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). 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

2 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.

Figure 2) Example configuration with eight SAP HANA hosts.

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.

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.

Figure 5) Backup architecture.

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 Technology

The same SnapCenter plug-in that is described in section 2.1, "SAP HANA Backup" is used to provide the asynchronous mirroring solution between a primary and secondary controller. A consistent Snapshot image of the database at the primary site is asynchronously replicated to the disaster recovery site by using NetApp SnapMirror technology. The servers at the disaster recovery site could be used for development and testing during normal operations to further reduce your TCO, as shown in Figure 6.

Space-efficient, instantaneous NetApp FlexClone® copies can be used at the disaster recovery site to run disaster failover tests without interrupting the replication process. FlexClone® copies can also be used to quickly create an SAP full system copy to refresh the test or training systems with current production data.

Figure 6) Asynchronous storage replication.

SnapMirror technology also offers synchronous replication. This synchronous replication offers also a StrictSync mode.

If the write to the secondary storage is not completed for any reason, the application I/O fails, thereby ensuring that the primary and secondary storage are identical. Application I/O to the primary storage 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 recovery point objective (RPO) is always zero, and recovery time objective (RTO) is very low.

Synchronous SnapMirror does not replicate application consistent Snapshot copies. Therefore, the replication target can’t be used for application or disaster recovery testing as shown with the asynchronous version of SnapMirror.
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.

Figure 7) Synchronous storage replication.

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 1) Number of SAP HANA hosts per SAS based 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.

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.
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.

**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.

![Figure 10) Disk shelf connection with SSDs.](image)

**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, two aggregates per controller must be configured, independently of which disk shelf or disk technology (SSDs or HDDs) is used. 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 SIDL_data_mnt00001 is configured on controller A and volume SIDL_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_mnt00001</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_mnt00003</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><code>vol modify -vserver &lt;vserver-name&gt; -volume &lt;volname&gt; -snapshot-policy none</code></td>
</tr>
<tr>
<td>Disable visibility of Snapshot directory</td>
<td><code>vol modify -vserver &lt;vserver-name&gt; -volume &lt;volname&gt; -snapdir-access false</code></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.

```
# sanlun lun show
controller(7mode/E-Series)/ lun vserver(cDOT/FlashRay) lun-pathname protocol size product
------------------------------------------------------------------------------------------------------------------------
controller(7mode/E-Series)/ lun vserver(cDOT/FlashRay) lun-pathname protocol size product
------------------------------------------------------------------------------------------------------------------------
                      hana                          /vol/SS3_log_mnt00002/SS3_log_mnt00002   /dev/sdah host11
                      FCP                          512.0g  cDOT
                      hana                          /vol/SS3_data_mnt00001/SS3_data_mnt00001 /dev/sdag host11
                      FCP                          1.2t   cDOT
                      hana                          /vol/SS3_data_mnt00002/SS3_data_mnt00002 /dev/sdaf host11
                      FCP                          1.2t   cDOT
                      hana                          /vol/SS3_log_mnt00002/SS3_log_mnt00002 /dev/sdae host11
                      FCP                          512.0g  cDOT
                      hana                          /vol/SS3_data_mnt00001/SS3_data_mnt00001 /dev/sdad host11
                      FCP                          1.2t   cDOT
                      hana                          /vol/SS3_data_mnt00002/SS3_data_mnt00002 /dev/sdac host11
                      FCP                          1.2t   cDOT
                      hana                          /vol/SS3_log_mnt00002/SS3_log_mnt00002 /dev/sdab host11
                      FCP                          512.0g  cDOT
                      hana                          /vol/SS3_data_mnt00001/SS3_data_mnt00001 /dev/sdaa host11
                      FCP                          1.2t   cDOT
                      hana                          /vol/SS3_data_mnt00002/SS3_data_mnt00002 /dev/sdz host11
                      FCP                          1.2t   cDOT
                      hana                          /vol/SS3_log_mnt00002/SS3_log_mnt00002 /dev/sdy host11
                      FCP                          512.0g  cDOT
```
<table>
<thead>
<tr>
<th>Mode</th>
<th>size</th>
<th>features</th>
<th>create</th>
<th>hwhandler</th>
<th>wp</th>
<th>names:</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCP</td>
<td>1.2t</td>
<td>cDOT</td>
<td>/vol/SS3_data_mnt00001/SS3_data_mnt00001 /dev/sdx</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>1.2t</td>
<td>cDOT</td>
<td>/vol/SS3_data_mnt00002/SS3_data_mnt00002 /dev/sdw</td>
<td>host11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>1.2t</td>
<td>cDOT</td>
<td>/vol/SS3_data_mnt00001/SS3_data_mnt00001 /dev/sdq</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>1.2t</td>
<td>cDOT</td>
<td>/vol/SS3_data_mnt00002/SS3_data_mnt00002 /dev/sdm</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>1.2t</td>
<td>cDOT</td>
<td>/vol/SS3_log_mnt00001/SS3_log_mnt00001 /dev/sdt</td>
<td>host11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>1.2t</td>
<td>cDOT</td>
<td>/vol/SS3_log_mnt00002/SS3_log_mnt00002 /dev/sdl</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>1.2t</td>
<td>cDOT</td>
<td>/vol/SS3_data_mnt00001/SS3_data_mnt00001 /dev/ddh</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>1.2t</td>
<td>cDOT</td>
<td>/vol/SS3_data_mnt00002/SS3_data_mnt00002 /dev/ddg</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>1.2t</td>
<td>cDOT</td>
<td>/vol/SS3_log_mnt00001/SS3_log_mnt00001 /dev/ddf</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>1.2t</td>
<td>cDOT</td>
<td>/vol/SS3_log_mnt00002/SS3_log_mnt00002 /dev/ddj</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>1.2t</td>
<td>cDOT</td>
<td>/vol/SS3_data_mnt00001/SS3_data_mnt00001 /dev/ddk</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>1.2t</td>
<td>cDOT</td>
<td>/vol/SS3_data_mnt00002/SS3_data_mnt00002 /dev/ddl</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>1.2t</td>
<td>cDOT</td>
<td>/vol/SS3_log_mnt00001/SS3_log_mnt00001 /dev/ddm</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>512.0g</td>
<td>cDOT</td>
<td>/vol/SS3_log_mnt00001/SS3_log_mnt00001 /dev/ddn</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>512.0g</td>
<td>cDOT</td>
<td>/vol/SS3_log_mnt00002/SS3_log_mnt00002 /dev/ddo</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>512.0g</td>
<td>cDOT</td>
<td>/vol/SS3_log_mnt00001/SS3_log_mnt00001 /dev/dde</td>
<td>host11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>512.0g</td>
<td>cDOT</td>
<td>/vol/SS3_log_mnt00002/SS3_log_mnt00002 /dev/ddf</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>512.0g</td>
<td>cDOT</td>
<td>/vol/SS3_log_mnt00001/SS3_log_mnt00001 /dev/ddi</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>512.0g</td>
<td>cDOT</td>
<td>/vol/SS3_log_mnt00002/SS3_log_mnt00002 /dev/ddj</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>512.0g</td>
<td>cDOT</td>
<td>/vol/SS3_log_mnt00001/SS3_log_mnt00001 /dev/ddn</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>512.0g</td>
<td>cDOT</td>
<td>/vol/SS3_log_mnt00002/SS3_log_mnt00002 /dev/ddo</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>512.0g</td>
<td>cDOT</td>
<td>/vol/SS3_log_mnt00001/SS3_log_mnt00001 /dev/ddp</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP</td>
<td>512.0g</td>
<td>cDOT</td>
<td>/vol/SS3_log_mnt00002/SS3_log_mnt00002 /dev/ddq</td>
<td>host10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.

```
stirx303a8-6:~ # multipath -r
create: 3600a09803804436375d4d442d753878 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 sdd 8:48 undef ready running
  |  | 11:0:0:0 sds 65:32 undef ready running
  |  | 11:0:2:0 sdo 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: 3600a09803804436375d4d442d753879 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 sdj 8:144 undef ready running
  |  | 10:0:3:1 sdp 8:240 undef ready running
  |  | 11:0:0:1 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.

  ```bash
  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
  ```

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

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

\[
\begin{align*}
\text{stlrx300s8-6:} & \# \text{mkdir -p /hana/data/SS3/mnt00001} \\
\text{stlrx300s8-6:} & \# \text{mkdir -p /hana/log/SS3/mnt00001} \\
\text{stlrx300s8-6:} & \# \text{mkdir -p /hana/shared} \\
\text{stlrx300s8-6:} & \# \text{chmod -R 777 /hana/log/SS3} \\
\text{stlrx300s8-6:} & \# \text{chmod -R 777 /hana/data/SS3} \\
\text{stlrx300s8-6:} & \# \text{chmod 777 /hana/shared}
\end{align*}
\]

- 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.

\[
\begin{align*}
\text{stlrx300s8-6:} & \# \text{mkdir -p /hana/data/SS3/mnt00001} \\
\text{stlrx300s8-6:} & \# \text{mkdir -p /hana/log/SS3/mnt00001} \\
\text{stlrx300s8-6:} & \# \text{mkdir -p /hana/data/SS3/mnt00002} \\
\text{stlrx300s8-6:} & \# \text{mkdir -p /hana/log/SS3/mnt00002} \\
\text{stlrx300s8-6:} & \# \text{mkdir -p /hana/shared} \\
\text{stlrx300s8-6:} & \# \text{chmod -R 777 /hana/log/SS3} \\
\text{stlrx300s8-6:} & \# \text{chmod -R 777 /hana/data/SS3} \\
\text{stlrx300s8-6:} & \# \text{chmod 777 /hana/shared}
\end{align*}
\]

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.

   \[
   \begin{align*}
   \text{stlrx300s8-6:} & \# \text{cat /etc/fstab} \\
   \text{/dev/mapper/hana-SS3_shared/} & \text{hana/shared xfs default 0 0} \\
   \text{/dev/mapper/hana-SS3_log_mnt00001/} & \text{hana/log/SS3/mnt00001 xfs relatime,inode64,nobarrier 0 0} \\
   \text{/dev/mapper/hana-SS3_data_mnt00001/} & \text{hana/data/SS3/mnt00001 xfs relatime,inode64 0 0}
   \end{align*}
   \]

   - 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.

   \[
   \begin{align*}
   \text{stlrx300s8-6:} & \# \text{cat /etc/fstab} \\
   \text{<storage-ip>/hana_shared/} & \text{hana/shared nfs rw,vers=3,hard,timeo=600, intr,nowtime,nolock 0 0}
   \end{align*}
   \]

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 hdfparam.

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

```
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, hdfparam 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 hdfparam in HANA 2. The parameters can be also set within the global.ini file.

```
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.

```
stlrx300s8-6:~ # cat /hana/shared/global.ini

[fileio]
async_read_submit = on
async_write_submit_active = on
max_parallel_io_requests = 128
async_write_submit_blocks = all
...
```
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 (stlx300s8-7) and the standby host (stlx300s8-8).

**Note:** Depending on the OS version being used, it might be necessary to install phyton 2.7 before installing the SAP HANA database. For example, `zypper in python` for SuSe SLES 15SP1.

```plaintext
stlx300s8-6:/mnt/hwval/Software/SAP-Installation/HANA-DB-20SPS3/51053061/DATA_UNITS/HDB_LCM_LINUX_X86_64 # ./hdblcm --action=install --addhosts=stlx300s8-7:role=worker:storage_partition=2,stlx300s8-8: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 (2.3.76.1521836270) in /mnt/hwval/Software/SAP-Installation/HANA-DB-20SPS3/51053061/DATA_UNITS/HDB_CLIENT_LINUX_X86_64/client
- SAP HANA Studio (2.3.35.000000) 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/HDB_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/XSACMSIP1UI2_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 '2.0.030.00.1522209842' 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 2.0.3.000.0</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 2.0.030.0001.1522223444</td>
</tr>
<tr>
<td>8</td>
<td>eml</td>
<td>Install SAP HANA EML AFL version 2.0.030.0001.1522223444</td>
</tr>
<tr>
<td>9</td>
<td>epmmds</td>
<td>Install SAP HANA EPM-MDS version 2.0.030.0001.1522223444</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.

   ```ini
   [customizable_functionalities]
   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 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 /etc/fstab entry</td>
</tr>
<tr>
<td>SID_data2_mnt00001</td>
<td>/hana/data2/SID/mnt00001</td>
<td>Mounted using /etc/fstab entry</td>
</tr>
<tr>
<td>SID_log_mnt00001</td>
<td>/hana/log/SID/mnt00001</td>
<td>Mounted using /etc/fstab entry</td>
</tr>
<tr>
<td>SID_shared</td>
<td>/hana/shared/SID</td>
<td>Mounted using /etc/fstab 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:

   ```
   stlrx300s8-6:~ # 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.

   ```
   stlrx300s8-6:~ # 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.

   ```
   stlrx300s8-6:~ # mkdir -p /hana/data2/SS3/mnt00001
   stlrx300s8-6:~ # 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:

```
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/2015/03/74cdb554-5a7c-0010-82c7-eda71af511fa.html](http://go.sap.com/documents/2015/03/74cdb554-5a7c-0010-82c7-eda71af511fa.html)
- SAP HANA Tailored Data Center Integration Frequently Asked Questions
  [https://www.sap.com/documents/2016/05/e8705aae-717c-0010-82c7-eda71af511fa.html](https://www.sap.com/documents/2016/05/e8705aae-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>
<tr>
<td>Version 2.0</td>
<td>February 2017</td>
<td>New NetApp storage systems and disk shelves&lt;br&gt;New features of ONTAP 9&lt;br&gt;New OS releases (SLES12 SP1 and RHEL 7.2)&lt;br&gt;New SAP HANA release</td>
</tr>
<tr>
<td>Version 2.1</td>
<td>July 2017</td>
<td>Minor Updates</td>
</tr>
<tr>
<td>Version 3.0</td>
<td>September 2018</td>
<td>New NetApp storage systems&lt;br&gt;New OS releases (SLES12 SP3 and RHEL 7.4)&lt;br&gt;Additional minor updates&lt;br&gt;SAP HANA 2.0 SPS3</td>
</tr>
<tr>
<td>Version 3.1</td>
<td>November 2019</td>
<td>New NetApp storage systems and NVMe shelf&lt;br&gt;New OS releases (SLES12 SP4, SLES 15, and RHEL 7.6)&lt;br&gt;Additional minor updates</td>
</tr>
<tr>
<td>Version 3.2</td>
<td>April 2020</td>
<td>New AFF ASA series storage systems&lt;br&gt;Introduced multiple data partition feature available since SAP HANA 2.0 SPS4</td>
</tr>
</tbody>
</table>
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