

High Availability (Failover)

The following topics describe how to configure and manage active/standby failover to accomplish high availability of the Firewall Threat Defense system.

- About High Availability (Failover), on page 1
- System Requirements for High Availability, on page 9
- Guidelines for High Availability, on page 11
- Configuring High Availability, on page 13
- Managing High Availability, on page 25
- Monitoring High Availability, on page 35
- Troubleshooting High Availability (Failover), on page 38

About High Availability (Failover)

A high availability or failover setup joins two devices so that if the primary device fails, the secondary device can take over. This helps you keep your network operational in case of device failure.

Configuring high availability requires two identical Firewall Threat Defense devices connected to each other through a dedicated failover link and, optionally, a state link. The two units constantly communicate over the failover link to determine the operating status of each unit and to synchronize deployed configuration changes. The system uses the state link to pass connection state information to the standby device, so that if a failover occurs, user connections are preserved.

The units form an active/standby pair, where one unit is the active unit and passes traffic. The standby unit does not actively pass traffic, but synchronizes configuration and other state information from the active unit.

The health of the active unit (hardware, interfaces, software, and environmental status) is monitored to determine if specific failover conditions are met. If those conditions are met, the active unit fails over to the standby unit, which then becomes active.

Active/standby failover

Active/standby failover is a high availability configuration that

- lets you use a standby Firewall Threat Defense device to take over the functionality of a failed unit,
- enables the standby unit to become the active unit when the active unit fails, and
- allows the failed unit to come back online as the standby unit if the problem is temporary.

The failed unit must be replaced if the problem is not temporary. Set the standby unit to primary before replacing the failed unit to retain the configuration of the secondary unit.

For multiple context mode, the ASA can fail over the entire unit (including all contexts) but cannot fail over individual contexts separately.

Primary/secondary roles and active/standby status

Primary/secondary roles and active/standby status are failover configuration concepts that

- define unit hierarchy, with primary units taking precedence during simultaneous startup
- determine IP address and MAC address usage patterns during failover operations, and
- establish traffic flow responsibilities between paired units in Active/Standby failover configurations.

Primary and secondary unit differences

The main differences between the two units in a failover pair are related to which unit is active and which unit is standby, namely which IP addresses to use and which unit actively passes traffic.

However, a few differences exist between the units depending on which unit is primary (as specified in the configuration) and which unit is secondary:

- The primary unit always becomes the active unit if both units start up at the same time (and are of equal operational health).
- The primary unit MAC addresses are always coupled with the active IP addresses. The exception to this rule occurs when the secondary unit becomes active and cannot obtain the primary unit MAC addresses over the failover link. In this case, the secondary unit MAC addresses are used.

Active unit determination at startup

Active unit determination at startup is a high availability process that

- sets a unit to standby if it boots and detects a peer already running as active,
- sets a unit to active if it boots and does not detect a peer, and
- sets the primary unit as active and secondary unit as standby if both units boot simultaneously.

Failover events

A failover event is a system condition that

- triggers an active unit to transfer control to a standby unit in Active/Standby failover configurations
- occurs on a unit basis, and
- follows specific failover policies that determine whether failover occurs and what actions each unit takes.

Failover event policies and actions

This table shows the failover action for each failure event. For each failure event, the table shows the failover policy (failover or no failover), the action taken by the active unit, the action taken by the standby unit, and any special notes about the failover condition and actions.

Table 1: Failover events

Failure Event	Policy	Active Unit Action	Standby Unit Action	Notes
Active unit failed (power or hardware)	Failover	n/a	Become active Mark active as failed	No hello messages are received on any monitored interface or the failover link.
Formerly active unit recovers	No failover	Become standby	No action	None.
Standby unit failed (power or hardware)	No failover	Mark standby as failed	n/a	When the standby unit is marked as failed, then the active unit does not attempt to fail over, even if the interface failure threshold is surpassed.
Failover link failed during operation	No failover	Mark failover link as failed	Mark failover link as failed	You should restore the failover link as soon as possible because the unit cannot fail over to the standby unit while the failover link is down.
Failover link failed at startup	No failover	Become active Mark failover link as failed	Become active Mark failover link as failed	If the failover link is down at startup, both units become active.
State link failed	No failover	No action	No action	State information becomes out of date, and sessions are terminated if a failover occurs.
Interface failure on active unit above threshold	Failover	Mark active as failed	Become active	None.
Interface failure on standby unit above threshold	No failover	No action	Mark standby as failed	When the standby unit is marked as failed, then the active unit does not attempt to fail over even if the interface failure threshold is surpassed.

Failover and Stateful Failover Links

The failover link is a dedicated connection between the two units. The stateful failover link is also a dedicated connection, but you can either use the one failover link as a combined failover/state link, or you can create a separate, dedicated state link. If you use just the failover link, the stateful information also goes over that link: you do not lose stateful failover capability.

By default, the communications on the failover and stateful failover links are plain text (unencrypted). You can encrypt the communications for enhanced security by configuring an IPsec encryption key.

The following topics explain these interfaces in more detail, and include recommendations on how to wire the devices for the best results.

Failover Link

The two units in a failover pair constantly communicate over a failover link to determine the operating status of each unit and to synchronize configuration changes.

The following information is communicated over the failover link:

- The unit state (active or standby).
- Hello messages (keep-alives).
- Network link status.
- MAC address exchange.
- Configuration replication and synchronization.
- System database updates, including VDB and rules, but not including the geolocation and Security Intelligence databases. Each system separately downloads geolocation and Security Intelligence updates. If you create an update schedule, these should remain synchronized. However, if you do a manual geolocation or Security Intelligence update on the active device, you should also do one on the standby device.



Note Eventing, reporting, and audit log data are not synchronized. Event viewer and the dashboards show data related to the given unit only. In addition, deployment history, task history, and other audit log events are not synchronized.

Stateful Failover Link

The system uses the state link to pass connection state information to the standby device. This information helps the standby unit maintain existing connections when a failover occurs.

Using a single link for both the failover and stateful failover links is the best way to conserve interfaces. However, you must consider a dedicated interface for the state link and failover link, if you have a large configuration and a high traffic network.

Interfaces for the Failover and State Links

You can use an unused, but enabled, data interface (physical or EtherChannel) as the failover link; however, you cannot specify an interface that is currently configured with a name. The failover link interface is not configured as a normal networking interface; it exists for failover communication only. This interface can only be used for the failover link (and also for the state link). You cannot use a management interface, subinterface, VLAN interface, or switch port for failover.

The Firewall Threat Defense device does not support sharing interfaces between user data and the failover link.

See the following guidelines for sizing the failover and state link:

- Firepower 4100/9300—We recommend that you use a 10 GB data interface for the combined failover and state link.
- All other models—1 GB interface is large enough for a combined failover and state link.

When using an EtherChannel interface as the failover or state link, you must confirm that the same EtherChannel with the same ID and member interfaces exists on both devices before establishing high availability. If there is an EtherChannel mismatch, you need to disable HA and corerct the configuration on the secondary unit before. To prevent out-of-order packets, only one interface in the EtherChannel is used. If that interface fails, then the next interface in the EtherChannel is used. You cannot alter the EtherChannel configuration while it is in use as a failover link.

Connecting the Failover and Stateful Failover Interfaces

You can use any unused data physical interfaces as the failover link and optional dedicated state link. However, you cannot select an interface that is currently configured with a name, or one that has subinterfaces. The failover and stateful failover link interfaces are not configured as normal networking interfaces. They exist for failover communication only, and you cannot use them for through traffic or management access.

Because the configuration is synchronized between the devices, you must select the same port number for each end of a link. For example, GigabitEthernet1/3 on both devices for the failover link.

Connect the failover link, and the dedicated state link if used, in one of the following two ways:

- Using a switch, with no other device on the same network segment (broadcast domain or VLAN) as the failover interfaces of the Firewall Threat Defense device. A dedicated state link has the same requirement, but must be on a different network segment than the failover link.



Note The advantage of using a switch is that if one of the unit's interfaces goes down, it is easy to troubleshoot which interface failed. If you are using a direct cable connection, if one interface fails, the link is brought down on both peers, which makes it difficult to determine which device is at fault.

- Using an Ethernet cable to connect the units directly, without the need for an external switch. The Firewall Threat Defense supports Auto-MDI/MDIX on its copper Ethernet ports, so you can either use a crossover cable or a straight-through cable. If you use a straight-through cable, the interface automatically detects the cable and swaps one of the transmit/receive pairs to MDIX.

For optimum performance when using long distance failover, the latency for the state link should be less than 10 milliseconds and no more than 250 milliseconds. If latency is more than 10 milliseconds, some performance degradation occurs due to retransmission of failover messages.

Avoiding Interrupted Failover and Data Links

We recommend that failover links and data interfaces travel through different paths to decrease the chance that all interfaces fail at the same time. If the failover link is down, the Firewall Threat Defense device can use the data interfaces to determine if a failover is required. Subsequently, the failover operation is suspended until the health of the failover link is restored.

See the following connection scenarios to design a resilient failover network.

Scenario 1—Not Recommended

If a single switch or a set of switches are used to connect both failover and data interfaces between two Firewall Threat Defense devices, then when a switch or inter-switch-link is down, both Firewall Threat Defense devices become active. Therefore, the two connection methods shown in the following figures are **not** recommended.

Figure 1: Connecting with a Single Switch—Not Recommended

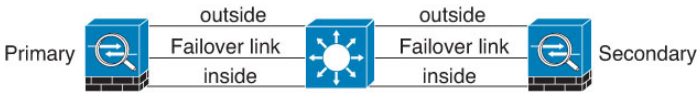
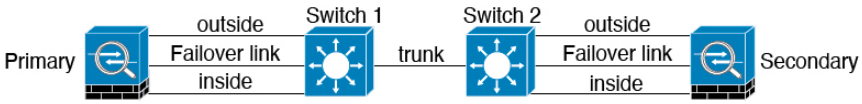


Figure 2: Connecting with a Double-Switch—Not Recommended



Scenario 2—Recommended

We recommend that failover links not use the same switch as the data interfaces. Instead, use a different switch or use a direct cable to connect the failover link, as shown in the following figures.

Figure 3: Connecting with a Different Switch

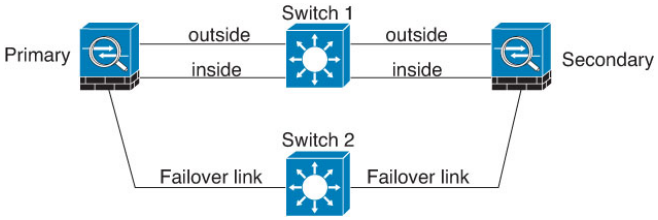
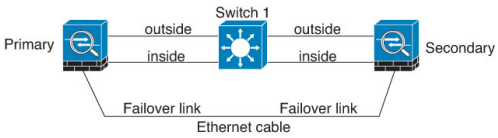


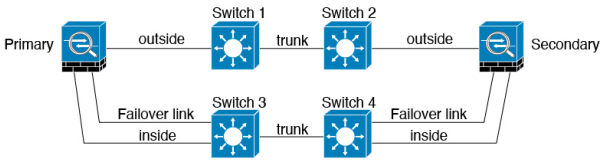
Figure 4: Connecting with a Cable



Scenario 3—Recommended

If the Firewall Threat Defense data interfaces are connected to more than one set of switches, then a failover link can be connected to one of the switches, preferably the switch on the secure (inside) side of network, as shown in the following figure.

Figure 5: Connecting with a Secure Switch



How Stateful Failover Affects User Connections

The active unit shares connection state information with the standby unit. This means that the standby unit can maintain certain types of connections without impacting the user.

However, there are some types of connections that do not support stateful failover. For these connections, the user will need to reestablish the connection if there is a failover. Often times, this happens automatically based on the behavior of the protocol used in the connection.

The following topics explain which features are supported or not supported for stateful failover.

Supported features

Supported features are high availability capabilities that

- enable state information to be passed to the standby Firewall Threat Defense device during Stateful Failover
- maintain connection states and critical information for seamless traffic flow, and
- ensure minimal disruption during failover events.

State information types

For Stateful Failover, these state information types are passed to the standby device:

- NAT translation table.
- TCP and UDP connections and states, including HTTP connection states. Other types of IP protocols, and ICMP, are not parsed by the active unit, because they get established on the new active unit when a new packet arrives.
- Snort connection states, inspection results, and pin hole information, including strict TCP enforcement.
- The ARP table
- The Layer 2 bridge table (for bridge groups)
- The ISAKMP and IPsec SA table
- GTP PDP connection database
- SIP signaling sessions and pin holes.
- Static and dynamic routing tables—Stateful Failover participates in dynamic routing protocols, like OSPF and EIGRP, so routes that are learned through dynamic routing protocols on the active unit are maintained in a Routing Information Base (RIB) table on the standby unit. Upon a failover event, packets travel normally with minimal disruption to traffic because the active secondary unit initially has rules that mirror the primary unit. Immediately after failover, the re-convergence timer starts on the newly active unit. Then the epoch number for the RIB table increments. During re-convergence, OSPF and EIGRP routes become updated with a new epoch number. Once the timer is expired, stale route entries (determined by the epoch number) are removed from the table. The RIB then contains the newest routing protocol forwarding information on the newly active unit.



Note Routes are synchronized only for link-up or link-down events on an active unit. If the link goes up or down on the standby unit, dynamic routes sent from the active unit may be lost. This is normal, expected behavior.

- DHCP Server—DHCP address leases are not replicated. However, a DHCP server configured on an interface will send a ping to make sure an address is not being used before granting the address to a DHCP client, so there is no impact to the service. State information is not relevant for DHCP relay or DDNS.
- Access control policy decisions—Decisions related to traffic matching (including URL, URL category, geolocation, and so forth), intrusion detection, malware, and file type are preserved during failover. However, for connections being evaluated at the moment of failover, there are the following caveats:
  - AVC—App-ID verdicts are replicated, but not detection states. Proper synchronization occurs as long as the App-ID verdicts are complete and synchronized before failover occurs.
  - Intrusion detection state—Upon failover, once mid-flow pickup occurs, new inspections are completed, but old states are lost.
  - File malware blocking—The file disposition must become available before failover.
  - File type detection and blocking—The file type must be identified before failover. If failover occurs while the original active device is identifying the file, the file type is not synchronized. Even if your file policy blocks that file type, the new active device downloads the file.
- Passive user identity decisions from the identity policy, but not those gathered through active authentication through captive portal.
- Security Intelligence decisions.
- RA VPN—Remote access VPN end users do not have to reauthenticate or reconnect the VPN session after a failover. However, applications operating over the VPN connection could lose packets during the failover process and not recover from the packet loss.
- From all the connections, only established ones will be replicated on the Standby device.

Unsupported features

Unsupported features are device capabilities that

- are not passed to the standby Firewall Threat Defense in Stateful Failover
- do not maintain state information during failover events, and
- may require re-establishment after a failover occurs.

State information limitations

For Stateful Failover, the following state information is not passed to the standby Firewall Threat Defense:

- Sessions in plaintext tunnels such as GRE or IP-in-IP. Sessions inside tunnels are not replicated and the new active node will not be able to reuse existing inspection verdicts to match the correct policy rules.
- Decrypted TLS/SSL connections—The decryption states are not synchronized, and if the active unit fails, then decrypted connections will be reset. New connections will need to be established to the new active unit. Connections that are not decrypted (in other words, those that match a TLS/SSL Do Not Decrypt rule action) are not affected and are replicated correctly.
- Multicast routing.

Configuration Changes and Actions Allowed on a Standby Unit

When operating in high-availability mode, you make configuration changes to the active unit only. When you deploy the configuration, the new changes are also transmitted to the standby unit.

However, some properties are unique to the standby unit. You can change the following on a standby unit:

- Management IP address and gateway.
- Customized login page.
- (CLI only.) The password for the admin user account and other local user accounts. You can make this change in the CLI only, you cannot make it in the Firewall Device Manager. Any local user will have to change their password on both units separately.

In addition, the following actions are available on a standby device.

- High availability actions, such as suspend, resume, reset, and break HA, and switch modes between active and standby.
- Dashboard and eventing data are unique per device, and are not synchronized. This includes custom views in Event Viewer.
- Audit log information is unique per device.
- Smart Licensing registration. However, you must enable or disable the optional licenses on the active unit, and the action is synchronized with the standby unit, which requests or releases the appropriate license.
- Backup, but not restore. You must break HA on the unit to restore a backup. If the backup includes the HA configuration, the unit will rejoin the HA group.
- Software upgrade installation.
- Generating troubleshooting logs.
- Manually updating the Geolocation or Security Intelligence databases. These databases are not synchronized between the units. If you create an update schedule, the units can independently maintain consistency.
- You can view active the Firewall Device Manager user sessions, and delete sessions, from the **Monitoring** > **Sessions** page.

System Requirements for High Availability

The following topics explain the requirements you must meet before incorporating two devices in a high availability configuration.

Hardware Requirements for HA

To link two devices together in a high availability configuration, you must meet the following hardware requirements.

- The devices must be the exact same hardware model.

For the Firepower 9300, High Availability is only supported between same-type modules; but the two chassis can include mixed modules. For example, each chassis has an SM-36 and SM-44. You can create High Availability pairs between the SM-36 modules and between the SM-44 modules.

- The devices must have the same number and type of interfaces.

  For the Firepower 4100/9300 chassis, all interfaces must be preconfigured in FXOS identically before you enable HA. If you change the interfaces after you enable HA, make the interface changes in FXOS on the standby unit, and then make the same changes on the active unit.

- The devices must have the same modules installed. For example, if one has an optional network interface module, then you must install the same module in the other device.
- Intra-chassis High Availability for the Firepower 9300 is not supported. You cannot configure HA between separate logical devices on the same chassis.

Software Requirements for HA

To link two devices together in a high availability configuration, you must meet the following software requirements.

- The devices must run the exact same software version, which means the same major (first), minor (second), and maintenance (third) numbers. You can find the version in the Firewall Device Manager on the **Devices** page, or you can use the **show version** command in the CLI. Devices with different versions are allowed to join, but the configuration is not imported into the standby unit and failover is not functional until you upgrade the units to the same software version.
- Both devices must be in local manager mode, that is, configured using the Firewall Device Manager. If you can log into the Firewall Device Manager on both systems, they are in local manager mode. You can also use the **show managers** command in the CLI to verify.
- You must complete the initial setup wizard for each device.
- Each device must have its own management IP address. The configuration for the management interface is not synchronized between the devices.
- The devices must have the same NTP configuration.
- You cannot configure any interface to obtain its address using DHCP. That is, all interfaces must have static IP addresses.
- For Cloud Services, either both devices must be enrolled in the same region, or neither device can be enrolled. You cannot have mixed Cloud Services enrollment.
- You must deploy any pending changes before you configure high availability.

License Requirements for HA

Before configuring high availability, the units must be in the same state: either both registered with the Essentials license, or both in evaluation mode. If the devices are registered, they can be registered to different Cisco Smart Software Manager accounts, but the accounts must have the same state for the export-controlled functionality setting, either both enabled or both disabled. However, it does not matter if you have enabled different optional licenses on the units. If you register both units, you must select the same Cisco Cloud Services region for the devices.

If the devices are registered, they must use the same mode, either Smart License or Permanent License Reservation (PLR).

During operation, the units in the high availability pair must have the same licenses. Any license changes you make on the active unit are repeated on the standby unit during deployment.

High availability configurations require two Smart License entitlements; one for each device in the pair. You must ensure there are sufficient licenses in your account to apply to each device. It is possible to be in compliance on one device, but out of compliance on the other, if there are insufficient licenses.

For example, if the active device has the Essentials license and the IPS, and the standby device has only the Essentials license, the standby unit communicates with the Cisco Smart Software Manager to obtain an available IPS from your account. If your Smart Licenses account does not include enough purchased entitlements, your account becomes Out-of-Compliance (and the standby device is Out-of-Compliance even though the active device is compliant) until you purchase the correct number of licenses.

Watch Out For:

- If you register the devices to accounts that have different settings for export controlled features, or try to create an HA pair with one unit registered and the other in evaluation mode, the HA join might fail.
- If you configure an IPsec encryption key with inconsistent settings for export controlled features, both devices will become active after you activate HA. This will impact routing on the supported network segments, and you will have to manually break HA on the secondary unit to recover.
- Do not change licensing in the middle of creating the HA group. Both units must have the same configuration at the time of HA join or you will see the following error: “FDM validation failure - Cloud Service enrollment status mismatch between Primary and Secondary Node. Check app-sync-history CLI for details.”

Guidelines for High Availability

Model Support

- Firepower 9300—You can configure HA on the Firepower 9300. However, you cannot configure HA between separate logical devices on the same Firepower 9300 chassis.
- Firepower 1010 and Secure Firewall 1210/1220:
  - You should not use the switch port functionality when using high availability. Because the switch ports operate in hardware, they continue to pass traffic on both the active *and* the standby units. High availability is designed to prevent traffic from passing through the standby unit, but this feature does not extend to switch ports. In a normal high availability network setup, active switch ports on both units will lead to network loops. We suggest that you use external switches for any switching capability. Note that VLAN interfaces can be monitored by failover, while switch ports cannot. Theoretically, you can put a single switch port on a VLAN and successfully use high availability, but a simpler setup is to use physical firewall interfaces instead.
  - You can only use a firewall interface as the failover link.
  - When the chassis is in a high availability pair, the "Active" LED is amber for the standby unit.

- (Firepower 1000 series)—Deploying the devices in HA with hundreds of interfaces configured on them can result in increased delay in the failover time (seconds).
- Firewall Threat Defense Virtual—HA configuration is not supported for Firewall Threat Defense Virtual for the Microsoft Azure Cloud or the Amazon Web Services (AWS) Cloud.

Additional Guidelines

- 169.254.0.0/16 and fd00:0:0:*::/64 are internally used subnets and you cannot use them for the failover or state links.
- The configuration from the active unit is synchronized to the standby unit when you run a deployment job on the active unit. However, some changes do not show up in the pending changes even though they are not synchronized on the standby unit until you deploy changes. If you alter any of the following, the changes are hidden and you must run a deployment job before they are configured on the standby unit. If you need to apply the change immediately, you will need to make some other change that does appear in the pending changes. Hidden changes include edits to the following: schedules for rule, geodatabase, Security Intelligence, or VDB updates; schedules for backups; NTP; HTTP proxy for management connections; license entitlement; cloud services options; URL filtering options.
- You should do backups on both the primary and secondary units. To restore a backup, you must first break HA. Do not restore the same backup on both units, because they would then both go active. Instead, restore the backup on the unit you want to go active first, then restore the equivalent backup on the other unit.
- The **Test** button for the various identity sources works on the active unit only. If you need to test identity source connectivity for the standby device, you must first switch modes to make the standby peer the active peer.
- Creating or breaking the high availability configuration restarts the Snort inspection process on both devices when the configuration change is deployed. This can result in through traffic disruption until the process completely restarts.
- When you initially configure high availability, if the Security Intelligence and Geolocation database versions on the secondary are different than they are on the primary, jobs to update the databases are scheduled on the secondary unit. These jobs are run on the next deployment from the active unit. Even if the HA join fails, these jobs remain and will execute on the next deployment.
- When the active unit fails over to the standby unit, the connected switch port running Spanning Tree Protocol (STP) can go into a blocking state for 30 to 50 seconds when it senses the topology change. To avoid traffic loss while the port is in a blocking state, you can enable the STP PortFast feature on the switch:

  interface *interface_id* **spanning-tree portfast**

  This workaround applies to switches connected to both routed mode and bridge group interfaces. The PortFast feature immediately transitions the port into STP forwarding mode upon linkup. The port still participates in STP. So if the port is to be a part of the loop, the port eventually transitions into STP blocking mode.
- Configuring port security on the switches connected to the high availability pair can cause communication problems when a failover event occurs. This problem occurs because when a secure MAC address configured or learned on one secure port moves to another secure port, a violation is flagged by the switch port security feature.

- For Active/Standby high availability and a VPN IPsec tunnel, you cannot monitor both the active and standby units using SNMP over the VPN tunnel. The standby unit does not have an active VPN tunnel, and will drop traffic destined for the network management system (NMS). You can instead use SNMPv3 with encryption so the IPsec tunnel is not required.
- Interfaces that you use for high-availability failover and stateful failover links do not have to be enabled. The interface status should show that the link is up, but the interfaces themselves might appear to be disabled. Additionally, the interface information is not updated with the IP addresses defined in the high-availability configuration.

Configuring High Availability

Use a high availability setup to ensure network connectivity even if a device fails. With active/standby high availability, two devices are linked, so that if the active device fails, the standby device takes over and users should see no more than a brief connectivity problem.

The following procedure explains the end-to-end process for setting up an active/standby high availability (HA) pair.

Procedure

Step 1 Prepare the Two Units for High Availability, on page 13.

Step 2 Configure the Primary Unit for High Availability, on page 15.

Step 3 Configure the Secondary Unit for High Availability, on page 18.

Step 4 Configure Failover Criteria for Health Monitoring, on page 19.

The criteria includes peer monitoring and interface monitoring. Although all failover criteria have default settings, you should at least examine them to verify that the default settings work for your network.

- Configure Peer Unit Health Monitoring Failover Criteria, on page 19.
- Configure Interface Health Monitoring Failover Criteria, on page 20.

  For information on interface testing, see How the System Tests Interface Health, on page 22.

Step 5 (Optional but recommended.) Configure Standby IP and MAC Addresses, on page 23.

Step 6 (Optional.) Verify the High Availability Configuration, on page 24.

Prepare the Two Units for High Availability

There are many things that you must prepare correctly before you can successfully configure high availability.

Procedure

Step 1 Ensure that the devices meet the requirements explained in Hardware Requirements for HA, on page 9.

Step 2 Determine whether you will use a single failover link, or separate failover and stateful failover links, and identify the ports you will use.

You must use the same port number on each device for each link. For example, GigabitEthernet 1/3 on both devices for the failover link. Know which ones you will use so that you do not accidentally use them for other purposes. For more information, see Failover and Stateful Failover Links, on page 3.

Step 3 Install the devices, connect them to the network, and complete the initial setup wizard on each device.

a) Review the recommended network designs in Avoiding Interrupted Failover and Data Links, on page 5.

b) Connect at least the outside interfaces, as explained in Connect the Interfaces.

You can also connect the other interfaces, but you must ensure that you use the same port on each device to connect to a given subnet. Because the devices will share the same configuration, you must connect them to your networks in a parallel manner.

Note
The setup wizard does not let you change the IP addresses on the management and inside interface. Thus, if you connect either of these interfaces on the primary device to the network, do not also connect the interfaces on the secondary device, or you will get an IP address conflict. You can directly connect your workstation to one of these interfaces and get an address through DHCP, so that you can connect to the Firewall Device Manager and configure the device.

c) Complete the initial setup wizard on each device. Ensure that you specify static IP addresses for the outside interface. In addition, configure the same NTP servers. For more information, see Complete the Initial Configuration Using the Setup Wizard.

Choose the same licensing and Cisco Success Network options for the units. For example, evaluation mode for each or register the devices.

d) On the secondary device, select **Device** > **System Settings** > **Management Interface** and configure a unique IP address, change the gateway if necessary, and disable or change the DHCP server settings to suit your needs.

e) On the secondary device, select **Device** > **Interface** and edit the inside interface. Either delete the IP address, or change it. Also, delete the DHCP server defined for the interface, because you cannot have two DHCP servers on the same network.

f) Deploy the configuration on the secondary device.

g) If necessary based on your network topology, log into the primary device and change the management address, gateway, and DHCP server settings, and the inside interface IP address and DHCP server settings. Deploy the configuration if you make any changes.

h) If you have not connected the inside interface, or management interface if you use a separate management network, you can now connect them to the switches.

Step 4 Verify that the devices have the exact same software version, which means the same major (first), minor (second), and maintenance (third) numbers. You can find the version in the Firewall Device Manager on the Devices page, or you can use the **show version** command in the CLI.

If they are not running the same software versions, obtain the preferred software version from Cisco.com and install it on each device. For details, see Upgrading Firewall Threat Defense.

Step 5 Connect and configure the failover and stateful failover links.

a) Following your preferred network design (chosen from Avoiding Interrupted Failover and Data Links, on page 5), connect the failover interfaces for each device appropriately, either to a switch or directly to each other.

b) If you are using a separate state link, also connect the stateful failover interfaces for each device appropriately.
c) Log into each device in turn and go to **Device** > **Interface**. Edit each interface and verify there are no interface names or IP addresses configured.

   If the interfaces are configured with names, you might need to remove them from security zones and delete other configurations before you can delete the name. If deleting the name fails, examine the error messages to determine what other changes you need to make.

Step 6 On the primary device, connect the remaining data interfaces and configure the device.
a) Select **Device** > **Interface**, edit each interface used for through traffic and configure the primary static IP addresses.
b) Add the interfaces to security zones, and configure the basic policies needed to handle traffic on the connected networks. For example configurations, see the topics listed in Best Practices: Use Cases for Firewall Threat Defense.
c) Deploy the configuration.

Step 7 Verify that you meet all the requirements explained in Software Requirements for HA, on page 10.

Step 8 Verify that you have consistent licensing (registered or in evaluation mode). For more information, see License Requirements for HA, on page 10.

Step 9 On the secondary device, connect the remaining data interfaces to the same networks as the equivalent interfaces on the primary device. Do not configure the interfaces.

Step 10 On each device, select **Device** > **System Settings** > **Cloud Services** and verify that you have the same settings.

You are now ready to configure high availability on the primary device.

Configure the Primary Unit for High Availability

To set up an active/standby high availability pair, you must first configure the primary device. The primary device is the unit that you intend should be active under normal circumstances. The secondary device remains in standby mode until the primary unit becomes unavailable.

Select which device you want to be primary, then log into the Firewall Device Manager on that device and follow this procedure.



Note Once you establish the high availability pair, you must break the pair in order to edit the configuration described in this procedure.

Before you begin

Ensure that the interfaces you will configure for the failover and stateful failover link are not named. If they currently are named, you must remove the interfaces from any policies that use them, including security zone objects, then edit the interfaces to delete the name. The interfaces must also be in routed mode, not passive mode. These interfaces must be dedicated for use in the HA configuration: you cannot use them for any other purposes.

If there are any pending changes, you must deploy them before you can configure HA.

Procedure

Step 1 Click **Device**.

Step 2 On the right side of the device summary, click **Configure** next to the **High Availability** group.

If you are configuring HA for the first time on the device, the group would look like the following.



Step 3 On the High Availability page, click the **Primary Device** box.

If the secondary device is already configured, and you copied the configuration to the clipboard, you can click the **Paste from Clipboard** button and paste in the configuration. This will update the fields with the appropriate values, which you can then verify.

Step 4 Configure the **Failover Link** properties.

The two units in a failover pair constantly communicate over a failover link to determine the operating status of each unit and to synchronize configuration changes. For more information, see Failover Link, on page 4.

- **Physical Interface**—Select the interface you connected to the secondary device for use as the failover link. This must be an unnamed interface.

  When using an EtherChannel interface as the failover or state link, you must confirm that the same EtherChannel with the same ID and member interfaces exists on both devices before establishing high availability. If there is an EtherChannel mismatch, you need to disable HA and corerct the configuration on the secondary unit before. To prevent out-of-order packets, only one interface in the EtherChannel is used. If that interface fails, then the next interface in the EtherChannel is used. You cannot alter the EtherChannel configuration while it is in use as a failover link.

- **Type**—Select whether you will use an IPv4 or IPv6 address for the interface. You can configure one type of address only.

- **Primary IP**—Enter the IP address for the interface on this device. For example, 192.168.10.1. For IPv6 addresses, you must include the prefix length in standard notation, for example, 2001:a0a:b00::a0a:b70/64.

- **Secondary IP**—Enter the IP address that should be configured on the other end of the link for the interface on the secondary device. The address must be on the same subnet as the primary address, and it must be different than the primary address. For example, 192.168.10.2 or 2001:a0a:b00::a0a:b71/64.

- **Netmask** (IPv4 only)—Enter the subnet mask for the primary/secondary IP address.

Step 5 Configure the Stateful Failover Link properties.

The system uses the state link to pass connection state information to the standby device. This information helps the standby unit maintain existing connections when a failover occurs. You can either use the same link as the failover link, or configure a separate link.

- **Use the Same Interface as the Failover Link**—Select this option if you want to use a single link for the failover and stateful failover communications. If you select this option, continue with the next step.

- **Physical Interface**—If you want to use a separate stateful failover link, select the interface you connected to the secondary device for use as the stateful failover link. This must be an unnamed interface. Then, configure the following properties:
  - **Type**—Select whether you will use an IPv4 or IPv6 address for the interface. You can configure one type of address only.
  - **Primary IP**—Enter the IP address for the interface on this device. The address must be on a different subnet than the one used for the failover link. For example, 192.168.11.1. For IPv6 addresses, you must include the prefix length in standard notation, for example, 2001:a0a:b00:a::a0a:b70/64.
  - **Secondary IP**—Enter the IP address that should be configured on the other end of the link for the interface on the secondary device. The address must be on the same subnet as the primary address, and it must be different than the primary address. For example, 192.168.11.2 or 2001:a0a:b00:a::a0a:b71/64.
  - **Netmask** (IPv4 only)—Enter the subnet mask for the primary/secondary IP address.

Step 6 (Optional.) Enter an **IPsec Encryption Key** string if you want to encrypt communication between the two units in the pair.

You must configure the exact same key on the secondary node, so make a note of the string you enter.

If you do not enter a key, all communication on the failover and stateful failover links is in plain text. If you are not using direct cable connections between the interfaces, this could be a security problem.

Note
If you configure HA failover encryption in evaluation mode, the systems use DES for the encryption. If you then register the devices using an export-compliant account, the devices will use AES after a reboot. Thus, if a system reboots for any reason, including after installing an upgrade, the peers will be unable to communicate and both units will become the active unit. We recommend that you do not configure encryption until after you register the devices. If you do configure this in evaluation mode, we recommend you remove the encryption before registering the devices.

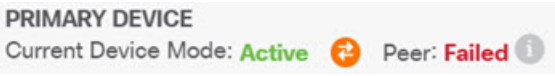
Step 7 Click **Activate HA**.

The system immediately deploys the configuration to the device. You do not need to start a deployment job. If you do not see a message saying that your configuration was saved and deployment is in progress, scroll to the top of the page to see the error messages.

The configuration is also copied to the clipboard. You can use the copy to quickly configure the secondary unit. For added security, the encryption key is not included in the clipboard copy.

After configuration completes, you get a message explaining the next steps you need to take. Click **Got It** after reading the information.

At this point, you should be on the High Availability page, and your device status should be “Negotiating.” The status should transition to Active even before you configure the peer, which should appear as Failed until you configure it.



You can now configure the secondary unit. See Configure the Secondary Unit for High Availability, on page 18.

Note
The selected interfaces are not configured directly. However, if you enter **show interface** in the CLI, you will see that the interfaces are using the specified IP addresses. The interfaces are named "failover-link" and if you configure a separate state link, "stateful-failover-link."

Configure the Secondary Unit for High Availability

After you configure the primary device for active/standby high availability, you must then configure the secondary device. Log into the Firewall Device Manager on that device and follow this procedure.

Note If you have not done so already, copy the high availability configuration from the primary device to the clipboard. It is much easier to configure the secondary device using copy/paste than to manually enter the data.

Procedure

Step 1 Click **Device**.

Step 2 On the right side of the device summary, click **Configure** next to the **High Availability** group.

If you are configuring HA for the first time on the device, the group would look like the following.



Step 3 On the High Availability page, click the **Secondary Device** box.

Step 4 Do one of the following:

- **Easy method**—Click the **Paste from Clipboard** button, paste in the configuration and click **OK**. This will update the fields with the appropriate values, which you can then verify.
- **Manual method**—Configure the failover and stateful failover links directly. Enter the exact same settings on the secondary device that you entered on the primary device.

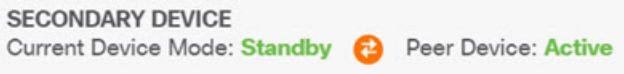
Step 5 If you configured an **IPSec Encryption Key** on the primary device, enter the exact same key for the secondary device.

Step 6 Click **Activate HA**.

The system immediately deploys the configuration to the device. You do not need to start a deployment job. If you do not see a message saying that your configuration was saved and deployment is in progress, scroll to the top of the page to see the error messages.

After configuration completes, you get a message saying that you have configured HA. Click **Got It** to dismiss the message.

At this point, you should be on the High Availability page, and your device status should indicate that this is the secondary device. If the join with the primary device was successful, the device will synchronize with the primary, and eventually the mode should be Standby and the peer should be Active.



Note
The selected interfaces are not configured directly. However, if you enter **show interface** in the CLI, you will see that the interfaces are using the specified IP addresses. The interfaces are named "failover-link" and if you configure a separate state link, "stateful-failover-link."

Configure Failover Criteria for Health Monitoring

The units in a high availability configuration monitor themselves for overall health and for interface health.

The failover criteria define the health monitoring metrics that determine whether a peer has failed. If the active peer is the unit that violates the criteria, then it triggers a failover to the standby unit. If the standby peer is the unit that violates the criteria, it is marked as failed and is not available for failover.

You can configure failover criteria on the active device only.

The following table shows the failover triggering events and associated failure detection timing.

Table 2: Failover Times Based on Failover Criteria

Failover Triggering Event	Minimum	Default	Maximum
The active unit loses power or stops normal operation.	800 milliseconds	15 seconds	45 seconds
An active unit interface physical link is down.	500 milliseconds	5 seconds	15 seconds
An active unit interface is up, but a connection problem causes interface testing.	5 seconds	25 seconds	75 seconds

The following topics explain how to customize the failover health monitoring criteria and also how the system tests interfaces.

Configure Peer Unit Health Monitoring Failover Criteria

Each peer in a high availability configuration determines the health of the other unit by monitoring the failover link with hello messages. When a unit does not receive three consecutive hello messages on the failover link, the unit sends LANTEST messages on each data interface, including the failover link, to validate whether the peer is responsive. The action that the device takes depends on the response from the other unit:

- If the device receives a response on the failover link, then it does not fail over.
- If the device does not receive a response on the failover link, but it does receive a response on a data interface, then the unit does not fail over. The failover link is marked as failed. You should restore the failover link as soon as possible because the unit cannot fail over to the standby while the failover link is down.

- If the device does not receive a response on any interface, then the standby unit switches to active mode and classifies the other unit as failed.

You can configure the poll and hold time for the hello messages.

Procedure

Step 1 On the active device, click **Device**.

Step 2 Click the **High Availability** link on the right side of the device summary.

The Failover Criteria are listed in the right column of the High Availability page.

Step 3 Define the **Peer Timing Configuration**.

These settings determine how quickly the active device can fail over to the standby device. With a faster poll time, the device can detect failure and trigger failover faster. However, faster detection can cause unnecessary switchovers when the network is temporarily congested. The default settings are appropriate for most situations.

If a unit does not hear hello packet on the failover interface for one polling period, additional testing occurs through the remaining interfaces. If there is still no response from the peer unit during the hold time, the unit is considered failed and, if the failed unit is the active unit, the standby unit takes over as the active unit.

- **Poll Time**—The amount of time between hello messages. Enter 1 - 15 seconds, or 200 - 999 milliseconds. The default is 1 second.
- **Hold Time**—The time during which a unit must receive a hello message on the failover link, after which the peer unit is declared failed. The hold time must be at least 3 times more than the poll time. Enter 1 - 45 seconds, or 800 - 999 milliseconds. The default is 15 seconds.

Step 4 Click **Save**.

Configure Interface Health Monitoring Failover Criteria

You can monitor up to 211 interfaces, depending on your device model. You should monitor important interfaces. For example, interfaces that ensure throughput between important networks. Monitor an interface only if you configure standby IP addresses for it, and if the interface should be always up.

When a unit does not receive hello messages on a monitored interface for 2 polling periods, it runs interface tests. If all interface tests fail for an interface, but this same interface on the other unit continues to successfully pass traffic, then the interface is considered to be failed. If the threshold for failed interfaces is met, then a failover occurs. If the other unit's interface also fails all the network tests, then both interfaces go into the “Unknown” state and do not count towards the failover limit.

An interface becomes operational again if it receives any traffic. A failed device returns to standby mode if the interface failure threshold is no longer met.

You can monitor interface HA status from the CLI or CLI Console using the **show monitor-interface** command. For more information, see Monitoring Status for HA-Monitored Interfaces, on page 37.

Note When an interface goes down, for failover it is still considered to be a unit issue. If the unit detects that an interface is down, failover occurs immediately (if you keep the default threshold of 1 interface), without waiting for the interface holdtime. The interface holdtime is only useful when the unit considers its status to be OK, although it is not receiving hello packets from the peer.

Before you begin

By default, all named physical interfaces are selected for HA monitoring. Thus, you should disable monitoring on unimportant physical interfaces. For subinterfaces or bridge groups, you must manually enable monitoring.

To disable interface monitoring completely and prevent failover due to interface failure, simply ensure that no interface is enabled for HA monitoring.

Procedure

Step 1 On the active device, click **Device**.

Step 2 Click the **High Availability** link on the right side of the device summary.

The Failover Criteria are listed in the right column of the High Availability page.

Step 3 Define the **Interface Failure Threshold**.

If the number of failed interfaces meets the threshold, the unit marks itself as failed. If the unit is the active unit, it fails over to the standby unit. If the unit is the standby unit, by marking itself as failed, the active unit will not consider the unit as available for failover.

When setting this criteria, consider how many interfaces you are monitoring. For example, if you enable monitoring on only 2 interfaces, then a threshold of 10 interfaces will never be reached. You configure monitoring for an interface by selecting the **Enable for HA Monitoring** option on the **Advanced Options** tab when editing interface properties.

By default, the unit marks itself as failed if one monitored interface fails.

You can set the interface failure threshold by selecting one of the following **Failover Criteria** options:

- **Number of failed interfaces exceeds**—Enter the raw number of interfaces. The default is 1. The maximum actually depends on the device model and can vary, but you cannot enter more than 211. If you use this criteria, you will get a deployment error if you enter a number larger than the device supports. Try a smaller number or use percentage instead.
- **Percentage of failed interfaces exceeds**—Enter a number from 1 - 100. For example, if you enter 50%, and you are monitoring 10 interfaces, then the device marks itself as failed if 5 interfaces fail.

Step 4 Define the **Interface Timing Configuration**.

These settings determine how quickly the active device can determine if an interface has failed. With a faster poll time, the device can detect interface failure faster. However, faster detection can mean that busy interfaces get marked as failed when in fact they are healthy, which can result in unnecessarily frequent failovers. The default settings are appropriate for most situations.

If an interface link is down, interface testing is not conducted and the standby unit could become active in just one interface polling period if the number of failed interfaces meets or exceeds the configured interface failover threshold.

- **Poll Time**—The frequency that hello packets are sent out on data interfaces. Enter 1 - 15 seconds, or 500 - 999 milliseconds. The default is 5 seconds.
- **Hold Time**—The hold time determines how long it takes from the time a hello packet is missed to when the interface is marked as failed. Enter 5 - 75 seconds. You cannot enter a hold time that is less than 5 times the poll time.

Step 5 Click **Save**.

Step 6 Enable HA monitoring for each interface you want to monitor.

a) Choose **Device** > **Interfaces**.

If an interface is being monitored, the Monitor for HA column indicates Enabled.

b) Click the edit icon ( ) for an interface whose monitoring status you want to change.

You cannot edit the failover or stateful failover interfaces. Interface monitoring does not apply to them.

c) Click the **Advanced Options** tab.

d) Select or deselect the **Enable for HA Monitoring** checkbox as preferred.

e) Click **OK**.

Step 7 (Optional, but recommended.) Configure standby IP addresses and MAC addresses for monitored interfaces. See Configure Standby IP and MAC Addresses, on page 23.

How the System Tests Interface Health

The system continuously tests interfaces that you are monitoring for high availability health. The address used for testing an interface is based on the address types you configure:

- If an interface has both IPv4 and IPv6 addresses configured on it, the device uses the IPv4 addresses to perform the health monitoring.
- If an interface has only IPv6 addresses configured on it, then the device uses IPv6 neighbor discovery instead of ARP to perform the health monitoring tests. For the broadcast ping test, the device uses the IPv6 all nodes address (FE02::1).

The system performs the following tests on each unit:

1. Link Up/Down test—A test of the interface status. If the Link Up/Down test indicates that the interface is down, then the unit considers it failed. If the status is Up, then the unit performs the Network Activity test.
2. Network Activity test—A received network activity test. The purpose of this test is to generate network traffic using LANTEST messages to determine which (if either) unit has failed. At the start of the test, each unit clears its received packet count for its interfaces. As soon as a unit receives any packets during the test (up to 5 seconds), then the interface is considered operational. If one unit receives traffic and the other unit does not, then the unit that received no traffic is considered failed. If neither unit received traffic, then the unit starts the ARP test.

3. ARP test—A reading of the unit ARP cache for the 2 most recently acquired entries. One at a time, the unit sends ARP requests to these devices, attempting to stimulate network traffic. After each request, the unit counts all received traffic for up to 5 seconds. If traffic is received, the interface is considered operational. If no traffic is received, an ARP request is sent to the next device. If at the end of the list no traffic has been received, the unit starts the ping test.
4. Broadcast Ping test—A ping test that consists of sending out a broadcast ping request. The unit then counts all received packets for up to 5 seconds. If any packets are received at any time during this interval, the interface is considered operational and testing stops. If no traffic is received, the testing starts over again with the ARP test.

Configure Standby IP and MAC Addresses

When you configure your interfaces, you can specify an active IP address and a standby IP address on the same network. Although recommended, the standby address is not required. Without a standby IP address, the active unit cannot perform network tests to check the standby interface health; it can only track the link state. You also cannot connect to the standby unit on that interface for management purposes.

1. When the primary unit fails over, the secondary unit assumes the IP addresses and MAC addresses of the primary unit and begins passing traffic.
2. The unit that is now in standby state takes over the standby IP addresses and MAC addresses.

Because network devices see no change in the MAC to IP address pairing, no ARP entries change or time out anywhere on the network.

If the secondary unit boots without detecting the primary unit, the secondary unit becomes the active unit and uses its own MAC addresses, because it does not know the primary unit MAC addresses. However, when the primary unit becomes available, the secondary (active) unit changes the MAC addresses to those of the primary unit, which can cause an interruption in your network traffic. Similarly, if you swap out the primary unit with new hardware, a new MAC address is used.

Virtual MAC addresses guard against this disruption because the active MAC addresses are known to the secondary unit at startup, and remain the same in the case of new primary unit hardware. You can manually configure virtual MAC addresses.

If you do not configure virtual MAC addresses, you might need to clear the ARP tables on connected routers to restore traffic flow. The device does not send gratuitous ARPs for static NAT addresses when the MAC address changes, so connected routers do not learn of the MAC address change for these addresses.

Procedure

Step 1 Choose **Device** > **Interfaces**.

You should at least configure standby IP and MAC addresses for the interfaces you are monitoring for HA. If an interface is being monitored, the Monitor for HA column indicates Enabled.

Step 2 Click the edit icon ( ) for the interface whose standby addresses you want to configure.

You cannot edit the failover or stateful failover interfaces. You set the IP addresses for these interfaces when you configure high availability.

Step 3 Configure the Standby IP addresses on the **IPv4 Address** and **IPv6 Address** tabs.

The standby address is used by this interface on the standby device. If you do not set the standby IP address, the active unit cannot monitor the standby interface using network tests; it can only track the link state. Configure standby addresses for each IP version you are using.

Step 4 Click the **Advance Options** tab and configure the MAC Addresses.

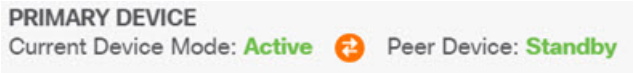
By default, the system uses the MAC address burned into the network interface card (NIC) for the interface. Thus, all subinterfaces on an interface use the same MAC address, so you might want to create unique addresses per subinterface. Manually configured active/standby MAC addresses are also recommended if you configure high availability. Defining the MAC addresses helps maintain consistency in the network in the event of failover.

- **MAC Address**—The Media Access Control address in H.H.H format, where H is a 16-bit hexadecimal digit. For example, you would enter the MAC address 00-0C-F1-42-4C-DE as 000C.F142.4CDE. The MAC address must not have the multicast bit set, that is, the second hexadecimal digit from the left cannot be an odd number.)
- **Standby MAC Address**—For use with high availability. If the active unit fails over and the standby unit becomes active, the new active unit starts using the active MAC addresses to minimize network disruption, while the old active unit uses the standby address.

Step 5 Click **OK**.

Verify the High Availability Configuration

After completing the high availability configuration, verify that the device status indicates that both devices are operational and in active/standby mode.



You can verify that the high availability configuration is working by following this procedure.

Procedure

Step 1 Test that your active unit is passing traffic as expected by using FTP (for example) to send a file between hosts on different interfaces.

At least test connections from one workstation to systems that are connected to each of the configured interfaces.

Step 2 Switch modes so that the active unit is now the standby unit by doing one of the following:

- In the Firewall Device Manager, select **Switch Mode** from the gear menu on the **Device** > **High Availability** page.
- In the CLI of the active unit, enter **no failover active**.

Step 3 Repeat the connection testing to verify that you can make the same connections through the other unit in the high availability pair.

If the test is not successful, verify that you connected the unit's interfaces to the same networks as the equivalent interfaces on the other unit.

You can see the HA status from the High Availability page. You can also use the CLI or CLI Console of the unit, and enter the **show failover** command to check the failover status. Also, use the **show interface** command to verify the interface configuration for the interfaces used in any connection tests that failed.

If these actions do not identify the problem, there are other steps you can take. See Troubleshooting High Availability (Failover), on page 38.

Step 4 When you are finished, you can switch modes to return active status to the original unit that was active.

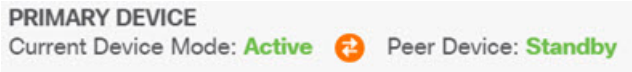
Managing High Availability

You can manage a high availability pair by clicking the **High Availability** link on the **Device** Summary page.



The High Availability page includes the following:

- **Role and Mode Status**—The left status area shows whether the device is the Primary or Secondary device in the group. The mode indicates whether this device is active or standby, or whether HA has been suspended or the device is waiting to join the peer device. It also shows the status of the peer device, which can be active, standby, suspended, or failed. For example, when you are logged into the primary device and it is also the active device, and the secondary device is healthy and ready for failover if needed, the status would look like the following. You can click the icon between the peers to get information on the configuration synchronization status between the devices.

- **Last Failure Reason**—If the High Availability (HA) configuration fails for some reason, such as the active device becoming unavailable and failing over to the standby device, the last reason for failure is shown below the status information for the role and mode status. This message is derived from the failover history.
- **Failover History** link—Click this link to see the detailed history of status of the devices in the pair. The system opens the CLI Console and executes the **show failover history details** command.
- **Deployment History** link—Click this link to go to the audit log with the events filtered to show deployment jobs only.
- **Gear button** —Click this button to perform actions on the devices.
  - **Suspend HA/Resume HA**—Suspending HA stops the devices from functioning as a high availability pair without removing the HA configuration. You can subsequently resume, that is, re-enable, HA on the devices. For details, see Suspending or Resuming High Availability, on page 26.
  - **Break HA**—Breaking HA removes the high availability configuration from both devices and returns them to standalone devices. For details, see Breaking High Availability, on page 27.

- **Switch Mode**—Switching mode lets you force an active device to become standby, or a standby device to become active, depending from which device you perform the action. For details, see Switching the Active and Standby Peers (Forcing Failover), on page 29.

- **High Availability Configuration**—This panel shows the configuration of the failover pair. Click the **Copy to Clipboard** button to load the information into the clipboard, from where you can paste it into the secondary device's configuration. You can also copy it into another file for your records. This information does not show whether you defined an IPsec encryption key.



Note The interface configuration for HA is not reflected on the Interfaces page (**Device** > **Interfaces**). You cannot edit the interfaces that you use in an HA configuration.

- **Failover Criteria**—This panel includes the settings that determine the health criteria used when evaluating whether the active unit has failed and the standby unit should become the active unit. Adjust these criteria so that you get the failover performance required in your network. For details, see Configure Failover Criteria for Health Monitoring, on page 19.

The following topics explain various management tasks related to a high availability configuration.

Suspending or Resuming High Availability

You can suspend a unit in a high availability pair. This is useful when:

- Both units are in an active-active situation and fixing the communication on the failover link does not correct the problem.
- You want to troubleshoot an active or standby unit and do not want the units to fail over during that time.
- You want to prevent failover while installing a software upgrade on the standby device.

When you suspend high availability, you stop the pair of devices from behaving as a failover unit. The currently active device remains active, handling all user connections. However, failover criteria are no longer monitored, and the system will never fail over to the now pseudo-standby device. The standby device will retain its configuration, but it will remain inactive.

The key difference between suspending HA and breaking HA is that on a suspended HA device, the high availability configuration is retained. When you break HA, the configuration is erased. Thus, you have the option to resume HA on a suspended system, which enables the existing configuration and makes the two devices function as a failover pair again.

If you suspend high availability from the active unit, the configuration is suspended on both the active and standby unit. If you suspend it from the standby unit, it is suspended on the standby unit only, but the active unit will not attempt to fail over to a suspended unit.

You can resume a unit only if it is in Suspended state. The unit will negotiate active/standby status with the peer unit.

Note If necessary, you can suspend HA from the CLI by entering the **configure high-availability suspend** command. To resume HA, enter **configure high-availability resume**.

Before you begin

If you suspend high availability through the Firewall Device Manager, it stays suspended until you resume it, even if you reload the unit. However, if you suspend it through the CLI, it is a temporary state, and upon reload, the unit resumes the high-availability configuration automatically and negotiates the active/standby state with the peer.

If you are suspending high availability on the standby unit, please check whether the active unit is currently running a deployment job. If you switch modes while a deployment job is in progress, the job will fail and you will lose your configuration changes.

Procedure

Step 1 Click **Device**.

Step 2 Click the **High Availability** link on the right side of the device summary.

Step 3 Choose the appropriate command from the gear icon ( ).

- **Suspend HA**—You are prompted to confirm the action. Read the message and click **OK**. The HA status should show that the device is in Suspended mode.
- **Resume HA**—You are prompted to confirm the action. Read the message and click **OK**. The HA status should return to normal, either active or standby, after the unit negotiates with the peer.

Breaking High Availability

If you no longer want the two devices to operate as a high availability pair, you can break the HA configuration. When you break HA, each device becomes a standalone device. Their configurations are changed as follows:

- The active device retains the full configuration as it is prior to the break, with the HA configuration removed.
- The standby device has all interface configuration removed in addition to the HA configuration. All physical interfaces are disabled, although subinterfaces are not disabled. The management interface remains active, so you can log into the device and reconfigure it.

Note Alternatively, you can use the BreakHAStatus API resource (from the API Explorer) and use the **interfaceOption** attribute to direct the system to reconfigure the standby device's interfaces using the standby IP addresses. You must use the API if you want this result; Firewall Device Manager always disables the interfaces. Note that the system reconfigures the IP addresses but otherwise does not reconfigure all interface options, so traffic might not behave as expected until you deploy changes after the break.

How the break actually affects the units depends on the state of each unit when you perform the break.

- If the units are in a healthy active/standby state, break HA from the active unit. This will remove the HA configuration from both devices in the HA pair. If you want to break HA on the standby unit only, you must log into it and first suspend HA, then you can break HA.
- If the standby unit is in a suspended or failed state, breaking HA from the active unit removes the HA configuration from the active unit only. You must log into the standby unit and also break HA on that unit.
- If the peers are still negotiating HA or are synchronizing their configuration, you cannot break HA. Wait for the negotiation or synchronization to complete or time out. If you believe the systems are stuck in this state, you can suspend HA and then break HA.

Note When using the Firewall Device Manager, you cannot break HA from the CLI using the **configure high-availability disable** command.

Before you begin

For ideal results, bring the devices into a healthy active/standby state, and perform this action from the active device.

Procedure

Step 1 Click **Device**.

Step 2 Click the **High Availability** link on the right side of the device summary.

Step 3 From the gear icon (⚙), choose **Break HA**.

Step 4 Read the confirmation message, decide whether to select the option to disable interfaces, and click **OK**.

You must select the option to disable interfaces if you are breaking HA from the standby unit.

The system immediately deploys your changes on both this device and the peer device (if possible). It might take a few minutes for deployment to complete on each device and for each device to become independent.

Switching the Active and Standby Peers (Forcing Failover)

You can switch the active/standby modes for a functioning high-availability pair, that is, one peer is active, the other is standby. For example, if you are installing a software upgrade, you can switch the active unit to standby so that the upgrade does not impact user traffic.

You can switch modes from either the active or standby unit, but the peer unit must be functioning from the other unit's point of view. You cannot switch modes if any unit is suspended (you must resume HA first) or failed.

Note If necessary, you can switch between active and standby modes from the CLI. From the standby unit, enter the **failover active** command. From the active unit, enter the **no failover active** command.

Before you begin

Before switching modes, verify that the active unit is not in the middle of a deployment job. Wait for the deployment to complete before switching modes.

If the active unit has pending undeployed changes, deploy them before switching modes. Otherwise, you will lose your changes if you run a deployment job from the new active unit.

Procedure

Step 1 Click **Device**.

Step 2 Click the **High Availability** link on the right side of the device summary.

Step 3 From the gear icon (⚙), choose **Switch Mode**.

Step 4 Read the confirmation message and click **OK**.

The system forces failover so that the active unit becomes standby, and the standby unit becomes the new active unit.

Preserving Undeployed Configuration Changes After Failover

When you make configuration changes to the units in a high availability pair, you edit the configuration on the active unit. You then deploy your changes, and both the active and standby unit are updated with the new configuration. It does not matter if the active unit is the primary or secondary device.

However, undeployed changes are not synchronized between the units. Any undeployed changes are available on the unit where you made those changes only.

Thus, if a failover happens when you have undeployed changes, those changes are not available on the new active unit. The changes do, however, remain in place on the unit that is now standby.

To retrieve your undeployed changes, you must switch modes to force a failover and return the other unit to active status. When you log into the newly-active unit, your undeployed changes are available, and you can deploy them. Use the **Switch Modes** command from the **High Availability** settings gear menu (⚙).

Please keep the following in mind:

- If you deploy changes from the active unit while there are undeployed changes on the standby unit, the undeployed changes on the standby unit will be erased. You will not be able to retrieve them.
- When a standby unit joins a high availability pair, any undeployed changes on the standby unit will be erased. The configuration is synchronized whenever a unit joins, or rejoins, the pair.
- If the unit that contains the undeployed changes failed catastrophically, and you had to replace or reimage the unit, your undeployed changes are permanently lost.

Changing Licenses and Registration in High Availability Mode

The units in a high availability pair must have the same licenses and registration status. To make changes:

- You enable or disable optional licenses on the active unit. Then, you deploy the configuration, and the standby unit requests (or frees) the necessary licenses. When enabling licenses, you must ensure that your Cisco Smart Software Manager account has sufficient licenses available, or you could have one unit compliant while the other unit is non-compliant.
- You register, or unregister, the units separately. To function correctly, the units must both be in evaluation mode, or both be registered. You can register the units to different Cisco Smart Software Manager accounts, but the accounts must have the same state for the export-controlled functionality setting, either both enabled or both disabled. You cannot deploy configuration changes if the units have inconsistent registration status.

Editing the HA IPsec Encryption Key or HA Configuration

You can change any of the failover criteria by logging into the active unit, making your changes, and deploying them.

However, if you need to change the IPsec encryption key used on your failover links, or change the interfaces or IP addresses for either the failover or stateful failover links, you must first break the HA configuration. You can then reconfigure the primary and secondary units with the new encryption key or failover/stateful failover link settings.

Marking a Failed Unit Healthy

A unit in a high availability configuration can be marked as failed due to regular health monitoring. If the unit is healthy, it should return to normal status when it meets health monitoring requirements again. If you see a healthy device failing frequently, you might want to increase the peer timeouts, stop monitoring specific interfaces that are less important, or change interface monitoring timeouts.

You can force a failed unit to be seen as healthy by entering the **failover reset** command from the CLI. We recommend that you enter the command from the active unit, which will reset the status of the standby unit. You can display the failover status of the unit with the **show failover** or **show failover state** commands.

Restoring a failed unit to an unfailed state does not automatically make it active. Restored units remain in the standby state until made active by failover (forced or natural).

Resetting the device status does not resolve the problems that led to the device being marked failed. If you do not address the problems, or relax your monitoring timeouts, the device can be marked as failed again.

Upgrading High Availability Firewall Threat Defense

Use this procedure to upgrade high availability devices. Upgrade them one at a time. To minimize disruption, always upgrade the standby. That is, upgrade the current standby, switch roles, then upgrade the new standby. If you need to update FXOS, do that on both chassis before you upgrade Firewall Threat Defense on either. Again, always upgrade the standby.

Caution Do not make or deploy configuration changes on one unit while the other is upgrading, or to a mixed version pair. Even if the system appears inactive, do not manually reboot or shut down during upgrade; you could place the system in an unusable state and require a reimage. You can manually cancel failed or in-progress upgrades, and retry failed upgrades. If you continue to have issues, contact Cisco TAC.

For details on these and other issues you may encounter during upgrade, see Troubleshooting High Availability Threat Defense Upgrades, on page 32.

Before you begin

Complete upgrade planning. Make sure your deployment is healthy and successfully communicating.

Note Upgrade planning starts with reading the Secure Firewall Threat Defense release notes. It then includes taking backups, obtaining upgrade packages, and performing associated upgrades (such as FXOS for the Firepower 4100/9300). It also includes checks for necessary configuration changes, readiness checks, disk space checks, and checks for both running and scheduled tasks. For details, see the Secure Firewall Threat Defense upgrade guides for Firewall Device Manager for your version.

Procedure

Step 1 Log into the standby unit.

Step 2 Select **Device**, then click **View Configuration** in the Updates panel.
The System Upgrade panel shows the currently running software version and any upgrade package that you have already uploaded.

Step 3 Upload the upgrade package.

You can upload one package only. If you upload a new package, it replaces the old one. Make sure you have the correct package for your target version and device model. Click **Browse** or **Replace File** to begin the upload.

When the upload completes, the system displays a confirmation dialog box. Before you click **OK**, optionally select **Run Upgrade Immediately** to choose rollback options and upgrade now. If you upgrade now, it is especially important to have completed as much of the pre-upgrade checklist as possible (see the next step).

Step 4 Perform final pre-upgrade checks, including the readiness check.

Revisit the pre-upgrade checklist. Make sure you have completed all relevant tasks, especially the final checks. If you do not run the readiness check manually, it runs when you initiate the upgrade. If the readiness check fails, the upgrade is canceled. For more information, see Running an Upgrade Readiness Check.

Step 5 Click **Upgrade Now** to start the upgrade.

a) Choose rollback options.

You can **Automatically cancel on upgrade failure and roll back to the previous version**. With this option enabled, the device automatically returns to its pre-upgrade state upon upgrade failure. Disable this option if you want to be able to manually cancel or retry a failed upgrade.

b) Click **Continue** to upgrade and reboot the device.

You are automatically logged off and taken to a status page where you can monitor the upgrade until the device reboots. The page also includes an option to cancel the in-progress installation. If you disabled automatic rollback and the upgrade fails, you can manually cancel or retry the upgrade.

Traffic is dropped while you upgrade.

Step 6 Log back in when you can and verify upgrade success.

The Device Summary page shows the currently running software version and high availability status. Do not proceed until you have verified success *and* high availability has resumed. If high availability remains suspended after successful upgrade, see Troubleshooting High Availability Threat Defense Upgrades, on page 32.

Step 7 Upgrade the second unit.

a) Switch roles, making this device active: Select **Device** > **High Availability**, then select **Switch Mode** from the gear menu ( ). Wait for the unit's status to change to active and confirm that traffic is flowing normally. Log out.

b) Upgrade: Repeat the previous steps to log into the new standby, upload the package, upgrade the device, monitor progress, and verify success.

Step 8 Examine device roles.

If you have preferred roles for specific devices, make those changes now.

Step 9 Log into the active unit.

Step 10 Complete post-upgrade tasks.

a) Update system databases. If you do not have automatic updates configured for intrusion rules, VDB, and GeoDB, update them now.

b) Complete any other required post-upgrade configuration changes.

c) Deploy.

Troubleshooting High Availability Threat Defense Upgrades

General Upgrade Troubleshooting

These issues can occur when you are upgrading any device, whether standalone or in a high availability pair.

Upgrade package errors.

To find the correct upgrade package, select or search for your model on the Cisco Support & Download site, then browse to the software download page for the appropriate version. Available upgrade packages are listed along with installation packages, hotfixes, and other applicable downloads. Upgrade package file names reflect the platform, package type (upgrade, patch, hotfix), software version, and build.

Upgrade packages from Version 6.2.1+ are signed, and terminate in .sh.REL.tar. If you are upgrading from an older version, download the package that terminates in .sh instead. The Cisco Support & Download site indicates the correct package for your version. Do not untar signed upgrade packages. Do not rename upgrade packages or transfer them by email.

Cannot reach the device at all during upgrade.

Devices stop passing traffic during the upgrade or if the upgrade fails. Before you upgrade, make sure traffic from your location does not have to traverse the device itself to access the device's management interface.

Device appears inactive or is unresponsive during upgrade.

You can manually cancel in-progress major and maintenance upgrades; see Canceling or Retrying Firewall Threat Defense Upgrades. If the device is unresponsive, or if you cannot cancel the upgrade, contact Cisco TAC.

Caution Even if the system appears inactive, do *not* manually reboot or shut down during upgrade. You could place the system in an unusable state and require a reimage.

Upgrade is successful but the system does not function to your expectations.

First, make sure that cached information gets refreshed. Do not simply refresh the browser window to log back in. Instead, delete any "extra" path from the URL and reconnect to the home page; for example, http://threat-defense.example.com/.

If you continue to have issues and need to return to an earlier major or maintenance release, you may be able to revert; see Reverting Firewall Threat Defense. If you cannot revert, you must reimage.

Upgrade fails.

When you initiate a major or maintenance upgrade, you use the **Automatically cancel on upgrade failure...** (auto-cancel) option to choose what happens if upgrade fails, as follows:

- Auto-cancel enabled (default): If upgrade fails, the upgrade cancels and the device automatically reverts to its pre-upgrade state. Correct any issues and try again later.
- Auto-cancel disabled: If upgrade fails, the device remains as it is. Correct the issues and retry immediately, or manually cancel the upgrade and try again later.

For more information, see Canceling or Retrying Firewall Threat Defense Upgrades. If you cannot retry or cancel, or if you continue to have issues, contact Cisco TAC.

High Availability Upgrade Troubleshooting

These issues are specific to high availability upgrades.

Upgrade will not begin without deploying uncommitted changes.

If you get an error message stating that you must deploy all uncommitted changes even though there are none, log into the active unit (remember, you should be upgrading the standby), create some minor change, and deploy. Then, undo the change, redeploy, and try the upgrade again on the standby.

If this does not work, and the units are running different software versions against recommendations, switch roles to make the standby unit active, then suspend high availability. Deploy from the

active/suspended unit, resume high availability, then switch roles to make the active unit the standby again. Upgrade should then work.

Deployment from active unit fails during standby upgrade, or causes an application synchronization error.

This can happen if you deploy from the active unit while the standby is upgrading, which is not supported. Proceed with the upgrade despite the error. After you upgrade both units, make any required configuration changes and deploy from the active unit. The error should resolve.

To avoid these issues, do not make or deploy configuration changes on one unit while the other is upgrading, or to a mixed version pair.

Configuration changes made during upgrade are lost.

If you absolutely must make and deploy changes to a mixed version pair, you must make the changes to both units or they will be lost after you upgrade the down-level active unit.

High availability is suspended after upgrade.

After the post-upgrade reboot, high availability is briefly suspended while the system performs some final automated tasks, such as updating libraries and restarting Snort. You are most likely to notice this if you log into the CLI *very* shortly after upgrade. If high availability does not resume on its own after the upgrade fully completes and Firewall Device Manager is available, do it manually:

1. Log into both the active device and the standby device and check the task lists. Wait until all tasks are finished running on both devices. If you resume high availability too soon, you may have a future issue where failover causes an outage.
2. Select **Device** > **High Availability**, then select **Resume HA** from the gear menu ( ).

Failover does not occur with a mixed version pair.

Although an advantage of high availability is that you can upgrade your deployment without traffic or inspection interruptions, failover is disabled during the entire upgrade process. That is, not only is failover necessarily disabled when one device is offline (because there is nothing to fail over to—you are essentially already failed over), but failover is also disabled with mixed version pairs. During upgrade is the only time where mixed version pairs are (temporarily) allowed. Schedule upgrades during maintenance windows when they will have the least impact if something goes wrong, and make sure you have enough time to upgrade both devices in that window.

Upgrade failed on only one device, or one device was reverted. The pair is now running mixed versions.

Mixed version pairs are not supported for general operations. Either upgrade the down-version device or revert the higher version device. For patches, because revert is not supported, if you cannot successfully upgrade the down-version device you must break high availability, reimage one or both devices, then re-establish high availability.

Replacing a Unit in a High Availability Pair

If necessary, you can replace a unit in a high availability group without disrupting network traffic.

Procedure

Step 1 If the unit you are replacing is functional, ensure that you fail over to the peer unit, then use the **shutdown** command from the device CLI to bring down the device gracefully. If the unit is not functional, confirm that the peer is operating in Active mode.

If you have Administrator privileges, you can also enter the **shutdown** command through the Firewall Device Manager CLI Console.

Step 2 Remove the unit from the network.

Step 3 Install the replacement unit and reconnect the interfaces.

Step 4 Complete the device setup wizard on the replacement unit.

Step 5 On the peer unit, go to the High Availability page and copy the configuration to the clipboard. Note whether the unit is the Primary or the Secondary unit.

If there are any pending changes, deploy them now and wait for deployment to complete before continuing.

Step 6 On the replacement unit, click **Configure** in the **High Availability** group, then select the opposite unit type from the peer. That is, if the peer is primary, select **Secondary**, if the peer is secondary, select **Primary**.

Step 7 Paste in the HA configuration from the peer, then enter the IPsec key if you use one. Click **Activate HA**.

Once deployment is complete, the unit will contact the peer and join the HA group. The active peer's configuration will be imported, and the replacement unit will be either the primary or secondary unit in the group, based on your selection. You can now verify that HA is operating correctly, and if desired, switch modes so that the new unit is the active unit.

Monitoring High Availability

The following topics explain how you can monitor high availability.

Note that the Event Viewer and dashboards show data related to the device you are logged into only. They do not show merged information for both devices.

Monitoring General Failover Status and History

You can monitor general high availability status and history using the following:

- On the Device Summary (click **Device**), the High Availability group shows unit status.



- On the High Availability page (click **Device** > **High Availability**), you can see the status of both units. If any failures have occurred, the last failure reason (from the failover history) is shown. Click the synchronization icon between them for additional status.



- From the High Availability page, click the **Failover History** link next to the status. The system opens the CLI Console and executes the **show failover history details** command. You can also enter this command directly in the CLI or CLI Console.

CLI Commands

From the CLI or CLI console, you can use the following commands:

- **show failover**

  Displays information about the failover state of the unit.

- **show failover history** [**details**]

  Displays the past failover state changes and the reason for the state change. Add the **details** keyword to display failover history from the peer unit. This information helps with troubleshooting.

- **show failover state**

  Displays the failover state of both units. The information includes the primary or secondary status of the unit, the Active/Standby status of the unit, and the last reported reason for failover.

- **show failover statistics**

  Displays the transmit (tx) and receive (rx) packet count of the failover interface. For example, if the output shows that the unit is sending packets, but not receiving any, then you have a problem with the link. This could be a bad wire, wrong IP addresses configured on the peers, or perhaps the units are connecting the failover interfaces to different subnets.

```
> show failover statistics
        tx:320875
        rx:0
```

- **show failover interface**

  Displays the configuration of the failover and stateful failover links. For example:

```
> show failover interface
        interface failover-link GigabitEthernet1/3
                System IP Address: 192.168.10.1 255.255.255.0
                My IP Address    : 192.168.10.1
                Other IP Address : 192.168.10.2
        interface stateful-failover-link GigabitEthernet1/4
                System IP Address: 192.168.11.1 255.255.255.0
                My IP Address    : 192.168.11.1
                Other IP Address : 192.168.11.2
```

- **show monitor-interface**

  Displays information about the interfaces monitored for high availability. For details, see Monitoring Status for HA-Monitored Interfaces, on page 37.

- **show running-config failover**

Displays the failover commands in the running configuration. These are the commands that configure high availability.

Monitoring Status for HA-Monitored Interfaces

If you enabled HA monitoring for any interface, you can check the status of the monitored interfaces in the CLI or CLI Console using the **show monitor-interface** command.

```
> show monitor-interface
 This host: Primary - Active
  Interface inside (192.168.1.13): Normal (Monitored)
  Interface outside (192.168.2.13): Normal (Monitored)
 Other host: Secondary - Standby Ready
  Interface inside (192.168.1.14): Normal (Monitored)
  Interface outside (192.168.2.14): Normal (Monitored)
```

Monitored interfaces can have the following status:

- (Waiting) coupled with any other status, such as Unknown (Waiting)—The interface has not yet received a hello packet from the corresponding interface on the peer unit.
- Unknown—Initial status. This status can also mean the status cannot be determined.
- Normal—The interface is receiving traffic.
- Testing—Hello messages are not heard on the interface for five poll times.
- Link Down—The interface or VLAN is administratively down.
- No Link—The physical link for the interface is down.
- Failed—No traffic is received on the interface, yet traffic is heard on the peer interface.

Monitoring HA-Related Syslog Messages

The system issues a number of syslog messages related to failover at priority level 2, which indicates a critical condition. The ranges of message IDs associated with failover are: 101xxx, 102xxx, 103xxx, 104xxx, 105xxx, 210xxx, 311xxx, 709xxx, 727xxx. For example, 105032 and 105043 indicate a problem with the failover link. For an explanation of the syslog messages, see the *Cisco Threat Defense Syslog Messages* guide at https://www.cisco.com/c/en/us/td/docs/security/firepower/Syslogs/b_fptd_syslog_guide.html.

Note During failover, the system logically shuts down and then brings up interfaces, generating syslog messages 411001 and 411002. This is normal activity.

To be able to see syslog messages, you must configure diagnostic logging on **Device** > **Logging Settings**. Set up an external syslog server so that you can monitor the messages reliably.

Remotely Executing CLI Commands on the Peer Unit

From the CLI, you can enter show commands on the peer device using the failover exec command without needing to log into the peer.

failover exec {**active** | **standby** | **mate**} *command*

You must indicate which unit should execute the command, either the active or the standby, or enter **mate** if you want to ensure the other unit responds instead of the unit that you are logged into.

For example, if you want to see the peer's interface configuration and statistics, you can enter:

```
> failover exec mate show interface
```

You cannot enter **configure** commands. This feature is for use with **show** commands.

Note If you are logged into the active unit, you can reload the standby unit using the **failover reload-standby** command.

You cannot enter the these commands through the Firewall Device Manager CLI Console.

Troubleshooting High Availability (Failover)

If the units in a high availability group are not performing as expected, consider the following steps for troubleshooting the configuration.

If the active unit shows the peer unit as Failed, see Troubleshooting Failed State for a Unit, on page 40.

Procedure

Step 1 From each device (primary and secondary):

- Ping the other device's IP address for the failover link.
- Ping the other device's IP address for the stateful failover link if you use a separate link.

If the ping fails, ensure that the interfaces on each device are connected to the same network segment. If you are using a direct cable connection, check the cable.

Step 2 Make the following general checks:

- Check for duplicate management IP addresses on the primary and secondary.
- Check for duplicate failover and stateful failover IP addresses on the units.
- Check that the equivalent interface port on each device is connected to the same network segment.

Step 3 Check the task list or audit log on the standby device. You should see a successful "Configuration import from Active node" task after every successful deployment on the active device. If the task fails, check the failover link and try deployment again.

Note
If the task list indicates there was a failed deployment task, there might have been a failover during the deployment job. If the standby device was the active unit when you started the deployment task, but failover occurred during the task, the deployment would fail. To resolve the issue, switch modes to make the standby unit the active unit again, then redeploy the configuration changes.

Step 4 Use the **show failover history** command to get detailed information on the state changes on a device.

Some things to look for:

- App Sync failures:

```
12:41:24 UTC Dec 6 2017

App Sync     Disabled     HA state progression failed due to APP SYNC timeout
```

  The Application Synchronization phase is where the configuration from the active device is transported to the standby device. An application synchronization failure puts the device in disabled state, and the device is no longer available to be made active.

  If the device is disabled due to an app sync problem, then you might be using different interfaces on the devices for the endpoints of the failover and stateful failover links. You must be using the same port number for each end of the link.

  If the show failover command shows the secondary device in Pseudo Standby state, this could indicate that you configured different IP addresses for the failover link on the secondary device than what you configured on the primary device. Ensure that you are using the same primary/secondary IP addresses on both devices for the failover link.

  The Pseudo Standby state might also indicate that you configured different IPsec keys on the primary and secondary.

  For additional app sync issues, see Troubleshooting HA App Sync Failures, on page 41.

- Abnormally frequent failovers (going from active to standby and back) might indicate problems with the failover link. In a worst-case scenario, both units might become active, which disrupts through traffic. Ping each end of the link to verify connectivity. You can also use **show arp** to check that the failover IP address and ARP mapping are proper.

  If the failover link is healthy and configured correctly, consider increasing the peer poll and hold time, the interface poll and holdtime, reducing the number of interfaces monitored for HA, or increasing the interface threshold.

- Failures due to interface checks. The Interface Check reason includes a list of the interfaces that were considered to have failed. Check those interfaces to ensure they are configured correctly and there are no hardware issues. Verify there are no issues with the switch configuration on the other end of the links. If there are no problems, consider disabling HA monitoring on those interfaces, Other options are to increase the interface failure threshold or timing.

```
06:17:51 UTC Jan 15 2017

Active     Failed     Interface check
```

```
This Host:3

   admin: inside

   ctx-1: ctx1-1

   ctx-2: ctx2-1

Other Host:0
```

Step 5 If the standby unit cannot be detected, and you cannot find a specific reason such as a bad LAN or cable connection on the failover link, try the following steps.

a) Log into the CLI on the standby unit and enter the **failover reset** command. This command should change a unit in failed state to unfailed state. Now, check the HA status on the active device. If the standby peer is now detected, you are done.

b) Log into the CLI on the active unit and enter the **failover reset** command. This should reset HA status on both the active and standby unit. Ideally, it will reestablish the link between the devices. Check the HA status; if it is not correct yet, continue.

c) Either from the CLI on the active device, or from the Firewall Device Manager, first suspend HA, then resume HA. The CLI commands are **configure high-availability suspend** and **configure high-availability resume**.

d) If these steps fail, **reboot** the standby device.

Troubleshooting Failed State for a Unit

If a unit is marked as Failed in the peer unit's high availability status (on the **Device** or **Device** > **High Availability** page), the following are the general possible reasons based on unit A being the active unit and unit B being the failed peer.

- If the unit B has not yet been configured for high availability (it is still in standalone mode), unit A shows it as Failed.
- If you suspend HA on unit B, then unit A will show it as Failed.
- If you reboot unit B, then unit A will show it as Failed until unit B completes the reboot and resumes communication over the failover link.
- If application synchronization (App Sync) fails on unit B, unit A will show it as Failed. See Troubleshooting HA App Sync Failures, on page 41.
- If unit B fails unit or interface health monitoring, then unit A marks it as failed. Check unit B for systemic problems. Try rebooting the device. If the unit is generally healthy, consider relaxing the unit or interface health monitoring settings. The **show failover history** output should provide information on interface health check failures.
- If both units become active, then each unit will show the peer as Failed. This usually indicates a problem with the failover link.

  It can also indicate a problem with licensing. The devices must have consistent licensing, either both in evaluation mode or both registered. If registered, the Smart License accounts used can be different, but both accounts must have the same selection for export controlled features, either enabled or disabled. If

you configure an IPsec encryption key with inconsistent settings for export controlled features, both devices will become active after you activate HA. This will impact routing on the supported network segments, and you will have to manually break HA on the secondary unit to recover.

Troubleshooting HA App Sync Failures

If the peer unit fails to join the HA group, or fails while you are deploying changes from the active unit, log into the failed unit, go to the **High Availability** page, and click the **Failover History** link. If the **show failover history** output indicates an App Sync failure, then there was a problem during the HA validation phase, where the system checks that the units can functioning correctly as a high availability group.

This type of failure might look like the following:

```
==========================================================================
From State                To State                  Reason
==========================================================================
16:19:34 UTC May 9 2018
Not Detected              Disabled                  No Error

17:08:25 UTC May 9 2018
Disabled                  Negotiation               Set by the config command

17:09:10 UTC May 9 2018
Negotiation               Cold Standby              Detected an Active mate

17:09:11 UTC May 9 2018
Cold Standby              App Sync                  Detected an Active mate

17:13:07 UTC May 9 2018
App Sync                  Disabled                  CD App Sync error is
High Availability State Link Interface Mismatch between Primary and Secondary Node
```

Ideally, you want to see the message “All validation passed” when the From State is App Sync, and the node will reach the Standby Ready state. Any validation failure will transition the peer to the Disabled (Failed) state. You must resolve the problems to make the peers function as a high availability group again. Note that if you fix an App Sync error by making changes to the active unit, you must deploy them and then resume HA for the peer node to join.

The following messages indicate failures, with an explanation of how you can resolve the issues. These errors can happen on node join and on each subsequent deployment. During node join, the system performs a check against the last deployed configuration on the active unit.

- License registration mode mismatch between Primary and Secondary Node.

  The license error indicates that one peer is registered while the other peer is in evaluation mode. The peers must both be registered or both in evaluation mode for them to join an HA group. Because you cannot return a registered device to evaluation mode, you must register the other peer from the **Device** > **Smart License** page.

  If the device you register is the active unit, after registering the device, perform a deployment. Deployment forces the units to refresh and synchronize configurations, which should allow the secondary unit to join the high availability group correctly.

- License export compliance mismatch between Primary and Secondary Node.

The license compliance error indicates that the devices are registered to different Cisco Smart Software Manager accounts, and one account is enabled for export-controlled functionality, whereas the other account is not. The devices must be registered with accounts that have the same setting, enabled or disabled, for export-controlled functionality. Change the device registration on the **Device** > **Smart License** page.

- Software version mismatch between Primary and Secondary Node.

  The software mismatch error indicates that the peers are running different versions of the Firewall Threat Defense software. The system allows a mismatch only temporarily, while you are installing software upgrades one device at a time. However, you cannot deploy configuration changes between upgrading the peers. To resolve this problem, upgrade the peer, then redo the deployment.

- Physical interfaces mismatch between Primary and Secondary Node.

  The standby unit in an HA group must have all of the physical interfaces that exist on the active unit, and these interfaces must have the same hardware names and types (such as GigabitEthernet1/1). This error indicates that the standby unit is missing some interfaces that are present on the active unit. You are allowed to have more interfaces on the standby unit than on the active unit, so either switch which unit is active, or choose another peer unit. However, mismatching interfaces should be temporary state, for example, if you are replacing an interface module on one unit and you need to run it without the module for a short time. For normal operations, both units should have the same number and type of interfaces.

- Failover link interface mismatch between Primary and Secondary Node.

  When you link the failover physical interface to the network on each unit, you must choose the same physical interface. For example, GigabitEthernet1/8 on each unit. This error indicates that you used different interfaces. To resolve the error, correct the cabling on the peer unit.

- Stateful failover link interface mismatch between Primary and Secondary Node.

  If you use a separate stateful failover link, when you link the stateful failover physical interface to the network on each unit, you must choose the same physical interface. For example, GigabitEthernet1/7 on each unit. This error indicates that you used different interfaces. To resolve the error, correct the cabling on the peer unit.

- Failover/Stateful failover link EtherChannel's member interfaces mismatch between Primary and Secondary Node

  If you select an EtherChannel interface for either the failover or stateful failover interfaces, the EtherChannels must have the same ID and member interfaces on each device. This error message indicates whether it is the failover or the stateful failover link that has the mismatch. To resolve the error, correct the configuration of the EtherChannel interfaces so they use the same ID and include the same interfaces on each device.

- Device Model Number mismatch between Primary and Secondary Node.

  For the peers to join an HA group, they must be devices of the exact same model. This error indicates that the peers are not the same device model. You must choose a different peer to configure HA.

- Active and Standby Nodes cannot be on the same chassis.

  You cannot configure high availability using devices that are hosted on the same hardware chassis. When configuring high availability on models that support multiple devices on the same chassis, you must select devices that reside on separate hardware.

- Unknown error occurred, please try again.

Something went wrong during the app sync, but the system could not identify the problem. Try deploying the configuration again.

- Rule package is corrupted. Please update the rule package and try again.

  There is an issue with the intrusion rules database. On the failed peer, go to **Device** > **Updates**, and click **Update Now** in the **Rule** group. Wait for the update to complete, and deploy changes. You can then retry the deployment from the active unit.

- Cloud Service enrollment status mismatch between Primary and Secondary Node.

  One of the nodes is enrolled with the Cisco cloud, but the other is not enrolled. Either both nodes must be enrolled or neither can be enrolled to form a high availability group. Go to **Device** > **System Settings** > **Cloud Services** on the each device and ensure both devices are enrolled in the same Cloud Services region.

- Active and Standby Nodes cannot have different cloud regions.

  The devices are registered in different Cisco Cloud Services regions. Determine which region is correct, unregister the other device from Smart Licensing, and select the correct region during re-registration. If both devices have the wrong region, unregister both devices and re-register in the correct region.

- Deployment package is corrupted. Please try again.

  This is a system error. Try the deployment again, which should resolve the problem.