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Executive summary

Disaster recovery capabilities are crucial for the SAP in-memory computing platform in the event that an entire computing site is lost and the organization cannot afford the time required to rebuild the SAP HANA Database.

In designing a disaster recovery solution for SAP HANA databases, the designer must focus on two key factors to specify the recovery parameters of a system in the event of a disaster: recovery time objective (RTO) and recovery point objective (RPO). HP provides the services and support needed to protect valuable business data from local or remote disasters.

In response to these factors, HP has developed a disaster recovery solution including implementation services for HP AppSystems for SAP HANA Scale-Out using SAP HANA database kernel-managed and IP network-based System Replication. This is an alternative high availability solution for SAP HANA databases and provides real time replication of all the changes at the active primary site to a standby SAP HANA system located at a distant secondary site. In the event of a service outage of the primary site, the secondary system allows a return to normal operations with minimal delay and very little or no loss of data, thus, reducing the outage.

This solution demonstrates a reference architecture for implementing a disaster recovery solution for HP AppSystems for SAP HANA Scale-Out using SAP HANA System Replication. This document describes an active/passive HP-validated disaster recovery solution for HP AppSystems for SAP HANA wherein a human decision initiates the failover of a production site to an alternate site in the event of the failure of the production site. Depending on the particular requirement and in order to effectively utilize the servers on the secondary system while replication is in progress, this solution also allows the added dual role on the secondary SAP HANA system to function in a non-production capacity (for example, TEST, QA or DEV) until it is required to be switched to an active state from the original standby state in the event of a disaster.

Target audience: This white paper covers the asynchronous mode of system replication for HP AppSystems for SAP HANA Scale-Out to support disaster-tolerance and disaster-recovery strategies and, as an option, using the secondary site either local or remote as dual role for non-production testing, QA and development activities by adding an additional HP P6500 EVA storage array.

This white paper is intended to assist SAP solution architects, SAP database and basis administrators, storage administrators or IT professionals who are involved in planning and deploying disaster recovery solutions for HP AppSystems for SAP HANA Scale-Out using SAP HANA System Replication. The reader requires some experience with SAP HANA database and familiarization with HP AppSystems for SAP HANA Scale-Out configuration setup.

Document purpose: The purpose of this document is to describe a reference architecture solution that provides guidance to deploy a disaster recovery solution for HP AppSystems for SAP HANA Scale-Out and also highlights recognizable benefits of using HP and SAP technologies for the target technical audiences and customers.

This white paper describes the information based on SAP HANA System Replication testing performed using asynchronous mode at an HP R&D lab in October 2013.

Introduction

SAP HANA and HP AppSystems for SAP HANA Scale-Out have been in customer use for a few years now. While there are several SAP HANA appliances available from multiple hardware vendors, there are very few disaster recovery solutions available for customers today that provide an alternative high availability with a small RTO including management and automation of processes. The key to achieving high availability is redundancy, including hardware redundancy, network redundancy and data center redundancy. SAP HANA solutions and deployment services from HP provide several levels of defense against failure-related outages.

System Replication is an alternative High Availability (HA) solution for SAP HANA providing a shortened RTO and it is compatible with HP AppSystems for SAP HANA Scale-Out. System Replication employs an "N+N" approach, with a secondary standby SAP HANA system that is configured identically to the active primary system, (although the secondary system may not necessarily have standby nodes). Each service and instance of the primary SAP HANA system communicates pair-wise with a counterpart in the secondary system at the DR site.

Customers are realizing the benefits of in-memory technology along with an efficient high availability and disaster recovery solution that acts as an enabler to also have a dual-purpose DR site for running the non-production SAP HANA database instances while maintaining critical data replication.

This solution also enables customers to perform a seamless technology refresh at a local site as well as remote sites from their current HP AppSystems for SAP HANA Scale-Out Gen 1.1 setup to HP AppSystems for SAP HANA Scale-Out Gen 1.2.

---

1 The process of recovering operations after an outage due to a prolonged data center or an entire site failure.
2 The time taken depends on the log and data volume size in the SAP HANA database.
Overview

HP and SAP have collaborated to offer HP AppSystems for SAP HANA Scale-Up and Scale-Out as a portfolio of optimally configured hardware appliances with preloaded software and a full range of included services — design, factory integration, on-site installation, and proactive support with a single point of contact. Configurations and options follow.

Scale-Out configurations

HP offers scale-out configurations that support very large data volumes on SAP HANA. This is an enterprise-class real-time analytics solution optimized to run SAP business application workloads while offering a disaster recovery architecture, including a semi-automated failover mechanism to a secondary system located in the same or different data center. This configuration uses industry-leading HP ProLiant BL680c G7 server blades.

SAP provides a product availability matrix (PAM) with information about SAP HANA supported software and hardware platforms. Please refer to this support matrix for the latest product availability configurations.

Figure 1 shows the different available scale-out configurations and options.

This document provides the options and ways in which a customer can deploy disaster recovery solutions for HP AppSystems for SAP HANA Scale-Out using SAP HANA System Replication along with configuring the secondary servers for using non-production systems in HP AppSystems for SAP HANA Scale-Out Gen 1.1. It also provides the required bill of materials for an add-on disaster recovery for SAP HANA 2TB HP AppSystems for SAP HANA Scale-Out Gen 1.1.

Business requirement

When data security and availability are critical to the success of their businesses, SAP customers require a computing solution that protects their information systems from planned maintenance, faults and disasters such as power outages, fires, or acts of vandalism. The effects of a disaster can range from temporary loss of availability to the outright physical destruction of a facility and its assets.

In the event of a disaster, the HANA environment must allow customers to shift their information-processing activities to another site as quickly as possible. Thus, procedures for disaster recovery must be predictable, well-defined, documented in advance, and executed by qualified Systems (or Storage) Administrators and IT decision-makers.
Figure 2 outlines the configuration requirement for implementing a disaster recovery solution for HP AppSystems for SAP HANA Scale-Out.

**Figure 2.** Logical view of the DR solution for HP AppSystems for SAP HANA Scale-Out Gen 1.1 (upper drawing) and Scale-Out Gen 1.2 (lower drawing)
Objectives of a disaster recovery solution

While planning the disaster recovery solutions for SAP HANA over IP network, it is important to set the objectives for recovering the persistent data and logs (along with preloaded column tables into the memory) in the event of any disaster. These objectives will have a major impact on the cost and effort of the recovery, as well as help to choose among recovery alternatives. There are two key objectives for a disaster recovery solution:

- **Recovery point objective (RPO)** – RPO refers to the point-in-time up to which data can be recovered following a disaster; in general, RPO specifies the amount of data loss an organization can tolerate.
- **Recovery time objective (RTO)** – RTO refers to the maximum length of time taken for the recovery site to be up-and-running following a disaster.

RPO

Some customers require RPO of near-zero. For an HP AppSystems for SAP HANA Scale-Out environment this means that in the event of a failure causing the loss of the storage service, the business cannot afford to lose even a single committed I/O transaction. Thus, you must be able to recover data up to the closest possible time the disaster occurred to avoid any inconsistency in the SAP HANA database.

One of the implications of implementing a DR solution with RPO of near-zero is the requirement for synchronous system replication. As SAP HANA writes data (for example, log file updates) to the storage system, SAP HANA System Replication immediately mirrors the write to the storage system at the remote site. The data written is not marked as complete until it is persisted at the secondary site as well as the primary site. In the event of a failure at the primary production site, only the in-flight transactions will be lost when resuming operations at the secondary DR site.

RTO

The design objective of a disaster recovery solution for HP AppSystems for SAP HANA Scale-Out using SAP HANA System Replication is an RTO of a few minutes. The asynchronous mode of SAP HANA System Replication testing performed in our R&D lab achieved this objective. Refer to the section, How System Replication works for more information on the available system replication modes.

However, an actual RTO is variable and depends on a number of factors, including customer-specific failover declaration and execution steps, the size of the SAP HANA database and type of data, etc. When the system administrator declares that a disaster has occurred and decides the necessity to takeover, the secondary site becomes active and online.

The disaster recovery solution described in this white paper refers to RTO that includes the time taken to achieve the following:

- SAP HANA database takeover to the secondary site
- SQL/MDX database client takeover using Network-based IP Redirection method

Solution components

This section lists disaster recovery solutions for HP AppSystems for SAP HANA Scale-Out with configurations. The disaster recovery solution for HP AppSystems for SAP HANA Scale-Out provides a mechanism for configuring a disaster-tolerant configuration that is distributed between distant sites. This solution is comprised of the following components:

- HP AppSystems for SAP HANA Scale-Out
- SAP HANA System Replication
- SAP HANA Studio

HP AppSystems for SAP HANA Scale-Out

Refer to the section Scale-Out configurations for more information on HP AppSystems for SAP HANA Scale-Out configurations. The disaster recovery solution for HP AppSystems for SAP HANA using SAP HANA System Replication replicates all data from the primary site to the secondary site over the IP network, as shown in Figure 3.

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1 Only with a dedicated alternate secondary system in System Replication relationship and not in case of a dual-purpose DR site.
Figure 3. Disaster Recovery Solution for HP AppSystems for SAP HANA Scale-Out Gen 1.1 (upper drawing) and Scale-Out Gen 1.2 (lower drawing).

Note
Refer to the section Configuration guidance for more details on setup and configuration of SAP HANA System Replication for takeover and failback procedures on HP AppSystems for SAP HANA Scale-Out.
The SAP HANA production instance deployed in the primary site is connected to the production system and runs the external transactions at this site. Unless a disaster occurs, all I/Os take place on the storage subsystem at the primary site. In the event that a significant failure were to occur at the primary site, data processing could be resumed at the alternate secondary site where data would be intact and consistent.

However, in the event of a disaster at the production site the initiation of a site failover using SAP HANA System Replication requires human intervention in order to takeover on the secondary (DR Site-B) and thus, the secondary becomes online and ready to accept client connections and respond to SQL queries as shown in Figure 4. As shown here, the upper drawing illustrates the HP AppSystems for SAP HANA Scale-Out Gen 1.1 takeover on the secondary site and the lower drawing illustrates the takeover for Scale-Out Gen 1.2.

**Figure 4.** Takeover on the secondary (DR Site-B) after detecting disaster at the primary (PROD. Site-A)

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4 Dependent on the SAP HANA data volume and the System Replication mode chosen.

5 Until there is any highly available automated tool that can be used to manage the failover and failback procedures.
SAP HANA System Replication

SAP HANA System Replication replicates all data from the primary (Prod. Site-A) to the secondary (DR Site-B) and the entire process of data replication occurs on the software level and is fully controlled by the SAP HANA database kernel.

The secondary system can be located near the primary system to serve as a rapid failover solution for planned downtime, or to handle storage corruption or other local faults. However, based on the customer specific requirement to have an effective disaster recovery solution, the secondary system can be located in a remote site miles away from the primary site. Like storage replication, this disaster recovery solution also requires a reliable low latency link between the primary and secondary sites.

**Note**

It is recommend to route the connection between the two sites, local and remote, over a special site-to-site high-speed network, which typically already implements security measures such as separation from other network access and encryption or authentication between sites.

The SAP HANA database instances in the secondary system operate in live replication mode. In this mode, all secondary system services constantly communicate with their primary counterparts, replicate and persist data and logs, and load data to memory as shown in Figures 5 and 6. The main difference between the two systems is that the secondary system does not accept client requests or queries as shown by the dedicated alternate secondary system in Figure 5.
Figure 5. SAP HANA database controlled System Replication across two sites

Figure 6 shows the configuration for a dual-purpose DR site with the secondary system being used for running non-production SAP HANA database instances while system replication is running as a shadow operation for the production database instances.

Figure 6. SAP HANA System Replication with dual-purpose DR site being used for non-production database instances
Refer to the section **Set up dual-purpose disaster recovery site** for more information on setting up an HP AppSystems for SAP HANA Scale-Out Gen 1.1 with dual-purpose DR site.

### How System Replication works

When the secondary system is brought up in live replication mode, each service component establishes a connection with its primary system counterpart and requests a snapshot of the data. From then on, all logged changes in the primary system are replicated. Whenever logs are persisted in the primary system, they are also sent to the secondary system.

SAP HANA provides the following log replication options depending on the customer requirement for performance, recovery time (RTO) and data availability (RPO):

- **Synchronous (mode=sync)**: The primary system waits for committing the transaction until it receives a reply that the log is persisted in the secondary system. This mode guarantees immediate data consistency between both systems, at a cost of delaying the transaction by the time for data transmission and persisting in the secondary system. This mode is useful when the distance between two data centers is less than 100 kilometers with a high-speed network link between the two sites.

- **Synchronous in-memory (mode=synmem)**: The primary system commits the transaction after it receives a reply that the log was received by the secondary system, but before it was persisted. The transaction delay in the primary system is shorter, because it only includes the data transmission time.

- **Asynchronous (mode=async)**: A transaction is finished when it is persisted on the primary site and the network interface of the primary has confirmed that it has been successfully transmitted to the secondary site. This eliminates the synchronization latency at the risk of minor theoretical data-loss during failover scenario. This mode is most useful when the secondary site is at a different location with a distance of hundreds to thousands of kilometers; having a high-speed network link between the two sites and reducing latency is critical.

In the event that the connection to the secondary system is lost or the secondary system becomes unavailable, the primary system will resume the replication process once again when the secondary system becomes available. Currently the secondary system persists, but does not immediately replay the received logs. However, incremental data snapshots are transmitted asynchronously from the primary system to the secondary system. If the secondary system has to take over, only that part of the log needs to be replayed that represents changes that were made after the most recent data snapshot.

In addition to snapshots, the primary system also transfers status information regarding which column tables are currently loaded into memory. The secondary system correspondingly preloads these columns into memory.

### SAP HANA Studio

SAP HANA Studio is used to set up, configure and monitor SAP HANA System Replication.

### Capacity and sizing

The disaster recovery solution for HP AppSystems for SAP HANA Scale-Out over IP network is available as a standard functionality of the scale-out appliance using SAP HANA System Replication.

Your specific installation will need to be considered during the sales cycle of either a new install or an add-on, and deployed with the assistance of an HP engagement.

With seamless integration or add-on, the DR solution for HP AppSystems for SAP HANA Scale-Out provides the key that unlocks the critical difference between recovering from a catastrophic event and incurring substantial business downtime. This DR solution using SAP HANA System Replication is characterized by a short recovery time (RTO) and the avoidance of data loss (RPO).

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**Note**

It is recommended to have a dedicated server network communication of 10 Gbit/s between the primary and the secondary system for an efficient data replication. See **SAP HANA Server Installation Guide** page 8.

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**Out**

Disaster recovery

**Gen 1.1**

**Replication.**

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**Supported with SAP HANA 1.0 SPS06 onwards.**

**In such case, the secondary system requests a data backup delta based on which the log replication can be restarted.**

**Only with a dedicated alternate secondary system in System Replication relationship and not in case of a dual-purpose DR site.**
**HP AppSystems for SAP HANA Scale-Out Gen 1.1 configurations**

Table 1 lists the supported HP server blade, processors, memory, and HP P6500 EVA storage disk configurations for a 2TB HP AppSystems for SAP HANA Scale-Out Gen 1.1 starter appliance.

<table>
<thead>
<tr>
<th>Server Blade</th>
<th>Processor</th>
<th>Memory</th>
<th>HP P6500 EVA storage disk</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 * HP ProLiant BL680c G7</td>
<td>Intel® Xeon® E7 Family</td>
<td>4 * 512GB</td>
<td>48 * 600GB 6G SAS 10K HDD</td>
</tr>
</tbody>
</table>

Two HP StoreAll 9300 Gateway Storage cluster nodes are needed per 4-nodes (HP ProLiant BL680c G7 server blades) in a 2TB starter appliance.

**HP AppSystems for SAP HANA Scale-Out Gen 1.2 configurations**

Table 2 lists the supported HP server blade, processors, memory, and HP 3PAR StoreServ 7400 storage disk configurations for a 2TB HP AppSystems for SAP HANA Scale-Out Gen 1.2 starter appliance with 4-node building block.

<table>
<thead>
<tr>
<th>Server Blade</th>
<th>Processor</th>
<th>Memory</th>
<th>HP 3PAR StoreServ 7400 storage disk</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 * HP ProLiant BL680c G7</td>
<td>Intel Xeon E7 Family</td>
<td>4 * 512GB</td>
<td>48 * 900GB 6G SAS 10K HDD</td>
</tr>
</tbody>
</table>

The base rack can have one or two 4-node building blocks based on the data volume and performance requirement in the customer scale-out environment.

Two HP ProLiant DL380p Gen8 Linux NFS servers are needed per 4/8-node base rack.

**Workload description**

**SAP HANA database workload – table schema creation and data loading**

The asynchronous mode of testing using SAP HANA System Replication was performed between the following scale-out configurations located adjacent to one another in the same data center:

- HP AppSystems for SAP HANA Scale-Out Gen 1.1 and HP AppSystems for SAP HANA Scale-Out Gen 1.1 (Base Rack with 2TB system memory)
- HP AppSystems for SAP HANA Scale-Out Gen 1.1 and HP AppSystems for SAP HANA Scale-Out Gen 1.2 (Base Rack with 2TB building block)

A script was used to create the table schema and insert the records in a sample SAP HANA 1.0 database version 1.00.67.383230. The total database size was approximately 208 GB comprised of 10 tables, each with 10 million record counts.

The metrics measured during the table schema creation and data loading come from the operating system using SAP HANA command line utilities hdbnsutil and hdbcons as <sid>adm user on OS level.

While testing the dual-purpose DR site for non-production instances along with system replication in progress for the production instances, a sample SAP HANA 1.0 database version 1.00.67.38230 was created with different SID and instance number. The table schema creation and data loading was initiated for the non-production SAP HANA database instances while the system replication was in progress for the production database instances.

**Workload data/configuration results**

**Takeover/failback phase**

The results of the testing performed revealed that the time taken for initial syncing of the data at the secondary site was approximately 24 minutes (that is 8.6 GB per minute) over a 10G data network in HP AppSystems for SAP HANA Scale-Out. Also, after detecting the disaster at the primary site and initiating the takeover on the secondary site, the *takeover time* was recorded as a few minutes before the alternate secondary site switched the role from standby to active state. The small
RTO has enabled the alternate secondary site to become operational in a very short span of time and start accepting the client connections and responding to the SQL queries from SAP HANA Studio server.

In a dual-purpose disaster recovery site where an additional non-production SAP HANA database instance with different SID and instance number was created, the results indicated that the takeover time was relatively longer considering the fact that there was no data preloaded into the memory.

Refer to the section Configuration guidance for more information on configuring/monitoring system replication and setting up a dual-purpose disaster recovery site for non-production SAP HANA database instances.

**Configuration guidance**

This section describes the details required for setting up takeover and failback in a dedicated system replication site and in a dual-purpose DR site along with SAP HANA System Replication that is using the secondary servers for running non-production SAP HANA database instances while the production data replication from primary to secondary site is enabled and is active.

**Recommended SAP documentation for review**

SAP HANA High Availability white paper: saphana.com/docs/DOC-2775

Introduction – SAP HANA in Data Centers: saphana.com/docs/DOC-2010


HANA High Availability: saphana.com/servlet/JiveServlet/downloadBody/2775-102-3-7957/HANA_HA_2c.pdf

How to Perform System Replication for SAP HANA: https://scn.sap.com/docs/DOC-47702

SAP Note 1876398 – Network configuration for System Replication in HANA SPS6

SAP Note 1834153 – HANA high availability disaster tolerance configuration

**Configuring SAP HANA system replication – takeover and failback**

The following steps describe how to set up and configure a disaster recovery solution using SAP HANA System Replication for HP AppSystems for SAP HANA Scale-Out, where an alternate secondary site is being used in a dedicated system replication relationship.

**Planning phase:** A disaster recovery solution needs to be planned based on the customer requirement for performance, data availability and recovery time in the event of a planned or un-planned disaster. If the business requirement is to have an RPO of near zero and RTO in a few minutes, SAP HANA System Replication is the best decision and, based on the distance between two data centers, the replication mode needs to be chosen.

Table 3 shows the different modes of log replication between two remote sites and their effect on data availability and recovery time, assuming that an alternate secondary site is being used in a dedicated replication relationship and not as a dual-purpose DR site.

**Table 3. Log replication modes affecting data availability and recovery time**

<table>
<thead>
<tr>
<th>Log replication mode</th>
<th>Distance between two remote sites (in KM)</th>
<th>RPO</th>
<th>RTO</th>
</tr>
</thead>
<tbody>
<tr>
<td>sync</td>
<td>&lt; 100</td>
<td>0</td>
<td>a few minutes</td>
</tr>
<tr>
<td>syncmem</td>
<td>&lt;100</td>
<td>0</td>
<td>a few minutes</td>
</tr>
<tr>
<td>async</td>
<td>&gt;100</td>
<td>&gt;=0</td>
<td>a few minutes</td>
</tr>
</tbody>
</table>

5 It will be dependent on the alert delay of the created monitoring of the system replication.
**Preparation phase:** This phase is for organizational readiness, which enables the system to prevent and get prepared for the inevitable fault. During this time, single points of failure are to be eliminated, SAP HANA database is backed up and standby secondary systems are ready to take over in the event of any disaster.

Install SAP HANA database version 10 (greater than or equal to the SAP HANA database at the primary systems) on the secondary systems. System Identifier (SID), system-number and host topology must be equal (that is, the same number of active hosts and same number of services on each host) to the dedicated primary systems.

Following are the steps required to set up the SAP HANA System Replication between two identically configured systems either by using SAP HANA Studio or as <sid>adm user on OS level.

**Key point**
This white paper describes the SAP HANA System Replication setup and configuration performed using <sid>adm user on OS level.

- **Backup the SAP HANA database** – Take a complete backup of the SAP HANA database at the primary system. This can be performed by using SAP HANA Studio and right-clicking on the primary system → Backup. This is mandatory to enable System Replication on the primary system and register a Secondary System with the primary system.

  - Use command line tool hdbnsutil as <sid>adm user on OS level:
    ```bash
    hdbnsutil -sr_enable --name=<primary_logical_name>, where the parameter "--name" is the primary system logical name.
    ```
    For example, the following command enables system replication on the primary system (hananode05) with logical name SiteA:
    ```bash
    hdbnsutil -sr_enable --name=SiteA
    ```
    Now, verify the system replication state to confirm "mode" is set as "primary":
    ```bash
    hdbnsutil -sr_state
    ```

- **Enable System Replication on primary system** – Use command line tool hdbnsutil as <sid>adm user on OS level:

  ```bash
  hdbnsutil -sr_enable --remoteHost=<primary_hostname FQDN> --remoteInstance=<instance number> --mode=async --name=<secondary logical name>;
  ```
  where the parameters:
  "--remoteHost" is the FQDN hostname of the primary system
  "--remoteInstance" is the instance number
  "--mode" is the replication mode
  "--name" is the secondary system logical name
  For example, the following command registers the secondary system with logical name SiteB:
  ```bash
  hdbnsutil -sr_register --remoteHost=hananode05 --remoteInstance01 --mode=async --name=SiteB;
  ```
  Now, verify the system replication state to confirm "mode" is set as "async" and correct host mappings between primary site and secondary site:
  ```bash
  hdbnsutil -sr_state
  ```

- **Register secondary system** – Stop the secondary system:

  ```bash
  su - <sid>adm
  HDB stop
  ```
  Use command line tool hdbnsutil as <sid>adm user on OS level:
  ```bash
  hdbnsutil -sr_register --remoteHost=<primary hostname FQDN> --remoteInstance=<instance number> --mode=async --name=<secondary logical name>;
  ```
  where the parameters:
  "--remoteHost" is the FQDN hostname of the primary system
  "--remoteInstance" is the instance number
  "--mode" is the replication mode
  "--name" is the secondary system logical name
  For example, the following command registers the secondary system with logical name SiteB:
  ```bash
  hdbnsutil -sr_register --remoteHost=hananode05 --remoteInstance01 --mode=async --name=SiteB;
  ```
  Now, verify the system replication state to confirm "mode" is set as "async" and correct host mappings between primary site and secondary site:
  ```bash
  hdbnsutil -sr_state
  ```

---

10 For asynchronous system replication the minimum supported SAP HANA database version is SAP HANA 1.0 SPS06
Key point
In order for the system replication to work, each host on both the primary and secondary sites must be able to resolve all logical hostnames and therefore, appropriate FQDN entries in /etc/hosts file have to be made.

- **Start the secondary system** – To initiate the System Replication from primary (PROD. Site-A) to secondary (DR Site-B).
  ```
  su - <sid>adm
  HDB start
  ```

- **Prepare for client or application server connection recovery** – Reconnect for failover case (SQL/MDX and HTTP). Irrespective of which site is currently the primary (PROD. Site-A in this example), the client and application server needs to be able to connect to the SAP HANA database system in the event of takeover to the secondary site. This can be achieved in two ways:
  
  **Network-based IP redirection**: A virtual IP address is assigned to the virtual host name. In the event of takeover the virtual IP needs to unbind from the network adapter of the primary system and should bind to the network adapter on the secondary system.
  
  **Network-based DNS redirection**: In this scenario the IP for the host name in the DNS will be changed from the address of the primary to the address of the secondary system.
  
  Since both of these methods have their advantages, the customer should decide their preferred approach based on their IT policies and infrastructure setup. If there are no existing constraints, the IP redirection approach has the clear benefit of being faster to process in a script rather than synchronizing changes of DNS entries over a global network.

- **Monitoring System Replication** – Monitor the status of system replication and host-mapping to ensure that both systems are in sync.
  
  Using "hdbnsutil -sr_state" as <sid>adm user on the OS level at the primary site verify the host-mapping between the primary and secondary site as shown below.

  ```
  hananode05:/usr/sap/DB1/HDE01> hdbnsutil -sr_state
  checking for active or inactive nameserver ...

  System Replication State
  ~~~~~~~~~~~~~~~~~~~~~~~~~~~

  mode: primary
  site id: 1
  site name: SiteA

  Host Mappings:
  ~~~~~~~~~~~~~~~

  hananode07 -> [SiteA] hananode07
  hananode07 -> [SiteB] hananode03
  hananode08 -> [SiteA] hananode08
  hananode08 -> [SiteB] hananode04
  hananode05 -> [SiteA] hananode05
  hananode05 -> [SiteB] hananode01
  hananode06 -> [SiteA] hananode06
  hananode06 -> [SiteB] hananode02

  done.
  ```
Note

SAP HANA 1.0 SPS06 also enables the configuration and monitoring of System Replication using SAP HANA Studio.

Use SQL to retrieve the detailed configuration and status of system replication from system view `<PUBLIC.M_SERVICE_REPLICATION>` as follows:

```
hdbsql -n <PRIMARY site hostname> -i <PRIMARY site instance number> -j -u <user_name> -p <password> "select * from M_SERVICE_REPLICATION"
```

However, in case of ASYNC System Replication mode no acknowledgement is shipped from the secondary site and therefore, the only option is to check the current log position at the secondary site using `hdbcons` on the secondary site on each node and for each persistency relevant service, for example:

```
su - <sid>/adm
hdbcons -e hdbindexserver "replication info"
```

Verify the “ReplicationStatus” parameter under “Secondary Statistics” as shown in Figure 7.

Figure 7 highlights in red the “ReplicationStatus” parameter under “Secondary Statistics” as “ReplicationStatus_Active,” meaning that the secondary site is now in sync with the primary site and ready for takeover in the event of any disaster. It also shows the “channel” under “Log Connection” and “Data Connection” that provides details about the replication network being used for system replication.

Figure 7. Output of `hdbcons -e hdbindexserver "replication info"`

```
Last Primary Host: hannaode05
Last Primary Port: 30203

Log Connection
  ...[Output Omitted]

  - node: NodeAsynchronous
  - logSizeLastBackup: 316246 bytes
  - timeSinceLastBackup: 3149704446 microseconds

Data Connection
  ...[Output Omitted]

  - node: NodeAsynchronous
  - logSizeLastBackup: 316246 bytes
  - timeSinceLastBackup: 3149704446 microseconds

Secondary Statistics
  - Creation Timestamp: 2020-03-04 04:58:13.583 (13920268526378979)
  - Last Reset Timestamp: 2020-03-04 04:58:13.583 (13920268526378979)
  - Statistic Reset Count: 0

  - ReplicationStatus: ReplicationStatus_Active
```

Figure 7 highlights in red the “ReplicationStatus” parameter under “Secondary Statistics” as “ReplicationStatus_Active,” meaning that the secondary site is now in sync with the primary site and ready for takeover in the event of any disaster. It also shows the “channel” under “Log Connection” and “Data Connection” that provides details about the replication network being used for system replication.
Using SAP HANA Studio, system replication status can also be monitored. As shown in Figure 8, double-click on primary system (red arrow 1) and in "Overview" tab click on "System Replication Status" (red arrow 2). In "Landscape" tab verify the "Replication_Status" (red arrow 3) as active for all the services before performing takeover on the secondary system.

**Figure 8.** Verifying System Replication Status using SAP HANA Studio

**Detection phase:** This phase is for identifying the server, hardware, network and storage component failure and then deciding upon the necessity to execute manual takeover operation.

Verify the system state using the Python script "landscapeHostConfiguration.py", delivered with SAP HANA database installation. If the script returns the status as "error" that means there are not enough hosts available anymore and it is time to decide takeover to the secondary site.

**Takeover phase:** The takeover process is the name for the task of switching the role of active system from the current primary system onto the secondary system. Once the takeover command is executed the former secondary system becomes the primary system.

- **On the secondary system** – Perform a takeover using the command line tool `hdbnsutil` as `<sid>adm` user on OS level:
  ```bash
  hdbnsutil -sr_takeover
  ```

- **Client and application server connection recovery** \(^\text{11}\) – Perform a takeover using the command line tool `hdbnsutil` as `<sid>adm` user on OS level. Unbind the virtual IP from the network adapter on the primary site and bind it with the network adapter on the secondary system.

**Key point**

SAP HANA System Replication automatically replicates the relevant license information from primary (PROD. Site-A) to secondary (DR Site-B) provided both sites have SAP HANA database configured with the same SID.

\(^\text{11}\) Using Network-based IP redirection method throughout the testing performed in this white paper.
The secondary system now becomes online with main columns as used in the primary system preloaded and ready to accept the client requests and able to respond to the SQL queries.

**Failback phase:** This phase describes the procedure to perform a failback on the previous primary Site-A (after Takeover on the secondary Site-B).

After a takeover has been carried out, and the data center is back in operation, the roles between primary and secondary can be switched over. In this case, the former primary now has to be registered as the secondary with the active primary system.

The data that is already available in the persistence cannot be reused, instead a complete initialization will be carried out. This means a full replica will be shipped until the previous primary is in sync again.

- **Backup the HANA database at Site-B (current primary)**
- **Register secondary system** – Activate previous primary (SiteA) as secondary when data center is back.
  
  Stop the secondary system:
  ```
  su - <sid>adm
  HDB stop
  ```

  Register the system named “SiteA” as secondary on the previous primary (current secondary):
  ```
  Use command line tool hdbnsutil as <sid>adm user on OS level:
  hdbnsutil -sr_register --remoteHost=hananode01 --remoteInstance=01 --mode=async --name=SiteA
  ```

  where the parameters
  ```
  "--remoteHost" is the hostname of the current primary system at Site-B
  "--remoteInstance" is the instance number
  "--mode" is the replication mode
  "--name" is the previous primary (current secondary) system logical name
  ```

- **Start the secondary (previous primary) system** – To initiate System Replication from primary (PROD. Site-B) to secondary (DR Site-A).
  ```
  su - <sid>adm
  HDB start
  ```

- **Performing Takeover** –
  
  **On secondary system** – Perform a takeover using the command line tool hdbnsutil as <sid>adm user on OS level:
  ```
  hdbnsutil -sr_takeover
  ```

  **Client and application server connection recovery** – Unbind the virtual IP from the network adapter on the primary site and bind it with the network adapter on the secondary system.

---

12 Only with a dedicated alternate secondary system in system replication relationship and not in case of a dual-purpose DR site.
### Set up dual-purpose disaster recovery site

This section describes the details required to set up the **secondary** system, that is, the computing nodes in HP AppSystems for SAP HANA Scale-Out Gen 1.1, for running non-production SAP HANA instances along with the production instance in standby mode in relationship with the primary system. While SAP HANA system replication is enabled for the production instances the secondary system can be used for running DEV/QA/TEST instances.

The following are the prerequisites that need to be considered while setting up a dual-purpose disaster recovery site:

- 10% of the system resources on each of the HP ProLiant BL680c G7 blades (computing node) are still needed for the system replication processes.
- Table preload is turned off on the secondary system for the production SAP HANA database instances in system replication relationship with the primary system. Consequently, the takeover process will take longer as no data is preloaded into memory.
- The secondary system uses additional independent disk volumes for DATA & LOG for the non-production SAP HANA database instances.
- The SIDs and instance numbers have to be different for non-production instances on the secondary system.
- The non-production SAP HANA database instances must be stopped before performing the takeover on the secondary system for the production instances and cannot be operational while the secondary site is acting as the primary site.

---

**Key point**

HP recommends setting the global allocation limit on the secondary system to a minimum value as follows for HP AppSystems for SAP HANA Scale-Out:

```
    global.ini -> [memorymanager] -> global_allocation_limit = 118784 (116 * 1024 MB)
```

---

Figure 9 outlines the components in HP AppSystems for SAP HANA Scale-Out Gen 1.1 that are required for setting up a dual-purpose disaster recovery site. As shown in the upper drawing of Figure 9, an additional HP P6500 EVA Storage array is required to set up a DATA & LOG repository for SAP HANA non-production instances. The lower drawing of the figure shows the FC SAN switch connectivity details for production and non-production SAP HANA database instances.
**Figure 9.** HP AppSystems for SAP HANA Scale-Out Gen 1.1 components for dual-purpose SR site
A sample configuration shown in Figure 10 using dual-purpose disaster recovery site for non-production SAP HANA database instances requires an additional HP P6500 EVA storage system (B1') for housing DATA and LOG of non-production instances. However, HP P6500 EVA storage system B1 is used for HANA DATA, LOG and SYSTEM as well as two boot disks (one for each HP StoreAll 9300).

As shown in Figure 10, four DATA and four LOG VDISKS in the additional HP P6500 EVA storage system B1' have been created and presented to the HP StoreAll 9300 cluster nodes B1 and B2. Using these VDISKS, create filesystems on the HP StoreAll 9300 Fusion Manager node as shown in Figure 11 below. The upper drawing in Figure 11 (in red box) shows NFS filesystem "HANADATA_NONPRD" (mounted on /HANADATA_NONPRD) housing data for non-production instances. The lower drawing in Figure 11 shows (in red box) NFS filesystem "HANALOG_NONPRD" (mounted on /HANALOG_NONPRD) housing logs for non-production instances.

**Figure 10.** Sample configuration using dual-purpose DR site for non-production SAP HANA database instances
Figure 11. NFS Filesystem for the non-production instances on the HP StoreAll 9300 Fusion Manager node.
As shown in below Figure 12 (in red box), the NFS filesystems `/HANADATA_NONPRD` and `/HANALOG_NONPRD` have been mounted as `/HANA/IMDB-data-nonprd` and `/HANA/IMDB-log-nonprd` respectively on the SAP HANA nodes (BL680c G7 server blades) in HP AppSystems for SAP HANA Scale-Out.

**Figure 12.** NFS Filesystem for the non-production instances mounted on the HANA blades

<table>
<thead>
<tr>
<th>filesystem</th>
<th>Size</th>
<th>Used</th>
<th>Avail</th>
<th>Used% Mounted on</th>
</tr>
</thead>
<tbody>
<tr>
<td>/</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/dev</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/dev/mapper</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/dev/cciss</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/MANIFEST</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/MANALOG/</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/HANADATA/</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/HANALOG/</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/HANALOG_BACKUP/</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/HANADATA_NONPRD/</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/HANADATA_LOG/NONPRD/</td>
<td>2.04</td>
<td>4.66</td>
<td>2.04</td>
<td>3% /HANA/IMDB-log-nonprd</td>
</tr>
</tbody>
</table>

**Key point**

HP recommends using the above NFS filesystems for non-production SAP HANA database instances on HP AppSystems for SAP HANA Scale-Out Gen 1.1.

**Bill of materials**

HP AppSystems for SAP HANA Scale-Out are available in different capacities and an add-on-disaster recovery for SAP HANA 2TB HP AppSystems for SAP HANA Scale-Out Gen 1.1 with dual-role configuration is available as listed in Table 4.

**Table 4.** Add-on disaster recovery for SAP HANA 2TB HP AppSystems for SAP HANA Scale-Out Gen 1.1 [dual-role]

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>T5518A</td>
<td>HP 8/8 and 8/24 SAN Switch 8-PT Upgr LTU</td>
</tr>
<tr>
<td>2 per HANA Rack</td>
<td>A2E83A</td>
<td>HP SAP HANA Rack Block</td>
</tr>
<tr>
<td>1</td>
<td>HA454A1-000</td>
<td>HP Fctry Express Solution Package 4 SVC</td>
</tr>
<tr>
<td>1</td>
<td>AF505A</td>
<td>HP Pwr Monitor 1PH 40A NA/JP Dual PDU</td>
</tr>
<tr>
<td>1</td>
<td>AF505A</td>
<td>Factory integrated</td>
</tr>
<tr>
<td>1 per HANA Rack</td>
<td>A2E64A</td>
<td>HP 2TB SAP HANA EVA1 Storage Block</td>
</tr>
<tr>
<td>1 per HANA Rack</td>
<td>A2E64A</td>
<td>Factory integrated</td>
</tr>
<tr>
<td>1 per HANA Rack</td>
<td>HA454A1-022</td>
<td>HP Fctry Exp Dsk Array San Sw Pkg 4 SVC</td>
</tr>
<tr>
<td>4 per HANA Rack</td>
<td>A2E65A</td>
<td>HP 2TB SAP HANA EVA2 Storage Block</td>
</tr>
<tr>
<td>4 per HANA Rack</td>
<td>A2E65A</td>
<td>Factory integrated</td>
</tr>
<tr>
<td>8 per HANA Rack</td>
<td>AJ839A</td>
<td>HP 50m Multi-mode OM3 LC/LC FC Cable</td>
</tr>
<tr>
<td>8 per HANA Rack</td>
<td>AJ716B</td>
<td>HP 8Gb Short Wave B-Series SFP+ 1 Pack</td>
</tr>
<tr>
<td>3</td>
<td>HE806A1</td>
<td>HP Bus Crit Server Implem Assist Svc</td>
</tr>
</tbody>
</table>
### Summary

With database sizes growing continually and substantially, many organizations are considering efficient and cost-effective disaster recovery solutions over long distances, designed for their SAP HANA database environment, suitable for their requirement of data availability and appreciative of a small RTO in the case of any disaster.

It is however, possible that a disaster recovery implementation can create challenges in different areas, for example, in storage utilization, SAP HANA database performance, management and availability. HP addresses these challenges through a robust, easy-to-use solution that combines the following technologies:

- **HP AppSystems for SAP HANA Scale-Out**
- **SAP HANA System Replication over IP network**

HP conducted a series of tests\(^\text{14}\) to demonstrate that this DR solution can ensure SAP HANA database is available at the alternate remote secondary site during typical disaster scenarios by supporting asynchronous system replication. Also, this solution is ideal for organizations that cannot afford to lose uptime by having to recover the SAP HANA database in the event of any disaster.

In addition, HP AppSystems for SAP HANA Scale-Out also supports HA between the NFS cluster nodes and thus, eliminates the requirement of site failover due to a single component failure.

HP AppSystems for SAP HANA Scale-Out along with SAP HANA is designed to satisfy tradeoffs between demanding high availability and disaster recovery requirements, while also considering cost and complexity. This solution is recommended for addressing SAP HANA database outage reduction due to planned maintenance, faults and disasters.

This solution is also helpful for customers to perform a technology refresh at local site as well as remote sites from their current HP AppSystems for SAP HANA Scale-Out setup.

### Implementing a proof-of-concept

As a matter of best practice for all deployments, HP recommends implementing a proof-of-concept using a test environment that matches as closely as possible the planned production environment. In this way, appropriate performance and scalability characterizations can be obtained. For help with implementing a proof-of-concept, contact an HP Services representative (hp.com/large/contact/enterprise/index.html) or your HP partner.

---

\(^\text{13}\) The customer should contact their HP TS/ES representative to get SOW for the required implementation services.

\(^\text{14}\) Testing performed in the HP lab between two adjacent HP AppSystems for SAP HANA Scale-Out Base Racks without any network simulator.
## Glossary

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DR</td>
<td>Disaster Recovery</td>
</tr>
<tr>
<td>DT</td>
<td>Disaster Tolerant</td>
</tr>
<tr>
<td>HA</td>
<td>High Availability</td>
</tr>
<tr>
<td>Blade</td>
<td>HP ProLiant BL680c G7 Server Blade</td>
</tr>
<tr>
<td>RPO</td>
<td>Recovery Point Objective</td>
</tr>
<tr>
<td>RTO</td>
<td>Recovery Time Objective</td>
</tr>
<tr>
<td>CV EVA</td>
<td>P6000 Command View</td>
</tr>
<tr>
<td>Disaster</td>
<td>The failure of an entire compute site or data center</td>
</tr>
<tr>
<td>Failover</td>
<td>Switching to an alternate standby system/site in the event of a disaster at the primary system/site</td>
</tr>
<tr>
<td>Failback</td>
<td>The process of restoring a site/system to its original state</td>
</tr>
</tbody>
</table>
For more information

HP & SAP Solutions                hp.com/go/sap
HP Solutions for SAP HANA         hp.com/go/hana
HP Storage                        hp.com/go/storage
HP Single point of connectivity knowledge (SPOCK) hp.com/storage/SPOCK
HP StoreAll 9300 Gateway Storage general information hp.com/go/storeall

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