



High-Availability Seamless Redundancy (HSR)

- [Information About HSR, on page 1](#)
- [Guidelines and Limitations, on page 15](#)
- [Default Settings, on page 17](#)
- [Configuring an HSR Ring, on page 18](#)
- [Enabling HSR Alarms, on page 19](#)
- [Clearing All Node Table and VDAN Table Dynamic Entries , on page 20](#)
- [Verifying Configuration, on page 21](#)
- [Configuration Example, on page 21](#)
- [Related Documents, on page 24](#)
- [Feature History, on page 25](#)

Information About HSR

High-availability Seamless Redundancy (HSR) is defined in International Standard IEC 62439-3-2016 clause 5. HSR is similar to Parallel Redundancy Protocol (PRP) but is designed to work in a ring topology. Instead of two parallel independent networks of any topology (LAN-A and LAN-B), HSR defines a ring with traffic in opposite directions. Port-A sends traffic counter clockwise in the ring, and Port-B sends traffic clockwise in the ring.

The HSR packet format is also different from PRP. To allow the switch to determine and discard duplicate packets, additional protocol specific information is sent with the data frame. For PRP, this is sent as part of a trailer called the redundancy control trailer (RCT), whereas for HSR this is sent as part of the header called the HSR header. Both the RCT and HSR header contain a sequence number, which is the primary data used to determine if the received frame is the first instance or a duplicate instance.



Note HSR is supported on IE3400 Rugged and IE3400 Heavy Duty Series Switches (see [Guidelines and Limitations, on page 15](#) for supported SKUs). The term *switch* in this document refers to the IE3400 Rugged and IE3400 Heavy Duty Series Switches unless otherwise noted.

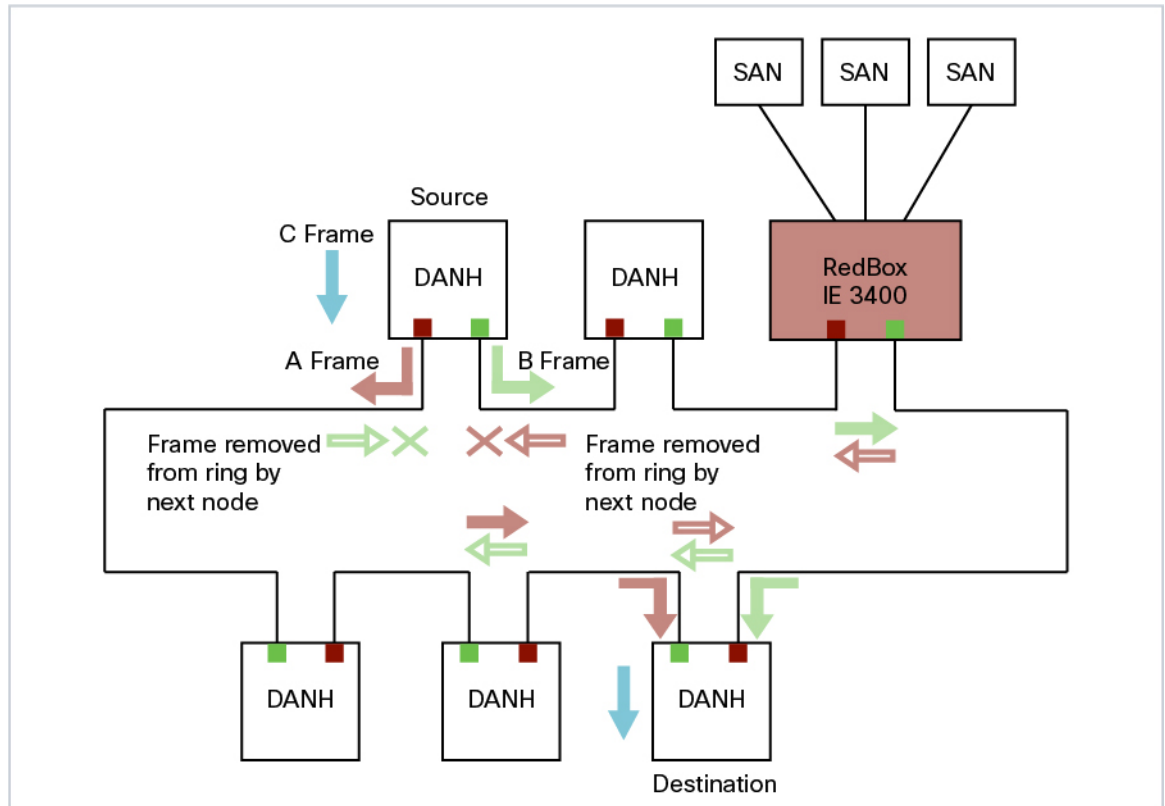
In this release, the switch supports only HSR-SAN mode and only one HSR instance. In addition, you can create only one HSR or one PRP instance. If you have created a PRP instance, no HSR instance can be created.

The non-switching nodes with two interfaces attached to the HSR ring are referred to as Doubly Attached Nodes implementing HSR (DANHs). Similar to PRP, Singly Attached Nodes (SANs) are attached to the HSR

ring through a device called a RedBox (Redundancy Box). The RedBox acts as a DANH for all traffic for which it is the source or the destination. The switch implements RedBox functionality using Gigabit Ethernet port connections to the HSR ring.

The following figure shows an example of an HSR ring as described in IEC 62439-3. In this example, the RedBox is an IE 3400.

Figure 1: Example of HSR Ring Carrying Unicast Traffic



Devices that do not support HSR out of the box (for example, laptops and printers) cannot be attached to the HSR ring directly because all HSR capable devices must be able to process the HSR header on packets received from the ring and add the HSR header to all packets sent into the ring. These nodes are attached to the HSR ring through a RedBox. As shown in the figure above, the RedBox has two ports on the DANH side. Non-HSR SAN devices are attached to the upstream switch ports. The RedBox generates the supervision frames on behalf of these devices so that they are seen as DANH devices on the ring. Because the RedBox emulates these as DANH, they are called Virtual Doubly Attached Nodes (VDAN).

Loop Avoidance

Each node in the HSR ring forwards frames received from one port to the other port of the HSR pair. To avoid loops and use network bandwidth effectively, the RedBox does not transmit frames that are already transmitted in same direction. When a node injects a packet into the ring, the packet is handled as follows to avoid loops:

- Unicast packet with destination inside the ring: When the unicast packet reaches the destination node, the packet is consumed by the respective node and is not forwarded.

- Unicast packet with destination not inside the ring: Because this packet does not have a destination node in the ring, it is forwarded by every node in the ring until it reaches the originating node. Because every node has a record of the packet it sent, along with the direction in which it was sent, the originating node detects that packet has completed the loop and drops the packet.
- Multicast packet: A multicast packet is forwarded by each node because there can be more than one consumer of this packet. For this reason a multicast packet always reaches the originating node. However, every node will check whether it has already forwarded the received packet through its outgoing interface. Once the packet reaches the originating node, the originating node determines that it already forwarded this packet and drops the packet instead of forwarding it again.

HSR RedBox Modes of Operation

The most basic mode of operation is HSR-SAN mode (single RedBox mode). In this mode, the RedBox is used to connect SAN devices to the HSR ring. The Redbox's responsibility in this mode is to represent SAN devices as VDANs on the ring.



Note In this release, the switch supports HSR-SAN mode only.

HSR-SAN Mode

In HSR-SAN mode, the RedBox inserts the HSR tag on behalf of the host and forwards the ring traffic, except for frames sent by the node itself, duplicate frames, and frames for which the node is the unique destination. In this mode, packets are handled as follows:

- A source DANH sends a frame passed from its upper layers ("C" frame), prefixes it with an HSR tag to identify frame duplicates, and sends the frame over each port ("A" frame and "B" frame).
- A destination DANH receives two identical frames from each port within a certain interval. The destination DANH removes the HSR tag of the first frame before passing it to its upper layers and discards any duplicate.
- Each node in the HSR ring forwards frames received from one port to the other port of the HSR pair. A node will not forward frames received on one port to the other under the following conditions:
 - The received frame returns to the originating node in the ring.
 - The frame is a unicast frame with a destination MAC address of a node upstream of the receiving node.
 - The node had already sent the same frame in the same direction. This rule prevents a frame from spinning in the ring in an infinite loop.

HSR-SAN Interfaces

HSR-SAN mode is supported on interfaces GigabitEthernet 1/1-4. HSR ring 1 is configured as a pair of ports: G1/1 and G1/2 or G1/3 and G1/4.

CDP and LLDP for HSR

HSR supports the Cisco Discovery Protocol (CDP) and Link Layer Discovery Protocol (LLDP). CDP and LLDP are Layer 2 neighbor discovery protocols. Both CDP and LLDP can provide information about nodes directly connected to the device. They also provide additional information such as the local and remote interface and device names.

When CDP or LLDP is enabled, you can use the CDP or LLDP information to find the adjacent nodes on an HSR ring and their status. You can then use the neighbor information from each node to determine the complete HSR network topology and debug and locate ring faults.

CDP and LLDP are configured on physical interfaces only.

For more information, see [Configuring an HSR Ring, on page 18](#) and [Verifying Configuration, on page 21](#).

PTP over HSR

Precision Time Protocol (PTP) is supported on the IE3400 Rugged and IE3400 Heavy Duty Series Switches for the PTP Power Profile only.

Because the PTP 1588 standard does not currently account for clocks synchronized over redundant, simultaneously active paths, HSR must handle PTP packets differently than other packet types. To provide high availability for PTP through redundancy, the HSR duplicate/discard logic is not used for PTP packets.

To understand how PTP clock synchronization works in an HSR network, suppose that a VDAN/SAN is the PTP grandmaster clock (GMC). Dually attached devices receive PTP synchronization information over both their HSR ports. However, only one of the ports (referred to as time recipient) is used to synchronize the local clock. The other HSR port (referred to as PASSIVE) continues to receive synchronization information, but is not used to synchronize the local clock. Suppose that RedBox 2 has its port-A as time recipient and port-B as PASSIVE. When port-A goes down, the port-B port takes over as the time recipient and is used to continue synchronizing the local clock on RedBox 2.



Note Cisco is moving from the traditional Master/Slave nomenclature. In this document, the terms *Grandmaster clock (GMC)* or *time source* and *time recipient* are used instead.

The PTP grandmaster in an HSR network can be a RedBox, a VDAN/SAN, or a DANH.

To use PTP over HSR, configure HSR and PTP separately. PTP over HSR works without any additional configuration. Note that in most cases, you do not need to perform any PTP configuration on the interfaces because PTP is enabled by default on all physical ethernet interfaces.

Supported PTP Profiles and Modes

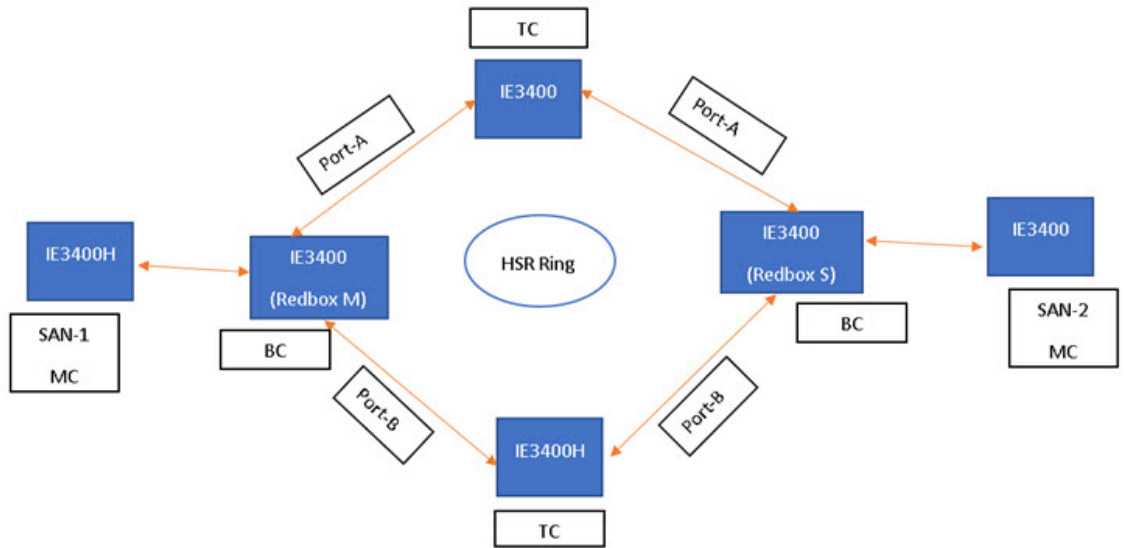
PTP over HSR is supported only for the for the PTP Power Profile. For unsupported PTP profiles, PTP traffic flows over HSR port-A only.

The following table shows the HSR support for PTP profiles, clock modes and RedBox types.

PTP Profile	Clock Mode	Supported?	HSR Redbox Type as per IEC 62439-3
Power Profile	BC	Yes	HSR RedBox as doubly attached BC (DABC) with P2P
	P2P TC	Yes	HSR RedBox as doubly attached TC (DATC) with P2P
	GMC-BC	No	Not applicable
	Forward	No	Not applicable
Default Profile	BC	No	Not applicable
	E2E TC	No	Not applicable

HSR RedBox as Doubly Attached BC (DABC) with P2P

This section describes the operation of PTP over HSR using an example where RedBox M and RedBox S are configured to run in Power Profile as Boundary Clocks that use the Peer-to-Peer delay measurement mechanism.



Assume for this example that SAN-1 is the GMC. All the clocks are configured to run Peer-to-Peer Delay measurement and the peer delay is regularly calculated and maintained on every link shown in the figure. The BMCA on RedBox M determines the port to SAN-1 to be connected to the time source. The PTP protocol running on RedBox M will forward Sync and Follow_up messages on ports A and B.

On RedBox S, the regular BMCA operation determines port A to be time recipient and port B to be PASSIVE. However, with the knowledge that ports A and B are part of the same HSR ring, port B is forced into PASSIVE_SLAVE state and port A becomes active for PTP.

Port A works as a regular time recipient port. It uses the Sync and Follow_Up messages along with their correction field to calculate the delay and offset from time source and synchronize the local clock. (Unlike

an E2E BC, it does not need to generate Delay_Req messages since all the link delays and residence times along the PTP path are accumulated in the correction field of the Follow_Up messages.)

Port B, which is in PASSIVE_SLAVE state operates as follows: Just like port A, it maintains the delay and offset from time source, but does not perform any operation on the local clock. Having all the synchronization information available enables it to seamlessly take over as the new time recipient in case port A loses communication with the GMC. Note that on IE switch platforms we currently do not support PTP profile conversion. For example, if RedBox S in the figure above were an IE switch, it would not support the Delay_Req/Delay_Resp message exchange. It would only support the Peer-to-Peer delay measurement mechanism using PDelay messages.

Configuration Example

```
SAN-1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SAN-1(config)#ptp profile power
SAN-1(config)#ptp mode boundary pdelay-req
SAN-1(config)#ptp priority1 1
SAN-1(config)#end

SAN-2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SAN-2(config)#ptp profile power
SAN-2(config)#ptp mode boundary pdelay-req
SAN-2(config)#end

REDBOX-M#conf t
Enter configuration commands, one per line. End with CNTL/Z.
REDBOX-M(config)#ptp profile power
REDBOX-M(config)#ptp mode boundary pdelay-req
REDBOX-M(config)#end

REDBOX-S#conf t
Enter configuration commands, one per line. End with CNTL/Z.
REDBOX-S(config)#ptp profile power
REDBOX-S(config)#ptp mode boundary pdelay-req
REDBOX-S(config)#end

DANH-TOP#conf t
Enter configuration commands, one per line. End with CNTL/Z.
DANH-TOP(config)#ptp profile power
DANH-TOP(config)#ptp mode p2pttransparent
DANH-TOP(config)#end

DANH-BOTTOM#conf t
Enter configuration commands, one per line. End with CNTL/Z.
DANH-BOTTOM(config)#ptp profile power
DANH-BOTTOM(config)#ptp mode p2pttransparent
DANH-BOTTOM(config)#end

SAN-1#sh ptp parent
PTP PARENT PROPERTIES
Parent Clock:
Parent Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
Parent Port Number: 0
Observed Parent Offset (log variance): N/A
Observed Parent Clock Phase Change Rate: N/A

Grandmaster Clock:
Grandmaster Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
Grandmaster Clock Quality:
Class: 248
```

```
Accuracy: Unknown
Offset (log variance): N/A
Priority1: 1
Priority2: 128
```

```
SAN-2#sh ptp parent
PTP PARENT PROPERTIES
  Parent Clock:
  Parent Clock Identity: 0x0:29:C2:FF:FE:3C:6A:C0
  Parent Port Number: 9
  Observed Parent Offset (log variance): N/A
  Observed Parent Clock Phase Change Rate: N/A

  Grandmaster Clock:
  Grandmaster Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
  Grandmaster Clock Quality:
  Class: 248
  Accuracy: Unknown
  Offset (log variance): N/A
  Priority1: 1
  Priority2: 128
```

```
REDBOX-M#sh ptp parent
PTP PARENT PROPERTIES
  Parent Clock:
  Parent Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
  Parent Port Number: 3
  Observed Parent Offset (log variance): N/A
  Observed Parent Clock Phase Change Rate: N/A

  Grandmaster Clock:
  Grandmaster Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
  Grandmaster Clock Quality:
  Class: 248
  Accuracy: Unknown
  Offset (log variance): N/A
  Priority1: 1
  Priority2: 128
```

```
REDBOX-S#sh ptp parent
PTP PARENT PROPERTIES
  Parent Clock:
  Parent Clock Identity: 0x0:29:C2:FF:FE:3C:5D:80
  Parent Port Number: 3
  Observed Parent Offset (log variance): N/A
  Observed Parent Clock Phase Change Rate: N/A

  Grandmaster Clock:
  Grandmaster Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
  Grandmaster Clock Quality:
  Class: 248
  Accuracy: Unknown
  Offset (log variance): N/A
  Priority1: 1
  Priority2: 128
```

```
DANH-TOP#sh ptp parent
PTP PARENT PROPERTIES
  Parent Clock:
  Parent Clock Identity: 0x0:29:C2:FF:FE:3C:5D:80
  Parent Port Number: 3
  Observed Parent Offset (log variance): N/A
  Observed Parent Clock Phase Change Rate: N/A
```

```

Grandmaster Clock:
Grandmaster Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
Grandmaster Clock Quality:
Class: 248
Accuracy: Unknown
Offset (log variance): N/A
Priority1: 1
Priority2: 128

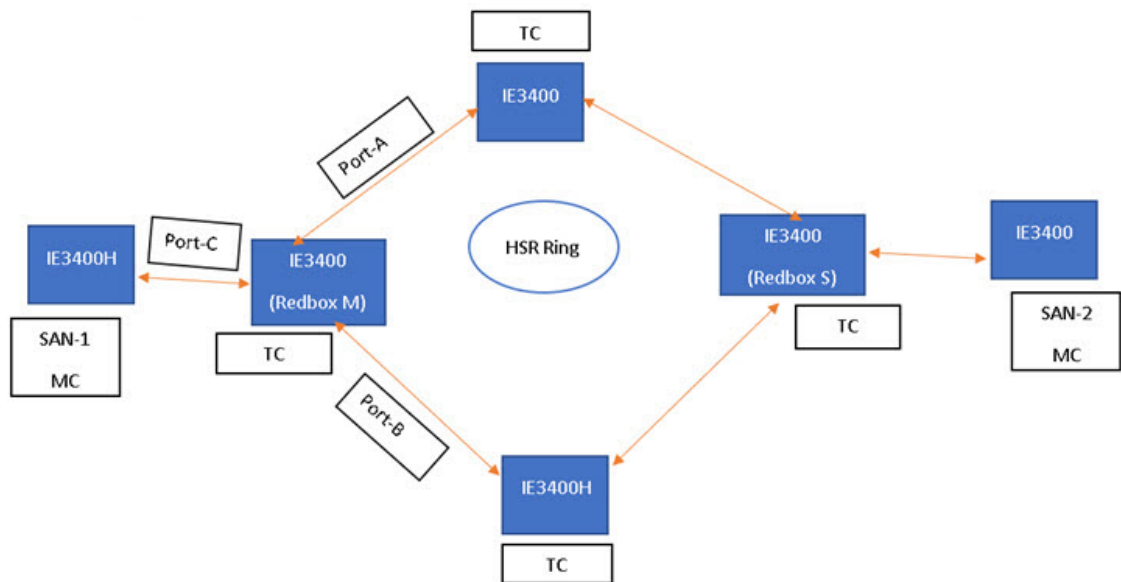
DANH-BOTTOM#sh ptp parent
PTP PARENT PROPERTIES
Parent Clock:
Parent Clock Identity: 0x0:29:C2:FF:FE:3C:5D:80
Parent Port Number: 4
Observed Parent Offset (log variance): N/A
Observed Parent Clock Phase Change Rate: N/A

Grandmaster Clock:
Grandmaster Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
Grandmaster Clock Quality:
Class: 248
Accuracy: Unknown
Offset (log variance): N/A
Priority1: 1
Priority2: 128

```

HSR RedBox as Doubly Attached TC (DATC) with P2P

This section describes the operation of PTP over HSR using an example where RedBox M and RedBox S are configured to run in Power Profile as Transparent Clocks.



Assume for this example that SAN-1 is the GMC. All the clocks are configured to run Peer-to-Peer Delay measurement and the peer delay is regularly calculated and maintained on every link shown in the figure. RedBox M and RedBox S run BMCA even though it is not mandatory for a P2P TC to run BMCA. On RedBox M, the BMCA on redbox M determines the port to SAN-1 to be connected to the time source. RedBox M forwards all Sync and Follow_Up messages received on port C out of ports A and B.

On RedBox S, port A is determined to be time recipient and port B to be PASSIVE_SLAVE as described earlier.

Port A operates as follows: It uses the Sync and Follow_Up messages along with their correction field to calculate the delay and offset from time source and synchronize the local clock. (Unlike a E2E BC, it does not need to generate Delay_Req messages since all the link delays and residence times along the PTP path are accumulated in the correction field of the Follow_Up messages.) It also forwards the Sync and Follow_Up messages out of port C.

Port B operates as follows: Just like port A, it maintains the delay and offset from time source, but does not perform any operation on the local clock. Having all the synchronization information available enables it to seamlessly take over as the new time recipient in case port A loses communication with the GMC. Post-processing, it drops the Sync/Follow_Up messages since the copy of Sync/Follow_Up that arrives on port A is forwarded out of port C.

Configuration Example

```
SAN-1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
SAN-1(config)#ptp profile power
SAN-1(config)#ptp mode boundary pdelay-req
SAN-1(config)#ptp priority1 1
SAN-1(config)#end
SAN-2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
SAN-2(config)#ptp profile power
SAN-2(config)#ptp mode boundary pdelay-req
SAN-2(config)#end
REDBOX-M#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
REDBOX-M(config)#ptp profile power
REDBOX-M(config)# ptp mode p2ptransparent
REDBOX-M(config)#end
REDBOX-S#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
REDBOX-S(config)#ptp profile power
REDBOX-S(config)# ptp mode p2ptransparent
REDBOX-S(config)#end
DANH-TOP#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
DANH-TOP(config)#ptp profile power
DANH-TOP(config)#ptp mode p2ptransparent
DANH-TOP(config)#end
DANH-BOTTOM#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
DANH-BOTTOM(config)#ptp profile power
DANH-BOTTOM(config)#ptp mode p2ptransparent
DANH-BOTTOM(config)#end
SAN-1#sh ptp parent
PTP PARENT PROPERTIES
  Parent Clock:
  Parent Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
  Parent Port Number: 0
  Observed Parent Offset (log variance): N/A
  Observed Parent Clock Phase Change Rate: N/A

  Grandmaster Clock:
  Grandmaster Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
  Grandmaster Clock Quality:
  Class: 248
  Accuracy: Unknown
  Offset (log variance): N/A
```

```

Priority1: 1
Priority2: 128
SAN-2#sh ptp parent
PTP PARENT PROPERTIES
  Parent Clock:
    Parent Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
    Parent Port Number: 3
    Observed Parent Offset (log variance): N/A
    Observed Parent Clock Phase Change Rate: N/A

  Grandmaster Clock:
    Grandmaster Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
    Grandmaster Clock Quality:
    Class: 248
    Accuracy: Unknown
    Offset (log variance): N/A
    Priority1: 1
    Priority2: 128
REDBOX-M#sh ptp parent
PTP PARENT PROPERTIES
  Parent Clock:
    Parent Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
    Parent Port Number: 3
    Observed Parent Offset (log variance): N/A
    Observed Parent Clock Phase Change Rate: N/A

  Grandmaster Clock:
    Grandmaster Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
    Grandmaster Clock Quality:
    Class: 248
    Accuracy: Unknown
    Offset (log variance): N/A
    Priority1: 1
    Priority2: 128
REDBOX-S#sh ptp parent
PTP PARENT PROPERTIES
  Parent Clock:
    Parent Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
    Parent Port Number: 3
    Observed Parent Offset (log variance): N/A
    Observed Parent Clock Phase Change Rate: N/A

  Grandmaster Clock:
    Grandmaster Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
    Grandmaster Clock Quality:
    Class: 248
    Accuracy: Unknown
    Offset (log variance): N/A
    Priority1: 1
    Priority2: 128
DANH-TOP#sh ptp parent
PTP PARENT PROPERTIES
  Parent Clock:
    Parent Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
    Parent Port Number: 3
    Observed Parent Offset (log variance): N/A
    Observed Parent Clock Phase Change Rate: N/A

  Grandmaster Clock:
    Grandmaster Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
    Grandmaster Clock Quality:
    Class: 248
    Accuracy: Unknown
    Offset (log variance): N/A

```

```

Priority1: 1
Priority2: 128
DANH-BOTTOM#sh ptp parent
PTP PARENT PROPERTIES
  Parent Clock:
    Parent Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
    Parent Port Number: 3
    Observed Parent Offset (log variance): N/A
    Observed Parent Clock Phase Change Rate: N/A

  Grandmaster Clock:
    Grandmaster Clock Identity: 0x0:35:1A:FF:FE:94:4F:0
    Grandmaster Clock Quality:
    Class: 248
    Accuracy: Unknown
    Offset (log variance): N/A
    Priority1: 1
    Priority2: 128

```

HSR Alarms

An HSR ring can generate the following two alarms:

- **Partial Ring Fault:** This fault is generated by an HSR RedBox when one of its physical ring ports/links is down. Because the packets can be sent using the redundant path, this is considered as a partial fault. However, this fault still requires user intervention to restore the ring. This is a minor fault and cannot be associated with an external hardware alarm relay.
- **Full Ring Fault:** This fault is generated by an HSR RedBox when both of its physical ring ports/links are down. This is a catastrophic failure and needs immediate attention. This is a major fault and can be associated with an external hardware alarm relay.

When an event that raises an alarm is generated, it can be associated with one or more of the following actions to notify the user:

- **Syslog:** A syslog is generated when the Alarm is raised/cleared.
- **SNMP Notification:** SNMP notification is sent when the alarm is raised/cleared.
- **Relay output:** External relay contacts can be asserted/de-asserted in response to the alarm. Relays are activated by major faults only.

See [Enabling HSR Alarms, on page 19](#) for steps to configure HSR alarms.

The following table lists the HSR events and their representations.

Event Number	Event Description	System Log (Level)	Alert/Alarm Log	Alarm LED and Output relay
1	Ring goes from UP to DOWN state.	2	2	Major Alarm/Assert
2	Ring goes from DOWN to UP state.	6	6	De-assert

Event Number	Event Description	System Log (Level)	Alert/Alarm Log	Alarm LED and Output relay
3	One ring port goes DOWN, the other ring port and the ring itself is UP.	3	3	
4	Both ring ports are UP again.	6	6	

You can view currently active alarms using the **show facility alarm status** command. The following example shows alarm status for minor and major HSR alarms:

```
Switch#show facility-alarm status
Source          Severity   Description                               Relay   Time
Switch          MINOR     34 HSR ring is partially down            MAJ     Oct 24 2017 10:16:10

-----
Switch# show facility-alarm status
Source          Severity   Description                               Relay   Time
Switch          MAJOR     33 HSR ring is down                      MAJ     Oct 24 2017 10:17:07
```

The following examples show the syslog entries that are generated for each HSR alarm event assertion and clear event (if configured):

- Syslog generated on occurrence of Partial fault:

```
Oct 24 11:07:13.952 IST: %HSR_ALARM-3-HSR_PARTIALFAULT: The HSR ring in now in PARTIAL
FAULT state
```

- Syslog generated when the Partial fault is cleared:

```
Oct 24 11:07:38.032 IST: %HSR_ALARM-3-HSR_PARTIALFAULT: The HSR ring in now in PARTIAL
FAULT state - event cleared
```

- Syslog generated on occurrence of Full fault:

```
Oct 24 11:07:38.036 IST: %HSR_ALARM-2-HSR_RINGFAULT: The HSR ring in now in FAULT state
```

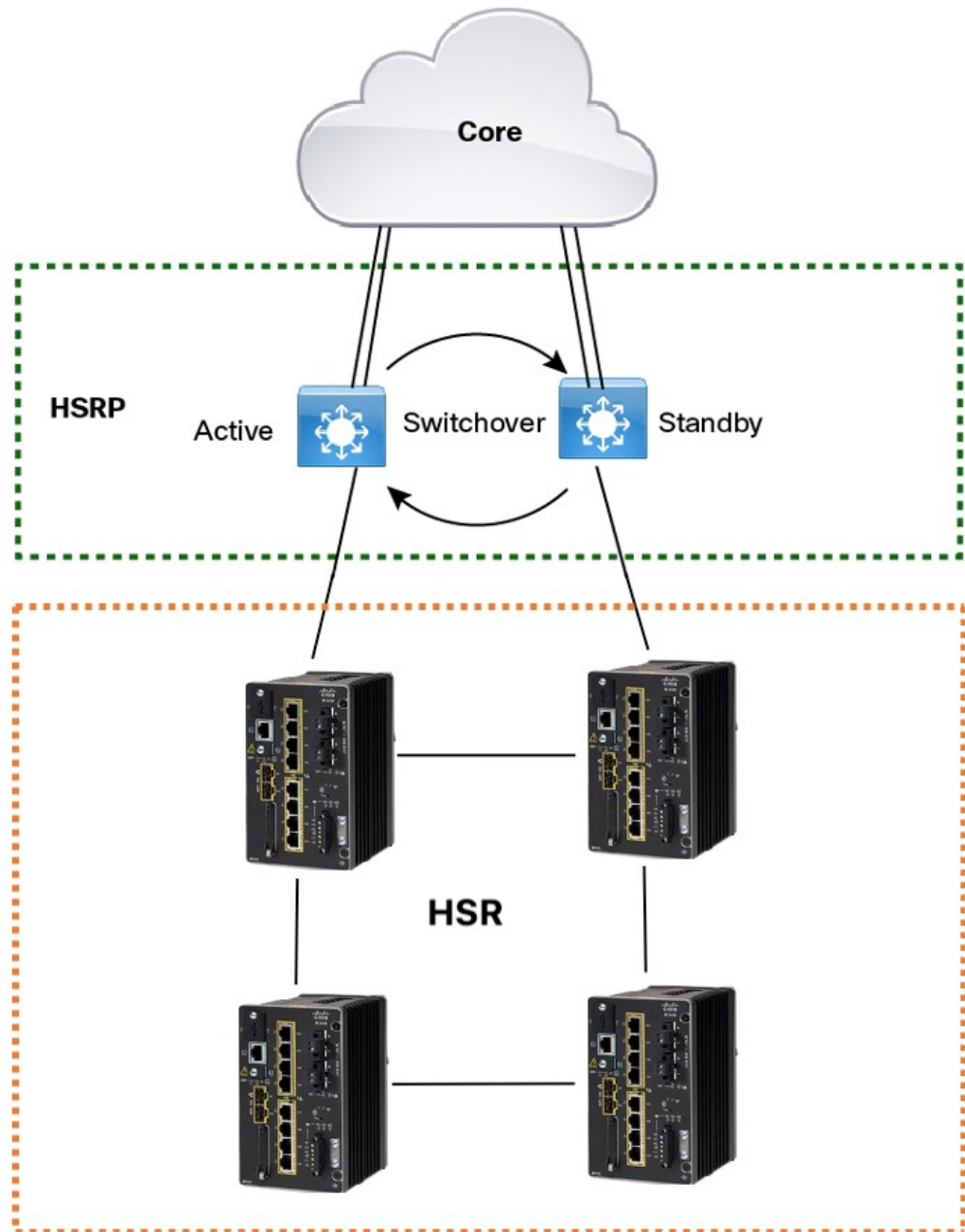
- Syslog generated when the Full fault is cleared:

```
Oct 24 11:08:19.082 IST: %HSR_ALARM-2-HSR_RINGFAULT: The HSR ring in now in FAULT state
- event cleared
```

HSR Uplink Redundancy Enhancement

The HSR Uplink Redundancy Enhancement feature allows for flexible designs that enable two separate interfaces to connect upstream from the HSR ring through two separate HSR RedBoxes. This ensures there is no single point of failure exiting the HSR ring. Examples of protocols that can leverage this feature to improve high availability include HSRP, VRRP and REP. Prior to this enhancement, if these protocols were utilized on redundant uplinks, undesirable results could occur, such as next-hop split-brain conditions or slow REP failover times.

The following diagram shows an example network with HSR and HSRP that allows uplink next-hop gateway redundancy out of the HSR ring.



To implement HSR Uplink Redundancy, ensure that the **fpgamode-DualUplinkEnhancement** feature is not disabled. This feature is required to support the connectivity to a dual router (HSRP in this case) on the distribution layer:

```
Switch#show hsr ring 1 detail | include fpgamode
fpgamode-DualUplinkEnhancement: Enabled
```

If the output shows *fpgamode-DualUplinkEnhancement*;*:Disabled* issue the following command:

```
Switch# conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)# hsr-ring 1 fpgamode-DualUplinkEnhancement
Switch(config)# end
```

HSRP Configuration

The following example HSRP configuration applies to the two distribution switches Active & Standby in the above figure. In the following configuration, HSRP is configured in a Switch Virtual Interface (SVI).

```
Active# conf t
Enter configuration commands, one per line. End with CNTL/Z.
Active(config)# interface vlan 10
Active(config-if)# ip address 30.30.30.2 255.255.255.0
Active(config-if)# standby 1 ip 30.30.30.1
Active(config-if)# standby 1 priority 120
Active(config-if)# end
```

```
Standby# conf t
Enter configuration commands, one per line. End with CNTL/Z.
Standby(config)# interface Vlan10
Standby(config-if)# ip address 30.30.30.4 255.255.255.0
Standby(config-if)# standby 1 ip 30.30.30.1
Standby(config-if)# end
```

```
Active# show standby
Vlan10 - Group 1
  State is Active
    8 state changes, last state change 00:03:55
    Track object 1 (unknown)
  Virtual IP address is 30.30.30.1
  Active virtual MAC address is 0000.0c07.ac01 (MAC In Use)
    Local virtual MAC address is 0000.0c07.ac01 (v1 default)
  Hello time 200 msec, hold time 750 msec
    Next hello sent in 0.176 secs
  Preemption enabled, delay min 5 secs, reload 5 secs, sync 5 secs
  Active router is local
  Standby router is 30.30.30.4, priority 100 (expires in 0.656 sec)
  Priority 120 (configured 120)
  Group name is "hsrp-Vl10-1" (default)
  FLAGS: 0/1
```

```
Active# show standby brief
          P indicates configured to preempt.
          |
Interface   Grp  Pri P State   Active           Standby           Virtual IP
Vl10        1    120 P Active local           30.30.30.4       30.30.30.1
```

```
Standby# show standby
Vlan10 - Group 1
  State is Standby
    13 state changes, last state change 00:04:17
    Track object 1 (unknown)
  Virtual IP address is 30.30.30.1
  Active virtual MAC address is 0000.0c07.ac01 (MAC Not In Use)
    Local virtual MAC address is 0000.0c07.ac01 (v1 default)
  Hello time 200 msec, hold time 750 msec
    Next hello sent in 0.064 secs
  Preemption enabled, delay min 5 secs, reload 5 secs, sync 5 secs
  Active router is 30.30.30.2, priority 120 (expires in 0.816 sec)
  Standby router is local
  Priority 100 (default 100)
  Group name is "hsrp-Vl10-1" (default)
```

```

FLAGS: 0/1
Standby# show standby brief
                P indicates configured to preempt.
                |
Interface  Grp  Pri P State   Active           Standby           Virtual IP
Vl10      1    100 P Standby 30.30.30.2      local             30.30.30.1

```

Guidelines and Limitations

- HSR-SAN is supported only on the following IE 3400 and IE 3400H Series switches:
 - Advanced System IE-3400-8P2S
 - Advanced System IE-3400-8T2S
 - All IE 3400H Series SKUs
- HSR-SAN (Single RedBox mode) is the only HSR mode supported in this release.
- Only 1 HSR instance is supported. Note that the switch supports only 1 HSR or 1 PRP instance, so if a PRP instance has been created, no HSR instance can be created.
- HSR ring 1 can only be configured as a pair of ports: G1/1 and G1/2 or G1/3 and G1/4. Using these port pairs, you can configure 1 HSR ring.
- The HSR feature requires the Network Essential license.
- The HSR feature is not enabled by default and you must explicitly configure the HSR rings.
- HSR is disabled automatically if the required firmware image is not available on the system.
- The recommended maximum number of nodes in the node table is 512. Nodes are all the DANH and VDAN devices that can be connected to the ring at same time. This number is not an absolute limit, but higher numbers of entries may increase the number of duplicate packets received by the end devices.
- The maximum number of nodes in the HSR ring is 50.
- HSR ring ports can only be configured in L2 mode.
- HSR is supported on following port types:
 - 100 mbps, Full Duplex. Half duplex is not supported.
 - 1000 mbps, Full Duplex. Half duplex is not supported.
 - Both ports of one ring must be of same speed and type (that is, both can be SFPs or both can be copper)
- The following protocols and features are mutually exclusive with HSR on the same port:
 - PRP
 - EtherChannels
 - Link Aggregation Control Protocol (LACP)
 - Port Aggregation Protocol (PAgP)
 - Resilient Ethernet Protocol (REP)

- The HSR feature does not work together with L2NAT.
- MACsec, HSR, and PRP are not allowed together.
- HSR supports an MTU size of up to 1998 bytes of Ethernet payload.
- STP is not supported on the HSR ring. By default, all modes of Spanning Tree Protocol (STP) will be disabled on the ring ports.
- PTP over HSR-SAN is supported on IE3400 Advanced FPGA SKUs and IE 3400H. PTP over HSR-SAN is not supported on IE3200 or IE3300.
- Switched Port Analyzer (SPAN) and Remote SPAN (RSPAN) are not supported on HSR. That is, SPAN and RSPAN should not be used to monitor the traffic on an HSR ring. In addition, traffic that has been monitored using RSPAN should not be transferred over an HSR ring.
- It is important for all interfaces in an HSR ring to have the same speed and duplex settings. It is recommended to apply those settings before configuring ring membership.
- Once a port is part of ring, the port cannot be shut down.

For example, if G1/3 and G1/4 are part of an HSR ring and you try to shut down G1/3 or G1/4, the operation will not be permitted:

```
Switch(config)# interface range g1/3
Switch(config-if-range)#shutdown
%Interface GigabitEthernet1/3 is configured in a HSR ring shutdown not permitted!
Switch(config-if-range)#
```

You can perform a shutdown of the HSR ring. For example:

```
Switch# conf t
Switch(config)#int hs1
Switch(config-if-range)#shut
```

- VLAN configuration such as trunk and access mode must be the same on both the ports participating in the ring. For example, if G1/4 and G1/3 in an HSR ring are in trunk mode and you attempt to change the mode of one port to access, the ports in the ring will not be bundled:

```
Switch(config)# interface range g1/3
Switch(config-if-range)# switchport mode access
Jul 27 22:00:27.809 IST: %EC-5-CANNOT_BUNDLE2: Gi1/3 is not compatible with Gi1/4 and
will be suspended (trunk mode of Gi1/3 is access, Gi1/4 is dynamic)
```

- After an interface is added in the HSR ring, only the primary interface counters are updated. You should not need to configure and check the status of individual physical interfaces after they are added to the HSR ring.
- As soon as you configure an HSR ring on two ports of a switch, MAC flaps will be observed on other switches where the HSR configuration is yet to be applied. We recommend that you shut down the newly created HSR ring on the switch before configuring the ring on all switches, and then reenabling them one by one as shown below. For example, if there are four switches in the ring, disable the HSR ring interfaces on each switch:

```
Switch1(config)# interface range g1/1-2
Switch1(config-if-range)# shutdown
Switch1(config-if-range)# hsr-ring hs1
Creating a HSR-ring interface hs1
Switch1(config-if-range)# int hs1
Switch1(config-if-range)# shutdown
Switch1(config-if-range)# end
```


After all four switches are configured with the ring, reenable the HSR ports on each switch:

```
Switch1# conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch1(config)# int hs1
Switch1(config-if-range)# no shutdown
Switch1(config-if-range)# end
Switch1#
```

This prevents interim MAC flapping during HSR ring configuration in member switches.

Default Settings

Table 1: HSR Ring Parameters

Parameter	Description	Range	Default Value
entryForgetTime	Time for clearing an inactive entry from duplicate discard table.	0-65535	400 ms
fpgaModeDualLinkEnhancement	Set FPGA register for source mac filtering.	enable or disable	enable
nodeForgetTime	Time to clear an inactive entry from the node table.	0-65535	60000 ms
nodeRebootInterval	Time after which the RedBox must start sending supervision frames after bootup.	0-65535	500 ms
pauseFrameTime	Time interval between HSR pause frames.	0-65535	25 ms
proxyNodeTableForgetTime	Time to clear an inactive entry from the proxy node table or vdan table.	0-65535	60000 ms
supervisionFrameLifeCheckInterval	Life check interval value for supervision frames.	0-65535	2000 ms
supervisionFrameOption			
mac-da	The last bytes of the destination MAC address of supervision frames (01:15:4E:00:01:00). The last 00 is replaced by the value of this parameter.	1-255 MAC DA last eight bits option value	No default

Parameter	Description	Range	Default Value
vlan-cfi	Enable Canonical Format Indicator (CFI) for the VLAN tagged frame.	enable or disable	disable
vlan-cos	Class of Service (COS) value to be set in the VLAN tag of the Supervision frame.	0-7	0
vlan-id	The VLAN tag of the supervision frame.	0-4095	0
vlan-tagged	Set VLAN tagging option.	enable or disable	disable
supervisionFrameRedBoxMacAddress	The RedBox MAC address in the supervision frames.	48-bit RedBox MAC address	The interface HSR ring MAC address
supervisionFrameTime	Time interval between supervision frames.	0-65535	3 ms

Configuring an HSR Ring

Follow these steps to configure an HSR ring:

Before you begin

- See [Guidelines and Limitations, on page 15](#).
- Ensure that the member interfaces of a HSR ring are not participating in any redundancy protocols such as FlexLinks, EtherChannel, REP, and so on before configuring a HSR ring.

Step 1 Enter global configuration mode:

```
Switch# configure terminal
```

Step 2 (Optional) Globally enable CDP to provide information about HSR ring nodes:

```
Switch(config)# cdp run
```

Step 3 (Optional) Globally enable LLDP to provide information about HSR ring nodes:

```
Switch(config)# lldp run
```

Step 4 Enter interface configuration mode and disable PTP on the ports to be assigned to the HSR ring:

```
Switch(config)# interface range gigabitEthernet 1/1-2  
Switch(config-if-range)# no ptp enable
```

Step 5 (Optional) Enable CDP on the ports to be assigned to the HSR ring:

```
Switch(config-if-range)#cdp enable
```

Step 6 (Optional) Enable LLDP on the ports to be assigned to the HSR ring:

```
Switch(config-if-range)#lldp transmit
Switch(config-if-range)#lldp receive
```

Step 7 Shut down the ports before configuring the HSR ring:

```
Switch(config-if-range)# shutdown
```

Step 8 Create the HSR ring interface and assign the ports to the HSR ring:

```
Switch(config)# interface range gigabitEthernet 1/1-2
Switch(config-if-range)# hsr-ring 1
```

Step 9 (Optional) If required, configure HSR ring optional parameters. See [Default Settings, on page 17](#) for the parameter descriptions, ranges and default values.

```
Switch(config-if-range)# hsr 1 supervisionFrameLifeCheckInterval 10000
```

Step 10 Turn on the HSR interface:

```
Switch(config-if-range)# no shutdown
Switch(config-if)# end
```

Example

```
Switch# conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)# interface range gigabitEthernet 1/1-2
Switch(config-if-range)# no ptp enable
Switch(config-if-range)# shutdown
Switch(config-if-range)# hsr-ring 1
Switch(config-if-range)# hsr-ring 1 supervisionFrameLifeCheckInterval 10000
Switch(config-if-range)# no shutdown
Switch(config-if-range)# end
```

Enabling HSR Alarms

To enable alarms for HSR, follow these steps:

Before you begin

Alarms and actions can be enabled/disabled at the facility level only. You cannot enable only partial faults or full faults; either all alarms for given facility are enabled or all are disabled.

See [HSR Alarms, on page 11](#) for details about HSR alarms.

SUMMARY STEPS

1. Enter global configuration mode:
2. Enable the HSR alarm facility:
3. (Optional) Enable SNMP notification for HSR alarms:
4. (Optional) Associate HSR alarms with the Major Relay:

5. (Optional) Send HSR alarms to a syslog server:
6. (Optional) Enable logging of informational HSR alarm messages:
7. Exit global configuration mode:
8. Verify the configuration:

DETAILED STEPS

- Step 1** Enter global configuration mode:
- ```
Switch# configure terminal
```
- Step 2** Enable the HSR alarm facility:
- ```
Switch(config)# alarm facility hsr enable
```
- To disable HSR alarms, enter **no alarm facility hsr enable**.
- Step 3** (Optional) Enable SNMP notification for HSR alarms:
- ```
Switch(config)# alarm facility hsr notifies
```
- Step 4** (Optional) Associate HSR alarms with the Major Relay:
- ```
Switch(config)# alarm facility hsr relay major
```
- Step 5** (Optional) Send HSR alarms to a syslog server:
- ```
Switch(config)# alarm facility hsr syslog
```
- Step 6** (Optional) Enable logging of informational HSR alarm messages:
- ```
Switch(config)# logging alarm informational
```
- Step 7** Exit global configuration mode:
- ```
Switch(config)# end
```
- Step 8** Verify the configuration:
- ```
Switch# show facility-alarm status
```
-

Clearing All Node Table and VDAN Table Dynamic Entries

To clear all dynamic entries in the node table, enter

clear hsr node-table

To clear all dynamic entries in the VDAN table, enter

clear hsr vdan-table

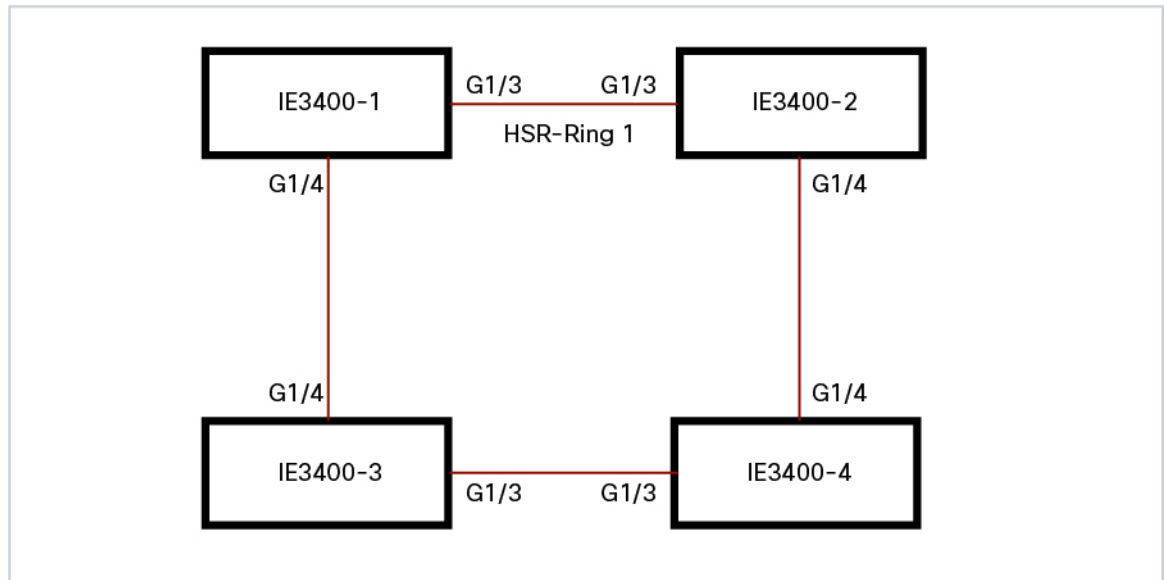
Verifying Configuration

Command	Purpose
<code>show hsr ring 1 [detail]</code>	Displays configuration details for the specified HSR ring.
<code>show hsr statistics {egressPacketStatistics ingressPacketStatistics nodeTableStatistics pauseFrameStatistics}</code>	Displays statistics for HSR components. Note To clear HSR statistics information, enter the command <code>clear hsr statistics</code> .
<code>show hsr node-table</code>	Displays HSR node table.
<code>show hsr vdan-table</code>	Displays HSR Virtual Doubly Attached Node (VDAN) table. Note The VDAN table and Proxy node table are the same.
<code>show cdp neighbors</code>	Displays CDP neighbor information for an HSR ring.
<code>show lldp neighbors</code>	Displays LLDP neighbor information for an HSR ring.
<code>show alarm settings begin hsr</code>	Display HSR alarm configuration.
<code>show alarm facility status</code>	Display HSR alarms, including partial or full ring faults.

Configuration Example

HSR-SAN

This example shows the configuration of an HSR ring (Ring 1) using G1/3 and G1/4 ports between four devices.



```

IE3400-1# conf t
Enter configuration commands, one per line. End with CNTL/Z.
IE3400-1(config)# interface range g1/3-4
IE3400-1(config-if-range)# shutdown
IE3400-1(config-if-range)# hsr-ring 1
IE3400-1(config-if-range)# no shutdown
IE3400-1(config-if-range)# end
IE3400-1#
IE3400-2# conf t
Enter configuration commands, one per line. End with CNTL/Z.
IE3400-2(config)# interface range g1/3-4
IE3400-2(config-if-range)# shutdown
IE3400-2(config-if-range)# hsr-ring 1
IE3400-2(config-if-range)# no shutdown
IE3400-2(config-if-range)# end
IE3400-2#
IE3400-3# conf t
Enter configuration commands, one per line. End with CNTL/Z.
IE3400-3(config)# interface range g1/3-4
IE3400-3(config-if-range)# shutdown
IE3400-3(config-if-range)# hsr-ring 1
IE3400-3(config-if-range)# no shutdown
IE3400-3(config-if-range)# end
IE3400-3#
IE3400-4# conf t
Enter configuration commands, one per line. End with CNTL/Z.
IE3400-4(config)# interface range g1/3-4
IE3400-4(config-if-range)# shutdown
IE3400-4(config-if-range)# hsr-ring 1
IE3400-4(config-if-range)# no shutdown
IE3400-4(config-if-range)# end
IE3400-4#
IE3400-1# sh hsr ring 1 detail
HSR-ring: HS1
-----
Layer type = L2
Operation Mode = mode-H
Ports: 2          Maxports = 2
Port state = hsr-ring is Inuse
Protocol = Enabled Redbox Mode = hsr-san
  
```

```

Ports in the ring:
  1) Port: Gi1/3
      Logical slot/port = 1/3      Port state = Inuse
      Protocol = Enabled
  2) Port: Gi1/4
      Logical slot/port = 1/4      Port state = Inuse
      Protocol = Enabled

```

```

Ring Parameters:
Redbox MacAddr: f454.3365.8a84
Node Forget Time: 60000 ms
Node Reboot Interval: 500 ms
Entry Forget Time: 400 ms
Proxy Node Forget Time: 60000 ms
Supervision Frame COS option: 0
Supervision Frame CFI option: 0
Supervision Frame VLAN Tag option: Disabled
Supervision Frame MacDa: 0x00
Supervision Frame VLAN id: 0
Supervision Frame Time: 3 ms
Life Check Interval: 2000 ms
Pause Time: 25 ms

```

```
IE3400-2# show hsr ring 1 detail
```

```
HSR-ring: HS1
```

```

-----
Layer type = L2
Operation Mode = mode-H
Ports: 2      Maxports = 2
Port state = hsr-ring is Inuse
Protocol = Enabled  Redbox Mode = hsr-san
Ports in the ring:
  1) Port: Gi1/3
      Logical slot/port = 1/3      Port state = Inuse
      Protocol = Enabled
  2) Port: Gi1/4
      Logical slot/port = 1/4      Port state = Inuse
      Protocol = Enabled

```

```

Ring Parameters:
Redbox MacAddr: 34c0.f958.ee83
Node Forget Time: 60000 ms
Node Reboot Interval: 500 ms
Entry Forget Time: 400 ms
Proxy Node Forget Time: 60000 ms
Supervision Frame COS option: 0
Supervision Frame CFI option: 0
Supervision Frame VLAN Tag option: Disabled
Supervision Frame MacDa: 0x00
Supervision Frame VLAN id: 0
Supervision Frame Time: 3 ms
Life Check Interval: 2000 ms
Pause Time: 25 ms

```

```
IE3400-4# sh hsr ring 1 de
```

```
HSR-ring: HS1
```

```

-----
Layer type = L2
Operation Mode = mode-H
Ports: 2      Maxports = 2
Port state = hsr-ring is Inuse
Protocol = Enabled  Redbox Mode = hsr-san
Ports in the ring:
  1) Port: Gi1/3

```

```

    Logical slot/port = 1/3      Port state = Inuse
      Protocol = Enabled
2) Port: Gi1/4
    Logical slot/port = 1/4      Port state = Inuse
      Protocol = Enabled

Ring Parameters:
Redbox MacAddr: f454.3312.5104
Node Forget Time: 60000 ms
Node Reboot Interval: 500 ms
Entry Forget Time: 400 ms
Proxy Node Forget Time: 60000 ms
Supervision Frame COS option: 0
Supervision Frame CFI option: 0
Supervision Frame VLAN Tag option: Disabled
Supervision Frame MacDa: 0x00
Supervision Frame VLAN id: 0
Supervision Frame Time: 3 ms
Life Check Interval: 2000 ms
Pause Time: 25 ms

IE3400-3# sh hsr ring 1 detail
HSR-ring: HS1
-----
Layer type = L2
Operation Mode = mode-H
Ports: 2          Maxports = 2
Port state = hsr-ring is Inuse
Protocol = Enabled Redbox Mode = hsr-san
Ports in the ring:
  1) Port: Gi1/3
    Logical slot/port = 1/3      Port state = Inuse
      Protocol = Enabled
  2) Port: Gi1/4
    Logical slot/port = 1/4      Port state = Inuse
      Protocol = Enabled

Ring Parameters:
Redbox MacAddr: f454.335c.4684
Node Forget Time: 60000 ms
Node Reboot Interval: 500 ms
Entry Forget Time: 400 ms
Proxy Node Forget Time: 60000 ms
Supervision Frame COS option: 0
Supervision Frame CFI option: 0
Supervision Frame VLAN Tag option: Disabled
Supervision Frame MacDa: 0x00
Supervision Frame VLAN id: 0
Supervision Frame Time: 3 ms
Life Check Interval: 2000 ms
Pause Time: 25 ms

```

Related Documents

- [Cisco Catalyst IE3400 Heavy Duty Series](#)
- [Cisco Catalyst IE3400 Rugged Series](#)
- IEC 62439-3, Industrial communication networks - High availability automation networks - Part 3: Parallel Redundancy Protocol (PRP) and High-availability Seamless Redundancy (HSR)

Feature History

Feature Name	Release	Feature Information
PTP over HSR-SAN	Cisco IOS XE 17.4.1	Initial support on IE 3400 and IE 3400H.
High-Availability Seamless Redundancy (HSR) - HSR-SAN (Single Redbox mode)	Cisco IOS XE 17.3.1	Initial support on IE 3400 and IE 3400H.

