SAP HANA Disaster Recovery with Asynchronous Storage Replication Using Snap Creator and SnapMirror

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The document describes the setup of a disaster recovery solution for SAP® HANA based on asynchronous storage replication. The solution uses NetApp SnapMirror® for storage replication and Snap Creator™ software from NetApp to manage the HANA database consistency as well as the storage Snapshot™ copies and SnapMirror replication.
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1 Solution Overview

This technical report covers the setup of a disaster recovery solution for SAP HANA based on asynchronous storage replication. The solution has been validated by SAP and is listed in SAP note 1755396, “Released DT solutions for SAP HANA with disk replication.”

The solution is supported with the SAP certified HANA multinode appliances from Cisco and Fujitsu using NetApp storage as well as for single-node and multinode setups with tailored data center integration (TDI) projects.

The solution uses NetApp SnapMirror® for storage replication and Snap Creator™ software from NetApp to manage the HANA database consistency as well as the storage Snapshot™ copies and SnapMirror replication.

The described configuration steps in this document are related to a HANA setup based on two multinode Cisco® appliances using NetApp storage. The documentation covers the scenario where the UCS® servers at the disaster recovery site are used for development and test during normal operation.

Figure 1) Solution overview.

In case of a disaster, the HANA development and test systems are shut down and are used for production DR. The servers are booted using the replicated production OS image and are connected to the replicated HANA database data. The DR failover is executed by the six steps shown in Figure 2.
Figure 2) Disaster recovery failover.

The recovery point objective (RPO) is defined by the frequency of consistency point creation followed by SnapMirror update cycles. Figure 3 shows an example where HANA and storage Snapshot copies are created every hour, followed by an update of the replication target. With this example it is assumed that the change rate and the network bandwidth allow replication of the changes within a time window of 30 minutes. Worst case would be a failure of the primary site just before the replication to the secondary storage is finished. Therefore, maximum RPO would be 1 hour 30 minutes for this example, as shown in Error! Reference source not found..

Figure 3) Snapshot copy schedule.

The HANA database currently only supports one HANA Snapshot. A normal HANA database backup also uses the HANA Snapshot feature to create a consistent image on the persistence layer. The HANA Snapshot copy exists as long as the backup is executing; the HANA Snapshot copy is dropped when the backup is completed. During the execution of the backup, a second HANA Snapshot copy cannot be created; therefore the DR target cannot be updated.

It is important to schedule backups in a way that they start executing immediately after a HANA and storage Snapshot copy is created. In our example the backup could take a maximum of one hour without blocking the next HANA and storage Snapshot copy creation.

Figure 4 shows a scheduling miscalculation, because the backup is started approximately 30 minutes after the HANA and storage Snapshot copy was created and is therefore blocking the next Snapshot copy.
The recovery time objective (RTO) is defined by the time needed to switch over servers and storage controllers to the secondary site plus the time needed to start the database. Switching over servers and storage controllers is done typically in less than 30 minutes; starting the database normally takes another 15 to 30 minutes depending on the size of the database and the preload table configuration.

Figure 5 shows the list of volumes that are replicated to the secondary storage. SnapMirror is configured as volume SnapMirror.

- All database data volumes
- The OS images (NFS root file systems) for all database nodes
- The configuration data for tftpboot
- The volume where HANA shared file system is stored

The log volumes don’t need to be replicated, because the HANA database is started based on the HANA Snapshot consistent image. However, these volumes need to be present on the target storage system before the HANA system is started in a DR scenario.
2 Snap Creator Plug-In for SAP HANA

The NetApp Snap Creator framework is used to create storage Snapshot copies and to trigger SnapMirror update transfers to the DR site. Consistency of the HANA database is enabled by a Snap Creator plug-in for HANA, which is responsible for executing the required database commands.

An additional set of example scripts is available to support initial SnapMirror configuration as well as automation of the storage and HANA-related tasks during a DR failover.

Figure 6) Snap Creator plug-in for SAP HANA.

3 Installation and Configuration Steps

The installation is done with the following steps:

1. Installation of SAP HANA hdbsql client software on the Cisco appliance management server
2. Installation of the example scripts and configuration files on the appliance management server
3. Installation of the get-log-dirs script on all HANA database nodes
4. Installation of Snap Creator framework on the management server

The configuration is done with the following steps:

1. Adapting the configuration files for the example scripts
2. Preparing SnapMirror replication on all storage controllers
3. Initializing the SnapMirror relationships for database, executable, and OS volumes
4. Configuring Snap Creator
5. Preparing /etc/fstab for DR failover
4 Installation

4.1 SAP HANA hdbsql Client Software

The Snap Creator HANA plug-in uses hdbsql commands to create a HANA global synchronized backup savepoint (HANA Snapshot copy). Because Snap Creator will be installed on the Cisco management host, the HANA hdbsql client software also needs to be installed on the management host.

```bash
mgmtsrv01:/sapcd/HANA_SP5/DATA_UNITS/HDB_CLIENT_LINUXINTEL # ./hdbinst
SAP HANA Database Client installation kit detected.

mgmtsrv01:/sapcd/HANA_SP5/DATA_UNITS/HDB_CLIENT_LINUXINTEL # ./hdbinst
SAP HANA Database Installation Manager - Client Installation 1.00.46.371989
***************************************************************************
Enter Installation Path [/usr/sap/hdbclient32]:
Checking installation...
Preparing package "Product Manifest"...
Preparing package "SQLDBC"...
Preparing package "ODBC"...
Preparing package "JDBC"...
Preparing package "Client Installer"...
Installing SAP HANA Database Client to /usr/sap/hdbclient32...
Installing package 'Product Manifest' ...
Installing package 'SQLDBC' ...
Installing package 'ODBC' ...
Installing package 'JDBC' ...
Installing package 'Client Installer' ...
Installation done
Log file written to '/var/tmp/hdb_client_2013-07-05 11.38.17/hdbinst_client.log'
mgmtsrv01:/sapcd/HANA_SP5/DATA_UNITS/HDB_CLIENT_LINUXINTEL #
```

4.2 Snap Creator Framework

The following description is based on Snap Creator version 4.1. Also check the Snap Creator installation guide for additional information.

1. Create the installation directory.

```bash
mgmtsrv01:/ # mkdir -p /opt/NetApp/Snap_Creator_Framework_41
```

2. Download the Snap Creator software and copy it to /opt/NetApp/Snap_Creator_Framework_41. Unzip and untar the file.

```bash
mgmtsrv01:/ # cd /opt/NetApp/Snap_Creator_Framework_41/
mgmtsrv01:/opt/NetApp/Snap_Creator_Framework_41 # gzip -d NetApp_Snap_Creator_Framework4.1.0-Linux32.tar.gz
mgmtsrv01:/opt/NetApp/Snap_Creator_Framework_41 # tar -xvf NetApp_Snap_Creator_Framework4.1.0-Linux32.tar
scAgent4.1.0/
  scAgent4.1.0/bin/
  scAgent4.1.0/etc/
  scAgent4.1.0/lib/
  scAgent4.1.0/logs/
  scAgent4.1.0/plugins/
  scAgent4.1.0/plugins/examples/
  scAgent4.1.0/plugins/examples/filesystem/
  scAgent4.1.0/plugins/examples/native/
  scAgent4.1.0/plugins/examples/native/bat/
  scAgent4.1.0/plugins/examples/native/c++/
  scAgent4.1.0/plugins/examples/native/filesystem/
  scAgent4.1.0/plugins/examples/native/java/
  ...
```
3. Run Snap Creator server setup.

```
mgmtsrv01:/opt/NetApp/Snap_Creator_Framework_41/scServer4.1.0 # ./Snap Creator --setup
Welcome to the NetApp Snap Creator Framework 4.1.0!
### Installation options ###
01. NetApp Snap Creator Framework 4.1.0 Server
02. NetApp Snap Creator Framework 4.1.0 Remote CLI
Select install option (enter a number or "q" to quit): 01
END USER LICENSE AGREEMENT FOR NETAPP, INC. SOFTWARE

IMPORTANT & READ CAREFULLY: This End User License Agreement (EULA) Under Your Software
Accept

1. License Grant. Subject to payment of the applicable fees and the limitations and restrictions set forth herein, NetApp and its licensors grant to You a non-exclusive, non-transferable, worldwide, limited license, without right of sublicense, to install and use the Software in object code form only on a host computer or storage controller for Your internal business use, in accordance with the terms contained within Your ordering documentation (Your Software Entitlement Documentation)

Do you accept the End User License Agreement (y|n): y
Enter controller serial number (Recommended): 12345678
Enter Snap Creator server port [8443]:
Enable job monitor (Y|N): Y
Enter job monitor size, how many jobs to allow [100]:
Enter scServer Administrator Username: scadmin
Enter password for scadmin:
Confirm password for scadmin:
INFO: Updated NetApp Snap Creator Framework 4.1.0
/opt/NetApp/Snap_Creator_Framework_41/scServer4.1.0c/engine/etc/Snap Creator.properties
INFO: Updated NetApp Snap Creator Framework 4.1.0
/opt/NetApp/Snap_Creator_Framework_41/scServer4.1.0c/bin/scServer
INFO: To start scServer please do the following:
/opt/NetApp/Snap_Creator_Framework_41/scServer4.1.0c/bin/scServer start
INFO: To access NetApp Snap Creator Framework 4.1.0 GUI goto https://hostname:8443/
```

4. Start the Snap Creator server.

```
mgmtsrv01:/opt/NetApp/Snap_Creator_Framework_41/scServer4.1.0 # cd bin
mgmtsrv01:/opt/NetApp/Snap_Creator_Framework_41/scServer4.1.0/bin # ./scServer start
Starting scServer:
Running
```

5. Run Snap Creator agent setup.
Welcome to the NetApp Snap Creator Framework 4.1.0!
### Installation options ###
01. NetApp Snap Creator Framework 4.1.0 Agent
   Select install option (enter a number or "q" to quit): 01
   END USER LICENSE AGREEMENT FOR NETAPP, INC. SOFTWARE
   IMPORTANT â READ CAREFULLY: This End User License Agreement
      (âEULAâYouâYourâNetAppâSoftwareâAcceptâ
   1. License Grant. Subject to payment of the applicable fees and the limitations and
      restrictions set forth herein, NetApp and its licensors grant to You a non-exclusive, non-
      transferable, worldwide, limited license, without right of sublicense, to install and use the
      Software in object code form only on a host computer or storage controller for Your internal
      business use, in accordance with the terms contained within Your ordering documentation (Your
      Software EntitlementDocumentationâ...
      ... Truncated
      ...
      Base Software EULA v2012Feb29
      Do you accept the End User License Agreement (y|n): y
      Enter Agent Port [9090]:
      INFO: Updated NetApp Snap Creator Framework 4.1.0
         /opt/NetApp/Snap_Creator_Framework_41/scAgent4.1.0c/etc/agent.properties
      INFO: To start scAgent please do the following:
         /opt/NetApp/Snap_Creator_Framework_41/scAgent4.1.0c/bin/scAgent start

6. Start the agent.

7. Install HANA plug-in.

   1. Install HANA community plug-in on Snap Creator Agent.
      Enter path to scAgent directory e.g. /opt/NetApp/scAgent4.1.0
      You selected #1 Install HANA community plug-in on Snap Creator Agent.
      Enter path to scAgent directory e.g. /opt/NetApp/scAgent4.1.0
Installation is completed, continue with agent restart? (Y/N)
Y
Shutting down scAgent:
scAgent failed to stop, not running!
Starting scAgent:
Watchdog: Running
Agent: Running

9. Install HANA plug-in GUI component.

```bash
mgmtsrv01:/opt/NetApp/hana_community_plugin # ./install.sh
1. Install HANA community plug-in on Snap Creator Agent.
2. Install HANA community plug-in GUI on Snap Creator Server.
You selected #2 Install HANA community plug-in GUI on Snap Creator Server.
Enter path to scServer directory e.g. /opt/NetApp/scServer4.1.0
Installation completed.
```

4.3 Example Scripts and Configuration Files

The documentation includes example scripts and configuration files (see appendix) to support the initial storage configuration and the DR failover process. The scripts are not part of the Snap Creator framework and need to be installed separately. Instead of using the scripts, the steps could also be executed manually.


```bash
mgmtsrv01:/NFS # mkdir -p /opt/NetApp/HANA-DR-Scripts
```

2. Scripts to be installed on the Cisco management host:

- `snapmirror-initialize.sh`
  Initializes the SnapMirror relationships based on the configuration files `db-data-volumes.txt` and `non-db-volumes.txt`.

- `snapmirror-break.sh`
  Used in case of a disaster. Breaks all SnapMirror relationships based on the configuration files `db-data-volumes.txt` and `non-db-volumes.txt`.

- `snaprestore-destination.sh`
  Used in case of a disaster. Performs SnapRestore® on all volumes based on the configuration files `db-data-volumes.txt` and `non-db-volumes.txt`. The Snapshot name must be provided with the command line.

- `post-steps-before-start.sh`
  Used in case of a disaster. Creates the necessary subdirectories within the log volumes and executes the hdbnsutil commands with the options useSnapshot and convertTopology.

- `call-get-log-dirs.sh`
  This script is executed by the Snap Creator framework. The script calls the get-log-dirs.sh script on one of the HANA database nodes.

3. Configuration files to be installed on the Cisco management host:

- `db-data-volumes.txt`
  Contains the list of all data volumes on the source and target storage controllers.

- `non-db-volumes.txt`
  Contains the list of all non-database volumes on the source and target storage controllers.
4. Scripts to be installed on all HANA database nodes:
   - get-log-dirs.sh
     The script creates a text file that includes all subdirectories in the log volumes. This script is called by the Snap Creator framework with each backup. In case of a disaster, the text file is used by the script post-steps-before-start.sh to create the needed subdirectories. If the subdirectories are not available, the hdbnsutil command will fail with an error message, and the directories will need to be created manually.

5. Create the target directory /opt/NetApp/HANA-DR-Scripts on all HANA database nodes. Copy the file to all nodes.

```bash
mgmtsrv01:/NFS # mkdir -p /NFS/cishanar08/opt/NetApp/HANA-DR-Scripts
mgmtsrv01:/NFS # cp /opt/NetApp/HANA-DR-Scripts/get-log-dirs.sh /NFS/cishanar08/opt/NetApp/HANA-DR-Scripts/
mgmtsrv01:/NFS # mkdir -p /NFS/cishanar09/opt/NetApp/HANA-DR-Scripts
mgmtsrv01:/NFS # mkdir -p /NFS/cishanar10/opt/NetApp/HANA-DR-Scripts
mgmtsrv01:/NFS # mkdir -p /NFS/cishanar11/opt/NetApp/HANA-DR-Scripts
```

5 Configuration

5.1 Configuration Files

The example scripts snapmirror-initialize.sh, snapmirror-break.sh, and snapstore-destination.sh (see appendix) read from these configuration files (db-data-volumes.txt, non-db-volumes.txt), which contain the source storage controllers, source volume, target storage controllers, and target volumes.

The configuration files need to be adapted depending on the customer environment. The following example shows a configuration with two storage controllers on the production side, hana1a and hana1b, and two controllers at the DR site, hana2a and hana2b.

**Note:** Typically there will be a dedicated network for replication traffic from the production storage controllers to the DR storage controllers. In this case the hostname of this interface needs to be used for the source storage system. So instead of hana1a, the hostname could be hana1a-rep. The target storage system hostname will remain unchanged and will still be hana2a.

```bash
mgmtsrv01:/opt/NetApp/HANA-DR-Scripts # cat db-data-volumes.txt
hana1a:data_00001:hana2a: data_00001
hana1a:data_00003:hana2a: data_00003
hana1b:data_00002:hana2b: data_00002
```

```bash
mgmtsrv01:/opt/NetApp/HANA-DR-Scripts # cat non-db-volumes.txt
hana1a:tftpboot: hana2a: tftpboot
hana1a:cishanar08_3080: hana2a: cishanar08_3080
hana1a:cishanar09_3080: hana2a: cishanar09_3080
hana1a:cishanar10_3080: hana2a: cishanar10_3080
hana1a:cishanar11_3080: hana2a: cishanar11_3080
hana1b:sapexe: hana2b: sapexe
```
5.2 Preparation of SnapMirror Relationships

All storage controllers must have a valid SnapRestore and SnapMirror license installed.

```
hana2a> license
Serial Number: 200000539150
Owner: hana2a
Package            Type          Description              Expiration
------------------ --------------- ------------------------ ---------------------
NFS                license        NFS License              -
SnapRestore        license        SnapRestore License     -
SnapMirror         license        SnapMirror License      -
hana2a>
```

SnapMirror must be enabled on all storage controllers.

```
hana1a> options snapmirror.enable on
hana1a>
hana1b> options snapmirror.enable on
hana1b
hana2a> options snapmirror.enable on
hana2a>
hana2b> options snapmirror.enable on
hana2b>
```

On all source storage controllers, access to the corresponding target storage controller must be configured.

```
hana1a> options snapmirror.access host=hana2a
hana1a>
hana1b> options snapmirror.access host=hana2b
hana1b>
```

**Note:** If a dedicated network is used for replication traffic, the hostname of this interface at the target storage controller needs to be configured. So instead of hana2a and hana2b, the hostname could be hana2a-rep and hana2b-rep.

5.3 Creating Volumes at the Target Storage

All volumes that need to be replicated must be created at the target storage controllers with the same or larger size than the source volumes.

All data volumes of the database:

- In our example: data_00001, data_00002, data_00003

Non-database volumes:

- OS images, in our example: cishanar08_3080, cishanar09_3080, cishanar10_3080, cishanar11_3080
- tftpboot volume: tftpboot
- Volume for HANA shared file system: sapexe

After the volumes have been created, they need to be set to restricted with the `vol restrict` command.

5.4 Initializing SnapMirror Relationships

The SnapMirror relationship is initialized with the command:

```
snapmirror initialize -S <source-storage>:<source-volume> <target-storage>:<target-volume>
```
This command has to be executed for all data volumes and for all non-database volumes at the target controllers. See preceding list.

**Note:** Typically there will be a dedicated network for replication traffic from the production storage to the DR storage. In this case the hostname of this interface needs to be used for the source storage system. So instead of hana1a, the hostname could be hana1a-rep. The target storage system hostname will remain unchanged and will still be hana2a.

Initializing the SnapMirror relationships can also be done with the example script snapmirror-initialize.sh.

Initializing non-db volumes:

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>mgmtsrv01:/opt/NetApp/HANA-DR-Scripts # ./snapmirror-initialize.sh non-db-volumes.txt</td>
<td>SnapMirror Initialize....</td>
</tr>
<tr>
<td>command: ssh hana2b snapmirror initialize -S hana1b:sapexe hana2b:sapexe</td>
<td>Transfer started.</td>
</tr>
<tr>
<td>Monitor progress with 'snapmirror status' or the snapmirror log.</td>
<td></td>
</tr>
<tr>
<td>command: ssh hana2a snapmirror initialize -S hana1a:cishanar11 hana2a:cishanar11</td>
<td>Transfer started.</td>
</tr>
<tr>
<td>Monitor progress with 'snapmirror status' or the snapmirror log.</td>
<td></td>
</tr>
<tr>
<td>command: ssh hana2a snapmirror initialize -S hana1a:cishanar10 hana2a:cishanar10</td>
<td>Transfer started.</td>
</tr>
<tr>
<td>Monitor progress with 'snapmirror status' or the snapmirror log.</td>
<td></td>
</tr>
<tr>
<td>command: ssh hana2a snapmirror initialize -S hana1a:cishanar09 hana2a:cishanar09</td>
<td>Transfer started.</td>
</tr>
<tr>
<td>Monitor progress with 'snapmirror status' or the snapmirror log.</td>
<td></td>
</tr>
<tr>
<td>command: ssh hana2a snapmirror initialize -S hana1a:cishanar08 hana2a:cishanar08</td>
<td>Transfer started.</td>
</tr>
<tr>
<td>Monitor progress with 'snapmirror status' or the snapmirror log.</td>
<td></td>
</tr>
<tr>
<td>command: ssh hana2a snapmirror initialize -S hana1a:tftpboot hana2a:tftpboot</td>
<td>Transfer started.</td>
</tr>
<tr>
<td>Monitor progress with 'snapmirror status' or the snapmirror log.</td>
<td></td>
</tr>
</tbody>
</table>

Initializing database data volumes:

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>mgmtsrv01:/opt/NetApp/HANA-DR-Scripts # ./snapmirror-initialize.sh db-data-volumes.txt</td>
<td>SnapMirror Initialize....</td>
</tr>
<tr>
<td>command: ssh hana2b snapmirror initialize -S hana1b:data_00002 hana2b:data_00002</td>
<td>Transfer started.</td>
</tr>
<tr>
<td>Monitor progress with 'snapmirror status' or the snapmirror log.</td>
<td></td>
</tr>
<tr>
<td>command: ssh hana2a snapmirror initialize -S hana1a:data_00003 hana2a:data_00003</td>
<td>Transfer started.</td>
</tr>
<tr>
<td>Monitor progress with 'snapmirror status' or the snapmirror log.</td>
<td></td>
</tr>
<tr>
<td>command: ssh hana2a snapmirror initialize -S hana1a:data_00001 hana2a:data_00001</td>
<td>Transfer started.</td>
</tr>
<tr>
<td>Monitor progress with 'snapmirror status' or the snapmirror log.</td>
<td></td>
</tr>
</tbody>
</table>
5.5 Snap Creator Framework and HANA Database Backup


2. Login using the user and password that was configured during the installation. Click Sign in.

3. Enter a profile name and click OK.

4. Enter configuration name and click Next.

With the current version of Snap Creator (4.1) the plug-in is not prepackaged with the Snap Creator product and needs: Therefore Community plug-in needs to be selected.
5. Select SAP HANA as application plug-in and click Next.

6. Enter the HANA plug-in specific parameter and click Next.

7. Enter the Agent configuration parameter and click Next.

8. Enter the storage connect settings and click Next.

**Note:** Typically a specific database user for backup purposes should be created instead of using the system user. This backup user has to have the minimum privileges “backup admin.”
9. Enter the storage login credentials and click Next.

10. Select the data volumes that are stored on this storage controller and click Save.

11. Click Add to add another storage controller.
12. Enter the storage login credentials and click Next.

13. Select the data volumes that are stored on this storage controller and click Save.

14. The next screen shows the storage controllers and volumes for our example configuration. Click Next.
Note: Naming convention Timestamp has to be selected. Naming convention Recent is not supported with the HANA plug-in.

15. Enter the Snapshot policy and retention configuration. The retention of 8 Snapshot copies is just an example and could be configured differently depending on the customer requirements.

16. No changes needed. Click Next.

17. Select SnapMirror and click Next.
18. Click Add.

19. Select a source storage controller from the list and click Next.

20. Select all volumes and click Save.

21. Select the second source storage controller from the list and click Next.
22. Select all volumes and click Save.

23. The next screen shows all volumes that should be protected in our example configuration. Click Next.

24. Enter the credentials for the target storage controllers and click Next.

25. Click Next.
26. The configuration is done. Click Finish.
Open the configuration file ANA_database.conf at the management server and add the call-get-log-dirs.sh script as a post application quiesce command.

```bash
mgmtsrv01:/opt/NetApp/Snap_Creator_Framework_41/scServer4.1.0c/engine/configs/HANA_profile_ANA # vi ANA_database.conf

# Post Commands
POST_APP_QUIESCE_CMD01=/opt/NetApp/HANA-DR-Scripts/call-get-log-dirs.sh
```

The post command needs to added to the agent configuration file to allow the execution of the command.

```bash
mgmtsrv01:/opt/NetApp/Snap_Creator_Framework_41/scAgent4.1.0/bin # cat /opt/NetApp/Snap_Creator_Framework_41/scAgent4.1.0/etc/allowed_commands.config
```

The agent need to be restarted.

```bash
mgmtsrv01:/opt/NetApp/Snap_Creator_Framework_41/scAgent4.1.0/bin # ./scAgent restart
Shutting down scAgent:
    Watchdog: Stopped
    Agent: Stopped
Starting scAgent:
    Watchdog: Running
    Agent: Running
```

If a dedicated network interface for replication has been configured this interface has to be included in the Snap Creator configuration file as a secondary interface.

It is also possible to configure dedicated management interfaces so that Snap Creator can access the source or the target storage system using a network interface that is not bound to the storage controllers host name.

```bash
mgmtsrv01:/opt/NetApp/Snap_Creator_Framework_41/scServer4.1.0c/engine/configs/HANA_profile_ANA # vi ANA_database.conf

SECONDARY_INTERFACES=hana1a:rep/hana2a;hana1b:rep/hana2b
MANAGEMENT_INTERFACES=hana2a:hana2a-mgmt;hana2b:hana2b-mgmt
```
5.6 Snap Creator Framework and Non-database File Backup

1. Click the profile and select New configuration.

   ![Snap Creator Framework - Windows Internet Explorer](image)

2. Enter the configuration name and click Next.

   ![Configuration](image)

3. Deselect any plug-in and click Next.

   ![Agent Configuration](image)
4. Enter the Agent configuration parameter and click Next.

5. Enter the storage connect settings and click Next.

6. Enter the storage login credentials and click Next.

7. Select the tftpboot volume and all the OS image volumes for the HANA database nodes and click Save.
8. Click Add to add the next storage controller.

9. Enter the storage login credentials and click Next.

10. Select the sapexe volume and click Save.

11. Click Next.
12. Enter the Snapshot policy and retention configuration. The retention of eight Snapshot copies is just an example and could be configured differently depending on the customer requirements.

13. No changes needed. Click Next.

14. Select SnapMirror and click Next.
15. Click Add.

16. Select a source storage controller from the list and click Next.

17. Select all volumes and add them to SnapMirror. Click Save.

18. Click Add and select the second storage controller. Click Next.

19. Select all volumes and add them to SnapMirror. Click Save.
20. Click Next.

21. Enter credentials for DR storage controllers. Click Next.

22. Click Next.
23. The configuration is done. Click Finish.

The profile for the HANA database now includes one configuration for the database and one configuration for the non-database files.
5.7 Preparation of /etc/fstab for DR Failover

In order to simplify the adjustments in /etc/fstab within the DR OS images, you can prepare a copy of fstab for disaster recovery. Every time changes are done within the original /etc/fstab (for example, expanding the landscape by adding a server), this copy needs to be adapted.

1. Adjust storage controllers and qtree for /usr/sap for first node.

2. Adjust storage controllers and qtree for /usr/sap for second node.

3. Adjust storage controllers and qtree for /usr/sap for third node.

4. Adjust storage controllers and qtree for /usr/sap for fourth node.

The storage controller hostnames need to be changed. In our configuration example, they change from hana1a->hana2a and hana1b->hana2b. The usr/sap qtree needs to be adapted for each node.

**Note:** Make sure that the hostnames that are used in /etc/fstab are included in the /etc/hosts file.

First node: vol/sapex/usr_sap_01, second vol/sapex/usr_sap_02, and so on.

The example shows the /etc/fstab.DT for the fourth node, cishanar11.

```bash
mgmtsrv01:/opt/NetApp/HANA-DR-Scripts # cd /NFS/cishanar08
mgmtsrv01:/NFS/cishanar08 # cd etc
mgmtsrv01:/NFS/cishanar08/etc # cp fstab fstab.DT
mgmtsrv01:/NFS/cishanar08/etc # vi fstab.DT

1. Adjust storage controllers and qtree for /usr/sap for first node.

mgmtsrv01:/NFS/cishanar08/etc # cp fstab.DT /NFS/cishanar09/etc/
mgmtsrv01:/NFS/cishanar08/etc # cp fstab.DT /NFS/cishanar10/etc/
mgmtsrv01:/NFS/cishanar08/etc # cp fstab.DT /NFS/cishanar11/etc/
mgmtsrv01:/NFS/cishanar08/etc # vi /NFS/cishanar09/etc/fstab.DT

2. Adjust storage controllers and qtree for /usr/sap for second node.

mgmtsrv01:/NFS/cishanar08/etc # vi /NFS/cishanar10/etc/fstab.DT

3. Adjust storage controllers and qtree for /usr/sap for third node.

mgmtsrv01:/NFS/cishanar08/etc # vi /NFS/cishanar11/etc/fstab.DT

4. Adjust storage controllers and qtree for /usr/sap for fourth node.

The example shows the /etc/fstab.DT for the fourth node, cishanar11.

```
```
## 6 Backup and SnapMirror Update

The database backup and the backup of the non-database files can be done using either the Snap Creator GUI or the command line. The Snap Creator GUI or the command line in combination with an external scheduler can be used to schedule the backups.

### 6.1 Database Backup

When Snap Creator is backing up the database, the following steps are executed:

1. Getting the list of subdirectories within the log volumes.
2. Creating a global synchronized backup save point (HANA Snapshot copy) to get a consistent image on the persistence layer.
3. Creating storage Snapshot copies for all data volumes. With our example there are three data volumes, which are distributed to both storage controllers, hana1a and hana1b.
4. Deleting the HANA Snapshot copy.
5. Triggerring a SnapMirror update for all data volumes.

The log volumes don’t need to be replicated, but the subdirectories within the target log volumes have to exist. Therefore, a list of the subdirectories is created with each backup; this list is used to create the directories within the DR failover process.
6.2 Database Backup with Snap Creator GUI

1. Click the ANA_database configuration and then, on Actions, and afterward Backup out of Actions menu.

2. Select the backup policy and click OK.

The action gets started.

**Note:** Snap Creator triggers the SnapMirror update, and Snap Creator checks the acknowledgement of the replication request. Snap Creator doesn't check that the data has been successfully replicated to the target storage system.
3. Database backup with Snap Creator command line: The backup of the database is executed with the command:

```
/opt/NetApp/Snap_Creator_Framework_41/scServer4.1.0c/Snap Creator --server localhost --port 8443 --user scadmin --passwd scadmin --profile HANA_profile_ANA --config ANA_database --action backup --policy HOURLY --verbose
```

```
########## Detecting Data ONTAP mode for hanala ##########
...
Truncated ...
```

6.3 OS Image and Executable Backup

Backup of OS images and the “hana shared” file system is done by creating storage Snapshot copies and replicating the data to the target storage with SnapMirror update.
6.4 Executable Files Backup with Snap Creator GUI

1. Click the ANA_non_database_files configuration and then click Actions Backup.

2. Select the backup policy and click OK.

The action gets started.

**Note:** Snap Creator triggers the SnapMirror update, and Snap Creator checks the acknowledgement of the replication request. Snap Creator doesn’t check that the data has been successfully replicated to the target storage system.
6.5 Executable Files Backup with Snap Creator Command Line

The backup of the database is executed with the command:

```
/opt/NetApp/Snap_Creator_Framework_41/scServer4.1.0c/Snap Creator --server localhost --port 8443
--user scadmin --passwd scadmin --profile HANA_profile_ANA --config ANA_non_database_files
--action backup --policy HOURLY --verbose
```

########## Detecting Data ONTAP mode for hana1a ##########


########## Agent validation ##########

[Thu Sep 12 14:02:37 2013] INFO: Application commands and plug-in not defined. Skipping Agent validation task
...
Truncated
...
7 Disaster Failover

The following description is based on the assumption that the HANA components at the primary site are shut down or no longer available.

The workflow for the switchover to the DR site is done using the following steps:

1. Break the SnapMirror relationship.
2. SnapRestore DR volumes to an existing storage Snapshot copy.
3. Stop HANA dev/test instance at DR site.
4. Adapt the network settings on the management server.
5. Mount replicated OS image to management server.
6. Adapt PXE configuration.
7. Switch servers to production DR and boot servers.
8. Run postprocessing before HANA start.
9. Start HANA.

7.1 Break the SnapMirror Relationship

The SnapMirror relationship is broken using the command:

```
snaphmirror break <target volume>
```

This command has to be executed for all data volumes and for all nondatabase volumes at the target controllers.

Breaking the SnapMirror relationships can also be done with the example script `snaphmirror-break.sh`.

Database data volumes:

The script is executed at the management server as user root.

```
mgmtsrv01:/opt/NetApp/HANA-DR-Scripts # ./snaphmirror-break.sh
usage: snaphmirror-break.sh <file_with_list_of_volumes>
mgmtsrv01:/opt/NetApp/HANA-DR-Scripts # ./snaphmirror-break.sh db-data-volumes.txt
========================================================================
SnapMirror Break: Make destination volumes writable ....
========================================================================
command: ssh hana2b snaphmirror break data_00002
snapmirror break: Destination data_00002 is now writable.
Volume size is being retained for potential snapmirror resync. If you would like to grow the
volume and do not expect to resync, set vol option fs_size_fixed to off.
command: ssh hana2a snaphmirror break data_00003
snapmirror break: Destination data_00003 is now writable.
Volume size is being retained for potential snapmirror resync. If you would like to grow the
volume and do not expect to resync, set vol option fs_size_fixed to off.
command: ssh hana2a snaphmirror break data_00001
snapmirror break: Destination data_00001 is now writable.
Volume size is being retained for potential snapmirror resync. If you would like to grow the
volume and do not expect to resync, set vol option fs_size_fixed to off.
mgmtsrv01:/opt/NetApp/HANA-DR-Scripts #
```

OS and executable volumes:

The script is executed at the management server as user root.

```
mgmtsrv01:/opt/NetApp/HANA-DR-Scripts #
```
mgmtsrv01:/opt/NetApp/HANA-DR-Scripts # ./snapmirror-break.sh non-db-volumes.txt
================================================================
SnapMirror Break: Make destination volumes writeable ....
command: ssh hana2b snapmirror break sapexe
snapmirror break: Destination sapexe is now writable.
Volume size is being retained for potential snapmirror resync. If you would like to grow the volume and do not expect to resync, set vol option fs_size_fixed to off.
cmd: ssh hana2a snapmirror break cishanar11_3080
snapmirror break: Destination cishanar11_3080 is now writable.
Volume size is being retained for potential snapmirror resync. If you would like to grow the volume and do not expect to resync, set vol option fs_size_fixed to off.
cmd: ssh hana2a snapmirror break cishanar10_3080
snapmirror break: Destination cishanar10_3080 is now writable.
Volume size is being retained for potential snapmirror resync. If you would like to grow the volume and do not expect to resync, set vol option fs_size_fixed to off.
cmd: ssh hana2a snapmirror break cishanar09_3080
snapmirror break: Destination cishanar09_3080 is now writable.
Volume size is being retained for potential snapmirror resync. If you would like to grow the volume and do not expect to resync, set vol option fs_size_fixed to off.
cmd: ssh hana2a snapmirror break cishanar08_3080
snapmirror break: Destination cishanar08_3080 is now writable.
Volume size is being retained for potential snapmirror resync. If you would like to grow the volume and do not expect to resync, set vol option fs_size_fixed to off.
mgmtsrv01:/opt/NetApp/HANA-DR-Scripts #

7.2 SnapRestore DR Volumes to Snapshot

The target volumes are restored using SnapRestore technology to a specific storage Snapshot copy using the command:

```
snap restore -f -t vol -s <Snapshot name> <target volume>
```

This command has to be executed for all data volumes and for all non-database volumes at the target controllers.

The volume SnapRestore can also be executed using the example script snaprestore-destination.sh.

Database data volumes:
The script is executed at the management server as user root.

mgmtsrv01:/opt/NetApp/HANA-DR-Scripts # ./snaprestore-destination.sh
usage: snaprestore-destination.sh <snap-name> <file_with_list_of_volumes>
mgmtsrv01:/opt/NetApp/HANA-DR-Scripts # ./snaprestore-destination.sh demo3 db-data-volumes.txt
SnapRestore destination volumes ....
command: ssh hana2b snap restore -f -t vol -s demo3 data_00002
Volume data_00002: revert successful.
command: ssh hana2a snap restore -f -t vol -s demo3 data_00003
Volume data_00003: revert successful.
command: ssh hana2a snap restore -f -t vol -s demo3 data_00001
Volume data_00001: revert successful.
mgmtsrv01:/opt/NetApp/HANA-DR-Scripts #

OS and executable volumes:
The script is executed at the management server as user root.

mgmtsrv01:/opt/NetApp/HANA-DR-Scripts # ./snaprestore-destination.sh demo3 non-db-volumes.txt
================================================================
SnapRestore destination volumes ....

command: ssh hana2b snap restore -f -t vol -s demo3 sapexe
Volume sapexe: revert successful.
command: ssh hana2a snap restore -f -t vol -s demo3 cishanar11_3080
Volume cishanar11_3080: revert successful.
command: ssh hana2a snap restore -f -t vol -s demo3 cishanar10_3080
Volume cishanar10_3080: revert successful.
command: ssh hana2a snap restore -f -t vol -s demo3 cishanar09_3080
Volume cishanar09_3080: revert successful.
command: ssh hana2a snap restore -f -t vol -s demo3 cishanar08_3080
Volume cishanar08_3080: revert successful.
command: ssh hana2a snap restore -f -t vol -s demo3 tftpboot
Volume tftpboot: revert successful.
mgtsrv01:/opt/NetApp/HANA-DR-Scripts #

7.3 Stop HANA Dev/Test Instance at the DR Site
Stop the HANA instance at the DR site and shut down the compute nodes.

7.4 Adapt the Network Settings on the Management Server
Make sure that the network environment of the management servers at the DR site is identical to the settings on the PRD site.

7.5 Mount Replicated OS Image to Management Server at DR Site
The replicated OS images are mounted to the management server to adapt the /etc/fstab configuration.

mgmtsrv01:/NFS # mkdir cishanar08-DT
mgmtsrv01:/NFS # mkdir cishanar09-DT
mgmtsrv01:/NFS # mkdir cishanar10-DT
mgmtsrv01:/NFS # mkdir cishanar11-DT
mgmtsrv01:/NFS # mount hana2a:/vol/cishanar08_3080 /NFS/cishanar08-DT
mgmtsrv01:/NFS # mount hana2a:/vol/cishanar09_3080 /NFS/cishanar09-DT
mgmtsrv01:/NFS # mount hana2a:/vol/cishanar10_3080 /NFS/cishanar10-DT
mgmtsrv01:/NFS # mount hana2a:/vol/cishanar11_3080 /NFS/cishanar11-DT

The prepared fstab.DT file must be copied back to the original fstab file.

mgmtsrv01:/NFS # for i in 08 09 10 11
> do
> cp /NFS/cishanar$i-DT/etc/fstab.DT /NFS/cishanar$i-DT/etc/fstab
> done

7.6 Adapt PXE Configuration
In order to boot the servers from the replicated OS image, the PXE boot configuration needs to be adapted. NFS root file system needs to be adjusted to the replication target storage controller.

1. Stop the PXE related services on both management servers:

mgmtsrv01:~ # service dhcpcd stop
mgmtsrv01:~ # service xinetd stop

2. Mount the replicated tftpboot volume:

mgmtsrv01:~ # umount /tftpboot
mgmtsrv01:~ # mount hana2a:/vol/tftpboot /tftpboot

3. Start the PXE related services on both management servers:

mgmtsrv01:~ # service dhcpcd start
This following steps have to be done for the PXE boot configurations of all servers.

The example shows the adapted configuration for the first server, cishanar08.

```bash
mgmtsrv01:~ # service xinetd start

mgmtsrv01:/tftpboot/pxelinux.cfg # vi cishanar08

default SLES4SAP
prompt 1
LABEL SLES4SAP
KERNEL vmlinuz
    APPEND initrd=initrd rw rootdev=192.168.127.13:/vol/cishanar08_3080
    intell_idle.max_cstate=0 ip=::::::dhcp
    APPEND initrd=initrd rw rootdev=192.168.127.11:/vol/cishanar08_3080
    intell_idle.max_cstate=0 ip=::::::dhcp

7.7 Switch Servers to Production DR and Boot Servers

Within Cisco UCS® Manager, the profiles for dev/test need to be disassociated from the dev/test servers.

Within Cisco UCS Manager, the profiles for production need to be associated with the dev/test servers.
The servers will be started automatically after association.

Check the environment of the HANA database nodes at the DR site:

```bash
mgmtsrv01:/tftpboot/pixelinux.cfg # ssh cishanar08
cishanar08:~ # cat /proc/mounts | grep cishanar08
192.168.127.13:/vol/cishanar08_3080 / nfs
rw,relatime,vers=3,rsize=65536,wsize=65536,namlen=255,hard,nolock,proto=tcp,timeo=600,retrans=2,sec=sys,mountaddr=192.168.127.13,mountvers=3,mountproto=udp,local_lock=all,addr=192.168.127.13 0 0
```

The preceding command shows that the NFS root file system is mounted from the DR storage system.

```bash
cishanar08:~ # df -h
Filesystem Size Used Avail Use% Mounted on
udev 253G 180K 253G 1% /dev
tmpfs 380G 0 380G 0% /dev/shm
hana2a-st:/vol/sapcd 190G 43G 148G 23% /NFS/Install
hana2b-st:/vol/sapexe/usr_sap_01 95G 35G 61G 37% /usr/sap
hana2b-st:/vol/sapexe/ANA 95G 35G 61G 37% /hana/shared/ANA
hana2a-st:/vol/data_00001/mnt00001 1.9T 1.5G 1.9T 1% /hana/data/ANA/mnt00001
hana2b-st:/vol/data_00002/mnt00002 2.0T 342M 1.9T 1% /hana/data/ANA/mnt00002
hana2a-st:/vol/data_00003/mnt00003 2.0T 404M 1.9T 1% /hana/data/ANA/mnt00003
hana2b-st:/vol/data_00004/mnt00004 1.4T 78G 1.4T 6% /hana/data/ANA/mnt00004
hana2b-st:/vol/log_00001/mnt00001 487G 2.4G 485G 1% /hana/log/ANA/mnt00001
hana2a-st:/vol/log_00002/mnt00002 487G 2.1G 485G 1% /hana/log/ANA/mnt00002
hana2b-st:/vol/log_00003/mnt00003 487G 2.1G 485G 1% /hana/log/ANA/mnt00003
hana2a-st:/vol/log_00004/mnt00004 487G 33M 487G 1% /hana/log/ANA/mnt00004
```

All related HANA file systems are now mounted from the DR storage system.
### 7.8 Run Postprocessing Before HANA Start

Before the HANA system can be started, a few steps need to be completed.

Subdirectories in the log volume need to be created if they do not exist. The list of subdirectories has been created while the backup of the HANA database was executed. The file is located at `/hana/shared/SID/.logfile_dir.txt`.

As described in SAP note 1703435, two hdbnsutil commands need to be executed before the HANA system can be started.

```
hdbnsutil -useSnapshot
hdbnsutil -convertTopology
```

The steps can also be executed using the example script `post-steps-before-start.sh`. The script needs to be executed as user SIDadm at one of the HANA nodes.

The following file exists messages appear if there have been no changes in the log volume structure.

```
cishanar08:/opt/NetApp/HANA-DR-Scripts> ./post-steps-before-start.sh
========================================================================
Create subdirectories in log volume ....
========================================================================
mkdir: cannot create directory `/hana/log/ANA/mnt00001/hdb00001': File exists
mkdir: cannot create directory `/hana/log/ANA/mnt00001/hdb00002': File exists
mkdir: cannot create directory `/hana/log/ANA/mnt00001/hdb00003': File exists
mkdir: cannot create directory `/hana/log/ANA/mnt00001/hdb00004': File exists
mkdir: cannot create directory `/hana/log/ANA/mnt00002/hdb00005': File exists
mkdir: cannot create directory `/hana/log/ANA/mnt00003/hdb00006': File exists

Run post commands hdbnsutil useSnapshot, convertTopology....
```

### 7.9 Start HANA

The HANA system can now be started at the DR site.

```
cishanar08:/usr/sap/ANA/HDB42> sapcontrol -nr 42 -function GetSystemInstanceList
18.09.2013 13:20:09
GetSystemInstanceList OK
hostname, instanceNr, httpPort, httpsPort, startPriority, features, dispstatus
cishanar11, 42, 54213, 0, 0.3, HDB, GRAY
cishanar10, 42, 54213, 0, 0.3, HDB, GRAY
cishanar08, 42, 54213, 0, 0.3, HDB, GRAY
cishanar09, 42, 54213, 0, 0.3, HDB, GRAY
```

```cishanar08:/usr/sap/ANA/HDB42>```
cishanar08:/usr/sap/ANA/HDB42> sapcontrol -nr 42 -function StartSystem HDB
StartSystem
OK

cishanar08:/usr/sap/ANA/HDB42> sapcontrol -nr 42 -function GetSystemInstanceList
GetSystemInstanceList
OK
hostname, instanceNr, httpPort, httpsPort, startPriority, features, dispstatus
cishanar10, 42, 54213, 0, 0.3, HDB, GREEN
cishanar11, 42, 54213, 0, 0.3, HDB, GREEN
cishanar08, 42, 54213, 0, 0.3, HDB, GREEN
cishanar09, 42, 54213, 0, 0.3, HDB, GREEN
cishanar08:/usr/sap/ANA/HDB42>
Appendix

Script call-get-log-dirs

```bash
#!/bin/bash
# HANA_NODE and HANA_SID is set by Snap Creator as environment variables
echo "Calling get-log-dirs.sh on HANA node: $HANA_NODE for SID: $HANA_SID."
ssh $HANA_NODE /opt/NetApp/HANA-DR-Scripts/get-log-dirs.sh $HANA_SID
```

Script get-log-dirs

```bash
#!/bin/bash
if [ $1 ] then
  SID=$1
else
  echo "usage: ./get-log-dirs.sh <SID>"
  exit
fi
echo "Get a list of subdirectories in the log volumes ...."
ls -R /hana/log/$SID|grep mnt000|grep hdb00|awk -F":" '{print $1}' > /hana/shared/$SID/.logfile_dir.txt
cat /hana/shared/$SID/.logfile_dir.txt
exit 0
```

Script snapmirror-initialize.sh

```bash
#!/bin/bash
if [ $1 ] then
  FILE=$1
else
  echo "usage: snapmirror-initialize.sh <file_with_list_of_volumes>"
  exit
fi
echo "SnapMirror Initialize...."
exec < $FILE
while read LINE
do
  FILER[index]="echo $LINE | awk -F":" '{print $1}"
  VOLUME[index]="echo $LINE | awk -F":" '{print $2}"
  DEST_FILER[index]="echo $LINE | awk -F":" '{print $3}"
  DEST_VOLUME[index]="echo $LINE | awk -F":" '{print $4}"
((index=index+1))
done
COUNT=$index
while [ $COUNT -gt 0 ]
do
  ((index=index-1))
echo "command: ssh ${DEST_FILER[index]} snapmirror initialize -S ${FILER[index]}:${VOLUME[index]} ${DEST_FILER[index]}:${DEST_VOLUME[index]}"
  ssh ${DEST_FILER[index]} snapmirror initialize -S ${FILER[index]}:${VOLUME[index]} ${DEST_FILER[index]}:${DEST_VOLUME[index]} ((COUNT=COUNT-1))
done
```
Script snapmirror-break.sh

```bash
#!/bin/bash

if [ $1 ]
then
  FILE=$1
else
  echo "usage: snapmirror-break.sh <file_with_list_of_volumes>"
  exit
fi

echo "SnapMirror Break: Make destination volumes writeable ...."
exec < $FILE
while read LINE
do
  FILER[index]=`echo $LINE | awk -F":" '{print $1}'`
  VOLUME[index]=`echo $LINE | awk -F":" '{print $2}'`
  DEST_FILER[index]=`echo $LINE | awk -F":" '{print $3}'`
  DEST_VOLUME[index]=`echo $LINE | awk -F":" '{print $4}'`
  ((index=index+1))
done

COUNT=$index
while [ $COUNT -gt 0 ]
do
  ((index=index-1))
  echo "command: ssh ${DEST_FILER[index]} snapmirror break ${DEST_VOLUME[index]}"
  ssh ${DEST_FILER[index]} snapmirror break ${DEST_VOLUME[index]}
  ((COUNT=COUNT-1))
done
```

Script snaprestore-destination.sh

```bash
#!/bin/bash

if [ $1 ]
then
  SNAP_NAME=$1
else
  echo "usage: snaprestore-destination.sh <snap-name> <file_with_list_of_volumes>"
  exit
fi
if [ $2 ]
then
  FILE=$2
else
  echo "usage: snaprestore-destination.sh <snap-name> <file_with_list_of_volumes>"
  exit
fi

exec < $FILE
while read LINE
do
  FILER[index]=`echo $LINE | awk -F":" '{print $1}'`
  VOLUME[index]=`echo $LINE | awk -F":" '{print $2}'`
  DEST_FILER[index]=`echo $LINE | awk -F":" '{print $3}'`
  DEST_VOLUME[index]=`echo $LINE | awk -F":" '{print $4}'`
  ((index=index+1))
done

COUNT=$index
while [ $COUNT -gt 0 ]
do
  ((index=index-1))
```

SAP HANA Disaster Recovery using Snap Creator and SnapMirror
Script post-steps-before-start.sh

```bash
#!/bin/bash

if [ $LOGNAME == "root" ]
  then
    echo "User must be SIDadm!"
  exit 4
fi

echo "======================================================================="
echo "Create subdirectories in log volume ...."
echo "======================================================================="
cat /hana/shared/$SAPSYSTEMNAME/.logfile_dir.txt | grep -v backup | while read FILE
do
  mkdir $FILE
done
echo "Run post commands hdbnsutil useSnapshot, convertTopology...."
echo "======================================================================="
hdbnsutil -useSnapshot
hdbnsutil -convertTopology
```

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

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