



## Synchronous Ethernet ESMC and SSM

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

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

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

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

The router supports QL-enabled mode.

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## Frequency Synchronization Timing Concepts

The Cisco IOS XR frequency synchronization infrastructure is used to select between different frequency sources to set the router backplane frequency and time-of-day. There are two important concepts that must be understood with respect to the frequency synchronization implementation.

### Sources

A source is a piece of hardware that inputs frequency signals into the system or transmits them out of the system. There are four types of sources:

- Line interfaces. This includes SyncE interfaces.

- Clock interfaces. These are external connectors for connecting other timing signals, such as, GPS, BITS.
- PTP clock. If IEEE 1588 version 2 is configured on the router, a PTP clock may be available to frequency synchronization as a source of the time-of-day and frequency.
- Internal oscillator. This is a free-running internal oscillator chip.

Each timing source has a Quality Level (QL) associated with it which gives the accuracy of the clock. This QL information is transmitted across the network via SSMs over the Ethernet Synchronization Messaging Channel (ESMC) or SSMs contained in the SONET/SDH frames so that devices know the best available source to synchronize to. In order to define a preferred network synchronization flow, and to help prevent timing loops, you can assign priority values to particular timing sources on each router. The combination of QL information and user-assigned priority levels allows each router to choose a timing source to use to clock its SyncE and SONET/SDH interfaces, as described in the ITU standard G.781.

## Selection Points

A selection point is any point where a choice is made between several frequency signals, and possibly one or more of them are selected. Selection points form a graph representing the flow of timing signals between the different cards in a router running Cisco IOS XR software. For example, one or multiple selection points select between the different Synchronous Ethernet inputs available on a single line card, and the result of these selection points is forwarded to a selection point on the RSP to select between the selected source from each card.

The input signals to the selection points can be:

- Received directly from a source.
- The output from another selection point on the same card.
- The output from a selection point on a different card.

The output of a selection point can be used in a number of ways:

- Used to drive the signals sent out of a set of sources.
- As input into another selection point on the card.
- As input into a selection point on another card.

Use the show frequency synchronization selection command to see a detailed view of the different selection points within the system.



### Note

- We recommend you to configure, and enable Frequency Synchronization selection input on two interfaces per line card.
- For link aggregation, you must configure and enable Frequency Synchronization selection input on a single bundle member.

## Restrictions

- SyncE is not supported on Gigabit Ethernet 0/0/0/24 to 0/0/0/31 ports.
- The Precision Time Protocol (PTP) session flaps during Route Processor Failover (RPFO).

## SyncE Hardware Support Matrix



**Note** The table also contains support details of upcoming releases. You can read this table in context of the current release and see relevant *Release Notes* for more information on supported features and hardware.

This table provides a detailed information on the timing features that are supported on the following hardware variants.

Hardware Variant	Features	Cisco IOS XR Release	Comments
NCS-57C3-MOD-SYS NCS-57C3-MODS-SYS	E-SyncE	Release 7.9.1	
NC57-24DD	SyncE	Release 7.5.1	
NC57-18DD-SE	SyncE	Release 7.5.1	
NCS-57C1-48Q6-SYS	SyncE	Release 7.5.1	
	E-SyncE	Release 7.9.1	
RP:NC57-MOD-RP2-E with NCS-57C3-MOD-SYS	SyncE	Release 7.4.1	1G Fiber clock recovery is supported from IOS XR Release 7.6.1 on SFP28 ports 0-7, 40-55, and not on MPA.
RP:NC57-MOD-RP2-E with NCS-57C3-MODS-SYS	SyncE	Release 7.4.1	1G Fiber clock recovery is supported from IOS XR Release 7.6.1 on SFP28 ports 0-7, 36-51, and not on MPA.

Hardware Variant	Features	Cisco IOS XR Release	Comments
RP: NC55-RP2-E Line card: NC57-36H6D-S	SyncE	Release 7.3.2	<ul style="list-style-type: none"> <li>• Release 7.3.2 - Supports Compatible Mode only</li> <li>• Release 7.7.1 - Supports both Native and Compatible mode.</li> <li>• SyncE is not supported on 100GE interfaces, when they are used in 1G mode.</li> </ul>
NCS-57B1-5DSE-SYS	SyncE	Release 7.3.1	
NCS-57B1-6D24-SYS	E-syncE	Release 7.9.1	
RP:NC55-RP-E with Line cards: NC55-MOD-A-S and NC55-32T16Q4H-AT	SyncE	Release 7.1.1	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
RP:NC55-RP2-E with Line cards: NC55-MOD-A-S and NC55-32T16Q4H-AT	SyncE	Release 7.1.1	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
RP:NC55-RP2-E with Line card:NC55-32T16Q4H-AT	SyncE	Release 7.1.1	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
NCS-55A1-36H-SE-S	SyncE	Release 7.0.1	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
NCS-55A1-36H-S	SyncE	Release 7.0.1	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
NCS-55A1-24Q6H-S NCS-55A1-24Q6H-SS	SyncE	Release 6.6.25	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.

Hardware Variant	Features	Cisco IOS XR Release	Comments
NCS-55A1-48Q6H	SyncE	Release 6.6.25	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
NCS-55A1-24H	SyncE	Release 6.5.2	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
NCS55A2-MOD	SyncE	Release 6.5.1	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
	E-syncE	Release 7.9.1	E-SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
RP:NC55-RP-E Linecard:NC55-MOD-A-S	SyncE	Release 6.5.1	SyncE is not supported on 100GE interfaces, when they are used in 1G mode.
RP:NC55-RP-E Linecard:NC55-36X100G-A-SE	SyncE	Release 6.3.2	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
NCS5501-SE	SyncE	Release 6.3.2	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.  SyncE is supported on 10G from ports 8 to 15, but it is not supported on these ports in 1G mode.

SyncE features are supported on the following MPAs:

- NC57-MPA-12L-S
- NC55-MPA-2TH-S
- NC55-MPA-1TH2H-S
- NC55-MPA-1TH2H-HD-S
- NC55-MPA-4H-S
- NC55-MPA-4H-HD-S
- NC55-MPA-12T-S

Table 1: Timing Features Supported on MPAs

Hardware Variant	Features	Cisco IOS XR Release	Comments
NC57-MPA-12L-S	SyncE SyncE clock recovery	Release 7.6.1	Route Processors: <ul style="list-style-type: none"> <li>• RP-E: Class B</li> <li>• RP2-E Enhanced: Class C</li> </ul>

## Configuring Frequency Synchronization

### Enabling Frequency Synchronization on the Router

This task describes the router-level configuration required to enable frequency synchronization.

```
RP/0/RP0/CPU0:Router# configure
RP/0/RP0/CPU0:Router (config)# frequency synchronization
RP/0/RP0/CPU0:Router (config-freqsync)# clock-interface timing-mode system
RP/0/RP0/CPU0:Router (config-freqsync)# quality itu-t option 1 generation 1
RP/0/RP0/CPU0:Router (config-freqsync)# log selection changes
RP/0/RP0/CPU0:Router (config-freqsync)# commit
```

### Configuring Frequency Synchronization on an Interface

By default, there is no frequency synchronization on line interfaces. Use this task to configure an interface to participate in frequency synchronization.

#### Before You Begin

You must enable frequency synchronization globally on the router.

```
RP/0/RP0/CPU0:R1#config terminal
RP/0/RP0/CPU0:R1 (config)#interface TenGigabitEthernet 0/0/0/0
RP/0/RP0/CPU0:R1 (config-if)#frequency synchronization
RP/0/RP0/CPU0:R1 (config-if-freqsync)#selection input
RP/0/RP0/CPU0:R1 (config-if-freqsync)#wait-to-restore 10
RP/0/RP0/CPU0:R1 (config-if-freqsync)#priority 5
RP/0/RP0/CPU0:R1 (config-if-freqsync)#quality transmit exact itu-t option 1 PRC
RP/0/RP0/CPU0:R1 (config-if-freqsync)#quality receive exact itu-t option 1 PRC
RP/0/RP0/CPU0:R1 (config-if-freqsync)#commit
or
RP/0/RP0/CPU0:router (config-freqsync)# commit
```

### Configuring Frequency Synchronization on a Clock Interface

To enable a clock interface to be used as frequency input or output, you must configure the port parameters and frequency synchronization, as described in this task.

```
RP/0/RP0/CPU0:R1#configure
RP/0/RP0/CPU0:R1 (config)# clock-interface sync 2 location 0/RP0/CPU0
RP/0/RP0/CPU0:R1 (config-clock-if) # port-parameters
```

```
RP/0/RP0/CPU0:R1(config-clk-parms)# gps-input tod-format cisco pps-input ttl
RP/0/RP0/CPU0:R1(config-clk-parms)# exit
RP/0/RP0/CPU0:R1(config-clock-if)# frequency synchronization
RP/0/RP0/CPU0:R1(config-clk-freqsync)# selection input
RP/0/RP0/CPU0:R1(config-clk-freqsync)# wait-to-restore 1
RP/0/RP0/CPU0:R1(config-clk-freqsync)# quality receive exact itu-t option 1 PRC
```

## Verifying the Frequency Synchronization Configuration

After performing the frequency synchronization configuration tasks, use this task to check for configuration errors and verify the configuration.

### 1. show frequency synchronization selection

```
RP/0/RP0/CPU0:R5# show frequency synchronization selection
Fri Apr 24 12:49:32.833 UTC
Node 0/RP1/CPU0:
=====
Selection point: T0-SEL-B (3 inputs, 1 selected)
Last programmed 3d04h ago, and selection made 3d04h ago
Next selection points
  SPA scoped      : None
  Node scoped     : CHASSIS-TOD-SEL
  Chassis scoped: LC_TX_SELECT
  Router scoped   : None
Uses frequency selection
Used for local line interface output
S  Input                               Last Selection Point           QL  Pri  Status
== =====
4  HundredGigE0/7/0/0                  0/RP1/CPU0 ETH_RXMUX 4         PRC  10  Locked
   PTP [0/RP1/CPU0]                    n/a                             PRC  254 Available
   Internal0 [0/RP1/CPU0]              n/a                             SEC  255 Available

Selection point: 1588-SEL (2 inputs, 1 selected)
Last programmed 3d04h ago, and selection made 3d04h ago
Next selection points
  SPA scoped      : None
  Node scoped     : None
  Chassis scoped: None
  Router scoped   : None
Uses frequency selection
S  Input                               Last Selection Point           QL  Pri  Status
== =====
4  HundredGigE0/7/0/0                  0/RP1/CPU0 ETH_RXMUX 4         PRC  10  Locked
   Internal0 [0/RP1/CPU0]              n/a                             SEC  255 Available

Selection point: CHASSIS-TOD-SEL (2 inputs, 1 selected)
Last programmed 3d04h ago, and selection made 3d04h ago
Next selection points
  SPA scoped      : None
  Node scoped     : None
  Chassis scoped: None
  Router scoped   : None
Uses time-of-day selection
S  Input                               Last Selection Point           Pri  Time  Status
== =====
1  PTP [0/RP1/CPU0]                    n/a                             100  Yes   Available
   HundredGigE0/7/0/0                  0/RP1/CPU0 T0-SEL-B 4         100  No    Available

Selection point: ETH_RXMUX (1 inputs, 1 selected)
Last programmed 3d04h ago, and selection made 3d04h ago
```

```

Next selection points
  SPA scoped      : None
  Node scoped     : T0-SEL-B 1588-SEL
  Chassis scoped  : None
  Router scoped   : None
Uses frequency selection
S  Input                Last Selection Point          QL  Pri  Status
== =====
4  HundredGigE0/7/0/0  n/a                               PRC  10  Available

```

## 2. show frequency synchronization configuration-errors

```

RP/0/RP0/CPU0:router# show frequency synchronization configuration-errors
Node 0/2/CPU0:
=====
  interface GigabitEthernet0/2/0/0 frequency synchronization
    * Frequency synchronization is enabled on this interface, but isn't enabled globally.
interface GigabitEthernet0/2/0/0 frequency synchronization quality transmit exact itu-t
  option 2 generation 1 PRS
    * The QL that is configured is from a different QL option set than is configured
  globally.

```

Displays any errors that are caused by inconsistencies between shared-plane (global) and local-plane (interface) configurations. There are two possible errors that can be displayed:

- Frequency Synchronization is configured on an interface (line interface or clock-interface), but is not configured globally.
- The QL option configured on some interface does not match the global QL option. Under an interface (line interface or clock interface), the QL option is specified using the quality transmit and quality receive commands. The value specified must match the value configured in the global quality itu-t option command, or match the default (option 1) if the global quality itu-t option command is not configured.

Once all the errors have been resolved, meaning there is no output from the command, continue to the next step.

## 3. show frequency synchronization interfaces brief

```

RP/0/RP0/CPU0:R5# show frequency synchronization interfaces brief
Flags: > - Up
      d - SSM Disabled
      s - Output squelched
Fl  Interface
D - Down          S - Assigned for selection
x - Peer timed out  i - Init state
Last Selection Point
Pri Time
Status
=====
>S  TenGigE0/0/0/0      PRC  PRC    1  DNU  TenGigE0/0/0/0
>x  TenGigE0/0/0/1      Fail n/a   100 PRC  TenGigE0/0/0/0
>x  TwentyFiveGigE0/0/0/30  Fail n/a  100 PRC  TenGigE0/0/0/0
RP/0/RP0/CPU0:R5#

```

Verifies the configuration. Note the following points:

- All line interface that have frequency synchronization configured are displayed.
- All clock interfaces and internal oscillators are displayed.



- Sources that have been nominated as inputs (in other words, have selection input configured) have 'S' in the Flags column; sources that have not been nominated as inputs do not have 'S' displayed.



**Note** Internal oscillators are always eligible as inputs.

- '>' or 'D' is displayed in the flags field as appropriate.

If any of these items are not true, continue to the next step.

#### 4. show processes fsyncmgr location node-id

This command verifies that the fsyncmgr process is running on the appropriate nodes.

```
RP/0/RP0/CPU0:R5# show processes fsyncmgr location 0/0/cPU0
Thu Feb 1 06:26:32.979 UTC
Job Id: 181
PID: HYPERLINK "tel:3411"3411
Process name: fsyncmgr
Executable path:
/opt/cisco/XR/packages/ncs540-iosxr-fwding-1.0.0.0-r63226I/all/bin/fsyncmgr Instance #:
1
Version ID: 00.00.0000
Respawn: ON
Respawn count: 1
Last started: Tue Jan 23 04:26:57 HYPERLINK "tel:2018"2018
Process state: Run
Package state: Normal
core: MAINMEM
Max. core: 0
Level: 100
Placement: None
startup_path:
/opt/cisco/XR/packages/ncs540-iosxr-fwding-1.0.0.0-r63226I/all/startup/fsyncmgr.startup
Ready: 2.063s
Process cpu time: 168.480 user, 129.980 kernel, 298.460 total
JID TID Stack pri state NAME rt_pri
181 HYPERLINK "tel:3411"3411 OK 20 Sleeping fsyncmgr 0
181 HYPERLINK "tel:3572"3572 OK 20 Sleeping lwm_debug_threa 0
181 HYPERLINK "tel:3573"3573 OK 20 Sleeping fsyncmgr 0
181 HYPERLINK "tel:3574"3574 OK 20 Sleeping lwm_service_thr 0
181 HYPERLINK "tel:3575"3575 OK 20 Sleeping qsm_service_thr 0
181 HYPERLINK "tel:3622"3622 OK 20 Sleeping fsyncmgr 0
181 HYPERLINK "tel:3781"3781 OK 20 Sleeping fsyncmgr 0
181 HYPERLINK "tel:3789"3789 OK 20 Sleeping fsyncmgr 0
```

## Verifying the ESMC Configuration

### show frequency synchronization interfaces

```
Router# show frequency synchronization interfaces
Interface TenGigE0/0/0/0 (up)
Assigned as input for selection
Wait-to-restore time 0 minutes
SSM Enabled
Peer Up for 2d01h, last SSM received 0.320s ago
Peer has come up 1 times and timed out 0 times
ESMC SSMs Total Information Event DNU/DUS
```

```

Sent: HYPERLINK "tel:178479"178479 HYPERLINK "tel:178477"178477 2 HYPERLINK "tel:178463"178463
0
Received: HYPERLINK "tel:178499"178499 HYPERLINK "tel:178499"178499 0
Input:
Up
Last received QL: Opt-I/PRC
Effective QL: Opt-I/PRC, Priority: 1, Time-of-day Priority 100
Supports frequency
Output:
Selected source: TenGigE0/0/0/0
Selected source QL: Opt-I/PRC
Effective QL: DNU
Next selection points: ETH_RXMUX
Interface TenGigE0/0/0/1 (up)
Wait-to-restore time 5 minutes
SSM Enabled
Peer Timed Out for 2d01h, last SSM received never
Peer has come up 0 times and timed out 1 times
ESMC SSMs Total Information Event DNU/DUS
Sent: HYPERLINK "tel:178479"178479 HYPERLINK "tel:178477"178477 2 0
Received: 0 0 0 0
Input:
Down - not assigned for selection
Supports frequency
Output:
Selected source: TenGigE0/0/0/0
Selected source QL: Opt-I/PRC
Effective QL: Opt-I/PRC
Next selection points: ETH_RXMUX
Interface TwentyFiveGigE0/0/0/30 (up)
Wait-to-restore time 5 minutes
SSM Enabled
Peer Timed Out for 01:50:24, last SSM received 01:50:30 ago
Peer has come up 1 times and timed out 1 times
ESMC SSMs Total Information Event DNU/DUS
Sent: HYPERLINK "tel:75086"75086 HYPERLINK "tel:75085"75085 1 0
Received: HYPERLINK "tel:68457"68457 HYPERLINK "tel:68455"68455 2 HYPERLINK "tel:68443"68443
Input:
Down - not assigned for selection
Supports frequency
Output:
Selected source: TenGigE0/0/0/0
Selected source QL: Opt-I/PRC
Effective QL: Opt-I/PRC
Next selection points: ETH_RXMUX

```

## Verifying Controllers Timing LEDs

```

Router# show controllers timing led status location 0/RP0/CPU0
LED Status:
BITS0: Off
BITS1: Off
Sync: Green
GNSS: Off
GPS: NA

```