

Dell EMC PowerFlex: Snapshots

Overview and Basic Configuration

Abstract

This paper provides an overview of snapshots in Dell EMC PowerFlex™ software-defined storage. It pays special attention to time-based secure snapshots, their uses, and restrictions in the overall context of PowerFlex's snapshot architecture.

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Executive summary

Snapshots are a block image in the form of a storage volume or LUN used to instantaneously capture the state of a volume at a specific point in time. Snapshots can be initiated manually or through automated snapshot policies.

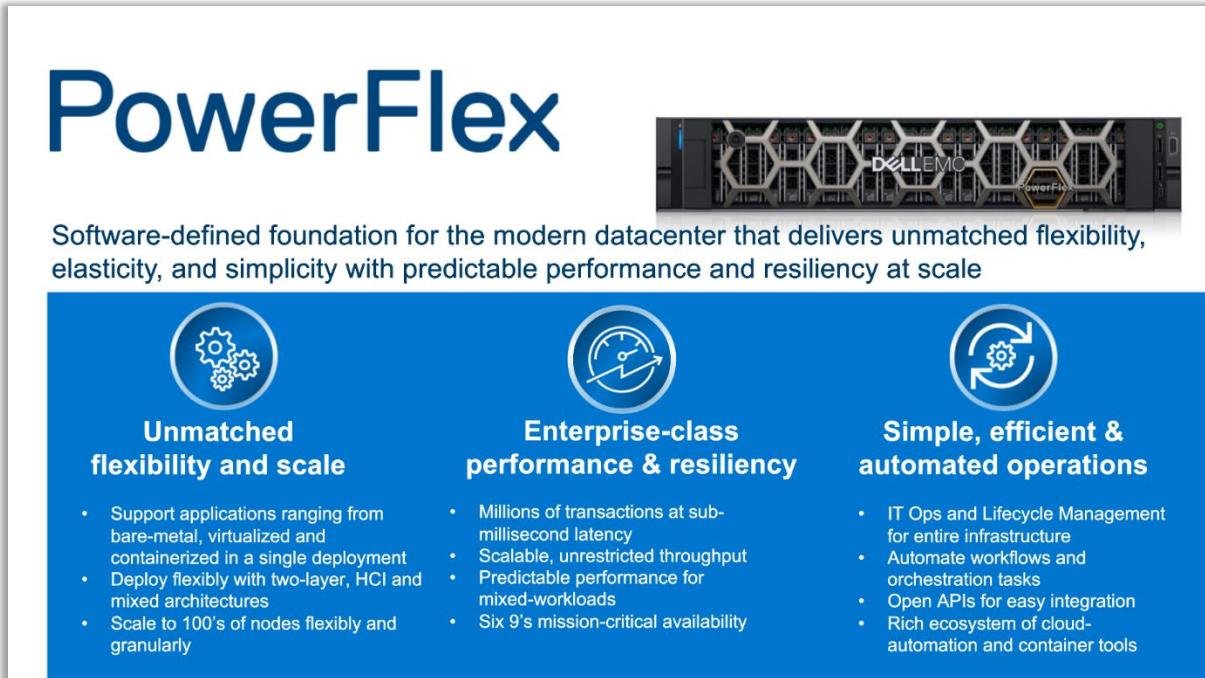
There are various use cases for snapshots including, but not limited to:

- Support for data retention policies to meet business and governmental compliance requirements
- Onboard rapid disaster recovery for avoiding DR site fail-over
- Enabling rapid application cloning
- Integrating with backup protection software to enable offsite or data retention requirements
- Providing cloning support for release cycles of custom or packaged software
- Defining and deploying templates of installed and configured applications or datasets
- Providing easy nondestructive what-if analysis of various business or other scenarios

This paper covers PowerFlex snapshot functionality including normal snapshots, secured snapshots, consistency groups, and snapshot policies.

1 Introduction

PowerFlex is a software-defined storage platform designed to reduce operational and infrastructure complexity. It empowers organizations to move faster by delivering flexibility, elasticity, and simplicity with predictable performance and resiliency at scale. The PowerFlex family provides a foundation that combines compute and high-performance storage resources in a managed unified fabric. Flexibility is offered as it comes in multiple hardware deployment options such as integrated rack, appliance or ready nodes, all of which provide Server SAN, HCI, and storage only architectures.



The diagram is a promotional graphic for PowerFlex. At the top, the word "PowerFlex" is written in a large, bold, blue sans-serif font. To the right of the text is a photograph of a Dell EMC PowerFlex storage system, which is a rack-mounted unit with multiple drive bays and a central processing unit. Below the title, a subtitle reads: "Software-defined foundation for the modern datacenter that delivers unmatched flexibility, elasticity, and simplicity with predictable performance and resiliency at scale". The main content is organized into three columns, each with a circular icon and a title. The first column is titled "Unmatched flexibility and scale" with an icon of three interlocking gears. The second column is titled "Enterprise-class performance & resiliency" with an icon of a speedometer. The third column is titled "Simple, efficient & automated operations" with an icon of a gear inside a circular arrow. Each column also contains a bulleted list of features.

Unmatched flexibility and scale	Enterprise-class performance & resiliency	Simple, efficient & automated operations
<ul style="list-style-type: none"> Support applications ranging from bare-metal, virtualized and containerized in a single deployment Deploy flexibly with two-layer, HCI and mixed architectures Scale to 100's of nodes flexibly and granularly 	<ul style="list-style-type: none"> Millions of transactions at sub-millisecond latency Scalable, unrestricted throughput Predictable performance for mixed-workloads Six 9's mission-critical availability 	<ul style="list-style-type: none"> IT Ops and Lifecycle Management for entire infrastructure Automate workflows and orchestration tasks Open APIs for easy integration Rich ecosystem of cloud-automation and container tools

Figure 1 PowerFlex Overview

PowerFlex provides the flexibility and scale demanded by a range of application deployments, whether they are on bare metal, virtualized, or containerized.

It provides the performance and resiliency required by the most demanding enterprises, demonstrating six 9's or greater of mission-critical availability with stable and predictable latency.

Providing millions of IOPs at sub-millisecond latency, PowerFlex is ideal for both high-performance applications and for private clouds that want a flexible foundation with synergies into public and hybrid cloud. It is also great for organizations consolidating heterogeneous assets into a single system with a flexible, scalable architecture that provides the automation to manage both storage and compute infrastructure.

2 PowerFlex Snapshots

Snapshots are a block image in the form of a storage volume or LUN used to instantaneously capture the state of a volume at a specific point in time. PowerFlex snapshots are thin-provisioned and writable. Once a snapshot is taken, it becomes a new unmapped volume in the system. It can be manipulated like any other volume exposed by the storage system: mapped, unmapped, renamed, resized, and so on.

PowerFlex snapshots can be initiated manually through any of the clients: the Web UI, CLI, or REST API. Snapshots are managed with any of these clients. The CLI and REST API, however, offer the ability to create snapshot policies, which automate the creation and deletion of snapshots according to a predefined schedule of your own choosing.

Snapshots and their source volume are organized into a Volume Tree, or V-Tree. Stated differently, a V-Tree includes the root volume and all the descendant snapshots resulting from that volume. A Volume Tree includes not only snapshots taken of the root volume at different points in time, but also descendants that are snapshots of snapshots. The following diagram depicts a small V-Tree with both types of descendant.

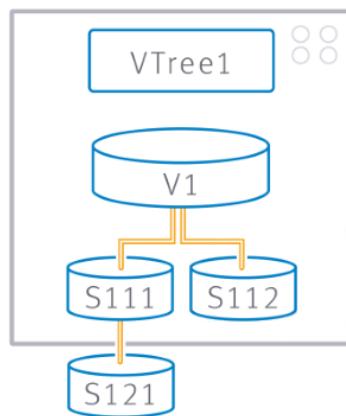


Figure 2 V-Tree where S111 and S112 are snapshots of volume V1 at different times, and S121 is a snapshot of another snapshot (S111).

2.1 Max Snapshot Count

A V-Tree can have up to 128 members of which 126 are usable descendants, or snapshots, in the V-Tree. The other two members consist of the root volume and a system reserved volume used when overwriting a member of the V-Tree with the contents of another member. The reserved V-Tree member is not visible in the system, but it consumes from the total possible snapshot count.

2.2 Snapshot Consistency Groups

PowerFlex Snapshots can also have relationships across different V-Trees. When you take a snapshot, multiple volumes can be selected simultaneously. All snapshots taken together this way form a Consistency Group.

The snapshots in a consistency group are guaranteed to be from precisely the same point in time. They can be used to capture a crash-consistent snapshot-based backup across multiple volumes.

In the PowerFlex Web UI, select the checkbox next to the volumes you want to create a snapshot and click the MORE button, then Create Snapshot.

Figure 3 Creating snapshot of multiple volumes for snapshot consistency group

Once created, all the members of the consistency group will appear in the Details for any single member.

Figure 4 Detail view of the V-Tree characteristics focusing on the Consistency Group

Because they were all taken simultaneously there is a contextual relationship among the members, and the consistency group can be manipulated together as a set. For example, the entire consistency group can be deleted as a single action.

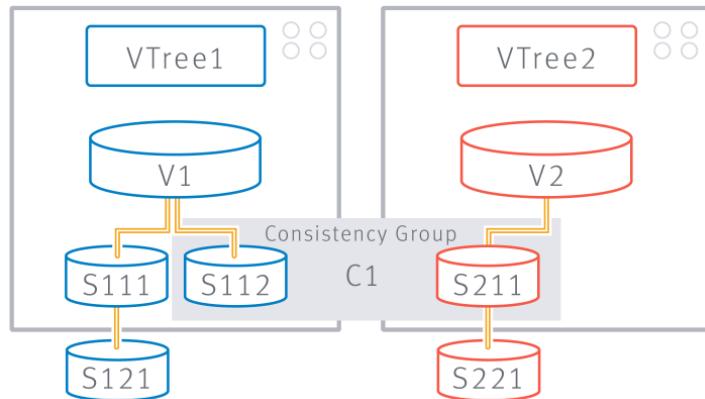
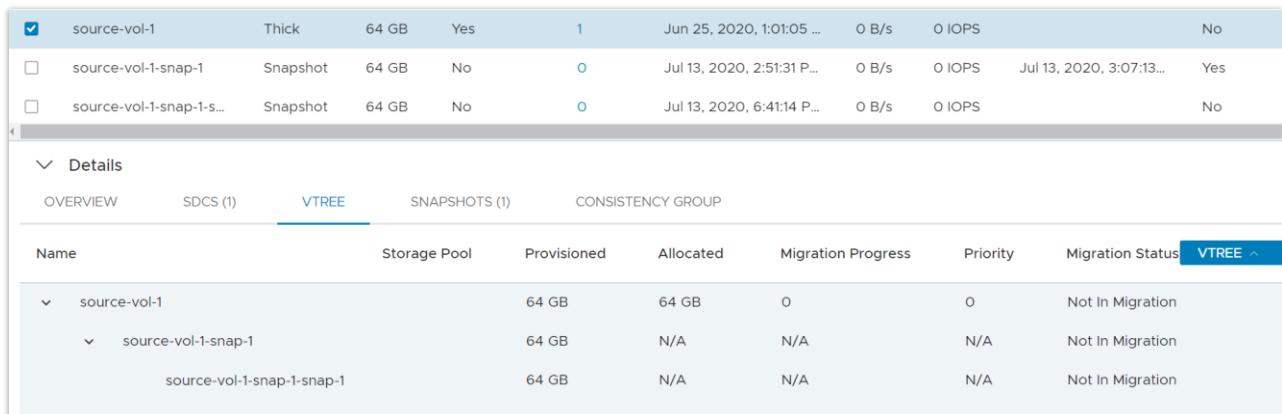


Figure 5 Snapshots S112 and S211 are taken together to form Consistency Group, C1.

However, PowerFlex does not enforce the relationship, and does not try to preserve it as originally created. A user can remove a member of a consistency group, resize it, overwrite its contents, or otherwise alter it. Snapshot consistency groups are for convenience purposes only.

2.3 Snapshot Independence

PowerFlex does not rigidly enforce the parent-child relationships in a V-Tree. It is possible to overwrite the contents of one snapshot with the contents from any other snapshot. In the following example, we have a root volume, a snapshot of the root volume, and a snapshot of the snapshot.



	source-vol-1	Thick	64 GB	Yes	1	Jun 25, 2020, 1:01:05 ...	0 B/s	0 IOPS	No
<input type="checkbox"/>	source-vol-1-snap-1	Snapshot	64 GB	No	0	Jul 13, 2020, 2:51:31 P...	0 B/s	0 IOPS	Jul 13, 2020, 3:07:13... Yes
<input type="checkbox"/>	source-vol-1-snap-1-snap-1...	Snapshot	64 GB	No	0	Jul 13, 2020, 6:41:14 P...	0 B/s	0 IOPS	No

Details		OVERVIEW	SDCS (1)	VTREE	SNAPSHOTS (1)	CONSISTENCY GROUP			
Name		Storage Pool	Provisioned	Allocated	Migration Progress	Priority	Migration Status	VTREE	
source-vol-1		64 GB	64 GB	0	0	0	Not In Migration		
source-vol-1-snap-1		64 GB	N/A	N/A	N/A	N/A	Not In Migration		
source-vol-1-snap-1-snap-1		64 GB	N/A	N/A	N/A	N/A	Not In Migration		

Figure 6 Base volume, snapshot, and a snapshot of the snapshot.

We can remove the root (or source) volume and choose whether we want to delete the descendant snapshots.



Figure 7 Detail of the volume deletion action

Alternatively, we might choose to overwrite the contents of the root volume with the contents of a child or 'grandchild' snapshot. Select the root volume as our target.

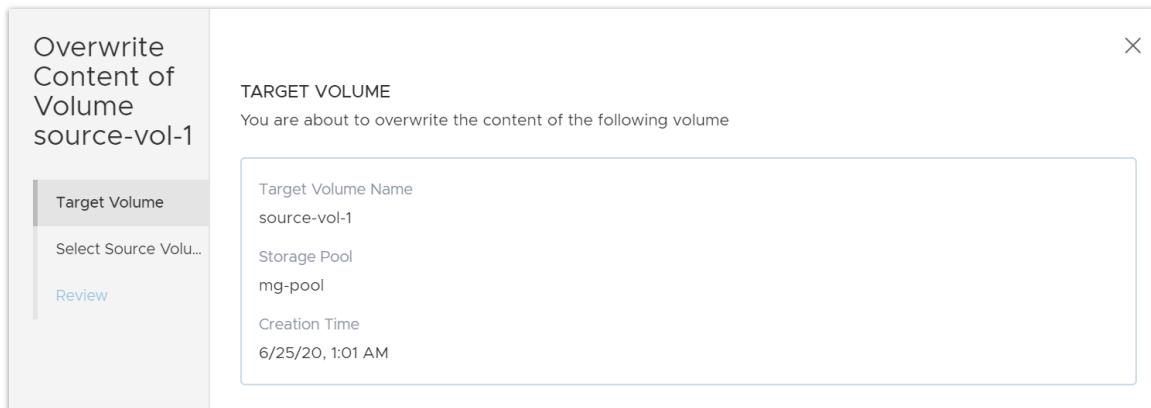


Figure 8

Then select the volume whose contents you want to use for the overwrite. You can select the time range in which to search for the snapshot you want. In this case, we will use the snapshot of a snapshot.

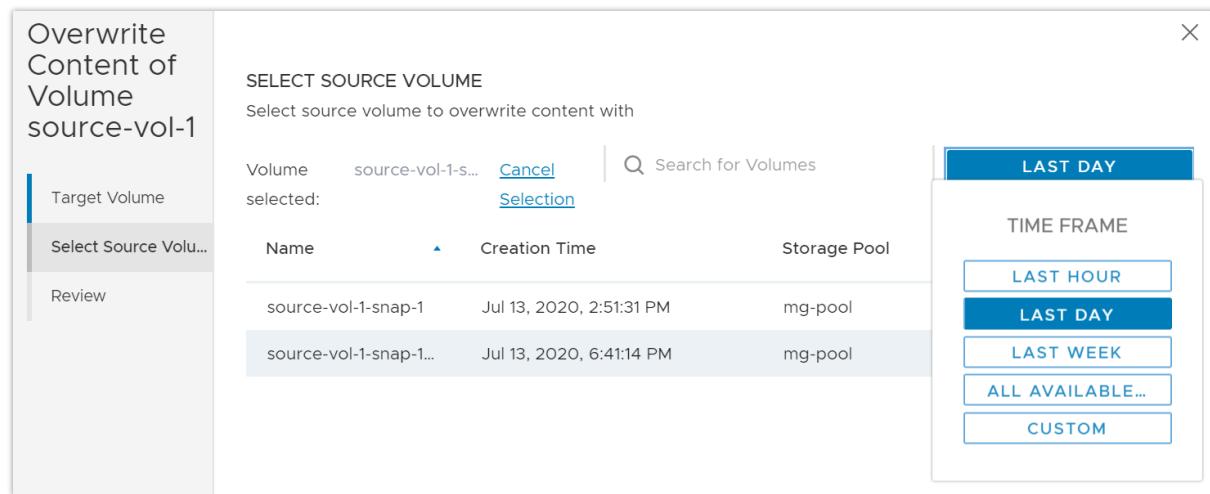


Figure 9

Click the OVERWRITE CONTENT button to start the overwrite process. The UI will warn of the destructiveness of the process.

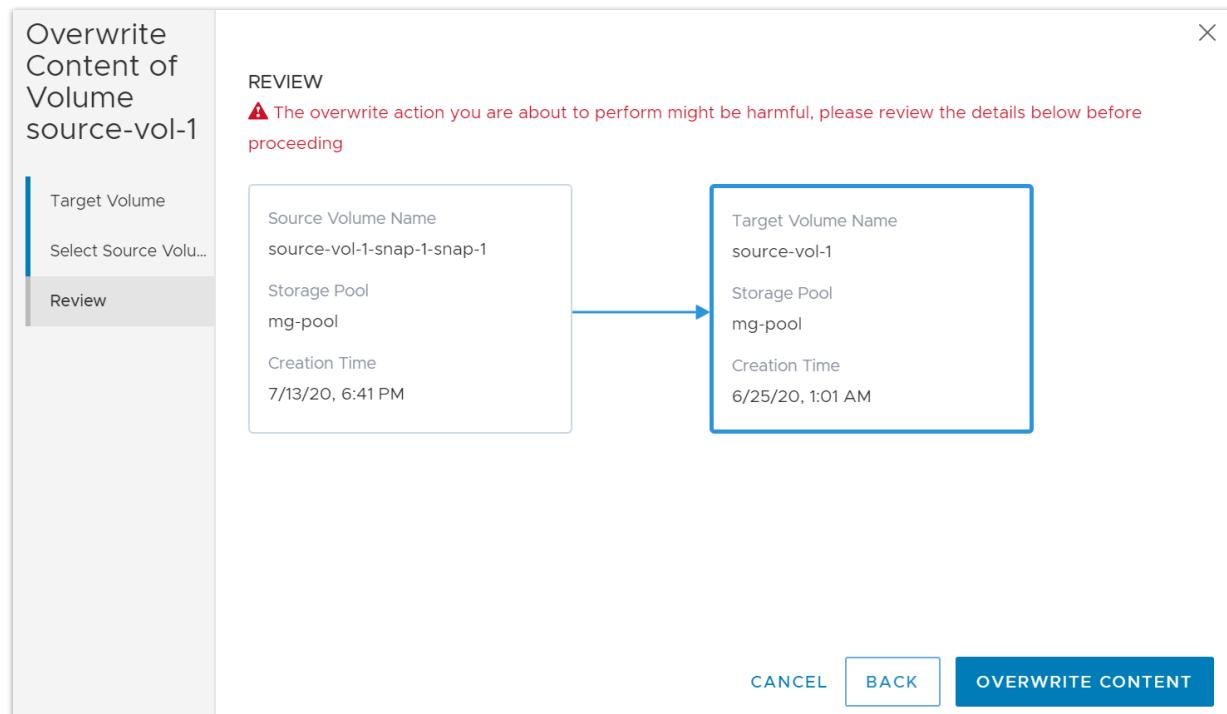


Figure 10 Images showing sequence for snapshot overwrite.

In general, there are few if any limits on the possible manipulations of members of a V-Tree. This sort of flexibility is useful in development scenarios wherein a gold copy might be used to develop and test many iterations and versions.

2.4 Snapshot Policies

Of the 126 user-available snapshots per volume, sixty (60) can be used for policy-based snapshot scheduling. Any given root volume can only participate in one snapshot policy, but a policy can apply to multiple source volumes simultaneously.

First a rule is created and then source volumes are attached to the rule. The rule itself defines the interval between snapshots and the number of them to keep. For example, *take a snapshot every 60 minutes and keep 24 of them*, ensuring you have a snapshot for every hour of the past 24 hours. The rule can also be created in a multilevel retention structure (up to six levels), where the intervals build upon one another as minutes/hours/days/weeks. For example, set the base interval to 60 minutes and another retention level to keep one snapshot for 7 days will result in keeping one daily copy for a week.

If we set another retention level to keep one of the daily copies for 4 weeks, we ensure that the system maintains (on a rotating basis):

- Hourly snapshots for a day (24)
- A daily snapshot for a week (7)
- And a weekly snapshot for a month (4)

Note: In Version 3.5.x, there is no UI for the policy scheduling. Rather, it is something to be handled programmatically using the CLI or REST API. For more information, see the section on Snapshot Policies in [Getting to Know Dell EMC PowerFlex v3.5.x](#).

To create the policy described above with the CLI, the following command would be used:

```
scli --add_snapshot_policy --snapshot_policy_name snap_policy_hourly \
--snapshot_creation_cadence 60 --number_of_snapshots_per_retention_level 24,7,4
```

Note: The snapshot_creation_cadence is set in minutes.

To add a source volume to this policy we would use, for example:

```
scli --add_source_volume_to_snapshot_policy --snapshot_policy_name snap_policy_hourly \
--source_vol_id 3b21a36600000003
```

For details on the CLI and the options available, see the section on snapshots in [Dell EMC PowerFlex v3.5.x CLI Reference Guide](#).

3 Secure Snapshots

When creating a volume snapshot the user can mark snapshots as “secure,” enabling customers to meet business and statutory requirements for data retention. Securing snapshots is especially important in the financial sector.

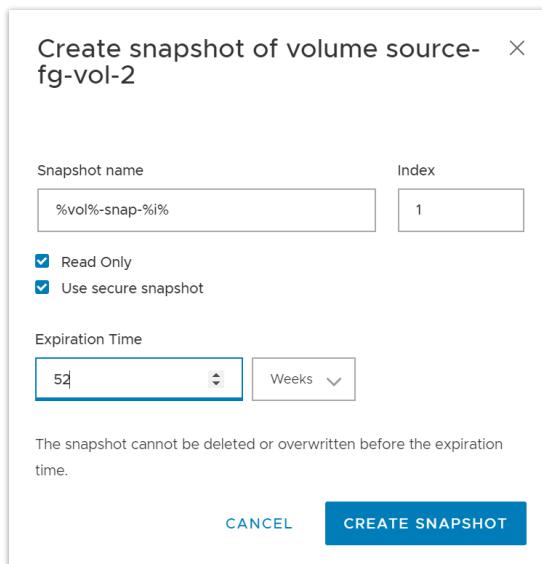


Figure 11 Secure snapshot with 1-year expiration time.

Once a snapshot is created with the secure option, it cannot be deleted until the assigned expiration time is reached. A formal process exists to delete secure snapshots. Contact Dell support for more information.

Note: Secure Snapshots are, by default, Read Only.

3.1 General Behavior

A snapshot can be created initially with or without the secure flag and expiration time. If it is initially created without the secure flag, the expiration time can be added later with the `set_snapshot_security` CLI command. (The REST API can also be used to add this marker.)

Secure snapshots cannot be altered before their expiration time. When a secure snapshot is mapped to an SDC, regardless of how it is mounted, it will be forced into the read-only option. We saw above that PowerFlex snapshots can be deleted or overwritten with the contents of another V-Tree member. These operations are not possible for secure snapshots.

It is possible to mark snapshots created through a scheduling policy as secure. However, any secure snapshots that exist in a policy-generated set will remain in place regardless of what is done to the snapshot policy. Pausing, altering, or deleting the policy will not delete the snapshots marked as secure.

The snapshot policy engine itself has been enhanced to enable the automatic creation of secure snapshots using the `secure_snapshots` flag. In this case, the snapshots created for and during each interval cannot be manually deleted until the normal intervals have occurred. At that point, the policy engine will remove the snapshots per the defined rule.

3.2 Creating a Secure Snapshot

Secure Snapshots can be created:

1. Via the Web UI
2. Via the PowerFlex command-line interface
3. With the REST API
4. With a predefined snapshot policy
5. By issuing a CLI or REST command to secure a previously created snapshot

The easiest approach is with the Web UI. We go to the **Configuration → Volumes** menu, select the volume, and click the **MORE** menu.

Name	Type	Size	Mapped	# SDCs	Creation Time
<input checked="" type="checkbox"/> source-fg-vol-1	Thin	128 GB	Yes	1	Jun 30, 2020, 9:59:12 PM
<input type="checkbox"/> source-fg-vol-2	Thin	128 GB	Yes	1	Jun 30, 2020, 9:59:12 PM
<input type="checkbox"/> source-fg-vol-3	Thin	128 GB	Yes	1	Jun 30, 2020, 9:59:12 PM

Figure 12

The create snapshot window opens, which allows us to name the snapshot and to set its properties (read-only; secure):

Create snapshot of volume source-fg-vol-1

Snapshot name: %vol%-snap-%i% Index: 1

Read Only Use secure snapshot

Expiration Time: 15 Minutes

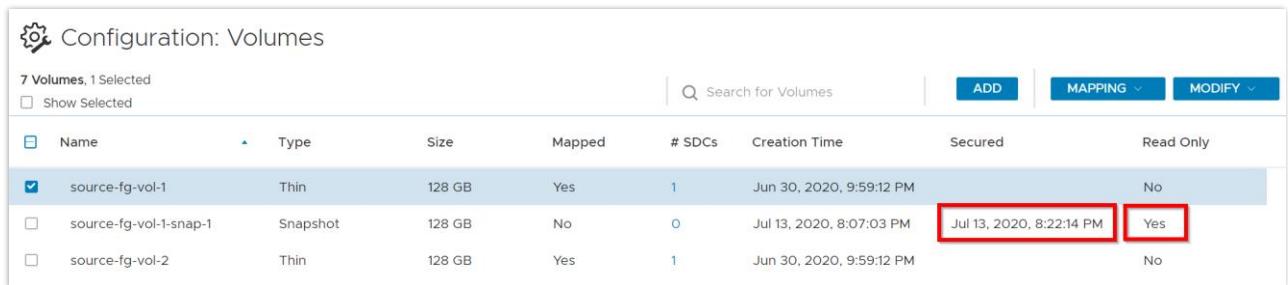
The snapshot cannot be deleted or overwritten before the expiration time.

CANCEL **CREATE SNAPSHOT**

Figure 13

For this example, we will set the expiration time to 15 minutes. But the interval can be set in the UI for minutes, hours, days, or weeks.

After creating the snapshot of our source volume, it appears and is marked both secure and read-only.



7 Volumes, 1 Selected		Search for Volumes		ADD	MAPPING	MODIFY	
Name	Type	Size	Mapped	# SDCs	Creation Time	Secured	Read Only
<input checked="" type="checkbox"/> source-fg-vol-1	Thin	128 GB	Yes	1	Jun 30, 2020, 9:59:12 PM	No	No
<input type="checkbox"/> source-fg-vol-1-snap-1	Snapshot	128 GB	No	0	Jul 13, 2020, 8:07:03 PM	Jul 13, 2020, 8:22:14 PM	Yes
<input type="checkbox"/> source-fg-vol-2	Thin	128 GB	Yes	1	Jun 30, 2020, 9:59:12 PM	No	No

Figure 14

If we try to delete it or overwrite the contents, we receive the following error:

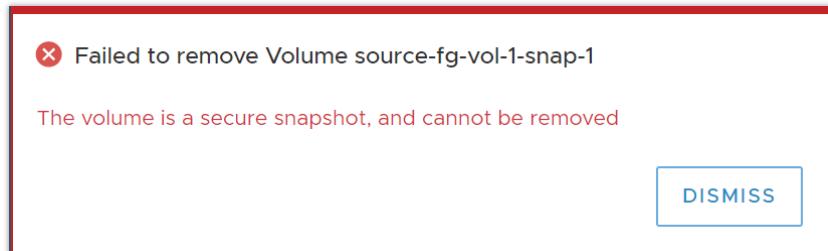


Figure 15

From the CLI, we would do something like the following to create a secure snapshot:

```
scli --snapshot_volume --volume_name source-fg-vol-1 \
--snapshot_name source-fg-vol-1-snap-1 --retention_period 15m
```

You are prompted to confirm the decision to create a secure snapshot:

```
[root@tme-102R-4 ~]# scli --snapshot_volume --volume_name source-fg-vol-1 --snapshot_name source-fg-vol-1-snap-1 --retention_period 15m
You are about to create secure snapshots that cannot be removed during the retention period. Press 'y' and then Enter to confirm: y
Snapshot created successfully
  Source volume source-fg-vol-1 => 404bfb4d0000000c source-fg-vol-1-snap-1
```

Alternatively, users can preemptively approve the creation by adding the `--i_am_sure` flag to the command.

Specifying a retention period denotes the snapshot as secure, and includes the read-only attribute. The time period is specified using m | h | D | W | M | Y respectively indicating minutes, hours, days, weeks, months, or years. Examples: 30m (thirty minutes), 5D (five days), 1M (one month, which equals 31 days)

3.3 Extending Retention Period of Secure Snapshot

While it is not possible to reduce the retention period of a snapshot, it is possible to use the CLI to *extend* the retention period. This operation cannot be performed from the Web UI.

```
scli --set_snapshot_security --volume_name source-fg-vol-1-snap-1 \
--retention_period 30m --i_am_sure
```

This command will alter the retention period and resets the expiration time to 30 minutes from the time the command is run.

Attempting to set a retention period shorter than the remaining time already defined will receive an error:

```
[root@tme-102R-4 ~]# scli --set_snapshot_security --volume_name source-fg-vol-1-snap-1 --retention_period 5m --i_am_sure
Error: MDM failed command. Status: The snapshot retention period cannot be reduced
```

3.4 Deleting Secure Snapshots on or after Expiration

Secure snapshot deletion is not automatic after the expiration time has been reached. But once the time period for the secure flag has expired, users are free to alter or delete the snapshot. In the Web UI, the date and time of the retention policy expiration are shown next to the snapshot.

3.5 Deleting Secure Snapshot before Expiration

A customer cannot delete secured snapshots. Instead, there is a multistep business-approval workflow with specific documentation requirements (including two business leader signatures) before a support ticket is created. The required documentation is reviewed, and a login session with support is facilitated in which the snapshot's retention period is reset and the snapshot is deleted.

3.6 Creating a Write-enabled Version of a Secured Snapshot

Although writes are not permitted to a secure snapshot, it is possible to create a normal snapshot of the secured snapshot, thereby creating a writable copy.

4 Summary

The addition of Secure Snapshots adds yet another feature to the data protection and management tool set in PowerFlex software-defined storage. Dell Technologies is passionate about meeting customer needs and expectations. This new feature accommodates business needs and government requirements while adding flexibility to the management of PowerFlex storage clusters. You should now have a better understanding of the secure snapshots and their limits and consequences.