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SUSE Best Practices

SAP

SAP S/4 HANA - Enqueue Replication 2 High Availability Cluster With Simple Mount

Setup Guide

SUSE Linux Enterprise Server for SAP Applications 15
SAP HANA

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SUSE

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SUSE® Linux Enterprise Server for SAP Applications is optimized in various ways for SAP* applications. This document explains how to deploy an S/4 HANA Enqueue Replication 2 High Availability Cluster solution. It is based on SUSE Linux Enterprise Server for SAP Applications 15. The concept however can also be used with newer service packs of SUSE Linux Enterprise Server for SAP Applications.

Contents

1 About this guide

The following sections focus on background information and the purpose of the document at hand.

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.

The described cluster solution can be used for SAP* SAP S/4HANA ABAP Platform.

SAP S/4HANA ABAP Platform is a common stack of middleware functionality used to support SAP business applications. The SAP Enqueue Replication Server 2 constitutes application level redundancy for one of the most crucial components of the SAP S/4HANA ABAP Platform stack, the enqueue service. An optimal effect of the enqueue replication mechanism can be achieved when combining the application level redundancy with a high availability cluster solution, as provided for example by SUSE Linux Enterprise Server for SAP Applications. Over years of productive operations, the components mentioned have proven their maturity for customers of different sizes and industries.

In contrast to the traditional setups, this setup uses an additional NFS mount for the SAP application layer without the need to have dedicated block devices and cluster-controlled file systems. That greatly simplifies the overall architecture, implementation and maintenance of a SUSE Linux Enterprise High Availability cluster for SAP S/4HANA ABAP Platform with SAP Enqueue Replication Server 2. The here described setup is expected to be default for new deployments on SUSE Linux Enterprise Server for SAP Applications 15.

FIGURE 1: CERTIFIED BY SAP

For additional information on the simple mount architecture, also read:

- SUSE blog article "Simple Mount Structure for SAP Application Platform" (https://www.suse.com/c/simple-mount-structure-for-sap-application-platform/).
- SUSE knowledge base TID ("Technical Information Document") 00019944 "Use of Filesystem resource for ASCS/ERS HA setup not possible" (https://www.suse.com/support/kb/doc/?id=000019944).
- Manual page ocf_suse_SAPStartSrv(7), shipped with package sapstartsrv-resource-agents.

The former setup with cluster-controlled file system resources as described in "SAP S/4 HANA - Enqueue Replication 2 High Availability Cluster - Setup Guide" (https://documentation.suse.com/sbp/all/html/SAP_S4HA10_SetupGuide-SLE15) will remain supported.

1.2 Additional documentation and resources

Chapters in this manual contain links to additional documentation resources that are either available on the system or on the Internet.

For the latest SUSE product documentation updates, see https://documentation.suse.com.

Find white-papers, best-practices guides, and other resources at the

- SUSE Linux Enterprise Server for SAP Applications resource library: https://www.suse.com/products/sles-for-sap/resource-library/
- SUSE best practices web page: https://documentation.suse.com/sbp/sap/
- Supported high availability solutions by SUSE Linux Enterprise Server for SAP Applications overview: https://documentation.suse.com/sles-sap/sap-ha-support/html/sap-ha-support/article-sap-ha-support.html

Lastly, there are manual pages shipped with the product.

1.3 Errata

To deliver urgent smaller fixes and important information in a timely manner, the Technical Information Document (TID) for this document will be updated, maintained and published at a higher frequency:

- In addition to this guide, check the SUSE SAP Best Practice Guide Errata for other solutions (https://www.suse.com/support/kb/doc/?id=7023713).

1.4 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 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 Scope of this document

The document at hand explains how to:

- plan a SUSE Linux Enterprise High Availability platform for SAP S/4HANA ABAP Platform, including SAP Enqueue Replication Server 2.
- plan and implement an NFS-based storage layout for SAP Enqueue Replication Server 2.

- set up a Linux high availability platform and perform a basic SAP S/4HANA ABAP Platform installation including SAP Enqueue Replication Server 2 on SUSE Linux Enterprise.
- integrate the high availability cluster with the SAP control framework via **sap-suse-cluster-connector** version 3 and the new **SAPStartSrv** resource agent, to get an SAP certified setup.

Note

This guide implements the cluster architecture for enqueue replication version 2. For SAP S/4HANA ABAP Platform versions 1909 or newer, enqueue replication version 2 is the default.

This guide focuses on the high availability of the central services. For SAP HANA system replication consult the guides for the performance-optimized or cost-optimized scenario (see *Section 1.2, "Additional documentation and resources"*).

3 Overview

This document describes setting up a pacemaker cluster using SUSE Linux Enterprise Server for SAP Applications 15 for the Enqueue Replication scenario. The focus is on matching the SAP S/4-HA-CLU 1.0 certification specifications and goals. For the setup described in this document, two or three nodes are used for the ASCS central services instance and ERS replicated enqueue instance. These nodes are controlled by the SUSE Linux Enterprise High Availability cluster. Additional nodes are used for running the database, and the PAS and AAS application server instances. Finally, you need a highly available NFS server.

The goals for the setup include:

- Implementation of a cluster with a shared SAP applications directory
- Integration of the new **SapStartSrv** resource agent
- Integration of the cluster with the native **systemd**-based SAP start framework *sapstartsrv* to ensure that maintenance procedures do not break the cluster stability
- Rolling Kernel Switch (RKS) awareness
- Standard SAP installation to improve support processes

- Support of automated HA maintenance mode for SAP resources by implementing support of SAP HACheckMaintenanceMode and HASetMaintenanceMode
- Support of more than two cluster nodes for ASCS and ERS instances allowed

The updated certification SAP S/4-HA-CLU 1.0 redefines some of the test procedures and describes new expectations how the cluster should behave in special conditions. These changes allowed to improve the cluster architecture and to design it for easier usage, maintenance procedures and setup.

All shared SAP resources are located on a central NFS server.

Shared disks allow using SBD as the cluster fencing mechanism.

3.1 Differences to previous cluster architectures

- The described architecture now includes the simple mount structure based on an external network file share. Instead of the file system resources needed for each SAP instance, a resource type **SAPStartSrv** controls the matching `sapstartsrv` framework process. The cluster configuration is straightforward.

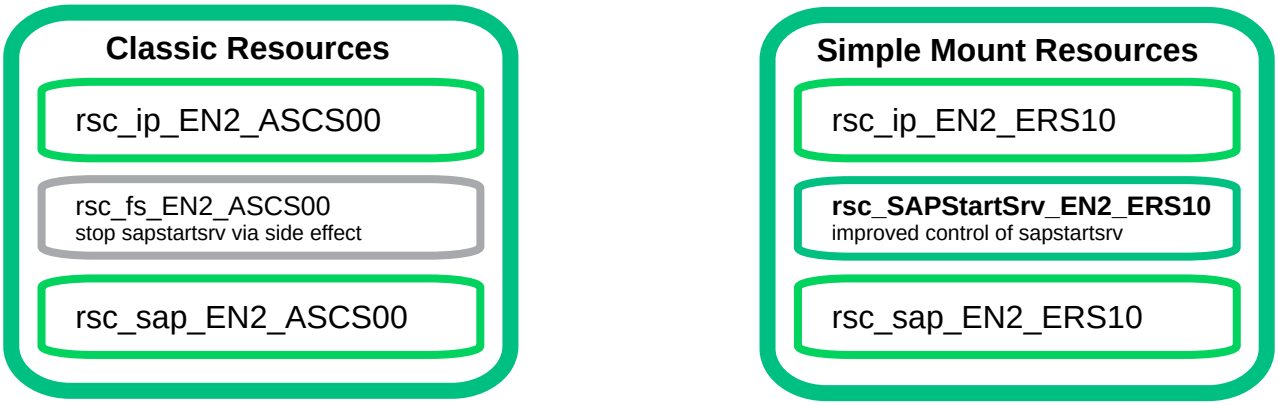

FIGURE 2: FROM CLASSIC RESOURCES TO SIMPLE MOUNT RESOURCES

- For SAP S/4HANA the new concept implies that, after a resource failure, the ASCS does not need to be started at the ERS side. The new enqueue architecture is also named ENSA2.
- Use of native **systemd** integration for SAP hostagent and instance´s `sapstartsrv`. Refer to the SAP documentation for the neccessary product version. See also SAP note 3139184. SUSE **systemd** version 234 at least is needed. For details refer to the SUSE Linux Enterprise Server for SAP Applications product documentation. SUSE resource agents are needed, at least *sapstartsrv-resource-agents 0.9.1* and *resource-agents 4.x* from November 2021.

3.2 Typical systems for ASCS, ERS, database and additional SAP instances

The document on hand describes the installation of a distributed SAP system on three and more systems. In this setup, only two or three systems reside inside the cluster. The database and SAP dialog instances can be controlled by an other cluster. We recommend to install the database on a separate cluster. The cluster configuration for three and more nodes is described at the end of this document. The number of nodes within one cluster should be either two or an odd number.

Note

Because the setup at hand focuses on the SAP S/4-HA-CLU 1.0 certification, the cluster detailed in this guide only manages the SAP instances ASCS and ERS.

If your database is SAP HANA, we recommend setting up the performance-optimized system replication scenario using the automation solution SAPHanaSR. The SAPHanaSR automation should be set up in an own two-node cluster. The setup is described in a separate best practices document available from the SUSE Best Practices documentation Web page at https://documentation.suse.com/en-us/sbp/sap/.

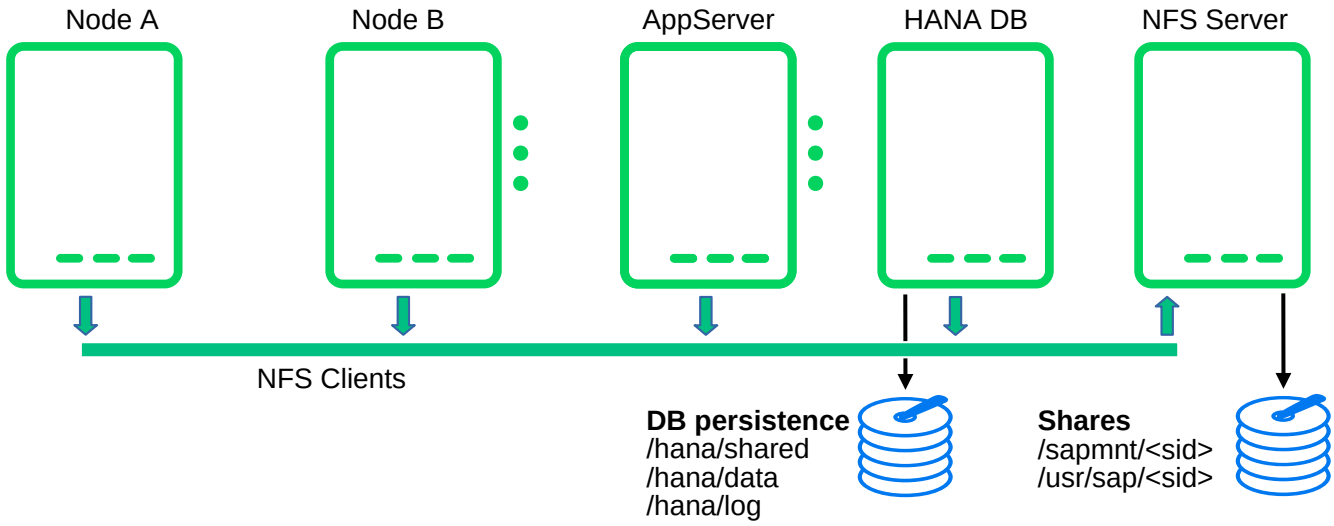

FIGURE 3: TYPICAL SYSTEMS FOR THE CERTIFICATION SETUP

CLUSTERED MACHINES TWO-NODE SCENARIO

- One machine (valuga11) for ASCS
  - Virtual host name: sapen2as
- One machine (valuga12) for ERS
  - Virtual host name: sapen2er

OPTIONALLY CLUSTERED MACHINES

- One machine (valuga01) for DB; Virtual host name: sapen2db
- One machine (valuga13) for the PAS; Virtual host name: sapen2d1
- One machine (valuga14) for the AAS; Virtual host name: sapen2d2

3.3 Increasing high availability for the database

Depending on your needs, you can increase the availability of the database if your database is not already highly available by design.

3.3.1 Implementing SAP HANA system replication

A perfect enhancement of the three-node scenario described in this document is to implement an SAP HANA system replication (SR) automation.

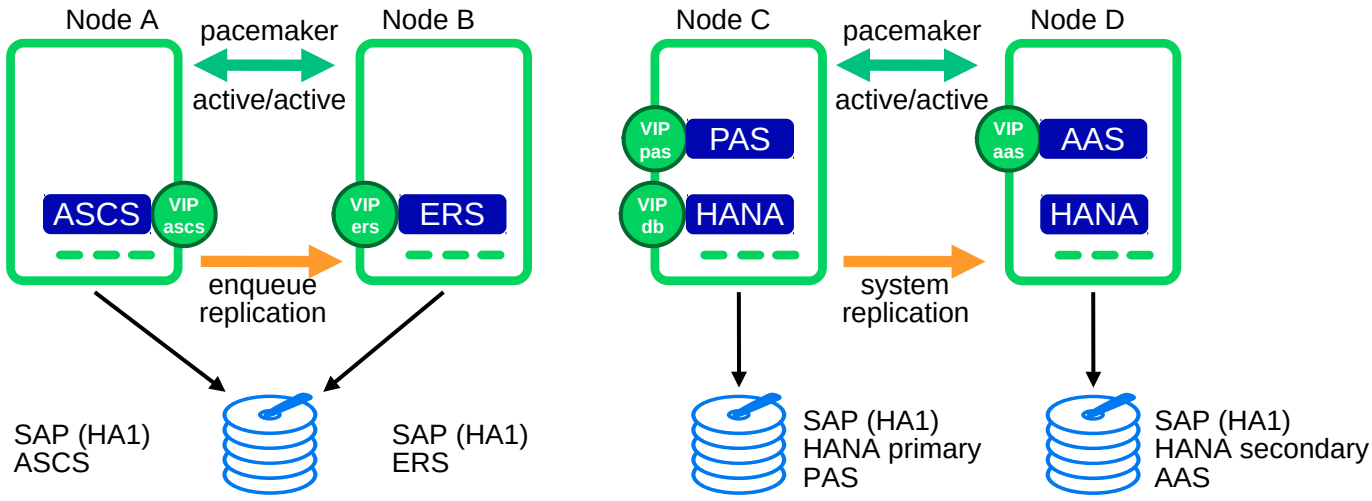

FIGURE 4: ONE CLUSTER FOR CENTRAL SERVICES, ONE FOR SAP HANA SR

TABLE 1: THE FOLLOWING OS/DATABASE COMBINATIONS ARE EXAMPLES FOR THIS SCENARIO

SUSE Linux Enterprise Server for SAP Applications 15	
Intel X86_64	SAP HANA DATABASE 2.0
IBM PowerLE	SAP HANA DATABASE 2.0

Note

Version for SAP S/4HANA ABAP Platform on Linux on AMD64/Intel 64 and IBM PowerLE. More information about the supported combinations of OS and databases for SAP S/4HANA Server 2021 or newer can be found at the SAP Product Availability Matrix at SAP PAM (https://apps.support.sap.com/sap/support/pam).

3.4 Integrating SAP S/4HANA into the cluster using the Cluster Connector

The integration of the HA cluster through the SAP control framework using the **sap_suse_cluster_connector** is of special interest. The service `sapstartsrv` controls SAP instances since SAP Kernel versions 6.40. One of the classic problems running SAP instances in a highly available environment is the following: If an SAP administrator changes the status (start/stop) of an SAP instance without using the interfaces provided by the cluster software, the cluster framework will detect that as an error status and will bring the SAP instance into the old status by either starting or stopping the SAP instance. This can result in very dangerous situations, if the cluster changes the status of an SAP instance during some SAP maintenance tasks. The new updated solution enables the central component `sapstartsrv` to report state changes to the cluster software. This avoids dangerous situations as previously described. More details can be found in the blog article "Using sap_vendor_cluster_connector for interaction between cluster framework and sapstartsrv" at https://blogs.sap.com/2014/05/08/using-sapvendorclusterconnector-for-interaction-between-cluster-framework-and-sapstartsrv/comment-page-1/.

Note

If you update from an SAP S/4HANA ABAP Platform version less than 1809, read SAP Note 2641019 carefully to adapt your cluster.

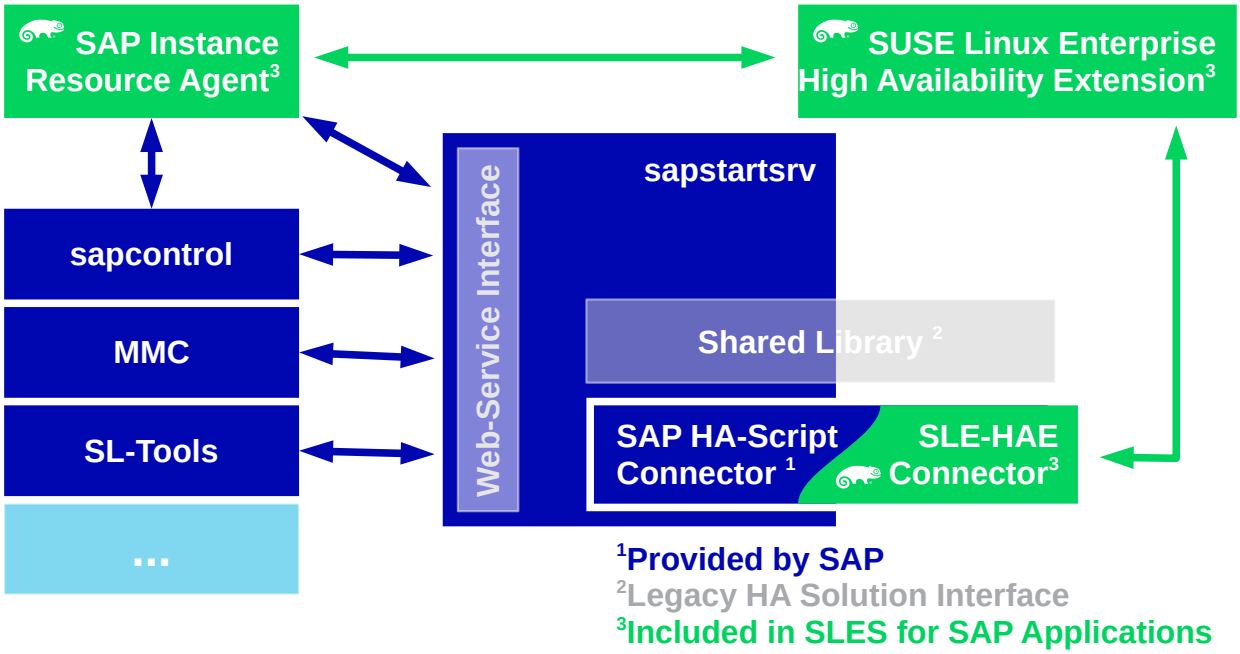

FIGURE 5: CLUSTER CONNECTOR TO INTEGRATE THE CLUSTER WITH THE SAP START FRAMEWORK

Note

For this scenario, an updated version of the **sap-suse-cluster-connector** is used. It implements the API version 3 for the communication between the cluster framework and the `sapstartsrv` service.

The new version of the **sap-suse-cluster-connector** allows starting, stopping and migrating an SAP instance. The integration between the cluster software and the `sapstartsrv` also implements the option to run checks of the HA setup using either the command line tool `sapcontrol` or even the SAP management consoles (SAP MMC or SAP MC). Since version 3.1.0 and later the maintenance mode of cluster resources triggered with SAP `sapcontrol` commands is supported. See also manual page sap_suse_cluster_connector(8).

3.5 Sharing disks and NFS

XFS is used for all local file systems. For */sapmnt/<SID>* and */usr/sap/<SID>*, NFS is used.

3.5.1 Sharing disk for SBD and mounting NFS for cluster ASCS and ERS

The disk for the fencing mechanism SBD must be shared and assigned to the cluster nodes valuga11 and valuga12 in the two-node cluster example. The NFS file systems for the ASCS and ERS instances are mounted both on valuga11 and valuga12. They could also be mounted on the SAP application servers (in this example valuga13/PAS and valuga14/AAS) to simplify the storage layout of the complete SAP system even more.

Make sure that your shared SBD disk */dev/disk/by-id/SUSE-Example-A* is visible on valuga11 and valuga12:

```
# lsblk | grep /dev/disk/by-id/SUSE-Example-A
```

During the SAP software installation you need to mount via NFS and entries in */etc/fstab*.

3.5.2 Preparing the disk for database and dialog instances (HANA DB)

The disk */dev/disk/by-id/SUSE-Example-B* for the database (260 GB) is assigned to valuga01 and formatted with XFS.

You can either use YaST or available command line tools to create the partitions. The following script can be used for non-interactive setups.

EXAMPLE 1: CREATE PARTITIONS AND FILE SYSTEMS FOR DB AND APP SERVERS ON VALUGA01

```
# lsblk
# parted -s /dev/disk/by-id/SUSE-Example-B print
# # we are on the 'correct' drive, right?
# mkfs.xfs /dev/disk/by-id/SUSE-Example-B
# mkdir /hana
# echo "/dev/disk/by-id/SUSE-Example-B /hana xfs defaults 0 2" >> /etc/fstab
# mount /dev/disk/by-id/SUSE-Example-B
```

Note

D01: Since NetWeaver 7.5 the primary application server instance directory has been renamed to 'D<Instance_Number>'.

NFS SERVER

- 192.168.1.1:/data/export/S4_HA_CLU_10/EN2/sapmnt/EN2 /sapmnt/EN2
- 192.168.1.1:/data/export/S4_HA_CLU_10/EN2/usr/sap/EN2 /usr/sap/EN2

MEDIA

- 192.168.1.1:/sapmedia /sapmedia

3.6 Adding IP addresses and virtual names

Check if the file */etc/hosts* contains at least the following address resolutions. Add those entries if they are missing.

```
192.168.1.100  valuga01
192.168.1.103  valuga11
192.168.1.104  valuga12
192.168.1.105  valuga13

192.168.1.112  sapen2as
192.168.1.113  sapen2er
192.168.1.114  sapen2db
192.168.1.110  sapen2d1
192.168.1.111  sapen2d2
```

3.7 Creating mount points and NFS shares

In the present setup, the directory */usr/sap* is part of the root file system. You can also create a dedicated file system for that area and mount */usr/sap* during the system boot. As */usr/sap* contains the SAP control file *sapservices* and the **saphostagent**, the directory should not be placed on a shared file system between the cluster nodes.

You need to create the directory structure on all nodes that should run the SAP resource.

- Create mount points and mounting NFS shares on all non-HANA nodes, for example on valuga11, valuga12. If the application servers should also profit from the simplified storage setup, they can use the share as well.

EXAMPLE 2: MOUNT NFS SHARES ON ALL NON-HANA NODES

```
# mkdir -p /sapmnt/EN2 /usr/sap/EN2 /sapmedia
# echo "192.168.1.1:/data/export/S4_HA_CLU_10/EN2/sapmnt/EN2 /sapmnt/EN2 nfs
 defaults 0 0" >> /etc/fstab
# echo "192.168.1.1:/data/export/S4_HA_CLU_10/EN2/usr/sap/EN2 /usr/sap/EN2 nfs
 defaults 0 0" >> /etc/fstab
# mount /sapmnt/EN2
# mount /usr/sap/EN2
```

> Mount options may depend on your particular environment. See also manual pages SAPStartsrv_basic_cluster(8) and mount.nfs(8).

4 Installing the SAP system

The overall procedure to install the distributed SAP system is as follows:

TASKS

1. Plan Linux user and group number scheme.
2. Install the ASCS instance for the central services.
3. Install the ERS to get a replicated enqueue scenario.
4. Prepare the ASCS and ERS installations for the cluster take-over.
5. Install the database.
6. Install the primary application server instance (PAS).
7. Install additional application server instances (AAS).

The result will be a distributed SAP installation as illustrated here:

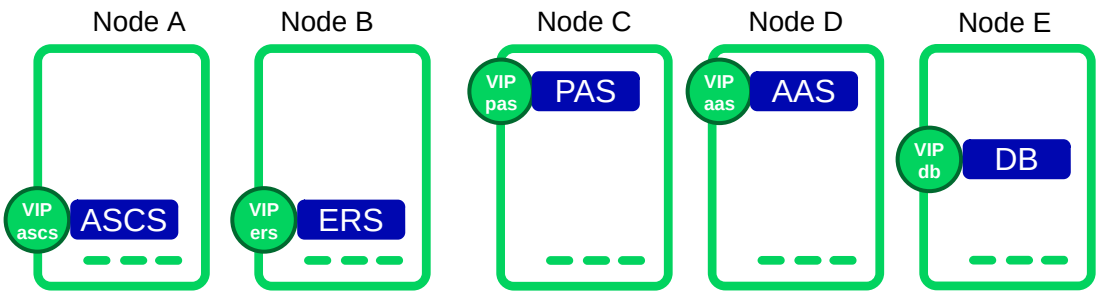

FIGURE 6: DISTRIBUTED INSTALLATION OF THE SAP SYSTEM

4.1 Linux user and group number scheme

Whenever asked by the SAP software provisioning manager (SWPM) which Linux User IDs or Group IDs to use, refer to the following table as an example:

```
Group sapinst      1001
```

```
Group sapsys       1002
Group ha1shm       1003

User  en2adm       2001
User  sapadm       2002
User  ha1adm       2003
```

4.2 Installing ASCS on valuga11

Temporarily, as the local IP address, set the service IP address which you will later use in the cluster, because the installer needs to be able to resolve and use it. Make sure to use the correct virtual host name for each installation step. If applicable, make sure to mount file systems like */sapmedia/*.

```
# ip a a 192.168.1.112/24 dev eth0
# # if not mounted yet, mount these now
# mount /sapmnt/EN2
# mount /usr/sap/EN2
# cd /sapmedia/SWPM20_P9/
# ./sapinst SAPINST_USE_HOSTNAME=sapen2as
```

- SWPM product installation path:
    - Installing SAP S/4HANA Server 2021 → SAP HANA DATABASE → Installation → Application Server ABAP → High-Availability System → ASCS Instance
- Use SID EN2.
- Use instance number 00.
- Deselect using FQDN.
- All passwords: use <use-your-secure-pwd>.
- Double-check during the parameter review if virtual name **sapen2as** is used.
- If you get an error during the installation about permissions, change the ownership of the ASCS directory.

```
# chown -R en2adm:sapsys /usr/sap/EN2/ASCS00
```

4.3 Installing ERS on valuga12

Temporarily, as the local IP address, set the service IP address which you will later use in the cluster, because the installer needs to be able to resolve and use it. Make sure to use the correct virtual host name for each installation step.

```
# ip a a 192.168.1.113/24 dev eth0
# # if not mounted yet, mount these now
# mount /sapmnt/EN2
# mount /usr/sap/EN2
# cd /sapmedia/SWPM20_P9/
# ./sapinst SAPINST_USE_HOSTNAME=sapen2er
```

- SWPM product installation path:
    - Installing SAP S/4HANA Server 2021 → SAP HANA DATABASE → Installation → Application Server ABAP → High-Availability System → ERS Instance
- Use instance number 10.
- Deselect using FQDN.
- Double-check during the parameter review that virtual name **sapen2er** is used.
- If you get an error during the installation about permissions, change the ownership of the ERS directory.

```
# chown -R en2adm:sapsys /usr/sap/EN2/ERS10
```

- If you get a prompt to manually stop/start the ASCS instance, log in to valuga11 as user en2adm and call 'sapcontrol'.

```
# sapcontrol -nr 00 -function Stop    # to stop the ASCS
# sapcontrol -nr 00 -function Start   # to start the ASCS
```

4.4 Performing subsequent steps for ASCS and ERS

After installation, you can perform several subsequent steps on the ASCS and ERS instances.

4.4.1 Stopping ASCS and ERS

To stop the ASCS and ERS instances, use the commands below. On *valuga11*, do the following:

```
# su - en2adm
# sapcontrol -nr 00 -function Stop
# sapcontrol -nr 00 -function StopService
```

On *valuga12*, do the following:

```
# su - en2adm
# sapcontrol -nr 10 -function Stop
# sapcontrol -nr 10 -function StopService
```

4.4.2 Disabling **systemd** services of the ASCS and the ERS SAP instance

This is mandatory for giving control over the instance to the HA cluster. See also manual pages ocf_suse_SAPStartSrv(7) and SAPStartSrv_basic_Cluster(7).

```
# systemctl disable SAPEN2_00.service
# systemctl stop SAPEN2_00.service
# systemctl disable SAPEN2_10.service
# systemctl stop SAPEN2_10.service
```

Note

Stopping this instance services will stop the SAP instance as well. Starting the instance services will not start the SAP instances.

- Check the SAP **systemd** integration:

```
# systemctl list-unit-files | grep SAP
SAPEN2_00.service disabled
SAPEN2_10.service disabled
```

The instance services are indeed disabled, as required.

```
# systemctl list-unit-files | grep sap
saphostagent.service enabled
sapinit.service generated
saprouter.service disabled
saptune.service enabled
```

The mandatory `saphostagent` service is enabled. This is the installation default. Some more SAP related services might be enabled, for example the recommended `saptune`.

```
# cat /usr/sap/sapservices
systemctl --no-ask-password start SAPEN2_00 # sapstartsrv pf=/usr/sap/EN2/SYS/profile/
EN2_ASCS00_sapen2as
systemctl --no-ask-password start SAPEN2_10 # sapstartsrv pf=/usr/sap/EN2/SYS/profile/
EN2_ERS10_sapen2er
```

The *sapservices* file is still there for compatibility. It shows native **systemd** commands, one per line for each registered instance. You will find a SystemV style example in the appendix.

4.4.3 Integrating the cluster framework using *sap-suse-cluster-connector*

Install the package `sap-suse-cluster-connector` version 3.1.0 from the SUSE repositories:

```
# zypper in sap-suse-cluster-connector
```

Note

The package `sap-suse-cluster-connector` contains the version 3.x.x (SAP API 3). The package `sap-suse-cluster-connector` with version 3.0.x implements the SUSE SAP API version 3. New features like SAP Rolling Kernel Switch (RKS) and migration of ASCS are only supported with this new version. The package`sap-suse-cluster-connector` with version 3.1.x supports in addition the maintenance mode of cluster resources triggered from SAP tools.

For the ERS and ASCS instances, edit the instance profiles EN2_ASCS00_sapen2as and EN2_ERS10_sapen2er in the profile directory */usr/sap/EN2/SYS/profile/*.

Tell the `sapstartsrv` service to load the HA script connector library and to use the connector `sap-suse-cluster-connector`. On the other hand, make sure the feature *Autostart* is **not** used.

```
service/halib = $(DIR_EXECUTABLE)/saphascriptco.so
service/halib_cluster_connector = /usr/bin/sap_suse_cluster_connector
```

Add the user *en2adm* to the Unix user group *haclient*.

```
# usermod -a -G haclient en2adm
```

See also manual pages sap_suse_cluster_connector(8), usermod(8) and groupmod(8).

4.4.4 Adapting SAP profiles to match the SAP S/4-HA-CLU 1.0 certification

For the ASCS instance, change the start command from *Restart_Program_xx* to *Start_Program_xx* for the enqueue server (Enqueue Server 2). This change tells the SAP start framework **not** to self-restart the enqueue process. Such a restart would result in a loss of the locks.

File **/usr/sap/EN2/SYS/profile/EN2_ASCS00_sapen2as**:

```
Start_Program_01 = local $(_ENQ) pf=$(_PF)
```

Optionally, you can limit the number of restarts of services (in the case of ASCS, this limits the restart of the message server).

For the ERS instance, change the start command from *Restart_Program_xx* to *Start_Program_xx* for the enqueue replication server (Enqueue Replicator 2).

File **/usr/sap/EN2/SYS/profile/EN2_ERS10_sapen2er**:

```
Start_Program_00 = local $(_ENQR) pf=$(_PF) NR=$(SCSID)
```

4.4.5 Starting ASCS and ERS

To start the ASCS and ERS instances, use the commands below.

On *valuga12*, do the following

```
# su - en2adm
# sapcontrol -nr 10 -function StartService EN2
# sapcontrol -nr 10 -function Start
```

On *valuga11*, do the following:

```
# su - en2adm
# sapcontrol -nr 00 -function StartService EN2
# sapcontrol -nr 00 -function Start
```

4.5 Installing database on valuga01

The HANA DB has very strict HW requirements. The storage sizing depends on many indicators. Check the supported configurations at SAP HANA Hardware Directory (https://support.sap.com/en/release-upgrade-maintenance.html#section_1969201630) and SAP HANA TDI (https://www.sap.com/documents/2016/05/e8705aae-717c-0010-82c7-eda71af511fa.html).

```
# ip a a 192.168.1.114/24 dev eth0
# mount /dev/disk/by-id/SUSE-Example-B /hana
# cd /sapmedia/SWPM20_P9/
# ./sapinst SAPINST_USE_HOSTNAME=sapen2db
```

- SWPM product installation path:
    - Installing SAP S/4HANA Server 2021 → SAP HANA DATABASE → Installation → Application Server ABAP → High-Availability System → Database Instance
- Profile directory is */sapmnt/EN2/profile*.
- Deselect using FQDN.
- Database parameters : Database ID (DBSID) is HA1; Database Host is sapen2db; Instance Number is 53.
- Database System ID enter Instance Number is 53; SAP Mount Directory is /sapmnt/EN2/profile.
- Account parameters: change them in case of custom values needed.
- Clean-up: select **Yes**, remove operating system users from the group `sapinst`.
- Double-check during the parameter review, if virtual name **sapen2db** is used.

4.6 Installing the primary application server (PAS) on valuga13

```
# ip a a 192.168.1.110/24 dev eth0
# mount /dev/disk/by-id/SUSE-Example-B-part2 /usr/sap/EN2/D01
# cd /sapmedia/SWPM20_P9/
# ./sapinst SAPINST_USE_HOSTNAME=sapen2d1
```

- SWPM product installation path:
    - Installing SAP S/4HANA Server 2021 → SAP HANA DATABASE → Installation → Application Server ABAP → High-Availability System → Primary Application Server Instance
- Use instance number 01.
- Deselect using FQDN.

- For this example setup, we have used a default secure store key.
- Do not install Diagnostic Agent.
- No SLD is used.
- Double-check during the parameter review, if virtual name **sapen2d1** is used.

4.7 Installing an additional application server (AAS) on valuga14

```
# ip a a 192.168.1.111/24 dev eth0
# mount /dev/disk/by-id/SUSE-Example-B-part3 /usr/sap/EN2/D02
# cd /sapmedia/SWPM20_P9/
# ./sapinst SAPINST_USE_HOSTNAME=sapen2d2
```

- SWPM product installation path:
  - Installing SAP S/4HANA Server 2021 → SAP HANA DATABASE → Installation → Application Server ABAP → High-Availability System → Additional Application Server Instance
- Use instance number 02.
- Deselect using FQDN.
- Do not install Diagnostic Agent.
- Double-check during the parameter review, if virtual name **sapen2d2** is used.

4.8 Optional: Preparing additional cluster nodes

If you install a cluster with three or more nodes to control the ASCS and ERS, you need to prepare these nodes to have SAP Linux users and system configuration in place to be ready to run the SAP instances. SWPM 2.0 already includes an installation option to prepare additional cluster nodes. In this case `sapinst` is called without SAPINST_USE_HOSTNAME.

Ensure that the SAP NFS shares are also mounted on the additional cluster node.

```
# cd /sapmedia/SWPM20_P9/
# ./sapinst
```

- SWPM product installation path:
  - Installing SAP S/4HANA Server 2021 → SAP HANA DATABASE → Installation → Application Server ABAP → High-Availability System → Prepare Additional Cluster Node
- Provide SAP profile path.
- Double-check the parameter review.

5 Implementing the cluster

The main procedure to implement the cluster is as follows:

TASKS

1. Prepare the operating system and install the cluster software.
2. Configure the cluster base including corosync and resource manager.
3. Configure the cluster resources.
4. Tune the cluster timing in special for the SBD.

Note

Before you continue to set up the cluster, perform the following actions: First stop all SAP instances. Then remove the (manually added) IP addresses on the cluster nodes. Finally unmount the file systems which will be controlled by the cluster later.

Note

The SBD device/partition needs to be created beforehand. Double-check which device/partition to use! In this setup guide, a disk */dev/disk/by-id/SUSE-Example-A* is already reserved for SBD usage.

5.1 Preparing the operating system and installing the cluster software

- Set up and enable `chrony` with `yast2`.
- Install the RPM pattern **ha_sles** and package `sapstartsrv-resource-agents` on both cluster nodes.

```
# zypper in -t pattern ha_sles
# zypper in sapstartsrv-resource-agents
```

5.2 Configuring the cluster base

TASKS

- To configure the cluster base, you can use either YaST or the interactive command line tool `ha-cluster-init`. The example below uses the command line wizard.
- Install and configure the watchdog device on the first machine.

Instead of deploying the software-based solution, rather use a hardware-based watchdog device. The following example uses the software device but can be easily adapted to the hardware device.

```
# modprobe softdog
# echo softdog > /etc/modules-load.d/watchdog.conf
# systemctl restart systemd-modules-load
# lsmod | egrep "(wd|dog|i6|iT|ibm)"
```

- Install and configure the cluster stack on the first machine

```
# ha-cluster-init -u -s  /dev/disk/by-id/SUSE-Example-A
```

- Join the second node.

On the second node, perform some preparation steps.

```
# modprobe softdog
# echo softdog > /etc/modules-load.d/watchdog.conf
# systemctl restart systemd-modules-load
```

```
# lsmod | egrep "(wd|dog|i6|iT|ibm)"
```

To configure the cluster base, you can use either YaST or the interactive command line tool `ha-cluster-join`. The example below uses the command line wizard.

```
# ha-cluster-join -c valuga11
```

- The *crm_mon -1r* output should look as follows:

```
Stack: corosync
Current DC: valuga11 (version 1.1.18+20180430.b12c320f5-1.14-b12c320f5) - partition with
 quorum
Last updated: Mon Jan 28 13:10:37 2019
Last change: Wed Jan 23 09:52:57 2019 by root via cibadmin on valuga11

2 nodes configured
1 resource configured

Online: [ valuga11 valuga12 ]

stonith-sbd (stonith:external/sbd): Started valuga11
```

5.3 Configuring cluster resources

The SAPInstance resource configuration is needed to start and stop the ASCS and the ERS instances themselves. See manual page ocf_heartbeat_SAPInstance(7) for details.

The SAPStartSrv resource starts and stops the `sapstartsrv` service and guarantees that only one instance is running per cluster at the same time. See manual page ocf_suse_SAPStartSrv(7) for details.

With the new version of ENSA2, the ASCS instance can be started on the same host. There is no longer a need to follow the ERS instance. The ASCS instance receives the enqueue lock table over the network from the ERS instance. If no other node is available, the ASCS instance will be started on the same host where the ERS instance is running.

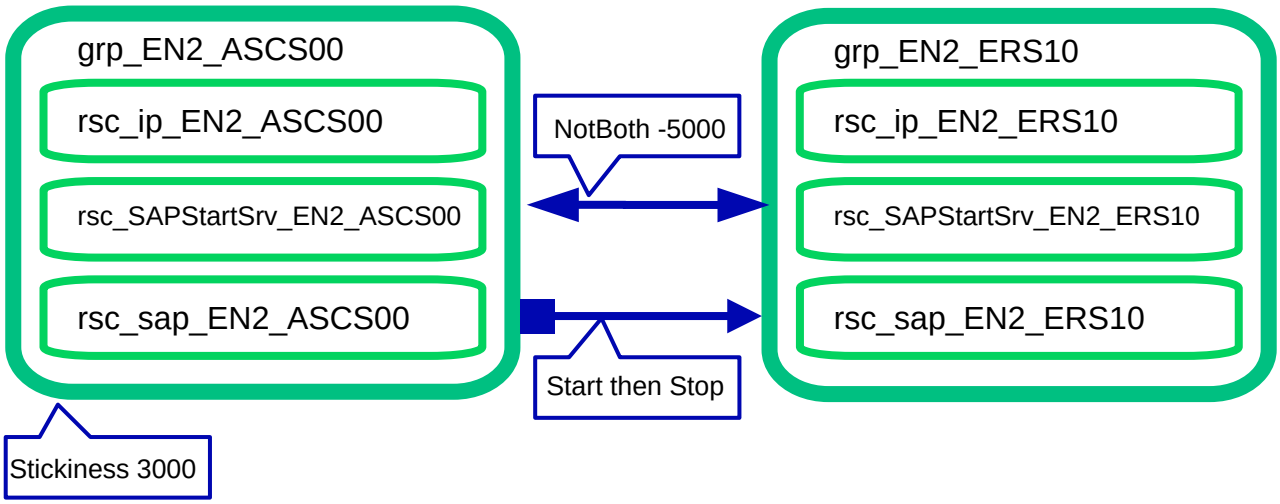

FIGURE 7: RESOURCES AND CONSTRAINTS

Another benefit of this concept is that you can work with native (mountable) file systems instead of a shared (NFS) file system for the SAP instance directories.

5.3.1 Preparing the cluster for adding the resources

To prevent the cluster from starting partially defined resources, set the cluster to the maintenance mode. This deactivates all monitor actions.

As user *root*, type the following command:

```
# crm configure property maintenance-mode="true"
```

5.3.2 Preparing the new SAPStartSrv resource agent implementation

As a prerequisite for having a single NFS mount for ASCS and ERS, the `sapstartsrv` instance agents of ASCS and ERS must not be started by the `sapinit` service during system start-up, as these services are started and stopped by dedicated cluster resources.

With the `sapstartsrv-resource-agents` RPM package there come two **systemd** services called `sapping` and `sappong`. `sapping` runs before `sapinit` and moves */usr/sap/sapservices* out of the way. Consequently, the `sapstartsrv` instance agents are not started automatically by `sapinit`. `sappong` runs after `sapinit` and moves */usr/sap/sapservices* back to its original location.

On valuga11 and valuga12, check for the `sapstartsrv-resource-agents` package and enable the `sapping` and `sappong` services.

```
# zypper info sapstartsrv-resource-agents
# systemctl enable sapping
# systemctl enable sappong
```

See manual pages ocf_suse_SAPStartSrv(7), sapping(8) and SAPStartSrv_basic_cluster(7) for details.

5.3.3 Configuring resources for the ASCS Instance

First, configure the resources for the IP address, the SAP instance agent and the SAP instance. You need to adapt the parameters for your specific environment.

Make sure that in the SAP instance definition the parameter **MINIMAL_PROBE** is set to **true**.

EXAMPLE 3: ASCS PRIMITIVE

```
primitive rsc_ip_EN2_ASCS00 IPaddr2 \
  params ip=192.168.1.112 \
  op monitor interval=10 timeout=20
primitive rsc_SAPStartSrv_EN2_ASCS00 ocf:suse:SAPStartSrv \
  params InstanceName=EN2_ASCS00_sapen2as
primitive rsc_sap_EN2_ASCS00 SAPInstance \
  op monitor interval=11 timeout=60 on-fail=restart \
  params InstanceName=EN2_ASCS00_sapen2as \
     START_PROFILE="/usr/sap/EN2/SYS/profile/EN2_ASCS00_sapen2as" \
     AUTOMATIC_RECOVER=false MINIMAL_PROBE=true \
  meta resource-stickiness=5000
```

The shown SAPInstance monitor timeout is a trade-off between fast recovery of the ASCS vs. resilience against sporadic temporary NFS issues. You may slightly increase it to fit your infrastructure. Consult your storage or NFS server documentation for appropriate timeout values. Make sure the SAPStartSrv resource has **NO** monitor operation configured. See also manual pages ocf_heartbeat_SAPInstance(7), ocf_heartbeat_IPaddr2(7) ocf_suse_SAPStartSrv(7) and nfs(5).

EXAMPLE 4: ASCS GROUP

```
group grp_EN2_ASCS00 \
```

```
  rsc_ip_EN2_ASCS00 rsc_SAPStartSrv_EN2_ASCS00 rsc_sap_EN2_ASCS00 \
  meta resource-stickiness=3000
```

Create a *txt* file (like *crm_ascs.txt*) with your preferred text editor. Add both examples (primitives and group) to that file and load the configuration to the cluster manager configuration.

As user *root*, type the following command:

```
# crm configure load update crm_ascs.txt
```

5.3.4 Configuring resources for the ERS Instance

Next, configure the resources for the IP address, the SAP instance agent and the SAP instance. You need to adapt the parameters for your specific environment.

Make sure that in the SAP instance definition the parameter **MINIMAL_PROBE** is set to **true**.

The specific parameter **IS_ERS = true** must only be set for the ERS instance.

EXAMPLE 5: ERS PRIMITIVE

```
primitive rsc_ip_EN2_ERS10 IPaddr2 \
  params ip=192.168.1.113 \
  op monitor interval=10 timeout=20
primitive rsc_SAPStartSrv_EN2_ERS10 ocf:suse:SAPStartSrv \
  params InstanceName=EN2_ERS10_sapen2er
primitive rsc_sap_EN2_ERS10 SAPInstance \
  op monitor interval=11 timeout=60 on-fail=restart \
  params InstanceName=EN2_ERS10_sapen2er \
     START_PROFILE="/usr/sap/EN2/SYS/profile/EN2_ERS10_sapen2er" \
     AUTOMATIC_RECOVER=false IS_ERS=true MINIMAL_PROBE=true
```

The shown SAPInstance monitor timeout is a trade-off between fast recovery of the ERS vs. resilience against sporadic temporary NFS issues. You may slightly increase it to fit your infrastructure. Consult your storage or NFS server documentation for appropriate timeout values. Make sure the SAPStartSrv resource has **NO** monitor operation configured. See also manual pages ocf_heartbeat_SAPInstance(7), ocf_heartbeat_IPaddr2(7) ocf_suse_SAPStartSrv(7) and nfs(5).

EXAMPLE 6: ERS GROUP

```
group grp_EN2_ERS10 \
  rsc_ip_EN2_ERS10 rsc_SAPStartSrv_EN2_ERS10 rsc_sap_EN2_ERS10
```

Create a *txt* file (like *crm_ers.txt*) with your preferred text editor. Add both examples (primitives and group) to that file and load the configuration to the cluster manager configuration.

As user *root*, type the following command:

```
# crm configure load update crm_ers.txt
```

5.3.5 Configuring the colocation constraints between ASCS and ERS

Compared to the ENSA1 configuration, the constraints between the ASCS and ERS instances are changed. An ASCS instance should avoid starting up on the cluster node running the ERS instance if any other node is available. Today the ENSA2 setup can resynchronize the lock table over the network.

If the ASCS instance has been started by the cluster on the ERS node, the ERS instance should be moved to another cluster node (col_sap_EN2_no_both). This constraint is needed to ensure that the ERS instance will synchronize the locks again and the cluster is ready for an additional take-over.

EXAMPLE 7: LOCATION CONSTRAINT

```
colocation col_sap_EN2_separate -5000: grp_EN2_ERS10 grp_EN2_ASCS00
order ord_sap_EN2_ascs_first Optional: rsc_sap_EN2_ASCS00:start \
      rsc_sap_EN2_ERS10:stop symmetrical=false
```

Create a *txt* file (like *crm_col.txt*) with a text editor. Add both constraints to that file and load the configuration to the cluster manager configuration.

As user *root*, type the following command:

```
# crm configure load update crm_col.txt
```

5.3.6 Activating the cluster

The last step is to end the cluster maintenance mode and to allow the cluster to detect already running resources.

As user *root*, type the following command:

```
# crm configure property maintenance-mode="false"
```

6 Administration

6.1 Dos and Don’ts

Note

Before each test, verify that the cluster is in idle state, no migration constraints are active, and no resource failure messages are visible. Start each procedure with a clean setup.

A minimal example sequence for checking the cluster status might look like the following:

```
# crm_mon -1r
# crm configure show | grep cli-
# cs_clusterstate -i
```

See also manual pages cs_clusterstate(8), crm(8) and crm_mon(8).

6.1.1 Maintenance procedure for a Linux cluster or operating system with ASCS and ERS instances remain running

Check state of Linux cluster and ASCS/ERS:

```
# cs_clusterstate -i
```

This must return the following output:

```
Cluster state: S_IDLE
```

Obtain a cluster summary, list of nodes, and a full list of resources:

```
# crm_mon -1r
```

Check for any undesired location constraints:

```
# crm configure show|grep cli-
```

If the command returns no output, it means that there are no undesired constraints.

Get a list of system instances:

```
# su - en2adm -c "sapcontrol -nr 00 -function GetSystemInstanceList"
```

Get a list of processes running on the ASCS and ERS instances:

```
# su - en2adm -c "sapcontrol -nr 00 -function GetProcessList"
```

Check whether maintenance mode is set in the cluster configuration:

```
# su - en2adm -c "sapcontrol -nr 00 -function HACheckMaintenanceMode"
```

Get the information about cluster solution, available HA nodes, and the active node where the given instance is running:

```
# su - en2adm -c "sapcontrol -nr 00 -function HAGetFailoverConfig"
```

Before you set the Linux cluster into the maintenance mode, check its state by running the `cs_clusterstate -i` command. Then run the command below to set the cluster into the maintenance mode:

```
# crm maintenance on
```

Stop the Linux cluster on all nodes:

```
# crm cluster stop
```

You can now perform maintenance on the Linux cluster or system. Before doing the system maintenance, you must bring down SAP instances as necessary. If the SAP instances were brought down, then you also need to bring up the SAP instances before activating the cluster.

When the maintenance is complete, start the Linux cluster on all nodes:

```
# crm cluster start
```

Let the Linux cluster detect the status of the ASCS and ERS resources:

```
# crm resource refresh rsc_sap_EN2_ASCS00
# crm resource refresh rsc_sap_EN2_ERS10
```

Set the cluster ready for operations:

```
# cs_clusterstate -i
# crm maintenance off
```

Check the status of the Linux cluster and ASCS/ERS:

```
# cs_clusterstate -i
# crm_mon -1r
# crm configure show|grep cli-
# su - en2adm -c "sapcontrol -nr 00 -function GetSystemInstanceList"
# su - en2adm -c "sapcontrol -nr 00 -function GetProcessList"
```

```
# su - en2adm -c "sapcontrol -nr 10 -function GetProcessList"
# su - en2adm -c "sapcontrol -nr 00 -function HACheckMaintenanceMode"
# su - en2adm -c "sapcontrol -nr 00 -function HAGetFailoverConfig"
# cs_clusterstate -i
```

6.1.2 Migrating the ASCS instance

To **migrate** the ASCS SAP instance, you should use SAP tools such as the SAP management console. This will trigger **sapstartsrv** to use the sap-suse-cluster-connector to migrate the ASCS instance. As user *en2adm* you can run the command below to migrate the ASCS. This will always migrate the ASCS to the ERS side which will keep the SAP enqueue locks.

As user *en2adm*, type the command:

```
# sapcontrol -nr 00 -function HAFailoverToNode ""
```

6.1.3 Using unique instance numbers

All SAP instance numbers controlled by the cluster must be unique. If you need multiple dialog instances with the same instance number running on different systems, they must not be controlled by the cluster.

6.1.4 Setting the cluster to maintenance mode

The procedure to set the cluster into maintenance mode can be executed as user *root* or *sidadm*.

As user *root*, type the following command:

```
# crm configure property maintenance-mode="true"
```

As user *en2adm*, type the following command (the full path is needed):

```
# /usr/sbin/crm configure property maintenance-mode="true"
```

6.1.5 Stopping the cluster maintenance

The procedure to end the maintenance mode for the cluster can be executed as user *root*. Type the following command:

```
# crm configure property maintenance-mode="false"
```

See also manual page crm(8).

6.1.6 Starting the Resource Maintenance Mode

The procedure to start the resource maintenance mode can be executed as user *en2adm*. This sets the ASCS and ERS cluster resource to **unmanaged**.

As user *en2adm*, type the command:

```
# sapcontrol -nr 00 -function HASetMaintenanceMode 1
```

6.1.7 Stopping the resource maintenance mode

The procedure to start the resource maintenance mode can be executed as user *en2adm*. This sets the ASCS and ERS cluster resource to **managed**.

As user *en2adm*, type the command:

```
# sapcontrol -nr 00 -function HASetMaintenanceMode 0
```

6.1.8 Cleaning up resources

You can also **clean up resource failures**. Failures are automatically deleted to allow a failback after a specified period of time. You can also clean up the status, including the failures, by running the following command as root:

```
# crm resource cleanup RESOURCE-NAME
```

6.2 Testing the cluster

It is strongly recommended to perform at least the following tests before you go into production with your cluster:

6.2.1 Checking product names with HAGetFailoverConfig

Check if the name of the SUSE cluster solution is shown in the output of `sapcontrol` or the SAP management console. This test checks the status of the SAP S/4HANA cluster integration.

As user *en2adm*, type the following command:

```
# sapcontrol -nr 00 -function HAGetFailoverConfig
```

6.2.2 Running SAP checks using HACheckConfig and HACheckFailoverConfig

Check if the HA configuration tests are passed successfully and do not produce error messages.

As user *en2adm*, type the following commands:

```
# sapcontrol -nr 00 -function HACheckConfig
# sapcontrol -nr 00 -function HACheckFailoverConfig
```

6.2.3 Manually migrating ASCS

Check if manually migrating the ASCS instance using HA tools works properly.

As user *root*, run the following commands:

```
# crm resource migrate rsc_sap_EN2_ASCS00 force
## wait until the ASCS is been migrated to the ERS host
# crm resource unmigrate rsc_sap_EN2_ASCS00
```

6.2.4 Migrating ASCS using HAFailoverToNode

Check if moving the ASCS instance using SAP tools like sapcontrol works properly.

As user *en2adm*, type the following command:

```
# sapcontrol -nr 00 -function HAFailoverToNode ""
```

6.2.5 Test ASCS migration after operating system failure

Check if the ASCS instance moves correctly after a node failure. This test will immediately trigger a hard reboot of the node.

As user *root*, type the following command:

```
## on the ASCS host
```

```
# echo b >/proc/sysrq-trigger
```

6.2.6 Restarting ASCS in-place using `Stop` and `Start`

Check if the in-place restart of the SAP resources have been processed correctly. The SAP instance should not failover to an other node, it must start on the same node where it has been stopped.

As user *en2adm*, do the following:

```
## example for ASCS
# sapcontrol -nr 00 -function Stop
# sapcontrol -nr 00 -function WaitforStopped 60 20
## cs_clusterstate -i
# sapcontrol -nr 00 -function Start
```

6.2.7 Performing an automated restart of the ASCS instance (simulating rolling kernel switch)

The next test should proof that the cluster solution did nor interact neither try to restart the ASCS instance during a maintenance procedure. In addition, it should verify that no locks are lost during the restart of an ASCS instance during a rolling kernel switch (RKS) procedure. The cluster solution should recognize that the restart of the ASCS instance was expected. No failure or error should be reported or counted.

Optionally, you can set locks and verify that they still exist after the maintenance procedure. There are multiple ways to do that. One example test can be performed as follows:

1. Log in to your SAP system and open the transaction SU01.
2. Create a new user. Do not finish the transaction to see the locks.
3. With the SAP MC / MMC, check if there are locks available.
4. Open the ASCS instance entry and go to *Enqueue Locks*.
5. With the transaction SM12, you can also see the locks.

Do this test multiple times in a short time frame. The restart of the ASCS instance in the example below happens five times.

As user *en2adm*, create and execute the following script:

```
$ cat ascs_restart.sh
```

```
#!/bin/bash
for lo in 1 2 3 4 5; do
  echo LOOP "$lo - Restart ASCS00"
  sapcontrol -host sapen2as -nr 00 -function StopWait 120 1
  sleep 1
  sapcontrol -host sapen2as -nr 00 -function StartWait 120 1
  sleep 1
done
```

```
$ bash ascs_restart.sh
```

6.2.8 Performing an RKS

The RKS is an automated procedure that enables the kernel in an ABAP system to be exchanged without any system downtime. During an RKS, all instances of the system, and generally all SAP start services (`sapstartsrv`), are restarted.

1. Check in SAP note 953653 whether the new kernel patch is RKS compatible to your currently running kernel.
2. Check SAP note 2077934 - Rolling kernel switch in HA environments.
3. Download the new kernel from the SAP service market place.
4. Make a backup of your current central kernel directory.
5. Extract the new kernel archive to the central kernel directory.
6. Start the RKS via SAP MMC, system overview (transaction SM51) or via command line.
7. Monitor and check the version of your SAP instances with the SAP MC / MMC or with **sapcontrol**.

As user *en2adm*, type the following commands:

```
## sapcontrol [-user <sidadm psw>] -host <host> -nr <INSTANCE_NR> -function UpdateSystem
 120 300 1
# sapcontrol -user en2adm <use-your-secure-pwd> -host sapen2as -nr 00 -function
 UpdateSystem 120 300 1
# sapcontrol -nr 00 -function GetSystemUpdateList -host sapen2as \
  -user en2adm <use-your-secure-pwd>
# sapcontrol -nr 00 -function GetVersionInfo -host sapen2as \
  -user en2adm <use-your-secure-pwd>
```

```
# sapcontrol -nr 10 -function GetVersionInfo -host sapen2er \
  -user en2adm <use-your-secure-pwd>
# sapcontrol -nr 01 -function GetVersionInfo -host sapen2d1 \
  -user en2adm <use-your-secure-pwd>
# sapcontrol -nr 02 -function GetVersionInfo -host sapen2d2 \
  -user en2adm <use-your-secure-pwd>
```

6.2.9 Additional tests

In addition to the already performed tests, you should do the following:

- Check the recoverable and non-recoverable outage of the message server process.
- Check the non-recoverable outage of the SAP enqueue server process.
- Check the outage of the SAP Enqueue Replication Server 2.
- Check the outage and restart of sapstartsrv.
- Check the simulation of an upgrade.
- Check the simulation of cluster resource failures.

7 Multi-node cluster setups for SAP S/4HANA

Multi-node cluster setups mean cluster configurations with more than two nodes. Depending on the starting point it is possible to extend a two-node cluster setup or directly start with more than two nodes for an ASCS / ERS high availability setup. The examples below will show the setting up of multi-node cluster and the extension of an existing two node cluster pair. The major configuration changes will be shown and the basic preparation of the new cluster member node.

The task list to set up the three node cluster is similar to the task list for the two-node cluster. However some details are described different here to get a diskless SBD setup. Such a diskless SBD setup is an optional improvement for three nodes, but does not work for two nodes. On the other hand, priority fencing is an optional improvement for two nodes, but does not work for three nodes. An example priority fencing configuration for the two-node cluster is shown in the appendix. See the SUSE Linux Enterprise High Availability product documentation for details (https://documentation.suse.com/sle-ha/15-SP3/single-html/SLE-HA-administration/#pro-ha-storage-protect-fencing ↗).

Note

When extending a cluster from two to three nodes, make sure to not use priority fencing.

7.1 Extending an existing two-node cluster configuration

TASKS

1. Backing up the current cluster
2. Installing the operating system of the new node
3. Patching the existing nodes
4. Preparing the new node's operating system
5. Installing the cluster software on the new node
6. Preparing SAPStartSrv resource agent on the new node
7. Preparing the SAP installation on the new node
8. Adding the new node to the cluster
9. Testing the new cluster configuration

7.1.1 Backing up the current cluster

To **back up the current cluster**, perform a

- Backup of your system including
  - cluster configuration
  - corosync.conf
  - all data and configuration which are important and customized and not default

The system is configured as described in the SUSE Best Practices document *SAP S/4 HANA - Enqueue Replication 2 High Availability Cluster With Simple Mount - Setup Guide*.

To **back up the cluster configuration**, go to one of the cluster nodes and safe the cluster configuration with *crm* and *crm report* commands:

```
# crm configure save 2node.txt
```

Back up the existing /etc/corosync/corosync.conf and all other files which may be important for a restore. This example is one method creating a backup. The important point is using an **external** destination.

```
# tar cvf /<path to an external storage>/bck_2nodes_configuration.tar \
      /etc/corosync/corosync.conf \
      2node.txt \
      <add your additional files here>
```

7.1.2 Installing the operating system of the new node

We recommend using automating the installation to ensure that the system setup across nodes is identical. Make sure to document any additional steps you take beyond the automated setup. In our example, we deploy our machines with an AutoYaST configuration file and run a post step script which does the basic configuration.

7.1.3 Patching the existing nodes

If applicable, install the latest updates and patches on your existing nodes. Alternatively, if you are using frozen repositories such as those provided by SUSE Manager, add the new system to the same repositories, so they have the same patch level as your existing nodes.

Use `zypper patch` or `zypper update` depending on your company's rules.

- We recommend installing the latest available patches to guarantee system stability and hardening. Bug fixing and security patches help avoid unplanned outages and make the system less vulnerable.

There are multiple ways:

```
# zypper patch
## or
# zypper update
```

7.1.4 Preparing the new node's operating system

EXAMPLE 8: CHECK FOR VALID DNS, TIME SYNCHRONIZATION, NETWORK SETTINGS

- Verify that DNS is working:

```
# ping <hostname>
```

- Set up **chrony** (this is best done with **yast2**) and enable it:

```
# yast ntp-client
```

- Check the network settings:

```
# ip r
```

You may run into trouble if there is no valid or no default route configured.

- Patch the new system like the existing nodes, verify that your systems have the same patch level and that all required reboots have been performed.

7.1.5 Installing cluster software on the new node

EXAMPLE 9: INSTALLING PACKAGES

- Install the pattern **ha_sles** on the new cluster node:

```
# zypper in -t pattern ha_sles
```

- Install the package **sap-suse-cluster-connector** version 3.1.0 from the SUSE repositories:

```
# zypper in sap-suse-cluster-connector
```

7.1.6 Preparing SAPStartSrv resource agent on the new node

- Install the sapstartsrv-resource-agents package and enable the sapping and sappong services.

```
# zypper in sapstartsrv-resource-agents
```

```
# systemctl enable sapping
# systemctl enable sappong
```

After installing all necessary packages, compare installed package versions.

EXAMPLE 10: CHECK THAT ALL NODES HAVE THE SAME SOFTWARE PACKAGES AND VERSIONS:

- On the existing cluster nodes, type:

```
# rpm -qa | sort >rpm_valuga11.log
```

- On the new node, type:

```
# rpm -qa | sort >rpm_valuga13.log
```

- Copy the file from one node to the other and compare the two versions:

```
# vimdiff rpm_valuga13.log rpm_valuga11.log
```

Note

If there any differences fix them first before you proceed.

EXAMPLE 11: INSTALL AND CONFIGURE THE WATCHDOG DEVICE ON THE NEW MACHINE.

Instead of deploying the software-based solution, preferably use a hardware-based watchdog device. The following example uses the software device but can be easily adapted to the hardware device.

```
# modprobe softdog
# echo softdog > /etc/modules-load.d/watchdog.conf
# systemctl restart systemd-modules-load
# lsmod | egrep "(wd|dog|i6|iT|ibm)"
```

Note

Ensure that the new node is connected to the same SBD disk connected to the existing two nodes. Ensure that the new node has the same exact SBD configurations already exist on the two existing nodes

```
# sbd -d /dev/disk/by-id/SUSE-Example-A dump
```

7.1.7 Preparing the SAP installation on the new node

With SWPM 2.0 (SP4 or later), which is part of the SL Toolset, SAP provides a new option which can perform all necessary steps to prepare a fresh install server to be able to fit into an existing SAP system. This new option will help us to prepare a new host which can later run either the ASCS or ERS in the cluster environment.

You need to create the directory structure that should run the SAP resource. The instance directory is located on an NFS share for all nodes.

- Create mount points and mount NFS shares on the new added node (valuga13):

EXAMPLE 12: MOUNT NFS SHARES ON VALUGA13

```
# mkdir -p /sapmnt/EN2 /usr/sap/EN2 /sapmedia
# mount -t nfs 192.168.1.1:/data/export/S4_HA_CLU_10/EN2/sapmnt/EN2    /sapmnt/EN2
# mount -t nfs 192.168.1.1:/data/export/S4_HA_CLU_10/EN2/usr/sap/EN2    /usr/sap/EN2
# mount -t nfs 192.168.1.1:/sapmedia /sapmedia
```

As the directories */sapmnt/EN2*, */usr/sap/EN2* need to be available at all time, make sure they are mounted during boot. This can be achieved by putting the information into the */etc/fstab*.

The next step requires the following information:

- profile directory
- password for SAP System Administrator
- UID for sapadm

```
# cd /sapmedia/SWPM20_P9/
# ./sapinst
```

- SWPM product installation path:
  - Installing SAP S/4HANA Server 2021 → SAP HANA DATABASE → Installation → Application Server ABAP → High-Availability System → Prepare Additional Cluster Node
- Use /sapmnt/EN2/profile for the profile directory
- All passwords: <use-your-secure-pwd>
- UID for sapadm: 2002

EXAMPLE 13: POST STEP PROCEDURE AFTER SAP PREPARATION STEP

- Add the user *en2adm* to the unix user group *haclient*.

```
# usermod -a -G haclient en2adm
```

- Register the ASCS and the ERS SAP instance:

```
# LD_LIBRARY_PATH=/usr/sap/hostctrl/exe:$LD_LIBRARY_PATH; export
 LD_LIBRARY_PATH
# /usr/sap/hostctrl/exe/sapstartsrv pf=/usr/sap/<SID>/SYS/profile/
<SID>_ERS<instanceNumberErs>_<virtHostNameErs> -reg
# /usr/sap/hostctrl/exe/sapstartsrv pf=/usr/sap/<SID>/SYS/profile/
<SID>_ASCS<instanceNumberAscs>_<virtHostNameAscs> -reg
```

Note

This must be done for each instance. Call sapstartsrv with parameters **pf** = <profile-of-the-sap-instance> and **-reg**.

- Disable **systemd** services of the ASCS and the ERS SAP instance:

```
# systemctl disable SAPEN2_00.service
# systemctl disable SAPEN2_10.service
```

Note

This is mandatory for giving control over the instance to the HA cluster.

- Check the SAP **systemd** integration:

```
# systemctl list-unit-files | grep sap
saphostagent.service enabled
sapinit.service generated
saprouter.service disabled
saptune.service enabled
# systemctl list-unit-files | grep SAP
SAPEN2_10.service disabled
SAPEN2_10.service disabled
# cat /usr/sap/sapservices
systemctl --no-ask-password start SAPEN2_00 # sapstartsrv pf=/usr/sap/EN2/SYS/
profile/EN2_ASCS00_sapen2as
systemctl --no-ask-password start SAPEN2_10 # sapstartsrv pf=/usr/sap/EN2/SYS/
profile/EN2_ERS10_sapen2er
```

7.1.8 Adding the new node to the cluster

EXAMPLE 14: ADDING THE NEW NODE TO THE CLUSTER

Check if the SBD device is available in case the SBD stonith method is in place for the two nodes. If the existing cluster using a different, supported stonith mechanism check and verify them too for the new cluster node.

```
# sbd -d /dev/disk/by-id/SUSE-Example-A dump
```

- Joining the cluster can be done with **`ha-cluster-join`**:

```
# ha-cluster-join -c valuga11
```

After the new node has joined the cluster, the configuration must be adapted to the new situation. Double-check if joining the cluster was successful and verify the file */etc/corosync/corosync.conf*.

```
# awk '/quorum/,/}/' /etc/corosync/corosync.conf
# corosync-quorumtool -s
```

The values **expected_votes** and **two_node** should now look like this on all nodes:

```
expected_votes: 3
two_node: 0
```

Modify the cluster configuration and set a new colocation rule with *crm*:

```
# crm configure delete col_sap_EN2_no_both
# crm configure colocation ASCS00_ERS10_separated_EN2 -5000: grp_EN2_ERS10
 grp_EN2_ASCS00
```

7.1.9 Testing the new cluster configuration

It is highly recommended to run certain test to verify that the new configuration is working as expected. A list of test can be found in the basic setup for the two node cluster above.

7.2 Pros and Cons for odd and even numbers of cluster nodes

There are certain use cases and infrastructure requirements which end up in different installation setups. We will cover some advantages and disadvantages of special configuration below:

- The two node cluster and two locations

    - Advantage: symmetric spread of all nodes over all locations
    - Disadvantage: no diskless SBD feature allowed for all two node clusters
- The two node cluster and more than two locations
    - Advantage: SBD device can be provided from there (must be HA himself)
    - Advantage: cluster could operate with three SBD devices from different locations
    - Disadvantage: no diskless SBD feature allowed for all two node clusters
- The three node cluster and two locations
    - Advantage: less complex infrastructure
    - Advantage: diskless SBD feature is allowed
    - Disadvantage: "pre selected" location (two node + one node)
- The three node cluster and three locations
    - Advantage: symmetric spread of all nodes over all locations
    - Advantage: diskless SBD feature is allowed
    - Disadvantage: higher planing effort and complexity for infrastructure planning

8 References

For more information, see the documents listed below.

8.1 SUSE product documentation

- SUSE product manuals and documentation can be downloaded at https://documentation.suse.com/
- SUSE release notes can be found at https://www.suse.com/releasenotes/
- SUSE Linux Enterprise Server technical information can be found at https://www.suse.com/products/server/technical-information/

8.2 Pacemaker

- Pacemaker 2.0 Configuration Explained: https://clusterlabs.org/pacemaker/doc/deprecated/en-US/Pacemaker/2.0/html-single/Pacemaker_Explained/

8.3 Related Manual Pages

- chronyc(8)
- corosync.conf(8)
- corosync_overview(8)
- crm(8)
- crm_mon(8)
- crm_simulate(8)
- cs_clusterstate(8)
- cs_man2pdf(8)
- cs_show_sbd_devices(8)
- cs_wait_for_idle(8)
- ha_related_sap_notes(7)
- ha_related_suse_tids(7)
- mount.nfs(8)
- ocf_heartbeat_IPaddr2(7)
- ocf_heartbeat_SAPInstance(7)
- ocf_suse_SAPStartSrv(7)
- sapping(7)
- sapservices-move(8)

- SAPStartSrv_basic_cluster(7)
- SAPStartSrv_maintenance_procedures(7)
- sap_suse_cluster_connector(8)
- saptune(8)
- sbd(8)
- stonith_sbd(7)
- supportconfig(8)
- systemctl(8)
- systemd-cgls(8)
- usermod(8)
- votequorum(5)
- zypper(8)

8.4 Related SUSE TIDs

- SUSE SAP Best Practice Guide Errata (https://www.suse.com/support/kb/doc/?id=7023713)
- Use of Filesystem resource for ASCS/ERS HA setup not possible (https://www.suse.com/support/kb/doc/?id=000019944)
- Integration of sap-suse-cluster-connector does not work as expected (https://www.suse.com/support/kb/doc/?id=000019244)
- Long Client hang to Cluster after failover of ERS Instance (https://www.suse.com/support/kb/doc/?id=000019293)
- sap_suse_cluster_connector stuck as HAActive: FALSE (https://www.suse.com/support/kb/doc/?id=000019924)

8.5 Related SUSE blogs

- Simple Mount Structure for SAP Application Platform (https://www.suse.com/c/simple-mount-structure-for-sap-application-platform/)
- First certified simple-mount cluster ever! (https://www.suse.com/c/first-certified-simple-mount-cluster-ever/)
- Handover for the Next Round – SAP on SUSE Cluster and systemd Native Integration (https://www.suse.com/c/handover-for-the-next-round-sap-on-suse-cluster-and-systemd-native-integration/)

8.6 Related SAP Documentation

- SAP Product Availability Matrix (https://support.sap.com/en/release-upgrade-maintenance.html#section_1969201630)
- Important Resources about the HA-Interface Certification for Partners (https://wiki.scn.sap.com/wiki/display/SI/Important+Resources+about+the+HA-Interface+Certification+for+Partners)

8.7 Related SAP Notes

- 768727 - Automatic restart functions in sapstart for processes (https://launchpad.support.sap.com/#/notes/768727)
- 927637 - Web service authentication in sapstartsrv as of Release 7.00 (https://launchpad.support.sap.com/#/notes/927637)
- 953653 - Rolling Kernel Switch (https://launchpad.support.sap.com/#/notes/953653)
- 1092448 - IBM XL C/C++ runtime environment for Linux on system p (https://launchpad.support.sap.com/#/notes/1092448)
- 1153713 - Problems with SAP Management Console (Java) (https://launchpad.support.sap.com/#/notes/1153713)
- 1552925 - Linux: High Availability Cluster Solutions (https://launchpad.support.sap.com/#/notes/1552925)

- 1619879 - licensing of HA/DR/cluster → invalid license (https://launchpad.support.sap.com/#/notes/1619879)
- 1693245 - SAP HA Script Connector Library (https://launchpad.support.sap.com/#/notes/1693245)
- 1763512 - Support details for SUSE Linux Enterprise for SAP Applications (https://launchpad.support.sap.com/#/notes/1763512)
- 1864705 - Compatibility tests for certified HA setups (https://launchpad.support.sap.com/#/notes/1864705)
- 1872602 Rolling kernel switch using kernel release limits (https://launchpad.support.sap.com/#/notes/1872602)
- 2077934 - Rolling kernel switch in HA environments (https://launchpad.support.sap.com/#/notes/2077934)
- 2235581 - SAP HANA: Supported Operating Systems (https://launchpad.support.sap.com/#/notes/2235581)
- 2254173 - Linux: Rolling Kernel Switch in Pacemaker based NetWeaver HA environments (https://launchpad.support.sap.com/#/notes/2254173)
- 2308598 - Error "Ifconfig is obsolete" happens when you run startsap to start SAP system (https://launchpad.support.sap.com/#/notes/2308598)
- 2369910 - SAP Software on Linux: General information (https://launchpad.support.sap.com/#/notes/2369910)
- 2464065 - Check of automatic maintenance mode for HA solutions (https://launchpad.support.sap.com/#/notes/2464065)
- 2578899 - SUSE Linux Enterprise Server 15: Installation Note (https://launchpad.support.sap.com/#/notes/2578899)
- 2625407 - SAP S/4HANA 1809: Release Information Note (https://launchpad.support.sap.com/#/notes/2625407)
- 2630416 - Support for Standalone Enqueue Server 2 (https://launchpad.support.sap.com/#/notes/2630416)
- 2641019 - Installation of ENSA2 and update from ENSA1 to ENSA2 in SUSE HA environment (https://launchpad.support.sap.com/#/notes/2641019)

- 2684254 - SAP HANA DB: Recommended OS settings for SLES 15 / SLES for SAP Applications 15 (https://launchpad.support.sap.com/#/notes/2684254)
- 2711036 - Usage of the Standalone Enqueue Server 2 in an HA Environment (https://launchpad.support.sap.com/#/notes/2711036)
- 2714839 - New security settings for S/4HANA 1909 (and later) (https://launchpad.support.sap.com/#/notes/2714839)
- 2717369 - Download files for installing of SAP S4/HANA 1809, SAP S4/HANA 1909, BW S/4HANA 2.0 (https://launchpad.support.sap.com/#/notes/2717369)
- 2855499 - FAIL: RKS Warning(s): Unsupported SCS instance with additional gateway found (https://launchpad.support.sap.com/#/notes/2855499)
- 3075829 - New sapstarstrv Web service method "ABAPSetServerInactive" (https://launchpad.support.sap.com/#/notes/3075829)
- 3091152 - sapstartsrv - improved deregistration for UNIX/Linux (https://launchpad.support.sap.com/#/notes/3091152)
- 3115889 - SAP Web Dispatcher embedded deployment in an ASCS/SCS instance (https://launchpad.support.sap.com/#/notes/3115889)
- 3139184 - Linux: systemd integration for sapstartsrv and SAP Hostagent (https://launchpad.support.sap.com/#/notes/3139184)
- 3145200 - SAP Host Agent 7.22 PL57 (https://launchpad.support.sap.com/#/notes/3145200)

9 Appendix

9.1 CRM configuration of the two-node cluster

Find below the complete crm configuration for SAP system EN2. This example is for the two node cluster, but without priority fencing. In a multi-node cluster you will find additonal node entries like **node 3: valuga13**.

```
node 1: valuga11
node 2: valuga12
primitive rsc_ip_EN2_ASCS00 IPaddr2 \
    params ip=192.168.1.112 \
    op monitor interval=10 timeout=20
primitive rsc_ip_EN2_ERS10 IPaddr2 \
    params ip=192.168.1.113 \
    op monitor interval=10 timeout=20
primitive rsc_SAPStartSrv_EN2_ASCS00 ocf:suse:SAPStartSrv \
    params InstanceName=EN2_ASCS00_sapen2as
primitive rsc_SAPStartSrv_EN2_ERS10 ocf:suse:SAPStartSrv \
    params InstanceName=EN2_ERS10_sapen2er
primitive rsc_sap_EN2_ASCS00 SAPInstance \
    op monitor interval=11 timeout=60 on-fail=restart \
    params InstanceName=EN2_ASCS00_sapen2as \
        START_PROFILE="/usr/sap/EN2/SYS/profile/EN2_ASCS00_sapen2as" \
        AUTOMATIC_RECOVER=false MINIMAL_PROBE=true \
        meta resource-stickiness=5000
primitive rsc_sap_EN2_ERS10 SAPInstance \
    op monitor interval=11 timeout=60 on-fail=restart \
    params InstanceName=EN2_ERS10_sapen2er \
         START_PROFILE="/usr/sap/EN2/SYS/profile/EN2_ERS10_sapen2er" \
         AUTOMATIC_RECOVER=false IS_ERS=true MINIMAL_PROBE=true
primitive stonith-sbd stonith:external/sbd \
    params pcmk_delay_max=30
group grp_EN2_ASCS00 rsc_ip_EN2_ASCS00 \
    rsc_SAPStartSrv_EN2_ASCS00 rsc_sap_EN2_ASCS00 \
    meta resource-stickiness=3000
group grp_EN2_ERS10 rsc_ip_EN2_ERS10 \
    rsc_SAPStartSrv_EN2_ERS10 rsc_sap_EN2_ERS10
colocation col_sap_EN2_separate -5000: \
    grp_EN2_ERS10 grp_EN2_ASCS00
order ord_sap_EN2_ascs_first Optional: rsc_sap_EN2_ASCS00:start \
    rsc_sap_EN2_ERS10:stop symmetrical=false
property cib-bootstrap-options: \
    have-watchdog=true \
```

```
    cluster-infrastructure=corosync \
    cluster-name=hacluster \
    stonith-enabled=true \
    stonith-timeout=150 \
    placement-strategy=balanced
rsc_defaults rsc-options: \
    resource-stickiness=1 \
    migration-threshold=3 \
    failure-timeout=86400
op_defaults op-options: \
    timeout=600 \
    record-pending=true
```

9.2 CRM configuration fragments of the two-node cluster with priority fencing

Find below crm configuration fragments for SAP system EN2. This example shows the specific items for the two node cluster with priority fencing. This configuration is basically the same as above, except the items shown below.

```
...
primitive rsc_sap_EN2_ASCS00 SAPInstance \
    op monitor interval=11 timeout=60 on-fail=restart \
    params InstanceName=EN2_ASCS00_sapen2as \
        START_PROFILE="/usr/sap/EN2/SYS/profile/EN2_ASCS00_sapen2as" \
        AUTOMATIC_RECOVER=false MINIMAL_PROBE=true \
        meta resource-stickiness=5000 priority=100
...
primitive stonith-sbd stonith:external/sbd \
    params pcmk_delay_max=15
...
property cib-bootstrap-options: \
    have-watchdog=true \
    cluster-infrastructure=corosync \
    cluster-name=hacluster \
    stonith-enabled=true \
    stonith-timeout=150 \
    placement-strategy=balanced \
    priority-fencing-delay=30
...
```

9.3 Corosync configuration of the two-node cluster

Find below the Corosync configuration for one corosync ring. Ideally two rings would be used.

```
valuga11:~ # cat /etc/corosync/corosync.conf
# Please read the corosync.conf.5 manual page
totem {
    version: 2
    secauth: on
    crypto_hash: sha1
    crypto_cipher: aes256
    cluster_name: hacluster
    clear_node_high_bit: yes
    token: 5000
    token_retransmits_before_loss_const: 10
    join: 60
    consensus: 6000
    max_messages: 20
    interface {
        ringnumber: 0
        mcastport: 5405
        ttl: 1
    }

    transport: udpu
}

logging {
    fileline: off
    to_stderr: no
    to_logfile: no
    logfile: /var/log/cluster/corosync.log
    to_syslog: yes
    debug: off
    timestamp: on
    logger_subsys {
        subsys: QUORUM
        debug: off
    }

}

nodelist {
    node {
        ring0_addr: 192.168.1.103
        nodeid: 1
    }
```

```
    node {
        ring0_addr: 192.168.1.104
        nodeid: 2
    }

}

quorum {

    # Enable and configure quorum subsystem (default: off)
    # see also corosync.conf.5 and votequorum.5
    provider: corosync_votequorum
    expected_votes: 2
    two_node: 1
}
```

9.4 Corosync configuration of the multi-node cluster

Find below the Corosync configuration for one corosync ring. Ideally two rings would be used.

```
# Please read the corosync.conf.5 manual page
totem {
 version: 2
 secauth: on
 crypto_hash: sha1
 crypto_cipher: aes256
 cluster_name: hacluster
 clear_node_high_bit: yes
 token: 5000
 token_retransmits_before_loss_const: 10
 join: 60
 consensus: 6000
 max_messages: 20
 interface {
  ringnumber: 0
  mcastport: 5405
  ttl: 1
 }

 transport: udpu
}

logging {
 fileline: off
```

```
 to_stderr: no
 to_logfile: no
 logfile: /var/log/cluster/corosync.log
 to_syslog: yes
 debug: off
 timestamp: on
 logger_subsys {
  subsys: QUORUM
  debug: off
 }

}

nodelist {
 node {
  ring0_addr: 192.168.1.103
  nodeid: 1
 }

 node {
  ring0_addr: 192.168.1.104
  nodeid: 2
 }

 node {
  ring0_addr: 192.168.1.105
  nodeid: 3
 }

}

quorum {

 # Enable and configure quorum subsystem (default: off)
 # see also corosync.conf.5 and votequorum.5
 provider: corosync_votequorum
 expected_votes: 3
 two_node: 0
}
```

9.5 /usr/sap/sapservices without native **systemd** integration

```
#!/bin/sh
```

```
LD_LIBRARY_PATH=/usr/sap/EN2/ASCS00/exe:$LD_LIBRARY_PATH; export LD_LIBRARY_PATH; /usr/
sap/EN2/ASCS00/exe/sapstartsrv pf=/usr/sap/EN2/SYS/profile/EN2_ASCS00_sapen2as -D -u
 en2adm
LD_LIBRARY_PATH=/usr/sap/EN2/ERS10/exe:$LD_LIBRARY_PATH; export LD_LIBRARY_PATH; /usr/
sap/EN2/ERS10/exe/sapstartsrv pf=/usr/sap/EN2/ERS10/profile/EN2_ERS10_sapen2er -D -u
 en2adm
```

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