



Technical Report

# Business-Critical Applications Built on OpenStack Using Manila on NetApp Storage Systems Solution Deployment

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March 2016 | TR-4410-DEPLOY

## Abstract

As enterprises make the shift to an OpenStack-based cloud infrastructure, there is an increasing need for deployment procedures for business-critical applications in an on-premises cloud. This proof-of-concept deployment guide targets architects, administrators, and others who are responsible for managing SAP applications and need to understand the possibilities for deploying such applications within OpenStack clouds. This guide describes the architecture used to deploy business-critical applications such as SAP ERP and SAP HANA on SUSE OpenStack Cloud 5 using the OpenStack Manila shared file system service with NetApp® storage systems using SAP LVM storage integration. The guide includes architectural considerations, technology choices, application configuration considerations, and lessons learned.

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# 1 Solution Overview

OpenStack has enjoyed more global support than any other open source software to date. OpenStack is being continually enhanced and is becoming more accepted by companies for their on-premises cloud platform to provide flexibility for their IT departments.

For more than a decade, NetApp has created storage and data-management solutions for highly demanding SAP landscapes. As an SAP global technology partner and storage supplier, NetApp is dedicated to driving efficiency and flexibility for SAP customers. SAP Landscape Virtualization Management (SAP LVM) provides enabling technology, management tools, and value-added services to deploy and manage SAP applications on the premises and in the cloud. NetApp integrates with this solution to deliver end-to-end automation for SAP system copy processes within an OpenStack deployment using the OpenStack Manila shared file system service.

SUSE OpenStack Cloud enables organizations to quickly set up private infrastructure-as-a-service (IaaS) clouds that people within the organization can use to rapidly deploy workloads through a self-service, on-demand portal. SUSE Linux Enterprise Server for SAP Applications is a specialized SUSE Linux distribution solution with advanced support and system adjustments for SAP requirements. Running your SAP workloads on SUSE Linux Enterprise in a SUSE Certified Public Cloud enables you to maintain the performance and reliability of your operating environment. In addition, SAP and SUSE have collaborated to optimize SUSE Linux Enterprise Server for SAP as the standard distribution for SAP solutions.

This document is an extension of the original proof-of-concept (PoC) solution that was developed in collaboration with NetApp, SAP, and SUSE to exhibit the capability of maintaining the operational efficiencies provided by NetApp within an OpenStack cloud. The objective was to define an architecture that is capable of running SAP applications and integrates SAP LVM, OpenStack Manila, and NetApp storage. This document also explains how to provide administrators with the ability to manage an SAP system landscape that is part of an OpenStack infrastructure.

The original PoC gave a basic overview along with the configurations and procedures used for deploying SAP applications and SAP LVM with SUSE Cloud 4. This update includes changes and new features using SUSE Cloud 5 together with the Kilo version of OpenStack Manila, shipped by SUSE as a technical preview release. This update outlines the technology used, provides design recommendations, and shows examples of the infrastructure being used for the PoC and for the development and testing of SAP's LVM OpenStack file storage adapter for OpenStack Manila.

## 1.1 Target Audience

The target audience for this document includes the following:

- **OpenStack cloud architects.** This document provides information to help these architects understand the requirements of an enterprise application such as SAP to be part of an OpenStack deployment. The document provides information about the point of integration between an OpenStack deployment and SAP. The document also provides details of the configurations used for the OpenStack projects such as Manila, Neutron, and Nova.
- **SAP administrators.** The integration between NetApp and SAP is well documented. This report provides SAP administrators with information about how to configure SAP LVM and SUSE OpenStack Cloud 5 to enable SAP applications within OpenStack. The report also shows that SAP LVM workflows can be performed within OpenStack and continue to take advantage of the NetApp storage benefits when used with both SAP and OpenStack.

This document provides an example implementation of SAP within an OpenStack deployment using the Manila file share service. Readers should have an understanding of the core components of SAP, SAP LVM, and OpenStack. This document does not define a complete installation and configuration of both OpenStack and SAP, but it does provide examples that illustrate points of integration that support high-value applications such as SAP and databases.

## 2 Solution Technology

This section describes the SAP and OpenStack services used for this solution.

### 2.1 SUSE OpenStack Cloud

OpenStack is an open-source project that implements services that establish infrastructure as a service (IaaS). OpenStack technology consists of a series of modular projects that control pools of processing, storage, and networking resources throughout a data center.

The solution described in this document uses the SUSE OpenStack Cloud 5 distribution of OpenStack, based on the Icehouse release of OpenStack. Along with the standard services provided by OpenStack, we also implemented the OpenStack shared file system service project Manila. This project provides shared file system services to tenants in the OpenStack deployment. Manila was provided as a technical preview version from SUSE and is based on the OpenStack Kilo version.

### 2.2 SAP and SAP LVM

SAP LVM is a management tool that enables the SAP basis administrator to automate SAP system operations, including end-to-end SAP system copy and clone operations. SAP LVM is used to manage and control the installed SAP systems within the OpenStack ecosystem for this solution.

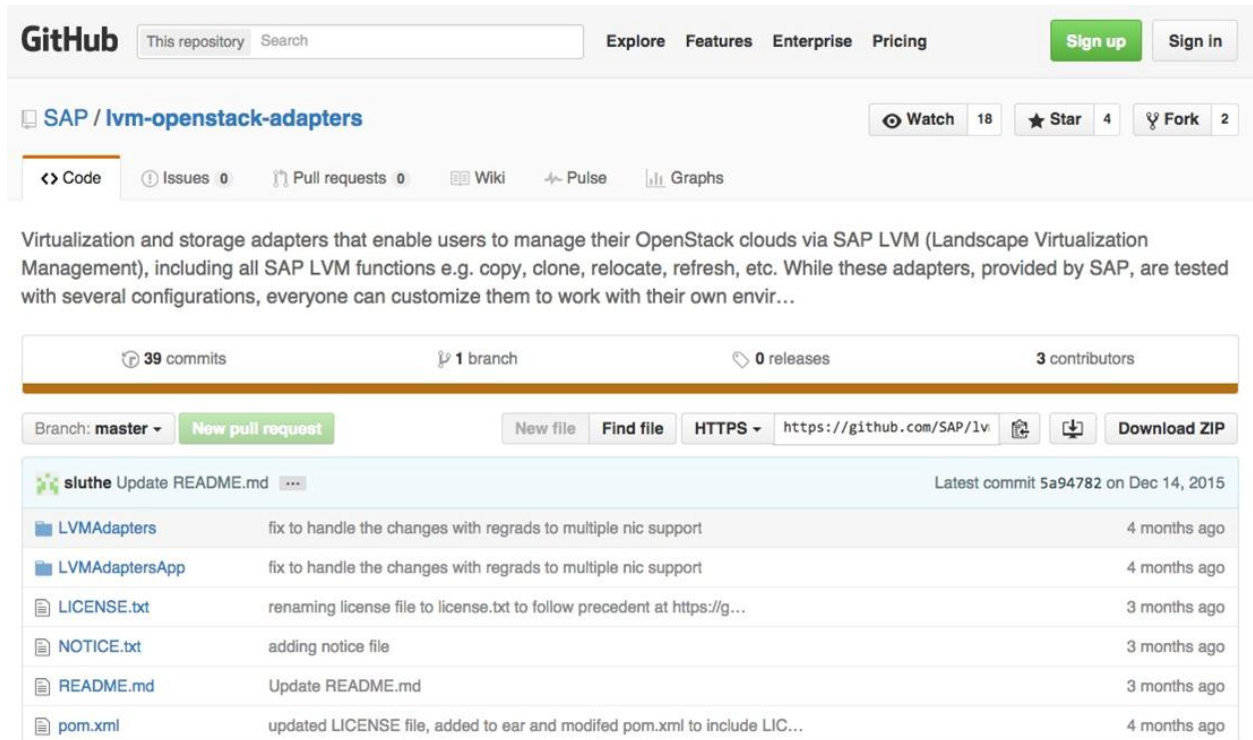
### 2.3 SAP LVM Storage Adapter for Manila

SAP LVM implements a storage adapter API that allows storage vendors to implement a storage adapter to manage the storage system from within SAP LVM. Using this adapter, SAP LVM can define high-level workflows such as SAP system copy, clone, and refresh and can call the corresponding storage functions through the API.

As of December 2015, SAP published on GitHub 3 OpenStack-specific adapters for SAP Landscape Virtualization Management (see <https://github.com/sap/lvm-openstack-adapters>). The three adapters are:

- Virtualization adapter for OpenStack Nova
- Block storage adapter for OpenStack Cinder
- File storage adapter for OpenStack Manila

Figure 1) SAP LVM OpenStack adapter on GitHub.



The storage adapter for OpenStack Manila was developed and tested in an environment as described in this document using NetApp FAS storage systems with the NetApp OpenStack Manila driver. This innovation provides SAP administrators with end-to-end management of the SAP software landscape within OpenStack.

## 2.4 NetApp Clustered Data ONTAP with OpenStack and SAP

The NetApp clustered Data ONTAP® operating system delivers high levels of performance, manageability, and reliability in OpenStack environments. NetApp Data ONTAP provides storage efficiencies through NetApp Snapshot® technology and NetApp FlexClone® technology to deliver efficient storage-related functions for SAP workflows.

The setup described in this document demonstrates how to leverage this technology using SAP LVM with its new Manila file-storage adapter and NetApp OpenStack unified driver for clustered Data ONTAP.

## 2.5 Solution Objectives

The objective of this solution is to implement an SAP-ready OpenStack infrastructure using the Manila shared file system service and NFS volumes supporting SAP applications and SAP LVM. SAP LVM manages and operates the SAP system landscape and infrastructure.

The solution demonstrates the integration between SAP LVM and OpenStack Manila through a storage adapter to use NetApp technology such as Snapshot copies and FlexClone to efficiently complete the SAP LVM system-copy workflow.

## 2.6 Solution Summary

Administrators and architects can use the results of this PoC as a blueprint for an OpenStack configuration with Manila. With it they can provision NFS storage for SAP systems using SAP LVM as the management tool for the SAP landscape.

## 3 Use Case Summary

An OpenStack deployment can support a variety of applications and workloads in a fully multitenant environment. This solution provides a prototype for integration between SAP LVM and OpenStack Manila while enabling the efficiencies and value-added capabilities of NetApp technology used in SAP deployments.

## 4 Deployment Fundamentals and Technology

### 4.1 SAP Application Requirements

The underlying infrastructure and architecture in an SAP deployment have specific requirements that must be considered when designing an SAP-ready OpenStack solution. These requirements are based on official SAP specifications for the underlying hardware, as well as other technical and business requirements. This section covers some of the requirements for optimizing an architecture to run SAP applications efficiently in OpenStack environments.

#### General SAP Software and Hardware Requirements

To enable the successful deployment of SAP applications and to get SAP support for its production environment, a very specific, certified, and supported combination of hardware and software infrastructure must be in place. For example, with SAP HANA, only certified and tested servers can be used. Other restrictions include the use of specific hypervisors, operating systems, and databases. Many SAP documents are available on the [SAP Service Marketplace](#) to guide SAP customers to the right versions of hardware and software. Taking these prerequisites into account is paramount in designing an SAP-ready OpenStack infrastructure.

#### Performance and I/O Requirements

SAP applications are database-centric, large business applications with special demands on:

- CPU type and load
- Memory consumption
- Storage I/O and throughput
- Network bandwidth and latency

Depending on the SAP applications, there are methods in place that allow customers and hardware partners to size an infrastructure based on application and business-specific metrics. A first step in gaining knowledge about SAP system sizing is to read the [SAP Sizing Overview webpage](#), and SAP customers can use the [SAP Quicksizer on the Service Marketplace](#).

For an SAP implementation using a virtual infrastructure such as OpenStack, these recommendations can help to identify the proper architecture and hardware selection:

1. Memory is one of the most efficient ways to tune an SAP application. NetApp and SAP recommend that you not use any memory compression or ballooning techniques. Because SAP applications use internal buffers for their application servers, having enough memory to support this buffering is key to good performance.

2. Network bandwidth and especially latency are also important factors. SAP is a multitier application with many application servers communicating internally as well as using a database server that requires sufficient network bandwidth and low latency. For instance, with SAP HANA, the SAP requirements for a HANA scale-out implementation include a 10Gb internal network for the HANA server-to-server communication. To improve latency, and thus internal communications, as few hops as possible should be designed into the networking layer.
3. SAP HANA and the SAP database have specific requirements that need to be fulfilled for the storage subsystem. For network-attached storage (NAS), NetApp and SAP recommend that you enable jumbo frames on all related network components to enlarge throughput. Also, routing the storage network should be avoided, if possible.

## 4.2 SAP Design and Deployment Considerations

In addition to the requirements and guidelines discussed earlier, an SAP landscape design should use all infrastructure features available to make administration and operation as comfortable and as automated as possible.

### Design and Deployment Recommendations

Following are some guidelines that were used for this PoC solution for an SAP infrastructure using OpenStack:

- **Use of shared storage.** Almost every SAP system requires shared storage. A typical mount point is the global SAPMNT as a standard. To avoid the manual setup of a shared storage server, the infrastructure should provide this shared storage for SAP. This PoC uses the NFS protocol for the shared storage that is provisioned by OpenStack Manila.
- **Use of storage subsystem features.** An optimized storage layout enables the use of as many storage subsystem features as possible. For example, we use NetApp Snapshot copy-based backups. Therefore, the database volumes and log volumes should be separated to allow restore of the database by using a NetApp Snapshot copy of the FlexVol<sup>®</sup> volume while still using the most current database logs to recover the database.
- **Storage and volume attachment.** There are many choices for how to attach the SAP application server (the host running the SAP application) to the storage, typically, grouped into block storage or NAS. The right choice depends on the operating system used and the choice of storage subsystem. In this OpenStack setup, we use NAS provisioned by the OpenStack Manila project and mounted on the compute instance running the SAP applications. This setup enables the use of clustered Data ONTAP technologies such as Snapshot copies and FlexClone to enable efficient cloning of SAP environments.
- **Preconfigured SUSE Linux Enterprise Server 11 SP3 for SAP applications.** The systems and OS images for the PoC are configured based on the SAP adaptive design principle. The OS images are prepared with the proper software and loaded into the OpenStack Glance repository to create compute instances used by SAP applications.

#### Best Practice

Use OS images that are preprepared for SAP using SAP adaptive design principles. Doing so enables the use of the workflow and functionality provided by SAP LVM.



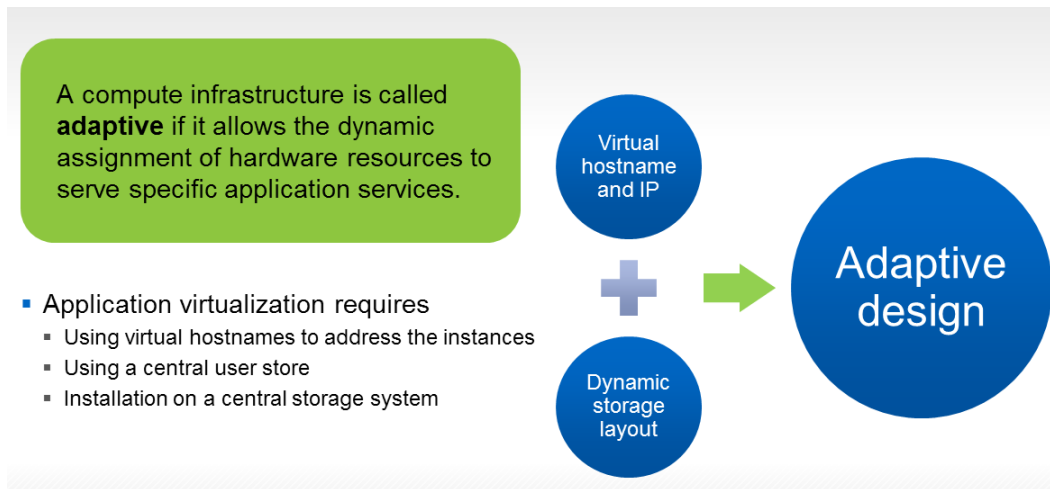
## SAP Adaptive Computing

Adaptive computing is a technology that SAP developed to separate the OS from the SAP installation, making it possible to migrate an installed SAP system from one host to another. This capability enables the following benefits:

- Changing the host type (CPU/memory)
- Patching the OS without disturbing the running SAP system
- Moving between hosts

Figure 2 shows adaptive design principles.

Figure 2) Adaptive design principles.



An SAP system, when installed on a host, creates not only users, groups, services, and file systems; it also stores many configuration options, such as host name and IP address, in its own database. Not using the SAP adaptive design principle makes it difficult to maintain or move the SAP system to another compute instance.

Therefore, NetApp and SAP recommend that you adopt the SAP adaptive computing paradigm even within OpenStack.

An adaptive design installation has the following features:

- Centralized user management such as LDAP or Microsoft AD.
- Central storage instead of local disks. All SAP specifics must be separated from the host file system.
- Use of virtual host names to address the instance. Instead of installing an SAP system onto a host using its physical host name and IP, every SAP service has its own set of virtual host name and IP addresses.
- Ability to relocate SAP applications from one host to another by relocating the storage file systems and the virtual IP addresses to the new host.

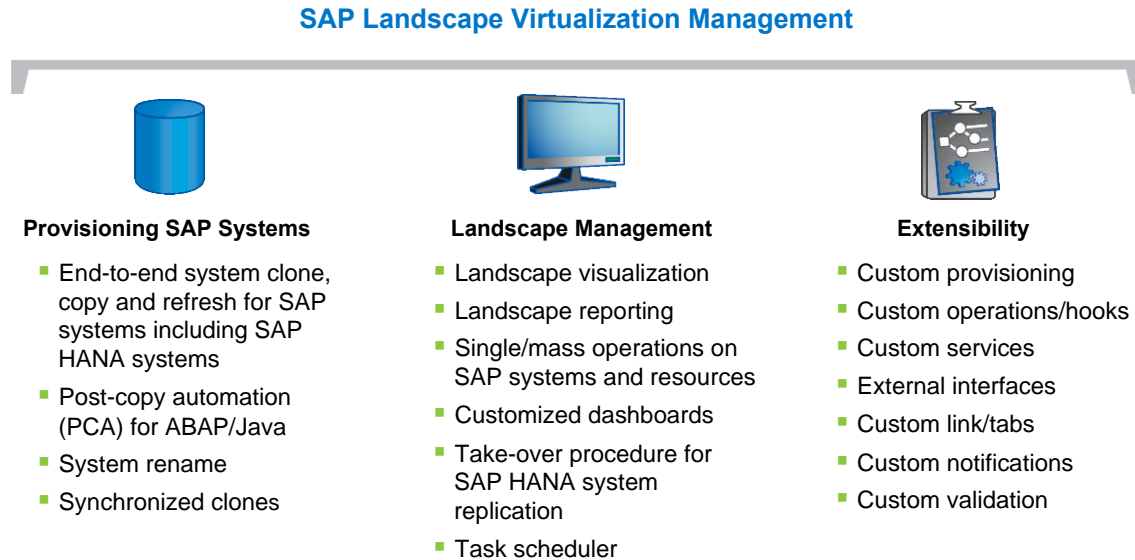
## SAP Landscape Virtualization Management

The OpenStack setup described in this report leverages the use of SAP Landscape Virtualization Manager (SAP LVM) to utilize the integration between SAP and OpenStack. SAP LVM is the central management platform to operate and monitor the SAP system landscape with deep integration into the underlying infrastructure. With SAP LVM, system administrators can create SAP system copies and clones. SAP LVM acts as a management component that provides controls for interaction with SAP systems (start, stop, relocate, and so on) and has extensive monitoring capabilities. This setup uses

several SAP LVM functions for integrating with OpenStack and Manila. However, the primary focus of this PoC is to describe end-to-end system clone, copy, and refresh for SAP systems.

Figure 3 shows the product functionality of SAP LVM.

Figure 3) SAP LVM product functionality.



Workflows such as SAP system copy or SAP system clone require SAP LVM to interact with the storage subsystem. For this interaction, SAP makes available a storage adapter API that storage hardware vendors can use to integrate their storage into SAP LVM. In this setup, the new SAP LVM OpenStack storage adapter for Manila has been used. SAP developed this adapter to connect SAP LVM and the OpenStack Manila API service. With this adapter, SAP administrators can utilize OpenStack Manila directly from SAP LVM. With the NetApp Manila drivers, SAP LVM uses NetApp Snapshot copy-based cloning technology (FlexClone) to efficiently perform an SAP system copy or system clone.

### 4.3 SUSE Cloud 5 OpenStack Design and Deployment Considerations

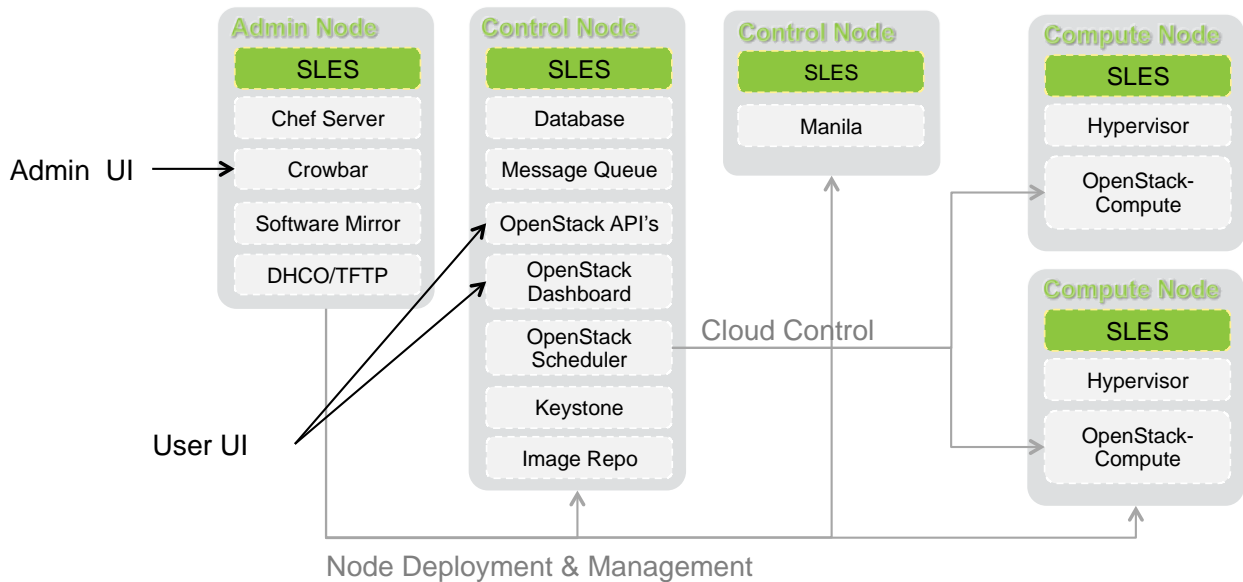
SUSE Cloud is a cloud infrastructure solution that is easily deployed and managed. This solution offers cloud management to help organizations centralize virtual machine deployment. SUSE Cloud 5 provides the following features:

- Open-source software that is based on the OpenStack Juno release
- Centralized resource tracking, providing insight into activities and the capacity of the cloud infrastructure for optimized automated deployment of services
- A self-service portal enabling end users to configure and deploy services as necessary, also offering the ability to track resource consumption (Horizon)
- An image repository from which standardized, preconfigured virtual machines can be published (Glance)
- Automated installation processes with Crowbar using predefined scripts for configuring and deploying the control nodes as well as compute and storage nodes
- Multitenant, role-based provisioning and access control for multiple departments and users within your organization

SUSE Cloud is based on SUSE Linux Enterprise Server, OpenStack, Crowbar, and Chef. SUSE Linux Enterprise Server is the underlying operating system for all cloud infrastructure machines (also called

nodes), whereas OpenStack, the cloud management layer, works as the cloud operating system. Crowbar and Chef automatically deploy and manage the OpenStack nodes from a central administration server. Figure 4 shows the SUSE Cloud infrastructure.

Figure 4) SUSE Cloud 5 infrastructure.



SUSE Cloud is deployed to three different types of machines:

- One administration server for node deployment and management, including the PXE boot environment to automatically include and configure new hardware.
- One or more control nodes hosting the cloud management services. All OpenStack services needed to orchestrate virtual machines deployed on the compute nodes in the SUSE Cloud are hosted and configured using Crowbar bar clamps. NetApp recommends that customers configure a high-availability cluster for control nodes. Doing so helps minimize cloud downtime because of hardware failures.
- Multiple compute nodes to support the Nova instances created by users.

This setup uses three node types for its SUSE Cloud 5 deployment: an admin node, two control nodes (one control node for Cloud 5 and a second node for OpenStack Manila services), and several compute nodes. The architecture described in this document focuses on functionality rather than a highly available or scalable deployment.

## Neutron Networking

This setup uses an architecture in which each tenant has two independent networks. One network is public (or routed) for client access and the other attaches the SAP data storage directly to the compute instance.

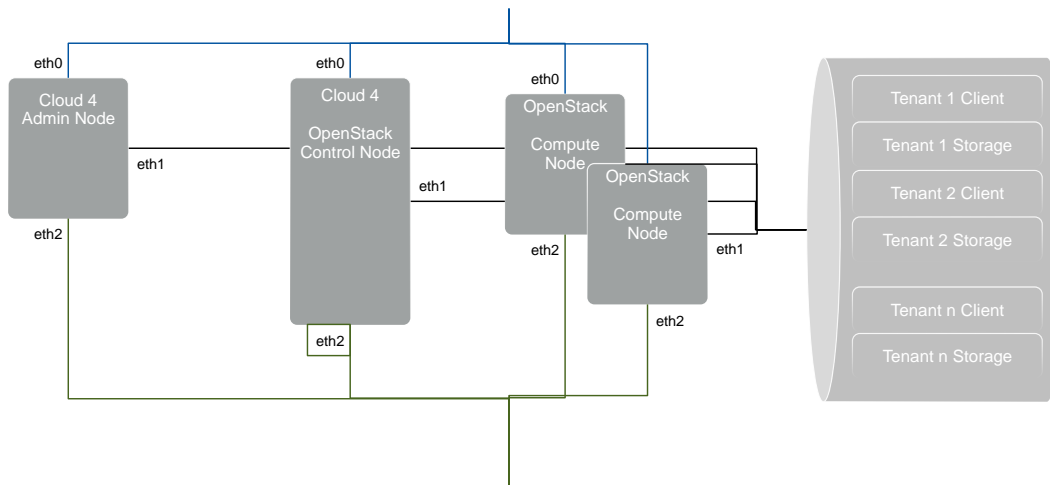
The reasons for this decision are to:

- Reduce the number of networking layers.
- Be able to attach NFS storage directly (layer 2) to the virtual SAP instances and avoid unnecessary hops.
- Be able to set the networking options such as jumbo frames independently for the storage network while keeping the access layer at the standard frame size.

When looking at the network architecture, as diagramed in Figure 5, each host has an identical configuration using three network interfaces with the following roles and VLANs attached to it:

- eth0 is the global administration LAN.
- eth2 is the global storage LAN for Cinder and Glance.
- eth1 is a port channel with VLANs for all the tenants' access and storage LANs.

**Figure 5) Network architecture.**



**Note:** The Neutron network configuration was designed to reduce the number of network hops and to allow layer 2 connectivity with the storage network to the compute instances.

## Nova Compute

Each compute node runs SUSE Linux Enterprise Server 11 SP3 using KVM as the hypervisor for OpenStack Nova. Each compute instance uses a prepared Glance image with the appropriate SAP software installed and appropriately configured. Each compute instance has two networks: one that allows access to the storage and one that allows access to the routed network, as mentioned in the "Neutron Networking" section.

Figure 6 shows an example of the networks assigned to each compute instance when they are created.

Figure 6) Instance creation.

**Launch Instance**

Details \* Access & Security \* **Networking \*** Post-Creation Advanced Options

**Selected Networks**

Choose network from Available networks to Selected Networks by push button or drag and drop, you may change nic order by drag and drop as well.

nic:1 os032-access (a6216a3b-0ad5-4b5b-8970-ea30cab113eb)

nic:2 os032-backend (adb5a711-251e-4a31-a741-adb4253407ec)

**Available networks**

fixed (75248ee-025-4d79-b3b6-513b170ac59)

Cancel Launch

**Note:** The configuration of the Neutron network used by each compute instance allows communication by SAP LVM to the compute instances to perform compute functions.

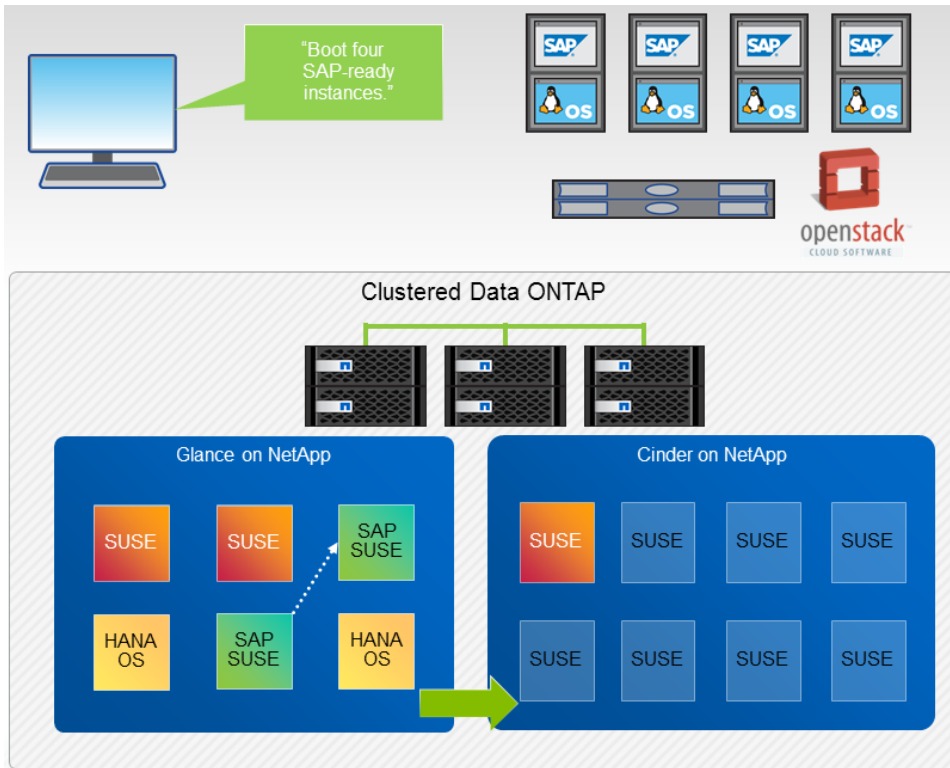
## Glance and Cinder

In this architecture, NetApp storage using the NFS protocol supports both Glance and Cinder. Placing images on a NetApp FlexVol volume allows you to:

- Leverage the NetApp Data ONTAP deduplication and compression features.
- Use thin provisioning, encryption, and mirroring and choose back ends by disk type.
- Instantly provision instances by leveraging the NetApp Data ONTAP FlexClone feature. Further details are available in the "OpenStack@NetApp Deployment and Operations Guide" ([http://netapp.github.io/openstack-deploy-ops-guide/kilo/content/section\\_cinder-deployment-choices.html#cinder.volume\\_types](http://netapp.github.io/openstack-deploy-ops-guide/kilo/content/section_cinder-deployment-choices.html#cinder.volume_types)).

NetApp deduplication reduces the total storage footprint for a Glance repository when maintaining many images within the repository. The NetApp Cinder driver identifies that the Glance image repository, used by instances to boot from an image, uses a NetApp FlexVol volume. Thus, rapid-instance creation becomes possible with NetApp FlexClone technology, which dramatically reduces the time required to create the Cinder bootable volume. Figure 7 shows the relationship of Glance and Cinder on NetApp storage.

Figure 7) Glance and Cinder storage.



In this configuration, Glance and Cinder are used only to provision the SAP-specific operating system images. Figure 8 shows an example of using the "Boot from Snapshot copy" template that is used when creating an SAP virtual host compute instance. The templates are preconfigured images based on SUSE Linux Enterprise Server 11 SP3 with the SAP-specific configurations and RPMs required to run an adaptive-enabled SAP LVM system.

Figure 8) Boot from Snapshot copy image template.

**Launch Instance**

Details \* Access & Security \* Networking \* Post-Creation Advanced Options

**Availability Zone**  
nova

**Instance Name \***  
os032-004

**Flavor \***  
m1.medium

**Instance Count \***  
1

**Instance Boot Source \***  
Boot from snapshot

**Instance Snapshot**  
SUSE11SP3-SAP-Template-05

Specify the details for launching an instance.  
The chart below shows the resources used by this project in relation to the project's quotas.

**Flavor Details**

Name	m1.medium
VCPUs	2
Root Disk	40 GB
Ephemeral Disk	0 GB
Total Disk	40 GB
RAM	4,096 MB

**Project Limits**

**Number of Instances** 4 of 10 Used

**Number of VCPUs** 8 of 20 Used

**Total RAM** 16,384 of 51,200 MB Used

Cancel Launch

## Best Practice

Because there is a high probability of duplicate blocks in a Glance repository of VM images, NetApp highly recommends enabling deduplication on the FlexVol volume where the images are stored.

## Manila

The OpenStack Manila service enables management of persistent, shared-file-system resources. Manila is typically deployed in conjunction with other OpenStack services such as compute, object storage, image, and so on as part of a larger, more comprehensive cloud infrastructure. However, doing so is not an explicit requirement; Manila has been successfully deployed as a stand-alone solution for shared-file-system provisioning and lifecycle management. Manila also enables users to manage shared file systems using a CLI, a GUI, or the REST API interface.

A Manila share is the fundamental resource unit that is allocated by the shared-file-system service. For the context of NetApp Data ONTAP, this unit of allocation is a NetApp FlexVol volume. This volume is in contrast to a Cinder volume, which exists as a file within a NetApp FlexVol volume. It represents a persistent, readable, and writable file system that is accessible by the OpenStack compute instances.

All shares exist on a Manila back end that is defined within the Manila configuration file. The back end contains the parameters pertaining to the instance of the Manila-share service. A Manila configuration file can have multiple back ends defined, each representing a Manila-share service. In the context of using the NetApp Manila clustered Data ONTAP driver, the configuration file has parameters about the back end that define the operation of the driver and the details of the NetApp storage controller associated with that Manila-share service.

The connectivity between the physical storage and the consumer of the share uses either NFS or CIFS protocols. In this setup, we use NFS for connectivity of the Manila shares to the SAP systems on the SUSE Linux Enterprise Server compute instances.

In our setup, all OpenStack Manila services have been installed on a dedicated control node. SAP LVM with SAP's newly released storage adapter for Manila is configured so that SAP LVM can call the Manila services through REST API calls. This storage adapter allows storage-related functionality to be performed by Manila out of SAP LVM. All SAP-specific storage is provisioned by Manila. After the storage is provisioned, the ability to access the share is configured to enable the target system to mount the NFS volumes.

**Note:** The storage adapter for this solution was developed to enable integration between SAP LVM and OpenStack Manila using the Manila open APIs. The adapter enables the use of NFS file systems to support SAP applications.

## 4.4 NetApp Storage Design

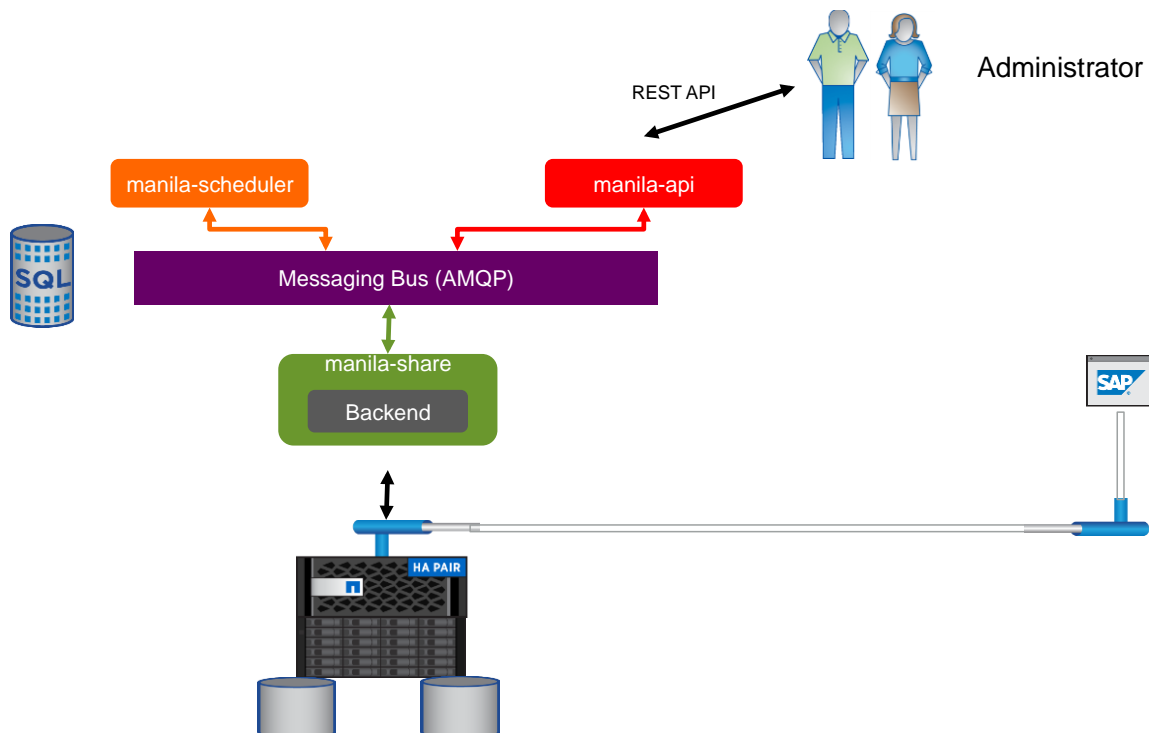
The NFS storage used for this setup follows guidelines and recommendations for SAP deployments. The storage design uses two NetApp FlexVol volumes per SAP instance: one for data and one for logs. The FlexVol volume used for the SAP logs is also used for the SAP executables. This design allows ease of cloning of SAP environments and easy recovery of the database, as required.

The initial storage provisioning for the SAP environment is performed with Manila. Two shares (or FlexVol volumes) are created for the initial SAP instance. These shares are then connected to an SAP-ready instance provisioned through OpenStack.

**Note:** The storage design for this setup might vary from other deployments. However, the key point is the separation of the log and data elements of the SAP system.

Figure 9 shows the logical architecture of Manila along with the storage design used for this PoC.

Figure 9) Manila storage design.



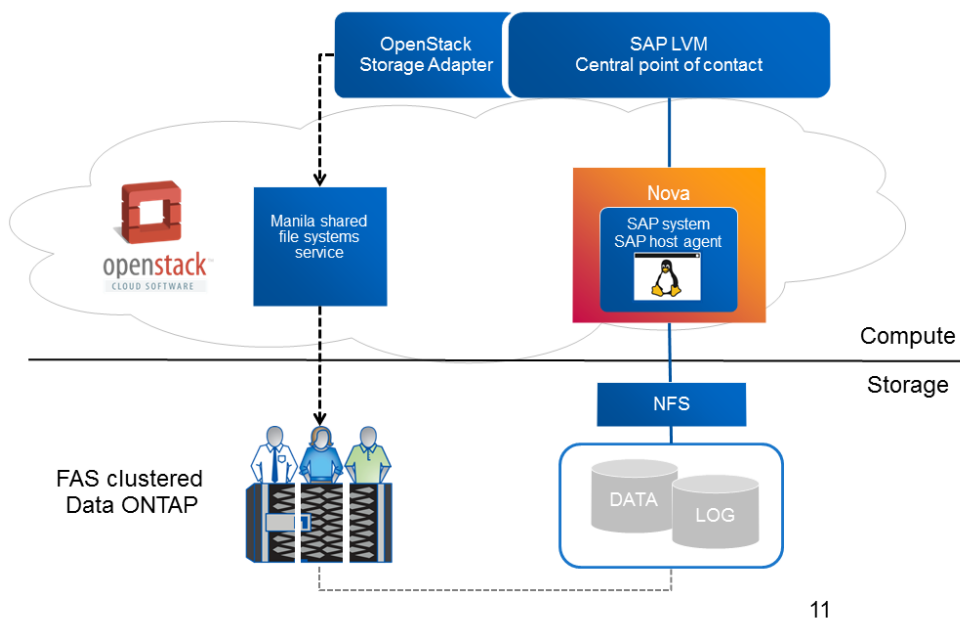


## 4.5 SAP LVM Storage Adapter

For this setup, the SAP environments are initially configured using NFS file systems based on the shares created with Manila. Using the NetApp Manila clustered Data ONTAP driver, the storage adapter is able to access NetApp storage features such as Snapshot copies and FlexClone. These features are important for improving SAP workflows such as SAP system copy and system clone and they allow efficient performance of those workflows within the OpenStack deployment.

This storage adapter was developed by SAP to demonstrate the integration of SAP LVM features into OpenStack using standard OpenStack API calls. With the help of NetApp OpenStack drivers integrated into OpenStack Manila, SAP LVM can utilize NetApp storage efficiency features through standard API calls. Figure 10 shows the architecture of the storage adapter.

Figure 10) Storage adapter logical architecture.



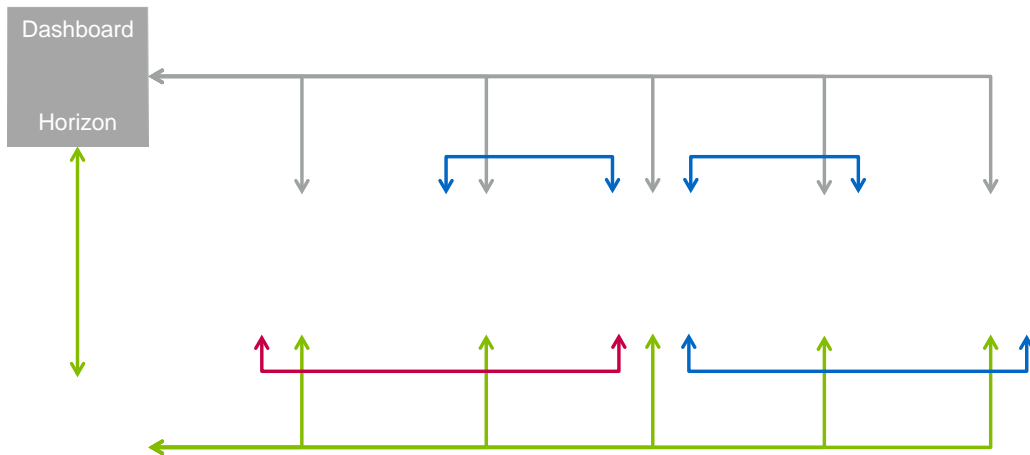
## 5 Architecture Requirements

Based on the requirements on an SAP-ready OpenStack infrastructure, the following architectures were chosen.

### 5.1 OpenStack Logical Architecture

Figure 11 shows the OpenStack modules used to architect an SAP-ready multitenant cloud solution using SUSE Cloud 5.

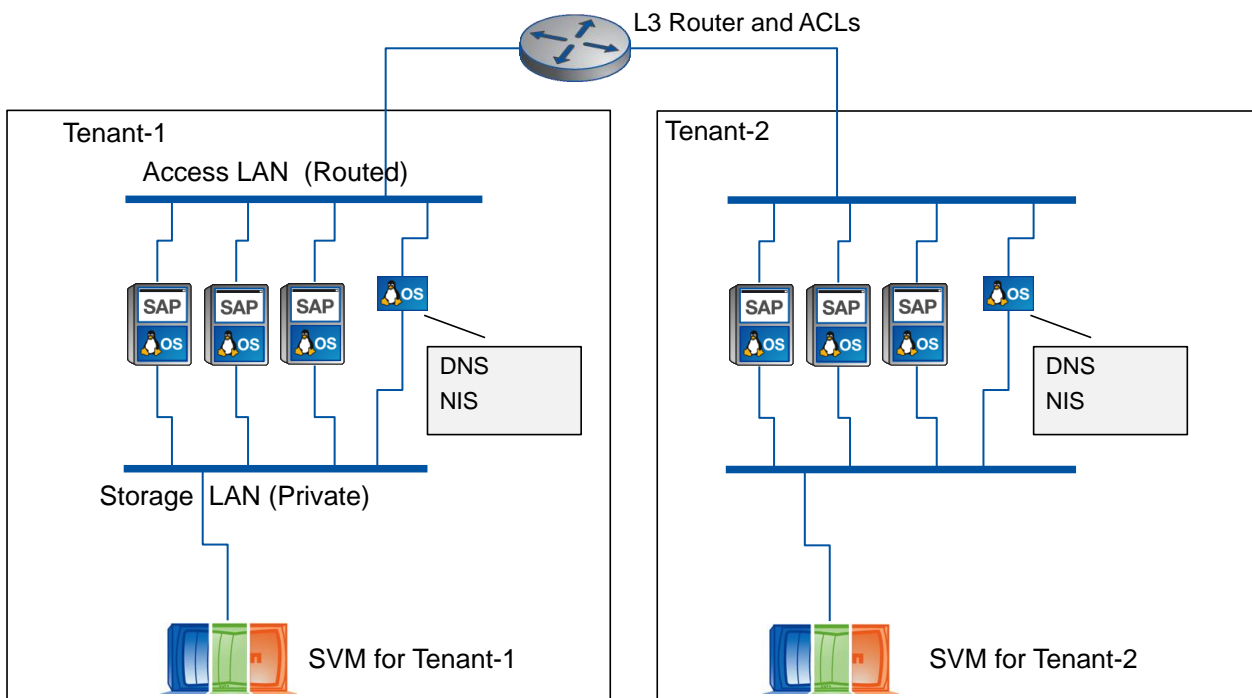
Figure 11) OpenStack logical architecture.



## 5.2 Tenant Logical Architecture

The purpose of the logical architecture shown in Figure 12 is to allow the tenant to isolate all SAP systems for one user from the SAP systems of another user. The isolation is achieved by using two independent Neutron networks using VLANs for each tenant. This setup provides the tenant isolation for the OpenStack instances, Manila shared networks, and NetApp storage virtual machines (SVMs).

Figure 12) Tenant architecture.



The following networking design points were taken into consideration to meet the requirements for this SAP setup:

- The access LAN (VLAN) is attached to a layer 3 router or firewall to allow customers to access the SAP systems.
- The storage LAN (VLAN) is a private network to allow the SAP systems to mount the NFS storage.
- A NetApp SVM dedicated to this tenant network is created to provision NFS storage.
- Each tenant hosts a small SUSE appliance to manage tenant-specific DNS name resolution and user management using NIS. This implementation is used as an example implementation for the required central services to implement the SAP adaptive design principles (see section 4.2).

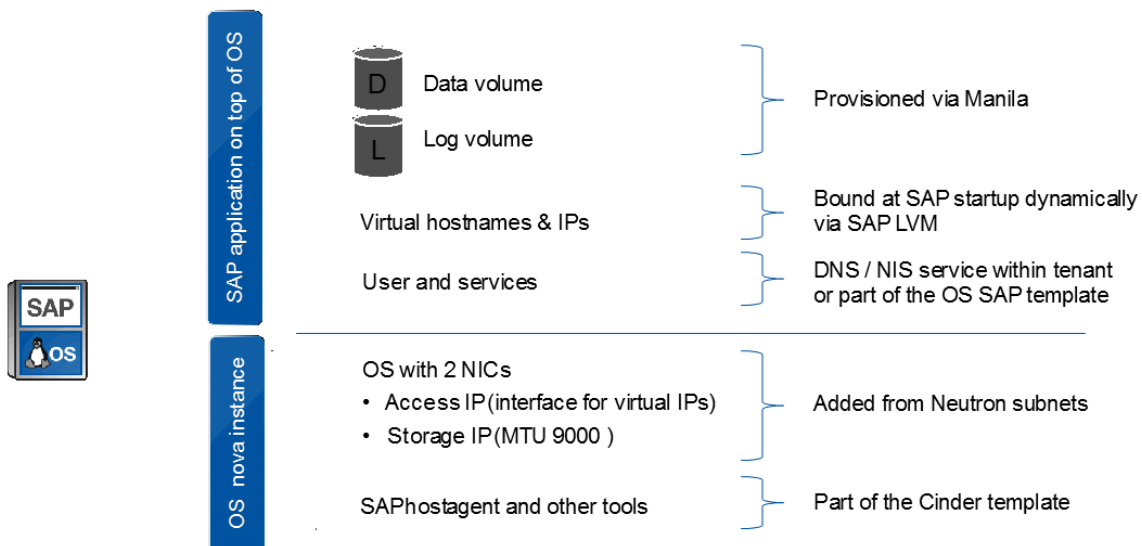
**Note:** The tenant architecture objective is to provide an example of multitenant isolation of SAP systems.

### 5.3 SAP Logical Architecture

The SAP systems are set up based on adaptive computing principles, discussed in “SAP Design and Deployment Considerations,” using a prepared SAP and SUSE image template from the Glance repository. This template was used to create all compute instances required for this PoC.

Figure 13 shows the logical architecture used for the SAP applications, storage, and Nova compute instances.

Figure 13) SAP architecture components.



### Networking

Virtual host names and IP addresses are used for the SAP services. For this PoC, a typical SAP NetWeaver AS ABAP environment defines three virtual host names. Following is an example of the three SAP services required to have virtual host names:

- db<sid>: System database host name
- cs<sid>: Central services host name
- ci<sid>: Central instance host name

### Storage

The SAP-specific file systems are stored on two NFS file systems. These file systems, as mentioned earlier, were initially created with Manila. This configuration also enables easy integration of the system

clone or system copy with the storage adapter. This setup is optimized to support a NetApp Snapshot copy-based backup.

## User and Services

During the installation, SAP-specific users and services are created. Depending on the type of SAP application and database, different naming conventions are used. In the case of an Oracle-based SAP installation, the users `<sid>adm` and `ora<sid>` are created for an SAP system using the system identifier (SID) of `<sid>`. In addition, an SAP host agent is available on each compute instance. This setup is part of the prepared SAP template within the OpenStack Glance repository.

**Note:** The SAP virtual host names must be configured in DNS using the correct fully qualified domain name (FQDN) for the appropriate tenant. Doing so enables SAP LVM to communicate with each host accordingly.

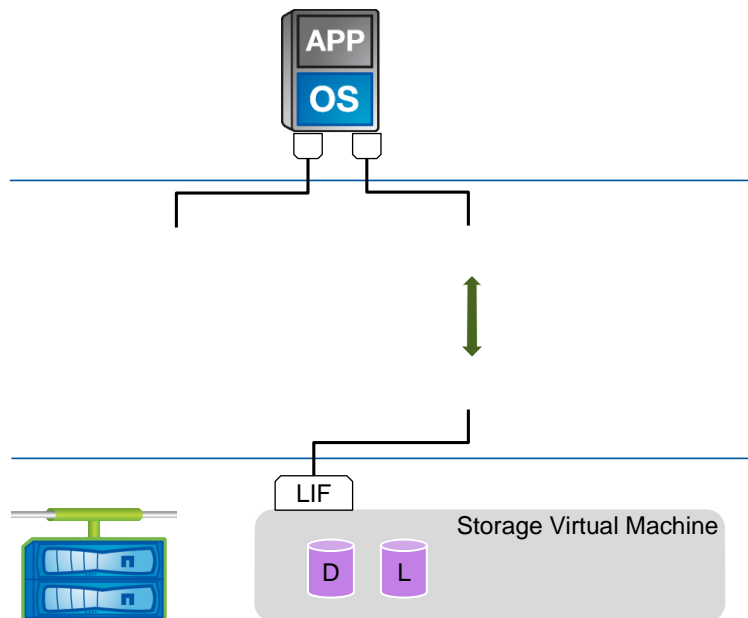
**Note:** The storage design is optimized by the separation of the data and the log into their own NetApp FlexVol volumes to allow data recovery if required.

**Note:** The SAP host agent must be available on each compute instance (VM) for proper communication between the SAP applications and SAP LVM.

## 5.4 Manila Logical Architecture

OpenStack Manila with the NetApp clustered Data ONTAP driver provisions the storage on a NetApp FAS system running clustered Data ONTAP. For every tenant, a Manila shared network is created for the configured Neutron storage network. A Neutron network is defined for storage connectivity between the storage and the compute instances. An additional Neutron network is defined that allows connectivity to the compute instances by SAP LVM or other SAP clients. Figure 14 shows the Manila and NetApp storage architecture.

Figure 14) Manila and NetApp logical architecture.



**Note:** It is important to configure the Manila share network elements with the proper Neutron network definitions to facilitate proper connectivity for SAP LVM and NetApp NFS storage for each compute instance.

## Share Server Management

Starting with the OpenStack Kilo version of Manila, the NetApp driver for clustered Data ONTAP offers two distinct methods to connect to the FAS back-end controller.

- **With share server management.** In this scenario, at the time of a share creation, Manila identifies in which Neutron network the file systems (that is, shares) need to be attached. Doing so creates a new Manila share server and, on the NetApp controller, a new storage virtual machine (SVM) with a LIF connected to that Neutron network. To do so, a Manila share network must be created and assigned to the Neutron network. You can get further details about using Manila with share server management in the “OpenStack@NetApp Deployment and Operations Guide” ([http://netapp.github.io/openstack-deploy-ops-guide/kilo/content/manila.cdott\\_multi\\_svm.configuration.html](http://netapp.github.io/openstack-deploy-ops-guide/kilo/content/manila.cdott_multi_svm.configuration.html)).

**Note:** Using share server management lets Manila take care about the complete storage configuration and is thus more automated, but it offers fewer configuration and tuning options for the storage administrator.

**Note:** To use Manila share server management, it is important to configure the Manila share network elements with the proper Neutron network definitions.

- **Without share server management.** In this case, no Neutron network integration is required. Instead, the administrator has to prepare one or more SVMs up front and the Manila back-end configurations are directly connected to these SVMs. This configuration is called a stand-alone or manual configuration. We discuss this specific use case in section 7, “Manila Stand-Alone Configuration.”

**Note:** SVMs are the NetApp storage virtualization layer. SVMs are used to map a virtualized storage controller to an OpenStack tenant to enable a secure multitenant environment within OpenStack that includes the storage layer. You can get further details about using Manila with share server management in the “OpenStack@NetApp Deployment and Operations Guide” ([http://netapp.github.io/openstack-deploy-ops-guide/kilo/content/manila.cdott\\_single\\_svm.configuration.html](http://netapp.github.io/openstack-deploy-ops-guide/kilo/content/manila.cdott_single_svm.configuration.html)).

## 6 Deployment Procedures

Using NFS file shares for an SAP application has many benefits, such as ease of use and configuration. These shares also offer more flexibility when moving or copying an SAP system from one platform to another or one system to another because the SAP data exists in a platform-independent format. NetApp storage features extend this concept to efficiently use SAP LVM workflows. We can extend that functionality to an OpenStack cloud with Manila. NetApp storage can also provide the flexibility to enable a data fabric with integration to SAP LVM.

The following sections provide information about the configuration of the different components used to accomplish the use-case objectives.

### 6.1 SAP, Neutron, and Manila Using Manila Shared Servers

We describe the full workflow for using Manila with share server management in the following section. Section 7 focuses on using Manila without shared server management in stand-alone mode.

Using SUSE Cloud 5, most of the OpenStack configuration steps can be provided using the SUSE graphical dashboard (Crowbar bar clamps), including the Manila configuration. For simplicity we discuss the configuration using the resulting `manila.conf` configuration file.

### Manila Configuration

The configuration of Manila is similar to that for Cinder, with one major difference. A Manila back end is a NetApp SVM, whereas a Cinder back end is a NetApp FlexVol volume. You must define a Manila back

end and associate the appropriate storage parameters to be configured for use by the NetApp Manila unified driver for clustered Data ONTAP.

The following is an example of a Manila configuration file (`manila.conf`) used by Manila to communicate to the defined NetApp storage controller. In this example configuration:

- A back end is defined using a NetApp unified driver for clustered Data ONTAP with share server management.
- The protocol used for communication between Manila and the NetApp storage is HTTPS.
- The Manila back end communicates to the clustered Data ONTAP controller cluster IP address of 172.23.111.100.

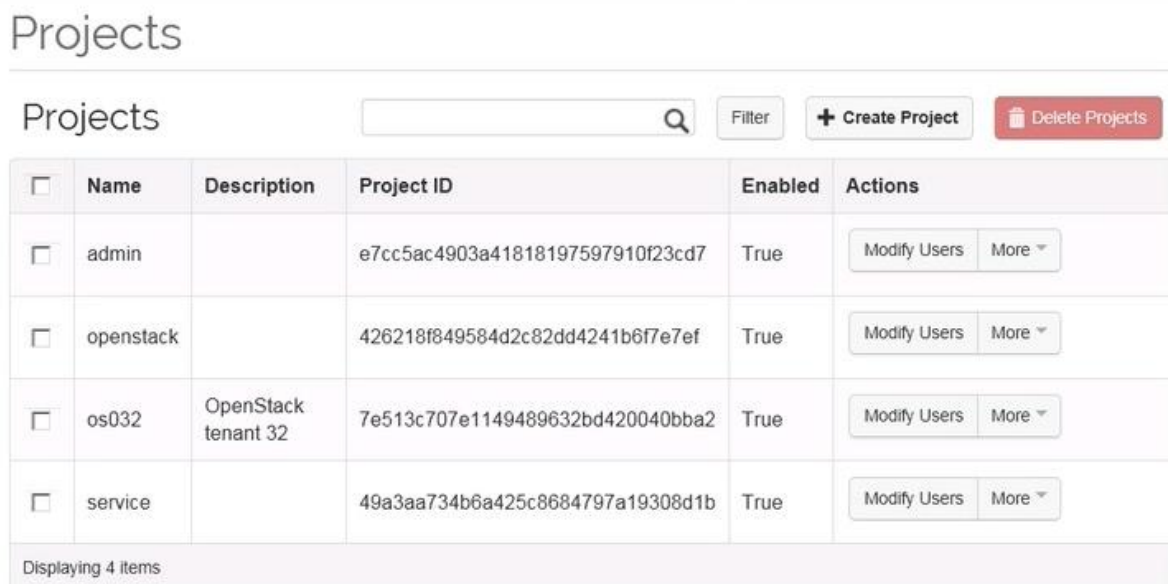
```
# A list of backend names to use. These backend names should
# be backed by a unique [CONFIG] group with its options (list
# value)
enabled_share_backends=BACKENDNETAPP
.
.
.
[BACKENDNETAPP]
share_backend_name=BACKENDNETAPP
share_driver=manila.share.drivers.netapp.common.NetAppDriver
driver_handles_share_servers=True
netapp_storage_family=ontap_cluster
netapp_server_hostname=172.23.111.100
netapp_login=admin_username
netapp_password=admin_password
netapp_transport_type=https
netapp_root_volume_aggregate=aggr1
```

For more details on the Manila configuration file, refer to the [OpenStack Deployment and Operations Guide V5.0](#).

## OpenStack Tenant Name

OpenStack is organized into tenants, or projects. The easiest way to identify the defined projects of an OpenStack deployment is to use the OpenStack Horizon dashboard, shown in Figure 15. In this example, the OpenStack project used is named “os032.”

Figure 15) Project view in OpenStack Horizon dashboard.



<input type="checkbox"/>	Name	Description	Project ID	Enabled	Actions
<input type="checkbox"/>	admin		e7cc5ac4903a41818197597910f23cd7	True	Modify Users More ▾
<input type="checkbox"/>	openstack		426218f849584d2c82dd4241b6f7e7ef	True	Modify Users More ▾
<input type="checkbox"/>	os032	OpenStack tenant 32	7e513c707e1149489632bd420040bba2	True	Modify Users More ▾
<input type="checkbox"/>	service		49a3aa734b6a425c8684797a19308d1b	True	Modify Users More ▾

Displaying 4 items

## Tenant Neutron Configuration

In this setup, each tenant has two Neutron networks configured to enable proper connectivity. Each network is assigned its own range of IPs, VLAN ID, and Neutron network name. The Neutron commands for the os032 tenant, with tenant ID 7e513c707e1149489632bd420040bba2, are shown here:

```
neutron net-create --tenant-id 7e513c707e1149489632bd420040bba2 os032-access --
provider:network_type vlan --provider:physical_network physnet1 --provider:segmentation_id 132

neutron subnet-create --tenant-id 7e513c707e1149489632bd420040bba2 os032-access --name net32 --
gateway 192.168.32.1 --allocation-pool 192.168.132.0/24

neutron net-create --tenant-id 7e513c707e1149489632bd420040bba2 os032-backend --
provider:network_type vlan --provider:physical_network physnet1 --provider:segmentation_id 332

neutron subnet-create --tenant-id 7e513c707e1149489632bd420040bba2 os032-backend --name net132
--allocation-pool start=192.168.132.10,end=192.168.132.50 192.168.132.0/24
```

The following text exhibits the available networks used by the os032 tenant.

```
d00-50-56-9e-bf-a2:~ # neutron net-list
+-----+-----+-----+
| id | name | subnets |
+-----+-----+-----+
| b033bf90-b333-4f65-8ce0-a534286289f5 | floating | 2a2b5085-0db4-4abc-9d2d-c81fb7134b90 |
192.168.30.0/24 |
| edb9a711-251e-4a81-a741-ab4283407ec4 | os032-backend | 2bdd0b0a-0590-4597-9c43-fc16fc138b5d |
192.168.132.0/24 |
| 79248eee-0f25-4d79-b3d6-513f9170ac9f | fixed | 652971b8-64d1-40be-be28-c0163a505772 |
192.168.31.0/24 |
| be216a3b-0ad5-4b9b-8670-ea30cab113eb | os032-access | 0a89735f-167c-4eeb-acc7-6d99fb2cd0da |
192.168.32.0/24 |
+-----+-----+-----+
```

The details of the os032 Neutron access network are shown next. The SAP clients and SAP LVM use this network for access to the compute instance.

```
d00-50-56-9e-bf-a2:~ # neutron net-show be216a3b-0ad5-4b9b-8670-ea30cab113eb
+-----+-----+
| Field | Value |
+-----+-----+
| admin_state_up | True |
| id | be216a3b-0ad5-4b9b-8670-ea30cab113eb |
| name | os032-access |
| provider:network_type | vlan |
| provider:physical_network | physnet1 |
| provider:segmentation_id | 132 |
| router:external | False |
| shared | False |
| status | ACTIVE |
| subnets | 0a89735f-167c-4eeb-acc7-6d99fb2cd0da |
| tenant_id | 7e513c707e1149489632bd420040bba2 |
+-----+-----+
```

**Note:** Note the IP address ranges that Neutron networks and Neutron subnets used for this tenant. The physical network infrastructure was configured to enable these VLANs.

## Manila Share Network Configuration

In this setup, a share network was required for Manila. A share network makes available the Neutron network information required when creating the Manila shares. Manila uses that network and IP

The following is an example of the creation of the share network named `share-os032-1` that uses the Neutron network configured for the storage network (`os032-backend`). This share network uses the `192.168.132.0/24` IP address pool as defined in the Neutron subnet network definition.

**Note:** To create a managed share server, the network information within Neutron is provided to Manila to define the proper network interfaces and the NFS export locations for the Manila shares used by the compute instances.

Virtual IPs and host names are part of the adaptive design principle and are SAP's method of application virtualization. During startup of the SAP system, virtual IPs are bound as additional (secondary) IPs onto the access network. The philosophy of this design is to allow an SAP application to move from one host to another. In this setup, a specific SAP application—or, more specifically, an SAP service—can run on any host within a given tenant.

To make this setup easier, segments of the tenant access subnet have been reserved for SAP virtual IPs. All instances within a tenant have been modified to allow communication for this SAP-specific virtual IP range.

1. Check the running instance to identify the instance IPs. In this example, we focus on the instance `os032-004`, using the `os032-access` network IP address `192.168.32.30`.

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ID	Name	Status	Task State	Power State
493e70ac-08bd-49df-9261-548725b4b812	os032-001	SHUTOFF	-	Shutdown
os032-backend=192.168.132.15; os032-access=192.168.32.15	e924056a-ae75-4e6d-a1fc-726370a6df0a	os032-002	ACTIVE	-
os032-backend=192.168.132.34; os032-access=192.168.32.28	ff738e03-997f-4e59-bb3f-f296cdf22cb5	os032-003	ACTIVE	-
os032-backend=192.168.132.35; os032-access=192.168.32.29	f275b1f9-4d46-452c-81a4-23cd0c9ea68a	os032-004	ACTIVE	-
os032-backend=192.168.132.36; os032-access=192.168.32.30	a52f08b6-afe6-44a6-96fe-db35d4eb0080	os032-senil	ACTIVE	-
os032-backend=192.168.132.2; os032-access=192.168.32.2				

## 2. Identify the Neutron port for this instance.

```
d00-50-56-9e-bf-a2:~ # neutron port-list
```

id	name	mac_address	fixed_ips
6e6805ab-2034-442b-b270-2655bc51eb4f		fa:16:3e:79:65:81	{"subnet_id": "2bdd0b0a-0590-4597-9c43-fc16fc138b5d", "ip_address": "192.168.132.26"}
138f1e36-a4f7-4738-8ffd-3942e0508314		fa:16:3e:a9:7e:b4	{"subnet_id": "0a89735f-167c-4eeb-acc7-6d99fb2cd0da", "ip_address": "192.168.32.30"}
4714bd8b-f9cf-4963-b81c-479aa61699b4		fa:16:3e:e5:c7:7a	{"subnet_id": "652971b8-64d1-40be-be28-c0163a505772", "ip_address": "192.168.31.1"}
71e02c1a-06c8-4b82-af76-a81518934308		fa:16:3e:04:f2:54	{"subnet_id": "0a89735f-167c-4eeb-acc7-6d99fb2cd0da", "ip_address": "192.168.32.11"}

## 3. Add the IP range on this port—138f1e36-a4f7-4738-8ffd-3942e0508314—for the SAP application requirements.

```
d00-50-56-9e-bf-a2:~ # neutron port-update 138f1e36-a4f7-4738-8ffd-3942e0508314 --
allowed_address_pairs list=true type=dict ip_address=192.168.32.128/27
Updated port: 138f1e36-a4f7-4738-8ffd-3942e0508314
d00-50-56-9e-bf-a2:~ # neutron port-show 138f1e36-a4f7-4738-8ffd-3942e0508314
```

Field	Value
admin_state_up	True
allowed_address_pairs	{"ip_address": "192.168.32.128/27", "mac_address": "fa:16:3e:a9:7e:b4"}
binding:host_id	d00-25-b5-00-7a-9f
binding:profile	{}
binding:vif_details	{"port_filter": true}
binding:vif_type	bridge
binding:vnuc_type	normal
device_id	f275b1f9-4d46-452c-81a4-23cd0c9ea68a
device_owner	compute:nova

```

| extra_dhcp_opts      |
|
| fixed_ips            | {"subnet_id": "0a89735f-167c-4eeb-acc7-6d99fb2cd0da", "ip_address":
"192.168.32.30"} |
| id                   | 138f1e36-a4f7-4738-8ffd-3942e0508314
|
| mac_address          | fa:16:3e:a9:7e:b4
|
| name                 |
|
| network_id           | be216a3b-0ad5-4b9b-8670-ea30cab113eb
|
| security_groups      | 6e5661a6-f833-4300-9578-9bdaf16f6e35
|
|                      | 8458134a-aab7-4f82-a5ac-a50222033ba1
|
| status               | ACTIVE
|
| tenant_id            | 7e513c707e1149489632bd420040bba2
|
+-----+-----+
-----+

```

Doing these things allows all SAP virtual IPs of the segment 192.168.32.128/27 to reach the compute instance.

## Manila Share Provisioning for SAP

In this setup, two Manila shares are used for the SAP instance. These shares are used as described in section 5.3 of this document. These shares, or FlexVol volumes, are created on NetApp storage as defined for the Manila back end used for this SAP instance.

The size of the Manila shares for the SAP environment depends on which SAP applications are installed. The Manila shares used by SAP for this small SAP NetWeaver ABAP system are 100GB and 40GB, respectively.

The following is an example of creating the `SAP-SID-data` share, or FlexVol volume, using the share network created in the section “Manila Share Network Configuration.” This share is available for the compute instances on the 192.168.132.0/24 network.

```
manila create --name SAP-SID-data --share-network 5b281fef-c968-4a9b-8071-dcb0cf4767cd NFS 100
```

## SAP File Systems

The volume and mount point layout must align with the SAP installation guidelines for the selected SAP applications. For more details about an SAP installation using Oracle with NFS, refer to [SAP with Oracle on UNIX and NFS with NetApp Clustered Data ONTAP | TR-4250](#).

Table 1 shows the volume layout, file system, and mount-point information referenced in TR-4250.

The two Manila shares created for this SAP NetWeaver ABAP system refer to the minimum configuration with the following file system layout.

**Table 1) Volume layout and mount points.**

sapdata	saplog
/oracle/SID/sapdata1	/oracle/SID/origlogA
/oracle/SID/sapdata2	/oracle/SID/origlogB
/oracle/SID/sapdata3	/oracle/SID/mirrlogA
/oracle/SID/sapdata4	/oracle/SID/mirrlogB
	/oracle/SID/oraarch
	/oracle/SID
	Oracle binaries
	SAP binaries

#### Best Practice

NetApp recommends that you follow the file system design described in [SAP with Oracle on UNIX and NFS with NetApp Clustered Data ONTAP | TR-4250](#).

## 6.2 SAP LVM Integration

SAP LVM can help manage the SAP systems within an OpenStack Cloud infrastructure by SAP basis administrators. To use SAP LVM, the infrastructure and installed SAP systems must be configured within SAP LVM. The following prerequisites must be fulfilled when using SAP LVM to manage this type of configuration:

- SAP LVM must be in a network in which it can reach all SAP systems within all managed tenants. Doing so requires access to the FQDNs for each host and service IP. Thus, DNS must be set up properly.
- For each tenant, the SAP LVM-specific organizational units and tenant configuration must be prepared before a system can be added.
- To add SAP systems to SAP LVM, the systems must be installed and running.

The following sections provide an overview of the necessary configuration tasks specific to this OpenStack installation.

### SAP LVM Tenant-Specific Configuration

The LVM equivalent of an OpenStack tenant is called a pool. A pool is configured to group the landscape entities, as well as to separate them. This logical grouping assists in more effective management of the environment and organizes SAP LVM to align with the OpenStack tenant structure. A pool must be created and the networks used by the OpenStack resources must also be added to SAP LVM. For this OpenStack setup, the pools and network elements must be configured within SAP LVM before adding compute nodes.

### Adding Compute Nodes to SAP LVM

Each compute instance within a tenant must be added to SAP LVM. The SAP LVM equivalent of an OpenStack compute instance is a host. The SAP host agent must be installed and running on each compute instance for SAP LVM to communicate with any of the compute instances. This setup is part of the preconfigured and prepared images maintained within the Glance repository.

Hosts, or OpenStack compute instances, are added by using the Hosts tab in the Configuration window using autodetection. Figure 16 shows hosts added to SAP LVM.

Figure 16) Add hosts using SAP LVM.

**SAP Landscape Virtualization Management**

Overview Operations Provisioning Automation Monitoring **Configuration** Infrastructure

Pools Systems **Hosts** Characteristics \*Generator Simulator\* \*VCM Simulator\*

Save Cancel Previous Next

1 Find Instances/Hosts 2 Add Instances 3 Add Hosts 4 Summary

Newly Assigned Instances: 0 of 0 non-managed instance(s) found  
Newly Assigned Hosts: 0 of 0 non-managed host(s) found

**Source Details**

Source: \* Detect Using Host and Instance Agent

Find: Instances and Hosts

Include Instances/Hosts Managed Already: ☐  
Include Diagnostics Agents for Instances: ☒  
Detect Standalone Databases: ☐  
Detect Shadow Databases: ☐

**Detect Using Host Agent and Instance Agent**

Detect Timeout (seconds): 30 Expert Mode

**Host Names Used for Detection**

Host Names (Separated by ','): \*

**Common Host Agent Settings for All Host Names Used**

Host Agent Port: 1128  
Use Secure Communication (HTTPS): ☐  
Authentication Type: Default Credentials (Basic)

**Instance Agent Settings**

The settings specified below will be used for all SAP instances found.  
If you specify the wrong parameters, some instances might not be detected. This can be corrected later by going to the instance configuration, editing these SAP instances, and entering the correct credentials and/or ports.  
For more information, see SAP Note [1474866](#).

Use Secure Communication (HTTPS): ☐

**Note:** SAP hosts must be resolvable by their FQDN.

## Adding SAP Systems

For this setup, a final step of the SAP LVM configuration is to add all of the SAP systems to SAP LVM.

To use the workflow wizard with autodetection, the SAP systems (the SAP system services) must be started. SAP LVM detects all SAP instances and NFS file systems and the available mount points. This configuration is used later by SAP LVM to dynamically mount the required file systems after a system copy operation. Figure 17 shows SAP systems detected using the workflow wizard.

Figure 17) SAP systems detected using the workflow wizard.

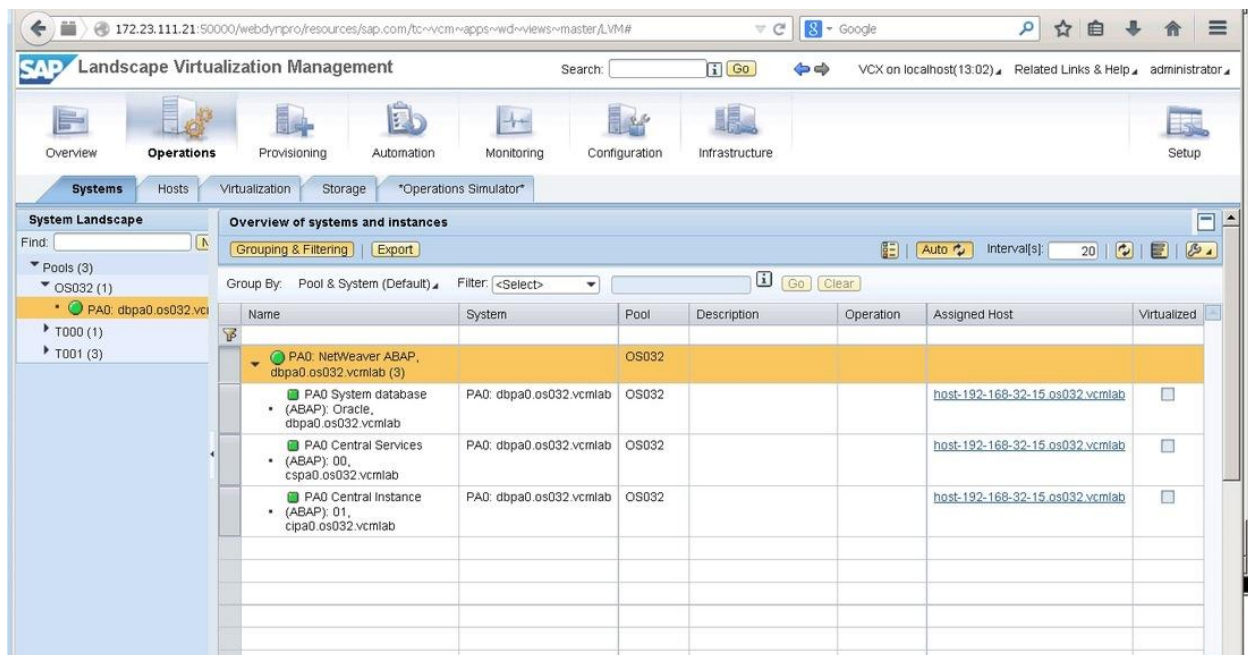


Figure 17 shows a typical ABAP stack for SAP systems running within an OpenStack deployment. The SAP system with SID `PA0` has three SAP instances:

- Database
- Central services
- Central instance

All three of the SAP instances run on the corresponding SAP virtual host names:

- `dbpa0.os032.vcmlab`
- `cspa0.os032.vcmlab`
- `cipa0.os032.vcmlab`

These services and SAP virtual host names run on the OpenStack/compute instance `host-192-168-32-15.os032.vcmlab`.

**Note:** An advantage of this configuration is that all SAP systems within an OpenStack tenant can be controlled and managed by SAP LVM. Another advantage is that SAP LVM is capable of mounting the NFS file systems created by Manila to the OpenStack compute instances.

## SAP LVM Extensibility

The extensibility of SAP LVM was leveraged to integrate additional OpenStack infrastructure functionality from Horizon into the SAP LVM management GUI. Doing so gives SAP administrators the opportunity to manage the infrastructure from SAP LVM. Custom tabs and custom links are examples of SAP LVM extensibility.

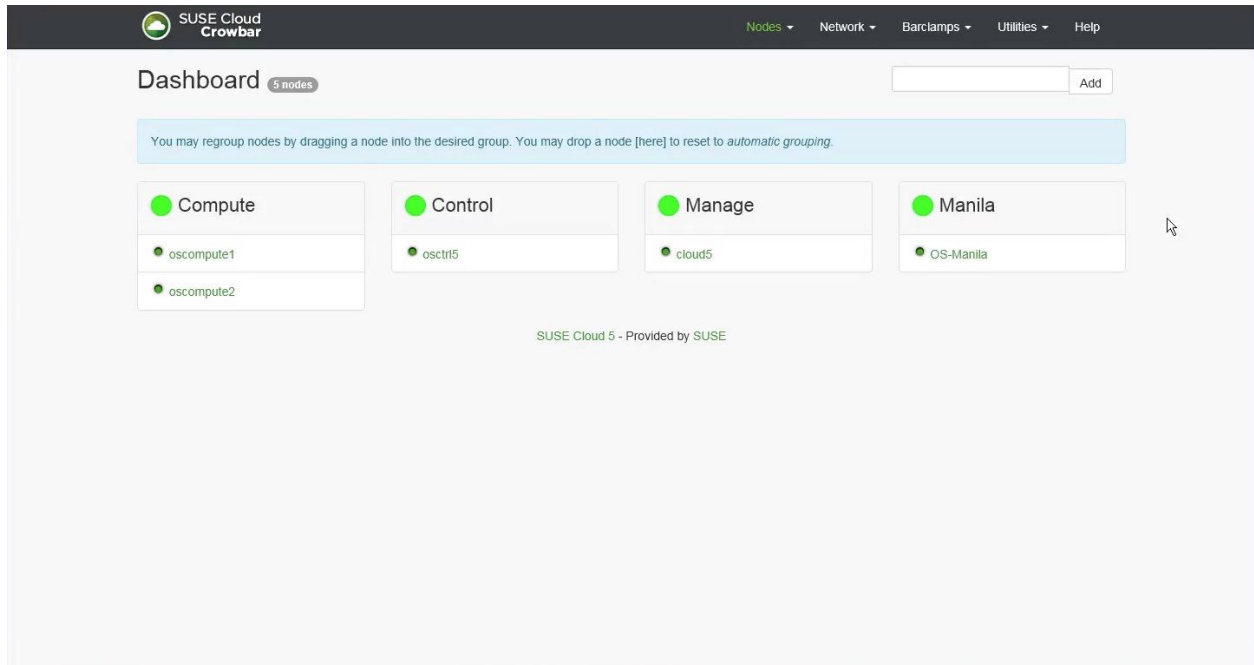
## Custom Tabs

Custom tabs provide integration with other browser-based pages. For example, in this setup, we integrated the following with SAP LVM using custom tabs:

- SUSE Cloud 5 management GUI
- NetApp OnCommand® System Manager

Figure 18 shows a custom tab for the SUSE Cloud 5 management GUI within the standard SAP LVM infrastructure.

Figure 18) SUSE Cloud 5 management custom tab.



## Custom Links

Another useful extension is the ability to make available custom links to the SAP administrator. In this setup, a custom link was implemented to view the compute instance information from within the OpenStack Horizon dashboard GUI. Viewing is done directly from an instance displayed in SAP LVM, providing the SAP administrator with a direct link to the OpenStack instance management pages within Horizon.

Figure 19 shows an example of a custom link within SAP LVM defined for the OpenStack Horizon GUI.

Figure 19) Custom link to OpenStack Horizon GUI.

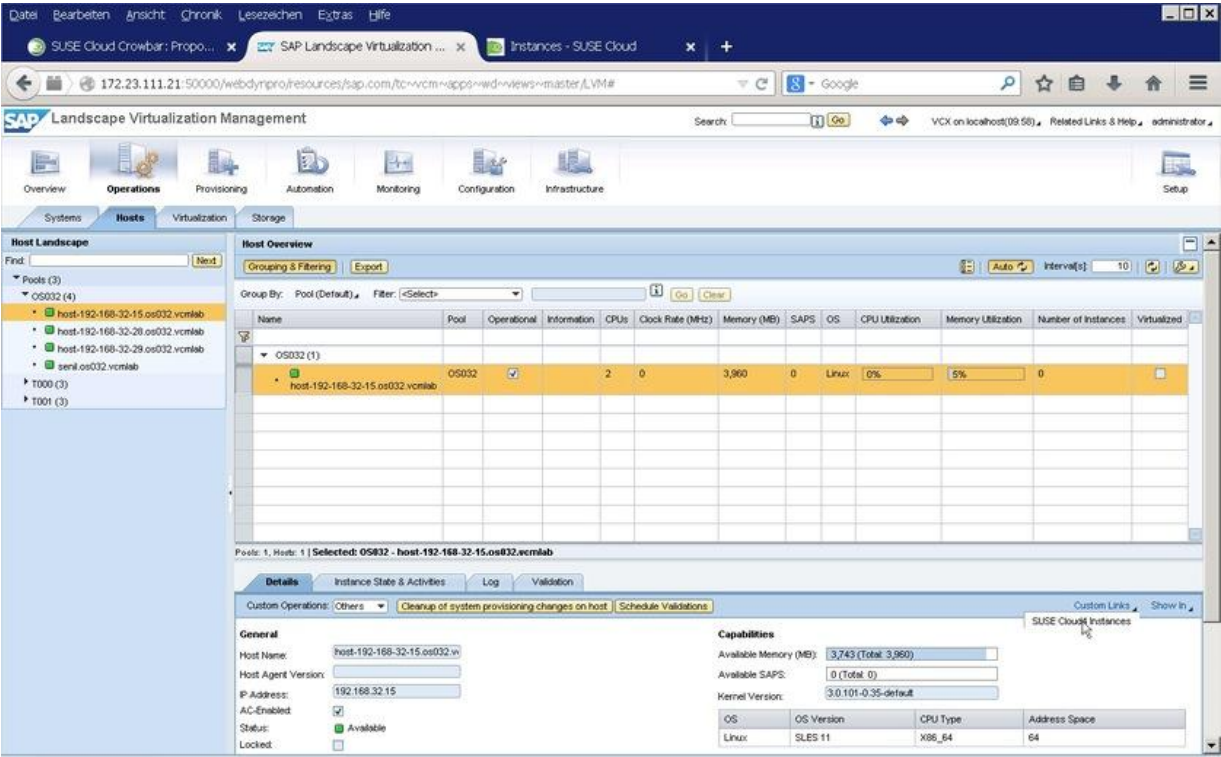
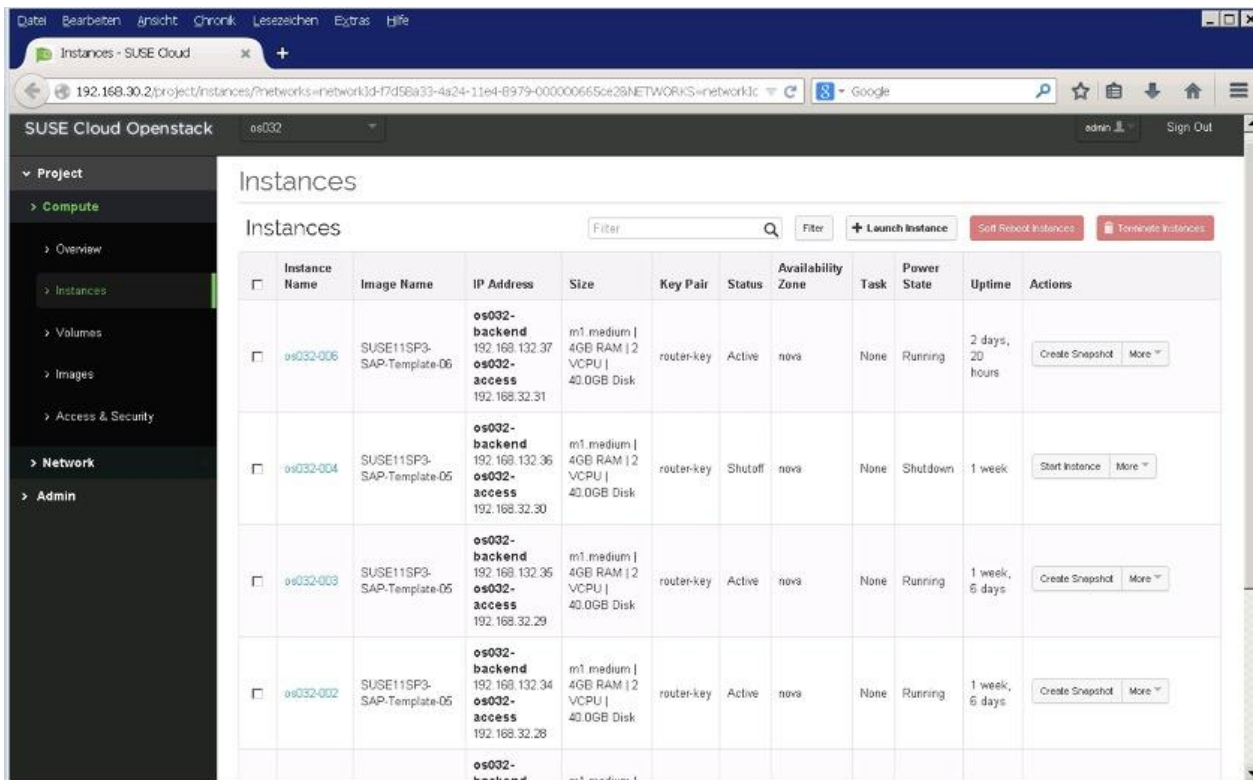


Figure 20 shows the result of using the custom link within SAP LVM shown in Figure 19. The custom link provides the link to the Instances view in Horizon.



Figure 20) OpenStack Horizon dashboard accessed using SAP LVM custom link.



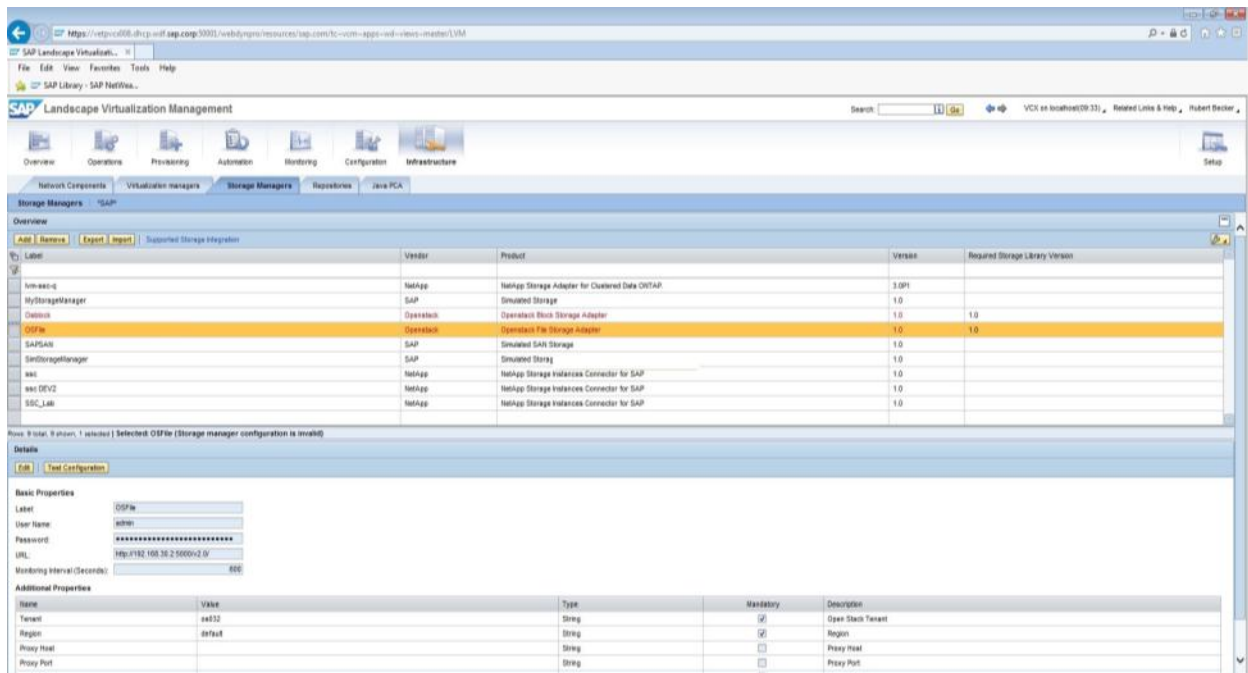
**Note:** Using both custom tabs and custom links provides access to other management tools through a single SAP LVM interface.

## SAP OpenStack Storage Adapter

Users need to deploy the precompiled .ear file from <https://github.com/SAP/lvm-openstack-adapters/blob/master/LVMAdaptersApp/target/LVMAdaptersApp-1.0.ear> into the SAP NetWeaver Java engine in which SAP LVM runs. You can find details about deployment options on SAP's GitHub page.

**Note:** The storage adapter must be configured within SAP LVM to leverage its functionality. The SAP administrator must add the necessary details within the SAP LVM infrastructure section for storage managers, as shown in Figure 21.

Figure 21) Storage manager configuration.



### 6.3 SAP Cloning

A typical SAP system landscape deploys multiple SAP systems and SAP system types. SAP basis administrators often have to copy or clone a system. Reasons for these copies include:

- The need for additional test systems
- The need to refresh a QA system as a copy of a production system to include new data
- The need to create a repair system as a copy of the production to narrow down an error situation

Copying or cloning an SAP system should not be a neglected effort and can consume several hours or days depending on the amount of data in the source system. Challenges with SAP system copies include:

- A huge amount of data must be copied and the source data must be in a consistent state, which is the reason why frequent backups are taken as the basis for system copies.
- To copy a system, the SAP system identifier must be changed to be able to integrate the new system into an existing landscape. Doing so requires a tremendous amount of SAP basis configuration and changes that could last a very long time.

To solve these challenges, the OpenStack storage adapter for Manila and NetApp unified driver for clustered Data ONTAP enable SAP LVM to leverage NetApp storage features and improve the copy or cloning process. The combination of SAP LVM cloning workflows together with SAP LVM's ability to integrate NetApp storage features reduces the time required for these functions to minutes instead of hours. This integration automates this process, even within OpenStack. SAP clones are both time and space efficient using the NetApp features. SAP clones consume almost no additional storage instead of the hundreds of gigabytes that an original SAP infrastructure can consume.

The basis for this improvement is the use of NetApp Snapshot copies. NetApp Snapshot copies can be used to create application-consistent backups of databases. NetApp Snapshot copies can also be used to create new cloned FlexVol volumes with NetApp FlexClone technology. Although this process is true in a conventional SAP and NetApp environment, it is also possible in an OpenStack infrastructure through NetApp Manila drivers and the SAP LVM prototype storage adapter.

The application improvement is built in as standard workflows within SAP LVM. SAP LVM workflows automatically include all components so that a cloned system can be started immediately without interfering with existing systems.

The SAP system-cloning workflow is initiated from the SAP LVM Provisioning section, from the System and AS Provisioning tab, as shown in Figure 22.

Figure 22) SAP system cloning workflow initiation.



As part of the workflow, the storage adapter is called and initiates the Manila Snapshot command to create the foundation for a NetApp FlexClone volume. With the NetApp Manila clustered Data ONTAP driver, Manila creates NetApp Snapshot copies based on the parameters passed from SAP LVM through the storage adapter to the Manila API. The creation of these Snapshot copies takes seconds. With the NetApp Snapshot copy, new Manila shares are created almost instantaneously by creating a new Manila share from a Manila Snapshot copy. This process within Manila creates new FlexClone volumes. The new Manila shares, or FlexClone volumes, automatically become part of the SAP LVM workflow and are linked to the new SAP system being created by the cloning workflow.

The following Manila command shows the initial and cloned Manila shares created by SAP LVM using the storage adapter to OpenStack Manila after the SAP LVM cloning workflow.

```
d00-50-56-9e-bf-a2:~ # manila list
```

ID	Name	Size	Share Proto	Status
Export Location				
6d0e2075-7c25-4578-bfcf-c1ea6b535d27	os032-PA0-data_clone	100	NFS	available
192.168.132.26:/share_6d0e2075_7c25_4578_bfcf_c1ea6b535d27				
7e120d32-e0b5-42eb-a01f-d3f3ba8606c8	os032-PA0-log	60	NFS	available
192.168.132.26:/share_7e120d32_e0b5_42eb_a01f_d3f3ba8606c8				
9db68370-802a-47f5-8ac6-2ee488f19966	os032-PA0-data	100	NFS	available
192.168.132.26:/share_9db68370_802a_47f5_8ac6_2ee488f19966				
e8b82047-a85b-4ed4-b36c-2d06561eeb77	os032-PA0-log_clone	60	NFS	available
192.168.132.26:/share_e8b82047_a85b_4ed4_b36c_2d06561eeb77				

Figure 23 shows the status of the cloning workflow.

Figure 23) Cloning workflow.

ID	Successor IDs	Predecessor IDs	Hook for ID	Status	Step Time	Duration	Operation	Instance/Virtual Element	Host/Parent Virtual Element
15	17	3,13		Completed	7:02	0:01	Enable Startup Protection for Clone	PA0 Central Instance (ABAP): 01_cipa0clone2.os032.vcm1ab	host-192-168-32-28.os032.vcm1ab
16	18,19	3,13	18	Completed	7:02	0:00	Change Local Host Name Lookup	PA0 Central Instance (ABAP): 01_cipa0clone2.os032.vcm1ab	host-192-168-32-28.os032.vcm1ab
17	20	14,15		Completed	7:22	0:00	Enable system	PA0 NetWeaver ABAP_dopa0clone2.os032.vcm1ab	
18	20	16		Completed	7:22	0:45	Force Register and Start Instance Agent	PA0 Central Instance (ABAP): 01_cipa0clone2.os032.vcm1ab	host-192-168-32-28.os032.vcm1ab
19	20	16		Completed	7:22	1:05	Force Register and Start Instance Agent	PA0 Central Services (ABAP): 00_cspa0clone2.os032.vcm1ab	host-192-168-32-28.os032.vcm1ab
20	21,22,23,24	3,17,18,19	22	Completed	8:42	0:00	Change Local Host Name Lookup	PA0 System database (ABAP): Oracle_dopa0clone2.os032.vcm1ab	host-192-168-32-28.os032.vcm1ab
21	22,23,24	20	22	Completed	9:02	0:40	Create Firewall Rules	PA0 System database (ABAP): Oracle_dopa0clone2.os032.vcm1ab	host-192-168-32-28.os032.vcm1ab
22	24	20,21		Completed	10:02	0:21	Start	PA0 System database (ABAP): Oracle_dopa0clone2.os032.vcm1ab	host-192-168-32-28.os032.vcm1ab
23	24	20,21		Completed	10:02	0:45	Start	PA0 Central Services (ABAP): 00_cspa0clone2.os032.vcm1ab	host-192-168-32-28.os032.vcm1ab
24		20,21,22,23		Completed	11:02	0:32	Start	PA0 Central Instance (ABAP): 01_cipa0clone2.os032.vcm1ab	host-192-168-32-28.os032.vcm1ab

The complete SAP system copy workflow, including the fencing and postclone activities, lasts several minutes. The cloned system is accessible, configured within SAP LVM, and the NFS shares are known to the OpenStack ecosystem after the SAP LVM workflow completes.

**Note:** The SAP systems are started as part of the system start process and the cloned NetApp FlexClone volumes created by Manila are also automatically mounted within the compute instance.

## 7 Manila Stand-Alone Configuration

As described in section 5.4, Manila can be used without share server management. With this setting, the storage administrator must manually create the SVMs and make the SVMs available on the network. Other than Manila and Keystone, no additional OpenStack component is necessary to integrate user management.

The stand-alone setup can be beneficial for customers who want to include shared file systems in their environment using an open API such as OpenStack. This setup can be beneficial even if the environment is not a fully configured OpenStack cloud. Also, environments in which administrators need to have full control of the storage and the network setup of the NetApp controller can benefit from the manual options of a stand-alone configuration.

In enterprise applications such as SAP HANA, administrators might want to ensure that there is a deterministic allocation of required resources such as physical NIC, data aggregates, and storage controller. Administrators might want to do so to ensure a dedicated throughput for each of the provisioned systems.

In the following example, we demonstrate how Manila in a stand-alone configuration with Manila share types and Manila how extra specs can be used to predetermine the physical allocation for the required resources.

### 7.1 SAP HANA Requirements

SAP defines throughput requirements for running SAP HANA in a tailored data-center-integration (TDI) scenario on TDI-certified compute and TDI-certified storage controllers. NetApp certifies FAS systems on NFS-attached storage to run SAP HANA and specifies setup and configuration guidelines for achieving the required throughput. In the solution described in this document, we use these guidelines to develop a solution to provision SAP HANA storage using Manila in stand-alone mode.

### Configuration Guidelines

Based on the NetApp configuration guide [SAP HANA on NetApp FAS Systems with NFS](#), the following configuration rules must be used:

- Use at least 10 SAS 10K SAS drives per HANA system.
- Use at least one 10GB NIC for each HANA system.

- Distribute the LOG and DATA volume to different aggregates.
- Evenly distribute the load of multiple HANA systems throughout the controllers.
- Use NICs that connect to a volume on the same controller as the aggregates; avoid cluster traffic.

## Storage Virtual Machines (SVMs)

In this example setup, we use an SAP HANA TDI-certified FAS system running clustered Data ONTAP, with the following hardware resources to be assigned to Manila.

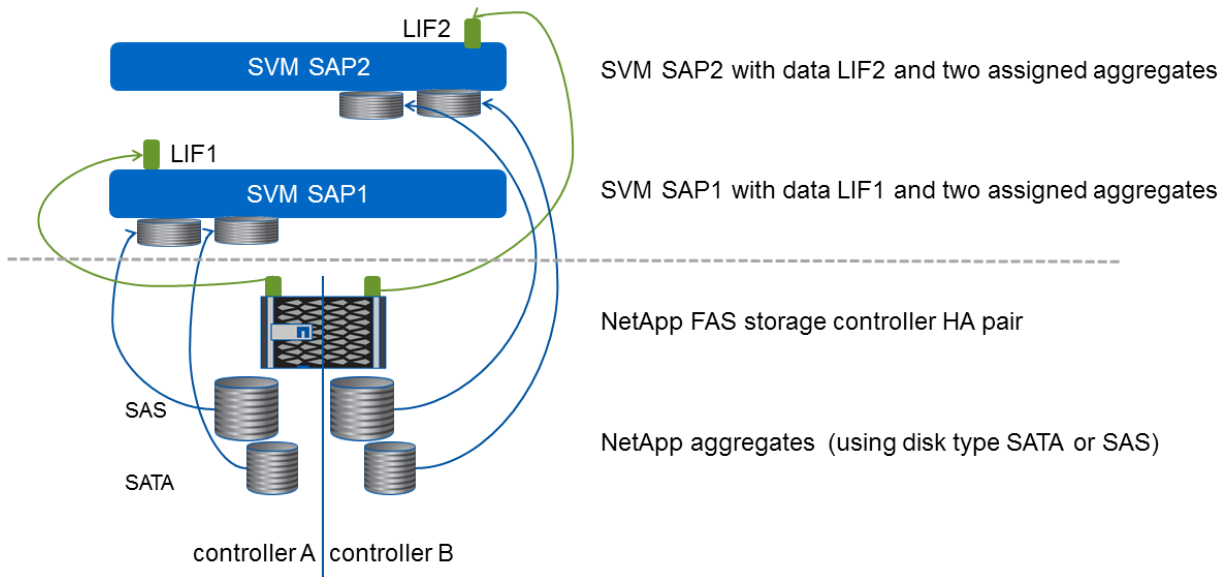
- One NetApp FAS HA controller pair with one physical NIC for the storage connectivity toward Manila.
- Each of the controllers has two aggregates attached. One with 20 10k SAS drives, the other with large SATA drives. Only the SAS drives should be used for SAP HANA.

The storage administrator creates two SVMs to be used for the OpenStack tenant os032.

- Under normal operation each of the SVMs is assigned to manage the resources (aggregates and NIC) of one physical controller.
- The data LIF must be assigned to a 10Gb NIC attached to the VLAN for the OpenStack tenant.
- The setup is HA aware so that in a controller failure both SVMs continue to operate nondisruptively.

Figure 24 shows an example of an SVM manual configuration.

Figure 24) Manual SVM configuration example.



## Manila Configuration

In Manila, both SVMs must be defined as back ends in the following `manila.conf`:

```
enabled_share_backends=os032-SAP1,os032-SAP2
...
enabled_share_protocols = NFS,CIFS
...
[os032-SAP1]
share_driver=manila.share.drivers.netapp.common.NetAppDriver
share_backend_name=os032-SAP1
driver_handles_share_servers=False
netapp_storage_family=ontap_cluster
```

```

netapp_server_hostname=172.23.111.100
netapp_login=openstack
netapp_password=xxxxxxx
netapp_vserver=os032-SAP1
..

[os032-SAP2]
share_driver=manila.share.drivers.netapp.common.NetAppDriver
share_backend_name=os032-SAP2
driver_handles_share_servers=False
netapp_storage_family=ontap_cluster
netapp_server_hostname=172.23.111.100
netapp_login=openstack
netapp_password=xxxxxxx
netapp_vserver=os032-SAP2
..

```

With this configuration, the following Manila services are started:

```

root@d00-50-56-9e-59-d8:/etc/manila # manila service-list
+-----+-----+-----+-----+-----+-----+-----+-----+
| Id | Binary | Host | Zone | Status | State | Updated_at |
+-----+-----+-----+-----+-----+-----+-----+
| 1 | manila-scheduler | d00-50-56-9e-59-d8 | nova | enabled | up | 2015-06-30T11:07:04.005924 |
| 2 | manila-share | d00-50-56-9e-59-d8@os032-SAP1 | nova | enabled | up | None |
| 3 | manila-share | d00-50-56-9e-59-d8@os032-SAP2 | nova | enabled | up | None |
+-----+-----+-----+-----+-----+-----+-----+

```

## Manila Share Types

Using the concept of share types, administrators are able to define a service catalog for the creation of shared file systems. Share types can reference specific features, such as disk types, back-end names, and deduplication.

For each of the share types, the administrator can specify the attributes the driver will later use to identify which SVM to use and on which aggregate the share will be created.

To make sure that each of the HANA systems gets its required resources, the following two share types were created.

- SAP1 selects only SVM1 and aggregates within SVM1 with fast SAS drives.
- SAP2 selects only SVM2 and aggregates within SVM2 with fast SAS drives.

The necessary configuration is applied with the following commands:

```

root@d00-50-56-9e-59-d8:/etc/manila # manila type-create SAP1 False
root@d00-50-56-9e-59-d8:/etc/manila # manila type-create SAP2 False

root@d00-50-56-9e-59-d8:/etc/manila # manila type-key SAP1 set netapp_disk_type=SAS
root@d00-50-56-9e-59-d8:/etc/manila # manila type-key SAP1 set share_backend_name=os032-SAP1
root@d00-50-56-9e-59-d8:/etc/manila # manila type-key SAP2 set netapp_disk_type=SAS
root@d00-50-56-9e-59-d8:/etc/manila # manila type-key SAP2 set share_backend_name=os032-SAP2

root@d00-50-56-9e-59-d8:/etc/manila # manila extra-specs-list
+-----+-----+-----+-----+
| ID | Name | all_extra_specs |
+-----+-----+-----+-----+

```

```

| 9b9e7d2c-a361-496b-85ab-57517f0f5b4a | SAP2 | share_backend_name : os032-SAP2 |
| | | netapp_disk_type : SAS |
| | | driver_handles_share_servers : False |
| ebf175e2-7e18-47cd-b3c4-451b04f90991 | SAP1 | share_backend_name : os032-SAP1 |
| | | netapp_disk_type : SAS |
| | | driver_handles_share_servers : False |
+-----+-----+-----+

```

```

root@d00-50-56-9e-59-d8:/etc/manila # manila type-list
+-----+-----+-----+-----+-----+
| ID | Name | Visibility | is_default |
+-----+-----+-----+-----+
| 9b9e7d2c-a361-496b-85ab-57517f0f5b4a | SAP2 | public | - |
driver_handles_share_servers : False |
| ebf175e2-7e18-47cd-b3c4-451b04f90991 | SAP1 | public | - |
driver_handles_share_servers : False |
+-----+-----+-----+-----+

```

## Manila Share File System Creation

To optimally load balance the two SAP HANA systems using the available resource, the shares of the first HANA system are created with the following command:

```

manila create --share-type SAP1 --name PA0-data NFS 100
manila create --share-type SAP2 --name PA0-log NFS 60

manila access-allow PA0-data ip 192.168.132.0/24
manila access-allow PA0-log ip 192.168.132.0/24

```

Using the option `share_type`, the user can select the administrator-defined type from the service catalog. In our case, the user can influence the selection of SVM, NIC placement, and the aggregate where the NetApp FlexVol volume will be created.

```

root@d00-50-56-9e-59-d8:~ # manila show PA0-data
+-----+-----+
| Property | Value |
+-----+-----+
| status | available |
| description | None |
| availability_zone | nova |
| share_network_id | None |
| export_locations | 192.168.132.3:/share_88358fdb_d4e0_4ce6_9f57_a8dfc7ac2267 |
| share_server_id | None |
| host | d00-50-56-9e-59-d8@os032-SAP1#aggr01 |
| snapshot_id | None |
| is_public | False |
| id | 88358fdb-d4e0-4ce6-9f57-a8dfc7ac2267 |
| size | 100 |
| name | PA0-data |
| share_type | SAP1 |
| created_at | 2015-07-01T13:15:57.798308 |
| share_proto | NFS |
| project_id | ed12e5e6be1d49559bd268090c3e21f3 |
| metadata | {} |
+-----+-----+

root@d00-50-56-9e-59-d8:~ # manila show PA0-log
+-----+-----+
| Property | Value |
+-----+-----+

```



status	available	
description	None	
availability_zone	nova	
share_network_id	None	
export_locations	192.168.132.4:/share_f74fac9a_c698_4737_8f6c_c93b856359bd	
share_server_id	None	
host	d00-50-56-9e-59-d8@os032-SAP2#aggr02	
snapshot_id	None	
is_public	False	
id	f74fac9a-c698-4737-8f6c-c93b856359bd	
size	60	
name	PA0-log	
share_type	<b>SAP2</b>	
created_at	2015-07-01T13:16:26.850720	
share_proto	NFS	
project_id	ed12e5e6be1d49559bd268090c3e21f3	
metadata	{}	
+-----+		

## Conclusion

More and more application workloads are shifting from the traditional IT infrastructure to either a private or a public cloud infrastructure. Emphasis is being placed on business-critical applications such as SAP and databases. The setup used for this technical report demonstrates the ability to design, configure, and prepare an OpenStack infrastructure to support an SAP deployment using SAP LVM to manage the SAP systems with NFS file systems created by Manila.

In this setup, SAP LVM manages SAP systems running within a SUSE Cloud OpenStack deployment. SAP basis administrators can still use SAP LVM to deliver a unique SAP-centric management GUI with in-depth NetApp infrastructure integration.

SAP LVM features for provisioning workflows in an OpenStack ecosystem can be realized using the new SAP LVM Manila storage adapter to manage integration between SAP LVM and the OpenStack Manila shared file service. This integration, and the use of the OpenStack Manila file share service, enables SAP deployments to access unique NetApp storage features such as FlexVol volumes, Snapshot copies, and FlexClone within an OpenStack infrastructure. With these features available to SAP basis administrators, customers can now extend their SAP environments to an OpenStack cloud using NFS services provided by OpenStack and continue using NetApp storage efficiency features.

## References

This report references the following documents and resources:

- SAP with Oracle on UNIX and NFS with NetApp Clustered Data ONTAP  
<http://www.netapp.com/us/system/pdf-reader.aspx?pdfuri=tcn:10-117883-16&m=sap-with-oracle-unix-nfs-with-netapp-clustered-data-ontap.pdf>
- Integrating NetApp Storage with SAP NetWeaver Landscape Virtualization Management  
<http://www.netapp.com/us/system/pdf-reader.aspx?pdfuri=tcn:10-61509-16&m=tr-4018.pdf>
- Highly Available OpenStack Deployments Built on NetApp Storage Systems: Solution Design  
<http://www.netapp.com/us/media/tr-4323-design.pdf>
- The NetApp OpenStack Deployment and Operations Guide  
[http://netapp.github.io/openstack-deploy-ops-guide/icehouse/content/ch\\_executive-summary.html](http://netapp.github.io/openstack-deploy-ops-guide/icehouse/content/ch_executive-summary.html)
- SUSE Cloud 5 Deployment Guide



[https://www.suse.com/documentation/suse-cloud-5/pdfdoc/book\\_cloud\\_deploy/book\\_cloud\\_deploy.pdf](https://www.suse.com/documentation/suse-cloud-5/pdfdoc/book_cloud_deploy/book_cloud_deploy.pdf)

- SAP Service Marketplace  
<https://service.sap.com>
- SAP Sizing Overview  
[http://global.sap.com/campaigns/benchmark/sizing\\_overview.epx](http://global.sap.com/campaigns/benchmark/sizing_overview.epx)
- SAP Quicksizer on the SAP Service Marketplace  
<http://service.sap.com/quicksizer>
- SAP HANA on NetApp FAS Systems with NFS Configuration Guide  
<http://www.netapp.com/us/media/tr-4290.pdf>

Refer to the [Interoperability Matrix Tool \(IMT\)](#) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.

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