

Dell EMC Unity: Replication Technologies

A detailed review

Abstract

This white paper explains the replication solutions for Dell EMC™ Unity systems. This paper outlines the native and non-native options available for replicating data. It also includes information on managing replication, and the benefits that replication provides.

Native file synchronous replication is covered separately in the *Dell EMC Unity: MetroSync* white paper which can be found on Dell EMC Online Support.

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Executive summary

Data is often one of the most valuable assets to an organization. It is being accessed constantly by the various applications, users, and sometimes directly by customers of the organization. This makes data a crucial part of the day to day operations of an organization. Outages can happen at any time, and can be restricted to a single system, or an entire data center or location. Whether they are planned outages, such as regular maintenance, or unplanned such as a power outage, ensuring that data critical to the organization is available at all times is a top priority. A business continuity plan for critical data is suggested to prevent costly outages. To protect against the different scenarios, an organization should plan and implement a data protection strategy. A data replication solution can ensure business continuity, high availability, and data protection. Dell EMC Unity™ provides native and non-native solutions that will help you protect your data and meet the goals of your business for both data availability and protection.

Dell EMC Unity systems provide synchronous and asynchronous replication solutions which allow you to replicate data locally within the same system, or to other systems, whether they are located at the same site or a remote facility. Having remote replicas of data protects you against outages on the main system and allows you to recover quickly and easily on a destination system with minimal to no data loss depending on the replication method selected.

This white paper describes the following replication technologies for Dell EMC Unity:

- Native Synchronous Block Replication
- Native Asynchronous Block and File Replication
- Dell EMC® RecoverPoint®

Dell EMC Unity also supports native file synchronous replication. For information on native file synchronous replication as well as MetroSync Manager, reference the Dell EMC Unity: MetroSync white paper on Dell EMC Online Support.

Synchronous Block Replication, Asynchronous Block and File Replication, and Manual Replication can easily be configured and managed in Unisphere, Unisphere CLI, or REST API. Unisphere is a simple and intuitive HTML5 web-based interface which not only allows users to configure and manage their replication setup, but also provides a visual representation of the configuration.

Dell EMC RecoverPoint is an appliance-based product providing an alternative solution for Block Replication for Dell EMC Unity systems. Configuring RecoverPoint protection is done through the intuitive Unisphere for RecoverPoint interface. RecoverPoint allows for the recovery of data for any point-in-time and replicate to other supported Dell EMC storage systems.

Audience

This white paper is intended for Dell EMC customers, partners, and employees who are considering the use of Native Synchronous Block Replication, Native Asynchronous Block and File Replication, or RecoverPoint for the Dell EMC Unity family of storage systems. It assumes familiarity with Dell EMC Unity and Dell EMC's management software.

1 Introduction

To protect against outages which can interrupt data availability, it is crucial to have a redundant copy of data. To protect against a storage system outage, you can utilize replication to create a copy of data on a remote system. Replication is a software feature which synchronizes data to a remote system within the same site or a different location. Replicating data helps to provide data redundancy, and safeguards against storage system failures at the main production site. Having a remote Disaster Recovery (DR) site protects against system and site-wide outages and provides a remote location to resume production and minimize downtime due to a disaster. For Dell EMC Unity, the platform offers many replication solutions to easily meet disaster recovery needs in customer environments.

Synchronous replication is a data protection solution which ensures each block of data written to a storage resource is first saved locally and to a remote image before the write is acknowledged to the host. This ensures that in the event of a disaster, there is zero data loss. In synchronous replication solutions, there are also trade-offs. As each write needs to be saved locally and remotely, added response time occurs during each transaction. This response time increases as distance increases between remote images. Synchronous replication has a distance limitation based on latency between systems. This limitation is generally 60 miles or 100 km between sites. It is recommended to ensure the latency of the link between the local and remote system is less than 10ms.

Asynchronous replication is primarily used to replicate data over long distances, but also can be utilized to replicate storage resources between Pools within the same system. Asynchronous replication does not impact host I/O latency as host writes are acknowledged once they are saved to the local storage resource. Because write operations are not immediately replicated to a destination resource, all writes are tracked on the source. This data will be replicated during the next synchronization. Asynchronous replication introduces the concept of a Recovery Point Objective (RPO). RPO is the acceptable amount of data, measured in units of time, which may be lost due to a failure. This delta of time also affects the amount of data which needs to be replicated during the next synchronization, and the amount of potential data loss if a disaster scenario were to occur.

Dell EMC Unity's synchronous and asynchronous replication features can easily be configured using Unisphere, Unisphere CLI, or REST API. Dell EMC Unity also supports manual replication, which does not automatically update a destination image with changes on the source. Manual replication will be discussed with asynchronous replication. RecoverPoint also supports block replication for Dell EMC Unity and will be discussed later in this paper. RecoverPoint utilizes physical or virtual appliances to replicate data between systems and is configured using the Unisphere for RecoverPoint user interface.

The Dell EMC Unity File synchronous replication feature and MetroSync Manager is covered in the *Dell EMC Unity: MetroSync white paper*, which can be found on Dell EMC Online Support.

1.1 Terminology

Asynchronous Replication – A replication method which allows you to replicate data over long distances and maintain a replica at a destination site. Updates to the destination image can be issued manually, or automatically based on a customizable Recovery Point Objective (RPO).

Bandwidth – The amount of data, represented in MB/s, which can be transferred in a given period of time.

Common Base – A pair of Unified Snapshots taken on a replication source and destination storage resource which have the same point-in-time image.

Consistency Group (Dell EMC Unity) – A storage instance which contains one or more LUNs within a storage system. Consistency Groups help organize the storage allocated for a particular host or hosts.

Consistency Group (RecoverPoint) – In RecoverPoint, a consistency group is a user-defined group of LUNs to be replicated. A consistency group needs to be created in RecoverPoint as a part of the workflow to configure replication. This consistency group containing Dell EMC Unity LUNs can be replicated locally or remotely. RecoverPoint consistency groups are synonymous with Dell EMC Unity Consistency Groups.

Destination Storage Resource – A storage resource that is used for disaster recovery in a replication session. This is also known as a target image.

Fracture Log – A bitmap held in persistent memory on each storage processor which indicates which physical areas of a source resource participating in a synchronous replication session have been updated since communication was interrupted (fracture).

Internal Snapshot (Replication Snapshot) – Unified Snapshots created by the system which are part of an asynchronous replication session. These Snapshots can be viewed in Unisphere, but user operations are not permitted. Each asynchronous replication session uses two internal snapshots taken on the source and destination storage resources.

Journal Volume – In RecoverPoint, a journal volume is a LUN designated to hold data associated with previous points-in-time. The journal is used to allow RecoverPoint to roll back data to any point-in-time. Journal volumes must be configured for each copy of a consistency group, including the production copy.

LUN – A block-based storage resource which a user provisions. It represents a SCSI logical unit.

RecoverPoint – An appliance-based disaster recovery solution that replicates synchronously or asynchronously and enables recovery to any point-in-time.

RecoverPoint Appliance (RPA) – An industry-standard server platform that runs RecoverPoint software and manages all aspects of data protection for a consistency group. RPAs are clustered at each site in a RecoverPoint system for high availability and load balancing. Virtual machines running RecoverPoint software, or vRPAs, are also supported as an alternative to physical appliances.

Recovery Point Objective (RPO) – The acceptable amount of data, measured in units of time, which may be lost due to a failure. For example, if a storage resource has an RPO of 1 hour, any data written to the storage resource within the most recent hour may be lost when the replication session is failed over to the destination storage resource.

Recovery Time Objective (RTO) – The duration of time in which a business process must be restored after a disaster. For example, an RTO of 1 hour requires access to the data be restored within 1 hour after a disaster is encountered.

Replication Session – A relationship configured between two storage resources of the same type, on the same or different systems, to automatically or manually synchronize the data from one resource to another.

Snapshot – A snapshot, also called a Unified Snapshot, is a point-in-time view of a storage resource. When a Snapshot is taken, the snapshot is an exact copy of the source storage resource and shares all blocks of data with it. As data changes on the source, new blocks are allocated and written to. Unified Snapshot technology can be used to take a snapshot of a Block or File storage resource.

Storage Resource – The top-level object a user can provision, associated with a specific quantity of storage. All host access and data protection activities are performed at this level. In this document, storage resource

refers specifically to those which support replication: LUNs, Consistency Groups, NAS Servers, File Systems, and VMware VMFS and NFS Datastores.

Synchronous Replication – A replication mode in which the host initiates a write to the system at a local site and the data must be successfully stored in both local and remote sites before an acknowledgement is sent back to the host.

Thin Clone – A Thin Clone is a read-write copy of a Thin Block storage resource (LUN, Consistency Group, or VMware VMFS Datastore) that shares blocks with the parent resource.

Unisphere – A web-based Dell EMC management interface for creating storage resources and configuring and scheduling protection of stored data on a Dell EMC Unity system. Unisphere can be used for all management of Dell EMC Unity native replication.

Unisphere for RecoverPoint – A web-based interface for managing RecoverPoint replication. It serves as a single pane of glass for replicating storage resources of multiple storage systems configured to use RecoverPoint. Consistency groups are created, replicated, and recovered through this interface.

User Snapshot – A snapshot created manually by the user or by a schedule. This is different than an internal snapshot, which is taken automatically by the system with asynchronous replication.

Write Intent Log – A record stored in persistent memory on the Dell EMC Unity storage system which tracks in-flight writes between systems participating in synchronous replication.

2 Native Synchronous Block Replication

This section will discuss the Native Synchronous Block Replication feature found on Dell EMC Unity systems. This feature allows users to create synchronous replication sessions for Block storage resources between supported systems. All configuration and management operations in this section will be demonstrated in Unisphere, though Unisphere CLI and REST API may also be used. The following sections of this paper will discuss:

- The licensing requirements for the native synchronous block replication feature
- How the native synchronous replication feature works
- The configurations supported for synchronous replication
- Unisphere configuration and management

Synchronous block replication using RecoverPoint will be discussed in the *RecoverPoint with Dell EMC Unity* section.

2.1 Licensing

For Dell EMC Unity, Synchronous Block Replication is only supported on physical deployments. The supported systems include the All Flash models, and the Hybrid models. For Dell EMC Unity All Flash and Hybrid systems, Synchronous Block Replication license comes included at no additional cost.

2.2 Theory of Operation

Native synchronous block replication is comprised of a number of physical and software components. Each of these components will be discussed in the following sections. To fully configure synchronous replication, you must complete each of following:

- Configure FC connectivity for synchronous replication data transfer
- Configure network interfaces on the synchronous replication management ports for replication command communication
- Configure a replication connection between systems
- Configure replication sessions between systems

Also discussed in this section will be the various storage resources which support synchronous replication, and the different replication modes and roles for synchronous replication. The following sections detail the functions, requirements, and interactions of these components. The configuration and management of these components in Unisphere will be discussed in the *Unisphere Management* subsection.

2.2.1 Synchronous Replication Interfaces

Native synchronous block replication is performed over the first Fibre Channel (FC) port configured on the system. Dell EMC Unity physical systems include two onboard Converged Network Adapter (CNA) ports which can be configured with either 16Gb FC SFPs, 10Gb Optical SFPs, or be used with Twinax cables. When configured as Fibre Channel, the lowest numbered port will be used for the synchronous replication interface on each SP. When the CNA is not configured for Fibre Channel, a 16Gb Fibre Channel I/O module must be purchased, installed, and persisted on each of the SPs of the system. The lowest numbered FC port on the I/O modules installed on the system will be utilized as the synchronous block replication interface.

Starting with Dell EMC Unity OE version 4.1, the Replication Capability field is displayed for the Fibre Channel ports. To view, navigate to Unisphere > System > System View > Enclosures, then select a Fibre Channel

port to review. Figure 1 shows an example of the Enclosures tab, with the SP B FC Port 4 selected. The Replication Capability can be seen from the quick properties of the port.

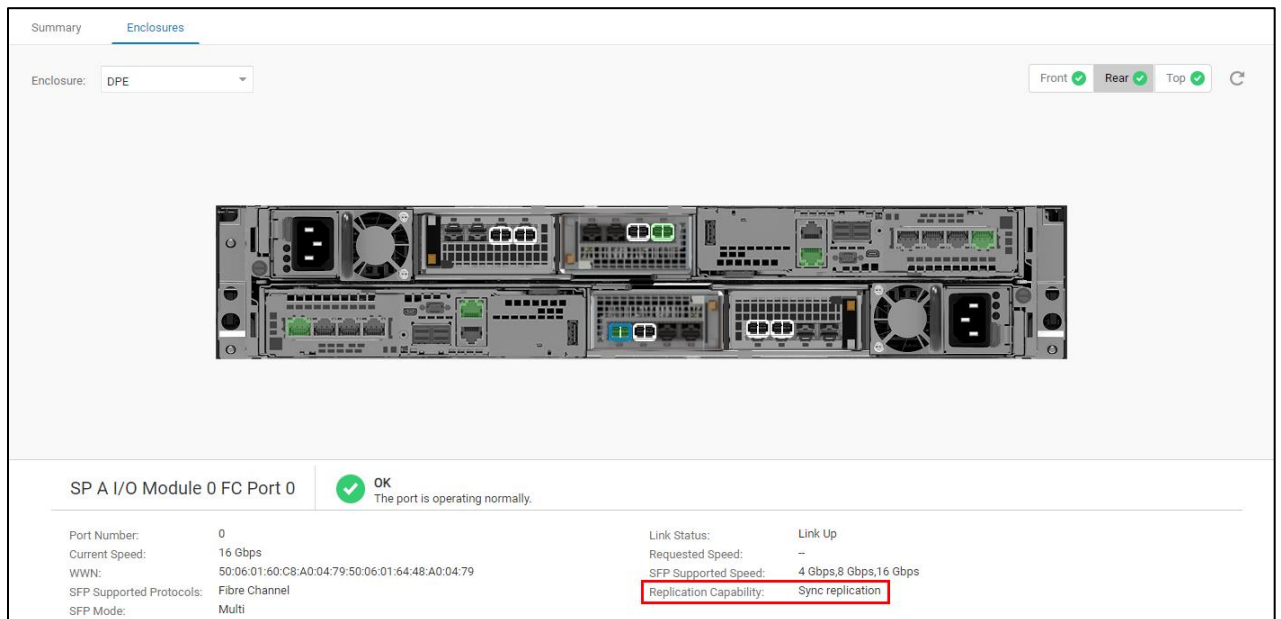


Figure 1 Replication Capability

With Unisphere CLI, you can also easily locate the synchronous block replication port by running the `/net/port/fc show -detail` command. This command will return information for Fibre Channel ports of the system. A sample output of this command with only the relevant information displayed is shown below:

```
C:\>uemcli -d ip_address -u username -p password /net/port/fc show -detail
1: ID = spa_fc4
  Replication capability = Sync replication
4: ID = spb_fc4
  Replication capability = Sync replication
```

In the above example, the first CNA port on the system, labeled as Fibre Channel Port 4 on both Storage Processors (SP) are used for synchronous block replication. These ports can be directly connected to the synchronous ports on the destination system or zoned to them via a switch. For zoning, the proper configuration is to zone the SPA replication port for the local and remote systems together, and in a different zone, zone the SPB replication ports together. It is recommended to dedicate the FC replication interfaces strictly for replication purposes, but it is not required, and hosts can also utilize these ports. For redundancy, it is best to configure SPA's replication connection over one FC network, and SPB's over another where possible.

2.2.2 Synchronous Replication Management Ports

The synchronous replication management port is a virtual port used by synchronous replication to pass management commands between systems. A synchronous replication management port is created on each SP and is configured on the management port of a storage processor. This port must be able to communicate with the destination system's synchronous replication management port interfaces and does not support VLAN tagging. This port only needs to be configured when the system will participate in synchronous replication with a remote system. Synchronous replication management ports must be configured on the source and destination systems participating in synchronous replication.

2.2.3 Replication Connections

When configuring replication, a trusted link must be created between two systems before any replication sessions can be made. A replication connection is a logical link that is created between systems that will participate in remote replication. The replication connection establishes a link for management, and the data path between a pair of systems. After the replication interfaces and the synchronous replication management ports are configured, you must create the replication connection between the systems. Once configured, all synchronous replication sessions will utilize the replication connections to transport data to the remote system.

Figure 2 below shows an example configuration of a replication connection between two systems. In this example, the systems are labeled "Production System" and "DR System". All synchronous replication will occur between the Production System and the DR System. Each system is also configured with 16Gb FC CNA ports, so port 4 on each SP is the synchronous replication port. After cabling each system to the network, configuring the synchronous replication management ports, and zoning the FC ports together, the replication connection can be established. All management related traffic will cross the LAN / WAN connections, and all data will be replicated across the FC Network synchronously. Once a replication connection is configured on one of the systems participating in replication, it is automatically created on the other system.

Verify and Update is a single operation that is used to update the replication connection information on the system it is issued on. This operation is performed on the replication connection itself, as opposed to an individual replication session. Verify and Update can be used to test a replication connection to a remote system or update the replication information if changes to the system have been made. Verify and Update should be issued to re-establish the replication connection to a remote system after an outage. Another use case for using Verify and Update is if a Synchronous Replication Management Port IP Address has been changed on the system.

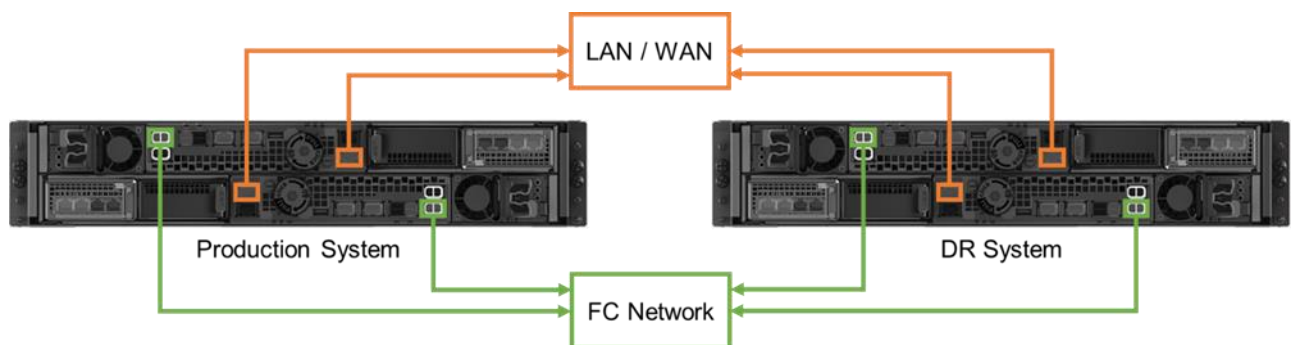


Figure 2 Native Synchronous Block Replication Connection Example

2.2.4 Replication Sessions

A replication session utilizes a configured replication connection to transfer data from a source to a destination storage resource. If a replication session is created using Unisphere, a storage resource of the same size and type is created on the destination system and a full synchronization occurs between the source and destination storage resource. If replication is configured when creating a new resource, the synchronization operation is fairly quick as no data needs to be copied across the link. When configuring Synchronous Block Replication, Snapshots and Snapshot Schedules are not replicated to the DR system.

The following steps outline a write operation to a storage resource with a synchronous replication session configured. In this example, assume the initial synchronization is complete.

1. A write I/O is sent to a storage resource on the Production System.
2. System cache on the Production System accepts the write I/O.
3. The Production System replicates the data to the DR System.
4. The DR System accepts the data into system cache.
5. The DR System responds to the Production System and acknowledges the write has been saved.
6. The Production System acknowledges the host that the data has been accepted and saved on the system.

2.2.5 Storage Resources

When configuring replication, the source and destination storage resource must be of the same type. In Dell EMC Unity, native synchronous replication is supported on the following storage resources:

- LUNs
- Consistency Groups
- VMware VMFS Datastores
- Thin Clones

On the system, replication for LUNs, Thin Clones, and VMware VMFS Datastores function identically to each other. When configuring replication on a LUN, a single replication session is created, and the source and destination storage resources will be the same size and type. When configuring replication session on a Thin Clone, the destination storage resource will be a regular storage resource and not a clone. While synchronous replication is configured, you will not be able to extend the storage resource. Other options, such as the LUN's name or tiering policy, may be configured differently between systems.

In Dell EMC Unity, a Consistency Group is a storage instance which contains one or more LUNs within a storage system. Consistency Groups help organize the storage allocated for a particular host or hosts. Consistency Groups are treated as a single entity when they are replicated, meaning that a single replication session is created for the entire Consistency Group no matter how many LUNs it contains. When pausing or resuming replication on a Consistency Group, the entire group is affected by the replication operation.

2.2.6 Replication Roles

Two storage resources are required for replication:

- A source storage resource which will be replicated
- A destination storage resource which is copied to from the source

When a replication session is created in Unisphere, the destination storage resource is automatically created with the session. In Unisphere, you may not choose a previously provisioned storage resource as a

replication destination when configuring a session. Upon creation, the destination resource is marked as a destination image. This restriction blocks Read/Write access on the destination storage resource. To view the data contained in the destination storage resource, you may take a Snapshot of the resource and provide host access to it.

In Unisphere, you can easily determine which storage resources are replicated and which are destination images from any of the storage resource pages, such as the LUNs tab on the Block page. While in this tab, select the gear icon, and hover over the Columns option to view the available columns that can be viewed. Select the check boxes for “Replication Type” and “Restricted Replication Access”. Replication Type displays what type of replication the storage resource is participating in, whether it is None, Remote, or Local. The Restricted Replication Access column will display “Yes” if the storage resource is labeled as a replication destination resource, or “No” if it is not. If a replication session is deleted, the destination storage resource will still be labeled as a replication destination image. The replication destination label must be edited manually via Unisphere CLI before the resource is allowed to receive I/O. For example, to remove the replication destination setting from a LUN, use the `uemcli /stor/prov/luns/lun -id <value> set - replDest no` command. For more information on removing the replication destination setting on other storage resource types, consult the *Dell EMC Unity: Unisphere Command Line Interface User Guide* on Dell EMC Online Support.

2.3 Replication Operations

Once a replication session has been created, a number of operations are available to manipulate the replication session as needed. Not all operations are available at all times, as some depend on the session being in a particular state. Also, certain operations will perform differently depending on which system they are issued on, source or destination. Only one replication operation can be issued and running per session at a particular point in time.

2.3.1 Pause and Resume

Pause and resume are used to stop and start replication between the systems for a particular replication session. In Unisphere, the pause operation can only be issued from the source system. While a session is paused, all write I/O to a storage resource is only saved on the source system before being acknowledged to the host. All I/O is tracked when the replication session is paused, and when the session is resumed, all blocks not already copied to the destination will be done at this time. During this time the state of the replication session will be “Syncing”. Once all I/O is copied to the destination, the state will change to “In Sync”.

Pausing a replication session may be done for a number of reasons. Some reasons include the need to power off the source or destination system for planned maintenance, a configuration change on the network between systems, or interface changes on either system. Another reason may be to physically move a system from one data center or site to another. In certain circumstances, configuring replication and synchronizing the data between systems may be done within the same site, then the destination system is later moved to its final destination.

2.3.2 Failover and Failback

When issuing the failover operation, the current destination storage resource becomes the production resource. Before issuing the failover operation, it is highly suggested to quiesce I/O to the source image first. Once the failover operation is initiated the destination resource will be available for Read/Write operations and the original source resource will no longer be available for reads or writes. If host access is configured on the

destination resource, hosts will be able to access the data at this time. The effects of issuing the failover operation will depend on which system the failover was initiated from.

A failover issued from the production system is also referred to as a planned failover. The destination resource will become Read/Write available, and the direction for replicating data will switch. When this occurs, the original destination system will start replicating all new writes it receives for the storage resource to the original source system for the replication session. Issuing a failover from the source is suggested when testing a site failover to ensure the DR configuration is working properly. To return the session to its original state, first quiesce I/O to the original destination storage resource. Then, issue a failover from the original destination system. This will make the original storage resource the production image and start replication in the original direction.

If a failover operation is issued from a destination system, an unplanned failover or disaster situation is initiated. An unplanned failover assumes a disaster has occurred on the production system, and the destination image is made Read/Write available. The replication session will also pause and not automatically switch the direction for replication. The replication session is left in this state until the user issues another replication operation.

Starting with Dell EMC Unity OE version 5.0, an unplanned failover operation can be initiated even when the replication is in a "Paused" state. Previously, unplanned failover operations were not allowed while the session was in a "Paused" state. Note that any changes made on the source system while the session is paused are not replicated to the destination.

When the original production system becomes available, the user has the option of issuing the Resume operation on the session from the original destination to replicate data to the original source which will result in a full sync. Then, at a later time, they can issue the Failover operation from the destination system to return to the original state for replication, from the production system to the destination system. The user also has the option of issuing the Failback operation from the destination system when the source becomes available. The Failback operation will do a full synchronization of the storage resource on the source system with the data on the destination resource, block access to the destination storage resource, and make the original production resource Read/Write. Replication will also then be resumed from the production system to the destination system for the replication session. It is suggested to quiesce all I/O before issuing the Failback operation.

2.3.3 Delete

Deleting a replication session can be issued on the source system or destination system, but it is recommended that the operation be issued on the source when the source is available. When there are no issues in the configuration and a Delete operation is issued on the source system, the replication session will be deleted from both the source and destination system. The destination storage resource is not automatically deleted when the replication session is deleted. If the delete operation is issued while the destination system cannot be reached, the session will need to be deleted from the destination system manually. If the delete operation is issued from the destination system, the source session is left configured and must be deleted manually. Once a replication session is deleted, a full sync will need to occur if replication is reconfigured.

A delete operation can also be issued for a replication connection. A replication connection can only be deleted after all configured replication sessions utilizing the connection have been deleted.

2.4 Data Protection Mechanisms

Synchronous replication has mechanisms to resync data differences between the source and/or destination resources in the event of replication disruption thereby preventing the need for full synchronization. The fracture log protects primarily against loss of communication with the destination resource. The write intent log protects primarily against interruptions to the source resource. Both of these structures exist to enable partial synchronizations in the event of interruptions to the source or destination resources.

2.4.1 Fracture Log

The fracture log is a bitmap held in the memory of the storage processor that owns the source resource. It indicates which physical areas of the source have been updated since communication was interrupted with the destination.

The fracture log is automatically invoked when the destination resource of a replication session is lost for any reason and becomes out of sync. The replication session is out of sync (no longer replicating) if the destination is not available, or it can be administratively paused through Unisphere or UEMCLI. Dell EMC Unity sets a replication session as out of sync if an outstanding I/O to the destination is not acknowledged within 25 seconds. While in a state of out of sync, the source pings the destination every 20 seconds to determine if communication has been restored.

The fracture log tracks changes on the source resource for as long as the destination resource is unreachable. It is a bitmap that represents areas of the source resource with regions called extents. The amount of data represented by an extent depends on the size of the data resource. Since the fracture log is a bitmap and tracks changed areas of the source resource, it is not possible to run out of fracture log capacity.

When the destination resource returns to service, it must be synchronized with the source. This is accomplished by reading those areas of the source addressed by the fracture log and writing them to the destination resource. This activity occurs in parallel with any writes coming into the source and replicated to the destination. Bits in the fracture log are cleared once the area of the source marked by an extent is copied to the destination. This ability to perform a partial synchronization can result in significant time savings. It may be necessary, depending on the length of the outage and the amount of write activity, to resynchronize the entire dataset.

By default, the fracture log is stored in memory. Therefore, it would be possible for a full resynchronization to be required if a destination resource is out of sync and an interruption in service occurs on the source SP. To protect against such scenarios, the write intent log is used.

2.4.2 Write Intent Log

The write intent log is a record stored in persistent memory (disk) on the storage system on which the source resource resides. During normal operation, the write intent log tracks in-flight writes to both the source and destination resources in a sync replication relationship. Much like the fracture log, the write intent log is a bitmap composed of extents indicating where data is written. The write intent log is always active, but the fracture log is only enabled when the replication session is out of sync.

When in use, Dell EMC Unity makes an entry in the write intent log of its intent to update the source and destination resources at a particular location, then proceeds with the attempted update. After both images respond that data has been written (i.e. written to write cache), the system clears previous write intent log entries. For performance reasons, the write intent log is not cleared immediately following the acknowledgement from the source and destination resources. It will be cleared while subsequent write intent log operations are performed.

In a recovery situation, the write intent log can be used to determine which extents must be synchronized from the source storage system to the destination system. For instance, if a single SP becomes unavailable (for example during a reboot or failure), there may be in-flight writes that were sent to the destination, but not acknowledged before the outage. These writes will remain marked in the write intent log. Then server software trespasses the resource to the peer SP. The remaining SP directly accesses the unavailable SP's write intent log and recovers the recent modification history. The SP then resends the data marked by the extents in the write intent log. This allows for recovery using only a partial resynchronization, rather than a full resynchronization because it ensures that any writes in process at the time of the failure are acknowledged by the destination resource. If the entire array becomes unavailable, then the write intent log is used to facilitate a partial resynchronization from source to destination, once the source array is recovered.

2.5 Supported Replication Configurations

Dell EMC Unity's Native Synchronous Block Replication feature is supported in two different topologies, and deployment models will vary depending on the requirements of the configuration. The following synchronous replication topologies outline the system configuration options supported in Dell EMC Unity.

- One-Directional
 - A single source system replicating to a single destination system
- Bi-Directional
 - A two-system topology in which each system acts as a replication destination for the peer's production data

The following figure, Figure 3, is a graphical view of the supported topologies listed above. Note the figure uses LUNs as an example. For synchronous replication, the source and destination system must be a physical system, but the models utilized can vary depending on the configuration requirements. Below are examples of the two topologies that can be utilized, either One-Directional or Bi-Directional replication. The source and destination system can either be the same model type, either All Flash or Hybrid, or the source and destination can be a mix of All Flash and Hybrid systems.

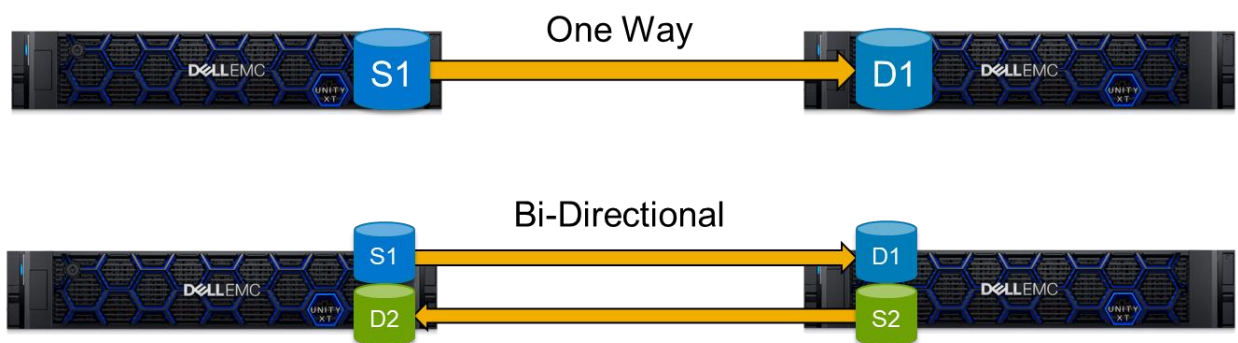


Figure 3 Supported Synchronous Block Replication Topologies

One-Directional replication is typically deployed when only one of the systems will be utilized for production I/O. The second system is a replication target for all production data and sits idle within the same data center or a remote location. If the need arises, the DR system can be placed into production and host production I/O. In this scenario, mirroring the production system's configuration, including the number of drives and Pool layout, on the DR system is suggested, as each system would then have the same performance potential.

The Bi-Directional replication topology is typically utilized when production I/O needs to be spread across multiple systems or locations. The systems may exist within a single data center or in different, remote locations. When utilizing this replication topology, production I/O from each system is mirrored to the peer system. In case of an outage, one of the systems can be promoted as the primary production system, and all production I/O can be sent to it. Once the outage is complete, the replication configuration can be changed back to its original configuration. This replication topology ensures both systems are in use by production I/O at all times.

On Dell EMC Unity, a block resource can only be synchronously replicated to one single storage resource on a remote system. This means that replicating a single storage resource to multiple destination resources is not supported. Therefore, only one replication connection between a source and destination pair of Dell EMC Unity systems can be used for synchronous replication. Cascading replication, when a destination storage resource is also replicated to another destination resource, is also not supported for synchronous block replication.

2.6 Unisphere Management

Creating and managing replication in Unisphere is easy and intuitive. All replication operations, including configuring of synchronous replication network interfaces, replication connections, and replication sessions can be performed in the Unisphere GUI. With the help of easy to follow wizards, replication can be configured quickly by IT generalists or advanced users alike. Replication can also be configured using Unisphere CLI, or REST API. For more information on configuring and managing replication using Unisphere CLI, refer to the Unisphere Command Line Interface Guide found on Dell EMC Online Support. For more information on REST API, refer to the *Unisphere Management REST API Programmer's Guide* found on Dell EMC Online Support.

2.6.1 Configuring Replication

When configuring synchronous block replication, the following components need to be configured and were previously discussed in this paper:

1. FC connectivity between the synchronous replication interfaces on the local and remote system
2. Synchronous Replication Management Port Interfaces
3. A Replication Connection
4. A Replication Session

Note that the first step above is completed by directly connecting the synchronous replication FC ports of two systems together or zoning the ports together over the fabric as outlined in the Synchronous Replication Interfaces section.

The following sections will outline the remaining steps needed to configure remote replication in Unisphere. Each of the following operations are completed from a particular page in Unisphere. Each page will be discussed in detail below. For more information on using Unisphere to configure and manage replication, refer to the *Unisphere Online Help*.

2.6.2 Synchronous Replication Management Ports

To create the synchronous replication management ports, you must first navigate to the **Interfaces** page, which is found under **Protection & Mobility** in the left pane in Unisphere. For releases prior to Dell EMC Unity OE version 4.1, the Interfaces can be found as a tab in the **Replication** page, under **Data Protection**. Figure 4 below shows the **Interfaces** page. From this page, you have the option to create or delete mobility interfaces, refresh the current page, or edit a configured mobility interface. In the example below, no mobility

interfaces have been created. Only one pair of synchronous replication management ports needs to be created on the source and destination system. Mobility Interfaces may be shared network interfaces for import and replication related data or management traffic using the virtual management port. In this section the mobility interfaces will be referenced as replication interfaces.



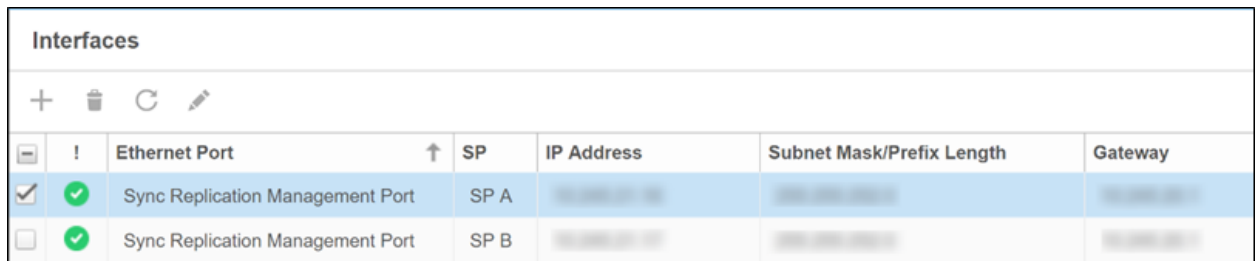
Figure 4 Interfaces Page

To create a replication interface, click the **Create Interface** button, shown as a + sign in the **Interfaces** page. Once selected, the **Create Interface** wizard appears, which is shown in Figure 5. For synchronous block replication, you must create the Synchronous Replication Management Ports on the system, which are used for management connectivity between the source and destination system. In the **Ethernet Port** drop down list, select **Sync Replication Management Port**. The status of the ports will be shown in parenthesis. Both system management ports, also used for Unisphere management, will need to be cabled to the network for these links to work properly.

Next, configure an IP address for SPA and SPB to be used for synchronous replication management. Note that VLAN tagging is not supported on these interfaces. Once done, click **OK**.

Figure 5 Create Interface Window

Once the synchronous replication management ports are created, they will be shown on the Interfaces page as shown in Figure 6. From here the status of each port is shown, currently operating normally as denoted by the green circle checkmark. To delete a synchronous replication management port, select the port and click the **Delete Interface** icon, which is shown as a trash can on this tab. To edit a replication management port, to change the IP address for example, select the **Edit** icon, which is shown as a pencil icon on this tab.

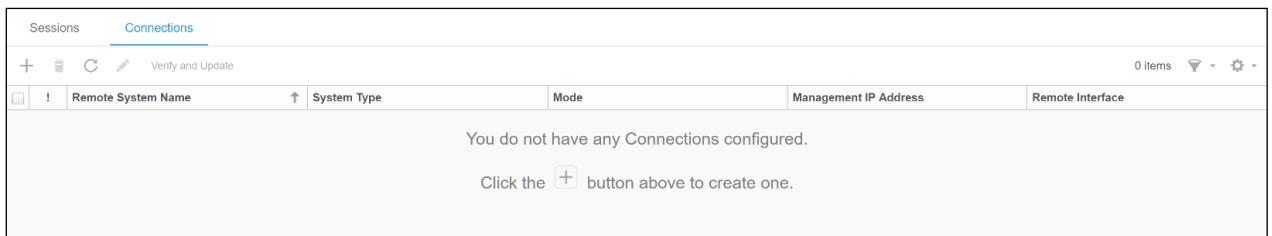


Interfaces							
+ [trash] [refresh] [edit]							
	!	Ethernet Port	↑	SP	IP Address	Subnet Mask/Prefix Length	Gateway
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Sync Replication Management Port		SP A	10.10.10.10	255.255.255.0	10.10.10.1
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Sync Replication Management Port		SP B	10.10.10.20	255.255.255.0	10.10.10.1

Figure 6 Synchronous Replication Management Interfaces

2.6.3 Creating a Replication Connection

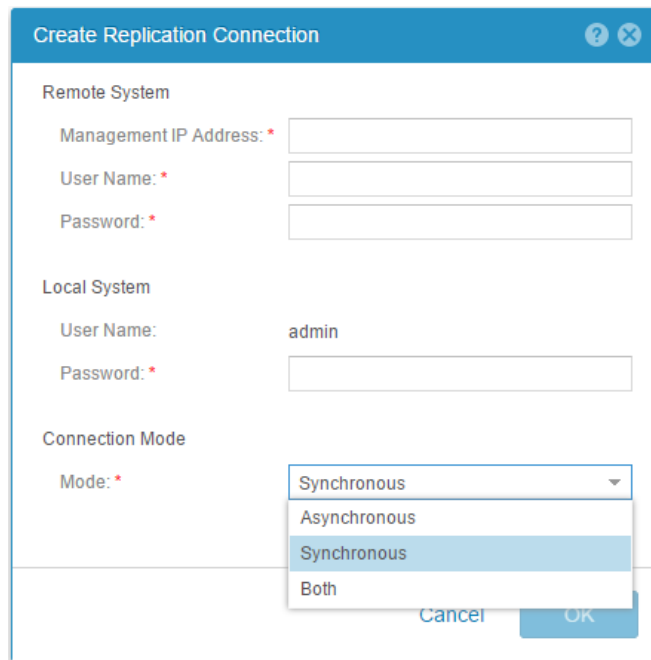
The next step in configuring synchronous block replication is to create a Replication Connection with another system. This configures a private replication connection for the pair of systems. To create the Replication Connection, you must first navigate to the **Replication** page, which is found under **Protection & Mobility** in the left-hand navigation pane in Unisphere. The Replication page has the Sessions and Connections tabs. From the **Replication** page, select the **Connections** tab. Figure 7 below shows an example of the **Connections** tab, without any replication connections configured. From this tab, you have the option to create or delete a replication connection, refresh the current page, or edit a configured replication connection. From this tab you can also select **Verify and Update**, which will verify the selected replication connection still exists with the remote system and update the connection details if any changes were made.



Sessions <u>Connections</u>							
+ [trash] [refresh] [edit] Verify and Update							
	!	Remote System Name	↑	System Type	Mode	Management IP Address	Remote Interface
You do not have any Connections configured. Click the + button above to create one.							

Figure 7 Replication Connections

To create a Replication Connection, select the **Create Replication Connection** icon, which is displayed as a + sign on this tab. The **Create Replication Connection** window appears, as shown in Figure 8. In this window, you must specify the Remote System's **Management IP Address**, which is the IP used to access Unisphere, and the Unisphere **User Name** and **Password**. Also, in this window you must enter the **Password** used to log into Unisphere on the system you are configuring the replication connection on. Lastly, you must select the **Connection Mode** that will be used between the systems. In the drop-down list, you have the option to choose **Asynchronous**, **Synchronous**, or **Both**. When configuring synchronous replication between two systems, select **Synchronous**. If asynchronous replication will also be used for replicating data to other storage resources, select **Both**, as both synchronous and asynchronous replication will be utilized. After entering the required information, click **OK**. Dell EMC Unity Asynchronous and Manual Replication is discussed in the *Native Asynchronous Replication* section.



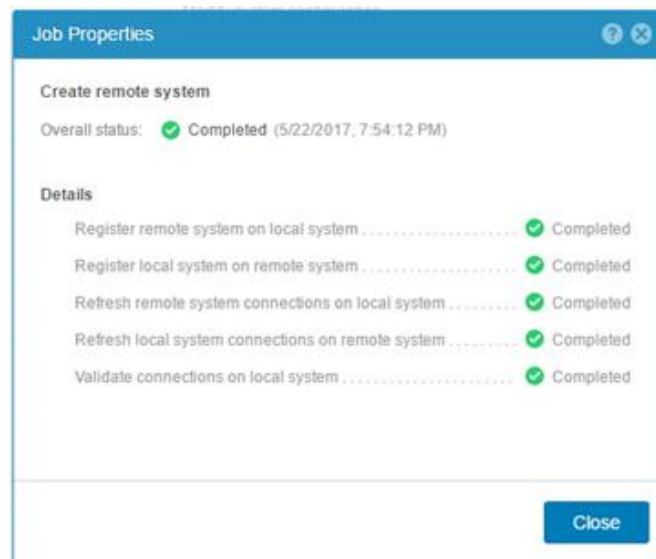
The 'Create Replication Connection' dialog box is shown with the following fields and options:

- Remote System:**
 - Management IP Address: *
 - User Name: *
 - Password: *
- Local System:**
 - User Name: admin
 - Password: *
- Connection Mode:**
 - Mode: * (Dropdown menu with options: Synchronous, Asynchronous, Synchronous, Both)

Buttons: Cancel, OK

Figure 8 Creation Replication Connection Window

After selecting **OK**, a Job is generated to create the replication connection. An example of the Details of the job can be seen in Figure 9. The job has multiple steps, which includes registering the remote and local system with its peer, refreshing the connection on both systems, and validating the connections on the local system. Once the job completes, the replication connection will be shown on the source and destination system.



The 'Job Properties' dialog box displays the following information:

- Job Title:** Create remote system
- Overall status:** ✔ Completed (5/22/2017, 7:54:12 PM)
- Details:**
 - Register remote system on local system ✔ Completed
 - Register local system on remote system ✔ Completed
 - Refresh remote system connections on local system ✔ Completed
 - Refresh local system connections on remote system ✔ Completed
 - Validate connections on local system ✔ Completed

Button: Close

Figure 9 Create Replication Connection Job

Figure 10 shows the Replication page **Connections** tab once the replication connection is created. In this example **DisasterRecovery** is the name of the remote system the connection was configured with. The System Type, Replication Mode, Management IP Address, and Remote Replication Interfaces will also be displayed. The Remote Interfaces displayed for synchronous block replication will be the IP Addresses

configured for the synchronous replication management ports on the remote system. The **Verify and Update** button is also shown and is used to update the replication information for the selected connection.

		Remote System Name	System Type	Management IP Address	Mode	Remote Interface
<input checked="" type="checkbox"/>	✔	DisasterRecovery	Unity 500	192.168.1.100	Synchronous Replication	192.168.1.120,192.168.1.121

Figure 10 Replication Connection Established

2.6.4 Creating a Replication Session

To create a replication session, you must enable replication on the storage resource you wish to replicate. This can be done at time of creation, or on an existing storage resource. Figure 11 shows an example of creating a new LUN and enabling Synchronous remote replication on it. From the **Replication** step, check the checkbox in front of **Enable Replication** to configure replication. For Synchronous replication, select **Synchronous** from the **Replication Mode** drop down box. When Synchronous is chosen as the Replication Mode, the **Replicate To** box will automatically be populated with the name of the system with which a synchronous Replication Connection has been configured. After completing this step, click **Next** and continue with the LUN creation. For Thin Clones, Consistency Groups and VMware VMFS Datastores, a Replication step exists in the creation wizards for each with the exact look and configuration options as the one shown in Figure 11.

Create LUNs ? X

- ✔ Configure
- ✔ Access
- ✔ Snapshot
- **Replication**
- Summary
- Results

Provide a Replication Mode and RPO

Enable Replication

Replication Mode: * Synchronous

Replicate To: * FNM00190100444

Destination Configuration

i If you want to set up replication using RecoverPoint, go back to the Access step and configure the RecoverPoint host to access the storage resource.

Cancel
Back
Next

Figure 11 Create LUNs Wizard - Replication

When the **Destination Configuration** box is selected in the Replication step, information about the remote storage resource's configuration will be displayed. Figure 12 below shows an example of this window.

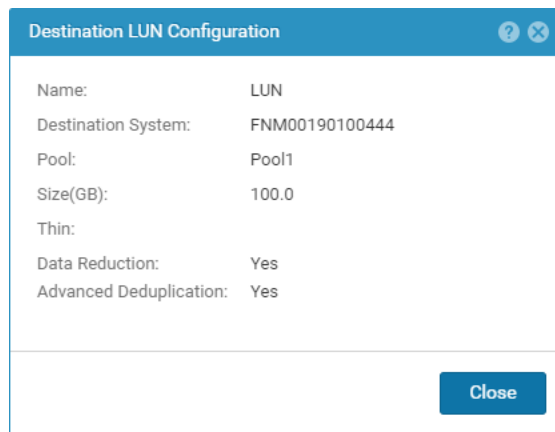


Figure 12 Destination LUN Configuration Window

After synchronous replication is configured on a new storage resource, you can view information about replication from the resource's properties window. From Unisphere, select the storage resource in question and click Edit or double-click the name of the storage resource. From the properties window, view the **Replication** tab. An example of this tab is shown in Figure 13. On this tab, you can view the following information:

- The replication **Session Name**
- The replication **Mode**
- The **Local Role** of the storage resource, which can either be listed as the **Source** or **Destination**
- The **Sync State**
- The **Replicate Scheduled Snapshots** option applies to asynchronous replication. It will be discussed in the *Native Asynchronous Replication* section.

Also shown is a pictorial representation of the replication session. The picture shows which storage resource is available for I/O, which direction the data is replicating in and its current state, and the destination storage resource and the system name, IP Address, and the destination LUN name. As the state of the replication session changes, this picture will update to reflect the new state.

Also shown on the Replication tab are buttons for each Replication Operation. This tab is also used to display asynchronous replication operations, so all replication operations for both synchronous and asynchronous replication are displayed. Not all replication operations are supported on each mode of replication, so only operations supported on the current replication mode will be selectable. Also, only certain operations are available depending on what the current state of the replication session is in, so only these options are available for selection. In Figure 13, the current session is Active and replicating for the Production System to the DR System. Available replication operations include **Delete**, **Pause**, and **Failover**.

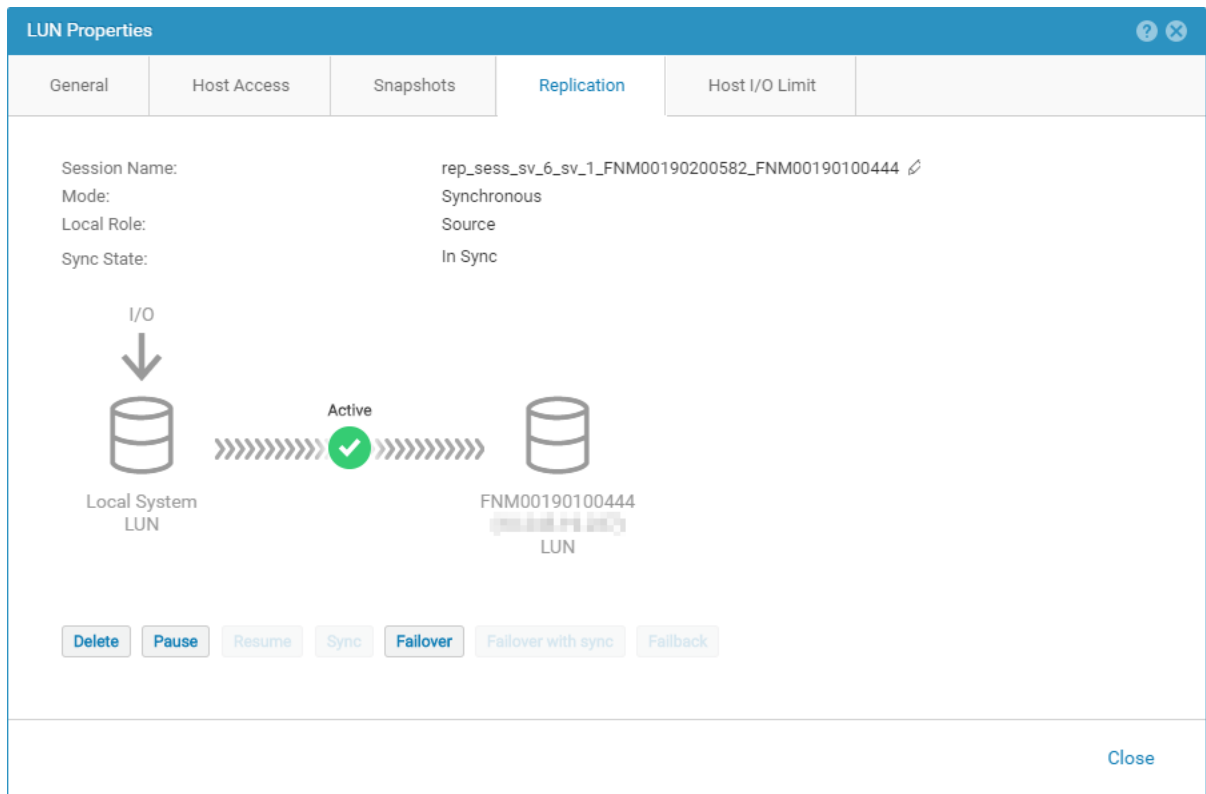


Figure 13 Replication Configured

Replication can also be configured on an existing storage resource. When replication is not configured on the storage resource, viewing the **Replication** tab in the storage resource's properties window will show what is displayed in Figure 14. To configure Replication on the storage resource, select **Configure Replication**.

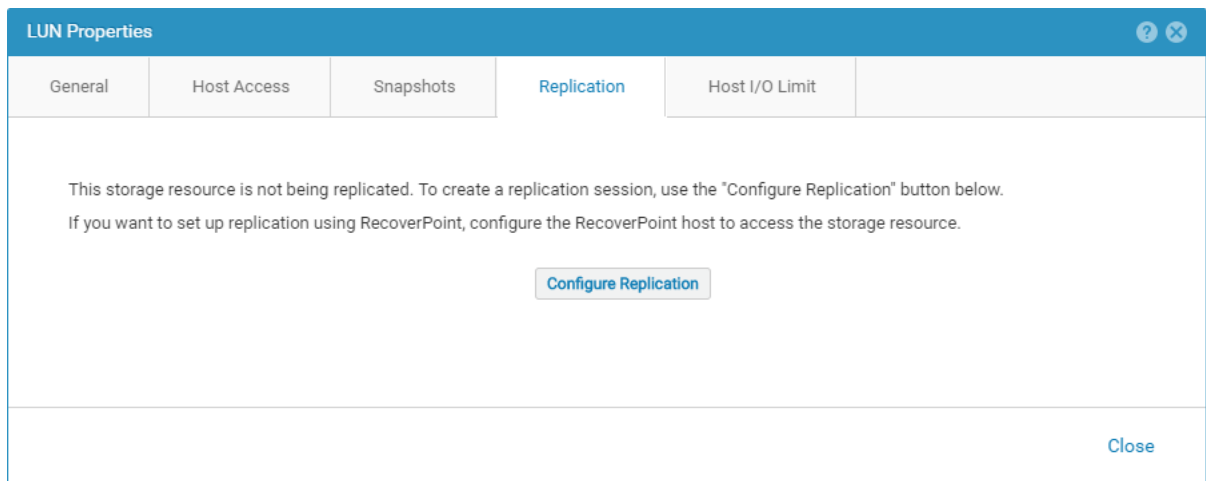


Figure 14 Replication Not Configured

After selecting **Configure Replication**, the **Create a Session** wizard is launched. An example of this wizard is shown in Figure 15. On the **Replication Settings** step, you need to customize which **Replication Mode** either Asynchronous, Manual, or Synchronous replication will be used. For Synchronous Replication, select Synchronous. Next, select the destination system by selecting the correct system in the **Replicate To** drop down box. After the previous selections have been made, click **Next**.

The screenshot shows the 'Create a Session' wizard with the following details:

- Header:** Create a Session
- Navigation:** Replication Settings (selected), Destination, Summary, Results.
- Section:** Provide a Replication Mode and RPO
- Fields:**
 - Replication Mode: * Synchronous
 - Replicate To: * FNM00190100444
- Help Text:**
 - To create a remote replication connection, navigate to the Protection & Mobility > Replication > Connections section.
 - To create interfaces for use with remote replication, navigate to the Protection & Mobility > Interfaces section.
 - Ensure that Ethernet ports, link aggregations and FSN ports with same names are available on destination, otherwise use override to change port assignment to NAS interfaces.
- Buttons:** Cancel, Next

Figure 15 Create a Session

The **Destination** step of the **Create a Session** wizard is now shown. An example of this step is shown in Figure 16. From here you can customize the storage resource's **Name** that will be displayed on the destination system, the **Pool** it will utilize, and the **Tiering Policy** on the destination system's Pool. For existing storage resources, you will be able to customize this exact same information. Similarly, when creating a replication session on an existing Consistency Group, you will be able to customize this same information for each LUN contained within the consistency group. After editing the available information, click **Next**.

The screenshot shows the 'Create a Session' wizard with the following details:

- Header:** Create a Session
- Navigation:** Replication Settings, Destination (selected), Summary, Results.
- Section:** Provide destination storage resource info
- Fields:**
 - Name: * LUN
 - Destination System: FNM00190100444
 - Pool: * Pool1 (Dynamic, Extreme Performance Pool, 6.3 TB free)
 - Size(GB): 100.0
 - Thin
 - Data Reduction
 - Advanced Deduplication
- Buttons:** Cancel, Back, Next

Figure 16 Create a Session - Destination

The **Summary** step is now shown, and an example of this screen is displayed in Figure 17. Here you can see a summary of the settings that will be used to create replication. If anything is incorrect, you can select **Back** to correct the desired setting. To create the replication session, click **Finish**. A Summary step will also be shown when creating a replication session on other supported storage resources.

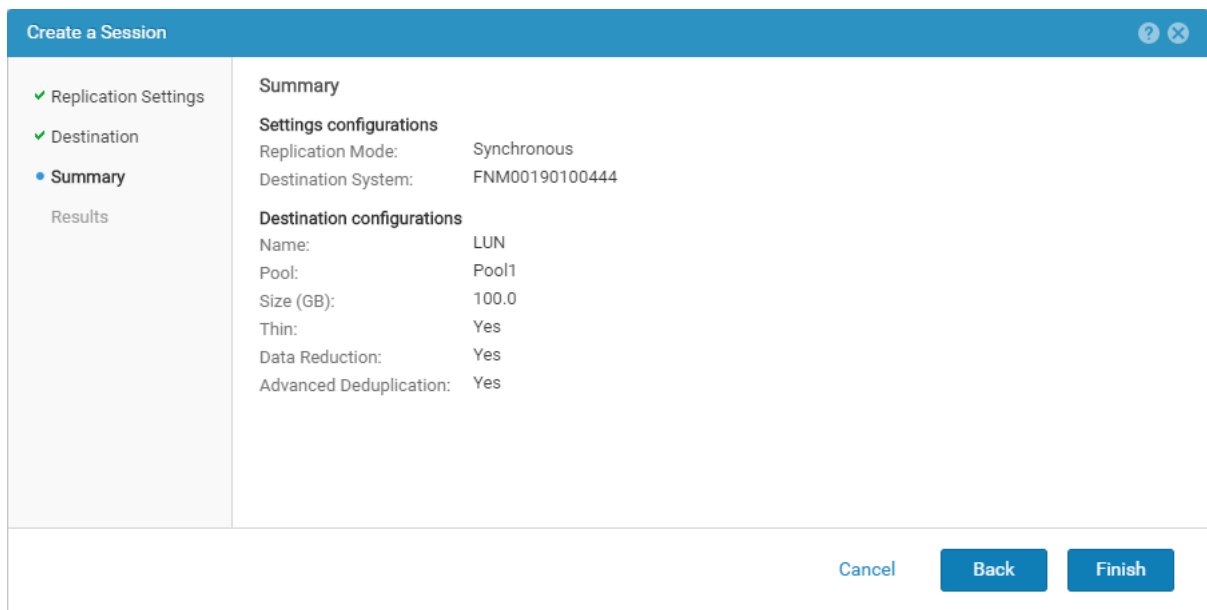


Figure 17 Create a Session - Summary

The **Results** step is now shown, and an example of this page is shown in Figure 18. This step shows the **Overall Status** of each of the jobs to create the replication session. The steps to create the replication session include creating the storage resource on the destination system, allowing the remote storage resource to finish the creation process, and lastly creating the replication session. You can either wait for the Overall status to say 100% Complete or close the window at any time by clicking **Close**. Closing this window will not impact the creation process since it is a background job in Unisphere.

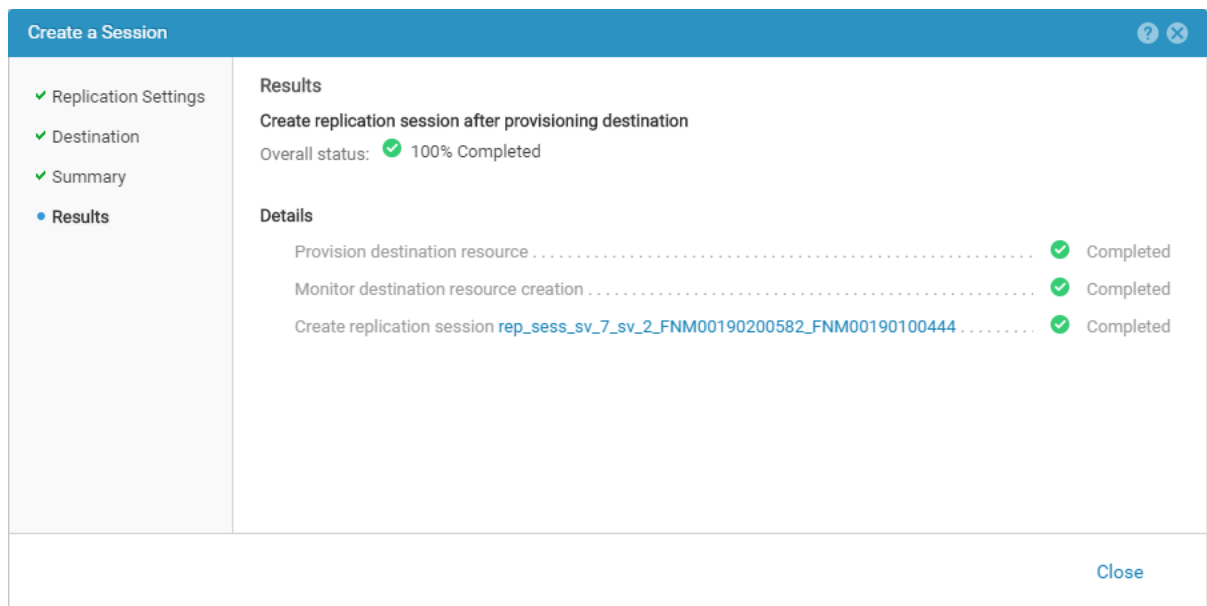


Figure 18 Create a Session - Results

Figure 19 shows the **Replication** tab in the LUN properties window after enabling replication. After enabling replication on an existing device, a full synchronization needs to be completed. During this process, the **Sync State** shows **Syncing**, and the **Sync Progress** displays the overall percentage of progress. This operation may take time and will be based on the amount of data that is needed to be copied to the remote system, and the available bandwidth of the link between the systems.

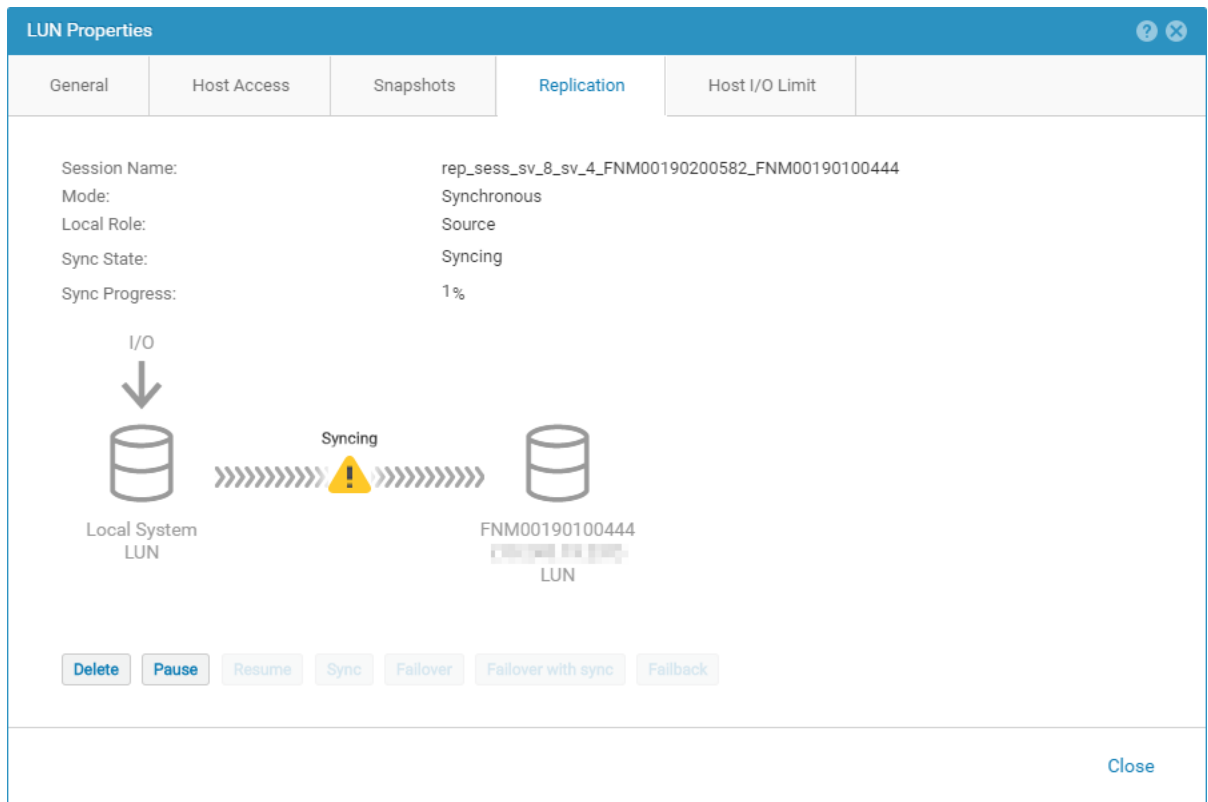


Figure 19 Synchronizing

Figure 20 shows the Replication tab after the full synchronization. Notice that the **Sync State** now shows **In Sync**, and the **Sync Progress** entry has been removed.

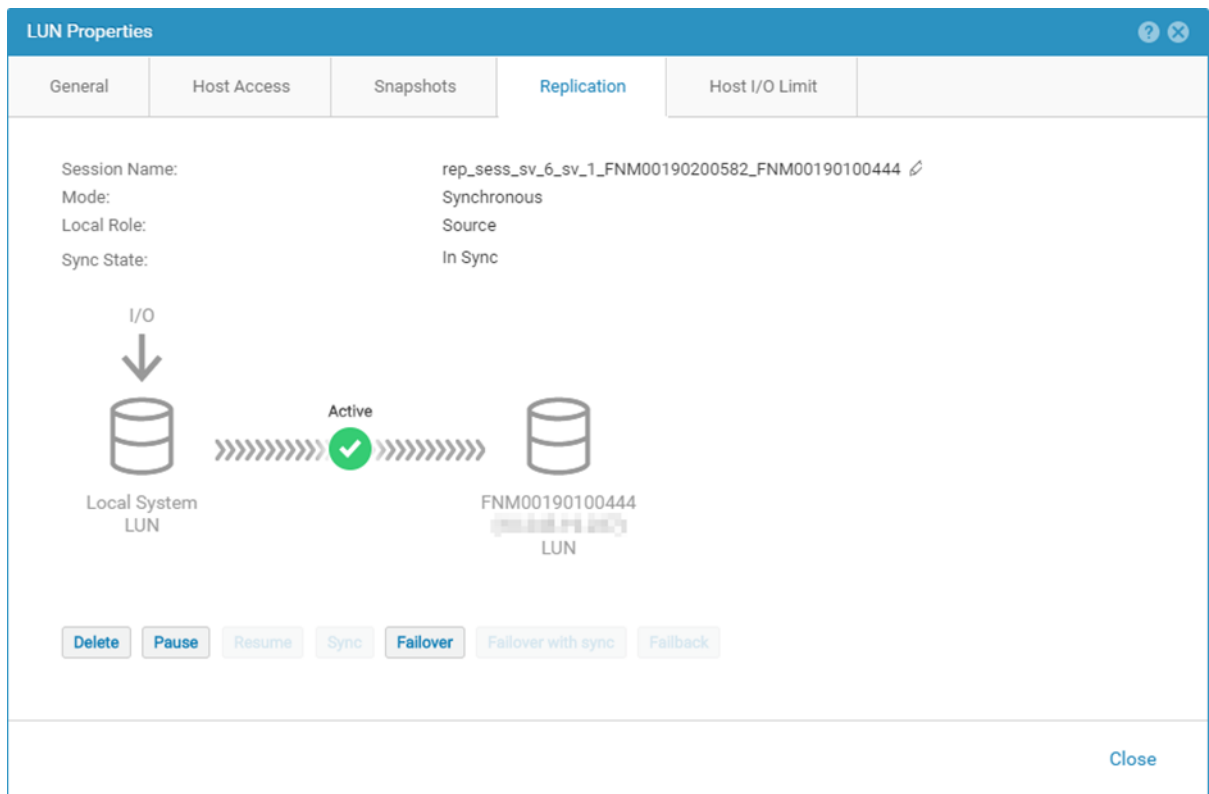


Figure 20 In Sync

2.6.5 Viewing the Replication Sessions

All replication sessions on the system can be viewed from the **Sessions** tab within the Replication page. This includes synchronous, asynchronous, and manual replication sessions. To navigate to this page, click **Replication** under **Protection & Mobility** in Unisphere. For releases prior to Dell EMC Unity OE version 4.1, the **Replication** page can be found under **Data Protection**. Figure 21 shows an example of the **Sessions** tab with multiple replication sessions created on the system. In this example, multiple LUNs, a Thin Clone, a Consistency Group, and a VMware VMFS Datastore are all being replicated to a remote system. From this window you can easily see information regarding each session. The following is a list of information displayed on this screen:

- The Replication Session **Name**
- The current **State**
- The **Source**, which includes the source system and the source storage resource
- The **Resource Type**
- The **Destination**, which includes the destination system name and the destination storage resource
- The Replication Session **ID**

	!	Name	State	Source		Resource Type	Destination		id
				System	Resource		System	Resource	
<input type="checkbox"/>	✓	rep_sess_res_20_re...	Active	Local System	VMware_VMFS_Sync...	VMware (VMFS)	DisasterRecovery	VMware_VMFS_Sync...	8160437863...
<input type="checkbox"/>	✓	rep_sess_res_21_re...	Active	Local System	CG_SyncRep	Consistency Group	DisasterRecovery	CG_SyncRep	8160437863...
<input type="checkbox"/>	✓	rep_sess_sv_14_sv_...	Active	Local System	SyncRep_LUN	LUN	DisasterRecovery	SyncRep_LUN	4294967561...
<input type="checkbox"/>	✓	rep_sess_sv_15_sv_...	Active	Local System	Marketing_LUN	LUN	DisasterRecovery	Marketing_LUN	4294967561...
<input type="checkbox"/>	✓	rep_sess_sv_16_sv_...	Active	Local System	ThnClone_SyncRep	LUN	DisasterRecovery	ThnClone_SyncRep	4294967563...

Figure 21 Replication Sessions

From the **Sessions** tab you can also issue replication operations on the sessions. After selecting the checkbox for a replication session in the list, select **More Actions** to view the replication operations available for that session in its current state. In Figure 22 below, you can see that only **Pause** and **Failover** are valid options based on the currently selected resource's replication session state.

Sessions Connections									
More Actions ▾									
	!	Name	State	Source		Resource Type	Destination		id
				System	Resource		System	Resource	
<input checked="" type="checkbox"/>	✓	rep_se	Active	Local System	VMware_VMFS_Sync...	VMware (VMFS)	DisasterRecovery	VMware_VMFS_Sync...	8160437863...
<input type="checkbox"/>	✓	rep_se	Active	Local System	CG_SyncRep	Consistency Group	DisasterRecovery	CG_SyncRep	8160437863...
<input type="checkbox"/>	✓	rep_se	Active	Local System	SyncRep_LUN	LUN	DisasterRecovery	SyncRep_LUN	4294967561...
<input type="checkbox"/>	✓	rep_sess_sv_15_sv_...	Active	Local System	Marketing_LUN	LUN	DisasterRecovery	Marketing_LUN	4294967561...
<input type="checkbox"/>	✓	rep_sess_sv_16_sv_...	Active	Local System	ThnClone_SyncRep	LUN	DisasterRecovery	ThnClone_SyncRep	4294967563...

Figure 22 Replication Actions

2.7 System Maximums

Please see *Appendix A: Replication Maximums* for information on Dell EMC Unity replication maximums.

3 Native Asynchronous Replication

This section will discuss the Native Asynchronous Replication feature found on Dell EMC Unity systems. This feature allows users to create replication sessions for block and file storage resources between Pools within a system or between supported systems. All configuration and management operations in this section will be illustrated in Unisphere, though Unisphere CLI and REST API may also be used. The following sections of this paper will discuss:

- The licensing requirements for native asynchronous replication feature
- How native asynchronous replication feature works
- The configurations supported for asynchronous replication
- Unisphere Configuration and management

3.1 Licensing

Asynchronous Replication is supported on all Dell EMC Unity systems. The supported systems include the All Flash models, the Hybrid models, and the Dell EMC UnityVSA. For all systems, Asynchronous Replication comes included at no additional cost.

3.2 Theory of Operation

Native asynchronous replication is comprised of a number of physical and software components. Each of these components will be discussed in the following sections. When creating asynchronous replication between Pools within a system, only a replication session needs to be created. To fully configure asynchronous replication between systems, you must do each of following:

- Configure connectivity for the replication interfaces used by asynchronous replication
- Configure the replication connection between systems
- Configure replication sessions between systems

This section will also discuss the various block and file resources which support asynchronous replication. The replication modes and roles will also be discussed. The sections below outline the different functions, requirements, and how these components interact with each other. Configuration and management of these components will be completed using Unisphere, which will be discussed in the *Unisphere Management* section.

3.2.1 Replication Interfaces

Replication interfaces are used to transport data to a destination system for remote replication sessions and must be defined for replication to work. Asynchronous replication between Pools within a system do not require replication interfaces to be configured. Asynchronous remote replication requires a replication interface be created on each SP on the system. For asynchronous replication, replication is performed over Ethernet interfaces configured on the system. On Dell EMC Unity physical systems, the onboard 10GbE BaseT ports, CNA ports with Ethernet personality, or Ethernet ports located on I/O modules, including 10GbE BaseT ports and 10GbE Optical ports, can be used for replication. In Dell EMC UnityVSA systems, any I/O port can be used for asynchronous replication. Replication interfaces can also be created on link aggregated ports for high availability, increased maximum throughput, and load balancing of replication traffic across physical ports in the aggregation. It is suggested to only configure replication interfaces on ports of the same type and speed. In order to have a successful asynchronous replication connection, all the asynchronous replication ports on a source system must be able to see and/or route to all the asynchronous replication ports

on the destination system, and vice versa. It is recommended to dedicate the replication interfaces strictly for replication purposes, but it is not required, and hosts can also utilize these ports.

3.2.2 Replication Connections

Before a remote replication session can be created, a trusted link must be created between systems participating in replication. A replication connection establishes this logical link between remote systems. This trusted link is used for replication management operations and the data path between the pair of remote systems. After the replication interfaces are created, you must create the replication connection between the systems. Once created, all asynchronous remote replication sessions will utilize the replication connections to transport data to the remote system. Figure 23 below shows an example configuration of an asynchronous replication connection between two physical systems. In the figure, the source of the replication session is labeled “Production System”, and the destination is labeled “DR System”. For each of these example systems, the onboard CNA ports are configured as 10GbE optical ports and are used as replication interfaces. The green lines in the figure show the connections for the 10GbE replication interfaces, and the orange lines are the system management connections. Once the replication interfaces are created and cabled to the network on both systems, the replication connection between the systems can be made. Once a replication connection is configured on one of the systems participating in replication, it is automatically created on the peer system.

Verify and Update is a single operation that is used to update the replication connection information on the system it is issued on. This operation is performed on the replication connection itself, as opposed to an individual replication session. Verify and Update can be used to test a replication connection to a remote system or update the replication information if changes to the system have been made. Verify and Update should be issued to re-establish the replication connection to a remote system after an outage. A use case for using Verify and Update is if an Asynchronous Replication Interface IP Address has been changed on the system.

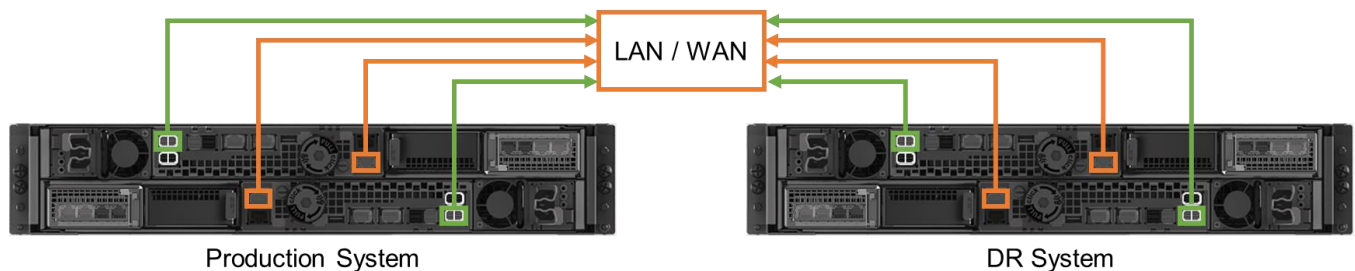


Figure 23 Native Asynchronous Replication Example

3.2.3 Replication Sessions

A replication session is used as a logical link between storage resources participating in replication. When utilizing asynchronous remote replication, a configured replication connection is used to transfer data to the remote system. A replication connection is not required when asynchronously replicating data between Pools within a system. When a replication session is created in Unisphere, a storage resource of the same size and type is created on the destination Pool, whether it is locally within the same system or on a destination system. Snapshot schedules are not replicated on the destination storage resource.

Asynchronous replication image synchronizations are triggered by a user defined Recovery Point Objective (RPO) or at any time manually by the user. The following characteristics define asynchronous replication:

- Writes to a storage resource are saved to the source storage resource and acknowledged to the host before being replicated to the destination storage resource.
 - When a host writes to a storage resource, the write is saved and tracked by the replication session. This data will be replicated at a later time.
- A user defined RPO is utilized to define the maximum amount of time between scheduled synchronizations.
 - During the time between synchronizations, new data is only saved on the source storage resource. The RPO is the maximum amount of data the user is willing to lose in the event of a disaster, measured in time. The RPO determines how often synchronizations occur at a minimum.

Manual replication operates the same as asynchronous replication, except all replication updates must be started manually by the user as opposed to using an RPO. Updates occur when the sync operation is initiated on the session, which is described later. When writing to a storage resource configured with a manual replication session, the data is stored locally and acknowledged and only replicated when a sync is issued.

When an asynchronous replication session is created, a full synchronization of the source and destination storage resource occurs. If replication is configured when a new resource is being created, the synchronization is quick as no data needs to be copied to the destination storage resource. If replication is added to an existing storage resource, a full synchronization occurs between the source and destination storage resource. Writes occurring during the initial synchronization period are not copied to the destination storage resource at this time, but rather tracked for a later synchronization. Once the initial synchronization is complete, a common base is established between the source storage resource and the destination. When creating a manual replication session, an initial synchronization does not automatically start. To synchronize the local and remote images, a manual sync needs to be initiated. Host write operations which occur after the initial synchronization are acknowledged with the host normally, and no data is replicated to the destination until the next sync. Manually at a later time, or at the RPO interval for asynchronous replication, all changes made to the source storage resource since the last synchronization will be replicated to the destination. A new common base is then established. If a failure is encountered on the source, all data not copied to the destination will be lost as the changes have not been copied to the destination.

3.2.4 Asynchronous Replication Internal Snapshots

Asynchronous replication in Dell EMC Unity leverages Unified Snapshots to maintain the common base images explained in the previous section. Figure 24 below shows how Unified Snapshots are utilized with asynchronous and manual replication.

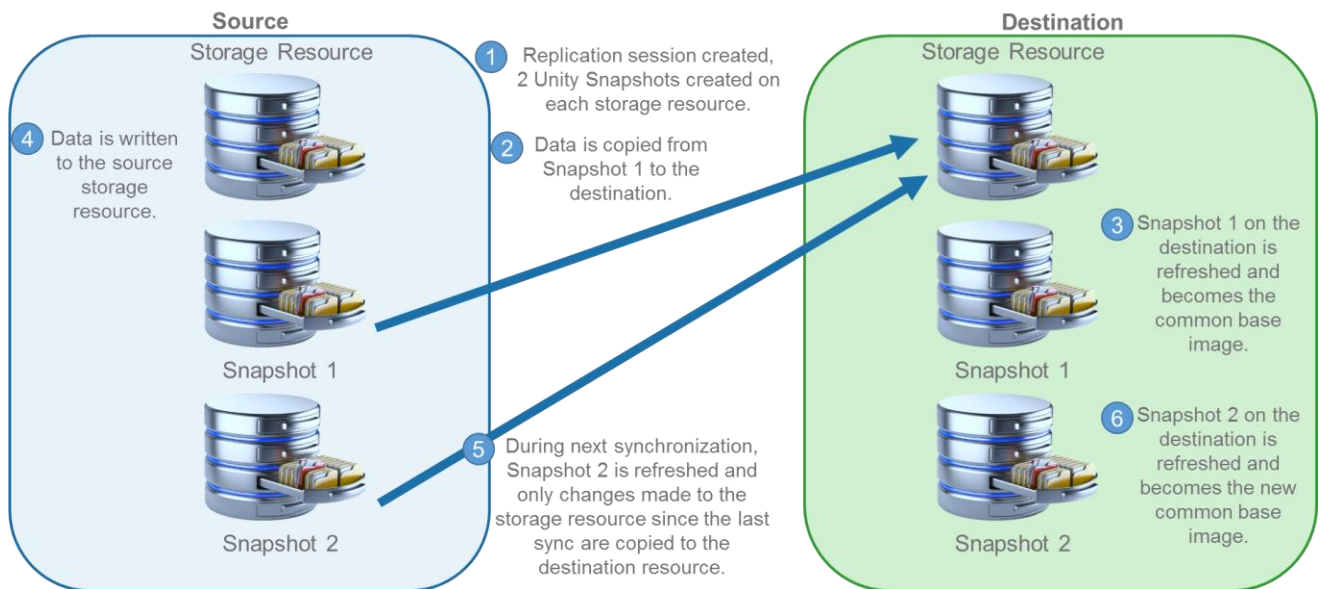


Figure 24 Asynchronous and Manual Replication Theory

Dell EMC Unity Asynchronous Replication operates in the following way:

1. When a replication session is created on a storage resource, two internal Unified Snapshots are created on the source and destination storage resources. At time of creation, Snapshot 1 and Snapshot 2 on the source have the same contents as the source storage resource.
2. Data is then replicated from Snapshot 1 to the newly created destination storage resource. This is the initial synchronization of the source and destination storage resources and is a full copy of all the data.
3. Once the initial synchronization is complete, Snapshot 1 is refreshed on the destination storage resource. Snapshot 1 on the source and destination storage resource contain the same information and represent the point-in-time in which the synchronization started. Snapshot 1 on each system is now a common base for the replication session.
4. Over time the host application writes new data to the source storage resource.
5. During the next update, either manually started or by the RPO with asynchronous replication, Snapshot 2 on the source storage resource is refreshed to reflect the current point-in-time view of the source storage resource. All changes since the last update of the destination are copied to the destination storage resource.
6. After the incremental copy is complete, Snapshot 2 on the destination storage resource is refreshed to reflect the current information located in the destination storage resource. Snapshot 2 on the source and destination contains the latest information and are the latest common base image for the replication session.

Each time the RPO is reached or a manual update is started, the common base image will alternate between Snapshot 1 and Snapshot 2.

Snapshots utilized for asynchronous replication behave the same as user Unified Snapshots and are based on Redirect on Write Technology. Space needed to preserve the point-in-time Snapshot is allocated from the same Pool as the source storage resource. Although user snapshots and replication snapshots share the same technology, replication snapshots have restrictions on their usage. Replication snapshots can be viewed in Unisphere, but user operations, such as restore, or mount operations are not allowed. Snapshots allocated for replication purposes do not count towards user snapshot maximums.

3.2.5 Storage Resources

When configuring asynchronous replication, the source and destination storage resource must be of the same type. In Dell EMC Unity, native asynchronous replication is supported on the following storage resources:

- LUNs
- Thin Clones
- Consistency Groups
- VMware VMFS Datastores
- File Systems
- NAS Servers
- VMware NFS Datastores

In Dell EMC Unity, asynchronous replication for LUNs, Thin Clones, and VMware VMFS Datastores function the same. When configuring asynchronous replication on a LUN in Unisphere, a single replication session is created, and the destination storage resource will be created the same size and type as the source storage resource. When configuring replication session on a Thin Clone, the destination storage resource will be a regular storage resource and not a clone. While replication is configured, you will be able to extend the size of LUNs, Thin Clone, and VMware VMFS Datastores, and the changes will be reflected on the destination storage resource after the next sync. Options such as the LUN's, Thin Clone's or VMware VMFS Datastore's name or tiering policy may be configured differently between systems.

In Dell EMC Unity, a Consistency Group is a storage resource which contains one or more LUNs within a storage system. Consistency Groups help organize storage resources allocated for a particular host or hosts. Consistency Groups are treated as a single entity when they are replicated, meaning that a single replication session is created for the entire Consistency Group no matter how many LUNs it contains. When replication is configured in Unisphere for a Consistency Group, the destination storage resource and its contents are created automatically. While a Consistency group is part of an asynchronous replication session, LUNs within the Consistency Group can be expanded. All changes to LUNs within a Consistency Group will be reflected on the destination image after the next completed synchronization. LUNs cannot be added or removed while replication is configured. When pausing or resuming replication on a Consistency Group, the entire group is affected by the replication operation.

When replicating existing File Systems or VMware NFS Datastores with asynchronous replication, you must first configure replication for the NAS Server it is mounted on. If replication is configured in Unisphere for the NAS Server, all File Systems and NFS Datastores on the NAS Server will also be replicated to the destination. Replication sessions for resources which do not require replication can be deleted later. All replication sessions automatically configured when the NAS Server is replicated will have the same RPO. The RPO for the individual replication sessions can be changed later. While replicated, all size changes to the File Systems and NFS Datastores will be reflected on the destination after the next synchronization. If a different IP address for NAS Server access needs to be specified on the destination NAS Server, you may specify an Override Address by editing a NAS Server Network Interface.

3.2.6 Replication Roles

For asynchronous replication to operate, two storage resources are required for replication:

- A source storage resource which will be replicated
- A destination storage resource to which the source is copied

When a replication session is created in Unisphere, the destination storage resource is automatically created. In Unisphere you may not choose a previously provisioned storage resource as a replication destination when

configuring a session. Upon creation, the destination resource is marked as a destination image. This restriction blocks Read/Write access on the destination storage resource. To view the data contained in the destination storage resource, you may take a Snapshot of the resource and provide host access to the Snapshot.

In Unisphere, you can easily determine which storage resources are replicated and which are destination images from any of the storage resource pages, such as the LUNs tab on the Block page. While in this tab, select the gear icon, and hover over the Columns option to view the available columns that can be viewed. Select the check boxes for “Replication Type” and “Restricted Replication Access”. Replication Type displays what type of replication the storage resource is participating in, whether it is None, Remote, or Local. The Restricted Replication Access column will display “Yes” if the storage resource is labeled as a replication destination resource, or “No” if it is not. If a replication session is deleted, the destination storage resource will still be labeled as a replication destination image. The replication destination label must be edited manually via Unisphere CLI before the resource is allowed to receive I/O. For example, to remove the replication destination setting from a LUN, use the `uemcli /stor/prov/luns/lun -id <value> set - replDest no` command. For more information on removing the replication destination setting on other storage resource types, consult the *Dell EMC Unity Unisphere Command Line Interface User Guide*.

3.3 Replication Operations

A number of operations are available to manipulate replication sessions as needed. Not all operations are available at all times, as some depend on the session being in a particular state. Also, certain operations will perform differently depending on which system they are issued on, source or destination. Only one replication operation can be issued and running at a particular point in time.

3.3.1 Pause and Resume

Pause and resume are used to stop and start replication between the resources for a particular replication session. In Unisphere, the pause operation can only be issued from the source system. If the session is paused while a sync is in progress, all incremental changes on the destination are discarded and the destination is reverted back to the common base. All I/O is tracked when the replication session is paused, and when the session is resumed, replication will resume and synchronizations to the destination storage resource will be based on the current RPO if asynchronous replication is being utilized. When a manual replication session is resumed, no replication updates occur until a manual sync is issued. While an asynchronous and manual replication session is paused, no sync updates can be performed on the session.

The resume option is also available after a failover operation. If a resume operation is initiated, replication begins running in the reverse direction. After a failover, it is possible for changes to be made to the destination resource. When running the resume operation, a checkbox is available to resync and overwrite any data written to the remote system. This checkbox may be necessary in situations where there are different changes on each system. The administrator must acknowledge they want replication to overwrite any changes made to the other system before the resume operation can complete successfully, as shown in Figure 25.

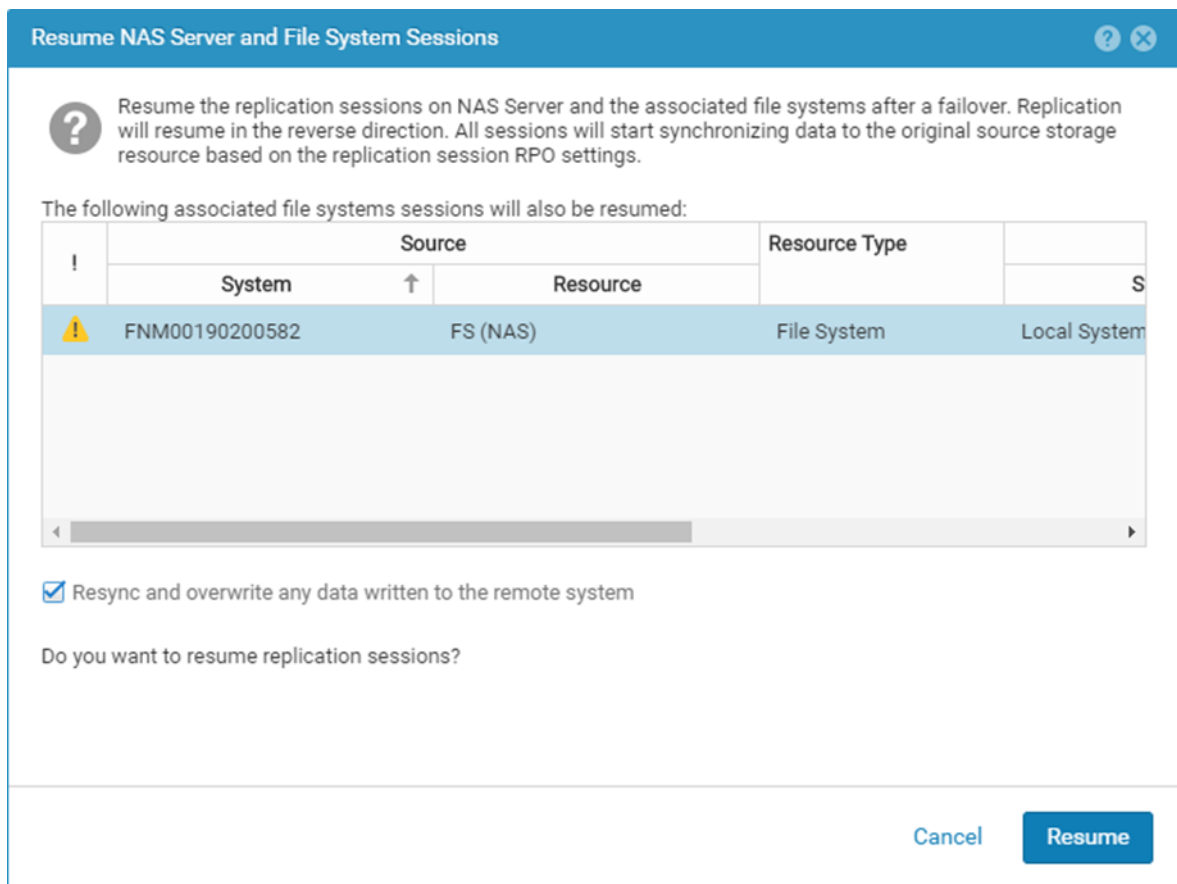


Figure 25 Resume with Resync

Pausing a replication session may be done for a number of reasons to stop updates from occurring to the destination. Some reasons include the need to power off the source or destination system for planned maintenance, a configuration change on the network between systems, or interface changes on either system. Another reason may be to physically move a system from one data center or site to another. In certain circumstances, configuring replication and synchronizing the data between systems may be done within the same site, then the destination system is later moved to its final destination. Depending on the network speeds between sites, this may save time and avoid lengthy initial synchronizations.

3.3.2 Sync

With asynchronous replication, updates to a destination storage resource happen at a set interval based on the defined RPO. At any point in time when replication is active, and an update is not already occurring, a sync operation can be issued to synchronize the latest changes to the destination resource. The sync operation is also used to update a remote image when manual replication is configured. After the sync operation is selected, all data changed since the last update will be copied to the destination storage resource. Issuing a manual sync operation also updates a destination image's size when the source image size has been changed.

3.3.3 Failover with Sync, Failover, and Failback

When utilizing asynchronous replication, the failover with sync option allows you to failover the session after first completing a last synchronization between the images. The failover with sync option is used in planned failover events. The failover with sync option is only available on the source storage resource when the replication session is operating normally and will result in a short period of data being unavailable during the

failover operation. Before issuing the failover with sync operation, it is suggested to issue a manual sync first, to reduce the amount of data to copy during the failover with sync. When issuing the failover with sync, it is highly suggested to quiesce I/O to the source image first. After the synchronization completes, the destination storage resource is available for production I/O and the original source will no longer allow Read/Write I/O. If host access is configured on the destination resource, hosts will be able to access the data at this time. Replication will not be resumed in either direction when the failover with sync operation is used.

The failover option is only available on the destination of the replication session. When issuing a failover operation on a replication session from the destination system, an unplanned failover is initiated, and a final synchronization of the data from the source storage resource is not completed. An unplanned failover assumes a disaster has occurred on the production system, and the destination image is made Read/Write available. When failover is selected on a destination resource of a replication session, Read/Write access is removed from the original source if the source is available to receive management commands. The replication session will also pause and not automatically switch the direction for replication. The replication session is left in this state until the user issues another replication operation. If I/O occurs to the original destination resource while in this state, the data must be replicated to the original source when the source becomes available.

Starting with Dell EMC Unity OE version 5.0, an unplanned failover operation can be initiated even when the replication is in a "Paused" state. Previously, unplanned failover operations were not allowed while the session was in a "Paused" state. Note that any changes made on the source system while the session is paused are not replicated to the destination.

When the failover with sync or failover option is used, the failback option becomes available. Failback restores the replication session to the state before failover with sync or failover was issued. After a failover, it is possible for changes to be made to the destination resource. When running a failback operation, the following options are available:

- **Keep local data changes by updating the remote resource** - Preserves the changes that were made on the destination site by replicating them back to the original source
- **Keep remote data by discarding all the local changes** - Discards any changes made on the destination site after the failover by replicating in the original direction and overwriting any changed data

These options may be necessary in situations where there are different changes on each system. The administrator must acknowledge which changes they want to keep before the failback operation can complete successfully.

Alternatively, running a resume, failover with sync, and another resume from the other system results in the same behavior as the first option. Once the failover with sync operation completes, the original configuration and replication direction is applied. Note that once a resume operation is initiated, the failback option is no longer available since replication is already running in the reverse direction. The failback options are shown in Figure 26.

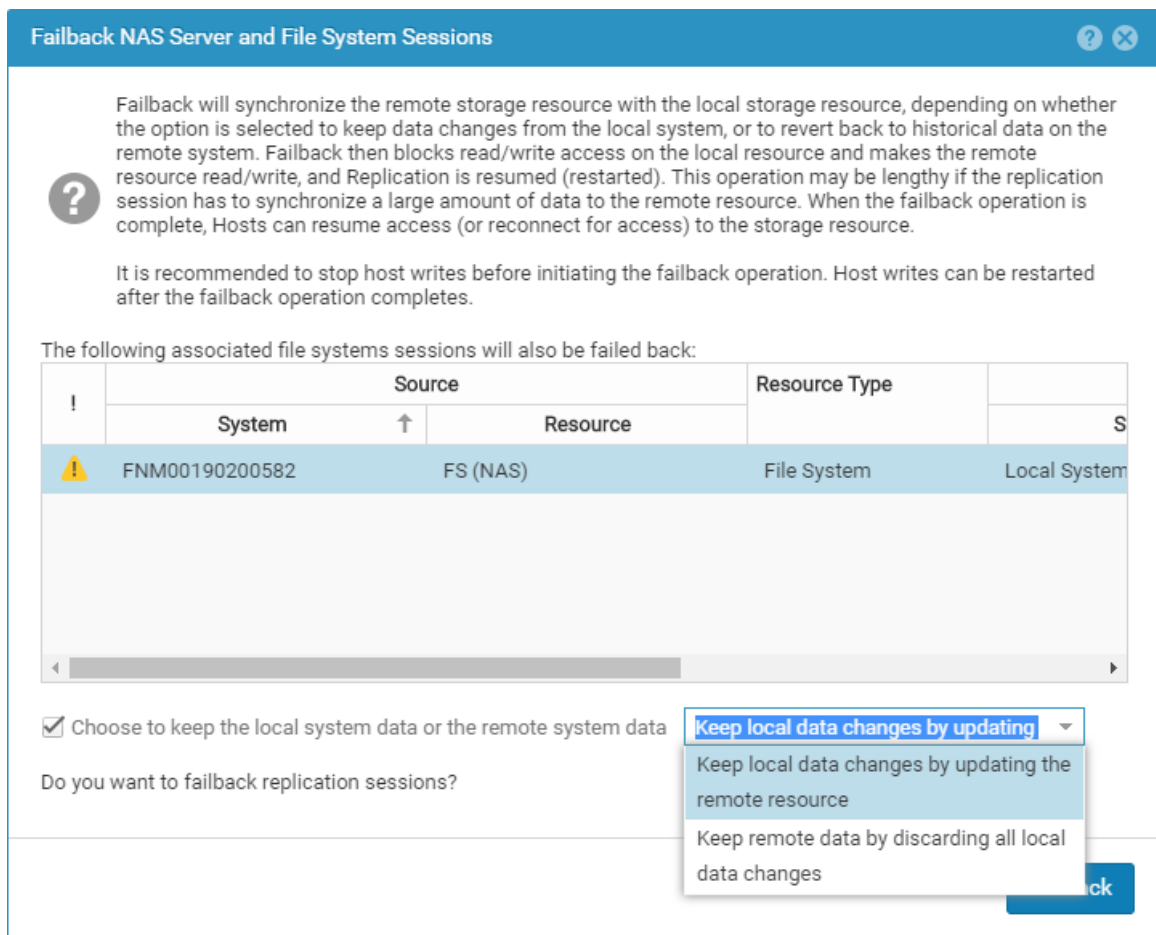


Figure 26 Failback Options

When the original source resource becomes available, the user has the option of issuing the Resume operation to replicate data to the original source. Clicking resume will reverse the direction of replication and resume updates based on the user RPO from the original destination resource to the original source. A manually sync must be issued when using manual replication. To return replication to the original replication configuration, the failover with sync operation can be issued on the original destination. A final synchronization of the data is performed, and the replication will be failed over to the original source. It is suggested to quiesce all I/O before issuing the failover with sync operation. The original source will become Read/Write available and host access will be removed from the destination resource. You will need to issue Resume on the source to resume replication from the source to destination.

3.3.4 Delete

Deleting a replication session can be issued on the source system or destination system, but it is recommended that the operation be issued on the source when the source is available. When there are no issues in the configuration and a delete operation is issued on the source system, the replication session will be deleted from both the source and destination system. The destination storage resource is not automatically deleted when the replication session is deleted. If the delete operation is issued while the destination system cannot be reached, the session will need to be deleted from the destination system manually. If the delete operation is issued from the destination system, the source session is left configured and must be deleted manually. Once a replication session is deleted, a full sync will need to occur if replication is reconfigured.

A delete operation can also be issued for a replication connection. A replication connection can only be deleted after all configured replication sessions utilizing the connection have been deleted.

3.3.5 Group Operations

Dell EMC Unity OE version 4.2, introduces the feature group operations at a NAS Server level. Group operations allow for the replication operation to be propagated from the NAS Server to the file systems automatically, and works with local and remote asynchronous replication. The group operations are available for the following operations: Failover, Failover with Sync, Failback, Pause, and Resume. Note that these operations remain available at the File System level. All other operations (Create, Sync, Delete, and Modify) remain individual commands. Before issuing a failover with sync operation, it is suggested to issue a manual sync first, to reduce the amount of data to copy during the failover with sync.

Do not perform a group operation at both sides of a replication session at the same time. This action is not prohibited by the storage system, however, a group operation performed at the same time at both sides of a replication session can cause the group replication session to enter an unhealthy state. Although a group asynchronous replication session looks like one operation, each File System is replicated individually. If any of the individual File System replication sessions fail, you can resolve the issue and then select the individual File System to replicate. Group operations skips File System replication sessions that are in a paused, error, or non-replicated state. Figure 60 in the *Viewing the Replication Sessions* section provides an example for the group Failover operation.

3.4 Supported Replication Configurations

Dell EMC Unity's Native Asynchronous Replication features allow supported storage resources to be replicated locally within the same system, or remotely between systems. The following sections outline the supported configurations for asynchronous replication. For more information on which systems are supported for asynchronous replication, please review *Appendix B: Replication Support Across Platforms*.

3.4.1 Local Replication

Dell EMC Unity's Native Asynchronous Replication feature allows Block and File resources to be replicated locally within the same system. When replicating File Systems or VMware NFS Datastores, the NAS Server must also be replicated. When configuring local replication, the source and destination storage resources cannot exist within the same Pool. By replicating to a different Pool, a storage resource is protected against the unlikely event the source Pool encounters a data unavailable situation. All asynchronous replication operations are supported when local replication is configured. Replication Connections and Interfaces are not required when local replication is configured. Figure 27 below shows an example of local replication.

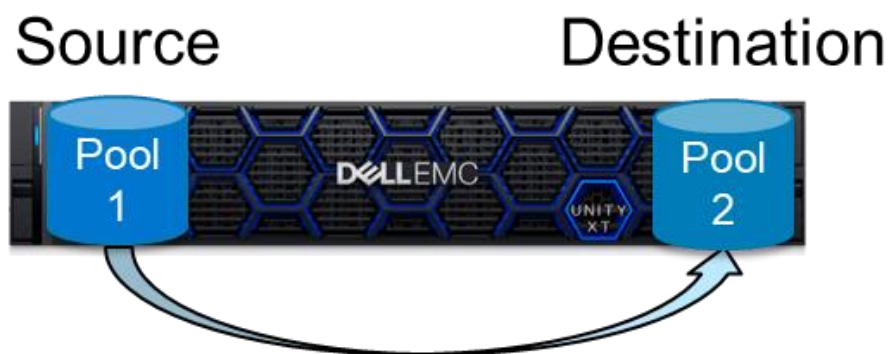


Figure 27 Local Asynchronous Replication

3.4.2 Remote Replication

Dell EMC Unity's Native Asynchronous Replication feature is supported in many different topologies, and deployment models will vary depending on the requirements of the configuration. At a system level, the following configurations are supported:

System Level

- One-Directional
 - A single source system replicating to a single destination system
- Bi-Directional
 - A two-system topology in which each system acts as a replication destination for the peer's production resources
- One-to-Many
 - A system topology in which a single system replicates multiple resources, each to a different remote system
- Many-to-One
 - A system topology in which multiple systems replicate their respective resources to a single system

Figure 28 is a graphical view of the supported topologies listed above. Note the figure uses LUNs to represent the storage resource, but file resources are also supported in these topologies. In all topologies mentioned, a Dell EMC Unity All Flash system, a Dell EMC Unity Hybrid system, or a Dell EMC UnityVSA system can be used for any system in the configuration. For a list of other Dell EMC storage systems supporting asynchronous replication to and from Dell EMC Unity, please see Appendix B. Replication Interfaces are required to be configured on each system participating in remote replication. A Replication Connection also needs to be configured between each system pair to allow replication sessions to be configured. Asynchronous replication allows for many different deployment models to meet the needs of an organization.

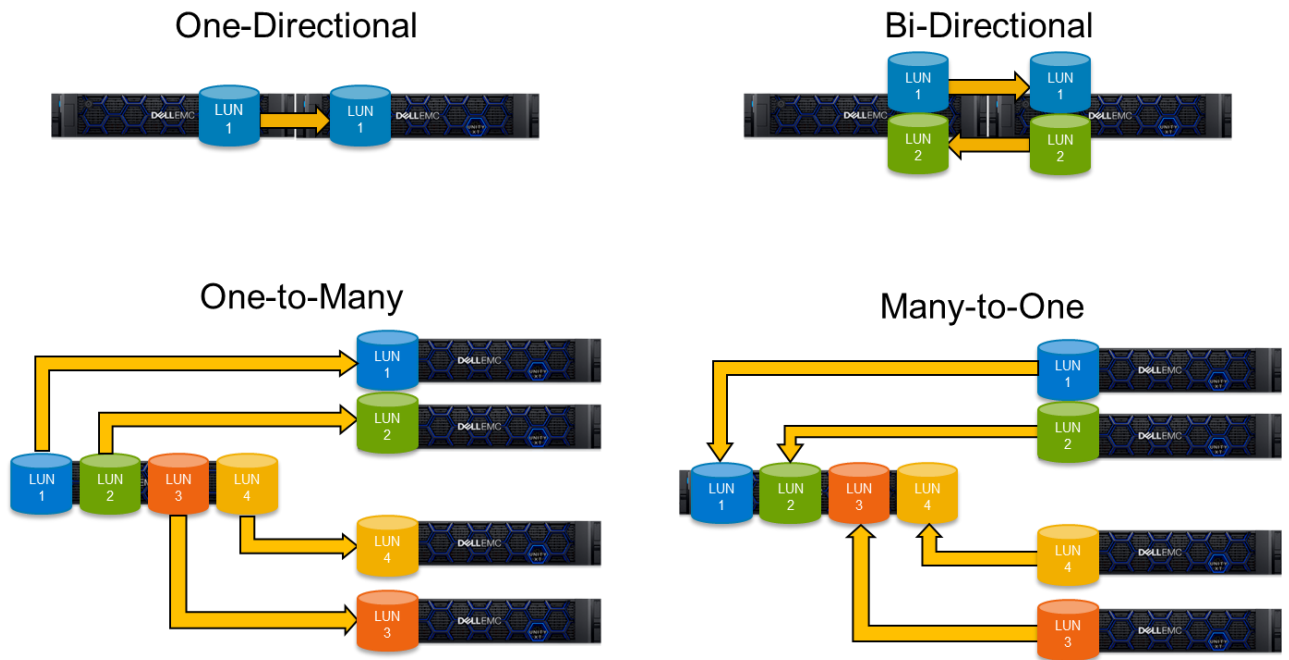


Figure 28 System-Level Asynchronous Replication Topologies

One-Directional replication is typically deployed when only one of the systems will be utilized for production I/O. The second system is a replication target for all production data and sits idle within the same data center or a remote location. If the need arises, the DR system can be placed into production and host production I/O. In this scenario, mirroring the production system's configuration on the DR system is suggested, as each system would then have the same performance potential. For physical systems this would mean mirroring the drive configurations and Pool layout, while on Dell EMC UnityVSA systems this would mean configuring similar Virtual Drives and Pools.

The Bi-Directional replication topology is typically utilized when production I/O needs to be spread across multiple systems or locations. The systems may exist within a single data center or in different, remote locations. When utilizing this replication topology, production I/O from each system is replicated to the peer system. In case of an outage, one of the systems can be promoted as the primary production system, and all production I/O can be sent to it. Once the outage is addressed, the replication configuration can be changed back to its original configuration. This replication topology ensures both systems are in use by production I/O at all times.

The One-to-Many replication topology is usually deployed when production exists on a single system, but replication needs to occur to multiple remote systems. This replication topology can be used to replicate data from a production system to a remote location to provide local data access to a remote team. At the remote location, Dell EMC Unity Snapshots can be utilized to provide host access to the local organization or test team. In this topology, any combination of Dell EMC Unity All Flash systems, Dell EMC Unity Hybrid systems, and Dell EMC UnityVSA systems can be utilized. The production system may be an All Flash system replicating to multiple physical All-Flash or Hybrid systems and/or Dell EMC UnityVSA systems.

The Many-to-One replication topology is deployed when multiple production systems exist and replicating to a single system to consolidate the data is required. This topology is useful when multiple production data sites exist, and data must be replicated from these sites to a single DR data center. One example of this configuration is Remote Office Branch Office (ROBO) locations. A Dell EMC UnityVSA may be deployed at

each ROBO site, and all replicate back to a single All Flash or Hybrid Flash system. Utilizing Dell EMC UnityVSA at ROBO locations eliminates the need for a physical Dell EMC Unity system at each site.

For the One-to-Many and Many-to-One replication topology examples in Figure 28, One-Directional replication is depicted. One-Directional replication is not a requirement when configuring the One-to-Many and Many-to-One replication topologies. Each individual Replication Connection can be utilized for bi-directional replication between systems, which allows for more replication options than what is depicted.

3.4.3 Advanced File Remote Replication

Starting with Dell EMC Unity OE version 5.0, asynchronously replicated file resources can also be configured in advanced replication topologies. This allows for configurations such as fan-out and cascading replication at the granularity of a NAS Server and its associated file resources. Prior to this, these configurations were not supported since asynchronous replication was limited to a single destination. The ability to replicate and store the same dataset on multiple systems provides additional data protection and enables use cases such as content distribution. Note that this feature does not support synchronous replication and is not available for block resources.

In order to use this feature, all systems in the topology must be running Dell EMC Unity OE version 5.0 or later. Replication between Dell EMC Unity OE 5.0 and 4.x is still supported in a one-directional configuration. This feature is available on both physical and virtual Dell EMC Unity systems. The following advanced topologies are supported:

File Resource Level

- One-Directional
 - A single file resource replicating to a single destination resource
 - Example: A → B
- Fan-Out
 - A single file resource replicating to up to four different destination systems
 - Example: A → B and A → C
- Cascade
 - A single file resource replicating to a second system and from there, replicating to a third system
 - Example: A → B → C
- Mixed
 - Leveraging a combination of both cascade and fan-out, or vice versa
 - Example: A → B and B → C and B → D

Fan-out replication configurations allow a file resource to be replicated to up to four different destination systems. Cascading replication configurations allow a destination file resource to be replicated again to another system. Note that when the RPO is reached from B → C, the data that is replicated is based on the last completed sync from A. That means if there is an ongoing sync from A → B when the B → C RPO is reached, the new changes from A are not replicated until the next RPO between B → C is reached.

With cascaded configurations, you can only failover to the directly adjacent site. For example, assume a cascaded configuration from A → B → C. In this configuration, you cannot failover directly from A → C. In

order to accomplish this, you would need to failover from A → B and then failover from B → C. Alternatively, you can failover from B → C directly if a failover with sync from A is not required.

A combination of fan-out and cascading can be configured as long as each resource does not exceed four total replication sessions. When designing replication topologies, it is important to note that a maximum of four total replication sessions can be created for each resource. For example, if you create a cascade from A → B → C, then C can only fan-out to three other systems due to the existing session from B → C. The tested limit for the number of cascaded sessions is three, but there is no hard limit.

Figure 29 shows an example of a supported advanced replication topology. An example of a cascaded topology is replicating from Hopkinton → Boston → London. An example of a fan-out topology is San Francisco → Tokyo and Mexico City. Also shown in the figure is the ability for each session in the topology to have its own custom RPO configured. The valid range for the for the RPO value is between 5 minutes and 1440 minutes (24 hours).

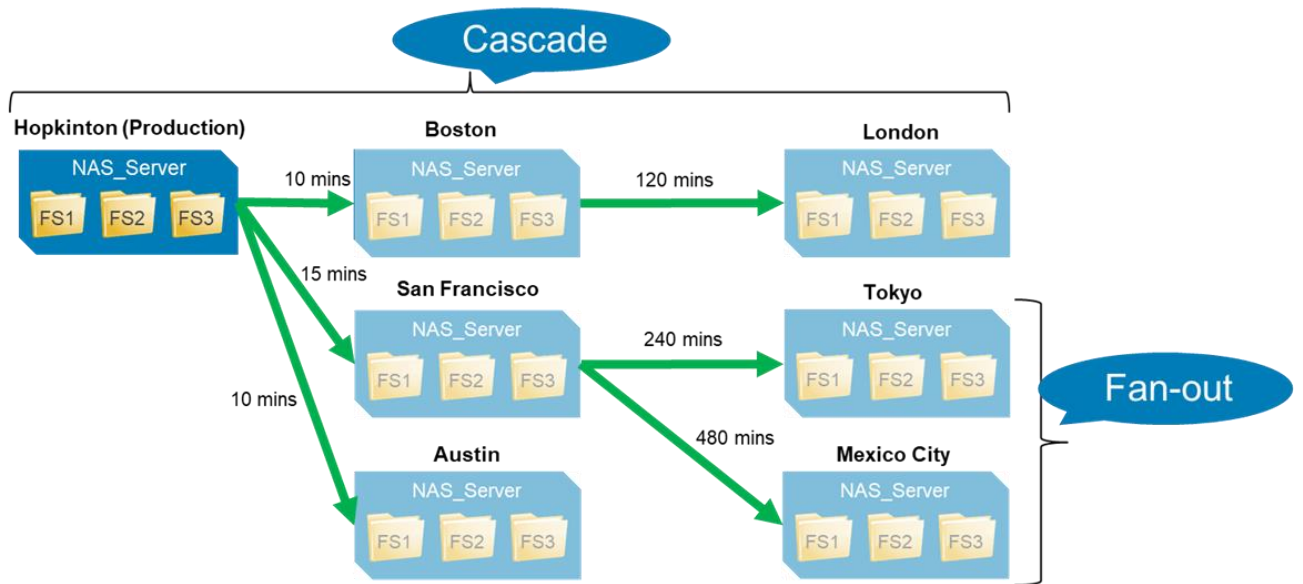


Figure 29 Advanced Replication Topologies

With advanced replication configured, snapshot replication is also supported. For a single storage object, snapshot replication can only be enabled on one session at a time when using advanced replication. For example, if you create a cascade from A → B → C, then either the A → B or B → C session can have snapshot replication enabled, but not both at the same time, as shown in Figure 30.

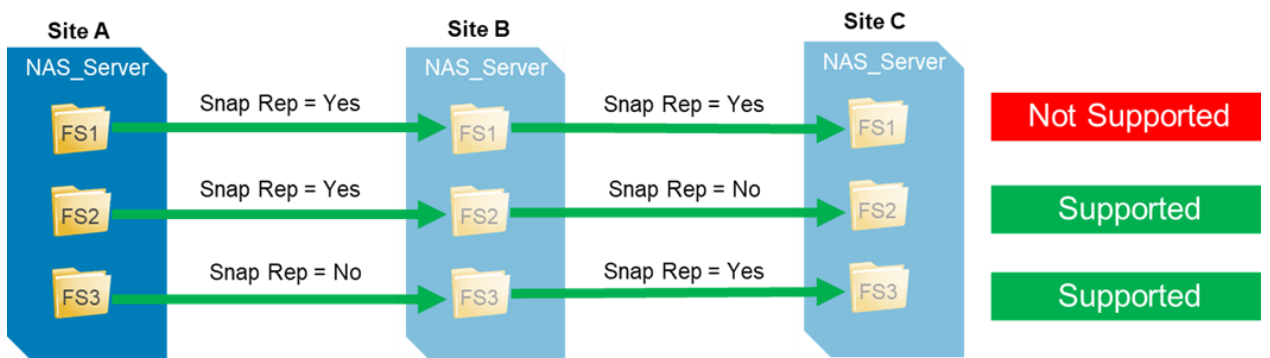


Figure 30 Snapshot Replication Configurations

In this configuration, it is still possible to replicate a snapshot from A → C, but a workaround is required. To accomplish this, following the procedure below:

1. Enable snapshot replication from A → B
2. Replicate the snapshot from A → B
3. Disable snapshot replication between A → B
4. Enable snapshot replication between B → C
5. Replicate the snapshot from B → C

Note that in order to enable or disable the snapshot replication feature, the replication session must first be paused and then the operation must be performed on the source system. This operation can be scripted using UEMCLI or REST API if this needs to be done often.

When configuring a cascaded replication topology that includes four or more systems, it may be possible to enable snapshot replication on multiple sessions simultaneously. This can be accomplished by enabling snapshot replication between A → B, leaving snapshot replication disabled between B → C, and also enabling snapshot replication between C → D. Note that in this configuration, the replicated snapshots for the separate sessions are not consistent with each other.

With a mixed topology, it may be possible to have snapshot replication enabled on multiple sessions. For example, you can create a fan-out from A → B and A → C along with a cascade from C → D. With this configuration, you can enable snapshot replication on both A → B and also from C → D. These configurations are allowed because from each site's point of view, there is still only one session that has snapshot replication enabled. An example of this configuration is shown in Figure 31.

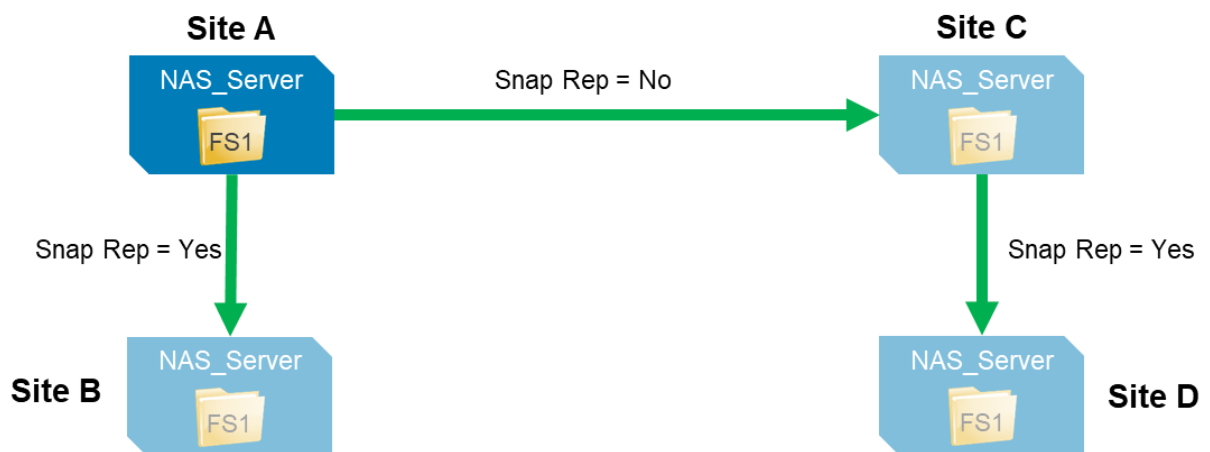


Figure 31 Dual Snapshot Replication Configuration

Advanced replication configurations are also supported with MetroSync's ability to asynchronously replicate to a third site. From the third site, cascaded and fan-out topologies can be configured. Since this feature is not supported for synchronous replication, you cannot cascade or fan-out from the synchronously replicated systems. Figure 32 shows a supported advanced replication topology with MetroSync.

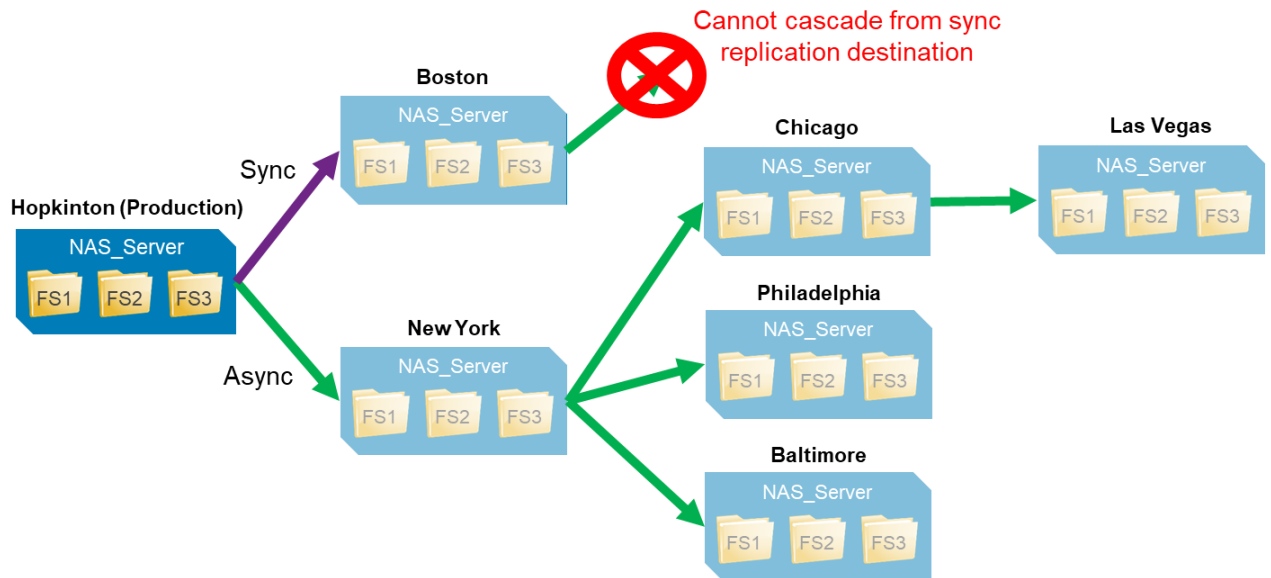


Figure 32 MetroSync with Advanced Replication

Advanced replication topologies can be used in conjunction with Proxy NAS Servers to enable access from any one of the destination systems. This is useful for use cases such as DR testing, test/dev, and analytics. Also, NDMP can be enabled on any one of the systems for backup operations.

Once a replication session is configured between two systems, a second replication session cannot be configured using the same two systems. A fan-out configuration requires each destination system to be unique physical or virtual systems. However, one of the sessions can be configured for local replication to a different pool within the same system. The local replication session counts towards the maximum limit of four sessions for that resource.

It is prohibited to configure a replication session to a resource that is already a replication destination for another resource. For example, assume a fan-out topology with $A \rightarrow B$ and $A \rightarrow C$. In this configuration, you cannot create a replication session from $B \rightarrow C$ as that results in multiple sessions writing to the same destination. You also cannot replicate a resource back to its original source system.

It is also prohibited to create a configuration or run operations that result in multiple systems replicating to the same destination resource. For example, assume a cascaded topology with $A \rightarrow B$ and $B \rightarrow C$. If you initiate a failover from $B \rightarrow C$, you cannot initiate a resume operation in order to start replicating from $C \rightarrow B$.

After advanced replication is configured, it is crucial to properly document the topology for future reference. This is very valuable during disaster scenarios where failing over the correct session is necessary to restore data access and minimize downtime. Each system is only aware of the systems that it is replicating to, so it is unable to provide an end-to-end topology view. Remember to keep this updated if any systems are added, removed, or has its role changed in the topology. For example, if you have a fan-out from $A \rightarrow B$ and $A \rightarrow C$, and a failover is initiated from $A \rightarrow B$. Afterwards, if you resume the failed over session from $B \rightarrow A$, this becomes a cascaded configuration from $B \rightarrow A \rightarrow C$.

Management of advanced replication sessions are performed at the NAS Server level and are automatically propagated to all associated file system sessions that are replicated to the same system. These operations include pause, resume, sync, failover with sync, failover, and failback. When failing over sessions in an advanced topology, it is also important to avoid failing over multiple sessions as that could result in a duplicate IP scenario. For example, you can create a fan-out configuration from $A \rightarrow B$ and $A \rightarrow C$. Initiating

failover operations on both B and C would result in both of those sites turning to production mode and cause a duplicate IP conflict. This could also happen if you initiate a failover from B → C in a cascaded configuration, since both A and C would be running in production mode.

After a failover, it is possible for changes to be made to the destination resource. For example, assume a fanout configuration from A → B and A → C, and a failover from A to B has occurred. In this case, both A and B could have different changes so a normal failback operation fails. The admin must check the box to either preserve any changes made or discard them by overwriting the data in order to successfully failback. The available options are:

- **Keep local data changes by updating the remote resource** - Preserves the changes that were made on B by replicating them back to A, which will also be replicated to C due to the fanout configuration
- **Keep remote data by discarding all local data changes** - Discards any changes made on B after the failover by replicating from A → B and overwriting any changed data

Using the same example as above, a normal resume operation also fails since both A and B could have different changes. In order to successfully resume the session, the admin must check the box to resync and overwrite any data written to the remote system. In this case, B starts replicating its changes to A and overwrites any changes that were made to A. After the resume operation completes, the topology is transformed into a cascaded configuration where B → A → C.

In each of these examples, the original configuration is restored after the failback or resume operation completes. All of the replication updates leverage the internal replication common base snapshots to replicate only the changed data.

3.4.4 MetroSync

In OE version 4.4, Dell EMC Unity supports the ability to use the MetroSync feature, also known as native file synchronous replication, which allows a file resource to be replicated synchronously to one destination system and asynchronously to another destination system simultaneously. For more information, see the *Dell EMC Unity: MetroSync* white paper on Dell EMC Online Support.

3.5 Snapshot Replication

With Dell EMC Unity OE version 4.2, Asynchronous Replication supports the replication of read-only file and block snapshots locally or to a remote site along with the storage resource's data. Both scheduled snapshots and user created snapshots can be replicated. Snapshot Replication can be enabled on all resources that support Asynchronous Replication, including: LUNs, Thin Clones, Consistency Groups, File Systems, and VMware NFS and VMFS Datastores. Snapshot Replication for scheduled snapshots can be enabled or disabled at any time in the lifetime of the replication session. The schedule and user snapshots can be replicated with a remote retention policy that is longer than that of the source resource. For example, the retention policy for the source snapshots might be set for 2 hours while the retention policy for the replicated snapshot might be set for 1 week.

Dell EMC Unity OE version 4.2 introduced the Replicated attribute for all snapshots. This attribute states the replication state for the snapshot. A snapshot can be in one of the following states:

- Yes – The snapshot has successfully transferred to the destination
- No – The snapshot is not marked for replication
- Pending – The snapshot is marked for replication but is awaiting transfer

- Failed – The snapshot failed to replicate

In Dell EMC Unity OE version 4.4 and later, the Replicated attribute was replaced by two separate attributes to account for the introduction of snapshot replication for file synchronous replication resources. In OE 4.4 and later, these two attributes for snapshots are called “Async Replicated” and “Sync Replicated”. The states referenced above are not affected by the introduction of the two new attributes.

Note that replicating a manually created snapshot from a system running Dell EMC Unity OE version 4.2 - 4.4 to a destination system running Dell EMC Unity OE version 5.x is not supported. In order to support this, the source system must be upgraded to Dell EMC Unity OE version 4.5 or later. Upgrading to Dell EMC Unity OE version 4.5 or later is recommended, but not required, if you want to leverage replication without snapshot replication.

For more details in regards operation that can be completed on snapshots, please review the white paper titled *Dell EMC Unity: Snapshots and Thin Clones* on Dell EMC Online Support.

To support snapshot replication, both the source and destination systems must be running Dell EMC Unity OE version 4.2 or later. Snapshots that existed prior to the creation of the replication session can be selected for replication during replication session creation. Snapshots that are older than the last sync (RPO) time can be manually selected for replication and included in the next RPO sync. The *Unisphere Management* section provides more information regarding the configuration and management of snapshot replication.

Additionally, with Dell EMC Unity OE 4.2 and Cloud Tiering Appliance (CTA) version 12, the block snapshots can be archived to and restored from the cloud. For more information on Cloud Tiering Appliance (CTA) and how it works with Dell EMC Unity, please review the white paper titled *Dell EMC Unity: Cloud Tiering Appliance (CTA)* on Dell EMC Online Support.

3.6 Unisphere Management

Creating and managing Replication in Unisphere is easy and intuitive. All replication operations, including configuring of replication network interfaces, replication connections, and replication sessions can be performed in the Unisphere GUI. With the help of easy to follow wizards, replication can be configured quickly by IT generalists or advanced users alike. Replication can also be configured using Unisphere CLI, or REST API. For more information on configuring and managing replication using Unisphere CLI, refer to the *Unisphere Command Line Interface Guide* found on Dell EMC Online Support. For more information on REST API, refer to the *Unisphere Management REST API Programmer's Guide* found on Dell EMC Online Support.

3.6.1 Configuring Replication

When configuring remote asynchronous replication, the following components need to be configured and were previously discussed in the paper:

1. Replication Interfaces
2. A Replication Connection
3. A Replication Session

Note: When configuring local replication between Pools on a system, Replication Interfaces and a Replication Connection do not need to be configured on the system.

The following sections will outline the remaining steps needed to configure remote replication in Unisphere. Each of the following operations are completed from a particular page in Unisphere. Each page will be

discussed in detail below. For more information on using Unisphere to configure and manage replication, refer to *Unisphere Online Help*.

3.6.2 Creating Replication Interfaces

Mobility Interfaces may be shared network interfaces for import and replication-related data or management traffic using the virtual management port. In this section the mobility interfaces will be referenced as replication interfaces. To create replication interfaces, you must first navigate to the **Interfaces** page, which is found under **Protection & Mobility** in the left pane in Unisphere. Creating replication interfaces is completed on the **Interfaces** page. For releases prior to Dell EMC Unity OE version 4.1, the **Interfaces** can be found as a tab in the **Replication** page, under **Data Protection** in the left pane.

Figure 33 below shows the Unisphere Interfaces page. From this page, you have the option to create or delete replication interfaces, refresh the current page, or edit a configured replication interface. In the example below, no replication interfaces have been created. One or more pairs of replication interfaces need to be created on the source and destination system to configure remote replication.



Figure 33 Interfaces Page

To create a replication interface for remote replication, click the **Create Interface** button, shown as a + sign in the Interfaces page. Once selected, the **Create Interface** wizard appears, which is shown on the left in Figure 34. For remote replication, you must create replication interfaces on the system, which are used for connectivity between the source and destination system. In the **Ethernet Port** drop down list, select an available port. The status of the ports will be shown in parenthesis. Both ports on each SP will need to be cabled to the network for these links to work properly. Figure 34 also shows an example of the Ethernet Port drop down choices on a physical system. All Ethernet ports are available to create a network interface. Also shown are Link Aggregation ports previously created on the system.

Next, configure an IP address for SPA and SPB to be used for the replication interfaces. Once done, click **OK**.

The 'Create Interface' window is a modal dialog with a blue header. It contains two sections for configuring interfaces on different storage processors. The first section is for 'Storage Processor: SPA' and the second is for 'Storage Processor: SPB'. Each section has three input fields: 'IP Address', 'Subnet / Prefix Length', and 'Gateway'. Below these sections is a 'VLAN ID' field with a 'Set' button. At the bottom right, there are 'Close' and 'OK' buttons.

Figure 34 Creation Interface Window

Once the replication interfaces are created, they will be shown on the Interfaces page as shown in Figure 35. From here the status of each port is shown, currently operating normally as denoted by the green circle checkmark. To delete a replication interface, select the port and click the **Delete Interface** icon, which is shown as a trash can on this tab. To edit a replication interface, to change the IP address for example, select the **Edit** icon, which is shown as a pencil icon on this tab.

Interfaces						
+ 🗑️ ↻ 🖋️						
<input type="checkbox"/>	!	Ethernet Port	↓ SP	IP Address	Subnet Mask / Prefix Length	Gateway
<input checked="" type="checkbox"/>	✓	Sync Replication Management Port	SP A	192.168.1.1	255.255.255.0	192.168.1.1
<input type="checkbox"/>	✓	Sync Replication Management Port	SP B	192.168.1.2	255.255.255.0	192.168.1.2
<input type="checkbox"/>	✓	Ethernet Port 2	SP A	192.168.1.3	255.255.255.0	192.168.1.3
<input type="checkbox"/>	✓	Ethernet Port 2	SP B	192.168.1.4	255.255.255.0	192.168.1.4

Figure 35 Replication Interfaces

3.6.3 Creating a Replication Connection

The next step in configuring remote replication is to create a Replication Connection with another system. This configures a private replication connection for the pair of systems. On the Replication page, multiple tabs exist, including Sessions and Connections. From the **Replication** page, select the **Connections** tab. Figure 36 below shows an example of the **Connections** tab, without any replication connections configured. From this tab, you have the option to create or delete a replication connection, refresh the current page, or edit a configured replication connection. From this tab you can also select **Verify and Update**, which will verify the selected replication connection still exists with the remote system, and update the connection details if any changes were made.

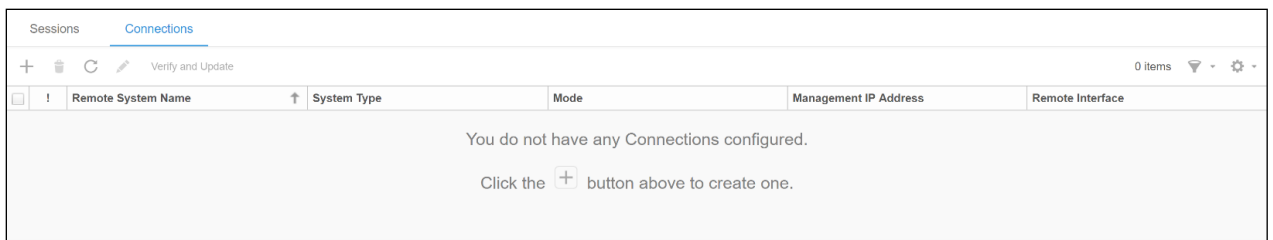


Figure 36 Replication Connections

To create a Replication Connection for remote replication, select the **Create Replication Connection** icon, which is displayed as a + sign on this tab. The **Create Replication Connection** window appears, as shown in Figure 37. In this window, you must specify the Remote System's **Management IP Address**, which is the IP used to access Unisphere, and the Unisphere **User Name** and **Password**. Also, in this window you must enter the **Password** used to log into Unisphere on the system you are configuring the replication connection in. Lastly, you must select the **Connection Mode** that will be used between the systems. In the drop-down list, you have the option to choose **Asynchronous**, **Synchronous**, or **Both**. When configuring asynchronous replication between two systems, select **Asynchronous**. If synchronous and asynchronous replication will be used, select **Both**. After entering the required information, click **OK**.

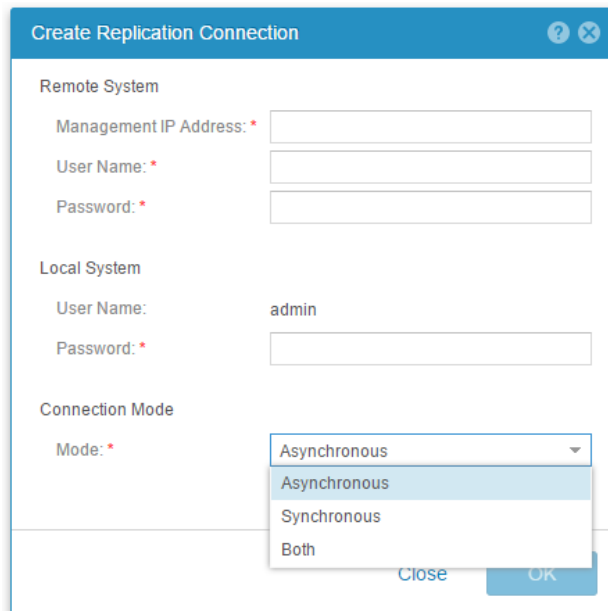


Figure 37 Create Replication Connection Window

After selecting **OK**, a Job is created to create the replication connection. An example of the properties of the job can be seen in Figure 38. The job has multiple steps, which includes registering the remote and local system with its peer, refreshing the connection on both systems, and validating the connections on the local system. Once the job completes, the replication connection will be shown on the source and destination system.

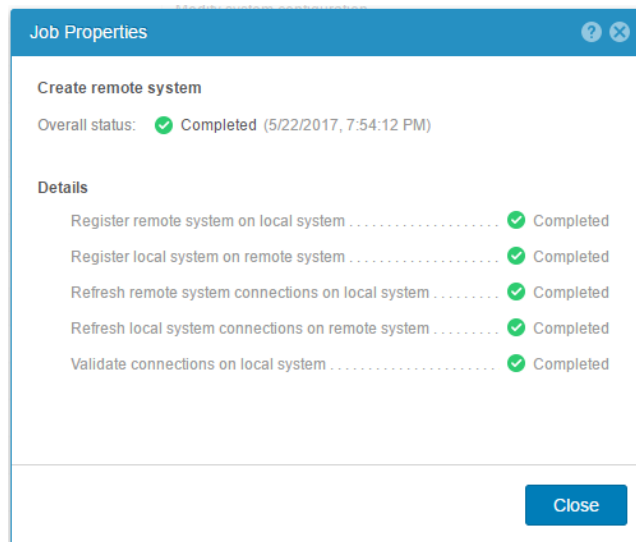


Figure 38 Create Replication Connection Job

Figure 39 shows the Replication page **Connections** tab once the replication connection is created. In this example **DisasterRecovery** is the name of the remote system the connection was configured with. The System Type, Management IP Address, Replication Mode, and Remote Interfaces will also be displayed. The Remote Interfaces displayed will be the IPs for the synchronous replication management ports and asynchronous replication interfaces on the remote system.

Sessions		Connections				
+ [Refresh] [Refresh] [Refresh] Verify and Update						
<input checked="" type="checkbox"/>	!	Remote System Name	↑ System Type	Management IP Address	Mode	Remote Interface
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	DisasterRecovery	Unity 500	192.168.1.100	Synchronous and Asynchronous Replication	192.168.1.120,192.168.1.121,192.168.1.122,192.168.1.123

Figure 39 Replication Connections

3.6.4 Creating a Replication Session

To create a replication session, you must enable replication on the storage resource you wish to replicate. This can be done at time of creation, or on an existing storage resource. Figure 40 shows an example of creating a new NAS Server and enabling Asynchronous remote replication on it. Before File Systems or VMware NFS Datastores can be replicated, the NAS Server must be replicated. From the **Replication** step, check the checkbox in front of **Enable Replication** to configure replication. Shown in Figure 40 are the available Replication Modes when replicating a NAS Server. For asynchronous replication, select **asynchronous** from the **Replication Mode** drop down box and customize the **RPO** as needed. Choose Manual to create a manual replication session. When asynchronous is chosen as the Replication Mode, the **Replicate To** box will automatically be populated with a remote system name asynchronous replication can be configured with. If you wish to replication locally with asynchronous or manual replication, choose **Local** found under **Replicate To**. After completing this step, click **Next** and continue with the NAS Server creation. For LUNs, Consistency Groups, VMware VMFS Datastores, Thin Clones, File Systems, and VMware NFS Datastores, a Replication step exists in the creation wizards for each with the similar look and configuration options as the one shown in Figure 40.

Create a NAS Server

- General
- Interface
- Sharing Protocols
- Unix Directory Service
- DNS
- Replication**
- Summary
- Results

Provide a Replication Mode and RPO

Enable Synchronous Replication

Replicate To: FNM00190100444 (10.245.19.237)

Destination Configuration (Using defaults)

Enable Asynchronous Replication

Replication Mode: * Asynchronous

RPO: * 60 minutes

Replicate To: * FNM00190201279

[Destination Configuration](#) (Using defaults)

Selecting a longer RPO may result in a larger data loss in the case of a failure. A shorter RPO may impact performance.
 To create a remote replication connection, navigate to the Protection & Mobility > Replication > Connections section.
 To create interfaces for use with remote replication, navigate to the Protection & Mobility > Interfaces section.
 Ensure that Ethernet ports, link aggregations and FSN ports with same names are available on destination, otherwise use override to change port assignment to NAS interfaces.

Cancel Back Next

Figure 40 Enable Asynchronous Replication

When the **Destination Configuration** box is selected in the Replication step, information about the remote storage resource's configuration will be displayed. Figure 41 below shows an example of this window.

Destination NAS Server Configuration

Name: * NAS

Destination System: FNM00190201279

Pool: * Pool (Extreme Performance Pool, 14.8 TB)

Storage Processor: * SP A

Used as backup only

Close OK

Figure 41 NAS Server Destination Configuration Window

After asynchronous replication is configured on a new storage resource, you can view information about replication from the resource's properties window. From Unisphere, select the storage resource in question and click Edit or double-click the name of the storage resource. From the properties window, view the **Replication** tab. An example of this tab for a NAS Server is shown in Figure 42. On this tab, you can view the following information:

- The replication **Session Name**
- The replication **Mode**
- The **Local Role** of the storage resource, which can either be listed as the **Source** or **Destination**

- The **Time of Last Sync**
- For block resources and File Systems, the **Replicate Scheduled Snapshots** option is shown. This option gives you the option to set if you want scheduled snapshots to be replicated.

Also shown is a pictorial representation of the replication session. The picture shows which storage resource is available for I/O, which direction the data is replicating in and its current state, and the destination storage resource and the system name, IP Address, and the destination LUN name. As the state of the replication session changes, this picture will update to reflect the new state.

Also shown on the Replication tab are buttons for each Replication Operation. This tab is also used to display synchronous replication operations, so all replication operations for synchronous and asynchronous replication are displayed. Not all replication operations are supported on each mode of replication, so only operations supported on the current replication mode will be selectable. Also, only certain operations are available depending on what the current state of the replication session is in, so only these options are available for selection. In Figure 42, the current session is Auto Sync Configured and replicating for the Production System to the DR System. Available replication operations for the asynchronously replicated NAS Server include **Delete**, **Pause**, **Sync**, and **Failover with Sync**.

The screenshot shows the 'NAS Properties' window with the 'Replication' tab selected. Below the tabs is a toolbar with '+', a trash icon, a refresh icon, an edit icon, and 'More Actions'. Below that, it says '1 item' with a filter and settings icon. The main table has columns: Name, Replication Mode, Destination (System, NAS Server), and State. One row is visible with a green checkmark in the Name column.

	Name	Replication Mode	Destination		State
			System	NAS Server	
<input checked="" type="checkbox"/>	rep_sess_nas_81_nas_4_FNM00190200582_FNM0019020...	Asynchronous	FNM00190...	NAS	Auto Sync Configured

Close

Figure 42 NAS Server Replication Configured

Replication can also be configured on an existing storage resource. When replication is not configured on the storage resource, viewing the **Replication** tab in the storage resource's properties window will show what is displayed in Figure 43. The **Replication** tab for a Consistency Group, VMware VMFS Datastore, Thin Clone, File System, and VMware NFS Datastore displays the same information as seen in Figure 43. To configure Replication on the storage resource, select **Configure Replication**.

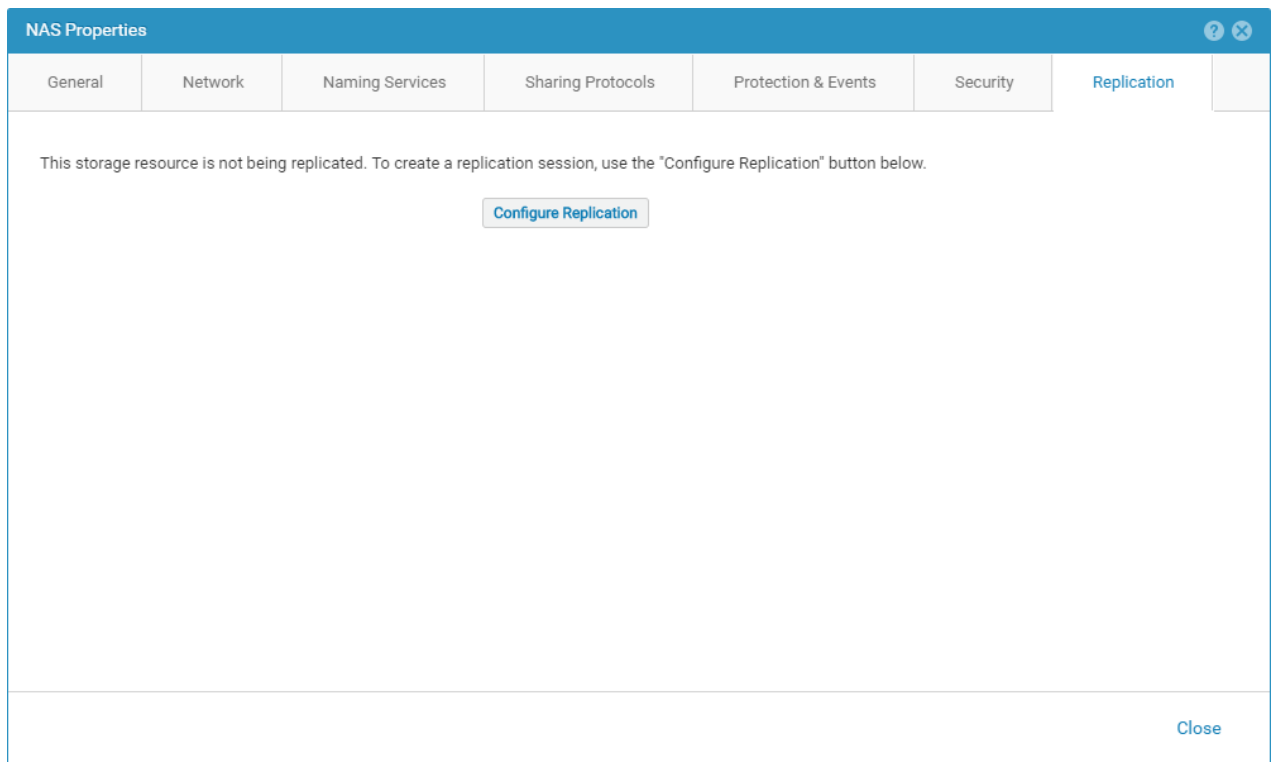


Figure 43 Replication Not Configured

After selecting Configure Replication, the **Create a Session** wizard is launched. An example of this wizard is shown in Figure 44. On the **Replication Settings** step, you need to customize which **Replication Mode** either Asynchronous, Manual, or Synchronous replication will be used. For Asynchronous Replication, select Asynchronous. Next, customize the desired RPO if needed. When manual replication is selected, RPO will not be an option. Then, select the destination system by selecting the correct system in the **Replicate To** drop down box, either Local for local replication, or a listed remote system. As mentioned previously, Dell EMC Unity OE version 4.2 supports the replication of scheduled and user snapshots. The **Replicate all existing snapshots** is a one-time option, given at creation time of the replication session, that can be used to replicate all existing snapshots. The **Replicate scheduled snapshots** option can be used to replicate the scheduled snapshots of a storage resource, this option can be modified after the replication session creation. Figure 44 shows both options already selected.

Figure 44 Create a Session

In the example in Figure 44, the File System(s) under the current NAS Server have both Hourly and Daily/Weekly snapshot schedules. In order to customize the remote retention policy for the snapshots that will be replicated, click the **Customize** button, which opens the **Customize Remote Retention** window. An example of this window is shown in Figure 45. This provides the options to either keep the same retention policy as the source, follow the Pool Automatic Deletion Policy, or retain the snapshots for a custom number of hours, days or weeks. The retention policy can go up to 255 weeks. In this example, Hourly Snapshots are retained for 7 Hours while the Daily/Weekly Snapshots are retained for 4 Weeks. After selecting the retention policy, click **OK**, and then **Next**.

Figure 45 Customize Remote Retention

The **Destination** step of the **Create a Session** wizard is now shown. An example of this step for a NAS Server is shown in Figure 46. From here you can customize the storage resource's **Name** that will be displayed on the destination Pool or system, the **Pool** it will utilize, the **Storage Processor** if applicable, the **Tiering Policy** if applicable on the destination's Pool, and enable **Data Reduction/Advanced Deduplication** if supported in the destination. For other existing storage resources being replicated, you will be able to customize this exact same information. When creating a replication session on an existing Consistency Group, you will be able to customize this same information for each LUN contained within the consistency group. In this example, replication for a NAS Server is being created, which causes all File Systems and VMware NFS Datastores configured on it to also be replicated. After editing the available information, click **Next**.

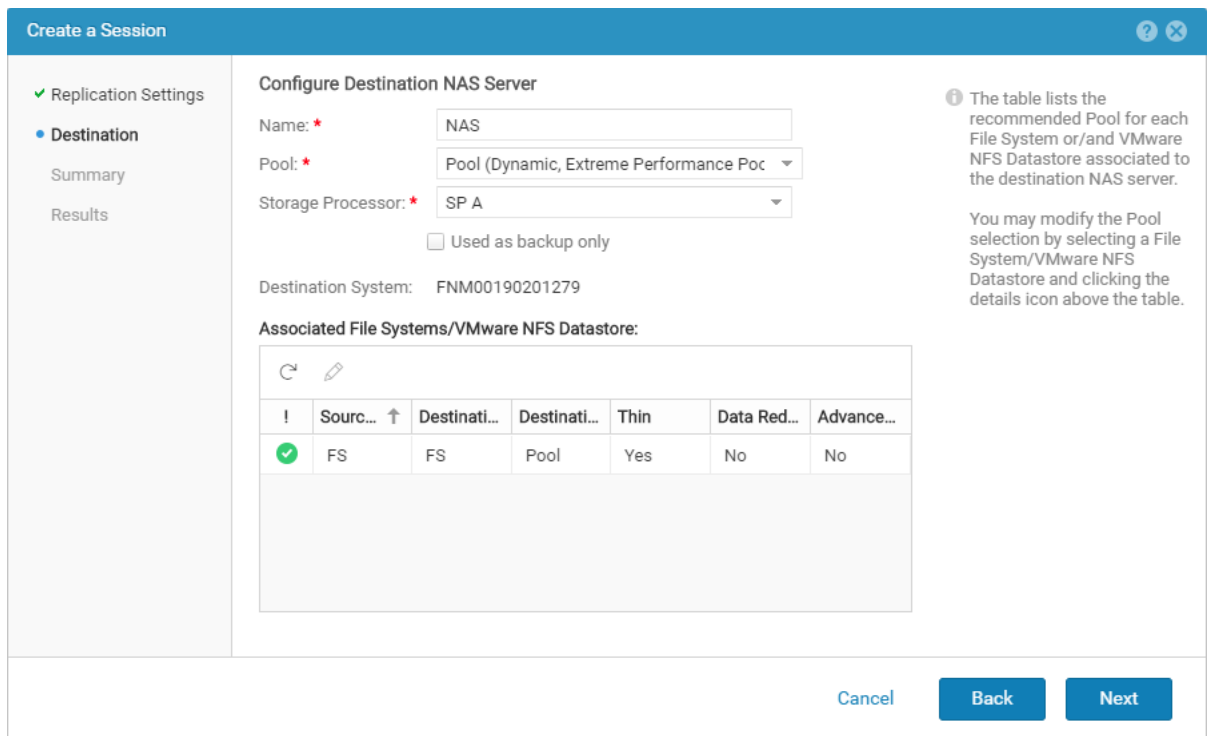


Figure 46 Configure Destination NAS Server

The **Summary** step is now shown, and an example of this screen for a NAS Server is displayed in Figure 47. Here you can see a summary of the settings that will be used to create replication. If anything is incorrect, you can select **Back** to correct the desired setting. To create the replication session, click **Finish**. A Summary step will also be shown when creating a replication session on other storage resources.

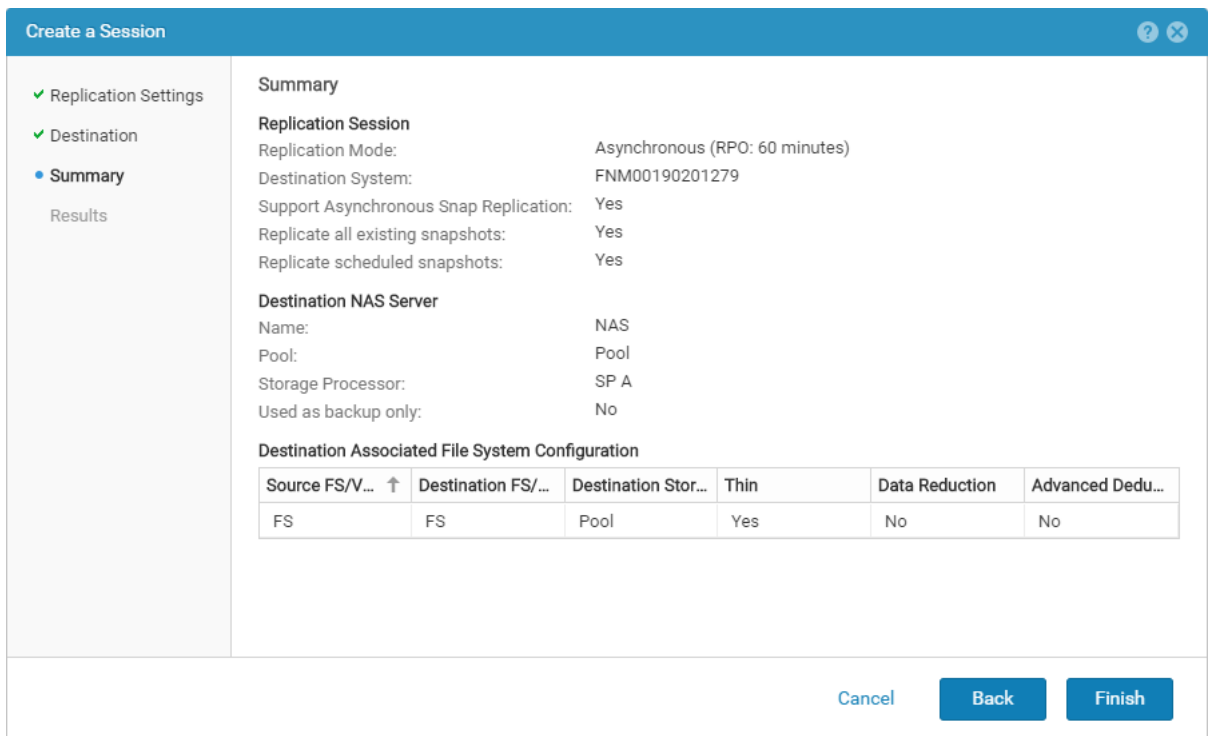


Figure 47 Summary

The **Results** step is now shown, and an example of this page is shown in Figure 48. This step shows the **Overall Status** of each of the jobs to create the replication session. The steps to create the replication session include creating the storage resource on the destination system, allowing the remote storage resource to finish the creation process, and lastly creating the replication session. You can either wait for the Overall status to say 100% Complete or close the window at any time by clicking **Close**. Closing this window will not impact the creation process since it is a background job in Unisphere.

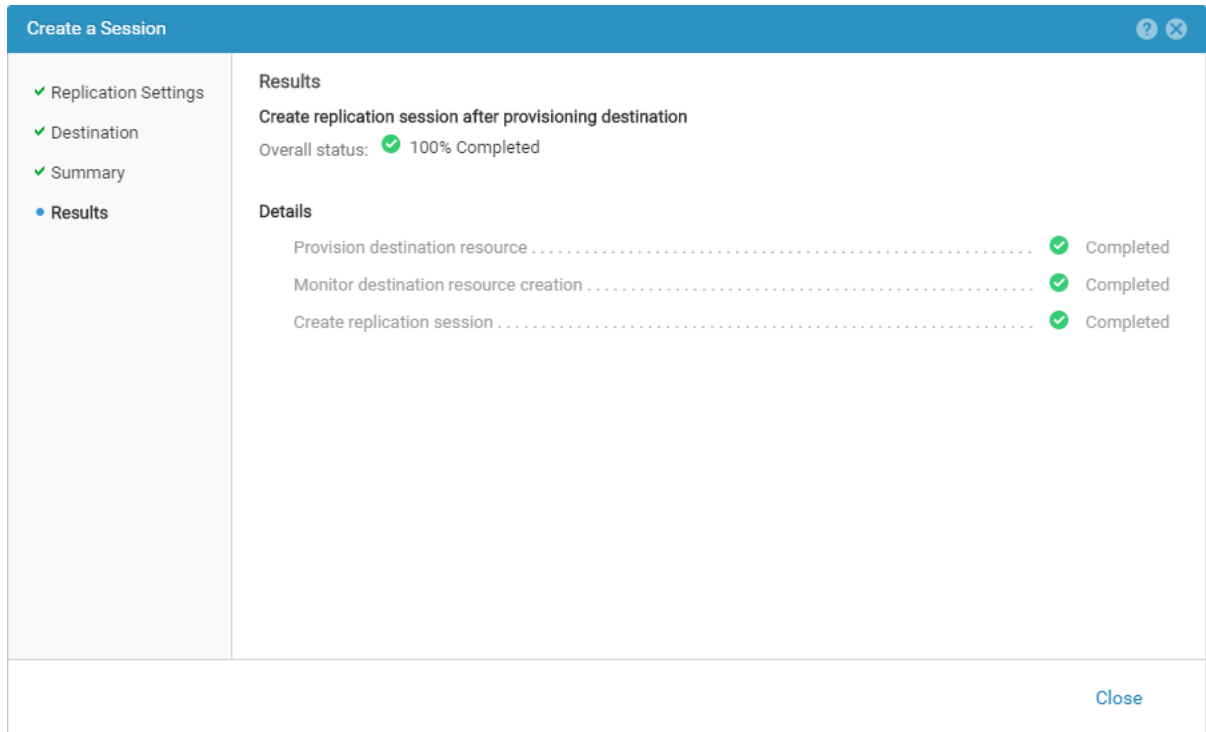


Figure 48 Create a Session Job

Figure 49 shows the Replication tab after the synchronization between the source and destination NAS Server. Notice that the **Time of Last Sync** now shows the date and time of the last completed sync. In this state, the supported replication operations are selectable. If you wish to switch between Asynchronous and Manual Replication, or change the Asynchronous RPO, select the pencil icon next to **Mode**.

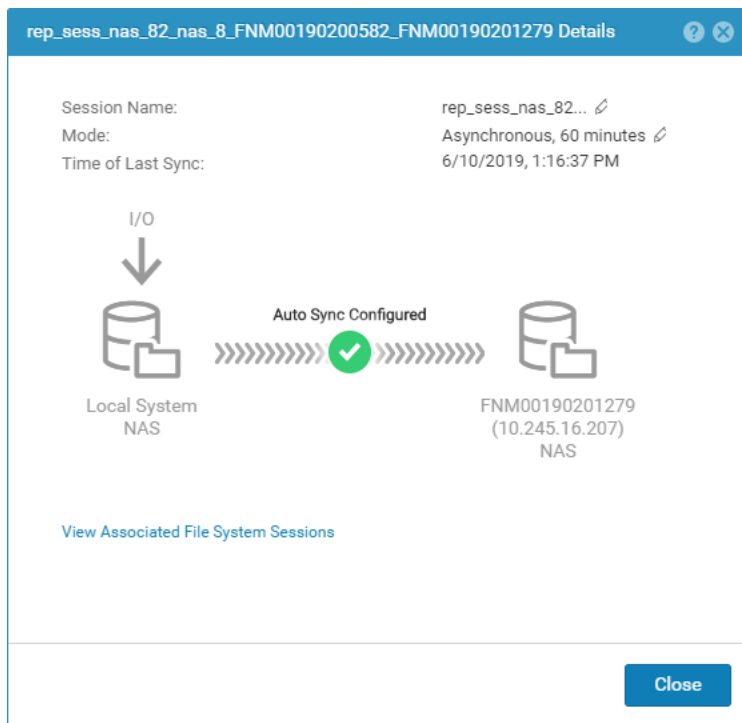


Figure 49 Synchronization Complete

Figure 50 below shows the **Modify Session Mode** window after selecting the pencil icon described in Figure 49. When asynchronous or manual replication is configured, you can switch between the two as needed. You can also edit the RPO as needed from this window.

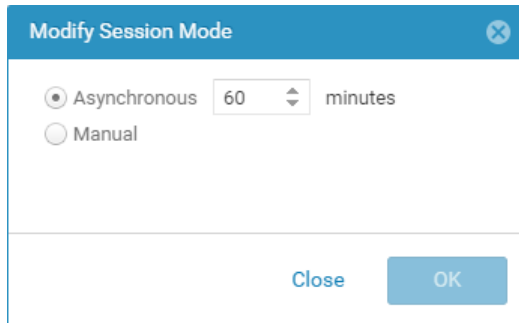


Figure 50 Modify Session Mode

With Dell EMC Unity OE version 4.2, there is the option to **View Associated File System Sessions** for a NAS Server. Figure 51 below shows the **View Associated File Systems** window after selecting the *View Associated File System Sessions* link shown in Figure 49. In this window, you can fully manage the replication sessions for the File Systems under the current NAS Server. This includes deleting, editing and executing any of the replication actions for one or more File Systems.

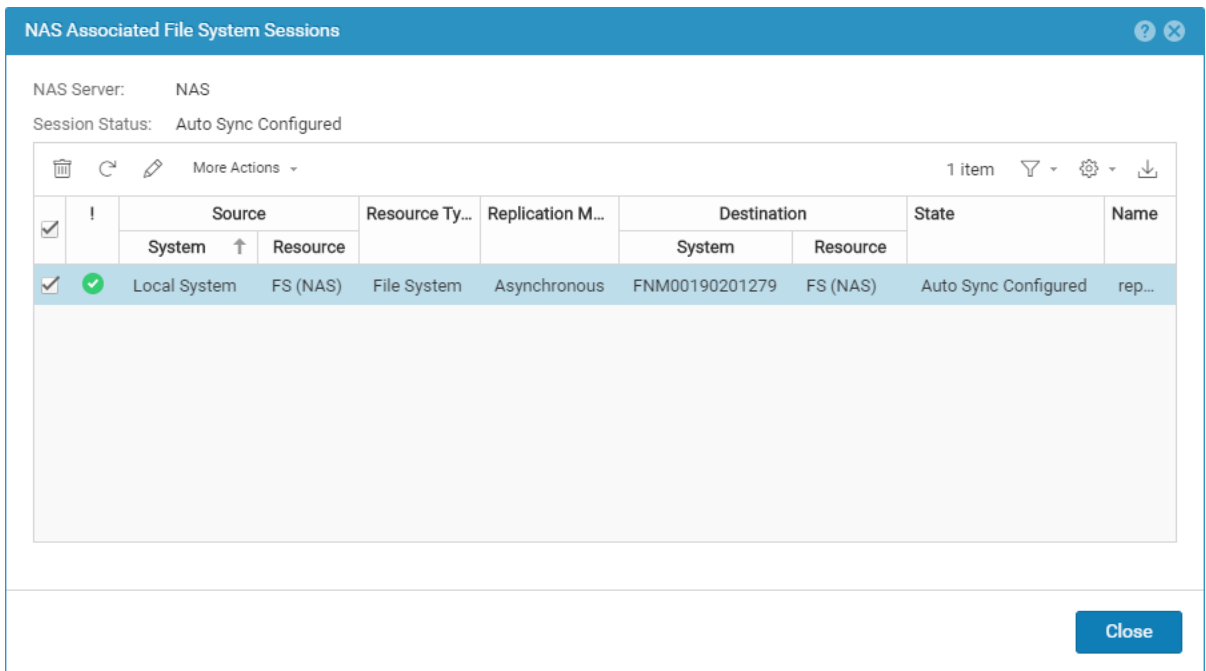


Figure 51 View Associated File Systems Window

As shown in Figure 52, if you select the edit icon for a File System the **Details** window is displayed. In this window you can modify the name of the session, the session mode, and the **Replicate Scheduled Snapshots** option. If you select the pencil icon for the **Replicate Scheduled Snapshots** option the **Customized Retention Policy** window, as in Figure 45, is shown.

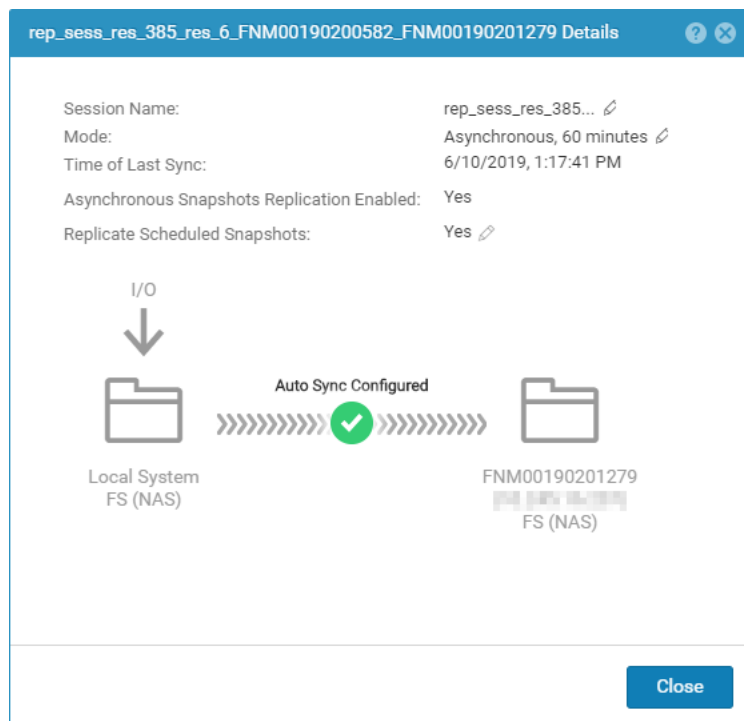


Figure 52 File System Replication Details

In addition to configuring snapshot replication at the creation of the replication session, you can manually replicate a snapshot at creation time or by executing the **Replicate** action. Figure 53 below shows the **Create**

Snapshot window when creating a snapshot for a File System, notice the **Replicate Snapshot** option. The **Replication Snapshot** option is also provided for the snapshots of LUNs, Consistency Group, Thin Clones, and VMware NFS and VMFS Datastores.

The screenshot shows the 'Create Snapshot' dialog box. The 'Name' field contains 'Replicate_Manually_UTC_2017-07-04_17:59:46'. The 'Description' field is empty. Under 'Local Retention Policy', 'Pool Automatic Deletion Policy' is selected. Under 'Access Type', 'Read-only (hidden .CKPT access)' is selected. The 'Replicate Snapshot' checkbox is checked. Under 'Remote Retention Policy', 'Retain Until' is selected with a date of '07/11/17' and a time of '1:59 PM'. 'Cancel' and 'OK' buttons are at the bottom right.

Figure 53 Create Read-Only File Snapshot

If you were to select the Access Type of Read/Write (shares), the **Replicate Snapshot** option will be disabled, as shown in Figure 54. Likewise, if you attach a block snapshot to a host and then try to replicate the snapshot, Unisphere will give you a warning stating that an attached snapshot cannot be replicated.

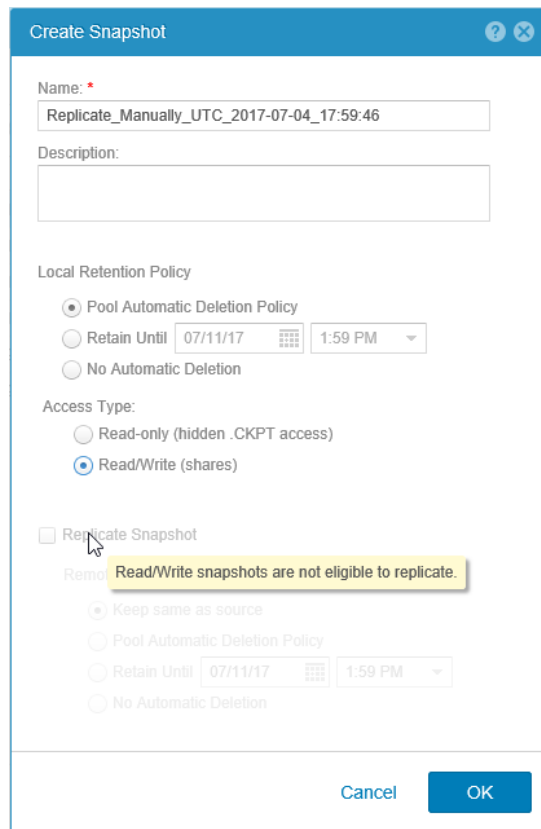


Figure 54 Create Read/Write File Snapshot

Figure 55 below shows the **Snapshots** tab window when creating a snapshot for a File System that already has asynchronous replication configured. The **Snapshots** tab within the Properties window for the Consistency Groups, Thin Clones, and VMware NFS and VMFS Datastores will display the same options.

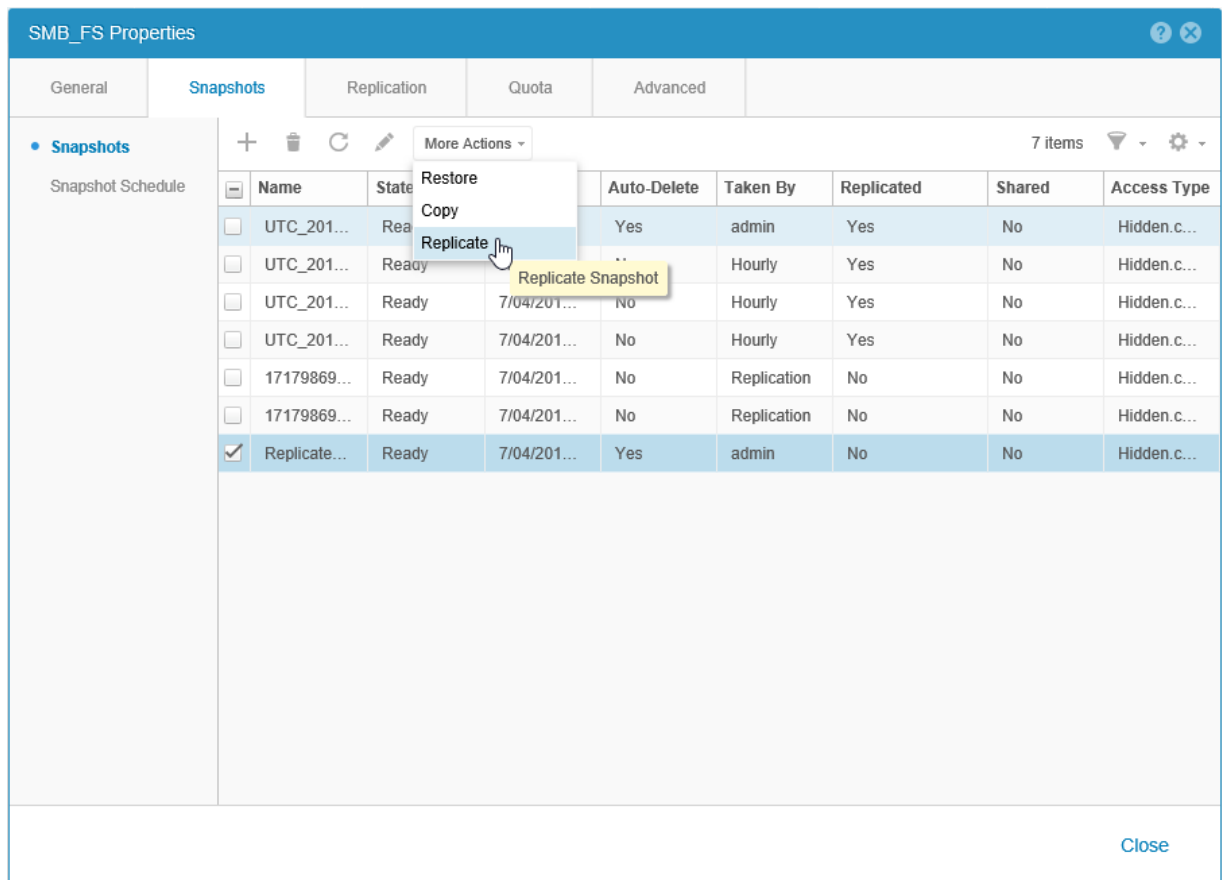


Figure 55 Replicate a Snapshot

3.6.5 Restore from A Replicated Snapshot

Once the source snapshots have been replicated to the destination, the source snapshot can be deleted from the source system to free up space. If there is ever a need to recover data that is in a replicated snapshot, the replicated data can be manually restored to the source storage resource. Taking a backup of the source resource is suggested, as this process will overwrite data within the source resource. To manually restore from a replicated snapshot, once the snapshot has been replicated, failover the storage resource's replication session, and on the destination system, restore the storage resource to the snapshot that has the data you're interested in. Once the restore is complete, failback the replication session. As result, the source storage resource will contain the data that was on the snapshot.

3.6.6 Override Network Address for File Replication

If you have file replication configured with a destination site on a different physical network, to ensure minimal downtime during a failover, ensure that you modify the destination NAS Server properties to include an override address for the network interface. Figure 56 shows an example of the destination NAS Server with the Production Interface being overridden to a different IP Address. Note that a different Ethernet Port can also be selected in this process.

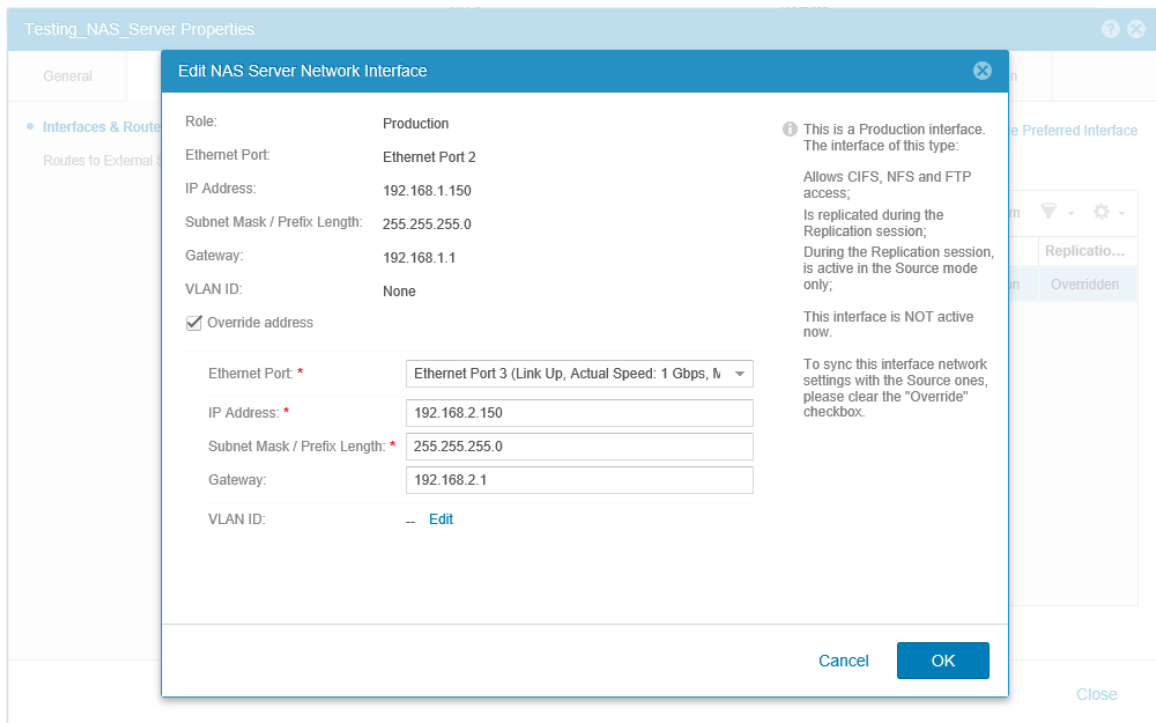


Figure 56 Override Address

3.6.7 Enable NDMP on NAS Server

Dell EMC Unity supports 3-way NDMP (Network Data Management Protocol) backup over Ethernet. Also, as of Dell EMC Unity OE version 4.4, 2-way NDMP backup over Fibre Channel is also supported. This support allows for data backup to NDMP backup clients which could be a tape library or virtual tape appliance. NDMP can also work in cohesion with replication for additional data protection. Therefore, if replication is enabled on a NAS Server and additional data protection is needed, NDMP can be enabled through the Protection & Events tab in the properties page of a NAS Server, as seen in Figure 57. NDMP can be enabled either on the source or destination NAS Server giving configuration flexibility in running incremental NDMP backups of file systems. Note that if you enable NDMP on a destination NAS Server, you will first need to create a Backup & DR testing network interface to be able to connect to destination file resources. Also note that enabling NDMP for the destination NAS Server is not supported in the initial OE 4.0 release but is supported in OE 4.1 and later.

The screenshot shows the 'NAS_Server_Async Properties' dialog box with the 'Protection & Events' tab selected. On the left, a sidebar lists 'NDMP Backup', 'DHSM', and 'Events Publishing'. The main area shows the 'Enable NDMP' checkbox checked, with a 'Change Password' button to its right. Below this, there are three input fields: 'Username' with the value 'ndmp', 'Password', and 'Confirm Password', all of which are masked with asterisks. At the bottom right of the dialog, there are 'Cancel' and 'Apply' buttons.

Figure 57 Enable NDMP

3.6.8 Viewing the Replication Sessions

All replication sessions on the system can be viewed from the **Sessions** tab within the Replication page. This includes synchronous and asynchronous replication sessions. To navigate to this page, click **Replication** under **Protection & Mobility** in Unisphere. For releases prior to Dell EMC Unity OE version 4.1, the **Replication** page can be found under **Data Protection**. Figure 58 shows an example of the **Sessions** tab with multiple replication sessions created on the system. In this example, you can see the replication sessions for LUNs, Thin Clones, Consistency Groups, NAS Servers, File Systems, and VMware NFS and VMFS Datastores. From this page you can easily see information regarding each session. The following is a list of information displayed on this screen:

- The Replication Session **Name**
- The current **State**
- The **Source**, which includes the source system and the source storage resource
- The **Resource Type**
- The **Destination**, which includes the destination system name and the destination storage resource
- The Replication Session **ID**

	!	Name	State	Source		Resource Type	Destination		id
				System	Resource		System	Resource	
<input type="checkbox"/>	<input checked="" type="checkbox"/>	rep_sess_sv_1_sv_37_FN...	Auto Sync Configured	Local System	AsyncRep_LUN	LUN	DisasterRec...	AsyncRep...	42949673003_F...
<input type="checkbox"/>	<input checked="" type="checkbox"/>	rep_sess_sv_19_sv_38_FN...	Auto Sync Configured	Local System	AsyncRep_ThinClone	LUN	DisasterRec...	AsyncRep...	42949675742_F...
<input type="checkbox"/>	<input checked="" type="checkbox"/>	rep_sess_res_25_res_44_F...	Auto Sync Configured	Local System	VMware_VMFS_Asyn...	VMware (VMFS)	DisasterRec...	VMware_V...	81604378637_F...
<input type="checkbox"/>	<input checked="" type="checkbox"/>	rep_sess_res_26_res_45_F...	Auto Sync Configured	Local System	CG_AsyncRep	Consistency Group	DisasterRec...	CG_AsyncR...	81604378639_F...
<input type="checkbox"/>	<input checked="" type="checkbox"/>	rep_sess_nas_5_nas_18_F...	Auto Sync Configured	Local System	Testing_NAS_Server	NAS Server	DisasterRec...	Testing_NA...	10307921511_...
<input type="checkbox"/>	<input checked="" type="checkbox"/>	rep_sess_res_22_res_41_F...	Auto Sync Configured	Local System	SMB_FS (Testing_NA...	File System	DisasterRec...	SMB_FS (T...	171798694438_...
<input type="checkbox"/>	<input checked="" type="checkbox"/>	rep_sess_res_23_res_42_F...	Auto Sync Configured	Local System	NFS_FS (Testing_NA...	File System	DisasterRec...	NFS_FS (T...	171798694439_...
<input type="checkbox"/>	<input checked="" type="checkbox"/>	rep_sess_res_24_res_43_F...	Auto Sync Configured	Local System	VMware_NFS_Datast...	VMware (NFS)	DisasterRec...	VMware_NF...	171798694462_...

Figure 58 Replication Sessions

From the **Sessions** tab you can also issue replication operations on the sessions. After selecting the checkbox for a replication session in the list, select **More Actions** to view the replication operations available for that session in its current state. In Figure 59 below, you can see that only **Pause**, **Sync** and **Failover with Sync** are valid options based on the current replication session state of the selected storage resource.

	!	Name	State	Source	
				System	Resource
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	rep_se	Auto Sync Configured	Local System	AsyncRep_LUN
<input type="checkbox"/>	<input checked="" type="checkbox"/>	rep_se	Auto Sync Configured	Local System	AsyncRep_ThinClone
<input type="checkbox"/>	<input checked="" type="checkbox"/>	rep_se	Auto Sync Configured	Local System	VMware_VMFS_Asyn...
<input type="checkbox"/>	<input checked="" type="checkbox"/>	rep_sess_res_26_res_45_F...	Auto Sync Configured	Local System	CG_AsyncRep

Figure 59 Replication Sessions More Actions

Dell EMC Unity OE version 4.2 also includes the group operations feature at a NAS Server level. The group operations are available for the following operations: Failover, Failover with Sync, Failback, Pause, and Resume. Figure 60 gives an example of executing a group Failover for a NAS Server.

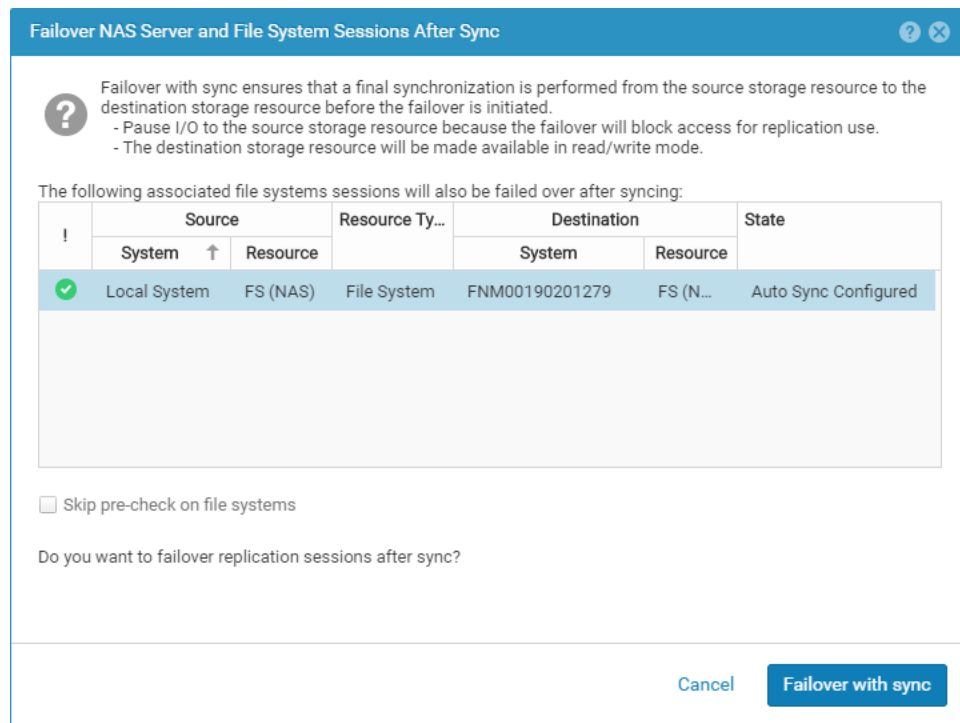


Figure 60 Group Failover Window

3.7 System Maximums

Please see Appendix A: Replication Maximums for information on Dell EMC Unity replication maximums.

4 Proxy NAS Servers

Dell EMC Unity OE 4.3 introduced the ability to utilize Proxy NAS Servers. This feature allows administrators to gain read-only access to files on replicated file resources (File Systems and VMware NFS datastores) on the destination (local or remote). Potential use cases for this feature include periodic verification of replicated data as well as retrieving old files from archived snapshots that may not exist on the production resource. For asynchronous file replication, Proxy NAS Servers allow access to the file system resource itself as well as associated snapshots, but it is recommended to only access data residing on snapshots due to instances where the file system is being actively replicated at each RPO. Note that no modifications can be made to the destination resources through Proxy NAS Servers as access is only granted as Read-only. Also, access for Proxy NAS Servers is only available to users who are a part of the local administrators group for SMB and root users on specified hosts or networks for NFS.

Proxy NAS Servers are NAS Servers that have been granted permission by the storage administrator to access specified destination NAS Server file resources. Therefore, the Proxy NAS Server needs to be created with the same sharing protocols (NFS, SMB, or Multiprotocol) as which the data needs to be read from. Multiple Proxy NAS Servers can be created, and each Proxy NAS Server can be configured to access one or more destination NAS Servers' data. Note that the configured Proxy NAS Server must reside on the same storage processor (SP) as the destination NAS Servers that it needs to have access to. For example, a Proxy NAS Server created on SPA can be configured to access any destination NAS Servers' data on SPA; a separate Proxy NAS Server would need to be created on SPB to access resources on SPB. Proxy NAS Servers do not violate multitenancy environments as each NAS Server is still segregated at the Tenant level so can't give proxy access across multiple tenants.

If enabling proxy access through SMB, the configured sharing protocol for SMB should be on the same domain as the destination NAS Server(s) that you would like to access to ensure appropriate file access permissions are granted. Once a NAS Server has been created on the destination that has been configured for the needed sharing protocols (NFS, SMB, Multiprotocol), the following steps can be done to configure it as a Proxy NAS Server:

Login to the SP via console and run the following service command for each destination NAS Server you would like to access on the same SP:

```
1. svc_nas <Proxy_NAS_Server_Name> -proxy -add <Destination_NAS_Server_Name>
   [-NFSRoot <Allowed_NFS_nodes>]
```

- The above command will create an admin share with the same name as the specified destination NAS Server. These shares are visible to SMB and NFS client management tools like MMC but are not shown in Unisphere and can only be administered through the above `svc_nas` command.

Note: SMB access is granted to users that are a member of the local administrators group of the SMB sharing protocol configured on the proxy NAS Server (via AD or standalone) while NFS access is granted with the specified `-NFSRoot` option as seen in the above command. If the option is not specified, then no NFS clients will have access even if they are root users.

- The `-NFSRoot` option supports the following format specifications:

```
[minSecurity=<security_mode>]
[host=<host_name>]
[ip=<ipv4|ipv6>]
[subnet=<ip_mask>]
```

```
[netgroup=<netgroup_name>]
```

- Example full command (including NFS options):

```
svc_nas DRACCESS -proxy -add foo -NFSRoot minSecurity=KRB5 host=ampere2  
ip=1.2.3.4 subnet=192.168.1.0/255.255.255.0 netgroup=ntgrp
```

- Example full command (SMB):

```
svc_nas DRACCESS -proxy -add NAS_Server_SMB
```

4. Connect to Proxy NAS Server and associated destination NAS Servers through the configured network interface or domain name

- Example: Access to the SMB “NAS01” NAS Server:

```
\\<Proxy_NAS_Server>\NAS01
```

- Example Access to the NFS “NAS01” NAS Server:

```
mount <Proxy_NAS_Server>:/NAS01 /mnt_point
```

5 Interoperability

Native Synchronous and Asynchronous Replication is supported between Dell EMC Unity OE versions 4.0 and later systems in either direction. If there is a specific feature related to Dell EMC Unity OE version 4.1 or later, that is in use in the source system, then the replication session may not be supported and may fail to setup. In some cases, the replication session may succeed, and ignore the newer capability on the target system.

For File Replication, some features that should be taken into account when configuring replication include Common Event Enabler (CEE), IP Multi-Tenancy, Advanced Static Routing (ASR), Packet Reflect, and Folder Rename and Locking policies. The Advanced Static Routing (ASR) and Packet Reflect features will not prevent replication to Dell EMC Unity OE version 4.0, but the settings for ASR and Packet Reflect will not be replicated. Similarly, if remote replication is already configured for a NAS Server and the destination system is running a previous version of Dell EMC Unity OE, and the source system is upgraded to the latest Dell EMC Unity OE, new features in the NAS Server cannot be enabled on the source system. To enable new features in the NAS Server on the source system, also upgrade the destination system to the latest version of Dell EMC Unity OE. Note that if replication between Dell EMC Unity systems is critical, consider upgrading all systems participating in the replication to the latest Dell EMC Unity OE version.

For more information on NAS Capabilities in the Dell EMC Unity systems, please review the white paper titled *Dell EMC Unity: NAS Capabilities* on Dell EMC Online Support.

5.1 File Import

Once a VNX VDM is imported as a NAS Server into a Dell EMC Unity system, the destination NAS Server and the File Systems under it can participate in a replication session. As long as the import session for the source VNX VDM was committed, the destination NAS Server can be replicated to a system running Dell EMC Unity OE version 4.0 and later. For more information on File Import, please review the white paper titled *Dell EMC Unity: Migration Technologies* on Dell EMC Online Support.

5.2 Data Reduction

The following section gives information on Data Reduction on Dell EMC Unity systems. Systems with data efficiency technologies enabled running versions prior to Dell EMC Unity OE version 4.3 will see Compression instead of Data Reduction.

Storage Resources utilizing data reduction can be replicated using any supported replication software, such as Native Synchronous Block Replication or Native Asynchronous Replication to any supported destination system. All data that is replicated, regardless if it is local replication or to a remote system, is first rehydrated, and then replicated to the destination. This method of replication ensures that all replication topologies are supported, including mixed configurations where data reduction is enabled only on one side. Replicating to systems which do not support data reduction is also supported, such as replicating to Dell EMC UnityVSA or a physical Dell EMC Unity system not running a code version which supports data reduction.

Dell EMC Unity Data Reduction can also be enabled on only the source, only the destination, or both the source and destination storage resources, depending on if the system and Pool configuration support Dell EMC Unity Data Reduction. This allows the user to fully control where to implement data reduction. One example of a supported replication configuration is when utilizing Asynchronous Local Replication. The source storage resource may reside on an All Flash Pool and have data reduction enabled, but the destination may be on a large capacity Hybrid Pool which does not support data reduction. Another example

of a supported configuration is when replicating a storage resource from a Dell EMC UnityVSA system or a production system not utilizing data reduction, to a storage resource with data reduction enabled on a remote system.

From Unisphere in order to enable data reduction on the destination resource, in the **Create a Session** wizard for the **Destination** step, select the checkbox in front of the **Data Reduction** option. Figure 61 gives an example on enabling data reduction on the destination for a LUN storage resource. The **Create a Session** wizard for Thin Clones, Consistency Groups, VMware VMFS Datastores, File Systems, and VMware NFS Datastores will have the same **Data Reduction** option in the **Replication** step.

In Dell EMC Unity OE version 4.5, Advanced Deduplication was introduced for Dell EMC Unity 450F, 550F, and 650F systems and can be enabled once Data Reduction is enabled. In Dell EMC Unity OE version 5.0, Advanced Deduplication is also available on Dell EMC Unity 380(F), 480(F), 680(F), and 880(F). This additional data efficiency technology has the same restrictions as noted above in relation to replication.

For more information on Data Reduction and Advanced Deduplication, please review the white paper titled *Dell EMC Unity: Data Reduction* on Dell EMC Online Support.

The screenshot shows a web-based configuration window titled "Create a Session". On the left, a sidebar contains navigation links: "Replication Settings" (checked), "Destination" (selected), "Summary", and "Results". The main area is titled "Provide destination storage resource info" and contains the following fields and options:

- Name:** LUN
- Destination System:** FNM00190100444
- Pool:** Pool1 (Dynamic, Extreme Performance Pool, 6.3 TB free)
- Size(GB):** 100.0
- Thin
- Data Reduction
- Advanced Deduplication

At the bottom right, there are three buttons: "Cancel", "Back", and "Next".

Figure 61 Data Reduction and Advanced Deduplication

5.3 Dynamic Pools

Dell EMC Unity Native Synchronous and Asynchronous Replication is fully supported with Traditional and Dynamic Pools. When configuring local or remote replication, the source or destination Pool can be either type of Pool, either Traditional or Dynamic. This flexibility in configuration options allows systems which do not support Dynamic Pools, such as a Dell EMC UnityVSA, a Dell EMC Unity Hybrid system, or another Dell EMC Unity All Flash system which is not running Dell EMC Unity OE version 4.2 or later to replicate to or from a Dynamic Pool. When configuring replication, a Type field has been added to easily determine the type of Pool that was selected as the destination. This Type field is only present on systems running Dell EMC Unity OE version 4.2 or later.

For more information on Dell EMC Unity Dynamic Pools, please review the white paper titled *Dell EMC Unity: Dynamic Pools* on Dell EMC Online Support.

For more details regarding the Interoperability of the features released in Dell EMC Unity OE version 4.1 or later, search for Interoperability for the Dell EMC Unity Family on the Dell EMC Online Support.

6 Upgrades

Prior to initiating an upgrade of the Dell EMC Unity OE, it is recommended to pause all ongoing replication sessions. The Pre-Upgrade Health Check (PUHC) checks for any active replication sessions and generates a warning if any are found. Once the upgrade completes, you can resume each replication session. The pause and resume operations should be initiated from the source system for each replication session. Note that if you're running Dell EMC Unity OE version 4.2 or later, pausing and resuming the NAS server replication session also pauses and resumes all of its associated file system replication sessions automatically.

7 RecoverPoint with Dell EMC Unity

Along with the native replication options provided with physical Dell EMC Unity systems, RecoverPoint is also supported. RecoverPoint is used for disaster recovery and data loss protection, protecting organizations from site outages due to unforeseen circumstances and data loss due to corruption or human error. RecoverPoint also assists in data migration solutions, providing the ability to move data between data centers and supported systems. RecoverPoint provides a DVR-like roll back function which allows data recovery to any point-in-time. RecoverPoint utilizes physical or virtual RecoverPoint appliances to replicate data locally within the same Dell EMC Unity system, or to remote systems. Replication solutions are designed to ensure the integrity of the replicated data at local and remote sites. Performance is also not compromised when using RecoverPoint with Dell EMC Unity. Through the use of proprietary software called the RecoverPoint Splitter, incoming write operations are split and sent to the local and remote storage system. This ensures there is minimal performance impact on the storage system when replicating data.

RecoverPoint can be configured to replicate Dell EMC Unity LUNs, VMware VMFS Datastores, and Thin Clones. Destination storage resources can be created locally within the same system, or on a remote system supported with RecoverPoint. Dell EMC Unity includes the RecoverPoint Basic license for free, allowing replication between Dell EMC Unity, VNX, and VNXe systems. Through RecoverPoint's own user interface, replication can be configured quickly and easily. For more information on which systems are supported, please view Appendix B.

When configuring RecoverPoint, LUNs, VMware VMFS Datastores, and Thin Clones already replicated with Dell EMC Unity native replication software are not supported. Also, RecoverPoint should not be configured to utilize the Dell EMC Unity Synchronous Replication Port on either storage processor. The Synchronous Replication Port is discussed in the *Synchronous Replication Interfaces* section of this paper.

For more information on RecoverPoint, including RecoverPoint specific concepts and management, refer to the RecoverPoint Administrator's Guide found on Dell EMC Online Support.

8 Conclusion

In this paper, the various native replication solutions provided in Dell EMC Unity were discussed. Configuring a data protection solution helps guard against unforeseen situations, such as data loss or site wide outages if they are encountered. Dell EMC Unity provides local and remote data protection solutions to help minimize the cost associated with downtime and provides easy recovery in the event of a disaster. Through the use of synchronous and asynchronous replication solutions, data protection can be configured to meet the needs of the application and organization.

Native Synchronous Block Replication is a data protection solution which replicates each write to a storage resource remotely to a peer system before the write is acknowledged with the host. In the event of a disaster, Synchronous Block Replication provides maximum protection and ensures that there is zero data loss. Dell EMC Unity Synchronous Block Replication is supported on LUNs, Thin Clones, Consistency Groups, and VMware VMFS Datastores configured on Dell EMC Unity All Flash and Hybrid Flash systems. Starting in Dell EMC Unity OE version 4.4, native file synchronous replication is also supported on Dell EMC Unity. See the *Dell EMC Unity: MetroSync* white paper on Dell EMC Online Support for more information.

Native Asynchronous Block and File Replication is a data protection solution which replicates storage resources locally within the same Dell EMC Unity system, or remotely to other Dell EMC Unity systems. Asynchronous replication leverages Dell EMC Unity's Unified Snapshot technology to provide consistent point-in-time replicas which can be utilized in the event of a disaster. Asynchronous replication is not only supported on Dell EMC Unity All Flash and Hybrid Flash systems, but also on Dell EMC UnityVSA. When utilizing asynchronous replication, no impact to host I/O is seen as data is not replicated as it enters the system. Asynchronous replication utilizes a customizable Recovery Point Objective, which automatically replicates changes in data at consistent intervals. When data needs to be replicated over long distances, asynchronous replication can meet the needs of an organization.

RecoverPoint support allows Dell EMC Unity to leverage the advanced replication features it provides. With RecoverPoint, Dell EMC Unity LUNs and VMware VMFS Datastores can be replicated locally or remotely to another supported system. With RecoverPoint's advanced functionality, such as point-in-time data recovery, Dell EMC Unity can be protected from disaster scenarios.

A Technical support and resources

[Dell.com/support](https://dell.com/support) is focused on meeting customer needs with proven services and support.

[Storage technical documents and videos](#) provide expertise that helps to ensure customer success on Dell EMC storage platforms.

A.1 Related resources

The following references can be found on Dell EMC Online Support:

- Dell EMC Unity: Best Practices Guide
- Dell EMC Unity: Cloud Tiering Appliance (CTA)
- Dell EMC Unity: Compression
- Dell EMC Unity: Compression for File
- Dell EMC Unity: Data at Rest Encryption
- Dell EMC Unity: Data Integrity
- Dell EMC Unity: Data Reduction
- Dell EMC Unity: DR Access and Testing
- Dell EMC Unity: Dynamic Pools
- Dell EMC Unity: FAST Technology Overview
- Dell EMC Unity: File-Level Retention (FLR)
- Dell EMC Unity: High Availability
- Dell EMC Unity: Introduction to the Platform
- Dell EMC Unity XT: Introduction to the Platform
- Dell EMC Unity: NAS Capabilities
- Dell EMC Unity: MetroSync
- Dell EMC Unity: MetroSync and Home Directories
- Dell EMC Unity: MetroSync and VMware vSphere NFS Datastores
- Dell EMC Unity: Migration Technologies
- Dell EMC Unity: OpenStack Best Practices for Ocata Release
- Dell EMC Unity: Performance Metrics
- Dell EMC Unity: Snapshots and Thin Clones
- Dell EMC Unity: Operating Environment (OE) Overview
- Dell EMC Unity: Unisphere Overview
- Dell EMC Unity: Virtualization Integration
- Dell EMC UnityVSA
- Dell EMC Unity Cloud Edition with VMware Cloud on AWS
- Dell EMC Unity Data Reduction Analysis
- Dell EMC Unity: Migrating to Dell EMC Unity with SAN Copy
- Dell EMC Unity Storage with Microsoft Hyper-V
- Dell EMC Unity Storage with Microsoft SQL Server
- Dell EMC Unity Storage with Microsoft Exchange Server
- Dell EMC Unity Storage with VMware vSphere
- Dell EMC Unity Storage with Oracle Databases
- Dell EMC Unity 350F Storage with VMware Horizon View VDI
- Dell EMC Unity: 3,000 VMware Horizon Linked Clone VDI Users
- Dell EMC Storage with VMware Cloud Foundation

B Appendix: Replication Maximums

The following table outlines the Dell EMC Unity replication system maximums.

	Dell EMC Unity 600/600F/650F 680/680F	Dell EMC Unity 500/500F/550F 580/580F	Dell EMC Unity 400/400F/450F 480/480F	Dell EMC Unity 300/300F/350F 380/380F	Dell EMC UnityVSA
Max Replication Sessions (Synchronous + Asynchronous)	2000	1500	1000	1000	16
Max Replication Sessions (Synchronous Replication)	2000	1000	750	500	N/A
Max Consistency Group Replication Sessions (Synchronous Replication)	128	64	64	64	N/A
Max LUNs per Replicated Consistency Group (Synchronous Replication)	32	32	32	32	N/A
Max Target Systems (Synchronous Replication)	1	1	1	1	N/A
Max Concurrent Replication Sessions (Asynchronous Replication)	256	256	256	256	8
Max Concurrent Initial Syncs (Asynchronous Replication)	32	32	32	32	4
Max LUNs per Replicated Consistency Group (Asynchronous Replication)	75	75	75	75	50
Max replicated NAS Servers (Asynchronous Replication)	256	128	128	90	4
Max Target Systems (Asynchronous Replication)	16	16	16	16	16

The table above outlines a number of system maximums when using synchronous and asynchronous replication. The maximum replication sessions includes all replication sessions on the system, which includes both synchronous and asynchronous replication sessions, local or remote. The replication destination storage resources count towards the system maximums, even though they are not host accessible when currently a destination image. In Dell EMC Unity, only one replication connection used for synchronous replication, or synchronous and asynchronous replication, can be created. This also means that only 1 pair of systems can replicate synchronously to each other.

C Appendix: Replication Support Across Platforms

The following table outlines replication support across the various Dell EMC midrange platforms.

Source	Destination	Block Replication		File Replication		RecoverPoint (Block)
		Sync	Async	Sync**	Async	
Dell EMC Unity	Dell EMC Unity	✓	✓	✓	✓	✓
Dell EMC Unity	Dell EMC UnityVSA	✗	✓	✗	✓	✗
Dell EMC Unity	VNXe3200*	✗	✓	✗	✗	✓
Dell EMC Unity	VNX1/VNX2	✗	✗	✗	✗	✓
Dell EMC Unity	VNXe1600	✗	✓	✗	✗	✗
Dell EMC UnityVSA	Dell EMC UnityVSA	✗	✓	✗	✓	✗
Dell EMC UnityVSA	Dell EMC Unity	✗	✓	✗	✓	✗
Dell EMC UnityVSA	VNXe3200*	✗	✓	✗	✗	✗
Dell EMC UnityVSA	VNX1/VNX2	✗	✗	✗	✗	✗
Dell EMC UnityVSA	VNXe1600	✗	✓	✗	✗	✗
VNX1/VNX2	Dell EMC Unity	✗	✗	✗	✗	✓

*Min VNXe3200 OE v3.1.5.6801782
 **Min Dell EMC Unity OE version 4.4

Footnote:
 ✓ – Supported
 ✗ – Not Supported