Overview of the Ethernet SPAs

This chapter provides an overview of the release history, and feature and Management Information Base (MIB) support for the Fast Ethernet and Gigabit Ethernet SPAs on the Cisco 7600 series router. This chapter includes the following sections:

- Release History, page 12-1
- Supported Ethernet SPA, page 12-2
- Restrictions, page 12-19
- Supported MIBs, page 12-20
- SPA Architecture, page 12-21
- Displaying the SPA Hardware Type, page 12-21

Release History

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.1(1)S</td>
<td>Support for Time of Day (ToD) feature on a 2-Port Gigabit Synchronous Ethernet SPA was introduced.</td>
</tr>
<tr>
<td>15.0(1)S</td>
<td>• Added support for 2-Port Gigabit Synchronous Ethernet SPA.</td>
</tr>
<tr>
<td></td>
<td>• Added restriction for 2-Port Gigabit Ethernet SPA regarding copper SFP.</td>
</tr>
<tr>
<td>12.2 (33)SRD</td>
<td>• Added Support for SPA-8X1FE-TX-V2 and SPA-4X1FE-TX-V2 on SIP400</td>
</tr>
<tr>
<td>12.2(33)SRC</td>
<td>• Added SFP-GE-T Support</td>
</tr>
<tr>
<td></td>
<td>• Added SPA-1X10GE-L-V2 support to the SIP-400</td>
</tr>
<tr>
<td>12.2(33)SRB1</td>
<td>The Any Transport over MPLS over GRE (AToMoGRE) feature was introduced on the Cisco 7600 SIP-400 on the Cisco 7600 series router.</td>
</tr>
<tr>
<td></td>
<td>The Backup Interface for Flexible UNI feature was introduced on the Cisco 7600 SIP-400 for Gigabit Ethernet SPAs.</td>
</tr>
</tbody>
</table>
Supported Ethernet SPA

This section lists and describes the Ethernet SPA supported by the Cisco 7600 platform and the SIP line cards supporting these Ethernet SPAs.

2-Port Gigabit Synchronous Ethernet SPA

The 2-Port Gigabit Synchronous Ethernet SPA provides time and frequency distribution across Ethernet networks. Synchronization is not traditionally present in all-packet networks. Synchronization is cost-effective, and especially important to service providers that migrated late to packet networks, and use an external time-division multiplexing (TDM) circuit to provide timing to remote networks. These remote networks constantly require synchronization for crucial voice services.

SPA-2X1GE-SYNCE also has the ability to interface with an external SSU/BITS interface or a GPS timing interface. The 2-Port Gigabit Synchronous Ethernet SPA comprises these clock interfaces:

- BITS In
- BITS Out
- GPS In
- GPS Out

The 2-Port Gigabit Synchronous Ethernet SPA (SPA-2X1GE-SYNCE) is compatible with 2-Port GigE SPA-v2, and provides additional services such as clock frequency and time of day synchronization, using the following technologies:

- Synchronous Ethernet (SyncE)
- Ethernet Synchronization Messaging Channel (ESMC)
IEEE1588v2

There are two standard ways to deliver timing across networks:

- **Synchronized Ethernet (SyncE):** Synchronous Ethernet (SyncE) defined by the ITU-T standards such as G.8261, G.8262, G.8264, and G.781 leverages the PHY layer of Ethernet to transmit frequency to remote sites. SyncE provides a cost-effective alternative to the SONET networks. For SyncE to work, each network element along the synchronization path must support SyncE.
- **IEEE 1588-2008 (PTPv2)**

## Supported Features

The following is a list of some of the significant hardware and software features supported by the Fast Ethernet and Gigabit Ethernet SPAs on the Cisco 7600 series router:

- Autonegotiation
- Full-duplex operation
- 802.1Q VLAN termination
- Jumbo frames support (9216 bytes)
- Support for command-line interface (CLI)-controlled OIR
- 802.3x flow control
- Up to 4000 VLANs per SPA
- Up to 5000 MAC accounting entries per SPA using Fugu hardware (source MAC accounting for the ingress direction and destination MAC accounting for the egress direction)
- Per-port byte and packet counters for policy drops, oversubscription drops, CRC error drops, packet sizes, unicast, multicast, and broadcast packets
- Per-VLAN byte and packet counters for policy drops, oversubscription drops, unicast, multicast, and broadcast packets
- Per-port byte counters for good bytes and dropped bytes
- Multiprotocol Label Switching (MPLS)
- Any Transport over MPLS over GRE (AToMoGRE)
- Ethernet over Multiprotocol Label Switching (EoMPLS)
- Quality of service (QoS)
- Hot Standby Router Protocol (HSRP)
- Virtual Router Redundancy Protocol (VRRP)
- User-set speed
- Hierarchal Virtual Private LAN Service (H-VPLS) (Gigabit Ethernet SPAs only)
- Multipoint Bridging (Gigabit Ethernet SPAs only)
- Connectivity Fault Management (CFM)
- IP Subscriber Awareness over Ethernet
- Generic SPA features such as FPD, LEDs, voltage margining, environment monitoring
- ETHERLIKE-MIB
- IP QoS parity between SIP-200 and SIP-400 FE SPAs
- MAC address filtering
- Multicast feature parity between SIP-200 and SIP-400 SPAs
- IPv6 support
- Legacy protocols (IPX, CLNS)
- Address Resolution Protocol (ARP)/RARP

Additional features supported by the 2-Port Gigabit Synchronous Ethernet SPA on the Cisco 7600 series router:

- L1 clock frequency distribution - In this mode the 2-Port Gigabit Synchronous Ethernet SPA recovers the received clock, synchronizes it to a traceable source, and uses it to transmit data to the next node.
- L2/L3 timing (event, phase, and frequency) is supported through IEEE 1588v2 PTP.
- A BITS interface for an external SSU/BITS device can be used as a clock source, or to clean up accumulated wander on a system or recovered clock.
- The GPS timing interface is used for external GPS devices and can be selected as an input or output reference. The GPS timing interface supports:
  - connectivity to GPS clock
  - translation of received GPS clock to IEEE1588v2 messages
- IEEE1558V2
- In order to maintain a communication channel in synchronous network connections, ethernet relies on a channel called Ethernet Synchronization Messaging Channel (ESMC) based on IEEE 802.3 Organization Specific Slow Protocol. ESMC relays the SSM code that represents the quality level of the Ethernet Equipment Clock (EEC) in a physical layer.

**1588V2 Overview**

IEEE 1588-2008 is a protocol specification standard. It is also known as Precision Time Protocol Version 2 (PTPv2). It is a specifically designed to provide precise timing and synchronization over packet-based ethernet infrastructures.

**Timing over Packet**

Timing over packet (ToP) works as a virtual interface on Route Processor which is the address for the 2-Port Gigabit Synchronous Ethernet SPA’s PTP stack to outside world. Other PTP entities send and receive packets from the interface’s IP address.

When a packet is received on the router destined to ToP’s IP address, the router’s hardware redirects to use the 2-Port Gigabit Synchronous Ethernet SPA and not the route processor. ToP is configured with 32 bit mask. ToP does not support QOS. CoPP is supported.

**Basic Operation of 1588V2**

This section describes how the PTP works. Figure 12-1 shows the message exchange between the PTPv2 Master and Slave.
The message exchange occurs in this sequence:

- The master relays a SYNC message to the slave. The time at which this message is received is recorded by the hardware assist unit on the slave. In Figure 12-1, this is represented as t1.
- The master records the actual time the SYNC message was sent (t0) from its own hardware assist unit and relays a follow-up message containing the time stamp of the previous SYNC message to the slave.
- To calculate the network delay, the slave sends a “Delay Request” message (t2) to the master. The slave hardware assist unit records the time when the message is sent.
- Upon receiving the delay request message, the master transmits a delay response message (t3), with the time stamp of t2, back to the slave.
- The slave uses the timestamps, t0 through t3, to calculate the offset and propagation delay to correct its clock.

**1588V2 Supported Models**

These are the two 1588V2 supported PTP models:

- Service SPA Model:

  In service SPA model, packets originates and terminate on the 2-Port Gigabit Synchronous Ethernet SPA through SIP400. The service SPA model is simple, uses the existing infrastructure, and works with different encapsulations.

  The 2-Port Gigabit Synchronous Ethernet SPA receives redirected PTP packets, processes and sends the reply packets to the central switching engine. These packets are forwarded based on the IP address of the client.

  These are the restrictions for the service SPA model:
  - The time is not stamped done at the exact packet entry or exit of the system.
Supported Features

- The PTP packet does not remain constant, leading to delays called the packet delay variations (PDV).

- Direct SPA Model:
  2-Port Gigabit Synchronous Ethernet SPA is capable of accurately timestamping the packet, on the receiver and transmitter for the existing line cards on 7600. So to meet the ideal requirements of 1588v2, the PTP packets are received and transmitted on the same 2-Port Gigabit Synchronous Ethernet SPA.

  In the Direct SPA model, PTP packets are received or transmitted through the Ethernet port of the 2-Port Gigabit Synchronous Ethernet SPA. The PTP packets coming on a 2-Port Gigabit Synchronous Ethernet SPA Ethernet interface are diverted to the PTP stack on the SPA by the FPGA. The PTP stack or the algorithm then takes necessary action based on the configuration (master or slave). The reply packets are sent out of the SPA’s Ethernet ports.

  These are the restrictions for the direct SPA model:
  - Only Limited encapsulations are supported.
  - The PTP packets are received only on 2-Port Gigabit Synchronous Ethernet SPA ports.

Supported Transport Modes

These are the transport modes that 1588v2 supports:

- Unicast Mode: In unicast mode, the 1588v2 master transmits the Sync or Delay_Resp messages to the slave on the unicast IP address of the slave and the slave in turn transmits the Delay_Req to the master on the unicast IP address of the master.

- Unicast Negotiation Mode: In unicast negotiation mode, Master does not know of any slave at the outset. The slave sends a negotiation message to the Master. Unicast Negotiation mode is good for scalability purpose as one master can have multiple slaves.

- Mix-multicast model: In Mix-multicast model, the master transmits messages in a multicast packet, to the IP address 224.0.1.129 (defined by the 1588v2 standard). The slave learns the IP address of the master in this process and transmits a delay request message. The master then transmits back a delay response message to the slave in unicast mode.

To send messages in multicast mode, the master needs to explicitly specify the multicast egress interface. This enables the intermediate network to route the IP address 224.0.1.129 to the slave.

Time of Day (TOD)

2 port Gigabit synchronous Ethernet SPA provides two physical interfaces to retrieve or generate timestamp to the GPS signal.

The physical interfaces are used to retrieve Time of Day(ToD) and estimated phase are:

- 1PPS interface
- RJ45 interface

Figure 12-2 shows the Time of Day(ToD) and 1 PPS Synchronization using 1588V2:
Time of Day on the 1588V2 Master

In 1588V2 master mode, Time of Day (TOD) enables 2-port Gigabit synchronous Ethernet SPA to receive the time from the GPS receiver through RJ45 interface and synchronizes with the SPA's current time. The 1588V2 master requires 1PPS input from the GPS device to read ToD correctly.

Time of Day on the 1588V2 Slave

In 1588V2 slave mode, 2-port Gigabit synchronous Ethernet SPA recovers ToD from the 1588v2 session. TOD and 1 PPS recovered from Precision Time Protocol (PTP) is replayed on the respective interfaces.

Restrictions

From 15.1(1)S release, these restrictions are applicable for the 1588V2 feature:

- The TOD recovered from the 1588v2 session is not in sync with the system clock.
- GPS interfaces can be used only for clock recovery. System clock cannot be transmitted out on the GPS interface.
- Only TOD format supported is UBOX, CISCO, and NTP.
  To use the clock recovered form the 1588v2 session the ToP interface should be configured as the clock source.
Precision Time Protocol (PTP)

The Cisco 7600 series router supports the Precision Time Protocol (PTP) as defined by the IEEE 1588-2008 standard. PTP provides accurate time synchronization over packet-switched networks. Table 12-1 provides the description of the nodes within a PTP network.

<table>
<thead>
<tr>
<th>Network Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grandmaster</td>
<td>A network device physically attached to the primary time source. All clocks are synchronized to the grandmaster clock.</td>
</tr>
<tr>
<td>Ordinary clock</td>
<td>An ordinary clock is a 1588 clock with a single PTP port that can operate in one of the following modes:</td>
</tr>
<tr>
<td></td>
<td>• Master mode—Distributes timing information over the network to one or more slave clocks, thus allowing the slave to synchronize its clock to the master.</td>
</tr>
<tr>
<td></td>
<td>• Slave mode—Synchronizes its clock to a master clock. You can enable the slave mode on up to two interfaces simultaneously in order to connect to two different master clocks.</td>
</tr>
<tr>
<td>Boundary clock</td>
<td>The device participates in selecting the best master clock and can act as the master clock if no better clocks are detected. Boundary clock starts its own PTP session with a number of downstream slaves. The boundary clock mitigates the number of network hops and results in packet delay variations in the packet network between the Grand Master and Slave.</td>
</tr>
<tr>
<td>Transparent clock</td>
<td>A transparent clock is a device or a switch that calculates the time it requires to forward traffic and updates the PTP time correction field to account for the delay, making the device transparent in terms of time calculations.</td>
</tr>
</tbody>
</table>

PTP Redundancy

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

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

**Note**
The PTP redundancy model available on the 2-Port Gigabit Synchronous Ethernet SPA is hot standby model.

## Hot Standby Master Model

The Cisco 7600 series router selects the best clock source from the PTP master clocks, and switches dynamically between them if the clock quality of the standby clock is greater than that of the current master clock. The best master clock is selected based on the following parameters:

- Clock class
- Packet Timing Signal Fail (PTSF) announce failure status
- PTSF sync failure status
- PTSF unusable status (PDV)
- Local priority

### Advantages of Hot Standby Master Model

The advantages of a hot standby master model are:

- Fast reference switching
- Monitor the PTSF unusable or PDV for the clock stream before selecting.

### Disadvantages of Hot Standby Model

The disadvantages of hot standby model are:

- Full communication with all the PTP master ports injects more packets to the network.
- Require to monitor all the clock streams which increases CPU load on the SPA.
- Scales to only three master clocks as the clock source.

## Restrictions

The maximum number of PTP master ports for 2-Port Gigabit Synchronous Ethernet SPA is limited to three.

## Configuring PTP Redundancy

### PTP Redundancy with 2-Port Gigabit Synchronous Ethernet SPA as Master

This section provides the configuration for the PTP redundancy with 2-Port Gigabit Synchronous Ethernet SPA as master.

Complete the following steps:
SUMMARY STEPS

- Step 1: enable
- Step 2: configure terminal
- Step 3: ptp clock ordinary/boundary domain domain-no
- Step 4: clock-port word master
- Step 5: transport ipv4 unicast interface gigabitethernet/top negotiation
- Step 6: exit
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>enable</td>
<td>Enables privileged EXEC mode. Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Router# enable</td>
</tr>
<tr>
<td>2</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Router# configure terminal</td>
</tr>
<tr>
<td>3</td>
<td>ptp clock ordinary/boundary domain domain-no</td>
<td>Configures PTP ordinary or boundary clock.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Router(config)# ptp clock ordinary domain 0</td>
</tr>
<tr>
<td>4</td>
<td>clock-port word master</td>
<td>Sets the clock port to PTP master mode; the port exchanges timing packets with PTP slave devices.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Router(config-ptp-clk)# clock-port port master</td>
</tr>
<tr>
<td>5</td>
<td>transport ipv4 unicast interface gigabitethernet/top negotiation</td>
<td>Sets port transport parameters. <strong>Note</strong> PTP redundancy is supported only on the unicast negotiation mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Router(config-ptp-port)# transport ipv4 unicast interface gi 5/2/2 negotiation</td>
</tr>
<tr>
<td>6</td>
<td>exit</td>
<td>Returns the command-line interface (CLI) to privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Router(config-ptp-port)# exit</td>
</tr>
</tbody>
</table>

### Configuration Example

This is an example for configuration of PTP redundancy as a master clock:

```
Router# enable
Router# configure terminal
Router(config)# ptp clock ordinary domain 0
Router(config-ptp-clk)# clock-port port master
Router(config-ptp-port)# transport ipv4 unicast interface gi 5/2/2 negotiation
Router(config-ptp-port)# exit
```
PTP Redundancy with 2-Port Gigabit Synchronous Ethernet SPA as Slave

This section provides the configuration for the PTP redundancy with 2-Port Gigabit Synchronous Ethernet SPA as slave.

Complete the following steps:

**SUMMARY STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>Router# enable</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>ptp clock ordinary/boundary domain domain-no</td>
<td>Configures PTP to either ordinary or boundary clock.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config)# ptp clock ordinary domain 0</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>clock-port word slave</td>
<td>Sets the clock port to PTP slave mode; the port exchanges timing packets with a PTP master device.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-ptp-clk)# clock-port port slave</td>
<td></td>
</tr>
</tbody>
</table>

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Step 2 configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Step 3 ptp clock ordinary/boundary domain domain-no</td>
<td>Configures PTP to either ordinary or boundary clock.</td>
</tr>
<tr>
<td>Step 4 clock-port word slave</td>
<td>Sets the clock port to PTP slave mode; the port exchanges timing packets with a PTP master device.</td>
</tr>
</tbody>
</table>
## Supported Features

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 5**
transport ipv4 unicast
interface gigabitethernet/top
negotiation         | Sets port transport parameters. |

**Example:**
```
Router(config-pty-port)#
transport ipv4 unicast
interface gi 5/2/2
negotiation
```

| **Step 6**
clock source ip local-priority | Sets IP address of the PTP slave device. |
|-------------------------------|----------------------------------------|

**Example:**
```
Router(config-pty-port)#
clock source 8.8.8.1
```

| **Step 7**
exit | Returns the CLI to privileged EXEC mode. |
|------|----------------------------------------|

**Example:**
```
Router(config-pty-port)#
exit
```
This is an example for configuration of PTP redundancy as a slave clock:

Router# enable
Router# configure terminal
Router(config)# ptp clock ordinary domain 0
Router(config-ptp-clk)# clock-port port slave
Router(config-ptp-port)# transport ipv4 unicast interface gi 5/2/2 negotiation
Router(config-ptp-port)# clock source 8.8.8.1
Router(config-ptp-port)# clock source 9.9.9.1
Router(config-ptp-port)# clock source 10.10.10.1 2
Router(config-ptp-port)# exit

Verifying PTP Redundancy on the 2-Port Gigabit Synchronous Ethernet SPA

This section provides show commands for verifying the PTP redundancy as slave:

Router# show ptp clock running

PTP Ordinary Clock [Domain 0]

State  Ports  Pkts sent  Pkts rcvd  Redundancy Mode
ACQUIRING 1 7354 38543  Hot standby

PORT SUMMARY
PTP Master
Name  Tx Mode  Role  Transport  State  Sessions  Port Addr
SLAVE  unicast  slave  Gi3/3/0  -  1  2.2.2.1

Router# show ptp clock running domain 0

PTP Ordinary Clock [Domain 0]

State  Ports  Pkts sent  Pkts rcvd  Redundancy Mode
ACQUIRING 1 2065 11432  Hot standby

PORT SUMMARY
PTP Master
Name  Tx Mode  Role  Transport  State  Sessions  Port Addr
SLAVE  unicast  slave  Gi3/3/0  -  1  2.2.2.1

SESSION INFORMATION

SLAVE [Gi3/3/0] [Sessions 1]

Peer addr  Pkts in  Pkts out  In Errs  Out Errs
1.1.1.1 7859 1444 0 0
2.2.2.1 3573 621 0 0

Router# show ptp port running

PORT [SLAVE] CURRENT PTP MASTER PORT
Protocol Address: 2.2.2.1
Clock Identity: 0x0:6:52:FF:FF:7C:6E:C0
Local Priority: 1
PTSF Status: PTSF_UNUSABLE
Alarm In Stream:
Clock Stream Id: 0
Priority1: 128
Priority2: 128
Class: 13
Accuracy: Within 1s
Offset (log variance): 52592
Steps Removed: 0

Router# `show ptp port running detail`

PORT [SLAVE] CURRENT PTP MASTER PORT
Protocol Address: 2.2.2.1
Clock Identity: 0x0:6:52:FF:FF:7C:6E:C0

PORT [SLAVE] PREVIOUS PTP MASTER PORT

PORT [SLAVE] LIST OF PTP MASTER PORTS

LOCAL PRIORITY 0
Protocol Address: 1.1.1.1
Clock Identity: 0x0:8:7C:FF:FF:B2:3F:40
PTSF Status: PTSF_UNUSABLE
Alarm In Stream:
Clock Stream Id: 1
Priority1: 128
Priority2: 128
Class: 13
Accuracy: Within 1s
Offset (log variance): 52592
Steps Removed: 0

LOCAL PRIORITY 1
Protocol Address: 2.2.2.1
Clock Identity: 0x0:6:52:FF:FF:7C:6E:C0
PTSF Status: PTSF_UNUSABLE
Alarm In Stream:
Clock Stream Id: 0
Priority1: 128
Priority2: 128
Class: 13
Accuracy: Within 1s
Offset (log variance): 52592
Steps Removed: 0

Router# `show platform ptp all`

Slave info : [GigabitEthernet3/3/0][0x530EC0E8]
-------------
clock role : 2
Slave Port hd1 : 3690987522
Tx Mode : 2
Slave IP : 1.1.1.2
Slave State Machine : 0x55EAEE0C
Slave state : 3
Config Vector : 0x457C1174
Selected Clk src : 2.2.2.1
Max Clk Srcs : 3
Boundary Clock : FALSE
Lock status : ACQUIRING
Refcnt : 1
-------------
PTP Engine Handle : 1
Master IP : 1.1.1.1
Route to Master : GigabitEthernet3/3/0
N-H Mac address : 0008.7cb2.3f40
N-H Route Handle : 0x53C46628
N-H ARP Handle : 0x562FB3C8

Cisco 7600 Series Router SIP, SSC, and SPA Software Configuration Guide
Local Priority : 0
Set Master IP : 1.1.1.1
Set route IDB : GigabitEthernet3/3/0
Set route MAC : 0008.7cb2.3f40

PTP Engine Handle : 0
Master IP : 2.2.2.1
Route to Master : GigabitEthernet3/3/1
N-H Mac address : 0006.527c.6ec0
N-H Route Handle : 0x53C465F4
N-H ARP Handle : 0x562FB418
Local Priority : 1
Set Master IP : 2.2.2.1
Set route IDB : GigabitEthernet3/3/1
Set route MAC : 0006.527c.6ec0

PTP Engine Handle : -1
Master IP : 0.0.0.0
Route to Master : Not Set
N-H Mac address : 0000.0000.0000
N-H Route Handle : 0x0
N-H ARP Handle : 0x0
Local Priority : 0
Set Master IP : 0.0.0.0
Set route IDB : Not Set
Set route MAC : 0000.0000.0000

This section includes show command to verify the PTP redundancy as master:

Router# show ptp clock running domain 0

PTP Ordinary Clock [Domain 0]

<table>
<thead>
<tr>
<th>State</th>
<th>Ports</th>
<th>Pkts sent</th>
<th>Pkts rcvd</th>
<th>Redundancy Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>FREQ_LOCKED</td>
<td>1</td>
<td>25077</td>
<td>4798</td>
<td>Not standby</td>
</tr>
</tbody>
</table>

PORT SUMMARY

<table>
<thead>
<tr>
<th>Name</th>
<th>Tx Mode</th>
<th>Role</th>
<th>Transport</th>
<th>State</th>
<th>Sessions</th>
<th>Port Addr</th>
</tr>
</thead>
<tbody>
<tr>
<td>MASTER1</td>
<td>unicast</td>
<td>master</td>
<td>Gi1/0/0</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>

SESSION INFORMATION

<table>
<thead>
<tr>
<th>Peer addr</th>
<th>Pkts in</th>
<th>Pkts out</th>
<th>In Errs</th>
<th>Out Errs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.1.2</td>
<td>4798</td>
<td>25077</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Synchronous Ethernet

Synchronous Ethernet (SyncE) is a procedure where we use a physical layer interface to pass timing from node to node in the same way timing is passed in SONET or SDH. SyncE, defined by the ITU-T standards such as G.8261, G.8262, G.8264, and G.781, leverages the PHY layer of Ethernet to transmit frequency to remote sites. SyncE over Ethernet provides a cost-effective alternative to the networks. For SyncE to work, each network element along the synchronization path must support SyncE.
The 2-Port Gigabit Synchronous Ethernet SPA has a dedicated external interface known as BITs interface to recover clock from a Synchronization Supply Unit (SSU). The 7600 router uses this clock for SyncE. The BITs interface supports E1 (European SSUs) and T1 (American BITs) framing. Table 12-2 lists the framing modes for the BITs port on a 2-Port Gigabit Synchronous Ethernet SPA.

Table 12-2 Framing Modes for BITs Port

<table>
<thead>
<tr>
<th>BITS/SSU port support Matrix</th>
<th>Framing modes supported</th>
<th>SSM/QL support</th>
<th>Tx Port</th>
<th>Rx Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>T1 ESF</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>T1</td>
<td>T1 SF</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>E1</td>
<td>E1 CRC4</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>E1</td>
<td>E1 FAS</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>E1</td>
<td>E1 CAS</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>E1</td>
<td>E1 CAS CRC4</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>2048kHz</td>
<td>2048kHz</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

You can implement SyncE on 2-Port Gigabit Synchronous Ethernet SPA with four different configurations:

- **Clock Recovery from SyncE**: System clock is recovered from the SyncE clocking source (gigabit and ten gigabit interfaces only). The router uses this clock as the Tx clock for other SyncE interfaces or ATM/CEoP interfaces.
- **Clock Recovery from External Interface**: System clock is recovered from a BITS clocking source or a GPS interface.
- **Line to External**: The clock received from an Ethernet is forwarded to an external Synchronization Supply Unit (SSU). During a synchronization chain, the received clock may have unacceptable wander and jitter. The router recovers the clock from the SyncE interface, converts it to the format required for the BITS interface, and sends to a SSU through the BITS port. The SSU performs the cleanup and sends it back to the BITS interface. This clock is used as Tx clock for the SyncE ports.
- **System to External**: The system clock is used as Tx clock for an external interface. By default the system clock is not transmitted on an external interface.

**Squelching**

Squelching is a process in which an alarm indication signal (AIS) is sent to the Tx interfaces whenever the clock source goes down. The squelching functionality is implemented in two cases:

- **Line to external**: If the line source goes down, an AIS is transmitted on the external interface to the SSU.
- **System to external**: If the router loses all the clock sources, an AIS is transmitted on the external interface to the SSU.

Squelching is performed only on an external device such as SSU or Primary Reference Clock (PRC).
SSM and ESMC

Network Clocking uses these mechanisms to exchange the quality level of the clock between the network elements:

- **Synchronization Status Message**
- **Ethernet Synchronization Messaging Channel**

**Synchronization Status Message**

Network elements use Synchronization Status Messages (SSM) to inform the neighboring elements about the Quality Level (QL) of the clock. The non-ethernet interfaces such as optical interfaces and SONET/T1/E1 SPA framers uses SSM. The key benefits of the SSM functionality:

- Prevents timing loops.
- Provides fast recovery when a part of the network fails.
- Ensures that a node derives timing from the most reliable clock source.

**Ethernet Synchronization Messaging Channel**

In order to maintain a logical communication channel in synchronous network connections, ethernet relies on a channel called Ethernet Synchronization Messaging Channel (ESMC) based on IEEE 802.3 Organization Specific Slow Protocol standards. ESMC relays the SSM code that represents the quality level of the Ethernet Equipment Clock (EEC) in a physical layer.

The ESMC packets are received only for those ports configured as clock sources and transmitted on all the SyncE interfaces in the system. These packets are then processed by the Clock selection algorithm on RP and are used to select the best clock. The Tx frame is generated based on the QL value of the selected clock source and sent to all the enabled SyncE ports.

**Clock Selection Algorithm**

Clock selection algorithm selects the best available synchronization source from the nominated sources. The clock selection algorithm has a non-revertive behavior among clock sources with same QL value and always selects the signal with the best QL value. For clock option 1, the default is revertive and for clock option 2, the default is non-revertive.

The clock selection process works in the QL enabled and QL disabled modes. When multiple selection processes are present in a network element, all processes work in the same mode.

**QL-enabled mode**

In QL-enabled mode, the following parameters contribute to the selection process:

- Quality level
- Signal fail via QL-FAILED
- Priority
- External commands.

If no external commands are active, the algorithm selects the reference (for clock selection) with the highest quality level that does not experience a signal fail condition. If multiple inputs have the same highest quality level, the input with the highest priority is selected. For multiple inputs having the same highest priority and quality level, the existing reference is maintained (if it belongs to this group), otherwise an arbitrary reference from this group is selected.
QL-disabled mode

In QL-disabled mode, the following parameters contribute to the selection process:

- Signal failure
- Priority
- External commands

If no external commands are active, the algorithm selects the reference (for clock selection) with the highest priority that does not experience a signal fail condition. For multiple inputs having the same highest priority, the existing reference is maintained (if it belongs to this group), otherwise an arbitrary reference from this group is selected.

Hybrid mode

The SyncE feature requires that each network element along the synchronization path needs to support SyncE. Timing over Packet (ToP) enables transfer of timing over an asynchronous network. The hybrid mode uses the clock derived from 1588 (PTP) to drive the system clock. This is achieved by configuring the Timing over Packet (ToP) interface on the PTP slave as the input source.

For more information on 1588V2, please see 1588V2 Overview, page 12-4:

Note

The ToP interface does not support QL and works only in the QL-disabled mode.

For information on configuring the network clock, see Configuring Boundary Clock for 2-Port Gigabit Synchronous Ethernet SPA on Cisco 7600 SIP-400, page 13-29

Restrictions

Note

For other SIP-specific features and restrictions see also Chapter 4, “Overview of the SIPS and SSC.”

These restrictions apply to the 2-Port Gigabit Synchronous Ethernet SPA introduced in Cisco IOS release 15.0(1)S:

- Synchronous SPA features are compatible with 2-Port Gigabit Synchronous Ethernet SPA.
- The maximum theoretical bandwidth of the 2-Port Gigabit Synchronous Ethernet SPA is 2 Gbps full-duplex. The actual performance is limited by the capability of the host or jacket card.
- In a failover scenario the SPA does not perform any autoswitchover to a secondary clock source, even if the secondary reference is configured on the same SPA. If the primary clock goes down then the platform explicitly sets the secondary clock as source.
- The 2-Port Gigabit Ethernet SPA has copper ports present and therefore does not allow the copper SFP to be enabled on it. Use the `show hw-module subslot <slot/subslot> transceiver <port number> status` command to view the status of the transceiver on the card.

Starting from the 12.2(33)SRD release SPA-8X1FE-TX-V2 and SPA-4X1FE-TX-V2 are supported on SIP-400

The following restrictions apply to Cisco IOS Release 12.2(18)SXF:

- EtherChannel is not supported on Fast Ethernet SPAs or the 2-Port Gigabit Ethernet SPA on the Cisco 7600 SIP-400.
Supported MIBs

The following MIBs are supported by the Fast Ethernet and Gigabit Ethernet SPAs on the Cisco 7600 series router:

- ENTITY-MIB (RFC 2737)
- CISCO-ENTITY-ASSET-MIB
- CISCO-ENTITY-FRU-CONTROL-MIB
- CISCO-ENTITY-ALARM-MIB
- CISCO-ENTITY-SENSOR-MIB
- IF-MIB
- ETHERLIKE-MIB (RFC 2665)
- Remote Monitoring (RMON)-MIB (RFC 1757)
- CISCO-CLASS-BASED-QOS-MIB
- MPLS-related MIBs
- Ethernet MIB/RMON

To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL:

http://tools.cisco.com/ITDIT/MIBS/servlet/index

If Cisco MIB Locator does not support the MIB information that you need, you can also obtain a list of supported MIBs and download MIBs from the Cisco MIBs page at the following URL:


To access Cisco MIB Locator, you must have an account on Cisco.com. If you have forgotten or lost your account information, send a blank e-mail to cco-locksmith@cisco.com. An automatic check will verify that your e-mail address is registered with Cisco.com. If the check is successful, account details with a new random password will be e-mailed to you.
SPA Architecture

This section provides an overview of the architecture of the Fast Ethernet and Gigabit Ethernet SPAs and describes the path of a packet in the ingress and egress directions. Some of these areas of the architecture are referenced in the SPA software and can be helpful to understand when troubleshooting or interpreting some of the SPA CLI and `show` command output.

Every incoming and outgoing packet on the Fast Ethernet SPAs goes through the physical port (PHY RJ45), the Media Access Controller (MAC), and a Layer 2 Filtering/Accounting ASIC. Every incoming and outgoing packet on the Gigabit Ethernet SPAs goes through the physical (PHY) SFP optics, the Media Access Controller (MAC), and a Layer 2 Filtering/Accounting ASIC.

Path of a Packet in the Ingress Direction

The following steps describe the path of an ingress packet through the Fast Ethernet or Gigabit Ethernet SPAs:

1. For Fast Ethernet SPAs, each of the ports receives incoming frames from one of the RJ45 interface connectors. For Gigabit Ethernet SPAs, the SFP optics receive incoming frames on a per-port basis from one of the optical fiber interface connectors.
2. For Fast Ethernet SPAs, the PHY device processes the frame and sends it over a serial interface to the MAC device. For Gigabit Ethernet SPAs, the SFP PHY device processes the frame and sends it over a serial interface to the MAC device.
3. The MAC device receives the frame, strips the CRCs, and sends the packet via the SPI 4.2 bus to the ASIC.
4. The ASIC takes the packet from the MAC devices and classifies the Ethernet information. CAM lookups based on etype, port, VLAN, and source and destination address information determine whether the packet is dropped or forwarded to the SPA interface.

Path of a Packet in the Egress Direction

The following steps describe the path of an egress packet from the SIP through the Fast Ethernet and Gigabit Ethernet SPAs:

1. The packet is sent to the ASIC using the SPI 4.2 bus. The packets are received with Layer 2 and Layer 3 headers in addition to the packet data.
2. The ASIC uses port number, destination MAC address, destination address type, and VLAN ID to perform parallel CAM lookups. If the packet is forwarded, it is forwarded via the SPI 4.2 bus to the MAC device.
3. For Fast Ethernet SPAs, the MAC device forwards the packets to the PHY RJ45 interface, which transmits the packet. For Gigabit Ethernet SPAs, the MAC device forwards the packets to the PHY laser-optic interface, which transmits the packet.

Displaying the SPA Hardware Type

To verify the SPA hardware type that is installed in your Cisco 7600 series router, you can use the `show interfaces` command.
Table 12-3 shows the hardware description that appears in the show command output for each type of Fast Ethernet and Gigabit Ethernet SPA that is supported on the Cisco 7600 series router.

### Table 12-3 SPA Hardware Descriptions in show Commands

<table>
<thead>
<tr>
<th>SPA</th>
<th>Description in show interfaces Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-Port Fast Ethernet SPA</td>
<td>Hardware is FastEthernet SPA</td>
</tr>
<tr>
<td>8-Port Fast Ethernet SPA</td>
<td>Hardware is FastEthernet SPA</td>
</tr>
<tr>
<td>1-Port 10-Gigabit Ethernet SPA</td>
<td>Hardware is TenGigEther SPA</td>
</tr>
<tr>
<td>2-Port Gigabit Ethernet SPA</td>
<td>Hardware is GigEther SPA</td>
</tr>
<tr>
<td>5-Port Gigabit Ethernet SPA</td>
<td>Hardware is GigEther SPA</td>
</tr>
<tr>
<td>10-Port Gigabit Ethernet SPA</td>
<td>Hardware is GigEther SPA</td>
</tr>
</tbody>
</table>

**Example of the show hw-module subslot transceiver Command**

The following example shows output from the `show hw-module subslot 1/1 transceiver 1 status` command on a Cisco 7600 series router with a 2-Port Gigabit Ethernet SPA installed in slot 1 and subslot 1:

```
Router# show hw-module subslot 1/1 transceiver 1 status
The transceiver in slot 1 subslot 1 port 1
    has been disabled because:
    it is not supported by this card.
    Sensor Data is not supported by this transceiver
```

**Example of the show interfaces Command**

The following example shows output from the `show interfaces fastethernet` command on a Cisco 7600 series router with a 4-Port Fast Ethernet SPA installed in slot 3:

```
Router# show interfaces fastethernet3/2/3
FastEthernet3/2/3 is up, line protocol is up
    Hardware is FastEthernet SPA, address is 000e.d623.e840 (bia 000e.d623.e840)
    Internet address is 33.1.0.2/16
    MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
         reliability 255/255, txload 83/255, rxload 83/255
    Encapsulation ARPA, loopback not set
    Keepalive not supported
    Full-duplex, 100Mb/s
    ARP type: ARPA, ARP Timeout 04:00:00
    Last input 00:00:11, output 00:00:08, output hang never
    Last clearing of "show interface" counters 3d00h
    Input queue: 0/75/626373350/0 (size/max/drops/flushes); Total output drops: 0
    Queueing strategy: fifo
    Output queue: 0/40 (size/max)
    5 minute input rate 32658000 bits/sec, 68032 packets/sec
    5 minute output rate 23333000 bits/sec, 48614 packets/sec
    17792456866 packets input, 1067548381456 bytes, 0 no buffer
    Received 0 broadcasts (0 IP multicasts)
    0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 130043940 overrun, 0 ignored
    0 watchdog
    0 input packets with dribble condition detected
    12719598014 packets output, 763177809958 bytes, 0 underruns
```
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Displaying the SPA Hardware Type

The following example shows output from the `show interfaces gigabitethernet` command on a Cisco 7600 series router with a 2-Port Gigabit Ethernet SPA installed in slot 2:

```
Router# show interfaces gigabitethernet 2/0/1
GigabitEthernet2/0/1 is down, line protocol is down
  Hardware is GigEther SPA, address is 000a.f330.2e40 (bia 000a.f330.2e40)
  Internet address is 2.2.2.1/24
  MTU 1500 bytes, BW 1000000 Kbit, DLY 10 usec,
  reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Full-duplex, 1000Mb/s, link type is force-up, media type is SX
  output flow-control is on, input flow-control is on
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 03:19:34, output 03:19:29, output hang never
  Last clearing of 'show interface' counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
      1703 packets input, 638959 bytes, 0 no buffer
      Received 23 broadcasts (0 IP multicasts)
      0 runts, 0 giants, 0 throttles
      0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
      0 watchdog, 1670 multicast, 0 pause input
      1715 packets output, 656528 bytes, 0 underruns
      0 output errors, 0 collisions, 4 interface resets
      0 babbles, 0 late collision, 0 deferred
      0 lost carrier, 0 no carrier, 0 PAUSE output
      0 output buffer failures, 0 output buffers swapped out
```

The following example shows output from the `show interfaces tengigabitethernet` command on a Cisco 7600 series router with a 1-Port 10-Gigabit Ethernet SPA installed in slot 7:

```
Router# show interfaces tengigabitethernet7/0/0
TenGigabitEthernet7/0/0 is up, line protocol is up (connected)
  Hardware is TenGigEther SPA, address is 0000.0c00.0102 (bia 000f.342f.c340)
  Internet address is 15.1.1.2/24
  MTU 1500 bytes, BW 10000000 Kbit, DLY 10 usec,
  reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive not supported
  Full-duplex, 10Gb/s
  input flow-control is on, output flow-control is on
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input never, output 00:00:10, output hang never
  Last clearing of 'show interface' counters 20:24:30
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
      237450882 packets input, 15340005588 bytes, 0 no buffer
      Received 25 broadcasts (0 IP multicasts)
```
Chapter 12      Overview of the Ethernet SPAs

Displaying the SPA Hardware Type

The following example shows output from the `show interfaces gigabitethernet` command on a Cisco 7600 series router with a 2-Port Gigabit Synchronous Ethernet SPA installed in slot 2:

Router# show interfaces gigabitethernet 2/0/1
GigabitEthernet2/0/1 is down, line protocol is down
Hardware is GigEther SPA, address is 000a.f330.2e40 (bia 000a.f330.2e40)
Internet address is 2.2.2.1/24
MTU 1500 bytes, BW 1000000 Kbit, DLY 10 usec,
reliability 255/255, txload 1/255, rxload 1/255
Encapsulation ARPA, loopback not set
Full-duplex, 1000Mb/s, link type is force-up, media type is SX
output flow-control is on, input flow-control is on
ARP type: ARPA, ARP Timeout 04:00:00
Last input 03:19:34, output 03:19:29, output hang never
Last clearing of "show interface" counters never
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: fifo
Output queue: 0/40 (size/max)
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
1703 packets input, 638959 bytes, 0 no buffer
Received 23 broadcasts (0 IP multicasts)
0 runts, 0 giants, 0 throttles
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
0 watchdog, 0 multicast, 0 pause input
1676 packets output, 198290 bytes, 0 underruns
0 output errors, 0 collisions, 4 interface resets
0 babbles, 0 late collision, 0 deferred
0 lost carrier, 0 no carrier, 0 PAUSE output
0 output buffer failures, 0 output buffers swapped out