SAP HANA backup and recovery with SnapCenter

NetApp solutions for SAP

NetApp
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SAP HANA backup and recovery with SnapCenter

TR-4614: SAP HANA backup and recovery with SnapCenter

Companies today require continuous, uninterrupted availability for their SAP applications. They expect consistent performance levels in the face of ever-increasing volumes of data and the need for routine maintenance tasks such as system backups. Performing backups of SAP databases is a critical task and can have a significant performance effect on the production SAP system.

Author: Nils Bauer, NetApp

Backup windows are shrinking, while the amount of data to be backed up is increasing. Therefore, it is difficult to find a time when backups can be performed with minimal effect on business processes. The time needed to restore and recover SAP systems is a concern, because downtime for SAP production and nonproduction systems must be minimized to reduce data loss and cost to the business.

The following points summarize the challenges facing SAP backup and recovery:

- **Performance effects on production SAP systems.** Typically, traditional copy-based backups create a significant performance drain on production SAP systems because of the heavy loads placed on the database server, the storage system, and the storage network.
- **Shrinking backup windows.** Conventional backups can only be made when few dialog or batch activities are in process on the SAP system. The scheduling of backups becomes more difficult when SAP systems are in use around the clock.
- **Rapid data growth.** Rapid data growth and shrinking backup windows require ongoing investment in backup infrastructure. In other words, you must procure more tape drives, additional backup disk space, and faster backup networks. You must also cover the ongoing expense of storing and managing these tape assets. Incremental or differential backups can address these issues, but this arrangement results in a very slow, cumbersome, and complex restore process that is harder to verify. Such systems usually increase recovery time objective (RTO) and recovery point objective (RPO) times in ways that are not acceptable to the business.
- **Increasing cost of downtime.** Unplanned downtime of an SAP system typically affects business finances. A significant part of any unplanned downtime is consumed by the requirement to restore and recover the SAP system. Therefore, the desired RTO dictates the design of the backup and recovery architecture.
- **Backup and recovery time for SAP upgrade projects.** The project plan for an SAP upgrade includes at least three backups of the SAP database. These backups significantly reduce the time available for the upgrade process. The decision to proceed is generally based on the amount of time required to restore and recover the database from the previously created backup. Rather than just restoring a system to its previous state, a rapid restore provides more time to solve problems that might occur during an upgrade.

The NetApp solution

NetApp Snapshot technology can be used to create database backups in minutes. The time needed to create a Snapshot copy is independent of the size of the database because a Snapshot copy does not move any physical data blocks on the storage platform. In addition, the use of Snapshot technology has no performance effect on the live SAP system because the NetApp Snapshot technology does not move or copy data blocks when the Snapshot copy is created or when data in the active file system is changed. Therefore, the creation

of Snapshot copies can be scheduled without considering peak dialog or batch activity periods. SAP and NetApp customers typically schedule multiple online Snapshot backups during the day; for example, every four hours is common. These Snapshot backups are typically kept for three to five days on the primary storage system before being removed.

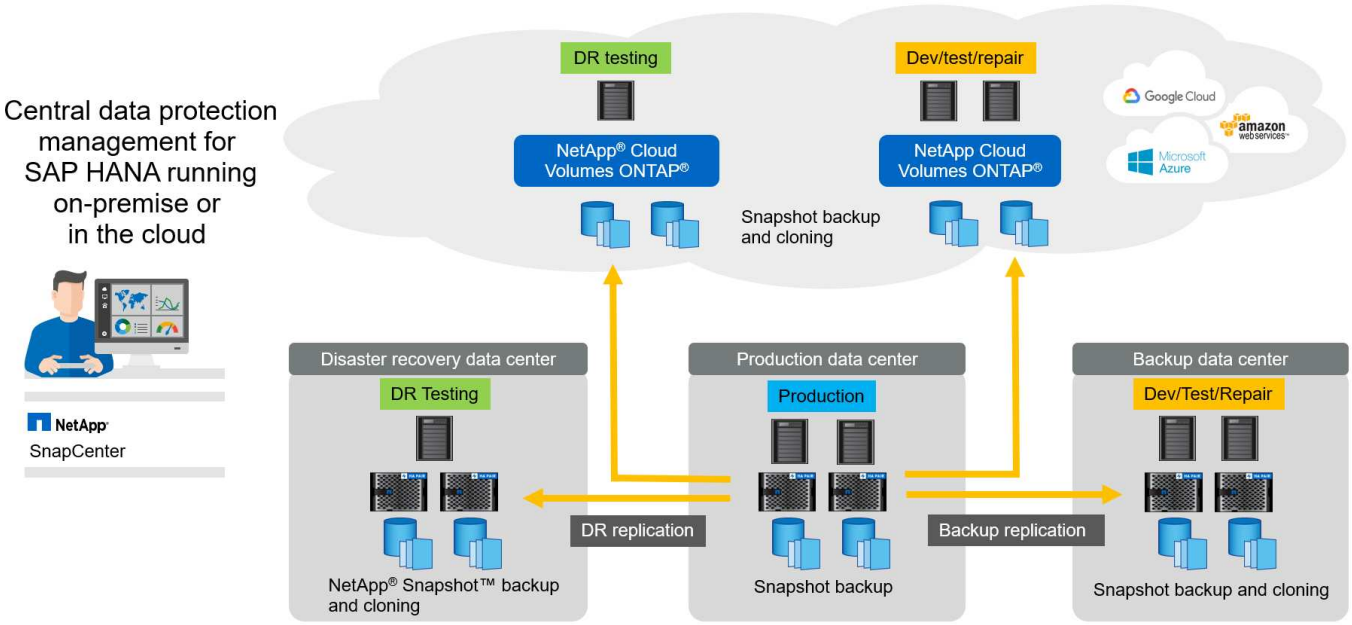
Snapshot copies also provide key advantages for restore and recovery operations. NetApp SnapRestore data recovery software enables the restore of an entire database or, alternatively, a portion of a database to any point in time, based on the available Snapshot copies. Such restore processes are finished in a few minutes, independent of the size of the database. Because several online Snapshot backups are created during the day, the time needed for the recovery process is significantly reduced relative to a traditional backup approach. Because a restore can be performed with a Snapshot copy that is only a few hours old (rather than up to 24 hours), fewer transaction logs must be applied. Therefore, the RTO is reduced to several minutes rather than the several hours required for conventional single-cycle tape backups.

Snapshot copy backups are stored on the same disk system as the active online data. Therefore, NetApp recommends using Snapshot copy backups as a supplement rather than a replacement for backups to a secondary location. Most restore and recovery actions are handled by using SnapRestore on the primary storage system. Restores from a secondary location are only necessary if the primary storage system containing the Snapshot copies is damaged. The secondary location can also be used if it is necessary to restore a backup that is no longer available from a Snapshot copy: a month-end backup, for example.

A backup to a secondary location is based on Snapshot copies created on the primary storage. Therefore, the data is read directly from the primary storage system without generating load on the SAP database server. The primary storage communicates directly with the secondary storage and sends the backup data to the destination by using a NetApp SnapVault disk-to-disk backup.

SnapVault offers significant advantages when compared to traditional backups. After an initial data transfer, in which all data has been transferred from the source to the destination, all subsequent backups copy only the changed blocks to the secondary storage. Therefore, the load on the primary storage system and the time needed for a full backup are significantly reduced. Because SnapVault stores only the changed blocks at the destination, a full database backup requires less disk space.

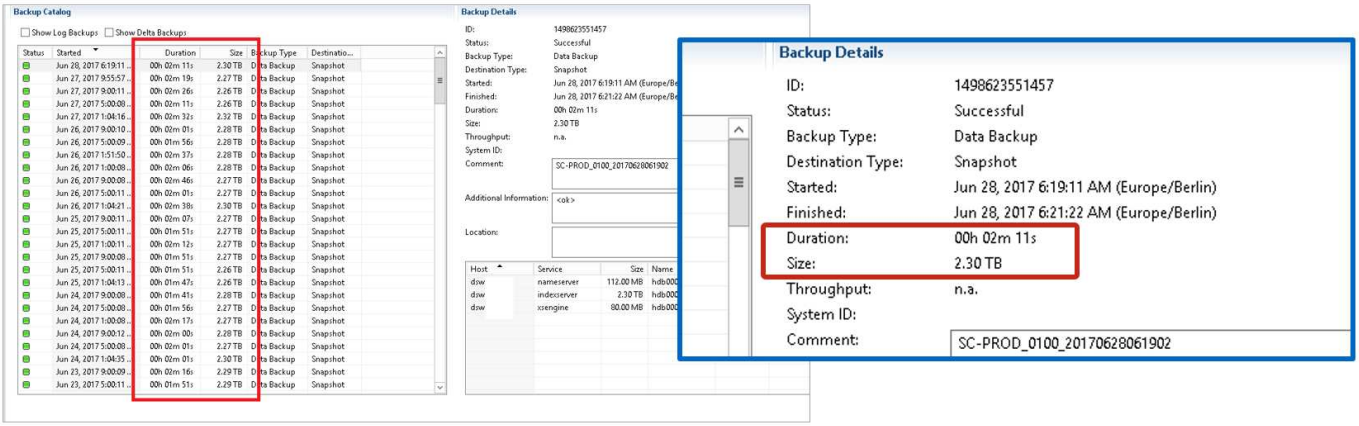
The solution can also be seamlessly extended to a hybrid cloud operation model. Data replication for disaster recovery or offsite backup purposes can be done from on-premises NetApp ONTAP systems to Cloud Volumes ONTAP instances running in the cloud. You can use SnapCenter as a central tool to manage the data protection and data replication, independent if the SAP HANA system run on-premises or in the cloud. The following figure shows an overview of the backup solution.



Runtime of Snapshot backups

The next screenshot shows a customer's HANA Studio running SAP HANA on NetApp storage. The customer is using Snapshot copies to back up the HANA database. The image shows that the HANA database (approximately 2.3TB in size) is backed up in 2 minutes and 11 seconds by using Snapshot backup technology.

The largest part of the overall backup workflow runtime is the time needed to execute the HANA backup savepoint operation, and this step is dependent on the load on the HANA database. The storage Snapshot backup itself always finishes in a couple of seconds.



Recovery time objective comparison

This section provides an RTO comparison of file-based and storage-based Snapshot backups. The RTO is defined by the sum of the time needed to restore the database and the time needed to start and recover the database.

Time needed to restore database

With a file-based backup, the restore time depends on the size of the database and backup infrastructure, which defines the restore speed in megabytes per second. For example, if the infrastructure supports a restore

operation at a speed of 250MBps, it takes approximately 1 hour and 10 minutes to restore a database 1TB in size.

With storage Snapshot copy backups, the restore time is independent of the size of the database and is in the range of a couple of seconds when the restore can be performed from primary storage. A restore from secondary storage is only required in the case of a disaster when the primary storage is no longer available.

Time needed to start database

The database start time depends on the size of the row and column store. For the column store, the start time also depends on how much data is preloaded during the database start. In the following examples, we assume that the start time is 30 minutes. The start time is the same for a file-based restore and recovery and a restore and recovery based on Snapshot.

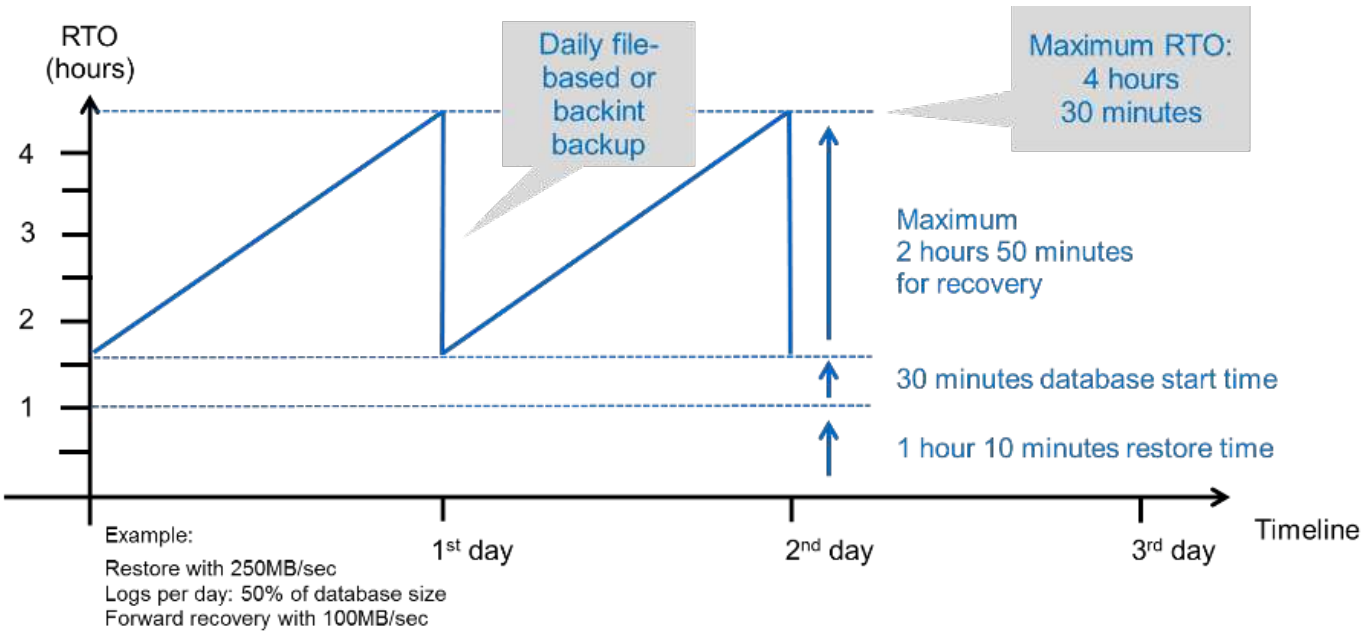
Time needed to recover database

The recovery time depends on the number of logs that must be applied after the restore. This number is determined by the frequency at which data backups are taken.

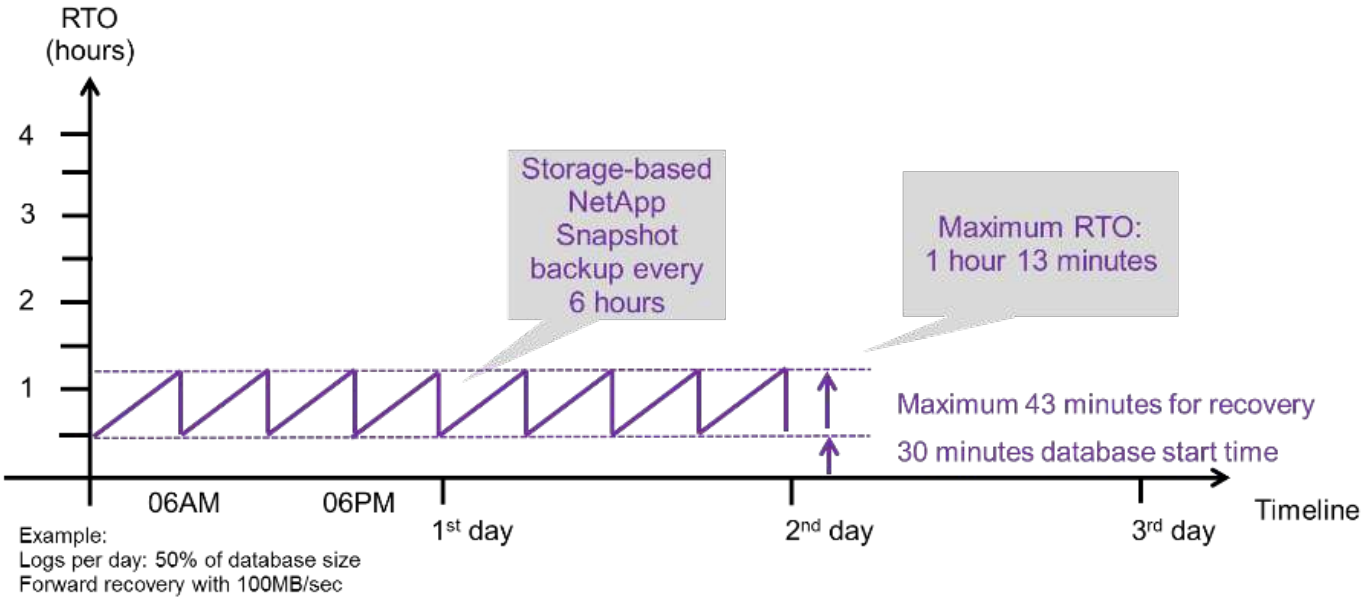
With file-based data backups, the backup schedule is typically once per day. A higher backup frequency is normally not possible, because the backup degrades production performance. Therefore, in the worst case, all the logs that were written during the day must be applied during forward recovery.

Storage Snapshot copy data backups are typically scheduled with a higher frequency because they do not influence the performance of the SAP HANA database. For example, if Snapshot copy backups are scheduled every six hours, the recovery time would be, in the worst case, one-fourth of the recovery time for a file-based backup (6 hours / 24 hours = ¼).

The following figure shows an RTO example for a 1TB database when file-based data backups are used. In this example, a backup is taken once per day. The RTO differs depending on when the restore and recovery were performed. If the restore and recovery were performed immediately after a backup was taken, the RTO is primarily based on the restore time, which is 1 hour and 10 minutes in the example. The recovery time increased to 2 hours and 50 minutes when restore and recovery were performed immediately before the next backup was taken, and the maximum RTO was 4 hours and 30 minutes.

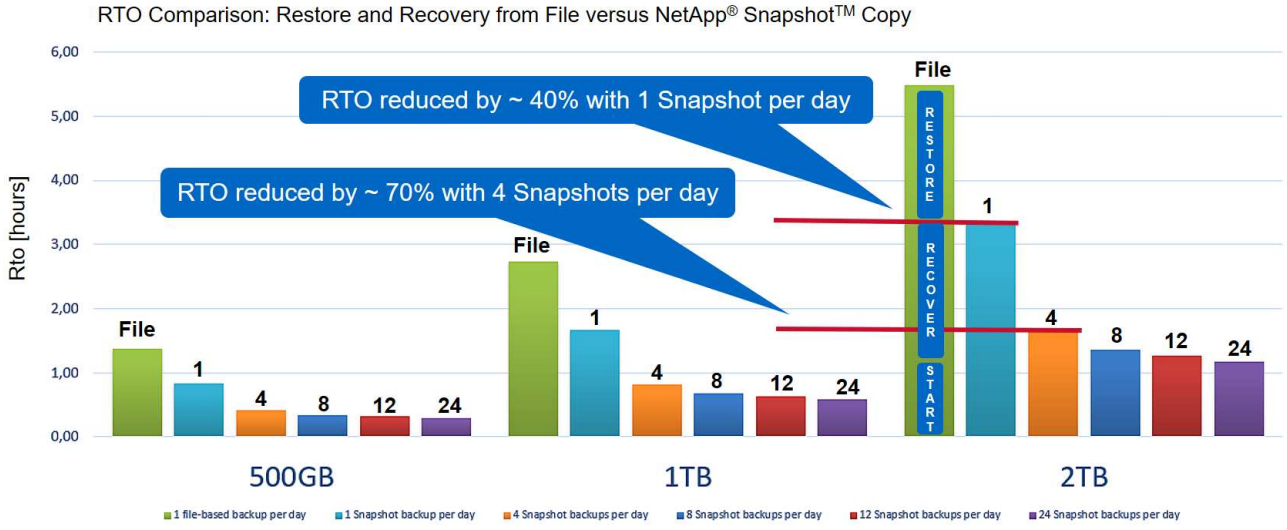


The following figure shows an RTO example for a 1TB database when Snapshot backups are used. With storage-based Snapshot backups, the RTO only depends on the database start time and the forward recovery time because the restore is completed in a few seconds, independent of the size of the database. The forward recovery time also increases depending on when the restore and recovery are done, but due to the higher frequency of backups (every six hours in this example), the forward recovery time is 43 minutes at most. In this example, the maximum RTO is 1 hour and 13 minutes.



The following figure shows an RTO comparison of file-based and storage-based Snapshot backups for different database sizes and different frequencies of Snapshot backups. The green bar shows the file-based backup. The other bars show Snapshot copy backups with different backup frequencies.

With a single Snapshot copy data backup per day, the RTO is already reduced by 40% when compared to a file-based data backup. The reduction increases to 70% when four Snapshot backups are taken per day. The figure also shows that the curve goes flat if you increase the Snapshot backup frequency to more than four to six Snapshot backups per day. Our customers therefore typically configure four to six Snapshot backups per day.



Assumptions: Restore from file with 250MB/sec; database start with 400MB/s; log files per day: 50% of database size; forward recovery with 250MB/sec

The graph shows the HANA server RAM size. The database size in memory is calculated to be half of the server RAM size.

The restore and recovery time is calculated based on the following assumptions. The database can be restored at 250MBps. The number of log files per day is 50% of the database size. For example, a 1TB database creates 500MB of log files per day. A recovery can be performed at 100MBps.

SnapCenter architecture

SnapCenter is a unified, scalable platform for application-consistent data protection. SnapCenter provides centralized control and oversight, while delegating the ability for users to manage application-specific backup, restore, and clone jobs. With SnapCenter, database and storage administrators learn a single tool to manage backup, restore, and cloning operations for a variety of applications and databases.

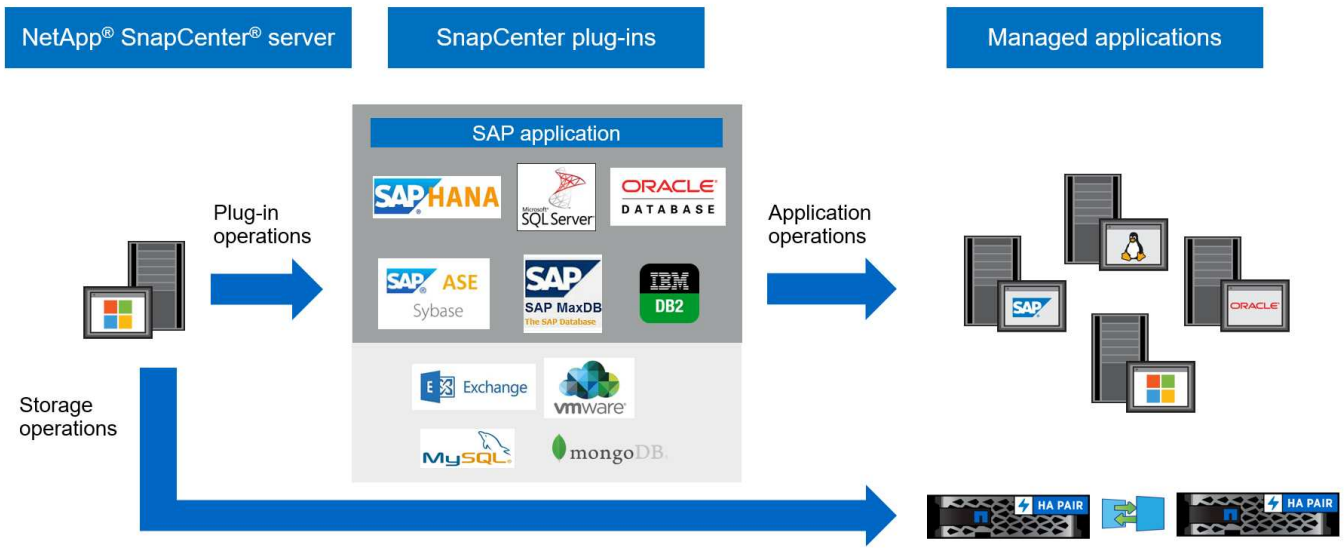
SnapCenter manages data across endpoints in the data fabric powered by NetApp. You can use SnapCenter to replicate data between on-premises environments; between on-premises environments and the cloud; and between private, hybrid, or public clouds.

SnapCenter components

SnapCenter includes the SnapCenter Server, the SnapCenter Plug-In Package for Windows, and the SnapCenter Plug-Ins Package for Linux. Each package contains plug-ins to SnapCenter for various applications and infrastructure components.

The SnapCenter custom plug-ins enable you to create your own plug-ins and protect your application using the same SnapCenter interface.

The following figure depicts SnapCenter components.



SnapCenter SAP HANA backup solution

This section lists the components, supported SAP HANA releases and configurations, and SnapCenter 4.6 enhancements used in this solution.

Solution components

The SnapCenter backup solution for SAP HANA covers the following areas:

- SAP HANA data backup with storage-based Snapshot copies:
  - Backup scheduling
  - Retention management
  - Housekeeping of the SAP HANA backup catalog
- Non-data volume (for example, `/hana/shared`) backup with storage-based Snapshot copies:
  - Backup scheduling
  - Retention management
- Replication to an off-site backup or disaster recovery location:
  - SAP HANA data Snapshot backups
  - Non-data volumes
  - Retention management configured at off-site backup storage
  - Housekeeping of the SAP HANA backup catalog
- Database block integrity checks using a file-based backup:
  - Backup scheduling
  - Retention management
  - Housekeeping of the SAP HANA backup catalog
- Retention management of HANA database log backup:
  - Retention management based on data backup retention
  - Housekeeping of the SAP HANA backup catalog
- Automatic discovery of HANA databases
- Automated restore and recovery
- Single-tenant restore operations with SAP HANA multitenant database container (MDC) systems

Database data file backups are executed by SnapCenter in combination with the plug-in for SAP HANA. The plug-in triggers an SAP HANA database backup save point so that the Snapshot copies, which are created on the primary storage system, are based on a consistent image of the SAP HANA database.

SnapCenter enables the replication of consistent database images to an off-site backup or disaster recovery location by using SnapVault or the NetApp SnapMirror. feature. Typically, different retention policies are defined for backups at primary and at the off-site backup storage. SnapCenter handles the retention at primary storage, and ONTAP handles the retention at the off-site backup storage.

To allow a complete backup of all SAP HANA-related resources, SnapCenter also allows you to back up all non- data volumes using the SAP HANA plug-in with storage-based Snapshot copies. Non-data volumes can be scheduled independently from the database data backup to enable individual retention and protection

policies.

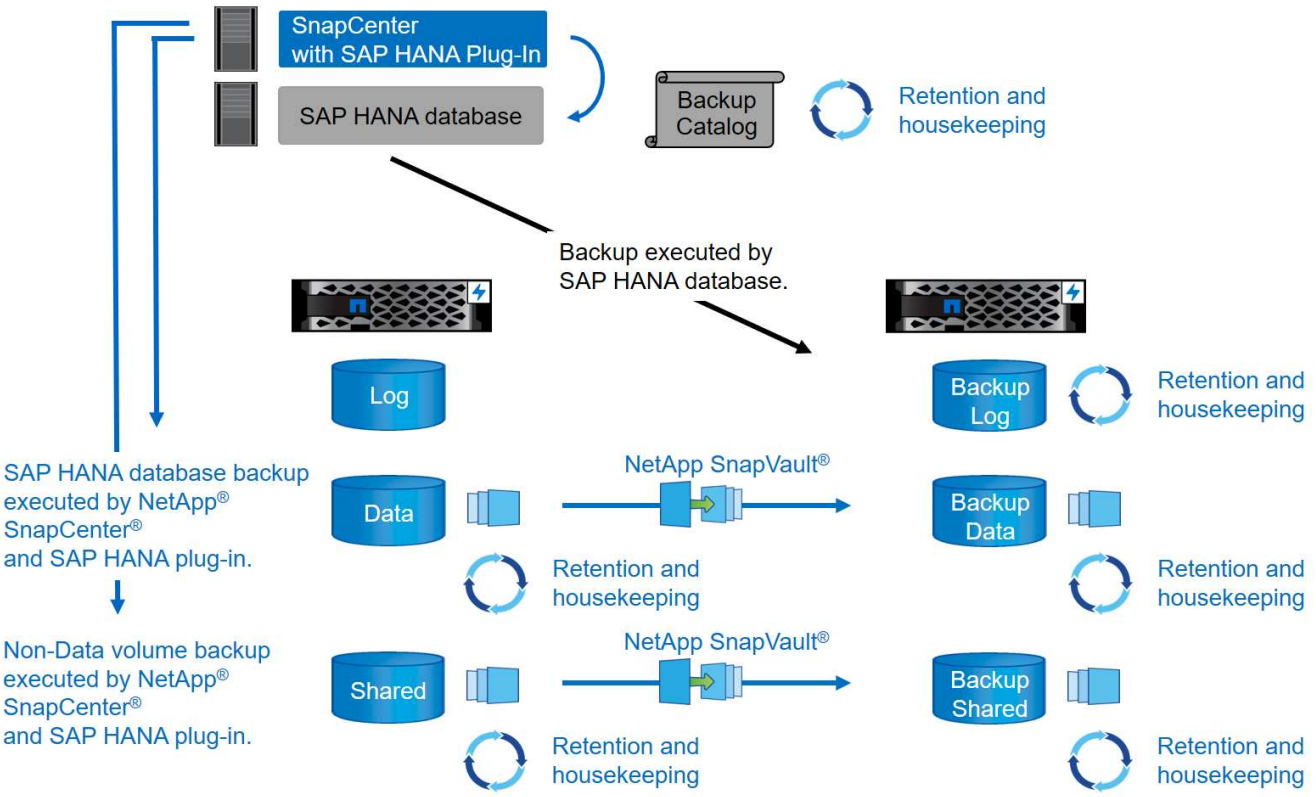
The SAP HANA database automatically executes log backups. Depending on the recovery point objectives, there are several options for the storage location of the log backups:

- The log backup is written to a storage system that synchronously mirrors the data to a second location with NetApp MetroCluster high-availability (HA) and disaster recovery storage software.
- The log backup destination can be configured on the same primary storage system and then replicated synchronously or asynchronously to a secondary storage with SnapMirror.
- The log backup destination can be configured on the same off-site backup storage in which the database backups are replicated with SnapVault. With this configuration, the off-site backup storage has availability requirements like those of the primary storage so that log backups can be written to the off-site backup storage.

SAP recommends combining storage-based Snapshot backups with a weekly file-based backup to execute a block integrity check. The block integrity check can be executed from within SnapCenter. Based on your configurable retention policies, SnapCenter manages the housekeeping of data file backups at the primary storage, log file backups, and the SAP HANA backup catalog.

SnapCenter handles the retention at primary storage, while ONTAP manages secondary backup retention.

The following figure shows an overview of the database and log backup configuration, where the log backups are written to an NFS mount of the off-site backup storage.



When executing a storage-based Snapshot backup of non-data volumes, SnapCenter performs the following tasks:

1. Creation of a storage Snapshot copy of the non-data volume.

2. Execution of a SnapVault or SnapMirror update for the data volume, if configured.
3. Deletion of storage Snapshot copies at the primary storage based on the defined retention policy.

When executing a storage-based Snapshot backup of the SAP HANA database, SnapCenter performs the following tasks:

1. Creation of an SAP HANA backup save point to create a consistent image on the persistence layer.
2. Creation of a storage Snapshot copy of the data volume.
3. Registration of the storage Snapshot back up in the SAP HANA backup catalog.
4. Release of the SAP HANA backup save point.
5. Execution of a SnapVault or SnapMirror update for the data volume, if configured.
6. Deletion of storage Snapshot copies at the primary storage based on the defined retention policy.
7. Deletion of SAP HANA backup catalog entries if the backups do not exist anymore at the primary or off-site backup storage.
8. Whenever a backup has been deleted based on the retention policy or manually, SnapCenter deletes all log backups that are older than the oldest data backup. Log backups are deleted on the file system and in the SAP HANA backup catalog.

Supported SAP HANA releases and configurations

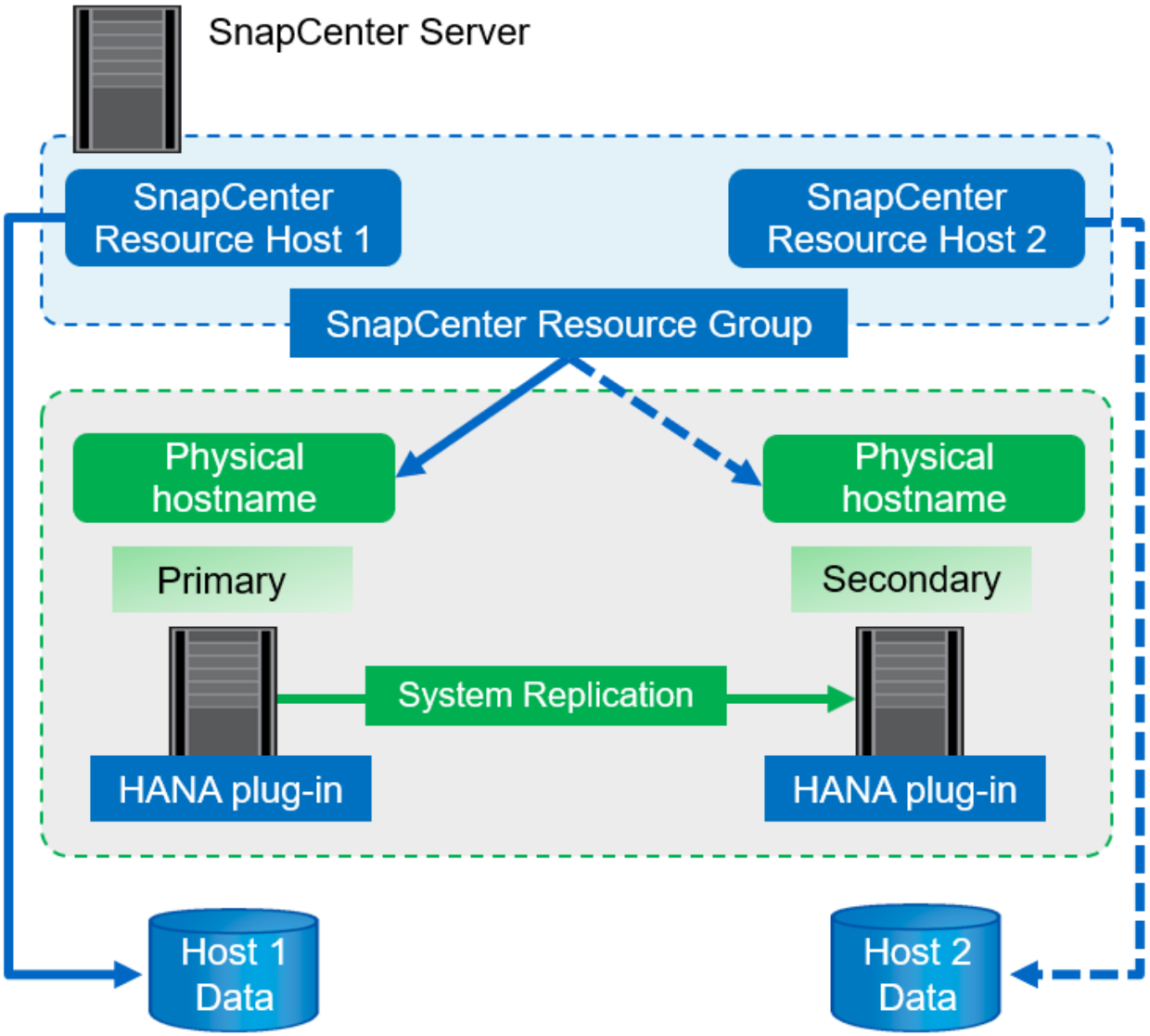
SnapCenter supports SAP HANA single-host and multiple-host configurations using NFS- or FC-attached NetApp storage systems (AFF and FAS), as well as SAP HANA systems running on Cloud Volumes ONTAP at AWS, Azure, the Google Cloud Platform, and AWS FSx ONTAP using NFS.

SnapCenter supports the following SAP HANA architectures and releases:

- SAP HANA single container: SAP HANA 1.0 SPS12
- SAP HANA multitenant-database container (MDC) single tenant: SAP HANA 2.0 SPS3 and later
- SAP HANA multitenant-database container (MDC) multiple tenants: SAP HANA 2.0 SPS4 and later

SnapCenter 4.6 enhancements

Starting with version 4.6, SnapCenter supports auto-discovery of HANA systems configured in a HANA System Replication relationship. Each host is configured using its physical IP address (host name) and its individual data volume on the storage layer. The two SnapCenter resources are combined in a resource group, SnapCenter automatically identifies which host is primary or secondary, and it then executes the required backup operations accordingly. Retention management for Snapshot and file-based backups created with SnapCenter is performed across both hosts to ensure that old backups are also deleted at the current secondary host. The following figure shows a high-level overview. A detailed description of the configuration and operation of HANA System Replication-enabled HANA systems in SnapCenter can be found in TR-4719 SAP HANA System Replication, Backup and Recovery with SnapCenter.



SnapCenter concepts and best practices

This section describes SnapCenter concepts and best practices as they relate to SAP HANA resource configuration and deployment.

SAP HANA resource configuration options and concepts

With SnapCenter, SAP HANA database resource configuration can be performed with two different approaches.

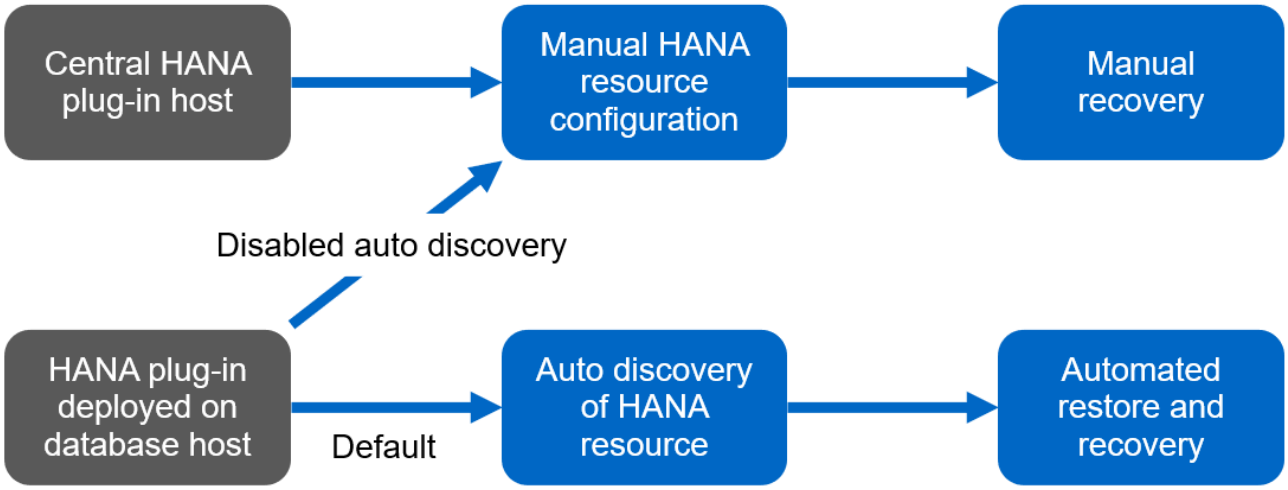
- **Manual resource configuration.** HANA resource and storage footprint information must be provided manually.
- **Automatic discovery of HANA resources.** Automatic discovery simplifies the configuration of HANA databases in SnapCenter and enables automated restore and recovery.

It is important to understand that only HANA database resources in SnapCenter that have been automatically discovered are enabled for automated restore and recovery. HANA database resources that are configured manually in SnapCenter must be recovered manually after a restore operation in SnapCenter.

On the other hand, automatic discovery with SnapCenter is not supported for all HANA architectures and infrastructure configurations. Therefore, HANA landscapes might require a mixed approach in which some HANA systems (HANA multiple host systems) require manual resource configuration and all others can be configured using automatic discovery.

Automatic discovery and automated restore and recovery depend on the ability to execute OS commands on the database host. Examples of this are file system and storage footprint discovery, and unmount, mount, or LUN discovery operations. These operations are executed with the SnapCenter Linux plug-in, which is automatically deployed together with the HANA plug-in. Therefore, it is prerequisite to deploy the HANA plug-in on the database host to enable automatic discovery as well as automated restore and recovery. It is also possible to disable the auto discovery after the deployment of the HANA plug-in on the database host. In this instance, the resource will be a manually configured resource.

The following figure summarizes the dependencies. More details on the HANA deployment options are covered in the section “Deployment options for the SAP HANA plug-in.”



The HANA and Linux plug-ins are currently only available for Intel-based systems. If the HANA databases are running on IBM Power Systems, a central HANA plug-in host must be used.

Supported HANA architectures for automatic discovery and automated recovery

With SnapCenter, automatic discovery and automated restore and recovery is supported for most HANA configurations with the exception that HANA multiple host systems require a manual configuration.

The following table shows supported HANA configurations for automatic discovery.

HANA plug-in installed on:	HANA architecture	HANA system configuration	Infrastructure
HANA database host	Single host	• HANA single container • SAP HANA multitenant database containers (MDC) with single or multiple tenants • HANA System Replication	• Bare metal with NFS • Bare metal with XFS and FC with or without Linux Logical Volume Manager (LVM) • VMware with direct OS NFS mounts

HANA MDC systems with multiple tenants are supported for automatic discovery, but not for automated restore and recovery with the current SnapCenter release.

Supported HANA architectures for manual HANA resource configuration

Manual configuration of HANA resources is supported for all HANA architectures; however, it requires a central HANA plug-in host. The central plug-in host can be the SnapCenter server itself or a separate Linux or Windows host.

When the HANA plug-in is deployed on the HANA database host, by default, the resource is auto discovered. Auto discovery can be disabled for individual hosts, so that the plug-in can be deployed; for example, on a database host with activated HANA System Replication and a SnapCenter release < 4.6, where auto discovery is not supported. For more information, see the section “Disable auto discovery on the HANA plug-in host.”

The following table shows supported HANA configurations for manual HANA resource configuration.

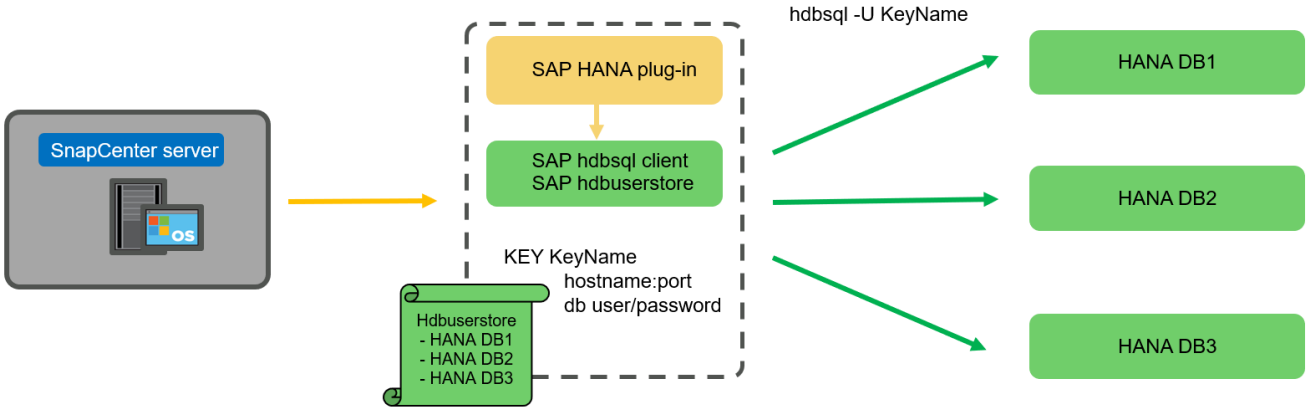
HANA Plug-In installed on:	HANA architecture	HANA system configuration	Infrastructure
Central plug-in host (SnapCenter Server or separate Linux host)	Single or multiple host	• HANA single container • HANA MDC with single or multiple tenants • HANA System Replication	• Bare metal with NFS • Bare metal with XFS and FC with or without Linux LVM • VMware with direct OS NFS mounts

Deployment options for the SAP HANA plug-in

The following figure shows the logical view and the communication between the SnapCenter Server and the SAP HANA databases.

The SnapCenter Server communicates through the SAP HANA plug-in with the SAP HANA databases. The SAP HANA plug-in uses the SAP HANA hdbsql client software to execute SQL commands to the SAP HANA databases. The SAP HANA hdbuserstore is used to provide the user credentials, the host name, and the port

information to access the SAP HANA databases.



The SAP HANA plug-in and the SAP hdbsql client software, which include the hdbuserstore configuration tool, must be installed together on the same host.

The host can be the SnapCenter Server itself, a separate central plug-in host, or the individual SAP HANA database hosts.

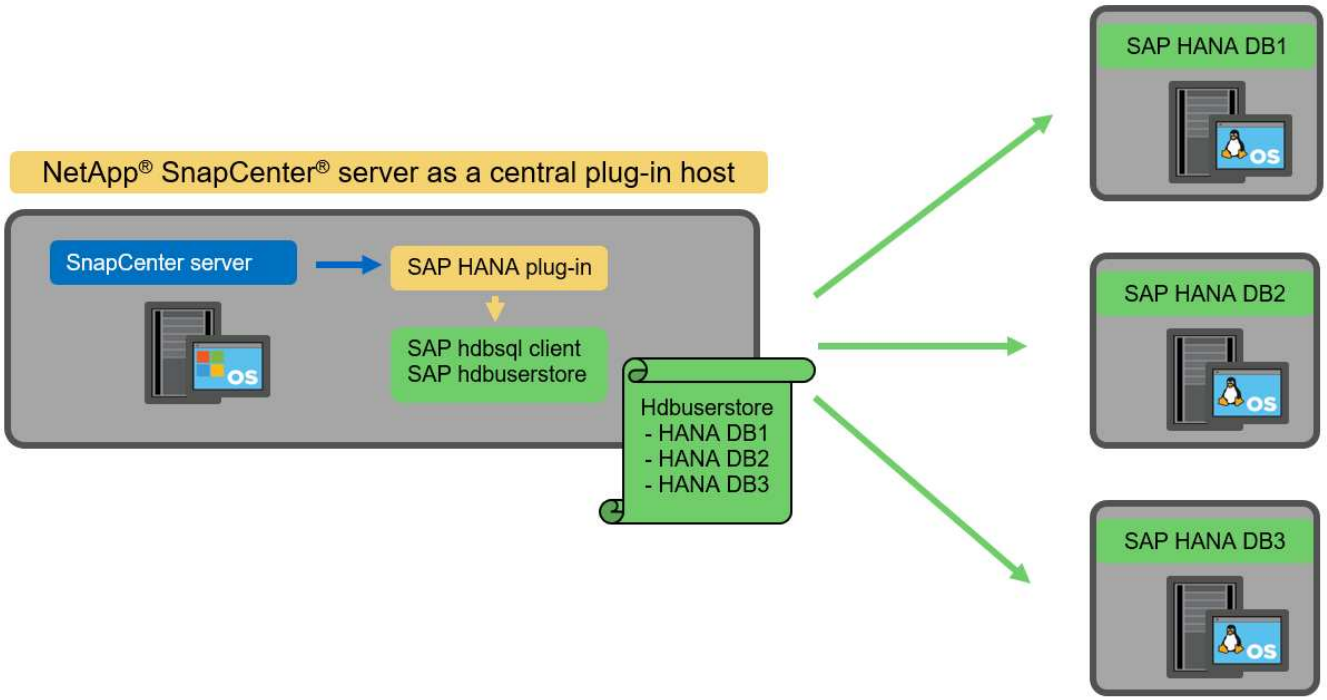
SnapCenter server high availability

SnapCenter can be set up in a two-node HA configuration. In such a configuration, a load balancer (for example, F5) is used in an active/passive mode using a virtual IP address pointing to the active SnapCenter host. The SnapCenter repository (the MySQL database) is replicated by SnapCenter between the two hosts so that the SnapCenter data is always in-sync.

SnapCenter server HA is not supported if the HANA plug-in is installed on the SnapCenter server. If you plan to set up SnapCenter in an HA configuration, do not install the HANA plug-in on the SnapCenter server. More details on SnapCenter HA can be found at this NetApp Knowledge Base page.

SnapCenter server as a central HANA plug-in host

The following figure shows a configuration in which the SnapCenter Server is used as a central plug-in host. The SAP HANA plug-in and the SAP hdbsql client software are installed on the SnapCenter Server.



Since the HANA plug-in can communicate with the managed HANA databases using the hdbclient through the network, you do not need to install any SnapCenter components on the individual HANA database hosts. SnapCenter can protect the HANA databases by using a central HANA plug-in host on which all userstore keys are configured for the managed databases.

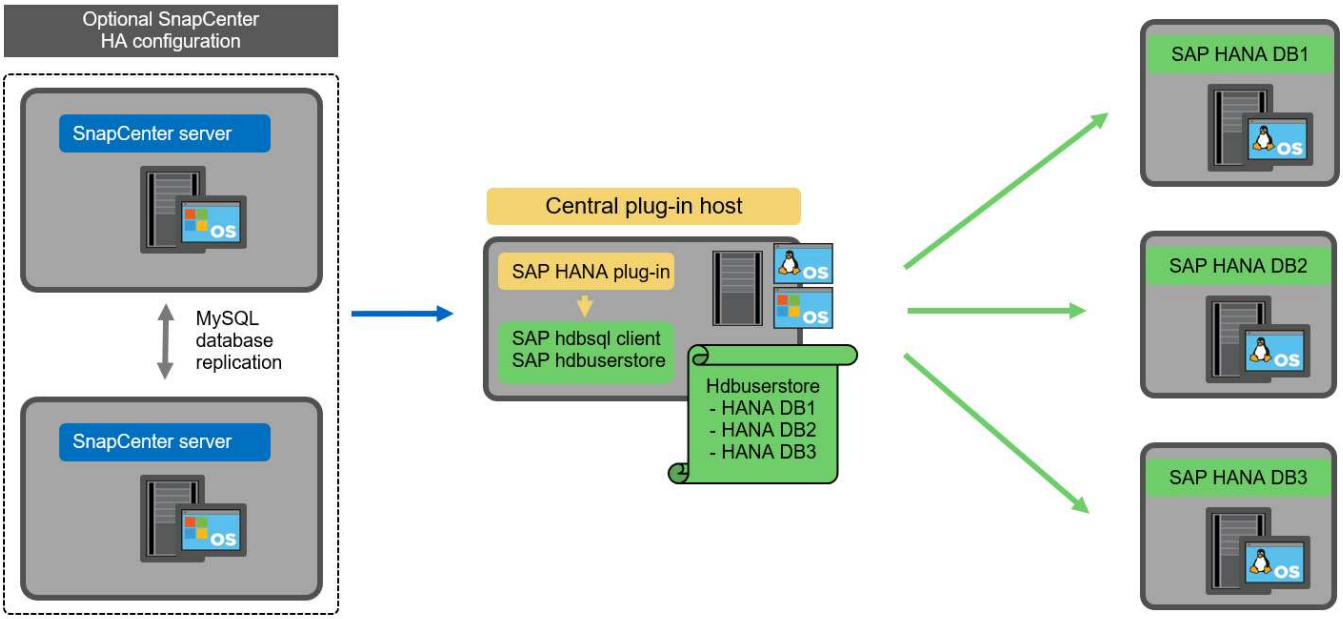
On the other hand, enhanced workflow automation for automatic discovery, automation of restore and recovery, as well as SAP system refresh operations require SnapCenter components to be installed on the database host. When using a central HANA plug-in host, these features are not available.

Also, high availability of the SnapCenter server using the in-build HA feature cannot be used when the HANA plug-in is installed on the SnapCenter server. High availability can be achieved using VMware HA if the SnapCenter server is running in a VM within a VMware cluster.

Separate host as a central HANA plug-in host

The following figure shows a configuration in which a separate Linux host is used as a central plug-in host. In this case, the SAP HANA plug-in and the SAP hdbsql client software are installed on the Linux host.

The separate central plug-in host can also be a Windows host.

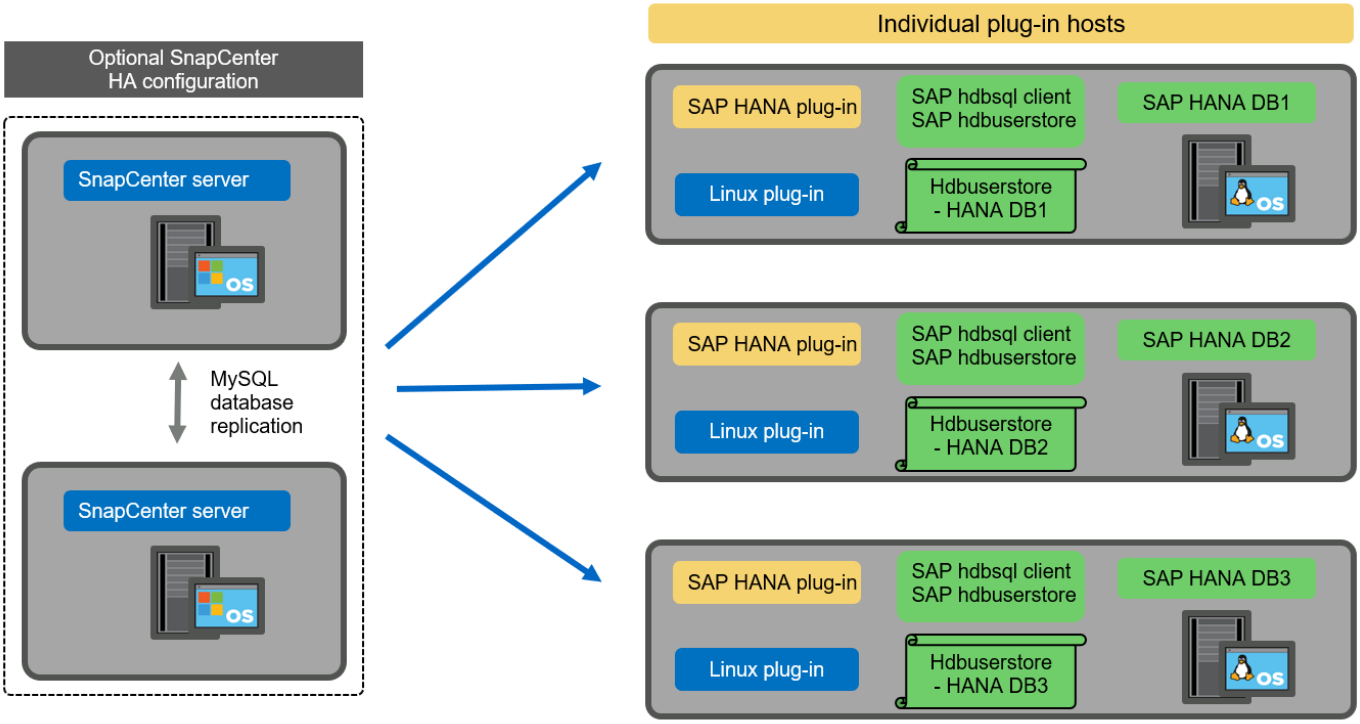


The same restriction regarding feature availability described in the previous section also applies for a separate central plug-in host.

However, with this deployment option the SnapCenter server can be configured with the in-build HA functionality. The central plug-in host must also be HA, for example, by using a Linux cluster solution.

HANA plug-in deployed on individual HANA database hosts

The following figure shows a configuration in which the SAP HANA plug-in is installed on each SAP HANA database host.



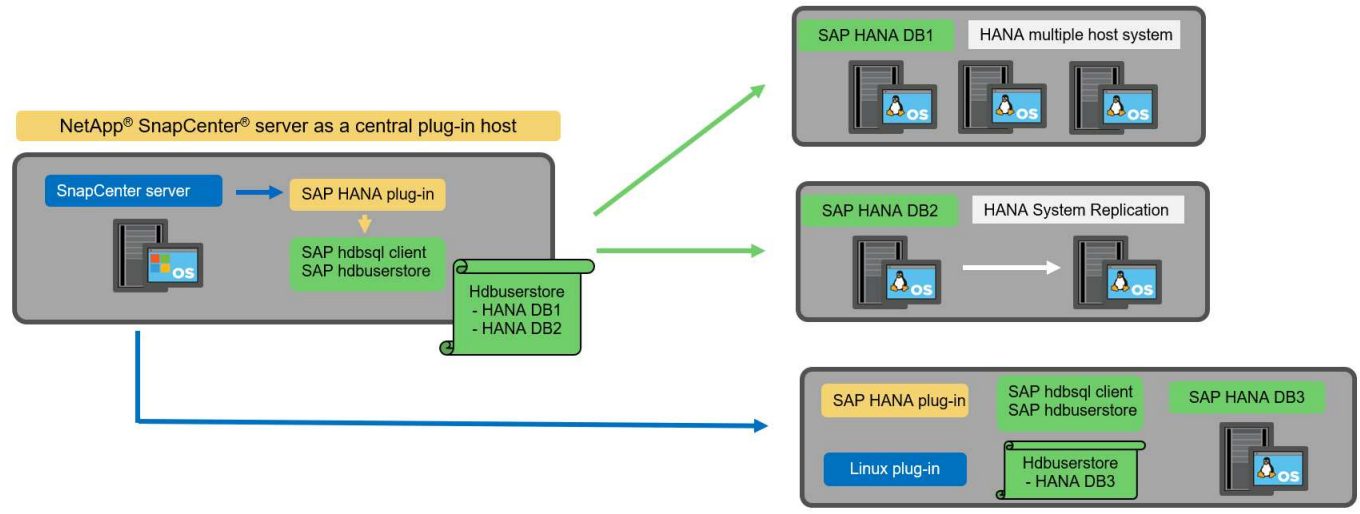
When the HANA plug-in is installed on each individual HANA database host, all features, such as automatic discovery and automated restore and recovery, are available. Also, the SnapCenter server can be set up in an HA configuration.

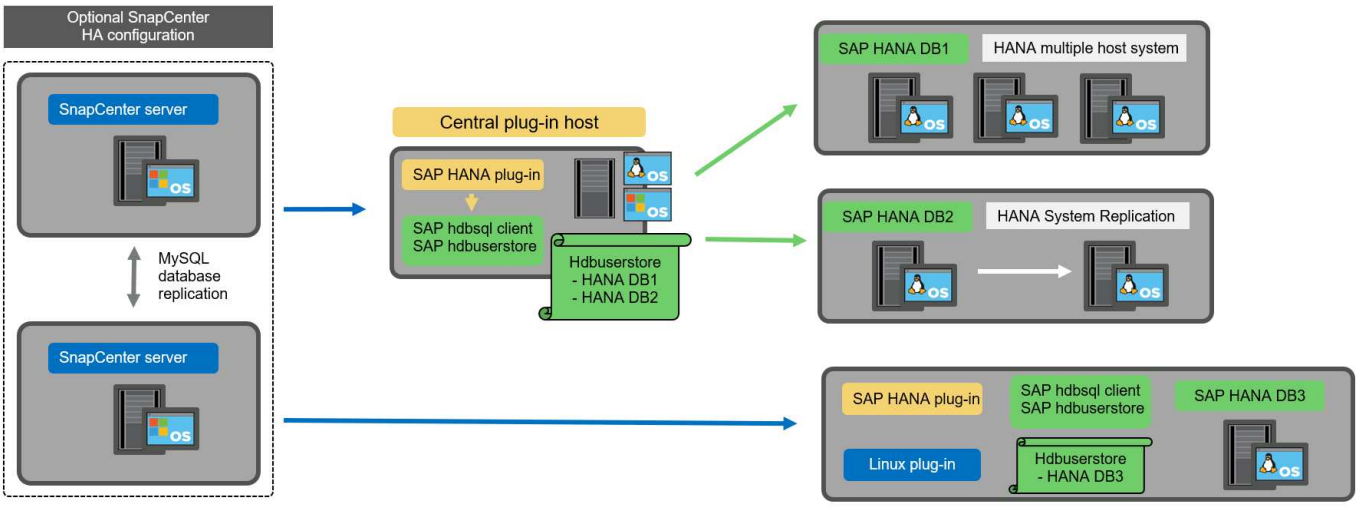
Mixed HANA plug-in deployment

As discussed at the beginning of this section, some HANA system configurations, such as multiple-host systems, require a central plug-in host. Therefore, most SnapCenter configurations require a mixed deployment of the HANA plug-in.

NetApp recommends that you deploy the HANA plug-in on the HANA database host for all HANA system configurations that are supported for automatic discovery. Other HANA systems, such as multiple-host configurations, should be managed with a central HANA plug-in host.

The following two figures show mixed plug-in deployments either with the SnapCenter server or a separate Linux host as a central plug-in host. The only difference between these two deployments is the optional HA configuration.





Summary and recommendations

In general, NetApp recommends that you deploy the HANA plug-in on each SAP HANA host to enable all

available SnapCenter HANA features and to enhance workflow automation.

> The HANA and Linux plug-ins are currently only available for Intel- based systems. If the HANA databases are running on IBM Power Systems, a central HANA plug-in host must be used.

For HANA configurations in which automatic discovery is not supported, such as HANA multiple-host configurations, an additional central HANA plug-in host must be configured. The central plug-in host can be the SnapCenter server if VMware HA can be leveraged for SnapCenter HA. If you plan to use the SnapCenter in-build HA capability, use a separate Linux plug-in host.

The following table summarizes the different deployment options.

Deployment option	Dependencies
Central HANA plug-in host Plug-in installed on SnapCenter server	Pros: * Single HANA plug-in, central HDB user store configuration * No SnapCenter software components required on individual HANA database hosts * Support of all HANA architectures Cons: * Manual resource configuration * Manual recovery * No single tenant restore support * Any Pre- and post-script steps are executed on the central plug-in host * In-build SnapCenter high availability not supported * Combination of SID and tenant name must be unique across all managed HANA databases * Log backup retention management enabled/disabled for all managed HANA databases
Central HANA plug-in host Plug-in installed on separate Linux or Windows server	Pros: * Single HANA plug-in, central HDB user store configuration * No SnapCenter software components required on individual HANA database hosts * Support of all HANA architectures * In-build SnapCenter high availability supported Cons: * Manual resource configuration * Manual recovery * No single tenant restore support * Any Pre- and post-script steps are executed on the central plug-in host * Combination of SID and tenant name must be unique across all managed HANA databases * Log backup retention management enabled/disabled for all managed HANA databases

Deployment option	Dependencies
Individual HANA plug-in host Plug-in installed on HANA database server	Pros: * Automatic discovery of HANA resources * Automated restore and recovery * Single tenant restore * Pre- and post-script automation for SAP system refresh * In-build SnapCenter high availability supported * Log backup retention management can be enabled/disabled for each individual HANA database Cons: * Not supported for all HANA architectures. Additional central plug-in host required, for HANA multiple host systems. * HANA plug-in must be deployed on each HANA database hosts

Data protection strategy

Before configuring SnapCenter and the SAP HANA plug-in, the data protection strategy must be defined based on the RTO and RPO requirements of the various SAP systems.

A common approach is to define system types such as production, development, test, or sandbox systems. All SAP systems of the same system type typically have the same data protection parameters.

The parameters that must be defined are:

- How often should a Snapshot backup be executed?
- How long should Snapshot copy backups be kept on the primary storage system?
- How often should a block integrity check be executed?
- Should the primary backups be replicated to an off-site backup site?
- How long should the backups be kept at the off-site backup storage?

The following table shows an example of data protection parameters for the system type's production, development, and test. For the production system, a high backup frequency has been defined, and the backups are replicated to an off-site backup site once per day. The test systems have lower requirements and no replication of the backups.

Parameters	Production systems	Development systems	Test systems
Backup frequency	Every 4 hours	Every 4 hours	Every 4 hours
Primary retention	2 days	2 days	2 days
Block integrity check	Once per week	Once per week	No
Replication to off-site backup site	Once per day	Once per day	No
Off-site backup retention	2 weeks	2 weeks	Not applicable

The following table shows the policies that must be configured for the data protection parameters.

Parameters	PolicyLocalSnap	PolicyLocalSnapAndSnapVault	PolicyBlockIntegrityCheck
Backup type	Snapshot based	Snapshot based	File based
Schedule frequency	Hourly	Daily	Weekly
Primary retention	Count = 12	Count = 3	Count = 1
SnapVault replication	No	Yes	Not applicable

The policy `LocalSnapshot` is used for the production, development, and test systems to cover the local Snapshot backups with a retention of two days.

In the resource protection configuration, the schedule is defined differently for the system types:

- **Production.** Schedule every 4 hours.
- **Development.** Schedule every 4 hours.
- **Test.** Schedule every 4 hours.

The policy `LocalSnapAndSnapVault` is used for the production and development systems to cover the daily replication to the off-site backup storage.

In the resource protection configuration, the schedule is defined for production and development:

- **Production.** Schedule every day.
- **Development.** Schedule every day.

The policy `BlockIntegrityCheck` is used for the production and development systems to cover the weekly block integrity check using a file-based backup.

In the resource protection configuration, the schedule is defined for production and development:

- **Production.** Schedule every week.
- **Development.** Schedule every week.

For each individual SAP HANA database that uses the off-site backup policy, a protection relationship must be configured on the storage layer. The protection relationship defines which volumes are replicated and the retention of backups at the off-site backup storage.

With our example, for each production and development system, a retention of two weeks is defined at the off-site backup storage.

In our example, protection policies and retention for SAP HANA database resources and non-data volume resources are not different.

Backup operations

SAP introduced the support of Snapshot backups for MDC multiple tenant systems with HANA 2.0 SPS4. SnapCenter supports Snapshot backup operations of HANA MDC systems with multiple tenants. SnapCenter also supports two different restore operations of a HANA MDC system. You can either restore the complete system, the System DB and all tenants, or you can restore just a single tenant. There are some pre-requisites to enable SnapCenter to execute these operations.

In an MDC System, the tenant configuration is not necessarily static. Tenants can be added or tenants can be deleted. SnapCenter cannot rely on the configuration that is discovered when the HANA database is added to SnapCenter. SnapCenter must know which tenants are available at the point in time the backup operation is executed.

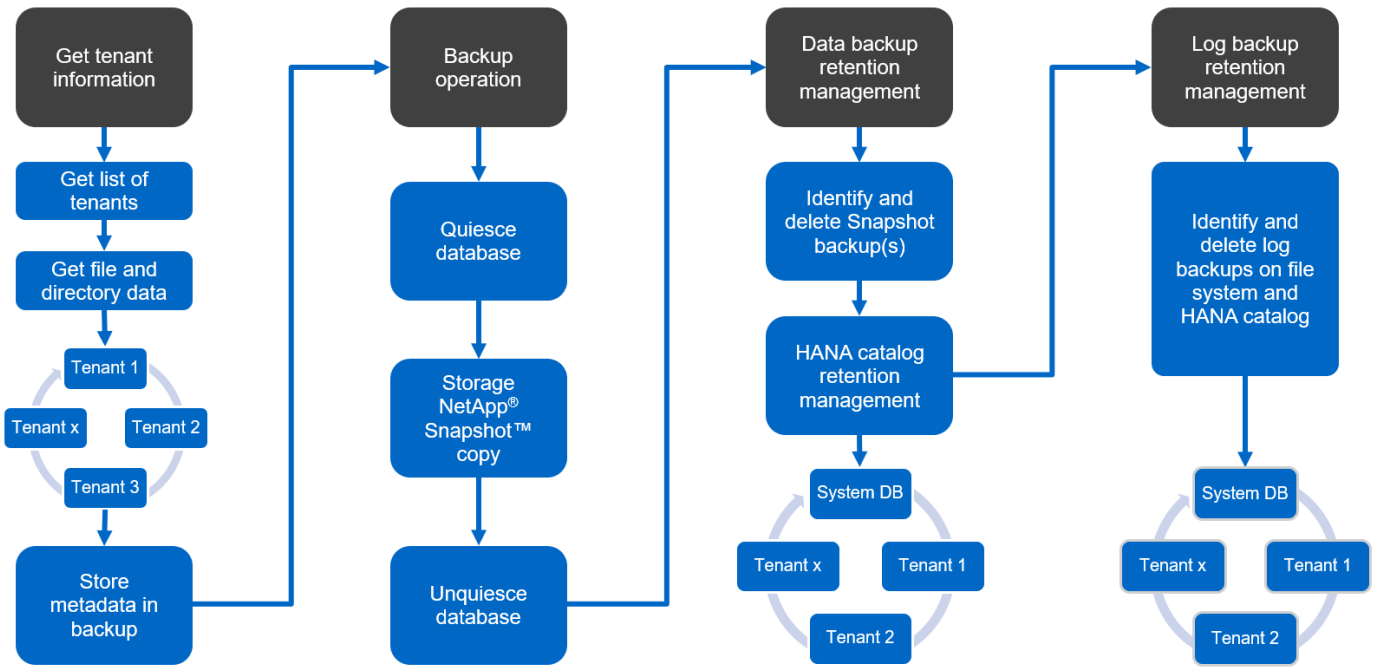
To enable a single tenant restore operation, SnapCenter must know which tenants are included in each Snapshot backup. In addition, it must know which files and directories belong to each tenant included in the Snapshot backup.

Therefore, with each backup operation, the first step in the workflow is to get the tenant information. This includes the tenant names and the corresponding file and directory information. This data must be stored in the Snapshot backup metadata in order to be able to support a single tenant restore operation. The next step is the Snapshot backup operation itself. This step includes the SQL command to trigger the HANA backup savepoint, the storage Snapshot backup, and the SQL command to close the Snapshot operation. By using the close command, the HANA database updates the backup catalog of the system DB and each tenant.

SAP does not support Snapshot backup operations for MDC systems when one or more tenants are stopped.

For the retention management of data backups and the HANA backup catalog management, SnapCenter must execute the catalog delete operations for the system database and all tenant databases that were identified in the first step. In the same way for the log backups, the SnapCenter workflow must operate on each tenant that was part of the backup operation.

The following figure shows an overview of the backup workflow.



Backup workflow for Snapshot backups of the HANA database

SnapCenter backs up the SAP HANA database in the following sequence:

1. SnapCenter reads the list of tenants from the HANA database.
2. SnapCenter reads the files and directories for each tenant from the HANA database.

3. Tenant information is stored in the SnapCenter metadata for this backup operation.
4. SnapCenter triggers an SAP HANA global synchronized backup save point to create a consistent database image on the persistence layer.

   For an SAP HANA MDC single or multiple tenant system, a synchronized global backup save point for the system database, and for each tenant database is created.

5. SnapCenter creates storage Snapshot copies for all data volumes configured for the resource. In our example of a single-host HANA database, there is only one data volume. With an SAP HANA multiple-host database, there are multiple data volumes.
6. SnapCenter registers the storage Snapshot backup in the SAP HANA backup catalog.
7. SnapCenter deletes the SAP HANA backup save point.
8. SnapCenter starts a SnapVault or SnapMirror update for all configured data volumes in the resource.

   This step is only executed if the selected policy includes a SnapVault or SnapMirror replication.

9. SnapCenter deletes the storage Snapshot copies and the backup entries in its database as well as in the SAP HANA backup catalog based on the retention policy defined for backups at the primary storage. HANA backup catalog operations are done for the system database and all tenants.

   If the backup is still available at the secondary storage, the SAP HANA catalog entry is not deleted.

10. SnapCenter deletes all log backups on the file system and in the SAP HANA backup catalog that are older than the oldest data backup identified in the SAP HANA backup catalog. These operations are done for the system database and all tenants.

    This step is only executed if log backup housekeeping is not disabled.

Backup workflow for block integrity check operations

SnapCenter executes the block integrity check in the following sequence:

1. SnapCenter reads the list of tenants from the HANA database.
2. SnapCenter triggers a file-based backup operation for the system database and each tenant.
3. SnapCenter deletes file-based backups in its database, on the file system, and in the SAP HANA backup catalog based on the retention policy defined for block integrity check operations. Backup deletion on the file system and HANA backup catalog operations are done for the system database and all tenants.
4. SnapCenter deletes all log backups on the file system and in the SAP HANA backup catalog that are older than the oldest data backup identified in the SAP HANA backup catalog. These operations are done for the system database and all tenants.

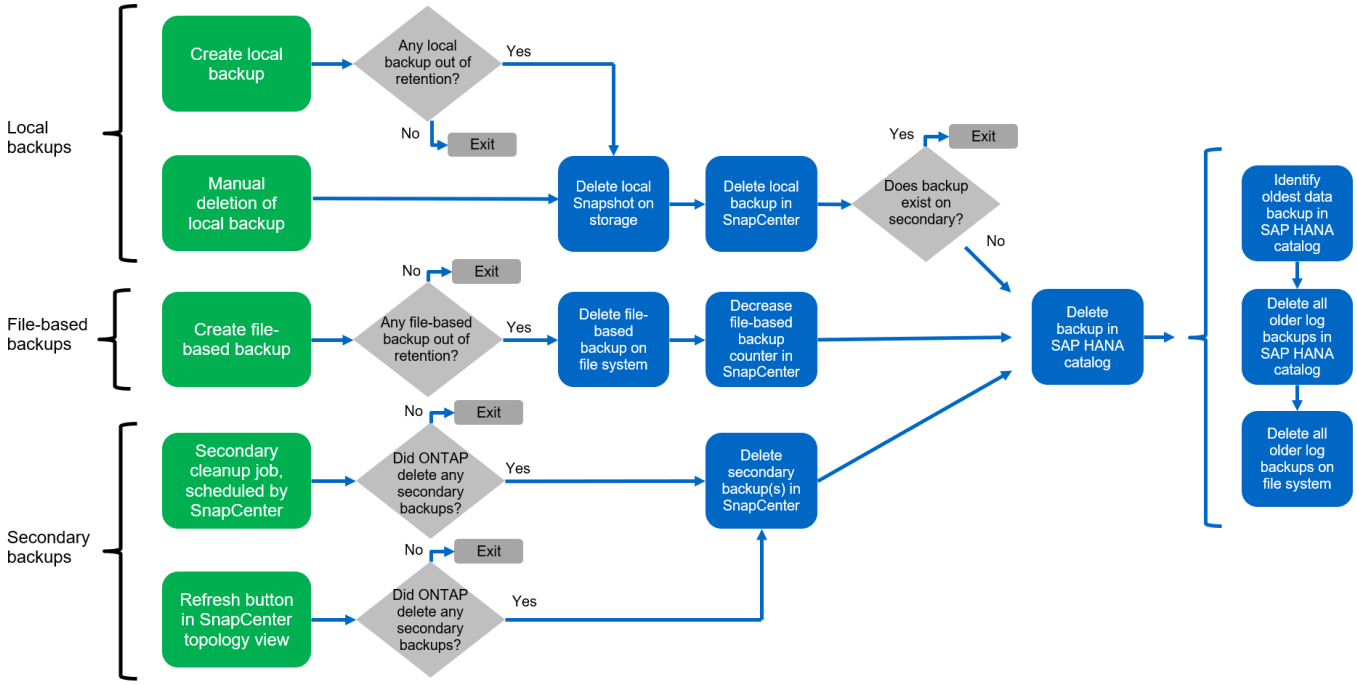
   This step is only executed if log backup housekeeping is not disabled.

Backup retention management and housekeeping of data and log backups

The data backup retention management and log backup housekeeping can be divided into five main areas, including retention management of:

- Local backups at the primary storage
- File-based backups
- Backups at the secondary storage
- Data backups in the SAP HANA backup catalog
- Log backups in the SAP HANA backup catalog and the file system

The following figure provides an overview of the different workflows and the dependencies of each operation. The following sections describe the different operations in detail.



Retention management of local backups at the primary storage

SnapCenter handles the housekeeping of SAP HANA database backups and non-data volume backups by deleting Snapshot copies on the primary storage and in the SnapCenter repository according to a retention defined in the SnapCenter backup policy.

Retention management logic is executed with each backup workflow in SnapCenter.

> Be aware that SnapCenter handles retention management individually for both scheduled and on-demand backups.

Local backups at the primary storage can also be deleted manually in SnapCenter.

Retention management of file-based backups

SnapCenter handles the housekeeping of file-based backups by deleting the backups on the file system

according to a retention defined in the SnapCenter backup policy.

Retention management logic is executed with each backup workflow in SnapCenter.

> Be aware that SnapCenter handles retention management individually for scheduled or on-demand backups.

Retention management of backups at the secondary storage

The retention management of backups at the secondary storage is handled by ONTAP based on the retention defined in the ONTAP protection relationship.

To synchronize these changes on the secondary storage in the SnapCenter repository, SnapCenter uses a scheduled cleanup job. This cleanup job synchronizes all secondary storage backups with the SnapCenter repository for all SnapCenter plug-ins and all resources.

The cleanup job is scheduled once per week by default. This weekly schedule results in a delay with deleting backups in SnapCenter and SAP HANA Studio when compared with the backups that have already been deleted at the secondary storage. To avoid this inconsistency, customers can change the schedule to a higher frequency, for example, once per day.

> The cleanup job can also be triggered manually for an individual resource by clicking the refresh button in the topology view of the resource.

For details about how to adapt the schedule of the cleanup job or how to trigger a manual refresh, refer to the section “Change scheduling frequency of backup synchronization with off-site backup storage.”

Retention management of data backups within the SAP HANA backup catalog

When SnapCenter has deleted any backup, local Snapshot or file based, or has identified the backup deletion at the secondary storage, this data backup is also deleted in the SAP HANA backup catalog.

Before deleting the SAP HANA catalog entry for a local Snapshot backup at the primary storage, SnapCenter checks if the backup still exists at the secondary storage.

Retention management of log backups

The SAP HANA database automatically creates log backups. These log backup runs create backup files for each individual SAP HANA service in a backup directory configured in SAP HANA.

Log backups older than the latest data backup are no longer required for forward recovery and can therefore be deleted.

SnapCenter handles the housekeeping of log file backups on the file system level as well as in the SAP HANA backup catalog by executing the following steps:

1. SnapCenter reads the SAP HANA backup catalog to get the backup ID of the oldest successful file-based or Snapshot backup.
2. SnapCenter deletes all log backups in the SAP HANA catalog and the file system that are older than this backup ID.

SnapCenter only handles housekeeping for backups that have been created by SnapCenter. If additional file-based backups are created outside of SnapCenter, you must make sure that the file-based backups are deleted from the backup catalog. If such a data backup is not deleted manually from the backup catalog, it can become the oldest data backup, and older log backups are not deleted until this file-based backup is deleted.

Even though a retention is defined for on-demand backups in the policy configuration, the housekeeping is only done when another on-demand backup is executed. Therefore, on-demand backups typically must be deleted manually in SnapCenter to make sure that these backups are also deleted in the SAP HANA backup catalog and that log backup housekeeping is not based on an old on-demand backup.

Log backup retention management is enabled by default. If required, it can be disabled as described in the section “Disable auto discovery on the HANA plug-in host.”

Capacity requirements for Snapshot backups

You must consider the higher block change rate on the storage layer relative to the change rate with traditional databases. Due to the HANA table merge process of the column store, the complete table is written to disk, not just the changed blocks.

Data from our customer base shows a daily change rate between 20% and 50% if multiple Snapshot backups are taken during the day. At the SnapVault target, if the replication is done only once per day, the daily change rate is typically smaller.

Restore and recovery operations

Restore operations with SnapCenter

From the HANA database perspective, SnapCenter supports two different restore operations.

- **Restore of the complete resource.** All data of the HANA system is restored. If the HANA system contains one or more tenants, the data of the system database and the data of all tenants are restored.
- **Restore of a single tenant.** Only the data of the selected tenant is restored.

From the storage perspective, the above restore operations must be executed differently depending on the used storage protocol (NFS or Fibre Channel SAN), the configured data protection (primary storage with or without offsite backup storage), and the selected backup to be used for the restore operation (restore from primary or offsite backup storage).

Restore of complete resource from primary storage

When restoring the complete resource from primary storage, SnapCenter supports two different ONTAP features to execute the restore operation. You can choose between the following two features:

- **Volume-based SnapRestore.** A volume based SnapRestore reverts the content of the storage volume to the state of the selected Snapshot backup.
  - Volume Revert check box available for auto discovered resources using NFS.
  - Complete Resource radio button for manual configured resources.
- **File-based SnapRestore.** A file-based SnapRestore, also known as Single File SnapRestore, restores all individual files (NFS), or all LUNs (SAN).

- Default restore method for auto discovered resources. Can be changed using the Volume revert check box for NFS.
- File-level radio button for manual configured resources.

The following table provides a comparison of the different restore methods.

	Volume-based SnapRestore	File-based SnapRestore
Speed of restore operation	Very fast, independent of the volume size	Very fast restore operation but uses background copy job on the storage system, which blocks the creation of new Snapshot backups
Snapshot backup history	Restore to an older Snapshot backup, removes all newer Snapshot backups.	No influence
Restore of directory structure	Directory structure is also restored	NFS: Only restores the individual files, not the directory structure. If the directory structure is also lost, it must be created manually before executing the restore operation SAN: Directory structure is also restored
Resource configured with replication to offsite backup storage	A volume-based restore cannot be done to a Snapshot copy backup that is older than the Snapshot copy used for SnapVault synchronization	Any Snapshot backup can be selected

Restore of complete resource from offsite backup storage

A restore from the offsite backup storage is always executed using a SnapVault restore operation where all files or all LUNs of the storage volume are overwritten with the content of the Snapshot backup.

Restore of a single tenant

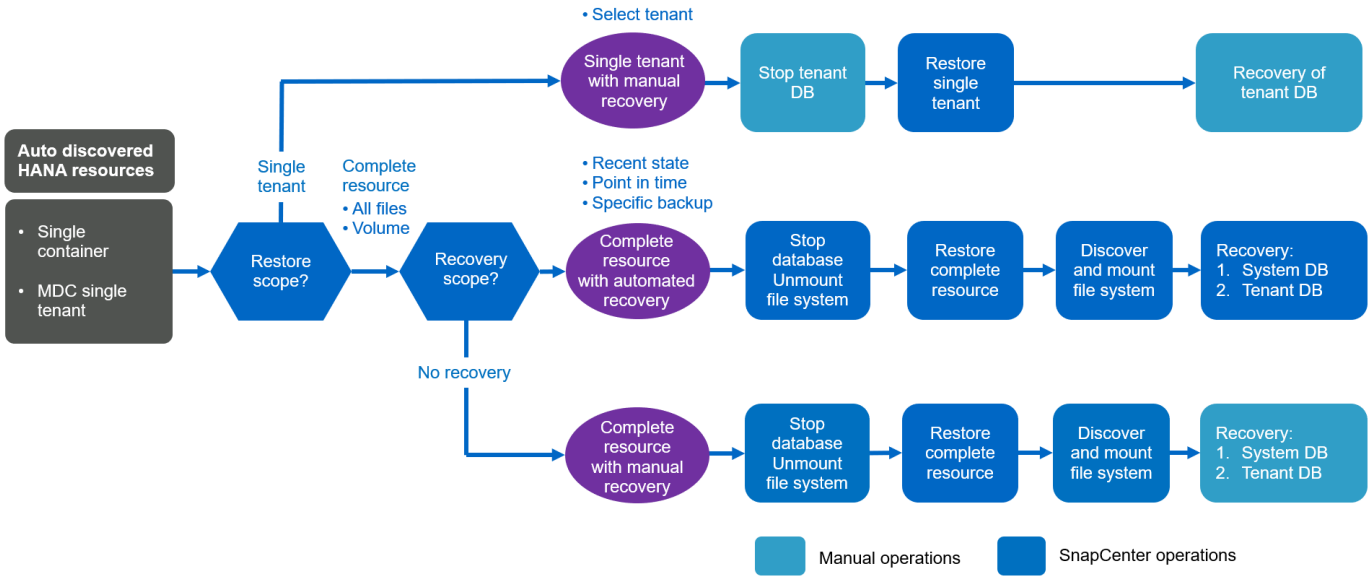
Restoring a single tenant requires a file-based restore operation. Depending on the used storage protocol, different restore workflows are executed by SnapCenter.

- NFS:
  - Primary storage. File-based SnapRestore operations are executed for all files of the tenant database.
  - Offsite backup storage: SnapVault restore operations are executed for all files of the tenant database.
- SAN:
  - Primary storage. Clone and connect the LUN to the database host and copy all files of the tenant database.
  - Offsite backup storage. Clone and connect the LUN to the database host and copy all files of the tenant database.

Restore and recovery of auto-discovered HANA single container and MDC single tenant systems

HANA single container and HANA MDC single tenant systems that have been auto discovered are enabled for automated restore and recovery with SnapCenter. For these HANA systems, SnapCenter supports three different restore and recovery workflows, as shown in the following figure:

- **Single tenant with manual recovery.** If you select a single tenant restore operation, SnapCenter lists all tenants that are included in the selected Snapshot backup. You must stop and recover the tenant database manually. The restore operation with SnapCenter is done with single file SnapRestore operations for NFS, or clone, mount, copy operations for SAN environments.
- **Complete resource with automated recovery.** If you select a complete resource restore operation and automated recovery, the complete workflow is automated with SnapCenter. SnapCenter supports up to recent state, point in time, or to specific backup recovery operations. The selected recovery operation is used for the system and the tenant database.
- **Complete resource with manual recovery.** If you select No Recovery, SnapCenter stops the HANA database and executes the required file system (unmount, mount) and restore operations. You must recover the system and tenant database manually.

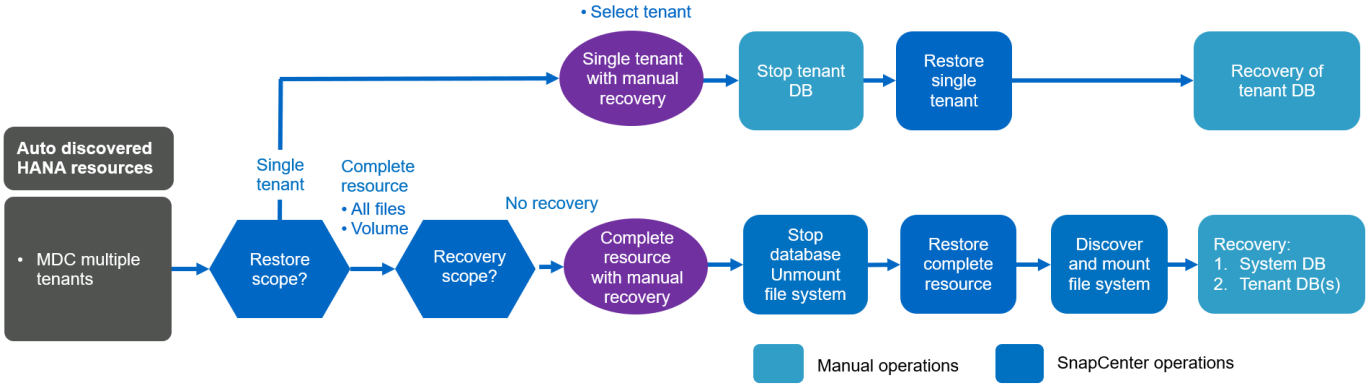


Restore and recovery of automatically discovered HANA MDC multiple tenant systems

Even though HANA MDC systems with multiple tenants can be automatically discovered, automated restore and recovery is not supported with the current SnapCenter release. For MDC systems with multiple tenants, SnapCenter supports two different restore and recovery workflows, as shown in the following figure:

- Single tenant with manual recovery
- Complete resource with manual recovery

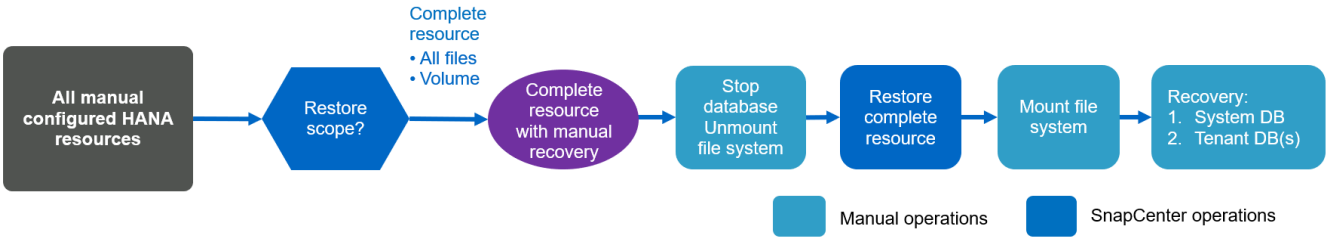
The workflows are the same as described in the previous section.



Restore and recovery of manual configured HANA resources

Manual configured HANA resources are not enabled for automated restore and recovery. Also, for MDC systems with single or multiple tenants, a single tenant restore operation is not supported.

For manual configured HANA resources, SnapCenter only supports manual recovery, as shown in the following figure. The workflow for manual recovery is the same as described in the previous sections.



Summary restore and recovery operations

The following table summarizes the restore and recovery operations depending on the HANA resource configuration in SnapCenter.

SnapCenter resource configuration	Restore and recovery options	Stop HANA database	Unmount before, mount after restore operation	Recovery operation
Auto discovered Single container MDC single tenant	• Complete resource with either • Default (all files) • Volume revert (NFS from primary storage only) • Automated recovery selected	Automated with SnapCenter	Automated with SnapCenter	Automated with SnapCenter

SnapCenter resource configuration	Restore and recovery options	Stop HANA database	Unmount before, mount after restore operation	Recovery operation
	• Complete resource with either • Default (all files) • Volume revert (NFS from primary storage only) • No recovery selected	Automated with SnapCenter	Automated with SnapCenter	Manual
	• Tenant restore	Manual	Not required	Manual
Auto discovered MDC multiple tenants	• Complete resource with either • Default (all files) • Volume revert (NFS from primary storage only) • Automated recovery not supported	Automated with SnapCenter	Automated with SnapCenter	Manual
	• Tenant restore	Manual	Not required	Manual
All manual configured resources	• Complete resource (= Volume revert, available for NFS and SAN from primary storage only) • File level (all files) • Automated recovery not supported	Manual	Manual	Manual

Lab setup used for this report

The lab setup used for this technical report includes five different SAP HANA

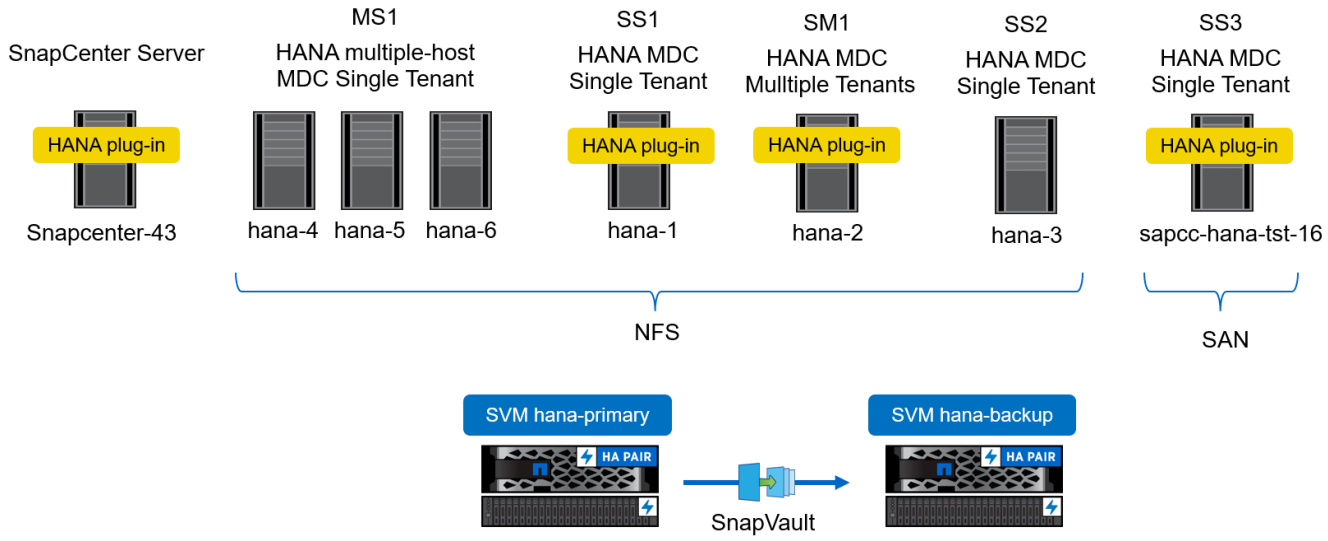
configurations:

- **MS1.**
  - SAP HANA multiple-host MDC single tenant system
  - Managed with a central plug-in host (SnapCenter server)
  - Uses NFS as storage protocol
- **SS1.**
  - SAP HANA single-host MDC single tenant system
  - Auto discovered with HANA plug-in installed on HANA database host
  - Uses NFS as storage protocol
- **SM1.**
  - SAP HANA single-host MDC multiple tenant system
  - Auto discovered with HANA plug-in installed on HANA database host
  - Uses NFS as storage protocol
- **SS2.**
  - SAP HANA single-host MDC single tenant system
  - Managed with a central plug-in host (SnapCenter Server)
  - Uses NFS as storage protocol
- **SS3.**
  - SAP HANA single-host MDC single tenant system
  - Auto discovered with HANA plug-in installed on HANA database host
  - Uses Fibre Channel SAN as storage protocol

The following sections describe the complete configuration and the backup, restore, and recovery workflows. The description covers local Snapshot backups as well as replication to backup storage using SnapVault. The storage virtual machines (SVMs) are `hana-primary` for the primary storage and `hana-backup` for the off-site backup storage.

The SnapCenter Server is used as a central HANA plug-in host for the HANA systems MS1 and SS2.

The following figure shows the lab setup.

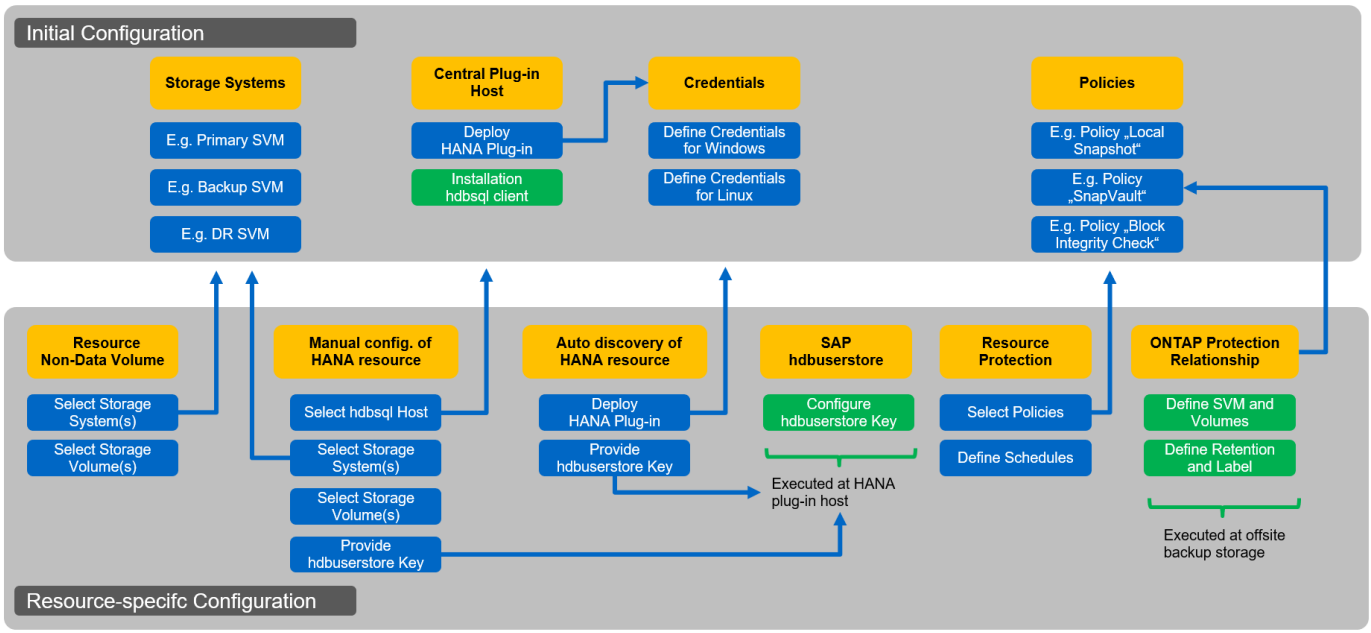


SnapCenter configuration

The SnapCenter configuration can be separated into two main areas:

- **Initial configuration.** Covers generic configurations, independent of an individual SAP HANA database. Configurations such as storage systems, central HANA plug-in hosts, and policies, which are selected when executing the resource-specific configurations.
- **Resource-specific configuration.** Covers SAP HANA system-specific configurations and must be done for each SAP HANA database.

The following figure provides an overview of the configuration components and their dependencies. The green boxes show configuration steps that must be done outside of SnapCenter; the blue boxes show the steps that are done using the SnapCenter GUI.



With the initial configuration, the following components are installed and configured:

- **Storage system.** Credential configuration for all SVMs that are used by the SAP HANA systems: typically, primary, off-site backup, and disaster recovery storage.

Storage cluster credentials can the also be configured instead of individual SVM credentials.

- **Credentials.** Configuration of credentials used to deploy the SAP HANA plug-in on the hosts.
- **Hosts (for central HANA plug-in hosts).** Deployment of SAP HANA plug-in. Installation of the SAP HANA hdbclient software on the host. The SAP hdbclient software must be installed manually.
- **Policies.** Configuration of backup type, retention, and replication. Typically, at least one policy for local Snapshot copies, one for SnapVault replication, and one for file-based backup is required.

The resource-specific configuration must be performed for each SAP HANA database and includes the following configurations:

- SAP HANA non-data volume resource configuration:
  - Storage systems and volumes
- SAP hdbuserstore key configuration:
  - The SAP hdbuserstore key configuration for the specific SAP HANA database must be performed either on the central plug-in host, or on the HANA database host, depending on where the HANA plug-in is deployed.
- Auto discovered SAP HANA database resources:
  - Deployment of SAP HANA plug-in on database host
  - Provide hdbuserstore key
- Manual SAP HANA database resource configuration:
  - SAP HANA database SID, plug-in host, hdbuserstore key, storage systems and volumes
- Resource protection configuration:
  - Selection of required policies
  - Definition of schedules for each policy
- ONTAP data protection configuration:
  - Only required if the backups should be replicated to an off-site backup storage.
  - Definition of relationship and retention.

Initial SnapCenter configuration

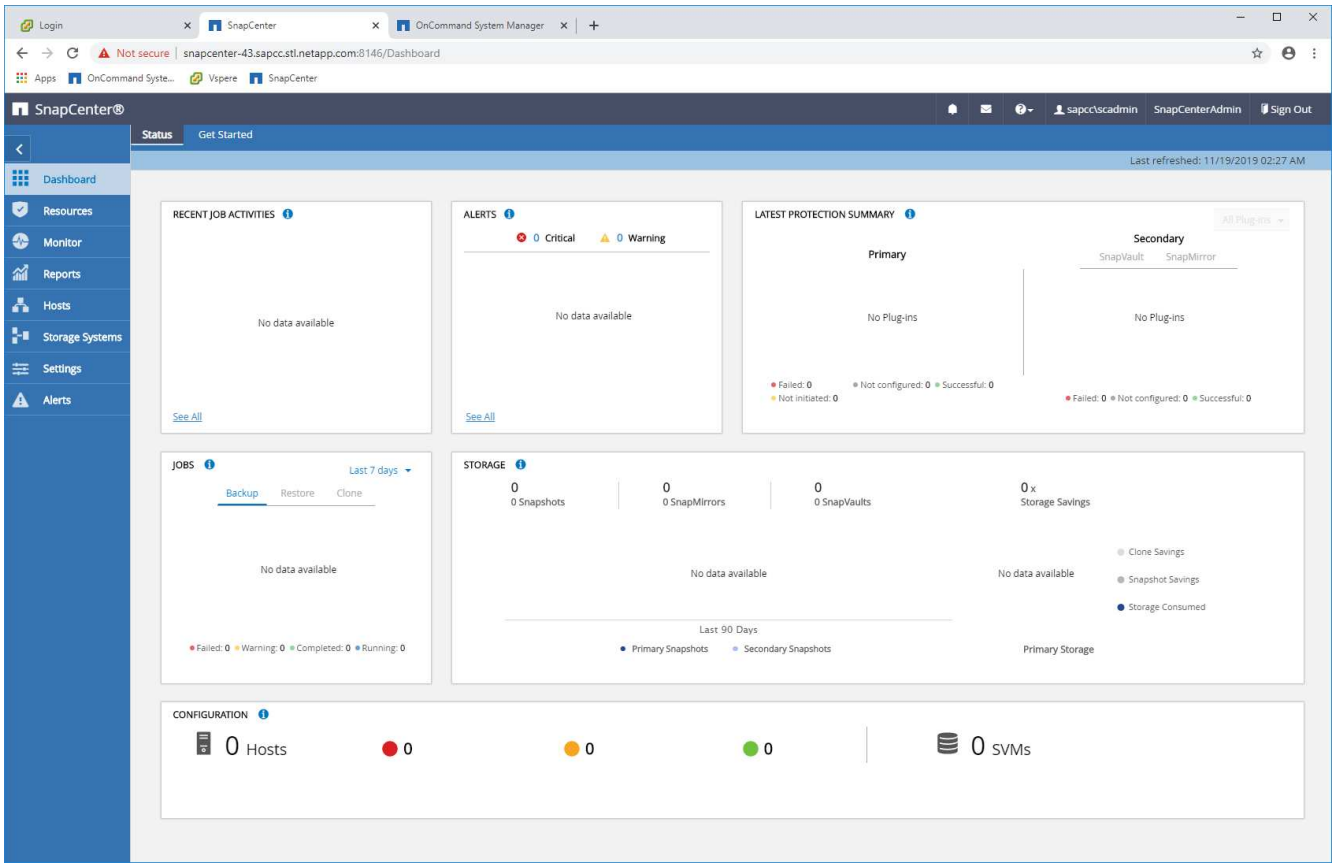
Initial configuration includes the following steps:

1. Storage system configuration
2. Credentials configuration for plug-in installation
3. For a central HANA plug-in host:
   a. Host configuration and SAP HANA plug-in deployment
   b. SAP HANA hdbsql client software installation and configuration
4. Policies configuration

The following sections describe the initial configuration steps.

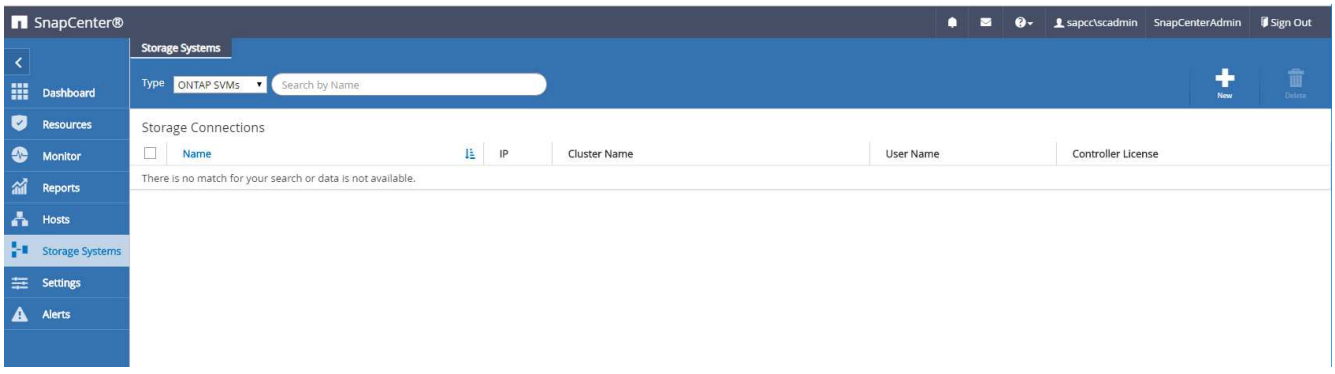
Storage system configuration

1. Log in to the SnapCenter Server GUI.



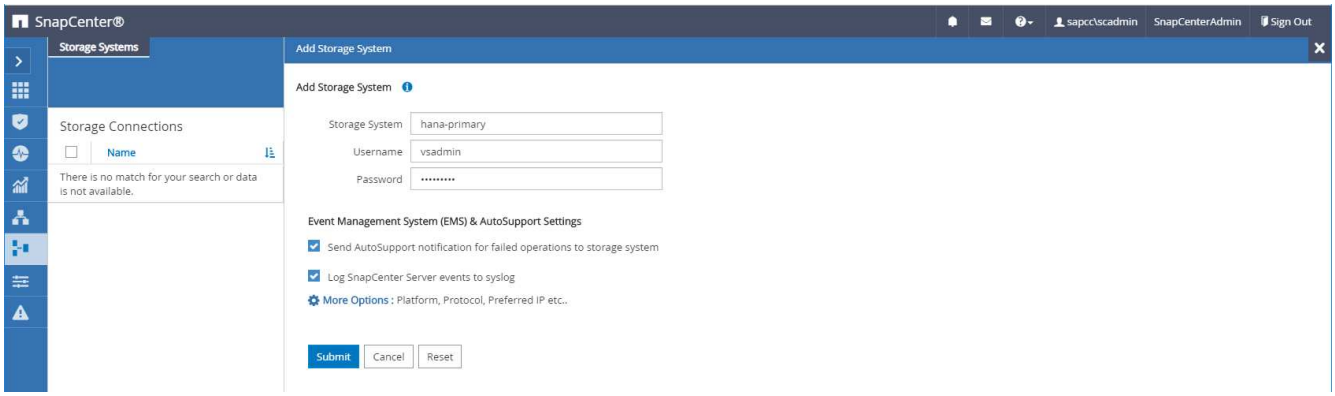
2. Select Storage Systems.

In the screen, you can select the storage system type, which can be ONTAP SVMs or ONTAP Clusters. If you configure the storage systems on SVM level, you need to have a management LIF configured for each SVM. As an alternative, you can use a SnapCenter management access on cluster level. SVM management is used in the following example.



3. Click New to add a storage system and provide the required host name and credentials.

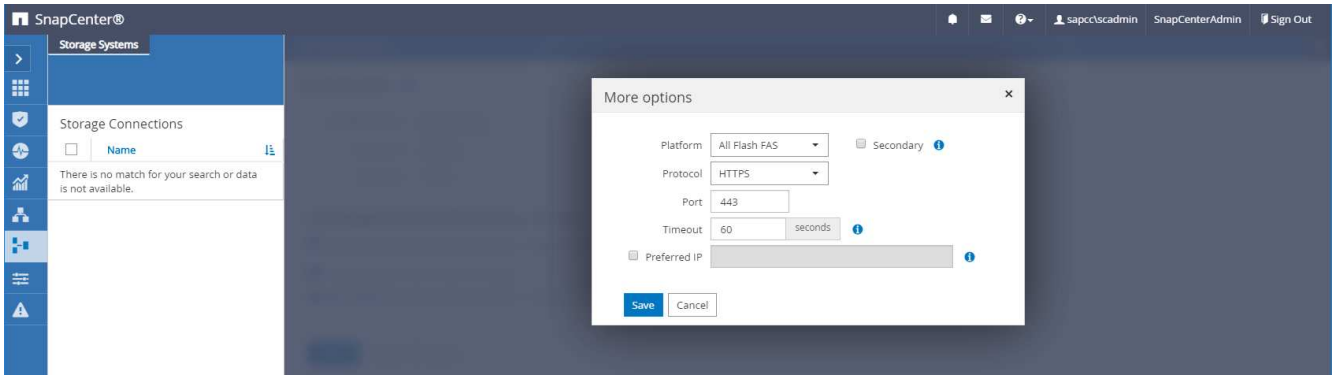
The SVM user is not required to be the vsadmin user, as shown in the screenshot. Typically, a user is configured on the SVM and assigned the required permissions to execute backup and restore operations. Details on required privileges can be found in the SnapCenter Installation Guide in the section titled “Minimum ONTAP privileges required”.



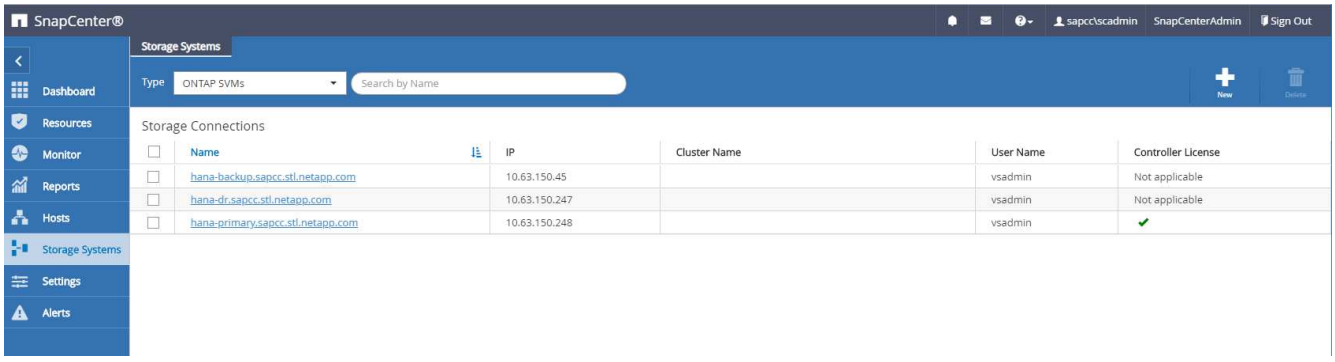
4. Click More Options to configure the storage platform.

   Storage platform can be FAS, AFF, ONTAP Select, or Cloud Volumes ONTAP.

   For a system used as a SnapVault or SnapMirror target, select the Secondary icon.

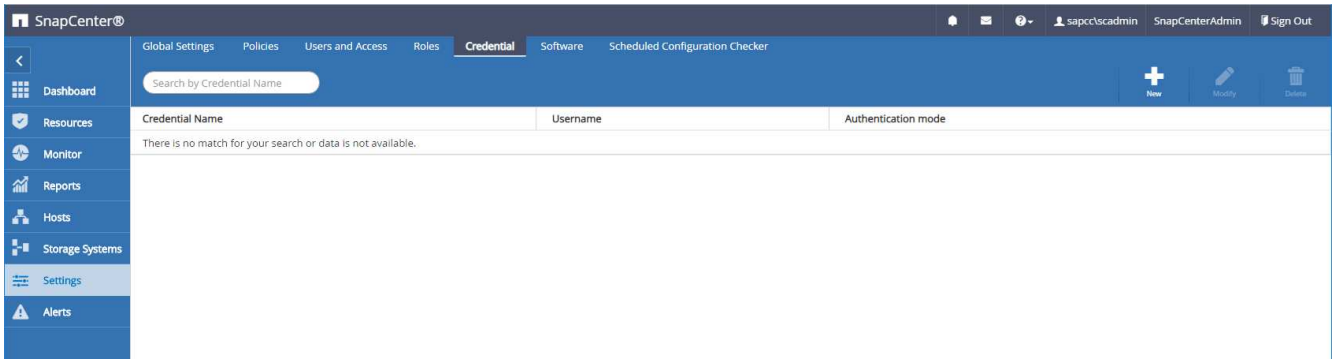


5. Add additional storage systems as required. In our example, an additional offsite backup storage and a disaster recovery storage has been added.

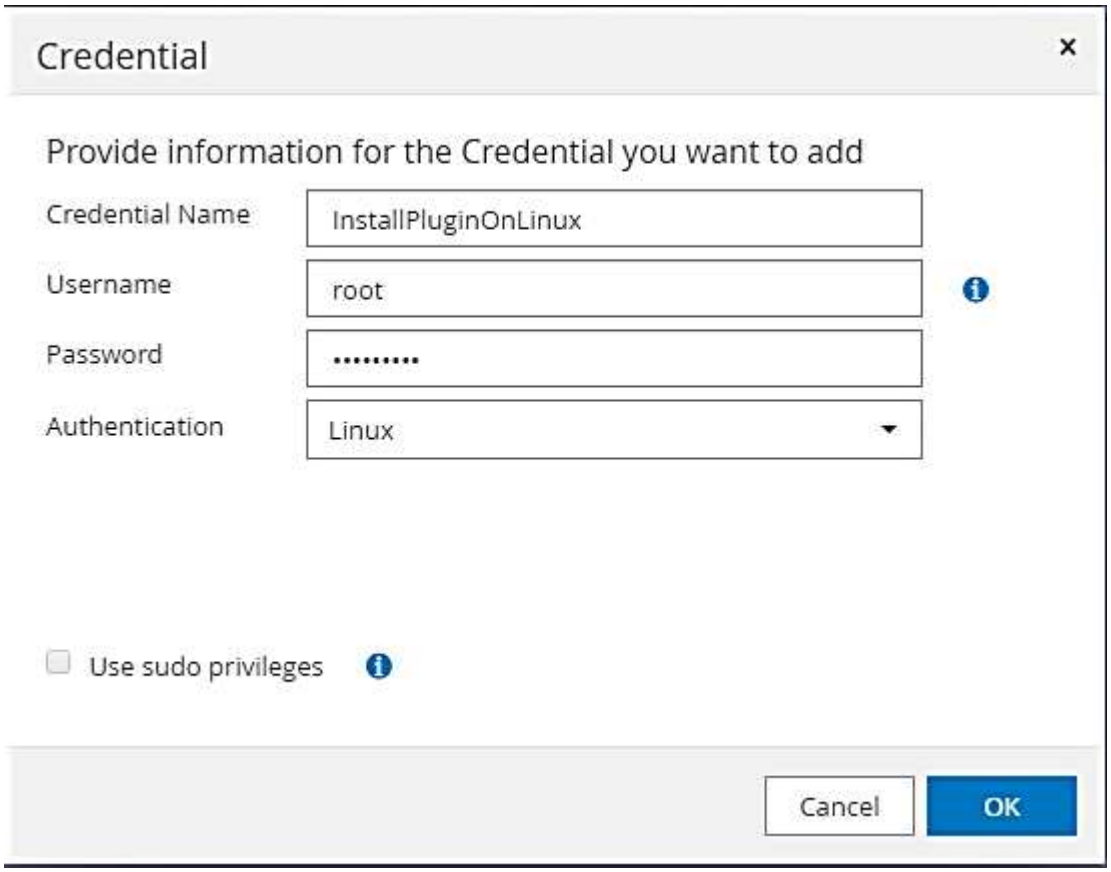


Credentials configuration

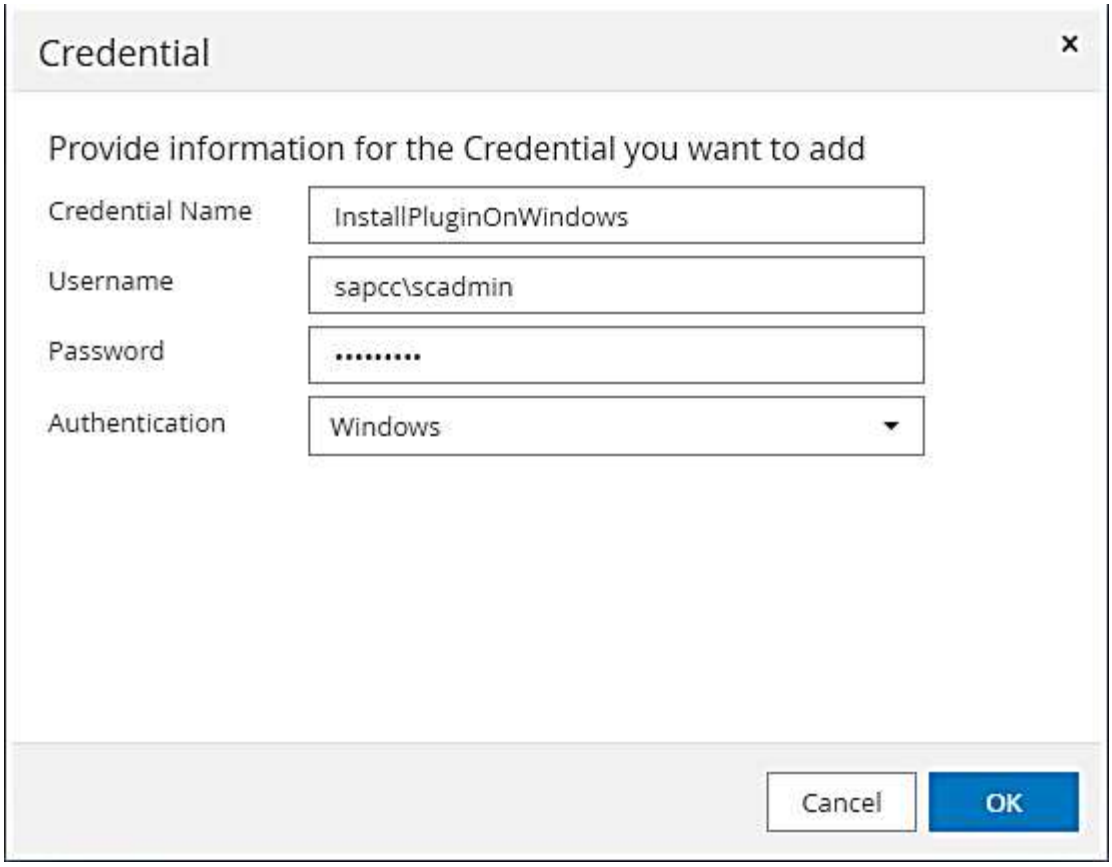
1. Go to Settings, select Credentials, and click New.



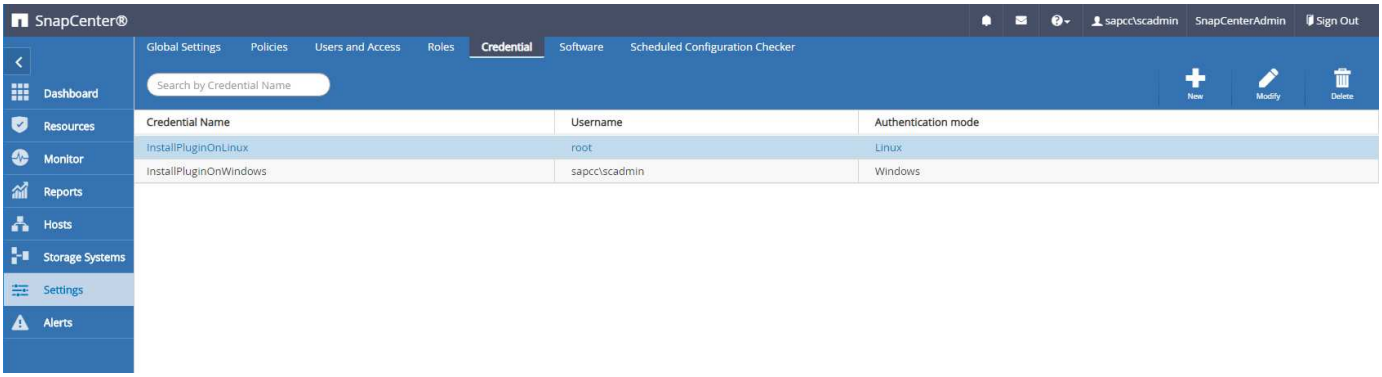
2. Provide the credentials for the user that are used for plug-in installations on Linux systems.



3. Provide the credentials for the user that are used for plug-in installations on Windows systems.



The following figure shows the configured credentials.

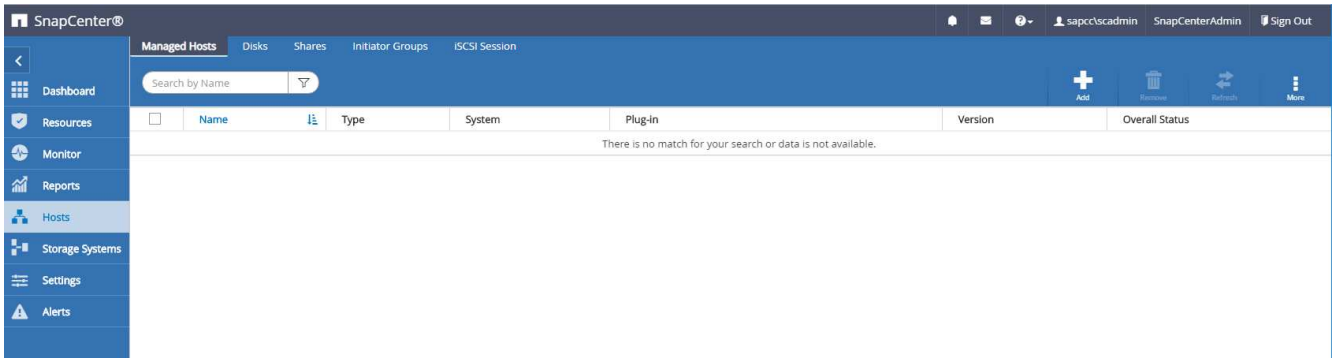


SAP HANA plug-in installation on a central plug-in host

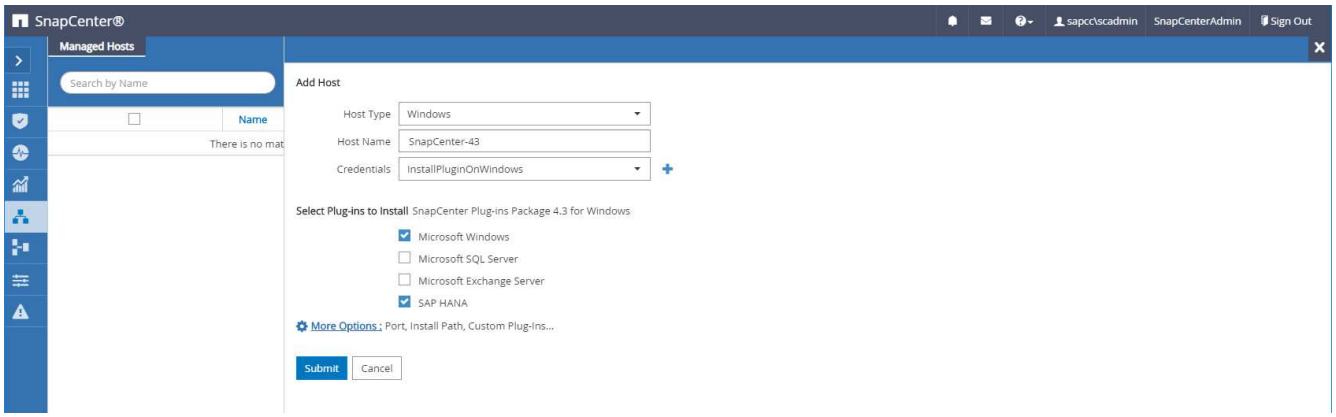
In the lab setup, the SnapCenter Server is also used as a central HANA plug-in host. The Windows host on which SnapCenter Server runs is added as a host, and the SAP HANA plug-in is installed on the Windows host.

The SAP HANA plug-in requires Java 64-bit version 1.8. Java needs to be installed on the host before the SAP HANA plug-in is deployed.

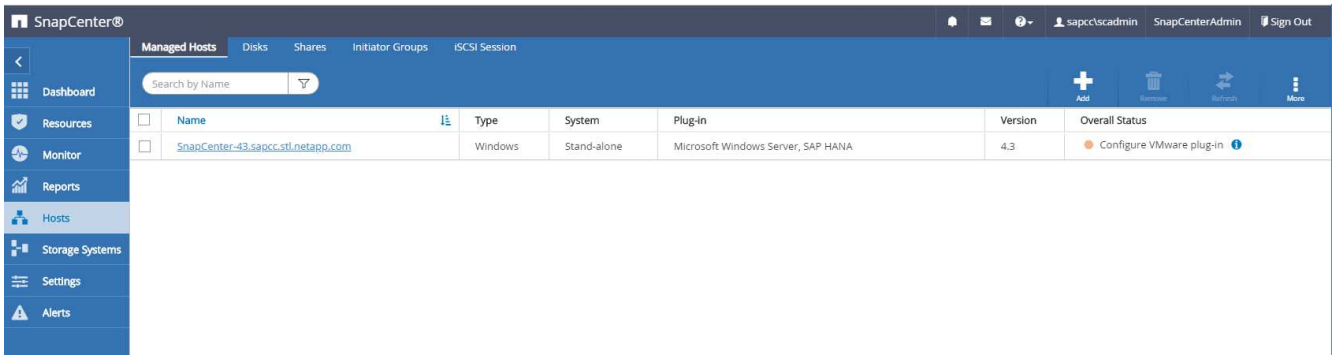
1. Go to Hosts and click Add.



2. Provide the required host information. Click Submit.



The following figure shows all the configured hosts after the HANA plug-in is deployed.



SAP HANA hdbsql client software installation and configuration

The SAP HANA hdbsql client software must be installed on the same host on which the SAP HANA plug-in is installed. The software can be downloaded from the SAP Support Portal.

The HDBSQL OS user configured during the resource configuration must be able to run the hdbsql executable. The path to the hdbsql executable must be configured in the `hana.properties` file.

- Windows:

```
C:\More C:\Program Files\NetApp\SnapCenter\Snapcenter Plug-in
Creator\etc\hana.properties
HANA_HDBSQL_CMD=C:\\Program Files\\sap\\hdbclient\\hdbsql.exe
```

- Linux:

```
cat /opt/NetApp/snapcenter/scc/etc/hana.properties
HANA_HDBSQL_CMD=/usr/sap/hdbclient/hdbsql
```

Policy configuration

As discussed in the section "Data protection strategy," policies are usually configured independently of the resource and can be used by multiple SAP HANA databases.

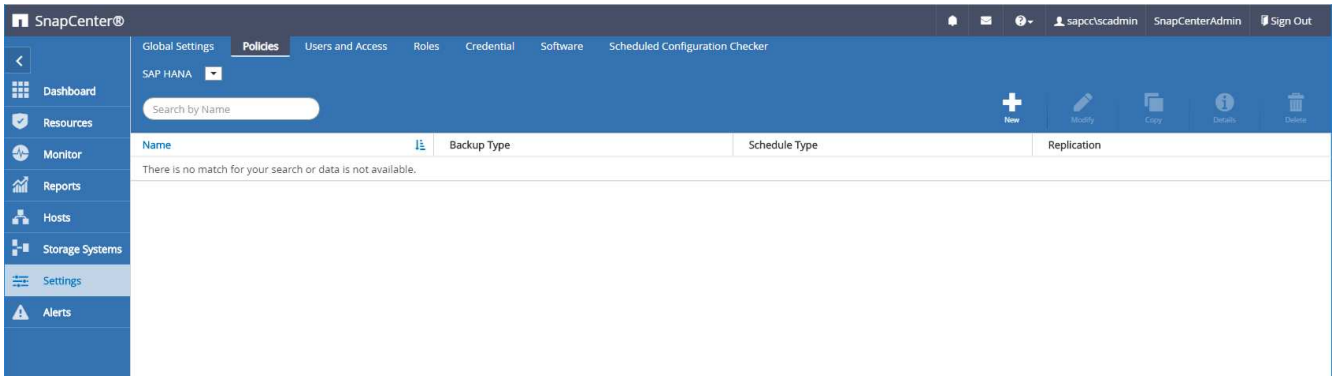
A typical minimum configuration consists of the following policies:

- Policy for hourly backups without replication: `LocalSnap`
- Policy for daily backups with SnapVault replication: `LocalSnapAndSnapVault`
- Policy for weekly block integrity check using a file-based backup: `BlockIntegrityCheck`

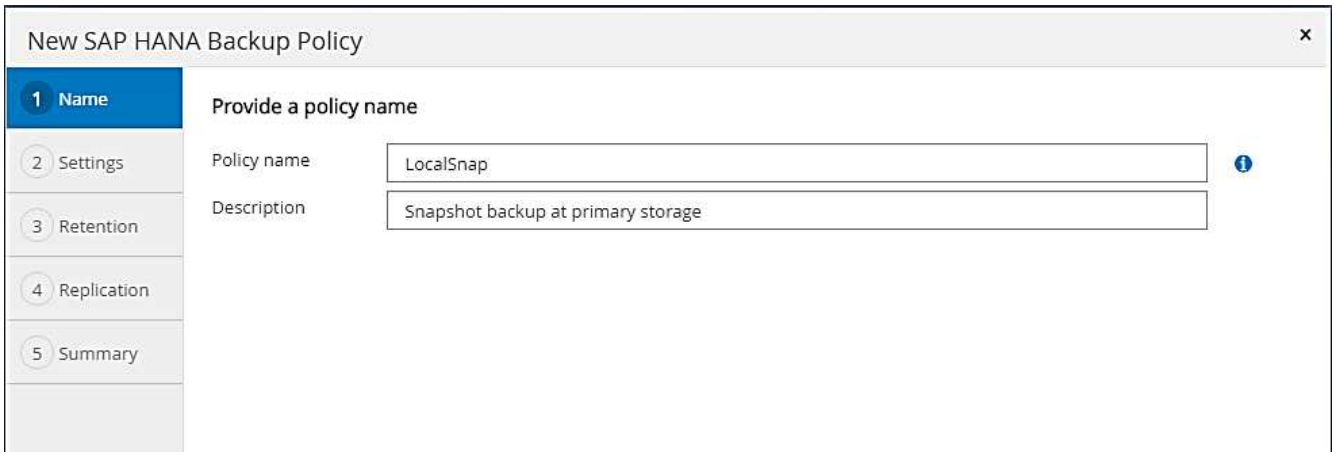
The following sections describe the configuration of these three policies.

Policy for hourly Snapshot backups

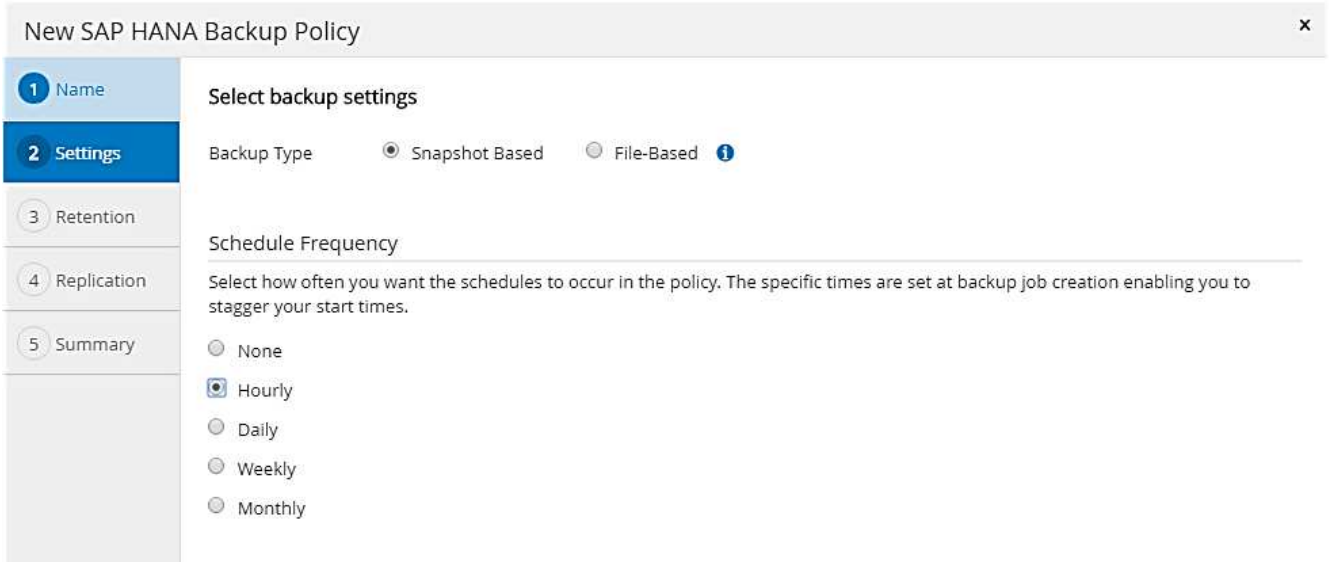
1. Go to Settings > Policies and click New.



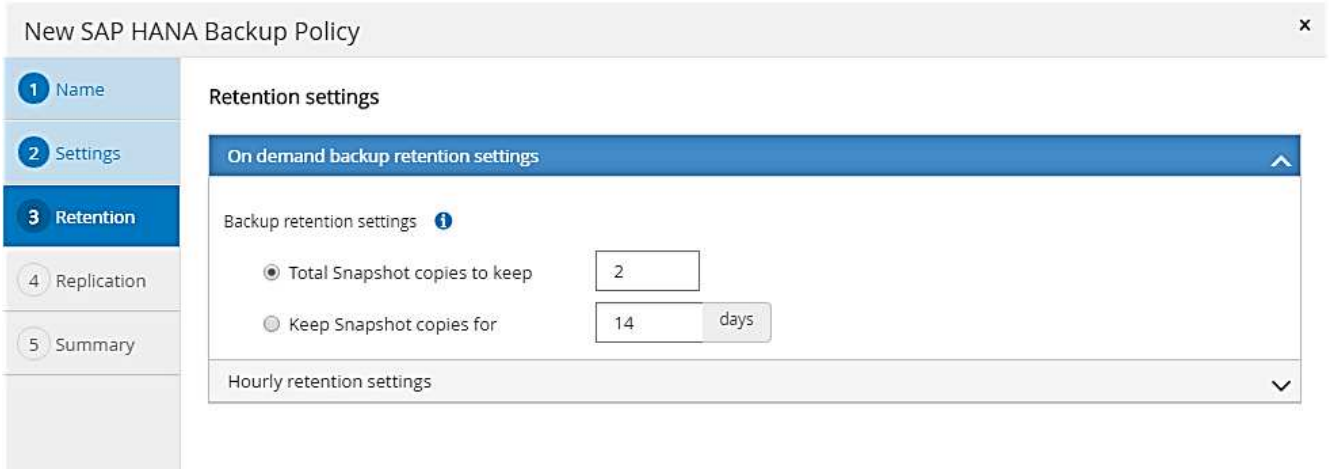
2. Enter the policy name and description. Click Next.



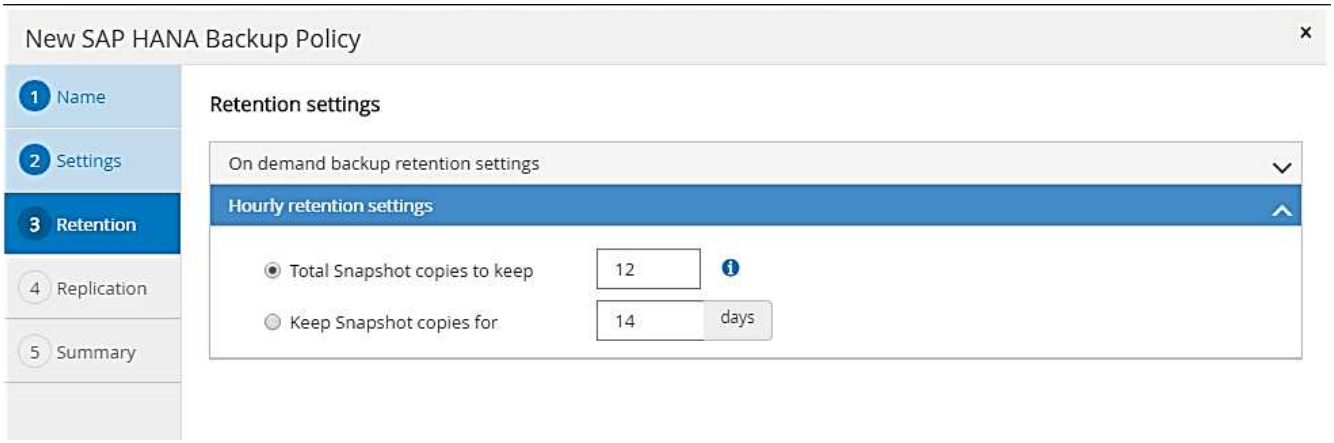
3. Select backup type as Snapshot Based and select Hourly for schedule frequency.



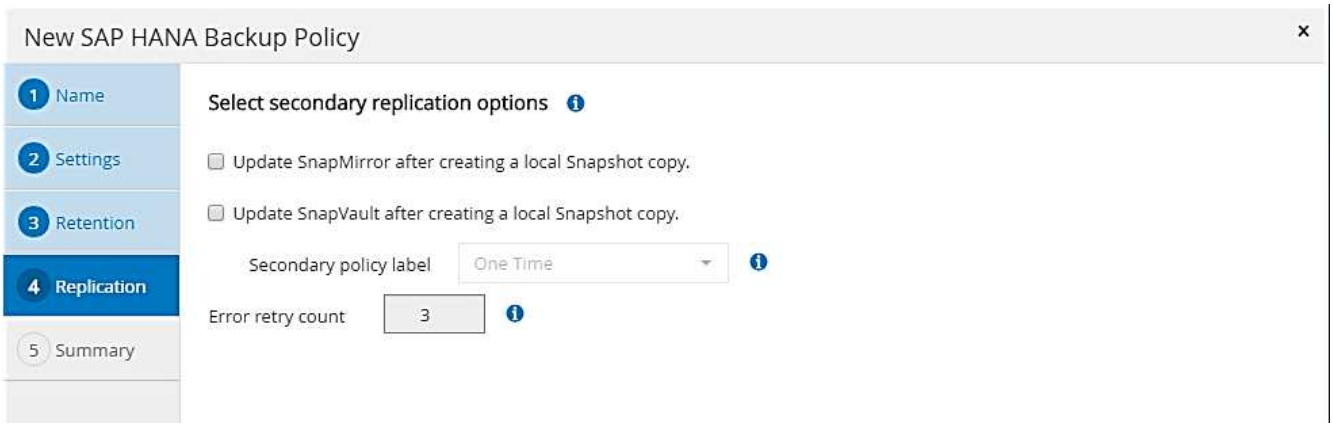
4. Configure the retention settings for on-demand backups.



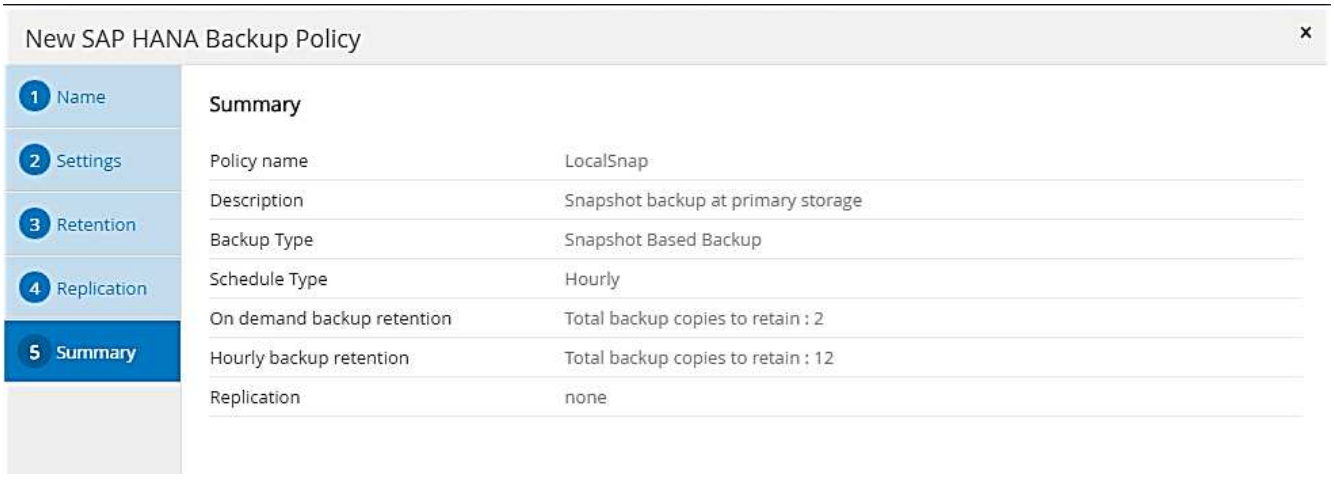
5. Configure the retention settings for scheduled backups.



6. Configure the replication options. In this case, no SnapVault or SnapMirror update is selected.

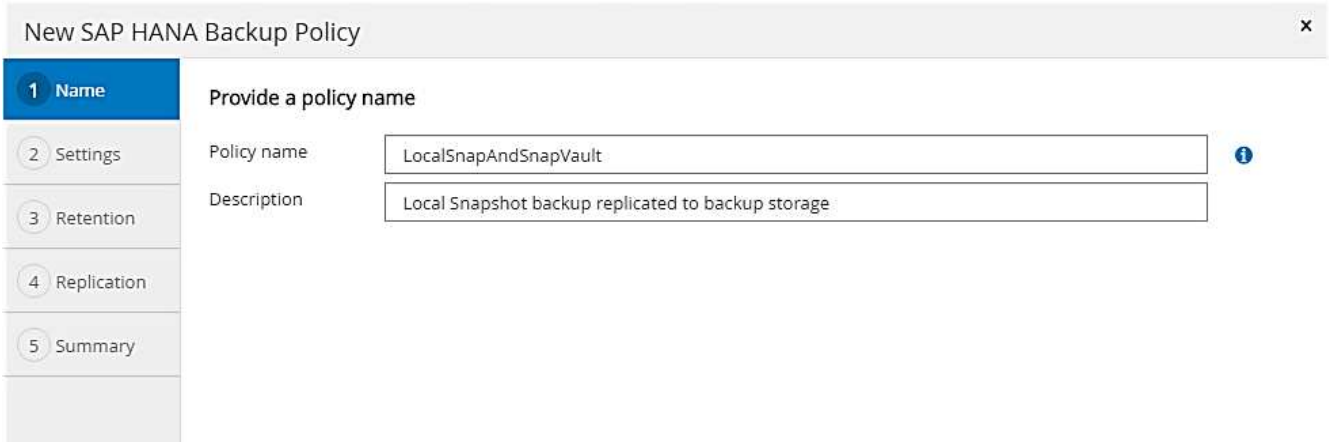


7. On the Summary page, click Finish.

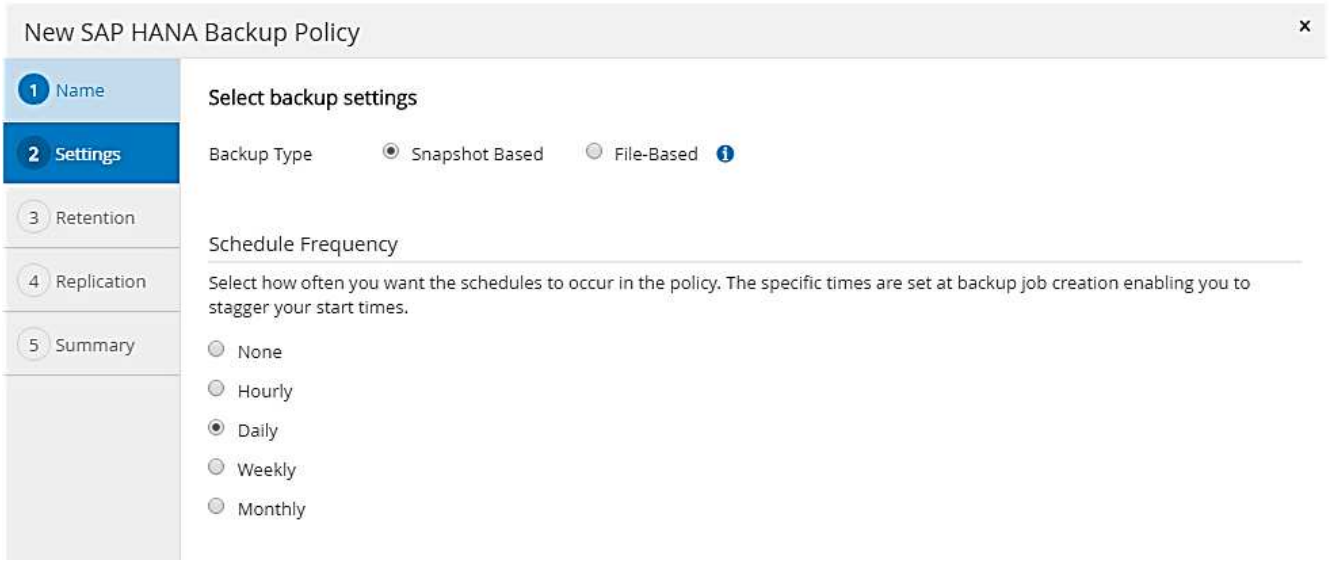


Policy for daily Snapshot backups with SnapVault replication

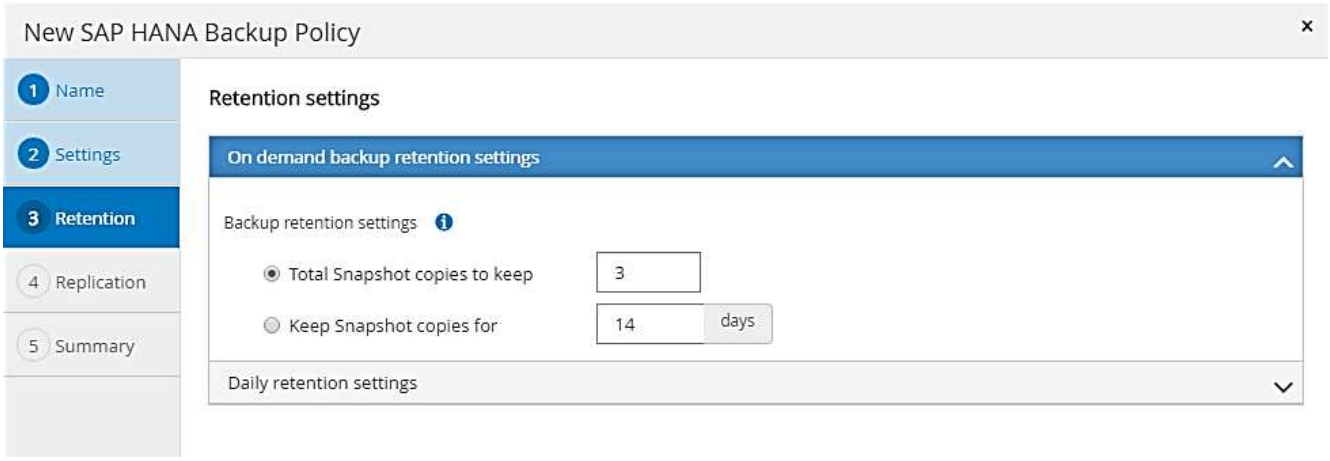
1. Go to Settings > Policies and click New.
2. Enter the policy name and description. Click Next.



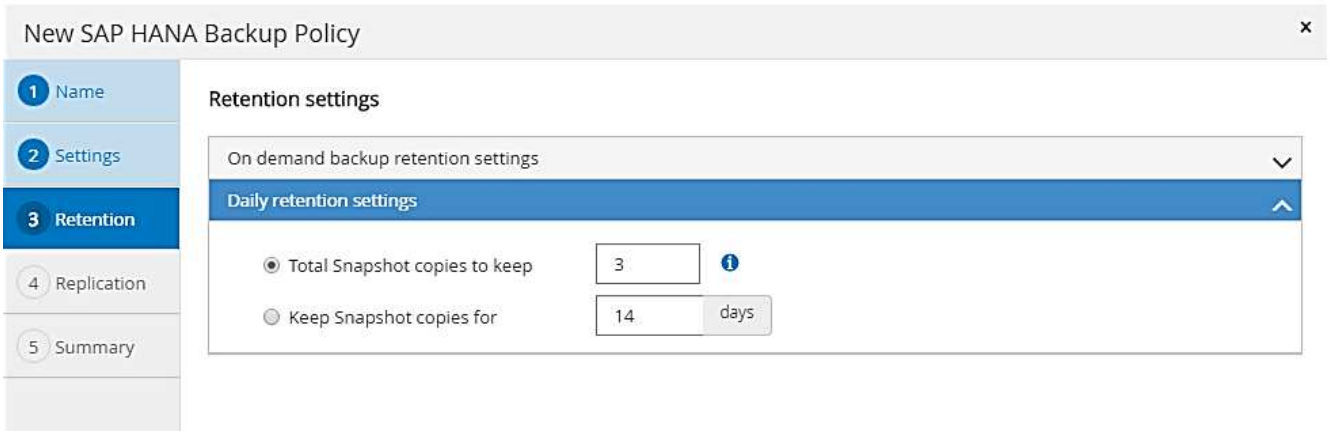
3. Set the backup type to Snapshot Based and the schedule frequency to Daily.



4. Configure the retention settings for on-demand backups.

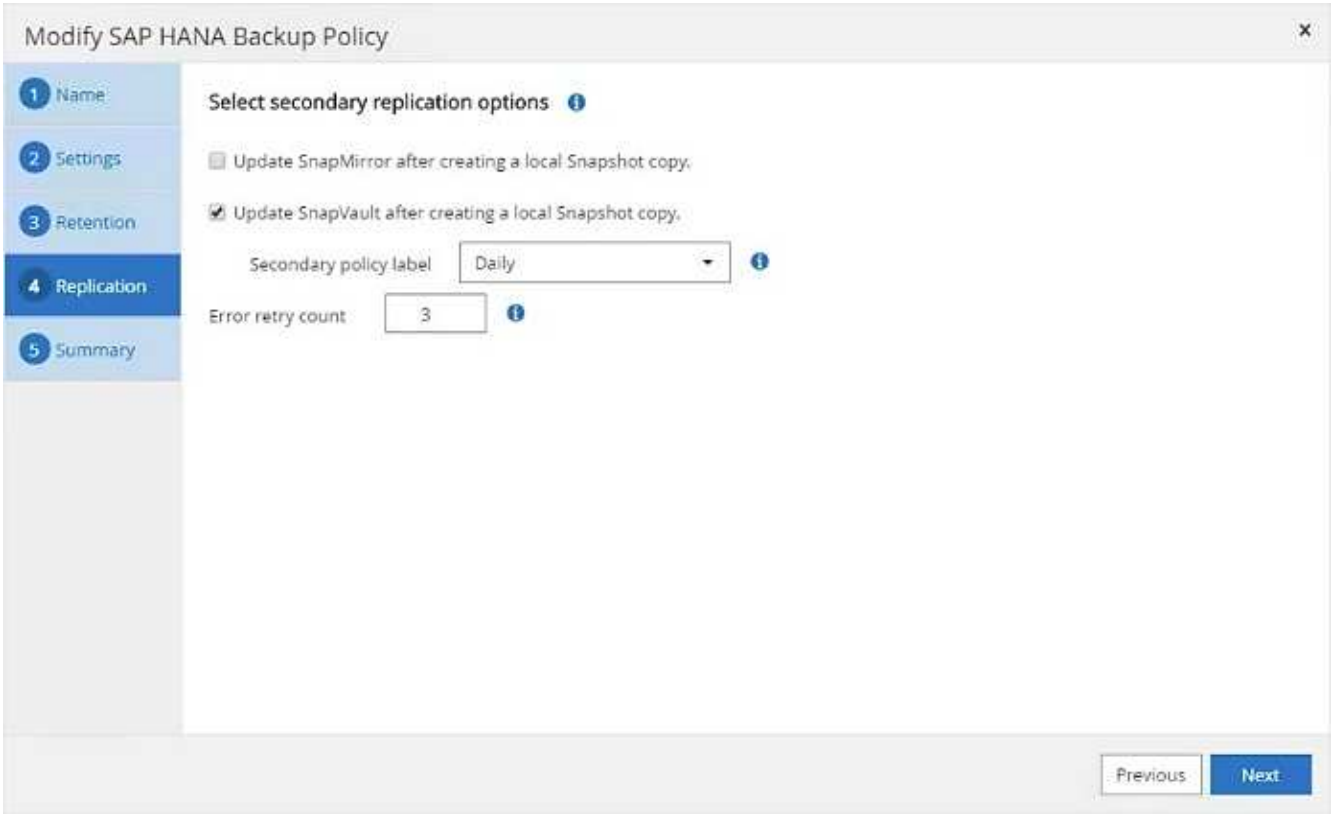


5. Configure the retention settings for scheduled backups.

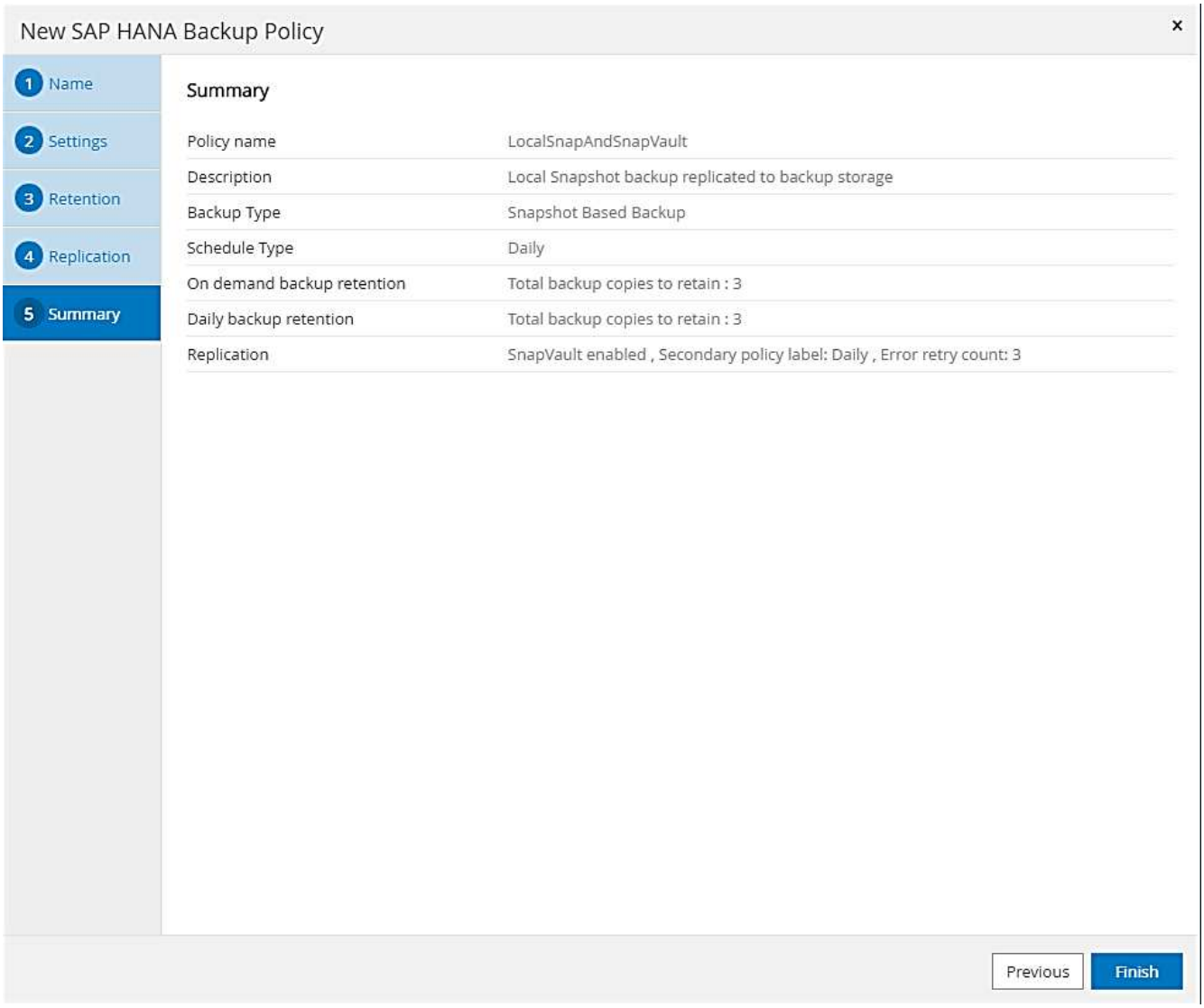


6. Select Update SnapVault after creating a local Snapshot copy.

> The secondary policy label must be the same as the SnapMirror label in the data protection configuration on the storage layer. See the section "Configuration of data protection to off-site backup storage."

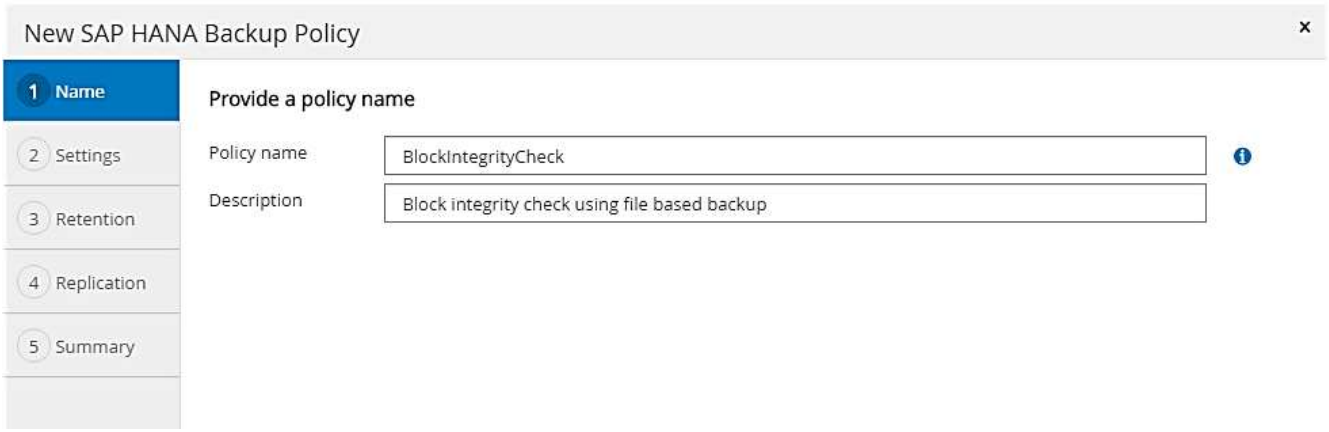


7. On the Summary page, click Finish.

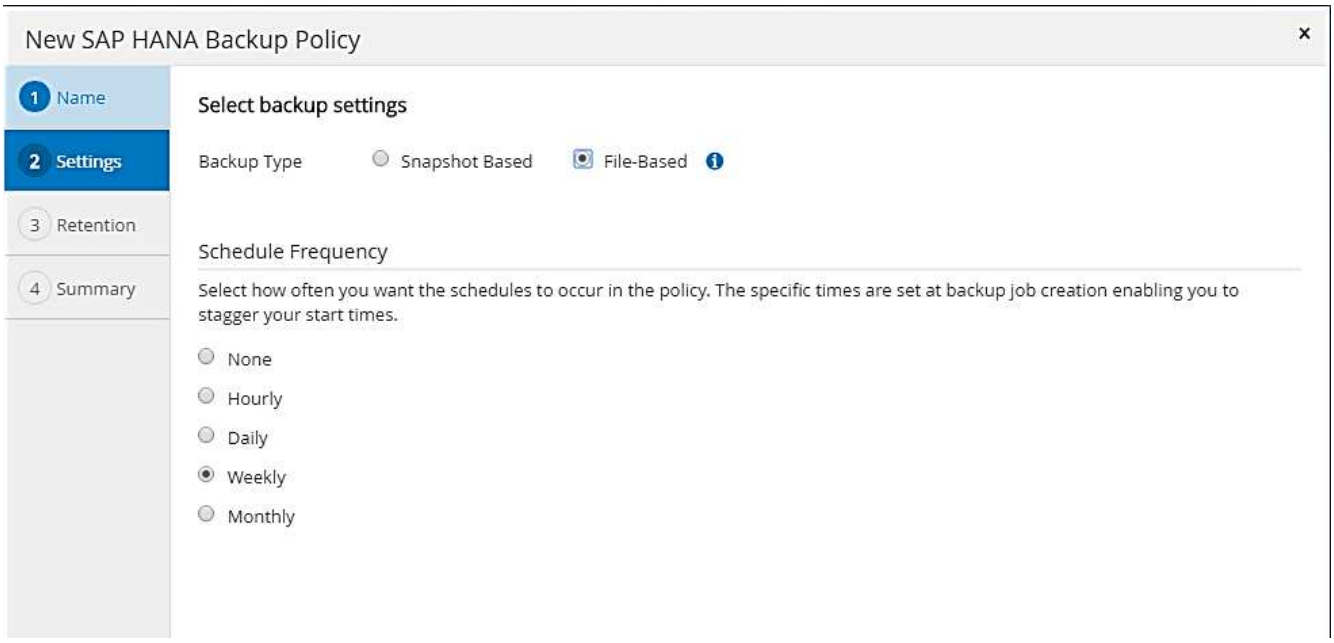


Policy for Weekly Block Integrity Check

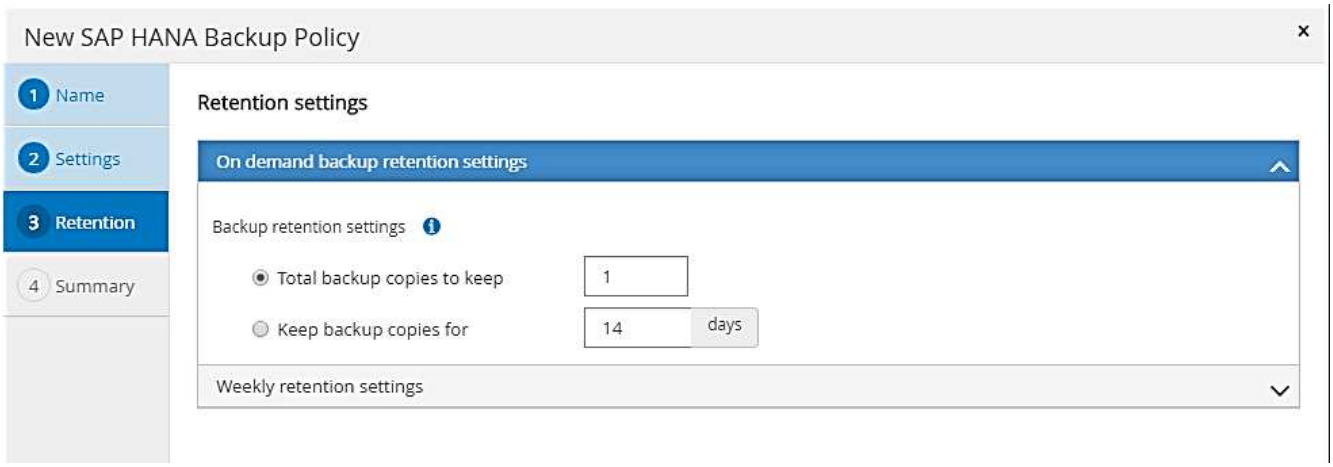
1. Go to Settings > Policies and click New.
2. Enter the policy name and description. Click Next.



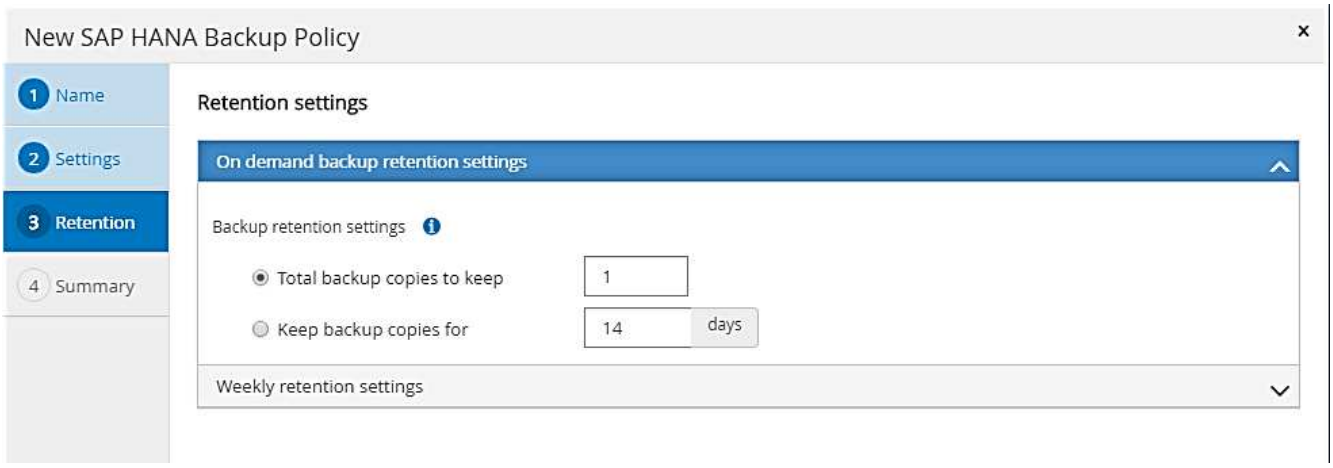
3. Set the backup type to File-Based and schedule frequency to Weekly.



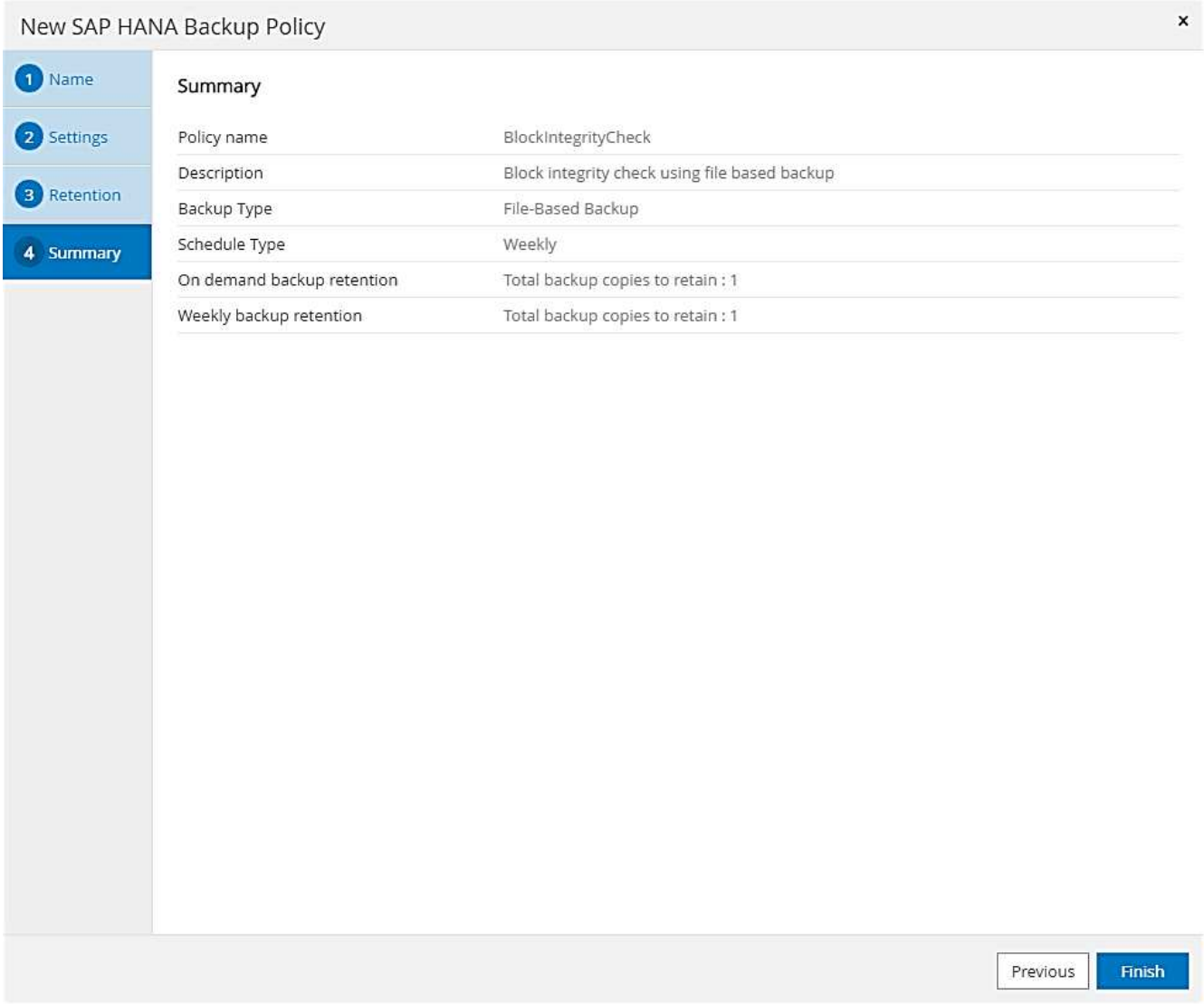
4. Configure the retention settings for on-demand backups.



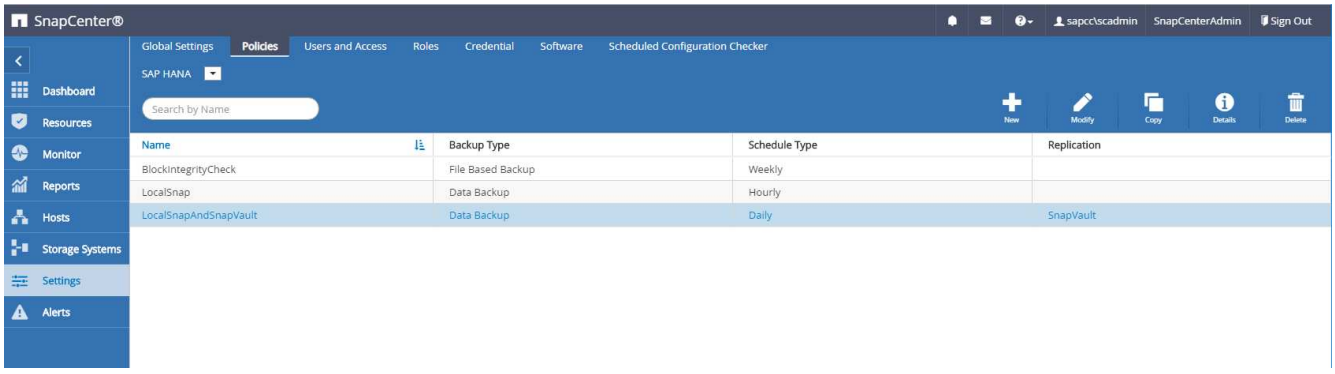
5. Configure the retention settings for scheduled backups.



6. On the Summary page, click Finish.



The following figure shows a summary of the configured policies.



SnapCenter resource-specific configuration for SAP HANA database backups

This section describes the configuration steps for two example configurations.

- **SS2.**
  - Single-host SAP HANA MDC single-tenant system using NFS for storage access
  - The resource is manually configured in SnapCenter.
  - The resource is configured to create local Snapshot backups and perform block integrity checks for the SAP HANA database using a weekly file-based backup.
- **SS1.**
  - Single-host SAP HANA MDC single-tenant system using NFS for storage access
  - The resource is auto-discovered with SnapCenter.
  - The resource is configured to create local Snapshot backups, replicate to an off-site backup storage using SnapVault, and perform block integrity checks for the SAP HANA database using a weekly file-based backup.

The differences for a SAN-attached, a single-container, or a multiple-host system are reflected in the corresponding configuration or workflow steps.

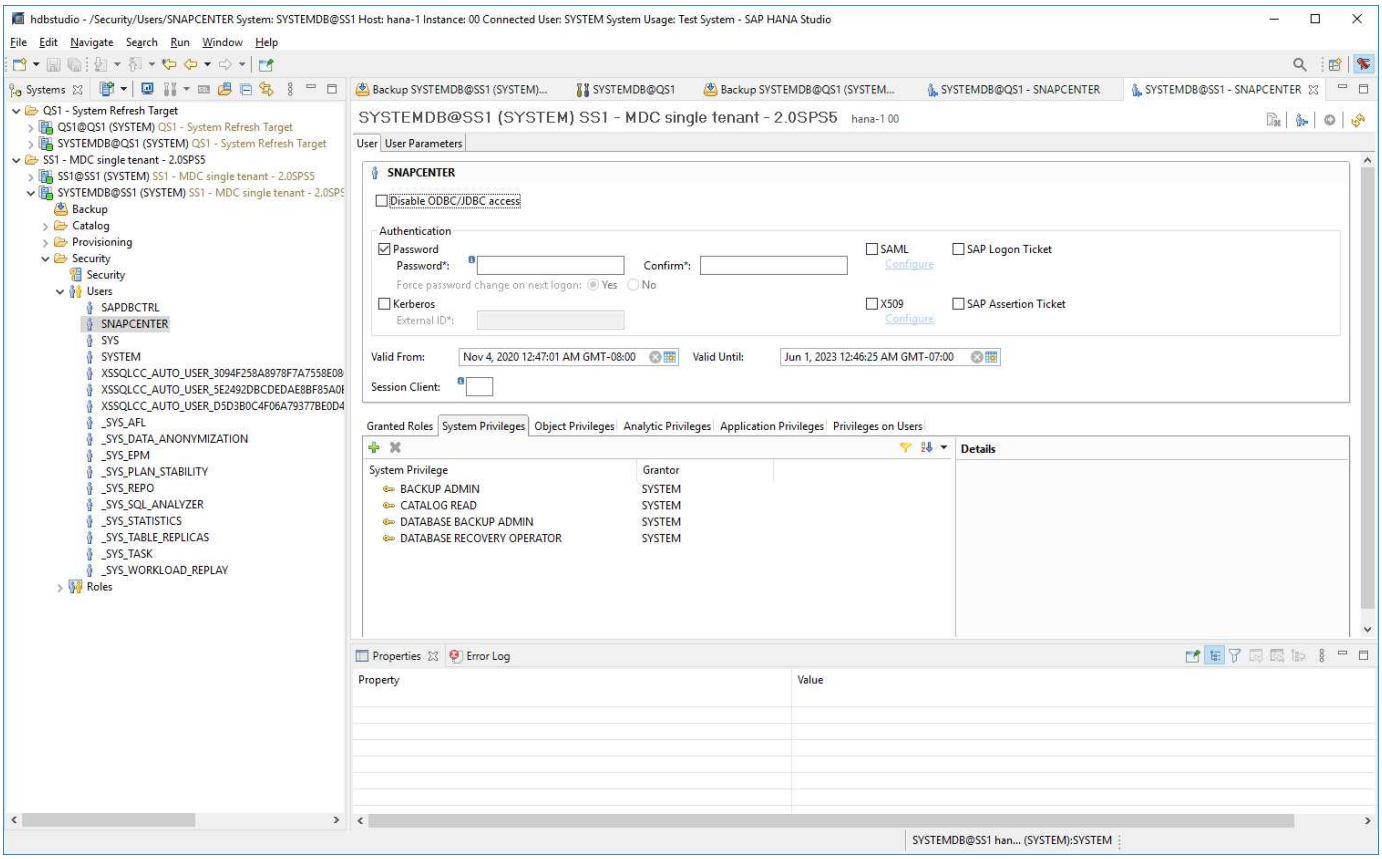
SAP HANA backup user and hdbuserstore configuration

NetApp recommends configuring a dedicated database user in the HANA database to run the backup operations with SnapCenter. In the second step, an SAP HANA user store key is configured for this backup user, and this user store key is used in the configuration of the SnapCenter SAP HANA plug-in.

The following figure shows the SAP HANA Studio through which the backup user can be created.

The required privileges were changed with the HANA 2.0 SPS5 release: backup admin, catalog read, database backup admin, and database recovery operator. For earlier releases, backup admin and catalog read are sufficient.

For an SAP HANA MDC system, the user must be created in the system database because all backup commands for the system and the tenant databases are executed using the system database.



At the HANA plug-in host, on which the SAP HANA plug-in and the SAP hdbsql client are installed, a userstore key must be configured.

Userstore configuration on the SnapCenter server used as a central HANA plug-in host

If the SAP HANA plug-in and the SAP hdbsql client are installed on Windows, the local system user executes the hdbsql commands and is configured by default in the resource configuration. Because the system user is not a logon user, the user store configuration must be done with a different user and the `-u <User>` option.

```
hdbuserstore.exe -u SYSTEM set <key> <host>:<port> <database user>
<password>
```

The SAP HANA hdbclient software must be first installed on the Windows host.

Userstore configuration on a separate Linux host used as a Central HANA plug-in host

If the SAP HANA plug-in and SAP hdbsql client are installed on a separate Linux host, the following command is used for the user store configuration with the user defined in the resource configuration:

```
hdbuserstore set <key> <host>:<port> <database user> <password>
```

The SAP HANA hdbclient software must be first installed on the Linux host.

Userstore configuration on the HANA database host

If the SAP HANA plug-in is deployed on the HANA database host, the following command is used for the user store configuration with the `<sid>adm` user:

```
hdbuserstore set <key> <host>:<port> <database user> <password>
```

SnapCenter uses the `<sid>adm` user to communicate with the HANA database. Therefore, the user store key must be configured using the <`sid>adm` user on the database host.

Typically, the SAP HANA hdbsql client software is installed together with the database server installation. If this is not the case, the hdbclient must be installed first.

Userstore configuration depending on HANA system architecture

In an SAP HANA MDC single-tenant setup, port `3<instanceNo>13` is the standard port for SQL access to the system database and must be used in the hdbuserstore configuration.

For an SAP HANA single-container setup, port `3<instanceNo>15` is the standard port for SQL access to the index server and must be used in the hdbuserstore configuration.

For an SAP HANA multiple-host setup, user store keys for all hosts must be configured. SnapCenter tries to connect to the database using each of the provided keys and can therefore operate independently of a failover of an SAP HANA service to a different host.

Userstore configuration examples

In the lab setup, a mixed SAP HANA plug-in deployment is used. The HANA plug-in is installed on the SnapCenter Server for some HANA systems and deployed on the individual HANA database servers for other systems.

SAP HANA system SS1, MDC single tenant, instance 00

The HANA plug-in has been deployed on the database host. Therefore, the key must be configured on the database host with the user ss1adm.

```
hana-1:/ # su - ss1adm
ss1adm@hana-1:/usr/sap/SS1/HDB00>
ss1adm@hana-1:/usr/sap/SS1/HDB00>
ss1adm@hana-1:/usr/sap/SS1/HDB00> hdbuserstore set SS1KEY hana-1:30013
SnapCenter password
ss1adm@hana-1:/usr/sap/SS1/HDB00> hdbuserstore list
DATA FILE       : /usr/sap/SS1/home/.hdb/hana-1/SSFS_HDB.DAT
KEY FILE        : /usr/sap/SS1/home/.hdb/hana-1/SSFS_HDB.KEY
KEY SS1KEY
  ENV : hana-1:30013
  USER: SnapCenter
KEY SS1SAPDBCTRLSS1
  ENV : hana-1:30015
  USER: SAPDBCTRL
ss1adm@hana-1:/usr/sap/SS1/HDB00>
```

SAP HANA system MS1, multiple-host MDC single tenant, instance 00

For HANA multiple host systems, a central plug-in host is required, in our setup we used the SnapCenter Server. Therefore, the user store configuration must be done on the SnapCenter Server.

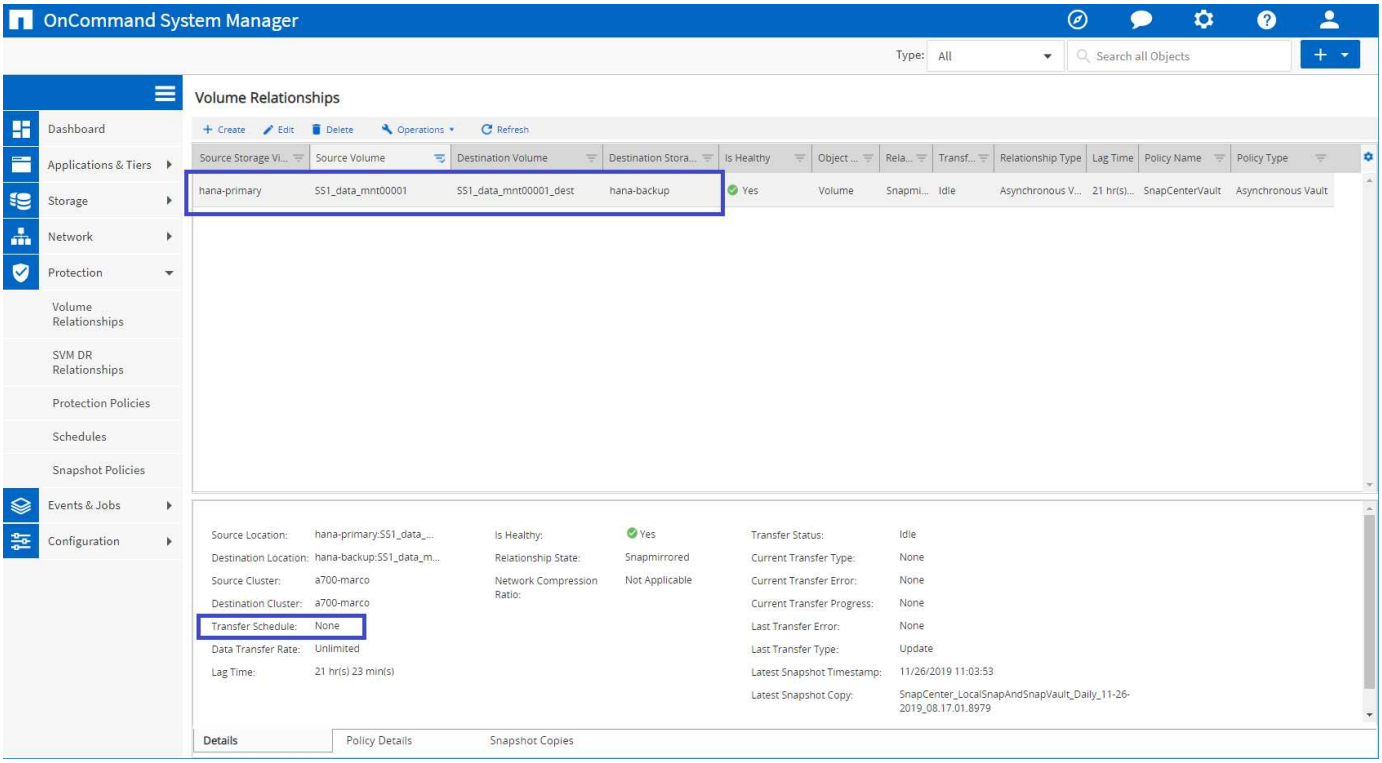
```
hdbuserstore.exe -u SYSTEM set MS1KEYHOST1 hana-4:30013 SNAPCENTER
password
hdbuserstore.exe -u SYSTEM set MS1KEYHOST2 hana-5:30013 SNAPCENTER
password
hdbuserstore.exe -u SYSTEM set MS1KEYHOST3 hana-6:30013 SNAPCENTER
password
C:\Program Files\sap\hdbclient>hdbuserstore.exe -u SYSTEM list
DATA FILE       : C:\ProgramData\.hdb\SNAPCENTER-43\S-1-5-18\SSFS_HDB.DAT
KEY FILE        : C:\ProgramData\.hdb\SNAPCENTER-43\S-1-5-18\SSFS_HDB.KEY
KEY MS1KEYHOST1
  ENV : hana-4:30013
  USER: SNAPCENTER
KEY MS1KEYHOST2
  ENV : hana-5:30013
  USER: SNAPCENTER
KEY MS1KEYHOST3
  ENV : hana-6:30013
  USER: SNAPCENTER
KEY SS2KEY
  ENV : hana-3:30013
  USER: SNAPCENTER
C:\Program Files\sap\hdbclient>
```

Configuration of data protection to off-site backup storage

The configuration of the data protection relation as well as the initial data transfer must be executed before replication updates can be managed by SnapCenter.

The following figure shows the configured protection relationship for the SAP HANA system SS1. With our example, the source volume `SS1_data_mnt00001` at the SVM `hana-primary` is replicated to the SVM `hana-backup` and the target volume `SS1_data_mnt00001_dest`.

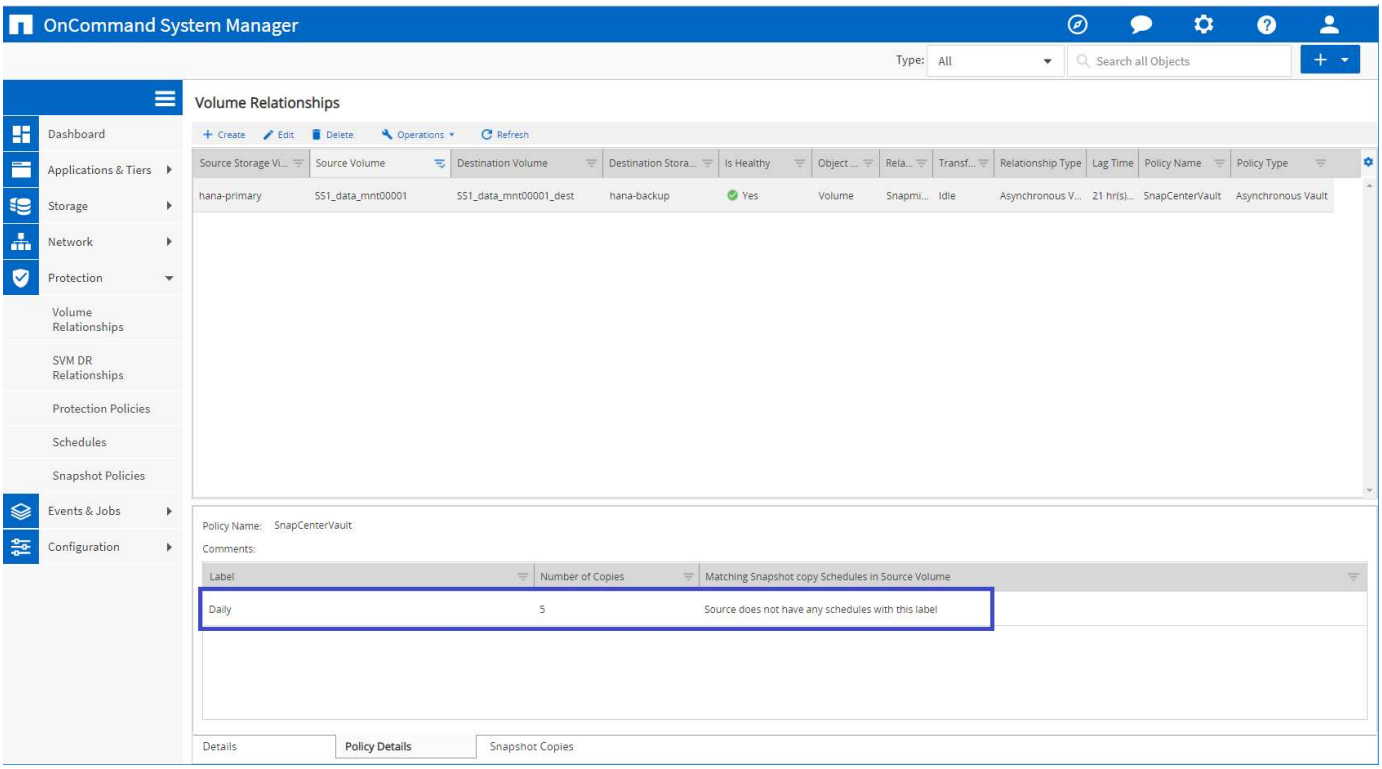
The schedule of the relationship must be set to None, because SnapCenter triggers the SnapVault update.



The following figure shows the protection policy. The protection policy used for the protection relationship defines the SnapMirror label, as well as the retention of backups at the secondary storage. In our example, the used label is `Daily`, and the retention is set to 5.

The SnapMirror label in the policy being created must match the label defined in the SnapCenter policy configuration. For details, refer to Policy for daily Snapshot backups with SnapVault replication.

The retention for backups at the off-site backup storage is defined in the policy and controlled by ONTAP.



Manual HANA resource configuration

This section describes the manual configuration of the SAP HANA resources SS2 and MS1.

- SS2 is a single-host MDC single-tenant system
- MS1 is a multiple-host MDC single-tenant system.

1. From the Resources tab, select SAP HANA and click Add SAP HANA Database.
2. Enter the information for configuring the SAP HANA database and click Next.

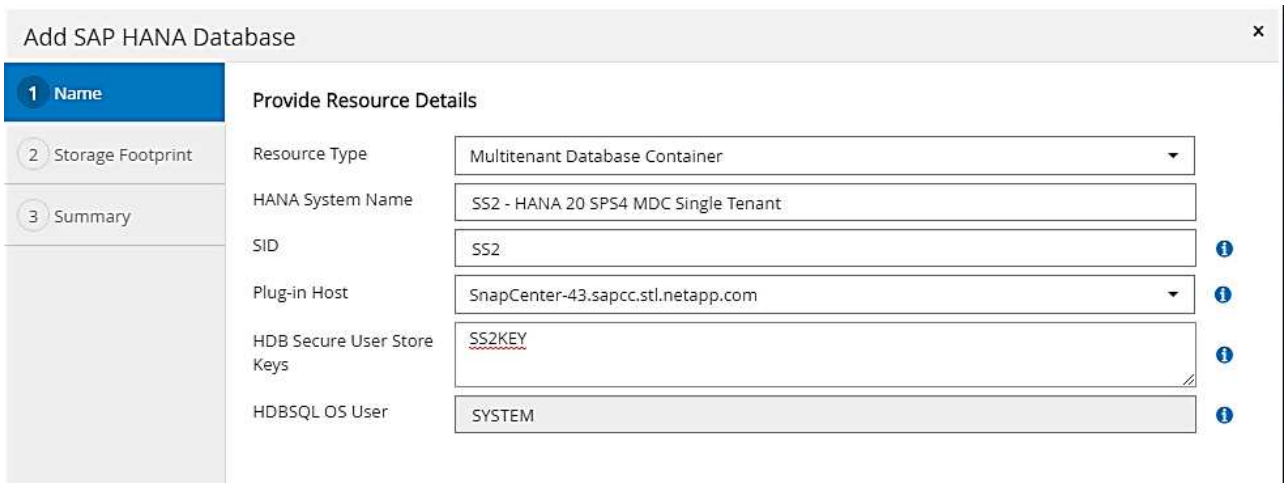
   Select the resource type in our example, Multitenant Database Container.

   For a HANA single container system, the resource type Single Container must be selected. All the other configuration steps are identical.

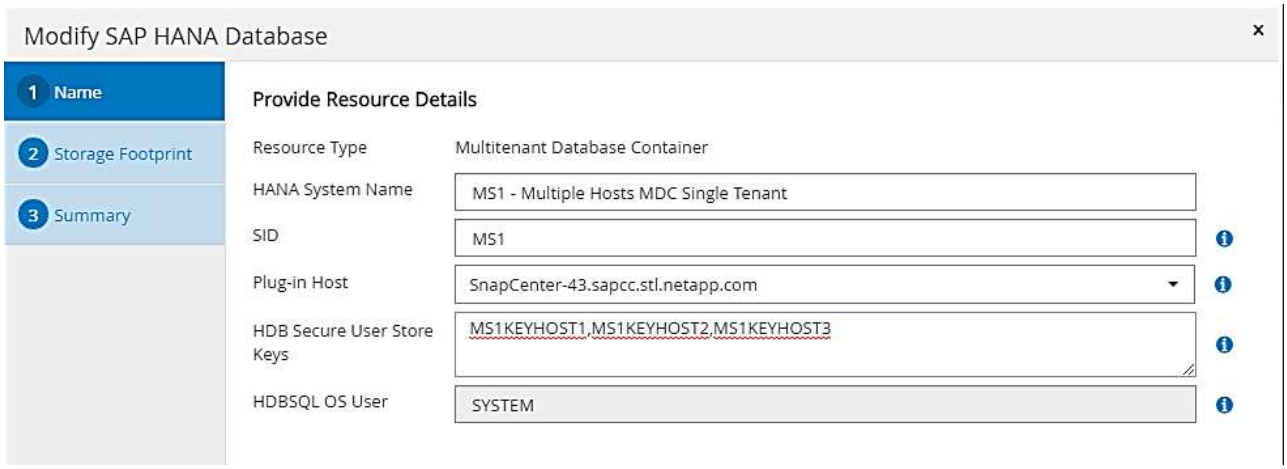
   For our SAP HANA system, the SID is SS2.

   The HANA plug-in host in our example is the SnapCenter Server.

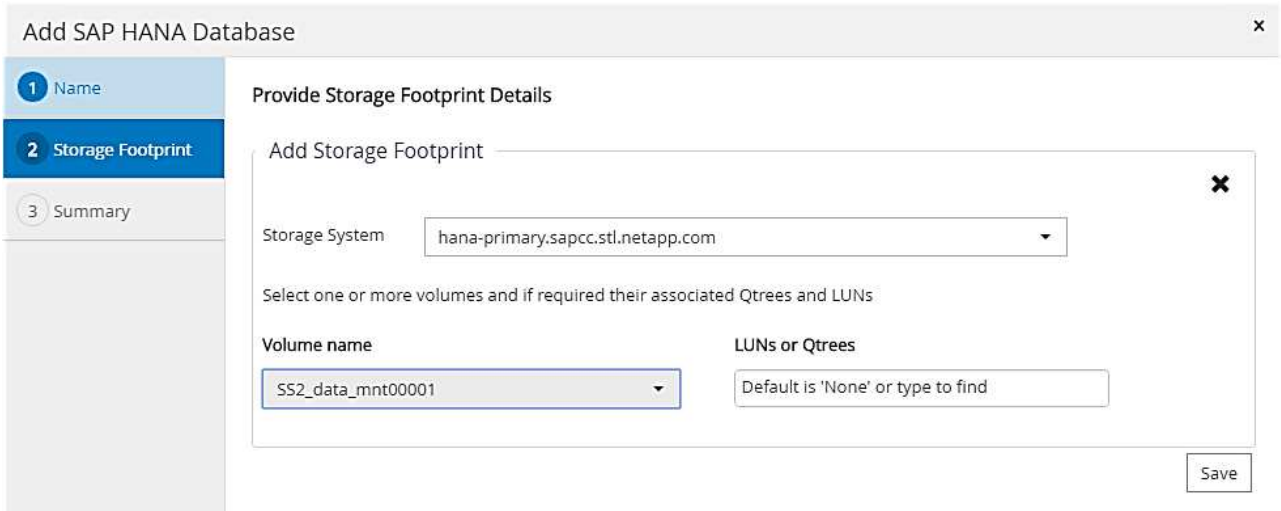
   The hdbuserstore key must match the key that was configured for the HANA database SS2. In our example it is SS2KEY.



For an SAP HANA multiple-host system, the hdbuserstore keys for all hosts must be included, as shown in the following figure. SnapCenter will try to connect with the first key in the list, and will continue with the other case, in case the first key does not work. This is required to support HANA failover in a multiple-host system with worker and standby hosts.

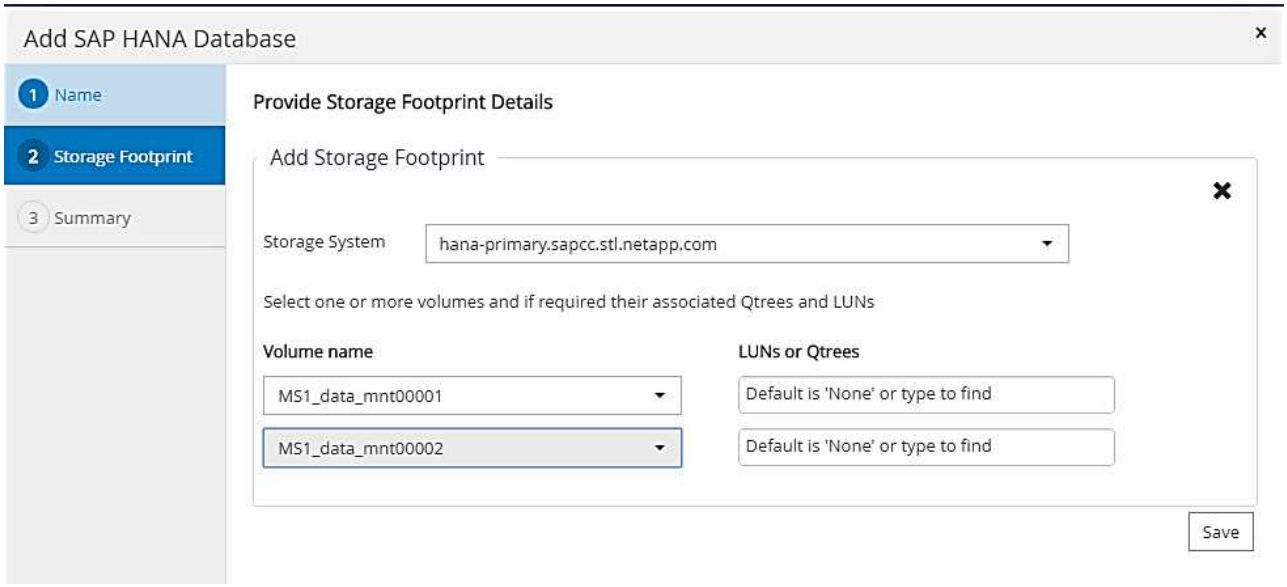


3. Select the required data for the storage system (SVM) and volume name.



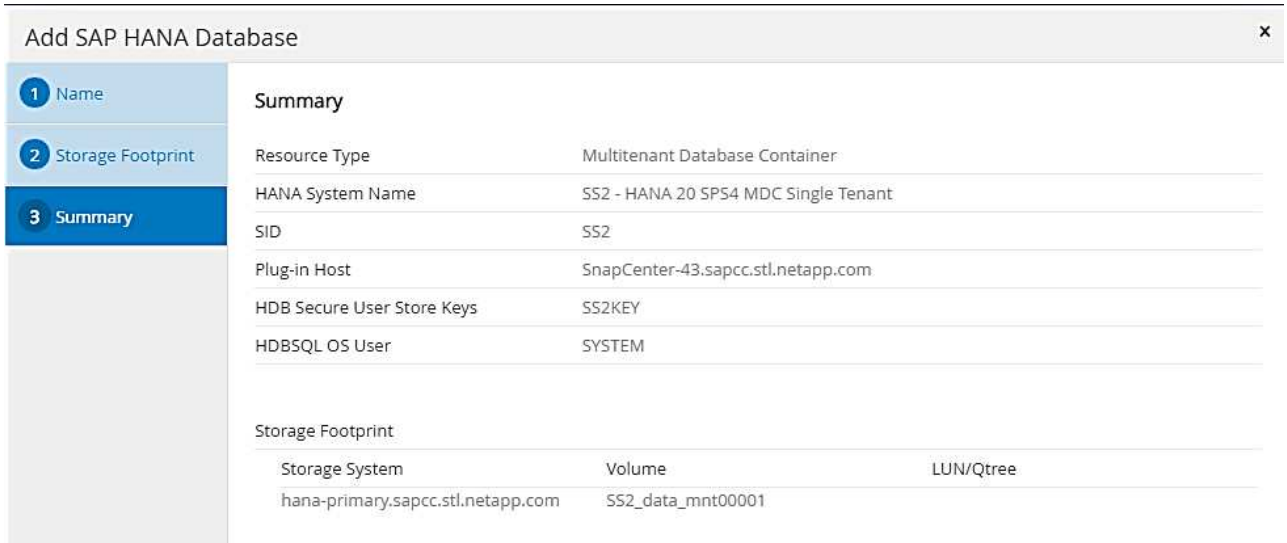
For a Fibre Channel SAN configuration, the LUN needs to be selected as well.

For an SAP HANA multiple-host system, all data volumes of the SAP HANA system must be selected, as shown in the following figure.



The summary screen of the resource configuration is shown.

4. Click Finish to add the SAP HANA database.



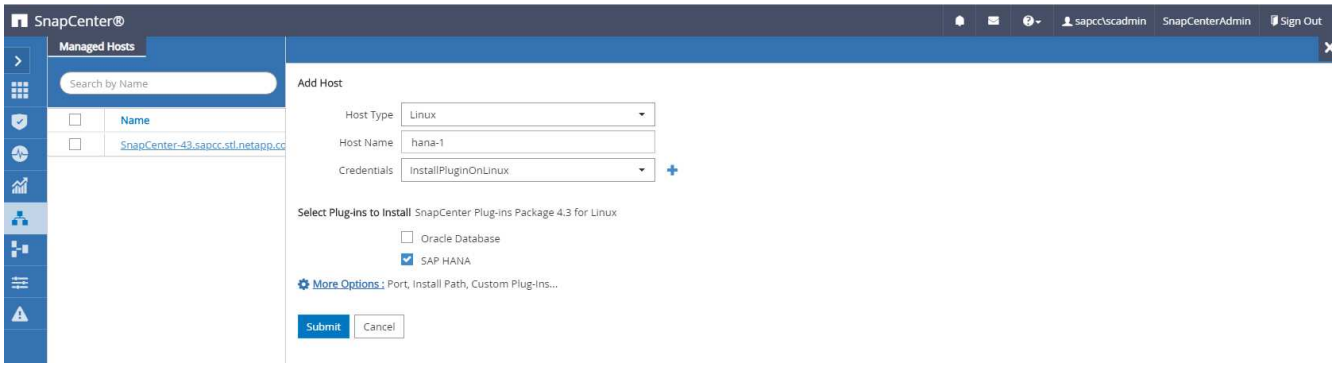
5. When resource configuration is finished, perform the configuration of resource protection as described in the section Resource protection configuration.

Automatic discovery of HANA databases

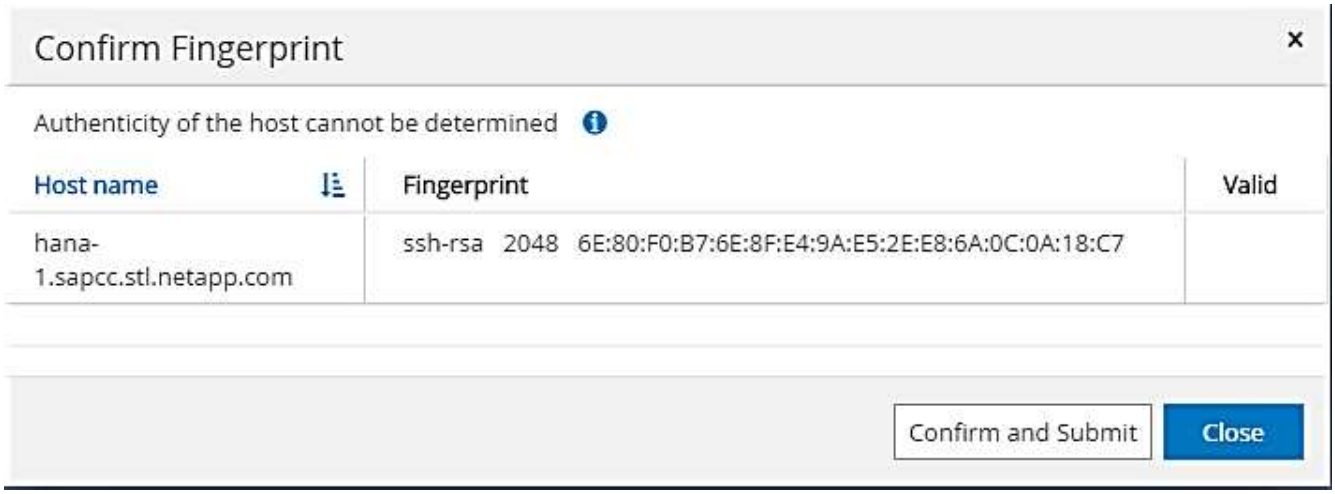
This section describes the automatic discovery of the SAP HANA resource SS1 (single host MDC single tenant system with NFS). All the described steps are identical for a HANA single container, HANA MDC multiple tenants' systems, and a HANA system using Fibre Channel SAN.

The SAP HANA plug-in requires Java 64-bit version 1.8. Java must be installed on the host before the SAP HANA plug-in is deployed.

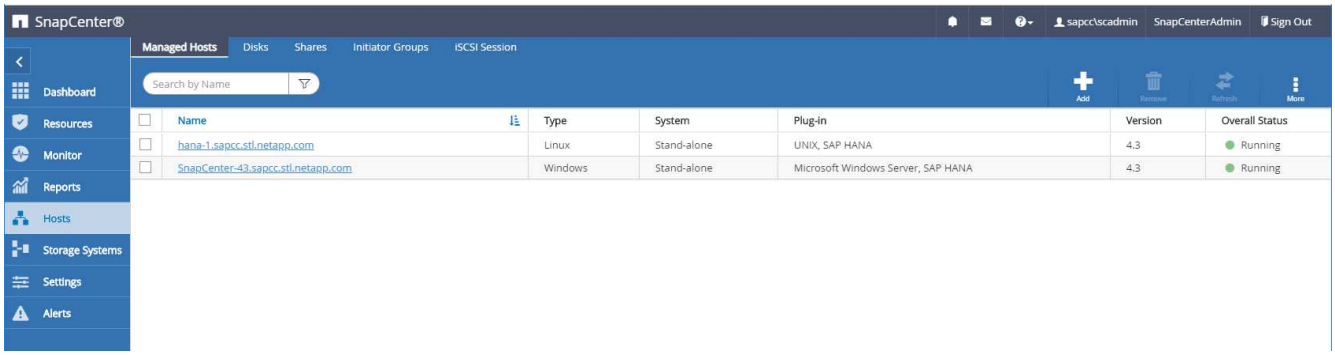
1. From the host tab, click Add.
2. Provide host information and select the SAP HANA plug-in to be installed. Click Submit.



3. Confirm the fingerprint.



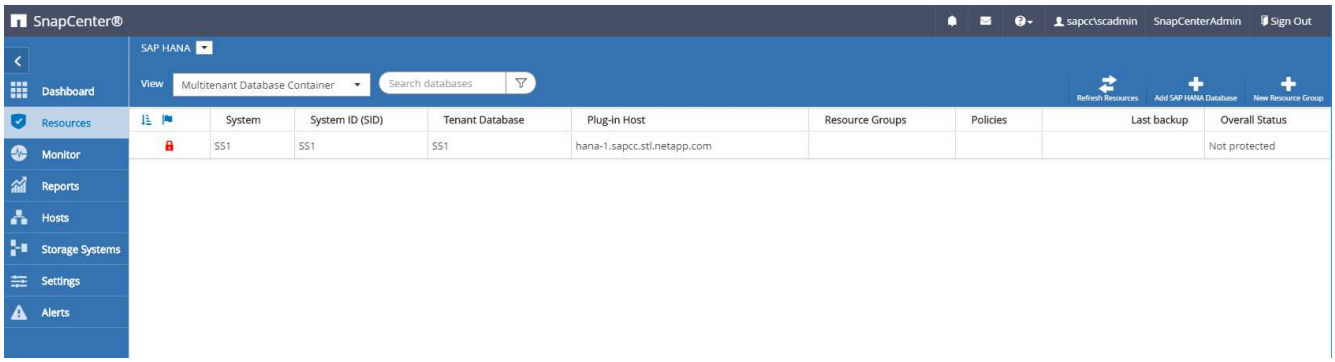
The installation of the HANA plug-in and the Linux plug-in starts automatically. When the installation is finished, the status column of the host shows Running. The screen also shows that the Linux plug-in is installed together with the HANA plug-in.



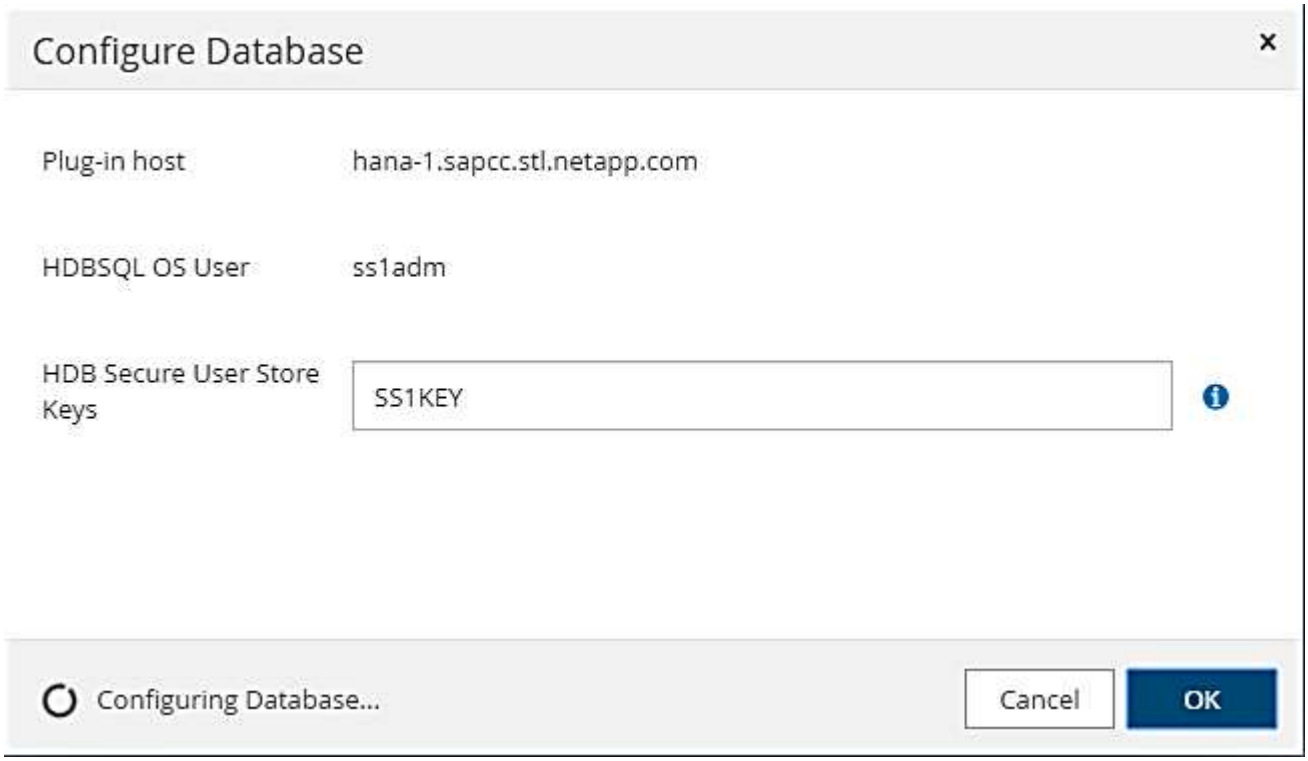
After the plug-in installation, the automatic discovery process of the HANA resource starts automatically. In the Resources screen, a new resource is created, which is marked as locked with the red padlock icon.

4. Select and click on the resource to continue the configuration.

> You can also trigger the automatic discovery process manually within the Resources screen, by clicking Refresh Resources.

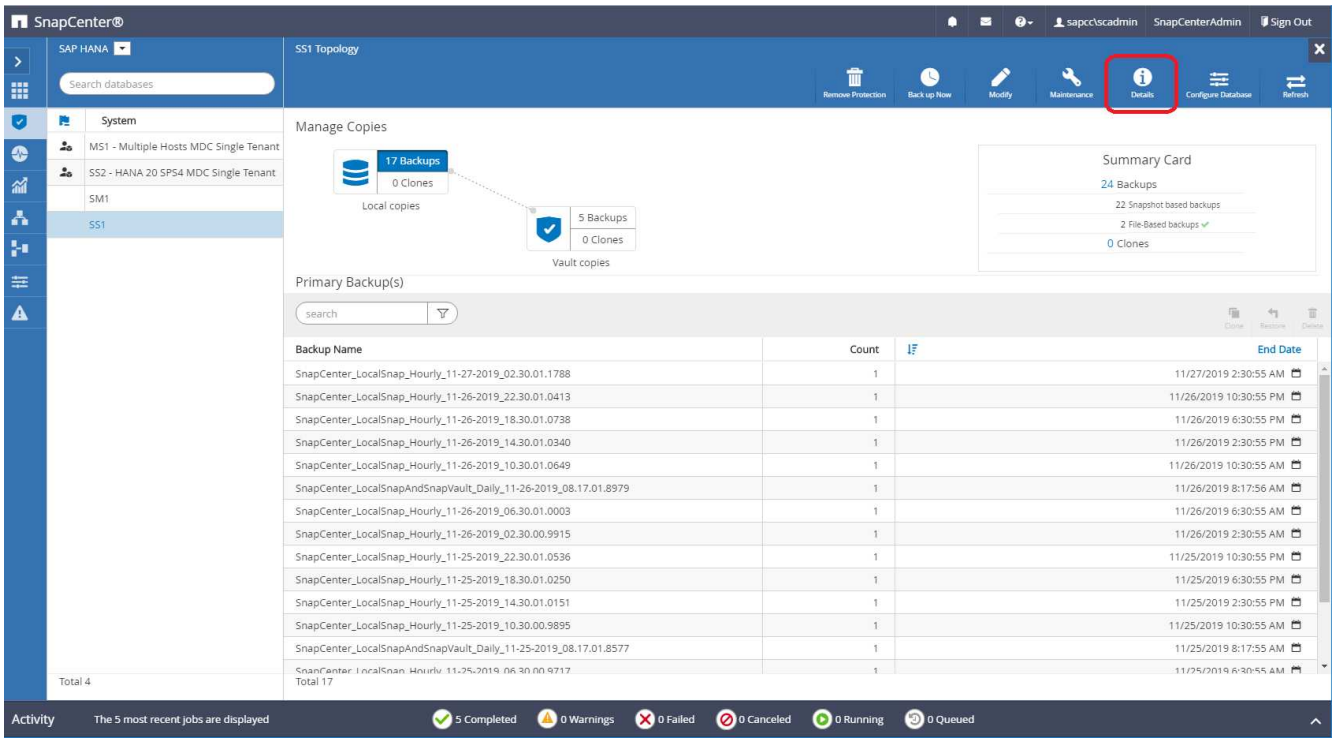


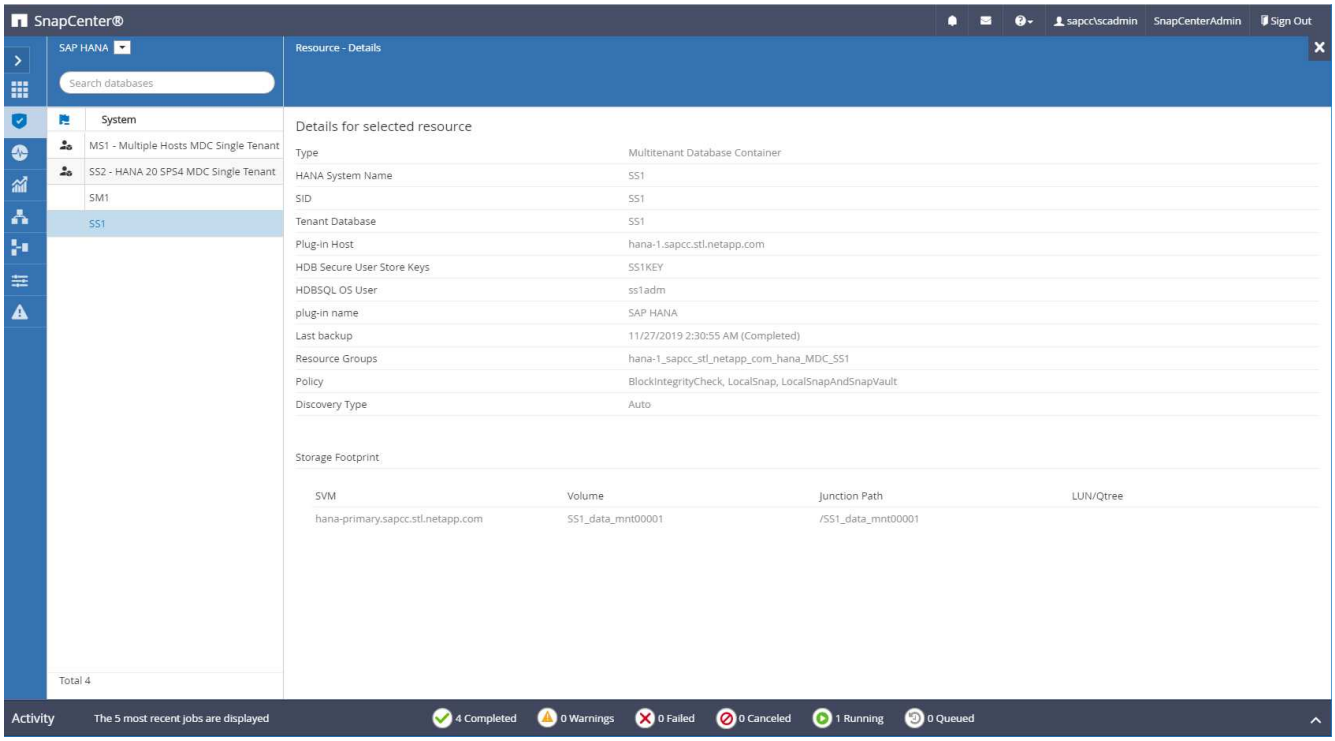
5. Provide the userstore key for the HANA database.



The second level automatic discovery process starts in which tenant data and storage footprint information is discovered.

6. Click Details to review the HANA resource configuration information in the resource topology view.





When the resource configuration is finished, the resource protection configuration must be executed as described in the following section.

Resource protection configuration

This section describes the resource protection configuration. The resource protection configuration is the same, whether the resource has been auto discovered or configured manually. It is also identical for all HANA architectures, single or multiple hosts, single container, or MDC systems.

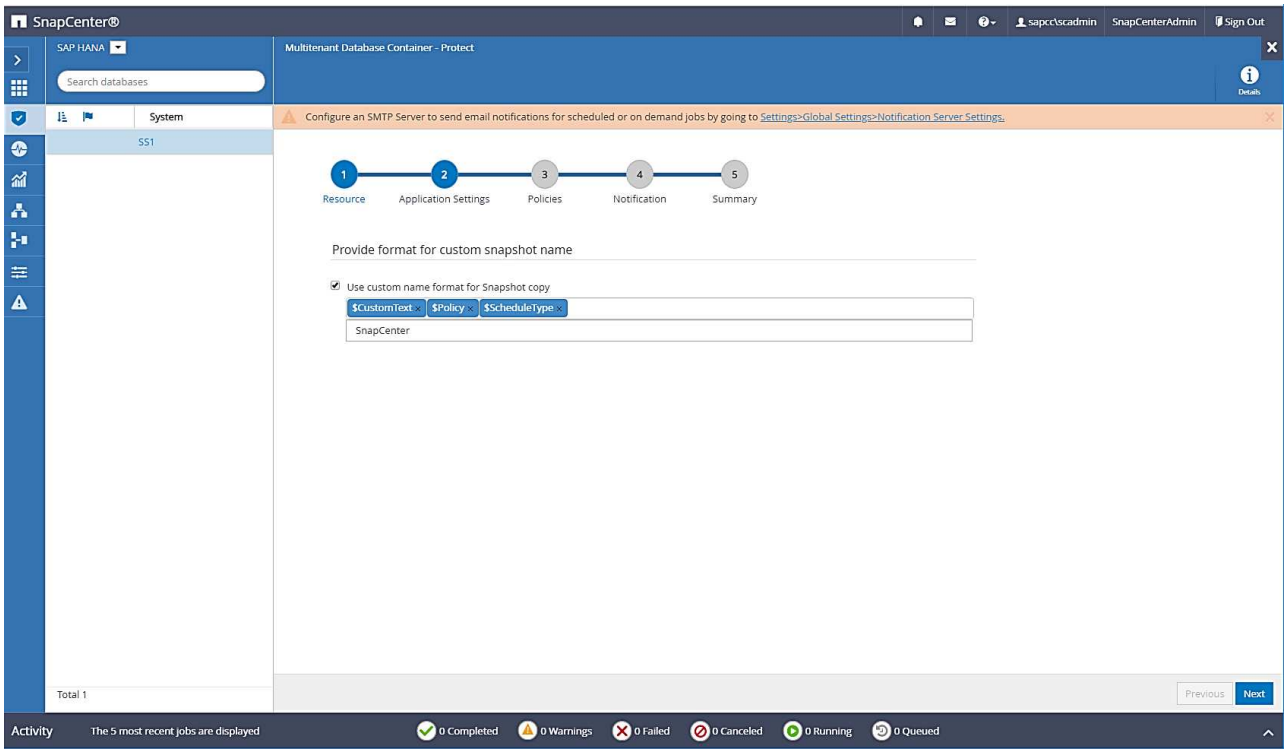
1. From the Resources tab, double-click the resource.
2. Configure a custom name format for the Snapshot copy.

> NetApp recommends using a custom Snapshot copy name to easily identify which backups have been created with which policy and schedule type. By adding the schedule type in the Snapshot copy name, you can distinguish between scheduled and on-demand backups. The `schedule name` string for on-demand backups is empty, while scheduled backups include the string `Hourly`, `Daily`, `or Weekly`.

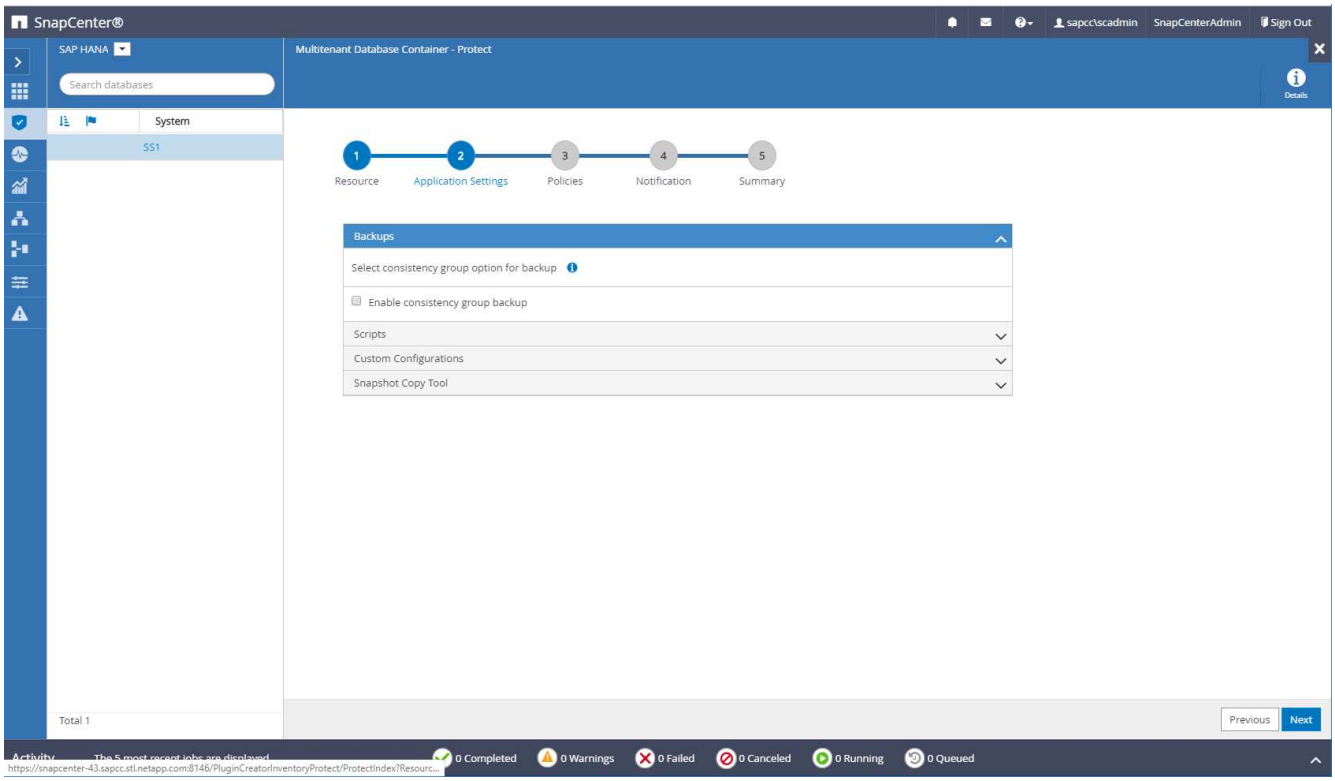
In the configuration shown in the following figure, the backup and Snapshot copy names have the following format:

- Scheduled hourly backup: `SnapCenter_LocalSnap_Hourly_<time_stamp>`
- Scheduled daily backup: `SnapCenter_LocalSnapAndSnapVault_Daily_<time_stamp>`
- On-demand hourly backup: `SnapCenter_LocalSnap_<time_stamp>`
- On-demand daily backup: `SnapCenter_LocalSnapAndSnapVault_<time_stamp>`

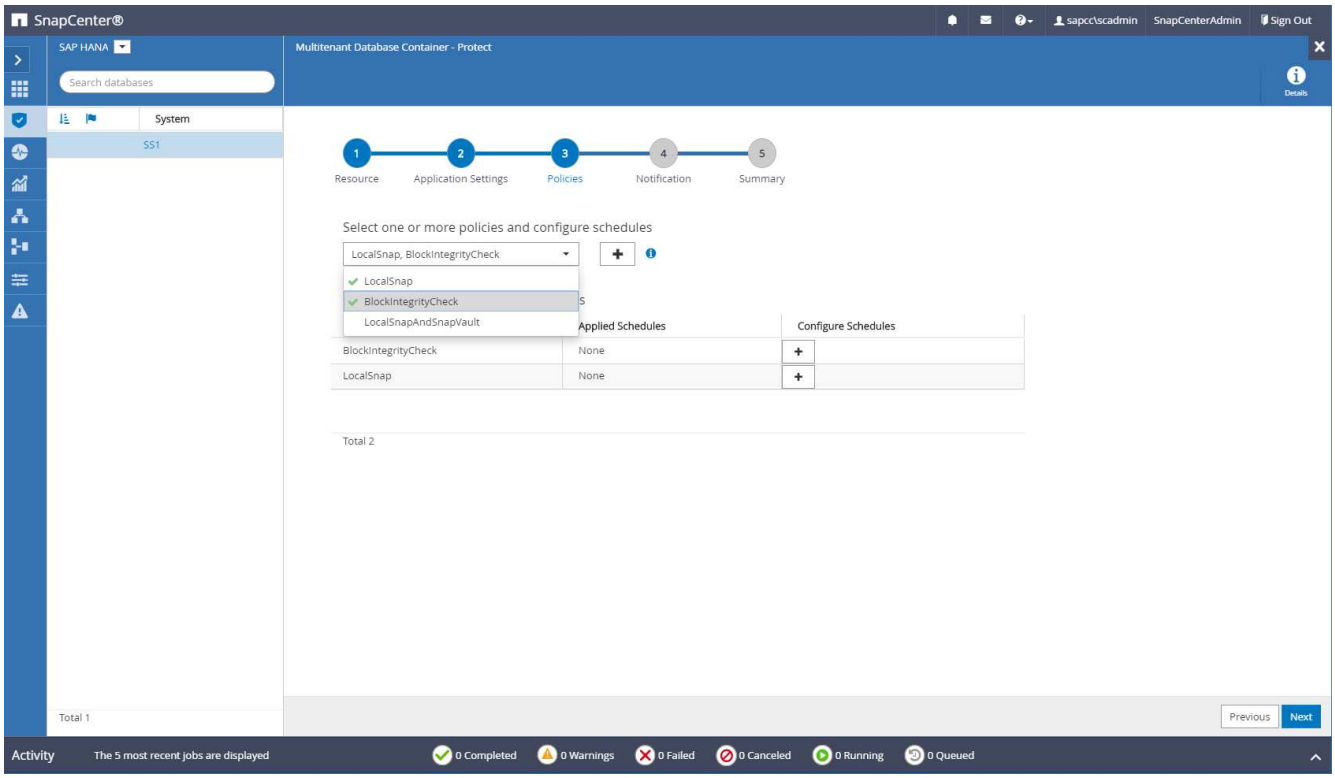
> Even though a retention is defined for on-demand backups in the policy configuration, the housekeeping is only done when another on-demand backup is executed. Therefore, on-demand backups must typically be deleted manually in SnapCenter to make sure that these backups are also deleted in the SAP HANA backup catalog and that the log backup housekeeping is not based on an old on-demand backup.



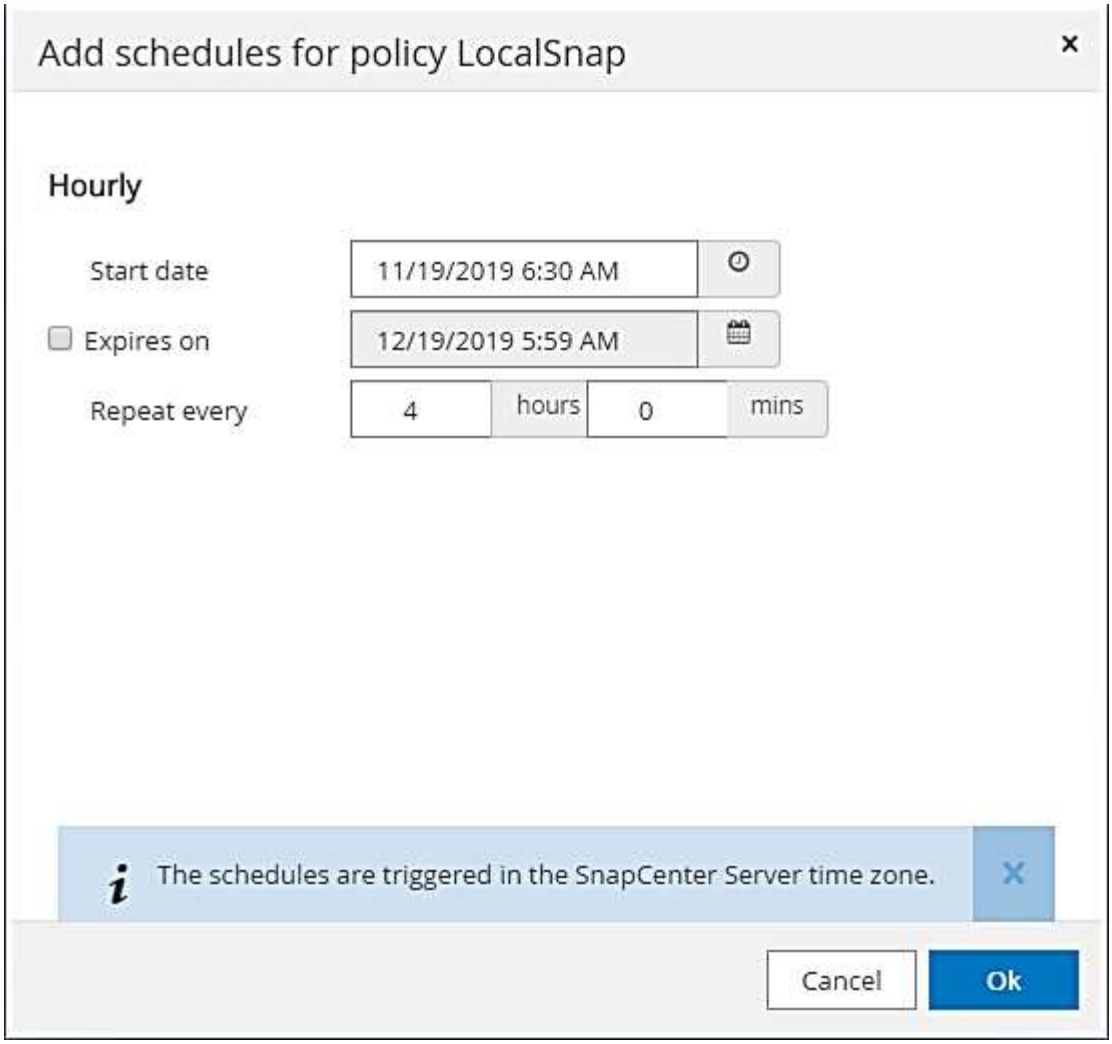
3. No specific setting needs to be made on the Application Settings page. Click Next.



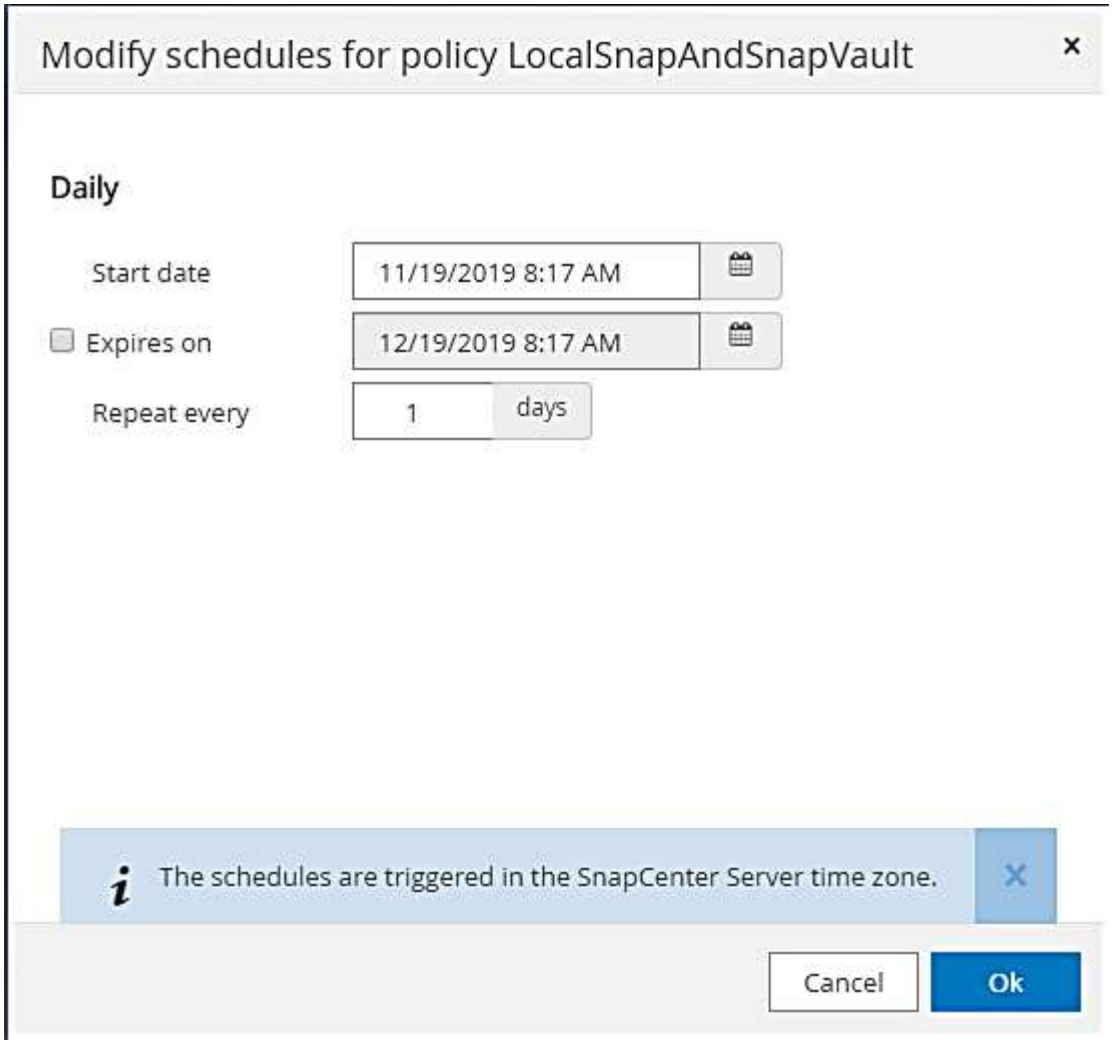
4. Select the policies to add to the resource.



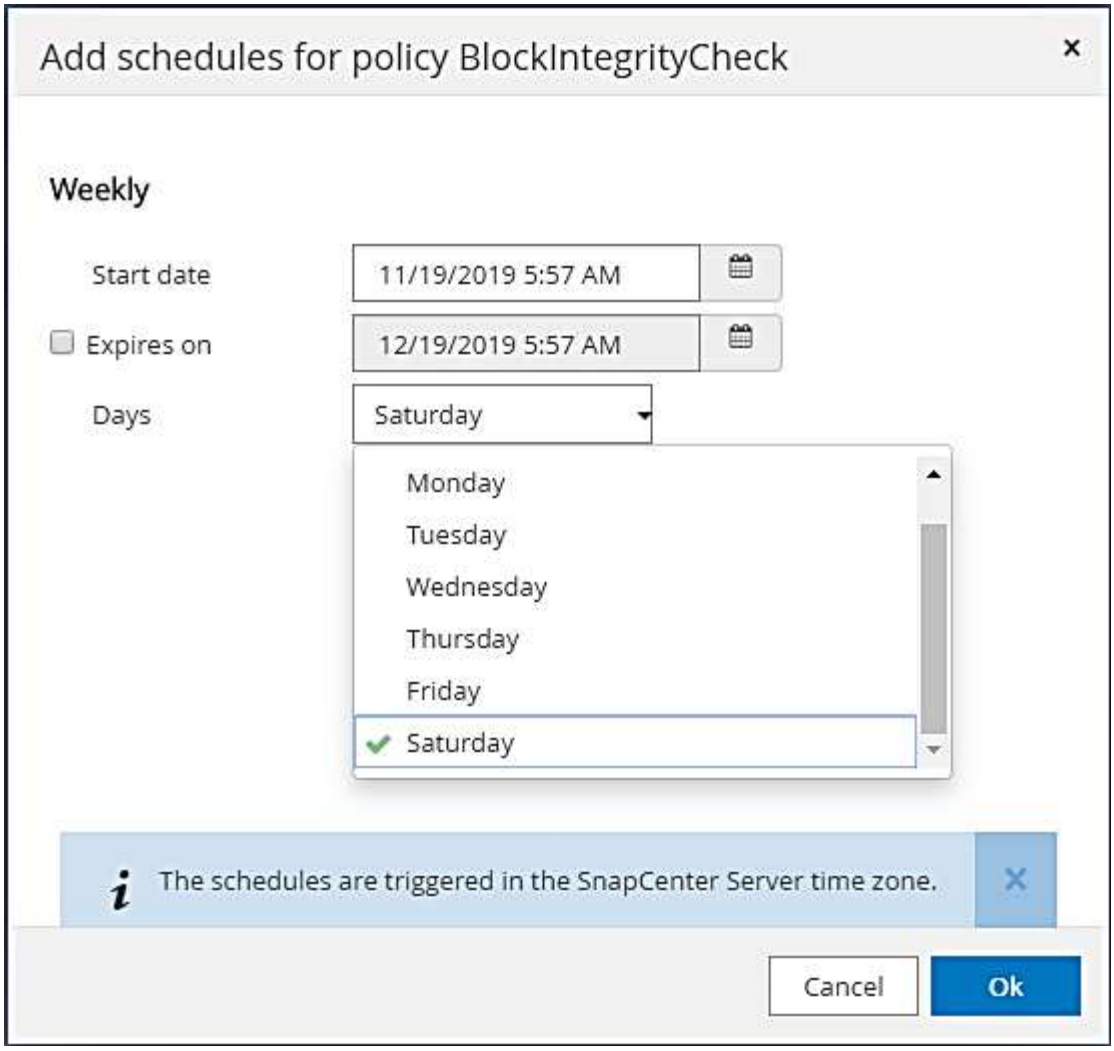
5. Define the schedule for the LocalSnap policy (in this example, every four hours).



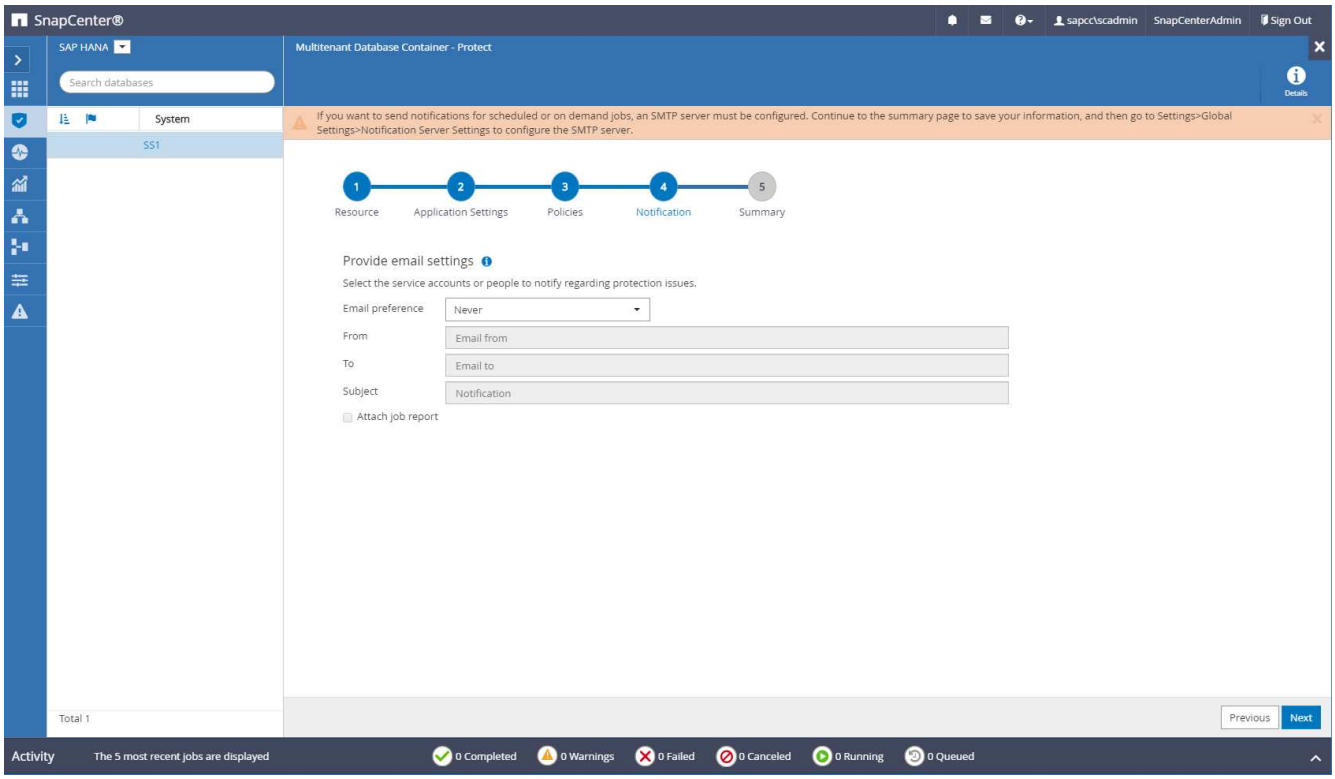
6. Define the schedule for the LocalSnapAndSnapVault policy (in this example, once per day).



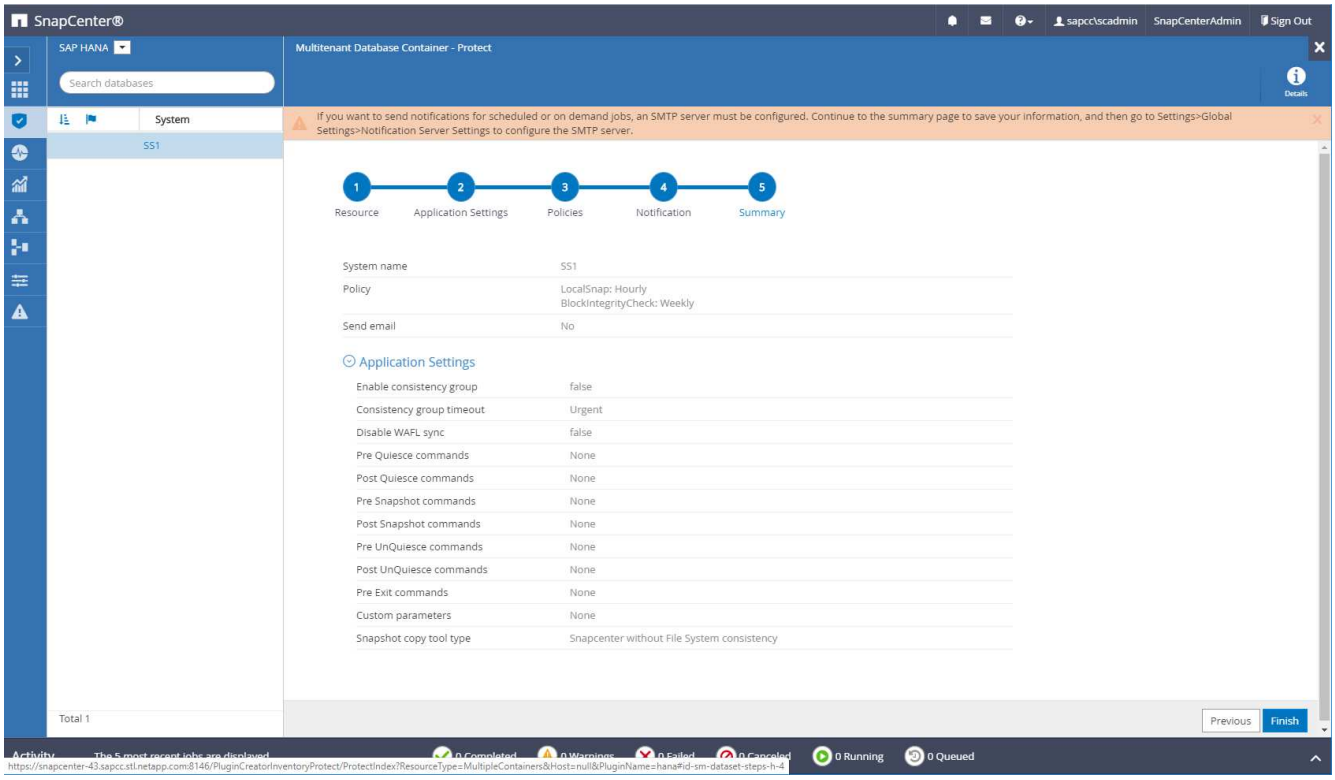
7. Define the schedule for the block integrity check policy (in this example, once per week).



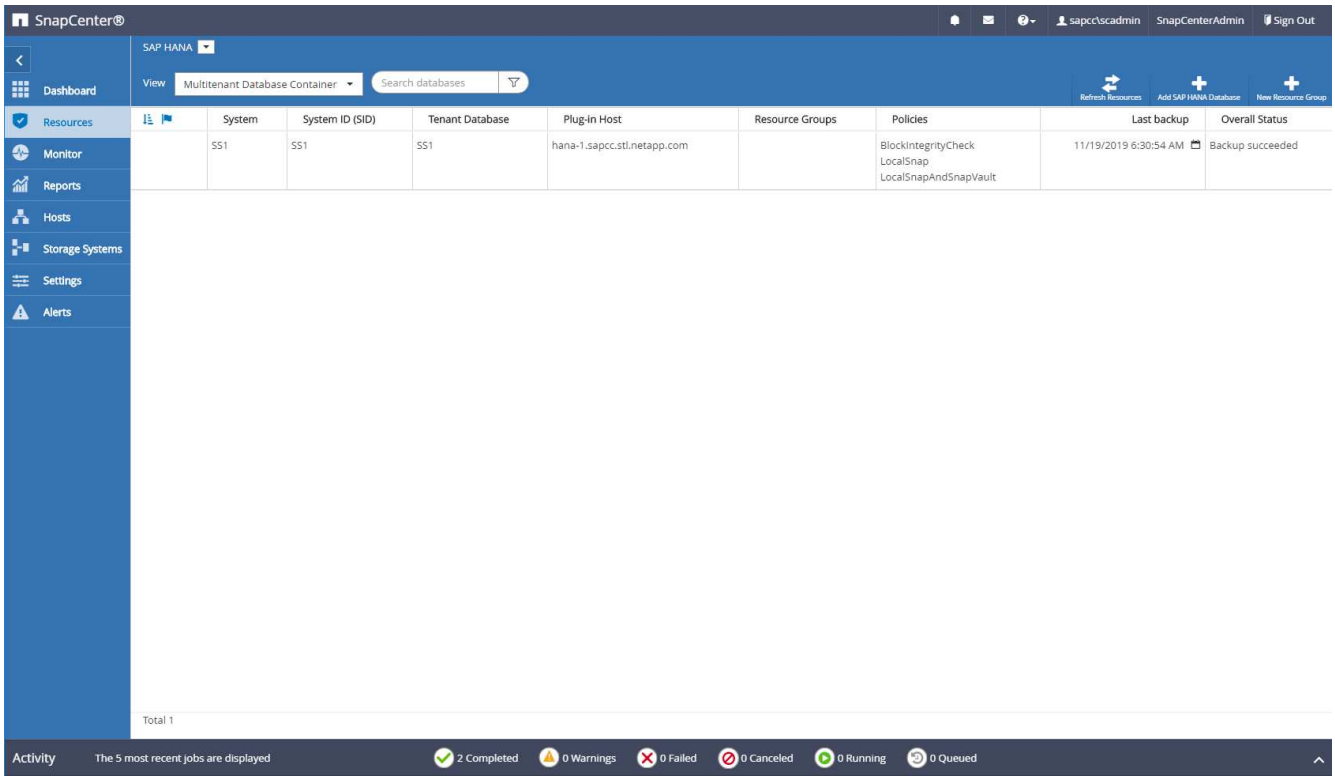
8. Provide information about the email notification.



9. On the Summary page, click Finish.



10. On-demand backups can now be created on the topology page. The scheduled backups are executed based on the configuration settings.



Additional configuration steps for Fibre Channel SAN environments

Depending on the HANA release and the HANA plug-in deployment, additional configuration steps are required for environments in which the SAP HANA systems are using Fibre Channel and the XFS file system.

These additional configuration steps are only required for HANA resources, which are configured manually in SnapCenter. It is also only required for HANA 1.0 releases and HANA 2.0 releases up to SPS2.

When a HANA backup save point is triggered by SnapCenter in SAP HANA, SAP HANA writes Snapshot ID files for each tenant and database service as a last step (for example, `/hana/data/SID/mnt00001/hdb00001/snapshot_databackup_0_1`). These files are part of the data volume on the storage and are therefore part of the storage Snapshot copy. This file is mandatory when performing a recovery in a situation in which the backup is restored. Due to metadata caching with the XFS file system on the Linux host, the file is not immediately visible at the storage layer. The standard XFS configuration for metadata caching is 30 seconds.

With HANA 2.0 SPS3, SAP changed the write operation of these Snapshot ID files to synchronously so that metadata caching is not a problem.

With SnapCenter 4.3, if the HANA plug-in is deployed on the database host, the Linux plug-in executes a file system flush operation on the host before the storage Snapshot is triggered. In this case, the metadata caching is not a problem.

In SnapCenter, you must configure a `postquiesce` command that waits until the XFS metadata cache is flushed to the disk layer.

The actual configuration of the metadata caching can be checked by using the following command:

```
stlrx300s8-2:/ # sysctl -A | grep xfssyncd_centisecs
fs.xfs.xfssyncd_centisecs = 3000
```

NetApp recommends using a wait time that is twice the value of the `fs.xfs.xfssyncd_centisecs` parameter. Because the default value is 30 seconds, set the sleep command to 60 seconds.

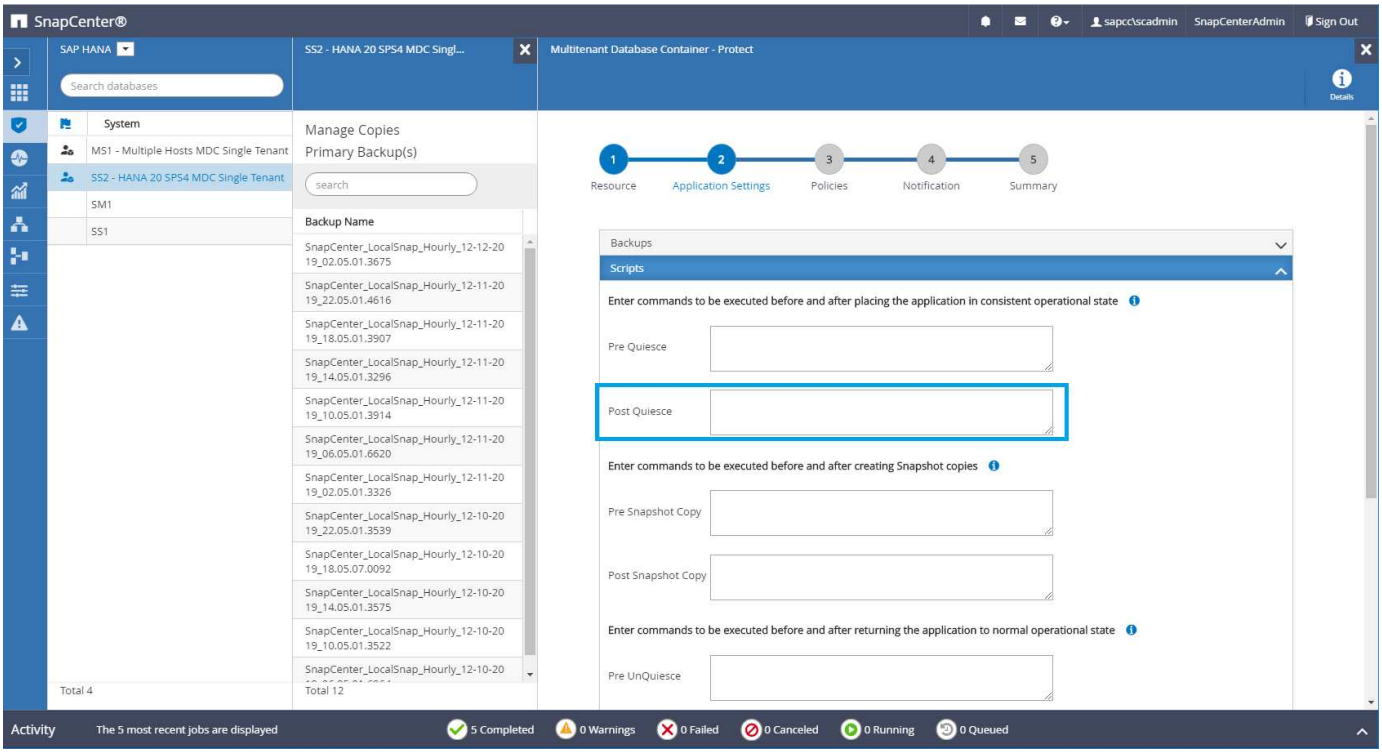
If the SnapCenter server is used as a central HANA plug-in host, a batch file can be used. The batch file must have the following content:

```
@echo off
waitfor AnyThing /t 60 2>NUL
Exit /b 0
```

The batch file can be saved, for example, as `C:\Program Files\NetApp\Wait60Sec.bat`. In the resource protection configuration, the batch file must be added as Post Quiesce command.

If a separate Linux host is used as a central HANA plug-in host, you must configure the command `/bin/sleep 60` as the Post Quiesce command in the SnapCenter UI.

The following figure shows the Post Quiesce command within the resource protection configuration screen.



SnapCenter resource-specific configuration for non-data volume backups

The backup of non-data volumes is an integrated part of the SAP HANA plug-in. Protecting the database data volume is sufficient to restore and recover the SAP HANA

database to a given point in time, provided that the database installation resources and the required logs are still available.

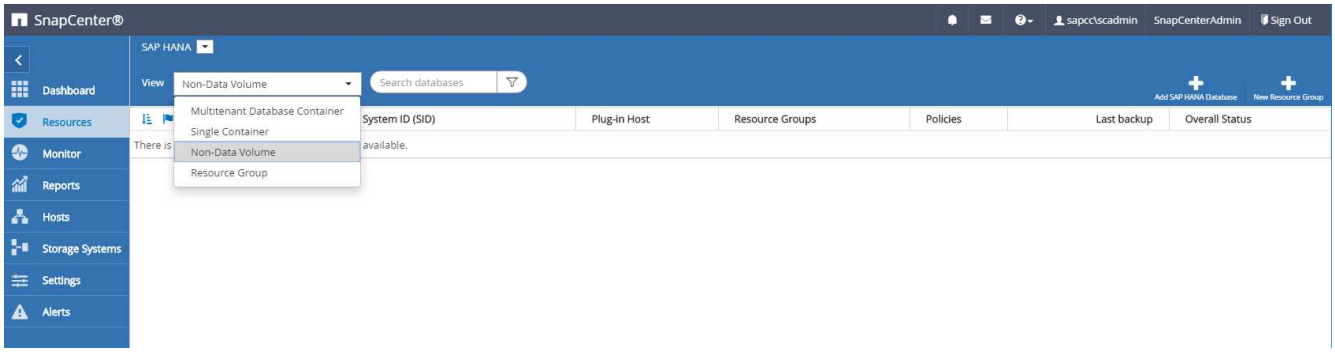
To recover from situations where other non-data files must be restored, NetApp recommends developing an additional backup strategy for non-data volumes to augment the SAP HANA database backup. Depending on your specific requirements, the backup of non-data volumes might differ in scheduling frequency and retention settings, and you should consider how frequently non-data files are changed. For instance, the HANA volume `/hana/shared` contains executables but also SAP HANA trace files. While executables only change when the SAP HANA database is upgraded, the SAP HANA trace files might need a higher backup frequency to support analyzing problem situations with SAP HANA.

SnapCenter non-data volume backup enables Snapshot copies of all relevant volumes to be created in a few seconds with the same space efficiency as SAP HANA database backups. The difference is that there is no SQL communication with SAP HANA database required.

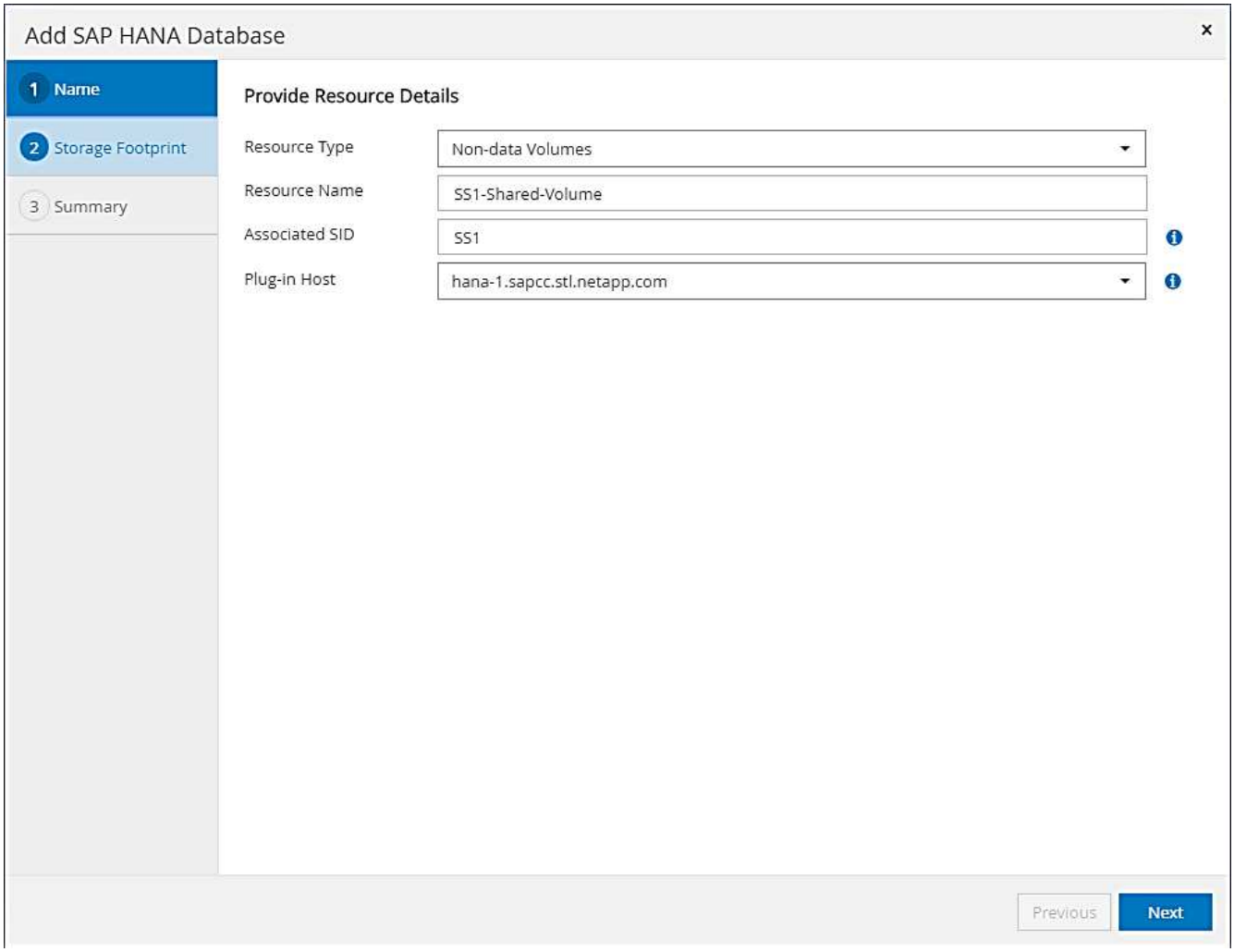
Configuration of non-data volume resources

In this example, we want to protect the non-data volumes of the SAP HANA database SS1.

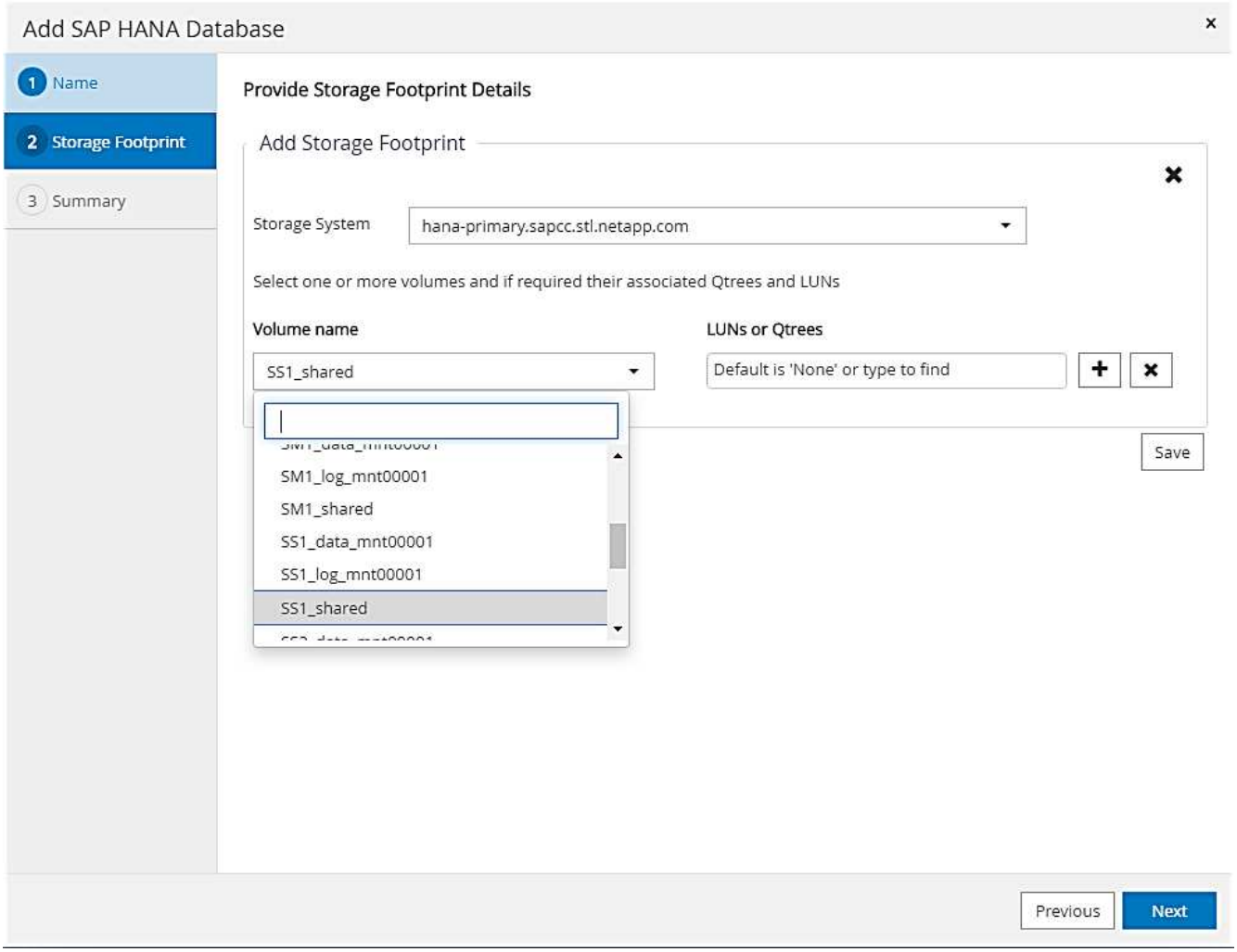
1. From the Resource tab, select Non-Data-Volume and click Add SAP HANA Database.



2. In step one of the Add SAP HANA Database dialog, in the Resource Type list, select Non-data Volumes. Specify a name for the resource and the associated SID and the SAP HANA plug-in host you want to use for the resource, then click Next.



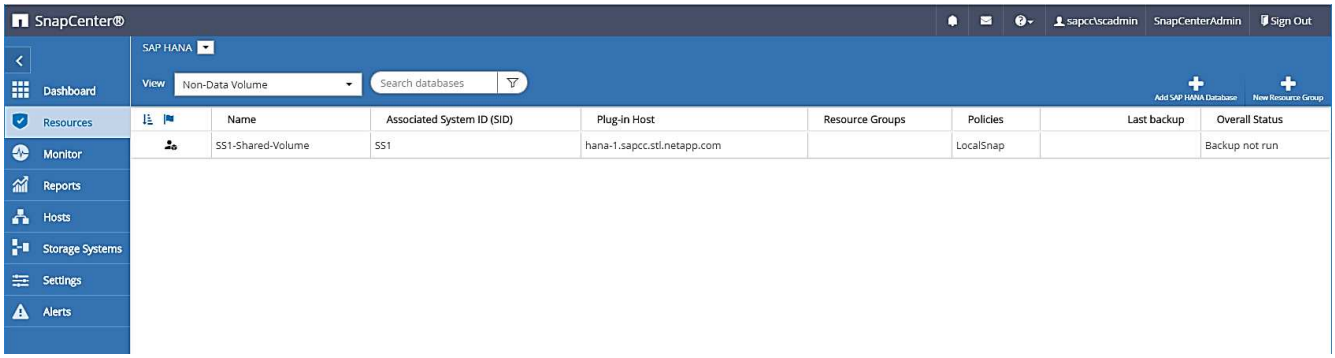
3. Add the SVM and the storage volume as storage footprint, then click Next.



4. In the summary step, click Finish to save the settings.
5. Repeat these steps for all the required non-data volumes.
6. Continue with the protection configuration of the new resource.

> Data protection for a non- data volume resources is identical to the workflow for SAP HANA database resources and can be defined on an individual resource level.

The following figure shows the list of the configured non-data volume resources.



Resource groups

Resource groups are a convenient way to define the protection of multiple resources that require the same protection policies and schedule. Single resources that are part of a resource group can still be protected on an individual level.

Resource groups provide the following features:

- You can add one or more resources to a resource group. All resources must belong to the same SnapCenter plug-in.
- Protection can be defined on a resource group level. All resources in the resource group use the same policy and schedule when protected.
- All backups in the SnapCenter repository and the storage Snapshot copies have the same name defined in the resource protection.
- Restore operations are applied on a single resource level, not as part of a resource group.
- When using SnapCenter to delete the backup of a resource that was created on a resource group level, this backup is deleted for all resources in the resource group. Deleting the backup includes deleting the backup from the SnapCenter repository as well as deleting the storage Snapshot copies.
- The main use case for resource groups is when a customer wants to use backups created with SnapCenter for system cloning with SAP Landscape Management. This is described in the next section.

Using SnapCenter together with SAP landscape management

With SAP Landscape Management (SAP LaMa), customers can manage complex SAP system landscapes in on-premises data centers as well as in systems that are running in the cloud. SAP LaMa, together with NetApp Storage Services Connector (SSC), can execute storage operations such as cloning and replication for SAP system clone, copy, and refresh use cases using Snapshot and FlexClone technology. This allows you to completely automate an SAP system copy based on storage cloning technology while also including the required SAP postprocessing. For more details about NetApp's solutions for SAP LaMa, refer to TR-4018: Integrating NetApp ONTAP Systems with SAP Landscape Management.

NetApp SSC and SAP LaMa can create on-demand Snapshot copies directly using NetApp SSC, but they can also utilize Snapshot copies that have been created using SnapCenter. To utilize SnapCenter backups as the basis for system clone and copy operations with SAP LaMa, the following prerequisites must be met:

- SAP LaMa requires that all volumes be included in the backup; this includes SAP HANA data, log and shared volumes.
- All storage Snapshot names must be identical.
- Storage Snapshot names must start with VCM.

In normal backup operations, NetApp does not recommend including the log volume. If you restore the log volume from a backup, it overwrites the last active redo logs and prevents the recovery of the database to the last recent state.

SnapCenter resource groups meet all these requirements. Three resources are configured in SnapCenter: one resource each for the data volume, the log volume, and the shared volume. The resources are put into a resource group, and the protection is then defined on the resource group level. In the resource group protection, the custom Snapshot name must be defined with VCM at the beginning.

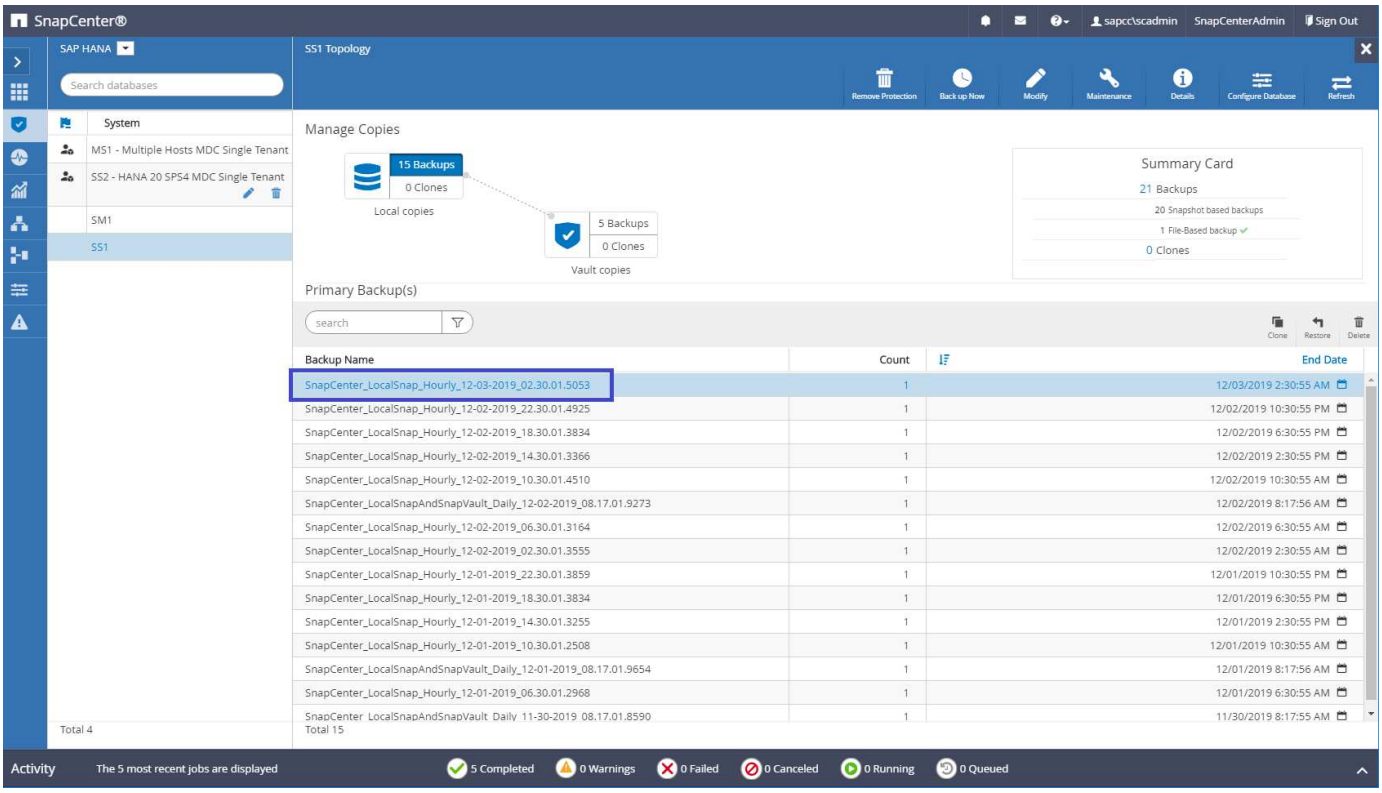
Database backups

In SnapCenter, database backups are typically executed using the schedules defined within the resource protection configuration of each HANA database.

On-demand database backup can be performed by using either the SnapCenter GUI, a PowerShell command line, or REST APIs.

Identifying SnapCenter backups in SAP HANA Studio

The SnapCenter resource topology shows a list of backups created using SnapCenter. The following figure shows the backups available on the primary storage and highlights the most recent backup.

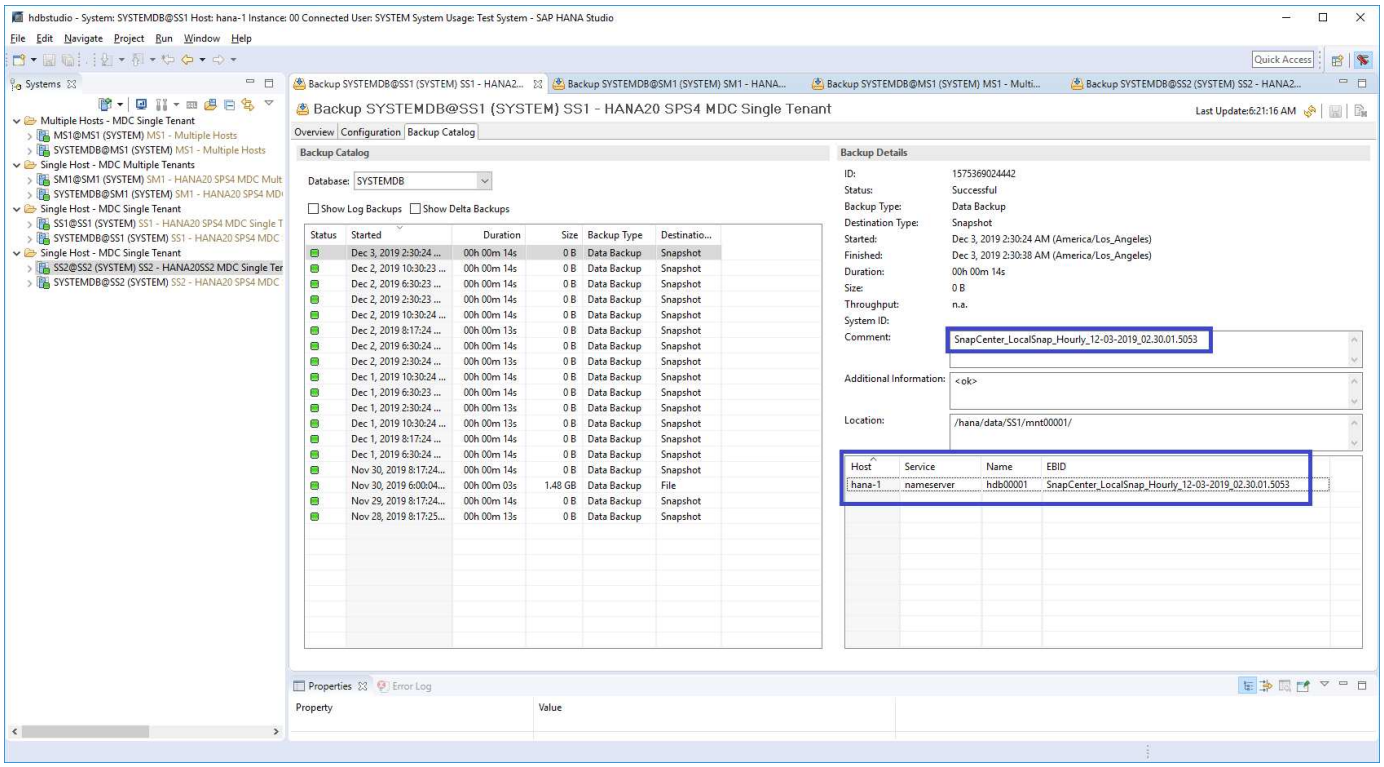


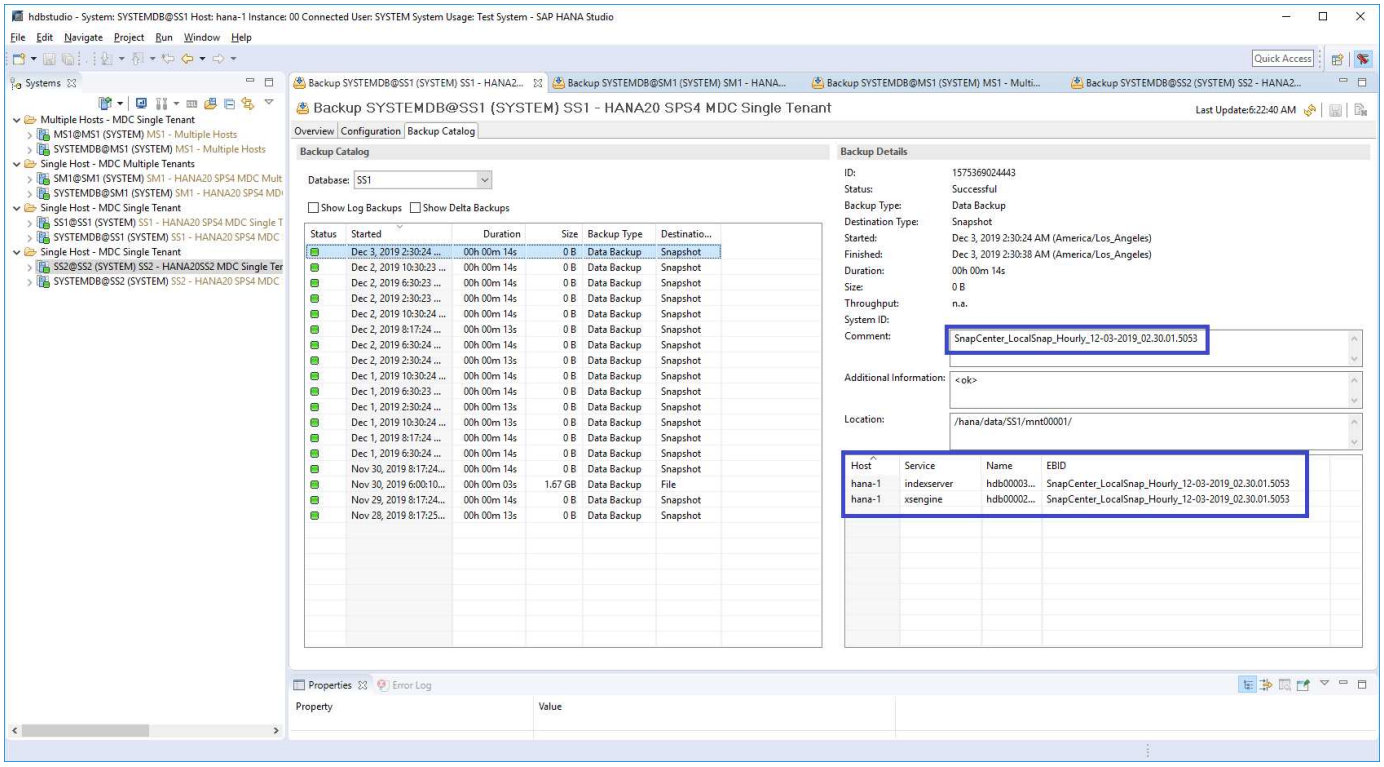
When performing a backup using storage Snapshot copies for an SAP HANA MDC system, a Snapshot copy of the data volume is created. This data volume contains the data of the system database as well as the data of all tenant databases. To reflect this physical architecture, SAP HANA internally performs a combined backup of the system database as well as all tenant databases whenever SnapCenter triggers a Snapshot backup. This results in multiple separate backup entries in the SAP HANA backup catalog: one for the system database and one for each tenant database.

For SAP HANA single-container systems, the database volume contains only the single database, and there is only one entry in SAP HANA's backup catalog.

In the SAP HANA backup catalog, the SnapCenter backup name is stored as a `Comment` field as well as `External Backup ID (EBID)`. This is shown in the following screenshot for the system database and in the screenshot after that for the tenant database SS1. Both figures highlight the SnapCenter backup name stored in the comment field and EBID.

The HANA 2.0 SPS4 (revision 40 and 41) release always shows a backup size of zero for Snapshot-based backups. This was fixed with revision 42. For more information, see the SAP Note https://launchpad.support.sap.com/#/notes/2795010.

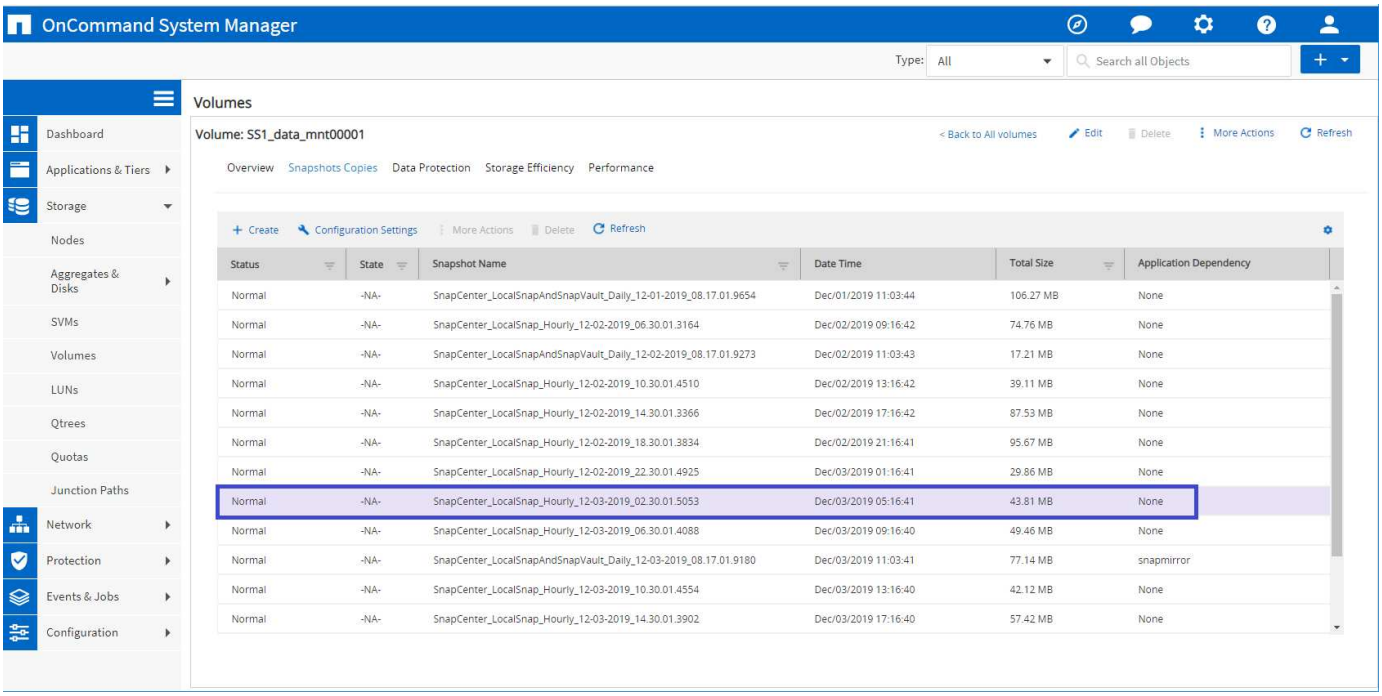




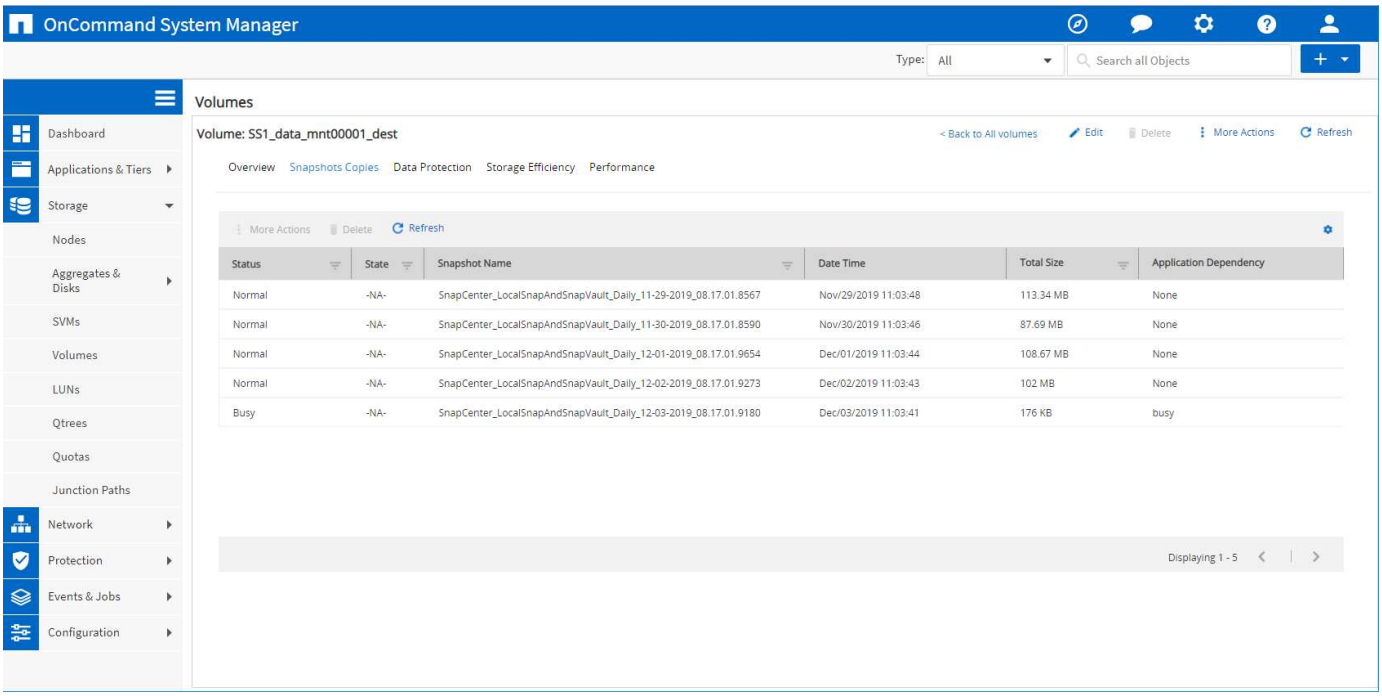
SnapCenter is only aware of its own backups. Additional backups created, for example, with SAP HANA Studio, are visible in the SAP HANA catalog but not in SnapCenter.

Identifying SnapCenter backups on the storage systems

To view the backups on the storage layer, use NetApp OnCommand System Manager and select the database volume in the SVM—Volume view. The lower Snapshot Copies tab displays the Snapshot copies of the volume. The following screenshot shows the available backups for the database volume `SS1_data_mnt00001` at the primary storage. The highlighted backup is the backup shown in SnapCenter and SAP HANA Studio in the previous images and has the same naming convention.



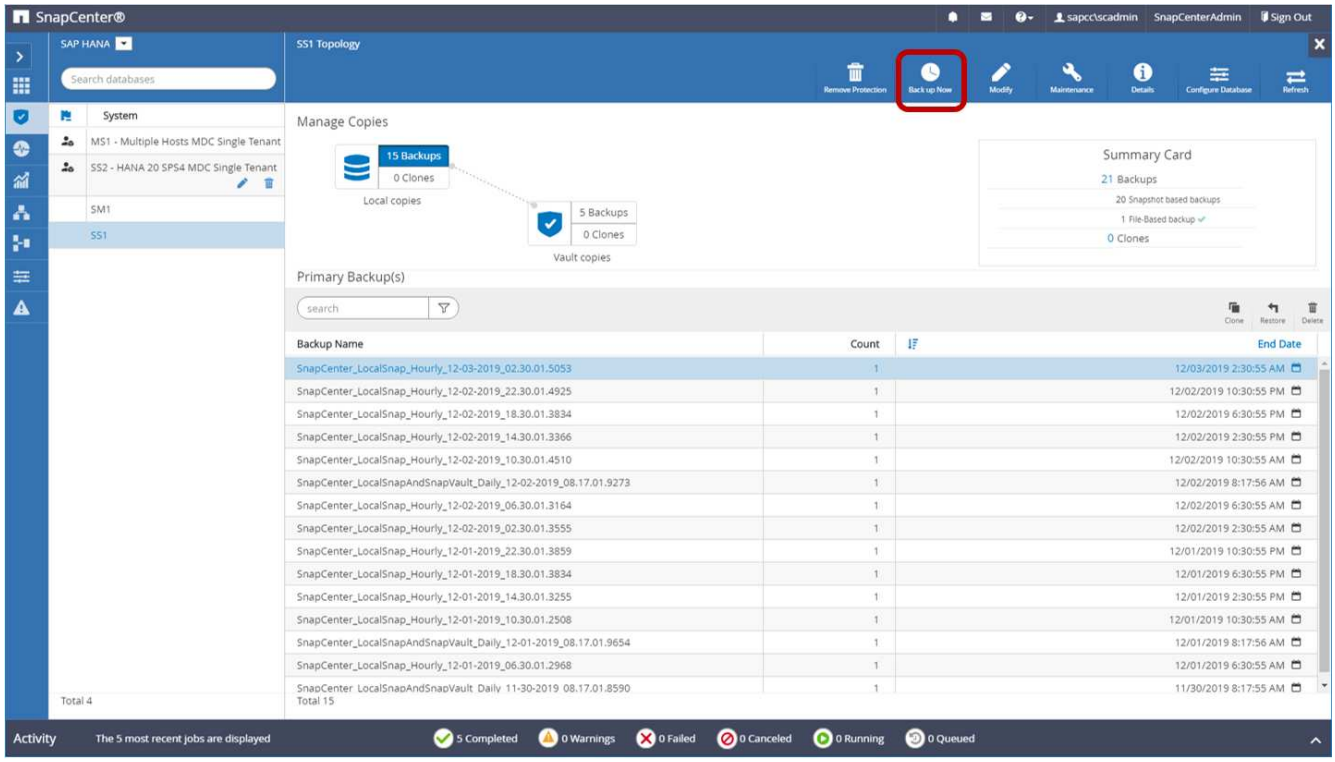
The following screenshot shows the available backups for the replication target volume `hana_SA1_data_mnt00001_dest` at the secondary storage system.



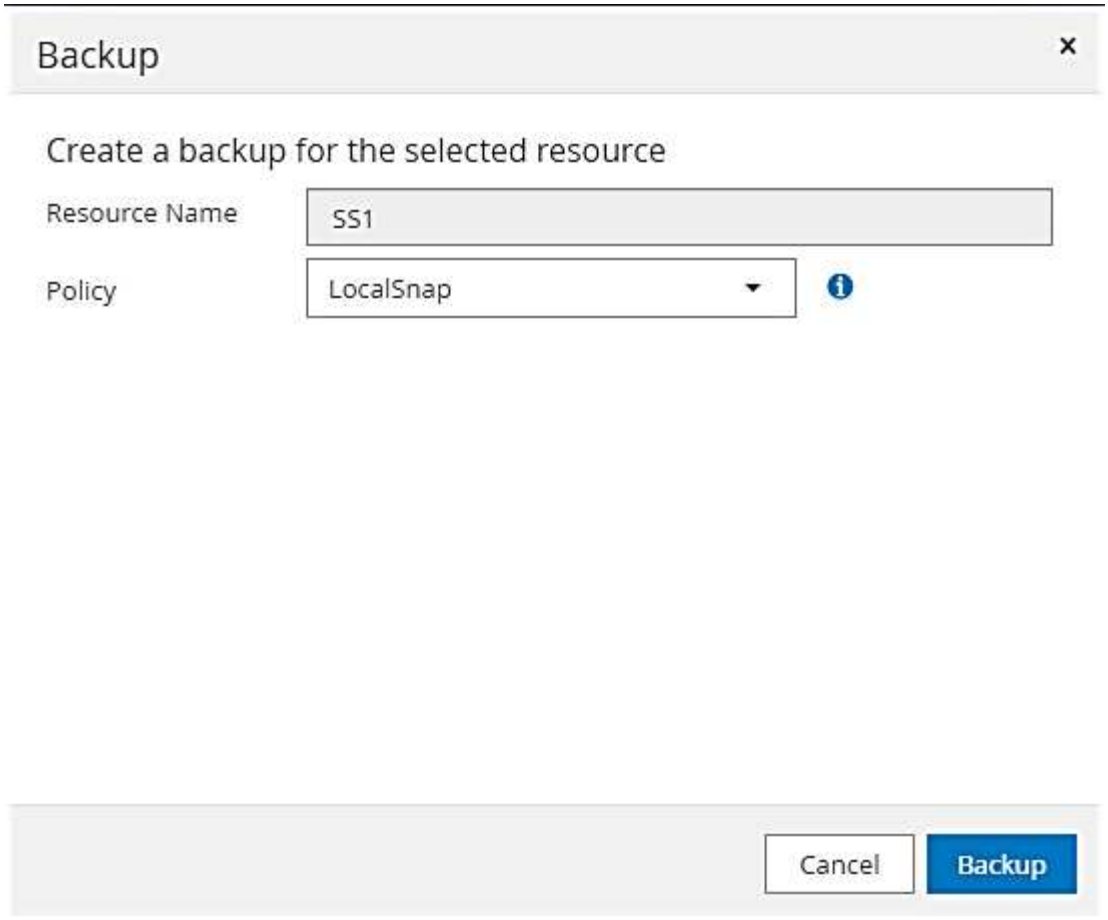
On-demand database backup at primary storage

1. In the resource view, select the resource and double-click the line to switch to the topology view.

   The resource topology view provides an overview of all available backups that have been created using SnapCenter. The top area of this view displays the backup topology, showing the backups on the primary storage (local copies) and, if available, on the off-site backup storage (vault copies).

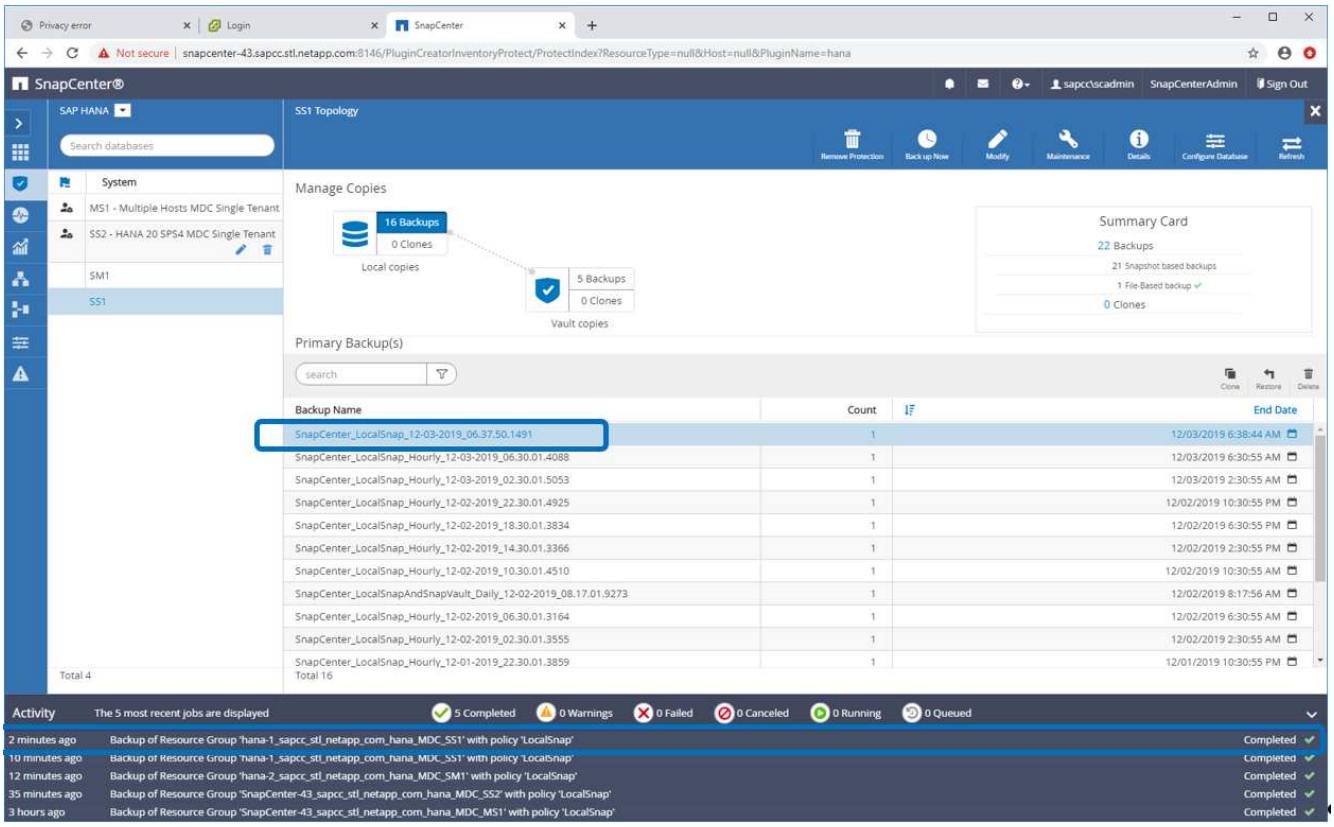


2. In the top row, select the Back up Now icon to start an on-demand backup. From the drop-down list, select the backup policy `LocalSnap` and then click Backup to start the on-demand backup.

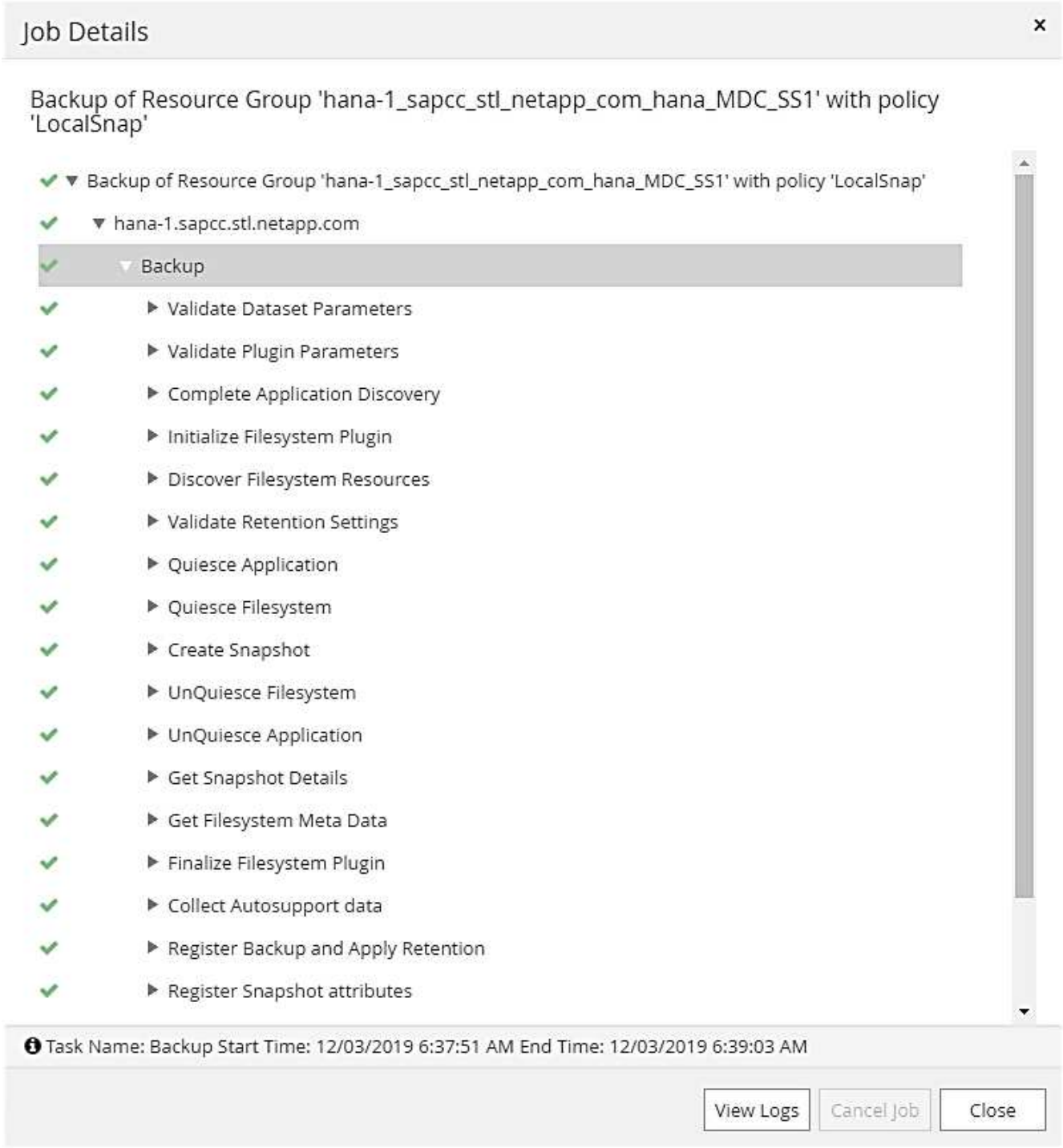


This starts the backup job. A log of the previous five jobs is shown in the Activity area below the topology view. When the backup is finished, a new entry is shown in the topology view. The backup names follow the same naming convention as the Snapshot name defined in the section "Resource protection configuration."

You must close and reopen the topology view to see the updated backup list.



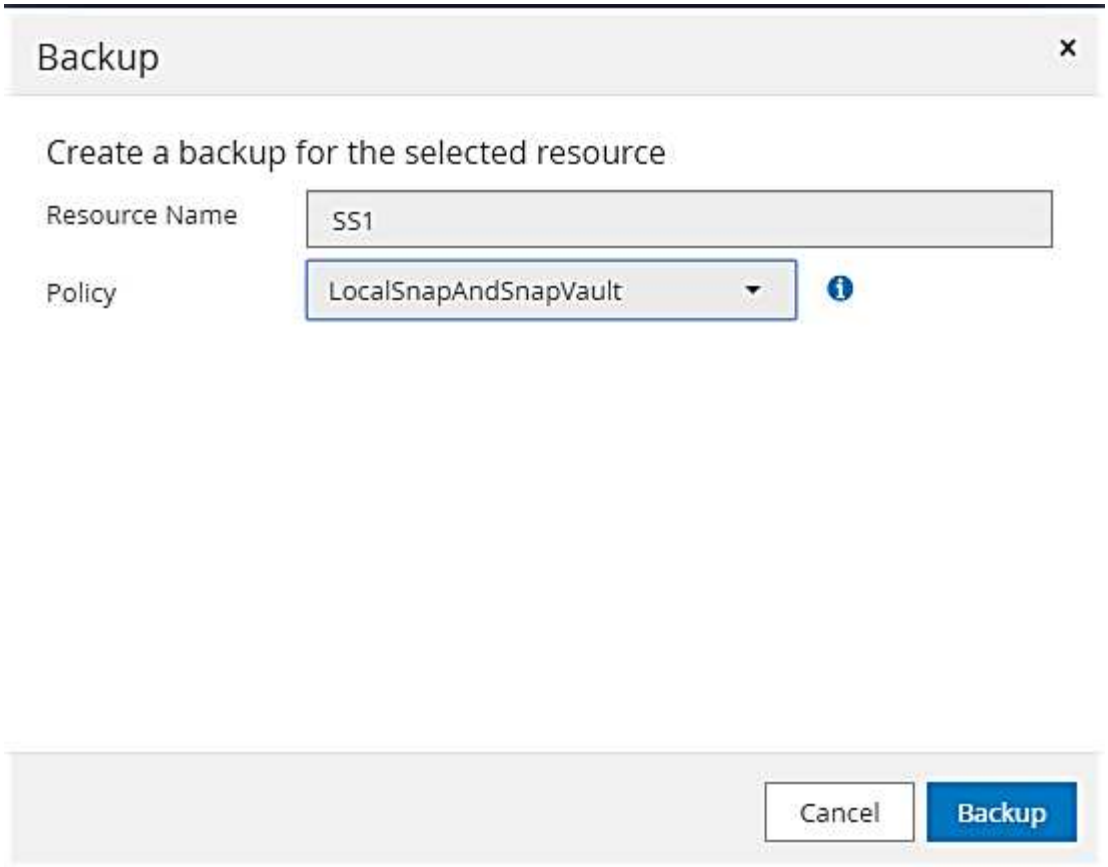
3. The job details are shown when clicking the job's activity line in the Activity area. You can open a detailed job log by clicking View Logs.



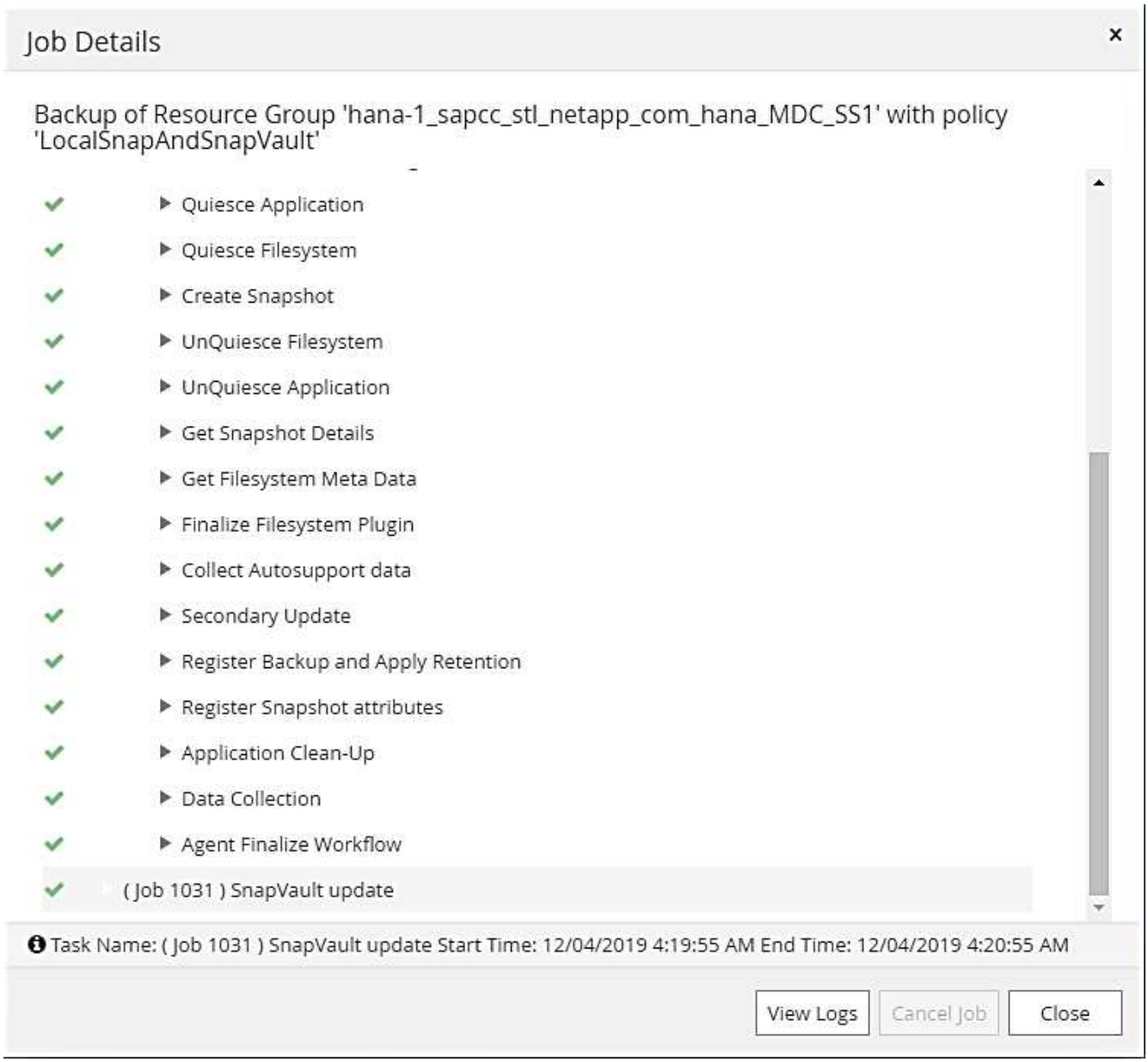
4. In SAP HANA Studio, the new backup is visible in the backup catalog. The same backup name in SnapCenter is also used in the comment and the EBID field in the backup catalog.

On-demand database backups with SnapVault replication

1. In the resource view, select the resource and double-click the line to switch to the topology view.
2. In the top row, select the Backup Now icon to start an on-demand backup. From the drop-down list, select the backup policy `LocalSnapAndSnapVault`, then click Backup to start the on-demand backup.

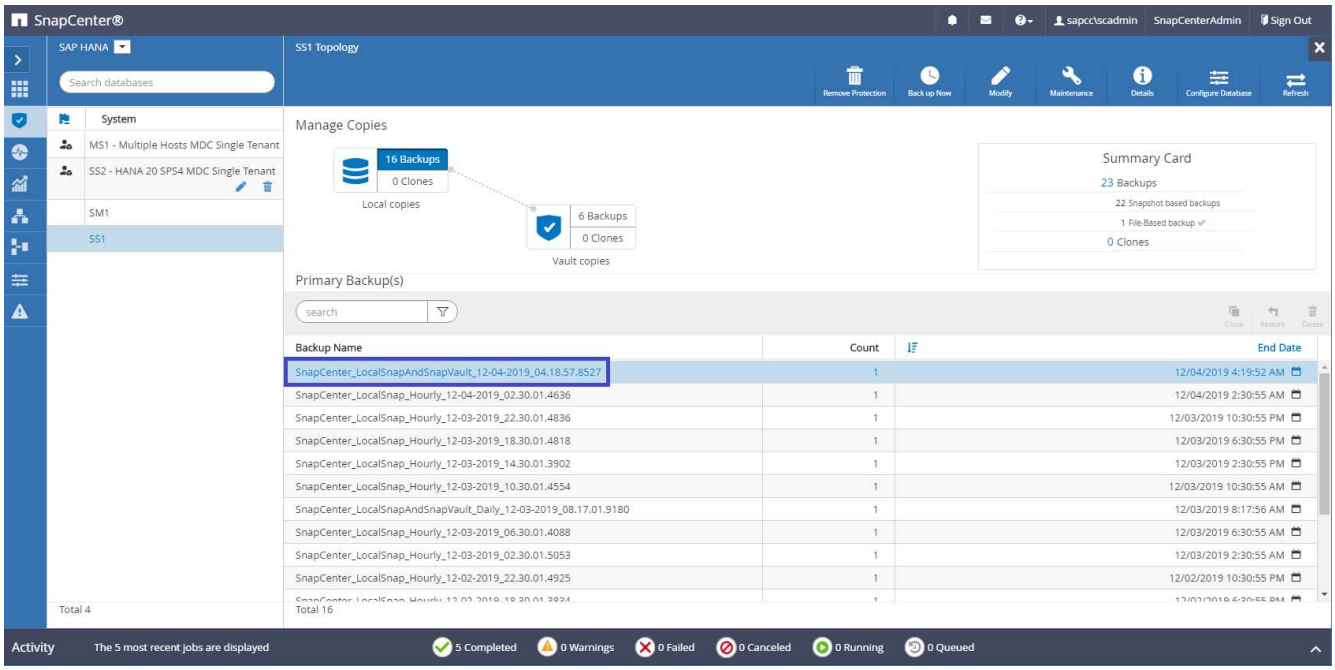


3. The job details are shown when clicking the job's activity line in the Activity area.

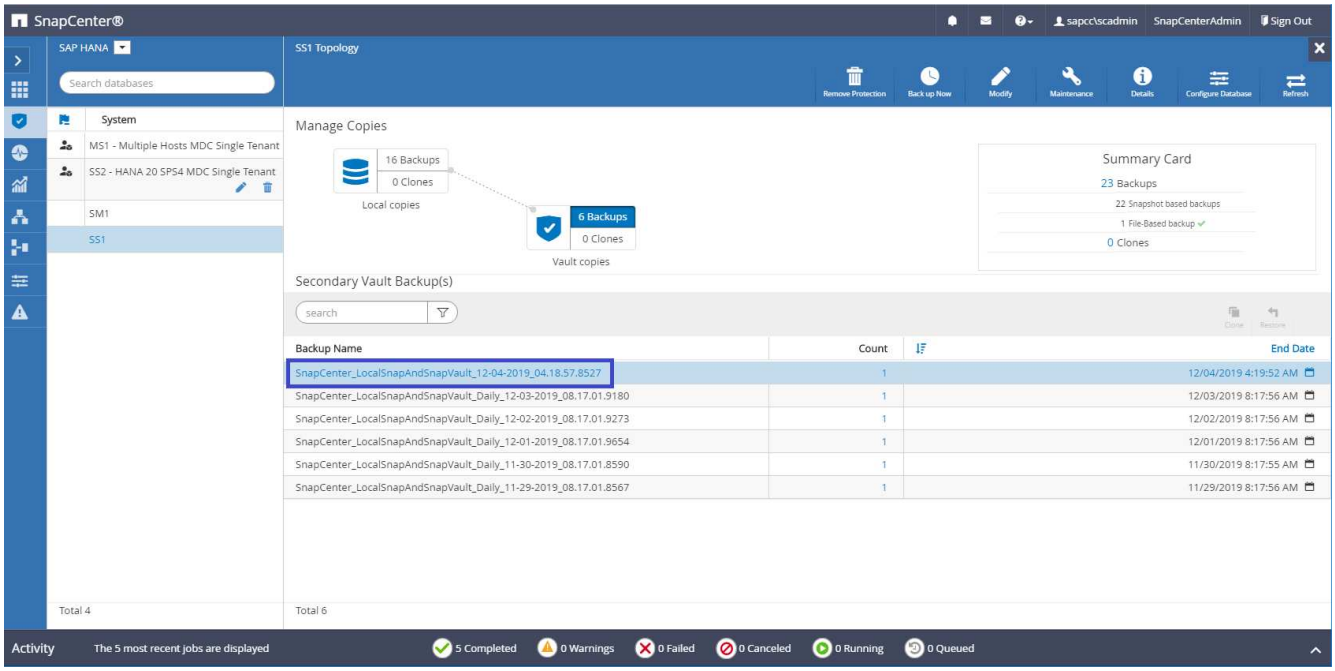


4. When the backup is finished, a new entry is shown in the topology view. The backup names follow the same naming convention as the Snapshot name defined in the section "Resource protection configuration."

You must close and reopen the topology view to see the updated backup list.



5. By selecting Vault copies, backups at the secondary storage are shown. The name of the replicated backup is identical to the backup name at the primary storage.



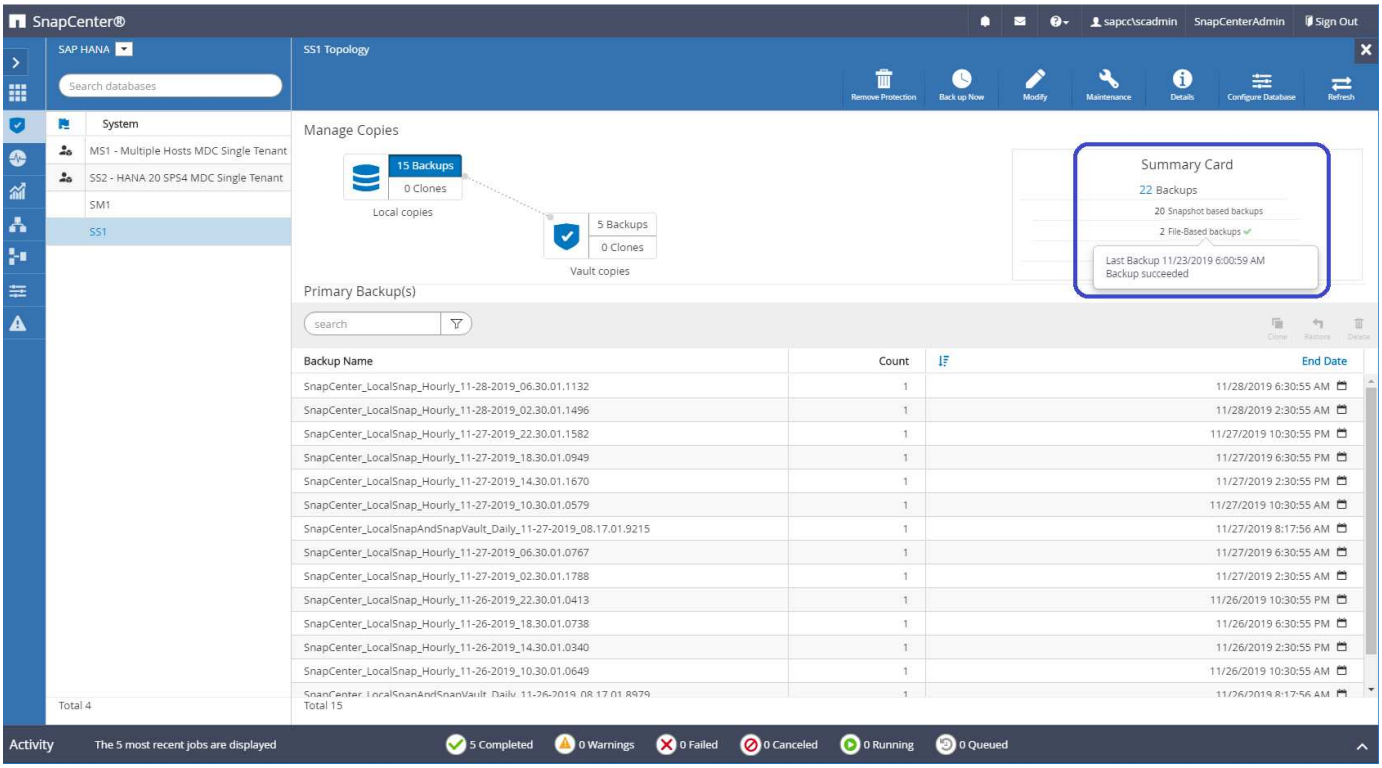
6. In SAP HANA Studio, the new backup is visible in the backup catalog. The same backup name in SnapCenter is also used in the comment and the EBID field in the backup catalog.

Block integrity check

SAP recommends combining storage-based Snapshot backups with a weekly file-based backup to execute a block integrity check. SnapCenter supports the execution of a block integrity check by using a policy in which file-based backup is selected as the backup type.

When scheduling backups using this policy, SnapCenter creates a standard SAP HANA file backup for the system and tenant databases.

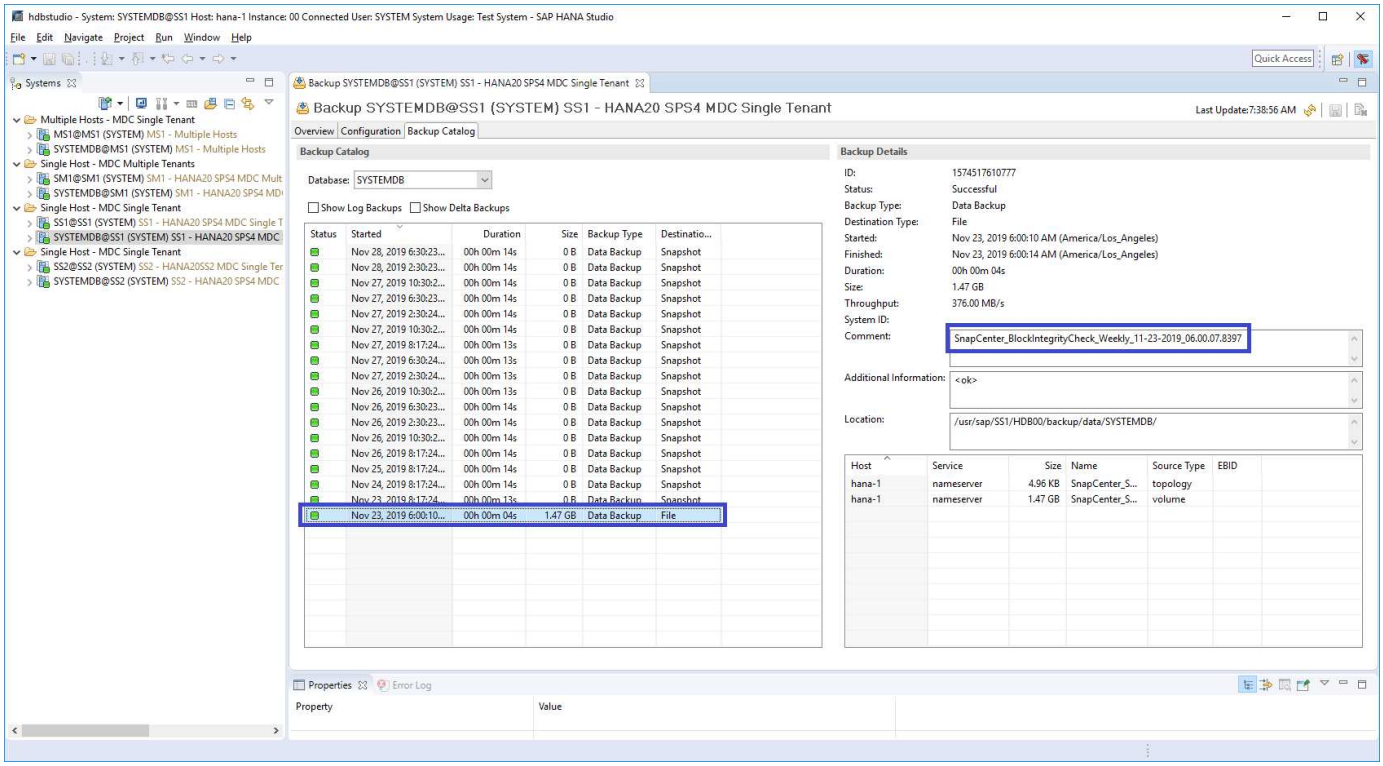
SnapCenter does not display the block integrity check in the same manner as Snapshot copy-based backups. Instead, the summary card shows the number of file-based backups and the status of the previous backup.



A block integrity check backup cannot be deleted using the SnapCenter UI, but it can be deleted using PowerShell commands.

```
PS C:\Users\scadmin> Get-SmBackupReport -Resource SS1
SmBackupId                : 9
SmJobId                   : 42
StartDateTime             : 11/19/2019 8:26:32 AM
EndDateTime               : 11/19/2019 8:27:33 AM
Duration                  : 00:01:00.7652030
CreatedDateTime           : 11/19/2019 8:27:24 AM
Status                    : Completed
ProtectionGroupName       : hana-1_sapcc_stl_netapp_com_hana_MDC_SS1
SmProtectionGroupId       : 1
PolicyName                : BlockIntegrityCheck
SmPolicyId                : 5
BackupName                : SnapCenter_BlockIntegrityCheck_11-19-
2019_08.26.33.2913
VerificationStatus        : NotApplicable
VerificationStatuses      :
SmJobError                :
BackupType                : SCC_BACKUP
CatalogingStatus          : NotApplicable
CatalogingStatuses        :
ReportDataCreatedDateTime :
PluginCode                : SCC
PluginName                : hana
JobTypeId                 : 0
JobHost                   :

PS C:\Users\scadmin> Remove-SmBackup -BackupIds 9

Remove-SmBackup
Are you sure want to remove the backup(s).
[Y] Yes  [A] Yes to All  [N] No  [L] No to All  [S] Suspend  [?] Help
(default is "Y"): y


BackupResult : {}
Result       : SMCoreContracts.SMResult
TotalCount   : 0
DisplayCount : 0
Context      :
Job          : SMCoreContracts.SmJob



PS C:\Users\scadmin>
```

The SAP HANA backup catalog shows entries for both the system and the tenant databases. The following figure shows a SnapCenter block integrity check in the backup catalog of the system database.



A successful block integrity check creates standard SAP HANA data backup files. SnapCenter uses the backup path that has been configured in the HANA database for file-based data backup operations.

```
hana-1:/usr/sap/SS1/HDB00/backup/data # ls -al *
DB_SS1:
total 1710840
drwxr-xr-- 2 ss1adm sapsys       4096 Nov 28 10:25 .
drwxr-xr-- 4 ss1adm sapsys       4096 Nov 19 05:11 ..
-rw-r----- 1 ss1adm sapsys     155648 Nov 23 08:46
SnapCenter_SnapCenter_BlockIntegrityCheck_Weekly_11-23-
2019_06.00.07.8397_databackup_0_1
-rw-r----- 1 ss1adm sapsys   83894272 Nov 23 08:46
SnapCenter_SnapCenter_BlockIntegrityCheck_Weekly_11-23-
2019_06.00.07.8397_databackup_2_1
-rw-r----- 1 ss1adm sapsys 1660952576 Nov 23 08:46
SnapCenter_SnapCenter_BlockIntegrityCheck_Weekly_11-23-
2019_06.00.07.8397_databackup_3_1
SYSTEMDB:
total 1546340
drwxr-xr-- 2 ss1adm sapsys       4096 Nov 28 10:24 .
drwxr-xr-- 4 ss1adm sapsys       4096 Nov 19 05:11 ..
-rw-r----- 1 ss1adm sapsys     159744 Nov 23 08:46
SnapCenter_SnapCenter_BlockIntegrityCheck_Weekly_11-23-
2019_06.00.07.8397_databackup_0_1
-rw-r----- 1 ss1adm sapsys 1577066496 Nov 23 08:46
SnapCenter_SnapCenter_BlockIntegrityCheck_Weekly_11-23-
2019_06.00.07.8397_databackup_1_1
```

Restore and recovery

The following sections describe the restore and recovery workflows of three different scenarios and example configurations.

- Automated restore and recovery:
  - Auto discovered HANA system SS1
  - SAP HANA single host, MDC single tenant system using NFS
- Single-tenant restore and recovery:
  - Auto discovered HANA system SM1
  - SAP HANA single host, MDC multiple tenant system using NFS
- Restore with manual recovery:
  - Manual configured HANA system SS2
  - SAP HANA single host, MDC multiple tenant system using NFS

In the following sections, the differences between SAP HANA single host and multiple hosts and Fibre Channel SAN attached HANA systems are highlighted.

The examples show SAP HANA Studio as a tool to execute manual recovery. You can also use SAP HANA

Cockpit or HANA SQL statements.

Automated restore and recovery

With SnapCenter 4.3, automated restore and recovery operations are supported for HANA single container or MDC single tenant systems that have been auto discovered by SnapCenter.

You can execute an automated restore and recovery operation with the following steps:

1. Select the backup to be used for the restore operation. The backup can be selected from the following storage options:
   - Primary storage
   - Offsite backup storage (SnapVault target)
2. Select the restore type. Select Complete Restore with Volume Revert or without Volume Revert.

   The Volume Revert option is only available for restore operations from primary storage and if the HANA database is using NFS as the storage protocol.

3. Select the recovery type from the following options:
   - To most recent state
   - Point in time
   - To specific data backup
   - No recovery

   The selected recovery type is used for the recovery of the system and the tenant database.

Next, SnapCenter performs the following operations:

1. It stops the HANA database.
2. It restores the database.

   Depending on the selected restore type and the used storage protocol, different operations are executed.

   - If NFS and Volume Revert are selected, then SnapCenter unmounts the volume, restores the volume using volume-based SnapRestore on the storage layer, and mounts the volume.
   - If NFS is selected and Volume Revert is not selected, SnapCenter restores all files using single-file SnapRestore operations on the storage layer.
   - If Fibre Channel SAN is selected, then SnapCenter unmounts the LUN(s), restores the LUN(s) using single file SnapRestore operations on the storage layer, and discovers and mounts the LUN(s).
3. It recovers the database:
   a. It recovers the system database.
   b. It recovers the tenant database.

      Or, for HANA single container systems, the recovery is executed in a single step:

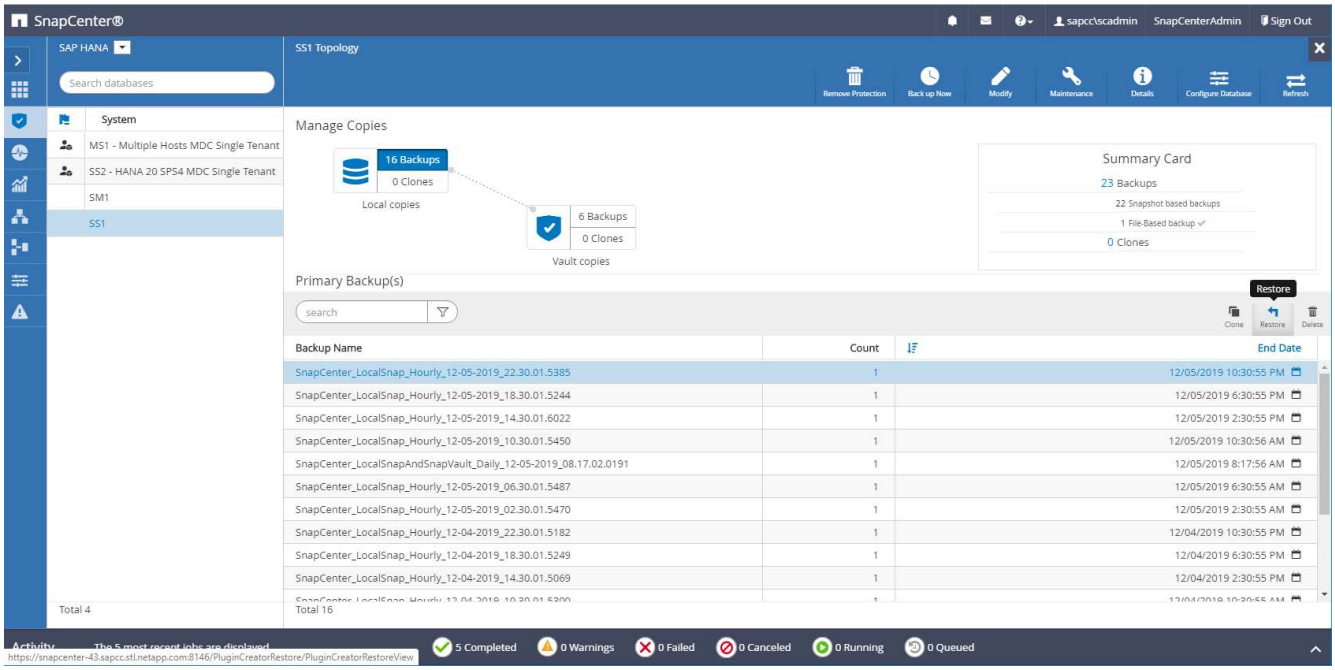
   c. It starts the HANA database.

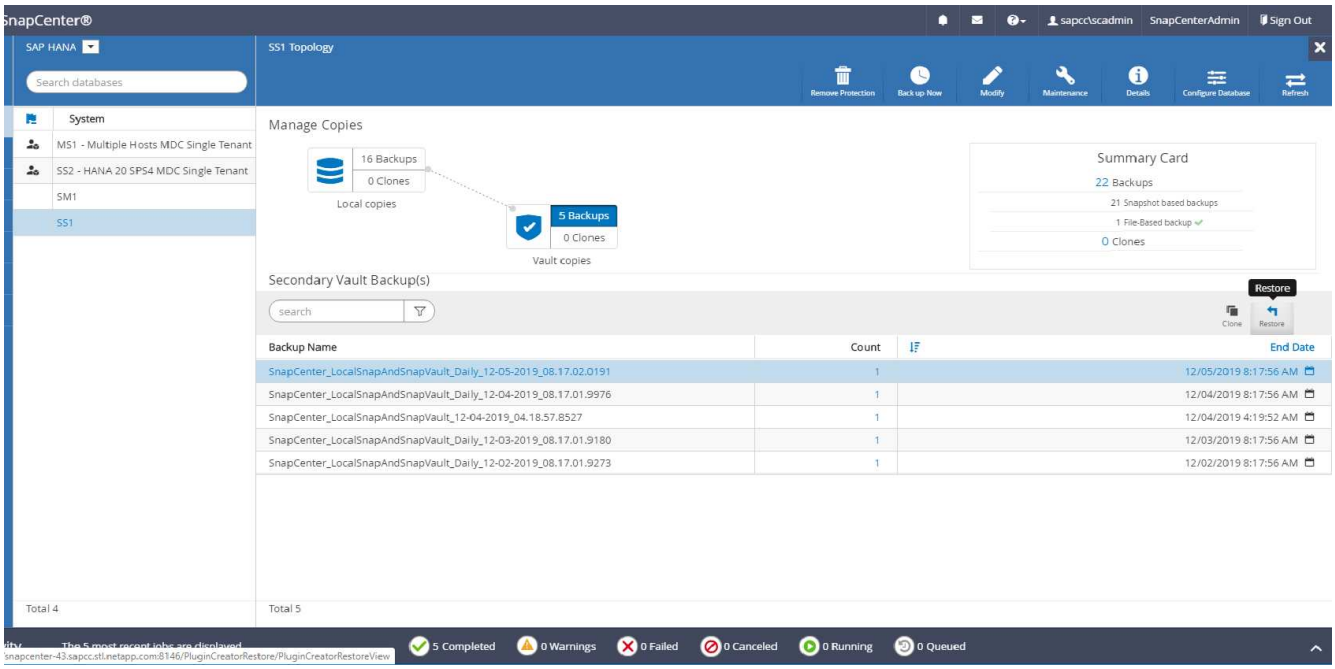
If No Recovery is selected, SnapCenter exits and the recovery operation for the system and the tenant database must be done manually.

This section provides the steps for the automated restore and recovery operation of the auto discovered HANA system SS1 (SAP HANA single host, MDC single tenant system using NFS).

1. Select a backup in SnapCenter to be used for the restore operation.

   You can select restore from primary or from offsite backup storage.





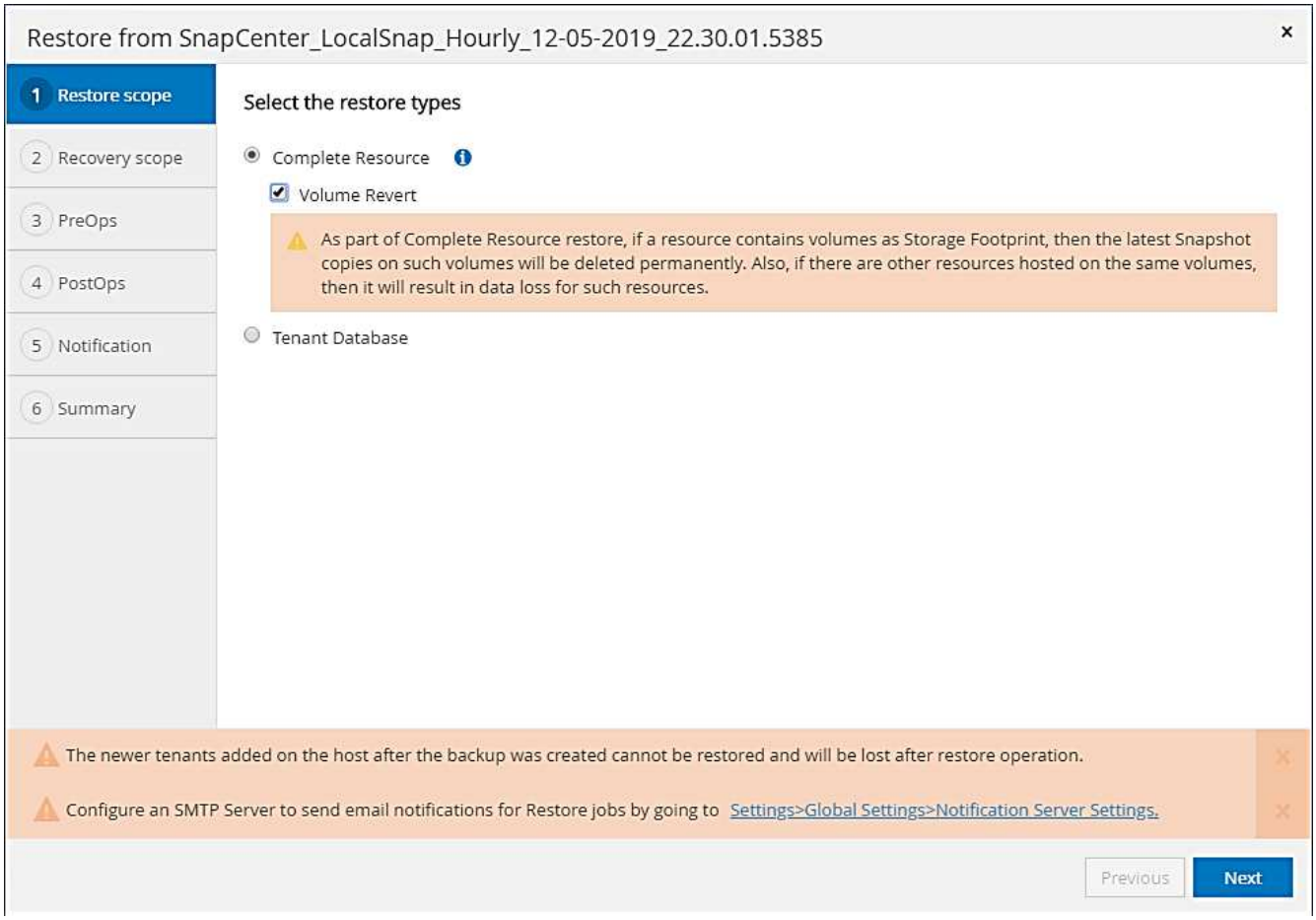
2. Select the restore scope and type.

   The following three screenshots show the restore options for restore from primary with NFS, restore from

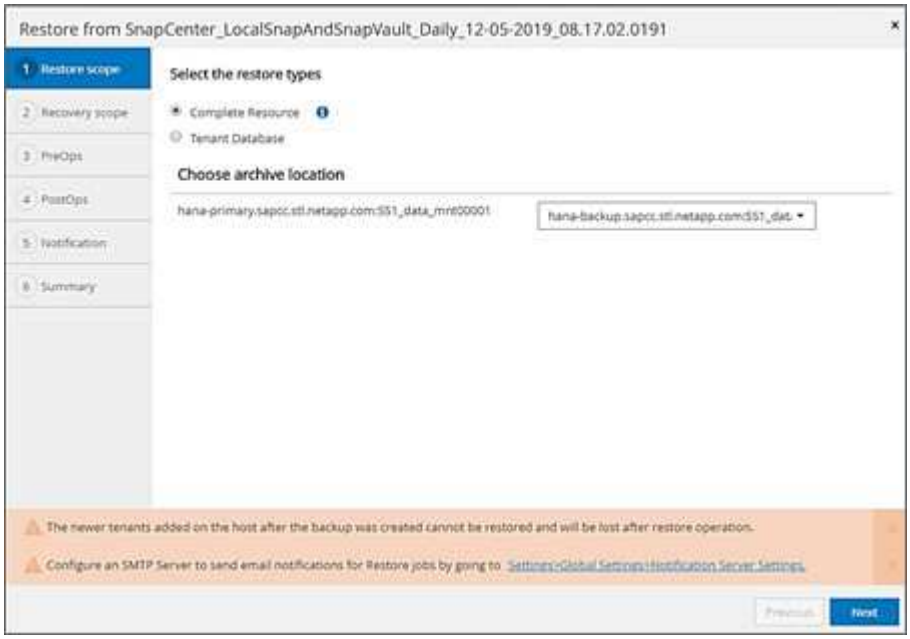
secondary with NFS, and restore from primary with Fibre Channel SAN.

The restore type options for restore from primary storage.

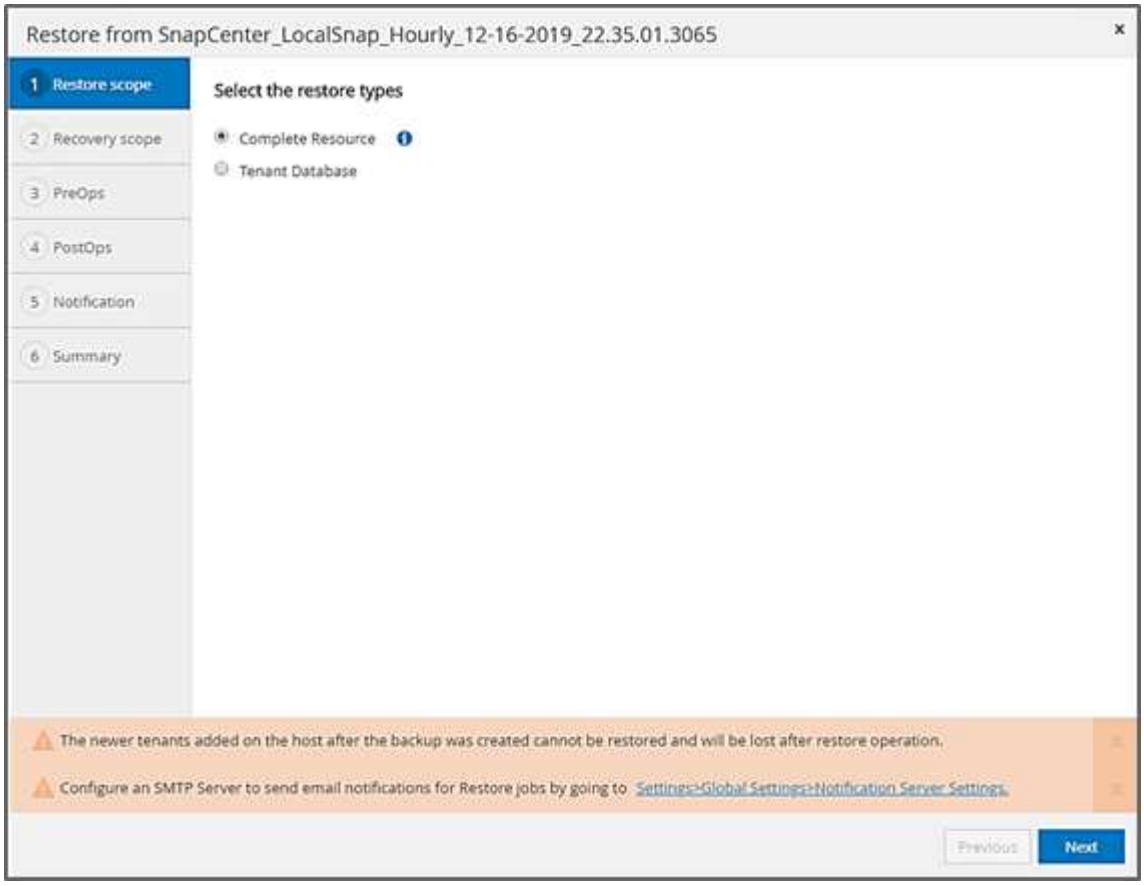
The Volume Revert option is only available for restore operations from primary with NFS.



The restore type options for restore from offsite backup storage.

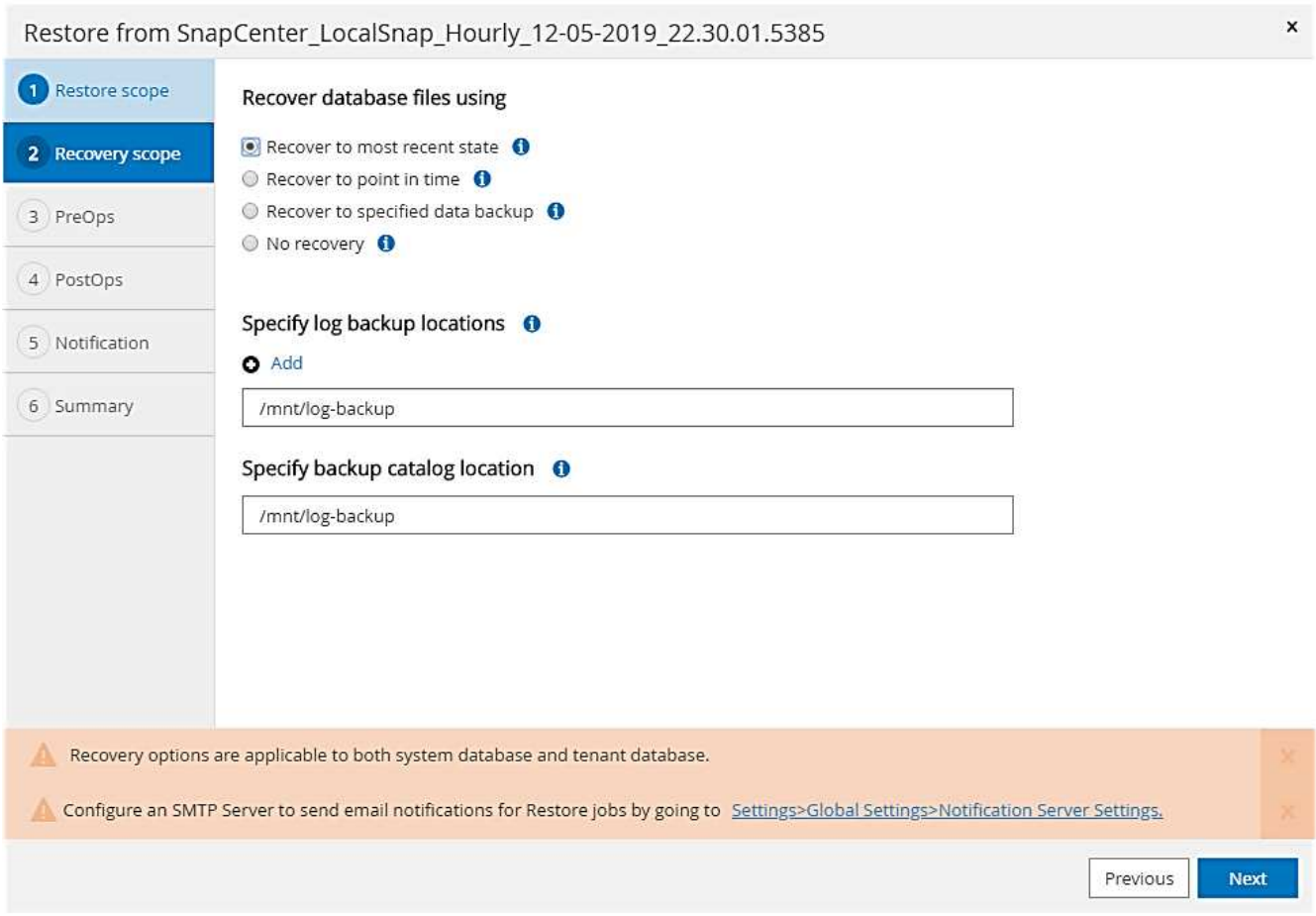


The restore type options for restore from primary storage with Fibre Channel SAN.

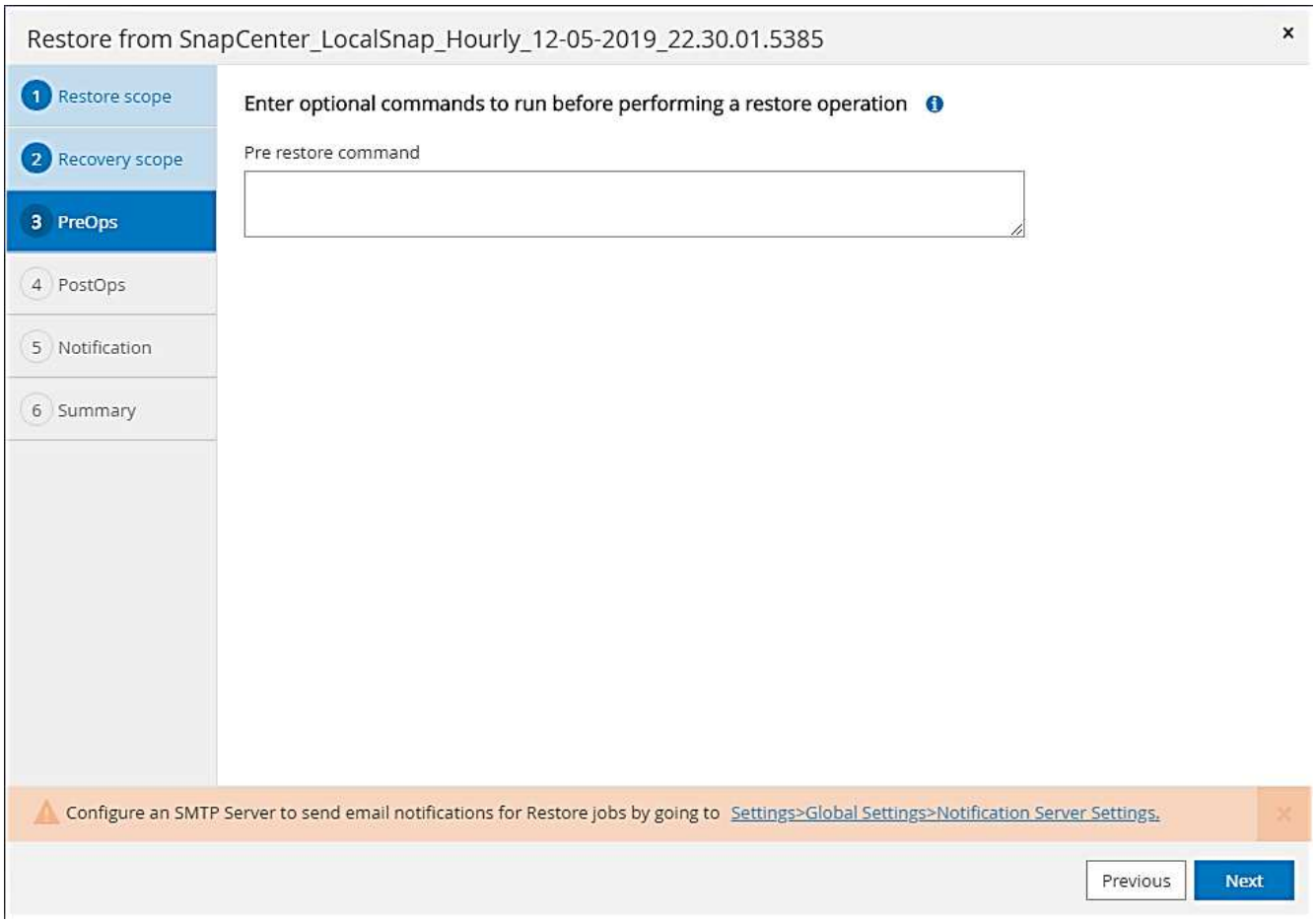


3. Select Recovery Scope and provide the location for log backup and catalog backup.

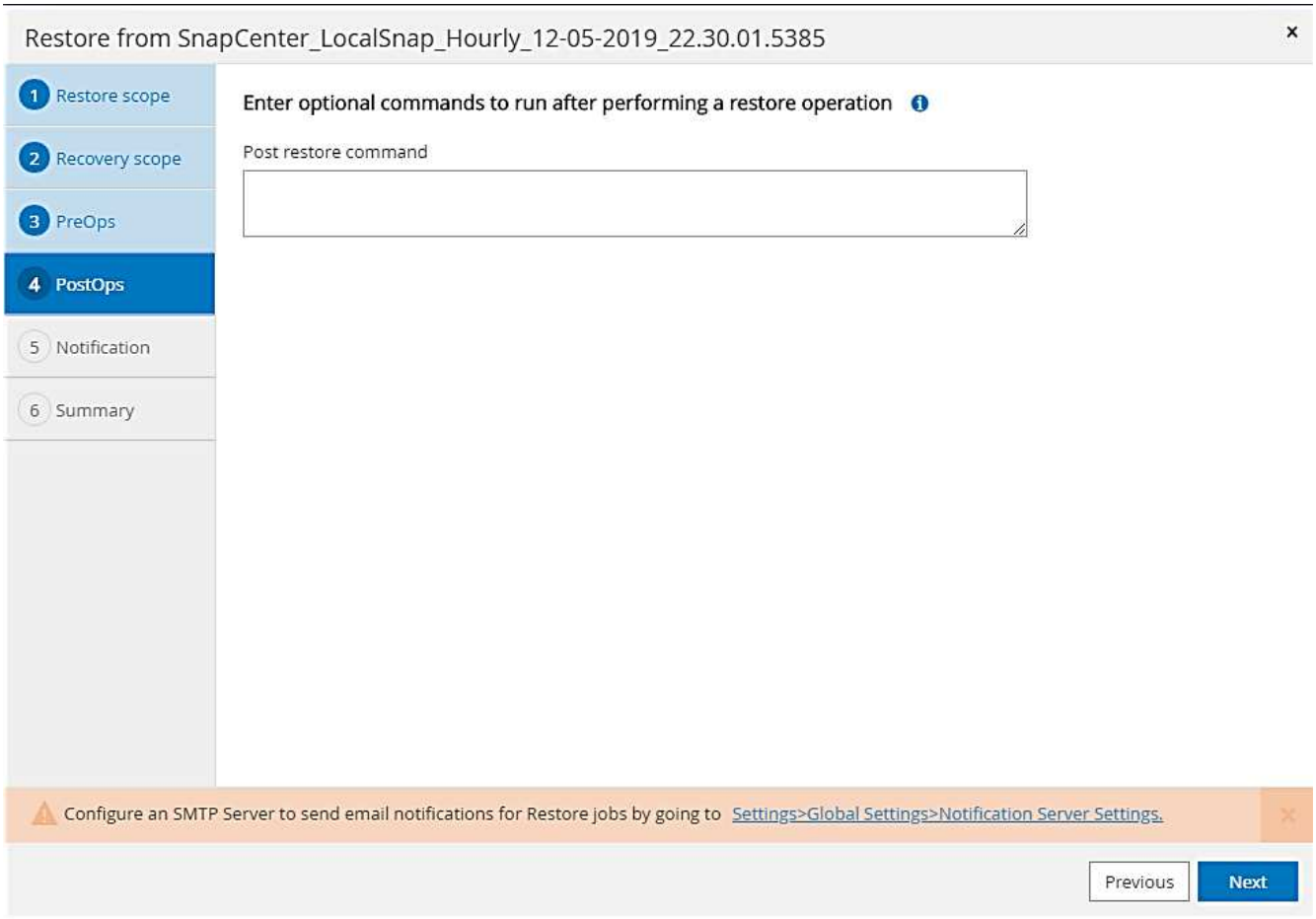
SnapCenter uses the default path or the changed paths in the HANA global.ini file to pre-populate the log and catalog backup locations.



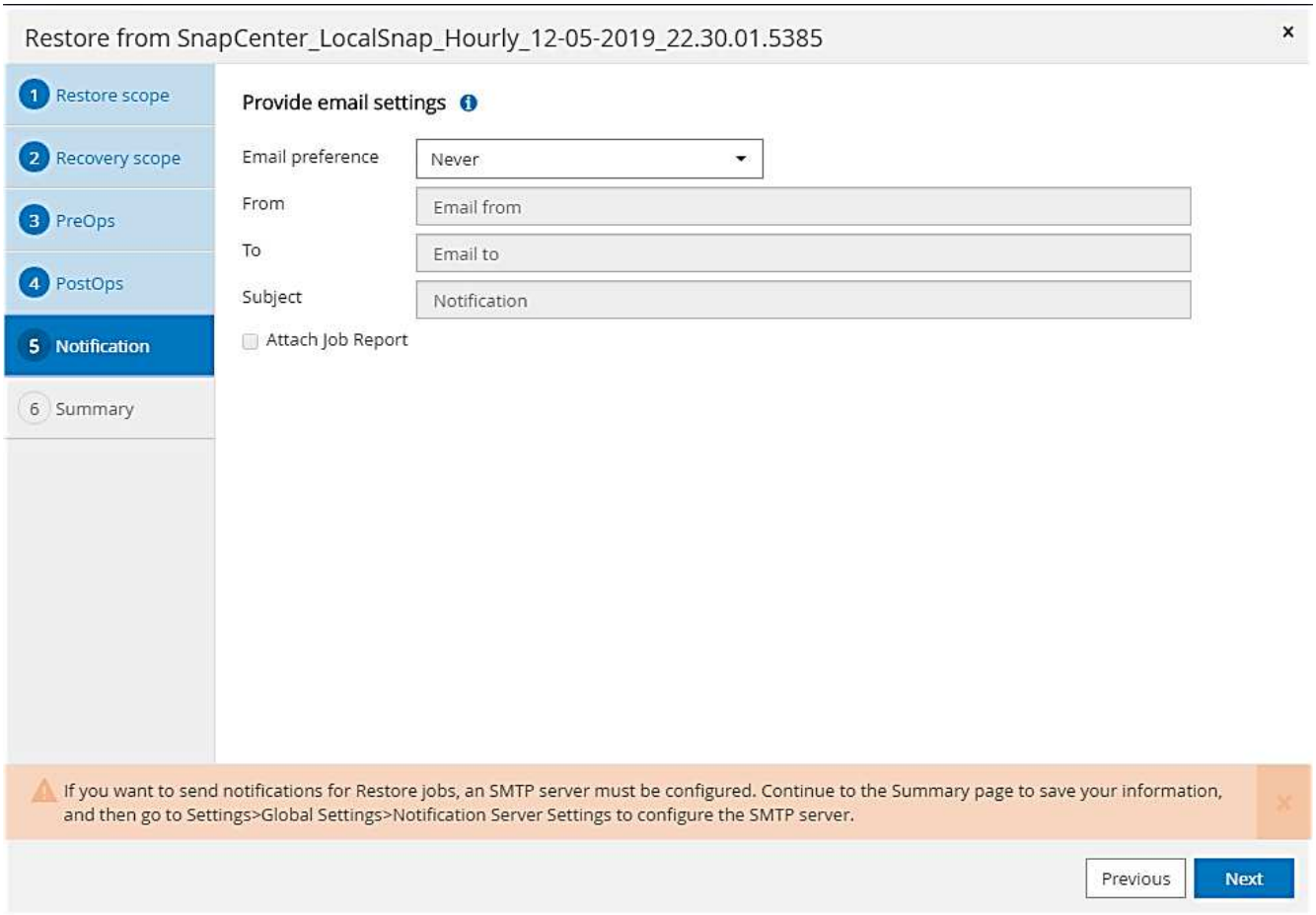
4. Enter the optional prerestore commands.



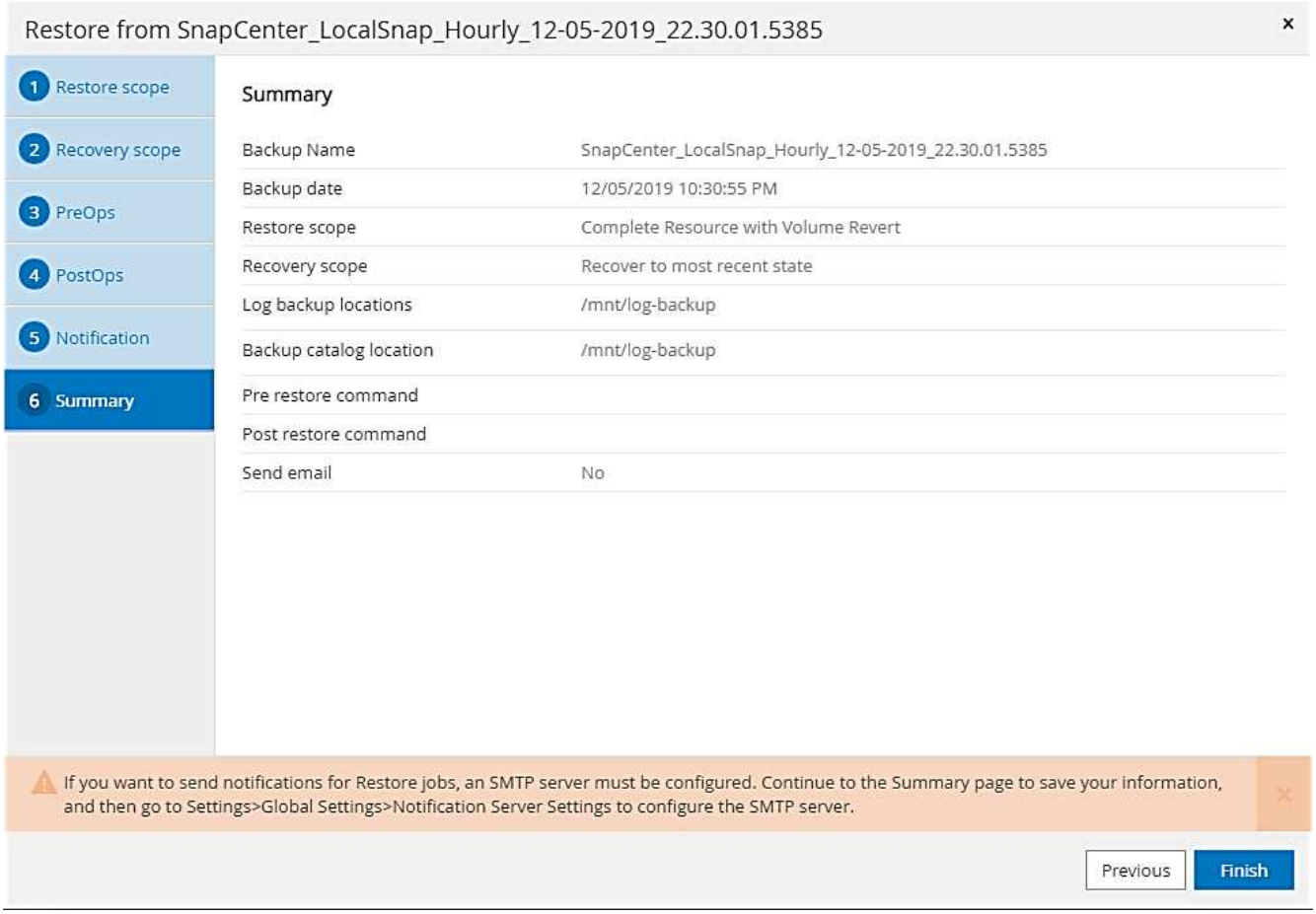
5. Enter the optional post-restore commands.



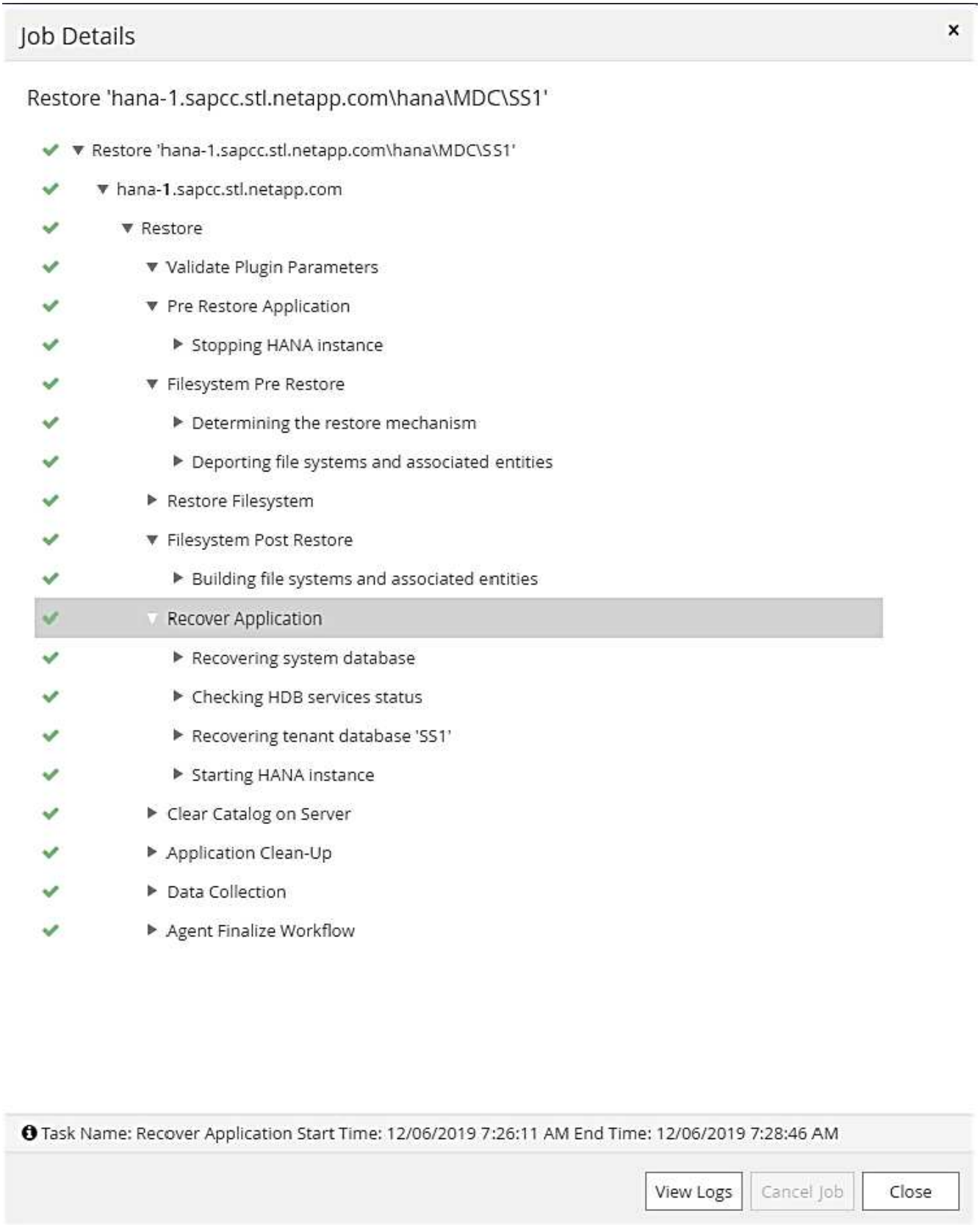
6. Enter the optional email settings.



7. To start the restore operation, click Finish.



8. SnapCenter executes the restore and recovery operation. This example shows the job details of the restore and recovery job.



Single-tenant restore and recovery operation

With SnapCenter 4.3, single-tenant restore operations are supported for HANA MDC systems with a single tenant or with multiple tenants that have been auto- discovered by SnapCenter.

You can perform a single-tenant restore and recovery operation with the following steps:

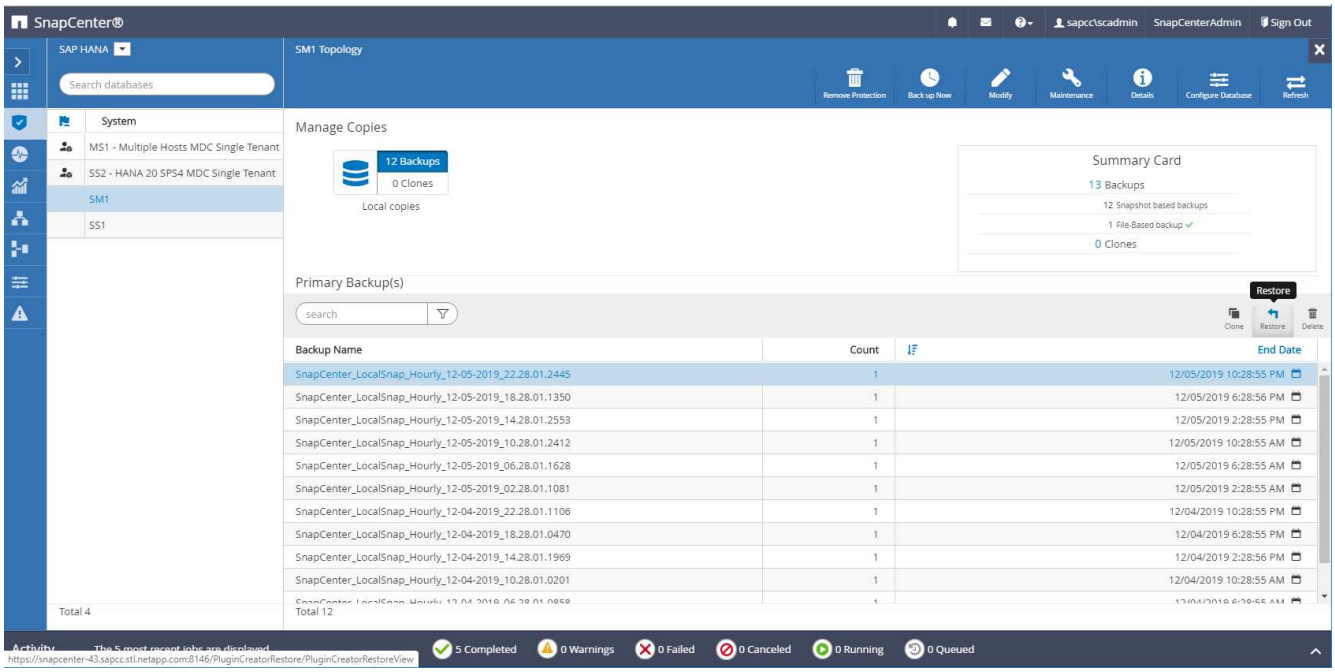
1. Stop the tenant to be restored and recovered.
2. Restore the tenant with SnapCenter.
   - For a restore from primary storage, SnapCenter executes the following operations:
     - **NFS.** Storage Single File SnapRestore operations for all files of the tenant database.
     - **SAN.** Clone and connect the LUN to the database host, and copy all files of the tenant database.
   - For a restore from secondary storage, SnapCenter executes the following operations:
     - **NFS.** Storage SnapVault Restore operations for all files of the tenant database
     - **SAN.** Clone and connect the LUN to the database host, and copy all files of the tenant database
3. Recover the tenant with HANA Studio, Cockpit, or SQL statement.

This section provides the steps for the restore and recovery operation from the primary storage of the auto-discovered HANA system SM1 (SAP HANA single-host, MDC multiple-tenant system using NFS). From the user input perspective, the workflows are identical for a restore from secondary or a restore in a Fibre Channel SAN setup.

1. Stop the tenant database.

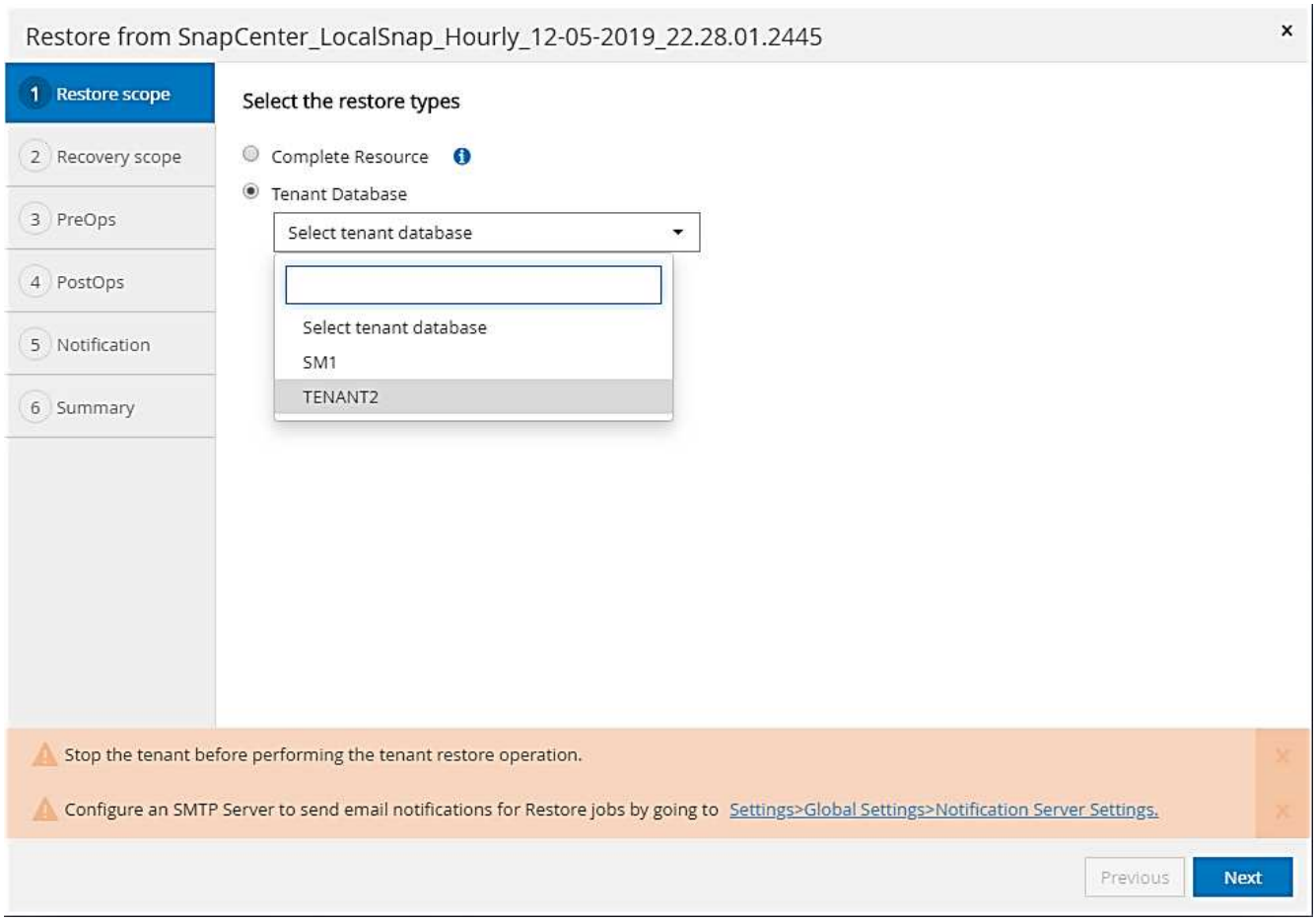
```
sm1adm@hana-2:/usr/sap/SM1/HDB00> hdbsql -U SYSKEY
Welcome to the SAP HANA Database interactive terminal.
Type:  \h for help with commands
       \q to quit
hdbsql=>
hdbsql SYSTEMDB=> alter system stop database tenant2;
0 rows affected (overall time 14.215281 sec; server time 14.212629 sec)
hdbsql SYSTEMDB=>
```

2. Select a backup in SnapCenter to be used for the restore operation.

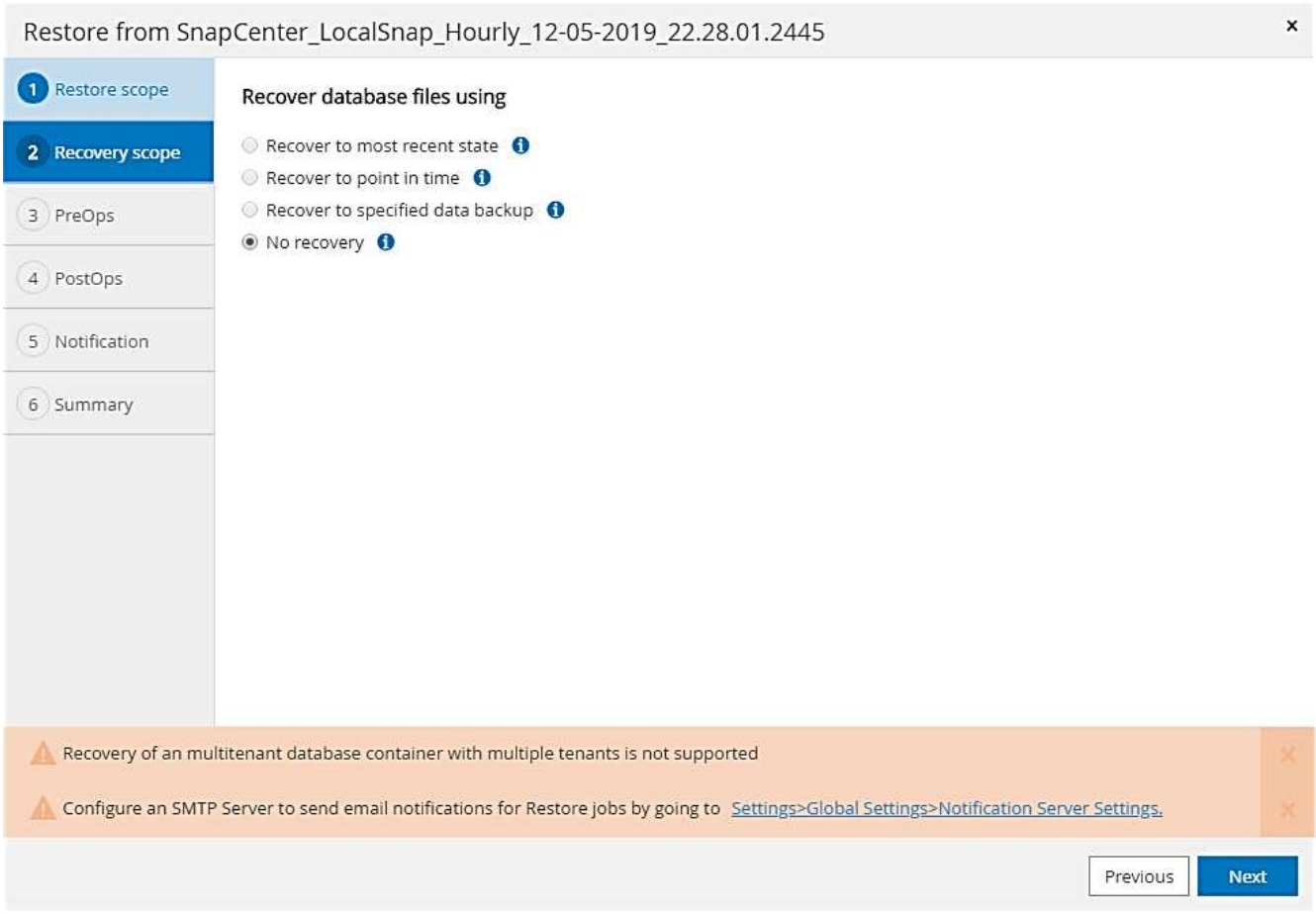


3. Select the tenant to be restored.

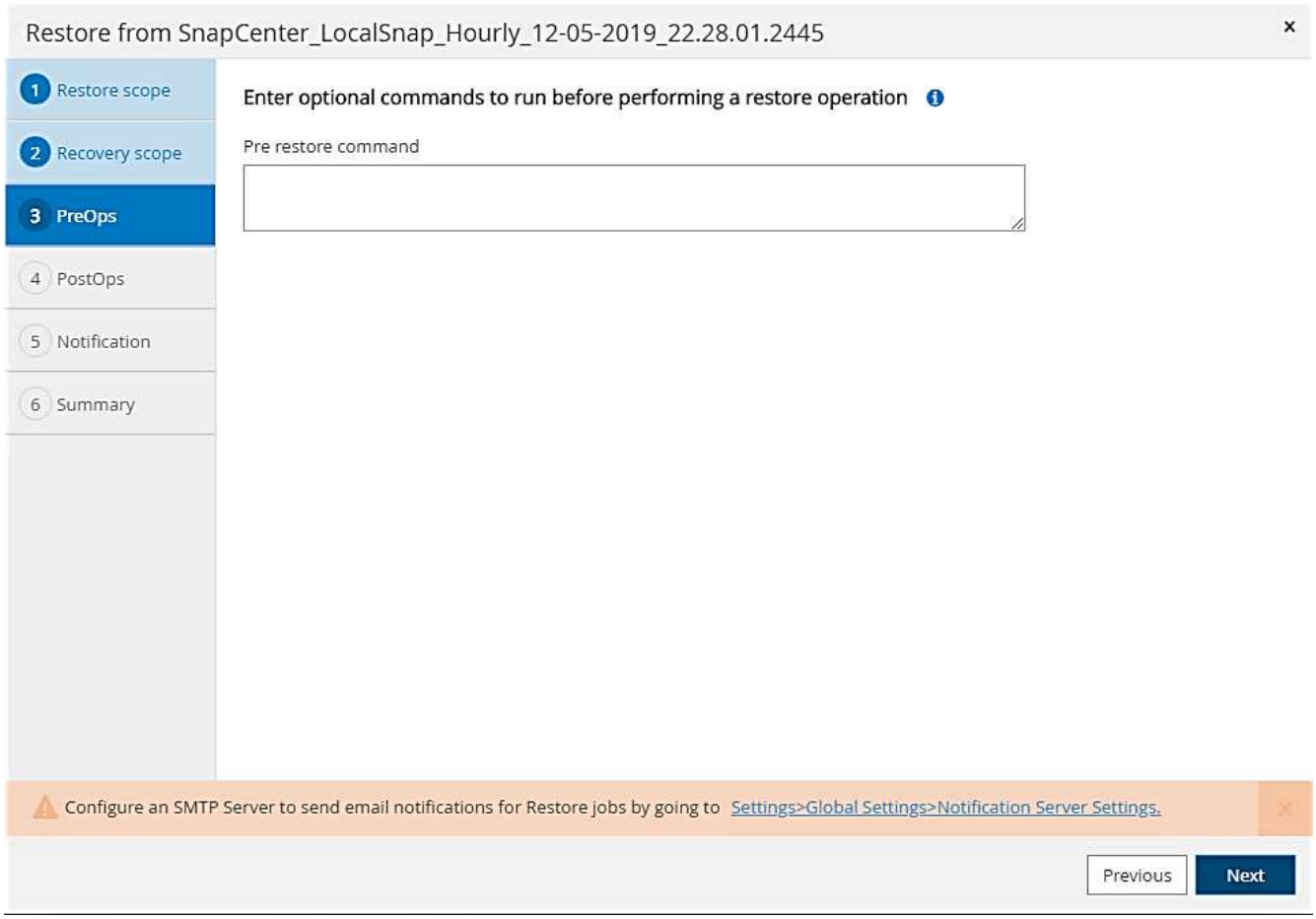
SnapCenter shows a list of all tenants that are included in the selected backup.



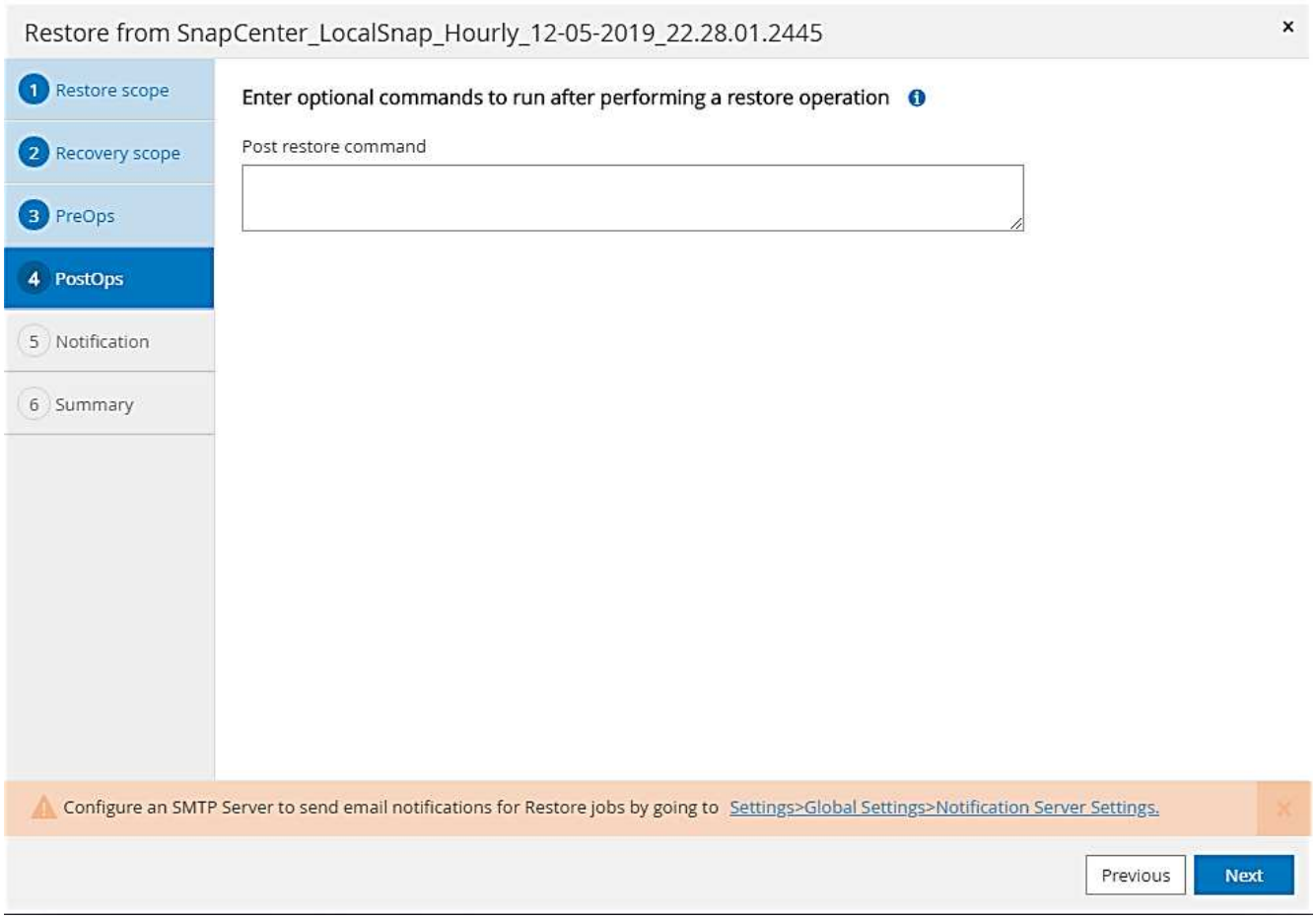
Single-tenant recovery is not supported with SnapCenter 4.3. No Recovery is preselected and cannot be changed.



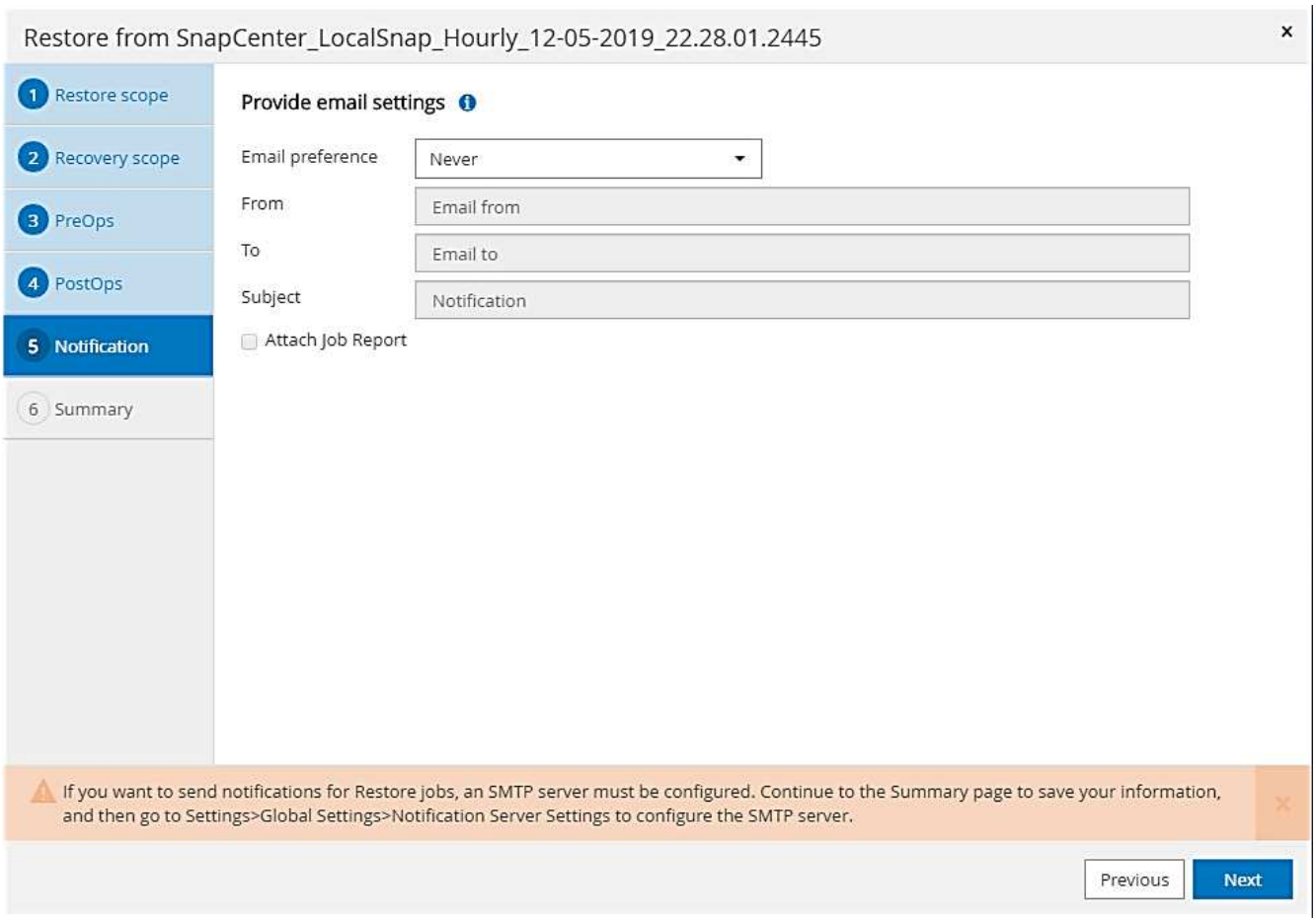
4. Enter the optional prerestore commands.



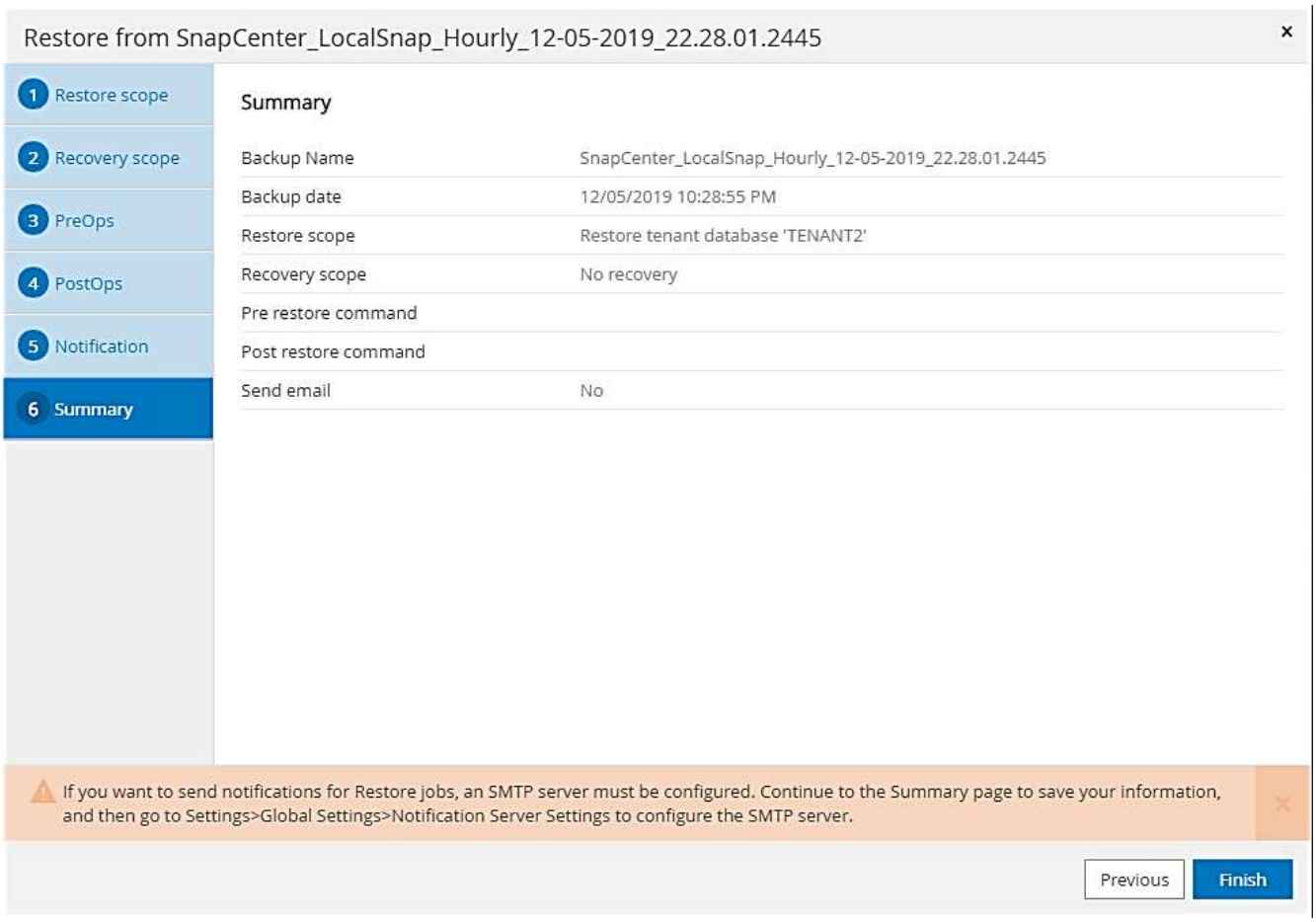
5. Enter optional post-restore commands.



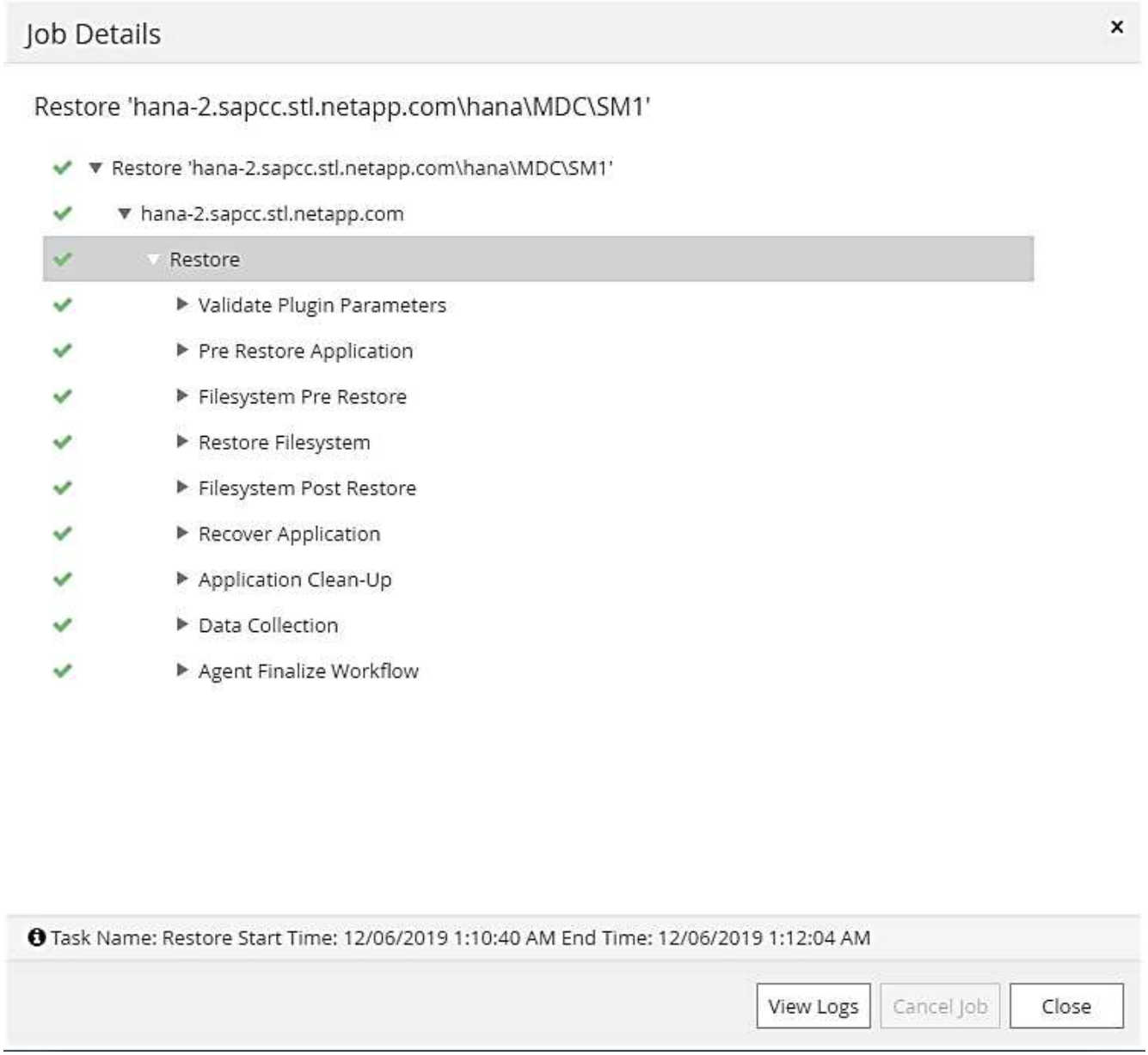
6. Enter the optional email settings.



7. To start the restore operation, click Finish.



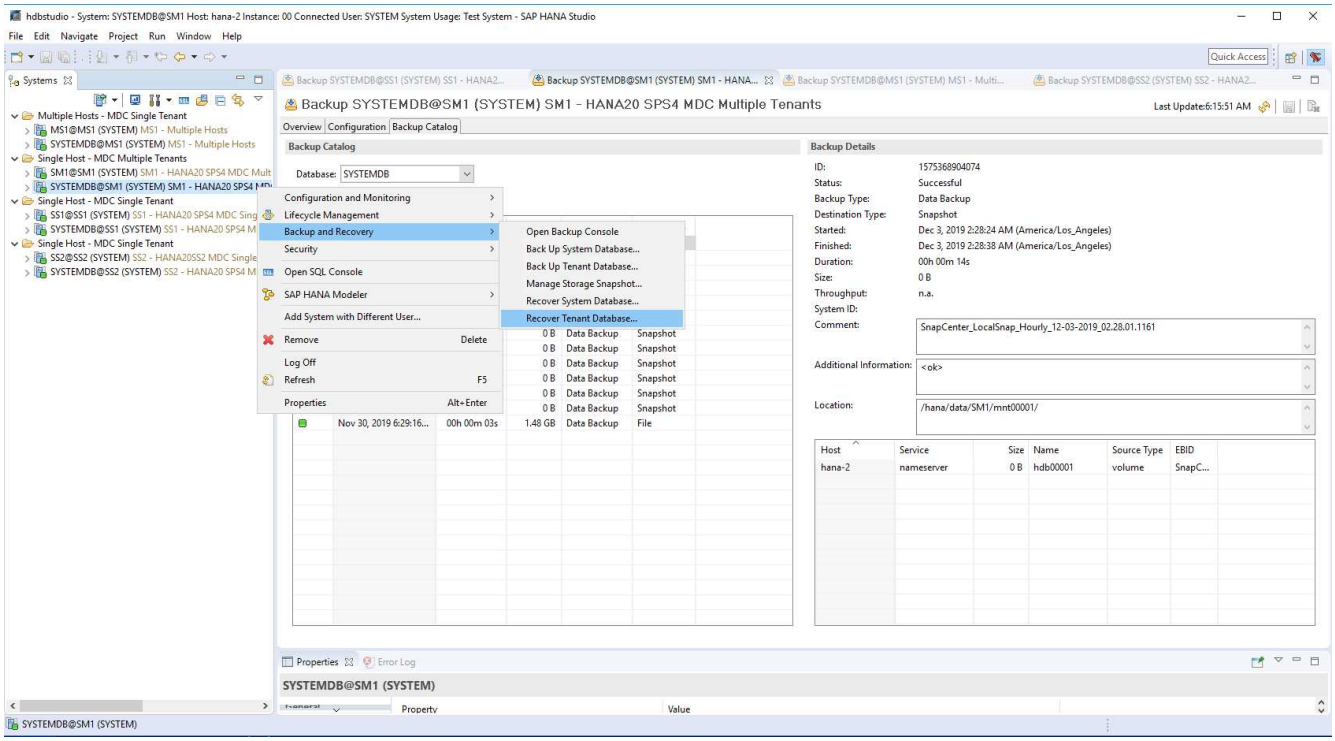
The restore operation is executed by SnapCenter. This example shows the job details of the restore job.



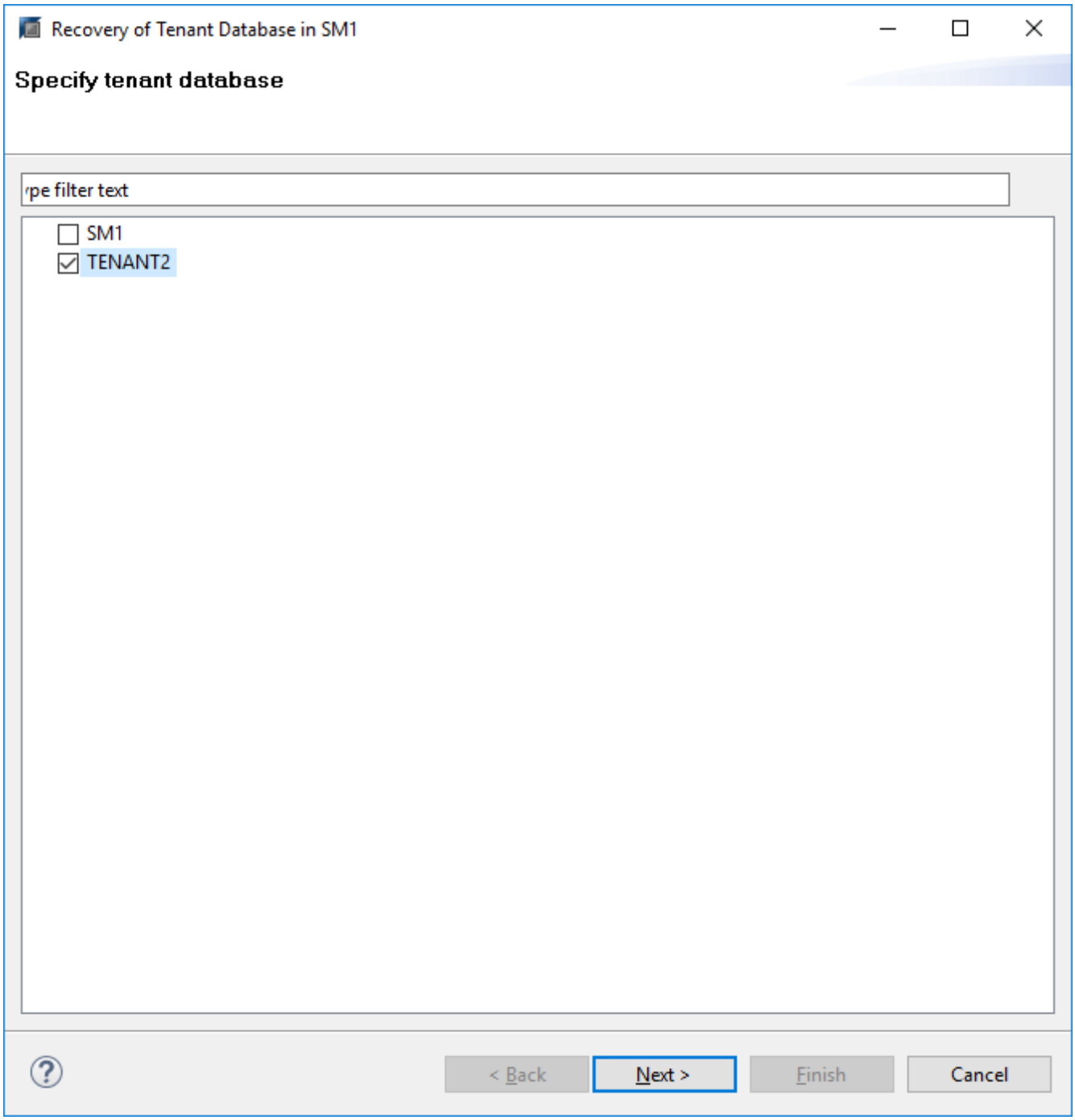
When the tenant restore operation is finished, only the tenant relevant data is restored. On the file system of the HANA database host, the restored data file and the Snapshot backup ID file of the tenant is available.

```
sm1adm@hana-2:/usr/sap/SM1/HDB00> ls -al /hana/data/SM1/mnt00001/*
-rw-r--r-- 1 sm1adm sapsys   17 Dec  6 04:01
/hana/data/SM1/mnt00001/nameserver.lck
/hana/data/SM1/mnt00001/hdb00001:
total 3417776
drwxr-x--- 2 sm1adm sapsys       4096 Dec  6 01:14 .
drwxr-x--- 6 sm1adm sapsys       4096 Nov 20 09:35 ..
-rw-r----- 1 sm1adm sapsys 3758096384 Dec  6 03:59 datavolume_0000.dat
-rw-r----- 1 sm1adm sapsys          0 Nov 20 08:36
__DO_NOT_TOUCH_FILES_IN_THIS_DIRECTORY__
-rw-r----- 1 sm1adm sapsys         36 Nov 20 08:37 landscape.id
/hana/data/SM1/mnt00001/hdb00002.00003:
total 67772
drwxr-xr-- 2 sm1adm sapsys      4096 Nov 20 08:37 .
drwxr-x--- 6 sm1adm sapsys      4096 Nov 20 09:35 ..
-rw-r--r-- 1 sm1adm sapsys 201441280 Dec  6 03:59 datavolume_0000.dat
-rw-r--r-- 1 sm1adm sapsys         0 Nov 20 08:37
__DO_NOT_TOUCH_FILES_IN_THIS_DIRECTORY__
/hana/data/SM1/mnt00001/hdb00002.00004:
total 3411836
drwxr-xr-- 2 sm1adm sapsys       4096 Dec  6 03:57 .
drwxr-x--- 6 sm1adm sapsys       4096 Nov 20 09:35 ..
-rw-r--r-- 1 sm1adm sapsys 3758096384 Dec  6 01:14 datavolume_0000.dat
-rw-r--r-- 1 sm1adm sapsys          0 Nov 20 09:35
__DO_NOT_TOUCH_FILES_IN_THIS_DIRECTORY__
-rw-r----- 1 sm1adm sapsys     155648 Dec  6 01:14
snapshot_databackup_0_1
/hana/data/SM1/mnt00001/hdb00003.00003:
total 3364216
drwxr-xr-- 2 sm1adm sapsys       4096 Dec  6 01:14 .
drwxr-x--- 6 sm1adm sapsys       4096 Nov 20 09:35 ..
-rw-r--r-- 1 sm1adm sapsys 3758096384 Dec  6 03:59 datavolume_0000.dat
-rw-r--r-- 1 sm1adm sapsys          0 Nov 20 08:37
__DO_NOT_TOUCH_FILES_IN_THIS_DIRECTORY__
sm1adm@hana-2:/usr/sap/SM1/HDB00>
```

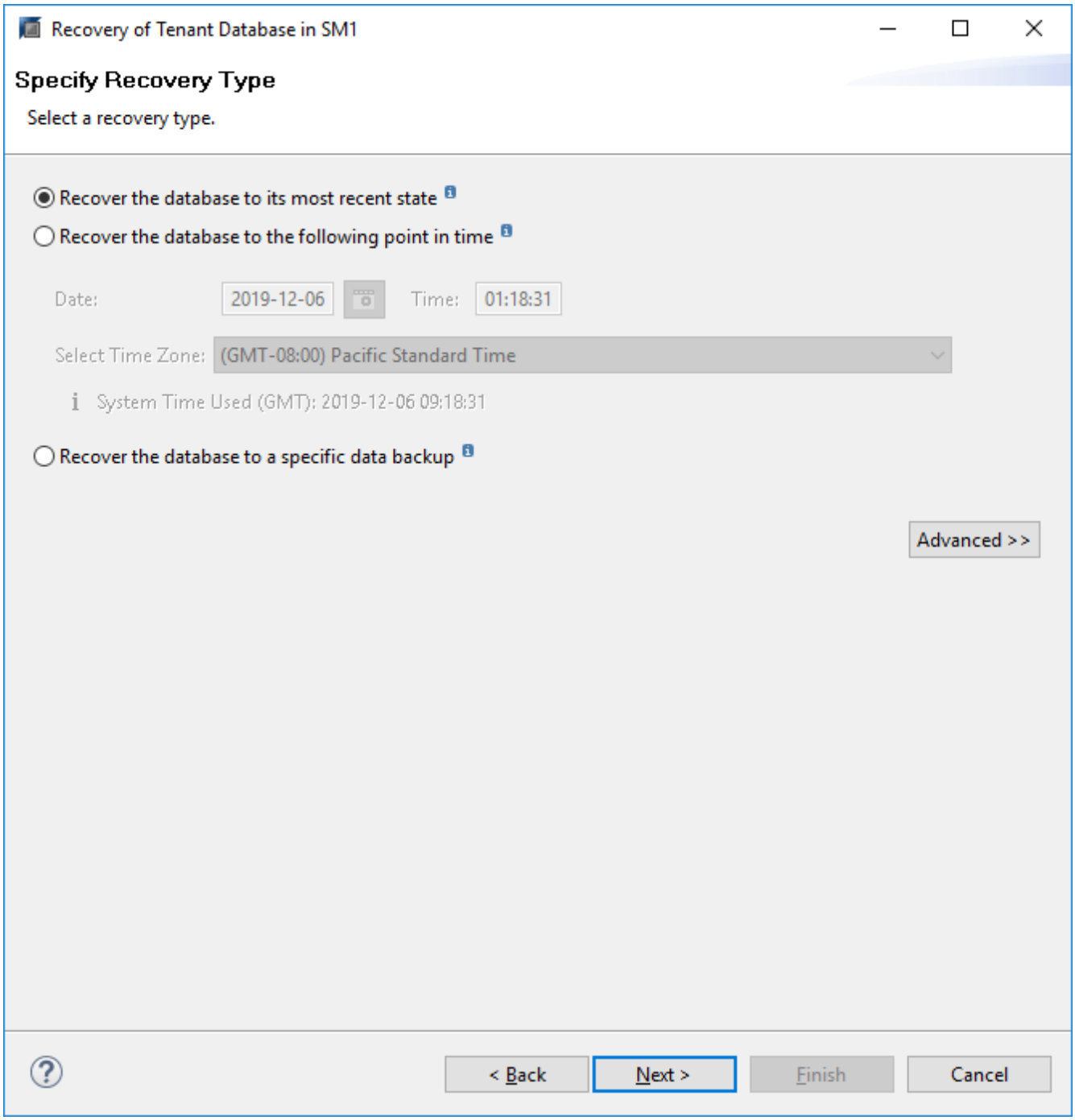
8. Start the recovery with HANA Studio.



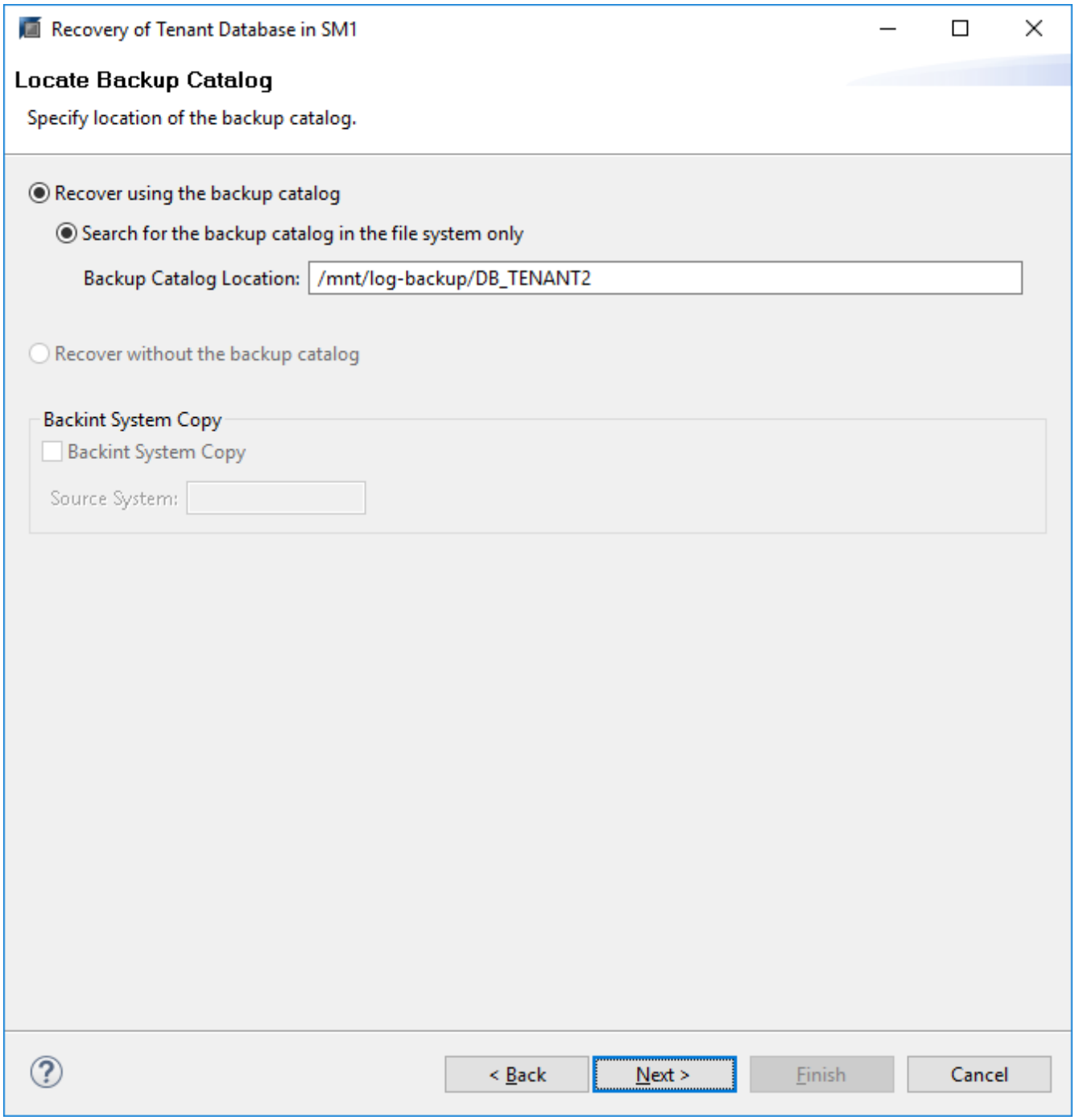
9. Select the tenant.

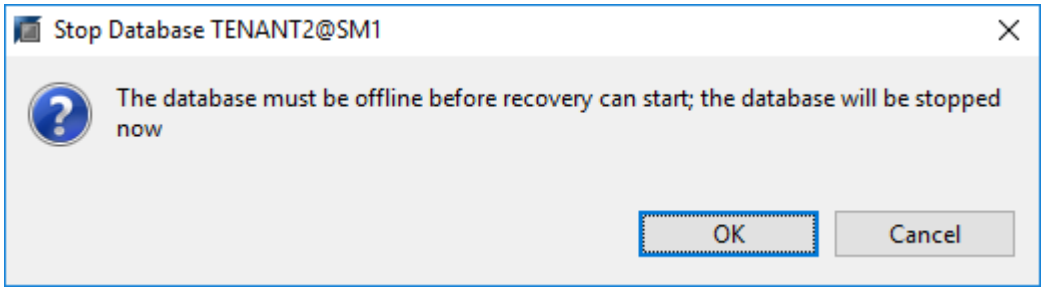


10. Select the recovery type.



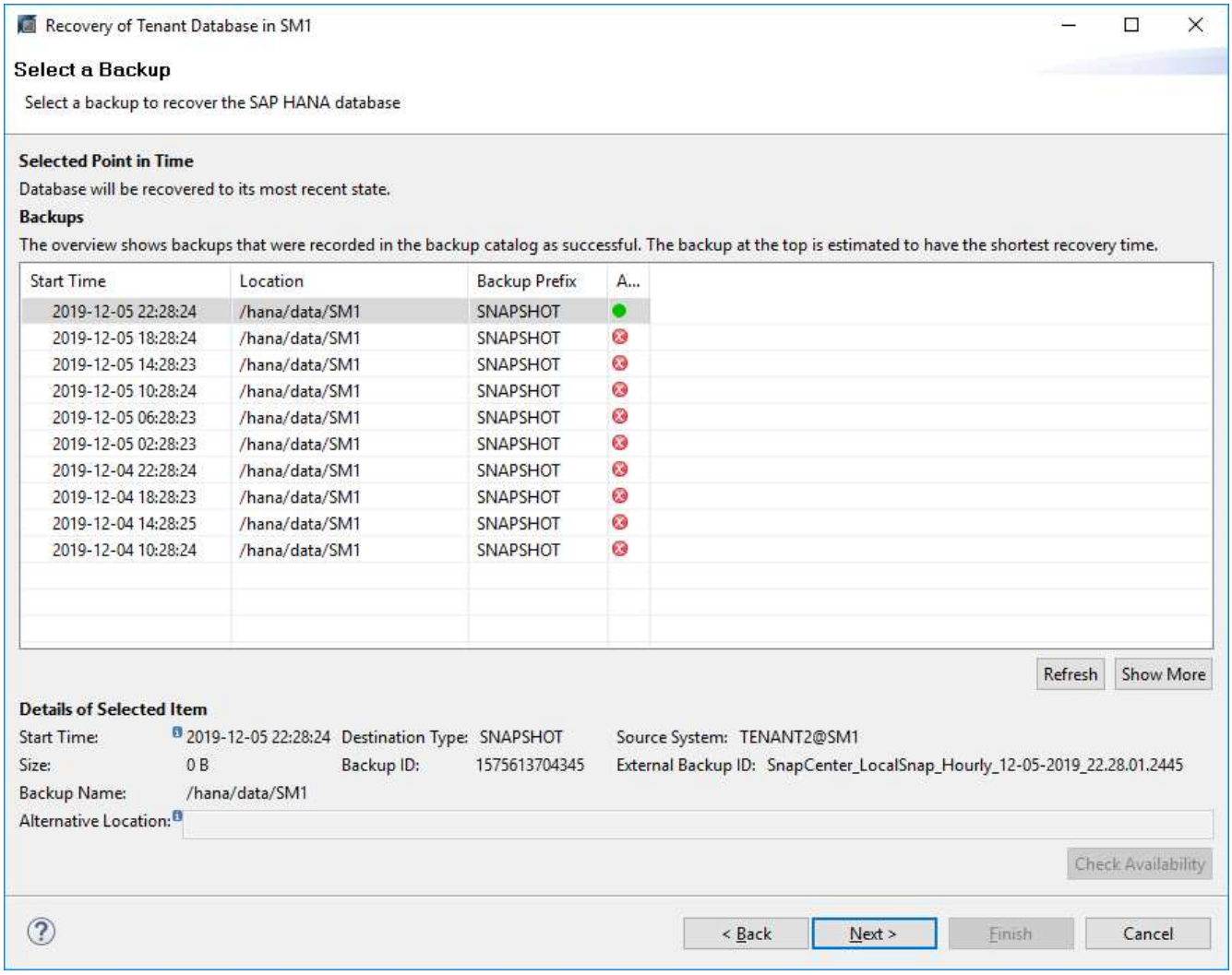
11. Provide the backup catalog location.



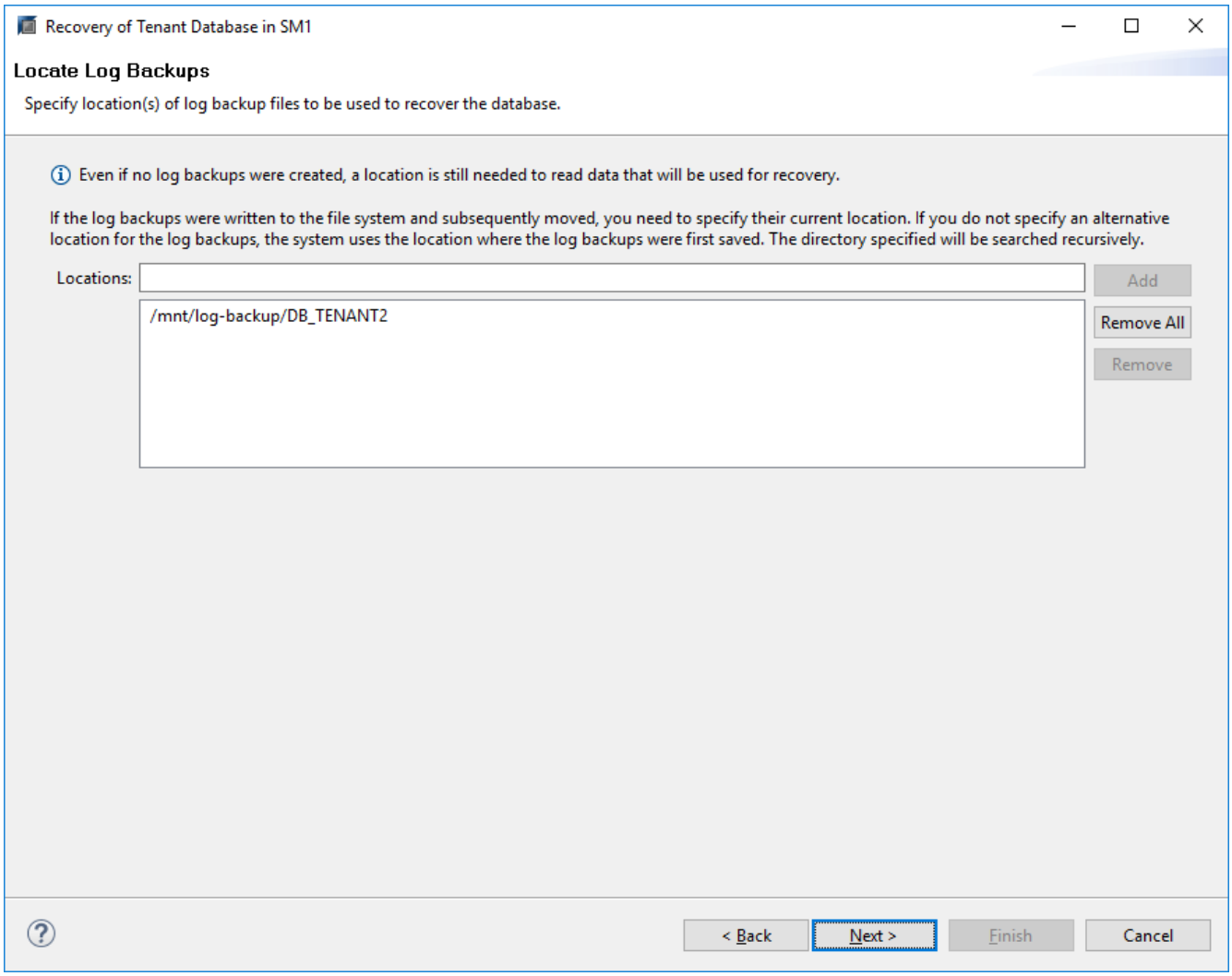


Within the backup catalog, the restored backup is highlighted with a green icon. The external backup ID shows the backup name that was previously selected in SnapCenter.

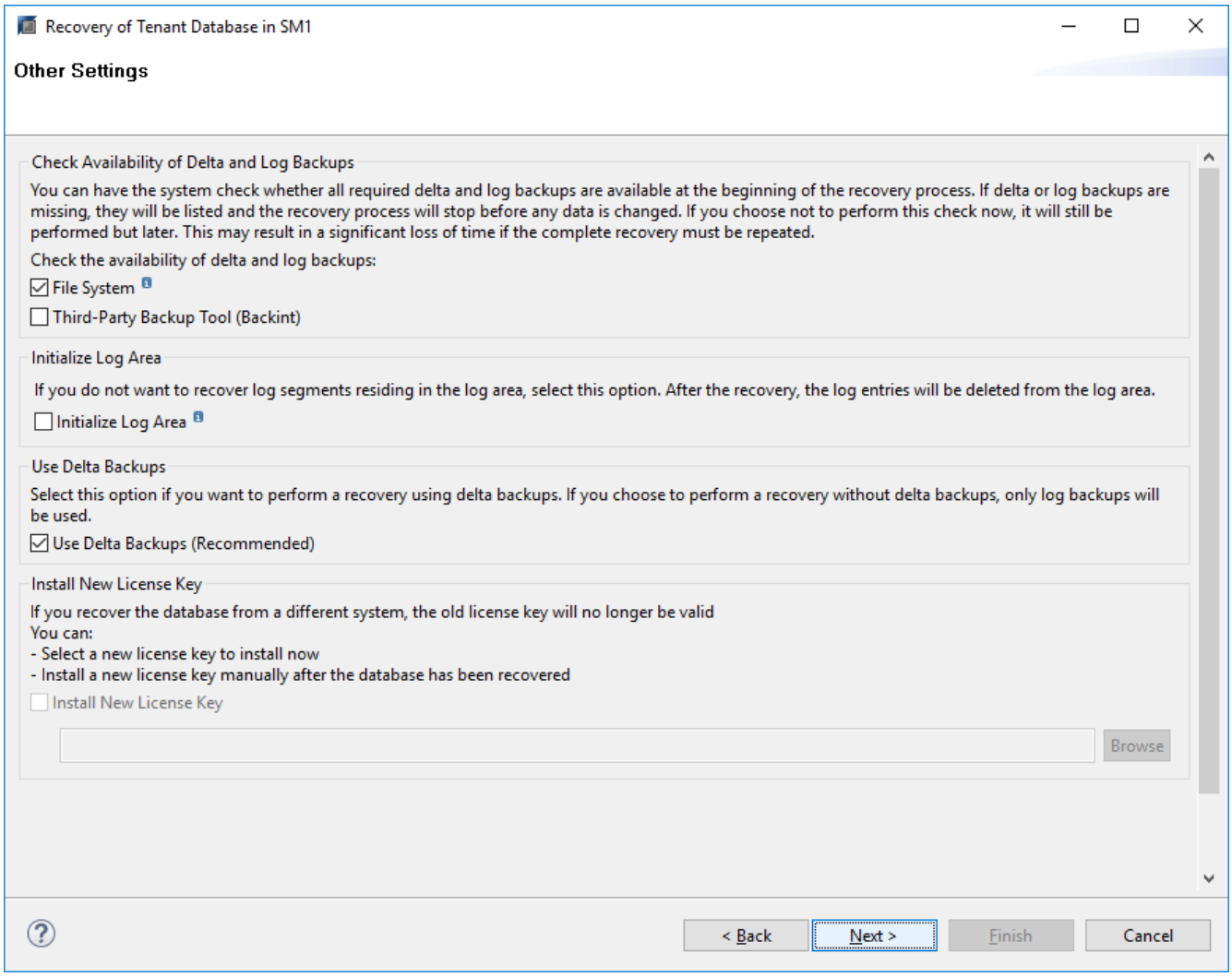
12. Select the entry with the green icon and click Next.



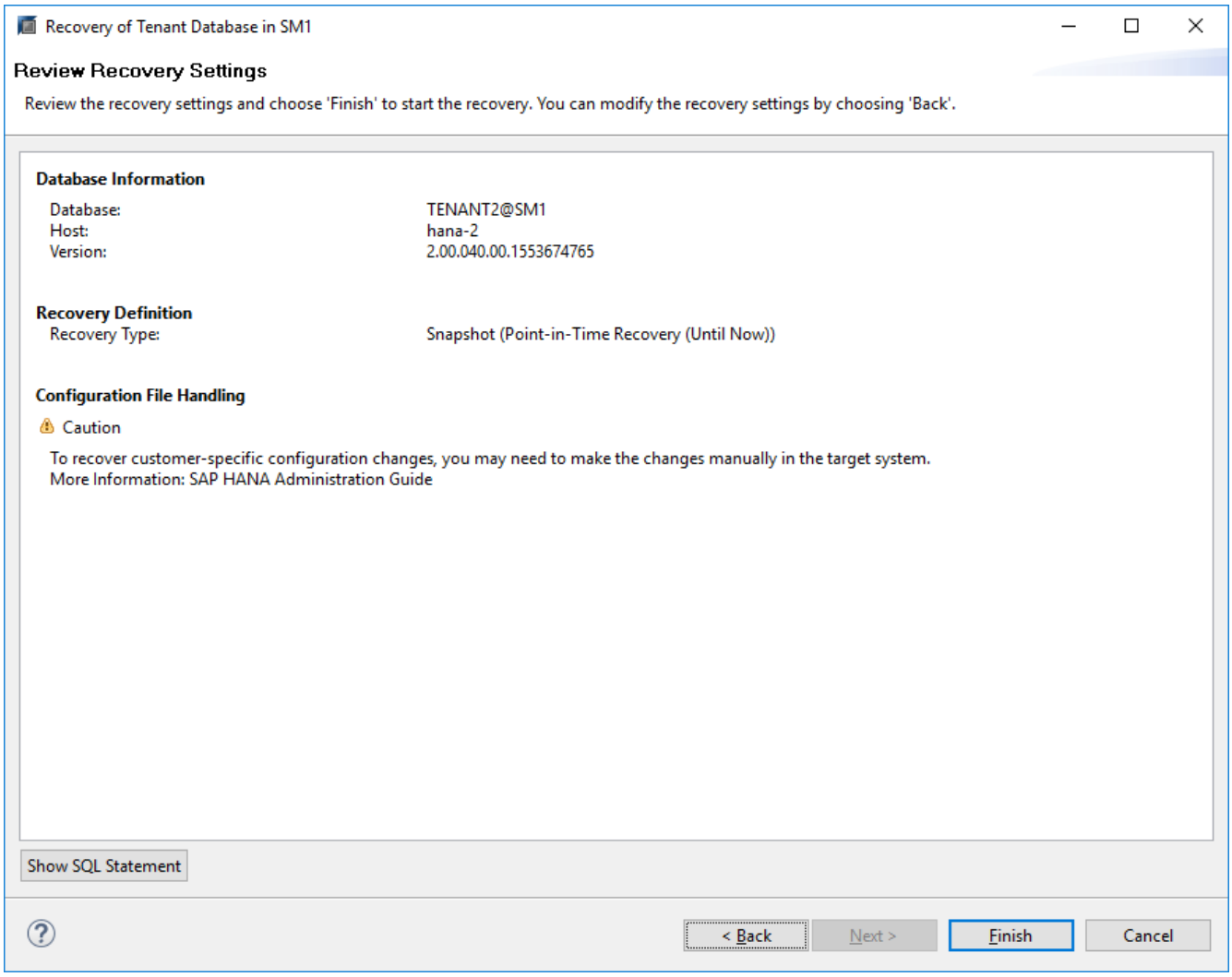
13. Provide the log backup location.

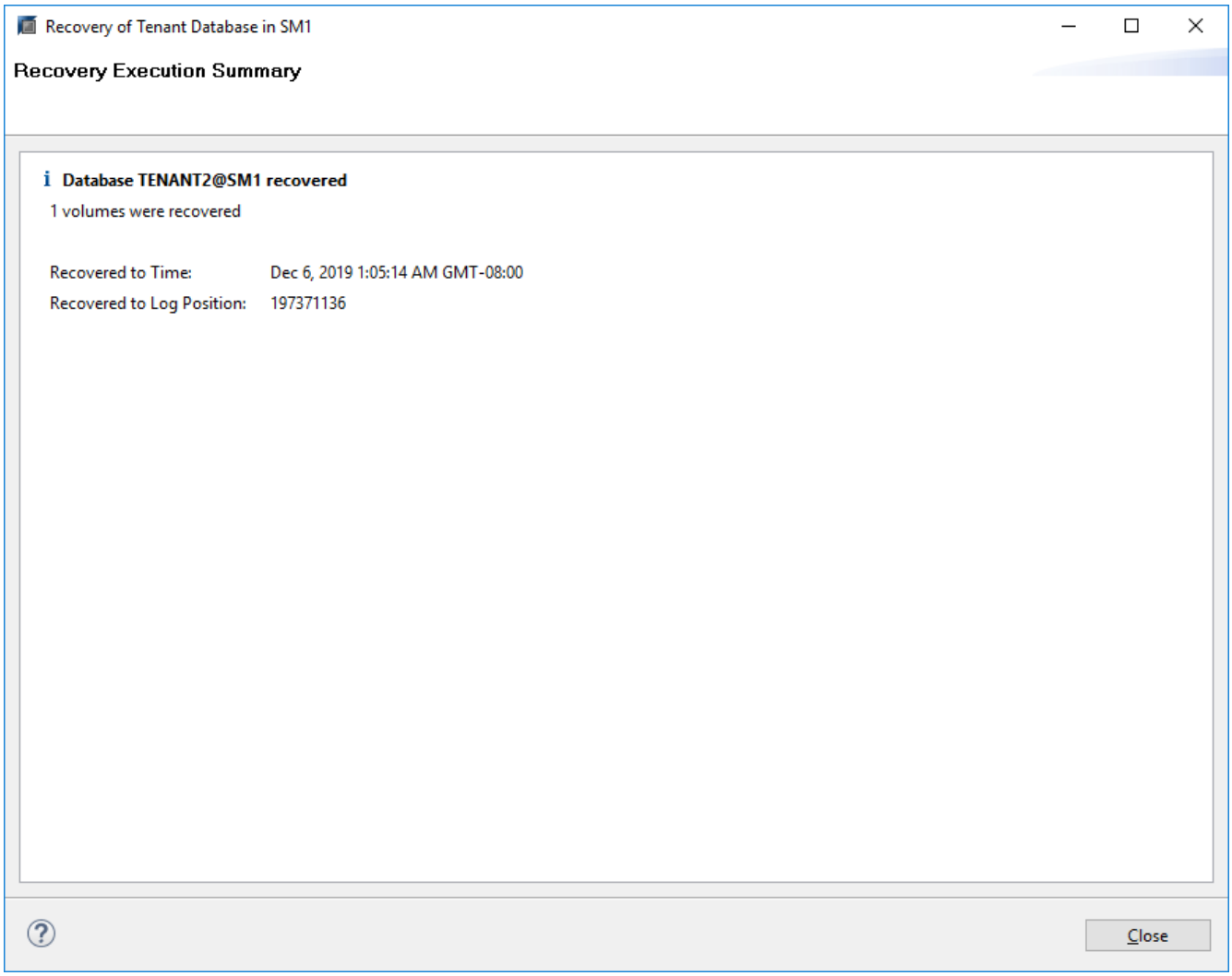


14. Select the other settings as required.



15. Start the tenant recovery operation.


Recovery of Tenant Database in SM1
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: TENANT2@SM1
Host: hana-2
Version: 2.00.040.00.1553674765
Recovery Definition
Recovery Type: Snapshot (Point-in-Time Recovery (Until Now))
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
< Back
Next >
Finish
Cancel



Restore with manual recovery

To restore and recover an SAP HANA MDC single-tenant system using SAP HANA Studio and SnapCenter, complete the following steps:

1. Prepare the restore and recovery process with SAP HANA Studio:
   a. Select Recover System Database and confirm shutdown of the SAP HANA system.
   b. Select the recovery type and the log backup location.
   c. The list of data backups is shown. Select Backup to see the external backup ID.
2. Perform the restore process with SnapCenter:
   a. In the topology view of the resource, select Local Copies to restore from primary storage or Vault Copies if you want to restore from an off-site backup storage.
   b. Select the SnapCenter backup that matches the external backup ID or comment field from SAP HANA Studio.
   c. Start the restore process.

> If a volume-based restore from primary storage is chosen, the data volumes must be unmounted from all SAP HANA database hosts before the restore and mounted again after the restore process is finished.

In an SAP HANA multiple-host setup with FC, the unmount and mount operations are executed by the SAP HANA name server as part of the shutdown and startup process of the database.

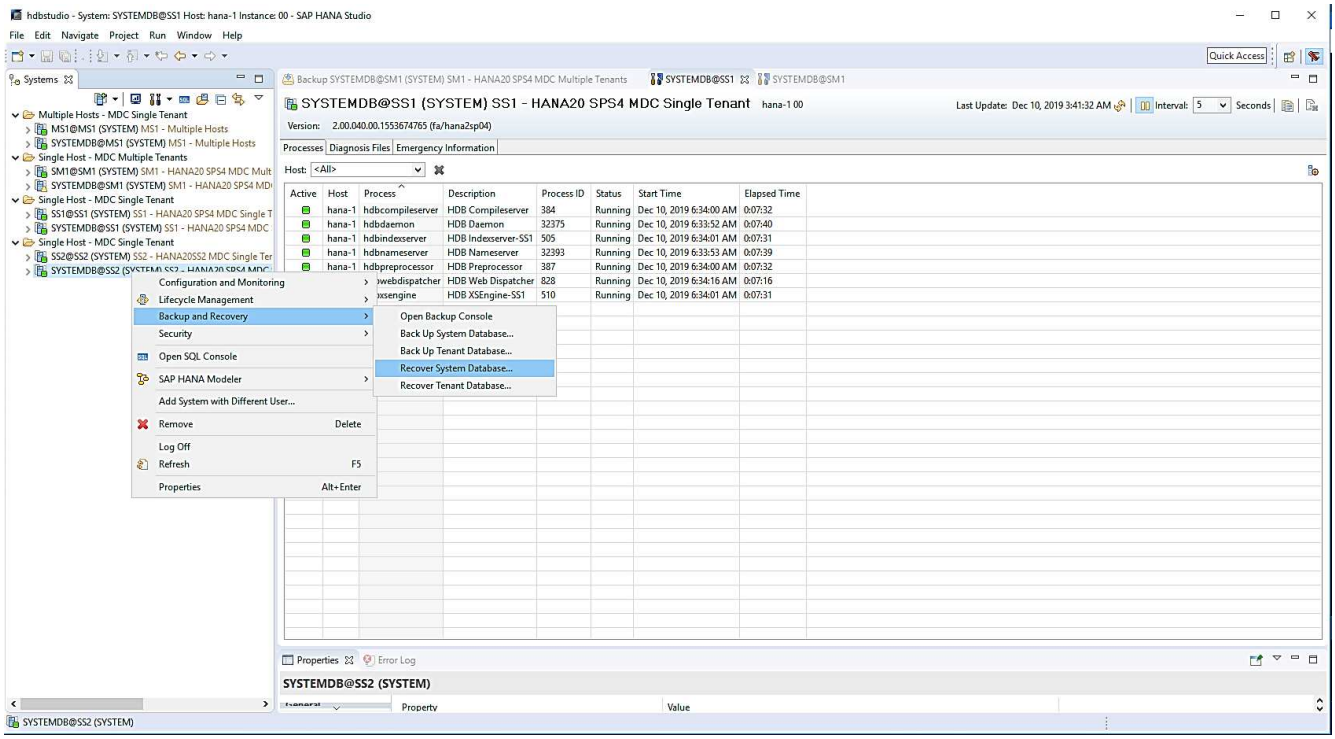
3. Run the recovery process for the system database with SAP HANA Studio:
   a. Click Refresh from the backup list and select the available backup for recovery (indicated with a green icon).
   b. Start the recovery process. After the recovery process is finished, the system database is started.
4. Run the recovery process for the tenant database with SAP HANA Studio:
   a. Select Recover Tenant Database and select the tenant to be recovered.
   b. Select the recovery type and the log backup location.

      A list of data backups displays. Because the data volume has already been restored, the tenant backup is indicated as available (in green).

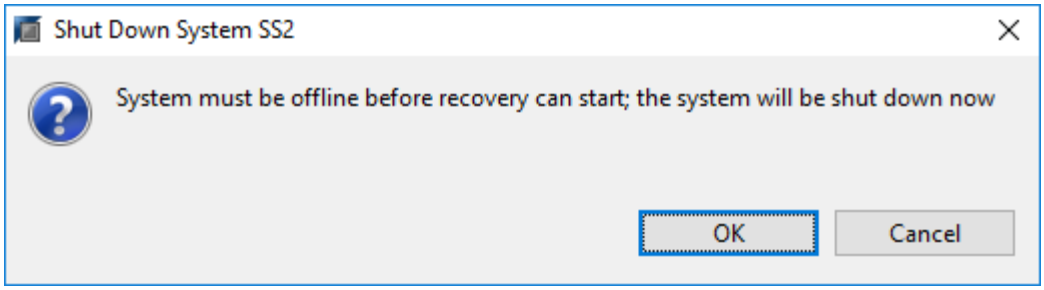
   c. Select this backup and start the recovery process. After the recovery process is finished, the tenant database is started automatically.

The following section describes the steps of the restore and recovery operations of the manually configured HANA system SS2 (SAP HANA single host, MDC multiple tenant system using NFS).

1. In SAP HANA Studio, select the Recover System Database option to start the recovery of the system database.

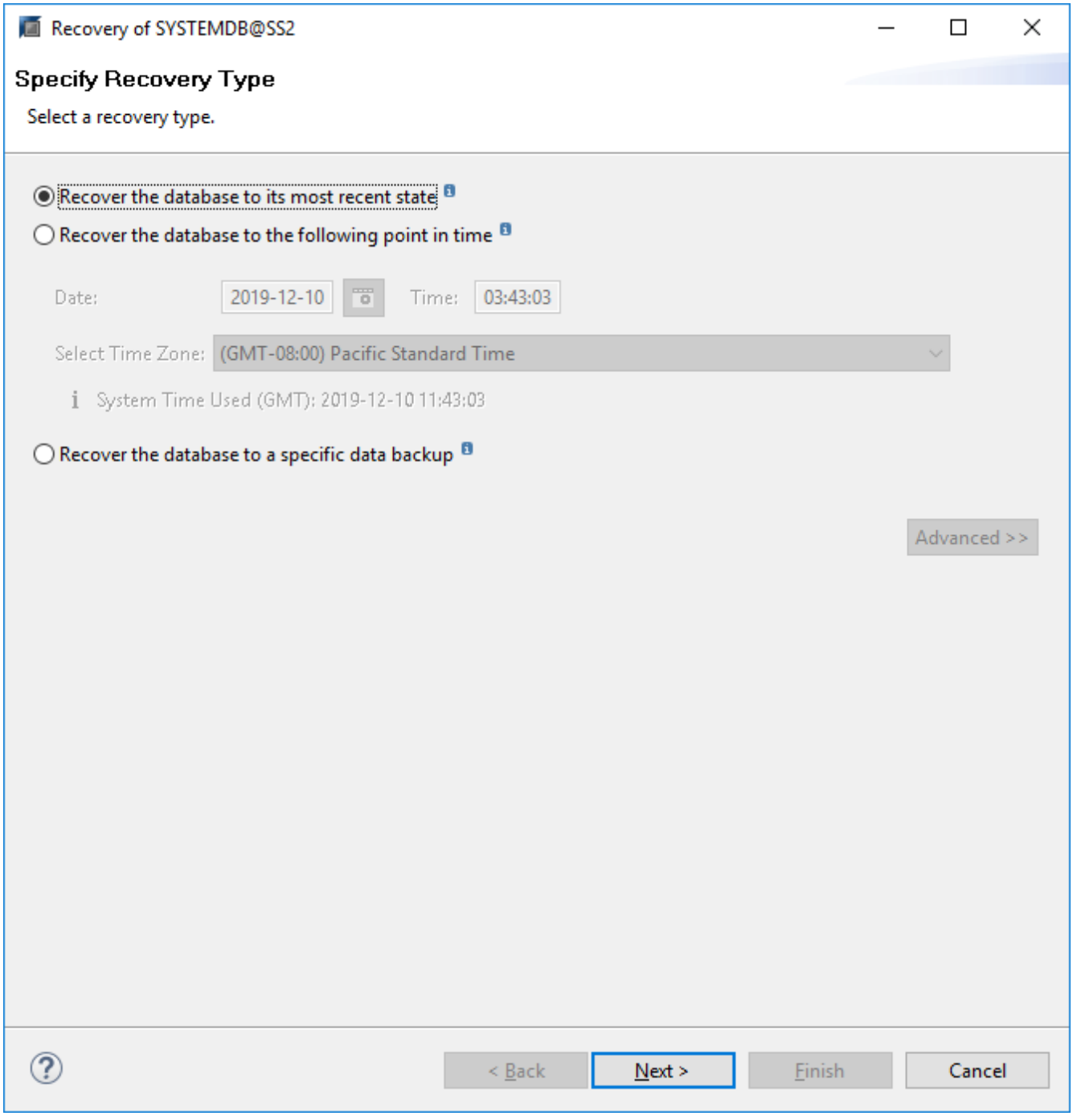


2. Click OK to shut down the SAP HANA database.

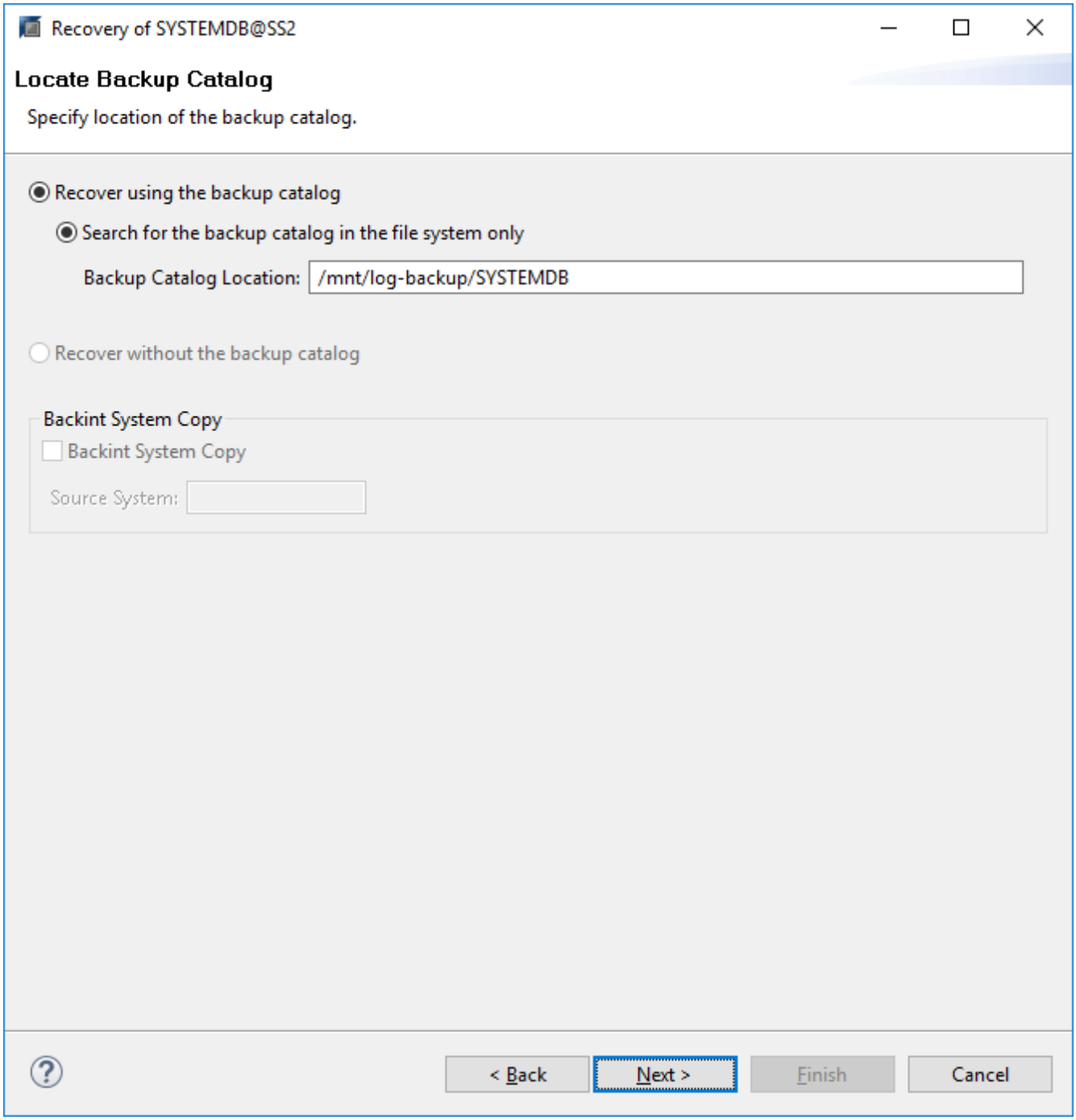


The SAP HANA system shuts down and the recovery wizard is started.

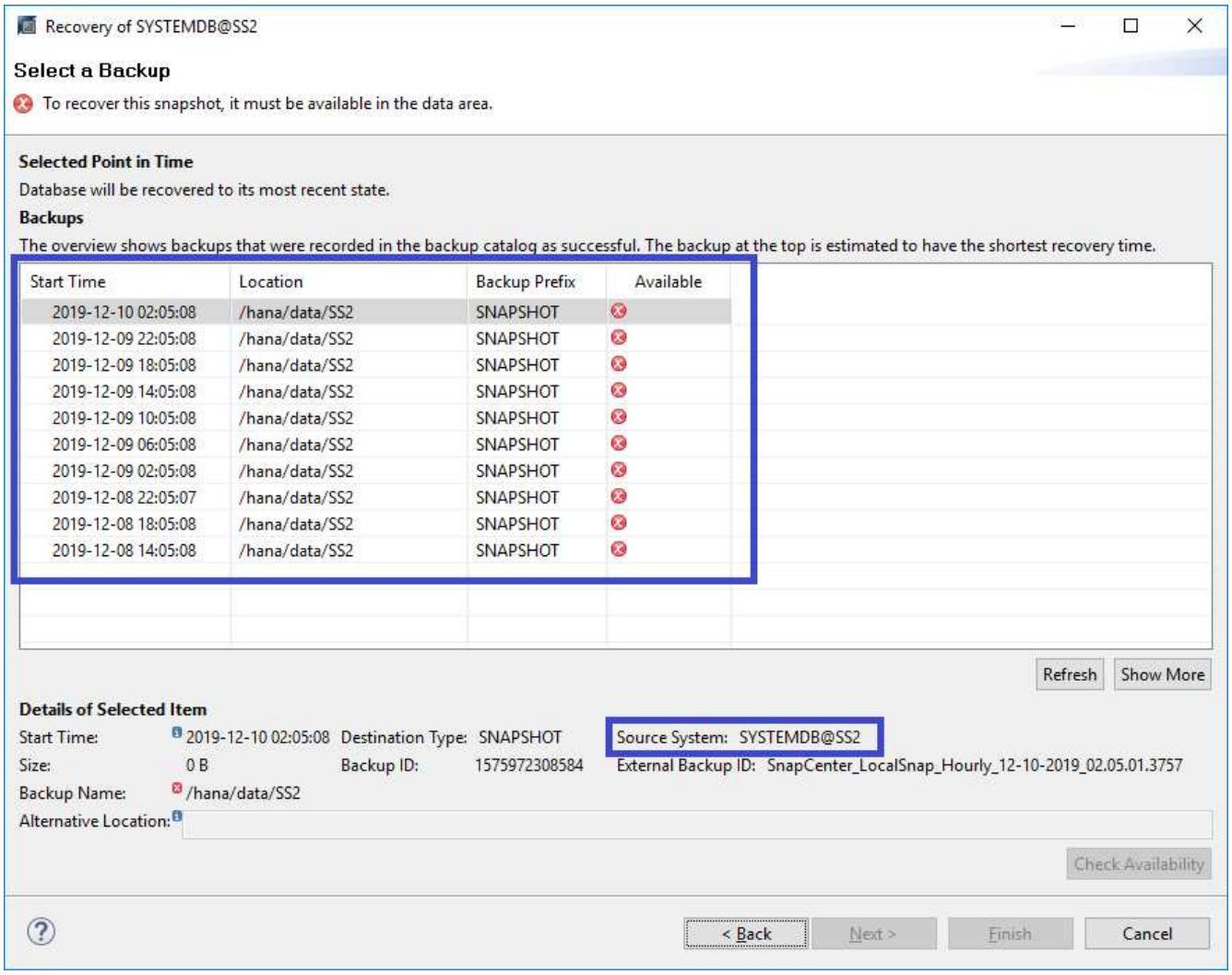
3. Select the recovery type and click Next.



4. Provide the location of the backup catalog and click Next.



5. A list of available backups displays based on the content of the backup catalog. Choose the required backup and note the external backup ID: in our example, the most recent backup.



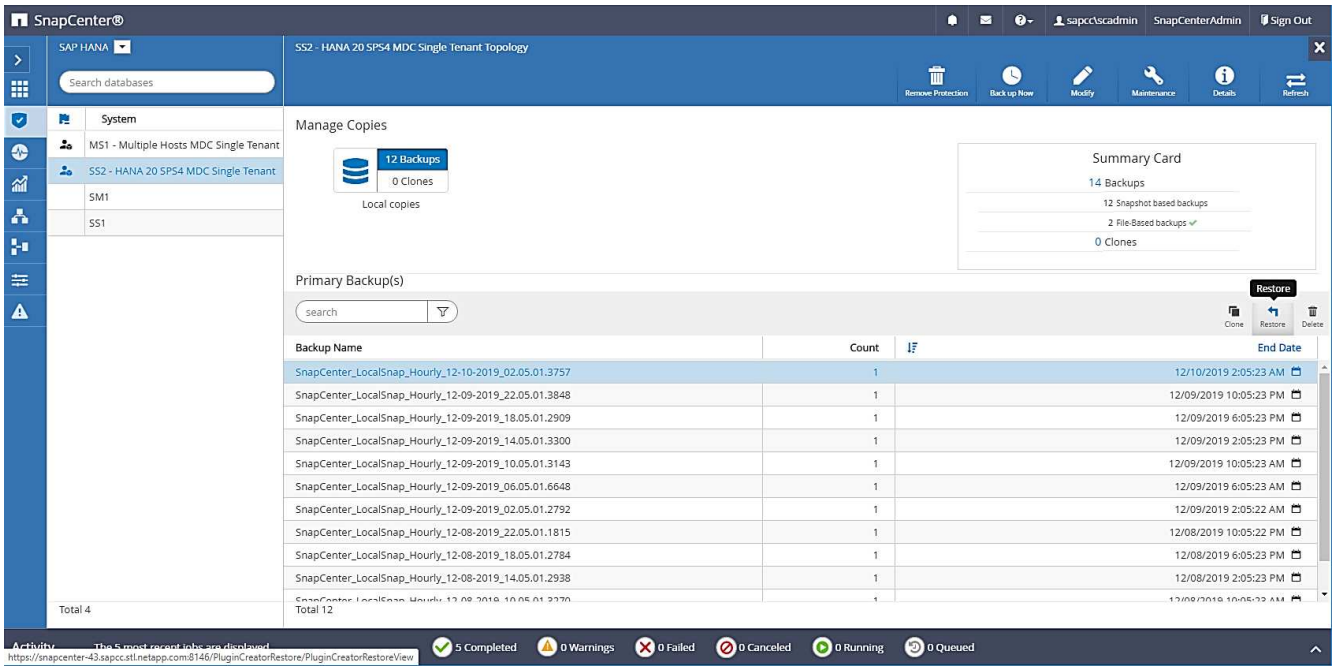
6. Unmount all data volumes.

```
umount /hana/data/SS2/mnt00001
```

For an SAP HANA multiple host system with NFS, all data volumes on each host must be unmounted.

In an SAP HANA multiple-host setup with FC, the unmount operation is executed by the SAP HANA name server as a part of the shutdown process.

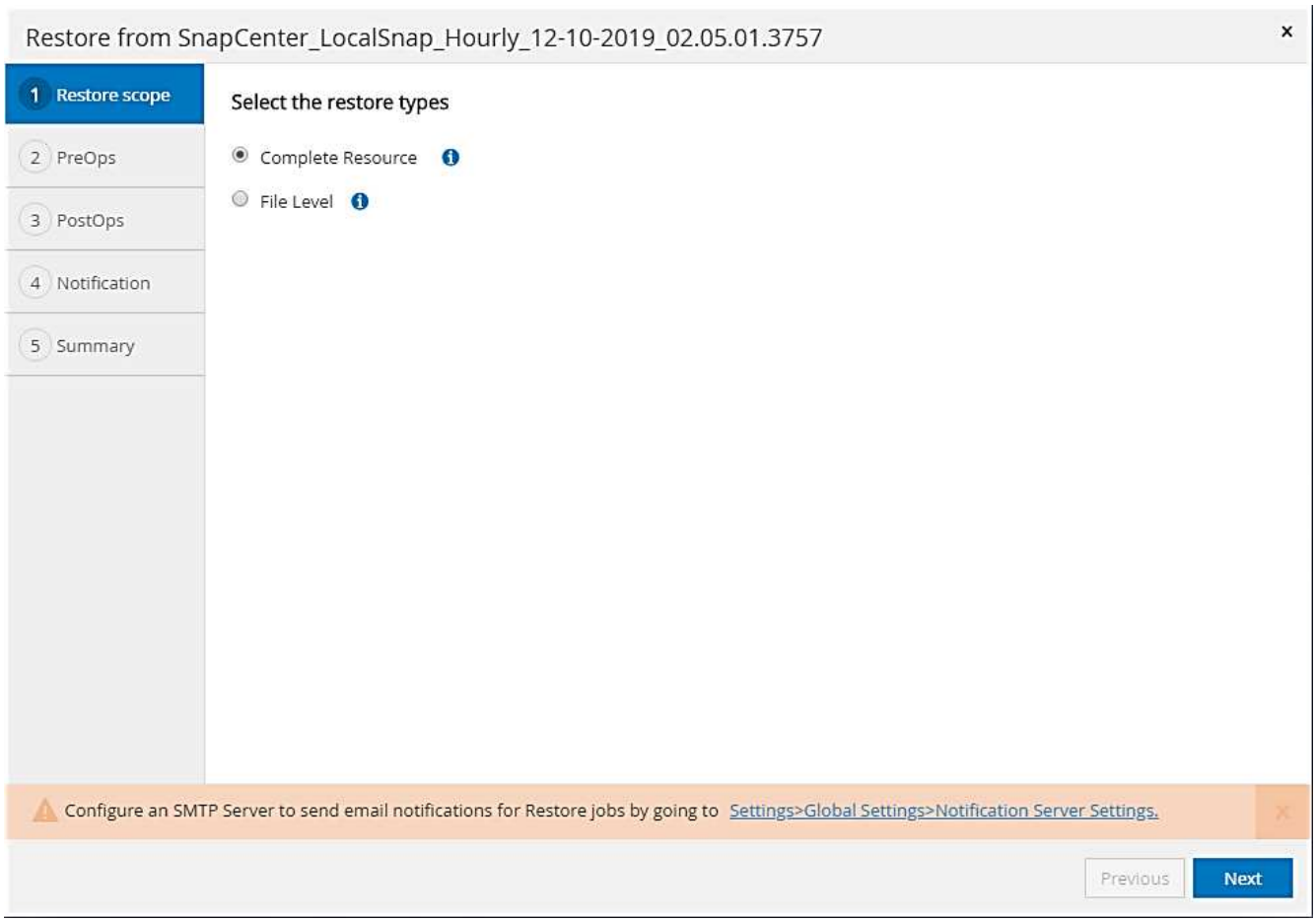
7. From the SnapCenter GUI, select the resource topology view and select the backup that should be restored; in our example, the most recent primary backup. Click the Restore icon to start the restore.



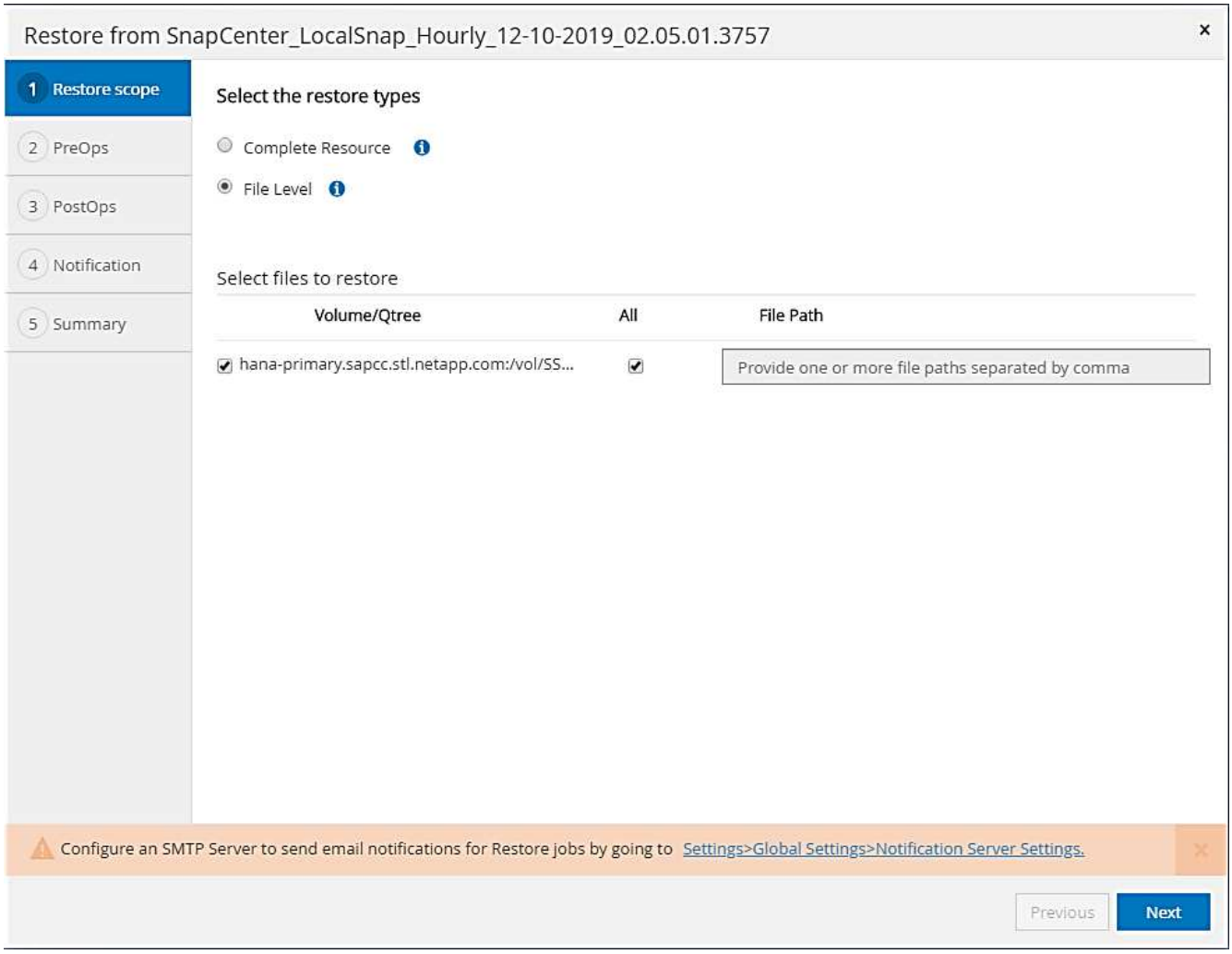
The SnapCenter restore wizard starts.

8. Select the restore type Complete Resource or File Level.

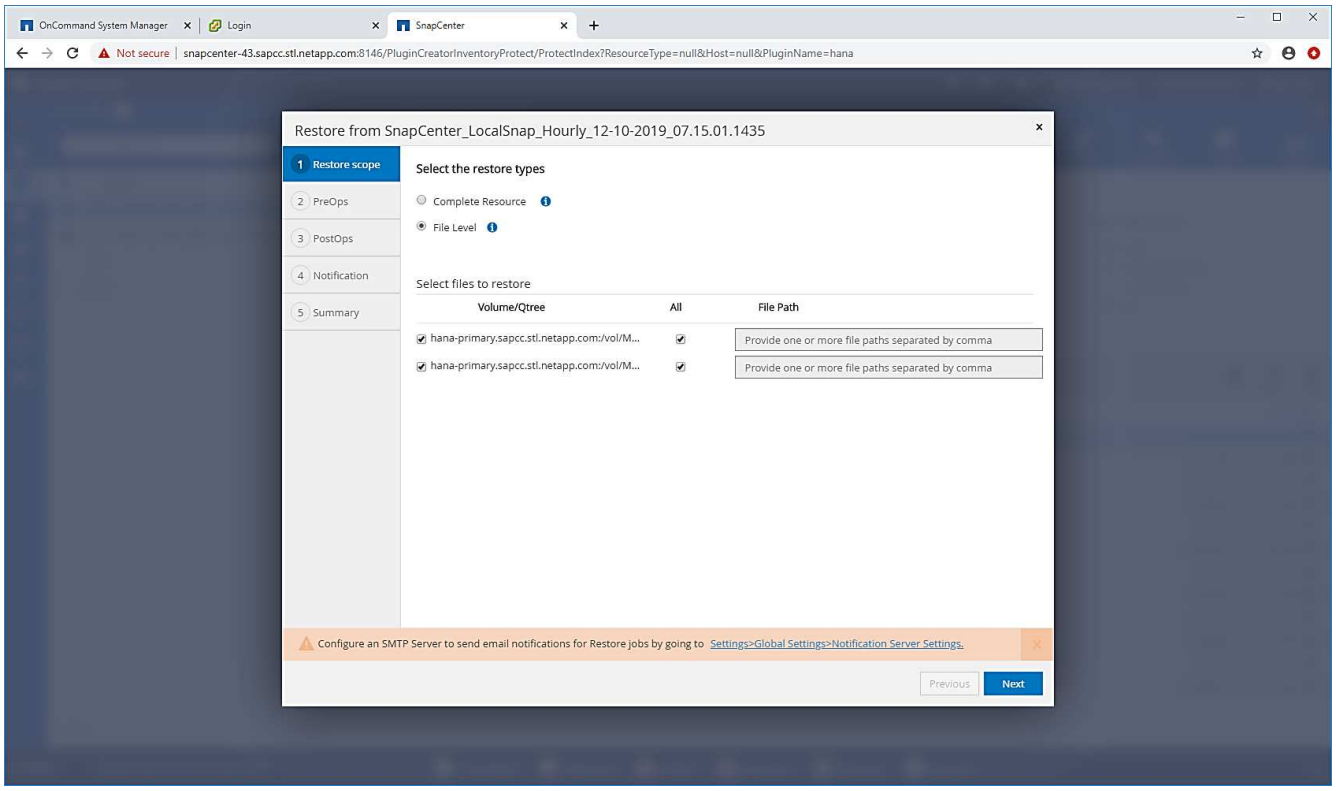
   Select Complete Resource to use a volume-based restore.



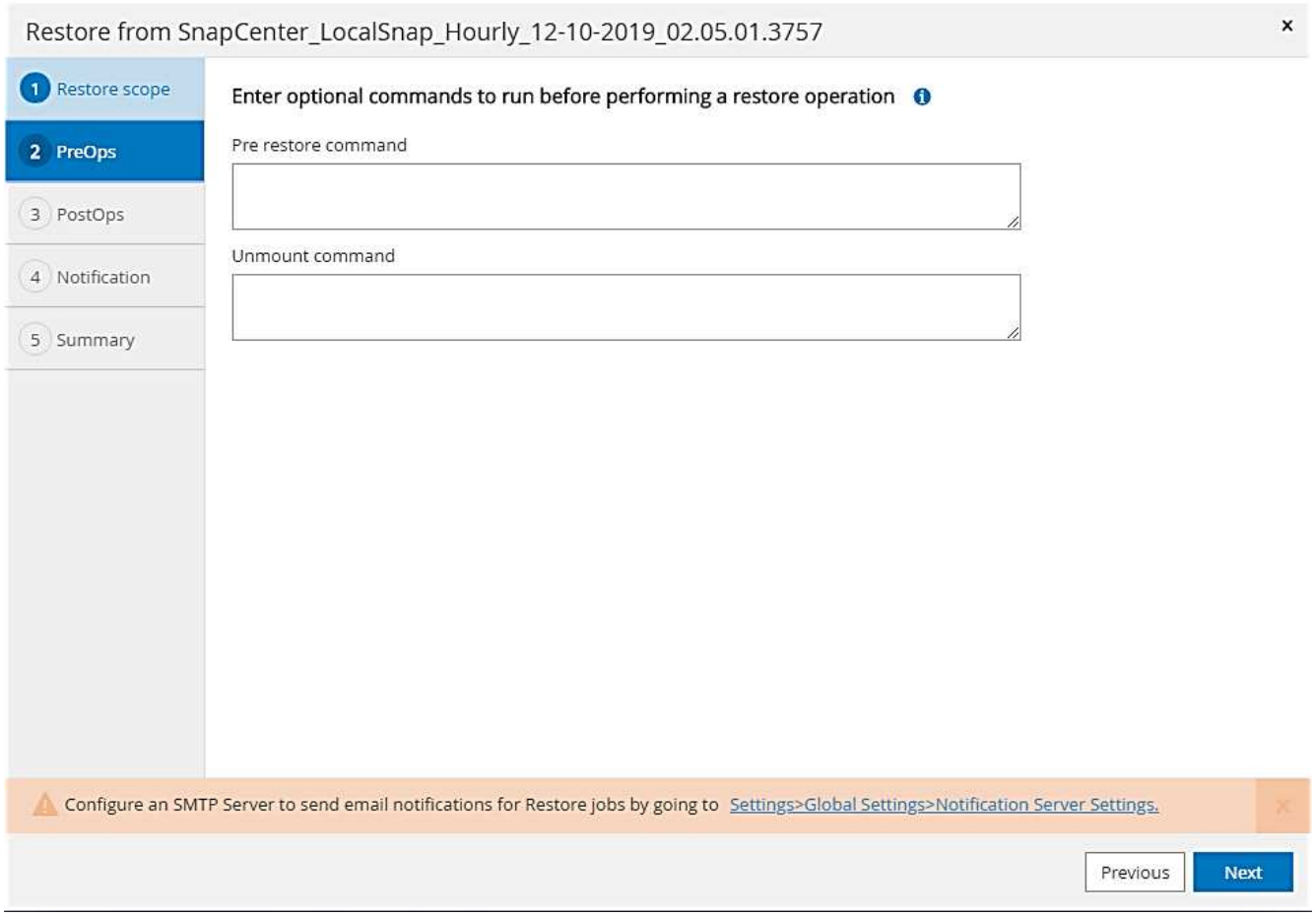
9. Select File Level and All to use a single-file SnapRestore operation for all files.



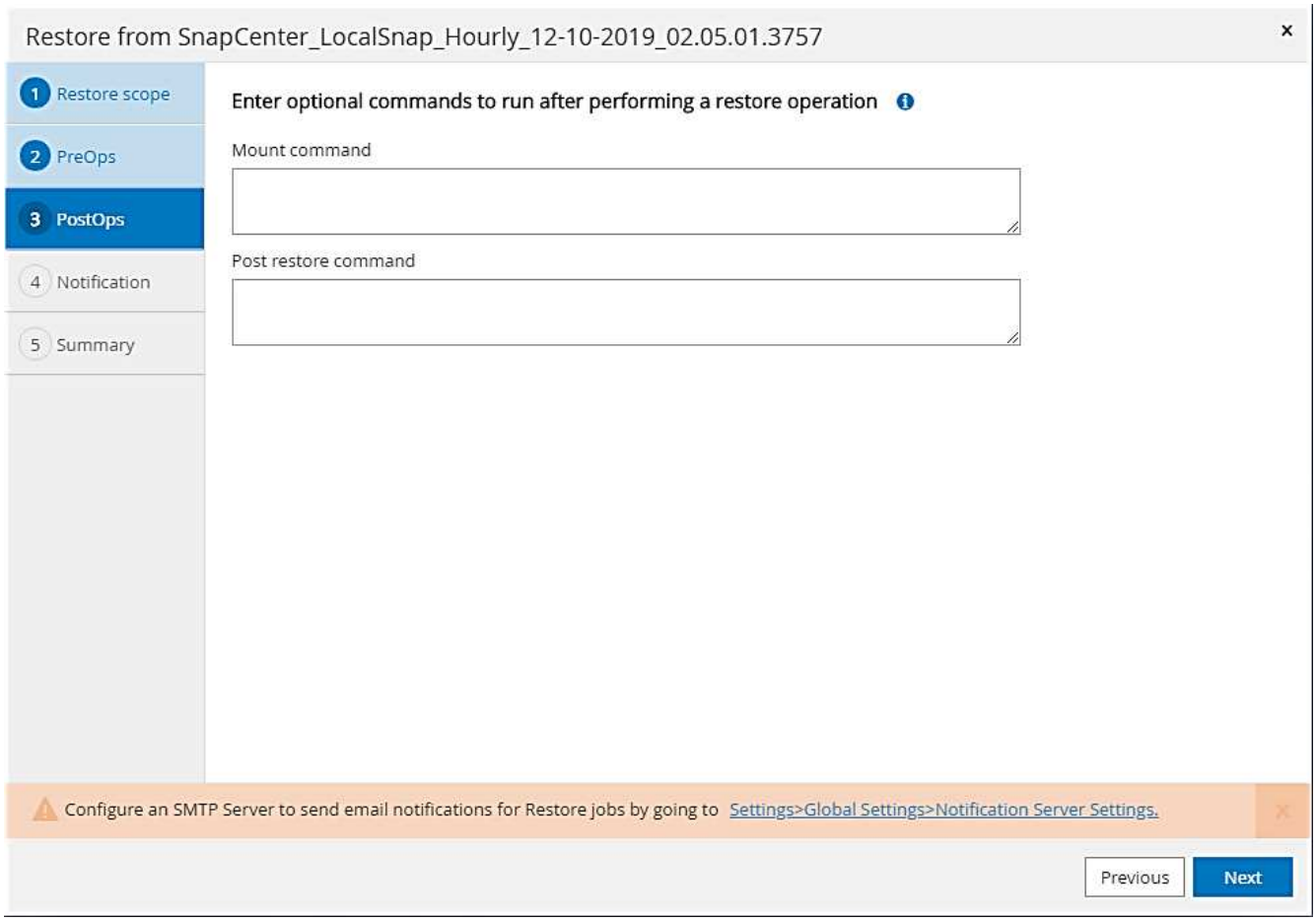
For a file-level restore of a SAP HANA multiple host system, select all the volumes.



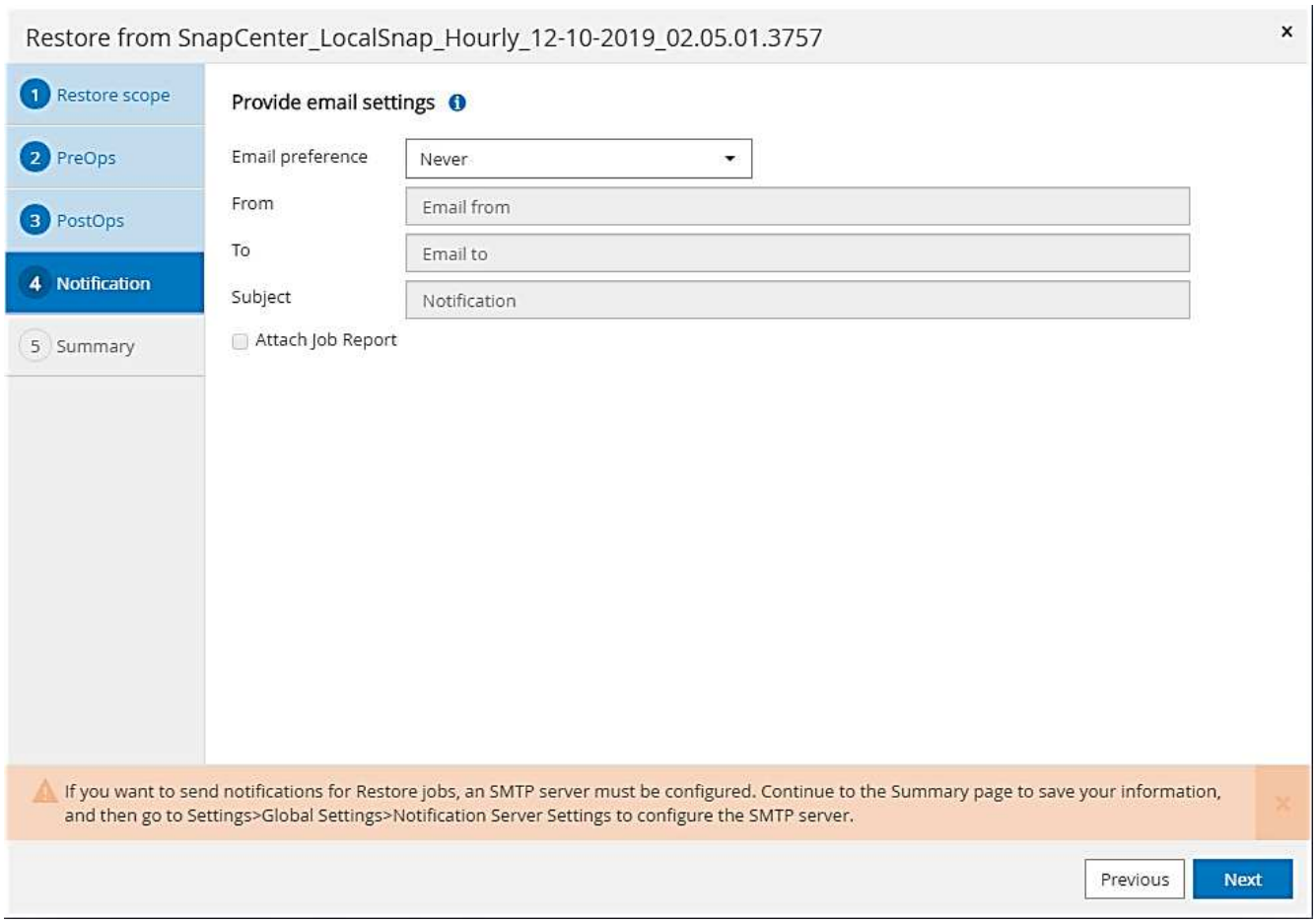
10. (Optional) Specify the commands that should be executed from the SAP HANA plug-in running on the central HANA plug-in host. Click Next.



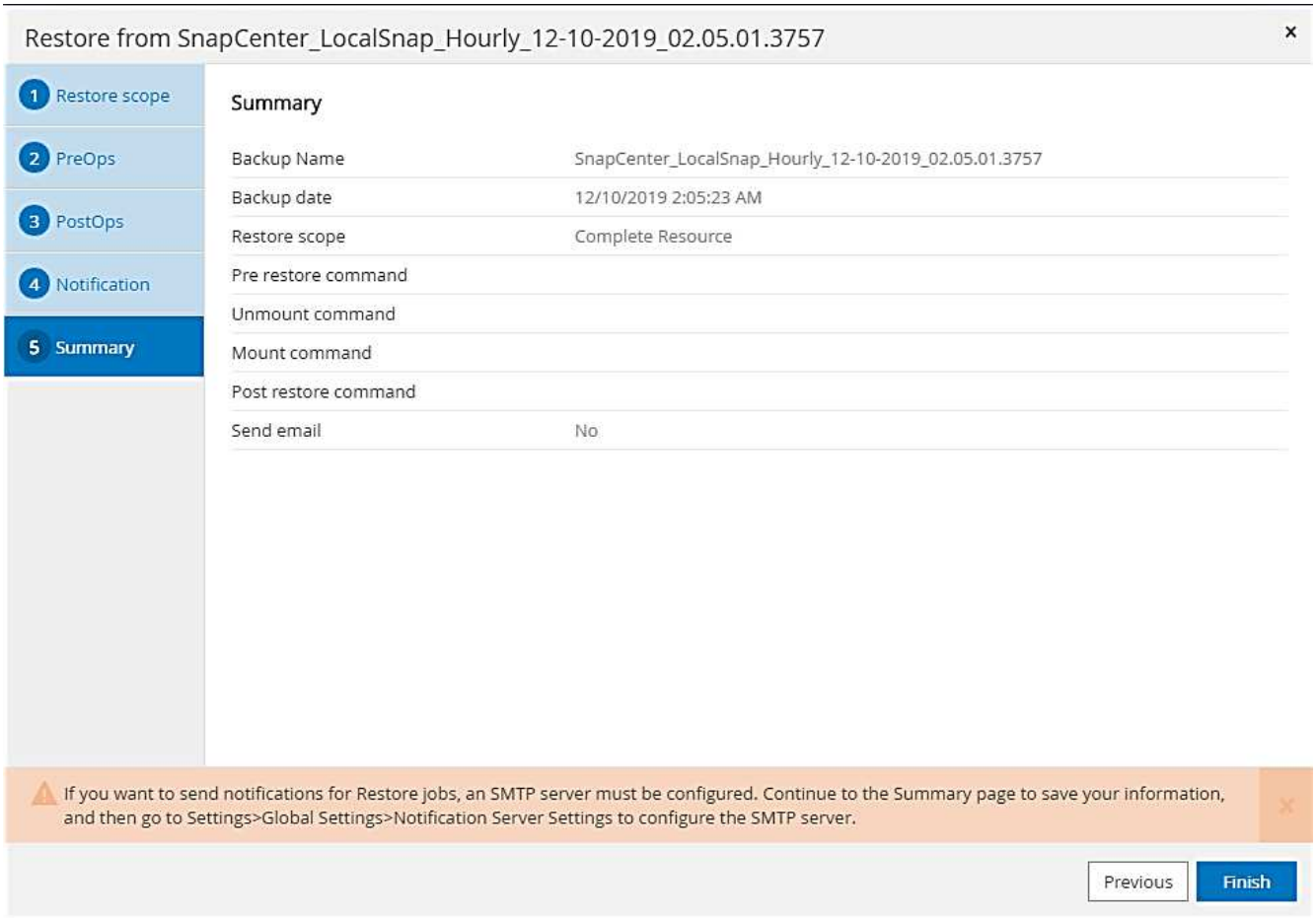
11. Specify the optional commands and click Next.



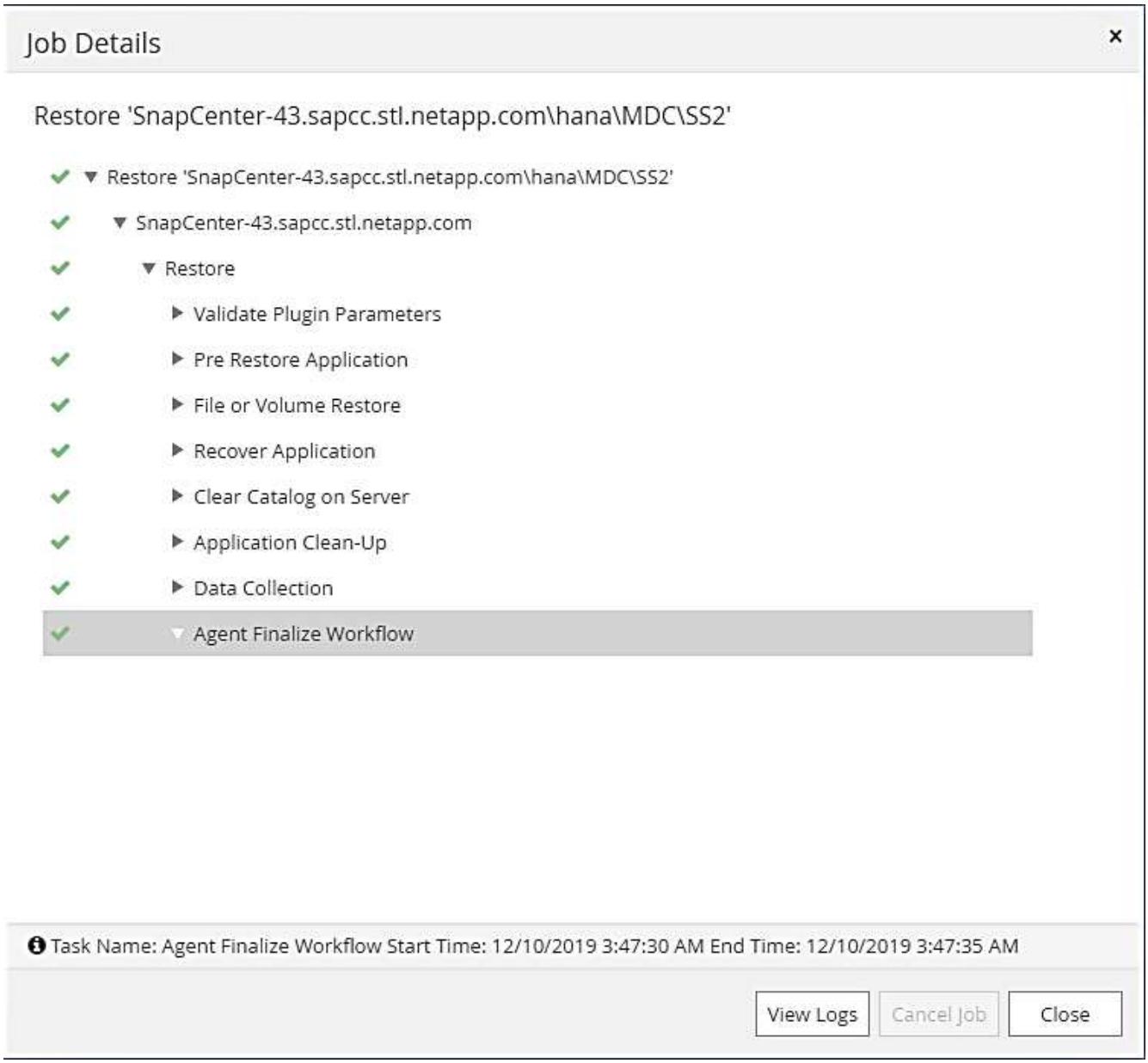
12. Specify the notification settings so that SnapCenter can send a status email and job log. Click Next.



13. Review the summary and click Finish to start the restore.



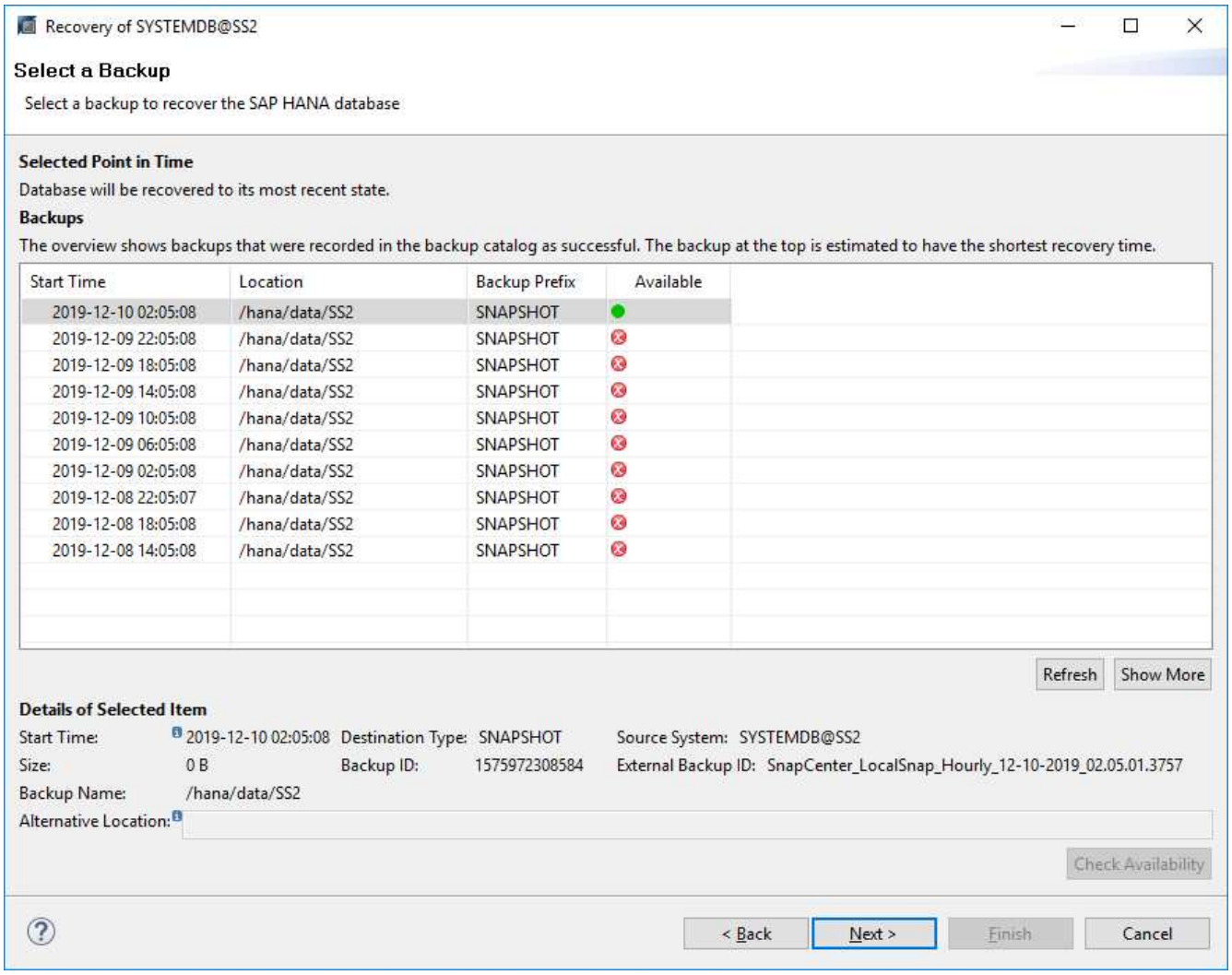
14. The restore job starts, and the job log can be displayed by double-clicking the log line in the activity pane.



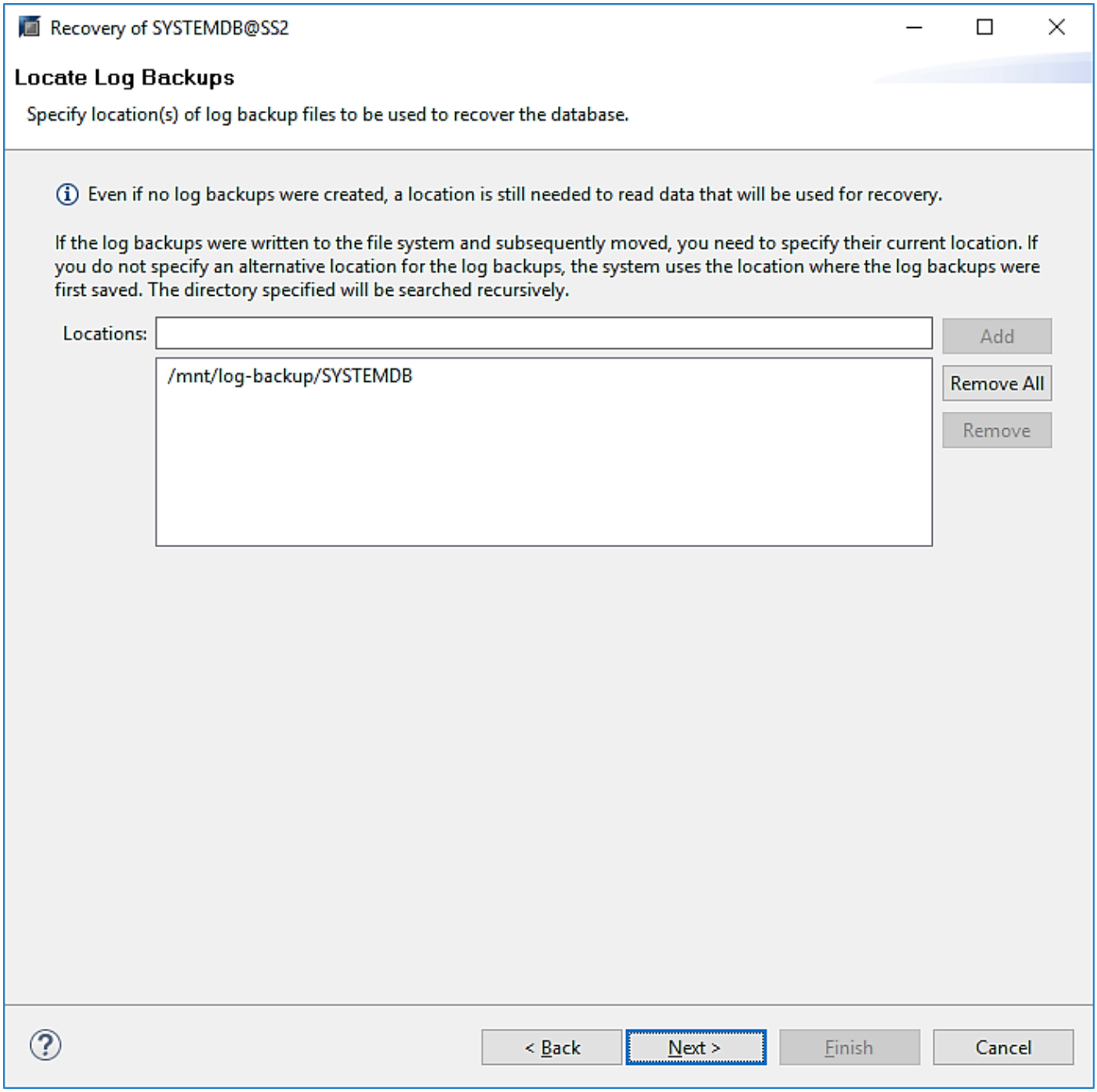
15. Wait until the restore process completes. On each database host, mount all data volumes. In our example, only one volume must be remounted on the database host.

```
mount /hana/data/SP1/mnt00001
```

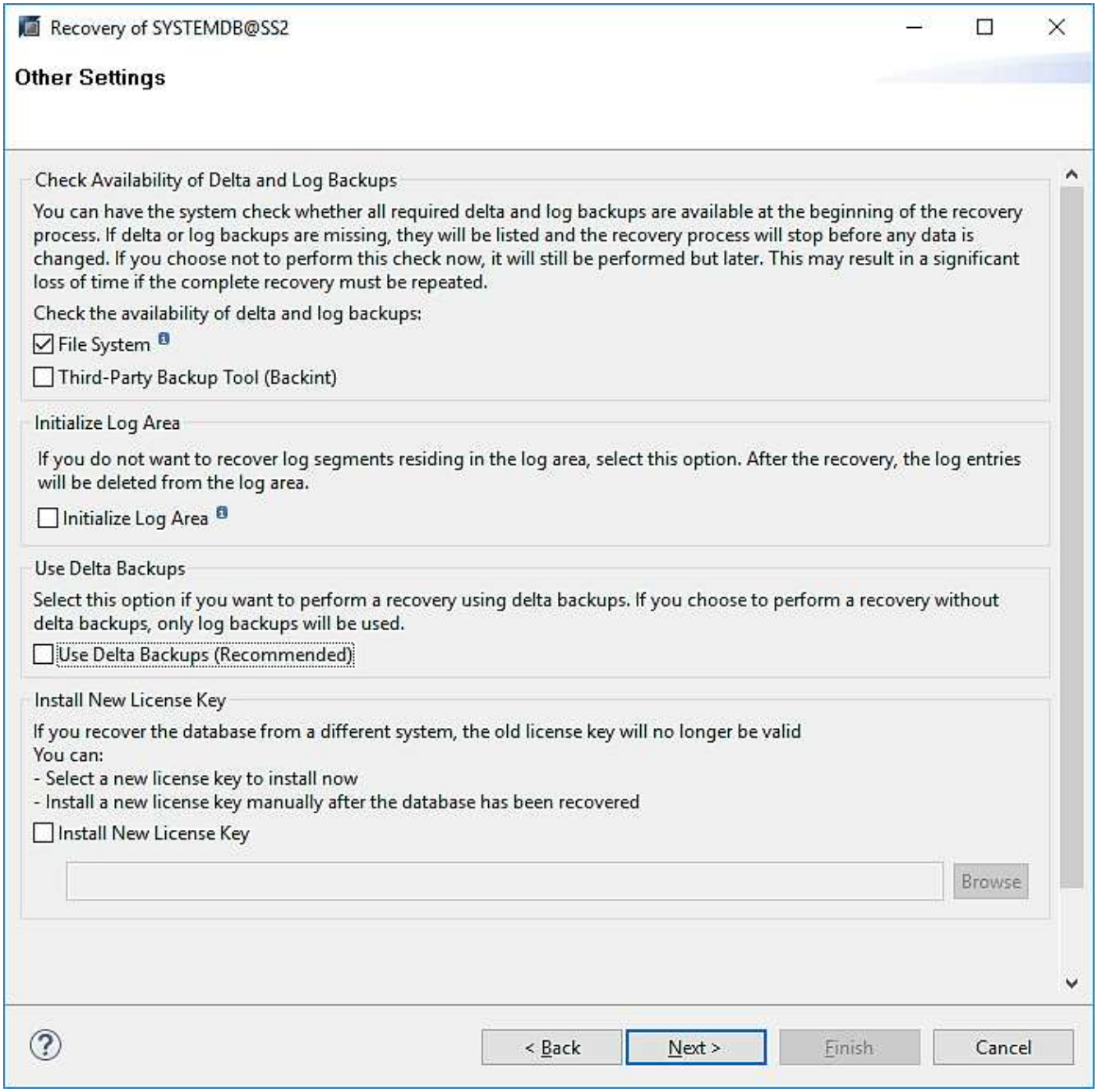
16. Go to SAP HANA Studio and click Refresh to update the list of available backups. The backup that was restored with SnapCenter is shown with a green icon in the list of backups. Select the backup and click Next.



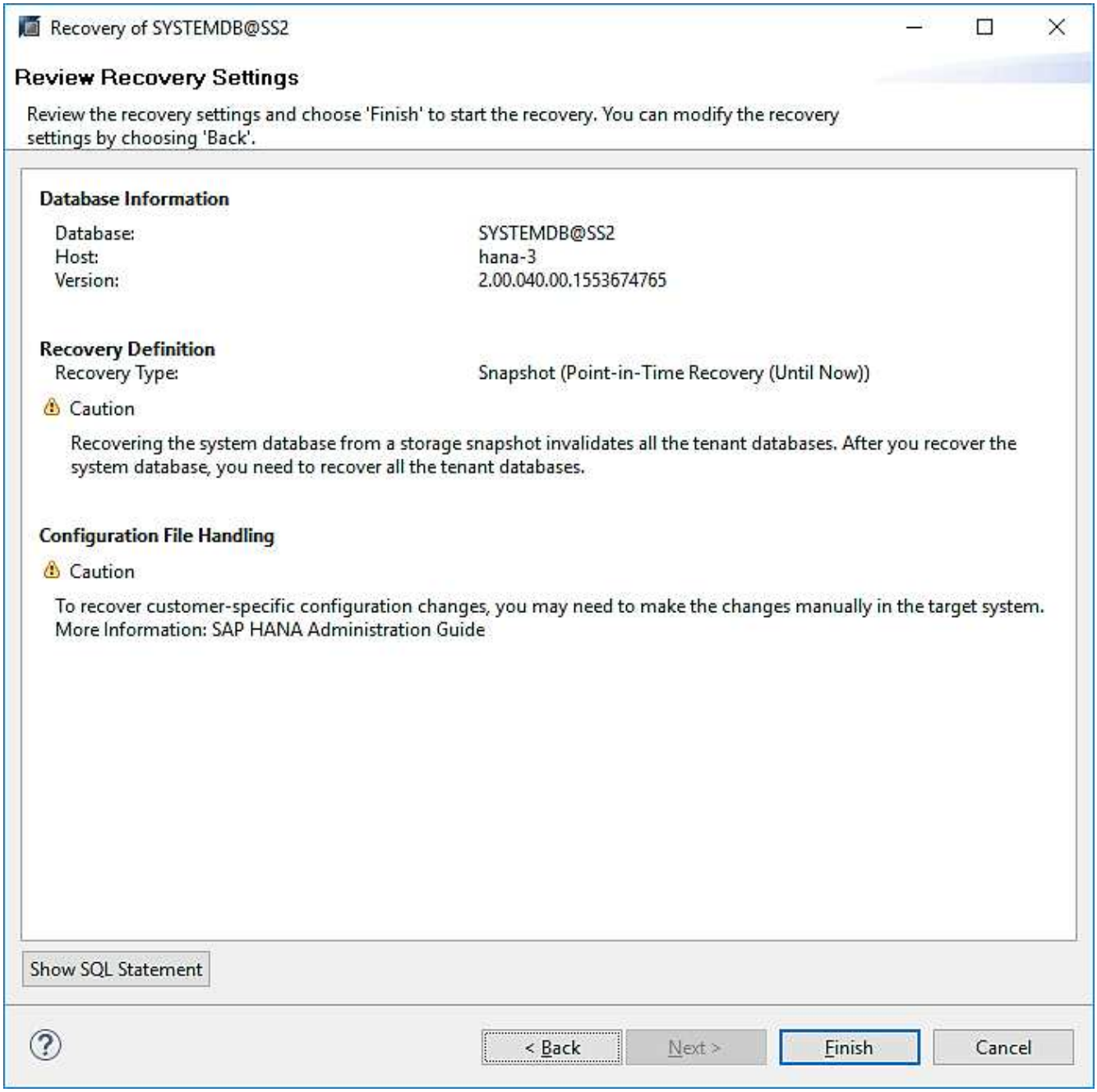
17. Provide the location of the log backups. Click Next.



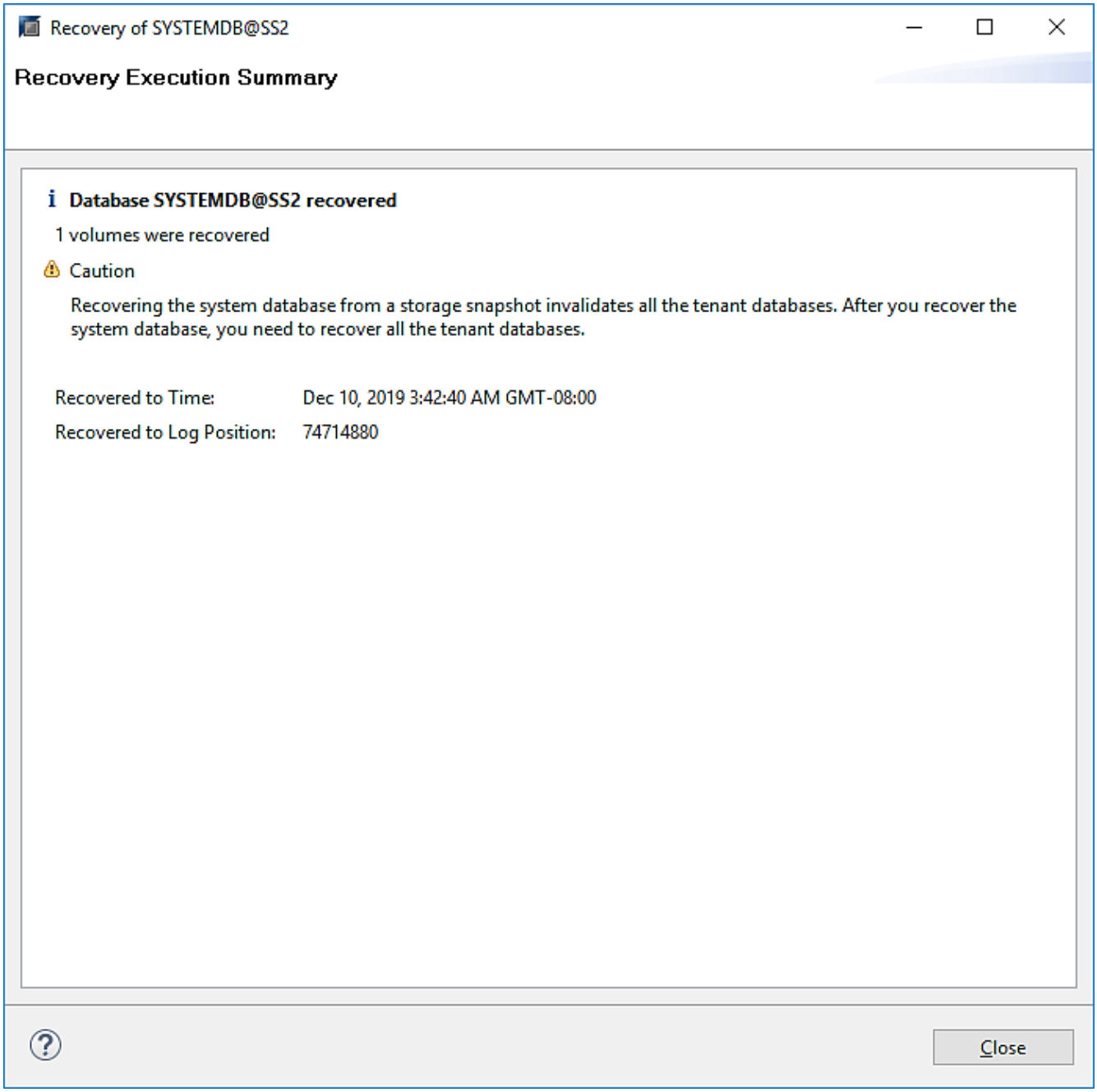
18. Select other settings as required. Make sure Use Delta Backups is not selected. Click Next.



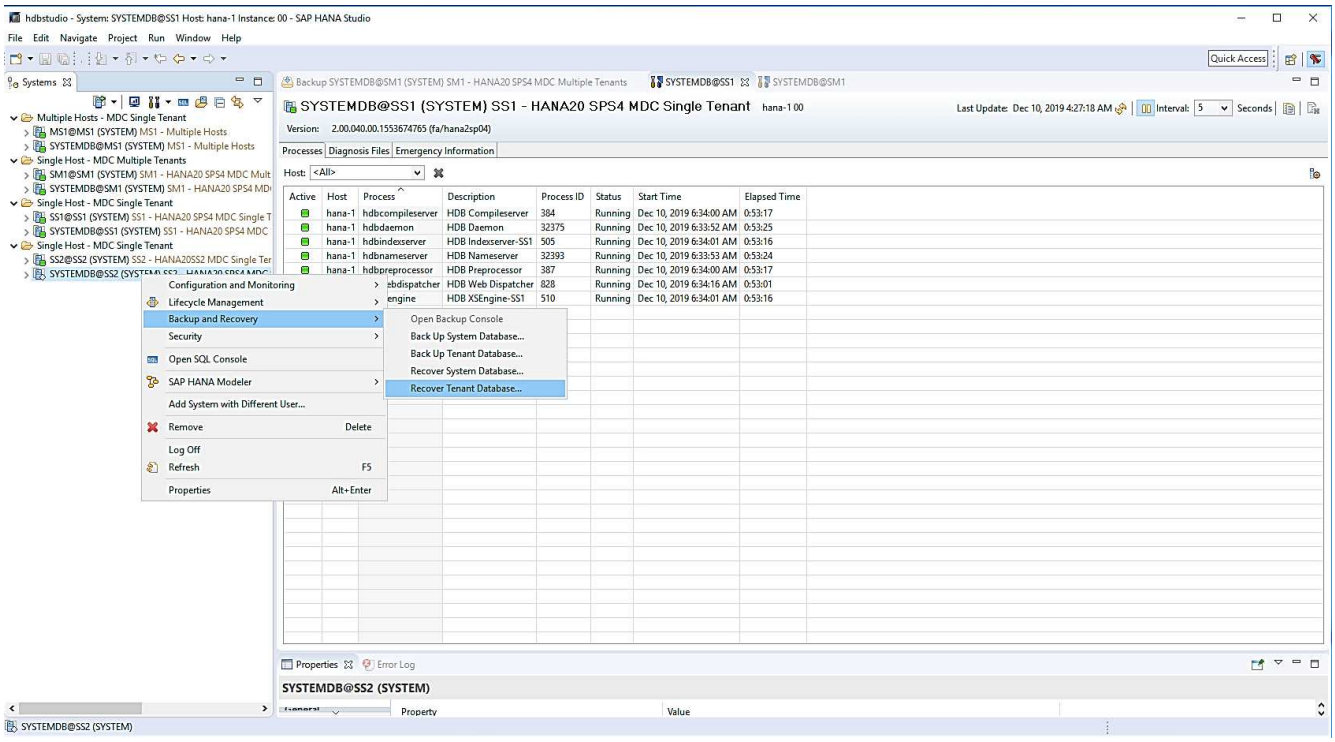
19. Review the recovery settings and click Finish.



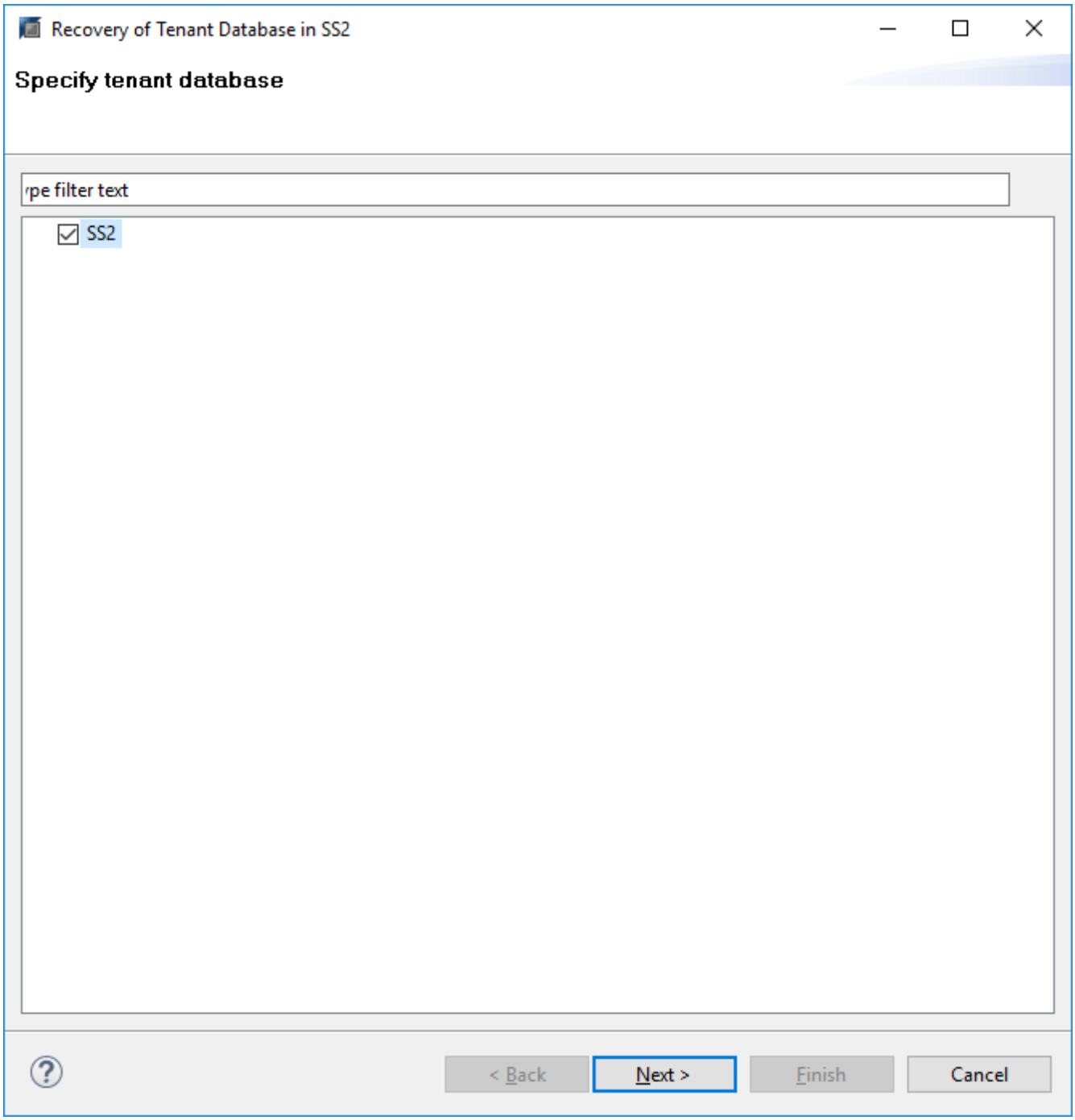
20. The recovery process starts. Wait until the recovery of the system database completes.



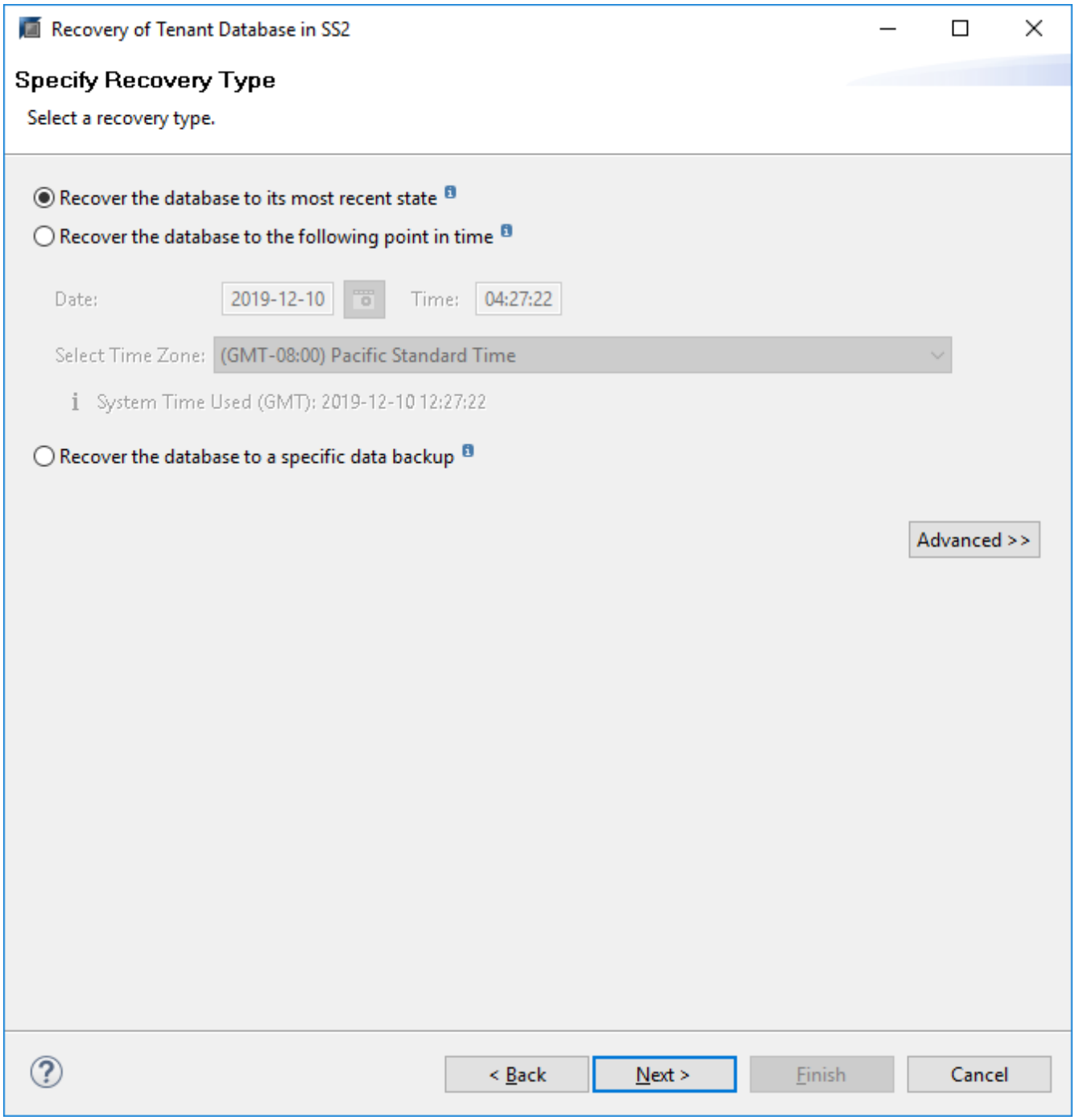
21. In SAP HANA Studio, select the entry for the system database and start Backup Recovery - Recover Tenant Database.



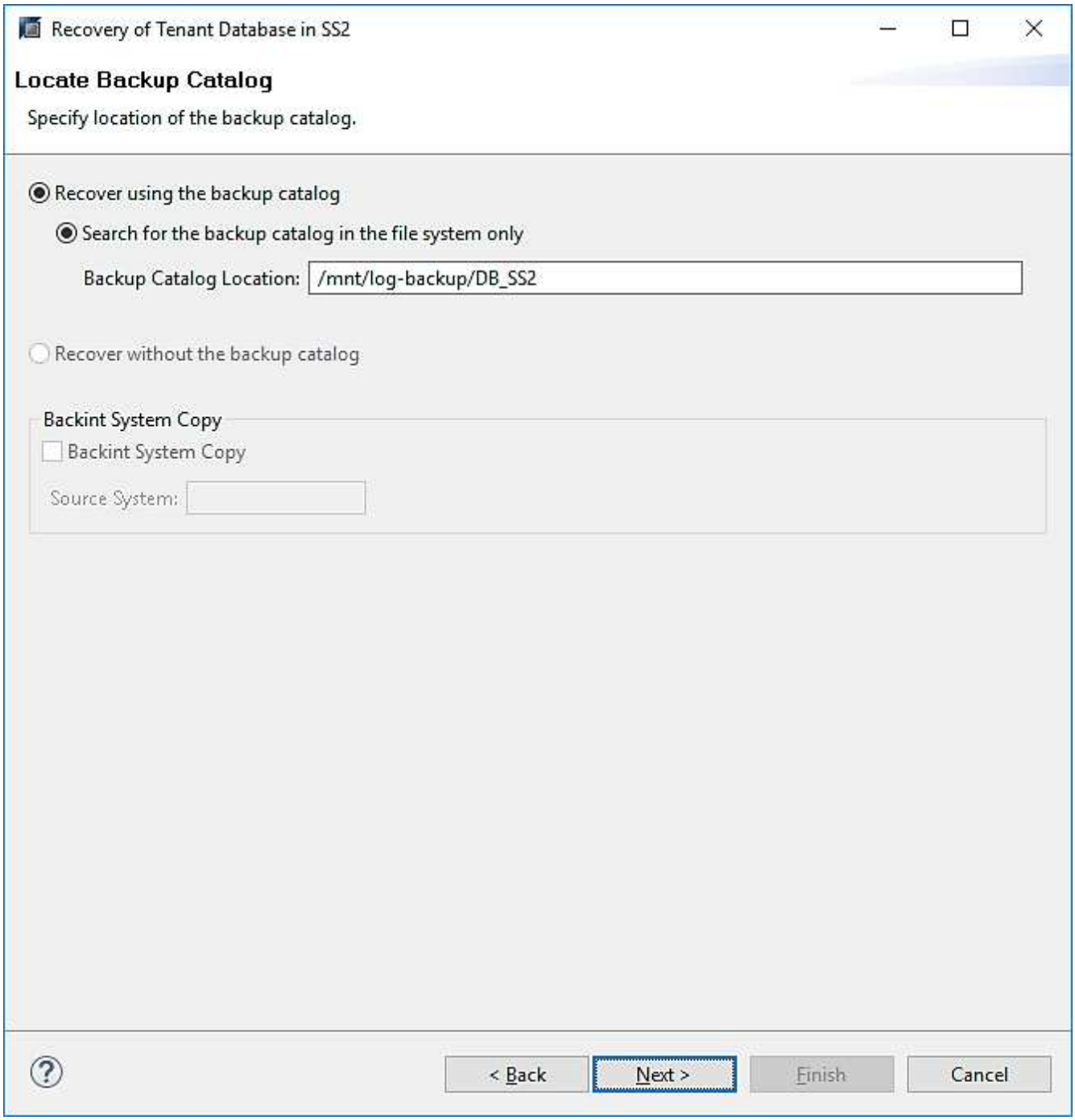
22. Select the tenant to recover and click Next.



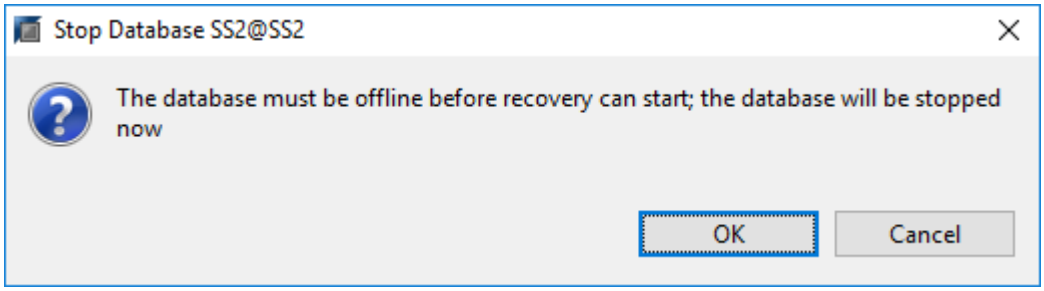
23. Specify the recovery type and click Next.



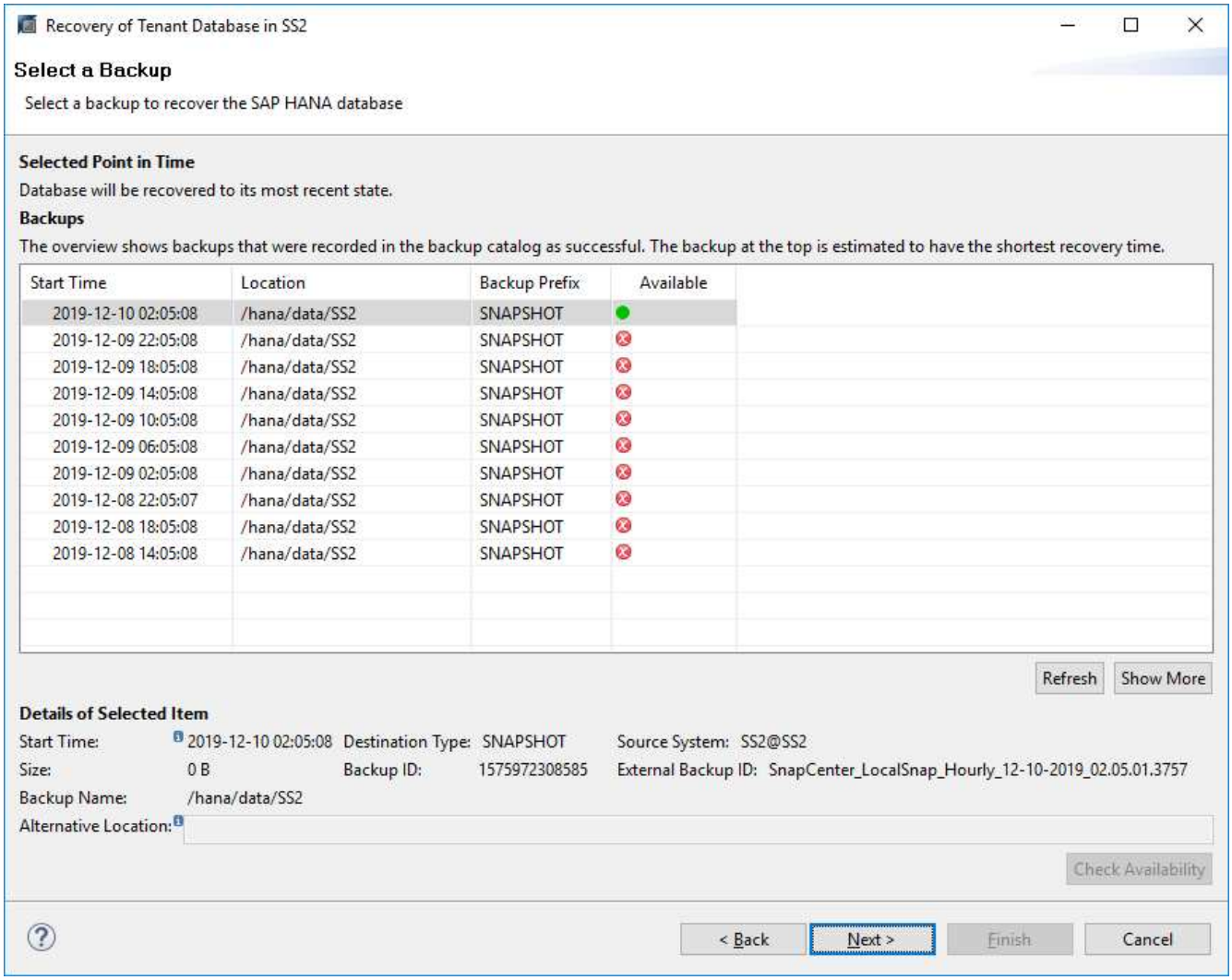
24. Confirm the backup catalog location and click Next.



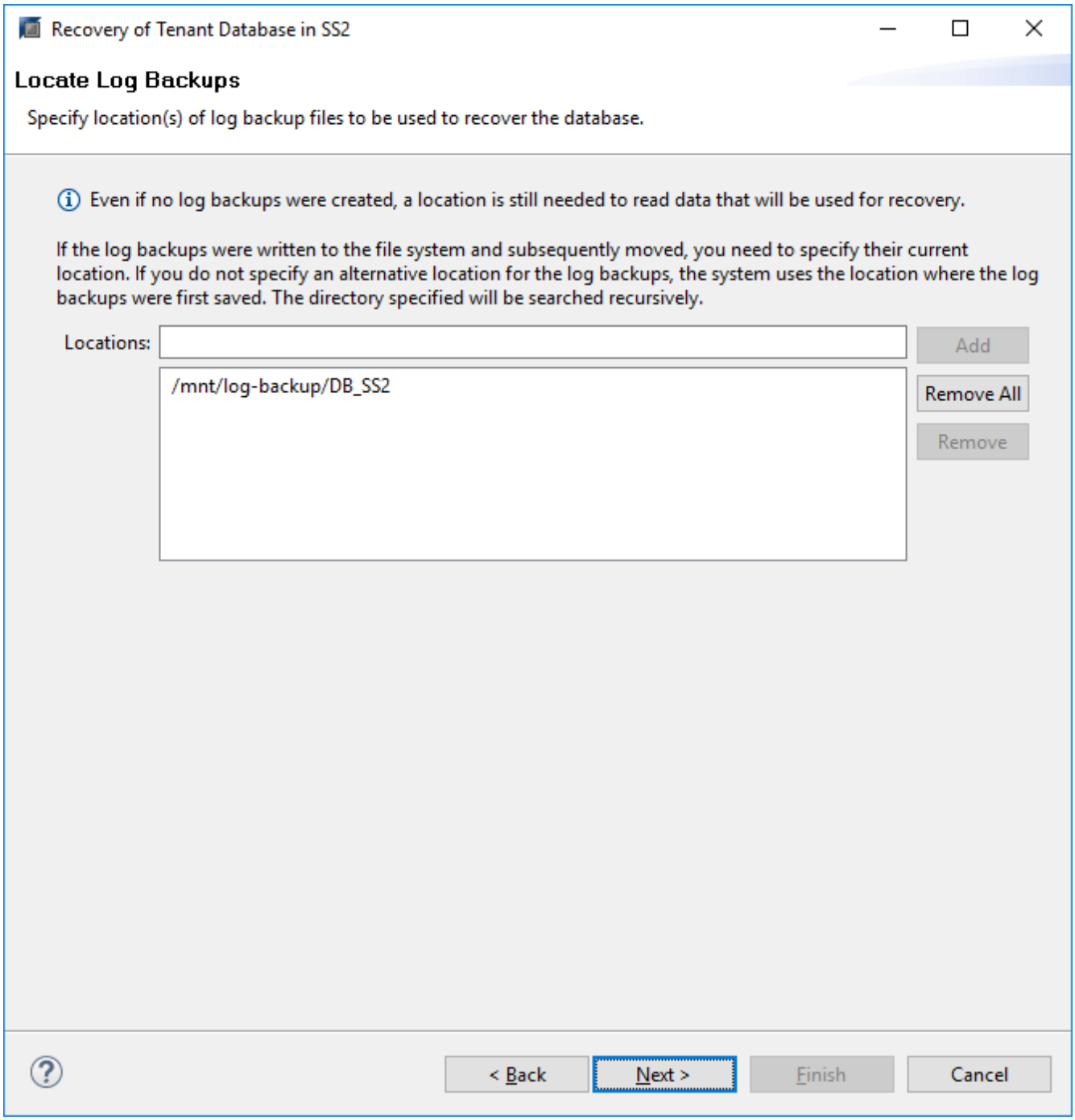
25. Confirm that the tenant database is offline. Click OK to continue.



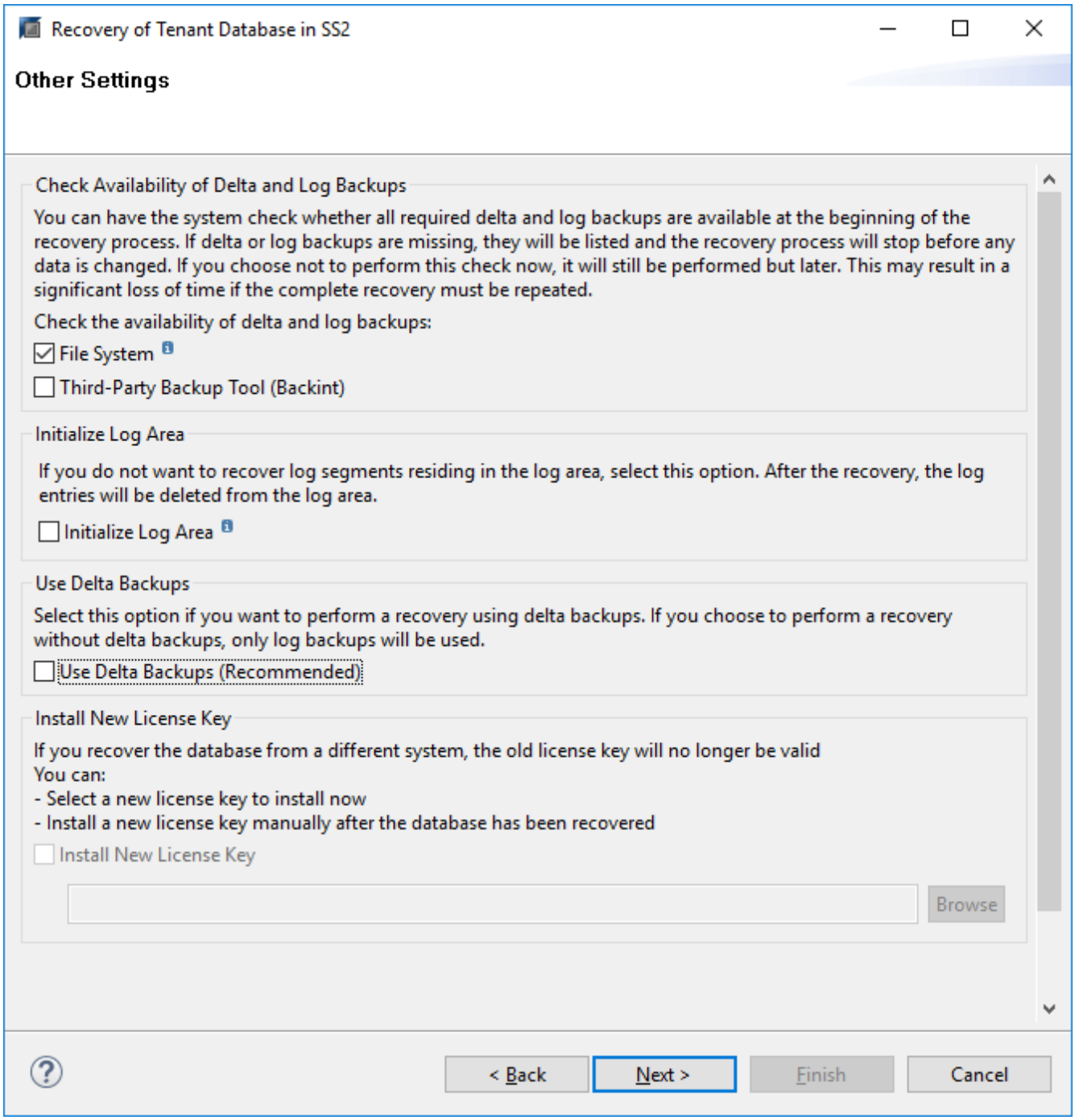
26. Because the restore of the data volume has occurred before the recovery of the system database, the tenant backup is immediately available. Select the backup highlighted in green and click Next.



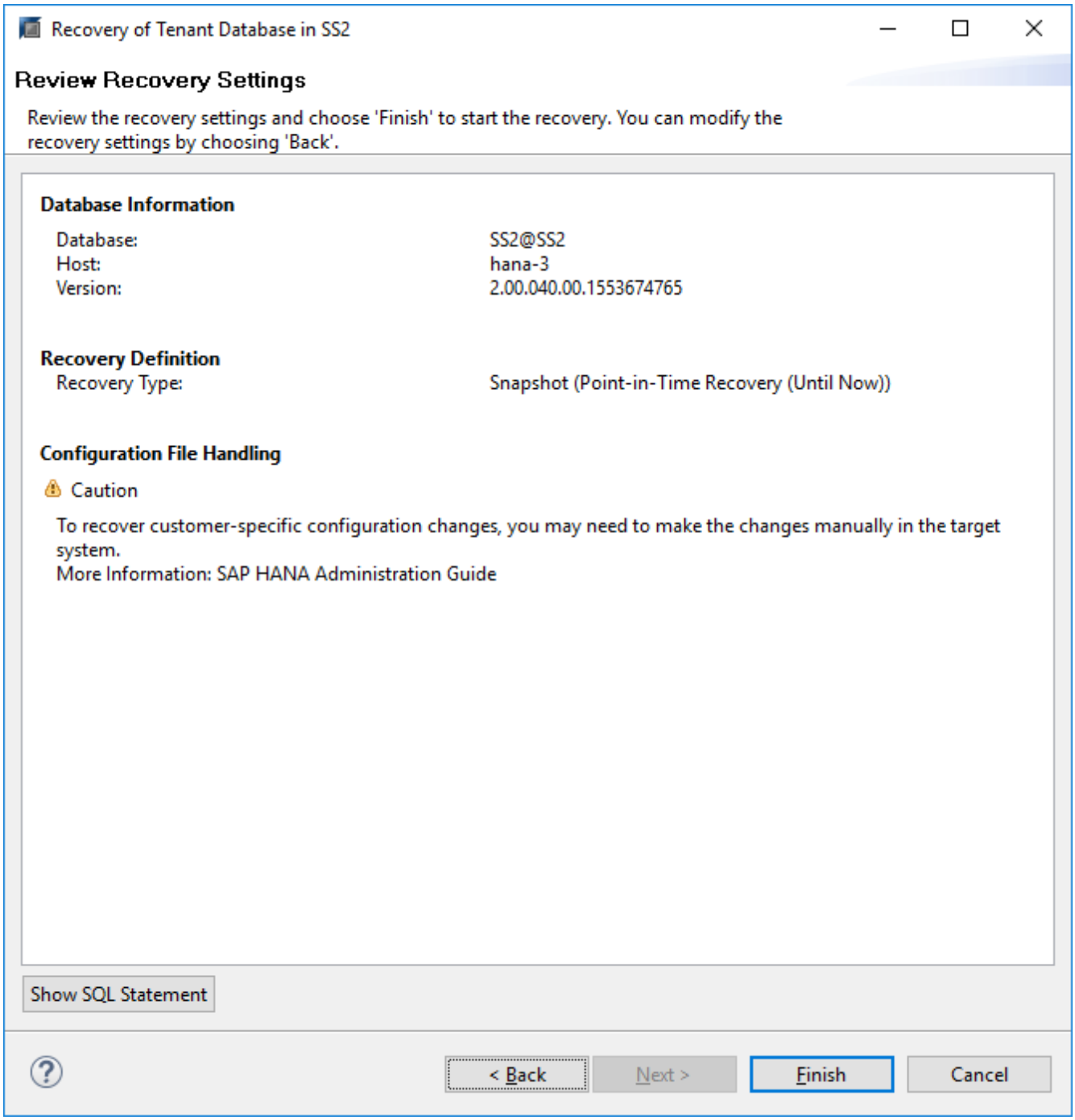
27. Confirm the log backup location and click Next.



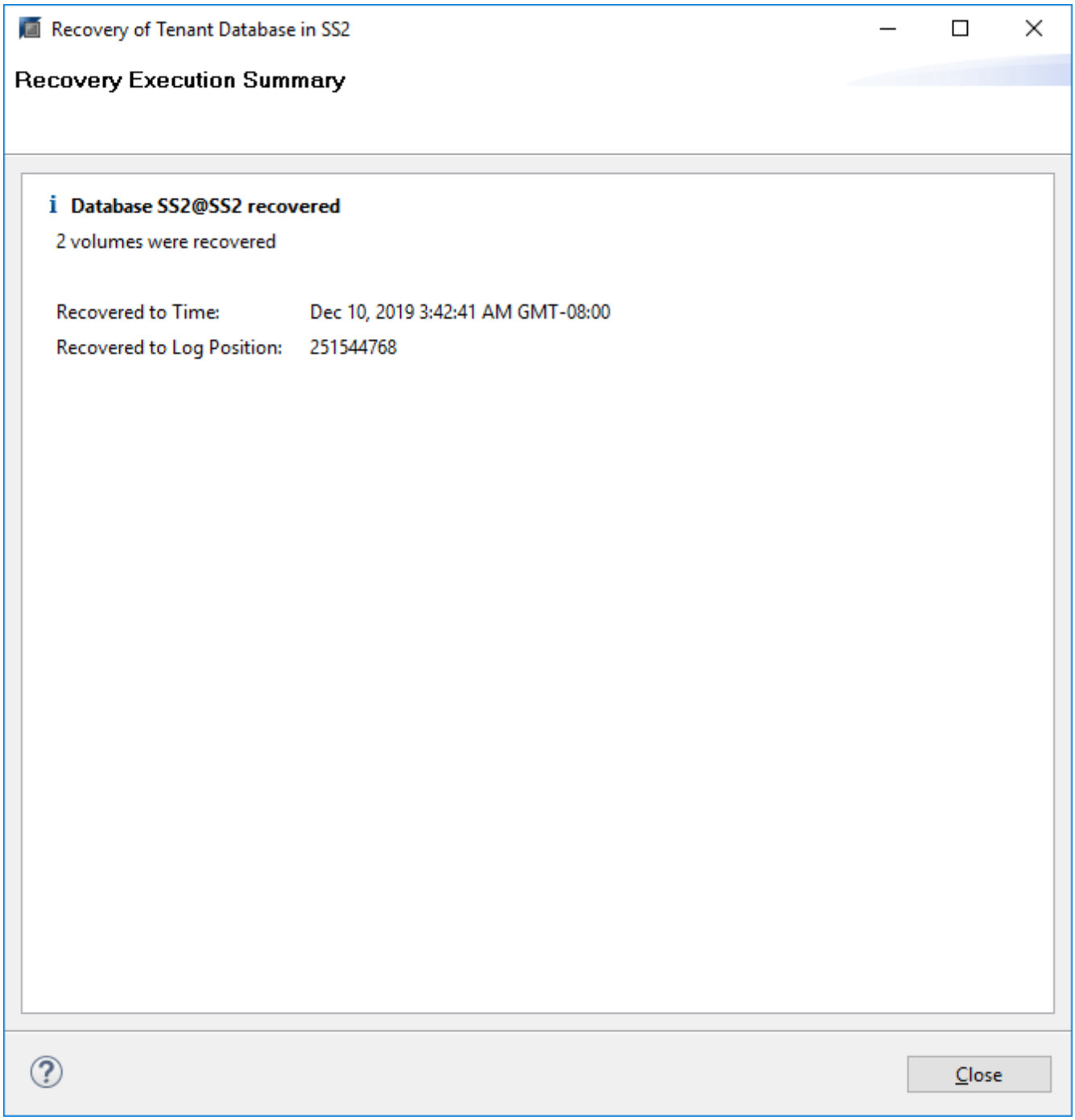
28. Select other settings as required. Make sure Use Delta Backups is not selected. Click Next.



29. Review the recovery settings and start the recovery process of the tenant database by clicking Finish.



30. Wait until the recovery has finished and the tenant database is started.



The SAP HANA system is up and running.

For an SAP HANA MDC system with multiple tenants, you must repeat steps 20–29 for each tenant.

Advanced configuration and tuning

This section describes configuration and tuning options that customers may use to adapt the SnapCenter setup to their specific needs. Not all the settings may apply for all customer scenarios.

Enable secure communication to HANA database

If the HANA databases are configured with secure communication, the `hdbsql` command that is executed by SnapCenter must use additional command-line options. This can be achieved by using a wrapper script which calls `hdbsql` with the required options.

> There are various options to configure the SSL communication. In the following examples, the simplest client configuration is described using the command line option, where no server certificate validation is done. If certificate validation on server and/or client side is required, different hdbsql command line options are needed, and you must configure the PSE environment accordingly as described in the SAP HANA Security Guide.

Instead of configuring the `hdbsql` executable in the `hana.properties` files, the wrapper script is added.

For a central HANA plug-in host on the SnapCenter Windows server, you must add the following content in `C:\Program Files\NetApp\SnapCenter\Snapcenter Plug-in Creator\etc\hana.properties`.

```
HANA_HDBSQL_CMD=C:\\Program Files\\sap\\hdbclient\\hdbsql-ssl.cmd
```

The wrapper script `hdbsql-ssl.cmd` calls `hdbsql.exe` with the required command-line options.

```
@echo off
"C:\Program Files\sap\hdbclient\hdbsql.exe" -e -ssltrustcert %*
```

> The `-e - ssltrustcert` hdbsql command-line option also works for HANA systems where SSL is not enabled. This option can therefore also be used with a central HANA plug-in host, where not all HANA systems have SSL enabled or disabled.

If the HANA plug-in is deployed on individual HANA database hosts, the configuration must be done on each Linux host accordingly.

```
HANA_HDBSQL_CMD = /usr/sap/SM1/HDB12/exe/hdbsqls
```

The wrapper script `hdbsqls` calls `hdbsql` with the required command-line options.

```
#/bin/bash
/usr/sap/SM1/HDB12/exe/hdbsql -e -ssltrustcert $*
```

Disable auto discovery on the HANA plug-in host

To disable autodiscovery on the HANA plug-in host, complete the following steps:

1. On the SnapCenter Server, open PowerShell. Connect to the SnapCenter Server by running the `Open-SmConnection` command and specify the username and password in the opening login window.

2. To disable auto discovery, run the `Set- SmConfigSettings` command.

   For a HANA host `hana-2`, the command is as follows:

```
PS C:\Users\administrator.SAPCC> Set-SmConfigSettings -Agent -Hostname
hana-2 -configSettings @{"DISABLE_AUTO_DISCOVERY"="true"}
Name                           Value
----                           -----
DISABLE_AUTO_DISCOVERY         true
PS C:\Users\administrator.SAPCC>
```

3. Verify the configuration by running the `Get- SmConfigSettings` command.

```
PS C:\Users\administrator.SAPCC> Get-SmConfigSettings -Agent -Hostname
hana-2 -key all
Key: CUSTOMPLUGINS_OPERATION_TIMEOUT_IN_MSEC            Value: 3600000
Details: Plug-in API operation Timeout
Key: CUSTOMPLUGINS_HOSTAGENT_TO_SERVER_TIMEOUT_IN_SEC   Value: 1800
Details: Web Service API Timeout
Key: CUSTOMPLUGINS_ALLOWED_CMDS                         Value: *;
Details: Allowed Host OS Commands
Key: DISABLE_AUTO_DISCOVERY                             Value: true
Details:
Key: PORT                                               Value: 8145
Details: Port for server communication
PS C:\Users\administrator.SAPCC>
```

   The configuration is written to the agent configuration file on the host and is still available after a plug-in upgrade with SnapCenter.

```
hana-2:/opt/NetApp/snapcenter/scc/etc # cat
/opt/NetApp/snapcenter/scc/etc/agent.properties | grep DISCOVERY
DISABLE_AUTO_DISCOVERY = true
hana-2:/opt/NetApp/snapcenter/scc/etc #
```

Deactivate automated log backup housekeeping

Log backup housekeeping is enabled by default and can be disabled on the HANA plug-in host level. There are two options to change these settings.

Edit the hana.property file

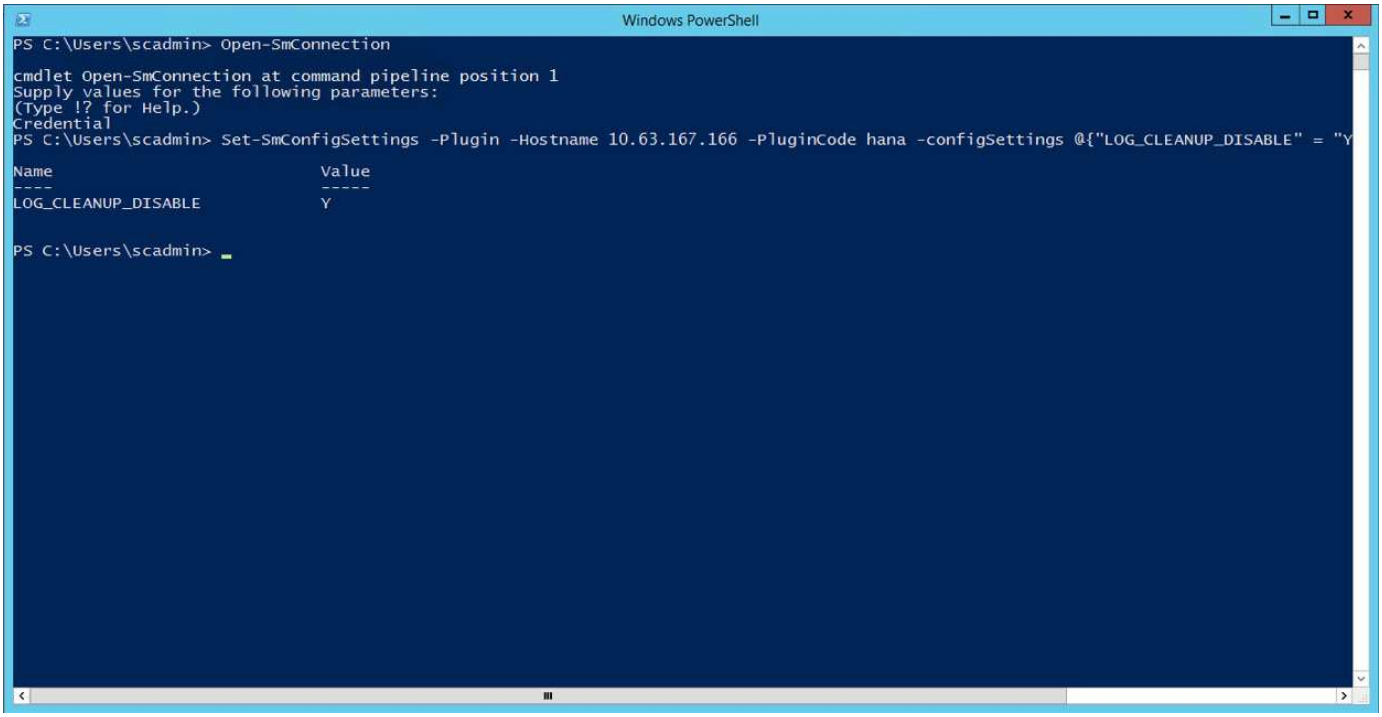
Including the parameter `LOG_CLEANUP_DISABLE = Y` in the `hana.property` configuration file disables the log backup housekeeping for all resources using this SAP HANA plug-in host as communication host:

- For the Hdbsql communication host on Windows, the `hana.property` file is located at `C:\Program Files\NetApp\SnapCenter\Snapcenter Plug-in Creator\etc`.
- For the Hdbsql communication host on Linux, the `hana.property` file is located at `/opt/NetApp/snapcenter/scc/etc`.

Use the PowerShell command

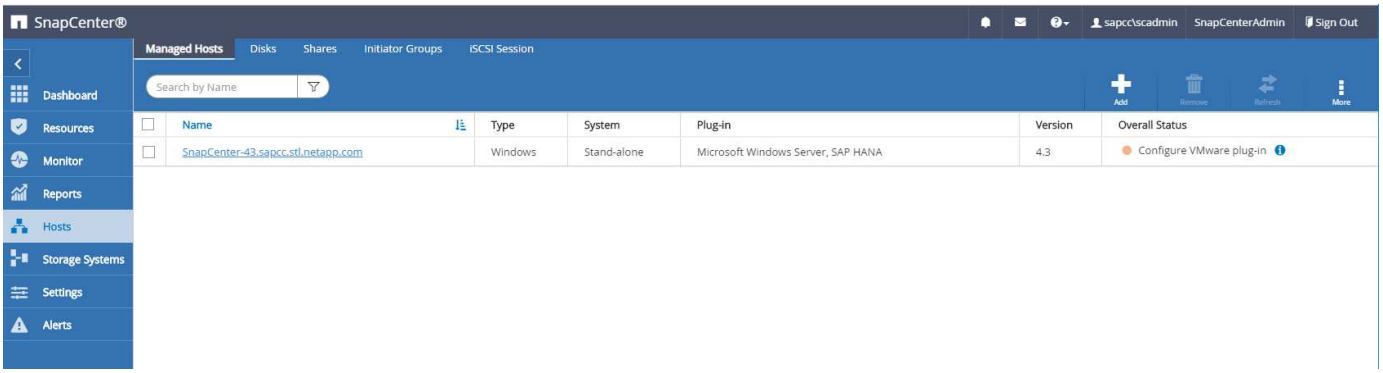
A second option to configure these settings is using a SnapCenter PowerShell command.

1. On the SnapCenter server, open a PowerShell. Connect to the SnapCenter server using the command `Open- SmConnection` and specify user name and password in the opening login window.
2. With the command `Set- SmConfigSettings -Plugin - HostName <pluginhostname> - PluginCode hana - configSettings @{"LOG_CLEANUP_DISABLE" = "Y"}`, the changes are configured for the SAP HANA plug-in host `<pluginhostname>` specified by the IP or host name (see the following figure).



Disable warning when running SAP HANA plug-in on a virtual environment

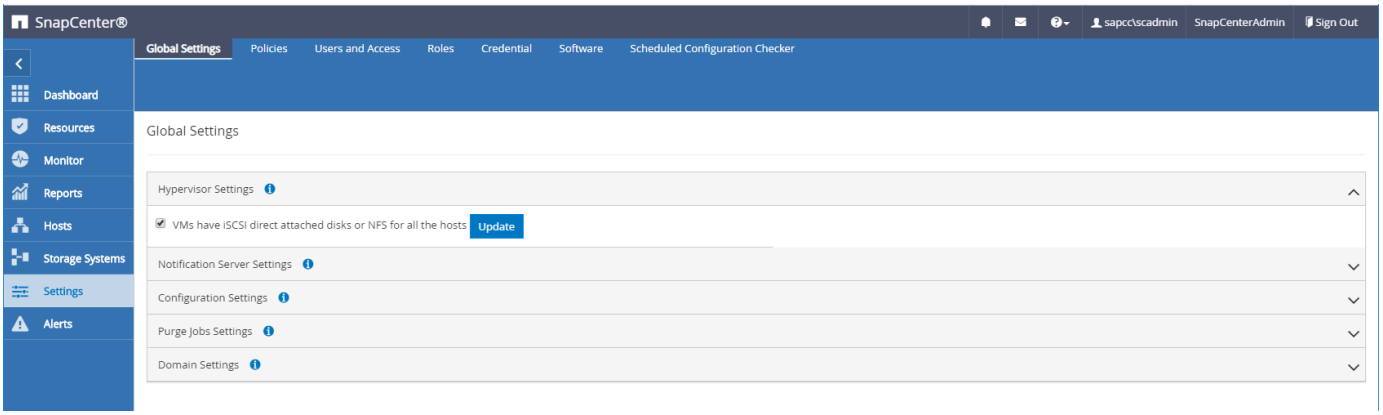
SnapCenter detects if the SAP HANA plug-in is installed on a virtualized environment. This could be a VMware environment or a SnapCenter installation at a public cloud provider. In this case, SnapCenter displays a warning to configure the hypervisor, as shown in the following figure.



It is possible to suppress this warning globally. In this case, SnapCenter is not aware of virtualized environments and, therefore, does not show these warnings.

To configure SnapCenter to suppress this warning, the following configuration must be applied:

1. From the Settings tab, select Global Settings.
2. For the hypervisor settings, select VMs Have iSCSI Direct Attached Disks or NFS For All the Hosts and update the settings.



Change scheduling frequency of backup synchronization with off-site backup storage

As described in the section "Retention management of backups at the secondary storage," retention management of data backups to an off-site backup storage is handled by ONTAP. SnapCenter periodically checks if ONTAP has deleted backups at the off-site backup storage by running a cleanup job with a weekly default schedule.

The SnapCenter cleanup job deletes backups in the SnapCenter repository as well as in the SAP HANA backup catalog if any deleted backups at the off-site backup storage have been identified.

The cleanup job also executes the housekeeping of SAP HANA log backups.

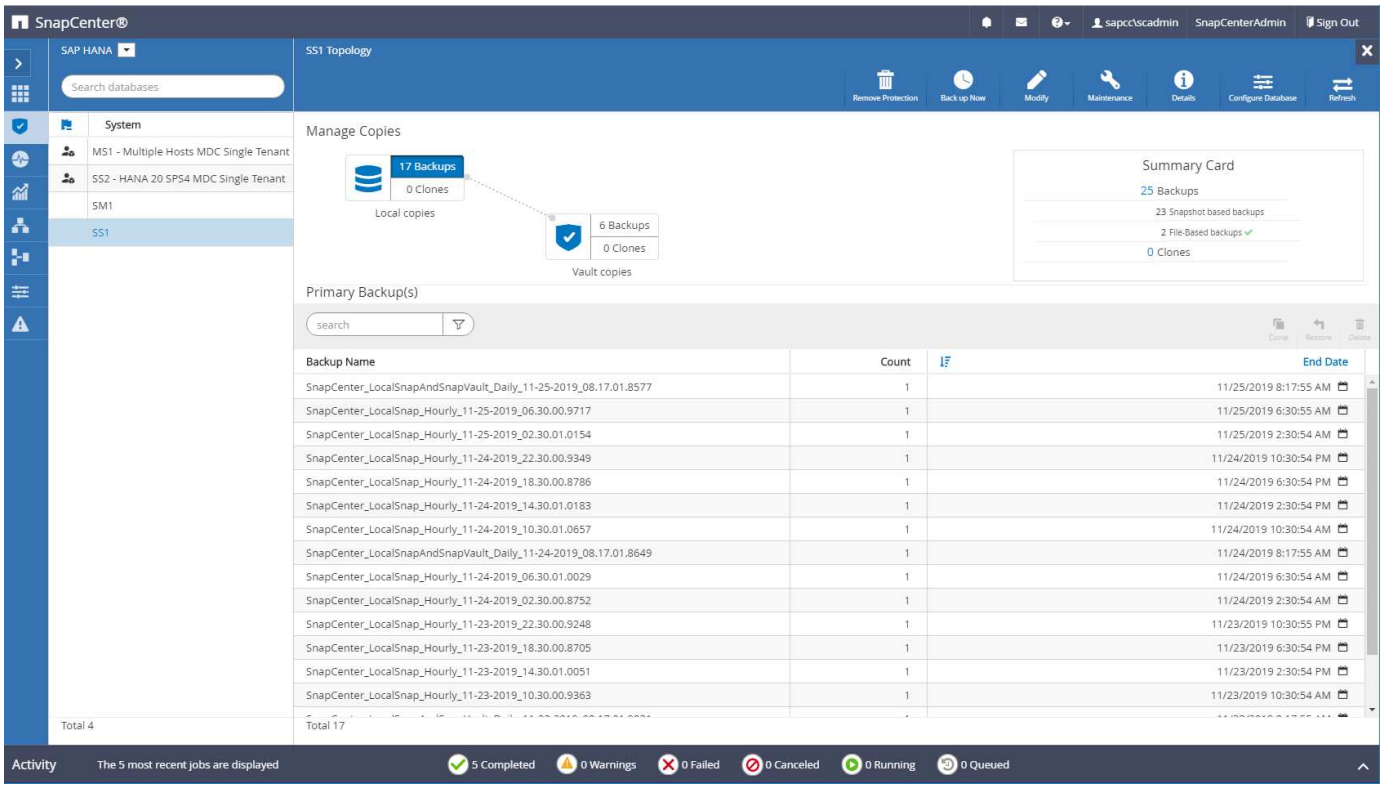
Until this scheduled cleanup has finished, SAP HANA and SnapCenter might still show backups that have already been deleted from the off-site backup storage.

This might result in additional log backups that are kept, even if the corresponding storage-based Snapshot backups on the off-site backup storage have already been deleted.

The following sections describe two ways to avoid this temporary discrepancy.

Manual refresh on resource level

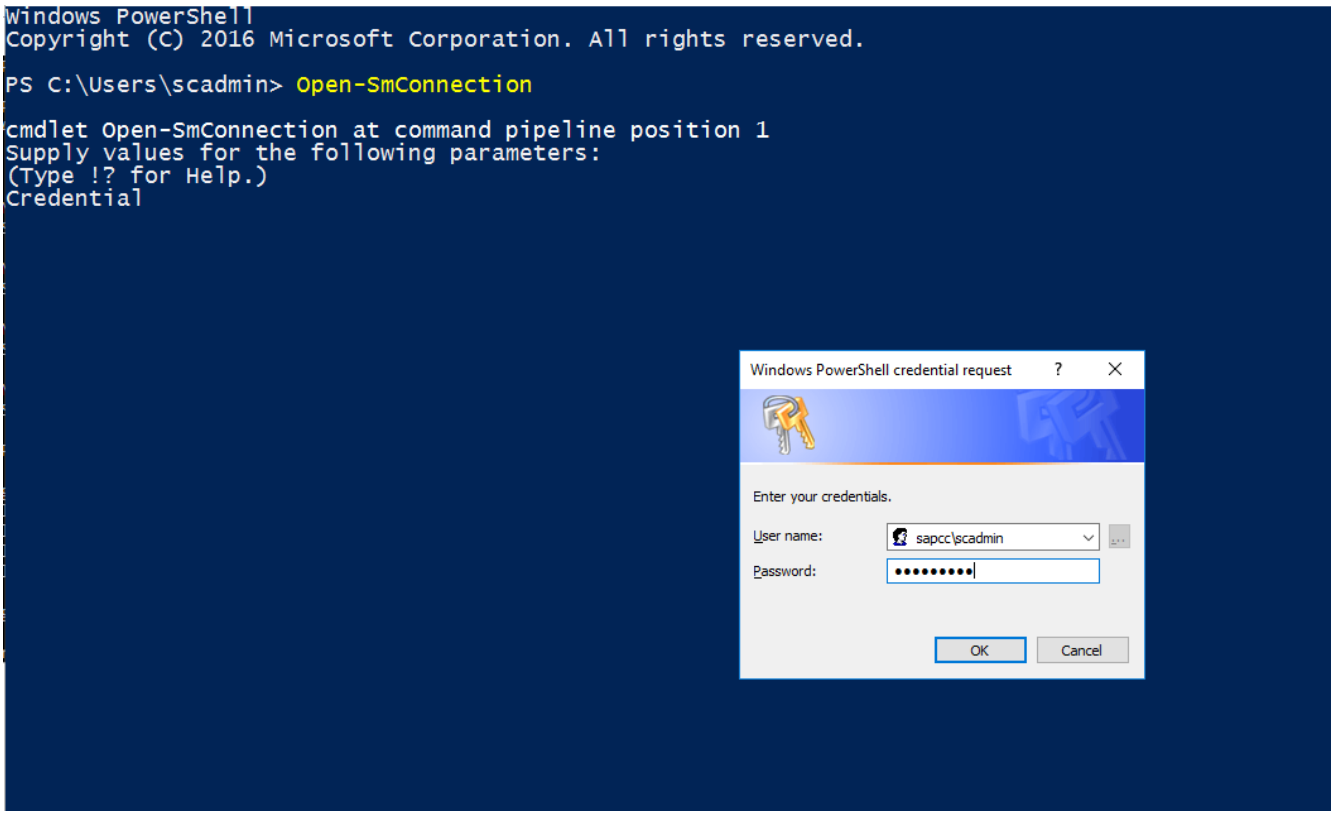
In the topology view of a resource, SnapCenter displays the backups on the off-site backup storage when selecting the secondary backups, as shown in the following screenshot. SnapCenter executes a cleanup operation with the Refresh icon to synchronize the backups for this resource.



Change the frequency of the SnapCenter cleanup job

SnapCenter executes the cleanup job `SnapCenter_RemoveSecondaryBackup` by default for all resources on a weekly basis using the Windows task scheduling mechanism. This can be changed using a SnapCenter PowerShell cmdlet.

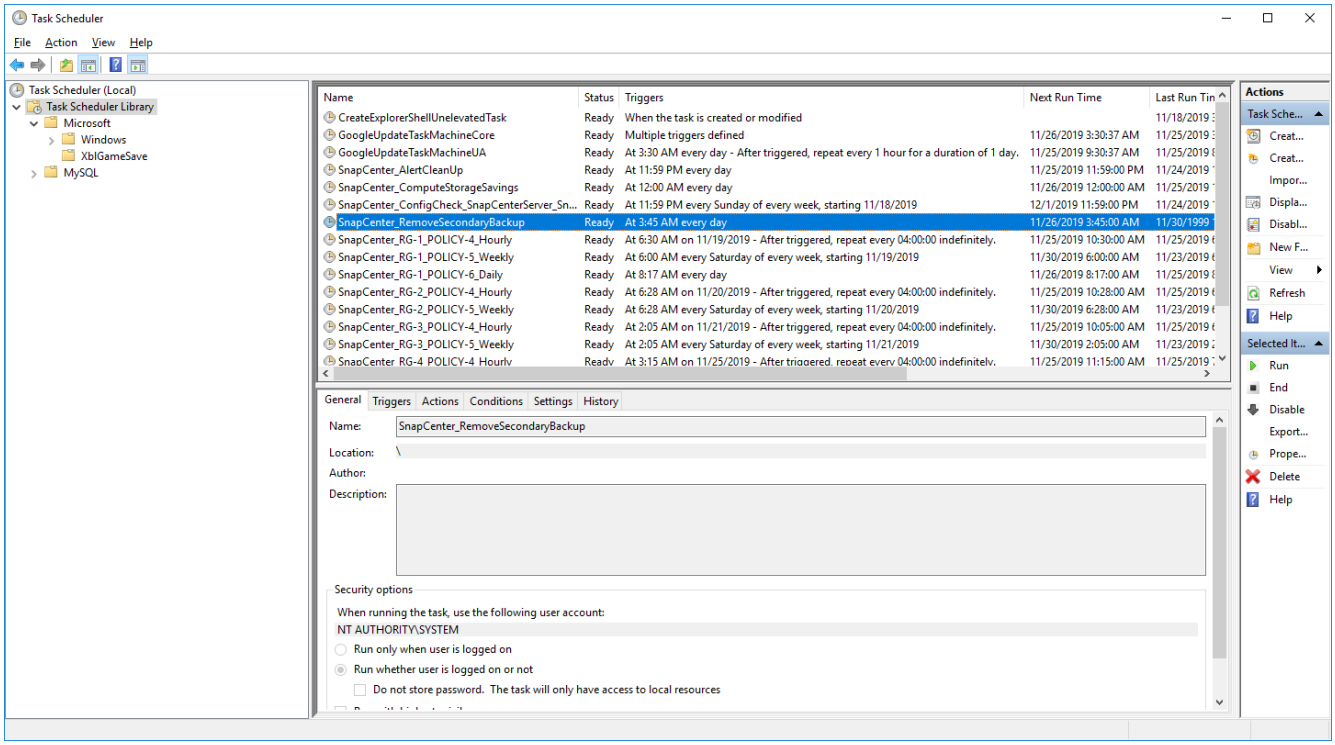
1. Start a PowerShell command window on the SnapCenter Server.
2. Open the connection to the SnapCenter Server and enter the SnapCenter administrator credentials in the login window.



3. To change the schedule from a weekly to a daily basis, use the cmdlet `Set- SmSchedule`.

```
PS C:\Users\scadmin> Set-SmSchedule -ScheduleInformation
@{"ScheduleType"="Daily";"StartTime"="03:45 AM";"DaysInterval"=
"1"} -TaskName SnapCenter_RemoveSecondaryBackup
TaskName              : SnapCenter_RemoveSecondaryBackup
Hosts                 : {}
StartTime             : 11/25/2019 3:45:00 AM
DaysoftheMonth        :
MonthsofTheYear       :
DaysInterval          : 1
DaysOfTheWeek         :
AllowDefaults         : False
ReplaceJobIfExist     : False
UserName              :
Password              :
SchedulerType         : Daily
RepeatTask_Every_Hour :
IntervalDuration      :
EndTime               :
LocalScheduler        : False
AppType               : False
AuthMode              :
SchedulerSQLInstance  : SMCoreContracts.SmObject
MonthlyFrequency      :
Hour                  : 0
Minute                : 0
NodeName              :
ScheduleID            : 0
RepeatTask_Every_Mins :
CronExpression        :
CronOffsetInMinutes   :
StrStartTime          :
StrEndTime            :
PS C:\Users\scadmin> Check the configuration using the Windows Task
Scheduler.
```

4. You can check the job properties in Windows task scheduler.



Where to find additional information and version history

To learn more about the information that is described in this document, review the following documents and/or websites:

- SnapCenter Resources Page

  https://www.netapp.com/us/documentation/snapcenter-software.aspx

- SnapCenter Software Documentation

  https://docs.netapp.com/us-en/snapcenter/index.html

- TR-4667: Automating SAP System Copies Using the SnapCenter

  Automating SAP System Copies Using the SnapCenter

- TR-4719: SAP HANA System Replication, Backup and Recovery with SnapCenter

  SAP HANA System Replication, Backup and Recovery with SnapCenter

- TR-4018: Integrating NetApp ONTAP Systems with SAP Landscape Management

  https://www.netapp.com/pdf.html?item=/media/17195-tr4018pdf.pdf

- TR-4646: SAP HANA Disaster Recovery with Storage Replication

  https://www.netapp.com/pdf.html?item=/media/8584-tr4646pdf.pdf

Version history

Version	Date	Document version history
Version 1.0	July 2017	• Initial release.
Version 1.1	September 2017	• Added the section “Advanced Configuration and Tuning.” • Minor corrections.
Version 2.0	March 2018	• Updates to cover SnapCenter 4.0: New data volume resource Improved Single File SnapRestore operation
Version 3.0	January 2020	• Added the section “SnapCenter Concepts and Best Practices.” • Updates to cover SnapCenter 4.3: Automatic discovery Automated restore and recovery Support of HANA MDC multiple tenants Single-tenant restore operation
Version 3.1	July 2020	• Minor updates and corrections: NFSv4 support with SnapCenter 4.3.1 Configuration of SSL communication Central plug-in deployment for Linux on IBM Power
Version 3.2	November 2020	• Added the required database user privileges for HANA 2.0 SPS5.
Version 3.3	May 2021	• Updated the SSL hdbsql configuration section. • Added Linux LVM support.
Version 3.4	August 2021	• Added the disable auto discovery configuration description.

Version	Date	Document version history
Version 3.5	February 2022	• Minor updates to cover SnapCenter 4.6 and auto discovery support for HANA System Replication-enabled HANA systems.

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