SUSE

SUSE Best Practices

SAP

SAP HANA High Availability Cluster Automation Operating on Azure

Getting Started

SUSE Linux Enterprise Server for SAP Applications 15 SP1 and later
Microsoft Azure

Abdelrahman Mohamed, Alliances Solutions Architect (SUSE)

SUSE

SAP HANA High Availability Cluster Automation Operating on Azure

Getting Started

Date: 2024-11-14

This document explains how to build an automated SAP* HANA System Replication (SR) Performance Optimized High Availability (HA) cluster operating on Microsoft* Azure public cloud. It is based on SUSE® Linux Enterprise Server for SAP Applications 15 SP1. The concept can also be used with newer service packs of SUSE Linux Enterprise Server for SAP Applications.

Contents

1 About this Guide

1.1 Introduction

SUSE® Linux Enterprise Server for SAP Applications is the optimal platform to run SAP* applications with high availability. Together with a redundant layout of the technical infrastructure, single points of failure can be eliminated.

SAP* Business Suite is a sophisticated application platform for large enterprises and mid-size companies. Many critical business environments require the highest possible SAP application availability.

1.2 Additional Documentation and Resources

Chapters in this best practice guide contain links to additional documentation resources that are either available on the system or on the Internet. For the latest documentation updates, check SUSE documentation portal (https://documentation.suse.com) .

1.3 Feedback

Several feedback channels are available:

Bugs and Enhancement Requests

For services and support options available for your product, refer to http://www.suse.com/support/.

To report bugs for a product component, go to https://scc.suse.com/support/ requests, log in, and select Submit New SR (Service Request).

Mail

For feedback on the documentation of this product, you can also send a mail to doc-team@suse.com (mailto:doc-team@suse.com). Make sure to include the document title, the product version and the publication date of the documentation. To report errors or suggest enhancements, provide a concise description of the problem and refer to the respective section number and page (or URL).

2 Document Scope

This guide aims to build an automated SAP HANA System Replication (SR) Performance Optimized High Availability (HA) cluster operating on Microsoft Azure public cloud.

The guide uses the Automated SAP HA Deployments in Public/Private Clouds with Terraform (https://github.com/SUSE/ha-sap-terraform-deployments) project that offers several functions. One of these functions is to provide an automated way to deploy SAP HANA HA cluster in public clouds.

The Automated SAP HA Deployments in Public/Private Clouds with Terraform project uses *Terraform* for the deployment phase and *Saltstack* for the provisioning phase. The project is organized in directories containing the *terraform* configuration files per public or private cloud providers and *Saltstack* pillars.

For more information about how to create an SAP HANA Database Scale-Up Performance Optimized High Availability cluster on Microsoft Azure public cloud, refer to the guide High Availability of SAP HANA on Azure VMs on SUSE Linux Enterprise Server (https://docs.microsoft.com/en-us/azure/virtual-machines/workloads/sap/sap-hana-high-availability).

Important

SAP HA solutions are highly customized software solutions based on the customer's environments. This guide provides a *testing environment* that enables SUSE customers to understand a basic implementation of an SAP HANA HA solution using the Microsoft Azure public cloud components. **The production environments must be preceded by a proper planning phase prior to the deployment phase.**

Contact SUSE Consulting Services (https://www.suse.com/services/consulting) for further help.

3 Environment Preparation

3.1 Azure Command-Line Interface Environment Preparation

This guide uses the Azure Command-Line Interface (CLI) which is installed on SUSE Linux Enterprise Server 15 Service Pack 1 (SP1) to interact with the Microsoft Azure public cloud. Follow the Microsoft instructions (https://docs.microsoft.com/en-us/cli/azure/install-azure-cli-zypper?view=azure-cli-latest) to install Azure CLI for SUSE distributions.

Tip

Refer to The Azure Command-Line Interface portal (https://docs.microsoft.com/en-us/cli/azure/?view=azure-cli-latest) for more information.

After a successful Azure CLI installation, log in to the Azure portal using the `az login` command. Then list the current Azure account information. Find below an example of the Azure account used during the creation date of this guide:

EXAMPLE 1: AZURE ACCOUNT INFORMATION LIST:

```
$ az account list
[
  {
    "cloudName": "AzureCloud",
    "homeTenantId": "<HOME TENANT ID>",
    "id": "<ACCOUNT ID>",
    "isDefault": true,
    "managedByTenants": [],
    "name": "<ACCOUNT NAME>",
    "state": "Enabled",
    "tenantId": "<TENANT ID>",
    "user": {
      "name": "<USER NAME>",
      "type": "<USER TYPE>"
    }
  }
]
```

3.2 Azure Storage Account Preparation

An Azure storage account is needed to host the SAP HANA installation media.

Create a new *file share* inside the Azure storage account, upload the SAP HANA installation media to the newly created file share, and extract it.

Important

It is a must to extract the SAP HANA installation media inside the Azure storage account file share. Saltstack provisioning will NOT work using the SAP HANA compressed installation media.

Tip

Refer to Create an Azure Storage account (https://docs.microsoft.com/en-us/azure/storage/common/storage-account-create?tabs=azure-portal) Microsoft documentation for more information about Azure storage account operations.

3.3 Terraform Installation

Starting with SUSE Linux Enterprise Server 15 SP1, `terraform` has been added to the SUSE Linux Enterprise Public Cloud Module. Activate the Public Cloud Module and install the `terraform` package.

The following example shows the terraform version available for SUSE Linux Enterprise Server 15 SP1 at the creation date of this guide:

```
$ sudo zypper in terraform

$ terraform version
Terraform v0.12.19
```

Alternatively, you can also use the `terraform` binary preinstalled in the Azure Cloud Shell (https://azure.microsoft.com/en-us/features/cloud-shell/). The following example shows the terraform version used in Azure cloud shell at the creation date of this guide:

```
$ terraform version
Terraform v0.12.23
```

Tip

The `terraform` version used to write this guide is `v0.12.19`. The terraform team keeps updating the terraform version over time. A newer version might already have been introduced at the time you are applying this guide.

3.4 GitHub Repository Cloning

This guide assumes that the *project directory path* is `/home/<USERNAME>/ha-sap-terraform-deployments` where `<USERNAME>` is the SUSE Linux Enterprise Server 15 SP1 user used to create the project.

Clone the *Automated SAP HA Deployments in Public/Private Clouds with Terraform* GitHub repository:

```
$ cd /home/<USERNAME>

$ git clone https://github.com/SUSE/ha-sap-terraform-deployments.git
```

4 Environment Deployment

4.1 *Saltstack* Pillars Adaptation

SAP HANA and cluster SaltStack Pillars templates are located in the cloned GitHub repository `pillar_example` directory.

Copy the SAP HANA and cluster SaltStack Pillars templates to the proper Salt directory:

```
$ cd /home/<USERNAME>/ha-sap-terraform-deployments

$ cp -av pillar_examples/automatic/hana/*.sls salt/hana_node/files/pillar/
```

Excepting some few parameters' values changes, `/home/<USERNAME>/ha-sap-terraform-deployments/salt/hana_node/files/pillar/hana.sls` SaltStack Pillar contents are suitable for this guide.

The main parameters' values to be updated are:

- SAP users-related passwords
- SAP HANA primary site name
- SPA HANA secondary site name

Note

Refer to the section **Appendix → SAP HANA SaltStack Pillar Configuration**, then change the parameters' values highlighted in bold with your appropriate ones.

4.2 Terraform Configuration Adaptation

The `terraform.tfvars.example` file contains the terraform variables template used to create the cluster infrastructure.

In this guide, we kept the default values except for the following changed ones:

- Azure virtual machine (VM) instance type
- SAP HANA VMs and iSCSI operating system (OS) subscription model details
- SSH keys path
- Azure storage account name
- SAP HANA installation media path
- HA/SAP deployment packages software repository

EXAMPLE 2: ADAPT THE TERRAFORM VARIABLES FILE:

1. Change the directory to the terraform azure provider directory path and rename the `terraform.tfvars.example` file to `terraform.tfvars`:

```
$ cd /home/<USERNAME>/ha-sap-terraform-deployments/azure
```

```
$ mv -v terraform.tfvars.example terraform.tfvars
```

2. Generate the private and public keys which will be used by the terraform deployment and SaltStack provisioning:

```
$ mkdir -v /home/<USERNAME>/ha-sap-terraform-deployments/salt/hana_node/files/
sshkeys

$ ssh-keygen -t rsa -f /home/<USERNAME>/ha-sap-terraform-deployments/salt/
hana_node/files/sshkeys/cluster.id_rsa
```

3. It is given that this guide uses the following OS-related values:

Parameter	Value
SAP HANA OS version	SUSE Linux Enterprise Server 15 for SAP Applications
iSCSI Target OS version	SUSE Linux Enterprise Server 15 SP1
Subscription Model	Pay as you GO (PAYGO)

Only change the following parameters' values in the `/home/<USERNAME>/ha-sap-terraform-deployments/azure/terraform.tfvars` terraform variables configuration file:

Parameter	Old Value	New Value
instancetype	Standard_M128s	**<CHOSEN INSTANCE TYPE>**
hana_public_sku	12-sp4	15
admin_user	OUR_USERNAME_HERE	**<CHOSEN ADMIN ID>**
public_key_location	/path/to/your/public/ssh/key	../salt/hana_node/files/sshkeys/cluster.id_rsa.pub
private_key_location	/path/to/your/private/ssh/key	../salt/hana_node/files/sshkeys/cluster.id_rsa

Parameter	Old Value	New Value
storage_account_name	YOUR_STORAGE_ACCOUNT_NAME	**<AZURE STORAGE ACCOUNT ID>**
storage_account_key	YOUR_STORAGE_ACCOUNT_KEY	**<AZURE STORAGE ACCOUNT KEY #1>**
hana_inst_master	//YOUR_STORAGE_ACCOUNT_NAME.file.core.windows.net/*path/to/your/hana/installation/master	**<SAP HANA INSTALLATION MEDIA PATH>**
ha_sap_deployment_repo	""	"https://download.opensuse.org/repositories/network:/ha-clustering:/Factory/SLE_15/"

Note

Refer to the section **Appendix → Terraform Configurations → Pay as you Go Subscription Model** to view a complete sample of a `terraform.tfvars` configuration file.

Important

Despite using a specific OS version and subscription model aims to provide a complete test case scenario for this guide, the **Automated SAP HA Deployments in Public/Private Clouds with Terraform** project gives the opportunity to use different OS version, subscription models and other parameters.

All parameters highlighted in bold in the section **Appendix → Terraform Configurations → Pay as you Go Subscription Model** can be adjusted based on the customer's environment and needs.

4.3 Terraform Deployment

EXAMPLE 3: DEPLOY THE AZURE INFRASTRUCTURE USING `terraform`:

1. Initialize the terraform Azure provider:

```
$ cd /home/<USERNAME>/ha-sap-terraform-deployments/azure
$ terraform init
```

2. Create a new terraform workspace. Select it to be used in the terraform plan and apply phases:

```
$ terraform workspace new <TERRAFORM WORKSPACE NAME>
$ terraform workspace select <TERRAFORM WORKSPACE NAME>
```

3. Plan the terraform deployment:

```
$ terraform plan
```

4. Apply the terraform deployment:

```
$ terraform apply
```

Tip

Terraform deployment and SaltStack provisioning take approximately 40 to 50 minutes.

5 Environment Post-Deployment Validation

5.1 Deployment Validation

The `terraform apply` command output provides information about the created cluster.

EXAMPLE 4: `terraform apply` OUTPUT SAMPLE:

```
$ terraform apply
[OUTPUT TRIMMED]

module.hana_node.null_resource.hana_node_provisioner[1]: Creation complete after 36m4s
 [id=2647934812513863765]
```

```
Apply complete! Resources: 33 added, 0 changed, 0 destroyed.

Outputs:

cluster_nodes_ip = [
  "10.74.1.11",
  "10.74.1.12",
]
cluster_nodes_name = [
  "vmhana01",
  "vmhana02",
]
cluster_nodes_public_ip = [
  "13.81.13.169",
  "13.81.13.149",
]
cluster_nodes_public_name = [
  "",
  "",
]
drbd_ip = []
drbd_name = []
drbd_public_ip = []
drbd_public_name = []
iscsisrv_ip = [
  "10.74.1.14",
]
iscsisrv_name = [
  "vmiscsisrv",
]
iscsisrv_public_ip = [
  "13.81.13.51",
]
iscsisrv_public_name = [
  "",
]
[OUTPUT TRIMMED]
```

5.2 Cluster Status Validation

Connect to any cluster node to check the cluster status:

EXAMPLE 5: CLUSTER STATUS CHECK:

1. Copy the created SSH keys to your default SSH directory:

```
$ cp -v /home/<USERNAME>/ha-sap-terraform-deployments/salt/hana_node/files/
sshkeys/cluster.id_rsa*  /home/<USERNAME>/.ssh/
```

2. Change the SSH keys files permissions as follows:

```
$ chmod -v 400 /home/<USERNAME>/.ssh/cluster.id_rsa

$ chmod -v 600 /home/<USERNAME>/.ssh/cluster.id_rsa.pub
```

3. Connect to any cluster node:

```
$ ssh -i .ssh/cluster.id_rsa <ADMIN USER>@<CLUSTER NODE PUBLIC IP>
```

4. Check the cluster status:

```
$ hostname
vmhana01

$ sudo su -
```

```
vmhana01:~ # crm_mon -rnf1
Stack: corosync
Current DC: vmhana01 (version 1.1.18+20180430.b12c320f5-3.18.1-b12c320f5) -
 partition with quorum
Last updated: Thu Mar  5 16:04:23 2020
Last change: Thu Mar  5 16:04:09 2020 by root via crm_attribute on vmhana01

2 nodes configured
7 resources configured

Node vmhana01: online
        rsc_SAPHana_PRD_HDB00  (ocf::suse:SAPHana):    Master
        rsc_ip_PRD_HDB00       (ocf::heartbeat:IPaddr2):       Started
        stonith-sbd     (stonith:external/sbd): Started
        rsc_SAPHanaTopology_PRD_HDB00  (ocf::suse:SAPHanaTopology):    Started
        rsc_socat_PRD_HDB00    (ocf::heartbeat:anything):      Started
Node vmhana02: online
        rsc_SAPHana_PRD_HDB00  (ocf::suse:SAPHana):    Slave
        rsc_SAPHanaTopology_PRD_HDB00  (ocf::suse:SAPHanaTopology):    Started
```

```
No inactive resources


Migration Summary:
* Node vmhana01:
* Node vmhana02:
```

6 Environment Destroy

Ensure that you are logged in to the Azure account. If you are not logged in, execute the command `az login`.

EXAMPLE 6: DESTROY THE ENVIRONMENT:

1. Change the directory to the terraform azure provider path:

```
$ cd /home/<USERNAME>/ha-sap-terraform-deployments/azure
```

2. List the terraform workspaces:

```
$ terraform workspace list
  default
* <WORKSPACE NAME>
```

3. Choose the terraform workspace that has been used to create this project:

```
$ terraform workspace select <WORKSPACE NAME>
```

4. Destroy the terraform workspace that has been used to create this project:

```
$ terraform destroy
```

7 Appendix

7.1 SAP HANA SaltStack Pillar Configuration

```
$ cat  /home/<USERNAME>/ha-sap-terraform-deployments/salt/hana_node/files/pillar/hana.sls
hana:
  {% if grains.get('qa_mode') %}
  install_packages: false
```

```
{% endif %}
saptune_solution: 'HANA'
nodes:
  - host: {{ grains['name_prefix'] }}01
    sid: prd
    instance: "00"
    password: <PASSWORD>
    install:
      software_path: {{ grains['hana_inst_folder'] }}
      root_user: root
      {% if grains['provider'] == 'libvirt' %}
      root_password: linux
      {% else %}
      root_password: ''
      {% endif %}
      system_user_password: <PASSWORD>
      sapadm_password: <PASSWORD>
    primary:
      name: <PRIMARY SITNE NAME>
      backup:
        key_name: backupkey
        database: SYSTEMDB
        file: backup
      userkey:
        key_name: backupkey
        environment: {{ grains['name_prefix'] }}01:30013
        user_name: SYSTEM
        user_password: <PASSWORD>
        database: SYSTEMDB
  {% if grains.get('monitoring_enabled', False) %}
    exporter:
      exposition_port: 9668
      user: SYSTEM
      password: YourPassword1234
  {% endif %}

  - host: {{ grains['name_prefix'] }}02
    sid: prd
    instance: "00"
    password: <PASSWORD>
    {% if grains['scenario_type'] == 'cost-optimized' %}
    scenario_type: 'cost-optimized'
    cost_optimized_parameters:
      global_allocation_limit: '32100'
      preload_column_tables: False
    {% endif %}
    install:
```

```
      software_path: {{ grains['hana_inst_folder'] }}
      root_user: root
      {% if grains['provider'] == 'libvirt' %}
      root_password: linux
      {% else %}
      root_password: ''
      {% endif %}
      system_user_password: <PASSWORD>
      sapadm_password: <PASSWORD>
    secondary:
      name: <SECONDARY SITE NAME>
      remote_host: {{ grains['name_prefix'] }}01
      remote_instance: "00"
      replication_mode: sync
      operation_mode: logreplay
      primary_timeout: 3000
{% if grains['scenario_type'] == 'cost-optimized' %}
- host: {{ grains['name_prefix'] }}02
  sid: qas
  instance: "01"
  password: YourPassword1234
  scenario_type: 'cost-optimized'
  cost_optimized_parameters:
    global_allocation_limit: '28600'
    preload_column_tables: False
  install:
    software_path: {{ grains['hana_inst_folder'] }}
    root_user: root
    {% if grains['provider'] == 'libvirt' %}
    root_password: linux
    {% else %}
    root_password: ''
    {% endif %}
    system_user_password: YourPassword1234
    sapadm_password: YourPassword1234
  {% if grains.get('monitoring_enabled', False) %}
  exporter:
    exposition_port: 9669
    user: SYSTEM
    password: YourPassword1234
  {% endif %}
{% endif %}
```

7.2 Terraform Configurations

7.2.1 Pay-as-you-Go (PAYGO) Subscription Model

```
$ cat /home/<USERNAME>/ha-sap-terraform-deployments/azure/terraform.tfvars
# VM size to use for the cluster nodes
hana_vm_size = "<CHOSEN INSTANCE TYPE>"

# Disk type for HANA
hana_data_disk_type = "StandardSSD_LRS"

# Disk size for HANA
hana_data_disk_size = "60"

# Caching used for HANA disk
hana_data_disk_caching = "ReadWrite"

# Number of nodes in the cluster
hana_count = "2"

# Instance number for the HANA database. 00 by default.
hana_instance_number = "00"

# Region where to deploy the configuration
az_region = "westeurope"

# Variable to control what is deployed in the nodes. Can be all, skip-hana or skip-
cluster
init_type = "all"

# SLES4SAP image information
# If custom uris are enabled public information will be omitted
# Custom sles4sap image
#sles4sap_uri = "/path/to/your/image"

# Custom iscsi server image
#iscsi_srv_uri = "/path/to/your/iscsi/image"

# Custom monitoring server image
#monitoring_uri = "/path/to/your/monitoring/image"

# Custom drbd nodes image
#drbd_image_uri = "/path/to/your/monitoring/image"

# Public sles4sap image
```

```
hana_public_publisher = "SUSE"
hana_public_offer     = "SLES-SAP"
hana_public_sku       = "gen2-15"
hana_public_version   = "latest"

# Public iscsi server image
iscsi_public_publisher = "SUSE"
iscsi_public_offer     = "sles-15-sp1"
iscsi_public_sku       = "gen2"
iscsi_public_version   = "latest"

# Public monitoring server image
#monitoring_public_publisher = "SUSE"
#monitoring_public_offer     = "SLES-SAP-BYOS"
#monitoring_public_sku       = "15"
#monitoring_public_version   = "latest"

# Public drbd nodes image
#drbd_public_publisher = "SUSE"
#drbd_public_offer     = "SLES-SAP-BYOS"
#drbd_public_sku       = "15"
#drbd_public_version   = "latest"

# Admin user
admin_user = "<CHOSEN USER ID>"

# SSH Public key to configure access to the remote instances
public_key_location = "../salt/hana_node/files/sshkeys/cluster.id_rsa.pub"

# Private SSH Key location
private_key_location = "../salt/hana_node/files/sshkeys/cluster.id_rsa"

# Azure storage account name
storage_account_name = "<AZURE STORAGE ACCOUNT NAME>"

# Azure storage account secret key (key1 or key2)
storage_account_key = "<AZURE STORAGE ACCOUNT KEY1>"

# Azure storage account path where HANA installation master is located
hana_inst_master = "//<AZURE STORAGE ACCOUNT NAME>.file.core.windows.net/<SAP HANA
 INSTALLATION MEDIA PATH>"

# Local folder where HANA installation master will be mounted
hana_inst_folder = "/root/hana_inst_media/"

# Device used by node where HANA will be installed
hana_disk_device = "/dev/sdc"
```

```
# Device used by the iSCSI server to provide LUNs
iscsidev = "/dev/sdc"

# IP address of the iSCSI server
iscsi_srv_ip = "10.74.1.14"

# Path to a custom ssh public key to upload to the nodes
# Used for cluster communication for example
cluster_ssh_pub = "salt://hana_node/files/sshkeys/cluster.id_rsa.pub"

# Path to a custom ssh private key to upload to the nodes
# Used for cluster communication for example
cluster_ssh_key = "salt://hana_node/files/sshkeys/cluster.id_rsa"

# Each host IP address (sequential order).
# example : host_ips = ["10.0.1.0", "10.0.1.1"]
host_ips = ["10.74.1.11", "10.74.1.12"]

# Each drbd cluster host IP address (sequential order).
# example : drbd_host_ips = ["10.0.1.10", "10.0.1.11"]
drbd_ips = ["10.74.1.21", "10.74.1.22"]

# Repository url used to install HA/SAP deployment packages"
# The latest RPM packages can be found at:
# https://download.opensuse.org/repositories/network:/ha-clustering:/Factory/{YOUR OS
 VERSION}
# Contains the salt formulas rpm packages.
ha_sap_deployment_repo = "https://download.opensuse.org/repositories/network:/ha-
clustering:/Factory/SLE_15/"

# Optional SUSE Customer Center Registration parameters
#reg_code = "<<REG_CODE>>"
#reg_email = "<<your email>>"

# For any sle12 version the additional module sle-module-adv-systems-management/12/x86_64
 is mandatory if reg_code is provided
#reg_additional_modules = {
#    "sle-module-adv-systems-management/12/x86_64" = ""
#    "sle-module-containers/12/x86_64" = ""
#    "sle-ha-geo/12.4/x86_64" = "<<REG_CODE>>"
#}

# Cost optimized scenario
#scenario_type: "cost-optimized"

# To disable the provisioning process
```

```
#provisioner = ""

# Run provisioner execution in background
#background = true

# Monitoring variables

# Enable the host to be monitored by exporters
#monitoring_enabled = true

# IP address of the machine where Prometheus and Grafana are running
monitoring_srv_ip = "10.74.1.13"

# Enable drbd cluster
#drbd_enabled = true

# Netweaver variables

#netweaver_enabled = true
#netweaver_ips = ["10.74.1.30", "10.74.1.31", "10.74.1.32", "10.74.1.33"]
#netweaver_virtual_ips = ["10.74.1.35", "10.74.1.36", "10.74.1.37", "10.74.1.38"]
#netweaver_storage_account_key = "YOUR_STORAGE_ACCOUNT_KEY"
#netweaver_storage_account_name = "YOUR_STORAGE_ACCOUNT_NAME"
#netweaver_storage_account = "//YOUR_STORAGE_ACCOUNT_NAME.file.core.windows.net/path/to/
your/nw/installation/master"

# QA variables

# Define if the deployment is using for testing purpose
# Disable all extra packages that do not come from the image
# Except salt-minion (for the moment) and salt formulas
# true or false (default)
#qa_mode = false

# Execute HANA Hardware Configuration Check Tool to bench filesystems
# qa_mode must be set to true for executing hwcct
# true or false (default)
#hwcct = false
```

7.2.2 Bring Your Own Subscription (BYOS) Model

```
$ cat /home/<USERNAME>/ha-sap-terraform-deployments/azure/terraform.tfvars
# Instance type to use for the cluster nodes
instancetype = "<CHOSEN INSTANCE TYPE>"
```

```
# Disk type for HANA
hana_data_disk_type = "StandardSSD_LRS"

# Disk size for HANA
hana_data_disk_size = "60"

# Caching used for HANA disk
hana_data_disk_caching = "ReadWrite"

# Number of nodes in the cluster
ninstances = "2"

# Region where to deploy the configuration
az_region = "westeurope"

# Variable to control what is deployed in the nodes. Can be all, skip-hana or skip-
cluster
init_type = "all"

# SLES4SAP image information
# If custom uris are enabled public information will be omitted
# Custom sles4sap image
#sles4sap_uri = "/path/to/your/image"

# Custom iscsi server image
#iscsi_srv_uri = "/path/to/your/iscsi/image"

# Custom monitoring server image
#monitoring_uri = "/path/to/your/monitoring/image"

# Custom drbd nodes image
#drbd_image_uri = "/path/to/your/monitoring/image"

# Public sles4sap image
hana_public_publisher = "SUSE"
hana_public_offer     = "SLES-SAP-BYOS"
hana_public_sku       = "15"
hana_public_version   = "latest"

# Public iscsi server image
iscsi_public_publisher = "SUSE"
iscsi_public_offer     = "SLES-SAP-BYOS"
iscsi_public_sku       = "15"
iscsi_public_version   = "latest"

# Public monitoring server image
#monitoring_public_publisher = "SUSE"
```

```
#monitoring_public_offer     = "SLES-SAP-BYOS"
#monitoring_public_sku       = "15"
#monitoring_public_version   = "latest"

# Public drbd nodes image
#drbd_public_publisher = "SUSE"
#drbd_public_offer     = "SLES-SAP-BYOS"
#drbd_public_sku       = "15"
#drbd_public_version   = "latest"

# Admin user
admin_user = "<CHOSEN USER ID>"

# SSH Public key to configure access to the remote instances
public_key_location = "../salt/hana_node/files/sshkeys/cluster.id_rsa.pub"

# Private SSH Key location
private_key_location = "../salt/hana_node/files/sshkeys/cluster.id_rsa"

# Azure storage account name
storage_account_name = "<AZURE STORAGE ACCOUNT NAME>"

# Azure storage account secret key (key1 or key2)
storage_account_key = "<AZURE STORAGE ACCOUNT KEY1>"

# Azure storage account path where HANA installation master is located
hana_inst_master = "//<AZURE STORAGE ACCOUNT NAME>.file.core.windows.net/<SAP HANA
 INSTALLATION MEDIA PATH>"

# Local folder where HANA installation master will be mounted
hana_inst_folder = "/root/hana_inst_media/"

# Device used by node where HANA will be installed
hana_disk_device = "/dev/sdc"

# Device used by the iSCSI server to provide LUNs
iscsidev = "/dev/sdc"

# Path to a custom ssh public key to upload to the nodes
# Used for cluster communication for example
cluster_ssh_pub = "salt://hana_node/files/sshkeys/cluster.id_rsa.pub"

# Path to a custom ssh private key to upload to the nodes
# Used for cluster communication for example
cluster_ssh_key = "salt://hana_node/files/sshkeys/cluster.id_rsa"

# Each host IP address (sequential order).
```

```
# example : host_ips = ["10.0.1.0", "10.0.1.1"]
host_ips = ["10.74.1.11", "10.74.1.12"]

# Each drbd cluster host IP address (sequential order).
# example : drbd_host_ips = ["10.0.1.10", "10.0.1.11"]
drbd_ips = ["10.74.1.21", "10.74.1.22"]

# Repository url used to install HA/SAP deployment packages"
# The latest RPM packages can be found at:
# https://download.opensuse.org/repositories/network:/ha-clustering:/Factory/{YOUR OS
 VERSION}
# Contains the salt formulas rpm packages.
ha_sap_deployment_repo = "https://download.opensuse.org/repositories/network:/ha-
clustering:/Factory/SLE_15/"

# Optional SUSE Customer Center Registration parameters
reg_code = "<SUSE REGISTRATION CODE>"
reg_email = "<SUSE REGISTRATION EMAIL>"

# For any sle12 version the additional module sle-module-adv-systems-management/12/x86_64
 is mandatory if reg_code is provided
#reg_additional_modules = {
#    "sle-module-adv-systems-management/12/x86_64" = ""
#    "sle-module-containers/12/x86_64" = ""
#    "sle-ha-geo/12.4/x86_64" = "<<REG_CODE>>"
#}

# Cost optimized scenario
#scenario_type: "cost-optimized"

# To disable the provisioning process
#provisioner = ""

# Run provisioner execution in background
#background = true

# Monitoring variables

# Enable the host to be monitored by exporters
#monitoring_enabled = true

# IP address of the machine where Prometheus and Grafana are running
monitoring_srv_ip = "10.74.1.13"

# Enable drbd cluster
#drbd_enabled = true
```

```
# Netweaver variables

#netweaver_enabled = true
#netweaver_ips = ["10.74.1.30", "10.74.1.31", "10.74.1.32", "10.74.1.33"]
#netweaver_virtual_ips = ["10.74.1.35", "10.74.1.36", "10.74.1.37", "10.74.1.38"]
#netweaver_storage_account_key = "YOUR_STORAGE_ACCOUNT_KEY"
#netweaver_storage_account_name = "YOUR_STORAGE_ACCOUNT_NAME"
#netweaver_storage_account = "//YOUR_STORAGE_ACCOUNT_NAME.file.core.windows.net/path/to/
your/nw/installation/master"

# QA variables

# Define if the deployment is using for testing purpose
# Disable all extra packages that do not come from the image
# Except salt-minion (for the moment) and salt formulas
# true or false (default)
#qa_mode = false

# Execute HANA Hardware Configuration Check Tool to bench filesystems
# qa_mode must be set to true for executing hwcct
# true or false (default)
#hwcct = false
```

7.3 Cluster Configurations

```
vmhana01:~ # crm configure show
node 1: vmhana01 \
        attributes lpa_prd_lpt=1583424440 hana_prd_vhost=vmhana01 hana_prd_site=NUE
 hana_prd_op_mode=logreplay hana_prd_srmode=sync hana_prd_remoteHost=vmhana02
node 2: vmhana02 \
        attributes lpa_prd_lpt=30 hana_prd_op_mode=logreplay hana_prd_vhost=vmhana02
 hana_prd_remoteHost=vmhana01 hana_prd_site=FRA hana_prd_srmode=sync
# SAP HANA resources
primitive rsc_SAPHanaTopology_PRD_HDB00 ocf:suse:SAPHanaTopology \
        params SID=PRD InstanceNumber=00 \
        op monitor interval=10 timeout=600 \
        op start interval=0 timeout=600 \
        op stop interval=0 timeout=300
primitive rsc_SAPHana_PRD_HDB00 ocf:suse:SAPHana \
        params SID=PRD InstanceNumber=00 PREFER_SITE_TAKEOVER=True
 AUTOMATED_REGISTER=False DUPLICATE_PRIMARY_TIMEOUT=7200 \
        op start interval=0 timeout=3600 \
        op stop interval=0 timeout=3600 \
        op promote interval=0 timeout=3600 \
        op monitor interval=60 role=Master timeout=700 \
```

```
        op monitor interval=61 role=Slave timeout=700
# Create virtual ip. gcp must be changed when gcp-vpc-move-route RA is available
primitive rsc_ip_PRD_HDB00 IPaddr2 \
        params ip=10.74.1.200 cidr_netmask=24 nic=eth0 \
        op start timeout=20 interval=0 \
        op stop timeout=20 interval=0 \
        op monitor interval=10 timeout=20
# Platform dependent (stonith, virtual ip address, cib options, etc) resource
primitive rsc_socat_PRD_HDB00 anything \
        params binfile="/usr/bin/socat" cmdline_options="-U TCP-
LISTEN:62500,backlog=10,fork,reuseaddr /dev/null" \
        op monitor timeout=20 interval=10 \
        op_params depth=0
primitive stonith-sbd stonith:external/sbd \
        params pcmk_delay_max=30s
group g_ip_PRD_HDB00 rsc_ip_PRD_HDB00 rsc_socat_PRD_HDB00
ms msl_SAPHana_PRD_HDB00 rsc_SAPHana_PRD_HDB00 \
        meta clone-max=2 clone-node-max=1 interleave=true
clone cln_SAPHanaTopology_PRD_HDB00 rsc_SAPHanaTopology_PRD_HDB00 \
        meta is-managed=true clone-node-max=1 interleave=true
colocation col_saphana_ip_PRD_HDB00 2000: g_ip_PRD_HDB00:Started
 msl_SAPHana_PRD_HDB00:Master
order ord_SAPHana_PRD_HDB00 Optional: cln_SAPHanaTopology_PRD_HDB00 msl_SAPHana_PRD_HDB00
property cib-bootstrap-options: \
        have-watchdog=true \
        dc-version="1.1.18+20180430.b12c320f5-3.18.1-b12c320f5" \
        cluster-infrastructure=corosync \
        cluster-name=hana_cluster \
        stonith-enabled=true
rsc_defaults rsc-options: \
        resource-stickiness=1000 \
        migration-threshold=5000
op_defaults op-options: \
        timeout=600 \
        record-pending=true
```

7.4 SAP System Overview

```
vmhana01:~ # su - prdadm
prdadm@vmhana01:/usr/sap/PRD/HDB00> HDBSettings.sh systemOverview.py
| Section    | Name            | Status  | Value                                      |
| ---------- | --------------- | ------- | ------------------------------------------ |
| System     | Instance ID     |         | PRD                                        |
| System     | Instance Number |         | 00                                         |
| System     | Distributed     |         | No                                         |
```

```
| System     | Version         |         | 2.00.040.00.1553674765 (fa/hana2sp04)       |
| System     | Platform        |         | SUSE Linux Enterprise Server 15             |
| Services   | All Started     | OK      | Yes                                         |
| Services   | Min Start Time  |         | 2020-03-05 13:48:38.000                     |
| Services   | Max Start Time  |         | 2020-03-05 13:50:51.444                     |
| Memory     | Memory          | OK      | Physical 62.86 GB, Swap 0.00 GB, Used 23.51 |
| CPU        | CPU             | OK      | Available 8, Used 0.32                      |
| Disk       | Data            | OK      | Size 60.0 GB, Used 7.1 GB, Free 88 %        |
| Disk       | Log             | OK      | Size 60.0 GB, Used 3.7 GB, Free 93 %        |
| Disk       | Trace           | OK      | Size 60.0 GB, Used 14.3 GB, Free 76 %       |
| Statistics | Alerts          | WARNING | cannot check statistics w/o SQL connection  |
```

7.5 SAP HANA Database Version

```
vmhana01:~ # su - prdadm
prdadm@vmhana01:/usr/sap/PRD/HDB00> HDB version
HDB version info:
  version:             2.00.040.00.1553674765
  branch:              fa/hana2sp04
  machine config:      linuxx86_64
  git hash:            c8210ee40a82860643f1874a2bf4ffb67a7b2add
  git merge time:      2019-03-27 09:19:25
  weekstone:           0000.00.0
  cloud edition:       0000.00.00
  compile date:        2019-03-27 09:30:26
  compile host:        ld4551
  compile type:        rel
```

8 Legal Notice

9 GNU Free Documentation License

0. PREAMBLE

The purpose of this License is to make a manual, textbook, or other functional and useful document "free" in the sense of freedom: to assure everyone the effective freedom to copy and redistribute it, with or without modifying it, either commercially or noncommercially. Secondarily, this License preserves for the author and publisher a way to get credit for their work, while not being considered responsible for modifications made by others.

This License is a kind of "copyleft", which means that derivative works of the document must themselves be free in the same sense. It complements the GNU General Public License, which is a copyleft license designed for free software.

We have designed this License in order to use it for manuals for free software, because free software needs free documentation: a free program should come with manuals providing the same freedoms that the software does. But this License is not limited to software manuals; it can be used for any textual work, regardless of subject matter or whether it is published as a printed book. We recommend this License principally for works whose purpose is instruction or reference.

1. APPLICABILITY AND DEFINITIONS

This License applies to any manual or other work, in any medium, that contains a notice placed by the copyright holder saying it can be distributed under the terms of this License. Such a notice grants a world-wide, royalty-free license, unlimited in duration, to use that work under the conditions stated herein. The "Document", below, refers to any such manual or work. Any member of the public is a licensee, and is addressed as "you". You accept the license if you copy, modify or distribute the work in a way requiring permission under copyright law.

A "Modified Version" of the Document means any work containing the Document or a portion of it, either copied verbatim, or with modifications and/or translated into another language.

A "Secondary Section" is a named appendix or a front-matter section of the Document that deals exclusively with the relationship of the publishers or authors of the Document to the Document's overall subject (or to related matters) and contains nothing that could fall directly within that overall subject. (Thus, if the Document is in part a textbook of mathematics, a Secondary Section may not explain any mathematics.) The relationship could be a matter of historical connection with the subject or with related matters, or of legal, commercial, philosophical, ethical or political position regarding them.

The "Invariant Sections" are certain Secondary Sections whose titles are designated, as being those of Invariant Sections, in the notice that says that the Document is released under this License. If a section does not fit the above definition of Secondary then it is not allowed to be designated as Invariant. The Document may contain zero Invariant Sections. If the Document does not identify any Invariant Sections then there are none.

The "Cover Texts" are certain short passages of text that are listed, as Front-Cover Texts or Back-Cover Texts, in the notice that says that the Document is released under this License. A Front-Cover Text may be at most 5 words, and a Back-Cover Text may be at most 25 words.

A "Transparent" copy of the Document means a machine-readable copy, represented in a format whose specification is available to the general public, that is suitable for revising the document straightforwardly with generic text editors or (for images composed of pixels) generic paint programs or (for drawings) some widely available drawing editor, and that is suitable for input to text formatters or for automatic translation to a variety of formats suitable for input to text formatters. A copy made in an otherwise Transparent file format whose markup, or absence of markup, has been arranged to thwart or discourage subsequent modification by readers is not Transparent. An image format is not Transparent if used for any substantial amount of text. A copy that is not "Transparent" is called "Opaque".

Examples of suitable formats for Transparent copies include plain ASCII without markup, Texinfo input format, LaTeX input format, SGML or XML using a publicly available DTD, and standard-conforming simple HTML, PostScript or PDF designed for human modification. Examples of transparent image formats include PNG, XCF and JPG. Opaque formats include proprietary formats that can be read and edited only by proprietary word processors, SGML or XML for which the DTD and/or processing tools are not generally available, and the machine-generated HTML, PostScript or PDF produced by some word processors for output purposes only.

The "Title Page" means, for a printed book, the title page itself, plus such following pages as are needed to hold, legibly, the material this License requires to appear in the title page. For works in formats which do not have any title page as such, "Title Page" means the text near the most prominent appearance of the work's title, preceding the beginning of the body of the text.

A section "Entitled XYZ" means a named subunit of the Document whose title either is precisely XYZ or contains XYZ in parentheses following text that translates XYZ in another language. (Here XYZ stands for a specific section name mentioned below, such as "Acknowledgements", "Dedications", "Endorsements", or "History".) To "Preserve the Title" of such a section when you modify the Document means that it remains a section "Entitled XYZ" according to this definition.

The Document may include Warranty Disclaimers next to the notice which states that this License applies to the Document. These Warranty Disclaimers are considered to be included by reference in this License, but only as regards disclaiming warranties: any other implication that these Warranty Disclaimers may have is void and has no effect on the meaning of this License.

2. VERBATIM COPYING

You may copy and distribute the Document in any medium, either commercially or noncommercially, provided that this License, the copyright notices, and the license notice saying this License applies to the Document are reproduced in all copies, and that you add no other conditions whatsoever to those of this License. You may not use technical measures to obstruct or control the reading or further copying of the copies you make or distribute. However, you may accept compensation in exchange for copies. If you distribute a large enough number of copies you must also follow the conditions in section 3.

You may also lend copies, under the same conditions stated above, and you may publicly display copies.

3. COPYING IN QUANTITY

If you publish printed copies (or copies in media that commonly have printed covers) of the Document, numbering more than 100, and the Document’s license notice requires Cover Texts, you must enclose the copies in covers that carry, clearly and legibly, all these Cover Texts: Front-Cover Texts on the front cover, and Back-Cover Texts on the back cover. Both covers must also clearly and legibly identify you as the publisher of these copies. The front cover must present the full title with all words of the title equally prominent and visible. You may add other material on the covers in addition. Copying with changes limited to the covers, as long as they preserve the title of the Document and satisfy these conditions, can be treated as verbatim copying in other respects.

If the required texts for either cover are too voluminous to fit legibly, you should put the first ones listed (as many as fit reasonably) on the actual cover, and continue the rest onto adjacent pages.

If you publish or distribute Opaque copies of the Document numbering more than 100, you must either include a machine-readable Transparent copy along with each Opaque copy, or state in or with each Opaque copy a computer-network location from which the general network-using public has access to download using public-standard network protocols a complete Transparent copy of the Document, free of added material. If you use the latter option, you must take reasonably prudent steps, when you begin distribution of Opaque copies in quantity, to ensure that this Transparent copy will remain thus accessible at the stated location until at least one year after the last time you distribute an Opaque copy (directly or through your agents or retailers) of that edition to the public.

It is requested, but not required, that you contact the authors of the Document well before redistributing any large number of copies, to give them a chance to provide you with an updated version of the Document.

4. MODIFICATIONS

You may copy and distribute a Modified Version of the Document under the conditions of sections 2 and 3 above, provided that you release the Modified Version under precisely this License, with the Modified Version filling the role of the Document, thus licensing distribution and modification of the Modified Version to whoever possesses a copy of it. In addition, you must do these things in the Modified Version:

A. Use in the Title Page (and on the covers, if any) a title distinct from that of the Document, and from those of previous versions (which should, if there were any, be listed in the History section of the Document). You may use the same title as a previous version if the original publisher of that version gives permission.

B. List on the Title Page, as authors, one or more persons or entities responsible for authorship of the modifications in the Modified Version, together with at least five of the principal authors of the Document (all of its principal authors, if it has fewer than five), unless they release you from this requirement.

C. State on the Title page the name of the publisher of the Modified Version, as the publisher.

D. Preserve all the copyright notices of the Document.

E. Add an appropriate copyright notice for your modifications adjacent to the other copyright notices.

F. Include, immediately after the copyright notices, a license notice giving the public permission to use the Modified Version under the terms of this License, in the form shown in the Addendum below.

G. Preserve in that license notice the full lists of Invariant Sections and required Cover Texts given in the Document's license notice.

H. Include an unaltered copy of this License.

I. Preserve the section Entitled "History", Preserve its Title, and add to it an item stating at least the title, year, new authors, and publisher of the Modified Version as given on the Title Page. If there is no section Entitled "History" in the Document, create one stating the title, year, authors, and publisher of the Document as given on its Title Page, then add an item describing the Modified Version as stated in the previous sentence.

J. Preserve the network location, if any, given in the Document for public access to a Transparent copy of the Document, and likewise the network locations given in the Document for previous versions it was based on. These may be placed in the "History" section. You may omit a network location for a work that was published at least four years before the Document itself, or if the original publisher of the version it refers to gives permission.

K. For any section Entitled "Acknowledgements" or "Dedications", Preserve the Title of the section, and preserve in the section all the substance and tone of each of the contributor acknowledgements and/or dedications given therein.

L. Preserve all the Invariant Sections of the Document, unaltered in their text and in their titles. Section numbers or the equivalent are not considered part of the section titles.

M. Delete any section Entitled "Endorsements". Such a section may not be included in the Modified Version.

N. Do not retitle any existing section to be Entitled "Endorsements" or to conflict in title with any Invariant Section.

O. Preserve any Warranty Disclaimers.

If the Modified Version includes new front-matter sections or appendices that qualify as Secondary Sections and contain no material copied from the Document, you may at your option designate some or all of these sections as invariant. To do this, add their titles to the list of Invariant Sections in the Modified Version's license notice. These titles must be distinct from any other section titles.

You may add a section Entitled "Endorsements", provided it contains nothing but endorsements of your Modified Version by various parties—for example, statements of peer review or that the text has been approved by an organization as the authoritative definition of a standard.

You may add a passage of up to five words as a Front-Cover Text, and a passage of up to 25 words as a Back-Cover Text, to the end of the list of Cover Texts in the Modified Version. Only one passage of Front-Cover Text and one of Back-Cover Text may be added by (or through arrangements made by) any one entity. If the Document already includes a cover text for the same cover, previously added by you or by arrangement made by the same entity you are acting on behalf of, you may not add another; but you may replace the old one, on explicit permission from the previous publisher that added the old one.

The author(s) and publisher(s) of the Document do not by this License give permission to use their names for publicity for or to assert or imply endorsement of any Modified Version.

5. COMBINING DOCUMENTS

You may combine the Document with other documents released under this License, under the terms defined in section 4 above for modified versions, provided that you include in the combination all of the Invariant Sections of all of the original documents, unmodified, and list them all as Invariant Sections of your combined work in its license notice, and that you preserve all their Warranty Disclaimers.

The combined work need only contain one copy of this License, and multiple identical Invariant Sections may be replaced with a single copy. If there are multiple Invariant Sections with the same name but different contents, make the title of each such section unique by adding at the end of it, in parentheses, the name of the original author or publisher of that section if known, or else a unique number. Make the same adjustment to the section titles in the list of Invariant Sections in the license notice of the combined work.

In the combination, you must combine any sections Entitled "History" in the various original documents, forming one section Entitled "History"; likewise combine any sections Entitled "Acknowledgements", and any sections Entitled "Dedications". You must delete all sections Entitled "Endorsements".

6. COLLECTIONS OF DOCUMENTS

You may make a collection consisting of the Document and other documents released under this License, and replace the individual copies of this License in the various documents with a single copy that is included in the collection, provided that you follow the rules of this License for verbatim copying of each of the documents in all other respects.

You may extract a single document from such a collection, and distribute it individually under this License, provided you insert a copy of this License into the extracted document, and follow this License in all other respects regarding verbatim copying of that document.

7. AGGREGATION WITH INDEPENDENT WORKS

A compilation of the Document or its derivatives with other separate and independent documents or works, in or on a volume of a storage or distribution medium, is called an "aggregate" if the copyright resulting from the compilation is not used to limit the legal rights of the compilation’s users beyond what the individual works permit. When the Document is included in an aggregate, this License does not apply to the other works in the aggregate which are not themselves derivative works of the Document.

If the Cover Text requirement of section 3 is applicable to these copies of the Document, then if the Document is less than one half of the entire aggregate, the Document’s Cover Texts may be placed on covers that bracket the Document within the aggregate, or the electronic equivalent of covers if the Document is in electronic form. Otherwise they must appear on printed covers that bracket the whole aggregate.

8. TRANSLATION

Translation is considered a kind of modification, so you may distribute translations of the Document under the terms of section 4. Replacing Invariant Sections with translations requires special permission from their copyright holders, but you may include translations of some or all

Invariant Sections in addition to the original versions of these Invariant Sections. You may include a translation of this License, and all the license notices in the Document, and any Warranty Disclaimers, provided that you also include the original English version of this License and the original versions of those notices and disclaimers. In case of a disagreement between the translation and the original version of this License or a notice or disclaimer, the original version will prevail.

If a section in the Document is Entitled "Acknowledgements", "Dedications", or "History", the requirement (section 4) to Preserve its Title (section 1) will typically require changing the actual title.

9. TERMINATION

You may not copy, modify, sublicense, or distribute the Document except as expressly provided for under this License. Any other attempt to copy, modify, sublicense or distribute the Document is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.

10. FUTURE REVISIONS OF THIS LICENSE

The Free Software Foundation may publish new, revised versions of the GNU Free Documentation License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns. See http://www.gnu.org/copyleft/.

Each version of the License is given a distinguishing version number. If the Document specifies that a particular numbered version of this License "or any later version" applies to it, you have the option of following the terms and conditions either of that specified version or of any later version that has been published (not as a draft) by the Free Software Foundation. If the Document does not specify a version number of this License, you may choose any version ever published (not as a draft) by the Free Software Foundation.

ADDENDUM: How to use this License for your documents

```
Copyright (c) YEAR YOUR NAME.
   Permission is granted to copy, distribute and/or modify this document
   under the terms of the GNU Free Documentation License, Version 1.2
```

```
   or any later version published by the Free Software Foundation;
   with no Invariant Sections, no Front-Cover Texts, and no Back-Cover Texts.
   A copy of the license is included in the section entitled “GNU
   Free Documentation License”.
```

If you have Invariant Sections, Front-Cover Texts and Back-Cover Texts, replace the “ with…Texts.” line with this:

```
with the Invariant Sections being LIST THEIR TITLES, with the
   Front-Cover Texts being LIST, and with the Back-Cover Texts being LIST.
```

If you have Invariant Sections without Cover Texts, or some other combination of the three, merge those two alternatives to suit the situation.

If your document contains nontrivial examples of program code, we recommend releasing these examples in parallel under your choice of free software license, such as the GNU General Public License, to permit their use in free software.