Abstract

Dell EMC provides availability and data-protection operations for SAP as modular add-ons to the Enterprise Hybrid Cloud platform. The solution guide introduces the architecture, features, and functionality of the availability, backup, and DR modules.

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Chapter 1: Executive Summary

Document purpose

This Dell EMC solution is one of several integral parts of the Enterprise Hybrid Cloud platform for SAP. The solution focuses on continuous availability (CA) and data protection (DP) for a complex SAP landscape. This solution guide describes the following:

- The technical and business value of the solution
- Technical components for implementing and operating the solution
- Use cases for the features and functionalities presented

This solution guide is a companion to the *Enterprise Hybrid Cloud 4.1.1 Foundation for SAP Solution Guide*. It provides reference information that you must be familiar with to plan and design a solution for CA and DP in the hybrid cloud.

Scope

This solution guide focuses on an SAP CA and DP service implementation that is deployed on an existing, fully functional Enterprise Hybrid Cloud platform. It does not include detailed information about products and functionalities specific to Enterprise Hybrid Cloud.

Audience

This solution guide is intended for: SAP operations managers; server, network, and storage administrators; IT architects; and technical managers who want to implement CA and DP for their hybrid cloud infrastructure-as-a-service (IaaS) platform for managing mission-critical SAP landscapes.

You should be familiar with the VMware vRealize Suite, storage technologies, and general IT functions and requirements, and with how the hybrid cloud architecture accommodates these technologies and requirements. You should also have a basic understanding of SAP database backup and recovery procedures. Knowledge of the basic backup and recovery concepts that are implemented in Dell EMC™ Avamar™ and Dell EMC Data Domain™ architectures is helpful but not required.

Solution purpose

Organizations using SAP as a major part of their core business operations need a business continuity plan to manage the risks that are associated with downtime in their IT environment. Business-continuity plans typically depend on service-level agreements (SLAs) negotiated with the business. The SLAs are based on recovery point objectives (RPOs) defining how much data loss the business can tolerate, and recovery time objectives (RTOs) determining when the business must be fully operational.
The solution’s DP options for SAP provide different levels of granularity through SLAs such as:

- **Always-on SAP production environments**—CA with a stretched cluster
- **SLAs measured in minutes to hours**—Automated disaster recovery (DR) to restore business operations
- **SLAs measured in hours to days**—Cost-effective and efficient point-in-time (PIT) recovery for SAP, with backup and restore capabilities

## Business challenge

To reduce the risk of unexpected system downtime, traditional infrastructure designs for SAP are usually very complex, and require specific combinations of operating systems and database software and hardware, which makes the designs inflexible, costly, and difficult to implement and operate.

The main business challenges that this DP and CA solution addresses include:

- Protecting against single points of failure
- Minimizing the impact of planned or unplanned downtimes, including data corruption
- Reducing the infrastructure complexity and operating costs
- Providing self-service and a resilient end-to-end automation model
- Improving resource utilization across data centers

The solution provides several levels of protection addressing the unique needs of engineers to manage complex SAP cloud environments:

- **Automation and self-service**
  
  With a single click, the solution reduces manual data-protection management for hundreds of cloud virtual machines (VMs) by integrating the configuration process to the automated SAP provisioning.

- **Backup retention requirements**
  
  The solution provides backup retention-policy compliance and clean up to reduce maintenance overhead and to simplify storage reclamation, even on complex SAP cloud landscapes.

- **Availability**
  
  The solution minimizes the impact of planned or unplanned infrastructure-level downtimes. Configurations are streamlined into a single user-friendly portal to reduce the management complexity that is created by a cloud environment.

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**Note:** Data corruption can also be at application level, which is beyond the scope of availability or DR solutions.
Executive Summary

- **Disaster recovery**
  
  The solution streamlines configuration and management into a single user-friendly portal to ensure smooth site-wide failovers, reduced complexity, and reduced operating costs across data centers.

Technology overview

This data-protection solution for SAP is one of several modular add-ons that you can add to the Enterprise Hybrid Cloud platform. The modular add-on enables automated deployment, management, and protection of SAP applications, and database backup and restore capabilities during the SAP application lifecycle. It also includes CA with Dell EMC VPLEX™ Metro™ software and DR with Dell EMC RecoverPoint™ data protection, VMware vCenter Site Recovery Manager, and Dell EMC RecoverPoint for Virtual Machines to fully protect SAP applications.

This solution takes advantage of the strong integration between Dell EMC technologies and the vRealize Suite. Developed by Dell EMC and VMware product and services teams, this solution includes Dell EMC scalable storage arrays, integrated Dell EMC and VMware monitoring, and DP suites to provide the foundation for enabling cloud services within the customer environment.

We value your feedback

Dell EMC and the authors of this document welcome your feedback on the solution and the solution documentation. Contact EMC.Solution.Feedback@emc.com with your comments.

Authors: Sam Bu, Forrest Xi, Colleen Jones
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- **Key components** ...................................................... 10
- **Architecture** ............................................................ 11
- **Protecting SAP applications with backup services** ............ 12
Overview

This data-protection modular add-on to the Enterprise Hybrid Cloud platform provides backup and recovery services for SAP. With this data-protection solution, enterprise administrators can offer IaaS to end users who want a flexible, on-demand backup service without having to manually configure or maintain it.

This add-on takes advantage of the features and functions of the Avamar backup and restore software and the Data Domain deduplication storage system. You must consider many factors when building and maintaining a comprehensive backup and recovery system for SAP in a multitenant hybrid cloud, including:

- Backup type and frequency
- Impact and interaction with replication
- Recoverability methods and requirements
- Retention periods
- Automation workflows
- Interface methods (workflows, APIs, GUI, CLI, and scripts, among others)
- Implementation in an environment that is enabled for CA or DR

VMware vRealize Orchestrator, an integral part of the solution, centralizes all the customizations and operations. vRealize Orchestrator manages operations across several Dell EMC and VMware products, including:

- VMware vRealize Automation
- VMware vCenter
- Dell EMC Avamar

This modular add-on focuses on the implementation, management, and automation of the backup service for SAP in Enterprise Hybrid Cloud.

Key components

**Dell EMC Avamar**

The Avamar backup and recovery system is a complete software and hardware solution. Equipped with integrated variable-length deduplication technology, Avamar backup and recovery software provides integrated source and global data deduplication, which facilitates fast, full daily backups for hybrid cloud environments.

**Dell EMC Data Domain**

Data Domain storage systems deduplicate data inline so that data that is written on the disk requires less disk space than the original dataset. With Data Domain systems, you can retain backup and archive data onsite longer to enable quick and reliable data restores from disk.
With vRealize Orchestrator, cloud administrators can use the data protection workflows to automate Avamar and Data Domain protection of VMs. These workflows are added to the vRealize Automation VM provisioning blueprints so that cloud users can easily set up protection at provisioning time and request on-demand restores for specific VMs, where they can choose to restore from all available backups.

Cloud infrastructure administrators can also use workflows that carry out the entire protection policy configuration on the Avamar software and vCenter. The workflows facilitate quick and easy deployment of the infrastructure to support all end-user protection needs.

### Architecture

Figure 1 shows the architecture of the Enterprise Hybrid Cloud backup solution, including the required sets of resources, separated by pod.

**Core Pod**

The Core Pod hosts a core set of resources that must exist before the remainder of the cloud can be deployed. These core resources include vCenter Server, Microsoft SQL Server 2012, and VMware NSX Manager. The hardware that hosts this pod does not need to be managed by cloud components, but the VMs it hosts are a critical foundation of the cloud.

**Automation Pod**

The Automation Pod hosts the VMs that automate and manage the cloud infrastructure supporting the workloads that the cloud's tenants consume. The pod supports the
components responsible for functions such as the user portal and automated provisioning, monitoring, metering, and reporting.

**NEI Pod**

The NEI Pod hosts the NSX Edge appliances and NSX Controllers. It is the convergence point at which the physical and virtual networks connect.

**Workload pods**

The Workload Pods are configured and assigned in vRealize Automation as shared resources to host SAP VMs deployed by the different business groups in the hybrid cloud environment. These pods are deployed as VMware vSphere clusters in vCenter endpoints.

Table 1 provides details of the backup software resources that are used in the solution.

<table>
<thead>
<tr>
<th>Software</th>
<th>Version</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise Hybrid Cloud Foundation Module</td>
<td>4.1.1.0</td>
<td>Customization package for storage-as-a-service (STaaS) and foundation workflows</td>
</tr>
<tr>
<td>Enterprise Hybrid Cloud Backup Module</td>
<td>4.1.1.0</td>
<td>Customization package for backup-as-a-service (BaaS) workflows</td>
</tr>
<tr>
<td>Dell EMC Avamar Plug-in for SAP with Oracle</td>
<td>7.3.100-233</td>
<td>Software that works with the Avamar server and client software. The SAP plug-in provides backup and recovery for SAP with Oracle.</td>
</tr>
<tr>
<td>SAP automation package</td>
<td>4.1.1.0</td>
<td>Customization package for provisioning SAP systems containing SAP backup services</td>
</tr>
</tbody>
</table>

For a complete, up-to-date list of all supported software versions for Enterprise Hybrid Cloud, refer to the Enterprise Hybrid Cloud Simple Support Matrix on Dell EMC Online Support.

### Protecting SAP applications with backup services

#### SAP backup scenarios

A typical SAP ERP 6.0 Advanced Business Application Programming (ABAP) system consists of the following instances:

- **ABAP SAP Central Services (ASCS) instance**
- **Application server (AS) instances**
  
  The first application server instance that is installed in an SAP system is called the primary application server (PAS) instance. Additional application server (AAS) instances can be installed later to expand compute resource capability.

- **Database (DB) instance**
Figure 2 shows the SAP system architecture.

![SAP System Architecture Diagram]

Figure 2. SAP system architecture

The Enterprise Hybrid Cloud Data Protection Backup solution offers different options to protect all SAP instances. Table 2 lists the protection scenarios for SAP instances.

Table 2. Protection scenarios for SAP instances

<table>
<thead>
<tr>
<th>SAP instance</th>
<th>Protection solution</th>
<th>Protected files</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASCS</td>
<td>Image-level backup</td>
<td>All virtual disks</td>
</tr>
<tr>
<td>PAS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AAS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DB *</td>
<td>Database-level backup</td>
<td>Data files, control files, parameter files, online/offline redo logs</td>
</tr>
<tr>
<td>DB *</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* For DB instances, the Avamar plug-in can be installed as an option.

SAP application instances and ASCS instances in a distributed installation require a quick and simple backup and restore. These instances benefit from the virtual machine (VM) image-level backup solution that Enterprise Hybrid Cloud offers.

With the integration of Avamar backup and restore, Data Domain deduplication, and vRealize Automation, the Enterprise Hybrid Cloud backup solution can:

- Abstract and simplify backup and restore operations for cloud users
- Use vSphere vStorage APIs for data protection, providing Changed Block Tracking (CBT) for faster backup and restore operations
- Provide online full-image backups for VMs
- Eliminate the management of backup agents for each VM
- Minimize network traffic by deduplicating and compressing data
Chapter 2: Backup

The SAP application owner can choose any of the following image-level backup options:

- **Scheduled backup**—Choose the default backup service level when provisioning SAP applications.

- **On-demand backup**—Request that an unscheduled image-level backup after the SAP application is provisioned. vRealize Automation automatically processes the request. The Avamar server receives the backup request, and then runs the backup without interrupting the running SAP application.

- **On-demand restore**—Request an on-demand restore. vRealize Automation processes the request automatically. The Avamar server receives the restore request and runs the restore to the chosen backup point.

You must implement and initialize the Enterprise Hybrid Cloud Data Availability and Data Protection solution. For information about implementing backup services, refer to the *Enterprise Hybrid Cloud 4.1.1 Administration Guide* or contact Dell EMC Professional Services.

**Backup retention requirements**

Many SAP customers must retain backups for specific periods of time. Backups are secured in offsite locations for compliance with information security standards such as ISO 27001:2005 and the Information Technology Infrastructure Library (ITIL). Compliance requirements incur resource costs:

- Traditional daily full backups consume storage resources, leaving a large storage footprint on backup media.

- Incremental backups conserve disk space but require more complex restore procedures.

Sending offsite backups over a wide area network (WAN) can consume a significant amount of network bandwidth.

**SAP database backup and restore**

SAP supports various database platforms. The Avamar client and the corresponding Avamar database plug-in must be installed and configured to protect the database instances. This solution uses vRealize Automation to automate the installation and configuration of the Avamar client and the database plug-in. When the SAP system is provisioned, database-level backup and restore are ready without additional manual configurations.

**Full protection using Avamar backup and restore and Data Domain deduplication**

Enterprise Hybrid Cloud offers full protection for SAP database instances using the integration of Avamar backup and restore and the Data Domain deduplication system.

The SAP database instance is the most critical component of an SAP system. Without a well-planned method to protect the database, the risk of excessive system downtime and data loss increases. The image-level backup approach protects the entire VM. However, the database requires a granular backup technology to minimize data loss and ensure data consistency.

**Backup process flow**

Dell EMC recommends a database-level backup for all SAP database instances. Enterprise Hybrid Cloud for SAP offers full protection for database instances, using the
integration of the Avamar and Data Domain systems. Figure 3 shows the database backup process flow.

Figure 3. Database backup process flow in Enterprise Hybrid Cloud

In Enterprise Hybrid Cloud, Avamar uses the Data Domain system as its backup target. Dell EMC DD Boost™ and the Data Domain system deduplicate data at both the source and target sides, therefore only a fraction of the backup footprint is sent through the network. The related metadata that is generated by the Avamar client is simultaneously sent to the Avamar server. This metadata enables Avamar to perform restore operations directly from the Data Domain system.

This backup process flow provides the consistency of a full database backup while increasing the speed of backup operations.

**Protecting SAP, Oracle, and SLES in Enterprise Hybrid Cloud**

With Oracle Database on SUSE Linux Enterprise Server (SLES) for SAP applications, administrators can perform an on-demand backup through the BR*Tools command line or DBA Cockpit (the SAP transaction code is dbacockpit). The following backup options are available to fully protect the database against data loss:
Chapter 2: Backup

- Online and offline backup
- Consistent online backup
- Offline redo log files backup

Administrators can perform a restore using the BR*Tools command line on the SAP database instance, as shown in Figure 4.

Figure 4. Restore and recovery options using BR*Tools on SAP database instance

Enabling automated backup options

When you administer hundreds of SAP VMs in a cloud, manual configuration is no longer a viable option. For every VM, you must satisfy the following requirements:

- Install and configure backup agents to enable backup.
- Fulfill SLAs within backup windows while monitoring space requirements.
- Manage storage and network bandwidth requirements due to simultaneous backup operations.
- Monitor resource consumption for billing purposes.
- Schedule on-demand backups as requested by tenants.

The Enterprise Hybrid Cloud platform automates these operational processes to increase your productivity. In addition, the solution provides a detailed overview of your resources so you can manage them better.

The solution provides the following options to automate the installation and configuration of Avamar client and SAP plug-in with Oracle:

- Enable the database backup option in Day 1 provisioning
- Enable the database backup option in Day 2 operations

Enabling the database backup option in Day 1 provisioning

When SAP application owners request a new SAP database instance, they can choose to enable the database backup option when configuring the instance parameters, as shown in Figure 5.
After the instance is provisioned and fully operational, SAP administrators can schedule a database backup using DBA Cockpit.

**Enabling the database backup option in Day 2 operations**

SAP administrators can enable the database backup after the SAP system is provisioned if **Enable DB Backup** is deselected during provisioning, or after an existing SAP system is ingested into Enterprise Hybrid Cloud. To enable the database backup on-demand, SAP administrators can enable the database instance and type the root user password and SAP SID, as shown in Figure 6.

After completing the request, SAP administrators can schedule a database backup using DBA Cockpit.
This chapter presents the following topics:

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Overview

This data-protection modular add-on for the Enterprise Hybrid Cloud platform is built on the proven design of the VMware vSphere Metro Stretched Cluster backed by VPLEX Metro storage. Using the features and functionality of Metro, the solution offers the following benefits:

- Workload mobility
- Disaster avoidance
- Location-optimized storage
- Increased uptime and utilization
- Storage provisioning automation

To reduce the risk of unexpected system downtime, traditional infrastructure designs for SAP are usually very complex, and require specific combinations of operating systems and database software and hardware, which makes the designs inflexible, costly, and difficult to implement and operate.

To address this challenge for SAP applications, Enterprise Hybrid Cloud offers dual strategies:

- **Risk management**—CA helps you to manage risks in an IT environment and plan for recovery when a technical failure occurs.
- **Application mobility**—Running workloads are moved between servers without disruption to avoid any planned or foreseeable downtime.

Storage for the solution is provided by Dell EMC XtremIO™, Dell EMC VMAX™, and Dell EMC VNX™ arrays that are at both of the data-center sites that host the infrastructure. The storage is presented to the VPLEX storage virtualization technology, also at both sites, which forms a synchronized distributed storage pair that is presented to the vSphere cluster as active/active LUNs.

VMware vRealize Orchestrator is central to all the customizations and operations that are used in this solution. It manages operations across several Dell EMC and VMware products, including:

- VMware vRealize Automation
- VMware vCenter
- Dell EMC ViPR™ software-defined storage

This modular add-on focuses on the implementation, management, and automation of the CA for SAP applications on Enterprise Hybrid Cloud.
Chapter 3: Availability

Key components

**Dell EMC VPLEX**
The Dell EMC VPLEX family removes physical barriers within, across, and between data centers. VPLEX Local provides simplified management and nondisruptive data mobility for heterogeneous arrays. VPLEX Metro provides data access and mobility between two VPLEX clusters within synchronous and asynchronous distances respectively. With a unique scale-out architecture, VPLEX advanced data caching and distributed cache coherency provide:

- Workload resiliency
- Automatic sharing, balancing, and failover of storage domains
- Local and remote data access with predictable service levels

**VMware vSphere Fault Tolerance**
VMware vSphere Fault Tolerance (FT) provides CA for applications in the event of physical server failures by creating a live shadow instance of a VM that is always up to date with the primary VM. If a hardware outage occurs, vSphere FT automatically triggers a failover, ensuring zero downtime and preventing data loss. vSphere FT is easy to set up and configure and does not require agents or configuration specific to operating systems or applications. It is tightly integrated with vSphere and is managed using vSphere Web Client.

Using a fast-checkpoint technology, vSphere FT 6.0 supports protection of VMs with up to four vCPUs and 64 GB of memory. This means that it can protect most mission-critical customer workloads, regardless of the application or operating system.
Architecture

Logical architecture

Figure 7 shows the overall logical architecture of the CA solution for Enterprise Hybrid Cloud.

In this configuration, each pod is stretched across both sites in active/active mode. The underlying VPLEX distributed storage enables all the management components and workloads to either proactively move before a known event using VMware vSphere vMotion or reactively restart using VMware vSphere High Availability (HA) if an unpredicted failure event occurs. For a detailed explanation of each pod, refer to Architecture in Chapter 2.
The Dell EMC GeoSynchrony™ operating environment supports the concept of a VPLEX Metro cluster with Cross-Connect. This configuration provides an ideal platform for a uniform vSphere stretched-cluster deployment.

ESXi hosts can access a distributed volume on the local VPLEX cluster and on the remote cluster in the event of a failure. When this configuration is used with VPLEX Witness, ESXi hosts can survive through multiple types of failure scenarios. For example, in the event of a VPLEX cluster or back-end storage array failure, the ESXi hosts can still access the second VPLEX cluster with no disruption in service.

Figure 8 shows the physical architecture of uniform host-access configuration with VPLEX host Cross-Connect.

![Physical architecture with VPLEX host Cross-Connect](image)

**Figure 8. Physical architecture**

Table 3 provides details of the CA software resources that are used in the solution.

<table>
<thead>
<tr>
<th>Software</th>
<th>Version</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise Hybrid Cloud Foundation module</td>
<td>4.1.1.0</td>
<td>Customization package for STaaS and foundation workflows containing CA functionalities</td>
</tr>
<tr>
<td>SAP automation package</td>
<td>4.1.1.0</td>
<td>Preinstalled customization containing blueprints to automate SAP services including the SAP AutoStart service</td>
</tr>
</tbody>
</table>

For a complete, up-to-date list of all supported software versions for Enterprise Hybrid Cloud, refer to the [Enterprise Hybrid Cloud Simple Support Matrix](Dell EMC Online Support) on Dell EMC Online Support.
Best practices

Understanding the risks of SPOF components

The CA modular add-on ensures infrastructure-level protection from storage to instance level. Some components are outside the protection of the add-on and, as a result, are single-point-of-failure (SPOF) components, especially in an SAP distributed architecture. Examples of SPOF components include application-level services such as the ASCS enqueue service, DB services, and Global File Systems in NFS shares.

SAP PAS and AAS instances offer redundancy for work processes such as dialog (DIA), background (BGD), update (UPD), and spool (SPO). This redundancy enables workload balance and protection against vSphere ESXi host or VM failures.

Table 4 provides details of the impact of an SAP instance outage on SPOF components.

<table>
<thead>
<tr>
<th>SPOF component</th>
<th>Technical impact</th>
<th>SAP end-user impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB server</td>
<td>SAP system is suspended.</td>
<td>SAP service becomes unavailable.</td>
</tr>
<tr>
<td>Enqueue server</td>
<td>Application transaction locks are lost.</td>
<td>SAP becomes unavailable.</td>
</tr>
</tbody>
</table>
| Message server | • Cannot run new connection or requests.  
|                | • RFC connections through message server in other SAP systems are unavailable. | • Users cannot log in via login group.  
|                | • Users might experience issues when completing transactions that involve a different application server. |
| Global File Systems /sapmnt/<SID> | • Cannot start new application servers.  
|                               | • Cannot write background job logs. | • If an AAS goes down during this time, it cannot be brought back up, leading to bottlenecks and a degraded user performance.  
|                               |                                   | • The tractability of background jobs is affected. |
| Global File Systems /usr/sap/trans | Cannot use change and transport system. | You cannot implement immediate corrections in a quality assurance (QA) system. This requires customization and development in a production environment, causing a high risk of a data or configuration error due to a lack of QA testing. |

- **SAP DB instance outage**

  If the SAP database instance component fails, the entire SAP system is suspended. When the database becomes available again, the SAP work processes in the SAP application servers reconnect automatically and users can resume their work. All in-flight transactions are rolled back for consistency.

- **SAP ASCS instance outage (Enqueue and message server services)**

  If the SAP ASCS instance component fails, both the enqueue and message server services become unavailable.
If the enqueue service fails, the SAP application transaction locks are lost and the SAP system becomes unavailable. If this happens, the SAP functional team must analyze the business process impact after the service is restarted.

If the message server stops working, existing connections are not affected. New requests cannot be run for the dialog, update, and enqueue services.

- **SAP Global File System outage**
  Failure of an SAP Global File System (NFS server) component results in the following consequences:
  
  - NFS shares /sapmnt/<SID> are not available. Additional SAP application servers are prevented from starting. Active SAP application servers are not affected. Also, the background job can no longer write logs under /sapmnt/<SID>/global.
  - The /usr.sap/trans transport directory is not available. The change and transport system cannot be used.

Outages can usually be resolved quickly, for example, within an hour.

Understanding the nature, business value, and risks for each SPOF component is the key to answering questions when deciding whether the current level of protection is adequate for your business scenario:

- Is the money lost from the downtime worth investing in an application-level high-availability technology?
- Is the cost of protection more than the cost of the downtime you are trying to prevent?

You can eliminate SPOF component outages at the application-level by using third-party high-availability technologies. Implementing these technologies is beyond the scope of this solution guide.

**Autostarting SAP instances**

In a large-scale cloud environment, a tenant can run hundreds of SAP systems. During hardware failure, vSphere HA restarts some SAP VMs. To start a distributed SAP system, implement the following start order:

1. ASCS with Global File System SAP instance
2. DB SAP instance
3. PAS/AAS SAP instance
Figure 9 shows the dependency among SAP instances.

**Figure 9. Dependency among SAP instances**

On the Linux OS, the SAP and Oracle database services are not restarted by default with the OS and must be started manually. To eliminate manual intervention and reduce recovery time, we developed scripts to start each type of SAP instance automatically on startup of the OS:

- For NFS services, the NFS client waits until the NFS server is available.
- For the DB service, shell scripts monitor the availability of the database in the background during startup. When the database is online, PAS/AAS starts automatically.

You can enable the autostart of SAP instances during provisioning by selecting **Auto start**, as shown in Figure 10.

**Figure 10. Enabling autostart of SAP ASCS instances during provisioning**
Admission control
Dell EMC recommends that you set Admission Control Policy to Percentage of Cluster Resources Reserved as failover spare capacity and reserve 50 percent of CPU and memory for the VMware vSphere Distributed Resource Scheduler (DRS) clusters where SAP production systems run. In the event of the failure of a single data center, this configuration reserves cluster-compute resources to guarantee the restart of all VMs to another surviving data center.

VM Restart Priority
Override the VM Restart Priority according to the rules listed in Table 5.

Table 5. VM Restart Priority for SAP instances

<table>
<thead>
<tr>
<th>SAP instance</th>
<th>VM Restart Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASCS</td>
<td>High</td>
</tr>
<tr>
<td>DB</td>
<td>Medium</td>
</tr>
<tr>
<td>PAS/AAS</td>
<td>Low</td>
</tr>
</tbody>
</table>

If an ESXi host fails, vSphere HA powers on the SAP VMs according to the VM Restart Priority, from High to Low. Although this setting does not guarantee the proper start order of SAP services, it ensures that VMs with higher priority are powered on first, avoiding the PAS or AAS instances being powered on before ASCS or DB.

vSphere DRS rule
Dell EMC recommends creating vSphere DRS rules manually to separate SAP PAS and AAS instances on different ESXi hosts. If the ESXi host running PAS or AAS instances fails, the surviving PAS or AAS instances can provide redundancy of SAP work processes.

Dell EMC also recommends creating vSphere DRS rules manually to separate SAP ASCS and DB on different ESXi hosts to minimize the duration of a service outage.

Enabling vSphere FT
Dell EMC recommends enabling vSphere FT on the ASCS instance only. DB and PAS/AAS instances are I/O- and CPU-intensive instances that require higher network bandwidth to synchronize when vSphere FT is enabled, potentially affecting the overall performance of the SAP application.

Version 6.0 of vSphere FT supports protection of VMs with up to four vCPUs and 64 GB of memory. The maximum number of fault-tolerant VMs per host is four vSphere FT VMs or eight vSphere FT-protected vCPUs, whichever limit is encountered first. This includes both primary and secondary VMs, regardless of the host performance and size.

To enable vSphere FT, perform an Enable FT action for the ASCS instance and submit the request, as shown in Figure 13.
Figure 11. Enabling vSphere FT for an ASCS instance
To disable vSphere FT, perform a **Disable FT** action for the ASCS instance, and then choose whether to turn off vSphere FT completely or choose to be able to re-enable it in the future, as shown in Figure 12.

![Figure 12. Disabling vSphere FT for an ASCS instance](image)
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Chapter 4: Disaster Recovery with vCenter Site Recovery Manager

Overview

The data-protection modular add-on enables the implementation, management, and automation of DR for SAP applications in Enterprise Hybrid Cloud. The add-on builds on the proven design and integration of Dell EMC RecoverPoint and vCenter Site Recovery Manager to offer the following benefits in a hybrid-cloud environment:

- Continuous data protection for disaster recovery
- Planned migration
- Centralized recovery plans
- Automated failover and failback
- Nondisruptive recovery testing

Disaster-recovery strategy

DR is essential for mission-critical SAP applications. A proper DR strategy typically requires a significant time and budget investment to meet a company’s RTOs and RPOs. The challenges of designing DR-capable solutions include:

- Ensuring RTOs and RPOs for a variety of SAP applications in different organizations in a cloud environment
- Performing periodic recovery plan testing without incurring significant costs or disruption to the business
- Minimizing the manual and reconfiguration effort that is required to prepare another site for DR
- Minimizing the human intervention that is required to carry out DR for hundreds of systems
- Ensuring application consistency for a federated application landscape

This solution offers automated, rapid DR for SAP applications running in Enterprise Hybrid Cloud.

Key components

Dell EMC storage services

Dell EMC ViPR Controller

Dell EMC ViPR Controller is storage automation software that centralizes and transforms multivendor storage into a simple and extensible platform. It abstracts and pools resources to deliver automated, policy-driven storage services on demand through a self-service catalog.

Dell EMC VNX and Dell EMC VMAX

VNX and VMAX systems are powerful, trusted, and smart storage arrays that provide high levels of performance, availability, and intelligence in the hybrid cloud. VNX and VMAX storage systems offer a broad array of functionality and tools, such as Dell EMC Fully Automated Storage Tiering with Virtual Pools (FAST VP™), enabling multiple storage service levels to support ViPR software-driven STaaS offerings in the hybrid cloud environment.
Dell EMC XtremIO

The XtremIO enterprise storage array is all-flash, scale-out storage that provides substantial improvements to I/O performance. Designed to use flash media, XtremIO delivers high performance, administrative ease, and advanced data services for applications.

Dell EMC RecoverPoint

Dell EMC RecoverPoint provides advanced data protection, replication, and disaster recovery. It is designed with the performance, reliability, and flexibility required for enterprise applications in heterogeneous storage and server environments. It provides local replication and bi-directional remote replication for physical, virtual, and cloud environments.

For disaster recovery in this solution, VMAX or VNX storage systems provide the storage at two data centers: a primary data center (Data Center A) and a recovery data center (Data Center B). The storage is presented to Dell EMC RecoverPoint appliances (RPAs) at both sites. The RPAs replicate changes from the primary site to the recovery site in accordance with predefined RPOs and RTOs. The storage is kept synchronized between the two sites using an active/passive mode, with synchronization and visibility coordinated by recovery plans in vCenter Site Recovery Manager.

Dell EMC storage replication adapters

Dell EMC storage replication adapters (SRAs) ensure tight integration between vCenter Site Recovery Manager and the Dell EMC RecoverPoint and ViPR products. The SRAs automate the replication and data-sync operations for coordinated DR failovers and planned migrations.

VMware vCenter Site Recovery Manager

vCenter Site Recovery Manager is a disaster-recovery management solution that provides automated orchestration and nondisruptive testing of centralized recovery plans to simplify disaster recovery for virtualized applications. vCenter Site Recovery Manager integrates with Dell EMC RecoverPoint replication and ViPR automated storage services through the Dell EMC SRAs.

vCenter Site Recovery Manager reduces the time and effort required to set up and maintain recovery plans. Simple, centralized recovery plans require significantly less time and coordination to update regularly than is required by solutions with complicated, manual runbooks.
Figure 13 shows the logical architecture of DR for the SAP solution.

The DR topology for the Enterprise Hybrid Cloud platform provides protection and restart capability for workloads that are deployed in the cloud. VMs for management and workload are placed on storage that is protected by Dell EMC RecoverPoint and are managed from vCenter Site Recovery Manager. For a detailed explanation of each pod, refer to Architecture in Chapter 2.
Table 6 lists the DR software resources that are used in the solution.

Table 6. Solution software resources for DR with vCenter Site Recovery Manager

<table>
<thead>
<tr>
<th>Software</th>
<th>Version</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise Hybrid Cloud, Foundation module</td>
<td>4.1.1.0</td>
<td>Customization package for storage as a service (STaaS) and foundation workflows</td>
</tr>
<tr>
<td>Enterprise Hybrid Cloud, disaster recovery with vCenter Site Recovery Manager module</td>
<td>4.1.1.0</td>
<td>Customization package for disaster-recovery-as-a-service (DRaaS) workflows using vCenter Site Recovery Manager</td>
</tr>
<tr>
<td>SAP automation module</td>
<td>4.1.1.0</td>
<td>Customization package for provisioning SAP systems, including SAP AutoStart</td>
</tr>
</tbody>
</table>

For a complete, up-to-date list of the software requirements for Enterprise Hybrid Cloud, refer to the [Enterprise Hybrid Cloud Simple Support Matrix](https://www.dell.com) on [Dell EMC Online Support](https://www.dell.com).

### Protecting SAP applications with disaster recovery

DR services must already be set up through the vRealize Automation portal before beginning this procedure. For details, refer to the [Enterprise Hybrid Cloud 4.1.1 Administration Guide](https://www.dell.com).

To create SAP provisioning services on a DR-enabled infrastructure:

1. Provision DR-enabled storage on both data centers and assign it to business group reservations. The RPO is defined in the ViPR virtual pool.
2. Create blueprints for SAP production (PRD), development (DEV), and quality assurance (QA) systems by copying from an existing SAP blueprint. Enable a VM restart priority for recovery.
3. Set a storage reservation policy that uses the DR-enabled storage.

When provisioning SAP systems from the vRealize Automation self-service portal, you can specify the vCenter Site Recovery Manager power-on priority for SAP instances so that ASCS is started first, followed by DB, and finally PAS and AAS.
Figure 14 shows the starting priority for SAP instances.

<table>
<thead>
<tr>
<th>Virtual Machine</th>
<th>Recovery Status</th>
<th>Protection Group</th>
<th>Priority</th>
<th>Synchronization Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>sapdevasce</td>
<td>Ready to Recover</td>
<td>SID-SAP-Gold-Dev_1442345461370</td>
<td>1</td>
<td>OK</td>
</tr>
<tr>
<td>sapprdasce</td>
<td>Ready to Recover</td>
<td>SID-SAP-Prd-PRD_1442344135003</td>
<td>1</td>
<td>OK</td>
</tr>
<tr>
<td>sappqasce</td>
<td>Ready to Recover</td>
<td>SID-SAP-Gold-QAS_1442349034284</td>
<td>1</td>
<td>OK</td>
</tr>
<tr>
<td>sapdevpdb</td>
<td>Ready to Recover</td>
<td>SID-SAP-Gold-Dev_1442345461370</td>
<td>2</td>
<td>OK</td>
</tr>
<tr>
<td>sapprdpdb</td>
<td>Ready to Recover</td>
<td>SID-SAP-Prd-PRD_1442344135003</td>
<td>2</td>
<td>OK</td>
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<td>SID-SAP-Gold-QAS_1442349034284</td>
<td>2</td>
<td>OK</td>
</tr>
<tr>
<td>sapdevpasa</td>
<td>Ready to Recover</td>
<td>SID-SAP-Gold-Dev_1442345461370</td>
<td>3</td>
<td>OK</td>
</tr>
<tr>
<td>sapprdpasa</td>
<td>Ready to Recover</td>
<td>SID-SAP-Prd-PRD_1442344135003</td>
<td>3</td>
<td>OK</td>
</tr>
<tr>
<td>sappqaspa</td>
<td>Ready to Recover</td>
<td>SID-SAP-Gold-QAS_1442349034284</td>
<td>3</td>
<td>OK</td>
</tr>
</tbody>
</table>

Figure 14. Starting priority for SAP instances
This chapter presents the following topics:

- Overview
- Key components
- Architecture
- Protecting SAP applications with Dell EMC RecoverPoint for Virtual Machines
Chapter 5: Disaster Recovery with Dell EMC RecoverPoint for VMs

Overview

Disaster recovery with Dell EMC RecoverPoint for Virtual Machines uses VM-level replication between sites to provide storage and compute resilience for workloads across sites. DR enables the individual recovery of SAP workloads and offers the following benefits:

- Protection for SAP VMs with VM-level replication
- Automated protection on provisioning
- Flexibility to protect and unprotect SAP VMs on demand

Key components

Dell EMC and VMware integration

Dell EMC RecoverPoint for Virtual Machines is a fully virtualized hypervisor-based replication and automated disaster-recovery solution that is tightly integrated with VMware cloud-management software. Virtual RPAs are easily installed on any existing ESXi servers with flexible deployment configurations. ESXi splitters reside on all servers with protected workloads, allowing replication and recovery at the virtual-disk-granularity level. Because the I/O splitter resides within the vSphere hypervisor, Dell EMC RecoverPoint for Virtual Machines can replicate VMs to and from any storage array that is supported by VMware.

Architecture

DR logical architecture

Figure 15 shows an example of a DR logical architecture based on Dell EMC RecoverPoint for Virtual Machines, where two vCenter instances and two hardware islands are used across two different sites and managed by Enterprise Hybrid Cloud.
Chapter 5: Disaster Recovery with Dell EMC RecoverPoint for VMs

Figure 15. Logical architecture for DR with Dell EMC RecoverPoint for Virtual Machines

The configuration that is shown in Figure 15 can be further replicated on additional vCenter instances to achieve additional scale or identical protection service levels across different combinations of sites.

Table 7 lists the DR solution software resources that are used in the solution.

Table 7. Solution software resources for DR with Dell EMC RecoverPoint for Virtual Machines

<table>
<thead>
<tr>
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<td>4.1.1.0</td>
<td>Customization package for provisioning SAP systems, including SAP AutoStart</td>
</tr>
</tbody>
</table>

For a complete, up-to-date list of the software requirements for Enterprise Hybrid Cloud, refer to the Enterprise Hybrid Cloud Simple Support Matrix on Dell EMC Online Support.
Protecting SAP applications with Dell EMC RecoverPoint for Virtual Machines

Overview

Before creating SAP provisioning services on an Dell EMC RecoverPoint for Virtual Machines infrastructure, refer to the Enterprise Hybrid Cloud 4.1.1 Concepts and Architecture Solution Guide for information about Dell EMC RecoverPoint for Virtual Machines DR services.

To prepare SAP provisioning services that enable protection by Dell EMC RecoverPoint for Virtual Machines, consult Dell EMC Professional Services. The high-level steps are:

1. Assign Dell EMC RecoverPoint for Virtual Machines storage systems to business group reservations on both sites.
2. Create blueprints for SAP applications with the Dell EMC RecoverPoint for Virtual Machines build profile enabled.
3. Create storage reservation policies for the Dell EMC RecoverPoint for Virtual Machines storage systems.
4. Create and publish deployment profiles in vRealize to use the blueprints with the Dell EMC RecoverPoint for Virtual Machines build profile enabled.
5. Create the Dell EMC RecoverPoint for Virtual Machines policies. Refer to the Enterprise Hybrid Cloud 4.1.1 Administration Guide for information.

The following use cases show:

- Automated Dell EMC RecoverPoint for Virtual Machines protection during SAP application provisioning
- SAP AAS on-demand protection

Automated Dell EMC RecoverPoint for Virtual Machines protection during SAP application provisioning

When you provision a distributed SAP ERP 6.0 EhP7 on Oracle Database 12c through the service catalog in vRealize Automation portal, on the Node Properties tab, enter the number of vCPUs, memory size, and hostname for each instance. These new properties are required to enable Dell EMC RecoverPoint for Virtual Machines protection:

- `ehc.rp4vm.3.bootPriority`—Start sequence of the SAP instance. For example, we set 1 for the ASCS instance, 2 for the DB instance, and 3 for the PAS/AAS instance.
- `ehc.rp4vm.2.consistencyGroupName`—Name of consistency group to which the SAP instance will be added. If the consistency group does not exist, a new consistency group is created automatically. Ensure that you enter the same consistency group name for all three instances.
- `ehc.rp4vm.1.policy`—Replication policy containing policy type (synchronous or asynchronous), journal size, and RPO. The policy is usually created in advance by the tenant administrator.

SAP AAS on-demand protection

You can add the SAP AAS VM into an existing consistency group using the RP4VM Protect VM action. Select No under Create New Consistency Group, and then select an existing consistency group.
Chapter 5: Disaster Recovery with Dell EMC RecoverPoint for VMs

After you submit the request, a back-end workflow is triggered to add an AAS instance to the consistency group and start re-initializing the replication.

This solution offers additional Dell EMC RecoverPoint for Virtual Machines operations, including:

- **RP4VM Change Boot Sequence**—Change the start sequence for VMs protected by Dell EMC RecoverPoint for Virtual Machines.
- **RP4VM Change CG**—Change the consistency groups of VMs protected by Dell EMC RecoverPoint for Virtual Machines.
- **RP4VM Unprotect VM**—Unprotect VMs from Dell EMC RecoverPoint for Virtual Machines. This operation removes the VM copy from the remote site and removes the VM from consistency groups.

**Failover and failback**

The failover and failback operations are similar to disaster recovery based on vCenter Site Recovery Manager. To fail over an SAP application, log in to vSphere Web Client as an administrator in the surviving site and click **Fail Over** in the Dell EMC RecoverPoint for Virtual Machines plug-in.

To fail back an SAP application, perform the same failover operation after the production site is back online.
Chapter 6  Conclusion

This chapter presents the following topics:

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Conclusion

The Enterprise Hybrid Cloud Availability and Data Protection for SAP solution integrates the best Dell EMC and VMware products and enables customers to protect SAP system landscapes fully, covering all SAP instances, using backup, continuous availability, and disaster-recovery strategies.

Through the vRealize Automation self-service portal, you can perform on-demand and scheduled backup and restore activities for SAP VMs. By automating the installation and configuration of the Avamar Client through vRealize Application Services, you can perform on-demand and scheduled database backup and restore through DBA Cockpit and BR*Tools.

With vSphere Metro Stretched Cluster powered by VPLEX software and vSphere, Enterprise Hybrid Cloud enables customers to continuously protect SAP system landscapes from events ranging from single-host failure to single data-center outage. vSphere HA can restart SAP instances within a few minutes of a hardware failure. VPLEX Cross-Connect enables high availability of SAP systems in case of VPLEX and storage failure in one of the data centers.

With the integration of ViPR software, vCenter Orchestrator, and vRealize Automation, you can easily provision SAP systems on DR-enabled infrastructures. With the integration of Dell EMC RecoverPoint and vCenter Site Recovery Manager, in just a few clicks, the DR processes are automated and orchestrated in their entirety.

This solution provides the following benefits for protecting SAP systems:

- **Backup benefits**
  - Self-service, enabling end users to perform on-demand SAP VM image-level backup and restore operations
  - Automated installation and configuration of the Avamar SAP database plug-in
  - Full protection for SAP database instances, providing for several OS/DB combinations with the Avamar SAP database plug-in
  - Flexible Oracle database restore options for SAP, including complete database recovery, database/tablespace PiT recovery, whole database reset, and disaster recovery
  - Continuous backup infrastructure monitoring and reporting

- **Continuous-availability benefits**
  - Eliminates single points of failure across all infrastructure layers
  - Eliminates recovery time in case of a single VPLEX or storage outage by using VPLEX Metro with Cross-Cluster Connect
  - Minimizes downtime and provides high availability across data centers
  - Enables mission-critical business continuity for SAP applications running across local and remote data centers
• **Disaster-recovery benefits**
  
  ▪ Disaster recovery on a data-center level can be easily done through VMware vCenter Site Recovery Manager. The failover and failback processes do not require additional intervention from the tenants.
  
  ▪ Dell EMC RecoverPoint for Virtual Machines enables you to fail over individual VMs without failing over the entire data center.
This chapter presents the following topics:

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**SAP documentation** ..................................................................................................................44

**VMware documentation** ..........................................................................................................45
Chapter 7: References

Dell EMC documentation

The following documentation on Dell EMC.com or Dell EMC Online Support provides additional and relevant information. Access to these documents depends on your login credentials. If you do not have access to a document, contact your Dell EMC representative.

- Enterprise Hybrid Cloud 4.1.1 Foundation for SAP Solution Guide
- Enterprise Hybrid Cloud 4.1.1 Reference Architecture Guide
- Enterprise Hybrid Cloud 4.1.1 Concepts and Architecture Solution Guide
- Enterprise Hybrid Cloud 4.1.1 Administration Guide
- Enterprise Hybrid Cloud 4.1.1 Infrastructure and Operations Management Solution Guide
- Enterprise Hybrid Cloud 4.1.1 Security Management Solution Guide
- EMC Cloud-Enabled Infrastructure for SAP – Business Continuity Series: High Availability and Application Mobility Bundle
- EMC Avamar Administration Guide
- EMC Avamar and EMC Data Domain System Integration Guide
- EMC Avamar Backup Clients User Guide
- EMC Avamar for SAP with Oracle User Guide
- EMC Avamar for VMware User Guide
- EMC Data Domain Operating System Administration Guide
- EMC VPLEX Overview and General Best Practices: Implementation Planning and Best Practices
- EMC RecoverPoint Administrator's Guide
- RecoverPoint for Virtual Machines Administrator's Guide

SAP documentation

The following documentation at help.sap.com or service.sap.com/notes provide additional relevant information:

- SAP Database Guide: Oracle
- SAP Note 1380654 - SAP support in public cloud environments
- SAP Note 1492000 - General Support Statement for Virtual Environments
- SAP Note 1122388 - Linux: VMware vSphere configuration guidelines
- SAP Note 98051 - Database Reconnect: Architecture and function
- SAP Note 24806 - Database Reconnect: Technical details and settings
- SAP Note 1122387 - Linux: SAP Support in virtualized environments
- SAP Note 171356 - SAP software on Linux: Essential information
- SAP Note 1310037 - SUSE Linux Enterprise Server 11: Installation notes
VMware documentation

The following document on the VMware website provides additional and relevant information:

- Site Recovery Manager Administration