BUSINESS CONTINUITY AND DISASTER RECOVERY WITH EMC XTREMIO FOR SAP HANA TAILORED DATA CENTER INTEGRATION

Enabled by EMC RecoverPoint asynchronous snap-based replication

EMC Solutions

Abstract
This solution guide provides a comprehensive set of EMC recommendations and procedures for data protection and availability using SAP HANA with EMC® XtremIO® storage in a Tailored Data Center Integration (TDI) deployment enabled by EMC RecoverPoint®.

February 2016
# Contents

## Chapter 1 Executive Summary

Executive summary ................................................................. 6
- Business case ........................................................................ 6
- Solution overview ................................................................. 6
- Introduction ........................................................................ 6
- Document purpose ............................................................... 7
- Scope .................................................................................. 7
- Audience ............................................................................ 7
- Terminology ....................................................................... 7

We value your feedback! .......................................................... 9

## Chapter 2 Solution Overview

Solution overview .................................................................... 11
- XtremIO .............................................................................. 11
- RecoverPoint ...................................................................... 11
- XtremIO replication with RecoverPoint .................................. 12
- SAP HANA .......................................................................... 14

Disaster recovery in SAP HANA .............................................. 14
- Backups ............................................................................ 15
- SAP HANA system replication ............................................ 15
- Storage-based replication .................................................... 15
- SAP HANA storage-based replication with XtremIO and RecoverPoint .................................................. 16

## Chapter 3 RecoverPoint Sizing Best Practices for XtremIO

RecoverPoint sizing best practices ........................................... 18
- Features and Limitations ...................................................... 18
- XtremIO replication scale considerations .............................. 18
- Sustained replication throughput .......................................... 19
- Distributed consistency group performance ........................ 19
- Multi-copy performance ..................................................... 20
- Recovery Point Objective (RPO) .......................................... 20
- Recovery Time Objective (RTO) .......................................... 21
- Maximum number of snapshots ........................................ 21
- Protection window ............................................................ 21
- Journal performance and sizing ......................................... 22
Chapter 4  Best Practices for SAP HANA Storage Replications  

Introduction ............................................................................................................. 25
General Requirements .......................................................................................... 25
Software requirements ........................................................................................ 26
SAP HANA considerations .................................................................................... 26
Test environment .................................................................................................. 27
Maintaining the SAP HANA global.ini file at the remote site ................................. 27
Use case 1: Configuring a remote copy for DR protection using snap-based replication (asynchronous mode) ........................................................................................ 29
Process overview ................................................................................................. 29
Detailed steps ..................................................................................................... 30
Use case 2: Creating a restartable and writeable local copy for rapid database recovery ............................................................................................................. 36
Process overview ................................................................................................. 36
Detailed steps ..................................................................................................... 36
Use case 3: Failing over the SAP HANA persistent volumes to the remote site when the local site is unavailable (planned or unplanned outages) .............................................. 39
Process overview ................................................................................................. 39
Detailed steps ..................................................................................................... 40
Use case 4: Failing over the SAP HANA persistent volumes back to the local site...... 44
Process overview ................................................................................................. 44
Detailed steps ..................................................................................................... 44
Use case 5: Using recover production technology for database recovery from remote copy .............................................................................................................. 48
Process overview ................................................................................................. 48
Detailed steps ..................................................................................................... 48
Use case 6: Creating local or remote restartable writeable copies with bookmark technology (using SAP HANA storage snapshot) ............................................. 52
Process overview ................................................................................................. 53
Detailed steps ..................................................................................................... 53

Chapter 5  Conclusion  

Conclusion ............................................................................................................... 57
Summary .............................................................................................................. 57

Chapter 6  References  

References ............................................................................................................. 59
EMC documentation ............................................................................................ 59
SAP documentation ............................................................................................. 59
This chapter presents the following topics:

Executive summary .......................................................... 6
Introduction ............................................................................ 6
We value your feedback! ...................................................... 9
Chapter 1: Executive Summary

Executive summary

Business case
Businesses deploy SAP databases and integrated applications in many mission critical functions, including manufacturing, financial accounting, inventory management, sales, and marketing. These and other functions are the lifeblood of a business, and interruptions or loss of data can be catastrophic. Ensuring the availability of these systems for the businesses that depend on them requires a comprehensive approach to business continuity planning and execution. SAP landscapes include many separate business-critical modules that all interact and communicate with critical cross-dependent data. Every complex business IT landscape also includes not only many SAP systems, but non-SAP systems that feed SAP, receive data from SAP, or are critical stand-alone systems. The introduction of HANA as the strategic database platform for SAP systems brings new challenges to these landscapes. Recovering these many interrelated systems, or periodically testing the effectiveness of recovery for business and audit requirements, is a unique requirement of federated systems such as SAP. True cross-database, cross-business system recovery is required for a single point-in-time, in contrast to recovering many individual databases separately.

Solution overview
EMC® XtremIO® is a highly-acclaimed all-flash array featuring scale-out architecture and high performance. XtremIO enables high and consistent performance, while being cost-effective because of its inherent data reduction technologies.

EMC RecoverPoint® is a popular replication solution and has thousands of worldwide deployments with both enterprise and commercial customers. RecoverPoint is a universal replication solution that supports all EMC block storage natively, including non-EMC storage through EMC VPLEX® storage virtualization.

This document is a comprehensive guide to using an XtremIO array with RecoverPoint protection for SAP HANA. This solution uses world-class RecoverPoint protection for SAP HANA environments that are deployed on XtremIO.

Introduction

When you use the SAP HANA in-memory database in tailored data center integration (TDI) deployments, you must protect your critical applications and the SAP HANA database against disasters, hardware or software failures, or human errors, by maintaining a copy of the data locally and/or remotely.

While SAP HANA offers disaster recovery (DR) support with backups or HANA System Replication, HANA Storage Replication offers more benefits. These benefits enable you to seamlessly integrate SAP HANA into existing business continuity solutions using storage-based replication with better federated consistency, easier DR testing, and faster recovery times, and deliver according to RTO/RPO service levels.
Document purpose

This solution guide introduces XtremIO storage replication enabled by RecoverPoint for SAP HANA. This guide also provides a comprehensive set of best practices and procedures to ensure business continuity in a TDI deployment of SAP HANA with XtremIO storage using RecoverPoint.

Scope

This solution guide:

- Introduces the key technologies of the solution.
- Describes the design considerations for the solution.
- Provides guidelines for performing RecoverPoint asynchronous replication operations, while leveraging DR test features and point-in-time recovery capabilities.
- Describes best practices with use cases that show how the solution can be successfully implemented.
- Describes XtremIO to XtremIO replication (homogeneous) use cases.

Heterogeneous replication is supported but not described in this solution guide.

Audience

This solution guide is for customers who want to add disaster tolerance over distance for SAP HANA to new or existing SAP landscapes. This includes database and system administrators, storage administrators, and system architects who are responsible for implementing, maintaining, and protecting SAP landscapes. Readers should be familiar with SAP HANA in-memory databases and EMC software and products.

Terminology

Table 1 lists key solution-specific terminology used in this guide.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asynchronous replication</td>
<td>A replication mode that enables you to replicate data over long distances while maintaining a dependent write-consistent copy of data between the local and remote sites at all times.</td>
</tr>
<tr>
<td>Bookmark</td>
<td>A text label that is applied to name a manually-created snapshot.</td>
</tr>
<tr>
<td>Consistency group</td>
<td>Replication sets grouped to ensure write order consistency across all the replication sets primary volumes.</td>
</tr>
<tr>
<td>DIFF</td>
<td>A SCSI command that RecoverPoint uses to query XtremIO to obtain a bitmap of changes between two snapshot sets.</td>
</tr>
<tr>
<td>Failover</td>
<td>The process of moving production to one of the copies</td>
</tr>
<tr>
<td>Fan-in</td>
<td>Multi-site support with n:1 for a centralized DR site protecting multiple sources.</td>
</tr>
</tbody>
</table>
## Chapter 1: Executive Summary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan-out</td>
<td>Multi-site 1:n replication for different target devices or sites for added protection or isolated development and test operations.</td>
</tr>
<tr>
<td>Full sweep</td>
<td>An efficient initialization process, which is performed on all volumes in a consistency group, when the RecoverPoint system cannot identify which blocks are identical between the production and replica volumes. The process marks as dirty all blocks for all volumes in the consistency group.</td>
</tr>
<tr>
<td>Image access</td>
<td>Enabling access to a selected point-in-time at one of the copies.</td>
</tr>
<tr>
<td>Key performance indicator (KPI)</td>
<td>A threshold that must be achieved in a test.</td>
</tr>
<tr>
<td>RecoverPoint appliance (RPA)</td>
<td>A hardware-based appliance that runs the RecoverPoint software.</td>
</tr>
<tr>
<td>RecoverPoint cluster</td>
<td>A group of 2-8 RecoverPoint appliances configured in a cluster.</td>
</tr>
<tr>
<td>RecoverPoint system</td>
<td>One or more connected RecoverPoint clusters.</td>
</tr>
<tr>
<td>Recovery point objective (RPO)</td>
<td>The maximum time span of data loss that is acceptable in a disaster situation.</td>
</tr>
<tr>
<td>Recovery time objective (RTO)</td>
<td>The maximum time span for a secondary or standby system to become available.</td>
</tr>
<tr>
<td>SAP HANA standby host</td>
<td>A passive host within an SAP HANA system. It has all services started but does not accept SQL requests. It waits for the failure of another host and then takes over the persistency and becomes active.</td>
</tr>
<tr>
<td>SAP HANA worker host</td>
<td>A host that is active within an SAP HANA system—that is, one that accepts SQL requests.</td>
</tr>
<tr>
<td>Scale-out system</td>
<td>An SAP HANA system that consists of more than a single host.</td>
</tr>
<tr>
<td>Scale-up system</td>
<td>An SAP HANA system that consists of exactly one host.</td>
</tr>
<tr>
<td>Short init</td>
<td>An initialization process that uses marking information to re-synchronize a copy's replica volumes with their production sources.</td>
</tr>
<tr>
<td><code>&lt;sid&gt;adm</code></td>
<td>The administrator user ID of the SAP HANA database. The <code>&lt;sid&gt;</code> value represents a three-character system ID.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Snap-based replication</td>
<td>An alternative asynchronous replication mode that uses array snap capabilities to create a point-in-time consistent snapshot of a consistency group’s production volumes; it uses the snapshot to synchronize the production volumes with the copy volumes.</td>
</tr>
<tr>
<td>Snapshot</td>
<td>A point-in-time record that includes only the data that has changed from the previous snapshot. The first snapshot has all the changes between the moment of snapshot creation and the current state.</td>
</tr>
<tr>
<td>Splitter</td>
<td>A mechanism used to intercept writes so that they are sent to their normally-designated storage volumes and the RPA simultaneously.</td>
</tr>
<tr>
<td>Synchronous replication</td>
<td>A replication mode in which the host begins a write to the array at local site and the data must be successfully stored in both local and remote sites before an acknowledgement is sent back to the host. There is always only one outstanding IO per LUN in a synchronous replication.</td>
</tr>
<tr>
<td>Tailored Data Center Integration (TDI)</td>
<td>An SAP hardware-partner program for certification of hardware components. The SAP HANA Hardware Directory lists certified components.</td>
</tr>
</tbody>
</table>

**We value your feedback!**

EMC and the authors of this document welcome your feedback on the solution and the solution documentation. Contact [EMC.Solution.Feedback@emc.com](mailto:EMC.Solution.Feedback@emc.com) with your comments.

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This chapter presents the following topics:

**Solution overview** ..................................................................................................... 11

**Disaster recovery in SAP HANA** ........................................................................... 14
Solution overview

This section describes the key components and features used for SAP HANA business continuity and DR with XtremIO, enabled by RecoverPoint. Figure 1 shows the XtremIO homogenous solution using RecoverPoint for asynchronous snap-based replication.

XtremIO

XtremIO is the leading all-flash array featuring scale-out architecture and ultra-high performance. XtremIO enables high and consistent performance while being cost-effective because of its data reduction technologies.

SAP certified XtremIO as an enterprise storage array that meets all SAP HANA performance and functional requirements. This certification enables customers to use XtremIO for SAP HANA TDI deployments in a fully supported environment using their existing data center infrastructures.

Note: For more information about XtremIO, refer to the Storage Configuration Best Practices for SAP HANA Tailored Data Center Integration on EMC XtremIO Storage Configuration Guide.

RecoverPoint

RecoverPoint is an enterprise-scale solution designed to protect application data on SAN-attached servers and storage arrays. RecoverPoint runs on a dedicated appliance and combines industry-leading continuous data protection technology with a bandwidth-efficient, no-data-loss replication technology. RecoverPoint can protect data both locally and remotely for any point-in-time recovery.

RecoverPoint dramatically improves application protection and recovery times compared to traditional host and array snapshots. RecoverPoint also includes bookmark capabilities, enabling you to roll back changes to support SAP database changes, corruption rollback, and so on.
For remote replication, the systems use existing IP connections or Fibre Channel (FC) infrastructure to replicate data asynchronously or synchronously.

If a disaster occurs at the primary site, RecoverPoint enables access to the image at the replica site to continue working and also enables recovery of the production copy.

RecoverPoint is a mature and established technology, offering enterprise-scale replication and business continuity services. The native XtremIO snap-based solution provides a fully-featured product to cover all DR needs, including:

- Asynchronous snap-based replication with definable RPO that can be as low as 60 seconds.
- Bi-directional replication on different consistency groups to leverage a single deployment to protect multiple sites
- Local replication, remote replication, local and remote replication combined
- Multi-site support for fan-in or fan-out
- Reduced physical capacity requirements due to XtremIO data reduction

This solution supports all required business continuity services and practices, including:

- Failover to the DR site, whenever needed
- Failing back from the DR site to the production site
- Restoring data from the DR site without failing back
- Perform DR testing at any time, without impacting replication. This ensures that your DR plan will work when you need it.
- Generate bookmarks to annotate an important point-in-time, such as failure consistent or application aware point-in-time copies.

**Snap-based replication**

Snap-based replication is a new asynchronous replication method used in RecoverPoint version 4.1 SP2 with XtremIO 4.0. Snap-based replication uses array-based snaps and transfers the difference between these to the target. This differs from traditional asynchronous RecoverPoint replication where writes are intercepted by a write splitter before being sent to the target.

Snap-based replication is available for XtremIO when it is at the production and/or target copies. In this guide, we will elaborate on homogeneous snap-based replication for XtremIO volumes in SAP HANA deployments. While there are common concepts, the implementation of snap-based replication for EMC VNX® and for XtremIO is very different.

**Note:** For more information about snap-based replication for VNX, refer to the *EMC RecoverPoint 4.1 Administrator’s Guide* and the *EMC RecoverPoint Deploying VNX/VNXe/CLARiiON Technical Notes*.

With XtremIO at the production site, there is no write splitter. This differs from asynchronous replication of EMC VMAX®, VNX, and VPLEX that use a write splitter.
integrated into the array operating environment. With XtremIO at the target site, RecoverPoint is replicating XtremIO snapshots. Moreover, the target volume is a reference to an XtremIO-based snapshot. In contrast to that, when non-XtremIO arrays are at the target site, RecoverPoint writes to journal volumes and the data is replicated to the target volumes by the target RPAs.

Asynchronous replication without snap-based replication means near-zero RPO with any point-in-time capability. In snap-based asynchronous replication for XtremIO, the number of the point-in-time snapshots is dictated by the maximum XtremIO snapshots that can be created by RecoverPoint. You can achieve a minimum of 60 seconds RPO in snap-based replication.

RecoverPoint replication of XtremIO volumes, using snap-based replication, fully supports heterogeneous and homogenous replication. This replication can be local and/or remote and enables the use of RecoverPoint’s multisite capabilities.

With heterogeneous replication, you can replicate from XtremIO to non-XtremIO, and vice versa. This solution guide focuses on homogeneous XtremIO to XtremIO replications.

As of RecoverPoint release 4.1SP2, two remote copies are supported per consistency group (CG) with XtremIO and with a maximum of three RPA clusters.

Snap-based replication use cases
You can use snap-based replication for write-intensive host environments, such as the SAP HANA workload, because RecoverPoint replicates deltas between array-based snapshots without intercepting the writes in real-time as they are sent to the storage array. When you have limited available bandwidth, snap-based replication in periodic mode can provide wide area network (WAN) savings because of write folding.

This snap-based asynchronous replication solution is suitable for environments where zero RPO is not required.

Replication modes
With XtremIO snap-based replication at the production site, you can configure two snap-based replication modes:

- **Continuous**—In continuous replication, each snap replication to the target site starts as soon as possible after the previous snap DIFF finishes replicating. Continuous replication provides the best RPO in snap-based replication because the delay between the replication of the first DIFF and the second DIFF is minimal. Use RPO in continuous mode for a minimum of 60 seconds. The effective RPO depends on variables such as the number of changes to be transferred, available WAN bandwidth, RPA utilization, and target side performance. The protection window is determined by the snapshot pruning policy and the maximum number of snaps specified.

- **Periodic**—Periodic replication is similar to continuous snap-based replication, but adds a user-configurable time interval between the transfers. That interval can range from one minute to one day and is counted from the time the snap transfer began. If the interval is reached while there is active replication (with a
replicating snap replication state) then the next snap replication will begin after the current replication is completed.

**SAP HANA**

SAP HANA is an in-memory database. The data is stored in the RAM of one or multiple SAP HANA worker hosts, and database operations are performed in the main memory of the host. This feature differentiates SAP HANA from other traditional databases, where all data resides on disk and only the current working set is cached in RAM.

SAP HANA uses persistent disk storage to provide a fallback in the event of a failure, ensuring that the SAP HANA database can always be restored to its most recent committed state. The in-memory state of the database is persisted every five minutes to the disk using the savepoints method, and all transactions since the last savepoint are captured on disk in redo logs.

**Scale-up compared with scale-out**

As an SAP-certified enterprise storage array for SAP HANA, XtremIO supports both single-host (scale-up) and multi-host (scale-out) SAP HANA systems in TDI deployments.

In single-host environments, the whole database must fit into the RAM of a single server. Single-host environments are preferred for online transaction processing (OLTP) type workloads, such as SAP Business Suite on SAP HANA.

In multi-host environments, the database is distributed across the RAM of multiple servers. Multi-host environments use worker and standby hosts. A worker host is an active component that accepts and processes database requests, while a standby host is a passive component that has all database services running, but no data exists in RAM. The standby host waits for a worker host to fail so that it can take over its role, a process known as host auto-failover.

Because the in-memory capacity requirements in these deployments can be high, scale-out SAP HANA clusters are perfectly suited for online analytical processing (OLAP) type workloads with very large data sets, such as SAP Business Warehouse (BW) on SAP HANA. You can extend a multi-host installation by adding worker hosts to the system.

**Disaster recovery in SAP HANA**

When using the SAP HANA in-memory database in TDI deployments with XtremIO, most customers will want to maintain a local or remote copy of the data for DR protection of their mission-critical applications and SAP HANA in-memory database.

SAP HANA provides three options for DR support:

- Backups
- SAP HANA system replication
- Storage-based replication

Each option addresses different RPOs within the required recovery time objective (RTO), where RPO denotes the point of consistency to which SAP HANA must recover,
and RTO denotes the time allowed for a recovery of the SAP HANA system to a specified point of consistency.

While SAP HANA offers DR support through backups and SAP HANA system replication, you can use SAP HANA storage-based replication to seamlessly integrate SAP HANA into existing business continuity solutions based on XtremIO replication enabled by RecoverPoint using federated DR strategies.

**Backups**

Backups protect the primary SAP HANA persistence against a storage failure. Therefore, the SAP HANA backup target should never be on the same storage array as the primary SAP HANA persistence. Backup systems can typically replicate the backup storage to a remote system to protect against a site failure.

With SAP HANA backups, the RPO can be minutes or hours, depending on the frequency at which you are performing SAP HANA backups. The RTO with backups can be several hours, because you must restore and recover an SAP HANA backup to the persistence and then read the data into memory before the database is available.

*Note:* EMC offers SAP HANA backup solutions based on EMC NetWorker® and EMC Data Domain® data protection technology. For more information about these technologies, see the following EMC white papers: *Protecting SAP HANA with EMC NetWorker* and *Protecting SAP HANA with Data Domain Boost for Databases and Applications*.

**SAP HANA system replication**

SAP HANA system replication is an application-based DR solution where a secondary standby SAP HANA system is configured as an exact copy of the active primary system. Each secondary system must consist of the same number of active SAP HANA nodes. SAP HANA system replication requires a reliable connection between the primary and secondary sites. The replication technology supports multiple replication modes: synchronous, synchronous in-memory, and asynchronous.

With SAP HANA system replication, only the database content is replicated to the secondary site.

*Note:* Beginning with SAP HANA Support Package Stack (SPS) 09, dynamic tiering is available with SAP Sybase IQ. At this time, neither SPS 09, SPS 10, nor SPS 11 supports the transfer of dynamic tiering contents using system replication.

**Storage-based replication**

Storage-based replication in SAP HANA TDI deployments provides a reliable, consistent, and convenient method to protect against a site failure. The SAP HANA primary persistence is replicated to a secondary site using storage-based replication technologies. Depending on your RTO and RPO requirements and the distance between the primary and secondary site, you can use synchronous storage-based replication (RPO=0) or asynchronous storage-based replication (RPO ≥ 0). If a disaster occurs, the RTO is typically the time it takes to start the SAP HANA database at the secondary site.
Chapter 2: Solution Overview

SAP HANA storage-based replication includes several benefits that are not provided by system replication:

- Replicates the SAP HANA database persistence to ensure that it is available at the secondary site while offloading replication processing from HANA servers to the storage arrays
- Includes applications and data outside of SAP HANA with the consistency technology of the storage arrays. This creates a consistent point-in-time image of the overall business applications at the secondary site, enabling a federated DR strategy.
- Integrates replication of components such as the OS boot volumes and the SAP HANA shared file system (which includes the binaries and configuration files) into a storage-based replication strategy.

This solution guide describes several use cases for SAP HANA local and remote storage-based replication on XtremIO storage arrays enabled by RecoverPoint.

Note: The SAP HANA Administration Guide provides more details about the different DR solutions and their advantages and disadvantages.

SAP HANA storage-based replication with XtremIO and RecoverPoint

The demand for database protection and availability increases as data grows in size and as databases become more interconnected. In the event of a disaster, whether a natural disaster or one caused by human error or hardware or software failure, an organization is measured by its ability to resume operations quickly, seamlessly, and with the minimum amount of data loss. A valid backup and restartable snapshot image of the entire information infrastructure helps achieve RPO, RTO, and service-level agreement goals.

XtremIO with RecoverPoint ensures that the persistent devices of the SAP HANA database are replicated to the remote site, ensuring the existence of a consistent remote restartable copy of the SAP HANA database. A local copy can also be included for local and rapid protection. You can use RecoverPoint bookmarks to annotate important point-in-time references. You can enhance these bookmarks to be application aware by including a SAP HANA internal database snapshot.

With RecoverPoint with XtremIO, you can create single or multiple snapshots of the SAP HANA database persistence, together with its external data and application files, all belonging to the same consistency group. Replicating the SAP HANA persistence in this way with RecoverPoint and XtremIO creates a point of consistency across business applications. Failover to the DR site requires only a series of application restart operations that reduce overall complexity and downtime.
Chapter 3  RecoverPoint Sizing Best Practices for XtremIO

This chapter presents the following topic:

RecoverPoint sizing best practices
RecoverPoint sizing best practices

The following sections provide best practices for using RecoverPoint with XtremIO.

RecoverPoint with XtremIO has the following features:

- Image access to the latest image and to any point-in-time image is instantaneous. No rolling forward or backward of the journal is required.
- A RecoverPoint consistency group containing an XtremIO volume and automatically creates the corresponding consistency group on the XtremIO array.
- Automatic integrity check supported on XtremIO copies.
- The journal volume of an XtremIO array does not need to be larger than 10 GB for non-distributed consistency groups or 40 GB for distributed consistency groups. The journal contains only metadata and pointers to snapshots. Snapshots are written directly to the XtremIO array and not to the journal.

RecoverPoint with XtremIO currently has the following limitations:

- RecoverPoint supports only physical RPAs.
- RecoverPoint supports XtremIO volumes only if configured with 512-byte blocks.
- RecoverPoint with XtremIO arrays supports a maximum of three copies (production and two copies).
- In periodic snapshot replication mode, the minimum recovery point objective (RPO, the time between snapshots) is one minute. In continuous snapshot replication mode, the recovery point objective may be less.
- RecoverPoint replicates XtremIO volumes in asynchronous snap-based replication mode only.
- Volume resizing must currently be done manually, by removing volumes from RecoverPoint, resizing volumes on the array, and adding volumes on RecoverPoint. This will cause a full sweep.
- Only IPv4 addressing is supported between RecoverPoint and XtremIO.

Table 2 describes XtremIO replication scale limitations.

<table>
<thead>
<tr>
<th>Scale limitation</th>
<th>Maximum limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volumes in CG</td>
<td>256</td>
</tr>
<tr>
<td>Replicated CGs per XtremIO array</td>
<td>128</td>
</tr>
<tr>
<td>Volumes and snapshots per XtremIO management server (XMS)</td>
<td>8,000</td>
</tr>
</tbody>
</table>
### Scale limitation

<table>
<thead>
<tr>
<th>Replicated volumes for:</th>
<th>Maximum limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Single XtremIO array connected to one or more RPA clusters</td>
<td>500</td>
</tr>
<tr>
<td>• Single RPA cluster connected to one or more XtremIO arrays</td>
<td></td>
</tr>
<tr>
<td>RecoverPoint clusters supported by an XtremIO array</td>
<td>4</td>
</tr>
<tr>
<td>XtremIO arrays replicated by a RecoverPoint cluster</td>
<td>4</td>
</tr>
<tr>
<td>Snapshots per CG on XtremIO array for a copy</td>
<td>500</td>
</tr>
</tbody>
</table>

Each RPA has a replication throughput limitation. This limitation is for the average sustainable bandwidth that can be replicated indefinitely by the RPA. Bandwidth reduction optimizations, such as compression and deduplication, can be enabled on the RPAs to increase the limit; however, these optimizations are useful only if the application has generated compressible or deduplicated I/Os.

**Note:** In our tests, the RPA replication throughput for HANA performed best with default settings of low compression and deduplication unchecked. The RPA compression ratio observed was between 1.5:1 and 2.0:1 using a distributed consistency group with 2 RPAs.

### Snapshot operation time

In a cycle of periodic snap-based replication, a portion of the time is consumed by snapshot operations, such as create, detach, and delete. In a one-minute cycle, snapshot operations may take as much as 20 percent of the time. The remaining time is used for the data replication. The sustained replication rate equals the actual replication rate multiplied by the percent of the time that actual data replication takes:

\[
\text{Sustained replication} = \text{actual replication rate} \times 80\%
\]

For example, when a snapshot is replicated, if the actual replication rate is 100 MB/s, the sustained replication rate would be 80 MB/s:

\[
80 \text{ MB/s} = 100 \text{ MB/s} \times 80\%
\]

Table 3 describes the sustained replication throughput per RPA for a pure random I/O pattern.

**Table 3.  Sustained remote replication throughput per RPA (MB/s)**

<table>
<thead>
<tr>
<th>Configuration</th>
<th>IP Without compression</th>
<th>IP With compression</th>
<th>Over FC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between XtremIO Arrays</td>
<td>80</td>
<td>240</td>
<td>300</td>
</tr>
</tbody>
</table>

In snap-based replication, you can use a distributed consistency group (DCG) with two to four RPAs to replicate a single CG that has performance requirements that are greater than the sustained replication throughput of a single RPA.
In continuous replication, there is an option to split a CG into several CGs that run on different RPAs, and to put them in a group set with parallel bookmarks enabled. For XtremIO arrays, however, group sets with parallel bookmarks are not supported.

In DCGs, the DIFF for the production volumes is divided into 1 MB slices that are distributed evenly between the RPAs that are replicating this group. This method balances the replication load over all RPAs of the DCG.

The maximum sustained replication performance of a DCG is the sustained replication performance of a single RPA multiplied by the number of RPAs in the DCG.

There is a limit of 8 DCGs in a RecoverPoint system. Switching from a single CG to a DCG will cause journal loss, but not a full sweep that marks as dirty all blocks for all volumes in the CG.

Multi-copy performance

When replicating from an XtremIO array, a snapshot is created for each link independently. By definition, there is a link from the production CG to each copy. Links may differ in any of the following ways:

- Snapshot mode—Continuous or Periodic
- Snapshot interval
- Replication performance

Creating a snapshot per link prevents a dependency between links where slow links can increase the lag of a fast link.

When sizing, consider the following:

- Application throughput to be replicated per CG must be multiplied by the number of links over which that CG is being replicated.
- Replication overhead increases in proportion to the number of links, since a DIFF operation and the DIFF data must be read from the XtremIO array once for each link.

Recovery Point Objective (RPO)

In RecoverPoint, RPO refers to the required lag. Lag represents the amount of data that has not yet been transferred to the target copy and is therefore considered unprotected. In the case of a disaster at the production site, the actual lag is the data that could be lost. Lag is measured in data, time, or transactions, and it is a system state, as opposed to a user setting.

In snap-based replication, the desired RPO is the required lag to transfer the data to the target copy. The actual lag time depends on the snapshot interval and the amount of time it takes to replicate a snapshot to the target copy. The desired RPO is indirectly configured by the snapshot period and should be longer than the actual lag time.

An SAP HANA environment can experience heavy write loads. In this case, if the amount of data changes written during a snapshot operation takes longer than the window between two snapshots (that is, if the periodic replication is set to three minutes and the snapshots takes more than three minutes to replicate), the system
might experience a longer lag. A new snapshot is not taken until the previous one finishes.

Figure 2 shows this lag under heavy load conditions. The snapshots were first taken every three minutes, but as the environment experienced heavy write load on the HANA system, the snapshot period and RPO increased, in some cases taking over 21 minutes to complete. As the workload dissipated again, the snapshot interval returned to the configured three-minute window.

<table>
<thead>
<tr>
<th>Point in Time</th>
<th>Size</th>
<th>Synchronization</th>
<th>Consistency</th>
<th>Consolidation Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/18/2015 12:32:39 PM</td>
<td>9.2 MB</td>
<td>Synchronization</td>
<td>Crash-Consistent</td>
<td>Always Consolidate</td>
</tr>
<tr>
<td>11/18/2015 12:29:39 PM</td>
<td>22.6 MB</td>
<td>Synchronization</td>
<td>Crash-Consistent</td>
<td>Always Consolidate</td>
</tr>
<tr>
<td>11/18/2015 12:26:39 PM</td>
<td>35.4 MB</td>
<td>Synchronization</td>
<td>Crash-Consistent</td>
<td>Always Consolidate</td>
</tr>
<tr>
<td>11/18/2015 12:21:00 PM</td>
<td>76.6 GB</td>
<td>Synchronization</td>
<td>Crash-Consistent</td>
<td>Always Consolidate</td>
</tr>
<tr>
<td>11/18/2015 11:59:35 AM</td>
<td>337 GB</td>
<td>Synchronization</td>
<td>Crash-Consistent</td>
<td>Always Consolidate</td>
</tr>
<tr>
<td>11/20/2015 14:42:34 AM</td>
<td>255 GB</td>
<td>Synchronization</td>
<td>Crash-Consistent</td>
<td>Always Consolidate</td>
</tr>
<tr>
<td>11/18/2015 11:32:49 AM</td>
<td>204 GB</td>
<td>Synchronization</td>
<td>Crash-Consistent</td>
<td>Always Consolidate</td>
</tr>
<tr>
<td>11/18/2015 11:27:24 AM</td>
<td>74.4 GB</td>
<td>Synchronization</td>
<td>Crash-Consistent</td>
<td>Always Consolidate</td>
</tr>
<tr>
<td>11/18/2015 11:24:24 AM</td>
<td>4.23 GB</td>
<td>Synchronization</td>
<td>Crash-Consistent</td>
<td>Always Consolidate</td>
</tr>
<tr>
<td>11/18/2015 11:21:24 AM</td>
<td>29.7 GB</td>
<td>Synchronization</td>
<td>Crash-Consistent</td>
<td>Always Consolidate</td>
</tr>
<tr>
<td>11/18/2015 11:18:23 AM</td>
<td>27.4 MB</td>
<td>Synchronization</td>
<td>Crash-Consistent</td>
<td>Always Consolidate</td>
</tr>
</tbody>
</table>

**Figure 2.** Snapshot period versus lag, and RPO from the copy journal

**Recovery Time Objective (RTO)**

RTO is a required limit on the time it takes to access an image at the copy, particularly the latest image. When the replication target is an XtremIO array, this operation is almost immediate, since it requires only exposing the snapshot to the host for the requested time.

**Maximum number of snapshots**

You can configure the maximum snapshots that RecoverPoint will use. With RecoverPoint release 4.1 SP2, you can configure up to 500 snapshots per CG at a target copy (default = 128). The maximum number of snapshots correlates to the maximum points in time that a certain target copy can have.

**Note:** The higher the number of snapshots that you configure RecoverPoint to create, the lower the number of native XtremIO snapshots (max 512) that can be created for the same volumes on the target copy.

**Protection window**

The protection window indicates the earliest time from which you can roll back a copy. This protection window is the amount of time between the first and last snapshot that can be recovered and can be defined.
In snap-based replication to an XtremIO array, the protection window is influenced by the maximum number of snapshots defined, the defined required protection window, and the snapshot pruning policy.

An automatic snapshot consolidation process deletes snapshots to enable the protection window to grow until it reaches the requirement, even when the number of snapshots is limited and snapshots are created frequently.

Table 4 shows the snapshot pruning policy, which cannot be changed.

**Table 4. Snapshot consolidation distribution**

<table>
<thead>
<tr>
<th>Age of snapshots</th>
<th>Percentage of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2 hours</td>
<td>40%</td>
</tr>
<tr>
<td>2-24 hours</td>
<td>30%</td>
</tr>
<tr>
<td>1-2 days</td>
<td>20%</td>
</tr>
<tr>
<td>2-4 days</td>
<td>5%</td>
</tr>
<tr>
<td>4-30 days</td>
<td>5%</td>
</tr>
</tbody>
</table>

The consolidation algorithm gives preference to native XtremIO snapshots and manually created bookmarks, so that it deletes the automatic RecoverPoint generated snapshots before native XtremIO snapshots and bookmarks.

The role of the journal for a copy with an XtremIO array is different from a copy with a non-XtremIO array.

When replicating to an XtremIO array, the entire role of the copy journal is to store metadata for the snapshots. Therefore, performance is not very important, and size does not determine the protection window. In fact, the journal can reside on a different array that does not have to be XtremIO.

The journal need not be more than 10 GB for non-distributed consistency groups and 40 GB for distributed consistency groups, because the XtremIO journal contains only pointers to snapshots and metadata.

Consider the following scenario to calculate the number of required RPAs:

- The application write change rate is \( x \text{ MB/s} \).

  **Note:** Reads can be omitted from the calculation. Either provide the application change rate or gather it from the environment using approved tools such as Business Continuity Solutions Designer (BCSD), EMC Mitrend, or RecoverPoint Basic Sizer. SAP HANA workloads may vary.

- RPAs sustained replication throughput according to Table 2 in this document is \( y \text{ MB/s} \).

Then, the number of required RPAs would be:

\[
\text{#required RPAs} = \text{RoundUp} \left( \frac{x}{y} \right) + 1
\]
The additional RPA is needed for redundancy. This will keep the data lag below the requested RPO in case of a single RPA failure.

**RecoverPoint sample calculations**

The following examples show how to calculate the required number of RPAs per site:

- **Example 1**—An SAP BW on HANA runs on a 4+1 scale-out environment. The overall average application write change (HANA writes to the disk) is 60 MB/s. How many RPAs are needed to replicate this traffic from XtremIO array to XtremIO array over IP?
  - Number of required RPAs = \( \text{RoundUp}(\frac{x}{y}) + 1 \)
  - \( x \): Average application write change rate of \( \sim 60 \text{ Mb/s} \)
  - \( y \): 240 MB/s over IP w/ compression
  - Result: 1 RPA required plus 1 for HA = 2 RPAs

- **Example 2**—A company has a scale-up SAP HANA (6 TB x 1 node) environment running SAP ERP on HANA. The average HANA writes to the disk is at 140 MB/s. The company wants a local copy and a remote copy. How many RPAs are needed to replicate over FC and also maintain a local copy?
  - Number of required RPAs = \( \text{RoundUp}(\frac{x}{y}) + 1 \)
  - \( x \): Average application change rate of 140 MB/s
  - \( y \): 300 MB/s over FC
  - Result: 1 RPA required plus 1 for HA = 2 RPAs

- **Example 3**—A company has a SAP HANA sidecar configuration (1 TB x 4 node+1) generating 400 MB/s writes average. How many RPAs are needed to replicate this traffic from XtremIO to XtremIO over IP?
  - Number of required RPAs = \( \text{RoundUp}(\frac{x}{y}) + 1 \)
  - \( x \): Average application write change rate of 400 MB/s
  - \( y \): 240 MB/s over IP w/ compression
  - Result: 2 RPAs required plus 1 for HA = 3 RPAs
Chapter 4  Best Practices for SAP HANA Storage Replications

This chapter presents the following topics:

Introduction ............................................................................................................... 25

Use case 1: Configure a remote copy for DR protection using snap-based replication (asynchronous mode) ..................................................................................... 29

Use case 2: Creating a restartable and writeable local copy for rapid database recovery ......................................................................................................... 36

Use case 3: Failing over the SAP HANA persistent volumes to the remote site when the local site is unavailable (planned or unplanned outages)................. 39

Use case 4: Failing over the SAP HANA persistent volumes back to the local site .... 44

Use case 5: Using recover production technology for database recovery from remote copy ............................................................................................................... 48

Use case 6: Creating local or remote restartable writeable copies with bookmark technology (using SAP HANA storage snapshot) .............................................. 52
Introduction

Homogenous XtremIO replication enables disaster recovery (DR) and business continuity solutions for high-performing SAP HANA environments residing on XtremIO volumes. RecoverPoint replication for XtremIO using snap-based replication can deliver RPO as low as 60 seconds with multiple point-in-time snapshots for operational recovery purposes. With this versatility, you can greatly enhance an SAP HANA environment by implementing the RecoverPoint DR and business continuity solution.

RecoverPoint replicates the SAP HANA persistent volumes to a remote site, either nearby or at a long distance. The business continuity solutions provide DR protection by using RecoverPoint in asynchronous mode.

RecoverPoint also extends the database protection to include local copies of SAP HANA persistent volumes for operational recovery. On the source site, RecoverPoint local copies can provide rapid point-in-time recovery of the database.

The use cases in this guide provide best practices for implementing SAP HANA storage-based replication on XtremIO arrays, using RecoverPoint asynchronous snap-based replication technology. The use cases show how RecoverPoint creates point-in-time copies of volumes, which can be used for DR, production recovery, and operational recovery. They also show how to implement RecoverPoint to provide a remote, restartable SAP HANA database in addition to providing local copies for rapid database recovery.

General Requirements

Your system must meet the following requirements before you establish an SAP HANA DR solution in an SAP HANA TDI scenario:

- Before configuring XtremIO and RecoverPoint to work together, the RecoverPoint system and the XtremIO system must be fully installed and running.

- A RecoverPoint license must be applied against the local and remote XtremIO arrays. A basic RecoverPoint license supports remote replication and a full license also supports local replication with and without remote replication. Refer to the *EMC RecoverPoint XtremIO Technical Notes* for further licensing information.

- An FC connection must exist between the RecoverPoint appliance and the XtremIO system in addition to an IP connection between the RecoverPoint appliances. Port 443 must be open between the RecoverPoint appliances and the XtremIO management system (XMS) and SYM on X1-Storage Controller (SC) 1 and X1-SC 2 IP addresses. Port 11111 must be open between RPAs and SYM on X1-SC1 and X1-SC2.

- Configure local and remote XtremIO arrays as described in the *Storage Configuration Best Practices for SAP HANA Tailored Datacenter Integration on EMC XtremIO Storage Configuration Guide*.

- Configure local and remote XtremIO arrays with the SAP HANA volumes that will be used as targets for the RecoverPoint operations. These volumes must be visible to the SAP HANA servers.
• To register the XtremIO storage in Unisphere for RecoverPoint, as shown in Figure 3, use the XtremIO user rp_user in the login credentials.

**Note:** The rp_user is predefined on XtremIO to handle snapshot management between RecoverPoint and XtremIO. Therefore, XtremIO administrators cannot manage the snapshot sets, snaps, and XtremIO consistency groups that RecoverPoint created and constantly manages. You must use the rp_user when connecting XtremIO to the RecoverPoint management interface.

![Figure 3. Registering XtremIO Storage](image)

**Software requirements**

We tested the use cases with the following software versions.

- SAP HANA 1.0 SPS 10
- SUSE Linux SLES11 for SAP Applications SP3
- XtremIO 4.0.2 (required minimum version)
- RecoverPoint 4.1.2.3 (required minimum version)

**SAP HANA considerations**

To reuse a consistent copy of the SAP HANA persistence in another SAP HANA installation, consider the following:

- SAP HANA stores hostnames within the persistence. EMC recommends using virtual hostnames with identical names in both installations. For more information, see the *SAP HANA Administration Guide*.
- If you are also copying the SAP HANA shared file system, take particular care with the configuration files. For more information, see the *SAP HANA Administration Guide*. 
These use cases do not include the replication of an SAP HANA shared file system, which includes the binaries and configuration files. Both sites must have access to the same NFS share with the SAP HANA shared file system, or SAP HANA must be installed at the DR site on a local NFS share. The SAP HANA installation at the DR site must be identical to the installation at the production site for the number of workers, standby nodes, RAM sizes, virtual hostnames, and the SAP HANA system identifier (SID).

**Test environment**

We tested the use cases described in this document in a scale-out SAP HANA deployment, with three worker nodes and one standby node on a local 2 X-Brick XtremIO array. The four RecoverPoint appliances are connected via FC to the XtremIO arrays and via IP to each other, as shown in Figure 4.

In our test environment, we configured local and remote replication, one consistency group with a remote copy, and a local copy. However, remote-only and local-only, or both remote and local replications, are fully supported.

![Figure 4. Testing environment](image)

The storage section in the SAP HANA global.ini file contains the references from the SAP HANA storage partitions to the storage LUNs. EMC uses the universally unique identifier (UUID) of the LUN to identify the correct storage volumes.

You can identify the UUIDs using either of the following two methods:

- **From the SAP HANA node**—For example, type the following command on the SAP HANA node to identify the UUID of a 512 GB data LUN:

  ```bash
  hana03:/ # multipath -ll | grep -B1 512G
  3514f0c5306c00003 dm-5 XtremIO,XtremApp
  size=512G features='0' hwhandler='0' wp=rw
  ```

  The string is the UUID of the `3514f0c5306c00003` corresponding storage LUN. Linux adds a preceding 3 to the storage UUID.
Chapter 4: Best Practices for SAP HANA Storage Replications

- **From the XtremIO management system (XMS)**—Type the `show-volumes` command to display the UUID, as shown in Figure 5.

```bash
xmcli (tech)> show-volumes
```

<table>
<thead>
<tr>
<th>Volume-Name</th>
<th>Index</th>
<th>Cluster-Name</th>
<th>Index Vol-Size</th>
<th>LB-Size</th>
<th>VSN-Space-In-Use</th>
<th>Offset</th>
<th>Created-From-Volume</th>
<th>NAA-Identifier</th>
<th>Certainty-State</th>
<th>Created-By-Application</th>
<th>Volume-Type</th>
<th>Creation-Time</th>
<th>Volume-Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>HANA_DATA_CPY_1</td>
<td>1</td>
<td>96L-600G-SN0360</td>
<td>1</td>
<td>512G</td>
<td>512</td>
<td>280K</td>
<td>xms</td>
<td>regular</td>
<td>2015-12-11 10:42:13</td>
<td>write_access</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>514f0cc593e30001</td>
<td>ok</td>
<td>xms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>514f0cc593e30001</td>
<td>ok</td>
<td>xms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 5. **UUID show volumes**

**Note:** XMS displays the UUID without the preceding 3.

Figure 6 shows an example of the SAP HANA `global.ini` file.

```bash
hana03:/hana/shared/XIO/global/hdb/custom/config # cat global.ini
```

```ini
[communication]
listeninterface = .global

[persistence]
basePath_datavolumes = /hana/data/XIO
basePath_logvolumes = /hana/log/XIO
use_mountpoints = yes

[storage]
ha_provider = hdb ha.fcClient
partition_1__ptype = s
partition_1_data__mountoptions = -o relatime,inode64
partition_1_log__mountoptions = -o relatime,inode64,nobarrier
partition_1_data__wwid = 514f0cc5306c00004
partition_1_log__wwid = 514f0cc5306c0000a
partition_2_data__wwid = 514f0cc5306c00005
partition_2_log__wwid = 514f0cc5306c0000b
partition_3_data__wwid = 514f0cc5306c00006
partition_3_log__wwid = 514f0cc5306c0000c

[trace]
ha桔client = info
```

Figure 6. **SAP HANA global.ini**

**Note:** If SAP HANA must start at the remote site with the copied volumes or on the local site with locally copied volumes, ensure that the storage section of the `global.ini` file contains the UUIDs pointing to the remote copy volumes or locally copied volumes.
Use case 1: Configuring a remote copy for DR protection using snap-based replication (asynchronous mode)

Use case 1, as shown in Figure 7, describes how to configure a remote copy for DR protection using RecoverPoint snap-based replication in asynchronous mode. The protection is established on the SAP HANA database persistent (data and log) volumes.

The local volumes in the source XtremIO are replicated to the remote volumes in the target XtremIO via RecoverPoint appliances. While the replication is active, writing to the copy volumes is not possible.

![Diagram of establishing a remote copy](image)

**Figure 7. Establishing a remote copy**

**Process overview** The following steps summarize the process of configuring a remote copy from the local site to the remote site. See Detailed steps for the complete procedure:

1. Define the source volumes for the consistency group.
2. Modify the consistency group protection policy.
3. Define the source production journal volume.
4. Define the target copy volumes for the consistency group.
5. Define the target copy journal volume.
6. Perform initial full sweep from source site to target site.
Chapter 4: Best Practices for SAP HANA Storage Replications

**Detailed steps**

To configure a remote copy from the local site to the remote site:

1. **In the Unisphere for RecoverPoint screen, click Protection, select Protect Volumes, and do the following:**
   
   **a.** In the Define Source Copy screen, as shown in Figure 8, define the consistency group name, the production name, and the RPA cluster that will manage the production.
   
   **b.** Select your production volumes from the volume list.

   ![Figure 8. Defining source copy volumes](image)

   **Note:** The RecoverPoint consistency group should contain all of the data and log volumes associated with a HANA instance

2. **Click Modify Policies to define the group policies and copy policies.**

   **Note:** You can define the policies now or skip this step and define the policies later. The policy settings are optional. The default values provide a practical configuration. We recommend accepting the default settings unless there is a specific business need to set different policies

   In the Modify Protection Policy screen, as shown in Figure 9, do the following to use distributed consistency groups:

   **a.** Select Distributed group writes across multiple RPAs
   
   **b.** Select the secondary RPA of either RPA1 or RPA2, and click OK.
   
   **c.** In the Define Source Copy screen, click Next Define the Production Journal.
Figure 9. Modifying the Protection Policy

Note: You can use a DCG with 2-4 RPAs to replicate a single CG that has performance requirements that are greater than the sustained replication throughput of a single RPA.

3. In the Define Production Journal screen, as shown in Figure 10, select the volume to use on the production site, and click Next Add a Copy.
Chapter 4: Best Practices for SAP HANA Storage Replications

Note: For XtremIO arrays, the journal need not be more than 10 GB for non-distributed consistency groups and 40 GB for distributed consistency groups, because the journals contain only pointers to snapshots and metadata.

4. In the Add Copy screen, define the copy name for the group of target volumes, as shown in Figure 11. Choose your snap replication mode either continuous or periodic and define the snap interval if periodic is selected.

Note: Periodic is the recommended snap-based replication mode for XtremIO replication. For sizing guidelines when using continuous snap-based replication mode and to ensure the desired protection window, refer to EMC Customer Support.

Select the target RPA cluster that will manage the copy volumes and the replication mode and do the following:

a. For each production volume, click the Select volume link to add a copy volume. The selected volume is the volume that the production volume will replicate to.

b. In the Select volume screen, as shown in Figure 12, select the relevant copy volume to replicate to, click Next Production volume until each production volume has a matching copy volume, and then click OK.

Note: The volume list only contains volumes of sizes that are equal to, or greater than, the specified production volume.
Chapter 4: Best Practices for SAP HANA Storage Replications

Figure 12. Selecting target copy volumes

Note: Figure 13 displays a completed volume list.

Figure 13. Viewing the production and copy volume relationship

5. Click Next Define Copy Journal to display the Define Copy Journal screen and then do the following, as shown in Figure 14:

a. Select the volume to use as the journal on the remote site.

b. Click Next Display Group Summary.
Figure 14. Defining the copy journal

6. In the **Group Summary** screen, as shown in Figure 15, do the following:
   
   a. Ensure that the consistency group diagram reflects your anticipated group configuration and that **Start replication to all copies in the group when I click “Finish”** is selected.

   **Note:** When selected, this starts a first-time initialization process to synchronize the production volumes to the copy volumes when the group is created.

   Snap-based replication includes the following new replication states:
   
   - **Snap Idle**—Represents a state where snap deltas are not being transferred
   
   - **Replicating Snap**—Represents active replication of snap deltas and includes a percentage to indicate the progress of the DIFF initialization.

   b. Click **Finish** to create the consistency group, and its copy.

   When you first create a consistency group, the system automatically starts a first-time initialization process at the copies (that is, synchronizing the copy volumes with the production volumes by sending the complete image of each production volume to each copy’s storage).
Figure 15. Viewing the Group Summary

As shown in the Manage Protection screen in Figure 16, replication has started.

Figure 16. Viewing the Manage Protection screen
Use case 2: Creating a restartable and writeable local copy for rapid database recovery

Use case 2 shows the steps to create a local copy of the production volumes within the same consistency group as the remote copy. Figure 17 shows where the production volumes on the local XtremIO system are replicated to the target copy volumes on the remote XtremIO system. A local copy of the production is also replicated simultaneously. If a failure occurs at the local site, a local copy could be used for rapid database recovery.

![Figure 17. Creating a restartable and writeable local copy](image)

**Process overview**

The following steps summarize the process of creating a local, restartable, and writeable database copy for rapid database recovery in the event of a failure of the SAP HANA database at the local site. See the **Detailed steps** for command examples:

1. Define the local copy volumes for the consistency group.
2. Define the local copy journal.
3. Review the copy summary and replication sets.
4. Perform initial full sweep within the local site.

**Detailed steps**

To create a local, restartable, and writeable database copy for rapid database recovery:

1. In the **Unisphere for RecoverPoint** screen, click **Protection**, select **Manage Protection**, click **Add Copy**, and do the following:
   a. As shown in Figure 18, enter a copy name for the group of target volumes, select the target RPA cluster, and click the **Select Volume** link.
b. For each production volume, select the relevant copy volume, click **Next Production volume** until each production volume has a matching copy volume, and click **OK**.

c. Click **Next Define Copy Journal**.

---

**Figure 18. Selecting copy volumes**

2. In the **Define Copy Journal** page, as shown in Figure 19, select the volume to use as the copy journal on the local site.

---

**Figure 19. Defining the copy journal**

3. In the **Define Copy Journal** page, click **Next Display Copy Summary** to display the **Copy Summary** screen, which is shown in Figure 20.
Figure 20. Viewing replication sets

4. Review the replication sets and do the following:
   
   a. Select **Start replication to all copy when I click “Finish.”** This starts a first-time initialization process to synchronize the production volumes to the local copy volumes when the group is created.
   
   b. Click **Finish.**

As shown in the **Manage Protection** screen in Figure 21, replication has started.

---

Figure 21. Viewing local and remote replication
Use case 3: Failing over the SAP HANA persistent volumes to the remote site when the local site is unavailable (planned or unplanned outages)

Use case 3, as shown in Figure 22, shows how to fail over the SAP HANA persistent volumes to the remote site. If a disaster occurs, use this process to enable the database persistence for the standby SAP HANA installation at the remote site. Alternatively, use this use case to temporarily fail over to the remote copy while performing DR testing or routine maintenance on the production system.

**Figure 22. Failing over SAP HANA persistent devices**

The following steps summarize the process for failing over to the remote site. See the Detailed steps for command examples:

1. Select the consistency group to failover and the non-production copy.
2. Select image to promote to the target volumes.
3. Test image and start failover to the target site.
4. Acknowledge warning messages
5. Set copy as production

**Note:** If you are failing over permanently, do the following before you begin: Gracefully shut down source-site host activities to ensure an up-to-date image of the file system. Flush all file systems that reside on the production volumes. Close all applications that are using the consistency group’s volumes at the production site and place each drive volume used by the consistency group into an offline state.
To fail over to a remote site:

1. In the Unisphere for RecoverPoint screen, click Recovery, select Test a Copy and Fail Over, and do the following:
   a. In the Select a Copy screen, as shown in Figure 23, select the consistency group to failover and also select the non-production copy that you want to failover to.
   b. Click Next Select an Image.

2. In the Select an Image screen, as shown in Figure 24, select an image that you want to failover to and click Next Start Failover.

   **Note:** You can select the latest image or select a particular point in time from the image list.
3. In the **Start Failover** screen, as shown in Figure 25, do the following to enable image access to the relevant copy volumes:

**Note:** The **Image access progress** indicator will confirm that image access is enabled. On XtremIO arrays, image access is nearly instantaneous.

a. At the copy hosts, prepare the volumes for testing and mount the copy volumes. Access the copy volumes, and test them as needed.

b. After the testing is completed, click **Finish** to disable image access and to start the failover.

c. Ensure that the **Start replication to all copies in group(s) after recovery** checkbox is:

   - **Selected**—In a planned failover scenario if you want RecoverPoint to automatically start replicating the group (or group set) when the failover is complete.
   
   - **Cleared**—If you do not want RecoverPoint to automatically start replicating the group (or group set) when the failover is complete, and you would rather start replication at a later time (for example, in an unplanned failover scenario).

**Note:** You may need to scroll down for the checkbox to be visible.

4. Click **Yes** to acknowledge the warning, as shown in in Figure 26, and continue.
5. Select **Set Copy as Production** to permanently fail over the production to the copy volumes, as shown in Figure 27.

**Note:** This option is only relevant for groups (or group sets containing groups) with more than one non-production copy.

Do the following:

a. In the **Set Production** dialog box, as shown in Figure 28, select what you want to do with any target copies of the new production and click **OK**:
   - **Configure a New Link between HANA-CPY and HANA-LCL**—Define a new link between the two copies if the source array is available and set the link policy.
   - **Disable Copy HANA-LCL**—Disable the copy.
   - **Remove Copy HANA-LCL**—Delete the copy data from the storage and the RecoverPoint settings.

The journal of the old remote copy (that is, the new production) is deleted. Replication starts from the remote copy to the old production, updating the old production data with the selected copy image.

b. Click **OK**.
Chapter 4: Best Practices for SAP HANA Storage Replications

Figure 28. Setting production links

As shown in Figure 29, the Manage Protection screen gives an overview of replication defined in the consistency group.

Figure 29. Viewing the Manage Protection and consistency group replication screen

If the failover was planned temporarily for performing routine maintenance on the production system, then select the Fail Back to Production option after the maintenance is complete and follow steps 2-4 of this use case.

Note: For the remote replication only scenario, or where you have only one copy in the consistency group, the option to set copy as production or to fail back to production is not available and the copy site is automatically set as production during the failover.
Use case 4: Failing over the SAP HANA persistent volumes back to the local site

If an outage occurs where a failover to the remote site has taken place, the remote site is set as production. After the local site is repaired and is back online again, establish replication from the remote to the local array, as shown in Figure 30 and outlined in use case 1. Use case 4 illustrates the process of failing over the SAP HANA persistent volumes back to the production site.

The following steps summarize the process for failing back to the local site. See the Detailed steps for command examples:

1. Select the consistency group to failover and the non-production copy.
2. Select image to promote to the production volumes.
3. Test image and start failover to the production site.
4. Acknowledge warning messages.
5. Set copy as production.

To fail over to the local site:

1. In the **Unisphere for RecoverPoint** screen, click **Recovery** and select **Test a Copy and Fail Over**.
   
   Do the following in the **Select a Copy** screen, as show in Figure 31:
   
   a. Select the consistency group to failover.
b. Select the non-production copy you want to failover to and click Next Select an Image.

Figure 31. Selecting a copy

2. In the Select an Image screen, as shown in Figure 32, select the image you want to failover to and click Next Start Failover.

   Note: You can select the latest image or select a particular point in time from the image list.

Figure 32. Selecting an image

3. In the Start Failover screen, as shown in Figure 33, enable image access to the relevant production volumes:

   a. Wait for image access to be enabled and the system to roll to the selected image to begin testing. The Image access progress indicator will confirm when image access is enabled. On XtremIO arrays, image access is nearly instantaneous.
b. At the copy hosts, prepare the volumes for testing and mount the copy volumes. Access the copy volumes, and test them as required.

c. When the testing is complete, click **Finish** to disable image access and start the failover.

---

**Figure 33. Failing over to a local site**

Ensure the **Start replication to all copies in group(s) after recovery** checkbox is:

- **Selected**—If you want RecoverPoint to automatically start replicating the group (or group set) when the failover is complete

- **Cleared**—If you do not want RecoverPoint to automatically start replicating the group (or group set) when the failover is complete, and would rather start replication at a later time

**Note:** You may need to scroll down for the checkbox to be visible.

4. Click **Yes** to acknowledge the warning, as shown in Figure 34, and continue.

---

**Warning**

- Transfer towards the other copies will not be restored until resuming production.
- Journal will be lost.
- All data transfer from current source will be paused.

Do you want to continue?

---

**Figure 34. Transferring copies warning**

5. Select **Set Copy as Production** to fail over to the production site, as shown in Figure 35.
Selecting Set Copy as Production

**Note:** This option is only relevant for groups (or group sets containing groups) with more than one non-production copy.

Click **Yes** to acknowledge the warning, as shown in Figure 36, and continue.

**Warning**

- All data transfer from current source will be briefly paused.
- When changing the production, a full sweep is required on all copies except for the former production.

Do you want to continue?

Transferring data warning

The **Manage Protection** screen, as shown in Figure 37, shows the direction of replication. After the failover is applied to production, the direction of replication is restored from the production to the copy and normal replication is resumed.

**Figure 37.** Viewing the Manage Protection and consistency group replication screen
Use case 5: Using recover production technology for database recovery from remote copy

Use case 5, as shown in Figure 38, uses the recover production technology in RecoverPoint for database recovery if an upgrade failure of the SAP HANA database occurs at the local site. The recover production option restores the production from the selected copy. Restoration starts from the point-of-time snapshot that you select. At the production source, data that is newer than the selected point in time will be rolled back and overwritten with data from the selected point in time.

Process overview
The following steps summarize the process of recovering production from the local site. See the Detailed steps for command examples:

1. Select a consistency group and the non-production copy to recover production from.
2. Select the image to promote to the local volumes.
3. Test the image and start recover production to the local site.
4. Acknowledge the warning messages.

Detailed steps
To recover production technology for database recovery from a remote copy:

1. In the Unisphere for RecoverPoint screen, click Recovery, select Test a Copy and Recover Production, and do the following:
Chapter 4: Best Practices for SAP HANA Storage Replications

**a.** In the *Select a Copy* screen, as shown in Figure 39, select the consistency group.

**b.** Select the non-production copy to recover production from and click **Next** Select an Image.

![Figure 39. Selecting a copy](image)

2. In the *Select an Image* screen, as shown in Figure 40, select the image you want to recover production from and click **Next Start Recovery**.

*Note:* You can select the latest image or select a particular point-in-time from the image list. To restore your production from a copy, we recommend selecting the most recent copy image that you know to be valid.

![Figure 40. Selecting an image](image)

3. In the *Start Recovery* screen, as shown in Figure 41, do the following:

**a.** RecoverPoint starts enabling image access to the copy volumes. At the copy host, prepare the copy volumes for testing. After you enable image
access, mount the copy volumes that you want to access and verify the copy.

b. After the copy is verified, click **Finish** to start the failover, disable image access, and start recovering production from the selected image.

![Figure 41. Starting recovery of a production copy to the source](image)

Ensure the **Start replication to all copies in group(s) after recovery** checkbox is:

- **Selected**—If you want RecoverPoint to automatically start replicating the group (or group set) when the failover is complete
- **Cleared**—If you do not want RecoverPoint to automatically start replicating the group (or group set) when the failover is complete, and would rather start replication at a later time

**Note:** You may need to scroll down for the checkbox to be visible.

4. Click **Yes** to acknowledge the warning, as shown in Figure 42, and continue.

![Figure 42. Acknowledging the production data and data transfer warning](image)

a. In the **Manage Protection** screen, as shown in Figure 43, notice that the direction of replication changes, and replication continues from the copy.
image to the production site, as the copy image is applied to the production site.

After the copy image is applied to production site, the direction of replication is restored from the production site to the copy and normal replication is resumed.

Figure 43. Viewing the Manage Protection screen

b. At the production hosts, test the production image, mount the production volumes, and start HANA. At the copy host, unmount the copy volumes.
Use case 6: Creating local or remote restartable writeable copies with bookmark technology (using SAP HANA storage snapshot)

A bookmark is a text label that is applied to a manually created snapshot to uniquely identify it. Bookmarks are useful to mark particular points in time, such as an event in an application, or a point in time you want to fail over to. All bookmarked snapshots are consistent and are displayed in the copy Journal.

Optionally, you can enhance a bookmark and use an SAP HANA database internal snapshot to clone a database while it is running, using the underlying storage system. With SAP HANA internal storage snapshots and RecoverPoint bookmarks, you can generate application-aware bookmarks to annotate important point-in-time references.

Use case 6 ensures a consistent point-in-time database by creating from SAP HANA a database-internal snapshot file, which is then stored in the data area. An SAP HANA storage snapshot consists of all the persisted data in the data area. For this reason, the files and directories under the mount point of the data area must all be included in the storage snapshot.

Figure 44 shows the scenario where production is running at the source site and the production data is replicated to the target site containing the SAP HANA storage snapshot file that can be used to start an SAP HANA database at a particular point in time.
Chapter 4: Best Practices for SAP HANA Storage Replications

**Process overview**

The following steps summarize the process using the SAP HANA storage snapshot for creating local or remote restartable and writeable database copy. See the Detailed steps for command examples:

1. Prepare the SAP HANA database for a storage snapshot.
2. Take a RecoverPoint bookmark image.
3. Locate the SAP HANA database storage snapshot.
4. Close the SAP HANA database storage snapshot.
5. Select the bookmark image during a failover or recover production operation.
6. Restart the HANA database or recover it to a specific SAP HANA data snapshot using SAP HANA Studio.

**Detailed steps**

To create local or remote restartable, writeable copies with bookmark technology:

1. Prepare the SAP HANA database for a storage snapshot by typing the following command from the SAP HANA **master node server01** with **<sid>adm user**: 

   ```
   server01:/usr/sap/RDF/HDB01> hdbsql -n server01 -i 01 -u system BACKUP DATA CREATE SNAPSHOT
   ```

   where:
   - **Server01** is the name of first SAP HANA node (master).
   - **RDF** is the SAP HANA SID.
   - **01** in HDB01 is the SAP HANA instance number.
   - **System** is the database user with snapshot privileges.

2. In the **Unisphere for RecoverPoint** screen, click **Protection**, and select **Manage Protection**, and do the following:
   a. Click **Create Bookmark** and enter a bookmark name.
   b. Mark the bookmark as **Application Consistent**, and click OK, as shown in Figure 45.
Chapter 4: Best Practices for SAP HANA Storage Replications

3. Type the following command to locate the SAP HANA database storage snapshot by retrieving the \textit{BACKUP ID} of the snapshot:

\begin{verbatim}
server01:/usr/sap/RDF/HDB01> hdbsql -n server01 -i 01 -u system -p <system password> "SELECT * FROM "PUBLIC"."M_BACKUP_CATALOG" WHERE STATE_NAME = 'prepared'
\end{verbatim}

The command returns the following:

<table>
<thead>
<tr>
<th>ENTRY_ID</th>
<th>ENTRY_TYPE_NAME</th>
<th>BACKUP_ID</th>
<th>SYS_START_TIME</th>
<th>UTC_START_TIME</th>
<th>SYS_END_TIME</th>
<th>UTC_END_TIME</th>
<th>STATE_NAME</th>
<th>COMMENT</th>
<th>MESSAGE</th>
<th>SYSTEM_ID</th>
</tr>
</thead>
</table>

Use the \textit{Backup ID} to close the storage snapshot.

4. Type the following command to close the SAP HANA database storage snapshot:

\begin{verbatim}
server01:/usr/sap/RDF/HDB01> hdbsql -n server01 -i 01 -u system -p <system password> "BACKUP DATA CLOSE SNAPSHOT BACKUP_ID 1436417247184 SUCCESSFUL 'HANA Storage Snap'
\end{verbatim}

5. When you are failing over or recovering production in the \textit{Select an Image} screen, as shown in Figure 46, select the bookmark image that you created previously and complete the remaining steps, as in the previous use cases.

**Figure 45. Creating a bookmark**

- Type the following command to locate the SAP HANA database storage snapshot by retrieving the \textit{BACKUP ID} of the snapshot:

  \begin{verbatim}
  server01:/usr/sap/RDF/HDB01> hdbsql -n server01 -i 01 -u system -p <system password> "SELECT * FROM "PUBLIC"."M_BACKUP_CATALOG" WHERE STATE_NAME = 'prepared'
  \end{verbatim}

  The command returns the following:

<table>
<thead>
<tr>
<th>ENTRY_ID</th>
<th>ENTRY_TYPE_NAME</th>
<th>BACKUP_ID</th>
<th>SYS_START_TIME</th>
<th>UTC_START_TIME</th>
<th>SYS_END_TIME</th>
<th>UTC_END_TIME</th>
<th>STATE_NAME</th>
<th>COMMENT</th>
<th>MESSAGE</th>
<th>SYSTEM_ID</th>
</tr>
</thead>
</table>

  Use the \textit{Backup ID} to close the storage snapshot.

- Type the following command to close the SAP HANA database storage snapshot:

  \begin{verbatim}
  server01:/usr/sap/RDF/HDB01> hdbsql -n server01 -i 01 -u system -p <system password> "BACKUP DATA CLOSE SNAPSHOT BACKUP_ID 1436417247184 SUCCESSFUL 'HANA Storage Snap'"
  \end{verbatim}

- When you are failing over or recovering production in the \textit{Select an Image} screen, as shown in Figure 46, select the bookmark image that you created previously and complete the remaining steps, as in the previous use cases.
6. Start and recover the SAP HANA database either at the OS level or by using SAP HANA Studio.

As `<sid>adm`, type the following command:

```
/usr/sap/hostctrl/exe/sapcontrol -nr <instance_number> –function StartSystem HDB
```

**Note:** An SAP HANA storage snapshot requires only the data area. If the log area is included in the storage snapshot, care must be taken with how the SAP HANA database is restarted. Any committed transactions will be replayed from the log area between the time of the SAP HANA storage snapshot and the actual storage snapshot. Optionally, in a DR scenario, you can replay the log backups.

SAP recommends using SAP HANA Studio when recovering the SAP HANA database. The backup catalog is stored in the data volume of the name server. For database operations, the backup catalog is loaded into the main memory of the name server.

To recover the database-internal snapshot of SAP HANA using SAP HANA Studio:

1. Highlight and right-click the SAP HANA SID, and select **Backup and Recovery** > **Recover System**.

2. Select **Recover the database to a specific data backup or storage snapshot**.

3. Select the SAP HANA storage snapshot from the backup catalog and select **initialize logs** to start the recovery to the consistent point-in-time snapshot. In both cases, the SAP HANA storage snapshot is used and removed after successful startup.

**Note:** The *SAP HANA Administration Guide* provides more information about SAP HANA storage snapshots and recovering the SAP HANA database.
Chapter 5: Conclusion

This chapter presents the following topic:

Conclusion ............................................................................................................ 57
Conclusion

Summary

Customers who deploy SAP landscapes, including those who use the SAP HANA database, can be assured that their mission-critical data is protected and available remotely on XtremIO with RecoverPoint, using asynchronous snap based replication.

With this XtremIO solution with RecoverPoint, you will get a fully featured, robust product to cover all DR needs. XtremIO with RecoverPoint ensures that the persistent devices of the SAP HANA database are replicated to the remote site, ensuring the existence of a consistent remote restartable copy of the SAP HANA database. A local copy can also be included for local and rapid protection. Additionally, with SAP HANA storage snapshots, you can generate application aware bookmarks to annotate important point-in-time references.

This solution provides the ability to restore data from the DR site without failing over, while enabling an operational recovery of the production HANA database to a consistent point-in-time. The solution allows you to perform DR testing at any time, without impacting replication. This provides additional reassurance that your DR plan for SAP HANA will work when you need it.
Chapter 6: References

This chapter presents the following topic:

References........................................................................................................................................................................... 59
The following documents are available on EMC Online Support (https://support.emc.com). Access to Online Support depends on your login credentials. If you do not have access to a document, contact your EMC representative:

- **EMC Host Connectivity Guide for Linux**
- **EMC XtremIO Storage Array User Guide**
- **EMC XtremIO Storage Array Hardware Installation and Upgrade Guide**
- **EMC XtremIO Storage Array Host Configuration Guide**
- **EMC RecoverPoint Installation and Deployment Guide**
- **EMC RecoverPoint Replication of XtremIO White Paper**
- **EMC RecoverPoint XtremIO Technical Notes**
- **EMC RecoverPoint Deploying VNX/VNXe/ CLARiiON Technical Notes**
- **EMC RecoverPoint 4.1 Administrator’s Guide**
- **EMC RecoverPoint 4.1 Release notes**

The following documents are available on EMC.com:

- **Storage Configuration Best Practices for SAP HANA Tailored Data Center Integration on EMC XtremIO Storage Configuration Guide**
- **EMC RecoverPoint Replication of XtremIO White Paper**
- **Protecting SAP HANA with EMC Networker White Paper**
- **Protecting SAP HANA with Data Domain Boost for Databases and Applications White Paper**

The following SAP HANA documents are available from SAP:

- **SAP HANA Administration Guide**
- **SAP HANA Server Installation and Update Guide**

**Note:** The following documentation requires an SAP user ID and password.

- **SAP HANA Storage Requirements**
- **SAP HANA Fibre Channel Storage Connector Admin Guide (available through SAP Note 1900823)**