



High Availability

- [Feature History for High Availability](#), on page 2
- [Information About High Availability](#), on page 3
- [Prerequisites for High Availability](#), on page 4
- [Restrictions on High Availability](#), on page 5
- [Configuring High Availability \(CLI\)](#), on page 6
- [Disabling High Availability](#), on page 7
- [Copying a WebAuth Tar Bundle to the Standby Controller](#), on page 8
- [System and Network Fault Handling](#), on page 10
- [Handling Recovery Mechanism](#), on page 15
- [Verifying High Availability Configurations](#), on page 16
- [Verifying AP or Client SSO Statistics](#), on page 16
- [Verifying High Availability](#), on page 18
- [High Availability Deployment for Application Centric Infrastructure \(ACI\) Network](#), on page 21
- [Information About Redundancy Management Interface](#), on page 25
- [Configuring Redundancy Management Interface \(GUI\)](#), on page 29
- [Configuring Redundancy Management Interface \(CLI\)](#), on page 30
- [Configuring Gateway Monitoring \(CLI\)](#), on page 32
- [Configuring Gateway Monitoring Interval \(CLI\)](#), on page 33
- [Gateway Reachability Detection](#), on page 33
- [Monitoring the Health of the Standby Controller](#), on page 34
- [Monitoring the Health of Standby Parameters Using SNMP](#), on page 36
- [Monitoring the Health of Standby Controller Using Programmatic Interfaces](#), on page 38
- [Monitoring the Health of Standby Controller Using CLI](#), on page 39
- [Verifying the Gateway-Monitoring Configuration](#), on page 42
- [Verifying the RMI IPv4 Configuration](#), on page 43
- [Verifying the RMI IPv6 Configuration](#), on page 44
- [Verifying Redundancy Port Interface Configuration](#), on page 44
- [Information About Auto-Upgrade](#), on page 47
- [Configuration Workflow](#), on page 48
- [Configuring Auto-Upgrade \(CLI\)](#), on page 48
- [Use Case for Link Layer Discovery Protocol \(LLDP\)](#), on page 48
- [Enabling LLDP \(CLI\)](#), on page 49
- [Enabling LLDP Timers \(CLI\)](#), on page 49

- [Enabling LLDP TLV-Select \(CLI\), on page 50](#)
- [Verifying LLDP, on page 50](#)
- [Feature History for Reload Reason History, on page 52](#)
- [Information About Reload Reason History, on page 52](#)
- [Verifying Reload Reason History , on page 52](#)
- [Requesting Reload Reason History using YANG, on page 55](#)

Feature History for High Availability

This table provides release and related information for the features explained in this module.

These features are available in all the releases subsequent to the one they were introduced in, unless noted otherwise.

Table 1: Feature History for High Availability

Release	Feature	Feature Information
Cisco IOS XE Amsterdam 17.1.1s	Redundant Management Interface	The Redundancy Management Interface (RMI) is used as a secondary link between the active and standby controllers. This interface is the same as the Wireless Management Interface and the IP address on this interface is configured in the same subnet as the Wireless Management Interface.
Cisco IOS XE Bengaluru 17.4.1	Gateway Reachability Detection	Gateway reachability feature minimizes the downtime on APs and clients when the gateway reachability is lost on the active controller.
Cisco IOS XE Bengaluru 17.5.1	Standby Monitoring Enhancements	The Standby Monitoring Enhancements feature monitors the standby CPU or memory information from the active controller. Also, this feature independently monitors the standby controller using SNMP for the interface MIB. The cLHaPeerHotStandbyEvent and cLHaPeerHotStandbyEvent MIB objects in CISCO-HA-MIB are used to monitor the standby HA status.
Cisco IOS XE Bengaluru 17.5.1	Auto-Upgrade	The auto-upgrade feature enables the standby controller to upgrade to active controller's software image, so that both controllers can form an high availability (HA) pair.
Cisco IOS XE Bengaluru 17.6.1	Standby Interface Status using Active SNMP	This feature allows the standby controller interface status to be queried at the active using SNMP.

Release	Feature	Feature Information
Cisco IOS XE Cupertino 17.9.1	High Availability Deployment for Application Centric Infrastructure (ACI) Network	This feature avoids interleaving traffic between the old and new active controller using the following functionalities: <ul style="list-style-type: none"> • Bringing down Wireless Management Interface (WMI) faster. • Disabling fast switchover notification.
	Link Layer Discovery Protocol (LLDP) Support in the Standby Controller	From this release, the Link Layer Discovery Protocol (LLDP) process will be up and running in both active and standby controllers.

Information About High Availability

High Availability (HA) allows you to reduce the downtime of wireless networks that occurs due to the failover of controllers. The HA Stateful Switch Over (SSO) capability on the controller allows AP to establish a CAPWAP tunnel with the active controller. The active controller shares a mirror copy of the AP and client database with the standby controller. The APs won't go into the discovery state and clients don't disconnect when the active controller fails. The standby controller takes over the network as the active controller. Only one CAPWAP tunnel is maintained between the APs and the controller that is in an active state.

HA supports full AP and client SSO. Client SSO is supported only for clients that have completed the authentication and DHCP phase, and have started passing traffic. With Client SSO, the client information is synced to the standby controller when the client associates to the controller or when the client parameters change. Fully authenticated clients, for example, the ones in RUN state, are synced to the standby. Thus, client reassociation is avoided on switchover making the failover seamless for the APs and clients, resulting in zero client service downtime and zero SSID outage. This feature reduces major downtime in wireless networks due to failure conditions such as box failover, network failover, or power outage on the primary site.



Note

- In HA mode, the RP port shut or no shut should not be performed during the controller bootup.
- If the RP communication is lost between active and standby controller during HA sync, the standby controller crashes as the IPC communication fails. The crash is intentional.
If RP link is restored, the standby controller gracefully reloads and forms an HA pair.



Note

When the controller works as a host for spanning tree, ensure that you configure portfast trunk, using **spanning-tree port type edge trunk** or **spanning-tree portfast trunk** commands, in the uplink switch to ensure faster convergence.



Note

You can configure FIPS in HA setup. For information, see the [Configuring FIPS in HA Setup](#).



Note The IPv4 secondary address is used internally for RMI purpose. So, it is not recommended to configure the secondary IPv4 address.

In case of IPv6, only one management IPv6 is allowed, secondary address is configured for RMI-IPv6 purpose. It is not recommended to have more than one IPv6 management on the Wireless Management Interface (WMI).

More than one management IPv4 and IPv6 addresses on WMI can result in unpredictable behavior.

Prerequisites for High Availability

External Interfaces and IPs

Because all the interfaces are configured only on the Active box, but are synchronized with the Standby box, the same set of interfaces are configured on both controllers. From external nodes, the interfaces connect to the same IP addresses, irrespective of the controllers they are connected to.

For this purpose, the APs, clients, DHCP, Cisco Prime Infrastructure, Cisco Catalyst Centre, and Cisco Identity Services Engine (ISE) servers, and other controller members in the mobility group always connect to the same IP address. The SSO switchover is transparent to them. But if there are TCP connections from external nodes to the controller, the TCP connections need to be reset and reestablished.

HA Interfaces

The HA interface serves the following purposes:

- Provides connectivity between the controller pair before an IOSd comes up.
- Provides IPC transport across the controller pair.
- Enables redundancy across control messages exchanged between the controller pair. The control messages can be HA role resolution, keepalives, notifications, HA statistics, and so on.

You can select either SFP or RJ-45 connection for HA port. Supported Cisco SFPs are:

- GLC-SX-MMD
- GLC-LH-SMD

When either SFP or RJ-45 connection is present, HA works between the two controllers. The SFP HA connectivity takes priority over RJ-45 HA connectivity. If SFP is connected when RJ-45 HA is up and running, the HA pair reloads. The reload occurs even if the link between the SFPs isn't connected.



-
- Note**
- It is recommended to have a dedicated physical NIC and Switch for RP when the HA pair is deployed across two host machines. This avoids any keep-alive loses and false HA switchovers or alarms.
 - Disable security scans on VMware virtual instances.
-

Restrictions on High Availability

- For a fail-safe SSO, wait till you receive the switchover event after completing configuration synchronization on the standby controller. If the standby controller has just been booted up, we recommend that you wait x minutes before the controller can handle switchover events without any problem. The value of x can change based on the platform. For example, a Cisco 9800-80 Series Controller running to its maximum capacity can take up to 24 minutes to complete the configuration synchronization before being ready for SSO. You can use the **show wireless stats redundancy config database** command to view the database-related statistics.
- The flow states of the NBAR engine are lost during a switchover in an HA scenario in local mode. Because of this, the classification of flows will restart, leading to incorrect packet classification as the first packet of the flow is missed.
- The HA connection supports only IPv4.
- Switchover and an active reload and forces a high availability link down from the new primary.
- Hyper threading is not supported and if enabled HA keepalives will be lost in case of an HA system that results in stack merge.
- Standby RMI interface does not support Web UI access.
- Two HA interfaces (RMI and RP) must be configured on the same subnet, and the subnet cannot be shared with any other interfaces on the device.
- It is not possible to synchronize a TCP session state because a TCP session cannot survive after a switchover, and needs to be reestablished.
- The Client SSO does not address clients that have not reached the RUN state because they are removed after a switchover.
- Statistics tables are not synced from active to standby controller.
- Machine snapshot of a VM hosting controller HA interfaces is not supported. It may lead to a crash in the HA controller.
- Mobility-side restriction: Clients which are not in RUN state will be forcefully reauthenticated after switchover.
- The following application classification may not be retained after the SSO:
 - AVC limitation—After a switchover, the context transfer or synchronization to the Standby box does not occur and the new active flow needs to be relearned. The AVC QoS does not take effect during classification failure.
 - A voice call cannot be recognized after a switchover because a voice policy is based on RTP or RTCP protocol.
 - Auto QoS is not effective because of AVC limitation.
- The active controller and the standby controller must be paired with the same interface for virtual platforms. For hardware appliance, there is a dedicated HA port.
- Static IP addressing can synch to standby, but the IP address cannot be used from the standby controller.

- You can map a dedicated HA port to a 1 GB interface only.
- To use EtherChannels in HA mode in releases until, and including, Cisco IOS XE Gibraltar 16.12.x, ensure that the channel mode is set to On.
- EtherChannel Auto-mode is not supported in HA mode in releases until, and including, Cisco IOS XE Gibraltar 16.12.x.
- LACP and PAGP is not supported in HA mode in releases until, and including, Cisco IOS XE Gibraltar 16.12.x.
- When the controller works as a host for spanning tree, ensure that you configure portfast trunk in the uplink switch using **spanning-tree port type edge trunk** or **spanning-tree portfast trunk** command to ensure faster convergence.
- The **clear chassis redundancy** and **write erase** commands will not reset the chassis priority to the default value.
- While configuring devices in HA, the members must not have wireless trustpoint with the same name and different keys. In such a scenario, if you form an HA pair between the two standalone controllers, the wireless trustpoint does not come up after a subsequent SSO. The reason being the *rsa keypair* file exists but it is incorrect as the *nvrn:private-config* file is not synched with the actual *WLC_WLC_TP* key pair.
As a best practice, before forming an HA, it is recommended to delete the existing certificates and keys in each of the controllers which were previously deployed as standalone.
- After a switchover, when the recovery is in progress, do not configure the WLAN or WLAN policy. In case you configure, the controller can crash.
- After a switchover, clients that are not in RUN state and not connected to an AP are deleted after 300 seconds.

Configuring High Availability (CLI)

Before you begin

The active and standby controller should be in the same mode, either Install mode or Bundle mode, with same image version. We recommend that you use Install mode.

Procedure

	Command or Action	Purpose
Step 1	chassis chassis-num priority chassis-priority Example: Device# chassis 1 priority 1	(Optional) Configures the priority of the specified device. Note From Cisco IOS XE Gibraltar 16.12.x onwards, device reload is not required for the chassis priority to become effective.

	Command or Action	Purpose
		<ul style="list-style-type: none"> • <i>chassis-num</i>—Enter the chassis number. The range is from 1 to 2. • <i>chassis-priority</i>—Enter the chassis priority. The range is from 1 to 2. The default value is 1. <p>Note When both the devices boot up at the same time, the device with higher priority(2) becomes active, and the other one becomes standby. If both the devices are configured with the same priority value, the one with the smaller MAC address acts as active and its peer acts as standby.</p>
Step 2	<p>chassis redundancy ha-interface GigabitEthernet <i>num</i> local-ip <i>local-chassis-ip-addr</i> network-mask <i>remote-ip</i> remote-chassis-ip-addr</p> <p>Example:</p> <pre>Device# chassis redundancy ha-interface GigabitEthernet 2 local-ip 4.4.4.1 /24 remote-ip 4.4.4.2</pre>	<p>Configures the chassis high availability parameters.</p> <ul style="list-style-type: none"> • <i>num</i>—GigabitEthernet interface number. The range is from 0 to 32. • <i>local-chassis-ip-addr</i>—Enter the IP address of the local chassis HA interface. • <i>network-mask</i>—Enter the network mask or prefix length in the <i>/nn</i> or <i>A.B.C.D</i> format. • <i>remote-chassis-ip-addr</i>—Enter the remote chassis IP address.
Step 3	<p>chassis redundancy keep-alive timer <i>timer</i></p> <p>Example:</p> <pre>Device# chassis redundancy keep-alive timer 6</pre>	<p>Configures the peer keepalive timeout value.</p> <p>Time interval is set in multiple of 100 ms (enter 1 for default).</p>
Step 4	<p>chassis redundancy keep-alive retries <i>retry-value</i></p> <p>Example:</p> <pre>Device# chassis redundancy keep-alive retries 8</pre>	<p>Configures the peer keepalive retry value before claiming peer is down. Default value is 5.</p>

Disabling High Availability

If the controller is configured using RP method of SSO configuration, use the following command to clear all the HA-related parameters, such as local IP, remote IP, HA interface, mask, timeout, and priority:

clear chassis redundancy

If the controller is configured using RMI method, use the following command:

no redun-management interface vlan chassis



Note Reload the devices for the changes to take effect.

After the HA unpairing, the standby controller startup configuration and the HA configuration will be cleared and standby will go to Day 0.

Before the command is executed, the user is prompted with the following warning on the active controller:

```
Device# clear chassis redundancy

WARNING: Clearing the chassis HA configuration will result in both the chassis move into
Stand Alone mode. This involves reloading the standby chassis after clearing its HA
configuration and startup configuration which results in standby chassis coming up as a
totally
clean after reboot. Do you wish to continue? [y/n]? [yes]:

*Apr 3 23:42:22.985: received clear chassis.. ha_supported:lyes
WLC#
*Apr 3 23:42:25.042: clearing peer startup config
*Apr 3 23:42:25.042: chkpt send: sent msg type 2 to peer..
*Apr 3 23:42:25.043: chkpt send: sent msg type 1 to peer..
*Apr 3 23:42:25.043: Clearing HA configurations
*Apr 3 23:42:26.183: Successfully sent Set chassis mode msg for chassis 1.chasfs file updated
*Apr 3 23:42:26.359: %IOSXE_REDUNDANCY-6-PEER_LOST: Active detected chassis 2 is no
longer standby
```

On the standby controller, the following messages indicate that the configuration is being cleared:

```
Device-stby#

*Apr 3 23:40:40.537: mcprp_handle_spa_oir_tsm_event: subslot 0/0 event=2
*Apr 3 23:40:40.537: spa_oir_tsm subslot 0/0 TSM: during state ready, got event 3(ready)
*Apr 3 23:40:40.537: @@@ spa_oir_tsm subslot 0/0 TSM: ready -> ready
*Apr 3 23:42:25.041: Removing the startup config file on standby

!Standby controller is reloaded after clearing the chassis.
```

Copying a WebAuth Tar Bundle to the Standby Controller

Use the following procedure to copy a WebAuth tar bundle to the standby controller, in a high-availability configuration.

Procedure

- Step 1** Choose **Administration > Management > Backup & Restore**.
- Step 2** From the **Copy** drop-down list, choose **To Device**.
- Step 3** From the **File Type** drop-down list, choose **WebAuth Bundle**.

Step 4 From the **Transfer Mode** drop-down list, choose **TFTP**, **SFTP**, **FTP**, or **HTTP**.

The **Server Details** options change based on the file transfer option selected.

- **TFTP**

- **IP Address (IPv4/IPv6):** Enter the server IP address (IPv4 or IPv6) of the TFTP server that you want to use.
- **File Path:** Enter the file path. The file path should start with slash a (*/path*).
- **File Name:** Enter a file name.
The file name should not contain spaces. Underscores (`_`) and hyphen (`-`) are the only special characters that are supported. Ensure that file name ends with `.tar`, for example, `webauthbundle.tar`.

- **SFTP**

- **IP Address (IPv4/IPv6):** Enter the server IP address (IPv4 or IPv6) of the SFTP server that you want to use.
- **File Path:** Enter the file path. The file path should start with slash a (*/path*).
- **File Name:** Enter a file name.
The file name should not contain spaces. Underscores (`_`) and hyphen (`-`) are the only special characters that are supported. Ensure that file name ends with `.tar`, for example, `webauthbundle.tar`.
- **Server Login UserName:** Enter the SFTP server login user name.
- **Server Login Password:** Enter the SFTP server login passphrase.

- **FTP**

- **IP Address (IPv4/IPv6):** Enter the server IP address (IPv4 or IPv6) of the TFTP server that you want to use.
- **File Path:** Enter the file path. The file path should start with slash a (*/path*).
- **File Name:** Enter a file name.
The file name should not contain spaces. Underscores (`_`) and hyphen (`-`) are the only special characters that are supported. Ensure that file name ends with `.tar`, for example, `webauthbundle.tar`.
- **Logon Type:** Choose the logon type as either **Anonymous** or **Authenticated**. If you choose **Authenticated**, the following fields are activated:
 - **Server Login UserName:** Enter the FTP server login user name.
 - **Server Login Password:** Enter the FTP server login passphrase.

- **HTTP**

- **Source File Path:** Click **Select File** to select the configuration file, and click **Open**.

Step 5 Click the **Yes** or **No** radio button to back up the existing startup configuration to Flash.

Save the configuration to Flash to propagate the WebAuth bundle to other members, including the standby controller. If you do not save the configuration to Flash, the WebAuth bundle will not be propagated to other members, including the standby controller.

Step 6 Click **Download File**.

System and Network Fault Handling

If the standby controller crashes, it reboots and comes up as the standby controller. Bulk sync follows causing the standby to become hot. If the active controller crashes, the standby becomes active. The new active controller assumes the role of primary and tries to detect a dual active.

The following matrices provide a clear picture of the conditions the controller switchover would trigger:

Table 2: System and Network Fault Handling

System Issues				
Trigger	RP Link Status	Peer Reachability through RMI	Switchover	Result
Critical process crash	Up	Reachable	Yes	Switchover happens
Forced switchover	Up	Reachable	Yes	Switchover happens
Critical process crash	Up	Unreachable	Yes	Switchover happens
Forced switchover	Up	Unreachable	Yes	Switchover happens
Critical process crash	Down	Reachable	No	No action. One controller in recovery mode.
Forced switchover	Down	Reachable	N/A	No action. One controller in recovery mode.
Critical process crash	Down	Unreachable	No	Double fault – as mentioned in Network Error handling
Forced switchover	Down	Unreachable	N/A	Double fault – as mentioned in Network Error handling

RP Link	Peer Reachability Through RMI	Gateway From Active	Gateway From Standby	Switchover	Result
Up	Reachable	Reachable	Reachable	No SSO	No action
Up	Reachable	Reachable	Unreachable	No SSO	No action. Standby is not ready for SSO in this state, as it does not have gateway reachability. The standby is shown to be in standby-recovery mode. If the RP goes down, standby (in recovery mode) becomes active.
Up	Reachable	Unreachable	Reachable	SSO	Gateway reachability message is exchanged over the RMI + RP links. Active reboots so that the standby becomes active.
Up	Reachable	Unreachable	Unreachable	No SSO	With this, when the active SVI goes down, the standby SVI also goes down. A switchover is then triggered. If the new active discovers its gateway to be reachable, the system stabilizes in the Active - Standby Recovery mode. Otherwise, switchovers happen in a ping-pong fashion.

RP Link	Peer Reachability Through RMI	Gateway From Active	Gateway From Standby	Switchover	Result
Up	Unreachable	Reachable	Reachable	No SSO	No action
Up	Unreachable	Reachable	Unreachable	No SSO	Standby is not ready for SSO in this state as it does not have gateway reachability. Standby moves in to recovery mode as LMP messages are exchanged over the RP link.
Up	Unreachable	Unreachable	Reachable	SSO	Gateway reachability message is exchanged over RP link. Active reboots so that standby becomes active.
Up	Unreachable	Unreachable	Unreachable	No SSO	With this, when the active SVI goes down, the standby SVI also goes down. A switchover is then triggered. If the new active discovers its gateway to be reachable, the system stabilizes in Active - Standby Recovery mode. Otherwise, switchovers happen in a ping-pong fashion.

RP Link	Peer Reachability Through RMI	Gateway From Active	Gateway From Standby	Switchover	Result
Down	Reachable	Reachable	Reachable	No SSO	Standby detects the presence of the Active over the RMI link and avoids switchover when the RP link goes down. In such a case, the standby goes to recovery mode. This mode is represented through suffix rp-rec-mode in the hostname. The standby in recovery mode reloads when the RP link comes up. Single faults are gracefully handled in the system.
Down	Reachable	Reachable	Unreachable	No SSO	Same as above.

RP Link	Peer Reachability Through RMI	Gateway From Active	Gateway From Standby	Switchover	Result
Down	Reachable	Unreachable	Reachable	RP link down, then active loses GW, then there won't be any SSO. GW down, within 8 seconds, RP link goes down, then there would be a SSO.	Gateway reachability message is exchanged over RP+RMI links. Old-Active goes to active-recovery mode. The configuration mode is disabled in active-recovery mode. All interfaces will be ADMIN DOWN with the wireless management interface having RMI IP. The controller in active-recovery will reload to become standby (or standby-recovery if gateway reachability is still not available) when the RP link comes up.
Down	Reachable	Unreachable	Unreachable	No SSO	Standby goes to standby-recovery.

RP Link	Peer Reachability Through RMI	Gateway From Active	Gateway From Standby	Switchover	Result
Down	Unreachable	Reachable	Reachable	SSO	Double fault – this may result in a network conflict as there will be two active controllers. Standby becomes active. Old active also exists. Role negotiation has to happen once the connectivity is restored and keep the active that came up last.
Down	Unreachable	Reachable	Unreachable	SSO	Same as above.
Down	Unreachable	Unreachable	Reachable	SSO	Same as above.
Down	Unreachable	Unreachable	Unreachable	SSO	Same as above.

Handling Recovery Mechanism

Active to Active Recovery

- When RP is down and RMI is up at boot up, the Active Recovery occurs.
- When HA is stable (active - standby), if RMI is down first and then RP goes down next, and later if RMI comes up before RP comes up, the Active to Active Recovery occurs. Once the RP is up, the Active Recovery reloads and HA is formed.

Standby to Standby Recovery

- When Standby goes to Standby Recovery for Gateway alone, once the Gateway is up, the HA comes up without any reboot.
- When Standby goes to Standby Recovery for RP down, once the RP is up, the standby recovery reboots automatically and HA is formed.

Verifying High Availability Configurations

To view the HA configuration details, use the following command:

```
Device# show romvar
ROMMON variables:
LICENSE_BOOT_LEVEL =
MCP_STARTUP_TRACEFLAGS = 00000000:00000000
BOOTLDR =
CRASHINFO = bootflash:crashinfo_RP_00_00_20180202-034353-UTC
STACK_1_1 = 0_0
CONFIG_FILE =
BOOT =
bootflash:boot_image_test,1;bootflash:boot_image_good,1;bootflash:rp_super_universalk9.vwlc.bin,1;

RET_2_RTS =
SWITCH_NUMBER = 1
CHASSIS_HA_REMOTE_IP = 10.0.1.9
CHASSIS_HA_LOCAL_IP = 10.0.1.10
CHASSIS_HA_LOCAL_MASK = 255.255.255.0
CHASSIS_HA_IFNAME = GigabitEthernet2
CHASSIS_HA_IFMAC = 00:0C:29:C9:12:0B
RET_2_RCALTS =
BSI = 0
RANDOM_NUM = 647419395
```

Verifying AP or Client SSO Statistics

To view the AP SSO statistics, use the following command:

```
Device# show wireless stat redundancy statistics ap-recovery wnc all
AP SSO Statistics
```

Inst	Timestamp	Dura (ms)	#APs	#Succ	#Fail	Avg (ms)	Min (ms)	Max (ms)
0	00:06:29.042	98	34	34	0	2	1	35
1	00:06:29.057	56	33	30	3	1	1	15
2	00:06:29.070	82	33	33	0	2	1	13

Statistics:

```
WNCD Instance : 0
No. of AP radio recovery failures : 0
No. of AP BSSID recovery failures : 0
No. of CAPWAP recovery failures : 0
No. of DTLS recovery failures : 0
No. of reconcile message send failed : 0
No. of reconcile message successfully sent : 34
No. of Mesh BSSID recovery failures: 0
No. of Partial delete cleanup done : 0
.
.
.
```

To view the Client SSO statistics, use the following command:

```
Device# show wireless stat redundancy client-recovery wncd all
Client SSO statistics
-----
```



```

WNCD instance      : 1
Reconcile messages received from AP      : 1
Reconcile clients received from AP       : 1
Recreate attempted post switchover        : 1
Recreate attempted by SANET Lib           : 0
Recreate attempted by DOT1x Lib           : 0
Recreate attempted by SISF Lib            : 0
Recreate attempted by SVC CO Lib          : 1
Recreate attempted by Unknown Lib         : 0
Recreate succeeded post switchover         : 1
Recreate Failed post switchover           : 0
Stale client entries purged post switchover : 0

Partial delete during heap recreate        : 0
Partial delete during force purge          : 0
Partial delete post restart                : 0
Partial delete due to AP recovery failure  : 0
Partial delete during reconciliation        : 0

Client entries in shadow list during SSO   : 0
Client entries in shadow default state during SSO : 0
Client entries in poison list during SSO   : 0

Invalid bssid during heap recreate         : 0
Invalid bssid during force purge           : 0
BSSID mismatch with shadow rec during reconciliation : 0
BSSID mismatch with shadow rec reconciliation(WGB client): 0
BSSID mismatch with dot11 rec during heap recreate : 0

AID mismatch with dot11 rec during force purge : 0
AP slotid mismatch during reconciliation    : 0
Zero aid during heap recreate              : 0
AID mismatch with shadow rec during reconciliation : 0
AP slotid mismatch shadow rec during reconciliation : 0
Client shadow record not present           : 0

```

To view the mobility details, use the following command:

```

Device# show wireless stat redundancy client-recovery mobilityd
Mobility Client Deletion Reason Statistics
-----
Mobility Incomplete State      : 0
Inconsistency in WNCD & Mobility : 0
Partial Delete                  : 0

General statistics
-----
Cleanup sent to WNCD, Missing Delete case : 0

```

To view the Client SSO statistics for SISF, use the following command:

```

Device# show wireless stat redundancy client-recovery sisf
Client SSO statistics for SISF
-----
Number of recreate attempted post switchover : 1
Number of recreate succeeded post switchover  : 1
Number of recreate failed because of no mac  : 0
Number of recreate failed because of no ip   : 0
Number of ipv4 entry recreate success        : 1
Number of ipv4 entry recreate failed         : 0
Number of ipv6 entry recreate success        : 0
Number of ipv6 entry recreate failed         : 0
Number of partial delete received           : 0

```

```

Number of client purge attempted           : 0
Number of heap and db entry purge success  : 0
Number of purge success for db entry only  : 0
Number of client purge failed              : 0
Number of garp sent                        : 1
Number of garp failed                      : 0
Number of IP entries validated in cleanup   : 0
Number of IP entry address errors in cleanup : 0
Number of IP entry deleted in cleanup      : 0
Number of IP entry delete failed in cleanup : 0
Number of IP table create callbacks on standby : 0
Number of IP table modify callbacks on standby : 0
Number of IP table delete callbacks on standby : 0
Number of MAC table create callbacks on standby : 1
Number of MAC table modify callbacks on standby : 0
Number of MAC table delete callbacks on standby : 0

```

To view the HA redundancy summary, use the following command:

```

Device# show wireless stat redundancy summary
HA redundancy summary
-----

```

```

AP recovery duration (ms)           : 264
SSO HA sync timer expired           : No

```

Verifying High Availability

Table 3: Commands for Monitoring Chassis and Redundancy

Command Name	Description
show chassis	<p>Displays the chassis information.</p> <p>Note When the peer timeout and retries are configured, the show chassis ha-status command output may show incorrect values.</p> <p>To check the peer keep-alive timer and retries, use the following commands:</p> <ul style="list-style-type: none"> • show platform software stack-mgr chassis active r0 peer-timeout • show platform software stack-mgr chassis standby r0 peer-timeout
show redundancy	Displays details about Active box and Standby box.
show redundancy switchover history	Displays the switchover counts, switchover reason, and the switchover time.

To start the packet capture in the redundancy HA port (RP), use the following commands:

- test wireless redundancy packet dump start
- test wireless redundancy packet dump stop

- test wireless redundancy packet dump start filter port 2300

```
Device# test wireless redundancy packetdump start
Redundancy Port PacketDump Start
Packet capture started on RP port.
```

```
Device# test wireless redundancy packetdump stop
Redundancy Port PacketDump Start
Packet capture started on RP port.
Redundancy Port PacketDump Stop
Packet capture stopped on RP port.
```

```
Device# dir bootflash:
```

```
Directory of bootflash:/
```

```
1062881 drwx          151552 Oct 20 2020 23:15:25 +00:00  tracelogs
47      -rw-          20480 Oct 20 2020 23:15:24 +00:00  haIntCaptureLo.pcap
1177345 drwx          4096 Oct 20 2020 19:56:14 +00:00  certs
294337  drwx          8192 Oct 20 2020 19:56:05 +00:00  license_evlog
15      -rw-           676 Oct 20 2020 19:56:01 +00:00  vlan.dat
14      -rw-           30 Oct 20 2020 19:55:16 +00:00  throughput_monitor_params
13      -rw-        134808 Oct 20 2020 19:54:57 +00:00  memleak.tcl
1586145 drwx          4096 Oct 20 2020 19:54:45 +00:00  .inv
1103761 drwx          4096 Oct 20 2020 19:54:39 +00:00  dc_profile_dir
17      -r--           114 Oct 20 2020 19:54:17 +00:00  debug.conf
1389921 drwx          4096 Oct 20 2020 19:54:17 +00:00  .installer
46      -rw-        1104760207 Oct 20 2020 19:26:41 +00:00  leela_katar_rping_test.SSA.bin
49057   drwx          4096 Oct 20 2020 16:11:21 +00:00  .prst_sync
45      -rw-        1104803200 Oct 20 2020 15:39:19 +00:00
C9800-L-universalk9_wlc.2020-10-20_14.57_yavadhan.SSA.bin
269809  drwx          4096 Oct 19 2020 23:41:49 +00:00  core
44      -rw-        1104751981 Oct 19 2020 17:42:12 +00:00
C9800-L-universalk9_wlc.BLD_POLARIS_DEV_LATEST_20201018_053825_2.SSA.bin
43      -rw-        1104286975 Oct 16 2020 12:05:47 +00:00
C9800-L-universalk9_wlc.BLD_POLARIS_DEV_LATEST_20201010_001654_2.SSA.bin
```

```
Device# test wireless redundancy packetdump start filter port 2300
Redundancy Port PacketDump Start
Packet capture started on RP port with port filter 2300.
```

To check connection between the two HA Ports (RP) and check if there are any drops, delays, or jitter in the connection, use the following command:

```
Device# test wireless redundancy rping
Redundancy Port ping
PING 169.254.64.60 (169.254.64.60) 56(84) bytes of data.
64 bytes from 169.254.64.60: icmp_seq=1 ttl=64 time=0.083 ms
64 bytes from 169.254.64.60: icmp_seq=2 ttl=64 time=0.091 ms
64 bytes from 169.254.64.60: icmp_seq=3 ttl=64 time=0.074 ms

--- 169.254.64.60 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2041ms
rtt min/avg/max/mdev = 0.074/0.082/0.091/0.007 ms
test wireless redundancy
```

To see the HA port interface setting status, use the **show platform hardware slot R0 ha_port interface stats** command.

```
Device# show platform hardware slot R0 ha_port interface stats
HA Port
ha_port  Link encap:Ethernet HWaddr 70:18:a7:c8:80:70
         UP BROADCAST MULTICAST MTU:1500 Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
```

```
RX bytes:0 (0.0 B) TX bytes:0 (0.0 B)
Memory:e0900000-e0920000
```

```
Settings for ha_port:
Supported ports:          [ TP ]
Supported link modes:    10baseT/Half 10baseT/Full
                        100baseT/Half 100baseT/Full
                        1000baseT/Full

Supported pause frame use: Symmetric
Supports auto-negotiation: Yes
Supported FEC modes:     Not reported
Advertised link modes:  10baseT/Half 10baseT/Full
                        100baseT/Half 100baseT/Full
                        1000baseT/Full

Advertised pause frame use: Symmetric
Advertised auto-negotiation: Yes
Advertised FEC modes:   Not reported
Speed:                  Unknown!
Duplex:                  Unknown! (255)
Port:                    Twisted Pair
PHYAD:                   1
Transceiver:             internal
Auto-negotiation:       on
MDI-X:                   off (auto)
Supports Wake-on:       pumbg
Wake-on:                 g
Current message level:  0x00000007 (7)
                        drv probe link
Link detected:          no
```

```
NIC statistics:
rx_packets:             0
tx_packets:             0
rx_bytes:               0
tx_bytes:               0
rx_broadcast:           0
tx_broadcast:           0
rx_multicast:           0
tx_multicast:           0
multicast:              0
collisions:             0
rx_crc_errors:          0
rx_no_buffer_count:     0
rx_missed_errors:       0
tx_aborted_errors:      0
tx_carrier_errors:      0
tx_window_errors:       0
tx_abort_late_coll:     0
tx_deferred_ok:         0
tx_single_coll_ok:      0
tx_multi_coll_ok:       0
tx_timeout_count:       0
rx_long_length_errors:  0
rx_short_length_errors: 0
rx_align_errors:        0
tx_tcp_seg_good:        0
tx_tcp_seg_failed:      0
rx_flow_control_xon:    0
rx_flow_control_xoff:   0
tx_flow_control_xon:    0
tx_flow_control_xoff:   0
rx_long_byte_count:     0
tx_dma_out_of_sync:     0
tx_smbus:               0
```

```
rx_smbus: 0
dropped_smbus: 0
os2bmc_rx_by_bmc: 0
os2bmc_tx_by_bmc: 0
os2bmc_tx_by_host: 0
os2bmc_rx_by_host: 0
tx_hwtstamp_timeouts: 0
rx_hwtstamp_cleared: 0
rx_errors: 0
tx_errors: 0
tx_dropped: 0
rx_length_errors: 0
rx_over_errors: 0
rx_frame_errors: 0
rx_fifo_errors: 0
tx_fifo_errors: 0
tx_heartbeat_errors: 0
tx_queue_0_packets: 0
tx_queue_0_bytes: 0
tx_queue_0_restart: 0
tx_queue_1_packets: 0
tx_queue_1_bytes: 0
tx_queue_1_restart: 0
rx_queue_0_packets: 0
rx_queue_0_bytes: 0
rx_queue_0_drops: 0
rx_queue_0_csum_err: 0
rx_queue_0_alloc_failed:0
rx_queue_1_packets: 0
rx_queue_1_bytes: 0
rx_queue_1_drops: 0
rx_queue_1_csum_err: 0
rx_queue_1_alloc_failed:0
```

High Availability Deployment for Application Centric Infrastructure (ACI) Network

Information About Deploying ACI Network in Controller

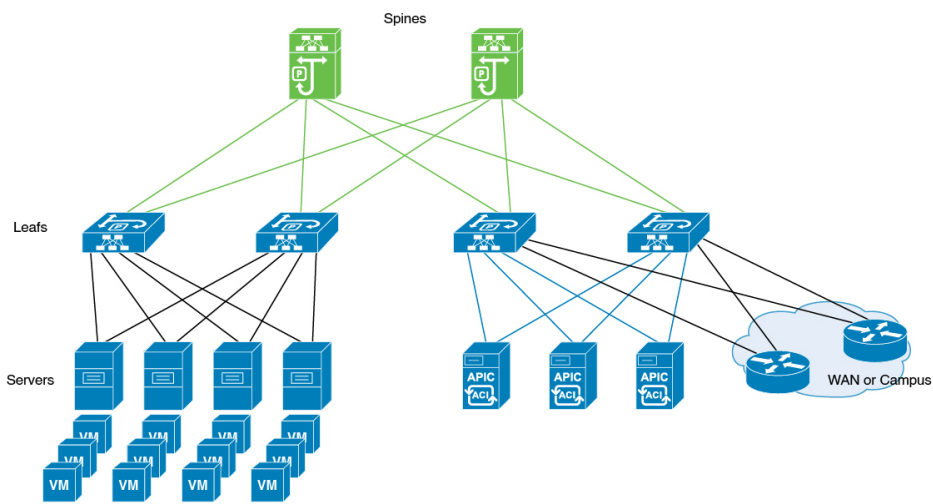
Cisco Application Centric Infrastructure (ACI) technology integrates virtual and physical workloads in a programmable and multihypervisor fabric to build a multiservice or a cloud data center.



Note The Cisco ACI technology is supported only in a Redundancy Management Interface (RMI) high-availability network.

The following figure depicts the discrete components connected in a spine and leaf switch topology provisioned and managed as a single entity.

Figure 1: Cisco ACI Network Deployment



The following mechanisms help avoid interleaving traffic.

Bringing Down Wireless Management Interface Faster

In case of a switchover in ACI deployments, APs and clients are dropped because of interleaving traffic between the old and the new active controller. To resolve this issue, bring down the traffic from the old active controller faster. You can do this by bringing down the wireless management interface as soon as a failure is detected. When the wireless management interface shuts down, the traffic that is sourced from the old active wireless management interface stops. This avoids conflicts in the management IP address. The standby controller transitions to the role of the active controller with a new IP-MAC binding.



Note The IP Data-Plane Learning feature in an ACI deployment tracks the following:

- A duplicate MAC address for the same IP.
- Alarm that blocks the IP address for a configured duration.

During failure detection, the controller sets up the chassis property **non-participant**. In IP Data-Plane Learning feature, listen to the property for bringing down the wireless management interface and shutting down traffic in the old active controller faster, thereby avoiding any kind of interleaving traffic between the old and new active controllers.

Disabling Fast Switchover Notification

This mechanism provides more control to avoid interleaving traffic.

During failure handling, the active controller sends an explicit notification to the standby controller, stating that it is going down. This triggers the standby node to take over as the active node. In the event of failure, you can use the disable fast switchover notification option to control the explicit notification from active to standby. In the absence of explicit notification, the standby controller takes over as the active controller on the basis of keepalive timeout.



Note You can configure the keepalive timeout so that you have control over when the traffic from the new active controller begins if a failure occurs. In such a failure scenario, the switchover also gets delayed.

When you enable this option, the active controller cannot send an explicit failure notification message to the standby controller. The standby controller relies solely on the keepalive timeout failures to detect when the active controller went down.

This delays the keepalive timeout in the commencing traffic in the new active controller, thus avoiding the overlapping traffic from the old active controller. Therefore, disabling fast switchover notification increases the switchover duration by the additional keepalive timeout duration.

GARP Burst

During a controller switchover event, the GARP traffic is generated in burst that overwhelms the ARP learning of ACI. This feature devises a way to retransmit the GARP packet at a much lower rate after a switchover from a new active controller.

Prerequisite for Deploying the ACI Network in the Controller

Check the maximum supported clients in High Availability to ensure that Cisco ACI does not exceed the configured IPv4 and IPv6 end points.

Disabling the Fast Switchover Notification Mechanism (CLI)

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	no redun-management fast-switchover Example: Device(config)# no redun-management fast-switchover	Disables explicit fast switchover notification. Note Configure the fast switchover notification mechanism in the primary controller. This configuration is not required in the secondary controller.
Step 3	end Example: Device(config)# end	Returns to privileged EXEC mode.

Configuring Gratuitous ARP (GARP) Retransmit (CLI)

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 2	redun-management garp-retransmit burst packet-burst-size interval time-interval Example: Device(config)# <code>redun-management garp-retransmit burst 0 interval 0</code>	Determines the rate at which the GARP resend is performed. Note <ul style="list-style-type: none"> • <i>packet-burst-size</i>: The valid range is from 0 to 1000. The value 0 refers to the disabled retransmit. • <i>time-interval</i>: Refers to the time interval, in seconds. The valid range is from 0 to 5 seconds. The value 0 refers to the disabled retransmit.
Step 3	end Example: Device(config)# <code>end</code>	Returns to privileged EXEC mode.

Disabling Initial GARP (CLI)

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 2	no redun-management garp-retransmit initial Example: Device(config)# <code>no redun-management garp-retransmit initial</code>	Disables the initial GARP.
Step 3	end Example: Device(config)# <code>end</code>	Returns to privileged EXEC mode.

Information About Redundancy Management Interface

The Redundancy Management Interface (RMI) is used as a secondary link between the active and standby Cisco Catalyst 9800 Series Wireless Controllers. This interface is the same as the wireless management interface, and the IP address on this interface is configured in the same subnet as the Wireless Management IP. The RMI is used for the following purposes:

- Dual Active Detection
- Exchange resource health information between controllers, for instance, gateway reachability status from either controller.
- Gateway reachability is checked on the active and the standby controller through the RMI when the feature is enabled. It takes approximately the configured gateway monitoring interval to detect that a controller has lost gateway reachability. The default gateway monitoring interval value is 8 seconds.



Note

- The RMI might trigger a switchover based on the gateway status of the active controller.
- Cisco TrustSec is not supported on the RMI.

When the device SGT is used, the IP-SGT mapping for RMI address is also applied along with the WMI address. So, you need to ensure that the SGACL is defined appropriately to allow ICMP and ARP traffic between the active and standby RMI addresses.

- If the RP and RMI links are down, the HA setup breaks into two active controllers. This leads to IP conflict in the network. The HA setup forms again when the RP link comes up. Depending on the state of the external switch at this time, the ARP table may or may not be updated to point to the active controller. That is, the switch may fail to process the GARP packets from the controller. As a best practice, we recommend that you keep the ARP cache timeout value to a low value for faster recovery from multiple fault scenarios. You need to select a value that does not impact the network traffic, for instance, 30 minutes.

**Note**

The AAA packets originating from the controller may use either the wireless management IP or the RMI IP. Therefore, ensure that you add RMI IP as the source IP along with WMI IP in the AAA server.

Active Controller

The primary address on the active controller is the management IP address. The secondary IPv4 address on the management VLAN is the RMI IP address for the active controller. Do not configure the secondary IPv4 addresses explicitly because a single secondary IPv4 address is configured automatically by RMI under the RMI.

Standby Controller

The standby controller does not have the wireless management IP configured; it has the RMI IP address configured as the primary IP address. When the standby controller becomes active, the management IP address

becomes the primary IP address and the RMI IP address becomes the secondary IP address. If the interface on the active controller is administratively down, the same state is reflected on the standby controller.

Dual Stack Support on Management VLAN with RMI

Dual stack refers to the fact that the wireless management interface can be configured with IPv4 and IPv6 addresses. If an RMI IPv4 address is configured along with an IPv4 management IP address, you can additionally configure an IPv6 management address on the wireless management interface. This IPv6 management IP address will not be visible on the standby controller.

If an RMI IPv6 address is configured along with an IPv6 management IP address, you can additionally configure an IPv4 management address on the wireless management interface. This IPv4 management IP address will not be visible on the standby controller.

Therefore, you can monitor only the IPv6 gateway when the RMI IPv6 address is configured, or only the IPv4 gateway when the RMI IPv4 address is configured.



Note The RMI feature supports the RMI IPv4 or IPv6 addresses.

RMI-Based High-Availability Pairing

You should consider the following scenarios for HA pairing:

- Fresh Installation
- Already Paired Controllers
- Upgrade Scenario
- Downgrade Scenario

Dynamic HA pairing requires both the active controller and the standby controller to reload. However, dynamic HA pairing occurs on the Cisco Catalyst 9800-L Wireless Controller, Cisco Catalyst 9800-40 Wireless Controller, and the Cisco Catalyst 9800-80 Wireless Controller when one of them reloads and becomes the standby controller.



Note Chassis numbers identify individual controllers. Unique chassis numbers must be configured before forming an HA pair.

HA Pairing Without Previous Configuration

When HA pairing is done for the first time, no ROMMON variables are found for the RP IP addresses. You can choose from the existing privileged EXEC mode RP-based commands or the RMI IP-based mechanisms. However, the privileged EXEC mode RP-based commands will be deprecated soon. If you use Cisco Catalyst Center, you can choose the privileged EXEC mode RP-based CLI mechanism till the Cisco Catalyst Center migrates to support the RMI.

The RP IPs are derived from the RMI IPs after an HA pair is formed. Also, the privileged EXEC mode RP-based CLI method of clearing and forming an HA pair is not allowed after the RMI IP-based HA mechanism is chosen.



-
- Note**
- Although you can choose RP or RMI for a fresh installation, we recommend that you use RMI install method.
 - To view the ROMMON variables, use the **show romvars** command.
-

If you choose the privileged EXEC RP-based CLI mechanism, the RP IPs are configured the same way as in the 16.12 release.

The following occurs when the RMI-based HA pairing is done on a brand-new system:

- RP IPs are derived from RMI IPs and used in HA pairing.
- Privileged EXEC mode RP-based CLIs are blocked.



Note The RMI migration is supported from Cisco Catalyst Center, 2.3.3.x release version.

The following are the limitations observed during RMI migration:

- The negative cases fail due to the following reasons:
 - When devices are not reachable.
 - When non-Cisco Catalyst 9800 Series Wireless Controllers are in use.
 - When an earlier controller version (Cisco IOS XE 17.3) is in use.
 - When High Availability is not configured.
 - When High Availability RMI is already configured.
 - When High Availability is upgraded to RMI-based High Availability for Cisco IOS XE release version greater than or equal to 17.3.
 - When upgrading to an already failed High Availability paired controller.
 - The controller GUI prohibits applying RMI migration configuration to High Availability failed devices.
-

Paired Controllers

If the controllers are already in an HA pair, the existing EXEC mode RP-based commands will continue to be used. You can enable RMI to migrate to the RMI-based HA pairing.

If the controllers are already paired and RMI is configured, it will overwrite the RP IPs with the RMI-derived IPs. The HA pair will not be disturbed immediately, but the controllers will pick up the new IP when the next reload happens. The RMI feature mandates a reload for the feature to be effective. When both the controllers are reloaded, they come up as a pair with the new RMI-derived RP IPs.

The following occurs when the RMI configuration is done:

- The RP IPs derived from the RMI IPs are overwritten, and used for HA pairing.
- If the active and standby controller already exist prior to HA pairing through the EXEC mode RP-based command mechanism, the pair is not interrupted.

- When the pair reloads later, the new RP IPs are used.
- EXEC mode RP-based commands are blocked.

Upgrading from Cisco IOS XE 16.1.x to a Later Release

A system that is being upgraded can choose to:

- Migrate with the existing RP IP configuration intact—In this case, the existing RP IP configuration will continue to be used. The EXEC mode RP-based commands are used for future modifications.
- Migrate after clearing the HA configuration—In this case, you can choose between the old (EXEC mode RP-based commands) and new RMI-based RP configuration methods.



Note In case the older configuration is retained, the RMI configuration updates the RP IPs with the IPs derived from the RMI IPs.

Downgrade Scenario



Note The downgrade scenario given below is not applicable for Cisco IOS XE Amsterdam 17.1.x.

The downgrade scenario will have only the EXEC mode RP-based commands. The following are the two possibilities:

- If the upgraded system used the RMI-based RP configuration.
- If the upgraded system continued to use the EXEC mode RP-based commands.



Note In the above cases, the downgraded system uses the EXEC mode RP-based commands to modify the configuration. However, the downgraded system will continue to use the new derived RP IPs.



Note When you downgrade the Cisco Catalyst 9800 Series Wireless Controller to any version below 17.1 and if the mDNS gateway is enabled on the WLAN/RLAN/GLAN interfaces, the mdns-sd-interface gateway goes down after the downgrade.

To enable the mDNS gateway on the WLAN/RLAN/GLAN interfaces in 16.12 and earlier versions, use the following commands:

wlan test 1 test

mdns-sd gateway

To enable the mDNS gateway on the WLAN/RLAN/GLAN interfaces from version 17.1 onwards, use the following command:

mdns-sd-interface gateway

Gateway Monitoring

From Cisco IOS XE Amsterdam 17.2.1 onwards, the method to configure the gateway IP has been modified. The **ip default-gateway** *gateway-ip* command is not used. Instead, the gateway IP is selected based on the static routes configured. From among the static routes configured, the gateway IP that falls in the same subnet as the RMI subnet (the broadest mask and least gateway IP) is chosen. If no matching static route is found, gateway failover will not work (even if management gateway-failover is enabled).

Configuring Redundancy Management Interface (GUI)

Before you begin

Before configuring RMI + RP using GUI, ensure that WMI is available.

Procedure

Step 1

In the **Administration > Device > Redundancy** window, perform the following:

- a. Set the **Redundancy Configuration** toggle button to **Enabled** to activate redundancy configuration.
- b. In the **Redundancy Pairing Type** field, select **RMI+RP** to perform RMI+RP redundancy pairing as follows:
 - In the **RMI IP for Chassis 1** field, enter RMI IP address for chassis 1.
 - In the **RMI IP for Chassis 2** field, enter RMI IP address for chassis 2.
 - From the **HA Interface** drop-down list, choose one of the HA interface.
Note You can select the HA interface only for Cisco Catalyst 9800 Series Wireless Controllers.
 - Set the **Management Gateway Failover** toggle button to **Enabled** to activate management gateway failover.
 - In the **Gateway Failure Interval** field, enter an appropriate value. The valid range is between 6 and 12 (seconds). The default is 8 seconds.
- c. In the **Redundancy Pairing Type** field, select **RP** to perform RP redundancy pairing as follows:
 - In the **Local IP** field, enter an IP address for Local IP.
 - In the **Netmask** field, enter the subnet mask assigned to all wireless clients.
 - From the **HA Interface** drop-down list, choose one of the HA interface.
Note You can select the HA interface only for Cisco Catalyst 9800 Series Wireless Controllers.
 - In the **Remote IP** field, enter an IP address for Remote IP.
- d. In the **Keep Alive Timer** field, enter an appropriate timer value. The valid range is between 1 and 10 (x100 milliseconds).

- e. In the **Keep Alive Retries** field, enter an appropriate retry value. The valid range is between 3 and 10 seconds.
- f. In the **Active Chassis Priority** field, enter a value.

Step 2 Click **Apply** and reload controllers.

Configuring Redundancy Management Interface (CLI)

Procedure

	Command or Action	Purpose
Step 1	<p>chassis <i>chassis-num</i> priority <i>chassis-priority</i></p> <p>Example:</p> <pre>Device# chassis 1 priority 1</pre>	<p>(Optional) Configures the priority of the specified device.</p> <p>Note From Cisco IOS XE Gibraltar 16.12.x onwards, device reload is not required for the chassis priority to become effective.</p> <ul style="list-style-type: none"> • <i>chassis-num</i>—Enter the chassis number. The range is from 1 to 2. • <i>chassis-priority</i>—Enter the chassis priority. The range is from 1 to 2. The default value is 1. <p>Note When both the devices boot up at the same time, the device with higher priority becomes active, and the other one becomes standby. If both the devices are configured with the same priority value, the one with the smaller MAC address acts as active and its peer acts as standby.</p>
Step 2	<p>chassis redundancy ha-interface GigabitEthernet <i>interface-number</i></p> <p>Example:</p> <pre>Device# chassis redundancy ha-interface GigabitEthernet 3</pre>	<p>Creates an HA interface for your controller.</p> <ul style="list-style-type: none"> • <i>interface-number</i>: GigabitEthernet interface number. The range is from 1 to 32.

	Command or Action	Purpose
		<p>Note This step is applicable only for Cisco Catalyst 9800-CL Series Wireless Controllers. The chosen interface is used as the dedicated interface for HA communication between the 2 controllers.</p>
Step 3	<p>configure terminal</p> <p>Example:</p> <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 4	<p>redun-management interface vlan <i>vlan-interface-number</i> chassis <i>chassis-number</i> address <i>ip-address</i> chassis <i>chassis-number</i> address <i>ip-address</i></p> <p>Example:</p> <pre>Device(config)# redun-management interface Vlan 200 chassis 1 address 9.10.90.147 chassis 2 address 9.10.90.149</pre>	<p>Configures Redundancy Management Interface.</p> <ul style="list-style-type: none"> • <i>vlan-interface-number</i> : VLAN interface number. The valid range is from 1 to 4094. <p>Note Here, the <i>vlan-interface-number</i> is the same VLAN as the Management VLAN. That is, both must be on the same subnet.</p> <ul style="list-style-type: none"> • <i>chassis-number</i>: Chassis number. The valid range is from 1 to 2. • <i>ip-address</i>: Redundancy Management Interface IP address. <p>Note Each controller must have a unique chassis number for RMI to form the HA pair. The chassis number can be observed as SWITCH_NUMBER in the output of show romvar command. Modification of SWITCH_NUMBER is currently not available through the web UI. To disable the HA pair, use the no redun-management interface vlan chassis command.</p>
Step 5	<p>end</p> <p>Example:</p> <pre>Device(config)# end</pre>	Returns to privileged EXEC mode.
Step 6	<p>write memory</p> <p>Example:</p>	Saves the configuration.

	Command or Action	Purpose
	Device# write memory	
Step 7	reload Example: Device# reload	Reloads the controllers. Note When the RMI configuration is done, you must reload the controllers for the configuration to take effect. For Cisco Catalyst 9800-CL Wireless Controller VM, both the active and standby controllers reload automatically. In the case of hardware platforms, you should reload the active controller manually, as only standby the controller reloads automatically.

Configuring Gateway Monitoring (CLI)

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	[no] management gateway-failover enable Example: Device(config)# management gateway-failover enable	Enables gateway monitoring. (Use the no form of this command to disable gateway monitoring.)
Step 3	end Example: Device(config)# end	Returns to privileged EXEC mode. Note To save the configuration, use the write memory command.

Configuring Gateway Monitoring Interval (CLI)

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	management gateway-failover interval <i>interval-value</i> Example: Device(config)# management gateway-failover interval 6	Configures the gateway monitoring interval. <i>interval-value</i> - Refers to the gateway monitoring interval. The valid range is from 6 to 12. Default value is 8.
Step 3	end Example: Device(config)# end	Saves the configuration and exits configuration mode and returns to privileged EXEC mode.

Gateway Reachability Detection

Information About Gateway Reachability Detection

Gateway Reachability Detection feature minimizes the downtime on APs and clients when the gateway reachability is lost on the active controller.

Both active and standby controllers keep track of gateway reachability. The gateway reachability is detected by sending Internet Control Message Protocol (ICMP) and ARP requests periodically to the gateway.

Both active and standby controllers use the RMI IP as the source IP. The messages are sent at 1 second interval. If it takes 8 (or configured value) consecutive failures in reaching the gateway, the controller declares the gateway as non-reachable. It takes approximately 8 seconds to detect if a controller has lost gateway reachability.

Gateway monitoring with native IPv6 uses ICMP Neighbor Discovery protocols and ICMPv6 ECHO to check gateway reachability.

Therefore, you can monitor only the IPv6 gateway when RMI IPv6 is configured.

This means that only one IPv4 or IPv6 gateways can be monitored.



Note If the standby controller loses gateway, the standby moves to the standby recovery mode.
If the active controller loses gateway, the active reloads and standby becomes active.

Configuration Workflow

1. Configuring Redundancy Management Interface (GUI) (or) Configuring Redundancy Management Interface (CLI). For more information, see [Configuring Redundancy Management Interface \(GUI\)](#), on page 29.



Note For RMI configuration to take effect, ensure that you reload your controllers.

2. Configuring IPv6 Static Route. For information, see [Gateway Monitoring](#).
3. Configuring Gateway Monitoring Interval (CLI). For more information, see [Configuring Gateway Monitoring Interval \(CLI\)](#), on page 33.

Migrating to RMI IPv6

From RMI IPv4

1. Unconfigure the RMI IPv4 using the following CLIs:

```
Device# conf t
Device(config)# no redun-management interface <vlan_name> chassis 1 address <ip_address1>
chassis 2 address <ip_address2>
```



Note This CLI unconfigures RMI on both the controllers.



2. **Note** Take a backup of the running config on active before you reload the controller.
-

Reload the controller.

3. Copy the backed up config to the running config on the box which would have lost all the config.
4. Configure the RMI IPv6 on both the controllers. For information on the CLI, see [#unique_1868](#).
5. Reload the controller.

From HA Pairing (Without RMI)

For information on HA pairing, see [Configuring Redundancy Management Interface \(GUI\)](#).

Monitoring the Health of the Standby Controller

The Standby Monitoring feature allows you to monitor the health of a system on a standby controller using programmatic interfaces and commands. This feature allows you to monitor parameters such as CPU, memory,

interface status, power supply, fan failure, and the system temperature. Standby Monitoring is enabled when Redundancy Management Interface (RMI) is configured, no other configuration is required. The RMI itself is used to connect to the standby and perform standby monitoring. Standby Monitoring feature cannot be dynamically enabled or disabled.



Note The active controller uses the management or RMI IP to initiate AAA requests. Whereas, the standby controller uses the RMI IP to initiate AAA requests. Thus, the RMI IPs must be added in AAA servers for a seamless client authentication and standby monitoring.

To enable standby console, ensure that the following configuration is in place:

```
redundancy
main-cpu
secondary console enable
```



Note The Standby Monitoring feature is not supported on a controller in the active-recovery and the standby-recovery modes.

The Standby Monitoring feature supports only the following traffic on the RMI interface of the standby controller:

- Address Resolution Protocol (ARP)
- Internet Control Message Protocol (ICMP)
- TCP Traffic (to or from) ports: 22, 443, 830, and 3200
- UDP RADIUS ports: 1645 and 1646
- UDP Extended RADIUS ports: 21645 to 21844

Feature Scenarios

- To monitor the health of the standby directly from the standby controller using Standby RMI IP.
- To get syslogs from the standby controller using the Standby RMI IP.

Use Cases

- Enabling SNMP agent and programmatic interfaces on the standby controller: You can directly perform an SNMP query or programmatic interface query to the standby's RMI IP and active controller.
- Enabling syslogs on the standby controller: You can directly get the standby syslogs from the standby controller.

RADIUS Accounting Support

Whenever you log in to a standby device, the RADIUS start record must be sent to the external RADIUS server. Similarly, when you log out of a device, the RADIUS stop record must be sent to the external RADIUS server.

TACACS+ Authentication Support

Users are authenticated through the RMI using the external TACACS+ server. The username and password are evaluated in the TACACS+ server. Depending on the response received from the server, a user will be able to log in to the standby device.

TACACS+ Accounting Support

Whenever you log in to the standby device, the TACACS+ accounting start record must be sent to the external TACACS+ server. Similarly, when you log out of a device, the TACACS+ accounting stop record must be sent to the external TACACS+ server.



Note The following configuration must be in place to configure AAA to send the accounting packets:

```
aaa accounting exec {default | named-list} start-stop group {RAD | tac-group-name}
```



Note The TACACS+ login to the standby device is not supported when TACACS+ server is configured with hostname.

Monitoring the Health of Standby Parameters Using SNMP

Standby Monitoring Using Standby RMI IP

When an SNMP agent is enabled on the standby controller, you can directly perform an SNMP query to the standby's RMI IP. From Release 17.5 onwards, you can query the following MIB on the standby controller:

Table 4: MIB Name and Notes

MIB Name	Notes
IF-MIB	This MIB is used to monitor the interface statistics of the standby controller using the standby RMI IP address.



Note If an SNMP agent is enabled on the active controller, by default, the SNMP is enabled on the standby controller.

Standby Monitoring Using the Active Controller

CISCO-LWAPP-HA-MIB

The CISCO-LWAPP-HA-MIB monitors the health parameters of the standby controller, that is, memory, CPU, port status, power statistics, peer gateway latencies, and so on.

You can query the following MIB objects of CISCO-LWAPP-HA-MIB.

Table 5: MIB Objects and Notes

MIB Objects	Notes
cLHaPeerHotStandbyEvent	This object can be used to check if the standby controller has turned hot-standby or not.
cLHaBulkSyncCompleteEvent	This object represents the time at which the bulksync is completed.

CISCO-PROCESS-MIB

The CISCO-PROCESS-MIB monitors CPU and process statistics. Use it to monitor CPU-related or memory-related BINOS processes. The standby CISCO-PROCESS-MIB can be monitored using the active controller.

ENTITY-MIB

The ENTITY-MIB is used to monitor hardware details of the active and standby controllers using the active controller.



Note The standby Route Processor (RP) sensors are appended in the active RP sensors.

Standby IOS Linux Syslogs

The standby logs are relayed using the same method as on the active Cisco IOS for wireless controllers.

From Release 17.5 onwards, external logging of syslogs from the standby IOS is enabled. As BINOS processes on standby also forwards the syslogs to Cisco IOS, all the syslogs generated on the standby controller is forwarded to the configured external server.



Note RMI IP address is used for logging purpose.

The following is the expected behavior when an HA pair is configured with the RMI IPv6 address, the active controller has dual stack, and logging is configured on the IPv4 address:

The standby controller tries to send syslogs to the IPv4 server because logging is only configured on IPv4 even though IPv4 is not supported by standby.

Standby Interface Status Using Active SNMP

The standby interface information is sent to the active controller using IPC in the following scenarios:

- When there is a change in the interface status.
- When a new interface is added or deleted on the standby controller.

When the active controller receives the interface information from the standby controller, the active controller's database is populated with the standby interface information.

When an SNMP query is received for the standby interface information, the SNMP handlers corresponding to the CISCO-LWAPP-HA-MIB reads them from the standby interface database on the active and populates the MIB objects in CISCO-LWAPP-HA-MIB.

You can query the following MIB objects of CISCO-LWAPP-HA-MIB.

Table 6: MIB Objects of CISCO-LWAPP-HA-MIB

MIB Object	Notes
stbyIfIndex	This is a unique value (greater than zero) for each interface of the standby controller.
stbyIfName	This is the name of the standby interface.
stbyIfPhysAddress	This is the interface address of the standby controller in the protocol sublayer.
stbyifOperStatus	This is the current operational state of the interface in the standby controller.
stbyifAdminStatus	This is the desired state of the interface of the standby controller.

To verify the logging on the active when the standby fails to send interface statistics, use the following command:

```
Device# debug snmp ha-chkpt
Device# debug snmp ha-intf_db
```

Monitoring the Health of Standby Controller Using Programmatic Interfaces

You can monitor parameters such as CPU, memory, sensors, and interface status on a standby controller using programmatic interfaces such as NETCONF and RESTCONF. The RMI IP of the standby controller can be used for access to the following operational models:

The models can be accessed through .

- Cisco-IOS-XE-device-hardware-oper.yang
- Cisco-IOS-XE-process-cpu-oper.yang
- Cisco-IOS-XE-platform-software-oper.yang
- Cisco-IOS-XE-process-memory-oper.yang
- Cisco-IOS-XE-interfaces-oper.yang

For more information on the YANG models, see the *Programmability Configuration Guide, Cisco IOS XE Amsterdam 17.3.x*.

Monitoring the Health of Standby Controller Using CLI

This section describes the different commands that can be used to monitor the standby device.

You can connect to the standby controller through SSH using the RMI IP of the standby controller. The user credentials must have been configured already. Both local authentication and RADIUS authentication are supported.



Note The **redun-management** command needs to be configured on both the controllers, primary and standby, prior to high availability (HA) pairing.

Monitoring Port State

The following is a sample output of the **show interfaces interface-name** command:

```
Device-standby# show interfaces GigabitEthernet1

GigabitEthernet1 is down, line protocol is down
Shadow state is up, true line protocol is up
  Hardware is CSR vNIC, address is 000c.2909.33c2 (bia 000c.2909.33c2)
  MTU 1500 bytes, BW 1000000 Kbit/sec, DLY 10 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Full Duplex, 1000Mbps, link type is force-up, media type is Virtual
  output flow-control is unsupported, input flow-control is unsupported
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:06, output 00:00:24, output hang never
  Last clearing of "show interface" counters never
  Input queue: 30/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 389000 bits/sec, 410 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
    3696382 packets input, 392617128 bytes, 0 no buffer
    Received 0 broadcasts (0 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
    18832 packets output, 1218862 bytes, 0 underruns
    Output 0 broadcasts (0 multicasts)
    0 output errors, 0 collisions, 2 interface resets
    3 unknown protocol drops
    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 is a sample output of the **show ip interface brief** command:

```
Device# show ip interface brief

Interface          IP-Address      OK? Method Status        Protocol
GigabitEthernet1  unassigned     YES unset  down          down
GigabitEthernet0  unassigned     YES NVRAM  administratively down down
Capwap1           unassigned     YES unset  up            up
Capwap2           unassigned     YES unset  up            up
Capwap3           unassigned     YES unset  up            up
```

```

Capwap10          unassigned      YES unset  up          up
Vlan1             unassigned      YES NVRAM  down       down
Vlan56            unassigned      YES unset  down       down
Vlan111           111.1.1.85     YES NVRAM  up         up

```

Monitoring CPU or Memory

The following is a sample output of the **show process cpu sorted 5sec** command:

```
Device-standby# show process cpu sorted 5sec
```

```

CPU utilization for five seconds: 0%/0%; one minute: 0%; five minutes: 0%
PID Runtime(ms)   Invoked    uSecs   5Sec   1Min   5Min  TTY Process
 10   1576556         281188    5606   0.15%  0.05%  0.05%  0 Check heaps
232   845057          54261160  15     0.07%  0.05%  0.06%  0 IPAM Manager
595    177             300       590   0.07%  0.02%  0.01%  2 Virtual Exec
138   1685973         108085955  15     0.07%  0.08%  0.08%  0 L2 LISP Punt Pro
193   19644           348767    56     0.07%  0.00%  0.00%  0 DTP Protocol
 5     0               1         0     0.00%  0.00%  0.00%  0 CTS SGACL db cor
 4     24             15        1600  0.00%  0.00%  0.00%  0 RF Slave Main Th
 6     0               1         0     0.00%  0.00%  0.00%  0 Retransmission o
 7     0               1         0     0.00%  0.00%  0.00%  0 IPC ISSU Dispatc
 2    117631          348801    337   0.00%  0.00%  0.00%  0 Load Meter
 8     0               1         0     0.00%  0.00%  0.00%  0 EDDRI_MAIN

```

To check CPU and memory utilization of binOS processes, run the following command:

```
Device-standby# show platform software process slot chassis standby R0 monitor
```

```

top - 23:24:14 up 8 days, 3:38, 0 users, load average: 0.69, 0.79, 0.81
Tasks: 433 total, 1 running, 431 sleeping, 1 stopped, 0 zombie
%Cpu(s): 1.7 us, 2.8 sy, 0.0 ni, 95.6 id, 0.0 wa, 0.0 hi, 0.0 si, 0.0 st
MiB Mem : 32059.2 total, 21953.7 free, 4896.8 used, 5208.6 buff/cache
MiB Swap: 0.0 total, 0.0 free, 0.0 used. 26304.6 avail Mem

```

```

PID USER PR NI VIRT RES SHR S %CPU %MEM TIME+ COMMAND
23565 root 20 0 2347004 229116 130052 S 41.2 0.7 5681:44 ucode_pkt+
2306 root 20 0 666908 106760 46228 S 5.9 0.3 15:06.14 smand
22807 root 20 0 3473004 230020 152120 S 5.9 0.7 510:56.90 fman_fp_it+
 1 root 20 0 14600 11324 7424 S 0.0 0.0 0:31.07 systemd
 2 root 20 0 0 0 0 S 0.0 0.0 0:00.28 kthreadd
 3 root 0 -20 0 0 0 I 0.0 0.0 0:00.00 rcu_gp
 4 root 0 -20 0 0 0 I 0.0 0.0 0:00.00 rcu_par_gp
 6 root 0 -20 0 0 0 I 0.0 0.0 0:00.00 kworker/0+
 7 root 20 0 0 0 0 I 0.0 0.0 0:00.49 kworker/u+
 8 root 0 -20 0 0 0 I 0.0 0.0 0:00.00 mm_percpu+
 9 root 20 0 0 0 0 S 0.0 0.0 0:03.26 ksoftirqd+
.
.
.
32258 root 20 0 57116 3432 2848 S 0.0 0.0 0:00.00 rotee
32318 root 20 0 139560 9500 7748 S 0.0 0.0 0:55.67 pttcd
32348 root 20 0 31.6g 3.1g 607364 S 0.0 9.8 499:12.04 linux_ios+
32503 root 20 0 3996 3136 2852 S 0.0 0.0 0:00.00 stack_snt+
32507 root 20 0 3700 1936 1820 S 0.0 0.0 0:00.00 sntp

```

Monitoring Hardware

The following is a sample output of the **show environment summary** command:

Device# **show environment summary**

Number of Critical alarms: 0
 Number of Major alarms: 0
 Number of Minor alarms: 0

Slot	Sensor	Current State	Reading
Threshold (Minor, Major, Critical, Shutdown)			

P0	Vin	Normal	231 V AC na
P0	Iin	Normal	2 A na
P0	Vout	Normal	12 V DC na
P0	Iout	Normal	30 A na
P0	Temp1	Normal	25 Celsius (na ,na ,na ,na) (Celsius)
P0	Temp2	Normal	31 Celsius (na ,na ,na ,na) (Celsius)
P0	Temp3	Normal	37 Celsius (na ,na ,na ,na) (Celsius)
R0	VDMB1: VX1	Normal	1226 mV na
R0	VDMB1: VX2	Normal	6944 mV na
R0	Temp: DMB IN	Normal	26 Celsius (45 ,55 ,65 ,70) (Celsius)
R0	Temp: DMB OUT	Normal	40 Celsius (70 ,75 ,80 ,85) (Celsius)
R0	Temp: Yoda 0	Normal	54 Celsius (95 ,105,110,115) (Celsius)
R0	Temp: Yoda 1	Normal	62 Celsius (95 ,105,110,115) (Celsius)
R0	Temp: CPU Die	Normal	43 Celsius (100,110,120,125) (Celsius)
R0	Temp: FC FANS	Fan Speed 70%	26 Celsius (29 ,39 ,0) (Celsius)
R0	VDDC1: VX1	Normal	1005 mV na
R0	VDDC1: VX2	Normal	7084 mV na
R0	VDDC2: VH	Normal	12003mV na
R0	Temp: DDC IN	Normal	25 Celsius (55 ,65 ,75 ,80) (Celsius)
R0	Temp: DDC OUT	Normal	35 Celsius (75 ,85 ,95 ,100) (Celsius)
P0	Stby Vin	Normal	230 V AC na
P0	Stby Iin	Normal	2 A na
P0	Stby Vout	Normal	12 V DC na
P0	Stby Iout	Normal	32 A na
P0	Stby Temp1	Normal	24 Celsius (na ,na ,na ,na) (Celsius)
P0	Stby Temp2	Normal	29 Celsius (na ,na ,na ,na) (Celsius)
P0	Stby Temp3	Normal	35 Celsius (na ,na ,na ,na) (Celsius)
R0	Stby VDMB1: VX1	Normal	1225 mV na
R0	Stby VDMB1: VX2	Normal	6979 mV na
R0	Stby VDMB2: VX2	Normal	5005 mV na
R0	Stby VDMB2: VX3	Normal	854 mV na
R0	Stby VDMB3: VX1	Normal	972 mV na
R0	Stby Temp: DMB IN	Normal	22 Celsius (45 ,55 ,65 ,70) (Celsius)
R0	Stby Temp: DMB ON	Normal	32 Celsius (70 ,75 ,80 ,85) (Celsius)
R0	Stby Temp: Yoda	Normal	43 Celsius (95 ,105,110,115) (Celsius)
R0	Stby Temp: Yoda	Normal	45 Celsius (95 ,105,110,115) (Celsius)
R0	Stby Temp: CPU D	Normal	33 Celsius (100,110,120,125) (Celsius)
R0	Stby Temp: FC FA	Fan Speed 70%	22 Celsius (29 ,39 ,0) (Celsius)
R0	Stby VDDC1: VX1	Normal	1005 mV na
R0	Stby VDDC1: VX2	Normal	7070 mV na
R0	Stby VDDC2: VX2	Normal	752 mV na
R0	Stby VDDC2: VX3	Normal	750 mV na
R0	Stby Temp: DDC IN	Normal	22 Celsius (55 ,65 ,75 ,80) (Celsius)
R0	Stby Temp: DDC ON	Normal	28 Celsius (75 ,85 ,95 ,100) (Celsius)



Note The command displays both active and standby hardware details.



Note The **show environment summary** command displays data only for physical appliances such as Cisco Catalyst 9800-80 Wireless Controller, Cisco Catalyst 9800-40 Wireless Controller, Cisco Catalyst 9800-L Wireless Controller, and Cisco Catalyst 9800 Embedded Wireless Controller for Switch. The command does not display data for Cisco Catalyst 9800 Wireless Controller for Cloud.

Verifying the Gateway-Monitoring Configuration

To verify the status of the gateway-monitoring configuration on an active controller, run the following command:

```
Device# show redundancy states

my state = 13 -ACTIVE
peer state = 8 -STANDBY HOT
Mode = Duplex
Unit = Primary
Unit ID = 1

Redundancy Mode (Operational) = sso
Redundancy Mode (Configured) = sso
Redundancy State = sso
Maintenance Mode = Disabled
Manual Swact = enabled
Communications = Up

client count = 129
client_notification_TMR = 30000 milliseconds
RF debug mask = 0x0
Gateway Monitoring = Disabled
Gateway monitoring interval = 8 secs
```

To verify the status of the gateway-monitoring configuration on a standby controller, run the following command:

```
Device-stby# show redundancy states

my state = 8 -STANDBY HOT
peer state = 13 -ACTIVE
Mode = Duplex
Unit = Primary
Unit ID = 2

Redundancy Mode (Operational) = sso
Redundancy Mode (Configured) = sso
Redundancy State = sso
Maintenance Mode = Disabled
Manual Swact = cannot be initiated from this the standby unit
Communications = Up

client count = 129
client_notification_TMR = 30000 milliseconds
RF debug mask = 0x0
Gateway Monitoring = Disabled
Gateway monitoring interval = 8 secs
```

Verifying the RMI IPv4 Configuration

Verify the RMI IPv4 configuration.

```
Device# show running-config interface vlan management-vlan

Building configuration...

Current configuration : 109 bytes
!
interface Vlan90
ip address 9.10.90.147 255.255.255.0 secondary
ip address 9.10.90.41 255.255.255.0
end
```

To verify the interface configuration for a standby controller, use the following command:

```
Device-stby# show running-config interface vlan 90

Building configuration...

Current configuration : 62 bytes
!
interface Vlan90
ip address 9.10.90.149 255.255.255.0
end
```

To verify the chassis redundancy management interface configuration for an active controller, use the following command:

```
Device# show chassis rmi

Chassis/Stack Mac Address : 000c.2964.1eb6 - Local Mac Address
Mac persistency wait time: Indefinite
      H/W Current
Chassis# Role      Mac Address      Priority  Version  State  IP              RMI-IP
-----
*1      Active   000c.2964.1eb6   1        V02     Ready  169.254.90.147  9.10.90.147
2       Standby  000c.2975.3aa6   1        V02     Ready  169.254.90.149  9.10.90.149
```

To verify the chassis redundancy management interface configuration for a standby controller, use the following command:

```
Device-stby# show chassis rmi

Chassis/Stack Mac Address : 000c.2964.1eb6 - Local Mac Address
Mac persistency wait time: Indefinite
      H/W Current
Chassis# Role      Mac Address      Priority  Version  State  IP              RMI-IP
-----
1       Active   000c.2964.1eb6   1        V02     Ready  169.254.90.147  9.10.90.147
*2      Standby  000c.2975.3aa6   1        V02     Ready  169.254.90.149  9.10.90.149
```

To verify the ROMMON variables on an active controller, use the following command:

```
Device# show romvar | include RMI

RMI_INTERFACE_NAME = Vlan90
RMI_CHASSIS_LOCAL_IP = 9.10.90.147
```

```
RMI_CHASSIS_REMOTE_IP = 9.10.90.149
```

To verify the ROMMON variables on a standby controller, use the following command:

```
Device-stby# show romvar | include RMI
```

```
RMI_INTERFACE_NAME = Vlan90
RMI_CHASSIS_LOCAL_IP = 9.10.90.149
RMI_CHASSIS_REMOTE_IP = 9.10.90.147
```

To verify the switchover reason, use the following command:

```
Device# show redundancy switchover history
```

Index	Previous active	Current active	Switchover reason	Switchover time
1	2	1	Active lost GW	17:02:29 UTC Mon Feb 3 2020

Verifying the RMI IPv6 Configuration

To verify the chassis redundancy management interface configuration for both active and standby controllers, run the following command:

```
Device# show chassis rmi
```

```
Chassis/Stack Mac Address : 00a3.8e23.a540 - Local Mac Address
Mac persistency wait time: Indefinite
Local Redundancy Port Type: Twisted Pair
```

Chassis#	Role	Mac Address	Priority	H/W Version	Current State	IP	RMI-IP
1	Standby	706d.1536.23c0	1	V02	Ready	169.254.254.17	2020:0:0:1::211
*2	Active	00a3.8e23.a540	1	V02	Ready	169.254.254.18	2020:0:0:1::212

To verify the RMI related ROMMON variables for both active and standby controllers, run the following command

```
Device# show romvar | i RMI
```

```
RMI_INTERFACE_NAME = Vlan52
RMI_CHASSIS_LOCAL_IPV6 = 2020:0:0:1::212
RMI_CHASSIS_REMOTE_IPV6 = 2020:0:0:1::211
```

Verifying Redundancy Port Interface Configuration

To verify the Redundancy Port Interface (RIF) resource status in an active instance, run the following command:

```
Device# show platform software rif-mgr chassis active R0 resource-status
RIF Resource Status
```

```
RP Status      : Up
RMI Status     : Up
```

```
Current Chassis State : Active
Peer Chassis State   : Standby
```

To verify the RIF resource status in a standby instance, run the following command:

```
Device# show platform software rif-mgr chassis standby R0 resource-status
RIF Resource Status

RP Status           : Up
RMI Status          : Up
Current Chassis State : Standby
Peer Chassis State  : Active
```

To verify the RMI link re-establishment count and the time since the RMI link is Up in the active instance, run the following command:

```
Device# show platform software rif-mgr chassis active R0 rmi-connection-details
RMI Connection Details
RMI Link re-establish count : 2
RMI Link Uptime             : 21 hours 8 minutes 43 seconds
RMI Link Upsince            : 08/05/2021 13:46:01
```

To verify the RMI link re-establishment count and the time since the RMI link is Down in the active instance, run the following command:

```
Device# show platform software rif-mgr chassis active R0 rmi-connection-details
RMI Connection Details
RMI Link re-establish count : 1
RMI Link Downtime           : 28 seconds
RMI Link Downsince         : 07/16/2021 03:19:11
```

To verify the RMI link re-establishment count and the time since the RMI link is Up in the standby instance, run the following command:

```
Device# show platform software rif-mgr chassis standby R0 rmi-connection-details
RMI Connection Details
RMI Link re-establish count : 1
RMI Link Uptime             : 1 hour 39 minute 9 seconds
RMI Link Upsince            : 07/16/2021 01:31:41
```

To verify the RMI link re-establishment count and the time since the RMI link is Down in the standby instance, run the following command:

```
Device# show platform software rif-mgr chassis standby R0 rmi-connection-details
RMI Connection Details
RMI Link re-establish count : 1
RMI Link Downtime           : 22 seconds
RMI Link Downsince         : 07/16/2021 03:19:17
```

To verify the RP link re-establishment count and the time since the RP link is UP for days in the active instance, run the following command:

```
Device# show platform software rif-mgr chassis active R0 rp-connection-details
RP Connection Details
RP Connection Uptime       : 12 days 17 hours 1 minute 39 seconds
RP Connection Upsince      : 07/03/2021 07:06:20
```

To verify the RP link re-establishment count and the time since the RP link is Down in the active instance, run the following command:

```
Device# show platform software rif-mgr chassis active R0 rp-connection-details
RP Connection Details
RP Connection Downtime     : 4 seconds
RP Connection Downsince    : 07/16/2021 03:33:04
```

To verify the RP link re-establishment count and the time since the RP link is UP in the standby instance, run the following command:

```
Device# show platform software rif-mgr chassis standby R0 rp-connection-details
RP Connection Details
  RP Connection Uptime   : 12 days 17 hours 2 minutes 1 second
  RP Connection Upsince  : 07/03/2021 07:05:58
```

To verify the RP link re-establishment count and the time since the RP link is Down in the standby instance, run the following command:

```
Device# show platform software rif-mgr chassis standby R0 rp-connection-details
RP Connection Details
  RP Connection Downtime   : 22 seconds
  RP Connection Downsince  : 07/16/2021 03:19:17
```

To verify the RIF and stack manager internal statistics in the active instance, run the following command:

```
Device# show platform software rif-mgr chassis active R0 rif-stk-internal-stats
RIF Stack Manager internal stats

  Stack-mgr reported RP down           : False
  DAD link status reported to Stack-Mgr : True
```

To verify the RIF and stack manager internal statistics in the standby instance, run the following command:

```
Device# show platform software rif-mgr chassis standby R0 rif-stk-internal-stats
RIF Stack Manager internal stats

  Stack-mgr reported RP down           : False
  DAD link status reported to Stack-Mgr : True
```

To verify the number of packets sent or received for each type in the active instance, run the following command:

```
Device# show platform software rif-mgr chassis active R0 lmp-statistics
LMP Statistics

Info Type Sent           : 6
Solicit Info Type Sent   : 0
Unsolicit Info Type Sent : 6
Reload Type Sent         : 0
Recovery Type Sent       : 1
Gateway Info Type Sent   : 0
Enquiry Type Sent        : 0
Solicit Enquiry Type Sent : 0
Unsolicit Enquiry Type Sent : 0

Info Type Received       : 5
Solicit Info Type Received : 2
Unsolicit Info Type Received : 3
Reload Type Received     : 0
Recovery Type Received   : 0
Gateway Info Type Received : 4
Enquiry Type Received    : 0
Solicit Enquiry Type Received : 0
Unsolicit Enquiry Type Received : 0
```

To verify the number of packets sent or received for each type in the standby instance, run the following command:

```
Device# show platform software rif-mgr chassis standby R0 lmp-statistics
LMP Statistics

Info Type Sent           : 6
Solicit Info Type Sent   : 0
```

```

Unsolicit Info Type Sent      : 6
Reload Type Sent              : 0
Recovery Type Sent           : 0
Gateway Info Type Sent       : 4
Enquiry Type Sent            : 0
Solicit Enquiry Type Sent    : 0
Unsolicit Enquiry Type Sent   : 0

Info Type Received           : 5
Solicit Info Type Received    : 3
Unsolicit Info Type Received  : 2
Reload Type Received         : 0
Recovery Type Received       : 1
Gateway Info Type Received    : 0
Enquiry Type Received        : 0
Solicit Enquiry Type Received : 0
Unsolicit Enquiry Type Received : 0

```

Information About Auto-Upgrade

The Auto-Upgrade feature enables the standby controller to upgrade with the software image of the active controller so that both controllers form an HA pair.



Note

- This feature supports the active controller in INSTALL mode.
- This feature supports Cisco Catalyst 9800 Series Wireless Controller software versions 17.5.1 and later.
- This feature is triggered in the standby controller only when the active image is in committed state.

Use Cases

The following are the use cases and functionalities supported by the Auto-Upgrade feature:

- Handling software version mismatch: During an upgrade, if one of the redundancy port is upgraded to a newer version, and the other one is not upgraded at the same time, the active port tries to copy its packages to the other port using the Auto-Upgrade feature. You can enable Auto-Upgrade in this situation using configuration or by manually running the **software auto-upgrade enable** privileged EXEC command.

The auto-upgrade configuration is enabled by default.



Note

Auto-upgrade upgrades the mismatched redundancy port only when both the active redundancy port and the mismatched redundancy port are in INSTALL mode.

- HA pair: If one of the controller is not upgraded successfully, use Auto-Upgrade to upgrade the controller on the newly deployed HA pair, which can each be a different version.

- SMUs (APSP, APDP, and so on): If the SMUs that are successfully installed on the active controller when the standby controller was offline. In this scenario, when the standby controller comes up online, the Auto-Upgrade copies this SMU to the standby controller and installs it.

Configuration Workflow

[#unique_1884](#)

Configuring Auto-Upgrade (CLI)

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 2	software auto-upgrade enable Example: Device(config)# <code>software auto-upgrade enable</code>	Enables the Auto-Upgrade feature. (This feature is enabled by default.) If you disable this feature using the no form of this command, you need to manually auto upgrade using the install autoupgrade command in privileged EXEC mode.
Step 3	end Example: Device(config)# <code>end</code>	Returns to privileged EXEC mode.

Use Case for Link Layer Discovery Protocol (LLDP)

In a high-availability (HA) setup, when two wireless units act as active and standby, the LLDP still runs independently in both.

When you execute the LLDP neighbors command, the system name as the neighbor entry in the uplink switch is displayed as *hostname-stbdy*.

Enabling LLDP (CLI)

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	lldp run Example: Device(config)# lldp run	Enables Link Layer Discovery Protocol (LLDP).
Step 3	end Example: Device(config)# end	Returns to privileged EXEC mode.

Enabling LLDP Timers (CLI)

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	lldp holdtime <i>time_in_secs</i> Example: Device(config)# lldp holdtime 100	Enables LLDP timers. The timer decides how long the receiver must keep the packet. Valid range is from 0 to 65535 seconds.
Step 3	lldp reinit <i>delay_in_secs</i> Example: Device(config)# lldp reinit 3	Specifies the delay, in seconds for LLDP to initialize. Valid range is from 2 to 5 seconds.
Step 4	lldp timer <i>time_in_secs</i> Example: Device(config)# lldp timer 7	Specifies the rate at which the LLDP packets are sent, in seconds. Valid range is from 5 to 65534 seconds.
Step 5	end Example: Device(config)# end	Returns to privileged EXEC mode.

Enabling LLDP TLV-Select (CLI)

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	lldp tlv-select [mac-phy-cfg management-address port-description port-vlan system-capabilities system-description] Example: Device(config)# lldp tlv-select port-vlan	Enables type, length, and value (TLV) selection for LLDP. <ul style="list-style-type: none"> • mac-phy-cfg: IEEE 802.3 MAC, physical configuration, or status TLV. • management-address: Management address TLV. • port-description: Port description TLV. • port-vlan: Port VLAN ID TLV. • system-capabilities: System capabilities TLV. • system-description: System description TLV.
Step 3	end Example: Device(config)# end	Returns to privileged EXEC mode.

Verifying LLDP

Use the following **show** commands to view the LLDP details independently in the active and standby controller.

To verify the timer and status in the active and standby controller, use the following command:

```
Device# show lldp
Global LLDP Information:
  Status: ACTIVE
  LLDP advertisements are sent every 30 seconds
  LLDP hold time advertised is 120 seconds
  LLDP interface reinitialisation delay is 2 seconds
```

To verify the neighbor details in the active controller, use the following command:

```
Device# show lldp neighbors
Capability codes:
  (R) Router, (B) Bridge, (T) Telephone, (C) DOCSIS Cable Device
  (W) WLAN Access Point, (P) Repeater, (S) Station, (O) Other
```

Device ID	Local Intf	Hold-time	Capability	Port ID
9500-SW	Tw0/0/0	120	B,R	Twel/0/14

To verify the neighbor details in the standby controller, use the following command:

```
Device# show lldp neighbors
Capability codes:
(R) Router, (B) Bridge, (T) Telephone, (C) DOCSIS Cable Device
(W) WLAN Access Point, (P) Repeater, (S) Station, (O) Other
Device ID          Local Intf      Hold-time  Capability    Port ID
9500-SW           Tw0/0/0        120        B,R           Twel/0/13
Total entries displayed: 1
```

To verify the LLDP neighbor (TLV) detail, use the following command:

```
Device# show lldp neighbors detail
-----
Local Intf: Te0/0/0
Chassis id: 2cd0.2d62.be80
Port id: Tel/1
Port Description: TenGigabitEthernet1/1
System Name: HSRP-ROUTER-1-15.cisco.com

System Description:
Cisco IOS Software, IOS-XE Software, Catalyst 4500 L3 Switch Software (cat4500e-UNIVERSAL-M),
  Version 03.09.00.E RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2016 by Cisco Systems, Inc.
Compiled Tue 19-Jul

Time remaining: 99 seconds
System Capabilities: B,R
Enabled Capabilities: B,R
Management Addresses:
  IP: 8.109.0.1
  IPV6: 2001:12:1::2
Auto Negotiation - not supported
Physical media capabilities:
  Other/unknown
Media Attachment Unit type - not advertised
Vlan ID: 109
Peer Source MAC: 2cd0.2d62.be80
```

To verify the LLDP details in the uplink switch, use the following command:

```
Device# show lldp neighbors detail
-----
Local Intf: Tel/1
Chassis id: d4e8.80b3.0420
Port id: Te0/0/0
Port Description: TenGigabitEthernet0/0/0
System Name: WLC-BGL15.cisco.com

System Description:
Cisco IOS Software [Bangalore], C9800 Software (C9800_IOSXE-K9), Experimental Version
17.9.20220630:200739
Copyright (c) 1986-2022 by Cisco Systems, Inc.
Compiled Thu 30-Jun-22 13:19

Time remaining: 107 seconds
System Capabilities: B,R
Enabled Capabilities: R
Management Addresses:
  IP: 8.109.0.47
  IPV6: FD09:8:109::45
Auto Negotiation - not supported
```

```
Physical media capabilities - not advertised
Media Attachment Unit type - not advertised
Vlan ID: 109
```

To verify LLDP packet errors, use the following command:

```
Device# show lldp errors
LLDP errors/overflows:
Total memory allocation failures: 0
Total encapsulation failures: 0
Total input queue overflows: 0
Total table overflows: 0
```

To verify LLDP traffic statistics, use the following command:

```
Device# show lldp traffic
LLDP traffic statistics:
Total frames out: 18470
Total entries aged: 0
Total frames in: 6156
Total frames received in error: 0
Total frames discarded: 0
Total TLVs discarded: 0
Total TLVs unrecognized: 0
```

Feature History for Reload Reason History

This table provides release and related information about the feature explained in this section.

This feature is also available in all the releases subsequent to the one in which they are introduced in, unless noted otherwise.

Table 7: Feature History for Reload Reason History

Release	Feature	Feature Information
Cisco IOS XE Dublin 17.11.1	Reload Reason History	The Reload Reason History feature tracks the reasons for controller reload. This is done for the last 10 reloads. In Cisco IOS-XE Dublin 17.10.x and earlier releases, it was possible to track only the reason for the last reload.

Information About Reload Reason History

The Reload Reason History feature tracks the reasons for controller reload. This is done for the last 10 reloads. You will be able to view the history using the `show version` and the Network Configuration Protocol (NETCONF). This history is useful for serviceability and troubleshooting.

Verifying Reload Reason History

To view the reload history details, use the following command:

```
Device# show reload-history

Reload History:
```

Reload Index: 1
Reload Code: Reload
Reload Description: Reload Command
Reload Severity: Normal Reboot
Reload Time: 01:33:44 UTC Wed Nov 30 2022

Reload Index: 2
Reload Code: Critical Process Fault
Reload Description: Critical process stack_mgr fault on rp_0_0 (rc=137), system report at bootflash:core/Yang_Test-system-report_20221130-012929-UTC.tar.gz
Reload Severity: Abnormal Reboot
Reload Time: 01:31:11 UTC Wed Nov 30 2022

Reload Index: 3
Reload Code: Image Install
Reload Description: Image Install
Reload Severity: Normal Reboot
Reload Time: 01:25:03 UTC Wed Nov 30 2022

Reload Index: 4
Reload Code: Critical Process Fault
Reload Description: Critical process rif_mgr fault on rp_0_0 (rc=137), system report at bootflash:core/Yang_Test-system-report_20221130-011127-UTC.tar.gz
Reload Severity: Abnormal Reboot
Reload Time: 01:13:08 UTC Wed Nov 30 2022

Reload Index: 5
Reload Code: Reload
Reload Description: Reload Command
Reload Severity: Normal Reboot
Reload Time: 01:08:26 UTC Wed Nov 30 2022

Reload Index: 6
Reload Code: Critical Process Fault
Reload Description: Critical process wncmgrd fault on rp_0_0 (rc=137), system report at bootflash:core/Yang_Test-system-report_20221130-010338-UTC.tar.gz
Reload Severity: Abnormal Reboot
Reload Time: 01:05:23 UTC Wed Nov 30 2022

Reload Index: 7
Reload Code: Reload
Reload Description: Reload Command
Reload Severity: Normal Reboot
Reload Time: 01:01:09 UTC Wed Nov 30 2022

Reload Index: 8
Reload Code: Reload
Reload Description: Reload Command
Reload Severity: Normal Reboot
Reload Time: 00:57:27 UTC Wed Nov 30 2022

Reload Index: 9
Reload Code: Reload
Reload Description: Reload Command
Reload Severity: Normal Reboot
Reload Time: 00:22:34 UTC Wed Nov 30 2022

Reload Index: 10
Reload Code: Fast Switchover
Reload Description: redundancy force-switchover
Reload Severity: Normal Reboot
Reload Time: 23:40:01 UTC Tue Nov 29 2022

To view reason for the last reload, use the following command:

```
Device# show platform software tdl-database content ios device data
Device Current time: 04:06:04
Device boot time: 01:33:37
Software version: Cisco IOS Software [Dublin], C9800-CL Software (C9800-CL-K9_IOSXE),
Experimental Version 17.11.20221012:120806
[BLD_POLARIS_DEV_S2C_20221010_023625-1-g5ebdd5c35512:/nobackup/saikarth/polaris_relhis 103]
Copyright (c) 1986-2022 by Cisco Systems, Inc.
Compiled Wed 12-Oct-22 05:08 by saikarth
Rommon version: IOS-XE ROMMON
Last Reboot reason: Reload Command
Reboot reason severity: Normal Reboot
Unsaved configuration: * Unknown boolean *
```

Reload History:

```
Reload Category: Reload
Reload Description: Reload Command
Reload Severity: Normal Reboot
Reload Time: 11/30/2022 01:33:44 UTC
```

```
Reload Category: Critical Process Fault
Reload Description: Critical process stack_mgr fault on rp_0_0 (rc=137), system report at
bootflash:core/Yang_Test-system-report_20221130-012929-UTC.tar.gz
Reload Severity: Abnormal Reboot
Reload Time: 11/30/2022 01:31:11 UTC
```

```
Reload Category: Image Install
Reload Description: Image Install
Reload Severity: Normal Reboot
Reload Time: 11/30/2022 01:25:03 UTC
```

```
Reload Category: Critical Process Fault
Reload Description: Critical process rif_mgr fault on rp_0_0 (rc=137), system report at
bootflash:core/Yang_Test-system-report_20221130-011127-UTC.tar.gz
Reload Severity: Abnormal Reboot
Reload Time: 11/30/2022 01:13:08 UTC
```

```
Reload Category: Reload
Reload Description: Reload Command
Reload Severity: Normal Reboot
Reload Time: 11/30/2022 01:08:26 UTC
```

```
Reload Category: Critical Process Fault
Reload Description: Critical process wncmgrd fault on rp_0_0 (rc=137), system report at
bootflash:core/Yang_Test-system-report_20221130-010338-UTC.tar.gz
Reload Severity: Abnormal Reboot
Reload Time: 11/30/2022 01:05:23 UTC
```

```
Reload Category: Reload
Reload Description: Reload Command
Reload Severity: Normal Reboot
Reload Time: 11/30/2022 01:01:09 UTC
```

```
Reload Category: Reload
Reload Description: Reload Command
Reload Severity: Normal Reboot
Reload Time: 11/30/2022 00:57:27 UTC
```

```
Reload Category: Reload
Reload Description: Reload Command
Reload Severity: Normal Reboot
Reload Time: 11/30/2022 00:22:34 UTC
```

```

Reload Category: Fast Switchover
Reload Description: redundancy force-switchover
Reload Severity: Normal Reboot
Reload Time: 11/29/2022 23:40:01 UTC

```

Requesting Reload Reason History using YANG

Use YANG with NETCONF and RESTCONF to provide the desired solution for automated and programmable network operations.

Use the following RPC to create a NETCONF GET request for reload history data:

```

<nc:rpc xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0"
message-id="urn:uuid:da15955f-5bb7-437c-aeb5-0fc7901a1e9e">
  <nc:get>
    <nc:filter>
      <device-hardware-data
xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-device-hardware-oper">
        <device-hardware>
          <device-system-data>
            <reload-history/>
          </device-system-data>
        </device-hardware>
      </device-hardware-data>
    </nc:filter>
  </nc:get>
</nc:rpc>

<rpc-reply message-id="urn:uuid:da15955f-5bb7-437c-aeb5-0fc7901a1e9e"
xmlns="urn:ietf:params:xml:ns:netconf:base:1.0"
xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0">
  <data>
    <device-hardware-data xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-device-hardware-oper">

      <device-hardware>
        <device-system-data>
          <reload-history>
            <rl-history>
              <reload-category>rc-rld</reload-category>
              <reload-desc>Reload Command</reload-desc>
              <reload-time>2022-11-30T01:33:44+00:00</reload-time>
              <reload-severity>normal</reload-severity>
            </rl-history>
            <rl-history>
              <reload-category>rc-crit-proc-fault</reload-category>
              <reload-desc>Critical process stack_mgr fault on rp_0_0 (rc=137), system
report at bootflash:core/Yang_Test-system-report_20221130-012929-UTC.tar.gz</reload-desc>
              <reload-time>2022-11-30T01:31:11+00:00</reload-time>
              <reload-severity>abnormal</reload-severity>
            </rl-history>
            <rl-history>
              <reload-category>rc-img-install</reload-category>
              <reload-desc>Image Install </reload-desc>
              <reload-time>2022-11-30T01:25:03+00:00</reload-time>
              <reload-severity>normal</reload-severity>
            </rl-history>
            <rl-history>
              <reload-category>rc-crit-proc-fault</reload-category>
              <reload-desc>Critical process rif_mgr fault on rp_0_0 (rc=137), system report
at bootflash:core/Yang_Test-system-report_20221130-011127-UTC.tar.gz</reload-desc>

```

```

        <reload-time>2022-11-30T01:13:08+00:00</reload-time>
        <reload-severity>abnormal</reload-severity>
    </rl-history>
    <rl-history>
        <reload-category>rc-rld</reload-category>
        <reload-desc>Reload Command</reload-desc>
        <reload-time>2022-11-30T01:08:26+00:00</reload-time>
        <reload-severity>normal</reload-severity>
    </rl-history>
    <rl-history>
        <reload-category>rc-crit-proc-fault</reload-category>
        <reload-desc>Critical process wncmgrd fault on rp_0_0 (rc=137), system report
at bootflash:core/Yang_Test-system-report_20221130-010338-UTC.tar.gz</reload-desc>
        <reload-time>2022-11-30T01:05:23+00:00</reload-time>
        <reload-severity>abnormal</reload-severity>
    </rl-history>
    <rl-history>
        <reload-category>rc-rld</reload-category>
        <reload-desc>Reload Command</reload-desc>
        <reload-time>2022-11-30T01:01:09+00:00</reload-time>
        <reload-severity>normal</reload-severity>
    </rl-history>
    <rl-history>
        <reload-category>rc-rld</reload-category>
        <reload-desc>Reload Command</reload-desc>
        <reload-time>2022-11-30T00:57:27+00:00</reload-time>
        <reload-severity>normal</reload-severity>
    </rl-history>
    <rl-history>
        <reload-category>rc-rld</reload-category>
        <reload-desc>Reload Command</reload-desc>
        <reload-time>2022-11-30T00:22:34+00:00</reload-time>
        <reload-severity>normal</reload-severity>
    </rl-history>
    <rl-history>
        <reload-category>rc-force-switchover</reload-category>
        <reload-desc>redundancy force-switchover</reload-desc>
        <reload-time>2022-11-29T23:40:01+00:00</reload-time>
        <reload-severity>normal</reload-severity>
    </rl-history>
</reload-history>
</device-system-data>
</device-hardware>
</device-hardware-data>
</data>
</rpc-reply>

```

For more information about the YANG models, see the following documents: The Cisco IOS XE Programmability Configuration Guide at <https://www.cisco.com/c/en/us/support/wireless/catalyst-9800-series-wireless-controllers/products-installation-and-configuration-guides-list.html>

The YANG Data Models on Github at <https://github.com/YangModels/yang/tree/main/vendor/cisco/xe>.

Contact the Developer Support Community for NETCONF and YANG features at:

<https://developer.cisco.com/>