Dell PowerScale OneFS: Writable Snapshots

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White Paper

Abstract

This white paper describes a storage solution based on Dell PowerScale scale-out NAS that helps organizations to drive down storage management cost and complexity. OneFS provides a simple, scalable file system solution for supporting space-efficient, writable snapshots.

D&LL Technologies

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Executive summary

Overview

The scale and demands of unstructured data continue to grow at a relentless rate, making the need for optimized file-based data storage, and its simplified management, more crucial than ever.

OneFS writable snapshots help customers maximize the long-term value of their critical business data and drive down storage management cost and complexity. This simple, scalable solution offers fast, space-efficient, consistent copies of large datasets on Dell PowerScale NAS storage.

This white paper presents information for managing writable snapshots in a Dell PowerScale cluster. This document does not intend to provide a comprehensive background to the OneFS architecture.

See the OneFS Technical Overview white paper for further details about the OneFS architecture.

Audience

The target audience for this white paper is anyone configuring and managing writable snapshots within a OneFS-powered clustered storage environment. It is assumed that the reader has an understanding and working knowledge of the OneFS components, architecture, commands, and features.

More information about OneFS commands and feature configuration is available in the OneFS Administration Guide.

Revisions

Date	Part number/ revision	Description
November 2022	H18901	Initial release for OneFS 9.3.0
February 2023	H18901.1	Updated for OneFS 9.4.0
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Dell Technologies and the authors of this document welcome your feedback on this document. Contact the Dell Technologies team by email.

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

Overview

Introduction

Writable snapshots are a data storage technique for generating temporary copies of a 'golden' dataset, while eliminating unnecessary duplication of data and the resulting capacity overhead.

Traditional methods of copying entire directory trees are often costly, both in terms of storage consumption and administrative overhead. They often rely on creating writable copies of a directory tree through:

- A simple recursive copy, which is expensive in terms of time and storage.

- Recursively cloning a directory, which is typically a lengthy serial operation.

- Replication (either locally or to a remote target), which is both capacity and time consuming.

Dell PowerScale writable snapshots, available in OneFS 9.3 and later, gives you the ability to create fast, simple, efficient copies of datasets. It enables a writable view of a regular snapshot that is presented at a target directory and is accessible by clients across the full range of supported NAS protocols.

Architecture

OneFS writable snapshots enable the creation and management of a space- and time-efficient, modifiable copy of a regular OneFS snapshot. As such, the snapshots present a writable copy of a source snapshot that is accessible at a directory path within the /ifs namespace. You can access and edit the snapshot through any of the cluster's file and object protocols, including NFS, SMB, and S3.

The writable snapshot architecture provides an overlay to a read-only source snapshot. This overlay allows a cluster administrator to create a lightweight copy of a production dataset using a simple CLI command, and present and use it as a separate writable namespace.
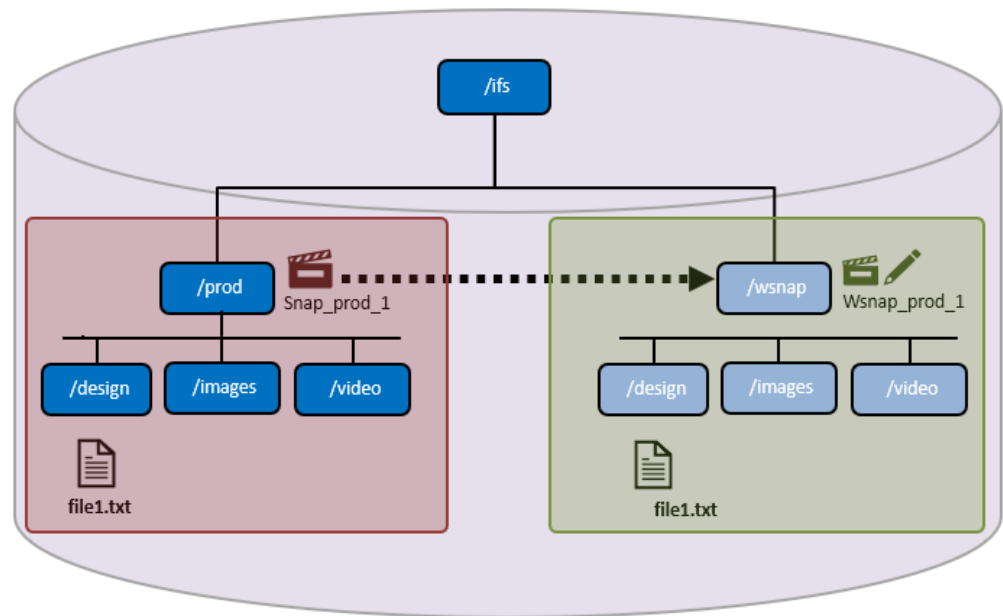
Figure 1.   OneFS writable snapshot architecture

In the scenario above, a SnapshotIQ snapshot (snap_prod_1) is taken of the /ifs/prod directory. The read-only 'snap_prod_1' snapshot is then used as the backing for a writable snapshot created at /ifs/wsnap. This writable snapshot contains the same subdirectory and file structure as the original 'prod' directory, but without the added data capacity footprint.

Internally, OneFS 9.3 and later support a new protection group data structure, 'PG_WSNAP'. This structure provides an overlay that allows unmodified file data to be read directly from the source snapshot, while storing only the changes in the writable snapshot tree.
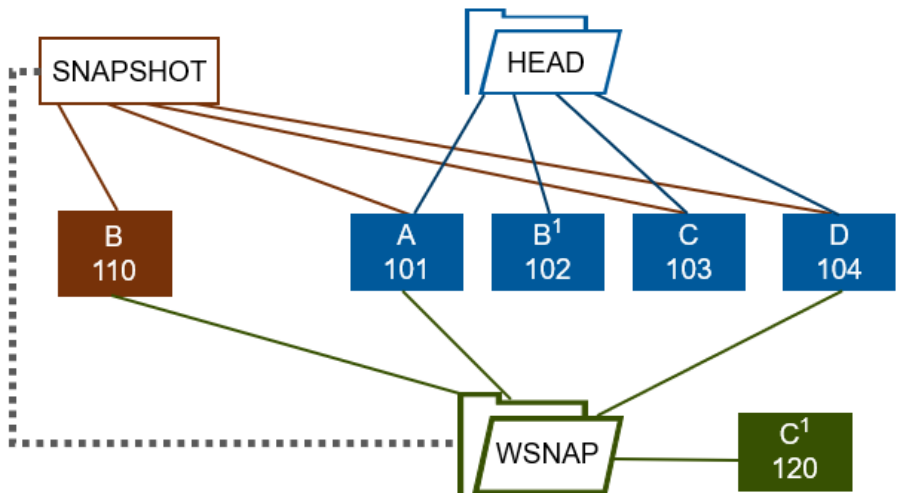
Figure 2.   OneFS writable snapshot block overlay and redirection

In this example, a file (Head) consists of four data blocks, A through D. A read-only snapshot is taken of the directory containing the Head file. This file is then modified through a copy-on-write operation. As a result, the new Head data, B^1, is written to block

102, and the original data block 'B' is copied to a new physical block (110). The snapshot pointer now references block 110 and the new location for the original data 'B', so the snapshot has its own copy of that block.

Next, a writable snapshot is created using the read-only snapshot as its source. This writable snapshot is then modified, so its updated version of block C is stored in its own protection group (PG_WSNAP). A client then issues a read request for the writable snapshot version of the file. This read request is directed, through the read-only snapshot, to the Head versions of blocks A and D, the read-only snapshot version for block B, and the writable snapshot file's own version of block C (C^1 in block 120).

OneFS directory quotas provide the writable snapshots accounting and reporting infrastructure, allowing users to easily view the space utilization of a writable snapshot. Also, IFS domains are also used to bound and manage writable snapshot membership. In OneFS, a domain defines a set of behaviors for a collection of files under a specified directory tree. If a directory has a protection domain applied to it, that domain will also affect all the files and subdirectories under that top-level directory.

When files within a newly created writable snapshot are first accessed, data is read from the source snapshot, populating the files' metadata, in a process known as copy-on-read (CoR). Unmodified data is read from the source snapshot and any changes are stored in the writable snapshot's namespace data structure (PG_WSNAP).

Since a new writable snapshot is not copy-on-read up front, its creation is extremely rapid. As files are accessed later, they are enumerated and begin to consume metadata space.

On accessing a writable snapshot file for the first time, a read is triggered from the source snapshot and the file's data is accessed directly from the read-only snapshot. At this point, the MD5 checksums for both the source file and writable snapshot file are identical. If, for example, the first block of file is overwritten, only that single block is written to the writable snapshot. Then, the remaining unmodified blocks are still read from the source snapshot. At this point, the source and writable snapshot files are now different, so their MD5 checksums will also differ.

Writable snapshots prerequisites

Overview

Before writable snapshots can be created and managed on a cluster, the following prerequisites must be met:

- The cluster is running OneFS 9.3 or later with the upgrade committed.

- SnapshotIQ is licensed across the cluster.

Note: For replication environments using writable snapshots and SyncIQ, all target clusters must be running OneFS 9.3 or later, have SnapshotIQ licensed, and provide sufficient capacity for the full replicated dataset.

Configuring and managing writable snapshots

Overview   By default, up to thirty active writable snapshots can be created and managed on a cluster using the following methods:

- OneFS command-line interface (CLI)

- OneFS RESTful platform API

The CLI subcommands and syntax for writable snapshots are as follows:

```
# isi snapshot writable -h
Description:
    Manage writable snapshots.

Required Privileges:
    ISI_PRIV_SNAPSHOT

Usage:
    isi snapshot writable <action>
        [--timeout <integer>]
        [{--help | -h}]

Actions:
    create    Create a writable snapshot.
    delete    Delete writable snapshots.
    list      View a list of writable snapshots.
    view      View properties of a writable snapshot.

Options:

  Display Options:
    --timeout <integer>
        Number of seconds for a command timeout (specified as 'isi
--timeout NNN
        <command>').
    --help | -h
        Display help for this command.

See 'isi snapshot writable <subcommand> --help' for more
information on a
specific subcommand.
```

Similarly, the platform API primitives can be viewed by browsing the following cluster URL: https://<cluster_IP>:8080/platform/14/snapshot/writable?describe

On creation of a new writable snapshot, all files contained in the snapshot source, or HEAD directory tree, are instantly available for both reading and writing in the target namespace. Once it is no longer required, a writable snapshot can be easily deleted by CLI.

Note: There are no corresponding WebUI controls for configuring writable snapshots.

Creating a writable snapshot

In OneFS 9.3 and later releases, a writable snapshot can easily be created from the CLI with the following command syntax.

Usage:

```
isi snapshot writable create <src-snap> <dst-path>
```

The source snapshot (src-snap) is an existing read-only snapshot (prod1), and the destination path (dst-path) is a new directory within the /ifs namespace (/ifs/test wsnap1). A read-only source snapshot can be generated as follows:

```
# isi snapshot snapshots create prod1 /ifs/test/prod
# isi snapshot snapshots list
ID     Name                            Path
--------------------------------------------------------
7142   prod1                           /ifs/test/prod
```

More information about configuring and managing OneFS SnapshotIQ is available in the document Data Protection with Dell PowerScale SnapshotIQ.

Next, the following command creates a writable snapshot in an 'active' state.

```
# isi snapshot writable create prod1 /ifs/test/wsnap1
# isi snapshot snapshots delete -f prod1
Snapshot "prod1" can't be deleted because it is locked
```

While the OneFS CLI is not explicitly prevented from unlocking a writable snapshot's lock on the backing snapshot, it does provide a clear warning.

```
# isi snap lock view prod1 1
    ID: 1
Comment: Locked/Unlocked by Writable Snapshot(s), do not force
delete lock.
Expires: 2106-02-07T06:28:15
  Count: 1
# isi snap lock delete prod1 1
Are you sure you want to delete snapshot lock 1 from s13590?
(yes/[no]):
```

Be aware that a writable snapshot cannot be created on an existing directory. A new directory path must be specified in the CLI syntax, otherwise the command will fail with the following error:

```
# isi snapshot writable create prod1 /ifs/test/wsnap1
mkdir /ifs/test/wsnap1 failed: File exists
```

Similarly, if an unsupported path is specified, the following error will be returned:

```
# isi snapshot writable create prod1 /isf/test/wsnap2
Error in field(s): dst_path
```

```
Field: dst_path has error: The value: /isf/test/wsnap2 does not
match the regular expression: ^/ifs$|^/ifs/ Input validation
failed.
```

A writable snapshot also cannot be created from a source snapshot of the /ifs root directory, and will fail with the following error:

```
# isi snapshot writable create s1476 /ifs/test/ifs-wsnap
Cannot create writable snapshot from a /ifs snapshot: Operation
not supported
```

OneFS 9.3 and later releases do not support scheduled or automated writable snapshot creation.

Deleting a writable snapshot

When it comes to deleting a writable snapshot, OneFS uses the job engine's TreeDelete job under the hood to unlink all the contents. As such, running the 'isi snapshots writable delete' CLI command automatically queues a TreeDelete instance. The job engine runs this instance asynchronously to remove and clean up a writable snapshot's namespace and contents. However, be aware that the TreeDelete job execution, and hence the data deletion, is not instantaneous. Instead, the writable snapshot's directories and files are moved under a temporary '*.deleted' directory. For example:

```
# isi snapshot writable create prod1 /ifs/test/wsnap2
# isi snap writable delete /ifs/test/wsnap2
Are you sure? (yes/[no]): yes
# ls /ifs/test
prod                        wsnap2.51dc245eb.deleted
wsnap1
```

Next, this temporary directory is removed in a non-synchronous operation. If the TreeDelete job fails for some reason, the writable snapshot can be deleted using its renamed path. For example:

```
# isi snap writable delete /ifs/test/wsnap2.51dc245eb.deleted
```

Note: Deleting a writable snapshot removes the lock on the backing read-only snapshot so it can also be deleted, if required. It can be deleted if there are no other active writable snapshots based off that read-only snapshot.

The deletion of writable snapshots in OneFS 9.3 and later is a manual process. There is no provision for automated, policy-driven control such as the ability to set a writable snapshot expiry date, or a bulk snapshot deletion mechanism.

Monitoring and reporting

Overview

In general, the 'isi writable snapshots' CLI syntax looks and feels similar to regular, read-only snapshots under OneFS. The currently available writable snapshots on a cluster can be easily viewed from the CLI with the 'isi snapshot writable list' command. For example:

```
# isi snapshot writable list
Path                Src Path          Src Snapshot
```

```
------------------------------------------------
/ifs/test/wsnap1  /ifs/test/prod  prod1
/ifs/test/wsnap2  /ifs/test/snap2 s73736
------------------------------------------------
```

The properties of a particular writable snapshot, including both its logical and physical size, can be viewed using the 'isi snapshot writable view' CLI command. For example:

```
# isi snapshot writable view /ifs/test/wsnap1
         Path: /ifs/test/wsnap1
     Src Path: /ifs/test/prod
 Src Snapshot: s73735
      Created: 2021-06-11T19:10:25
 Logical Size: 100.00
Physical Size: 32.00k
        State: active
```

OneFS SmartQuotas provides the capacity resource accounting for writable snapshots. The physical, logical, and application logical-space usage is retrieved from a directory quota on the writable snapshot's root. This usage can be viewed directly from the OneFS CLI as follows:

```
# isi quota quotas list
Type       AppliesTo  Path             Snap  Hard  Soft  Adv  Used  Reduction  Efficiency
------------------------------------------------------------------------------------------
directory DEFAULT     /ifs/test/wsnap1 No    -     -     -    76.00 -          0.00 : 1
------------------------------------------------------------------------------------------
```

Or from the OneFS WebUI by going to File system > SmartQuotas > Quotas and usage:
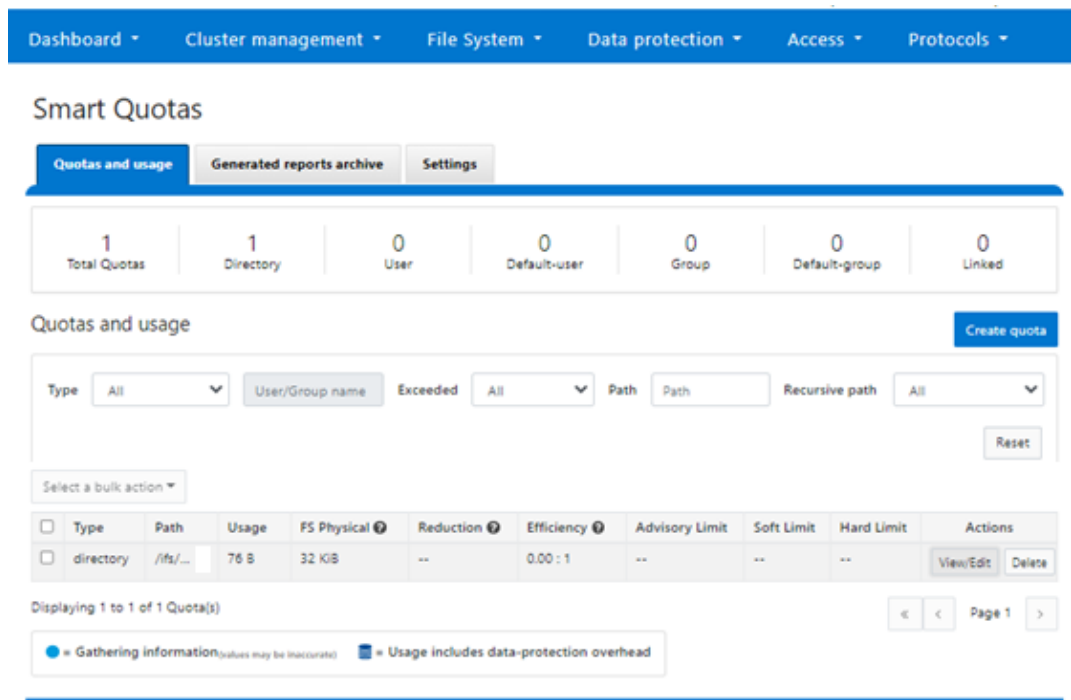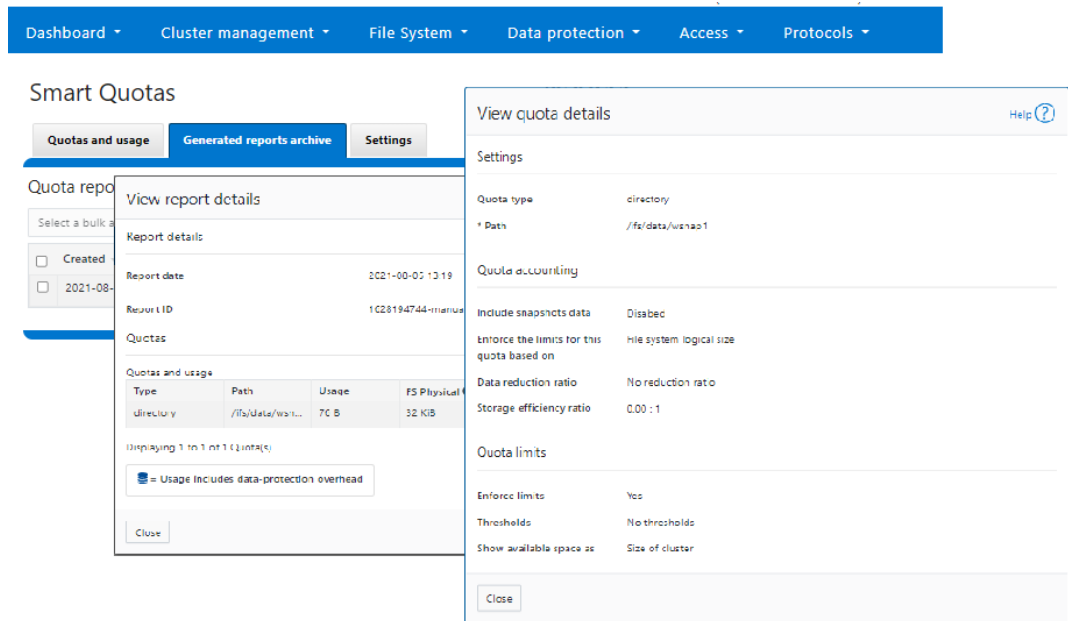

Figure 3.   OneFS SmartQuotas WebUI usage dashboard

Verifying space efficiency on a writable snapshot

For more detail, the 'isi quota quotas view' CLI command provides a thorough appraisal of a writable snapshot's directory quota domain. This information includes physical, logical, and storage efficiency metrics plus a file count. For example:

```
# isi quota quotas view /ifs/test/wsnap1 directory
                        Path: /ifs/test/wsnap1
                        Type: directory
                   Snapshots: No
                    Enforced: Yes
                   Container: No
                      Linked: No
                       Usage
                          Files: 10
       Physical(With Overhead): 32.00k
     FSPhysical(Deduplicated): 32.00k
       FSLogical(W/O Overhead): 76.00
     AppLogical(ApparentSize): 0.00
                ShadowLogical: -
                 PhysicalData: 0.00
                   Protection: 0.00
      Reduction(Logical/Data): None : 1
Efficiency(Logical/Physical): 0.00 : 1
                         Over: -
                Thresholds On: fslogicalsize
               ReadyToEnforce: Yes
                   Thresholds
              Hard Threshold: -
               Hard Exceeded: No
          Hard Last Exceeded: -
                     Advisory: -
  Advisory Threshold Percentage: -
            Advisory Exceeded: No
       Advisory Last Exceeded: -
               Soft Threshold: -
     Soft Threshold Percentage: -
                Soft Exceeded: No
           Soft Last Exceeded: -
                   Soft Grace: -
```

This information is also available from the OneFS WebUI by going to **File system** > **SmartQuotas** > **Generated reports archive** > **View report details**. For example:

Figure 4.   OneFS SmartQuotas WebUI usage report

Also, the 'isi get' CLI command can be used to inspect the efficiency of individual writable snapshot files. First, run the following command syntax on the chosen file in the source snapshot path (in this case /ifs/test/source).

Note: In the example below, the source file, /ifs//test/prod/testfile1, is reported as 147 MB in size and occupying 18019 physical blocks:

```
# isi get -D /ifs/test/prod/testfile1.zip
POLICY    W   LEVEL PERFORMANCE COAL   ENCODING        FILE                   IADDRS
default      16+2/2 concurrency on     UTF-8            testfile1.txt
<1,9,92028928:8192>
*************************************************
* IFS inode: [ 1,9,1054720:512 ]
*************************************************
*
*   Inode Version:      8
*   Dir Version:        2
*   Inode Revision:     145
*   Inode Mirror Count: 1
*   Recovered Flag:     0
*   Restripe State:     0
*   Link Count:         1
*   Size:               147451414
*   Mode:               0100700
*   Flags:              0x110000e0
*   SmartLinked:        False
*   Physical Blocks:    18019
```

However, when running the 'isi get' CLI command on the same file within the writable snapshot tree (/ifs/test/wsnap1/testfile1), the writable, space-efficient copy now only consumes five physical blocks, as compared with 18019 blocks in the original file:

```
# isi get -D /ifs/test/wsnap1/testfile1.zip
POLICY   W   LEVEL PERFORMANCE COAL  ENCODING      FILE              IADDRS
default     16+2/2 concurrency on    UTF-8        testfile1.txt
<1,9,92028928:8192>
*************************************************
* IFS inode: [ 1,9,1054720:512 ]
*************************************************
*
*   Inode Version:       8
*   Dir Version:         2
*   Inode Revision:      145
*   Inode Mirror Count:  1
*   Recovered Flag:      0
*   Restripe State:      0
*   Link Count:          1
*   Size:                147451414
*   Mode:                0100700
*   Flags:               0x110000e0
*   SmartLinked:         False
*   Physical Blocks:     5
```

More information about OneFS commands and feature configuration is available in the OneFS Administration Guide.

Writable snapshots and OneFS domains

Overview

Writable snapshots use the OneFS policy domain manager, or PDM, for domain membership checking and verification. For each writable snapshot, a 'WSnap' domain is created on the target directory. The 'isi_pdm' CLI utility can be used to report on the writable snapshot domain for a particular directory.

```
# isi_pdm -v domains list --patron Wsnap /ifs/test/wsnap1
Domain          Patron          Path
b.0700          WSnap           /ifs/test/wsnap1
```

Other details of the backing domain can also be displayed with the following CLI syntax:

```
# isi_pdm -v domains read b.0700
('b.0700',):
{ version=1 state=ACTIVE ro store=(type=RO SNAPSHOT, ros_snapid=650,
ros_root=5:23ec:0011)ros_lockid=1) }
```

Domain association does have some ramifications for writable snapshots in OneFS 9.3 and later, and there are a couple of notable caveats. For example, files within the writable snapshot domain cannot be renamed outside of the writable snapshot to allow the file system to track files in a simple manner.

```
# mv /ifs/test/wsnap1/file1 /ifs/test
```

```
mv: rename file1 to /ifs/test/file1: Operation not permitted
```

Nested writable snapshots

Overview The nesting of writable snapshots is not permitted in OneFS 9.3 and later releases. An attempt to create a writable snapshot on a subdirectory under an existing writable snapshot will fail with the following CLI command warning output:

```
# isi snapshot writable create prod1 /ifs/test/wsnap1/wsnap1-2
Writable snapshot:/ifs/test/wsnap1 nested below another writable
snapshot: Operation not supported
```

Symbolic and hard links with writable snapshots

Overview When a writable snapshot is created, any existing hard links and symbolic links (symlinks) that reference files within the snapshot's namespace will continue to work as expected. However, existing hard links with a file external to the snapshot's domain will disappear from the writable snapshot, including the link count.

Link type	Supported	Details
Existing external hard link	No	Old external hard links will fail.
Existing internal hard link	Yes	Existing hard links within the snapshot domain will work as expected.
External hard link	No	New external hard links will fail.
New internal hard link	Yes	Existing hard links will work as expected.
External symbolic link	Yes	External symbolic links will work as expected.
Internal symbolic link	Yes	Internal symbolic links will work as expected.

Be aware that any attempt to create a hard link to another file outside of the writable snapshot boundary will fail.

```
# ln /ifs/test/file1 /ifs/test/wsnap1/file1
ln: /ifs/test/wsnap1/file1: Operation not permitted
```

However, symbolic links will work as expected. OneFS hard-link and symbolic-link actions and expectations regarding writable snapshots are illustrated in the following diagram:
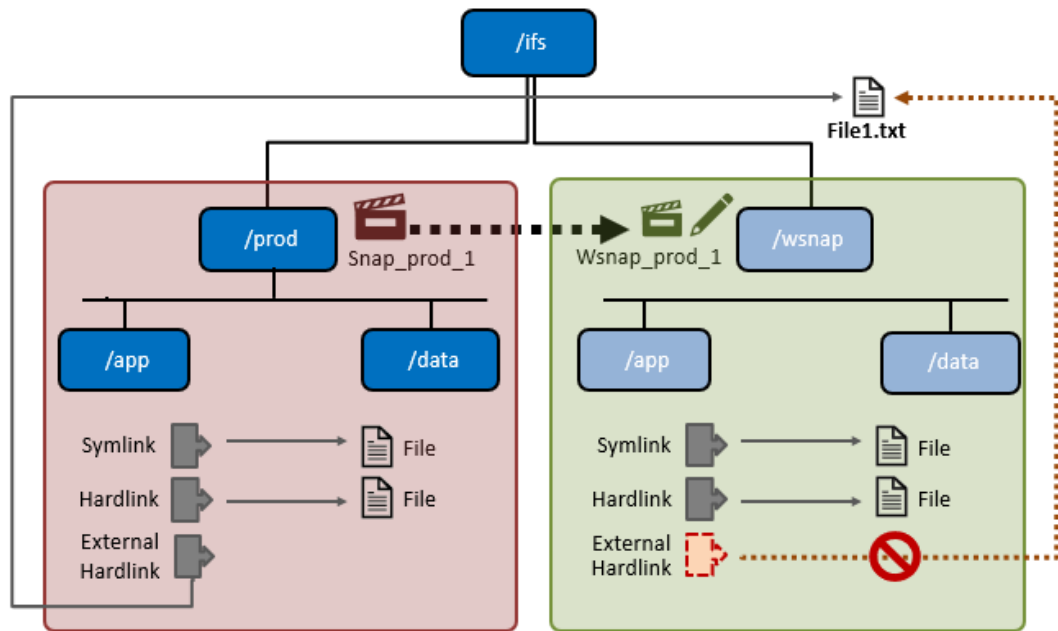
Figure 5.   Writable snapshots, hard links, and symbolic links

Licensing requirements

Overview

While the writable snapshots feature does not have its own specific license, its use is governed by the OneFS SnapshotIQ data service. As such, in addition to a general OneFS license, SnapshotIQ must be licensed across all the nodes in order to use writable snapshots on a PowerScale cluster running OneFS 9.3 or later. Also, the 'ISI_PRIV_SNAPSHOT' role-based administration privilege is required on any cluster administration account that will create and manage writable snapshots. For example:

```
# isi auth roles view SystemAdmin | grep -i snap
            ID: ISI_PRIV_SNAPSHOT
```

More information about OneFS roles-based administration and access control is available in the document Access Control Lists on Dell PowerScale OneFS.

Writable snapshots performance

Overview

In general, writable snapshots file access is marginally less performant compared to the source files, or head files, since an additional level of indirection is required to access the data blocks. This case is true for older source snapshots, where a lengthy read-chain can require considerable 'ditto' block resolution. This result occurs when parts a file no longer resides in the source snapshot, and the block tree of the inode on the snapshot does not point to a real data block. Instead it has a flag marking it as a 'ditto block'. A ditto block indicates that the data is the same as the next newer version of the file. Therefore, OneFS automatically looks ahead to find the more recent version of the block. If there are large numbers (such as hundreds or thousands) of snapshots of the same unchanged file, reading from the oldest snapshot can have a considerable impact on latency.
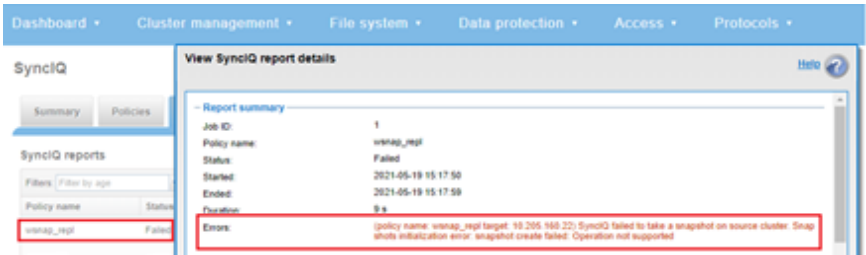
Performance attribute	Details
Large Directories	Since a writable snapshot performs a copy-on-read to populate file metadata on first access, the initial access of a large directory (containing millions of files, for example) that tries to enumerate its contents will be relatively slow because the writable snapshot has to iteratively populate the metadata. This scenario is applicable to namespace discovery operations such as 'find' and 'ls', unlinks and renames, plus other operations working on large directories. However, any subsequent access of the directory or its contents will be fast since file metadata will already be present and there will be no copy-on-read overhead. The unlink_copy_batch and readdir_copy_batch parameters under the sysctl 'efs.wsnap' control of the size of batch metadata copy operations. These parameters can be helpful for tuning the number of iterative metadata copy-on-reads for datasets containing large directories. However, these sysctls should only be modified under the direct supervision of Dell technical support.
Writable snapshot metadata read/write	Initial read and write operations will perform a copy-on-read and will therefore be marginally slower compared to the head. However, once the copy-on-read has been performed for the LINs, the performance of read/write operations will be nearly equivalent to head.
Writable snapshot data read/write	In general, writable snapshot data reads and writes will be slightly slower compared to head.

Multiple writable snapshots of single source	The performance of each subsequent writable snapshot created from the same source read-only snapshot will be the same as that of the first, up to the default recommended limit of 30 writable snapshots. This is governed by the 'max_active_wsnpas' sysctl.
	
	`# sysctl efs.wsnap.max_active_wsnaps`
	`efs.wsnap.max_active_wsnaps: 30`
	
	The 'max_active_wsnaps' sysctl can be configured up to a maximum of 2048 writable snapshots per cluster. However, changing this sysctl from its default value of 30 is discouraged in OneFS 9.3 and later.

Writable snapshots and SmartPools tiering	Unmodified file data in a writable snapshot is read directly from the source snapshot. If the source is stored on a lower performance tier than the writable snapshot's directory structure, this placement will negatively impact the writable snapshot's latency.
Storage Impact	The storage capacity consumption of a writable snapshot is proportional to the number of writes, truncate, or similar operations it receives. This result occurs because only the changed blocks relative to its source snapshot are stored. The metadata overhead will grow linearly as a result of copy-on-reads with each new writable snapshot that is created and accessed.
Snapshot Deletes	Writable snapshot deletes are de-staged and performed out of band by the TreeDelete job. As such, the performance impact should be minimal, although the actual delete of the data is not instantaneous. Also, the TreeDelete job has a path to avoid copy-on-writing any files within a writable snapshot that have yet to have been enumerated.

Writable snapshots and OneFS data services

Overview   Writable snapshots in OneFS 9.3 and later releases co-exist with most other OneFS data services, although there are several caveats to bear in mind. The following table describes the integration, influence, and compatibility between writable snapshots and the various OneFS data services.

Table 1.   OneFS writable snapshots and data services integration

OneFS feature	Detail
SyncIQ	SyncIQ is unable to replicate the data within a writable snapshot in OneFS 9.3 and later. Specifically:

Replication condition	Description
Writable snapshot as SyncIQ source	Replication fails because snapshot creation on the source writable snapshot is not permitted.
Writable snapshot as SyncIQ target	Replication job fails as snapshot creation on the target writable snapshot is not supported.
Writable snapshot one or more levels below in SyncIQ source	Data under a writable snapshot will not get replicated to the target cluster. However, the rest of the source will get replicated as expected
Writable snapshot one or more levels below in SyncIQ target	If the state of a writable snapshot is ACTIVE, the writable snapshot root directory will not get deleted from the target, so replication will fail.

Attempts to replicate the files within a writable snapshot with fail with the following SyncIQ job error:

OneFS cannot create writable snapshots based on SyncIQ-generated snapshots, since SyncIQ does not allow its snapshots to be locked. This scenario includes all read-only snapshots with a 'SIQ-*' naming prefix. Any attempts to use snapshots with an SIQ* prefix will fail with the following error:

```
# isi snapshot writable create SIQ-4b9c0e85e99e4bcfbcf2cf30a3381117-latest
/ifs/rwsnap
Source SnapID(62356) is a SyncIQ related snapshot: Invalid argument
```

OneFS feature	Detail

SnapshotIQ	Taking a SnapshotIQ read-only snapshot of a writable snapshot is not permitted and will fail with the following error message:
	
	`# isi snapshot snapshots create /ifs/wsnap2`
	`snapshot create failed: Operation not supported`
	
	Similarly, creating a writable snapshot of an existing writable snapshot is also not supported.
	
	Writable snapshots cannot be nested in the namespace under other writable snapshots. Such operations will return ENOTSUP.
	
	Only IFS domains-based snapshots are permitted as the source of a writable snapshot. Any snapshots taken on a cluster prior to OneFS 8.2 cannot be used as the source for a writable snapshot.
	
	Snapshot aliases cannot be used as the source of a writable snapshot, even if using the alias target ID instead of the alias target name. The full name of the snapshot must be specified.
	
	`# isi snapshot snapshots view snapalias1`
	`             ID: 134340`
	`           Name: snapalias1`
	`           Path: /ifs/test/rwsnap2`
	`      Has Locks: Yes`
	`       Schedule: -`
	`  Alias Target ID: 106976`
	`Alias Target Name: s106976`
	`        Created: 2021-08-16T22:18:40`
	`        Expires: -`
	`           Size: 90.00k`
	`    Shadow Bytes: 0.00`
	`      % Reserve: 0.00%`
	`    % Filesystem: 0.00%`
	`          State: active`
	`# isi snapshot writable create 134340 /ifs/testwsnap1`
	`Source SnapID(134340) is an alias: Operation not supported`
	
	The creation of SnapRevert domain is not permitted at or above a writable snapshot. Similarly, the creation of a writable snapshot inside a directory with a SnapRevert domain is not supported. Such operations will return ENOTSUP.
	
	The SnapshotDelete job has no interaction with writable snapshots. Instead, the TreeDelete job handles writable snapshot deletion.

| OneFS feature	Detail

SmartLock	A SmartLock WORM domain cannot be created at or above a writable snapshot.
	
	``# isi snapshot writable list
	Path Src Path Src Snapshot
	-- 	
	/ifs/test/rw-head /ifs/test/head1 s159776
	-- 	
	Total: 1
	# isi worm domain create -d forever /ifs/test/rw-head/worm
	Are you sure? (yes/[no]): yes
	Failed to enable SmartLock: Operation not supported```
	
	Creating a writable snapshot inside a directory with a WORM domain is not permitted.
	
	``# isi worm domains list
	ID Path Type
	-------------------------------- 	
	2228992 /ifs/test/worm enterprise
	-------------------------------- 	
	Total: 1
	# isi snapshot writable create s32106 /ifs/test/worm/wsnap
	Writable Snapshot cannot be nested under WORM domain 22.0300: Operation not supported```

SED Encryption	Clusters using data encryption with SED drives are fully compatible with writable snapshots.
SmartQuotas	Writable snapshots capacity reporting uses directory quotas to track both physical and logical space utilization. This same information is reported using the `isi quota` CLI command.
SmartPools	Writable snapshots co-exist with SmartPools tiering, and configuring SmartPools above writable snapshots is supported. In OneFS 9.3 and later, SmartPools file-pool tiering policies will not apply to a writable snapshot path. Instead, the writable snapshot data will follow the tiering policies which apply to the source of the writable snapshot. SmartPools is frequently used to house snapshots on a slower tier of storage. In this case, the performance of a writable snapshot will likely be negatively impacted.
CloudPools	In OneFS 9.3 and later, CloudPools is incompatible with writable snapshots. CloudPools on a writable snapshot destination is not supported.
Non-disruptive Upgrade	Writable snapshot support is introduced in OneFS 9.3, and writable snapshot functionality is enabled after committing an upgrade to OneFS 9.3 and later releases. Non-disruptive upgrade to OneFS 9.3 and to later releases is fully supported.
File Clones	Cloning of a file within a writable snapshot (cp -c) is not permitted and will fail with the following error: ```# isi snapshot writable list Path Src Path Src Snapshot -- /ifs/wsnap1 /ifs/test1 s32106 -- Total: 31 # cp -c /ifs/wsnap1/file1 /ifs/wsnap1/file1.clone cp: file1.clone: cannot clone from 1:83e1:002b::HEAD to 2:705c:0053: Invalid argument```

OneFS feature	Detail
In-line Data Reduction	While OneFS in-line compression works with writable snapshots data, deduplication is not supported, and existing files under writable snapshots will be ignored by in-line deduplication. However, inline deduplication can occur on any new files created fresh on the writable snapshot.
SmartDedupe	Deduplication of writable snapshot data is not supported. SmartDedupe will ignore the files under writable snapshots.
Small File Storage Efficiency (SFSE)	Small file storage efficiency file packing is not supported by writable snapshots and the files under a writable snapshot will be ignored by SFSE. There is also no support for data inode inlining within a writable snapshot domain.
Job Engine	The job engine and restriping jobs support writable snapshots and, in general, most jobs can be run from inside a writable snapshot's path. However: JE jobs involving tree-walks will not perform copy-on-read for LINs under writable snapshots. The PermissionsRepair job is unable to fix the files under a writable snapshot which have yet to be copy-on-read. Before you start the PermissionsRepair job, run the `find` CLI command (which searches for files in directory hierarchy) on the writable snapshot's root directory to populate the writable snapshot's namespace. The TreeDelete job works for subdirectories under writable snapshot. TreeDelete, run on or above a writable snapshot, will not remove the root, or head, directory of the writable snapshot (unless scheduled through writable snapshot library). The ChangeList, FileSystemAnalyze, and IndexUpdate jobs are unable to see files in a writable snapshot. As such, the FilePolicy job, which relies on index update, cannot manage files in writable snapshot.

Access Zones	Writable snapshots work as expected with OneFS access zones.
	
	<pre># isi zone zones list
	Name Path
	----------------------- 	
	System /ifs
	zone1 /ifs/data/zone1
	zone2 /ifs/data/zone2
	----------------------- 	
	Total: 2
	# isi snapshot snapshots list
	118224 s118224 /ifs/data/zone1
	# isi snapshot writable create s118224 /ifs/data/zone2/wsnap1
	# isi snapshot writable list
	Path Src Path Src Snapshot
	--- 	
	/ifs/data/zone2/wsnap1 /ifs/data/zone1 s118224
	--- 	
	Total: 1</pre>

InsightIQ and DataIQ	InsightIQ and DataIQ both support and accurately report on writable snapshots as expected.
NDMP	Writable snapshots in OneFS 9.3 and later are positioned for use as temporary data repositories which are discarded after testing, and are not intended to be archived or backed up. NDMP is incompatible with writable snapshots. Since NDMP uses read-only snapshots for checkpointing, it is unable to backup writable snapshot data.

Note: Most of the abovementioned services each require a product license or specific hardware. Licensed data services are not enabled, configured, and activated by default on a cluster.

Writable snapshots and data replication

Overview   A common use case for writable snapshots is in disaster recovery testing. For DR purposes, an enterprise typically has two PowerScale clusters configured in a source/target SyncIQ replication relationship. Many organizations have a requirement to conduct periodic DR tests to verify the functionality of their processes and tools in the event of a business continuity interruption or disaster recovery event.
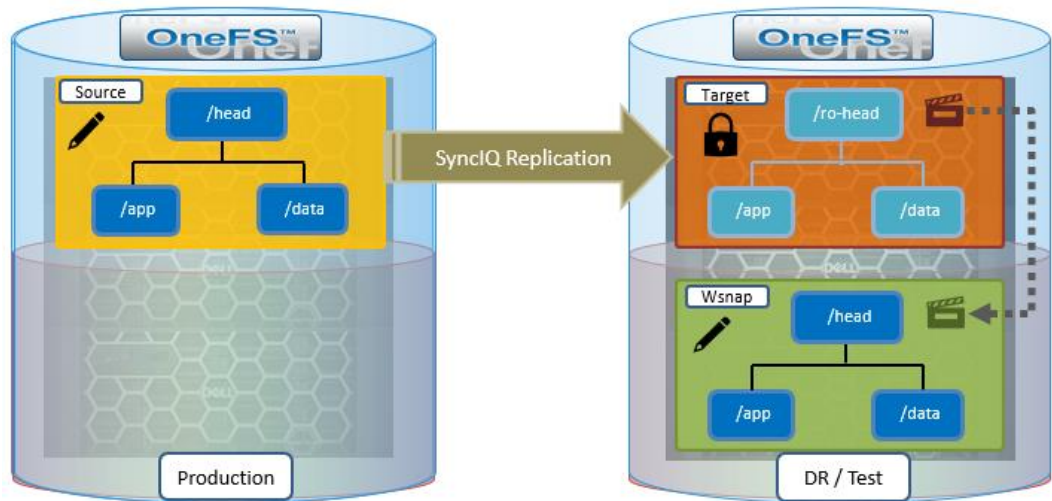
Figure 6.   Writable snapshots and SyncIQ DR test workflow

Given the writable snapshots compatibility with SyncIQ caveats described in the previous table, a writable snapshot of a production dataset replicated to a target DR cluster can be created as follows:

1. On the source cluster, create a SyncIQ policy to replicate the source directory (/ifs/test/head) to the target cluster:

```
# isi sync policies create --name=ro-head sync --source-
rootpath=/ifs/prod/head --target-host=10.224.127.5 --
targetpath=/ifs/test/ro-head

# isi sync policies list
Name   Path              Action  Enabled  Target
---------------------------------------------------
ro-head /ifs/prod/head  sync     Yes      10.224.127.5
---------------------------------------------------
Total: 1
```

2. Run the SyncIQ policy to replicate the source directory to /ifs/test/ro-head on the target cluster:

```
# isi sync jobs start ro-head --source-snapshot s14

# isi sync jobs list
Policy Name   ID    State    Action   Duration
----------------------------------------------
ro-head        1     running run      22s
----------------------------------------------
Total: 1

# isi sync jobs view ro-head
Policy Name: ro-head
        ID: 1
     State: running
    Action: run
      Duration: 47s
    Start Time: 2021-06-22T20:30:53

   Target:
```

3. Take a read-only snapshot of the replicated dataset on the target cluster:

```
# isi snapshot snapshots create /ifs/test/ro-head

# isi snapshot snapshots list
ID    Name                                     Path
-------------------------------------------------------------------
2     SIQ_HAL_ro-head_2021-07-22_20-23-initial /ifs/test/ro-head
3     SIQ_HAL_ro-head                          /ifs/test/ro-head
5     SIQ_HAL_ro-head_2021-07-22_20-25         /ifs/test/ro-head
8     SIQ-Failover-ro-head-2021-07-22_20-26-17 /ifs/test/ro-head
9     s106976                                  /ifs/test/ro-head
-------------------------------------------------------------------
```

4. Using the (non SIQ_*) snapshot of the replicated dataset above as the source, create a writable snapshot on the target cluster at /ifs/test/head:

```
# isi snapshot writable create s106976 /ifs/test/head
```

5. Confirm the writable snapshot has been created on the target cluster:

```
# isi snapshot writable list
Path             Src Path         Src Snapshot
----------------------------------------------------------------------
/ifs/test/head  /ifs/test/ro-head  s106976
----------------------------------------------------------------------
Total: 1

# du -sh /ifs/test/ro-head
 21M    /ifs/test/ro-head
```

6. Export or share the writable snapshot data under /ifs/test/head on the target cluster using the protocol or protocols of choice. Mount the export or share on the client systems and perform DR testing and verification as appropriate.
7. When DR testing is complete, delete the writable snapshot on the target cluster:

```
# isi snapshot writable delete /ifs/test/head
```

Writable snapshots cannot be refreshed from a newer read-only source snapshot. A new writable snapshot would need to be created using the newer snapshot source in order to reflect and subsequent updates to the production dataset on the target cluster.

More information about OneFS SyncIQ replication configuration and management is available in the *SyncIQ best practices guide.*

Writable snapshots workflows

Overview

OneFS writable snapshots are used to create and manage space-efficient copies of production environments, which can be beneficial for the following workflow scenarios:

Workflow	Description
Development and test	Writable snapshots allow test and development personnel to work with real workloads and use all data services that are associated with production storage resources without interfering with production.
Parallel processing	Parallel processing workloads that span multiple servers can be configured to use multiple writable snapshots of a single production dataset to accelerate time to outcomes and results.
System deployment	Writable snapshots can be used to build and deploy templates for identical or near-identical environments. For example, take a read-only snapshot of a test template or golden image, and create writable snapshots of it as needed for predictable testing.
Disaster recovery testing	Writable snapshots can be used to quickly create clones of production datasets. This action allows disaster recovery procedures to be routinely tested on identical, space-efficient copies of production data. A growing number of enterprises are using Bubble or Isolate and Test networks where the DR test is conducted inside a replicated environment, so it closely resembles production.

Best practices and considerations

Overview

Recommended best practices for writable snapshots on OneFS include:

- Not exceeding the default OneFS limit of 30 active writable snapshots per cluster. If the max_active_wsnaps limit is increased for some reason, do not attempt to delete more than 30 writable snapshots at a time.

- The writable snapshots feature can be enabled and disabled using a sysctl. However, disabling it will not affect any existing writable snapshots.

- In OneFS 9.3 and later, the primary focus of writable snapshots is for DR testing. Although writable snapshots cannot use SyncIQ-generated snapshots, a separate read-only snapshot can be taken of the replicated dataset and used as a writable snapshot source.

- Writable snapshots cannot be refreshed from a newer read-only source snapshot. However, a new writable snapshot can be created from a more current source snapshot in order to include subsequent updates to the replicated production dataset.

- While the contents of a writable snapshot will retain the permissions they had in the source, ensure the parent directory tree has appropriate access permissions for the users of the writable snapshot.

- Writable snapshots are highly space efficient, however the savings are strictly in terms of file data. Metadata will be consumed in full for each file and directory in a snapshot. So, for large sizes and quantities of writable snapshots, inode consumption should be considered, especially for metadata read and metadata write SSD strategies.

- Writable snapshots do not support OneFS deduplication or small file storage efficiency.

- Writable snapshot configuration and management is performed solely using the CLI or platform API, and there are no corresponding WebUI controls available in OneFS 9.3 and later.

- If automation of the writable snapshot life cycle is required, it can be scripted using the OneFS PlatformAPI. However, in OneFS 9.3 and later, there is no support for policy-driven writable snapshot creation. Similarly, writable snapshots cannot currently be batch deleted and can only be manually deleted one at a time.

- The 'ISI_PRIV_SNAPSHOT' roles-based administration privilege is required for configuring and managing writable snapshots and, as such, their creation and deletion can be authorized and audited based on 'isi auth' roles.

- The recommended practice is to quiesce any client sessions to a writable snapshot before its deletion. Since the backing snapshot can no longer be trusted once its lock is removed during the deletion process, any ongoing IO may experience errors as the writable snapshot is removed.

- If the deletion and cleanup of a writable snapshot fails for some reason, it can be removed from its top-level directory using its renamed path (*.deleted). For example:

```
# isi snap writable delete /ifs/test/wsnap2.51dc245eb.deleted
```

- There are certain caveats governing where a writable snapshot's mount point can reside in the file system. These locations include not at an existing directory, below a source snapshot path, or under a SmartLock or SyncIQ domain.

- A writable snapshot cannot be created from a source snapshot of the /ifs root directory.

- Taking a read-only snapshot of a writable snapshot is not permitted in OneFS 9.3 and later releases.

- A writable snapshot cannot be locked or changed to read-only. However, the read-only source snapshot will be locked for the entire life cycle of a writable snapshot.

- Writable snapshots in OneFS 9.3 and later cannot be replicated using SyncIQ or backed up over NDMP.

- Snapshot aliases cannot be used as the source of a writable snapshot, even if using the alias target ID in place of the alias target name

- Most Job Engine jobs can be run from inside a writable snapshot path. However, certain jobs like SmartDedupe and SmartPools will run but not be able to enact their function (such as deduplicate or tier data) upon writable snapshot files and namespace.

Conclusion

Overview

OneFS writable snapshots, on top of the industry's leading scale-out NAS architecture, deliver on the promise for the evolving needs of surveillance, scientific, media, backup applications, and other workloads. OneFS meets these needs without sacrificing the ease of management, performance, scalability, and protection that OneFS affords.

Dell PowerScale clusters provide a scalable, multi-protocol solution, which is further evidence of the Dell commitment to developing the next generation of data management products and solutions for the enterprise.

Technical support and resources

The Dell Technologies Info Hub provides expertise to ensure customer success with Dell storage and data protection products.

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