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Appendix B: Example Cluster Configuration
Appendix C: Revision History
1 Executive Summary

As SAP HANA moves to take on a more central function as the primary database platform for SAP landscapes, requirements for stability and reliability increase dramatically. Red Hat Enterprise Linux for SAP HANA with High Availability and Smart Management meets those requirements by enhancing native SAP HANA replication and fail-over technology to automate the takeover process. During a fail-over in a typical SAP HANA System Replication deployment, a system administrator must manually instruct the application to perform a takeover to the secondary server in case there is an issue on the primary server. Red Hat Enterprise Linux for SAP HANA with High Availability and Smart Management provides pacemaker resource agents to automate the takeover from primary to secondary server.

Red Hat Enterprise Linux for SAP HANA with High Availability and Smart Management consist of these components:

- Red Hat Enterprise Linux for SAP HANA
- Red Hat Enterprise Linux High Availability Add-on

This document provides a step-by-step guide on how to set up a working automated SAP HANA System Replication solution using Red Hat Enterprise Linux for SAP HANA with High Availability and Smart Management.

Although the solution shown here has been extensively tested and is proven to work the challenges of a real implementation are usually more complex than what this document can cover. Red Hat therefore recommends that setting up and subsequently servicing such a solution should be guided by a certified consultant familiar with both SAP HANA and the Pacemaker based RHEL HA add-on.
2 Concepts and Planning

As documented in the High Availability for SAP HANA section of the SAP HANA Administration Guide there are a number of ways to increase the availability of a SAP HANA system and improve its resiliency against disasters. Customers could for example use external mechanisms like storage replication or set up a SAP HANA Scale-out environment.

For customers who want to increase the availability of their HANA installations using the mechanisms provided by SAP HANA itself without needing the complexity of a full SAP HANA scale-out setup SAP HANA System Replication offers a simple method of achieving this goal. SAP HANA System Replication however does not provide any automatic mechanisms to ensure that the DB is moved to a secondary location that is still functioning in case there is a failure of the primary site. The host system therefore needs to provide a mechanism for monitoring the SAP HANA System replication status and the SAP HANA processes to initiate and control the take-over process in case of a problem. It also needs to provide a fencing mechanism to ensure that in case of a failure the system is still in a well defined state.

In this document we will focus on the second part, the host system cluster setup. For detailed information about the setup of the SAP HANA System replication components, please refer to the “How to Perform System Replication for SAP HANA” guide and other documentation available from SAP (see Appendix A).

2.1 How it works: overview of the basic setup

In this document we describe how to use the Pacemaker cluster resource manager from the RHEL HA add-on to automate a SAP HANA Scale-Up setup with SAP HANA System Replication between two nodes. Using SAP HANA System Replication all data is constantly preloaded in memory on all nodes and all changes are replicated from the primary node to the secondary node, so that in case of a fail-over recovery time can be minimized.

To automate the management of the SAP HANA System Replication setup the Pacemaker based cluster stack provided by the RHEL HA add-on in RHEL6.5 and later is used.

The central part of the Pacemaker cluster setup are two Open Cluster Framework (OCF) resource agents which have been developed upstream in cooperation with SAP:

- SAPHana
- SAPHanaTopology

These agents are provided in the resource-agents-sap-hana RPM package which is available via the “RHEL for SAP HANA” channel on the Red Hat Customer Portal or your local Red Hat Satellite server.

The resource agents use various interfaces provided by SAP HANA, like hdbsql or hdbnsutil, to monitor the status of the SAP HANA System replication and, depending on the configuration, will initiate a SAP HANA System Replication takeover from the primary to the secondary node and optionally register the former primary replication node as the new secondary in case a failure is detected.
2.2 Supported scenarios

For the first version of the SAP HANA System Replication HA solution the support is limited to the following scenarios and parameters:

- SAP HANA SPS8 and later
- Two-Node SAP HANA Scale-Up (single-box to single-box) System Replication only, no support for HANA Scale-Out or HANA installations configured with a standby node
- Both SAP HANA instances must have the same SAP Identifier (SID) and Instance Number
- Only one system replication for the SAP HANA database, no "Multitier System Replication"/"replication chains"
- No other SAP HANA system (like QAS or TST) on the secondary node which needs to be stopped during takeover
- No support for SAP HANA System Replication "Multiple components One Database (MCOD)" or “Multiple Database Containers (MDC)" ([http://scn.sap.com/docs/DOC-59893](http://scn.sap.com/docs/DOC-59893)) setups; MCOS is only supported if all databases running on the hosts are replicated and the replication is always to the same secondary node
- All nodes must be in the same network segment (layer 2)
- Technical users and groups such as "<SID>adm" must be identically defined on all cluster nodes
- Name resolution of the cluster nodes and the virtual IP address can be done locally on all cluster nodes
- Time on all cluster nodes must be in sync (using NTP or some other time synchronization method)
- If the cluster nodes are installed in different data centers or data center areas, the environment must match both the requirements defined by SAP for HANA System Replication (see chapter "4.2 Distance between data centers" in the SAP "How to Perform System Replication for SAP HANA" guide) and also the RHEL HA add-on stretch cluster requirements, specifically the network latencies between the nodes and the recommended maximum distance
2.3 Resource Agents

2.3.1 SAPHana Resource Agent

The SAPHana resource agent runs on both nodes in a master/slave configuration. The master assumes responsibility for the SAP HANA databases running in primary mode, and the slave is responsible for instances that are operated in synchronous (secondary) status.

The SAPHana resource agent understands the following mandatory parameters:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SID</td>
<td>none</td>
<td>The SAP System Identifier (SID) of the SAP HANA installation (must be identical for the SAP HANA installations on all nodes) Example: RH1</td>
</tr>
<tr>
<td>InstanceNumber</td>
<td>none</td>
<td>The Instance Number of the SAP HANA installation (must be identical for the SAP HANA installations on all nodes) Example: 00</td>
</tr>
<tr>
<td>PREFER_SITE_TAKEOVER</td>
<td>none</td>
<td>Should resource agent prefer to switch over to slave instance instead of restarting master locally? (true: prefer takeover to remote site; false: prefer restart locally)</td>
</tr>
<tr>
<td>AUTOMATED_REGISTER</td>
<td>false</td>
<td>Whether a former primary instance should be registered automatically as a secondary by the resource agent during cluster/resource start, if a takeover event has occurred and the DUPLICATE_PRIMARY_TIMEOUT is expired</td>
</tr>
<tr>
<td>DUPLICATE_PRIMARY_TIMEOUT</td>
<td>7200</td>
<td>Time difference (in seconds) needed between two primary time stamps, if a dual-primary situation occurs. If the time difference is less than the time gap, then the cluster holds one or both instances in a &quot;WAITING&quot; status. This is to give a admin a chance to react on a takeover. If AUTOMATED_REGISTER is set to &quot;true&quot; a failed former primary will be registered after the time difference is passed. After this registration as a secondary to the new primary all data will be overwritten by the system replication.</td>
</tr>
<tr>
<td>SAPHanaFilter</td>
<td>ra-act-dec-lpa</td>
<td>Define SAPHana resource agent messages to be printed. Possible Values: any combination of &quot;ra-act-lpa-dec-flow-dbg-dbg2&quot; or &quot;all&quot; or &quot;none&quot;</td>
</tr>
</tbody>
</table>
2.3.2 SAPHanaTopology Resource Agent

The SAPHanaTopology resource agent runs as a stateless cloned agent on all nodes and gathers information about the status and configuration of SAP HANA System Replication on each node.

The SAPHanaTopology agent understands the following mandatory parameters:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SID</td>
<td>none</td>
<td>The SAP System Identifier (SID) of the SAP HANA installation (must be identical for the SAP HANA installations on all nodes) Example: RH1</td>
</tr>
<tr>
<td>InstanceNumber</td>
<td>none</td>
<td>The Instance Number of the SAP HANA installation (must be identical for the SAP HANA installations on all nodes) Example: 00</td>
</tr>
<tr>
<td>SAPHanaFilter</td>
<td>ra-act-dec-lpa</td>
<td>Define SAPHanaTopology resource agent messages to be printed. Possible Values: any combination of “ra-act-lpa-dec-flow-dbg-dbg2” or “all” or “none”</td>
</tr>
</tbody>
</table>
2.4 Red Hat Enterprise Linux High Availability Add-On Overview

The Red Hat Enterprise Linux for SAP High Availability add-on provides the following components to set up HA environments:

- Cluster Manager (CMAN)
- Pacemaker
- STONITH

2.4.1 CMAN

Cluster Manager (CMAN) is a Red Hat specific service module that manages the cluster communication infrastructure. It provides a user API that is used by Red Hat layered cluster components. CMAN also provides additional functionality such as APIs for a distributed lock manager, clustered Logical Volume Manager, conditional shutdown, and barriers.

2.4.2 Pacemaker

Pacemaker is the Cluster Resource Manager. Clustered services and resources are defined there. Pacemaker can control user requests like service start, restart, disable or relocate, as well as provide fail-over capabilities as necessary.

Pacemaker uses OCF-compliant resource agents to control and monitor required resources.

2.4.3 Fencing/STONITH

All cluster relevant components are installed locally on all participating nodes so both of the cluster member nodes can perform all services. In case of switching services, the now-disabled node has to be switched off, which is why there has to be a working power fencing mechanism in place. In our example setup, we will describe an ipmi fencing. But Pacemaker supports several different fencing methods, and every one of them may be applied. Since all storage components are exclusively local, there is no need for storage fencing.
3 Example Setup and Configuration

3.1 Introduction

This part of the document describes the entire installation process based on an example configuration. It provides some background information, describes the necessary steps and the commands to use.

Setups will hardly ever be performed exactly the same way as they are described here; it is the consultant's job to understand and modify the configuration and commands as appropriate to the respective context.

Basically, the whole process includes the following steps:

- Installing and configuring Red Hat Enterprise Linux for SAP HANA on all nodes according to the SAP guidelines
- Installing SAP HANA on all nodes using the same SID and instance number
- Manually configuring SAP HANA System Replication and verifying that it works according to SAP guidelines
- Installation of the RHEL HA add-on and configuration of the cluster
- Performing cluster tests to verify that fail-over works under all circumstances

3.1.1 Parameters used for example configuration

The following parameter values are used for the example setup described in the following chapters. Please adapt them to your own environment.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SID</td>
<td>RH1</td>
</tr>
<tr>
<td>Instance Number</td>
<td>00</td>
</tr>
<tr>
<td>Primary HANA Site name</td>
<td>DC1</td>
</tr>
<tr>
<td>Secondary HANA Site name</td>
<td>DC2</td>
</tr>
<tr>
<td>Public network</td>
<td>192.168.1.0/24</td>
</tr>
<tr>
<td>Cluster network</td>
<td>192.168.2.0/24</td>
</tr>
<tr>
<td>Virtual IP for clients to connect to</td>
<td>192.168.1.10</td>
</tr>
<tr>
<td>Primary Node public hostname/IP</td>
<td>node1/192.168.1.11</td>
</tr>
<tr>
<td>Primary Node cluster hostname/IP</td>
<td>node1hb/192.168.2.11</td>
</tr>
<tr>
<td>Secondary Node public hostname/IP</td>
<td>node2/192.168.1.12</td>
</tr>
<tr>
<td>Secondary Node cluster hostname/IP</td>
<td>node2hb/192.168.2.12</td>
</tr>
</tbody>
</table>
3.2 Prerequisites

3.2.1 General preparations
Make sure your environment meets the following requirements:

- A working Fencing/STONITH mechanism must be available for all cluster nodes; HA setups without working Fencing/STONITH are not supported by Red Hat
- The time on all nodes must be in sync. This can be achieved by using a time synchronization mechanism like NTP
- All nodes must have access to the RHEL6 and HA and "RHEL for SAP HANA" add-on channels either on the Red Hat Customer Portal or a local Red Hat Satellite; at least the following versions of cman, pacemaker, pcs and agents packages (and their dependencies) are required:
  - cman-3.0.12.1-58.el6.x86_64
  - libqb-0.16.0-2.el6.x86_64
  - pacemaker-1.1.12-4.el6.x86_64
  - fence-agents-3.1.5-34.el6.x86_64
  - pcs-0.9.90-2.el6.noarch
  - resource-agents-sap-hana-3.9.5-12.el6_6.6.x86_64
- A current set of SAP HANA installation media must be available (see SAP HANA Installation Guides for the correct list of installation media); at least the following SAP HANA revisions should be used: SPS8_rev85_3 or SPS9_rev94

3.2.2 Storage requirements
SAP HANA is an in-memory database. All cluster relevant components are kept in memory and are replicated to the cluster nodes using replication mechanisms provided by SAP HANA, so there is no need for shared storage, which simplifies the storage setup very much.

3.2.3 Operating System Installation
Please make sure that the OS on all nodes is configured according to the SAP guidelines for installation of SAP HANA on RHEL (see Appendix A).

3.2.4 Cluster package installation
In addition please make sure that all cluster nodes are subscribed to the "RHEL Server High Availability" channel and install the cluster packages:

[root]# yum install cman pacemaker pcs resource-agents-sap-hana

Make sure the cluster will not be started at boot time by switching off the Corosync framework daemon:

[root]# chkconfig corosync off
3.3 SAP HANA Installation

For SAP HANA System Replication to work SAP HANA must be installed using the same SID and Instance Number on all nodes. The installation of SAP HANA is not covered in this document. Please refer to the setup manuals available at the SAP Service Marketplace, download the SAP HANA software and perform the SAP HANA installation on all nodes following the instructions in the SAP Installation Guides.

After successful installation of the database, verify that SAP HANA is running on all nodes by using the SAP HDB tool:

```
[rh1adm]# HDB info
USER       PID  PPID %CPU    VSZ   RSS COMMAND
rh1adm    4949  4948  1.5 110452  3924 -bash
rh1adm    5032  4949  0.0 114064  1924
\_ /bin/sh /usr/sap/RH6/HDB00/HDB info
rh1adm    5059  5032  0.0 118036  1508 \_ ps fx -U rh6adm -o
user,pid,ppid,vsz,rss,args
rh1adm  16918   1  0.0 22088 1496 sapstart
pf=/usr/sap/RH1/SYS/profile/RH6_HDB00_node1
rh1adm  16927 16918  0.0 896912 301692
\_ /usr/sap/RH1/HDB00/node1/trace/hdb.sapRH1_HDB00 -d -nw
-f /usr/sap/RH1/HDB00/node1/daemon.ini
pf=/usr/sap/RH1/SYS/profile/RH1_HDB00_node1
rh1adm  16947 16927  3.5 9589920 1925852 \_ hdbnameserver
rh1adm  17093 16927  4.4 12878916 3763036 \_ hdbindexserver
rh1adm  17096 16927  4.4 12475796 4040556 \_ hdbstatisticsserver
rh1adm  17099 16927  3.5 11216184 2070452 \_ hdbsengine
rh1adm  17535 16927  0.0 930408 72500 \_ sapwebdisp_hdb
pf=/usr/sap/RH1/HDB00/node1/wdisp/sapwebdisp.pfl
-f /usr/sap/RH1/HDB00/node1/trace/dev_webdisp
rh6adm  23804     1  0.0 678508 75720 /usr/sap/RH1/HDB00/exe/sapstartsrv
pf=/usr/sap/RH1/SYS/profile/RH1_HDB00_node1 -D -u rh1adm
```

For the system replication to work, the SAP HANA "log_mode" variable must be set to "normal". This can be verified after installation with the following command:

```
[rh1adm]# hdbsql -u system -i 00 "select value from \n"SYS"."M_INIFILE_CONTENTS" where key='log_mode'"
Password:
VALUE "normal"
1 row selected (overall time 191.885 msec; server time 188.704 msec)
```

Also, please make sure that SAP HANA is not configured to automatically start after system boot, since startup and shutdown of SAP HANA will be controlled by the cluster. To verify this run the following command on all nodes:

```
[root]# grep Autostart /usr/sap/RH1/SYS/profile/* /usr/sap/RH1/SYS/profile/RH1_HDB00_node1:Autostart = 0
```

If the output of the command includes "Autostart = 1" then HANA is still configured to start automatically and needs to be reconfigured.
3.4 SAP HANA System Replication Setup

If SAP HANA System Replication uses a separate network for its traffic, you need to configure the System Replication hostname resolution as described in Host Name Resolution for System Replication.

3.4.1 Primary node

The first step is to prepare the primary node. The SAP HANA system replication will only work after an initial backup has been performed:

```
[rh1adm]# hdbsql -i 00 -u system -p <pw of user system> "BACKUP DATA USING \nFILE ('/tmp/foo')"
0 rows affected (overall time 35.458355 sec; server time 35.426372 sec)
```

After successful backup, replication can be initialized:

```
[rh1adm]# hdbnsutil -sr_enable --name=DC1
checking for active nameserver ...
nameserver is active, proceeding ...
successfully enabled system as system replication source site
done.
```

As a final step, check replication status and make sure it both shows the current node is running and the current node as primary.

```
[rh1adm]# hdbnsutil -sr_state
checking for active or inactive nameserver ...
System Replication State
~~~~~~~~~~~~~~~~~~~~~~~~
mode: primary
site id: 1
site name: DC1
Host Mappings:
```

3.4.2 Secondary Node

The second step is to initialize the secondary node. This has only one step: register the second node to the SAP HANA cluster

```
[rh1adm]# hdbnsutil -sr_register --remoteHost=node1 -remoteInstance=00 \n--mode=syncmem --name=DC2
adding site ...
checking for inactive nameserver ...
nameserver node2:30001 not responding.
collecting information ...
updating local ini files ...
done.
```

Make sure that everything has worked as expected by checking the replication status. You should now see both nodes, node1 still as primary; the secondary node should show up in “syncmem” mode.

```
[rh1adm]# hdbnsutil -sr_state
checking for active or inactive nameserver ...
System Replication State
~~~~~~~~~~~~~~~~~~~~~~~~
```
mode: synccmem
site id: 2
site name: DC2
active primary site: 1
re-setup replication: hdbnsutil -sr_register --name=DC2 -mode=synccmem
--remoteHost=node1 --remoteInstance=00
Host Mappings:
~~~~~~~~~~~~~~
node2 -> [DC1] node1
node2 -> [DC2] node2

### 3.4.3 Create a monitoring account in SAP HANA

A technical user with “CATALOG READ” and “MONITOR ADMIN” privileges must exist in SAP HANA for the resource agents to be able to run queries on the system replication status.

Run the following commands on the primary node to create a technical user "rhelhasync" (the name of this user can be freely chosen) inside SAP HANA (replace <password> with your own password):

- [rh1adm]# hdbsql -i 00 -u system -p <pw of system user> "create user \n  rhelhasync password <password>"
- [rh1adm]# hdbsql -i 00 -u system -p <pw of system user> "grant CATALOG \n  READ to rhelhasync"
- [rh1adm]# hdbsql -i 00 -u system -p <pw of system user> "grant MONITOR \n  ADMIN to rhelhasync"
- [rh1adm]# hdbsql -i 00 -u system -p <pw of system user> "ALTER USER \n  rhelhasync DISABLE PASSWORD LIFETIME"

Then add a userkey "SAPHANA<SID>SR" (replace <SID> with the SID of the SAP HANA installation; in our example the SID of the HANA installation is "RH1", therefore the userkey must be "SAPHANARH1SR") for this user to the local HANA user store for the root user. Run the following command on all nodes:

- [root]# /usr/sap/RH1/HDB00/exe/hdbuserstore SET SAPHANARH1SR \n  localhost:30015 rhelhasync <password>

Please verify that it is possible to run `hdbsql` commands as root using the SAPHANA<SID>SR userkey without being prompted for a password by running the following command on the primary node (when replication is active you will (as of SAP HANA SPS08) not be able to read from, write to or connect to the secondary system using tools like `hdbsql` or HANA Studio):

- [root]# /usr/sap/RH1/HDB00/exe/hdbsql -U SAPHANARH1SR -i 00 "select \n  distinct REPLICATION_STATUS from SYS.M_SERVICE_REPLICATION"

If you get an error message about issues with the password or are being prompted for a password please verify with HANAStudio that the password for the user "rhelhasync" is not configured to be changed on first login or that the password has expired.

Also `hdbsql` will stop functioning if no valid HANA license is installed, therefore it is important to make sure that the HANA license is valid before starting the cluster setup.
3.5 Cluster Setup

3.5.1 Initialize the cluster

Run the following command on each cluster node to configure the cluster infrastructure and start the cluster:

```
[root]# pcs cluster setup --name hanasr --local node1hb node2hb
[root]# service pacemaker start
```

Check if your cluster node is running and connected with the following command:

```
[root]# pcs status
Cluster name: hanasr
Last updated: Thu Dec 4 12:14:34 2014
Last change: Mon Dec 1 17:05:31 2014
Stack: cman
Current DC: node1 - partition with quorum
Version: 1.1.11-97629de
2 Nodes configured
0 Resources configured
Online: [ node1hb node2hb ]
Full list of resources:
[...]
```

The following commands need only to be issued on one of the cluster nodes, as Pacemaker propagates configuration to all cluster nodes automatically the moment they are committed.

Configure some basic cluster parameters. As this is a two-node cluster you have to set "no-quorum-policy" to "ignore". Adjust resource stickiness and default timeout to values which are manageable with the SAP HANA system:

```
[root]# pcs property set no-quorum-policy="ignore"
[root]# pcs resource defaults default-resource-stickness=1000
[root]# pcs resource defaults default-migration-threshold=5000
[root]# pcs resource op defaults timeout=600s
```

3.5.2 Configure Fencing/STONITH

The following is just an example of how to configure fencing using the ipmi fencing method. Please choose the correct fencing method for your environment.

To use IPMI for fencing you can set up STONITH with the following commands:

```
[root]# pcs stonith create st_ipmi_node1 fence_ipmilan \
ipaddr=<ip of management card of node1> \ 
login="<user of management card of node1>" \ 
passwd="<password of user of management card of node1>" \ 
pcmk_host_list="node1hb"
[root]# pcs stonith create st_ipmi_node1 fence_ipmilan \
ipaddr=<ip of management card of node2> \ 
login="<user of management card of node2>" \ 
passwd="<password of user of management card of node2>" \ 
pcmk_host_list="node2hb"
[root]# pcs constraint location st-ipmi-node1 avoids node1
[root]# pcs constraint location st-ipmi-node2 avoids node2
```
Unfortunately "pcs stonith" currently does not provide any information on which node the fencing agent is running, so you have to use "pcs status" to get this information:

```
[root]# pcs status
Cluster name: hanasr
Last updated: Thu Dec 4 12:14:30 2014
Last change: Mon Dec 1 17:05:31 2014
Stack: cman
Current DC: node1 - partition with quorum
Version: 1.1.11-97629de
2 Nodes configured
2 Resources configured
Online: [ node1 node2 ]
Full list of resources:
st-ipmi-node1 (stonith:fence_ipmilan): Started node2hb
st-ipm-node2 (stonith:fence_ipmilan): Started node1hb
```

To check if fencing actually works, test the fencing by initializing fencing on node2:

```
[root]# pcs stonith fence node2
```

Verify if fencing was successful by monitoring node2 activity.

### 3.5.3 Virtual IP addresses and hostnames

Set up the virtual IP address that SAP HANA clients use to connect. This address will always be connected to the primary node. Make sure that your switches and network will permit the IP address takeover:

```
[root]# pcs resource create rsc_ip_SAPHana_RH1_HDB00 IPaddr2 \ ip="192.168.1.10"
```

### 3.5.4 Create the SAPHanaTopology resource

Now create the primary SAPHanaTopology resource:

```
[root]# pcs resource create rsc_SAPHanaTopology_RH1_HDB00 SAPHanaTopology \ SID=RH1 \ InstanceNumber=00 \ op start timeout=600 \ op stop timeout=300 \ op monitor interval=10 timeout=600
```

### 3.5.5 Create clone resource for SAPHanaTopology

Create a clone of the primary resource, making sure that SAP HANA will be active on both nodes:

```
# pcs resource clone rsc_SAPHanaTopology_RH1_HDB00 \ meta is-managed=true clone-max=2 clone-node-max=1 interleave=true
```
3.5.6 Create SAPHana resource

This master/slave resource will make sure that the SAP HANA system is running on both nodes, where the master will be the primary active node:

```
[root]# pcs resource create rsc_SAPHana_RH1_HDB00 SAPHana \ 
SID=RH1 \ 
InstanceNumber=00 \ 
PREFER_SITE_TAKEOVER=true \ 
DUPLICATE_PRIMARY_TIMEOUT=7200 \ 
AUTOMATED_REGISTER=false \ 
op start timeout=3600 \ 
op stop timeout=3600 \ 
op promote timeout=3600 \ 
op demote timeout=3600 \ 
op monitor interval=59 role="Master" timeout=700 \ 
op monitor interval=61 role="Slave" timeout=700
```

3.5.7 Create Master/Slave resource for SAPHana

Make the SAPHana resource a master/slave resource:

```
root]# pcs resource master msl_rsc_SAPHana_RH1_HDB00 rsc_SAPHana_RH1_HDB00 \ 
meta is-managed=true notify=true clone-max=2 clone-node-max=1 \ 
interleave=true
```

3.5.8 Set up constraints

To ensure that the IP address and the SAP Hana primary instance always run on the same node, and the SAPHanaTopology resource always starts before the SAPHANA resource a colocation and an order constraint are required:

```
[root]# pcs constraint colocation add rsc_ip_SAPHana_RH1_HDB00 with master \ 
msl_rsc_SAPHana_RH1_HDB00 2000 
[root]# pcs constraint order rsc_SAPHanaTopology_RH1_HDB00-clone then \ 
msl_rsc_SAPHana_RH1_HDB00 symmetrical=false
```

---

The timeouts shown below for the start, stop, promote and demote operations are only examples and should be adjusted on the local SAP HANA setup (e. g. large HANA DBs can take longer to start up therefore the start timeout might have to be increased)
Appendix A: Reference Documentation

The following list includes the existing documentation and articles referenced by this document.

- SAP Note 2009879 - SAP HANA Guidelines for RedHat Enterprise Linux (RHEL) Operating System
- SAP Note 2013638 - SAP HANA DB: Recommended OS settings for RHEL 6.5
- SAP Note 2136965 - SAP HANA DB: Recommended OS settings for RHEL 6.6
- SAP Note 2001528 - Linux: SAP HANA Database SPS 08 revision 80 (or higher) on RHEL 6 or SLES 11
- SAP Note 2063657 - HANA System Replication takeover decision guideline
- SAP HANA Administration Guide - High Availability for SAP HANA
- How to Perform System Replication for SAP HANA
- HANA System Replication - Take-over process
- Configuring the Red Hat High Availability Add-On with Pacemaker
- Red Hat Enterprise Linux Cluster, High Availability Knowledge Base Index
Appendix B: Example Cluster Configuration

Here is the example configuration we used in this document:

Cluster Name: hanasr
Corosync Nodes:
node1hb node2hb
Pacemaker Nodes:
node1hb node2hb

Resources:
Clone: rsc_SAPHanaTopology_RH1_HDB00-clone
  Meta Attrs: is-managed=true clone-max=2 clone-node-max=1 interleave=true
  Resource: rsc_SAPHanaTopology_RH1_HDB00 (class=ocf provider=heartbeat
type=SAPHanaTopology)
    Attributes: SID=RH1 InstanceNumber=00
    Operations: start interval=0 timeout=600
      (rsc_SAPHanaTopology_RH1_HDB00-start-timeout-600)
        stop interval=0 timeout=300
      (rsc_SAPHanaTopology_RH1_HDB00-stop-timeout-300)
        monitor interval=10 timeout=600
      (rsc_SAPHanaTopology_RH1_HDB00-monitor-interval-10-timeout-600)
Master: msl_rsc_SAPHana_RH1_HDB00
  Meta Attrs: is-managed=true notify=true clone-max=2 clone-node-max=1
            interleave=true
  Resource: rsc_SAPHana_RH1_HDB00 (class=ocf provider=heartbeat
type=SAPHana)
    Attributes: SID=RH1 InstanceNumber=00 PREFER_SITE_TAKEOVER=true
                DUPLICATE_PRIMARY_TIMEOUT=7200 AUTOMATED_REGISTER=false
    Operations: start interval=0 timeout=3600
      (rsc_SAPHana_RH1_HDB00-name-start-timeout-3600)
        stop interval=0 timeout=3600
      (rsc_SAPHana_RH1_HDB00-name-stop-timeout-3600)
        promote interval=0 timeout=3600
      (rsc_SAPHana_RH1_HDB00-name-promote-timeout-3600)
        demote interval=0s timeout=3600
      (rsc_SAPHana_RH1_HDB00-name-demote-timeout-3600)
        monitor interval=59 role=Master timeout=700
      (rsc_SAPHana_RH1_HDB00-name-monitor-interval-59-role-Master-timeout-700)
        monitor interval=61 role=Slave timeout=700
      (rsc_SAPHana_RH1_HDB00-name-monitor-interval-61-role-Slave-timeout-700)
Resource: rsc_ip_SAPHana_RH1_HDB00 (class=ocf provider=heartbeat
type=IPaddr2)
  Attributes: ip=192.168.1.10
  Operations: start interval=0s timeout=20s
    (rsc_ip_SAPHana_RH1_HDB00-start-timeout-20s)
      stop interval=0s timeout=20s
    (rsc_ip_SAPHana_RH1_HDB00-stop-timeout-20s)
      monitor interval=10s timeout=20s
Stonith Devices:
Resource: st-ipmi-node1 (class=stonith type=fence_ipmilan)
  Attributes: ipaddr=node1-drac login=xxxx passwd=yyyy
  pcmk_host_list=node1hb
  Operations: monitor interval=60s (st-ipmi-node1-monitor-interval-60s)
Resource: st-ipmi-node2 (class=stonith type=fence_ipmilan)
  Attributes: ipaddr=node2-drac login=xxxx passwd=yyyy
  pcmk_host_list=node2hb
  Operations: monitor interval=60s (st-ipmi-node2-monitor-interval-60s)

Fencing Levels:

Location Constraints:
Resource: st-ipmi-node1
  Disabled on: node1hb (score:-INFINITY)
(id:location-st-ipmi-node1-node1hb--INFINITY)
Resource: st-ipmi-node2
  Disabled on: node2hb (score:-INFINITY)
(id:location-st-ipmi-node2-node2hb--INFINITY)

Ordering Constraints:
  start rsc_SAPHanaTopology_RH1_HDB00-clone then start
  msl_rsc_SAPHana_RH1_HDB00 (kind:Mandatory) (non-symmetrical)
(id:order-rsc_SAPHanaTopology_RH1_HDB00-clone-msl_rsc_SAPHana_RH1_HDB00-mandatory)

Colocation Constraints:
  rsc_ip_SAPHana_RH1_HDB00 with msl_rsc_SAPHana_RH1_HDB00 (score:2000)
  (rsc-role:Started) (with-rsc-role:Master)
(id:colocation-rsc_ip_SAPHana_RH1_HDB00-msl_rsc_SAPHana_RH1_HDB00-2000)

Cluster Properties:
cluster-infrastructure: cman
dc-version: 1.1.11-97629de
last-lrm-refresh: 1418642423
no-quorum-policy: ignore
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<th>Friday, May 29, 2015</th>
<th>Dieter Jäger, Dieter Thalmayr, Frank Danapfel</th>
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