HA pair management

ONTAP 9

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HA pair management overview

Cluster nodes are configured in high-availability (HA) pairs for fault tolerance and nondisruptive operations. If a node fails or if you need to bring a node down for routine maintenance, its partner can take over its storage and continue to serve data from it. The partner gives back storage when the node is brought back on line.

The HA pair controller configuration consists of a pair of matching FAS/AFF storage controllers (local node and partner node). Each of these nodes is connected to the other's disk shelves. When one node in an HA pair encounters an error and stops processing data, its partner detects the failed status of the partner and takes over all data processing from that controller.

Takeover is the process in which a node assumes control of its partner's storage.

Giveback is the process in which the storage is returned to the partner.

By default, takeovers occur automatically in any of the following situations:

- A software or system failure occurs on a node that leads to a panic. The HA pair controllers automatically fail over to their partner node. After the partner has recovered from the panic and booted up, the node automatically performs a giveback, returning the partner to normal operation.

- A system failure occurs on a node, and the node cannot reboot. For example, when a node fails because of a power loss, HA pair controllers automatically fail over to their partner node and serve data from the surviving storage controller.

  ⓘ   If the storage for a node also loses power at the same time, a standard takeover is not possible.

- Heartbeat messages are not received from the node's partner. This could happen if the partner experienced a hardware or software failure (for example, an interconnect failure) that did not result in a panic but still prevented it from functioning correctly.

- You halt one of the nodes without using the `-f` or `-inhibit-takeover true` parameter.

  ⓘ   In a two-node cluster with cluster HA enabled, halting or rebooting a node using the `-inhibit-takeover true` parameter causes both nodes to stop serving data unless you first disable cluster HA and then assign epsilon to the node that you want to remain online.

- You reboot one of the nodes without using the `-inhibit-takeover true` parameter. (The `-onboot` parameter of the `storage failover` command is enabled by default.)

- The remote management device (Service Processor) detects failure of the partner node. This is not applicable if you disable hardware-assisted takeover.

You can also manually initiate takeovers with the `storage failover takeover` command.

How hardware-assisted takeover works

Enabled by default, the hardware-assisted takeover feature can speed up the takeover

process by using a node's remote management device (Service Processor).

When the remote management device detects a failure, it quickly initiates the takeover rather than waiting for ONTAP to recognize that the partner's heartbeat has stopped. If a failure occurs without this feature enabled, the partner waits until it notices that the node is no longer giving a heartbeat, confirms the loss of heartbeat, and then initiates the takeover.

The hardware-assisted takeover feature uses the following process to avoid that wait:

1. The remote management device monitors the local system for certain types of failures.

2. If a failure is detected, the remote management device immediately sends an alert to the partner node.

3. Upon receiving the alert, the partner initiates takeover.

System events that trigger hardware-assisted takeover

The partner node might generate a takeover depending on the type of alert it receives from the remote management device (Service Processor).

Alert	Takeover initiated upon receipt?	Description
abnormal_reboot	No	An abnormal reboot of the node occurred.
l2_watchdog_reset	Yes	The system watchdog hardware detected an L2 reset. The remote management device detected a lack of response from the system CPU and reset the system.
loss_of_heartbeat	No	The remote management device is no longer receiving the heartbeat message from the node. This alert does not refer to the heartbeat messages between the nodes in the HA pair; it refers to the heartbeat between the node and its local remote management device.
periodic_message	No	A periodic message is sent during a normal hardware-assisted takeover operation.
power_cycle_via_sp	Yes	The remote management device cycled the system power off and on.
power_loss	Yes	A power loss occurred on the node. The remote management device has a power supply that maintains power for a short period after a power loss, allowing it to report the power loss to the partner.
power_off_via_sp	Yes	The remote management device powered off the system.
reset_via_sp	Yes	The remote management device reset the system.
test	No	A test message is sent to verify a hardware-assisted takeover operation.

How automatic takeover and giveback works

The automatic takeover and giveback operations can work together to reduce and avoid client outages.

By default, if one node in the HA pair panics, reboots, or halts, the partner node automatically takes over and then returns storage when the affected node reboots. The HA pair then resumes a normal operating state.

Automatic takeovers may also occur if one of the nodes become unresponsive.

Automatic giveback occurs by default. If you would rather control giveback impact on clients, you can disable automatic giveback and use the `storage failover modify -auto-giveback false -node <node>` command. Before performing the automatic giveback (regardless of what triggered it), the partner node waits for a fixed amount of time as controlled by the `-delay-` seconds parameter of the `storage failover modify` command. The default delay is 600 seconds. By delaying the giveback, the process results in two brief outages: one during takeover and one during giveback.

This process avoids a single, prolonged outage that includes time required for:

- The takeover operation
- The taken-over node to boot up to the point at which it is ready for the giveback
- The giveback operation

If the automatic giveback fails for any of the non-root aggregates, the system automatically makes two additional attempts to complete the giveback.

> ℹ️ During the takeover process, the automatic giveback process starts before the partner node is ready for the giveback. When the time limit of the automatic giveback process expires and the partner node is still not ready, the timer restarts. As a result, the time between the partner node being ready and the actual giveback being performed might be shorter than the automatic giveback time.

What happens during takeover

When a node takes over its partner, it continues to serve and update data in the partner's aggregates and volumes.

The following steps occur during the takeover process:

1. If the negotiated takeover is user-initiated, aggregated data is moved from the partner node to the node that is performing the takeover. A brief outage occurs as the current owner of each aggregate (except for the root aggregate) changes over to the takeover node. This outage is briefer than an outage that occurs during a takeover without aggregate relocation.

    ◦ You can monitor the progress using the `storage failover show-takeover` command.

    ◦ You can avoid the aggregate relocation during this takeover instance by using the `-bypass -optimization` parameter with the `storage failover takeover` command.

    > ℹ️ Aggregates are relocated serially during planned takeover operations to reduce client outage. If aggregate relocation is bypassed, longer client outage occurs during planned takeover events.

2. If the user-initiated takeover is a negotiated takeover, the target node gracefully shuts down, followed by takeover of the target node's root aggregate and any aggregates that were not relocated in Step 1.

3. Before the storage takeover begins, data LIFs (logical interfaces) migrate from the target node to the takeover node, or to any other node in the cluster based on LIF failover rules. You can avoid the LIF migration by using the `-skip-lif-migration` parameter with the `storage failover takeover` command.

4. Existing SMB sessions are disconnected when takeover occurs.

   > (i) Due to the nature of the SMB protocol, all SMB sessions are disrupted (except for SMB 3.0 sessions connected to shares with the Continuous Availability property set). SMB 1.0 and SMB 2.x sessions cannot reconnect after a takeover event; therefore, takeover is disruptive and some data loss could occur.

5. SMB 3.0 sessions that are established to shares with the Continuous Availability property enabled can reconnect to the disconnected shares after a takeover event. If your site uses SMB 3.0 connections to Microsoft Hyper-V and the Continuous Availability property is enabled on the associated shares, takeovers are non-disruptive for those sessions.

What happens if a node performing a takeover panics

If the node that is performing the takeover panics within 60 seconds of initiating takeover, the following events occur:

- The node that panicked reboots.
- After it reboots, the node performs self-recovery operations and is no longer in takeover mode.
- Failover is disabled.
- If the node still owns some of the partner's aggregates, after enabling storage failover, return these aggregates to the partner using the `storage failover giveback` command.

What happens during giveback

The local node returns ownership to the partner node when issues are resolved, when the partner node boots up, or when giveback is initiated.

The following process takes place in a normal giveback operation. In this discussion, Node A has taken over Node B. Any issues on Node B have been resolved and it is ready to resume serving data.

1. Any issues on Node B are resolved and it displays the following message: `Waiting for giveback`

2. The giveback is initiated by the `storage failover giveback` command or by automatic giveback if the system is configured for it. This initiates the process of returning ownership of Node B's aggregates and volumes from Node A back to Node B.

3. Node A returns control of the root aggregate first.

4. Node B completes the process of booting up to its normal operating state.

5. As soon as Node B reaches the point in the boot process where it can accept the non-root aggregates, Node A returns ownership of the other aggregates, one at a time, until giveback is complete. You can monitor the progress of the giveback by using the `storage failover show-giveback` command.

> (i) The `storage failover show-giveback` command does not (nor is it intended to) display information about all operations occurring during the storage failover giveback operation. You can use the `storage failover show` command to display additional details about the current failover status of the node, such as if the node is fully functional, takeover is possible, and giveback is complete.

I/O resumes for each aggregate after giveback is complete for that aggregate, which reduces its overall outage window.

HA policy and its effect on takeover and giveback

ONTAP automatically assigns an HA policy of CFO (controller failover) and SFO (storage failover) to an aggregate. This policy determines how storage failover operations occur for the aggregate and its volumes.

The two options, CFO and SFO, determine the aggregate control sequence ONTAP uses during storage failover and giveback operations.

Although the terms CFO and SFO are sometimes used informally to refer to storage failover (takeover and giveback) operations, they actually represent the HA policy assigned to the aggregates. For example, the terms SFO aggregate or CFO aggregate simply refer to the aggregate's HA policy assignment.

HA policies affect takeover and giveback operations as follows:

- Aggregates created on ONTAP systems (except for the root aggregate containing the root volume) have an HA policy of SFO. Manually initiated takeover is optimized for performance by relocating SFO (non-root) aggregates serially to the partner before takeover. During the giveback process, aggregates are given back serially after the taken-over system boots and the management applications come online, enabling the node to receive its aggregates.

- Because aggregate relocation operations entail reassigning aggregate disk ownership and shifting control from a node to its partner, only aggregates with an HA policy of SFO are eligible for aggregate relocation.

- The root aggregate always has an HA policy of CFO and is given back at the start of the giveback operation. This is necessary to allow the taken-over system to boot. All other aggregates are given back serially after the taken-over system completes the boot process and the management applications come online, enabling the node to receive its aggregates.

> (i) Changing the HA policy of an aggregate from SFO to CFO is a Maintenance mode operation. Do not modify this setting unless directed to do so by a customer support representative.

How background updates affect takeover and giveback

Background updates of the disk firmware will affect HA pair takeover, giveback, and aggregate relocation operations differently, depending on how those operations are initiated.

The following list describes how background disk firmware updates affect takeover, giveback, and aggregate relocation:

- If a background disk firmware update occurs on a disk on either node, manually initiated takeover operations are delayed until the disk firmware update finishes on that disk. If the background disk firmware update takes longer than 120 seconds, takeover operations are aborted and must be restarted manually after the disk firmware update finishes. If the takeover was initiated with the `-bypass-optimization` parameter of the `storage failover takeover` command set to `true`, the background disk firmware update occurring on the destination node does not affect the takeover.

- If a background disk firmware update is occurring on a disk on the source (or takeover) node and the takeover was initiated manually with the `-options` parameter of the `storage failover takeover` command set to `immediate`, takeover operations start immediately.

- If a background disk firmware update is occurring on a disk on a node and it panics, takeover of the panicked node begins immediately.

- If a background disk firmware update is occurring on a disk on either node, giveback of data aggregates is delayed until the disk firmware update finishes on that disk.

- If the background disk firmware update takes longer than 120 seconds, giveback operations are aborted and must be restarted manually after the disk firmware update completes.

- If a background disk firmware update is occurring on a disk on either node, aggregate relocation operations are delayed until the disk firmware update finishes on that disk. If the background disk firmware update takes longer than 120 seconds, aggregate relocation operations are aborted and must be restarted manually after the disk firmware update finishes. If aggregate relocation was initiated with the `-override -destination-checks` of the `storage aggregate relocation` command set to `true`, the background disk firmware update occurring on the destination node does not affect aggregate relocation.

Automatic takeover commands

Automatic takeover is enabled by default on all supported NetApp FAS, AFF, and ASA platforms. You might need to change the default behavior and control when automatic takeovers occur when the partner node reboots, panics, or halts.

If you want takeover to occur automatically when the partner node…	Use this command…
Reboots or halts	`storage failover modify -node nodename -onreboot true`
Panics	`storage failover modify -node nodename -onpanic true`

Enable email notification if the takeover capability is disabled

To receive prompt notification if the takeover capability becomes disabled, you should configure your system to enable automatic email notification for the "takeover impossible" EMS messages:

- `ha.takeoverImpVersion`
- `ha.takeoverImpLowMem`
- `ha.takeoverImpDegraded`
- `ha.takeoverImpUnsync`
- `ha.takeoverImpIC`
- `ha.takeoverImpHotShelf`
- `ha.takeoverImpNotDef`

Automatic giveback commands

By default, the take-over partner node automatically gives back storage when the off-line node is brought back on line, thus restoring the high-availability pair relationship. In most cases, this is the desired behavior. If you need to disable automatic giveback - for example, if you want to investigate the cause of the takeover before giving back – you need to be aware of the interaction of non-default settings.

If you want to…	Use this command…
Enable automatic giveback so that giveback occurs as soon as the taken-over node boots, reaches the Waiting for Giveback state, and the Delay before Auto Giveback period has expired. The default setting is true.	`storage failover modify -node nodename -auto-giveback true`
Disable automatic giveback. The default setting is true. **Note:** Setting this parameter to false does not disable automatic giveback after takeover on panic; automatic giveback after takeover on panic must be disabled by setting the `-auto-giveback-after-panic` parameter to false.	`storage failover modify -node nodename -auto-giveback false`
Disable automatic giveback after takeover on panic (this setting is enabled by default).	`storage failover modify -node nodename -auto-giveback-after-panic false`
Delay automatic giveback for a specified number of seconds (the default is 600). This option determines the minimum time that a node remains in takeover before performing an automatic giveback.	`storage failover modify -node nodename -delay-seconds seconds`

How variations of the storage failover modify command affect automatic giveback

The operation of automatic giveback depends on how you configure the parameters of the storage failover modify command.

The following table lists the default settings for the `storage failover modify` command parameters that apply to takeover events not caused by a panic.

Parameter	Default setting
`-auto-giveback` *true* | *false*	*true*
`-delay-seconds` *integer* (seconds)	600

`-onreboot` *true* | *false*	*true*

The following table describes how combinations of the `-onreboot` and `-auto-giveback` parameters affect automatic giveback for takeover events not caused by a panic.

`storage failover modify` **parameters used**	**Cause of takeover**	**Does automatic giveback occur?**
`-onreboot` *true*	reboot command	Yes
`-auto-giveback` *true*	halt command, or power cycle operation issued from the Service Processor	Yes
`-onreboot` *true*	reboot command	Yes
`-auto-giveback` *false*	halt command, or power cycle operation issued from the Service Processor	No
`-onreboot` *false*	reboot command	N/A In this case, takeover does not occur
`-auto-giveback` *true*	halt command, or power cycle operation issued from the Service Processor	Yes
`-onreboot` *false*	reboot command	No
`-auto-giveback` *false*	halt command, or power cycle operation issued from the Service Processor	No

The `-auto-giveback` parameter controls giveback after panic and all other automatic takovers. If the `-onreboot` parameter is set to `true` and a takeover occurs due to a reboot, then automatic giveback is always performed, regardless of whether the `-auto-giveback` parameter is set to `true`.

The `-onreboot` parameter applies to reboots and halt commands issued from ONTAP. When the `-onreboot` parameter is set to false, a takeover does not occur in the case of a node reboot. Therefore, automatic giveback cannot occur, regardless of whether the `-auto-giveback` parameter is set to true. A client disruption occurs.

The effects of automatic giveback parameter combinations that apply to panic situations.

The following table lists the `storage failover modify` command parameters that apply to panic situations:

Parameter	**Default setting**

`-onpanic` *true* | *false*	*true*
`-auto-giveback-after-panic` *true* | *false* (Privilege: Advanced)	*true*
`-auto-giveback` *true* | *false*	*true*

The following table describes how parameter combinations of the `storage failover modify` command affect automatic giveback in panic situations.

`storage failover` **parameters used**	**Does automatic giveback occur after panic?**

`-onpanic true`
`-auto-giveback true`
`-auto-giveback-after-panic true`
	Yes

`-onpanic true`
`-auto-giveback true`
`-auto-giveback-after-panic false`
	Yes

`-onpanic true`
`-auto-giveback false`
`-auto-giveback-after-panic true`
	Yes

`-onpanic true`
`-auto-giveback false`
`-auto-giveback-after-panic false`
	No

`-onpanic false` If `-onpanic` is set to `false`, takeover/giveback does not occur, regardless of the value set for `-auto-giveback` or `-auto-giveback-after-panic`	No

> ⓘ A takeover can result from a failure not associated with a panic. A *failure* is experienced when communication is lost between a node and its partner, also called a *heartbeat loss*. If a takeover occurs because of a failure, giveback is controlled by the `-onfailure` parameter instead of the `-auto-giveback-after-panic` parameter.

> ⓘ When a node panics, it sends a panic packet to its partner node. If for any reason the panic packet is not received by the partner node, the panic can be misinterpreted as a failure. Without receipt of the panic packet, the partner node knows only that communication has been lost, and does not know that a panic has occurred. In this case, the partner node processes the loss of communication as a failure instead of a panic, and giveback is controlled by the `-onfailure` parameter (and not by the `-auto-giveback-after-panic` parameter).

For details on all `storage failover modify` parameters, see the ONTAP manual pages.

Manual takeover commands

You can perform a takeover manually when maintenance is required on the partner, and in other similar situations. Depending on the state of the partner, the command you use to perform the takeover varies.

If you want to…	Use this command…
Take over the partner node	`storage failover takeover`
Monitor the progress of the takeover as the partner's aggregates are moved to the node doing the takeover	`storage failover show-takeover`
Display the storage failover status for all nodes in the cluster	`storage failover show`
Take over the partner node without migrating LIFs	`storage failover takeover -skip-lif -migration-before-takeover true`
Take over the partner node even if there is a disk mismatch	`storage failover takeover -skip-lif -migration-before-takeover true`
Take over the partner node even if there is an ONTAP version mismatch **Note:** This option is only used during the nondisruptive ONTAP upgrade process.	`storage failover takeover -option allow -version-mismatch`
Take over the partner node without performing aggregate relocation	`storage failover takeover -bypass -optimization true`
Take over the partner node before the partner has time to close its storage resources gracefully	`storage failover takeover -option immediate`

> ℹ️ Before you issue the storage failover command with the immediate option, you must migrate the data LIFs to another node by using the following command: `network interface migrate-all -node` *node*
>
> If you specify the `storage failover takeover -option immediate` command without first migrating the data LIFs, data LIF migration from the node is significantly delayed even if the `skip-lif-migration-before-takeover` option is not specified.
>
> Similarly, if you specify the immediate option, negotiated takeover optimization is bypassed even if the bypass-optimization option is set to *false*.

Moving epsilon for certain manually initiated takeovers

You should move epsilon if you expect that any manually initiated takeovers could result in your storage system being one unexpected node failure away from a cluster-wide loss of quorum.

About this task

To perform planned maintenance, you must take over one of the nodes in an HA pair. Cluster-wide quorum must be maintained to prevent unplanned client data disruptions for the remaining nodes. In some instances, performing the takeover can result in a cluster that is one unexpected node failure away from cluster-wide loss of quorum.

This can occur if the node being taken over holds epsilon or if the node with epsilon is not healthy. To maintain a more resilient cluster, you can transfer epsilon to a healthy node that is not being taken over. Typically, this would be the HA partner.

Only healthy and eligible nodes participate in quorum voting. To maintain cluster-wide quorum, more than N/2 votes are required (where *N* represents the sum of healthy, eligible, online nodes). In clusters with an even number of online nodes, epsilon adds additional voting weight toward maintaining quorum for the node to which it is assigned.

> (i) Although cluster formation voting can be modified by using the `cluster modify -eligibility false` command, you should avoid this except for situations such as restoring the node configuration or prolonged node maintenance. If you set a node as ineligible, it stops serving SAN data until the node is reset to eligible and rebooted. NAS data access to the node might also be affected when the node is ineligible.

Steps

1. Verify the cluster state and confirm that epsilon is held by a healthy node that is not being taken over:

   a. Change to the advanced privilege level, confirming that you want to continue when the advanced mode prompt appears (*>):

   ```
   set -privilege advanced
   ```

   b. Determine which node holds epsilon:

   ```
   cluster show
   ```

   In the following example, Node1 holds epsilon:

Node	Health	Eligibility	Epsilon
Node1	true	true	true
Node2	true	true	false

   If the node you want to take over does not hold epsilon, proceed to Step 4.

2. Remove epsilon from the node that you want to take over:

   ```
   cluster modify -node Node1 -epsilon false
   ```

3. Assign epsilon to the partner node (in this example, Node2):

   ```
   cluster modify -node Node2 -epsilon true
   ```

4. Perform the takeover operation:

   ```
   storage failover takeover -ofnode node_name
   ```

5. Return to the admin privilege level:

   ```
   set -privilege admin
   ```

Manual giveback commands

You can perform a normal giveback, a giveback in which you terminate processes on the partner node, or a forced giveback.

> (i) Prior to performing a giveback, you must remove the failed drives in the taken-over system as described in Disks and aggregates management.

If giveback is interrupted

If the takeover node experiences a failure or a power outage during the giveback process, that process stops and the takeover node returns to takeover mode until the failure is repaired or the power is restored.

However, this depends upon the stage of giveback in which the failure occurred. If the node encountered failure or a power outage during partial giveback state (after it has given back the root aggregate), it will not return to takeover mode. Instead, the node returns to partial-giveback mode. If this occurs, complete the process by repeating the giveback operation.

If giveback is vetoed

If giveback is vetoed, you must check the EMS messages to determine the cause. Depending on the reason or reasons, you can decide whether you can safely override the vetoes.

The `storage failover show-giveback` command displays the giveback progress and shows which subsystem vetoed the giveback, if any. Soft vetoes can be overridden, while hard vetoes cannot be, even if forced. The following tables summarize the soft vetoes that should not be overridden, along with recommended workarounds.

You can review the EMS details for any giveback vetoes by using the following command:

```
event log show -node * -event gb*
```

Giveback of the root aggregate

These vetoes do not apply to aggregate relocation operations:

Vetoing subsystem module	Workaround
vfiler_low_level	Terminate the SMB sessions causing the veto, or shutdown the SMB application that established the open sessions. Overriding this veto might cause the application using SMB to disconnect abruptly and lose data.
Disk Check	All failed or bypassed disks should be removed before attempting giveback. If disks are sanitizing, you should wait until the operation completes. Overriding this veto might cause an outage caused by aggregates or volumes going offline due to reservation conflicts or inaccessible disks.

Giveback of the SFO aggregates

These vetoes do not apply to aggregate relocation operations:

Vetoing subsystem module	Workaround
Lock Manager	Gracefully shutdown the SMB applications that have open files, or move those volumes to a different aggregate. Overriding this veto results in loss of SMB lock state, causing disruption and data loss.
Lock Manager NDO	Wait until the locks are mirrored. Overriding this veto causes disruption to Microsoft Hyper-V virtual machines.
RAID	Check the EMS messages to determine the cause of the veto: If the veto is due to nvfile, bring the offline volumes and aggregates online. If disk add or disk ownership reassignment operations are in progress, wait until they complete. If the veto is due to an aggregate name or UUID conflict, troubleshoot and resolve the issue. If the veto is due to mirror resync, mirror verify, or offline disks, the veto can be overridden and the operation restarts after giveback.
Disk Inventory	Troubleshoot to identify and resolve the cause of the problem. The destination node might be unable to see disks belonging to an aggregate being migrated. Inaccessible disks can result in inaccessible aggregates or volumes.
Volume Move Operation	Troubleshoot to identify and resolve the cause of the problem. This veto prevents the volume move operation from aborting during the important cutover phase. If the job is aborted during cutover, the volume might become inaccessible.

Commands for performing a manual giveback

You can manually initiate a giveback on a node in an HA pair to return storage to the original owner after completing maintenance or resolving
any issues that caused the takeover.

If you want to…	Use this command…

Give back storage to a partner node	`storage failover giveback -ofnode` *`nodename`*

Give back storage even if the partner is not in the waiting for giveback mode	`storage failover giveback -ofnode`
	`nodename`
	`-require-partner-waiting false`
	
	Do not use this option unless a longer client outage is acceptable.

Give back storage even if processes are vetoing the giveback operation (force the giveback)	`storage failover giveback -ofnode`
	`nodename`
	`-override-vetoes true`
	
	Use of this option can potentially lead to longer client outage, or aggregates and volumes not coming online after the giveback.

Give back only the CFO aggregates (the root aggregate)	`storage failover giveback -ofnode`
	`nodename`
	
	`-only-cfo-aggregates true`

Monitor the progress of giveback after you issue the giveback command	`storage failover show-giveback`

Testing takeover and giveback

After you configure all aspects of your HA pair, you need to verify that it is operating as expected in maintaining uninterrupted access to both nodes' storage during takeover and giveback operations. Throughout the takeover process, the local (or takeover) node should continue serving the data normally provided by the partner node. During giveback, control and delivery of the partner's storage should return to the partner node.

Steps

1. Check the cabling on the HA interconnect cables to make sure that they are secure.

2. Verify that you can create and retrieve files on both nodes for each licensed protocol.

3. Enter the following command:

   `storage failover takeover -ofnode partnernode`

   See the man page for command details.

4. Enter either of the following commands to confirm that takeover occurred:

   `storage failover show-takeover`

   `storage failover show`

If you have the `storage failover` command's `-auto-giveback` option enabled:

Node	Partner	Takeover Possible	State Description
node 1	node 2	-	Waiting for giveback
node 2	node 1	false	In takeover, Auto giveback will be initiated in number of seconds

If you have the `storage failover` command's `-auto-giveback` option disabled:

Node	Partner	Takeover Possible	State Description
node 1	node 2	-	Waiting for giveback
node 2	node 1	false	In takeover

5. Display all the disks that belong to the partner node (Node2) that the takeover node (Node1) can detect:

```
storage disk show -home node2 -ownership
```

The following command displays all disks belonging to Node2 that Node1 can detect:
```
cluster::> storage disk show -home node2 -ownership
```

Disk	Aggregate	Home	Owner	DR Home	Home ID	Owner ID	DR Home ID	Reserver	Pool
1.0.2	-	node2	node2	-	4078312453	4078312453	-	4078312452	Pool0
1.0.3	-	node2	node2	-	4078312453	4078312453	-	4078312452	Pool0

6. Cconfirm that the takeover node (Node1) controls the partner node's (Node2) aggregates:

```
aggr show -fields home-id,home-name,is-home
```

aggregate	home-id	home-nameh	is-home
aggr0_1	2014942045	node1	true
aggr0_2	4078312453	node2	false
aggr1_1	2014942045	node1	true
aggr1_2	4078312453	node2	false

During takeover, the "is-home" value of the partner node's aggregates is false.

7. Give back the partner node's data service after it displays the "Waiting for giveback" message:

```
storage failover giveback -ofnode partnernode
```

8. Enter either of the following commands to observe the progress of the giveback operation:

```
storage failover show-giveback
```

```
storage failover show
```

9. Proceed, depending on whether you saw the message that giveback was completed successfully:

If takeover and giveback…	Then…
Are completed successfully	Repeat Step 2 through Step 8 on the partner node.
Fail	Correct the takeover or giveback failure and then repeat this procedure.

Commands for monitoring an HA pair

You can use ONTAP commands to monitor the status of the HA pair. If a takeover occurs, you can also determine what caused the takeover.

If you want to check	Use this command
Whether failover is enabled or has occurred, or reasons why failover is not currently possible	`storage failover show`
View the nodes on which the storage failover HA-mode setting is enabled You must set the value to ha for the node to participate in a storage failover (HA pair) configuration. The `non-ha` value is used only in a stand-alone, or single node cluster configuration.	`storage failover show -fields mode`
Whether hardware-assisted takeover is enabled	`storage failover hwassist show`
The history of hardware-assisted takeover events that have occurred	`storage failover hwassist stats show`
The progress of a takeover operation as the partner's aggregates are moved to the node doing the takeover	`storage failover show-takeover`
The progress of a giveback operation in returning aggregates to the partner node	`storage failover show-giveback`
Whether an aggregate is home during takeover or giveback operations	`aggregate show -fields home-id,owner -id,home-name,owner-name,is-home`
Whether cluster HA is enabled (applies only to two node clusters)	`cluster ha show`
The HA state of the components of an HA pair (on systems that use the HA state)	`ha-config show` This is a Maintenance mode command.

Node states displayed by storage failover show-type commands

The following list describes the node states that the `storage failover show` command displays.

Node State	Description
Connected to partner_name, Automatic takeover disabled.	The HA interconnect is active and can transmit data to the partner node. Automatic takeover of the partner is disabled.
Waiting for partner_name, Giveback of partner spare disks pending.	The local node cannot exchange information with the partner node over the HA interconnect. Giveback of SFO aggregates to the partner is done, but partner spare disks are still owned by the local node. • Run the `storage failover show-giveback` command for more information.
Waiting for partner_name. Waiting for partner lock synchronization.	The local node cannot exchange information with the partner node over the HA interconnect, and is waiting for partner lock synchronization to occur.
Waiting for partner_name. Waiting for cluster applications to come online on the local node.	The local node cannot exchange information with the partner node over the HA interconnect, and is waiting for cluster applications to come online.
Takeover scheduled. target node relocating its SFO aggregates in preparation of takeover.	Takeover processing has started. The target node is relocating ownership of its SFO aggregates in preparation for takeover.
Takeover scheduled. target node has relocated its SFO aggregates in preparation of takeover.	Takeover processing has started. The target node has relocated ownership of its SFO aggregates in preparation for takeover.
Takeover scheduled. Waiting to disable background disk firmware updates on local node. A firmware update is in progress on the node.	Takeover processing has started. The system is waiting for background disk firmware update operations on the local node to complete.
Relocating SFO aggregates to taking over node in preparation of takeover.	The local node is relocating ownership of its SFO aggregates to the taking-over node in preparation for takeover.
Relocated SFO aggregates to taking over node. Waiting for taking over node to takeover.	Relocation of ownership of SFO aggregates from the local node to the taking-over node has completed. The system is waiting for takeover by the taking-over node.

Relocating SFO aggregates to partner_name. Waiting to disable background disk firmware updates on the local node. A firmware update is in progress on the node.	Relocation of ownership of SFO aggregates from the local node to the taking-over node is in progress. The system is waiting for background disk firmware update operations on the local node to complete.
Relocating SFO aggregates to partner_name. Waiting to disable background disk firmware updates on partner_name. A firmware update is in progress on the node.	Relocation of ownership of SFO aggregates from the local node to the taking-over node is in progress. The system is waiting for background disk firmware update operations on the partner node to complete.
Connected to partner_name. Previous takeover attempt was aborted because reason. Local node owns some of partner's SFO aggregates. Reissue a takeover of the partner with the `-bypass-optimization` parameter set to true to takeover remaining aggregates, or issue a giveback of the partner to return the relocated aggregates.	The HA interconnect is active and can transmit data to the partner node. The previous takeover attempt was aborted because of the reason displayed under reason. The local node owns some of its partner's SFO aggregates. • Either reissue a takeover of the partner node, setting the -bypass-optimization parameter to true to takeover the remaining SFO aggregates, or perform a giveback of the partner to return relocated aggregates.
Connected to partner_name. Previous takeover attempt was aborted. Local node owns some of partner's SFO aggregates. Reissue a takeover of the partner with the `-bypass-optimization` parameter set to true to takeover remaining aggregates, or issue a giveback of the partner to return the relocated aggregates.	The HA interconnect is active and can transmit data to the partner node. The previous takeover attempt was aborted. The local node owns some of its partner's SFO aggregates. • Either reissue a takeover of the partner node, setting the -bypass-optimization parameter to true to takeover the remaining SFO aggregates, or perform a giveback of the partner to return relocated aggregates.
Waiting for partner_name. Previous takeover attempt was aborted because reason. Local node owns some of partner's SFO aggregates. Reissue a takeover of the partner with the "-bypass-optimization" parameter set to true to takeover remaining aggregates, or issue a giveback of the partner to return the relocated aggregates.	The local node cannot exchange information with the partner node over the HA interconnect. The previous takeover attempt was aborted because of the reason displayed under reason. The local node owns some of its partner's SFO aggregates. • Either reissue a takeover of the partner node, setting the -bypass-optimization parameter to true to takeover the remaining SFO aggregates, or perform a giveback of the partner to return relocated aggregates.

Waiting for partner_name. Previous takeover attempt was aborted. Local node owns some of partner's SFO aggregates. Reissue a takeover of the partner with the "-bypass-optimization" parameter set to true to takeover remaining aggregates, or issue a giveback of the partner to return the relocated aggregates.	The local node cannot exchange information with the partner node over the HA interconnect. The previous takeover attempt was aborted. The local node owns some of its partner's SFO aggregates. • Either reissue a takeover of the partner node, setting the -bypass-optimization parameter to true to takeover the remaining SFO aggregates, or perform a giveback of the partner to return relocated aggregates.
Connected to partner_name. Previous takeover attempt was aborted because failed to disable background disk firmware update (BDFU) on local node.	The HA interconnect is active and can transmit data to the partner node. The previous takeover attempt was aborted because the background disk firmware update on the local node was not disabled.
Connected to partner_name. Previous takeover attempt was aborted because reason.	The HA interconnect is active and can transmit data to the partner node. The previous takeover attempt was aborted because of the reason displayed under reason.
Waiting for partner_name. Previous takeover attempt was aborted because reason.	The local node cannot exchange information with the partner node over the HA interconnect. The previous takeover attempt was aborted because of the reason displayed under reason.
Connected to partner_name. Previous takeover attempt by partner_name was aborted because reason.	The HA interconnect is active and can transmit data to the partner node. The previous takeover attempt by the partner node was aborted because of the reason displayed under reason.
Connected to partner_name. Previous takeover attempt by partner_name was aborted.	The HA interconnect is active and can transmit data to the partner node. The previous takeover attempt by the partner node was aborted.
Waiting for partner_name. Previous takeover attempt by partner_name was aborted because reason.	The local node cannot exchange information with the partner node over the HA interconnect. The previous takeover attempt by the partner node was aborted because of the reason displayed under reason.
Previous giveback failed in module: module name. Auto giveback will be initiated in number of seconds seconds.	The previous giveback attempt failed in module module_name. Auto giveback will be initiated in number of seconds seconds. • Run the `storage failover show-giveback` command for more information.
Node owns partner's aggregates as part of the non-disruptive controller upgrade procedure.	The node owns its partner's aggregates due to the non- disruptive controller upgrade procedure currently in progress.

Connected to partner_name. Node owns aggregates belonging to another node in the cluster.	The HA interconnect is active and can transmit data to the partner node. The node owns aggregates belonging to another node in the cluster.
Connected to partner_name. Waiting for partner lock synchronization.	The HA interconnect is active and can transmit data to the partner node. The system is waiting for partner lock synchronization to complete.
Connected to partner_name. Waiting for cluster applications to come online on the local node.	The HA interconnect is active and can transmit data to the partner node. The system is waiting for cluster applications to come online on the local node.
Non-HA mode, reboot to use full NVRAM.	Storage failover is not possible. The HA mode option is configured as non_ha. • You must reboot the node to use all of its NVRAM.
Non-HA mode. Reboot node to activate HA.	Storage failover is not possible. • The node must be rebooted to enable HA capability.
Non-HA mode.	Storage failover is not possible. The HA mode option is configured as non_ha. • You must run the `storage failover modify -mode ha -node nodename` command on both nodes in the HA pair and then reboot the nodes to enable HA capability.

Commands for enabling and disabling storage failover

Use the following commands to enable and disable storage failover functionality.

If you want to…	Use this command…
Enable takeover	`storage failover modify -enabled true -node nodename`
Disable takeover	`storage failover modify -enabled false -node nodename`

ⓘ   You should only disable storage failover if required as part of a maintenance procedure.

Halt or reboot a node without initiating takeover in a two-node cluster

You halt or reboot a node in a two-node cluster without initiating takeover when you

perform certain hardware maintenance on a node or a shelf and you want to limit down time by keeping the partner node up, or when there are issues preventing a manual takeover and you want to keep the partner node's aggregates up and serving data. Additionally, if technical support is assisting you with troubleshooting problems, they might have you perform this procedure as part of those efforts.

About this task

- Before you inhibit takeover (using the `-inhibit-takeover true` parameter), you disable cluster HA.

  > ⚠️
  >   - In a two-node cluster, cluster HA ensures that the failure of one node does not disable the cluster. However, if you do not disable cluster HA before using the `-inhibit-takeover true` parameter, both nodes stop serving data.
  >   - If you attempt to halt or reboot a node before disabling cluster HA, ONTAP issues a warning and instructs you to disable cluster HA.

- You migrate LIFs (logical interfaces) to the partner node that you want to remain online.
- If on the node you are halting or rebooting there are aggregates you want to keep, you move them to the node that you want to remain online.

Steps

1. Verify both nodes are healthy:
   `cluster show`

   For both nodes, `true` appears in the `Health` column.

   ```
   cluster::> cluster show
   Node           Health  Eligibility
   ------------   ------- ------------
   node1          true       true
   node2          true       true
   ```

2. Migrate all LIFs from the node that you will halt or reboot to the partner node:
   `network interface migrate-all -node node_name`

3. If on the node you will halt or reboot there are aggregates you want to keep online when the node is down, relocate them to the partner node; otherwise, go to the next step.

   a. Show the aggregates on the node you will halt or reboot:
      `storage aggregates show -node node_name`

      For example, node1 is the node that will be halted or rebooted:

```
cluster::> storage aggregates show -node node1
Aggregate   Size   Available   Used%   State   #Vols    Nodes    RAID
Status
---------   ----   ---------   -----   -----   -----    -----    ----
------
aggr0_node_1_0
            744.9GB   32.68GB   96% online        2 node1    raid_dp,

normal
aggr1       2.91TB    2.62TB    10% online        8 node1    raid_dp,

normal
aggr2
            4.36TB    3.74TB    14% online       12 node1    raid_dp,

normal
test2_aggr  2.18TB    2.18TB     0% online        7 node1    raid_dp,

normal
4 entries were displayed.
```

b. Move the aggregates to the partner node:
   `storage aggregate relocation start -node` *node_name* `-destination` *node_name*
   `-aggregate-list` *aggregate_name*

   For example, aggregates aggr1, aggr2 and test2_aggr are being moved from node1 to node2:

   `storage aggregate relocation start -node` *node1* `-destination` *node2* `-aggregate`
   `-list` *aggr1,aggr2,test2_aggr*

4. Disable cluster HA:
   `cluster ha modify -configured false`

   The return output confirms HA is disabled: `Notice: HA is disabled`

   > (i) This operation does not disable storage failover.

5. Halt or reboot and inhibit takeover of the target node, by using the appropriate command:

   ° `system node halt -node` *node_name* `-inhibit-takeover true`

   ° `system node reboot -node` *node_name* `-inhibit-takeover true`

   > (i) In the command output, you will see a warning asking you if you want to proceed, enter
   > y.

6. Verify that the node that is still online is in a healthy state (while the partner is down):
   `cluster show`

For the online node, `true` appears in the `Health` column.

> ⓘ In the command output, you will see a warning that cluster HA is not configured. You can ignore the warning at this time.

7. Perform the actions that required you to halt or reboot the node.

8. Boot the offlined node from the LOADER prompt:
   `boot_ontap`

9. Verify both nodes are healthy:
   `cluster show`

   For both nodes, `true` appears in the `Health` column.

> ⓘ In the command output, you will see a warning that cluster HA is not configured. You can ignore the warning at this time.

10. Reenable cluster HA:
    `cluster ha modify -configured true`

11. If earlier in this procedure you relocated aggregates to the partner node, move them back to their home node; otherwise, go to the next step:
    ```
    storage aggregate relocation start -node node_name -destination node_name
    -aggregate-list aggregate_name
    ```

    For example, aggregates aggr1, aggr2 and test2_aggr are being moved from node node2 to node node1:
    ```
    storage aggregate relocation start -node node2 -destination node1 -aggregate
    -list aggr1,aggr2,test2_aggr
    ```

12. Revert LIFs to their home ports:

    a. View LIFs that are not at home:
       `network interface show -is-home false`

    b. If there are non-home LIFs that were not migrated from the down node, verify it is safe to move them before reverting.

    c. If it is safe to do so, revert all LIFs home.
       `network interface revert *`