Dell PowerScale SyncIQ: Architecture, Configuration, and Considerations

April 2024

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White Paper

Abstract

Dell PowerScale SyncIQ is an application that enables the flexible management and automation of data replication. This white paper describes the key features, architecture, and considerations for SyncIQ.

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Contents

Executive summary

Overview

Simple, efficient, and scalable, Dell PowerScale SyncIQ data replication software provides data-intensive businesses with a multi-threaded, multi-site solution for reliable disaster protection.

All businesses want to protect themselves against unplanned outages and data loss. The best practice is typically to create and keep copies of critical data, so it can always be recovered. There are many approaches to creating and maintaining data copies. The right approach depends on the criticality of the data to the business and its timeliness, in essence, how long the business can afford to be without it.

As the sheer amount of data requiring management grows, it puts considerable strain on a company's ability to protect its data. Backup windows shrink, bottlenecks emerge, and logical and physical divisions of data fragment data protection processes. The result is increased risk with storing data and the growing complexity in managing it.

PowerScale SyncIQ offers powerful, flexible, and easy-to-manage asynchronous replication for collaboration, disaster recovery, business continuity, disk-to-disk backup, and remote disk archiving.

Note to readers

Before making changes on a production cluster, extreme caution is recommended. The concepts explained in this paper must be understood in their entirety before you implement data replication. As with any significant infrastructure update, testing changes in a lab environment is best practice. After updates are confirmed in a lab environment, a gradual roll-out to a production cluster may commence.

Revisions

Date	Part number/ revision	Description
March 2019		Completely rewritten and updated.
April 2019		Updated for OneFS 8.2. Added SyncIQ encryption and bandwidth reservation sections.
August 2019		Added section for SyncIQ requiring System Access Zone and source and target cluster replication performance. Updated SyncIQ worker calculations.
October 2019		Added Small File Storage Efficiency and SyncIQ section. Updated SyncIQ Encryption X.509 certificate details.
January 2020		Updated for OneFS 8.2.2: Added section for 16 TiB SyncIQ implications and added Data Reduction section.
April 2020		Moved SyncIQ password and SyncIQ encryption sections under new SyncIQ security section. Updated SyncIQ encryption section. Added SyncIQ encryption with self-signed certificates to Appendix.
May 2020		Updated Isilon branding to PowerScale. Added PowerScale nodes to SyncIQ replication and data reduction section.

Date	Part number/ revision	Description
June 2020		Added Target cluster Snapshot Alias section. Updated Cascaded replication and Whenever the source is modified sections.
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February 2022		Updated template.
April 2022		Updated for OneFS 9.4.0.0.
May 2022		Updated Prepare policy for accelerated failback, SyncIQ encryption, and Failback sections. Added Hard links and SyncIQ section.
June 2022		Updated Cascaded section under Deployment topologies with best practices. Added Dell CSI and SyncIQ section.
October 2022		Minor update.
January 2023	H8224.25	Updated for OneFS 9.5.0.0.
June 2023	H8224.26	Updated SyncIQ pre-shared key topic.
July 2023	H8224.27	Updated SyncIQ pre-shared key topic.
October 2023	H8224.28	Minor updates in the following sections: • File matching criteria • 16 TiB large file support and SyncIQ implications • OneFS version compatibility
March 2024	H8224.29	Minor update
April 2024	H8224.30	Minor formatting update

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Author: Aqib Kazi

Note: For links to other documentation for this topic, see the PowerScale Info Hub.

Introduction to SyncIQ

SyncIQ delivers unique, highly parallel replication performance that scales with the dataset to provide a solid foundation for disaster recovery. SyncIQ can send and receive data on every node in a PowerScale cluster, taking advantage of any available network bandwidth, so replication performance increases as the data store grows. Data replication starts and remains a simple process because both the replication source and target can scale to multiple petabytes without fragmentation into multiple volumes or file systems.

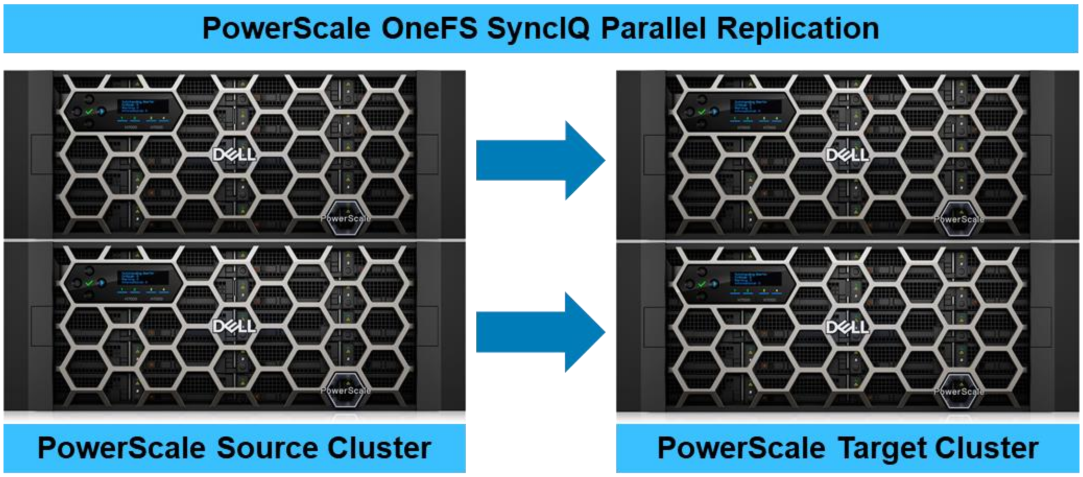

PowerScale OneFS SyncIQ Parallel Replication
PowerScale Source Cluster
PowerScale Target Cluster

Figure 1. PowerScale SyncIQ parallel replication

A simple and intuitive web-based user interface allows administrators to easily organize SyncIQ replication job rates and priorities to match business continuity priorities. Typically, a SyncIQ recurring job is defined to protect the data required for each major Recovery Point Objective (RPO) in the disaster recovery plan. For example, an administrator can choose to sync every 6 hours for customer data, every 2 days for HR data, and so on. A directory, file system, or even specific files can be configured for more- or less-frequent replication, based on their business criticality. In addition, administrators can create remote archive copies of noncurrent data that needs to be retained, reclaiming valuable capacity in a production system.

SyncIQ can be tailored to use as much or as little system resources and network bandwidth as necessary. The sync jobs can be scheduled to run at any time to minimize the impact of the replication on production systems.

Deployment topologies

Introduction to deployment topologies

Meeting and exceeding the data replication governance requirements of an organization are critical for an IT administration. SyncIQ exceeds these requirements by providing an array of configuration options, ensuring that administrators have flexible options to satisfy all workflows with simplicity.

Under each deployment, the configuration could be for the entire cluster or a specified source directory. Further, the deployment could have a single policy configured between the clusters or several policies, each with different options aligning to RPO and RTO requirements. For more information about configuration options, see Configuring a SyncIQ policy.

One-to-one

In the most common deployment scenario of SyncIQ, data replication is configured between a single source and single target cluster, as illustrated in the following figure.

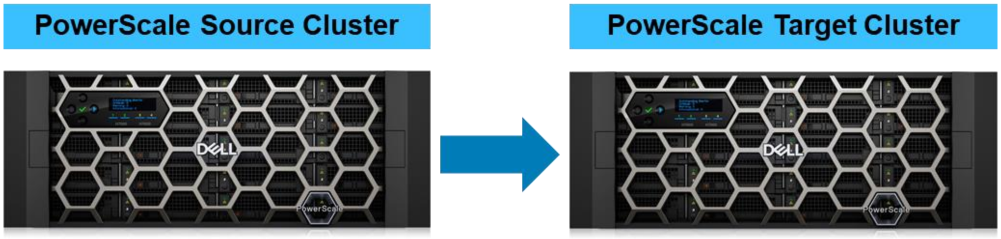


Figure 2. SyncIQ one-to-one data replication

One-to-many

SyncIQ supports data replication from a single source cluster to many target clusters, allowing the same dataset to exist in multiple locations, as illustrated in the following figure. A one-to-many deployment could also be referenced as a hub-and-spoke deployment, with a central source cluster as the hub and each remote location representing a spoke.

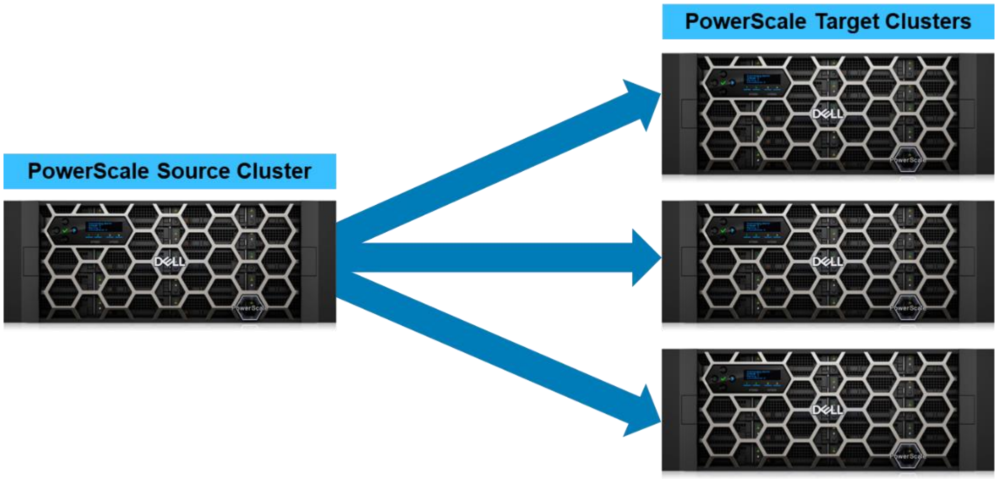


Figure 3. SyncIQ one-to-many data replication

Many-to-one

The many-to-one deployment topology is essentially the flipped version of the one-to-many explained in the previous section. Several source clusters replicate to a single target cluster as illustrated in the following figure. The many-to-one topology may also be referred to as a hub-and-spoke configuration. However, in this case, the target cluster is the hub, and the spokes are source clusters.

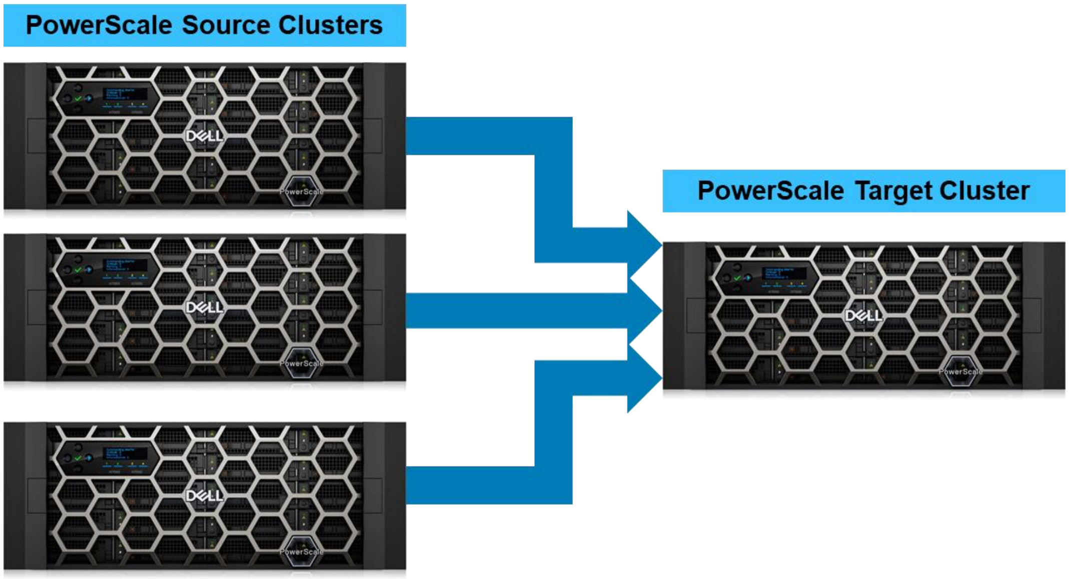


Figure 4. **SyncIQ many-to-one data replication**

Local target

A local target deployment allows a single PowerScale cluster to replicate within itself providing the SyncIQ powerful configuration options in a local cluster as illustrated in the following figure. If a local target deployment is used for disaster readiness or archiving options, the cluster protection scheme and storages pools must be considered.

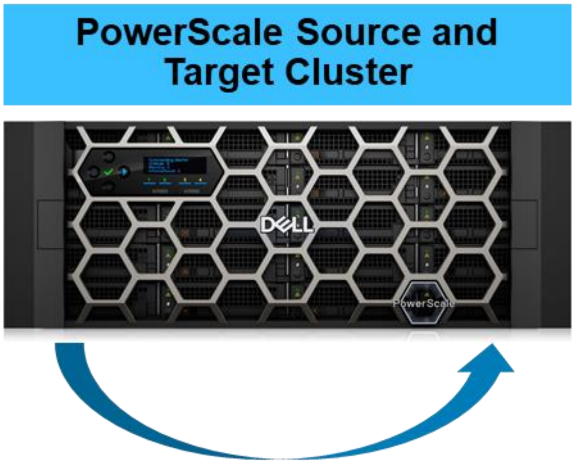


Figure 5. **SyncIQ local target data replication**

Cascaded

A cascaded deployment replicates a dataset through a series of clusters. It allows a primary cluster to replicate to a secondary cluster, next to a tertiary cluster, and so on, as illustrated in Figure 6. Essentially, each cluster replicates to the next in the chain. For a cascaded SyncIQ implementation, consider how the replication start times are configured on the second and subsequent clusters. Ensure that the start times do not start before the SyncIQ job completes from the previous cluster.

For illustration purposes, consider a cascaded SyncIQ replication with the implementation in the following figure.

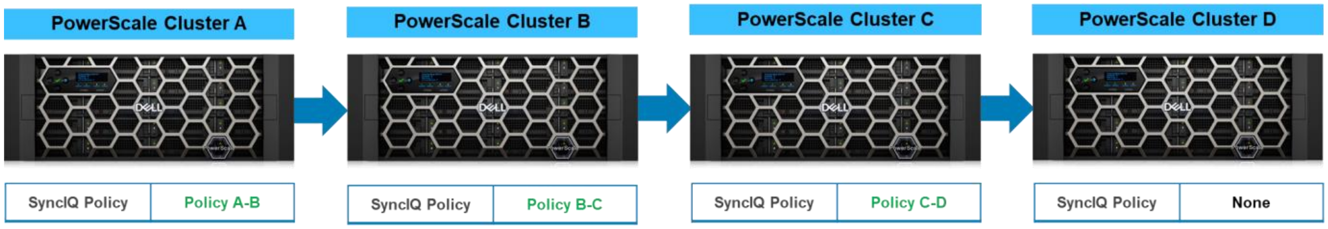


Figure 6. SyncIQ cascaded data replication

As a best practice, configure the SyncIQ policies on the second and subsequent clusters to use the **Whenever a snapshot of the source directory is taken** option, resulting in a consistent view of the source cluster's data. For example, to configure the SyncIQ cascaded implementation in Figure 6, configure the SyncIQ policies B-C and C-D using the **Whenever a snapshot of the source directory is taken** option based on a real snapshot name, rather than an alias name. Also, configure the policies at the root of the SyncIQ target path. Configuring a cascaded policy to sync the root of the SyncIQ target path will help ensure that the job is not able to run if the previous sync in the cascade has not completed.

For more information about this option, see Whenever a snapshot of the source directory is taken. For a configuration example using this implementation, see Appendix C: Configuring cascaded replication.

Custom

A custom deployment combines the previous deployments. For example, as illustrated in the following figure, a primary cluster replicates to a secondary, and then the secondary replicates to a set of tertiary clusters. Essentially, this implementation is a combination of the "Cascaded" and "One-to-many" deployments.

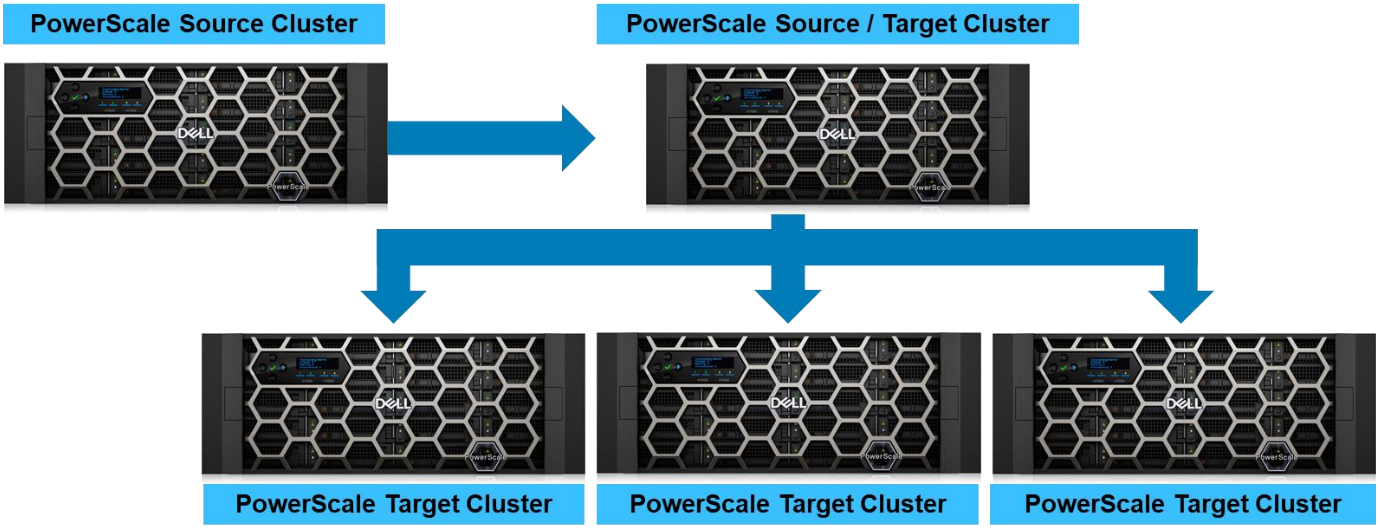

PowerScale Source Cluster
PowerScale Source / Target Cluster
PowerScale Target Cluster
PowerScale Target Cluster
PowerScale Target Cluster

Figure 7. SyncIQ cascaded and one-to-many data replication

For more information about this option, see Whenever a snapshot of the source directory is taken. For a configuration example using this implementation, see Appendix D: Configuring custom replication.

Use cases

Introduction to use cases

PowerScale SyncIQ offers powerful, efficient, and easy-to-manage data replication for disaster recovery, business continuity, remote collaboration, disk-to-disk backup, and remote disk archive.

The following figure illustrates the typical SyncIQ architecture—replicating data from a primary to a target PowerScale cluster which can be local or remote. SyncIQ can also use the primary cluster as a target in order to create local replicas.

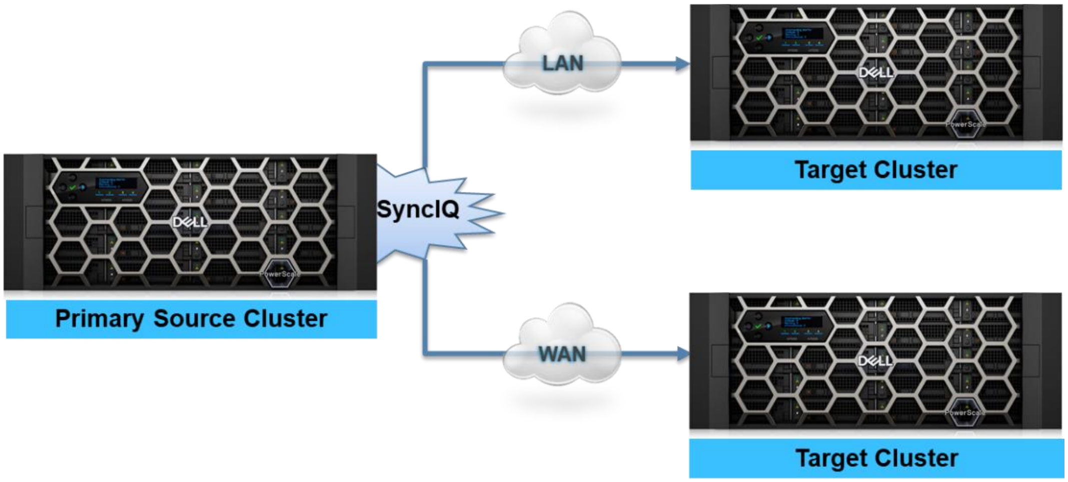


Figure 8. SyncIQ data replication over the LAN and WAN

Disaster recovery

Disaster recovery requires quick and efficient replication of critical business data to a secondary site. SyncIQ delivers high performance, asynchronous replication of data, providing protection from both local site and regional disasters, to satisfy a range of recovery objectives. SyncIQ has a robust policy-driven engine that allows customization of replication datasets to minimize system impact while still meeting data protection requirements. SyncIQ automated data failover and failback reduces the time, complexity, and risks involved with transferring operations between a primary and secondary site, in order to meet an organization’s recovery objectives. This functionality can be crucial to the success of a disaster recovery plan.

Business continuance

By definition, a business continuity solution needs to meet the most aggressive recovery objectives for the most timely, critical data. The SyncIQ highly efficient architecture provides performance that scales to maximize usage of any available network bandwidth and provides administrators the best-case replication time for aggressive Recovery Point Objectives (RPO). SyncIQ can also be used in concert with Dell PowerScale SnapshotIQ software, which allows the storage of point-in-time snapshots in order to support secondary activities like the backup to tape.

Disk-to-disk backup and restore

Enterprise IT organizations face increasingly complex backup environments with costly operations, shrinking backup and restore windows, and stringent service-level agreement (SLA) requirements. Backups to tape are traditionally slow and hard to manage as they grow. This limitation is compounded by the size and rapid growth of digital content and unstructured data. SyncIQ, as a superior disk-to-disk backup and restore solution, delivers scalable performance and simplicity, enabling IT organizations to reduce backup and restore times and costs, eliminate complexity, and minimize risk. With PowerScale scale-out network-attached storage (NAS), petabytes of backup storage can be managed within a single system-as one volume, and one file system and can be the disk backup target for multiple PowerScale clusters.

Remote archive

For data that is too valuable to throw away but not frequently accessed enough to justify maintaining it on production storage, replicate it with SyncIQ to a secondary site and reclaim the space on the primary system. Using a SyncIQ copy policy, data can be deleted on the source without affecting the target, leaving a remote archive for disk-based tertiary storage applications or staging data before it moves to offline storage. Remote archiving is ideal for intellectual property preservation, long-term records retention, or project archiving.

Architecture and processes

Architecture and processes overview

SyncIQ leverages the full complement of resources in a PowerScale cluster and the scalability and parallel architecture of the Dell PowerScale OneFS file system. SyncIQ uses a policy-driven engine to run replication jobs across all nodes in the cluster.

Multiple policies can be defined to allow for high flexibility and resource management. The replication policy is created on the source cluster, and data is replicated to the target cluster. As the source and target clusters are defined, source and target directories are also selected, provisioning the data to replicate from the source cluster and where it is replicated on the target cluster. The policies can either be performed on a user-defined schedule or started manually. This flexibility allows administrators to replicate datasets based on predicted cluster usage, network capabilities, and requirements for data availability.

After the replication policy starts, a replication job is created on the source cluster. Within a cluster, many replication policies can be configured.

During the initial run of a replication job, the target directory is set to read-only and is solely updated by jobs associated with the replication policy configured. When access is required to the target directory, the replication policy between the source and target must be broken. When access is no longer required on the target directory, the next jobs require an initial or differential replication to establish the sync between the source and target clusters.

Note: Practice extreme caution before breaking a policy between a source and target cluster or allowing writes on a target cluster. First ensure that you understand the repercussions. For more information, see Impacts of modifying SyncIQ policies and Allow-writes compared to break association.

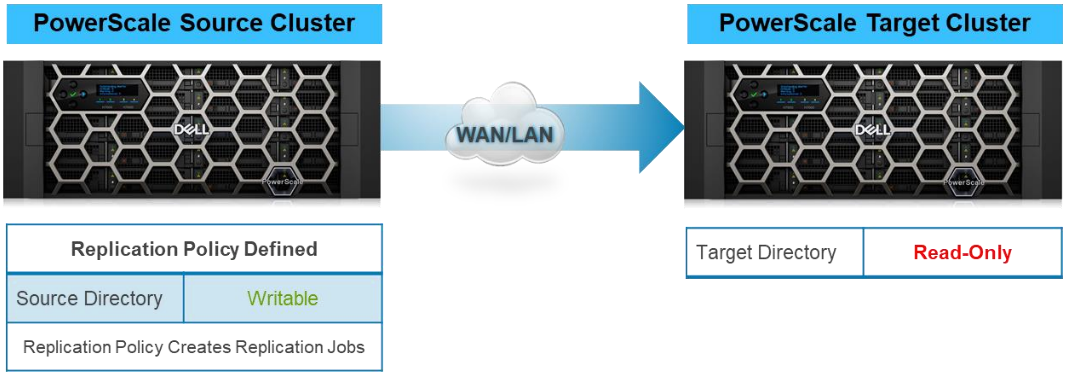

PowerScale Source Cluster
PowerScale Target Cluster
WAN/LAN
Replication Policy Defined
Source Directory
Writable
Replication Policy Creates Replication Jobs
Target Directory
Read-Only

Figure 9. PowerScale SyncIQ replication policies and jobs

When a SyncIQ job is initiated, from either a scheduled or manually applied policy, the system first takes a snapshot of the data to be replicated. SyncIQ compares this snapshot to the snapshot from the previous replication job to quickly identify the changes to be propagated. Those changes can be new files, changed files, metadata changes, or file deletions. SyncIQ pools the aggregate resources from the cluster, splitting the replication job into smaller work items and distributing the items among multiple workers across all nodes in the cluster. Each worker scans a part of the snapshot differential for changes and transfers those changes to the target cluster. While the cluster resources are managed to maximize replication performance, administrators can decrease the impact on other workflows using configurable SyncIQ resource limits in the policy.

Replication workers on the source cluster are paired with workers on the target cluster to accrue the benefits of parallel and distributed data transfer. As more jobs run concurrently, SyncIQ employs more workers to use more cluster resources. As more nodes are added to the cluster, file system processing on the source cluster and file transfer to the remote cluster are accelerated, a benefit of the PowerScale scale-out NAS architecture.

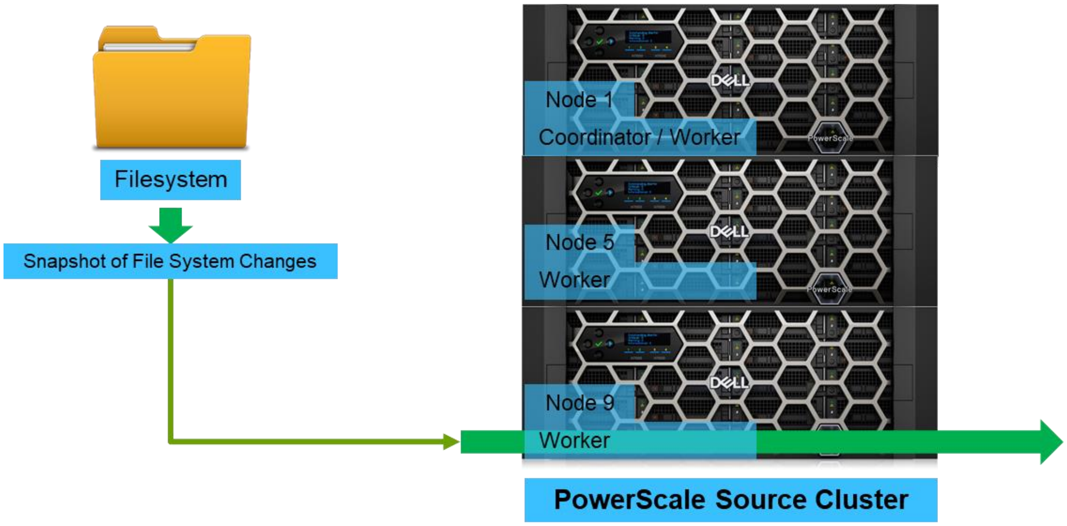


Figure 10. SyncIQ snapshots and work distribution

SyncIQ is configured through the OneFS WebUI, providing a simple, intuitive method to create policies, manage jobs, and view reports. In addition to the web-based interface, all

SyncIQ functionality is integrated into the OneFS command-line interface. For a full list of all commands, run `isi sync --help`.

Asynchronous source-based replication

SyncIQ is an asynchronous remote replication tool. It differs from synchronous remote replication tools where the writes to the local storage system are not acknowledged back to the client until those writes are committed to the remote storage system. SyncIQ asynchronous replication allows the cluster to respond quickly to client file system requests while replication jobs run in the background, per policy settings.

To protect distributed workflow data, SyncIQ prevents changes on target directories. If the workflow requires writable targets, the SyncIQ source/target association must be broken before writing data to a target directory, and any subsequent reactivation of the synchronize association requires a full synchronization.

Note: Practice extreme caution before breaking a policy between a source and target cluster or allowing writes on a target cluster. First ensure that you understand the repercussions. For more information, see Impacts of modifying SyncIQ policies and Allow-writes compared to break association.

Source cluster snapshot integration

To provide point-in-time data protection, when a SyncIQ job starts, it automatically generates a snapshot of the dataset on the source cluster. After it takes a snapshot, it bases all replication activities (scanning, data transfer) on the snapshot view. Subsequent changes to the file system while the job is in progress will not be propagated; those changes will be picked up the next time the job runs. OneFS creates instantaneous snapshots before the job begins – applications remain online with full data access during the replication operation.

Note: This source-cluster snapshot does not require a SnapshotIQ module license. Only the SyncIQ license is required.

Source-cluster snapshots are named `SIQ-<policy-id>-[new, latest]`, where `<policy-id>` is the unique system-generated policy identifier. SyncIQ compares the newly created snapshot with the snapshot taken during the previous run and determines the changed files and blocks to transfer. Each time a SyncIQ job is completed, the associated `latest` snapshot is deleted and the previous `new` snapshot is renamed to `latest`.

Note: A SyncIQ snapshot should never be deleted. Deleting a SyncIQ snapshot breaks a SyncIQ relationship, forcing a resync.

Regardless of the existence of other inclusion or exclusion directory paths, only one snapshot is created on the source cluster at the beginning of the job based on the policy root directory path.

Note: Deleting a SyncIQ policy also deletes all snapshots created by that policy.

Snapshot integration alleviates treewalks

When a SyncIQ job starts, if a previous source-cluster snapshot is detected, SyncIQ sends to the target only those files that are not present in the previous snapshot as well as changes to files since the last source-cluster snapshot was taken. Comparing two snapshots to detect these changes is a much more lightweight operation than walking the entire file tree, resulting in significant gains for incremental synchronizations after the initial full replication.

If there is no previous source-cluster snapshot (for example, if a SyncIQ job is running for the first time), a full replication will be necessary.

When a SyncIQ job completes, the system deletes the previous source-cluster snapshot, retaining the most recent snapshot to be used as the basis for comparison on the next job iteration.

Processes

In order to understand how SyncIQ implements each policy, it is essential to understand the processes associated with data replication as illustrated in the following figure.

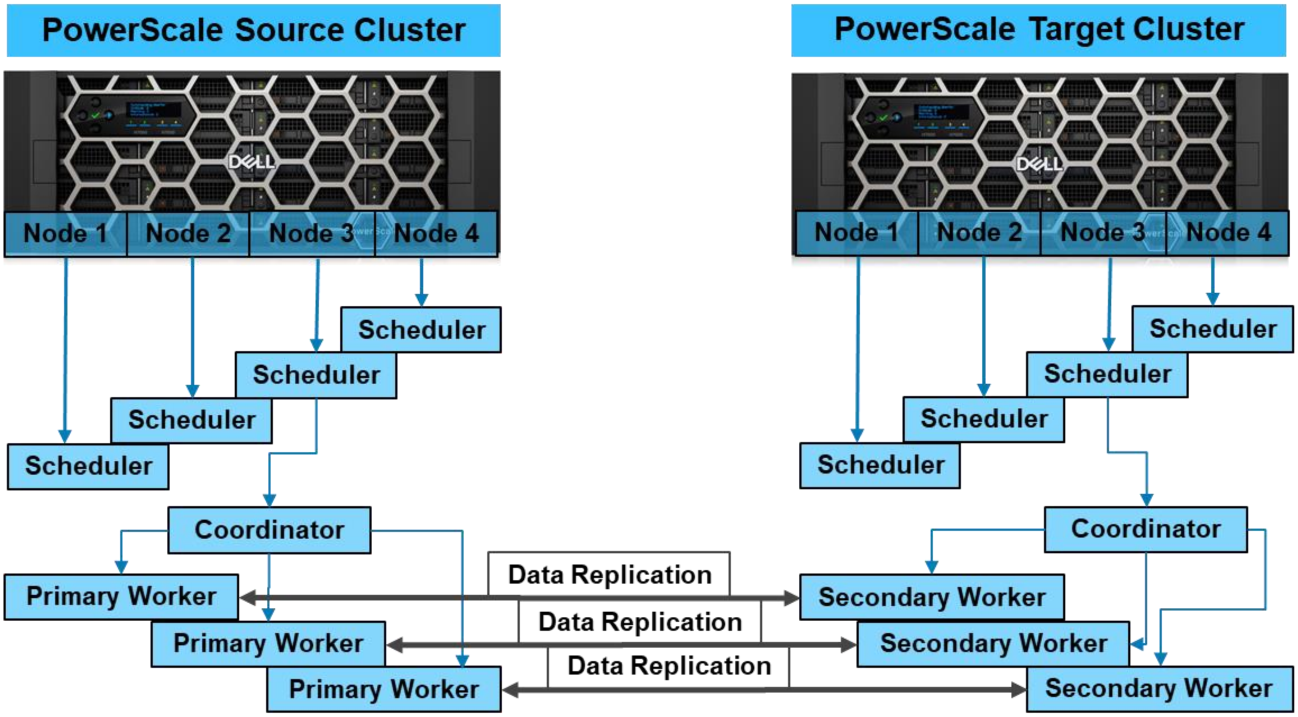


Figure 11. PowerScale SyncIQ processes

Scheduler

Each PowerScale node has a Scheduler process running. It is responsible for the creation and launch of SyncIQ data replication jobs and creating the initial job directory. Based on the current SyncIQ configuration, the Scheduler starts a new job and updates jobs based on any configuration changes.

Coordinator

The Scheduler launches the Coordinator process. The Coordinators create and oversee the worker processes as a data replication job runs. The Coordinator is responsible for snapshot management, report generation, bandwidth throttling, managing target monitoring, and work distribution.

Snapshot management involves capturing the file system snapshots for SyncIQ. The snapshots are locked while in use and deleted after completion. Report management acquires job data from each process and combines it in a single report. Bandwidth throttling provides the Coordinator with bandwidth information to align jobs with available bandwidth. Target monitoring management is monitoring the target cluster's worker process. And finally, work distribution maximizes job performance by ensuring all worker process have even utilization.

Primary and secondary workers

Primary workers and secondary workers run on the source and target clusters, respectively. They are responsible for the actual data replication piece during a SyncIQ job.

Target monitor

The target monitor provides critical information about the target cluster and does not participate in the data transfer. It reports back with IP addresses for target nodes including any changes on the target cluster. Also, the target monitor takes target snapshots as they are required.

Data replication

Introduction to data replication

When SyncIQ replicates data, it goes through one of three phases. The three phases are Initial, Incremental, and Differential. This section explains each phase.

Note: This section provides a detailed explanation of the SyncIQ data replication process. Many of the details in this section may not be necessary for implementing and managing SyncIQ. Understanding all the steps in this section is not required. However, the details in this section are provided for a granular understanding of how SyncIQ data replication occurs, enabling a foundation of the concepts explained throughout this paper.

Initial replication

After a policy is configured, the first time it runs, an Initial Replication is performed. During the policy configuration, a user can configure a synchronization or copy policy.

The synchronization policy ensures that the target cluster has a precise duplicate of the source directory. As the source directory is modified through additions and deletions, those updates are propagated to the target cluster when the policy runs next. Under Disaster Recovery use cases, the synchronization policy supports a failover to the target cluster, allowing users to continue with access to the same dataset as the source directory.

On the contrary, a copy policy is targeted for archive and backup use cases. A copy policy maintains current versions of files stored on the source cluster.

The first segment of the Initial Replication is the job start. A scheduler process is responsible for starting a data replication job. It determines the start time based on either the scheduled time or a manually started job. When the time arrives, the scheduler updates the policy to a pending status on the source record and creates a directory with information specific to the job.

After the creation of the initial directory with the SyncIQ policy ID, a scheduler process of a node takes control of the job. After a node's scheduler process has taken control of the job, the directory is renamed again to reflect the node's device ID. Next, one of the scheduler processes create the coordinator process and the directory structure is renamed again.

After the directory structure is renamed to reflect the SyncIQ policy ID, node ID, and coordinator PID, the data transfer stage commences. The coordinator has a primary worker process start a treewalk of the current SyncIQ snapshot. This snapshot is named `snapshot-<SyncIQ Policy ID>-new`. On the target cluster, the secondary workers receive the treewalk information, mapping out the LINs accordingly.

During the treewalk and exchange of LIN information, a list of target node IP addresses is gathered through the target monitor process. At this point, the primary workers setup TCP connections with the secondary workers of target nodes for the remainder of the job. If a worker on a cluster crashes, the corresponding worker will also crash. In this event, the coordinator launches a new primary worker process and establishes a new TCP connection with a secondary worker. If the coordinator crashes, the scheduler restarts the coordinator, and all workers must establish TCP connections again. The number of workers is calculated based on many factors. See Worker and performance scalability for more information about calculating workers.

Now that the primary and secondary workers are created with TCP connections between each, data transfer is started between each set of workers.

As each set of workers completes data transfer, they go into an idle state. After all workers are in an idle state and the restart queue does not contain any work items, the data replication is complete. The coordinator then renames the snapshot taken at the onset to `snapshot-<SyncIQ Policy ID>-latest`. Next, the coordinator files a job report. If the SyncIQ policy is configured to create a target-side snapshot, that snapshot is taken at this time. Finally, the coordinator removes the job directory that was created at the onset and the job is complete.

Incremental replication

An Incremental Replication of a SyncIQ policy only transfers the portions of files that have changed since the last run. Therefore, the amount of data replicated, and bandwidth consumption is significantly reduced in comparison to the initial replication.

Similar to the Initial Replication, at the start of an Incremental Replication, the scheduler processes create the job directory. Next, the coordinator starts a process of collecting changes to the dataset, by taking a new snapshot and comparing it to the previous snapshot. The changes are compiled into an incremental file with a list of LINs that have been modified, added, or deleted.

After all the new modifications to the dataset are logged, workers read through the file and start to apply the changes to the target cluster. On the target cluster, the deleted LINs are removed first, followed by updating directories that have changed. Finally, the data and metadata are updated on the target cluster.

As all updates complete, the coordinator creates the job report, and the replication is complete.

Differential replication or target aware sync

In the event where the association between a source and target is lost or broken, incremental replications will not work. At this point, the only available option is to run an initial replication on the complete dataset. Running the initial replication again, is bandwidth and resource intensive, as it is essentially running again as a new policy. The Differential Replication offers a far better alternative to running the initial replication again.

Note: Running an initial replication again after the source and target cluster association is broken affects not only bandwidth and cluster resources. It also creates ballooning snapshots on the target cluster for snapshots outside of SyncIQ re-replication. A Differential Replication eliminates these concerns.

The term “Differential Replication” is also referred to as “Target Aware Sync,” “Target Aware Initial Sync,” and “Diff Sync.” All these terms are referencing a Differential Replication.

A Differential Replication compares the source and target directories to identify any differences and only replicates data that does not exist in the target directory. If a data difference between a specific file’s source and target copies is found, the entire file is replicated from the source to the target. However, files may bypass the comparison process and proceed with a complete transfer for any of the following conditions:

- File size is under 32 KiB
- Multiply-linked file
- Symlink file
- Smartlinked file

Note: Target Aware Synchronizations are much more CPU-intensive than regular baseline replication, but they potentially yield much less network traffic if both source and cluster datasets are already seeded with similar data.

The Target Aware Initial Sync feature, available only using the CLI. To enable target-aware initial synchronization, use the following command:

```
isi sync policies modify <policy_name> --target-compare-initial-
sync=true
```

Configuring a SyncIQ policy

Introduction to configuring a SyncIQ policy

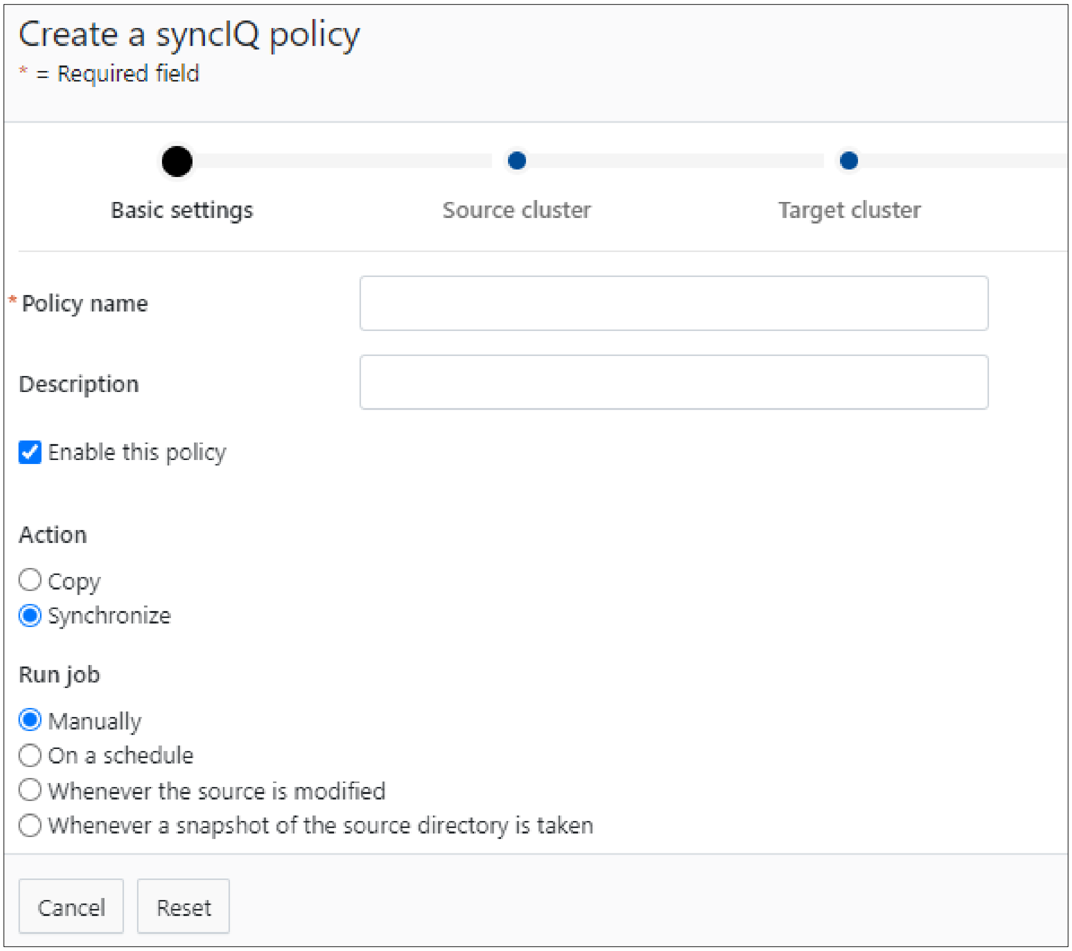
SyncIQ is configured through policies. The policies provide the starting point of OneFS data replication. The policies offer a breadth of options for an administrator to configure data replication specific to a workflow. SyncIQ is disabled by default on Greenfield PowerScale clusters on OneFS 9.1 or newer. Enable SyncIQ by clicking **Activate SyncIQ** under **Data Protection > SyncIQ**. After SyncIQ is enabled, encryption is required for new policies. For more information about configuring encryption, see SyncIQ security.

SyncIQ configuration may depend on the Access Zone configuration. It is important to understand the impacts as SyncIQ policies are configured. For more information about best practices with Access Zones, see the PowerScale Network Design Considerations white paper. Before proceeding with a SyncIQ policy configuration, ensure that the

Access Zones best practices are considered. In addition, the design of policies must consider other resources as stated in SyncIQ design considerations.

The SyncIQ policies are configurable through the CLI or the web interface. To configure SyncIQ from the CLI, start with the command isi sync policies --help**.**

To access the SyncIQ policies from the web interface, when logged in, click **Data Protection > SyncIQ**, then click the **Policies** tab. A new SyncIQ policy is created by clicking **Create a SyncIQ Policy**, displaying the **Create SyncIQ Policy** window, as displayed in the following figure.



Create a syncIQ policy

* = Required field

* Policy name

Description

☑ Enable this policy

Action

○ Copy
● Synchronize

Run job

● Manually
○ On a schedule
○ Whenever the source is modified
○ Whenever a snapshot of the source directory is taken

Figure 12. OneFS WebUI SyncIQ policy

Naming and enabling a policy

Considering the previously described best practices, because several policies could be configured on a cluster, make the **Policy Name** field descriptive enough for administrators to easily gather the policy workflow. A unique name makes it easy to recognize and manage. Use the **Description** field, if necessary, to provide additional descriptive information.

The **Enable this policy** checkbox is a powerful option that allows an administrator to start configuration before a target cluster or directory is ready for replication. Temporarily disabling a policy allows for a less intrusive option to deleting a policy when it may not be required. Further, after policy configuration is complete, the policy can be reviewed for a final check before it is enabled.

Synchronization and copy policies

SyncIQ provides two types of replications policies: synchronization and copy. Data replicated with a synchronization policy is maintained on the target cluster precisely as it is on the source–files deleted on the source are deleted the next time the policy runs. A copy policy produces essentially an archived version of the data – files deleted on the source cluster will not be deleted from the target cluster. However, there are some specific behaviors in certain cases, explained below.

If a directory is deleted and replaced by an identically named directory, SyncIQ recognizes the re-created directory as a “new” directory, and the “old” directory and its contents will be removed.

Example: If an administrator deletes `/ifs/old/dir` and all its contents on the source with a copy policy, `/ifs/old/dir` still exists on the target. Then, a new directory is created, named /`ifs/old/dir` in its place, the old `dir` and its contents on the target will be removed, and only the new directory’s contents will be replicated.

SyncIQ tracks file moves and maintains hard link relationships at the target level. SyncIQ also removes links during repeated replication operations if it points to the file or directory in the current replication pass.

Example: If a single linked file is moved within the replication set, SyncIQ removes the old link and adds a new link. Assume that:

- The SyncIQ policy root directory is set to /ifs/data/cluster1.
- /ifs/data/cluster1/user1/foo is hard linked to /ifs/data/cluster1/user2/bar.
- /ifs/data/cluster1/user2/bar is moved to /ifs/data/cluster1/user3/bar.
- With copy replication, on the target cluster, /ifs/data/cluster1/user1/foo will remain, and ifs/data/cluster1/user2/bar will be moved to /ifs/data/cluster1/user3/bar.

If a single hard link to a multiply linked file is removed, SyncIQ removes the destination link.

Note: See Hard links and SyncIQ to understand how SyncIQ interacts with hard links.

Example: Using the preceding example, if `/ifs/data/cluster1/user2/bar` is deleted from the source, copy replication also removes `/ifs/data/cluster1/user2/bar` from the target.

If the last remaining link to a file is removed on the source, SyncIQ does not remove the file on the target unless another source file or directory with the same filename is created in the same directory (or unless a deleted ancestor is replaced with a conflicting file or directory name).

Example: Continuing with the same example, assume that `/ifs/data/cluster1/user2/bar` has been removed, which makes `/ifs/data/cluster1/user1/foo` the last remaining link. If `/ifs/data/cluster1/user1/foo` is deleted on the source cluster, with a copy replication, SyncIQ does not delete /ifs/data/cluster1/user1/foo from the target cluster unless a new file or directory was created on the source cluster that was named /ifs/data/cluster1/user1/foo. After SyncIQ creates the new file or directory with this name, the old file on the target cluster is removed and re-created upon copy replication.

If a file or directory is renamed or moved on the source cluster and still falls within the SyncIQ policy's root path when copied, SyncIQ will rename that file on the target. It does not delete and re-create the file. However, if the file is moved outside of the SyncIQ policy root path, with copy replication SyncIQ will leave that file on the target but no longer associate it with the file on the source. If that file is moved back to the original source location or even to another directory within the SyncIQ policy root path, with copy replication SyncIQ creates a new file on the target because it no longer associates it with the original target file.

Example: Consider a copy policy rooted at /ifs/data/cluster1/user. If /ifs/data/cluster1/user1/foo is moved to /ifs/data/cluster1/user2/foo, SyncIQ renames the file on the target on the next replication. However, if /ifs/data/cluster1/user1/foo is moved to /ifs/data/cluster1/home/foo, which is outside the SyncIQ policy root path, with copy replication, SyncIQ does not delete /ifs/data/cluster1/user1/foo on the target, but it does disassociate, or orphan it, from the source file, that now resides at /ifs/data/cluster1/home/foo. If, on the source cluster, the file is moved back to /ifs/data/cluster1/user1/foo, an incremental copy writes that entire file to the target cluster because the association with the original file has been broken.

Running a SyncIQ job

A SyncIQ policy may be configured to run with four different options. Each of those options is explained in this section.

Note: Although SyncIQ offers many options for configuring a SyncIQ policy, as explained in this section, **Whenever a snapshot of the source directory is taken** is the best practice and recommended configuration. For more information about this configuration, see Whenever a snapshot of the source directory is taken.

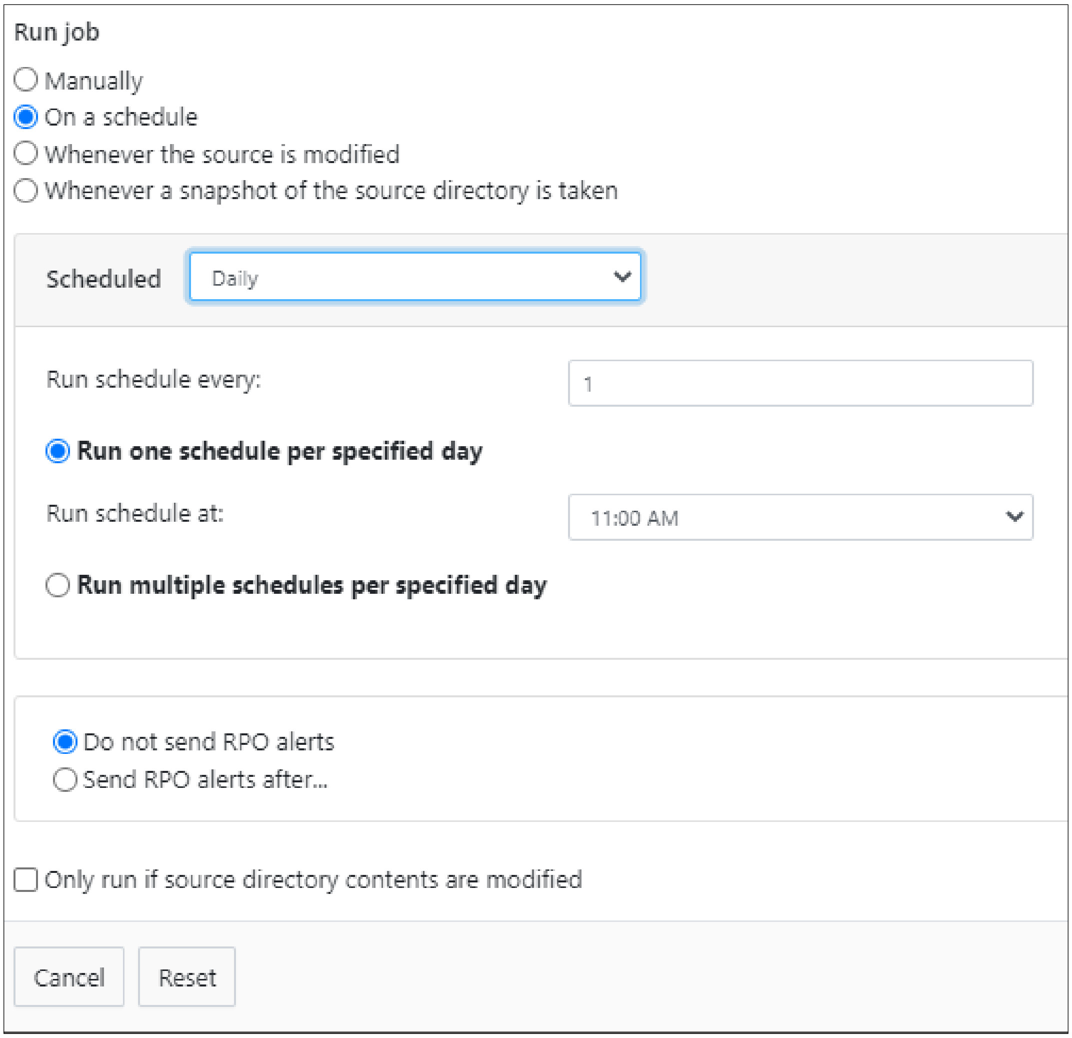
Manually

The manual option allows administrators to have a SyncIQ Policy completely configured and ready to run when a workflow requires data replication. If continuous data replication is not required and on an as-needed basis, the manual option is the best option. Administrators can just select the policy to run when it is required, limiting cluster overhead and saving bandwidth.

Note: Manual SyncIQ jobs still maintain a source snapshot that accumulates changed blocks. Therefore, it is recommended to run the manual job frequently, to ensure that the source snapshot growth is limited.

On a schedule

Running a SyncIQ Policy on a schedule is one of the more common options. When this option is selected, another drop-down appears, to specify the frequency of the job, as displayed in the following figure.



Run job

○ Manually
● On a schedule
○ Whenever the source is modified
○ Whenever a snapshot of the source directory is taken

Scheduled: Daily

Run schedule every: 1

● **Run one schedule per specified day**

Run schedule at: 11:00 AM

○ **Run multiple schedules per specified day**

● Do not send RPO alerts
○ Send RPO alerts after...

□ Only run if source directory contents are modified

Figure 13. SyncIQ Job on a schedule

Options include daily, weekly, monthly, or yearly. When the frequency is selected, further options appear to refine the frequency selection.

Before OneFS 8.0, a snapshot is always taken for scheduled jobs, even if no data changes have occurred since the previous execution. In OneFS 8.0, a policy parameter can be specified so that SyncIQ checks for changes since the last replication as the first step in the policy. If there are no changes, no further work will be done on that policy iteration, and the policy will report as **skipped**. If there are changes, the source data snapshot will be taken, and the policy will proceed. This capability reduces the amount of work performed by the cluster if there is no changed data to be replicated. To enable this behavior, select **Only run if source directory contents are modified** on the WebUI or specify `--skip-when-source-unmodified true` on the CLI.

Note: As a best practice, avoid the overlap of policy start times or have several policies running during the same time period. As explained in SyncIQ design considerations, consider policy start times and cluster resources. As policies complete, monitor completion times and adjust policy start times to minimize overlap. Staggering policy start times is especially critical for a high-volume dataset.

RPO alerts

An option for sending RPO alerts is available when **On a Schedule** is selected for a running a job. Administrators can specify an RPO (recovery point objective) for a scheduled SyncIQ policy and trigger an event to be sent if the RPO is exceeded. The RPO calculation is the interval between the current time and the start of the last successful sync job.

Note: The RPO option only appears if RPO is enabled under SyncIQ global settings. From the web interface, select **Data Protection** > **SyncIQ**, and then select the **Settings** tab. **The Enable RPO Alerts** checkbox is displayed.

For example, consider a policy scheduled to run every 8 hours with a defined RPO of 12 hours. Suppose the policy runs at 3 pm and completes successfully at 4 pm. Thus, the start time of the last successful sync job is 3 pm. The policy should run next at 11 pm, based on the 8-hour scheduled interval. If this next run completes successfully before 3 am, 12 hours since the last sync start, no alert will be triggered, and the RPO timer is reset to the start time of the replication job. If for any reason the policy has not run to successful completion by 3 a.m., an alert will be triggered because more than 12 hours elapsed between the current time (after 3 a.m.) and the start of the last successful sync (3 p.m.).

If an alert has been triggered, it is automatically canceled after the policy successfully completes.

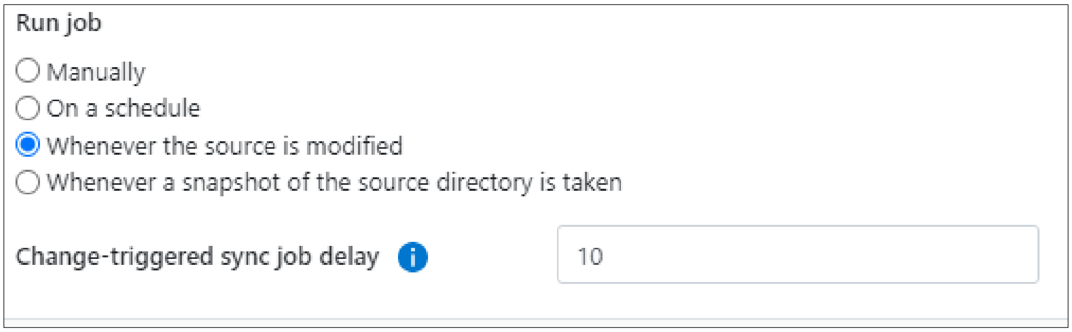
The RPO alert can also be used for policies that have never been run, as the RPO timer starts at the time the policy is created. For example, consider a policy created at 4 pm with a defined RPO of 24 hours. If by 4 pm the next day, the policy has not successfully completed at least one synchronization operation, the alert will be triggered. As stated previously, the first run of a policy is a full synchronization and will probably require a longer elapsed time than subsequent iterations.

An RPO can only be set on a policy if the global SyncIQ setting for RPO is already set to enabled: `isi sync settings modify –rpo-alerts true|false`. By default, RPO alerts are enabled.

Individual policies by default have no RPO alert setting. Use `--rpo-alert <duration>` on the `isi sync policies create` or `modify` command to specify the duration for a particular policy.

Whenever the source is modified

The **Whenever the source is modified** option is also referred to as, “SyncIQ continuous mode” or “Replicate on Change.” When the **Whenever the source is modified** policy configuration option is selected (or `--schedule when-source-modified` on the CLI), SyncIQ will continuously monitor the replication dataset and automatically replicate changes to the target cluster. Continuous replication mode is applicable when the target cluster dataset must always be consistent with the source, or if data changes at unpredictable intervals.



Run job

○ Manually

○ On a schedule

● Whenever the source is modified

○ Whenever a snapshot of the source directory is taken

Change-triggered sync job delay: 10

Figure 14. SyncIQ source modified option

Note: Practice extreme caution with the **Whenever the source is modified** option because it can trigger a large amount of replication, snapshot, and network traffic if the data is volatile. The source modified option is not synchronous data replication. Consider the cluster resources and frequency of dataset updates when applying this option. It may result in SyncIQ policies constantly running and excessive resource consumption. Another factor to consider is, by default, snapshots of the source directory are taken before each SyncIQ job. If the dataset is frequently modified, many snapshots are triggered, possibly conflicting with other snapshot activity. If selecting this option is necessary, ensure that the sync delay is configured with ample time to encapsulate new data and allows for the policy to complete.

Events that trigger replication include file additions, modifications and deletions, directory path, and metadata changes. SyncIQ checks the source directories every ten seconds for changes, as illustrated in the following figure.

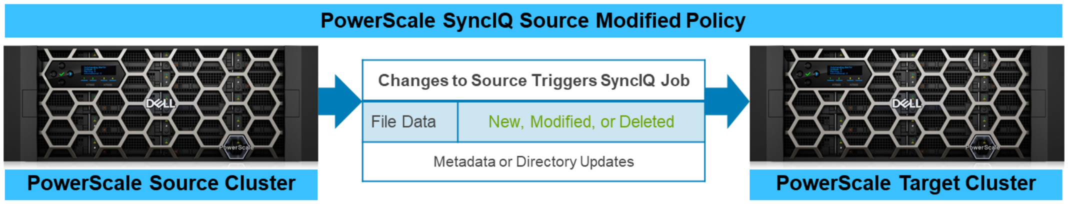

PowerScale SyncIQ Source Modified Policy
Changes to Source Triggers SyncIQ Job
File Data
New, Modified, or Deleted
Metadata or Directory Updates
PowerScale Source Cluster
PowerScale Target Cluster

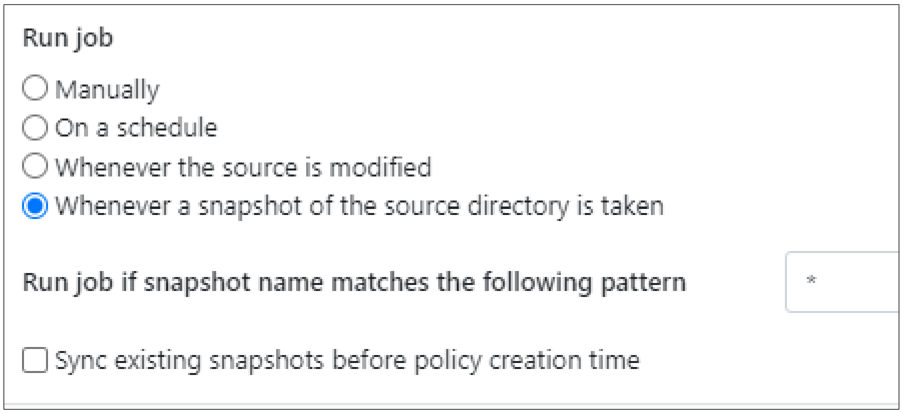
Figure 15. SyncIQ source modified policy triggers

Before OneFS 8.0, jobs in Continuous Replication mode run immediately after a change is detected. OneFS 8.0 introduces a policy parameter to delay the replication start for a specified time after the change is detected. The delay allows a burst of updates to a dataset to be propagated more efficiently in a single replication event rather than triggering multiple events. To enable the delay for a continuous replication policy, specify the delay period in the **Change-Triggered Sync Job Delay** option on the UI, as shown in Figure 14, or specify `--job-delay <duration>` on the CLI.

Note: As a best practice, if the **Whenever the source is modified** option is selected, configure the **Change-Triggered Sync Job Delay** option for a reasonable delay to propagate multiple updates into a single update.

Whenever a snapshot of the source directory is taken

A SyncIQ policy can be configured to trigger when the administrator takes a snapshot of the specified source directory and matching a specified pattern as displayed in the following figure.



Run job

○ Manually

○ On a schedule

○ Whenever the source is modified

● Whenever a snapshot of the source directory is taken

Run job if snapshot name matches the following pattern *

□ Sync existing snapshots before policy creation time

Figure 16. Whenever a snapshot of the source directory is taken

If this option is specified, the administrator-taken snapshot will be used as the basis of replication, rather than generating a system snapshot. Basing the replication start on a snapshot is useful for replicating data to multiple targets. They can all be simultaneously triggered when a matching snapshot is taken, and only one snapshot is required for all the replications. To enable this behavior, select the **Whenever a snapshot of the source directory is taken** policy configuration option on the UI. Alternatively, from the CLI, use the flag, `--schedule=when-snapshot-taken`.

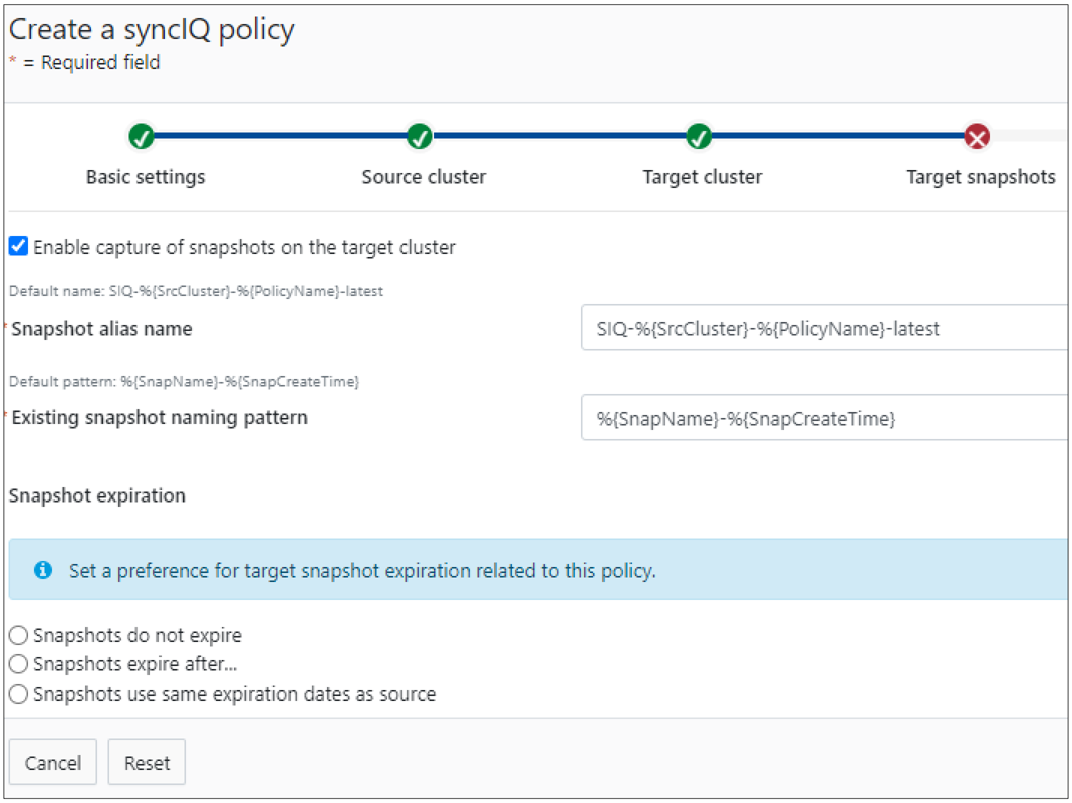
All snapshots taken of the specified source directory trigger a SyncIQ job to start, replicating the snapshot to the target cluster. An administrator may limit all snapshots from triggering replication by specifying a naming convention to match in the **Run job if snapshot name matches the following pattern**: field. By default, the field contains an asterisk, triggering replication for all snapshots of the source directory. Alternatively, from the CLI, if the flag `--snapshot-sync-pattern <string>` is not specified, the policy automatically enters an asterisk, making this flag optional.

The checkbox **Sync existing snapshots before policy creation time** is displayed only for a new policy. If an existing policy is edited, this option is not available. Alternatively, from the CLI, the flag `--snapshot-sync-existing` is available for new policies. The **Sync existing snapshots before policy creation time** option replicates all snapshots to the target cluster that were taken on the specified source cluster directory.

Note: The **Whenever a snapshot of the source directory is taken** is the best practice and recommended policy for scheduling SyncIQ policies. Further, the `when-snapshot-taken` SyncIQ policy schedule should be driven by first creating a SnapshotIQ policy on the source directory with the desired schedule. After configuring the SnapshotIQ policy, the `when-snapshot-taken` SyncIQ policy can be created or modified to use the SnapshotIQ schedule and the `--snapshot-sync-existing` option. For more information about SnapshotIQ and SyncIQ, see SnapshotIQ and SyncIQ.

When snapshots are replicated to the target cluster, by default, only the most recent snapshot is retained and the naming convention on the target cluster is system generated. However, to prevent only a single snapshot from being overwritten on the target cluster and the default naming convention, select the **Enable capture of snapshots on the target cluster** as stated in Target snapshots. When this checkbox is selected, specify a naming pattern and select the **Snapshots do not expire** option. Alternatively, specify a date for snapshot expiration in the **Snapshots expire after** option. Limiting snapshots from expiring ensures that they are retained on the target cluster rather than overwritten when a newer snapshot is available. The target cluster snapshot options map to `--target-snapshot-archive`, `--target-snapshot-alias`, `--target-snapshot-expiration`, and `--target-snapshot-pattern` in the CLI.

OneFS release 9.4.0.0 introduces a feature to retain the original snapshot's name and creation time from the source cluster in the field **Existing snapshot naming pattern**, as shown in the following figure. The original snapshot's name maps to **SnapName**, and the original snapshot creation time maps to SnapCreateTime. Both naming patterns are based on the name and creation time originally from the source cluster, allowing administrators to easily manage snapshots on the target cluster. Also, to have the snapshots use the expiration specified on the source cluster, select **Snapshots use same expiration dates as source.** The new snapshot management option maps to `--sync-existing-target-snapshot-pattern` in the CLI.


Create a syncIQ policy

* = Required field

☑ Enable capture of snapshots on the target cluster

Default name: SIQ-%{SrcCluster}-%{PolicyName}-latest

* Snapshot alias name: SIQ-%{SrcCluster}-%{PolicyName}-latest

Default pattern: %{SnapName}-%{SnapCreateTime}

* Existing snapshot naming pattern: %{SnapName}-%{SnapCreateTime}

Snapshot expiration

Set a preference for target snapshot expiration related to this policy.

○ Snapshots do not expire
○ Snapshots expire after...
○ Snapshots use same expiration dates as source

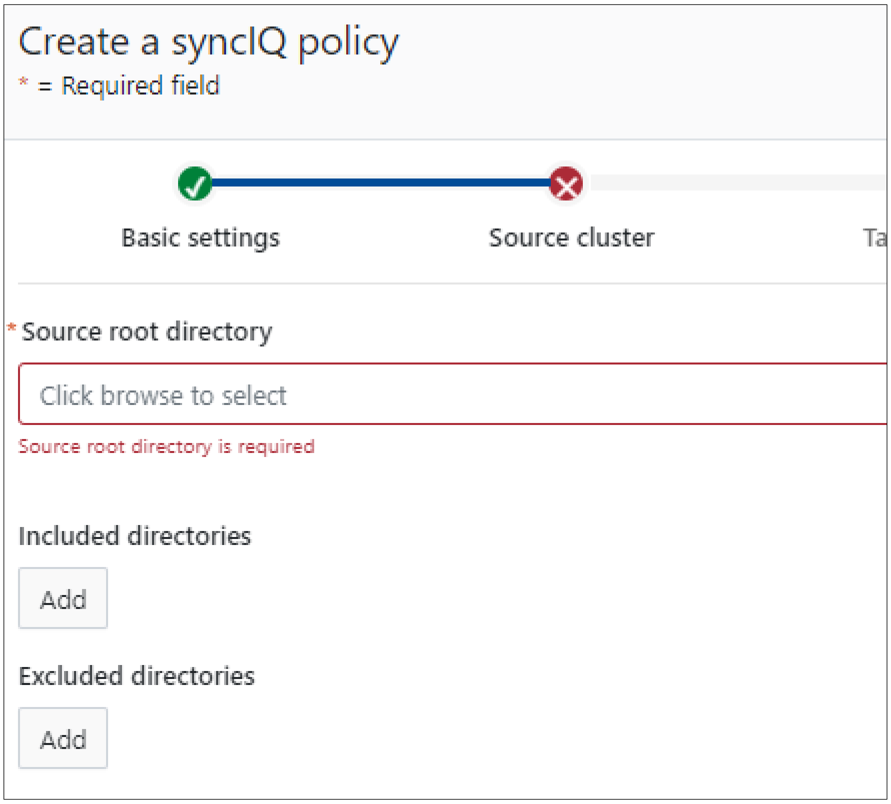
Figure 17. Target cluster snapshot naming and retention

Note: Configuration of snapshots for automatic capture based on a time-frequency triggers the SyncIQ policy to run. If SyncIQ policies are constantly running, consider the impact on system resources before configuring them. As with any major storage infrastructure update, test the configuration in a lab environment before updating a production cluster to ensure that all resource impacts are considered and calculated.

Alternatively, SyncIQ also provides an option for manually specifying an existing snapshot for SyncIQ replication, as explained in SnapshotIQ and SyncIQ.

Source cluster directory

The Source Cluster section is used to specify where the source data resides that will be replicated to the target cluster, as displayed in the following figure.



Create a syncIQ policy

* = Required field

* Source root directory

Click browse to select

Source root directory is required

Included directories

Excluded directories

Figure 18. SyncIQ policy source cluster configuration

Note: Specifying the source cluster directory as `/ifs/data` is not supported. Create subdirectories for replication under /`ifs/data`. The `/ifs/data` directory includes the `Isilon_Support` folder where cluster logs are written and is the path cited for placing installation files. Replicating the `/ifs/data` directory as root, causes issues during failover and failback.

A SyncIQ policy by default includes all files and folders under the specified root directory. Optionally, directories under the root directory can be explicitly included or excluded.

Note: As a best practice, avoid overlapping source directory SyncIQ policies with differing retention times to prevent nested snapshots.

Access zones and replication directories

As source and target cluster replication directories are specified, consider the impacts on understanding where data originated through failovers and failbacks. Also, if the data is replicated across multiple clusters, understanding the origin of the data becomes further complicated. The best practice is to use the cluster name, a numerical access zone number, and a directory. For example, Access Zone 1 maps to `/ifs/data/clustername/az1/<data directories>`, Access Zone 2 maps to `/ifs/data/clustername/az2/<data directories>`, as shown in the following figure. A root-based path with this delineation provides data separation and multitenancy, maintains the Unified Permission model, and makes SyncIQ failover and failbacks easier. For more information about access zones, see the *Access zones best practices* section in the PowerScale: Network Design Considerations white paper. For more information about the Unified Permission Model, see the PowerScale OneFS Authentication, Identity Management, and Authorization white paper.

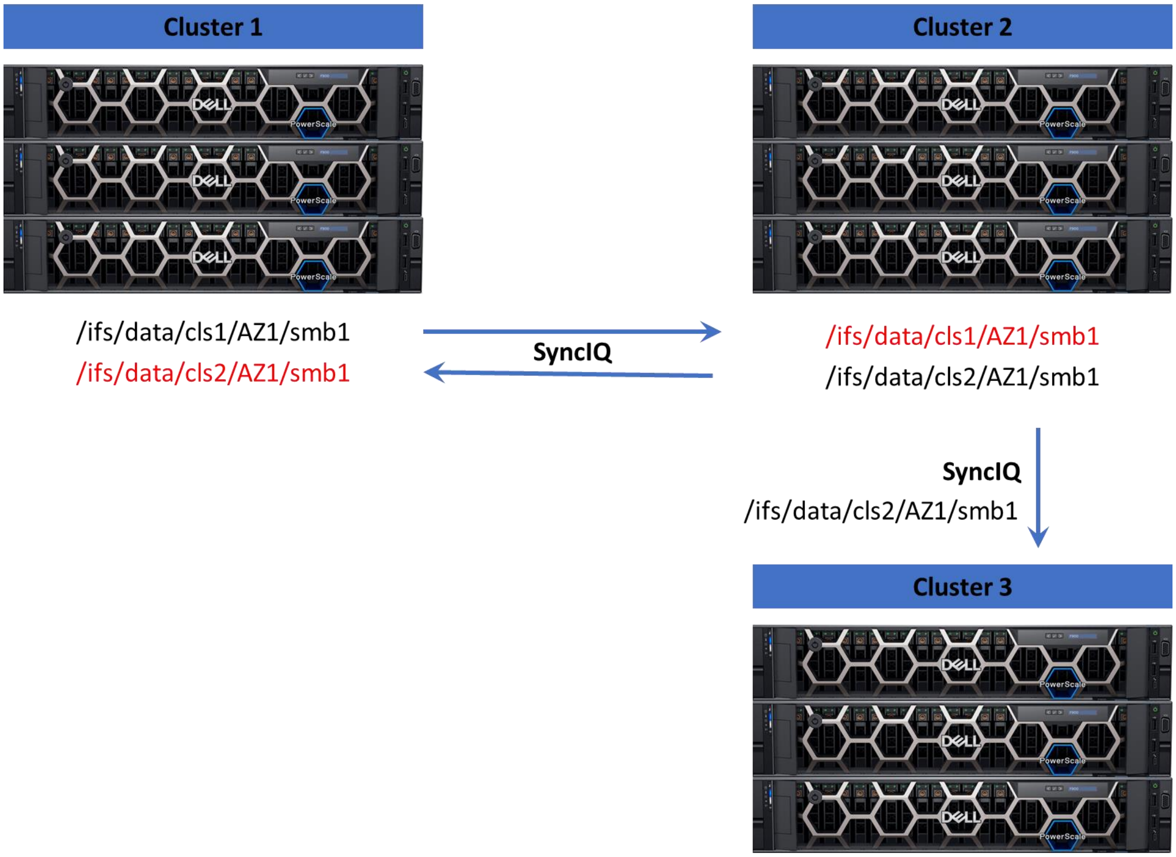


Figure 19. Replication directory structure

Includes and excludes

If any directories are explicitly included in the policy configuration, the system synchronizes *only* those directories and their included files to the target cluster. If any directories are explicitly excluded, those directories and any files contained in them are not synchronized to the target cluster.

Any directories explicitly included must reside within the specified root directory tree. Consider a policy with the root directory `/ifs/data/cluster1` and explicitly include the `/ifs/data/cluster1/media` directory because it is under `/ifs/data/cluster1`. When the associated policy runs, only the contents of the `/ifs/data/cluster1/media` directory would be synchronized to the target cluster. However, the directory `/ifs/data/projects` is not included because it is not part of the `/ifs/data/cluster1` tree.

If a directory is explicitly excluded within the specified root directory, all the contents of the root directory except for the excluded directory will be synchronized to the target cluster.

If both included and excluded directories are specified, every explicitly included directory will be replicated, and every other file, or directory, under the exclude directory, will be excluded from the replication dataset.

For example, consider a policy with the root directory `/ifs/data/cluster1`, and the following directories explicitly included and excluded:

Explicitly included directories:

```
/ifs/data/cluster1/media/music
/ifs/data/cluster1/media/movies
```

Explicitly excluded directories:

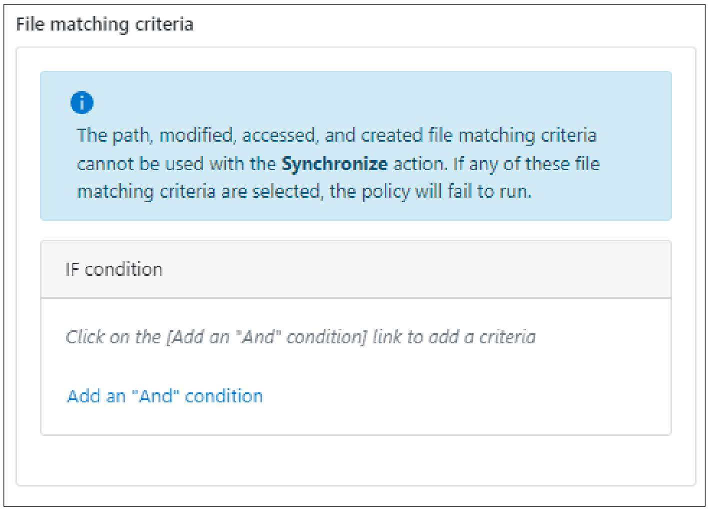
```
/ifs/data/cluster1/media/music/working
/ifs/data/cluster1/media
```

In this example, all directories below `/ifs/data/cluster1/media` are excluded except for those directories that are specifically included. Therefore, directories such as `/ifs/data/cluster1/media/pictures`, `/ifs/data/cluster1/media/books`, `/ifs/data/cluster1/media/games` are excluded because of the exclude rule. The directory and all subdirectories of `/ifs/data/cluster1/media/music` will be synchronized to the target cluster, except for the directory `/ifs/data/cluster1/media/music/working`.

Note: Depending on the include and exclude directory configuration, SyncIQ performance may be affected. If possible, avoiding an include and exclude configuration simplifies policy configuration and ensures that performance is not degraded. As a best practice, test the impacts of include and exclude policies in a lab environment before updating a production cluster. Alternatively, multiple policies can be configured with different source directories rather than creating a single policy with includes and excludes.

File matching criteria

In addition to refining the source dataset through the included and excluded directories, file matching further refines the selected source dataset for replication, as displayed in the following figure.



File matching criteria

The path, modified, accessed, and created file matching criteria cannot be used with the **Synchronize** action. If any of these file matching criteria are selected, the policy will fail to run.

IF condition

Click on the [Add an "And" condition] link to add a criteria

Figure 20. SyncIQ policy file matching criteria

A SyncIQ policy can have file-criteria statements that explicitly include or exclude files from the policy action. A file-criteria statement can include one or more elements, and each file-criteria element contains a file attribute, a comparison operator, and a comparison value. To combine multiple criteria elements into a criteria statement, use the Boolean `AND` and `OR` operators. Any number of `AND` and `OR` file-criteria definitions may be configured.

However, when you configure file matching criteria, recognize that the impact they have depends on the SyncIQ action selected. If **Copy** was selected, more settings are available than Synchronize policies.

Note: Although the File Matching Criteria options are available for the Synchronize and Copy policies, specifying a directory path with the File Matching Criteria is only supported for Copy policies.

In both Synchronize and Copy policies, the wildcard characters *, ?, and [] or advanced POSIX regular expressions (regex) may be used. Regular expressions are sets of symbols and syntactic elements that match patterns of text. These expressions can be more powerful and flexible than simple wildcard characters. Isilon clusters support IEEE Std 1003.2 (POSIX.2) regular expressions. For more information about POSIX regular expressions, see the BSD manual pages. For example:

- To select all files ending in .jpg, use *\.jpg$.
- To select all files with either .jpg or .gif file extensions, use *\.(jpglgif)$.
- Include or exclude files based on file size by specifying the file size in bytes, KB, MB, GB, TB, or PB. File sizes are represented in multiples of 1,024, not 1,000.
- Include or exclude files based on the following type options: regular file, directory, or a soft link. A soft link is a particular type of POSIX file that contains a reference to another file or directory.

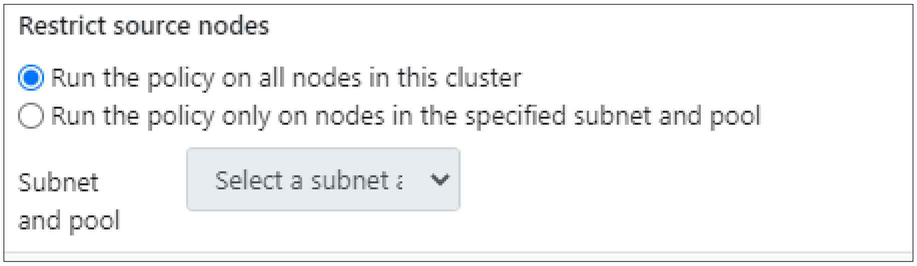
Note: With a policy of type Synchronize, modifying file attributes comparison options and values causes a re-sync and deletion of any nonmatching files from the target the next time the job runs. This does not apply to Copy policies.

Copy policies also allow an administrator to select files based on file creation time, access time, and modification time.

Note: Specifying file criteria in a SyncIQ policy requires additional time to complete, degrading overall SyncIQ performance. Conversely, if the source directories are refined using the **Included** and **Excluded** directories option, as stated in Source cluster directory, performance is not affected to the same degree as specifying the file criteria. However, depending on the configuration, **Includes** and **Excludes** could also significantly affect performance. If possible, the first preference is to create policies without includes, excludes, and file criteria. The second preference is to use includes and excludes and finally, the last preference is file criteria. As a best practice, test the impacts of file criteria, includes, and excludes in a lab environment to confirm performance before updating a production cluster.

Restricting SyncIQ source nodes

SyncIQ uses a node's front-end network ports to send replication data from the source to the target cluster. By default, SyncIQ policies use all nodes and interfaces to allow for maximum throughput of a given policy. However, an administrator may want to exclude certain nodes from a SyncIQ policy. Excluding nodes from a SyncIQ policy is beneficial for larger clusters where data replication jobs can be assigned to certain nodes. In other cases, a client workflow may require a higher priority on a performance node over participating in data replication. From the policy configuration window, an option is available to run the policy on all nodes, or specifying a subnet and pool, as displayed in the following figure.



Restrict source nodes

● Run the policy on all nodes in this cluster
○ Run the policy only on nodes in the specified subnet and pool

Subnet and pool: Select a subnet a

Figure 21. Restricting SyncIQ source nodes

By selecting a predefined IP address pool, administrators can restrict replication processing to specific nodes on the source cluster. This option is useful to ensure that replication jobs are not competing with other applications for specific node resources. Specifying the IP address pool allows administrators to define which networks are used for replication data transfer.

Note: By default, SyncIQ uses all interfaces in the nodes that belong to the IP address pool, disregarding any interface membership settings in the pool. To restrict SyncIQ to use only the interfaces in the IP address pool, use the following CLI command to modify the SyncIQ policy**:**

```
isi sync policies modify --policy <my_policy> --force_interface=on
```

The same option is also available as a global SyncIQ setting, under **Data Protection > SyncIQ** and selecting the **Settings** tab. Administrators may use a single IP address pool globally across all policies or select different IP address pools for use on a per-policy basis.

Note: As stated in SyncIQ policy requirement for System Access Zone, SyncIQ data replication is only supported through the System Access Zone because SyncIQ is not zone-aware. If a new SyncIQ policy is created or an existing policy is edited, an error is displayed if it is not configured for the System Access Zone. This zone requirement applies to both the source and target clusters.

To restrict sending replication traffic to specific nodes on the target cluster, an administrator can associate, globally or per policy, a SmartConnect zone name with the target cluster.

Note: Changing the default policy global settings only affects newly created policies; existing policies will not be modified.

Target host and directory

In the **Target Host** field, specify the IP address or fully qualified domain name of the target cluster. Ensure that the DNS hosts specified on the source cluster can resolve the FQDN of the target cluster.

In the **Target Directory** field, specify the directory where data from the source cluster is replicated. As stated above, it is recommended to consider the Access Zones best practices as the location of the target directory eases failover and failback operations in the future.

Target cluster SmartConnect zones

When a policy target cluster name or address is specified, a SmartConnect DNS zone name is used instead of an IP address or a DNS name of a specific node. An administrator may choose to restrict the connection to nodes in the SmartConnect zone, ensuring the replication job will only connect with the target cluster nodes assigned to that zone. During the initial part of a replication job, SyncIQ on the source cluster establishes an initial connection with the target cluster using SmartConnect. After a connection with the target cluster is established, the target cluster replies with a set of target IP addresses assigned to nodes restricted to that SmartConnect zone. SyncIQ on the source cluster will use this list of target cluster IP addresses to connect local replication workers with remote workers on the target cluster.

To use target cluster SmartConnect zones, perform the following steps:

1. On the target cluster, create a SmartConnect zone using the cluster networking WebUI.
2. Add only those nodes that will be used for SyncIQ to the newly created zone.
3. On the source cluster, SyncIQ replication jobs (or global settings) specify the SmartConnect zone name as the target server name.

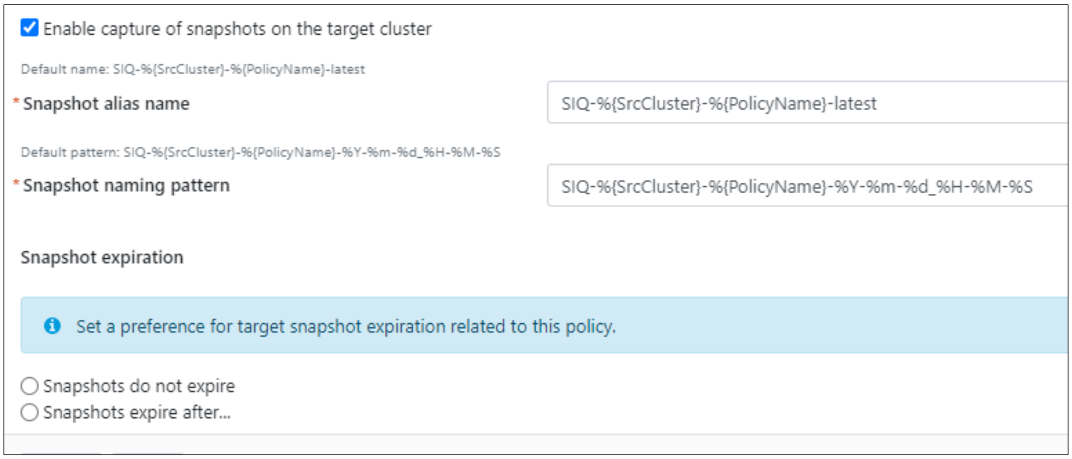
Note: SyncIQ requires a static allocation method of IP addresses and does not support SmartConnect Dynamic Allocation Method of IP address pools. If Dynamic Allocation IPs are specified, the replication job will fail with an error message in the log file and trigger an alert.

The same option is also available as a global SyncIQ setting, under **Data Protection > SyncIQ** and selecting the **Settings** tab. While SmartConnect node restriction settings are available per SyncIQ policy, often it is more useful to set them globally. Those settings will be applied by default to new policies unless they are overridden on a per-policy basis. However, changing these global settings will not affect existing policies.

Note: As stated in SyncIQ policy requirement for System Access Zone, SyncIQ data replication is only supported through the System Access Zone because SyncIQ is not zone-aware. If a new SyncIQ policy is created or an existing policy is edited, an error is displayed if it is not configured for the System Access Zone. This zone requirement applies to both the source and target clusters.

Target snapshots

Depending on the administrator’s requirements, archiving snapshots may be required on the target cluster. Configuring snapshot archival on the target cluster is an optional configuration, as displayed in the following figure.



☑ Enable capture of snapshots on the target cluster

Default name: SIQ-%{SrcCluster}-%{PolicyName}-latest

*Snapshot alias name: SIQ-%{SrcCluster}-%{PolicyName}-latest

Default pattern: SIQ-%{SrcCluster}-%{PolicyName}-%Y-%m-%d_%H-%M-%S

*Snapshot naming pattern: SIQ-%{SrcCluster}-%{PolicyName}-%Y-%m-%d_%H-%M-%S

Snapshot expiration

Set a preference for target snapshot expiration related to this policy.

○ Snapshots do not expire
○ Snapshots expire after...

Figure 22. SyncIQ target snapshots

By default, if the **Enable capture of snapshots on the target cluster** is *not* selected, the target cluster only retains the most recent snapshot, which is used during a failover.

To enable snapshot archiving on the target cluster, a SnapshotIQ license is required. When SyncIQ policies are set with snapshots on the target cluster, on the initial sync a snapshot will be taken at the beginning and the end. For incremental syncs, a snapshot will only be taken at the completion of the job.

Note: Before initializing a job, SyncIQ checks for the SnapshotIQ license on the target cluster. If it has not been licensed, the job will proceed without generating a snapshot on the target cluster, and SyncIQ will issue an alert noting that the license was not available.

Administrators can control how many snapshots of the target replication path are maintained over time by defining an expiration period on each of the target-cluster snapshots. For example, if a replication job is performed every day for a week (with target snapshots enabled), seven snapshots of the dataset on the target cluster are available, representing seven available versions of the dataset. In this example, if the target-cluster snapshot is configured to expire after seven days on a replication policy that is run once per day, only seven snapshots will be available on the target cluster dataset.

Note: If snapshot-based replication is configured as explained in Whenever a snapshot of the source directory is taken and in SnapshotIQ and SyncIQ, target snapshot archival may be a necessity. If target snapshots are not archived, a separate snapshot copy is not retained when a new snapshot becomes available.

For more information about snapshots and SyncIQ, reference SnapshotIQ and SyncIQ and Snapshots and SyncIQ policies.

Target cluster Snapshot Alias

Snapshot aliasing on a target cluster provides a powerful option for accessing SyncIQ based snapshots directly on a target cluster. A Snapshot Alias is recommended for scenarios where a workflow requires access to the most current snapshot on the target cluster and a consistent snapshot name. After a SyncIQ policy is configured on the source cluster with a Snapshot Alias, an NFS export may be configured on the target cluster, pointing directly to the Snapshot Alias.

If a workflow uses the HEAD snapshot, or the most recent SyncIQ snapshot, errors occur if the snapshot is accessed directly when a SyncIQ job is running. The errors occur because the HEAD SyncIQ snapshot is in the process of updating.

Note: As a best practice, accessing SyncIQ based snapshots for client access is not recommended. For client access, a Snapshot Alias should be configured with an NFS export pointing to the Snapshot Alias.

To create or modify an existing SyncIQ policy with a snapshot alias on the target cluster, perform the following steps:

1. Create a new SyncIQ policy with a target cluster Snapshot Alias. On the source cluster:

   ```
   isi sync policies create [Policy Name] sync --source-root-
   path=[Source Cluster Rooth Path] --target-host=[Target
   Cluster IP] --target-path=[Target Cluster Directory] --
   target-snapshot-archive=true --target-snapshot-
   alias=example_sync_snap
   ```

   In the preceding example, the snapshot alias is defined as `example_sync_snap`.

   Alternatively, to modify an existing SyncIQ policy on the source cluster:

   ```
   isi sync policies modify [Policy Name] --target-snapshot-
   archive=true --target-snapshot-alias=example_sync_snap
   ```

   Note: As a best practice, consider configuring a target snapshot expiration date that is reasonable for the workflow. The target snapshot expiration is configured using the --target-snapshot-expiration option in the CLI. This parameter specifies the expiration in seconds.

2. Run the new, or modified, policy from the previous step on the source cluster at least once to generate the Snapshot Alias. On the target cluster, create the NFS export pointing to the Snapshot Alias:

   ```
   isi nfs exports create --paths=[Target Cluster Directory
   defined in SyncIQ policy in step 1] --
   snapshot=example_sync_snap
   ```

3. Mount the new NFS export on a Linux client:

   ```
   Linux-client# mount [Target cluster IP]:[Target Cluster
   Directory defined in step 1] [Specify local mount location]
   ```

   Alternatively, for a Microsoft Windows 10 client, enable the NFS service under **Control Panel** > **Programs** > **Programs and Features** > **Turn Windows features on or off**. Enable **Services for NFS** and mount the export from the Windows command prompt:

   ```
   mount \\[Target Cluster IP]\[Target Cluster Directory defined
   in step 1] [Select a drive to map this mount]
   ```

As each new SyncIQ policy runs, the Snapshot Alias continues to point to the newest or HEAD SyncIQ snapshot. The Snapshot Alias pointer can be confirmed by listing the snapshot details. To check the snapshot details, perform the following steps:

1. On the target cluster, list the snapshots by running the `isi snapshot snapshots list` command:

```
isi9-s2-n1-1# isi snapshot snapshots list
ID   Name                                   Path
----------------------------------------------------------
2    SIQ-isi9-s1-n1-foo-2020-06-25_11-08-10 /ifs/data/cls1
3    example_sync_snap                      /ifs/data/cls1
5    SIQ-Failover-foo-2020-06-25_11-08-14   /ifs/data/cls1
----------------------------------------------------------
Total: 3
```

   In this example, the snapshot `example_sync_snap` is the Snapshot Alias defined in the SyncIQ policy on the source cluster.

2. From the snapshot list, view details for the Snapshot Alias by using the `Snapshot ID`. In this example, the Snapshot Alias `example_sync_snap` maps to ID `3`:

```
isi9-s2-n1-1# isi snapshot snapshots view 3
               ID: 3
             Name: example_sync_snap
             Path: /ifs/data/cls1
        Has Locks: No
         Schedule: -
  Alias Target ID: 2
Alias Target Name: SIQ-isi9-s1-n1-foo-2020-06-25_11-08-10
          Created: 2020-06-25T11:08:13
          Expires: -
             Size: 4.00k
     Shadow Bytes: 0.00
        % Reserve: 0.00%
     % Filesystem: 0.00%
            State: active
```

   Currently, the Snapshot Alias is pointing to the Alias Target ID 2. After the SyncIQ policy is run again, the snapshots list is updated with the new snapshot:

```
isi9-s2-n1-1# isi snapshot snapshots list
ID   Name                                   Path
----------------------------------------------------------
2    SIQ-isi9-s1-n1-foo-2020-06-25_11-08-10 /ifs/data/cls1
3    example_sync_snap                      /ifs/data/cls1
7    SIQ-Failover-foo-2020-06-25_11-15-28   /ifs/data/cls1
9    SIQ-isi9-s1-n1-foo-2020-06-25_11-15-31 /ifs/data/cls1
----------------------------------------------------------
Total: 4
```

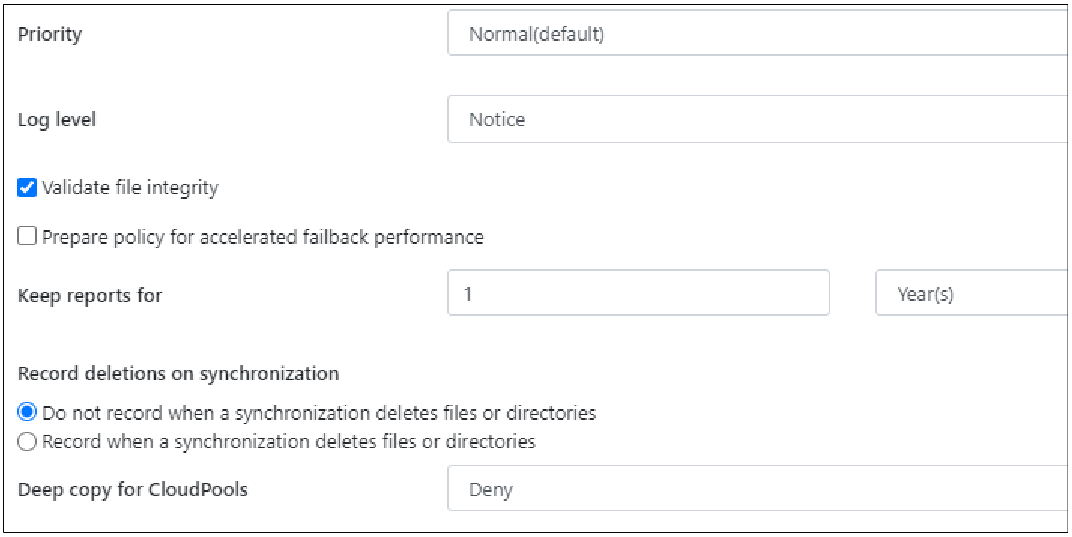
3. View more details on the Snapshot Alias to confirm it is pointing to the newest, or HEAD, snapshot:

```
isi9-s2-n1-1# isi snapshot snapshots view 3
               ID: 3
             Name: example_sync_snap
             Path: /ifs/data/cls1
        Has Locks: No
         Schedule: -
  Alias Target ID: 9
Alias Target Name: SIQ-isi9-s1-n1-foo-2020-06-25_11-15-31
          Created: 2020-06-25T11:08:13
          Expires: -
             Size: 4.00k
     Shadow Bytes: 0.00
        % Reserve: 0.00%
     % Filesystem: 0.00%
            State: active
```

The Snapshot Alias is now pointing the Alias Target ID 9, which is the newest, or HEAD snapshot.

Advanced settings

SyncIQ Advanced Settings provide several options to configure a SyncIQ policy, as displayed in the following figure.



Priority: Normal(default)

Log level: Notice

☑ Validate file integrity

☐ Prepare policy for accelerated failback performance

Keep reports for: 1 Year(s)

Record deletions on synchronization

● Do not record when a synchronization deletes files or directories

○ Record when a synchronization deletes files or directories

Deep copy for CloudPools: Deny

Figure 23. SyncIQ Policy Advanced Settings

Priority

From the **Priority** drop-down, as displayed in Figure 23, select a priority level for the SyncIQ policy. PowerScale SyncIQ provides a mechanism to prioritize particular policies. Policies can optionally have a priority setting – policies with the priority bit set will start before unprioritized policies. If the maximum number of jobs are running, and a prioritized job is queued, the shortest running unprioritized job will be paused by the system to allow the prioritized job to run. The paused job will then be started next.

Alternatively, to set the priority bit for a job from the CLI, use `--priority 1` on the `isi sync policies create` or `modify` command, which maps to **High** in the web interface. The default is 0, which is unprioritized, which maps to **Normal** in the web interface.

Log Level

From the **Log Level** drop-down, as displayed in Figure 23, specify a level of logging for this SyncIQ policy. The log level may be modified as required during a specific event.

SyncIQ logs provide detailed job information. To access the logs, connect to a node and view its `/var/log/isi_migrate.log` file. The output detail depends on the log level, with the minimal option being **Fatal** and the maximum logging option being **Trace**.

Note: Notice is the default log level and is recommended for most SyncIQ deployments. It logs job-level and process-level activity, including job starts and stops, as well as worker coordination information. **Debug** and **Trace** options should only be used temporarily as they create a significant number of logs.

Validate file integrity

The **Validate File Integrity** checkbox, as displayed in Figure 23, provides an option for OneFS to compare checksums on SyncIQ file data packets pertaining to the policy. In the event a checksum value does not match, OneFS attempts to transmit the data packet again.

Prepare policy for accelerated failback performance

The checkbox **Prepare policy for accelerated failback performance** (Figure 23) enables you to expedite failback to the source cluster after the failover to the target cluster. For more information, see Failover and failback.

The failback to the source cluster is accelerated when you run the DomainMark job in advance of the actual failback. The checkbox **Prepare policy for accelerated failback performance** prepares the source cluster for failback under normal operation, before a failback, by allowing the DomainMark job to run the next time the policy runs. Alternatively, from the CLI, set the `--accelerated-failback true` flag to enable accelerated failback.

After you complete a failover to the target cluster and new data is written to the target cluster, a failback to the source cluster requires a resync-prep action to accept the intervening changes from the target cluster. The resync-prep action requires the original source cluster to temporarily function as a target cluster, where the original target cluster is now writing data to the original source cluster. During this process, before the original target cluster can write data to the original source cluster, is when the DomainMark job must run on the original source cluster. However, by selecting the checkbox **Prepare policy for accelerated failback performance,** the DomainMark job ran before the failback, minimizing the failback duration.

Conversely, if you do *not* select this checkbox, the failback process consumes more time because the DomainMark job runs during the failback rather than in advance.

Alternatively, to manually run the DomainMark job, rather than the next time the policy runs, use the following command:

```
isi job start DomainMark --root=<patm> --dm-type=synciq
```

Note: As a best practice, select the checkbox **Prepare policy for accelerated failback performance** during the initial policy configuration. This action minimizes downtime during an actual outage where time is of the essence. If an existing policy does not have this checkbox selected, you may select it retroactively. Otherwise, to avoid extending the failback time, you must run the above manual CLI command before the first failover.

After you select the checkbox, the DomainMark job runs only once for the policy. Depending on the policy and dataset, it can take several hours or more to complete. When you select the checkbox, it does not require any further configuration, irrespective of the failover duration and how the dataset on the target cluster has changed.

Note: Selecting the checkbox **Prepare policy for accelerated failback performance** increases the overall runtime of the next sync job. After that sync, SyncIQ performance is not affected.

Hard links and DomainMark

If a policy contains hard links outside of the policy's base path, the DomainMark job fails on the source cluster. The failure may occur during a failback to the source cluster, or the next time a policy runs after you have selected the checkbox **Prepare policy for accelerated failback performance.**

Note: As a best practice, ensure the source cluster base path does not contain hard links outside of the base path. Otherwise, the DomainMark job fails, and then the failback to the source cluster fails.

For more information about hard links and SyncIQ, see Hard links and SyncIQ.

Keep reports duration

The **Keep Reports** option, as displayed in Figure 23, defines how long replication reports are retained in OneFS. When the defined time has exceeded, reports are deleted.

Record deletions on synchronization

Depending on the IT administration requirements, a record of deleted files or directories on the target cluster may be required. By default, OneFS does not record when files or directories are deleted on the target cluster. However, the **Record Deletions on Synchronization** option, as displayed in Figure 23, can be enabled if it is required.

Deep copy for CloudPools

PowerScale clusters that are using CloudPools to tier data to a cloud provider have a stub file, known as a SmartLink. The file is retained on the cluster with the relevant metadata for retrieval of the file at a later time. Without the SmartLink, a file that is tiered to the cloud, cannot be retrieved. If a SmartLink is replicated to a target cluster, the target cluster must have CloudPools active with the same configuration as the source cluster, to be able to retrieve files tiered to the cloud. For more information about SyncIQ and CloudPools, see SyncIQ and CloudPools.

Deep Copy is a process that retrieves all data that is tiered to a cloud provider on the source cluster, allowing all the data to be replicated to the target cluster. Depending on if the target cluster has the same CloudPools configuration as the source cluster, Deep

Copy could be required. However, in certain workflows, Deep Copy may not be required, as the SmartLink file allows for the retrieval of files tiered to the cloud.

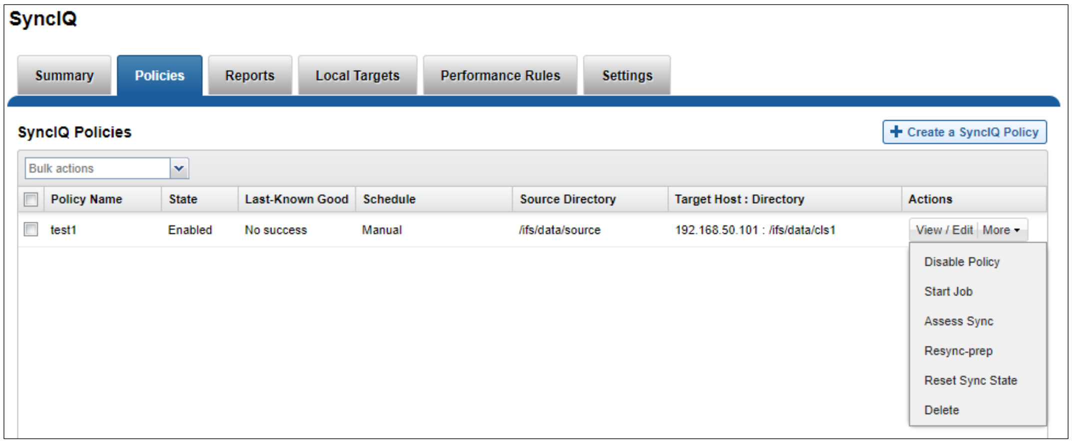
The **Deep copy for CloudPools** drop-down, as displayed in Figure 23, provides the following options:

- Deny: This setting, which is the default, allows only the SmartLinks to be replicated from the source to the target cluster, assuming the target cluster has the same CloudPools configuration.
- Allow: This option also replicates the SmartLinks from the source to the target cluster. However, this option also checks the SmartLinks versions on both clusters. If a mismatch is found between the versions, the complete file is retrieved from the cloud on the source, and then replicated to the target cluster.
- Force: This option requires CloudPools to retrieve the complete file from the cloud provider on to the source cluster and replicates the complete file to the target cluster.

Note: Deep Copy takes significantly more time and system resources when enabled. It is recommended that Deep Copy only be enabled if it is required for a specific workflow requirement.

Assess Sync

SyncIQ can conduct a trial run of a policy without actually transferring file data between locations; this functionality is referred to as an “Assess Sync.” Not only does an Assess Sync double-check the policy configuration, but it also provides an indication of the time and the level of resources an initial replication policy is likely to consume. This functionality is only available immediately after a policy is created, before it has been run for the first time. To run an Assess Sync, from the SyncIQ Policies tab click **More** for the appropriate policy, and select **Assess Sync**, as displayed in the following figure.



Policy Name	State	Last-Known Good	Schedule	Source Directory	Target Host : Directory	Actions
test1	Enabled	No success	Manual	/ifs/data/source	192.168.50.101 : /ifs/data/cls1	View / Edit More

Figure 24. SyncIQ Assess Sync

Note: As a best practice, run an Assess Sync to confirm the policy configuration and resource commitment prior to the replication requirement of the policy.

Impacts of modifying SyncIQ policies

SyncIQ policies may be modified and updated through the CLI or the web interface. The impact of the change is dependent upon how the policy is modified. Rather than modifying or deleting a policy when a suspension is required, the policy may also be disabled, allowing for it to be reenabled with minimal impact at a later point.

After a policy is configured and the policy has run, SyncIQ will run either the initial replication again or a differential replication if the following variables are modified:

- Source directory
- Included or excluded directories
- File criteria: type, time, and regular expressions
- Target cluster, even if the new target cluster is identical to the old target cluster

  IP and DNS changes will not trigger a full replication. However, if the cluster GUID changes, the job will fail at runtime. Also, unlike the other settings, a manual reset of the affected policy is required in order to be able to run an associated job.
- Target directory

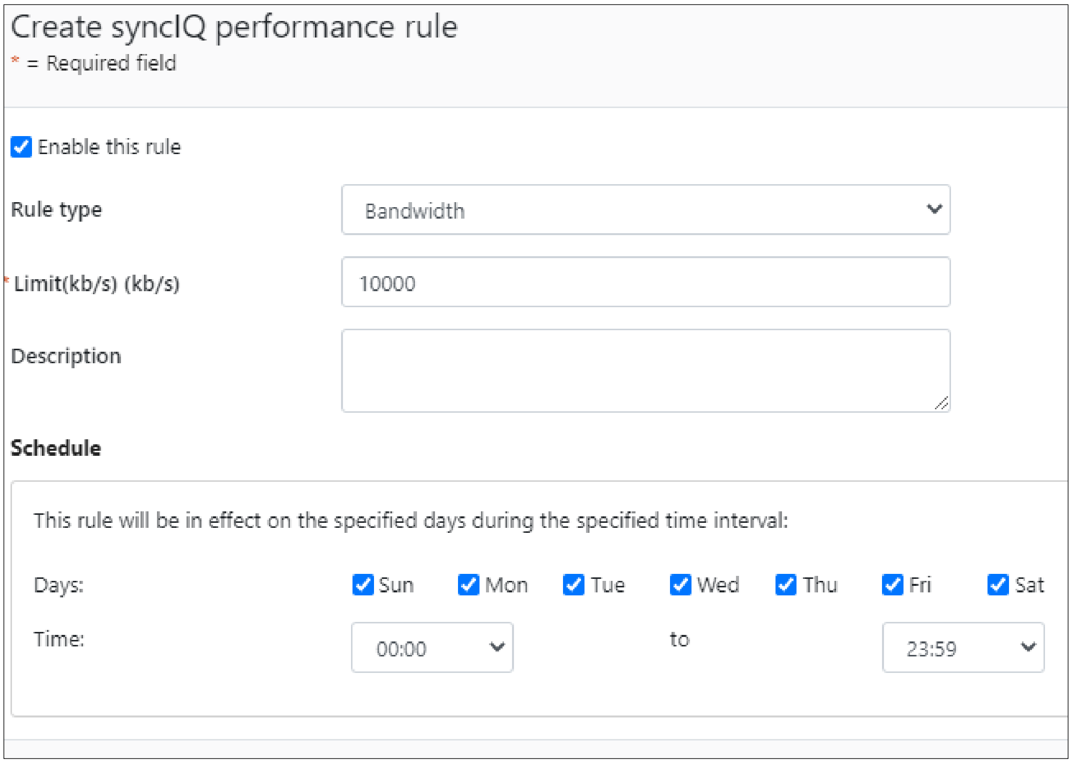
If a SyncIQ replication policy is deleted, replication jobs will not be created for the policy. Any snapshots and reports associated with the policy are also deleted. The target cluster will break the association to the source cluster, removing the local target entry, and the target directory will allow writes.

SyncIQ performance rules

Performance Rules provide several options for administrators to define limits of resource consumption for SyncIQ policies during specific times or continuously. Setting performance limits allows for minimal impact to high priority workflows but allows nodes to participate in replication within a defined set of resources.

SyncIQ uses aggregate resources across the cluster to maximize replication performance, thus potentially affecting other cluster operations and client response. The default performance configurations, number of workers, network use, and CPU consumption may not be optimal for certain datasets or the processing needs of the business. CPU and network use are set to `unlimited` by default. However, SyncIQ allows administrators to control how resources are consumed and balance replication performance with other file system operations by implementing a number of cluster-wide controls. Rules are created to define available resources for SyncIQ policies for different time periods.

To view or create SyncIQ Performance Rules from the OneFS web interface, click **Data Protection** > **SyncIQ** and select the **Performance Rules** tab. Existing Performance Rules are displayed. Click **Create a SyncIQ Performance Rule**, to add a rule, as displayed in the following figure.



Create syncIQ performance rule

* = Required field

☑ Enable this rule

Rule type: Bandwidth

* Limit(kb/s) (kb/s): 10000

Description:

Schedule

This rule will be in effect on the specified days during the specified time interval:

Days: ☑ Sun ☑ Mon ☑ Tue ☑ Wed ☑ Thu ☑ Fri ☑ Sat

Time: 00:00 to 23:59

Figure 25. Creating a SyncIQ performance rule

From the **Rule Type** drop-down menu, select one of the following options:

- Bandwidth: This option provides a limit on the maximum amount of network bandwidth a SyncIQ policy can consume. When **Bandwidth** is selected the **Limit** field changes to **kb/s**. In the **Limit** field, specify the maximum allowable bandwidth in kb/s.
- File Count: This option allows administrators to define a maximum number of files that replication jobs can send per second. When **File Count** is selected, the **Limit** field changes to **files/sec**. In the **Limit** field, specify the maximum allowable files/sec.
- CPU: This option limits the CPU consumption to a percentage of the total available. When **CPU** is selected, the **Limit** field changes to **%.** In the **Limit** field, specify the maximum allowable percentage for the maximum CPU consumption.
- Workers: This option limits the number of workers available to a percentage of the maximum possible. When **Workers** is selected, the **Limit** field changes to **%.** In the **Limit** field, specify the maximum percentage of workers.

These performance rules will apply to all policies running during the specified time interval.

Node participation in a SyncIQ policy may be limited as described in Restricting SyncIQ source nodes and Target cluster SmartConnect zones.

Note: While SyncIQ allows multiple Performance Rules to be created, not all rules are applicable to every workflow. Consider the impact on RPO times. Depending on the RPO requirements, a Performance Rule could severely affect replication times. In the initial implementation of rules, starting with high maximum limits and gradually reducing them as RPO times are monitored is recommended.

For more information about SyncIQ performance tuning, see Optimizing SyncIQ performance.

SnapshotIQ and SyncIQ

Introduction to SnapshotIQ and SyncIQ

OneFS provides an option to replicate a specific point-in-time dataset with SyncIQ. By default, SyncIQ creates a snapshot automatically at the start of a job. A use case example is when a specific dataset is required to replicate to multiple target clusters. A separate policy must be configured for each target cluster, resulting in each policy taking a separate snapshot and the snapshot could be composed of a different dataset. Unless the policies start at the same time and depending on how quickly the source is modified, each target cluster could have a different dataset. Therefore, complicating administrator management of multiple clusters and policies, as each cluster has a different dataset.

As stated in Whenever a snapshot of the source directory is taken, SyncIQ policies provide an option for triggering a replication policy when a snapshot of the source directory is completed. Also, at the onset of a new policy configuration when the **Whenever a Snapshot of the Source Directory is Taken** option is selected, a checkbox appears to sync any existing snapshots in the source directory.

Depending on the IT administrative workflows, triggering replication automatically after a snapshot may simplify tasks. However, snapshots that are scheduled to run on a schedule could trigger SyncIQ to run at a higher frequency than required, consuming cluster resources. Limiting automatic replication based on a snapshot may be a better option.

SyncIQ offers many options for using snapshots. After reviewing this section, also see Target snapshots and Snapshots and SyncIQ policies.

Specifying snapshots for replication

If a specific dataset must be restored to a specific point-in-time, SyncIQ supports importing a manually taken snapshot with SnapshotIQ for use by a policy. Importing and selecting the snapshot of a policy ensures that administrators control the target cluster's dataset by selecting the same snapshot for multiple policies.

To start a SyncIQ policy with a specified snapshot, use the following command:

```
isi sync jobs start <policy-name> [--source-snapshot <snapshot>]
```

The command replicates data according to the specified SnapshotIQ snapshot, as only selecting a snapshot from SnapshotIQ is supported. Snapshots taken from a SyncIQ policy are not supported. When importing a snapshot for policy, a SyncIQ snapshot is not generated for this replication job.

Note: The root directory of the specified snapshot must contain the source directory of the replication policy. This option is valid only if the last replication job completed successfully or if a full or differential replication is performed. If the last replication job completed successfully, the specified snapshot must be more recent than the snapshot referenced by the last replication job.

When snapshots are replicated to the target cluster, by default, only the most recent snapshot is retained, and the naming convention on the target cluster is system generated. However, in order to prevent only a single snapshot being overwritten on the target cluster and the default naming convention, select the **Enable capture of snapshots on the target cluster** as stated in Target snapshots. When this checkbox is selected, specify a naming pattern and select the **Snapshots do not expire** option. Alternatively, specify a date for snapshot expiration. Limiting snapshots from expiring ensures that they are retained on the target cluster rather than overwritten when a newer snapshot is available. The target cluster snapshot options map to --target-snapshot-archive, `--target-snapshot-alias`, `--target-snapshot-expiration`, and `--target-snapshot-pattern` in the CLI.

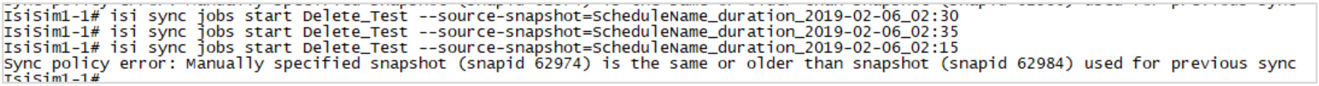
Archiving SnapshotIQ snapshots to a backup cluster

Specifying a snapshot to replicate from is also an option for cases where SnapshotIQ snapshots are consuming a significant amount of space on a cluster. The snapshots must be retained for administrative requirements. In this case, the snapshots are replicated to a remote backup or disaster recovery cluster, opening additional space on the source cluster.

When replicating SnapshotIQ snapshots to another cluster, the dataset and its history must be replicated from the source cluster. Therefore, snapshots are replicated from the source in chronological order, from the first snapshot to the last. The snapshots are placed into sequential jobs replicating to the target cluster. Replicating in this process, allows the target cluster to create a snapshot with a delta between each job, as each job replicates a snapshot that is more up to date than the previous.

Note: As stated in Specifying snapshots for replication, ensure that target snapshots are configured and retained before initiating the archiving process.

If snapshots are not archived in chronological order, an error occurs, as displayed in the following figure.



```
IsiSim1-1# isi sync jobs start Delete_Test --source-snapshot=ScheduleName_duration_2019-02-06_02:30
IsiSim1-1# isi sync jobs start Delete_Test --source-snapshot=ScheduleName_duration_2019-02-06_02:35
IsiSim1-1# isi sync jobs start Delete_Test --source-snapshot=ScheduleName_duration_2019-02-06_02:15
Sync policy error: Manually specified snapshot (snapid 62974) is the same or older than snapshot (snapid 62984) used for previous sync
IsiSim1-1#
```

Figure 26. Out-of-order snapshots create Sync Policy Error

To ensure that SyncIQ retains the multiple snapshots required to recreate the dataset, SnapshotIQ must be installed with archival snapshots enabled.

After all snapshots are replicated to the target cluster, an archive of the source cluster’s snapshots is complete. The source cluster’s snapshots may now be deleted, creating additional space.

Note: Archiving snapshots creates a new set of snapshots on the target cluster based on the source cluster snapshots, but it does not "migrate" the snapshots from one cluster to another. The new snapshots have the same data, but with different data times. This may not meet compliance requirements for ensuring data integrity or evidentiary requirements.

Target cluster SnapshotIQ snapshots

Although a SyncIQ policy configures the target directory as read-only, SnapshotIQ snapshots are permitted. As a best practice, consider configuring target cluster SnapshotIQ snapshots at a differing schedule than the source cluster, providing an additional layer of data protection and a point-in-time dataset. Target snapshots could also be used as a longer-term retention option if the cost of storage space is less than the cost of storage space of the source cluster. In this arrangement, the source cluster snapshots are retained short term, target cluster SyncIQ snapshots are medium term, and the long-term archive snapshots are SnapshotIQ snapshots on the target cluster.

Writeable snapshots

OneFS Release 9.3.0.0 introduced support for writable snapshots. Although SnapshotIQ snapshots may be specified for SyncIQ replication, writable snapshots are not supported for SyncIQ replication. If a writable snapshot is specified as the source or target, the data replication fails. Further, creating a writable snapshot based on a SyncIQ generated snapshot is not supported. For more information about writable snapshots, see the Dell PowerScale OneFS Writable Snapshots whitepaper.

SyncIQ design considerations

Introduction to SnapIQ design considerations

Before data replication policies are configured with SyncIQ, mapping out how policies align with IT administration requirements is recommended. Data replication between clusters is configured based on either entire cluster replication or directory-based replication. Designing the policy to align with departmental requirements ensures that policies satisfy requirements at the onset, minimizing policy reconfiguration. When creating policies, Disaster Recovery (DR) plans must be considered. DR readiness is a key factor to success during a DR event.

Failover and failback are specific to a policy. If a DR event occurs, failing over several policies would require additional time. On the contrary, if entire cluster replication is configured, only a single policy is failed over, minimizing downtime. Also consider that clients must be redirected to the target cluster manually, through either a DNS update or by manual advisement. If entire cluster replication is configured, a single DNS name change will minimize impacts. However, DR steps may not be a concern if Superna Eyeglass, described in Superna Eyeglass DR Edition, is used.

As policies are created for new departments, consider policy overlap. Although the overlap does not affect the policy running, the concerns include managing many cumbersome policies and resource consumption. If the directory structure in policies overlaps, data is being replicated multiple times, affecting cluster and network resources. During a failover, time is a critical asset. Minimizing the number of policies allows administrators to focus on other failover activities during an actual DR event. In addition, RPO times may be affected by overlapping policies.

During the policy configuration stage, select options that have been tested in a lab environment. For example, for a synchronize policy that is configured to run any time the source is modified, consider the time delay for the policy to run. If the delay is set to zero, every time a client modifies the dataset, a replication job is triggered. Although this setting may be required to meet RPO and RTO requirements, administrators must consider if the cluster resources and network bandwidth can meet the aggressive replication policy. Therefore, test the configuration in a lab environment to ensure that the replication policy requirements are satisfied. Superna Eyeglass, explained in Superna Eyeglass DR Edition, provides additional insight into expected RPO and RTO times, based on a policy.

Cluster resources with data replication

As the overall architecture of SyncIQ Policies is designed, other factors to consider are the number of policies running together. Depending on how policies are configured, the cluster may have many policies running at once. If many policies are running together, cluster resources and network bandwidth must be considered. Under standard running conditions, the cluster resources are also providing client connectivity with an array of services running. It is imperative to consider the cluster and network utilization when the policies are running.

Given the number of policies running simultaneously, administrators may consider staggering the policies to run a certain number of policies in a specific time period. Policy schedules can be updated to stagger policy requirements and run times, matching policies with the administration requirements.

While considering the number of policies running in a specified time period, the permitted system and network resources may also be tuned to meet administration requirements. OneFS provides options for tuning SyncIQ performance based on CPU utilization, bandwidth, file count, and the number of workers, as discussed in SyncIQ performance rules. A higher level of granularity is possible by only allowing certain nodes to participate in data replication, as discussed in Restricting SyncIQ source nodes. Administrators may also consider assigning a priority to each policy, as discussed in Priority. As policies run, it is crucial to monitor cluster resources through the many available tools, as stated in Monitoring, alerting, reporting, and optimizing performance.

Source and target cluster replication performance

During the design phase, consider the node types on the source and target cluster affecting the overall data replication performance. When a performance node on the source cluster is replicating to archive nodes on the target cluster, the overall data replication performance is compromised based on the limited performance of the target cluster’s nodes. For example, if a source cluster is composed of F800 nodes and the target cluster is composed of A200 nodes, the replication performance reaches a threshold because the A200 CPUs cannot perform at the same level as the F800 CPUs.

Depending on the workflow and replication requirements, the longer replication times may not be a concern. However, if replication performance is time sensitive, consider the node types and associated CPUs on the source and target clusters, as this could bottleneck the overall data replication times.

Snapshots and SyncIQ policies

As snapshots and SyncIQ policies are configured, consider the scheduled time. As a best practice, stagger the scheduled times for snapshots and SyncIQ policies. Staggering snapshots and SyncIQ policies at different times ensures that the dataset is not interacting with snapshots while SyncIQ jobs are running, or conversely. Also, having snapshots and SyncIQ policies with exclusive scheduled times ensures that the maximum system resources are available, minimizing overall run times. However, system resources are also dependent on any performance rules that are configured, as descriged in SyncIQ performance rules.

Another factor to consider is the impact on system resources if SyncIQ policies are triggered based on snapshots, as discussed in Whenever a snapshot of the source directory is taken. For example, if a snapshot policy is configured to run every 5 minutes, the policy is triggered when the snapshot completes. Depending on the dataset and the rate of updates, SyncIQ could be far behind the newest snapshot. In addition, a constant trigger of data replication affects cluster resources. Consider how the snapshot frequency affects overall system performance. Alternatively, rather than using snapshot triggered replication, consider manually running a SyncIQ policy with a specified snapshot, as explained in Specifying snapshots for replication.

For more information about snapshots and SyncIQ, see Target snapshots and SnapshotIQ and SyncIQ.

Network considerations

As stated previously in Target cluster SmartConnect zones, SyncIQ only functions under static IP pool allocation strategies. A dynamic allocation of IPs leads to SyncIQ failures.

During data replication, certain SyncIQ packets set the “Do not fragment” (DF) bit, causing the connection to fail if fragmentation is required. A common instance is if jumbo frames are configured on the cluster, but are not supported on all network devices, requiring fragmentation at a specific hop. If jumbo frames are configured, ensure that they are supported end-to-end on all hops between the source and target cluster, eliminating the need for fragmentation. Otherwise, set the network subnet used by SyncIQ to an MTU of 1500. For more information about jumbo frames, see the PowerScale Network Design Considerations white paper.

SyncIQ policy requirement for System Access Zone

During the design phase of SyncIQ policies and network hierarchy, SyncIQ is not zone aware, requiring SyncIQ policies and data replication to be aligned with the System Access Zone. If a new SyncIQ policy or an existing policy is configured for anything other than the System Access Zone, the configuration fails with an error message. The SyncIQ requirement for this zone applies to the source and target clusters. Considering this requirement during the design phase allows administrators to plan policies, subnets, and pools accordingly, if SyncIQ replication must be limited to a set of nodes and interfaces.

Network ports

For a list of network ports used by SyncIQ, see the Security Configuration Guide for the specified release at PowerScale OneFS Info Hubs.

Jobs targeting a single directory tree

Creating SyncIQ policies for the same directory tree on the same target location is not supported. For example, consider the source directory `/ifs/data/cluster1/users`. Creating two separate policies on this source to the same target cluster is not supported:

- One policy excludes `/ifs/data/cluster1/users/ceo` and replicates all other data in the source directory.

- One policy includes only `/ifs/data/cluster1/users/ceo` and excludes all other data in the source directory.

Splitting the policy with this format is not supported with the same target location. It would only be supported with different target locations. However, consider the associated increase in complexity required in the event of a failover or other data restore.

Authentication integration

UID/GID information is replicated, using SID numbers, with the metadata to the target cluster. It does not require to be separately restored on failover.

SyncIQ and Hadoop Transparent Data Encryption

OneFS 8.2 introduces support for Apache Hadoop Distributed File System (HDFS) Transparent Data Encryption (TDE), providing end-to-end encryption between HDFS clients and a PowerScale cluster. HDFS TDE is configured in OneFS through encryption zones where data is transparently encrypted and decrypted as data is read and written. For more information about HDFS TDE for OneFS, see the blog post Using HDFS TDE with PowerScale OneFS.

SyncIQ does not support the replication of the TDE domain and keys. Therefore, on the source cluster, if a SyncIQ policy is configured to include an HDFS TDE directory, the encrypted data is replicated to the target cluster. However, on the target cluster, the encrypted data is not accessible as the target cluster is missing the metadata that is stored in the IFS domain for clients to decrypt the data. TDE ensures that the data is encrypted before it is stored on the source cluster. Also, TDE stores the mapping to the keys required to decrypt the data, but not the actual keys, making the encrypted data on the target cluster inaccessible.

Small File Storage Efficiency (SFSE) and SyncIQ

OneFS Small File Storage Efficiency (SFSE) provides a feature for small files in OneFS, packing them into larger files, resulting in increased storage efficiency. If a SyncIQ policy is configured for an SFSE dataset, the data is replicated to the target cluster. However, the SFSE dataset is unpacked on the source cluster before replication. If the target cluster has SFSE enabled, the dataset is packed when the next SmartPools job runs on the target cluster. If the target cluster does not have SFSE enabled, the dataset remains unpacked.

Hard links and SyncIQ

Hard-link relationships are only maintained within a SyncIQ policy. If hard links to the same file are replicated by multiple SyncIQ policies to the same target cluster, each SyncIQ policy maintains copies of that file and its links within the policy's path.

Hard links outside of the source base path of a SyncIQ policy cause the DomainMark job to fail on the source cluster. If you have selected the checkbox **Prepare Policy for Accelerated Failback Performance**, the DomainMark job runs automatically on the source cluster during a failback to the source cluster or in advance of a failback. The failover to the target cluster is not affected by hard links outside of the source base path.

Note: As a best practice, ensure the source cluster base path does not contain hard links outside of the base path. Otherwise, the DomainMark job fails, and then the failback to the source cluster fails.

For more information about the DomainMark job and the checkbox **Prepare policy for accelerated failback performance,** see Prepare policy for accelerated failback performance. For more information about failover and failback, see Failover and failback.

Dell Container Storage Interface (CSI) and SyncIQ

The Dell Container Storage Interface (CSI) provides storage enablement as part of the Dell Container Storage Modules (CSM). CSM extends enterprise storage capabilities to Kubernetes for cloud-native stateful applications. The CSI driver for PowerScale provides an interface between a CSI-enabled Container Orchestrator (CO) and a PowerScale cluster.

CSI allows administrators to replicate groups of volumes using OneFS SyncIQ and provides an option to restart applications in case of planned and unplanned migrations, as shown in Figure 27.

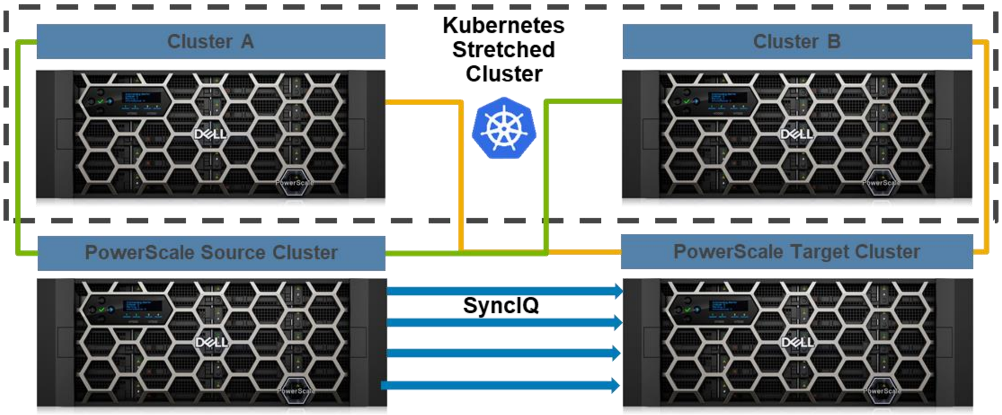

Cluster A
Kubernetes Stretched Cluster
Cluster B
PowerScale Source Cluster
SyncIQ
PowerScale Target Cluster

Figure 27. PowerScale and Dell CSI

For more information about configuring Dell CSI and PowerScale, see https://dell.github.io/csm-docs/docs/replication/.

Failover and failback

Introduction to failover and failback

This section explains the failover and failback processes. For a detailed set of instructions, see Appendix A: Failover and failback steps.

Under normal operation, SyncIQ target directories can be written to only by the SyncIQ job itself—all client writes to any target directory are disabled. This is referred to as a protected replication domain. In a protected replication domain, files cannot be modified, created, deleted, or moved within the target path of a SyncIQ job.

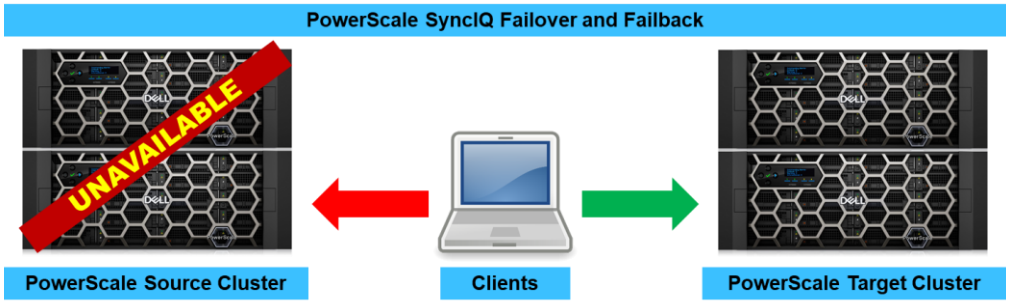

PowerScale SyncIQ Failover and Failback
UNAVAILABLE
PowerScale Source Cluster
Clients
PowerScale Target Cluster

Figure 28. PowerScale SyncIQ failover and failback

SyncIQ provides integrated recovery to the target cluster with minimal interruption to clients. By default, the RPO (recovery point objective) is to the last completed SyncIQ replication point. Optionally, with the use of SnapshotIQ, multiple recovery points can be made available, as explained in SnapshotIQ and SyncIQ.

Note: SyncIQ Failover and Failback does not replicate cluster configurations such as SMB shares and NFS exports, quotas, snapshots, and networking settings, from the source cluster. PowerScale does copy over UID/GID ID mapping during replication. In the case of failover to the remote cluster, other cluster configurations must be configured manually.

Failover

In the event of a planned or unplanned outage to the source cluster, a failover is the process of directing client traffic from the source cluster to the target cluster. An unplanned outage of the source cluster could be a disaster recovery scenario where the source cluster no longer exists, or it could be unavailable if the cluster is not reachable.

On the contrary, a planned outage is a coordinated failover, where an administrator knowingly makes a source cluster unavailable for disaster readiness testing, cluster maintenance, or other planned event. Before performing a coordinated failover, ensure that a final replication is completed, ensuring that the dataset on the target matches the source.

To perform a failover, set the target cluster or directory to **Allow Writes**.

Note: As a best practice, configure DNS to require single forwarding change only. During an outage, this configuration minimizes downtime and simplifies the failover process.

Failover while a SyncIQ job is running

It is important to note that if the replication policy is running at the time when a failover is initiated, the replication job will fail, allowing the failover to proceed successfully. The data on the target cluster is restored to its previous state before the replication policy ran. The restore completes by utilizing the snapshot taken by the replication job after the last successful replication job.

Target cluster dataset

If for any reason the source cluster is entirely unavailable, for example, under a disaster scenario, the data on the target cluster will be in the state after the last successful replication job completed. Any updates to the data since the last successful replication job are not available on the target cluster.

Failback

Users continue to read and write to the target cluster while the source cluster is repaired. When the source cluster becomes available again, the administrator decides when to revert client I/O back to it. To do so, the administrator initiates a SyncIQ failback, which synchronizes any incremental changes made to the target cluster during failover back to the source. When the failback is complete, the administrator redirects client I/O back to the original cluster.

Failback may occur almost immediately in the event of a functional test, or (more likely) after time elapses and the issue which prompted the failover can be resolved. Updates to the dataset while in the failover state will almost certainly have occurred. Therefore, the failback process must include propagation of these updates back to the source.

Failback policy requirements

Data may be failed back to a source cluster from a target cluster after a failover for any replication policy with the following requirements:

- The policy has been failed over to the target cluster.
- The policy is a synchronization policy and not a copy policy.
- The policy does not exclude any files or directories from replication.

Failback consists of three phases. Each phase should complete before proceeding.

Resync-prep

Run the preparation phase (resync-prep) on the source cluster to prepare it to receive intervening changes from the target cluster. This phase creates a read-only replication domain with the following steps:

1. The last known good snapshot is restored on the source cluster.
2. A SyncIQ policy is created on the target policy appended with **_mirror**. This policy is used to failback the dataset with any modification that has occurred since the last snapshot on the source cluster. During this phase, clients are still connected to the target.

Mirror policy

Run the mirror policy created in the previous step to sync the most recent data to the source cluster.

Verify

Verify that the failback has completed using the replication policy report, and redirect clients back to the source cluster. The target cluster is then automatically relegated back to its role as a target.

Allow-writes compared to break association

When a SyncIQ policy is configured between a source and target cluster, an association is formed between the two clusters. OneFS associates a policy with its specified target directory by placing a cookie on the source cluster when the job runs for the first time. The cookie allows the association to persist, even if the target cluster's name or IP address is modified. SyncIQ provides two options for making a target cluster writable after a policy is configured between the two clusters. The first option is to **Allow-Writes**, as stated previously in this section. The second option to make the target cluster writable is to break a target association.

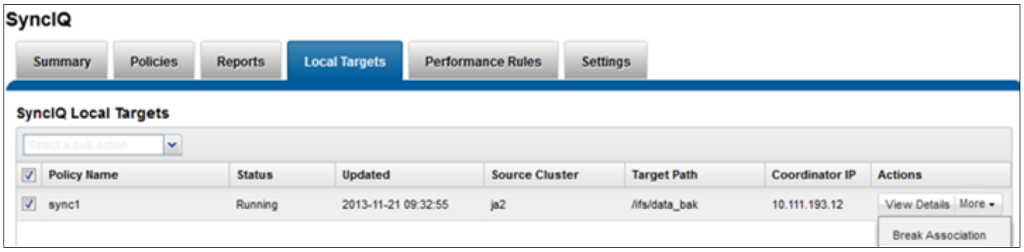
If the target association is broken, the target dataset will become writable, and the policy must be reset before the policy can run again. A full or differential replication will occur the next time the policy runs. During this full resynchronization, SyncIQ creates a new association between the source and its specified target.

To perform a break association, run the following command from the target cluster's CLI:

```
isi sync target break –policy=[Policy Name]
```

Note: Practice caution before issuing a policy break command. Ensure that the repercussions, as described in this section, are understood.

To perform this activity from the target cluster’s web interface, select **Data Protection > SyncIQ** and select the **Local Targets** tab. Then click **More** under the **Actions** column for the appropriate policy, and click **Break Association**, as displayed in the following figure.



☑	Policy Name	Status	Updated	Source Cluster	Target Path	Coordinator IP	Actions
☑	sync1	Running	2013-11-21 09:32:55	ja2	/ifs/data_bak	10.111.193.12	View Details More

Figure 29. Break association from web interface

On the contrary, the **Allow-Writes** option does not result in a full or differential replication to occur after the policy is active again, as the policy is not reset.

Typically, breaking an association is useful to temporary test scenarios or if a policy has become obsolete for various reasons. Allowing writes is useful for failover and failback scenarios. Typical applications of both options are listed in the following table.

Table 1. Allow-writes compared to break association scenarios

Allow-writes	Break association
Failover and failback	Temporary test environments
Temporarily allowing writes on a target cluster, while the source is restored	Obsolete SyncIQ policies
When the source cluster is brought up, it does not require a full or differential replication, depending on the policy	Data migrations
	When the source cluster is brought up, it requires a full or differential replication

As with any major IT implementation, it is recommended to test all functions in a lab environment, rather than a production environment to understand how each function performs.

Superna Eyeglass DR Edition

Many SyncIQ failover and failback functions can be automated with additional features through Superna Eyeglass DR Edition. Superna provides software that integrates with PowerScale, delivering disaster recovery automation, security, and configuration management. Dell sells Superna software as a Select partner.

Superna’s DR Edition supports PowerScale SyncIQ by automating the failover process. Without Superna, the failover process requires manual administrator intervention. Complexity is minimized with DR Edition as it provides one-button failover, but also updates Active Directory, DNS, and client data access, as illustrated in the following figure.

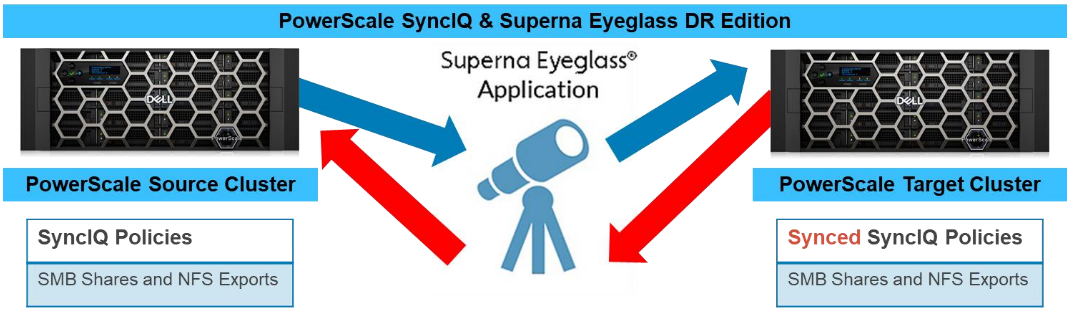

PowerScale SyncIQ & Superna Eyeglass DR Edition
Superna Eyeglass®
Application
PowerScale Source Cluster
SyncIQ Policies
SMB Shares and NFS Exports
PowerScale Target Cluster
Synced SyncIQ Policies
SMB Shares and NFS Exports

Figure 30. PowerScale SyncIQ and Superna Eyeglass configuration

After DR Edition is configured, it continually monitors the PowerScale cluster for DR readiness through auditing, SyncIQ configuration, and several other cluster metrics. The monitoring process includes alerts and steps to rectify discovered issues. In addition to alerts, DR edition also provides options for DR testing, which is highly recommended, ensuring IT administrators are prepared for DR events. The DR testing can be configured to run on a schedule. For example, depending on the IT requirements, DR testing can be configured to run on a nightly basis, ensuring DR readiness.

As DR Edition collects data, it provides continuous reports on RPO compliance, ensuring data on the target cluster is current and relevant.

Superna Eyeglass DR Edition is recommended as an integration with PowerScale SyncIQ, providing a simplified DR process and further administrator insight into the SyncIQ configuration. For more information about Superna Eyeglass DR Edition, see https://www.supernaeyeglass.com/dr-edition.

SyncIQ and CloudPools

Introduction to SyncIQ and CloudPools

OneFS SyncIQ and CloudPools features are designed to work together seamlessly. CloudPools tiers data to a cloud provider. The cloud provider could be Dell Elastic Cloud Storage (ECS), a public, private, or hosted cloud. As data is tiered to a cloud provider, a small file is retained on the cluster, referred to as a SmartLink, containing the relevant metadata to retrieve the file at a later point. A file that is tiered to the cloud, cannot be retrieved without the SmartLink file. For more information about CloudPools, see PowerScale OneFS CloudPools Administration Guide or the PowerScale CloudPools and ECS Solution Guide.

If a directory on the source cluster is configured for data replication to a target cluster containing the SmartLink files, the SmartLink files are also replicated to the target cluster.

Note: Although configuration to a cloud provider exists on the source and target clusters, it is important to understand that only a single cluster may have **read and write access** to the cloud provider. Both the source and target cluster have read access, but only a single cluster may have read and write access.

During normal operation, the source cluster has read/write access to the cloud provider, while the target cluster is read-only, as illustrated in the following figure.

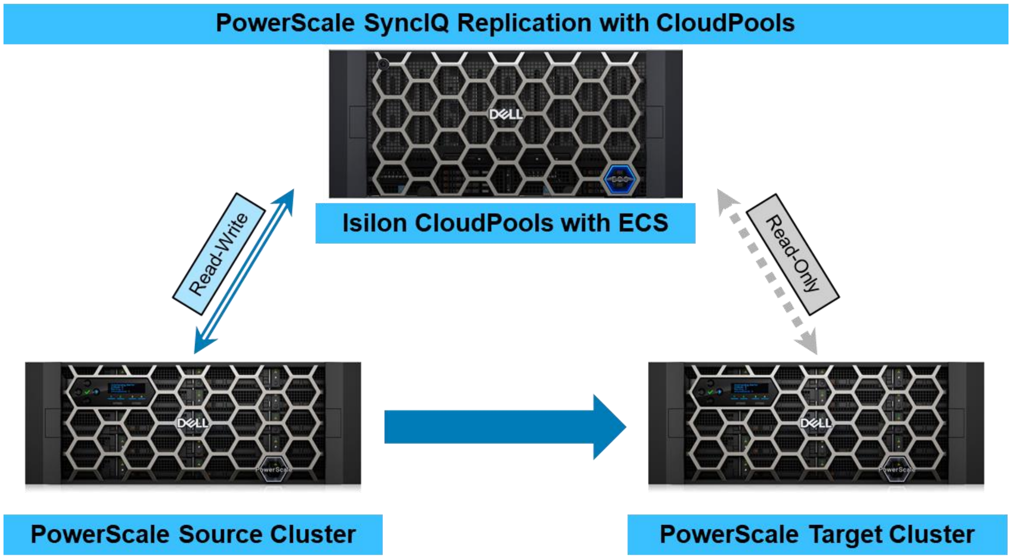

PowerScale SyncIQ Replication with CloudPools
Isilon CloudPools with ECS
Read-Write
Read-Only
PowerScale Source Cluster
PowerScale Target Cluster

Figure 31. PowerScale SyncIQ and CloudPools with ECS

CloudPools failover and failback implications

SyncIQ provides a seamless failover experience for clients. The experience does not change if CloudPools is configured. After a failover to the target cluster, clients continue accessing the data stored at the cloud provider without interruption to the existing workflow. The target cluster has read-only access to the specified cloud provider. As clients request files stored in the cloud, the target cluster retrieves these files with the SmartLinks and delivers them in the same method the source cluster did.

However, if the files are modified those changes are not propagated to the cloud provider. Instead, any changes to the cloud tiered files are stored locally in the target cluster's cache. When the failback is complete to the source cluster, the new changes to the cloud tiered files are sent to the source cluster. The source cluster then propagates the changes to the cloud provider.

If a failover is permanent, or for an extended time, the target cluster requires read/write access to the cloud provider. The read/write status is updated through the `isi cloud access` command. For more information about this command, see the administration and solution guide referenced above.

Target cluster SyncIQ and CloudPools configuration

Irrespective of when CloudPools is configured on the source cluster, the cloud provider account information, CloudPools, and filepool policy are automatically configured on the target cluster.

Configuring CloudPools before a SyncIQ policy

Configuring CloudPools before creating a SyncIQ policy is a supported option. When the SyncIQ policy runs for the first time, it checks if the specified source directory contains SmartLink files.

If SmartLink files are found in the source directory, on the target cluster SyncIQ performs the following actions:

- Configures the cloud storage account and CloudPools matching the source cluster configuration

- Configures the file pool policy matching the source cluster configuration

Although the target cluster is configured for the same cloud provider using CloudPools, it only has read access to the provider.

Configuring CloudPools after a SyncIQ policy

An existing SyncIQ policy also supports the replication of SmartLink files. If the SyncIQ policy is already configured and active, the source directory could be updated to work with CloudPools. After the CloudPools configuration is complete, the following SyncIQ job detects the SmartLink files on the source.

In this case, when the SmartLink files are detected in the source directory, on the target cluster SyncIQ performs the following actions:

- Configures the cloud storage account and CloudPools matching the source cluster configuration
- Configures the file pool policy matching the source cluster configuration

Although the target cluster is configured for the same cloud provider using CloudPools, it only has read access to the provider.

Note: As a best practice, before configuring CloudPools on a source cluster directory, temporarily disable the associated SyncIQ policy. After updating the source cluster directory for CloudPools, enable the SyncIQ policy, allowing the next job to detect the SmartLink files and configure the target cluster accordingly.

SyncIQ security

Introduction to SyncIQ security

By default, SyncIQ starts replication to a specified target PowerScale cluster without any configuration necessary on the target cluster. The replication policy is configured on the source cluster only, and if network connectivity is available through the front-end ports, the replication policy is initiated.

Depending on the network architecture hierarchy and where the PowerScale clusters are placed in the hierarchy, this action could be a concern. For instance, a cluster could receive many replication policies from a source cluster that could overwhelm its resources. In environments where several PowerScale clusters are active, an administrator may inadvertently specify the IP address of another cluster rather than the intended target cluster.

Securing a PowerScale cluster from unauthorized replication of data is performed through two available options. As a best practice and per DSA-2020-039, Dell PowerScale OneFS Security Update for a SyncIQ Vulnerability, enabling SyncIQ encryption, is recommended, preventing man-in-the-middle attacks and alleviating security concerns. SyncIQ encryption was introduced in OneFS 8.2.

SyncIQ is disabled by default on greenfield OneFS release 9.1 clusters. After SyncIQ is enabled, the global encryption flag is enabled, requiring all SyncIQ policies to be encrypted. For PowerScale clusters upgraded to OneFS 9.1, the global encryption flag is also enabled. However, the global encryption flag is not enabled on PowerScale clusters upgraded to OneFS 9.1 with an existing SyncIQ policy.

As an alternative for PowerScale clusters running a release earlier than OneFS 8.2, a SyncIQ pre-shared key (PSK) can be configured, protecting a cluster from unauthorized replication policies without the PSK. For more information about SyncIQ PSK, see SyncIQ pre-shared key.

SyncIQ encryption

OneFS release 8.2 introduced over-the-wire, end-to-end encryption for SyncIQ data replication, protecting and securing in-flight data between clusters. A global setting is available, enforcing encryption on all incoming and outgoing SyncIQ policies.

Note: Before you enable SyncIQ encryption on a production cluster, test it in a lab environment that mimics the production environment. Encryption adds minimal overhead to the transmission, but it may affect a production workflow depending on the network bandwidth, cluster resources, workflow, and policy configuration. Only after you successfully test encryption in a lab environment and collect satisfactory measurements, you may consider implementing SyncIQ encryption for the production cluster.

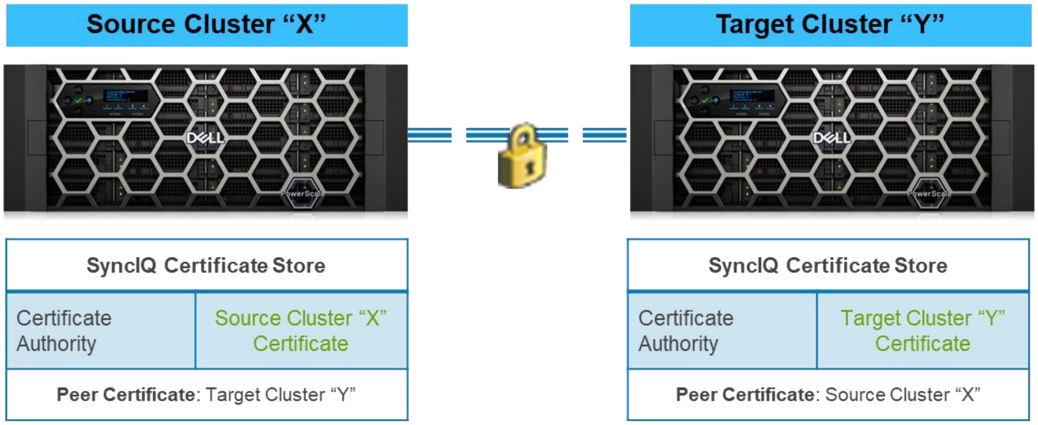


Figure 32. SyncIQ encryption

SyncIQ provides encryption through X.509 certificates paired with TLS version 1.2 and OpenSSL version 1.0.2o. The certificates are stored and managed in the source and target cluster's certificate stores, as shown in Figure 32. Encryption between clusters is enforced by each cluster, storing its certificate and its peer's certificate. Therefore, the source cluster is required to store the target cluster's certificate, and conversely. Storing the peer's certificate essentially creates a list of approved clusters for data replication. SyncIQ encryption also supports certificate revocation through the use of an external OCSP responder.

Note: Before you enable SyncIQ encryption, you must upgrade and commit both the source and target cluster to OneFS release 8.2 or newer.

Configuring SyncIQ encryption

OneFS release 9.1 introduced support for SyncIQ configuration through the WebUI. For releases before OneFS 9.1, SyncIQ encryption configuration is available through the CLI only. To configure SyncIQ encryption between a source and target cluster, perform the following steps:

1. Using publicly available tools, create X.509 certificates for the source and target cluster. This process results in a Certificate Authority certificate, source certificate, source private key, target certificate, and target private key.

   Certain certificate authorities do not generate the public and private key pairs. In that case, the public and private key pairs must be manually generated with a Certificate Signing Request (CSR), requiring a manually generated CSR. To manually generate the CSR file, as an example, run the following command:

   ```
   openssl req -new -newkey rsa:2048 -keyout <src_key> -out
   <src_csr>
   ```

   Next, provide the CSR file for each cluster to the certificate authority, and signed certificates are returned.

   Note: The certificates should be configured for use in TLS connections with client authentication enabled. They must be signed by a certificate authority and be able to act as both a client and a server certificate. Certificate extensions are not required and are not recommended because they result in additional restrictions and may cause SyncIQ policies to fail.

   The procedure explained in this step with the certificate authority is the recommended process. Alternatively, for environments where a Certificate Authority is not available, a self-signed certificate can be used for SyncIQ encryption. To configure SyncIQ encryption with a self-signed certificate, see Appendix B: SyncIQ encryption with self-signed certificates.

2. Use the following commands to add the certificates created in step 1 to the source cluster certificate store:

   ```
   isi sync cert server import <src_cert_id> <src_key>
   isi sync cert peer import <tgt_cert_id> --name=[Specify a
   certificate name]
   isi cert authority import <ca_cert_id> --name=[Specify the
   authority name]
   ```

   Alternatively, activate each certificate through the WebUI. Only selecting the certificate is supported through the WebUI. The certificates must first be transferred to the cluster. When the certificates are transferred to the cluster, activate each certificate as follows:

   - Add the source cluster certificate under **Data Protection > SyncIQ > Certificates**. Click **Add certificate**, specify the certificate file location, and provide an alias.
   - Add the target server certificate under **Data Protection > SyncIQ > Settings**. Find the **Server Certificates** section and click **Add certificate**. Specify the certificate file location and provide an alias.

- Add the Certificate Authority, under **Access > TLS Certificates**, under the **Authority** tab, and select **Import authority**. Specify the certificate file location and provide an alias.

Note: Activating the Certificate Authority is only supported in OneFS Release 9.5 and later. Use the `isi cert authority import` command in the CLI for previous releases.

3. This step can be skipped if encryption is configured through the WebUI. On the source cluster, activate the SyncIQ cluster certificate from step 1 using the following command:

```
isi sync settings modify --cluster-certificate-
id=<src_cert_id>
```

4. Use the following commands to add the certificates created in step 1 to the target cluster certificate store:

```
isi sync cert server import <tgt_cert_id> <tgt_key>
isi sync cert peer import <src_cert_id> --name=[Specify a
certificate name]
isi cert authority import <ca_cert_id> –-name=[Specify the
authority name]
```

Alternatively, activate each certificate through the WebUI. Only selecting the certificate is supported through the WebUI. The certificates must first be transferred to the cluster. When the certificates are transferred to the cluster, activate each certificate as follows:

- Add the target server certificate under **Data Protection > SyncIQ > Settings**. Find the **Server Certificates** section and click **Add certificate**. Specify the certificate file location and provide an alias.
- Add the source cluster certificate under **Data Protection > SyncIQ > Certificates**. Click **Add certificate**, specify the certificate file location, and provide an alias.
- Add the Certificate Authority, under **Access > TLS Certificates**, under the **Authority** tab, and select **Import authority**. Specify the certificate file location and provide an alias.

Note: Activating the Certificate Authority is only supported in OneFS 9.5 and later. Use the `isi cert authority import` command in the CLI for previous releases.

5. This step can be skipped if encryption is configured through the WebUI. On the target cluster, activate the SyncIQ cluster certificate from step 1 using the following command:

```
isi sync settings modify --cluster-certificate-
id=<tgt_cert_id>
```

6. Optionally, select the global option to require all incoming and outgoing SyncIQ policies to be encrypted.

Note: Running this command affects existing SyncIQ policies that may not have encryption enabled. Only run this command after all existing policies have encryption enabled. Otherwise, existing policies that do not have encryption enabled will fail.

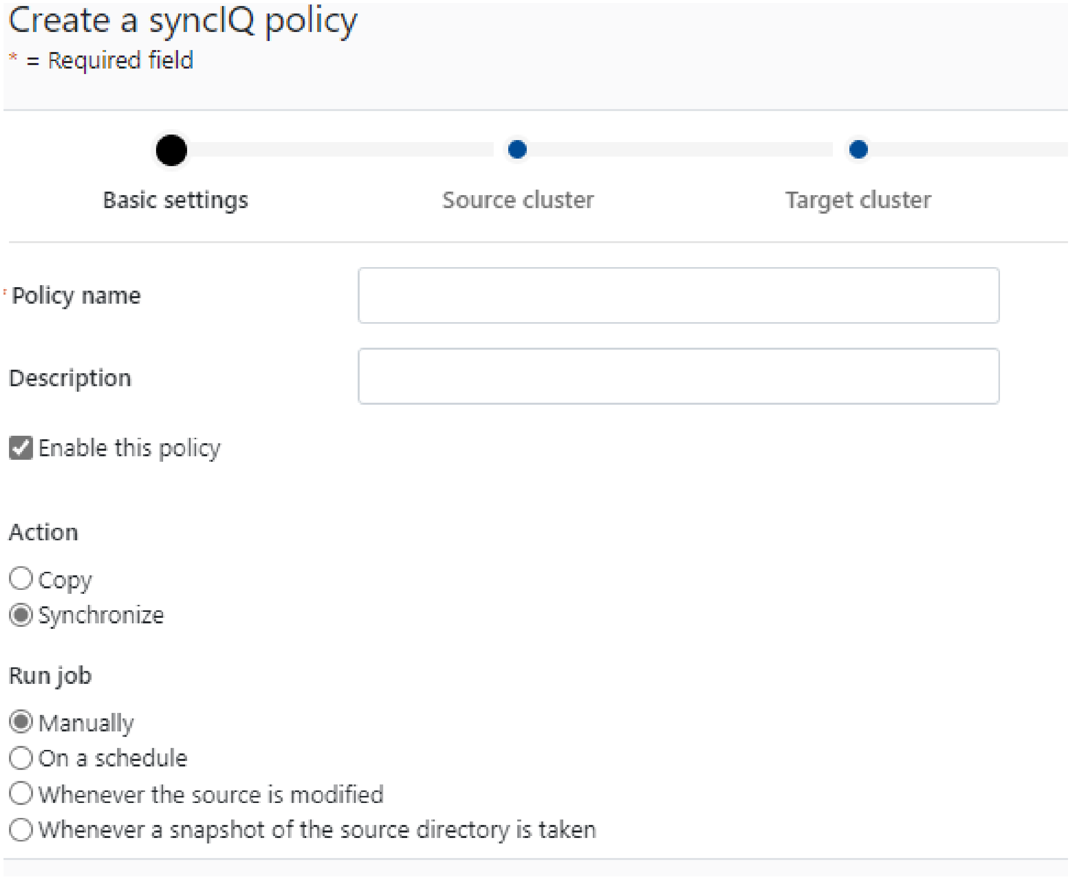
To enable this option, run the following command:

```
isi sync settings modify --encryption-required=True
```

7. To modify an existing SyncIQ policy for encryption, go to the next step. Otherwise, to create a new encrypted SyncIQ policy, on the source cluster, use the following command:

```
isi sync policies create <SyncIQ Policy Name> sync <Source
Cluster Directory> <Target Cluster IP Address> <Target
Cluster Directory> --target-certificate-id=<tgt_cert_id>
```

Alternatively, from the WebUI, go to **Data Protection > SyncIQ > Policies**, and click **Create a SyncIQ policy**. Specify the policy name, action, and job run trigger, as illustrated in the following figure.



Create a syncIQ policy

* = Required field

* Policy name

Description

☑ Enable this policy

Action

○ Copy
● Synchronize

Run job

● Manually
○ On a schedule
○ Whenever the source is modified
○ Whenever a snapshot of the source directory is taken

Figure 33. Creating a SyncIQ policy

8. To modify an existing SyncIQ policy for encryption, on the source cluster, use the following command:

```
isi sync policies modify <pol_name> --target-certificate-
id=<tgt_cert_id>
```

Alternatively, from the WebUI, go to **Data Protection > SyncIQ > Policies**, select an existing SyncIQ policy, and click **View/Edit** on the right. From the **Target certificate** drop-down, select the appropriate target cluster certificate.

Other optional commands

SyncIQ provides an option to require a policy to use a specified SSL cipher suite. To update a policy and enforce a specific SSL suite, use the following command:

```
isi sync policies modify <pol_name> --encryption-cipher-list=<suite>
```

You can update a target cluster to check the revocation status of incoming certificates using the following command:

```
isi sync settings modify --ocsp-address=<FQDN of OCSP server> --ocsp-issuer-certificate-id=<ca_cert_id>
```

By default, the encrypted connection is renegotiated on a cluster every eight hours. You can update this value using the following command:

```
isi sync settings modify --renegotiation-period=<Specify time period in hours>
```

Troubleshooting

As with other SyncIQ policies, errors are documented in the SyncIQ reports. The same applies to SyncIQ encryption because the reason for failure is listed in the report. For instance, if the job failed due to a TLS authentication failure, the error message from the TLS library is provided in the report.

Also, for a TLS authentication failure, a detailed log is available in the `/var/log/messages` directory on the source and target clusters. The log includes the error code and reason for failure, the depth at which the failure occurred in the certificate chain, the certificate ID, and the subject name of the certificate that caused the failure.

SyncIQ pre-shared key

A SyncIQ pre-shared key (PSK) is only configured on the target cluster and limits policies from source clusters if they do not have the PSK configured in the SyncIQ policy.

Note: A SyncIQ PSK is only recommended for environments where SyncIQ encryption may not be configured. These environments include clusters running a OneFS version earlier than OneFS 8.2 or other environmental factors. For more information about configuring SyncIQ encryption, see SyncIQ encryption.

SmartLock Compliance mode clusters do not support SyncIQ PSK. For clusters in SmartLock Compliance mode, upgrading to OneFS 8.2 or later is recommended and configuring SyncIQ encryption. SmartLock Enterprise mode clusters support SyncIQ PSK.

To configure a SyncIQ PSK on a source and target cluster with OneFS release 9.5.0.0 or later, perform the following steps:

1. Ensure that SyncIQ jobs are not running.

   Configuring the PSK will cause all jobs replicating to the target cluster to fail. Before proceeding with the SyncIQ PSK configuration, either wait for SyncIQ jobs to complete or cancel running jobs. To manually cancel a SyncIQ job, run the following command:

```
isi sync jobs cancel <policy-name>
```

Alternatively, to cancel all SyncIQ jobs, run:

```
isi sync jobs cancel –all
```

2. On the target cluster, configure the PSK by running the following command:

   ```
   isi sync settings modify --set-password
   ```

3. After the PSK is configured on the target cluster, modify policies on the source cluster through the CLI with the following command:

   ```
   isi sync policies modify [Policy Name] --set-password --
   password=[Target Cluster PSK]
   ```

To configure a SyncIQ PSK on a source and target cluster with a OneFS release earlier than 9.5.0.0, perform the following steps:

1. Ensure that SyncIQ jobs are not running.

   Configuring the PSK will cause all jobs replicating to the target cluster to fail. Before proceeding with the SyncIQ PSK configuration, either wait for SyncIQ jobs to complete or cancel running jobs.

   To manually cancel a SyncIQ job, run the following command:

   ```
   isi sync jobs cancel <policy-name>
   ```

   Alternatively, to cancel all SyncIQ jobs, run:

   ```
   isi sync jobs cancel --all
   ```

2. Create a file named `passwd` under `/ifs/.ifsvar/modules/tsm/`. If the file does not already exist, create it with ACLs to limit access:

   ```
   touch /ifs/.ifsvar/modules/tsm/passwd
   chmod 700 /ifs/.ifsvar/modules/tsm/passwd
   ```

3. In the `passwd` file, specify a single text string limited to 255 characters as the target cluster's SyncIQ PSK.

   The PSK must be the only line in the file and cannot contain any spaces or tab characters. Enter the PSK using the `vi` or other utility. As a best practice, ensure that this PSK is unique to this system only, ensuring further security.

   ```
   vi /ifs/.ifsvar/modules/tsm/passwd
   ```

4. After saving the PSK in the `passwd` file, confirm the PSK entry:

   ```
   cat /ifs/.ifsvar/modules/tsm/passwd
   ```

5. After the PSK is configured on the target cluster, modify policies on the source cluster through the CLI.

   For OneFS 8.0 and later, run the following command:

```
isi sync policies modify [Policy Name] --set-password --
password=[Target Cluster PSK specified in ‘passwd’ file]
```

For OneFS 7.1.x or 7.2.x, run the following command:

```
isi sync policies modify [Policy Name] --password [Target
Cluster PSK specified in ‘passwd’ file]
```

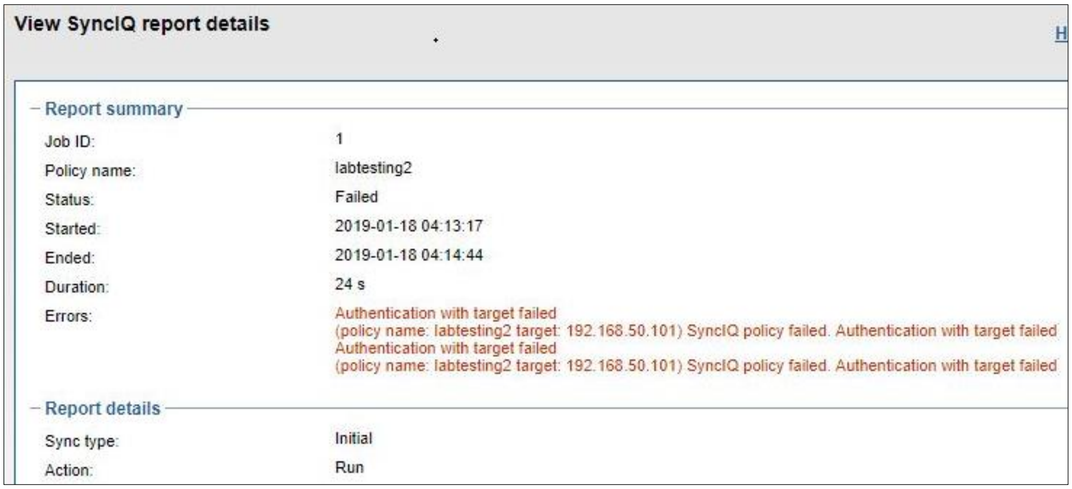
For OneFS 7.0.x and earlier, run the following command:

```
isi sync policy modify [Policy Name] --passwd=[Target Cluster
PSK specified in ‘passwd’ file]
```

After the policies on the source cluster are updated, the source cluster does not require any additional configuration. To confirm if the PSK is configured on a source cluster policy, view the policy using `isi sync policies view`, and check the `Password Set` field. A `Yes` should be listed.

To resume a stopped SyncIQ job, use the following command: `isi sync jobs start [policy-name]`

If a target cluster has a PSK in place for SyncIQ and the source cluster policy is not configured with the PSK using the `--set-password` flag, the policy will fail. An error is listed under the report, stating **Authentication with target failed**, as displayed in the following figure.



View SyncIQ report details

Report summary

Job ID:	1
Policy name:	labtesting2
Status:	Failed
Started:	2019-01-18 04:13:17
Ended:	2019-01-18 04:14:44
Duration:	24 s
Errors:	Authentication with target failed (policy name: labtesting2 target: 192.168.50.101) SyncIQ policy failed. Authentication with target failed Authentication with target failed (policy name: labtesting2 target: 192.168.50.101) SyncIQ policy failed. Authentication with target failed

Report details

Sync type:	Initial
Action:	Run

Figure 34. SyncIQ authentication failed with target cluster

To unconfigure the SyncIQ PSK on clusters running a release earlier than OneFS 9.5, remove the `passwd` file on the target cluster. For clusters running OneFS 9.5 and later, the command to set the `passwd` file to null is as follows:

```
isi sync settings modify --password "<null>"
```

Next, modify all policies on the source cluster.

For OneFS 8.0 and later, use the following command:

```
isi sync policies modify [policy-name] --set-password --
password="<null>"
```

For OneFS 7.1.x or 7.2.x, use the following command:

```
isi sync policies modify [policy-name] --password ""
```

For OneFS 8.0 and later, use the following command:

```
isi sync policy modify [policy-name] --passwd=""
```

SyncIQ bandwidth reservations

Introduction to SyncIQ bandwidth reservations

Before OneFS 8.2, a global bandwidth configuration was available, affecting all SyncIQ policies. The global reservation is then split among the running policies. For more information about configuring the SyncIQ global bandwidth reservation, see SyncIQ performance rules.

OneFS 8.2 introduces an option to configure bandwidth reservations on a per-policy basis, providing granularity for each policy. The global bandwidth reservation available in previous releases continues in OneFS 8.2. However, it is applied as a combined limit of the policies, allowing for a reservation configuration per policy, as illustrated in the following figure. As bandwidth reservations are configured, consider the global bandwidth policy which may have an associated schedule.

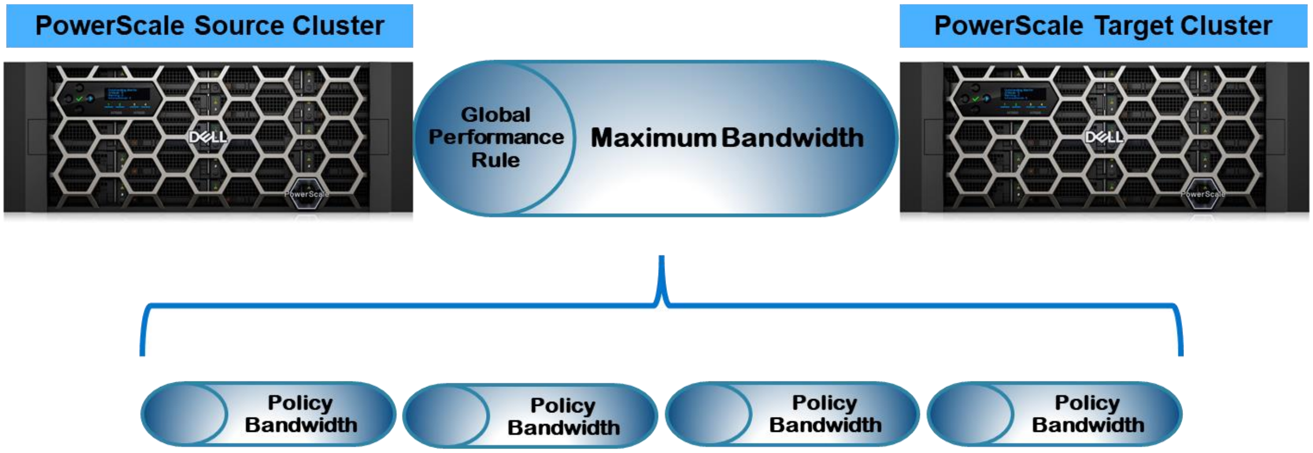


Figure 35. SyncIQ bandwidth reservation

Note: As bandwidth reservations are configured, consider that SyncIQ calculates bandwidth based on the bandwidth rule, rather than the actual network bandwidth or throughput available.

Bandwidth reservation configuration

The first step in configuring a per policy bandwidth reservation is to configure a global bandwidth performance rule, as explained in SyncIQ performance rules. From the CLI, the global bandwidth reservation is configured using the `isi sync rules` command.

After a global bandwidth reservation is configured, a per-policy bandwidth reservation is configured for new or existing policies using the `--bandwidth-reservation` option in bits per second with the `isi sync policies` command.

Bandwidth reserve

If a bandwidth reservation is not created for a policy, the bandwidth reserve is applied. The bandwidth reserve is specified as a global configuration parameter, as a percentage of the global configured bandwidth or an absolute limit in bits per second.

Note: If a bandwidth reservation is not configured in OneFS 8.2 for a specific policy, the default bandwidth reserve is 1% of the global configured bandwidth. The default is set at this level to encourage administrators to configure the bandwidth reservation per policy. For clusters upgrading from a previous release to OneFS 8.2, note that any existing policies default to the 1% bandwidth reservation, assuming a global bandwidth reserve is not configured.

In the case where a bandwidth reservation is not configured for a policy, the bandwidth reserve is applied if sufficient bandwidth is not available. To configure a bandwidth reservation percentage, use the following command:

```
isi sync settings modify --bandwidth-reservation-reserve-
percentage=[% of global bandwidth reservation]
```

To configure a bandwidth reservation in bits per second rather than a percentage, use the following command:

```
isi sync settings modify --bandwidth-reservation-reserve-
absolute=[kb/s]
```

Further, to clear a configured bandwidth reserve, use the following command:

```
isi sync settings modify --clear-bandwidth-reservation-reserve
```

Bandwidth reservation scenarios

How a bandwidth reservation is applied to a policy varies depending on two factors, the global bandwidth rule and the number of policies running at once. These two factors lead to two possible scenarios.

Under the first scenario, more bandwidth is available than all the running policies. In this case, the available bandwidth is split evenly across all running policies, the same as the pre-OneFS 8.2 behavior.

In the second scenario, the global configured bandwidth is less than the sum of the per-policy configured bandwidth for the running policies. Therefore, SyncIQ is unable to provide all the policies the requested bandwidth. Under this scenario, an even split occurs of bandwidth across all running policies, until the requested reservation is met. The even split ensures that the policies with the lowest reservation meet their reservation before the policies with larger reservations, preventing starvation across the policies.

Bandwidth reservation example 1: insufficient bandwidth

In this example, the total requested bandwidth of running policies is more than the global bandwidth reservation. For example, with a global bandwidth rule of 30 Mb and 3 policies running simultaneously:

- Policy 1 has a bandwidth reservation of 20 Mb
- Policy 2 has a bandwidth reservation of 40 Mb
- Policy 3 has a bandwidth reservation of 60 Mb

In this scenario, enough bandwidth is not available for each policy to meet its reservation. Therefore, each policy is allocated 10 Mb, as illustrated in the following figure.

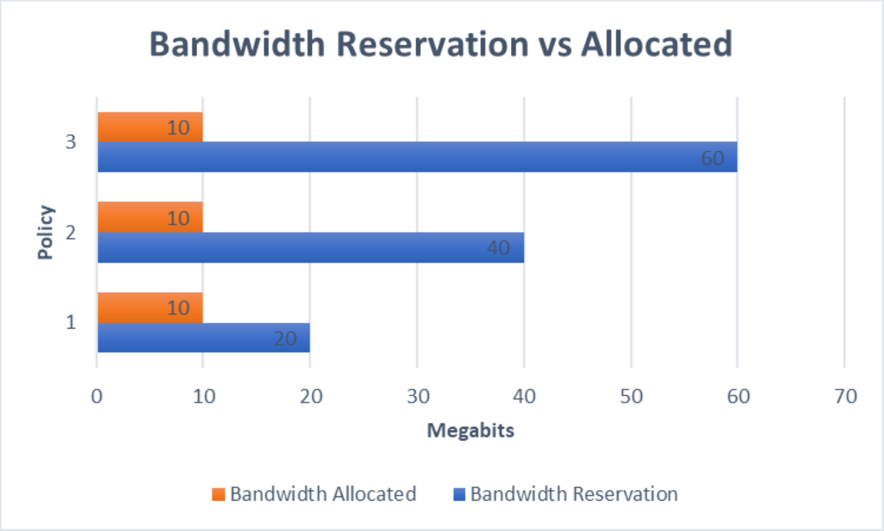


Figure 36. Insufficient bandwidth example 1

Bandwidth reservation example 2: insufficient bandwidth

In this example, the total requested bandwidth of running policies is more than the global bandwidth reservation. However, ample bandwidth is available for some of the policies to meet their reservation. For example, with a global bandwidth rule of 80 Mb and 3 policies running simultaneously:

- Policy 1 has a bandwidth reservation of 20 Mb
- Policy 2 has a bandwidth reservation of 40 Mb
- Policy 3 has a bandwidth reservation of 60 Mb

In this scenario, enough bandwidth is not available for each policy to meet its reservation, but enough is available for Policy 1. Therefore, Policy 1 is allocated its full reservation of 20 Mb, but Policy 2 and Policy 3 are allocated a split of the remaining bandwidth of 30 Mb each, as illustrated in the following figure.

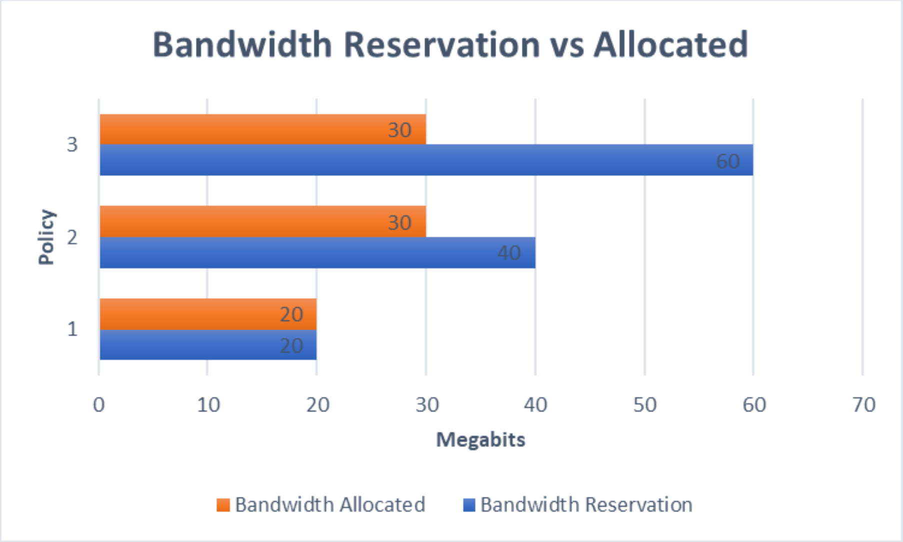


Figure 37. Insufficient bandwidth example 2

Bandwidth reservation example 3: extra bandwidth available

In this example, the total requested bandwidth of running policies is less than the global bandwidth reservation, allowing additional bandwidth to be granted to policies. For instance, with a global bandwidth rule of 80 Mb and 3 policies running simultaneously:

- Policy 1 has a bandwidth reservation of 10 Mb
- Policy 2 has a bandwidth reservation of 20 Mb
- Policy 3 has a bandwidth reservation of 30 Mb

In this scenario, enough bandwidth is available for each policy to meet its reservation, but additional bandwidth is available that is not granted. Therefore, Policy 3 is allocated its full reservation of 30 Mb, but Policy 2 and Policy 3 are allocated 25 Mb each, as additional bandwidth is available, as illustrated in the following figure.

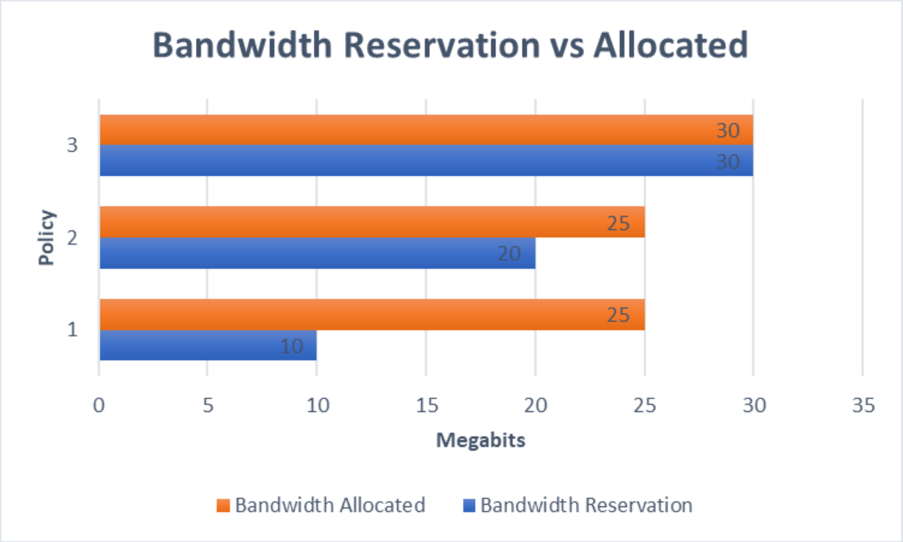


Figure 38. Extra bandwidth example 3

Monitoring, alerting, reporting, and optimizing performance

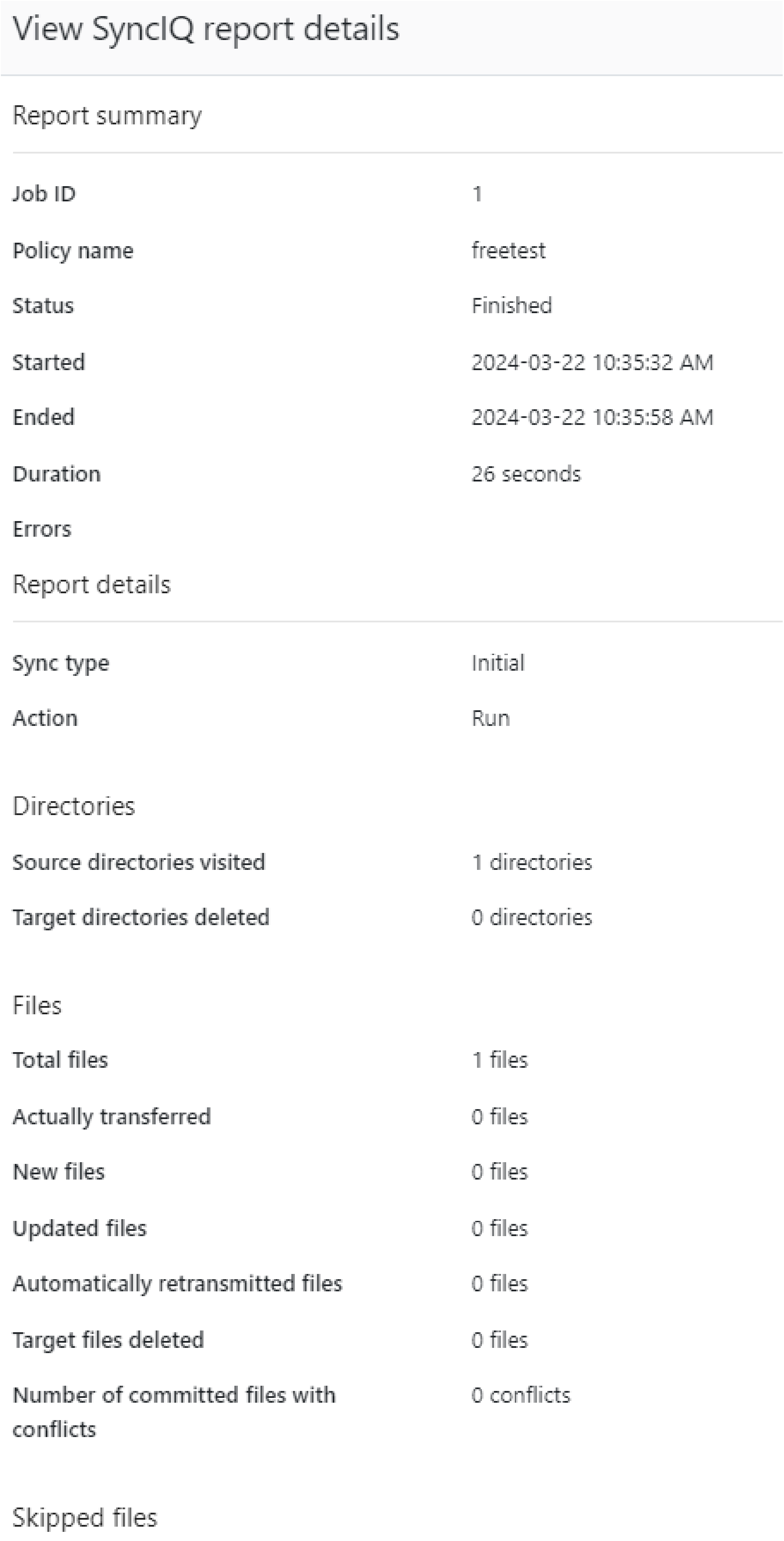
Introduction to monitoring, alerting, reporting, and optimizing performance

SyncIQ allows administrators to monitor the status of policies and replication jobs with real-time performance indicators and resource utilization. Administrators can determine how different policy settings affect job execution and affect performance on the cluster. In addition, every job execution produces a comprehensive report that can be reviewed for troubleshooting and performance analysis. The real-time reports provide information about the amount of data replicated and the effectiveness of those jobs, enabling resources to be tuned accordingly. For more information about SyncIQ tuning, see SyncIQ performance rules.

In addition to including cluster-wide performance monitoring tools, such as the `isi statistics` command or the PowerScale InsightIQ software module, SyncIQ includes module-specific performance monitoring tools. For information about `isi statistics` and InsightIQ, see the PowerScale OneFS 8.2.1 CLI Administration Guide and the PowerScale InsightIQ 4.1 User Guide.

Policy job monitoring

For high-level job monitoring, use the SyncIQ Summary page where job duration and total dataset statistics are available. The Summary page includes currently running jobs, as well as reports on completed jobs. For more information about a particular job, click the **View Details** link to review job-specific datasets and performance statistics. Use the Reports page to select a specific policy that was run within a specific period and completed with a specific job status.



View SyncIQ report details

Report summary

Job ID	1
Policy name	freetest
Status	Finished
Started	2024-03-22 10:35:32 AM
Ended	2024-03-22 10:35:58 AM
Duration	26 seconds
Errors	

Report details

Sync type	Initial
Action	Run

Directories

Source directories visited	1 directories
Target directories deleted	0 directories

Files

Total files	1 files
Actually transferred	0 files
New files	0 files
Updated files	0 files
Automatically retransmitted files	0 files
Target files deleted	0 files
Number of committed files with conflicts	0 conflicts

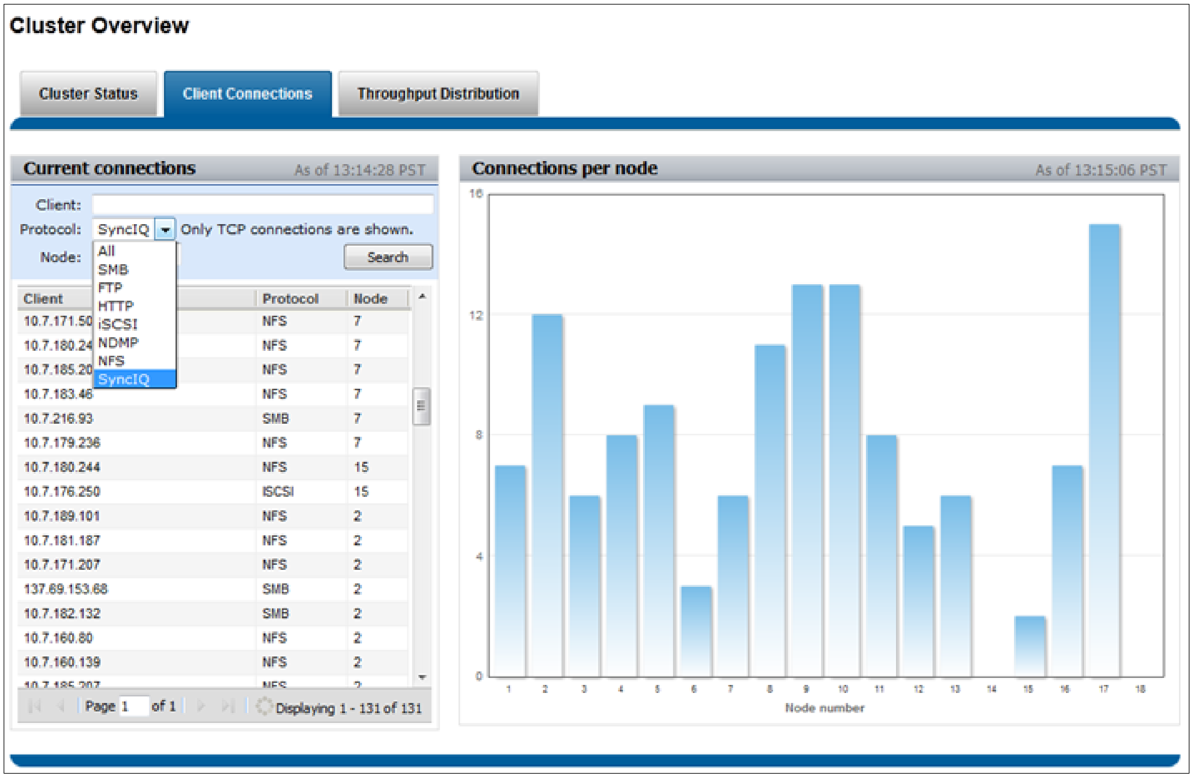
Skipped files

Figure 39. SyncIQ Job report details

In addition to the Summary and Reports pages, the Alerts page displays SyncIQ specific alerts extracted from the general-purpose cluster Alerts system.

Performance monitoring

For performance tuning purposes, use the WebUI Cluster Overview performance reporting pages, providing network and CPU utilization rates through real-time or historical graphs. The graphs display both cluster-wide performance and per-node performance. These limits are cluster-wide and are shared across simultaneous running jobs.



Client	Protocol	Node
10.7.171.50	NFS	7
10.7.180.24	NFS	7
10.7.185.20	NFS	7
10.7.183.46	NFS	7
10.7.216.93	SMB	7
10.7.179.236	NFS	7
10.7.180.244	NFS	15
10.7.176.250	ISCSI	15
10.7.189.101	NFS	2
10.7.181.187	NFS	2
10.7.171.207	NFS	2
137.69.153.68	SMB	2
10.7.182.132	SMB	2
10.7.160.80	NFS	2
10.7.160.139	NFS	2
10.7.185.207	NFS	2

Figure 40. Cluster overview SyncIQ monitoring

Comprehensive resource utilization cluster statistics are available using the PowerScale InsightIQ multi-cluster reporting and trending analytics suite.

Alerts

In addition to the dashboard of alerts presented above, errors are also reported in the following log:

```
/var/log/isi_migrate.log
```

For information about RPO alerts, see RPO alerts.

Reporting

As SyncIQ jobs are running, report data is written at phase changes and checkpoints. The report files are at the following location:

```
/ifs/.ifsvar/modules/tsm/sched/reports/<syncpolicyid>/report[-
timestamp].gc
```

Optimizing SyncIQ performance

The recommended approach for measuring and optimizing performance is as follows:

- Establish reference network performance using common tools such as Secure Copy (SCP) or NFS copy from cluster to cluster. This provides a baseline for a single thread data transfer over the existing network.
- After creating a policy and before running the policy for the first time, use the policy assessment option to see how long it takes to scan the source cluster dataset with default settings.
- Use file rate throttling to roughly control how much CPU and disk I/O SyncIQ consumes while jobs are running through the day.
- Remember that “target aware synchronizations” are much more CPU-intensive than regular baseline replication but they potentially yield much less network traffic if both source and cluster datasets are already seeded with similar data.
- Use IP address pools to control which nodes participate in a replication job and to avoid contention with other workflows accessing the cluster through those nodes.
- Use network throttling to control how much network bandwidth SyncIQ can consume through the day.

Worker and performance scalability

For releases prior to OneFS 8.0, the number of primary and secondary workers is calculated between both clusters based on two factors. First, the lowest number of nodes between the two clusters is considered. The lowest number of nodes is then multiplied by the number of workers per node, which is a configurable value. The default value for workers per node is three. SyncIQ randomly distributes workers across the cluster with each node having at least one worker. If the number of workers is less than the number of nodes, then all nodes will not participate in the replication. The following figure shows a calculation example:

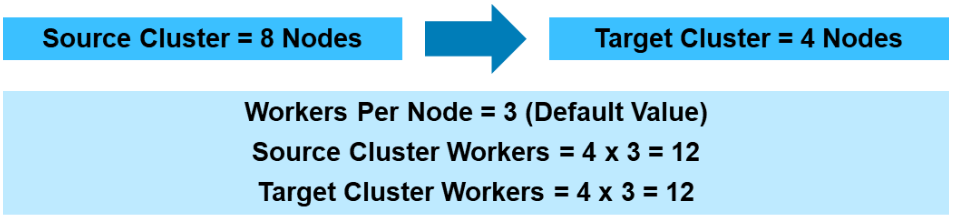

Source Cluster = 8 Nodes
Target Cluster = 4 Nodes
Workers Per Node = 3 (Default Value)
Source Cluster Workers = 4 x 3 = 12
Target Cluster Workers = 4 x 3 = 12

Figure 41. Calculating primary and secondary workers for release earlier than OneFS 8.0

In OneFS 8.0, the limits have increased to provide additional scalability and capability in line with cluster sizes and higher-performing nodes that are available. The maximum number of workers and workers per policy both scale as the number of nodes in the cluster increase. The defaults should be changed only with the guidance of PowerScale Technical Support.

- A maximum of 1,000 configured policies and 50 concurrent jobs are now available.
- Maximum workers per cluster are determined by the total number of physical cores in the node’s CPUs. The default is 4 * [total physical cores in the cluster]
- Maximum workers per policy is determined by the total number of nodes in the cluster. The default is 8 * [total nodes in the cluster]

- Instead of a static number of workers as in previous releases, workers are dynamically allocated to policies, based on the size of the cluster and the number of running policies. Workers from the pool are assigned to a policy when it starts, and the number of workers on a policy will change over time as individual policies start and stop. The goal is that each running policy always has an equal number (+/- 1) of the available workers assigned.
- Maximum number of target workers remains unchanged at 100 per node

Note: The source and target cluster must have the same number of workers, as each set of source and target workers create a TCP session. Any inconsistency in the number of workers results in failed sessions. As stated above, the maximum number of target workers is 100 per node, implying the total number of source workers is also 100 per node.

Note: The following example is provided to show how a node's CPU type affects worker count, how workers are distributed across policies, and how SyncIQ works on a higher level. The actual number of workers is calculated dynamically by OneFS based on the node type. The calculations in the example are not a tuning recommendation and are merely for illustration. If the worker counts require adjustment, contact PowerScale Technical Support, as the number of physical cores, nodes, and other factors are considered before making changes.

As an example, consider a 4-node cluster, with 4 cores per node. Therefore, there are 16 total cores in the cluster. Following the previous rules:

- Maximum workers on the cluster = 4 * 16 = 64 workers
- Maximum workers per policy = 8 * 4 = 32

When the first policy starts, it will be assigned 32 workers (out of the maximum 64). A second policy starting will also be assigned 32 workers. The maximum number of workers per policy has been determined previously as 32, and there are now a total of 64 workers—the maximum for this cluster. When a third policy starts, assuming the first two policies are still running, the maximum of 64 workers are redistributed evenly, so that 21 workers are assigned to the third policy, and the first two policies have their number of workers reduced from 32 to 21 and 22 respectively, as 64 does not split into 3 evenly. Therefore, there are 3 policies running, each with 21 or 22 workers, keeping the cluster maximum number of workers at 64. Similarly, a fourth policy starting would result in all four policies having 16 workers. When one of the policies is complete, the reallocation again ensures that the workers are distributed evenly among the remaining running policies.

Note: Any reallocation of workers on a policy occurs gradually to reduce thrashing when policies are starting and stopping frequently.

Specifying a maximum number of concurrent SyncIQ jobs

Administrators may want to specify a limit for the number of concurrent SyncIQ jobs running. Limiting the number is particularly useful during peak cluster usage and client activity. Forcing a limit on cluster resources for SyncIQ ensures that clients do not experience any performance degradation.

Note: Consider all factors prior to limiting the number of concurrent SyncIQ jobs, as policies may take more time to complete, affecting RPO and RTO times. As with any significant cluster update, testing in a lab environment is recommended before a production cluster is updated. Also, a production cluster should be updated gradually to minimize impact and allow measurements of the impacts.

To limit the maximum number of concurrent SyncIQ jobs, perform the following steps from the OneFS CLI:

1. Modify `/ifs/.ifsvar/modules/tsm/config/siq-conf.gc` using a text editor.
2. Change the following line to represent the maximum number of concurrent jobs for the cluster: `scheduler.max_concurrent_jobs`
3. Restart SyncIQ services by running the following command: `isi sync settings modify --service off;sleep5; isi sync settings modify --service on`

Performance tuning for OneFS 8.x releases

OneFS 8.0 introduced an updated SyncIQ algorithm taking advantage of all available cluster resources, improving overall job run times significantly. SyncIQ is exceptionally efficient in network data scaling and uses 2 MB TCP windows, considering WAN latency while delivering maximum performance.

Note: The steps and processes mentioned in this section may significantly affect RPO times and client workflow. Prior to updating a production cluster, test all updates in a lab environment that mimics the production environment. Only after successful lab trials, should the production cluster be considered for an update. As a best practice, gradually implement changes and closely monitor the production cluster after any significant updates.

SyncIQ achieves maximum performance by using all available cluster resources. SyncIQ consumes the following resources if they are available:

- All available CPU bandwidth
- Worker global pool—Default compute is based on node count and total cluster size, as previously described
- All available bandwidth

As SyncIQ consumes cluster resources, this may affect current workflows depending on the environment and available resources. If data replication is affecting other workflows, consider tuning SyncIQ as a baseline as follows:

- Limit CPU to 33% per node
- Limit workers to 33% of global—Factoring in lower performance nodes
- Configure bandwidth rules—For example, limit to 10 GB during business hours and 20 GB during off-hours

For information about updating the variables above, see SyncIQ performance rules. After the baseline is configured, gradually increase each parameter and collect measurements to ensure that workflows are not affected. Also consider modifying the maximum number of SyncIQ jobs, as described in Specifying a maximum number of concurrent SyncIQ jobs.

Note: The baseline variables provided here are only for guidance and are not a one-size-fits-all metric. Every environment is different. Carefully consider cluster resources and workflow when the intersection of workflow affects SyncIQ performance.

Administration

Introduction to administration

For administration, SyncIQ uses:

- Options provided by OneFS for access control
- Platform API

Role-based access control

Role-based access control (RBAC) divides up the powers of the root and administrator users into more granular privileges and allows them to be assigned to specific roles. For example, data protection administrators can be assigned full access to SyncIQ configuration and control, but only read-only access to other cluster functionality. SyncIQ administrative access is assigned through the ISI_PRIV_SYNCIQ privilege. RBAC is fully integrated with the SyncIQ CLI, WebUI, and Platform API.

OneFS Platform API

The OneFS Platform API provides a RESTful programmatic interface to SyncIQ, allowing automated control of cluster replication. The Platform API is integrated with RBAC, as previously described, providing a granular authentication framework for secure, remote SyncIQ administration using scripting languages.

SyncIQ replication and data reduction

Introduction to SyncIQ replication and data reduction

Data reduction includes deduplication and compression. This section describes how SyncIQ interacts with each of the PowerScale data reduction processes.

SmartDedupe

When deduplicated files are replicated to another PowerScale cluster using SyncIQ, the deduplicated files are rehydrated back to their original size, since they no longer share blocks on the target PowerScale cluster. When replication is complete, SmartDedupe can run on the target cluster, providing the same space efficiency benefits as the source cluster.

Shadow stores are not transferred to target clusters or backup devices. Hence, deduplicated files do not consume less space than non-deduplicated files when they are replicated or backed up. To avoid running out of space on target clusters or tape devices, it is essential to verify that the total amount of storage space saved, and storage space consumed does not exceed the available space on the target cluster or tape device. To reduce the amount of storage space consumed on a target PowerScale cluster, configure deduplication for the target directories of the replication policies. Although this configuration deduplicates data on the target directory, it does not allow SyncIQ to transfer shadow stores. Deduplication is still performed post-replication using a deduplication job running on the target cluster.

Isilon F810, H5600, and PowerScale nodes

The Isilon F810 and H5600 platforms provide inline compression and deduplication. OneFS 9.0 introduces the PowerScale nodes with inline compression and deduplication.

For source clusters that contain F810, H5600, or PowerScale nodes, during SyncIQ replication, the source data is rehydrated, decompressed, and transferred uncompressed to the target cluster. If the target cluster consists of F810, H5600, or PowerScale nodes, the replication data goes through the same inline compression and deduplication as any other data that is written to these platforms.

16 TiB large file support and SyncIQ implications

OneFS 8.2.2 introduced a feature for large file support, permitting the maximum allowable file size in a PowerScale cluster to increase four-fold, from 4 TiB previously to 16 TiB. For more information about the large file support feature for 16 TiB, see the Dell PowerScale OneFS Best Practices white paper.

Important: It is critical to note the implications of this feature, because after it is enabled, it cannot be disabled.

SyncIQ requires matching file support sizes on the source and target clusters. If large file support is enabled for 16 TiB on a source cluster, all SyncIQ policies only connect with target clusters that also have large file support enabled, as illustrated in Figure 42. Otherwise, SyncIQ policies fail when establishing a connection with a cluster without large file support. The same concept applies for a source cluster without the 16 TiB feature replicating to a target cluster with the 16 TiB feature, causing SyncIQ policies to fail.

These unique requirements apply to new and existing SyncIQ policies. Furthermore, workflow impacts for existing SyncIQ policies are possible, if for any reason the target cluster does not have resources for the 16 TiB feature.

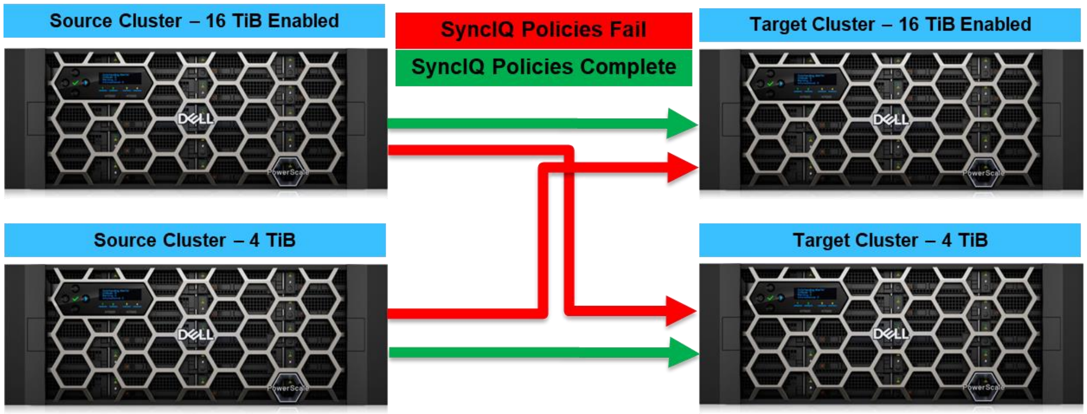


Figure 42. 16 TiB large file support and SyncIQ implications

OneFS version compatibility

Having the same OneFS version and patches on both the source and target cluster is recommended but is not always possible in some environments due to various factors.

Note: As a best practice, upgrade the target cluster before upgrading the source cluster to ensure that no interruptions to replication jobs occur as part of the upgrade process.

OneFS 8.2.2 introduces large file support for 16 TiB files. When enabled, a source or target cluster only establishes connections with clusters that have the 16 TiB feature enabled. For more information about the 16 TiB feature, see 16 TiB large file support and SyncIQ implications.

If the source and target cluster are running different versions of OneFS, to confirm SyncIQ compatibility see the following table.

Table 2. SyncIQ OneFS version compatibility

Source Cluster OneFS Version	Target Cluster OneFS Version		
	7.2.x	8.x and 9.x+	8.2.2 and 9.x+ with 16 TiB feature
7.2.x	✓	✓	X
8.x and 9.0+	✓	✓	X
8.2.2 and 9.0+ with 16 TiB feature	X	X	✓

SmartLock compatibility

Introduction to SmartLock compatibilty

Data replication is a crucial requirement for many WORM protected data sets. OneFS provides WORM functionality through SmartLock, which is compatible with SyncIQ for data replication.

For SyncIQ and SmartLock environments, you must ensure that all node clocks are synchronized. Therefore, having all nodes on the source and target clusters configured with Network Time Protocol (NTP) Peer Mode is recommended. If Compliance SmartLock is required, all source and target nodes must be configured in NTP Peer Mode before the compliance clock is configured.

Replicating data from a source SmartLock directory to a target SmartLock directory, ensures that all metadata related to the retention date and commit status persists on the target. On the contrary, replicating from a SmartLock directory to a non-SmartLock directory causes all metadata relating to the retention date and commit status to be lost.

It is recommended to have to the source and target directory in the same compliance mode. In many environments, it may not be possible to have the source and target directories in the same compliance mode. Depending on the source and target directory types, SyncIQ may be compatible. However, to confirm if the source and target directories are compatible with SmartLock, see the following table.

Table 3. SyncIQ SmartLock source to target compatibility

Source directory type	Target directory type	SyncIQ source-to-target compatibility	Failback allowed
Non-SmartLock	Non-SmartLock	Yes	Yes
Non-SmartLock	Enterprise SmartLock	Yes	Yes, unless files are committed to a WORM state on the target cluster.
Non-SmartLock	Compliance SmartLock	No	No
Enterprise SmartLock	Non-SmartLock	Yes, replication type is allowed. However, retention will not be enforced.	Yes, however, files will not have WORM status.
Enterprise SmartLock	Enterprise SmartLock	Yes	Yes, any newly committed WORM files will be included.
Enterprise SmartLock	Compliance SmartLock	No	No
Compliance SmartLock	Non-WORM	No	No
Compliance SmartLock	Enterprise SmartLock	No	No
Compliance SmartLock	Compliance SmartLock	Yes	Yes, any newly committed WORM files will be included.

Compliance mode

Replicating data with SyncIQ from a source cluster configured for SmartLock compliance directories to a target cluster is only supported if the target cluster is running in SmartLock compliance mode. The source and target directories of the replication policy must be root paths of SmartLock compliance directories on the source and target cluster. Replicating data from a compliance directory to a non-compliance directory is not supported, causing the replication job to fail.

Failover and failback with SmartLock

OneFS 8.0 introduced support for failover and failback functions of Enterprise mode directories. OneFS 8.0.1 introduced support for failover and failback of Compliance mode directories, delivering automated disaster recovery for the financial services SEC-17a4 regulatory compliance. See Table 3 to confirm if failback is supported, depending on the source and target directory types.

SmartLock and SyncIQ security

As a best practice, securing a SmartLock cluster is recommended using either SyncIQ encryption or a pre-shared key. Configuring encryption is preferred. However, for environments where it is not possible, the pre-shared key (PSK) is recommended.

SmartLock Compliance mode clusters do not support SyncIQ PSK. For clusters in SmartLock Compliance mode, upgrading to OneFS 8.2 or later is recommended and configuring SyncIQ encryption. SmartLock Enterprise mode clusters support SyncIQ PSK.

For more information about configuring SyncIQ encryption or a PSK, see SyncIQ security.

Conclusion

SyncIQ implements scale-out asynchronous replication for PowerScale clusters, providing scalable replication performance, easy failover and failback, and dramatically improving recovery objectives. SyncIQ design, combined with tight integration with OneFS, native storage tiering, point-in-time snapshots, retention, and leading backup solutions, makes SyncIQ a powerful, flexible, and easy-to-manage solution for disaster recovery, business continuity, disk-to-disk backup, and remote archive.

Appendix A: Failover and failback steps

Introduction to failover and failback steps

This section provides detailed steps to complete a SyncIQ failover and failback.

CAUTION: Ensure that the steps provided in this section are followed in **sequential order in their entirety**. If the steps in this section are not followed sequentially in their entirety, data could be lost and become unrecoverable.

Assumptions

Note the following assumptions:

- In order to failover to an associated cluster, a SyncIQ policy must exist between the source and target cluster, as explained in Configuring a SyncIQ policy.
- If the policy is configured, it must have successfully run at least once.
- All system configuration is complete on the target cluster, emulating the source cluster's configuration. This includes licensing, access zones, SmartConnect, shares, authentication providers, etc.
- This section does not consider any network or other environmental changes required. During disaster readiness testing, ensure that all other environmental steps are documented and shared with administrators.

Note: As a best practice, configure DNS to require a single forwarding change only. During an outage, this configuration minimizes downtime and simplifies the failover process.

Failover

After a policy is configured and run successfully, a failover may be initiated with the following steps:

1. **If the source cluster is online**, stop all writes affecting the directory path of the replication policy, limiting any new data from being written on the cluster. In large environments it may be difficult to stop all clients from writing data, it may be easier to stop SMB, NFS, and FTP services on the source cluster.

   To stop services on the source cluster, run the following commands:

   ```
   Source-cluster# isi services smb disable
   Source-cluster# isi services nfs disable
   Source-cluster# isi services vsftpd disable
   ```

2. **If the source cluster is online**, ensure that any scheduled policies on the source cluster do not replicate data during the failover. Place the policies in manual mode by running the following command:

   ```
   Source-cluster# isi sync policies modify [Policy Name] –
   schedule “”
   ```

3. **If the source cluster is online**, run the associated policy manually by running the following command:

   ```
   Source-cluster# isi sync jobs start [Policy Name]
   ```

   Ensure that the policy completes before proceeding to the next step.

4. On the target cluster, from the web interface select **Data Protection** > **SyncIQ** > **Local Targets**. From the **Local Targets** tab, scroll to the appropriate policy and select **More** > **Allow Writes**.

   To perform this work from the CLI, run the following command:

   ```
   Target-cluster# isi sync recovery allow-write --policy-
   name=[Policy Name]
   ```

   At this point, the target cluster is now accessible and writable.

   Clients must now be **redirected** to the target cluster to continue accessing the file system. Make any necessary network, DNS, and environmental updates. Depending on the DNS configuration, a single DNS update only changing the forwarding is sufficient.

Failback

When the failover is complete and the source cluster is operational, continue the failback process as follows:

1. On the source cluster, select **Data Protection** > **SyncIQ** > **Policies**. In the **SyncIQ Policies** list, for the associated replication policy, select **More** > **Resync-prep**. Alternatively, from the source cluster CLI, run the following command:

   ```
   Source-cluster# isi sync recovery resync-prep [Policy Name]
   ```

   To check the current status of the resync-prep, with duration, transfer, and throughput, run the following command:

   ```
   Source-cluster# isi sync jobs reports list
   ```

   This action causes SyncIQ to create a mirror policy for the replication policy on the target cluster. The mirror policy is placed under **Data Protection** > **SyncIQ** > **Local Targets** on the target cluster.

   SyncIQ names mirror policies according to the following pattern:

   ```
   <replication-policy-name>_mirror
   ```

2. Before beginning the failback process, prevent clients from accessing the target cluster. In large environments it may be difficult to stop all clients from writing data, it may be easier to stop SMB, NFS, and FTP services on the source cluster.

   To stop services on the target cluster, run the following commands:

   ```
   Target-cluster# isi services smb disable
   Target-cluster# isi services nfs disable
   Target-cluster# isi services vsftpd disable
   ```

3. On the target cluster, click **Data Protection** > **SyncIQ** > **Policies**. In the **SyncIQ Policies** list, for the mirror policy, click **More** > **Start Job**. Alternatively, to start the mirror policy from the CLI, run the following command:

   ```
   Target-cluster# isi sync jobs start --policy-name=[Mirror
   Policy Name]
   ```

   If required, the mirror policy on the target cluster may be modified to specify a schedule for the policy to run.

CAUTION: Before proceeding to the next step, ensure that the mirror policy completes successfully; otherwise, data may be lost and unrecoverable.

4. On the source cluster, click **Data Protection** > **SyncIQ** > **Local Targets**. In the **SyncIQ Local Targets** list, for the mirror policy, select **More** > **Allow Writes**. Alternatively, to perform the allow writes from the CLI, run the following command:

   ```
   Source-cluster# isi sync recovery allow-write –-policy-
   name=[Policy Name]
   ```

5. On the target cluster, click **Data Protection** > **SyncIQ** > **Policies**. For the appropriate mirror policy in the **SyncIQ Policies** list, click **More** > **Resync-prep**. Alternatively, to perform the resync-prep from the CLI, run the following command:

   ```
   Target-cluster# isi sync recovery resync-prep [Policy Name]
   ```

   This places the target cluster back into read-only mode and ensures that the datasets are consistent on both the source and target clusters.

Finalizing the failback

Redirect clients to begin accessing their data on the source cluster. Although not required, it is safe to remove a mirror policy after failback has completed successfully.

Appendix B: SyncIQ encryption with self-signed certificates

Introduction

SyncIQ encryption was introduced in OneFS 8.2. For more information about SyncIQ encryption, see SyncIQ encryption. Configuring SyncIQ encryption with self-signed certificates is only suggested for specific environments that may not have access to a Certificate Authority. Utilizing a Certificate Authority for configuring SyncIQ encryption is the best practice, as explained in Configuring SyncIQ encryption.

Note: The Common Name value used for the server and client certificates/keys must each differ from the Common Name value used for the CA certificate, otherwise, the certificate and key files will not work for servers compiled using OpenSSL. When OpenSSL prompts for the Common Name for each Certificate, you must use different names.

To configure SyncIQ encryption using self-signed certificates, perform the procedures in the following sections.

Generate keys

To generate keys:

1. On the source cluster, generate keys:

   a. `mkdir /ifs/data/[Specify a directory]`

   b. `cd /ifs/data/[New directory from step a]`

   c. `openssl req -newkey rsa:2048 -keyout source_cluster_key.key -x509 -days [Number of days the certificate is valid for] -out source_cluster_cert.pem`

   Record and take note of the passphrase created at this step.

2. On the target cluster, generate keys:

   a. `mkdir /ifs/data/[Specify a directory]`

   b. `cd /ifs/data/[New directory from step a]`

   c. `openssl req -newkey rsa:2048 -keyout target_cluster_key.key -x509 -days [Number of days the certificate is valid for] -out target_cluster_cert.pem`

   Record and take note of the passphrase created at this step.

Import keys and apply SyncIQ settings

To import keys:

1. On the source cluster, import the target cluster’s certificate:

   ```
   scp root@[target cluster IP]:/ifs/data/[Directory specified
   in Generate keys]/target_cluster_cert.pem
   /ifs/data/[Directory specified in Generate keys]/
   ```

2. For the source and target cluster to successfully SSL handshake, add the target cluster’s self-signed certificate to the certificate authority list on the source cluster, ensuring the source cluster trusts the target cluster’s signature. On the source cluster:

```
isi cert auth import ./target_cluster_cert.pem --name
TargetCluster_Self-Signed
```

3. On the source cluster, define the target cluster as a SyncIQ peer:

```
isi sync cert peer import ./target_cluster_cert.pem --
name=[Specify a descriptive certificate name]
```

4. On the source cluster, provide SyncIQ with the source cluster server certificate and private key:

```
isi sync cert server import ./source_cluster_cert.pem
./source_cluster_key.key --name=[Specify a name for the
source server certificate] –set-certificate-key-password
[Passphrase for the private key created in Generate keys,
step 1.c]
```

5. To apply the cluster certificate with SyncIQ, the full certificate ID is required. On the source cluster, retrieve the truncated certificate ID for the server certificate:

   a. `isi sync cert server list`

      Make a note of the appropriate truncated certificate ID, from the `ID` column. On the source cluster, retrieve the full certificate ID, using the truncated certificate ID from step a:

   b. `isi sync cert server view [truncated certificate ID from step a]`

      Make a note of the full certificate ID, from the `ID` field.

6. On the source cluster, apply the full certificate ID from the previous step as the cluster certificate:

```
isi sync settings modify --cluster-certificate-id=[full
certificate ID from the previous step]
```

7. A global option is available, requiring that all incoming and outgoing SyncIQ policies are encrypted.

Note: Running this command affects existing SyncIQ policies that may not have encryption enabled. Only run this command after all existing policies have encryption enabled. Otherwise, existing policies that do not have encryption enabled will fail.

On the source cluster, require encryption globally for all SyncIQ policies:

```
isi sync settings modify --encryption-required=true
```

8. On the target cluster, import the source cluster's certificate:

```
scp root@[source cluster IP]:/ifs/data/[Directory specified
in Generate keys]/source_cluster_cert.pem
/ifs/data/[Directory specified in Generate keys]/
```

9. For the target and source cluster to successfully SSL handshake, add the source cluster's self-signed certificate to the certificate authority list on the target cluster,

ensuring the target cluster trusts the source cluster's signature. On the target cluster:

```
isi cert auth import ./source_cluster_cert.pem --name
SourceCluster_Self-Signed
```

10. On the target cluster, define the source cluster as a SyncIQ peer:

```
isi sync cert peer import ./source_cluster_cert.pem --
name=[Specify a descriptive certificate name]
```

11. On the target cluster, provide SyncIQ with the target server certificate and private key:

```
isi sync cert server import ./target_cluster_cert.pem
./target_cluster_key.key  --name=[Specify a name for the
target server certificate] –set-certificate-key-password
[Passphrase for the private key created in Generate keys,
step 2.c]
```

12. To apply the cluster certificate with SyncIQ, the full certificate ID is required.

    a. On the target cluster, retrieve the truncated certificate ID for the server certificate:

    ```
    isi sync cert server list
    ```

    Make a note of the appropriate truncated certificate ID, from the `ID` column.

    b. On the target cluster, retrieve the full certificate ID, using the truncated certificate ID from step a:

    ```
    isi sync cert server view [truncated certificate ID from
    step a]
    ```

    Make a note of the full certificate ID, from the `ID` field.

13. On the target cluster, apply the full certificate ID from the previous step as the cluster certificate:

```
isi sync settings modify --cluster-certificate-id=[full
certificate ID from the previous step]
```

14. A global option is available, requiring that all incoming and outgoing SyncIQ policies are encrypted.

Note: Running this command affects existing SyncIQ policies that may not have encryption enabled. Only run this command after all existing policies have encryption enabled. Otherwise, existing policies that do not have encryption enabled will fail.

On the target cluster, require encryption globally for all SyncIQ policies:

```
isi sync settings modify --encryption-required=true
```

Create an encrypted SyncIQ policy

To create an encrypted SyncIQ policy:

1. On the source cluster, find the truncated certificate ID of the target cluster, also known as the SyncIQ peer:

a. Run:

```
isi sync certificates peer list
```

Make a note of the appropriate truncated certificate ID, from the `ID` column.

b. On the source cluster, retrieve the full certificate ID, using the truncated certificate ID from step a:

```
isi sync certificates peer view [truncated certificate
ID from step a]
```

Make a note of the full certificate ID, from the `ID` field.

2. On the source cluster, create an encrypted SyncIQ policy, using the following command:

```
isi sync pol create [SyncIQ Policy Name] sync [Source Cluster
Directory] [Target Cluster IP Address] [Target Cluster
Directory] --target-certificate-id=[full certificate ID from
the previous step]
```

Modify an existing SyncIQ policy for encryption

To modify an existing SyncIQ policy for encryption:

1. On the source cluster, find the truncated certificate ID of the target cluster, also known as the SyncIQ peer:

a. Run:

```
isi sync certificates peer list
```

Make a note of the appropriate truncated certificate ID, from the `ID` column.

b. On the source cluster, retrieve the full certificate ID, using the truncated certificate ID from step a:

```
isi sync certificates peer view [truncated certificate
ID from step a]
```

Make a note of the full certificate ID, from the `ID` field.

2. To modify an existing SyncIQ policy for encryption, on the source cluster, run the following command:

```
isi sync policies modify <pol_name> --target-certificate-
id=<full certificate ID from the previous step>
```

Additional SyncIQ information and optional commands

For more information about SyncIQ encryption and optional commands, see SyncIQ encryption.

Appendix C: Configuring cascaded replication

The steps provided in this appendix provide an example of configuring cascaded replication. For this example, the steps configure the implementation in the following figure.

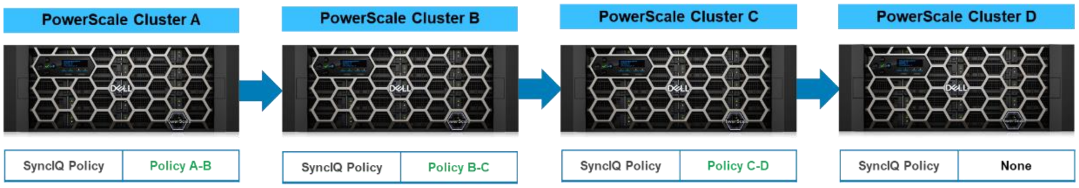


Figure 43. Cascaded replication

The configuration described in this appendix triggers replication from Cluster A only when a snapshot of the specified source directory on Cluster A is taken. For more information about this option, see Whenever a snapshot of the source directory is taken and SnapshotIQ and SyncIQ. To implement the cascaded replication in Figure 43, log in to CLI of each cluster, and perform the following steps:

1. On Cluster A, configure replication from Cluster A to Cluster B based on when a snapshot of the source directory is taken:

   ```
   IsilonClusterA# isi sync policies create --name=pol_a_b sync
   --source-root-path=/ifs/data/cluster1/pol_a_b --target-
   host=[Cluster B IP Address] --target-
   path=/ifs/data/cluster1/pol_a_b --schedule=when-snapshot-
   taken
   ```

   Modify policy `pol_a_b` to specify a snapshot naming pattern and archive snapshots:

   ```
   IsilonClusterA# isi sync policies modify pol_a_b --target-
   snapshot-pattern=SIQ_%{SrcCluster}-%{PolicyName}-%Y-%m-%d_%H-
   %M-%S --target-snapshot-archive=true
   ```

   Confirm policy `pol_a_b` is configured for when a snapshot is taken, the snapshot is archived, and the naming pattern is specified:

   ```
   IsilonClusterA# isi sync policies view pol_a_b
   <Output truncated – Confirm the fields listed below>
   .
   .
   .
   Target Snapshot Archive: Yes
   Target Snapshot Pattern: SIQ_%{SrcCluster}-%{PolicyName}-%Y-
   %m-%d_%H-%M-%S
   Target Snapshot Expiration: Never
   Schedule: when-snapshot-taken
   ```

2. On Cluster B, configure replication from Cluster B to Cluster C based on when a snapshot of the source directory is taken:

```
IsilonClusterB# isi sync policies create --name=pol_b_c sync
--source-root-path=/ifs/data/cluster1/pol_a_b --target-
host=[Cluster C IP Address] --target-
path=/ifs/data/cluster1/pol_a_b --schedule=when-snapshot-
taken
```

Modify policy `pol_b_c` to specify a snapshot naming pattern and archive snapshots:

```
IsilonClusterB# isi sync policies modify pol_b_c --target-
snapshot-pattern=SIQ_%{SrcCluster}-%{PolicyName}-%Y-%m-%d_%H-
%M-%S --target-snapshot-archive=true
```

Confirm policy `pol_b_c` is configured for when a snapshot is taken, the snapshot is archived, and the naming pattern is specified:

```
IsilonClusterB# isi sync policies view pol_b_c
<Output truncated - Confirm the fields listed below>
.
.
.
Target Snapshot Archive: Yes
Target Snapshot Pattern: SIQ_%{SrcCluster}-%{PolicyName}-%Y-
%m-%d_%H-%M-%S
Target Snapshot Expiration: Never
Schedule: when-snapshot-taken
```

3. On Cluster C, configure replication from Cluster C to Cluster D based on when a snapshot of the source directory is taken:

```
IsilonClusterC# isi sync policies create --name=pol_c_d sync --
source-root-path=/ifs/data/cluster1/pol_a_b --target-
host=[Cluster D IP Address] --target-
path=/ifs/data/cluster1/pol_a_b --schedule=when-snapshot-taken
```

Modify policy `pol_c_d` to specify a snapshot naming pattern and archive snapshots:

```
IsilonClusterC# isi sync policies modify pol_c_d --target-
snapshot-pattern=SIQ_%{SrcCluster}-%{PolicyName}-%Y-%m-%d_%H-
%M-%S --target-snapshot-archive=true
```

Confirm policy `pol_c_d` is configured for when a snapshot is taken, the snapshot is archived, and the naming pattern is specified:

```
IsilonClusterC# isi sync policies view pol_c_d
<Output truncated - Confirm the fields listed below>
.
.
.
Target Snapshot Archive: Yes
Target Snapshot Pattern: SIQ_%{SrcCluster}-%{PolicyName}-%Y-
%m-%d_%H-%M-%S
Target Snapshot Expiration: Never
Schedule: when-snapshot-taken
```

Appendix D: Configuring custom replication

The steps provided in this appendix provide an example of configuring a custom replication, combining the cascaded and one-to-many topologies. For this example, the steps configure the implementation in the following figure.

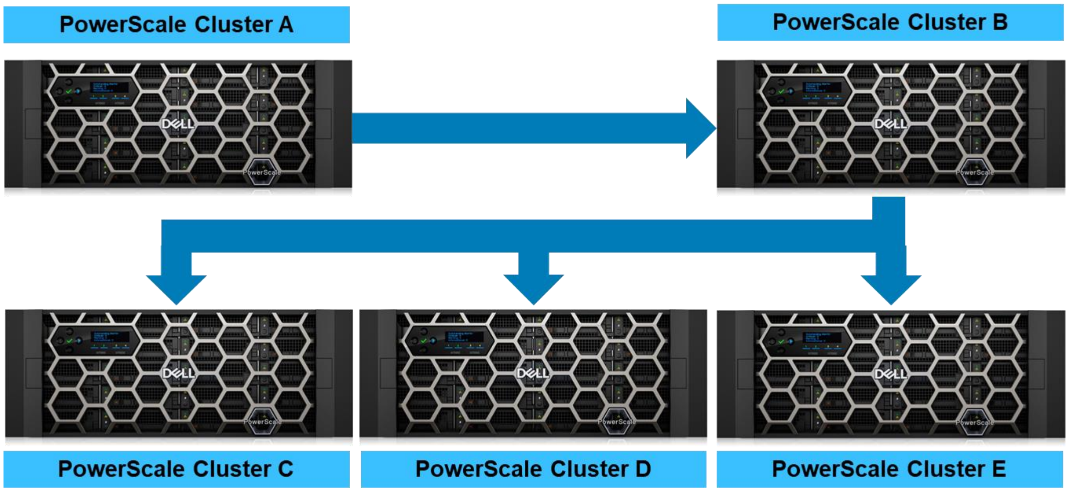


Figure 44. Cascaded and one-to-many replication

The configuration described in this appendix triggers replication from Cluster A only when a snapshot of the specified source directory on Cluster A is taken. For more information about this option, see Whenever a snapshot of the source directory is taken and SnapshotIQ and SyncIQ. To implement the cascaded replication in Figure 44, log in to CLI of each cluster, and perform the following steps:

1. On Cluster A, configure replication from Cluster A to Cluster B based on when a snapshot of the source directory is taken:

   ```
   IsilonClusterA# isi sync policies create --name=pol_a_b sync
   --source-root-path=/ifs/data/pol_a_b --target-host=[Cluster B
   IP Address] --target-path=/ifs/data/pol_a_b --schedule=when-
   snapshot-taken
   ```

   Modify policy `pol_a_b` to specify a snapshot naming pattern and archive snapshots:

   ```
   IsilonClusterA# isi sync policies modify pol_a_b --target-
   snapshot-pattern=SIQ_%{SrcCluster}-%{PolicyName}-%Y-%m-%d_%H-
   %M-%S --target-snapshot-archive=true
   ```

   Confirm policy `pol_a_b` is configured for when a snapshot is taken, the snapshot is archived, and the naming pattern is specified:

   ```
   IsilonClusterA# isi sync policies view pol_a_b
   <Output truncated – Confirm the fields listed below>
   .
   .
   .
   Target Snapshot Archive: Yes
   ```

```
Target Snapshot Pattern: SIQ_%{SrcCluster}-%{PolicyName}-%Y-
%m-%d_%H-%M-%S
Target Snapshot Expiration: Never
Schedule: when-snapshot-taken
```

2. On Cluster B, configure replication from Cluster B to Cluster C based on when a snapshot of the source directory is taken:

   ```
   IsilonClusterB# isi sync policies create --name=pol_b_c sync
   --source-root-path=/ifs/data/pol_a_b --target-host=[Cluster C
   IP Address] --target-path=/ifs/data/pol_a_b --schedule=when-
   snapshot-taken
   ```

   Modify policy `pol_b_c` to specify a snapshot naming pattern and archive snapshots:

   ```
   IsilonClusterB# isi sync policies modify pol_b_c --target-
   snapshot-pattern=SIQ_%{SrcCluster}-%{PolicyName}-%Y-%m-%d_%H-
   %M-%S --target-snapshot-archive=true
   ```

   Confirm policy `pol_b_c` is configured for when a snapshot is taken, the snapshot is archived, and the naming pattern is specified:

   ```
   IsilonClusterB# isi sync policies view pol_b_c
   <Output truncated – Confirm the fields listed below>
   .
   .
   .
   Target Snapshot Archive: Yes
   Target Snapshot Pattern: SIQ_%{SrcCluster}-%{PolicyName}-%Y-
   %m-%d_%H-%M-%S
   Target Snapshot Expiration: Never
   Schedule: when-snapshot-taken
   ```

3. On Cluster B, configure replication from Cluster B to Cluster D based on when a snapshot of the source directory is taken:

   ```
   IsilonClusterB# isi sync policies create --name=pol_b_d sync
   --source-root-path=/ifs/data/pol_a_b --target-host=[Cluster D
   IP Address] --target-path=/ifs/data/pol_a_b --schedule=when-
   snapshot-taken
   ```

   Modify policy `pol_b_d` to specify a snapshot naming pattern and archive snapshots:

   ```
   IsilonClusterB# isi sync policies modify pol_b_d --target-
   snapshot-pattern=SIQ_%{SrcCluster}-%{PolicyName}-%Y-%m-%d_%H-
   %M-%S --target-snapshot-archive=true
   ```

   Confirm policy `pol_b_d` is configured for when a snapshot is taken, the snapshot is archived, and the naming pattern is specified:

   ```
   IsilonClusterB# isi sync policies view pol_b_d
   <Output truncated – Confirm the fields listed below>
   .
   ```

```
.
.
Target Snapshot Archive: Yes
Target Snapshot Pattern: SIQ_%{SrcCluster}-%{PolicyName}-%Y-
%m-%d_%H-%M-%S
Target Snapshot Expiration: Never
Schedule: when-snapshot-taken
```

4. On Cluster B, configure replication from Cluster B to Cluster E based on when a snapshot of the source directory is taken:

```
IsilonClusterB# isi sync policies create --name=pol_b_e sync
--source-root-path=/ifs/data/pol_a_b --target-host=[Cluster E
IP Address] --target-path=/ifs/data/pol_a_b --schedule=when-
snapshot-taken
```

Modify policy `pol_b_e` to specify a snapshot naming pattern and archive snapshots:

```
IsilonClusterB# isi sync policies modify pol_b_e --target-
snapshot-pattern=SIQ_%{SrcCluster}-%{PolicyName}-%Y-%m-%d_%H-
%M-%S --target-snapshot-archive=true
```

Confirm policy `pol_b_e` is configured for when a snapshot is taken, the snapshot is archived, and the naming pattern is specified:

```
IsilonClusterB# isi sync policies view pol_b_e
<Output truncated – Confirm the fields listed below>
.
.
.
Target Snapshot Archive: Yes
Target Snapshot Pattern: SIQ_%{SrcCluster}-%{PolicyName}-%Y-
%m-%d_%H-%M-%S
Target Snapshot Expiration: Never
Schedule: when-snapshot-taken
```

Appendix E: Technical support and resources

Dell.com/support is focused on meeting customer needs with proven services and support.

The Dell Technologies Info Hub provides expertise that helps to ensure customer success on Dell storage platforms.

For more information, see the following related resources:

- PowerScale OneFS Documentation - PowerScale Info Hubs
- PowerScale Network Design Considerations
- Superna Eyeglass
- High Availability and Data Protection with Dell PowerScale Scale-Out NAS
- PowerScale InsightIQ Info Hubs
- PowerScale OneFS CloudPools Administration Guide
- PowerScale CloudPools and ECS Solution Guide
- Dell PowerScale OneFS Best Practices