EMC HYBRID CLOUD FOR SAP
VMware vCloud Automation Center, VMware vCloud Application Director, EMC ViPR, EMC ViPR SRM

- Integrate two clouds securely
- Simplify and accelerate provisioning
- Scale out and charge back resources flexibly and accurately

EMC Solutions

Abstract

This white paper details how to deploy an SAP environment on an EMC® Hybrid Cloud with VMware vCloud Automation Center (vCAC) as its core. This solution addresses provisioning, key security, migration, and operational efficiency challenges specific to an SAP infrastructure.

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Test scenario

Test objective

Test procedure

Test results

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Executive summary

SAP's overall theme for 2014 centers on simplifying today's complex application landscapes while enabling increased value to the business and customers. Customers want to redefine their SAP systems for “real-time business” taking advantage of 3rd generation applications and devices including social networks, mobile applications, and real-time analytics.

Many CIOs turn to hybrid cloud models for SAP to simplify infrastructure, increase agility, and provide enhanced experiences for business functions. As a result, CIOs will increasingly become brokers of a portfolio of SAP applications and IT services across a hybrid cloud, and potentially using:

- Private cloud infrastructure, either customer built on-premises or off-premises as managed IT, or a combination of the two, to provide ItaaS SAP deployments.
- Public cloud infrastructure to create next-generation consumer-grade applications, and to extend cloud and on-premises applications.

Interlocking two autonomous cloud environments raises new challenges for integration, migration, security, and privacy. SAP customers require unique considerations in their architectures to maximize the benefits of using a hybrid cloud.

EMC Hybrid Cloud for SAP was designed to address these challenges. The solution transforms a hybrid cloud’s challenges into advantages by introducing SAP-specific functionalities that are designed to improve efficiency and reduce total cost of ownership (TCO) by balancing the cost of the resources to the criticality of the SAP system.

Business case

Hybrid cloud integration raises new challenges for the IT department. In a recent independent Hybrid Cloud Customer Report, a survey of 2001 respondents identified their pain points related to adopting a hybrid cloud. EMC Hybrid Cloud for SAP addresses their most critical concerns:

- Security
- Integration of internal and public cloud services
- Usage monitoring
- Data ownership, data location, and privacy

EMC Hybrid Cloud for SAP goes beyond adoption challenges and exceeds customers’ expectations about business advancement:

- Improved operational efficiency
- Ability to scale resources up and down as needed
- Reduction in TCO
- Increased workload and process standardization across complete cloud environments.

The solution reduces the complexity of configuring the individual components, and even allows a level of self-service capabilities that reduces the need for lengthy approval processes and manual administrative operations.
The solution is comprised of a combination of software add-ons, automation workflows, and configuration overlays on an existing EMC Hybrid Cloud infrastructure. The solution's configuration was customized for an SAP environment.

The solution uses EMC Hybrid Cloud 2.5 as its main platform, with the VMware vCloud Automation Center (vCAC) version 6.0 as its core cloud multitenancy component. To display EMC Hybrid Cloud’s capabilities on a hybrid cloud, we have interlocked another cloud environment based on vCloud Director (vCD).

EMC Hybrid Cloud empowers an IT organization by automating and orchestrating otherwise manual processes in terms of administration, multitenancy, security, self-service provisioning, migration, monitoring, and chargeback while keeping autonomy in an EMC Hybrid Cloud scenario.

**Administration**

The VMware vCloud Automation Center (vCAC), the core cloud administration component of EMC Hybrid Cloud for SAP, provides a secure portal where authorized administrators, developers, or business users can request new IT services. vCAC also allows administrators to configure cloud and IT resources to deliver services to business lines in a simple self-service experience.

**Multitenancy, resource scaling, and chargeback**

A multitenant model isolates the business data and resources consumed by an organizational entity from each other. EMC Hybrid Cloud, through vCAC, uses this model to structure its computing, storage, and network resources to enable more advanced management features, such as resource pooling, service measurement, and chargeback. With these functionalities integrated in EMC Hybrid Cloud for SAP's core, cloud administrators gain control of service performance, cost, and vendors to successfully run IT as a business.

**Security**

Current physical network and security solutions are rigid, complex, and expensive. The provisioning is slow and workload placement and mobility is limited by physical topology. We used VMware NSX as the network and security platform in our SAP environment, which is the network and security virtualization platform that delivers the operational mode of a virtual machine for the network. NSX reproduces the entire network model in software, enabling any network topology—from simple to complex multitier networks—to be created and provisioned in seconds. NSX enables a library of logical networking elements and services, such as logical switches, routers, firewalls, VPN, and workload security. We used the VPN to connect EMC Hybrid Cloud and vCloud Director enabled cloud. Firewall rules are used to control the SAP application connections that customers request.

**Self-service provisioning**

SAP unattended installation mode used side-by-side with vCAD enables a fully customizable, fully automated installation from storage provisioning, virtual machine creation, SAP system installation, to a logon-ready SAP system. A user only needs to trigger an automated vCAC request and input a few parameters. EMC Hybrid Cloud

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1 “We” refers to the EMC Engineering Team who tested the solution.
handles the rest, and you are provided with a fully functional SAP system that is ready for logon².

Migration
EMC Hybrid Cloud allows you to import a non-EMC Hybrid Cloud SAP virtual machine from another environment, and “standardize” it to become an EMC Hybrid Cloud compatible virtual machine.

Health monitoring and root cause analysis
EMC Hybrid Cloud uses VMware vCenter Operations Manager (vC Ops) and EMC ViPR SRM to monitor the whole platform. vC Ops’ customizable dashboard reveals at a glance which virtual machines need attention, and allows administrators to countercheck SAP-level key performance indicators (KPIs), such as those found in Memory management (ST02) or Workload Monitor (ST03N), without having to log into the SAP system. EMC ViPR SRM enables you to visualize applications for storage dependencies, analyze configurations and capacity growth, and optimize your environment to improve return on investment (ROI).

² After a fresh SAP installation, a 30-day temporary SAP license is automatically applied to the system. The system owner or its SAP administrator is responsible for requesting a permanent license from the SAP Marketplace website and installing it in the system.
Introduction

Purpose
This white paper serves as the foundation—the first of a series of solutions that describe in detail the design and specific configurations needed for an SAP environment to maximize the capabilities of the EMC Hybrid Cloud.

This solution is a direct application of the EMC Hybrid Cloud solution to an SAP environment. This White Paper serves as an enablement reference for SAP customers, who plan to deploy their SAP environment on EMC Hybrid Cloud.

Scope
This White Paper focuses on all SAP-related architecture, design, and implementation best practices deployed on an existing, fully functional EMC Hybrid Cloud solution. While some excerpts were taken from the *EMC Hybrid Cloud Solution Guide*, EMC Hybrid Cloud specific products or functionalities will not be covered in detail. For all EMC Hybrid Cloud topics beyond the scope of this document, refer to *EMC Hybrid Cloud Solution with VMware: Foundation Infrastructure Solution Guide 2.5*.

Audience
This document is intended for technical architects and cloud solution engineers who are considering adopting a private cloud or a hybrid cloud model for their data center infrastructure and business processes. Readers are expected to have basic competency in EMC, VMware, and SAP implementations and operations.

Readers must have a clear understanding of their current implementations and operational processes within their own environments. The target audience must have a fair understanding of what true cloud computing is, while being fully aware of what their end users require or are expecting when implementing a hybrid-cloud computing environment. This includes, but is not limited to, security, monitoring, resource management, multitenancy, and service metering.
Table 1 defines the terms used in this document.

### Table 1. Terminology

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEV</td>
<td>SAP Development System. An SAP system built for SAP programmers and consultants to develop programs and configurations.</td>
</tr>
<tr>
<td>EMC ViPR SRM</td>
<td>EMC ViPR Storage Resource Management Suite</td>
</tr>
<tr>
<td>FQDN</td>
<td>Fully qualified domain name</td>
</tr>
<tr>
<td>LDAP</td>
<td>Lightweight Directory Access Protocol</td>
</tr>
<tr>
<td>Off premises</td>
<td>The application or service is running on resources (hardware, software, locations) that are owned by a third party and not under the full control of the enterprise in question.</td>
</tr>
<tr>
<td>On premises</td>
<td>The application or service is running on resources (hardware, software, locations) that are owned by and in the full control of the enterprise in question.</td>
</tr>
<tr>
<td>OvDC</td>
<td>Organization Virtual Data Center. A vCD abstraction partitioned from a PvDC that maps resources to an organization.</td>
</tr>
<tr>
<td>PRD</td>
<td>SAP Production System. The system used in live operations of end users.</td>
</tr>
<tr>
<td>PvDC</td>
<td>Provider Virtual Data Center. A vCD abstraction that combines the computer and memory resources of a single vCenter Server resource pool with the storage resources of one or more data stores connected to that resource pool.</td>
</tr>
<tr>
<td>QAS</td>
<td>SAP Quality Assurance System. A replica of the PRD system, QAS serves as the test environment of configurations and programs designed in DEV.</td>
</tr>
</tbody>
</table>
EMC Hybrid Cloud Overview

The EMC Hybrid Cloud solution enables a well-run hybrid cloud by bringing new functionality not only to IT organizations, but also to developers, end users, and line-of-business owners. Beyond delivering baseline infrastructure as a service (IaaS), built on a software-defined data center (SDDC) architecture, the solution delivers feature-rich capabilities to expand from IaaS to business-enabling IT as a service (ITaaS).

Backup as a service (BaaS) and disaster recovery as a service (DRaaS) are now policies that users can enable with just a few mouse clicks. End users and developers can quickly access a marketplace of resources for Microsoft, Oracle, SAP, EMC Syncplicity, and Pivotal applications, and can add third-party packages as required. All of these resources can be deployed on private cloud or public cloud services, including VMware vCloud Air, from EMC-powered cloud service providers.

The EMC Hybrid Cloud solution uses the best of EMC and VMware products and services, and takes advantage of the strong integration between EMC and VMware technologies to provide the foundation for enabling IaaS on new and existing infrastructure for the hybrid cloud.

Figure 1 shows the key components of the EMC Hybrid Cloud solution.

Figure 1. EMC Hybrid Cloud key components

For detailed information, refer to *EMC Hybrid Cloud Solution with VMware: Foundation Infrastructure Solution Guide 2.5*. For information on EMC Hybrid Cloud modular add-on solutions, which provide functionality such as data protection, application services, and platform as a service, refer to *Modular add-on components*. For detailed information on the add-on solutions, refer to the individual Solution Guides for those solutions.
The EMC Hybrid Cloud solution incorporates the following features and functionality:

- Automation and self-service provisioning
- Multitenancy and secure separation
- Workload-optimized storage
- Elasticity and service assurance
- Operational monitoring and management
- Metering and chargeback
- Modular add-on components

The solution provides self-service provisioning of automated cloud services to both users and infrastructure administrators. It uses VMware vCloud Automation Center (vCAC), integrated with EMC ViPR® software-defined storage and VMware NSX, to provide the compute, storage, network, and security virtualization platforms for the SDDC.

Cloud users can request and manage their own applications and compute resources within established operational policies. This can reduce IT service delivery times from days or weeks to minutes. Automation and self-service provisioning features include:

- **Self-service portal**—Provides a cross-cloud storefront that delivers a catalog of custom-defined services for provisioning workloads based on business and IT policies, as shown in Figure 2
- **Role-based entitlements**—Ensure that the self-service portal presents only the virtual machine, application, or service blueprints appropriate to a user’s role within the business
- **Resource reservations**—Allocate resources for use by a specific group and ensure that those resources are inaccessible to other groups
- **Service levels**—Define the amount and types of resources that a particular service can receive during initial provisioning or as part of configuration changes
- **Blueprints**—Contain the build specifications and automation policies that define the process for building or reconfiguring compute resources
The solution provides the ability to enforce physical and virtual separation for multitenancy, as strongly as the administrator requires. This separation can encompass network, compute, and storage resources to ensure appropriate security and performance for each tenant.

The solution supports secure multitenancy through vCAC role-based access control (RBAC), which enables vCAC roles to be mapped to Microsoft Active Directory groups. The self-service portal shows only the appropriate views, functions, and operations to cloud users, based on their role within the business.

The solution enables customers to take advantage of the proven benefits of EMC storage in a hybrid cloud environment. Using ViPR storage services, which leverage the capabilities of EMC VNX® and EMC Symmetrix® VMAX® storage systems, the solution provides software-defined, policy-based management of block- and file-based virtual storage. ViPR abstracts the storage configuration and presents it as a single storage control point, enabling cloud administrators to access all heterogeneous storage resources within a data center as if the resources were a single large array.

The solution leverages the capabilities of vCAC and various EMC tools to provide the intelligence and visibility required to proactively ensure service levels in virtual and cloud environments. Infrastructure administrators can add storage, compute, and network resources to their resource pools as needed. Cloud users can select from a range of service levels for compute, storage, and data protection for their applications and can expand the resources of their virtual machines on demand to achieve the service levels they expect for their application workloads.
The solution features automated monitoring and management capabilities that provide IT administrators with a comprehensive view of the cloud environment to enable smart decision-making for resource provisioning and allocation. These automated capabilities are based on a combination of EMC ViPR Storage Resource Management (ViPR SRM), VMware vCenter Log Insight, and VMware vCenter Operations Manager (vC Ops), and use EMC plug-ins for ViPR, VNX, VMAX, and EMC Avamar® systems to provide extensive additional storage detail.

Cloud administrators can use ViPR SRM to understand and manage the impact that storage has on their applications and to view their storage topologies from application to disk, as shown in Figure 3.

Figure 3. EMC ViPR Analytics with VMware vCenter Operations Manager

Capacity analytics and what-if scenarios in vC Ops identify over-provisioned resources so they can be right-sized for the most efficient use of virtualized resources. In addition, for centralized logging, infrastructure components can be configured to forward their logs to vCenter Log Insight, which aggregates logs from disparate sources for analytics and reporting.

The solution uses VMware IT Business Management Suite (ITBM) to provide cloud administrators with comprehensive metering and cost information across all business groups in the enterprise. ITBM is integrated into the cloud administrator’s self-service portal and presents a dashboard overview of the hybrid cloud infrastructure, as shown in Figure 4.
The EMC Hybrid Cloud solution provides modular add-on components for the following services:

- **Application services**
  This add-on solution uses VMware vCloud Application Director to optimize application deployment and release management through logical application blueprints in vCAC. Users can quickly and easily deploy blueprints for applications and databases such as Microsoft Exchange, Microsoft SQL Server, Microsoft SharePoint, Oracle, and SAP.

- **Data protection services**
  Avamar and EMC Data Domain® systems provide a backup infrastructure that offers features such as deduplication, compression, and VMware integration. By using VMware vCenter Orchestrator (vCO) workflows customized by EMC, administrators can quickly and easily set up multiter data protection policies and enable users to select an appropriate policy when they provision their virtual machines.

- **Continuous availability**
  A combination of EMC VPLEX virtual storage and VMware vSphere High Availability (HA) provides the ability to federate information across multiple data centers over synchronous distances. With virtual storage and virtual servers working together over distance, the infrastructure can transparently provide load balancing, real-time remote data access, and improved application protection.
• **Disaster recovery**

This add-on solution enables cloud administrators to select disaster recovery (DR) protection for their applications and virtual machines when they provision their hybrid cloud environment. ViPR automatically places these systems on storage that is protected remotely by EMC RecoverPoint® technology. VMware vCenter Site Recovery Manager automates the recovery of all virtual storage and virtual machines.

• **Platform as a service**

The EMC Hybrid Cloud solution provides an elastic and scalable IaaS foundation for platform-as-a-service (PaaS) and software-as-a-service (SaaS) services. Pivotal CF provides a highly available platform that enables application owners to easily deliver and manage applications over the application lifecycle. The EMC Hybrid Cloud service offerings enable PaaS administrators to easily provision compute and storage resources on demand to support scalability and growth in their Pivotal CF enterprise PaaS environments.
EMC Hybrid Cloud and SAP

Overview

This chapter identifies the unique considerations in implementing an SAP landscape that needs a hybrid cloud, and the benefits of this implementation. Here are the features required to support the solution:

- Administration
- Multitenancy
- Security
- Self-service provisioning
- Migration
- Chargeback
- Health monitoring and root-cause analysis

The following sections explain how these key features address the hybrid cloud requirement as well as the SAP challenges.

Why use a hybrid cloud for SAP?

Regardless of deployment, all cloud solutions should improve operational efficiency, scale resources up and down as needed, and reduce the TCO in the long run. Why would a company that already uses either a private or public cloud need to use the other?

To answer this, you must compare and understand the key strengths of one type of cloud versus the other, from an architecture perspective.

- Public clouds are large implementations. The cost of maintaining systems at this level can be very expensive and difficult to maintain. However because of the economies of scale, as more companies share the overhead expenditures, the cost of leased resources becomes cheaper for each tenant. In addition your company does not have to assign resources to maintain that cloud. Using a public cloud will reduce the TCO, but you will have limited control over your systems.

- Private clouds reside within your own company. Internal IT maintains these systems, which enables you to have full ownership of your critical data and complete control of every part of the infrastructure. You can customize and protect your cloud environment precisely for what your business needs. You can deploy the latest technologies that are not offered in other cloud environments, and respond to incidents more quickly.

A hybrid cloud allows you to balance the TCO versus the criticality of the systems, so that you can keep critical SAP and non-SAP systems in your on-premises EMC Hybrid Cloud solution, while maintaining the rest in a cheaper, remote cloud.

A private-to-public integration is a popular hybrid deployment for a variety of reasons:

- **Lower TCO** – A more economical option is that an organization may choose to keep all its critical production (PRD) SAP systems in a private cloud while deploying all development (DEV) and quality assurance (QAS) systems on a
typically cheaper public cloud. Due to the economies of scale, the TCO in deploying and maintaining a DEV or QAS system in a public cloud is invariably lower than deploying them in a private cloud.

- **Resource expansion** – A hybrid cloud removes the hardware limits of a private cloud by extending several of its workload and functionalities to a public cloud’s much larger resource pool.

- **Testing cloud options** – An organization that has yet to build its own cloud can opt to try it on a public cloud until they are comfortable enough to invest, build, and manage their own private cloud.

A public-private cloud architecture ensures that the company maintains absolute control over all privately-owned resources dedicated to the most business-critical systems, while deploying the less critical systems on more cost-effective alternatives.
Technology overview

Overview

This EMC Hybrid Cloud for SAP solution introduces the following key technology components that are integrated as shown in Figure 5:

- VMware vCloud Automation Center (vCAC)
- VMware vCloud Application Director (vCAD)
- VMware vCenter Operations Manager (vC Ops) with SAP adapter
- VMware vCenter Orchestrator (vCO)
- VMware NSX
- VMware IT Business Management Suite
- EMC VNX storage
- EMC Symmetrix VMAX storage
- EMC ViPR SRM
- EMC ViPR Software-defined Storage
- EMC PowerPath/VE

![Figure 5. EMC Hybrid Cloud for SAP key components](image-url)
Key components | **VMware vCloud Suite**
---|---
VMware vCloud Suite combines multiple components into a single product to cover the complete set of cloud infrastructure capabilities. When used together, the vCloud Suite components provide virtualization, software-defined data center services, policy-based provisioning, disaster recovery, application management, and operations management. The following VMware vCloud Suite Enterprise components are used in the EMC Hybrid Cloud for SAP solution:

**VMware vCloud Automation Center (vCAC)**
vCAC provides a secure portal where authorized administrators, developers, or business users can request new IT services. Also, the authorized administrators can manage specific cloud and IT resources that enable IT organizations to deliver services that can be configured to their lines of business in a self-service catalog.

**VMware vSphere and VMware vCenter Server**
VMware vSphere is a virtualization platform for building cloud infrastructures. vSphere enables you to run business-critical applications confidently to meet the most demanding service level agreements (SLAs) at the lowest total cost of ownership (TCO). vSphere combines this virtualization platform with the award-winning management capabilities of VMware vCenter Server.

**VMware vCloud Application Director (vCAD)**
vCAD automates application provisioning in the cloud including deploying, configuring, and updating the application’s components and dependent middleware platform services on infrastructure clouds. vCAD simplifies complex deployments of custom and packaged applications on infrastructure clouds that are based on vCloud Director (vCD), vSphere, and Amazon Elastic Compute Cloud (Amazon EC2).

**VMware vCenter Operations Manager (vC Ops) with SAP adapter**
vC Ops automates operations management using predictive analytics and an integrated approach to performance, capacity, and configuration management. It enables IT organizations to get greater visibility and actionable intelligence to proactively ensure service levels, optimum resource usage, and configuration compliance in dynamic virtual and cloud environments.

The SAP adapter is an embedded adapter that uses SAP BAPI calls to collect metrics from an SAP server. vC Ops provides a comprehensive monitoring solution for SAP in a virtualized environment.

**VMware vCenter Orchestrator (vCO)**
VMware vCenter Orchestrator is a drag-and-drop workflow software that helps automate IT service delivery and integrates VMware vCloud Suite with the rest of the IT environment. The software, included at no extra charge with VMware vCenter, enables administrators to develop complex automation tasks within the workflow designer. The workflows can be quickly accessed and launched directly from the VMware vSphere client, from VMware vCloud Automation Center or through various triggering mechanisms.

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3 The SAP adapter delivered with this solution is a 3rd party software available to customers through EMC Select.
VMware NSX

VMware NSX is the leading network virtualization platform that delivers the operational model of a virtual machine for the network. Similar to virtual machines for compute, virtual networks are programmatically provisioned and managed independent of underlying hardware. NSX reproduces the entire network model in software, enabling any network topology—from simple to complex multi-tier networks—to be created and provisioned in seconds. NSX enables a library of logical networking elements and services, such as logical switches, routers, firewalls, load balancers, VPN, and workload security. Users can create isolated virtual networks through custom combinations of these capabilities.

VMware vCenter Log Insight

VMware vCenter Log Insight delivers automated log management through log aggregation, analytics, and search. With an integrated cloud operations management approach, it provides the operational intelligence and enterprise-wide visibility needed to proactively enable service levels and operational efficiency in dynamic hybrid-cloud environments.

VMware IT Business Management Suite

VMware IT Business Management (ITBM) Suite provides transparency and control over the cost and quality of IT services. By providing a business context to the services that IT offers, ITBM helps IT organizations shift from a technology orientation to a service-broker orientation, delivering a portfolio of IT services that align with the needs of business stakeholders.

EMC VNX and EMC Symmetrix VMAX

EMC VNX and EMC Symmetrix VMAX are powerful, trusted, and smart storage array platforms that provide the highest level of performance, availability, and intelligence in the enterprise private cloud. EMC storage systems offer a broad array of functionality and tools that simplify storage management and reduce costs in any type of cloud. Optimized for virtual environments and applications, EMC storage platforms provide unsurpassed simplicity and efficiency while providing storage replication for business continuity and disaster recovery solutions.

Enterprise customers can use the advanced storage tiering features and efficiencies of VNX and VMAX to deliver multiple storage service levels to their various organizations, and accelerate and simplify their private cloud as-a-service offerings.

EMC ViPR Software-defined Storage

EMC ViPR is a software-defined platform that abstracts, pools, and automates a data center's underlying physical storage infrastructure. It provides a single control plane for heterogeneous storage systems to data center administrators.

ViPR is more than storage virtualization; it is true software-defined storage. Basic storage services such as file, block, and object storage and storage characteristics such as replication, compression, and high availability are defined in software and delivered as services. Storage administrators define various virtual storage pools that reflect different service levels. Examples could include a high availability virtual storage pool, a transactional virtual storage pool or a geo-replicated object-based
A user subscribes to the virtual storage pool that best meets the needs of their application workload.

**EMC ViPR SRM**

ViPR SRM is monitoring and reporting software that increases visibility and control through multivendor capacity, performance, and configuration analysis for traditional and software-defined storage environments.

ViPR SRM provides detailed relationship and topology views from virtual or physical hosts down through the storage infrastructure. It increases visibility into storage dependencies across virtualization technologies like VMware, Hyper-V, AIX-VIO, VPLEX, and ViPR. It allows storage teams to analyze historical performance trends across the data path to understand the impact traditional and software-defined storage have on applications. ViPR SRM dashboards show capacity utilization and consumption trends to quickly spot where and how capacity is used and when more will be required. It continuously validates compliance with design best practices and the EMC Support Matrix to ensure the environment is always configured correctly to ensure service level requirements.

Armed with this information, you can now meet SLAs while improving productivity and optimizing storage investments to reduce costs.

Virtualization enables businesses of all sizes to simplify management, control costs, and guarantee uptime. However, virtualized environments also add layers of complexity to the IT infrastructure that reduce visibility and can complicate the management of storage resources. ViPR SRM addresses these layers by providing visibility between the physical and virtual relationships, ensuring consistent service levels. As you build out your cloud infrastructure, ViPR SRM can help you ensure storage service levels while optimizing IT resources - key attributes for a successful cloud deployment.

**EMC PowerPath/VE**

EMC PowerPath/VE for VMware vSphere is a multipathing extensions module for vSphere that provides software that works with SAN storage to intelligently manage Fibre Channel, iSCSI, and Fibre Channel over Ethernet I/O paths. PowerPath/VE is installed on the vSphere host and scales to the maximum number of virtual machines on the host, improving I/O performance. The virtual machines do not have PowerPath/VE installed nor are they aware that PowerPath/VE is managing I/O to storage. PowerPath/VE dynamically load-balances I/O requests and automatically detects and recovers from path failures.
Validated solution

Architecture

This section describes the environment and supporting infrastructure for this EMC Hybrid Cloud for SAP solution.

Figure 6 shows the overall architecture of the solution.

![Solution Architecture Diagram]

Figure 6. Solution architecture
Table 2 details the hardware resources for the solution.

Table 2. Solution hardware resources

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Quantity</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage (EMC Hybrid Cloud)</td>
<td>2</td>
<td>One EMC VNX8000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>One EMC VMAX20K</td>
</tr>
<tr>
<td>ESXi hosts (EMC Hybrid Cloud resource cluster)</td>
<td>3</td>
<td>Four 10-core CPUs, 384 GB</td>
</tr>
<tr>
<td>ESXi hosts (EMC Hybrid Cloud management cluster)</td>
<td>3</td>
<td>Two 10-core CPUs, 160 GB RAM</td>
</tr>
<tr>
<td>Ethernet switches</td>
<td>2</td>
<td>10 GbE (gigabit Ethernet)</td>
</tr>
<tr>
<td>Core switches</td>
<td>2</td>
<td>10 GbE (gigabit Ethernet)</td>
</tr>
<tr>
<td>SAN switch</td>
<td>2</td>
<td>8 Gb FC</td>
</tr>
</tbody>
</table>

Table 3 details the software resources used in the solution.

Table 3. Solution software resources

<table>
<thead>
<tr>
<th>Software</th>
<th>Version</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMC Block Operating Environment</td>
<td>5.33</td>
<td>Operating environment for VNX</td>
</tr>
<tr>
<td>EMC Enginuity</td>
<td>5876</td>
<td>Operating environment for VMAX</td>
</tr>
<tr>
<td>EMC PowerPath/VE</td>
<td>5.9 SP1</td>
<td>Multipathing and load balancing for block access</td>
</tr>
<tr>
<td>EMC SMI-S Provider</td>
<td>4.6.2</td>
<td>SMI-compliant interface for EMC storage arrays</td>
</tr>
<tr>
<td>EMC ViPR SRM (formerly known as EMC Storage Resource Suite)</td>
<td>3.5</td>
<td>Monitoring, reporting, and analysis software</td>
</tr>
<tr>
<td>EMC ViPR</td>
<td>2.0 P1</td>
<td>Storage virtualization and management</td>
</tr>
<tr>
<td>SAP ERP</td>
<td>6.0 EhP 7</td>
<td>SAP system</td>
</tr>
<tr>
<td>SAP NetWeaver</td>
<td>7.4</td>
<td>SAP system</td>
</tr>
<tr>
<td>Oracle Database</td>
<td>11g R2</td>
<td>Database used on the SAP systems</td>
</tr>
<tr>
<td>Microsoft SQL Server</td>
<td>2012</td>
<td>Used by VMware vCenter and vCAC</td>
</tr>
<tr>
<td>VMware vSphere ESXi</td>
<td>5.5.5.0c</td>
<td>Hypervisor</td>
</tr>
<tr>
<td>VMware vCenter Server</td>
<td>5.5.5.0c</td>
<td>vSphere management server</td>
</tr>
<tr>
<td>VMware vCloud Automation Center</td>
<td>6.0.1.1</td>
<td>VMware cloud management and infrastructure</td>
</tr>
<tr>
<td>VMware vCloud Application Director</td>
<td>6.0.1</td>
<td>Application provisioning software</td>
</tr>
<tr>
<td>VMware NSX</td>
<td>6.0.5</td>
<td>Networking and security software</td>
</tr>
</tbody>
</table>
Table 4 lists key software components of a second cloud connected to the EMC Hybrid Cloud environment during testing.

**Table 4. Solution software resources**

<table>
<thead>
<tr>
<th>Software</th>
<th>Version</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMware vCloud Director</td>
<td>5.1</td>
<td>Management tool for provisioning virtual data centers</td>
</tr>
<tr>
<td>vCloud Networking and Security</td>
<td>5.0</td>
<td>Networking and security software</td>
</tr>
</tbody>
</table>
Administration

Overview

The vCloud Automation Center (vCAC), the central cloud administration component of EMC Hybrid Cloud for SAP, provides a secure portal where authorized administrators, developers, or business users can request new IT services. Authorized administrators can also manage specific cloud and IT resources that enable IT organizations to deliver services to their lines of business in a simple, yet highly configurable, self-service experience.

Using the self-service portal of vCAC, EMC Hybrid Cloud for SAP offers cloud users a range of cloud operations, including:

- A catalog of storage and data protection services
- A catalog of SAP applications
- Streamlined deployment of SAP applications
- On-demand virtual machine-level backup, restore, and billing operations
- Scheduled protection of mission-critical SAP applications

For more detailed administration capabilities about the EMC Hybrid Cloud solution, see *EMC Hybrid Cloud Solution with VMware: Foundation Infrastructure Solution Guide 2.5*.

vCAC has the ability to integrate multiple clouds, both private and public. Users can then manage multiple clouds in one unified self-service portal. This section introduces how to integrate another cloud into vCAC, and demonstrates the unified provisioning process in the self-service portal.

Integration with another cloud environment

According to National Institute of Standards and Technology (NIST), a hybrid cloud is: “...a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (for example, cloud bursting for load balancing between clouds).”

The EMC Hybrid Cloud platform adheres to this definition by using vCAC as its core component. Figure 7 shows an example of EMC Hybrid Cloud’s integration to a cloud managed by vCloud Director.
From the vCAC portal follow the instructions below to integrate a vCloud Director-managed cloud:

1. Connect an endpoint to vCloud Director.
2. Create a fabric group and assign the compute resources.
3. Create reservation.
4. Create a blueprint and map to a catalog item in vCloud Director.
5. Create a service and assign an entitlement.

**Connecting an endpoint to vCloud Director using the vCAC portal**

An endpoint represents an infrastructure source. vCAC can integrate a variety of cloud infrastructures including vCenter, vCloud Director, and Amazon Web Services (AWS). To integrate vCloud Director as an endpoint, follow the instructions below:

1. Log in to vCAC portal as a cloud administrator.
2. Browse to **Infrastructure** → **Endpoints** → **Credentials**.
3. Create a vCAC credential that can connect to vCloud Director.
4. Browse to **Endpoints**; create a vCloud Director endpoint with the URL and vCAC credential created.
5. Start the data collection process of the vCloud Director endpoint to synchronize the resources in vCloud Director.

**Creating a fabric group and assigning a compute resource**

A fabric group allows the fabric administrator to reserve compute resources from an endpoint. Follow the instructions below to create a fabric group that uses resources in vCloud Director:

1. Log in to vCAC portal as a cloud administrator.
2. Browse to **Infrastructure→Groups→Fabric Groups.**

3. Create a fabric group with fabric administrator and select the Organization virtual Data Center (OvDC) you want to consume. The OvDC is synchronized from vCloud Director. In this example we selected **OrgA Committed** for the compute resource, as shown in Figure 8.

**Figure 8. Fabric group**

**Creating a reservation**

A reservation reserves a certain amount of compute resources (CPU, memory, and storage) for a business group user to deploy SAP systems. A reservation of vCloud Director resources was created for the Finance business group in Tenant A to demonstrate the process. Follow the instructions below to create a reservation:

1. Log in to vCAC portal as a fabric administrator.
2. Navigate to **Infrastructure→Reservations→Reservation.**
3. Create a reservation that consumes the resources in Organization vDC. In the reservation settings, specify the amount of memory and storage reservation needed. Figure 9 shows the settings when creating the reservation.
There are two approaches for deploying an SAP system to a vCloud Director managed cloud connected to an EMC Hybrid Cloud:

- Map the existing vCloud Director catalog item to a blueprint. This allows reuse of the catalog items already developed in vCloud Director.
- Create an application in vCAD and map it to the vCloud Director catalog item. This allows automated provisioning of SAP systems with unattended installation.

In this section, we display the first approach as shown in Figure 10.
1. Log in to vCAC portal as a business group administrator.
2. Browse to Infrastructure → Blueprints → Blueprints.
3. Create a vApp Component (vCloud Director) blueprint. In the “Clone from” property, select the catalog item in vCloud Director.
4. In the component property, select the vApp Component (vCloud Director) component blueprint you previously created.
5. Publish the vApp (vCloud Director) blueprint.
6. Add the published vApp (vCloud Director) blueprint to an existing service or create a new service for the blueprint.

Test scenario
If a customer has implemented a vCloud Director cloud solution, the integration into EMC Hybrid Cloud allows unified provisioning in one interface. The guide in the previous section shows how the vCloud Director cloud was successfully integrated into EMC Hybrid Cloud.

This use case demonstrates how to provision an SAP DEV system to a vCloud Director cloud and connect it to an existing SAP PRD system in an EMC Hybrid Cloud.

Test objective
The use case shows a process for provisioning an SAP DEV system into a vCloud Director managed cloud, through the EMC Hybrid Cloud. The customer will be able to
log into the vCAC portal and provision an SAP system from the catalog to a vCloud Director cloud. The newly provisioned SAP system will be able to connect to an existing SAP system in the EMC Hybrid Cloud.

To successfully connect two SAP systems in different clouds, network and security rules must be pre-configured. For detailed information, refer to Networking and security.

**Test procedure**

Follow these instructions to test the procedure:

1. Log in to vCAC portal as business group user.
2. Request for an SAP DEV system to be provisioned in vCloud Director.
3. Log in to the SAP DEV system. Verify the system by checking system status, t-code SICK (SAP Installation Check).
4. Log in to the existing SAP PRD system. Create an RFC connection to the SAP DEV system.
5. Verify the connection logs.

**Test results**

The SAP DEV system is deployed on vCloud Director. Total provisioning time is 21 minutes. Figure 11 shows the IP of the SAP DEV system.

![Image of IP address of the SAP DEV system](image)

**Figure 11. IP address of the SAP DEV system**

We logged into the SAP DEV system and verified the status. Figure 12 shows the verification.
After the verification, we built the connection between two SAP systems in different clouds. The network and security rules were preconfigured. Table 5 shows the detailed information about the two systems:

Table 5. Detailed information about SAP systems

<table>
<thead>
<tr>
<th>SAP System</th>
<th>SID</th>
<th>Hostname</th>
<th>IP address</th>
<th>Cloud Endpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>NetWeaver 7.4 PRD</td>
<td>DM3</td>
<td>sapnw74dm3</td>
<td>192.168.150.100</td>
<td>vCenter (EMC Hybrid Cloud)</td>
</tr>
<tr>
<td>NetWeaver 7.4 DEV</td>
<td>DM1</td>
<td>fin-10</td>
<td>192.168.100.14</td>
<td>vCloud Director</td>
</tr>
</tbody>
</table>

We logged into the SAP PRD system and created an RFC connection by running t-code SM59. As shown in Figure 13, the connection test between the SAP PRD system in EMC Hybrid Cloud and the SAP DEV system in vCloud Director succeeded. Using Log Insight, we verified that the firewall also captured the network package and logged all of the connection information.
Figure 13. Connection test result between SAP systems
Migration

Overview

For organizations that intend to migrate to the EMC Hybrid Cloud platform, a simple migration is not enough: the virtual machines must be “standardized” on migration. EMC Hybrid Cloud standard virtual machines are provisioned with monitoring and chargeback mechanisms to enable central management. EMC Hybrid Cloud can automate this procedure and bring the virtual machines under the full control of the cloud.

This section outlines the steps on how to import non-EMC Hybrid Cloud virtual machines into EMC Hybrid Cloud.

Scenarios and Procedure

Full migration and standardization of non EMC Hybrid Cloud provisioned virtual machines requires EMC Hybrid Cloud based customization of the virtual machine and storage migration to EMC Hybrid Cloud’s ViPR. An EMC Hybrid Cloud managed virtual machine has the following characteristics:

- Virtual machine lease and expiration policies
- ITBM chargeback compliant
- EMC Hybrid Cloud Monitoring compliant
- Data stores completely managed by ViPR in EMC Hybrid Cloud

Due to the variety of different cloud providers’ environments, the pre-configurations before migrating virtual machines must be performed on a case-by-case basis. This solution is one example. We strongly recommend employing EMC professional services to complete these tasks.

Non EMC Hybrid Cloud managed virtual machines will fall in one of the following scenarios:

Scenario 1: Non EMC Hybrid Cloud managed virtual machines are located under the vCenter being used by the EMC Hybrid Cloud solution.

Solution (Online migration):

1. Perform a storage vMotion in vCenter to EMC Hybrid Cloud's ViPR storage under the planned business group.
2. Use Infrastructure Organizer to import the virtual machine's to the planned business group.
3. Migrate the network to the planned VxLAN port group during maintenance window.

Scenario 2: Virtual machines are located in a non-EMC Hybrid Cloud managed vCenter that will be connected as an endpoint.

Solution (Offline migration):

1. Offline export the virtual machines to the EMC Hybrid Cloud managed vCenter. Select the right ViPR storage under the planned business group. Reconfigure the network to VxLAN port group.
2. Use Infrastructure Organizer to import the virtual machines to the designated business group.

3. After all virtual machines are exported, disconnect the ESXi hosts from the non EMC Hybrid Cloud managed vCenter and connect to the EMC Hybrid Cloud managed vCenter.

4. Perform EMC Hybrid Cloud customizations for the ESXi hosts according to EMC Hybrid Cloud build guide.

Alternate Solution (Online migration):

1. Create a new endpoint in vCAC that connects to the non EMC Hybrid Cloud managed vCenter.

2. Reconfigure the non EMC Hybrid Cloud managed vCenter to become EMC Hybrid Cloud compliant according to the EMC Hybrid Cloud build guide.

3. Use infrastructure organizer to import VMs to the designated business group.

4. Migrate the network to the planned VxLAN port group during the maintenance window

We focused on Scenario 1. Migrate the storage to EMC Hybrid Cloud’s ViPR using storage vMotion, and followed these instructions to import the virtual machines to the corrected business group, using Infrastructure Organizer:

1. Create blueprints to automate the import of virtual machines.

2. Import the existing virtual machines and verify that these virtual machines can be managed by EMC Hybrid Cloud, such as chargeback and monitoring agents.

Validation use case

This section describes how to configure the workflow in EMC Hybrid Cloud.

Creating blueprints to automate virtual machine imports

We created a new blueprint from the vCAC console to import virtual machines. The blueprint defines how long the virtual machines will be leased or archived, whether you want the virtual machines to be reconfigured, and what the blueprint will cost. In this case, we set the following values as shown in Figure 14.

- Lease (days): 30
- Archive (days): 2
- Allow reconfigured: yes

Note: The value for daily cost specified in the machine blueprint is added to the total cost of the machine. This value can represent a markup for using the machine and for the resources consumed by the machine.
Figure 14. Creating a blueprint for existing virtual machines

**Importing existing virtual machines**

After creating the endpoint, fabric group, and organizing the compute resources for the existing virtual SAP systems, they can be imported to an EMC Hybrid Cloud platform through the vCAC Infrastructure Organizer wizard. In this case, we had two unmanaged existing virtual machines that needed to be imported as shown in Figure 15.

**Infrastructure Organizer**

Bring compute resources and machines under vCAC management using the Infrastructure Organizer.

Figure 15. Importing existing virtual machines

We assigned these two machines to Finance Business Group as shown in Figure 16.
Figure 16. Assign business group to the virtual machines imported

The last step is to select the blueprint for the machines as shown in Figure 17.

Figure 17. Apply a blueprint to the virtual machines imported

Verifying that EMC Hybrid Cloud can manage these virtual machines

After importing the virtual machines under the Finance business group, we used the Actions menu to manage them as shown in Figure 18.

Figure 18. Manage machines using the Actions menu

We clicked View Details of the Actions menu to get the detailed machine configuration as shown in Figure 19.
Figure 19. Detailed information of the virtual machines managed by vCAC.

As defined in the blueprint, the virtual machine lease period is 30 days. When the lease expires, the virtual machines will be destroyed after two days (archive day). You can change the lease period, receive expiration reminders, and expire them immediately through the **Actions** menu.

**Test results**

You can import the existing virtual machines to an EMC Hybrid Cloud platform. Through the vCAC Infrastructure Organizer wizard, you can register the existing VMware virtual SAP systems, enable cloud, and import it into the EMC Hybrid Cloud platform. Virtual machines can be migrated, standardized and managed through the EMC Hybrid Cloud platform.
Self-service SAP provisioning

Overview
EMC Hybrid Cloud uses vCAD scripts to orchestrate processes across several virtual machines. vCAD can run these scripts from both the VMware environment and the guest operating system (OS) level. You can predefine values that can be passed on later as environment variables, and write flexible and portable scripts, with as many variables as you need.

vCAD can also import “catalogs” from another cloud (for example vCloud Director) and map these catalogs to vCAD’s own service catalog, to trigger remote cloud operations from the same EMC Hybrid Cloud interface.

This chapter describes how to enable full self-service provisioning of an SAP system. The top-level steps are:

- Check prerequisites
- Create an SAP-ready guest virtual machine template
- Set up SAP unattended installation script
- Create vCAC blueprint to automate cloning from the virtual machine template
- Create vCAD blueprint to automate SAP installation
- Create vCAC Service Catalog Item to serve as user input screen
- Deploy an SAP system

Check prerequisites
The following must already be present before continuing:

- Configured vCenter Server and vCAC, according to the *EMC Hybrid Cloud Solution Guide*.
- vCAD configured according to Appendix D.
- The component IDs of the SAP systems that you want to include in the self-service portal, see Appendix C (you can also refer to SAP note 950619).
- SAP installation media downloaded from the SAP service marketplace, SAP S-user and authorization to download required.
- A mountable NFS file system that contains the SAP installation media. The automation script will mount this file system to the newly created virtual machines.

Create an SAP-ready virtual machine template
This section describes the specifications needed for an SAP-ready virtual machine template.

*Note:* The amounts of resources specified are initial values only. You must observe the proper sizing strictly based on business requirements on provisioning.

Table 6 shows the virtual machine specifications used for testing.
## Table 6. Virtual machine specification and installation media

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Software</th>
<th>SAP Installation media (SAP ECC 6.0 EhP7 SR1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 4-core CPU (1 socket x 4 cores/socket)</td>
<td>• SUSE Linux 11 SP3</td>
<td>• SAP Software Provisioning Manager (SWPM) 1.0 for Linux X86_64</td>
</tr>
<tr>
<td>• 8 GB RAM</td>
<td>• Oracle 11.2</td>
<td>• SAP UC Kernel 741 (D51047455_6)</td>
</tr>
<tr>
<td>• 1 SCSI controller</td>
<td>• SAP ERP 6.0 EhP 7</td>
<td>• SAP ECC 6.0 EhP7 SR1 Installation export DVD 1 and 2</td>
</tr>
<tr>
<td>• 150 GB disk space</td>
<td></td>
<td>• Oracle RDBMS 11.2.0.3 for Linux X86_64 (D51041939)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Oracle CLIENT 11.2.0.3 (CD51041940)</td>
</tr>
</tbody>
</table>

1. Ensure that the following packages are installed (check using RPM or YaST) during SUSE Linux Enterprise Installation (SLES) installation:

   a. SAP Application Server Base (sapconf)
   b. C/C++ compiler and tools
      - gcc (x86_64)
      - gcc-c++ (x86_64)
      - glibc-devel
      - libaio-devel
      - libstdc++
   c. SAPlocales (See SAP note 171356)
   d. Java Developer Kit 1.4.2 (See SAP note 709140)
   e. Bourne Again Shell (bash) and C Shell (csh)
   f. Public Domain Korn Shell (ksh)
   g. Change the soft and hard limit for SAP and Oracle users to 65536 in /etc/sysconfig/sapconf
      ```
      LIMIT_1="@sapsys soft nofile 65536"
      LIMIT_2="@sapsys hard nofile 65536"
      LIMIT_3="@sdba soft nofile 65536"
      LIMIT_4="@sdba hard nofile 65536"
      LIMIT_5="@dba soft nofile 65536"
      LIMIT_6="@dba hard nofile 65536"
      
      Reload the sapconf file by executing the command
      /etc/init.d/boot.sapconf reload
      ```

2. Save the virtual machine to a template when all the adjustments are completed. This will be imported later.

3. Set up silent installation scripts.
The automation is enabled using three executables:

- **vCAD MAIN SCRIPT** which you need to write
- **RUNINSTALLER** to run an unattended Oracle installation
- **SAPINST** to run the SAP silent installation

**vCAD MAIN SCRIPT**

vCAD invokes this main script that you developed to prepare the virtual machine and call **RUNINSTALLER** and **SAPINST**. The main installation script only needs to be written once. If there are changes in the software, paths, or the installation executables, this script will continue to work. Appendix B: Creating the main installation script shows how to create this script.

**RUNINSTALLER**

This SAP-customized script is used to install the Oracle database. The script calls the compressed executables from the SAP Oracle RDBMS DVD. The preparation script is responsible for decompressing the executables. The syntax is:

```bash
RUNINSTALLER -oracle_base <Oracle base folder> -silent -nocheck
```

You can run this script directly and need no further customization. Later you will find that this command is changed to match the standard naming convention in the main script.

```bash
$oracle_stage/database/SAP/RUNINSTALLER -oracle_base $ORACLE_BASE -silent -nocheck
```

**SAPINST**

You need to configure the files needed by SAPINST to perform an unattended installation, as detailed in SAP note 950619. Appendix C: Configuring SAP silent installation guides you through the process, with some solution-specific customizations.

Once the scripts are prepared, you are now ready to create blueprints that will incorporate the scripts and workflows to automate the process. Figure 17 depicts the workflow and shows the components that must be configured.

![Figure 20. User workflow in self-provisioning an SAP system using vCAC]
The configuration workflow is encapsulated in (A) vCAD Application container. The Application consists of: (B) A vCAD workflow blueprint that contains all parameters and orchestrates the whole process; and (C) deployment profiles, which serve as the blueprint’s customization. For example, the deployment profile “small” is used to implement a blueprint with minimal resources, while “large” is used to deploy with the same blueprint but with larger allocations.

Each vCAD blueprint has two components: A Logical Template and a Service. The Logical Template contains information on the (D) Cloud Provider and OS version. The vCAD blueprint contains the information needed to provision the virtual machine later.

The Cloud Provider contains information about which cloud the application is working on. vCAD extracts the templates from the Cloud Provider depending on what type it is: (E) a vCAC blueprint, a vCD catalog, or even another public cloud template. For this solution, we used a vCAC blueprint that clones the virtual machine template as was discussed in the previous section.

The Service contains the script that we want to run against the virtual machine, and the OS that the script is compatible with. The script is the main script described in the previous section that triggers the SAP installation.

The Application container can be accessed through a service catalog in vCAC. The service catalog is mapped to an application’s deployment profile in vCAD.

Appendix D: Creating vCAC and vCAC blueprints and service catalogs describes the procedure in more detail.

When the templates, scripts and NFS media server are ready, you can compose all these in vCAD. Figure 21 shows the vCAD interface.
Take the following steps to deploy the automation workflow:

1. Log in to vCAC. Under **Catalog**, select the deployment profile/catalog item that you configured in the previous section.

2. Type a description under **Request Information**.

3. There is an input screen under **Properties** where you can customize the details based on the **Properties** settings were configured previously.

4. Quick deploy and wait for the operations to finish. You can monitor the progress using vCenter.

This use case validates the effectiveness and efficiency of the automation feature of EMC Hybrid Cloud for SAP.

**Test scenario**

An EMC Hybrid Cloud user intends to install new SAP systems. In this scenario all PRD systems will be created in the EMC Hybrid Cloud platform, while all non PRD (for example, QAS, DEV) will be deployed on an autonomous vCloud-based environment (for example: vCloud Air).
Test objectives
Our test objective was to fully provision the SAP systems in EMC Hybrid Cloud.

Test procedure
To conduct this test, we configured the automation as described in the previous section and deployed five SAP PRD systems in EMC Hybrid Cloud. Each system has its own SID, hostname, system number, and master password, Figure 22.

We ran an installation check to verify integrity and noted the duration of the manual input and the whole provisioning process.

Figure 22. Install new SAP system

Test results
The average time to complete five SAP ECC 6 standard installations systems was 3 hours and 25 minutes. Figure 23 shows the result of SAP provisioning.

Figure 23. Result of SAP provisioning
Multitenancy, resource scaling, and chargeback

Overview

This section describes how these capabilities are implemented in an EMC Hybrid Cloud for SAP in a hybrid cloud environment. To implement this whole model, follow this general procedure:

1. Create tenants and business groups in vCAC.
2. Segregate the resources into business group using the reservation.
3. Configure ITBM for service measurement and chargeback.

To display these functionalities, we validated these characteristics in the EMC Hybrid Cloud for SAP platform. The results are shown in a later section.

Create tenants and business groups in vCAC

EMC Hybrid Cloud’s computing resources are pooled to serve multiple consumers using a multitenant model. vCAC groups the resources into two tiers:

- **Tenants** that represent different companies
- **Business groups** that represent different business units or entities under the same tenant or different departments (such as Finance, Human Resources, or Operations).

While the use of tenants and business groups is usually considered on a case-by-case basis, medium to large-scale SAP environments will benefit from a tenant business group model in many ways, such as:

- **Individual billing** – OPEX can be billed accurately to the department (business group), and not as a single consolidated cost to the organization’s IT department (tenant). Individual billing encourages each department to use cloud resources more efficiently and to avoid unnecessary charges.

- **Increased business data security** – For example, it is obvious that we want to separate the data of Company A and Company B (tenant). However, we may also opt to prevent access of any other business group to the HR SAP systems that contain the employees’ payroll details as an added security layer.

This multitenant model is implemented at the computing, storage, and network level environments, so that each tenant uses the same physical resource pool, while tenants remain virtually exclusive from each other.

Segregate the resources into business group using the reservation

A proper segregation of resources is critical to secure the SAP business data of every tenant.

In EMC Hybrid Cloud’s multitenancy model, the tenants’ SAP systems initially share the same physical resources. vCAC assigns, distributes, and reallocates resources to different tenants/business groups on a per-use basis. Unused resources can be reclaimed back to the pool. To segregate the resources and map them to the multitenancy model, take the following steps:

1. Create the following users and groups in LDAP:
   - Tenant admins for each tenant
- IaaS admins for each tenant
- Business group admins for each business group
- Business group users for each business group

2. Log in to vCAC self-service portal as administrator@vsphere.local.

3. Create tenants based on business requirements. Assign cloud admins and IaaS admins for each tenant.

4. For each tenant, log into the vCAC self-service portal as a tenant IaaS admin.

5. Create a fabric group that contains the compute and storage resources required for each tenant.

6. Log into the vCAC self-service portal as a tenant cloud admin.

7. Create business groups and reservations on top of the compute resources allocated by the IaaS admin.

**Configure ITBM for service measurement and chargeback**

ITBM keeps track of the resource usage and other cloud capabilities used by tenants over time. ITBM quantifies these IT operations as metered “services.” These metered services/additional resources can be associated with a monetary cost that the Cloud Administrator can then bill to tenants, known as chargeback.

EMC Hybrid Cloud’s chargeback mechanisms can benefit SAP customers in the following ways:

- SAP tenants can scale out and scale in their compute and storage reservations on demand, but only pay for what they use.

- The chargeback is calculated on the following:
  - Server hardware
  - Storage
  - OS licensing
  - Maintenance
  - Labor
  - Network
  - Facilities
  - Other costs

To create a chargeback model, refer to *EMC Hybrid Cloud Solution with VMware: Foundation Infrastructure Solution Guide 2.5*.

To apply a chargeback model to the segregated resources and associate the chargeback to the multitenancy model, ensure that each virtual machine is sorted according to its tenant and business group by folder in the vCenter.
**Test scenario**

The HR business group in Tenant A provisioned an SAP HR training system on EMC Hybrid Cloud. Due to an increase in the number of users, the compute and storage resources are insufficient to meet their needs. The SAP HR system owner decides to increase CPU, memory, and storage through the EMC Hybrid Cloud self-service portal. After the training period, the system is no longer needed. The SAP HR system owner decommissions the virtual machine. Table 7 lists the required resource increase.

**Table 7. Resource scaling**

<table>
<thead>
<tr>
<th>Resource</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of vCPUs</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Memory</td>
<td>16 GB</td>
<td>32 GB</td>
</tr>
<tr>
<td>Storage</td>
<td>264 GB</td>
<td>364 GB</td>
</tr>
</tbody>
</table>

**Test objective**

The use case shows the process of expanding and decommissioning the compute and storage resources through the EMC Hybrid Cloud self-service portal. The resources are allocated or reclaimed on demand.

**Test procedure**

Follow these instructions to expand the compute and storage resources for this scenario:

1. Log into vCAC portal as business group user.
2. Navigate to the SAP HR system and change the parameters according to Table 7. Apply the changes and reboot the virtual machine.
3. Update the memory-related parameter values in DB and SAP.
4. Add the new disk to the volume group at the OS and expand the database file system.
5. Start the SAP system and keep it running for a few days.
6. Decommission the SAP HR system.

**Test results**

The compute and storage resources of the SAP HR system were successfully expanded and decommissioned. The physical resources were allocated and reclaimed accurately.
Figure 24 shows how the compute and storage resource are expanded in the EMC Hybrid Cloud self-service portal.

**Figure 24.** Expanding compute and storage resources in the EMC Hybrid Cloud self-service portal
The physical resources are dynamically allocated or reclaimed as depicted in Figure 25.

Figure 25. Physical resource allocation

Validation use case: chargeback

Test scenario
Using the previous test scenario, the administrator wants to find out what the new cost of the system will be after expanding the resources and decommissioning.

Test objective
To show that chargeback was automatically updated to accurately reflect the resource usage, and to present a cost comparison before and after the resource scaling.

Test procedure
We logged into vCAC portal as a business group admin to test this scenario. We selected Business Management and captured the chargeback report before and after resource scaling.

Test results
As shown in Figure 26, the ITBM was able to capture the resource scaling of the SAP HR system. The amount of CPU, memory, and storage was changed after expansion. The total monthly cost is calculated based on average utilization. Therefore there was no significant charge increase because the expanded resources were not fully utilized.
**Note:** The expected CPU and memory utilization of the whole virtual infrastructure affects the base rate card computation. For example, if the expected CPU utilization is 75 percent, then the full cost is allocated for 75 percent of the resources. That means 25 percent is reserved for peaking. Also once the utilization exceeds the expected utilization then the cost starts coming down proportionately. If the actual utilization is less than the expected utilization then there is some unused capacity and cost associated with it.

---

### Figure 26. Chargeback report comparison

#### Before expansion

<table>
<thead>
<tr>
<th>TenantA - Virtual Machines</th>
<th># of Vcpu</th>
<th>CPU Usage (GHz)</th>
<th>RAM Cost ($)</th>
<th>RAM Usage (GB)</th>
<th>Storage Cost ($)</th>
<th>Storage Usage (GB)</th>
<th>Direct VM Cost</th>
<th>Total ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>saphr6-40Y44EJ6</td>
<td>4</td>
<td>0.97</td>
<td>$0.79</td>
<td>15.17</td>
<td>$11.26</td>
<td>169.16</td>
<td>$49.40</td>
<td>$66</td>
</tr>
<tr>
<td>saphr6-A9D97C4S</td>
<td>4</td>
<td>0.99</td>
<td>$0.79</td>
<td>15.29</td>
<td>$11.30</td>
<td>169.45</td>
<td>$49.40</td>
<td>$66</td>
</tr>
<tr>
<td>saphr6-VUY7000R</td>
<td>8</td>
<td>0.00</td>
<td>$0.00</td>
<td>0.00</td>
<td>$4.96</td>
<td>148.84</td>
<td>$49.40</td>
<td>$54</td>
</tr>
</tbody>
</table>

**Total:** $1,276

#### After expansion

<table>
<thead>
<tr>
<th>TenantA - Virtual Machines</th>
<th># of Vcpu</th>
<th>CPU Usage (GHz)</th>
<th>RAM Cost ($)</th>
<th>RAM Usage (GB)</th>
<th>Storage Cost ($)</th>
<th>Storage Usage (GB)</th>
<th>Direct VM Cost</th>
<th>Total ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>saphr6-40Y44EJ6</td>
<td>4</td>
<td>0.54</td>
<td>$1.61</td>
<td>15.50</td>
<td>$20.08</td>
<td>200.77</td>
<td>$49.40</td>
<td>$76</td>
</tr>
<tr>
<td>saphr6-A9D97C4S</td>
<td>8</td>
<td>0.56</td>
<td>$1.62</td>
<td>15.57</td>
<td>$21.14</td>
<td>211.36</td>
<td>$49.40</td>
<td>$77</td>
</tr>
<tr>
<td>saphr6-VUY7000R</td>
<td>8</td>
<td>0.73</td>
<td>$1.59</td>
<td>30.60</td>
<td>$13.77</td>
<td>206.48</td>
<td>$49.40</td>
<td>$68</td>
</tr>
</tbody>
</table>

**Total:** $1,549
Networking and security

Overview

This chapter provides an introduction to the network and security design of the NSX and vCNS platforms, and the network and security integration of an EMC Hybrid Cloud solution for SAP. Use this chapter as a reference to begin the networking, security planning and design process for your hybrid cloud.

The following designs will be demonstrated:

- How SAP applications can communicate securely across the hybrid cloud
- How SAP application networks can address data security by isolating different tenants/business groups

Solution architecture

In designing the physical architecture, our main considerations are: security, high availability, performance, and scalability. As shown in Figure 27, each layer is fault tolerant with physically redundant connectivity throughout. The loss of any one infrastructure component or link does not result in a loss of service to the tenant. If the architecture is scaled appropriately, the loss of a component or link does not impact service performance.

Logical network topology

The logical topology is designed to address the requirements of enabling multitenancy and securing separation between the two cloud environments, and between tenants and business groups in EMC Hybrid Cloud. The topology is also designed to align with security best practices to segment the networks according to the purpose or traffic type.

Figure 27 shows the logical topology of the physical and virtual networks defined in the EMC Hybrid Cloud solution for SAP.
Valid concerns exist around information leakage and unauthorized access on a shared network infrastructure. Provisioned resource users need to operate in a dedicated environment. They also benefit from infrastructure standardization. To address these needs, the EMC Hybrid Cloud solution was designed with multitenancy in mind. The Solution Guide takes a defense-in-depth approach in the following way:

- Implementation of VLANs to enable isolation at Layer 2 in the cloud management pod, and where the solution intersects with the physical network.
- Use of VXLAN overlay networks to segment tenant and business group traffic flows.
- Integration with firewalls that are functioning at the hypervisor level to protect virtualized applications, and enable security policy enforcement in a consistent fashion throughout the solution.
- Deployment of provider and business group Edge firewalls to protect the business group and tenant perimeters

In this solution, we assigned subnets to predefined business groups on which the firewall rules can be based.

To validate this solution on an SAP cloud environment, we built two hybrid clouds with the vCD-managed cloud using vCNS, and the EMC Hybrid Cloud environment using NSX.

**Test scenario**
In this scenario, we used a VPN to set up the connection between the two cloud environments. The default configuration for our environment was that only virtual machines belonging to the same business group were allowed. More detailed rules can always be set, depending on requirements.

Figure 28 shows the test environment for segregating business data within the two cloud environments.
Figure 28. Sample scenario

For brevity, we only tested the systems in blue. Table 8 shows the detailed information about the SAP systems that we tested.

Table 8. Detailed information about SAP systems

<table>
<thead>
<tr>
<th>SID</th>
<th>IP Address</th>
<th>Cloud Endpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>ED1</td>
<td>192.168.101.5</td>
<td>vCloud Director Environment</td>
</tr>
<tr>
<td>EQ1</td>
<td>192.168.101.6</td>
<td>vCloud Director Environment</td>
</tr>
<tr>
<td>EP1</td>
<td>192.168.170.100</td>
<td>EMC Hybrid Cloud Environment</td>
</tr>
<tr>
<td>HRP</td>
<td>192.168.171.103</td>
<td>EMC Hybrid Cloud Environment</td>
</tr>
<tr>
<td>PIP</td>
<td>192.168.180.101</td>
<td>EMC Hybrid Cloud Environment</td>
</tr>
</tbody>
</table>

Test objectives

The use case validates the following tests:

- EMC Hybrid Cloud can ALLOW connectivity across the two clouds if the virtual machines belong to the same business group.
- EMC Hybrid Cloud can BLOCK all external connectivity outside its business group/tenant.
- EMC Hybrid Cloud can be flexible enough to make exemptions to the rules.
Test procedure

The validation is summarized by the following procedure:

1. Configure Edge in the EMC Hybrid Cloud environment.
2. Configure Edge in the vCD environment.
3. Set up the VPN Tunnel between the two clouds.
4. Configure the firewall rule on Edge as shown in Figure 29.
5. Deploy the systems in two different clouds.

Test results

We created an RFC connection from EQ1 (vCD-managed cloud) to EP1 (EMC Hybrid Cloud) using t-code SM59. The connection test succeeded as shown in Figure 29. The firewall also captured the network packets and logged the detailed connection information.

![Figure 29. Connection allowed between different cloud environments](image)

We then established an STMS transport route as shown in Figure 30.

![Figure 30. Connection between ED1, EQ1, and EP1](image)

We created firewall rules in the Edge to control the access to the SAP system. The rules enabled us to define each of the SAP systems’ access rules to enhance the network security and monitor firewall logs.
Figure 31 shows the firewall rules from PIP to EP1. The rules below show that all traffic to EP1 is blocked from PIP, except the RFC protocol, which uses TCP port 3300.

<table>
<thead>
<tr>
<th>Rule Description</th>
<th>Source IP</th>
<th>Destination IP</th>
<th>Service Port</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finance-VCD_to_Finance-EHC</td>
<td>192.168.101.0/24</td>
<td>192.168.176.0/24</td>
<td>any</td>
<td>Accept</td>
</tr>
<tr>
<td>Sales-EHC_to_Finance-EHC</td>
<td>192.168.196.0/24</td>
<td>192.168.176.0/24</td>
<td>any</td>
<td>Accept</td>
</tr>
<tr>
<td>Default Rule</td>
<td>any</td>
<td>any</td>
<td>any</td>
<td>Deny</td>
</tr>
<tr>
<td>Finance-VCD_to_Finance-EHC</td>
<td>192.168.161.0/24</td>
<td>192.168.170.0/24</td>
<td>any</td>
<td>Accept</td>
</tr>
<tr>
<td>Sales-EHC_to_Finance-EHC</td>
<td>192.168.190.0/24</td>
<td>192.168.170.0/24</td>
<td>any</td>
<td>Accept</td>
</tr>
<tr>
<td>Default Rule</td>
<td>any</td>
<td>any</td>
<td>any</td>
<td>Deny</td>
</tr>
</tbody>
</table>

**Figure 31. Firewall rules**

We tested two RFC connections from PIP to EP1. As shown in Figure 32, the connection between PIP and EP1 was blocked except for the RFC port 3300. The firewall also captured the network packet and logged the detailed connection information.

**Test results for firewall rules**

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Table 9 summarizes the test results. EMC Hybrid Cloud for SAP is capable of securing your data at the level that is required across different clouds, without impacting productivity.

**Table 9. Use case test result**

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Expected</th>
<th>Result</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ED1</td>
<td>EQ1</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Passed</td>
</tr>
<tr>
<td>EQ1</td>
<td>EP1</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Passed</td>
</tr>
<tr>
<td>EQ1</td>
<td>HRP</td>
<td>Blocked</td>
<td>Blocked</td>
<td>Passed</td>
</tr>
<tr>
<td>EP1</td>
<td>HRP</td>
<td>Blocked</td>
<td>Blocked</td>
<td>Passed</td>
</tr>
<tr>
<td>HRP</td>
<td>EP1</td>
<td>Blocked</td>
<td>Blocked</td>
<td>Passed</td>
</tr>
<tr>
<td>PIP</td>
<td>HRP</td>
<td>Blocked</td>
<td>Blocked</td>
<td>Passed</td>
</tr>
<tr>
<td>PIP</td>
<td>EP1</td>
<td>Blocked except port 3300</td>
<td>Blocked except port 3300</td>
<td>Passed</td>
</tr>
</tbody>
</table>
Cloud monitoring and root-cause analysis

Overview

Multiple management interfaces used to gather performance and capacity information are not a practical solution when you maintain tens to hundreds of SAP systems. Using multiple management interfaces is time-consuming and often results in mismanaged resources. These challenges require end-to-end visibility (from backend storage to SAP application level) across the entire cloud.

This section shows how an integrated management solution—powered by EMC ViPR SRM and vC Ops technologies - provides service assurance by using management automation to the cloud administrator or a tenant admin:

- Obtain virtualized data center visibility (ViPR SRM)
- Enable system efficiency and maintain IT compliance to standards and best practices (ViPR SRM)
- Customized and intelligent views and reports to get detailed information (ViPR SRM+vC Ops)

Real-time performance monitoring and analysis

SAP tenant administrators can use role-based performance dashboards to analyze individual metric behaviors and determine the health of an enterprise, in part or as a whole. An SAP adapter enables vC Ops to collect SAP performance metrics (for example, CPU, Memory, and response time KPIs measured in ST03N, ST02, and ST06). It provides a unified view of the health, risk, and efficiency of the infrastructure and the health of SAP applications. Real-time monitoring, displayed as widgets, improves the quality of service and provides early detection of issues related to performance, capacity, and configuration.

Figure 33 shows an example of a customized dashboard for the SAP tenant administrator.
Figure 33. vC Ops performance dashboard for SAP tenant admin

There are two SAP system statistics shown.

The widgets in this example are numbered from 1 to 6 and display:

1. Health overview shows the health status of several SAP systems belonging to a tenant.

2. SAP system real-time KPIs include the following counters:
   - SAP Dialog response time
   - Database response time
   - Total online SAP users
   - Batch utilization

3. Tenant generic scoreboard shows the workload and read/write latency of the DX1 and EP1 systems.

4. Metric graph of the DX1 and EP1 systems showing:
   - CPU utilization
   - Space usage under the /oracle folder
     - The blue line indicates that the file system of DX1 systems is full, and the tenant administrator can reclaim the space or assign more space to the /oracle folder.
   - Swap space usage

5. Health workload scorecard.
6. Health tree of Tenant A’s SAP application instances.

**EMC ViPR integration**

As shown in Figure 34, ViPR SRM provides a global view via a dashboard of the underlying ViPR infrastructure. This allows cloud administrators to easily monitor each virtual array’s capacity and utilization, virtual pool, and tenants.

**ViPR Summary**

<table>
<thead>
<tr>
<th>System</th>
<th>IP address</th>
<th>Tenants</th>
<th>Projects</th>
<th>Virtual Arrays</th>
<th>Virtual Pools</th>
<th>Block Volumes</th>
<th>File Systems</th>
<th>Data Stores</th>
<th>Usable Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMC-ViPR</td>
<td>192.168.221.38</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>270.57 TB</td>
<td></td>
</tr>
</tbody>
</table>

**Virtual Pool Capacity**

**Virtual Array Capacity**

**Tenants Provisioned Capacity**

Figure 34. ViPR dashboard in EMC ViPR SRM

**Reporting**

EMC Hybrid Cloud for SAP provides various reports which enable cloud administrators to see:

- How much storage is in use
- Which pool is oversubscribed
- Which components in the cloud environments have high CPU utilization, high memory utilization, and high traffic utilization
- Which file systems are oversized
- How much time remains until new investments are necessary

These reports enable cloud administrators to balance the workload or add more resources to meet SLAs.

Figure 35 shows the usage of Storage Pool 0 and Pool 1 in VNX5300-1432 has reached 91%. This information suggests that you may need to add more disks to this pool, or create a new pool to prepare for the future growth of data.
Each file system of saperp_DB contains at least 250 GB of never-used free space. The report provides better sizing insight to how reduce unnecessary storage allocation.

**Situations to Watch / Storage Reclamation: Oversized FileSystems**

December 2013 × June 2014, the 13 at 5:10 PM CST  |  Last Semester

All File Systems with a free capacity > 100GB, and never had to use it for the last 6 months.

**Situations to Watch / Compliance: Pool Oversubscription**

June 2014, Friday 6 × Friday 13, 5:09 PM CST  |  Last 1 Week

Configuration changes that are not compliant with best practices or with the EMC Support Matrix can lead to application outages. EMC Hybrid Cloud automates the process of validating the storage infrastructure's configuration against EMC's proven best practices. The dashboard is shown in Figure 32.

**Storage Compliance / Breach Report**

2014, May × June, the 6 at 2:00 PM CST  |  Last 1 Month

**Figure 35.** Oversized filesystems and pool oversubscription Report in EMC ViPR SRM

**Figure 36.** Storage compliance and breach report in EMC ViPR SRM
EMC ViPR SRM alerting

As shown in Figure 37, EMC ViPR SRM consolidates all alerts from all sources in one Alert Dashboard. The Cloud Administrator can easily monitor all alerts from hosts, SAN switches and storages from a single dashboard, avoiding potential issues before they occur.

**Alerts / Dashboard**

June 2014, Wednesday 11 x Wednesday 18, 11:32 AM CET | Last 1 Week: count on 7 day

The Alerts Dashboard is generated for the aggregate of all alerts consolidated from all sources, and not the aggregate of unique alerts. Therefore, the number of alerts in the Alerts Dashboard could be equal to or more than the number of alerts shown in the All Alerts report.

**Figure 37.** Alerts dashboard in EMC ViPR SRM

Scheduling and sending report through emails

You can automatically schedule and send all ViPR SRM reports to the email address specified in your recipients’ settings with the format that the operator prefers, as shown in Figure 38.
To deploy the ViPR SRM to manage the whole data take the following steps:

1. Deploy the ViPR SRM as a virtual appliance in a VMware environment or Install the ViPR SRM core software on Linux or Windows Server.
2. Log into the ViPR SRM GUI and apply the core suite licenses
3. Enable the SNMPv1 on the SAN switch to support switch discovery, data collection, and alert consolidation.
4. Install and configure EMC SMI-S to support EMC VMAX data collection
5. Install and configure the required solution package for each of the following:
   a. Solution Package for SAN Switch
   b. Solution Package for EMC ViPR
   c. Solution Package for EMC VMAX
   d. Solution Package for EMC VNX
   e. Solution Package for VMware vCenter
6. Install vCenter Operations Manager.
7. Install and configure the SAP adapter.
8. Customize the dashboard in vCenter Operations Manager.
Validation use case

Test scenario

In this use case, we simulated an SAP system that was experiencing an abnormally high workload. The simulation demonstrates how a tenant administrator can monitor the SAP systems in real-time and coordinate with the cloud administrator to perform an end-to-end root-cause analysis.

Test procedure and results

The monitoring and root-cause analysis procedure and the derived conclusion are explained in the following section.

Monitoring the SAP application

We logged into vC Ops to monitor Tenant A’s SAP systems to identify the affected area. As shown in Figure 39, EP1’s dialog response time reached 1,124 ms and DB response time reached 785 ms while DX1’s dialog response time reached 1,292 ms and DB response time reached 986 ms. On the workload generic scoreboard, EP1’s workload reached 21,225 IOPS and DX1 workload reached 20,609 IOPS. The EP1 and DX1 workloads had high disk latency, but CPU and memory utilization were acceptable.

![Figure 39. Tenant_A’s SAP system DX1 and EP1 performance dashboard](image)

Identifying the topology path from virtual machine to storage

To efficiently locate the ESXi host and the storage of the affected virtual machine, we quickly retrieved an end-to-end view of the relationship between the virtual machine (saperp6-9V0YQYU) and storage in ViPR SRM, as shown in Figure 40. The virtual machine on the C460-22 ESXi server was connected to the VNX storage (VNX2-2852) through two fabric switches.
Next, we examined more details about the virtual machine, ESXi host, fabric switches, and array. By clicking each of these objects and selecting CPU, memory, and storage performance, we could detect performance irregularities through the trends that the KPI charts in Figure 41.

**End-to-end detailed performance analysis of the affected virtual machine**

*Figure 40. End-to-end view from the virtual machine to storage*
Figure 41. Performance dashboard on EMC ViPR SRM

Figure 41 above shows the performance dashboards that relate to the SAP system in EMC ViPR SRM. The widgets comprising the dashboard are numbered from 1 to 3 and show:

1. CPU and memory usage on the ESXi server which hosts SAP systems
2. FC port throughput on the SAN switch that is used by the ESXi server
3. Disk response time, utilization, and IOPS on the storage

As shown in Table 10 we analyzed virtual-machine-to-array end-to-end performance using EMC ViPR SRM and detected the following performance activities.

Table 10. Virtual-machine-to-array performance analysis in EMC ViPR SRM

<table>
<thead>
<tr>
<th>Component</th>
<th>Measure</th>
<th>Value</th>
<th>Normal values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual machine (saperp6-9VOYQYU)</td>
<td>CPU utilization</td>
<td>71%</td>
<td>&lt; 80%</td>
</tr>
<tr>
<td></td>
<td>IOPS</td>
<td>22,000</td>
<td>(informational)</td>
</tr>
<tr>
<td>ESXi server</td>
<td>CPU utilization</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Memory Utilization</td>
<td>53%</td>
<td></td>
</tr>
<tr>
<td>SAN switch</td>
<td>Port Throughput</td>
<td>750 MB/s</td>
<td></td>
</tr>
<tr>
<td>Component</td>
<td>Measure</td>
<td>Value</td>
<td>Normal values</td>
</tr>
<tr>
<td>-----------</td>
<td>------------------</td>
<td>----------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td></td>
<td>Port link status</td>
<td>No link failure, no signal loss</td>
<td>No failure</td>
</tr>
<tr>
<td>Array</td>
<td>SP Utilization</td>
<td>SPA: 50% SPB: 54%</td>
<td>&lt;70%</td>
</tr>
<tr>
<td></td>
<td>SP dirty page</td>
<td>80%</td>
<td>&lt;100%</td>
</tr>
<tr>
<td></td>
<td>SP total throughput</td>
<td>42,665 IOPS</td>
<td>(informational)</td>
</tr>
<tr>
<td>Disk IOPS</td>
<td>125 IOPS/disk</td>
<td>≤80 for NL_SAS</td>
<td></td>
</tr>
<tr>
<td>Disk Latency</td>
<td>14 ms</td>
<td>≤10 ms</td>
<td></td>
</tr>
</tbody>
</table>

The virtual machine’s I/O reached 22,000 IOPS. However, the virtual machine's CPU utilization was 71 percent. The virtual machine's CPU did not cause the bottleneck, and the administrator proceeded to the host level.

The ESXi host and SAN switch showed similar behavior to that of the virtual machine chart. The CPU and switch port utilization were both acceptable. Neither the ESXi host nor the switches caused the bottleneck, and the administrator proceeded to the array level.

The array’s SPA and SPB utilization were 50% and 54% respectively, with no force flush (100% dirty page), so the array’s SPs were healthy. But when we looked at the disks in the storage pool used by this SAP system, each NL_SAS disk I/O reached up to 125 IOPS, and the response time was about 14 ms. Therefore, we concluded that this is a storage-level issue.

**Root cause**

The root cause for the performance degradation was that the NL_SAS storage pool used is not sufficient to handle the workload of the two SAP systems. The average disk IOPS reached 125, which exceeds the prescribed workload of 80 IOPS for an NL_SAS disk. This resulted in high disk latency on the disk layer, leading to high SAP dialog response time.

EMC recommends that you add more SAS or Flash disks in this pool, or migrate some SAP systems to a higher storage service level (for example VNX SAS tier) to resolve this issue.
Conclusion

EMC Hybrid Cloud enables an IT organization to balance the criticality requirements versus the TCO of each SAP virtual machine in the environment, while maintaining management autonomy and data privacy.

EMC Hybrid Cloud demonstrates higher operational efficiency for the following:

- **Administration** – EMC Hybrid Cloud allows you to connect to a private and a public cloud, such as vCloud Director-based clouds, vSphere-based clouds, and Amazon Elastic Compute Cloud (Amazon EC2). You can select which cloud environment to provision an SAP system based on its criticality and cost priority.

- **Multitenancy, resource scaling, and chargeback** – EMC Hybrid Cloud provides a tenant-business group segregation scheme to enable better and more detailed management options and accurate billing.

- **Security** – EMC Hybrid Cloud offers an easy way to implement network and security rules that can be mapped to a two-tier multitenancy model and across different cloud environments.

- **Self-service provisioning** – EMC Hybrid Cloud provides tools that can automate virtual machine lifecycle processes, such as the creation of a virtual machine, up to installing a full SAP system, greatly reducing the manual effort required to do similar tasks.

- **Migration** – EMC Hybrid Cloud allows you to migrate and transform SAP systems into an EMC Hybrid Cloud-ready virtual machine with a few clicks.

- **Cloud monitoring and root-cause analysis** – EMC Hybrid Cloud gives you full and user-friendly visibility across all components in the EMC Hybrid Cloud environment, from the storage level all the way up to SAP level.
### Appendixes

#### Appendix A: Table of vCAC properties

Table 10 lists the vCAD properties that we defined in our solution. When a property is marked as both Required and Overridable, this unlocks a particular property for user input in the service catalog.

**Table 11. List of variables to be entered as vCAD properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
<th>Type</th>
<th>Default value</th>
<th>Required</th>
<th>Secured</th>
<th>Overridable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hostname</td>
<td>Hostname of the virtual machine</td>
<td>String</td>
<td>-</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>FQDN</td>
<td>Fully qualified domain name of the virtual machine</td>
<td>String</td>
<td>-</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>SAP_SID</td>
<td>SID of SAP system</td>
<td>String</td>
<td>-</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Master_Password</td>
<td>Master password for SAP system</td>
<td>String</td>
<td>-</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>INST_MOUNT</td>
<td>Local Path for mounting SAP installation media</td>
<td>String</td>
<td>/sapmedia</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>NFS_SERVER</td>
<td>IP or DNS name of the NFS server</td>
<td>String</td>
<td>192.168.150.15:/nfsshare/nw74_lnxora</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>SAPCAR</td>
<td>SAPCAR executable</td>
<td>String</td>
<td>$(INST_MOUNT)/SAPCAR</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>ORACLE_BASE</td>
<td>Oracle base path</td>
<td>String</td>
<td>/oracle</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>ORACLE_VER</td>
<td>Oracle version, used to compose path of Oracle Stage</td>
<td>String</td>
<td>112_64</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>ORACLE_SAR</td>
<td>Path of Oracle SAR files</td>
<td>String</td>
<td>$(INST_MOUNT)/oradbms11203lnx</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>INI_FILE</td>
<td>Path of inifile</td>
<td>String</td>
<td>$(INST_MOUNT)/inifile</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>SWPM_SAPINST</td>
<td>Path SWPM</td>
<td>String</td>
<td>$(INST_MOUNT)/swpm</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>SAP_WORKDIR</td>
<td>SAP work dir for unattended installation</td>
<td>String</td>
<td>/unattended</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>PRODUCT_ID</td>
<td>SAP Product ID</td>
<td>String</td>
<td>NW_ABAP_O neHost:NW740SR1.OR.A.PI</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Property</td>
<td>Description</td>
<td>Type</td>
<td>Default value</td>
<td>Required</td>
<td>Secured</td>
<td>Overridable</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------------</td>
<td>-----------</td>
<td>---------------</td>
<td>----------</td>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>FS_ORACLE_SIZE</td>
<td>Size of /oracle</td>
<td>Computed</td>
<td>N/A</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>FS_SAPMNT_SIZE</td>
<td>Size of /sapmnt</td>
<td>Computed</td>
<td>N/A</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>FS_USRSAP_SIZE</td>
<td>Size of /usr.sap</td>
<td>Computed</td>
<td>N/A</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
We provide a detailed workflow to serve as guideline. You can develop your own scripts based on the following procedure.

**Note:** You can use the Linux command sed to find and replace the placeholder `<INST_MOUNT>` with `$INST_MOUNT`.

1. Change the root password (use $Master_Password as the placeholder)
2. Back up `/etc/hosts`
3. Rename the hostname in `/etc/HOSTNAME` and `/etc/hosts` (use $Hostname as the placeholder).
4. Comment the lines that begin with 127.0.0.1 in the `/etc/hosts`.
5. Prepare, create, and mount the following file systems
   ```
   /oracle
   /sapmnt
   /usr/sap
   ```
   Use vgcreate, lvcreate, mkfs, mount; use $vg_name, $device as placeholders for volume group and device, respectively. Observe proper file system sizing.

6. Set the following Oracle and SAP parameters in `/etc/sysctl.conf`:
   ```
   kernel.shmmax = 4096
   fs.file-max = 6815744
   fs.aio-max-nr = 1048576
   net.ipv4.ip_local_port_range = 9000 65300
   net.core.rmem_default = 262144
   net.core.rmem_max = 4194304
   net.core.wmem_default = 262144
   net.core.wmem_max = 1048576
   ```

7. Create the following user groups (use groupadd):
   ```
   sapinst
dba
oper
   ```

8. Create the Oracle user ora$SAP_SID, assign the three user groups created previously, and home directory to `/ oracle/$SAP_SID`.

9. Create the following folders and assign to group sapinst (Use $ORACLE_VER for Oracle version as placeholder)
   ```
   /oracle/stage
   /oracle/stage/$ORACLE_VER
   ```

10. Create the folder $SAP_WORKDIR. Assign to group sapinst with permission 775.

11. Create the folder $SAP_WORKDIR/inifile where the files needed for unattended installation will be copied later.

12. Change ownership of `/oracle` to $oracle_user:dba.
13. Create /oracle/$SAP_SID and assign to $oracle_user:dba.

14. Mount the file system containing the installation media in read-only mode (use $NFS_SERVER and $INST_MOUNT as placeholders for NFS server path and local mount point name respectively).

15. Extract the Oracle installation files from $ORACLE_SAR to $oracle_stage using sapcar. Ensure that sapcar already exists in the $ORACLE_SAR.

16. Switch to the orasid user and run RUNINSTALLER to trigger Oracle silent installation and post install steps. (Use $SAP_SID, $oracle_stage, $ORACLE_BASE as placeholders for SID, staging folder and the Oracle base folders, respectively), using the following example:

   su - $oracle_user -c "setenv DB_SID $SAP_SID;$oracle_stage/database/SAP/RUNINSTALLER oracle_base $ORACLE_BASE -silent -nocheck"
   /oracle/oraInventory/orainstRoot.sh
   /oracle/$SAP_SID/$ORACLE_VER/root.sh

17. Copy the configuration files for SAP unattended installation from $INI_FILE to $SAP_WORKDIR/inifile/

18. Replace the entries in start_dir.cd with absolute paths to the installation media (tip: you can use the Linux command sed to find and replace the placeholder <INST_MOUNT> with $INST_MOUNT).

19. Backup the file $SAPWORKDIR/inifiles/inifile.xml and replace entries in it with $HOSTNAME, $SAP_SID, $MASTER_PASSWORD, $FQDN.

20. Calculate the number of R3load jobs based on the number of vCPUs, or use the default value of 3.

21. Run the SAP unattended installation. The command is (type in one continuous line):

   $SWPM_DIR/sapinst
   SAPINST_PARAMETER_CONTAINER_URL="$SAP_WORKDIR/inifile/inifile.xml" SAPINST_CWD="$SAP_WORKDIR"
   SAPINST_EXECUTE_PRODUCT_ID=$PRODUCT_ID
   SAPINST_SKIP_DIALOGS=true -nogui -noguiserver

22. Remove all temporary installation files and the inifiles that contained the master password, and unmount the installation NFS folder.
This procedure is based on *SAP note 950619 - Installation of SAP Systems with Unattended Mode* (in SWPM). We include some steps that were not documented in the original note.

Running an SAP silent installation requires certain files to be generated and customized before use. These files are:

- `inifile.xml` - stores all parameters needed for SAP installation
- `keydb.dtd` - needed to parse `inifile.xml`
- `doc.dtd` - needed to parse `inifile.xml`
- `keydb.xsl` - needed to parse `inifile.xml`
- `start_dir.cd` - contains the path to the SAP installation media

For this solution, each distinct product installation (for example, NetWeaver 7.0 Central instance, ECC 6.0 EHP 7 App instance, Solman 7.1 database instance) has a unique set of preconfigured files. Generate a new set of files whenever you install a new product. The procedure is as follows.

1. Generate the inifiles:
   a. Run the SAPINST application from the SWPM DVD like a normal installation. For reference, see [http://scn.sap.com/docs/DOC-30236](http://scn.sap.com/docs/DOC-30236). Choose **Custom** installation mode.
   b. Type the values for the different parameters as required. The variables and the hardcoded values that you type, shown in Table 12, will be replaced by placeholders later.

   **Table 12. SAPINST sample hardcoded values**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sample hardcoded value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hostname</td>
<td>sapnwprd1</td>
</tr>
<tr>
<td>SID (SAP &amp; DB)</td>
<td>PR2</td>
</tr>
<tr>
<td>Master Password*</td>
<td>welcome1</td>
</tr>
<tr>
<td>FQDN</td>
<td>sse.ea.emc.com</td>
</tr>
<tr>
<td>Oracle Home</td>
<td>/oracle/PR2/112_64</td>
</tr>
<tr>
<td>Oracle Stage</td>
<td>/oracle/stage/112_64</td>
</tr>
<tr>
<td>Parallel SAPINST jobs</td>
<td>50</td>
</tr>
</tbody>
</table>

c. When you reach the **Parameter Summary** step, cancel SAPINST.

d. Browse to the TMP installation directory (for example, `/tmp/sapinst_instdir/...`) Copy `inifile.xml`, `keydb.dtd`, `doc.dtd`, and `keydb.xsl`. Save to the inifile folder on NFS (for example, `/nfsshare/ecc6slesora/inifile`). You must edit `inifile.xml` and `start_dir.cd` while the rest are unchanged.

e. Edit `inifile.xml` and replace the values that you previously typed with the placeholders shown in Table 13.
### Table 13. Placeholders to use in the scripts

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sample hardcoded value</th>
<th>Replace with these placeholders</th>
<th>Sample number of occurrences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hostname</td>
<td>sapnwprd1</td>
<td>&amp;&amp;HOSTNAME&amp;&amp;</td>
<td>1</td>
</tr>
<tr>
<td>Master Password</td>
<td>des24(221</td>
<td>79</td>
<td>207</td>
</tr>
<tr>
<td>FQDN</td>
<td>sse.ea.emc.com</td>
<td>&amp;&amp;FQDN&amp;&amp;</td>
<td>1</td>
</tr>
<tr>
<td>Oracle Home</td>
<td>/oracle/PR2/112_64</td>
<td>&amp;&amp;ORACLE_HOME&amp;&amp;</td>
<td>1</td>
</tr>
<tr>
<td>Oracle Stage</td>
<td>/oracle/stage/112_64</td>
<td>&amp;&amp;ORACLE_STAGE&amp;&amp;</td>
<td>1</td>
</tr>
<tr>
<td>Parallel SAPINST jobs</td>
<td>50</td>
<td>&amp;&amp;MIGMONJOBS&amp;&amp;</td>
<td>1</td>
</tr>
<tr>
<td>SID (SAP and DB)</td>
<td>PR2</td>
<td>&amp;&amp;SAP_SID&amp;&amp;</td>
<td>77</td>
</tr>
</tbody>
</table>

**Note:** The master password will look encrypted. The infile also accepts plain text for the password. Sample number of occurrences may differ depending on version. The solman key is no longer required to begin or complete the installation.

f. Save the file.

2. Create the media repository lookup file `start_dir.cd`.

   a. Create a file `start_dir.cd` and you must save it in the main `$SAP_WORKDIR` folder.

   b. Edit the file and type the paths to the installation DVDs, including the string `<INST_MOUNT>/`.

   For Linux, if the DVD contains OS-specific folders with its own LABEL.ASC, include that folder in your path.

   This is a sample `start_dir.cd` file:

   ```
   /<INST_MOUNT>/swpm
   /<INST_MOUNT>/kernel/DATA_UNITS/K_741_U_LINUX_X86_64
   /<INST_MOUNT>/exp
   /<INST_MOUNT>/oradbms11203lnx
   /<INST_MOUNT>/oraclient11203/OCL_LINUX_X86_64
   ```

   A separate line is required for each DVD path.

   **Note:** `start_dir.cd` only accepts an absolute path. The placeholder `<SAPINST>` is replaced by the main script later.

   c. Save the file.
3. Find the correct product ID. This will be used by the main script installation later.

The product ID is needed as a primary parameter of SAPINST for silent installation. You have several ways to find it:

- **keydb.xml** – Open the keydb.xml from the installation directory from where you copied the inifiles. Search for the string PRODUCT_ID. You find an entry that looks like the following:

  `<property name="PRODUCT_ID_FROM_CATALOG_FILE" value="NW_ABAP_OneHost:NW700.ADA.CP" />

In this example, the parameter has the value that you need:

  `SAPINST_EXECUTE_PRODUCT_ID=NW_ABAP_OneHost:NW700.ADA.CP`

- **sapinst_dev.log** – Also found in the original installation directory, you can search for the string PRODUCT_ID

- **product.catalog** – This contains the PRODUCT_ID for all the possible installations available in an SWPM DVD.

  The value of the PRODUCT_ID is the value of the PROPERTY $PRODUCT_ID for the script.

4. The general syntax for SAPINST unattended installation mode is:

```
./sapinst SAPINST_PARAMETER_CONTAINER_URL="<path to inifile.xml>" SAPINST_CWD="<path to installation working directory/location of start_dir.cd>"

SAPINST_EXECUTE_PRODUCT_ID=<product/component ID>
SAPINST_SKIP_DIALOGS=true -nogui -noguiserver
```

However, type this command in the main script later:

```
SAPINST_PARAMETER_CONTAINER_URL="$SAP_WORKDIR/inifile/inifile.xml" SAPINST_CWD="$SAP_WORKDIR"
SAPINST_EXECUTE_PRODUCT_ID=$PRODUCT_ID
SAPINST_SKIP_DIALOGS=true -nogui -noguiserver
```

Once this has been completed, you can start creating the master script and incorporate RUNINSTALLER and SAPINST.
The output of this procedure is a deployment profile resulting from the virtual machine provisioning and SAP installation workflow blueprints:

1. Create a virtual machine automation blueprint using vCAC:
   a. Under **Blueprint Information**, set the following parameters:
      - Blueprint options= Shared blueprint
      - Machine prefix = use group default
   b. Under **Build Information**, set the following parameters:
      - Type=server
      - Action=Clone
      - Provisioning Workflow=CloneWorkflow
      - Clone From=(the virtual machine template that you created earlier)
      - Machine resources=(base this on your sizing/capacity analysis)

2. Create an SAP provisioning automation blueprint using vCAD:
   a. Prepare the vCAD blueprint components:
      i. Create/define Cloud Provider: add the vCAC blueprint from the previous step
      ii. Define OS and version (for example, SLES64, OS version 11.3.0)
      iii. Create/define Logical Template, (for example, SLES 11 SP3 for SAP Application) Map the logical template to the Cloud Provider where the blueprint was added.
      iv. Create/define Service (for example, SAP_Standard Installation on Linux/Oracle, v 1.0.0)
         1. Edit Properties. The properties table contains the environment variables that you intend to use to run the installation scripts later. Refer to Appendix A for a sample.
         2. Copy the whole main script that you created and paste it onto the **INSTALL Lifecycle stage entry** under **Actions**.
         3. Create application (for example, SAP ECC 6 EhP 7 ABAP Standard on Linux/Oracle, version 6.0.7)
   b. Assemble the vCAD blueprint.
      i. Create vCAD blueprint.
      ii. From the left panel, drag the logical template created earlier towards the center workspace. A dialog box appears.
      iii. Input name and hostname.

      **Note:** you can use sapecc6-${random} to generate random hostnames.

   iv. Under **Disks**, add new disk (for example, 100 GB)
Drag the service you created earlier towards the center workspace. Create a deployment profile.

(1) Set the deployment profile, application properties, execution plan, and review.

(2) Click Publish.

At this point, the published deployment profile contains the vCAC and vCAD blueprints to automate the virtual machine provisioning and install SAP. However, you need to create a service catalog to provide an authorization-based and user-friendly interface.

3. Create a service catalog in vCAC to serve as the user interface.
   
a. Define Services and create a service (for example, SAP Standard Linux/Oracle). Edit as needed.

b. Define Entitlements and create an entitlement (for example, SAP Provisioning). Edit this as needed. Check the users and groups assigned.

c. Add the service created under Entitled Services. Add entitled Actions as necessary.

d. The vCAD deployment profile you created appears as an entry under vCAC’s Catalog Items.

e. Edit the catalog item and assign the vCAC service you defined previously. The service catalog item is now ready for quick deployment.