E-Series

NetApp® E-Series Storage Systems

Mirroring Feature Guide

Contents

About this guide

The information in this guide provides the conceptual framework necessary to understand the Mirroring Features used with SANtricity Storage Manager Version 11.10. To access this software, go to the NetApp Support Site at *support.netapp.com*.

Some software features described in this document might not be available for your NetApp E-Series Storage System. For questions about available features, contact your NetApp account representative.

Note: The SANtricity Storage Manager software is also referred to as the storage management software.

Mirroring features

This document provides a functional overview of the Asynchronous Mirroring feature and the Synchronous Mirroring feature.

Features activation

Like other features, you must enable the Asynchronous Mirroring feature and the Synchronous Mirroring feature by purchasing a feature key file for each mirroring feature that you want to use and applying the key through the features dialog. You must enable the feature on both the primary storage array and the remote storage array. Unlike other features, you must activate the mirroring feature after you enable it.

Contact technical support to purchase a feature key file.

About the mirroring features

The Asynchronous Mirroring feature and the Synchronous Mirroring feature are for online, real-time replication of data between two storage arrays in separate locations.

With Asynchronous Mirroring or Synchronous Mirroring, you can create mirrored pairs to copy data from one storage array to another storage array to protect against local or wide area disasters, or centrally back up your data at a remote location.

The mirrored volume pair is created from two volumes, which are logical structures that are created on a storage array for data storage. The pair consists of a primary volume at a local storage array and a secondary volume at a remote storage array.

If a disaster occurs, or if there is a catastrophic failure in the local storage array, you can promote the secondary volume in the remote storage array to the role of primary volume to take over responsibility for maintaining computer operations.

Related concepts

How does asynchronous mirroring differ from synchronous mirroring?

The Storage Management Software provides two types of mirror methods:

- Asynchronous Mirroring is a remote point-in-time replication method.

- Synchronous Mirroring is a continuous remote replication method for mirrored volumes and co-exists with the Asynchronous Mirroring feature.
  The Synchronous Mirroring feature includes an asynchronous write mode, which is different from the Asynchronous Mirroring feature. With the asynchronous write mode, host write requests that are written to the primary volume are copied to the secondary volume on the remote storage array on a periodic basis, whereas the Asynchronous Mirroring feature captures the differences between the current point-in-time image and the previous one and copies them to the remote storage array.

When you upgrade to a release that supports both mirror features, the Synchronous Mirroring configurations and the new Asynchronous Mirroring configurations are unaffected and continue to operate normally.

Note: The asynchronous write mode previously available in the legacy Synchronous Mirroring feature is only supported on the E2600 controller and the E5400 controller. It is not supported on later controller models. The new Asynchronous Mirroring feature is the preferred method to use to achieve the asynchronous write mode when mirroring.

Differences between mirroring features

Asynchronous Mirroring differs from Synchronous Mirroring in one essential way: it captures the state of the source volume at a particular point in time and copies just the data that has changed since the last image capture.

- With Asynchronous Mirroring, the remote storage array is not fully synchronized with the local storage array, so if the application needs to transition to the remote storage array due to a loss of the local storage array, some transactions could be lost.

- With Synchronous Mirroring the state of the source volume is not captured at some point in time, but rather reflects all changes that were made on the source volume to the target volume. The copy is identical to production data at every moment because, with this type of mirror, each time a write is done to the production volume, a write is done to the remote volume. The host does not receive an acknowledgment that the write was successful until the remote volume is successfully updated with the changes that were made on the production volume.

Comparison between mirroring features

Asynchronous Mirroring	Synchronous Mirroring
Replication Method	
• **Point-in-Time** Mirroring is done on demand or automatically according to a user-defined schedule. Schedules can be defined at the granularity of minutes.	• **Continuous** Mirroring is automatically executed continuously, copying data from every host write.
Repository	
• **Multiple** A repository is required for each mirrored pair.	• **Single** Single repository for all mirrored volumes.
Synchronization	
• **Writes Only Changed Data** Differences between the current point-in-time image and the previous one are copied to the remote storage array.	• **Writes All Data** All writes captured on the primary volume are copied to the secondary volume.
Communication	
• **iSCSI and Fibre Channel** Supports iSCSI and Fibre Channel interfaces between storage arrays.	• **Fibre Channel** Supports only Fibre Channel interfaces between storage arrays.
Distance	
• **Unlimited** Support for virtually unlimited distances between the local storage array and the remote storage array, with the distance typically limited only by the capabilities of the network and the channel extension technology.	• **Restricted** Typically must be within about 10 km (6.2 miles), of the local storage array to meet the latency and application performance requirements.

Typical use scenarios

Asynchronous mirroring is ideal for satisfying the demand for non-stop operations and, in general, is far more network efficient for periodic processes, such as backup and archive.

Although Synchronous Mirroring is ideal for continuous replication between a small number of systems for business continuity purposes, it is not ideal for periodic processes such as backup and archive.

Reasons for using asynchronous mirroring

- Remote backup consolidation

- Wide area content distribution

- Long distance disaster recovery

- Backup of 24 x 7 application data

- Application development and testing on a point-in-time image of live data

- Application data replication to secondary site

Reasons for using synchronous mirroring

- Data center type environment for top-tier applications and data

- Protection of databases and other highly transactional applications

- Local and near-local disaster recovery; secondary data center in the same metro area

- Business continuity during scheduled maintenance of the primary storage array, with the secondary system acting as the primary system

Understanding Synchronous Mirroring write modes

The type of write mode that you chose when you create the remote mirror determines when the I/O completion indication is sent to the host software application, which signals that the data has successfully been copied to the secondary storage array. You can choose one of the following write modes.

- Synchronous Write Mode (Recommended)
  This write mode offers the best chance of full data recovery from the secondary storage array in the event of a disaster, at the expense of host I/O performance. When you select this write mode, any host write requests are written to the primary volume and then copied to the secondary volume. The controller sends an I/O completion indication to the host system after the copy has been successfully completed. This write mode is selected by default and is the recommended write mode.

- Asynchronous Write Mode
  This write mode offers faster host I/O performance, but it does not guarantee that the copy has been successfully completed before processing the next write request. When you select this write mode, host write requests are written to the primary volume. The controller sends an I/O completion indication back to the host system before the data has been successfully copied to the secondary storage array.

You can use consistency groups for Synchronous Mirroring. Consistency groups help ensure consistent remote copies of data from one or more applications for disaster recovery purposes. Mirrored volumes stay in sync and are recoverable in the event of an outage at the primary site. Synchronous Mirroring supports one consistency group per storage array.

Features of asynchronous mirroring

The features of asynchronous mirroring include the following:

- **Self-Consistent Data**: Data on the remote storage array is protected during the synchronization process so that writes to the remote storage array do not render the data unusable.

- **Minimizes Performance Impact**: Copying data from the local storage array to the remote storage array asynchronously decouples host I/O requests from the remote synchronization process, minimizing the performance impact to the hosts accessing the local storage array.

- **Schedule-Based or On-Demand Replication**: Enables a user-configurable schedule for automatic, interval-based replication of changes, or a manual (or scripted) user command.

- **Heterogeneous Protocol Environment**: Enables asynchronous mirroring of data between storage arrays that are different in terms of hardware type. For example, an E5400 controller can mirror with an E2600 controller as long as the mirroring implementations on the two storage arrays are compatible and both storage arrays support a common inter-controller communication channel, either Fibre Channel or iSCSI protocol.

- **Flexible Remote Communication Methods**: Allows the local and remote storage arrays to connect through a Fibre Channel fabric interface, iSCSI interface or both.

Related concepts

What is an asynchronous mirror group?

An asynchronous mirror group is a container that can house several mirrored pairs, which are synchronized as a coordinated data set to provide a consistent data set at the remote site. The asynchronous mirror group is associated with a local storage array and a remote storage array that are used for mirroring.

- The local storage array will be the primary side of the mirror group, while the remote storage array will be the secondary side of the mirror group.

- All volumes added to the mirror group on the local storage array will hold the primary role in the mirror relationship.

- All volumes added to the mirror group on the remote storage array will hold the secondary role in the mirror relationship.

- The types of volumes that might participate in a mirror relationship are a standard volumes and thin volumes. Snapshot volumes cannot participate.

Because applications might need to use more than one volume, asynchronous mirror groups allow multiple mirrored pairs to be synchronized and managed as a group. This ensures that all of the secondary volumes in the same mirror group are always synchronized to the exact same point in time.

You create an asynchronous mirror group to define the synchronization settings for all mirrored pairs within the mirror group. Each mirrored pair in an asynchronous mirror group share the same synchronization settings, primary and secondary role, and write mode.

What is an asynchronous mirrored pair and a mirror repository?

An asynchronous mirrored pair is comprised of two volumes, a primary volume and a secondary volume, that contain identical copies of the same data. The mirrored pair is a part of an asynchronous mirror group, which allows the mirrored pair to synchronize at the same time as any other mirrored pairs within the mirror group. Write operations are performed first to the primary volume and then to the secondary volume.

What kind of volumes can be used?

Standard volumes and thin volumes can be used for an asynchronous mirrored pair, however, the primary volume must be paired with a secondary volume that is the same volume type.

Operational differences when using thin volumes for Asynchronous Mirroring

The operational differences when using thin volumes are as follows:

- If an existing thin volume is used to complete an asynchronous mirrored pair by adding it to the secondary side of the asynchronous mirror group, that thin volume is re-initialized with a new repository. Only provisioned blocks on the primary side are transferred during the initial synchronization process.

- For thin volumes to be considered as valid primary volume or secondary volume candidates, Auto-Expansion must be enabled. Thin volumes with Auto-Expansion disabled are not shown as candidates for asynchronous mirroring.

- The provisioned capacity quota and growth alert thresholds can be changed only on the primary side of an asynchronous mirrored pair. Any changes to these parameters on the primary side are automatically propagated to the secondary side.

- Removing a thin volume from an asynchronous mirror group does not cause any changes to the parameters controlling its capacity expansion.

About mirror repository volumes

Special mirror repository volumes are used to manage mirror data synchronization. Mirror repository volumes are required for both the primary volume and the secondary volume in a mirrored pair.

A mirror repository stores three types of data.

1. The first is a repository used for preserving resynchronization images on the primary volume and recovery point images on the secondary volume.

2. The second type of data is a pair of delta logs that are used to track regions on the primary volume that are written between synchronization intervals. The delta logs are used only on the primary side of the mirrored pair, but they also must be allocated on the secondary side of the mirrored pair because a role-reversal can occur at any time.

3. The third type of data is a log that tracks synchronization statistics on a per mirrored pair basis.

What you need to know about Asynchronous Mirroring

This topic describes what you need to know before you start using asynchronous mirroring.

Using mirrored volume candidates and storage array mirrors

The following notes apply to mirrored volume candidates and storage array mirrors.

- RAID level, caching parameters, and segment size can be different on the two mirrored volumes.

- The secondary volume must be at least as large as the primary volume.

- A primary volume can be only a source volume in a volume copy. A secondary volume cannot be a source volume or a target volume unless a role reversal was initiated after the copy has completed. If a role reversal is initiated during a Copy in Progress status, the copy fails and cannot be restarted.

- A given volume may participate in only *one* mirror relationship.

- A volume participating in a copy request cannot be a mirrored secondary volume.

Note: Asynchronous mirroring is supported only in dual-controller hardware configurations.

Requirements for using Asynchronous Mirroring

Keep in mind the following requirements when using asynchronous mirroring.

- You must have two storage arrays.

- You must have write access to both storage arrays.

- You must have enough space on the remote site for the remote copy of production data.

- Mirror repository volumes are required for both the primary volume and the secondary volume in a mirrored pair.

- Inter-controller communication for the asynchronous mirroring feature uses the host-connected ports to initiate connections to the remote storage array and is only supported on controllers with Fibre Channel or iSCSI host-connect ports.

- SAS and InfiniBand are not supported as inter-array communication channels.

- The connection between the two storage arrays must be capable of transferring data at a rate that ensures that all data written to the collection of primary volumes in a 24-hour period can be copied to the secondary storage array within that same 24-hour period.

FC Connection and iSCSI connection requirements

- Fibre Channel Connection Requirements:

  - You must attach dedicated asynchronous mirroring ports to a Fibre Channel fabric environment. In addition, these ports must support the Name Service.

  - You can use a fabric configuration that is dedicated solely to the asynchronous mirroring ports on each controller. In this case, host systems can connect to the storage arrays using fabric.

  - Fibre Channel Arbitrated Loop (FC-AL), or point-to-point configurations are not allowed for inter-array connections. FC-AL/P2P is for host connections only. These configurations are independent of the dedicated asynchronous mirroring fabric.

  - The maximum distance between the local site and the remote site is 10 km (6.2 miles), using single-mode fibre gigabit interface converters (GBICs) and optical long-wave GBICs.

- iSCSI Connection Considerations:

  - iSCSI does not require dedicated asynchronous mirroring ports when using asynchronous mirroring.

  - The iSCSI inter-controller communication must use a host-connect port and not the management Ethernet port.

  - The controller maintains a list of the remote storage arrays to which the iSCSI initiator attempts to establish a session. The first port that successfully establishes an iSCSI connection is used for all subsequent communication with that remote storage array. If communication fails, a new session is attempted using all available ports.

- FC Connection and iSCSI Connection Considerations:

  - There is no failover from one channel to the other.

  - If both storage arrays are connected with both FC connections and iSCSI connections, one asynchronous mirror group may be mirrored over FC and the other asynchronous mirror group can be mirrored over iSCSI.

Additional notes on using Asynchronous Mirroring

Connectivity and Volume Ownership	The controller that owns the primary volume determines the current owner of the secondary volume. The primary volume and the secondary volume in a mirrored pair use the following ownership rules:
	• If the primary volume is owned by controller A on the primary side, the secondary volume is owned by controller A on the secondary side.
	• If the primary volume is owned by controller B on the primary side, the secondary volume is owned by controller B on the secondary side.
	• If primary controller A cannot communicate with secondary controller A, controller ownership changes do not take place. A primary controller attempts to communicate only with its matching controller in the secondary asynchronous mirror group.
	The next remote write processed automatically triggers a matching ownership change on the secondary side if one of these conditions exists:
	• When an I/O path error causes a volume ownership change on the primary side.
	• If the storage administrator changes the current owner of the primary volume. For example, a primary volume is owned by controller A, and then you change the controller owner to controller B. In this case, the next remote write changes the controller owner of the secondary volume from controller A to controller B. Because controller ownership changes on the secondary side are controlled by the primary side, they do not require any special intervention by the storage administrator.
Controller Resets and Storage Array Power Cycles	• Sometimes a remote write is interrupted by a controller reset or a storage array power cycle before it can be written to the secondary volume. The storage array controller does not need to perform a full synchronization of the mirrored pair in this case.
	• A controller reset causes a controller ownership change on the primary side from the preferred controller owner to the alternate controller in the storage array.
	• When a remote write has been interrupted during a controller reset, the new controller owner on the primary side reads information stored in a log file in the mirror repository volume of the preferred controller owner. The new controller owner then copies the affected data blocks from the primary volume to the secondary volume, eliminating the need for a full synchronization of the mirrored volumes.

Force to Primary in the Event of Disaster	• In the event of a disaster at the primary site, you can force the asynchronous mirror group on the secondary side to transition to the primary role. Then the recovery host is able to access the newly promoted group, and business operations can continue.
	• Forced promotion of the asynchronous mirror group on the secondary side causes all mirrored pairs in the group to function as primary volumes, allowing write access and tracking writes to resynchronize with the asynchronous mirror group on the secondary side.
	• Forced promotion of an asynchronous mirror group on the secondary side is allowed only if all mirrored pairs of the group had been previously synchronized and currently have snapshot images of a consistent data set.
	• If any mirrored pairs of the group were in the midst of the initial synchronization, then forced promotion is not allowed. If any mirrored pairs of the group do not have a point-in-time image of the consistency point (e.g. due to a full-repository error), the forced promotion is not allowed.

Features of Synchronous Mirroring

The features of Synchronous Mirroring include the following:

- Updates two distributed copies simultaneously.

- Mirrored volume pairs behave like one shared drive.

- Eliminates single points of failure.

- Replication is managed on a per-volume basis, so you can mirror individual volumes in a primary storage array to appropriate secondary volumes in several *different* remote storage arrays.

Related concepts

What you need to know about Synchronous Mirroring

This topic describes what you need to know before you start using Synchronous Mirroring.

Using mirrored volume candidates and storage array mirrors

The following notes apply to mirrored volume candidates and storage array mirrors.

- RAID level, caching parameters, and segment size can be different on the two mirrored volumes.

- The secondary volume must be at least as large as the primary volume.

- The only type of volume that may participate in a mirror relationship is a standard volume. Snapshot volumes cannot participate.

- You can create a snapshot volume by using either a primary volume or a secondary volume as the base volume.

- A primary volume can be a source volume or a target volume in a volume copy. A secondary volume cannot be a source volume or a target volume unless a role reversal was initiated after the copy has completed. If a role reversal is initiated during a Copy in Progress status, the copy fails and cannot be restarted.

- A given volume may participate in only *one* mirror relationship.

Connection requirements

Keep in mind the following connection requirements when using Synchronous Mirroring.

- You must attach dedicated Synchronous Mirroring ports to a Fibre Channel fabric environment. In addition, these ports must support the Directory Service interface and the Name Service.

- You can use a fabric configuration that is dedicated solely to the Synchronous Mirroring ports on each controller. In this case, host systems can connect to the storage arrays using fabric, Fibre Channel Arbitrated Loop (FC-AL), or point-to-point configurations. These configurations are totally independent of the dedicated Synchronous Mirroring fabric.

- Alternatively, you can use a single Fibre Channel fabric configuration for both the Synchronous Mirroring connectivity and for the host I/O paths to the controllers.

- The maximum distance between the primary site and the secondary site is 10 km (6.2 miles), using single-mode fiber gigabit interface converters (GBICs) and optical long-wave GBICs.

Additional notes on using Synchronous Mirroring

Journaling File Systems and Synchronous Mirroring	When you are using a journaling file system, you cannot gain read-only access to a remote volume. A journaling file system does not let you mount the remote volume in Windows (NTFS); however, you can mount the snapshot of the remote volume.

Connectivity and Volume Ownership	A primary controller attempts to communicate only with its matching controller in the secondary storage array. For example, controller A in the primary storage array attempts communication only with controller A in the secondary storage array. The controller (A or B) that owns the primary volume determines the current owner of the secondary volume. If the primary volume is owned by controller A on the primary side, the secondary volume is owned by controller A on the secondary side. If primary controller A cannot communicate with secondary controller A, controller ownership changes do not take place. The next remote write processed automatically triggers a matching ownership change on the secondary side if one of these conditions exists: • When an I/O path error causes a volume ownership change on the primary side • If the storage administrator changes the current owner of the primary volume For example, controller A owns a primary volume, and then you change the controller owner to controller B. In this case, the next remote write changes the controller owner of the secondary volume from controller A to controller B. Because controller ownership changes on the secondary side are controlled by the primary side, they do not require any special intervention by the storage administrator.
Controller Ownership/ Preferred Path	During a remote volume mirroring operation, the same controller must own both the primary volume and the secondary volume. If both volumes do not have the same preferred controller when a remote volume mirror starts, the ownership of the secondary volume is automatically transferred to the preferred controller of the primary volume. • When the remote volume mirror is deleted, ownership of the secondary volume is restored to its preferred controller. • If ownership of the primary volume is changed and there are host writes to the primary volume, ownership of the secondary volume is also changed.

Controller Resets and Storage Array Power Cycles	• Sometimes a controller reset or a storage array power cycle interrupts a remote write before it can be written to the secondary volume. The storage array controller does not need to perform a full synchronization of the mirrored volume pair in this case. • A controller reset causes a controller ownership change on the primary side from the preferred controller owner to the alternate controller in the storage array. • When a remote write has been interrupted during a controller reset, the new controller owner on the primary side reads information stored in a log file in the mirror repository volume of the preferred controller owner. The new controller owner then copies the affected data blocks from the primary volume to the secondary volume, which eliminates the need for a full synchronization of the mirrored volumes.
Link Interruptions or Secondary Volume Errors	• When processing write requests, the primary controller may be able to write to the primary volume, but a link interruption prevents communication with the remote secondary controller. • In this case, the remote write cannot complete to the secondary volume. The primary volume and the secondary volume are no longer appropriately mirrored. The primary controller changes the mirrored pair into Unsynchronized status and sends an I/O completion to the primary host. The primary host can continue to write to the primary volume, but remote writes do not take place. • When connectivity is restored between the current owner of the primary volume and the current owner of the secondary volume, re-synchronization takes place if you have selected the option to automatically resynchronize upon restoration of the link (You can also choose not to allow auto re-synchronization.) Only the blocks of data that have changed on the primary volume during the link interruption are copied to the secondary volume. The mirrored pair changes from an Unsynchronized state to Mirror Synchronization in Progress status. • The primary controller also marks the mirrored pair as Unsynchronized when a volume error on the secondary side prevents the remote write from completing. For example, an offline secondary volume or a failed secondary volume can cause the remote mirror to become unsynchronized. When the volume error is corrected (the secondary volume is placed online or is recovered to Optimal status), a full synchronization automatically begins. The mirrored pair then changes to Synchronization in Progress status.

Managing the mirror relationship between two volumes

Mirroring creates a set of consistent data that can be used by production applications in the event of problems with production volumes or for other purposes.

Mirroring, whether Synchronous Mirroring or Asynchronous Mirroring, requires two or more storage arrays. The source and target of the mirroring can reside on the same site and form a local mirror or they can reside on different sites and enable a disaster recovery plan.

A volume is assigned either a primary role or a secondary role when the mirror relationship is defined. By default, in a new mirror definition, the location of the primary volume designates the local storage array, and the secondary volume designates the remote storage array. A mirror relationship must have one primary volume and one secondary volume.

> **Attention: Possible loss of data access** – You cannot create a mirror relationship if the primary volume contains unreadable sectors. Furthermore, if an unreadable sector is discovered during a mirroring operation, the mirror status changes to Unsynchronized.

Related concepts

About primary volumes and secondary volumes in a mirror relationship

Before you can use either Asynchronous Mirroring or Synchronous Mirroring feature, you must enable and activate the mirroring feature that you intend to use on both the local storage array and the remote storage array. If a volume does not exist on either the local storage array or the remote storage array, you must create the volumes. Both the local storage array and the remote storage array show the primary volume and the secondary volume.

When both the primary volume and the secondary volume are available, you can create a mirrored pair. When the remote mirrored volume is first created, a full synchronization automatically occurs. The data from the primary volume is copied completely to the secondary volume.

Related concepts

Prerequisites for creating a mirror relationship between two volumes

Make sure that the following prerequisites have been met before you create a mirror relationship between two storage arrays.

Asynchronous Mirroring

- The Asynchronous Mirroring feature must be enabled and activated on the local and remote storage arrays that is used for mirroring.

- The local storage array and the remote storage array must be connected through a proper Fibre Channel fabric or iSCSI interface.

- The remote storage array must contain a volume that has a capacity that is greater than or equal to the capacity of the mirrored volume that is to be used as the primary volume on the local storage array.

- You can protect your mirror group with Full Disk Encryption (FDE), but the drive attributes must match on both the primary volume on the local storage array and the secondary volume on the remote storage array regardless of whether FDE is enabled or disabled.

- The primary volume on the local storage array must match the Data Assurance (DA) settings as the secondary volume on the remote storage array.

- Make sure that you know the password for the local storage array and remote storage array.

Synchronous Mirroring

- The Synchronous Mirroring feature has been activated.

- The local storage array contains two mirror repository volumes.

- The local storage array contains the primary volume, and the remote storage array contains the secondary volume. If either volume does not exist, you must create it before you can create the remote volume mirror.

- The secondary volume meets these requirements:

  ◦ The local storage array and the remote storage array must be connected through a proper Fibre Channel fabric interface.

  ◦ The secondary volume on the remote storage array must match the Data Assurance (DA) settings as the primary volume on the local storage array.

  ◦ The Full Disk Encryption (FDE) settings on the secondary volume can be different from the FDE settings on the primary volume.

  ◦ The RAID level of the secondary volume can be different from the RAID level of the primary volume.

  ◦ The capacity of the secondary volume must be equal to or greater than the capacity of the primary volume.

About mirror repository volumes

For the Asynchronous Mirroring feature, a mirror repository volume is required for both the primary volume and the secondary volume in a mirrored pair. The Synchronous Mirroring feature requires two mirror repositories, one for each controller, which are created during activation and then used for all Synchronous Mirroring relationships. The controller stores mirroring information on the mirror repository volume, which includes information about remote writes that are not yet complete. You can use this information to recover from controller resets and the accidental shutting down of storage arrays.

Mirror repository volume details

- You can create the mirror repository volume from the unconfigured free capacity of a volume group or a disk pool.

- You can create a new volume group or a new disk pool and its member mirror repository volume from the unconfigured free capacity of the storage array.

- The Synchronous Mirroring activation process creates two mirror repository volumes with equal capacity. The default capacity for the mirror repository volumes is 128 MB. You can neither increase the capacity nor decrease the capacity.

- When you activate the Synchronous Mirroring feature and create the volume group and mirror repository volumes from the unconfigured free capacity of the storage array, you select the RAID level. However, when you create the mirror repository volumes from an existing storage array, you do not select the RAID level.

- For Asynchronous Mirroring, the minimum mirror repository size is the minimum of 0.02 percent of the base volume capacity or 32 MB; the maximum mirror repository size is 101 percent of the base volume capacity.

- For Asynchronous Mirroring, primary and secondary mirror repository volumes are not required to be the same size. Mirror repository volumes can be created on separate volume groups with different RAID levels. However, mirror repository volumes must have compatible security and data assurance and quality of service of the associated mirrored volume.

  Attention: Potential loss of data – Because the data stored on the mirror repository volumes is critical, do not create mirror repository volumes in an existing volume group that has RAID Level 0. If you create a new volume group for the mirror repository volumes, do not select RAID Level 0.

Resynchronizing volumes in a mirror relationship

This section describes the methods for re-synchronizing data in Asynchronous Mirroring and in Synchronous Mirroring. You might need to periodically test the communication between the primary storage array and the local storage array before resynchronizing the data.

Note: The Manual Resynchronization option is the recommended method because it lets you manage the resynchronization process in a way that provides best opportunity for recovering data.

Asynchronous Mirroring resynchronization

The following describes the Asynchronous Mirroring resynchronization methods.

- **Manual**
  Manual resynchronization means that you can manually start resynchronization of the data on all of the mirrored pairs within the asynchronous mirror group
  If a communication failure occurs between the primary volume and the secondary volume of the mirrored pairs, at least one of the mirrored pairs within the asynchronous mirror group is in a Stopped or Failed status and the asynchronous mirror group is in an Internally-Suspended state. Any write requests to the primary volume of the mirrored pairs are logged, and a Needs Attention status appears for the storage array.
  After the controller owner of the primary volume detects that communication has been restored, you must recover all the mirrored pairs that are in a in a Stopped or Failed status within the asynchronous mirror group and then resume the Internally-Suspended asynchronous mirror group.

- **Automatic**
  Automatic resynchronization means that resynchronization of the data is handled automatically based on user-configurable synchronization settings (interval-based) that were set up when creating the asynchronous mirror group.
  If a communication failure occurs between the local storage array and the remote storage array, the volumes on the remote storage array become inaccessible. After the controller owner on the primary storage array detects that communication has been restored, it automatically re-starts the synchronization process.

Synchronous Mirroring resynchronization

The following describes the Synchronous Mirroring resynchronization methods.

- **Manual**

Manual resynchronization means that you can manually start resynchronization of the data on the primary volume and the secondary volume after communication has been restored to the unsynchronized mirrored pair.

If a communication failure occurs between the primary volume and the secondary volume, the volumes on the remote storage array become inaccessible. After the controller owner of the primary volume detects that communication has been restored, the remote mirror stays in an Unsynchronized status until you resume the mirrored pair.

- **Automatic**

  When the Automatic Resynchronization option is selected and a communication failure occurs between the primary storage array and the local storage array, the controller owner of the primary volume starts resynchronizing the primary volume and the secondary volume. This action occurs immediately after the controller owner detects that communication has been restored for an Unsynchronized mirrored pair.

  When connectivity is restored between the current owner of the primary volume and the current owner of the secondary volume, only the blocks of data that have changed on the primary volume during the link interruption are copied to the secondary volume. The mirrored pair changes from an Unsynchronized state to Mirror Synchronization in Progress status.

  The primary controller also marks the mirrored pair as Unsynchronized when a volume error on the secondary side prevents the remote write from completing. For example, an offline secondary volume or a failed secondary volume can cause the remote mirror to become unsynchronized. When the volume error is corrected (the secondary volume is placed online or is recovered to Optimal status), a full synchronization automatically begins. The mirrored pair then changes to Synchronization in Progress status.

Reversing the roles in a mirror relationship

Asynchronous Mirroring

Use the **Change Role** option to perform a role reversal between asynchronous mirror groups. You can either promote the selected asynchronous mirror group to a primary role or demote the selected asynchronous mirror group to a secondary role.

- A suspended asynchronous mirror group resumes during the change role operation.

- The role reversal change affects all mirrored pairs within the selected asynchronous mirror group. For example, when a primary asynchronous mirror group is demoted to a secondary role, all the primary volumes of the mirrored pairs in that mirror group are also demoted to secondary volumes.

- If you are demoting a primary asynchronous mirror group to a secondary role and the current secondary asynchronous mirror group can be contacted, the secondary asynchronous mirror group is automatically promoted to a primary role in the mirror relationship. Likewise, if you are promoting a secondary asynchronous mirror group to a primary role and the current primary asynchronous mirror group can be contacted, the primary asynchronous mirror group is automatically demoted to a secondary role in the mirror relationship.

- You also can use the **Change Role** option during a Recovery Guru procedure for a dual primary Asynchronous Mirroring condition. To avoid the dual primary Asynchronous Mirroring condition and subsequent recovery steps, wait until the connection between the storage arrays is operational to perform the role reversal.

Synchronous Mirroring

If the primary volume in a remote volume mirror fails in a disaster situation, you can reverse the roles of the primary volume and the secondary volume to transfer the data back to the restored volume. Reversing the roles promotes the secondary volume to the role of primary volume and demotes the primary volume to the role of secondary volume in a remote volume mirror.

Note: Potential loss of data access – If you try to reverse roles between the secondary volume and the primary volume while a volume copy is in progress, the role reversal succeeds, but the volume copy fails and cannot be restarted.

Keep the following guidelines in mind when performing a role reversal between mirror groups:

- You cannot perform a volume copy on a secondary volume in a remote volume mirror. To create a volume copy of a secondary volume, you must reverse the roles of the secondary volume and the primary volume, and then perform the volume copy on the new primary volume.

- While a remote volume mirror is synchronizing, you cannot perform a volume copy on either the primary volume or the secondary volume.

Removing the mirror relationship between two volumes

Asynchronous Mirroring

Use the **Remove Mirrored Pair** option to remove the mirror relationship between the two volumes in an Asynchronous Mirroring relationship.

Removing an asynchronous mirrored pair from an asynchronous mirror group breaks the mirror relationship between the primary volume on the local storage array and the secondary volume on the remote storage array. Data on the volumes is not affected. As a result of this operation, the primary volume and the secondary volume become standard, host-accessible, non-mirrored volumes.

Keep these guidelines in mind when removing an asynchronous mirrored pair:

- This option is not available unless the asynchronous mirror group contains mirrored pairs.

- This option is available either by selecting the individual mirrored pair itself, or by selecting the associated asynchronous mirror group.

- The mirror relationship is first removed on the local storage array and then on the remote storage array. Sometimes, the mirror relationship is successfully removed on the local storage array but cannot be removed on the remote storage array because of a communication problem. In this case, an error message appears, which shows the following information:

  ◦ The name of the remote storage array with the orphaned mirrored pair

  ◦ The name of the volume
    To resolve the problem, open the Array Management Window for the remote storage array, select the orphaned mirrored pair, and remove the mirror relationship.

- Sometimes, the mirror relationship is successfully removed on the remote storage array, but not on the local storage array. In this case, the next synchronization operation from the primary volume to the secondary volume causes the synchronization process to pause. The Logical pane of the primary Array Management Window also shows an unresponsive remote secondary volume. Remove the mirror relationship on the local storage array to correct the problem.

Synchronous Mirroring

Use the **Remove Mirror Relationship** option to remove the mirror relationship between the two volumes in a Synchronous Mirroring relationship.

Keep these guidelines in mind when removing the mirror relationship between the two volumes.

- This option is not available unless defined mirror relationships exist on the storage array.

- This option does not delete the primary volume, secondary volume, or the mirror repository volumes that support Synchronous Mirroring for the storage arrays. Data on the volumes is not affected. As a result of this operation, the primary volume and the secondary volume become standard, host -accessible, non-mirrored volumes.

- This option is only available for the local volume (primary or secondary) that is present in the storage array that you are currently managing. This option is not available if you select a remote secondary volume in the Logical pane.

- The mirror relationship is first removed on the local storage array and on the remote storage array. Sometimes, the mirror relationship is successfully removed on the local storage array but cannot be removed on the remote storage array because of a communication problem. In this case, an error message appears, which shows the following information:

  ◦ The name of the remote storage array with the orphaned mirrored volume

  ◦ The name of the volume

  To resolve the problem, open the Array Management Window for the remote storage array, select the specified volume, and remove the mirror relationship.

  ◦ Sometimes, the mirror relationship was successfully removed on the secondary side, but not the primary side. In this case, the first I/O write to the primary volume causes the mirror state to change to Unsynchronized. The Logical pane of the primary Array Management Window also shows an unresponsive remote secondary. Remove the mirror relationship on the primary storage array to correct the problem.

  Attention: Do not remove a mirror relationship to back up a mirrored volume. To perform backups of either the primary volume or the secondary volume, suspend the remote volume mirror so that the mirror relationship is not broken or take a snapshot of the primary or secondary volume, and backup the snapshot.

Suspending a mirrored pair

Asynchronous Mirroring

Use the **Suspend** option to suspend data transfer between all mirrored pairs in an asynchronous mirror group without removing the mirror relationship.

The **Suspend** option lets you suspend the synchronization of data on all mirrored pairs at the asynchronous mirror group level. This option is more efficient than suspending mirrored pairs individually.

When an asynchronous mirror group is in a Suspended state, no attempt is made to copy data from the primary volumes to the secondary volumes of the mirrored pairs. Any writes to the primary side of the asynchronous mirror group are persistently logged in its associated mirror repository volumes. After the asynchronous mirror group is resumed, only the modified regions of the primary volumes are written to the secondary volumes.

  Note: The **Suspend Asynchronous Mirror Group** option is available on the local storage array only. This option is not available on the remote storage array.

Keep these guidelines in mind when you suspend an asynchronous mirror group:

- Any data that is written to the primary side of the asynchronous mirror group is logged while the mirror group is suspended and is written automatically to the secondary side of the asynchronous mirror group when the mirror group is resumed. A full synchronization is not required.

- The state of the asynchronous mirror group and mirrored pairs stays suspended until you use the **Resume** option to resume synchronization activity.

Synchronous Mirroring

Use the **Suspend** option to suspend data transfer between a primary volume and a secondary volume that are participating in Synchronous Mirroring without removing the mirror relationship.

The Suspend option lets you control when the data on the primary volume and the secondary volume should be synchronized. This option helps to reduce any performance impact to the host application that might occur while any changed data on the primary volume is copied to the secondary volume.

When a remote mirror is in a Suspended status, no attempt is made to contact the secondary volume. Any writes to the primary volume are persistently logged in the mirror repository volumes. After the mirrored pair is resumed, only the modified regions of the primary volume are written to the secondary volume.

> **Attention: Possible loss of data access** – If the selected mirrored pair is part of a write consistency mode group, you will automatically suspend all mirrored pairs in the write consistency mode group. Use the command line interface to resume single write-consistent mirrored pairs.

Keep these guidelines in mind when you suspend a mirrored pair:

- Any data that is written to the primary volume will be logged while the mirrored pair is suspended, and will be written automatically to the secondary volume when Synchronous Mirroring is resumed. A full synchronization is not required.

- The state of the remote mirror stays suspended until you use the **Resume Mirrored Pair** option to resume synchronization activity.

Resuming a mirrored pair

Asynchronous Mirroring

Use the **Resume Asynchronous Mirror Group** option to resume data transfer between all mirrored pairs in an asynchronous mirror group. Data written to the primary volumes while the asynchronous mirror group was suspended is written to the secondary volumes immediately. Periodic synchronization resumes if an automatic synchronization interval has been set.The **Resume Asynchronous Mirror Group** option enables you to resume synchronization of data for all mirrored pairs at the asynchronous mirror group level. After an asynchronous mirror group is resumed, only the modified regions of the primary volumes are written to the secondary volumes.

The **Resume Asynchronous Mirror Group** option is available on the local storage array only. This option is not available on the remote storage array.

Synchronous Mirroring

Use the **Resume Synchronous Mirroring** dialog to resume data transfer between a primary volume and a secondary volume participating in Synchronous Mirroring, after the mirror has been suspended or unsynchronized. When a remote volume mirror is suspended, data continues to be written to the primary volume, but the data is not written to the secondary volume. Writes to the primary volume are persistently logged in to the mirror repository volumes

After communications are restored in a remote volume mirror, data transfer between the primary volume and the secondary volume must be resynchronized. After the remote volume mirror resumes, data is automatically written to the secondary volume. Only the regions of the primary volume that changed since the mirrored pair was suspended are written to the secondary volume.

Using other features with mirroring

You can use the Mirroring features with the following features that are enabled and active on the primary storage array.

- **SANshare® Storage Partitioning**

- **Snapshot Volume**

- **Volume Copy**

- **Dynamic Volume Expansion (DVE)**

Related concepts

Using the SANshare storage partitioning feature with Synchronous Mirroring

The SANshare Storage Partitioning feature lets hosts share access to volumes in a storage array. A storage partition is created when you define a collection of hosts (a host group) or a single host and then define a volume-to-logical unit number (LUN) mapping. This mapping lets you define which host group or host will have access to a particular volume in the storage array.

The storage partition definitions for the local storage array and the remote storage array are independent of each other. If these definitions are put in place while the secondary volume is in a secondary role, it reduces the administrative effort that is associated with site recovery if it becomes necessary to promote the volume to a primary role.

Using the Volume Copy feature with mirroring

The Volume Copy feature copies data from a source volume to a target volume within the same storage array.

> **Attention: Potential loss of data access** – If a role reversal is started while a volume copy is in progress, the volume copy fails and cannot be restarted.

- For Synchronous Mirroring, a primary volume in a remote volume mirror can be either a source volume or a target volume in a volume copy. For Asynchronous Mirroring, a primary volume in a remote volume mirror can only be a source volume in a volume copy.

- You can create a volume copy on the primary volume in a mirrored pair, but you cannot create a volume copy on a secondary volume in a mirrored pair. You can make a copy of a secondary volume in two ways:

  ◦ Promote the secondary volume to the role of primary volume.

  ◦ Create a snapshot volume of the secondary volume, and then perform a volume copy on the snapshot volume.

Using the Dynamic Volume Expansion feature with mirroring

Dynamic Volume Expansion (DVE) increases the capacity of a volume. The increased capacity is achieved by using the free capacity that is available on the volume group of the standard volume or the snapshot repository volume. The new usable mirror capacity is limited by the smaller of the primary volume and secondary volume of the mirrored pair.

Performing a DVE operation does not interrupt access to data on volume groups, volumes, or drives.

You can perform a DVE operation on a primary volume or a secondary volume of a mirrored pair. However, you cannot perform a DVE operation on a mirror repository volume.

> **Note:** To perform a DVE operation, the remote volume mirror must be in an Optimal status. The Properties pane in Logical view shows the status of a volume.

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