NetApp

SnapMirror volume replication

ONTAP 9

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About SnapMirror volume replication

Traditionally, ONTAP replication technologies served the need for disaster recovery (DR) and data archiving. In ONTAP 9.3, these technologies were combined in a way that allows you to configure disaster recovery and archiving on the same destination volume.

Asynchronous SnapMirror disaster recovery basics

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.

Cluster and SVM peering

The figure below 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 two 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

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 copy of the source volume.
- Transfer the Snapshot copy and all the data blocks it references to the destination volume.
- Transfer the remaining, less recent Snapshot copies 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 copy of the source volume and transfers that Snapshot copy and any Snapshot copies 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 copy when SnapMirror updates the relationship.

- `MirrorAllSnapshots` has rules "sm_created" and "all_source_snapshots", indicating that both the Snapshot copy created by SnapMirror and any Snapshot copies 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: Asynchronous SnapMirror 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 copy created by SnapMirror is transferred at initialization and update.

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

SnapMirror Synchronous disaster recovery basics

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.

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

Supported features

The following features are supported for SnapMirror Synchronous technology in ONTAP 9.10.1; provided all nodes in the source and destination cluster are running ONTAP 9.10.1:

- NFSv4.2
- NVMe/TCP

In ONTAP 9.5 and later, SnapMirror Synchronous technology supports the NFSv3, FC, and iSCSI protocols over all networks for which the latency does not exceed 10ms.

The following features are supported for SnapMirror Synchronous technology in ONTAP 9.7:

- Replication of application-created Snapshot copies
  If a Snapshot copy 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 Snapshot copies, both user

created or those created with external scripts, after quiescing the applications. Scheduled Snapshot copies created using a Snapshot policy are not replicated. For more information about replicating application-created Snapshot copies, see the Knowledge Base article: How to replicate application created snapshots with SnapMirror Synchronous.

- FC-NVMe

- LUN clones and NVMe namespace clones
  LUN clones backed by application-created Snapshot copies are also supported.

The following features are supported for SnapMirror Synchronous technology in ONTAP 9.6; provided all nodes in the source and destination cluster are running ONTAP 9.6:

- SVM DR

  ◦ A SnapMirror Synchronous source can also be a SVM DR source, for example, a fan-out configuration with SM-S as one leg and SVM DR as the other.

  ◦ A SnapMirror Synchronous source cannot be an SVM DR destination because SM-S does not support cascading a DP source.
  You must release the synchronous relationship before performing an SVM DR flip resync in the destination cluster.

  ◦ A SnapMirror Synchronous destination cannot be an SVM DR source because SVM DR does not support replication of DP volumes.
  A flip resync of the synchronous source would result in the SVM DR excluding the DP volume in the destination cluster.

- NFSv4.0 and NFSv4.1

- SMB 2.0 or later

- Mixed protocol access (NFSv3 and SMB)

- Antivirus on the primary volume of the SnapMirror Synchronous relationship

- Hard or soft quotas on the primary volume of the SnapMirror Synchronous relationship
  The quota rules are not replicated to the destination; therefore, the quota database is not replicated to the destination.

- FPolicy on the primary volume of the SnapMirror Synchronous relationship

- SnapMirror Synchronous mirror-mirror cascade
  The relationship from the destination volume of the SnapMirror Synchronous relationship must be an asynchronous SnapMirror relationship.

- Timestamp parity between source and destination volumes for NAS
  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.

- Removal of high metadata operation frequency limitation

- Security for sensitive data in-transit using TLS 1.2 encryption

- Clone autodelete

Unsupported features

The following features are not supported with Synchronous SnapMirror relationships:

- MetroCluster configurations

- SFMoD

- SFCoD

- VVol

- Mixed SAN and NAS access
  The primary volume of a SnapMirror Synchronous relationship can either serve NAS data or SAN data. Both SAN and NAS access from the primary volume of a SnapMirror Synchronous relationship is not supported.

- Mixed SAN and NVMe access
  LUNs and NVMe namespaces are not supported on the same volume or SVM.

- SnapLock volumes

- FlexGroup volumes

- FlexCache volumes

- SnapRestore

- DP_Optimized (DPO) systems

- Tape backup or restore using dump and SMTape on the destination volume

- Tape based restore to the source volume

- Throughput floor (QoS Min) for source volumes

- In a fan-out configuration, only one relationship can be a SnapMirror Synchronous relationship; all the other relationships from the source volume must be asynchronous SnapMirror relationships.

- Global throttling

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 for ONTAP 9.11.1

About workloads supported by 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.
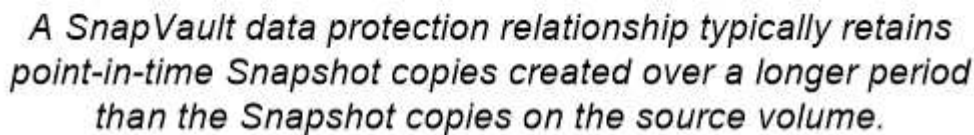
Related information
SnapMirror Synchronous Configuration and Best Practices

Vault archiving using 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 copy replication for standards compliance and other governance-related purposes. In contrast to a SnapMirror relationship, in which the destination usually contains only the Snapshot copies currently in the source volume, a vault destination typically retains point-in-time Snapshot copies created over a much longer period.

You might want to keep monthly Snapshot copies 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 copy 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 Snapshot copies 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 Snapshot copies 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 Snapshot copies 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 copy when SnapMirror updates the relationship.
- `XDPDefault` has rules "daily" and "weekly", indicating that all Snapshot copies 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 -
-
```

SnapMirror unified replication basics

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 copy 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 Snapshot copies in the baseline.

How unified data protection relationships are updated

At each update under the `MirrorAndVault` policy, SnapMirror creates a Snapshot copy of the source volume and transfers that Snapshot copy and any Snapshot copies 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 copy when SnapMirror updates the relationship.

- `MirrorAndVault` has rules "sm_created", "daily", and "weekly", indicating that both the Snapshot copy created by SnapMirror and the Snapshot copies 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 Synchronous SnapMirror 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 Snapshot copies 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 copy created by SnapMirror at initialization. At each update, SnapMirror creates another Snapshot copy of the source and transfers that Snapshot copy and any new Snapshot copies that have labels matching the labels defined in the Snapshot policy rules.

You can protect against the possibility that an updated Snapshot copy is corrupted by creating a copy of the last transferred Snapshot copy 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 Snapshot copies of database transaction logs, for example.

XDP replaces DP as the SnapMirror default

Beginning with ONTAP 9.3, SnapMirror extended data protection (XDP) mode replaces SnapMirror data protection (DP) mode as the SnapMirror default.

Until ONTAP 9.3, SnapMirror invoked in DP mode and SnapMirror invoked in XDP mode used different replication engines, with different approaches to version-dependence:

- SnapMirror invoked in DP mode used a *version-dependent* replication engine in which the ONTAP version was required to be the same on primary and secondary storage:

```
cluster_dst::> snapmirror create -type DP -source-path ... -destination
-path ...
```

- SnapMirror invoked in XDP mode used a *version-flexible* replication engine that supported different ONTAP versions on primary and secondary storage:

```
cluster_dst::> snapmirror create -type XDP -source-path ...
-destination-path ...
```

With improvements in performance, the significant benefits of version-flexible SnapMirror outweigh the slight advantage in replication throughput obtained with version-dependent mode. For this reason, beginning with ONTAP 9.3, XDP mode has been made the new default, and any invocations of DP mode on the command line or in new or existing scripts are automatically converted to XDP mode.

Existing relationships are not affected. If a relationship is already of type DP, it will continue to be of type DP. Beginning with ONTAP 9.5, MirrorAndVault is the new default policy when no data protection mode is specified or when XDP mode is specified as the relationship type. The table below shows the behavior you can expect.

If you specify…	The type is…	The default policy (if you do not specify a policy) is…
DP	XDP	MirrorAllSnapshots (SnapMirror DR)
Nothing	XDP	MirrorAndVault (unified replication)
XDP	XDP	MirrorAndVault (unified replication)

As the table shows, the default policies assigned to XDP in different circumstances ensure that the conversion maintains the functional equivalence of the old types. Of course, you can use different policies as needed, including policies for unified replication:

If you specify…	And the policy is…	The result is…
DP	MirrorAllSnapshots	SnapMirror DR
	XDPDefault	SnapVault
	MirrorAndVault	Unified replication
XDP	MirrorAllSnapshots	SnapMirror DR
	XDPDefault	SnapVault
	MirrorAndVault	Unified replication

The only exceptions to conversion are as follows:

- SVM data protection relationships continue to default to DP mode in ONTAP 9.3 and earlier.

  Beginning with ONTAP 9.4, SVM data protection relationships default to XDP mode.

- Root volume load-sharing data protection relationships continue to default to DP mode.
- SnapLock data protection relationships continue to default to DP mode in ONTAP 9.4 and earlier.

  Beginning with ONTAP 9.5, SnapLock data protection relationships default to XDP mode.

- Explicit invocations of DP continue to default to DP mode if you set the following cluster-wide option:

```
options replication.create_data_protection_rels.enable on
```

  This option is ignored if you do not explicitly invoke DP.

When a 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:

- FAS2220, default DP volume max-autosize = 60TB
- FAS6220, default DP volume max-autosize = 70TB
- FAS8200, default DP volume max-autosize = 100TB

For more information, see NetApp Hardware Universe.

Fan-out and cascade data protection 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; however, SnapMirror Synchronous relationships (supported beginning with ONTAP 9.5) support only fan-out deployments with one or more asynchronous SnapMirror relationships and do not support cascade deployments. Only one relationship in the fan-out configuration can be a SnapMirror Synchronous relationship, all the other relationships from the source volume must be asynchronous SnapMirror relationships. SnapMirror Business Continuity (supported beginning with ONTAP 9.8) 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 asynchronous SnapMirror 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.

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, beginning with ONTAP 9.2, 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.

- (Beginning with ONTAP 9.2) 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.

Further Reading
- Resume protection in a fan-out configuration with SM-BC

SnapMirror licensing

SnapMirror licensing overview

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. Users can now purchase a SnapMirror license to support ONTAP replication for both backup and disaster recovery use cases.

Prior to the ONTAP 9.3 release, two licenses were available to support different replication use cases. A SnapVault license was needed to configure *vault* relationships between ONTAP instances, where the DP instance could retain a higher number of Snapshot copies to support backup use cases where retention times are longer. A SnapMirror license was needed to configure *mirror* relationships between ONTAP instances, where each ONTAP instance would maintain the same number of snapshot copies (that is, a *mirror* image) to support disaster recovery use cases where cluster failovers would be possible. Both SnapMirror and SnapVault licenses can continue to be used and supported for ONTAP 8.x and 9.x releases.

SnapVault licenses continue to function and are supported for both ONTAP 8.x and 9.x releases, but they are no longer being sold. The SnapMirror license continues to be available and can be used in place of SnapVault 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 Data Protection bundle which you can purchase for your ONTAP clusters. The Data Protection bundle price is based on the raw capacity of the cluster.

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 enabled with either the Premium bundle or the Data Protection bundle.

  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 Snapshot copies 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. ONTAP 9.8 approved object storage targets include ONTAP S3, StorageGRID, AWS S3 Standard, S3 Standard-IA, and S3 One Zone-IA, Microsoft Azure Blob Premium, Hot and Cool, and GCP Standard and Nearline storage.

SnapMirror Cloud is not available as a standalone license and is available only with purchase of the Hybrid Cloud Bundle. Hybrid Cloud Bundle is a term-based subscription license that is priced based on capacity. Only one license is needed per ONTAP cluster. Capacity is defined as the "used" capacity (not raw capacity) within any volume which is protected by SnapMirror Cloud. Users will purchase this license based on the total used capacity of volumes on the cluster being backed up by SnapMirror Cloud. As of October 2021, the Hybrid Cloud Bundle includes only a SnapMirror Cloud license (previously Hybrid Cloud Bundle included a FabricPool license, which was removed from the bundle effective October 2021). In addition to SnapMirror Cloud, the async SnapMirror license is also required and is available only with the purchase of the Data Protection Bundle.

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

- Both a SnapMirror license (purchased through Data Protection Bundle, or through Premium Bundle) and a SnapMirror Cloud license (purchased through Hybrid Cloud Bundle) are needed 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.

SnapMirror Cloud is an end user license which can be purchased from NetApp or from an approved NetApp reseller partner. The SnapMirror Cloud license provides end user entitlement but does not enable asynchronous ONTAP to object storage replication. To invoke ONTAP APIs for SnapMirror Cloud, a unique API key from an authorized application is required. Authorized and licensed applications used to orchestrate SnapMirror Cloud replication include System Manager, and are also available from multiple third-party application providers. These authorized applications will embed the unique API key to invoke ONTAP APIs. A combination of the SnapMirror Cloud end user license and an authorized third-party backup application is required to orchestrate and enable SnapMirror Cloud replication.

Beginning with ONTAP 9.9.1, you can use System Manager for SnapMirror Cloud replication. For more information, see Back up to the cloud.

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

Data Protection Optimized (DPO)

Beginning with ONTAP 9.1, new ONTAP data protection features were packaged with the FAS8200 as part of a solution called the Data Protection Bundle. This new hardware and software bundle included a new DP_Optimized (DPO) license that provided unique ONTAP features for secondary workloads. With the introduction of ONTAP 9.3 the DPO license increased the number of volumes per node from 1,000 to 1,500. Also introduced with ONTAP 9.3 were new configurations of the Data Protection Bundle based on configurations of FAS2620.

The DPO license was specifically designed for ONTAP clusters that were to be dedicated as secondary targets for SnapMirror replication. In addition to increasing the maximum volumes per node on the DPO controller, the DPO license also modified controller QoS settings to support greater replication traffic at the expense of application I/O. For this reason, the DPO license should never be installed on a cluster that supports application I/O, as application performance would be impacted. Later, Data Protection Bundles based on the FAS8200 and FAS2620 were offered as a solution and included programmatic free licenses based on the customer environment. When purchasing the solution bundles, free SnapMirror licenses would be provided for select older clusters which replicated to the DPO secondary. While the DPO license is needed on the Data Protection solution cluster, primary clusters from the following platform list would be provided free SnapMirror licenses. Primary clusters not included in this list would require purchase of SnapMirror licenses. The DPO hardware and software bundle was based on both FAS2620 and FAS8200 systems which are both EOA status and no are longer available.

- FAS2200 Series
- FAS3000 Series
- FAS6000 Series
- FAS8000 Series

Data Protection Optimized (DPO) License

Data Protection hardware and software solution bundles introduced with ONTAP 9.1 and 9.3 were based on FAS8200 and FAS2620 only. As these platforms matured and new platforms were introduced new requests to support ONTAP features for secondary replication use cases increased. As a result, a new standalone DPO license was introduced in November 2018 with the ONTAP 9.5 release.

The standalone DPO license was supported on both FAS and AFF platforms and could be purchased pre-configured with new clusters or added to deployed clusters as a software upgrade in the field. Because these new DPO licenses were not part of a hardware and software solution bundle, they carried a lower price, and free SnapMirror licenses for primary clusters were not provided. Secondary clusters configured with the a la carte DPO license must also purchase a SnapMirror license, and all primary clusters replicating to the DPO secondary cluster must purchase a SnapMirror license.

Additional ONTAP features were delivered with the DPO across multiple ONTAP releases.

Feature	9.3	9.4	9.5	9.6	9.7+
Max vols/node	1500	1500	1500	1500/2500	1500/2500

Max concurrent repl sessions	100	200	200	200	200
Workload bias*	client apps	Apps/SM	SnapMirror	SnapMirror	SnapMirror
Cross volume aggregate deduplication for HDD	No	Yes	Yes	Yes	Yes

- Details about priority for the SnapMirror backoff (workload bias) feature:
- Client: cluster I/O priority is set to client workloads (production apps), not SnapMirror traffic.
- Equality: SnapMirror replication requests have equal priority to I/O for production apps.
- SnapMirror: all SnapMirror I/O requests have higher priority that I/O for production apps.

Table 1: Max FlexVolumes per node across ONTAP releases

	9.3—9.5 Without DPO	9.3—9.5 With DPO	9.6 Without DPO	9.6 With DPO	9.7—9.9.1 Without DPO	9.7—9..9.1 With DPO
FAS2620	1000	1500	1000	1500	1000	1500
FAS2650	1000	1500	1000	1500	1000	1500
FAS2720	1000	1500	1000	1500	1000	1500
FAS2750	1000	1500	1000	1500	1000	1500
A200	1000	1500	1000	1500	1000	1500
A220	1000	1500	1000	1500	1000	1500
FAS8200/8300	1000	1500	1000	2500	1000	2500
A300	1000	1500	1000	2500	2500	2500
A400	1000	1500	1000	2500	2500	2500
FAS8700/9000	1000	1500	1000	2500	1000	2500
A700	1000	1500	1000	2500	2500	2500
A700s	1000	1500	1000	2500	2500	2500

A800	1000	1500	1000	2500	2500	2500

For the latest maximum FlexVol volume support for your configuration, see Hardware Universe.

Considerations for all new DPO installations

- After it is enabled, the DPO license feature cannot be disabled or undone.
- Installation of the DPO license requires a re-boot of ONTAP or failover to enable.
- The DPO solution is intended for secondary storage workloads; application workload performance on DPO clusters may be impacted
- The DPO license is supported on a select list of NetApp storage platform models.
- DPO features vary by ONTAP release. Refer to the compatibility table for reference.
- New FAS and AFF systems are not qualified with DPO. DPO licenses cannot be purchased for clusters not listed above.

Install a SnapMirror Cloud license

Beginning with ONTAP 9.8, SnapMirror Cloud provides asynchronous snapshot replication from ONTAP to object storage endpoints. SnapMirror Cloud relationships can only be configured using pre-qualified third-party backup applications. To configure ONTAP to object storage replication, both SnapMirror and SnapMirror Cloud licenses are required on the ONTAP source cluster configured for replication to the object store endpoint.

About this task

The SnapMirror Cloud license is a single-instance cluster-wide license, which means it does not need to be installed on every node in the cluster. It is a term-based license where both term and backup capacity are enforced. In addition to this end user license, SnapMirror Cloud requires an authorized and approved backup application to configure and invoke ONTAP APIs for replication. Both SnapMirror Cloud end user license and authorized app are necessary to utilize SnapMirror Cloud replication.

SnapMirror Cloud licenses are acquired through purchase of the Hybrid Cloud Bundle, which can be purchased with 1 or 3 year terms in 1 TB increments. The Hybrid Cloud Bundle includes a license for SnapMirror Cloud. Each license has a unique serial number. Purchases of the Hybrid Cloud Bundle are based on capacity, where the purchased capacity of the Hybrid Cloud Bundle is applied to the SnapMirror Cloud license.

The SnapMirror Cloud license can be installed on the cluster using the ONTAP command line or System Manager.

Steps

1. Download two NetApp License File (NLF) for SnapMirror Cloud from the NetApp Support Site.

   NetApp Support

2. Use System Manager to upload the SnapMirror Cloud NLF file to the cluster:
   a. Click **Configuration** > **Licenses**.
   b. In the **Cluster Settings** pane, click **Licenses**.

c. In the **Packages** window, click **Add**.

d. In the **Add License Packages** dialog box, click **Choose Files** to select the NLF you downloaded, and then click **Add** to upload the file to the cluster.

Related information

[NetApp Software License Search](#)

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, cross-volume inline 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.

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

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

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