

WHITE PAPER

FlashArray[™] Protection for SAP HANA[®]

Technical white paper addressing data protection using storage snapshots, business continuity using Purity ActiveCluster,[™] and Multi-Site Disaster recovery solutions.

September 2019



Quick Start



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Executive Summary

Pure Storage® offers a range of solutions to solve data protection and business continuity problems posed to organizations using the SAP HANA in-memory data platform. The FlashArray™ product family is recommended as persistence storage for data and transaction logs in any SAP HANA deployment as it offers organizations a range of benefits and incredible flexibility in solving multiple business problems in a single storage device.

Some of the problems which organizations are faced with in any SAP HANA deployment are how to ensure the continued availability of the solution when various components fail, how to meet short recovery point objectives and how to ensure business rules are adhered to with regards to recovering to a point in time or in the event of a complete data loss.

Pure Storage FlashArray and the Purity operating environment are capable of meeting these needs with an easy to use and built in management interface, a consistent understanding of any SAP HANA deployment type and without any additional license costs.

In order to meet the various business needs for data protection and business continuity the following solutions are provided by FlashArray:

- **Data protection** – Space efficient volume snapshots combined with SAP HANA storage snapshots to create application consistent recovery points in order to protect business data over time. Using offload features such as Snap-to-NFS and Snap-to-Amazon® S3 any storage snapshot can be transported from the storage array to inexpensive network file system storage or an Amazon S3 bucket, ensuring that any snapshot can be used during a full recovery in the event of rectifying system or data loss.
- **Business Continuity for device loss** – A single FlashArray offers a range of redundancies in a single chassis such as redundant controllers, port redundancy and protection against the loss of a single solid-state storage device. To further guarantee availability of the solution in the event of an entire FlashArray failure, ActiveCluster can be used as a synchronous replication solution providing an Active/Active architectural configuration where data can be read and written to any of the two arrays.
- **Business continuity for site loss** – using FlashRecover replication one or many FlashArray devices can be used as the target of an asynchronous relationship where volume snapshots can be copied to multiple sites and locations. These snapshots can then be used as recovery points in the event of a site loss.

Any of these solutions can be combined with one another to reduce business risk and create multiple resilient recovery domains ensuring organizations can focus on core business operations without the fear of disruption.

The purpose of this white paper is to provide a detailed insight into how storage snapshots, ActiveCluster and FlashRecover replication can be implemented to meet the various business needs SAP HANA has for availability and recoverability. Various reference architectures and deployment types are discussed herein attempting to highlight the differences in approach required for each scenario.



Introduction

Pure Storage® FlashArray™ is set a software defined, all flash block storage products catering to multiple business needs and use cases. The FlashArray product line is offered in 3 distinct classes:

- **FlashArray//M** - Offers exceptional block storage value for general purpose consolidation of on-premises workloads.
- **FlashArray//X** - The first all-flash, 100% NVMe® storage solution designed for a range of solutions deployed on-premises.
- **Pure Cloud Block Store™ on Amazon Web Services** – Block storage delivered natively in the cloud, powered by Purity software.

Key differentiators of the FlashArray product line are that the storage offers an effortless experience, behaves in an efficient manner by offering deduplication and compression without a reduction in performance and offers an Evergreen™ product model to increase capacity and performance without the need to keep buying new storage products. With Cloud Block Store on AWS Pure Storage further extends its ability to provide hybrid solutions to seamlessly and effortlessly move between cloud and on-prem while maintaining the benefits of both.

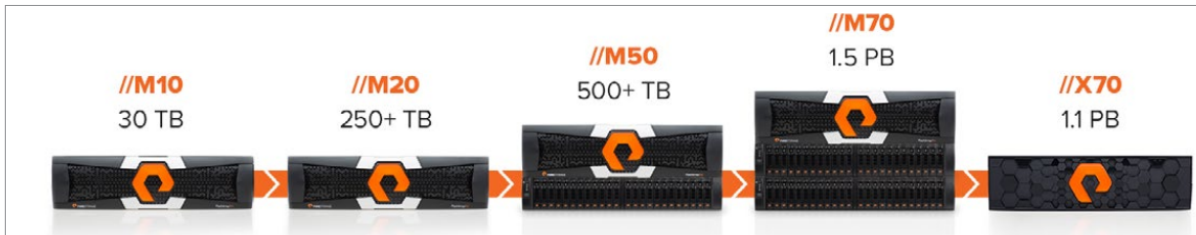


Fig. 1 Pure Storage FlashArray//M product models, capacity and Evergreen upgrade options.

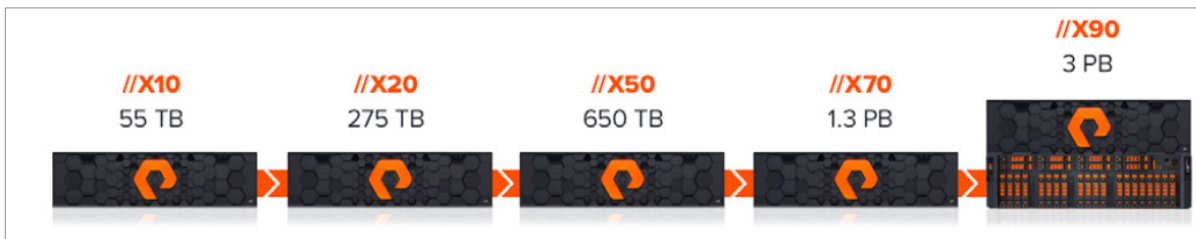


Fig. 2 Pure Storage FlashArray//X product models, capacity and Evergreen upgrade options.

Each FlashArray is operated by the Purity operating environment, the software defined solution for flash management, basic and advanced software defined data services and storage API's. Purity offers a range of mechanisms in which the effective data protection of a business solution can be achieved at different levels, these features are collectively known as Purity Protect.

Purity Protect encompasses the following features and functionality:

- Full business continuity with Purity ActiveCluster™
- Multi-site replication
- Space-efficient local and remote snapshots



Purity ActiveCluster is a business continuity solution where Active/Active synchronous replication is enabled between two FlashArray devices at no extra cost for transparent failover mediated by an instance of the Pure1® management software. Utilizing this solution organizations can achieve zero recovery point (RPO) and zero recovery time (RTO) objectives for tier 1 applications such as hypervisors, databases and file storage services. As both FlashArray devices in the cluster are Active simultaneously the second array is not wasted and can be used for further read-only operations in the solution.



Fig. 3 Pure Storage Multi-Site Active/Active Stretch Cluster design topology.

Multi-site replication offers the flexibility to replicate volumes and snapshots in a 1: Many, Many:1 or Many: Many manners between FlashArray devices. This is typically appropriate for data sharing, centralised data protection strategies and disaster recovery.

SAP HANA is an in-memory data platform engineered, marketed and sold by SAP® SE. The data platform offers an in-memory, column oriented relational database management system primarily focused on data processing and analysis in a performant manner. Even though SAP HANA is an in-memory data platform, it requires a high performing persistence layer which is based storage area network (SAN) or network attached storage (NAS). Typical deployments require that a data and log area be provisioned for the persistence layer where both are required to meet a range of key performance indicators (KPI) for production instances. One of the characteristics of the log area is that it is required to achieve as low a latency as possible, this is due to the architecture of SAP HANA where transactions/operations are entered simultaneously in memory and serialized as a write operation to the log volume. As soon as both complete the transaction/operation is considered completed. The low latency requirement becomes more apparent when dealing with systems which perform enormous amount of transaction-processing style operations as when the log area comes under load, the entire data platform must not slow down and provide a high performant service to all users and applications. SAP HANA is offered in two distinct deployment scenarios:

- **Scale up** – a single compute and memory domain scaled by adding more resources directly to the domain. i.e. increasing memory or compute capacity.
- **Scale out** – multiple compute and memory domains scaled by adding additional similar domains alongside existing deployments. Also provides for hardware failures through the provisioning of a standby node for the instance i.e. adding another server to an existing server pool and extended the SAP HANA instance to utilise it.

Pure Storage FlashArray devices offer SAP HANA deployments a distinct advantage due to the following reasons:

- The FlashArray//X product line is a 100% NVMe storage solution providing low latency for both the log and data areas in any SAP HANA Tailored Datacenter Integration (TDI) deployment.
- Like other vendors, Pure Storage offers turn-key appliances for SAP HANA covering networking, compute and storage. . But Pure Storage pursues an SAP TDI strategy. So both FlashArray and our FlashStack SAP appliance are SAP TDI-certified to provide organizations with the flexibility to choose the best, cost-effective and appropriate solution that meets their needs. And either deployment option scales from on-prem into the cloud. .
- The Evergreen product model allows organizations to increase performance, scalability and capacity over time without the need to purchase entirely new storage.
- Pure Storage FlashArray includes a range of data services aimed at enabling customers to realize the full potential of their SAP HANA deployment, namely ActiveCluster and Multi-Site replication.

SAP HANA offers its own internal business continuity approach for data protection and replication solutions each of which is integrated into the core product. Business continuity can be achieved by utilising a scale out instance with one or more failover nodes, backups to NFS or a backint certified storage target, storage replication and system replication.

The purpose of this white paper is to provide a detailed overview of the different business protection and continuity areas provided by Purity Protect for SAP HANA deployed on a FlashArray. Different sections explored are how to configure each solution area or an appropriate business case for each.



Architectural Overview

Architectures of Pure Storage solutions with SAP HANA covered within this white paper are **data protection**, **high availability** and **multi-site disaster recovery**.

All of the outlined architectures rely on the Purity operating environment's ability to create snapshots of volumes on an on-premise FlashArray solution or hybrid Cloud Block Store deployment. Data protection architectural solutions will encompass the ability of volume snapshots to be transported to a third platform for retention and recovery purposes. High availability architectural solutions focus on eliminating business downtime risk by creating a storage failure domain both inside a single datacenter and across a campus or metro deployment area. Business continuity architectural solutions are similar to the outline of data protection solutions but provide for the ability to replicate snapshots to other FlashArray or Cloud Block Storage devices.

The limit of snapshots created by the Purity operating environment are not isolated to data protection or business continuity solutions. Once the volume snapshot is created it can be used to enable data mobility architectural solutions. Data mobility in the instance of SAP HANA is defined to be the architectural federation of 2 or more FlashArray storage devices where volumes and snapshots can be transported from a resource constrained system to another with more resource availability. This process enables organizations to continue to function in an efficient manner without an impact on responsiveness. This is particularly useful for SAP HANA deployments where resource constraints are a critical issue as business needs scale over time.

SAP HANA Important information and terminology

SAP HANA releases are based around a major revision, minor version and a minor database revision for patches and patch rollups (e.g. SAP HANA 2.0 SPS 03 Database Revision 034). Currently there are only two major revisions (SAP HANA 1.0 and SAP HANA 2.0), 12 minor versions for SAP HANA 1.0 and 4 minor versions for SAP HANA 2.0. The minor versions are identified as "Support Package Stacks" or "SPS" abbreviated where the most recent release is SAP HANA 2.0 SPS04.

SAP HANA is available for Intel®-based hardware platforms (x86_64) and IBM® Power® Systems (PowerPC® architecture). It is also only supported to run on SUSE® Enterprise Linux® (SLES) and Red Hat® Enterprise Linux (RHEL), further information can be found at <https://launchpad.support.sap.com/#/notes/2235581> (SAP Support login required). It is recommended to use the "SUSE Linux Enterprise Server for SAP Applications" and "Red Hat Enterprise Linux for SAP Solutions".

Pure Storage offers a flexible SAP HANA solution aimed at tailored datacenter integration scenarios. Organizations have the opportunity to choose the most suitable server, networking and storage platform separately to meet both efficiency and cost business requirements.

With the release of SAP HANA 1.0 SPS 09 a new feature called multitenant database containers (MDC) was introduced. A multitenant database container is a single system with a system database which stores and maintains a system-wide landscape to allow configuration and monitoring of the overall system while allowing for multiple other databases to be deployed in parallel to one another. Each system can be made up of multiple tenant databases which are isolated from one another in terms of application data and user management. For SAP HANA 1.0 SPS 09 onwards MDC is an optional feature until SAP HANA 2 SPS 01 where it becomes the only operation mode.



With the release of SAP HANA 2.0 SPS03, the use of Intel® Optane™ DC Persistent memory is supported and provides a streamlined data tiering perspective and lower TCO through reduced downtime. Even with the existence of persistent memory SAP HANA requires performant storage with data services as a persistence layer in order to meet many of the business requirements set out by organizations.

Data Protection Solutions

SAP HANA Scale Up / Single host system deployment



SAP HANA Scale up deployments commonly utilise a set of volumes mounted over direct attached storage, Fibre channel or network file system (NFS) connectivity.

These volumes are then formatted with a file system (typically XFS) and are then mounted at various locations within the Linux operating system.



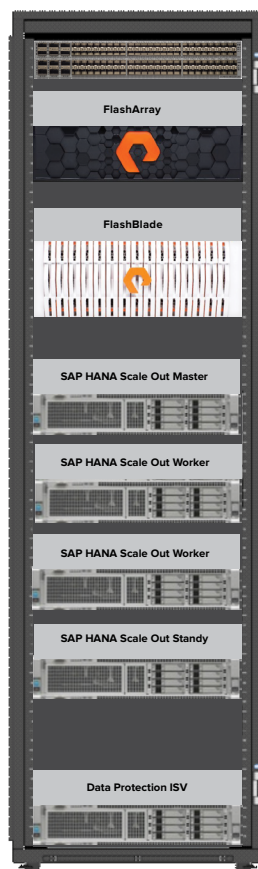
In this document the volumes for SAP HANA are mounted at the locations set out below:

- Install/base/binaries directory -
/hana/shared
- Data persistence directory -
/hana/data
- Transaction log directory -
/hana/log
- Backup directory -
/hana/backup

Included in the scale up deployment is a Pure Storage FlashBlade™ and Data Protection independent software vendor to manage the protection and retention of transaction logs. When using FlashBlade as a target for block volume snapshot offload this is considered a rapid recovery scenario, utilising the performance capabilities of this device to shorten recovery operations.

Transaction log backups can be sent directly to a local volume formatted with a file system or Network File System (NFS) target; however, this approach does not include retention management of protected transaction logs.

SAP HANA Scale Out/Multiple host (distributed) system deployment



SAP HANA Scale out deployments are made up of multiple hosts where each can be configured as an active worker or idle standby host. The minimum required hosts for a highly available scale out system is a single master worker, a worker and a standby host (2 + 1 topology). While having standby nodes for high availability is not necessary in a scale out deployment, it is strongly advised.



When deploying a scale out system it is mandatory to utilise a network file system (NFS) for the install/base/binaries directory and this directory must be shared across all of the hosts (both worker and standby) which will be included in the deployment. In a scale out deployment each host will have its own data and log volumes, and all volumes for each worker must be presented to each standby host.

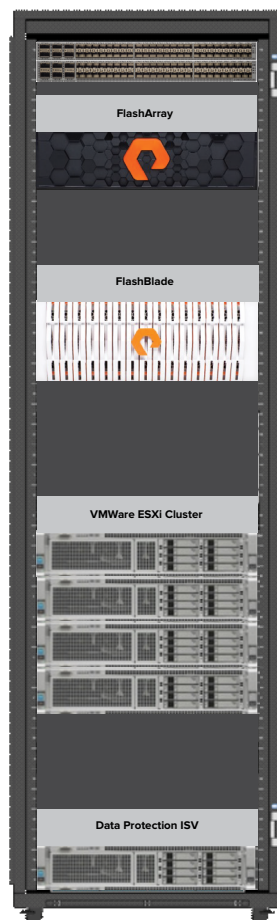
In this document the volumes for the SAP HANA scale out deployment (3 worker and one standby host) are set out below:

- SAP HANA scale out master
/hana/shared, /hana/data, /hana/log, /hana/backup
- SAP HANA scale out worker 1
/hana/shared, /hana/data, /hana/log, /hana/backup
- SAP HANA scale out worker 2
/hana/shared, /hana/data, /hana/log, /hana/backup
- SAP HANA scale out standby
/hana/shared
Master, worker 1 and worker 2 Data Volume
Master, worker 1 and worker 2 Log Volume

Included in the scale up deployment is a Pure Storage FlashBlade and Data Protection independent software vendor to manage the protection and retention of transaction logs. The FlashBlade will be used as the shared NFS storage provider for the **/hana/shared** directory on each host.



SAP HANA Deployment on VMware ESXi™ Hypervisors



SAP HANA is supported to be deployed on VMware vSphere® as a virtual machine or set of virtual machines. Both Scale up and scale out deployment scenarios can be configured, but it is advised that when deploying production instances, a scale up configuration be used. Some of the benefits of a virtualised SAP HANA instance are as follows

- Provisioning instances of SAP HANA in virtual machines is significantly faster
- Live migrations of SAP HANA instances can be performed using VMware vSphere vMotion®
- Standardised high availability using VMware vSphere High Availability (HA)

This document will only look at SAP HANA scale up deployment scenarios when utilising VMware vSphere as a platform.

Business Continuity Solutions (High Availability - ActiveCluster)

Availability and live migration within the datacenter

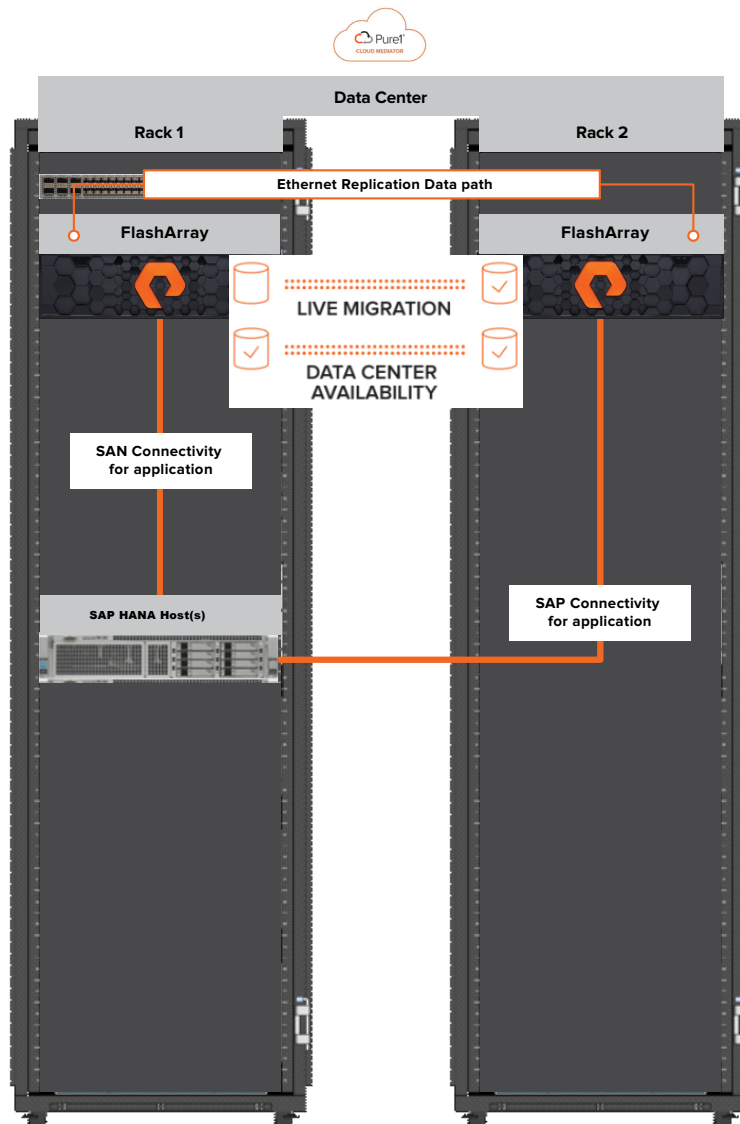


Fig. 4 ActiveCluster inside a Datacenter deployment scenario.

For business continuity within a single datacenter, ActiveCluster is used to ensure the availability of storage for a single SAP HANA deployment (both scale up and scale out) within a single datacenter. This is a synchronous clustering of a separate set of the data volumes used for the SAP HANA deployment. Block storage data and operations are performed over ethernet between the two FlashArray storage appliances. Pure1 (Data storage, management and support) is used to mediate the availability of the storage in an ActiveCluster deployment.

ActiveCluster can also be used to migrate live data between two sets of systems without the need for any downtime or performance degradation.



Campus or metro availability (multiple datacenter availability)

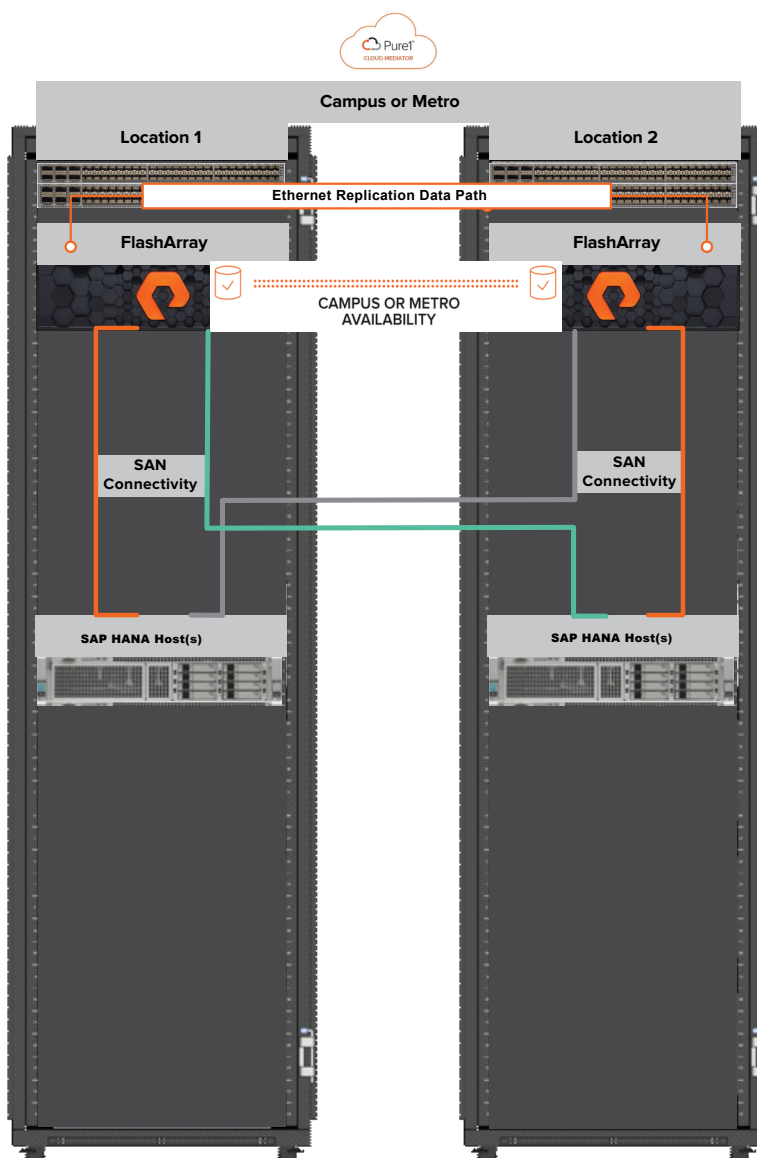


Fig. 5 ActiveCluster across campus or metro availability zones with secondary compute at the redundant site.

For business continuity across multiple datacenters, ActiveCluster can be used as both a high availability and disaster recovery solution based on the replication of data and log disks to remote storage attached to a secondary SAP HANA system (both scale up and scale out). This solution can be configured to operate both synchronous and asynchronously over ethernet depending on the customer need and business rules. When using this deployment, the secondary system is not wasted and can be used for test, quality assurance or read only operations on the production data. Pure1 is used to mediate the availability of the storage in this deployment scenario and can provide information on which system should be utilised for business operations.



Localised high availability and remote disaster recovery

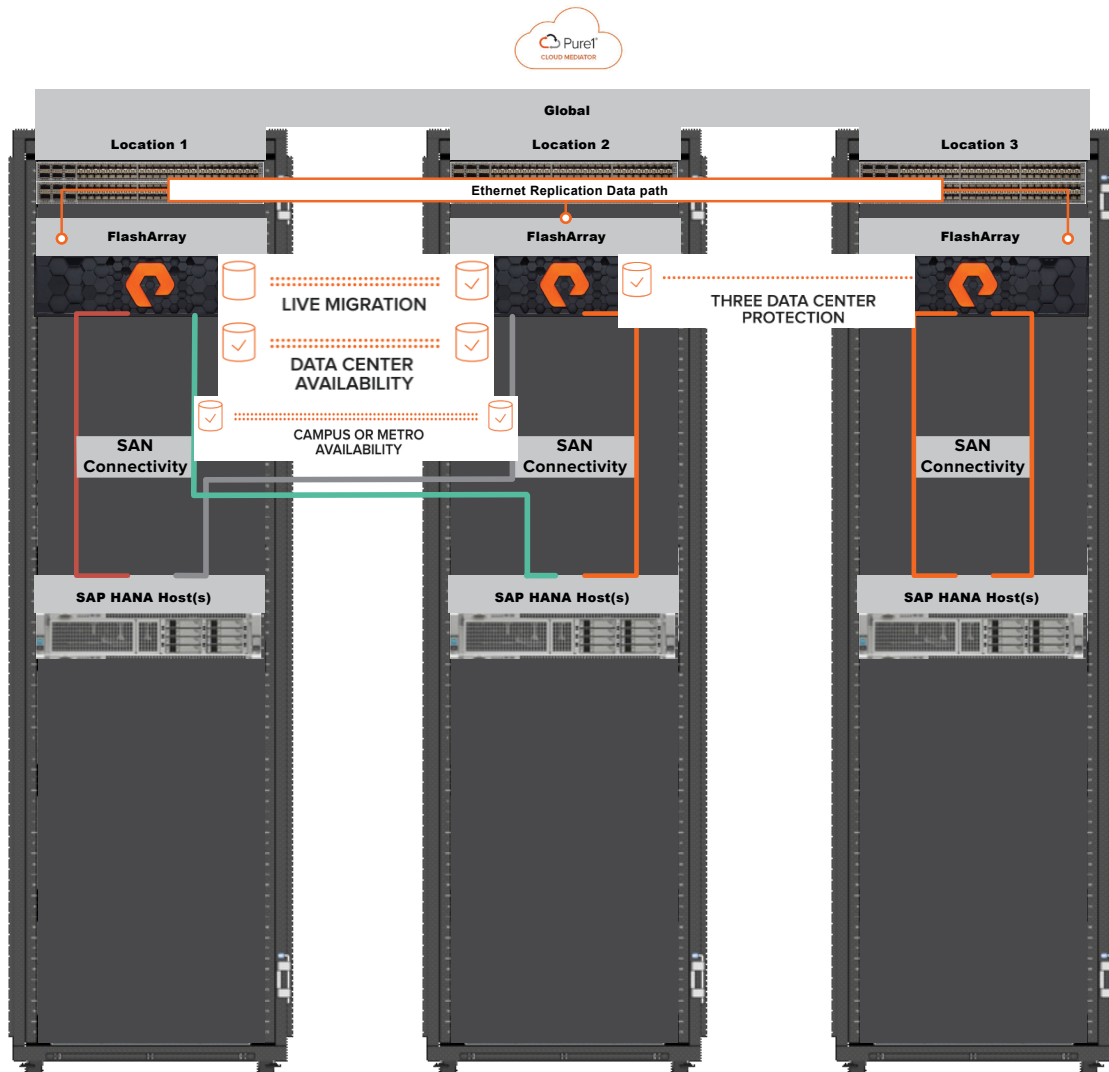


Fig. 6 ActiveCluster deployed in a localised area and remote asynchronous replication for a third site.

ActiveCluster can be further extended from localised high availability scenarios (storage availability and storage replication with a secondary SAP HANA system) by adding a remote FlashArray to the ActiveCluster group and having a standby SAP HANA host attached to it. Deploying this scenario requires that the localized high availability group operate synchronous replication over ethernet between each FlashArray and asynchronous replication is then used for replication to the remote system. Pure1 is used to mediate the availability and status of the storage replication relationships and can provide information on which location needs to be used by business applications and operations. An onsite virtual machine can be used as a mediator if the use of Pure1 is not possible.



Business Continuity Solutions (Multi-Site Disaster Recovery)

One to Many snapshot replication

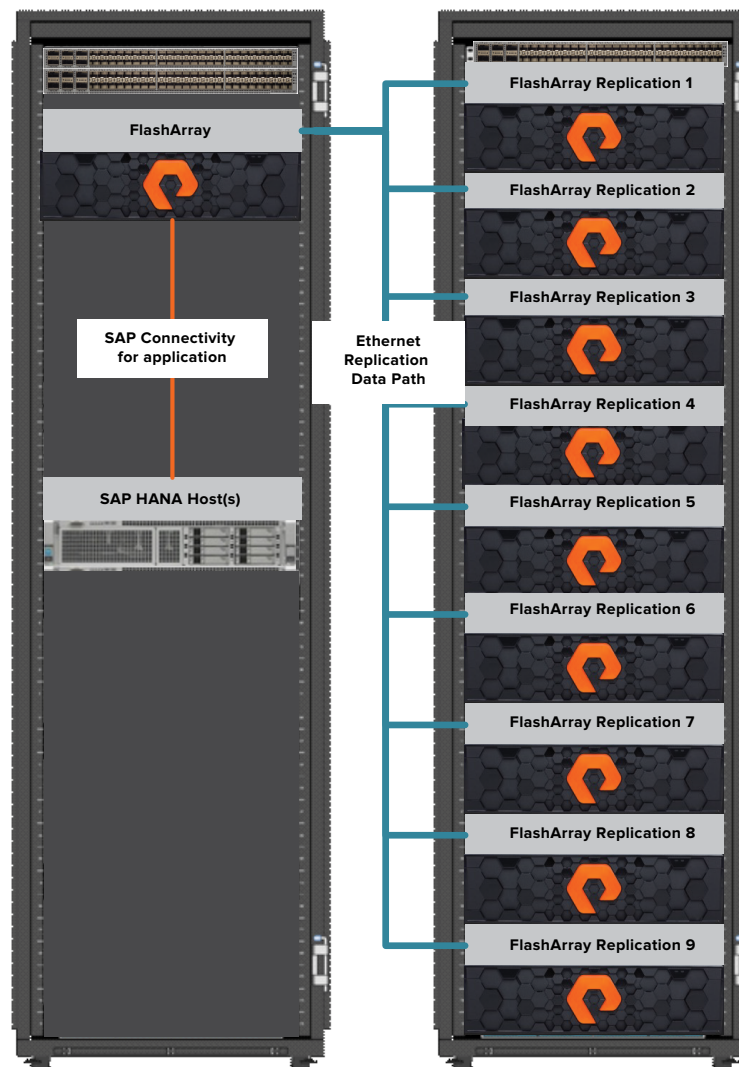


Fig. 7 A single FlashArray system replicating snapshots and volumes to as many as 9 other FlashArrays.

On-Premise FlashArray and hybrid Cloud Block Store deployments can be configured to replicate snapshots to multiple other Pure Storage Purity based deployments to enable disaster recovery over multiple sites or availability zones.



Many to One snapshot and volume replication

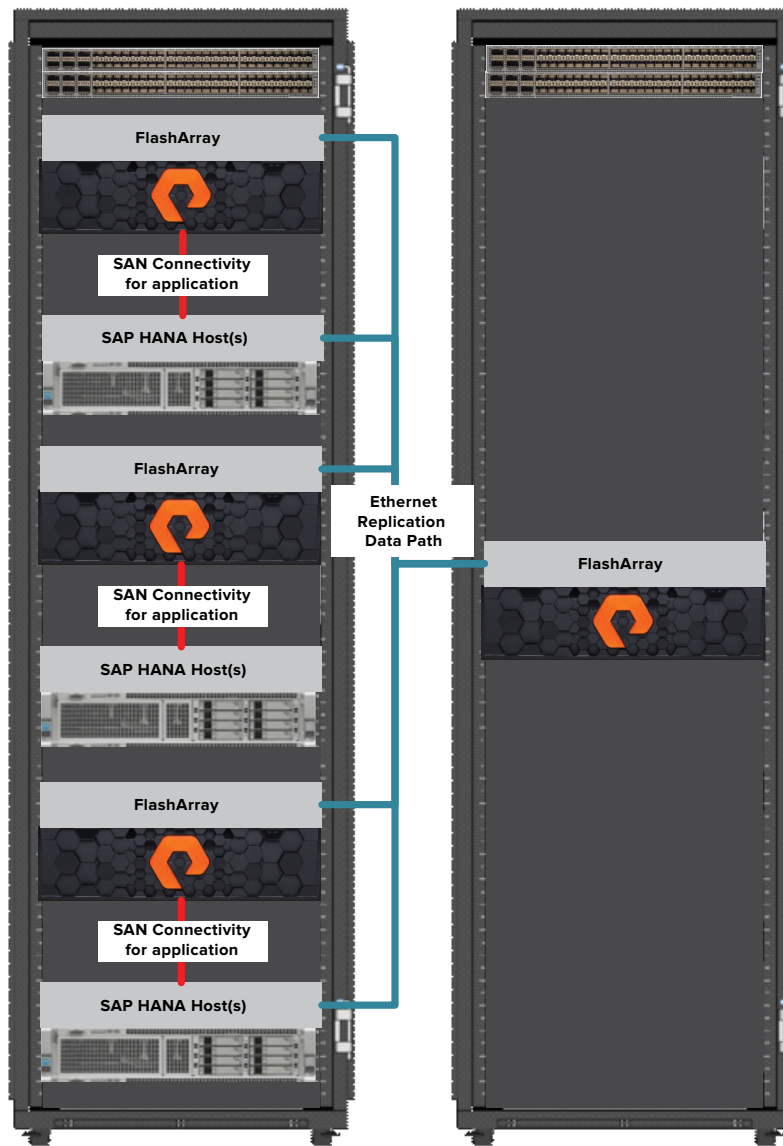


Fig. 8 Many FlashArray systems replicating snapshots and volumes to a single FlashArray.

A single on premise FlashArray or hybrid Cloud Block Store deployment can be used as a single replication target for many other Pure Storage Purity based deployments to centralise business continuity business operations.



Data Protection Solutions for SAP HANA

SAP HANA offers a range of backup types to enable backup and recovery operations. The following backup types are supported by SAP HANA:

Full Backups

Full backups can be performed in one of two ways,

- Backup of the data area streamed off to a local disk, NFS mount or via a supported third-party backup tool using SAP HANA backint.
- Data snapshots where the data persisted in the data area at a particular point in time is created with all of the information required to recover SAP HANA to a consistent state.

Delta backups (incremental and differential backups) can be created after a full backup has been taken (excluding data snapshots) to shorten the amount of time required for a backup window.

Data Snapshots are created in the storage system with minimal impact on database performance and do not consume any additional resources such as memory or compute. Recovery operations from data snapshots are significantly faster than recovery from a streamed backup as it only needs to be made available in the data area of the storage system.

Redo log backups

The architecture of SAP HANA In-memory databases is one which requires the persistence of transaction logs to ensure durability. With each insert, update or delete command executed the operations are serialised and written to the log area. As the log area fills to capacity, in order to ensure both further durability and capacity management, backups of each transaction log need to be made and moved to another storage medium. Once a backup of a transaction log has been created, the space it occupies in the log area can be freed up for further transactions to take its place. If the log area fills to capacity then the SAP HANA database will be unable to process any further transactions and the system will halt until the space is available to create new transaction logs. Transaction logs are rolled up and changes are merged into the persisted data volume every 5 minutes (default) allowing for the data area to be in a consistent state when row or columnar data must be read from storage.

During the recovery of a database both the log area (if it still exists) and any redo log backups can be used to replay transactions which have occurred since the last backup ensuring the database and business data available is in its most recent state.

Backups created using third-part backup tools

Backups created using 3rd party tools use Backint for SAP HANA which is an API focused on integrating backup and recovery, retention and vendor specific parameters directly from SAP HANA's tools. Vendors which develop backint for SAP HANA functionality and support are required to undergo a certification and approval processes by SAP in order to be used in production deployments.



In the instance where the SAP HANA deployment is a virtual machine hosted within a VMware vSphere environment the data protection solution can be done on multiple levels namely data streaming or storage snapshots. However, the data protection solution an organization will choose depends on factors such as SAP HANA deployed on virtual volumes (VVOs) or VMFS based storage.

Application Consistent Storage Snapshots

Overview

In order to create application consistent storage snapshots for SAP HANA databases it is important to note that this operation requires the database instance, operating system and storage system to all be synchronised during execution.

Application consistent snapshots can be manually performed using SAP HANA Studio, a secure shell terminal (SSH) signed in with a user who has read/write and execute permissions to the SAP HANA data volume and the Pure Storage FlashArray web user interface. The process can also be automated using programmatic logic interfacing with SAP HANA database SQL, secure shell bash commands and Pure Storage FlashArrays ReST API or the associated software development kit (SDK).

The process for creating application consistent snapshots differs for systems deployed with multiple database containers (a system with a single tenant is still deployed as MDC), single containers, single host (scale up) and distributed host (scale out) systems. Storage snapshots are only supported by SAP from the SAP HANA 2.0 SPSSPS 04 release and onwards.

Within this section the areas explored will be how storage snapshots for SAP HANA systems can be created manually by a user or automatically for a landscape of different systems and system types. The concepts discussed within each deployment type for automation are high level and can be applied to any scripting or high-level programming language with the relevant libraries and support. It is assumed that any SAP HANA Scale up deployment has a single volume for data and log mount points separate from one another and not configured using logical volume manager. Recovery for each deployment type is also explored.

Required libraries/modules for automation

- A library/module which enables the user to SSH into the SAP HANA system with a username and password
 - Posh-SSH for PowerShell (<https://www.powershellgallery.com/packages/Posh-SSH/2.0.2>)
 - SSH.Net for .Net Languages (<https://github.com/sshnet/SSH.NET>)
 - JSch for Java® (<http://www.jcraft.com/jsch/>)
 - Paramiko for Python® (<https://github.com/paramiko/paramiko>)
- If possible, an SDK to work with the Pure Storage FlashArray ReST API
 - PowerShell SDK for FlashArray – (<https://www.powershellgallery.com/packages/PureStoragePowerShellSDK/1.13.1.12>)
 - Python Pure Storage REST Client – (<https://pypi.org/project/purestorage/>)
 - View the ReST API documentation for FlashArray on the FlashArray Web GUI (Help->REST API Guide)
- A library/module to interact with SAP HANA using the hdbsql query language.
 - SAP HANA Client on Windows® (<https://help.sap.com/viewer/e7e79e15f5284474b965872bf0fa3d63/2.0.01/en-US/68f5b289fab2427e9580a4524071ba96.html>)
 - SAP HANA Client on Linux/UNIX® (<https://help.sap.com/viewer/e7e79e15f5284474b965872bf0fa3d63/2.0.01/en-US/006cc8dc05b2404cb6148493f854b7cb.html>)



Configuration and operation

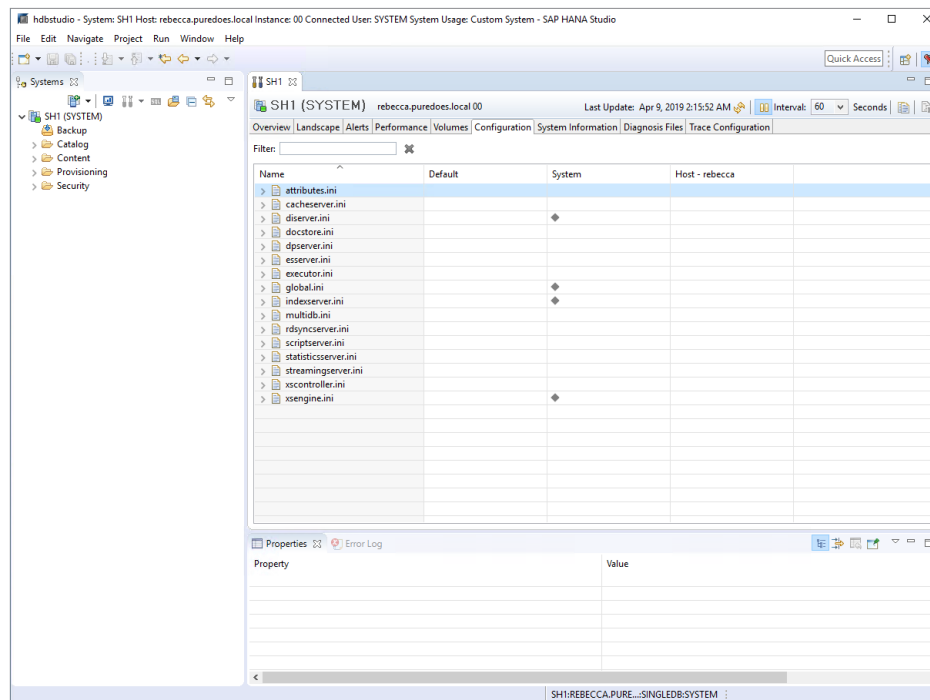
SAP HANA Scale Up / Single host system deployment

MANUAL OPERATION

Step 1. Verify the system type

Using **SAP HANA Studio** connected to the system deployed with the SAP HANA Instance, navigate towards the **configuration** page

SAP HANA Studio, Configuration Page.



Expand **global.ini** and then further expand the **multidb** section. Look for the key **mode** and observe its value. If this value is “singledb” then the system is a single container and if the value is “multidb” the system is then set to be a multiple container system.



In SAP HANA Studio the global.ini file is expanded.

Overview Landscape Alerts Performance Volumes Configuration System Information Diagnosis Files Trace Configuration				
Filter: <input type="text"/> ✕				
Name	Default	System	Host - rebecca	
> [] executor.ini				
▼ [] global.ini		◆		
> [] advisory_file_lock				
> [] auditing_configuration				
> [] authentication				
> [] authorization				
> [] backup				
> [] cache				
> [] cds				
> [] communication				
> [] crashdump				
> [] cross_database_access				
> [] cryptography				
> [] customizable_functionalities				
> [] database_initial_encryption				
> [] debug				
> [] event_handler				
> [] executed_statement				
> [] execution				
> [] expensive_statement				
> [] extended_storage				
> [] fileio				
> [] infile				
> [] infile_checker				

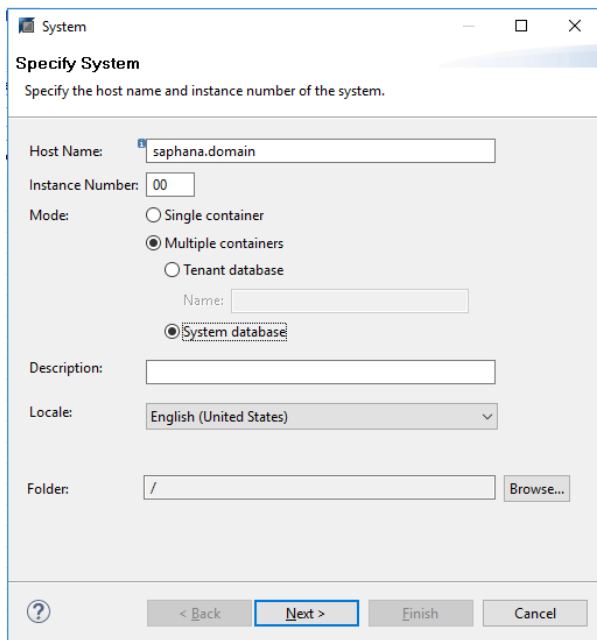
In SAP HANA Studio the multodb section under global.ini shows the system properties.

Overview Landscape Alerts Performance Volumes Configuration System Information Diagnosis Files Trace Configuration				
Filter: <input type="text"/> ✕				
Name	Default	System	Host - rebecca	
> [] ldap				
> [] memorymanager				
> [] memoryobjects				
▼ [] multodb				
database_isolation	low			
enforce_ssl_database_replica	true			
mode	multodb			
reserved_instance_numbers	0			
singletenant	yes			
systemdb_reserved_memory	0			
systemdb_separated_sql_pool	false			
systemdb_sql_listeninterface	.all			
> [] persistence		◆		
> [] public_hostname_resolution				
> [] resource_tracking				
> [] runtime_dump				
> [] self_watchdog				
> [] spark_communication				
> [] storage				
> [] system_information				
> [] system_landscape_hostname_verification				
> [] system_replication				
> [] system_replication_communication				
> [] telemetry				

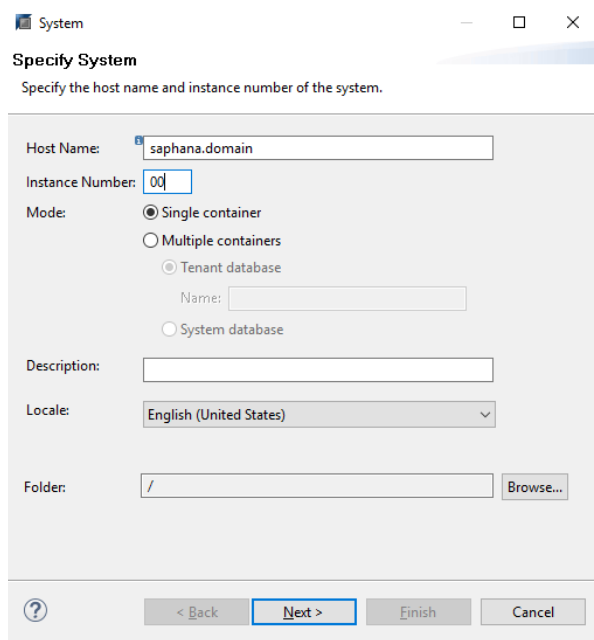
Step 2. Connect to the correct database instance for the creation and management of storage snapshots

If the system is a single database container then ensure that under mode the **Single container** is selected, for a multiple container system ensure that **Multiple containers** is selected, and when available ensure that **System database** is the selected target to connect to. It is important to note that selecting Single container and the mode to connect to will still connect to the single tenant container.

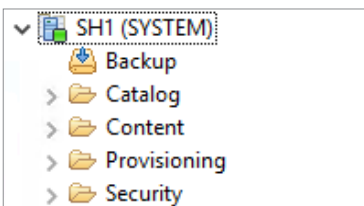
Using SAP HANA Studio connect to a single container system.



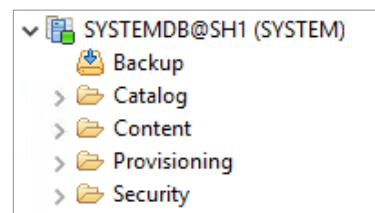
Using SAP HANA Studio connect to the System dataset on a system with multiple containers.



Connected to a single container system.



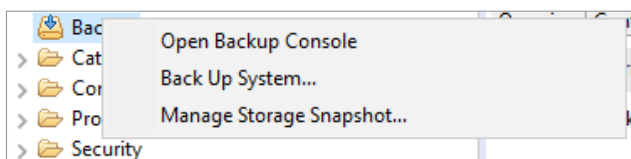
Connected to a multiple container system.



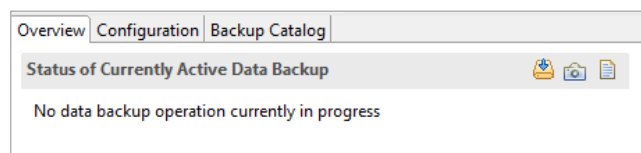
Step 3. Prepare the system for a storage snapshot

This can be done from the backup console or using the side menu by right-clicking on the **Backup** system folder and selecting **Manage Storage Snapshot...**

In SAP HANA Studio right click on the "Backup" system folder and select "Manage Storage Snapshot..."



In SAP HANA Studio and the backup console, select the camera next to "Status of Currently Active Data Backup".



Select Prepare and add a comment if needed, then press the OK button.

Manage Storage Snapshot for System SH1

Manage Storage Snapshot
Prepare, abandon, or confirm a storage snapshot

Status
Currently no snapshot prepared
Start Time:
Size:

Actions
☒ **Prepare**
 Prepare the database for the storage snapshot. After the storage snapshot has been prepared, no other data backup is possible until you have confirmed or abandoned the storage snapshot.
 Comment (Optional): <Today's-Date>
☐ **Confirm**
 Confirm that the storage snapshot has been created and mark the storage snapshot as "successful" in the backup catalog.
 External Backup ID:
☐ **Abandon**
 Abandon the snapshot and mark the storage snapshot as "failed" in the backup catalog.
 Comment (Optional):

OK Cancel

Once the database snapshot is ready then the below will show in the backup console.

Overview Configuration Backup Catalog

Status of Currently Active Data Backup

Preparing the database for a storage snapshot...
 The database is now prepared for a storage snapshot
 Started: Apr 9, 2019 3:11:21 AM (America/Los_Angeles)
 Size: 0 B

After you have created the storage snapshot, you can confirm it or abandon it.

Step 4. Retrieve the SAP HANA prepared storage backup ID using the SQL console in SAP HANA Studio

Use the SQL console for the database instance the prepared snapshot has been created for and run the query:

```
"SELECT BACKUP_ID, COMMENT FROM M_BACKUP_CATALOG WHERE ENTRY_TYPE_NAME = 'data snapshot'
AND STATE_NAME = 'prepared'"
```

This will return the backup ID for the prepared snapshot, which is used in the FlashArray block device snapshot creation as a suffix to link the SAP HANA storage snapshot ID to the Volume snapshot.

In SAP HANA Studio right click on the instance and select "Open SQL Console".

- Configuration and Monitoring >
- Lifecycle Management >
- Backup and Recovery >
- Security >
- SQL** Open SQL Console
- SAP HANA Modeler >
- Add System with Different User...
- Remove Delete
- Log Off
- Refresh F5
- Properties Alt+Enter

In SAP HANA Studio execute the query to return the Backup_ID of the prepared database snapshot.

SQL Result

```
SELECT BACKUP_ID, COMMENT
FROM M_BACKUP_CATALOG
WHERE ENTRY_TYPE_NAME = 'data snapshot'
AND STATE_NAME = 'prepared'
```

The Backup ID is returned with any comments added to the entry, take note of the Backup.

	BACKUP_ID	COMMENT
1	1,554,804,681,328	SNAPSHOT-2019-04-09 03:10:25



Step 5. Freeze the filesystem for the SAP HANA data persistence mount point

Open a terminal (SSH or local to the system) and ensure the prompt is logged in as a user who has read, write and execute permissions on the SAP HANA data persistence mount point. The data persistence mount point can be identified by inspecting the global.ini persistence section for “basepath_datavolumes”. Take the value offered by the global.ini file and remove the database name from the path to only get the base path mount point (this assumes that the SAP HANA systems has been setup with a mount point and single volume each for log and data). We will then use the “fsfreeze” Linux utility to halt any IO to the volume and ensure consistency.

In SAP HANA Studio the multiddb section under global.ini shows the system properties.

Overview	Landscape	Alerts	Performance	Volumes	Configuration	System Information	Diagnosis Files	Trace Configuration
Filter: <input type="text"/> ✕								
Name	Default	System	Host - rebecca					
> [] multiddb								
▼ [] persistence		◆						
basepath_catalogbackup	\$(DIR_INSTANCE)/backup/log							
basepath_databackup	\$(DIR_INSTANCE)/backup/data	● /hana/backup/data						
basepath_databackup_ets	\$(DIR_INSTANCE)/backup/data_ets							
basepath_datavolumes	/hana/data/SH1							
basepath_datavolumes_es	\$(DIR_GLOBAL)/hdb/data_es							
basepath_datavolumes_ets	\$(DIR_GLOBAL)/hdb/data_ets							
basepath_export	\$(DIR_INSTANCE)/work							
basepath_filedownload_rdsync	\$(DIR_GLOBAL)/hdb/data_rdsync/file_transfer/d...							
basepath_fileupload_rdsync	\$(DIR_GLOBAL)/hdb/data_rdsync/file_transfer/u...							
basepath_logbackup	\$(DIR_INSTANCE)/backup/log	● /hana/backup/log						
basepath_logbackup_ets	\$(DIR_INSTANCE)/backup/log_ets							
basepath_logmirror	\$(DIR_GLOBAL)/hdb/logmirror							
basepath_logvolumes	/hana/log/SH1							
basepath_logvolumes_es	\$(DIR_GLOBAL)/hdb/log_es							
basepath_logvolumes_ets	\$(DIR_GLOBAL)/hdb/log_ets							
basepath_shared	yes							
basepath_xsa_appworkspace								
checksum_algorithm	CRC32							
datavolume_stripping	false							
datavolume_stripping_size_gb	2000							
dump_corrupt_pages	true							
enable_auto_log_backup	yes	● yes						
enable_logmirror	false							

Freeze the filesystem of the data persistence mount point using the fsfreeze utility

```
!~ # /sbin/fsfreeze --freeze /hana/data
```

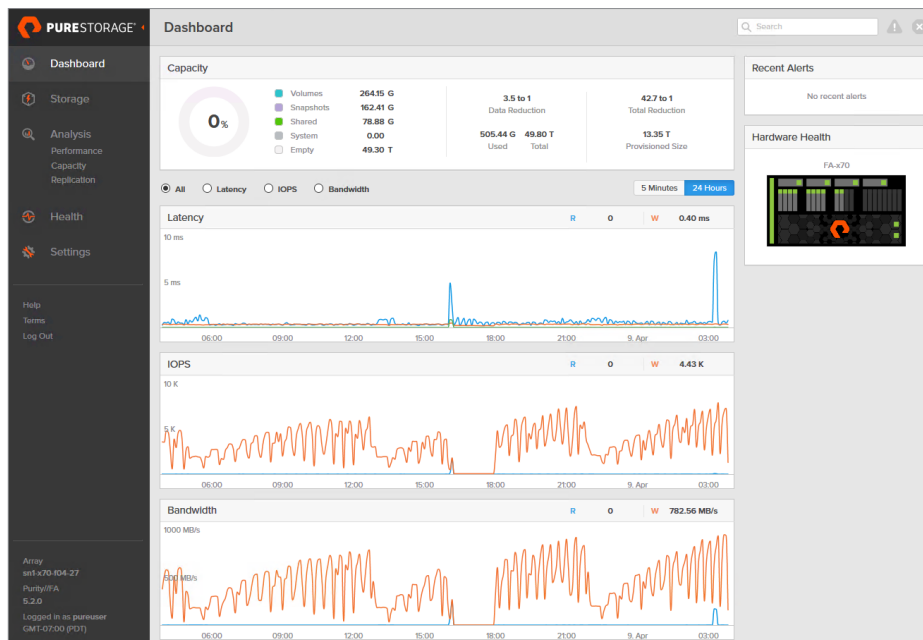
Step 6. Take a snapshot of the block device in the FlashArray

This step is shown using the web based graphical user interface to operate the FlashArray storage device. It is assumed the user can identify the block volume which matches the SAP HANA persistence data volume. In the user interface navigate to **Storage**, select the **Volumes** tab. Select the volume which corresponds to the SAP HANA persistence data volume.

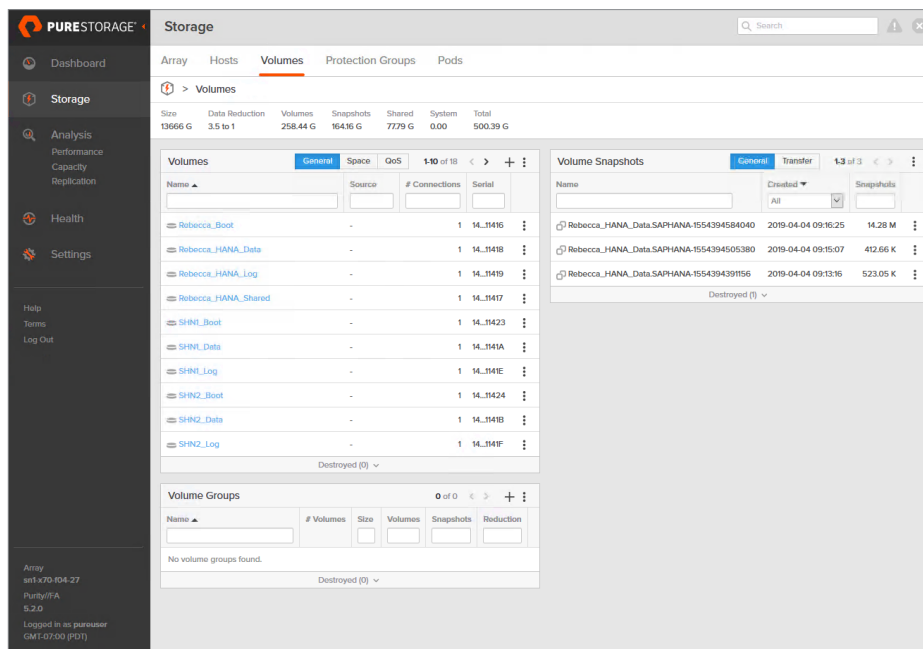
Under **Volume Snapshots**



Pure Storage FlashArray Web Graphical User interface – Main page.



Select Storage and navigate to the “Volumes” section to view all volumes and snapshots.



Select the volume which matches the SAP HANA Data persistence volume and select the “+” next to Volume Snapshots.

The screenshot shows the Pure Storage console interface. The 'Volumes' tab is selected, displaying details for the volume 'Rebecca_HANA_Data'. The 'Volume Snapshots' section shows three existing snapshots and a '+' icon to create a new one.

Name	Created	Size
Rebecca_HANA_Data.SAPHANA-1554394584040	2019-04-04 09:16:25	14.28 M
Rebecca_HANA_Data.SAPHANA-1554394505380	2019-04-04 09:15:07	412.66 K
Rebecca_HANA_Data.SAPHANA-1554394391156	2019-04-04 09:13:16	523.05 K

Create the snapshot with the suffix “SAPHANA-<Backup_ID from SAP HANA prepared snapshot>”

The screenshot shows the 'Create Snapshot' dialog box. The 'Optional Suffix' field contains the text 'SAPHANA-155480468,328'. The 'Create' button is highlighted in blue.



The snapshot is created and listed under the Volume snapshots.

The screenshot shows the Pure Storage console interface. The left sidebar contains navigation links: Dashboard, Storage, Analysis (Performance, Capacity, Replication), Health, Settings, Help, Terms, and Log Out. The main content area is titled 'Storage' and has tabs for Array, Hosts, Volumes, Protection Groups, and Pods. The 'Volumes' tab is selected, showing a list of volumes. The volume 'Rebecca_HANA_Data' is selected, and its details are shown. The 'Details' section includes Source, Created (2019-04-01 06:25:07), Serial (1441EFCB40254A2B00011418), # Hosts (1), and # Connections (1). The 'Volume Snapshots' section shows a table of snapshots:

Name	Created	Size
Rebecca_HANA_Data.SAPHANA-1554804681328	2019-04-09 03:11:55	162.13 G
Rebecca_HANA_Data.SAPHANA-1554394584040	2019-04-04 09:16:25	14.27 M
Rebecca_HANA_Data.SAPHANA-1554394505380	2019-04-04 09:15:07	412.66 K
Rebecca_HANA_Data.SAPHANA-1554394391156	2019-04-04 09:13:16	523.05 K

Step 7. Unfreeze the filesystem for the SAP HANA data persistence mount point

Open a terminal (SSH or local to the system) and ensure the prompt is logged in as a user who has read, write and execute permissions on the SAP HANA data persistence mount point. The data persistence mount point can be identified by inspecting the global.ini persistence section for “basepath_datavolumes”. Take the value offered by the global.ini file and remove the database name from the path to only get the base path mount point (this assumes that the SAP HANA systems has been setup with a mount point and single volume each for log and data). We will then use the “fsfreeze” Linux utility to resume IO to the volume and allow the database to continue operation.

Unfreeze the filesystem of the data persistence mount point using the fsfreeze utility

```
:~ # /sbin/fsfreeze --unfreeze /hana/data
```



Step 8. Confirm or abandon the snapshot

Confirm or abandon the snapshot in SAP HANA studio, allowing the backup to be marked as valid or invalid. If something has not operated as expected then the snapshot should be abandoned. To confirm the snapshot an External Backup ID must be supplied, the Backup_ID originally offered by the prepared snapshot and used as a suffix for the Block volume storage snapshot is used for the value.

Confirm the Snapshot and supply the External Backup ID, and press OK.

Manage Storage Snapshot for System SH1

Manage Storage Snapshot
Prepare, abandon, or confirm a storage snapshot

Status
Prepared Snapshot: 'SNAPSHOT-2019-04-09 04:26:13'
Start Time: Apr 9, 2019 4:26:26 AM (America/Los_Angeles)
Size: 217.52 GB

Actions

☐ Prepare
Prepare the database for the storage snapshot. After the storage snapshot has been prepared, no other data backup is possible until you have confirmed or abandoned the storage snapshot.
Comment (Optional):

☒ **Confirm**
Confirm that the storage snapshot has been created and mark the storage snapshot as "successful" in the backup catalog.
External Backup ID: 155480468328

☐ Abandon
Abandon the snapshot and mark the storage snapshot as "failed" in the backup catalog.
Comment (Optional):

?

OK Cancel

The backup now shows in the backup catalog as complete.

Backup Catalog

☐ Show Log Backups

☐ Show Delta Backups

Status	Started	Duration	Size	Backup Type	Destination...
	Apr 9, 2019 4:26:26 AM	00h 01m 30s	217.52 GB	Data Backup	Snapshot
	Apr 9, 2019 3:11:21 AM	00h 00m 35s	239.94 GB	Data Backup	Snapshot

AUTOMATED OPERATION

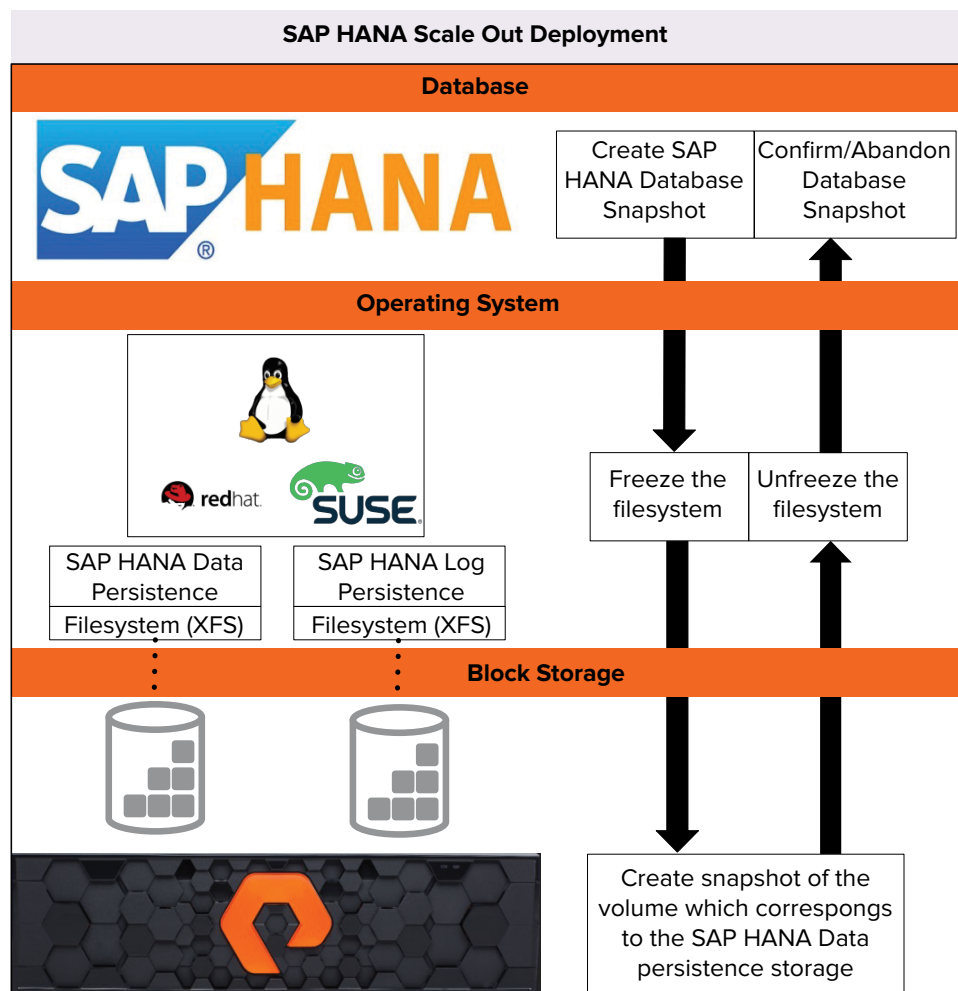


Fig. 9 Workflow to create a storage snapshot for a single host SAP HANA database.



Step 1. Check the SAP HANA System mode

Using the connection string

```
Driver={HDBODBC}; ServerNode=<HostAddress>:3 <InstanceNumber> 15; UID=
<Database User>; PWD=<DatabasePassword>;
```

Connect to the SAP HANA database and run the following query to determine system mode:

```
SELECT VALUE FROM M_INIFILE_CONTENTS WHERE FILE_NAME = 'global.ini' AND
SECTION = 'multidb' AND KEY = 'mode'
```

<pre>SELECT VALUE FROM M_INIFILE_CONTENTS WHERE FILE_NAME = 'global.ini' AND SECTION = 'multidb' AND KEY = 'mode'</pre>		
1	VALUE	multidb

The result will be either “singledb” or “multidb”, if the result is “multidb” then change the connection string to:

```
Driver={HDBODBC}; ServerNode=<HostAddress>:3 <InstanceNumber> 13; UID=
<Database User>; PWD=<DatabasePassword>;
```

Changing the port number allows the application to connect to the System database. In this case the port to connect on for instance 00 would change from 30015 to 30013. In the event of the system running in “singledb” mode, continue to use the original connection string.

Step 2. Determine the block storage volume on FlashArray that corresponds to the SAP HANA persistent data volume mount point in Linux

Using the established connection string run the following query to determine the SAP HANA persistence data volume mount point:

```
SELECT VALUE FROM M_INIFILE_CONTENTS WHERE FILE_NAME = 'global.ini' AND SECTION = 'persistence'
AND KEY = 'basepath_datavolumes' AND VALUE NOT LIKE '%$'
```

<pre>SELECT VALUE FROM M_INIFILE_CONTENTS WHERE FILE_NAME = 'global.ini' AND SECTION = 'persistence' AND KEY = 'basepath_datavolumes' AND VALUE NOT LIKE '%\$'</pre>		
	VALUE	/hana/data/SH1

The value returned will include the database name at the end (e.g. SH1 will correspond to /hana/data/SH1). The mount point needed to interact with is the directory above the database name (e.g. /hana/data/SH1 becomes /hana/data/).



An SSH connection needs to be created to query the operating system for the device serial number for the SAP HANA data persistence volume, once the command line is available for reading and writing we run the “df -h” command to view all mounted volumes and mount points as well as retrieving the device mapper or storage device (sd) the mount point is mapped to. The output of df -h then needs to be piped and “grep” used to isolate the specific entry for the required volume. It is possible to query the /etc/fstab for the same information but the contents of fstab may not always be what the system is working on at that point in time.

```
df -h | grep <SAP HANA Data Persistence mount point>
```

```
Rebecca:~ # df -h | grep /hana/data
/dev/mapper/3624a93701441efcb40254a2b00011418-part1 1.0T 470G 554G 46% /hana/data
```

Once the device the mountpoint corresponds to has been isolated, udevadm is then queried for the serial number known as “DM_SERIAL” in its output using the command:

```
udevadm info --query=all --name<device name> | grep DM_SERIAL
```

```
Rebecca:~ # udevadm info --query=all --name=/dev/mapper/3624a93701441efcb40254a2b00011418-part1 | grep DM_SERIAL
E: DM_SERIAL=3624a93701441efcb40254a2b00011418
```

Using the serial number returned for the device, it is possible to match it up to the block storage volume a FlashArray. Note that the block volume serial number will be all of the characters after “3624a9370”

Step 3. Prepare the database snapshot and retrieve the backup ID for it

Using the established connection string to execute the query needed to prepare a database snapshot.

```
BACKUP DATA FOR FULL SYSTEM CREATE SNAPSHOT COMMENT 'SNAPSHOT-<Snapshot Time>
```

To retrieve the backup ID, execute the following query:

```
SELECT BACKUP_ID, COMMENT FROM M_BACKUP_CATALOG WHERE
ENTRY_TYPE_NAME = 'data snapshot' AND STATE_NAME = 'prepared'
```

	BACKUP_ID	COMMENT
1	1,554,804,681,328	SNAPSHOT-2019-04-09 03:10:25

Step 4. Freeze the filesystem

An SSH connection needs to be created with the operating system on which the SAP HANA instance is installed to execute command line arguments. To freeze the filesystem the fsfreeze utility will be used as it supports EXT3/4, ReiserFS, JFS and XFS. The mount point retrieved in step 2 will be used during the freeze operation.

```
/sbin/fsfreeze --freeze <path to mount point> /sbin/fsfreeze --freeze <path to mount point>
```

```
Rebecca:~ # /sbin/fsfreeze --freeze /hana/data
```



Step 5. Query the relevant FlashArray for a list of its volumes and search them for the serial number contained with the serial number returned by step 2, then create a snapshot once the volume has been located

```
$Array = New-PfaArray -EndPoint $FlashArrayAddress -username $User -Password  
$Password -IgnoreCertificateError  
$Volumes = Get-PfaVolumes -Array $Array
```

Example of PowerShell using the Pure Storage PowerShell SDK

```
$VolumeSnapshot = New-PfaVolumeSnapshots -Array $Array -Sources $volume.name -Suffix $SnapshotSuffix
```

Once the correct volume has been found create a snapshot with a specified Snapshot suffix

```
return $VolumeSnapshot.serial
```

Return the serial number for the volume to be used as a reference when confirming or abandoning the snapshot

Step 6. Unfreeze the filesystem

An SSH connection needs to be created with the operation system on which the SAP HANA instance is installed to execute command line arguments. To unfreeze the filesystem, use the same mount point used in step 3.

```
/sbin/fsfreeze --unfreeze <path to mount point>
```

```
:~ # /sbin/fsfreeze --unfreeze /hana/data
```

Step 7. Confirm or abandon the database snapshot

Using the connection string established in step 1, confirm or abandon the snapshot using hdbsql commands:

```
BACKUP DATA FOR FULL SYSTEM CLOSE SNAPSHOT BACKUP_ID <External Backup ID> SUCCESSFUL;
```

Confirm the snapshot if all of the previous steps executed successfully.

```
BACKUP DATA FOR FULL SYSTEM CLOSE SNAPSHOT BACKUP_ID <Prepared database snapshot backup ID>  
UNSUCCESSFUL <additional comments>;
```

Abandon the snapshot if one of the previous steps did not execute successfully.



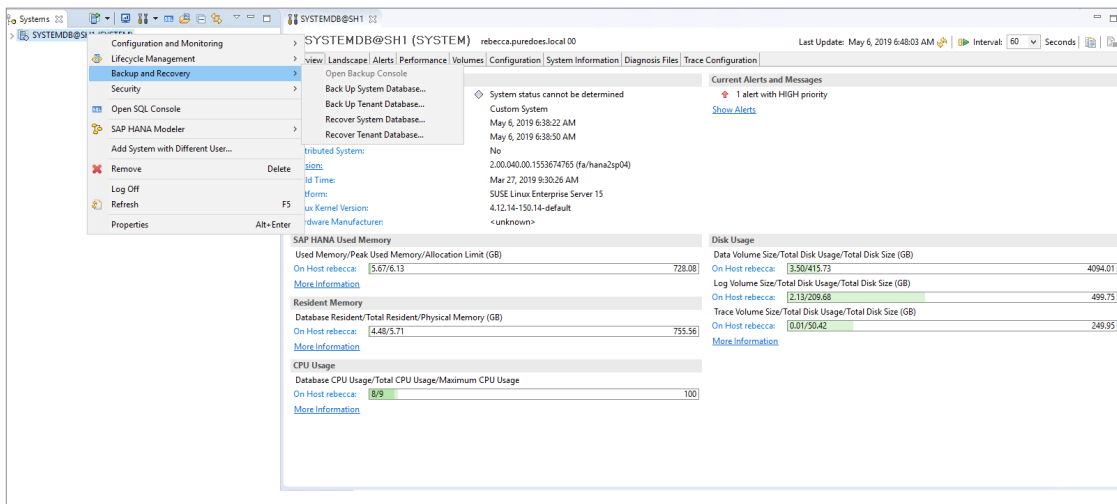
RECOVERY PROCESS

The recovery process for a storage snapshot will restore the SAP HANA instance and all of the data to the point in time at which the storage snapshot was taken. It is important to note that the recovery of a system using storage snapshots with multiple database containers (MDC) is only supported from SAP HANA 2.0 SPS04.

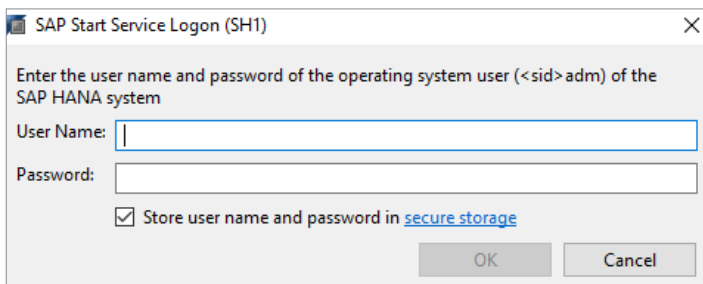
SAP HANA Studio Step 1. Prepare to Recover System Database (MDC systems only)

Navigate to the Systems inventory and right-click on the SystemDB connection for the relevant database and navigate to the Backup and Recovery sub menu then select “Recover System Database...”. A prompt to shut down the relevant system will be shown as recovery can only be done when it is offline.

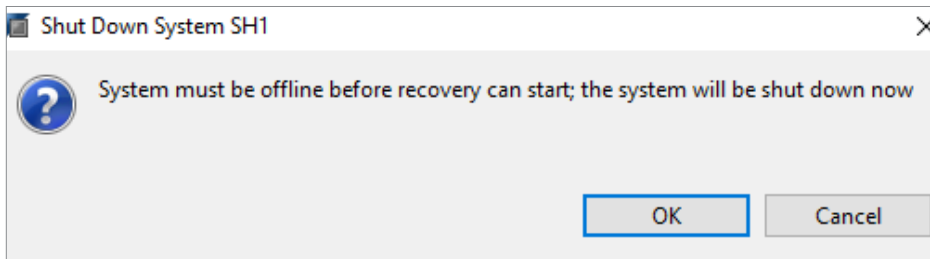
Navigate to the systems inventory , right click the SystemDB and navigate to Backup and Recovery > Recover System Database...



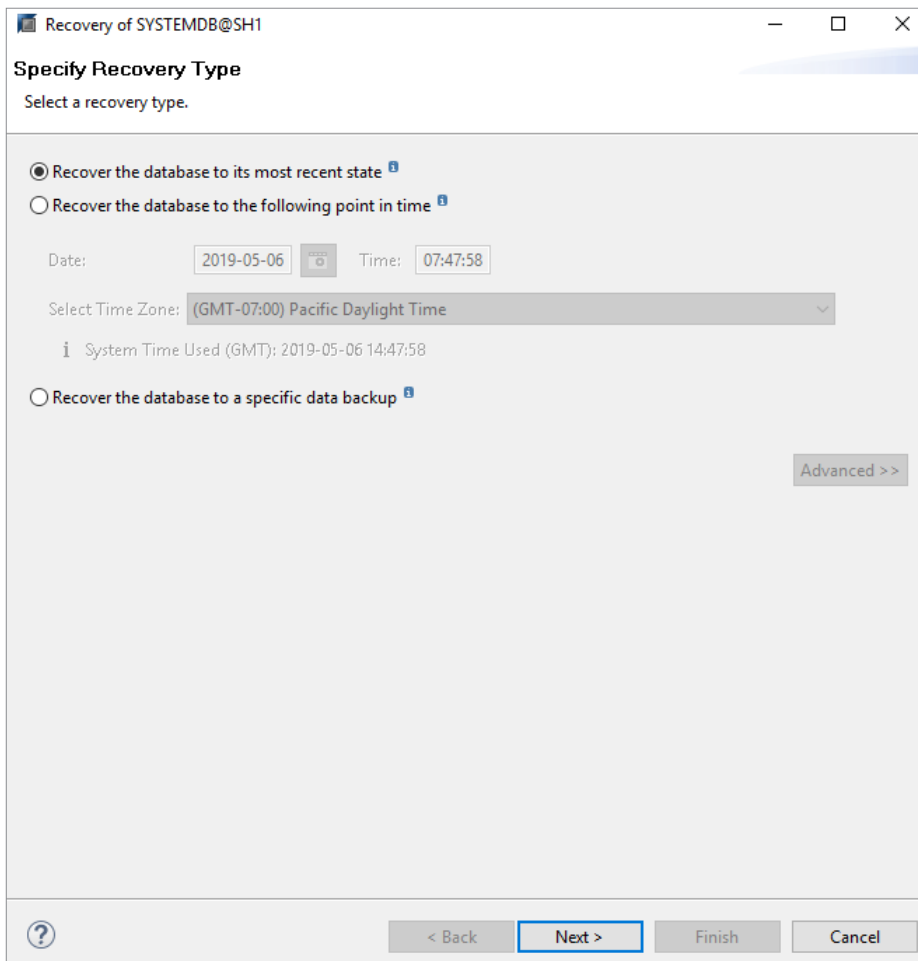
Enter the relevant values for the <sid>adm user created during initial SAP HANA installation.



SAP HANA studio will display a prompt to shut down the system.



The graphical process gives the user an option of choosing a recovery type.



The location of the backup catalog is normally populated, only change this under specialized circumstances where the recovery catalog is in a different location.

The screenshot shows a Windows-style dialog box titled "Recovery of SYSTEMDB@SH1". The main heading is "Locate Backup Catalog" with the instruction "Specify location of the backup catalog." Below this, there are two radio button options: "Recover using the backup catalog" (which is selected) and "Recover without the backup catalog". Under the selected option, there is a sub-option "Search for the backup catalog in the file system only" (also selected) and a text field labeled "Backup Catalog Location:" containing the path "/usr/sap/SH1/HDB00/backup/log/SYSTEMDB". Below these options is a section titled "Backint System Copy" containing a checkbox labeled "Backint System Copy" (which is unchecked) and a text field labeled "Source System:". At the bottom of the dialog, there is a help icon (question mark in a circle) on the left and four buttons: "< Back", "Next >" (highlighted with a blue border), "Finish", and "Cancel".

All records in the catalog will be shown with the relevant information, take note of the Backup ID for the required recovery point.

[illegible]

SAP HANA Studio Step 1a. Recover block storage volume

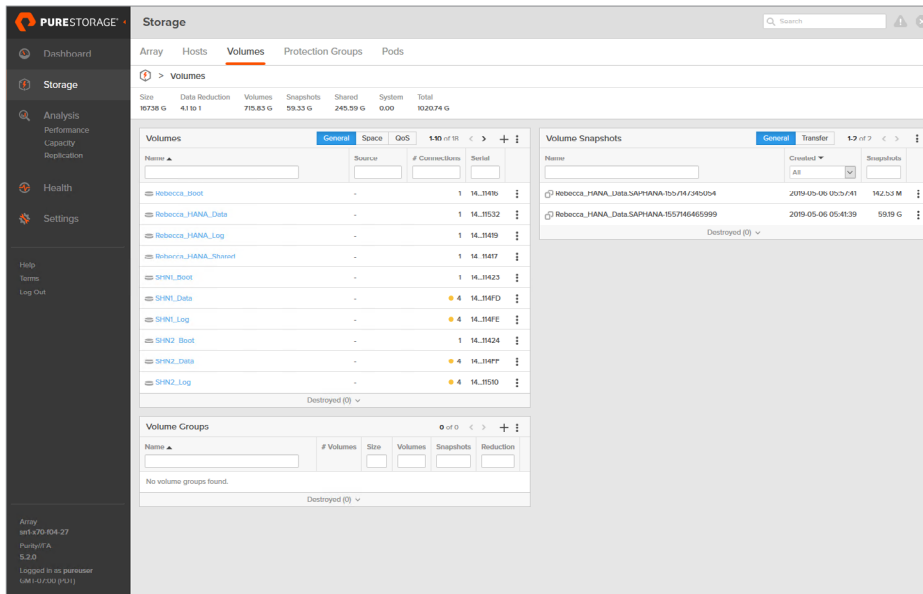
Recover the relevant storage volume using the FlashArray web user interface. This operation can also be completed using the command line interface or ReST API.

Important: The persistence data volume must be unmounted from the operating system before a snapshot is restored. This can be done using the “umount” command in a terminal or SSH connection.

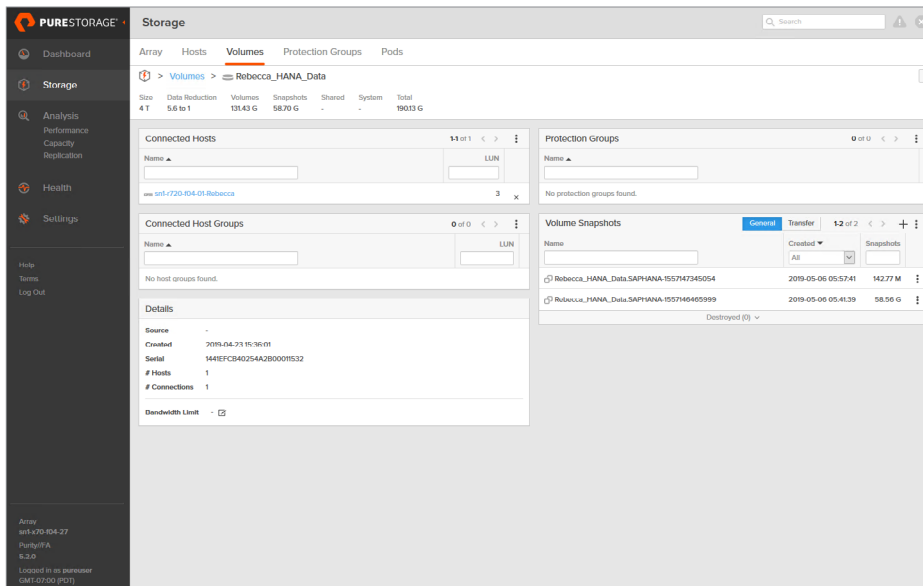
SSH command to unmount the volume at the specified location.

```
:~ # umount /hana/data
```

Navigate to the FlashArray web user interface and select “Storage” from the sidebar and then navigate to the “Volumes” section.



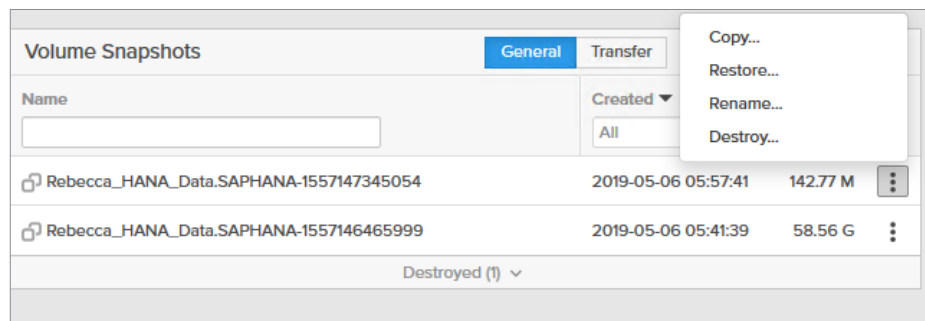
Navigate to the block volume on which the relevant hosts SAP HANA data volume is located.



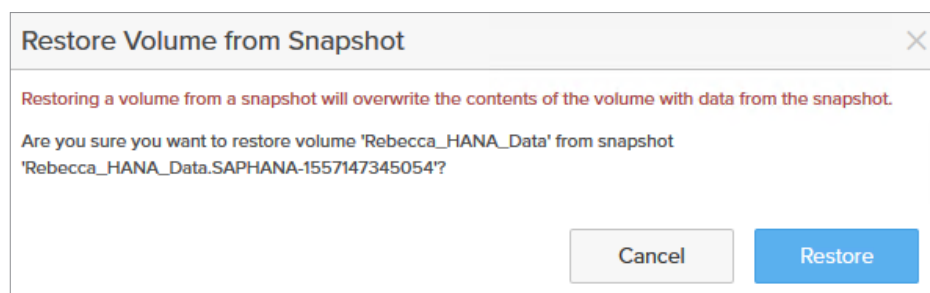
Important: The snapshot which matches the “Backup ID” in the catalog is appended with the exact same value, this is the volume which should be restored. Note that the addition of this value is done during storage snapshot creation by the user.



Select the 3 vertical dots to bring up the context menu and select Restore...



Check the snapshot to be restored matches the requirements for this recovery scenario and then confirm the operation by selecting "Restore".



Return to the SSH connection and remount the volume to the SAP HANA data location. This assumes that the correct values in /etc/fstab are present.

```
:~ # mount /hana/data/
```

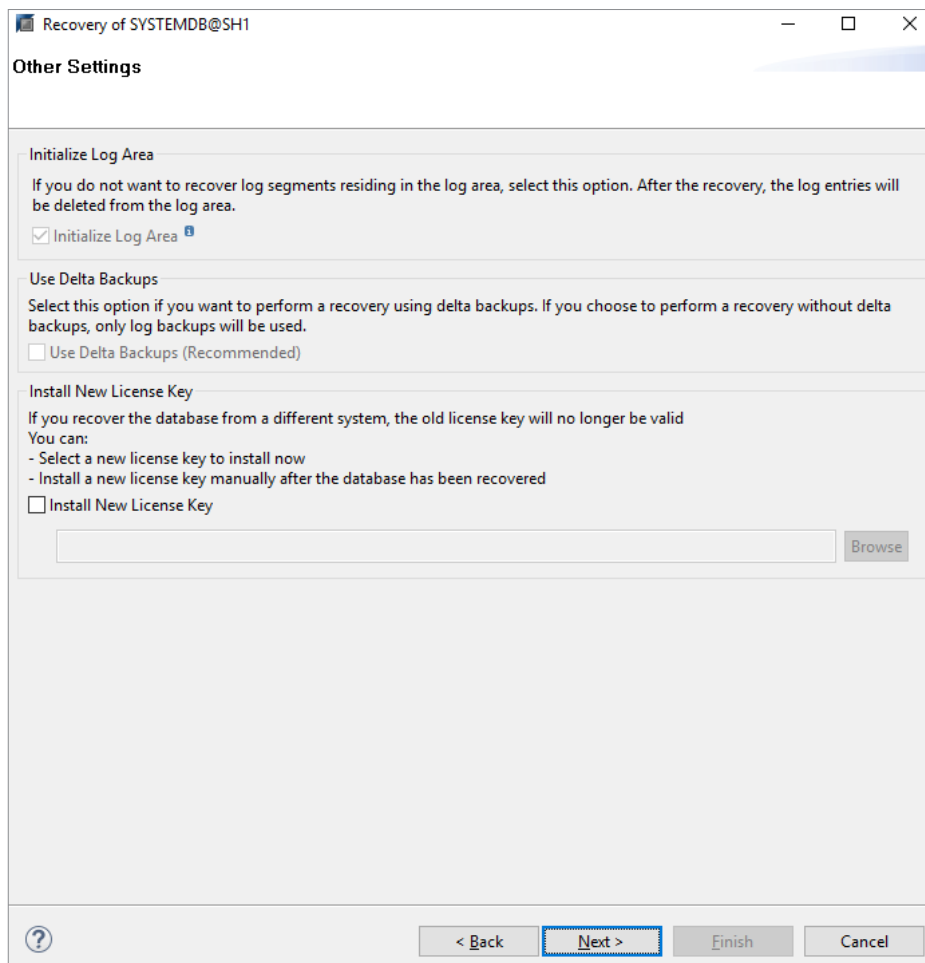


SAP HANA Studio Step 1b. Recover the System Database

Select “Refresh” from the Recovery window in SAP HANA studio and the relevant recovery point should be shown as available, then select “Next” to proceed.

[illegible]

Review the relevant settings for “Initialize Log Area”, “Use Delta Backups” and “Install New License Key”. In some scenarios these selections will be greyed out depending on the recovery type.

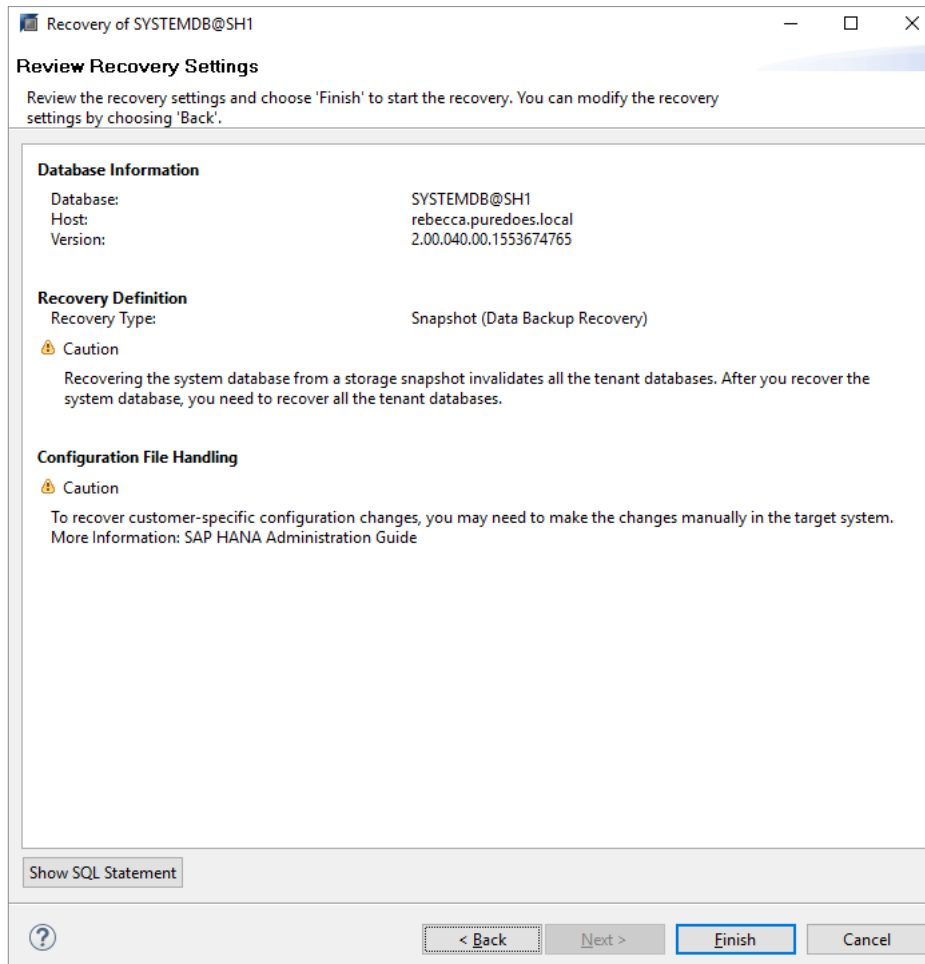


The screenshot shows a window titled "Recovery of SYSTEMDB@SH1" with standard Windows window controls. The main content area is titled "Other Settings" and contains three sections:

- Initialize Log Area**
If you do not want to recover log segments residing in the log area, select this option. After the recovery, the log entries will be deleted from the log area.
☒ Initialize Log Area ⓘ
- Use Delta Backups**
Select this option if you want to perform a recovery using delta backups. If you choose to perform a recovery without delta backups, only log backups will be used.
☐ Use Delta Backups (Recommended)
- Install New License Key**
If you recover the database from a different system, the old license key will no longer be valid
You can:
- Select a new license key to install now
- Install a new license key manually after the database has been recovered
☐ Install New License Key
Below this checkbox is a text input field and a "Browse" button.

At the bottom of the window is a navigation bar with a help icon (question mark), and four buttons: "< Back", "Next >" (which is highlighted with a blue border), "Finish", and "Cancel".

Review all of the recovery settings and proceed by selecting “finish”.



The screenshot shows a window titled "Recovery of SYSTEMDB@SH1". Inside, there's a section "Review Recovery Settings" with a brief instruction. Below this are three main sections: "Database Information" showing details for SYSTEMDB@SH1, "Recovery Definition" showing a Snapshot recovery type with a caution note, and "Configuration File Handling" with another caution note. At the bottom, there's a "Show SQL Statement" button and a navigation bar with "Back", "Next", "Finish", and "Cancel" buttons. The "Finish" button is highlighted with a blue border.

Recovery of SYSTEMDB@SH1

Review Recovery Settings

Review the recovery settings and choose 'Finish' to start the recovery. You can modify the recovery settings by choosing 'Back'.

Database Information

Database:	SYSTEMDB@SH1
Host:	rebecca.puredoes.local
Version:	2.00.040.00.1553674765

Recovery Definition

Recovery Type: Snapshot (Data Backup Recovery)

Caution


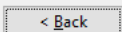

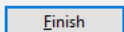
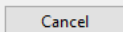
Recovering the system database from a storage snapshot invalidates all the tenant databases. After you recover the system database, you need to recover all the tenant databases.

Configuration File Handling

Caution

To recover customer-specific configuration changes, you may need to make the changes manually in the target system. More Information: SAP HANA Administration Guide

Show SQL Statement

SAP HANA Studio Step 2. Recover Tenant Database

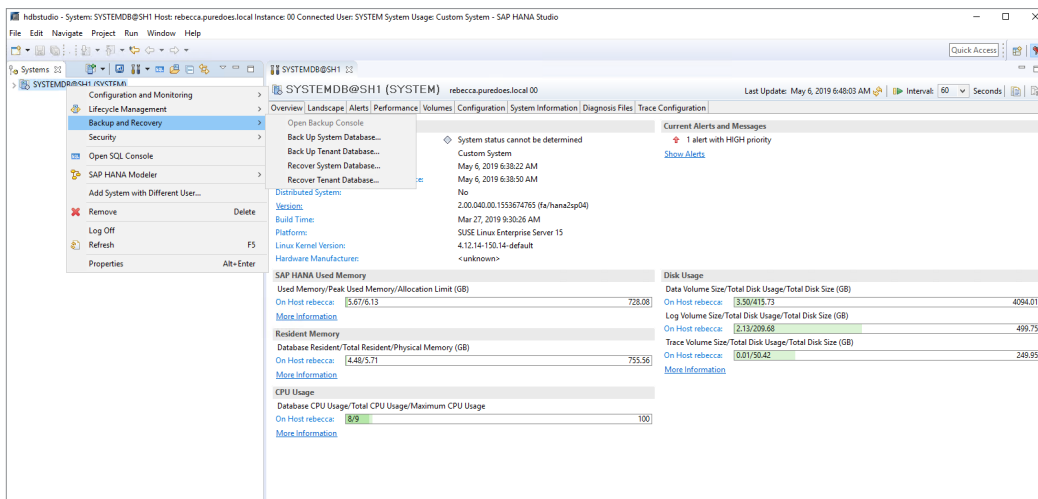
During the recovery of the System database all tenant databases are invalidated and need to be individually recovered by repeating the below steps.

Important: Follow from here if using single container SAP HANA 1.0 system. Notable differences are the absence of “System” and “Tenant” terminology.

Important: In SAP HANA 2.0 SPS04 and onwards repeat these steps for each additional tenant database.

Important: Ensure that Step 1a is completed, while the database is offline, for SAP HANA 1.0 Single tenant systems before proceeding with the below.

Navigate to the main database view in SAP HANA Studio, right click on the relevant database connection, navigate to “Backup and Recovery” and then Select “Recover Tenant Database...”. When using a single container SAP HANA 1.0 system this will simple state “Recover database...”



(MDC Only) Select the tenant database to restore. In SAP HANA 2.0 SPS03 and previous releases only a single tenant system can be restored.

Recovery of Tenant Database in SH1

Specify tenant database

Type filter text

- ☒ SH1
- ☐ SH2
- ☐ SH3
- ☐ SH4

? < Back Next > Finish Cancel

The location of the backup catalog is normally populated, only change this under specialized circumstances where the recovery catalog is in a different location.

The screenshot shows a window titled "Recovery of Tenant Database in SH1". The main heading is "Locate Backup Catalog" with the instruction "Specify location of the backup catalog." Below this, there are two radio button options: "Recover using the backup catalog" (which is selected) and "Recover without the backup catalog". Under the selected option, there is a sub-option "Search for the backup catalog in the file system only" (also selected), followed by a text field labeled "Backup Catalog Location:" containing the path "/usr/sap/SH1/HDB00/backup/log/DB_SH1". Below these options is a section titled "Backint System Copy" containing a checkbox labeled "Backint System Copy" (which is unchecked) and a text field labeled "Source System:". At the bottom of the window, there is a navigation bar with a help icon, and buttons for "< Back", "Next >", "Finish", and "Cancel". The "Next >" button is highlighted with a blue border.

Accept the prompt to shut down the database.

The screenshot shows a small dialog box titled "Stop Database SH1@SH1". It contains a question mark icon and the text "The database must be offline before recovery can start; the database will be stopped now". At the bottom right, there are two buttons: "OK" and "Cancel". The "OK" button is highlighted with a blue border.

The relevant recovery point should be shown as available, then select “Next” to proceed.

Recovery of Tenant Database in SH1

Select a Backup

Select a backup to recover the SAP HANA database

Selected Point in Time

Database will be recovered to its most recent state.

Backups

The overview shows backups that were recorded in the backup catalog as successful. The backup at the top is estimated to have the shortest recovery time.

Start Time	Location	Backup Prefix	Available
2019-05-06 05:55:45	/hana/data/SH1	SNAPSHOT	
2019-05-06 05:41:05	/hana/data/SH1	SNAPSHOT	

<

>

Refresh

Show More

Details of Selected Item

Start Time: 2019-05-06 05:55:45 Destination Type: SNAPSHOT Source System: SH1@SH1

Size: 0 B Backup ID: 15571473450 External Backup ID: 1441EFCB40254A2B00011!

Backup Name: /hana/data/SH1

Alternative Location:

Check Availability

< Back

Next >

Finish

Cancel



The log backup location is typically populated with the system default values, only change these values in specialised circumstances.

The screenshot shows a window titled "Recovery of Tenant Database in SH1" with standard window controls (minimize, maximize, close). The main heading is "Locate Log Backups". Below it, a subtitle reads "Specify location(s) of log backup files to be used to recover the database." An information icon (i) is followed by the text: "Even if no log backups were created, a location is still needed to read data that will be used for recovery." Below this, a paragraph explains: "If the log backups were written to the file system and subsequently moved, you need to specify their current location. If you do not specify an alternative location for the log backups, the system uses the location where the log backups were first saved. The directory specified will be searched recursively." The "Locations:" label is followed by a text input field containing "/hana/backup/log/DB_SH1". To the right of the input field are three buttons: "Add", "Remove All", and "Remove". At the bottom left is a help icon (?). At the bottom right are four buttons: "< Back", "Next >", "Finish", and "Cancel". The "Next >" button is highlighted with a blue border.

Recovery of Tenant Database in SH1

Locate Log Backups

Specify location(s) of log backup files to be used to recover the database.

❗ Even if no log backups were created, a location is still needed to read data that will be used for recovery.

If the log backups were written to the file system and subsequently moved, you need to specify their current location. If you do not specify an alternative location for the log backups, the system uses the location where the log backups were first saved. The directory specified will be searched recursively.

Locations:

Add Remove All Remove

? < Back Next > Finish Cancel

Review the relevant settings for “Check the availability of delta and log backups”, “Initialize Log Area”, “Use Delta Backups” and “Install New License Key”. In some scenarios these selections will be greyed out depending on the recovery type.

Recovery of Tenant Database in SH1

Other Settings

Check Availability of Delta and Log Backups
You can have the system check whether all required delta and log backups are available at the beginning of the recovery process. If delta or log backups are missing, they will be listed and the recovery process will stop before any data is changed. If you choose not to perform this check now, it will still be performed but later. This may result in a significant loss of time if the complete recovery must be repeated.
Check the availability of delta and log backups:
☒ File System [?]
☐ Third-Party Backup Tool (Backint)

Initialize Log Area
If you do not want to recover log segments residing in the log area, select this option. After the recovery, the log entries will be deleted from the log area.
☐ Initialize Log Area [?]

Use Delta Backups
Select this option if you want to perform a recovery using delta backups. If you choose to perform a recovery without delta backups, only log backups will be used.
☒ Use Delta Backups (Recommended)

Install New License Key
If you recover the database from a different system, the old license key will no longer be valid
You can:
- Select a new license key to install now
- Install a new license key manually after the database has been recovered
☐ Install New License Key

Browse



Review all of the recovery settings and proceed by selecting “finish”.

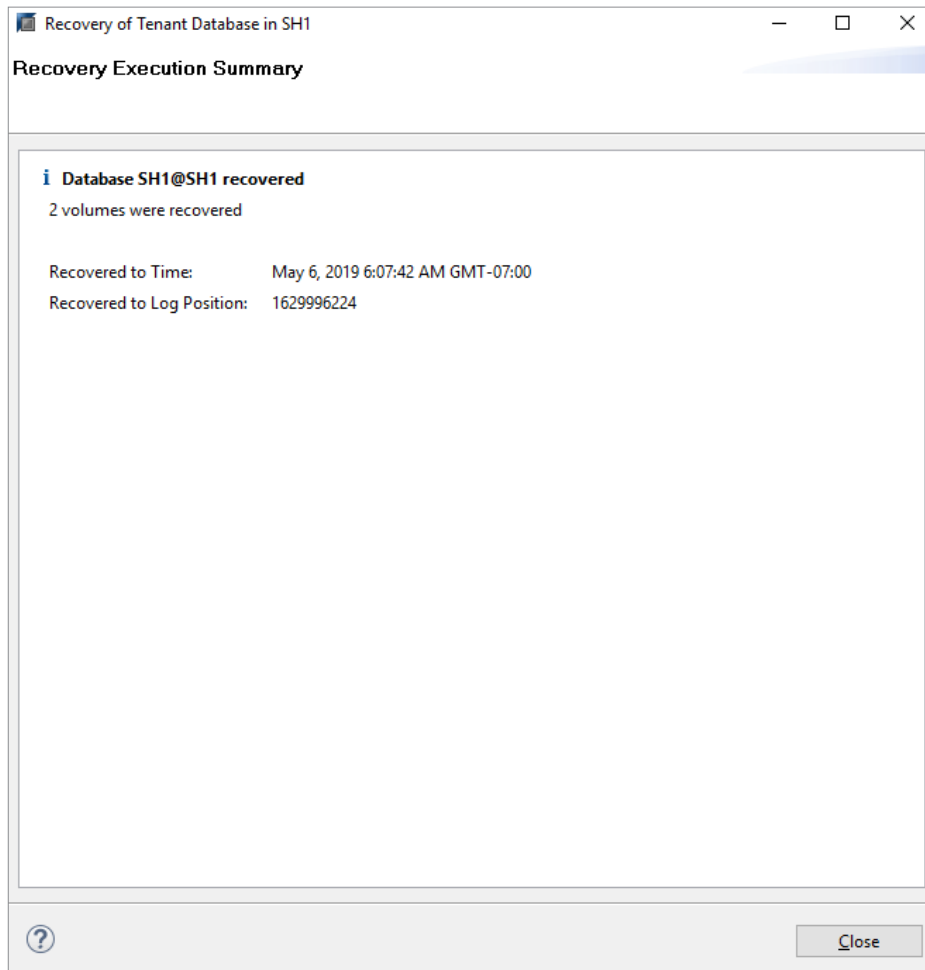
The screenshot shows a window titled "Recovery of Tenant Database in SH1" with standard window controls. The main heading is "Review Recovery Settings". Below it, a message states: "Review the recovery settings and choose 'Finish' to start the recovery. You can modify the recovery settings by choosing 'Back'".

The settings are organized into three sections:

- Database Information**
 - Database: SH1@SH1
 - Host: rebecca.puredoes.local
 - Version: 2.00.040.00.1553674765
- Recovery Definition**
 - Recovery Type: Snapshot (Point-in-Time Recovery (Until Now))
- Configuration File Handling**
 - Caution (Warning icon): To recover customer-specific configuration changes, you may need to make the changes manually in the target system.
 - More Information: SAP HANA Administration Guide

At the bottom left, there is a button labeled "Show SQL Statement". At the bottom right, there are four buttons: a help button (question mark icon), "< Back", "Next >", and "Finish" (highlighted with a blue border). A "Cancel" button is also present to the right of "Finish".

When recovery is completed the status will be shown.



SAP HANA Cockpit Step 1. Prepare to Recover System Database (MDC systems only)

Navigate to the SAP HANA Cockpit web interface and ensure that all of the relevant information is available for it to interface with the relevant deployment to be restored. SAP HANA Systems can be started and stopped from the cockpit interface, where the database will need to be stopped before a recovery can proceed.

Ensure SAP Control credentials are entered and that the resource for HANA cockpit is connected to the SystemDB. Then select the relevant resource for restore operations.

Resources (1)


Group by System

Status	Resource	Description	Alerts	Group	Availability / Performance / Capacity		Usage Type	Type/Version	Credentials	SAP Control Credentials
<div><div></div><div>Running with issues</div></div>	<div>SYSTEMDB@SH1</div> <div>rebecca.puredoes.local</div> <div>Manage Databases</div>		<div><div></div><div>1</div></div>		<div><div></div></div> <div><div></div></div> <div><div></div></div>	Custom	<div>SAP HANA SYSTEM Database</div> <div>2.00.040.00.155367476</div> <div>5 (fa/hana2sp04)</div>	<div>User: SYSTEM</div> <div>Manage Credentials</div>	<div>User: sh1adm</div> <div>Manage Credentials</div>	


From SAP HANA cockpit choose the overall database status tile and select “stop system”.

Overall Database Status

rebecca.puredoes.local 0

 Running with issues

Related Alerts:

 1 high

Usage Type:

Custom

Description:

Hosts:

1

Services:

5

Stop System



Stop the system using either “softly” or “immediately”.

Stop System

How do you want to stop system SH1?

Softly

Timeout: 5 minutes

Running statements finish executing. If the system doesn't stop within the specified timeout period, there will be an immediate hard stop.

immediately

Stop System

Cancel

Monitor the system processes until all have been shut down.

Service (10)										
Host	Service	Status	Role	Port	Start Time	Service Alerts	Process ID	CPU	Memory	Action
rebecca.puredoes.local	Daemon	Stopping			May 6, 2019, 5:31:04 AM		17957			
	Compileserver	Scheduled								Stop Service
	Nameserver	Scheduled								Stop Service
	Preprocessor	Scheduled								Stop Service
	Web Dispatcher	Scheduled								Stop Service
	Indexserver-SH1	Scheduled								Stop Service
	XSEngine-SH1	Scheduled								Stop Service
	Indexserver-SH2	Scheduled								Stop Service
	Indexserver-SH3	Scheduled								Stop Service
	Indexserver-SH4	Stopping			May 6, 2019, 5:38:11 AM		20845			Stop Service

Once all of the system has shut down, select the relevant resource.

SAP

SAP HANA Cockpit

Resource Directory

Default

Manage Resources

Search

Status: All

Alerts: All

Group: All

Usage Type: All

Type: All

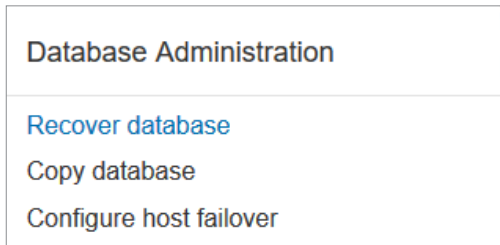
Restore

Adapt Filters

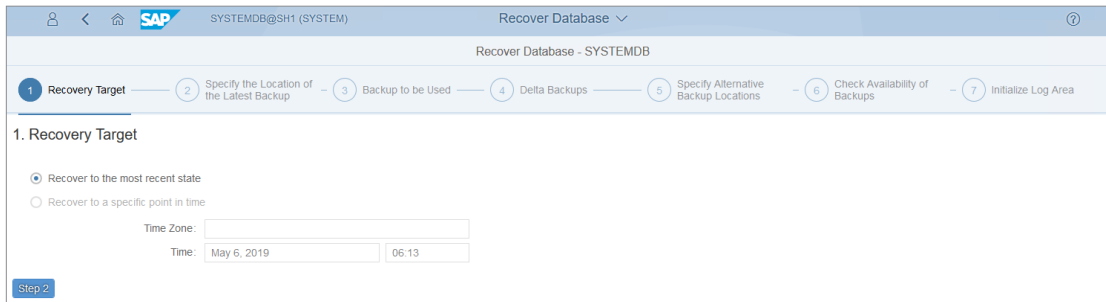
Resources (1)									
Status	Resource	Description	Alerts	Group	Availability / Performance / Capacity	Usage Type	Type/Version	Credentials	SAP Control Credentials
Stopped	SYSTEMDB@SH1	rebecca.puredoes.local				Custom	SAP HANA SYSTEM Database 2.00.040.00.1553674765 (fa/hana2sp04)	User: SYSTEM	User: sh1adm Manage Credentials



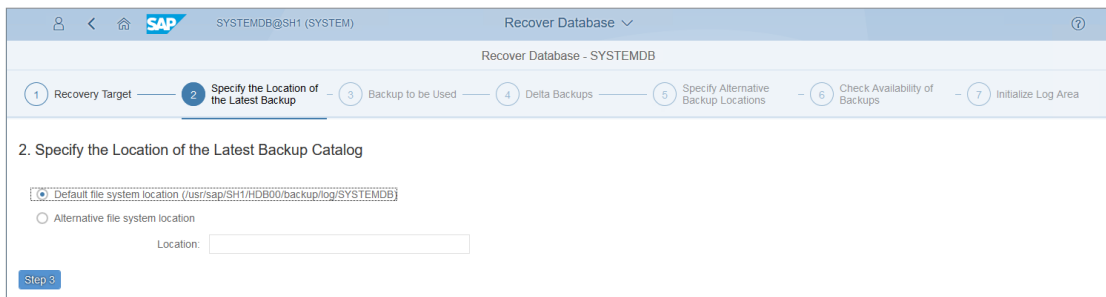
In the “Database Administration” tile, select “Recover database”.



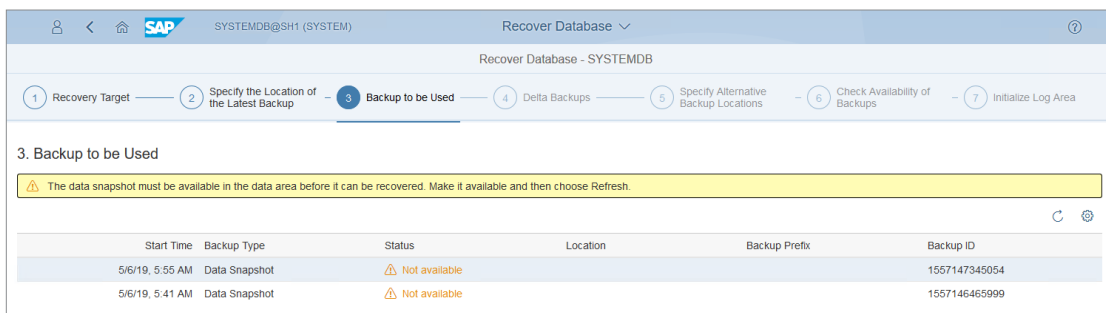
Select the recovery target type.



Specify the location of the latest backup catalog, only change these values under specialised circumstances.



Note the “Backup ID” of the backup to be used and its availability.



SAP HANA Cockpit Step 1a. Recover block storage volume

Recover the relevant storage volume using the FlashArray web user interface. This operation can also be completed using the command line interface or ReST API.

Important: The persistence data volume must be unmounted from the operating system before a snapshot is restored. This can be done using the “umount” command in a terminal or SSH connection.

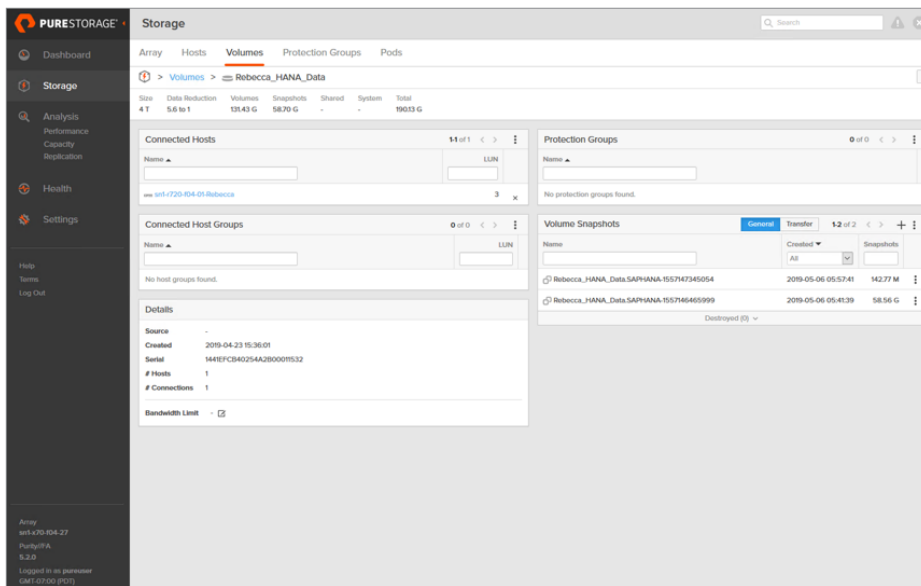
SSH command to unmount the volume at the specified location.

```
:~ # umount /hana/data
```

Navigate to the FlashArray web user interface and select “Storage” from the sidebar and then navigate to the “Volumes” section.

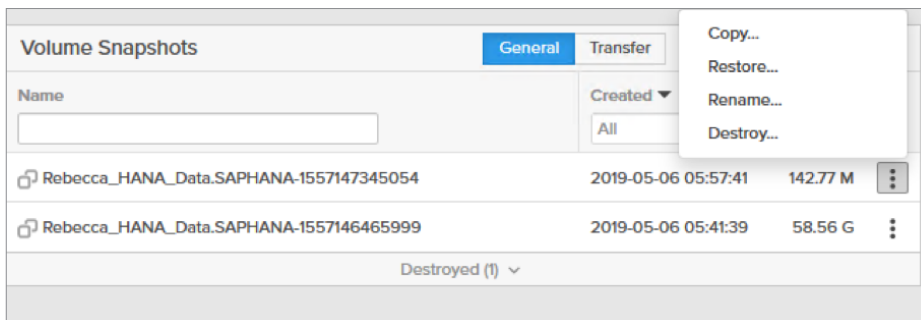
The screenshot displays the Pure Storage FlashArray web interface. The left sidebar shows the navigation menu with 'Storage' selected. The main content area is titled 'Storage' and shows a summary of system metrics: Size (16728 G), Data Reduction (43 to 1), Volumes (755.83 G), Snapshots (59.33 G), Shared (245.59 G), System (0.00), and Total (1020.74 G). Below this, there are three sections: 'Volumes', 'Volume Snapshots', and 'Volume Groups'. The 'Volumes' section lists various volumes with columns for Name, Source, # Connections, and Serial. The 'Volume Snapshots' section shows a list of snapshots with columns for Name, Created, and Snapshots. The 'Volume Groups' section shows a table with columns for Name, # Volumes, Size, Volume, Snapshots, and Reduction. The interface is clean and professional, with a dark sidebar and a light main content area.

Navigate to the block volume on which the relevant hosts HANA data volume is located.

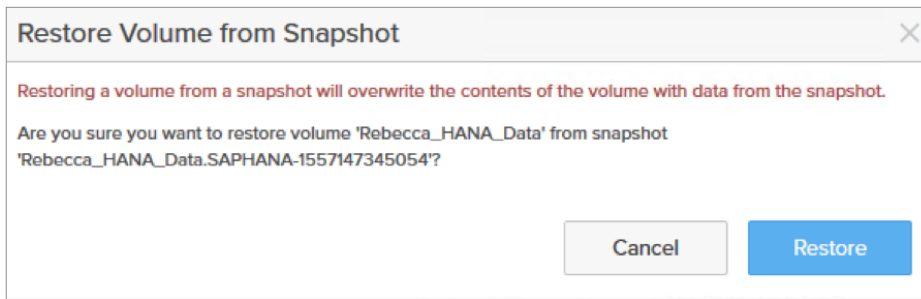


Important: The snapshot which matches the “Backup ID” in the catalog is appended with the exact same value, this is the volume which should be restored. Note that the addition of this value is done during storage snapshot creation by the user.

Select the 3 vertical dots to bring up the context menu and select Restore...



Check the snapshot to be restored matches the requirements for this recovery scenario and then confirm the operation by selecting “Restore”.

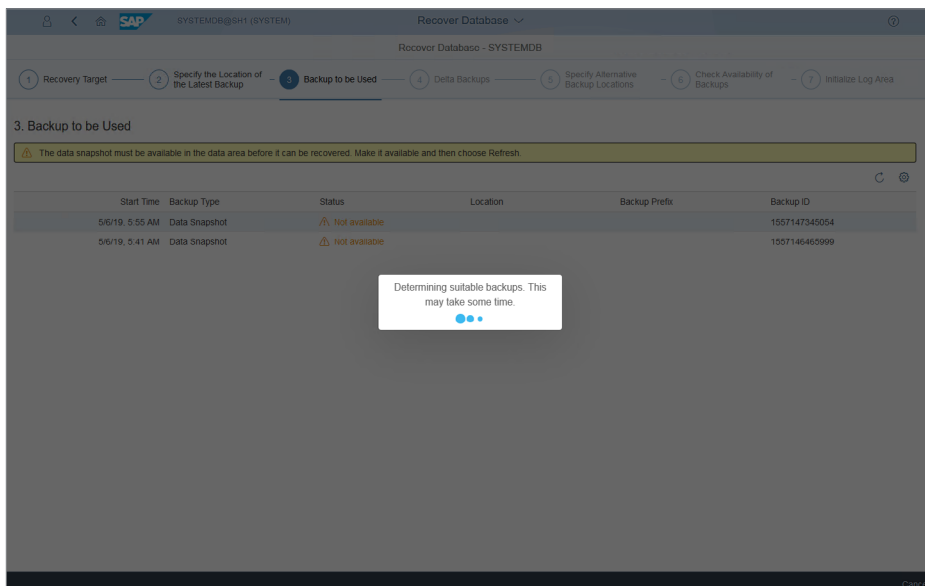


Return to the SSH connection and remount the volume to the HANA data location. This assumes that the correct values in /etc/fstab are present.

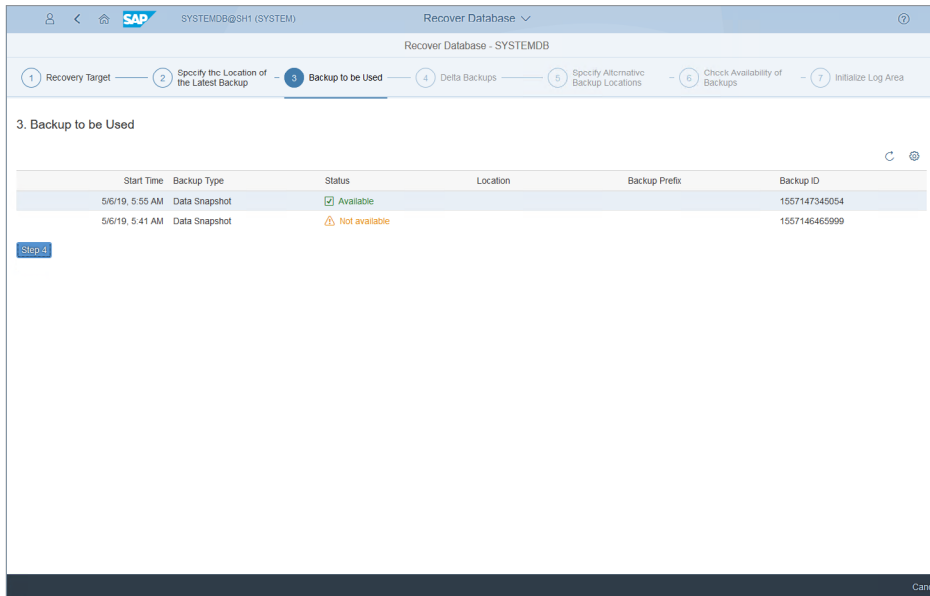
```
:~ # mount /hana/data/
```

SAP HANA Cockpit Step 1b. Recover the System Database

Select the refresh icon in the top right-hand corner under Backups to be Used to rescan the backup catalog.



Once the relevant recovery point has been located it should show as “Available”, select “Step 4” to proceed.

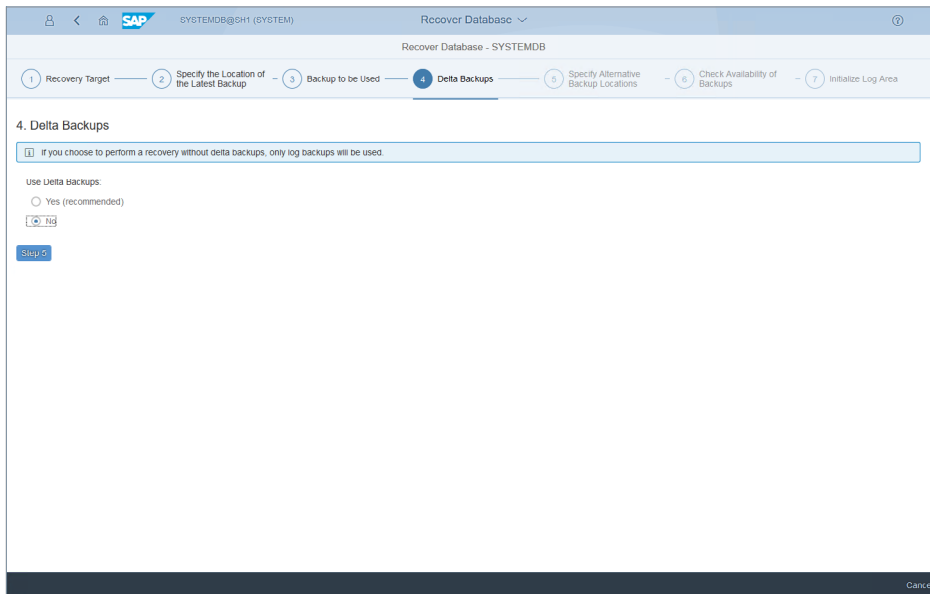


The screenshot shows the 'Recover Database - SYSTEMDB' wizard in SAP. The progress bar at the top indicates the current step is '3. Backup to be Used'. Below the progress bar, the title '3. Backup to be Used' is displayed. A table lists backup information:

Start Time	Backup Type	Status	Location	Backup Prefix	Backup ID
5/6/19, 5:55 AM	Data Snapshot	Available			1557147345054
5/6/19, 5:41 AM	Data Snapshot	Not available			1557146465999

Below the table, a 'Step 4' button is visible. The bottom right corner of the window shows a 'Cancel' button.

Select the preferred value for Delta Backups.



The screenshot shows the 'Recover Database - SYSTEMDB' wizard in SAP. The progress bar at the top indicates the current step is '4. Delta Backups'. Below the progress bar, the title '4. Delta Backups' is displayed. A text box contains the following information:

If you choose to perform a recovery without delta backups, only log backups will be used.

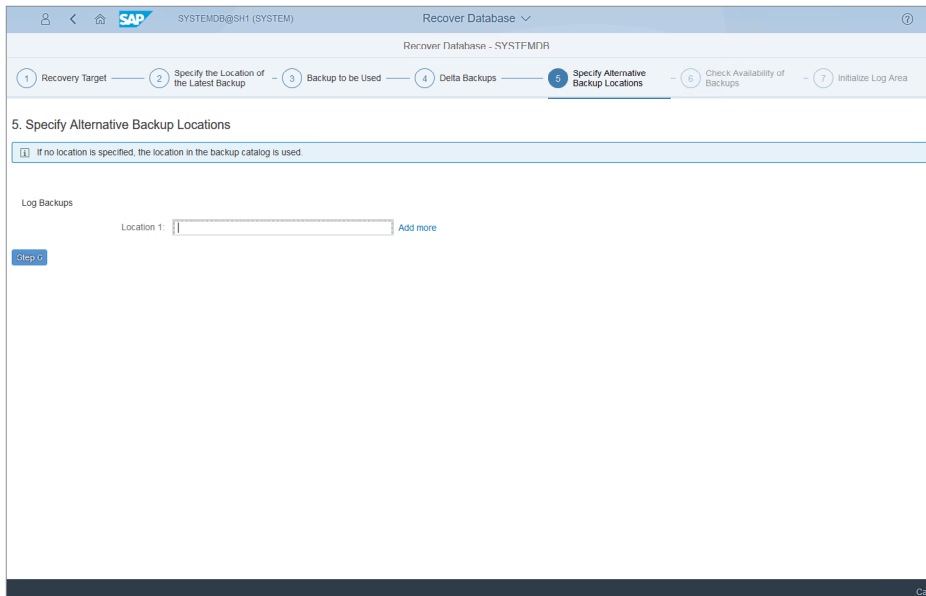
Use Delta backups:

☐ Yes (recommended)

☒ No

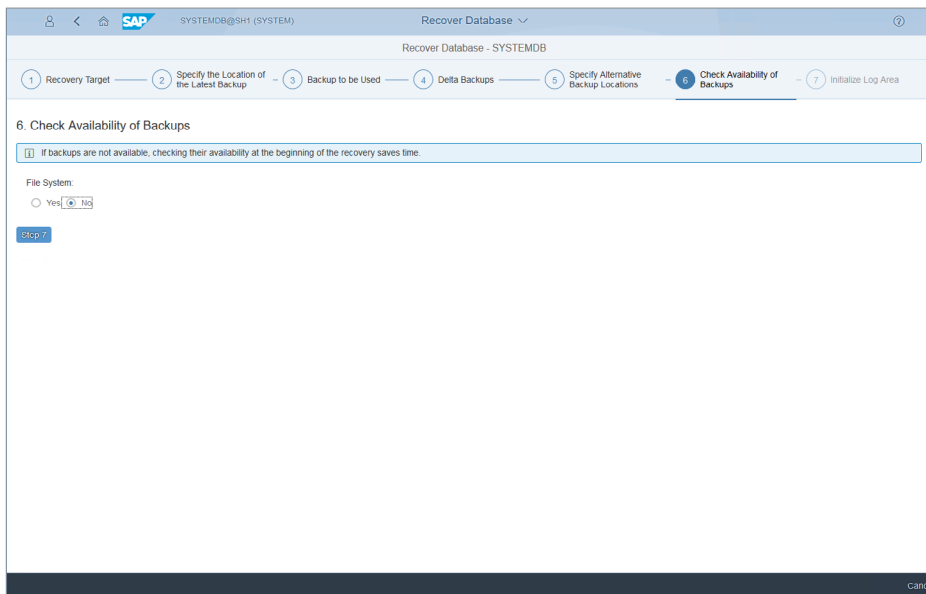
Below the options, a 'Step 5' button is visible. The bottom right corner of the window shows a 'Cancel' button.

Specify any alternative backup locations.



The screenshot shows the SAP 'Recover Database - SYSTEMDBR' wizard at Step 5, 'Specify Alternative Backup Locations'. The progress bar at the top indicates the current step. Below the title, a tip states: 'If no location is specified, the location in the backup catalog is used.' Under the 'Log Backups' section, there is a 'Location 1:' label followed by a text input field and an 'Add more' link. A 'Step 6' button is visible on the left side of the main content area.

Specify if the availability of backups should be checked.



The screenshot shows the SAP 'Recover Database - SYSTEMDB' wizard at Step 6, 'Check Availability of Backups'. The progress bar at the top indicates the current step. Below the title, a tip states: 'If backups are not available, checking their availability at the beginning of the recovery saves time.' Under the 'File System:' section, there is a radio button labeled 'Yes' followed by a checkbox labeled 'No'. A 'Step 7' button is visible on the left side of the main content area.

Specify if the log area should be initialized, doing so invalidates any logs or log backups made after the recovery point.

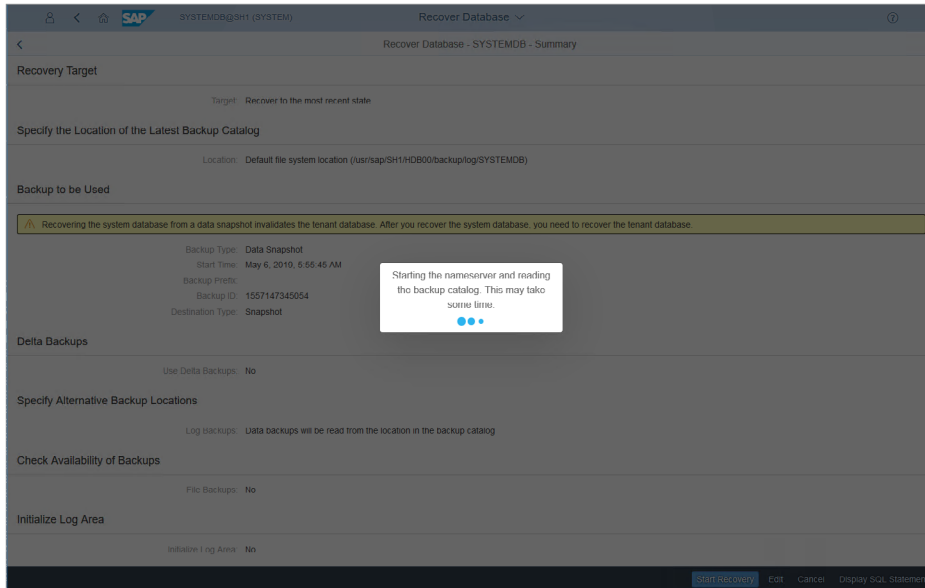
The screenshot shows the 'Recover Database - SYSTEMDB' wizard in SAP. The progress bar at the top indicates seven steps: 1. Recovery Target, 2. Specify the Location of the Latest Backup, 3. Backup to be Used, 4. Delta Backups, 5. Specify Alternative Backup Locations, 6. Check Availability of Backups, and 7. Initialize Log Area. Step 7 is currently active. Below the progress bar, a warning message states: 'If the log area is initialized, all changes performed after the latest log backup are irretrievably lost.' Underneath, the prompt 'Initialize the log area:' is followed by two radio buttons: 'No' (selected) and 'Yes'. A 'Review' button is located at the bottom left of the step content area. The bottom right corner of the window has a 'Cancel' button.

Review the information for the recovery operation and then select “Start Recovery”.

The screenshot displays the 'Recover Database - SYSTEMDB - Summary' screen. It provides a comprehensive overview of the recovery configuration. The 'Recovery Target' is set to 'Recover to the most recent state'. The 'Specify the Location of the Latest Backup Catalog' section shows the 'Location' as 'D:\sap\SH1\HDB00\backup\log\SYSTEMDB'. The 'Backup to be Used' section includes a warning: 'Recovering the system database from a data snapshot invalidates the tenant database. After you recover the system database, you need to recover the tenant database.' Below this, details for the backup are listed: 'Backup Type: Data Snapshot', 'Start Time: May 6, 2019, 5:55:45 AM', 'Backup Prefix: ', 'Backup ID: 1557147345054', and 'Destination Type: Snapshot'. The 'Delta Backups' section indicates 'Use Delta Backups: No'. The 'Specify Alternative Backup Locations' section shows 'Log Backups: Data backups will be read from the location in the backup catalog'. The 'Check Availability of Backups' section shows 'File Backups: No'. Finally, the 'Initialize Log Area' section shows 'Initialize Log Area: No'. At the bottom right, there are four buttons: 'Start Recovery' (highlighted in blue), 'Exit', 'Cancel', and 'Display SQL Statement'.



While restoring the System Database the status can be observed from the same view.



SAP HANA Cockpit Step 2. Recover Tenant Database

During the recovery of the System database all tenant databases are invalidated and need to be individually recovered by repeating the below steps.

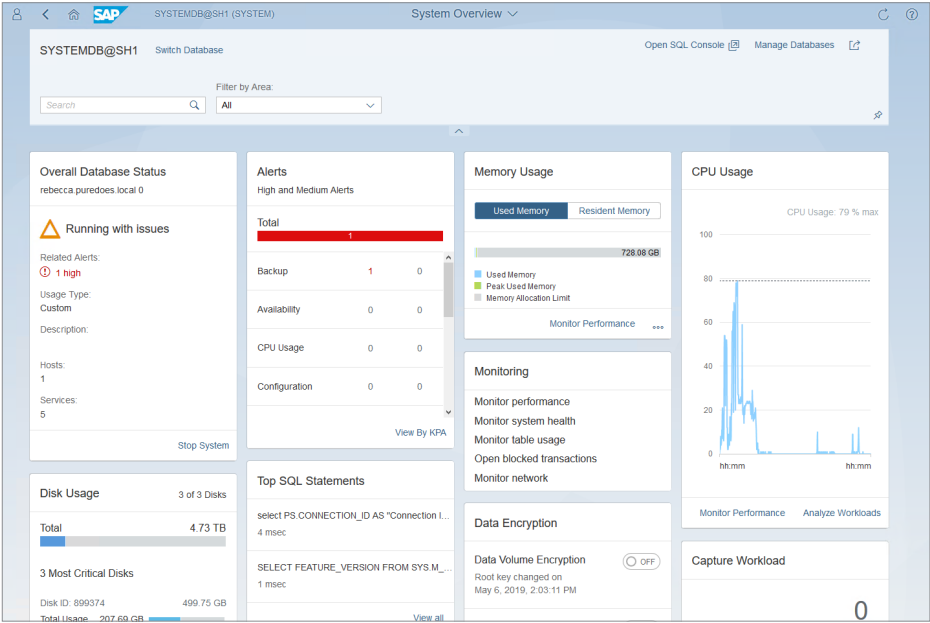
Important: Follow from here if using single container SAP HANA 1.0 system. Notable differences are the absence of “System” and “Tenant” terminology.

Important: In SAP HANA 2.0 SPS04 and onwards repeat these steps for each additional tenant database.

Important: Ensure that Step 1a is completed, while the database is offline, for SAP HANA 1.0 Single tenant systems before proceeding with the below.



Once the System Database has been recovered select “Manage Databases” from the SystemDB database view.



All of the tenants will be shown, but in an offline state. In SAP HANA SPS03 and previous releases only a single tenant system can be recovered.

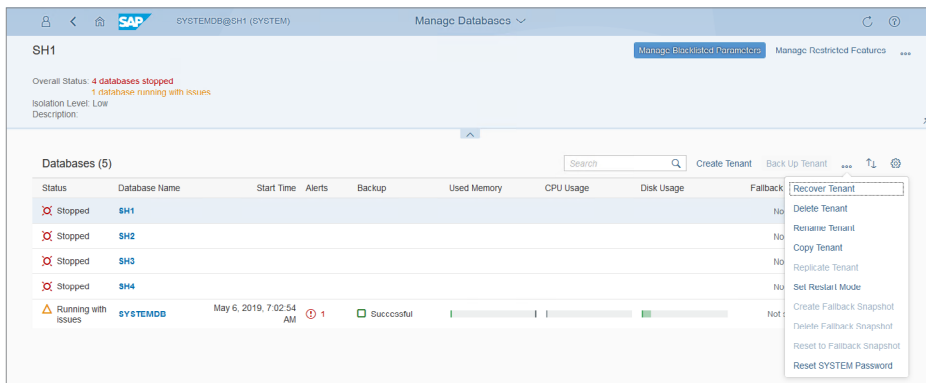
The screenshot displays the SAP HANA 'Manage Databases' page for the SH1 instance. The page shows the overall status of the instance and a table of databases.

Overall Status: 4 databases stopped, 1 database running with issues. Isolation Level: Low. Description: [Empty]

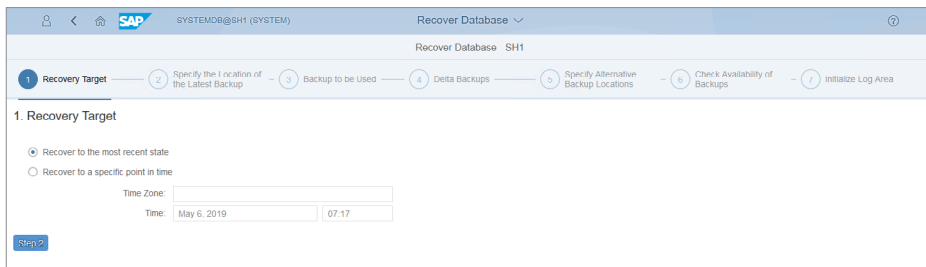
Status	Database Name	Start Time	Alerts	Backup	Used Memory	CPU Usage	Disk Usage	Fallback Snapshot	Action
Stopped	SH1							No snapshot	Start Tenant
Stopped	SH2							No snapshot	Start Tenant
Stopped	SH3							No snapshot	Start Tenant
Stopped	SH4							No snapshot	Start Tenant
Running with issues	SYSTEMDB	May 6, 2019, 7:02:54 AM	1	Successful				Not supported	



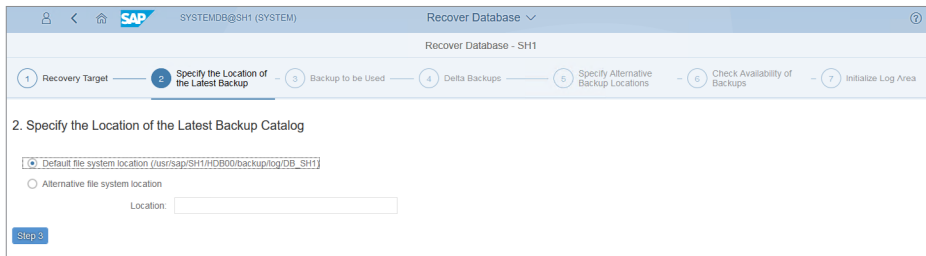
Highlight the relevant tenant database to be recovered and then select the three dots in the right-hand corner to bring up the context menu, then select “Recover Tenant”.



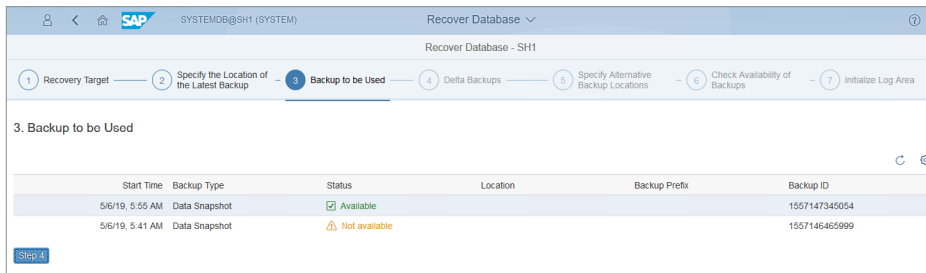
Select the recovery target type.



Specify the location of the latest backup catalog, only change these values under specialised circumstances.



The relevant backup to be used will have the Status of “Available”, select this and then select “Step 4”.



Specify if Delta Backups are to be used.

The screenshot shows the SAP Recovery Database - SH1 wizard at Step 4: Delta Backups. The progress bar at the top indicates the sequence of steps: 1. Recovery target, 2. Specify the Location of the Latest Backup, 3. Backup to be Used, 4. Delta Backups (current step), 5. Specify Alternative Backup Locations, 6. Check Availability of Backups, and 7. Initialize Log Area. The main content area contains a tip: "If you choose to perform a recovery without delta backups, only log backups will be used." Below this, there is a section titled "Use Delta Backups:" with two radio buttons: "Yes (recommended)" and "No". The "No" option is selected. A "Step 5" button is located at the bottom left.

Specify an Alternative Backup location if any exist.

The screenshot shows the SAP Recovery Database - SH1 wizard at Step 5: Specify Alternative Backup Locations. The progress bar at the top indicates the sequence of steps: 1. Recovery target, 2. Specify the Location of the Latest Backup, 3. Backup to be Used, 4. Delta Backups, 5. Specify Alternative Backup Locations (current step), 6. Check Availability of Backups, and 7. Initialize Log Area. The main content area contains a tip: "If no location is specified, the location in the backup catalog is used." Below this, there is a section titled "Log Backups" with a text input field labeled "Location 1:" and an "Add more" button. A "Step 6" button is located at the bottom left.

Specify if the log area must be initialized.

The screenshot shows the SAP Recovery Database - SH1 wizard at Step 7: Initialize Log Area. The progress bar at the top indicates the sequence of steps: 1. Recovery target, 2. Specify the Location of the Latest Backup, 3. Backup to be Used, 4. Delta Backups, 5. Specify Alternative Backup Locations, 6. Check Availability of Backups, and 7. Initialize Log Area (current step). The main content area contains a tip: "If the log area is initialized, all changes performed after the latest log backup are irretrievably lost." Below this, there is a section titled "Initialize the log area:" with two radio buttons: "No" and "Yes". The "No" option is selected. A "Review" button is located at the bottom left.

Review the information for the recovery operation and then select “Start Recovery”.

The screenshot shows the 'Recover Database' summary screen in SAP. The breadcrumb trail is 'SYSTEMDB@SH1 (SYSTEM) > Recover Database > SH1 > Summary'. The screen is divided into several sections:

- Recovery Target:** Target: Recover to the most recent state.
- Specify the Location of the Latest Backup Catalog:** Location: Default file system location (/usr/sap/SH1/HCB00/backup/log/DB_SH1).
- Backup to be Used:**
 - Backup Type: Data Snapshot
 - Start Time: May 6, 2019, 5:55:45 AM
 - Backup Prefix:
 - Backup ID: 1557147345054
 - Destination Type: Snapshot
- Delta Backups:** Use Delta Backups: No.
- Specify Alternative Backup Locations:** Log Backups: Data backups will be read from the location in the backup catalog.
- Check Availability of Backups:** File Backups: Yes.
- Initialize Log Area:** Initialize Log Area: No.

At the bottom right, there are buttons: 'Start Recovery' (highlighted in blue), 'Edit', 'Cancel', and 'Display SQL Statement'.

Once the tenant has been successfully recovered the status will be shown.

The screenshot shows the 'Recovery Status - SH1' screen in SAP. The breadcrumb trail is 'SYSTEMDB@SH1 (SYSTEM) > Recover Database > SH1'. The screen displays the following information:

- Start Time (UTC): May 6, 2019, 2:27:11 PM.
- A green bar with a checkmark icon and the text: 'Recovery completed in 40 seconds. Point in time reached (UTC): May 6, 2019, 2:14:49 PM'.
- System Restart (Phase 3 of 3):**
 - rebecca
 - rsengine: 100%
 - indexserver: 100%

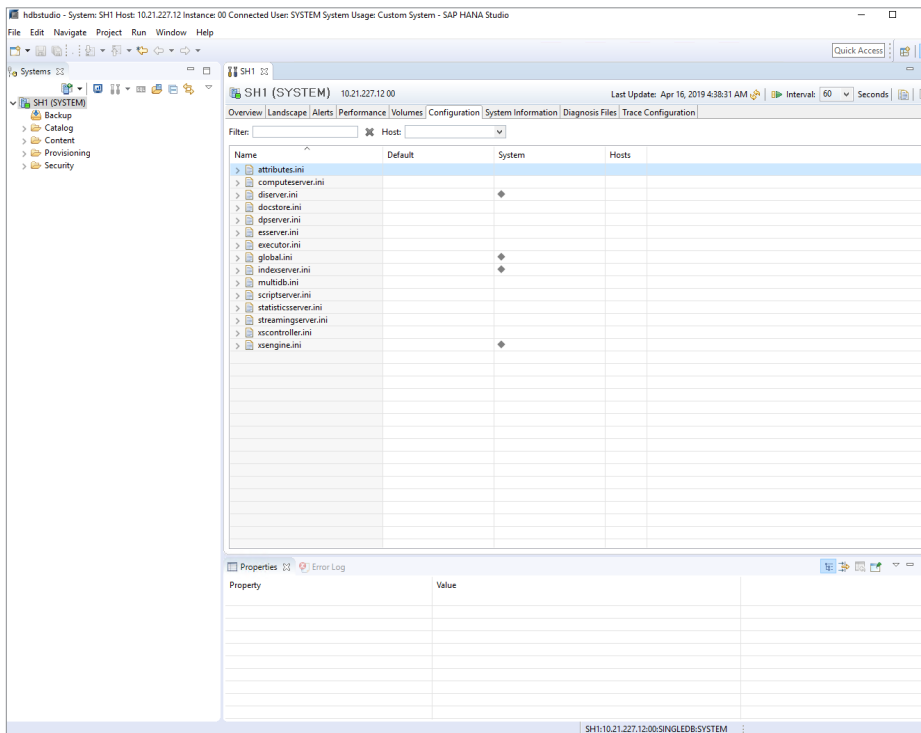
SAP HANA Scale out / Distributed Host deployment

MANUAL OPERATION

Step 1. Verify the system type

Using SAP HANA Studio connected to any one of the systems deployed with the SAP HANA instance, navigate towards the configuration page

SAP HANA Studio, Configuration Page.



Expand the **global.ini** filename and then further expand the **multidb** section. Look for the key **mode** and observe its value. If this value is “singledb” then the system is a single container and if the value is “multidb” the system is then set to be a multiple container system.

In SAP HANA Studio the global.ini file is expanded.

Overview Landscape Alerts Performance Volumes Configuration System Information Diagnosis Files Trace Configuration				
Filter: <input type="text"/>		Host: <input type="text"/>		
Name	Default	System	Hosts	
<ul style="list-style-type: none"> global.ini <ul style="list-style-type: none"> abstract_sql_plan advisory_file_lock auditing configuration authentication authorization backup cache cds communication configuration crashdump cross_database_access cryptography customizable_functionalities database_initial_encryption debug event_handler executed_statement execution expensive_statement fileio infile infile_checker ldap memorymanager memoryobjects multidb persistence persistent_memory public_hostname_resolution 				

In SAP HANA Studio the multidb section under global.ini shows the system properties.

Overview Landscape Alerts Performance Volumes Configuration System Information Diagnosis Files Trace Configuration				
Filter: <input type="text"/>		Host: <input type="text"/>		
Name	Default	System	Hosts	
<ul style="list-style-type: none"> <ul style="list-style-type: none"> ldap memorymanager memoryobjects multidb <ul style="list-style-type: none"> database_isolation: low enforce_sql_database_replica: true mode: multidb reserved_instance_numbers: 0 singletenant: yes systemdb_reserved_memory: 0 systemdb_separated_sql_po: false systemdb_sql_listeninterface: .all persistence persistent_memory public_hostname_resolution resource_tracking runtime_dump self_watchdog spark_communication storage system_information system_landscape_hostname_v system_replication system_replication_communic telemetry threads trace trace_cleaner traceprofile_sap_passport_high traceprofile_sap_passport_med 				























Step 1a. In the event of the database mode being “multidb” find the host on which the SYSTEMDB is running

To identify the host which the SYSTEMDB is running on the nameserver and other non-persistent services needs to be identified. As per the SAP Knowledge Base article (201244) the most notable differences between the list of services running on the SYSTEM DB and tenant database are the nameserver and other non-persistent services are available on the SYSTEMDB. The SYSTEMDB will only ever exist on a single host in a scale out/distributed system environment and cannot be distributed across multiple hosts.

To investigate the services on each system in a scale out/distributed environment the landscape view and services tab is inspected to provide the required information.

The host on which the “nameserver” service and “master” detail are shown, is the system on which the SYSTEMDB is running.

In SAP HANA Studio, under Landscape for the deployment, the SYSTEMDB is running on SHN3.

Overview	Landscape	Alerts	Performance	Volumes	Configuration	System Information	Diagnosis Files	Trace Configuration			
Services	Hosts	Redistribution	System Replication	Hosts: <All>	Service: <All>						
Active	Host	Port	Service	Detail	Start Time	Process ID	CPU	Memory	Used Memory (MB)	Peak Used Memory (MB)	Effects
	shn1	30010	compilesrvr		Apr 15, 2019 9:34:37 AM	3401	<div><div></div></div>	<div><div></div></div>	1,572	1,572	
	shn2	30010	compilesrvr		Apr 15, 2019 9:34:39 AM	2902	<div><div></div></div>	<div><div></div></div>	1,574	1,574	
	shn3	30010	compilesrvr		Apr 15, 2019 9:34:34 AM	2489	<div><div></div></div>	<div><div></div></div>	1,574	1,574	
	shn2	30000	daemon		Apr 15, 2019 9:33:42 AM	1697	<div><div></div></div>	<div><div></div></div>	0		
	shn1	30000	daemon		Apr 15, 2019 9:33:50 AM	2214	<div><div></div></div>	<div><div></div></div>	0		
	shn3	30000	daemon		Apr 15, 2019 9:33:21 AM	1138	<div><div></div></div>	<div><div></div></div>	0		
	shn1	30003	indexserver		Apr 15, 2019 9:34:42 AM	3495	<div><div></div></div>	<div><div></div></div>	5,725	6,016	
	shn2	30003	indexserver		Apr 15, 2019 9:34:44 AM	2995	<div><div></div></div>	<div><div></div></div>	5,662	5,714	
	shn3	30003	indexserver	master	Apr 15, 2019 9:34:35 AM	2548	<div><div></div></div>	<div><div></div></div>	7,107	7,375	
	shn1	30001	nameserver		Apr 15, 2019 9:33:50 AM	2232	<div><div></div></div>	<div><div></div></div>	2,380	2,380	
	shn2	30001	nameserver		Apr 15, 2019 9:33:42 AM	1717	<div><div></div></div>	<div><div></div></div>	2,321	2,321	
	shn3	30001	nameserver	master	Apr 15, 2019 9:33:21 AM	1186	<div><div></div></div>	<div><div></div></div>	4,529	4,529	
	shn1	30002	preprocessor		Apr 15, 2019 9:34:37 AM	3404	<div><div></div></div>	<div><div></div></div>	583	583	
	shn2	30002	preprocessor		Apr 15, 2019 9:34:39 AM	2905	<div><div></div></div>	<div><div></div></div>	582	582	
	shn3	30002	preprocessor		Apr 15, 2019 9:34:34 AM	2492	<div><div></div></div>	<div><div></div></div>	582	582	
	shn3		sapstartsrv				<div><div></div></div>	<div><div></div></div>			
	shn1		sapstartsrv				<div><div></div></div>	<div><div></div></div>			
	shn2		sapstartsrv				<div><div></div></div>	<div><div></div></div>			
	shn1	30006	webdispatcher		Apr 15, 2019 9:34:39 AM	3455	<div><div></div></div>	<div><div></div></div>	1,821	1,821	
	shn2	30006	webdispatcher		Apr 15, 2019 9:34:40 AM	2955	<div><div></div></div>	<div><div></div></div>	1,820	1,820	
	shn3	30006	webdispatcher		Apr 15, 2019 9:35:24 AM	3359	<div><div></div></div>	<div><div></div></div>	1,819	1,819	
	shn3	30007	xsengine		Apr 15, 2019 9:34:35 AM	2551	<div><div></div></div>	<div><div></div></div>	2,927	3,198	



Step 1b. Identify which host each storage device is mounted to it at that point in time

The volumes and services used can be identified by selecting the volumes view and viewing the information for the “indexserver” service where “Data Volume Size” has a value. Each data persistence mount point for the scale out/distributed environment will typically be in the form “{BASE_PATH}/Data/<Database Name>/mntXXXXX” but this can vary between each deployment.

In SAP HANA Studio the relevant volumes can be identified under the “Volumes” view. In this case the mount points and hosts they are attached to are

SHN1: /hana/data/SH1/mnt00002

SHN2: /hana/data/SH1/mnt00003

SHN3: /hana/data/SH1/mnt00001

rts	Performance	Volumes	Configuration	System Information	Diagnosis Files	Trace Configuration	
▼	Host:	<All>	▼				
	Service	Total Volume Size (MB)	Data Volume Size (MB)	Log Volume Size (MB)	Path		
	indexserver	674,809	627,704	47,105	/hana/data/SH1/mnt00002/hdb00004.00003		
		627,704	627,704		/hana/log/SH1/mnt00002/hdb00004.00003		
		47,105		47,105	/hana/log/SH1/mnt00002/hdb00004.00003		
	indexserver	673,914	628,857	45,057	/hana/data/SH1/mnt00003/hdb00005.00003		
		628,857	628,857		/hana/log/SH1/mnt00003/hdb00005.00003		
		45,057		45,057	/hana/log/SH1/mnt00003/hdb00005.00003		
	indexserver	823,172	628,611	194,561	/hana/data/SH1/mnt00001/hdb00003.00003		
		628,611	628,611		/hana/log/SH1/mnt00001/hdb00003.00003		
		194,561		194,561	/hana/log/SH1/mnt00001/hdb00003.00003		
	xsengine	217	192	25	/hana/data/SH1/mnt00001/hdb00002.00003		
		192	192		/hana/log/SH1/mnt00001/hdb00002.00003		
		25		25	/hana/log/SH1/mnt00001/hdb00002.00003		



Step 2. Connect to the correct database instance for the creation and management of storage snapshots

If the system is a single database container then ensure that under mode the **Single container** selection is selected, for a multiple container system ensure that **Multiple containers** is selected, and when available ensure that **System database** is the selected target to connect to. It is important to note that selecting **Single container** and the mode to connect to will still connect to the single tenant container.

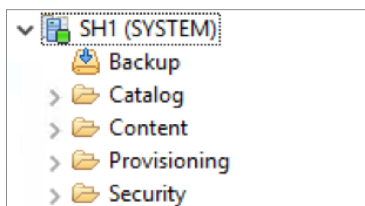
Using SAP HANA Studio connect to a single container system.

The 'Specify System' dialog box in SAP HANA Studio. The 'Host Name' field contains 'shn3.saphana.domain' and the 'Instance Number' field contains '00'. Under the 'Mode' section, the 'Single container' radio button is selected. Below it, the 'Multiple containers' section is collapsed. The 'Description' field is empty. The 'Locale' dropdown is set to 'English (United States)'. The 'Folder' field contains '/' and has a 'Browse...' button next to it. At the bottom, there are buttons for '< Back', 'Next >', 'Finish', and 'Cancel'.

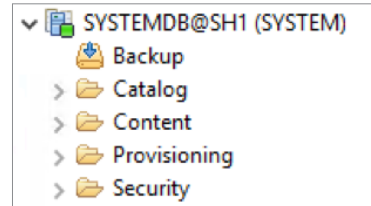
Using SAP HANA Studio connect to the System dataset on a system with multiple containers.

The 'Specify System' dialog box in SAP HANA Studio. The 'Host Name' field contains 'shn3.saphana.domain' and the 'Instance Number' field contains '00'. Under the 'Mode' section, the 'Multiple containers' radio button is selected. Below it, the 'System database' radio button is selected. The 'Description' field is empty. The 'Locale' dropdown is set to 'English (United States)'. The 'Folder' field contains '/' and has a 'Browse...' button next to it. At the bottom, there are buttons for '< Back', 'Next >', 'Finish', and 'Cancel'.

Connected to a single container system.



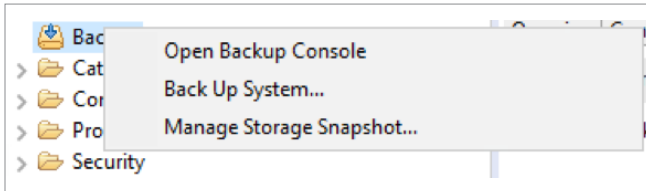
Connected to a multiple container system.



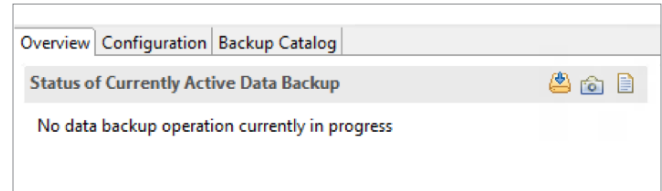
Step 3. Prepare the system for a storage snapshot

This can be done from the backup console or using the side menu by right-clicking on the **Backup** system folder and selecting **Manage Storage Snapshot....**

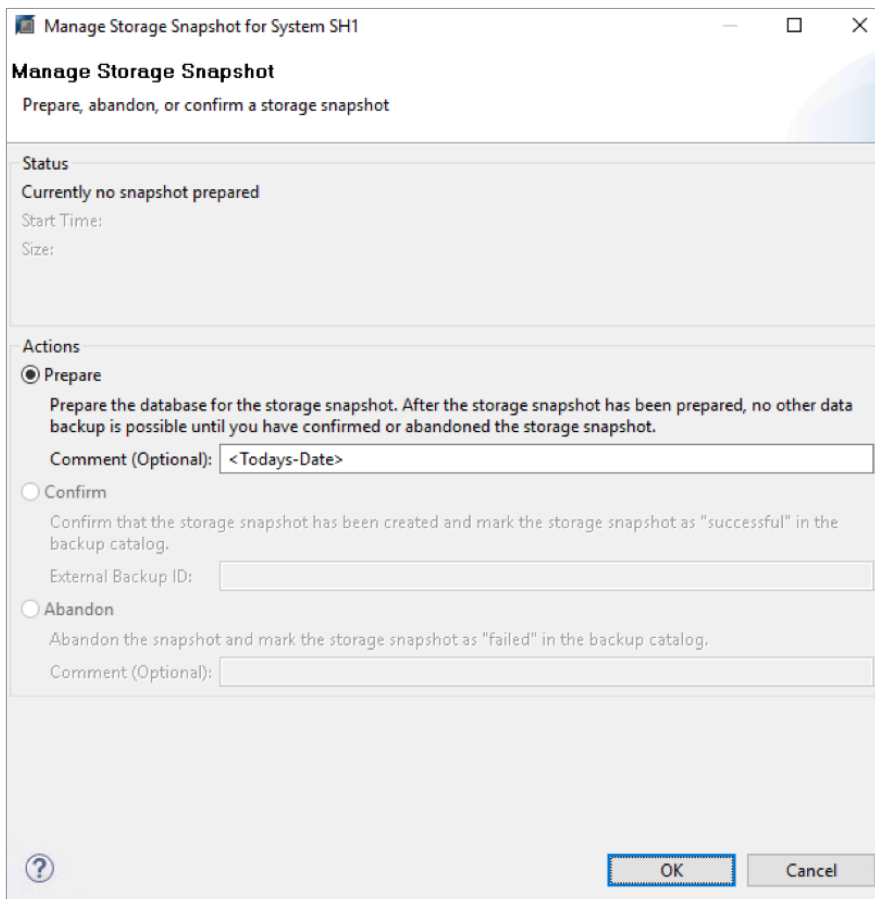
In SAP HANA Studio right-click on the “Backup” system folder and select “Manage Storage Snapshot...”.



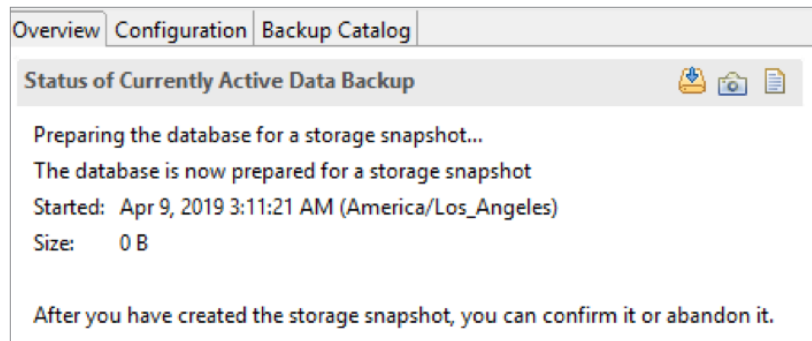
In SAP HANA Studio and the backup console, select the camera next to “Status of Currently Active Data Backup”.



Select Prepare and add a comment if needed, then press the OK button.



Once the database snapshot is ready then the below will show in the backup console.



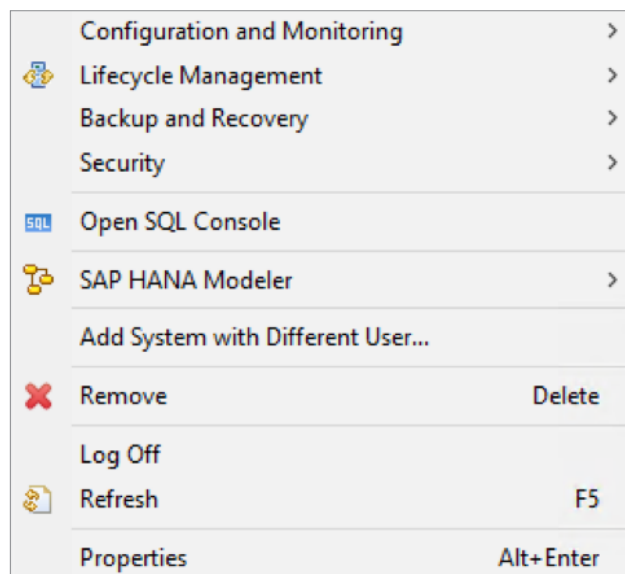
Step 4. Retrieve the SAP HANA prepared storage backup ID using the SQL console in SAP HANA Studio

Use the SQL console for the database instance the prepared snapshot has been created for and run the query:

```
"SELECT BACKUP_ID, COMMENT FROM M_BACKUP_CATALOG WHERE ENTRY_TYPE_NAME = 'data snapshot'
AND STATE_NAME = 'prepared'"
```

This will return the backup ID for the prepared snapshot, which is used in the FlashArray block device snapshot creation as a suffix to link the SAP HANA storage snapshot ID to the Volume snapshot.

In SAP HANA Studio right-click on the instance and select "Open SQL Console".



In SAP HANA Studio execute the query to return the Backup_ID of the prepared database snapshot.

```
SQL SQL Result
SELECT BACKUP_ID, COMMENT
FROM M_BACKUP_CATALOG
WHERE ENTRY_TYPE_NAME = 'data snapshot'
AND STATE_NAME = 'prepared'
```

The Backup ID is returned with any comments added to the entry, take note of the Backup.

	BACKUP_ID	COMMENT
1	1,554,804,681,328	SNAPSHOT-2019-04-09 03:10:25

Step 5. Freeze the filesystem for the SAP HANA data persistence mount points on each host

Open a terminal (SSH or local to the system) and ensure the prompt is logged in as a user who has read, write and execute permissions on the SAP HANA data persistence mount point. The data persistence mount points and each host they are attached to were identified in step 1b. The “fsfreeze” Linux utility will be used to halt any IO to the volume and ensure consistency.

Freeze the filesystem of each data persistence mount point using the fsfreeze utility.

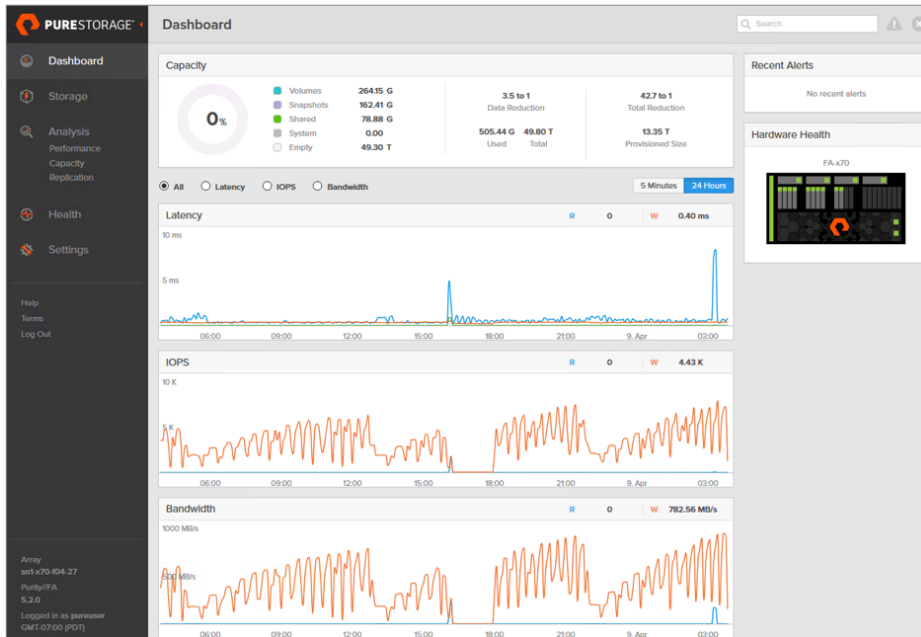
```
SHN1:~ # /sbin/fsfreeze --freeze /hana/data/SH1/mnt00002
SHN2:~ # /sbin/fsfreeze --freeze /hana/data/SH1/mnt00003
SHN3:~ # /sbin/fsfreeze --freeze /hana/data/SH1/mnt00001
```



Step 6. Take a snapshot of the block device in the FlashArray

This step is shown using the web based graphical user interface to operate the FlashArray storage device. It is assumed the user can identify the block volume which matches each SAP HANA persistence data volume. In the user interface navigate to the “Storage” section, select “Volumes”. Select the volume which corresponds to each SAP HANA persistence data volume. Under “Volume Snapshots”

Pure Storage FlashArray Web Graphical User interface – Main page.



Select Storage and navigate to the “Volumes” section to view all volumes and snapshots.

PURE STORAGE Storage

Dashboard Storage Analysis Health Settings

Array: sn1-x79-04-27, PureStorFA, 5.2.0, Logged in as pureuser (GMT-07:00 (PDT))

Volumes

Name	Size	Data Reduction	Volumes	Snapshots	Shared	System	Total
Rebecca_Boot	12142 G	4.9 to 1	539.96 G	50.78 G	181.80 G	0.00	771.73 G
Rebecca_HANA_Data							
Rebecca_HANA_Log							
Rebecca_HANA_Shared							
SHN1_Boot							
SHN1_Data							
SHN1_Log							
SHN2_Boot							
SHN2_Data							
SHN2_Log							

Volume Snapshots

Name	Created	Snapshots
SHN2_Data.SAPHANA-1555348983220-Host-shn3-Path-mnt00001	2019-04-15 10:23:14	22.95 M
SHN3_Data.SAPHANA-1555348983220-Host-shn2-Path-mnt00003	2019-04-15 10:23:14	2.52 M
SHN1_Data.SAPHANA-1555348983220-Host-shn1-Path-mnt00002	2019-04-15 10:23:13	165.61 K

Volume Groups

No volume groups found.

Select the volume which matches the SAP HANA Data persistence volume and select the “+” next to Volume Snapshots.

PURE STORAGE Storage

Dashboard Storage Analysis Health Settings

Array: sn1-x79-04-27, PureStorFA, 5.2.0, Logged in as pureuser (GMT-07:00 (PDT))

Volumes > SHN1_Data

Name	Size	Data Reduction	Volumes	Snapshots	Shared	System	Total
SHN1_Data	68.06 G	105.61 K					68.06 G

Connected Hosts

Name	LUN	Connections
sn1-x79-04-03-SHN1		2 x
sn1-x79-04-05-SHN2		4 x
sn1-x79-04-07-SHN3		4 x
sn1-x79-04-09-SHN4		2 x

Protection Groups

No protection groups found.

Volume Snapshots

No snapshots found.

Destroyed Volume Snapshots

No snapshots found.

Details

Source	-
Created	2019-04-13 07:56:19
Serial	1448EFCB40254A2B00014FD
# Hosts	4
# Connections	4
Bandwidth Limit	-



Create the snapshot with the suffix “SAPHANA-<Backup_ID from SAP HANA prepared snapshot>-Host-<Host>-Path-<mounted Path At time of Snapshot>

Create Snapshot

Optional Suffix

SAPHANA-1555348983220-Host-shn3-Path-mnt00001

Cancel

Create

The snapshot is created and listed under the Volume snapshots.

Dashboard

Storage

Analysis

Performance

Capacity

Replication

Health

Settings

Help

Terms

Log Out

Array

shn320-104-27

Path/IFA

5.2.0

Logged in as pureuser

GMT-07:00 (PDT)

Storage

Array

Hosts

Volumes

Protection Groups

Pods

Volumes > SHN1_Data

Size	Data Reduction	Volumes	Snapshots	Shared	System	Total
1 T	6.9 to 1	68.06 G	165.61 K	-	-	68.06 G

Connected Hosts

14 of 4

Name	LUN
shn1-720-104-03-SHN1	2 x
shn1-720-104-05-SHN2	4 x
shn1-720-104-07-SHN3	4 x
shn1-720-104-09-SHN4	2 x

Connected Host Groups

0 of 0

No host groups found.

Details

Source

-

Created

2019-04-13 07:56:19

Serial

141EFCB40254A2B00014FD

Hosts

4

Connections

4

Bandwidth Limit

☒

Protection Groups

0 of 0

No protection groups found.

Volume Snapshots

General

Transfer

1:1 of 1

Name

SHN1_Data.SAPHANA-1555348983220-Host-shn1-Path-mnt00001

Created

2019-04-15 10:23:13

Snapshots

165.61 K

2

Destroyed (0)

75

Step 7. Unfreeze the filesystem for each SAP HANA data persistence mount point

Open a terminal (SSH or local to the system) and ensure the prompt is logged in as a user who has read, write and execute permissions on each SAP HANA data persistence mount point. We will then use the “fsfreeze” Linux utility to resume IO to the volume and allow the database to continue operation.

Unfreeze the filesystem of each data persistence mount point using the fsfreeze utility

```
SHN1:~ # /sbin/fsfreeze --unfreeze /hana/data/SH1/mnt00002
```

```
SHN2:~ # /sbin/fsfreeze --unfreeze /hana/data/SH1/mnt00003
```

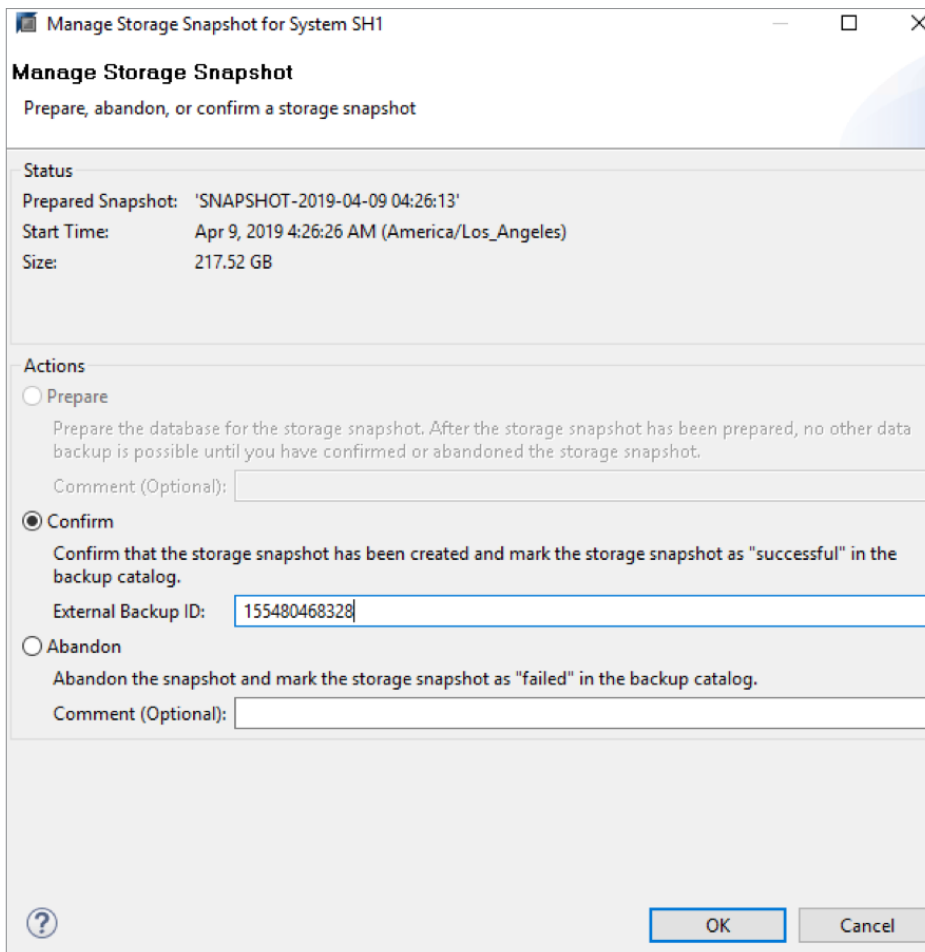
```
SHN3:~ # /sbin/fsfreeze --unfreeze /hana/data/SH1/mnt00001
```



Step 8. Confirm or abandon the snapshot

Confirm or abandon the snapshot in SAP HANA studio , allowing the backup to be marked as valid or invalid. If something has not operated as expected then the snapshot should be abandoned. To confirm the snapshot an External Backup ID must be supplied. The Backup_ID originally offered by the prepared snapshot and used as a suffix for the Block volume storage snapshot is used for the value.

Confirm the Snapshot and supply the External Backup ID, and press OK.



Manage Storage Snapshot for System SH1

Manage Storage Snapshot
Prepare, abandon, or confirm a storage snapshot

Status
Prepared Snapshot: 'SNAPSHOT-2019-04-09 04:26:13'
Start Time: Apr 9, 2019 4:26:26 AM (America/Los_Angeles)
Size: 217.52 GB

Actions

☐ Prepare
Prepare the database for the storage snapshot. After the storage snapshot has been prepared, no other data backup is possible until you have confirmed or abandoned the storage snapshot.
Comment (Optional):

☒ **Confirm**
Confirm that the storage snapshot has been created and mark the storage snapshot as "successful" in the backup catalog.
External Backup ID: 155480468328

☐ Abandon
Abandon the snapshot and mark the storage snapshot as "failed" in the backup catalog.
Comment (Optional):

?

OK Cancel

The backup now shows in the backup catalog as complete.

Backup Catalog						Backup Details					
Database: SYSTEMDB						ID:	1555333476146				
<input type="checkbox"/> Show Log Backups <input type="checkbox"/> Show Delta Backups						Status:	Successful				
						Backup Type:	Data Backup				
						Destination Type:	Snapshot				
Status	Started	Duration	Size	Backup Type	Destination...	Started:	Apr 15, 2019 6:04:36 AM (America/Los_Angeles)				
	Apr 15, 2019 6:04:36 ...	00h 00m 20s	0 B	Data Backup	Snapshot	Finished:	Apr 15, 2019 6:04:57 AM (America/Los_Angeles)				
	Apr 15, 2019 8:56:49 ...	00h 00m 14s	0 B	Data Backup	Snapshot	Duration:	00h 00m 20s				
	Apr 15, 2019 9:40:40 ...	00h 00m 55s	0 B	Data Backup	Snapshot	Size:	0 B				
	Apr 15, 2019 10:23:0...	00h 00m 16s	0 B	Data Backup	Snapshot	Throughput:	n.a.				
						System ID:					
						Comment:	SNAPSHOT-2019-04-15 06:04:12				
						Additional Information:	<ok>				
						Location:	/hana/data/SH1/mnt00001/				
						Host	Service	Size	Name	Source Typ	
						shn1	nameserver	0 B	hdb00001	volume	

AUTOMATED OPERATION

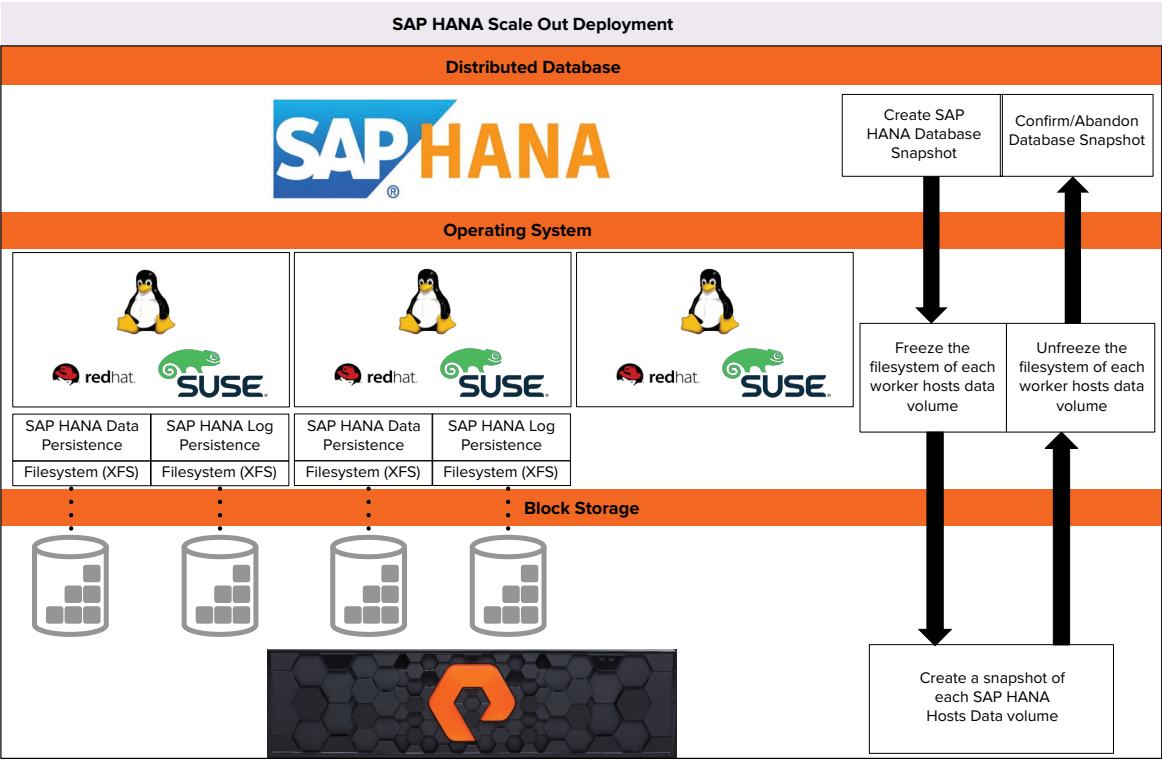


Fig. 10 Workflow to create a storage snapshot for a distributed system/multi-host SAP HANA database.



Step 1. Check the SAP HANA System mode

Using the resilient connection string:

```
Driver={HDBODBC}; ServerNode=<Host-01-Address>:3 <InstanceNumber> 15, <Host-02-Address>:3 <InstanceNumber> 15, <Host-03-Address>:3 <InstanceNumber> 15; UID= <Database User>; PWD=<DatabasePassword>;
```

Connect to the SAP HANA database and run the following query to determine system mode:

```
SELECT VALUE FROM M_INIFILE_CONTENTS WHERE FILE_NAME = 'global.ini' AND SECTION = 'multidb' AND KEY = 'mode'
```

SELECT VALUE FROM M_INIFILE_CONTENTS WHERE FILE_NAME = 'global.ini' AND SECTION = 'multidb' AND KEY = 'mode'		
1	VALUE	
	multidb	

The result will be either “singledb” or “multidb”, if the result is “multidb” then a further query needs to be run to identify which host the SYSTEMDB is running on:

```
“SELECT HOST FROM SYS.M_SERVICES WHERE DETAIL = 'master' AND SERVICE_NAME = 'nameserver'”
```

SELECT HOST FROM SYS.M_SERVICES WHERE DETAIL = 'master' AND SERVICE_NAME = 'nameserver'		
1	HOST	
	shn3	

Once the host on which the host is running has been isolated change the connection string to the following:

```
Driver={HDBODBC}; ServerNode=<SystemDBHost>:3 <InstanceNumber> 13; UID= <Database User>; PWD=<DatabasePassword>;
```



Changing the port number allows the application to connect to the system database on the specified host. In this case the port to connect on for instance 00 would change from 30015 to 30013. In the event of the system running in “singledb” mode, continue to use the original connection string.

Step 2. Identify which host each volume is attached to and the associated mount point for each of the SAP HANA persistent data volumes

Using the established connection string run the following query to determine all of the SAP HANA persistence data volume mount points:

```
SELECT HOST, STORAGE_ID, PATH, KEY, VALUE
FROM SYS.M_ATTACHED_STORAGES WHERE KEY = 'WWID'
AND PATH LIKE (SELECT CONCAT(VALUE,'%') FROM M_INIFILE_CONTENTS
```

```
WHERE FILE_NAME = 'global.ini'
AND SECTION = 'persistence'
AND KEY = 'basepath_datavolumes'
AND VALUE NOT LIKE '$%')
```

```
SELECT HOST, STORAGE_ID, PATH, KEY, VALUE
FROM SYS.M_ATTACHED_STORAGES WHERE KEY = 'WWID'
AND PATH LIKE (SELECT CONCAT(VALUE,'%') FROM M_INIFILE_CONTENTS
WHERE FILE_NAME = 'global.ini'
AND SECTION = 'persistence')
```

	HOST	STORAGE_ID	PATH	KEY	VALUE
1	shn1	3	/hana/data/SH1/mnt00002	WWID	3624a93701441efcb40254a2b000114fd
2	shn2	7	/hana/data/SH1/mnt00003	WWID	3624a93701441efcb40254a2b00011511
3	shn3	11	/hana/data/SH1/mnt00001	WWID	3624a93701441efcb40254a2b000114ff



Step 3. Prepare the database snapshot and retrieve the backup ID for it

Using the established connection string to execute the query needed to prepare a database snapshot.

```
BACKUP DATA FOR FULL SYSTEM CREATE SNAPSHOT COMMENT 'SNAPSHOT-<Snapshot Time>
```

To retrieve the backup ID, execute the following query:

```
SELECT BACKUP_ID, COMMENT FROM M_BACKUP_CATALOG WHERE ENTRY_TYPE_NAME = 'data snapshot'  
AND STATE_NAME = 'prepared'
```

	BACKUP_ID	COMMENT
1	1,554,804,681,328	SNAPSHOT-2019-04-09 03:10:25

Step 4. Freeze the filesystem for each mountpoint attached to each host

An SSH connection needs to be created with the operating system on which the SAP HANA instance is installed to execute command line arguments. To freeze the filesystem the fsfreeze utility will be used as it supports EXT3/4, ReiserFS, JFS and XFS. The mount points and hosts retrieved in step 2 will be used during the freeze operation.

```
/sbin/fsfreeze --freeze <path to mount point>
```

```
SHN1:~ # /sbin/fsfreeze --freeze /hana/data/SH1/mnt00002
```

```
SHN2:~ # /sbin/fsfreeze --freeze /hana/data/SH1/mnt00003
```

```
SHN3:~ # /sbin/fsfreeze --freeze /hana/data/SH1/mnt00001
```

Step 5: Query the relevant FlashArray for a list of its volumes and search them for the serial number contained with the values returned by step 2, then create a snapshot once each volume has been located

Example of PowerShell using the Pure Storage PowerShell SDK

```
$Array = New-PfaArray -EndPoint $FlashArrayAddress -username $User -Password $Password -IgnoreCertificateError  
$Volumes = Get-PfaVolumes -Array $Array
```

Once the correct volume has been found create a snapshot with a specified Snapshot suffix

```
$VolumeSnapshot = New-PfaVolumeSnapshots -Array $Array -Sources $volume.name -Suffix $SnapshotSuffix
```



Step 5. Unfreeze the filesystem for each mountpoint attached to each host

An SSH connection needs to be created with the operation system on which the SAP HANA instance is installed to execute command line arguments. To unfreeze the filesystem, use the same mount points and hosts in step 3.

```
/sbin/fsfreeze --unfreeze <path to mount point>
```

```
SHN1:~ # /sbin/fsfreeze --unfreeze /hana/data/SH1/mnt00002
```

```
SHN2:~ # /sbin/fsfreeze --unfreeze /hana/data/SH1/mnt00003
```

```
SHN3:~ # /sbin/fsfreeze --unfreeze /hana/data/SH1/mnt00001
```

Step 6. Confirm or abandon the database snapshot

Using the connection string established in step 1, confirm or abandon the snapshot using hdbsql commands:

Confirm the snapshot if all of the previous steps executed successfully.

```
BACKUP DATA FOR FULL SYSTEM CLOSE SNAPSHOT BACKUP_ID <External Backup ID> SUCCESSFUL; BACKUP DATA  
FOR FULL SYSTEM CLOSE SNAPSHOT BACKUP_ID <External Backup ID> SUCCESSFUL;
```

Abandon the snapshot if one of the previous steps did not execute successfully.

```
BACKUP DATA FOR FULL SYSTEM CLOSE SNAPSHOT BACKUP_ID <Prepared database snapshot backup ID>  
UNSUCCESSFUL <additional comments>;
```



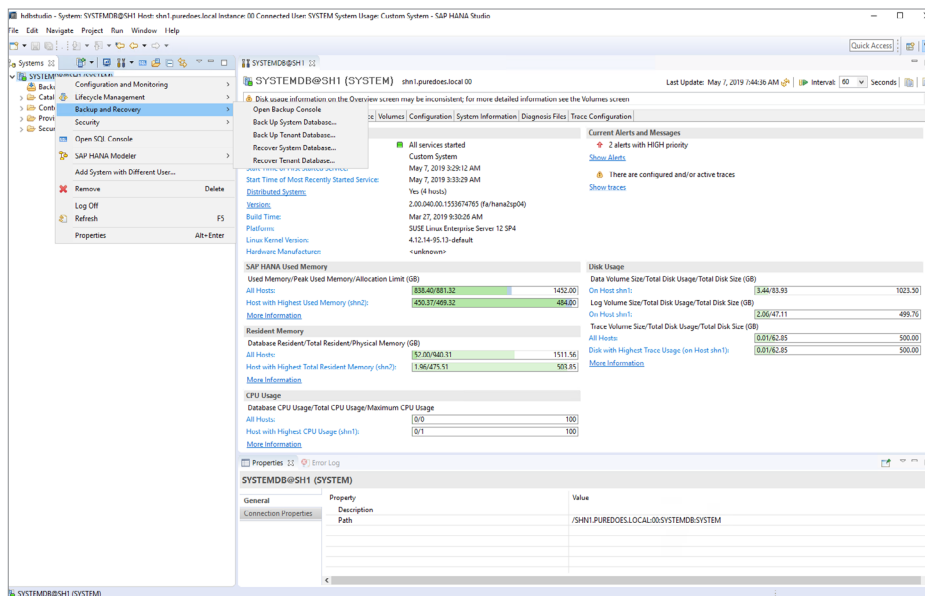
RECOVERY PROCESS

The recovery process for a storage snapshot will restore the SAP HANA instance and all of the data to the point in time at which the storage snapshot was taken. It is important to note that the recovery of a system using storage snapshots with multiple database containers (MDC) is only supported from SAP HANA 2.0 SPS04.

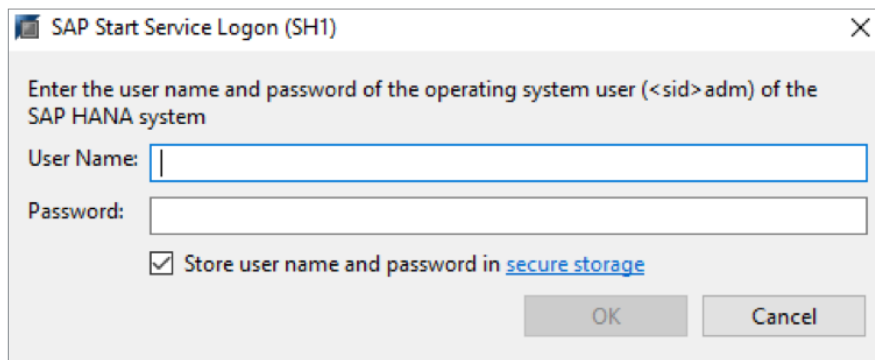
SAP HANA Studio Step 1. Prepare to Recover System Database (MDC systems only)

Navigate to the Systems inventory and right-click on the SystemDB connection for the relevant database and navigate to the Backup and Recovery sub menu then select “Recover System Database...”. A prompt to shut down the relevant system will be shown as recovery can only be done when it is offline.

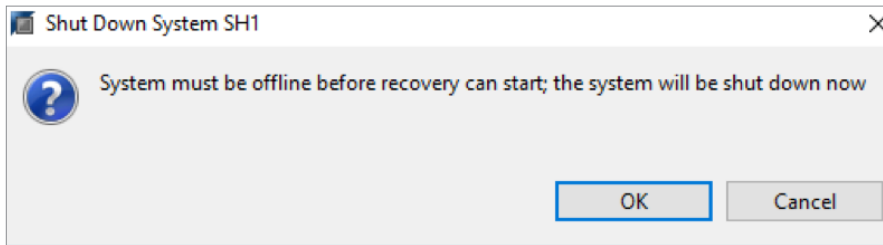
Navigate to the systems inventory , right-click the SystemDB and navigate to Backup and Recovery > Recover System Database...



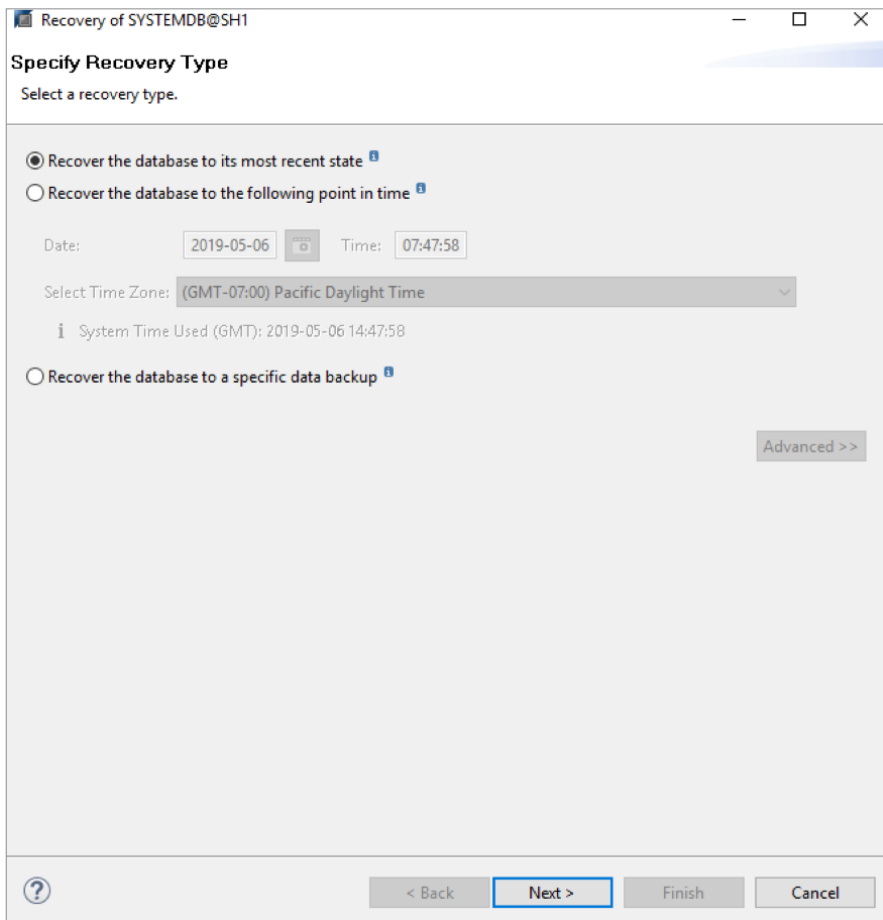
Enter the relevant values for the <sid>adm user created during initial SAP HANA installation.



SAP HANA studio will display a prompt to shut down the system.



The graphical process gives the user an option of choosing a recovery type.



The location of the backup catalog is normally populated, only change this under specialized circumstances where the recovery catalog is in a different location.

The screenshot shows a Windows-style dialog box titled "Recovery of SYSTEMDB@SH1". The main heading is "Locate Backup Catalog" with the instruction "Specify location of the backup catalog." Below this, there are three radio button options: "Recover using the backup catalog" (selected), "Search for the backup catalog in the file system only" (selected), and "Recover without the backup catalog". A text field labeled "Backup Catalog Location:" contains the path "/usr/sap/SH1/HDB00/backup/log/SYSTEMDB". Below the radio buttons is a section titled "Backint System Copy" with a checkbox "Backint System Copy" (unchecked) and a "Source System:" text field. At the bottom, there is a help icon (?), and four buttons: "< Back", "Next >" (highlighted with a blue border), "Finish", and "Cancel".

All records in the catalog will be shown with the relevant information, take note of the Backup ID for the required recovery point.

[illegible]

SAP HANA Studio Step 1a. Recover block storage volume

Recover the relevant storage volume using the FlashArray web user interface. This operation can also be completed using the command line interface or ReST API.

Important: The persistence data volumes must be unmounted from the operating system before a snapshot is restored. This can be done using the “umount” command in a terminal or SSH connection.

In the FlashArray web user interface navigate to “Storage” and select the “Volumes” section.

Important: The snapshot which matches the “Backup ID” in the catalog is appended with the exact same value, this is the volume which should be restored. Note that the addition of this value is done during storage snapshot creation by the user.

Identify the snapshots relevant to the Backup_ID of the recovery point.

Volume Snapshots		General	Transfer	1-6 of 6	<	>	⋮
Name	Created ▾	Snapshots					
<div><div></div><div>SHN1_Data.SAPHANA-1557240045531-Host-shn3-Path-hanadatasH1mnt00002</div></div>	2019-05-07 07:41:36	18.52 M					⋮
<div><div></div><div>SHN3_Data.SAPHANA-1557240045531-Host-shn2-Path-hanadatasH1mnt00003</div></div>	2019-05-07 07:41:36	66.24 M					⋮
<div><div></div><div>SHN2_Data.SAPHANA-1557240045531-Host-shn1-Path-hanadatasH1mnt00001</div></div>	2019-05-07 07:41:35	717.00 M					⋮
<div><div></div><div>SHN1_Data.SAPHANA-1557226685421-Host-shn3-Path-hanadatasH1mnt00002</div></div>	2019-05-07 03:58:16	14.52 G					⋮
<div><div></div><div>SHN3_Data.SAPHANA-1557226685421-Host-shn2-Path-hanadatasH1mnt00003</div></div>	2019-05-07 03:58:16	14.34 G					⋮
<div><div></div><div>SHN2_Data.SAPHANA-1557226685421-Host-shn1-Path-hanadatasH1mnt00001</div></div>	2019-05-07 03:58:15	13.83 G					⋮
Destroyed (0) ▾							

Unmount each persistence data volume from the mount point on each host

```
SHN1:~ # umount /hana/data/SH1/mnt00001
SHN2:~ # umount /hana/data/SH1/mnt00003
SHN3:~ # umount /hana/data/SH1/mnt00002
```



Select the 3 dots on the right-hand side of the relevant snapshot” and select “Restore” for each required block device. A prompt will appear for each snapshot, check the information and then confirm the restore operation.

Volume Snapshots			
Name		Created	
<input type="text"/>		All	
SHN1_Data.SAPHANA-1557240045531-Host-shn3-Path-hanadataSH1mnt00002		2019-05-07 07:41:36	17.86 M ⋮
SHN3_Data.SAPHANA-1557240045531-Host-shn2-Path-hanadataSH1mnt00003		2019-05-07 07:41:36	59.65 M ⋮
SHN2_Data.SAPHANA-1557240045531-Host-shn1-Path-hanadataSH1mnt00001		2019-05-07 07:41:35	703.57 M ⋮
SHN1_Data.SAPHANA-1557226685421-Host-shn3-Path-hanadataSH1mnt00002		2019-05-07 03:58:16	14.52 G ⋮
SHN3_Data.SAPHANA-1557226685421-Host-shn2-Path-hanadataSH1mnt00003		2019-05-07 03:58:16	14.34 G ⋮
SHN2_Data.SAPHANA-1557226685421-Host-shn1-Path-hanadataSH1mnt00001		2019-05-07 03:58:15	13.83 G ⋮
Destroyed (0) ▾			



Verify that the volumes have restored correctly.

The screenshot displays the Pure Storage console interface. The left sidebar shows the navigation menu with options: Dashboard, Storage, Analysis, Health, and Settings. The main content area is titled 'Storage' and shows the 'Volumes' tab. A table lists various volumes, including SHN1_Data, SHN2_Data, SHN3_Data, and SHN4_Data. Below the table, there are sections for 'Volume Groups' and 'Volume Snapshots'. The 'Volume Snapshots' section shows a list of snapshots with columns for Name, Created, and Size.

Navigate to each volume and check the details match what is required of the SAP HANA scale out system.

The screenshot displays the Pure Storage console interface, specifically the 'Details' view for a volume. The left sidebar shows the navigation menu. The main content area is titled 'Storage' and shows the 'Details' tab for the selected volume. It includes sections for 'Connected Hosts', 'Protection Groups', 'Volume Snapshots', and 'Details'. The 'Details' section shows information about the volume's source, created date, serial number, and number of connections.



Check the details for each volume required to attach to any host in the distributed host setup.

Details	
Source	SHN1_Data
Created	2019-05-07 07:41:36
Serial	1441EFCB40254A2B000114FD
# Hosts	4
# Connections	4 ●
Bandwidth Limit - <input type="checkbox"/>	

Check the details for each volume required to attach to any host in the distributed host setup.

Details	
Source	SHN2_Data
Created	2019-05-07 07:41:35
Serial	1441EFCB40254A2B000114FF
# Hosts	4
# Connections	4 ●
Bandwidth Limit - <input type="checkbox"/>	

Check the details for each volume required to attach to any host in the distributed host setup.

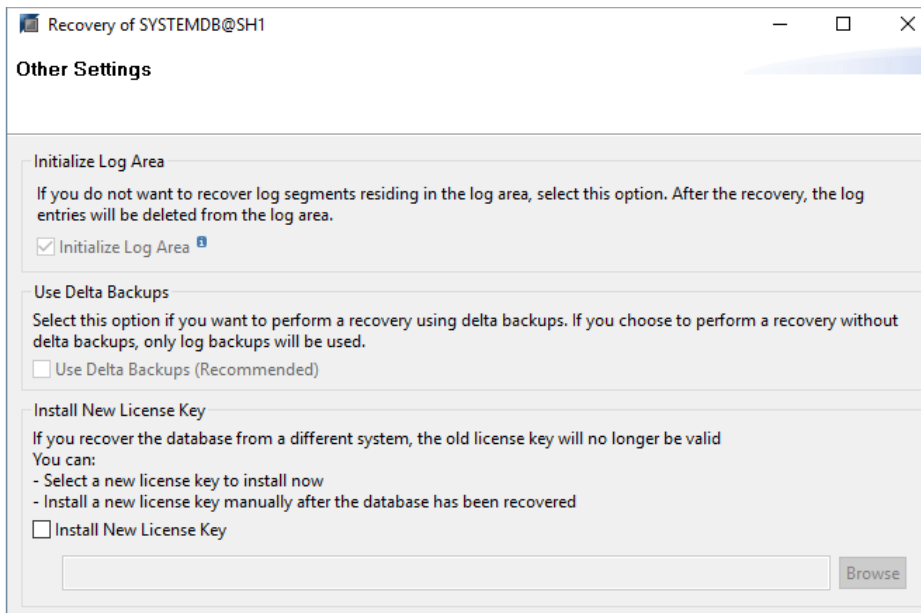
Details	
Source	SHN3_Data
Created	2019-05-07 07:41:36
Serial	1441EFCB40254A2B00011511
# Hosts	4
# Connections	4 ●
Bandwidth Limit - <input type="checkbox"/>	



Select “Refresh” once all of the steps in Step 1a are completed and wait for the user interface to refresh. Once the required recovery point is shown to be available select “Next”.



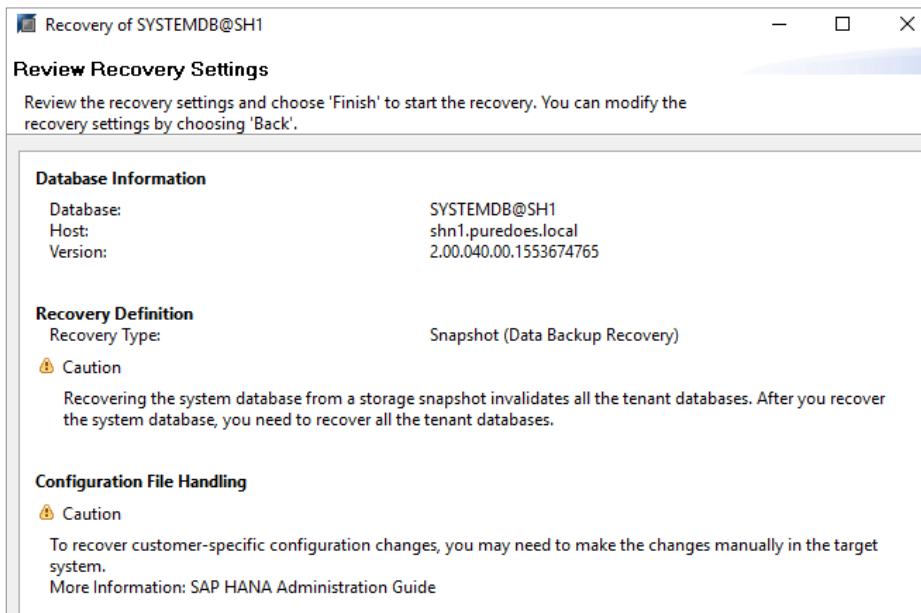
Review the relevant settings for “Initialize Log Area”, “Use Delta Backups” and “Install New License Key”. In some scenarios these selections will be greyed out depending on the recovery type.



The screenshot shows a window titled "Recovery of SYSTEMDB@SH1" with a standard Windows title bar. The main heading is "Other Settings". There are three sections:

- Initialize Log Area**: A text box explaining that if you do not want to recover log segments, this option should be selected, as log entries will be deleted. A checkbox labeled "Initialize Log Area" is checked.
- Use Delta Backups**: A text box explaining that this option is for recovery using delta backups. A checkbox labeled "Use Delta Backups (Recommended)" is unchecked.
- Install New License Key**: A text box explaining that the old license key will no longer be valid if recovered from a different system. It lists two options: selecting a new key now or installing one manually after recovery. A checkbox labeled "Install New License Key" is unchecked. Below this is a text input field and a "Browse" button.

Review all of the recovery settings and proceed by selecting “finish”.



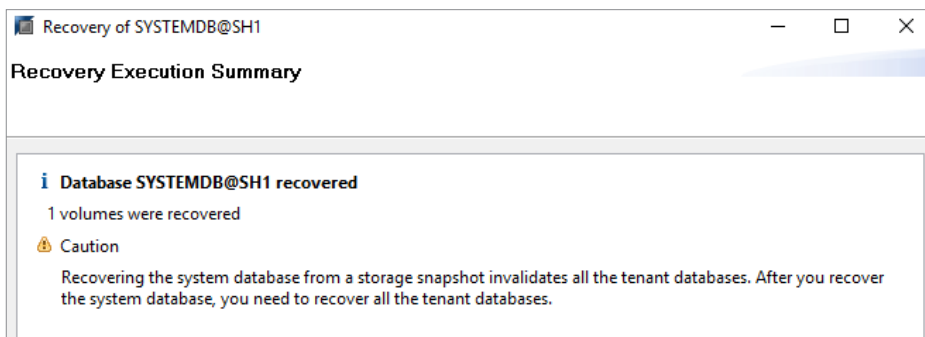
The screenshot shows the same window titled "Recovery of SYSTEMDB@SH1", but the main heading is "Review Recovery Settings". A sub-heading says "Review the recovery settings and choose 'Finish' to start the recovery. You can modify the recovery settings by choosing 'Back'". The content is organized into three sections:

- Database Information**: A table-like view showing Database: SYSTEMDB@SH1, Host: shn1.puredoes.local, and Version: 2.00.040.00.1553674765.
- Recovery Definition**: Shows Recovery Type: Snapshot (Data Backup Recovery). Below this is a "Caution" icon and text: "Recovering the system database from a storage snapshot invalidates all the tenant databases. After you recover the system database, you need to recover all the tenant databases."
- Configuration File Handling**: Shows a "Caution" icon and text: "To recover customer-specific configuration changes, you may need to make the changes manually in the target system. More Information: SAP HANA Administration Guide".

Monitor the recovery process.



Verify the system was restored successfully.



SAP HANA Studio Step 2. Recover Tenant Database

During the recovery of the System database all tenant databases are invalidated and need to be individually recovered by repeating the below steps.

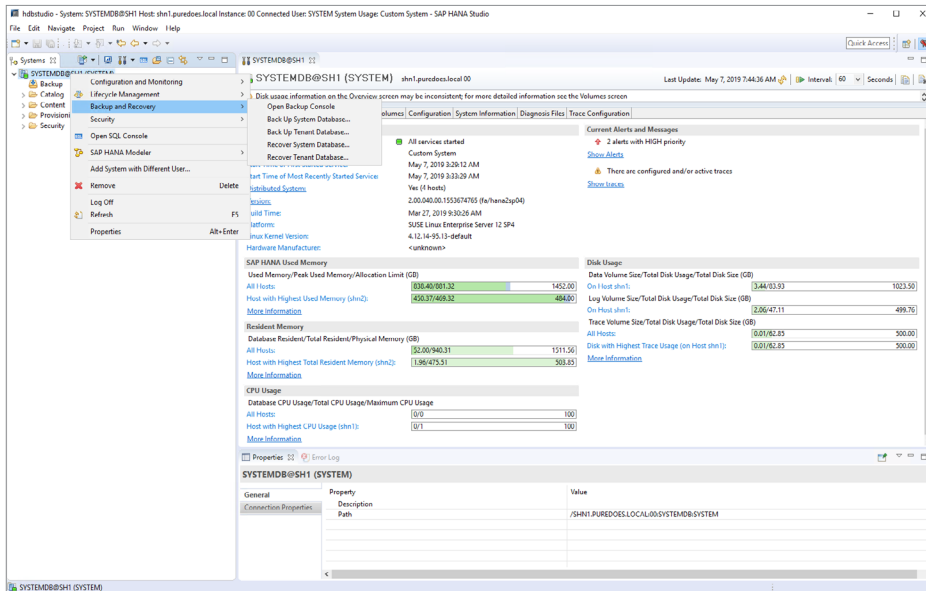
Important: Follow from here if using single container SAP HANA 1.0 system. Notable differences are the absence of “System” and “Tenant” terminology.

Important: In SAP HANA 2.0 SPS04 and onwards repeat these steps for each additional tenant database.

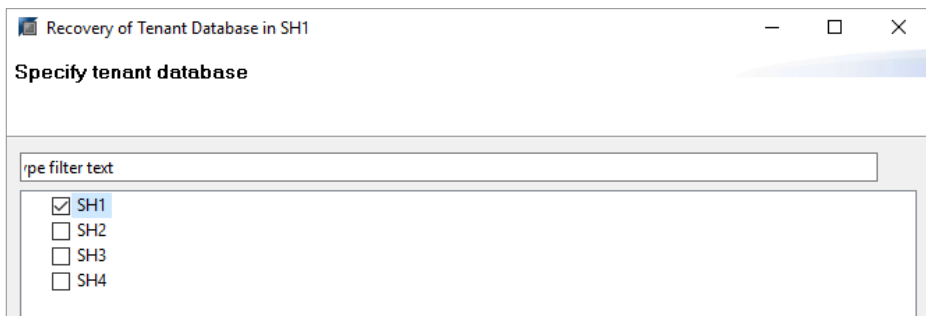
Important: Ensure that Step 1a is completed, while the database is offline, for SAP HANA 1.0 Single tenant systems before proceeding with the below.



Navigate to the main database view in SAP HANA Studio, right-click on the relevant database connection, navigate to “Backup and Recovery” and then Select “Recover Tenant Database...”. When using a single container SAP HANA 1.0 system this will simply state “Recover database... ”



(MDC Only) Select the tenant database to restore. In SAP HANA 2.0 SPS03 and previous releases only a single tenant system can be restored.



Specify the Recovery Type.

The dialog box is titled "Recovery of Tenant Database in SH1". The main heading is "Specify Recovery Type" with the instruction "Select a recovery type." Below this, there are three radio button options:

- ☐ Recover the database to its most recent state
- ☐ Recover the database to the following point in time
- ☒ Recover the database to a specific data backup

Below the radio buttons, there are input fields for "Date:" (2019-05-07) and "Time:" (08:29:47). A "Select Time Zone:" dropdown menu is set to "(GMT-07:00) Pacific Daylight Time". A small information icon and text state "System Time Used (GMT): 2019-05-07 15:29:47". At the bottom right, there is an "Advanced >>" button.

The location of the backup catalog is normally populated, only change this under specialized circumstances where the recovery catalog is in a different location.

The dialog box is titled "Recovery of Tenant Database in SH1". The main heading is "Specify Backup Location" with the instruction "Choose whether you want to select a backup from a backup catalog or enter the name and the path of a backup in the next step." Below this, there are two radio button options:

- ☒ Recover using the backup catalog
 - ☒ Search for the backup catalog in the file system only
 - Backup Catalog Location: /usr/sap/SH1/HDB00/backup/log/DB_SH1
- ☐ Recover without the backup catalog

Below these options, there is a section titled "Backint System Copy" with a checkbox labeled "Backint System Copy" (which is unchecked) and a "Source System:" input field.

Accept the prompt to shut down the database.

The dialog box is titled "Stop Database SH1@SH1". It features a question mark icon and the text "The database must be offline before recovery can start; the database will be stopped now". At the bottom, there are two buttons: "OK" and "Cancel".

The relevant recovery point should be shown as available, then select “Next” to proceed.

Recovery of Tenant Database in SH1

Select a Backup

Select a backup to recover the SAP HANA database

Backups

The overview shows backups that were recorded in the backup catalog as successful.

Start Time	Location	Backup Prefix	Available	
2019-05-07 07:40:45	/hana/data/SH1	SNAPSHOT		
2019-05-07 03:58:05	/hana/data/SH1	SNAPSHOT		

Refresh

Show More

Details of Selected Item

Start Time:

2019-05-07 07:40:45

Destination Type:

SNAPSHOT

Source System:

SH1@SH1

Size:

0 B

Backup ID:

1557240045531

External Backup ID:

ScaleOut

Backup Name:

/hana/data/SH1

Alternative Location:

Check Availability

< Back

Next >

Finish

Cancel

Review the relevant settings for “Initialize Log Area”, “Use Delta Backups” and “Install New License Key”. In some scenarios these selections will be greyed out depending on the recovery type.

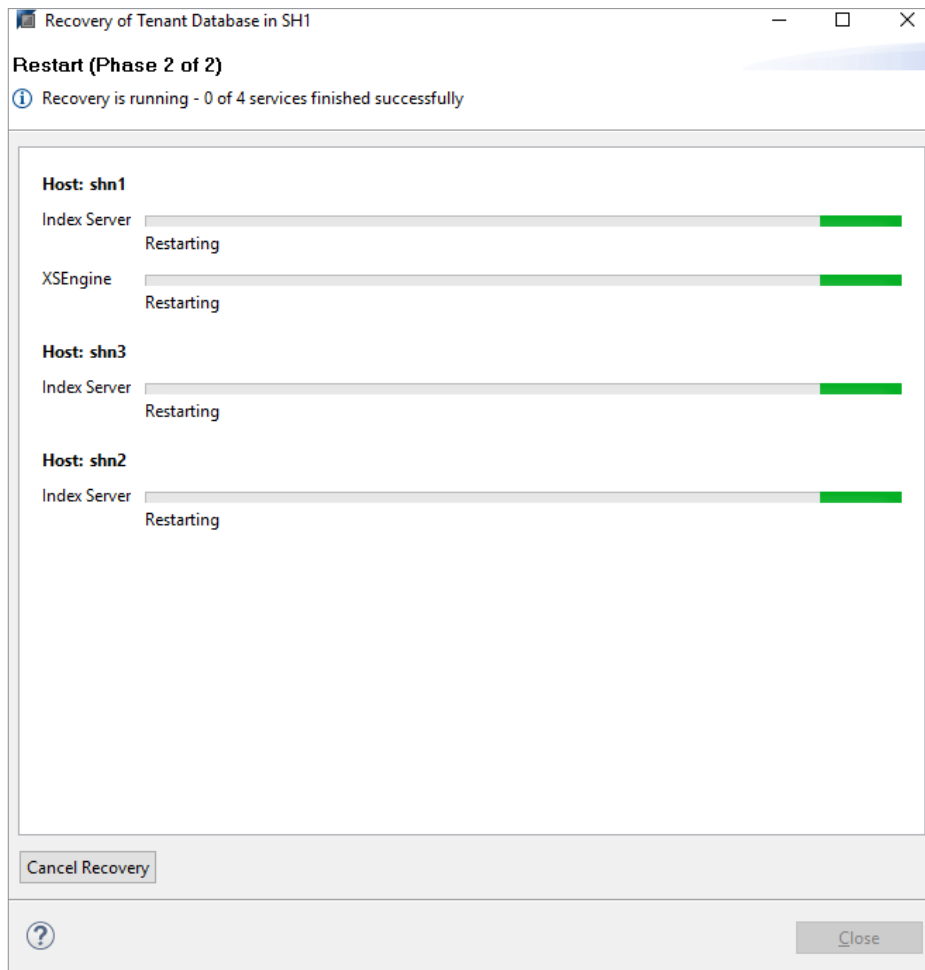
The screenshot shows a window titled "Recovery of Tenant Database in SH1" with standard Windows window controls (minimize, maximize, close). The window contains a section titled "Other Settings" with three sub-sections:

- Initialize Log Area**
If you do not want to recover log segments residing in the log area, select this option. After the recovery, the log entries will be deleted from the log area.
☒ Initialize Log Area
- Use Delta Backups**
Select this option if you want to perform a recovery using delta backups. If you choose to perform a recovery without delta backups, only log backups will be used.
☐ Use Delta Backups (Recommended)
- Install New License Key**
If you recover the database from a different system, the old license key will no longer be valid
You can:
 - Select a new license key to install now
 - Install a new license key manually after the database has been recovered☐ Install New License Key
Below this checkbox is a text input field and a "Browse" button.

At the bottom of the window, there is a navigation bar with a help icon (question mark), and four buttons: "< Back", "Next >" (which is highlighted with a blue border), "Finish", and "Cancel".



Monitor the data recovery operation.



SAP HANA Cockpit Step 1. Prepare to Recover System Database (MDC systems only)

Navigate to the SAP HANA Cockpit web interface and ensure that all of the relevant information is available for it to interface with the relevant deployment to be restored. SAP HANA Systems can be started and stopped from the cockpit interface, where the database will need to be stopped before a recovery can proceed.


Ensure SAP Control credentials are entered and that the resource for HANA cockpit is connected to the SystemDB. Then select the relevant resource for restore operations.

Resources (1)										Group by System	
Status	Resource	Description	Alerts	Group	Availability / Performance / Capacity		Usage Type	Type/Version	Credentials	SAP Control Credentials	
<div><div></div><div>Running with issues</div></div>	SYSTEMDB@SH1	SHN1.puredoes.local Manage Databases	<div><div></div><div>2</div></div>		<div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div></div>	Custom	SAP HANA SYSTEM Database 2.00.040.00.155367476 5 (fa/hana2sp04)	User: SYSTEM Manage Credentials	User: sh1adm Manage Credentials	


From SAP HANA cockpit choose the overall database status tile and select “stop system”.

Overall Database Status

SHN1.puredoes.local 0

 Running with issues

Related Alerts:

 2 high

Usage Type:

Custom

Description:

Hosts:

4

Services:

20

Stop System



Stop the system using either “softly” or “immediately”.

Stop System

How do you want to stop system SH1?

☒ Softly

Timeout: 5 minutes

Running statements finish executing. If the system doesn't stop within the specified timeout period, there will be an immediate hard stop.

☐ Immediately

Stop System

Cancel

Monitor the system processes until all have been shut down.

SYSTEMDB

Start System

Reset Memory Statistics

Go to Alerts

Overall Database Status: Stopped Number of Hosts: 4 Description:

Service (4)

Search

↑↓

Host	Service	Status	Role	Port	Start Time	Service Alerts	Process ID	CPU	Memory	Action
SHN1.puredoes.local	Daemon	Stopped					8704			
shn2	Daemon	Stopped					48639			
shn3	Daemon	Stopped					8245			
shn4	Daemon	Stopped					33489			



Navigate towards the SystemDB resource page.

The screenshot shows the SAP System Overview page for SYSTEMDB@SH1. The page has a top navigation bar with the SAP logo and the text 'SYSTEMDB@SH1 (SYSTEM)'. Below the navigation bar, there is a search bar and a 'Filter by Area' dropdown menu. The main content area is divided into several sections: 'Overall Database Status' (showing 'No SQL access' and 'SHN1.puredoes local 0'), 'System Replication' (showing 'System replication has not been configured'), 'Help' (with links to various help topics), 'Database Administration' (with links to 'Recover database', 'Copy database', and 'Configure host failover'), 'General Information' (showing 'SAP HANA Version: 2.00.040.00.1553674765' and 'Platform: SUSE Linux Enterprise Server 12 SP4'), and 'Platform Lifecycle Management' (with links to various lifecycle management tasks). There is also an 'Alerting and Diagnostics' section with links to 'View trace and diagnostic files' and 'Manage full system information dumps'.

In the “Database Administration” tile, select “Recover database”.

The screenshot shows the 'Database Administration' tile. It has a title 'Database Administration' and three main options: 'Recover database', 'Copy database', and 'Configure host failover'.

Select the recovery target type.

The screenshot shows the 'Recover Database - SYSTEMDB' page. It has a top navigation bar with the SAP logo and the text 'SYSTEMDB@SH1 (SYSTEM)'. Below the navigation bar, there is a search bar and a 'Filter by Area' dropdown menu. The main content area is divided into several sections: 'Recovery Target' (with options 'Recover to the most recent state' and 'Recover to a specific point in time'), 'Specify the Location of the Latest Backup', 'Backup to be Used', 'Delta Backups', 'Specify Alternative Backup Locations', 'Check Availability of Backups', and 'Initialize Log Area'. The 'Recovery Target' section is currently selected, and it shows the 'Recover to the most recent state' option selected. There are also input fields for 'Time Zone' and 'Time' (May 7, 2019 06:50). A 'Step 2' button is visible at the bottom left.

Specify the location of the latest backup catalog, only change these values under specialised circumstances.

Note the “Backup ID” of the backup to be used and its availability.

Start Time	Backup Type	Status	Location	Backup Prefix	Backup ID
5/7/19, 7:40 AM	Data Snapshot	Not available			1557240045531

SAP HANA Studio Step 1a. Recover block storage volume

Recover the relevant storage volume using the FlashArray web user interface. This operation can also be completed using the command line interface or ReST API.

Important: The persistence data volumes must be unmounted from the operating system before a snapshot is restored. This can be done using the “umount” command in a terminal or SSH connection.

In the FlashArray web user interface navigate to “Storage” and select the “Volumes” section.

Name	Source	# Connections	Serial
Rebecca_Boot	-	1 14.3146	
Rebecca_Data	-	1 14.3142	
Rebecca_Log	-	1 14.3143	
Rebecca_Shared	-	1 14.3144	
SHR1_Boot	-	1 14.31423	
SHR1_Data	-	4 14.314FD	
SHR1_Log	-	4 14.314FE	
SHR2_Boot	-	1 14.31424	
SHR2_Data	-	4 14.314FF	
SHR2_Log	-	4 14.3150	

Name	Created	Snapshots
SHR1_Data.SAP.HANA-1557240045531-Host-shr3-Path-hamadataSH1-mv00002	2019-05-07 07:41:36	18.52 M
SHR3_Data.SAP.HANA-1557240045531-Host-shr2-Path-hamadataSH1-mv00003	2019-05-07 07:41:36	66.24 M
SHR1_Data.SAP.HANA-1557240045531-Host-shr1-Path-hamadataSH1-mv00001	2019-05-07 07:41:35	717.00 M
SHR1_Data.SAP.HANA-1557226685421-Host-shr3-Path-hamadataSH1-mv00002	2019-05-07 03:58:36	14.52 G
SHR3_Data.SAP.HANA-1557226685421-Host-shr2-Path-hamadataSH1-mv00003	2019-05-07 03:58:36	14.34 G
SHR2_Data.SAP.HANA-1557226685421-Host-shr1-Path-hamadataSH1-mv00001	2019-05-07 03:58:35	13.83 G

Important: The snapshot which matches the “Backup ID” in the catalog is appended with the exact same value, this is the volume which should be restored. Note that the addition of this value is done during storage snapshot creation by the user.



Identify the snapshots relevant to the Backup_ID of the recovery point.

Volume Snapshots			
		General	Transfer
		1-6 of 6	< > ⋮
Name	Created ▼	Snapshots	
<input type="text"/>	All ▼	<input type="text"/>	
SHN1_Data.SAPHANA-1557240045531-Host-shn3-Path-hanadataSH1mnt00002	2019-05-07 07:41:36	18.52 M	⋮
SHN3_Data.SAPHANA-1557240045531-Host-shn2-Path-hanadataSH1mnt00003	2019-05-07 07:41:36	66.24 M	⋮
SHN2_Data.SAPHANA-1557240045531-Host-shn1-Path-hanadataSH1mnt00001	2019-05-07 07:41:35	717.00 M	⋮
SHN1_Data.SAPHANA-1557226685421-Host-shn3-Path-hanadataSH1mnt00002	2019-05-07 03:58:16	14.52 G	⋮
SHN3_Data.SAPHANA-1557226685421-Host-shn2-Path-hanadataSH1mnt00003	2019-05-07 03:58:16	14.34 G	⋮
SHN2_Data.SAPHANA-1557226685421-Host-shn1-Path-hanadataSH1mnt00001	2019-05-07 03:58:15	13.83 G	⋮
Destroyed (0) ▼			

Unmount each persistence data volume from the mount point on each host.

```
SHN1:~ # umount /hana/data/SH1/mnt00001
```

```
SHN2:~ # umount /hana/data/SH1/mnt00003
```

```
SHN3:~ # umount /hana/data/SH1/mnt00002
```



Select the 3 dots on the right-hand side of the relevant snapshot” and select “Restore” for each required block device. A prompt will appear for each snapshot, check the information and then confirm the restore operation.

Volume Snapshots

General

Transfer

Copy...

Restore...

Rename...

Destroy...

Name	Created	
SHN1_Data.SAPHANA-1557240045531-Host-shn3-Path-hanadataSH1mnt00002	2019-05-07 07:41:36	17.86 M
SHN3_Data.SAPHANA-1557240045531-Host-shn2-Path-hanadataSH1mnt00003	2019-05-07 07:41:36	59.65 M
SHN2_Data.SAPHANA-1557240045531-Host-shn1-Path-hanadataSH1mnt00001	2019-05-07 07:41:35	703.57 M
SHN1_Data.SAPHANA-1557226685421-Host-shn3-Path-hanadataSH1mnt00002	2019-05-07 03:58:16	14.52 G
SHN3_Data.SAPHANA-1557226685421-Host-shn2-Path-hanadataSH1mnt00003	2019-05-07 03:58:16	14.34 G
SHN2_Data.SAPHANA-1557226685421-Host-shn1-Path-hanadataSH1mnt00001	2019-05-07 03:58:15	13.83 G

Destroyed (0) ▾

Verify that the volumes have restored correctly.

Dashboard

Storage

Analysis

Performance

Capacity

Replication

Health

Settings

Help

Terms

Log Out

Storage

Array

Hosts

Volumes

Protection Groups

Pods

Volumes

General

Space

GoS

1.0 of 18

<

>

+

-

Name	Source	# Connections	Serial
SNIN2_Data	SHIN2_Data	4	14_1531
SNIN2_Data	SHIN2_Data	4	14_14FF
SNIN2_Data	SHIN2_Data	4	14_154FD
Rebecca_Boot	-	1	14_1446
Rebecca_Data	-	1	14_1542
Rebecca_Log	-	1	14_1543
Rebecca_Shared	-	1	14_1544
SNIN_Boot	-	1	14_1423
SNIN_Log	-	4	14_14FE
SNIN2_Boot	-	1	14_1424

Destroyed (5)

Volume Groups

0 of 0

<

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-

Name	# Volumes	Size	Volumes	Snaphots	Reduction

No volume groups found.

Destroyed (5)

Volume Snapshots

General

Transfer

16 of 6

<

>

+

-

Name	Created	Snaphots
SHIN2_Data.SAPHANA:1557240045531-Host-sh3-Path-hanadadSHIN2000002	2019-05-07 07:41:36 0.00	
SHIN2_Data.SAPHANA:1557240045531-Host-sh3-Path-hanadadSHIN2000003	2019-05-07 07:41:36 0.00	
SHIN2_Data.SAPHANA:1557240045531-Host-sh3-Path-hanadadSHIN2000001	2019-05-07 07:41:35 0.00	
SHIN2_Data.SAPHANA:1557226685421-Host-sh3-Path-hanadadSHIN2000002	2019-05-07 03:58:16 14.52	
SHIN2_Data.SAPHANA:1557226685421-Host-sh3-Path-hanadadSHIN2000003	2019-05-07 03:58:16 14.34	
SHIN2_Data.SAPHANA:1557226685421-Host-sh3-Path-hanadadSHIN2000001	2019-05-07 03:58:15 13.83	

Destroyed (5)

Destroyed Volume Snapshots

13 of 3

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-

Name	Snaphots	Time Remaining
SHIN2_Data.copy4	8.87 M	23 h 55 m
SHIN2_Data.copy5	83.88 M	23 h 55 m
SHIN2_Data.copy4	25.30 M	23 h 55 m

Array

ser1x70.R04.27

Purity//A

6.2.0

Logged in as puruser

(GMT 07:00 (PST))



Navigate to each volume and check the details match what is required of the SAP HANA scale out system.

Pure Storage

Dashboard

Storage

Analysis

Performance

Capacity

Replication

Health

Settings

Help

Home

Log Out

Array

SHN1-20-04-27

Purity/FA

5.2.0

Logged in as pratt

SAF (2/10) (POT)

Storage

Array

Hosts

Volumes

Protection Groups

Pods

Search

SHN1_Data

Size

1T

Data Reduction

79 to 1

Volumes

40.43 G

Snapshots

14.52 G

Shared

-

System

-

Total

54.95 G

Connected Hosts

14 of 4

Name

SHN1-20-04-03-SH01

LUN

2

SHN1-20-04-05-SH02

4

SHN1-20-04-07-SH03

4

SHN1-20-04-09-SH04

2

Connected Host Groups

0 of 0

Name

LUN

No host groups found.

Details

Source

SHN1_Data

Created

2019-05-07 07:41:36

Serial

1441EFCB40254A2B000114FD

Hosts

4

Connections

4

Bandwidth Limit

-

Protection Groups

0 of 0

Name

No protection groups found.

Volume Snapshots

General

Transfer

1.2 of 2

Name

SHN1_Data.SAPHANA-1557240045531-Host-shn3-Path-hanadatuSHN1-20-04-03-SH01

Created

2019-05-07 07:41:36

Snapshots

0.00

SHN1_Data.SAPHANA-1557226685421-Host-shn3-Path-hanadatuSHN1-20-04-03-SH01

2019-05-07 03:58:16

14.52 G

Destroyed (0)

Check the details for each volume required to attach to any host in the distributed host setup.

Details

Source

SHN1_Data

Created

2019-05-07 07:41:36

Serial

1441EFCB40254A2B000114FD

Hosts

4

Connections

4

Bandwidth Limit

-

105

Check the details for each volume required to attach to any host in the distributed host setup.

Details	
Source	SHN2_Data
Created	2019-05-07 07:41:35
Serial	1441EFCB40254A2B000114FF
# Hosts	4
# Connections	4 ●
Bandwidth Limit - <input type="checkbox"/>	

Check the details for each volume required to attach to any host in the distributed host setup.

Details	
Source	SHN3_Data
Created	2019-05-07 07:41:36
Serial	1441EFCB40254A2B00011511
# Hosts	4
# Connections	4 ●
Bandwidth Limit - <input type="checkbox"/>	

SAP HANA Cockpit Step 1b. Recover the System Database

Select the refresh icon in the top right-hand corner under Backups to be Used to rescan the backup catalog.

The screenshot shows the 'Recover Database' wizard in SAP HANA Cockpit. The title bar indicates 'SYSTEMDB@SH1 (SYSTEM)' and 'Recover Database'. The wizard progress bar shows seven steps: 1. Recovery Target, 2. Specify the Location of the Latest Backup, 3. Backup to be Used (current step), 4. Delta Backups, 5. Specify Alternative Backup Locations, 6. Check Availability of Backups, and 7. Initialize Log Area. The main content area is titled '3. Backup to be Used' and contains a table with backup information. A refresh icon (circular arrow) is visible in the top right corner of the table area. A 'Step 4' button is located at the bottom left.

Start Time	Backup Type	Status	Location	Backup Prefix	Backup ID
5/7/19, 7:40 AM	Data Snapshot	<input checked="" type="checkbox"/> Available			1557240045531



Select the preferred value for Delta Backups.

The screenshot shows the 'Recover Database - SYSTEMDB' wizard in SAP. The progress bar at the top indicates seven steps: 1. Recovery Target, 2. Specify the Location of the Latest Backup, 3. Backup to be Used, 4. Delta Backups (current step), 5. Specify Alternative Backup Locations, 6. Check Availability of Backups, and 7. Initialize Log Area. The main content area for Step 4 is titled '4. Delta Backups'. It contains a blue box with the text: 'If you choose to perform a recovery without delta backups, only log backups will be used.' Below this, there is a section 'Use Delta Backups:' with two radio buttons: 'Yes (recommended)' and 'No'. The 'No' button is selected. At the bottom left, there is a 'Step 5' button.

Specify any alternative backup locations.

The screenshot shows the 'Recover Database - SYSTEMDB' wizard in SAP. The progress bar at the top indicates seven steps: 1. Recovery Target, 2. Specify the Location of the Latest Backup, 3. Backup to be Used, 4. Delta Backups, 5. Specify Alternative Backup Locations (current step), 6. Check Availability of Backups, and 7. Initialize Log Area. The main content area for Step 5 is titled '5. Specify Alternative Backup Locations'. It contains a blue box with the text: 'If no location is specified, the location in the backup catalog is used.' Below this, there is a section 'Log Backups' with a label 'Location 1:' followed by a text input field and an 'Add more' link. At the bottom left, there is a 'Step 6' button.

Specify if the availability of backups should be checked.

The screenshot shows the 'Recover Database - SYSTEMDB' wizard in SAP. The progress bar at the top indicates seven steps: 1. Recovery Target, 2. Specify the Location of the Latest Backup, 3. Backup to be Used, 4. Delta Backups, 5. Specify Alternative Backup Locations, 6. Check Availability of Backups (current step), and 7. Initialize Log Area. The main content area for Step 6 is titled '6. Check Availability of Backups'. It contains a blue box with the text: 'If backups are not available, checking their availability at the beginning of the recovery saves time.' Below this, there is a section 'File System:' with two radio buttons: 'Yes' and 'No'. The 'Yes' button is selected. At the bottom left, there is a 'Step 7' button.

Specify if the log area should be initialized, doing so invalidates any logs or log backups made after the recovery point.

The screenshot shows the 'Recover Database - SYSTEMDB' wizard in SAP. The progress bar at the top indicates seven steps: 1. Recovery Target, 2. Specify the Location of the Latest Backup, 3. Backup to be Used, 4. Delta Backups, 5. Specify Alternative Backup Locations, 6. Check Availability of Backups, and 7. Initialize Log Area (current step). The main content area for Step 7 is titled '7. Initialize Log Area'. It contains a blue box with the text: 'If the log area is initialized, all changes performed after the latest log backup are irretrievably lost.' Below this, there is a section 'Initialize the log area:' with two radio buttons: 'No' and 'Yes'. The 'No' button is selected. At the bottom left, there is a 'Review' button.

Review the information for the recovery operation and then select “Start Recovery”.

SYSTEMDB@SH1 (SYSTEM)

Recover Database

Recover Database - SYSTEMDB - Summary

Recovery Target

Target: Recover to the most recent state

Specify the Location of the Latest Backup Catalog

Location: Default file system location (/usr/sap/SH1/HDB00/backup/log/SYSTEMDB)

Backup to be Used

Backup Type: Data Snapshot

Start Time: May 7, 2019, 7:40:45 AM

Backup Prefix: 1557240045531

Backup ID: 1557240045531

Destination Type: Snapshot

Delta Backups

Use Delta Backups: No

Specify Alternative Backup Locations

Log Backups: Data backups will be read from the location in the backup catalog

Check Availability of Backups

File Backups: Yes

Initialize Log Area

Initialize Log Area: No

Start Recovery

Edit

Cancel

Display SQL Statement

While restoring the System Database the status can be observed from the same view.

SYSTEMDB@SH1 (SYSTEM)

Recover Database

Recover Database - SYSTEMDB - Summary

Recovery Target

Target: Recover to the most recent state

Specify the Location of the Latest Backup Catalog

Location: Default file system location (/usr/sap/SH1/HDB00/backup/log/SYSTEMDB)

Backup to be Used

Backup Type: Data Snapshot

Start Time: May 7, 2019, 7:40:45 AM

Backup Prefix: 1557240045531

Backup ID: 1557240045531

Destination Type: Snapshot

Starting the nameserver and reading the backup catalog. This may take some time.

Delta Backups

Use Delta Backups: No

Specify Alternative Backup Locations

Log Backups: Data backups will be read from the location in the backup catalog

Check Availability of Backups

File Backups: Yes

Initialize Log Area

Initialize Log Area: No

Start Recovery

Edit

Cancel

Display SQL Statement



SAP HANA Cockpit Step 2. Recover Tenant Database

During the recovery of the System database all tenant databases are invalidated and need to be individually recovered by repeating the below steps.

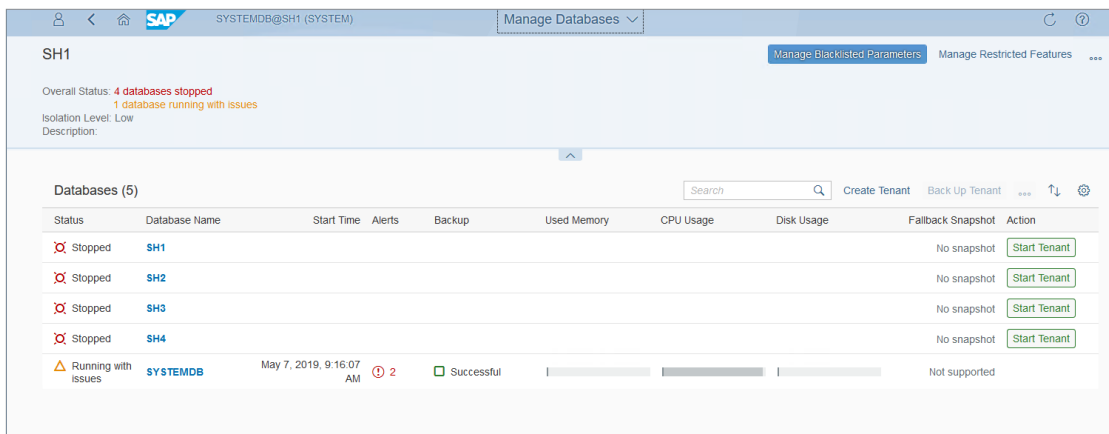
Important: Follow from here if using single container SAP HANA 1.0 system. Notable differences are the absence of “System” and “Tenant” terminology.

Important: In SAP HANA 2.0 SPS04 and onwards repeat these steps for each additional tenant database.

Important: Ensure that Step 1a is completed, while the database is offline, for SAP HANA 1.0 Single tenant systems before proceeding with the below.

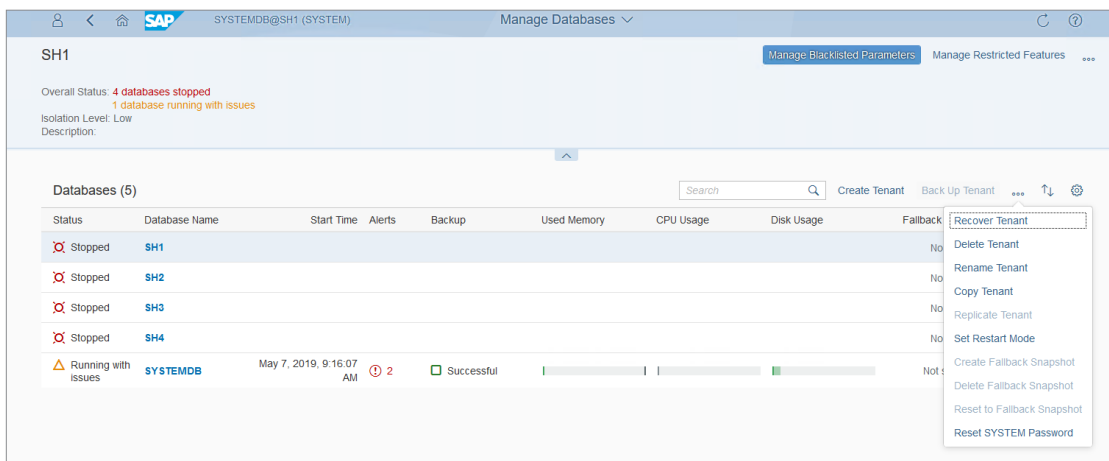
Once the System Database has been recovered select “Manage Databases” from the SystemDB database view.

All of the tenants will be shown, but in an offline state. In SAP HANA SPS03 and previous releases only a single tenant system can be recovered.



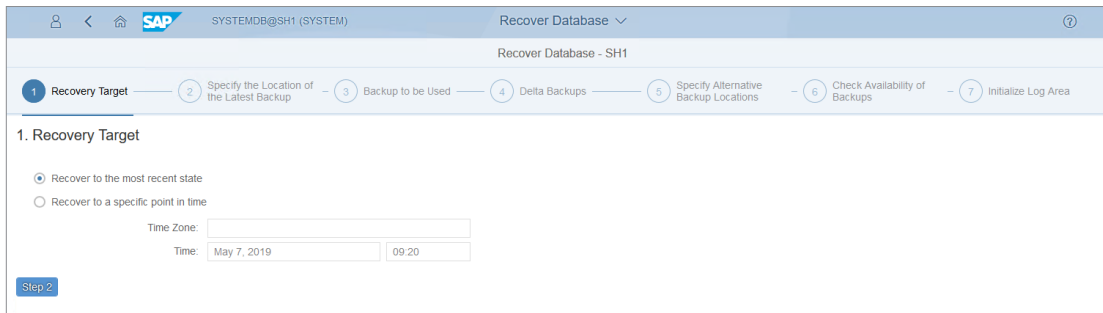
Status	Database Name	Start Time	Alerts	Backup	Used Memory	CPU Usage	Disk Usage	Failback Snapshot	Action
Stopped	SH1							No snapshot	Start Tenant
Stopped	SH2							No snapshot	Start Tenant
Stopped	SH3							No snapshot	Start Tenant
Stopped	SH4							No snapshot	Start Tenant
Running with issues	SYSTEMDB	May 7, 2019, 9:16:07 AM	2	Successful				Not supported	

Highlight the relevant tenant database to be recovered and then select the three dots in the right-hand corner to bring up the context menu, then select “Recover Tenant”.



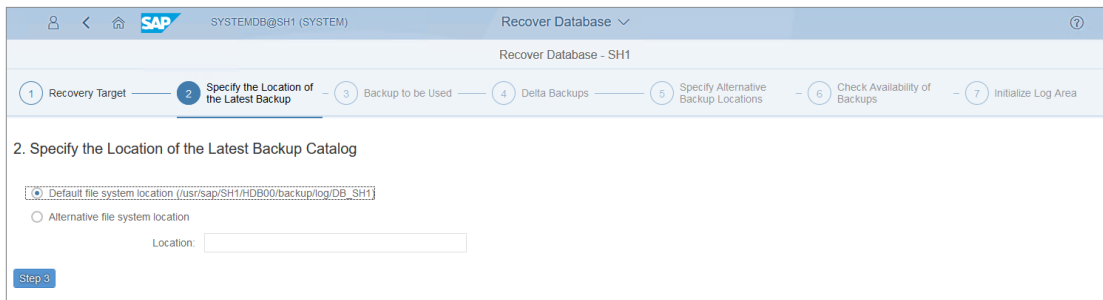
Status	Database Name	Start Time	Alerts	Backup	Used Memory	CPU Usage	Disk Usage	Failback Snapshot	Action
Stopped	SH1							No snapshot	Recover Tenant Delete Tenant Rename Tenant Copy Tenant Replicate Tenant Set Restart Mode Create Failback Snapshot Delete Failback Snapshot Reset to Failback Snapshot Reset SYSTEM Password
Stopped	SH2							No snapshot	
Stopped	SH3							No snapshot	
Stopped	SH4							No snapshot	
Running with issues	SYSTEMDB	May 7, 2019, 9:16:07 AM	2	Successful				Not supported	

Select the recovery target type.



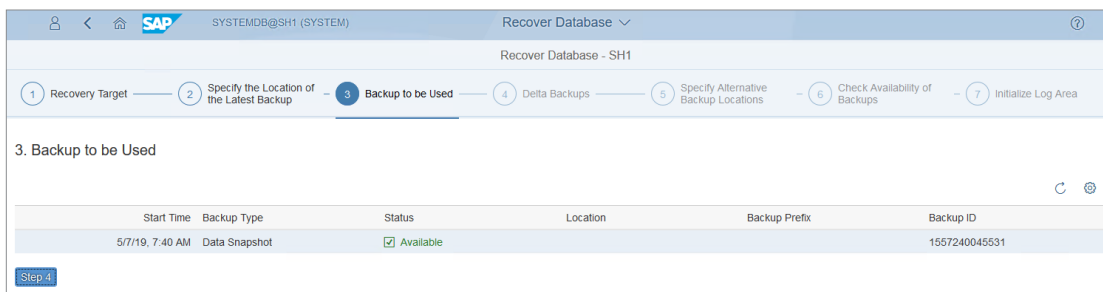
The screenshot shows the SAP Recovery Database - SH1 interface. The top navigation bar includes the SAP logo, user information (SYSTEMDB@SH1 (SYSTEM)), and the title 'Recover Database'. Below the navigation bar, a progress bar indicates seven steps: 1. Recovery Target (selected), 2. Specify the Location of the Latest Backup, 3. Backup to be Used, 4. Delta Backups, 5. Specify Alternative Backup Locations, 6. Check Availability of Backups, and 7. Initialize Log Area. The main content area for Step 1, 'Recovery Target', contains two radio button options: 'Recover to the most recent state' (selected) and 'Recover to a specific point in time'. Below these options, there are input fields for 'Time Zone' and 'Time' (set to May 7, 2019, 09:20). A 'Step 2' button is located at the bottom left.

Specify the location of the latest backup catalog, only change these values under specialised circumstances.



The screenshot shows the SAP Recovery Database - SH1 interface at Step 2, 'Specify the Location of the Latest Backup Catalog'. The progress bar shows Step 2 is selected. The main content area contains a text input field with the default file system location: '/usr/sap/SH1/HDB00/backup/log/DB_SH1'. Below this, there is an 'Alternative file system location' radio button option and a 'Location' input field. A 'Step 3' button is located at the bottom left.

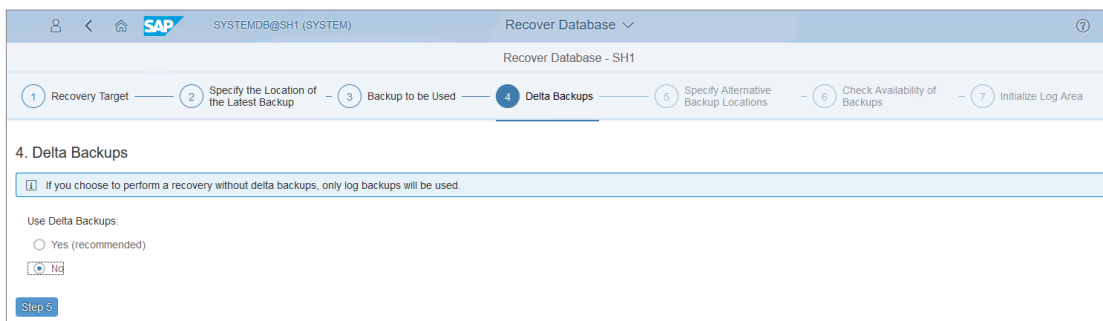
The relevant backup to be used will have the status of "Available", select this and then select "Step 4".



The screenshot shows the SAP Recovery Database - SH1 interface at Step 3, 'Backup to be Used'. The progress bar shows Step 3 is selected. The main content area displays a table with backup information. The table has columns: Start Time, Backup Type, Status, Location, Backup Prefix, and Backup ID. One backup is listed with a status of 'Available'. A 'Step 4' button is located at the bottom left.

Start Time	Backup Type	Status	Location	Backup Prefix	Backup ID
5/7/19, 7:40 AM	Data Snapshot	Available			1557240045531

Specify if Delta Backups are to be used.



The screenshot shows the SAP Recovery Database - SH1 interface at Step 4, 'Delta Backups'. The progress bar shows Step 4 is selected. The main content area contains a text box with the instruction: 'If you choose to perform a recovery without delta backups, only log backups will be used.' Below this, there is a section titled 'Use Delta Backups' with a radio button option 'Yes (recommended)' selected. A 'Step 5' button is located at the bottom left.

Specify an Alternative Backup location if any exist.

The screenshot shows the SAP 'Recover Database - SH1' wizard. The progress bar at the top indicates seven steps: 1. Recovery Target, 2. Specify the Location of the Latest Backup, 3. Backup to be Used, 4. Delta Backups, 5. Specify Alternative Backup Locations (current step), 6. Check Availability of Backups, and 7. Initialize Log Area. The main content area is titled '5. Specify Alternative Backup Locations'. It contains a tip: 'If no location is specified, the location in the backup catalog is used.' Below this, there is a section for 'Log Backups' with a 'Location 1:' text box and an 'Add more' link. A 'Step 6' button is at the bottom left.

Specify if the Availability of Backups must be checked.

The screenshot shows the SAP 'Recover Database - SH1' wizard at Step 6, 'Check Availability of Backups'. The progress bar shows steps 1 through 7, with step 6 being the current step. The main content area has a tip: 'If backups are not available, checking their availability at the beginning of the recovery saves time.' Below the tip, there is a 'File System:' section with two radio buttons: 'Yes' (selected) and 'No'. A 'Step 7' button is at the bottom left.

Specify if the log area must be initialized.

The screenshot shows the SAP 'Recover Database - SH1' wizard at Step 7, 'Initialize Log Area'. The progress bar shows steps 1 through 7, with step 7 being the current step. The main content area has a tip: 'If the log area is initialized, all changes performed after the latest log backup are irretrievably lost.' Below the tip, there is a section 'Initialize the log area:' with two radio buttons: 'No' (selected) and 'Yes'. A 'Review' button is at the bottom left.

Review the information for the recovery operation and then select “Start Recovery”.

SYSTEMDB@SH1 (SYSTEM)

Recover Database

Recover Database - SH1 - Summary

Recovery Target

Target: Recover to the most recent state

Specify the Location of the Latest Backup Catalog

Location: Default file system location (/usr/sap/SH1/HDB00/backuplog/DB_SH1)

Backup to be Used

Backup Type: Data Snapshot
Start Time: May 7, 2019, 7:40:45 AM
Backup Prefix:
Backup ID: 1557240045531
Destination Type: Snapshot

Delta Backups

Use Delta Backups: No

Specify Alternative Backup Locations

Log Backups: Data backups will be read from the location in the backup catalog

Check Availability of Backups

File Backups: Yes

Initialize Log Area

Initialize Log Area: No

Start Recovery

Edit

Cancel

Display SQL Statement

Once the tenant has been successfully recovered the status will be shown.

SYSTEMDB@SH1 (SYSTEM)

Recover Database

Recovery Status - SH1

Start Time (UTC): May 7, 2019, 4:25:40 PM

Recovery completed in 44 seconds.

System Restart (Phase 3 of 3)

shn1

xsengine100%

indexserver100%

shn2

indexserver100%

shn3

indexserver100%



SAP HANA Deployment on VMware ESXi Hypervisors

In many scenarios it is appropriate to use snapshots of the virtual machine and to recover by simply restoring this snapshot. In other specialised scenarios it is possible to combine the recovery catalog present in SAP HANA with virtual machine snapshots and storage snapshots. Best practices for using snapshots in a VMware vSphere environment indicate that virtual machine snapshots should not be used as backups, instead ensure that snapshots are used in conjunction with an independent software vendor for backup to move the virtual machine snapshot to a different location. Virtual machine snapshots should not be retained for more than 72 hours due to storage space management and performance degradation.

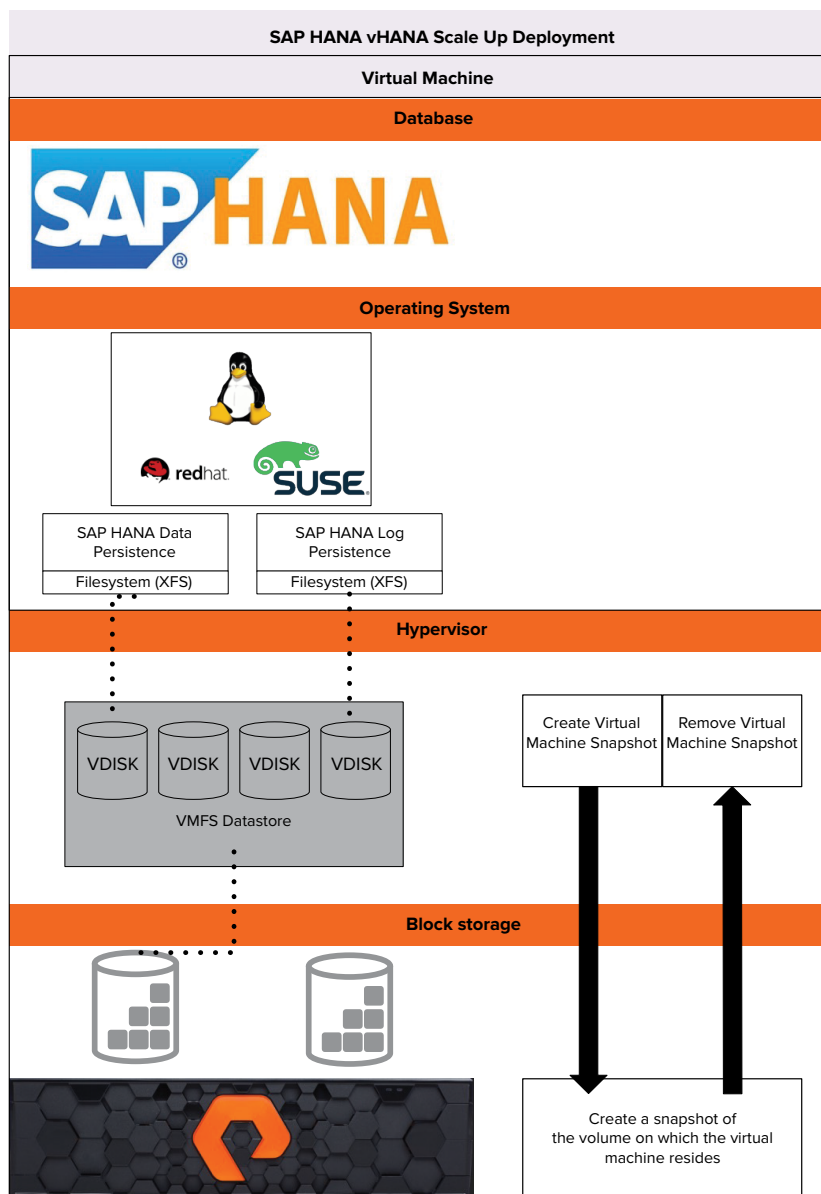


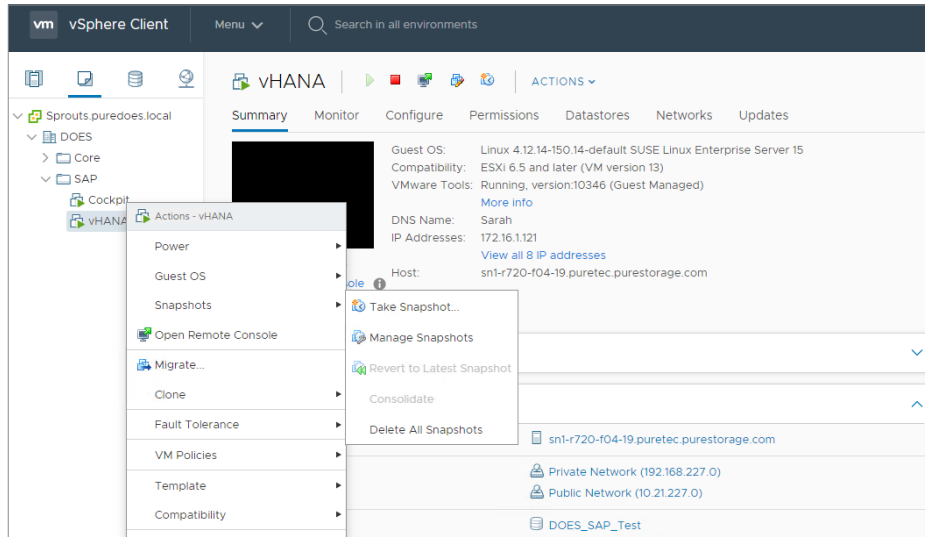
Fig. 11 Workflow to create a storage snapshot for SAP HANA database deployed on VMware vSphere.

With FlashArray and the Purity operating environment, storage snapshots containing a previously snapshotted virtual machine can be considered a point-in-time recovery point, or if the storage snapshot is transported using Snap-to-NFS or Snap-to-S3 then it can be considering a backup.

VIRTUALISED SAP HANA PROTECTION USING VMWARE VSPHERE SNAPSHOTS

In order to create a virtual machine snapshot a user with the necessary permissions should be logged into the vSphere web client. Navigate to the VMs and Templates view, select the relevant SAP HANA system and right-click to bring up the context menu and then select "Take Snapshot..."

VMware vSphere web client with the context menu for a SAP HANA virtual machine.



A prompt will show waiting for the relevant information to be entered for a snapshot to be created. If a stateful snapshot of the virtual machine needs to be created ensure that "Snapshot the virtual machines memory" is selected, otherwise unselect it. Creating a snapshot of the virtual machine's memory can take longer and impact performance.

Prompt waiting for the user to enter specifics about the SAP HANA virtual machine.

Take Snapshot

vHANA

×

Name

VM Snapshot 5/13/2019, 2:51:39 AM

Description

☒ Snapshot the virtual machine's memory

☐ Quiesce guest file system (Needs VMware Tools installed)

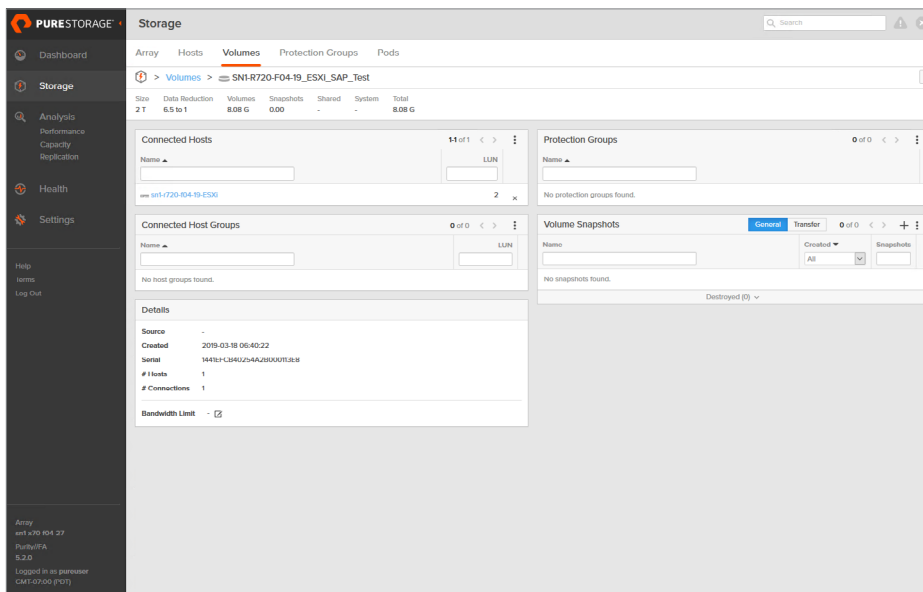
CANCEL

OK

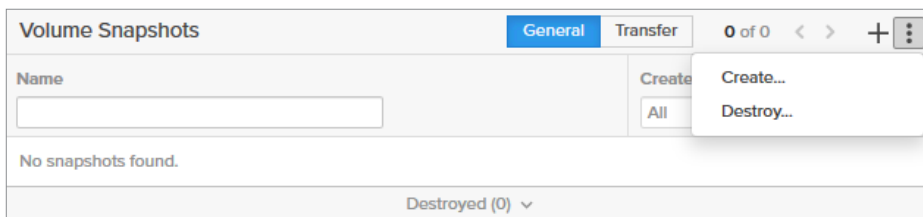
Once the snapshot is created navigate to the FlashArray web user interface and create a storage snapshot of the relevant block storage volume.



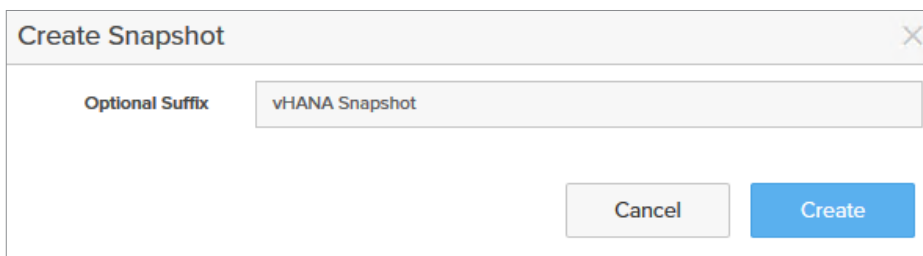
In the FlashArray web user interface navigate to the Storage view and select Volumes, then select the volume(s) on which the virtual machine resides.



Select the three dots in the upper right-hand corner of Volume snapshots and select “Create...””.



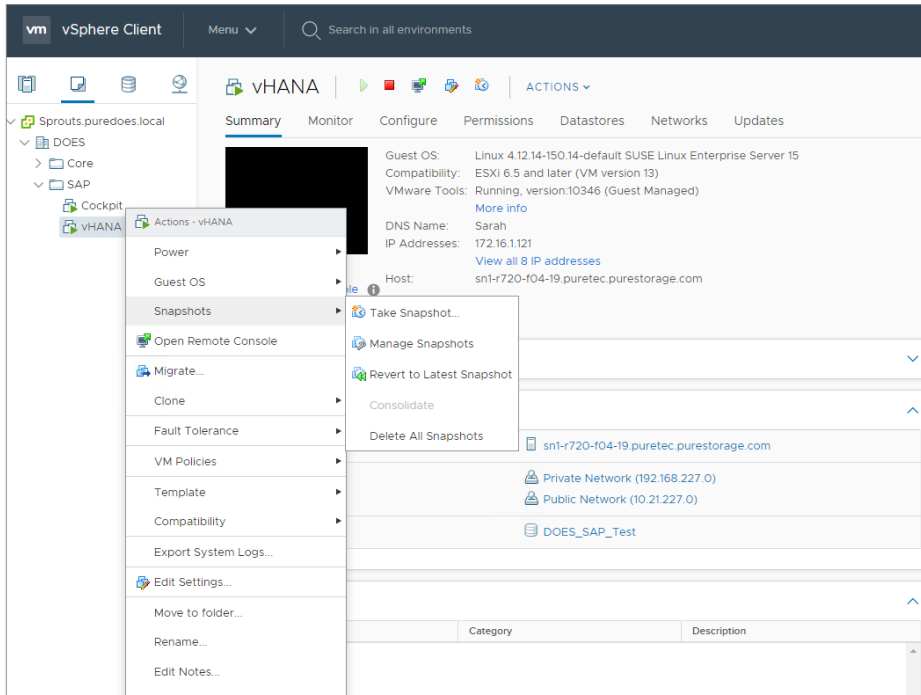
Give the snapshot an optional suffix and then select “Create”.



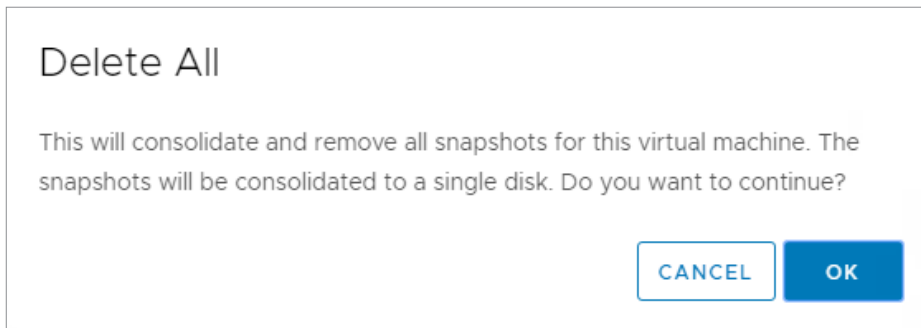
Once the block volume snapshot has been created the virtual machine snapshot must be discarded. This can be done using the vSphere web client, selecting the VMs and templates view and then bringing up the context menu for the vHANA virtual machine and selecting “Snapshots” and then further selecting “Delete All Snapshots”.



In the vSphere web client bring up the context menu for the SAP HANA virtual machine and delete all of the snapshots.



Select OK from the prompt to delete all of the snapshots for the SAP HANA virtual machine.



VIRTUALISED SAP HANA PROTECTION USING APPLICATION CONSISTENT STORAGE SNAPSHOTS

The exact same workflow as set out in the section “Data Protection Solutions for SAP HANA, SAP HANA Scale Up/ Single Host System” can be applied to accomplish application consistent storage snapshots, with the exception that the volume(s) on which the SAP HANA instance is deployed must be identified beforehand. This applies to any implementation of virtual volumes (VVOLS) as well but differs that each virtual disk attached to the virtual machine will have a corresponding block volume in the FlashArray.

Crash Consistent Storage Snapshots

Overview

The creation of a storage snapshot without any application or system coordination to create a record of the operation and ensure that no data is written to the storage device while the operation executes is typically named a crash consistent storage snapshot. It is possible to use this snapshot method to create a point in time recovery point on the storage array and then use it to create system copies or rollback points during development operations. Due to the complex nature of SAP HANA scale out/ distributed host systems only scale up/single host crash consistent snapshots are explored.

The recommended way of creating storage snapshots for production systems would be to use application consistent storage snapshots, crash consistent snapshots do not create a catalog entry for the recovery point nor does it guarantee consistency for a point in time recovery.

Configuration and operation

Creating crash consistent snapshots

The recovery point, when created, must at minimum create a snapshot for both the log and data volumes. Including the /hana/ shared (install path) volume is also possible but does not affect recovery. It is optional to have the instance and any tenant database(s) online while creating the storage snapshot. If a degree of data consistency is required then it is advised that “ALTER SYSTEM SAVEPOINT” be run from the database and any tenant databases present on the instance.



In the FlashArray web user interface navigate to the Storage view and select Volumes.

The screenshot shows the Pure Storage FlashArray web interface. The 'Storage' tab is active, and the 'Volumes' sub-tab is selected. The interface displays a list of volumes with columns for Name, Source, # Connections, and Serial. A context menu is visible over the volume list, showing options like Create..., Create Snapshots..., Move..., Destroy..., Show Protocol Endpoints, and Download CSV.

In the volumes view select the vertical ellipsis in the top right-hand corner and select “Create Snapshots...”

The screenshot shows the Pure Storage FlashArray web interface with the 'Volumes' tab selected. A context menu is open over the volume list, showing options like Create..., Create Snapshots..., Move..., Destroy..., Show Protocol Endpoints, and Download CSV. The 'Create Snapshots...' option is highlighted.

In the Create Volume Snapshots view select the log and data volumes for the SAP HANA instance, then select “Create”.

Create Volume Snapshots

Existing Volumes

☐

1-16 of 16

☐ Rebecca_Boot

580.33 M

☒ Rebecca_Data

79.07 G

☒ Rebecca_Log

36.48 G

☐ Rebecca_Shared

78.26 M

☐ SHN1_Boot

85.60 M

☐ SHN2_Boot

101.27 M

☐ SHN3_Boot

87.09 M

☐ SHN4_Boot

85.53 M

☐ SN1-R720-F04-19_ESXI_Production

121.80 G

☐ SN1-R720-F04-19_ESXI_SAP_Test

14.03 G

Suffix

Automatic

Cancel

Create

Selected Volumes

2 selected

Clear all

Rebecca_Data

79.07 G

x

Rebecca_Log

36.48 G

x

Once the block volume snapshots have been created, they will be shown in the Volume Snapshots view.

Volume Snapshots			
		General	Transfer
		1-2 of 2	< > ⋮
Name	Created	Snapshots	
<input type="text"/>	All		
Rebecca_Data.5494	2019-05-13 04:57:03	0.00	⋮
Rebecca_Log.5495	2019-05-13 04:57:03	0.00	⋮
Destroyed (0) ^			



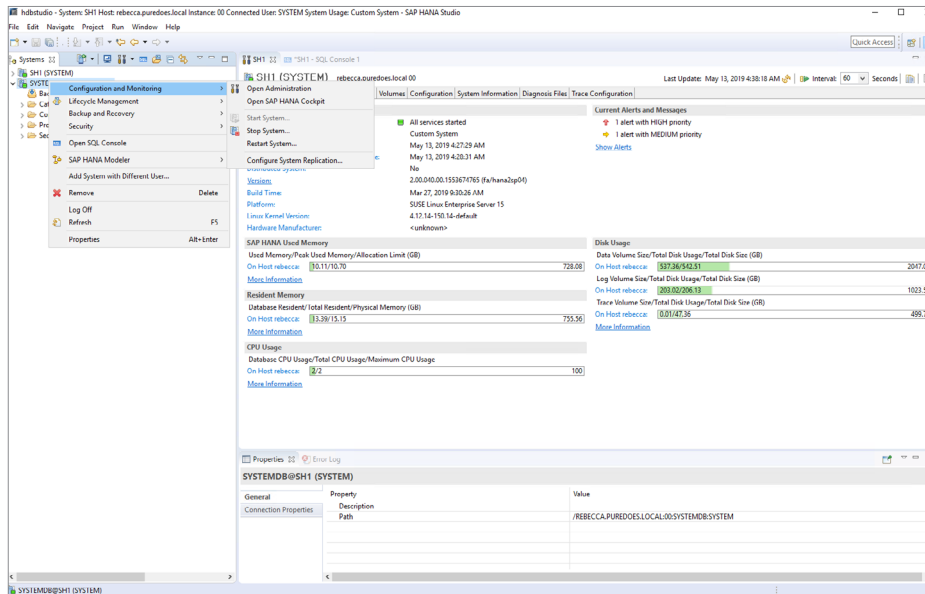
RECOVERING FROM CRASH CONSISTENT SNAPSHOTS

In order to restore the SAP HANA instance from a crash consistent storage snapshot, any existing instances must first be shut down.

Step 1: Shut down existing SAP HANA instance

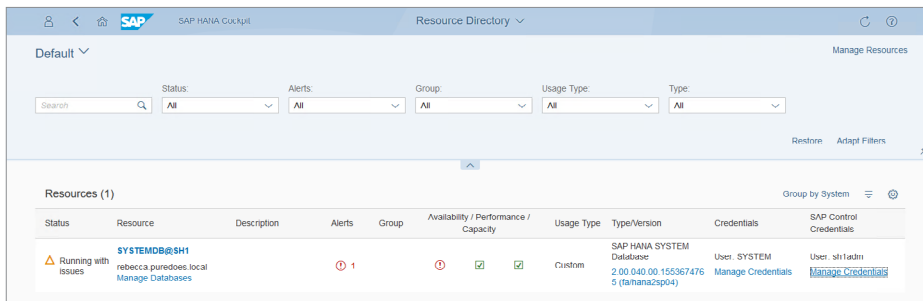
SAP HANA Studio:

In SAP HANA Studio, using the systems view right-click on the relevant instance and select the “Configuration and Monitoring” submenu and then select “Stop System... ”.



SAP HANA Cockpit:

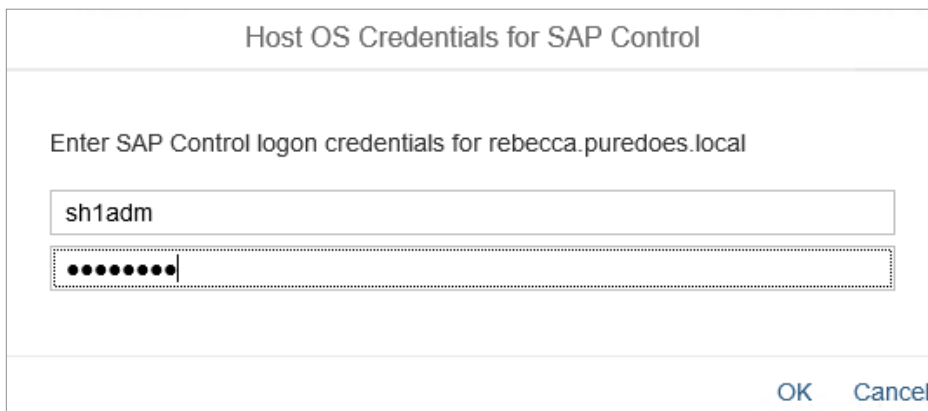
Under the resources view in SAP HANA cockpit identify the relevant resource. Select the resource to proceed to the system overview.



The screenshot shows the SAP HANA Cockpit interface with the 'Resource Directory' tab selected. At the top, there are filters for Status, Alerts, Group, Usage Type, and Type, all set to 'All'. Below the filters is a table titled 'Resources (1)'. The table has columns for Status, Resource, Description, Alerts, Group, Availability / Performance / Capacity, Usage Type, Type/Version, Credentials, and SAP Control Credentials. The first row shows a resource with a status of 'Running with issues', a resource name of 'SYSTEMDB@SH1', and a description of 'rebecca.puredoes.local'. The 'Alerts' column shows a red circle with a white '1'. The 'Availability / Performance / Capacity' column shows a red circle with a white '1' and two green checkmarks. The 'Usage Type' is 'Custom'. The 'Type/Version' is 'SAP HANA SYSTEM Database 2.00.040.00.155367476 5 (sahanaz2p04)'. The 'Credentials' column shows 'User: SYSTEM' and a link to 'Manage Credentials'. The 'SAP Control Credentials' column shows 'User: sh1adm' and a link to 'Manage Credentials'.

Status	Resource	Description	Alerts	Group	Availability / Performance / Capacity	Usage Type	Type/Version	Credentials	SAP Control Credentials
Running with issues	SYSTEMDB@SH1 rebecca.puredoes.local Manage Databases		1		1 <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	Custom	SAP HANA SYSTEM Database 2.00.040.00.155367476 5 (sahanaz2p04)	User: SYSTEM Manage Credentials	User: sh1adm Manage Credentials

Ensure the relevant resource has the correct SAP Control login credentials.



The screenshot shows a dialog box titled 'Host OS Credentials for SAP Control'. Inside the dialog, there is a text prompt 'Enter SAP Control logon credentials for rebecca.puredoes.local'. Below the prompt, there are two input fields. The first field contains the text 'sh1adm'. The second field is a password field with a series of dots and a cursor. At the bottom right of the dialog, there are 'OK' and 'Cancel' buttons.

Host OS Credentials for SAP Control

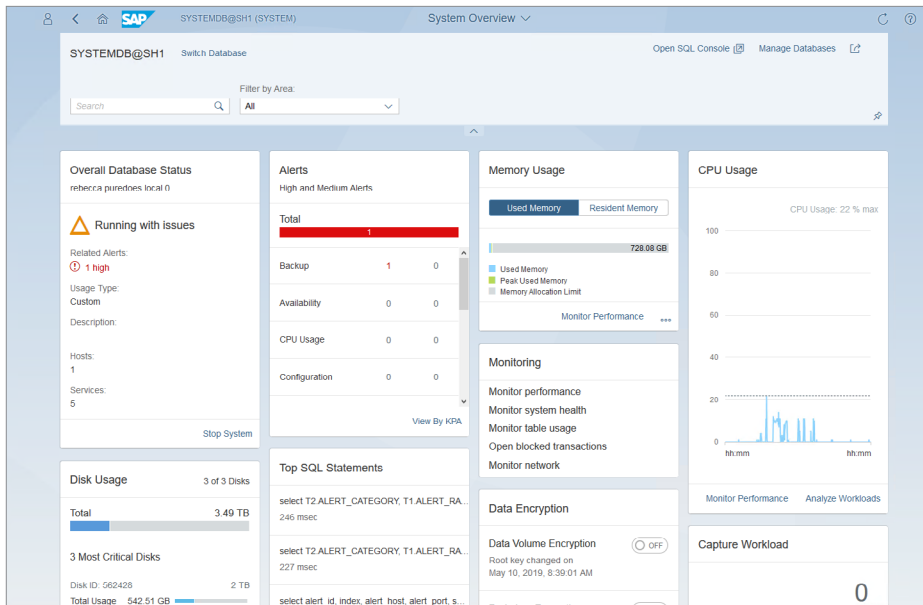
Enter SAP Control logon credentials for rebecca.puredoes.local

sh1adm

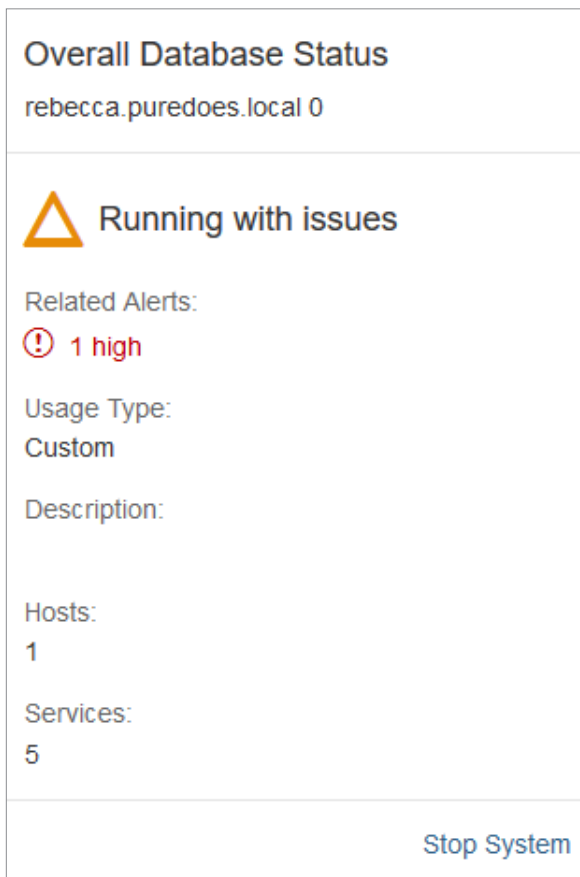
.....

OK Cancel

In the system overview identify the “Overall Database Status” tile.



On the “Overall Database Status” tile, select “Stop System”.



Command Line:

Logged in as <sid>adm :

In the command line logged in as <sid>adm execute "sapcontrol -nr <instance number> -function Stop"

```
/usr/sap/SH1/home> sapcontrol -nr 00 -function Stop
```

Logged in as a root or other user execute `"/usr/sap/hostctrl/exe/sapcontrol -nr <instance number> -function Stop"`

```
/usr/sap/hostctrl/exe/sapcontrol -nr 00 -function Stop
```

Step 2: Umount data and log persistence volumes from the operating system

Umount the data volume using the "umount" command.

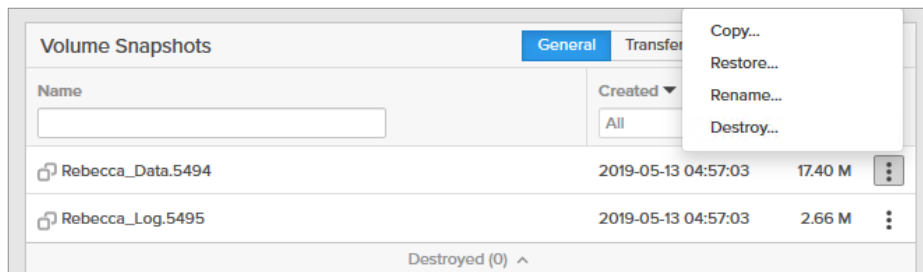
```
umount /hana/data
```

Umount the log volume using the "umount" command.

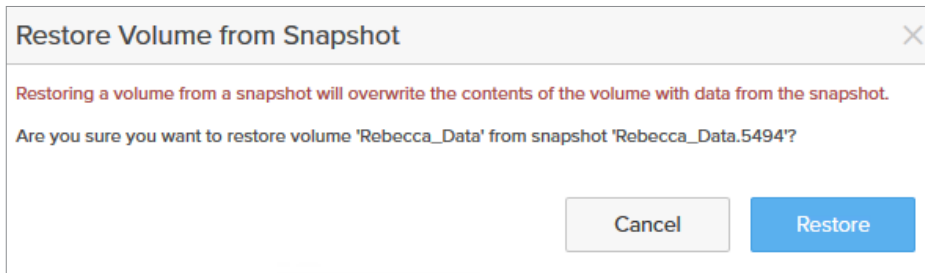
```
umount /hana/log
```

Step 3: Restore block volume snapshots in the FlashArray user interface

In the Volumes view, identify the relevant volumes to restore and select the top vertical ellipsis to bring up the context menu and select "Restore".



Check that the volume snapshot name presented by the context menu matches what is required.



Repeat the operation for any other required volumes. Ensure both the log and data volume are done at minimum by the end of this step.

Step 4: Remount the data and persistent log volumes

Mount the data volume using the “mount” command.

```
mount /hana/data/
```

Mount the log volume using the “mount” command.

```
mount /hana/log/
```



SAP HANA Studio:

File Edit Navigate Project Run Window Help
 SYSTEMDB@SH1 Host: rebecca.puredoes.local DB: SYSTEMDB@SH1 System usage: Custom System - SAP HANA Studio

[Icons] Quick Access

SYSTEMDB@SH1

Configuration and Monitoring
 Lifecycle Management
 Backup and Recovery
 Security
 Open SQL Console
 SAP HANA Modular
 Add System with Different User...
 Remove
 Log On
 Refresh
 Properties

SYSTEMDB@SH1 (SYSTEM) rebecca.puredoes.local 00

Open Administration
 Open SAP HANA Cockpit
 Get System...
 Stop System...
 Restart System...
 Configure System Replication...
 MANY SELECT on SCHEMA_3FS_AWAITING to COCKPIT_ADMIN_ROLE;
 MANY COCKPIT_TECH_ROLE to COCKPIT_TECH_USER;
 MANY COCKPIT_ADMIN_ROLE to COCKPIT_ADMIN_USER;
 REVOKE USER USER1 PASSWORD ON*
 REVOKE USER USER2 PASSWORD ON*
 REVOKE USER USER3 PASSWORD ON*
 REVOKE USER USER4 PASSWORD ON*
 GRANT ROLE DOES_ROLE;
 GRANT CREATE SCHEMA to DOES_ROLE;
 GRANT DEFINER to DOES_ROLE;
 GRANT EXPORT to DOES_ROLE;
 GRANT IMPORT to DOES_ROLE;
 GRANT MONITORING to DOES_ROLE;
 GRANT BACKUP OPERATOR to DOES_ROLE;
 GRANT CATALOG READ to DOES_ROLE;
 GRANT DOES_ROLE to USER1;
 GRANT DOES_ROLE to USER2;
 GRANT DOES_ROLE to USER3;
 GRANT DOES_ROLE to USER4;
 Statement 'GRANT DOES_ROLE to USER4'
 successfully executed in 22 ms 481 us (server processing time: 22 ms 78 us) - Rows Affected: 0
 Duration of 30 statements: 949 ms

Properties [?] Error Log

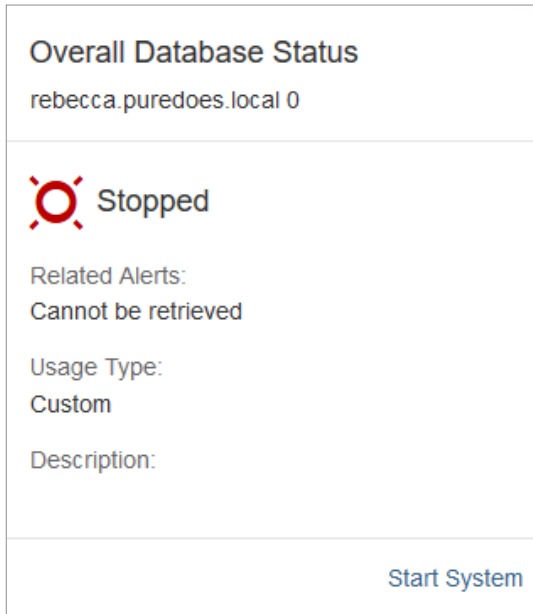
SYSTEMDB@SH1 (SYSTEM)

General	Property	Value
Connection Properties	Description Path	/REBECCA.PUREDOES.LOCAL/00/SYSTEMDB/SYSTEM

SYSTEMDB@SH1 (SYSTEM)

SAP HANA Cockpit:

In the System overview for the relevant resource find the "Overall Database Status" tile and select "Start System".



Command Line:

Logged in as <sid>adm:

In the command line logged in as <sid>adm execute "sapcontrol -nr <instance number> -function Start"

```
sapcontrol -nr 00 -function Start
```

Logged in as root

Logged in as a user with the correct permissions execute "/usr/sap/hostctrl/exe/sapcontrol -nr <instance number> -function Start"

```
/usr/sap/hostctrl/exe/sapcontrol -nr 00 -function Start
```

Portable Snapshot Technology

Once a snapshot has been created on any FlashArray//X, FlashArray//M or cloud block store instance it is considered to only be a recovery point and cannot be used for backup and recovery purposes. For snapshots to be appropriate for data protection purposes, block volume data must be moved to a separate location for recoverability to be ensured in the event of critical system loss and eventual failure.



The Purity operating environment offers several distinct mechanisms to offload volume snapshots to a separate location:

- Purity Snap- To- NFS
- Purity CloudSnap™ to S3 on AWS
- Purity FlashRecover (discussed in the section “Business Continuity Solutions for SAP HANA – Multi-Site Disaster Recovery)

Portable snapshot technology is the ability for any snapshot created by FlashArray or Cloud Block Store instances to be transported to a third-party storage target. Once the snapshot has been transported it can then be restored to any other FlashArray or Cloud Block Store instance. No additional backup software, cloud gateways or software licenses are required to make use of this functionality.

The technology functions using an incremental forever model of data movement, minimising the amount of data moved over an interface and limiting backup windows. This is achieved by running an initial full backup, followed by incremental forever snapshots (maintaining data compression) after which every subsequent snapshot is compared against the next, only moving changed blocks of data.

Snapshot offload features makes use of an embedded application deployment system on the FlashArray called Purity Run. Releases prior to Purity 5.2 require Pure Storage Support to install and configure this solution alongside the Snap to NFS feature. In Purity 5.2 and onwards Purity Run is user configurable but Pure Storage Support must be involved for the installation of Snap-to-NFS and Purity CloudSnap.

Snapshot management is accomplished through the use of a Protection Group. This is a collection of common volumes, hosts, targets and policies within which snapshot and replication schedules for any volume members can be applied.

Possible schedules and polices for snapshots and replication.

Snapshot Schedule
Enabled: False
Create a snapshot on source every 1 hours
Retain all snapshots on source for 1 days
then retain 4 snapshots per day for 7 more days

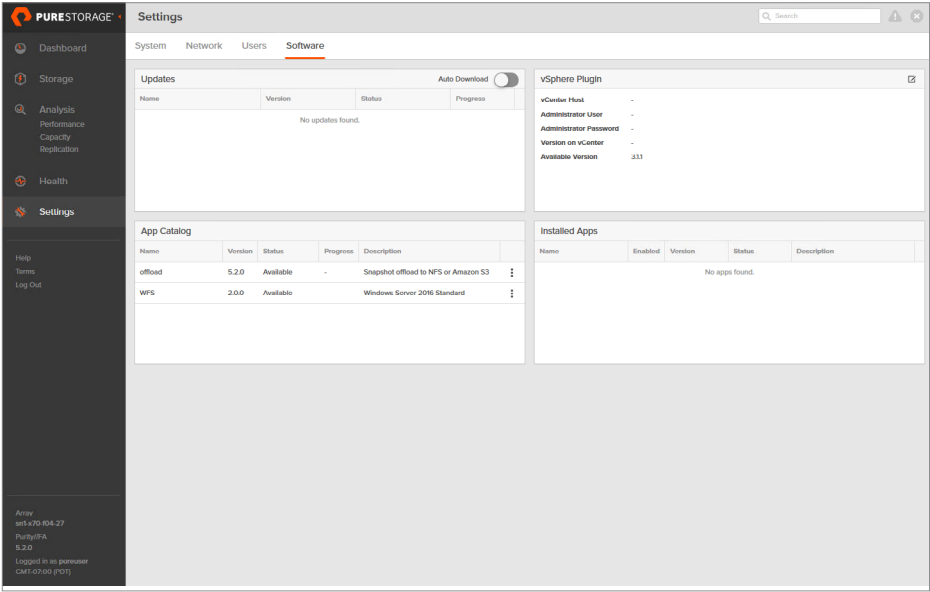
Replication Schedule
Enabled: False
Replicate a snapshot to targets every 4 hours
Retain all snapshots on targets for 1 days
then retain 4 snapshots per day for 7 more days

Configuration for offload functionality

Step 1. Install the app from the app catalog

In the FlashArray web user interface navigate to the **Software** tab under **Settings**. This view allows for the app catalog to be viewed and any installed applications are managed from here. In the app catalog install the “offload” application and wait for it to complete. The same operation can be accomplished from the command line by executing “puresw app install offload” and checking the status of the install with “puresw app list”.

Navigate to the FlashArray web user interface and select the Settings view and then navigate to the Software tab.



The App catalog tile shows all available applications available for installation, take note of the “offload” app as this is used for Snap-to-NFS functionality.

App Catalog					
Name	Version	Status	Progress	Description	
offload	5.2.0	Available	-	Snapshot offload to NFS or Amazon S3	⋮
WFS	2.0.0	Available	-	Windows Server 2016 Standard	⋮



Select the vertical ellipsis for the “offload” application and select “Install”.

App Catalog				
Name	Version	Status	Progress	Description
offload	5.2.0	Available	-	Snapshot offload to NFS or Amazon S3
WFS	2.0.0	Available	-	Windows Server 2016 Standard

Install

Confirm that the offload app is to be installed by selecting “Install”.

Install App

Are you sure you want to install app 'offload'?

Cancel

Install

Monitor the progress of the install by viewing the App Catalog.

App Catalog				
Name	Version	Status	Progress	Description
offload	5.2.0	Downloading	27.531%	Snapshot offload to NFS or Amazon S3
WFS	2.0.0	Available	-	Windows Server 2016 Standard



Once the “offload” app has completed installing it will show in the Installed Apps tile. Note that the Enabled and Status columns reading as “false” and “unhealthy” is normal at this stage.

Installed Apps				
Name	Enabled	Version	Status	Description
offload	false	5.2.0	unhealthy	Snapshot offload to NFS or Amazon S3

Step 2. Assign network connectivity for the application to use

The command line must be used for this step. A virtual interface must be created for the offload app and then a physical interface on the FlashArray is assigned to it. Any connections assigned to the virtual interface must be enabled in order for communication to work.

Create the virtual interface on the replbond (if present).

```
purenetwork create vif @offload.data0 --subinterfacelist replbond
```

If the replbond is not present create the virtual interface using the physical ports (eth2 or eth3 only).

```
purenetwork create vif @offload.data0 --subinterfacelist ct0.eth2,ct1.eth2
```

Set the network address and associated information for the virtual interface.

```
purenetwork setattr --address 10.21.227.205 --netmask 255.255.255.0 --gateway 10.21.227.1 @offload.data0
```

Enable the physical ports and the virtual interface.

```
purenetwork enable ct0.eth2
```

```
purenetwork enable ct1.eth2
```

```
purenetwork enable @offload.data0
```




Step 3. Enable the offload app

Enabling the offload app allows the feature to be used and checks that all of the required services are healthy.

Select the vertical ellipsis in the top right-hand corner and select "Enable".

Installed Apps					
Name	Enabled	Version	Status	Description	
offload	false	5.2.0	unhealthy	Snapshot offload to NFS or Amazon S3	
<div><div>Enable</div><div>Uninstall</div></div>					

Once the app has started and all features are healthy it will show Enabled as "true" and Status as "healthy".

Installed Apps					
Name	Enabled	Version	Status	Description	
offload	true	5.2.0	healthy	Snapshot offload to NFS or Amazon S3	



Purity Snap-To-NFS

Overview

Purity Snap-to-NFS allows for snapshots to be transported to a heterogeneous network file system target, natively managed via the FlashArray web interface, command line interface or over the ReST API. This solution allows organizations to back-up to generic inexpensive NFS servers for long-term storage or use existing infrastructure as a data protection target.

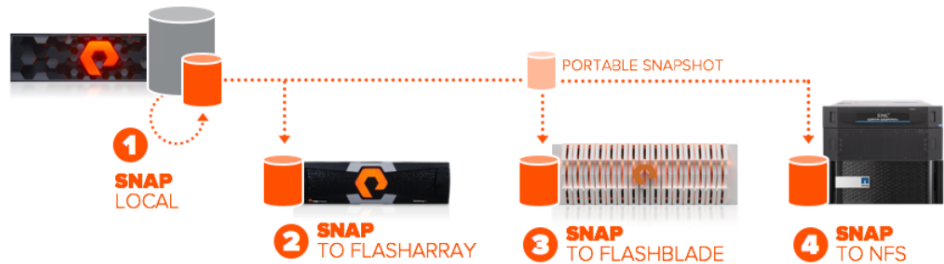


Fig. 12 Portable Snapshots offer the flexibility for various backup targets to be used.

This feature is only available on Purity 5.1 and above for FlashArray models //M20 and above, and //X20 and above.

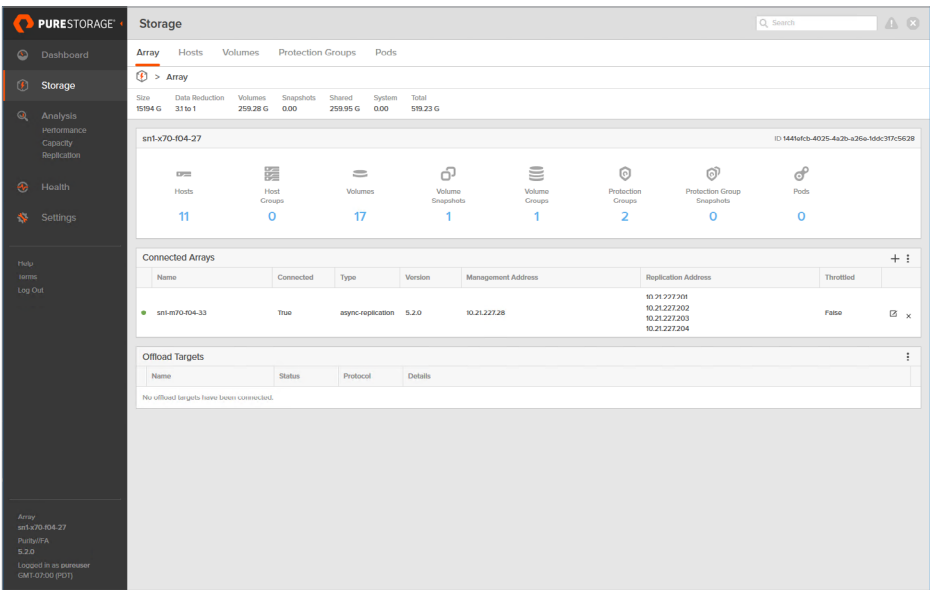
Configuration and operation

An NFS server supporting NFS v3.X or 4.X is required to serve as the offload target. This NFS server must have network connectivity to the FlashArray replication ports that are assigned to the offload application. The FlashArray must have read/write/execute permissions to the NFS share and authentication must be done locally on the NFS server. .T..

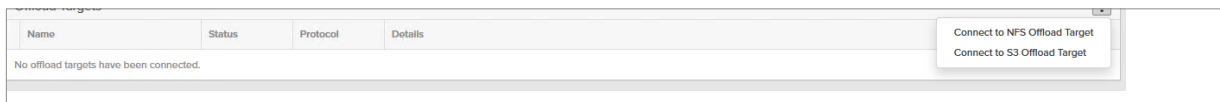
Step 1. Connect to NFS target

With the app running and enabled, the NFS target server needs to be connected to. This can be done by navigating to **Storage** and selecting the **Array** tab and identifying the section for **Offload targets**. When connecting to an offload target the information required for the prompt will be a unique name, the NFS server address, the mount point of the NFS share and any specific mount options.

In the Storage view navigate to the Array tab.



In the Array tab identify the “Offload Targets” section and select the vertical ellipsis to bring up the options and then select “Connect to NFS offload Target”.



Enter in the information for a target name, the address of the NFS server, the mount point exported from the NFS server as an NFS share and any specific mount options required.

A dialog box titled "Connect NFS Target" with a close button (X) in the top right corner. It contains four input fields: "Name", "Address", "Mount Point", and "Mount Options". The "Mount Options" field has a placeholder text: "port=num,rsize=num,wsiz=um,nfsvers=num,tcp,udp". At the bottom right, there are two buttons: "Cancel" and "Connect".

Once all of the relevant information is provided select “Connect”.

A dialog box titled "Connect NFS Target" with a close button (X) in the top right corner. It contains four input fields: "Name" with the value "HANASnapToNFS", "Address" with the value "10.21.131.90", "Mount Point" with the value "/HANA_nfs_target", and "Mount Options" with the placeholder text "port=num,rsize=num,wsiz=um,nfsvers=num,tcp,udp". At the bottom right, there are two buttons: "Cancel" and "Connect". Below the dialog box, there is a blue bar with the text "Connecting..." in white.

Once the connection has been established it will be shown in the Offload Targets section.

Offload Targets				
Name	Status	Protocol	Details	
nfstarget	connected	nfs	Address: 10.21131.90 Mount Point: /HANA_nfs_target	

Step 25. Offload snapshots to the NFS target

When offloading snapshots to a target they must be a part of a protection group. A protection group consist of one or many volumes and have different policies applied to it for snapshot schedules and retention or replication schedules. The **Protection Groups** tab can be found in **Storage**.

In the Storage view navigate to the Protection Groups Tab. In this example there is already a protection group created with the name “HANA” with the SAP HANA data persistence volume added as a member.

Storage

ArrayHostsVolumesProtection GroupsPods

> Protection Groups > HANA

0.00

Members11 of 1

Name

Rebecca_Data

Targets0 of 0

Name

No targets found.

Snapshot Schedule

Enabled: False

Create a snapshot on source every 1 hours

Retain all snapshots on source for 1 days

then retain 4 snapshots per day for 7 more days

Replication Schedule

Enabled: False

Replicate a snapshot to targets every 4 hours

Retain all snapshots on targets for 1 days

then retain 4 snapshots per day for 7 more days

Protection Group Snapshots0 of 0

Name

No snapshots found.

CreatedAllSnapshots

Destroyed (0)

In the section for Members and Targets, select the vertical ellipsis in the upper right-hand corner of Targets and select “Add”.

Members11 of 1

Name

Rebecca_Data

Targets0 of 0

Name

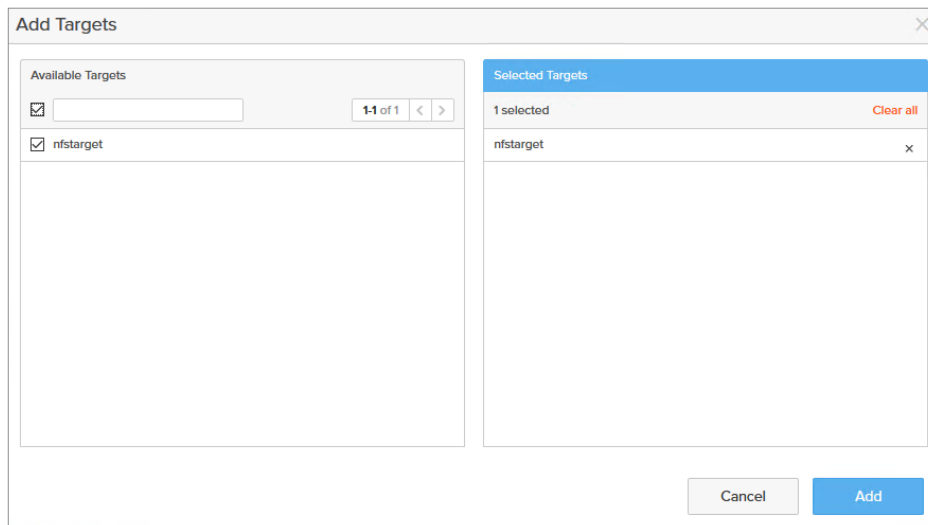
No targets found.

Add...

Remove...

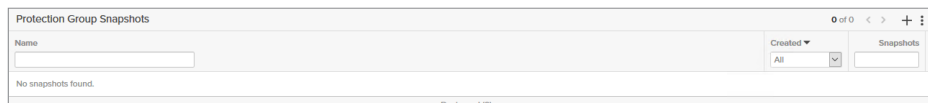


Ensure the required target is selected and then select “Add”.



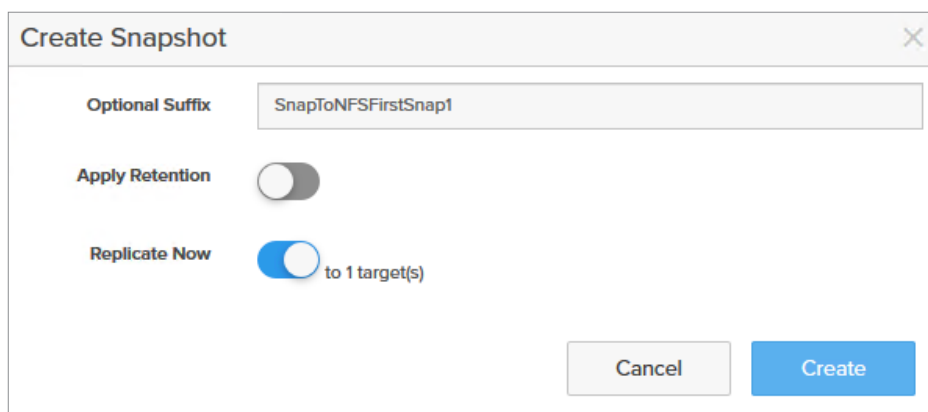
The "Add Targets" dialog box is shown. It has two main sections: "Available Targets" on the left and "Selected Targets" on the right. In the "Available Targets" section, there is a search bar and a list of targets. The target "nfstarget" is selected, indicated by a checkmark. In the "Selected Targets" section, "nfstarget" is listed with a close button (x) next to it. At the bottom right, there are "Cancel" and "Add" buttons.

In the Protection Group Snapshots section select the “+” in the top right-hand corner to create a snapshot.




The "Protection Group Snapshots" section is shown. It includes a search bar for "Name", a "Created" dropdown menu set to "All", and a "Snapshots" button. Below the search bar, it says "No snapshots found." In the top right corner, there is a "+" icon for creating a new snapshot.

Give the snapshot an optional suffix and then ensure that “Replicate Now” is selected, then select Create.



The "Create Snapshot" dialog box is shown. It has three main sections: "Optional Suffix" with a text input field containing "SnapToNFSFirstSnap1", "Apply Retention" with a toggle switch that is currently off, and "Replicate Now" with a toggle switch that is currently on. At the bottom right, there are "Cancel" and "Create" buttons.

The snapshot is then created and will offload to the NFS share.



Protection Group Snapshots		11 of 1	
Name	Created	Snapshot	
HANA.SnapToNFSFirstSnap1	2019-05-14 05:10:56	0.00	

Viewing “offload targets” found in the Array tab within the Storage view will show the offload progress.

Storage

Search

Array

Hosts

Volumes

Protection Groups

Pods

>

Array

>

Offload Targets

>

nfs target

Status

Protocol

connected

nfs

Protection Groups

11 of 1

Name

Source

Remote

sn1-x70-404-27-HANA

sn1-x70-404-27

nfs target

Destroyed (0)

Protection Group Snapshots

11 of 1

Name

Source

Remote

Created

Started

Completed

Transferred

Progress

sn1-x70-404-27-HANA.SnapToNFSFirstSnap1

sn1-x70-404-27-HANA

nfs target

2019-05-15 08:08:17

2019-05-15 08:08:17

2019-05-15 08:18:32

309.40 G

100%

Destroyed (0)

Purity CloudSnap to AWSS3

Overview

Purity CloudSnap allows snapshots to be offloaded to a cloud vendor, extending data protection on FlashArray to cloud storage services. CloudSnap to AWS S3 enables snapshots to be offloaded directly to an S3 bucket on Amazon Web Services. This solution offers organizations cost and efficiency benefits by using less space in the S3 bucket, minimising network utilization and shortening backup windows.

This feature is only available on Purity 5.2 and above for FlashArray models //M20 and above, and //X20 and above.

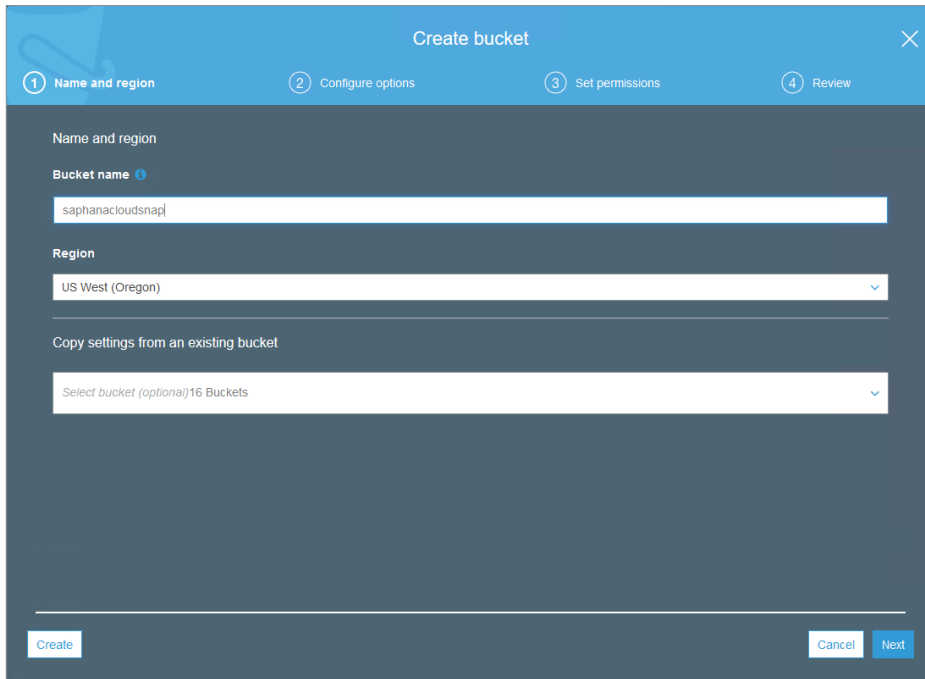
Configuration and operation

Step 1. Create Amazon Web Services S3 bucket

In the **S3 Management Console** select **Create bucket**. When the prompt appears give the bucket a name and select the appropriate region for it. Blocking public access is recommended for the bucket to ensure that any data stored in it is secure.



In the S3 Management Console, create a bucket and give it a DNS complaint name and set the region it needs to be located in.

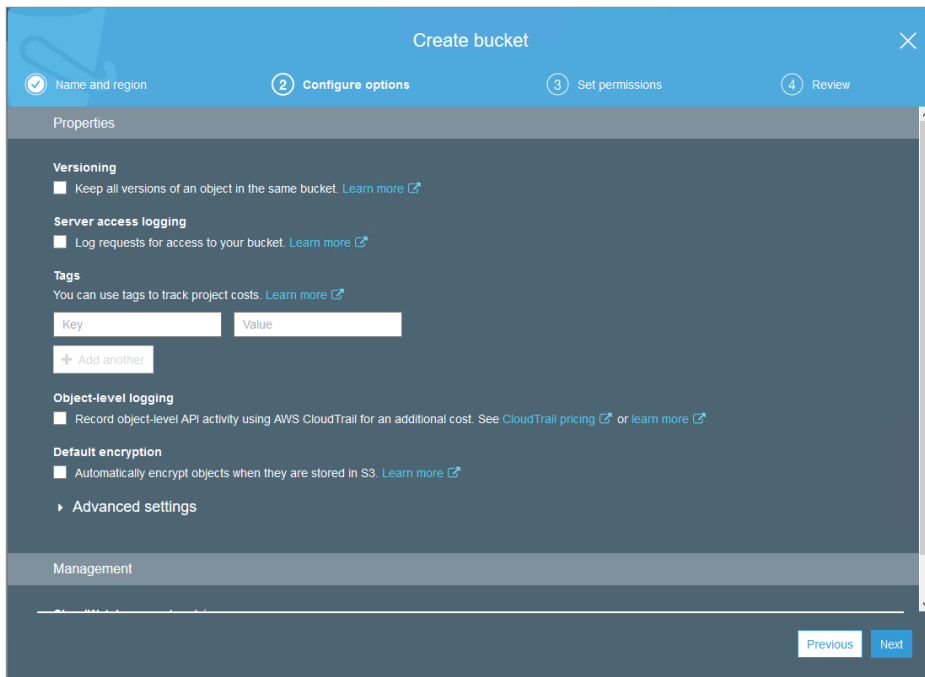


The screenshot shows the 'Create bucket' wizard in the AWS S3 Management Console. The title bar is blue with a close button (X) on the right. Below the title bar is a progress bar with four steps: 1. Name and region (active), 2. Configure options, 3. Set permissions, and 4. Review. The main content area is dark blue and contains the following fields:

- Name and region**
 - Bucket name**: A text input field containing 'saphanacloudsnap'.
 - Region**: A dropdown menu showing 'US West (Oregon)'.
- Copy settings from an existing bucket**: A dropdown menu showing 'Select bucket (optional) 16 Buckets'.

At the bottom of the form are three buttons: 'Create' (white), 'Cancel' (blue), and 'Next' (blue).

In the configuration options no properties are required for CloudSnap.



The screenshot shows the 'Create bucket' wizard in the AWS S3 Management Console, Step 2: Configure options. The progress bar at the top shows four steps: 1. Name and region (checked), 2. Configure options (active), 3. Set permissions, and 4. Review. The main content area is dark blue and contains the following sections:

- Properties**
 - Versioning**: A checkbox labeled 'Keep all versions of an object in the same bucket. Learn more'.
 - Server access logging**: A checkbox labeled 'Log requests for access to your bucket. Learn more'.
 - Tags**: A section with the text 'You can use tags to track project costs. Learn more'. It includes a 'Key' input field, a 'Value' input field, and an 'Add another' button.
 - Object-level logging**: A checkbox labeled 'Record object-level API activity using AWS CloudTrail for an additional cost. See CloudTrail pricing or learn more'.
 - Default encryption**: A checkbox labeled 'Automatically encrypt objects when they are stored in S3. Learn more'.
 - Advanced settings**: A link to expand the section.
- Management**: A section at the bottom of the form.

At the bottom of the form are two buttons: 'Previous' (blue) and 'Next' (blue).

In the permissions ensure all public access is blocked for security reasons.

Create bucket

1 Name and region 2 Configure options 3 Set permissions 4 Review

Note: You can grant access to specific users after you create the bucket.

Block public access (bucket settings)

Public access is granted to buckets and objects through access control lists (ACLs), bucket policies, or both. In order to ensure that public access to all your S3 buckets and objects is blocked, turn on Block all public access. These settings apply only to this bucket. AWS recommends that you turn on Block all public access, but before applying any of these settings, ensure that your applications will work correctly without public access. If you require some level of public access to your buckets or objects within, you can customize the individual settings below to suit your specific storage use cases. [Learn more](#)

☒ **Block all public access**
Turning this setting on is the same as turning on all four settings below. Each of the following settings are independent of one another.

- ☒ **Block public access to buckets and objects granted through new access control lists (ACLs)**
S3 will block public access permissions applied to newly added buckets or objects, and prevent the creation of new public access ACLs for existing buckets and objects. This setting doesn't change any existing permissions that allow public access to S3 resources using ACLs.
- ☒ **Block public access to buckets and objects granted through any access control lists (ACLs)**
S3 will ignore all ACLs that grant public access to buckets and objects.
- ☒ **Block public access to buckets and objects granted through new public bucket policies**
S3 will block new bucket policies that grant public access to buckets and objects. This setting doesn't change any existing policies that allow public access to S3 resources.
- ☒ **Block public and cross-account access to buckets and objects through any public bucket policies**
S3 will ignore public and cross-account access for buckets with policies that grant public access to buckets and objects.

[Manage system permissions](#)

Previous Next

Review configuration for the bucket and select "Create bucket".

Create bucket

1 Name and region 2 Configure options 3 Set permissions 4 Review

Name and region

Bucket name saphanacloudsnap Region US West (Oregon) [Edit](#)

Options

[Edit](#)

Versioning	Disabled
Server access logging	Disabled
Tagging	0 Tags
Object-level logging	Disabled
Default encryption	None
CloudWatch request metrics	Disabled
Object lock	Disabled

Permissions

[Edit](#)

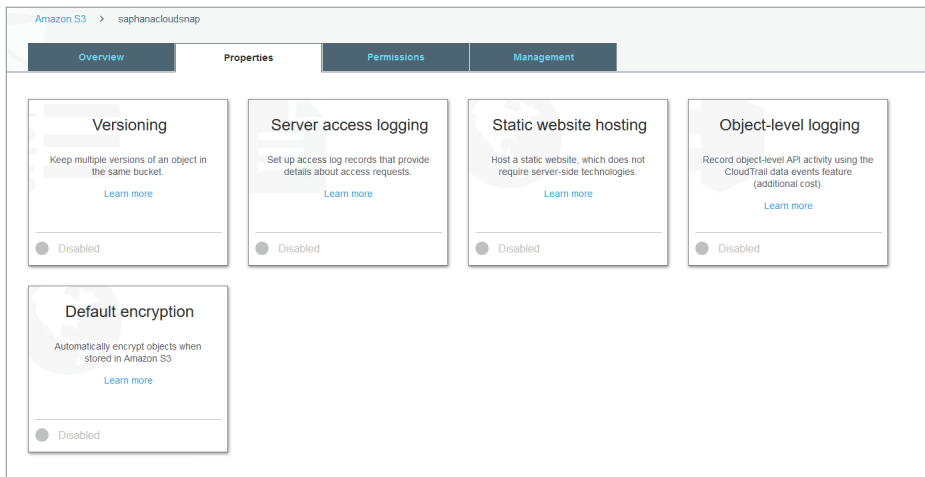
Block all public access
On

- Block public access to buckets and objects granted through new access control lists (ACLs)**
On
- Block public access to buckets and objects granted through any access control lists (ACLs)**
On

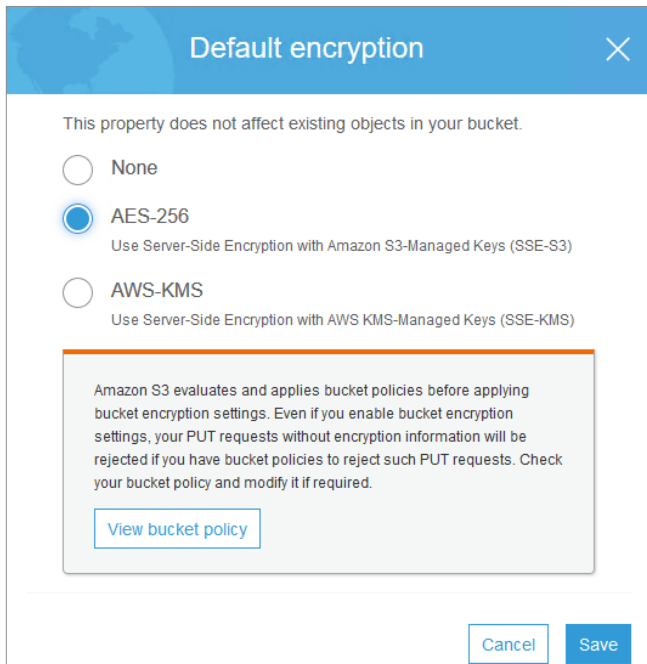
Previous Create bucket



Once the bucket has been created navigate to the management screen, select the “Properties” tab and then select the “Default encryption” tile.



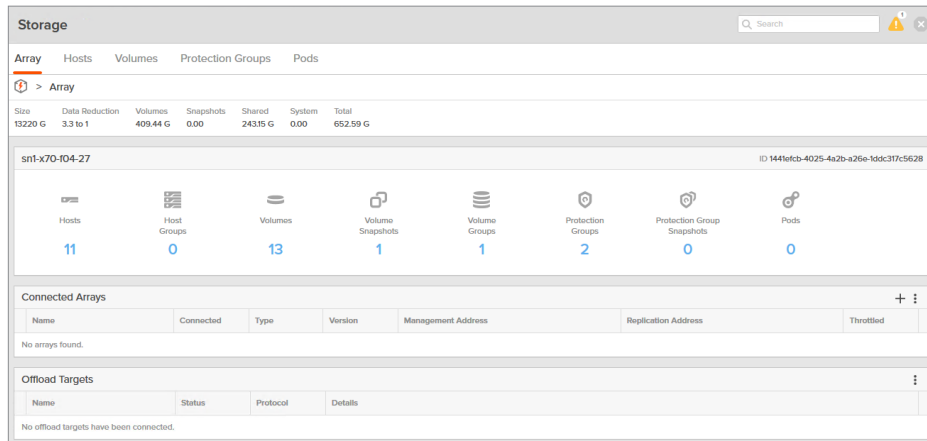
Set the default encryption to “AES-256” and select Save.



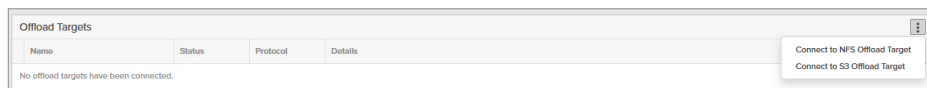
Step 2. Connect to AWS S3 bucket

With the app running and enabled and an S3 bucket created in AWS, the FlashArray needs to be connected to the target. This can be done by navigating to **Storage** and selecting the **Array** tab and identifying the section for **Offload targets**. When connecting to an offload target the information required for the prompt will be a unique name, the Access Key, the bucket name and the Secret Access key.

In the FlashArray web user interface enter the Storage view and navigate to the Array tab.



In the Array tab identify the “Offload Targets” section and select the vertical ellipsis to bring up the options and then select “Connect to S3 offload Target”.



Enter the information for a target name, the Access key ID, Bucket name and Secret Access Key. If the S3 bucket is newly created then Initialize needs to be enabled.

The 'Connect S3 Target' dialog box is shown. It contains the following fields: 'Name' (AWSS3Target), 'Access Key ID' (AKIAQX5UTLWQC74XAD32), 'Bucket' (saphanacloudsnap), and 'Secret Access Key' (represented by a series of dots). There is also an 'Initialize' toggle switch which is currently turned on. At the bottom right, there are 'Cancel' and 'Connect' buttons.

Once the target has been connected, it will be displayed in the Offload Targets section.

Offload Targets			
Name	Status	Protocol	Details
AWS3Target	connected	s3	Bucket: saphanackloudsnap Access Key ID: AKIAQK5UTLWGC74KAD32 Secret Access Key: ****

Step 3. Offload snapshots to the AWS S3 target

When offloading snapshots to a target they must be a part of a protection group. A protection group consists of one or many volumes and has different policies applied to it for snapshot schedules and retention or replication schedules. The **Protection Groups** tab can be found in **Storage**.

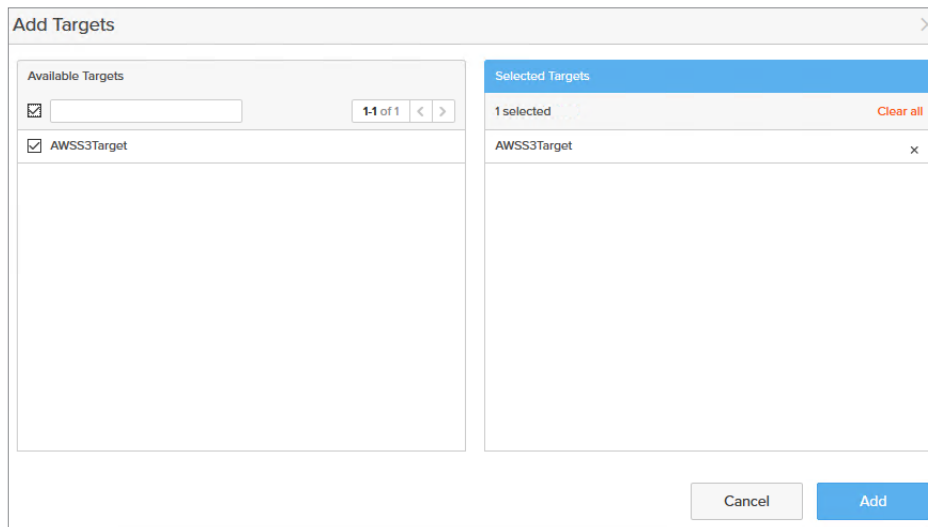
In the Storage view navigate to the Protection Groups tab. In this example there is already a protection group created with the name "HANA" with the SAP HANA data persistence volume added as a member.

The screenshot shows the 'Storage' view with the 'Protection Groups' tab selected. The group 'HANA' is chosen. The interface is divided into several sections: 'Members' (showing 'Rebecca_Data'), 'Targets' (empty), 'Snapshot Schedule' (configured for 1-hour snapshots, 1-day retention), and 'Replication Schedule' (configured for 4-hour replication to targets, 1-day retention). At the bottom, there is a 'Protection Group Snapshots' section which is currently empty.

In the section for Members and Targets, select the vertical ellipsis in the upper right-hand corner of Targets and select "Add".

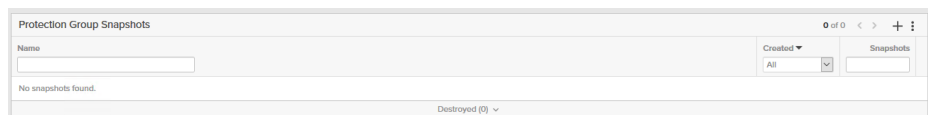
This is a close-up of the 'Targets' section. It shows a text input field for 'Name' and a message 'No targets found.' To the right, a vertical ellipsis menu is open, displaying two options: 'Add...' and 'Remove...'.

Ensure the required target is selected and then select “Add”.



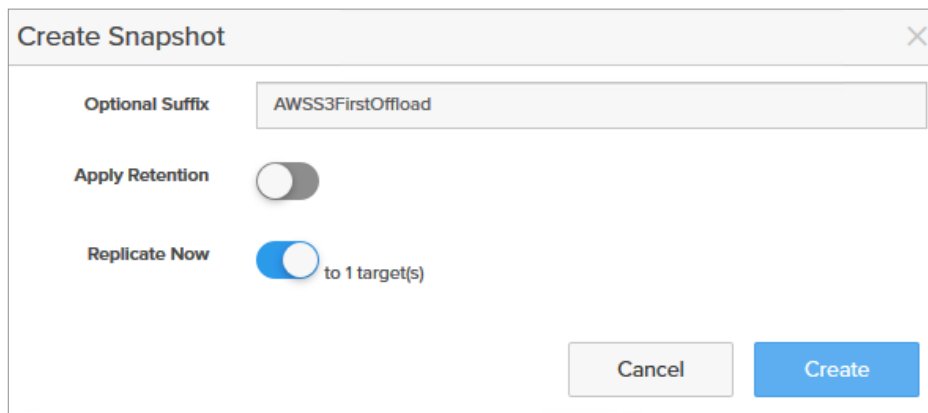
The "Add Targets" dialog box is shown. It has two main sections: "Available Targets" on the left and "Selected Targets" on the right. In the "Available Targets" section, there is a search bar and a list of targets. The target "AWSS3Target" is selected, indicated by a checkmark. In the "Selected Targets" section, there is a list of selected targets. "AWSS3Target" is listed here. At the bottom of the dialog, there are "Cancel" and "Add" buttons.

In the Protection Group Snapshots section select the “+” in the top right-hand corner to create a snapshot.



The "Protection Group Snapshots" section is shown. It has a search bar and a list of snapshots. The "Created" dropdown is set to "All". The "Snapshots" dropdown is set to "All". The "Destroyed (0)" dropdown is visible at the bottom.

Give the snapshot an optional suffix and then ensure that “Replicate Now” is selected, then select Create.



The "Create Snapshot" dialog box is shown. It has three main sections: "Optional Suffix", "Apply Retention", and "Replicate Now". The "Optional Suffix" field contains the text "AWSS3FirstOffload". The "Apply Retention" toggle is turned off. The "Replicate Now" toggle is turned on, and it says "to 1 target(s)". At the bottom of the dialog, there are "Cancel" and "Create" buttons.

The snapshot is then created and will offload to the AWS S3 bucket.

The screenshot shows the 'Storage' view in the FlashArray web interface. The 'Array' tab is selected, and the 'Offload Targets' section is expanded, showing 'AWS S3 Target'. The 'Protection Groups' section shows a table with columns: Name, Source, Remote, Created, Started, Completed, Transferred, and Progress. A single entry is visible: 'snf-x70-104-27-HANA' with source 'snf-x70-104-27' and remote 'AWS S3 Target'. Below this, the 'Protection Group Snapshots' section shows a table with columns: Name, Source, Remote, Created, Started, Completed, Transferred, and Progress. A single entry is visible: 'snf-x70-104-27-HANA.AWS S3 First Offload' with source 'snf-x70-104-27-HANA' and remote 'AWS S3 Target'. The 'Created' column shows '2019-05-16 04:59:13', 'Started' shows '2019-05-16 04:59:13', 'Completed' shows '2019-05-16 05:10:23', 'Transferred' shows '310.58 G', and 'Progress' shows '100%'.

Recovering offloaded snapshots

Recovery of an SAP HANA system using NFS or AWS S3 offloaded snapshots is accomplished by retrieving the block volume snapshot from the target to a relevant FlashArray. Once any volume snapshot has been retrieved from the target it can be used to recover the SAP HANA database with processes detailed in the sections “Application Consistent Storage Snapshots” and “Crash Consistent Storage Snapshots”.

Offloaded snapshots are retrieved in an efficient manner by only retrieving blocks which are not present on the FlashArray, ensuring that a limited amount of bandwidth is used and reducing recovery time.

In the FlashArray web user interface, under the storage view and inside the Array tab, select the NFS or AWS S3 offload target by selecting its name.

The screenshot shows the 'Storage' view in the FlashArray web interface. The 'Array' tab is selected, and the 'Offload Targets' section is expanded, showing 'nfs target'. The 'Array' section shows a table with columns: Size, Data Reduction, Volumes, Snapshots, Shared, System, and Total. A single entry is visible: 'snf-x70-104-27' with size '13156 G', data reduction '3.4 to 1', volumes '395.97 G', snapshots '5.00 M', shared '254.91 G', system '0.00', and total '650.88 G'. Below this, the 'Offload Targets' section shows a table with columns: Name, Status, Protocol, and Details. A single entry is visible: 'nfs target' with status 'connected' and protocol 'nfs'. The details show 'Address: 10.21.131.90' and 'Mount Point: /HANA_nfs_target'.



In the properties for the offload target identify the section for “Protection Group Snapshots”.

The screenshot shows the 'Storage' console with the 'Array' tab selected. The breadcrumb path is 'Array > Offload Targets > nfs-target'. The 'Protection Groups' section shows a single group: 'sn1-x70-104-27:HANA' with source 'sn1-x70-104-27' and remote 'nfs-target'. Below it, the 'Protection Group Snapshots' section shows a table with one snapshot:

Name	Source	Remote	Created	Started	Completed	Transferred	Progress
sn1-x70-104-27:HANA.SnapToNFSFirstSnap1	sn1-x70-104-27:HANA	nfs-target	2019-05-15 08:08:17	2019-05-15 08:08:17	2019-05-15 08:18:32	309.40 G	100%

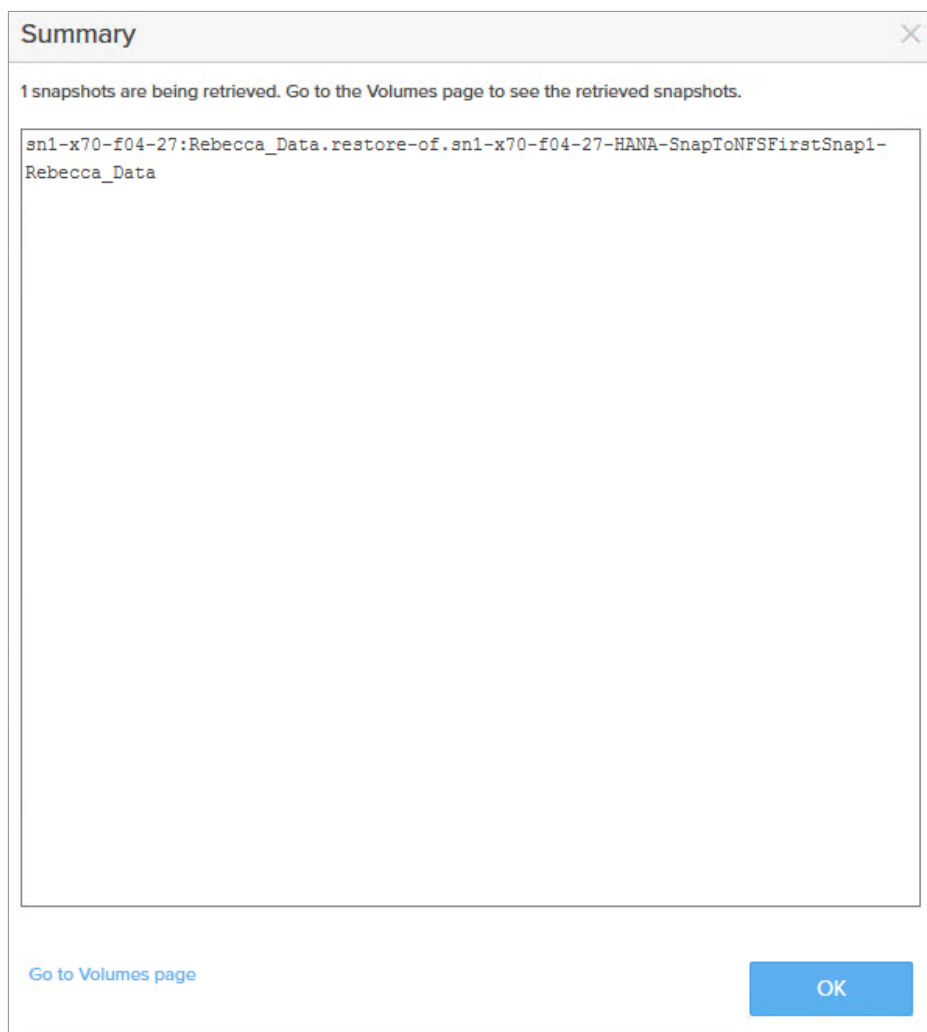
In the section for Protection Group Snapshots, identify the required protection group snapshot to retrieve from the offload target and select the download icon to the right of it.

This is a close-up of the 'Protection Group Snapshots' table from the previous screenshot. It shows the snapshot 'sn1-x70-104-27:HANA.SnapToNFSFirstSnap1' with a download icon (a downward arrow) in the 'Progress' column.

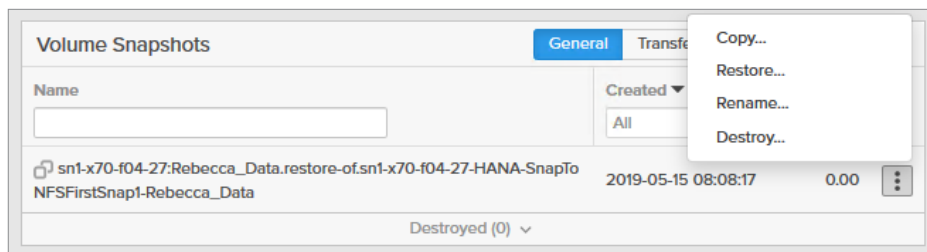
In the prompt for “Get Volume Snapshots” select the volume snapshot that needs to be retrieved and then select “Get”.

The 'Get Volume Snapshots' dialog box is shown. It has two main sections: 'Existing Snapshots' and 'Selected Snapshots'. In 'Existing Snapshots', the snapshot 'sn1-x70-104-27:HANA.SnapToNFSFirstSnap1.Re...' is selected. In 'Selected Snapshots', the same snapshot is listed. At the bottom, there is a 'Suffix' field set to 'Automatic' and two buttons: 'Cancel' and 'Get'.

In the summary prompt which appears, select “Go to Volumes page” in the bottom left-hand corner to view the recovered snapshot.



The volume snapshot will show as recovered from the offload target and is available locally on a FlashArray. This can now be copied, restored, renamed or deleted.



Business Continuity Solutions for SAP HANA

High Availability – ActiveCluster

Overview

Purity ActiveCluster is a flexible Pure Storage technology in the Purity operating environment which can be used as an SAP HANA Storage Replication solution to ensure business continuity in the event of system and site failure scenarios. This solution can be implemented for any SAP HANA system, both single and multiple host, making use of FlashArray in TDI deployments. This is a zero-recovery time objective (RTO) where no time elapses between failure and resolution. The configuration can be extended to provide for a zero-recovery point object (RPO) as well as further increasing operational resiliency (discussed in the section for Multi-Site Disaster Recovery – Adding an asynchronous snapshot replication target to an Active Cluster configuration).

SAP HANA replication can be done either on the system platform (system replication) or underlying storage vendor (storage replication) where each is implemented based on business needs and use case suitability. System replication is a top down (compute to storage) solution replicating the entire platform to another instance, offering organizations a feature set defined by SAP HANA where shadow instances can be preloaded resulting in fast takeovers with little to no impact on performance. Storage replication is a bottom up (storage to compute) solution where data, log and any other block volume data is replicated to remote storage, delivering no preloading capabilities as the whole system is replaced or started fresh on alternative hardware.



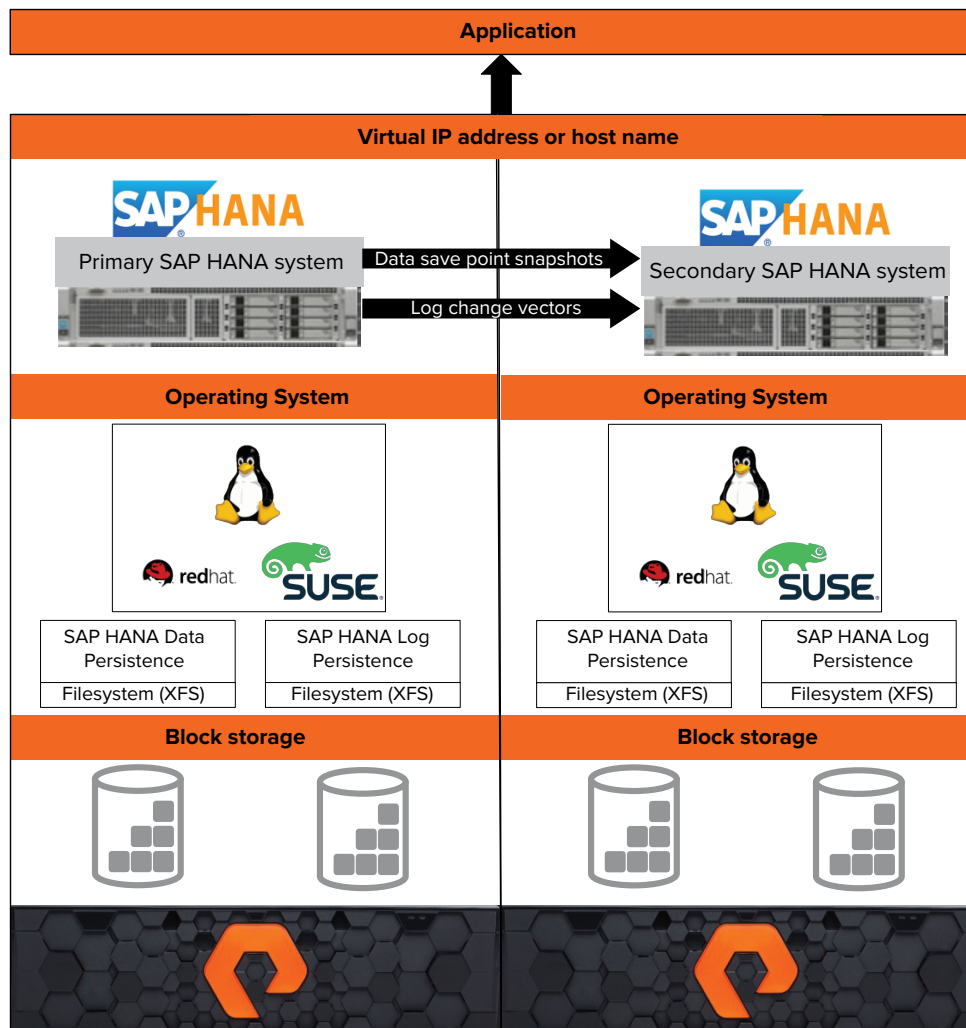


Fig. 13 SAP HANA System replication topology

SAP HANA system replication offers a number of different replication modes, providing high availability and resilience for a number of different scenarios. The terms typically used in system replication are “primary” and “secondary” system, where the primary system is the target for normal operations and data is then sent to the secondary to ensure it continues to be available if the primary is lost. The following replication modes are offered by SAP HANA:

- **Synchronous replication** – The primary system waits until the secondary system has received data and persisted it to disk. In the event of a secondary system failure the primary system will wait until a timeout is reached and then proceeds without replicating data.
- **Synchronous in-memory replication** – The primary system waits until secondary system has received data, but it does not need to be persisted to disk. In the event of a secondary system failure the primary system will wait until a timeout is reached and then proceeds without replicating data.
- **Synchronous full sync replication** – The primary system waits until the secondary system has received data and persisted it to disk. In a failure scenario the primary system will block operations until the secondary system becomes available.
- **Asynchronous replication** – the primary system does not wait for the secondary system to commit data and in the event of the secondary system failing, the primary system will continue to perform operations.

SAP HANA Storage replication with Purity ActiveCluster offers organizations the ability to establish a flexible domain for business continuity through the use of a single user interface without any additional license costs. Storage replication is more suitable for addressing multiple failure domains starting from the storage layer and working towards the platform (SAP HANA database instance) as opposed to system replication which only addresses platform availability and requires each area to be addressed individually.

ActiveCluster is typically configured using two FlashArray storage arrays, defined as “primary”, “secondary” or “tertiary” arrays, but can be extended to three in certain scenarios. The following replication configurations are offered by ActiveCluster:

- **Synchronous replication (Symmetric Active/Active)** – Changes are synchronized and protected in non-volatile memory on both primary and secondary arrays before being acknowledged to the host. Read and write operations can be performed to the same volumes on either primary or secondary array, with optional host-to-array site awareness.
- **Asynchronous replication for snapshots** – Changes are asynchronously written to the secondary (or tertiary) array volumes on a schedule. Any operations performed to the primary (or synchronous active/active) volumes will acknowledge to the host while the asynchronous tertiary array will not be required to complete operations. Asynchronous relationships can be used to convert standby systems to an active state if the primary site(s) are lost. This replication mode is useful for remote site disaster recovery without impacting system performance on the primary site(s).

Pods

ActiveCluster is built on the concept of a **pod**, a stretched storage container that defines a set of objects (hosts, volumes or protection groups) that are replicated together and the arrays they are replicated between. Any FlashArray or cloud block store instance can support multiple pods and any pod that is replicated between them is considered to be “stretched”. A pod is also considered a consistency group where multiple volumes in the same pod are write-order consistent. Pods also provide volume namespaces where different volumes can have the same name if they are in a different pod, allowing the migration of workloads between arrays or consolidating multiple workloads from many arrays onto one without volume name conflicts.

Transparent failover

Transparent failover between arrays when using ActiveCluster is automatic, requiring no intervention from a storage administrator. Failover occurs within standard host I/O timeouts, similar to the way failover occurs between two controllers in one array during non-disruptive hardware or software upgrades. ActiveCluster is designed to provide maximum availability across symmetric active/active storage arrays while preventing a split-brain condition from occurring – split brain being the case where two arrays might serve I/O to the same volume without keeping the data in sync between the two arrays.

Any active/active synchronous replication solution designed to provide continuous availability across two different sites requires a component referred to as a witness, or voter, to mediate failovers while preventing split brain. ActiveCluster includes a simple to use, lightweight, and automatic way for applications to failover transparently, or simply move, between sites in the event of a failure without user intervention: the Pure1 Cloud Mediator.

The Pure1 Cloud Mediator is responsible for ensuring that only one array is allowed to stay active for each pod when there is a loss of communication between the arrays. In the event that the arrays can no longer communicate with each other over the replication interconnect, both arrays will pause I/O and reach out to the mediator to determine which array can stay active for each sync-replicated pod. The first array to reach the mediator is allowed to keep its synchronously replicated pods online. The second array to reach the mediator must stop servicing I/O to its synchronously replicated volumes, in order to prevent split brain. The entire operation occurs within standard host I/O timeouts to ensure that applications experience no more than a pause and resume of I/O.



THE PURE1 CLOUD MEDIATOR

A failover mediator must be located in a third site that is in a separate failure domain from either site where the arrays are located. Each array site must have independent network connectivity to the mediator such that a single network outage does not prevent both arrays from accessing the mediator. A mediator should also provide a very lightweight and easy to administer component of the solution. The Pure Storage solution provides this automatically by utilizing an integrated cloud-based mediator. The Pure1 Cloud Mediator provides two main functions:

- Prevent a split-brain condition from occurring, where both arrays are independently allowing access to data without synchronization between arrays.
- Determine which array will continue to service IO to synchronously replicated volumes in the event of an array failure, replication link outage, or site outage.

The Pure1 Cloud Mediator has the following advantages over a typical non-Pure, heavy-handed voter or witness component:

- **SaaS Operational Benefits** – As with any SaaS solution the operational maintenance complexity is removed: nothing to install onsite, no hardware or software to maintain, nothing to configure and support for HA, no security patch updates, etc.
- **Automatically a third site** – The Pure1 Cloud Mediator is inherently in a separate failure domain from either of the two arrays.
- **Automatic Configuration** – Arrays configured for synchronous replication will automatically connect to and use the Pure1 Cloud Mediator.
- **No Misconfiguration** – With automatic and default configuration there is no risk that the mediator might be incorrectly configured.
- **No Human Intervention** – A significant number of issues in non-Pure active/active synchronous replication solutions, particularly those related to accidental split brain, are related to human error. Pure's automated non-human mediator eliminates operator error from the equation.
- **Passive Mediation** – Continuous access to the mediator is not required for normal operations: the arrays will maintain a heartbeat with the mediator. However, if the arrays lose connection to the mediator, they will continue to synchronously replicate and serve data as long as the replication link is active.

ON-PREMISES FAILOVER MEDIATOR

Failover mediation for ActiveCluster can also be provided using an on-premises mediator distributed as an OVF file and deployed as a VM. Failover behaviours are exactly the same as described above. The on-premises mediator simply replaces the role of the Pure1 Cloud Mediator during failover events. The on-premises mediator has the following basic requirements:

- The on-premises mediator can only be deployed as a VM on virtualized hardware. It is not installable as a stand-alone application.
- High Availability for the mediator must be provided by the hosts on which the mediator is deployed. For example, using VMware HA or Microsoft Hyper-V HA Clustering.
- Storage for the mediator must not allow the configuration of the mediator to be rolled back to previous versions. This applies to situations such as storage snapshot restores, or cases where the mediator might be stored on mirrored storage.
- The arrays must be configured to use the on-premises mediator rather than the Pure1 Cloud Mediator.
- The mediator must be deployed in a third site, in a separate failure domain that will not be affected by any failures in either of the sites where the arrays are installed.
- Both array sites must have independent network connections to the mediator such that a failure of one network connection does not prevent both arrays from accessing the mediator



Multipathing

There are different combinations of various multipathing configurations with ActiveCluster each with their own advantages and disadvantages. A Uniform Access Configuration is where all hosts have access to both FlashArrays. When using a uniform access configuration, inter-site network performance and reliability are lower than those of the intra-site storage network, hence it is optimal for hosts at each site to route pod volume I/O to the array local to them and to access the remote array only when the local one is unresponsive.

FlashArray provides an option named preferred array to specify whether a host connection to a volume in a stretched pod is optimized or not.

Most multipathing I/O stacks support Asymmetric Logical Unit Assignment (ALUA), a SCSI feature that allows a host to query an array to determine which of its paths to a logical unit are optimized, meaning a direct path to an array owning the LUN, and which are not. Hosts then route I/O commands solely to optimized paths and use non-optimized paths when the optimized paths are unavailable.

Uniform host access

Uniform host access for any SAP HANA deployment can be configured by allowing two of the arrays to be visible to the compute host, providing an even more resilient setup in the event of any single storage array failure. The underlying volumes required for the SAP HANA system are replicated between the arrays using ethernet connectivity but the SAP HANA platform is not aware of the underlying storage configuration. Synchronous replication is appropriate to be used within a single datacenter or multiple datacenters on the same campus (5ms response latency in a datacenter or 11ms across a metro area) and asynchronous snapshot replication extends this to longer distances with higher latencies.



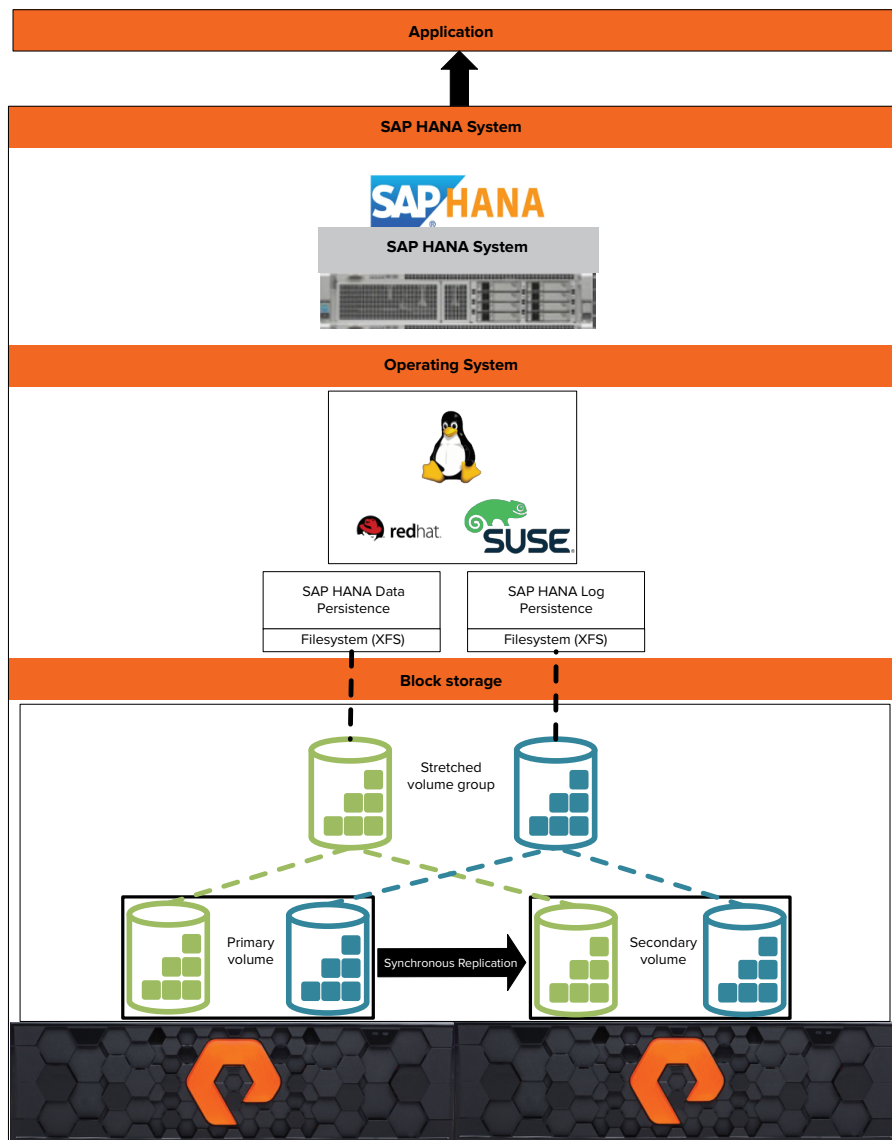


Fig. 14 Uniform storage access for SAP HANA System.

Symmetric Active/Active host access

An Active/Active host access can be configured two separate arrays and compute instances. The arrays will replicate block volume data either synchronously and data can then be read or written by either the primary or secondary system. ActiveCluster makes use of ALUA to expose paths to local hosts as active or optimised to provide the following advantages:

- Volumes in stretched pods are read/write on both arrays. There is no such thing as a passive volume that cannot service both reads and writes.
- The optimized path is defined on a per host-to-volume connection basis using a preferred-array option; this ensures that, regardless of what host a VM or application is running on, it will have a local-optimized path to that volume.

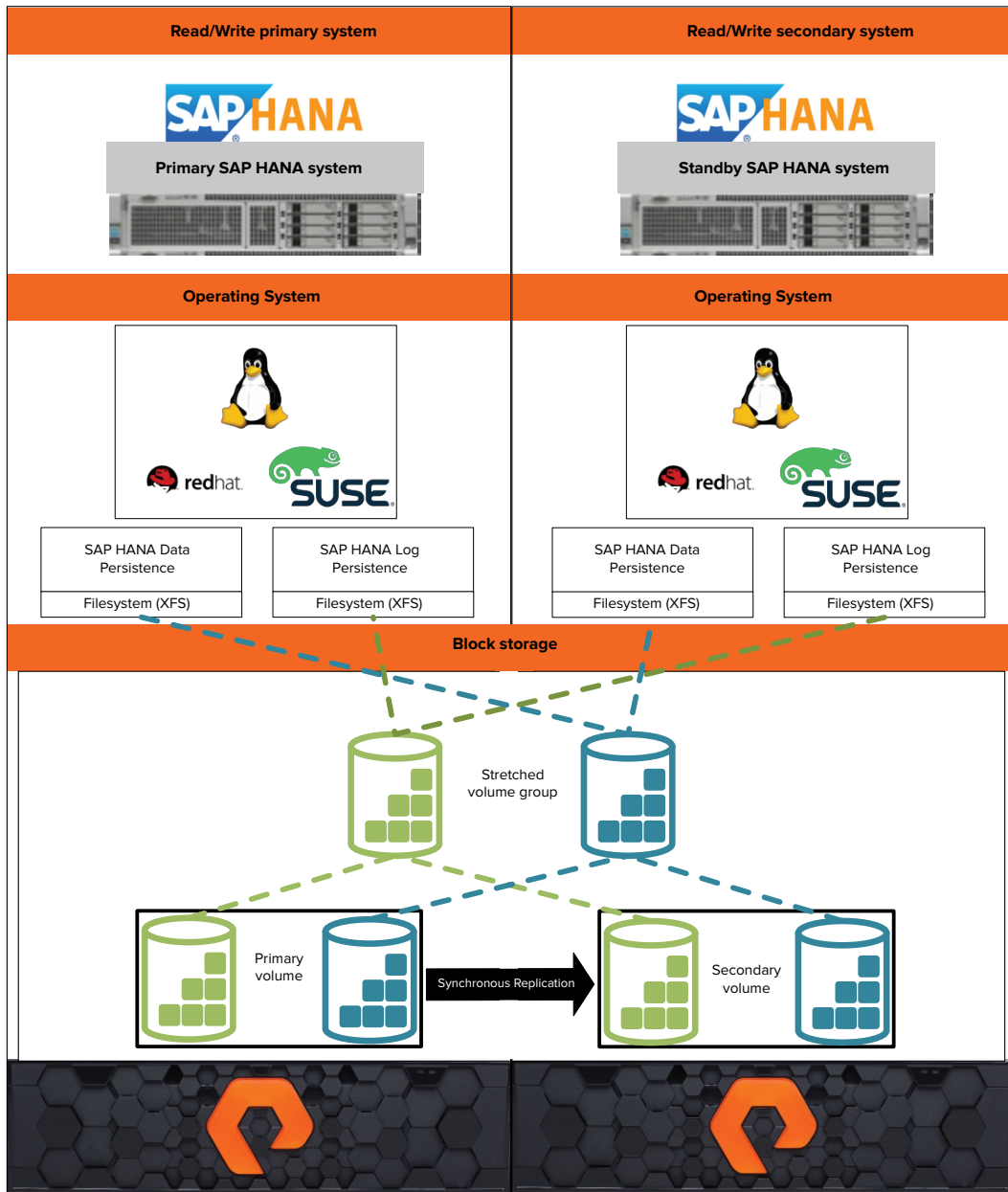


Fig. 15 Symmetric Active/Active configuration.

Configuration and operation

Before processing further, ensure the following environment is configured as set out in the below Requires and Best Practices:

https://support.purestorage.com/FlashArray/PurityFA/Protect/ActiveCluster/ActiveCluster_Requirements_and_Best_Practices

ActiveCluster Glossary of Terms

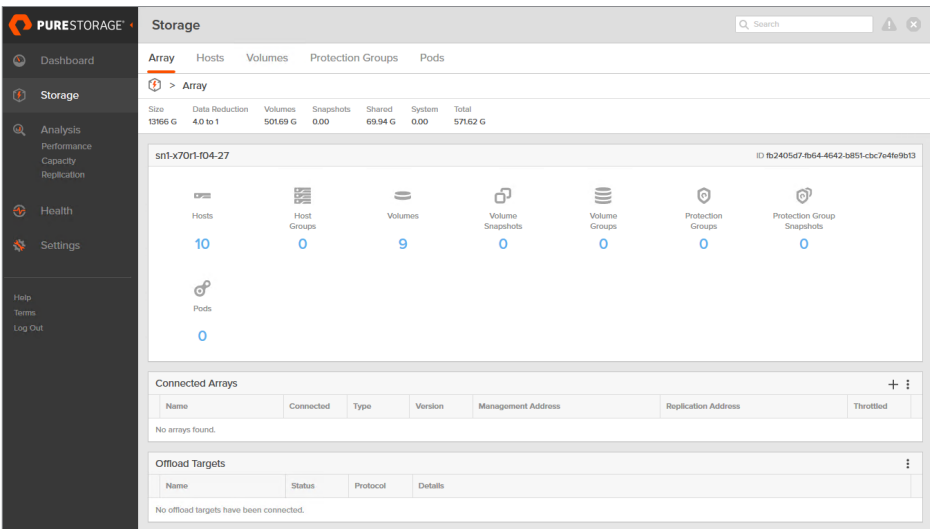
The following terms have been introduced for ActiveCluster and will be used repeatedly in this document:

- **Pod** – A pod is a namespace and a consistency group. Synchronous replication can be activated on a pod, which makes all volumes in that pod present on both FlashArrays in the pod.
- **Stretching** – Stretching a pod is the act of adding a second FlashArray to a pod. When stretched to another array, the volume data will begin to synchronize, and when complete all volumes in the pod will be available on both FlashArrays.
- **Unstretching** – Unstretching a pod is the act of removing a FlashArray from a pod. This can be done from either FlashArray. When removed, the volumes and the pod itself are no longer available on the FlashArray from which they were removed.
- **Restretching** – When a pod is unstretched, the other array (the array unstretched from) will keep a copy of the pod in the trash can for 24 hours. This allows the pod to be quickly re-stretched without having to resend all data, if re-stretched within 24 hours.

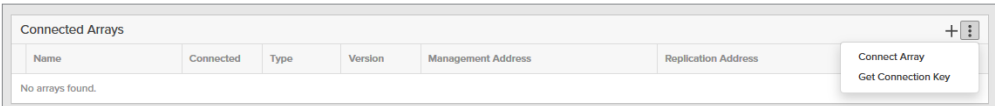
Step 1. Connect to an array and create a synchronous connection

Connecting to another FlashArray requires that a connection key is acquired from the corresponding array attempting to be connected to. This key is used as a secure way of ensuring only authorised individuals can connect to the other array. The other array can be connected to using the virtual IP address of fully qualified domain name of the remote array. ActiveCluster can be configured to use synchronous replication and with a third array use asynchronous snapshot replication.

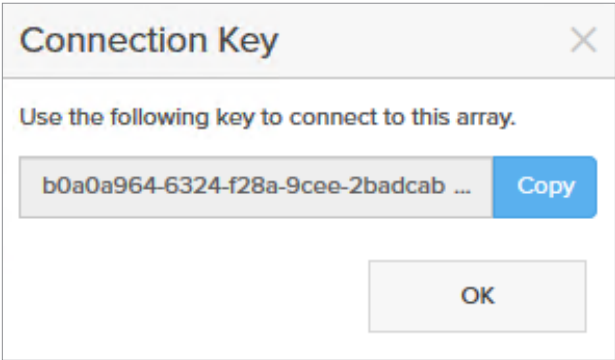
In the FlashArray web user interface for both the local and remote system, in the Storage section navigate to the Array tab.



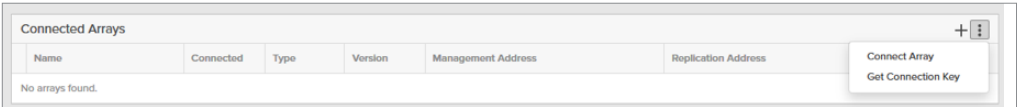
In the interface for the array to be connected to, identify the section for connected arrays and select the 3 vertical ellipses and select “Get Connection Key”.



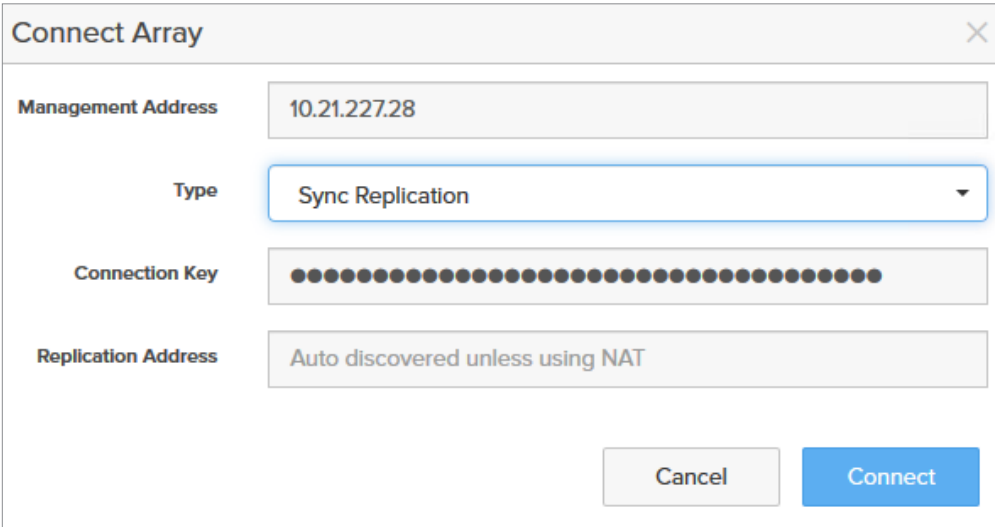
A prompt will show up with the connection key for that array, Select Copy and then navigate to the array to connect from.



In the user interface for the FlashArray to connect from, return to the Connected Arrays section, select the three vertical ellipses and select “Connect Array”.



A prompt will show, enter the relevant information for Management Address, Type (Synchronous replication), the connection key and any replication addresses required. Select Connect when all of the relevant information has been entered.



Once connected, the connected array will show under the relevant section.

Connected Arrays								
Name	Connected	Type	Version	Management Address	Replication Address	Throttled		
● snt-m70-104-33	True	sync-replication	5.2.3	10.21.227.28	10.21.227.201 10.21.227.202 10.21.227.203 10.21.227.204	False		

Step 2. Create a POD and add volumes to it

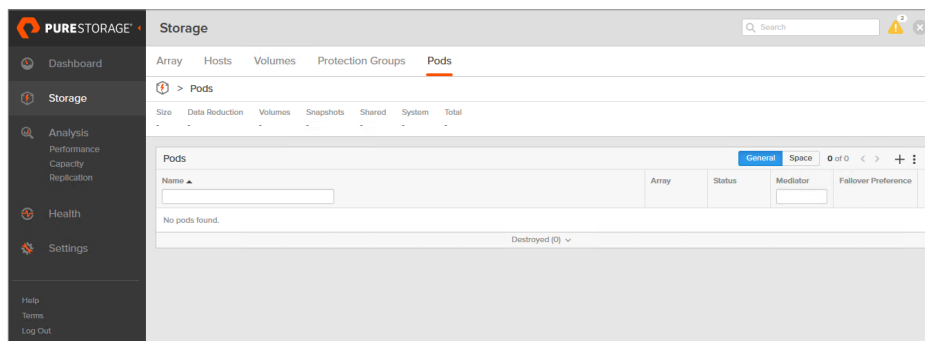
Creating a POD and adding volumes to it is known more commonly as a consistency group. Pods are stretched, unstretched and failover over together. A POD will have its own unique name and any volumes added to that POD will become a part of that namespace.

The default configuration for a new pod used by ActiveCluster is to use the Cloud Mediator – no configuration is required other than to ensure the management network from the FlashArray is redundant and to have IP access to the mediator.

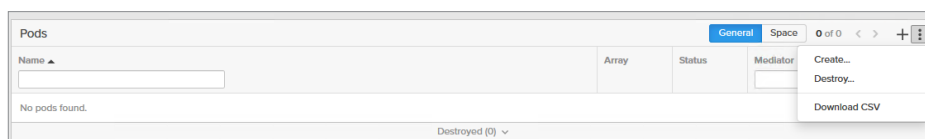
It is important to note once a pod has been “stretched”, pre-existing volumes cannot be added to it until it is “un-stretched”. Alternatively, once a pod has been stretched, only new volumes can be created in the pod. Therefore, if you would like to add existing volumes to the pod, return to the beginning of this step and then stretch the pod.

Any existing volumes added to the pod should already be exported to a host, new volumes will need to be exported to a host after creation.

In the storage view navigate to the Pods tab.



Identify the section for Pods and the three vertical ellipses and then select “Create...”.



In the prompt which appears give the Pod a name and then select Create.

Create Pod

Name

POD-SAPHANA

Cancel

Create

The POD will show up in the Pods section with the default mediator, pure storage, which is Pure1.

Pods					
<div>GeneralSpace11 of 1<>+⋮</div>					
Name ▲	Array	Status	Mediator	Fallover Preference	
POD-SAPHANA	sn1-x70r1-k04-27	online	purestorage	(auto)	<div>🔍🗑️</div>
Destroyed (0) ▾					

Selecting the Pod will show the management view for it including sections for Arrays, Volumes, Protection Groups, Volume Snapshots, Protection Group Snapshots and any miscellaneous details.

Storage

Search

ArrayHostsVolumesProtection GroupsPods

> Pods > POD-SAPHANA

Size	Data Reduction	Volumes	Snapshots	Shared	System	Total
0	10 to 1	0.00	0.00	0.00	-	0.00

Arrays

Name

sn1-x70r1-k04-27

Status

online

Frozen At

-

Mediator Status

online

🗑️

Volumes

GeneralSpaceQoS0 of 0<>+⋮

Name ▲

Source

Connections

Serial

No volumes found.

Destroyed (0) ▾

Volume Snapshots

GeneralTransfer0 of 0<>+⋮

Name

Created ▾

Snapshots

No snapshots found.

Destroyed (0) ▾

Details

Source

-

Mediator

purestorage ☒

Fallover Preference

(auto)

Protection Groups

0 of 0<>+⋮

Name ▲

Snapshots

Targets

No protection groups found.

Destroyed (0) ▾

Protection Group Snapshots

0 of 0<>+⋮

Name

Created ▾

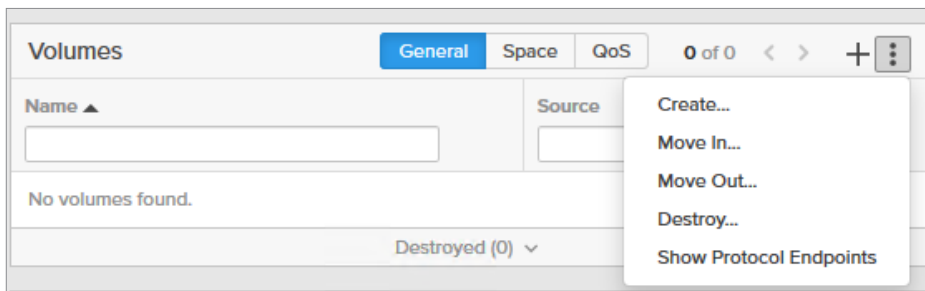
Snapshots

No snapshots found.

Destroyed (0) ▾

157

To add volumes to the pod, identify the volumes section and select the three vertical ellipses. To create a new volume in the pod, select “Create...”, to move existing volumes into the pod select “Move In...”.



When creating a volume to add to the pod enter an appropriate name, provisioned size and unit, any bandwidth limits and select Create.

Create Volume

Container

POD-SAPHANA

Name

Letters, Numbers, -

Provisioned Size

Numbers

G

Bandwidth Limit

Numbers

MB/s

Create Multiple...

Cancel

Create

When moving volumes into the pod, select the relevant volumes on the left-hand window and then select “Move” to migrate the volumes to the right-hand window.

Move Volumes In

Available Volumes

☐

19 of 9

<input type="checkbox"/>	Rebecca_Boot	388.52 M
<input checked="" type="checkbox"/>	Rebecca_HANA_Data	169.59 G
<input checked="" type="checkbox"/>	Rebecca_HANA_Log	118.20 G
<input checked="" type="checkbox"/>	Rebecca_HANA_Shared	1.33 G
<input type="checkbox"/>	SHIN1_Boot	230.21 M
<input type="checkbox"/>	SHIN2_Boot	238.18 M
<input type="checkbox"/>	SHIN3_Boot	227.76 M
<input type="checkbox"/>	SHIN4_Boot	223.36 M
<input type="checkbox"/>	sn1-r720-f04-19-ESXi-Core	231.12 G

Selected Volumes

3 selected

Clear all

Rebecca_HANA_Data	169.59 G	x
Rebecca_HANA_Log	118.20 G	x
Rebecca_HANA_Shared	1.33 G	x

Cancel

Move

158

To stretch the pod to another array, select the “+” icon in the top right-hand corner.

Arrays					+
Name	Status	Frozen At	Mediator Status		
sn1-x70r1-f04-27	● online	-	online		🗑

Select the array to add to the pod from the drop-down menu and then select add.

Add Array ✕

Array

-- Select an array --

sn1-m70-f04-33

Cancel

Add

The array will show up in the pod’s array view, with the status “resyncing”.

Arrays					+
Name	Status	Frozen At	Mediator Status		
sn1-m70-f04-33	● resyncing (6.28%)	-	online		🗑
sn1-x70r1-f04-27	● online	-	online		🗑

When the pod has completed stretching (where all of the volume data has been copied to the other array) the Status will be shown to be online.

Arrays					+
Name	Status	Frozen At	Mediator Status		
sn1-m70-f04-33	● online	-	online		🗑
sn1-x70r1-f04-27	● online	-	online		🗑

Step 3. Set Failover preference

In the event that a specific failover preference is required for the arrays in a pod, this can be changed in the details section of the pod view. The arrays for failover preference can then be appropriately set.

In the pod management view select the three vertical ellipses and select “Add Arrays to Failover Preference...”.

Details ⋮

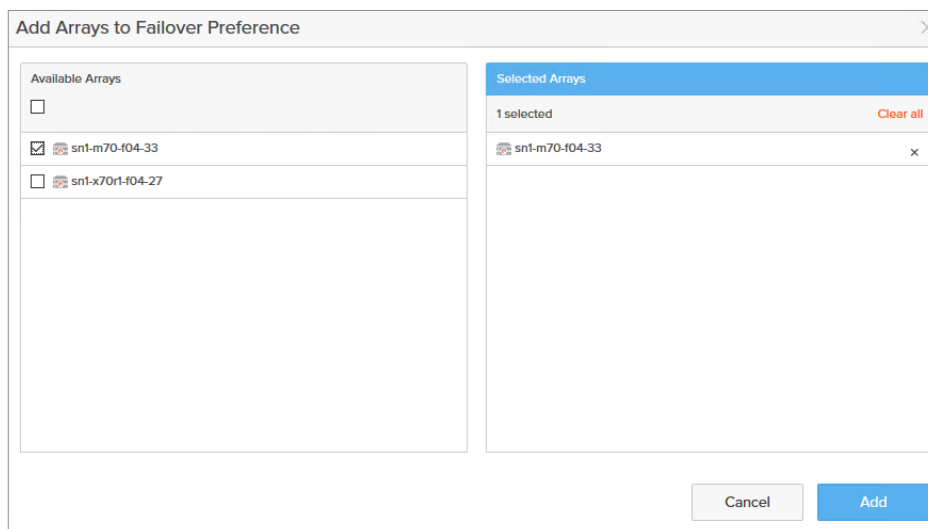
Source -

Add Arrays to Failover Preference...

Mediator purestorage ☒

Failover Preference (auto)

In the prompt displayed select the available array for failover preference in the left-hand window and it will appear in the Select Arrays window. Select Add to confirm this selection.



The dialog box is titled "Add Arrays to Failover Preference". It has two main sections: "Available Arrays" on the left and "Selected Arrays" on the right. In the "Available Arrays" section, there are two items: "sn1-m70-f04-33" (which is checked) and "sn1-x70r1-f04-27". In the "Selected Arrays" section, there is one item: "sn1-m70-f04-33". At the bottom right, there are two buttons: "Cancel" and "Add".

Step 4. Set Preferred array access

To set preferred array access, on the local array the host entry can be set to use which array is local to it. This is appropriate when active cluster is deployed using a multisite scenario where the speed and responsiveness of connectivity will vary. This is a way of ensuring storage requests are routed to a desired array.

In the storage view navigate to the hosts tab and identify a host which the volumes in an ActiveCluster configuration are a part of.

Array

Hosts

Volumes

Protection Groups

Pods

> Hosts

Size

Data Reduction

Volumes

Snapshots

Shared

System

Total

13166 G

4.0 to 1

518.63 G

0.00

53.84 G

0.00

572.47 G

Hosts

General

Space

1-10 of 10

<

>

+

:

Name

Host Group

Interface

Volumes

Preferred Array

SHN1

FC

1

SHN2

FC

1

SHN3

FC

1

SHN4

FC

1

sn1-c460-f04-23

FC

0

sn1-r620-f04-15

FC

0

sn1-r620-f04-16

FC

0

sn1-r620-f04-18

FC

0

sn1-r720-f04-01-Rebecca

FC

4

sn1-r720-f04-19-ESXi

FC

1



Select the relevant host and navigate to its management view.

Storage

Array

Hosts

Volumes

Protection Groups

Pods

> Hosts

> sn1-1720-f04-01-Rebecca

Size

Data Reduction

Volumes

Snapshots

Shared

System

Total

2974 G

4.6 to 1

286.46 G

0.00

-

-

286.46 G

Connected Volumes

14 of 4

Name

Shared

LUN

POD-SAPHANA-Rebecca_HANA_Data

False

3

POD-SAPHANA-Rebecca_HANA_Log

False

4

POD-SAPHANA-Rebecca_HANA_Shared

False

2

Rebecca_Boot

False

1

Protection Groups

0 of 0

Name

No protection groups found.

Host Ports

Port

21:00:00:0E:1E:F0:D0

21:00:00:0E:1E:F0:D1

Details

CHAP Credentials

Personality

Preferred Arrays

Identify the details section and select the three vertical ellipses and then select “Add Preferred Arrays”.

Details

CHAP Credentials

Personality

Preferred Arrays

Configure CHAP...

Set Personality...

Add Preferred Arrays...

In the prompt select the preferred array, the array local to the system, and then select add.

Add Preferred Arrays

Available Arrays

sn1-m70-f04-33

sn1-x70r1-f04-27

Selected Arrays

1 selected

sn1-x70r1-f04-27

Cancel

Add



Removing ActiveCluster Configuration

In the event that replication needs to be terminated, pod volume membership changed or replication needs to be temporarily suspended the POD can be “unstretched” to remove operations from the other arrays. If a pod is stretched to two or more arrays and only one array is needed, the FlashArray no longer required is removed from the pod. Before removing a FlashArray from a pod the following must be done:

- Disconnect the pod’s volumes from the host that is connected to the FlashArray that is being removed from the pod. Purity will not allow un-stretching a pod if even one of its volumes is connected to a host or host groups.
- Ensure that any hosts using those volumes have access to the FlashArray that you intend to keep in the pod. If hosts only have access to the pod you plan to remove through the FlashArray that is being removed, they will lose access to their volumes once the FlashArray is removed from the pod, which may result in an application error based on the setup.
- Ensure you are removing the FlashArray you intend to – double-check the array before removing it.

Navigate to the pod management view for a specific pod in the storage view under Pods.

Storage

Array Hosts Volumes Protection Groups **Pods**

> Pods > POD-SAPHANA

Size 2474 G Data Reduction 5.0 to 1 Volumes 270.88 G Snapshots 0.00 Shared 1.97 G System - Total 272.86 G

Arrays

Name	Status	Frozen At	Mediator Status
sn1-m70-f04-33	online	-	online
sn1-x70r1-f04-27	online	-	online

Volumes General Space QoS 13 of 3 < > +

Name	Source	# Connections	Serial
POD-SAPHANA:Rebecca_HANA_Data	-	2	FB_113ED
POD-SAPHANA:Rebecca_HANA_Log	-	2	FB_113EF
POD-SAPHANA:Rebecca_HANA_Shared	-	2	FB_113EC

Destroyed (0)

Protection Groups 0 of 0 < > +

No protection groups found.

Destroyed (0)

Protection Group Snapshots 0 of 0 < > +

No snapshots found.

Destroyed (0)

Volume Snapshots General Transfer 0 of 0 < > +

No snapshots found.

Destroyed (0)

Details

Source -

Mediator purestorage ☒

Failover Preference (auto)

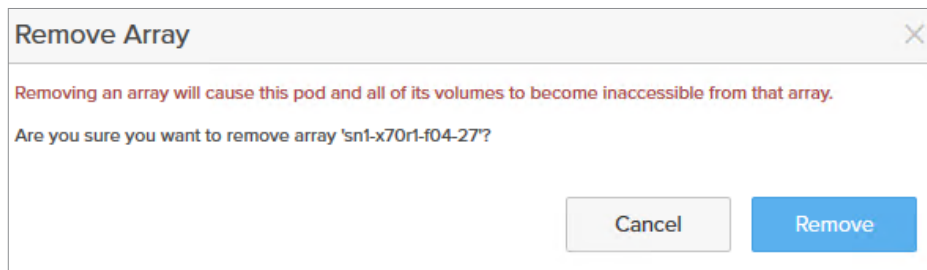
Identify the section for Arrays. To remove an array, select the “bin” icon for the relevant array to remove.

Arrays

Name	Status	Frozen At	Mediator Status
sn1-m70-f04-33	online	-	online
sn1-x70r1-f04-27	online	-	online



A prompt will show, ensure the correct array is being removed and select remove. This will cause the pod to be “un-stretched”.



Multi-Site Disaster Recovery

Overview

Multi-Site Disaster recovery is delivered through FlashRecover Replication – a snapshot-based asynchronous replication solution leveraging space efficient snapshots to replicate point-in-time consistent copies of one or more block storage volumes. This solution combines snapshots and replication into a single concept allowing the creation of multiple recovery points on a replication target. The replication target can be an on-premise FlashArray or Cloud Block Store instance, allowing for organizations to adapt this solution towards the required business need, be it a low recovery point objective or multiple site protection.

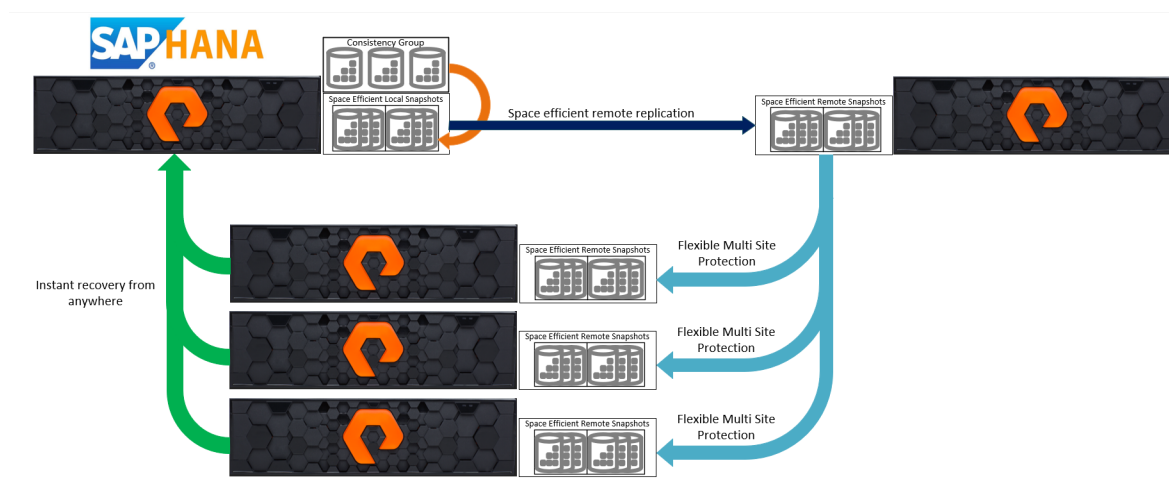


Fig. 16 Multi-Site Disaster Recovery achieved through FlashRecover replication.

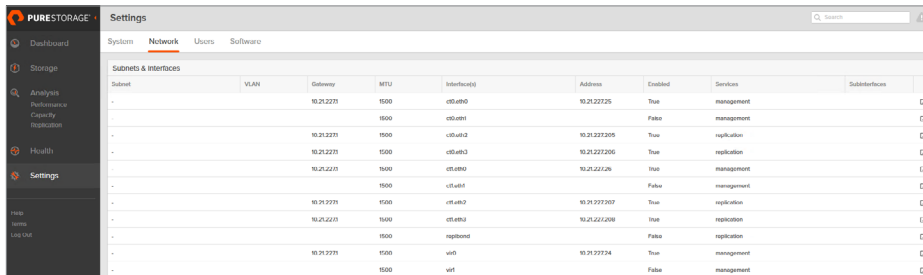


Configuration and operation

In order to configure FlashRecover replication the following requirements must be met:

- The source and target arrays must be connected to ethernet switches.
- Each array must have a replbond interface or interfaces configured for use with the replication service.

In the FlashArray web user interface, in the Storage view navigate towards the Network tab to identify and configure the network settings. To configure a new interface or an existing one, use either the + in the top right-hand corner or the edit clipboard alongside each individual interface.



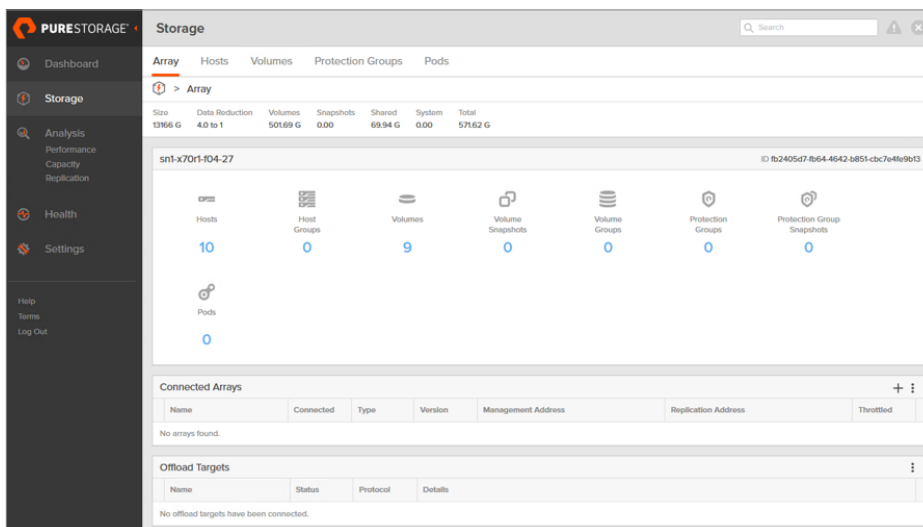
Subnet	VLAN	Gateway	MTU	Interface(s)	Address	Enabled	Service	Subinterface
-	10.21.227.0	9500	9500	eth0a0	10.21.227.25	True	management	[-]
-			9500	eth0a1		False	management	[-]
-	10.21.227.0	9500	9500	eth0a2	10.21.227.255	True	replication	[-]
-	10.21.227.0	9500	9500	eth0a3	10.21.227.255	True	replication	[-]
-	10.21.227.0	9500	9500	eth0a4	10.21.227.26	True	management	[-]
-			9500	eth0a5		False	management	[-]
-	10.21.227.0	9500	9500	eth0a6	10.21.227.255	True	replication	[-]
-	10.21.227.0	9500	9500	eth0a7	10.21.227.255	True	replication	[-]
-			9500	replbond		False	replication	[-]
-	10.21.227.0	9500	9500	virt0	10.21.227.24	True	management	[-]
-			9500	virt1		False	management	[-]

- Any replication interface must be configured with an IP address, netmask and (optionally) gateway while being set to enabled on all arrays.
- Connecting arrays to one another requires access on port 443 and 8117. In the event of cross site replication through firewalls these ports must be set to allow transfers.

Step 1. Connect to the remote storage array(s) and create an asynchronous connection

Connecting to another FlashArray requires that a connection key is acquired from the corresponding array attempting to be connected to. This key is used as a secure way of ensuring only authorised individuals can connect to the other array. The other array can be connected to using the virtual IP address of fully qualified domain name of the remote array.

In the FlashArray web user interface for both the local and remote system, in the Storage section navigate to the Array tab.



Size	Data Reduction	Volumes	Snapshots	Shared	System	Total
13966 G	4.0 to 1	50169 G	0.00	69.94 G	0.00	571.62 G

snf-x70r1-004-27 © 6b2405d7-8b64-4642-b851-cbc7e46e9b13

Hosts

10

Host Groups

0

Volumes

9

Volume Snapshots

0

Volume Groups

0

Protection Groups

0

Protection Group Snapshots

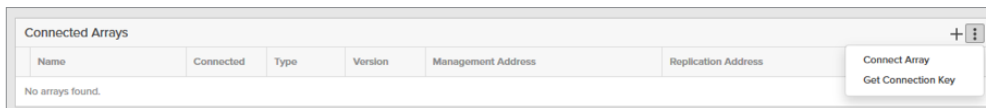
0

Pods

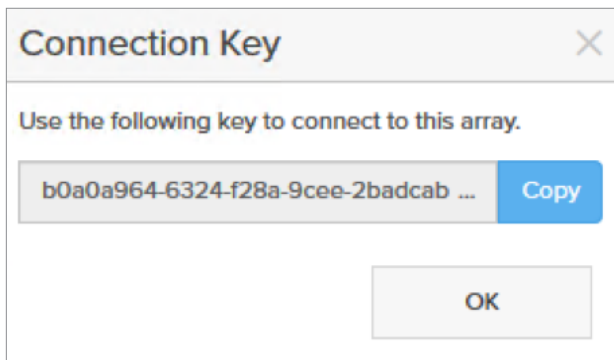
0



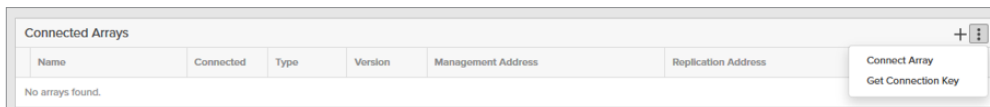
In the interface for the array to be connected to identify the section for connected arrays and select the 3 vertical ellipses and select “Get Connection Key”.



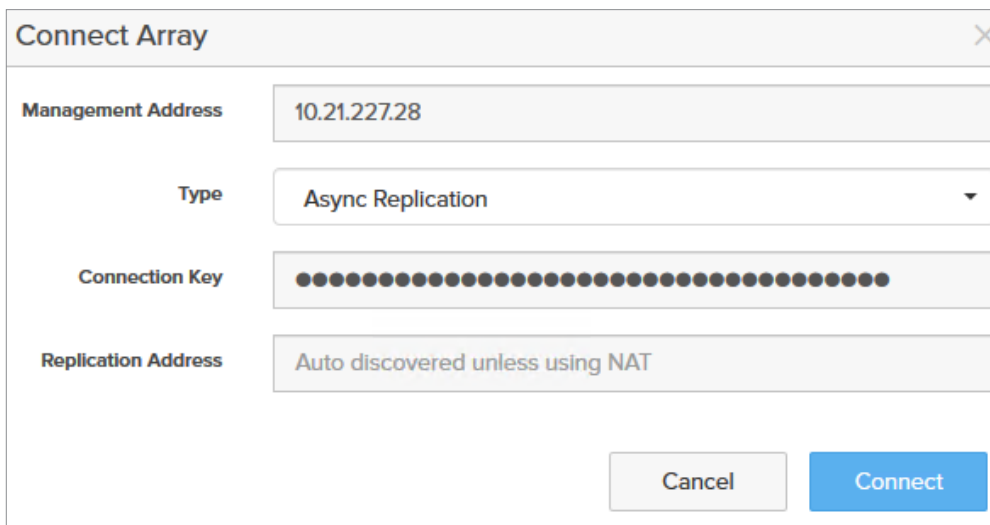
A prompt will show up with the connection key for that array, Select Copy and then navigate to the array to connect from.



In the user interface for the FlashArray to connect from, return to the Connected Arrays section, select the three vertical ellipses and select “Connect Array”.



A prompt will show, enter the relevant information for Management Address, Type (Asynchronous replication), the connection key and any replication addresses required. Select Connect when all of the relevant information has been entered.



Once connected, the connected array will show under the relevant section.

Connected Arrays								+	:
Name	Connected	Type	Version	Management Address	Replication Address	Throttled			
sn1-m70-404-33	True	async-replication	5.2.3	10.21.227.28	10.21.227.201 10.21.227.202 10.21.227.203 10.21.227.204	False			

Step 1a. Set throttling for asynchronous replication target

When organizations need to limit the amount of bandwidth used by a service, to ensure that other services are still capable of communication without a delay due to saturation of the network link, a network throttling policy is usually applied. With asynchronous replication a throttling policy is applied per connected array. Throttling policies can be applied to bandwidth limits at all times or during a time range.

For the array which needs to be throttled, select the “Edit Bandwidth Throttle” icon on the left-hand side.

Connected Arrays								+	:
Name	Connected	Type	Version	Management Address	Replication Address	Throttled			
sn1-m70-404-33	True	async-replication	5.2.3	10.21.227.28	10.21.227.201 10.21.227.202 10.21.227.203 10.21.227.204	False			

In the prompt which appears a Default throttle can be applied or a window throttle.

Edit Bandwidth Throttling

Configure bandwidth throttling for asynchronous replication.

Default Throttle

Window Throttle

Cancel

Save



For the default throttling which will be on at all times , set the desired bandwidth limit.

Edit Bandwidth Throttling

Configure bandwidth throttling for asynchronous replication.

Default Throttle

☒

Limit

500

MB/s

Window Throttle

☐

Cancel

Save

For throttling to be applied during a period of time, set the time range and the bandwidth limit.

Edit Bandwidth Throttling

Configure bandwidth throttling for asynchronous replication.

Default Throttle

☐

Window Throttle

☒

Time Range

12am

to

12am

Limit

500

MB/s

Cancel

Save

The array will now show us as throttled.

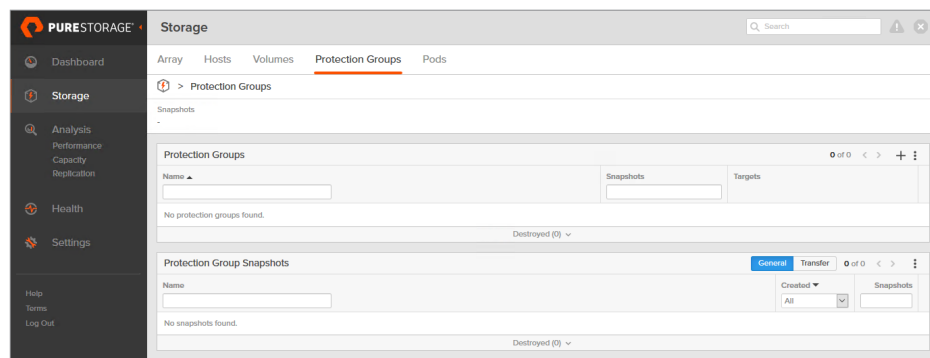
Connected Arrays								+ ⋮	
Name	Connected	Type	Version	Management Address	Replication Address	Throttled			
sn1-m70-i04-33	True	sync-replication	5.2.3	10.21.227.28	10.21.227.201 10.21.227.202 10.21.227.203 10.21.227.204	True	<input checked="" type="checkbox"/>	x	



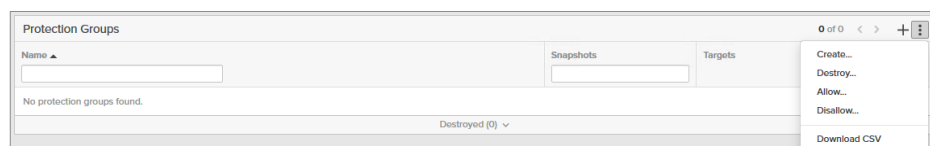
Step 2. Create a Protection Group

FlashRecover makes use of a single interface to manage the creation and/or replicate of snapshots. This interface is located in the Storage View under Protection Groups. A unique name must be given to the Protection Group.

In the Storage view, the Protection Groups tab is used to manage consistency groups of volumes, hosts and host groups.



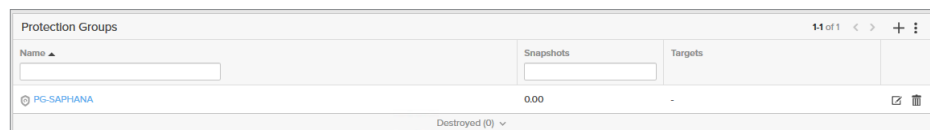
In the Protection Groups tab, identify the section for Protection Groups where all existing Protection Groups will be located. To create a new Protection Group, select the 3 vertical ellipses in the top right-hand corner and select “Create...”.



When the prompt is shown give the protection group an appropriate name and then select “Create”.

The screenshot shows a 'Create Protection Group' dialog box. It has a title bar with a close button. Inside, there are two input fields: 'Container' with a '/' character and 'Name' with the text 'SAPHANA-PG'. At the bottom right, there are two buttons: 'Cancel' and 'Create'.

The new Protection Group will now be shown.



Selecting the Protection Group will navigate towards the management view for it.

The screenshot shows the 'Storage' management interface with the 'Protection Groups' tab selected. The breadcrumb navigation shows 'Protection Groups > PG-SAPHANA'. The 'Targets' section is currently empty, displaying 'No targets found.' The 'Snapshot Schedule' and 'Replication Schedule' sections show configuration options for snapshots and replication, both currently disabled. The 'Protection Group Snapshots' section at the bottom shows a table with columns for Name, Created, and Snapshots, currently displaying 'No snapshots found.'

Step 3. Add Asynchronous replication target(s)

In the management view for the specific protection group, the area for “Targets” allows for multiple FlashArray or Pure Cloud Block Store instances to add. Each system added as a target in the Protection Group will be a target for any replication policies set up for it.

In the management view for the Protection Group, identify the section for “Targets”. Select the three vertical ellipses and select “Add...”.

This screenshot shows the 'Targets' section of the management interface. A context menu is open, displaying 'Add...' and 'Remove...' options. The 'Targets' section currently shows 'No targets found.'

Identify any available targets, select them and then select “Add” to complete the process.

The 'Add Targets' dialog box is shown, divided into two panes. The 'Available Targets' pane on the left lists two targets: an empty input field and 'sn1-m70-f04-33', both with checked selection boxes. The 'Selected Targets' pane on the right shows '1 selected' and lists 'sn1-m70-f04-33' with a red 'x' icon. At the bottom right, there are 'Cancel' and 'Add' buttons.



The target will show up in the Protection Group management view once it has been added.

Targets		
1-1 of 1 < > ⋮		
Name ▲	Allowed	
<input type="text"/>		
sn1-m70-f04-33	True	

Step 4. Add Host, Host Group or Volumes to Protection Group

In order to asynchronously replicate volume data, the volumes required to be replicated must be added to the Protection Group. Volumes can be added by making the host or host group to which those volumes are attached, or just adding the volumes themselves, a member of the Protection Group. Any volumes added to a Protection group are considered a consistency group, ensuring that all of the data on each volume is synchronised to the same point in time when a snapshot is created.

In the Protection Group Management view, navigate to the Members section and select the three vertical ellipses. Then select the type of member to add.

Members

0 of 0 < > ⋮

Name ▲

No members found.

Add Hosts...

Add Host Groups...

Add Volumes...

Remove...

To add the volumes attached to a host as a member, select the host and then select Add.

Add Members

×

Available Members

☐

1-10 of 10 < >

☐ SHN1

☐ SHN2

☐ SHN3

☐ SHN4

☒ sn1-c460-f04-23

☐ sn1-620-f04-15

☐ sn1-620-f04-16

☐ sn1-620-f04-18

☐ sn1-r720-f04-01-Rebecca

☐ sn1-r720-f04-19-ESXi

Selected Members

1 selected Clear all

sn1-c460-f04-23

×

Cancel

Add



To add volume(s) as a member select the volumes and then select Add.

Add Members

Available Members

☐

1-12 of 12

<

>

☒

Hannah-HANA-Data

☒

Hannah-HANA-Log

☒

Hannah-HANA-Shared

☐

Rebecca_Boot

☐

Rebecca_HANA_Data

☐

Rebecca_HANA_Log

☐

Rebecca_HANA_Shared

☐

SHN1_Boot

☐

SHN2_Boot

☐

SHN3_Boot

Selected Members

3 selected

Clear all

Hannah-HANA-Data

x

Hannah-HANA-Log

x

Hannah-HANA-Shared

x

Cancel

Add

To add any volume(s) attached to all of the hosts in a host group select the host group and then select Add.

Add Members

Available Members

☒

1-1 of 1

<

>

☒

SAP-HANA-ScaleOut

Selected Members

1 selected

Clear all

SAP-HANA-ScaleOut

x

Cancel

Add



Step 5. Set Snapshot Schedule (Optional)

A snapshot schedule will create a snapshot for any volumes present as a member of the Protection Group, on a set time basis. The retention of snapshots can also be managed here ensuring that effective capacity management is exercised. The recovery point objective (RPO) is set here, for an hour RPO a new snapshot must be created every hour and retained for long enough that it can be utilised as a recovery point. This only creates volume snapshots on the local array.

In the Protection Group management view, identify the section for Snapshot Schedules. To edit the snapshot schedule, select the edit box in the top right-hand corner.

Snapshot Schedule

Enabled: **False**

Create a snapshot on source every **1** hours

Retain all snapshots on source for **1** days

then retain **4** snapshots per day for **7** more days

A prompt will show, ensure that snapshot schedule is enabled and the correct values for creation frequency and retention are entered. Select Save when the values are satisfactory.

Edit Snapshot Schedule

☒ Enabled

Create a snapshot on source every hours at

Retain all snapshots on source for days

then retain snapshots per day for more days

After some time, snapshots created by the policy will be shown in the Protection Group management view.

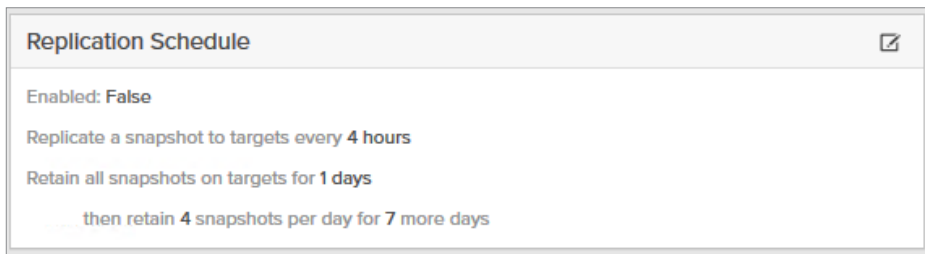
Protection Group Snapshots				14 of 4	<	>	+	:
Name	Created	Snapshots						
<input type="text"/>	All							
PG-SAPHANA.4	2019-06-03 05:27:00	0.00						
PG-SAPHANA.3	2019-06-03 05:22:00	452.69 G						
PG-SAPHANA.2	2019-06-03 05:17:00	0.00						
PG-SAPHANA.1	2019-06-03 05:16:30	2774 G						
Destroyed (0)								



Step 6. Set Replication Schedule

To enable multi-site disaster recovery the snapshots being created on the FlashArray or Cloud Block Store instance must be replicated to another location. This is accomplished by using a replication schedule, also used to manage retention of those snapshots on the target(s) for capacity management. All targets added in step 3 will be replicated to when setting this policy and any volumes added as members of the Protection group will be replicated as a part of this policy.

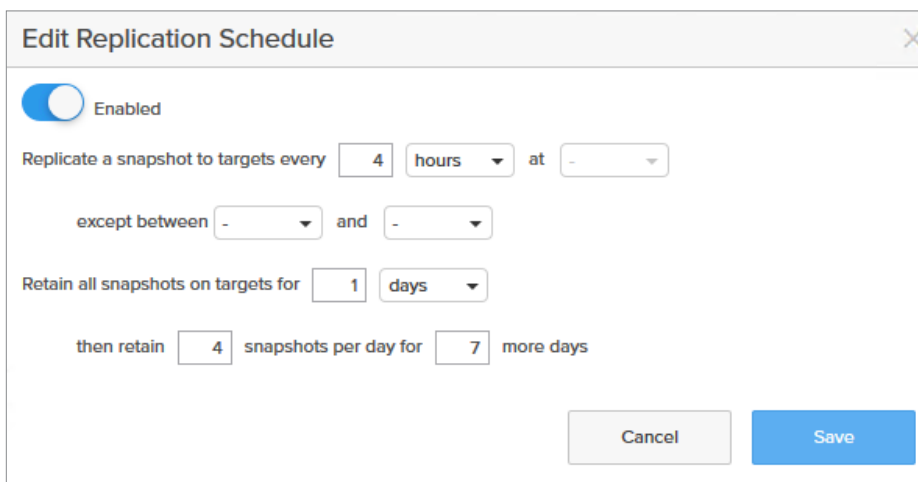
In the Protection Group management view, identify the section for Replication Schedules. To edit the replication schedule, select the edit box in the top right-hand corner.



A configuration window titled "Replication Schedule" with an edit icon in the top right corner. The window displays the following settings:

- Enabled: **False**
- Replicate a snapshot to targets every **4** hours
- Retain all snapshots on targets for **1** days
- then retain **4** snapshots per day for **7** more days

In the prompt set the replication schedule to enabled and then set the relevant values for when to replicate a snapshot, any exclusion times and the relevant retention information.



An "Edit Replication Schedule" window with a close button in the top right corner. The window contains the following controls and settings:

- ☒ Enabled
- Replicate a snapshot to targets every hours at
- except between and
- Retain all snapshots on targets for days
- then retain snapshots per day for more days
-

Adding additional replication target(s)

FlashRecover can perform one to many, many to many and many to one replication techniques. In order to add an additional replication target, repeat the process for adding a connected array in Step 1, and then adding that array to the relevant protection group as set out in Step 3.

In the FlashArray web user interface find the connected arrays section under the Array tab in the Storage view. Once the array has been added it will display alongside any other connected arrays.

Connected Arrays								+ ⋮	
Name	Connected	Type	Version	Management Address	Replication Address	Throttled			
● sn1-m70-f04-33	True	async-replication	5.2.3	10.21.227.28	10.21.227.201 10.21.227.202 10.21.227.203 10.21.227.204	False	<input checked="" type="checkbox"/>	x	
● sn1-m20r2-f09-25	True	async-replication	5.2.3	10.21.232.32	10.21.232.35	False	<input checked="" type="checkbox"/>	x	

In the Protection Group management view, identify the section for targets and select the three vertical ellipses to add a new target.

Targets			1-1 of 1	<	>	⋮
Name ▲	Allowed					
<input type="text"/>						
sn1-m70-f04-33	True	<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>

In the prompt which appears select the array to add as an asynchronous replication target and then select Add.

Add Targets

Available Targets

☒

1-1 of 1 < >

☒ sn1-m20r2-f09-25

Selected Targets

1 selected Clear all

sn1-m20r2-f09-25 x

Cancel

Add



Once added to the Protection Group the additional array(s) will be shown in the targets view.

Targets		
1-2 of 2 < > ⋮		
Name ▲	Allowed	
<input type="text"/>		
sn1-m20r2-f09-25	True	🗑
sn1-m70-f04-33	True	🗑

Once replication has occurred, snapshots of the Protection group will be shown in the Protection Group management view created with the source array as the name – appended with the relevant protection group name.

PURESTORAGE

Dashboard

Storage

Analysis

Performance

Capacity

Replication

Health

Settings

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Log Out

Array

Hosts

Volumes

Protection Groups

Pods

Search

🔍

🔧

✕

Storage

> Protection Groups > sn1-x70r1-f04-27-PG-SAPHANA

🔍

Snapshots

188.26 G

Members

11 of 1 < >

Name ▲

sn1-x70r1-f04-27-sn1-c460-f04-23

Targets

1-2 of 2 < > ⋮

Name ▲	Allowed
<input type="text"/>	
sn1-m20r2-f09-25	True
sn1-m70-f04-33	True

Source Arrays

Array

No source array found.

Snapshot Schedule

Enabled: True

Create a snapshot on source every 5 minutes

Retain all snapshots on source for 1 days

then retain 4 snapshots per day for 7 more days

Replication Schedule

Enabled: True

Replicate a snapshot to targets every 10 minutes

Retain all snapshots on targets for 1 days

then retain 4 snapshots per day for 7 more days

Protection Group Snapshots

General Transfer 11 of 1 < > + ⋮

Name

Created

All

Snapshots

sn1-x70r1-f04-27-PG-SAPHANA1

2019-06-03 05:16:30

188.26 G

🗑

Destroyed (0) ▾



Adding an asynchronous snapshot replication target to an ActiveCluster configuration

Third site Disaster recovery for Active Cluster

Any ActiveCluster configuration can be extended for disaster recovery scenarios by having a third array configured for asynchronous snapshot replication for an existing pod. In the event of the first two arrays failing, data on the third site can be resynchronised back to the first two sites allowing for business processes to resume in a rapid fashion. Any third site array can be used by multiple ActiveCluster configurations.

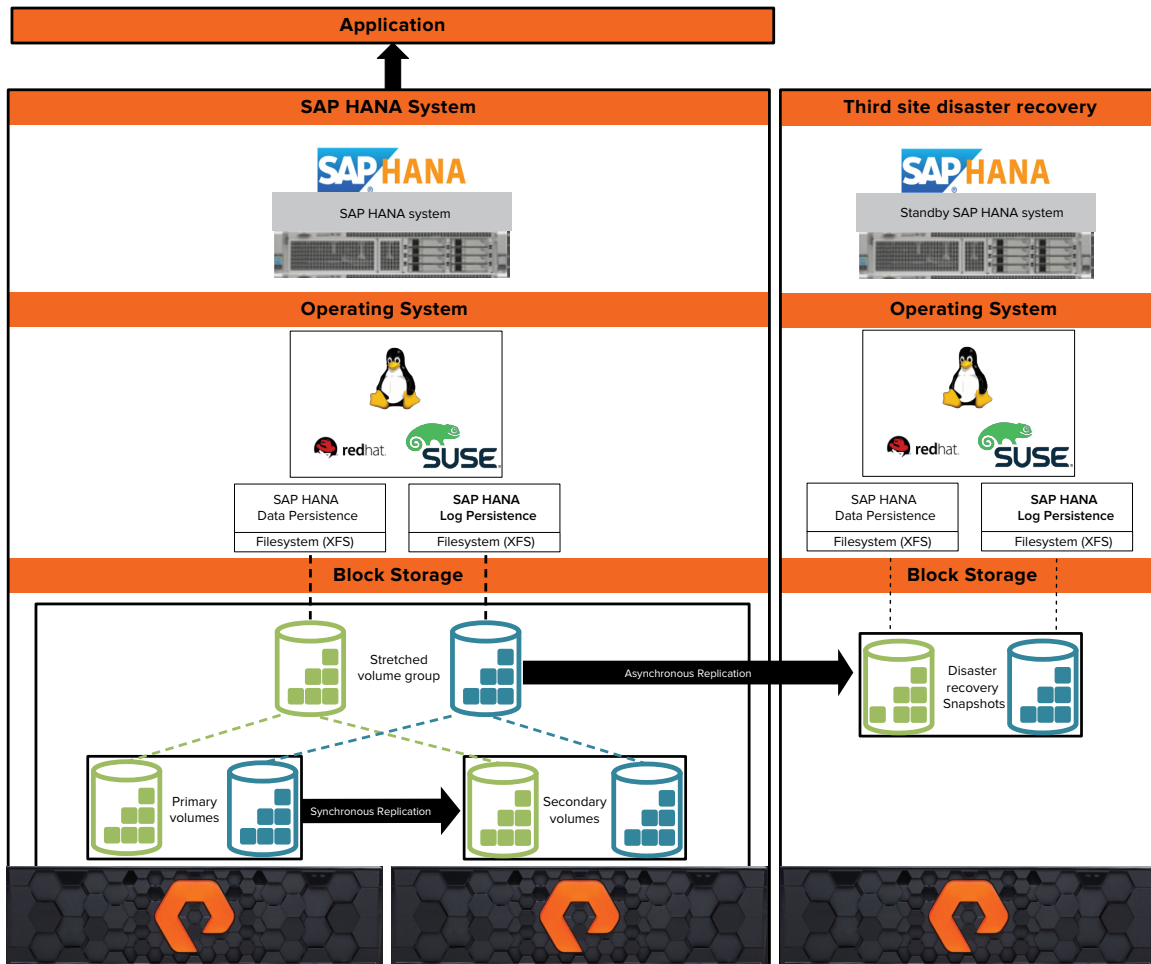


Fig. 17 Extending uniform host access to a third site for DR purposes.

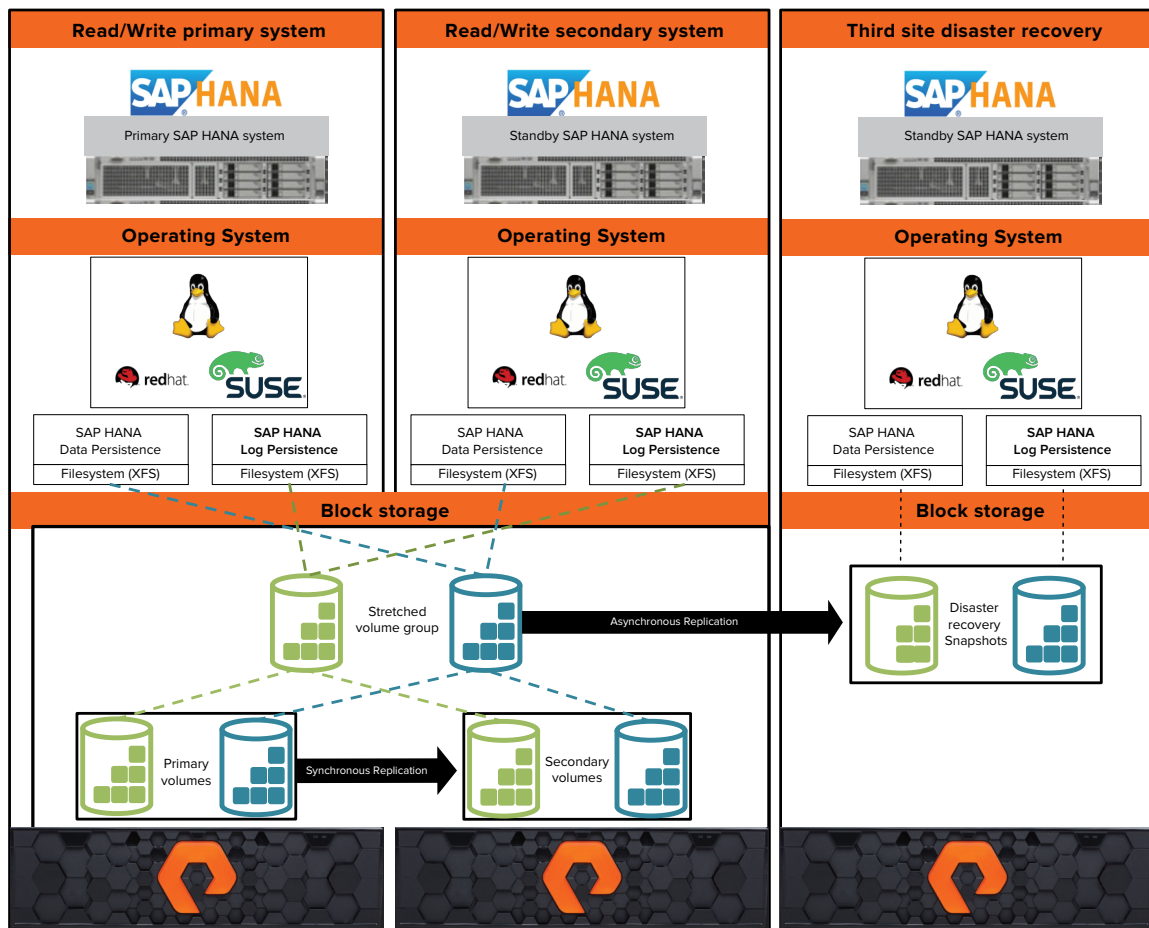


Fig. 18 Extending Symmetric Active/Active host access to a third site for DR purposes.

With the release of Purity 5.2, synchronous (ActiveCluster) and asynchronous (FlashRecover) functionality can be combined to achieve a zero-recovery target and zero recovery point objective and further enhance business continuity solutions. Volumes must be added to a protection group before being added to a pod for active cluster in order to configure this solution.

In the Pure storage web user interface, where an existing active cluster configuration is present find the section for Connected Arrays and select the “+” to add a new array.

Storage

! ×

Array

Hosts

Volumes

Protection Groups

Pods

> Array

Size	Data Reduction	Volumes	Snapshots	Shared	System	Total
13166 G	4.3 to 1	482.60 G	0.00	5707 G	0.00	539.67 G

sn1-x70r1-f04-27

ID fb2405d7-fb64-4642-b851-cbc7e4fe9b13

Hosts

10

Host Groups

0

Volumes

9

Volume Snapshots

0

Volume Groups

0

Protection Groups

0

Protection Groups Snapshots

0

Pods

1

Connected Arrays

+

:

Name	Connected	Type	Version	Management Address	Replication Address	Throttled	
● sn1-m70-f04-33	True	sync-replication	5.2.3	10.21.227.28	10.21.227.201 10.21.227.202 10.21.227.203 10.21.227.204	False	<input checked="" type="checkbox"/> ✕

Offload Targets

:

Name	Status	Protocol	Details
No offload targets have been connected.			

Connect the third array as an asynchronous replication target, ensure the connection key and any relevant replication addresses have been retrieved from it to enter here.

[illegible]

The array will show up as an async-replication target type under connected arrays.

Connected Arrays							
Name	Connected	Type	Version	Management Address	Replication Address	Throttled	
sn1-m70-104-33	True	sync-replication	5.2.3	10.21.227.28	10.21.227.201 10.21.227.202 10.21.227.203 10.21.227.204	False	<input checked="" type="checkbox"/> x
sn1-x10r2-d01-17	True	async-replication	5.2.3	10.21.121.26	10.21.121.28 10.21.121.29	False	<input checked="" type="checkbox"/> x

Navigate to the management view for the Pod for the SAP HANA instance.

Storage

Search

Array Hosts Volumes Protection Groups Pods

> Pods > SAPHANA-POD

Size 0

Data Reduction 1.0 to 1

Volumes 0.00

Snapshots 0.00

Shared 185.93 G

System -

Total 185.93 G

Arrays

Name	Status	Frozen At	Mediator Status
sn1-x70r1-104-27	online	-	online

Volumes

General Space QoS

0 of 0 < > +

Name

Source

Connections

Serial

No volumes found.

Destroyed (0)

Volume Snapshots

General Transfer

0 of 0 < > +

Name

Created

Snapshots

All

No snapshots found.

Destroyed (0)

Protection Groups

0 of 0 < > +

Name

Snapshots

Targets

No protection groups found.

Destroyed (0)

Protection Group Snapshots

0 of 0 < > +

Name

Created

Snapshots

All

No snapshots found.

Destroyed (0)

Details

Source

Mediator purestorage

Fallover Preference (auto)

In the pod identify the Protection Groups section and select the three vertical ellipses and then select “Create...”.

Protection Groups

0 of 0 < > +

Name

Snapshots

No protection groups found.

Destroyed (0)

Create...

Destroy...

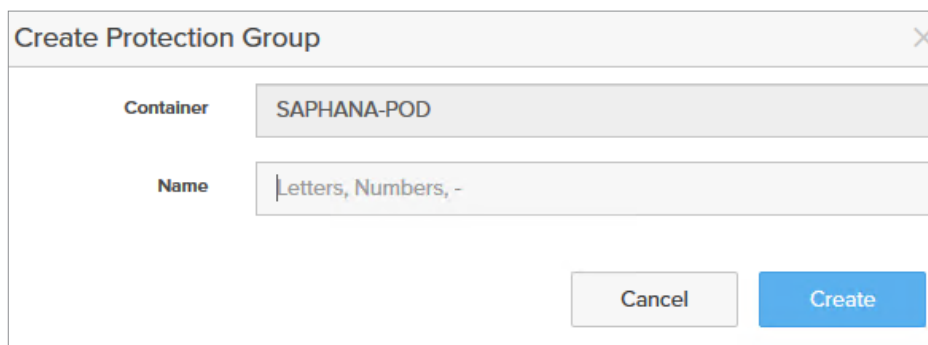
Allow...

Disallow...

Download CSV

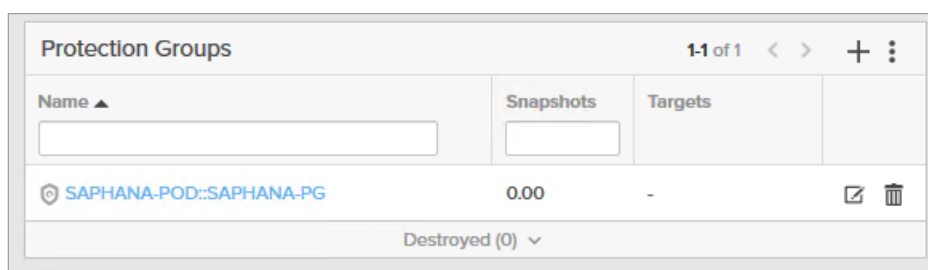





In the prompt ensure the Container is the same name as the pod, and then give the protection group a unique name before selecting Create.



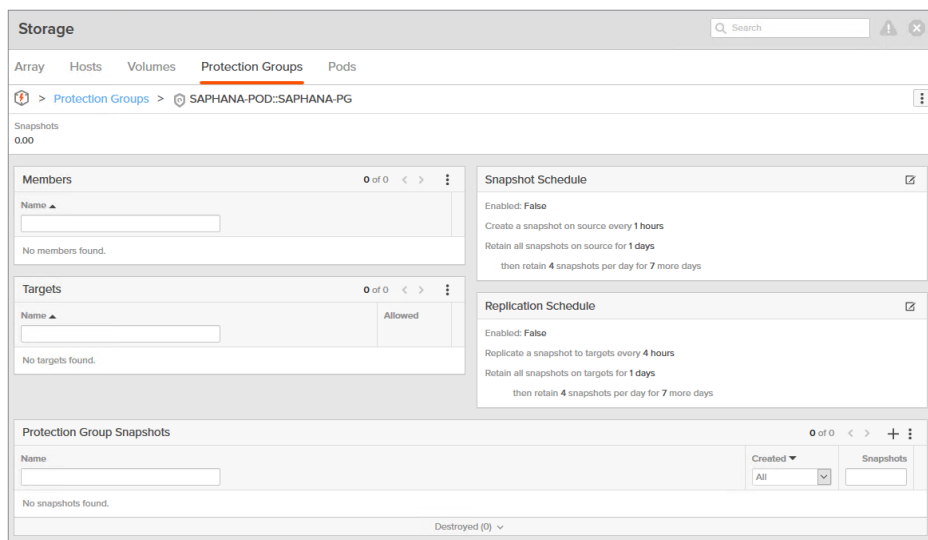
The 'Create Protection Group' dialog box has a title bar with a close button. It contains two input fields: 'Container' with the value 'SAPHANA-POD' and 'Name' with the value 'Letters, Numbers, -'. At the bottom right are 'Cancel' and 'Create' buttons.

The Protection group will now be shown in the pod.



Protection Groups				11 of 1 < > + ⋮	
Name ▲	Snapshots	Targets			
 SAPHANA-POD::SAPHANA-PG	0.00	-			
Destroyed (0) ▼					

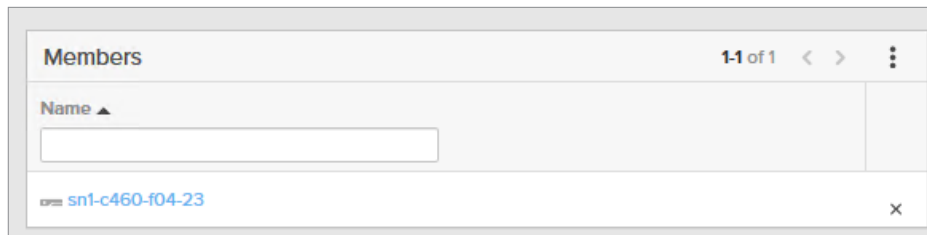
Navigate to the Protection group name which has been created as a part of the pod (the naming convention will be POD NAME::PROTECTION GROUP NAME).



The 'Storage' page shows a breadcrumb trail: 'Array > Hosts > Volumes > Protection Groups > SAPHANA-POD::SAPHANA-PG'. The 'Protection Groups' tab is active. Below the breadcrumb, it shows 'Snapshots 0.00'. The main content area is divided into four panels: 'Members' (empty), 'Targets' (empty), 'Snapshot Schedule' (Enabled: False, Create a snapshot on source every 1 hours, Retain all snapshots on source for 1 days, then retain 4 snapshots per day for 7 more days), and 'Replication Schedule' (Enabled: False, Replicate a snapshot to targets every 4 hours, Retain all snapshots on targets for 1 days, then retain 4 snapshots per day for 7 more days). At the bottom is a 'Protection Group Snapshots' section with a table header 'Name', 'Created', and 'Snapshots'. The table is empty, and the 'Created' dropdown is set to 'All'. At the bottom right of the table is a 'Destroyed (0) ▼' link.



Add the volumes which will be synchronously replicated in the ActiveCluster configuration, to the protection group.

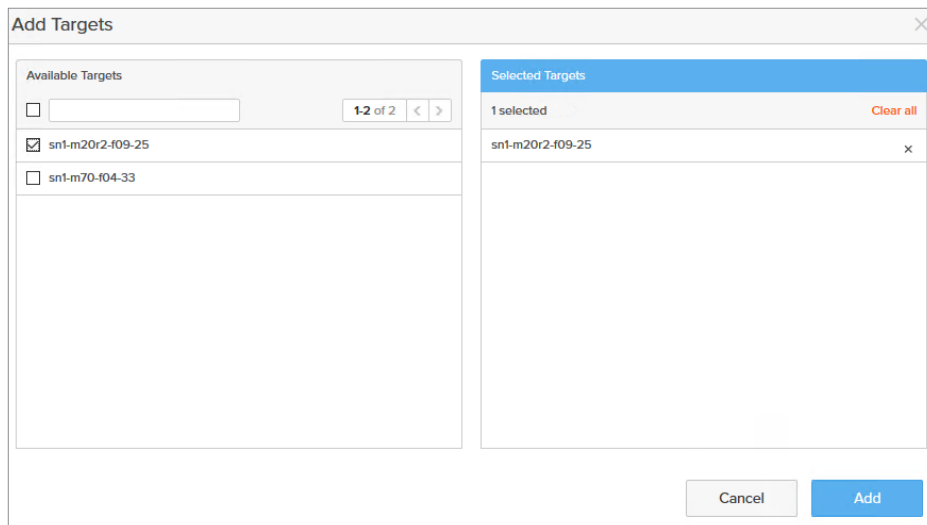


Members 1-1 of 1

Name ▲

sn1-c460-f04-23	
-----------------	--

Add the asynchronous replication target to the protection group. Do not add the ActiveCluster synchronous target.



Add Targets

Available Targets

☐ 1-2 of 2

☒ sn1-m20r2-f09-25

☐ sn1-m70-f04-33

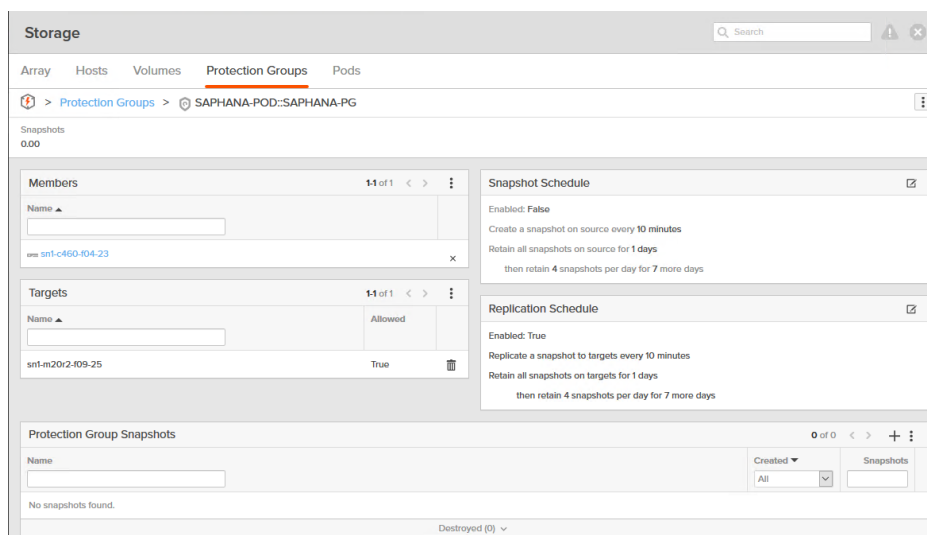
Selected Targets

1 selected Clear all

sn1-m20r2-f09-25

Cancel Add

Configure the replication schedule for the protection group.



Storage Search

Array Hosts Volumes **Protection Groups** Pods

> Protection Groups > SAPHANA-POD::SAPHANA-PG

Snapshots 0.00

Members 1-1 of 1

Name ▲

sn1-c460-f04-23	
-----------------	--

Targets 1-1 of 1

Name ▲ Allowed

sn1-m20r2-f09-25	True
------------------	------

Snapshot Schedule

Enabled: False

Create a snapshot on source every 10 minutes

Retain all snapshots on source for 1 days

then retain 4 snapshots per day for 7 more days

Replication Schedule

Enabled: True

Replicate a snapshot to targets every 10 minutes

Retain all snapshots on targets for 1 days

then retain 4 snapshots per day for 7 more days

Protection Group Snapshots 0 of 0

Name Created Snapshots

All

No snapshots found.

Destroyed (0)



Return to the pod management view and add the array for synchronous replication to it.

Storage

Array

Hosts

Volumes

Protection Groups

Pods

> Pods > SAPHANA-POD

Size

Data Reduction

Volumes

Snapshots

Shared

System

Total

0

1.0 to 1

0.00

0.00

76.81 G

-

76.81 G

Arrays

Name

Status

Frozen At

Mediator Status

snt-m70-104-33

resyncing (14.17%)

-

online

snt-x70r1-104-27

online

-

online

Volumes

General

Space

QoS

0 of 0

Name

Source

Connections

Serial

No volumes found.

Destroyed (0)

Protection Groups

1-1 of 1

Name

Snapshots

Targets

SAPHANA-POD:SAPHANA-PG

0.00

Allowed on 1 of 1 replication targets

Destroyed (0)

Volume Snapshots

General

Transfer

0 of 0

Name

Created

Snapshots

No snapshots found.

Destroyed (0)

Protection Group Snapshots

0 of 0

Name

Created

Snapshots

No snapshots found.

Destroyed (0)

Details

Source

Mediator

Fallover Preference

-

purestorage

(auto)

Once the array has completed synchronous replication it will display its status as online.

Arrays

Name

Status

Frozen At

Mediator Status

snt-m70-104-33

online

-

online

snt-x70r1-104-27

online

-

online



References

[SAP HANA Hardware and Software Requirements](#)

[SAP HANA Supported Operating Systems](#)

[SAP HANA Revision Strategy for HANA 1.0](#)

[//X Product Data Sheet](#)

[Purity//FA Data Sheet](#)

[Cloud Block Store Data Sheet](#)

[Purity ActiveCluster Data Sheet](#)

[How to perform system replication for SAP HANA](#)

[SAP HANA Backup types](#)

[SAP HANA Intel DC Optane Memory](#)

[SAP HANA multitenant database](#)

[Best practices for using snapshots in the vSphere environment](#)

[SAP HANA System replication](#)

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