Virtualizing Oracle Workloads with VMware vSphere Virtual Volumes on VMware Hybrid Cloud REFERENCE ARCHITECTURE

## Table of contents

Executive Summary	5
Business Case	5
Solution Overview	5
Key Results	5
ntroduction	7
Purpose	7
Audience	7
Terminology	7
Fechnology Overview	7
Overview	7
VMware vSphere	3
VMware vSphere Virtual Volumes (vVols)8	3
vVols Objects	)
VMware Virtual Machine Snapshots	)
VMware Virtual Machine Clones	)
VMware Virtual Disk Provisioning Policies	1
VMware Multi-Writer Attribute for Shared VMDKs12	2
Storage Policy-Based Management (SPBM)13	3
vVols Storage Policy	3
Storage Providers	5
VMware vSphere Metro Storage Cluster (vMSC)	ò
Pure ActiveCluster VMware vSphere Metro Storage Cluster	7
Hybrid and Multi-Cloud as the VMware Cloud	3
VMware Cloud on AWS	3
Pure Storage Cloud Block Store (CBS)	)
Oracle Database Architecture	)
Oracle ASM, ASMLIB and ASMFD	1
Oracle Backup and Recovery	1
Oracle User Managed Database Backup22	2
Oracle Crash-Consistent Backup	2
Oracle RMAN	3
Oracle Database Cloning	3
	Secutive Summary



	Oracle Database Refresh
	Oracle Database Patching
	Considerations for Oracle Database Day 2 Operations
	Oracle Database Day 2 Operations and vVols
	Oracle Real Application Cluster (RAC)
	Extended Oracle RAC
	Oracle RAC on VMware vSphere
	Oracle RAC on VMware Virtual Volumes (vVols)
	Extended Oracle RAC on Pure ActiveCluster vMSC
So	lution Configuration
	Architecture Diagram
	Hardware Resources
	Software Resources
	Network Configuration
	Storage Configuration
	Pure Storage Plugin for VMware vSphere Client
	Virtual Machine and Oracle Configuration
So	lution Validation
	Solution Test Overview
	Oracle Database Backup
	Oracle Backup of Single Instance
	Oracle Backup of RAC
	Oracle Restore and Recovery
	Oracle Restore and Recovery of Single Instance
	Oracle Restore and Recovery of RAC
	Oracle Database Cloning
	Oracle Single-Instance Database
	Oracle RAC
	Oracle Database Refresh
	Oracle Single Instance Database
	Oracle RAC
	Oracle Database Patching
	Oracle Single Instance Database



Oracle RAC
VM Provisioning Using vVols SPBM
Conclusion
Appendix A Oracle Initialization Parameter Configuration
Oracle Initialization Parameters
Reference
White Paper
Product Documentation
Other Documentation
Acknowledgements

## **Executive Summary**

### **Business Case**

Business-critical databases are among the last workloads to be virtualized in most enterprises, primarily because of the challenges posed as workloads grow and scale. In a typical virtualization project, once a proof of concept (POC) is successfully run, development and testing and staging databases come relatively easy, leaving production databases as the final hurdle to overtake.

Customers have successfully run their business-critical Oracle workloads with high performance demands on VMware vSphere\* for many years. Virtualization of mission-critical databases adds layers of complexity to the infrastructure, however, making common operations like backup and recovery, cloning and other day-to-day activities difficult. The most efficient storage operations for mission-critical databases are offloaded to the storage array.

Concerns that often delay virtualization of business-critical database workloads include:

- Difficulties of meeting strict SLAs for performance with typically slow traditional storage.
- Rapid database growth and the need to reduce backup windows to meet performance and business SLAs.
- The size of modern databases makes it harder to regularly clone and refresh data from production to QA and other environments.
- While storage-based replication speed is superior, its array LUN-level granularity causes unnecessary data to be copied over when replicating select databases over metro distance.
- Databases of different levels of criticality need different storage performance characteristics and capabilities.
- Database and systems administrators continue to debate the utility of filesystems versus raw devices and VMware vSphere\* Virtual Machine File System (VMFS) versus Raw Device Mapping, primarily due to deficiencies that existed in the past with virtualization.

#### Solution Overview

VMware vSphere Virtual Volumes<sup>™</sup> (vVols) addresses the business challenges discussed in the previous section regarding businesscritical databases' day-to-day operations like backup and recovery, cloning, and database provisioning.

vVols is an integration and management framework that virtualizes SAN/NAS arrays, enabling a more efficient operational model that is optimized for virtualized environments and centered on the application instead of the infrastructure.

vVols exposes virtual disks as native storage objects and enables array-based operations at the virtual disk level. vVols transform the data plane of SAN/NAS devices by aligning storage consumptions and operations with the VM. In other words, vVols make SAN/NAS devices VM-aware and unlocks the ability to leverage array-based data services with a VM-centric approach at the granularity of a single virtual disk.

vVols allows customers to leverage the unique capabilities of their current storage investments and transition without disruption to a simpler and more efficient operational model optimized for virtual environments that work across all storage types. It simplifies the delivery of storage service levels to individual applications by providing finer control of hardware resources and native array-based data services that can be instantiated with VM granularity.

vVols are very useful for backup and recovery, cloning, enhanced storage policy-based management (SPBM) control and other operations for business-critical databases.



FIGURE 1. VMWARE VSPHERE VIRTUAL VOLUMES OVERVIEW

#### **Key Results**

vVols provides simplicity, speed, performance and granularity of operations to business-critical Oracle workloads in the following ways:

- Flexible consumption at the logical level vVols virtualize SAN and NAS devices by abstracting physical hardware resources into logical pools of capacity (i.e., virtual datastore) that can be flexibly consumed and configured to span a portion of one to several storage arrays. The vVols virtual datastore defines capacity boundaries and access logic and exposes a set of data services accessible to VMs provisioned in the pool. vVols virtual datastores are purely logical constructs that may be configured on the fly – when needed and without disruption – and do not require file system formatting.
- Precise Control at a VM level It becomes possible to execute storage operations with VM granularity and to provision native array-based data services to individual VMs. This allows admins to provide the right storage service levels to each VM. For example, it enables storage-level snapshots with VM granularity due to the fact that every VMDK is natively represented by an independent vVol.
- Efficient Operations through Automation SPBM allows capturing storage service level requirements, such as capability, performance, or availability, in the form of logical templates (policies) to which VMs are associated. SPBM automates VM placement by identifying available datastores that meet policy requirements and, coupled with vVols, dynamically instantiates necessary data services. Through policy enforcement, SPBM also automates service-level monitoring and compliance throughout the lifecycle of the VM.
- **Simplified Storage Operations** For both the virtualization admin and storage admin, vVols greatly simplifies management over the existing operational model. vVols allow the separation of provisioning and consumption of storage for VMs.
- Simplified Delivery of Storage Service Levels With vVols, it is easier to deliver and enable the right storage service levels according to the specific requirements of individual applications. With granular control over storage resources and native array-based data services at the VM level, administrators can create specific policy combinations and precisely deliver storage service levels on a case-by-case basis. Additionally, policy-driven automation enwsures desired service levels are met, and enables dynamic adjustments in real time when needed, making it possible to adapt to ever-changing application and business requirements quickly.
- Improved Resource utilization Precisely mapping application requirements with storage resources when they are needed fundamentally eliminates over-provisioning issues. By virtualizing the storage infrastructure, vVols enables more flexible, VM-centric consumption of storage capacity and data services. Through automation, it enables dynamic adjustments in real time. This is in contrast with the legacy operational model, in which resources had to be pre-allocated and were hard to change, contributing to inefficient upfront investments in capacity and misuse of data services that create inefficient use of infrastructure resources over time.

## Introduction

## Purpose

This reference architecture validates the capability of vVols to provide flexible storage consumption, granularity of control at a VM level, simplicity and efficiency of operations through automation, simplified storage operations and delivery of storage service levels, and improved resource utilization to business-critical Oracle workloads.

### Audience

This reference architecture is intended for Oracle database administrators (DBAs) and virtualization and storage architects involved in planning, architecting, and administering business-critical Oracle environments on the VMware software-defined datacenter (SDDC) platform.

## Terminology

The following terms are used throughout this paper:

Term	Definition
Oracle Single Instance	Oracle Single-Instance database consists of a set of memory structures, background processes, and physical database files, which serves the database users.
Oracle Clusterware	Oracle Clusterware is a portable cluster software that allows clustering of independent servers so that they cooperate as a single system.
Oracle Automatic Storage Management (Oracle ASM)	Oracle ASM is a volume manager and a file system for Oracle database files that support Single-Instance Oracle Database and Oracle Real Application Cluster (RAC) configurations.
Oracle ASMLIB and Oracle ASMFD	Oracle ASMLIB maintains permissions and disk labels that are persistent on the storage device, so that the label is available even after an operating system upgrade. Oracle ASMFD helps prevent corruption in Oracle ASM disks and files within the disk group.

#### TABLE 1. TERMINOLOGY

## Technology Overview

### Overview

This section provides an overview of the technologies used in this solution:

- VMware vSphere<sup>®</sup>
- VMware vSphere<sup>®</sup> Virtual Volumes<sup>™</sup> (vVols)
- VMware vSphere Metro Storage Cluster (vMSC)
- VMware Virtual Disk Provisioning Policies
- VMware Multi-Writer Attribute for Shared VMDKs
- Shared Disks Using vVols
- Storage Policy-Based Management (SPBM)
- vVols Storage Policy



- Oracle Database Architecture
- Oracle ASM, ASMLIB and ASMFD
- Oracle Clusterware
- Oracle Real Application Cluster (RAC)
- Oracle RAC One Node
- Extended Oracle RAC
- Oracle RAC on vVols
- Extended Oracle RAC on vVols

#### VMware vSphere

VMware vSphere, the industry-leading virtualization and cloud platform, is the efficient and secure platform for hybrid clouds, accelerating digital transformation by delivering simple and efficient management at scale, comprehensive built-in security, a universal application platform, and a seamless hybrid cloud experience. The result is a scalable, secure infrastructure that provides enhanced application performance and can be the foundation of any cloud.

As the next-generation infrastructure for next-generation applications, vSphere 7.0 has been rearchitected with native Kubernetes, enabling IT admins to use VMware vCenter Server\* to operate Kubernetes clusters through namespaces. VMware vSphere with Tanzu allows IT admins to leverage their existing skillset to deliver self-service infrastructure access to their DevOps teams, while providing observability and troubleshooting of Kubernetes workloads. vSphere 7 provides an enterprise platform for both traditional and modern applications, enabling customers and partners to deliver a developer-ready infrastructure, scale without compromise, and simplify operations.

Learn more about VMware vSphere 7.0.

#### VMware vSphere Virtual Volumes (vVols)

Historically, vSphere storage management used a datastore-centric approach, with the datastore providing the lowest granularity level for data management. With a single datastore containing multiple VMs, each with its own unique requirements, meeting these individual requirements is difficult.

Using vVols, an individual VM (not the datastore) becomes a unit of storage management, while storage hardware gains complete control over virtual disk content, layout, and management.

vVols helps to improve granularity. It helps to differentiate VM services on a per-application level by offering a new approach to storage management. Rather than arranging storage around features of a storage system, vVols arranges storage around the needs of individual VMs, making storage VM-centric.

vVols maps virtual disks and their derivatives, clones, snapshots, and replicas, directly to objects (i.e., virtual volumes) on a storage system. This mapping allows vSphere to offload intensive storage operations such as snapshot, cloning, and replication to the storage system.

By creating a volume for each virtual disk, policies can be set at the optimal level. One can decide in advance what the storage requirements of an application will be and communicate these requirements to the storage system. The storage system creates an appropriate virtual disk based on these requirements. For example, if the VM requires an active-active storage array, one no longer must select a datastore that supports the active-active model. Instead, one can create an individual vVol that is automatically placed to the active-active array.



#### FIGURE 2. VMWARE VSPHERE CLUSTER WITH VIRTUAL VOLUMES

#### Learn more about VMware Virtual Volumes.

VMware recommends talking with your storage vendor to obtain guidance for vVols implementation, as each vendor accomplishes this differently.

A vVols datastore represents a storage container in vCenter Server and in the vSphere client.

After vCenter Server discovers storage containers exported by storage systems, they must be mounted as vVols datastores. The vVols datastores are not formatted in a traditional (e.g., VMFS datastores). These must be created as all vSphere functionalities (e.g., FT, HA, and DRS) require the datastore construct to function properly.

#### Review VMware Docs and core.vmware.com/vVols to learn more about VMware Virtual Volumes.

#### vVols Objects

vVols are stored natively inside a storage system that is connected to a VMware ESXi<sup>™</sup> host through Ethernet or SAN. They are exported as objects by a compliant storage system and are managed entirely by hardware on the storage side.

Typically, a unique GUID identifies a vVol. vVols are not pre-provisioned but created automatically when VM management operations are performed. These operations include VM creation, cloning, and snapshotting. ESXi and vCenter Server associate one or more vVols with a VM.

The following types of vVols represent the core elements of the VM:

• Data-vVol – A data-vVol corresponds directly to each virtual disk VMDK file. As virtual disk files on traditional datastores, vVols are presented to VMs as SCSI disks. A data-vVol can be thick or thin-provisioned.



- **Config-vVol** A config-vVol, or a home directory, represents a small directory that contains metadata files for a VM. The files include but are not exclusive to a .vmx file, descriptor files for virtual disks, and log files. The configuration vVol is formatted with a file system. When ESXi uses the SCSI protocol to connect to storage, configuration vVols are formatted with VMFS. With NFS protocol, configuration a vVol is presented as an NFS directory. Typically, it is thin-provisioned.
- Swap-vVol The swap-vVol is created when a VM is powered on. It holds copies of VM memory pages that cannot be retained in memory. Its size is determined by the VM's memory size. A swap-vVol is thick-provisioned by default.
- Snapshot-vVol A snapshot-vVol is an array-based snapshot that holds the contents of a VM and memory. It is thick-provisioned.
- Other Other vVol are designed to address specific features. For example, a digest-vVol is created for content-based read cache (CBRC).

Typically, a VM creates a minimum of three vVol: a data-vVol, config-vVol, and swap-vVol. The maximum is determined by the number of virtual disks and snapshots residing on the VM.

By using different vVols for different VM components, admins can apply and manipulate storage policies at the finest level of granularity. For example, a vVol containing a log or database virtual disk can have a richer set of services than a vVol for the VM boot disk. Similarly, a snapshot-vVol can use a different storage tier compared to a current vVol.

Learn more about VMware Virtual Volume object types.

#### VMware Virtual Machine Snapshots

Snapshots preserve the state and data of a VM at the time the snapshot is taken. When a VM snapshot is captured, an image of the VM in a given state is copied and stored. Snapshots are useful when frequently reverting to a particular VM state and creating multiple VMs is undesirable.

Snapshots for Oracle databases on VMware vSphere can be performed in three ways:

- **Database** using Oracle ACFS snapshots, for example, which is an online, read-only or read-write point-in-time copy of an Oracle ACFS file system. See *About Oracle ACFS Snapshots* for detailed information.
- vSphere VM using VMware snapshots.
- Storage using LUN-based snapshots available in a traditional storage array.

VMware vSphere, using VM snapshots, enables users to capture point-in-time state and data of a VM. This includes the VM's storage, memory, and other devices, such as virtual NICs.

Snapshots are useful for creating point-in-time state and data of a VM for backup or archival purposes and for creating test and rollback environments for applications.

#### For further information about using VM snapshots in a vSphere environment, see Using Snapshots To Manage Virtual Machines.

A VM snapshot can be taken through:

- Web Client GUI see Taking a Snapshot for detailed information.
- PowerCLI commands see PowerCLI Reference: New Snapshot for detailed information.

#### VMware Virtual Machine Clones

Cloning a VM creates a VM that is a copy of the original. The new VM is configured with the same virtual hardware, installed software, and other properties that were configured for the original VM.

Clones for Oracle databases on VMware vSphere can be performed in three ways:

• **Database** – using Oracle Enterprise Manager Cloud Control, for example, or classic cloning using RMAN backups. See *Cloning Oracle Databases and Pluggable Databases* for more information.



- vSphere using VMware cloning technology.
- Storage using traditional storage-array-based cloning.

There are two types of cloning operations performed in this guide:

- Cloning of an entire VM containing all VMDKs, including the operating system, Oracle binaries, and Oracle data VMDKs.
- Cloning the database VMDKs of a VM alone.

#### For further information about VM cloning in a vSphere environment, see Clone a Virtual Machine.

#### VMware Virtual Disk Provisioning Policies

When creating virtual disk, cloning a VM to a template, or migrating a VM with VMware vSphere<sup>\*</sup> Storage vMotion<sup>\*</sup>, it's possible to specify a provisioning policy for the virtual disk file. It's also possible to use Storage vMotion or cross-host Storage vMotion to transform virtual disks from one format to another.

Option	Description
Thick-Provision Lazy Zeroed	Creates a virtual disk in a default thick format. Space required for the virtual disk is allocated when the disk is created. Data remaining on the physical device is not erased during creation but is zeroed out on demand later on first write from the VM. VMs do not read stale data from the physical device.
Thick-Provision Eager Zeroed	A type of thick virtual disk that supports clustering features such as the multi-writer attribute for Oracle RAC. Space required for the virtual disk is allocated at creation time. In contrast to the thick-provision lazy zeroed format, the data remaining on the physical device is zeroed out when the virtual disk is created. It can take longer to create virtual disks in this format than to create other types of disks. Increasing the size of an eager zeroed thick virtual disk causes a significant stun time for the VM.
Thin-Provision	Use this format to save storage space. For the thin disk, provision as much datastore space as the disk would require based on the value entered for the virtual disk size. However, the thin disk starts small and at first, using only as much datastore space as the disk needs for its initial operations. If the thin disk needs more space later, it can grow to its maximum capacity and occupy the entire datastore space provisioned to it. Thin provisioning is the fastest method to create a virtual disk because it creates a disk with just the header information. It does not allocate or zero out storage blocks. Storage blocks are allocated and zeroed out when they are first accessed.

#### TABLE 2. VIRTUAL DISK PROVISIONING POLICIES

VMDK modes are reflected in the table below:

Option	Description					
Dependent	Dependent disks are included in snapshots.					
Independent-persistent	Disks in persistent mode behave like conventional disks on a physical computer. All data written to a disk in persistent mode is written permanently to the disk.					

Independent– non-persistent	Changes to disks in non-persistent mode are discarded when a VM is turned off or reset. With non-persistent mode, a VM can be restarted with a virtual disk in the same state every time. Changes to the disk are written to and read from a redo log file that is deleted when the VM is turned off or reset.
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#### TABLE 3. VMDK MODES

Learn more about VMware virtual disk provisioning policies.

#### VMware Multi-Writer Attribute for Shared VMDKs

VMFS is a clustered file system that disables (by default) multiple VMs from opening and writing to the same virtual disk (.vmdk file). This prevents more than one VM from inadvertently accessing the same .vmdk file. The multi-writer option allows VMFS-backed disks to be shared by multiple VMs. An Oracle Real Application Cluster (RAC) cluster using shared storage is a common use case.

VMware vSphere on VMFS, VVols (beginning with ESXi 6.5), network files system (NFS) datastores and VMware vSAN<sup>™</sup> prevents multiple VMs from opening the same virtual disk (VMDK) in read-write mode.

Current restrictions of the multi-writer attribute documented in KB 1034165 include:

- Storage vMotion is disallowed.
- Snapshots are not supported (snapshots of VMs with independent-persistent disks are supported, however).
- Changed block tracking (CBT) is not supported.
- Cloning, hot-extend virtual disk are not supported.

Independent-persistent mode is **NOT** required for enabling multi-writer attribute.

When working with VMware vSphere on VMFS, NFS datastores and vVols (beginning with ESXi 6.5), using multi-writer to share VMDKs for Oracle RAC requires:

- SCSI bus-sharing is set to None.
- VMKDs must be thick-provision eager zeroed (i.e., VMDKs cannot be thick-provision lazy zeroed or thin-provisioned).

Beginning with VMware vSphere 6.5, vVols 2.0, and vSphere APIs for Storage Awareness 3.0 (VASA), vVols are now validated to support Oracle RAC workloads delivering policy-based, VM-centric storage for Oracle RAC clusters.

For a detailed explanation, read What's New in Virtual Volumes (vVols) 2.0.

Learn more about using shared disks with vVols here.

Oracle RAC shared storage provisioning for vVols can be summarized as follows:

VMware Platform	Datastore	Version	RAC shared VMDK requirement for multi- writer attribute	Reference
VMware vSphere	vVol	ESXi 6.5 and above	Vendor specific	KB 1034165 and KB 2113013

#### TABLE 4. ORACLE RAC SHARED STORAGE PROVISIONING



#### Storage Policy-Based Management (SPBM)

Storage policy-based management (SPBM) is a storage policy framework that helps administrators match VM workload requirements to storage capabilities. SPBM runs as an independent service in vCenter Server and helps to align storage with the application demands of VMs.

SPBM enables the following mechanisms:

- Advertisement of storage capabilities and data services offered by storage arrays and other entities, such as I/O filters.
- Bidirectional communication between ESXi and vCenter Server on one side and storage arrays and entities on the other.
- VM provisioning based on VM storage policies.

Administrators build policies by selecting the desired capabilities of the underlying storage array. The SPBM engine interprets the storage requirements of individual applications specified in policies associated with individual VMs and dynamically composes the storage service, placing the VM on the right storage tier, allocating capacity, and instantiating the necessary data services (e.g., snapshots, replication).

As an abstraction layer, SPBM abstracts storage services delivered by vVols, vSAN, I/O filters, or other storage entities.

Rather than integrating with each individual type of storage and data service, SPBM provides a universal framework for multiple types of storage.





Learn more about VMware storage policy-based management (SPBM).

#### vVols Storage Policy

For vVols, VMware provides a default storage policy that contains no rules or storage requirements (vVol No Requirements Policy). This policy is applied to VM objects when another policy for the VM on the vVols datastore is not specified.

The policy allows storage arrays to determine the optimum placement for the VM objects.



The default vVol No Requirements Policy provided by VMware has the following characteristics:

- The policy cannot be deleted, edited, or cloned.
- It is compatible only with vVols datastores.
- Users can create a VM storage policy for vVols and designate it as the default.

The default vVol No Requirements Policy is shown below:

vm vSphere Client Menu → C	2 Search in all environments					
Policies and Profiles	VM Storage Policies					
Host Profiles	🔀 Create VM Storage Policy 🛛 隆 Check Compliance 🛛 🖓 Reapply VM Storage Policy					
Storage Policy Components	Name					
	Not-local PMem Default Storage Policy					
	I ■ HyTrust-KMS-VM-Encryption-Policy					
	Reversion Policy					
	👔 vSAN Default Storage Policy					
	1 Vol No Requirements Policy					
	ReflashSoft Write Through Caching Policy					
	Host-local PMem Default Storage Policy					
	R Oracle RAC vSAN - OSR 0					
	R Oracle RAC vSAN Storage Policy					
	R VM Encryption Policy					
	😰 vSAN Default Storage Policy					
	1 Vol No Requirements Policy					
	Rules VM Compliance VM Template Storage Compatibility					
	General					
	Name VVoI No Requirements Policy					
	Description Allow the datastore to determine the best placement strategy for storage objects					

FIGURE 4. VMWARE VVOL NO REQUIREMENTS POLICY

The Pure Storage FlashArray storage policy is shown below:

VM Storage Policies										
CRE	ATE	EDIT CL	ONE	СНЕСК	REA	PPLY	DELETE			
	Name							$\uparrow$	VC	
	📑 Fla	ashArray							đ	tsa-vcsa-70-b.tsalab.local
	🅞 Fla	ashArray							đ	TSA-VCSA-70-A.tsalab.local
	📑 Ho	ost-local PMem	Default	Storage Po	olicy				đ	tsa-vcsa-70-b.tsalab.local
	🕕 Ho	ost-local PMem	Default	Storage Po	olicy				đ	TSA-VCSA-70-A.tsalab.local
	📑 Ma	anagement Stor	age po	licy - Encry	ption				G	tsa-vcsa-70-b.tsalab.local
	📑 Ma	anagement Stor	age po	licy - Encry	ption				G	TSA-VCSA-70-A.tsalab.local
	📑 Ma	anagement Stor	rage Po	licy - Large					G	tsa-vcsa-70-b.tsalab.local
	📑 Ma	anagement Stor	age Po	licy - Large					đ	TSA-VCSA-70-A.tsalab.local
	in Ma	anagement Stor	age Po	licy - Regul	ar				G	tsa-vcsa-70-b.tsalab.local
1										
Rules		M Compliance	V	M Templat	е	Storag	ge Compatibi	lity		
Gener	ral									
Nai	me			F	lashArı	ray				
Description Fla					lashArı	ray Stor	age Policy.			
Rule-set 1: com.purestorage.storage.policy										
Placement										
Sto	orage Ty	/pe		C	om.pur	estorag	ge.storage.pol	licy		
Pur	re Stora	ge FlashArray		Y	es					

FIGURE 5. PURE STORAGE FLASHARRAY STORAGE POLICY

Learn more about VMware vVols storage policy.

#### **Storage Providers**

A storage provider is a software component that is offered by VMware or developed by a third party through VASA, also referred to as a VASA provider. Storage providers integrate with various storage methods or types, including both external physical storage and storage abstractions (e.g., vSAN and vVols). Storage providers can also support software solutions (e.g., I/O filters).

Generally, vCenter Server and ESXi use storage providers to obtain information about storage configuration, status, and the storage data services offered in an environment. This information appears in the vSphere client and aids decision-making with regard to VM placement, setting of storage requirements, and monitoring of a storage environment.

A VASA for a Pure Storage x50 FlashArray is shown below:

b.tsalab.local Actions	s ✔ Datacenters Hosts & Clust	ers VMs Datastores	Networks Linked vCen	ter Server Systems Extens	ions Updates		
Storage Providers + Add Synchronize Storage	e Providers   📃 Rescan 🗙 Re	emove 🛛 🏀 Refresh certificate					
Storage Provider/Storage Sys 🔻	Status T	Active/Standby T	Priority	URL T	Last Rescan Time	VASA API Version	Certificate Expiry
IOFILTER Provider 10.128.136.1	Offline		-	https://10.128.136.128:9080/v	10/12/2020, 8:22:27 PM	1.5	1657 days
IOFILTER Provider 10.128.136.1	Offline (DETAILS )			https://10.128.136.129:9080/v	10/13/2020, 3:01:42 PM	1.5	1658 days
IOFILTER Provider 10.128.136.1	Offline			https://10.128.136.127:9080/v	10/13/2020, 3:46:16 PM	1.5	1658 days
IOFILTER Provider 10.128.136.1	Offline			https://10.128.136.130:9080/v	10/14/2020, 2:54:24 PM	1.5	1661 days
∡ wdc-tsa-pure-01-ct0	Online			https://10.128.136.59:8084/ve	12/21/2020, 8:16:35 PM	3.0	356 days
wdc-tsa-pure-01 (2/2 online)		Active	200				
⊿ wdc-tsa-pure-01-ct1	Online			https://10.128.136.61:8084/ver		3.0	356 days
wdc-tsa-pure-01 (2/2 online)		Standby	200				
General							
Name UUID Vendor ID Model ID Firmware Alternative names Supported block interfaces Supported fire system interfaces Supported profiles	wdc-tsa-pure-01 com.purestorage:fabf667e-84P PURE FlashArray 53.10 FC ISCSI 	9b-44c5-bd42-85c681eae44b					
	Actions     Configure Permissions     Configure Permissions     Storage Providers     + Add @ Synchronize Storage     Storage Provider 10.28.136.1     OFILTER Provider 10.28.146.1     OFILTER P	Actions ▼       Configur     Permissions       Datacenters     Hosts & Clusts       Storage Providers     ■ Rescan X R       + Add     Synchronize Storage Providers     ■ Rescan X R       Storage Provider 10128.136.1     Offline       + IOPILTER Provider 10128.136.1     Offline       + Wdc-tas-pure-0+ct0     Online       wdc-tas-pure-01ct0     Online       wdc-tas-pure-01ct1     Online       Wdc-tas-pure-01ct2/2 online)     Compurestorage fabri60?e=.44       PURE     PashArray       Stapported block interfaces     FC       Supported block interfaces     FC       Supported block interfaces     FC	Actions     Actions       Configure     Permissions     Datacenters     Hosts & Clusters     VMs     Datastores       Storage     Providers     Image: Clusters     VMs     Datastores       + Add     Synchronize Storage Providers     Image: Clusters     Rescan     Remove     Refresh certificate       Storage     Provider 10.128.136.1.     Offline	Dataslab.local       Actives >         Configure       Permissions       Datacenters       Hosts & Clusters       VMs       Datastores       Networks       Linked vCent         Storage       Providers	Actives >         Configur       Permission       Datacenters       Hosts & Clusters       VMs       Datactores       Extended         Storage       Provider       Bysnchronize       Storage Providers       Inked VCenter Server Systems       Extended         + Add       Bysnchronize       Storage Providers       Remove       Refresh certificate         Storage       Provider 10.128.136.L       offline       -       -         + IOFILTER Provider 10.128.136.L       offline       -       -       Ntps://10.128.136.129.0800/         + Volctas-pure-O1c10       online       -       -       Ntps://10.128.136.129.0800/         vdc-tas-pure-O1c2/2 online)       Active       200       -         vdc-tas-pure-O1c2/2 online)       Standby       200       -         VUUD       Ordin D	Actions >         Configur       Permission       Datacenters       Hosts & Clusters       VMs       Datacones       Extension       Updates         Storage Providers       +       Adl © Synchronize Storage Providers       Rescan       Kennee       Refresh certificate         Storage Provider 10128.136.L       offline       -       -       Ntps://0.128.136.128.9080/v.       Nt/12/2020, 822.27 PM         I-OFILTER Provider 10.128.136.L       offline       -       -       Ntps://0.128.136.128.9080/v.       Nt/12/2020, 30.14.2 PM         I-OFILTER Provider 10.128.136.L       offline       -       -       -       Ntps://0.128.136.129.080/v.       Nt/12/2020, 30.14.2 PM         I-OFILTER Provider 10.128.136.L       offline       -       -       -       Ntps://0.128.136.129.080/v.       Nt/12/2020, 30.14.2 PM         I-OFILTER Provider 10.128.136.L       offline       -       -       -       Ntps://0.128.136.139.0908/v.       Nt/12/2020, 254.24 PM         I-OFILTER Provider 10.128.136.L       offline       -       -       -       Ntps://0.128.136.618.084/ver.       -       -       -       Ntps://0.128.136.618.084/ver.       -       -       -       Ntps://0.128.136.618.084/ver.       -       -       -       Ntps://0.128.136.618.084/ver.       -       -	Actions V     Configur   Permissions   Datacenters     Mode Case-pure Of L/2 online     Provider 10 128 138.1   Offline Offl

FIGURE 6. VASA FOR PURE STORAGE X50 FLASHARRAY

Learn more about using storage providers.

#### VMware vSphere Metro Storage Cluster (vMSC)

A VMware vSphere Metro Storage Cluster (vMSC) is a specific storage configuration commonly referred to as stretched storage clusters or metro storage clusters. These configurations are usually implemented in environments where disaster and downtime avoidance are a key requirement.

A vMSC configuration is a specific storage configuration that combines replication with array-based clustering. These solutions are typically deployed in environments where the distance between datacenters is limited, often in metropolitan or campus environments.

vMSC infrastructures are implemented with a goal of reaping the same benefits that vSphere HA clusters provide to a local site, in a geographically dispersed model with two datacenters in different locations. A vMSC infrastructure is essentially a stretched cluster. The architecture is built on the premise of extending what is defined as "local" in terms of network, storage and compute to enable these subsystems to span geographies, presenting a single and common base infrastructure set of resources to the vSphere cluster at both sites. It in essence stretches storage, network and compute between sites.

The primary benefit of a stretched cluster model is that it enables fully active and workload-balanced data centers to be used to their full potential and it allows for an extremely fast recovery in the event of a host or even full site failure. The capability of a stretched cluster to provide this active balancing of resources should always be the primary design and implementation goal. Although often associated with disaster recovery, vMSC infrastructures are not recommended as primary solutions for pure disaster recovery.

vMSC solutions are classified into two distinct categories. These categories are based on a fundamental difference in how hosts access storage. It is important to understand the different types of stretched storage solutions because this influences design considerations.

The following two main categories are as described on the VMware hardware compatibility list:

- Uniform host access configuration ESXi hosts from both sites are all connected to a storage node in the storage cluster across all sites. Paths presented to ESXi hosts are stretched across a distance.
- Non-uniform host access configuration ESXi hosts at each site are connected only to storage node(s) at the same site. Paths presented to ESXi hosts from storage nodes are limited to the local site.

Learn more about VMware vSphere Metro Storage Cluster.



#### Pure ActiveCluster VMware vSphere Metro Storage Cluster

Pure Storage Purity//FA ActiveCluster is a fully symmetric active-active bidirectional replication capability for FlashArrays that provides zero RPO zero and automatic transparent failover for zero RTO.

ActiveCluster spans multiple sites enabling clustered arrays and clustered ESXi hosts to be used to deploy flexible active/active datacenter configurations for applications like Extended Oracle RAC.



FIGURE 7. PURE STORAGE PURITY//FA ACTIVECLUSTER

Key features of ActiveCluster include symmetric active-active replication, synchronous operation, transparent failover, transparent mediation, and simple management model.

#### Core Components

Purity ActiveCluster is composed of three core components: the Pure1 Cloud Mediator, active/active clustered array pairs, and stretched storage containers.



FIGURE 8. PURE1 CLOUD MEDIATOR



- The Pure1 Cloud Mediator A required component of the solution that is used to determine which array will continue data services should an outage occur in the environment. An on-premises mediator VM is also available.
- Active/Active clustered FlashArrays Utilize synchronous replication to maintain a copy of data on each array and present those as one consistent copy to hosts that are attached to either, or both, arrays.
- Stretched storage objects Management containers, called pods, that collect storage objects such as volumes into groups that are stretched between two arrays.

Learn more about the Pure Storage ActiveCluster VMware vMSC.

#### Hybrid and Multi-Cloud as the VMware Cloud

The term hybrid cloud describes the use of both private and public cloud platforms, working in conjunction. It can refer to any combination of cloud solutions that work together on-premises and off-site to provide cloud computing services to a company. A hybrid cloud environment allows organizations to benefit from the advantages of both types of cloud platforms and choose which cloud to use based on specific data needs.

A multi-cloud environment is as its name suggests, reflecting multiple and disparate cloud offerings and forms, all of which are part of the ubiquitous VMware Cloud.

VMware's *hybrid cloud* portfolio offers a combination of solutions that enable organizations to easily extend, protect, or replace on-premises infrastructure. These hybrid cloud offerings are built on an SDDC architecture, leveraging VMware's industry-leading compute, networking, and storage virtualization technologies.

Any combination of clouds powered by VMware creates a common operating environment across VMware-based on-premises private clouds and VMware-based public clouds. Cloud solutions from VMware Cloud Provider Partners (VCPP) including IBM, Oracle, Microsoft, Google, Amazon Web Services (AWS) and others. Native public clouds such as AWS, Azure, Oracle and Google Cloud Platform using VMware technologies including VMware Cloud Foundation<sup>™</sup>, VMware vRealize<sup>\*</sup> and VMware Cloud<sup>™</sup> Services, along with on-premises managed cloud services such as VMware Cloud on DellEMC, form the core of VMware Cloud offerings.

This approach enables a diverse set of use cases, including regional capacity expansion, disaster recovery, application migration, data center consolidation, new application development and burst capacity.

Learn more about VMware Hybrid Cloud.

#### VMware Cloud on AWS

VMware Cloud on AWS is an on-demand service that enables customers to run applications across vSphere-based cloud environments with access to a broad range of AWS services. Powered by VMware Cloud Foundation, this service integrates vSphere, vSAN and VMware NSX\* along with VMware vCenter management, and is optimized to run on dedicated, elastic, bare-metal AWS infrastructure.

With VMware Hybrid Cloud Extension<sup>™</sup> (HCX), customers can easily and rapidly perform large-scale bi-directional migrations between on-premises and VMware Cloud on AWS environments.

With the same architecture and operational experience on-premises and in the cloud, IT teams can now quickly derive instant business value from use of the AWS and VMware hybrid cloud experience. VMware Cloud on AWS is ideal for enterprise IT infrastructure and operations organizations looking to migrate on-premises vSphere-based workloads to the public cloud, consolidate and extend data center capacities, and optimize, simplify and modernize their disaster recovery solutions.



#### FIGURE 9. VMWARE CLOUD ON AWS

Learn more about VMware Cloud on AWS.

### Pure Storage Cloud Block Store (CBS)

Pure Storage Cloud Block Store (CBS) for AWS is block storage delivered natively in the cloud. CBS is a software-defined storage solution powered by the Purity Operating Environment (POE), which uses the native resources of AWS to provide block storage capabilities to cloud workloads.



#### FIGURE 10. PURE STORAGE CLOUD BLOCK STORE (CBS)

#### Learn more about Pure Storage Cloud Block Store.

Pure Storage array-based replication can be used for migrating data vVols via async replication from an on-premises FlashArray to CBS on AWS. The replica data vVol(s) can then be presented to an existing VM on VMware Cloud on AWS via in-guest iSCSI using the Pure CBS service over the AWS ENI.

Learn more about vVol migration and presentation using Pure CBS.

#### **Oracle Database Architecture**

Oracle Database 19c, the latest generation of the world's most popular database, provides businesses of all sizes with access to the world's fastest, most scalable and reliable database technology for secure and cost-effective deployment of transactional and analytical workloads in the cloud, on-premises and hybrid cloud configurations.

An Oracle database server consists of a database and at least one database instance. In Oracle RAC, an Oracle database will have more than one instance accessing the database.

- A database is a set of files, located on disk, that store data. These files can exist independently of a database instance.
- An instance is a set of memory structures that manage database files. The instance consists of a shared memory area, called the system global area (SGA), and a set of background processes. An instance can exist independently of database files.

The physical database structures that comprise a database are:

- Data files Every Oracle database has one or more physical data files, which contain all database data. The data of logical database structures, such as tables and indexes, is physically stored in the data files.
- **Control files** Every Oracle database has a control file. A control file contains metadata specifying the physical structure of the database, including the database name, along with the names and locations of the database files.
- Online redo log files Every Oracle database has an online redo log, representing a set of two or more online redo log files. An online redo log is made up of redo entries (also called redo log records), which record all changes made to data.
- Many other files, including parameter files, archived redo files, backup files and networking files, are important to any oracle database operation.

Learn more about Oracle database architecture.

#### Oracle ASM, ASMLIB and ASMFD

#### ASM

Oracle Automatic Storage Management (ASM) is a volume manager and a file system for Oracle database files that supports single-instance Oracle Database and Oracle RAC configurations.

Oracle ASM is Oracle's recommended storage-management solution that can be used for both Oracle RAC and single-instance Oracle databases and provides an alternative to conventional volume managers, file systems, and raw devices.

Oracle ASM uses disk groups to store data files. An Oracle ASM disk group is a collection of disks that Oracle ASM manages as a unit. Users can add or remove disks from a disk group while a database continues to access files from the disk group.

Learn more about Oracle Automatic Storage management (ASM).

#### ASMLIB

Oracle ASMLIB maintains permissions and disk labels that are persistent on the storage device, so that the label is available even after an operating system upgrade.

The Oracle ASMLIB driver simplifies the configuration and management of block disk devices by eliminating the need to rebind block disk devices used with Oracle Automatic Storage Management (ASM) each time the system is restarted.

Learn more about Oracle ASMLIB.

#### ASMFD

Oracle ASMFD helps prevent corruption in Oracle ASM disks and files within the disk group. Oracle ASMFD simplifies the configuration and management of disk devices by eliminating the need to rebind disk devices used with Oracle ASM each time the system is restarted.

Learn more about Oracle ASMFD.

#### Oracle Backup and Recovery

The purpose of backup and recovery is to protect the database against data loss and reconstruct the database after data loss. Oracle provides different options for database backup and recovery.

Oracle Recovery Manager (RMAN) is the most popular and preferred backup solution for Oracle database.

Common Oracle backup and recovery options include:

- User-managed database backup (hot and cold backup)
- Crash-consistent backup using storage-based snapshots
- Oracle RMAN
- Oracle Data Pump export/import

Learn more about Oracle Backup and Recovery Solutions.



#### Oracle User Managed Database Backup

The user-managed backup and recovery mechanism includes performing backup and recovery with a mixture of host operating system commands and SQL\*Plus recovery commands. This strategy does not depend on using the Oracle RMAN.

A database-consistent backup is a whole database backup that can be opened with the **RESETLOGS** option without performing media recovery. It's not necessary to apply redo to this backup to make it consistent. Unless the redo generated is applied after the consistent backup is created, however, all transactions since the time of the consistent backup will be lost.

All datafiles in a consistent backup must:

- Have the same checkpoint system change number (SCN) in their headers, unless they are datafiles in tablespaces that are read-only or offline normal (in which case they will have a clean SCN that is earlier than the checkpoint SCN).
- Contain no changes past the checkpoint SCN (i.e., are not fuzzy).
- Match the data file checkpoint information stored in the control file.

#### See Oracle Backup and Recovery User Guide for more information.

Consistent backups can only be taken after a clean shutdown has been made or by turning on hot backup mode of the database. This is the most trusted backup by DBAs but is also complex, as the admin will need to run scripts to put the database in hot-backup mode, take a snapshot, and then take the database out of the hot-backup mode.

Oracle data pump backups are "logical" database backups in that they extract logical definitions and data from the database to a file.

With a cold backup, it's possible to make a consistent whole database backup of all files in a database after the database is shut down with the **NORMAL**, **IMMEDIATE**, or **TRANSACTIONAL** options.

#### See Making User-Managed Backups of the Whole Database for more information.

With a hot backup, this would require:

- Putting the tablespace/database (depending on whether it is a tablespace level or database level backup) in a **BEGIN** backup mode by the **ALTER TABLESPACE/DATABASE BEGIN BACKUP** command.
- Taking an operating system-level backup of the tablespace/database data files.
- Taking the tablespace/database out of the backup mode with the ALTER TABLESPACE/ DATABASE END BACKUP command.

There is overhead involved in transitioning a database in and out of backup mode:

- Additional redo data is logged
- Complete database checkpoint is required
- More operational steps and complexity during the backup operation

#### Oracle Crash-Consistent Backup

A crash-consistent backup is the backup of a point-in-time image of an Oracle database that is equivalent to a database crash induced by a power outage, other failures, or a shutdown abort.

When the database is started up, instance recovery (i.e., the process of applying records in the online redo log to data files to reconstruct changes) is performed automatically to bring the database to a consistent state.

This is one of the most common backup methods used for storage-based backups and is fully supported by Oracle as long as the following conditions are met.



As noted in *Supported Backup, Restore and Recovery Operations using Third Party Snapshot Technologies* (Oracle Doc ID 604683.1), third-party vendor snapshots must conform to the following requirements:

- Integrated with Oracle's recommended restore and recovery operations above
- Database crash-consistent at the point of the snapshot
- Write-ordering is preserved for each file within a snapshot

See Making Backups with Third-Party Snapshot Technologies for more information.

#### **Oracle RMAN**

Oracle RMAN is an Oracle Database client that performs backup and recovery tasks on databases and automates administration of backup strategies. It greatly simplifies backing up, restoring, and recovering database files.

The RMAN environment consists of the utilities and databases that play a role in backing up data. Minimally, the environment for RMAN must include the following components:

- A target database An Oracle database to which RMAN is connected with the **TARGET** keyword. A target database is a database on which RMAN is performing backup and recovery operations. RMAN always maintains metadata about its operations on a database in the control file of the database. The RMAN metadata is known as the RMAN repository.
- The RMAN client An Oracle database executable that interprets commands, directs server sessions to execute those commands, and records its activity in the target database control file. The RMAN executable is automatically installed with the database and is typically located in the same directory as the other database executables.

Advantages of Oracle RMAN-based backups include:

- Only used space in the database is backed up
- RMAN does not put tablespaces in backup mode, saving on redo generation overhead. RMAN will re-read database blocks until it gets a consistent image of it.

Learn more about Oracle RMAN.

#### Oracle Database Cloning

Cloning of an Oracle database is the process of making an exact copy of another database for various reasons. The cloned database is both fully functional and separate in its own right.

Use cases for cloning include making copies of the production database to use it:

- As a development database for developing new applications or adding new features to existing applications.
- As a QA database for testing existing software for bugs or testing new software features or versions.
- As a test database for backup and recovery scenarios.
- To provision a copy of a database for different business units.
- To test database patching, upgrade, and migration strategies.
- To benchmark for performance.

After cloning, the DBA may choose to mask sensitive data in the cloned database before releasing it for general consumption.

For example, a production database for a credit card company will have real customer data that cannot be revealed for security purposes, so Oracle data masking is used to mask customer names and social security number.

Examples of database cloning include using Oracle Enterprise Manager Cloud Control or classic cloning using RMAN backups. See *Cloning Oracle Databases and Pluggable Databases* for more information.

The database cloning process may also occasionally include making copies of Oracle database home directories, along with a copy of the Oracle database, for those instances when testing database patching, upgrade, or migration strategies is needed.

#### Oracle Database Refresh

Database refresh is typically the process of refreshing the contents of a development or testing database from a copy of the production database, ensuring the latest data is available to develop or test against.

Common use cases for database refresh include:

- Development and test environments may not have latest data to test the current application against.
- A production bug needs to be investigated in the test environment, but the data is not the latest.

Oracle provides tools for database refresh, including:

- Oracle RMAN
- Data Pump

#### Oracle Database Patching

Oracle DBAs are responsible for patching databases to apply system patches, including patch set update (PSU), security patch update (SPU) and critical patch update (CPU). The process for applying these patches can be tedious and time-consuming.

It's important that patches are applied carefully. Multiple factors must be taken into consideration when performing a patch, including communicating the expected outage window to application owners and ensuring a solid backup and restore mechanism is in place in the event of a roll back following a failed patching exercise. Ignoring these steps risks a full system restore being required, resulting in a lengthy outage and potential revenue loss.

Begninning with Oracle Database 11g Release 2 (11.2), Oracle ASM is installed as part of an Oracle Grid Infrastructure installation.

Patching single-instance databases using Grid Infrastructure requires patching the Grid Infrastructure binaries, the RDBMS binaries, or both, depending on the patch type. See *Introduction to OPatch and Patching* for more information.

When patching an Oracle RAC, Oracle offers flexibility, allowing a rolling patch upgrade in which RAC nodes are patched one by one. This avoids taking the entire cluster down for patching, ensuring SLAs are met and uptime is guaranteed.

See Oracle Database Upgrade Guide for more information.

See My Oracle Support document for more information on Rolling Patch—OPatch Support for RAC (Doc ID 244241.1).

#### Considerations for Oracle Database Day 2 Operations

The duration of a database backup is determined by the following:

• Level of backup – The duration of the backup varies based on the backup level.

A full backup has to back up the entire database, while incremental or cumulative backups leverage and backup only things that have changed since the previous backup.

- Data churn The amount of data that changes between backups impacts the duration of incremental and cumulative backups. The more churn, the longer the backups.
- Backup mechanism The mechanism used for backups impacts the duration. Backups can be tape or disk-based and leverage compression and parallel streams. Some backups track block-level changes and back up only the blocks that have changed. The backup mechanism can critically affect the backup duration and potentially affect the databases being backed up.
- Underlying infrastructure The network and storage infrastructure along with backup medium can affect the duration. If the backups happen over the network and the network is shared with applications, there can be an adverse effect on backup and database performance.

SAN-based backups traditionally have minimal impact on the infrastructure.

Production database backup and restore operations must meet strict SLAs and requirements, including:

- Small backup windows to minimize the impact on the database.
- The need to be recoverable and repeatable.



While database storage continues to grow exponentially, there is a tremendous pressure to reduce and optimize backup windows.

Due to restricted backup windows and data churn, it is not feasible to make full backups of multi-terabyte databases in the allotted backup windows.

For example, it's possible to increase the number of RMAN channels if the production system has enough bandwidth for data transfer but adding more channels can introduce performance overhead into the production system.

Backups for large databases have traditionally been a challenge in virtual environments due to the additional layer of abstraction they introduce. Special provisions, such as dedicated RDMs and storage-level snapshots, must be leveraged for efficient backups.

Cloning multi-terabyte databases and refreshing multi-terabyte databases present the same challenges outlined above.

#### Oracle Database Day 2 Operations and vVols

Generally speaking, regular database operations (e.g., database backup, cloning, or data refresh) can be triggered in three ways:

- At the application (Oracle Database) level
- At the VMware VM level
- At the storage level

Each of these approaches offers advantages and drawbacks:

• Application (Oracle Database) level – Leveraging database backup applications such as Oracle RMAN or Oracle Data Pump to backup or clone databases.

It provides a finer level of granularity (i.e., tablespace, datafile, or table level granularity) but it is not always the fastest.

• VMware VM level – Leverages VMware snapshots, the way by which most VMs are backed up, including third-party backup applications.

VM-level granularity is ideal, however a VM-level snapshot may stun a VM for some time during snapshot coalescing and deletion. See VMware *KB 1002836* for more information.

This may not be acceptable for tier-one business-critical databases. Removal of snapshots may impact the performance of the database as the VMDKs are consolidated.

• Storage Array level – Operations at the storage level offer better performance but lack VM-level granularity, as operations are executed at storage LUN level.

If the database to be backed up contains dedicated LUNs in the SAN, it can potentially be backed up at the SAN level with a storage-level snapshot.

In the event the database is sharing the datastore/LUN with other databases, the database can still be backed up using storage-level backup, however it will include VMDKs of the other databases as well.

For large databases, DBAs typically prefer triggering the above database operations at either the application level or storage level for the reasons outlined above.

Combining VMDK-level granularity with the speed of storage array database operations like backup and recovery, cloning, or provisioning a database VM provides an ideal solution to the challenges outlined above. This approach enables:

- Triggering of backups and clones with VMDK granularity simultaneously.
- Performing a storage-level snapshot or clone at the VM level (the fastest of the three options available).

This approach should also allow:

- Operations like backup and restore and cloning to flexibly operate at VMDK-level granularity.
- Rapid storage-level snapshotting or cloning, with operations triggered at the VM level.
- Alignment of different database components with different storage data services needed for SPBM.



vVols storage management and automation framework addresses the following requirements:

- vVols eliminates the need for a native file system. vVols objects are natively represented on the storage array, mitigating any performance concerns and potentially eliminating debate between DBAs and vSphere administrators regarding the appropriate approach.
- Backups can be triggered at a VM level and at VMDK-level granularity, with the actual operation run natively by the array.
- Regular DBA tasks such as database backup and restore, cloning, and database refresh of non-production databases from production takes less time.
- Because vVols snapshots are array-based, taking a snapshot of the machine is much faster and less disruptive to the VM. Snapshots do not incur a performance penalty, regardless of the number of snapshots taken.





### Oracle Real Application Cluster (RAC)

Oracle Clusterware is portable cluster software that provides comprehensive multi-tiered high availability and resource management for consolidated environments. It supports clustering of independent servers so that they cooperate as a single system.

Oracle Clusterware is the integrated foundation for Oracle Real Application Clusters (Oracle RAC), and the high-availability and resource management framework for all applications on any major platform.

#### More information on Oracle Clusterware 19c can be found here.

Non-cluster Oracle Database instances have a one-to-one relationship between Oracle Database and the instance. Oracle RAC environments, however, have a one-to-many relationship between the database and instances. An Oracle RAC database can have several instances, all of which access one Oracle database. All database instances must use the same interconnect, which can also be used by Oracle Clusterware.

The combined processing power of the multiple servers can provide greater throughput and Oracle RAC scalability than is available from a single server.

A cluster comprises multiple interconnected computers or servers that appear as if they are one server to end users and applications. The Oracle RAC option with Oracle Database enables users to cluster Oracle Database instances. Oracle RAC uses Oracle Clusterware for the infrastructure to bind multiple servers, so they operate as a single system.





FIGURE 12. ORACLE RAC

Learn more about Oracle RAC 19c.

#### Extended Oracle RAC

An Oracle Extended Cluster consists of nodes that are in multiple locations called sites.

When deploying an Oracle Standalone Cluster, administrators can also choose to configure the cluster as an Oracle Extended Cluster. An Oracle RAC cluster can be extended across two, or more, geographically separate sites, each equipped with its own storage. In the event that one of the sites fails, the other site acts as an active standby.

Oracle RAC on extended distance (stretched) clusters provides extremely fast recovery from a site failure and allows for all nodes, in all sites, to actively process transactions as part of a single database cluster

Both Oracle ASM and the Oracle Database stack, in general, are designed to use enterprise-class shared storage in a datacenter. Fibre Channel technology, however, enables distribution of compute and storage resources across two or more datacenters, connecting them through Ethernet cables and Fibre Channel, for compute and storage needs, respectively.

The high impact of latency, and therefore distance, creates some practical limitations as to where this architecture can be deployed. An active/active Oracle RAC architecture fits best where the two datacenters are located relatively close (<100km) and where the costs of setting up a low latency and dedicated direct connectivity between the sites for Oracle RAC has already taken place, which is why it cannot be used as a replacement for a disaster recovery solution such as Oracle Data Guard or Oracle GoldenGate.





FIGURE 13. ORACLE RAC ON EXTENDED DISTANCE CLUSTERS CHARACTERISTICS

More information about Extended Oracle RAC 19c can be found here and here.

#### Oracle RAC on VMware vSphere

There are two key requirements for Oracle RAC:

- Shared storage
- Multicast Layer 2 networking

These requirements are fully addressed when running Oracle RAC on VMware vSphere, as both shared storage and Layer 2 networking are natively supported by vSphere.

vSphere high availability (HA) clusters enable a collection of ESXi hosts to work together so that, as a group, they provide higher levels of infrastructure level availability for VMs than each ESXi host can provide individually.

vSphere HA provides high availability for VMs by pooling the VMs and the hosts they reside on into a cluster. Hosts in the cluster are monitored and in the event of a failure, the VMs on a failed host are restarted on alternate hosts.

When creating a vSphere HA cluster, a single host is automatically elected as the master host. The master host communicates with vCenter Server and monitors the state of all protected VMs and of the slave hosts.

#### Learn more about VMware vSphere HA.

Oracle RAC and VMware HA solutions are completely complementary to each other. Running Oracle RAC on a VMware platform provides the application-level HA enabled by Oracle RAC, in addition to the infrastructure-level HA enabled by VMware vSphere.

Learn more about Oracle RAC on VMware vSphere.



#### Oracle RAC on VMware Virtual Volumes (vVols)

The steps for deploying an Oracle RAC, whether traditional or extended, on VMware vSphere are essentially the same across all VMware vSphere platforms.

Beginning with VMware vSphere 6.5, vVols 2.0 and VASA 3.0, vVols are now validated to support Oracle RAC workloads delivering policy-based, VM-centric storage for Oracle RAC clusters.

#### Learn more by reading What's New in Virtual Volumes (vVols) 2.0.

The RAC shared storage provisioning for vVols can be summarized in the table below:

VMware Platform	Datastore	Version	RAC shared VMDK requirement for multi- writer attribute	Reference
VMware vSphere	vVol	Beginning with ESXi 6.5	Vendor specific	KB 1034165 and KB 2113013

#### TABLE 5. ORACLE RAC SHARED STORAGE FOR VVOLS

The RAC private interconnect networking setup for VMware on-premises is shown as below:

VMware Platform	Distributed Switch	Distributed Port Group	Version	Reference
VMware vSphere, vSAN, vVols	Regular Distributed Switch	Dedicated Distributed Port Group for RAC	Beginning with 5.5	https://docs.vmware.com/en/ VMware-vSphere/7.0/com. vmware.vsphere.networking. doc/GUID-D21B3241-0AC9- 437C-80B1-0C8043CC1D7D. html

#### TABLE 6. ORACLE RAC PRIVATE INTERCONNECT NETWORKING

The previous details provide guidance for Oracle RAC storage deployment on vVols using Pure Storage, Network deployment details, along with the basic steps for RAC deployment on VMware vVols using Pure Storage, can be found in *Oracle VMware Hybrid Cloud High Availability Guide REFERENCE ARCHITECTURE*.

### Extended Oracle RAC on Pure ActiveCluster vMSC

Many business-critical applications require five 9s of availability, or 99.999% availability (less than 5 minutes of downtime per year). This is where the marriage of vSphere HA and Oracle RAC really shines. This combination has been used to great effect by several very large organizations globally.

As mentioned above, Oracle RAC and VMware HA solutions are completely complementary to each other. Running Oracle RAC on the VMware platform provides application-level HA enabled by Oracle RAC, in addition to the infrastructure-level HA enabled by vSphere.

Extended Oracle RAC provides greater availability than local Oracle RAC. It provides extremely fast recovery from a site failure and enables all servers, in all sites, to actively process transactions as part of a single database cluster.



Running Extended Oracle RAC on a stretched cluster architecture provides the same advantages as traditional Oracle RAC across datacenters and sites, in addition to the site-level protection enabled by stretched cluster architecture.

Both traditional Oracle RAC and extended Oracle RAC require:

- Layer 2 network adjacency
- Shared storage

In addition to these requirements, it's important to keep the following in mind when deploying an extended Oracle RAC:

- Latency requirements of the workload, for which considerations include:
  - Site distance (0, 25, 50, 100, > 100KM)
  - Maintaining network latency at 5ms (milliseconds) or less, as latency between RAC nodes and across sites increases
  - Network connection and bandwidth between sites. Dark Fiber over Dense Wavelength Division Multiplexing (DWDM)
- Storage that is synchronously, bi-directionally replicated in 5ms or less is required at each site
- A witness or quorum site is required for any clustered app or storage to avoid a "split brain"

There are two general implementations of VMware stretched cluster architectures:

- VMware vSphere Metro Storage Cluster (vMSC)
- VMware vSAN Stretched Cluster

#### Learn more about vMSC.

Learn more about Extended Oracle RAC on vMSC.

#### More information about Pure ActiveCluster VMware vMSC can be found here and here.

Running Extended Oracle RAC on Pure ActiveCluster VMware vMSC is beyond the scope of this document.

## Solution Configuration

This section introduces the resources and configurations for the solution, including:

- Architecture diagram
- Hardware resources
- Software resources
- Network configuration
- Storage configuration
- Pure Storage Plugin for VMware vSphere client
- VM and Oracle configuration

#### Architecture Diagram

This solution architecture relies on a three-site scenario:

- On-premises vSphere cluster on Site A (Santa Clara)
- On-premises vSphere cluster on Site B (Wenatchee)
- VMware Cloud on AWS





FIGURE 14. SITE ARCHITECTURE DIAGRAM

The on-premises setup features two separate and dedicated vSphere cluster configurations: Site A and Site B.

- Site A is hosting non-production RAC and non-RAC workloads, including disaster recover (DR)
- Site B is hosting production RAC and production single-instance workloads
- Both sites are connected to VMware Cloud on AWS

This solution focuses on vVols and will examine the on-premises Site B configurations for traditional Oracle single-instance and Oracle RAC setup.

Site B infrastructure details are as follows:

- A 4-node vSphere VMware ESXi, 7.0.1, 16850804
- Each ESXi server is a Dell PowerEdge R630 Server with Intel Xeon CPU E5-2680 v4 at 2.40GHz, 2x14 cores, and 384GB RAM with hyperthreading
- Each ESXi server has access to a Pure Storage FlashArray//x50 (Purity/FA 5.3.10) for both block FC storage and vVols
- Each ESXi server features:
  - 2 x QLogic 8Gb FC host bus adapters for FC storage
  - 2 x 10Gb connections

## Hardware Resources

Below are the hardware resources for the vSphere cluster on Site B:

Description	Specification
Server	4 x ESXi Server
Server Model	Dell Inc. PowerEdge R630
CPU	2 sockets with 14 cores each, Intel(R) Xeon(R) CPU E5-2680 v4 @ 2.40GHz, 2x14 cores, with Hyperthreading enabled
RAM	384GB RAM
Storage controller	2 x 8Gb ISP2532-based Fibre Channel to PCI Express HBA
Storage Array	Pure x50 AFA (Purity/FA 5.3.10)
vSAN Storage Controller	Dell HBA330 Mini
Storage Network	2 x QLogic 8Gb FC Host Bus Adapters for FC Storage
Network	2 x 10Gbit connections

TABLE 7. SITE B HARDWARE RESOURCES

The following summarizes one of the ESXi servers in the vSphere cluster on site B:

10.128	8.136.129 Act	ions 🗸					
Summary	Monitor Configur	e Permissions	VMs	Datastores	Networks	Updates	
	Hypervisor: Model: Processor Type: Logical Processors: NICs: Virtual Machines: State: Uptime:	VMware ESXi, 7.0.1, PowerEdge R630 Intel(R) Xeon(R) CPI 56 4 9 Connected 41 days	16850804 U E5-2680 \	∕4 @ 2.40GHz			
Hardware							^
Manufa	cturer	C	ell Inc.				
Model		F	owerEdge I	R630			
✓ CPU							
CPU C	ores		28 CPUs >	< 2.4 GHz			
Proces	ssor Type	Ir	ntel(R) Xeon	(R) CPU E5-2680	) v4 @ 2.40GHz	z	
Socket	ts	2					
Cores	per Socket	1.	4				
Logica	l Processors	5	6				
Hypert	threading	A	Active				
Memory	ý		114.94 GB	/ 383.91 GB			
> Virtual	Flash Resource	C	B/OB				
> Netwo	rking	е	sx129.tsalab	o.local			
> Storag	e	1	6 Datastore	(S)			

FIGURE 15. SITE B VMWARE ESXI SERVER SUMMARY

#### Software Resources

The following is a summary of the software resources used:

Software	Version	Purpose
VMware vCenter Server	7.0.1 Build 16858589	VMware vCenter Server provides a centralized platform for managing VMware vSphere environments
VMware ESXi Server	7.0.1 Build 16850804	ESXi servers to host VMs
ESXi Datastores	Purity//FA 5.3.10	Pure AFA provides both VMFS and vVol datastores
Oracle Linux	8.3 UEK	Oracle database server nodes
Oracle Database 19c	19.8.0.0.0	Oracle database

#### TABLE 8. SOFTWARE RESOURCES

#### Network Configuration

A VMware vSphere Distributed Switch (VDS) acts as a single virtual switch across all associated hosts in the datacenter. This setup enables VMs to maintain a consistent network configuration as they migrate across multiple hosts.

A port group defines properties regarding security, traffic-shaping, and network adapter-teaming. Jumbo frames (MTU=9000 bytes) are enabled on the VMware vSphere\* vMotion\* interface and the default port group setting is used.

For Site B, VDS TSA-WDC-70B-vDS01 uses 2x 10GbE adapter and 2 x 1GbE adapter per host:

- 2 x 10GbE uplinks for VM traffic
- 2 x 1GbE uplinks for VMkernel non-VM traffic

The following distributed switch-port groups were created for Oracle RAC and Oracle VM traffic to balance traffic across the available uplinks:

- Port group TSA-WDC-70B-PG1403 with VLAN ID 1403 is for VM user traffic
- Port group TSA-WDC-70B-PG70-NFS with VLAN ID 70 for NFS traffic
- Port group TSA-WDC-70B-PG71-OraPrivate with VLAN ID 71 is for Oracle RAC interconnect traffic with two active/active uplinks set to Route based on originating virtual port.

TSA-WDC-70B-VDS01 Actions Y									
Summary Monitor Configur	e F	Permissions Ports	Hosts VM:	s Networks					
Distributed Port Groups Uplin	nk Por	t Groups							
Name ↑	~	VLAN ID	~	NSX Port Group ID	~	VNI ~	Port Binding	~	
🚔 TSA-VCF-Infra		VLAN trunk: 0-4094					Static binding (elastic)		
A TSA-WDC-70B-PG1363		VLAN access: 1363	Static binding (elastic)						
A TSA-WDC-70B-PG1403		VLAN access: 1403					Static binding (elastic)		
🛆 TSA-WDC-70B-PG69-VSAN		VLAN access: 69					Static binding (elastic)		
SA-WDC-70B-PG70-NFS		VLAN access: 70					Static binding (elastic)		
SA-WDC-70B-PG71-OraPrivate		VLAN access: 71					Static binding (elastic)		
A TSA-WDC-70B-PG72-OraPrivate		VLAN access: 72					Static binding (elastic)		

FIGURE 16. SITE B VSPHERE DISTRIBUTED SWITCH PORT GROUP CONFIGURATION



#### Storage Configuration

Site B has access to a Pure Storage FlashArray//x50 all-flash storage (Purity/FA 5.3.2) for vVols.

On Site B, each of the 4 ESXi servers contains 2 x QLogic 8Gb FC host bus adapters for vVols.



I0.128.136.12 Summary Monitor	9   ca	ACTIONS Y	res Network:	s Updates	5								
Storage	~	Storage Adapters											
Storage Adapters		+ Add Software Adapter 🗟 Refresh 🖏 Resci	in Storage 🛛 🕅	Rescan Adapter	r 🗙 Remove								
Storage Devices		Adapter T	Type 🔻	Status	T Identifier					Targets	T Devices	Ŧ	Paths
Host Cache Configur	ation	Model: Dell HBA330 Mini											
Protocol Endpoints		Model: Emulex LPe12000 8Gb PCIe Fibre Char	nnel Adapter										
I/O Filters		Model: ISP2532-based 8Gb Fibre Channel to F	CI Express HBA										
Networking	>	🚱 vmhba3	Fibre Channel	Online	20:00:00	0:24:ff:5e:2b:1a 21:00:00:24:ff:5a:2b:1a				4	3		12
Material Manaking an		🔄 vmhba4	Fibre Channel	Online	20:00:00	0:24:ff:5e:2b:1b 21:00:00:24:ff:5e:2b:1b				4	3		12
Virtual Machines	'	Model: USB Storage Controller											
System	>	Model: Wellsburg AHCI Controller											
Hardware	>												
Virtual Flash	>												
Alarm Definitions													
Scheduled Tasks													
												-	
												Copy	All 8
		Properties Devices Paths											
		Refresh   🔂 Attach 😡 Detach 📺 Renar	ne										
		Name	✓ LUN ✓	Type ~	Capacity 🗸	Datastore	~	Operational State 🗸	Hardware Acceleration	Drive Type 🗸	Transport	~	
		PURE Fibre Channel Disk (naa.624a9370fabf667e	349 249	disk	1.00 MB	Not Consumed		Attached	Supported	Flash	Fibre Channe	1	
		PURE Fibre Channel Disk (naa.624a9370fabf667el	349 251	disk	1.00 TB	Not Consumed		Attached	Supported	Flash	Fibre Channe	1	
		PURE Fibre Channel Disk (naa.624a9370fabf667el	349 254	disk	4.00 TB	TSA_PURE_FLASH_4TB_01		Attached	Supported	Flash	Fibre Channe	L	

FIGURE 17. ESXI SERVER FC STORAGE CONNECTIONS

On Site B, on the 4-node vSphere cluster, a Pure x50 storage-backed vVols datastore (TSA\_PURE\_FLASH\_VVOL) was created. The graphic below outlines the vVols datastores using Pure Storage in Site B:

I TSA-WDC-70-DC01B ACTIONS ✓					
Summary Monitor Configure Permissions Hosts & Clusters VMs Datastores Networks Updates					
Datastore Clusters Datastore Folders					
				Filt	er.
Name↑ ✓	Status ~	Type V Dat	astore C V Capacity	~	Free ~
ESX27-local	✓ Normal	VMFS 6	745 GB		734.87 GB
MGMT-TNTR_ITB-Thin-PerfLUN	🗸 Normal	NFS 3	190.95 1	в	148.91 TB
Implate TNTR_ICO_1TB Thin-Cep-LUN	🗸 Normal	NFS 3	190.95 1	в	148.91 TB
(I TSA-Pure-VVOL-SC-DS >	<ul> <li>Normal</li> </ul>	vVol	8,192 TE		8,191.69 TB
	<ul> <li>Normal</li> </ul>	VMFS 6	4 TB		2.21 TB
TSA_TNTR_Auto_5TB_01	<ul> <li>Normal</li> </ul>	NFS 3	190.95 1	В	148.91 TB
TSA_TNTR_Auto_5TB_02	<ul> <li>Normal</li> </ul>	NFS 3	190.95 1	В	148.91 TB
TSA_TNTR_Csp_10TB_01	<ul> <li>Normal</li> </ul>	NFS 3	190.95 1	В	148.91 TB
TSA_TNTR_Csp_10TB_02	<ul> <li>Normal</li> </ul>	NFS 3	190.95 1	В	148.91 TB
TSA_TNTR_Mgmt	<ul> <li>Normal</li> </ul>	NFS 3	190.95 1	В	148.91 TB
□ TSA_TNTR_MS	<ul> <li>Normal</li> </ul>	NFS 3	190.95 1	В	148.91 TB
STA_TNTR_Oracle	<ul> <li>Normal</li> </ul>	NFS 3	190.95 1	в	148.91 TB
TSA_TNTR_Perf_10TB_01	<ul> <li>Normal</li> </ul>	NFS 3	190.95 1	B	148.91 TB
∃ TSA_TNTR_SAP	<ul> <li>Normal</li> </ul>	NFS 3	190.95 1	B	148.91 TB
E TSA_TNTR_SOL	<ul> <li>Normal</li> </ul>	NFS 3	190.95 1	в	148.91 TB
E TSALAB-TinVMstore-T800-01	🗸 Normal	NFS 3	190.95 1	в	148.91 TB
S vsanDatastore	<ul> <li>Normal</li> </ul>	VSAN	10.48 TE	j	10.3 TB

#### FIGURE 18. SITE B VVOLS DATASTORES

### Pure Storage Plugin for VMware vSphere Client

The Pure Storage Plugin for the vSphere client enables VMware users to have insight into, and control of, their Pure Storage FlashArray environment while directly logged into the vSphere client.

The Pure Storage Plugin extends the vSphere client interface to include environmental statistics and objects that underpin the VMware objects in use and to provision new resources as needed.

#### Learn more about installing the Pure Storage Plugin for the vSphere client.

Pure Storage Plugin details are shown below:

P	PURESTORAGE" •	Settings		
۹	Dashboard	System Networ	rk Users Software	
( <b>f</b> )		🔆 > Software		
$\checkmark$		vSphere Plugin		Ø
		vCenter Host Administrator User Administrator Password Version on vCenter	10.128.138.123 administrator@vsphere.local **** 4.4.0	
€		Available Version	4.3.1 Unin	nstall
*	Settings			

#### FIGURE 19. PURE STORAGE PLUGIN DETAILS
VMware vCenter and Pure Storage Plugin:

vm vSphere Client	lenu 🗸 🛛 📿 Search in all environments	
🖞 Home		
Shortcuts	<b>PURE</b> STORAGE <sup>®</sup>	
Hosts and Clusters	+ ADD	윈 IMPORT PROTECTION GROUPS
VMs and Templates	A way Allag	
Storage	Array Allas	Array URL
Networking	• wdc-tsa-pure-01	https://10.128.136.60
🔢 Content Libraries		
🗞 Workload Management		
🕞 Global Inventory Lists		
Policies and Profiles		
🕗 Auto Deploy		
lightarrow Hybrid Cloud Services		
< > Developer Center		
🎇 Administration		
🗊 Tasks	Load Pure1 Tags Volume Groups	
Events		
Tags & Custom Attributes		
🔷 Lifecycle Manager	vvol	Q
	vvolvSphere-HA-4d3e9f32-vg	
💽 vRealize Operations	🗅 vvolvSphere-HA-a44c9013-vg	
PRaaS	PT vvol-vvolrac2-e8777402-vg	
🛞 Site Recovery		
🕐 Pure Storage		



Once the Plugin is installed, from the VM **Oracle19c-OL8-VVOL** view and summary tab, there is a FlashArray widget box indicating whether or not the VM has undelete protection. Undelete protection means that there is currently a FlashArray snapshot of the VM's config-vVol.

🔓 Oracle19c-OL8-VVOL	🕨 🛢 👹 🤯 🔹 actions 🗸						
Summary Monitor Configure	Permissions Datastores Networks Snapshots Updates						
Powered Cn     In Aunor Web console     LAUNCH REMOTE CONSole	t OS: Oracle Linux 8 (64-bit) patibility: ESX 7.0 and later (VM version 17) are Tools: Running, version:1296 (Guest Managed) More: INFO Name: oracle19c-018-vvol.corp.localdomain Idresses: 10.128.140.102 : 10.128.136.128						
VM Hardware		^	Notes				
> CPU	12 CPU(s)		Custom Attributes				
> Memory	128 GB, 1.28 GB memory active						
> Hard disk 1	80 GB	VM Storage Policies					
Total hard disks	5 hard disks						
> Network adapter 1	TSA-WDC-70B-PG1403 (connected)		vSphere HA				
CD/DVD drive 1	Disconnected	°q <sub>₽</sub> , ∨					
> Video card	8 MB		HashArray				
VMCI device	Device on the virtual machine PCI bus that provides support for communication interface	or the virtual machine	UNTREAL VOLUMES				
> Other	Additional Hardware		Undelete Protection ①	(No snapshot found) Snapshot now			
Compatibility ESXi 7.0 and later (VM version 17)							
Edit Settings							

### FIGURE 21. UNDELETE PROTECTION WIDGET

Navigate to VM **Oracle19c-OL8-VVOL**'s Configure tab to see vVols on Pure Storage.

Summary Monitor	Cracle19c-OL8-VVOL   E 😻 🥐 🐼 🕼 Actions 🗸												
Settings VM SDRS Rules vApp Options	Vir	tual Volume				0	1						
Alarm Definitions	4	IMPORT DISK	I RESTORE DELETED DISK		+ CREATE SNAPSHOT	G OVERWRITE DISK	]	l autori					
Scheduled Tasks		Name	т	Virtual Devi	ce T	Size	Ϋ́Υ	Datastore	Ŧ	Array	Ŧ	Volume	
VMware EVC		) Hard disk 1		SCSI (0:0)		80.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-20c34be7	
Guest User Mappings		Hard disk 2		SCSI (0:1)		80.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-c552b187	
Pure Storage V		Hard disk 3		SCSI (1:0)		100.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-57b48797	
Virtual Volumes	C	Hard disk 4		SCSI (2:0)		1.0 TB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-03decfb2	
		Hard disk 5		SCSI (3:0)		250.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-efe1c0b0	
		VM home		-		4.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Config-950dc3ea	

### FIGURE 22. VVOLS ON PURE STORAGE

The Pure Storage Plugin enables the following operations:

- Import Disk to import a virtual disk (vVol)
- Restore Deleted Disk to restore a destroyed vVol
- Create Snapshot to take a snapshot
- Overwrite Disk to overwrite an existing vVol

Learn more about Pure Storage Plugin operations.



### Virtual Machine and Oracle Configuration

Three VMs were created as follows:

- VM Oracle19c-OL8-VVOL
- VM Oracle19c-OL8-VVOL-QAVM
- VM Oracle19c-OL8-VVOL-RMAN

Each VM was created with the following tools or characteristics:

- VM version 17 on ESXi 7.0
- Guest operating system Oracle Enterprise Linux 8.3 UEK
- Oracle Grid and RDBMS binaries version 19.8
- ASM disk group for Oracle Grid Infrastructure Management Repository (GIMR) named MGMT\_DATA
- Different names for DATA and FRA ASM disks on VMs Oracle19c-OL8-VVOL and Oracle19c-OL8-RMAN
  - On VM **Oracle19c-OL8-VVOL**, ASM diskgroup DATA\_DG contains a ASM disk **DATA\_01** and ASM diskgroup FRA\_DG has a ASM disk **FRA\_01**
  - On VM Oracle19c-OL8-RMAN, ASM diskgroup RMAN\_DATA\_DG contains a ASM disk RMAN\_DATA\_01
- Storage for all three VMs was provisioned on the vVols datastore TSA-Pure-VVOL-SC-DS

TSA-Pure-VVOL-SC-DS Actions V												
Summary Monitor Configure Permissions Files Hosts VMs												
Virtual Machines VM Templates											Filter	r
Name 🕇	~	State	~	Status	~	Provisioned Space	~	Used Space	~	Host CPU	~	Host Mem
G Oracle19OL8-VVOL		Powered On		✓ Normal		1.62 TB		56.03 GB		144 MHz		102.83 GB
Praclet9OLB-VVOLOAVM		Powered On		🗸 Normal		260.01 GB		43.93 GB		96 MHz		3.83 GB
Cracle19c-OL8-VVOL-RMAN		Powered On		✓ Normal		73.88 GB		73.88 GB		360 MHz		21.03 GB

### FIGURE 23. ORACLE CONFIGURED VIRTUAL MACHINES

Details for VM Oracle19c-OL8-VVOL are as follows:

- 12 vCPUs with 128GB RAM
- Oracle SGA set to 96GB with traditional HugePages and PGA set to 6GB
- VM hosts both Oracle Grid and RDBMS 19.8 multi-tenant production database vvol19c with a pluggable database pdb1
- 3 ASM disks groups:
  - MGMT\_DATA for Oracle Grid Infrastructure Management Repository (GIMR) with ASM disk MGMT\_DATA01
  - DATA\_DG for data and redo log files with ASM disk DATA\_01
  - FRA\_DG for archive logs files with ASM disk FRA\_01

All Oracle on VMware platform best practices were followed as per the VMware Hybrid Cloud Best Practices Guide for Oracle Workloads.

🔓 C	Pracle19c-OL8	3-VVOL   🕨 🗖	🛃 🦻 🔯 actions 🗸	
Summ	ary Monitor	Configure Permiss	ions Datastores Networks Snapshots Updates	
Po LAUNG	wered On CH WEB CONSOLE	Guest OS: Compatibility: VMware Tools: DNS Name: IP Addresses: Host: 1)	Oracle Linux 8 (64-bit) ESXi 7.0 and later (VM version 17) Running, version:11296 (Guest Managed) MORE INFO oracle19c-ol8-vvol.corp.localdomain 10.128.140.102 10.128.136.128	
VM H	lardware			^
>	CPU		12 CPU(s)	
>	Memory		128 GB, 1.28 GB memory active	
>	Hard disk 1		80 GB	
	Total hard disks		5 hard disks	
>	Network adapter 1		TSA-WDC-70B-PG1403 (connected)	
	CD/DVD drive 1		Disconnected 4	<b>,                                    </b>
>	Video card		8 MB	
,	VMCI device		Device on the virtual machine PCI bus that provides support for the virtual machine communication interface	
>	Other		Additional Hardware	
	Compatibility		ESXi 7.0 and later (VM version 17)	
Edit S	Settings			

### FIGURE 24. VM ORACLE19C-OL8-VVOL SUMMARY

VM Oracle19c-OL8-VVOL virtual disks (VMDKs) are shown below. All SCSI controllers are set to VMware Paravirtual SCSI Controller type.

✓ Hard disks	5 total   1.5 TB
> Hard 80 GB   SCSI(0:0) disk 1 -	
> Hard 80 GB   SCSI(0:1) disk 2 ×	
> Hard 100 GB   SCSI(1:0) disk 3 -	
> Hard 1024 GB   SCSI(2:0) disk 4 ×	
> Hard 250 GB   SCSI(3:0) disk 5 <	
> SCSI controller 0	VMware Paravirtual
> SCSI controller 1	VMware Paravirtual
> SCSI controller 2	VMware Paravirtual
> SCSI controller 3	VMware Paravirtual

### FIGURE 25. VM ORACLE19C-OL8-VVOL VMDKS

Virtual disk (VMDK) details:

- Hard Disk 1 80GB for operating system
- Hard Disk 2 80GB for Oracle Grid and RDBMS binaries
- Hard Disk 3 100GB for Oracle Grid Infrastructure Management Repository (GIMR) (Management Database (MGMTDB)) (ASM Disk Group MGMT\_DATA)
- Hard Disk 4 1TB for database vvol19c data and redo log files (ASM Disk Group DATA\_DG)
- Hard Disk 5 250GB for database vvol19c archive logs files (ASM Disk Group FRA\_DG)

Oracle ASM disk group details:

grid@ora	cle19c-c	18-vvol	l:+ASM:/h	ome/grid> asmcr	nd lsdg								
State	Type	Rebal		Logical_Sector			Total_MB	Free_MB	Req_mir_free_MB	Usable_file_MB	Offline_disks	Voting_files	Name
MOUNTED					2 4096	1048576	1048575	1036823		1036823			DATA_DG/
MOUNTED					2 4096	1048576	255999						FRA DG/
MOUNTED						4194304							MGMT DATA/
aridfora	clel9c-c	18-vvol	I:+ASM:/h	ome/grid>									

FIGURE 26. ORACLE ASM DISK GROUP

### Hard Disk 4 (1TB) details are shown below:

✓ Hard disk 4	<u>1</u>
Maximum Size	62 TB
VM storage policy	Datastore Default ~
Туре	Thin Provision
Sharing	No sharing 🗸
Disk File	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1f02-4f8d-af37- 93f8bc1f9399/Oracle19c-OL8-VVOL_3.vmdk
Shares	Normal V 1000
Limit - IOPs	Unlimited ~
Disk Mode	Dependent 🗸
Virtual Device Node	SCSI controller 2 🗸 SCSI(2:0) Hard disk 4 🗸

### FIGURE 27. HARD DISK 4 (1TB)

Additional vVols-backed VMDKs details are shown below:

Search						
TSA-Pure-VVOL-SC-DS	🎦 New Folder 🛕 Upload Files 🏦 Upload Folder   🔐 Register VM 🛓 Download	id 📋 Copy to 🚽	Move to	🔊 Rename to 🗙 Delete 🛔	Inflate	
vSphere-HA	Name	Ψ Size	т М., т	Туре т	Path	
Clone-Oracle19c-OL8-VVOL	🖾 .dvsData		12/1	Folder	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1102-4f8d-af37-93f8bc119399/.dvsData	
Clone-Oracle19c-OL8-VVOL	sdd.sf		12/1	Folder	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1102-4f8d-af37-93f8bc119399/.sdd.sf	
Clone-Oracle19c-OL8-VVOL	Cracle19c-OL8-VVOL-7b9393b0.hlog	0.05 K	B 12/1	File	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1102-4f8d-af37-93f8bc1f9399/Oracle19c-OL8-VVOL-7b9393b0.hlog	
Oracle19c-OL8-VVOL	Oracle19c-OL8-VVOL-97e92c12.vswp	0.31 K	B 12/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1f02-4f8d-af37-93f8bc1f9399/Oracle19c-OL8-VVOL-97e92c12.vswp	
Oracle19c-OL8-VVOL-QAVM	Cracle19c-OL8-VVOL-97e92c12.vswp.lck	0 K	B 12/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1102-4f8d-af37-93f8bc1f9399/Oracle19c-OL8-VVOL-97e92c12.vswp.lck	
<ul> <li>Oracle19c-OL8-VVOL-RMAN</li> </ul>	Oracle19c-OL8-VVOL-aux.xml	0.01 K	B 12/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1102-4f8d-af37-93f8bc1f9399/Oracle19c-OL8-VVOL-aux.xml	
	Cracle19c-OL8-VVOL.nvram	264.49 K	B 12/2	Non-volatile Memory File	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1102-4f8d-af37-93f8bc119399/Oracle19c-OL8-VVOL.nvram	
	and Oracle19c-OL8-VVOL.vmdk	4,593,664 K	B 12/2	Virtual Disk	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1f02-4f8d-af37-93f8bc1f9399/Oracle19c-OL8-VVOL.vmdk	
	Oracle19c-OL8-VVOL.vmsd	0.04 K	B 12/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1102-418d-af37-93f8bc119399/Oracle19c-OL8-VVOLvmsd	
	Oracle19c-OL8-VVOL.vmx	4.83 K	B 12/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1f02-4f8d-af37-93f8bc1f9399/Oracle19c-OL8-VVOL.vmx	
	Oracle19c-OL8-VVOL.vmx.lck	0 K	B 12/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1102-418d-af37-93f8bc119399/Oracle19c-OL8-VVOLvmx.lck	
	Oracle19c-OL8-VVOL.vmx~	4.83 K	B 12/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1f02-4f8d-af37-93f8bc1f9399/Oracle19c-OL8-VVOL.vmx~	
	and Oracle19c-OL8-VVOL_1.vmdk	41,616,384 K	B 12/2	Virtual Disk	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1f02-4f8d-af37-93f8bc1f9399/Oracle19c-OL8-VVOL_1.vmdk	
	an Oracle19c-OL8-VVOL_2.vmdk	98,304 K	B 12/2	Virtual Disk	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1f02-4f8d-af37-93f8bc1f9399/Oracle19c-OL8-VVOL_2.vmdk	
	a Oracle19c-OL8-VVOL_3.vmdk	10,188,800 K	B 12/2	Virtual Disk	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1f02-4f8d-af37-93f8bc1f9399/Oracle19c-OL8-VVOL_3.vmdk	
	and Oracle19c-OL8-VVOL_4.vmdk	2,233,344 K	B 12/2	Virtual Disk	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1f02-4f8d-af37-93f8bc1f9399/Oracle19c-OL8-VVOL_4.vmdk	
	🚵 test.vmdk	4,592,640 K	B 12/2	Virtual Disk	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1f02-4f8d-af37-93f8bc1f9399/test.vmdk	
	vmware-10.log	184.18 K	B 12/2	VM Log File	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1f02-4f8d-af37-93f8bc1f9399/vmware-10.log	
	vmware-5.log	182.15 K	B 12/1	VM Log File	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1f02-4f8d-af37-93f8bc1f9399/vmware-5.log	
	vmware-6.log	181.78 K	B 12/1	VM Log File	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1f02-4f8d-af37-93f8bc1f9399/vmvare-6.log	
	vmware-7.log	1,036.6 K	B 12/1	VM Log File	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1f02-4f8d-af37-93f8bc1f9399/vmware-7.log	
	vmware-8.log	756.25 K	B 12/1	VM Log File	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1f02-4f8d-ef37-93f8bc1f9399/vmware-8.log	
	vmware-9.log	184.49 K	B 12/2	VM Log File	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1f02-4f8d-ef37-93f8bc1f9399/vmware-9.log	
	www.ware.log	164.5 K	B 12/2	VM Log File	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-tf02-4f8d-af37-93f8bc1f9399/vmware.log	
	wmx-Oracle19c-OL8-VVOL-846308b8f679077b683ffcce4dcaa7e938d74dbf-1.vswp	104,448 K	B 12/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.0b4146e3-1f02-4f8d-af37-93f8bc1f9399/vmx-Oracle19c-OL8-VVOL-846308b8f67907	/b683f

### FIGURE 28. VVOLS-BACKED VMDKS

The subtlety lies in the way a vVols datastore type is implemented compared to a regular VMFS datastore. A **df** command on the ESXi server will reveal that vVols datastores are implemented as a datastore of type **vvol**.

[root@esx1	29:~] df			
Filesystem	Bytes	Used	Available	e Usef Mounted on
NFS	209949611261952	46224916664320	163724694597632	2 22% /vmfs/volumes/Template-TNTR ISOs-1TB-Thin-Cap-LUN
NFS	209949611261952	46224916664320	163724694597632	2 22% /vmfs/volumes/TSA_TNTR_SQL
NFS	209949611261952	46224916664320	163724694597632	2 22% /vmfs/volumes/TSA TNTR SAP
NFS	209949611261952	46224916664320	163724694597632	2 22% /vmfs/volumes/TSA TNTR Auto 5TB 01
NFS	209949611261952	46224916664320	163724694597632	2 22% /vmfs/volumes/TSALAB-TinVMstore-T800-01
NFS	209949611261952	46224916664320	163724694597632	2 22% /vmfs/volumes/TSA TNTR MS
NFS	209949611261952	46224916664320	163724694597632	2 22% /vmfs/volumes/TSA TNTR Auto 5TB 02
NFS	209949611261952	46224916664320	163724694597632	2 22% /vmfs/volumes/TSA TNTR Cap 10TB 02
NFS	209949611261952	46224916664320	163724694597632	2 22% /vmfs/volumes/MGMT-TNTR 1TB-Thin-Perf-LUN
NFS	209949611261952	46224916664320	163724694597632	2 22% /vmfs/volumes/TSA TNTR Cap 10TB 01
NFS	209949611261952	46224916664320	163724694597632	2 22% /vmfs/volumes/TSA TNTR Mgmt
NFS	209949611261952	46224916664320	163724694597632	2 22% /vmfs/volumes/TSA TNTR Oracle
NFS	209949611261952	46224916664320	163724694597632	2 22% /vmfs/volumes/TSA TNTR Perf 10TB 01
VMFS-6	4397778075648	1968705634304	2429072441344	4 45% /vmfs/volumes/TSA PURE FLASH 4TB 01
VMFS-L	13690208256	1719664640	11970543616	6 13% /vmfs/volumes/LOCKER-5f862770-9cd1a2c9-119c-246e965377bc
vfat	1073577984	183894016	889683968	8 17% /vmfs/volumes/BOOTBANK2
vfat	1073577984	174227456	899350528	8 16% /vmfs/volumes/BOOTBANK1
vvol	9007199254740992	341226553344	9006858028187648	8 0% /vmfs/volumes/TSA-Pure-VVOL-SC-DS <
vsan	11522248015872	197623776542	11324624239330	0 2% /vmfs/volumes/vsanDatastore
[moot door 1]	201			

### FIGURE 29. DF COMMAND RESULT

Unlike any regular VM files in the VM folder on a datastore where we can see the different –flat.vmdk files, with VMs on vVols, the folder contents appear as follows:

	_						
[root@esx129	:/vm	ufs/volu	umes/vvol:5	52cc3c9a587	e393e-a	20e901:	faf033899/rfc4122.0b4146e3-1f02-4f8d-af37-93f8bc1f9399] pwd
vmfs/volume	s/TS	A-Pure	-VVOL-SC-DS	S/Oracle19c	-OT8-AA	OL	
root@esx129	:/vm	nfs/vol	umes/vvol:5	52cc3c9a587	e393e-a	20e901:	faf033899/rfc4122.0b4146e3-1f02-4f8d-af37-93f8bc1f9399] ls -1
otal 113680:							
rw-rr				53	Dec 15	16:20	Oracle19c-OL8-VVOL-7b9393b0.hlog
-rw				315	Dec 29	01:25	Oracle19c-OL8-VVOL-97e92c12.vswp
-rw					Dec 29	01:25	Oracle19c-OL8-VVOL-97e92c12.vswp.lck
rw-rr				13	Dec 28	22:25	Oracle19c-OL8-VVOL-aux.xml
-rw				270840	Dec 29	01:25	Oracle19c-OL8-VVOL.nvram
-rw				672	Dec 29	01:25	Oracle19c-OL8-VVOL.vmdk
rw-rr				43	Dec 28	22:25	Oracle19c-OL8-VVOL.vmsd
rwxr-xr-x				4948	Dec 29	01:25	Oracle19c-OL8-VVOL.vmx
-rw					Dec 29	01:25	Oracle19c-OL8-VVOL.vmx.lck
rwxr-xr-x				4947	Dec 29	01:25	Oracle19c-OL8-VVOL.vmx~
-rw				673	Dec 29	01:25	Oracle19c-OL8-VVOL_1.vmdk
-rw				617	Dec 29	01:25	Oracle19c-OL8-VVOL_2.vmdk
-rw				621	Dec 29	01:25	Oracle19c-OL8-VVOL_3.vmdk
-rw				618	Dec 29	01:25	Oracle19c-OL8-VVOL_4.vmdk
-rw				633	Dec 28	19:57	test.vmdk
rw-rr				188605	Dec 28	19:57	vmware-10.log
rw-rr				186517	Dec 16	00:51	vmware-5.log
-rw-rr				186143	Dec 16	03:03	vmware-6.log
rw-rr				1061478	Dec 18	18:18	vmware-7.log
rw-rr				774398	Dec 18	20:20	vmware-8.log
-rw-rr				188913	Dec 21	16:22	vmware-9.log
rw-rr				168449	Dec 29	20:27	vmware.log
-rw				106954752	Dec 29	01:25	vmx-Oracle19c-OL8-VVOL-846308b8f679077b683ffcce4dcaa7e938d74dbf-1.vswp
[root@esx129	:/vn	ifs/vol	umes/vvol:5	52cc3c9a587	e393e-a	20e901:	faf033899/rfc4122.0b4146e3-1f02-4f8d-af37-93f8bc1f9399]

FIGURE 30. VM FOLDER ON VVOLS

Notice the lack of -flat.vmdk files as they exist on the vVols storage.

Logging into the Pure x50 storage GUI shows the various vVols which represent the different virtual disks of VM Oracle19c-OL8-VVOL.

$\mathbf{O}$	PURESTORAGE" •	Storage										
۲	Dashboard	Array Hosts Volumes Protection Groups Pods										
	Storage	(f) > Volumes > vvol-Oracle19c-OL8-VVOL-0b4146e3-vg	) > Volumes > 😂 vvol-Oracle19c-OL8-VVOL-0b4146e3-vg									
→ @	Analysis	Size         Data Reduction         Volumes         Snapshots         Shared         System         Total           1666 G         25.7 to 1         428.28 M         0.00         -         -         -										
	Performance Capacity	Volumes	Space	QoS Detail	5 <b>1-7</b> of 7	<> +	- :					
	Replication	Name	Size	Volumes	Snapshots	Reduction						
æ	Health											
		⇐ vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Config-950dc3ea	4 G	4.10 M	0.00	3.7 to 1	:					
	Settings	vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-20c34be7	80 G	24.83 M	0.00	26.8 to 1	:					
		Svol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-c552b187	80 G	47.19 M	0.00	29.9 to 1	:					
		vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-57b48797	100 G	1.44 K	0.00	30.8 to 1	:					
End U	lser Agreement	vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Swap-5c283b5b	128 G	0.00	0.00	1.0 to 1	:					
Terms Log O	: Put	vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-efe1c0b0	250 G	280.68 M	0.00	7.0 to 1	:					
		Svvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-03decfb2	1 T	71.48 M	0.00	26.1 to 1	:					
		Destroyed (0) 🗸										
		Details										
		QoS 🗹 Bandwidth Limit - IOPS Limit -										

### FIGURE 31. PURE STORAGE VOLUMES OF VM ORACLE19C-OL8-VVOL

Logging into Pure Storage via Putty and running the following command also produces the information provided above:

pureuser@wdc-tsa-pure-01> purevgroup list Name vvol-Oracle19c-OL8-VVOL-0b4146e3-vg pureuser@wdc-tsa-pure-01>	Volumes vvol-Oracle19c-OL8-V vvol-Oracle19c-OL8-V vvol-Oracle19c-OL8-V vvol-Oracle19c-OL8-V vvol-Oracle19c-OL8-V vvol-Oracle19c-OL8-V	/OL-0b4146e3-vg/Config-950dc3ea /OL-0b4146e3-vg/Data-03decfb2 /OL-0b4146e3-vg/Data-20c34be7 /OL-0b4146e3-vg/Data-57b48797 /OL-0b4146e3-vg/Data-c522b187 /OL-0b4146e3-vg/Data-efe1c0b0 /OL-0b4146e3-vg/Swap-5c283b5b		
pureuser@wdc-tsa-pure-01> purevol list				
Name	Size	Source	Created	Serial
vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Config-	-950dc3ea 4G	-	2020-12-14 20:13:01 PST	FABF667E849B44C500013526
vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-03	3decfb2 1T	-	2020-12-15 14:37:54 PST	FABF667E849B44C50001353C
vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-57	7b48797 100G	-	2020-12-15 08:32:16 PST	FABF667E849B44C50001352E
vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-26	0c34be7 80G	-	2020-12-14 20:13:02 PST	FABF667E849B44C500013527
vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-c5	552b187 80G	-	2020-12-14 20:14:18 PST	FABF667E849B44C500013528
vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-ef	fe1c0b0 250G	-	2020-12-18 11:56:35 PST	FABF667E849B44C5000135A7
<pre>vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Swap-5c pureuser@wdc-tsa-pure-01&gt;</pre>	c283b5b 128G	-	2020-12-29 13:29:22 PST	FABF667E849B44C5000139E9

### FIGURE 32. PURE STORAGE VOLUMES OF VM ORACLE19C-OL8-VVOL

It's important to note that when following an SSH to the ESXi server and navigating to the vVol datastore mount to check the VM **Oracle19c-OL8-VVOL** folder, there are no **XXXX-flat.vmdk**. We only see the .vmdk files.



The VMDK file contents point to the actual vVol, which backs the XXXX-flat.vmdk.

### FIGURE 33. ORACLE VM VMDK FILE

Details of VM Oracle19c-OL8-QAVM are as follows:

- 8 vCPUs with 96GB RAM
- VM hosts both Oracle Grid and RDBMS 19.8 binaries only for staging and mount purposes
- 1 ASM disk group
  - MGMT\_DATA for Oracle Grid Infrastructure Management Repository (GIMR) with ASM disk MGMT\_DATA01

All Oracle on VMware platform best practices were followed as outlined in VMware Hybrid Cloud Best Practices Guide for Oracle Workloads.

🔂 Oracle19c-OL8-V	VOL-QAVM	🕨 🛢 🛃 🤯 🔞 ACTIONS 🗸	
Summary Monitor Cor	nfigure Permissio	ons Datastores Networks Snapshots Updates	
Powered On LAUNCH WEB CONSOLE LAUNCH REMOTE CONSOLE	Guest OS: Compatibility: VMware Tools: DNS Name: IP Addresses: Host: $\underbrace{\&}$	Oracle Linux 8 (64-bit) ESXi 7.0 and later (VM version 17) Running, version:11296 (Guest Managed) MORE INFO oracle19c-ol8-vvol-qavm.corp.localdomain 10.128.140.104 10.128.136.129	
VM Hardware			^
> CPU		8 CPU(s)	
> Memory		32 GB, 0.32 GB memory active	
> Hard disk 1		80 GB	
Total hard disks		3 hard disks	
> Network adapter 1		TSA-WDC-70B-PG1403 (connected)	
CD/DVD drive 1		Disconnected	⊒ <sub>₽</sub> . ∨
> Video card		8 MB	
VMCI device		Device on the virtual machine PCI bus that provides support for the virtual machine communication interface	
> Other		Additional Hardware	
Compatibility		ESXi 7.0 and later (VM version 17)	
Edit Settings			

### FIGURE 34. VM ORACLE19C-OL8-VVOL-QAVM SUMMARY

VM Oracle19c-OL8-VVOL-QAVM virtual disks (VMDKs) are shown below. All SCSI controllers are set to VMware Paravirtual SCSI Controller type.

> Hard disk 1	80 <u>GB v</u>
> Hard disk 2	80 GB V
> Hard disk 3	100 <u>GB v</u>
> SCSI controller 0	VMware Paravirtual
> SCSI controller 1	VMware Paravirtual
> SCSI controller 2	VMware Paravirtual
> SCSI controller 3	VMware Paravirtual

#### FIGURE 35. VM ORACLE19C-OL8-VVOL-QAVM VMDKS

Virtual disk (VMDKs) details:

- Hard Disk 1 80GB for operating system
- Hard Disk 2 80GB for Oracle Grid and RDBMS binaries
- Hard Disk 3 100GB for Oracle Grid Infrastructure Management Repository (GIMR) (Management Database (MGMTDB)) (ASM Disk Group MGMT\_DATA)

Additional vVols-backed VMDK details are shown below:

TSA-Pure-VVOL-SC-	DS Actions -				
Q Search					
V TSA-Pure-VVOL-SC-DS	The New Folder 1 Upload Files 1 Upload Folder	$\square$ Copy to $\rightarrow N$	love to	Rename to X Delete	Inflate
> 🛄 .vSphere-HA	Name	Size T	М т	Туре т	Path T
> Clone-Oracle19c-OL8-VVOL	D.dvsData		12/1	Folder	[TSA-Pure-VVOL-SC-DS] rfc4122.5cae54d1-2f11-42b7-bb92-522c3c18e30e/.dvsData
> Clone-Oracle19c-OL8-VVOL	sdd.sf		12/1	Folder	[TSA-Pure-VVOL-SC-DS] rfc4122.5cae54d1-2f11-42b7-bb92-522c3c18e30e/.sdd.sf
Clone-Oracle19c-OL8-VVOL	Cracle19c-OL8-VVOL-QAVM-2b552681.hlog	0.85 KB	12/1	File	[TSA-Pure-VVOL-SC-DS] rfc4122.5cae54d1-2f11-42b7-bb92-522c3c18e30e/Oracle19c-OL8-VVOL-QAVM-2b552681.hlog
> Cracle19c-OL8-VVOL	Oracle19c-OL8-VVOL-QAVM-d8672f61vswp	0.31 KB	12/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.5cae54d1-2f11-42b7-bb92-522c3c18e30e/Oracle19c-OL8-VVOL-QAVM-d8672f61.vswp
> Oracle19c-OL8-VVOL-QAVM	Oracle19c-OL8-VVOL-QAVM-d8672f61.vswp.lck	0 KB	12/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.5cae54d1-2f11-42b7-bb92-522c3c18e30e/Oracle19c-OL8-VVOL-QAVM-d8672f61.vswp.lck
> Cracle19c-OL8-VVOL-RMAN	Dracle19c-OL8-VVOL-QAVM.nvram	264.49 KB	12/2	Non-volatile Memory File	[TSA-Pure-VVOL-SC-DS] rfc4122.5cae54d1-2f11-42b7-bb92-522c3c18e30e/Oracle19c-OL8-VVOL-QAVM.nvram
	a Oracle19c-OL8-VVOL-QAVM.vmdk	4,547,584 KB	12/2	Virtual Disk	[TSA-Pure-VVOL-SC-DS] rfc4122.5cae54d1-2f11-42b7-bb92-522c3c18e30e/Oracle19c-OL8-VVOL-QAVM.vmdk
	Oracle19c-OL8-VVOL-QAVM.vmsd	0 KB	12/1	File	[TSA-Pure-VVOL-SC-DS] rfc4122.5cae54d1-2f11-42b7-bb92-522c3c18e30e/Oracle19c-OL8-VVOL-QAVM.vmsd
	Oracle19c-OL8-VVOL-QAVM.vmx	4.46 KB	12/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.5cae54d1-2f11-42b7-bb92-522c3c18e30e/Oracle19c-OL8-VVOL-QAVM.vmx
	Oracle19c-OL8-VVOL-QAVM.vmx.lck	0 KB	12/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.5cae54d1-2f11-42b7-bb92-522c3c18e30e/Oracle19c-OL8-VVOL-QAVM.vmx.lck
	Oracle19c-OL8-VVOL-QAVM.vmx <sup>w</sup>	4.46 KB	12/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.5cae54d1-2f11-42b7-bb92-522c3c18e30e/Oracle19c-OL8-VVOL-GAVM.vmx~
	and Oracle19c-OL8-VVOL-QAVM_1.vmdk	41,409,536	12/2	Virtual Disk	[TSA-Pure-VVOL-SC-DS] rfc4122.5cae54d1-2f11-42b7-bb92-522c3c18e30e/Oracle19c-OL8-VVOL-QAVM_1.vmdk
	and Oracle19c-OL8-VVOL-QAVM_2.vmdk	98,304 KB	12/1	Virtual Disk	[TSA-Pure-VVOL-SC-DS] rfc4122.5cae54d1-2f11-42b7-bb92-522c3c18e30e/Oracle19c-OL8-VVOL-GAVM_2.vmdk
	vmware-1.log	199.45 KB	12/1	VM Log File	[TSA-Pure-VVOL-SC-DS] rfc4122.5cae54d1-2f11-42b7-bb92-522c3c18e30e/vmware-1.log
	vmware-2.log	162.77 KB	12/2	VM Log File	[TSA-Pure-VVOL-SC-DS] rfc4122.5cae54d1-2f11-42b7-bb92-522c3c18e30e/vmware-2.log
	umware.log	145.5 KB	12/2	VM Log File	[TSA-Pure-VVOL-SC-DS] rfc4122.5cae54d1-2f11-42b7-bb92-522c3c18e30e/vmware.log
	vmx-Oracle19c-OL8-VVOL-Q-b579503a44f98d0aef699748edcae38db14f2094-1vswp	96,256 KB	12/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.5cae54d1-2f11-42b7-bb92-522c3c18e30e/vmx-Oracle19c-OL8-VVOL-Q-b579503a44f98d0a

### FIGURE 36. VVOLS-BACKED VMDKS

Logging into the Pure x50 storage GUI shows the various vVols representing the different virtual disks of VM **Oracle19c-OL8-VVOL-QAVM**.



	Storage					
Dashboard	Array Hosts Volumes Protection Groups Pods					
🕐 Storage	> Volumes > = vvol-Oracle19c-OL8-VVOL-QAVM-5cae54d1-vg					
🔍 Analysis	Size Data Reduction Volumes Snapshots Shared System Total 270337 M 30.0 to 1 46.49 M 0.00					
Performance Capacity	Volumes	Space	QoS Details	1-5 of 5	<> +	
Replication	Name	Size	Volumes	Snapshots	Reduction	
🚸 Health	vvol-Oracle19c-OL8-VVOL-QAVM-5cae54d1-vg/Config-b3f586b9	4 G	1.11 M	0.00	6.9 to 1	:
🐝 Settings	vvol-Oracle19c-OL8-VVOL-QAVM-5cae54d1-vg/Data-045fdad3	80 G	15.21 M	0.00	28.2 to 1	:
	vvol-Oracle19c-OL8-VVOL-QAVM-5cae54d1-vg/Data-17772e0a	100 G	0.00	0.00	30.8 to 1	:
Help	wol-Oracle19c-OL8-VVOL-QAVM-5cae54d1-vg/Data-50f12800	80 G	30.18 M	0.00	30.2 to 1	:
End User Agreement	vvol-Oracle19c-OL8-VVOL-QAVM-5cae54d1-vg/Swap-15025d55	1 M	0.00	0.00	1.0 to 1	:
Log Out	Destroyed (0) V					
	Details					
	QoS 🗹 Bandwidth Limit - IOPS Limit -					

#### FIGURE 37. PURE STORAGE VOLUMES OF VM ORACLE19C-OL8-VVOL-QAVM

### VM Oracle19c-OL8-RMAN details are as follows:

- 8 vCPUs with 96GB RAM
- Oracle SGA set to 16GB with traditional HugePages and PGA set to 6GB
- VM hosts both Oracle Grid and RDBMS 19.8 multi-tenant production database rmandb with a pluggable database pdb1 for Oracle RMAN catalog purpose and a xfs file system /rman for holding Oracle RMAN backups
- 2 ASM disks groups
  - MGMT\_DATA for Oracle Grid Infrastructure Management Repository (GIMR) with ASM disk MGMT\_DATA01
  - RMAN\_DATA\_DG for data, redo log files and archive log files with ASM disk RMAN\_DATA\_01

All Oracle on VMware platform best practices were followed as outlined in VMware Hybrid Cloud Best Practices Guide for Oracle Workloads.

🔓 Oracle19c-OL8-V\	/OL-RMAN	🕨 📕 👺 🤯 🔹 Actions 🗸
Summary Monitor Confi	gure Permissio	ons Datastores Networks Snapshots Updates
Powered On LAUNCH WEB CONSOLE	Guest OS: Compatibility: VMware Tools: DNS Name: IP Addresses: Host: kost:	Oracle Linux 8 (64-bit) ESXi 7.0 and later (VM version 17) Running, version:11296 (Guest Managed) MORE INFO oracle19c-ol8-vvol-rman.corp.localdomain 10.128.140.105 10.128.136.130
VM Hardware		/
> CPU		8 CPU(s)
> Memory		32 GB, 0.32 GB memory active
> Hard disk 1		80 GB
Total hard disks		5 hard disks
> Network adapter 1		TSA-WDC-70B-PG1403 (connected)
CD/DVD drive 1		Disconnected $q_{\rm p} \checkmark$
> Video card		8 MB
VMCI device		Device on the virtual machine PCI bus that provides support for the virtual machine communication interface
> Other		Additional Hardware
Compatibility		ESXi 7.0 and later (VM version 17)
Edit Settings		

### FIGURE 38. VM ORACLE19C-OL8-VVOL-RMAN SUMMARY

VM Oracle19c-OL8-VVOL-RMAN virtual disks (VMDKs) are shown below. All SCSI controllers are set to VMware Paravirtual SCSI Controller type.

∨ Hard disks	5 total   1.5 TB
> Hard 80 GB   SCSI(0:0) disk 1 ×	
> Hard 80 GB   SCSI(0:1) disk 2 ×	
> Hard 100 GB   SCSI(1:0) disk 3 -	
> Hard 250 GB   SCSI(2:0 disk 4 ×	))
> Hard 1024 GB   SCSI(3) disk 5	0)
> SCSI controller 0	VMware Paravirtual
> SCSI controller 1	VMware Paravirtual
> SCSI controller 2	VMware Paravirtual
> SCSI controller 3	VMware Paravirtual

### FIGURE 39. VM ORACLE19C-OL8-VVOL-RMAN VMDKS

Virtual disk (VMDK) details:

- Hard Disk 1 80GB for operating system
- Hard Disk 2 80GB for Oracle Grid and RDBMS binaries
- Hard Disk 3 100GB for Oracle Grid Infrastructure Management Repository (GIMR) (Management Database (MGMTDB)) (ASM Disk Group MGMT\_DATA)
- Hard Disk 4 250GB for Oracle Database rmandb database, redo log and archive log files (ASM Disk Group DATA\_DG)
- Hard Disk 5 1TB for XFS filesystem /rman mount point for storing physical RMAN backups

Oracle ASM disk group details:



FIGURE 40. ORACLE ASM DISK GROUP



Additional vVols-backed VMDKs are shown below:

Search							
TSA-Pure-VVOL-SC-DS	🎦 New Folder 🛧 Upload Files 🏦 Upload Folder   🧬 Register VM 🛓 Download	d 📋 Copy to	$\rightarrow$ Move	e to 👔	) Rename to 🗙 Delete (	Inflate	
VSphere-HA	Name	⊤ Size	т М	1 т	Туре т	Path	
Clone-Oracle19c-OL8-VVOL	🗀 .dvsData		12	2/1	Folder	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ec1f8cd8/.dvsData	
Clone-Oracle19c-OL8-VVOL	🖾 .sdd.sf		12	2/1	Folder	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ec1f8cd8/.sdd.sf	
Clone-Oracle19c-OL8-VVOL	Oracle19c-OL8-VVOL-RMAN-54c6d641.hlog	0.85	KB 12	2/1	File	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ec1f8cd8/Oracle19c-OL8-VVOL-RMAN-54c6d641.hlog	
> Oracle19c-OL8-VVOL	Oracle19c-OL8-VVOL-RMAN-8eb59be3.vswp	0.31	KB 12	2/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ec1f8cd8/Oracle19c-OL8-VVOL-RMAN-8eb59be3.vswp	
> Oracle19c-OL8-VVOL-QAVM	Oracle19c-OL8-VVOL-RMAN-8eb59be3.vswp.lck	0	KB 12	2/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ec1f8cd8/Oracle19c-OL8-VVOL-RMAN-8eb59be3.vswp	lck
> Oracle19c-OL8-VVOL-RMAN	Cracle19c-OL8-VVOL-RMAN.nvram	264.49	KB 12	2/2	Non-volatile Memory File	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ec1f8cd8/Oracle19c-OL8-VVOL-RMAN nvram	
	and Oracle19c-OL8-VVOL-RMAN.vmdk	4.549,632	KB 12	2/2	Virtual Disk	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ec1f8cd8/Oracle19c-OL8-VVOL-RMAN.vmdk	
	Oracle19c-OL8-VVOL-RMAN.vmsd	0	KB 12	2/1	File	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ec1f8cd8/Oracle19c-OL8-VVOL-RMAN.vmsd	
	Dracle19c-OL8-VVOL-RMAN.vmx	4.85	KB 12	2/2	Virtual Machine	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ec1f8cd8/Oracle19c-OL8-VVOL-RMAN.vmx	
	Oracle19c-OL8-VVOL-RMAN.vmc.lck	0	KB 12	2/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ec1f8cd8/Oracle19c-OL8-VVOL-RMAN.vmx.lck	
	Oracle19c-OL8-VVOL-RMAN.vmx*	4.85	KB 12	2/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ec1f8cd8/Oracle19c-OL8-VVOL-RMAN.vmx*	
	a Oracle19c-OL8-VVOL-RMAN_1.vmdk	41,408,512	KB 12	2/2	Virtual Disk	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ec1f8cd8/Oracle19c-OL8-VVOL-RMAN_1.vmdk	
	Oracle19c-OL8-VVOL-RMAN_2.vmdk	98,304	KB 12	2/2	Virtual Disk	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ec1f8cd8/Oracle19c-OL8-VVOL-RMAN_2.vmdk	
	e Oracle19c-OL8-VVOL-RMAN_3.vmdk	31,345,664	13	2/2	Virtual Disk	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ec1f8cd8/Oracle19c-OL8-VVOL-RMAN_3.vmdk	
	e Oracle19c-OL8-VVOL-RMAN_4.vmdk	2,048	KB 12	2/2	Virtual Disk	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ec1f8cd8/Oracle19c-OL8-VVOL-RMAN_4.vmdk	
	vmware-1.log	316.07	KB 12	2/1	VM Log File	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ecff8cd8/vmware-1.log	
	vmware-2.log	181.91	KB 12	2/2	VM Log File	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ec1f8cd8/vmware-2.log	
	vmware.log	53,953.66	KB 12	2/2	VM Log File	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ec1f8cd8/vmware.log	
	wmx-Oracle19c-OL8-VVOL-R-e1bb20950c3a124544c05bfa39468b84f11722a7-1.vswp	89,088	KB 12	2/2	File	[TSA-Pure-VVOL-SC-DS] rfc4122.30b48cfc-cf41-44bc-bb67-c6b4ec1f8cd8/vmx-Oracle19c-OL8-VVOL-R-e1bb20950c3a1	245

### FIGURE 41. VVOLS-BACKED VMDKS

Logging into the Pure x50 storage GUI shows the various vVols representing the different virtual disks of VM **Oracle19c-OL8-VVOL-RMAN**.

	Storage					
Dashboard	Array Hosts Volumes Protection Groups Pods					
1 Storage	Volumes > vol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg					
Analysis	Size         Data Reduction         Volumes         Snapshots         Shared         System         Total           1574913 M         30.4 to 1         834.31 M         0.00         -         -         -					
Performance	Volumes	Space	QoS Detail:	6 <b>1-7</b> of 7	<> +	- :
Replication	Name	Size	Volumes	Snapshots	Reduction	
🚸 Health	C vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Config-896abc95	4 G	7.16 M	0.00	7.6 to 1	:
🔆 Settings	Svvol-Oracle19c-OL8 VVOL-RMAN-30b48cfc-vg/Data-2b58df2c	1 T	630.14 K	0.00	3.9 to 1	:
	wol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-4cf52fad	80 G	29.04 M	0.00	26.3 to 1	:
Help	wol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-9b859e65	80 G	72.28 M	0.00	29.4 to 1	:
End User Agreement	Swol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-c88e6c68	100 G	14.86 K	0.00	30.7 to 1	:
Terms Log Out	wol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-e20d80c6	250 G	725.20 M	0.00	32.9 to 1	:
	vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Swap-b0283d3e	1 M	0.00	0.00	1.0 to 1	:
	Destroyed (0) V					
	Details					
	QoS II					
	Bandwidth Limit -					

### FIGURE 42. PURE STORAGE VOLUMES OF VM ORACLE19C-OL8-VVOL-RMAN

# 

The previous details provide guidance for Oracle RAC storage deployment on vVols using Pure Storage. Network deployment details, along with the basic steps for RAC deployment on VMware vVols using Pure Storage, can be found in *Oracle VMware Hybrid Cloud High Availability Guide REFERENCE ARCHITECTURE*.

A simple 2-node Oracle 19c RAC cluster with VMs vvolrac1 and vvolrac2 was created to easily illustrate various use cases.

Both Oracle RAC VMs contain three VMDKs:

- 2 non-shared VMDKs
  - Hard Disk 1 80GB for Operating System with disk mode Dependent
  - Hard Disk 180GB for Oracle Grid Infrastructure and RDBMS binaries with disk mode Dependent
- 1 shared VMDK (1TB) with multi-writer attribute and disk mode Independent-Persistent

Details of the shared VMDK with multi-writer flag and disk mode Independent-Persistent are shown below:



FIGURE 43. ORACLE RAC VVOLRAC SHARED VMDK DETAILS

### Solution Validation



Site B was chosen as the site for on-premises Oracle RAC and single-instance deployments.

FIGURE 44. 4-NODE VSPHERE CLUSTER WITH CONNECTIVITY TO AFF PURE X50 ARRAY

This solution primarily validated the functional design of Oracle single-instance deployments on vVols storage backed by Pure x50 Storage.

The functional design of Oracle RAC deployments on vVols storage using Pure x50 Storage can be found in Oracle VMware Hybrid Cloud High Availability Guide REFERENCE ARCHITECTURE.

### Solution Test Overview

This solution validated the following Day 2 operations of both Oracle Single Instance and RAC database on vVols using Pure Storage FlashArray//x50.

- Database backup using vVol-based snapshots and Oracle RMAN
- Database restore and recovery using vVol-based snapshots and Oracle mechanism
- Database cloning using vVol-based snapshots
- Database refresh using vVol-based snapshots
- Database patching using vVol-based snapshots
- VM provisioning and cloning using vVols SPBM



Use Case	Database	Pure Plugin Option	Snapshot	Level of Operation
Database Backup	Single Instance/RAC	Import / Overwrite	VM Level	VM
Database Cloning	Single Instance/RAC	Import	VMDK Level	VMDK
Database Refresh	Single Instance/RAC	Overwrite	VMDK Level	VMDK
Database Patching	Single Instance/RAC	Import / Overwrite	VMDK Level	VMDK

#### TABLE 9. SOLUTION TEST OVERVIEW

The functional design of Oracle RAC deployments on vVols using Pure x50 Storage can be found in Oracle VMware Hybrid Cloud High Availability Guide REFERENCE ARCHITECTURE.

Performance testing was not included as part of this reference architecture. Any performance data is a result of the combination of hardware configuration, software configuration, test methodology, test tool, and workload profile used in the testing.

Performance testing can be conducted by using the SLOB tool against the Oracle RAC cluster and generating a load on the database. Oracle AWR and Linux SAR reports can be captured to compare the performance and validate the testing use cases.

### Oracle Database Backup

This section validates the database backup using VMware vVol-based snapshots and Oracle RMAN of an Oracle single-instance and Oracle RAC using Pure x50 Storage.

This use case focuses on the use of the Oracle RMAN utility with RMAN catalog database **rmandb** to back up the Oracle production database **vvol19c** and Oracle RAC database **vvolrac**.

### Oracle Backup of Single Instance

Two VMs are utilized for this use case:

- Production VM Oracle19c-OL8-VVOL
- RMAN VM Oracle19c-OL8-VVOL-RMAN

The following steps were used for this testing:

1. Ensure that we can use the Oracle **tnsping** command from production VM **Oracle19c-OL8-VVOL** to check for Oracle service on RMAN VM **Oracle19c-OL8-RMAN** 

oracle@oracle19c-ol8-vvol:vvol19c:/home/oracle> tnsping rmandb TNS Ping Utility for Linux: Version 19.0.0.0.0 - Production on 29-DEC-2020 17:06:49 Copyright (c) 1997, 2020, Oracle. All rights reserved.

Used parameter files:

Used TNSNAMES adapter to resolve the alias

Attempting to contact (DESCRIPTION = (ADDRESS\_LIST = (ADDRESS = (PROTOCOL = TCP)(HOST = 10.128.140.105) (PORT = 1521))) (CONNECT\_DATA = (SERVER = DEDICATED)(SERVICE\_NAME = pdb1))) OK (0 msec)

oracle@oracle19c-ol8-vvol:vvol19c:/home/oracle>



2. Ensure that the production database vvol19c is registered with RMAN catalog database rmandb. If not, register the database vvol19c first with RMAN catalog database rmandb.

oracle@oracle19c-ol8-vvol:vvol19c:/home/oracle> rman Recovery Manager: Release 19.0.0.0.0 - Production on Sat Dec 19 20:53:18 2020 Version 19.8.0.0.0 Copyright (c) 1982, 2019, Oracle and/or its affiliates. All rights reserved.

RMAN> connect catalog rman/rman@rmandb connected to recovery catalog database

RMAN> create catalog; recovery catalog created

RMAN> connect target / connected to target database: VVOL19C (DBID=2713363709)

RMAN> register database; database registered in recovery catalog starting full resync of recovery catalog full resync complete

RMAN> report schema;

Report of database schema for database with db\_unique\_name VVOL19C

### List of Permanent Datafiles

File	Size(MB)	Tablespace	RB segs	Datafile Name
1	512	SYSTEM	YES	+DATA_DG/vvol19c/system_01.dbf
2	185	PDB\$SEED:SYSTEM	NO	+DATA_DG/pdbseed/system_01.dbf
3	512	SYSAUX	NO	+DATA_DG/vvol19c/sysaux_01.dbf
4	130	PDB\$SEED:SYSAUX	NO	+DATA_DG/pdbseed/sysaux_01.dbf
5	512	UNDOTBS01	YES	+DATA_DG/vvol19c/undotbs01_01.dbf
6	512	USERS	NO	+DATA_DG/vvol19c/users_01.dbf
7	512	PDB\$SEED:USERS	NO	+DATA_DG/pdbseed/users_01.dbf
8	512	PDB\$SEED:USERTBS	NO	+DATA_DG/pdbseed/usertbs_01.dbf
9	195	PDB1:SYSTEM	NO	+DATA_DG/pdb1/system_01.dbf
10	170	PDB1:SYSAUX	NO	+DATA_DG/pdb1/sysaux_01.dbf
11	512	PDB1:USERS	NO	+DATA_DG/pdb1/users_01.dbf
12	512	PDB1:USERTBS	NO	+DATA_DG/pdb1/usertbs_01.dbf
13	250	PDB1:PDB_USER	NO	+DATA_DG/pdb1/pdb_user_01.dbf

List of Temporary Files

====												
File	Size(MB)	Tablespace	Maxsize(MB)	Tempfile Name								
1	512	TEMP	32767	+DATA_DG/vvol19c/temp_01.dbf								
2	512	PDB\$SEED:TEMP	32767	+DATA_DG/pdbseed/temp_01.dbf								
3	512	PDB1:TEMP	32767	+DATA_DG/pdb1/temp_01.dbf								

RMAN>



- 3. Take two RMAN backups of the database current controlfile; the destination of the backups is the ASM diskgroup FRA\_DG
  - controlfile control\_db\_start will be used to mount the clone of the database on RMAN VM **Oracle19c-OL-RMAN**. The CONTROL\_FILES parameter in the mount host init.ora will point to the control\_db\_start control file
  - controlfile control\_rman\_backup will be part of the RMAN backupset

As part of the RMAN backup process, force the database vvol19c current log to be archived as well.

```
rman target / <<EOF
run
{
allocate channel t1 type disk;
alter system archive log current;
copy current controlfile to +FRA_DG/vvol19c/CONTROLFILE/control_db_start ;
copy current controlfile to +FRA_DG/vvol19c/CONTROLFILE/control_rman_backup;
}
EOF
RMAN>
Recovery Manager: Release 19.0.0.0.0 - Production on Tue Dec 29 19:25:02 2020
Version 19.8.0.0.0
Copyright (c) 1982, 2019, Oracle and/or its affiliates. All rights reserved.
connected to target database: VVOL19C (DBID=2713363709)
RMAN>
using target database control file instead of recovery catalog
allocated channel: t1
channel t1: SID=1015 device type=DISK
Statement processed
Starting backup at 29-DEC-20
channel t1: starting datafile copy
copying current control file
output file name=+FRA_DG/vvol19c/CONTROLFILE/control_db_start tag=TAG20201229T192503 RECID=3 STAMP=1060457104
channel t1: datafile copy complete, elapsed time: 00:00:01
Finished backup at 29-DEC-20
Starting backup at 29-DEC-20
channel t1: starting datafile copy
copying current control file
output file name=+FRA_DG/vvol19c/CONTROLFILE/control_rman_backup tag=TAG20201229T192505 RECID=4
STAMP=1060457105
channel t1: datafile copy complete, elapsed time: 00:00:01
Finished backup at 29-DEC-20
Starting Control File Autobackup at 29-DEC-20
piece handle=/u01/app/oracle/product/19.0.0/dbhome_1/dbs/c-2713363709-20201229-00 comment=NONE
Finished Control File Autobackup at 29-DEC-20
released channel: t1
RMAN>
Recovery Manager complete.
```

oracle@oracle19c-ol8-vvol:vvol19c:/home/oracle>



rid@oracle19c-ol8-vvol:+ASM:/home/grid> asmcmd ls -l +FRA_DG/vvol19c/CONTROLFILE											
ľype	Redund	Striped	Time		Sys	Name					
CONTROLFILE	UNPROT	FINE	DEC 29	19:00:00		Backup.361.1060456915					
CONTROLFILE	UNPROT	FINE	DEC 29	19:00:00		Backup.362.1060456917					
CONTROLFILE	UNPROT	FINE	DEC 29	19:00:00		control db start => +FRA DG/vvol19c/CONTROLFILE/Backup.361.1060456915					
CONTROLFILE	UNPROT	FINE	DEC 29	19:00:00		control rman backup => +FRA DG/vvol19c/CONTROLFILE/Backup.362.1060456917					
rid@oracle1	9c-018-v	vol:+ASM:	/home/gi	rid>							



4. On production VM **Oracle19c-OL8-VVOL**, resynchronize the RMAN catalog with the production database **vvol19c**. This will add the most recent archive log info into the RMAN catalog.

rman target=/ catalog=rman/rman@rmandb <<EOF resync catalog; exit; EOF

RMAN>

Recovery Manager: Release 19.0.0.0.0 - Production on Tue Dec 29 19:30:10 2020 Version 19.8.0.0.0 Copyright (c) 1982, 2019, Oracle and/or its affiliates. All rights reserved.

connected to target database: VVOL19C (DBID=2713363709) connected to recovery catalog database

RMAN> starting full resync of recovery catalog full resync complete RMAN> Recovery Manager complete. oracle@oracle19c-ol8-vvol:vvol19c:/home/oracle>

5. Take a snapshot of the database.

In the case of production VM **Oracle19c-OL8-VVOL**, the database data and redo log files were on ASM disk group DATA\_DG, the database archive log files were on ASM disk group FRA\_DG.

We can take a snapshot of the database in two ways:

- A traditional VM-level snapshot using a web client
- A VMDK-level snapshot using the Pure Storage Plugin

A VM-level snapshot can be taken as shown below:



FIGURE 46. TAKING A VM-LEVEL SNAPSHOT

The VM-level snapshot has been successfully taken for production VM Oracle19c-OL8-VVOL.

Cracle19c-OL8-VVOL		
TARE BNAPSHOT BEVERT EDIT DELETE DELETE ALL		
16 VMSnap-2020-12-29	Name	VMSnap-2020-12-29
Vou are here	Description	VMSnap-2020-12-29
	Timestamp	12/29/20, 3:28 PM
	Size	277.47 KB
	Snapshot the virtual machine's memory	No
	Quiesce guest file system	No

FIGURE 47. VM-LEVEL SNAPSHOT

Logging into the Pure Storage GUI indicates snapshots are created for all VM VMDKs.

Storage					
Array Hosts Volumes Protection Groups Pods					
() > Volumes > vvol-Oracle19c-OL8-VVOL-0b4146e3-vg					
SizeData ReductionVolumesSnapshotsSharedSystemTotal3200 G33.2 to 14.92 M0.00					
Volumes	Space	QoS Details	1-10 of 12	<> +	- :
Name	Size	Volumes	Snapshots	Reduction	
C wol-Oracle19c-OL8-VVOL-0b4146e3-vg/Config-950dc3ea	4 G	4.10 M	0.00	3.7 to 1	:
vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-20c34be7	80 G	118.22 K	0.00	33.3 to 1	:
vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-20c34be7-snap-93d4e795	80 G	0.00	0.00	33.3 to 1	:
Svvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-c552b187	80 G	0.00	0.00	33.3 to 1	:
Svvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-c552b187-snap-5846aae6	80 G	0.00	0.00	33.3 to 1	:
S vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-57b48797	100 G	118.22 K	0.00	32.2 to 1	:
C vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-57b48797-snap-7b0698a5	100 G	564.00 B	0.00	33.3 to 1	:
<pre>&gt; vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Swap-5c283b5b</pre> vVol snapshot	128 G	0.00	0.00	1.0 to 1	:
C vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-efe1c0b0	250 G	118.22 K	0.00	33.2 to 1	:
vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-efe1c0b0-snap-408d1d39	250 G	564.00 B	0.00	33.3 to 1	:

### FIGURE 48. PURE STORAGE GUI – VOLUMES

Stora	Storage												
Array	Hosts V	/olumes	Protectio	on Group	os Po	ods							
>	Volumes >	vvol-Orac	cle19c-OL8-\	VOL-0b	4146e3-\	′g							
Size 3200 G	Data Reduction 33.2 to 1	Volumes 4.92 M	Snapshots 0.00	Shared	System	Total -							
Volum	ies								Space	QoS Details	<b>11-12</b> of 12	< > +	- :
Name									Size▲	Volumes	Snapshots	Reduction	
	-Oracle19c-OL8-VV	OL-0b4146e3	l-vg/Data-03de	cfb2					1 T	472.86 K	0.00	33.2 to 1	:
	-Oracle19c-OL8-VV(	OL-0b4146e3	-vg/Data-03de	cfb2-snap-	3e2607aa				1T	9.36 K	0.00	33.3 to 1	:

FIGURE 49. PURE STORAGE GUI – VOLUMES



A VMDK-level snapshot using the Pure Storage Plugin can be taken as shown below:

.,	coning	jure Permis	sions Datasto	res Networks	Snapsnots Updates						
gs ∨	Virti	ual Volume									
Options lefinitions	۹.	MPORT DISK		TED DISK ( + CREAT	E SNAPSHOT	)					
Juled Tasks		Name	<b>↑ ▼</b>	Virtual Device	Y Size	т	Datastore	τ	Array	Ψ	Volume
s re EVC		Hard disk 1		SCSI (0:0)	80.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-20c34be7
Jser Mappings		Hard disk 2		SCSI (0:1)	80.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-c552b187
torage 🗸 🗸		Hard disk 3		SCSI (1:0)	100.0 GB		TSA-Pure-N/OL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-57b48797
al Volumes	0	Hard disk 4		SCSI (2:0)	1.0 TB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-03decfb2
		Hard disk 5		SCSI (3:0)	250.0 GB		TSA-Pure-VVOL-SC-DS	~	wdc-tsa-nure-01		vvnl-Oracle19c-OI 8-VVOI -0h4146e3-vo/Data-efe1c0h0
		VM home			4.0 GB		TSA-Pure-VVOL-SC-DS	(	Create Snap	oshc	ot

Suffix



DBSnap

### FIGURE 50. VMDK-LEVEL SNAPSHOT USING PURE STORAGE PLUGIN

In this use case, a VM-level snapshot is preferred over a VMDK-level snapshot as a VM-level snapshot will include a snapshot for both ASM disk groups DATA\_DG and FRA\_DG taken at the same time. A VMDK-level snapshot using the Pure Storage Plugin, would require two separate VMDK-level snapshots, one for the DATA VMDK and one for the FRA VMDK.

Remember, the VMDKs containing redo log files, controlfiles and database files must be snapshotted as a part of a single consistency group to avoid any timestamp mismatch.

In this use case, all redo log files, controlfiles and database files are part of the DATA\_DG ASM disk group. A VMDK-level snapshot for both DATA\_DG and FRA\_DG VMDKs would have resulted in two different snapshot operations with different timestamps.

While technically workable for this use case, we chose to adopt Oracle and storage best practice recommendations to snapshot the entire database in one operation and avoid any timestamp-related issues.

A VMDK-level snapshot is can be employed for use cases like database cloning, database refresh, or database patching which are explained in the sections below.

6. On the RMAN VM Oracle19c-OL8-RMAN, use the Pure Plugin option Import Disk to import or create a new DATA VMDK (1TB) and a new FRA VMDK (250GB) from the production VM Oracle19c-OL8-VVOL from the snapshot VMSnap-2020-12-29.

To import a new DATA VMDK (1TB) from the production VM Oracle19c-OL8-VVOL snapshot VMSnap-2020-12-29, do the following:



FIGURE 51. DATA VMDK IMPORT

A new DATA VMDK (1TB) is created on RMAN VM Oracle19c-OL8-RMAN at SCSI 0:2.

Summary Monitor	Oracle19C-OL8-VVOL-RMAN   > = # > 20   ACTIONS > iummary Monitor Configure Permissions Datastores Networks Snapshots Updates												
Settings V VM SDRS Rules vApp Options Alarm Definitions	Vii 4	rtua D imi	DI VOIUME		DELETED DISK	+ CREATE SNAPS		VRITE DISK.					
Scheduled Tasks			Name	1 τ	Virtual Device	Υ	Size	Ψ	Datastore	Ψ	Array	Ψ	Volume
Policies VMware EVC			Hard disk 1		SCSI (0:0)		80.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-4cf52fad
Guest User Mappings			Hard disk 2		SCSI (0:1)		80.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-9b859e65
Pure Storage 🛛 🗸			Hard disk 3		SCSI (1:0)		100.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-c88e6c68
Virtual Volumes			Hard disk 4		SCSI (3:0)		1.0 TB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-2b58df2c
			Hard disk 5		SCSI (2:1)		250.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-39df6da5
		D	Hard disk 6		SCSI (0:2)		1.0 TB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-5d4be9d5

FIGURE 52. NEW DATA VMDK



To import a new FRA VMDK (250GB) from the production VM Oracle19c-OL8-VVOL snapshot VMSnap-2020-12-29, do the following:





A new FRA VMDK (250GB) is created on RMAN VM Oracle19c-OL8-RMAN at SCSI 0:3.

Summary Monitor	Oracle19c-OL8-VVOL-RMAN   > = # 20 20 Actions ~           Summary         Monitor         Configure         Permissions         Datastores         Networks         Snapshots         Updates												
Settings V VM SDRS Rules vApp Options Alarm Definitions	Virtu 1	ual Volume	A RESTORE DE	LETED DISK	+ CREATE SNAPSH	IOT & OVER	WRITE DISK.						
Scheduled Tasks		Name	т	Virtual Device	т	Size	<b>↑ τ</b>	Datastore	٣	Array	т	Volume	
Policies VMware EVC		Hard disk 1		SCSI (0:0)		80.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-4cf52fad	
Guest User Mappings		Hard disk 2		SCSI (0:1)		80.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-9b859e65	
Pure Storage 🗸 🗸		Hard disk 3		SCSI (1:0)		100.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-c88e6c68	
Virtual Volumes		Hard disk 4		SCSI (3:0)		1.0 TB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-2b58df2c	
		Hard disk 5		SCSI (2:1)		250.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-39df6da5	
		Hard disk 6		SCSI (0:2)		1.0 TB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-5d4be9d5	
	0	Hard disk 7		SCSI (0:3)		250.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-bea4098d	

FIGURE 54. NEW FRA VMDK



RMAN VM Oracle19c-OL8-RMAN VMDK details are shown below:

$\sim$	Hard disks		7 total   2.74 TB
	> Hard disk 1	80 GB   SCSI(0:0)	
	> Hard disk 2	80 GB   SCSI(0:1)	
	> Hard disk 3	100 GB   SCSI(1:0)	
	> Hard disk 4	1024 GB   SCSI(3:0)	
	> Hard disk 5	250 GB   SCSI(2:1)	New DATA vmdk (0:2) and FRA vmdk (0:3) of production database 'vvol19c'
/	> Hard disk 6	1024 GB   SCSI(0:2)	
· · ·	> Hard disk 7	250 GB   SCSI(0:3)	A

FIGURE 55. RMAN VM ORACLE19C-OL8-RMAN VMDKS

7. Delete the snapshot taken on production VM Oracle19c-OL8-VVOL.

ί

8. On RMAN VM Oracle19c-OL8-RMAN, scan for new ASM disks using the Oracle oracleasm command to discover new VMDKs DATA\_01 and FRA\_01.



FIGURE 56. ASM DISK SCAN (ORACLEASM)

Mount the new disk groups **+DATA\_DG** and **+FRA\_DG**.

grid@ora	cle19c-c	18-vvol	rman:+A	SM:/home/grid> a	asmemd m	ount DATA	_DG						
grid@ora	cle19c-c			SM:/home/grid> a	asmcmd m	ount FRA							
grid@ora	cle19c-c	l8-vvol		SM:/home/grid> a	smcmd 1	.sdg							
State	Type	Rebal	Sector	Logical Sector	Block	AU	Total MB	Free MB	Req mir free MB	Usable file MB	Offline disks	Voting files	Name
MOUNTED	EXTERN		512	512	4096	1048576	1048575	1036823		1036823			DATA_DG/
MOUNTED	EXTERN		512	512									FRA DG/
MOUNTED	EXTERN		512	512		4194304							MGMT_DATA/
MOUNTED	EXTERN		512	512	4096	1048576	255999	223714		223714			RMAN DATA DG/

FIGURE 57. ASMCMD MOUNT

9. On RMAN VM Oracle19c-OL8-RMAN, start the database vvol19c in mount mode.

Make sure the init.ora file for the database vvol19c points to +FRA\_DG/vvol19c/CONTROLFILE/control\_db\_start.

Make appropriate changes to the database vvol19c init.ora file for memory and file directory settings.

Copy the orapwvvol19c file from production VM Oracle19c-OL8 VVOL to RMAN VM Oracle19c-OL8-RMAN.

oracle@oracle19c-ol8-vvol-rman:rmandb:/home/oracle> export ORACLE\_SID=vvol19c

oracle@oracle19c-ol8-vvol-rman:vvol19c:/home/oracle> sqlplus / as sysdba SQL\*Plus: Release 19.0.0.0.0 - Production on Tue Dec 29 21:08:18 2020 Version 19.8.0.0.0 Copyright (c) 1982, 2020, Oracle. All rights reserved.

Connected to an idle instance.

SQL> startup mount pfile=/u01/app/oracle/product/19.0.0/dbhome\_1/dbs/initvvol19c.ora ORACLE instance started.

Total System Global Area	1.2885E+10 bytes
Fixed Size	12691536 bytes
Variable Size	1811939328 bytes
Database Buffers	1.1039E+10 bytes
Redo Buffers	20860928 bytes
Database mounted.	
SQL>	

10. On the RMAN VM **Oracle19c-OL8-RMAN**, backup the database **vvol19c** using RMAN including the archived logs and backup control file.

```
export ORACLE_SID=vvol19c
rman target=/ catalog=rman/rman@rmandb <<EOF
run
{
    allocate channel t1 type disk;
    backup controlfilecopy +FRA_DG/vvol19c/CONTROLFILE/control_rman_backup format /rman/vvol19c/ctl_%d_%s_%p_%t;
    backup as backupset database format /rman/vvol19c/db_%d_%s_%p_%t;
    backup archivelog all format /rman/vvol19c/al_%d_%s_%p_%t;
    release channel t1;
    }
    exit
    EOF
</pre>
```



Recovery Manager: Release 19.0.0.0.0 - Production on Tue Dec 29 22:09:08 2020 Version 19.8.0.0.0 Copyright (c) 1982, 2019, Oracle and/or its affiliates. All rights reserved.

connected to target database: VVOL19C (DBID=2713363709, not open) connected to recovery catalog database

### RMAN>

allocated channel: t1 channel t1: SID=384 device type=DISK

Starting backup at 29-DEC-20 channel t1: starting full datafile backup set channel t1: specifying datafile(s) in backup set input control file copy name=+FRA\_DG/vvol19c/CONTROLFILE/control\_rman\_backup channel t1: starting piece 1 at 29-DEC-20 channel t1: finished piece 1 at 29-DEC-20 piece handle=/rman/vvol19c/ctl\_VVOL19C\_9\_1\_1060466951 tag=TAG20201229T220910 comment=NONE channel t1: backup set complete, elapsed time: 00:00:01 Finished backup at 29-DEC-20

Starting backup at 29-DEC-20 channel t1: starting full datafile backup set channel t1: specifying datafile(s) in backup set input datafile file number=00003 name=+DATA\_DG/vvol19c/sysaux\_01.dbf input datafile file number=00001 name=+DATA\_DG/vvol19c/system\_01.dbf input datafile file number=00005 name=+DATA DG/vvol19c/undotbs01 01.dbf input datafile file number=00006 name=+DATA\_DG/vvol19c/users\_01.dbf channel t1: starting piece 1 at 29-DEC-20 channel t1: finished piece 1 at 29-DEC-20 piece handle=/rman/vvol19c/db\_VVOL19C\_10\_1\_1060466953 tag=TAG20201229T220913 comment=NONE channel t1: backup set complete, elapsed time: 00:00:03 channel t1: starting full datafile backup set channel t1: specifying datafile(s) in backup set input datafile file number=00011 name=+DATA\_DG/pdb1/users\_01.dbf input datafile file number=00012 name=+DATA\_DG/pdb1/usertbs\_01.dbf input datafile file number=00013 name=+DATA\_DG/pdb1/pdb\_user\_01.dbf input datafile file number=00009 name=+DATA\_DG/pdb1/system\_01.dbf input datafile file number=00010 name=+DATA\_DG/pdb1/sysaux\_01.dbf channel t1: starting piece 1 at 29-DEC-20 channel t1: finished piece 1 at 29-DEC-20 piece handle=/rman/vvol19c/db\_VVOL19C\_11\_1\_1060466956 tag=TAG20201229T220913 comment=NONE channel t1: backup set complete, elapsed time: 00:00:01 channel t1: starting full datafile backup set channel t1: specifying datafile(s) in backup set input datafile file number=00007 name=+DATA\_DG/pdbseed/users\_01.dbf input datafile file number=00008 name=+DATA\_DG/pdbseed/usertbs\_01.dbf input datafile file number=00002 name=+DATA\_DG/pdbseed/system\_01.dbf input datafile file number=00004 name=+DATA\_DG/pdbseed/sysaux\_01.dbf channel t1: starting piece 1 at 29-DEC-20 channel t1: finished piece 1 at 29-DEC-20 piece handle=/rman/vvol19c/db\_VVOL19C\_12\_1\_1060466957 tag=TAG20201229T220913 comment=NONE channel t1: backup set complete, elapsed time: 00:00:01 Finished backup at 29-DEC-20



Starting backup at 29-DEC-20 channel t1: starting archived log backup set channel t1: specifying archived log(s) in backup set input archived log thread=1 sequence=64 RECID=1 STAMP=1059237675 input archived log thread=1 sequence=197 RECID=134 STAMP=1060457103 channel t1: starting piece 1 at 29-DEC-20 channel t1: finished piece 1 at 29-DEC-20 piece handle=/rman/vvol19c/al\_VVOL19C\_15\_1\_1060466966 tag=TAG20201229T220919 comment=NONE channel t1: backup set complete, elapsed time: 00:00:03 Finished backup at 29-DEC-20 released channel: t1 RMAN> Recovery Manager complete. oracle@oracle19c-ol8-vvol-rman:vvol19c:/rman> RMAN Backup is successful oracle@oracle19c-ol8-vvol-rman:vvol19c:/rman/vvol19c> II total 4242212 -rw-r----1 oracle asmadmin 963555328 Dec 29 22:09 al\_VVOL19C\_13\_1\_1060466960 -rw-r---- 1 oracle asmadmin 962817536 Dec 29 22:09 al\_VVOL19C\_14\_1\_1060466963 -rw-r----1 oracle asmadmin 906104320 Dec 29 22:09 al\_VVOL19C\_15\_1\_1060466966 -rw-r----1 oracle asmadmin 23740416 Dec 29 22:09 ctl\_VVOL19C\_9\_1\_1060466951 -rw-r----1 oracle asmadmin 958324736 Dec 29 22:09 db\_VVOL19C\_10\_1\_1060466953 -rw-r---- 1 oracle asmadmin 288104448 Dec 29 22:09 db\_VVOL19C\_11\_1\_1060466956 -rw-r----1 oracle asmadmin 241377280 Dec 29 22:09 db\_VVOL19C\_12\_1\_1060466957

oracle@oracle19c-ol8-vvol-rman:vvol19c:/rman/vvol19c>

11. On successful completion of RMAN backup, On RMAN VM Oracle19c-OL8-RMAN

- shutdown database **vvol19c**
- dismount the vvol19c ASM disk groups DATA\_DG and FRA\_DG
- delete the vvol19c ASM disks DATA\_01 and FRA\_01 using the oracleasm deletedisk command
- delete the added VMDKs from the mount VM Oracle19c-OL8-RMAN

oracle@oracle19c-ol8-vvol-rman:vvol19c:/home/oracle> sqlplus / as sysdba SQL\*Plus: Release 19.0.0.0.0 - Production on Wed Dec 30 12:33:04 2020 Version 19.8.0.0.0 Copyright (c) 1982, 2020, Oracle. All rights reserved.

Connected to: Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 - Production Version 19.8.0.0.0

SQL> shutdown immediate; Database closed. Database dismounted. ORACLE instance shut down. SQL> exit Disconnected from Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 - Production Version 19.8.0.0.0 oracle@oracle19c-ol8-vvol-rman:vvol19c:/home/oracle>



grid@oracle19c-ol8-vvol-rman:+ASM:/home/grid> asmcmd umount DATA\_DG grid@oracle19c-ol8-vvol-rman:+ASM:/home/grid> asmcmd umount FRA\_DG

grid@oracle19c-ol8-vvol-rman:+ASM:/home/grid> asmcmd lsdg

State	Туре	Rebal	Sector	Logical_Sector	Block	AU Total_MB	Free_MB	Req_mir_free_MB	Usable_file_MB	Offline_disks	Voting_files	Name
MOUNTED EXTERN	Ν	512	512	4096	4194304	102396	102296	0	102296	0	Ν	MGMT_DATA/
MOUNTED EXTERN	Ν	512	512	4096	1048576	255999	223714	0	223714	0	Ν	RMAN_DATA_DG/
grid@oracle19c-ol8-vvol-rman:+ASM:/home/grid>												
[root@oracle19c-ol8-vvol-rman ~]# oracleasm deletedisk DATA_01 Clearing disk header: done Dropping disk: done [root@oracle19c-ol8-vvol-rman ~]#												
[root@oracle1 Clearing disk I Dropping disk [root@oracle1	[root@oracle19c-ol8-vvol-rman ~]# oracleasm deletedisk FRA_01 Clearing disk header: done Dropping disk: done [root@oracle19c-ol8-vvol-rman ~]#											
[root@oracle19c-ol8-vvol-rman ~]# oracleasm scandisks ; oracleasm listdisks Reloading disk partitions: done Cleaning any stale ASM disks Scanning system for ASM disks MGMT_DATA01 RMAN_DATA_01 [root@oracle19c-ol8-vvol-rman ~]#												

12. As the RMAN backup is typically a regular database Day 2 operation, we do not have to delete the newly added ASM disks nor the VMDKs from RMAN VM **Oracle19c-OL8-RMAN**.

We can use the Pure Plugin **Overwrite Disk** option to overwrite the newly added VMDKs for **vvol19c** with the same snapshot taken of production VM **Oracle19c-OL8-VVOL.** 

On RMAN VM Oracle19c-OL8-RMAN, choose the newly added DATA\_DG disk 1TB and click Overwrite Disk.

Summary Monitor	8-VV( Configu	OL-RMAN ure Permis:	sions Datas	F 🦻 🔯 stores Netv	ACTIONS V	nots Updates						
Settings VM SDRS Rules	Virtu	ial Volume										
vApp Options Alarm Definitions	€ IM	€ IMPORT DISK A RESTORE DELETED DISK + CREATE SNAPSHOT				WRITE DISK						
Scheduled Tasks		Name	<b>↑ τ</b>	Virtual Device	т	Siz	Ŧ	Datastore	т	Array	τ	Votume
Policies VMware EVC		Hard disk 1		SCSI (0:0)	/	80.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-4cf52fad
Guest User Mappings		Hard disk 2		SCSI (0:1)		80.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-9b859e65
Pure Storage 🗸 🗸		Hard disk 3		SCSI (1-0)		100.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-c88e6c68
Virtual Volumes		Hard disk 4	/	SCSI (3:0)		1.0 TB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-2b58df2c
		Hard disk 5	/	SCSI (2:1)		250.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-39df6da5
	0	Hard disk 6		SCSI (0:3)		1.0 TB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-846ee259
		Hard disk 7		SCSI (0:4)		250.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Data-b02edad0
		VM home				4.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-RMAN-30b48cfc-vg/Config-896abc95

FIGURE 58. DISK OVERWRITE

Under production VM Oracle19c-OL8-VVOL, choose Hard Disk 4 (1TB) and Click Overwrite.

Overwi	rite	Virtual Volume Disk			×
(i) This ope array vo	ratior lume	n will overwrite the content of Hard disk 'vvol-Oracle19c-OL8-VVOL-RMAN-30b4	6 - 1.0 TB. This di I8cfc-vg/Data-84	sk corresponds to the 6ee259'	×
Select a s	ouro	ce disk:	Filter	Q	
>	ð	Clone-Oracle19c-OL8-VVOL			*
>	ð	Clone-Oracle19c-OL8-VVOL-G	AVM		
>	ð	Clone-Oracle19c-OL8-VVOL-1	9.8		
$\sim$	ð	Oracle19c-OL8-VVOL			
	>	🖨 Hard disk 1			
	>	🖨 Hard disk 2			
	>	⊟ Hard disk 3			
	>	🖨 Hard disk 🛃			
	>	🖂 Hard disk 5			-
Volume Info	orma	ation:			
Volume Na	me:	vvol-Oracle19c-OL8-VVOL- Ob4146e3-vg/Data-O3decfb2	Array:	wdc-tsa-pure-01	
Disk File:		Oracle19c-OL8-VVOL_3.vmdk	Created:	Tuesday, December 15, 2020 2:37:54 PM -0800	)
Volume Siz	e:	1.0 TB	Datastore:	TSA-Pure-VVOL-SC-DS	
			[		те

FIGURE 59. DISK OVERWRITE

Perform the same steps for newly added FRA\_DG (250GB) disk. Under production VM **Oracle19c-OL8-VVOL**, Choose **Hard Disk 5 (250GB)** and click **Overwrite**.

Overwrit	e V	′irtual Volume Disk			×		
array volum	ion will ne 'vvo	I-Overwrite the content of Hard disk I-Oracle19c-OL8-VVOL-RMAN-30b4	7 - 250.0 GB. 11 8cfc-vg/Data-bi	his disk corresponds to the 02edad0'	~		
Select a sou	urce c	lisk:	Filter				
> 6	S CI	one-Oracle19c-OL8-VVOL-19	9.8		^		
~ d		racle19c-OL8-VVOL					
>		Hard disk 1					
>		Hard disk 2					
>		Hard disk 3					
>		Hard disk 4					
~		Hard disk 5					
		l vvol-Oracle19c-OL8-VV	/OL-0b4146e	-3-vg/Data-efe1c0b0-snap	·		
		5a06c438			Ŧ		
Volume Inform	natio	n:					
Volume Name	e: vv Ok	ol-Oracle19c-OL8-VVOL- 04146e3-vg/Data-efe1c0b0	Array:	wdc-tsa-pure-01			
Disk File:	Or	acle19c-OL8-VVOL_4.vmdk	Cleated:	Tuesday, December 29, 2020 7:47:50 PM -0800			
Volume Size:	25	60.0 GB	Datastore:	TSA-Pure-VVOL-SC-DS			
				$\searrow$			
			1				
				CANCEL	ТΕ		

FIGURE 60. DISK OVERWRITE

Perform rescan of ASM disks on RMAN VM Oracle19c-OL8-RMAN using the oracleasm scandisks command.

[root@oracle19c-ol8-vvol-rman ~]# oracleasm scandisks ; oracleasm listdisks Reloading disk partitions: done Cleaning any stale ASM disks... Scanning system for ASM disks... Instantiating disk "DATA\_01" Instantiating disk "FRA\_01" DATA\_01 FRA\_01 FRA\_01 MGMT\_DATA01 RMAN\_DATA\_01 [root@oracle19c-ol8-vvol-rman ~]#



grid@oracle19c-ol8-vvol-rman:+ASM:/home/grid> asmcmd mount DATA\_DG grid@oracle19c-ol8-vvol-rman:+ASM:/home/grid> asmcmd mount FRA\_DG

grid@oracle19c-ol8-vvol-rman:+ASM:/home/grid> asmcmd lsdg

State		Туре	Rebal	Sector	Logical_Sector	Block	AU Total_MB	Free_MB	Req_mir_free_MB	Usable_file_MB	Offline_disks	Voting_files	Name
MOUNTED EXT	TERN	Ν	512	512	4096	1048576	1048575	1036823	0	1036823	0	Ν	DATA_DG/
MOUNTED EXT	TERN	Ν	512	512	4096	1048576	255999	253665	0	253665	0	Ν	FRA_DG/
MOUNTED EXT	TERN	Ν	512	512	4096	4194304	102396	102296	0	102296	0	Ν	MGMT_DATA/
MOUNTED EXT	TERN	Ν	512	512	4096	1048576	255999	223714	0	223714	0	Ν	RMAN_DATA_DG/

grid@oracle19c-ol8-vvol-rman:+ASM:/home/grid>

oracle@oracle19c-ol8-vvol-rman:rmandb:/home/oracle>export ORACLE\_SID=vvol19c

oracle@oracle19c-ol8-vvol-rman:vvol19c:/home/oracle> sqlplus / as sysdba SQL\*Plus: Release 19.0.0.0.0 - Production on Wed Dec 30 10:21:16 2020 Version 19.8.0.0.0 Copyright (c) 1982, 2020, Oracle. All rights reserved. Connected to an idle instance.

SQL> startup mount pfile=/u01/app/oracle/product/19.0.0/dbhome\_1/dbs/initvvol19c.ora

ORACLE instance started.

Total System Global Area	1.2885E+10 bytes
Fixed Size	12691536 bytes
Variable Size	1811939328 bytes
Database Buffers	1.1039E+10 bytes
Redo Buffers	20860928 bytes
Database mounted.	
SQL>	

The newly mounted database vvol19c is now ready to be backed up via Oracle RMAN.

Some caveats to keep in mind when using Overwrite Disk:

- Ensure that the production database **vvol19c** VMDKs (DATA\_01 and FRA\_01) match in size with the newly added VMDKs of the RMAN VM **Oracle19c-OL8-RMAN** in order to use **Overwrite Disk**.
- RMAN VM **Oracle19c-OL8-RMAN** requires that target disks be pre-configured for **Overwrite Disk**, which may result in consumption of storage space.

### Oracle Backup of RAC

A 2-node Oracle RAC vvolrac with RAC VMs vvolrac1 and vvolrac2 is used in this use case example.

As previously mentioned, in the case of an Oracle RAC cluster, independent-persistent disk mode is <u>not</u> required to enable multi-writer for shared VMDKs. However, the default dependent disk mode causes a "cannot snapshot shared disk" error when a VM-level snapshot is taken of an Oracle RAC VM.

Use of independent-persistent disk mode allows taking a snapshot of the non-shared disk or disks (e.g., OS, Oracle binaries, standalone file system), while the shared disk(s) are backed up separately via a VMware-level snapshot mechanism (e.g., vVol-level backup of the shared VMDKs).

In the case of an Oracle RAC cluster, the snapshot process occurs in two steps:

- VM-level snapshot for non-shared VMDKs with disk mode set to Dependent for all RAC VMs vvolrac1 and vvolrac2
- Storage-based snapshot for shared VMDKs with disk mode set to Independent-Persistent from any RAC VM (e.g., vvolrac1).



The snapshot details of a 2-node Oracle 19c RAC cluster with VMs **vvolrac1** and **vvolrac2** follow with a VM-level snapshot of RAC VM **vvolrac1** shown immediately below:



FIGURE 61. TAKING A RAC VM-LEVEL SNAPSHOT

The VM-level snapshot has been successfully taken for production of RAC VM vvolrac1.

🕆 vvolrac1 🔰 🖷 🐙 🕸 🛛 Actions 🗸		
Summary Monitor Configure Permissions Datastores Networks Snapshots Updates		
TAKE ENAPSHOT REVERT EDIT DELETE DELETE ALL		
🔥 vvoiracl-Snap-2021-02-07	Name	vvoirac1-Snap-2021-02-07
You are here	Description	
	Timestamp	2/7/21, 10:09 PM
	Size	37.38 GB
	Snapshot the virtual machine's memory	No
	Quiesce guest file system	No

FIGURE 62. RAC VM VVOLRAC1 SNAPSHOT



Snapshot of the RAC VM **vvolrac2** is taken using the same process shown above.

The VM-level snapshot has been successfully taken for production of RAC VM vvolrac2.

🚯 VVOIrac2 🛛 🕨 🖷 😻 💩 🔹 Actions Y		
Summary Monitor Configure Permissions Datastores Networks Snapshots Updates		
TAKE SNAPSHOT REVERT EDIT DELETE OELETE ALL		
n vvoirac2-Snap-2021-02-07	Name	vvoirac2-Snap-2021-02-07
Vou are here	Description	
	Timestamp	2/7/21, 10:12 PM
	Size	81.08 GB
	Snapshot the virtual machine's memory	No
	Quiesce guest file system	No

### FIGURE 63. RAC VM VVOLRAC2 SNAPSHOT

Logging into the Pure Storage GUI indicates snapshots are created for all both RAC VM non-shared VMDKs.

### Details of RAC VM **vvolrac1** snapshot are shown below:

Storage										
Array Hosts Volumes Protection Groups Pods										
😢 > Volumes										
Size         Data Reduction         Volumes         Snapshots         Shared         System         Total           230562612 M         8.9 to 1         4.41 T         0.00         1.08 T         0.00         5.48 T										
Volumes	Space	QoS Deta	ils 1-7 of 7	<> +	- :					
Name A vvoiract	Size	Volumes	Snapshots	Reduction						
vvol-vvolrac1-cd11eee6-vg/Config-eeee07f9	4 G	1.62 M	0.00	5.1 to 1	:					
vvol-vvolrac1-cd11eee6-vg/Data-8570d9e7	1 T	3.43 G	0.00	9.8 to 1	:					
vvol-vvolrac1-cd1teee6-vg/Data-86f7t5da	80 G	2.48 M	0.00	58.1 to 1	:					
Swol-wolract-cdtteee6-vg/Data-86f7t5da-snap-02e98075	80 G	2.19 M	0.00	58.3 to 1	:					
wol-wolract-cd11eee6-vg/Data-8d449c11  vVOL Snapshot	80 G	27.41 M	0.00	58.3 to 1	:					
vvol-vvolraci-cd1teee6-vg/Data-8d449c11-snap-963e238b	80 G	32.90 M	0.00	57.8 to 1	:					
C vvol-vvolrac1-cd1teee6-vg/Swap-c3eafaee	32 G	0.00	0.00	1.0 to 1	:					

FIGURE 64. PURE STORAGE GUI – RAC VM VVOLRAC1 VOLUMES
Details of RAC VM vvolrac2 snapshot are shown below:

Storage											
Array Hosts Volumes Protection Groups Pods											
Yolumes											
SizeData ReductionVolumesSnapshotsSharedSyster230562612 M8.9 to 14.41 T0.001.08 T0.00	n Total 5.48 T										
Volumes	Space	QoS Details 1-6 of 6	· · + :								
Name Name	Size	Volumes Snapshots F	Reduction								
vvol-vvolrac2-2758794e-vg/Config-26160b0e	4 G	1.68 M 0.00	4.7 to 1								
vvol-vvolrac2-2758794e-vg/Data-92e4e917	80 G	25.08 M 0.00	58.2 to 1								
vvol-vvolrac2-2758794e-vg/Data-92e4e917-snap-b5abab41	80 G	36.33 M 0.00	57.3 to 1								
C vvol-vvolrac2-2758794e-vg/Data-f283fad0	DL Snapshot 80 G	334.69 K 0.00	59.9 to 1								
vvol-vvolrac2-2758794e-vg/Data-f283fad0-snap-f7ad7101	80 G	2.31 M 0.00	58.2 to 1								
vvol-vvolrac2-2758794e-vg/Swap-192897b3	32 G	0.00 0.00	1.0 to 1								

FIGURE 65. PURE STORAGE GUI – RAC VM VVOLRAC2 VOLUMES

Notice that the shared VMDK (1TB) does not have a snapshot associated with it.

A storage-based vVol snapshot is then taken within the Pure GUI of the database VMDKs. Click **Create** to produce the snapshot **vvolrac-DBSnap**.

Storage			🔏 🛞 🔍 Search
Array Hosts Volumes Protection Groups Pods			
Volumes > = vvol-vvolract-cd11eee6-vg / Data-8570d9e7			1
Size         Data Reduction         Volumes         Snapshots         Shared         System         Total           1T         9.8 to 1         3.42 G         0.00         -         -         3.42 G			
Connected Hosts	1-2 of 2 < >	Protection Groups	ocro <> :
Name	LUN	Name	
em 522esx09	253:14 ×	No protection groups found.	
ow sc2esrl0	253:5 ×	Volume Snanshots	General Transfer Option ( )
Connected Host Groups	ooro < > ∎	Name	Created V Snapshots Create Snapshots
Name	LUN		
No host arouns found.		No snapsnots round.	Destroyed (0) v
Details Source Croated Source Croated Source Source Croated Source Add1940533348C.00072544 Add1940533348C.00072544 Add1940533348C.00072544 Add19405 Z # Add1 Cost Cost Cost Cost Cost Cost Cost Cost		Create Snapshot Optional Suffix	wolrac-DESnap
			Cancel Create





vVol-based snapshot vvolrac-DBSnap is created for the database VMDKs.

Volume Snapshots	General Transfer 1-1	of1 < > 🕂 :
Name	Created▼ Snapshot	s
J vvol-vvolrac1-cd11eee6-vg/Data-8570d9e7.vvolrac-DBSnap	2021-02-07 22:53:56 0.0	
Destroyed (0) 🗸		



Follow the same steps described above to import/overwrite the RAC database VMDKs on the RMAN VM **Oracle19c-OL8-RMAN** and back up the RAC database via Oracle RMAN.



FIGURE 68. PURE PLUGIN - IMPORT DISK

The RAC database VMDKs are now present on the RMAN VM Oracle19c-OL8-RMAN and ready to be backup up via Oracle RMAN.

Summary Monitor	_8-VV Config	OL- RMAI	N 🕨 🗖 ns Data	😻 🤣 🔯 stores Networl	ACTIONS V	ts Updates						
Settings V VM SDRS Rules vApp Options Alarm Definitions	Vir	tual Volume	A RESTORE	DELETED DISK	G OVERWRITE D	15K						
Scheduled Tasks		Name	↑ <b>т</b>	Virtual Device	Ŧ	Size	Ψ	Datastore	Υ	Array	Ψ	Volume
VMware EVC		Hard disk 1		SCSI (0:0)		80.0 GB		OraVVOL		Pure-X50-BCA		vvol-Oracle19c-OL8-VVOL-QAVM-ab2dff46-vg/Data-18d58ea1
Guest User Mappings		Hard disk 2		SCSI (0:1)		80.0 GB		OraVVOL		Pure-X50-BCA		vvol-Oracle19c-OL8-VVOL-QAVM-ab2dff46-vg/Data-e304e83c
Pure Storage V		Hard disk 3		SCSI (1:0)		100.0 GB		OraVVOL		Pure-X50-BCA		vvol-Oracle19c-OL8-VVOL-QAVM-ab2dff46-vg/Data-4fa12108
virtuai volumes		Hard disk 4		SCSI (0:2)		1.0 TB		OraVVOL		Pure-X50-BCA		vvol-Oracle19c-OL8-VVOL-QAVM-ab2dff46-vg/Data-67928989

FIGURE 69. RMAN VM ORACLE19C-OL8-RMAN VMDK

# **m**ware<sup>®</sup>

Delete the vVol-based snapshot vvolrac-DBSnap after the disk import is completed as part of cleanup.

#### **Oracle Restore and Recovery**

This section validates database restore using VMware vVol-based snapshots of an Oracle single-instance and Oracle RAC on vVols using Pure x50 Storage.

In the event a database restore and recovery is required, one could use:

- 1. Oracle database restore using RMAN backup (this backup was created in the previous Oracle Backup section) followed by database-level recovery using Oracle
- 2. Restore of database vVol followed by database-level recovery using Oracle

Database restore could involve one of two scenarios:

- 1. A full database restore is required, in which case the production database is shut down before the contents of the database VMDKs are restored form VMware vVol snapshot using Pure Plugin **Overwrite Disk**
- 2. A partial database restore is required, in which case the production database is shut down and new VMDKs are imported from VMware vVol snapshot using the Pure Plugin Import Disk. We can now change the database name and/or database ID using Oracle MySupport Note *How to Change the DBID, DBNAME Using NID Utility (Doc ID 863800.1)*. We can then use Oracle to copy the data from the new imported database over to the production database.

This section examines:

- vVol-level restore of the database VMDKs followed by database-level recovery using Oracle.
- Full database restore from a VMware vVol snapshot using Pure Plugin Overwrite Disk

#### Oracle Restore and Recovery of Single Instance

Ensure that a VM-level snapshot is taken for production VM Oracle19c-OL8-VVOL before beginning any database operations.

VM-level snapshot VMSnap-2021-02-08 is shown below:

🚯 Oracle19c-OL8-VVOL 🛛 🕨 🛢 😻 💿 🔕 🔹 actions 🗸		
Summary Monitor Configure Permissions Datastores Networks Snapshots Updates		
TAKE SNAPSHOT. EDIT DELETE DELETE ALL		
6 VMSnap-2021-02-08	Name	VMSnap-2021-02-08
You are here	Description	
	Timestamp	2/8/21, 1:00 PM
	Size	277.47 KB
	Snapshot the virtual machine's memory	No
	Quiesce guest file system	No

#### FIGURE 70. VM ORACLE19C-OL8-VVOL VM SNAPSHOT

In order to restore the database on production VM Oracle19c-OL8-VVOL from a VMware vVol snapshot, the production database is shut down cleanly first before the contents of the database VMDKs are restored using Pure Plugin **Overwrite Disk**.

After the production database is shut down, select the VMDKs to be restored and choose Pure Plugin Overwrite Disk.



Dracle19c-Ol Summary Monitor	Oracle19c-OL8-VVOL   > = + > 10 Actions - Acti												
Settings VM SDRS Rules	\ \	Virtu	ial Volume						7				
Alarm Definitions	l	-£ IN	IPORT DISK	A RESTORE DEL	ETED DISK	+ CREATE SNAPSHO	T G OVERW	RITE DISK					
Scheduled Tasks			Name	1 τ	Virtual Device		Size	т	Datastore	Ψ	Array	т	Volume
Policies			Hard disk 1		SCSI (0:0)		80.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-20c34be7
Guest User Mappings			Hard disk 2		8CSI (0:1)		80.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-c552b187
Pure Storage 🗸 🗸			Hard disk 3		SCSI (1:0)		100.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-57b48797
Virtual Volumes		0	Hard disk 4		SCSI (2:0)		1.0 TB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-03decfb2
			Hard disk 5		SCSI (3:0)		250.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-efe1c0b0
			VM home		-		4.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Config-950dc3ea

FIGURE 71. PURE PLUGIN - OVERWRITE DISK

Select the VMDKs snapshot and click Overwrite.



FIGURE 72. OVERWRITE VMDK WITH SNAPSHOT

Delete the VM-level snapshot **VMSnap-2021-02-08** after the disk overwrite operation completes. Login to the VM and follow the Oracle database recovery steps to recover the database if needed.



#### Oracle Restore and Recovery of RAC

Ensure that storage vVol-level snapshot **vvolrac-DBSnap** is taken from the Pure GUI for production RAC **vvolrac** database VMDKs before beginning any database operations.

It's recommended to shut the RAC cluster down in order to get a clean, high-quality snapshot of the database VMDKs.

A vVol-based snapshot vvolrac-DBSnap is created for the database VMDKs.

Volume Snapshots	General Trans	sfer 1-1 of 1	<> + :
Name	Created  All	Snapshots	
🗗 vvol-vvolrac1-cd11eee6-vg/Data-8570d9e7.vvolrac-DBSnap	2021-02-07 22:53:56	0.00	:
Destroyed (0) 🗸			

FIGURE 73. STORAGE VVOL-BASED SNAPSHOT VVOLRAC-DBSNAP

Proceed with planned database operations.

In the event a database restore is needed, before restoring the RAC database **vvolrac** from the storage vVol snapshot, shut down the RAC cluster. Cleanly shutting down RAC VMs **vvolrac1** and **vvolrac2** is recommended before proceeding.

After the production database is shut down, click on the database vVol snapshot and select Restore.

Storage			🔓 😒 🔍 Search	
Array Hosts Volumes Protection Groups Pods				
Volumes > = vvol-vvolrac1-cdffeee6-vg / Data-8570d9e7				:
Size         Data Reduction         Volumes         Snapshots         Shared         System         Total           1T         593 to 1         4.99 M         877.34 M         -         882.32 M				
Connected Hosts 0 of 0	$\sim 1$	Protection Groups	4	0 of 0 🔿 🚦
Name	LUN	Name		
No hosts found.		No protection groups found.		
Connected Host Groups 0 or 0		Volume Snapshots Cre	General Transfer Copy Best Sated Sina Rent	y lore ame
No host groups found.		ි wol-woiract-officee6-vg/Data-8570d9e7.wolrac-DBSnap 202	21-02-08 15:06:41 0.00	roy
Details		Destroyed (0) v		
Source         -           Created         2024-03-20 2105.3.8           Semial         Add18405/A.3.48CA000125.4.4           Hood Receptore May Status         nohe           # Hoods         0		Restore Volume from Snapshot Restoring a volume from a snapshot will overwrite the contents of the volume	with data from the sn	× apshot.
r connectors 0		Are you sure you want to restore volume 'wol-wolract-cd1leee6-vg/Data-8570 wolract-cd1leee6-vg/Data-8570d9e7.wolrac-DBSnap?	)d9e7' from snapshot	t'wol-

FIGURE 74. RESTORE RAC DATABASE VMDKS FROM STORAGE SNAPSHOT VVOLRAC-DBSNAP

The database VMDKs are now restored from the vVol-based snapshot **vvolrac-DBSnap**, taken before the start of the database operations.

Power on the RAC VM **vvolrac1** and **vvolrac2**. Start the RAC cluster if needed and check RAC services. The RAC cluster is up. Delete the vVol snapshot **vvolrac-DBSnap** as part of the cleanup.

RAC cluster **vvolrac** service is successfully up after the restore.



# FIGURE 75. RAC DATABASE VVOLRAC SERVICES

[root@vvolrac1	~]# /u0	1/app/19.0.0/	grid/bin/crsctl s	status re	s -t
Name	Target	State	Server		State details
Local Resource:	5 5				
ora.LISTENER.l	snr				
	ONLINE	ONLINE	vvolrac1		STABLE
	ONLINE	ONLINE	vvolrac2		STABLE
ora.chad	ONI THE	ONI THE			CESDI E
	ONLINE	ONLINE	vvolraci vvolrac2		STABLE STABLE
ora.net1.netwo:	rk	ONDIND	VVOILGOL		
	ONLINE	ONLINE	vvolrac1		STABLE
	ONLINE	ONLINE	vvolrac2		STABLE
ora.ons	ONLINE	ONL THE	TTTO I NO GI		CTADIE
	ONLINE	ONLINE	vvolrac2		STABLE
Cluster Resourd	ces 				
ora.ASMNET1LSN	R_ASM.ls:	nr(ora.asmgro	up)		
1	ONLINE	ONLINE	vvolrac1		STABLE
2	ONLINE	ONLINE	vvolrac2		STABLE
J ora DATA DG da	ONLINE	OFFLINE			STABLE
1	ONLINE	ONLINE	vvolrac1		STABLE
2	ONLINE	ONLINE	vvolrac2		STABLE
3	OFFLINE	OFFLINE			STABLE
ora.LISTENER_S	CAN1.lsn				
1 ora.LISTENER S	ONLINE CAN2.lsn	ONLINE	vvolrac1		STABLE
1 -	ONLINE	ONLINE	vvolrac2		STABLE
ora.LISTENER_S	CAN3.lsn	r			
L AND MCMUI CND	ONLINE	ONLINE	vvolracz		STABLE
1	ONLINE	ONLINE	vvolrac2		169.254.25.178 192.1 68.14.242,STABLE
ora.asm(ora.asm	mgroup)				
1	ONLINE	ONLINE	vvolrac1		Started, STABLE
2	ONLINE	ONLINE	vvolrac2		Started, STABLE
ن ora asmnetl asm	OFFLINE mnetwork	OFFLINE			STABLE
1	ONLINE	ONLINE	/ vvolrac1		STABLE
2	ONLINE	ONLINE	vvolrac2		STABLE
3	OFFLITNE	OFFLITNE			STABLE
ora.cvu					
1	ONLINE	ONLINÈ	vvolrac2		STABLE
ora.mgmtdb 1	ONLINE	ONLINE	wwolrac?		Open STARLE
ı ora.gosmserver	ONLINE	ONLINE	VVUITACZ		open, stable
1	ONLINE	ONLINE	vvolrac2		STABLE
ora.scan1.vip					
1	ONLINE	ONLINE	vvolrac1		STABLE
ora.scan2.vip	ONL THE	ONL THE			
ana ggan? win	ONLINE	ONLINE	vvolrac2		STABLE
ora.scans.vrp 1	ONLINE	ONLINE	vvolrac2		STABLE
ora.vvolrac.db					
1	ONLINE	ONLINE	vvolrac1		Open,HOME=/u01/app/o racle/product/19.0.0 /dbhome_1.STABLE
2	ONLINE	ONLINE	vvolrac2		Open,HOME=/u01/app/o racle/product/19.0.0 /dbhome_1,STABLE
ora.vvolraci.v: 1	IP ONLINE	ONLINE	vvolrac1		STABLE
ora.vvolrac2.v: 1	ip ONLINE	ONLINE	vvolrac2		STABLE
[root@vvolracl	~]#				

### Oracle Database Cloning

This section validates database cloning using VMware snapshots of an Oracle single-instance and Oracle RAC on vVols using Pure x50 Storage.

#### **Oracle Single-Instance Database**

Two VMs are utilized for this use case:

- Production VM Oracle19c-OL8-VVOL
- QA VM Oracle19c-OL8-VVOL-QAVM

This use case focuses on cloning an existing Oracle database **vvol19c** to a QA VM **Oracle19c-OL8-QAVM** for a variety of database purposes (e.g., testing a new version of the software code, testing database patching).

#### The following steps were used for this testing:

1. Clone the DATA\_DG and FRA\_DG ASM disks of the production database **vvol19c**. In production VM **Oracle19c-OL8-VVOL**, the database data and redo log files were on ASM disk group DATA\_DG, the archive log files were on ASM disk group FRA\_DG.

We can clone the production database **vvol19c** disks in two ways:

Take a snapshot of the database, either a traditional VM-level snapshot using the web client or a VMDK-level snapshot of DATA\_DG and FRA\_DG VMDKs using the Pure storage Plugin, then create clones of the two VMDKs from the above snapshot.
 For example, the Pure Plugin Import Disk option will indicate that the VMDK is being cloned from a snapshot.

Select a so	ourc	e disk:		Filter
>	ð	Clone-Oracle19c-OL8-VVOL		
>	ð	Clone-Oracle19c-OL8-VVOL-	QAVM	
>	ð	Clone-Oracle19c-OL8-VVOL-	19.8	
$\sim$	ß	Oracle19c-OL8-VVOL		
	>	🖨 Hard disk 1		
	>	Hard disk 2		
	>	Hard disk 3		
	$\sim$	Hard disk 4		
		図 vvol-Oracle19c-OL8-V	VOL-0b4146e	-3-vg/Data-03decfb2-snap-
olume Info	rma	tion:		
/olume Nan	ne:	vvol-Oracle19c-OL8-VVOL- 0b4146e3-vg/Data-O7decfb2	Array:	wdc-tsa-pure-01
Disk File:		Oracle19c-OL8-VVOL_3.vmdk	Created:	Wednesday, December 30 2020 10:46:23 AM -0800
/olume Size		1.0 ТВ	Datastore:	TSA-Pure-VVOL-SC-DS

FIGURE 76. PURE STORAGE PLUGIN - IMPORT DISK



- Clone the DATA\_DG and FRA\_DG VMDKs directly without taking a snapshot. For example, the Pure Plugin **Import Disk** option will indicate that the VMDK is being cloned from the source VMDK directly.

Select a sou	irce disk:		Filter
> (	Diclone-Oracle19c-OL8-VVOL		
> (	Diclone-Oracle19c-OL8-VVOL-C	MVAQ	
> (	Diclone-Oracle19c-OL8-VVOL-1	9.8	
$\sim d$	Dracle19c-OL8-VVOL		
	🖨 Hard disk 1		
	Hard disk 2		
	🖨 Hard disk 3		
	🖨 Hard disk 4		
	🖨 Hard disk 5		
olume Inforr	nation:		
Volume Name	vvol-Oracle19c-OL8-VVOL- 0b4146e3-vg/Data-03decfb2	Array:	wdc-tsa-pure-01
Disk File:	Oracle19c-OL8-VVOL_3.vmdk	Created:	Tuesday, December 15, 2020 2:37:54 PM -0800
Volume Size:	1.0 TB	Datastore:	TSA-Pure-VVOL-SC-DS

FIGURE 77. PURE STORAGE PLUGIN - IMPORT DISK

For production database vvol19c, all redo log files, controlfiles and database files are part of the DATA\_DG ASM disk group, so this use case used a VMDK-level snapshot for DATA\_DG and FRA\_DG VMDKs.

2. Take VMDK-level snapshots for DATA\_DG and FRA\_DG VMDKs on production VM Oracle19c-OL8-VVOL as shown below:

🔓 Oracle19c-OL	8-VV	ol   🕨	🔮 🤣 🕲	ACTIONS	· <b>~</b>			
Summary Monitor	Config	ure Permi	ssions Datast	ores Net	works Snapshots	Updates	Create Snapshot >	
Settings VM SDRS Rules vApp Options	Virt	ual Volume	A RESTORE DEL	ETED DISK	+ CREATE-TNAPSHO		Create a snapshot of the virtual volume 'Hard disk 4 - SCSI (2:0)'	
Alarm Definitions Scheduled Tasks		Name	<b>↑</b> <del>γ</del>	Virtual Device	т т	Size	Suffix vmdkSnap-2020-12-29	
Policies VMware EVC		Hard disk 1		SCSI (0:0)		80.0 GB		3-vg/Data-20c34be7
Guest User Mappings		Hard disk 2		SCSI (0:1)		80.0 GB		3-vg/Data-c552b187
Pure Storage 🗸 🗸		Hard disk 3		SCSI (1:0)		100.0 GB		13-vg/Data-57b48797
Virtual Volumes	0	Hard disk 4		SCSI (2:0)		1.0 TB		3-vg/Data-03decfb2
		Hard disk 5		SCSI (3:0)		250.0 GB		3-vg/Data-efe1c0b0
		VM home		-		4.0 GB		+3-vg/Config-950dc3ea
							CANCEL	





🔂 Oracle19c-OL	.8-VV	OL   🕨 🗖	🔮 🐉 🔯 ACTIONS	~							
Summary Monitor	Config	ure Permissio	ons Datastores Netw	orks Snapshots	Updates		Create Snapshot			$\times$	
Settings ~	Virtu	ual Volume					Create a snapshot of the virt				
Alarm Definitions	£10	MPORT DISK	RESTORE DELETED DISK	+ CREATE SNAPSHOT	G OVERW	RITE DISK	Suffix	vmdkSnap-2020-12-29			
Scheduled Tasks		Name	↑ ▼ Virtual Device	<b>T</b>	Size	т		$\mathbf{X}$			
VMware EVC		Hard disk 1	SCSI (9:0)	8	80.0 GB						20c34be7
Guest User Mappings		Hard disk 2	SCSI (0:1)	٤	80.0 GB			$\sim$			c552b187
Pure Storage 🛛 🗸		Hard disk 3	SCSI (1:0)	1	100.0 GB						57b48797
Virtual Volumes		Hard disk 4	SCSI (2:0)	1	1.0 TB				$\mathbf{i}$		03decfb2
	0	Hard disk 5	SCSI (3:0)	3	250.0 GB				$\sim$		efe1c0b0
		VM home			4.0 GB						3-950dc3ea
									CANCEL	CREATE	



The Pure Storage GUI shows the snapshots at the vVol level:

P	PURESTORAGE" •	Storage							Q Search	9 8
٩	Dashboard	Array Hosts Volumes Protection Groups Pods								
۲	Storage	() > Volumes > wvol-Oracle19c-OL8-VVOL-0b4146e3-vg								:
a	Analysis	Size         Data Reduction         Volumes         Snapshots         Shared         System         Total           1666 G         36.9 to 1         95.88 M         0.00         -         -         -								
	Performance Capacity Replication	Volumes	Space	QoS Deta	Ils 1-7 of 7	Perturtion	•	Volume Snapshots	General Transfer 1-2 of 2 < >	1
÷	Health	C wol-Oracle19c-OL8-WOL-0b4146e3-vg/Data-03decfb2	1 T	1.21 M	72.70 K	38.9 to 1	:	Wol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-efe1c0b0.smdkSnap-2020-12-29	2020-12-30 11:43:54 275.00 B	:
4	Settings	Contemporaria Conte Contemporaria Contemporaria Contempora	250 G	24.67 K	275.00 B	39.0 to 1	1	O wol-Oracle19c-OL8-VVOL-0b446e3-vg/Data-03dectb2.vmdkSnap-2020-12-29	2020-12-30 11:41:10 72:70 K	÷
		Swol Oracle19: OL8 VVOL 0b4146e3 vg/Swap 5c283b5b	128 G	0.00	0.00	1.0 to 1	:	Destroyed (0) v		
Help		C wol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-57b48797	100 G	8.49 K	0.00	38.9 to 1	÷			
Endl	ser Agreement	S Wol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-20c34be7	80 G	31.46 M	0.00	31.4 to 1	:			
Term Log C	ut	C Wol-Oracle19c-OL8-WVOL-0b4146e3-vg/Data<552b187	80 G	59.43 M	0.00	37.2 to 1	:			
		C Wol-Oracle19c-OL8-VVOL-0b4146e3-vg/Config-950dc3ea	4 G	3.74 M	0.00	4.3 to 1	1			
		Destroyed (0) ~								
		Details								
		CoS EZ Bandwidth Limit - IOPS Limit -								

FIGURE 80. PURE STORAGE GUI – VOLUMES

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3. On VM Oracle19c-OL8-QAVM, using the Pure Plugin, choose Import Disk and Import DATA\_DG ASM disk (1TB).





On VM Oracle19c-OL8-QAVM, using the Pure Plugin, choose Import Disk and Import FRA\_DG ASM disk (250GB).

					Import Virtual Volume Disk	
Summary Monitor	S-VVOL-QAVM	📕 😻 🤣 🚺 ACTIO Datastores Networks	Snapshots Updates		Select a source disk:	
Settings V VM SDRS Rules vApp Options Alarm Definitions	Virtual Volume	RE DELETED DISK + CREA	te snapshot G overwrite dis	<ul> <li> <sup>™</sup>             Clone-Oracle19c-OL8-VVOL-19.3             <sup>™</sup> <sup>™</sup></li></ul>		
Scheduled Tasks	Name 1	T Virtual Device	T Size T	Datastore T	Hard disk 3	
VMware EVC	Hard disk 1	SCSI (0:0)	80.0 GB	TSA-Pure-VVOL-SC-DS	> 🖂 Hard disk 4	
Guest User Mappings	Hard disk 2	SCSI (0:1)	80.0 GB	TSA-Pure-VVOL-SC-DS	V 🖨 Hard disk 5	
Pure Storage 🗸 🗸	Hard disk 3	SCSI (1:0)	100.0 GB	TSA-Pure-VVOL-SC-DS	vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-	
Virtual Volumes	Hard disk 4	SCSI (0:2)	1.0 TB	TSA-Pure-VVOL-SC-DS	efe1c0b0.vmdkSnap-2020-12-29	
	○ VM home	-	4.0 GB	TSA-Pure-VVOL-SC-DS	Volume Information: Volume Name: vvol-Oracle19c-OL8-VVOL- Array: wdc-tsa-pure-0 Ob4146e3-vg/Data-efelc0b0	I.
					Disk File: Oracle19c-OL8-VVOL_4.vmdk Created: Wednesday, De 2020 11:43:54 A	cember 30, M -0800
					Volume Size: 250.0 GB Datastore: ISA-Pure-VVOI	SC-DS
						<b>`</b>
					CANCEL	IMPORT

FIGURE 82. PURE STORAGE PLUGIN - IMPORT DISK

VM Oracle19c-OL8-QAVM now has two new VMDKs: DATA\_DG ASM disk (1TB) and FRA\_DG ASM disk (250GB).

Summary Monitor	S Oracle19c-OL8-VVOL-QAVM > = # # % 20 Actions ~ ummary Monitor <u>Configure</u> Permissions Datastores Networks Snapshots Updates											
Settings V VM SDRS Rules vApp Options Alarm Definitions	Virti ปี เ	ual Volume	A RESTORE DE	LETED DISK	+ CREATE SNAPSH	HOT GOVERWA	RITE DISK.					
Scheduled Tasks		Name	1 τ	Virtual Device	т	Size	Ψ	Datastore	Ψ	Array	Ψ	Volume
Policies VMware EVC		Hard disk 1		SCSI (0:0)		80.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-QAVM-5cae54d1-vg/Data-045fdad3
Guest User Mappings		Hard disk 2		SCSI (0:1)		80.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-QAVM-5cae54d1-vg/Data-50f12800
Pure Storage 🗸 🗸		Hard disk 3		_SCSI (1:0)		100.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-QAVM-5cae54d1-vg/Data-17772e0a
Virtual Volumes	,0	Hard disk 4		SCSI (0:2)		1.0 TB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-QAVM-5cae54d1-vg/Data-6a93137f
	0	Hard disk 5		SCSI (0:3)		250.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-QAVM-5cae54d1-vg/Data-9e1caf1e
		VM home		-,		4.0 GB		TSA-Pure-VVOL-SC-DS		wdc-tsa-pure-01		vvol-Oracle19c-OL8-VVOL-QAVM-5cae54d1-vg/Config-b3f586b9



4. Delete the snapshot taken of the VMDKs from the Pure Storage GUI as shown below:

	Storage			Q, Search
	Array Hosts Volumes Protection Groups Pods			
Storage	Volumes > vvol-Oracle19c-OL8-VVOL-0b4146e3-vg			I
	Size         Data Reduction         Volumes         Snapshots         Shared         System         Total           1666 G         36.8 to 1         9723 M         0.00         -         -         -			
	Volumes	Space GoS Details 17 of 7 <> + :	Volume Snapshots	General Transfer 1.2 of 2 < >
	Namo	Size Volumes Snapshots Reduction	Name	Creates* Sai Det/170/ All ~ Sourrised CSV
	Consciente-OLB-VVOL-064145e3-vg/Data-03dectb2	1T 211 M 1009.59 K 38.7 to 1	g <sup>1</sup> wol-Oracle19:- OLB-WOL-0b4146e3-vg/Data-efe1c0b0.vmdkSnap-2020-12-29	2020-12-30 11:4354 956.00 8
	wei-Oraclettic-OLB-VVOL-0s4146e3-vg/Data-eletcob0	250 G 37.46 K 956.00 B 38.9 to 1	J woi Oraciet9c OL8-WOL-0b4146e3-vg/Data-03dectb2xmskSnap 2020-12-29	2020-19-00 TL41:00 1009:59 K
	wol Oraclettic-OL8-VVOL-064446e3-vg/5wsp-5c283b5b	128 G 0.00 0.00 1.0 to 1	Destroyed (0) ~	
	wol-Oraclettic OL8 VVOL-064146e3 vg/Data 57548797	100 G 8.21 K 0.00 38.8 to 1	Destroy shapshots	~
	weil Oraclettic OL8-WOL 064446e3 vg/Data 20c34be7	80 G 31.57 M 0.00 31.3 to 1		
	wei-Oraclettic OL8 VVOL-064445e3 vg/Data c552887	80 G 60.08 M 0.00 370 to 1	Existing Snapshots	Selected Snapshots
	S wol Oracletic OLB VVOL 004446e3 vg/Config 9500c3ea	4 G 3.53 M 0.00 4.1to 1	✓ 1-2 of 2 < >	2 selected Clear all
	Dataile		vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-0 1009.59 K	wol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-03de 1009.59 K x
	ore of			
	Bandwidth Limit -		Vioi-Oracie19C-OL8-VVOL-004146e3-vg/bata-e 956.00 B	Wol-Oracleisc-OL8-VVOL-Ob4146e3-Vg/Data-eleic 956.00 B X
	IOPS Limit ·			
				Cancel Destroy



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5. On QA VM Oracle19c-OL8-QAVM, scan for new ASM disks using the Oracle oracleasm command to discover new VMDKs DATA\_01 and FRA\_01 of production database vvol19c.

[root@oracle19c-ol8-vvol-qavm ~]# oracleasm scandisks ; oracleasm listdisks Reloading disk partitions: done Cleaning any stale ASM disks... Scanning system for ASM disks... Instantiating disk "DATA\_01" Instantiating disk "FRA\_01" DATA\_01 FRA\_01 MGMT\_DATA01 [root@oracle19c-ol8-vvol-gavm ~]#

Mount the new disk groups +DATA\_DG and +FRA\_DG

grid@oracle19c-ol8-vvol-qavm:+ASM:/home/grid> asmcmd mount DATA\_DG grid@oracle19c-ol8-vvol-qavm:+ASM:/home/grid> asmcmd mount FRA\_DG

grid@oracle19c-ol8-vvol-qavm:+ASM:/home/grid> asmcmd lsdg

State	Туре	Rebal	Sector	Logical_Sector	Block	AU Total_MB	Free_MB	Req_mir_free_MB	Usable_file_MB	Offline_disks	Voting_files	Name
MOUNTED EXTERN	Ν	512	512	4096	1048576	1048575	1036823	0	1036823	0	Ν	DATA_DG/
MOUNTED EXTERN	Ν	512	512	4096	1048576	255999	253526	0	253526	0	Ν	FRA_DG/
MOUNTED EXTERN	Ν	512	512	4096	4194304	102396	102296	0	102296	0	Ν	MGMT_DATA/

grid@oracle19c-ol8-vvol-qavm:+ASM:/home/grid>

#### 6. On the QA VM Oracle19c-OL8-QAVM, start up the database vvol19c.

Make appropriate changes to the database vvol19c init.ora file for memory and file directory setings.

Copy the orapwvvol19c file from Production VM Oracle19c-OL8 VVOL to QA VM Oracle19c-OL8-QAVM.

oracle@oracle19c-ol8-vvol-qavm:vvol19c:/home/oracle> export ORACLE\_SID=vvol19c

oracle@oracle19c-ol8-vvol-qavm:vvol19c:/home/oracle> sqlplus / as sysdba SQL\*Plus: Release 19.0.0.0.0 - Production on Wed Dec 30 12:11:44 2020 Version 19.8.0.0.0 Copyright (c) 1982, 2020, Oracle. All rights reserved.

Connected to an idle instance.

SQL> startup pfile=/u01/app/oracle/product/19.0.0/dbhome\_1/dbs/initvvol19c.ora ORACLE instance started. Total System Global Area 3.4360E+10 bytes Fixed Size 12697696 bytes Variable Size 3892314112 bytes 3.0400E+10 bytes Database Buffers Redo Buffers 54407168 bytes Database mounted. Database opened. SQL> Disconnected from Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 - Production Version 19.8.0.0.0 oracle@oracle19c-ol8-vvol-gavm:vvol19c:/home/oracle>



- 7. We can now change the database name and/or database ID using Oracle MySupport Note *How to Change the DBID, DBNAME Using NID Utility (Doc ID 863800.1).*
- 8. The new database is now ready for a variety of database purposes (e.g., testing a new version of the software code, testing database patching).

# Oracle RAC

A 2-node Oracle RAC vvolrac with RAC VMs vvolrac1 and vvolrac2 is used in the RAC cloning use case example.

As explained earlier, to clone RAC database VMDKs, it's recommended to take a consistent storage vVol-based snapshot **vvolrac-DBSnap** for shared VMDKs from the Pure GUI.

Storage			🔓 🗴 🔍 Search
Array Hosts Volumes Protection Groups Pods			
(2) > Volumes > = vvol-vvolrac1-bafa6fb0-vg / Data-839da6af			1
Size         Data Reduction         Volumes         Snapshots         Shared         System         Total           11         58.2 to 1         19.41 M         0.00         -         19.41 M			
Connected Hosts	1-2 of 2 < >	Protection Groups	0 of 0 < >
Name	LUN	Name	
om sc2esx09	253:14 ×	No protection groups found.	
enu sc2esxt0	253:7 ×	Volume Snapshots	General Transfer 1-1 of 1 < > + :
Connected Host Groups	0 of 0 < >	Name	Created Snapshots
Name	LUN		
		√vol-vvolrac1-bafa6tb0-vg/Data-839da6at/volrac-DBSnap	2021-02-09 10:46:41 0.00
No host groups found.		Destroyed (0) V	

#### FIGURE 85. STORAGE VVOL SNAPSHOT OF RAC DATABASE VVOLRAC VMDKS

One possible requirement could be to simply clone the RAC database **vvolrac** and mount the database clone **vvolrac-db-clone** on a target VM to be used for database operations.

In this instance, use Pure Plugin **Import Disk** on VM **Oracle19c-OL8-QAVM** and import a new disk from the storage vVol-based snapshot **vvolrac-DBSnap**.



FIGURE 86. PURE PLUGIN – IMPORT DISK (VM ORACLE19C-OL8-QAVM)

For example, we have another RAC 19c cluster rac19c with 2 RAC nodes rac19c1 and rac19c2.

Another possible requirement could be to clone the current RAC database **vvolrac** and add it as a new database to a RAC cluster **rac19c** with existing databases.

In this case, use Pure Plugin Import Disk to mount the RAC database vvolrac VMDKs on RAC VM rac19c1.



FIGURE 87. PURE PLUGIN - IMPORT DISK (RAC VM RAC19C1)



The RAC database vvolrac is now added to the RAC VM rac19c1.

s rac19c1 🛛 🕨 🖷 🐲 🚳 🔹 Actions 🗸												
Summary Monitor	unimary Monitor <mark>Configure</mark> Permissions Datastores Networks Snapshots Updates											
Settings VM SDRS Rules VApp Options Alarm Definitions	Virtual Volume <sup>¶</sup> IMPORT DISK	ARESTORE DELETE	ED DISK & OVI	ERWRITE DISK								
Scheduled Tasks	Name	<b>↑ ▼</b>	Virtual Device	Υ	Size	Ŧ	Datastore	Ψ	Array	Ŧ	Volume	
VMware EVC	Hard disk 4		SCSI (0:2)		1.0 TB		OraVVOL		Pure-X50-BCA		vvol-rac19c1-81a3deb6-vg/Data-9fc7feb6	
Guest User Mappings												
Pure Storage 🛛 🗸												
Virtual Volumes												

FIGURE 88. RAC VM RAC19C1 WITH VVOLRAC VMDKS

On RAC VM **rac19c1**, set the disk sharing to **Multi-writer**. The RAC node **rac19c2** then refers to the shared VMDKs on RAC VM **rac19c1** with disk sharing set to **Multi-writer**.

Edit Settings rac19c1		×	Edit Settings rac19c2		:
Virtual Hardware VM Options			Virtual Hardware VM Options		
	ADD	NEW DEVICE Y			ADD NEW DEVICE *
> CPU	8 ~	٩	> CPU	8 ~	٩
> Memory	32 × GB ×		> Memory	32 × GB ×	
> Hard disk 1	80 GB ~		> Hard disk 1	GB ~	
> Hard disk 2	80 GB ~		> Hard disk 2	80 <u>GB v</u>	
> Hard disk 3	500 GB ~		> Hard disk 3	500 GB ~	
✓ Hard disk 4	<u>1 TB ~</u>		✓ Hard disk 4	<u>1</u>	
Maximum Size	62 TB		Maximum Size	62 TB	
VM storage policy	VVol No Requirements Policy ~		VM storage policy	VVol No Requirements Policy ~	
Туре	Thin Provision	🥕 Sharing Multi-wr	iter 🖛 Type	Thin Provision	
Sharing	Multi-writer 🗸		Sharing	Multi-writer 🗸	
Disk File	[OraVVOL] rfc4122.81a3deb6-7fbc-4426-8a63- 6971bcd7e922/rac19c1.vmdk		Disk File	[OraVVOL] rfc4122.81a3deb6-7fbc-4426 6971bcd7e922/rac19c1.vmdk	-8a63-
Shares	Normal ~ 1000		Shares	Normal V 1000	
Limit - IOPs	Unlimited ~		Limit - IOPs	Unlimited ~	
Disk Mode	Independent - Persistent		Disk Mode	Independent - Persistent 🗸 🗸	
Virtual Device Node	SCSI controller 3 🗸 SCSI(3:0) Hard disk 4 🗸	Disk Mode Independen Persistent	Virtual Device Node	SCSI controller 3 v SCSI(3:0) Hard	disk 4 ×

FIGURE 89. RAC VM RAC19C1 AND RAC19C2 WITH VVOLRAC DATABASE VMDKS SHARED WITH MULTI-WRITER

The subsequent steps to add the cloned database vvolrac to RAC cluster rac19c are outside the scope of this document.

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# Oracle Database Refresh

This section validates database refresh using VMware vVol-based snapshots of an Oracle single-instance and Oracle RAC using Pure x50 Storage.

### Oracle Single Instance Database

Two VMs are utilized for this use case:

- Production VM Oracle19c-OL8-VVOL
- QA VM Oracle19c-OL8-VVOL-QAVM

Database refresh is typically the process of refreshing the contents of a development or testing database from a copy of the production database so that they have the latest data to develop or test against.

This use case focuses on refreshing an older version of database vvol19c running on QA VM Oracle19c-OL8-QAVM from the latest copy of the production database vvol19c running on production VM Oracle19c-OL8-VVOL.

#### 1. On QA VM Oracle19c-OL8-QAVM:

- Shutdown the running database vvol19c
- Dismount the vvol19c ASM disk groups DATA\_DG and FRA\_DG

oracle@oracle19c-ol8-vvol-qavm:vvol19c:/home/oracle> sqlplus / as sysdba SQL\*Plus: Release 19.0.0.0.0 - Production on Wed Dec 30 12:33:04 2020 Version 19.8.0.0.0 Copyright (c) 1982, 2020, Oracle. All rights reserved. Connected to: Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 - Production Version 19.8.0.0.0 SQL> shutdown immediate; Database closed. Database dismounted. ORACLE instance shut down. SQL> exit Disconnected from Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 - Production Version 19.8.0.0.0 oracle@oracle19c-ol8-vvol-gavm:vvol19c:/home/oracle> grid@oracle19c-ol8-vvol-gavm:+ASM:/home/grid> asmcmd umount DATA\_DG grid@oracle19c-ol8-vvol-qavm:+ASM:/home/grid> asmcmd umount FRA\_DG grid@oracle19c-ol8-vvol-qavm:+ASM:/home/grid> asmcmd lsdg Type Rebal Sector Logical\_Sector Block AU Total\_MB Free\_MB Req\_mir\_free\_MB Usable\_file\_MB Offline\_disks Voting\_files Name State MOUNTED EXTERN N 512 512 4096 4194304 102396 102296 0 102296 0 MGMT DATA/ N grid@oracle19c-ol8-vvol-qavm:+ASM:/home/grid> [root@oracle19c-ol8-vvol-gavm ~]# oracleasm scandisks ; oracleasm listdisks Reloading disk partitions: done Cleaning any stale ASM disks... Scanning system for ASM disks... DATA\_01 FRA\_01 MGMT\_DATA01 [root@oracle19c-ol8-vvol-qavm ~]#



2. We can use Pure Plugin **Overwrite Disk** to overwrite the older version of database **vvol19c** VMDKs on QA VM **Oracle19c-OL8-QAVM** from current production database vvol19c VMDKs running on production VM **Oracle19c-OL8-VVOL**.

Take VMDK-level snapshots for DATA\_DG and FRA\_DG VMDKs on production VM **Oracle19c-OL8-VVOL** as shown below:



#### FIGURE 90. DATA\_DG VMDK-LEVEL SNAPSHOT

🚯 Oracle19c-Ol	L8-VVOL   🕨 🗖	actions 🗸				
Summary Monitor	Configure Permis	sions Datastores Networks	Snapshots Updates	Create Snapshot		×
Settings V VM SDRS Rules VApp Options	Virtual Volume			Create a snapshot of the virt	tual volume 'Hard disk 5 - SCSI (3:0)'	
Alarm Definitions	I IMPORT DISK	A RESTORE DELETED DISK + CREA	TE SNAPSHOT	Suffix	vmdkSnap-2020-12-29	
Scheduled Tasks	Name	1 T Virtual Device	T Size T		<u> </u>	
VMware EVC	O Hard disk 1	SCSI (9:0)	80.0 GB			20c34be7
Guest User Mappings	Hard disk 2	SCSI (0:1)	80.0 GB			c552b187
Pure Storage 🛛 🗸	O Hard disk 3	SCSI (1:0)	100.0 GB			57b48797
Virtual Volumes	Hard disk 4	SCSI (2:0)	1.0 TB			03decfb2
	• Hard disk 5	SCSI (3:0)	250.0 GB			efe1c0b0
	UM home		4.0 GB			3-950dc3ea
					CANCEL	EATE

FIGURE 91. FRA\_DG VMDK-LEVEL SNAPSHOT

VMDK snapshots can be viewed by logging into the Pure Storage GUI.

0	PURESTORAGE" •	Storage							Q, Search	4	. 🗵
٩	Dashboard	Array Hosts Volumes Protection Groups Pods									
۲	Storage	Volumes > wol-Oracle19c-OL8-VVOL-0b4146e3-vg									3
۹	Analysis	Size         Data Reduction         Volumes         Snapshots         Shared         System         Total           1666.G         36.7 to 1         98.45 M         0.00         -         -         -									
		Volumes	Space G	205 Details	1-7 of 7	<> +	•	Volume Snapshots	General Transfer	1-2 of 2 < →	
		Name	Size	Volumes 5	inapshots	Reduction		Namo	Created Snapsho	ots	
€		Config 950dc3es	4 G	3.93 M	0.00	4.1 to 1	1	6 <sup>1</sup> vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-ete1c0b0vmdkSnsp-2020-12-29	2020-12-30 13:35:54 0.0	00	1
\$		C wol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-03decfb2	1 T	2.14 M	0.00	38.6 to 1	1	2 wol-Oraclet9c-OL8-VVOL-0b4M6e3-vg/Data-03decfb2.vmdkSnap-2020-12-29	2020-12-30 13:35:43 0.0	00	:
		C wol-Oracle19c-0L8-VV0L-0b4146e3-vg/Data-20c34be7	80 G	31.58 M	0.00	31.2 to 1	:	Destroyed (0) v			
Helo		C wol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data 57b48797	100 G	8.21 K	0.00	38.7 to 1	:				
End U		C Wol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data<552b187	80 G	60.75 M	0.00	36.9 to 1	÷				
Terms Log C		C wol-Oraclet9c-DL8-VVOL-0b4446e3-vg/Data-etetc0b0	250 G	37.46 K	0.00	38.8 to 1	:				
		C wol-Oracle19:-OL8-VVOL-0b4146e3-vg/Swap-5c283b5b	128 G	0.00	0.00	1.0 to 1	:				
		Destroyed (0) ~									
		Details									
		GoS EZ Bandwidth Limit -									



3. On VM Oracle19c-OL8-QAVM, using the Pure Plugin, click on the DATA\_DG VMDK (1TB), Choose Overwrite Disk and overwrite the current DATA\_DG ASM disk from contents of the production VM Oracle19c-OL8\_VVOL.



FIGURE 93. DISK OVERWRITE USING PURE STORAGE PLUGIN

# **vm**ware<sup>®</sup>

On VM **Oracle19c-OL8-QAVM**, using the Pure Plugin, click on the FRA\_DG VMDK (250GB), Choose **Overwrite Disk** overwrite the current FRA\_DG ASM disk from contents of the production VM **Oracle19c-OL8\_VVOL**.



FIGURE 94. DISK OVERWRITE USING PURE STORAGE PLUGIN

VM Oracle19c-OL8-QAVM DATA\_DG ASM disk and FRA\_DG ASM disk have now been refreshed from production VM Oracle19c-OL8-VVOL.

4. Delete the snapshot taken of the VMDKs from the Pure Storage GUI as shown below:

PURESTORAGE"	Storage							O, Search		
	Array Hosts Volumes Protection Groups Pods									
Storage	Yolumes > wol-Oracle19c-OL8-VVOL-0b4146e3-vg							1		
	Size         Data Reduction         Volumes         Snapshots         Shared         System         Total           1666.6         36.8101         9723.M         0.00         -         -         -									
	Volumes	Space	GoS Deta	15 17 of 7	<ul> <li>→</li> </ul>	+ 1	Volume Snapshots	General Transfer 12 of 2 <>		
	Namo	Size	Volumes	Snapshots	Reduction		Norme	Created T Six Destroy		
	wol-OracleNic-OLB-VVOL-064M463 vg/Data-03dectb2	17	2.11 M	1009.59 K	38.7 to 1	1	J wei Oraclet9c OL8-WOL-0b4146e3 vg/Data-efetc0b0.vmdk5nap-2020-12-29	2020-12-30 11:43:5 956.00 8		
	work-Oraclettic OLB VVOL-0644663 vg/Data-efetc060	250 G	37.46 K	956.00 B	38.9 to 1	1	of wei Oraclet9c OL8-WOL-0b4H6e3-vg/Data-03dectb2xmdK5nap 2020-12-29	2020-13-00 TE41:10 1009.59 K		
	wei-Oracletto-OL8-VVOL-064446e3-vg/Swap-5c283b5b	128 G	0.00	0.00	1.0 to 1		Destroyed (0) ~			
	wei-Oraclettic-OL8-VVOL-0b4446e3-vg/Data 57b48797	100 G	8.21 K	0.00	38.8 to 1	:	Destroy Snapshots			×
	wei-Oraclettic OL8 VVOL-064446e3 vg/Data-20c34be7	80 G	31.57 M	0.00	31.3 to 1	:				
	www.oracletisc.OL8.VVOL-064446e3 vg/Data c552b187	80 G	60.08 M	0.00	37.0 to 1	:	Existing Snapshots	Selected Snapshots		
	wol-Oracletisc OL8 VVOL-0x4446e3 vg/Config 950dc3ea	46	3.93 M	0.00	4.110.1	1	▼ 1-2 of 2 < >	2 selected		Clear all
	Destroyed (0) ~									
	Details						Vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-0 1009.59 K	wol-Oracle19c-OL8-VVOL-0b4146e3-w	J/Data-03de	1009.59 K ×
	QoS IZ						vvol-Oracle19c-OL8-VVOL-0b4146e3-vg/Data-e 956.00 B	vvol-Oracle19c-OL8-VVOL-0b4146e3-v	g/Data-efe1c	956.00 B 🗙
	Bandwidth Limit - IOPS Limit -									
									Cancel	Destroy





#### 5. On QA VM Oracle19c-OL8-QAVM, scan for ASM disks using the Oracle oracleasm command.

[root@oracle19c-ol8-vvol-qavm ~]# oracleasm scandisks ; oracleasm listdisks Reloading disk partitions: done Cleaning any stale ASM disks... Scanning system for ASM disks... Instantiating disk "DATA\_01" Instantiating disk "FRA\_01" DATA\_01 FRA\_01 MGMT\_DATA01 [root@oracle19c-ol8-vvol-qavm ~]#

#### Mount the new disk groups +DATA\_DG and +FRA\_DG.

grid@oracle19c-ol8-vvol-qavm:+ASM:/home/grid> asmcmd mount DATA\_DG grid@oracle19c-ol8-vvol-qavm:+ASM:/home/grid> asmcmd mount FRA\_DG

grid@oracle19c-ol8-vvol-qavm:+ASM:/home/grid> asmcmd lsdg

State	Туре	Rebal	Sector	Logical_Sector	Block	AU Total_MB	Free_MB	Req_mir_free_MB	Usable_file_MB	Offline_disks	Voting_files	Name
MOUNTED EXTERN	Ν	512	512	4096	1048576	1048575	1036823	0	1036823	0	Ν	DATA_DG/
MOUNTED EXTERN	Ν	512	512	4096	1048576	255999	253526	0	253526	0	Ν	FRA_DG/
MOUNTED EXTERN	Ν	512	512	4096	4194304	102396	102296	0	102296	0	Ν	MGMT_DATA/

grid@oracle19c-ol8-vvol-qavm:+ASM:/home/grid>

#### 6. On the QA VM Oracle19c-OL8-QAVM, start up the database vvol19c.

Make appropriate changes to the database vvol19c init.ora file for memory and file directory setings.

#### Copy the orapwvvol19c file from production VM Oracle19c-OL8 VVOL to QA VM Oracle19c-OL8-QAVM.

oracle@oracle19c-ol8-vvol-qavm:vvol19c:/home/oracle> export ORACLE\_SID=vvol19c

oracle@oracle19c-ol8-vvol-qavm:vvol19c:/home/oracle> sqlplus / as sysdba SQL\*Plus: Release 19.0.0.0.0 - Production on Wed Dec 30 12:11:44 2020 Version 19.8.0.0.0

Copyright (c) 1982, 2020, Oracle. All rights reserved.

Connected to an idle instance.

SQL> startup pfile=/u01/app/oracle/product/19.0.0/dbhome\_1/dbs/initvvol19c.ora ORACLE instance started. Total System Global Area 3.4360E+10 bytes Fixed Size 12697696 bytes 3892314112 bytes Variable Size Database Buffers 3.0400E+10 bytes Redo Buffers 54407168 bytes Database mounted. Database opened. SQL> Disconnected from Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 - Production Version 19.8.0.0.0 oracle@oracle19c-ol8-vvol-gavm:vvol19c:/home/oracle>



- 7. We can now change the database name and/or database ID using Oracle MySupport Note *How to Change the DBID, DBNAME Using NID Utility (Doc ID 863800.1).*
- 8. The new database is now ready for a variety of database purposes (e.g., testing a new version of the software code, testing database patching)

# Oracle RAC

A 2-node Oracle RAC vvolrac with RAC VMs vvolrac1 and vvolrac2 is used in the RAC cloning use case example.

The steps to take a consistent storage vVol-based snapshot **vvolrac-DBSnap** for shared VMDKs from Pure GUI are the same as described in the above database cloning of Oracle RAC section.

In this case, use Pure Plugin **Overwrite Disk** on VM **Oracle19c-OL8-QAVM** and overwrite existing database VMDKs from the storage vVol-based snapshot **vvolrac-DBSnap**.

Settings VM SDRS Rules VM SDRS Rules vApp Options	외 IMPORT DISK 스 REST	ORE DELETED DISK GOVE	RWRITE DISK		Overwrite Virtual Volum		×		
cheduled Tasks	Name	T Virtual Device	T Size	τ ι	This operation will overwrite the conte	nt of Hard disk 4 - 1.0	TB. This disk	$\times$	
Mware EVC	Hard disk 1	SC81 (0:0)	80.0 GB	c	ab2dff46-vg/Data-2136b9bc'	-01306190-018-4400	- C8/14/ V IVI -		46-vg/Data-18d58
uest User Mappings	Hard disk 2	SCSI (0:1)	80.0 GB	¢	Select a source disk:		Filter	Q	46-vg/Data-e304
Virtual Volumes	Hard disk 3	SCSI (1:0)	100.0 GB	¢	> E vels			•	46-vg/Data-4fa12
virtual volumes	<ul> <li>Hard disk 4</li> </ul>	SCSI (2:0)	1.0 TB		✓ ☐ Oracle(Reserved)				46-vg/Data-2136b
					> 🗟 Oracle19c-OL8-VVOL				
					> 🗗 vvolrac2				
					Hard disk 1				
					Hard disk 2				
					V 🖂 Haroudisk 3				
					D vvol-vvolrac1-ba	fa6fb0-vg/Data-839di	a6af.vvolrac-DBSnap		
					> 🗗 Clone-vvolrac2			*	
					Volume Information:	$\sim$			
					Volume Name: vvol-vvolrac1-bafa6fb0 vg/Data-839da6af	- Arrays	Pure-X50-BCA		
					Disk File: vvolrac1_2.vmdk	Created:	Tuesday, February 9, 2021 12:39:59 PM -0800		

FIGURE 96. PURE PLUGIN – OVERWRITE DISK (VM ORACLE19C-OL8-QAVM)

For example, we have another RAC 19c cluster rac19c with 2 RAC nodes rac19c1 and rac19c2.

Another requirement could be to refresh the contents of an existing RAC database in another RAC cluster rac19c from the current RAC database vvolrac.

Use the Pure Plugin **Overwrite Disk** to overwrite an RAC database in RAC cluster **rac19c** with the contents of the **vvolrac** database. Shuting down the target RAC database before it's refreshed is recommended.





FIGURE 97. PURE PLUGIN - OVERWRITE DISK (RAC VM RAC19C1)

#### **Oracle Database Patching**

This section validates the Database patching using VMware snapshots use case of an Oracle Single-instance and Oracle RAC on vVols using Pure x50 Storage:

#### Oracle Single Instance Database

Two VMs are utilized for this use case:

- Production VM Oracle19c-OL8-VVOL
- QA VM Oracle19c-OL8-VVOL-QAVM

For Oracle DBAs patching databases can be a tedious and time-consuming process. As explained earlier, however, it's important that these patches are safely applied.

Two approaches also explained earlier in this paper are available:

- Clone a copy of the production database vvol19c from production VM Oracle19c-OL8-VVOL to QA VM Oracle19c-OL8-QAVM, using the steps explained in the Oracle Database Cloning section.
- Refresh a copy of the production database vvol19c from production VM Oracle19c-OL8-VVOL to QA VM Oracle19c-OL8-QAVM using the steps explained in the Oracle Database Refresh section.

The patching procedures can then be tested on the target VM before being implemented on the Production VM.

It's recommended to take a VM-level snapshot of the production VM before starting the patching process. In the event of any patching related issues, the database can be simply shut down down before restoring the older version of the VMDKs from the VM-level snapshot using **Overwrite Disk** in the Pure Plugin.



## Oracle RAC

A 2-node Oracle RAC vvolrac with RAC VMs vvolrac1 and vvolrac2 is used in the RAC patching use case example.

Before starting the patch, it's recommended to take a snapshot of the Oracle RAC VM along with a storage-based snapshot for shared VMDKs.

In the event of any patching-related issues, the database can be simply shutdown down before restoring from the VMware snapshot, then using Pure Plugin **Overwrite Disk** to restore from the storage vVol snapshot **vvolrac-DBSnap** of the RAC database **vvolrac**.

# VM Provisioning Using vVols SPBM

This section validates the VM provisioning using vVols SPBM for both an Oracle Single-instance and Oracle RAC on vVols using Pure x50 Storage:

Production VM Oracle19c-OL8-VVOL is utilized in this use case.

We can assign a VM storage policy in an initial deployment of a VM or when we perform other VM operations, such as cloning or migrating. This use case examines how to assign the VM storage policy when cloning a VM using vVols SPBM.

The same storage policy can be applied to the VM virtual disks and, if needed, different storage policies can be associated with different VMDKs.

The steps for cloning a VM from production VM Oracle19c-OL8-VVOL using vVols SPBM are shown below:

1. Production VM Oracle19c-OL8-VVOL currently uses the VM storage policy VVol No Requirements Policy.

🔓 Oracle19c-OL8-VV	'OL   🕨 🗖	🔮 🤯 🔯 actions 🗸					
Summary Monitor Config	gure Permiss	ions Datastores Networks S	Snapshots	Updates			
M The second	Guest OS: Compatibility: VMware Tools:	Oracle Linux 8 (64-bit) ESXi 7.0 and later (VM version 17) Running, version:11296 (Guest Managed) MORE INFO					
📲 Powered On	DNS Name: IP Addresses: Host:	oracle19c-ol8-vvol.corp.localdomain 10.128.140.102 10.128.136.128					
LAUNCH WEB CONSOLE	Δ 🗔						
VM Hardware					~	Notes	
Related Objects					~	Custom Attributes	
Tags					~	VM Storage Policies	
					Ć	VM Storage Policies	👔 VVol No Requirements Policy
					<b>`</b>	VM Storage Policy Compliance	✓ Compliant
						Last Checked Date	12/30/2020, 1:07:23 PM
						VM Replication Groups	
						Check VM Storage Policy Compliance	

FIGURE 98. vVOL NO REQUIREMENTS POLICY



### 2. Clone a VM TestClone from production VM Oracle19c-OL8-VVOL using vVols SPBM.

Choosing VM Storage Policy as FlashArray automatically shows datastores which are compatible and incompatible with this storage policy. This saves VM admins a considerable amount of time in choosing the correct datastore based on the storage characteristics needed.

# Oracle19c-OL8-VVOL - Clone Existing Virtual Machine

1 Select a name and folder	Select storage											
2 Select a compute resource	Select the storage for the configuration and disk files											
3 Select storage						Config						
4 Select clone options	Select virtual disk format:											
5 Ready to complete	Select witten disk format.											
	VM Storage Policy:				FlashArray		~					
	Name	Capacity	Provisioned	Free	Туре	Cluster						
	Storage Compatibility: Compatible											
	TSA-Pure-VVOL-SC-DS	8 PB	9.55 TB	8 PB	vVol							
	<ul> <li>Storage Compatibility: Incompatible</li> </ul>	e										
	MGMT-TNTR_1TB-Thin-P	190.94 TB	42.14 TB	148.9 TB	NFS v3							
	Template-TNTR_ISOs-1T	190.94 TB	42.05 TB	148.9 TB	NFS v3							
	TSA_PURE_FLASH_4TB	4 TB	2.4 TB	2.21 TB	VMFS 6							
	TSA_TNTR_Auto_5TB_01	190.94 TB	42.04 TB	148.9 TB	NFS v3							
	TSA_TNTR_Auto_5TB	190.94 TB	42.04 TB	148.9 TB	NFS v3							
	TSA_TNTR_Cap_10TB_01	190.94 TB	42.04 TB	148.9 TB	NFS v3							
	TSA_TNTR_Cap_10TB	190.94 TB	42.04 TB	148.9 TB	NFS v3							
	TSA_TNTR_Mgmt	190.94 TB	42.06 TB	148.9 TB	NFS v3							
	TEA THITD MC	190 94 TR	42 04 TR	148 9 TR	NES V2							
				,								
	Compatibility											
	L						]					
					c	ANCEL						

FIGURE 99. CLONING A VM

Follow the remaining steps as indicated to complete cloning of the VM.

# Conclusion

Business-critical databases are among the last workloads to be virtualized in most enterprises, primarily because of the challenges posed as workloads grow and scale. In a typical virtualization project, once a proof of concept (POC) is successfully run, development, testing and staging databases come relatively easy, leaving production databases as the final hurdle to overcome.

Meeting strict business SLAs for performance, managing rapidly growing production databases, and simultaneously reducing backup windows and their impact on system performance often force DBAs to delay virtualization of business-critical databases and workloads. Frequent demands for database cloning and refreshing further complicate matters.

VMware Virtual Volumes addresses the challenges of day-to-day operations, including backup and recovery, cloning, and database provisioning.

vVols is an integration and management framework that virtualizes SAN/NAS arrays, enabling a more efficient operational model that is optimized for virtualized environments and centered on the application instead of the infrastructure.

This solution validated the following Day 2 operations of both Oracle Single Instance and RAC database on vVols using Pure Storage FlashArray//x50.

- Database backup using vVol-based snapshots and Oracle RMAN
- Database restore and recovery vVol-based snapshots and Oracle mechanism
- Database cloning using vVol-based snapshots
- Database refresh using vVol-based snapshots
- Database patching using vVol-based snapshots
- VM provisioning and cloning using vVols SPBM

# Appendix A Oracle Initialization Parameter Configuration

# **Oracle Initialization Parameters**

- \*.audit\_file\_dest='/u01/admin/vvol19c/adump'
- \*.audit\_trail='db'
- \*.audit\_sys\_operations=TRUE
- \*.awr\_pdb\_autoflush\_enabled=TRUE
- \*.compatible=12.1.0.0.0
- \*.control\_files='+DATA\_DG/vvol19c/control01.ctl','+DATA\_DG/vvol19c/control02.ctl','+DATA\_DG/vvol19c/control03.ctl'
- \*.db\_block\_size=8192
- \*.db\_domain=''
- \*.db\_name='vvol19c'
- \*.db\_create\_file\_dest='+DATA\_DG'
- \*.db\_cache\_advice='ON'
- \*.db\_recovery\_file\_dest='+FRA\_DG'
- \*.db\_recovery\_file\_dest\_size=100G
- \*.diagnostic\_dest='/u01/admin/vvol19c'
- \*.enable\_pluggable\_database=true
- \*.instance\_number=1
- \*.instance\_name='vvol19c'
- \*.log\_archive\_format='%t\_%s\_%r.dbf'
- \*.open\_cursors=1000
- \*.processes=2000
- \*.parallel\_instance\_group='vvol19c'
- \*.parallel\_max\_servers=100
- \*.pga\_aggregate\_target=256M
- \*.pga\_aggregate\_limit=6G
- \*.pre\_page\_sga=TRUE
- \*.remote\_login\_passwordfile='exclusive'
- \*.resource\_manager\_plan=''
- \*.result\_cache\_max\_size=4M
- \*.sga\_max\_size=96G
- \*.sga\_target=96G
- \*.thread=1
- \*.undo\_tablespace='UNDOTBS01'
- \*.use\_large\_pages='only'



# Reference

### White Paper

For additional information, see the following white papers:

- VMware Hybrid Cloud Best Practices Guide for Oracle Workloads
- Enabling or disabling simultaneous write protection provided by VMFS using the multi-writer flag (1034165)
- Oracle VMware Hybrid Cloud High Availability Guide
- What's New in Virtual Volumes (vVols) 2.0

# Product Documentation

For additional information, see the following product documentation:

- Oracle 19c Database Online Documentation
- VMware Virtual Volumes (vVols)
- vVols collateral: Demos, Getting Started, FAQs, etc. on Core.vmware.com/vVols
- vSphere Plugin User Guide: Installing the vSphere Plugin

# Other Documentation

For additional information, see the following document:

VMware Solutions Lab

# Acknowledgements

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