SAP HANA on NetApp ASA Systems with FCP Configuration Guide

NetApp solutions for SAP

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SAP HANA on NetApp ASA Systems with Fibre Channel Protocol

The NetApp ASA product family is certified for use with SAP HANA in TDI projects. This guide provides best practices for SAP HANA on this platform.

Marco Schoen, NetApp

Introduction

The NetApp ASA A-Series and ASA C-Series product families have been certified for use with SAP HANA in tailored data center integration (TDI) projects.
This guide describes the best practices for the following certified models:

- ASA A20, ASA A30, ASA A50, ASA A70, ASA A90, ASA A1K
- ASA C30

For a complete list of NetApp certified storage solutions for SAP HANA, see the Certified and supported SAP HANA hardware directory.

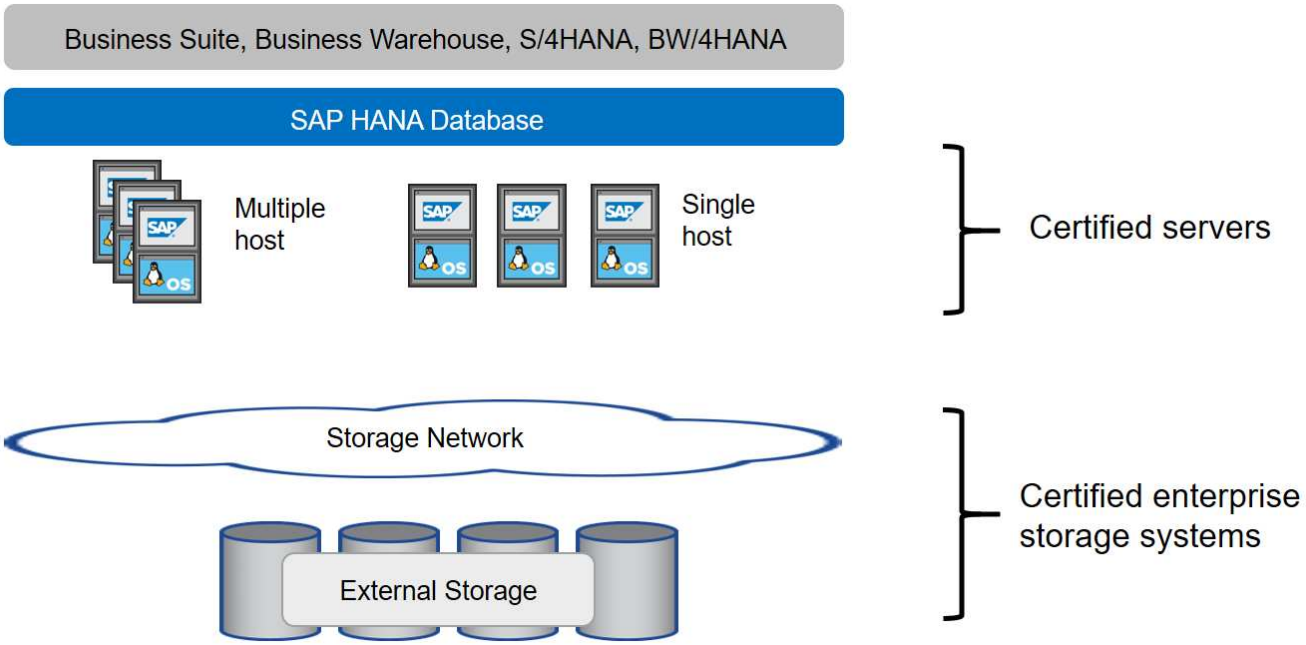
This document describes ASA configurations that use the Fibre Channel Protocol (FCP).

> The configuration described in this paper is necessary to achieve the required SAP HANA KPIs and the best performance for SAP HANA. Changing any settings or using features not listed herein might cause performance degradation or unexpected behavior and should only be done if advised by NetApp support.

In an SAP HANA multiple-host environment, the standard SAP HANA storage connector is used to provide fencing in the event of an SAP HANA host failover. Always refer to the relevant SAP notes for operating system configuration guidelines and HANA specific Linux kernel dependencies. For more information, see SAP Note 2235581 – SAP HANA Supported Operating Systems.

SAP HANA tailored data center integration

NetApp ASA storage systems are certified in the SAP HANA TDI program using FC (SAN) protocols They can be deployed in any of the current SAP HANA scenarios, such as SAP Business Suite on HANA, S/4HANA, BW/4HANA, or SAP Business Warehouse on HANA in either single-host or multiple-host configurations. Any server that is certified for use with SAP HANA can be combined with NetApp certified storage solutions. The following figure shows an architecture overview.



For more information regarding the prerequisites and recommendations for productive SAP HANA systems, see the following resource:

- SAP HANA Tailored Data Center Integration Frequently Asked Questions

SAP HANA using VMware vSphere

There are several options to connect storage to virtual machines (VMs).
Raw device mappings (RDM), FCP datastores, or VVOL datastores with FCP are supported. For both datastore options, only one SAP HANA data or log volume must be stored within the datastore for productive use cases.

For more information about using vSphere with SAP HANA, see the following links:

- SAP HANA on VMware vSphere - Virtualization - Community Wiki
- SAP HANA on VMware vSphere Best Practices Guide
- 2161991 - VMware vSphere configuration guidelines - SAP ONE Support Launchpad (Login required)

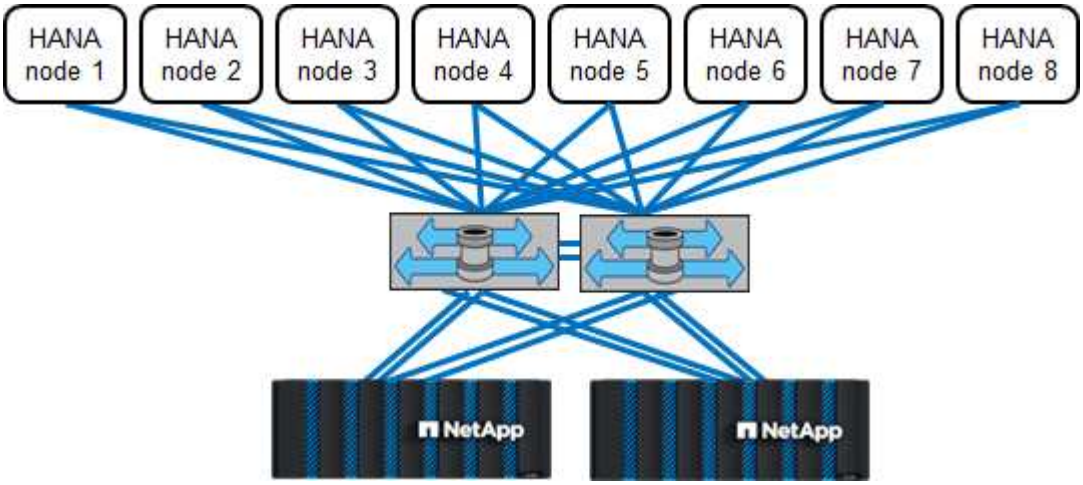
Architecture

SAP HANA hosts are connected to storage controllers using a redundant FCP infrastructure and multipath software. A redundant FCP switch infrastructure is required to provide fault-tolerant SAP HANA host-to-storage connectivity in case of switch or host bus adapter (HBA) failure. Appropriate zoning must be configured at the switch to allow all HANA hosts to reach the required LUNs on the storage controllers.

Different models of the ASA system product family can be mixed and matched at the storage layer to allow for growth and differing performance and capacity needs. The maximum number of SAP HANA hosts that can be attached to the storage system is defined by the SAP HANA performance requirements and the model of NetApp controller used. The number of required disk shelves is only determined by the capacity and performance requirements of the SAP HANA systems.

The following figure shows an example configuration with eight SAP HANA hosts attached to a storage HA

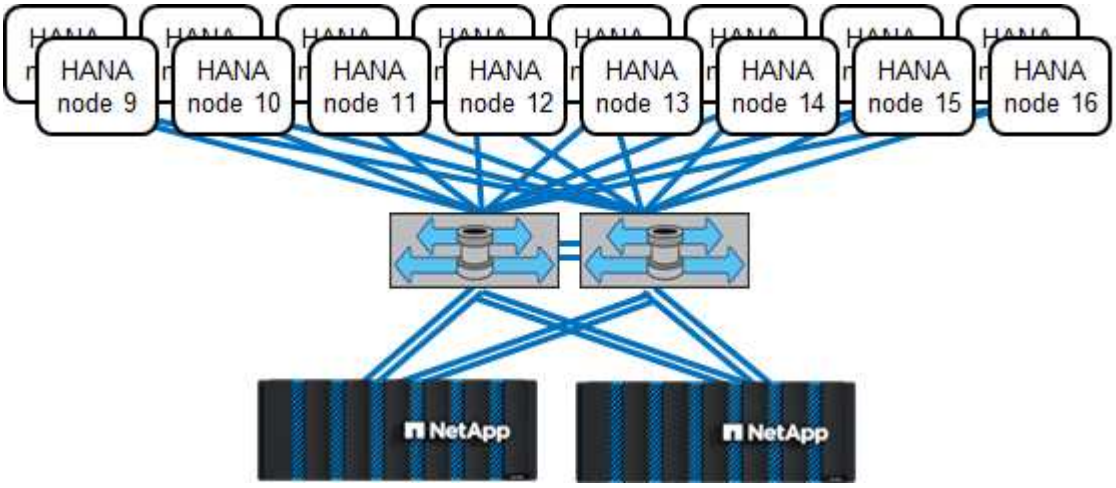
pair.



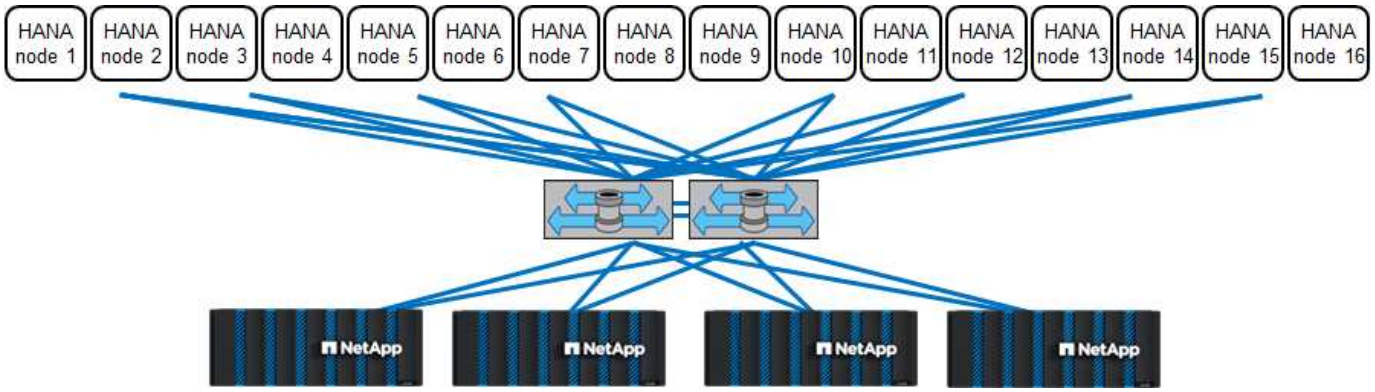
This architecture can be scaled in two dimensions:

- By attaching additional SAP HANA hosts and storage capacity to the existing storage, if the storage controllers provide enough performance to meet the current SAP HANA KPIs
- By adding more storage systems with additional storage capacity for the additional SAP HANA hosts

The following figure shows a configuration example in which more SAP HANA hosts are attached to the storage controllers. In this example, more disk shelves are necessary to meet the capacity and performance requirements of the 16 SAP HANA hosts. Depending on the total throughput requirements, you must add additional FC connections to the storage controllers.



Independent of the deployed ASA system, the SAP HANA landscape can also be scaled by adding any certified storage controllers to meet the desired node density, as shown in the following figure.

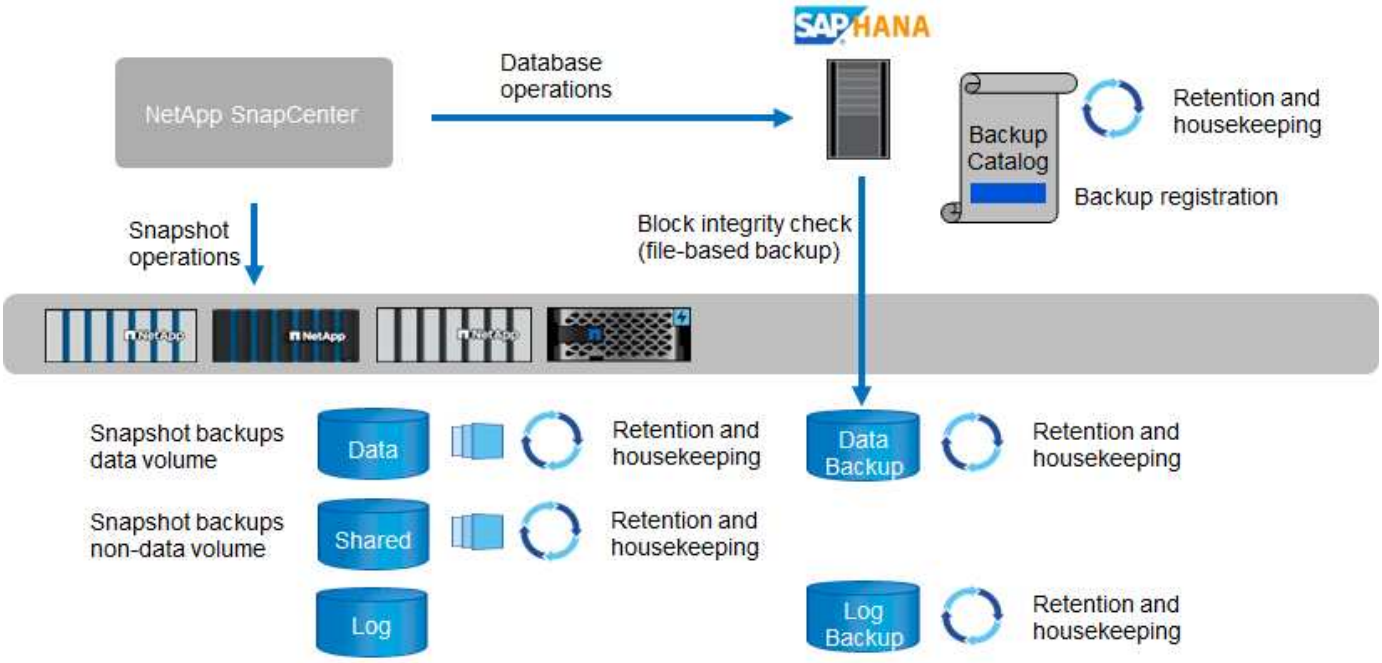


SAP HANA backup

The ONTAP software present on all NetApp storage controllers provides a built-in mechanism to back up SAP HANA databases while in operation with no effect on performance. Storage-based NetApp Snapshot backups are a fully supported and integrated backup solution available for SAP HANA single containers and for SAP HANA MDC systems with a single tenant or multiple tenants.

Storage-based Snapshot backups are implemented by using the NetApp SnapCenter plug-in for SAP HANA. This allows users to create consistent storage-based Snapshot backups by using the interfaces provided natively by SAP HANA databases. SnapCenter registers each of the Snapshot backups into the SAP HANA backup catalog. Therefore, backups taken by SnapCenter are visible within SAP HANA Studio or Cockpit where they can be selected directly for restore and recovery operations.

NetApp SnapMirror technology allows for Snapshot copies that were created on one storage system to be replicated to a secondary backup storage system that is controlled by SnapCenter. Different backup retention policies can then be defined for each of the backup sets on the primary storage and also for the backup sets on the secondary storage systems. The SnapCenter Plug-in for SAP HANA automatically manages the retention of Snapshot copy-based data backups and log backups, including the housekeeping of the backup catalog. The SnapCenter Plug-in for SAP HANA also allows for the execution of a block integrity check of the SAP HANA database by executing a file-based backup.



Storage-based Snapshot backups provide significant advantages compared to conventional file-based

backups. These advantages include, but are not limited to the following:

- Faster backup (a few minutes)
- Reduced RTO due to a much faster restore time on the storage layer (a few minutes) as well as more frequent backups
- No performance degradation of the SAP HANA database host, network, or storage during backup and recovery operations
- Space-efficient and bandwidth-efficient replication to secondary storage based on block changes

For detailed information about the SAP HANA backup and recovery solution, see SAP HANA data protection and high availability with SnapCenter, SnapMirror active sync and VMware Metro Storage Cluster.

At creation of this documents only VMware based VMs using VMDKs as storage are supported by SnapCenter for ASA.

SAP HANA disaster recovery

SAP HANA disaster recovery can be done either on the database layer by using SAP HANA system replication or on the storage layer by using storage replication technologies. The following section provides an overview of disaster recovery solutions based on storage replication.

For detailed information about the SAP HANA disaster recovery solutions, see TR-4646: SAP HANA Disaster Recovery with Storage Replication.

Storage replication based on SnapMirror

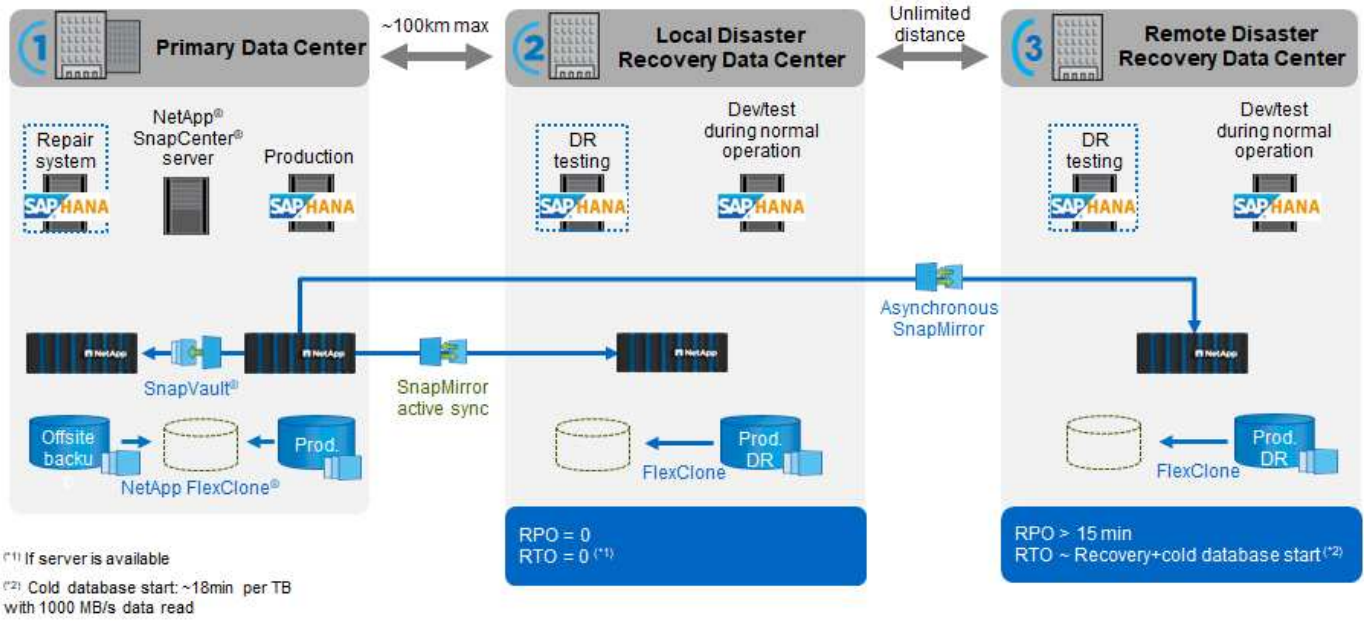
The following figure shows a three-site disaster recovery solution using synchronous SnapMirror active sync to the local DR datacenter and asynchronous SnapMirror to replicate the data to the remote DR datacenter. SnapMirror active sync enables business services to continue operating even through a complete site failure, supporting applications to fail over transparently using a secondary copy (RPO=0 and RTO=0). There is no manual intervention or custom scripting required to trigger a failover with SnapMirror active sync.
Beginning with ONTAP 9.15.1, SnapMirror active sync supports a symmetric active/active capability. Symmetric active/active enable read and write I/O operations from both copies of a protected LUN with bidirectional synchronous replication so that both LUN copies can serve I/O operations locally.

More details can be found at SnapMirror active sync overview in ONTAP..

The RTO for the asynchronous SnapMirror replication primarily depends on the time needed to start the HANA database at the DR site and load the data into memory. With the assumption that the data is read with a throughput of 1000MBps, loading 1TB of data would take approximately 18 minutes.

The servers at the DR sites can be used as dev/test systems during normal operation. In the case of a disaster, the dev/test systems would need to be shut down and started as DR production servers.

Both replication methods allow to you execute DR workflow testing without influencing the RPO and RTO. FlexClone volumes are created on the storage and are attached to the DR testing servers.



Storage sizing

The following section provides an overview of performance and capacity considerations required for sizing a storage system for SAP HANA.

Contact your NetApp or NetApp partner sales representative to support the storage sizing process and to assist you with creating a properly sized storage environment.

Performance considerations

SAP has defined a static set of storage key performance indicators (KPIs). These KPIs are valid for all production SAP HANA environments independent of the memory size of the database hosts and the applications that use the SAP HANA database. These KPIs are valid for single-host, multiple-host, Business Suite on HANA, Business Warehouse on HANA, S/4HANA, and BW/4HANA environments. Therefore, the current performance sizing approach depends on only the number of active SAP HANA hosts that are attached to the storage system.

Storage performance KPIs are only mandated for production SAP HANA systems, but you can implement them in for all HANA system.

SAP delivers a performance test tool which must be used to validate the storage systems performance for active SAP HANA hosts attached to the storage.

NetApp tested and predefined the maximum number of SAP HANA hosts that can be attached to a specific storage model, while still fulfilling the required storage KPIs from SAP for production-based SAP HANA systems.

The maximum number of SAP HANA hosts that can be run on a disk shelf and the minimum number of SSDs required per SAP HANA host were determined by running the SAP performance test tool. This test does not consider the actual storage capacity requirements of the hosts. You must also calculate the capacity requirements to determine the actual storage configuration needed.

NS224 NVMe shelf

One NVMe SSDs (data) supports up to 2/5 SAP HANA hosts depending on the specific NVMe disk being used.

> Adding more disk shelves does not increase the maximum number of SAP HANA hosts that a storage controller can support.

Mixed workloads

SAP HANA and other application workloads running on the same storage controller or in the same storage aggregate are supported. However, it is a NetApp best practice to separate SAP HANA workloads from all other application workloads.

You might decide to deploy SAP HANA workloads and other application workloads on either the same storage controller or the same aggregate. If so, you must make sure that adequate performance is available for SAP HANA within the mixed workload environment. NetApp also recommends that you use quality of service (QoS) parameters to regulate the effect these other applications could have on SAP HANA applications and to guarantee throughput for SAP HANA applications.

The SAP HCMT test tool must be used to check if additional SAP HANA hosts can be run on an existing storage controller that is already in use for other workloads. SAP application servers can be safely placed on the same storage controller and/or aggregate as the SAP HANA databases.

Capacity considerations

A detailed description of the capacity requirements for SAP HANA is in the SAP Note 1900823 white paper.

> The capacity sizing of the overall SAP landscape with multiple SAP HANA systems must be determined by using SAP HANA storage sizing tools from NetApp. Contact NetApp or your NetApp partner sales representative to validate the storage sizing process for a properly sized storage environment.

Configuration of performance test tool

Starting with SAP HANA 1.0 SPS10, SAP introduced parameters to adjust the I/O behavior and optimize the database for the file and storage system used. These parameters must also be set for the performance test tool from SAP when the storage performance is being tested with the SAP test tool.

NetApp conducted performance tests to define the optimal values. The following table lists the parameters that must be set within the configuration file of the SAP test tool.

Parameter	Value
max_parallel_io_requests	128
async_read_submit	on
async_write_submit_active	on
async_write_submit_blocks	all

For more information about the configuration of SAP test tool, see SAP note 1943937 for HWCCT (SAP HANA 1.0) and SAP note 2493172 for HCMT/HCOT (SAP HANA 2.0).

The following example shows how variables can be set for the HCMT/HCOT execution plan.

```
…
{
          "Comment": "Log Volume: Controls whether read requests are
submitted asynchronously, default is 'on'",
          "Name": "LogAsyncReadSubmit",
          "Value": "on",
          "Request": "false"
      },
      {
          "Comment": "Data Volume: Controls whether read requests are
submitted asynchronously, default is 'on'",
          "Name": "DataAsyncReadSubmit",
          "Value": "on",
          "Request": "false"
      },
      {
          "Comment": "Log Volume: Controls whether write requests can be
submitted asynchronously",
          "Name": "LogAsyncWriteSubmitActive",
          "Value": "on",
          "Request": "false"
      },
      {
          "Comment": "Data Volume: Controls whether write requests can be
submitted asynchronously",
          "Name": "DataAsyncWriteSubmitActive",
          "Value": "on",
          "Request": "false"
      },
      {
          "Comment": "Log Volume: Controls which blocks are written
asynchronously. Only relevant if AsyncWriteSubmitActive is 'on' or 'auto'
and file system is flagged as requiring asynchronous write submits",
          "Name": "LogAsyncWriteSubmitBlocks",
          "Value": "all",
          "Request": "false"
      },
      {
          "Comment": "Data Volume: Controls which blocks are written
asynchronously. Only relevant if AsyncWriteSubmitActive is 'on' or 'auto'
and file system is flagged as requiring asynchronous write submits",
          "Name": "DataAsyncWriteSubmitBlocks",
          "Value": "all",
          "Request": "false"
```

```
      },
      {
         "Comment": "Log Volume: Maximum number of parallel I/O requests
per completion queue",
         "Name": "LogExtMaxParallelIoRequests",
         "Value": "128",
         "Request": "false"
      },
      {
         "Comment": "Data Volume: Maximum number of parallel I/O requests
per completion queue",
         "Name": "DataExtMaxParallelIoRequests",
         "Value": "128",
         "Request": "false"
      }, …
```

These variables must be used for the test configuration. This is usually the case with the predefined execution plans SAP delivers with the HCMT/HCOT tool. The following example for a 4k log write test is from an execution plan.

```
…
      {
         "ID": "D664D001-933D-41DE-A904F304AEB67906",
         "Note": "File System Write Test",
         "ExecutionVariants": [
            {
               "ScaleOut": {
                  "Port": "${RemotePort}",
                  "Hosts": "${Hosts}",
                  "ConcurrentExecution": "${FSConcurrentExecution}"
               },
               "RepeatCount": "${TestRepeatCount}",
               "Description": "4K Block, Log Volume 5GB, Overwrite",
               "Hint": "Log",
               "InputVector": {
                  "BlockSize": 4096,
                  "DirectoryName": "${LogVolume}",
                  "FileOverwrite": true,
                  "FileSize": 5368709120,
                  "RandomAccess": false,
                  "RandomData": true,
                  "AsyncReadSubmit": "${LogAsyncReadSubmit}",
                  "AsyncWriteSubmitActive":
"${LogAsyncWriteSubmitActive}",
                  "AsyncWriteSubmitBlocks":
"${LogAsyncWriteSubmitBlocks}",
                  "ExtMaxParallelIoRequests":
"${LogExtMaxParallelIoRequests}",
                  "ExtMaxSubmitBatchSize": "${LogExtMaxSubmitBatchSize}",
                  "ExtMinSubmitBatchSize": "${LogExtMinSubmitBatchSize}",
                  "ExtNumCompletionQueues":
"${LogExtNumCompletionQueues}",
                  "ExtNumSubmitQueues": "${LogExtNumSubmitQueues}",
                  "ExtSizeKernelIoQueue": "${ExtSizeKernelIoQueue}"
               }
            },
…
```

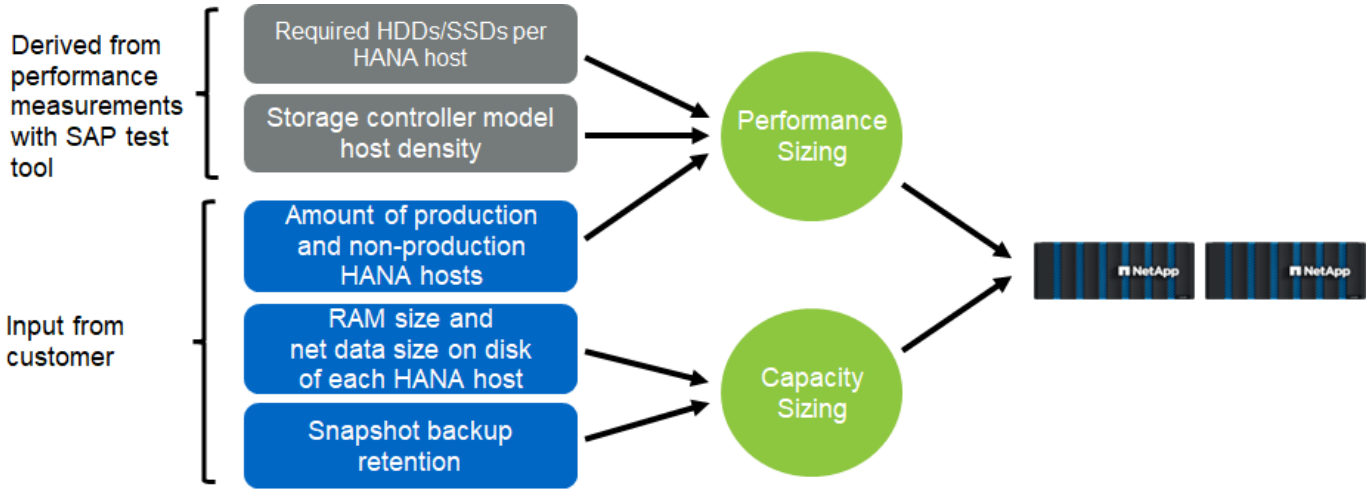
Storage sizing process overview

The number of disks per HANA host and the SAP HANA host density for each storage model were determined using the SAP HANA test tool.

The sizing process requires details such as the number of production and nonproduction SAP HANA hosts, the RAM size of each host, and the backup retention of the storage-based Snapshot copies. The number of SAP HANA hosts determines the storage controller and the number of disks required.

The size of the RAM, net data size on the disk of each SAP HANA host, and the Snapshot copy backup retention period are used as inputs during capacity sizing.

The following figure summarizes the sizing process.



Infrastructure setup and configuration

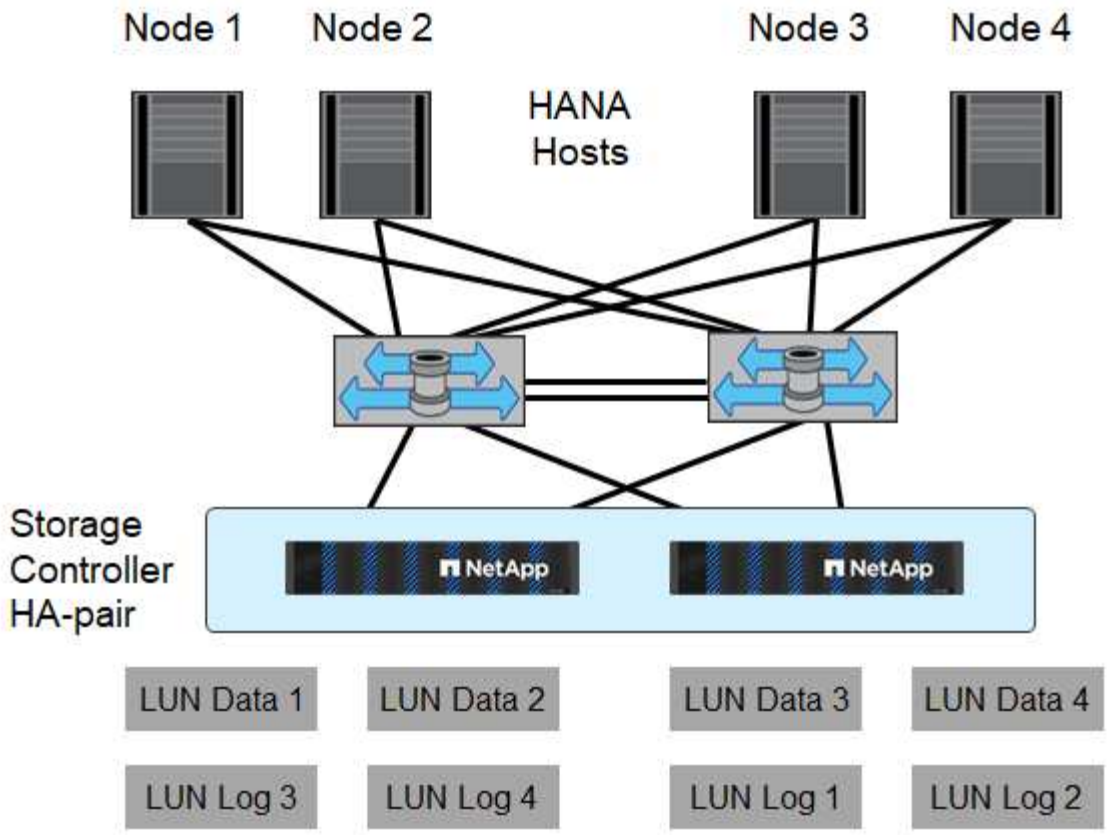
The following sections provide SAP HANA infrastructure setup and configuration guidelines and describes all the steps needed to set up an SAP HANA system. Within these sections, the following example configurations are used:

- HANA system with SID=FC5
  - SAP HANA single and multiple host

SAN fabric setup

Each SAP HANA server must have a redundant FCP SAN connection with a minimum of 8Gbps bandwidth. For each SAP HANA host attached to a storage controller, at least 8Gbps bandwidth must be configured at the storage controller.

The following figure shows an example with four SAP HANA hosts attached to two storage controllers. Each SAP HANA host has two FCP ports connected to the redundant fabric. At the storage layer, four FCP ports are configured to provide the required throughput for each SAP HANA host.



In addition to the zoning on the switch layer, you must map each LUN on the storage system to the hosts that connect to this LUN. Keep the zoning on the switch simple; that is, define one zone set in which all host HBAs can see all controller HBAs.

Time synchronization

You must synchronize the time between the storage controllers and the SAP HANA database hosts. To do so, set the same time server for all storage controllers and all SAP HANA hosts.

Storage controller setup

This section describes the configuration of the NetApp storage system. You must complete the primary installation and setup according to the corresponding Data ONTAP setup and configuration guides.

Storage efficiency

Inline deduplication, cross-volume inline deduplication, inline compression, and inline compaction are supported with SAP HANA in an SSD configuration.

Quality of Service

QoS can be used to limit the storage throughput for specific SAP HANA systems or non-SAP applications on a shared controller.

Production and Dev/Test

One use case would be to limit the throughput of development and test systems so that they cannot influence production systems in a mixed setup.
During the sizing process, you should determine the performance requirements of a nonproduction system. Development and test systems can be sized with lower performance values, typically in the range of 20% to 50% of a production-system KPI as defined by SAP.
Large write I/O has the biggest performance effect on the storage system. Therefore, the QoS throughput limit should be set to a percentage of the corresponding write SAP HANA storage performance KPI values in the data and log volumes.

Shared Environments

Another use case is to limit the throughput of heavy write workloads, especially to avoid that these workloads have an impact on other latency sensitive write workloads.
In such environments it is best practice to apply a non-shared throughput ceiling QoS group-policy to each LUN within each Storage Virtual Machine (SVM) to restrict the max throughput of each individual storage object to the given value. This reduces the possibility that a single workload can negatively influence other workloads.

To do so, a group-policy needs to be created using the CLI of the ONTAP cluster for each SVM:

```
qos policy-group create -policy-group <policy-name> -vserver <vserver
name> -max-throughput 1000MB/s -is-shared false
```

and applied to each LUN within the SVM. Below is an example to apply the policy group to all existing LUNs within an SVM:

```
lun modify -vserver <vserver name>  -path * -qos-policy-group  <policy-
name>
```

This needs to be done for every SVM. The name of the QoS police group for each SVM needs to be different. For new LUNs, the policy can be applied directly:

```
lun create -vserver <vserver_name> -path  /vol/<volume_name>/<lun_name>
-size <size> -ostype <e.g. linux>  -qos-policy-group <policy-name>
```

It is recommended to use 1000MB/s as maximum throughput for a given LUN. If an application requires more throughput, multiple LUNs with LUN striping shall be used to provide the needed bandwidth. This guide provides an example for SAP HANA based on Linux LVM in section Host Setup.

The limit applies also to reads. Therefore use enough LUNs to fulfil the required SLAs for SAP HANA database startup time and for backups.

Configure storage

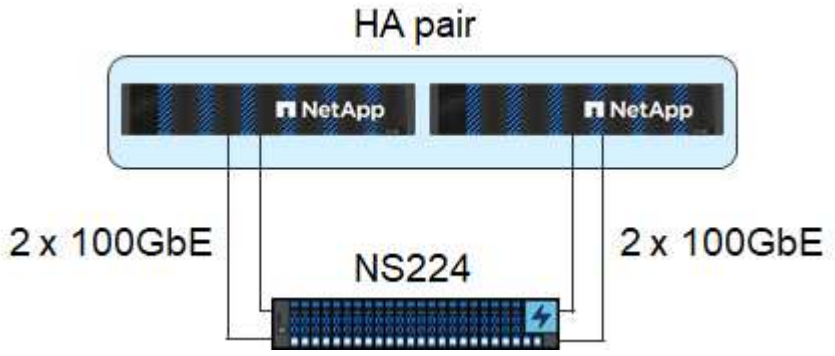
The following overview summarizes the required storage configuration steps. Each step is covered in more detail in the subsequent sections. In this section, we assume that the storage hardware is set up and that the ONTAP software is already installed. Also, the connection of the storage FCP ports to the SAN fabric must

already be in place.

1. Check the correct disk shelf configuration, as described in NVMe-based disk shelves.
2. Create initiator groups (igroups) with worldwide names (WWNs) of HANA servers as described in the section xref:./bp/saphana-asa-fc-storage-controller-setup.html#initiator-groups Initiator groups.
3. Create LUNs and map them to the servers described in the section LUN configuration for SAP HANA single-host systems and LUN configuration for SAP HANA multiple-hosts systems

NVMe-based disk shelves

Each NS224 NVMe disk shelf is connected with two 100GbE ports per controller, as shown in the following figure. The disks are automatically distributed to both controllers of the HA pair.



Initiator groups

An igroup can be configured for each server or for a group of servers that require access to a LUN. The igroup configuration requires the worldwide port names (WWPNs) of the servers.

Using the `sanlun` tool, run the following command to obtain the WWPNs of each SAP HANA host:

```
sapcc-hana-tst:~ # sanlun fcp show adapter
/sbin/udevadm
/sbin/udevadm

host0 ..... WWPN:2100000e1e163700
host1 ..... WWPN:2100000e1e163701
```

The `sanlun` tool is part of the NetApp Host Utilities and must be installed on each SAP HANA host. More details can be found in section Host setup.

Single host

This section describes the configuration of the NetApp storage system specific to SAP HANA single-host systems

Creating LUNs and mapping LUNs to initiator groups

You can use NetApp ONTAP System Manager to create storage volumes and LUNs and the map them to the igroups of the servers and the ONTAP CLI.

Creating LUNs and mapping LUNs to initiator groups using the CLI

This section shows an example configuration using the command line with ONTAP 9 for a SAP HANA single host system with SID FC5 using LVM and two LUNs per LVM volume group:

1. Create all LUNs.

```
lun create -path  FC5_data_mnt00001_1 -size 1t -ostype linux  -class
regular
lun create -path FC5_data_mnt00001_2 -size 1t -ostype linux  -class
regular
lun create -path FC5_log_mnt00001_1 -size 260g -ostype linux  -class
regular
lun create -path FC5_log_mnt00001_2 -size 260g -ostype linux  -class
regular
lun create -path FC5_shared -size 260g -ostype linux  -class regular
```

2. Create the initiator group for all servers belonging to system FC5.

```
lun igroup create -igroup HANA-FC5 -protocol fcp -ostype linux
-initiator 10000090fadcc5fa,10000090fadcc5fb -vserver svm1
```

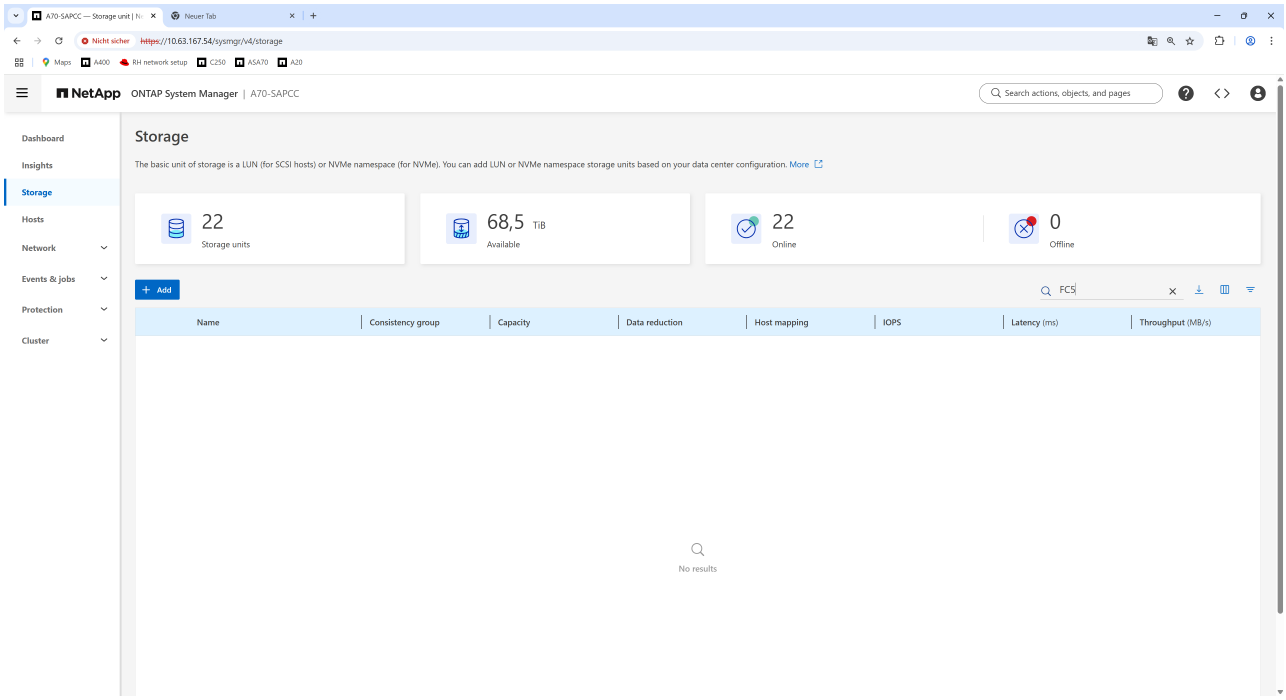
3. Map all LUNs to created initiator group.

```
lun map -path FC5_data_mnt00001_1 -igroup HANA-FC5
lun map -path FC5_data_mnt00001_2 -igroup HANA-FC5
lun map -path FC5_log_mnt00001_1 -igroup HANA-FC5
lun map -path FC5_log_mnt00001_2 -igroup HANA-FC5
lun map -path FC5_shared -igroup HANA-FC5
```

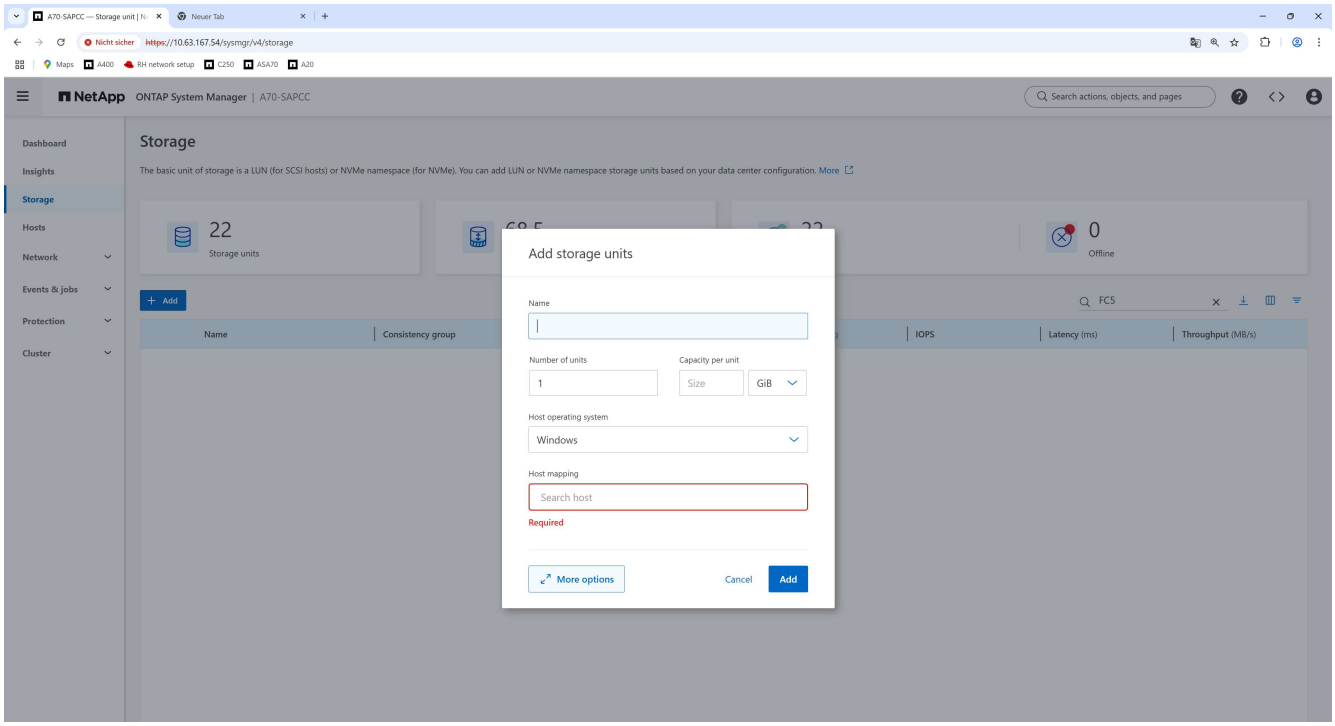
Creating LUNs and mapping LUNs to initiator groups using the GUI

This section shows an example configuration using `ONTAP System Manager` for a SAP HANA single host system with SID FC5 using LVM and two LUNs per LVM volume group:

1. Log on to the `ONTAP System Manager` of your ONTAP Cluster and choose `Storage` from the left menu.
   a. Press `Add`



2. Choose `More options`

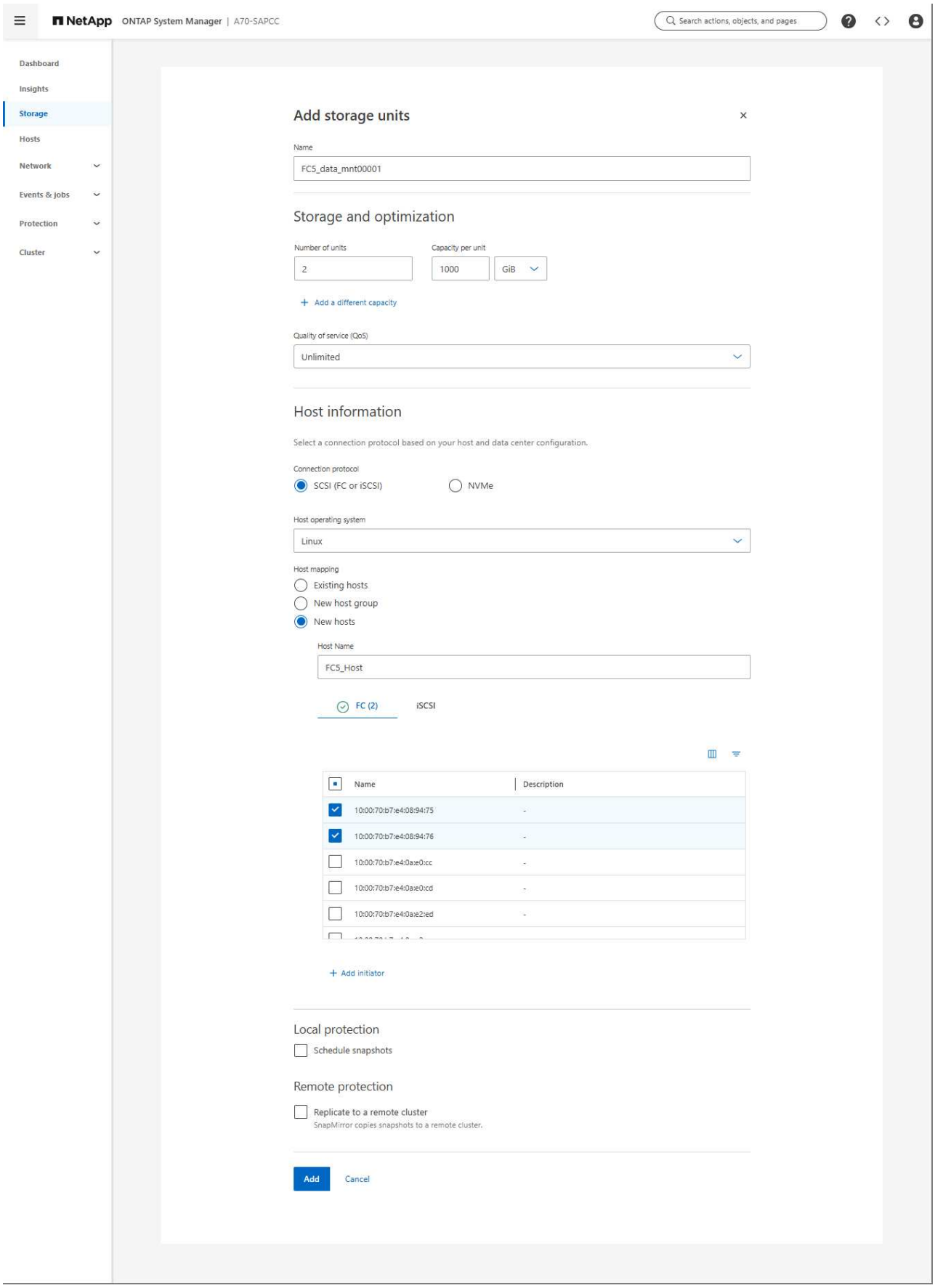


3. Provide the required information:
   a. the name of the data LUNs, e.g.`FC5_data_mnt00001`
   b. the amount of LUNs to be combined with LVM, e.g. 2
   c. the size of each LUN, e.g. 1000 GB
   d. choose `SCSI (FC or iSCSI)`
   e. choose `Linux` as `Host Operating system`

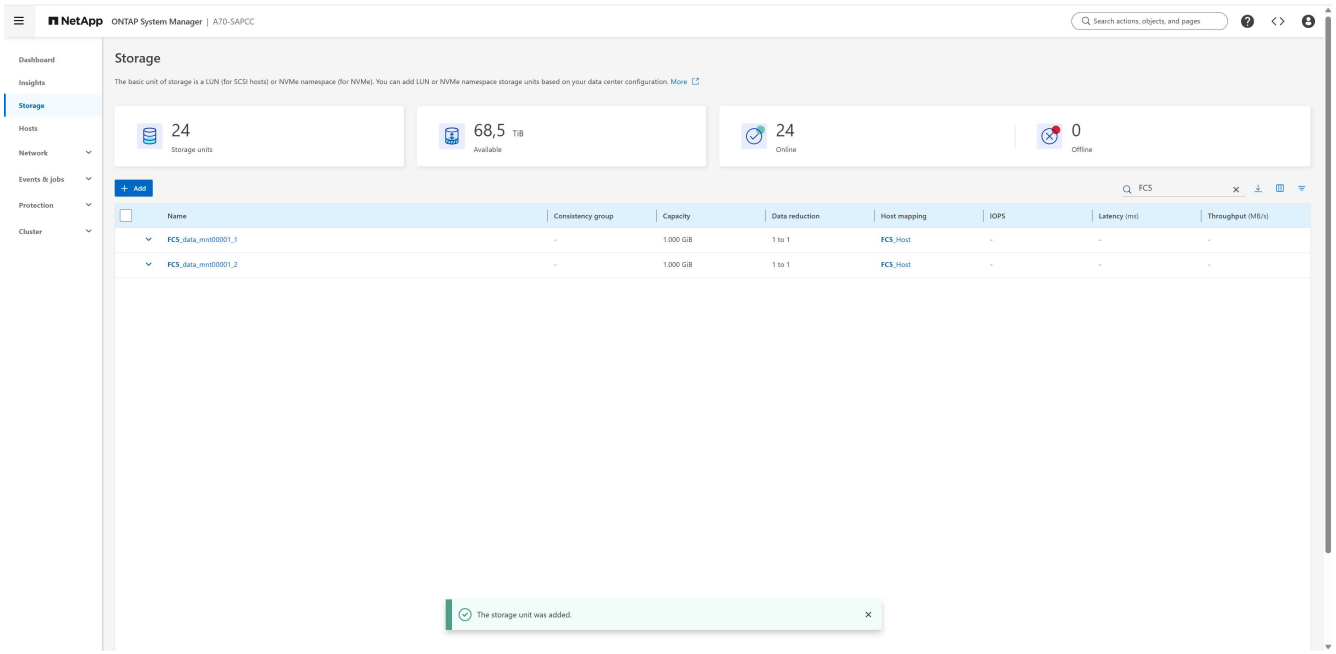
f. choose `New host` for the `Host mapping` option, provide a nam, e.g `FC5_host`, pick or add the desired initiators

g. Keep `Schedule snapshots` unchecked

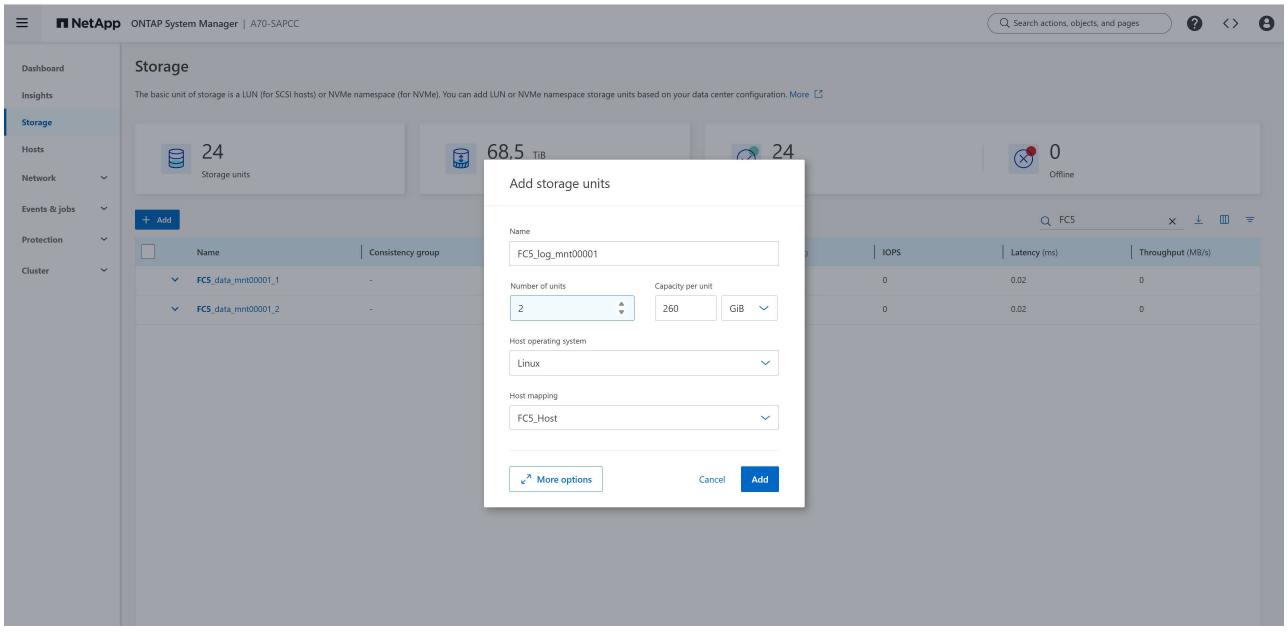
h. press `Add`



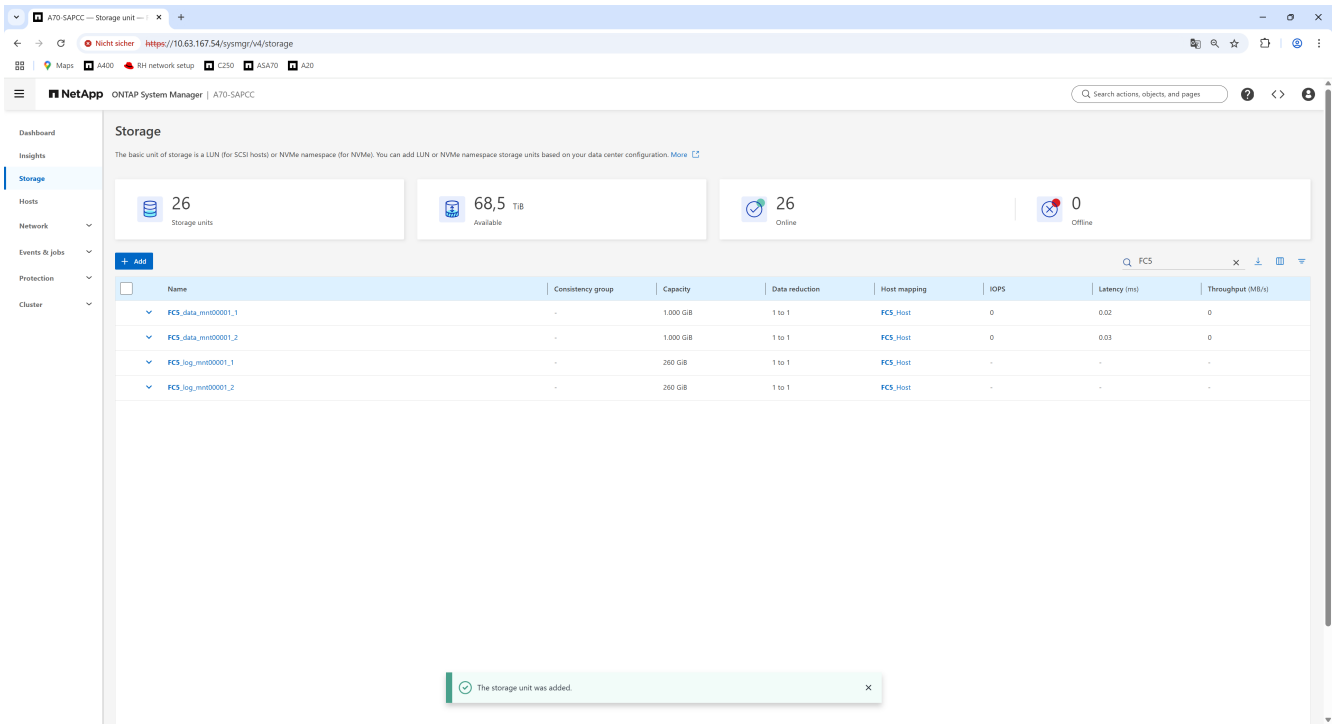
4. After successful creation of the data LUNs create the log LUNs by pressing `Add`



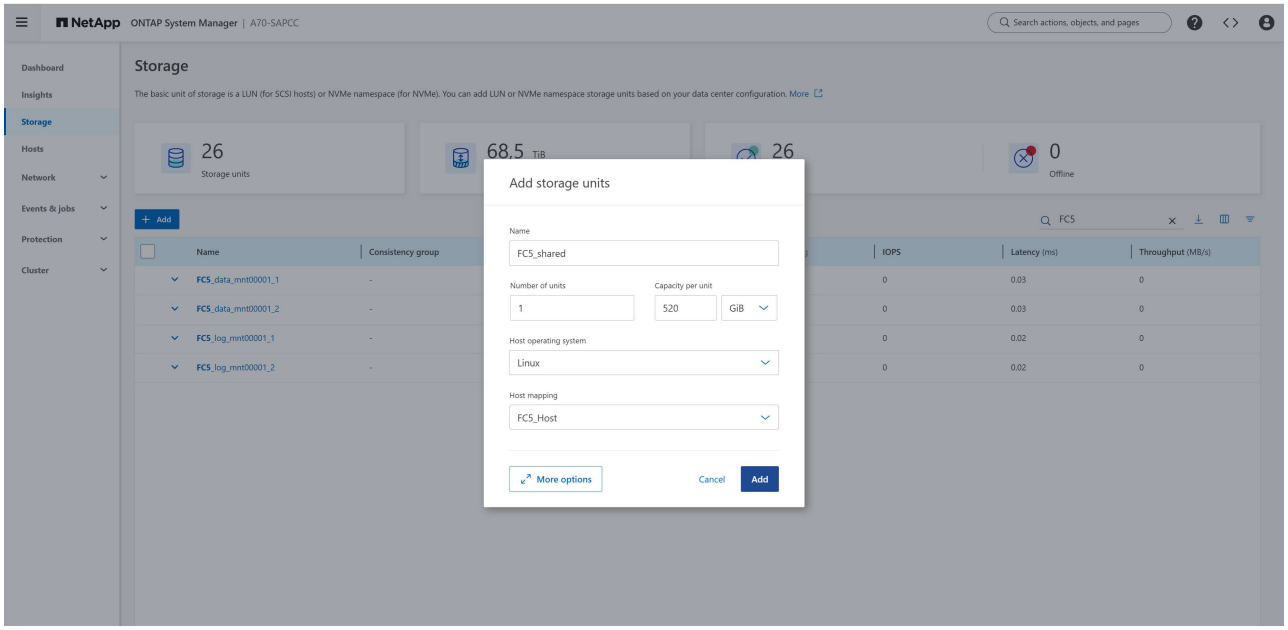
5. Provide the required information:
   a. teh name of the log LUNs, e.g. `FC5_log_mnt00001`
   b. the amount of LUNs to be combined with LVM, e.g. 2
   c. the size of each LUN, e.g. 260 GB
   d. choose `Linux` as `Host Operating system`
   e. choose the previously created mapping `FC5_host` for the `Host mapping` option
   f. press `Add`



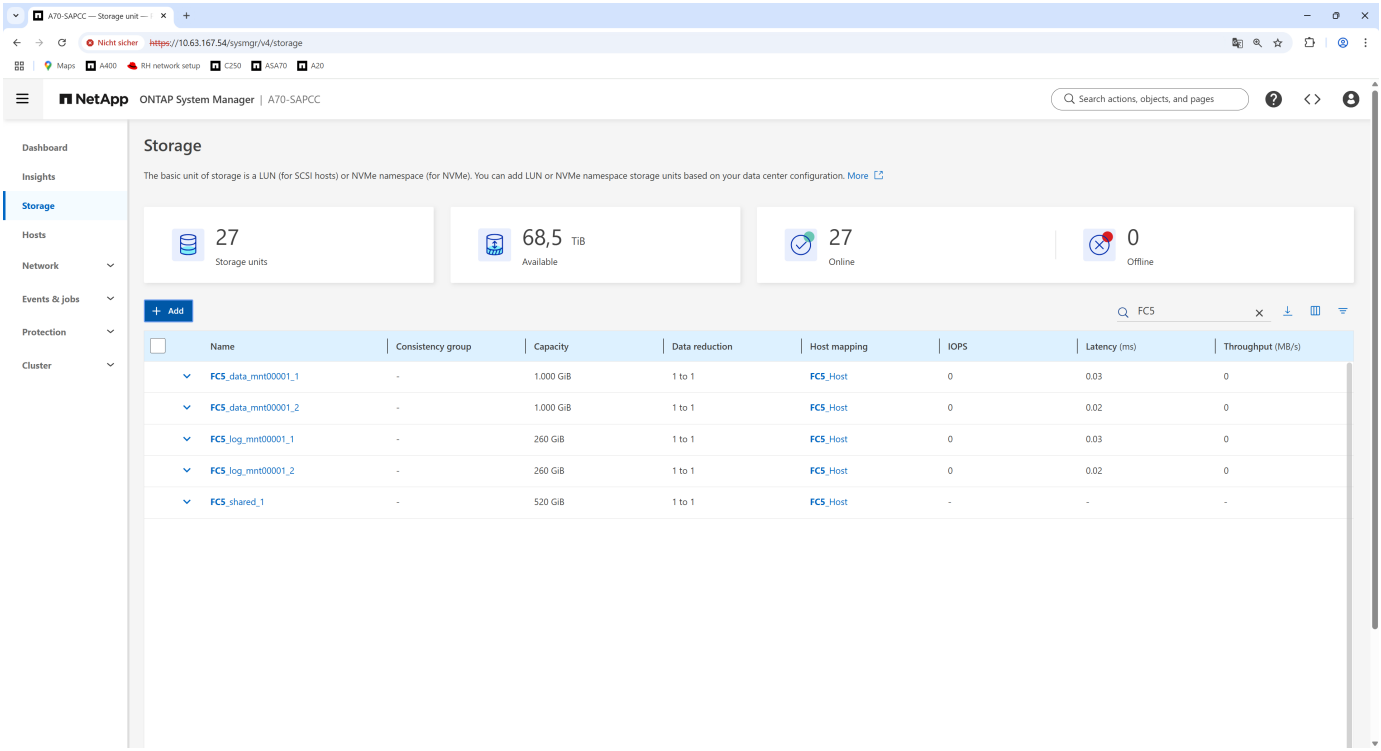
6. After successful creation of the log LUNs create the shared LUN by pressing `Add`



7. Provide the required information:
   a. the name of the shared LUN, e.g.`FC5_shared`
   b. the amount of LUNs, e.g. 1
   c. the size of the LUN, e.g. 520 GB
   d. choose `Linux` as `Host Operating system`
   e. choose the previously created mapping `FC5_host` for the `Host mapping` option
   f. press `Add`



All required LUNs for a SAP HANA single-host system have been created.



Multiple hosts

This section describes the configuration of the NetApp storage system specific to SAP HANA multiple-hosts systems

Creating LUNs and mapping LUNs to initiator groups

You can use NetApp ONTAP System Manager to create storage volumes and LUNs and the map them to the igroups of the servers and the ONTAP CLI.

Creating LUNs and mapping LUNs to initiator groups using the CLI

This section shows an example configuration using the command line with ONTAP 9 for a 2+1 SAP HANA multiple host system with SID FC5 using LVM and two LUNs per LVM volume group:

1. Create all LUNs.

```
lun create -path FC5_data_mnt00001_1 -size 1t -ostype linux  -class
regular
lun create -path FC5_data_mnt00001_2 -size 1t -ostype linux  -class
regular
lun create -path FC5_data_mnt00002_1 -size 1t -ostype linux  -class
regular
lun create -path FC5_data_mnt00002_2 -size 1t -ostype linux  -class
regular
lun create -path FC5_log_mnt00001_1 -size 260g -ostype linux  -class
regular
lun create -path FC5_log_mnt00001_2 -size 260g -ostype linux  -class
regular
lun create -path FC5_log_mnt00002_1 -size 260g -ostype linux  -class
regular
lun create -path FC5_log_mnt00002_2 -size 260g -ostype linux  -class
regular
```

2. Create the initiator group for all servers belonging to system FC5.

```
lun igroup create -igroup HANA-FC5 -protocol fcp -ostype linux
-initiator
10000090fadcc5fa,10000090fadcc5fb,10000090fadcc5c1,10000090fadcc5c2,1000
0090fadcc5c3,10000090fadcc5c4 -vserver svm1
```

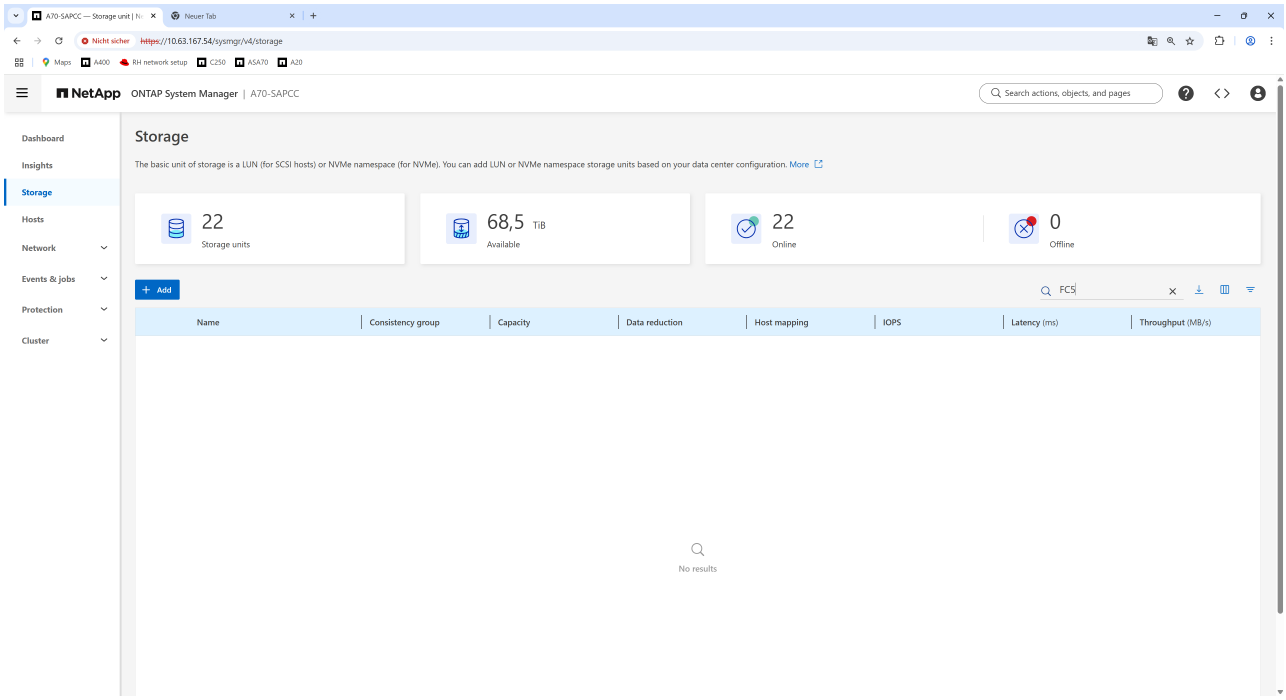
3. Map all LUNs to created initiator group.

```
lun map -path FC5_data_mnt00001_1 -igroup HANA-FC5
lun map -path FC5_data_mnt00001_2 -igroup HANA-FC5
lun map -path FC5_data_mnt00002_1 -igroup HANA-FC5
lun map -path FC5_data_mnt00002_2 -igroup HANA-FC5
lun map -path FC5_log_mnt00001_1 -igroup HANA-FC5
lun map -path FC5_log_mnt00001_2 -igroup HANA-FC5
lun map -path FC5_log_mnt00002_1 -igroup HANA-FC5
lun map -path FC5_log_mnt00002_2 -igroup HANA-FC5
```

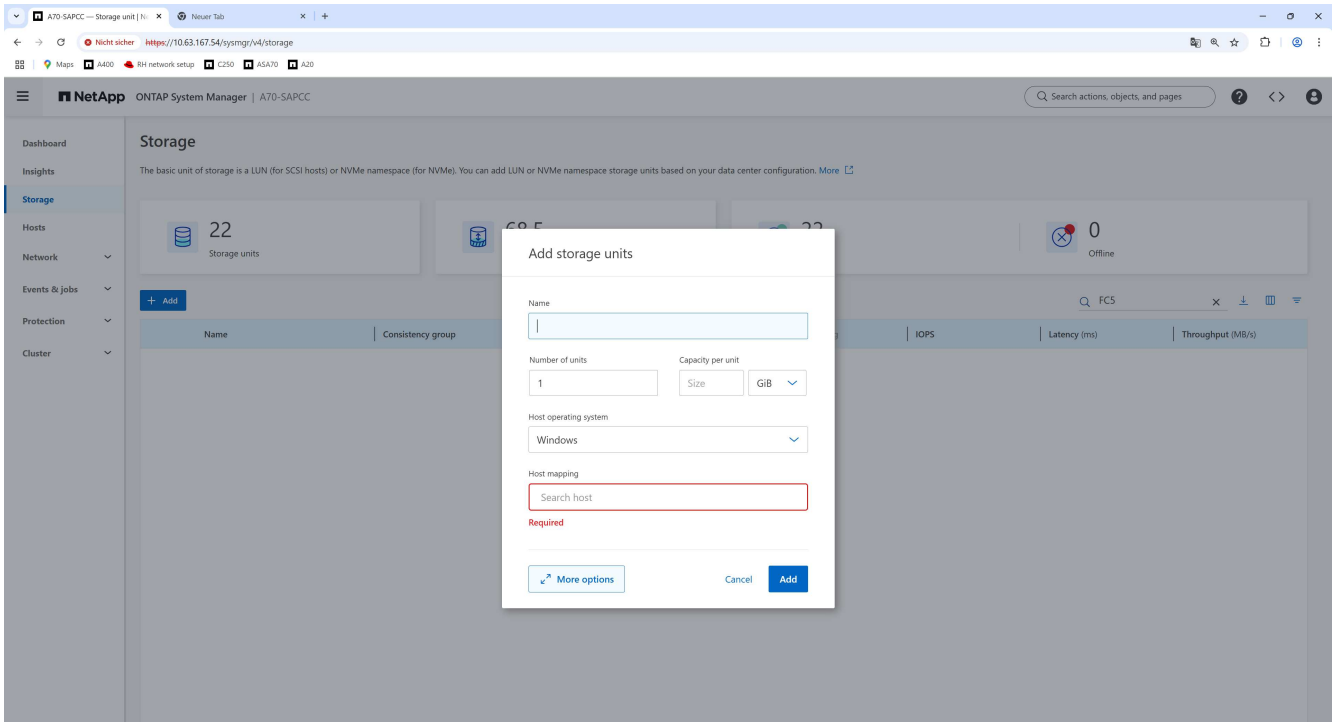
Creating LUNs and mapping LUNs to initiator groups using the GUI

This section shows an example configuration using `ONTAP System Manager` for a 2+1 SAP HANA multiple host system with SID FC5 using LVM and two LUNs per LVM volume group:

1. Log on to the `ONTAP System Manager` of your ONTAP Cluster and choose `Storage` from the left menu.
   a. Press `Add`



2. Choose `More options`

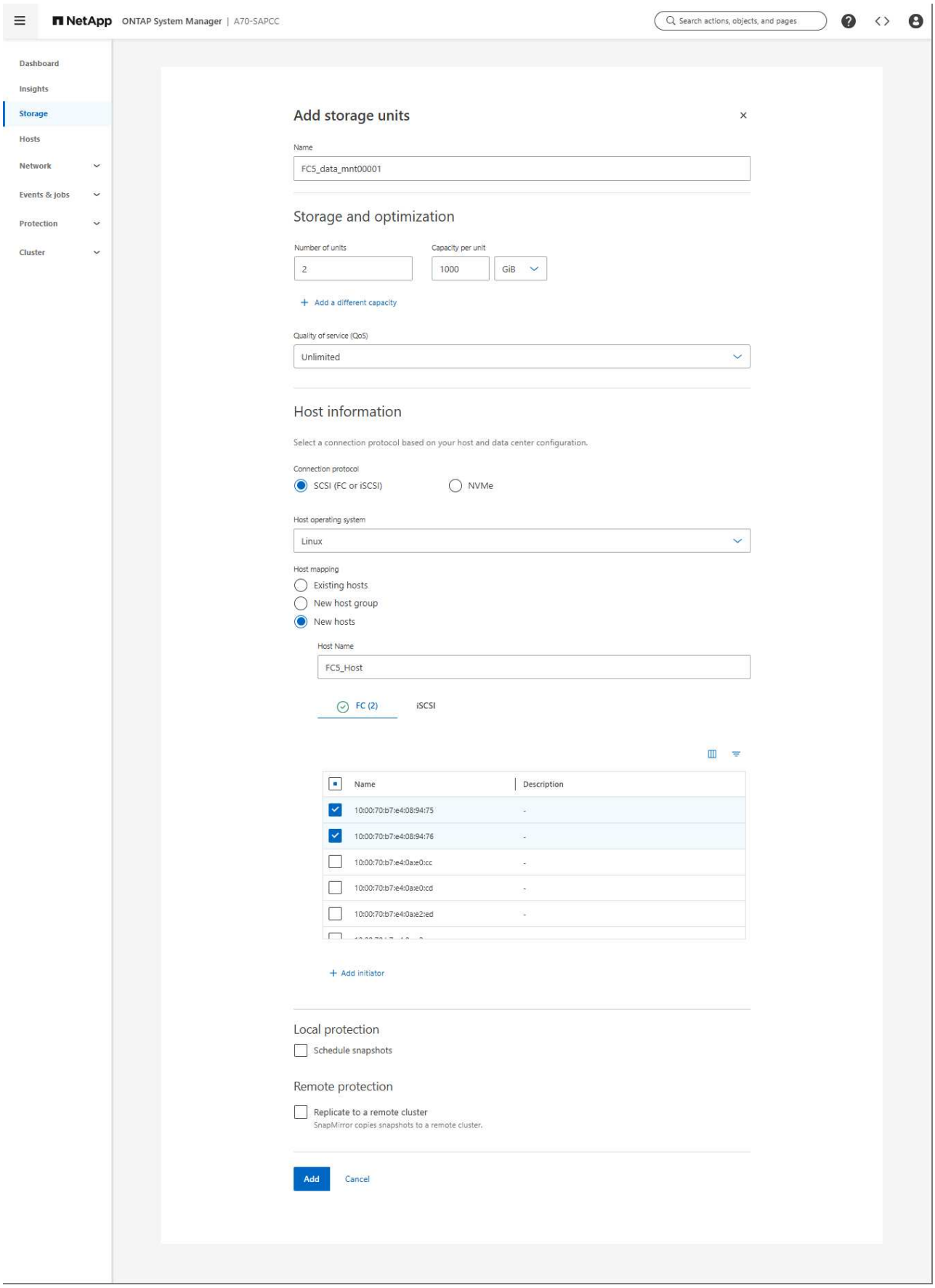


3. Provide the required information:
   a. name of the data LUNs, e.g.`FC5_data_mnt00001`
   b. the amount of LUNs to be combined with LVM, e.g. 2
   c. the size of each LUN, e.g. 1000 GB
   d. choose `SCSI (FC or iSCSI)`
   e. choose `Linux` as `Host Operating system`

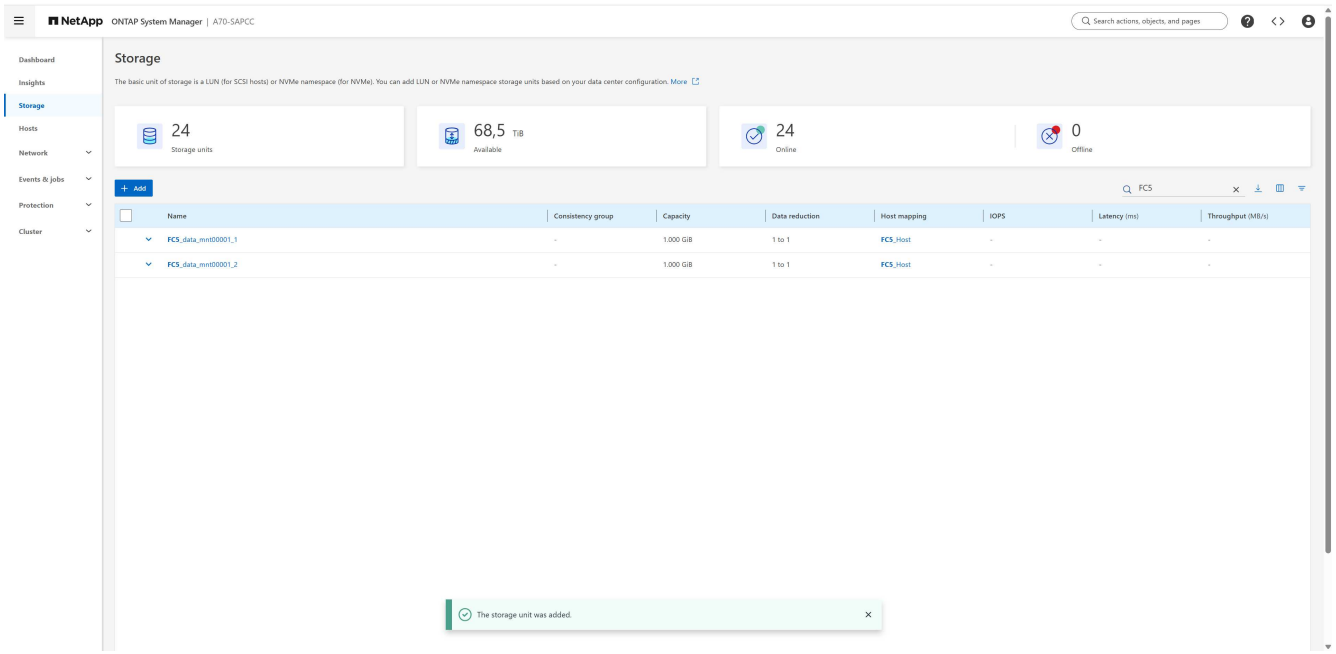
f. choose `New host` for the `Host mapping` option, provide a nam, e.g `FC5_host`, pick or add the desired initiators

g. Keep `Schedule snapshots` unchecked

h. press `Add`



4. Create the data LUNs for the next worker host by pressing `Add`



5. Provide the required information:

   a. the name of the additional data LUNs , e.g. `FC5_data_mnt00002`

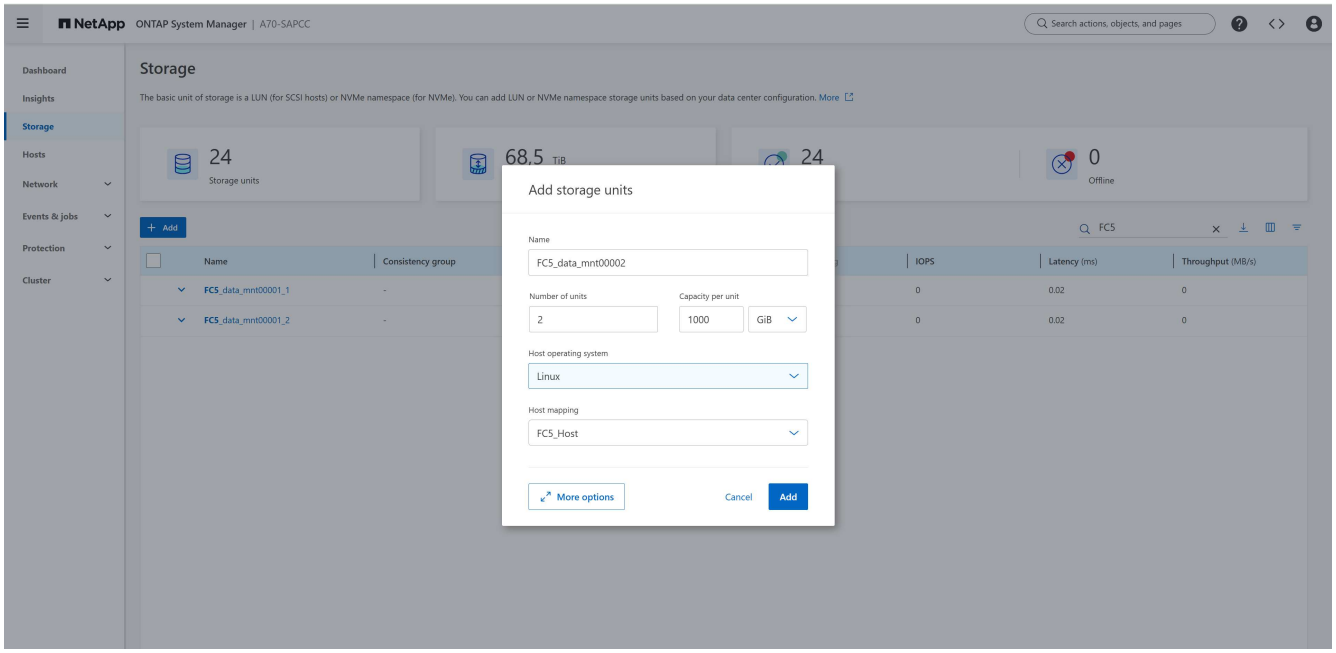
   b. the amount of LUNs to be combined with LVM, e.g. 2

   c. the size of each LUN, e.g. 1000 GB

   d. choose `Linux` as `Host Operating system`

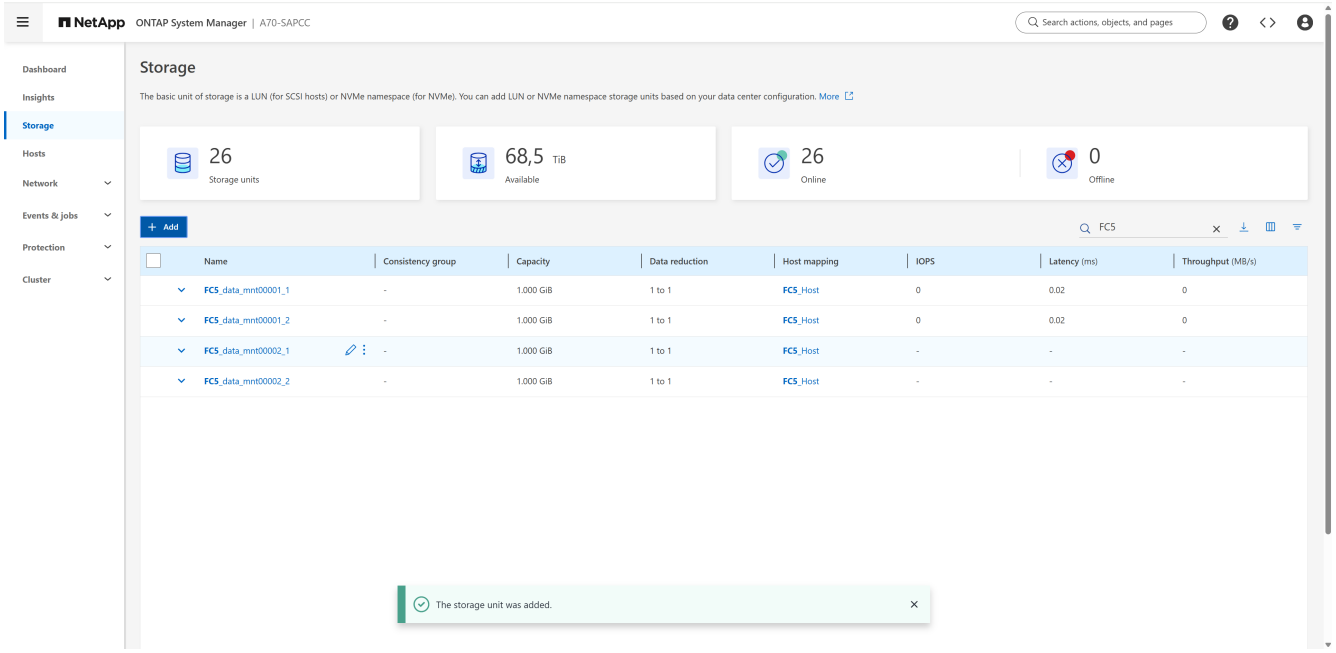
   e. choose the previously created mapping `FC5_host` for the `Host mapping` option

   f. press `Add`

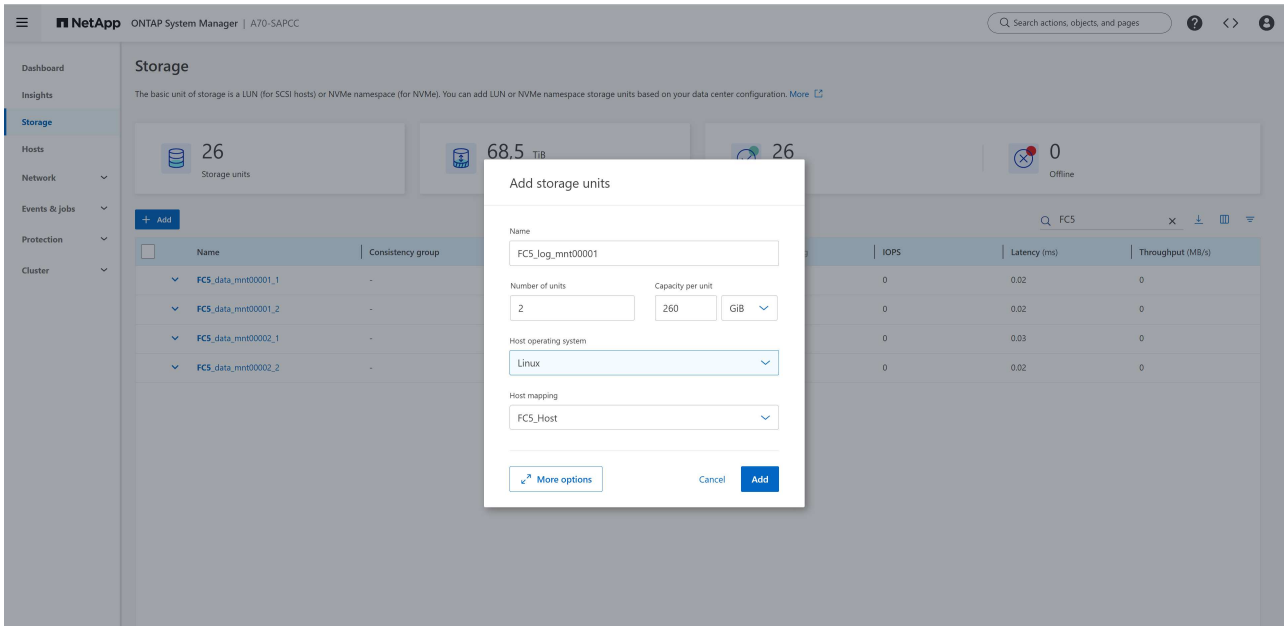


6. Repeat steps 4 and 5 for every additional worker host

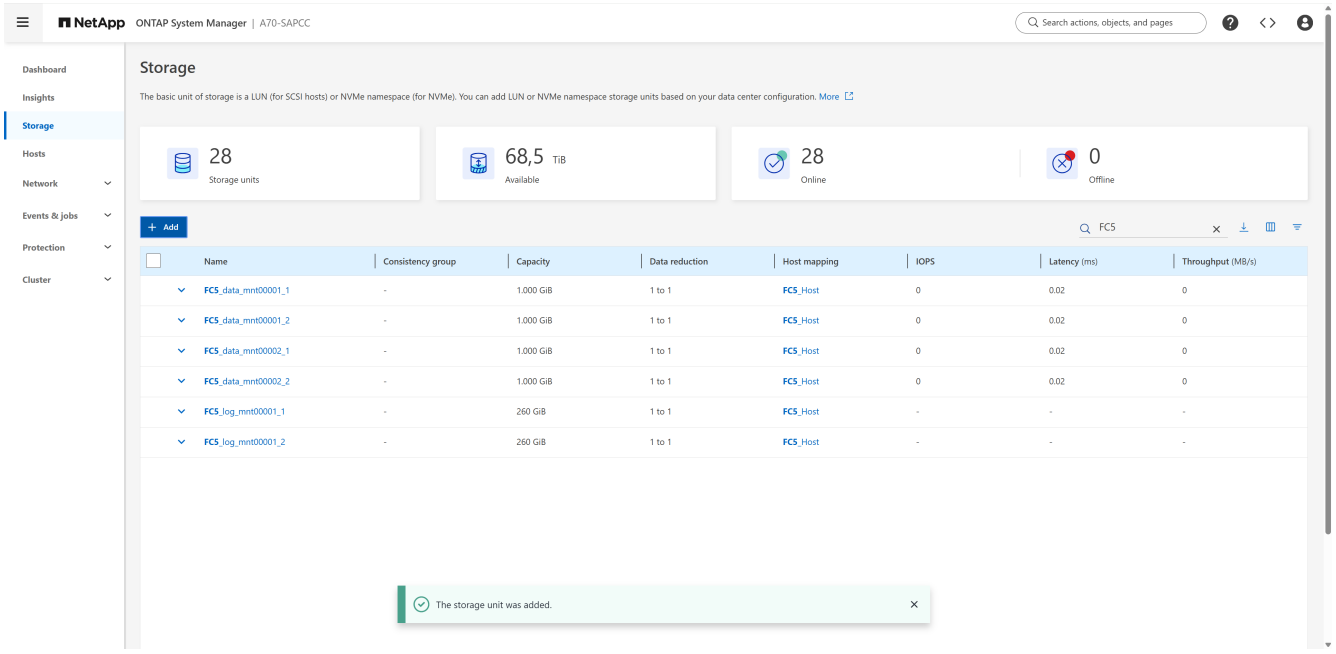
7. After successful creation of the data LUNs create the log LUNs by pressing `Add`



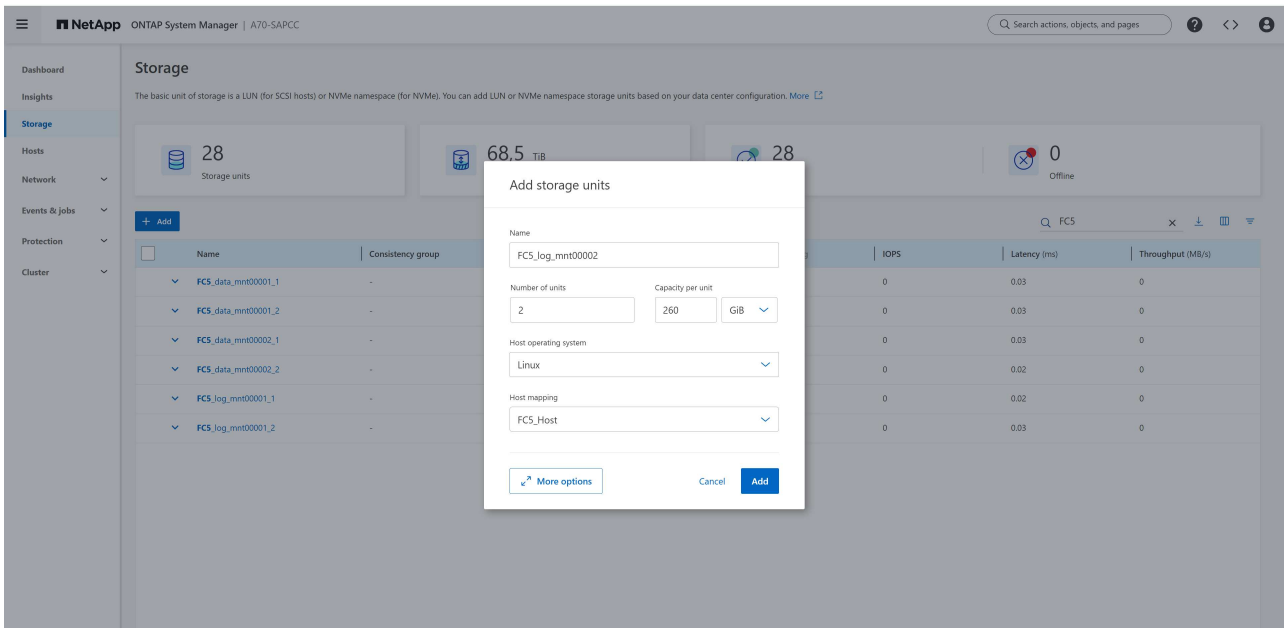
8. Provide the required information:
   a. the name of the log LUNsto be combined with LVM, e.g. `FC5_log_mnt00001`
   b. the amount of LUNs to be combined with LVM, e.g. 2
   c. the size of each LUN, e.g. 260 GB
   d. choose `Linux` as `Host Operating system`
   e. choose the previously created mapping `FC5_host` for the `Host mapping` option
   f. press `Add`



9. Create the log LUNs for the next worker host by pressing `Add`

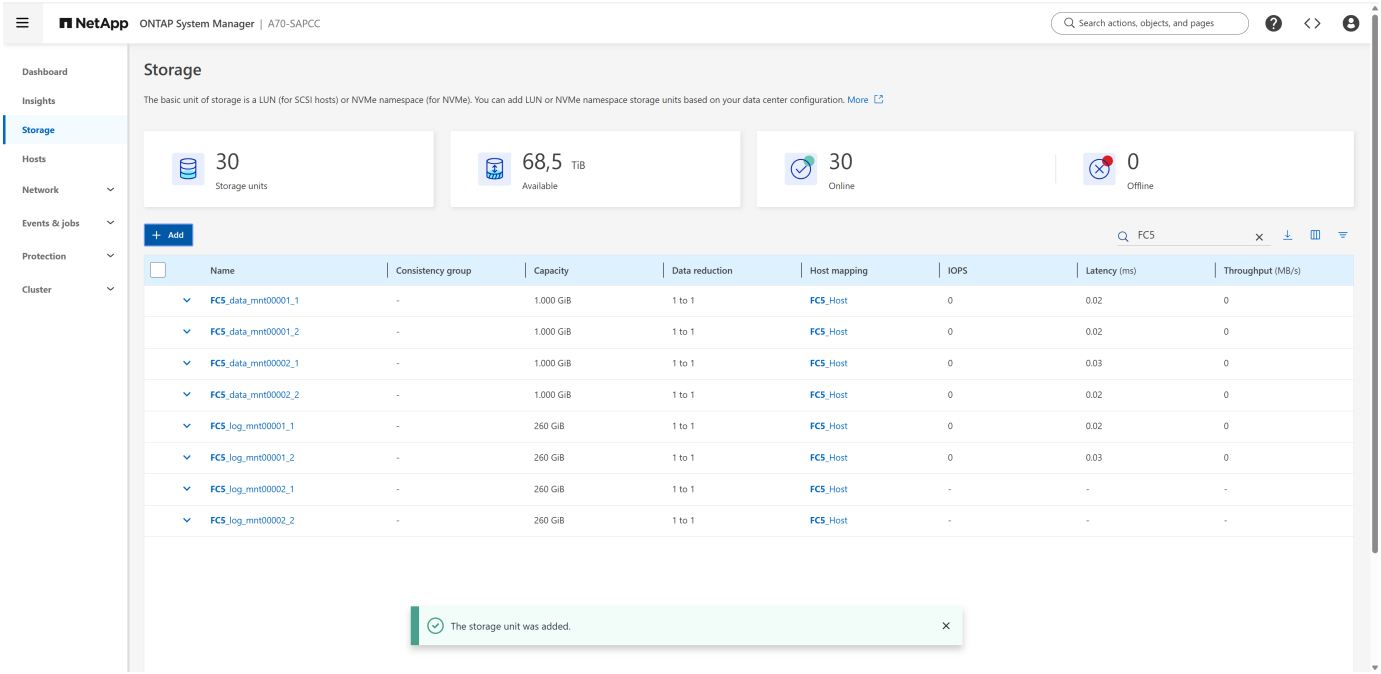


10. Provide the required information:
    a. the name of the additional log LUNs, e.g. `FC5_log_mnt00002`
    b. the amount of LUNs to be combined with LVM, e.g. 2
    c. the size of each LUN, e.g. 260 GB
    d. choose `Linux` as `Host Operating system`
    e. choose the previously created mapping `FC5_host` for the `Host mapping` option
    f. press `Add`



11. Repeat steps 9 and 10 for every additional worker host

All required LUNs for a SAP HANA multiple-hosts system have been created.



SAP HANA storage connector API

A storage connector is required only in multiple-host environments that have failover capabilities. In multiple-host setups, SAP HANA provides high-availability functionality so that an SAP HANA database host can fail over to a standby host.

In this case, the LUNs of the failed host are accessed and used by the standby host. The storage connector is used to make sure that a storage partition can be actively accessed by only one database host at a time.

In SAP HANA multiple-host configurations with NetApp storage, the standard storage connector delivered by SAP is used. The “SAP HANA Fibre Channel Storage Connector Admin Guide” can be found as an attachment to SAP note 1900823.

Host setup

Before setting up the host, NetApp SAN host utilities must be downloaded from the NetApp Support site and installed on the HANA servers. The host utility documentation includes information about additional software that must be installed depending on the FCP HBA used.

The documentation also contains information on multipath configurations that are specific to the Linux version used. This document covers the required configuration steps for SLES 12 SP1 or higher and RHEL 7. 2 or later, as described in the Linux Host Utilities 7.1 Installation and Setup Guide.

Configure multipathing

Steps 1 through 6 must be executed on all worker and standby hosts in an SAP HANA multiple-host configuration.

To configure multipathing, complete the following steps:

1. Run the Linux `rescan-scsi-bus.sh -a` command on each server to discover new LUNs.

2. Run the `sanlun lun show` command and verify that all required LUNs are visible. The following example shows the `sanlun lun show` command output for a 2+1 multiple-host HANA system with two data LUNs and two log LUNs. The output shows the LUNs and the corresponding device files, such as LUN `FC5_data_mnt00001` and the device file `/dev/sdag` Each LUN has eight FC paths from the host to the storage controllers.

```
sapcc-hana-tst:~ # sanlun lun show
controller(7mode/E-Series)/                                    device
host                  lun
vserver(cDOT/FlashRay)        lun-pathname                     filename
adapter    protocol   size    product
------------------------------------------------------------------------
---------------------------------------
svm1                          FC5_log_mnt00002_2               /dev/sdbb
host21     FCP        500g    cDOT
svm1                          FC5_log_mnt00002_1               /dev/sdba
host21     FCP        500g    cDOT
svm1                          FC5_log_mnt00001_2               /dev/sdaz
host21     FCP        500g    cDOT
svm1                          FC5_log_mnt00001_1               /dev/sday
host21     FCP        500g    cDOT
svm1                          FC5_data_mnt00002_2              /dev/sdax
host21     FCP        1t      cDOT
svm1                          FC5_data_mnt00002_1              /dev/sdaw
host21     FCP        1t      cDOT
svm1                          FC5_data_mnt00001_2              /dev/sdav
host21     FCP        1t      cDOT
svm1                          FC5_data_mnt00001_1              /dev/sdau
host21     FCP        1t      cDOT
svm1                          FC5_log_mnt00002_2               /dev/sdat
host21     FCP        500g    cDOT
svm1                          FC5_log_mnt00002_1               /dev/sdas
host21     FCP        500g    cDOT
svm1                          FC5_log_mnt00001_2               /dev/sdar
host21     FCP        500g    cDOT
svm1                          FC5_log_mnt00001_1               /dev/sdaq
host21     FCP        500g    cDOT
svm1                          FC5_data_mnt00002_2              /dev/sdap
host21     FCP        1t      cDOT
svm1                          FC5_data_mnt00002_1              /dev/sdao
host21     FCP        1t      cDOT
svm1                          FC5_data_mnt00001_2              /dev/sdan
host21     FCP        1t      cDOT
svm1                          FC5_data_mnt00001_1              /dev/sdam
host21     FCP        1t      cDOT
svm1                          FC5_log_mnt00002_2               /dev/sdal
```

```
host20     FCP         500g    cDOT
svm1                           FC5_log_mnt00002_1             /dev/sdak
host20     FCP         500g    cDOT
svm1                           FC5_log_mnt00001_2             /dev/sdaj
host20     FCP         500g    cDOT
svm1                           FC5_log_mnt00001_1             /dev/sdai
host20     FCP         500g    cDOT
svm1                           FC5_data_mnt00002_2            /dev/sdah
host20     FCP         1t      cDOT
svm1                           FC5_data_mnt00002_1            /dev/sdag
host20     FCP         1t      cDOT
svm1                           FC5_data_mnt00001_2            /dev/sdaf
host20     FCP         1t      cDOT
svm1                           FC5_data_mnt00001_1            /dev/sdae
host20     FCP         1t      cDOT
svm1                           FC5_log_mnt00002_2             /dev/sdad
host20     FCP         500g    cDOT
svm1                           FC5_log_mnt00002_1             /dev/sdac
host20     FCP         500g    cDOT
svm1                           FC5_log_mnt00001_2             /dev/sdab
host20     FCP         500g    cDOT
svm1                           FC5_log_mnt00001_1             /dev/sdaa
host20     FCP         500g    cDOT
svm1                           FC5_data_mnt00002_2            /dev/sdz
host20     FCP         1t      cDOT
svm1                           FC5_data_mnt00002_1            /dev/sdy
host20     FCP         1t      cDOT
svm1                           FC5_data_mnt00001_2            /dev/sdx
host20     FCP         1t      cDOT
svm1                           FC5_data_mnt00001_1            /dev/sdw
host20     FCP         1t      cDOT
```

3. Run the `multipath -r` and `multipath -ll` command to get the worldwide identifiers (WWIDs) for the device file names.

   In this example, there are eight LUNs.

```
sapcc-hana-tst:~ # multipath -r
sapcc-hana-tst:~ # multipath -ll
3600a098038314e63492b59326b4b786d dm-7 NETAPP,LUN C-Mode
size=1.0T features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
`-+- policy='service-time 0' prio=50 status=active
  |- 20:0:4:2 sdaf 65:240 active ready running
  |- 20:0:5:2 sdx  65:112 active ready running
```

```
  |- 21:0:4:2 sdav 66:240 active ready running
  `- 21:0:6:2 sdan 66:112 active ready running
3600a098038314e63492b59326b4b786e dm-9 NETAPP,LUN C-Mode
size=1.0T features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
`-+- policy='service-time 0' prio=50 status=active
  |- 20:0:4:4 sdah 66:16  active ready running
  |- 20:0:5:4 sdz  65:144 active ready running
  |- 21:0:4:4 sdax 67:16  active ready running
  `- 21:0:6:4 sdap 66:144 active ready running
3600a098038314e63492b59326b4b786f dm-11 NETAPP,LUN C-Mode
size=500G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
`-+- policy='service-time 0' prio=50 status=active
  |- 20:0:4:6 sdaj 66:48  active ready running
  |- 20:0:5:6 sdab 65:176 active ready running
  |- 21:0:4:6 sdaz 67:48  active ready running
  `- 21:0:6:6 sdar 66:176 active ready running
3600a098038314e63492b59326b4b7870 dm-13 NETAPP,LUN C-Mode
size=500G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
`-+- policy='service-time 0' prio=50 status=active
  |- 20:0:4:8 sdal 66:80  active ready running
  |- 20:0:5:8 sdad 65:208 active ready running
  |- 21:0:4:8 sdbb 67:80  active ready running
  `- 21:0:6:8 sdat 66:208 active ready running
3600a098038314e63532459326d495a64 dm-6 NETAPP,LUN C-Mode
size=1.0T features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
`-+- policy='service-time 0' prio=50 status=active
  |- 20:0:4:1 sdae 65:224 active ready running
  |- 20:0:5:1 sdw  65:96  active ready running
  |- 21:0:4:1 sdau 66:224 active ready running
  `- 21:0:6:1 sdam 66:96  active ready running
3600a098038314e63532459326d495a65 dm-8 NETAPP,LUN C-Mode
size=1.0T features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
`-+- policy='service-time 0' prio=50 status=active
  |- 20:0:4:3 sdag 66:0   active ready running
  |- 20:0:5:3 sdy  65:128 active ready running
  |- 21:0:4:3 sdaw 67:0   active ready running
  `- 21:0:6:3 sdao 66:128 active ready running
3600a098038314e63532459326d495a66 dm-10 NETAPP,LUN C-Mode
size=500G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
`-+- policy='service-time 0' prio=50 status=active
```

```
  |- 20:0:4:5 sdai 66:32  active ready running
  |- 20:0:5:5 sdaa 65:160 active ready running
  |- 21:0:4:5 sday 67:32  active ready running
  `- 21:0:6:5 sdaq 66:160 active ready running
3600a098038314e63532459326d495a67 dm-12 NETAPP,LUN C-Mode
size=500G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
`-+- policy='service-time 0' prio=50 status=active
  |- 20:0:4:7 sdak 66:64  active ready running
  |- 20:0:5:7 sdac 65:192 active ready running
  |- 21:0:4:7 sdba 67:64  active ready running
  `- 21:0:6:7 sdas 66:192 active ready running
```

4. Edit the `/etc/multipath.conf` file and add the WWIDs and alias names.

The example output shows the content of the `/etc/multipath.conf` file, which includes alias names for the four LUNs of a 2+1 multiple-host system. If there is no multipath.conf file available, you can create one by running the following command: `multipath -T > /etc/multipath.conf`.

```
sapcc-hana-tst:/ # cat /etc/multipath.conf
multipaths {
                multipath {
                wwid    3600a098038314e63492b59326b4b786d
                alias   svm1-FC5_data_mnt00001_2
        }
        multipath {
                wwid    3600a098038314e63492b59326b4b786e
                alias   svm1-FC5_data_mnt00002_2
        }
        multipath {
                wwid    3600a098038314e63532459326d495a64
                alias   svm1-FC5_data_mnt00001_1
        }
        multipath {
                wwid    3600a098038314e63532459326d495a65
                alias   svm1-FC5_data_mnt00002_1
        }
        multipath {
                wwid    3600a098038314e63492b59326b4b786f
                alias   svm1-FC5_log_mnt00001_2
        }
        multipath {
                wwid    3600a098038314e63492b59326b4b7870
                alias   svm1-FC5_log_mnt00002_2
        }
        multipath {
                wwid    3600a098038314e63532459326d495a66
                alias   svm1-FC5_log_mnt00001_1
        }
        multipath {
                wwid    3600a098038314e63532459326d495a67
                alias   svm1-FC5_log_mnt00002_1
        }


}
```

5. Run the `multipath -r` command to reload the device map.
6. Verify the configuration by running the `multipath -ll` command to list all the LUNs, alias names, and active and standby paths.

The following example output shows the output of a 2+1 multiple-host HANA system with two data and two log LUNs.

```
sapcc-hana-tst:~ # multipath -ll
svm1-FC5_data_mnt00001_2 (3600a098038314e63492b59326b4b786d) dm-7
NETAPP,LUN C-Mode
size=1.0T features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
`-+- policy='service-time 0' prio=50 status=active
  |- 20:0:4:2 sdaf 65:240 active ready running
  |- 20:0:5:2 sdx  65:112 active ready running
  |- 21:0:4:2 sdav 66:240 active ready running
  `- 21:0:6:2 sdan 66:112 active ready running
svm1-FC5_data_mnt00002_2 (3600a098038314e63492b59326b4b786e) dm-9
NETAPP,LUN C-Mode
size=1.0T features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
`-+- policy='service-time 0' prio=50 status=active
  |- 20:0:4:4 sdah 66:16  active ready running
  |- 20:0:5:4 sdz  65:144 active ready running
  |- 21:0:4:4 sdax 67:16  active ready running
  `- 21:0:6:4 sdap 66:144 active ready running
svm1-FC5_data_mnt00001_1 (3600a098038314e63532459326d495a64) dm-6
NETAPP,LUN C-Mode
size=1.0T features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
`-+- policy='service-time 0' prio=50 status=active
  |- 20:0:4:1 sdae 65:224 active ready running
  |- 20:0:5:1 sdw  65:96  active ready running
  |- 21:0:4:1 sdau 66:224 active ready running
  `- 21:0:6:1 sdam 66:96  active ready running
svm1-FC5_data_mnt00002_1 (3600a098038314e63532459326d495a65) dm-8
NETAPP,LUN C-Mode
size=1.0T features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
`-+- policy='service-time 0' prio=50 status=active
  |- 20:0:4:3 sdag 66:0   active ready running
  |- 20:0:5:3 sdy  65:128 active ready running
  |- 21:0:4:3 sdaw 67:0   active ready running
  `- 21:0:6:3 sdao 66:128 active ready running
svm1-FC5_log_mnt00001_2 (3600a098038314e63492b59326b4b786f) dm-11
NETAPP,LUN C-Mode
size=500G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
`-+- policy='service-time 0' prio=50 status=active
  |- 20:0:4:6 sdaj 66:48  active ready running
  |- 20:0:5:6 sdab 65:176 active ready running
  |- 21:0:4:6 sdaz 67:48  active ready running
  `- 21:0:6:6 sdar 66:176 active ready running
```

```
svm1-FC5_log_mnt00002_2 (3600a098038314e63492b59326b4b7870) dm-13
NETAPP,LUN C-Mode
size=500G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
`-+- policy='service-time 0' prio=50 status=active
  |- 20:0:4:8 sdal 66:80  active ready running
  |- 20:0:5:8 sdad 65:208 active ready running
  |- 21:0:4:8 sdbb 67:80  active ready running
  `- 21:0:6:8 sdat 66:208 active ready running
svm1-FC5_log_mnt00001_1 (3600a098038314e63532459326d495a66) dm-10
NETAPP,LUN C-Mode
size=500G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
`-+- policy='service-time 0' prio=50 status=active
  |- 20:0:4:5 sdai 66:32  active ready running
  |- 20:0:5:5 sdaa 65:160 active ready running
  |- 21:0:4:5 sday 67:32  active ready running
  `- 21:0:6:5 sdaq 66:160 active ready running
svm1-FC5_log_mnt00002_1 (3600a098038314e63532459326d495a67) dm-12
NETAPP,LUN C-Mode
size=500G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
`-+- policy='service-time 0' prio=50 status=active
  |- 20:0:4:7 sdak 66:64  active ready running
  |- 20:0:5:7 sdac 65:192 active ready running
  |- 21:0:4:7 sdba 67:64  active ready running
  `- 21:0:6:7 sdas 66:192 active ready running
```

Single host setup

This chapter describes the setup of an SAP HANA single host.

LUN configuration for SAP HANA single-host systems

The Linux LVM is being used to increase performance and to address LUN size limitations.
At the SAP HANA host, volume groups and logical volumes need to be created and mounted, as indicated in the following table.

Logical volume/LUN	Mount point at SAP HANA host	Note
LV: FC5_data_mnt00001-vol	/hana/data/FC5/mnt00001	Mounted using /etc/fstab entry
LV: FC5_log_mnt00001-vol	/hana/log/FC5/mnt00001	Mounted using /etc/fstab entry
LUN: FC5_shared	/hana/shared/FC5	Mounted using /etc/fstab entry

With the described configuration, the `/usr/sap/FC5` directory in which the default home directory of user FC5adm is stored, is on the local disk. In a disaster recovery setup with disk-based replication, NetApp recommends creating an additional LUN for the `/usr/sap/FC5` directory so that all file systems are on the central storage.

Create LVM volume groups and logical volumes

1. Initialize all LUNs as a physical volume.

```
pvcreate /dev/mapper/svm1-FC5_data_mnt00001_1
pvcreate /dev/mapper/svm1-FC5_data_mnt00001_2
pvcreate /dev/mapper/svm1-FC5_log_mnt00001_1
pvcreate /dev/mapper/svm1-FC5_log_mnt00001_2
```

2. Create the volume groups for each data and log partition.

```
vgcreate FC5_data_mnt00001 /dev/mapper/svm1-FC5_data_mnt00001_1
/dev/mapper/svm1-FC5_data_mnt00001_2
vgcreate FC5_log_mnt00001 /dev/mapper/svm1-FC5_log_mnt00001_1
/dev/mapper/svm1-FC5_log_mnt00001_2
```

3. Create a logical volume for each data and log partition. Use a stripe size that is equal to the number of LUNs used per volume group (in this example, it is two) and a stripe size of 256k for data and 64k for log. SAP only supports one logical volume per volume group.

```
lvcreate --extents 100%FREE -i 2 -I 256k --name vol FC5_data_mnt00001
lvcreate --extents 100%FREE -i 2 -I 64k --name vol FC5_log_mnt00001
```

4. Scan the physical volumes, volume groups, and vol groups at all other hosts.

```
modprobe dm_mod
pvscan
vgscan
lvscan
```

If these commands do not find the volumes, a restart is required.

To mount the logical volumes, the logical volumes must be activated. To activate the volumes, run the following command:

```
vgchange -a y
```

Create file systems

Create the XFS file system on all data and log logical volumes and the hana shared LUN.

```
mkfs.xfs /dev/mapper/FC5_data_mnt00001-vol
mkfs.xfs /dev/mapper/FC5_log_mnt00001-vol
mkfs.xfs /dev/mapper/svm1-FC5_shared
```

The multiple host example commands show a 2+1 multiple-host HANA system.

Create mount points

Create the required mount point directories, and set the permissions on the database host:

```
sapcc-hana-tst:/ # mkdir -p /hana/data/FC5/mnt00001
sapcc-hana-tst:/ # mkdir -p /hana/log/FC5/mnt00001
sapcc-hana-tst:/ # mkdir -p /hana/shared
sapcc-hana-tst:/ # chmod -R 777 /hana/log/FC5
sapcc-hana-tst:/ # chmod -R 777 /hana/data/FC5
sapcc-hana-tst:/ # chmod 777 /hana/shared
```

Mount file systems

To mount file systems during system boot using the `/etc/fstab` configuration file, add the required file systems to the `/etc/fstab` configuration file:

```
# cat /etc/fstab
/dev/mapper/hana-FC5_shared /hana/shared xfs defaults 0 0
/dev/mapper/FC5_log_mnt00001-vol /hana/log/FC5/mnt00001 xfs
relatime,inode64 0 0
/dev/mapper/FC5_data_mnt00001-vol /hana/data/FC5/mnt00001 xfs
relatime,inode64 0 0
```

The XFS file systems for the data and log LUNs must be mounted with the `relatime` and `inode64` mount options.

To mount the file systems, run the `mount -a` command at the host.

Multiple hosts setup

This chapter describes the setup of a 2+1 SAP HANA multiple host system as example.

LUN configuration for SAP HANA multiple-hosts systems

The Linux LVM is being used to increase performance and to address LUN size limitations.

At the SAP HANA host, volume groups and logical volumes need to be created and mounted, as indicated in the following table.

Logical volume (LV)	Mount point at SAP HANA host	Note
LV: FC5_data_mnt00001-vol	/hana/data/FC5/mnt00001	Mounted using storage connector
LV: FC5_log_mnt00001-vol	/hana/log/FC5/mnt00001	Mounted using storage connector
LV: FC5_data_mnt00002-vol	/hana/data/FC5/mnt00002	Mounted using storage connector
LV: FC5_log_mnt00002-vol	/hana/log/FC5/mnt00002	Mounted using storage connector
External NFS share: FC5_shared	/hana/shared	Mounted at all hosts using NFS and /etc/fstab entry

SAP HANA multiple-host systems require the `/hana/shared` file system connected to all hosts of a system. Usually this is a NFS share provided by by an NFS server.
It is recommended to use a high available NFS server e.g. such as an NetApp FAS ot AFF system. Another option is to use the build-in NFS server of a LINUX host for this.

With the described configuration, the `/usr/sap/FC5` directory in which the default home directory of user FC5adm is stored, is on the local disk for each HANA host. In a disaster recovery setup with disk-based replication, NetApp recommends using four additional LUNs for `/usr/sap/FC5` file system each host so that each database host has all its file systems on the central storage.

Create LVM volume groups and logical volumes

1. Initialize all LUNs as a physical volume.

```
pvcreate /dev/mapper/svm1-FC5_data_mnt00001_1
pvcreate /dev/mapper/svm1-FC5_data_mnt00001_2
pvcreate /dev/mapper/svm1-FC5_data_mnt00002_1
pvcreate /dev/mapper/svm1-FC5_data_mnt00002_2
pvcreate /dev/mapper/svm1-FC5_log_mnt00001_1
pvcreate /dev/mapper/svm1-FC5_log_mnt00001_2
pvcreate /dev/mapper/svm1-FC5_log_mnt00002_1
pvcreate /dev/mapper/svm1-FC5_log_mnt00002_2
```

2. Create the volume groups for each data and log partition.

```
vgcreate FC5_data_mnt00001 /dev/mapper/svm1-FC5_data_mnt00001_1
/dev/mapper/svm1-FC5_data_mnt00001_2
vgcreate FC5_data_mnt00002 /dev/mapper/svm1-FC5_data_mnt00002_1
/dev/mapper/svm1-FC5_data_mnt00002_2
vgcreate FC5_log_mnt00001 /dev/mapper/svm1-FC5_log_mnt00001_1
/dev/mapper/svm1-FC5_log_mnt00001_2
vgcreate FC5_log_mnt00002 /dev/mapper/svm1-FC5_log_mnt00002_1
/dev/mapper/svm1-FC5_log_mnt00002_2
```

3. Create a logical volume for each data and log partition. Use a stripe size that is equal to the number of LUNs used per volume group (in this example, it is two) and a stripe size of 256k for data and 64k for log. SAP only supports one logical volume per volume group.

```
lvcreate --extents 100%FREE -i 2 -I 256k --name vol FC5_data_mnt00001
lvcreate --extents 100%FREE -i 2 -I 256k --name vol FC5_data_mnt00002
lvcreate --extents 100%FREE -i 2 -I 64k --name vol FC5_log_mnt00002
lvcreate --extents 100%FREE -i 2 -I 64k --name vol FC5_log_mnt00001
```

4. Scan the physical volumes, volume groups, and vol groups at all other hosts.

```
modprobe dm_mod
pvscan
vgscan
lvscan
```

If these commands do not find the volumes, a restart is required.

To mount the logical volumes, the logical volumes must be activated. To activate the volumes, run the following command:

```
vgchange -a y
```

Create file systems

Create the XFS file system on all data and log logical volumes.

```
mkfs.xfs /dev/mapper/FC5_data_mnt00001-vol
mkfs.xfs /dev/mapper/FC5_data_mnt00002-vol
mkfs.xfs /dev/mapper/FC5_log_mnt00001-vol
mkfs.xfs /dev/mapper/FC5_log_mnt00002-vol
```

Create mount points

Create the required mount point directories, and set the permissions on all worker and standby hosts:

```
sapcc-hana-tst:/ # mkdir -p /hana/data/FC5/mnt00001
sapcc-hana-tst:/ # mkdir -p /hana/log/FC5/mnt00001
sapcc-hana-tst:/ # mkdir -p /hana/data/FC5/mnt00002
sapcc-hana-tst:/ # mkdir -p /hana/log/FC5/mnt00002
sapcc-hana-tst:/ # mkdir -p /hana/shared
sapcc-hana-tst:/ # chmod -R 777 /hana/log/FC5
sapcc-hana-tst:/ # chmod -R 777 /hana/data/FC5
sapcc-hana-tst:/ # chmod 777 /hana/shared
```

Mount file systems

To mount the `/hana/shared` file systems during system boot using the `/etc/fstab` configuration file, add the `/hana/shared` file system to the `/etc/fstab` configuration file of each host.

```
sapcc-hana-tst:/ # cat /etc/fstab
<storage-ip>:/hana_shared /hana/shared nfs rw,vers=3,hard,timeo=600,
intr,noatime,nolock 0 0
```

All the data and log file systems are mounted through the SAP HANA storage connector.

To mount the file systems, run the `mount -a` command at each host.

I/O Stack configuration for SAP HANA

Starting with SAP HANA 1.0 SPS10, SAP introduced parameters to adjust the I/O behavior and optimize the database for the file and storage system used.

NetApp conducted performance tests to define the ideal values. The following table lists the optimal values as inferred from the performance tests.

Parameter	Value
max_parallel_io_requests	128
async_read_submit	on
async_write_submit_active	on
async_write_submit_blocks	all

For SAP HANA 1.0 up to SPS12, these parameters can be set during the installation of the SAP HANA database, as described in SAP Note 2267798 – Configuration of the SAP HANA Database during Installation Using hdbparam.

Alternatively, the parameters can be set after the SAP HANA database installation by using the `hdbparam` framework.

```
FC5adm@sapcc-hana-tst:/usr/sap/FC5/HDB00> hdbparam --paramset
fileio.max_parallel_io_requests=128
FC5adm@sapcc-hana-tst:/usr/sap/FC5/HDB00> hdbparam --paramset
fileio.async_write_submit_active=on
FC5adm@sapcc-hana-tst:/usr/sap/FC5/HDB00> hdbparam --paramset
fileio.async_read_submit=on
FC5adm@sapcc-hana-tst:/usr/sap/FC5/HDB00> hdbparam --paramset
fileio.async_write_submit_blocks=all
```

Starting with SAP HANA 2.0, `hdbparam` is deprecated, and the parameters are moved to the `global.ini` file. The parameters can be set by using SQL commands or SAP HANA Studio. For more details, refer to SAP note 2399079: Elimination of hdbparam in HANA 2. The parameters can be also set within the `global.ini` file.

```
FC5adm@sapcc-hana-tst: /usr/sap/FC5/SYS/global/hdb/custom/config> cat
global.ini
…
[fileio]
async_read_submit = on
async_write_submit_active = on
max_parallel_io_requests = 128
async_write_submit_blocks = all
…
```

For SAP HANA 2.0 SPS5 and later, use the `setParameter.py` script to set the correct parameters.

```
fc5adm@sapcc-hana-tst-03:/usr/sap/FC5/HDB00/exe/python_support>
python setParameter.py
-set=SYSTEM/global.ini/fileio/max_parallel_io_requests=128
python setParameter.py -set=SYSTEM/global.ini/fileio/async_read_submit=on
python setParameter.py
-set=SYSTEM/global.ini/fileio/async_write_submit_active=on
python setParameter.py
-set=SYSTEM/global.ini/fileio/async_write_submit_blocks=all
```

SAP HANA software installation

This section describes the preparation necessary to install SAP HANA on single-host and multiple-host systems.

Installation on single-host system

SAP HANA software installation does not require any additional preparation for a single-host system.

Installation on multiple-host system

Before beginning the installation, create a `global.ini` file to enable use of the SAP storage connector during the installation process. The SAP storage connector mounts the required file systems at the worker hosts during the installation process. The `global.ini` file must be available in a file system that is accessible from all hosts, such as the `/hana/shared` file system.

Before installing SAP HANA software on a multiple-host system, the following steps must be completed:

1. Add the following mount options for the data LUNs and the log LUNs to the `global.ini` file:
   - `relatime` and `inode64` for the data and log file system
2. Add the WWIDs of the data and log partitions. The WWIDs must match the alias names configured in the `/etc/multipath.conf` file.

   The following example shows a 2+1 multiple-host setup with SID=FC5.

```
sapcc-hana-tst-03:/hana/shared # cat global.ini
[communication]
listeninterface = .global
[persistence]
basepath_datavolumes = /hana/data/FC5
basepath_logvolumes = /hana/log/FC5
[storage]
ha_provider = hdb_ha.fcClientLVM
partition_*_*__prtype = 5
partition_*_data__mountOptions = -o relatime,inode64
partition_*_log__mountOptions = -o relatime,inode64
partition_1_data__lvmname = FC5_data_mnt00001-vol
partition_1_log__lvmname = FC5_log_mnt00001-vol
partition_2_data__lvmname = FC5_data_mnt00002-vol
partition_2_log__lvmname = FC5_log_mnt00002-vol
sapcc-hana-tst-03:/hana/shared #
```

Using the SAP hdblcm installation tool, start the installation by running the following command at one of the worker hosts. Use the `addhosts` option to add the second worker (sapcc-hana-tst-06) and the standby host (sapcc-hana-tst-07).

+

The directory where the prepared `global.ini` file is stored is included with the `storage_cfg` CLI option (`--storage_cfg=/hana/shared`).

+

Depending on the OS version being used, it might be necessary to install Python 2.7 before installing the SAP HANA database.

+

```
./hdblcm --action=install --addhosts=sapcc-hana-tst
-06:role=worker:storage_partition=2,sapcc-hana-tst-07:role=standby
--storage_cfg=/hana/shared/

AP HANA Lifecycle Management - SAP HANA Database 2.00.073.00.1695288802
************************************************************************


Scanning software locations...
Detected components:
    SAP HANA AFL (incl.PAL,BFL,OFL) (2.00.073.0000.1695321500) in
/mnt/sapcc-share/software/SAP/HANA2SPS7-
73/DATA_UNITS/HDB_AFL_LINUX_X86_64/packages
    SAP HANA Database (2.00.073.00.1695288802) in /mnt/sapcc-
share/software/SAP/HANA2SPS7-73/DATA_UNITS/HDB_SERVER_LINUX_X86_64/server
    SAP HANA Database Client (2.18.24.1695756995) in /mnt/sapcc-
share/software/SAP/HANA2SPS7-
73/DATA_UNITS/HDB_CLIENT_LINUX_X86_64/SAP_HANA_CLIENT/client
    SAP HANA Studio (2.3.75.000000) in /mnt/sapcc-
share/software/SAP/HANA2SPS7-73/DATA_UNITS/HDB_STUDIO_LINUX_X86_64/studio
    SAP HANA Local Secure Store (2.11.0) in /mnt/sapcc-
share/software/SAP/HANA2SPS7-
73/DATA_UNITS/HANA_LSS_24_LINUX_X86_64/packages
    SAP HANA XS Advanced Runtime (1.1.3.230717145654) in /mnt/sapcc-
share/software/SAP/HANA2SPS7-73/DATA_UNITS/XSA_RT_10_LINUX_X86_64/packages
    SAP HANA EML AFL (2.00.073.0000.1695321500) in /mnt/sapcc-
share/software/SAP/HANA2SPS7-
73/DATA_UNITS/HDB_EML_AFL_10_LINUX_X86_64/packages
    SAP HANA EPM-MDS (2.00.073.0000.1695321500) in /mnt/sapcc-
share/software/SAP/HANA2SPS7-73/DATA_UNITS/SAP_HANA_EPM-MDS_10/packages
    Automated Predictive Library (4.203.2321.0.0) in /mnt/sapcc-
share/software/SAP/HANA2SPS7-73/DATA_UNITS/PAAPL4_H20_LINUX_X86_64/apl-
4.203.2321.0-hana2sp03-linux_x64/installer/packages
    GUI for HALM for XSA (including product installer) Version 1 (1.015.0)
in /mnt/sapcc-share/software/SAP/HANA2SPS7-
73/DATA_UNITS/XSA_CONTENT_10/XSACALMPIUI15_0.zip
    XSAC FILEPROCESSOR 1.0 (1.000.102) in /mnt/sapcc-
share/software/SAP/HANA2SPS7-
73/DATA_UNITS/XSA_CONTENT_10/XSACFILEPROC00_102.zip
    SAP HANA tools for accessing catalog content, data preview, SQL
console, etc. (2.015.230503) in /mnt/sapcc-share/software/SAP/HANA2SPS7-
73/DATA_UNITS/XSAC_HRTT_20/XSACHRTT15_230503.zip
    Develop and run portal services for customer applications on XSA
(2.007.0) in /mnt/sapcc-share/software/SAP/HANA2SPS7-
```

```
73/DATA_UNITS/XSA_CONTENT_10/XSACPORTALSERV07_0.zip
    The SAP Web IDE for HANA 2.0 (4.007.0) in /mnt/sapcc-
share/software/SAP/HANA2SPS7-
73/DATA_UNITS/XSAC_SAP_WEB_IDE_20/XSACSAPWEBIDE07_0.zip
    XS JOB SCHEDULER 1.0 (1.007.22) in /mnt/sapcc-
share/software/SAP/HANA2SPS7-
73/DATA_UNITS/XSA_CONTENT_10/XSACSERVICES07_22.zip
    SAPUI5 FESV6 XSA 1 - SAPUI5 1.71 (1.071.52) in /mnt/sapcc-
share/software/SAP/HANA2SPS7-
73/DATA_UNITS/XSA_CONTENT_10/XSACUI5FESV671_52.zip
    SAPUI5 FESV9 XSA 1 - SAPUI5 1.108 (1.108.5) in /mnt/sapcc-
share/software/SAP/HANA2SPS7-
73/DATA_UNITS/XSA_CONTENT_10/XSACUI5FESV9108_5.zip
    SAPUI5 SERVICE BROKER XSA 1 - SAPUI5 Service Broker 1.0 (1.000.4) in
/mnt/sapcc-share/software/SAP/HANA2SPS7-
73/DATA_UNITS/XSA_CONTENT_10/XSACUI5SB00_4.zip
    XSA Cockpit 1 (1.001.37) in /mnt/sapcc-share/software/SAP/HANA2SPS7-
73/DATA_UNITS/XSA_CONTENT_10/XSACXSACOCKPIT01_37.zip


SAP HANA Database version '2.00.073.00.1695288802' will be installed.

Select additional components for installation:

  Index | Components      | Description

-------------------------------------------------------------------------
------------------------
  1     | all             | All components
  2     | server          | No additional components
  3     | client          | Install SAP HANA Database Client version
2.18.24.1695756995
  4     | lss             | Install SAP HANA Local Secure Store version
2.11.0
  5     | studio          | Install SAP HANA Studio version 2.3.75.000000
  6     | xs              | Install SAP HANA XS Advanced Runtime version
1.1.3.230717145654
  7     | afl             | Install SAP HANA AFL (incl.PAL,BFL,OFL)
version 2.00.073.0000.1695321500
  8     | eml             | Install SAP HANA EML AFL version
2.00.073.0000.1695321500
  9     | epmmds          | Install SAP HANA EPM-MDS version
2.00.073.0000.1695321500
  10    | sap_afl_sdk_apl | Install Automated Predictive Library version
4.203.2321.0.0
```

```
Enter comma-separated list of the selected indices [3,4]: 2,3
```

1. Verify that the installation tool installed all selected components at all worker and standby hosts.

Where to find additional information

To learn more about the information described in this document, refer to the following documents and/or websites:

- SAP HANA Software Solutions
- SAP HANA Disaster Recovery with Storage Replication
- SAP HANA data protection and high availability with SnapCenter, SnapMirror active sync and VMware Metro Storage Cluster
- SAP HANA Backup and Recovery with SnapCenter
- TR-4667: Automating SAP HANA System Copy and Clone Operations with SnapCenter
- NetApp Documentation Centers

  https://www.netapp.com/support-and-training/documentation/
- SAP Certified Enterprise Storage Hardware for SAP HANA

  https://www.sap.com/dmc/exp/2014-09-02-hana-hardware/enEN/
- SAP HANA Storage Requirements

  https://www.sap.com/documents/2024/03/146274d3-ae7e-0010-bca6-c68f7e60039b.html
- SAP HANA Tailored Data Center Integration Frequently Asked Questions

  https://www.sap.com/documents/2016/05/e8705aae-717c-0010-82c7-eda71af511fa.html
- SAP HANA on VMware vSphere Wiki

  https://help.sap.com/docs/SUPPORT_CONTENT/virtualization/3362185751.html
- SAP HANA on VMware vSphere Best Practices Guide

  https://www.vmware.com/docs/sap_hana_on_vmware_vsphere_best_practices_guide-white-paper

Update history

The following technical changes have been made to this solution since its original publication.

Date	Update summary
July 2025	Initial Version

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