EMC DATA PROTECTION FOR SAP HANA

EMC MirrorView, EMC SRDF, and EMC Data Domain with EMC NetWorker

- Disaster tolerance
- Disaster recovery
- Efficient backup

EMC Solutions

Abstract

Organizations deploying SAP HANA are faced with the task of protecting ever-growing volumes of rapidly changing mission-critical data. This white paper illustrates how EMC’s high availability, disaster tolerance, and backup and recovery solutions deliver the level of data persistence and protection demanded by enterprise-scale SAP HANA environments.

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Executive Summary

To harness the potential of big data and support the SAP Business Suite, SAP developed the SAP HANA consolidated in-memory database. SAP HANA is optimized for both real-time analytics and transaction processing environments. Delivering real-time agility, it enables organizations to make decisions instantly to meet rapidly changing business conditions.

Initial HANA deployments were appliance-based and focused on the Business Warehouse application and analytics. Now organizations are migrating mission-critical SAP applications including ECC to SAP HANA to run their businesses in real time. What’s more, they now have the flexibility of several approaches to deploying SAP HANA: as an appliance, through a Tailored Datacenter Integration approach, or virtualized.

Regardless of the deployment model, technical teams must ensure the platform will deliver continuous availability while protecting data and meeting recovery-time and recovery-point objectives.

All of these needs are addressed by EMC® Datacenter-Ready SAP HANA certified storage solutions based on EMC storage systems and software. These solutions provide data and availability protection for every deployment model.

Audience

This white paper is intended for SAP Basis Administrators, storage administrators, IT architects, and technical managers responsible for designing, creating, managing, and protecting mission-critical SAP applications in 24/7 landscapes.

Business case

Disasters and disruptions are more prevalent than many would expect. A recent study reported that a quarter of respondents had experienced a disaster within a five-year period, while many had experienced as many as five disasters. While we hear a lot about fires, tornados, and hurricanes, it’s important to note that power failures and IT infrastructures failures—including human error—cause four times as many disasters.

Today’s organizations must consider the possibility that a natural disaster or building emergency can cause the temporary or permanent loss of an entire datacenter. Disaster tolerance between datacenters is necessary to provide continuity of service.

The market analysts are advising businesses and organizations to consider Disaster Tolerance and Disaster Recovery capabilities when they are planning deployments of these business critical applications. In this context, they face a litany of challenges as they deploy and expand their SAP HANA environment:

Businesses are increasing their reliance on technology. Round the clock competition and the escalating demands of customers are dictating that we think of down time in terms of seconds or even “zero”, even in the case of complete datacenter outage.

While protecting customer and business data is a general requirement of running a business, regulations, such as Dodd-Frank, mandate that data be stored and protected for as long as five years or more.
As the range of supported applications has increased, so have customers’ deployment options. In addition to physical deployments, customers now have the option to deploy SAP HANA in virtualized production environments to achieve a lower cost structure while increasing deployment flexibility. These physical—as well as virtualized—SAP HANA deployments must also be considered in an IT data protection strategy.

To minimize the potential damage from outages and disasters, businesses and organizations need solutions that offer in-depth data protection with capabilities and deployment choices that can be tailored to their individual requirements and risks. As we will see in the next section, EMC provides a range of choices for data protection.

**Solution overview**

EMC takes a layered data approach to data protection as shown in figure 1.

**Figure 1. SAP HANA Data Protection Layers**

Building a Datacenter-ready SAP HANA deployment requires protection at multiple layers with the following capabilities:

- **Persistence**: booting and fallback in case of in-memory data failure.
- **High Availability (HA)**: accommodating server failure within the datacenter with redundant components, manageability, and node failover.
- **Disaster Tolerance (DT)**: protecting the SAP HANA environment from complete cluster failure within and between datacenters
- **Backup and Recovery (DR) from Disasters**: saving organizations from complete disaster with backup and DR systems

EMC meets the above data protection requirements with solutions employing the following technologies:

- **EMC MirrorView®** synchronous and asynchronous solutions are designed as block-based storage-system DT and DR solutions for mirroring local production
data across a campus or metro cluster, or to a remote/disaster recovery site for VNX-based SAP HANA deployments.

- **EMC Synchronous Remote Data Facility (SRDF)** remote replication software solutions deliver DT and DR to VMAX-based SAP HANA locally or to remote sites, with deployment flexibility and massive scalability for mission-critical business continuity.

- **EMC Data Domain® with EMC Networker®** provides overall data protection with the EMC Data Domain Data Invulnerability Architecture. The architecture supports end-to-end data verification, continuous fault detection, and self-healing mechanisms coupled with other resiliency features transparent to the application. EMC Networker is SAP-certified and fully integrated with the SAP HANA BACKINT API.

**SAP HANA Overview**

The SAP HANA (short for “High-Performance Analytic Appliance”) database is an in-memory database that combines transactional data processing, analytical data processing, and application logic processing functionality in memory. SAP HANA’s database design thus enables one to perform real-time online application processing (OLAP) analysis on an online transaction processing (OLTP) data structure. As a result, one can address today’s demand for real-time business insights by creating business applications that previously were neither feasible nor cost-effective.

Since its debut, it has become the fastest growing product in the history of SAP AG, and has been identified as the focus for innovation for SAP. Already proven enormously successful for analytics using SAP Business Warehouse applications, SAP HANA now supports SAP Business Suite, SAP’s flagship enterprise resource planning (ERP) application. This significant leap in capability drives new requirements for the protection of transactional data in mission-critical HANA systems. IT departments must plan how to protect their data and meet recovery time objectives without disrupting IT operations.

**Deploying SAP HANA**

There are three approaches to deploying SAP HANA—two hardware-based and one virtualized.

You can deploy SAP HANA on physical hardware in the datacenter as a dedicated appliance or through tailored Datacenter Integration (TDI) using existing infrastructure. You may also deploy virtualized SAP HANA on physical hardware or on cloud-based platforms.

**SAP HANA Dedicated Appliance**

An SAP-certified factory-integrated SAP HANA appliance comprises a server, storage and network components, operating system, and SAP HANA database software in either a single-node server or multi-node cluster. The appliance is delivered as a complete system, fully supported by the hardware vendors and SAP.

- Server, network, and storage are SAP-certified together with scalability chosen by the server vendor
- SAP HANA software is installed by the server vendor
• The appliance is installed and supported seamlessly by server vendor and EMC
• EMC monitors storage remotely

As shown in figure 2, the SAP HANA appliance is a dedicated environment that uses SAP HANA processes.

Figure 2. SAP HANA Appliance Model

The SAP HANA Appliances from EMC, Cisco, and VCE

EMC has partnered with Cisco and VCE to deliver appliance solutions for SAP HANA. These datacenter-ready appliances based on the Cisco USC architecture are designed for large enterprises seeking the highest levels of SAP HANA scalability and data protection.

With fast deployment and complete vendor support this approach reduces the overall time-to-value, risks, and customer support requirements.

These SAP HANA appliances combine the innovative Cisco UCS platform with EMC VNX Series unified storage. This delivers a high-performance, scalable infrastructure that can be deployed quickly and efficiently in configurations up to 16 nodes. EMC Data Domain deduplication storage systems are SAP-certified to add simple, efficient backup to any SAP-certified HANA configuration.

Tailored Datacenter Integration (TDI)

Consistent with SAP's appliance definition, SAP HANA appliances include integrated storage. You can, however, also deploy SAP HANA through the Tailored Datacenter Integration (TDI) approach. This enables you to use existing multi-site data center designs and established automation and operations processes.

TDI offers greater deployment flexibility and leverages your installed storage infrastructure by connecting SAP-certified servers to new or existing SAP-certified enterprise storage systems.
As shown in figure 3, a TDI implementation starts with a certified SAP HANA server from your preferred vendor. You then use your new or installed EMC VMAX® or EMC VNX® arrays configured to EMC recommendations and sized to support the server capacity in configurations up to 104 nodes.

In this way, you can leverage the existing skills of datacenter personnel and retain proven technologies and procedures, reusing existing hardware components and maintaining existing operational processes.

Figure 3. SAP HANA TDI Model with EMC

SAP HANA physical deployment options and customer considerations are summarized in table 1.
### Table 1. EMC SAP HANA Physical Deployment Options and Customer Considerations

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<th>APPLIANCE</th>
<th>TAILORED DATACENTER INTEGRATION</th>
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<td>EMC VMAX</td>
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<td>EMC VNX</td>
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<td><strong>Scaling</strong></td>
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<td>SAP HANA Memory (Uncompressed)</td>
<td>Up to 16TB</td>
<td>Up to 104TB</td>
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<td><strong>EMC Storage</strong></td>
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<td>VMAX 10K, 20K, 40K, 100K, 200K, 400K</td>
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<td>VNX5400, 5600, 5800, 7600, 8000</td>
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<td><strong>Persistence</strong></td>
<td>Standard</td>
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<td><strong>SAP HANA System Replication (DT)</strong></td>
<td>Standard</td>
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<td><strong>EMC Storage Replication (DT)</strong></td>
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<td><strong>EMC Backup and Recovery (Data Domain &amp; NetWorker)</strong></td>
<td>Supported and Integrated with SAP BACKINT</td>
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<td><strong>Customer Considerations</strong></td>
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<tr>
<td><strong>Scalability</strong></td>
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<td><strong>Delivery</strong></td>
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<td>Complex</td>
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<td><strong>Customer Responsibility</strong></td>
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<td>High</td>
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<tr>
<td><strong>Deployment Flexibility</strong></td>
<td>Moderate</td>
<td>High</td>
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</table>

*Customers requiring storage replication, in addition to SAP System Replication, can build this capability using the TDI process.*

**High availability at the server level is also provided through EMC and server technologies. It varies by implementation.**

### Virtualized HANA

SAP HANA database deployments have evolved rapidly from stand-alone appliances to TDI set-ups and the evolution continues. Now SAP customers can also virtualize SAP HANA to take advantage of the economics and operational agility of the virtualized environment.

EMC’s close integration with VMware® enables you to be on the leading edge of virtualized SAP HANA on VMware vCloud® Suite deployments. You can quickly and easily deploy applications in test/dev and production using virtualized SAP HANA to improve performance while lowering infrastructure and operational costs. And you can ensure the availability and protection of your data with EMC storage solutions.

Pictured in figure 4, Virtualized SAP HANA on VMware vCloud Suite solutions measurably increases business agility. You can deploy a SAP HANA instance in two hours instead of the two or three weeks required to acquire and install physical gear. You can also live migrate SAP HANA databases across VMware vsphere hosts in just minutes with zero downtime. This eliminates planned maintenance periods.
In the case of a server outage, VMware vSphere High Availability (HA) automatically restarts SAP HANA VMs on other hosts in the cluster and automatically fails over to a virtual HANA backup appliance. Research in 2014 by Taneja Group Research and EMC IT showed 99.9 percent uptime and zero data loss through this approach. These features supplement the already robust high availability capabilities of the server and storage platform for appliances and TDI.

**Figure 4. Virtualized HANA**

EMC IT has been the leader in the adoption of virtualized SAP HANA with the industry's first production deployment. Running SAP Business Planning and Consolidation software, EMC IT has substantially enhanced productivity with a 400% improvement in Cost Center Retrieval execution and a reduction in data load times from 40 minutes to 1.

**Data Protection**

Having reviewed SAP HANA deployment options, it is time to take a deeper dive into the SAP and EMC approach to SAP HANA data protection—available for both physical and virtualized implementations. As noted above, EMC defines data protection within the context of persistence, high availability, disaster tolerance, and disaster recovery.

EMC measures the success of data protection solutions with the industry-standard Recovery Point Objective (RPO) and Recovery Time Objective (RTO) metrics.

- **RPO** defines the amount of acceptable data loss in the event of a disaster. The business requirement for RPO is typically expressed as a measure of time.

- **RTO** is defined as the amount of time required to bring the business application back online after a disaster occurs.

**Persistence**

Unlike a typical database protection model, SAP HANA requires persistence to back up its in-memory database in case of power failure or data corruption. The persistence enables the database to be restarted like a disk-based database after a power or other failure. This persistence is the key to all the other layers of protection from backup to remote replication.

The SAP HANA in-memory database holds the bulk of its data in memory for maximum performance, but still uses persistent storage to provide for booting and fallback in case of a failure. Persistence is managed by the SAP Block API to ensure exclusive
access to persistence. The SAP HANA persistence volumes reside on EMC VMAX or EMC VNX arrays. As shown in figure 5, each node uses two LUNs, one for data and another for logs. SAP HANA data can be backed up to an EMC Data Domain system as described in subsequent sections.

Figure 5. The SAP HANA Persistence Layer

The Persistence Layer ensures that there is always a current copy of the data and logs on non-volatile storage.

Data and undo log information is automatically saved to disk by SAP HANA at regular savepoints as described below.

**Data volume**

Data in memory is asynchronously written to the persistence mechanism as a savepoint every five minutes by default. This data volume also contains undo log information and additional HANA information such as modeling data. The data volume savepoint capture method uses a locking mechanism to prevent the modification of pages while copying modified pages and capturing open transactions before finally increasing the savepoint version and releasing the lock.

**Log volume**

The log file system captures all database transactions since the last savepoint. It is saved to disk continuously and synchronously after each commit of a database transaction at the end of the disk write operation, or if the internal log buffer (1MB) is full. As always, this information allows the database to be rolled back to any point in time as well as to back out of or redo individual transactions. In case of failure, the log volume allows the database to be restored from the last savepoint onwards.

**Restore from persistence**

After a power failure, the database can be restarted like a disk-based database:

- Lazy reload: To keep restart time short, column store tables employ “lazy” reloading. This means that tables with a preload flag and subsequently requested tables are loaded first.

- Replay logs: System returns to its last consistent state by replaying the redo log since the last savepoint.
**SAP Storage Connector API**

Persistence is controlled by the SAP HANA name server using the SAP Storage Connector (Block) API. This ensures exclusive access to persistence using SCSI-3 persistent group reservations so only the owning node has access to the persistence layer as well as has persistence mounted. The SAP Block API was co-developed by SAP and EMC.

**High Availability**

High availability within the data center provides protection from failures. To ensure high availability, EMC helps customers build a resilient infrastructure with a redundant configuration that eliminates single points of failure with host auto-failover.

EMC and SAP jointly developed SAP’s Block API for a non-disruptive failover when a node fails. The whole process is controlled by the SAP HANA name server, which also triggers the calls to the Block API. During a node failure, the standby node assumes its workload. When the node is restored, it becomes the new standby. The SAP Storage Connector (block) API, co-developed by SAP and EMC, eliminates the restriction on unattended high availability. As discussed above, VMware vSphere High Availability adds automation to ensure high availability through automatic restarts and failovers.

**Disaster Tolerance**

Disaster tolerance can be provided by the SAP HANA Studio-supported system replication or EMC storage replication solution.

This section describes the basic concepts of EMC’s SAP HANA disaster tolerance implementation based on EMC VMAX and EMC VNX storage arrays, EMC storage replication products, and SAP HANA software.

SAP HANA solutions from EMC provide the flexibility to scale disaster tolerance capabilities to meet the needs of each company. There are three available options for failover—system replication, storage replication, and system plus storage replication. Each brings an increasing amount of data protection. Let’s look at system replication first.

**System replication through SAP HANA Studio**

SAP HANA System Replication is accessed through SAP HANA Studio. It allows a secondary system to be used as a warm standby DT solution. In this solution, the data and log content is continuously transferred to the secondary site under control of the SAP HANA database. This synchronous replication solution is supported by SAP.

Providing active/active disaster tolerance, system replication is implemented inside SAP HANA. During a failure of either system, the synchronous mode ensures that there is no data loss and production is maintained with the other active system. The key advantage to system replication is that fail-over only takes about five minutes. System replication is depicted in figure 6.
Figure 6. System Replication

When SAP HANA Studio delivers system replication the secondary system must remain in a warm standby mode and is synchronously updated from the primary system.

**Storage replication with EMC MirrorView and EMC VNX**

The EMC storage replication solution using EMC MirrorView® is fully validated and certified by SAP. EMC MirrorView has two variants—Synchronous and Asynchronous.

**Synchronous**

EMC MirrorView/S is used to create a no-data-loss solution of committed transactions. It replicates multiple databases and applications data remotely while guaranteeing that the data on both the source and target devices is exactly the same.

With MirrorView/S each write on the local host is concurrently written to the remote site as shown in figure 7. After the remote unit acknowledges successful receipt of the write I/O, the write is acknowledged to the local host. If a disaster occurs at the local site, data at the secondary site is exactly the same as the data at the local site. The remote service profile can be quickly changed to that of the production system, providing a recovery point of zero.

Because SAP HANA requires low-latency write I/Os to the persistence, a consideration for synchronous replication is the latency of its write I/O operations, which limits the distance between the two sites.

Figure 7. EMC MirrorView Synchronous Replication

**Asynchronous**

To enable replication at longer distances, MirrorView/Asynchronous uses a periodic update model to provide a consistent point-in-time image on the target devices with a recovery point greater than 0.
As shown in figure 8, MirrorView/A tracks and stores data changes in the global reserved LUN pool, which is required on the local and the remote array. Data changes at the primary site are tracked and applied at the remote site at a user-defined frequency. The primary benefit of MirrorView/A is that it allows longer distance replication because SAP HANA response time is not dependent on the latency of the link.

Figure 8.  EMC MirrorView Asynchronous Replication

Business Continuity with EMC Synchronous Remote Data Facility (SRDF) and EMC VMAX

The EMC VMAX family is widely used with traditional databases in SAP landscapes because of its ability to support a very high level of data protection for mission-critical applications. EMC VMAX systems now provide the same level of data protection for SAP HANA databases.

SRDF enables complete high availability and business continuity for mission-critical environments for synchronous and asynchronous data protection.

EMC SRDF can extend the SAP HANA persistent devices to a remote site as shown in figure 9. The business continuity solutions use EMC SRDF in synchronous mode for close distances and asynchronous mode for long distances.

These solutions provide disaster recovery and business continuity for mission-critical environments with deployment flexibility and massive scalability.
The many lines of defense for data protection provided by EMC Datacenter-Ready SAP HANA solutions have been described in this paper. However, in extreme cases where a disaster occurs that cannot be solved with local persistence and HA methods, it is always a recommended practice to have a defined backup and disaster recovery strategy. For SAP HANA, the final line of defense is a backup, which is required in the unlikely event that an SAP HANA database is unable to start from a consistent point-in-time after a failure. The recovery of the SAP HANA database is performed through SAP HANA Studio.

**Backup with EMC Data Domain**

The SAP HANA backup solution consists of backups orchestrated through SAP HANA and EMC NetWorker to the EMC Data Domain system as seen in figure 10.

Data Domain functionality provides a reliable and efficient means to perform normal backups and restoration of system files. In the event of a disaster, a current copy of the data, logs, and even configuration files can be easily restored from a local or remote Data Domain system. The Data Invulnerability Architecture ensures that the data can always be restored.

EMC Data Domain is the ideal solution to protect SAP HANA because it provides:
• **Performance and scale:** With inline deduplication to reduce storage requirements and a throughput of up to 31 TB per hour, it provides the speed and scalability needed to handle big data.

• **Reliable recovery:** The Data Invulnerability Architecture provides end-to-end data verification, continuous fault detection, self-healing, and additional resiliency features to ensure recovery in any circumstance.

• **Network-efficient replication:** Data Domain replicator software sends only unique, compressed data across existing networks, providing faster time-to-DR readiness.

• **Seamless integration:** SAP-certified for all SAP HANA configurations and EMC NetWorker is integrated with SAP BACKINT API.

Backups can be triggered using EMC NetWorker, the SAP HANA Studio, the DBA Cockpit in Business Warehouse (BW), SQL script commands, or third party tools.

All Data Domain systems are built as the storage of last resort. The data in each Data Domain system is protected by the EMC Data Domain Data Invulnerability Architecture with end-to-end data verification, continuous fault detection, and self-healing mechanisms coupled with other resiliency features transparent to the application.

The HANA BACKINT interface enables integration with third-party backup tools. This allowed EMC to develop that integration into EMC NetWorker, enabling customers to keep their datacenter practices consistent by using a single tool to protect SAP HANA and other datacenter applications across both physical and virtualized environments.

EMC NetWorker Module for SAP (NMSAP) is an add-on module for the NetWorker server and client that provides backup and recovery services for SAP HANA. Database administrators can continue to use existing, familiar workflows to protect virtual SAP HANA with NMSAP. The solution described in this paper covers NMSAP configuration and automatic backup and test validation including virtual SAP HANA migration, backup, and recovery. NMSAP delivers:

• Easy migration of SAP HANA from a physical to a virtualized environment
• Compatibility between the NMSAP backup solution and the virtual HANA database
• Easy scheduling of routine backups by the NetWorker console

Data Domain systems also integrate easily into your existing environment, enabling you to consolidate all backup and archive data on a single protection storage system. For example, you can use the same Data Domain system to protect SAP HANA, Microsoft Exchange, and VMware backup data as well as database archives.
Conclusion

SAP HANA database deployments have evolved rapidly from stand-alone appliances to TDI to virtualized implementations. In any case—whether stand-alone, integrated in a datacenter, or virtualized—a SAP HANA database needs high levels of data protection. As shown in this white paper, EMC hardware and software solutions deliver the level of data persistence and protection demanded by enterprise-scale SAP HANA environments.

Resources

EMC

Storage Configuration Best Practices for SAP HANA Tailored Datacenter Integration on EMC VNX Series Storage Systems

This white paper describes how the SAP HANA Tailored Datacenter Integration process can be used to deploy SAP HANA on EMC VNX storage systems in an existing datacenter infrastructure.

Storage Configuration Best Practices for SAP HANA Tailored Datacenter Integration on EMC VMAX and VMAX3 Storage Systems

This white paper describes how the SAP HANA Tailored Datacenter Integration process can be used to deploy SAP HANA on EMC VMAX storage systems in an existing datacenter infrastructure.

Protecting SAP HANA with EMC NetWorker

This white paper validates the functionality of EMC NetWorker as a tool for protecting SAP HANA systems through NetWorker Module for SAP (NMSAP), and enabling efficient SAP HANA migration from physical to virtualized environments.

Business Continuity Best Practices for SAP HANA Tailored Datacenter Integration with EMC Symmetrix VMAX

This white paper provides EMC recommendations and procedures for data protection and availability using SAP HANA with EMC Symmetrix VMAX 10K, 20K, and 40K arrays enabled by Symmetrix Remote Data Facility (SRDF) and EMC TimeFinder.

Business Continuity Best Practices for SAP HANA TDI on EMC VNX Storage with MirrorView and SnapView

This white paper provides best practices and procedures for high availability and business continuity for SAP HANA with EMC VNX in a TDI deployment with EMC MirrorView and SnapView.

SAP

SAP HANA Tailored Data Center Integration

SAP HANA Platform Reference Documents

FAQ - SAP HANA tailored data center integration