[edit system ntp]
broadcast address <key key-number> <version value> <ttl value>;
```

Specify the broadcast address on one of the local networks or a multicast address assigned to NTP. You must specify an address, not a hostname. If the multicast address is used, it must be 224.0.1.1. Multicast protocols PIM and IGMP should be enabled on the NTP client facing interfaces in order to facilitate the device to transmit NTP packets over multicast address 224.0.1.1. Run the following commands to do so:

```
set protocols igmp interface <interface_name> static group 224.0.1.1
set protocols pim rp local address <interface_ip>
set protocols pim interface <interface_name> mode sparse-dense
```

NOTE: NTP over multicast is not supported within the routing instance on the device.

To include an authentication key in all messages sent to the remote system, include the key option. The key corresponds to the key number you specify in the `authentication-key` statement.

By default, the router or switch sends NTP version 4 packets to the remote system. To set the NTP version level to 1, 2, or 3, include the version option.

Configure the Router or Switch to Operate in Server Mode

In server mode, the router or switch acts as an NTP server for clients when the clients are configured appropriately. The only prerequisite for " server mode" is that the router or switch must be receiving time from another NTP peer or server. No other configuration is necessary on the router or switch.

When configuring the NTP service in the management VRF (`mgmt_junos`), you must configure at least one IP address on a physical or logical interface within the default routing instance and ensure that this interface is up in order for the NTP service to work with the mgmt_junos VRF.

To configure the local router or switch to operate as an NTP server, include the following statements at the `[edit system ntp]` hierarchy level:

```
[edit system ntp]
authentication-key  key-number type type value password;
server address <key key-number> <version value> <prefer>;
trusted-key [key-numbers];
```

Specify the address of the system acting as the time server. You must specify an address, not a hostname.

To include an authentication key in all messages sent to the time server, include the **key** option. The key corresponds to the key number you specify in the `authentication-key` statement.

By default, the router or switch sends NTP version 4 packets to the time server. To set the NTP version level to 1,or 2, or 3, include the **version** option.

If you configure more than one time server, you can mark one server preferred by including the **prefer** option.

The following example shows how to configure the router or switch to operate in server mode:

```
[edit system ntp]
authentication-key 1 type md5 value "$ABC123";
server 192.168.27.46 prefer;
trusted-key 1;
```

Starting unos OS Evolved release version 24.2R1, the following options are added to configure the NTS feature:

```
[edit system ntp]
 nts
{
       local-certificate <certificate-id of local certificate>;
    trusted-ca (trusted-ca-group <trusted ca-group name> | trusted-ca-profile <ca-profile name>);
}

[edit system ntp server <server>]
 nts remote-identity
{
     hostname <FQDN of server>;
     distinguished-name (container <container-string> | wildcard <wild-card string>);
}
```

RELATED DOCUMENTATION

show ntp associations

show ntp status

NTP Authentication Keys

SUMMARY

Time synchronization can be authenticated to ensure that the switch obtains its time services only from known sources. By default, network time synchronization is unauthenticated. The switch will synchronize to whatever system appears to have the most accurate time. We strongly encourage you to configure authentication of network time services.

To authenticate other time servers, include the `trusted-key` statement at the `[edit system ntp]` hierarchy level. The trusted keys refer to the configured key that is trusted and used by NTP for secure clock synchronization. Any configured key not referenced in the `trusted-key` is not qualified and is rejected by NTP. Only time servers that transmit network time packets containing one of the specified key numbers are eligible to be synchronized. Additionally, the key needs to match the value configured for that key number. Other systems can synchronize to the local switch without being authenticated.

```
[edit system ntp]
 trusted-key[ key-numbers ];
```

Each key can be any 32-bit unsigned integer except 0. Include the **key** option in the **peer**, **server**, or `broadcast` statements to transmit the specified authentication key when transmitting packets. The key is necessary if the remote system has authentication enabled so that it can synchronize to the local system.

To define the authentication keys, include the `authentication-key` statement at the `[edit system ntp]` hierarchy level:

```
[edit system ntp]
authentication-key key-number type type value password;
```

number is the key number, **type** is the authentication type (only Message Digest 5 [MD5], SHA1, and SHA256 are supported), and **password** is the password for this key. The key number, type, and password must match on all systems using that particular key for authentication. There must be no space in the password for configuring the Network Time Protocol (NTP) authentication-key.

NOTE: EX4300, EX4600, and related non-MP devices such as QFX5100 (EX and QFX models that run BSD6) support only MD5 authentication for NTP and do not support SHA-1 and SHA-256 authentication types.

Network Time Security (NTS) Support for NTP

SUMMARY

NTS provides cryptographic security for network time synchronization and supports client-server mode of NTP.

IN THIS SECTION

- NTS Overview | 190
- Benefits of NTS | 190
- Network Time Synchronization with NTS | 191

NTS Overview

NTS provides cryptographic security for network time synchronization and supports client-server mode of NTP. NTS uses Transport Layer Security (TLS) protocol and Authenticated Encryption with Associated Data (AEAD) to obtain network time in an authenticated manner to the users. NTS also provides support for encryption of NTP extension fields.

The most important security processes are dependent on accurate time. Network time synchronization from a malicious source leads to serious consequences. Enabling NTS ensures accurate network time synchronization on your device.

Starting Junos OS Evolved release version 24.2R1, supports RFC 8915 compliance for Network Time Security (NTS) using Network Time Protocol (NTP) on ACX-Series, QFX-Series and PTX-Series devices. NTS provides cryptographic security for network time synchronization and supports the client/server mode of NTP.

This RFC 8915 compliance feature supports:

- Configuration of local-certificate for server and certificate verification options for client.

- Verification of x.509 certificates to establish a TLS channel between client and server.

- TLS NTS-KE protocol support.

- Support for NTS secured client-server NTP communication at server and client.

Benefits of NTS

- Provides strong cryptographic protection against wide range of security attacks such as packet manipulation, spoofing, DDOS amplification attacks, and replay attacks
- Ensures accurate network time synchronization from a reliable source

- Provides scalability: Servers can serve several clients without manually pre-configuring any client-specific configuration. Because of the usage of cookies the server does not need to locally store the client specific data such as keys and AEAD algorithm
- Prevents tracking of mobile devices

Network Time Synchronization with NTS

NTS consists of two protocols, the NTS Key Establishment protocol (NTS-KE) and the NTP time synchronization using NTS extension fields.

NTS-KE Protocol

The NTS Key Establishment protocol (NTS-KE) uses TLS protocol to manage the initial authentication of the server, NTS parameter negotiation, and key establishment over TLS in the following order:

1. The client performs a TLS handshake with the NTS-KE server and successfully verify the certificates.
2. The client performs the NTS parameters negotiation with the server over the TLS-protected channel. The cryptographic algorithms negotiated are AEAD methods, which protects the NTP packets in the second phase.
3. The client and the server successfully establish the key material for communication.
4. The server also sends a supply of initial cookies to the client to use in next phase.
5. The TLS channel closes and NTP proceeds to the next phase where actual exchange of time data happens.

NTS supports only the TLS version 1.3. The older TLS versions get rejected during the NTS-KE protocol phase.

NTP Time Synchronization Using NTS Extension Fields

This phase manages the encryption and authentication during NTP time synchronization through the extension fields in the NTP packets in the following order:

1. The client queries the NTP server about time with NTS extension fields. These extension fields include cookies and an authentication tag computed using negotiated AEAD algorithm and key material extracted from the NTS-KE handshake.

   An NTS-secured NTP client request contains the following NTS extension fields:

   - **Unique Identifier Extension Field**: Contains randomly generated data and provides the means for replay protection at the NTS level.

- **NTS Cookie Extension Field**: Contains the information about the key material, which establishes during NTS-KE phase, and the negotiated cryptographic algorithm. A cookie is only used once in a request to prevent tracking.

- **NTS Cookie Placeholder Extension Field**: (Optional) Communicates to the server that the client wants to receive additional cookies in the response packet.

- **NTS Authenticator and Encrypted Extension Fields**: Generated using AEAD Algorithm and key established during NTS-KE. This field provides the integrity protection for the NTP header and all the previous extension fields.

Constant refreshing of cookies protects a device from tracking when it changes network addresses. For example a mobile device moving across different networks. The lack of any recognizable data prevents an adversary from determining that two packets sent over different network addresses came from the same client.

2. When the server receives an NTS-secured request from the client, the server decrypts the cookie with a master key.

3. The server extracts the negotiated AEAD algorithm and the keys that are available in the cookie. Using this key, the server checks the integrity of the NTP packet to ensure no manipulations to the packet.

4. The server generates one or more new cookies and creates the NTP response packet. The server generates at least one new cookie and one additional cookie for each Cookie Placeholder Extension Field that the client added in the request packet.

   The response packet contains two NTS extension fields:

   - The Unique Identifier Extension Field, which has the same contents from the Unique Identifier field in request packet.

   - The NTS Authenticator and Encrypted Extension Field, which secures the NTP header and the previous extension fields using the extracted keys.

5. The server also encrypts the cookies and includes them in the NTS Authenticator and Encrypted Extension Fields. This procedure also protects the client from tracking because an attacker cannot extract the cookies from a response message.

6. The server finalizes the response packet and sends the packet to the client.

7. The client receives the response packet.

8. The client checks the Unique Identifier field and verifies that the Unique Identifier matches with an outstanding request.

9. The client successfully performs the integrity check of the packet using the key and the AEAD algorithm.

10. The client decrypts the cookies and adds them to its pool and processes the time information received from server.

Synchronize and Coordinate Time Distribution Using NTP

SUMMARY

You can use NTP to synchronize and coordinate time distribution in a large network.

Using NTP to synchronize and coordinate time distribution in a large network involves these tasks:

Configure NTP

To configure NTP on the switch, include the `ntp` statement at the `[edit system]` hierarchy level:

```
[edit system]
ntp {
    authentication-key number type type value password;
    boot-server (address | hostname);
    broadcast <address> <key key-number> <version value> <ttl value>;
    broadcast-client;
    multicast-client <address>;
    peer address <key key-number> <version value> <prefer>;
    server address <key key-number> <version value> <prefer>;
    ntp source-address routing-instance routing-instance-name;
    trusted-key [ key-numbers ];
}
```

Configure NTP Boot Server

When you boot the switch, it issues an **ntpdate** request, which polls a network server to determine the local date and time. You need to configure a server that the switch uses to determine the time when the switch boots. Otherwise, NTP will not be able to synchronize to a time server if the server's time appears to be very far off of the local switch's time.

- To configure the NTP boot server, include the `set ntp server` statement at the `[edit system ntp]` hierarchy level. Specify either the IP address or the hostname of the network server:

```
[edit system ntp]
set server (address | hostname);
```

- Prior to Junos OS Release 15.1, to configure the NTP boot server, include the `boot-server` statement at the `[edit system ntp]` hierarchy level:

```
[edit system ntp]
boot-server (address | hostname);
```

NOTE: The `boot-server` option is deprecated starting in Junos OS Release 20.4R1.

Specify a Source Address for NTP Server

For IP version 4 (IPv4), you can specify that if the NTP server configured at the `[edit system ntp]` hierarchy level is contacted on one of the loopback interface addresses, the reply always uses a specific source address. This is useful for controlling which source address NTP will use to access your network when it is either responding to an NTP client request from your network or when it itself is sending NTP requests to your network.

To configure the specific source address that the reply will always use, and the source address that requests initiated by NTP server will use, include the `source-address` statement at the `[edit system ntp]` hierarchy level. The *source-address* is a valid IP address configured on one of the router or switch interfaces.

```
[edit system ntp]
user@host#set source-address source-address
```

For example:

```
[edit system ntp]
user@host# set source-address 10.1.4.3
```

Starting in Junos OS Release 13.3, and Junos OS Evolved Release 20.2R1 you can configure the source address using the `routing-instance` statement at the `[edit system ntp source-address` *`source-address`*`]` hierarchy level:

As a result, while sending NTP message through any interface in the *ntp-source-test* routing instance, the source address 12.12.12.12 is used.

> **NOTE**: The `routing-instance` statement is optional and if not configured, the primary address of the interface will be used.

Specify one source address per family for each routing instance,

```
[edit system ntp]
user@host# set source-address source-address routing-instance routing-instance-name
```

For example:

```
[edit system ntp]
user@host# set source-address 10.1.4.3 routing-instance ntp-instance
```

When configuring the NTP service in the management VRF (`mgmt_junos`), you must configure at least one IP address on a physical or logical interface within the default routing instance and ensure that this interface is up in order for the NTP service to work with the mgmt_junos VRF.

> **NOTE**: If a firewall filter is applied on the loopback interface, ensure that the `source-address` specified for the NTP server at the `[edit system ntp]` hierarchy level is explicitly included as one of the match criteria in the firewall filter. This enables the Junos OS to accept traffic on the loopback interface from the specified source address.
>
> The following example shows a firewall filter with the source address `10.1.4.3` specified in the `from` statement included at the `[edit firewall filter` *`firewall-filter-name`*`]` hierarchy:

```
[edit firewall filter Loopback-Interface-Firewall-Filter]
term Allow-NTP {
    from {
        source-address {
            172.17.27.46/32; // IP address of the NTP server
            10.1.4.3/32 routing-instance ntp-instance; // Source address specified
for the NTP server            }
        then accept;
```

```
        }
    }
```

If no `source-address` statement is configured for the NTP server, include the primary address of the loopback interface in the firewall filter.

Configure Devices to Listen to Broadcast Messages Using NTP

SUMMARY

Configure the local router or switch to listen for broadcast messages using NTP. It listens for, and synchronizes to, succeeding broadcast messages.

When you are using NTP, you can configure the local router or switch to listen for broadcast messages on the local network to discover other servers on the same subnet by including the `broadcast-client` statement at the `[edit system ntp]` hierarchy level:

```
[edit system ntp]
broadcast-client;
```

When the router or switch detects a broadcast message for the first time, it measures the nominal network delay using a brief client-server exchange with the remote server. It then enters *broadcast client* mode, in which it listens for, and synchronizes to, succeeding broadcast messages.

To avoid accidental or malicious disruption in this mode, both the local and remote systems must use authentication and the same trusted key and key identifier.

Configure Devices to Listen to Multicast Messages Using NTP

SUMMARY

Configure the local router or switch to listen for multicast messages using NTP. It listens for, and synchronizes to, succeeding multicast messages.

When you are using NTP, you can configure the local router or switch to listen for multicast messages on the local network to discover other servers on the same subnet by including the `multicast-client` statement at the `[edit system ntp]` hierarchy level:

```
[edit system ntp]
user@host# set multicast-client address
```

When the router or switch receives a multicast message for the first time, it measures the nominal network delay using a brief client-server exchange with the remote server. It then enters *multicast client* mode, in which it listens for, and synchronizes to, succeeding multicast messages.

You can specify one or more IP addresses. (You must specify an address, not a hostname.) If you do, the router or switch joins those multicast groups. If you do not specify any addresses, the software uses `224.0.1.1`.

To avoid accidental or malicious disruption in this mode, both the local and remote systems must use authentication and the same trusted key and key identifier.

CHAPTER 12

NTP Configuration Examples

IN THIS CHAPTER

- NTP Configuration | **198**
- Example: Configure NTP | **202**
- Example: Configure NTP as a Single Time Source for Router and Switch Clock Synchronization | **207**

NTP Configuration

SUMMARY

The Network Time Protocol (NTP) provides the mechanisms to synchronize time and coordinate time distribution in a large, diverse network. Debugging and troubleshooting are much easier when the timestamps in the log files of all the routers or switches are synchronized, because events that span the network can be correlated with synchronous entries in multiple logs. We recommend using the Network Time Protocol (NTP) to synchronize the system clocks of routers, switches, and other network equipment.

To configure NTP:

1. Configure Junos OS to retrieve the time when it first boots up.

   Use the `boot-server` statement with the IP address of your NTP server. If DNS is configured, you can use a domain name instead of an IP address.

   ```
   [edit system ntp]
   user@host# set boot-server (name | ip-address)
   ```

For example, set an IP address of 172.16.1.1 for your NTP server.

```
[edit system ntp]
user@host# set boot-server 172.16.1.1
```

For example, set a domain name. In this example, the domain name is provided by pool.ntp.org.

```
[edit system ntp]
user@host# set boot-server 0.north-america.pool.ntp.org
```

2. Specify the source address that the reply will always use, and the source address that requests initiated by NTP server will use, include the `source-address` statement at the `[edit system ntp]` hierarchy level.

```
[edit system ntp]
user@host# set source-address source-address
```

For example:

```
[edit system ntp]
user@host# set source-address 10.0.10.100
```

3. Specify one source address per family for each routing instance.

```
[edit system ntp source-address source-address
user@host# set routing-instance routing-instance-name
```

For example, the following statement is configured:

```
[edit system ntp source-address 10.0.10.100]
user@host# set routing-instance ntp-instance
```

4. (Optional) Configure one or more reference NTP servers to keep the device synchronized with periodic updates.

It is a good practice to do this, as the Junos OS device can remain up for a long time, and therefore the clock can drift.

```
[edit system ntp]
user@host# set server (name | ip-address)
```

For example, set an IP address of 172.16.1.1 for your NTP server.

```
[edit system ntp]
user@host# set server 172.16.1.1
```

For example, set a domain name provided by pool.ntp.org.

```
[edit system ntp]
user@host# set server 0.north-america.pool.ntp.org
```

5. (Optional) Set the local time zone to match the device's location.

   Universal Coordinated Time (UTC) is the default. Many administrators prefer to keep all their devices configured to use the UTC time zone. This approach has the benefit of allowing you to easily compare the time stamps of logs and other events across a network of devices in many different time zones.

   On the other hand, setting the time zone allows Junos OS to present the time in the correct local format.

```
[edit system ntp]
user@host# set time-zone time-zone
```

   For example:

```
[edit system ntp]
user@host# set time-zone America/Los_Angeles
```

6. Verify the configuration.

   Check the system uptime. This command provides the current time, when the device was last booted, when the protocols started, and when the device was last configured.

```
user@host> show system uptime
Current time: 2013-07-25 16:33:38 PDT
```

```
System booted: 2013-07-11 17:14:25 PDT (1w6d 23:19 ago)
Protocols started: 2013-07-11 17:16:35 PDT (1w6d 23:17 ago)
Last configured: 2013-07-23 12:32:42 PDT (2d 04:00 ago) by user
 4:33PM  up 13 days, 23:19, 1 user, load averages: 0.00, 0.01, 0.00
```

Check the NTP server status and associations of the clocking sources used by your device.

```
user@host> show ntp associations

     remote           refid      st t when poll reach   delay   offset  jitter
==============================================================================
 tux.brhelwig.co .INIT.          16 -    -  512    0    0.000    0.000 4000.00
```

```
user@host > show ntp status
status=c011 sync_alarm, sync_unspec, 1 event, event_restart,
version="ntpd 4.2.0-a Thu May 30 19:14:15 UTC 2013 (1)",
processor="i386", system="JUNOS13.2-20130530_ib_13_3_psd.1", leap=11,
stratum=16, precision=-18, rootdelay=0.000, rootdispersion=5.130,
peer=0, refid=INIT,
reftime=00000000.00000000  Wed, Feb  6 2036 22:28:16.000, poll=4,
clock=d59d4f2e.1793bce9  Fri, Jul 26 2013 12:40:30.092, state=1,
offset=0.000, frequency=62.303, jitter=0.004, stability=0.000
```

To configure NTP on the router or switch, include the `ntp` statement at the `[edit system]` hierarchy level:

```
[edit system]
ntp {
    authentication-key number type type value password;
    boot-server (address | hostname);
    broadcast <address> <key key-number> <routing-instance-name routing-instance-name> <ttl
value> <version value> ;
    broadcast-client;
    multicast-client <address>;
    peer address <key key-number> <version value> <prefer>;
    server address <key key-number> <version value> <prefer>;
    source-address <source-address> <routing-instance routing-instance-name>;
    trusted-key [ key-numbers ];
}
```

Example: Configure NTP

SUMMARY

This topic provides an example to configure NTP.

IN THIS SECTION

- Requirements | 202
- Overview | 202
- Configuration | 203
- Verification | 204

The Network Time Protocol (NTP) provides the mechanism to synchronize time and coordinate time distribution in a large, diverse network. NTP uses a returnable-time design in which a distributed subnet of time servers operating in a self-organizing, hierarchical primary-secondary configuration synchronizes local clocks within the subnet and to national time standards by means of wire or radio. The servers also can redistribute reference time using local routing algorithms and time daemons.

This example shows how to configure NTP:

Requirements

This example uses the following software and hardware components:

- Junos OS Release 11.1 or later
- A switch connected to a network on which an NTP boot server and NTP server reside

Overview

Debugging and troubleshooting are much easier when the timestamps in the log files of all switches are synchronized, because events that span a network can be correlated with synchronous entries in multiple logs. We recommend using the Network Time Protocol (NTP) to synchronize the system clocks of your switch and other network equipment.

In this example, an administrator wants to synchronize the time in a switch to a single time source. We recommend using authentication to make sure that the NTP peer is trusted. The `boot-server` statement identifies the server from which the initial time of day and date are obtained when the switch boots. The `server` statement identifies the NTP server used for periodic time synchronization. The `authentication-key` statement specifies that an HMAC-Message Digest 5 (MD5) scheme is used to hash the key value for authentication, which prevents the switch from synchronizing with an attacker's host that is posing as the time server.

Configuration

IN THIS SECTION

- Procedure | 203

To configure NTP:

Procedure

CLI Quick Configuration

To quickly configure NTP, copy the following commands and paste them into the switch's terminal window:

```
[edit system]
set ntp boot-server 10.1.4.1
set ntp server 10.1.4.2
set ntp authentication-key 2 type md5 value "$ABC123"
```

Step-by-Step Procedure

To configure NTP :

1. Specify the boot server:

   ```
   [edit system]
   user@host# set ntp boot-server 10.1.4.1
   ```

2. Specify the NTP server:

   ```
   [edit system]
   user@host# set ntp server 10.1.4.2
   ```

3. Specify one source address per family for each routing-instance:

```
[edit system]
user@host# set system ntp source-address 10.10.4.3 routing-instance ntp-instance
```

4. Specify the key number, authentication type (MD5), and key for authentication:

```
[edit system]
user@host# set ntp authentication-key 2 type md5 value "$ABC123"
```

Results

Check the results:

```
[edit system]
user@host# show
ntp {
    boot-server 10.1.4.1;
    authentication-key 2 type md5 value "$ABC123"; ## SECRET-DATA
    server 10.1.4.2;
    source-address 10.10.4.3 routing-instance ntp-instance;
}
```

Verification

IN THIS SECTION

- Checking the Time | 205
- Displaying the NTP Peers | 205
- Displaying the NTP Status | 206

To confirm that the configuration is correct, perform these tasks:

Checking the Time

Purpose

Check the time that has been set on the switch.

Action

Enter the `show system uptime` operational mode command to display the time.

```
user@host> show system uptime
fpc0:
--------------------------------------------------------------------------
Current time: 2009-06-12 12:49:03 PDT
System booted: 2009-05-15 06:24:43 PDT (4w0d 06:24 ago)
Protocols started: 2009-05-15 06:27:08 PDT (4w0d 06:21 ago)
Last configured: 2009-05-27 14:57:03 PDT (2w1d 21:52 ago) by admin1
12:49PM  up 28 days,  6:24, 1 user, load averages: 0.05, 0.06, 0.01
```

Meaning

The output shows that the current date and time are June 12, 2009 and 12:49:03 PDT. The switch booted 4 weeks, 6 hours, and 24 minutes ago, and its protocols were started approximately 3 minutes before it booted. The switch was last configured by user **admin1** on May 27, 2009, and there is currently one user logged in to the switch.

The output also shows that the load average is 0.05 seconds for the last minute, 0.06 seconds for the last 5 minutes, and 0.01 seconds for the last 15 minutes.

Displaying the NTP Peers

Purpose

Verify that the time has been obtained from an NTP server.

Action

Enter the `show ntp associations` operational mode command to display the NTP server from switch obtained its time.

```
user@host> show ntp associations
     remote           refid      st t when poll reach   delay   offset  jitter
==============================================================================
*ntp.net .GPS.            1 u  414 1024  377    3.435    4.002   0.765
```

Meaning

The asterisk (*) in front of the NTP server name, or peer, indicates that the time is synchronized and obtained from this server. The delay, offset, and jitter are displayed in milliseconds.

Displaying the NTP Status

Purpose

View the configuration of the NTP server and the status of the system.

Action

Enter the `show ntp status` operational mode command to view the status of the NTP.

```
user@host> show ntp status
status=0644 leap_none, sync_ntp, 4 events, event_peer/strat_chg,
version="ntpd 4.2.0-a Mon Apr 13 19:09:05 UTC 2009 (1)",
processor="powerpc", system="JUNOS9.5R1.8", leap=00, stratum=2,
precision=-18, rootdelay=2.805, rootdispersion=42.018, peer=48172,
refid=192.168.28.5,
reftime=cddd397a.60e6d7bf  Fri, Jun 12 2009 13:30:50.378, poll=10,
clock=cddd3b1b.ec5a2bb4  Fri, Jun 12 2009 13:37:47.923, state=4,
offset=3.706, frequency=-23.018, jitter=1.818, stability=0.303
```

Meaning

The output shows status information about the switch and the NTP.

Example: Configure NTP as a Single Time Source for Router and Switch Clock Synchronization

SUMMARY

We strongly recommend using the Network Time Protocol (NTP) to synchronize the system clocks of routers, switches, and other network equipment. This topic lists a sample configuration.

Debugging and troubleshooting are much easier when the timestamps in the log files of all the routers or switches are synchronized, because events that span the network can be correlated with synchronous entries in multiple logs. We strongly recommend using the Network Time Protocol (NTP) to synchronize the system clocks of routers, switches, and other network equipment.

By default, NTP operates in an entirely unauthenticated manner. If a malicious attempt to influence the accuracy of a router or switch's clock succeeds, it could have negative effects on system logging, make troubleshooting and intrusion detection more difficult, and impede other management functions.

The following sample configuration synchronizes all the routers or switches in the network to a single time source. We recommend using authentication to make sure that the NTP peer is trusted. The `boot-server` statement identifies the server from which the initial time of day and date is obtained when the router boots. The `server` statement identifies the NTP server used for periodic time synchronization. The `source-address` statement enables you to specify one source address per family for each routing instance, The `authentication-key` statement specifies that an HMAC-Message Digest 5 (MD5) scheme should be used to hash the key value for authentication, which prevents the router or switch from synchronizing with an attacker's host posing as the time server.

```
[edit]
system {
    ntp {
        authentication-key 2 type md5 value "$ABC123"; # SECRET-DATA
        boot-server 10.1.4.1;
        server 10.1.4.2 key 2;
        source-address 10.1.4.3 routing-instance ntp-instance;
        trusted key 2;
    }
}
```

5

PART

Synchronous Ethernet

Synchronous Ethernet Overview | 209

Synchronous Ethernet on 10-Gigabit Ethernet MIC | 226

CHAPTER 13

Synchronous Ethernet Overview

IN THIS CHAPTER

- Synchronous Ethernet | 209
- Ethernet Synchronization Message Channel (ESMC) | 213
- Example: Configure Synchronous Ethernet | 219

Synchronous Ethernet

SUMMARY

Synchronous Ethernet, also referred as SyncE, is an ITU-T standard for computer networking that facilitates the transference of clock signals over the Ethernet physical layer.

IN THIS SECTION

- Synchronous Ethernet Overview | 209

Synchronous Ethernet Overview

IN THIS SECTION

- Synchronous Ethernet Configuration | 211
- Synchronous Ethernet over LAG | 211
- Synchronous Ethernet on Routers | 211
- Ingress Monitoring on Routers | 212
- Supported Platforms | 212

Synchronous Ethernet (ITU-T G.8261 and ITU-T G.8264) is a physical layer technology that functions regardless of the network load and supports hop-by-hop frequency transfer, where all interfaces on the trail must support Synchronous Ethernet. It enables you to deliver synchronization services that meet the requirements of the present-day mobile network, as well as future Long Term Evolution (LTE)–based infrastructures.

Synchronization is a key requirement for circuit (emulation) services and mobile radio access technologies. Traditionally, mobile networks used SONET/SDH technologies to backhaul voice and data traffic, and the native support for frequency of SONET/SDH to synchronize their radio network. With the need for greater-capacity backhaul networks, packet-based technologies such as Carrier Ethernet (which do not support the transfer of frequency) and wireless technologies such as frequency division duplex and time-division duplex require not only frequency synchronization but also proper time and phase alignment. This requirement is fulfilled by Synchronous Ethernet, which is used for physical layer frequency synchronization of connected access devices (such as base stations, access nodes, and so on). Synchronous Ethernet supports sourcing and transfer of frequency for synchronization purposes for both wireless and wireline services and is primarily used for mobile backhaul and converged transport.

Synchronous Ethernet is used to transfer clock signals over Ethernet interfaces. The Synchronous Ethernet operation is described in three ITU recommendations:

- G.8261—Defines the architecture and wander performance of Synchronous Ethernet networks.
- G.8262—Specifies timing characteristics of synchronous Ethernet equipment clock (EEC).
- G.8264—Describes the Ethernet Synchronization Message Channel (ESMC).

Synchronous Ethernet is not supported in the following instances on an MX Series router:

- Slot 10 on an MX Series router with Switch Control Board (SCB).
- RJ45 ports

However, note that Synchronous Ethernet is supported on slot 10 on an MX Series router with SCBE and SCBE2.

Unified in-service software upgrade (unified ISSU) is currently not supported when clock synchronization is configured for PTP and Synchronous Ethernet on MX80 Universal Routing Platforms and on the MICs and MPCEs on MX240, MX480, MX960, MX2010, and MX2020 routers.

The following sections explain Synchronous Ethernet:

Synchronous Ethernet Configuration

SyncE configuration can be performed under the `[edit chassis synchronization]` hierarchy. A configuration snippet is provided below:

```
set chassis synchronization network-option option-1
set chassis synchronization selection-mode received-quality
set chassis synchronization quality-mode-enable
set chassis synchronization source interfaces ifname priority priority wait-to-restore sec
quality-level quality-level
set chassis synchronization esmc-transmit ifname
```

Synchronous Ethernet over LAG

Link aggregation enables to group Ethernet interfaces to form a single, aggregated Ethernet interface, also known as a link aggregation group (LAG) or bundle. The aggregated Ethernet interfaces that participate in a LAG are called member links.
To configure synchronous ethernet over LAG, an aggregated-ether (AE) group shall be defined as the clock source. Any number of interfaces from the same AE group can be configured as the clock source. The ESMC transmit shall be configured on individual link.

A configuration snippet is provided below:

```
set interfaces ae0 aggregated-ether-options link-speed mixed
set interfaces ae0 unit 0 family inet address 2.2.0.1/24
set interfaces et-0/0/2 ether-options 802.3ad ae0
set interfaces et-0/0/4 ether-options 802.3ad ae0
set chassis synchronization network-option option-1
set chassis synchronization source interfaces et-0/0/2 aggregated-ether ae0
set chassis synchronization source interfaces et-0/0/2 quality-level sec
```

Synchronous Ethernet on Routers

Synchronous Ethernet is supported on the ACX Series routers with Gigabit Ethernet and 10-Gigabit Ethernet SFP and SFP+ transceivers and is compliant with ITU-T Recommendation G.8261: *Timing and synchronization aspects in packet networks* and ITU-T Recommendation G8264: *Distribution of timing through packet networks*.Synchronous Ethernet is a physical layer frequency transfer technology modeled after synchronization in SONET/SDH. Traditional Ethernet nodes, which do not support Synchronous Ethernet, do not carry synchronization from one node link to another. Synchronous Ethernet–capable nodes however can synchronize their chassis clock to a clock recovered from an interface connected to an upstream primary clock . After this, the clock is used to time data sent to downstream clock secondary clocks, forming a synchronization trail from a Primary Reference Clock (PRC) to Ethernet equipment clocks (EECs) and transferring frequency synchronization along the trail.

The ITU-T G.8264 specification defines the Synchronization Status Message (SSM) protocol and its format for Synchronous Ethernet to ensure interoperability between Synchronous Ethernet equipment used for frequency transfer—for example, SONET/SDH. Synchronous Ethernet provides stable frequency synchronization to a PRC and is not affected by load on the network. However, it requires that all the nodes from the PRC to the last downstream node are Synchronous Ethernet capable. Synchronous Ethernet is a recommended technology for mobile networks that require frequency-only synchronization—for example, 2G or 3G base stations.

Ingress Monitoring on Routers

The ingress clock monitoring feature is supported on all MX Series routers including the 16-port 10-Gigabit Ethernet MPC. On these routers, the incoming Synchronous Ethernet signals cannot be monitored on the 16-port 10-Gigabit Ethernet MPC but are monitored by other Modular Port Concentrators (MPCs) in the chassis. Therefore, you can use the 16-port 10-Gigabit Ethernet MPC for incoming Synchronous Ethernet signals if at least one other MPC with an Ethernet Equipment Clock (EEC) is present in the chassis. This behavior is referred to as *ingress clock monitoring*. Note that the 16-port 10-Gigabit Ethernet MPC does not have a built-in EEC or internal clock; therefore, it can only input (accept) a clock signal but cannot act as a clock source.

When an MX Series router is configured for Synchronous Ethernet on the 16-port 10-Gigabit Ethernet MPC and no other MPC with an EEC is present in the chassis, the Synchronous Ethernet feature cannot be supported by the system. The system notifies the user through log messages and CLI output and justifies its inability to support Synchronous Ethernet.

Supported Platforms

Synchronous Ethernet (SyncE) summarizes the first Junos OS release that supports Synchronous Ethernet on the various Juniper Networks routers and their components.

Ethernet Synchronization Message Channel (ESMC)

SUMMARY

Ethernet Synchronization Message Channel (ESMC) is a logical communication channel. It transmits Synchronization Status Message (SSM) information, which is the quality level of the transmitting synchronous Ethernet equipment clock (EEC), by using ESMC protocol data units (PDUs).

IN THIS SECTION

- Ethernet Synchronization Message Channel Overview | 213
- Ethernet Synchronization Message Channel Quality Level Mapping | 215

Ethernet Synchronization Message Channel Overview

Ethernet Synchronization Message Channel (ESMC) is a logical communication channel. It transmits Synchronization Status Message (SSM) information, which is the quality level of the transmitting synchronous Ethernet equipment clock (EEC), by using ESMC protocol data units (PDUs). ESMC support is based on the ITU G.8264 specification.

Synchronized Ethernet with Ethernet synchronized Message Channel (ESMC) is supported on MX204 and MX10003 routers.

A Synchronous Ethernet interface is configured to operate in the following modes:

- Nonsynchronous mode—In this mode, the Synchronous Ethernet interface does not process the ESMC message and does not extract the quality level information.
- Synchronous mode—In this mode, the Synchronous Ethernet interface processes the ESMC message and extracts the quality level information. While operating in synchronous mode, the ESMC messages transmit the quality level.

You can enable ESMC on a Synchronous Ethernet port by adding the port to a list of ESMC interfaces. The ESMC messages are transmitted through the port indicating the quality level of the clock it is capable of driving and the ESMC messages are received (if the other endpoint supports ESMC) with the quality level of the transmitting clock. The MPC receiving the ESMC messages on its configured Synchronous Ethernet ports extracts the quality level and transmits it to the Routing Engine. The clock selection algorithm on the Routing Engine collects the ESMC data from each of the ESMC-enabled ports to select the clock sources.

The clock selection process supports revertive and nonrevertive modes. When the clock selection process has selected two clock sources—a primary and a secondary—and the active primary clock source degrades over a period of time and then improves again, this primary clock source again becomes the active clock source only if revertive mode is enabled. If nonrevertive mode is set and the secondary clock source is currently active (due to a previous degradation of primary clock source), the primary clock source is not reactivated even after its quality improves.

The clock selection is based on the following three operational modes:

- Forced free-run—In this mode, you can set the clock source either from a free-run local oscillator or from an external qualified clock. For MX80 routers, the free-run clock is provided by the local oscillator. For MX240, MX480, and MX960 routers, the free-run clock is provided by the Switching Control Board (SCB).
- Forced holdover—This mode is an internal state the synchronous Ethernet Equipment Clock (EEC) goes into, when an upstream clock source that the system locks on to is no longer available. You cannot configure this mode because it is an internal state.
- Automatic selection—In this mode, the system chooses up to two best upstream clock sources. The system then uses the clock recovered from one of the sources to generate a frequency of 19.44 MHz and clock the transmit side of the Ethernet interfaces. If no upstream clock with acceptable good quality is available or if the system is configured in free-run mode, the system uses the internal clock. Automatic clock selection is based on the quality level, priority, signal fail, and external commands.

For more information about clock selection, see "Configure External Clock Synchronization for MX Series Routers" on page 272.

The synchronous EEC is in free-run mode when the chassis is switched on or restarted. When a synchronous EEC locks on to an upstream reference clock source at least once for a continuous period of 60 seconds, the EEC will have stored sufficient Synchronous Ethernet data in a replay holdover buffer. In case of failure of a reference clock source, the system goes to holdover mode and uses the replay data in the holdover buffer to service the downstream Synchronous Ethernet clients.

When a Modular Port Concentrator (MPC) with an EEC restarts (because of either a system crash or a manual restart), the holdover buffer data gets erased. Therefore, downstream Synchronous Ethernet clients cannot be serviced. This is also applicable when a new MPC containing an EEC is inserted into the system.

In a practical deployment scenario, the status display of holdover mode is invalid only when the chassis is switched on or restarted.

When an MPC containing an EEC is restarted or a new MPC containing an EEC is inserted into a system that is (already) in holdover mode, the EEC on this MPC cannot be considered to be in holdover mode because it does not have any Synchronous Ethernet replay information in its holdover data buffer. Therefore, you must first fix the system holdover issue before attempting to service the downstream Synchronous Ethernet clients on this MPC. To accomplish this, you must find a suitable upstream reference clock source and let the synchronous EEC lock on to this upstream reference clock source, and then service the downstream Synchronous Ethernet clients on this MPC.

Ethernet Synchronization Message Channel Quality Level Mapping

IN THIS SECTION

- Synchronous Ethernet Mode | 215
- Precision Time Protocol Mode | 216
- Hybrid Mode | 218
- Feature Mode Changes | 219

Ethernet Synchronization Message Channel (ESMC) is a logical communication channel. It transmits Synchronization Status Message (SSM) information, which is the quality level of the transmitting synchronous Ethernet equipment clock (EEC), by using ESMC protocol data units (PDUs). ESMC support is based on the ITU G.8264 specification. In order for an interface to receive or transmit ESMC messages, at least one *logical interface* must be configured on that interface. If the interface is currently not configured with a logical interface, you must configure a logical interface by using the `[set interfaces interface-name unit 0]` statement at the `[edit]` hierarchy level.

The following factors affect the ESMC quality level value that is transmitted out on the interfaces configured at the `[edit chassis synchronization esmc-transmit interfaces]` hierarchy level:

- Quality mode
- Selection mode
- Conversion of PTP clock class flag

Other than the aforementioned factors, the software phase lock loop (spll) state or the hybrid state impacts the transmitted ESMC quality level when the router is in PTP mode or hybrid mode, respectively.

The following sections explain how the ESMC quality level is handled in various situations:

Synchronous Ethernet Mode

In Synchronous Ethernet mode, the ESMC quality level is handled in the following way:

- In quality mode:
  - If the `quality-mode-enable` option at the `[show chassis synchronization]` hierarchy level is not set, then the configured quality and the priority set for the clock sources are used for the clock selection. The ESMC quality level is based on the configured quality level corresponding to the active clock source.

- If the `quality-mode-enable` option at the `[show chassis synchronization]` hierarchy level is set, then only those clock sources that receive ESMC quality level is higher than or equal to the configured quality are considered for selection. The ESMC quality level value transmitted also depends on the selection mode option as discussed next.

- In selection mode:

  - If the `selection-mode` option at the `[show chassis synchronization]` hierarchy level is set to `configured-quality`, then the configured quality for the selected, active source is used as the system ESMC quality level value that is transmitted out.

  - If the `selection-mode` option at the `[show chassis synchronization]` hierarchy level is set to `received-quality`, then the received ESMC quality level value from the selected clock source is transmitted out.

- When no clock sources are locked:

  1. Do Not Use (DNU)/Don't Use for Synchronization (DUS) quality level is transmitted.

  2. The ESMC quality level value sent out on the selected, active clock source interface is always DNU/DUS.

Precision Time Protocol Mode

In Precision Time Protocol (PTP) mode, you can transmit ESMC quality level values with the following parameters set:

- The `network-option` option must be configured at the `[edit chassis synchronization]` hierarchy level.

- Synchronous Ethernet sources must not be configured at the `[edit chassis synchronization]` hierarchy level.

- The `convert-clock-class-to-quality-level` option at the `[edit protocols ptp slave]` hierarchy level must be enabled so that the PTP clock class received from the selected primary is converted to the appropriate ESMC quality level.

Clock class is a value that ranges from 80 through 109 and is used to map the clock class to the set ESMC quality level. The ESMC quality level value is mapped to the clock class value by one of the following methods:

- Mapping of PTP clock class to ESMC quality level—By default, the standard mappings suggested by ITU-T G.781 specification are used as shown in Table 10 on page 217 and irrespective of the clock being configured in hybrid mode or pure PTP mode, the outgoing quality level is always based on the PTP clock class mapping. To map the PTP clock class to the ESMC quality level, you must set the `convert-clock-class-to-quality-level` option at the `[edit protocols ptp slave]` hierarchy level. For default mapping values, see Table 10 on page 217.

Table 10: Default Quality Level to PTP Clock-Class Mapping

SSM QL (Binary)	Standard Mappings Given in ITU-T G.781 Specification		PTP Clock Class
	Option I	**Option II**	
0001	-	QL-PRS	80
0000	-	QL-STU	82
0010	QL-PRC	-	84
0111	-	QL-ST2	86
0011	-	-	88
0100	QL-SSU-A	QL-TNC	90
0101	-	-	92
0110	-	-	94
1000	QL-SSU-B	-	96
1001	-	-	98
1101	-	QL-ST3E	100
1010	-	QL-ST3/ QL-EEC2	102
1011	QL-SEC/ QL-EEC1		104
1100	-	QL-SMC	106

Table 10: Default Quality Level to PTP Clock-Class Mapping *(Continued)*

SSM QL (Binary)	Standard Mappings Given in ITU-T G.781 Specification		PTP Clock Class
1110	-	QL-PROV	108
1111	QL-DNU	QL-DUS	110

- User-defined mapping of PTP clock class to ESMC quality level—You can manually override the clock class to ESMC mapping by setting the `clock-class` option at the `[edit protocols ptp slave clock-class-to-quality-level-mapping quality level` *`ql-value`*`]` hierarchy level.

Unlike Synchronous Ethernet, the DNU/DUS quality level value is not transmitted on the interface on which the PTP primary is configured. In PTP mode, an interface is configured as part of the `[edit chassis esmc-transmit interfaces]` hierarchy level, and an appropriate ESMC quality level value is transmitted through it. Note that when the PTP clock class value received from the primary changes, the ESMC quality level transmitted also changes appropriately. If there is no valid clock class value as input, then the DNU/DUS value is transmitted on the interfaces configured under the `esmc-transmit` option at the `[edit chassis synchronization]` hierarchy level.

To view the current mapping between the clock class and the ESMC quality level, run the `show ptp quality-level-mapping` *operational mode command.*

To display the ESMC quality level currently transmitted by the interface, run the `show ptp global-information` operational mode command in PTP or hybrid mode. Note that when the `convert-clock-class-to-quality-level` option is disabled or when there is no valid clock class as input, the `show ptp global information` command does not display the ESMC quality level value.

To view the ESMC quality level transmitted in all modes, run the `show synchronous-ethernet esmc transmit detail` operational mode command.

Hybrid Mode

Hybrid mode is a combination of PTP and Synchronous Ethernet modes.

The configuration required for transmitting the ESMC quality level in hybrid mode differs from that in PTP mode in the following ways:

- In hybrid mode, synchronous Ethernet source interfaces must be configured at the `[edit chassis synchronization]` hierarchy level.
- In hybrid mode, configuring the `convert-clock-class-to-quality-level` option is optional. When this option is configured, the outgoing ESMC quality level behavior is the same as that in PTP mode.

When the `convert-clock-class-to-quality-level` option is not configured, the outgoing ESMC quality level behavior is the same as that in Synchronous Ethernet mode.

Feature Mode Changes

When the router configuration is changed from one feature mode to another mode—that is from or to Synchronous Ethernet, PTP, or hybrid mode—the following occurs:

1. The ESMC quality level is reset to DNU.
2. Based on the new feature mode, the ESMC quality level is decided:
   - When the reference clock qualifies for Synchronous Ethernet mode.
   - When PTP goes into phase-aligned state or hold-over state in PTP mode.
   - When the hybrid state reaches *frequency and phase aligned* state in hybrid mode.

Sometimes PTP is required to drive Synchronous Ethernet and ESMC. This scenario occurs when:

- After certain PTP hops, the network branches out, and one branch of the network requires only frequency synchronization while the other branch requires both phase and frequency synchronization.
- A packet-based distribution network is located between a time-division multiplexing (TDM), a SONET, and a Synchronous Ethernet network.

In such situations, the clock recovered by PTP is sent over the Ethernet physical transceiver for Synchronous Ethernet, and the ESMC quality level value mapping with the PTP clock class is sent over the interfaces.

Example: Configure Synchronous Ethernet

SUMMARY

You can configure Synchronous Ethernet, which enables you to synchronize clocks between nodes in a network through frequency synchronization.

IN THIS SECTION

- Example Prerequisites | 220
- Overview | 220
- Configuration | 220
- Verification | 222

Example Prerequisites

Hardware requirements	One of MX240, MX480, or MX960 router
Software requirements	Junos 11.2R4 or later

Overview

You can configure Synchronous Ethernet, which enables you to synchronize clocks between nodes in a network through frequency synchronization.

You can set the values for each parameter according to your requirement. The values given in this example are for illustration purposes only.

Configuration

IN THIS SECTION

- CLI Quick Configuration | 220
- Procedure | 221
- Results | 222

CLI Quick Configuration

To quickly configure synchronization on the aforementioned routers, copy the following commands, paste them in a text file, remove any line breaks, and then copy and paste the commands into the CLI.

```
set chassis synchronization clock-mode auto-select
set chassis synchronization network-type option-1
set chassis synchronization quality-mode-enable
set chassis synchronization selection-mode configured-quality
set chassis synchronization switchover-mode revertive
set chassis synchronization hold-interval configuration-change 1 restart 1 switchover 1
set chassis synchronization esmc-transmit interfaces ge-2/0/0
set chassis synchronization source external-a priority 2 quality-level prc request force-switch
set chassis synchronization interfaces ge-2/0/0 priority 1 quality-level prc request force-
switch wait-to-restore 1
```

Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see Using the CLI Editor in Configuration Mode in the CLI User Guide.

To configure Synchronous Ethernet, perform the following tasks:

1. Configure the clock mode, network type, quality mode, selection mode, and switchover mode.

```
[edit chassis synchronization]
user@host# set clock-mode auto-select network-type option-1 quality-mode-enable selection-
mode configured-quality switchover-mode revertive
```

2. Configure the hold interval for configuration change, restart interval, and the switchover interval in seconds.

```
[edit chassis synchronization]
user@host# set hold-interval configuration-change 1 restart 1 switchover 1
```

3. Configure the interfaces for transmitting ESMC.

```
[edit chassis synchronization]
user@host# set esmc-transmit interfaces ge-2/0/0
```

4. Configure the source node with its quality level, priority, and request type.

```
[edit chassis synchronization]
user@host# set source external-a priority 2 quality-level prc request force-switch
```

5. Configure the interfaces with priority, quality level, request type, and time to restore the interface to default.

```
[edit chassis synchronization]
user@host# set interfaces ge-2/0/0 priority 1 quality-level prc request force-switch wait-to-
restore 1
```

Results

Display the results of the configuration:

```
user@host# show chassis
synchronization {
    clock-mode auto-select;
    esmc-transmit {
        interfaces ge-2/0/0;
    }
    hold-interval {
        configuration-change 1;
        restart 1;
        switchover 1;
    }
    network-type option-1;
    quality-mode-enable;
    selection-mode configured-quality;
    switchover-mode revertive;
    source {
        external-a {
            priority 2;
            quality-level prc;
            request force-switch;
        }
        interfaces ge-2/0/0 {
            priority 1;
            quality-level prc;
            request force-switch;
            wait-to-restore 1;
        }
    }
}
```

Verification

IN THIS SECTION

- Verify the Basic Parameters for Synchronization | 223

- Verify All the Parameters for Synchronization | 223
- Verify the Global Configuration | 224
- Verify the ESMC Transmit Parameters | 224
- Verify the ESMC Statistics Parameters | 224
- Verify that the ESMC Statistics are Cleared | 225

Confirm that the configuration is working properly.

Verify the Basic Parameters for Synchronization

Purpose

Verify that the basic synchronization parameters such as the current clock status, clock locked to, and configured sources are working as expected.

Action

From operational mode, enter the `run show chassis synchronization` command to display the synchronization details.

Meaning

The output displays the basic synchronization parameters configured on the interface.

Verify All the Parameters for Synchronization

Purpose

Verify that all the synchronization parameters are working as expected.

Action

From operational mode, enter the `run show chassis synchronization extensive` command to display all the synchronization details.

Meaning

The output displays all the synchronization parameters configured on the interface.

Verify the Global Configuration

Purpose

Verify that all the global configuration parameters are working as expected.

Action

From operational mode, enter the `run show synchronous-ethernet global-information` command to display the set parameters for the global configuration.

Meaning

The output displays global information about the configured node.

Verify the ESMC Transmit Parameters

Purpose

Verify that the transmission parameters of ESMC on the interface are working as expected.

Action

From operational mode, enter the `run show synchronous-ethernet esmc transmit detail` command to display the set parameters for the ESMC transmission.

Meaning

The output displays all the transmission details about the configured ESMC interface.

Verify the ESMC Statistics Parameters

Purpose

Verify the statistics related to ESMC on the interface.

Action

From operational mode, enter the `run show synchronous-ethernet esmc statistics` command to display the statistics for the ESMC transmission.

Meaning

The output displays information about the ESMC statistics.

Verify that the ESMC Statistics are Cleared

Purpose

Clear the statistics related to ESMC on the interface.

Action

From operational mode, enter the `clear synchronous-ethernet esmc statistics` command to clear the statistics for the ESMC transmission.

Meaning

The output displays the message that the ESMC statistics have been cleared.

CHAPTER 14

Synchronous Ethernet on 10-Gigabit Ethernet MIC

IN THIS CHAPTER

- Synchronous Ethernet on 10-Gigabit Ethernet MIC | 226
- Example: Configure Framing Mode for Synchronous Ethernet with 10-Gigabit Ethernet MIC | 230

Synchronous Ethernet on 10-Gigabit Ethernet MIC

SUMMARY

Synchronous Ethernet (ITU-T G.8261) is a physical layer technology that functions regardless of the network load. 10-Gigabit Ethernet MIC with XFP supports Synchronous Ethernet in LAN-PHY framing mode.

IN THIS SECTION

- Overview | 226

Overview

Synchronous Ethernet (ITU-T G.8261) is a physical layer technology that functions regardless of the network load. Synchronous Ethernet supports hop-by-hop frequency transfer, where all interfaces on the trail must support Synchronous Ethernet.

10-Gigabit Ethernet MIC with XFP supports Synchronous Ethernet in LAN-PHY framing mode. This is possible only when all the Physical Interface Cards (PICs) under the given Modular Interface Card (MIC) and its ingress interfaces are configured in LAN framing mode. For more information about configuring LAN framing mode, see "Example: Configure Framing Mode for Synchronous Ethernet with 10-Gigabit Ethernet MIC" on page 230. In this mode, the LAN frequency is directly supplied by the MIC's on-board clocking circuitry.

On MX80 Universal Routing Platforms, when the PIC-level framing type is changed, the pluggable MIC (2-port 10-Gigabit Ethernet MIC with XFP) is restarted and the Forwarding Engine Board with the built-in MIC (4-port 10-Gigabit Ethernet MIC with XFP) is restarted.

On MX240, MX480, and MX960 routers, when the PIC-level framing type is changed from LAN mode to non-LAN mode (on a MIC), the entire MPC restarts.

The default interface framing mode is LAN-PHY framing mode. For WAN-PHY framing mode operation, interface framing needs to be set to the `wan-phy` framing option explicitly. For more information about the interface-level and PIC-level configuration combination, see "Example: Configure Framing Mode for Synchronous Ethernet with 10-Gigabit Ethernet MIC" on page 230.

Synchronous Ethernet is not supported in the following instances:

- MX240, MX480, and MX960 routers with 10-Gigabit Ethernet MICs or 10-Gigabit Ethernet built-in interfaces do not support Synchronous Ethernet or Ethernet Synchronization Message Channel (ESMC) transmit in LAN physical layer device (LAN-PHY) framing mode. To configure Synchronous Ethernet or ESMC transmit interfaces on these routers with 10-Gigabit Ethernet Interfaces, you must configure all the 10-Gigabit Ethernet interfaces on the MIC in WAN physical layer device (WAN PHY) framing mode.

- Primary and secondary sources cannot be from the same MIC. Alternatively, only the port with the highest quality clock source from a given MIC is used for clock selection.

- Synchronous Ethernet is not supported on 10-Gigabit Ethernet ports in LAN-PHY mode except for the 10-Gigabit Ethernet MIC with XFP.

- Prior to Junos OS Release 11.4, Synchronous Ethernet was supported only in WAN-PHY framing mode on the 10-Gigabit Ethernet MICs with XFP.

On the MX Series 5G Universal Routing Platforms, the placement of MICs varies from router to router, the following key points has to be taken into consideration while configuring the MICs:

- On the fixed MX80 chassis, the MICs (10-Gigabit Ethernet MIC) come preinstalled and cannot be replaced. The MIC is labeled as 0/MIC 0 and it consists of four 10-Gigabit Ethernet ports labeled 0 through 3, left to right.

- On the modular MX5, MX10, MX40, and MX80 chassis, there are two MIC slots that are labeled as 1/MIC 0 and 1/MIC 1.

- On the MX240, MX480, and MX960 Universal Routing Platforms, there are two slots for MICs which are labeled as PIC 0/1 and PIC 2/3 on the Modular Port Concentrators (MPCs).

Note that hereon the term *PIC* is being used in synonymous with the term *MIC slot* or *Ethernet ports* (in the case of fixed MX80 chassis).

You can configure a MIC in LAN-PHY framing mode by configuring all the constituent logical PICs in the same LAN-PHY framing mode on MX80, MX240, MX480, and MX960 routers.

You can also alternatively configure a MIC in WAN-PHY framing mode on MX80, MX240, MX480, and MX960 routers by configuring all the constituent logical PICs in the same WAN-PHY framing mode in any one of the following configurations:

- No framing mode configured on all the constituent logical PICs of the MIC.
- Incompatible framing mode configured on constituent logical PICs of the MIC.
- No framing mode configured on some of the constituent logical PICs of the MIC.

All the logical PICs in a single MIC must be configured in the same framing mode.

You can also configure the framing mode at the interface level and at the PIC level. For more information about configuring the framing mode at the PIC level and at the interface level, see "Example: Configure Framing Mode for Synchronous Ethernet with 10-Gigabit Ethernet MIC" on page 230.

When the PIC-level framing type is changed between LAN mode and non-LAN mode on a MIC:

- The Forwarding Engine Board (FEB) is restarted in the case of the built-in MIC (4-port 10-Gigabit Ethernet MIC with XFP) on MX80 routers.
- Only the corresponding MIC is restarted in the case of the pluggable MIC (2-port 10-Gigabit Ethernet MIC with XFP) on MX80 routers.
- The entire MPC restarts in the case of MX240, MX480, and MX960 routers.

By default, the PIC-level framing mode is set to WAN framing type, that is, `e1 | e3 | sdh | sonet | t1 | t3`. Synchronous Ethernet works on the 10-Gigabit Ethernet MIC with XFP in LAN-PHY mode only when the PIC-level framing configuration is configured to the `lan` framing type explicitly.

By default, the interface-level framing mode is set to `lan-phy`. For WAN-PHY operation, interface framing needs to be set to `wan-phy` framing explicitly.

Table 11 on page 228 summarizes the possible configuration combination for Synchronous Ethernet on the 10-Gigabit Ethernet MIC with XFP that are available at the interface level and the PIC level:

Table 11: Configuration Options

Framing Configuration		Operation		
PIC Level	**Interface Level**	**Interface Status**	**Will Synchronous Ethernet Function?**	**Will Non-Synchronous Ethernet Functions Work?**
LAN	LAN-PHY (Default)	Up	Yes	Yes

Table 11: Configuration Options *(Continued)*

Framing Configuration		Operation		
LAN	WAN-PHY	Down (Framing Conflict)	No	No
WAN (Default)	LAN-PHY (Default)	Up	No	Yes
WAN (Default)	WAN-PHY	Up	Yes	Yes

The following cases and corresponding behaviors explain Table 11 on page 228 in detail.

- The PIC is being brought up online:

  This case is applicable when either the MIC is restarted or when the MIC is being brought online by an operational command. In this case, the behavior can be presented as:

  - No framing mode is configured for any or all of the constituent logical PICs of the MIC—The MIC is configured to operate in WAN-PHY framing mode as the WAN mode is the default mode.

    Here, the WAN-PHY framing-based interfaces operate in normal state and provides Synchronous Ethernet services. However, the LAN-PHY framing-based interfaces operate normally but cannot provide Synchronous Ethernet services.

  - All the constituent logical PICs of a MIC are configured in LAN-PHY mode—The MIC is configured to operate in LAN-PHY framing mode.

    In this scenario, the WAN-PHY framing-based interfaces cannot operate in normal state. As a result, these interfaces are administratively brought down. The reason for the interface being in **admin-down** state is displayed as **Framing Conflict** in the output of the `show interfaces` operational command. This is because the interface framing configuration (WAN-PHY) is in conflict with the PIC-level framing configuration of LAN-PHY. Because the interfaces are in **admin-down** state, neither the Synchronous Ethernet services nor other services are provided.

    Alternatively, all the LAN-PHY framing-based interfaces can operate in normal state and can continue to provide any of the Synchronous Ethernet services.

- The PIC is already online:

  - In WAN-PHY framing mode—The interface framing configuration on the PIC has changed from WAN-PHY to LAN-PHY.

    The interface continues to be operational for data transceiving purposes. However, it cannot provide any of the Synchronous Ethernet services.

- In WAN-PHY framing mode—The interface framing configuration on the PIC has changed from LAN-PHY to WAN-PHY.

  The interface continues to be operational for data transceiving purposes, and it can also provide Synchronous Ethernet services.

- In LAN-PHY framing mode—The interface framing configuration on the PIC has changed from WAN-PHY to LAN-PHY.

  The interface is operational for data transceiving purposes, and it can also provide Synchronous Ethernet services.

- In LAN-PHY framing mode—The interface framing configuration on the PIC has changed from LAN-PHY to WAN-PHY.

  The interface is down; therefore, it cannot provide any Synchronous Ethernet services.

Support for Synchronous Ethernet is limited in the following instances:

- Primary and secondary sources cannot be from the same MIC. Alternatively, only the port with the highest quality clock source from a given MIC is used for clock selection.
- Prior to Junos OS Release 11.4, Synchronous Ethernet was supported only in WAN-PHY framing mode on the 10-Gigabit Ethernet MICs with XFP.

Example: Configure Framing Mode for Synchronous Ethernet with 10-Gigabit Ethernet MIC

SUMMARY

Learn how to configure framing mode for Synchronous Ethernet with 10-Gigabit Ethernet MIC with XFP.

IN THIS SECTION

- Requirements | 230
- Overview | 231
- Configuration | 231

Requirements

This example uses the following hardware and software components:

- Junos OS Release 11.4 or later for MX240, MX480, or MX960 routers
- One MX240, MX480, and MX960 router with 10-Gigabit Ethernet MIC with XFP

Overview

You can set the framing mode at the PIC level and at the interface level with various configuration combinations. For more information about the various configuration combinations, see "Synchronous Ethernet on 10-Gigabit Ethernet MIC" on page 226.

This example provides information about configuring framing mode at the interface level and the PIC level for Synchronous Ethernet on the 10-Gigabit Ethernet MIC with XFP.

The 10-Gigabit Ethernet MIC with XFP supports Synchronous Ethernet in LAN-PHY framing mode. This is possible only when all the logical PICs under the given Modular Interface Card (MIC) and its ingress interfaces are configured in LAN framing mode.

You can also alternatively configure a MIC in WAN-PHY framing mode on MX80, MX240, MX480, and MX960 routers by configuring all the constituent logical PICs in the same WAN-PHY framing mode in any one of the following configurations:

- No framing mode configured on all the constituent logical PICs of the MIC.
- Incompatible framing mode configured on constituent logical PICs of the MIC.
- No framing mode configured on some of the constituent logical PICs of the MIC.

By default, the PIC-level framing mode is set to WAN framing type, that is **e1 | e3 | sdh | sonet | t1 | t3**. Synchronous Ethernet works on 10-Gigabit Ethernet MIC with XFP in LAN-PHY mode only when the PIC level framing configuration is configured to **lan** framing type explicitly.

By default, the interface-level framing mode is set to **lan-phy**. For WAN-PHY operation, interface framing needs to be set to **wan-phy** framing explicitly.

You can set the values for each parameter according to your requirement. The values given in this example are for illustration purposes only.

Configuration

IN THIS SECTION

- CLI Quick Configuration | 232
- Procedure | 232
- Results | 233

CLI Quick Configuration

To quickly configure PIC-level framing and interface-level framing on the 10-Gigabit Ethernet MIC with XFP, copy the following commands and paste it into the CLI.

```
set chassis fpc 2 pic 0 framing lan
set chassis fpc 2 pic 1 framing lan
set interfaces xe-2/1/0 framing-mode lan-phy
```

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see Using the CLI Editor in Configuration Mode in the CLI User Guide.

Procedure

Step-by-Step Procedure

To configure PIC-level framing on the 10-Gigabit Ethernet MIC with XFP, perform the following tasks:

1. In configuration mode, go to the `[edit chassis]` hierarchy level.

```
[edit]
user@host# edit chassis
```

2. Configure the FPC slot and the first PIC slot.

```
[edit chassis]
user@host# edit fpc 2 pic 0
```

3. Configure the framing type as LAN on the first PIC slot.

```
[edit chassis fpc2 pic 0]
user@host# set framing lan
```

4. Configure the FPC slot and the second PIC slot.

```
[edit chassis]
user@host# edit fpc 2 pic 1
```

5. Configure the framing type as LAN on the second PIC slot.

```
[edit chassis fpc2 pic 0]
user@host# set framing lan
```

Step-by-Step Procedure

To configure interface-level framing on the 10-Gigabit Ethernet MIC with XFP, perform the following tasks:

1. In configuration mode, go to the `[edit interfaces]` hierarchy level and set the interface as **xe-2/1/0**.

```
[edit]
user@host# edit interfaces xe-2/1/0
```

2. Configure the interface in LAN-PHY framing mode.

```
[edit interfaces xe-2/1/0]
user@host# set framing-mode lan-phy
```

Results

Display the results of the configuration at the PIC level:

```
[edit]
user@host# show
chassis {
    fpc 2 {
        pic 0 {
            framing lan;
        }
    }
    fpc 2 {
        pic 1 {
            framing lan;
        }
    }
}
```

Display the results of the configuration at the interface level:

```
[edit]
user@host# show
interfaces xe-2/1/0 {
    framing-mode lan-phy;
}
```

6

PART

Clock Synchronization

Clock Synchronization Concepts | 236

Clock Synchronization for ACX Series Routers | 264

Clock Synchronization for MX Series Routers | 272

Clock Synchronization for PTX Series Routers | 290

Centralized Clocking | 297

CHAPTER 15

Clock Synchronization Concepts

IN THIS CHAPTER

- Clock Synchronization | 236
- Clocking Modes, External Clock Synchronization, and Configuration Parameters | 238
- Automatic Clock Selection | 257
- Interface and Router Clock Sources | 260

Clock Synchronization

SUMMARY

Clock synchronization aims to coordinate otherwise independent clocks.

IN THIS SECTION

- Clock Synchronization Overview | 236

Clock Synchronization Overview

MX Series and PTX Series routers support external clock synchronization and automatic clock selection for Synchronous Ethernet, T1 or E1 line timing sources, and external inputs.

Configuring external clock synchronization and automatic clock selection requires making clock selection, quality level, and priority considerations. The clock source selection algorithm is used to pick the two best upstream clock sources from among the various sources on the basis of system configuration and execution criteria such as quality level, priority, and hardware restrictions.

You can configure several options for external clock synchronization.

MX 10003 routers support external clock synchronization and automatic clock selection for Synchronous Ethernet, T1 or E1 line timing sources, and external inputs.

MX240, MX480, MX960, MX2020, PTX3000, and PTX5000 routers support external clock synchronization using Synchronous Ethernet. Synchronous Ethernet is a physical layer technology that functions regardless of the network load and supports hop-by-hop frequency transfer, where all interfaces on the trail must support Synchronous Ethernet.

Currently, two types of clocking modes are supported on MX Series routers, the distributing clocking mode and the centralized clocking mode.

The Switch Control Board (SCB) supports distributed clocking mode. The Enhanced Switch Control Board—SCBE—supports centralized clocking mode and has one external clock interface.

The Enhanced Switch Control Board—SCBE2—supports centralized clocking mode and has two external clock interfaces external-0/0 and external-1/0. Note that the external-0/0 interface refers to the external interface on the SCB in slot 0 and the external 1/0 interface refers to the external interface on the SCB slot 1.

On SCBE2, you can configure the external synchronization options only on the external interface on the active SCB. Therefore, if the active SCB is in slot 0, then you can configure the external-0/0 interface only. If the active SCB is in slot 1, then you can configure the external-1/0 interface only.

The Enhanced Switch Control Board—SCBE3—provides improved fabric performance and bandwidth capabilities and supports centralized clocking mode. SCBE3 does not support BITS E1/T1 external interfaces.

On SCBE3, you can configure the external synchronization options only on the external interface on the active SCB. Therefore, if the active SCB is in slot 0, then you can configure the external-0/0 GPS interface only. If the active SCB is in slot 1, then you can configure the external-1/0 GPS interface only. In a non-redundant configuration the SCBE3-MX provides fabric bandwidth of up to 1 Tbps per slot (four fabric planes) and 1.5 Tbps per slot fabric bandwidth when all six fabric planes are used (with MPC10E line cards). The SCBE3-MX is supported on Junos 18.4R1 and later releases. It is supported on the MX960, MX480 and MX240 devices.

The PTX Series Packet Transport Routers support an external synchronization interface that can be configured to synchronize the internal Stratum 3 clock on the CCG to an external source, and then synchronize the chassis interface clock to that source.

Clocking Modes, External Clock Synchronization, and Configuration Parameters

SUMMARY

Read this topic to understand the clocking modes, external clock synchronization and configuration parameters for Junos OS devices.

IN THIS SECTION

- Distributed Clocking Mode | 238
- Centralized Clocking Mode | 239
- Clock Selection | 241
- Network Option | 243
- Clock Mode | 244
- Quality Mode | 244
- Selection Mode | 245
- Hold Interval | 245
- Switchover Mode | 246
- Clock Source | 246
- ESMC Packet Transmit | 249
- Global Wait To Restore | 250
- Maximum Transmit Quality Level | 250
- Interfaces with Upstream Clock Source | 250
- External Output Interface | 253
- Clock Synchronization Ports | 254
- MIC-Level Framing Mode | 257

The following sections explain clocking modes, external clock synchronization and its configuration parameters in detail:

Distributed Clocking Mode

In the distributing clocking mode, the Switch Control Board (SCB) supports synchronizing the MX Series router's chassis to an internal Stratum 3 free-run oscillator. The Synchronous Ethernet timing messages are sent through the chassis to support the network timing trails that are traceable to a high-quality timing source. The timing messages are carried through the network by the Ethernet switches that were traditionally handled by time-division multiplexing (TDM) equipment over SONET/SDH interfaces. The distributing clocking mode is handled through ESMC messages. The ESMC support is based on the ITU-

G.8264 specification. The ESMC messages transmit the clock quality of the line timing signal in the form of the (Synchronous Status Message) SSM TLV that is carried in the ESMC packet.For more information, see "Ethernet Synchronization Message Channel Overview" on page 213.

The distributed clocking mode has the following limitations:

- There is no SCB centralized clock module to synchronize the entire chassis.
- The recovered line timing is driven out only by the line interface of the 16-port 10-Gigabit Ethernet MPC.
- The distributed mode does not support external clock interface timing.

Centralized clocking mode overcomes these limitations by distributing and driving timing out on all the chassis line interfaces.

Centralized Clocking Mode

The Enhanced SCB SCBE on the MX240, MX480, and MX960 routers supports a Stratum 3 clock module. This clock module functions as a centralized point within the chassis for clock monitoring, filtering, holdover, and selection. It has only one external clock interface.

The Enhanced SCB SCBE2 on the MX240, MX480, and MX960 routers supports two external clock interfaces external-0/0 and external-1/0. The external-0/0 interface refers to the external interface on the SCB in slot 0 and the external 1/0 interface refers to the external interface on the SCB in slot 1.

In SONET/SDH networks, the routers use the best-quality clock available in the network. The quality level of various clock sources in the network is determined by monitoring the Synchronization Status Messages (SSMs) from the clock sources. An SSM occupies a fixed location in the SONET frame. On Ethernet networks that use Synchronous Ethernet for clock synchronization, the SSM is not a part of the timing signal. The SSM is carried in the Ethernet packets that flow in the Ethernet Synchronization Message Channel (ESMC). By interpreting the SSM values, the router determines the clock quality associated with the clock source, and performs its clock selection accordingly. The ESMC messages transmit the clock quality of the line timing signal in the form of the SSM TLV that is part of the ESMC packet.

Note that the clock in the router goes into holdover mode in the absence of any clock sources with best quality level and in turn uses the timing information stored in its buffer to synchronize itself.

The following processes play a crucial role during external synchronization of the clock sources in the control board. Note that PTX Series routers need two best clock sources that act as primary and secondary clock sources, whereas MX Series routers need only one best clock source.

- The clock sync process (clksyncd) performs the clock selection and participates in ESMC message exchange. For clock selection, in the absence of user-configured primary or secondary clock sources, the clksyncd runs a clock selection algorithm and selects the two best clocks available as the primary and secondary clock sources, respectively, for a PTX Series router or selects a best clock for an MX Series router. The clksyncd also sends out periodic ESMC packets to transmit its clock's quality level to the other routers in the network—this is specified in the SSM TLV in the ESMC packet—and receives ESMC packets from other clock sources and tracks the received clock signal quality level. ESMC packets are received on all the interfaces that are configured as clock sources. ESMC packets are also transmitted to the clock-source interfaces on other routers, as well as to the interfaces that are configured to receive ESMC packets on other routers.

- The chassis process (chassisd) is responsible for interfacing with the Enhanced Switch Control Board (SCBE) on MX Series routers and Centralized Clock Generator (CCG) on PTX Series routers. It monitors the clock quality and assists SCBE or the CCG to determine the clock source with the best quality level. When it detects clock quality deterioration, it informs clksyncd to select another primary clock source. After clock selection chassisd is updated with the latest clock source information. Note that in the absence of user-configured primary and secondary clock sources on PTX Series routers, the clock sources are selected through the clock algorithm and chassisd is updated with the latest clock information. Consequently, a new interprocess connection is established between chassisd and clksyncd.

- The periodic packet management process (ppmd) performs periodic transmission of ESMC packets to others routers in the network. It also receives incoming ESMC packets from other routers. The ppmd filters out repetitive ESMC packets to reduce packet flows between ppmd and clksyncd.

The following explains a simple clock selection process using ESMC packets:

- The Synchronous Ethernet (line timing) signal is an Ethernet physical layer signal that is received on the Ethernet interface. ESMC is a Layer 2 Ethernet packet. The Synchronous Ethernet signal and the ESMC packets are received on the Ethernet interface of the router.

- The received Synchronous Ethernet signal is sent to the clock hardware in the SCBE or in the CCG, whereas the ESMC packets—with the quality level—is directed to the clksyncd.

- The clock selection algorithm in clksyncd selects the best clock signal based on the quality level in the ESMC packet from one of the interfaces that is configured as a clock source. On PTX Series routers, the algorithm also selects the next best—when available—clock as the secondary clock.

- The best clock information is transmitted to the chassisd, which in turn generates a command to the clock hardware to use the best clock as the reference clock. On PTX Series routers, both primary and secondary clocks are used..

- The reference clock uses the best—primary in PTX Series routers—clock signal as the system clock that is used to generate Synchronous Ethernet signal to transmit on all its interfaces.

- The ESMC transmit module in clksyncd is notified of the quality level corresponding to the best—primary—clock. This quality level is used for ESMC packets that are transmitted out of the router.

- ESMC packets are transmitted on all the source interfaces and on those interfaces that are configured as esmc-transmit interfaces.

The centralized mode is applicable to mobile backhaul infrastructures and for network transition from traditional TDM to Ethernet network elements with the support of Synchronous Ethernet.

Clock Selection

Configuring external clock synchronization requires making clock selection, quality level, and priority considerations. The clock selection algorithm is used to pick the two best clock sources—primary and secondary—from among the various sources.

The clock selection algorithm is on the basis of the system configuration and execution criteria such as quality level, priority, hardware restrictions, and so on, and is achieved using the following logic and restrictions:

- The following parameters must be configured irrespective of whether the quality level is enabled or not (You can set the quality level with the `set chassis synchronization source interfaces external quality-level` *`quality-level`* configuration command at the `[edit]` hierarchy level.):

  - Quality level must be configured for nonexternal clocks.

  - In the case of option-1, the quality level must be configured for the external clocks.

  - In the case of option-2, the default quality level for the external clocks is QL_STU.

  The synchronous Ethernet Equipment Clock (EEC) synchronization networking types option-1 and option-2 map to G.813 option 1 (EEC1) and G.812 type IV clock (EEC1) standards, respectively, and can be configured at the `[edit chassis synchronization]` hierarchy level.

- When the `quality-mode-enable` statement is included at the `[edit chassis synchronization]` hierarchy level, the received quality level must be equal to or better than the configured quality level for that particular source, otherwise that source is not considered for clock selection. This is so that a downstream timeReceiver is guaranteed clock quality of a certain level. (Note that the term *certain level* here denotes the configured quality level.)

- Configuring the quality level for a Synchronous Ethernet interface is optional when the `quality-mode-enable` and the `selection-mode received-quality` statements are included at the `[edit chassis synchronization]` hierarchy level.

  The default quality level value for a Synchronous Ethernet interface is:

  - `SEC` for the option-1 network type.

  - `ST3` for the option-2 network type.

- Configuring the `priority` statement is optional. When not specified, the external-a interface has a higher default priority than the external-b interface, and the external-b interface has a higher default priority than Ethernet-based sources such as ge or xe clock sources, which have the lowest default priority.

> **NOTE**: Configured priority is higher than any default priority.

- During clock selection:
  - The active source with the highest quality level is selected.
  - The configured (or default) quality level of the selected clock source is used for Ethernet Synchronization Message Channel (ESMC). In order to receive or transmit ESMC messages out of an interface, at least one logical interface must be configured on that interface.
  - Table 12 on page 242 explains a few scenarios that must be taken into consideration during clock selection:

Table 12: Clock Selection Scenarios

If	Then
Two or more sources have the same quality level.	The source with highest priority is selected.
Two or more sources have the same quality level and priority.	The current active source, if any, among these sources is selected.
Two or more sources have the same quality level and priority, and none of these is currently active.	Any one of these sources is selected.
Primary clock source is ge|xe-*x*/*y*/*z*, where *y* is even (0 or 2).	The secondary clock source cannot be ge|xe-*x*/*y*/* or ge|xe-*x*/*y* + 1/*. For example, if ge-1/2/3 is the primary clock source, then the secondary clock source cannot be ge-1/2/* or ge-1/3/* for an MX80, MX240, MX480, or an MX960 router.

Table 12: Clock Selection Scenarios *(Continued)*

If	Then
Primary clock source is ge|xe-*x*/*y*/*z*, where *y* is odd (1 or 3).	The secondary clock source cannot be ge|xe-*x*/*y*/* or ge|xe-*x*/*y*-1/*. For example, if xe-2/3/4 is the primary clock source, then the secondary clock source cannot be xe-2/2/* or xe-2/3/* for an MX80, MX240, MX480, or an MX960 router.
Primary clock source is ge|xe-*x*/*y*/*z*.	The secondary clock source cannot be ge|xe-*x*/*y*/* in the case of 12-port or 16-port 10-Gigabit Ethernet DPC on an MX Series router. For example, if ge-0/1/2 is the primary clock source, then ge-0/1/* cannot be the secondary clock source, but ge-0/0/* can be the secondary clock source.

On PTX Series routers, you can specify the primary and secondary clock sources provided the clock source meets the necessary qualification as set by the clock algorithm. However, in the absence of any user-selected clock source, the clock source with the best quality level is selected by the clock algorithm in the router. Note that the user selection is honored even when better quality level clock sources are available. You can select the clock source with the `request chassis synchronization switch` *`clock-source`* operational mode command.

The clock sources used as primary or secondary clock sources cannot originate from the same FPC.

Network Option

The clock type or network option is the synchronous Ethernet Equipment Clock (EEC) synchronization networking type. You can set the network option to one of the following values:

- **option-1**—This option maps to G.813 option 1 (EEC1).
- **option-2**—This option maps to G.812 type IV clock (EEC1).

NOTE: On MX104 routers, to configure the OC-192, OC-3, OC-12, or OC-48 interfaces as clock sources, ensure that the *option-2* network option is configured.

NOTE: For SCB, this option is configured with the `set chassis synchronization network-type (option-1 | option-2)` configuration command at the `[edit]` hierarchy level.

To configure the clock type, execute the `set chassis synchronization network-option (option-1 | option-2)` configuration command at the `[edit]` hierarchy level.

NOTE: For Junos OS Releases 11.2R4 through 13.3R3 for MX240, MX480, MX960, MX2010, and MX2020 with SCB, SCBE or SCBE2, you must execute some specific commands after you change the network option at the `[edit chassis synchronization]` hierarchy level. This is because the loop bandwidth does not change automatically when you change the network option. These are the required commands:

```
user@host# deactivate chassis synchronization
user@host# activate chassis synchronization
```

Clock Mode

You can set the Synchronous Ethernet clock source to one of the following modes:

- **free-run**—In this mode, the free-running local oscillator is used as a clock source.

  NOTE: For MX80 routers, the free-run clock is provided by the local oscillator.

  For MX240, MX480, and MX960 routers with an SCB, the free-run clock is provided by the MPCs.

  For MX240, MX480, and MX960 routers with an SCBE or an SCBE2, the free-run clock is provided by the local oscillator.

- **auto-select**—In this mode, the best external clock source is selected.

By default, the auto-select option is selected.

To configure the clock mode, execute the `set chassis synchronization clock-mode (free-run | auto-select)` configuration command at the `[edit]` hierarchy level.

Quality Mode

When the `quality-mode-enable` statement is included at the `[edit chassis synchronization]` hierarchy level, the system ascertains that the clock selection algorithm uses both quality and priority of the clock sources to select the best clock source for clock synchronization. When the `quality-mode-enable` statement is not included, only the priority of the clock source is taken into account by the algorithm.

To enable the synchronization quality mode, include the `quality-mode-enable` statement at the `[edit chassis synchronization]` hierarchy level.

The Synchronous Ethernet ESMC quality mode is disabled by default. The Synchronous Ethernet ESMC quality mode is disabled when the `quality-mode-enable` statement is not included.

Selection Mode

You can specify whether the clock source selection must use the configured or the received ESMC or SSM quality level for a qualifying interface. In both selection modes, the interface qualifies for clock source selection only when the received ESMC or SSM quality level on the interface is equal to or greater than the configured ESMC or SSM quality level for the interface.

The selection modes are:

- **configured-quality**—In this mode, the clock source selection algorithm uses the ESMC or SSM quality level configured for a qualifying interface.
- **received-quality**—In this mode, the clock source selection algorithm uses the ESMC or SSM quality level received on the qualifying interface.

To configure the clock source algorithm selection mode, execute the `set chassis synchronization selection-mode (configured-quality|received-quality)` configuration command at the `[edit]` hierarchy level.

NOTE: For the `selection-mode` statement to take effect, you must include the `quality-mode-enable` statement at the `[edit chassis synchronization]` hierarchy level.

Hold Interval

You can set the chassis synchronization wait time after a change in configuration, the clock selection wait time after reboot of the router, and the switchover wait time after a switchover of SCB before selecting the new clock source. The hold interval options are:

- **configuration-change**—In this mode, the wait time for clock selection after a change in configuration (clock synchronization configuration) can be set from 15 seconds through 60 seconds.
- **restart**—In this mode, the wait time for clock selection after reboot of the router can be set from 60 seconds through 180 seconds.
- **switchover**—In this mode, the switchover wait time after clock recovery can be set from 30 seconds through 60 seconds.

To set the hold interval, execute the `set chassis synchronization hold-interval (configuration-change | restart | switchover) seconds` configuration command at the `[edit]` hierarchy level.

The default switchover wait time is 30 seconds and the default restart wait time is 120 seconds.

Switchover Mode

You can set the switchover mode to switch the clock from a lower quality source to higher quality source or to use the current clock source only. You can configure the switchover mode to one of the following:

- **non-revertive**—In this mode, the router uses the current clock source as long as it is valid.
- **revertive**—In this mode, the router automatically switches from a lower to a higher quality clock source whenever the higher clock source becomes available.

The default mode is revertive mode.

To configure the switching mode, execute the `set chassis synchronization switchover-mode (revertive | non-revertive)` configuration command at the `[edit]` hierarchy level.

Clock Source

You can specify the parameters that must be considered by the clock selection algorithm while selecting the best clock source. The parameters include the quality level value, the priority of the clock source, the request criteria, and the wait time to restore the interface signal to up state. You must specify these parameters on the external clock interfaces or other qualifying interfaces—which are connected to valid clock sources—to select the best clock source on the basis of the timing messages that are received on these interfaces.

For an SCBE, you can configure only one external interface and configure multiple Ethernet interfaces as needed.

On SCBE2, you can configure two external interfaces—external-0/0 and external-1/0—and configure multiple Ethernet interfaces as needed.

To configure the clock source, execute the `set chassis synchronization source interfaces interface-name` configuration command. You can also configure the clock source with the `set chassis synchronization source interfaces external` at the `[edit]` hierarchy level, where the external option refers to an external clock interface.

> **NOTE**: Incorporate the external option as needed on the basis of the SCB in your MX Series router.

To specify the clock source for an interface, you must set the following options:

- **priority**—You can set the user priority for the selected clock source from 1 through 5.

  To set the synchronization source priority for the selected clock source, execute the `set chassis synchronization source interfaces` *`interface-name`* `priority` *`number`* configuration command or the `set chassis synchronization source interfaces external priority` *`number`* configuration command at the `[edit]` hierarchy level.

- **request**—You can set the clock selection request criterion as one of the following:

  - **force-switch**—With this option, you can force the SCB to switch to a clock source you prefer on a particular interface (that is you can select a clock source on an interface overriding the algorithm), provided the source is enabled and not locked out. Only one configured source can be force-switched.

  - **lockout**—With this option configured, the clock source is not to be considered by the selection process. Lockout can be configured for any source.

  To configure these options, execute the `set chassis synchronization source interfaces` *`interface-name`* `request (force-switch|lockout)` configuration command or the `set chassis synchronization source interfaces external request (force-switch|lockout)` configuration command at the `[edit]` hierarchy level.

- **wait-to-restore**—You can set the wait-to-restore time for each interface. When an interface's signal transitions out of the signal fail state, it must be fault-free for the wait-to-restore time before it is again considered by the clock selection process. You can configure the interface signal upstate time—wait time before opening the interface to receive ESMC messages—from 0 through 12 minutes. The default time is 5 minutes. When the ESMC clock's EEC quality level (QL) mode is enabled, it sends a signal failure to the clock selection process during the wait-to-restore time. After the wait-to-restore time ends, a new quality level value is sent to the clock selection process.

  To configure the wait-to-restore time, execute the `set chassis synchronization source interfaces` *`interface-name`* `wait-to-restore` *`minutes`* configuration command or the `set chassis synchronization source interfaces external wait-to-restore` *`minutes`* configuration command at the `[edit]` hierarchy level.

- **hold-off-time**—You can configure hold-off time for Synchronous Ethernet interfaces and external clock source interfaces to prevent rapid successive switching between signal fail states. If an interface goes down, hold-off time delays short signal failures from being sent to the clock selection process.

  > **NOTE**: During the hold-off time period, if the clock synchronization process restarts, hold-off time is not considered.

  If you configure hold-off time when the ESMC clock's EEC QL mode is enabled, the configured quality level is used in the clock selection process during the hold-off time period. During the hold-off time period, the external clock source appears in a locked state until the hold-off time period ends. After the hold-off time period ends, a signal failure is sent to the clock selection process.

You can configure hold-off time for a range of 300 through 1800 milliseconds. The default hold-off time is 1000 milliseconds.

To configure hold-off time, execute the `set chassis synchronization source interfaces` *`interface-name`* `hold-off-time` configuration command at the `[edit]` hierarchy level.

> **NOTE**: When a link goes down and comes back up within the configured hold-off time in a clocking hybrid mode configuration (the combined operation of Synchronous Ethernet and Precision Time Protocol) that includes the `protocols ptp slave convert-clock-class-to-quality-level` configuration statement at the `[edit]` hierarchy level, the phase might not get locked before the timer expires. This might result in a degradation of clock quality level.

- **quality**—You can set the ESMC clock's EEC quality level as prc, prs, sec, smc, ssu-a, ssu-b, st2, st3, st3e, st4, stu, or tnc. Both option I and option II SSM quality levels are supported. Table 13 on page 248 explains the quality level values.

Table 13: Quality Levels

Quality Level	Description
`prc`	Timing quality of a primary reference clock (option-1 only).
`prs`	Clock traceable to a primary reference source (option-2 only).
`sec`	Timing quality of an SDH equipment clock (option-1 only).
`smc`	Clock traceable to a self-timed SONET clock (option-2 only).
`ssu-a`	Timing quality of a type I or IV timeReceiver clock (option-1 only).
`ssu-b`	Timing quality of a type VI timeReceiver clock (option-1 only).
`st2`	Clock traceable to Stratum 2 (option-2 only).

Table 13: Quality Levels *(Continued)*

Quality Level	Description
st3	Clock traceable to Stratum 3 (option-2 only).
st3e	Clock traceable to Stratum 3E (option-2 only).
st4	Clock traceable to Stratum 4 free-run (option-2 only).
stu	Clock traceable to an unknown quality (option-2 only).
tnc	Clock traceable to a transit node clock (option-2 only).

NOTE: When the quality level is not configured and no ESMC messages are received by the clock source, then the quality level is set to DNU for option-1 and DUS for option-2. You can configure the network options, option-1 and option-2 at the `[edit chassis synchronization network-option]` hierarchy level.

To avoid source looping on the selected active source—primary or secondary source, whichever is active—even when ESMC transmit is not enabled, a DNU ESMC message is sent out when the `network-option` statement is configured as option-1, and a DUS ESMC message is sent out when the `network-option` statement is configured as option-2. This is applicable only for clock sources configured on the Ethernet interfaces.

To configure the quality level, execute the `set chassis synchronization source interfaces` *`interface-name`*`) quality-level (prc | prs |sec | smc | ssu-a | ssu-b | st2 | st3 | st3e | st4 | stu | tnc)` configuration command or the `set chassis synchronization source interfaces external quality-level (prc | prs |sec | smc | ssu-a | ssu-b | st2 | st3 | st3e | st4 | stu | tnc)` configuration command at the `[edit]` hierarchy level.

ESMC Packet Transmit

You can enable all the interfaces or configure one or more qualifying interfaces on which to permit ESMC transmit messages by executing the `set chassis synchronization esmc-transmit interfaces (all |` *`interface-name`*`)` configuration command at the `[edit]` hierarchy level.

Global Wait To Restore

You can globally configure the time in minutes for source ports to be up before opening the Ethernet Synchronization Message Channel (ESMC) for messages. When a port's signal transitions out of the signal fail state, it must be fault-free for the global wait-to-restore time before it is again considered by the clock selection process.

To configure the global wait-to-restore time, include the `global-wait-to-restore` statement at the `[edit chassis synchronization]` hierarchy level.

To override the global wait-to-restore time on a specific interface, include the `wait-to-restore` statement at the `[edit chassis source interfaces (external-a | external-b | interface interface-name)]` hierarchy level.

Maximum Transmit Quality Level

To configure the maximum transmit quality level for SCBE2 as prc, prs, sec, smc, ssu-a, ssu-b, st2, st3, st3e, st4, stu, or tnc, execute the `set chassis synchronization max-transmit-quality-level quality-level` configuration command at the `[edit]` hierarchy level.

You can configure the `max-transmit-quality-level` statement on SCB and SCBE.

For GPS external output, when you configure the maximum transmit quality level as PRC and router is rebooted, no valid output is obtained from SCBE. However, when the maximum transmit quality level is configured to any other quality level other than PRC and the router gets rebooted, then the SCBE works normally.

Interfaces with Upstream Clock Source

You can configure the external interface to operate with a connected router for a clock source. This external interface can be configured for a clock source, which then becomes a candidate for selection as the chassis clock source by the clock source selection algorithm. You can configure several options for the external clock source interface on the SCBE and for the two external clock source interfaces on the SCBE2.

The options include E1 interface options, pulse-per-second option, the signal type for the provided reference clocks, and the T1 interface options at the `[edit chassis synchronization interfaces external]` hierarchy level.

The following sections explain the clock source interface parameters in detail:

E1 Interface Options

You can set the E1 interface-specific options as:

- **framing**—Set the framing mode for the E1 interface as one of the following:

- g704—G.704 framing format for E1 interfaces
- g704-no-crc4—G.704 framing without CRC4 for E1 interfaces.

To set the framing mode for the E1 interface, execute the `set chassis synchronization interfaces external e1-options framing (g704|g704-no-crc4)` configuration command at the `[edit]` hierarchy level for SCBE or the `set chassis synchronization interfaces (external-0/0 | external-1/0) e1-options framing (g704|g704-no-crc4)` configuration command at the `[edit]` hierarchy level for SCBE2.

By default, the g704 framing format is selected.

- **line-encoding**—Set the `line-encoding` statement as automatic mark inversion or high-density bipolar 3 code. The line encoding technique converts signals to bipolar pulses. You can set the `line-encoding` option as one of the following:
  - ami—Automatic mark inversion
  - hdb3—High-density bipolar 3 code

  To configure the `line-encoding` statement on the E1 interface, execute the `set chassis synchronization interfaces external e1-options line-encoding (ami|hdb3)` configuration command for SCBE at the `[edit]` hierarchy level or the `set chassis synchronization interfaces (external-0/0 | external-1/0) e1-options line-encoding (ami|hdb3)` configuration command at the `[edit]` hierarchy level for SCBE2.

  By default, the hdb3 line encoding technique is selected.

- **sabit**—Set the SA bit to a value from 4 through 8. SA bits are used for exchanging the SSM quality between the clock source and the router on the E1 interface.

  To set the SA bit on the E1 interface, execute the `set chassis synchronization interfaces external e1-options sabit` *sabit-value* configuration command at the `[edit]` hierarchy level for SCBE or the `set chassis synchronization interfaces (external-0/0 | external-1/0) e1-options sabit` *sabit-value* configuration command at the `[edit]` hierarchy level for SCBE2.

Pulse Per Second

You can enable the `pulse-per-second-enable` option on the GPS interface to receive the pulse per second (PPS) signal by executing the `set chassis synchronization interfaces external pulse-per-second-enable` configuration command at the `[edit]` hierarchy level for SCBE or the `set chassis synchronization interfaces (external-0/0 | external-1/0) pulse-per-second-enable` configuration command at the `[edit]` hierarchy level for SCBE2.

Signal Type

You can set the frequency for the provided reference clock (GPS or BITS) as one of the following:

- `1mhz`—Set the signal with a clock frequency of 1 MHz.
- `5mhz`—Set the signal with a clock frequency of 5 MHz.
- `10mhz`—Set the signal with a clock frequency of 10 MHz.
- `2048khz`—Set the signal with a clock frequency of 2048 kHz.
- `e1`—Set the signal as an E1-coded 2048 kHz signal on a 120-ohm balanced line.
- `t1`—Set the signal as a T1-coded 1.544 MHz signal on a 100-ohm balanced line.

Configure the signal type by executing the `set chassis synchronization interfaces external signal-type (1mhz | 5mhz | 10mhz | 2048khz | e1 | t1)` configuration command at the `[edit]` hierarchy level for SCBE or the `set chassis synchronization interfaces (external-0/0 | external-1/0) signal-type (1hz | 5mhz | 10mhz | 2048khz | e1 | t1)` configuration command at the `[edit]` hierarchy level for SCBE2.

The 1mhz, 5mhz, and the 10mhz signals are traceable to a GPS-capable clock source, where the source can be an atomic clock. The e1 and t1 signals are traceable to a BITS clock source.

T1 Interface Options

You can set the T1 interface-specific options as:

- **framing**—Set the framing mode for the T1 interface as one of the following:
  - `esf`—Extended superframe
  - `sf`—Superframe

  To set the framing mode for the T1 interface, execute the `set chassis synchronization interfaces external t1-options framing (esf|sf)` configuration command at the `[edit]` hierarchy level for SCBE or the `set chassis synchronization interfaces (external-0/0 | external-1/0) t1-options framing (esf|sf)` configuration command at the `[edit]` hierarchy level for SCBE2.

  By default, the esf framing mode is selected.

- **line-encoding**—Set the `line-encoding` option on the T1 interface as one of the following:
  1. `ami`—Automatic mark inversion
  2. `b8zs`—8-bit zero suppression

  To configure the `line-encoding` option on the T1 interface, execute the `set chassis synchronization interfaces external t1-options line-encoding (ami|b8zs)` configuration command at the `[edit]` hierarchy level for SCBE or the `set chassis synchronization interfaces (external-0/0 | external-1/0) t1-options line-encoding (ami|b8zs)` configuration command at the `[edit]` hierarchy level for SCBE2.

By default, the b8z3 line encoding technique is selected.

External Output Interface

You can set several options for the external clock output interface for SCBE or for the two external clock output interfaces for SCBE2.

The options include disabling the holdover mode; configuring a minimum quality threshold; configuring a mode to select a clock source; configuring the transmit quality level to DNU or DUS; and disabling wander filtering at the `[edit chassis synchronization output interfaces external]` hierarchy level for SCBE or at the `[edit chassis synchronization output interfaces (external0-0 | external-1/0)]` hierarchy level for SCBE2.

The following sections explain the external output interface parameters in detail:

Holdover Mode

You can disable the holdover mode on the external output interface by executing the `set chassis synchronization output interfaces external holdover-mode-disable` configuration command at the `[edit]` hierarchy level for SCBE or the `set chassis synchronization output interfaces (external-0/0 | external-1/0) holdover-mode-disable` configuration command at the `[edit]` hierarchy level for SCBE2.

Minimum Quality

When the quality of the source signal—used to derive the output—falls below a minimum quality level, the output of the external interface is placed in holdover mode. When the signal type supports the SSM quality level, the SSM quality level is set as the holdover quality level. The output interface remains in holdover mode until a source with the minimum quality level or higher is available. Note that when the `holdover-mode-disable` option is configured, the output is suppressed completely.

You can set the minimum quality on the external output interface as prc, prs, sec, smc, ssu-a, ssu-b, st2, st3, st3e, st4, stu, or tnc by executing the `set chassis synchronization output interfaces external minimum-quality` *`quality-level`* configuration command at the `[edit]` hierarchy level for SCBE or the `set chassis synchronization output interfaces (external-0/0 | external-1/0) minimum-quality` *`quality-level`* configuration command at the `[edit]` hierarchy level for SCBE2.

Source Mode

When the source mode is set to chassis, the source selected by the chassis clock module is used as the clock source. When the source mode is set to line, the best available line clock is selected.

You can set the source mode for selecting a clock source as either a chassis clock or the best line clock source as output by executing the `set chassis synchronization output interfaces external source-mode (chassis| line)` configuration command at the `[edit]` hierarchy level for SCBE or the `set chassis synchronization output` interfaces (external-0/0 | external-1/0) source-mode (chassis|line) configuration command at the [edit] hierarchy level for SCBE2.

Transmit Quality Level

You can configure the tx-dnu-to-line-source-enable statement to enable the transmit quality level to DNU or DUS when the chassis clock is the BITS input signal and when a valid line source signal is sent out through the BITS output.

You can set the transmitting quality level to DNU or DUS on the line source interface by executing the set chassis synchronization output interfaces external tx-dnu-to-line-source-enable configuration command at the [edit] hierarchy level for SCBE or the set chassis synchronization output interfaces (external-0/0 | external-1/0) tx-dnu-to-line-source-enable configuration command at the [edit] hierarchy level at SCBE2.

Wander Filter

You can disable the wander filter by executing the set chassis synchronization output interfaces external wander-filter-disable configuration command at the [edit] hierarchy level for SCBE or the set chassis synchronization output interfaces (external-0/0 | external-1/0) wander-filter-disable configuration command at the [edit] hierarchy level for SCBE2.

Clock Synchronization Ports

You can set the time-of-day-format statement as an ASCII string on SCBE and SCBE2 by executing the set chassis synchronization port auxiliary client time-of-day-format ascii string configuration command at the [edit] hierarchy level.

The time of day (TOD) format is specified as a string of ASCII characters. The TOD format string contains information that specifies which ASCII characters to match, which ASCII characters to ignore, and which ASCII characters to translate to particular time units (such as month, day, hour, minute, and so on).

The TOD format string specifies how the incoming string is to be parsed so that the information embedded can be extracted. The format of the TOD option can be executed with the set chassis synchronization port auxiliary time-of-day-format ascii *string* configuration command at the [edit] hierarchy level, where the format of the data string is $GPRMC,%hh%mm%ss,^,^^^^.^^,^,^^^^^^^^,^,^^^^^,^^^^^,%DD%MM %YY,^^^^^,^*^^.

Table 14 on page 255 explains pattern-matching characters used in the TOD data string.

Table 14: Pattern-Matching Characters

Character construct	Number of characters	Description
-	1	The *DO NOT CARE* (DNC) character
%hh	2	Hours (00–23)
%mm	2	Minutes (00–59)
%ss	2	Seconds (00–59)
%DD	2	Day (01–31)
%MM	2	Month (01–12)
%YY	2	Year without century
%YYY	4	Year with century
%DDD	3	Day of year (001–366)
%MMM	3	Month of year (JAN, FEB, etc.)
%cc	2	NMEA message checksum
%Q	1	Time quality indicator (‘ ‘ = valid ‘*’ = error)

There are several patterns that can be received by a router. The following pattern shows an example of a received TOD data string (as defined in the National Marine Electronics Association (NMEA) 0183 standard. The data string is called the Recommended Minimum Specific GPS/Transit Data (RMC) message.) and Table 15 on page 256 explains it in detail.

```
$GPRMC,225446,A,4916.45,N,12311.12,W,000.5,054.7,191194,020.3,E*68<CR><LF>
```

Table 15: Received TOD Data String

Pattern	Description
$GPRMC	NMEA sentence ID
225446	UTC time of fix (22:54:46 UTC)
A	Data status (A=Valid position, V=navigation receiver warning)
4916.45	Latitude of fix
N	N or S of longitude
12311.12	Longitude of fix
W	E or W of longitude
000.5	Speed over ground in knots
054.7	Track made good in degrees True
191194	UTC date of fix (19 November 1994)
020.3	Magnetic variation degrees
E	E or W of magnetic variation
*68	Checksum (XOR of all characters between $ and *)

NOTE: Whenever a TOD data string does not provide sufficient information, the router extracts it from Junos OS and generates a log message. The TOD data string that is either transmitted or received is always of fixed length and is delimited by a

<CR><LF>character pair, where CR (carriage return) and LF (line feed) are the line break types used to end the ASCII format string.

MIC-Level Framing Mode

You can configure the LAN framing mode on the 10-Gigabit Ethernet MIC with XFP by executing the `set chassis fpc *fpc-slot* pic *pic-slot* framing lan` at the `[edit]` hierarchy level.

Note that to operate in LAN framing mode on the 10-Gigabit Ethernet MIC with XFP, you must configure the interface framing mode on the MIC interface. Execute the `set interfaces xe-*fpc*/*pic*/*port* framing-mode (lan-phy | wan-phy)` configuration command at the `[edit]` hierarchy level, where the lan-phy option denotes a 802.3ae 10-Gbps LAN-mode interface and the wan-phy option denotes a 802.3ae 10-Gbps WAN-mode interface.

Automatic Clock Selection

SUMMARY

Automatic clock selection is the selection of the best quality clock source by the clock source selection algorithm based on the Ethernet Synchronization Message Channel (ESMC) Synchronization Status Message (SSM) quality level, the configured quality level, and the priority.

IN THIS SECTION

- Clock Source Selection Algorithm | 257
- Clock Selection and Quality Level | 258
- Selection Mode for the Incoming ESMC Quality | 259
- Automatic Clock Selection for ACX Series Routers | 259

Clock Source Selection Algorithm

The clock source selection algorithm uses the following logic and restrictions:

- QL must be configured for non-external clocks, whether or not QL is enabled.
- For **network-option option-1**, QL must be configured for external clocks (**gps** or **bits**) whether or not QL is enabled.
- In the case of **network-option option-2**, the default QL for the external clocks is QL_STU, whether or not QL is enabled.

- Configuring priority is optional. When not specified, **gps** has a higher default priority than **bits**, and **bits** has a higher default priority than Gigabit Ethernet, 10-Gigabit Ethernet, and T1 or E1 clock, which have the lowest default priority.

- When QL is enabled, the received QL must be equal to or better than the configured QL for that particular source or else that source will not be considered for clock selection. This is so that a downstream timeReceiver is guaranteed clock quality of a certain level (that "certain level" being the configured QL).

During clock selection:

- The active source with the highest QL is selected.

- If QL is the same for two or more sources, then the source with the highest priority is selected.

- If two or more sources have the same QL and priority, then the currently active source, if any, among these sources is selected.

- If two or more sources have the same QL and priority, and none of these is currently active, then any one of these may be selected.

- If selection-mode is *configured quality*, then the configured (or default) QL of the selected clock source is used for transmitting ESMC. If selection-mode is *received quality*, then the received QL of the selected clock source is used for ESMC transmit.

- In order to receive or transmit ESMC messages out of an interface, at least one *logical interface* should be configured on that interface. If the interface is currently not configured with a logical interface, you may do so using the `set interfaces` *`interface-name`* `unit 0` statement at the **edit** hierarchy level.

The clock source selection algorithm is triggered by the following events:

- Changes in the received ESMC SSM quality level (QL)

- Configuration changes. For example, the addition or deletion of a clock source, a change to the QL mode, and so on.

- Signal failure detected on the currently selected source.

When the router is configured with automatic clock selection, the system chooses up to two best upstream clock sources. The system then uses the clock recovered from one of the sources to lock the chassis clock. If an upstream clock with acceptable good quality is not available or if the system is configured in free-run mode, the system uses the internal oscillator.

Clock Selection and Quality Level

Automatic clock selection supports two modes: QL enabled and QL disabled.

- QL disabled— In this mode, the best clock is selected based on the configured ESMC SSM QL. If the QL of the configured clocks are equal, the clock selection is based on the configured priority. If both the configured QL and priority are equal, one of the sources is randomly selected. Absence of the `quality-mode-enable` statement at the [`edit chassis synchronization`] hierarchy level means that QL is disabled.

  > **NOTE**: The default setting is QL disable.

- QL enabled—In this mode, the best clock is selected based on the incoming ESMC SSM QL as long as the incoming QL is at least as good as the source's configured QL. If the QLs are equal, the clock selection is based on the configured priority. If both the received QL and the priority are equal, one of the sources is selected randomly.

Selection Mode for the Incoming ESMC Quality

Depending on the configuration, the clock source selection algorithm uses the configured or received ESMC SSM quality level for clock selection. In both configured and received selection modes, the interface qualifies for clock source selection only when the received ESMC SSM quality level on the interface is equal to or greater than the configured ESMC SSM quality level for the interface.

Automatic Clock Selection for ACX Series Routers

The ACX Series Universal Metro routers support external clock synchronization and automatic clock selection for Synchronous Ethernet, T1 or E1 line timing sources, and external inputs. Configuring external clock synchronization and automatic clock selection requires making clock selection, quality level (QL), and priority considerations. The clock source selection algorithm is used to pick the two best upstream clock sources from among all the various sources, based on system configuration and execution criteria such as QL, priority, and hardware restrictions.

With automatic clock selection, the system chooses up to two best upstream clock sources. The system then uses the clock recovered from one of the sources to lock the chassis clock. If an upstream clock with acceptable good quality is not available or if the system is configured in free-run mode, the system uses the internal oscillator. The following automatic clock selection features are supported for Synchronous Ethernet, T1 or E1 line timing sources, and external inputs:

> **NOTE**: Automatic clock selection does not apply to the IEEE 1588v2 recovered clock.

Automatic clock selection is supported on the ACX Series routers. Automatic clock selection of the best quality clock source is based on the Ethernet Synchronization Message Channel (ESMC) Synchronization Status Message (SSM) quality level, the configured quality level, and the priority. To configure automatic clock selection, include the **auto-select** option at the [**edit chassis synchronization**] hierarchy level. You can also configure the chassis to lock to the free-running local oscillator, which is the Stratum 3E oscillator, by including the **free-run** option at the [**edit chassis synchronization**] hierarchy level. The **auto-select** option enables the clock source selection algorithm to run. The clock source selection algorithm is triggered by the following events:

- Signal failure detected on the currently selected source
- Changes in the received Ethernet Synchronization Message Channel (ESMC) Synchronization Status Message (SSM) quality level (QL)
- Configuration changes. For example, the addition or deletion of a clock source, a change to the QL mode, and so on.

Automatic clock selection supports two modes on the ACX Series router: QL enabled and QL disabled. To configure QL mode, include the `quality-mode-enable` statement at the [**edit chassis synchronization**] hierarchy level.

- QL disabled—The default setting is disable, which means that when the `quality-mode-enable` statement is not configured, QL is disabled. In this mode, the best clock is selected based on the configured ESMC SSM QL. If the QL of the best clocks are equal, the clock selection is based on the configured priority. If both the configured QL and priority are equal, one of the sources is randomly selected.
- QL enabled—In this mode, the best clock is selected based on the incoming ESMC SSM QL as long as the incoming QL is at least as good as the source's configured QL. If the QLs are equal, the clock selection is based on the configured priority. If both the received QL and the priority are equal, one of the sources is selected randomly.

Interface and Router Clock Sources

SUMMARY

For both the router and interfaces, the clock source can be the router's internal Stratum 3 clock, which resides on the control board, or an external clock that is received from the interface configured.

IN THIS SECTION

- Interface and Router Clock Sources Overview | **260**
- Configure an External Clock Synchronization Interface | **262**

Interface and Router Clock Sources Overview

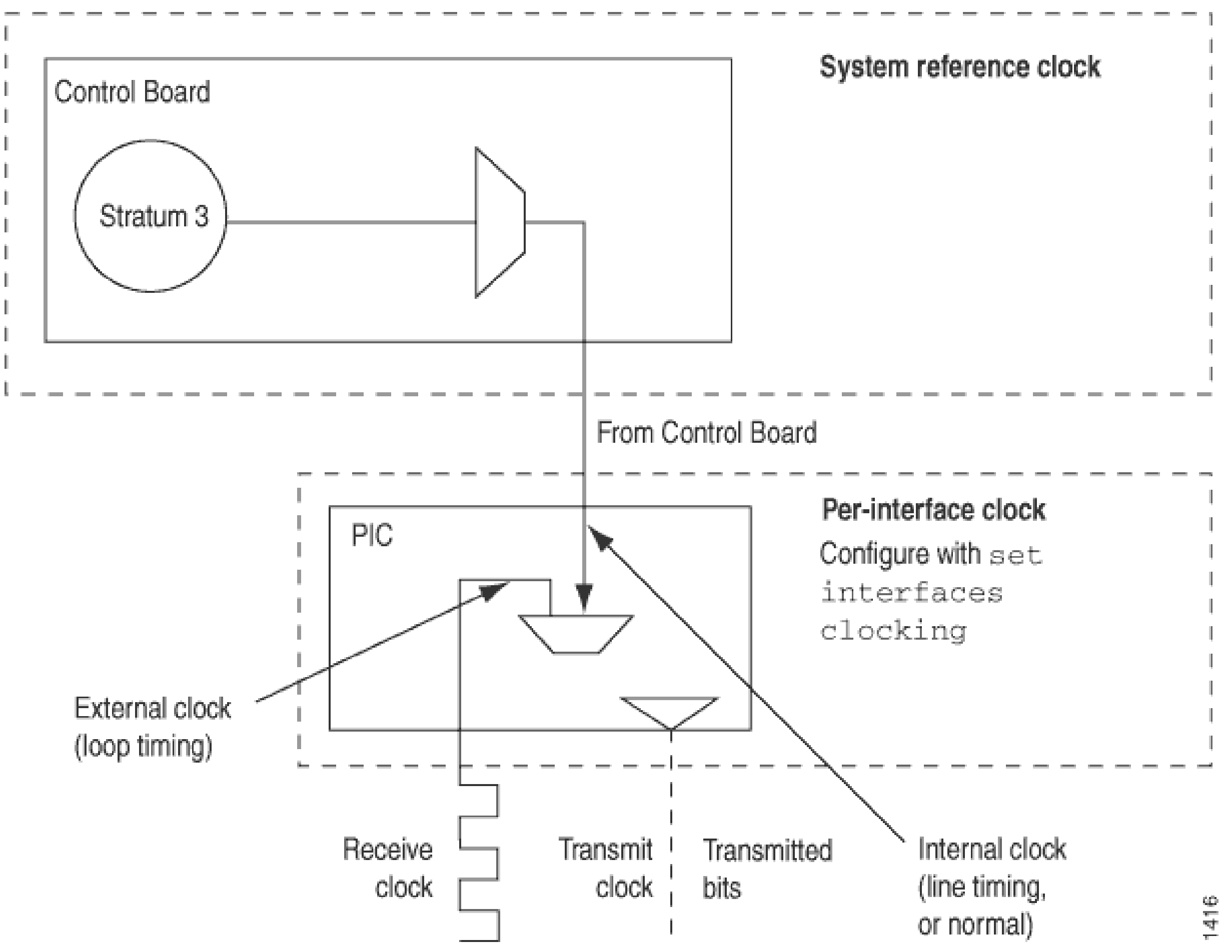
When configuring the router, you can configure the *transmit clock* on each interface; the transmit clock aligns each outgoing packet transmitted over the router's interfaces. For both the router and interfaces, the clock source can be the router's internal Stratum 3 clock, which resides on the control board, or an external clock that is received from the interface you are configuring. For example, interface A can transmit on interface A's received clock (external, loop timing) or the Stratum 3 clock (internal, line timing). Interface A cannot use a clock from any other source.

By default, each interface uses the router's internal Stratum 3 clock. To configure the clock source of each interface, include the `clocking` statement at the `[edit interfaces interface-name]` hierarchy level:

```
[edit interfaces interface-name]
clocking (internal | external);
```

System reference clocks can be generated from different system components, depending on the router type. For example, Figure 3 on page 261 illustrates the different clock sources on the M120 router.

Figure 3: M120 Router Clock Sources



Configure an External Clock Synchronization Interface

The M40e, M120, M320, T640, and T1600 routers support an external synchronization interface that can be configured to synchronize the internal Stratum 3 clock to an external source, and then synchronize the chassis interface clock to the external source.

This feature can be configured for external primary and secondary interfaces that use Building Integrated Timing System (BITS) or SDH Equipment Timing Source (SETS) timing sources, or an equivalent quality timing source. When internal timing is set for SONET/SDH, Plesiochronous Digital Hierarchy (PDH), and digital hierarchy (DS1) interfaces on the Physical Interface Cards (PICs), the transmit clock of the interface is synchronized to BITS/SETS timing and traceable to timing within the network.

Routers and switches that support an external clock synchronization interface include:

- M40e, M120, and M320 routers
- T640 and T1600 routers

To configure external synchronization on the router, include the `synchronization` statement at the `[edit chassis]` hierarchy level:

```
[edit chassis]
synchronization {
    signal-type (t1 | e1);
    switching--mode (revertive | non-revertive);
    y-cable-line-termination;
    transmitter-enable;
    validation-interval seconds;
    primary (external-a | external-b);
    secondary   (external-a | external-b);
}
```

Use the `synchronization` statement options to specify a primary and secondary timing source. To do this, configure the following options:

- For the M120 and M320 routers, specify a signal type mode for interfaces, either **t1** or **e1**. For the M40e, T640, and T1600 routers, only the `t1` signal type mode is supported. The default setting is `t1`.
- For the T640 and T1600 routers, external clock interfaces are supported on the SONET Clock Generators (SCG-T-EC). The external clock interfaces on the SONET Clock Generators (SCG-T) are not supported.
- Specify the switching mode as `revertive` if a lower-priority synchronization can be switched to a valid, higher-priority synchronization.

- For the M320 router, specify that a single signal should be wired to both Control Boards (CBs) using a Y-cable. For the M40e router, the signal is wired to the CIP and Y-cable functionality is embedded in this system.

  The `y-cable-line-termination` option is not available on the M40e, M120, T640, and T1600 routers.

- Control whether the diagnostic timing signal is transmitted.

  The `transmitter-enable` option is not available on the M120, T640, and T1600 routers.

- Set a validation interval. The `validation-interval` option validates the synchronized deviation of the synchronization source. If revertive switching is enabled and a higher-priority clock is validated, the clock module is directed to the higher-priority clock, and all configured and active synchronizations are validated. The validation timer resumes after the current validation interval expires. The validation interval can be a value from 90 through 86,400 seconds. The default value is 90 seconds. For the M120 router, the range for the `validation-interval` option is 30 through 86,400 and the default value is `30`.

- Specify the primary external timing source by using the `primary (external-a | external-b)` statement.

- Specify the secondary external timing source by using the `secondary (external-a | external-b)` statement.

CHAPTER 16

Clock Synchronization for ACX Series Routers

IN THIS CHAPTER

- Configure External Clock Synchronization for ACX Series Routers | **264**

Configure External Clock Synchronization for ACX Series Routers

SUMMARY

The ACX Series Routers support external clock synchronization for Synchronous Ethernet, T1 or E1 line timing sources, and external inputs.

Configuring external clock synchronization requires making clock selection, quality level (QL), and priority considerations. The clock source selection algorithm is used to pick the two best upstream clock sources from among all the various sources, based on system configuration and execution criteria such as QL, priority, and hardware restrictions.

To configure external synchronization on the router, include the `synchronization (ACX Series)` statement at the `[edit chassis]` hierarchy level.

Setting the Ethernet equipment clock (EEC) network type

The network type options set the frequency of the configured clock. When **bits** is configured with **option-1** on the ACX router, the Synchronous Ethernet equipment is optimized for 2048 Kbps, the speed of an E1 interface. When **bits** is configured with **option-2** on the ACX router, the Synchronous Ethernet equipment is optimized for 1544 Kbps, the speed of a T1 interface. To set the clock type, use the following command:

```
set chassis synchronization network-option (option-1 | option-2)
```

For **option-1**, QL must be configured for external clocks (**gps** or **bits**) whether or not QL is enabled. For **option-2**, the default QL for external clocks is QL_STU whether or not QL is enabled.

The following output shows an example of the configuration of the **network type** with **option-1**:

```
[edit]
user@host# show chassis
synchronization {
    network-option option-1;
}
```

Setting the clock mode

Clock mode sets the selection of the clock source from a free-running local oscillator or from an external qualified clock. The default clock mode is **auto-select**, which uses the best clock source. To set the clock mode, use the following command:

```
set chassis synchronization clock-mode (free-run | auto-select)
```

The following output shows an example of the configuration of the **free-run** option:

```
[edit]
user@host# show chassis
synchronization {
    clock-mode free-run;
}
```

NOTE: Automatic clock selection does not apply to the IEEE 1588v2 recovered clock.

Setting the quality mode

Specify the expected quality of the incoming clock on this source. The default is disable. To set the synchronization quality mode, use the following command:

```
set chassis synchronization quality-mode-enable
```

The following output shows the configuration of the `quality-mode-enable` statement:

```
[edit]
user@host# show chassis
synchronization {
```

```
    quality-mode-enable;
}
```

Setting the selection mode

The selection mode specifies whether the clock source selection algorithm should use the configured or received ESMC SSM quality level for clock selection. In both selection modes (**configured-quality** and **received-quality**), the interface qualifies for clock source selection only when the received ESMC SSM quality level on the interface is equal to or greater than the configured ESMC SSM quality level for the interface. To configure the ESMC SSM quality-based clock source selection mode, use the following command:

```
set chassis synchronization selection-mode (configured-quality | received-quality)
```

The following output shows the configuration of the `selection-mode` statement with the **configured-quality** option and the mandatory `quality-mode-enable` statement:

```
[edit]
user@host# show chassis
synchronization {
    selection-mode configured-quality;
    quality-mode-enable;
}
```

NOTE: For the `selection-mode` statement configuration to take effect, you must set the `quality-mode-enable` statement at the `[edit chassis synchronization]` hierarchy level.

Setting the time interval before a new clock source is selected

For routers operating with Synchronous Ethernet , set the time interval to wait before the router selects a new clock source. After a change in the configuration, the time to wait is between 15 and 60 seconds. After a reboot (restart), the time to wait is from 60 to 180 seconds. After clock recovery (switchover), the time to wait is from 30 to 60 seconds. The default switchover time is 30 seconds and cold boot time is 120 seconds. To set the time interval before a new clock source is selected, use the following command:

```
set chassis synchronization hold-interval (configuration-change | restart | switchover) seconds
```

The following output shows the configuration of the `hold-interval` statement with the **configuration-change** option:

```
[edit]
user@host# show chassis
synchronization {
    hold-interval {
        configuration-change 20;
    }
}
```

Setting the synchronization switching mode

The configured switching mode determines the clock source used. In revertive mode, the system switches from a lower to a higher quality clock source whenever the higher clock source becomes available. In non-revertive mode, the system continues to use the current clock source as long as it is valid. The default mode is revertive. To set the synchronization switchover mode, use the following command:

```
set chassis synchronization switchover-mode (revertive | non-revertive)
```

The following output shows the configuration of the `switchover-mode` statement with the **non-revertive** option:

```
[edit]
user@host# show chassis
synchronization {
    switchover-mode non-revertive;
}
```

Setting the clock source

The configured clock source is the candidate for selection by the clock selection algorithm. The clock source can be the router’s BITS T1 or E1 interface, GPS, or an interface with an upstream clock source. To set the clock source, use the following command:

```
set chassis synchronization source (bits | gps | interfaces interface-name)
```

The following output shows the configuration of the `source` statement with the **bits** option and the mandatory `network-option` statement. When **bits** is configured with **option-1** on the ACX2000 router, the Synchronous Ethernet equipment is optimized for 2048 Kbps, the speed of an E1 interface.

```
[edit]
user@host# show chassis
synchronization {
    network-option option-1;
    source {
        bits;
    }
}
```

NOTE: For the `source` statement configuration to take effect, you must set the `network-option (option-1 | option-2)` statement at the `[edit chassis synchronization]` hierarchy level. The **bits** option is not supported on the ACX1000 router.

Setting ESMC transmit interface

The ESMC transmit interface is the interface on which ESMC transmit messages are permitted. To enable ESMC packet transmit, use the following command:

```
set chassis synchronization esmc-transmit interfaces interface-name
```

The following output shows the configuration of the `esmc-transmit` statement:

```
[edit]
user@host# show chassis
synchronization {
    esmc-transmit {
        interfaces ge-0/1/0;
    }
}
```

You can also enable ESMC on all interfaces with the `interfaces all` statement at the preceding hierarchy level.

Setting the synchronization source quality level

Specify the expected quality of the incoming clock on this source. Specific quality-level options are valid depending on the configured **network-option**; **option-1** or **option-2**. Both option-1 and option-2 SSM quality levels are supported. To set the synchronization source quality level, use the following command:

```
set chassis synchronization source (bits | gps | interfaces interface-name) quality-level (prc |
prs |sec | smc | ssu-a | ssu-b | st2 | st3 | st3e | st4 | stu | tnc)
```

The following output shows the configuration of the `quality-level` statement configured with the **prc** option:

```
[edit]
user@host# show chassis
synchronization {
    source {
        bits {
            quality-level prc;
        }
    }
}
```

Setting the synchronization source priority

Specify a priority level between 1 and 5. When not specified, **gps** has a higher priority than **bits**,and **bits** has a higher default priority than other Gigabit Ethernet or 10 Gigabit Ethernet clock sources, which have the lowest priority. To set the synchronization source priority, use the following command:

```
set chassis synchronization source (bits | gps | interfaces interface-name) priority number
```

The following output shows the configuration of the `priority` statement:

```
[edit]
user@host# show chassis
synchronization {
    source {
        bits {
            priority 2;
        }
    }
}
```

Setting the synchronization source wait to restore time

A wait-to-restore time can be configured for each port. When a port's signal transitions out of the signal fail state, it must be fault free for the wait-to-restore time before it is again considered by the selection process. The range is from **0** through **12** minutes. The default time is 5 minutes.

To set the synchronization source wait-to-restore time, use the following command:

```
set chassis synchronization source interfaces interface-name wait-to-restore minutes
```

The following output shows the configuration of the `wait-to-restore` statement:

```
[edit]
user@host# show chassis
synchronization {
    network-option option-1;
    source {
        interfaces ge-0/1/0 {
            wait-to-restore 2;
        }
    }
}
```

Setting the synchronization source lockout

A lockout may be configured for any source. When a lockout is configured for a source, that source will not be considered by the selection process. To set the synchronization source lockout, use the following command:

```
set chassis synchronization source (bits | gps | interfaces interface-name) request lockout
```

The following output shows the configuration of the `request lockout` statement:

```
[edit]
user@host# show chassis
synchronization {
    network-option option-1;
    source {
        bits {
            request lockout;
        }
```

```
    }
}
```

Setting the forced switch

Force a switch to the source provided that the source is enabled and not locked out. Only one configured source may be force-switched. To set the forced switch, use the following command:

```
set chassis synchronization source (bits | gps | interfaces interface-name) request force-switch
```

The following output shows the configuration of the `request force-switch` statement:

```
[edit]
user@host# show chassis
synchronization {
    network-option option-1;
    source {
        bits {
            request force-switch;
        }
    }
}
```

CHAPTER 17

Clock Synchronization for MX Series Routers

IN THIS CHAPTER

- Configure External Clock Synchronization for MX Series Routers | 272

Configure External Clock Synchronization for MX Series Routers

SUMMARY

MX Series routers support external clock synchronization for Synchronous Ethernet, T1 or E1 line timing sources, and external inputs.

IN THIS SECTION

- Configure Clock Synchronization Options | 273
- Display the External Clock Synchronization Configuration for SCB | 282
- Display the External Clock Synchronization Configuration for SCBE | 283
- Display the External Clock Synchronization Configuration for SCBE2 | 285
- Display the External Clock Synchronization Configuration for MX2020 Control Board | 287

Configuring external clock synchronization requires making clock selection, quality level, and priority considerations. The clock source selection algorithm is used to pick the two best upstream clock sources from among the various sources on the basis of system configuration and execution criteria such as quality level, priority, and hardware restrictions.

The following sections explain configuring clock synchronization options for MX Series routers:

NOTE: The following scenarios occur when you configure Synchronous Ethernet without the `clock-class-to-quality-level-mapping` statement at the `[edit protocols ptp slave]` hierarchy level:

- Qualified clock source quality level (that is the secondary clock source quality level) is transmitted out of the external interface and the Ethernet interface during clock reference switchover when two clock sources on different MICs of the same FPC exist or when two clock sources on two different FPCs exist.
- Lower quality level is transmitted out the external interface and the Ethernet interface during clock reference switchover when two clock sources on the same MIC of an FPC exist due to hardware limitation.

Before you remove the SCBE from the router, you must delete the configuration under the `[edit chassis synchronization]` hierarchy level. Similarly, before you remove the SCBE2 from the router, you must delete the configuration under the `[edit chassis synchronization]` hierarchy level.

On SCBE2, the external-0/0 interface is located on **SCB0** and the external-1/0 interface is located on **SCB1**.

Configure Clock Synchronization Options

To configure the clock synchronization options.

1. In configuration mode, go to the `[edit chassis synchronization]` hierarchy level.

```
[edit]
user@host# edit chassis synchronization
```

2. Configure the Synchronous Ethernet clock selection mode as auto-select or free-run.

```
[edit chassis synchronization]
user@host# set clock-mode (auto-select | free-run)
```

3. Configure the ESMC transmit parameters on all the interfaces or on selected interfaces.

```
[edit chassis synchronization]
user@host# set esmc-transmit interfaces (all | interface-name)
```

4. Configure the hold interval as configuration-change, which is the wait time (from 15 seconds through 60 seconds) after a change in configuration; restart, which is the wait time (from 60

seconds through 180 seconds) after reboot of the router; and switchover, which is the switchover wait time (from 30 seconds through 60 seconds) after clock recovery.

```
[edit chassis synchronization]
user@host# set hold-interval configuration-change secs
user@host# set hold-interval restart secs
user@host# set hold-interval switchover secs
```

5. Configure the options for the external interfaces on the basis of the type of Enhanced Switch Control Board on your MX Series router.

   The SCBE has only one external interface. Configure the following options for SCBE:

   a. Go to the `[edit chassis synchronization interfaces external]` hierarchy level.

   ```
   [edit chassis synchronization]
   user@host# edit interfaces external
   ```

   b. Configure all the E1 interface-specific options—the `framing` statement as g704 or g704-no-crc, the `line-encoding` statement as ami or hdb3, and the `sabit` statement from 4 bits through 8 bits.

   ```
   [edit chassis synchronization interfaces external]
   user@host# set e1-options framing (g704 | g704-no-crc)
   user@host# set e1-options line-encoding (ami | hdb3)
   user@host# set e1-options sabit bit
   ```

   c. Configure the `pulse-per-second-enable` statement to enable the pulse per second (PPS) signal to be received on the GPS interface.

   ```
   [edit chassis synchronization interfaces external]
   user@host# set pulse-per-second-enable
   ```

   d. Configure the frequency for the provided reference clock as 1 MHz, 5 MHz, 10 MHz, 2048 kHz, e1, or t1.

   ```
   [edit chassis synchronization interfaces external]
   user@host# set signal-type (1hz | 5mhz | 10mhz | 2048khz | e1 | t1)
   ```

e. Configure the T1 interface-specific options—the `framing` statement as esf or sf and the `line-encoding` statement as ami or b8zs.

```
[edit chassis synchronization interfaces external]
user@host# set t1-options framing (esf | sf)
user@host# set t1-options line-encoding (ami | b8zs)
```

The SCBE2 Control Board has two external interfaces—external-0/0 and external-1/0. Configure the following options for SCBE2 Control Board:

a. Go to the `[edit chassis synchronization interfaces external-0/0]` or `[edit chassis synchronization interfaces external-1/0]` hierarchy level.

```
[edit chassis synchronization]
user@host# edit interfaces external-0/0
```

OR

```
[edit chassis synchronization]
user@host# edit interfaces external-1/0
```

b. Configure all the E1 interface-specific options—the `framing` statement as g704 or g704-no-crc, the `line-encoding` statement as ami or hdb3, and the `sabit` statement from 4 bits through 8 bits-—on the external-0/0 interface or the external-1/0 interface.

```
[edit chassis synchronization interfaces (external-0/0 | external-1/0)]
user@host# set e1-options framing (g704 | g704-no-crc)
user@host# set e1-options line-encoding (ami | hdb3)
user@host# set e1-options sabit bit
```

c. Configure the `pulse-per-second-enable` statement to enable the pulse per second (PPS) signal to be received on the GPS interface of the router.

```
[edit chassis synchronization interfaces (external-0/0 | external-1/0)]
user@host# set pulse-per-second-enable
```

d. Configure the frequency for the provided reference clock as 1 MHz, 5 MHz, 10 MHz, 2048 kHz, e1, or t1.

```
[edit chassis synchronization interfaces (external-0/0 | external-1/0)]
user@host# set signal-type (1hz | 5mhz | 10mhz | 2048khz | e1 | t1)
```

e. Configure the T1 interface-specific options—the `framing` statement as esf or sf and the `line-encoding` statement as ami or b8zs.

```
[edit chassis synchronization interfaces (external-0/0 | external-1/0)]
user@host# set t1-options framing (esf | sf)
user@host# set t1-options line-encoding (ami | b8zs)
```

The MX2020 Control Board has two external interfaces—external-a and external-b. Configure the following options for MX2020 Control Board:

a. Go to the `[edit chassis synchronization interfaces external-a]` or `[edit chassis synchronization interfaces external-b]` hierarchy level.

```
[edit chassis synchronization]
user@host# edit interfaces external-a
```

OR

```
[edit chassis synchronization]
user@host# edit interfaces external-b
```

b. For BITS interface, configure all the E1 interface-specific options—the `framing` statement as g704 or g704-no-crc, the `line-encoding` statement as ami or hdb3, and the `sabit` statement from 4 bits through 8 bits-—on the external-a interface or the external-b interface.

```
[edit chassis synchronization interfaces (external-a | external-b)]
user@host# set e1-options framing (g704 | g704-no-crc)
user@host# set e1-options line-encoding (ami | hdb3)
user@host# set e1-options sabit bit
```

c. Configure the `pulse-per-second-enable` statement to enable the pulse per second (PPS) signal to be received on the GPS interface of the router.

```
[edit chassis synchronization interfaces (external-a | external-b)]
user@host# set pulse-per-second-enable
```

d. Configure the frequency for the provided reference clock as 1 MHz, 5 MHz, or 10 MHz for GPS interface and 2048 kHz, e1, or t1 for BITS interface.

```
[edit chassis synchronization interfaces (external-a | external-b)]
user@host# set signal-type (1hz | 5mhz | 10mhz | 2048khz | e1 | t1)
```

e. For BITS interface, configure the T1 interface-specific options—the `framing` statement as esf or sf and the `line-encoding` statement as ami or b8zs.

```
[edit chassis synchronization interfaces (external-a | external-b)]
user@host# set t1-options framing (esf | sf)
user@host# set t1-options line-encoding (ami | b8zs)
```

6. Configure the maximum transmit quality level as prc, prs, sec, ssu-a, ssu-b, st2, st3e, stu, or tnc.

```
[edit chassis synchronization]
user@host# set max-transmit-quality-level (prc | prs | sec | ssu-a | ssu-b | st2 | st3e |
stu | tnc)
```

7. Configure the EEC synchronization networking type as option-1 or option-2.

```
[edit chassis synchronization]
user@host# set network-option (option-1 | option-2)
```

8. Configure the options for the external clock interface output on the basis of the type of Enhanced Switch Control Board on your MX Series router.

For SCBE:

a. Go to the `[edit chassis synchronization output interfaces external]` hierarchy level.

```
[edit chassis synchronization]
user@host# edit output interfaces external
```

b. Configure all the external clock interface output options. The options include the `holdover-mode-disable` statement; the `minimum-quality` statement, which can be set as prc, prs, sec, ssu-a, ssu-b, st2, st3e, stu, or tnc; the `source-mode` statement, which can be set as chassis or line; the `tx-dnu-to-line-source-enable` statement; and the `wander-filter-disable` statement.

```
[edit chassis synchronization output interfaces external]
user@host# set holdover-mode-disable
user@host# set minimum-quality (prc | prs | sec | ssu-a | ssu-b | st2 | st3e | stu | tnc)
user@host# set source-mode (chassis | line)
user@host# set tx-dnu-to-line-source-enable
user@host# set wander-filter-disable
```

For SCBE2:

a. Go to the `[edit chassis synchronization output interfaces external-0/0]` hierarchy level or the `[edit chassis synchronization output interfaces external-1/0]` hierarchy level.

```
[edit chassis synchronization]
user@host# edit output interfaces (external-0/0 | external-1/0)
```

b. Configure all the external clock interface output options on the external-0/0 interface or the external-1/0 interface. The options include the `holdover-mode-disable` statement; the `minimum-quality` statement, which can be set as prc, prs, sec, ssu-a, ssu-b, st2, st3e, stu, or tnc; the `source-mode` option, which can be set as chassis or line; the `tx-dnu-to-line-source-enable` statement; and the `wander-filter-disable` statement.

```
[edit chassis synchronization output interfaces (external-0/0 | external-1/0)]
user@host# set holdover-mode-disable
user@host# set minimum-quality (prc | prs | sec | ssu-a | ssu-b | st2 | st3e | stu | tnc)
user@host# set source-mode (chassis | line)
user@host# set tx-dnu-to-line-source-enable
user@host# set wander-filter-disable
```

For MX2020 Control Board:

a. Go to the [edit chassis synchronization output interfaces external-a] hierarchy level or the [edit chassis synchronization output interfaces external-b] hierarchy level.

```
[edit chassis synchronization]
user@host# edit output interfaces (external-a | external-b)
```

b. Configure all the external clock interface output options on the external-a interface or the external-b interface. The options include the holdover-mode-disable statement; the minimum-quality statement, which can be set as prc, prs, sec, ssu-a, ssu-b, st2, st3e, stu, or tnc; the source-mode option, which can be set as chassis or line; the tx-dnu-to-line-source-enable statement; and the wander-filter-disable statement.

```
[edit chassis synchronization output interfaces (external-a | external-b)]
user@host# set holdover-mode-disable
user@host# set minimum-quality (prc | prs | sec | ssu-a | ssu-b | st2 | st3e | stu | tnc)
user@host# set source-mode (chassis | line)
user@host# set tx-dnu-to-line-source-enable
user@host# set wander-filter-disable
```

9. Configure the time-of-day message format as ASCII on the auxiliary port that receives the external clock signals.

```
[edit chassis synchronization]
user@host# set port auxiliary client time-of-day-format ascii string
```

10. Configure the quality-mode-enable statement to enable Synchronous Ethernet ESMC quality mode.

```
[edit chassis synchronization]
user@host# set quality-mode-enable
```

11. Configure the selection mode for the incoming ESMC quality as configured-quality or received-quality.

```
[edit chassis synchronization]
user@host# set selection-mode (configured-quality | received-quality)
```

12. Configure the options for the ESMC source related external clock source interface on the basis of the type of Enhanced Switch Control Board on your MX Series router.

For SCBE:

a. Go to the `[edit chassis synchronization source interfaces external]` hierarchy level or the `[edit chassis synchronization source interfaces` *`ethernet-interface-name`*`]` hierarchy level.

```
[edit chassis synchronization]
user@host# edit source interfaces external
```

OR

```
[edit chassis synchronization]
user@host# edit source interfaces ethernet-interface-name
```

b. Configure the external clock interface and the Ethernet interface with their options. Configure the `priority` statement from 1 through 5; the `quality-level` statement as prc, prs, sec, ssu-a, ssu-b, st2, st3e, stu, or tnc; the `request` statement as force-switch or lockout; the `wait-to-restore` statement from 0 minutes to 12 minutes; and the `hold-off-time` statement from 300 through 1800 milliseconds. You can configure the same options for the Ethernet interfaces as well.

```
[edit chassis synchronization source interfaces (external | ethernet-interface-name)]
user@host# set priority value
user@host# set quality-level (prc | prs | sec | ssu-a | ssu-b | st2 | st3e | stu | tnc)
user@host# set request (force-switch | lockout)
user@host# set wait-to-restore minutes
user@host# set hold-off-time time
```

For SCBE2 Control Board:

a. Go to the `[edit chassis synchronization source interfaces (external-0/0]` hierarchy level or the `[edit chassis synchronization source interfaces (external-1/0]` hierarchy level.

```
[edit chassis synchronization]
user@host# edit source interfaces external-0/0
```

OR

```
[edit chassis synchronization]
user@host# edit source interfaces external-1/0
```

b. Configure the options on the external-0/0 interface or the external-1/0 interface. Set the `priority` statement from 1 through 5; the `quality-level` statement as prc, prs, sec, ssu-a, ssu-b, st2, st3e, stu, or tnc; the `request` statement as force-switch or lockout; the `wait-to-restore` statement from 0 minutes to 12 minutes; and the `hold-off-time` statement from 300 through 1800 milliseconds.

```
[edit chassis synchronization source interfaces (external-0/0 |external-1/0)]
user@host# set priority value
user@host# set quality-level (prc | prs | sec | ssu-a | ssu-b | st2 | st3e | stu | tnc)
user@host# set request (force-switch | lockout)
user@host# set wait-to-restore minutes
user@host# set hold-off-time time
```

For MX2020 Control Board:

a. Go to the `[edit chassis synchronization source interfaces (external-a]` hierarchy level or the `[edit chassis synchronization source interfaces (external-b]` hierarchy level.

```
[edit chassis synchronization]
user@host# edit source interfaces external-a
```

OR

```
[edit chassis synchronization]
user@host# edit source interfaces external-b
```

b. Configure the options on the external-a interface or the external-b interface. Set the `priority` statement from 1 through 5; the `quality-level` statement as prc, prs, sec, ssu-a, ssu-b, st2, st3e, stu, or tnc; the `request` statement as force-switch or lockout; the `wait-to-restore` statement from 0 minutes to 12 minutes; and the `hold-off-time` statement from 300 through 1800 milliseconds.

```
[edit chassis synchronization source interfaces (external-a |external-b)]
user@host# set priority value
user@host# set quality-level (prc | prs | sec | ssu-a | ssu-b | st2 | st3e | stu | tnc)
user@host# set request (force-switch | lockout)
user@host# set wait-to-restore minutes
user@host# set hold-off-time time
```

13. Configure the switchover mode as revertive or non-revertive.

```
[edit chassis synchronization]
user@host# set switchover-mode (non-revertive | revertive)
```

Display the External Clock Synchronization Configuration for SCB

IN THIS SECTION

- Purpose | 282
- Action | 282

Purpose

Display the options for external clock synchronization for SCB.

Action

Execute the `show` command at `[edit chassis]` hierarchy level.

```
[edit chassis]
user@host# show
synchronization {
    clock-mode (auto-select | free-run);
    esmc-transmit {
        interfaces (all | <interface-name>);
    }
    hold-interval {
        configuration-change <seconds>;
        restart <seconds>;
        switchover <seconds>;
    }
    interfaces <interface-name> {
        hold-off-time <time>;
     priority <number>;
        quality-level (prc | prs |sec | smc | ssu-a | ssu-b | st2 | st3 | st3e | st4 | stu |
tnc);
```

```
        request (force-switch | lockout);
        wait-to-restore <minutes>;
    }
}
    max-transmit-quality-level (prc | prs | sec | ssu-a | ssu-b | st2 | st3e |stu | tnc);    #
Applicable from 13.3 onwards
    network-type (option-1 | option-2);
    quality-mode-enable;
    selection-mode (configured-quality | received-quality);
    source {
        (external-a | external-b) {
        priority <number>;
        quality-level (prc | prs |sec | smc | ssu-a | ssu-b | st2 | st3 | st3e | st4 | stu |
tnc);
        request (force-switch | lockout);
    }
    switchover-mode (revertive | non-revertive);
}
```

Display the External Clock Synchronization Configuration for SCBE

IN THIS SECTION

- Purpose | 283
- Action | 283

Purpose

Display the options for external clock synchronization for SCBE. Note that the SCBE has only one external interface.

Action

Execute the show command at `[edit chassis]` hierarchy level.

```
[edit chassis]
user@host# show
synchronization {
```

```
    clock-mode (auto-select | free-run);
    esmc-transmit {
        interfaces (all | <interface-name>);
    }
    hold-interval {
        configuration-change <seconds>;
        restart <seconds>;
        switchover <seconds>;
    }
    interfaces {
        external {
            e1-options {
                framing (g704 | g704-no-crc4);
                line-encoding (ami | hdb3);
                sabit <number>;
            }
            pulse-per-second-enable;
            signal-type (1mhz | 5mhz | 10mhz | 2048khz | t1 | e1);
            t1-options {
                framing (esf | sf);
                line-encoding (ami | b8zs);
            }
        }
    }
    max-transmit-quality-level (prc | prs | sec | ssu-a | ssu-b | st2 | st3e |stu | tnc);   #
Applicable from 13.3 onwards
    network-option (option-1 | option-2);
    output {
        interfaces {
            external {
                holdover-mode-disable;
                minimum-quality (prc | prs | sec | smc | ssu-a | ssu-b |st2 | st3 | st3e | st4 |
stu | tnc);
                source-mode (chassis | line);
                tx-dnu-to-line-source-enable;
                wander-filter-disable;
            }
       }
    }
    port {
        auxiliary client {
           time-of-day-format {
               ascii <string>;
```

```
            }
         }
     }
     quality-mode-enable;
     selection-mode (configured-quality | received-quality);
     source {
         interfaces (<interface-name> | external) {
             hold-off-time <time>;
                priority <number>;
                quality-level (prc | prs |sec | smc | ssu-a | ssu-b | st2 | st3 | st3e | st4 |
stu | tnc);
                request (force-switch | lockout);
             wait-to-restore <minutes>;
         }
     }
     switchover-mode (revertive | non-revertive);
}
```

Display the External Clock Synchronization Configuration for SCBE2

IN THIS SECTION

- Purpose | 285
- Action | 285

Purpose

Display the options for external clock synchronization for SCBE2. SCBE2 has two external interfaces, external-0/0 and external-1/0.

Action

Execute the show command at `[edit chassis]` hierarchy level.

```
[edit chassis]
user@host# show
synchronization {
    clock-mode (auto-select | free-run);
```

```
    esmc-transmit {
        interfaces (all | <interface-name>);
    }
    hold-interval {
        configuration-change <seconds>;
        restart <seconds>;
        switchover <seconds>;
    }
    interfaces {
        (external-0/0 | external-1/0) {
            signal-type (1mhz | 5mhz | 10mhz | 2048khz | t1 | e1);
            e1-options {
                framing (g704 | g704-no-crc4);
                line-encoding (ami | hdb3);
                sabit <number>;
            }
            pulse-per-second-enable;
            t1-options {
                framing (esf | sf);
                line-encoding (ami | b8zs);
            }
        }
    }
    max-transmit-quality-level (prc | prs | sec | ssu-a | ssu-b | st2 | st3e |stu | tnc);
    network-option (option-1 | option-2);
    output {
        interfaces {
            (external-0/0 | external-1/0) {
                holdover-mode-disable;
                minimum-quality (prc | prs | sec | smc | ssu-a | ssu-b |st2 | st3 | st3e | st4 |
stu | tnc);
                source-mode (chassis | line);
                tx-dnu-to-line-source-enable;
                wander-filter-disable;
            }
       }
    }
    port {
        auxiliary client {
           time-of-day-format {
               ascii <string>;
           }
        }
```

```
    }
    quality-mode-enable;
    selection-mode (configured-quality | received-quality);
    source {
        interfaces {
            (external-0/0 | external-1/0 | <interface-name>) {
                hold-off-time <time>;
          priority <number>;
                quality-level (prc | prs |sec | smc | ssu-a | ssu-b | st2 | st3 | st3e | st4 |
stu | tnc);
                request (force-switch | lockout);
                wait-to-restore <minutes>;
        }
    }
    switchover-mode (revertive | non-revertive);
}
```

Display the External Clock Synchronization Configuration for MX2020 Control Board

IN THIS SECTION

- Purpose | 287
- Action | 287

Purpose

Display the options for external clock synchronization for MX2020 Control Board. MX2020 Control Board has two external interfaces, external-a and external-b.

Action

Execute the show command at [edit chassis] hierarchy level.

```
[edit chassis]
user@host# show
synchronization {
    clock-mode (auto-select | free-run);
    esmc-transmit {
```

```
        interfaces (all | <interface-name>);
    }
    hold-interval {
        configuration-change <seconds>;
        restart <seconds>;
        switchover <seconds>;
    }interfaces {
        (external-a | external-b) {
            signal-type (1mhz | 5mhz | 10mhz | 2048khz | t1 | e1);
            e1-options {
                framing (g704 | g704-no-crc4);
                line-encoding (ami | hdb3);
                sabit <number>;
            }
            pulse-per-second-enable;
            t1-options {
                framing (esf | sf);
                line-encoding (ami | b8zs);
            }
        }
    }max-transmit-quality-level (prc | prs | sec | ssu-a | ssu-b | st2 | st3e |stu | tnc);
    network-option (option-1 | option-2);
    output {
        interfaces {
            (external-a | external-b) {
                holdover-mode-disable;
                minimum-quality (prc | prs | sec | smc | ssu-a | ssu-b |st2 | st3 | st3e | st4 |
stu | tnc);
                source-mode (chassis | line);
                tx-dnu-to-line-source-enable;
                wander-filter-disable;
            }
       }
    }
    port {
        auxiliary client {
           time-of-day-format {
               ascii <string>;
           }
        }
    }
    quality-mode-enable;
    selection-mode (configured-quality | received-quality);
```

```
    source {
        interfaces {
            (external-a | external-b | <interface-name>) {
                hold-off-time <time>;
          priority <number>;
                quality-level (prc | prs |sec | smc | ssu-a | ssu-b | st2 | st3 | st3e | st4 |
stu | tnc);
                request (force-switch | lockout);
                wait-to-restore <minutes>;
        }
    }
    switchover-mode (revertive | non-revertive);
}
```

CHAPTER 18

Clock Synchronization for PTX Series Routers

IN THIS CHAPTER

- Clock Sources for PTX Series Routers | 290
- Synchronize Internal Stratum 3 Clock to External Clock Sources on PTX Series Routers | 293

Clock Sources for PTX Series Routers

SUMMARY

System clocking on PTX Series Packet Transport Routers is controlled by a Centralized Clock Generator (CCG). The CCG is capable of deriving a *primary clock* from a valid source and synchronizing all interfaces on the chassis to this primary clock. The CCG plugs into the rear of the chassis. A pair of CCGs installed in the chassis provide a redundant fallback option.

IN THIS SECTION

- Clock Sources for PTC Series Packet Transport Routers | 290
- Getting Started to Configure Clock Synchronization on PTX Series Routers | 292

Synchronous Ethernet is configured on external primary and secondary interfaces that use building-integrated timing system (BITS), SDH Equipment Timing Source (SETS) timing sources, or an equivalent quality timing source such as GPS. On the PICs, the transmit clock of the interface is synchronized to a BITS or SETS timing source and is traceable to the timing source within the network.

Clock Sources for PTC Series Packet Transport Routers

PTX Series Packet Transport Routers can use an internal clock source or it can extract clocking from an external source.

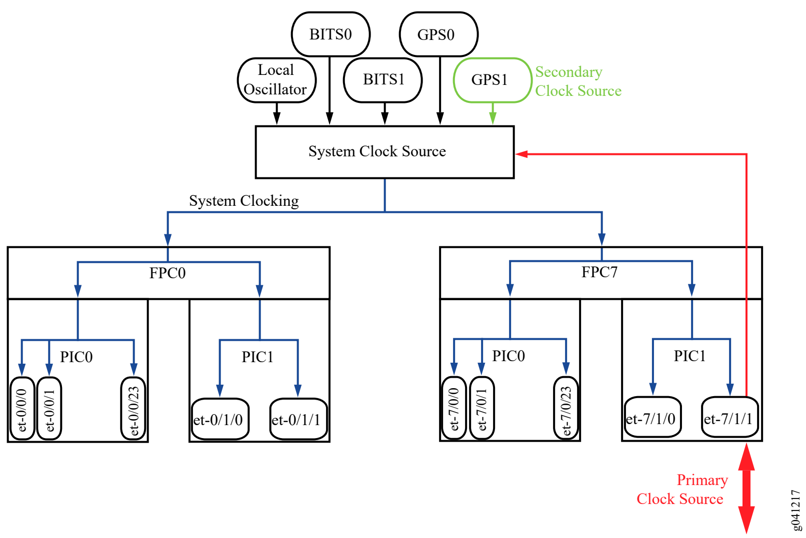
Clock sources and specifications include:

- The PTX Series Packet Transport Router clock is a Stratum 3E-compliant clock with Free Run +/- 4.6 ppm/20 years, Holdover +/- 0.01 ppm/24 hours, and Drift +/- 0.001 ppm/24 hours.

- The internal clock is based on Freerun OCXO with +/- 10 ppb accuracy.
- External clocking includes a choice of GPS-based clock recovery (5 MHz and 10 MHz) or BITS-T1/E1 Line synchronization (1.544 MHz and 2.048 MHz).
- Synchronous Ethernet is supported based on the ITU-T G.8261, ITU-T G.8262, and ITU-T G8264 specifications with line timing from the 10-Gigabit Ethernet, 40-Gigabit Ethernet, or 100-Gigabit Ethernet interface.

  Synchronous Ethernet is a key requirement for circuit (emulation) services and mobile radio access technologies. Synchronous Ethernet supports sourcing and transfer of frequency for synchronization purposes for both wireless and wireline services and is primarily used for mobile backhaul and converged transport.

Figure 4: Clocking Example for PTX Series Packet Transport Routers



In this example, the interface et-7/1/1 is configured as the primary clock source and GPS1 as the secondary clock source.

Note that you can specify the primary and secondary clock sources provided that the clock source meets the necessary qualification as set by the clock algorithm. However, in the absence of any user-selected clock source, the clock source with the best quality level is selected by the clock algorithm in the router. Note that the user selection is honored even when better quality level clock sources are available. You can select the clock source with the `request chassis synchronization switch` *`clock-source`* operational mode command.

NOTE: The clock sources used as primary or secondary clock sources cannot originate from the same FPC.

For more information about clock source ports, see PTX3000 Clocking Port Cable Specifications and Pinouts, PTX5000 Centralized Clock Generator Description, and Connecting the PTX5000 to an External Clocking Device.

Getting Started to Configure Clock Synchronization on PTX Series Routers

System clocking on PTX Series Packet Transport Routers is controlled by a Centralized Clock Generator (CCG). The CCG is capable of deriving a *primary clock* from a valid source and synchronizing all interfaces on the chassis to this primary clock.

Table 16: Locating the Information You Need to Configure Clock Synchronization on PTX Series Routers

Task You Need to Perform	Where The Information Is Located
Configure a clock source.	"Synchronize Internal Stratum 3 Clock to External Clock Sources on PTX Series Routers" on page 293 *synchronization (PTX Series)*
Identify clock sources.	"Clock Sources for PTC Series Packet Transport Routers" on page 290
Change the clock source.	*request chassis synchronization switch*
Configure the clock source mode to be revertive or non-revertive.	*switchover-mode*
Verify the clock source is operational.	*show chassis synchronization*

Synchronize Internal Stratum 3 Clock to External Clock Sources on PTX Series Routers

SUMMARY

The PTX Series Packet Transport Routers support an external synchronization interface that can be configured to synchronize the internal Stratum 3 clock to an external source, and then synchronize the chassis interface clock to that source. You can also configure a primary and a secondary clock source.

IN THIS SECTION

- Configure a Recovered Clock for an FPC | 293
- Configure External Clock Synchronization Options | 293

The following tasks explain how to configure a recovered clock for an FPC and to configure the clock synchronization options:

Configure a Recovered Clock for an FPC

To configure a recovered clock for an FPC on PTX Series routers:

1. Go to the `[edit chassis fpc slot-number pic pic-number]` hierarchy level.

```
[edit]
user@host# edit chassis fpc slot-number pic pic-number
```

2. Configure a port from 0 through 47 through which the clock is recovered.

```
[edit]
user@host# set recovered-clock port port-number
```

Configure External Clock Synchronization Options

You must configure a recovered clock (`recovered-clock port` *port-number*) for an interface before configuring clock synchronization options for the same interface.

Use the `synchronization` statement options to specify a primary and a secondary timing source. To do this, you must configure the following options:

- Specify the switching mode as `revertive` when a lower-priority synchronization source is to be switched to a valid, higher-priority synchronization source.

- Specify the primary external timing source with the `primary (fpc-slot-number | gps-0 | gps-1 | bits-a | bits-b)` statement.
- Specify the secondary external timing source with the `secondary (fpc-slot-number | gps-0 | gps-1 |bits-a | bits-b)` statement.

To configure the clock synchronization options:

1. In configuration mode, go to the `[edit chassis synchronization]` hierarchy level.

```
[edit]
user@host# edit chassis synchronization
```

2. Configure the Synchronous Ethernet clock selection mode as *auto-select* to select the best external clock source or *free-run* to use the free-running local oscillator as a clock source.

```
[edit chassis synchronization]
user@host# set clock-mode (auto-select | free-run)
```

3. Configure the ESMC transmit parameters on all the interfaces or on selected interfaces.

```
[edit chassis synchronization]
user@host# set esmc-transmit interfaces (all | interface-name)
```

4. Configure the hold interval as configuration-change, which is the wait time (from 15 seconds through 60 seconds) after a change in configuration; restart, which is the wait time (from 60 seconds through 180 seconds) after reboot of the router; and switchover, which is the switchover wait time (from 30 seconds through 60 seconds) after clock recovery.

```
[edit chassis synchronization]
user@host# set hold-interval configuration-change secs
user@host# set hold-interval restart secs
user@host# set hold-interval switchover secs
```

5. Configure the interface with an available upstream clock source where the clock source is bits-a, bits-b, gps-0, or gps-1. Configure the `pulse-per-second-enable` statement to enable the pulse per

second (PPS) signal to be received on the GPS interface and configure the frequency for the provided reference clock as 5 MHz, 10 MHz, e1, or t1.

```
[edit chassis synchronization]
user@host# set interfaces (bits-a | bits-b | gps-0 | gps-1) (pulse-per-second-enable |
signal-type (5mhz | 10mhz |e1 | t1))
```

6. Configure the maximum transmit quality level as prc, prs, sec, ssu-a, ssu-b, st2, st3e, stu, or tnc.

```
[edit chassis synchronization]
user@host# set max-transmit-quality-level (prc | prs | sec | ssu-a | ssu-b | st2 | st3e |
stu | tnc)
```

7. Configure the EEC synchronization networking type as option-1 to map to G.813 option 1 (EEC1)or option-2 to map to G.812 type IV clock (EEC1).

```
[edit chassis synchronization]
user@host# set network-option (option-1 | option-2)
```

8. Configure the primary synchronization reference source as bits-a, bits-b, gps-0, gps-1, fpc-0, fpc-1, fpc-2, fpc-3, fpc-4, fpc-5, fpc-6, or fpc-7. The selected source is considered to be the best choice among the available sources.

```
[edit chassis synchronization]
user@host# set primary (fpc-slot-number | gps-0 | gps-1 | bits-a | bits-b)
```

9. Configure the `quality-mode-enable` statement to enable Synchronous Ethernet ESMC quality mode.

```
[edit chassis synchronization]
user@host# set quality-mode-enable
```

10. Configure the secondary synchronization reference source as bits-a, bits-b, gps-0, gps-1, fpc-0, fpc-1, fpc-2, fpc-3, fpc-4, fpc-5, fpc-6, or fpc-7. The selected source is considered to be the best alternative among the available sources.

```
[edit chassis synchronization]
user@host# set secondary (fpc-slot-number | gps-0 | gps-1 | bits-a | bits-b)
```

11. Configure the quality selection mode for the incoming ESMC packets as configured-quality or received-quality.

```
[edit chassis synchronization]
user@host# set selection-mode (configured-quality | received-quality)
```

12. Configure the ESMC source as bits-a, bits-b, gps-0, or gps-1. For the configured source, configure the `priority` statement from 1 through 5; the `quality-level` statement as prc, prs, sec, ssu-a, ssu-b, st2, st3e, stu, or tnc; the `request` statement as force-switch or lockout.

```
[edit chassis synchronization]
user@host# source (bits-a | bits-b | gps-0 | gps-1) (priority number | quality-level (prc |
prs |sec | smc | ssu-a | ssu-b | st2 | st3 | st3e | st4 | stu | tnc) | request (force-
switch | lockout)
```

13. Configure the switchover mode as revertive or non-revertive.

```
[edit chassis synchronization]
user@host# set switchover-mode (non-revertive | revertive)
```

NOTE: To configure the Synchronous Ethernet clock sources, you must configure `network-option` *`option`*, `quality-mode-enable`, and `source interfaces` *`interface-name`* `priority` *`value`* `quality-level` *`level`* along with other parameters as needed at the `[edit chassis synchronization]` hierarchy level.

To configure ESMC transmit interface, you must configure `esmc-transmit interface` *`interface-name`* along with other parameters as needed at the `[edit chassis synchronization]` hierarchy level.

CHAPTER 19

Centralized Clocking

IN THIS CHAPTER

- Centralized Clocking | 297
- Example: Configure Centralized Clocking on MX2020 | 303
- Example: Configure Centralized Clocking on the Enhanced MX Switch Control Board | 317

Centralized Clocking

SUMMARY

Centralized Clocking is an internal clock synchronization approach where clocks of system are synchronized with one of clock of system.

IN THIS SECTION

- Centralized Clocking Overview | 297

Centralized Clocking Overview

IN THIS SECTION

- Stratum 3 Clock Module | 299
- BITS and GPS Support | 299
- External Clock Interface Input | 299
- External Clock Interface Output | 302
- G.703 2.048MHz Signal Type for BITS Interfaces | 302
- Redundancy | 303

The Enhanced SCB SCBE and the Enhanced SCB SCBE2 on the MX240, MX480, and MX960 routers support a Stratum 3 clock module that functions as a centralized point within the chassis for clock monitoring, filtering, holdover, and selection.

The Stratum 3 clock module produces a 19.44 MHz clock that is locked to a chassis synchronization clock source that is configured with the highest quality. The chassis clock signals are transmitted through the backplane to all the MPCs. The MPCs route the clock signals to their MICs, where the clock signals are driven out on all line interfaces thereby allowing the timing information to be distributed to the downstream routers.

You can configure external and line input synchronization sources at the `[edit chassis synchronization output]` hierarchy level, at the `[edit chassis synchronization source interfaces]` hierarchy level, and at the `[edit chassis synchronization interfaces]` hierarchy level, that become candidates to be selected by the chassis's clock selection algorithm. The clock selection algorithm selects the highest-quality candidate clock source, which is then used as the chassis's synchronization source.

The external clock interface on SCBE allows the building-integrated timing supply (*BITS*) clock source or the clock signals received from the global positioning system (GPS) receiver to act as an input clock source to the centralized timing circuit, or allows the centralized timing signals to act as an output clock source to the BITS source or to the GPS receiver.

The centralized mode is applicable to mobile backhaul infrastructures and for network transition from traditional TDM to Ethernet network elements with the support of Synchronous Ethernet.

Points to Remember

The following are the points to remember about centralized clocking:

- Before you begin configuring centralized clocking on an interface that uses Synchronous Ethernet, ensure that you have configured the interface as a chassis synchronization source to the router that provides a Synchronous Ethernet clock source.

- Before you remove the SCBE from the router, you must delete the configuration under the `[edit chassis synchronization]` hierarchy. Similarly, before you remove the SCBE2 from the router, you must delete the configuration under the `[edit chassis synchronization]` hierarchy.

- On SCBE2, the external-0/0 interface is located on **SCB0** and the external-1/0 interface is located on **SCB1**.

  When you configure the external clock interface for input, the BITS or GPS clock source—the source depends on how you configure the interface—sends the synchronized input clock signals to the centralized timing circuit in the SCBE. When you configure the external clock interface for output, the centralized timing circuit sends out the synchronized clock signal—BITS or GPS—to be transmitted to the downstream routers.

  For more information about SCBE hardware, see SCBE2-MX Description and SCBE2-MX LEDs.

The following sections explain centralized clocking and its features in detail:

> **NOTE**: Hereafter, all features that are explained for SCBE are also applicable for SCBE2 unless otherwise specified.

Stratum 3 Clock Module

SCBE has a Stratum 3 centralized clock module that takes in synchronization sources on its reference input pins. When instructed by the clock selection algorithm, the clock module selects one of the reference inputs to lock its 19.44 MHz output clock. The MPCs select the chassis clock from the active SCBE to use it as a clock for their interface transmitters, thereby allowing the downstream routers to recover and synchronize to the chassis clock. A 20 MHz oscillator provides Stratum 3 free-run and holdover quality.

The clock module does not perform any automatic switching between the reference clocks, rather when Junos OS detects the loss of signal or clock, frequency inaccuracy, or phase irregularities, the clock module runs a clock selection algorithm and switches to the next highest-quality input reference.

The Stratum 3 clock modules—on the primary and the backup SCBE—are cross-wired to eliminate any phase transients during SCBE switchover. The backup SCBE locks to the primary's Stratum 3 clock module.

BITS and GPS Support

Table 17 on page 299 maps the Junos OS Release with the feature release of BITS and GPS on SCBE and SCBE2:

Table 17: BITS and GPS Support on SCBE and SCBE2

Feature	Switch Control Board	Junos OS Release
BITS	SCBE	12.3
GPS	SCBE	13.3
BITS	SCBE2	13.3

External Clock Interface Input

BITS and GPS can be configured on the external clock interface on the SCBE.

The following sections explain external clock interface input for BITS and GPS:

External Clock Interface Input for BITS

When the BITS clock is qualified by the Stratum 3 clock module, it becomes a candidate clock source to the clock selection algorithm. BITS can simultaneously support both input and output clocking.

The external clock interface for BITS can recover:

- A framed 1.544 Mbps (T1) clock or a framed 2.048 Mbps (E1) clock. The T1/E1 framer supports sending and receiving of SSM quality levels through SA bits.
- An unframed 2048 kHz (G.703 T12) clock. You must configure an input SSM quality level when the external clock interface is configured for a signal type that does not support SSM, such as an unframed 2048 kHz (T12) clock, or a T1 superframe (T1 SF) clock.

On T1/T12 interfaces that do not support SSM, you must configure the SSM quality levels. On E1 interfaces, the Sa bits receive and transmit the SSM quality level.

MX10003 and MX204 routers support T1/E1 framed and 2.048MHz unframed clock input.

External Clock Interface Input for GPS

The GPS external clock interface supports:

- 1 MHz, 5 MHz, and 10 MHz frequencies.
- Pulse per second (PPS) signals on BNC connectors—a special cable converts signals between the BNC connector and the RJ–45 port. These signals are fed into the Stratum 3 centralized clock module for qualification and monitoring. After qualification, the GPS source becomes a valid chassis clock source candidate.
- Time of day (TOD) over a serial link. Most GPS source TOD string formats are supported by Junos OS, thereby enabling you to configure a generic TOD format string. This format tells the Routing Engine how to interpret the incoming TOD character string.

You must also configure an input SSM quality level value, where the quality level is used by the chassis clock selection algorithm when the quality level mode is enabled.

For the GPS receiver to be qualified as a clock source, the frequency and the PPS signal from it must be qualified by the SCBE Stratum 3 module. The SCBE is synchronized with the GPS source TOD.

The 10MHz frequency and PPS are supported by an RJ–45 connector for SCBE/SCBE2. Figure 5 on page 301 illustrates the actual pinout of the connector.

Figure 5: RJ–45 Connector for SCBE/SCBE2

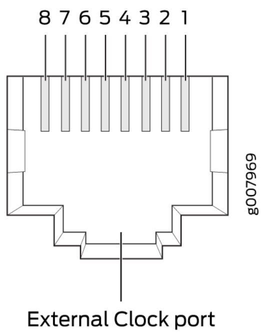


Table 18: RJ–45 Connector Pinout Information for SBE/SCBE2

Pin	Signal
1	RX
2	RX
3	1 PPS GND
4	TX
5	TX
6	10 MHz GND
7	1 PPS
8	10 MHz

Note that the GPS receiver is configured to support 10 MHz, 1 PPS, and TOD by default when it acts as a primary reference time clock.

MX10003 router supports one GPS port per SPM which can be configured with 1MHz, 5MHz, and 10MHz frequencies and 1PPS signal.

MX204 router supports GPS with 1MHz, 5MHz, and 10MHz frequencies and 1PPS signal.

External Clock Interface Output

The external clock interface can be configured to drive BITS or GPS timing output (GPS timing output for frequency and PPS signal only). The BITS or GPS output is configured to select the output clock source but in the absence of an output configuration, the BITS or the GPS output is disabled. When the external clock interface is configured for output, it selects the clock source on the basis of the configured source mode.

The external clock interface can be configured to drive BITS timing output. When the external clock interface is configured as a BITS timing output, the following scenarios occur:

- The external clock interface drives the BITS timing output.

  The chassis clock or the line clock are used as the source on the basis of the source mode configuration.

  The best—configured—line source is transmitted out the BITS interface, when the output `source-mode` statement is configured as line.

  The central clock module is set to holdover and the output is suppressed when the BITS output is configured and there are no valid clock sources available.

G.703 2.048MHz Signal Type for BITS Interfaces

The ITU-T Recommendation G.703, *Physical/electrical characteristics of hierarchical digital interfaces*, is a standard method for encoding clock and data signals into a single signal. This signal is then used to synchronize various data communications devices, such as switches, routers and multiplexers at a data rate of 2.048 MHz. Both directions of the G.703 signal must use the same signal type. To configure signal type parameters for a building-integrated timing supply (BITS) interface, include the following statements at the [`edit chassis synchronization`] hierarchy level:

```
interfaces bits {
     signal-type (2048khz | e1 | t1);
          e1-options {
               framing (g704 | g704-no-crc4);
          }
          t1-options {
               framing (esf | sf);
          }
     }
}
```

Redundancy

On SCBE, the primary and the secondary SCBs monitor their respective clock sources, and the external clock interface source is accessible only to its local clocking hardware. Therefore, the clock signals cannot be routed between the primary and the secondary SCB. Redundancy is achieved after a Routing Engine switchover. When a switchover occurs, the new primary SCB reruns the clock selection algorithm after the configured switchover time expires to select a new clock source.

On SCBE2, simultaneous BITS/BITS redundancy can be achieved because the external interfaces for BITS on the primary SCB and the secondary SCB are wired. Note that BITS redundancy is achieved without a Routing Engine switchover on SCBE2.

The following scenarios are supported for BITS/BITS redundancy:

- You can configure both the external interfaces for BITS input as reference clocks. Therefore, on the basis of the configured clock quality, one of the BITS inputs is considered as a primary clock source and the other as a secondary clock source.
- When the signal from the primary BITS input stops or degrades, the secondary BITS input takes over as primary, thereby providing redundancy across BITS interfaces.

GRES is supported on MX240, MX480, and MX960 routers with SCBE2.

Example: Configure Centralized Clocking on MX2020

SUMMARY

These examples show how to configure the following clock sources and features on an MX2020 router.

IN THIS SECTION

- Requirements | 303
- Overview | 304
- Configuration | 305
- Verification | 313

These examples show how to configure the following clock sources and features on an MX2020 router: Synchronous Ethernet, Precision Time Protocol (PTP) timeReceiver, hybrid PTP timeReceiver, and retiming through the building-integrated timing supply (BITS) external interface.

Requirements

These examples use the following hardware and software components:

- One MX2020, with MPC 16x10GE or MPC2Es (see MPCs Supported by MX Series Routers) for Synchronous Ethernet clock sources, or MPC2E-P for PTP clock sources
- One Synchronous Ethernet clock source device
- One PTP grandmaster clock device
- One BITS device (may be the same as the PTP grandmaster clock device)
- Junos OS Release 13.3 for MX2020 routers
- Junos OS Release 13.3 or later to configure a BITS interface as an input, output, or I/O clock source for MX2020 router
- Configure the MX Series interface as a chassis synchronization source to the device that provides a Synchronous Ethernet clock source.

Overview

With the addition of a Stratum 3 (ST3) clock module the MX2020 chassis can perform clock monitoring, filtering, and holdover in a centralized chassis location. Chassis line cards can be configured to recover network timing clocks at the physical layer via Synchronous Ethernet or by a packet-based PTP implementation. These recovered clocks are routed to MX2020 SCB ST3 clock module via the chassis backplane. A clock selection algorithm is run that selects the best quality recovered clock from the list of configured clock sources. The ST3 clock module locks to the selected clock source and fans it out to the chassis line cards. 16x10GE 3D and MPC2Es (see MPCs Supported by MX Series Routers) can distribute this clock to downstream network elements via Synchronous Ethernet.

The ST3 clock module acquires holdover data while locked to the selected clock source. If the clock fails, the ST3 clock module enters holdover mode and replays collected holdover data to maintain its output clock. The ST3 holdover performance depends on the drift of the MX SCB OCXO device.

In Junos 13.3, support was added for synchronizing an MX2020 chassis to a BITS timing source using any of the two BITS interfaces. The quality level is used by the chassis clock-selection algorithm. When BITS output is configured, the source-mode can be configured as either `chassis` or `line`.

The BITS external interface can be connected to a retiming device, which cleans up the clock and sends it back in the external BITS interface. The conditioned input BITS clock is selected as the chassis clock and distributed downstream via Synchronous Ethernet interfaces. The `tx-dnu-to-line-source-enable` option is used to prevent a timing loop. For instructions on how to configure retiming through the BITS external interface, see "Configure Retiming through the BITS External Interface" on page 310.

Prior to 13.3, clock monitoring, filtering, and holdover functions were distributed throughout the chassis and performed on MPC2E line cards. This distributed clocking mode limits the distribution of timing to downstream network elements on MPC2E interfaces only. Centralized clocking mode removes this limitation by supporting the distribution of timing on MPC 16x 10GE line interfaces as well.

Configuration

IN THIS SECTION

- Configure Centralized Clocking from a Synchronous Ethernet Clock Source | 305
- Configure an Ordinary PTP Clock Source | 306
- Configure Centralized Clocking from a Hybrid Mode PTP Clock Source | 307
- Configure Hybrid Mode PTP | 308
- Configure Retiming through the BITS External Interface | 310

To configure centralized clocking, perform one or more of these tasks:

Configure Centralized Clocking from a Synchronous Ethernet Clock Source

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the `[edit]` hierarchy level.

```
set chassis synchronization network-option option-2
set chassis synchronization source interfaces ge-4/1/0 priority 1
set chassis synchronization source interfaces ge-4/1/0 quality-level st3
```

Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see Using the CLI Editor in Configuration Mode in the CLI User Guide.

To configure a Synchronous Ethernet clock source:

1. Configure the network option:

```
[edit chassis synchronization]
user@host# set network-option option-2
```

2. Configure the priority and quality level of the clock source on this interface:

```
[edit chassis synchronization source interfaces ge-4/1/0]
user@host# set priority 1
user@host# set quality-level st3
```

Results

From configuration mode, confirm your configuration by entering the `show chassis synchronization` command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show chassis synchronization
network-option option-2;
source {
     interfaces ge-4/1/0 {
          priority 1;
          quality-level st3;
     }
}
```

After you configure the device, enter `commit` from configuration mode.

Configure an Ordinary PTP Clock Source

Step-by-Step Procedure

To configure a PTP clock source:

1. Configure ordinary mode PTP on the ge-4/1/9 interface to the PTP grandmaster clock device. See "Example: Configure Precision Time Protocol" on page 14.

Configure Centralized Clocking from a Hybrid Mode PTP Clock Source

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the `[edit]` hierarchy level.

```
set chassis synchronization network-option option-2
set chassis synchronization source interfaces ge-4/1/0 priority 1
set chassis synchronization source interfaces ge-4/1/0 quality-level st3
```

Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see Using the CLI Editor in Configuration Mode in the CLI User Guide.

To configure a hybrid mode PTP clock source:

1. Configure the network option:

   ```
   [edit chassis synchronization]
   user@host# set network-option option-2
   ```

2. Configure the priority and quality level of the clock source on this interface:

   ```
   [edit chassis synchronization source interfaces ge-4/1/0]
   user@host# set priority 1
   user@host# set quality-level st3
   ```

3. To configure hybrid mode PTP on the ge-4/1/9 interface to the PTP grandmaster clock device, see "Configure Hybrid Mode PTP" on page 308.

Results

From configuration mode, confirm your configuration by entering the `show chassis synchronization` command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show chassis synchronization
network-option option-2;
source {
     interfaces ge-4/1/0 {
          priority 1;
          quality-level st3;
     }
}
```

After you configure the device, enter `commit` from configuration mode.

Configure Hybrid Mode PTP

CLI Quick Configuration

To quickly configure hybrid mode on the ge-4/1/0 interface with the clock source IP address as 2.2.2.2, copy the following commands, paste them in a text file, remove any line breaks, and then copy and paste the commands into the CLI.

```
[edit]
set protocols ptp slave hybrid
set protocols ptp slave hybrid synchronous-ethernet-mapping
set protocols ptp slave hybrid synchronous-ethernet-mapping clock-source 2.2.2.2 interface
ge-4/1/0
set protocols ptp slave convert-clock-class-to-quality-level
```

Step-by-Step Procedure

To configure hybrid mode on an MX240 router with mapping of the PTP clock class perform the following steps:

1. Configure the `convert-clock-class-to-quality-level` option on the timeReceiver at the `[edit protocols ptp slave]` hierarchy level.

```
[edit protocols ptp slave]
user@host# set convert-clock-class-to-quality-level
```

2. Configure hybrid mode on the timeReceiver.

```
[edit protocols ptp slave]
user@host# edit hybrid
```

3. Configure the Synchronous Ethernet mapping option, IP address of the timeTransmitter clock as 2.2.2.2, and the interface ge-4/1/0 for hybrid mode on the timeReceiver.

```
[edit protocols ptp slave hybrid]
user@host# set synchronous-ethernet-mapping clock-source 2.2.2.2 interface ge-4/1/0
```

Results

Display the results of the configuration of hybrid mode with the mapping of the PTP clock class to the ESMC quality level:

```
[edit protocols ptp slave]
user@host# show
convert-clock-class-to-quality-level
hybrid {
    synchronous-ethernet-mapping {
        clock-source 2.2.2.2 {
        interface  ge-4/1/0;
        }
    }
}
```

Configure Retiming through the BITS External Interface

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the `[edit]` hierarchy level.

```
set chassis synchronization network-option option-2
set chassis synchronization interfaces external signal-type t1
set chassis synchronization interfaces external t1-options line-encoding b8zs
set chassis synchronization interfaces external t1-options framing sf
set chassis synchronization output interfaces external wander-filter-disable
set chassis synchronization output interfaces external holdover-mode-disable
set chassis synchronization output interfaces external source-mode line
set chassis synchronization output interfaces external tx-dnu-to-line-source-enable
set chassis synchronization output interfaces external minimum-quality st3
set chassis synchronization source interfaces ge-4/0/1 quality-level st3
set chassis synchronization source interfaces external quality-level prs
```

Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see Using the CLI Editor in Configuration Mode in the CLI User Guide.

To configure retiming through the BITS external interface using an SSU:

1. Configure the network option (G.812 type IV clock):

   ```
   [edit chassis synchronization]
   user@host# set network-option option-2
   ```

2. Configure the external BITS signal type (T1-coded 1.544-MHz signal on 100-ohm balanced line):

   ```
   [edit chassis synchronization interfaces external]
   set signal-type t1
   ```

3. Configure the external BITS signal line-encoding (B8ZS) and framing (superframe) options:

```
[edit chassis synchronization interfaces external]
user@host# set t1-options line-encoding b8zs
user@host# set t1-options framing sf
```

4. Configure the output external BITS signal properties:

   - Disable wander filtering:

   ```
   [edit chassis synchronization output interfaces external]
   user@host# set wander-filter-disable
   ```

   - Disable holdover:

   ```
   [edit chassis synchronization output interfaces external]
   user@host# set holdover-mode-disable
   ```

   - Select the best line clock source for output:

   ```
   [edit chassis synchronization output interfaces external]
   user@host# set source-mode line
   ```

   - Set Tx QL to DNU/DUS on the line source interface to prevent a timing loop:

   ```
   [edit chassis synchronization output interfaces external]
   user@host# set tx-dnu-to-line-source-enable
   ```

   - Set minimum quality level:

   ```
   [edit chassis synchronization output interfaces external]
   user@host# set minimum-quality st3
   ```

5. Configure the incoming clock source and quality level:

```
[edit chassis synchronization source interfaces ge-4/0/1]
user@host# set quality-level st3
```

6. Configure the external clock source and quality level:

```
[edit chassis synchronization source interfaces external]
user@host# set quality-level prs
```

Results

From configuration mode, confirm your configuration by entering the `show chassis synchronization` command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show chassis synchronization
network-option option-2;
interfaces external {
    signal-type t1;
    t1-options {
        line-encoding b8zs;
        framing sf;
    }
}
output {
    interfaces external {
        wander-filter-disable;
        holdover-mode-disable;
        source-mode line;
        tx-dnu-to-line-source-enable;
        minimum-quality st3;
    }
}
source {
    interfaces ge-4/0/1 {
        quality-level st3;
    }
    interfaces external {
```

```
        quality-level prs;
    }
}
```

After you configure the device, enter `commit` from configuration mode.

Verification

IN THIS SECTION

- Verify the Synchronous Ethernet Clock Source | **313**
- Verify the Ordinary PTP Clock Source | **314**
- Verify the Hybrid PTP Clock Source | **315**
- Verify the Retiming through the BITS External Interface | **316**

Confirm that the configuration is working properly.

Verify the Synchronous Ethernet Clock Source

Purpose

Verify that the MX Series router recovers, selects, qualifies, and locks to the configured Synchronous Ethernet clock source.

Action

From operational mode, enter the `show chassis synchronization clock-module` command.

```
user@host> show chassis synchronization clock-module

Clock module on SCB0
  Current role     : master
  Current state    : locked to ge-4/1/0
    State for      : 0 days, 00 hrs, 00 mins, 15 secs
    State since    : Mon Jun  6 07:28:47 2011
  Monitored clock sources
```

```
    Interface      Type         Status
    ge-4/1/0       syncE        qualified-selected
```

Meaning

The Monitored clock sources field shows that the ge-4/1/0 interface has the Synchronous Ethernet type and is the qualified and selected centralized clock source.

Verify the Ordinary PTP Clock Source

Purpose

Verify that the MX Series router recovers, selects, qualifies, and locks to the configured PTP clock source.

Action

From operational mode, enter the `show chassis synchronization clock-module` command.

```
user@host> show chassis synchronization clock-module

Clock module on SCB0
  Current role     : master
  Current state    : locked to ge-4/1/9
    State for      : 0 days, 00 hrs, 00 mins, 45 secs
    State since    : Wed Jun 29 10:52:05 2011
  Monitored clock sources
    Interface      Type         Status
    ge-4/1/9       ptp          qualified-selected
```

Meaning

The Monitored clock sources field shows that the ge-4/1/9 interface has the ptp type and is the qualified and selected centralized clock source.

Verify the Hybrid PTP Clock Source

Purpose

Verify that the MX Series router recovers, selects, qualifies, and locks to the configured hybrid PTP clock source.

Action

From operational mode, enter the `show chassis synchronization clock-module` command.

```
user@host> show chassis synchronization clock-module

Clock module on SCB0
  Current role     : master
  Current state    : locked to ge-4/1/9
    State for      : 0 days, 00 hrs, 00 mins, 15 secs
    State since    : Wed Jun 29 11:19:25 2011
  Monitored clock sources
    Interface      Type         Status
    ge-4/1/9       ptp-hybrid   qualified-selected

Configured sources:

Interface           : ge-4/1/0
Status              : Primary       Index       : 218
Clock source state  : Clk qualified Priority    : 1
Configured QL       : ST3           ESMC QL     : DUS
Clock source type   : ifd           Clock Event : Clock locked
Kernel flags        : Up,sec,
```

Meaning

The Monitored clock sources field shows that the ge-4/1/9 interface has the ptp-hybrid type and is the qualified and selected centralized clock source. The Configured sources field shows that the ge-4/1/0 interface has the Clock locked Clock Event .

Verify the Retiming through the BITS External Interface

Purpose

Verify that the MX Series router recovers, selects, qualifies, and locks to the configured clock source, and that the external clock is locked to the configured clock source.

Action

From operational mode, enter the `show chassis synchronization extensive` command.

```
user@host> show chassis synchronization extensive

Current clock status  : Locked
Clock locked to       : Primary

Configured interfaces:

Name         : external
Signal type  : t1 (sf b8zs)
Rx status    : active
Tx status    : active
LED color    : green

Configured outputs:

Interface      : external
Tx status      : active
Minimum QL     : ST3              Tx QL         : ST3
Holdover mode  : disabled         Wander filter : disabled
Source mode    : line             Source Tx DNU : enabled
Holdover data  : valid
Current state  : locked to ge-4/0/1
  State for    : 0 days, 00 hrs, 24 mins, 47 secs
  State since  : Thu Sep  6 13:01:07 2012

Configured sources:

Interface           : external
Status              : Primary       Index       : 0
Clock source state  : Clk qualified Priority    : Default(6)
Configured QL       : PRS           ESMC QL     : PRS
```

```
Clock source type   : extern        Clock Event : Clock locked
Interface State     : Up,pri,

Interface           : ge-4/0/1
Status              : Secondary     Index       : 152
Clock source state  : Clk qualified Priority    : Default(8)
Configured QL       : ST3           ESMC QL     : DUS
Clock source type   : ifd           Clock Event : Clock qualified
Interface State     : Up,sec,ESMC TX(QL DUS/SSM 0xf),
```

Meaning

The Configured interfaces field shows that the external interface receive and transmit statuses are active. The Configured outputs field shows that the current state is locked to ge-4/0/1. The Configured sources field shows that the external interface is the qualified and selected centralized clock source, and has the Clock locked Clock Event. The Configured sources field shows that the ge-4/0/1 interface is the secondary clock source, and has the Clock qualified Clock Event.

Example: Configure Centralized Clocking on the Enhanced MX Switch Control Board

SUMMARY

These examples show how to configure the following clock sources and features on an Enhanced MX Switch Control Board (SCBE).

IN THIS SECTION

- Requirements | 317
- Overview | 318
- Configuration | 319
- Verification | 326

These examples show how to configure the following clock sources and features on an Enhanced MX Switch Control Board (SCBE): Synchronous Ethernet, ordinary Precision Time Protocol (PTP) timeReceiver, hybrid PTP timeReceiver, and retiming through the building-integrated timing supply (BITS) external interface.

Requirements

These examples use the following hardware and software components:

- One MX240, MX480, or MX960 router with MPC 16x10GE or MPC2Es (see MPCs Supported by MX Series Routers) for Synchronous Ethernet clock sources, or MPC2E-P for PTP clock sources
- One Synchronous Ethernet clock source device (may be an MX240, MX480, or MX960 router)
- One PTP grandmaster clock device
- One BITS device (may be the same as the PTP grandmaster clock device)
- Junos OS Release 12.2 or later for MX240, MX480, or MX960 routers
- Junos OS Release 12.3 or later to configure a BITS interface as an input, output, or I/O clock source for MX240, MX480, or MX960 routers

Before you begin configuring centralized clocking on an interface that uses Synchronous Ethernet, ensure that you have configured the MX Series interface as a chassis synchronization source to the device that provides a Synchronous Ethernet clock source.

- Configure the MX Series interface as a chassis synchronization source to the device that provides a Synchronous Ethernet clock source.

Overview

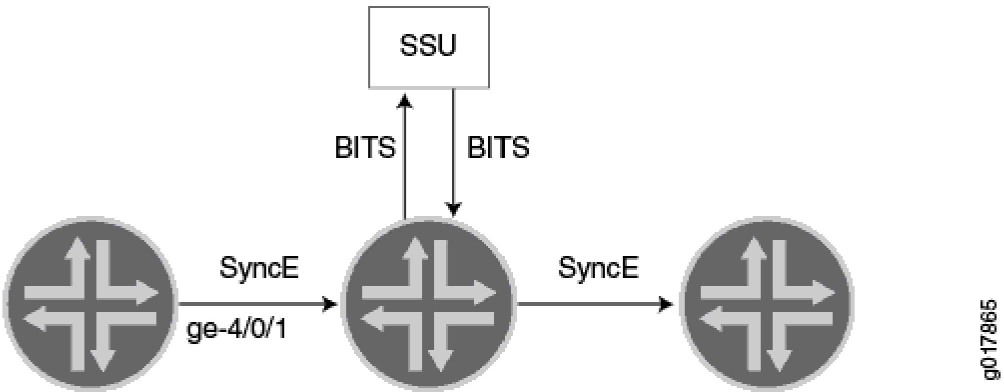
With the addition of a Stratum 3 clock module to the SCBE, an MX240, MX480, or MX960 chassis can perform clock monitoring, filtering, and holdover in a centralized chassis location. Chassis line cards can be configured to recover network timing clocks at the physical layer via Synchronous Ethernet or by a packet-based PTP implementation. These recovered clocks are routed to the SCBE Stratum 3 clock module via the chassis backplane. A clock selection algorithm is run that selects the best quality recovered clock from the list of configured clock sources. The Stratum 3 clock module locks to the selected clock source and fans it out to the chassis line cards. 16x10GE 3D and MPC2Es (see MPCs Supported by MX Series Routers) can distribute this clock to downstream network elements via Synchronous Ethernet.

The Stratum 3 clock module acquires holdover data while locked to the selected clock source. If the clock fails, the Stratum 3 clock module enters holdover mode and replays collected holdover data to maintain its output clock. The Stratum 3 holdover performance depends on the drift of the SCBE OCXO device.

In Junos 12.3, support was added for synchronizing an MX240, MX480, or MX960 chassis with an SCBE to a BITS timing source through an RJ-48 port on the SCBE. The BITS external clock interface supports the sending and receiving of Synchronization Status Message (SSM) quality levels. The quality level is used by the chassis clock-selection algorithm. When BITS output is configured, the source-mode default is the selected line clock source.

The BITS external interface can be connected to a retiming device, which cleans up the clock and sends it back in the external BITS interface. The conditioned input BITS clock is selected as the chassis clock and distributed downstream via Synchronous Ethernet interfaces. The `tx-dnu-to-line-source-enable` option is used to prevent a timing loop. Figure 6 on page 319 shows the BITS retiming functionality using a Synchronization Supply Unit (SSU). For instructions on how to configure retiming through the BITS external interface, see "Configure Retiming through the BITS External Interface" on page 323.

Figure 6: BITS Retiming with Synchronization Supply Unit (SSU)



Prior to the SCBE, clock monitoring, filtering, and holdover functions were distributed throughout the chassis and performed on MPC2E line cards. This distributed clocking mode limits the distribution of timing to downstream network elements on MPC2E interfaces only. Centralized clocking mode removes this limitation by supporting the distribution of timing on MPC 16x 10GE line interfaces as well.

Configuration

IN THIS SECTION

- Configure Centralized Clocking from a Synchronous Ethernet Clock Source | 320
- Configure Centralized Clocking from an Ordinary PTP Clock Source | 321
- Configure Centralized Clocking from a Hybrid PTP Clock Source | 321
- Configure Retiming through the BITS External Interface | 323

To configure centralized clocking, perform one or more of these tasks:

Configure Centralized Clocking from a Synchronous Ethernet Clock Source

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the `[edit]` hierarchy level.

```
set chassis synchronization network-option option-2
set chassis synchronization source interfaces ge-4/1/0 priority 1
set chassis synchronization source interfaces ge-4/1/0 quality-level st3
```

Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see Using the CLI Editor in Configuration Mode in the CLI User Guide.

To configure a Synchronous Ethernet clock source:

1. Configure the network option:

   ```
   [edit chassis synchronization]
   user@host# set network-option option-2
   ```

2. Configure the priority and quality level of the clock source on this interface:

   ```
   [edit chassis synchronization source interfaces ge-4/1/0]
   user@host# set priority 1
   user@host# set quality-level st3
   ```

Results

From configuration mode, confirm your configuration by entering the `show chassis synchronization` command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show chassis synchronization
network-option option-2;
```

```
source {
     interfaces ge-4/1/0 {
          priority 1;
          quality-level st3;
     }
}
```

After you configure the device, enter `commit` from configuration mode.

Configure Centralized Clocking from an Ordinary PTP Clock Source

Step-by-Step Procedure

To configure a PTP clock source:

1. Configure ordinary mode PTP on the ge-4/1/9 interface to the PTP grandmaster clock device. See "Example: Configure Precision Time Protocol" on page 14.

Configure Centralized Clocking from a Hybrid PTP Clock Source

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the `[edit]` hierarchy level.

```
set chassis synchronization network-option option-2
set chassis synchronization source interfaces ge-4/1/0 priority 1
set chassis synchronization source interfaces ge-4/1/0 quality-level st3
```

Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see Using the CLI Editor in Configuration Mode in the CLI User Guide.

To configure a hybrid PTP clock source:

1. Configure the network option:

```
[edit chassis synchronization]
user@host# set network-option option-2
```

2. Configure the priority and quality level of the clock source on this interface:

```
[edit chassis synchronization source interfaces ge-4/1/0]
user@host# set priority 1
user@host# set quality-level st3
```

3. Configure hybrid mode PTP on the ge-4/1/9 interface to the PTP grandmaster clock device. For the `synchronous-ethernet-mapping` interface, specify the Synchronous Ethernet interface used in Step 2.

Results

From configuration mode, confirm your configuration by entering the `show chassis synchronization` command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show chassis synchronization
network-option option-2;
source {
     interfaces ge-4/1/0 {
          priority 1;
          quality-level st3;
     }
}
```

After you configure the device, enter `commit` from configuration mode.

Configure Retiming through the BITS External Interface

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the `[edit]` hierarchy level.

```
set chassis synchronization network-option option-2
set chassis synchronization interfaces external signal-type t1
set chassis synchronization interfaces external t1-options line-encoding b8zs
set chassis synchronization interfaces external t1-options framing sf
set chassis synchronization output interfaces external wander-filter-disable
set chassis synchronization output interfaces external holdover-mode-disable
set chassis synchronization output interfaces external source-mode line
set chassis synchronization output interfaces external tx-dnu-to-line-source-enable
set chassis synchronization output interfaces external minimum-quality st3
set chassis synchronization source interfaces ge-4/0/1 quality-level st3
set chassis synchronization source interfaces external quality-level prs
```

Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see Using the CLI Editor in Configuration Mode in the CLI User Guide.

To configure retiming through the BITS external interface using an SSU:

1. Configure the network option (G.812 type IV clock):

   ```
   [edit chassis synchronization]
   user@host# set network-option option-2
   ```

2. Configure the external BITS signal type (T1-coded 1.544-MHz signal on 100-ohm balanced line):

   ```
   [edit chassis synchronization interfaces external]
   set signal-type t1
   ```

3. Configure the external BITS signal line-encoding (B8ZS) and framing (superframe) options:

```
[edit chassis synchronization interfaces external]
user@host# set t1-options line-encoding b8zs
user@host# set t1-options framing sf
```

4. Configure the output external BITS signal properties:

   - Disable wander filtering:

   ```
   [edit chassis synchronization output interfaces external]
   user@host# set wander-filter-disable
   ```

   - Disable holdover:

   ```
   [edit chassis synchronization output interfaces external]
   user@host# set holdover-mode-disable
   ```

   - Select the best line clock source for output:

   ```
   [edit chassis synchronization output interfaces external]
   user@host# set source-mode line
   ```

   - Set Tx QL to DNU/DUS on the line source interface to prevent a timing loop:

   ```
   [edit chassis synchronization output interfaces external]
   user@host# set tx-dnu-to-line-source-enable
   ```

   - Set minimum quality level:

   ```
   [edit chassis synchronization output interfaces external]
   user@host# set minimum-quality st3
   ```

5. Configure the incoming clock source and quality level:

```
[edit chassis synchronization source interfaces ge-4/0/1]
user@host# set quality-level st3
```

6. Configure the external clock source and quality level:

```
[edit chassis synchronization source interfaces external]
user@host# set quality-level prs
```

Results

From configuration mode, confirm your configuration by entering the `show chassis synchronization` command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show chassis synchronization
network-option option-2;
interfaces external {
    signal-type t1;
    t1-options {
        line-encoding b8zs;
        framing sf;
    }
}
output {
    interfaces external {
        wander-filter-disable;
        holdover-mode-disable;
        source-mode line;
        tx-dnu-to-line-source-enable;
        minimum-quality st3;
    }
}
source {
    interfaces ge-4/0/1 {
        quality-level st3;
    }
    interfaces external {
```

```
        quality-level prs;
    }
}
```

After you configure the device, enter `commit` from configuration mode.

Verification

IN THIS SECTION

- Verify the Synchronous Ethernet Clock Source | 326
- Verify the Ordinary PTP Clock Source | 327
- Verify the Hybrid PTP Clock Source | 328
- Verify the Retiming through the BITS External Interface | 329

Confirm that the configuration is working properly.

Verify the Synchronous Ethernet Clock Source

Purpose

Verify that the MX Series router recovers, selects, qualifies, and locks to the configured Synchronous Ethernet clock source.

Action

From operational mode, enter the `show chassis synchronization clock-module` command.

```
user@host> show chassis synchronization clock-module

Clock module on SCB0
  Current role      : master
  Current state     : locked to ge-4/1/0
    State for       : 0 days, 00 hrs, 00 mins, 15 secs
    State since     : Mon Jun  6 07:28:47 2011
  Monitored clock sources
```

```
    Interface       Type         Status
    ge-4/1/0        syncE        qualified-selected
```

Meaning

The Monitored clock sources field shows that the ge-4/1/0 interface has the Synchronous Ethernet type and is the qualified and selected centralized clock source.

Verify the Ordinary PTP Clock Source

Purpose

Verify that the MX Series router recovers, selects, qualifies, and locks to the configured PTP clock source.

Action

From operational mode, enter the `show chassis synchronization clock-module` command.

```
user@host> show chassis synchronization clock-module

Clock module on SCB0
  Current role     : master
  Current state    : locked to ge-4/1/9
    State for      : 0 days, 00 hrs, 00 mins, 45 secs
    State since    : Wed Jun 29 10:52:05 2011
  Monitored clock sources
    Interface       Type         Status
    ge-4/1/9        ptp          qualified-selected
```

Meaning

The Monitored clock sources field shows that the ge-4/1/9 interface has the ptp type and is the qualified and selected centralized clock source.

Verify the Hybrid PTP Clock Source

Purpose

Verify that the MX Series router recovers, selects, qualifies, and locks to the configured hybrid PTP clock source.

Action

From operational mode, enter the `show chassis synchronization clock-module` command.

```
user@host> show chassis synchronization clock-module

Clock module on SCB0
  Current role     : master
  Current state    : locked to ge-4/1/9
    State for      : 0 days, 00 hrs, 00 mins, 15 secs
    State since    : Wed Jun 29 11:19:25 2011
  Monitored clock sources
    Interface      Type         Status
    ge-4/1/9       ptp-hybrid   qualified-selected

Configured sources:

Interface           : ge-4/1/0
Status              : Primary       Index       : 218
Clock source state  : Clk qualified Priority    : 1
Configured QL       : ST3           ESMC QL     : DUS
Clock source type   : ifd           Clock Event : Clock locked
Kernel flags        : Up,sec,
```

Meaning

The Monitored clock sources field shows that the ge-4/1/9 interface has the ptp-hybrid type and is the qualified and selected centralized clock source. The Configured sources field shows that the ge-4/1/0 interface has the Clock locked Clock Event .

Verify the Retiming through the BITS External Interface

Purpose

Verify that the MX Series router recovers, selects, qualifies, and locks to the configured clock source, and that the external clock is locked to the configured clock source.

Action

From operational mode, enter the `show chassis synchronization extensive` command.

```
user@host> show chassis synchronization extensive

Current clock status  : Locked
Clock locked to       : Primary

Configured interfaces:

Name         : external
Signal type  : t1 (sf b8zs)
Rx status    : active
Tx status    : active
LED color    : green

Configured outputs:

Interface      : external
Tx status      : active
Minimum QL     : ST3              Tx QL         : ST3
Holdover mode  : disabled         Wander filter : disabled
Source mode    : line             Source Tx DNU : enabled
Holdover data  : valid
Current state  : locked to ge-4/0/1
  State for    : 0 days, 00 hrs, 24 mins, 47 secs
  State since  : Thu Sep  6 13:01:07 2012

Configured sources:

Interface           : external
Status              : Primary       Index       : 0
Clock source state  : Clk qualified Priority    : Default(6)
Configured QL       : PRS           ESMC QL     : PRS
```

```
Clock source type   : extern        Clock Event : Clock locked
Interface State     : Up,pri,

Interface           : ge-4/0/1
Status              : Secondary     Index       : 152
Clock source state  : Clk qualified Priority    : Default(8)
Configured QL       : ST3           ESMC QL     : DUS
Clock source type   : ifd           Clock Event : Clock qualified
Interface State     : Up,sec,ESMC TX(QL DUS/SSM 0xf),
```

Meaning

The Configured interfaces field shows that the external interface receive and transmit statuses are active. The Configured outputs field shows that the current state is locked to ge-4/0/1. The Configured sources field shows that the external interface is the qualified and selected centralized clock source, and has the Clock locked Clock Event. The Configured sources field shows that the ge-4/0/1 interface is the secondary clock source, and has the Clock qualified Clock Event.

7

PART

Hybrid Mode

Hybrid Mode Overview | 332

Hybrid Mode and ESMC Quality-Level Mapping | 337

CHAPTER 20

Hybrid Mode Overview

IN THIS CHAPTER

- Hybrid Mode | 332
- Guidelines to Configure Hybrid Mode on ACX Series Routers | 335

Hybrid Mode

IN THIS SECTION

- Hybrid Mode Overview | 332
- Hybrid Mode Support on Junos OS and Junos OS Evolved Devices | 334

Hybrid Mode Overview

The combined operation of Synchronous Ethernet and Precision Time Protocol (PTP) is also known as hybrid mode.

In hybrid mode, the synchronous Ethernet equipment clock (EEC) on the Modular Port Concentrator (MPC) derives the frequency from Synchronous Ethernet and the phase and time of day from PTP. Time synchronization includes both phase synchronization and frequency synchronization.

Synchronous Ethernet is a physical layer–based technology that functions regardless of the network load. Synchronous Ethernet supports hop-by-hop frequency transfer, where all interfaces on the trail must support Synchronous Ethernet. PTP (also known as IEEE 1588v2) synchronizes clocks between nodes in a network, thereby enabling the distribution of an accurate clock over a packet-switched network. This synchronization is achieved through packets that are transmitted and received in a session between a *timeTransmitter clock* (commonly called the timeTransmitter) and a *timeReceiver clock* (also known as the timeReceiver in PTP terminology).

NOTE: Router clocks are categorized based on the role of the router in the network. Router clocks are broadly categorized into ordinary clocks and boundary clocks. The timeTransmitter clock and the timeReceiver clock are known as ordinary clocks. The boundary clock can operate as either a timeTransmitter or a timeReceiver.

Synchronous Ethernet works on the principle of frequency synchronization, whereby the frequencies of all the clocks (intermediate timeTransmitter and timeReceiver clocks) in the network are synchronized to the frequency of the timeTransmitter clock at the starting end of the network trail. PTP works on the principle of phase synchronization and frequency synchronization—it synchronizes both frequency and phase, including time of day. Phase synchronization is achieved either by adjusting the phase of the timeReceiver clock (the router's internal clock oscillator) discontinuously by receiving clock signals from the timeTransmitter clock at irregular periods of time or by adjusting the phase-locked loop of the timeReceiver internal clock at regular intervals. The accuracy of clock synchronization depends on factors such as packet delay variation, quality of oscillator used, network asymmetry, and so on.

Synchronous Ethernet and PTP provide frequency and phase synchronization; however, accuracy in the order of nanoseconds is difficult to achieve through PTP or Synchronous Ethernet and these technologies do not support a large number of network hops. Hybrid mode resolves these issues by extending the number of network hops and also provides clock synchronization accuracy in the order of tens of nanoseconds. Hybrid mode is configured on the timeReceiver. On the timeReceiver, you can configure one or more interfaces as Synchronous Ethernet source interfaces.

Hybrid mode has an internal threshold value of 100 nanoseconds for the PTP phase difference before the PTP phase adjustment can initiate. To understand PTP phase difference and adjustment, consider a scenario involving two PTP sources—PTP1 and PTP2—and one Synchronous Ethernet source. Assume that initially the PTP1 source and the Synchronous Ethernet source are up and the PTP2 source is down. Also, assume that the router clock (timeReceiver) is synchronized to the available PTP source—PTP1—and the Synchronous Ethernet source. Suppose that after sometime the PTP1 source goes down because of technical issues—during which time the PTP2 source has come up—which, in turn, triggers the best timeTransmitter clock algorithm to run automatically, latching the router clock to the next available PTP source—that is, the PTP2 source—and the Synchronous Ethernet source. Note that a PTP phase adjustment is triggered when the phase difference between the current actual time of day (TOD) and the TOD as calculated by the algorithm as a result of the communication with the PTP2 source is at least 100 nanoseconds. Although this phase difference can occur anytime during the operation of the router in hybrid mode, this phase difference is more likely to occur only during PTP source switchover. You must always add a measurement error of 10 through 20 nanoseconds to the original internal threshold value. This error adjustment results in a phase difference threshold value of 110–120 nanoseconds.

In hybrid mode, the following `show` commands display information regarding the hybrid status configuration:

- The `show ptp status details` command displays the time and phase plane status.

- The `show chassis synchronization extensive` command displays the frequency plane status.
- The `show ptp hybrid status` command displays the hybrid (combined status of frequency and phase plane) status.
- In hybrid mode, the `show ptp hybrid status` and `show ptp lock-status` commands indicate the lock status as `Phase Aligned` in the output.

You can use the `show ptp hybrid status` operational command to find the current operating mode.

> **NOTE**: In hybrid mode, the EEC in the MPC derives frequency synchronization from Synchronous Ethernet and the phase and time of day from PTP. However, the `show chassis synchronization extensive` operational mode command output displays the lock status that is derived from the EEC located on the SCB.

Hybrid Mode Support on Junos OS and Junos OS Evolved Devices

See the following Feature Explorer links to know more about the devices that support this feature.

- Junos OS Evolved: PTP Hybrid with SyncE over LAG
- Junos OS: PTP, Synchronous Ethernet, and hybrid mode over link aggregation group (LAG)

The 10GE, 40G, and 100GE WAN ports on MX10003 and MX204 routers support the hybrid mode feature.

On the MX240, MX480, MX960, MX2008, MX2010, and MX2020 routers, the combined operation is possible only when the PTP timeReceiver and the Synchronous Ethernet source are on the same enhanced MPC and are traceable to the same primary reference clock (PRC). On MX10003, the Synchronous Ethernet source can be from any MPC for the combined operation.

Junos OS supports hybrid mode over link aggregation group (LAG). The hybrid operation over LAG is supported only when primary and secondary Synchronous Ethernet interfaces are present on the same line card.

Unified in-service software upgrade (unified ISSU) is not supported when clock synchronization is configured for hybrid mode on MX10003, MX2008, MX2010, MX2020 routers, and on the MICs and enhanced MPCs on MX240, MX480, and MX960 routers.

> **NOTE**: To switch between PTP and Synchronous Ethernet modes, you must first deactivate the configuration for the current mode and then commit the configuration.

Wait for 30 seconds and then configure the new mode and its related parameters, and then commit the configuration.

Guidelines to Configure Hybrid Mode on ACX Series Routers

SUMMARY

Read this topic to understand the guidelines to configure hybrid mode on ACX routers.

Guidelines to configure hybrid mode on ACX Series Routers are provided below:

- In a Hybrid Operation, the Frequency module derives frequency from the Synchronous Ethernet or BITS (T1/E1) clock or 10 MHz clock and Phase from the IEEE-1588v2 (PTPv2). The current deployments are all LTE-TDD based and require a phase accuracy of only 1.5us and it is expected that this performance can be achieved without requiring frequency assist.
- Frequency Plane (Synchronous Ethernet, BITS (T1/E1), 10 MHz) is not impacted by the phase or time plane. The frequency plane derives the frequency from Synchronous Ethernet, BITS (T1/E1) and 10 MHz.
- Phase/Time Plane uses the Frequency which is derived locally from the equipment (Synchronous Ethernet, BITS (T1/E1), 10 MHz). To achieve phase accuracy of less than 1.5us, both Frequency Input source and PTP sources traceable to a primary reference source (PRS) or primary reference clock (PRC). Hybrid mode is supported in a ring topology.
- You can configure the following frequency sources for hybrid node:
    - Synchronous Ethernet 1G, 10G with/without ESMC
    - BITS T1 Clock
    - BITS E1 Clock
    - 10 MHz Clock
    - T1 Interface
    - E1 Interface
- You can configure the following phase sources for hybrid node:

  - PTP IPv4 with or without unicast negotiation
  - PTPoE with or without stateful port
- By enabling the hybrid mode, the convergence time period is reduced and locking happens quickly.
- You can configure the PTP Source as phase or time source for hybrid mode.
- You can configure Layer 2 rings for PTPoE with stateful ports and Synchronous Ethernet with ESMC for Layer 2 ring topologies.
- When you enable hybrid mode, each node generates a phase error of or plus or minus 100 nanoseconds (without Phy Timestamping) or plus or minus 50 nanoseconds with Phy timestamping feature. This phenomenon requires Frequency (SyncE/BITS/10 MHz) source and PTP source must be traceable to same PRC/PRS source.
- Fully redundant and resilient ring based configurations of up to 10 nodes are supported, targeting the 1 microsecond phase requirement for a form of 4G known as Long-Term Evolution-Time Division Duplex (LTE-TDD). A single node or link failure is accommodated and all nodes are able to maintain phase accuracy to be +/- 1us accurate to a common source.
- Hybrid mode for PTP IPv4 rings is not supported.
- Dynamic switchover from Hybrid to PTP mode is not supported in ACX routers.
- BITS T1 Clock with SSM is not supported. BITS E1 Clock with SSM is not supported.
- Hybrid Mode: Time Of Day (TOD) as Phase and Frequency as SyncE/BITS/10 MHz is not supported. Simultaneous PTP IPv4 Ring and SyncE Hybrid Mode are not supported.
- Hybrid Mode with Phy Timestamping feature is not supported only on ACX500 series routers.
- Dynamic Switchover from Hybrid to the PTP Mode feature is not supported.
- When you configure hybrid mode, the following processes take place.
  - The best of the configured PTP time sources is selected by the PTP Best TimeTransmitter Clock Algoritm (BTCA).
  - The best of configured chassis synchronization sources is selected by the synchronization source selection algorithm.
  - During the boot-up process, if valid sources are configured at the `[edit chassis synchronization]` hierarchy level and chassis synchronization mode in free-running mode, valid PTP source available case, system continues to operate in hybrid mode (In this case, chassis synchronization is in free-run mode, whereas PTP is in locked mode). When both primary and secondary frequency sources fail, system still works under hybrid mode (In this case, chassis synchronization is in hybrid mode and PTP is in locked mode).

CHAPTER 21

Hybrid Mode and ESMC Quality-Level Mapping

IN THIS CHAPTER

- Configure Hybrid Mode and ESMC Quality-Level Mapping Overview | 337
- Configure Hybrid Mode with Mapping of the PTP Clock Class to the ESMC Quality-Level | 338
- Configure Hybrid Mode with a User-Defined Mapping of the PTP Clock Class to the ESMC Quality-Level | 340
- Example: Configure Hybrid Mode and ESMC Quality-Level Mapping on ACX Series Router | 343
- Example: Configure Hybrid Mode and ESMC Quality-Level Mapping on MX240 Router | 351

Configure Hybrid Mode and ESMC Quality-Level Mapping Overview

IN THIS SECTION

- Configure the Router in Hybrid Mode | 338

You can configure hybrid mode (that is, the combined operation of Synchronous Ethernet and PTP) on ACX Series routers, MX240, MX480, and MX960 Universal Routing Platforms . On the MX240, MX480, and MX960 routers, the combined operation is possible only when the PTP timeReceiver and the Synchronous Ethernet source are on the same enhanced Modular Port Concentrator (MPC) and are traceable to the same timeTransmitter. On the ACX Series routers, the combined operation is possible only when the PTP timeReceiver and the Synchronous Ethernet source are on the same device and are traceable to the same timeTransmitter. When acting as a PTP timeReceiver, the router can accept any external Synchronous Ethernet clock as reference. Note that when the selected Synchronous Ethernet reference fails, the router continues to work in PTP mode.

In hybrid mode, the synchronous Ethernet equipment clock (EEC) on the MPC derives the frequency from Synchronous Ethernet and the phase and time of day from PTP.

The hybrid mode is configured on the timeReceiver. On the timeReceiver, one or more interfaces are configured as Synchronous Ethernet source interfaces.

The Ethernet Synchronization Message Channel (ESMC) quality level value is mapped to the clock class value either by mapping the PTP clock class to the ESMC quality level or by configuring a user-defined mapping of PTP clock class to ESMC quality level. The following procedures explain configuring hybrid mode with either of the modes in detail.

Configure the Router in Hybrid Mode

To configure the router in hybrid mode, you must:

1. Configure Synchronous Ethernet options at the `[edit chassis synchronization]` hierarchy level:
   - Configure the `auto-select` mode of operation. You can select the clock source either from a free-run local oscillator or from an external qualified clock.

     When the router is configured with the `auto-select` option, the router chooses up to two best upstream clock sources. It then uses the clock recovered from one of the sources to lock the chassis clock. If an upstream clock with acceptable quality is not available or if the router is configured in free-run mode, the router uses the internal oscillator.
   - Configure the `esmc-transmit` and `network-option` options at the `[edit chassis synchronization` hierarchy level.
   - Configure one or more interfaces at the `[edit chassis synchronization]` hierarchy level as Synchronous Ethernet sources as needed.
2. Configure PTP options at the `[edit protocols ptp]` hierarchy level.
3. Configure hybrid mode options at the `[edit protocols ptp slave]` hierarchy level.

Configure Hybrid Mode with Mapping of the PTP Clock Class to the ESMC Quality-Level

SUMMARY

Read this topic to configure hybrid mode with mapping the PTP clock class to ESMC quality level.

To configure hybrid mode options with mapping of the PTP clock class to the ESMC quality level, perform the following steps:

1. In configuration mode, go to the `[edit protocols ptp slave]` hierarchy level:

```
[edit]
user@host# edit protocols ptp slave
```

2. Configure the `convert-clock-class-to-quality-level` option to set the default mapping between the ESMC SSM quality level and the PTP clock class.

```
[edit protocols ptp slave]
user@host# set convert-clock-class-to-quality-level
```

3. Configure the hybrid mode option on the timeReceiver.

```
[edit protocols ptp slave]
user@host# edit hybrid
```

4. For MX routers, perform the following steps:

   a. Configure the Synchronous Ethernet mapping option in hybrid mode.

   ```
   [edit protocols ptp slave hybrid]
   user@host# edit synchronous-ethernet-mapping
   ```

   b. Configure the IP address of the clock source.

   ```
   [edit protocols ptp slave hybrid synchronous-ethernet-mapping]
   user@host# edit clock-source ip-address
   ```

   c. Configure one or more Synchronous Ethernet source interfaces for the timeReceiver as needed.

   ```
   [edit protocols ptp slave hybrid synchronous-ethernet-mapping clock-source ip-address]
   user@host# set interface interface1-name
   user@host# set interface interface2-name
   ```

NOTE: You must first configure these interfaces at the `[edit chassis synchronization]` hierarchy level as Synchronous Ethernet sources. For information about configuring these interfaces, see *synchronization (MX Series)*.

5. For ACX series routers, perform the following steps:

   a. Configure the upstream unicast PTP timeTransmitter interface and IP address of the clock source.

```
[edit protocols ptp slave]
user@host# set interface interface-name clock-source ip-address
```

   b. Configure one or more Synchronous Ethernet source interfaces for the timeReceiver as needed.

```
[edit protocols ptp slave ]
user@host# set interface interface1-name unicast-mode clock-source ip-address
user@host# set interface interface2-name unicast-mode clock-source ip-address
```

NOTE: You must first configure these interfaces at the `[edit chassis synchronization]` hierarchy level as Synchronous Ethernet sources. For information about configuring these interfaces, see *synchronization (ACX Series)*.

Configure Hybrid Mode with a User-Defined Mapping of the PTP Clock Class to the ESMC Quality-Level

SUMMARY

Read this topic to configure hybrid mode options with a user-defined mapping of the PTP clock class to ESMC quality level.

To configure hybrid mode options with a user-defined mapping of the PTP clock class to the ESMC quality level, perform the following steps:

1. In configuration mode, go to the `[edit protocols ptp slave]` hierarchy level:

```
[edit]
user@host# edit protocols ptp slave
```

2. To override the default mapping option, perform the following steps:

   a. Configure the `clock-class-to-quality-level-mapping` option with one of the quality level values. The quality level values are prc, prs, sec, smc, ssu-a, ssu-b, st2, st3, st3e, st4, stu, and tnc.

   ```
   [edit protocols ptp slave]
   user@host# edit clock-class-to-quality-level-mapping quality-level prc | prs | sec | smc |
   ssu-a | ssu-b | st2 | st3 | st3e | st4 | stu | tnc
   ```

   b. Configure the `clock-class` option for the set quality level. The clock class value ranges from 80 through 109.

   ```
   [edit protocols ptp slave clock-class-to-quality-level-mapping quality-level quality-level-
   value]
   user@host# set clock-class clock-class
   ```

NOTE: In hybrid mode, the boundary node advertises the grandmaster clock class value only after phase lock is achieved.

3. Configure the hybrid mode option on the timeReceiver.

```
[edit protocols ptp slave]
user@host# edit hybrid
```

4. For MX routers, perform the following steps:

   a. Configure the Synchronous Ethernet mapping option in hybrid mode.

   ```
   [edit protocols ptp slave hybrid]
   user@host# edit synchronous-ethernet-mapping
   ```

b. Configure the IP address of the clock source.

```
[edit protocols ptp slave hybrid synchronous-ethernet-mapping]
user@host# edit clock-source ip-address
```

c. Configure one or more Synchronous Ethernet source interfaces for the timeReceiver as needed.

```
[edit protocols ptp slave hybrid synchronous-ethernet-mapping clock-source ip-address]
user@host# set interface interface1-name
user@host# set interface interface2-name
```

> **NOTE**: You must first configure these interfaces at the `[edit chassis synchronization]` hierarchy level as Synchronous Ethernet sources. For information about configuring these interfaces, see *synchronization (MX Series)*.

5. For ACX series routers, perform the following steps:

a. Configure the upstream unicast PTP timeTransmitter interface and IP address of the clock source.

```
[edit protocols ptp slave]
user@host# set interface interface-name unicast-mode clock-source ip-address
```

b. Configure one or more Synchronous Ethernet source interfaces for the timeReceiver as needed.

```
[edit protocols ptp slave ]
user@host# set interface interface1-name unicast-mode clock-source ip-address
user@host# set interface interface2-name unicast-mode clock-source ip-address
```

> **NOTE**: You must first configure these interfaces at the `[edit chassis synchronization]` hierarchy level as Synchronous Ethernet sources. For information about configuring these interfaces, see *synchronization (ACX Series)*.

Example: Configure Hybrid Mode and ESMC Quality-Level Mapping on ACX Series Router

SUMMARY

This example shows the configuration of hybrid mode by mapping the PTP clock class to the ESMC quality level and also by configuring a user-defined mapping of the PTP clock class to the ESMC quality level on ACX Series Routers.

IN THIS SECTION

- Requirements for Hybrid Mode Configuration | 343
- Overview | 343
- Configuration | 344
- Verification | 347

Requirements for Hybrid Mode Configuration

This example uses the following hardware and software components:

- One ACX Series router
- Junos OS Release 12.2R2 or later

Overview

The combined operation of Synchronous Ethernet and Precision Time Protocol (PTP) is also known as hybrid mode. In hybrid mode, the synchronous Ethernet equipment clock (EEC) on the Modular Port Concentrator (MPC) derives the frequency from Synchronous Ethernet and the phase and time of day from PTP.

You can configure hybrid mode on ACX Series routers. On these routers, the combined operation is possible only when the PTP timeReceiver and the Synchronous Ethernet source are on the same device and are traceable to the same timeTransmitter. When acting as a PTP timeReceiver, the router can accept any external Synchronous Ethernet clock as reference. Note that when the selected Synchronous Ethernet reference fails, the router continues to work in PTP mode.

Hybrid mode is configured on the timeReceiver. On the timeReceiver, one or more interfaces are configured as Synchronous Ethernet source interfaces.

NOTE: You can set the values for each parameter according to your requirement. The values given in this example are for illustration purposes only.

The ESMC quality level value is mapped to the clock class value either by mapping the PTP clock class to the ESMC quality level or by configuring a user-defined mapping of the PTP clock class to the ESMC quality level. The following examples explain configuring hybrid mode with either of the modes in detail.

To configure the router in hybrid mode, you must:

1. Configure Synchronous Ethernet options at the `[edit chassis synchronization]` hierarchy level:

   - Configure the `auto-select` mode of operation. You can select the clock source either from a free-run local oscillator or from an external qualified clock.

     When the router is configured with the `auto-select` option, the router chooses up to two best upstream clock sources. It then uses the clock recovered from one of the sources to lock the chassis clock. If an upstream clock with acceptable quality is not available or if the router is configured in free-run mode, the router uses the internal oscillator.

   - Configure the `esmc-transmit` and `network-option` options at the `[edit chassis synchronization]` hierarchy level.

   - Configure one or more interfaces at the `[edit chassis synchronization]` hierarchy level as Synchronous Ethernet sources as needed.

2. Configure PTP options at the `[edit protocols ptp]` hierarchy level.

3. Configure hybrid mode options at the `[edit protocols ptp slave]` hierarchy level.

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see Use the CLI Editor in Configuration Mode.

Configuration

IN THIS SECTION

- Hybrid Mode with Mapping of the PTP Clock Class to the ESMC Quality-Level | 345
- Hybrid Mode with a User-Defined Mapping of the PTP Clock Class to the ESMC Quality-Level | 346

Hybrid Mode with Mapping of the PTP Clock Class to the ESMC Quality-Level

CLI Quick Configuration

To quickly configure hybrid mode on the ge-1/2/3.0 interface with the clock source IP address as 2.2.2.2, copy the following commands, paste them in a text file, remove any line breaks, and then copy and paste the commands into the CLI.

```
[edit]
set protocols ptp slave hybrid
set protocols ptp slave interface ge-1/2/3.0 unicast-mode clock-source 2.2.2.2
set protocols ptp slave convert-clock-class-to-quality-level
```

Step-by-Step Procedure

To configure hybrid mode on an ACX Series router with mapping of the PTP clock class to the ESMC quality level, perform the following steps:

1. Configure the `convert-clock-class-to-quality-level` option on the timeReceiver at the `[edit protocols ptp slave]` hierarchy level.

   ```
   [edit protocols ptp slave]
   user@host# set convert-clock-class-to-quality-level
   ```

2. Configure hybrid mode on the timeReceiver.

   ```
   [edit protocols ptp slave]
   user@host# edit hybrid
   ```

3. Configure the Synchronous Ethernet mapping option, IP address of the timeTransmitter clock as 2.2.2.2, and the interface ge-1/2/3.0 for hybrid mode on the timeReceiver.

   ```
   [edit protocols ptp slave]
   user@host# set interface ge-1/2/3.0 unicast-mode clock-source 2.2.2.2
   ```

Results

Display the results of the configuration of hybrid mode with the mapping of the PTP clock class to the ESMC quality level:

```
[edit protocols ptp slave]
user@host# show
convert-clock-class-to-quality-level
interface  ge-1/2/3.0 unicast-mode clock-source 2.2.2.2
hybrid
```

Hybrid Mode with a User-Defined Mapping of the PTP Clock Class to the ESMC Quality-Level

CLI Quick Configuration

To quickly configure hybrid mode on the interface ge-1/2/3.0, copy the following commands, paste them in a text file, remove any line breaks, and then copy and paste the commands into the CLI.

```
[edit]
set protocols ptp slave hybrid
set protocols ptp slave hybrid
set protocols ptp slave interface unicast-mode ge-1/2/3.0 clock-source 2.2.2.2
set protocols ptp slave clock-class-to-quality-level-mapping quality-level prc clock-class 80
```

Step-by-Step Procedure

To configure hybrid mode with a user-defined mapping of the PTP clock class to the ESMC quality level on an ACX Series router, perform the following steps:

1. Configure the `quality-level` option for the `clock-class-to-quality-level-mapping` statement on the timeReceiver at the `[edit protocols ptp slave]` hierarchy level and then configure the `clock-class` option for the set quality level if you want to manually override the mapping of the ESMC quality level to the clock class.

   ```
   [edit protocols ptp slave]
   user@host# set clock-class-to-quality-level-mapping quality-level prc clock-class 80
   ```

2. Configure hybrid mode on the timeReceiver.

```
[edit protocols ptp slave]
user@host# edit hybrid
```

3. Configure the IP address of the timeTransmitter clock as 2.2.2.2 , and the interface ge-1/2/3.0 for hybrid mode on the timeReceiver.

```
[edit protocols ptp slave]
user@host# set  interface ge-1/2/3.0 unicast-mode clock-source 2.2.2.2
```

Results

Display the results of the configuration of hybrid mode with a user-defined mapping of the PTP clock class to the ESMC quality level:

```
[edit protocols ptp slave]
user@host# show
clock-class-to-quality-level-mapping {
    quality-level prc {
        clock-class 80;
    }
}
interface  ge-1/2/3.0 unicast-mode clock-source 2.2.2.2
hybrid
```

Verification

IN THIS SECTION

- Verify That the Router Is Operating in Hybrid Mode | **348**
- Verify the Quality Level Change on the Transmit Side | **348**
- Verify Global Information Parameters After Mapping of the PTP Clock Class to the ESMC Quality-Level in Hybrid Mode | **349**
- Verify Global Information Parameters After Configuring User-Defined Mapping of the PTP Clock Class to the ESMC Quality-Level in Hybrid Mode | **350**

Verify That the Router Is Operating in Hybrid Mode

Purpose

Verify the current mode of operation of the timeReceiver.

Action

In operational mode, enter the `run show ptp hybrid` command to display the current configuration and current mode of operation of the timeReceiver.

In operational mode, enter the `run show ptp hybrid config` command to display the PTP source to Synchronous Ethernet interface mappings.

In operational mode, enter the `run show ptp hybrid status` command to display the current hybrid mode operational status.

Meaning

The output displays the current configuration and current mode of operation of the timeReceiver. For information about the `run show ptp hybrid` operational command, see *show ptp hybrid*.

Verify the Quality Level Change on the Transmit Side

Purpose

Verify the quality level change on the transmit side of the router.

Action

In operational mode, enter the `run show synchronous-ethernet esmc transmit detail` command to display the ESMC transmit interface details.

Meaning

The output displays the ESMC SSM quality level transmitted out of various Ethernet interfaces. For information about the `run show synchronous-ethernet esmc transmit detail` operational command, see *show synchronous-ethernet esmc transmit*.

Verify Global Information Parameters After Mapping of the PTP Clock Class to the ESMC Quality-Level in Hybrid Mode

Purpose

Verify the global information parameters after mapping of the PTP clock class to the ESMC quality level in hybrid mode by enabling the `convert-clock-class-to-quality-level` option.

Action

In operational mode, enter the `run show ptp global-information` command to display the following output:

```
user@host> run show ptp global-information
PTP Global Configuration:
Domain number          : 0
Transport Encapsulation : IPv4
Clock mode             : Ordinary
Priority Level1        : 128
Priority Level2        : 128
Unicast Negotiation    : Disabled
ESMC QL From Clock Class: Enabled
Clock Class/ESMC QL    : 84 / (QL SSU-A/SSM 0x4)
Slave Parameters:
  Sync Interval        : -
  Delay Request Interval: -6 (64 packets per second)
  Announce Interval    : -
  Announce Timeout     : 3
Master Parameters:
  Sync Interval        : -6 (64 packets per second)
  Delay Request Interval: -
  Announce Interval    : 1 (1 packet every 2 seconds)
  Clock Step           : one-step
Number of Slaves      : 1
Number of Masters     : 0
```

In operational mode, enter the `run show ptp quality-level-mapping` command to display the following output:

```
user@host> run show ptp quality-level-mapping
quality level         ptp clock class
PRC                      84
SSU-A                    92
```

```
SSU-B                   96
SEC                     104
```

Meaning

The output for `run show ptp global-information` displays the parameters set in Synchronous Ethernet mode and the parameters set for the timeTransmitter and the timeReceiver.

The output of `run show ptp quality-level-mapping` displays the default mapping of the clock class to the ESMC quality level.

Verify Global Information Parameters After Configuring User-Defined Mapping of the PTP Clock Class to the ESMC Quality-Level in Hybrid Mode

Purpose

Verify the global information parameters after configuring a user-defined mapping of the PTP clock class to the ESMC quality level in hybrid mode by disabling the `convert-clock-class-to-quality-level` option.

Action

In operational mode, enter the `run show ptp global-information` command to display the following output:

```
user@host> run show ptp global-information
PTP Global Configuration:
Domain number           : 0
Transport Encapsulation : IPv4
Clock mode              : Ordinary
Priority Level1         : 128
Priority Level2         : 128
Unicast Negotiation     : Disabled
ESMC QL From Clock Class: Disabled
Clock Class/ESMC QL     :  -
Slave Parameters:
  Sync Interval         : -
  Delay Request Interval: -6 (64 packets per second)
  Announce Interval     : -
  Announce Timeout      : 3
Master Parameters:
  Sync Interval         : -6 (64 packets per second)
  Delay Request Interval: -
```

```
Announce Interval      : 1 (1 packet every 2 seconds)
Clock Step             : one-step
```

Meaning

The output displays the parameters set in Synchronous Ethernet mode and the parameters set for the timeTransmitter and the timeReceiver.

Example: Configure Hybrid Mode and ESMC Quality-Level Mapping on MX240 Router

SUMMARY

This example shows the configuration of hybrid mode by mapping the PTP clock class to the ESMC quality level and also by configuring a user-defined mapping of the PTP clock class to the ESMC quality level on MX240 Universal Routing Platforms.

IN THIS SECTION

- Requirements for Hybrid Mode Configuration | 351
- Overview | 351
- Configuration | 353
- Verification | 356

Requirements for Hybrid Mode Configuration

This example uses the following hardware and software components:

- One MX240 router
- Junos OS Release 12.2R2 or later

Overview

The combined operation of Synchronous Ethernet and Precision Time Protocol (PTP) is also known as hybrid mode. In hybrid mode, the synchronous Ethernet equipment clock (EEC) on the Modular Port Concentrator (MPC) derives the frequency from Synchronous Ethernet and the phase and time of day from PTP.

You can configure hybrid mode on MX240, MX480, and MX960 Universal Routing Platforms and on MX80 Universal Routing Platforms with precision timing support (MX80-P) and with timing support (MX80-T). On the MX240, MX480, and MX960 routers, the combined operation is possible only when the PTP timeReceiver and the Synchronous Ethernet source are on the same enhanced MPC and are traceable to the same timeTransmitter. When acting as a PTP timeReceiver, an MX80-P or MX80-T router can accept any external Synchronous Ethernet clock as reference. Note that when the selected Synchronous Ethernet reference fails, the router continues to work in PTP mode.

Hybrid mode is configured on the timeReceiver. On the timeReceiver, one or more interfaces are configured as Synchronous Ethernet source interfaces.

> **NOTE**: You can set the values for each parameter according to your requirement. The values given in this example are for illustration purposes only.
>
> The ESMC quality level value is mapped to the clock class value either by mapping the PTP clock class to the ESMC quality level or by configuring a user-defined mapping of the PTP clock class to the ESMC quality level. The following examples explain configuring hybrid mode with either of the modes in detail.

To configure the router in hybrid mode, you must:

1. Configure Synchronous Ethernet options at the `[edit chassis synchronization]` hierarchy level:

   - Configure the `auto-select` mode of operation. You can select the clock source either from a free-run local oscillator or from an external qualified clock.

     When the router is configured with the `auto-select` option, the router chooses up to two best upstream clock sources. It then uses the clock recovered from one of the sources to lock the chassis clock. If an upstream clock with acceptable quality is not available or if the router is configured in free-run mode, the router uses the internal oscillator.

   - Configure the `esmc-transmit` and `network-option` options at the `[edit chassis synchronization]` hierarchy level.

   - Configure one or more interfaces at the `[edit chassis synchronization]` hierarchy level as Synchronous Ethernet sources as needed.

2. Configure PTP options at the `[edit protocols ptp]` hierarchy level.

3. Configure hybrid mode options at the `[edit protocols ptp slave]` hierarchy level.

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see Use the CLI Editor in Configuration Mode.

Configuration

IN THIS SECTION

- Hybrid Mode with Mapping of the PTP Clock Class to the ESMC Quality-Level | 353
- Hybrid Mode with a User-Defined Mapping of the PTP Clock Class to the ESMC Quality-Level | 354

Hybrid Mode with Mapping of the PTP Clock Class to the ESMC Quality-Level

CLI Quick Configuration

To quickly configure hybrid mode on the `ge-1/2/3.0` interface with the clock source IP address as `2.2.2.2`, copy the following commands, paste them in a text file, remove any line breaks, and then copy and paste the commands into the CLI.

```
[edit]
set protocols ptp slave hybrid
set protocols ptp slave hybrid synchronous-ethernet-mapping
set protocols ptp slave hybrid synchronous-ethernet-mapping clock-source 2.2.2.2 interface
ge-1/2/3.0
set protocols ptp slave convert-clock-class-to-quality-level
```

Step-by-Step Procedure

To configure hybrid mode on an MX240 router with mapping of the PTP clock class to the ESMC quality level, perform the following steps:

1. Configure the `convert-clock-class-to-quality-level` option on the timeReceiver at the `[edit protocols ptp slave]` hierarchy level.

   ```
   [edit protocols ptp slave]
   user@host# set convert-clock-class-to-quality-level
   ```

2. Configure hybrid mode on the timeReceiver.

```
[edit protocols ptp slave]
user@host# edit hybrid
```

3. Configure the Synchronous Ethernet mapping option, IP address of the timeTransmitter clock as 2.2.2.2, and the interface ge-1/2/3.0 for hybrid mode on the timeReceiver.

```
[edit protocols ptp slave hybrid]
user@host# set synchronous-ethernet-mapping clock-source 2.2.2.2 interface ge-1/2/3.0
```

Results

Display the results of the configuration of hybrid mode with the mapping of the PTP clock class to the ESMC quality level:

```
[edit protocols ptp slave]
user@host# show
convert-clock-class-to-quality-level
hybrid {
    synchronous-ethernet-mapping {
        clock-source 2.2.2.2 {
        interface  ge-1/2/3.0;
        }
    }
}
```

Hybrid Mode with a User-Defined Mapping of the PTP Clock Class to the ESMC Quality-Level

CLI Quick Configuration

To quickly configure hybrid mode on the interface ge-1/2/3.0, copy the following commands, paste them in a text file, remove any line breaks, and then copy and paste the commands into the CLI.

```
[edit]
set protocols ptp slave hybrid
set protocols ptp slave hybrid synchronous-ethernet-mapping
set protocols ptp slave hybrid synchronous-ethernet-mapping clock-source 2.2.2.2 interface
```

```
ge-1/2/3.0
set protocols ptp slave clock-class-to-quality-level-mapping quality-level prc clock-class 80
```

Step-by-Step Procedure

To configure hybrid mode with a user-defined mapping of the PTP clock class to the ESMC quality level on an MX240 router, perform the following steps:

1. Configure the `quality-level` option for the `clock-class-to-quality-level-mapping` statement on the timeReceiver at the `[edit protocols ptp slave]` hierarchy level and then configure the `clock-class` option for the set quality level if you want to manually override the mapping of the ESMC quality level to the clock class.

   ```
   [edit protocols ptp slave]
   user@host# set clock-class-to-quality-level-mapping quality-level prc clock-class 80
   ```

2. Configure hybrid mode on the timeReceiver.

   ```
   [edit protocols ptp slave]
   user@host# edit hybrid
   ```

3. Configure the Synchronous Ethernet mapping option, IP address of the timeTransmitter clock as 2.2.2.2 , and the interface ge-1/2/3.0 for hybrid mode on the timeReceiver.

   ```
   [edit protocols ptp slave hybrid]
   user@host# set synchronous-ethernet-mapping clock-source 2.2.2.2 interface ge-1/2/3.0
   ```

Results

Display the results of the configuration of hybrid mode with a user-defined mapping of the PTP clock class to the ESMC quality level:

```
[edit protocols ptp slave]
user@host# show
clock-class-to-quality-level-mapping {
    quality-level prc {
        clock-class 80;
    }
```

```
}
hybrid {
    synchronous-ethernet-mapping {
        clock-source 2.2.2.2 {
        interface ge-1/2/3.0;
        }
    }
}
```

Verification

IN THIS SECTION

- Verify That the Router Is Operating in Hybrid Mode | 356
- Verify the Quality Level Change on the Transmit Side | 357
- Verify Global Information Parameters After Mapping of the PTP Clock Class to the ESMC Quality-Level in Hybrid Mode | 357
- Verify Global Information Parameters After Configuring User-Defined Mapping of the PTP Clock Class to the ESMC Quality-Level in Hybrid Mode | 358

Verify That the Router Is Operating in Hybrid Mode

Purpose

Verify the current mode of operation of the timeReceiver.

Action

In operational mode, enter the `run show ptp hybrid` command to display the current configuration and current mode of operation of the timeReceiver.

In operational mode, enter the `run show ptp hybrid config` command to display the PTP source to Synchronous Ethernet interface mappings.

In operational mode, enter the `run show ptp hybrid status` command to display the current hybrid mode operational status.

Meaning

The output displays the current configuration and current mode of operation of the timeReceiver. For information about the `run show ptp hybrid` operational command, see *show ptp hybrid*.

Verify the Quality Level Change on the Transmit Side

Purpose

Verify the quality level change on the transmit side of the router.

Action

In operational mode, enter the `run show synchronous-ethernet esmc transmit detail` command to display the ESMC transmit interface details.

Meaning

The output displays the ESMC SSM quality level transmitted out of various Ethernet interfaces. For information about the `run show synchronous-ethernet esmc transmit detail` operational command, see *show synchronous-ethernet esmc transmit*.

Verify Global Information Parameters After Mapping of the PTP Clock Class to the ESMC Quality-Level in Hybrid Mode

Purpose

Verify the global information parameters after mapping of the PTP clock class to the ESMC quality level in hybrid mode by enabling the `convert-clock-class-to-quality-level` option.

Action

In operational mode, enter the `run show ptp global-information` command to display the following output:

```
user@host> run show ptp global-information
PTP Global Configuration:
Domain number            : 0
Transport Encapsulation : IPv4
Clock mode               : Ordinary
Priority Level1          : 128
Priority Level2          : 128
```

```
Unicast Negotiation     : Disabled
ESMC QL From Clock Class: Enabled
Clock Class/ESMC QL     : 84 / (QL SSU-A/SSM 0x4)
Slave Parameters:
  Sync Interval         : -
  Delay Request Interval: -6 (64 packets per second)
  Announce Interval     : -
  Announce Timeout      : 3
Master Parameters:
  Sync Interval         : -6 (64 packets per second)
  Delay Request Interval: -
  Announce Interval     : 1 (1 packet every 2 seconds)
  Clock Step            : one-step
Number of Slaves       : 1
Number of Masters      : 0
```

In operational mode, enter the `run show ptp quality-level-mapping` command to display the following output:

```
user@host> run show ptp quality-level-mapping
quality level         ptp clock class
PRC                      84
SSU-A                    92
SSU-B                    96
SEC                      104
```

Meaning

The output for `run show ptp global-information` displays the parameters set in Synchronous Ethernet mode and the parameters set for the timeTransmitter and the timeReceiver.

The output of `run show ptp quality-level-mapping` displays the default mapping of the clock class to the ESMC quality level.

Verify Global Information Parameters After Configuring User-Defined Mapping of the PTP Clock Class to the ESMC Quality-Level in Hybrid Mode

Purpose

Verify the global information parameters after configuring a user-defined mapping of the PTP clock class to the ESMC quality level in hybrid mode by disabling the `convert-clock-class-to-quality-level` option.

Action

In operational mode, enter the `run show ptp global-information` command to display the following output:

```
user@host> run show ptp global-information
PTP Global Configuration:
Domain number            : 0
Transport Encapsulation : IPv4
Clock mode               : Ordinary
Priority Level1          : 128
Priority Level2          : 128
Unicast Negotiation      : Disabled
ESMC QL From Clock Class: Disabled
Clock Class/ESMC QL      :  -
Slave Parameters:
  Sync Interval          : -
  Delay Request Interval: -6 (64 packets per second)
  Announce Interval      : -
  Announce Timeout       : 3
Master Parameters:
  Sync Interval          : -6 (64 packets per second)
  Delay Request Interval: -
  Announce Interval      : 1 (1 packet every 2 seconds)
  Clock Step             : one-step
```

Meaning

The output displays the parameters set in Synchronous Ethernet mode and the parameters set for the timeTransmitter and the timeReceiver.

8

PART

Configuration Statements and Operational Commands

Junos CLI Reference Overview | 361

Junos CLI Reference Overview

We've consolidated all Junos CLI commands and configuration statements in one place. Learn about the syntax and options that make up the statements and commands and understand the contexts in which you'll use these CLI elements in your network configurations and operations.

- Junos CLI Reference

Click the links to access Junos OS and Junos OS Evolved configuration statement and command summary topics.

- Configuration Statements
- Operational Commands

9

PART

Appendix

Appendix - Inclusive Terms | 363

Appendix - Inclusive Terms

IN THIS SECTION

- Inclusive Terms in the Guide | 363

Inclusive Terms in the Guide

As of March 2023, IEEE 1588 has adopted the inclusive terms "timeTransmitter" to replace "master clock" and “timeReceiver” in the place of “slave clock.” Juniper documentation uses these new terms except in cases where specific CLI statements are referenced.

RELATED DOCUMENTATION

https://standards.ieee.org/ieee/1588g/10478/