Abstract

The NetApp® AFF product family is certified for use with SAP HANA in tailored data center integration (TDI) projects. This document describes best practices for a Fibre Channel (FC) storage setup using the NetApp ONTAP® data management software with the AFF product family.
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1 Introduction

The NetApp AFF product family is certified for use with SAP HANA in TDI projects. The certified enterprise storage platform is characterized by the NetApp ONTAP software.

The certification is valid for the following models:

- AFF A200, AFF A220, AFF A300, AFF A320, AFF A400, AFF A700s, AFF A700, AFF A800
- ASA AFF A220, ASA AFF A400, ASA AFF A700, ASA AFF A800

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

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

Note: 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.

The configuration guides for AFF systems using NFS and NetApp FAS systems can be found using the following links:

- [SAP HANA on NetApp FAS Systems with FCP](#)
- [SAP HANA on NetApp FAS Systems with NFS](#)
- [SAP HANA on NetApp AFF Systems with NFS](#)

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](#).

1.1 SAP HANA Tailored Data Center Integration

NetApp AFF storage systems are certified in the SAP HANA TDI program using both NFS (NAS) and 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. Figure 1 shows an architecture overview.
For more information regarding the prerequisites and recommendations for productive SAP HANA systems, see the following resources:

- [SAP HANA Tailored Data Center Integration Frequently Asked Questions](#)
- [SAP HANA Storage Requirements](#)

## 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 AFF 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.

Figure 2 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.

Figure 3 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.
Independently of which deployed AFF system, the SAP HANA landscape can also be scaled by adding any of the certified storage controllers to meet the desired node density, as shown in Figure 4.

Figure 4) Scaling with additional storage systems.

2.1 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, the backups taken by SnapCenter are visible within SAP HANA Studio 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.

The database logs can be backed up directly to the secondary storage by using an NFS mount, as shown in Figure 5.
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 TR-4614: SAP HANA Backup and Recovery with SnapCenter.

2.2 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 Asynchronous Storage Replication

Storage Replication Based on SnapMirror

Figure 6 shows a three-site disaster recovery solution using synchronous SnapMirror replication to the local DR datacenter and asynchronous SnapMirror to replicate the data to the remote DR datacenter.
Data replication using synchronous SnapMirror provides an RPO of zero. The distance between the primary and the local DR datacenter is limited to around 100km.

Protection against failures of both the primary and the local DR site is performed by replicating the data to a third remote DR datacenter using asynchronous SnapMirror. The RPO depends on the frequency of replication updates and how fast they can be transferred. In theory, the distance is unlimited, but the limit depends on the amount of data that must be transferred and the connection that is available between the data centers. Typical RPO values are in the range of 30 minutes to multiple hours.

The RTO for both replication methods 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 you to 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.

Figure 6) Disaster recovery with synchronous and asynchronous SnapMirror replication.

Synchronous replication offers StrictSync mode. If the write to secondary storage is not completed for any reason, the application I/O fails, thereby ensuring that the primary and secondary storage systems are identical. Application I/O to the primary resumes only after the SnapMirror relationship returns to the InSync status. If the primary storage fails, application I/O can be resumed on the secondary storage after failover with no loss of data. In StrictSync mode, the RPO is always zero.

Storage Replication Based on NetApp MetroCluster

Figure 7 shows a high-level overview of the solution. The storage cluster at each site provides local high availability and is used for the production workload. The data of each site is synchronously replicated to the other location and is available in case of disaster failover.
3 Storage Sizing

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

**Note:** 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.

### 3.1 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.

**Note:** 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.

**SAS Disk Shelf**

With the 12Gb SAS disk shelf (DS224C), the performance sizing is performed by using fixed disk-shelf configurations:

- Half-loaded disk shelves with 12 SSDs
- Fully loaded disk shelves with 24 SSDs

Both configurations use advanced drive partitioning (ADPv2). A half-loaded disk shelf supports up to 9 SAP HANA hosts; a fully loaded shelf supports up to 14 hosts in a single disk shelf. The SAP HANA hosts must be equally distributed between both storage controllers.

**Note:** The DS224C disk shelf must be connected by using 12Gb SAS to support the number of SAP HANA hosts.

The 6Gb SAS disk shelf (DS2246) supports a maximum of 4 SAP HANA hosts. The SSDs and the SAP HANA hosts must be equally distributed between both storage controllers. Table 1 summarizes the supported number of SAP HANA hosts per disk shelf.

<table>
<thead>
<tr>
<th></th>
<th>6Gb SAS Shelves (DS2246) Fully Loaded with 24 SSDs</th>
<th>12Gb SAS Shelves (DS224C) Half-Loaded with 12 SSDs and ADPv2</th>
<th>12Gb SAS Shelves (DS224C) Fully Loaded with 24 SSDs and ADPv2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum number of SAP HANA hosts per disk shelf</td>
<td>4</td>
<td>9</td>
<td>14</td>
</tr>
</tbody>
</table>

**Note:** This calculation is independent of the storage controller used.

**NS224 NVMe Shelf**

The minimum number of 12 NVMe SSDs for the first shelf supports up to 16 SAP HANA hosts. A fully populated shelf supports up to 34 SAP HANA hosts.

### 3.2 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 HWCCT 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.

### 3.3 Capacity Considerations

A detailed description of the capacity requirements for SAP HANA is in the [SAP HANA Storage Requirements white paper](#).
Note: 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.

3.4 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. Table 2 lists the parameters that must be set within the configuration file of the SAP test tool.

Table 2) Test tool configuration file parameter values.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>max_parallel_io_requests</td>
<td>128</td>
</tr>
<tr>
<td>async_read_submit</td>
<td>on</td>
</tr>
<tr>
<td>async_write_submit_active</td>
<td>on</td>
</tr>
<tr>
<td>async_write_submit_blocks</td>
<td>all</td>
</tr>
</tbody>
</table>

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.

```json
...
{
    "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"
}
,...
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.

```json
...{
  "ID": "D664D001-933D-41DE-A904F304AEB67906",
  "Note": "File System Write Test",
  "ExecutionVariants": [ {
    "ScaleOut": {},
    "Port": "${RemotePort}",
    "Hosts": "${Hosts}"
  },
  "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}"
  }
  ...}
```

### 3.5 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.

Figure 8 summarizes the sizing process.

Figure 8) Storage sizing overview.

4 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. The storage system used in this example setup is an AFF A300, and the corresponding SVM is called *hana*.

4.1 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.

Figure 9 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.

4.2 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.

4.3 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.

NetApp Volume Encryption

The use of NetApp Volume Encryption (NVE) is supported with SAP HANA.

Quality of Service

QoS can be used to limit the storage throughput for specific SAP HANA systems or no-SAP applications on a shared-use controller. 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.
Starting with ONTAP 9, QoS is configured on the storage volume level and uses maximum values for throughput (MBps) and the amount of I/O (IOPS).

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.

**NetApp FabricPool**

NetApp FabricPool technology must not be used for active primary file systems in SAP HANA systems. This includes the file systems for the data and log area as well as the /hana/shared file system. Doing so results in unpredictable performance, especially during the startup of an SAP HANA system.

Using the “snapshot-only” tearing policy is possible as well as using FabricPool in general at a backup target such as SnapVault or SnapMirror destination.

**Note:** Using FabricPool for tiering Snapshot copies at primary storage or using FabricPool at a backup target changes the required time for the restore and recovery of a database or other tasks such as creating system clones or repair systems. Take this into consideration for planning your overall lifecycle-management strategy, and check to make sure that your SLAs are still being met while using this function.

FabricPool is a good option for moving log backups to another storage tier. Moving backups affects the time needed to recover an SAP HANA database. Therefore, the option “tiering-minimum-cooling-days” should be set to a value that places log backups, which are routinely needed for recovery, on the local fast storage tier.

**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 “Disk Shelf Connection.”
2. Create and configure the required aggregates, as described in “Aggregate Configuration.”
3. Create a storage virtual machine (SVM), as described in “Storage Virtual Machine Configuration.”
4. Create logical interfaces (LIFs), as described in “Logical Interface Configuration.”
5. Create FCP portsets, as described in “FCP Portsets.”
6. Create volumes and LUNs within the aggregates, as described in “Creating LUNs, Volumes, and Mapping LUNs to Initiator Groups.”

**Disk Shelf Connection**

**SAS-Based Disk Shelves**

A maximum of one disk shelf can be connected to one SAS stack to provide the required performance for the SAP HANA hosts, as shown in Figure 10. The disks within each shelf must be distributed equally between both controllers of the HA pair. ADPv2 is used with ONTAP 9 and the new DS224C disk shelves.

**Note:** With the DS224C disk shelf, quad path SAS cabling can also be used, but is not required.
NVMe (100GbE) Based Disk Shelves

Each NS224 NVMe desk shelf is connected with two 100GbE ports per controller, as shown in Figure 11. The disks within each shelf must be distributed equally to both controllers of the HA pair. ADPv2 is also used for the NS224 disk shelf.

Aggregate Configuration

In general, you must configure two aggregates per controller, independent of which disk shelf or disk technology (SSD or HDD) is used. This step is necessary so that you can use all available controller resources. For AFF A200 series systems, one data aggregate is sufficient.

Figure 12 shows a configuration of 12 SAP HANA hosts running on a 12Gb SAS shelf configured with ADPv2. Six SAP HANA hosts are attached to each storage controller. Four separate aggregates, two at each storage controller, are configured. Each aggregate is configured with 11 disks with nine data and two parity disk partitions. For each controller, two spare partitions are available.
Storage Virtual Machine Configuration

Multiple SAP landscapes with SAP HANA databases can use a single SVM. An SVM can also be assigned to each SAP landscape, if necessary, in case they are managed by different teams within a company.

Logical Interface Configuration

Within the storage cluster configuration, one network interface (LIF) must be created and assigned to a dedicated FCP port. If, for example, four FCP ports are required for performance reasons, four LIFs must be created. Figure 13 shows a screenshot of the eight LIFs (named `fc_*`) that were configured on the `hana` SVM.
Figure 13) Logical interface configuration.

FCP Portsets

An FCP portset is used to define which LIFs are to be used by a specific initiator group. Typically, all LIFs created for the HANA systems are placed in the same portset. Figure 14 shows the configuration of a portset named 32g that includes the four LIFs that were already created.
Volume and LUN Configuration for SAP HANA Single-Host Systems

Figure 15 shows the volume configuration of four single-host SAP HANA systems. The data and log volumes of each SAP HANA system are distributed to different storage controllers. For example, volume SID1_data_mnt00001 is configured on controller A and volume SID1_log_mnt00001 is configured on controller B. Within each volume, a single LUN is configured.

Note: If only one storage controller of a HA pair is used for the SAP HANA systems, data volumes and log volumes can also be stored on the same storage controller.
For each SAP HANA host, a data volume, a log volume, and a volume for /hana/shared are configured. Table 3 shows an example configuration with four SAP HANA single-host systems.

Table 3) Volume configuration for SAP HANA single-host systems.

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Aggregate 1 at Controller A</th>
<th>Aggregate 2 at Controller A</th>
<th>Aggregate 1 at Controller B</th>
<th>Aggregate 2 at Controller B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data, log, and shared volumes for system SID1</td>
<td>Data volume: SID1_data_mnt0001</td>
<td>Shared volume: SID1_shared</td>
<td>–</td>
<td>Log volume: SID1_log_mnt0001</td>
</tr>
<tr>
<td>Data, log, and shared volumes for system SID2</td>
<td>–</td>
<td>Log volume: SID2_log_mnt0001</td>
<td>Data volume: SID2_data_mnt0001</td>
<td>Shared volume: SID2_shared</td>
</tr>
<tr>
<td>Data, log, and shared volumes for system SID3</td>
<td>Shared volume: SID3_shared</td>
<td>Data volume: SID3_data_mnt0001</td>
<td>Log volume: SID3_log_mnt0001</td>
<td>–</td>
</tr>
<tr>
<td>Data, log, and shared volumes for system SID4</td>
<td>Log volume: SID4_log_mnt0001</td>
<td>–</td>
<td>Shared volume: SID4_shared</td>
<td>Data volume: SID4_data_mnt0001</td>
</tr>
</tbody>
</table>

Table 4 shows an example of the mount point configuration for a single-host system.
Table 4) Mount points for single-host systems.

<table>
<thead>
<tr>
<th>LUN</th>
<th>Mount Point at HANA Host</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>SID1_data_mnt00001</td>
<td>/hana/data/SID1/mnt00001</td>
<td>Mounted using /etc/fstab entry</td>
</tr>
<tr>
<td>SID1_log_mnt00001</td>
<td>/hana/log/SID1/mnt00001</td>
<td>Mounted using /etc/fstab entry</td>
</tr>
<tr>
<td>SID1_shared</td>
<td>/hana/shared/SID1</td>
<td>Mounted using /etc/fstab entry</td>
</tr>
</tbody>
</table>

**Note:** With the described configuration, the /usr/sap/SID1 directory in which the default home directory of user SID1adm is stored, is on the local disk. In a disaster recovery setup with disk-based replication, NetApp recommends creating an additional LUN within the SID1_shared volume for the /usr/sap/SID1 directory so that all file systems are on the central storage.

**Volume and LUN Configuration for SAP HANA Multiple-Host Systems**

Figure 16 shows the volume configuration of a 4+1 multiple-host SAP HANA system. The data volumes and log volumes of each SAP HANA host are distributed to different storage controllers. For example, the volume SID_data_mnt00001 is configured on controller A and the volume SID_log_mnt00001 is configured on controller B. One LUN is configured within each volume.

The /hana/shared volume must be accessible by all HANA hosts and is therefore exported by using NFS. Even though there are no specific performance KPIs for the /hana/shared file system, NetApp recommends using a 10Gb Ethernet connection.

**Note:** If only one storage controller of an HA pair is used for the SAP HANA system, data and log volumes can also be stored on the same storage controller.

**Note:** NetApp ASA AFF systems do not support NFS as a protocol. NetApp recommends using an additional AFF or FAS system for the /hana/shared file system.

Figure 16) Volume layout for SAP HANA multiple-host systems.
For each SAP HANA host, a data volume and a log volume are created. The /hana/shared volume is used by all hosts of the SAP HANA system. Table 5 shows an example configuration for a 4+1 multiple-host SAP HANA system.

Table 5) Volume configuration for SAP HANA multiple-host systems.

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Aggregate 1 at Controller A</th>
<th>Aggregate 2 at Controller A</th>
<th>Aggregate 1 at Controller B</th>
<th>Aggregate 2 at Controller B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data and log volumes for node 1</td>
<td>Data volume: SID_data_mnt0001</td>
<td>–</td>
<td>Log volume: SID_log_mnt0001</td>
<td>–</td>
</tr>
<tr>
<td>Data and log volumes for node 2</td>
<td>Log volume: SID_log_mnt0002</td>
<td>–</td>
<td>Data volume: SID_data_mnt0002</td>
<td>–</td>
</tr>
<tr>
<td>Data and log volumes for node 3</td>
<td>–</td>
<td>Data volume: SID_data_mnt0003</td>
<td>–</td>
<td>Log volume: SID_log_mnt0003</td>
</tr>
<tr>
<td>Data and log volumes for node 4</td>
<td>–</td>
<td>Log volume: SID_log_mnt0004</td>
<td>–</td>
<td>Data volume: SID_data_mnt0004</td>
</tr>
<tr>
<td>Shared volume for all hosts</td>
<td>Shared volume: SID_shared</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

Table 6 shows the configuration and the mount points of a multiple-host system with four active SAP HANA hosts.

Table 6) Mount points for multiple-host systems.

<table>
<thead>
<tr>
<th>LUN or Volume</th>
<th>Mount Point at SAP HANA Host</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>LUN: SID_data_mnt00001</td>
<td>/hana/data/SID/mnt00001</td>
<td>Mounted using storage connector</td>
</tr>
<tr>
<td>LUN: SID_log_mnt00001</td>
<td>/hana/log/SID/mnt00001</td>
<td>Mounted using storage connector</td>
</tr>
<tr>
<td>LUN: SID_data_mnt00002</td>
<td>/hana/data/SID/mnt00002</td>
<td>Mounted using storage connector</td>
</tr>
<tr>
<td>LUN: SID_log_mnt00002</td>
<td>/hana/log/SID/mnt00002</td>
<td>Mounted using storage connector</td>
</tr>
<tr>
<td>LUN: SID_data_mnt00003</td>
<td>/hana/data/SID/mnt00003</td>
<td>Mounted using storage connector</td>
</tr>
<tr>
<td>LUN: SID_log_mnt00003</td>
<td>/hana/log/SID/mnt00003</td>
<td>Mounted using storage connector</td>
</tr>
<tr>
<td>LUN: SID_data_mnt00004</td>
<td>/hana/data/SID/mnt00004</td>
<td>Mounted using storage connector</td>
</tr>
<tr>
<td>LUN: SID_log_mnt00004</td>
<td>/hana/log/SID/mnt00004</td>
<td>Mounted using storage connector</td>
</tr>
<tr>
<td>Volume: SID_shared</td>
<td>/hana/shared</td>
<td>Mounted at all hosts using NFS and /etc/fstab entry</td>
</tr>
</tbody>
</table>

Note: With the described configuration, the /usr/sap/SID directory in which the default home directory of user SIDadm is stored, is on the local disk for each HANA host. In a disaster recovery setup with disk-based replication, NetApp recommends creating four additional subdirectories in the SID_shared volume for the /usr/sap/SID file system so that each database host has all its file systems on the central storage.
Volume Options
The volume options listed in Table 7 must be verified and set on all SVMs.

Table 7) Volume options.

<table>
<thead>
<tr>
<th>Action</th>
<th>ONTAP 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disable automatic Snapshot copies</td>
<td>vol modify -vserver &lt;vserver-name&gt; -volume</td>
</tr>
<tr>
<td></td>
<td>&lt;volname&gt; -snapshot-policy none</td>
</tr>
<tr>
<td>Disable visibility of Snapshot directory</td>
<td>vol modify -vserver &lt;vserver-name&gt; -volume</td>
</tr>
<tr>
<td></td>
<td>&lt;volname&gt; -snapdir-access false</td>
</tr>
</tbody>
</table>

Creating LUNs, Volumes, and Mapping LUNs to Initiator Groups
You can use NetApp ONTAP System Manager to create storage volumes and LUNs and map them to the servers.

NetApp offers an automated application wizard for SAP HANA within ONTAP System Manager, which simplifies the volume and LUN provisioning process significantly. It creates and configures the volumes and LUNs automatically according to NetApp best practices for SAP HANA.

Using the `sanlun` tool, run the following command to obtain the worldwide port names (WWPNs) of each SAP HANA host:

```
stlrx300s8-6:~ # sanlun fcp show adapter
/sbin/udevadm
/sbin/udevadm
host0 ...... WWPN:2100000e1e163700
host1 ...... WWPN:2100000e1e163701
```

**Note:** The `sanlun` tool is part of the NetApp Host Utilities and must be installed on each SAP HANA host. For more information, see section “Host Setup.”

The following steps show the configuration of a 2+1 multiple-host HANA system with the SID SS3:

1. Start the Application Provisioning wizard for SAP HANA in System Manager and provide the required information. All initiators (WWPNs) from all hosts need to be added.
2. Confirm that storage is successfully provisioned.
4.4 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 is 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.

4.5 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

**Note:** 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` 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 SS3_data_mnt00001 and the device file `/dev/sdah`. Each LUN has eight FC paths from the host to the storage controllers.

```
stirx300s8-6:~ # sanlun lun show
controller(7mode/E-Series)/lun vserver(cDOT/FlashRay) lun-pathname device filename adapter
-----------------------------------------------------------------------------------------------
controller(7mode/E-Series)/lun vserver(cDOT/FlashRay) lun-pathname device filename adapter
-----------------------------------------------------------------------------------------------

hana FCP 512.0g cDOT /vol/SS3_log_mnt00002/SS3_log_mnt00002 /dev/sdah host11
hana FCP 1.2t cDOT /vol/SS3_data_mnt00001/SS3_data_mnt00001 /dev/sdag host11
hana FCP 1.2t cDOT /vol/SS3_data_mnt00002/SS3_data_mnt00002 /dev/sdaf host11
hana FCP 1.2t cDOT /vol/SS3_data_mnt00001/SS3_data_mnt00001 /dev/sdad host11
hana FCP 1.2t cDOT /vol/SS3_data_mnt00002/SS3_data_mnt00002 /dev/sdac host11
hana FCP 1.2t cDOT /vol/SS3_data_mnt00001/SS3_data_mnt00001 /dev/sdbz host11
hana FCP 1.2t cDOT /vol/SS3_data_mnt00002/SS3_data_mnt00002 /dev/sdsy host11
```
3. Run the `multipath -r` command to get the worldwide identifiers (WWIDs) for the device file names:

   **Note:** In this example, there are four LUNs.

```
--snip--
stirx300s8-6:~ # multipath -r
create: 3600a098038304436375d4d442d753878 undef NETAPP,LUN C-Mode
size=512G features='3 pg_init_retries 50 queue_if_no_path' hwhandler='0' wp=undef
|--- policy='service-time 0' prio=50 status=undef
|   | 10:0:1:0 sdd 8:48 undef ready running
|   | 10:0:1:0 sds 65:32 undef ready running
|   | 11:0:1:0 sda 65:64 undef ready running
|--- policy='service-time 0' prio=10 status=undef
|   | 10:0:0:0 sdc 8:32 undef ready running
|   | 10:0:2:0 sde 8:64 undef ready running
|   | 11:0:1:0 sdt 65:48 undef ready running
|   | 11:0:3:0 sdv 65:80 undef ready running
create: 3600a098038304436375d4d442d753878 undef NETAPP,LUN C-Mode
size=1.2T features='3 pg_init_retries 50 queue_if_no_path' hwhandler='0' wp=undef
|--- policy='service-time 0' prio=50 status=undef
|   | 10:0:1:1 sdx 8:144 undef ready running
|   | 10:0:3:1 sdp 8:240 undef ready running
|   | 11:0:1:1 sdw 65:96 undef ready running
|   | 11:0:2:1 sdac 65:192 undef ready running
|--- policy='service-time 0' prio=10 status=undef
```

---

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

   Note: 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.

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

   Note: 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.

```

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.

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

```
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.

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

```

Create File Systems

To create the XFS file system on each LUN belonging to the HANA system, take one of the following actions:

- For a single-host system, create the XFS file system on the data, log, and /hana/shared LUNs.

  ```
stlrx300s8-6:/ # mkfs.xfs /dev/mapper/hana-SS3_data_mnt00001
stlrx300s8-6:/ # mkfs.xfs /dev/mapper/hana-SS3_log_mnt00001
stlrx300s8-6:/ # mkfs.xfs /dev/mapper/hana-SS3_shared
  
stlrx300s8-6:/ # mkfs.xfs /dev/mapper/hana-SS3_data_mnt00002
stlrx300s8-6:/ # mkfs.xfs /dev/mapper/hana-SS3_log_mnt00002
stlrx300s8-6:/ # mkfs.xfs /dev/mapper/hana-SS3_data_mnt00001
stlrx300s8-6:/ # mkfs.xfs /dev/mapper/hana-SS3_log_mnt00001
  
stlrx300s8-6:/ # mkfs.xfs /dev/mapper/hana-SS3_data_mnt00002
stlrx300s8-6:/ # mkfs.xfs /dev/mapper/hana-SS3_log_mnt00002
  ```

- For a multiple-host system, create the XFS file system on all data and log LUNs.

  ```
stlrx300s8-6:/ # mkfs.xfs /dev/mapper/hana-SS3_data_mnt00001
stlrx300s8-6:/ # mkfs.xfs /dev/mapper/hana-SS3_log_mnt00001
stlrx300s8-6:/ # mkfs.xfs /dev/mapper/hana-SS3_data_mnt00002
stlrx300s8-6:/ # mkfs.xfs /dev/mapper/hana-SS3_log_mnt00002
stlrx300s8-6:/ # mkfs.xfs /dev/mapper/hana-SS3_data_mnt00001
stlrx300s8-6:/ # mkfs.xfs /dev/mapper/hana-SS3_log_mnt00001
  ```
Create Mount Points

To create the required mount point directories, take one of the following actions:

- For a single-host system, set permissions and create mount points on the database host.

```
# mkdir -p /hana/data/SS3/mnt00001
# mkdir -p /hana/log/SS3/mnt00001
# mkdir -p /hana/shared
```

```
# chmod 777 /hana/data/SS3/mnt00001
# chmod 777 /hana/log/SS3/mnt00001
# chmod 777 /hana/shared
```

- For a multiple-host system, set permissions and create mount points on all worker and standby hosts.

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

```
# mkdir -p /hana/data/SS3/mnt00001
# mkdir -p /hana/log/SS3/mnt00001
# mkdir -p /hana/data/SS3/mnt00002
# mkdir -p /hana/log/SS3/mnt00002
# mkdir -p /hana/shared
```

```
# chmod 777 /hana/data/SS3/mnt00001
# chmod 777 /hana/log/SS3/mnt00001
# chmod 777 /hana/data/SS3/mnt00002
# chmod 777 /hana/log/SS3/mnt00002
# chmod 777 /hana/shared
```

Mount File Systems

To mount file systems during system boot using the `/etc/fstab` configuration file, complete the following steps:

1. Take one of the following actions:
   - For a single-host system, add the required file systems to the `/etc/fstab` configuration file.

     **Note:** The XFS file systems for the data LUN must be mounted with the `relatime` and `inode64` mount options. The XFS file systems for the log LUN must be mounted with the `relatime`, `inode64`, and `nobarrier` mount options.

```
# cat /etc/fstab
/dev/mapper/hana-SS3_shared /hana/shared xfs default 0 0
/dev/mapper/hana-SS3_log_mnt00001 /hana/log/SS3/mnt00001 xfs relatime,inode64,nobarrier 0 0
/dev/mapper/hana-SS3_data_mnt00001 /hana/data/SS3/mnt00001 xfs relatime,inode64 0 0
```

   - For a multiple-host system, add the `/hana/shared` file system to the `/etc/fstab` configuration file of each host.

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

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

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

### 4.6 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. Table 8 lists the optimal values as inferred from the performance tests.
Table 8) Performance test optimum values.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>max_parallel_io_requests</td>
<td>128</td>
</tr>
<tr>
<td>async_read_submit</td>
<td>on</td>
</tr>
<tr>
<td>async_write_submit_active</td>
<td>on</td>
</tr>
<tr>
<td>async_write_submit_blocks</td>
<td>all</td>
</tr>
</tbody>
</table>

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.

```bash
SS3adm@stlrx300s8-6:/usr/sap/SS3/HDB00> hdbparam --paramset fileio.max_parallel_io_requests=128
SS3adm@stlrx300s8-6:/usr/sap/SS3/HDB00> hdbparam --paramset fileio.async_write_submit_active=on
SS3adm@stlrx300s8-6:/usr/sap/SS3/HDB00> hdbparam --paramset fileio.async_read_submit=on
SS3adm@stlrx300s8-6:/usr/sap/SS3/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.

```bash
SS3adm@stlrx300s8-6: /usr/sap/SS3/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
...
```

### 4.7 SAP HANA Software Installation

#### 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 file system
   - relatime, inode64, and nobarrier for the 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 output shows an example of a 2+1 multiple-host setup in which the system identifier (SID) is SS3.

```bash
stirx300s8-6:~ # cat /hana/shared/global.ini
```
3. Using the SAP hdbclm 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 (stlrx300s8-7) and the standby host (stlrx300s8-8).

   ```
   stlrx300s8-6:/mnt/hwval/Software/SAP-Installation/HANA-DB-20SPS3/51053061/DATA_UNITS/HDB_LCM_LINUX_X86_64 # ./hdbclm --action=install --addhosts=stlrx300s8-7:role=worker:storage_partition=2,stlrx300s8-8:role=standby --storage_cfg=/hana/shared
   ```

   SAP HANA Lifecycle Management - SAP HANA Database 2.00.030.00.1522209842
   **********************************************************************************************

   Scanning software locations...
   Detected components:
   SAP HANA Database (2.00.030.00.1522209842) in /mnt/hwval/Software/SAP-Installation/HANA-DB-20SPS3/51053061/DATA_UNITS/HDB_SERVER_LINUX_X86_64/server
   SAP HANA AFL (incl.PAL,BFL,OFL) (2.00.030.0001.1522223444) in /mnt/hwval/Software/SAP-Installation/HANA-DB-20SPS3/51053061/DATA_UNITS/HDB_AFL_LINUX_X86_64/packages
   SAP HANA EML AFL (2.00.030.0001.1522223444) in /mnt/hwval/Software/SAP-Installation/HANA-DB-20SPS3/51053061/DATA_UNITS/HDB_EML_AFL_10_LINUX_X86_64/packages
   SAP HANA EPM-MDS (2.00.030.0001.1522223444) in /mnt/hwval/Software/SAP-Installation/HANA-DB-20SPS3/51053061/DATA_UNITS/SAP_HANA_EPM-MDS_10/packages
   SAP HANA Database Client (2.3.78.1521836270) in /mnt/hwval/Software/SAP-Installation/HANA-DB-20SPS3/51053061/DATA_UNITS/HDB_CLIENT_LINUX_X86_64/client
   SAP HANA Studio (2.3.35.00000) in /mnt/hwval/Software/SAP-Installation/HANA-DB-20SPS3/51053061/DATA_UNITS/HDB_STUDIO_LINUX_X86_64/studio
   SAP HANA Smart Data Access (2.00.3.0000.0) in /mnt/hwval/Software/SAP-Installation/HANA-DB-20SPS3/51053061/DATA_UNITS/SAP_HANA_SDA_20_LINUX_X86_64/packages
   SAP HANA XS Advanced Runtime (1.0.82.303870) in /mnt/hwval/Software/SAP-Installation/HANA-DB-20SPS3/51053061/DATA_UNITS/XSA_RT_10_LINUX_X86_64/packages
   GUI for HALM for XSA (including product installer) Version 1 (1.12.5) in /mnt/hwval/Software/SAP-Installation/HANA-DB-20SPS3/51053061/DATA_UNITS/XSA_CONTENT_10/XSACALMPUI12_5.zip
   XSAC FILEPROCESSOR 1.0 (1.000.22) in /mnt/hwval/Software/SAP-Installation/HANA-DB-20SPS3/51053061/DATA_UNITS/XSA_CONTENT_10/XSACFILEPROC00_22.zip
SAP HANA Database version '2.00.030.00.1522209842' will be installed.

Select additional components for installation:

<table>
<thead>
<tr>
<th>Index</th>
<th>Components</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>all</td>
<td>All components</td>
</tr>
<tr>
<td>2</td>
<td>server</td>
<td>No additional components</td>
</tr>
<tr>
<td>3</td>
<td>client</td>
<td>Install SAP HANA Database Client version 2.3.78.1521836270</td>
</tr>
<tr>
<td>4</td>
<td>studio</td>
<td>Install SAP HANA Studio version 2.3.35.000000</td>
</tr>
<tr>
<td>5</td>
<td>smartda</td>
<td>Install SAP HANA Smart Data Access version 2.00.3.000.0</td>
</tr>
<tr>
<td>6</td>
<td>xs</td>
<td>Install SAP HANA XS Advanced Runtime version 1.0.82.303870</td>
</tr>
<tr>
<td>7</td>
<td>afl</td>
<td>Install SAP HANA AFL (incl.PAL,BFL,OFL) version 2.00.030.0001.1522223444</td>
</tr>
<tr>
<td>8</td>
<td>eml</td>
<td>Install SAP HANA EML AFL version 2.00.030.0001.1522223444</td>
</tr>
<tr>
<td>9</td>
<td>epmmds</td>
<td>Install SAP HANA EPM-MDS version 2.00.030.0001.1522223444</td>
</tr>
</tbody>
</table>

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

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

4.8 Adding Additional Data Volume Partitions for SAP HANA Single-Host Systems

Starting with SAP HANA 2.0 SPS4, additional data volume partitions can be configured. This feature allows you to configure two or more LUNs for the data volume of an SAP HANA tenant database and to scale beyond the size and performance limits of a single LUN.

**Note:** Using two or more individual LUNs for the data volume is only available for SAP HANA single-host systems. The SAP storage connector required for SAP HANA multiple-host systems does only support one device for the data volume.

Adding additional data volume partitions can be done at any time but might require a restart of the SAP HANA database.

**Enabling Additional Data Volume Partitions**

To enable additional data volume partitions, complete the following steps:

1. Add the following entry within the `global.ini` file.

```plaintext
[persistences]
persistence_datavolume_partition_multipath = true
```

2. Restart the database to enable the feature. Adding the parameter through the SAP HANA Studio to the `global.ini` file by using the Systemdb configuration prevents the restart of the database.

**Volume and LUN Configuration**

The layout of volumes and LUNs is like the layout of a single host with one data volume partition, but with an additional data volume and LUN stored on a different aggregate as the log volume and the other data volume. Table 9 shows an example configuration of an SAP HANA single-host systems with two data volume partitions.

Table 9) Volume configuration for SAP HANA single-host systems.

<table>
<thead>
<tr>
<th>Aggregate 1 at Controller A</th>
<th>Aggregate 2 at Controller A</th>
<th>Aggregate 1 at Controller B</th>
<th>Aggregate 2 at Controller B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data volume: SID_data_mnt00001</td>
<td>Shared volume: SID_shared</td>
<td>Data volume: SID_data2_mnt00001</td>
<td>Log volume: SID_log_mnt00001</td>
</tr>
</tbody>
</table>

Table 10 shows an example of the mount point configuration for a single-host system with two data volume partitions.

Table 10) Mount points for single-host systems.

<table>
<thead>
<tr>
<th>LUN</th>
<th>Mount Point at HANA Host</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>SID_data_mnt00001</td>
<td>/hana/data/SID/mnt00001</td>
<td>Mounted using <code>/etc/fstab</code> entry</td>
</tr>
<tr>
<td>SID_data2_mnt00001</td>
<td>/hana/data2/SID/mnt00001</td>
<td>Mounted using <code>/etc/fstab</code> entry</td>
</tr>
<tr>
<td>SID_log_mnt00001</td>
<td>/hana/log/SID/mnt00001</td>
<td>Mounted using <code>/etc/fstab</code> entry</td>
</tr>
<tr>
<td>SID_shared</td>
<td>/hana/shared/SID</td>
<td>Mounted using <code>/etc/fstab</code> entry</td>
</tr>
</tbody>
</table>

Create the new data LUNs using either ONTAP System Manager or the ONTAP CLI.

**Host Configuration**

To configure a host, complete the following steps:

1. Configure multipathing for the additional LUNs, as described in chapter 4.5.
2. Create the XFS file system on each additional LUN belonging to the HANA system:

   ```
   tstlr300s8-6:/ # mkfs.xfs /dev/mapper/hana-SS3_data2_mnt00001
   ```

3. Add the additional file system/s to the `/etc/fstab` configuration file.

   **Note:** The XFS file systems for the data LUN must be mounted with the `relatime` and `inode64` mount options. The XFS file systems for the log LUN must be mounted with the `relatime`, `inode64`, and `nobarrier` mount options.

   ```
   tstlr300s8-6:/ # cat /etc/fstab
   /dev/mapper/hana-SS3_shared /hana/shared/xfs default 0 0
   /dev/mapper/hana-SS3_log_mnt00001 /hana/log/SS3/mnt00001 xfs relatime,inode64,nobarrier 0 0
   /dev/mapper/hana-SS3_data_mnt00001 /hana/data/SS3/mnt00001 xfs relatime,inode64 0 0
   /dev/mapper/hana-SS3_data2_mnt00001 /hana/data2/SS3/mnt00001 xfs relatime,inode64,0 0
   ```

4. Create mount points and set permissions on the database host.

   ```
   tstlr300s8-6:/ # mkdir -p /hana/data2/SS3/mnt00001
   tstlr300s8-6:/ # chmod -R 777 /hana/data2/SS3
   ```

5. Mount the file systems, run the `mount -a` command.
Adding an Additional Datavolume Partition

To add an additional datavolume partition to your tenant database, complete the following step:

1. Execute the following SQL statement against the tenant database. Each additional LUN can have a different path:

   ```sql
   ALTER SYSTEM ALTER DATAVOLUME ADD PARTITION PATH '/hana/data2/SID/';
   ```

Where to Find Additional Information

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

- Best Practices and Recommendations for Scale-Up Deployments of SAP HANA on VMware vSphere
- Best Practices and Recommendations for Scale-Out Deployments of SAP HANA on VMware vSphere
- SAP Certified Enterprise Storage Hardware for SAP HANA
- SAP HANA Storage Requirements
  [http://go.sap.com/documents/2015/03/74db554-5a7c-0010-82c7-eda71af511fa.html](http://go.sap.com/documents/2015/03/74db554-5a7c-0010-82c7-eda71af511fa.html)
- SAP HANA Tailored Data Center Integration Frequently Asked Questions
  [https://www.sap.com/documents/2016/05/e8705ael-717c-0010-82c7-eda71af511fa.html](https://www.sap.com/documents/2016/05/e8705ael-717c-0010-82c7-eda71af511fa.html)
- TR-4646: SAP HANA Disaster Recovery with Asynchronous Storage Replication Using SnapCenter 4.0 SAP HANA Plug-In
- TR-4614: SAP HANA Backup and Recovery with SnapCenter
- TR-4338: SAP HANA on VMware vSphere with NetApp FAS and AFF Systems
- TR-4667: Automating SAP System Copies Using the SnapCenter 4.0 SAP HANA Plugin
### Version History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Document Version History</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version 1.0</td>
<td>October 2015</td>
<td>Initial version</td>
</tr>
<tr>
<td>Version 1.1</td>
<td>March 2016</td>
<td>Updated capacity sizing</td>
</tr>
</tbody>
</table>
| Version 2.0 | February 2017 | New NetApp storage systems and disk shelves  
New features of ONTAP 9  
New OS releases (SLES12 SP1 and RHEL 7.2)  
New SAP HANA release |
| Version 2.1 | July 2017   | Minor Updates                                                                                                                                              |
| Version 3.0 | September 2018 | New NetApp storage systems  
New OS releases (SLES12 SP3 and RHEL 7.4)  
Additional minor updates  
SAP HANA 2.0 SPS3 |
| Version 3.1 | November 2019 | New NetApp storage systems and NVMe shelf  
New OS releases (SLES12 SP4, SLES 15, and RHEL 7.6)  
Additional minor updates |
| Version 3.2 | April 2020  | New AFF ASA series storage systems  
Introduced multiple data partition feature available since SAP HANA 2.0 SPS4 |
| Version 3.3 | June 2020   | Additional information about optional functionalities  
Minor updates |
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