Learn about SnapMirror volume replication

ONTAP 9

NetApp
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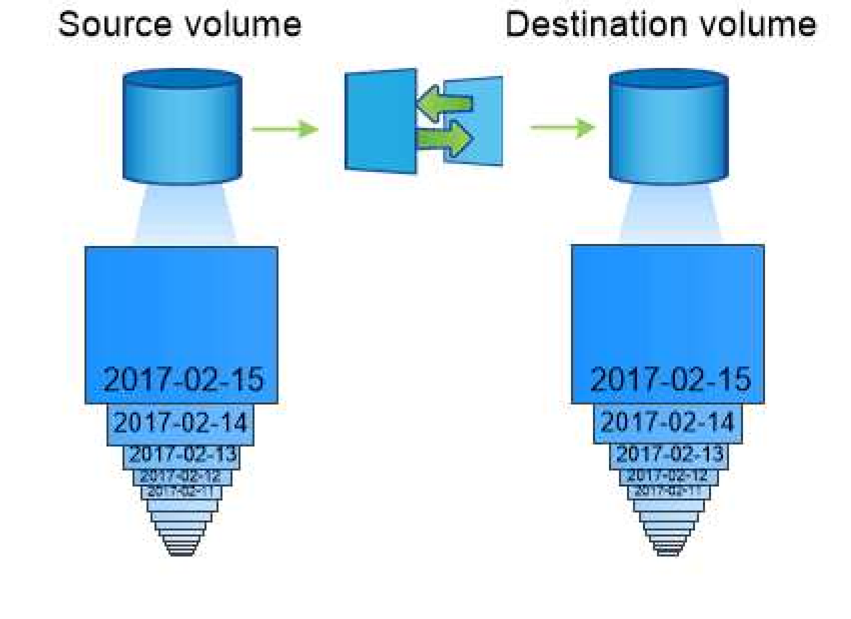
SnapMirror is disaster recovery technology, designed for failover from primary storage to secondary storage at a geographically remote site. As its name implies, SnapMirror creates a replica, or *mirror,* of your working data in secondary storage from which you can continue to serve data in the event of a catastrophe at the primary site.

If the primary site is still available to serve data, you can simply transfer any needed data back to it, and not serve clients from the mirror at all. As the failover use case implies, the controllers on the secondary system should be equivalent or nearly equivalent to the controllers on the primary system to serve data efficiently from mirrored storage.

Data protection relationships

Data is mirrored at the volume level. The relationship between the source volume in primary storage and the destination volume in secondary storage is called a *data protection relationship.* The clusters in which the volumes reside and the SVMs that serve data from the volumes must be peered. A peer relationship enables clusters and SVMs to exchange data securely.

This figure illustrates SnapMirror data protection relationships:



A SnapMirror data protection relationship typically mirrors the Snapshot copies available on the source volume.

Scope of data protection relationships

You can create a data protection relationship directly between volumes or between the SVMs that own the volumes. In an *SVM data protection relationship,* all or part of the SVM configuration, from NFS exports and SMB shares to RBAC, is replicated, as well as the data in the volumes that the SVM owns.

You can also use SnapMirror for special data protection applications:

- A *load-sharing mirror* copy of the SVM root volume ensures that data remains accessible in the event of a node outage or failover.
- A data protection relationship between *SnapLock volumes* lets you replicate WORM files to secondary storage.

  Archive and compliance using SnapLock technology

- Beginning with ONTAP 9.13.1, you can use SnapMirror asynchronous to protect consistency groups. Beginning with ONTAP 9.14.1, you can use SnapMirror asynchronous to replicate volume-granular snapshots to the destination cluster using the consistency group relationship. For more information, see Configure SnapMirror asynchronous protection.

How SnapMirror data protection relationships are initialized

The first time you invoke SnapMirror, it performs a *baseline transfer* from the source volume to the destination volume. The *SnapMirror policy* for the relationship defines the contents of the baseline and any updates.

A baseline transfer under the default SnapMirror policy `MirrorAllSnapshots` involves the following steps:

- Make a snapshot of the source volume.
- Transfer the snapshot and all the data blocks it references to the destination volume.
- Transfer the remaining, less recent snapshots on the source volume to the destination volume for use in case the “active” mirror is corrupted.

How SnapMirror data protection relationships are updated

Updates are asynchronous, following the schedule you configure. Retention mirrors the snapshot policy on the source.

At each update under the `MirrorAllSnapshots` policy, SnapMirror creates a snapshot of the source volume and transfers that snapshot and any snapshots that have been made since the last update. In the following output from the `snapmirror policy show` command for the `MirrorAllSnapshots` policy, note the following:

- `Create Snapshot` is “true”, indicating that `MirrorAllSnapshots` creates a snapshot when SnapMirror updates the relationship.
- `MirrorAllSnapshots` has rules “sm_created” and “all_source_snapshots”, indicating that both the snapshot created by SnapMirror and any snapshots that have been made since the last update are transferred when SnapMirror updates the relationship.

```
cluster_dst::> snapmirror policy show -policy MirrorAllSnapshots -instance

                     Vserver: vs0
      SnapMirror Policy Name: MirrorAllSnapshots
      SnapMirror Policy Type: async-mirror
                Policy Owner: cluster-admin
                 Tries Limit: 8
           Transfer Priority: normal
   Ignore accesstime Enabled: false
     Transfer Restartability: always
 Network Compression Enabled: false
             Create Snapshot: true
                     Comment: SnapMirror asynchronous policy for mirroring
all snapshots
                              and the latest active file system.
       Total Number of Rules: 2
                  Total Keep: 2
                       Rules: SnapMirror Label     Keep  Preserve Warn
Schedule Prefix
                              ----------------     ----  -------- ----
-------- ------
                              sm_created              1  false       0 -
-
                              all_source_snapshots    1  false       0 -
-
```

MirrorLatest policy

The preconfigured `MirrorLatest` policy works exactly the same way as `MirrorAllSnapshots`, except that only the snapshot created by SnapMirror is transferred at initialization and update.

```
                       Rules: SnapMirror Label     Keep  Preserve Warn
Schedule Prefix
                              ----------------     ----  -------- ----
-------- ------
                              sm_created              1  false       0 -
-
```

Related information

- snapmirror policy show

Learn about ONTAP SnapMirror synchronous disaster recovery

Beginning with ONTAP 9.5, SnapMirror synchronous (SM-S) technology is supported on all FAS and AFF platforms that have at least 16 GB of memory and on all ONTAP Select platforms. SnapMirror synchronous technology is a per-node, licensed feature that provides synchronous data replication at the volume level.

This functionality addresses the regulatory and national mandates for synchronous replication in financial, healthcare, and other regulated industries where zero data loss is required.

SnapMirror synchronous operations allowed

The limit on the number of SnapMirror synchronous replication operations per HA pair depends on the controller model.

The following table lists the number of SnapMirror synchronous operations that are allowed per HA pair according to platform type and ONTAP release.

Platform	ONTAP 9.14.1 through ONTAP 9.11.1	ONTAP 9.10.1	ONTAP 9.9.1	Releases earlier than ONTAP 9.9.1
AFF	400	200	160	80
ASA	400	200	160	80
FAS	80	80	80	40
ONTAP Select	40	40	40	20

Supported features

The following table indicates the features supported with SnapMirror synchronous and the ONTAP releases in which support is available.

Feature	Release first supported	Additional information
Antivirus on the primary volume of the SnapMirror synchronous relationship	ONTAP 9.6	

Application-created snapshot replication	ONTAP 9.7	If a snapshot is tagged with the appropriate label at the time of the `snapshot create` operation, using the CLI or the ONTAP API, SnapMirror synchronous replicates the snapshots, both user created or those created with external scripts, after quiescing the applications. Scheduled snapshots created using a snapshot policy are not replicated. For more information about replicating application-created snapshots, see the NetApp Knowledge Base: How to replicate application created snapshots with SnapMirror synchronous.
Clone auto delete	ONTAP 9.6	
FabricPool aggregates with tiering policy of None, Snapshot, or Auto are supported with SnapMirror synchronous source and destination.	ONTAP 9.5	The destination volume in a FabricPool aggregate cannot be set to All tiering policy.
FC	ONTAP 9.5	Over all networks for which latency does not exceed 10ms
FC-NVMe	ONTAP 9.7	
File clones	ONTAP 9.7	
FPolicy on the primary volume of the SnapMirror synchronous relationship	ONTAP 9.6	
Hard and soft quotas on the primary volume of the SnapMirror synchronous relationship	ONTAP 9.6	The quota rules are not replicated to the destination; therefore, the quota database is not replicated to the destination.
Intra-cluster synchronous relationships	ONTAP 9.14.1	High availability is provided when source and destination volumes are placed on different HA pairs. If the entire cluster goes down, access to volumes will not be possible until the cluster is recovered. Intra-cluster SnapMirror synchronous relationships will contribute to the overall limit of simultaneous relationships per HA pair.
iSCSI	ONTAP 9.5	
LUN clones and NVMe namespace clones	ONTAP 9.7	
LUN clones backed by application-created snapshots	ONTAP 9.7	
Mixed protocol access (NFS v3 and SMB)	ONTAP 9.6	
NDMP/NDMP restore	ONTAP 9.13.1	Both the source and destination cluster must be running ONTAP 9.13.1 or later to use NDMP with SnapMirror Synchronous. For more information, see Transfer data using ndmp copy.

Non-disruptive SnapMirror synchronous operations (NDO) on AFF/ASA platforms, only.	ONTAP 9.12.1	Support for non-disruptive operations enables you to perform many common maintenance tasks without scheduling down time. Operations supported include takeover and giveback, and volume move, provided that a single node is surviving among each of the two clusters.
NFS v4.2	ONTAP 9.10.1	
NFS v4.0	ONTAP 9.6	
NFS v4.1	ONTAP 9.6	
NVMe/TCP	9.10.1	
Removal of high metadata operation frequency limitation	ONTAP 9.6	
Security for sensitive data in-transit using TLS 1.2 encryption	ONTAP 9.6	
Single file and partial file restore	ONTAP 9.13.1	
SMB 2.0 or later	ONTAP 9.6	
SnapMirror synchronous mirror-mirror cascade	ONTAP 9.6	The relationship from the destination volume of the SnapMirror synchronous relationship must be an SnapMirror asynchronous relationship.
SVM disaster recovery	ONTAP 9.6	* A SnapMirror synchronous source can also be a SVM disaster recovery source, for example, a fan-out configuration with SnapMirror synchronous as one leg and SVM disaster recovery as the other. * A SnapMirror synchronous source cannot be an SVM disaster recovery destination because SnapMirror synchronous does not support cascading a data protection source. You must release the synchronous relationship before performing an SVM disaster recovery flip resync in the destination cluster. * A SnapMirror synchronous destination cannot be an SVM disaster recovery source because SVM disaster recovery does not support replication of DP volumes. A flip resync of the synchronous source would result in the SVM disaster recovery excluding the DP volume in the destination cluster.
Tape-based restore to the source volume	ONTAP 9.13.1	
Timestamp parity between source and destination volumes for NAS	ONTAP 9.6	If you have upgraded from ONTAP 9.5 to ONTAP 9.6, the timestamp is replicated only for any new and modified files in the source volume. The timestamp of existing files in the source volume is not synchronized.

Unsupported features

The following features are not supported with SnapMirror synchronous relationships:

- Autonomous Ransomware Protection
- Consistency groups
- DP_Optimized (DPO) systems
- FlexGroup volumes
- FlexCache volumes
- Global throttling
- In a fan-out configuration, only one relationship can be a SnapMirror synchronous relationship; all the other relationships from the source volume must be SnapMirror asynchronous relationships.
- LUN move
- MetroCluster configurations
- Mixed SAN and NVMe access
  LUNs and NVMe namespaces are not supported on the same volume or SVM.
- SnapCenter
- SnapLock volumes
- Tamperproof snapshots
- Tape backup or restore using dump and SMTape on the destination volume
- Throughput floor (QoS Min) for source volumes
- Volume SnapRestore
- VVol

Modes of operation

SnapMirror synchronous has two modes of operation based on the type of the SnapMirror policy used:

- **Sync mode**
  In Sync mode, application I/O operations are sent in parallel to the primary and secondary storage systems. If the write to the secondary storage is not completed for any reason, the application is allowed to continue writing to the primary storage. When the error condition is corrected, SnapMirror synchronous technology automatically resynchronizes with the secondary storage and resumes replicating from primary storage to secondary storage in synchronous mode.
  In Sync mode, RPO=0 and RTO is very low until a secondary replication failure occurs at which time RPO and RTO become indeterminate, but equal the time to repair the issue that caused secondary replication to fail and for the resync to complete.
- **StrictSync mode**
  SnapMirror synchronous can optionally operate in StrictSync mode. If the write to the secondary storage is not completed for any reason, the application I/O fails, thereby ensuring that the primary and secondary storage are identical. Application I/O to the primary resumes only after the SnapMirror relationship returns to the `InSync` status. If the primary storage fails, application I/O can be resumed on the secondary storage, after failover, with no loss of data.
  In StrictSync mode RPO is always zero, and RTO is very low.

Relationship status

The status of a SnapMirror synchronous relationship is always in the `InSync` status during normal operation. If the SnapMirror transfer fails for any reason, the destination is not in sync with the source and can go to the `OutofSync` status.

For SnapMirror synchronous relationships, the system automatically checks the relationship status (`InSync` or `OutofSync`) at a fixed interval. If the relationship status is `OutofSync`, ONTAP automatically triggers the auto resync process to bring back the relationship to the `InSync` status. Auto resync is triggered only if the transfer fails due to any operation, such as unplanned storage failover at source or destination or a network outage. User-initiated operations such as `snapmirror quiesce` and `snapmirror break` do not trigger auto resync.

If the relationship status becomes `OutofSync` for a SnapMirror synchronous relationship in the StrictSync mode, all I/O operations to the primary volume are stopped. The `OutofSync` state for SnapMirror synchronous relationship in the Sync mode is not disruptive to the primary and I/O operations are allowed on the primary volume.

Related information

- NetApp Technical Report 4733: SnapMirror synchronous configuration and best practices
- snapmirror break
- snapmirror quiesce

Default ONTAP data protection policies

ONTAP includes several default protection policies you can use for your data protection relationships. The policy you use depends on the protection relationship type.

If the default policies don’t meet your data protection relationships needs, you can create a custom policy.

List of default protection policies and descriptions

Default protection policies and their associated policy types are described below.

Name	Description	Policy type
Asynchronous	A unified SnapMirror asynchronous and vault policy for mirroring the latest active file system and daily and weekly snapshots with an hourly transfer schedule.	Asynchronous
AutomatedFailOver	Policy for SnapMirror synchronous with zero RTO guarantee where client I/O will not be disrupted on replication failure.	Synchronous
AutomatedFailOverDuplex	Policy for SnapMirror synchronous with zero RTO guarantee and bi-directional sync replication.	Synchronous
CloudBackupDefault	Vault policy with daily rule.	Asynchronous
Continuous	Policy for S3 bucket mirroring.	Continuous
DailyBackup	Vault policy with a daily rule and a daily transfer schedule.	Asynchronous

Name	Description	Policy type
DPDefault	SnapMirror asynchronous policy for mirroring all snapshots and the latest active file system.	Asynchronous
MirrorAllSnapshots	SnapMirror asynchronous policy for mirroring all snapshots and the latest active file system.	Asynchronous
MirrorAllSnapshotsDiscardNetwork	SnapMirror asynchronous policy for mirroring all snapshots and the latest active file system excluding the network configurations.	Asynchronous
MirrorAndVault	A unified SnapMirror asynchronous and vault policy for mirroring the latest active file system and daily and weekly snapshots.	Asynchronous
MirrorAndVaultDiscardNetwork	A unified SnapMirror asynchronous and vault policy for mirroring the latest active file system and daily and weekly snapshots excluding the network configurations.	Asynchronous
MirrorLatest	SnapMirror asynchronous policy for mirroring the latest active file system.	Asynchronous
SnapCenterSync	Policy for SnapMirror synchronous for SnapCenter with Application Created Snapshot configuration.	Synchronous
StrictSync	Policy for SnapMirror synchronous where client access will be disrupted on replication failure.	Synchronous
Synchronous	Policy for SnapMirror synchronous where client access will not be disrupted on replication failure.	Synchronous
Unified7year	Unified SnapMirror policy with 7-year retention.	Asynchronous
XDPDefault	Vault policy with daily and weekly rules.	Asynchronous

Learn about workloads supported by ONTAP StrictSync and Sync policies

StrictSync and Sync policies support all LUN-based applications with FC, iSCSI, and FC-NVMe protocols, as well as NFSv3 and NFSv4 protocols for enterprise applications such as databases, VMWare, quota, SMB, and so on. Beginning with ONTAP 9.6, SnapMirror synchronous can be used for enterprise file services such as electronic design automation (EDA), home directories, and software build workloads.

In ONTAP 9.5, for a Sync policy, you need to consider a few important aspects while selecting the NFSv3 or NFSv4 workloads. The amount of data read or write operations by workloads is not a consideration, as Sync policy can handle high read or write IO workloads. In ONTAP 9.5, workloads that have excessive file creation, directory creation, file permission changes, or directory permission changes may not be suitable (these are referred to as high-metadata workloads). A typical example of a high-metadata workload is a DevOps workload in which you create multiple test files, run automation, and delete the files. Another example is parallel build workload that generate multiple temporary files during compilation. The impact of a high rate of write metadata activity is that it can cause synchronization between mirrors to temporarily break which stalls the read and write

IOs from the client.

Beginning with ONTAP 9.6, these limitations are removed and SnapMirror synchronous can be used for enterprise file services workloads that include multiuser environments, such as home directories and software build workloads.

Related information

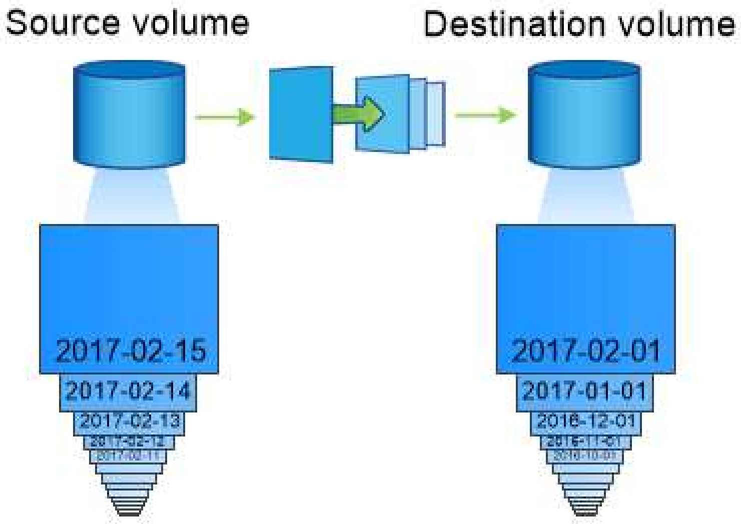
SnapMirror synchronous Configuration and Best Practices

Learn about vault archiving using ONTAP SnapMirror technology

SnapMirror vault policies replace SnapVault technology in ONTAP 9.3 and later. You use a SnapMirror vault policy for disk-to-disk snapshot replication for standards compliance and other governance-related purposes. In contrast to a SnapMirror relationship, in which the destination usually contains only the snapshots currently in the source volume, a vault destination typically retains point-in-time snapshots created over a much longer period.

You might want to keep monthly snapshots of your data over a 20-year span, for example, to comply with government accounting regulations for your business. Since there is no requirement to serve data from vault storage, you can use slower, less expensive disks on the destination system.

The figure below illustrates SnapMirror vault data protection relationships.



A SnapVault data protection relationship typically retains point-in-time Snapshot copies created over a longer period than the Snapshot copies on the source volume.

How vault data protection relationships are initialized

The SnapMirror policy for the relationship defines the contents of the baseline and any updates.

A baseline transfer under the default vault policy `XDPDefault` makes a snapshot of the source volume, then transfers that copy and the data blocks it references to the destination volume. Unlike SnapMirror relationships, a vault backup does not include older snapshots in the baseline.

How vault data protection relationships are updated

Updates are asynchronous, following the schedule you configure. The rules you define in the policy for the relationship identify which new snapshots to include in updates and how many copies to retain. The labels defined in the policy ("monthly," for example) must match one or more labels defined in the snapshot policy on the source. Otherwise, replication fails.

At each update under the `XDPDefault` policy, SnapMirror transfers snapshots that have been made since the last update, provided they have labels matching the labels defined in the policy rules. In the following output from the `snapmirror policy show` command for the `XDPDefault` policy, note the following:

- `Create Snapshot` is "false", indicating that `XDPDefault` does not create a snapshot when SnapMirror updates the relationship.
- `XDPDefault` has rules "daily" and "weekly", indicating that all snapshots with matching labels on the source are transferred when SnapMirror updates the relationship.

```
cluster_dst::> snapmirror policy show -policy XDPDefault -instance

                     Vserver: vs0
      SnapMirror Policy Name: XDPDefault
      SnapMirror Policy Type: vault
                Policy Owner: cluster-admin
                 Tries Limit: 8
           Transfer Priority: normal
   Ignore accesstime Enabled: false
     Transfer Restartability: always
 Network Compression Enabled: false
             Create Snapshot: false
                     Comment: Default policy for XDP relationships with
daily and weekly
                              rules.
       Total Number of Rules: 2
                  Total Keep: 59
                       Rules: SnapMirror Label     Keep  Preserve Warn
Schedule Prefix
                              ----------------     ----  -------- ----
-------- ------
                              daily                   7  false       0 -
-
                              weekly                 52  false       0 -
-
```

Related information

- snapmirror policy show

Learn about ONTAP SnapMirror unified replication

SnapMirror *unified replication* allows you to configure disaster recovery and archiving on the same destination volume. When unified replication is appropriate, it offers benefits in reducing the amount of secondary storage you need, limiting the number of baseline transfers, and decreasing network traffic.

How unified data protection relationships are initialized

As with SnapMirror, unified data protection performs a baseline transfer the first time you invoke it. The SnapMirror policy for the relationship defines the contents of the baseline and any updates.

A baseline transfer under the default unified data protection policy `MirrorAndVault` makes a snapshot of the source volume, then transfers that copy and the data blocks it references to the destination volume. Like vault archiving, unified data protection does not include older snapshots in the baseline.

How unified data protection relationships are updated

At each update under the `MirrorAndVault` policy, SnapMirror creates a snapshot of the source volume and transfers that snapshot and any snapshots that have been made since the last update, provided they have labels matching the labels defined in the snapshot policy rules. In the following output from the `snapmirror policy show` command for the `MirrorAndVault` policy, note the following:

- `Create Snapshot` is “true”, indicating that `MirrorAndVault` creates a snapshot when SnapMirror updates the relationship.
- `MirrorAndVault` has rules “sm_created”, “daily”, and “weekly”, indicating that both the snapshot created by SnapMirror and the snapshots with matching labels on the source are transferred when SnapMirror updates the relationship.

```
cluster_dst::> snapmirror policy show -policy MirrorAndVault -instance

                     Vserver: vs0
      SnapMirror Policy Name: MirrorAndVault
      SnapMirror Policy Type: mirror-vault
                Policy Owner: cluster-admin
                 Tries Limit: 8
           Transfer Priority: normal
   Ignore accesstime Enabled: false
     Transfer Restartability: always
 Network Compression Enabled: false
             Create Snapshot: true
                     Comment: A unified SnapMirror synchronous and
SnapVault policy for
                              mirroring the latest file system and daily
and weekly snapshots.
       Total Number of Rules: 3
                  Total Keep: 59
                       Rules: SnapMirror Label     Keep  Preserve Warn
Schedule Prefix
                              ----------------     ----  -------- ----
-------- ------
                              sm_created              1  false       0 -
-
                              daily                   7  false       0 -
-
                              weekly                 52  false       0 -
-
```

Unified7year policy

The preconfigured `Unified7year` policy works exactly the same way as `MirrorAndVault`, except that a fourth rule transfers monthly snapshots and retains them for seven years.

```
                       Rules: SnapMirror Label     Keep  Preserve Warn
Schedule Prefix
                              ----------------     ----  -------- ----
-------- ------
                              sm_created              1  false       0 -
-
                              daily                   7  false       0 -
-
                              weekly                 52  false       0 -
-
                              monthly                84  false       0 -
-
```

Protect against possible data corruption

Unified replication limits the contents of the baseline transfer to the snapshot created by SnapMirror at initialization. At each update, SnapMirror creates another snapshot of the source and transfers that snapshot and any new snapshots that have labels matching the labels defined in the snapshot policy rules.

You can protect against the possibility that an updated snapshot is corrupted by creating a copy of the last transferred snapshot on the destination. This “local copy” is retained regardless of the retention rules on the source, so that even if the snapshot originally transferred by SnapMirror is no longer available on the source, a copy of it will be available on the destination.

When to use unified data replication

You need to weigh the benefit of maintaining a full mirror against the advantages that unified replication offers in reducing the amount of secondary storage, limiting the number of baseline transfers, and decreasing network traffic.

The key factor in determining the appropriateness of unified replication is the rate of change of the active file system. A traditional mirror might be better suited to a volume holding hourly snapshots of database transaction logs, for example.

Related information

- snapmirror policy show

When an ONTAP data protection destination volume grows automatically

During a data protection mirror transfer, the destination volume grows automatically in size if the source volume has grown, provided there is available space in the aggregate that contains the volume.

This behavior occurs irrespective of any automatic growth setting on the destination. You cannot limit the volume’s growth or prevent ONTAP from growing it.

By default, data protection volumes are set to the `grow_shrink` autosize mode, which enables the volume to grow or shrink in response to the amount of used space. The max-autosize for data protection volumes is equal to the maximum FlexVol size and is platform dependent. For example:

- FAS8200, default DP volume max-autosize = 100TB

For more information, see NetApp Hardware Universe.

Learn about ONTAP data protection fan-out and cascade deployments

You can use a *fan-out* deployment to extend data protection to multiple secondary systems. You can use a *cascade* deployment to extend data protection to tertiary systems.

Both fan-out and cascade deployments support any combination of SnapMirror DR, SnapVault, or unified replication. Beginning with ONTAP 9.5, SnapMirror synchronous relationships support fan-out deployments with one or more SnapMirror asynchronous relationships. Only one relationship in the fan-out configuration can be a SnapMirror synchronous relationship, all the other relationships from the source volume must be SnapMirror asynchronous relationships. SnapMirror synchronous relationships also support cascade deployments (beginning with ONTAP 9.6); however, the relationship from the destination volume of the SnapMirror synchronous relationship must be a SnapMirror asynchronous relationship. SnapMirror active sync (supported beginning with ONTAP 9.13.1) also supports fan-out configurations.

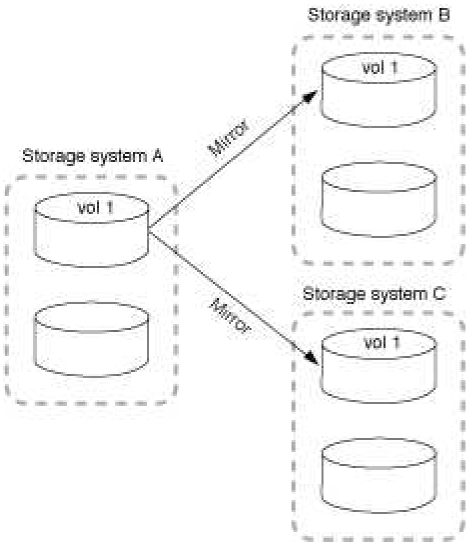
> ⓘ You can use a *fan-in* deployment to create data protection relationships between multiple primary systems and a single secondary system. Each relationship must use a different volume on the secondary system.

> ⓘ You should be aware that volumes that are part of a fan-out or cascade configuration can take longer to
> resynchronize. It is not uncommon to see the SnapMirror relationship reporting
> the status "preparing" for an extended time period.

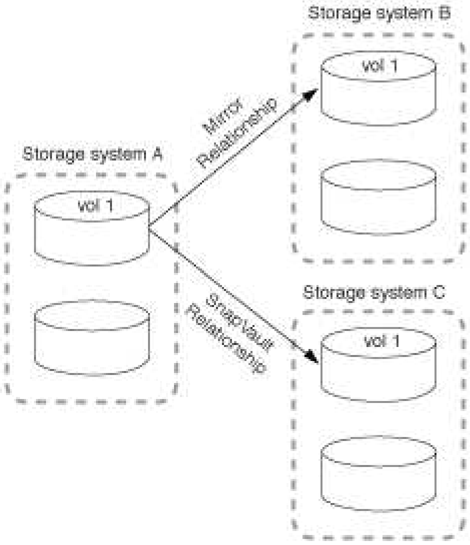
How fan-out deployments work

SnapMirror supports *multiple-mirrors* and *mirror-vault* fan-out deployments.

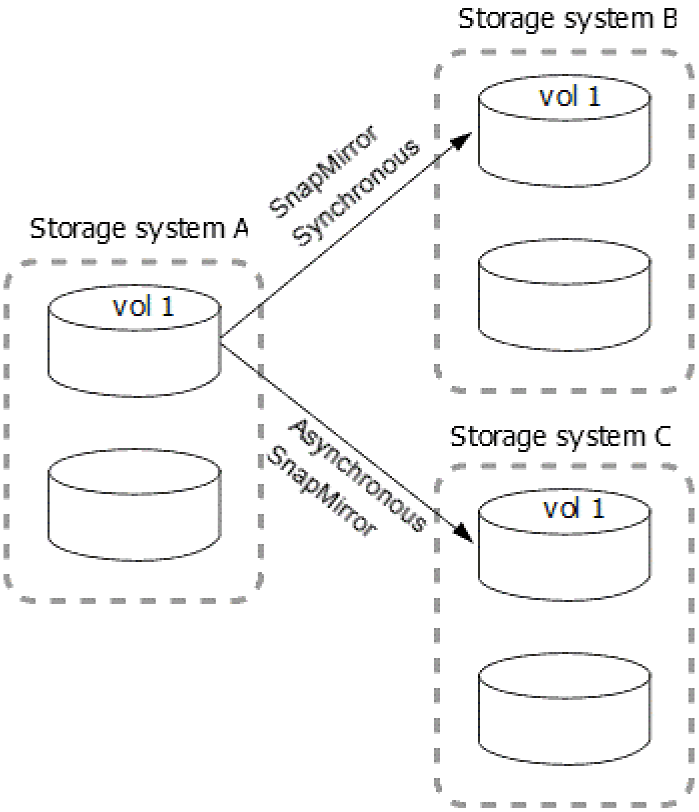
A multiple-mirrors fan-out deployment consists of a source volume that has a mirror relationship to multiple secondary volumes.



A mirror-vault fan-out deployment consists of a source volume that has a mirror relationship to a secondary volume and a SnapVault relationship to a different secondary volume.



Beginning with ONTAP 9.5, you can have fan-out deployments with SnapMirror synchronous relationships; however, only one relationship in the fan-out configuration can be a SnapMirror synchronous relationship, all the other relationships from the source volume must be SnapMirror asynchronous relationships.



How cascade deployments work

SnapMirror supports *mirror-mirror*, *mirror-vault*, *vault-mirror*, and *vault-vault* cascade deployments.

A mirror-mirror cascade deployment consists of a chain of relationships in which a source volume is mirrored to a secondary volume, and the secondary volume is mirrored to a tertiary volume. If the secondary volume becomes unavailable, you can synchronize the relationship between the primary and tertiary volumes without performing a new baseline transfer.

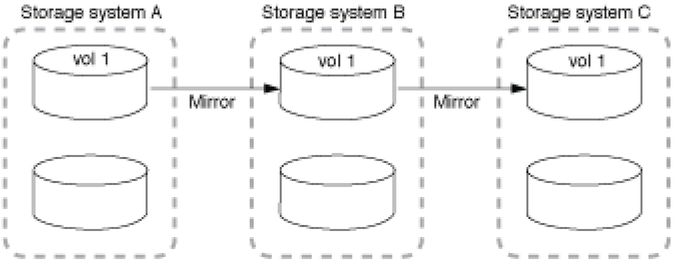
In a relationship of cascaded volumes, long-term retention snapshots are supported only on the final SnapMirror destination volume of the cascade in all versions of ONTAP 9. Enabling long-term retention snapshots on any middle volume in the cascade results in missed backups and snapshots. If you have an unsupported configuration in which long-term retention snapshots have been enabled on any middle volume of a cascade, contact technical support and reference the NetApp Knowledge Base: Cascading a volume with Long-Term Retention (LTR) snapshots enabled is not supported for assistance.

The following ONTAP versions do not allow you to enable long-term retention snapshots on any volume in a cascade except the final SnapMirror destination volume.

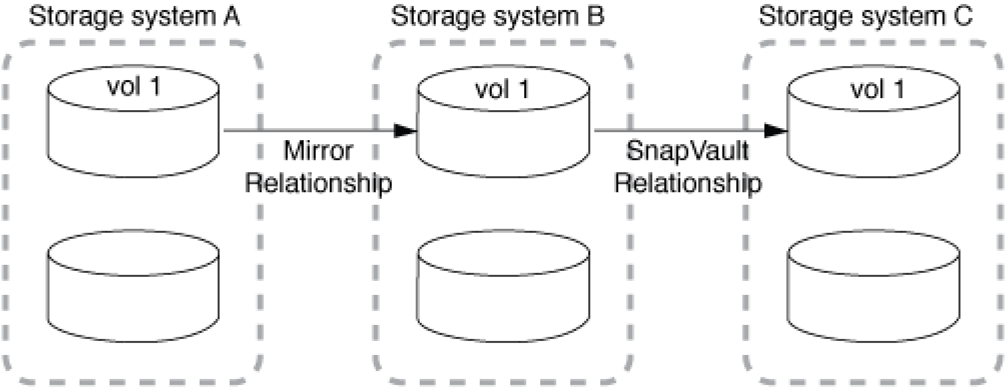
- 9.15.1 and later
- 9.14.1P2 and P4 through P14
- 9.13.1P9 through P17
- 9.12.1 P12 through P19
- 9.11.1P15 through P20
- 9.10.1P18 through P20
- 9.9.1P20

Learn more about long-term retention snapshots.

Beginning with ONTAP 9.6, SnapMirror synchronous relationships are supported in a mirror-mirror cascade deployment. Only the primary and secondary volumes can be in a SnapMirror synchronous relationship. The relationship between the secondary volumes and tertiary volumes must be asynchronous.



A mirror-vault cascade deployment consists of a chain of relationships in which a source volume is mirrored to a secondary volume, and the secondary volume is vaulted to a tertiary volume.



Vault-mirror and vault-vault cascade deployments are also supported:

- A vault-mirror cascade deployment consists of a chain of relationships in which a source volume is vaulted to a secondary volume, and the secondary volume is mirrored to a tertiary volume.
- A vault-vault cascade deployment consists of a chain of relationships in which a source volume is vaulted to a secondary volume, and the secondary volume is vaulted to a tertiary volume.

Related information

- Resume protection in a fan-out configuration with SnapMirror active sync

Learn about ONTAP SnapMirror licensing

Beginning with ONTAP 9.3, licensing has been simplified for replicating between ONTAP instances. In ONTAP 9 releases, the SnapMirror license supports both vault and mirror relationships. You can use a SnapMirror license to support ONTAP replication for both backup and disaster recovery use cases.

Prior to the ONTAP 9.3 release, a separate SnapVault license was needed to configure *vault* relationships between ONTAP instances, where the DP instance could retain a higher number of snapshots to support backup use cases with longer retention times, and a SnapMirror license was needed to configure *mirror* relationships between ONTAP instances, where each ONTAP instance would maintain the same number of snapshots (that is, a *mirror* image) to support disaster recovery use cases to make cluster failovers possible.

Both SnapMirror and SnapVault licenses continue to be used and supported for ONTAP 8.x and 9.x releases.

While SnapVault licenses continue to function and are supported for both ONTAP 8.x and 9.x releases, the SnapMirror license can be used in place of a SnapVault license and can be used for both mirror and vault configurations.

For ONTAP asynchronous replication, beginning with ONTAP 9.3 a single unified replication engine is used to configure extended data protection mode (XDP) policies, where the SnapMirror license can be configured for a mirror policy, a vault policy, or a mirror-vault policy. A SnapMirror license is required on both the source and destination clusters. A SnapVault license is not required if a SnapMirror license is already installed. The SnapMirror asynchronous perpetual license is included in the ONTAP One software suite that’s installed on new AFF and FAS systems.

Data protection configuration limits are determined using several factors, including your ONTAP version, hardware platform, and the licenses installed. For more information, see Hardware Universe.

SnapMirror synchronous license

Beginning with ONTAP 9.5, SnapMirror synchronous relationships are supported. You require the following licenses for creating a SnapMirror synchronous relationship:

- The SnapMirror synchronous license is required on both the source cluster and the destination cluster.

  The SnapMirror synchronous license is part of the ONTAP One license suite.

  If your system was purchased before June 2019 with a Premium or Flash Bundle, you can download a NetApp master key to get the required SnapMirror synchronous license from the NetApp Support Site: Master License Keys.

- The SnapMirror license is required on both the source cluster and the destination cluster.

SnapMirror cloud license

Beginning with ONTAP 9.8, the SnapMirror cloud license provides asynchronous replication of snapshots from ONTAP instances to object storage endpoints. Replication targets can be configured using both on-premises object stores as well as S3 and S3-compatible public cloud object storage services. SnapMirror cloud relationships are supported from ONTAP systems to pre-qualified object storage targets.

SnapMirror cloud is not available as a standalone license. Only one license is needed per ONTAP cluster. In addition to a SnapMirror cloud license, the SnapMirror asynchronous license is also required.

You require the following licenses for creating a SnapMirror cloud relationship:

- Both a SnapMirror license and a SnapMirror cloud license for replicating directly to the object store endpoint.
- When configuring a multi-policy replication workflow (for example, Disk-to-Disk-to-Cloud), a SnapMirror license is required on all ONTAP instances, while the SnapMirror cloud license is only required for the source cluster which is replicating directly to the object storage endpoint.

Beginning with ONTAP 9.9.1, you can use System Manager for SnapMirror cloud replication.

A list of authorized SnapMirror cloud third-party applications is published on the NetApp web site.

Data Protection Optimized license

Data Protection Optimized (DPO) licenses are no longer being sold, and DPO is not supported on current platforms; however, if you have a DPO license installed on a supported platform, NetApp continues to provide support until the end of availability of that platform.

DPO is not included with the ONTAP One license bundle, and you cannot upgrade to the ONTAP One license bundle if the DPO license is installed on a system.

For information about supported platforms, see Hardware Universe.

ONTAP DPO systems feature enhancements

Beginning with ONTAP 9.6, the maximum number of FlexVol volumes supported increases when the DP_Optimized (DPO) license is installed. Beginning with ONTAP 9.4, systems with the DPO license support SnapMirror backoff, cross-volume background deduplication, use of snapshot blocks as donors, and compaction.

Beginning with ONTAP 9.6, the maximum supported number of FlexVol volumes on secondary or data protection systems has increased, enabling you to scale up to 2,500 FlexVol volumes per node, or up to 5,000 in failover mode. The increase in FlexVol volumes is enabled with the DP_Optimized (DPO) license. A SnapMirror license is still required on both the source and destination nodes.

Beginning with ONTAP 9.4, the following feature enhancements are made to DPO systems:

- SnapMirror backoff: In DPO systems, replication traffic is given the same priority that client workloads are given.

  SnapMirror backoff is disabled by default on DPO systems.

- Volume background deduplication and cross-volume background deduplication: Volume background deduplication and cross-volume background deduplication are enabled in DPO systems.

  You can run the `storage aggregate efficiency cross-volume-dedupe start -aggregate` *`aggregate_name`* `-scan-old-data true` command to deduplicate the existing data. The best practice is to run the command during off-peak hours to reduce the impact on performance.

  Learn more about `storage aggregate efficiency cross-volume-dedupe start` in the ONTAP command reference.

- Increased savings by using snapshot blocks as donors: The data blocks that are not available in the active file system but are trapped in snapshots are used as donors for volume deduplication.

  The new data can be deduplicated with the data that was trapped in snapshots, effectively sharing the snapshot blocks as well. The increased donor space provides more savings, especially when the volume has a large number of snapshots.

- Compaction: Data compaction is enabled by default on DPO volumes.

Learn about path name pattern matching in ONTAP SnapMirror commands

You can use pattern matching to specify the source and destination paths in `snapmirror` commands.

`snapmirror` commands use fully qualified path names in the following format: `vserver:volume`. You can abbreviate the path name by not entering the SVM name. If you do this, the `snapmirror` command assumes the local SVM context of the user.

Assuming that the SVM is called “vserver1” and the volume is called “vol1”, the fully qualified path name is `vserver1:vol1`.

You can use the asterisk (*) in paths as a wildcard to select matching, fully qualified path names. The following table provides examples of using the wildcard to select a range of volumes.

`*`	Matches all paths.
`vs*`	Matches all SVMs and volumes with SVM names beginning with `vs`.
`:*src`	Matches all SVMs with volume names containing the `src` text.
`:vol`	Matches all SVMs with volume names beginning with `vol`.

```
vs1::> snapmirror show -destination-path *:*dest*

Progress
Source              Destination  Mirror        Relationship  Total
Last
Path          Type  Path         State         Status        Progress
Healthy Updated
------------- ---- ------------ ------------- -------------- ----------
------- --------
vs1:sm_src2
              DP   vs2:sm_dest1
                                Snapmirrored  Idle           -
true    -
```

Learn more about `snapmirror show` in the ONTAP command reference.

Learn about extended queries for ONTAP SnapMirror relationship operations

You can use *extended queries* to perform SnapMirror operations on many SnapMirror relationships at one time. For example, you might have multiple uninitialized SnapMirror relationships that you want to initialize using one command.

About this task

You can apply extended queries to the following SnapMirror operations:

- Initializing uninitialized relationships
- Resuming quiesced relationships
- Resynchronizing broken relationships
- Updating idle relationships
- Aborting relationship data transfers

Step

1. Perform a SnapMirror operation on many relationships:

   ```
   snapmirror command {-state state } *
   ```

   The following command initializes SnapMirror relationships that are in an `Uninitialized` state:

   ```
   vs1::> snapmirror initialize {-state Uninitialized} *
   ```

   Learn more about `snapmirror initialize` in the ONTAP command reference.

Compatible ONTAP versions for SnapMirror relationships

The source and destination volumes must be running compatible ONTAP versions before creating a SnapMirror data protection relationship. Before you upgrade ONTAP, you should verify that your current ONTAP version is compatible with your target ONTAP version for SnapMirror relationships.

Unified replication relationships

For SnapMirror relationships of type “XDP”, using on premises or Cloud Volumes ONTAP releases:

Beginning with ONTAP 9.9.0:

- ONTAP 9.x.0 releases are cloud-only releases and support Cloud Volumes ONTAP systems. The asterisk (*) after the release version indicates a cloud-only release.

ⓘ ONTAP 9.16.0 is an exception to the cloud-only rule because it provides support for ASA r2 systems. The plus sign (+) after the release version indicates both an ASA r2 and cloud supported release. ASA r2 systems support SnapMirror relationships only to other ASA r2 systems.

- ONTAP 9.x.1 releases are general releases and support both on-premises and Cloud Volumes ONTAP systems.

ⓘ When advanced capacity balancing is enabled on volumes in clusters running ONTAP 9.16.1 or later, SnapMirror transfers are not supported to clusters running ONTAP versions earlier than ONTAP 9.16.1.

ⓘ Interoperability is bidirectional.

Interoperability for ONTAP version 9.4 and later

ONTAP version…	**Interoperates with these previous ONTAP versions…**																					
	9.18.1	9.17.1	9.16.1	9.16.0+	9.15.1	9.15.0*	9.14.1	9.14.0*	9.13.1	9.13.0*	9.12.1	9.12.0*	9.11.1	9.11.0*	9.10.1	9.10.0*	9.9.1	9.9.0*	9.8	9.7	9.6	9.5
9.18.1	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	**Yes**	No	**Yes**	**Yes**	No	No	No	No	No	No	No	No	No	No	No	No
9.17.1	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No	No	No	No	No	No	No	No	No
9.16.1	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No	No	No	No	No	No	No
9.16.0+	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	No	No	No	No	No	No	No
9.15.1	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No	No	No
9.15.0*	No	**Yes**	**Yes**	No	**Yes**	**Yes**	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	No	No	No	No	No
9.14.1	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No	No
9.14.0*	No	**Yes**	**Yes**	No	**Yes**	No	**Yes**	**Yes**	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	No	No	No	No	No
9.13.1	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No

9.13.0*	No	**Yes**	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	**Yes**	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	No	No	No
9.12.1	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No
9.12.0*	No	No	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	**Yes**	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	**Yes**	No	No
9.11.1	No	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No
9.11.0*	No	No	No	No	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	**Yes**	**Yes**	No	**Yes**	No	**Yes**	**Yes**	**Yes**	No
9.10.1	No	No	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
9.10.0*	No	No	No	No	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	**Yes**	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**
9.9.1	No	No	No	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
9.9.0*	No	No	No	No	No	No	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
9.8	No	No	No	No	No	No	No	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
9.7	No	No	No	No	No	No	No	No	No	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
9.6	No	No	No	No	No	No	No	No	No	No	No	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
9.5	No	No	No	No	No	No	No	No	No	No	No	No	No	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

SnapMirror synchronous relationships

SnapMirror synchronous is not supported for ONTAP cloud instances.

ONTAP version…	**Interoperates with these previous ONTAP versions…**													
	9.18.1	9.17.1	9.16.1	9.15.1	9.14.1	9.13.1	9.12.1	9.11.1	9.10.1	9.9.1	9.8	9.7	9.6	9.5
9.18.1	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No	No	No	No	No
9.17.1	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No	No	No	No	No
9.16.1	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No	No	No	No

9.15.1	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No	No	No
9.14.1	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No
9.13.1	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No
9.12.1	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No
9.11.1	No	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No	No
9.10.1	No	No	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No
9.9.1	No	No	No	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No
9.8	No	No	No	No	**Yes**	**Yes**	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No
9.7	No	No	No	No	No	**Yes**	**Yes**	No	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
9.6	No	No	No	No	No	No	No	No	No	No	**Yes**	**Yes**	**Yes**	**Yes**
9.5	No	No	No	No	No	No	No	No	No	No	No	**Yes**	**Yes**	**Yes**

SnapMirror SVM disaster recovery relationships

- This matrix applies to the SVM data mobility migration feature beginning with ONTAP 9.10.1.
- You can use SVM DR to migrate an SVM that does not meet the restrictions indicated for SVM migration (SVM data mobility).
- In both cases, a maximum of 2 major **newer** ONTAP versions can separate the source and destination clusters, with the requirement that the destination be same version or newer than source ONTAP version.

For SVM disaster recovery data and SVM protection:

SVM disaster recovery is supported only between clusters running the same version of ONTAP. **Version-independence is not supported for SVM replication**.

For SVM disaster recovery for SVM migration:

- Replication is supported in a single direction from an earlier version of ONTAP on the source to the same or later version of ONTAP on the destination.
- The ONTAP version on the target cluster must be no more than two major on-premises versions newer or two major cloud versions newer (beginning with ONTAP 9.9.0), as shown in the table below.
  - Replication is not supported for long-term data protection use cases.

The asterisk (*) after the release version indicates a cloud-only release.

To determine support, locate the source version in the left table column, and then locate the destination version on the top row (DR/Migration for like versions and Migration only for newer versions).

If you are using ONTAP 9.10.1 or later, you can use the SVM data mobility feature instead of SVM DR to migrate SVMs from one cluster to another.

Source	**Destination**

	9.5	9.6	9.7	9.8	9.9.0*	9.9.1	9.10.0*	9.10.1	9.11.0*	9.11.1	9.12.0*	9.12.1	9.13.0*	9.13.1	9.14.0*	9.14.1	9.15.0*	9.15.1	9.16.0	9.16.1	9.17.1	9.18.1
9.5	DR/Migration	Migration	Migration																			
9.6		DR/Migration	Migration	Migration																		
9.7			DR/Migration	Migration	Migration																	
9.8				DR/Migration	Migration	Migration		Migration														
9.9.0*					DR/Migration	Migration	Migration	Migration	Migration	Migration												
9.9.1						DR/Migration	Migration	Migration	Migration	Migration												
9.10.0*							DR/Migration	Migration	Migration	Migration	Migration	Migration										
9.10.1								DR/Migration	Migration	Migration	Migration	Migration										
9.11.0*									DR/Migration	Migration	Migration	Migration	Migration	Migration								
9.11.1										DR/Migration	Migration	Migration	Migration	Migration								
9.12.0*											DR/Migration	Migration	Migration	Migration	Migration	Migration						

9.12.1												DR/Migration	Migration	Migration	Migration	Migration						
9.13.0*													DR/Migration	Migration	Migration	Migration	Migration	Migration				
9.13.1														DR/Migration	Migration	Migration	Migration	Migration				
9.14.0*															DR/Migration	Migration	Migration	Migration	Migration	Migration		
9.14.1																DR/Migration	Migration	Migration	Migration	Migration		
9.15.0*																	DR/Migration	Migration	Migration	Migration	Migration	
9.15.1																		DR/Migration	Migration	Migration	Migration	
9.16.0																			DR/Migration	Migration	Migration	Migration
9.16.1																				DR/Migration	Migration	Migration
9.17.1																					DR/Migration	Migration
9.18.1																						DR/Migration

SnapMirror disaster recovery relationships

For SnapMirror relationships of type “DP” and policy type “async-mirror”:

DP-type mirrors cannot be initialized beginning with ONTAP 9.11.1 and are completely deprecated in ONTAP 9.12.1. For more information, see Deprecation of data protection SnapMirror relationships.

In the following table, the column on the left indicates the ONTAP version on the source volume, and the top row indicates the ONTAP versions you can have on your destination volume.

Source	Destination								
	9.11.1	9.10.1	9.9.1	9.8	9.7	9.6	9.5	9.4	9.3
9.11.1	Yes	No	No	No	No	No	No	No	No
9.10.1	Yes	Yes	No	No	No	No	No	No	No
9.9.1	Yes	Yes	Yes	No	No	No	No	No	No
9.8	No	Yes	Yes	Yes	No	No	No	No	No
9.7	No	No	Yes	Yes	Yes	No	No	No	No
9.6	No	No	No	Yes	Yes	Yes	No	No	No
9.5	No	No	No	No	Yes	Yes	Yes	No	No
9.4	No	No	No	No	No	Yes	Yes	Yes	No
9.3	No	No	No	No	No	No	Yes	Yes	Yes

Interoperability is not bidirectional.

Learn about ONTAP SnapMirror limitations

You should be aware of basic SnapMirror limitations before creating a data protection relationship.

- A destination volume can have only one source volume.

  A source volume can have multiple destination volumes. The destination volume can be the source volume for any type of SnapMirror replication relationship.

- Depending on the array model, you can fan out a maximum of eight or sixteen destination volumes from a single source volume. See the Hardware Universe to learn details for your specific configuration.
- You cannot restore files to the destination of a SnapMirror DR relationship.
- Source or destination SnapVault volumes cannot be 32-bit.
- The source volume for a SnapVault relationship should not be a FlexClone volume.

  The relationship will work, but the efficiency offered by FlexClone volumes will not be preserved.

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