

VersaStack Solution by Cisco and IBM with Oracle RAC, IBM FlashSystem V9000, and IBM Spectrum Protect

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International Technical Support Organization

VersaStack Solution by Cisco and IBM with Oracle RAC, IBM FlashSystem V9000, and IBM Spectrum Protect

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Note: Before using this information and the product it supports, read the information in "Notices" on page vii.

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This edition applies to the software and hardware described in Chapter 3, "Software configuration and revision guidelines" on page 25.

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Preface

Dynamic organizations want to accelerate growth while reducing costs. To do so, they must speed the deployment of business applications and adapt quickly to any changes in priorities. Organizations today require an IT infrastructure that is easy, efficient, and versatile.

The VersaStack solution by Cisco and IBM® can help you accelerate the deployment of your data centers. It reduces costs by more efficiently managing information and resources while maintaining your ability to adapt to business change.

The VersaStack solution combines the innovation of Cisco UCS Integrated Infrastructure with the efficiency of the IBM Storwize® storage system. The Cisco UCS Integrated Infrastructure includes the Cisco Unified Computing System (Cisco UCS), Cisco Nexus and Cisco MDS switches, and Cisco UCS Director. The IBM FlashSystem® V9000 enhances virtual environments with its Data Virtualization, IBM Real-time Compression[™], and IBM Easy Tier® features. These features deliver extraordinary levels of performance and efficiency.

The VersaStack solution is Cisco Application Centric Infrastructure (ACI) ready. Your IT team can build, deploy, secure, and maintain applications through a more agile framework. Cisco Intercloud Fabric capabilities help enable the creation of open and highly secure solutions for the hybrid cloud. These solutions accelerate your IT transformation while delivering dramatic improvements in operational efficiency and simplicity.

Cisco and IBM are global leaders in the IT industry. The VersaStack solution gives you the opportunity to take advantage of integrated infrastructure solutions that are targeted at enterprise applications, analytics, and cloud solutions.

The VersaStack solution is backed by Cisco Validated Designs (CVD) to provide faster delivery of applications, greater IT efficiency, and less risk.

This IBM Redbooks® publication is aimed at experienced storage administrators who are tasked with deploying a VersaStack solution with Oracle Real Application Clusters (RAC) and IBM Spectrum[™] Protect.

Authors

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Introduction

IBM and Cisco have a long history of working together to deliver technology that benefits our mutual clients. Expanding on this success, IBM and Cisco have jointly developed VersaStack, an innovative validated design that brings together IBM Storwize, IBM FlashSystem, and Cisco Unified Computing System (UCS) integrated infrastructure, allowing business partners and customers to create solutions that transform their business and reduce risk.

This collaboration incorporates IBM Storwize and IBM FlashSystem storage into the single pane of glass management environment that is provided by Cisco UCS Director. Future capabilities will deliver Application Centric Infrastructure (ACI) and Intercloud Fabric from Cisco and use within the IBM Cloud Builder Professional Services offering from IBM Global Services.

VersaStack will be backed by a series of Cisco Validated Designs (CVD) and IBM Redbooks developed in conjunction by Cisco and IBM. These materials will provide faster delivery of applications, and greater reliability and confidence for customers and business partners.

This chapter includes the following sections:

- ► Easy, efficient, and versatile
- Evolving data center requirements
- ► Holistic approach
- ► Hardware options
- Related information

1.1 Easy, efficient, and versatile

In today's environment, quick deployment and execution of business applications plus the versatility to adapt as business priorities change are essential for dynamic organizations that want to accelerate business growth while reducing costs. Organizations today require an IT infrastructure that is easy, efficient, and versatile. The VersaStack solution by Cisco and IBM helps accelerate data center infrastructure deployment, efficiently manage information and resources, and adapt to business change.

VersaStack includes technologies that complement and enhance virtual environments with built-in functions such as IBM Data Virtualization, Real-time Compression, and Easy Tier that deliver extraordinary levels of performance and efficiency.

Alternatively (and outside the intended scope of this book) for clients who require the combined capabilities to support block and file data, the IBM Storwize V7000 Unified storage product is also offered in VersaStack. This validated design also includes the performance and innovation of Cisco UCS integrated infrastructure, which includes the Cisco UCS, Cisco Nexus and Cisco MDS 9000 Family switches, and Cisco UCS Director, with the performance and efficiency of the IBM FlashSystem storage system.

VersaStack is backed by Cisco Validated Designs for faster delivery of applications and increased IT efficiency with less risk. VersaStack is supported by a broad range of services from IBM Business Partners and IBM Global Services.

VersaStack is also ready for Cisco ACI, enhancing business agility by allowing IT to build, deploy, secure, and maintain applications through a more agile framework. This capability, combined with Cisco Intercloud Fabric, can enable the creation of open and secure hybrid cloud-ready solutions that accelerate IT agility while delivering dramatic improvements in deployment, operation efficiency, and simplicity.

1.2 Evolving data center requirements

As anyone that has been around this industry knows, the data center industry is always evolving, and current trends make evolution more critical than ever. The data center has moved far beyond a simple repository for digital records, and way beyond just a vehicle for backup and restore.

Increasingly, its compute, storage, and networking facilities are being used to power complex analytical operations that are becoming essential for competitive advantage and business agility.

This trend is exemplified by the growth in demand for big data applications, and the Internet of Things. These applications involve data sets so large and complex that they cannot easily be processed using traditional computing tools.

Two other trends are making it easier to provision data center resources:

- Cloud computing, in which computing and storage assets are managed and allocated from a shared pool rather than from application-based silos, is rapidly becoming the standard for data center resource deployment.
- The advent of virtualization and software-defined networking (SDN), in which management is abstracted from lower-level functions, promises to make it easier than ever to allocate resources.

These trends are related because the scalability of big data and the simplicity implied by SDN help organizations manage the increased compute requirements of big data. And underpinning these trends are changes in hardware. Vendors are adapting specific data center components to address cloud, SDN, and big data requirements. IBM, for example, has changed its Storwize family of virtualized storage technologies specifically for software-defined environments.

Cisco, meanwhile, developed Cisco ACI to accelerate the configuration of infrastructure to match the needs of applications, and Cisco Intercloud Fabric technology to make it easier to move workloads between different cloud models.

Another significant development is the emergence of integrated infrastructure solutions for the data center. Previously, data center teams purchased computing, storage, and network building blocks separately and assembled, configured, and tested the various technologies with the hope that everything would work together. With integrated infrastructure, servers, networking resources, storage systems, and management systems are combined into a predesigned, tested, and supported solution. This approach massively simplifies asset purchasing, deployment, and management.

1.3 Holistic approach

So, to be absolutely clear on one thing, this is not about just bolting hardware and software together. Both IBM and Cisco are fully aware of the requirements of the enterprise today. With that in mind, it makes perfect sense to streamline and consolidate the traditional infrastructure into a full stack solution that is a new way to management efficiency and enhanced productivity. IT professionals the world over trust IBM and Cisco products, and this partnership takes this trust to a new level.

The VersaStack solution by Cisco and IBM is optimized for those IT professionals.

1.4 Hardware options

IBM FlashSystem V9000 offers full integration and is a comprehensive all-flash enterprise storage solution. IBM FlashSystem V9000 delivers the full capabilities of IBM FlashCore[™] technology plus a rich set of storage virtualization features. It is optimized for flash storage with an upcoming release that will support a simple two-tier easy tier solution. IBM FlashSystem V9000 is ideal for migrating external storage into the new configuration and providing future flexibility.

FlashSystem V9000 uses a fully featured and scalable all-flash architecture that performs at up to 2.5 M IOPS with IBM MicroLatency®, is scalable to 19.2 GBps, and delivers up to 2.28 PB effective capacity. Leveraging its Flash-optimized design, IBM FlashSystem V9000 can provide response times of 200 microseconds. It delivers better acquisition costs than high-performance spinning disk for the same effective capacity while achieving five times the performance, making it ideal for environments that require extreme performance. For more information, see these websites:

http://www.ibm.com/systems/uk/storage/flash/v9000/ http://www.redbooks.ibm.com/abstracts/tips1281.html?Open

For customers who want to go outside the IBM FlashSystem V9000 solution, the FlashSystems 900 can go behind stand-alone SVC 2145-DH8 nodes, offering greater flexibility.

The IBM FlashSystem 900 can be added to a storage array and provide high performance and low latency to connected hosts, while taking advantage of the IBM storage management services. By using Spectrum Control, you can use advanced analytics to automatically tier I/O-intensive payloads to the FlashSystem.

The IBM FlashCore technology used in IBM FlashSystem 900 employs several new and patented mechanisms to achieve greater capacity and throughput. These mechanisms enable you to accelerate your mid-range storage solution by taking advantage of the extreme performance and low latency of the FlashSystem.

This option is also available with the existing Storwize V7000, and is as simple as adding the FlashSystem 900 to an existing pool.

For more information, see the following websites:

```
http://www.ibm.com/systems/storage/flash/
http://www.redbooks.ibm.com/abstracts/tips1261.html?Open
http://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/sg248271.html?Open
```

1.5 Related information

This section provides links to other material related to VersaStack that might be of interest:

VersaStack Solution - Cisco

http://www.cisco.com/c/en/us/solutions/data-center-virtualization/versastack-so lution-cisco-ibm/index.html

VersaStack Solution by Cisco and IBM

http://www.ibm.com/common/ssi/cgi-bin/ssialias?infotype=PM&subtype=SP&htmlfid=T SS03159USEN&appname=TAB_2_1_Appname

VersaStack Designs (links to PDF download page)

http://www.cisco.com/c/en/us/solutions/enterprise/data-center-designs-cloud-com
puting/versastack-designs.html

Video: New VersaStack Solution by Cisco and IBM

https://www.youtube.com/watch?v=HHtgEABDYts

- Video: High Level Business Value of VersaStack from IBM & CISCO
 - https://www.youtube.com/watch?v=EOW4ggyN99o
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- Video: IBM and Cisco VersaStack Flash Optimization and IBM EasyTIER https://www.youtube.com/watch?v=J7Rr13fEv0U
- Video: IBM and Cisco VersaStack Compression https://www.youtube.com/watch?v=xDbk4ddXzL0

- Video: Talking VersaStack with Your Customers https://www.youtube.com/watch?v=UHANwo51ie0
- Video: Client value of VersaStack https://www.youtube.com/watch?v=dvDG6UHMEuQ
- Video: Growth Opportunities with VersaStack Solution https://www.youtube.com/watch?v=h32TsA2smLk
- Video: Take 5 VersaStack by Cisco & IBM https://www.youtube.com/watch?v=18mKR0sKQ3o

2

Architecture

This chapter describes the features of the architecture that is implemented later in this book.

This chapter includes the following sections:

- Architecture features
- Environment overview
- ► IBM Spectrum Protect server deployment on Cisco UCS C3260

2.1 Architecture features

The Oracle database on VersaStack design combines a high availability Oracle-RAC cluster configuration running on VersaStack with IBM FlashSystem V9000, as shown in Figure 2-1.



Figure 2-1 Architecture diagram

Figure 2-1, illustrates a four node Oracle-RAC built on VersaStack components and the network connections for a configuration with an IBM FlashSystem V9000 storage system.

The VersaStack architecture is highly modular, and has sufficient architectural flexibility and design options to scale as required, providing investment protection. The platform can be scaled up (adding resources to existing VersaStack units) or out (adding more VersaStack units).

Specifically, this VersaStack is a defined set of hardware and software that serves as an integrated foundation for both virtualized and non-virtualized solutions. VersaStack All-Flash includes IBM FlashSystem V9000, Cisco networking, Cisco UCS, Cisco MDS Fibre Channel switches, and VMware vSphere software in a single package. The design is flexible enough that the networking, computing, and storage can fit in one data center rack or be deployed according to a customer's data center design. Port density enables the networking components to accommodate multiple configurations.

One benefit of the VersaStack architecture is the ability to meet any client's capacity or performance needs in a cost effective manner. The Converged Infrastructure system is capable of serving multiple protocols across a single interface, which allows for customer choice and investment protection because it is wire-once architecture.

This architecture references relevant criteria that pertain to resiliency, cost benefit, and ease of deployment of all components including IBM FlashSystem V9000 storage.

The architecture for this solution, which is shown in Figure 2-2, uses two sets of hardware resources:

- ► Common Infrastructure services on redundant and self-contained hardware
- VersaStack PoD with Oracle-RAC



Figure 2-2 Oracle-RAC built on VersaStack

Common infrastructure services such as Active Directory, DNS, DHCP, vCenter, Nexus 1000v virtual supervisor module (VSM), and UCS Performance Manager can be deployed on redundant and self-contained hardware in a Common Infrastructure Pod along with the VersaStack Pod. Because these services are integral to the deployment and operation of the platform, you need to adhere to preferred practices in their design and implementation. These practices include such features as high-availability, choosing the appropriate RAID setup, and considering performance and scalability because these services might need to be extended to multiple PoDs.At a client's site, depending on whether this is a new data center, there might not be a need to build this infrastructure from scratch.

Figure 2-2 illustrates Oracle-RAC built on VersaStack components and the network connections for a configuration with a IBM FlashSystem V9000 storage system.

The reference hardware configuration includes the following items:

- Two Cisco Nexus 9396 or 9372 switches.
- ► Two Cisco UCS 6248UP Fabric Interconnects.

- ► Two Cisco MDS 9148S Fibre Channel switches.
- Cisco UCS C3260 Server.
- Support for 32 Cisco UCS C-Series servers without any additional networking components.
- ► Support for eight Cisco UCS B-Series servers without any additional blade server chassis.
- Support for 160 Cisco UCS C-Series and B-Series servers by way of extra fabric extenders and blade server chassis.
- Two IBM FlashSystem V9000 control enclosures, and one FlashSystem V9000 Storage enclosure. Support for up to 12 flash modules of the same capacity within storage enclosures.

For server virtualization, the deployment includes VMware vSphere. Although this is the base design, each of the components can be scaled easily to support specific business requirements. For example, more (or different) servers or even blade chassis can be deployed to increase compute capacity, extra disk shelves can be deployed to improve I/O capability and throughput, and special hardware or software features can be added to introduce new features.

This book guides you through the low-level steps for deploying the base architecture. These procedures cover everything from physical cabling to network, compute, and storage device configurations, including Oracle-RAC deployment.

For more information about the design of VersaStack, see the Design guide at:

http://www.cisco.com/c/en/us/td/docs/unified_computing/ucs/UCS_CVDs/Versastack_vmw
6_flash_design.html

IBM Spectrum Protect[™] has been deployed on a Cisco UCS C3260 server, which has support for high capacity onboard storage that is used as backup repository in the solution. The Cisco UCS C3260 addresses the need for highly scalable computing with high-capacity local storage and is ideal for small to large-scale IT environments.

The IBM Spectrum Protect software embedded in Cisco UCS C3260 is simple to deploy and manage. Together, IBM and Cisco UCS C3260 create the perfect staging area for backups by reducing backup ingest bottlenecks and providing faster backups by using parallel processing.

The Cisco UCS C3260 offers these main benefits:

- Fully modular chassis
- Innovative airflow design for a compact 4RU, 31.8-inch-deep, industry-standard rack server
- Ease of upgradeability

Figure 2-3 shows the architecture.



Figure 2-3 Cisco UCS C3260 Architecture

In addition, IBM Spectrum Protect Backup and Replication provides these advantages:

- Advanced data protection and flexible recovery options for virtual machines, file servers, email, databases, enterprise resource planning (ERP) systems, mainframes, and desktops
- Application-aware and virtual machine optimized options enable customized data protection for critical workloads
- A single platform for virtual, physical, software- defined, and cloud backups
- Auto- discovery of new virtual backups helps ensure that all data in the virtualized environment is protected
- Application- consistent backup helps ensure complete application backups and simplifies restore processes
- Instant access/ instant restore reduces the user impact to nearly zero during virtual machine restores

IBM and Cisco offer the correct solution for performance, flexibility, and reliability, providing a highly efficient and cost effective data protection solution for your virtual and application environments on VersaStack.

Figure 2-4 illustrates a high-level overview of VersaStack All-Flash environment with integrated backup infrastructure.



Figure 2-4 VersaStack data protection with IBM Spectrum Protect on Cisco UCS C3260

The VM and application data from the VersaStack gets backed up to the IBM Spectrum Protect appliance that is deployed on Cisco UCS C3260 server. The Cisco UCS C-Series servers can be seamlessly integrated into the VersaStack environment by being connected to the Cisco 9k Nexus Unified Fabric, providing organizations with a built-in path to unified computing. The main benefits of the VersaStack integrated data protection solution are reduced TCO, improved IT agility and flexibility, investment protection, and future readiness.

IBM Spectrum Protect Snapshot, formerly IBM Tivoli® Storage FlashCopy® Manager, delivers high levels of protection for key applications and databases by using advanced integrated application snapshot backup and restore capabilities.

VersaStack data protection environment can be further optimized with IBM Spectrum Protect snapshot integration. It lets you perform and manage frequent, near-instant, nondisruptive, application-aware backups and restores using integrated application and VM-aware snapshot technologies in both IBM and non-IBM storage systems.

However, this document does not cover the implementation details of IBM Spectrum Protect Snapshot, but the customer's can chose this optional deployment for their data protection needs.

IBM Spectrum Protect Snapshot has these characteristics:

- Easy to install, configure, and deploy while supporting a wide range of applications, operating systems, and storage.
- Improves application availability and service levels through high-performance, near-instant restore capabilities that reduce downtime.
- Manages application-aware snapshots on VersaStack storage.
- Enables fast, simple recovery of individual files, volumes, and mailboxes.
- Allows "instant" restore for VMware datastores and simplifies database cloning.
- Enables off-site copying for enhanced data protection using either IBM Spectrum Protect (Tivoli Storage Manager) or IBM Metro Global Mirror.



Figure 2-5 illustrates IBM Spectrum Protect Snapshot in a VersaStack Environment.

Figure 2-5 VersaStack data protection with IBM Spectrum Protect Snapshot

2.2 Environment overview

This section details the IBM Spectrum Protect server components that are deployed in the example Oracle DB server on VersaStack environment.

IBM Spectrum Protect has these core components:

- Hardware:
 - Cisco UCS C3260 Server
- Software:
 - IBM Spectrum Protect backup server
 - Spectrum Operations Center
 - IBM Spectrum Protect Data Protection for Databases: Oracle

2.2.1 Cisco UCS C3260 Server

As described earlier, the C3260 is a modular, high-storage-density rack server for storage-driven and high availability use cases. The rack server offers the highest levels of drive density and availability.

The C3260 is a dual-node, high-density, bare-metal, x86-based enterprise storage server. Its features include the following:

- Enterprise-class redundancy with full featured Redundant Array of Independent Disks (RAID) plus just a bunch of disks (JBOD)
- Stand-alone management interface (Cisco Integrated Management Controller)
- No data migration required when replacing or upgrading server nodes
- No need for extended depth racks

The C3260 supports:

- Network File System (NFS)
- Internet Small Computer System Interface (iSCSI)
- Fibre Channel over Ethernet (FCoE)
- ► SMB
- SMB Direct

The following are the specifications at a glance:

- Supports up to 360 TB of modular storage capacity
- Optimized for high throughput performance, high capacity, and a small footprint
- Enterprise-class redundancy with full featured RAID plus JBOD
- Stand-alone management interface (Cisco Integrated Management Controller)
- ► Up to 512 GB of memory per server node
- Up to 62 drive bays
- Up to 4 GB of RAID cache

The UCS C3260 server can be customized based on the initial and predicted growth of the protected data on a VersaStack. Also, the performance and capacity needs of IBM Spectrum Protect can be met with the varying drive options supported on the C3260.

For more information about IBM Spectrum Protect scale points and sizing guidelines, see the blueprints at the following URL:

https://ibm.biz/BdHc6b

2.3 IBM Spectrum Protect server deployment on Cisco UCS C3260

This section describes the Cisco UCS C3260 server deployment. Note that this does not cover specific customer needs and is a generic deployment with suggestations. See the UCS C-Series and IBM Spectrum Protect deployment documents for more information and best practices:

http://www.cisco.com/c/en/us/support/servers-unified-computing/ucs-c3260-rack-serv
er/model.html

2.3.1 Pre-installation Steps

Perform the following steps before starting the installation.

Connect Server to the Switches

The UCS C3260 Server supports two VIC cards and can be ideally connected to the Cisco Nexus Switches in the VersaStack as shown in Figure 2-6. Connect each port on the adapter to each of the Nexus 9k switches. This setup provides high availability during a switch failure. During this validation, we used one VIC card only within the server that was connected to both the Nexus Switches for high availability.

N9K - A N9K - B N9K - B Cisco VIC Adapter 1 Cisco VIC Adapter 2

Figure 2-6 shows the Nexus 9k switches to Cisco C3260 connectivity.

Figure 2-6 Nexus 9k switches to Cisco C3260 connectivity

Connect the Management IP Interface

Connect the keyboard, video, and mouse (KVM) dongle. Connect the CIMC management port to the Cisco Nexus 9000 Series Switch to access through InBand management network or to the dedicated management switch according to your specific VersaStack deployment. Set the management interface.

Upgrade to the Latest Firmware and Patches

Log in to http://software.cisco.com and navigate to Downloads Home \rightarrow Products \rightarrow Servers—Unified Computing \rightarrow UCS C-Series Rack-Mount Standalone Server Software \rightarrow UCS C3260 Rack Server Software. Upgrade to the latest and the suggested firmware.

Create Additional vNIC Interfaces

Log in to the Cisco Integrated Management Controller (IMC) user interface and open the Inventory tab under Server and Cisco VIC adapters. Add interfaces to adapter. The validation environment consisted of only one VLAN (11) that was used for management and backup connectivity. Two VLANs are suggested: One for the public network (VLAN 11), and one for the backup network (VLAN 3176).

Figure 2-7 shows adding vNICs on Adapter 1.

h / / Adapter (Card 1 /	vNICs	贪							Refres
General vNICs	VM FE	EXs v	HBAs							
▼ VNICs	Host	Etherne	t Interfaces							
eth1	A	dd vNIC	Clone vNIC	Delete vNICs						
eth3		Name	CDN	MAC Address	MTU	usNIC	Uplink Port	CoS	VLAN	VLAN Mode
eth4		eth0	VIC-1-eth0	00:F2:8B:E6:D0:2A	9000	0	0	0	3176	TRUNK
		eth1	VIC-1-eth1	00:F2:8B:E6:D0:2B	9000	0	1	0	3176	TRUNK
		eth3	VIC-1-eth3	00:F2:8B:E6:D0:2F	9000	0	0	0	11	TRUNK
		eth4	VIC-1-eth4	00:F2:8B:E6:D0:30	9000	0	1	0	11	TRUNK

Figure 2-7 Adding vNIC's on Adapter 1

The Cisco UCS C3260 IBM Spectrum Protect appliance is connected to the VersaStack environment by using the Cisco Virtual Interface Card (VIC) adapters on the server.

The server can connect at 40 Gbps to the switches if needed. In the lab environment, we connected the server at 10 Gbps speeds to the two upstream Nexus 9k switches that were part of VersaStack.

Configuring Interfaces and creating Virtual Port channel on the Nexus 9k switches

See the VersaStack V9000 CVD for detailed Nexus Configuration information and for the variables that need to be defined:

VLAN ID 3176 can be additionally defined for a backup network if a dedicated network is of interest to you.

Cisco Nexus 9000 A

Complete these steps to configure the Cisco Nexus 9000 A:

1. Define a description for the port-channel connecting to UCS C3260:

```
interface Po15
description Spectrum-Protect-PC
```

2. Make the port-channel a switchport, and configure a trunk to allow in-band management, NFS, VM traffic, and the native VLANs:

```
switchport
switchport mode trunk
switchport trunk native vlan <<var_native_vlan_id>>
switchport trunk allowed vlan <<var_ib-mgmt_vlan_id>>, <<var_backup_vlan_id>>
```

3. Make the port channel and associated interfaces spanning tree edge ports:

spanning-tree port type edge trunk

4. Set the MTU to 9216 to support jumbo frames:

mtu 9216

5. Make this a VPC port-channel and bring it online:

vpc 15 no shutdown

6. Define a port description for the interface that connects to UCS C3260, NIC1:

```
interface Eth1/47
description Spectrum-Protect-NIC1
```

7. Apply it to a port channel and open the interface:

```
channel-group 15 force mode active
no shutdown
copy run start
```

Cisco Nexus 9000 B

Complete these steps to configure the Cisco Nexus 9000 B:

1. Define a description for the port-channel connecting to UCS C3260:

```
interface Po15
description Spectrum-Protect-PC
```

2. Make the port-channel a switchport, and configure a trunk to allow in-band management, NFS, VM traffic, and the native VLANs:

```
switchport
switchport mode trunk
switchport trunk native vlan <<var_native_vlan_id>>
switchport trunk allowed vlan <<var ib-mgmt vlan id>>, <<var backup vlan id >>
```

3. Make the port channel and associated interfaces spanning tree edge ports:

spanning-tree port type edge trunk

Set the MTU to be 9216 to support jumbo frames:

mtu 9216

5. Make this a VPC port-channel and bring it up:

```
vpc 15
no shutdown
```

6. Define a port description for the interface connecting to UCS C3260 NIC2:

```
interface Eth1/47
description Spectrum-Protect-NIC2
```

7. Apply it to a port channel and open the interface:

```
channel-group 15 force mode active
no shutdown
copy run start
```

UCS C3260 Storage configuration using Cisco IMC

The Cisco UCS C3260 RAID controller supports various RAID configurations. The disk drives can be allocated to the operating system by configuring them using hardware RAID. The drives can also be presented in pass-through mode to the operating system optionally. This solution validation presents the drives to Red Hat OS in pass-through mode and did not create RAID groups.

In client production environments, create RAID groups for high availability and better performance. The RAID type and the drive capacity can be determined based on the IBM suggestation for IBM Spectrum Protect installation, and that in turn depends on protected environment size and specific customer requirements.

The following procedure details the configuration of RAID drives:

1. Open up a web browser and enter the IP for the Cisco IMC. You are directed to the login window where you can enter your credentials for access as shown in Figure 2-8.



Figure 2-8 Cisco Integrated Management Controller

2. After you are logged in, click the menu options in the upper left corner in Figure 2-9. Expand the **Storage** menu from the left side pane and select the controller.

😕 Cisco Integrated Manag	gement Controller		🐥 🔽 admin@192.168.159.138 - C3260-
) / (Server 1) RAID controller for Storage Servers (SLOT-MEZZ) / C	UCS C3X60 ontroller Info 🔺		Refresh Host Power Launch KVM Ping Reboot 👻 Lo
Controller Info Physical Drive Info Vin	tual Drive Info Battery Backup Unit	Storage Log	
Create Virtual Drive from Unused Physical Drives C	reate Virtual Drive from an Existing Virtual Drive	Group Import Foreign Config Clear Foreign Con	fig Clear Boot Drive Get TTY Log
✓ Health/Status		▼ Settings	
Composite Health:	Good Good	Predictive Fail Poll Interval:	300 sec
Controller Status:	Optimal	Rebuild Rate:	30 %
RAID Chip Temperature:	60	Patrol Read Rate:	30 %
TTY Log Status:	Not Downloaded	Consistency Check Rate:	30 %
- Firmware Versions		Reconstruction Rate:	30 %
		Cache Flush Interval:	4 sec
Product Name:	RAID controller for UCS C3X60 Storage	Max Drives To Spin Up At Once:	4
Serial Number:	FCH18457CC0	Delay Among Spinup Groups:	6 sec
Firmware Package Build:	24.9.1-0011	Physical Drive Coercion Mode:	1 GB
▼ PCI Info		Cluster Mode:	false
DOI SI-4		Battery Warning:	true
PCI Sidt:	SLUT-WEZZ	ECC Bucket Leak Rate:	1440 min
vendor iD:	1000	Expose Enclosure Devices:	true

Figure 2-9 Menu options

- Under the Physical Drive Info tab, select each drive individually and click Set State as Unconfigured Good. Repeat this for all physical drives available, then click the Controller Info tab.
- Click Create Virtual Drive from Unused Physical Drives and a configuration box opens (Figure 2-10). The selections made here result in a new virtual drive that is used as a IBM Spectrum Protect backup repository.

Create Virtu	ual Drive fr	om Unused Physical	Drives				0 ×
Raid Lev	0		•				
Create Di Physical	1 5 6		elected 0 / Tr	otal 3 🔅 🔹		Drive Groups Selected 0 / T	otal 0 🛛 🛱 👻
ID	50 60		nterface IDD	Type SAS		Name No data available	
55	572203 572203	1 MB SEAGA 1 MB SEAGA	HDD HDD	SAS SAS	~		
Virtual Di	rive Prope	rties					
	Name:	RAID0		D	isk Cache Policy:	Unchanged	•
Acc	ess Policy:	Read Write	•]	Write Policy:	Write Through	•
Re	ead Policy:	No Read Ahead	•]	Strip Size (MB):	64k	•
Cae	che Policy:	Direct IO	•		Size		MB 🔻

Figure 2-10 Create virtual drive

For more information about IBM Spectrum Protect scale points and sizing guidelines, see to the blueprints at the following URL:

https://ibm.biz/BdHc6b

Note: IBM DB2® as part of IBM Spectrum Protect installation has a limitation on disk sector sizes. DB2 only supports storage devices with a sector size of 512 bytes. The 6 TB drives supported in UCS C3260 have a sector size of 4096 bytes, so these drives are not supported for DB2 database in an IBM Spectrum Protect environment. Lower capacity drives need to be considered for DB2. SSDs provide the best performance and therefore accelerate backup and restore operations.

Install the operating system

Complete these steps to install the OS:

- Load the OS installation disk into your CD/DVD drive, or copy the disk image files to your computer.
- 2. If Cisco IMC is not open, log in.
- 3. In the Navigation pane, click the **Compute** menu.
- 4. In the Compute menu, click Server 1 or Server 2.
- 5. In the Server pane, click the Remote Management tab.
- 6. In the Remote Management pane, click the Virtual KVM tab.
- In the Actions area, click Launch KVM Console. The KVM Console opens in a separate window.
- 8. From the KVM console, click the VM tab.
- 9. In the VM tab, map the virtual media by using either of the following methods:
 - Select the Mapped check box for the CD/DVD drive containing the OS installation disk.
 - Click Add Image, navigate to and select the OS installation disk image, click Open to mount the disk image, and then select the Mapped check box for the mounted disk image.

You must keep the VM tab open during the OS installation process.

10. Reboot the server and select the virtual CD/DVD drive as the boot device.

When the server reboots, it begins the installation process from the virtual CD/DVD drive. See the installation guide for the Red Hat OS to guide you through the rest of the installation process at www.redhat.com.

Perform NIC Bonding

Log in to the server after Red Hat OS installation and create bond interfaces: bond0 for public and client traffic, and bond1 for the backup network. Separate backup network was not created for validation of the solution. However, generally have a separate backup network to segregate the production, application, and management traffic from the backup traffic.

Complete these steps to create NIC bonding by using the GUI:

- 1. Click Application and select the System Tools and Settings.
- 2. Double-click **Network** under the Hardware section.
- 3. Click the **plus** symbol to open the selection list. Select **Bond**. The Editing Bond connection 1 window opens.

- 4. On the Bond tab, click **Add** and select the type of interface you want to use with the bond connection. Click the **Create** button. Note that the dialog to select the slave type only comes up when you create the first slave. After that, it will automatically use that same type for all further slaves.
- 5. The Editing bond0 slave 1 window appears. Use the **Device MAC address** menu to select the MAC address of the interface to be bonded. The first slave's MAC address is used as the MAC address for the bond interface.
- 6. Select 802.3ad as the failover mode and leave all the other entries to default.
- 7. Click the Save button to add further slaves as shown in Figure 2-11.

E	diting Bond conne	ection 1
Connection name: Bon	d connection 1	
General Bond	IPv4 Set	tings IPv6 Settings
Interface name:	bond0	
Bonded connections:		
bond0 slave 1		Add
bondO slave 2		Edit
		Delete
Mode:	802.3ad	-
Link Monitoring:	MII (recommend	ed) 🔻
Monitoring frequency:	1	— + ms
Link up delay:	0	— + ms
Link down delay:	0	— + ms
MTU:	automatic	+ bytes
		Cancel Save

Figure 2-11 Editing Bond connection 1

8. Click the IPv4 Settings tab, select **Manual Method**, and assign the management IP address details of the server as shown in Figure 2-12.

Editing Bond connection 1									
Connection name: Bond connection 1									
General Bond IPv4 Settings IPv6 Settings									
Method:	Method: Manual								
Addresse	s								
Addres	5S	Netmask	Gateway	Add					
192.16	58.161.45	255.255.252.0	192.168.160.1	Delete					
DNS sei	rvers:								
Search	domains:								
DHCP c	lient ID:								
Require IPv4 addressing for this connection to complete									
				Routes					
			Cancel	Save					

Figure 2-12 Assigning the management IP address details
9. Repeat the above steps to create another bond interface if dedicated backup network is deployed as shown in Figure 2-13.

E	diting Bond c	onnecti	on 2		
Connection name: Bon	d connection 2	2			
General Bond	d IPv4	Setting	Is	IPv6 Settings	
Interface name:	bond1				
Bonded connections:					
bond1 slave 1				Add	
bond1 slave 2				Edit	
				Delete	
Mode:	802.3ad			•	
Link Monitoring:	MII (recomm	nended)		•	
Monitoring frequency:	1	-	+	ms	
Link up delay:	0	-	+	ms	
Link down delay:	0		+	ms	
MTU:	automatic	-	+	bytes	
			(Cancel Save	

Figure 2-13 Edit Bond Connection 2

Software configuration and revision guidelines

This chapter describes the software revisions and versions that are used, and the configuration that is deployed.

This chapter includes the following sections:

- Software revisions
- Configuration guidelines

3.1 Software revisions

Table 3-1 describes the software revisions that are used for validating various components of the Cisco Nexus 9000 based VersaStack architecture at the time of writing.

For the latest supported versions, see the following IBM and Cisco support matrix links:

IBM System Storage® Interoperability Center:

http://www.ibm.com/systems/support/storage/ssic/interoperability.wss

- Spectrum Control Interoperability Matrix: http://www.ibm.com/support/docview.wss?uid=swg21386446
- IBM Spectrum Protect Interoperability Matrix:

http://www.ibm.com/support/docview.wss?uid=swg21243309

FlashCopy Manager Interoperability Matrix:

http://www.ibm.com/support/docview.wss?uid=swg21829854

Cisco UCS Interoperability Matrix:

http://www.cisco.com/web/techdoc/ucs/interoperability/matrix/matrix.html

After the software versions are validated, it is necessary to validate the Cisco Drivers:

- To validate your ENIC version, run ethtool -i vmnic0 by using the command-line interface (CLI) of the ESX host.
- To validate your FNIC version, run vmkload_mod -s fnic by using the CLI of the ESX host.

Layer	Device	Version/Release	Details
Compute	Cisco UCS fabric interconnect 6248	3.1(1e))	Embedded management
	Cisco UCS 5108 Blade Server Chassis	N/A	Software runs on FI
	Cisco UCS B 200 M4	3.1(e) Software bundle release	
	Cisco ENIC	2.3.0.6	Ethernet driver for Cisco VIC
	Cisco FNIC	1.6.0.24	FCoE driver for Cisco VIC
Network	Cisco Nexus 9000 c9372PX	6.1(2)I3(5)	Operating system version
	Cisco MDS 9148S	6.2(13b)	FC switch firmware version
Storage	IBM FlashSystem V9000	7.6.1.4	Software version

Table 3-1 Software revisions

Layer	Device	Version/Release	Details
Software	Cisco UCS hosts	VMware vSphere ESXi 6.0u1	Operating system version
	Oracle	12.1.0.2	Built-in server for vCenter
	VMware vCenter	6.0 u1	Software version
	Linux Server	Red Hat Enterprise Linux Server v7.2	Operating system version
	IBM Spectrum Control™ (IBM SmartCloud® Virtual Storage Center)	5.2.6	Software version
	IBM Spectrum Protect	7.1.6	Software version

3.2 Configuration guidelines

This document provides details about configuring a fully redundant, highly available VersaStack unit with IBM FlashSystem V9000 storage. This process is covered by *VersaStack for Data Center with All-Flash Storage and VMware vSphere 6.0 Deployment Guide*, which is available here:

http://www.cisco.com/c/en/us/td/docs/unified_computing/ucs/UCS_CVDs/Versastack_vmw
6_flash.html

The Cisco UCS fabric Interconnects are similarly configured. Additionally, this document details the steps for provisioning multiple Cisco UCS hosts. These hosts are identified sequentially (vm-host-Oracle-01, vm-host-Oracle-02, and so on).

Finally, to indicate that you should include information pertinent to your environment in a step, <text> appears as part of the command structure.

The following example shows the network port vlan createcommand parameters:

network port vlan create ?

Where:

[-node] <nodename> Node
{ [-vlan-name] {<netport>|<ifgrp>} VLAN name
| -port {<netport>|<ifgrp>} Associated network port
[-vlan-id] <integer> } Network switch VLAN identifier

Example 3-1 shows an example of the command.

Example 3-1	Examp	le of the	e network po	ort command			
network por	rt vlan	-node	<node01></node01>	-vlan-name	iOa- <vlan< td=""><td>id></td><td></td></vlan<>	id>	

You can use this book to configure the VersaStack PoD in the environment. Various steps require you to insert customer-specific naming conventions, IP addresses, and VLAN schemes, and to record the appropriate MAC addresses.

Table 3-2 describes the VLANs that are necessary for deployment, as outlined in this book.

Table 3-2	Necessary VLANs	
-----------	-----------------	--

VLAN name	VLAN ID used in validating this document	Purpose
DevMgmt	11	All structure management in this VLAN
vMotion	3173	VMware vMotion traffic
InterConnect	3175	Oracle RAC heartbeat traffic

Table 3-3 lists the virtual machines (VMs) necessary for deployment, as outlined in this book.

Table 3-3 VMware virtual machine created

Virtual machine description	Quantity
Red Hat Enterprise Linux v7.2 x86-64 VM	4
vCenter Server	1

Table 3-4 lists the configuration variables that are used throughout this book. This table can be completed based on the specific site variables used in implementing the document configuration steps. These variables are referenced at various places within this book.

Table 3-4 Configuration variables

Variable	Description	Customer value
< <var_node01_mgmt_ip>></var_node01_mgmt_ip>	Out-of-band management IP for cluster node 01	
< <var_node01_mgmt_mask>></var_node01_mgmt_mask>	Out-of-band management network netmask	
< <var_node01_mgmt_gateway>></var_node01_mgmt_gateway>	Out-of-band management network default gateway	
< <var_node02_mgmt_ip>></var_node02_mgmt_ip>	Out-of-band management IP for cluster node 02	
< <var_node02_mgmt_mask>></var_node02_mgmt_mask>	Out-of-band management network netmask	
< <var_node02_mgmt_gateway>></var_node02_mgmt_gateway>	Out-of-band management network default gateway	
< <var_cluster_mgmt_ip>></var_cluster_mgmt_ip>	Out-of-band management IP for cluster	
< <var_cluster_mgmt_mask>></var_cluster_mgmt_mask>	Out-of-band management network netmask	
< <var_cluster_mgmt_gateway> ></var_cluster_mgmt_gateway>	Out-of-band management network default gateway	
< <var_password>></var_password>	Global default administrative password	
<var_dns_domain_name>></var_dns_domain_name>	DNS domain name	

Variable	Description	Customer value
< <var_nameserver_ip>></var_nameserver_ip>	DNS server IPs	
< <var_timezone>></var_timezone>	VersaStack time zone (for example, America/New_York)	
< <var_global_ntp_server_ip> ></var_global_ntp_server_ip>	NTP server IP address	
< <var_email_contact>></var_email_contact>	Administrator email address	
< <var_admin_phone>></var_admin_phone>	Local contact number for support	
< <var_mailhost_ip>></var_mailhost_ip>	Mail server host IP	
< <var_country_code>></var_country_code>	Two-letter country code	
< <var_state>></var_state>	State or province name	
< <var_city>></var_city>	City name	
< <var_org>></var_org>	Organization or company name	
< <var_unit>></var_unit>	Organizational unit name	
< <var_street_address>></var_street_address>	Street address for support information	
< <var_contact_name>></var_contact_name>	Name of contact for support	
< <var_admin>></var_admin>	Secondary admin account for storage login	
< <var_nexus_a_hostname>></var_nexus_a_hostname>	Cisco Nexus A host name	
< <var_nexus_a_mgmt0_ip>></var_nexus_a_mgmt0_ip>	Out-of-band Cisco Nexus A management IP address	
< <var_nexus_a_mgmt0_netmask >></var_nexus_a_mgmt0_netmask 	Out-of-band management network netmask	
< <var_nexus_a_mgmt0_gw>></var_nexus_a_mgmt0_gw>	Out-of-band management network default gateway	
< <var_nexus_b_hostname>></var_nexus_b_hostname>	Cisco Nexus B host name	
< <var_nexus_b_mgmt0_ip>></var_nexus_b_mgmt0_ip>	Out-of-band Cisco Nexus B management IP address	
< <var_nexus_b_mgmt0_netmask>></var_nexus_b_mgmt0_netmask>	Out-of-band management network netmask	
< <var_nexus_b_mgmt0_gw>></var_nexus_b_mgmt0_gw>	Out-of-band management network default gateway	
< <var_devmgmt_vlan_id>></var_devmgmt_vlan_id>	In-band management network VLAN ID	
< <var_vmotion_vlan_id>></var_vmotion_vlan_id>	VMware vMotionVLAN ID	
< <var_orarac_vlan_id>></var_orarac_vlan_id>	Oracle RAC heartbeat traffic	
< <var_backup_vlan_id>></var_backup_vlan_id>	Backup traffic for storage	

Variable	Description	Customer value
< <var_ucs_clustername>></var_ucs_clustername>	Cisco UCS Manager cluster host name	
< <var_ucsa_mgmt_ip>></var_ucsa_mgmt_ip>	Cisco UCS Fabric Interconnect (FI) out-of-band management IP address	
< <var_ucsa_mgmt_mask>></var_ucsa_mgmt_mask>	Out-of-band management network netmask	
< <var_ucsa_mgmt_gateway>></var_ucsa_mgmt_gateway>	Out-of-band management network default gateway	
< <var_ucs_cluster_ip>></var_ucs_cluster_ip>	Cisco UCS Manager cluster IP address	
< <var_ucsb_mgmt_ip>></var_ucsb_mgmt_ip>	Cisco UCS FI B out-of-band management IP address	
< <var_vsan_a_id>></var_vsan_a_id>	VSAN ID for Fabric A (101 is used)	
< <var_vsan_b_id>></var_vsan_b_id>	VSAN ID for Fabric B (102 is used)	
< <var_fabric_a_fcoe_vlan_id >></var_fabric_a_fcoe_vlan_id 	Fabric ID for Fabric A (101 is used)	
< <var_fabric_b_fcoe_vlan_id >></var_fabric_b_fcoe_vlan_id 	Fabric ID for Fabric B (102 is used)	
< <var_in-band_mgmtblock_net >></var_in-band_mgmtblock_net 	Block of IP addresses for KVM access for UCS	
< <var_vmhost_oracle_o1_ip>></var_vmhost_oracle_o1_ip>	VMware ESXi host 01 in-band management IP	
< <var_vmhost_oracle_o1_2nd_ ip>></var_vmhost_oracle_o1_2nd_ 	VMware ESXi host 01 secondary in-band management IP	
< <var_vmotion_vlan_id_ip_ho st-01>></var_vmotion_vlan_id_ip_ho 	vMotion VLAN IP address for ESXi host 01	
< <var_vmotion_vlan_id_mask_ host-01>></var_vmotion_vlan_id_mask_ 	vMotion VLAN netmask for ESXi host 01	
The last four variables should be repeated for all ESXi hosts.		

Example 3-2 shows the volumes that are mapped to VMware hosts from IBM FlashSystem V9000.

Example 3-2 Volumes mapped

```
IBM_FlashSystem:VersaStack:superuser>lshostvdiskmap 6
id name SCSI_id vdisk_id vdisk_name vdisk_UID
IO_group_id IO_group_name
6 VM-Host-Oracle-01 0 29 VM-Host-Oracle-01
600507680C81811388000000000021 0 io_grp0
```

ITSO repository io_grp0 ITSO Infra datastore1 io grp0 ITSO Infra datastore2 io grp0 ITSO_Infra_datastore3 io grp0 ITSO Infra datastore4 io grp0 ITSO_Oracle_redo_log io grp0 ITSO_OracleVM_boot_01 io grp0 ITSO Infra datastore5 io grp0 ITSO Infra datastore6 io_grp0 big_test io_grp0

4

Planning for Oracle Real Application Clusters

This chapter describes some of the considerations and assumptions that are followed during the design of the Oracle Real Application Clusters (RAC) installation on VersaStack.

This chapter includes the following sections:

- Design considerations
- Network and Storage Design

4.1 Design considerations

The goal of this section is to come up with a simple and efficient Oracle RAC database design that is suited for a VersaStack solution. The major design considerations of the suggested architecture are described in the following subsections. These assumptions are influenced by several factors, including the status of the technology and the specific business requirements that drive each specific solution.

The upcoming sections detail the design considerations from different layers of the architectural stack.

4.1.1 Database workload

The entire architecture is designed for an online transaction processing (OLTP) workload, which is characterized by small number of random I/Os. Log I/O is the most critical component, as it directly affects the transaction latency. Memory mitigates the I/O pressure on the storage system. However, beyond a certain threshold, increasing memory might not yield any noticeable benefit. Certain OLTP workloads have reporting or End-Of-Day (EOD) consolidation jobs in the mix. For these reporting and EOD jobs, I/O capacity must be carefully evaluated to ensure that such workloads are not affecting regular production OLTP transactions. Many of the reporting and batch jobs use temporary database space. To provide optimal performance for these workloads, use disks with highest performance to store redo log files in Oracle database.

4.1.2 Server virtualization

The database deployment is built on server virtualization by using VMware ESXi. This design provides an efficient and flexible back end for hosting Oracle RAC database transactional workloads. Each of the virtual machines (VMs) hosting the Oracle RAC database instances should be configured with the optimal computational and storage resources to suit the workload. Typical OLTP workloads are not CPU-intensive. For a virtualized database platform, you can start with four vCPUs and scale when the aggregate usage of those vCPUs crosses the threshold that is set by internal IT practices.

4.1.3 Database availability

Oracle RAC enables continuous and uninterrupted database operations by providing multiple database instances running on different nodes. If one of the database instances fails, the Oracle server moves the services from the failed instance to a surviving alternate instance. Meanwhile, the VMware hypervisor back end provides a rich medium for VM high availability and optimal performance by using the VMware HA and Distributed Resource Scheduler (DRS) features. However, on the Oracle VMs, anti-affinity rules are set to prevent VMs from migrating under the HA/DRS feature. This feature ensures that VMs are not placed on the same ESXi host, and that VMs are not migrated to a different ESXi host.

4.1.4 Quality of service and network segregation

The network traffic within the proposed architecture is segregated to ensure maximum bandwidth availability. Each of the network interfaces that are defined follow a quality of service (QoS) policy, which is assumed to provide the intended performance and functions.

4.1.5 Network availability

All the networking elements in the architecture have a high amount of redundancy. All the network paths are configured to ensure aggregated bandwidth for the traffic and resiliency against individual failures.

4.2 Network and Storage Design

This section introduces the network design and storage design for a sample Oracle RAC database environment to be built later following the considerations mentioned in 4.1, "Design considerations" on page 34.

The sample Oracle RAC database environment is built on four virtual machines, running on four ESXi hosts, and the hardware of each ESXi host is a Cisco UCS B200-M4 Blade.

4.2.1 Network Design

Oracle RAC database has the following network requirements and suggestations on each node in the cluster:

- Each node must have at least two network adapters: One for the public network interface and the other for the private network interface or interconnect.
- The public interface ports and private interface ports from each node connect to the public switch and private switch, respectively.
- It is suggest to use redundant network cards, bonded as one Ethernet port, to serve as a public or private network interface.
- The switches and network interface adapters must be at least 1 GbE, with 10 GbE suggested.
- Public network and private network are on different VLANs.

Following Oracle's requirements, and the considerations mentioned in 4.1, "Design considerations" on page 34, the designed network topology in this environment is as shown in Figure 4-1 on page 36:

- Configure NIC teaming on each ESXi host to provide network high availability in case one of the Ethernet adapters goes down.
- Create two host networkings on each ESXi host: One for public network and one for private network, with different VLAN IDs configured.
- Create two Ethernet adapters on each virtual machine: One adapter connects to public network, and the other adapter connects to private network.
- ► Enable jumbo frames on private Ethernet interfaces on each node to improve performance, and enable jumbo frames on virtual switch on each ESXi host.



Figure 4-1 Network design

4.2.2 Single Client Access Name (SCAN)

Single Client Access Name (SCAN) is a feature used in Oracle RAC environments that provides a single name for clients to access any Oracle database running in a cluster. One of the benefits of SCAN is that the connect information does not need to change while Oracle RAC scales to more or less nodes in the cluster. For more information about SCAN, see the following white paper:

http://www.oracle.com/technetwork/products/clustering/overview/scan-129069.pdf

SCAN is used in this Oracle RAC database environment. SCAN also supports at least one and up to three IP addresses with one single name. This environment uses three IP addresses. Therefore, registering these three IP addresses with one name in the DNS server is required.

4.2.3 Storage Design

IBM FlashSystem V9000 supports various volumes, as shown in Figure 4-2, and each volume type has its own usage scenarios. Three types of volumes are used in this environment.



Figure 4-2 Flexible volumes in FlashSystem V9000

A generic volume is a fully allocated volume. It is used for Oracle redo log files and OCR files because these files are frequently accessed, but the capacity growth of these files is flat.

A thin-provisioned volume has a virtual capacity and a real capacity. Virtual capacity is the volume storage capacity that is available to a host. Real capacity is the storage capacity that is allocated to this volume from a storage pool. The virtual capacity can be much larger than the real capacity. Thin provisioning eliminates almost all white space, helping to avoid the poor usage rates that occur in the traditional storage allocation method where large pools of storage capacity are allocated to individual servers but remain unused (not written to). Thin-provisioned volume is used for storing operating system data of each virtual machine in this environment.

A compressed volume is a special type of volume where data is compressed as it is written to disk, saving additional space. Database information is stored in table space files. It is common to see high compression ratios in database volumes. Examples of databases that can greatly benefit from Real-time Compression are IBM DB2, Oracle, and Microsoft SQL Server. Expected compression ratios are 50 - 80%. Compressed volume is used for storing Oracle data files in this environment.



The storage design in this environment is shown in Figure 4-3.

Figure 4-3 Storage design

4.2.4 Oracle Automatic Storage Management (ASM) design

Oracle Automatic Storage Management (ASM) is a volume manager and file system that is designed for Oracle database files, which is integrated in the Oracle Grid Infrastructure. Oracle ASM provides three redundancy types while managing disks:

External redundancy: ASM relies on the storage system to provide redundancy. All disks must be located to successfully mount the disk group.

Note: Use external redundancy on SAN disks to save disk space, and it is not suggested to use it on local disks because it has a data loss risk during any local disk member failure.

- Normal redundancy: ASM provides two-way mirroring. By default, all files are mirrored across different disks so that there are two copies of every data extent.
- High redundancy: ASM provides triple mirroring by default.

Because all data is protected by IBM Flashsystem V9000 RAID, use external redundancy while configuring disk groups in Oracle ASM.

Oracle ASM supports different allocation unit sizes while creating disk groups. This value can be 1, 2, 4, 8, 16, 32, or 64 MB, depending on the specific disk group compatibility level. Usually larger allocation unit sizes provide performance advantages for data warehouse applications that use large sequential reads. The allocation unit size of ASM disk groups in this environment is set to 4 MB.

Physical infrastructure

This chapter covers the physical infrastructure for VersaStack.

This chapter includes the following sections:

- VersaStack cabling
- Storage compatibility and interoperability
- VersaStack system build process

5.1 VersaStack cabling

The information in this section is provided as a reference for cabling the equipment in a VersaStack environment. To simplify cabling requirements, the tables include both local and remote device and port locations.

This book assumes that out-of-band management ports are plugged into an existing management infrastructure at the deployment site. These interfaces are used in various configuration steps.

Be sure to follow the cabling directions in this section. Failure to do so will result in changes to the deployment procedures that follow because specific port locations are mentioned here.

It is possible to order IBM FlashSystem V9000 storage systems in a different configuration by using Cisco Nexus 9000 and IBM FlashSystem V9000. Before starting, be sure that the configuration matches the descriptions in the tables and the diagrams in this section.

Figure 5-1 shows the cabling diagram for a VersaStack configuration that uses the Cisco Nexus 9000 and IBM FlashSystem V9000 storage system. For more information about IBM FlashSystem V9000 enclosure cabling information, see the following website:





Figure 5-1 VersaStack cabling diagram

Figure 5-2 shows the VersaStack management cabling. IBM FlashSystem V9000 has redundant management connections. One path is through the dedicated out-of-band management switch, and the secondary path is through the in-band management path going up through the IBM FlashSystem V9000 to the production network.



Figure 5-2 VersaStack management cabling

The details of all these connections have been tabulated and described in the section titled "VersaStack Cabling" in *VersaStack for Data Center with All-Flash Storage and VMware vSphere 6.0 Deployment Guide: Design Guide for Cisco Unified Computing System 3.1 and IBM FlashSystem V9000 with VMware vSphere 6.0 Update 1a*, which is available at:

http://www.cisco.com/c/en/us/td/docs/unified_computing/ucs/UCS_CVDs/Versastack_vmw
6_flash_design.html

5.2 Storage compatibility and interoperability

The IBM System Storage Interoperation Center (SSIC) provides information about supported external hardware and software for the specific IBM FlashSystem V9000 version.

Make sure that the hardware and software components are supported by the version of Storwize V7000 storage system that you plan to install by checking the SSIC. Click **IBM System Storage Enterprise Flash**, then click **FlashSystem V9000 Host Attachment or FlashSystem V9000 Storage Controller Support**.

Software and hardware limitations for IBM FlashSystem V9000 running firmware v7.6.x can be found at:

http://www.ibm.com/support/docview.wss?uid=ssg1S1005242

Detailed information about supported hardware, device driver, firmware, and software level information can be found at:

http://www.ibm.com/support/docview.wss?uid=ssg1S1005419

5.3 VersaStack system build process

Figure 5-3 depicts the VersaStack build process for the environment used for this book.



Figure 5-3 VersaStack build process

6

IBM FlashSystem V9000 storage configuration

This chapter describes the steps that are necessary to create and configure the storage volumes for Oracle RAC (four nodes) from IBM FlashSystem V9000 storage system in the VersaStack environment.

As a prerequisite, the user must have configured the IBM FlashSystem V9000 as described in the "Storage Configuration" section of the document *VersaStack for Data Center with All-Flash Storage and VMware vSphere 6.0 Deployment Guide:* Design Guide for Cisco Unified Computing System 3.1 and IBM FlashSystem V9000 with VMware vSphere 6.0 Update 1a available here:

http://www.cisco.com/c/en/us/td/docs/unified_computing/ucs/UCS_CVDs/Versastack_vmw
6_flash_design.html

This chapter includes the following sections:

- Volume layout for four node Oracle-RAC
- Volume creation and mapping

6.1 Volume layout for four node Oracle-RAC

For the Oracle-RAC configuration, a total of six volumes were created. Table 6-1 describes the type, size, and purpose of each volume created.

Volume Name	Volume Type	Volume Size	Volume Purpose	Volume Quantity		
ITSO_VMOS_vol	Thin-provisioned	1 TB	To store guest OSs for VMware environment	1		
ITSO_DB_vol_ <x ></x 	Compressed	2 TB each	For Oracle database files	3		
ITSO_DB_LOG_ vol	Regular	100 GB	For Oracle Redo logs	1		

Table 6-1 Volumes layout for Oracle-RAC configuration

6.2 Volume creation and mapping

This section illustrates the steps for volume creation and mapping them to VMware hosts. The sequence and steps provided here are for one volume. However, it can be repeated by specifying the relevant parameters, such as volume size, volume type, and volume name, for the wanted number of volumes.

- 1. Open a browser and go to https://<V9000_Management_IP>.
- 2. Log in as "superuser" with the password for that user.
- 3. As shown in Figure 6-1, click Volumes.



Figure 6-1 Volumes pane from the initial window

4. Select **Volumes**, which shows all the volumes that exist in the system as shown in Figure 6-2.

+ Create Volumes 🛛 🗄 Actions	Q Filter		-		
Name	State	Pool	UID	Host Mappings	Capacity
IOmeter_Compressed4	✓ Online	mdiskgrp0	600507680C8181138800000000000019	No	20.00 GiB
10meter_Compressed5	🗸 Online	mdiskgrp0	600507680C81811388000000000001A	No	🧝 20.00 GiB
IOmeter_Compressed6	🗸 Online	mdiskgrp0	600507680C818113880000000000001B	No	🧝 20.00 GiB
IOmeter_Compressed7	🗸 Online	mdiskgrp0	600507680C818113880000000000001C	No	🧝 20.00 GiB
IOmeter_regular0	🗸 Online	mdiskgrp0	600507680C818113880000000000000D	Yes	20.00 GiB
IOmeter_regular1	🗸 Online	mdiskgrp0	600507680C818113880000000000000E	Yes	20.00 GiB
IOmeter_regular2	🗸 Online	mdiskgrp0	600507680C818113880000000000000F	Yes	20.00 GiB
IOmeter_regular3	🗸 Online	mdiskgrp0	600507680C8181138800000000000010	Yes	20.00 GiB
IOmeter_regular4	🗸 Online	mdiskgrp0	600507680C8181138800000000000011	Yes	20.00 GiB
IOmeter_regular5	🗸 Online	mdiskgrp0	600507680C8181138800000000000012	Yes	20.00 GiB
IOmeter_regular6	🗸 Online	mdiskgrp0	600507680C8181138800000000000013	Yes	20.00 GiB
IOmeter_regular7	🗸 Online	mdiskgrp0	600507680C8181138800000000000014	Yes	20.00 GiB
ITSO_DB_LOG_vol	🗸 Online	mdiskgrp0	600507680C818113880000000000049	Yes	100.00 GiB
ITSO_DB_vol_1	🗸 Online	mdiskgrp0	600507680C818113880000000000046	Yes	🞅 2.00 TiB
ITSO_DB_vol_2	🗸 Online	mdiskgrp0	600507680C8181138800000000000047	Yes	😪 2.00 TiB
ITSO_DB_vol_3	🗸 Online	mdiskgrp0	600507680C818113880000000000048	Yes	😪 2.00 TiB
ITSO_VMOS_vol	🗸 Online	mdiskgrp0	600507680C818113880000000000045	Yes	📵 1.00 TiB
ITSO_repository	🗸 Online	mdiskgrp0	600507680C81811388000000000002C	Yes	200.00 GiB
Infra-ESXi-iSCSI-ACI-05	🗸 Online	mdiskgrp0	600507680C81811388000000000001D	Yes	😪 10.00 GiB
Infra-ESXi-iSCSI-ACI-06	🗸 Online	mdiskgrp0	600507680C818113880000000000001E	Yes	😪 10.00 GiB
Infra_datastore1	🗸 Online	mdiskgrp0	600507680C8181138800000000000005	Yes	2.00 TiB
Infra_datastore2	🗸 Online	mdiskgrp0	600507680C8181138800000000000000	Yes	2.00 TiB
Test	🗸 Online	mdiskgrp0	600507680C81811388000000000004B	Yes	35.00 GiB
VDBench_compressed	🗸 Online	mdiskgrp0	600507680C818113880000000000000B	Yes	🞅 2.00 TiB
VDBench_regular	🗸 Online	mdiskgrp0	600507680C818113880000000000000C	Yes	2.00 TiB
VM-Host-Infra-01	🗸 Online	mdiskgrp0	600507680C8181138800000000000000	Yes	40.00 GiB
VM-Host-Infra-02	🗸 Online	mdiskgrp0	600507680C8181138800000000000000	Yes	40.00 GiB
VM-Host-Infra-03	🗸 Online	mdiskgrp0	600507680C8181138800000000000002	Yes	40.00 GiB
VM-Host-Infra-04	🗸 Online	mdiskgrp0	600507680C8181138800000000000003	Yes	40.00 GiB
VM-Host-Oracle-01	🗸 Online	mdiskgrp0	600507680C818113880000000000021	Yes	40.00 GiB
VM-Host-Oracle-02	🗸 Online	mdiskgrp0	600507680C818113880000000000022	Yes	40.00 GiB
VM-Host-Oracle-03	🗸 Online	mdiskgrp0	600507680C818113880000000000023	Yes	40.00 GiB
VM-Host-Oracle-04	🗸 Online	mdiskgrp0	600507680C818113880000000000024	Yes	40.00 GiB
infra_swap	🗸 Online	mdiskgrp0	600507680C8181138800000000000007	Yes	500.00 GiB

Figure 6-2 List of volumes

5. Select Create Volumes as shown in Figure 6-3.

	TIRCI				
le le	State	Pool	UID	Host Mappings	Capacity
ACI-IOM	🗸 Online	mdiskgrp0	600507680C818113880000000000038	Yes	100.00
ACI-IOM-1	🗸 Online	mdiskgrp0	600507680C8181138800000000003A	Yes	20.0
ACI-IOM-2	🗸 Online	mdiskgrp0	600507680C81811388000000000003B	Yes	20.0
ACI-IOM-3	🗸 Online	mdiskgrp0	600507680C81811388000000000003C	Yes	20.0
ACI-IOM-4	🗸 Online	mdiskgrp0	600507680C81811388000000000003D	Yes	20.0
ACI-IOM-5	🗸 Online	mdiskgrp0	600507680C81811388000000000003E	Yes	20.0
ACI-IOM-6	🗸 Online	mdiskgrp0	600507680C81811388000000000003F	Yes	20.0
ACI-IOM-7	🗸 Online	mdiskgrp0	600507680C818113880000000000040	Yes	20.0
ACI-IOM-8	🗸 Online	mdiskgrp0	600507680C818113880000000000041	Yes	20.0
ACI-Infra-Datastore	🗸 Online	mdiskgrp0	600507680C818113880000000000020	Yes	📵 1.0
ACI-Infra-Swap	🗸 Online	mdiskgrp0	600507680C818113880000000000001F	Yes	200.0
10meter_Compressed0	🗸 Online	mdiskgrp0	600507680C818113880000000000015	No	20.0
IOmeter_Compressed1	🗸 Online	mdiskgrp0	600507680C8181138800000000000016	No	20.0
10meter_Compressed2	🗸 Online	mdiskgrp0	600507680C8181138800000000000017	No	20.0
10meter_Compressed3	🗸 Online	mdiskgrp0	600507680C818113880000000000018	No	20.0
10meter_Compressed4	🗸 Online	mdiskgrp0	600507680C8181138800000000000019	No	20.0
10meter_Compressed5	🗸 Online	mdiskgrp0	600507680C818113880000000000001A	No	20.0
10meter_Compressed6	🗸 Online	mdiskgrp0	600507680C81811388000000000001B	No	20.0
10meter_Compressed7	🗸 Online	mdiskgrp0	600507680C81811388000000000001C	No	20.0
10meter_regular0	🗸 Online	mdiskgrp0	600507680C81811388000000000000D	Yes	20.0
10meter_regular1	🗸 Online	mdiskgrp0	600507680C81811388000000000000E	Yes	20.0
10meter_regular2	🗸 Online	mdiskgrp0	600507680C81811388000000000000F	Yes	20.0
10meter_regular3	🗸 Online	mdiskgrp0	600507680C8181138800000000000010	Yes	20.0
10meter_regular4	🗸 Online	mdiskgrp0	600507680C818113880000000000011	Yes	20.0
10meter_regular5	🗸 Online	mdiskgrp0	600507680C8181138800000000000012	Yes	20.0
10meter_regular6	🗸 Online	mdiskgrp0	600507680C8181138800000000000013	Yes	20.0
10meter_regular7	🗸 Online	mdiskgrp0	600507680C818113880000000000014	Yes	20.0
ITS0_repository	🗸 Online	mdiskgrp0	600507680C818113880000000000002C	Yes	200.0
Infra-ESXi-iSCSI-ACI-05	🗸 Online	mdiskgrp0	600507680C81811388000000000001D	Yes	🧝 10.0
Infra-ESXi-iSCSI-ACI-06	🗸 Online	mdiskgrp0	600507680C81811388000000000001E	Yes	30.0
Infra_datastore1	🗸 Online	mdiskgrp0	600507680C818113880000000000000	Yes	2.0
Infra_datastore2	🗸 Online	mdiskgrp0	600507680C818113880000000000000	Yes	2.0
VDBench_compressed	🗸 Online	mdiskgrp0	600507680C81811388000000000000B	Yes	2.0
VDBench regular	🖌 Online		C00C07C00C040442000000000000000	Vac	

Figure 6-3 Options for Create Volumes

6. Select **Custom** as shown in Figure 6-4.

Create Volumes		-	x
Basio	Quick Volume of	reation ———	Advanced
Volume Details Quantity:	Capacity: Capacity saving * GiB None	s: Name:	
Volume Location			
Thin Provisionin]		
Compressed			
General			
Summary			
0	Create Cr	eate and Map to Host	

Figure 6-4 Custom volume creation

7. Specify the **Quantity**, **Capacity**, **Capacity savings**, and **Name** parameters as shown in Figure 6-5.

EUUYUX283UU.84844.588UU	nuuuuuuuse	Vac	20.00.038	
reate Volumes				
Basic	Mirrored	— Quick Volume Creati	ion	Advanced
Volume Details Quantity: Capac	city: 1) TiB •	Capacity savings:	Name: TISO_VMOS_vol	
Volume Location				
I nin Provisioning				
Compressed				
General				
Summary				
0	(Create Create	and Map to Host Can	ICE

Figure 6-5 Volume specifications

8. Click Create, which completes the task of creating the volume as shown in Figure 6-6.

✓ Task completed.		100%
• View more details		
Task Starteu.	2.00	en 🔺
Verifying limits	9:50	AM
Checking for name collisions	9:50	AM
The task is 0% complete.	9:50	AM
Creating the volume ITSO_WMOS_vol (1,099,511,627,776 b)	9:50	AM
Running command:	9:50	AM
 svctask mkvdisk -autoexpand -cache readwrite -grainsize 256 -mdiskgrp name ITSO_WMOS_vol -rsize 2% -size 1099511627776 -unit b -warning f 	9:50 80%	AM
The volume (ID 34) was successfully created.	9:50	AM
Synchronizing memory cache.	9:50	AM
The task is 100% complete.	9:50	AM
Task completed.	9:50	AM 🖉
		Ŧ

Figure 6-6 Volume Creation completion

9. From the Volumes window, select the volume that was just created as shown in Figure 6-7.

🗥 Vers	saStack > Volumes > Volumes				IBM	FlashSystem V9000
	+ Create Volumes 🛛 🗄 Actions	C Filter				
	Name	State	Pool	UID	Host Mappings	Capacity
	ACI-IOM	🗸 Online	mdiskgrp0	600507680C818113880000000000038	Yes	📵 100.00 GiB
	ACI-IOM-1	🗸 Online	mdiskgrp0	600507680C81811388000000000003A	Yes	20.00 GiB
	ACI-IOM-2	🗸 Online	mdiskgrp0	600507680C81811388000000000003B	Yes	20.00 GiB
	ACI-IOM-3	🗸 Online	mdiskgrp0	600507680C81811388000000000003C	Yes	20.00 GiB
	ACI-IOM-4	🗸 Online	mdiskgrp0	600507680C81811388000000000003D	Yes	20.00 GiB
	ACI-IOM-5	🗸 Online	mdiskgrp0	600507680C81811388000000000003E	Yes	20.00 GiB
	ACI-IOM-6	🗸 Online	mdiskgrp0	600507680C81811388000000000003F	Yes	20.00 GiB
	ACI-IOM-7	🗸 Online	mdiskgrp0	600507680C8181138800000000000040	Yes	20.00 GiB
	ACI-IOM-8	🗸 Online	mdiskgrp0	600507680C818113880000000000041	Yes	20.00 GiB
	ACI-Infra-Datastore	🗸 Online	mdiskgrp0	600507680C8181138800000000000020	Yes	📵 1.00 TiB
	ACI-Infra-Swap	🗸 Online	mdiskgrp0	600507680C818113880000000000001F	Yes	200.00 GiB
E	IOmeter_Compressed0	🗸 Online	mdiskgrp0	600507680C8181138800000000000015	No	🧝 20.00 GiB
	IOmeter_Compressed1	🗸 Online	mdiskgrp0	600507680C8181138800000000000016	No	🧝 20.00 GiB
-	10meter_Compressed2	🗸 Online	mdiskgrp0	600507680C8181138800000000000017	No	🧝 20.00 GiB
	IOmeter_Compressed3	🗸 Online	mdiskgrp0	600507680C8181138800000000000018	No	🧝 20.00 GiB
. 1	IOmeter_Compressed4	🗸 Online	mdiskgrp0	600507680C8181138800000000000019	No	🧝 20.00 GiB
20	IOmeter_Compressed5	🗸 Online	mdiskgrp0	600507680C818113880000000000001A	No	🧝 20.00 GiB
	IOmeter_Compressed6	🗸 Online	mdiskgrp0	600507680C818113880000000000001B	No	🧝 20.00 GiB
	IOmeter_Compressed7	🗸 Online	mdiskgrp0	600507680C818113880000000000001C	No	🧝 20.00 GiB
2	IOmeter_regular0	🗸 Online	mdiskgrp0	600507680C81811388000000000000D	Yes	20.00 GiB
-0	IOmeter_regular1	🗸 Online	mdiskgrp0	600507680C818113880000000000000	Yes	20.00 GiB
Seat.	IOmeter_regular2	🗸 Online	mdiskgrp0	600507680C81811388000000000000F	Yes	20.00 GiB
	IOmeter_regular3	🗸 Online	mdiskgrp0	600507680C8181138800000000000010	Yes	20.00 GiB
	IOmeter_regular4	🗸 Online	mdiskgrp0	600507680C8181138800000000000011	Yes	20.00 GiB
	IOmeter_regular5	🗸 Online	mdiskgrp0	600507680C8181138800000000000012	Yes	20.00 GiB
	IOmeter_regular6	🗸 Online	mdiskgrp0	600507680C8181138800000000000013	Yes	20.00 GiB
	IOmeter_regular7	🗸 Online	mdiskgrp0	600507680C818113880000000000014	Yes	20.00 GiB
	ITSO_DB_LOG_vol	🗸 Online (formatting)	mdiskgrp0	600507680C818113880000000000049	No	100.00 GiB
	ITSO_DB_vol_1	🗸 Online	mdiskgrp0	600507680C818113880000000000046	No	🧝 2.00 TiB
	ITSO_DB_vol_2	🗸 Online	mdiskgrp0	600507680C818113880000000000047	No	🧝 2.00 TiB
	ITSO_DB_vol_3	🗸 Online	mdiskgrp0	600507680C818113880000000000048	No	🧝 2.00 TiB
	ITSO_VMOS_vol	🗸 Online	mdiskgrp0	600507680C818113880000000000045	No	🕞 1.00 TiB
	ITS0_repository	🗸 Online	mdiskgrp0	600507680C81811388000000000002C	Yes	200.00 GiB
	Infra-ESXi-iSCSI-ACI-05	🗸 Online	mdiskgrp0	600507680C818113880000000000001D	Yes	🧝 10.00 GiB

Figure 6-7 Volume listing

10. Right-click the volume name that was just created as shown in Figure 6-8.



11. Click Map to Host as shown in Figure 6-9.



Figure 6-9 Map to host

12. Select all the hosts that this volume needs to be mapped to as shown in Figure 6-10.

Map	Volume ITSO_VMOS_vol to Host			x
	Select the Host:			
	VM-Host-Oracle-01,VM-Host-Oracle-02,VM-	Host-	Oracle-03,VM-Host-Oracle-04 🔻	
	VM-Host-Infra-01		A	
	VM-Host-Infra-02			
	🗌 VM-Host-Infra-03			
	□ VM-Host-Infra-04			
	🔲 Infra-ESXi-iSCSI-A			_
	Infra-ESXi-iSCSI-A			
	VM-Host-Oracle-01			
	VM-Host-Oracle-02			
	VM-Host-Oracle-03			
	VM-Host-Oracle-04		*	
	No 🗑 2.00 TiB		_	

Figure 6-10 Select hosts that need to have this volume mapped

13. Click **Map** as shown in Figure 6-11.



Figure 6-11 Map the volumes to hosts

14. Mapping of the selected volume to the hosts is completed as shown in Figure 6-12.

3XXIIIIIIIIIIIIIIIIIIIIIIIIIIII	YPC	20.00.038		
Modify Mappings				
✔ Task completed.				100%
View more details				
Creating the mapping 03	g tor volume ITSO_VMOS	5_vol to host	VM-Host-Oracle-10:09	AM 🔺
Running command:			10:09	AM
svctask mkvdiskhostr	map -force -host 8 34		10:09	AM
The task is 75% com	plete.		10:09	AM .
Creating the mapping 04	g for volume ITSO_VMOS	5_vol to host	VM-Host-Oracle-10:09	AM
Running command:			10:09	AM
svctask mkvdiskhostr	map -force -host 9 34		10:09	AM
The task is 100% cor	mplete.		10:09	AM
Synchronizing memory	y cache.		10:09	AM
Task completed.			10:09	AM 🚽
	Close	Cancel		
000000000000000000000000000000000000000	163	20.00 010		

Figure 6-12 Mapping completed

For the Oracle-RAC configuration, repeat the steps 1 - 14 for all the volumes as listed in Table 6-1 on page 44. After following the steps described above, all the wanted VMware hosts that are going to be part of the Oracle-RAC configuration will have the required volumes mapped.

Complete these steps from the IBM FlashSystem V9000 GUI to verify the host-to-volume mapping:

- 1. Click the Home icon on the GUI.
- 2. Click **Hosts** as shown in Figure 6-13.



Figure 6-13 Hosts window

3. Click Volumes by Host as shown in Figure 6-14.



Figure 6-14 Volumes by Host window

4. Select the host from under the Host Filter pane as shown in Figure 6-15.

Number P Variant Variant	Note Third 4 V Area Construction Construction<	Nor Cirito A V Arcon Construction									
Vision Vision<	Version Version	Image: Section of the sectio	Host Filter	۹,							
Market Market Mark	Water Control	Visco Control from the cont	VM-Host-Infra 2 ports	G	215 HD	M-Host-Oracle-01 orts st Type: Generic					
Wet Houst Advance State Pool Up Copyreg Vet Houst Advance THO 00, 00 /// 00 // 00 // 00 // 00 // 00 // 00 // 00 /	Market Allers Nation Parket Humo Company V Market Allers 1000 0.0000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.000000 0.000000 0.000000 0.00000000 0.000000000 0.00000000000 0.00000000000000000000000000000000000	Nume Nation Paral Humo Copyright 2 Joint 1000000000000000000000000000000000000	VM-Host-Infra 2 ports	ю	+ Create Volumes III Artic	er G. Filter					Showing 1
Joint No Toto, 20, 20, 20, 30, 30, 30, 30, 30, 30, 30, 30, 30, 3	Jessie No 100, 00, 00, 00 ····································	Jestis 100 00.0.00, 00.4 Othere 000.000000000000000000000000000000000	VM.Host.Infra		Name	State	Poul	UIÐ	Capacity		
V Markelsham Tro 30, 20, 41, 1 * Okec makagat 400, 201, 201, 100, 100, 100, 100, 100, 1	V Mind Inflat T152,00,01,1 volume madaugut 100,00,01,2 volume madaugut volume madaugut volume madaugut volume madaugut volume madaugut volume volume madaugut volume volum	V Hand Inflat T100, 00, 00, 01 I 000 00, 00, 00 I 000 00, 00, 00<	2 ports	R.	ITSO_DB_LOG_wol	 Online (formatting) 	mdiskgrp0	£00507680C81811388800808080808	100.00 GB		
Villation Trans, group, zowej z	Willing Unitarian Image: Unitarian	Will Hall Sharman Tro (20, m, m) Challer Challer Tro (20, m, m) Challer	P		ITSO_08_vol_1	✓ Online	mdiskgrp0	600507680C818113880000000000046	🧝 2.00 TIB		
With Mark SCN SIGNAL V Make malakagkaj 40002/14/C197130000000000 00 02 03 10 10 Mark SCN SIGNAL V Make malakagkaj 40002/14/C1971300000000000 02 03 10 10 Mark SCN SIGNAL V Make malakagkaj 40002/14/C19713000000000002 23 20 10 Mark SCN SIGNAL V V Make malakagkaj 40002/14/C1971300000000002 23 20 10 V Mark Oracha V V Mark Oracha V V Mark Oracha V V Mark Oracha V V V Mark Oracha V V V Mark Oracha V V V V V V Mark Oracha	Info.gtt.out.3 Codee madadupad GENERALCONTRISEGNEESSES 2 2 10 Info.gtt.out.3 Codee Codee madadupad GENERALCONTRISEGNEESSES 2 3 0 Info.gtt.out.3 Codee Codee Madadupad GENERALCONTRISEGNEESSESSE 2 3 0 Info.gtt.out.3 Codee Codee Madadupad GENERALCONTRISEGNEESSESSE 3 3 3 Info.gtt.out.3 Codee Codee Madadupad GENERALCONTRISEGNEESSESSE 3 3 3 Info.gtt.out.3 Codee Codee Madadupad GENERALCONTRIS	Inter SEXISC G Inter SexisC	VM-Host-Infra	KB	ITSO_08_vol_2	✓ Online	mdiskgrp0	600507680C818113880000000000047	🧝 2.00 TIB		
Index SXISCC VP0VM05sd V 0.0me mailukup3 44007/MCC1111300000000056 S VM 10 Index SXISCC VP0VM05sd VP0VP0Sd VP0VP0Sd VP0VP0Sd VP0VP0Sd VP0V	Ibin das SAUSCC Validadi Oracle Validad	Implementation Imple			ITSO_08_vol_3	✓ Online	mdiskgrp0	\$00507680C81811388000000000048	🧝 2.00 TiB		
Intel 100 100.0000000000000000000000000000000000	Intel State S	Intel Tello Argentitory V follow malakaged 4000/TellCollection (College) 2000/TellCollection (College) Intel SENSE G If tello Crash G	Infra-ESXI-ISC		ITSO_VMOS_eol	✓ Online	mdiskgrp0	600507680C81811388000000000045	1.00 TiB		
Matrix SSUISC VM Mark Arctice H1 V Mark Arctice	Infard SSUISC VM March Oracles 91 V March Oracle	Infar ESSUSC VM Mind Oracle 81 V Mind Oracle 81 V Mind Oracle 81 V Mind Oracle 81 V Mind Oracle 81 Aug GB V Mind Oracle Q V Mind Oracle Q 2 zono VM Mind Oracle Q 2 zono VM Mind Oracle Q	1 port	13	ITSO_repository	✓ Online	mdiskgrp0	600507680C81811388100001000002C	200.00 GiB		
Marka Statistics Value Value Value	Index Statistics 43 Image: Main Condex 43 VetMont Oraclex 43	Image Statistics Value Value Value Value Value Value Value Value Value Value Value	-		VM-Host-Oracle-01	✓ Online	mdiskgrp0	600507680C81811388100000000021	40.00 GiB		
VEMBed Gradewine kg Vember kg Vember kg Vember kg Vember kg Vember kg Vember kg	Vielous Oracles value	VM.Not Oracle Value V.M.Not Oracle Value	1 port	6							
VKHestOradk vg 2xmb V 2xmb V 2xmb V VKHestOradk vg VKHestOradk vg	VM Host Oracle value VM Host Oracle value VM Host Oracle value VM Host Oracle value	UM InterConden V3 Variation V3	VM-Host-Oracle 2 ports	G							
Vit Most Oracle va Zonts Vit Most Oracle va Zonts	VMHosOrade V3 Zoota Zoota	VELNos Oreda vg Zamin Oreda vg	VM-Host-Oracle 2 ports	G							
Viktios Orada 19 2005	VANNetOrade vg	VR Net Oracle vg	VM-Host-Oracle 2 ports	G							
			VM-Host-Oracle	G							

Figure 6-15 Host Filter pane

5. After selecting the host, the right pane displays the volumes that are mapped to that host as shown in Figure 6-16.

🔺 Versa	aStack > Volumes > Volumes by Hos	st				IBM FlashSystem V9000	
	Host Filter	٩					
	VM-Host-Infra 2 ports	K)	2 ports Host Ty	pe: Generic	>		
	VM-Host-Infra 2 ports	R	+ Create Volumes I≣ Actions	Gilter			
	VM-Host-Infra	0	Name	State	Pool	UID	Capacity
	2 ports	1	ITSO_DB_LOG_vol	√ Online	mdiskgrp0	600507680C818113880000000000049	100.00 GiB
	- In Million Infor		ITSO_DB_vol_1	✓ Online	mdiskgrp0	600507680C818113880000000000046	🧝 2.00 TiB
	2 ports	K.	ITSO_DB_vol_2	✓ Online	mdiskgrp0	600507680C818113880000000000047	2.00 TiB
	-	-	ITSO_DB_vol_3	✓ Online	mdiskgrp0	600507680C818113880000000000048	2.00 TiB
6	Infra-ESXi-iSC	N	TISO_VMOS_VOI	✓ Online	mdiskgrp0	600507680C818113880000000000045	1.00 TiB
-3	1 port		VM Host Oracle 84	✓ Online	mdiskgrp0	600507680C8181138800000000000002C	200.00 GIB
*	Infra-ESXi-iSC 1 port	10	VM-1051-014LIE-01	V Onnie	maiskyrpu	600507660C.61071366000000000021	40.00 GID
	VM-Host-Oracle 2 ports	R					
3	VM-Host-Oracle 2 ports	1					
00	VM-Host-Oracle 2 ports	k)					
	VM-Host-Oracle 2 ports	B					

Figure 6-16 Volumes mapped to VMware host for Oracle-RAC

Repeat steps 1 - 5 for all the VMware hosts planned for Oracle-RAC to ensure that the required volumes have been mapped to them.

7

Virtual infrastructure configuration

This chapter provides detailed instructions for configuring VMware ESXi hosts and creating virtual machines in a VersaStack environment that is used for Oracle Database installation later.

This chapter includes the following sections:

- ESXi Configuration
- Create and modify virtual machines
- Considerations of installing Red Hat Enterprise Linux

7.1 ESXi Configuration

These sections show how to configure ESXi hosts in a VersaStack environment. Four ESXi hosts are available in this environment and, unless specified, the instructions in this section need to be executed on all four ESXi hosts.

7.1.1 Scan Disk Devices

After FlashSystem V9000 volumes are mapped to ESXi hosts, complete these steps to scan disk devices:

- 1. Log in using the Administrator@vsphere.local user from the vSphere Web Client.
- vmware[®] vSphere Web Client Ŭ | Administrator@VSPHERE.LOCAL ▼ | Help ▼ | π≡ Q Search Navigator I 🔂 Home (2) • 🔊 Home Work In Progress Inventories 🚮 Ho by vCenter Inventory Lists > ٢ Hosts and Clusters 6 Ο VMs and Templates Networking Hybrid Cloud Manager vCenter Inventory Lists Hosts and Clusters VMs and Templates Storage Content Libraries vRealize Orchestrato Storage Networking > Policies and Profiles > di alta cisco Hybrid Cloud Manager > Cisco Virtual Switch Update Manager O vRealize Orchestrator > 🍓 Administration > Monitoring 😴 Tasks 🔁 Log Browser 5 -8 🔣 Events Customization Specification Manager vCenter Operations Manager Task Console Event Consol Host Profile: VM Storage Policies 🦪 Tags Q New Search > Administration Saved Searches 2 Relesh How-to Videystem Configuration Licensing Custome Experience
- 2. Click Hosts and Clusters in the left pane, as shown in Figure 7-1.

Figure 7-1 VMware vCenter GUI

Note: Run all the actions with vSphere Web Client using Administrator@vsphere.local or an equivalent user.

3. Click the cluster name **VersaStack_Oracle** to expand the ESXi host list, and click the first ESXi host **vm-host-oracle-01** in the inventory, as shown in Figure 7-2.



Figure 7-2 ESXi server

 Click Manage → Storage → Storage Devices to list current disk devices, and click Rescan All Storage Adapters (the second icon from left) to start a device scan on all storage adapters, as shown in Figure 7-3.

vm-host-oracle-03.versastack	cal Actions -				=*
Getting Started Summary Mon	Manage Related Objects				
Settings Storage Networking	rm Definitions Tags Permissions				
	torage Devices				
Storage Adapters	🛃 📕 🗟 🖪 🗉 🥝 💿 🚥 🍪 f	II Action		Q Filter	•
Storage Devices	Name Type	Capacity Operational State	Hardware Acceleration	Drive Type	Transport
Host Cache Configuration	IBM Fibre Rescans all storage adapters on t	he host to Attached	Supported	Flash	Fibre Channel
Protocol Endpoints	IBM Fibre VMES volumes.	ttached	Supported	Flash	Fibre Channel

Figure 7-3 List storage devices

 A window opens that prompts you to choose scan options. Select Scan for new Storage Devices and Scan for new VMFS Volumes, and click OK to continue, as shown in Figure 7-4.

vm-host-oracle-03.versastack.local - Rescan Storage	?
Scan for new Storage Devices	
Rescan all host bus adapters for new storage devices. Rescanning all adapters can be slow.	
Scan for new VMFS Volumes	
Rescan all known storage devices for new VMFS volumes that h the last scan. Rescanning known storage for new file systems is rescanning for new storage.	ave been added since faster than
	OK Cancel

Figure 7-4 Rescan storage options

6. After the rescan action is finished, the newly mapped volumes will show up in the list, as shown in Figure 7-5.

vm-host-oracle-03.versastack	Actions -					
Getting Started Summary Mo	nitor Manage Related Objects					
Settings Storage Networking	Alarm Definitions Tags Permissions					
•	Storage Devices					
Storage Adapters	Ee 🖳 🗔 🛃 📖 🥔 🔘 🎟	🛛 🙆 All Action 📳 🕶			Q Filter	
Storage Devices	Name	Type Capacity	Operational State H	lardware Acceleration	Drive Type	Transport
Host Cache Configuration	IBM Fibre Channel Disk (naa.600507	disk 200 GB	Attached	Supported	Flash	Fibre Channe
Protocol Endpoints	IBM Fibre Channel Disk (naa.600507	disk 40 GB	Attached	Supported	Flash	Fibre Channe
	IBM Fibre Channel Disk (naa.600507	disk 2 TB	Attached	Supported	HDD	Fibre Chann
	IBM Fibre Channel Disk (naa.600507	disk 2 TB	Attached	Supported	HDD	Fibre Chann
	IBM Fibre Channel Disk (naa.600507	disk 2 TB	Attached	Supported	HDD	Fibre Chann
	IBM Fibre Channel Disk (naa.600507	disk 1 TB	Attached	Supported	HDD	Fibre Chann
	IBM Fibre Channel Disk (naa.600507	disk 100 GB	Attached	Supported	HDD	Fibre Chann
			_			

Figure 7-5 List storage devices

7.1.2 Mark FlashSystem V9000 Disks as Flash Disks

The newly mapped volumes cannot be recognized as Flash disks by VMware ESXi host automatically. For performance reasons, it is suggested that you mark these FlashSystem V9000 volumes as Flash disks.

To mark FlashSystem V9000 volumes as Flash disks, complete these procedures:

 Select all the FlashSystem V9000 volumes that are listed as HDD in the list, and click Mark Flash Disks (the third icon from right) to mark these selected disks as Flash disks, as shown in Figure 7-6.

Storage Devices						
🛃 📃 🗟 🗟 🛝 🥝 💽	I 🎲 All Action				Q Filter	
Name 1	T)	the coloctr	d dicks as flas	dicks	Drive Type	Transport
IBM Fibre Channel Disk (naa.600507	Gion	the selecte		oupported	Flash	Fibre Channel
IBM Fibre Channel Disk (naa.600507	disk	200 GB	Attached	Supported	Flash	Fibre Channel
IBM Fibre Channel Disk (naa.600507	disk	1 TB	Attached	Supported	HDD	Fibre Channel
IBM Fibre Channel Disk (naa.600507	disk	2 TB	Attached	Supported	HDD	Fibre Channel
IBM Fibre Channel Disk (naa.600507	disk	2 TB	Attached	Supported	HDD	Fibre Channel
IBM Fibre Channel Disk (naa.600507	disk	2 TB	Attached	Supported	HDD	Fibre Channel
IBM Fibre Channel Disk (naa.600507	disk	100 GB	Attached	Supported	HDD	Fibre Channel

Figure 7-6 Mark selected disks as Flash disks

2. A warning window prompts you to confirm this action. Click **Yes** to continue, as shown in Figure 7-7.

Mark as Flash Disk						
1	Marking HDD disks as flash disks could deteriorate the performance of datastores and services that use them. Mark disks as flash disks only if you are certain that those disks are flash disks.					
	Mark the selected disks as flash disks?					
	Yes No					

Figure 7-7 Warning to confirm marking Flash disks

3. After the marking disks action is completed, all the FlashSystem V9000 volumes will show up as Flash disks in the list, as shown in Figure 7-8.

Storage Devices							
- 			stion.			Q Filter	
Name	Туре	Capacity	Operational State	Hardware Acceleration	Drive Type	Transport	
IBM Fibre Channel Disk (naa.600507	disk	2 TB	Attached	Supported	Flash	Fibre Channel	
IBM Fibre Channel Disk (naa.600507	disk	40 GB	Attached	Supported	Flash	Fibre Channel	
IBM Fibre Channel Disk (naa.600507	disk	2 TB	Attached	Supported	Flash	Fibre Channel	
IBM Fibre Channel Disk (naa.600507	disk	2 TB	Attached	Supported	Flash	Fibre Channel	
IBM Fibre Channel Disk (naa.600507	disk	100 GB	Attached	Supported	Flash	Fibre Channel	
IBM Fibre Channel Disk (naa.600507	disk	1 TB	Attached	Supported	Flash	Fibre Channel	
IBM Fibre Channel Disk (naa.600507	disk	200 GB	Attached	Supported	Flash	Fibre Channel	

Figure 7-8 List storage devices

7.1.3 Modify Path Selection Policy

For each storage device, VMware ESXi host sets the Path Selection Policy (PSP) based on the defined claim rules, usually three PSPs are supported in ESXi, as shown in Table 7-1.

Policy	Meaning			
Fixed	The host uses the designated preferred path, if it has been configured.			
Most Recently Used	The host selects the path that it used most recently. When the path becomes unavailable, the host selects an alternative path.			
Round Robin	The host uses an automatic path selection algorithm rotating through all active paths when connecting to storage subsystems.			

Table 7-1 ESXi Path Selection Policy

For FlashSystem V9000 volumes, it is suggested to use **Round Robin** Path Selection Policy. To modify PSP for a FlashSystem V9000 volume, complete these steps:

- 1. Select one FlashSystem V9000 volume in storage device list. Navigate to Properties tab of Device Details pane.
- 2. The Path Selection Policy configured for this volume is **Most Recently Used**, as shown in Figure 7-9. To change the Path Selection Policy, click **Edit Multipathing** button.



Figure 7-9 Show disk device details
3. From the dialog, it shows current Path Selection Policy, and all available paths and active paths to the disk, as shown in Figure 7-10.

vm-host-oracle-01.ver	sastack.local - Edit M	ultipathing Policies for naa.600507680c81	811388000	00000000021 (?)
Path selection policy:				
Most Recently Used (VMw	/are)			•
Select the preferred path fo	r this policy:			
•		Q	Filter	•
Runtime Name	Status	Target	LUN	Preferred
vmhba0:C0:T1:L0	Active	50:05:07:68:0c:00:22:71 50:05:07:68:	0	
vmhba0:C0:T0:L0	 Active 	50:05:07:68:0c:00:22:67 50:05:07:68:	0	
vmhba1:C0:T1:L0	 Active 	50:05:07:68:0c:00:22:67 50:05:07:68:	0	
vmhba1:C0:T0:L0	 Active (I/O) 	50:05:07:68:0c:00:22:71 50:05:07:68:	0	
			ОК	Cancel

Figure 7-10 List current Path Selection Policy

4. Click the Path Selection Policy drop list, and select **Round Robin (VMware)** as the new Path Selection Policy. Click **OK** to continue, as shown in Figure 7-11.

vm-host-oracle-01.ve	ersastack.local - Edit Mu	Itipathing Policies for naa.600507680c81	811388000	0000000021 ?
Path selection policy:				
Round Robin (VMware)				
Most Recently Used (VM	ware)			
Round Robin (VMware)				
Fixed (VMware)	- Set 14 11112			
vmhba0:C0:T1:L0	 Active 	50:05:07:68:0c:00:22:71 50:05:07:68:	0	110/01/00
vmhba0:C0:T0:L0	Active	50:05:07:68:0c:00:22:67 50:05:07:68:	0	
vmhba1:C0:T1:L0	 Active 	50:05:07:68:0c:00:22:67 50:05:07:68:	0	
vmhba1:C0:T0:L0	 Active (I/O) 	50:05:07:68:0c:00:22:71 50:05:07:68:	0	
			ОК	Cancel

Figure 7-11 Change disk Path Selection Policy

5. The change is effective immediately and shown on the Properties tab, as shown in Figure 7-12.

D	evio	ce Details				
ſ	Pro	operties	Paths			
_	P	Primary	Parutions	ö		
	Þ	Logical F	Partitions	0		
	Mu	ultipathing	g Policies	1	Edit Multipathing	
	Þ	Path Sel	ection Pol	icy	Round Robin (VMware)	
		Storage	Array Type	e Policy	VMW_SATP_ALUA	•

Figure 7-12 Disk Properties tab

6. Repeat these steps to change Path Selection Policy for all FlashSystem V9000 disks.

Tip: Changing Path Selection Policy through GUI can take a long time if there are a few FlashSystem V9000 volumes. In this case, running a command on ESXi host would be a quicker way.

Log in to the ESXi host using root user, and run the following command:

[root@VM-Host-Oracle-01:~] for i in `esxcli storage nmp device list | grep
'^naa.60050768'`; do esxcli storage nmp device set --device \$i --psp
VMW_PSP_RR; done

7.1.4 Create datastore

According to our planning, three datastores need to be created in this environment as shown in Table 7-2.

Datastore	Capacity	Usage
VM_OS	1 TB * 1	Boot disks of Linux virtual machines
OCR_REDO	100 GB * 1	Oracle RAC OCR and Redo log files
DATABASE	2 TB * 3	Oracle RAC database data files

Table 7-2 Datastore list

To create datastores in the VMware ESXi host, complete these steps. It is only necessary to perform datastore creation actions on one ESXi host.

- 1. From the vSphere Web Client, select vm-host-oracle-01 in the inventory.
- 2. Click Related Objects \rightarrow Datastores to list current datastores.

3. Click **Create a New Datastore** (the first icon from left) to add a datastore, as shown in Figure 7-13.

vm-host-oracle-01.versastack.lo	Actions -				≡
Getting Started Summary Monite	or Manage Relat	ed Objects			
Virtual Machines VM Templates in	Folders Networks	Distributed Switches Datastores			
	2 A - 4/				
		_			•)
Name 1 A	Status	Туре	Datastore Cluster	Capacity	Free
ESXI	Normal	VMFS5		32.5 GB	31.55
ISO_repository	 Normal 	VMFS5		199.75 GB	194.68
4					•
M				2 Objec	cts 📑 🕶

Figure 7-13 List datastores

4. Select **VMFS** as the type of new datastore, as shown in Figure 7-14, and click **Next** to continue.



Figure 7-14 Choose new datastore type

5. Input the name of new datastore, and select the disk device to be used to create a datastore, as shown in Figure 7-15. Click **Next** to continue.

1 New Datastore						(?)»
✓ 1 Туре	atastore name: VM_OS					
2 Name and device selection				(Q Filter	•
3 Partition configuration	Name	LUN	Capacity	Hardware Acceler	Drive Type	Snapshot Vol
4 Ready to complete	IBM Fibre Channel Disk (naa.600507680c818113880000	2	1 TB	Supported	Flash	
	IBM Fibre Channel Disk (naa.600507680c818113880000	3	2 TB	Supported	Flash	
	IBM Fibre Channel Disk (naa.600507680c818113880000	4	2 TB	Supported	Flash	
	IBM Fibre Channel Disk (naa.600507680c818113880000	5	2 TB	Supported	Flash	
	IBM Fibre Channel Disk (naa.600507680c818113880000	6	100 GB	Supported	Flash	
	84					5 items
			Back	Next	Finish	Cancel

Figure 7-15 Select disk device

6. Select the **Use all available partitions** option, as shown in Figure 7-16. Click **Next** to continue.

1 New Datastore					• • •
✓ 1 Type	Partition Layout	Datastore Details			
 2 Name and device selection 		Partition Configuration	Use all available partitions		-
✓ 3 Partition configuration		Datastore Size		GB	
4 Ready to complete					
	VM_OS				
	Capacity: 1 T	В			
	Free Space: 1 T	B			
			Back	Next Finish	Cancel
Figure 7-16 Choose pa	artition configuration				

7. From the datastore configuration summary window, as shown in Figure 7-17, click **Finish** to finish datastore configuration.

1 New Datastore			(?) >>
🗸 1 Туре	General:		
 2 Name and device selection 	Name	VM_OS	
 3 Partition configuration 	Туре	VMFS	
✓ 4 Ready to complete	Datastore size	1,024 GB	
	Device and Format	ting:	
	Disk/LUN	IBM Fibre Channel Disk (naa.600507680c8181138800000000000045)	
	Partition Format	GPT	
	VMFS Version	VMFS 5	
		Back Next Finish	Cancel

Figure 7-17 Datastore configuration summary

8. After VMware ESXi host finishes datastore creation, the new datastore will be listed in Datastores tab, as shown in Figure 7-18.

vm-host-oracle-01.versastack.lo	Actions -					≡∗
Getting Started Summary Monito	or Manage Relat	ed Objects				
Virtual Machines VM Templates in F	Folders Networks	Distributed Switches Dat	astores			
1 🔐 🛱 C 🖻 🗔 🛯	Actions -				S Q Filter	•
Name 1 🛦	Status	Туре	Datastore Cluster	Capacity	Free	
DATABASE	Normal	VMFS5		2 TB	0 B	
ESXi1	Normal	VMFS5		32.5 GB	31.55 GB	
ISO_repository	Normal	VMFS5		199.75 GB	194.68 GB	
OCR_REDO	Normal	VMFS5		99.75 GB	98.8 GB	
VM_OS	Normal	VMFS5		1,023.75 GB	1,022.79 GB	
M					5 Objects	₽ .

Figure 7-18 List datastores

9. For the datastore, which is planned to have multiple disks, right-click the datastore name and select **Increase Datastore Capacity**, as shown in Figure 7-19.



Figure 7-19 Increase Datastore Capacity

10. Select the disk to be added into the datastore, as shown in Figure 7-20, and click **Next** to continue.

DATABASE - Increase Datastore 0	Capacity						?
1 Select Device						Q Filter	-
2 Specify Configuration	Name	LUN	Capacity	Hardware Accel	Drive Type	e Expandable	
3 Ready To Complete	IBM Fibre Channel Disk (naa.600507680c818113	4	2 TB	Supported	Flash	No	
	IBM Fibre Channel Disk (naa.600507680c818113	5	2 TB	Supported	Flash	No	
	A4						
				Back	Next	Finish	Cancel

Figure 7-20 Select disk device

11.Select the **Use all available partitions** option, as shown in Figure 7-21, and click **Next** to continue.

DATABASE - Increase Datastore C	Capacity			?	**
✓ 1 Select Device	Partition Layout	Datastore Details			
2 Specify Configuration		Partition Configuration	Use all available partitions	•	
3 Ready To Complete		Increase Size by	2,048 👗 GB		
	DATABASE Capacity: 2 Free Space: 2	TB TB	e datastore on this device. Selecting any configuration option astore.	will add	Ι
			Back Next Finish	Cancel)

Figure 7-21 Choose partition configuration

12. In the datastore configuration summary window, as shown in Figure 7-22, click **Finish** to complete the increasing datastore capacity process.

DATABASE - Increase Datastore C	apacity			•
✓ 1 Select Device	General:			
 2 Specify Configuration 	Name		DATABASE	
✓ 3 Ready To Complete	Increase Datastore Siz	ze by	2 TB	
	Future Datastore Size		4 TB	
	Device and Formatting:			
	Disk/LUN	IBM F	ibre Channel Disk (naa.600507680c8181138800000000000047)	
	Partition Format	GPT		
	VMFS Version	VMFS	5.61	
	Maximum File Size	62.94	TB	
	Block Size	1 MB		
			Back Next Finish Car	icel
				,dl,

Figure 7-22 Increase Datastore Capacity summary

7.1.5 Configure NIC Teaming

NIC teaming is a feature that is provided in ESXi to increase network capacity for the virtual switch through teaming multiple Ethernet network adapters. It also provides failover if one of the adapters in the team goes down. It is suggested to configure NIC teaming on ESXi hosts in a VersaStack environment.

Complete these steps to configure NIC teaming on ESXi host from vSphere web client:

- 1. From the vSphere Web Client, select vm-host-oracle-01 in the inventory.
- Click Manage → Networking → Virtual Switches, then select vSwitch0 from the list, as shown in Figure 7-23.

vm-host-oracle-01.versastack.	Iocal Actions -		≡*
Getting Started Summary Mon	itor Manage Related Objects		
Settings Storage Networking A Virtual switches VMkernel adapters Physical adapters TCP/IP configuration Advanced	Narm Definitions Tags Permissions Virtual switches Image: Second State Stat	Discovered Issues	¢.

Figure 7-23 Virtual switches

3. Click **Manage the Physical Network Adapters** (the third icon from left) to manage the physical network adapters that are connected to **vSwitch0**.

4. Click **Add Adapters** (the first icon from left) to add adapters to virtual switch **vSwitch0**, as shown in Figure 7-24.

🕅 vm-host-oracle-01.versastack.local - Manage Physical Network Adapters for vSwitch0 🔋			
Assigned adapters:			
$+ \times + +$			
Active adapters			
vmnic0			
Standby adapters	Select a physical network adapter from		
Unused adapters	the list to view its details.		
	OK Cancel		

Figure 7-24 Manage physical network adapters for vSwitch0

5. Select network adapter vmnic1 and select **Active Adapters** in **Failover order group**, as shown in Figure 7-25. Click **OK** to continue.

M VI	회 vm-host-oracle-01.versastack.local - Manage Physical Network Adapters for vSwitch0				
Assig	Add Physical Adapters	s to t	the Switch	×	
Activ M Stan	Failover order group: Network Adapters:	Ac	tive adapters	q	
Unus			Adapter Name Location Driver Status	Cisco Systems	
				OK Cancel	
				OK Cance	

Figure 7-25 Add physical adapters to the Switch

6. Confirm **vmnic1** is added in vSwitch0 active adapters, as shown in Figure 7-26. Click **OK** to continue.

vm-host-oracle-01.versastack.local	- Manage Physical Network Adapte	rs for vSwitch0 (?)	
Assigned adapters:	All Properties CDP LLDP		
+ × 🕆 🖡	Adapter	Cisco Systems	
Active adapters		Inc Cisco VIC Ethernet NIC	
vmnic0	Name	vmnic1	
vmnic1	Location	PCI 0000:0c:00.0	
Standby adapters	Driver enic		
Unused adapters	Status		
	Status	Connected	
	Configured speed, Duplex	20000 Mb, Full Duplex	
	Actual speed, Duplex	20000 Mb, Full Duplex	
	Networks	0.0.0.1- 255.255.255.254	
	Network I/O Control		
	Status	Allowed	
	DirectPath I/O	•	
		P	
		OK Cancel	

Figure 7-26 Manage physical network adapters for vSwitch0

7. The change is reflected on the virtual switch network diagram, as shown in Figure 7-27.

vm-host-oracle-01.versastacl	k.local Actions -		≡.
Getting Started Summary Mo	mitor Manage Related Objects		
Settings Storage Networking	Alarm Definitions Tags Permissions		
Virtual switches VMkernel adapters	2 😥 😥 🤴 🕾 🥒 🗙 😗	Discovered Issues	
Physical adapters TCP/IP configuration Advanced	Standard switch: vSwitch0 (VMkernel-MGMT)		
	/ ×		C
	 ♥ VMkernel-MGMT VLAN ID: 11 ♥ VMkernel Ports (1) wmk0 : 192.168.161.111 ♥ VMkernel-vMotion VLAN ID: 3173 ♥ VMkernel Ports (1) wmk1 : 172.17.73.111 	Physical Adapters Im vmnic0 20000 Full	

Figure 7-27 List virtual switches

VMware ESXi supports several load balancing policies. Make sure to use the default **Route based on originating virtual port** policy in ESXi hosts in VersaStack environment. To check the load balancing policy, click the **Edit Settings** icon (the fifth icon from left). A dialog is prompted as shown in Figure 7-28. Click **Teaming and Failover** \rightarrow **Load Balancing** to check the current load balancing policy. Make sure that **Route based on originating virtual port** is used.

T vSwitch0 - Edit Settings			?
Properties Security Traffic shaping Teaming and failover	Load balancing: Network failure detection: Notify switches: Failback:	Route based on originating virtual port • Link status only • Yes • Yes •]]]
	Failover order Active adapters wmnic1 Standby adapters Unused adapters Select active and standby adapters	Select a physical network a	adapter from the list to view its details.
			OK Cancel

Figure 7-28 List load balancing policy

7.1.6 Enable Jumbo Frames

Enabling jumbo frames allow ESXi host to send larger frames out onto the physical network, which could reduce the CPU load caused by transferring data. To enable jumbo frames on ESXi virtual switches, complete these steps:

- 1. From the vSphere Web Client, select vm-host-oracle-01 in the inventory.
- Click Manage → Networking → Virtual Switches, select the vSwitch0 from the list, as shown in Figure 7-27 on page 68.

3. Click **View Switch Settings** (the first icon from right) in Figure 7-27 on page 68, a window is displayed as shown in Figure 7-29. In this example, the current MTU of vSwitch0 is 1500.

vSwitch0	(x
All Properties Policies		
Properties	-	-
MTU	1500	
Security		
Promiscuous mode	Reject	
MAC address changes	Accept	
Forged transmits	Accept	
Traffic shaping		
Average bandwidth	-	
Peak bandwidth	-	
Burst size	-	
Teaming and failover		
Load balancing	Route based on originating virtual port	
···· · · · · ·		

Figure 7-29 vSwitch0 properties

4. Click **Edit Settings** (the fifth icon from left) in Figure 7-27 on page 68. A window is displayed as shown in Figure 7-30.

vSwitch0 - Edit Settings			
Properties Security Traffic shaping	Number of ports: MTU (Bytes):	Elastic 1500 🔹	
leaming and failover			
			OK

Figure 7-30 Edit settings for vSwitch0

5. Enter 9000 in the MTU (Bytes) box, as shown in Figure 7-31, and click OK to continue.

1 vSwitch0 - Edit Settings			?
Properties Security Traffic shaping	Number of ports: MTU (Bytes):	Elastic 9000	
Teaming and failover			
			OK Cancel

Figure 7-31 Edit settings for vSwitch0

7.1.7 Add Host Networking

This section shows how to add more host networkings in ESXi host. The planned host networkings are shown in Table 7-3.

Name	VLAN ID	Usage
Public	11	For Oracle RAC Database services
InterConnect	3175	For Oracle RAC nodes internal communication

Table 7-3 Planned host networking

To add host networking, complete these steps:

- 1. From the vSphere Web Client, select vm-host-oracle-01 in the inventory.
- Click Manage → Networking → Virtual Switches, select vSwitch0 from the list, as shown in Figure 7-27 on page 68.

3. Click **Add Host Networking** (the first icon from left) in Figure 7-27 on page 68. In the window that is displayed, select **Virtual Machine Port Group for a Standard Switch**, as shown in Figure 7-32, and click **Next** to continue.



Figure 7-32 Select connection type

4. Select an existing standard switch, as shown in Figure 7-33, and click Next to continue.

vm-host-oracle-01.versastack.loc	al - Add Networking	?
 vm-host-oracle-01.versastack.loc 1 Select connection type 2 Select target device 3 Connection settings 4 Ready to complete 	al - Add Networking Select target device Select at arget device for the new connection. Select an existing standard switch VSwitch0 New standard switch	3
	Back Next Finish Cance	el

Figure 7-33 Select target device

5. Input the planned Network label and VLAN ID, as shown in Figure 7-34. Click **Next** to continue.

vm-host-oracle-01.versastack.local - Add Networking				
 1 Select connection type 2 Select target device 	Connection settings Use network labels to identify migrat	ion-compatible connections common to t	vo or more hosts.	
2 Select target device 3 Connection settings 4 Ready to complete	Network label: VLAN ID (Optional):	Public 11 •		
			Back Next	Finish Cancel

Figure 7-34 Enter planned network label

6. Review the settings before the host networking is created and click **Finish** to submit, as shown in Figure 7-35.

vm-host-oracle-01.versastack.loc	vm-host-oracle-01.versastack.local - Add Networking				
 1 Select connection type 2 Select target device 	Ready to complete Review your settings selections before	e finishing the wizard.			
 3 Connection settings 4 Ready to complete 	Standard switch: Virtual machine port group: VLAN ID:	vSwitch0 Public 11			
			Back Next	Finish Cancel	

Figure 7-35 Review settings

7. After all the host networkings are created, they will be reflected on virtual switch network diagram, as shown in Figure 7-36.

vm-host-oracle-01.versastack	k.local Actions -		=*
Getting Started Summary Mo	nitor Manage Related Objects		
Settings Storage Networking	Alarm Definitions Tags Permissions		
	Virtual switches		
Virtual switches	😟 😡 👼 🖺 🥖 🗙 🕄		
VMkernel adapters	Switch	Discovered Issues	
Physical adapters	1 vSwitch0	-	
TCP/IP configuration			
Advanced			
	Standard switch: vSwitch0 (VMkernel-MGMT)	
	/ ×		C
	 InterConnect VLAN ID: 3175 Virtual Machines (0) Public VLAN ID: 11 Virtual Machines (0) VMkernel-MGMT VLAN ID: 11 	Physical Adapters Winicol 20000 Full Im vmnic1 20000 Full	

Figure 7-36 List host networkings

7.2 Create and modify virtual machines

This section shows how to create virtual machines on an ESXi host, and make the necessary modifications to build the environment for installing the Oracle RAC Database.

The target of this section is to create four virtual machines as planned in Table 7-4.

VM Name	ESXi Host	CPU	Memory	Ethernet Adapters	Disks
ITSO_VM1	vm-host-oracle-01	56 cores	240 GB	1 Public and 1 InterConnect	1 local, 8 shared
ITSO_VM2	vm-host-oracle-02	56 cores	240 GB	1 Public and 1 InterConnect	1 local, 8 shared
ITSO_VM3	vm-host-oracle-03	56 cores	240 GB	1 Public and 1 InterConnect	1 local, 8 shared
ITSO_VM4	vm-host-oracle-04	56 cores	240 GB	1 Public and 1 InterConnect	1 local, 8 shared

Table 7-4 Planned virtual machine configuration

7.2.1 Create virtual machines

Complete these steps to create a virtual machine on one ESXi host from vSphere Web Client:

 From the vSphere Web Client, select vm-host-oracle-01 in the inventory, then right-click vm-host-oracle-01, and select New Virtual Machine → New Virtual Machine as shown in Figure 7-37.



Figure 7-37 New virtual machine

2. Select the creation type as **Create a new virtual machine**, as shown in Figure 7-38, and click **Next** to continue.



Figure 7-38 Select a creation type

3. Specify the name and location of the virtual machine, as shown in Figure 7-39, and click **Next** to continue.



Figure 7-39 Select virtual machine name and folder

4. Select the compute resource of the virtual machine, in this example it is shown on one ESXi host as in Figure 7-40, and click **Next** to continue.

1 New Virtual Machine	(?)
 Select creation type 1a Select a creation type Edit settings 2a Select a name and folder 2b Select a compute resource 2c Select storage 2d Select a guest OS 2f Customize hardware 3 Ready to complete 	Select a compute resource Select the destination compute resource for this operation Q Search WersaStack_DC WersaStack_MGMT WersaStack_Oracle Wm-host-oracle-01.versastack.local Wm-host-oracle-02.versastack.local Wm-host-oracle-04.versastack.local
	Compatibility: Compatibility checks succeeded. Back Next Finish Cancel

Figure 7-40 Select compute resource

5. Select a Datastore for the boot disk of the virtual machine. The boot disk is then stored in the VM_OS datastore, as shown in Figure 7-41, and click Next to continue.

1 New Virtual Machine							€ €	
 Select creation type 1a Select a creation type 	Select storage Select the datastore	Select storage Select the datastore in which to store the configuration and disk files						
2 Edit settings	VM Storage Policy:	Datastore Defau	ult	• 0				
 2a Select a name and folder 	The following datast	ores are accessit	ble from the destin	ation resource that	t you selected. Select the	destination datas	store for the virtual	
✓ 2b Select a compute resource	machine configuration	on files and all of	the virtual disks.					
✓ 2c Select storage	Name		Capacity	Provisioned	Free	Туре	Storage DRS	
2d Select compatibility	DATABASE		6 TB	1,006 MB	6 TB	VMFS 5		
2e Select a quest OS	VM_OS		1,023.75 GB	980 MB	1,022.79 GB	VMFS 5		
2f Customize hardware	ISO_repository		199.75 GB	5.07 GB	194.68 GB	VMFS 5		
	OCR_REDO		99.75 GB	976 MB	98.8 GB	VMFS 5		
3 Ready to complete	ESXI1		32.5 GB	976 MB	31.55 GB	VMFS 5		
	4						Þ	
	Compatibility:	hecks succeeded	1.					
					Back	lext Finis	h Cancel	

Figure 7-41 Select storage

6. For the virtual machine compatibility, keep the default setting as shown in Figure 7-42, and click **Next** to continue.

1 New Virtual Machine			?₩				
Select creation type 1a Select a creation type	Select compatibili Select compatibili	lity ty for this virtual machine depending on the hosts in your environment					
2 Edit settings	The host or cluste	The host or cluster supports more than one VMware virtual machine version. Select a compatibility for the virtual machine.					
 2a Select a name and tolder 2b Select a compute resource 	Compatible with:	ESXI 6.0 and later					
 ✓ 2c Select storage ✓ 2d Select compatibility 	This virtual machi available in ESXi	ne uses hardware version 11 and provides the best performance and latest features 6.0.					
2e Select a guest OS							
2f Customize hardware							
3 Ready to complete							
		Back Next Finish Ca	incel				

Figure 7-42 Select compatibility

 Select a Guest Operating System, Choose Linux in the Guest OS Family menu, and Red Hat Enterprise Linux 7 (64-bit) as the Guest OS Version, as shown in Figure 7-43. Click Next to continue.

1 New Virtual Machine		? >>
Select creation type 1a Select a creation type	Select a guest OS Choose the guest OS that will be installed on the virtual machine	
2 Edit settings	Identifying the guest operating system here allows the wizard to provide the appropriate defaults for the	operating system installation.
 2a Select a name and loider 2b Select a compute resource 	Guest OS Family:	
 2c Select storage 2d Select compatibility 	Guest OS Version: Red Hat Enterprise Linux 7 (64-bit) •	
2e Select a guest OS 2f Customize hardware		
3 Ready to complete		
	Compatibility: ES	Xi 6.0 and later (VM version 11)
	Back Next	Finish Cancel

Figure 7-43 Select guest OS

8. Customize virtual machine hardware, input **CPU** and **Memory** and choose the **Network Adapter** to connect to Public Networking, as shown in Figure 7-44.

🔁 New Virtual Machine		? »
 1 Select creation type ✓ 1a Select a creation type 	Customize hardware Configure the virtual machine hard	tware
2 Edit settings	Virtual Hardware VM Options	SDRS Rules
 2a Select a name and folder 	▶ 🔲 *CPU	56 🗸
2b Select a compute resource 2c Select storage	▶ m *Memory	240 V GB V
 2d Select compatibility 	▶ 🔜 *New Hard disk	
✓ 2e Select a guest OS	▶ 🛃 New SCSI controller	VMware Paravirtual
2f Customize hardware	▶ m *New Network	Public 🗸 🗸 Connect
3 Ready to complete	▶ New CD/DVD Drive 	Client Device
	New Floppy drive	Client Device
	▶ Uideo card	Specify custom settings
	▶ ﷺ VMCI device	
	▶	
	 Other Devices 	
	New device:	Select Add
		Compatibility: ESXi 6.0 and later (VM version 11)
		Back Next Finish Cancel

Figure 7-44 Customize hardware

9. Click the small arrow in front of **New Hard Disk** to expand the disk options, as shown in Figure 7-45. Select **Thick provision eager zeroed** for the **Disk Provisioning** type, and click **Next** to continue.

🔁 New Virtual Machine			? ₩
1 Select creation type	Customize hardware Configure the virtual machine hard	ware	
2 Edit settings	Virtual Hardware VM Options	SDRS Rules	
 2a Select a name and folder 	Maximum Size	1,022.79 GB	
 2b Select a compute resource 	VM storage policy	Datastore Default	
 2c Select storage 	Location	Store with the virtual machine	
 2d Select compatibility 2e Select a guest OS 2f Customize hardware 	Disk Provisioning	Thick provision lazy zeroed Thick provision eager zeroed Thin provision	
3 Ready to complete	Sharing	Unspecified -	
	Shares	Normal - 1000	
	Limit - IOPs	Unlimited	
	Virtual flash read cache	0 GB 🔹 Advanced	
	Virtual Device Node	New SCSI controller	
	Disk Mode	Dependent 🔹 🛈	
		Advance Beneddood	Ŧ
	New device:	Select Add	
		Compatibility: ESXi 6.0 and later (VM version	in 11)
		Back Next Finish Ca	ncel

Figure 7-45 Select disk options

10. Review the virtual machine configuration in the summary tab, as shown in Figure 7-46. If the configuration is correct, click **Finish** to submit virtual machine creation.

1 New Virtual Machine			€ ₩
1 Select creation type	Provisioning type:	Create a new virtual machine	
 1a Select a creation type 	Virtual machine name:	ITSO_VM1	
2 Edit settings	Folder:	VersaStack_DC	
✓ 2a Select a name and folder	Host:	vm-host-oracle-01.versastack.local	
✓ 2b Select a compute resource	Datastore:	VM_OS	
✓ 2c Select storage	Guest OS name:	Red Hat Enterprise Linux 7 (64-bit)	
✓ 2d Select compatibility	CPUs:	56	
✓ 2e Select a guest OS	Memory:	240 GB	
✓ 2f Customize hardware	NICs:	1	
✓ 3 Ready to complete	NIC 1 network:	Public	
	NIC 1 type:	VMXNET 3	
	SCSI controller 1:	VMware Paravirtual	
	Create hard disk 1:	New virtual disk	
	Capacity:	200 GB	
	Datastore:	VM_OS	
	Virtual device node:	SCSI(0:0)	
	Mode:	Dependent	
			Compatibility: ESXi 6.0 and later (VM version 11)
			Back Next Finish Cancel

Figure 7-46 Review virtual machine configuration

Repeat these steps to create four virtual machines according to the planning for this environment.

7.2.2 Add network adapter

Complete these steps to add one additional network adapter for the virtual machines that were created in 7.2.1, "Create virtual machines" on page 75:

1. From the vSphere Web Client, select **ITSO_VM1** in the inventory, right-click **ITSO_VM1**, and select **Edit Settings**, as shown in Figure 7-47.



Figure 7-47 Edit virtual machine settings

2. Click the Virtual Hardware tab, click **New Device** to expand the drop list, and select **Network** in the list, as shown in Figure 7-48, then click **Add** button to continue.



Figure 7-48 Edit virtual machine hardware

3. Select **InterConnect** as the host networking of the newly added network adapter, and select **Connect**, as shown in Figure 7-49. Click the **OK** button to add the network adapter.

ITSO_VM1 - Edit Set	tings (?	¥
Virtual Hardware VM C	Options SDRS Rules vApp Options	
F 🔲 CPU	56 🔹 🔹	
► IIII Memory	245760 V MB V	
▶ 🛄 Hard disk 1	200 GB 💌	
▶ ☑ SCSI controller 0	VMware Paravirtual	
Network adapter 1	Public 🗸 🗸 Connect	
▶	Client Device	
Floppy drive 1	Client Device	_
▶ 🛄 Video card	Specify custom settings	
▶		
VMCI device		
 Other Devices 		
▶ Mew Network	InterConnect Connect	
New device:	Network	
Compatibility: ESXi 6.0 an	nd later (VM version 11) OK Cancel].

Figure 7-49 Add a network adapter

7.2.3 Create shared disks for virtual machines

The plan is to build an environment for running Oracle RAC Database. The shared VMware virtual disks shown in Table 7-5 are planned on all four virtual machines.

Disk Name	Datastore	Size (GB)	SCSI ID	Usage	Shared
OS	VM_OS	200	0:0	Linux OS	No
OCR1	OCR_REDO	5	1:0	Oracle OCR and Voting	Yes
OCR2		5	1:1	Oracle OCR and Voting	Yes
OCR3		5	1:2	Oracle OCR and Voting	Yes
REDO		80	1:3	Oracle Redo log file	Yes

Table 7-5 Disk planning for virtual machines

Disk Name	Datastore	Size (GB)	SCSI ID	Usage	Shared
DATA1	DATABASE	1024	1:4	Oracle data files	Yes
DATA2		1024	1:5	Oracle data files	Yes
DATA3		1024	1:6	Oracle data files	Yes
DATA4		1024	1:8	Oracle data files	Yes

To create shared disks for virtual machines, complete these steps:

- 1. From the vSphere Web Client, select **ITSO_VM1** in the inventory, right-click **ITSO_VM1**, and select **Edit Settings** from pop-up menu.
- 2. Click the Virtual Hardware tab, click **New Device** to expand the drop list, select **SCSI Controller** in the list, as shown in Figure 7-50, then click **Add** to continue.

ITSO_VM1 - Edit Sett	ings		(?) ₩
Virtual Hardware VM C	options SDRS Rules vA	pp Options	
F 🔲 CPU	56 🔹	0	
Memory	245760 👻	MB	
► → Hard disk 1	New Hard Disk	GB 👻	
▶ ☑ SCSI controller 0	Existing Hard Disk		
Network adapter 1		Connect	
▶ Metwork adapter 2	Network	Connect	
▶		Connect	
Floppy drive 1	Floppy Drive	Connect	
Video card		-	
Image: Image	Serial Port		
► i VMCI device	Host USB Device		
 Other Devices 	USB Controller		
	SCSI Device PCI Device Shared PCI Device	_	
	SCSI Controller		
New device:	Select	- Add	
Compatibility: ESXi 6.0 an	d later (VM version 11)	ОК	Cancel

Figure 7-50 Add a SCSI Controller

3. Make sure that the type of the new SCSI controller is **VMware Paravirtual**, as shown in Figure 7-51.

🗗 ITSO_VM1 - Edit Set	tings	(?) ♦
Virtual Hardware VM	Options SDRS Rules vApp Options	
F 🔲 CPU	56 🔹 🖬	
► IIII Memory	245760 v MB v	
▶ / Hard disk 1	200 A GB V	
▶ SCSI controller 0	VMware Paravirtual	
▶ G SCSI controller 1	VMware Paravirtual	
Network adapter 1	Public 🗸 🗸 Connect	
Network adapter 2	InterConnect 🗸 🗸 Connect	
▶	Client Device	
Floppy drive 1	Client Device	
▶ 🛄 Video card	Specify custom settings	
SATA controller 0		
VMCI device		
 Other Devices 		
New device:	Select Add	
Compatibility: ESXi 6.0 ar	nd later (VM version 11) OK	Cancel

Figure 7-51 Virtual machine hardware configuration

4. Click **New Device** to expand the drop list and select **New Hard Disk** in the list, as shown in Figure 7-52. Click **Add** to continue.

🗗 ITSO_VM1 - Edit Sett	ings	- ? »
Virtual Hardware VM C	Dptions SDRS Rules vApp Options	
F 🔲 CPU	56 🔍	
► III Memory	245760 V MB V	
▶ 🛄 Hard disk 1	GB 🗸	
▹ ☑ SCSI controller 0	Existing Hard Disk	
▶ G SCSI controller 1		
Network adapter 1	Vetwork	
Network adapter 2	Connect	
▶	■ CD/DVD Drive	
Floppy drive 1	Connect	
▶ 📃 Video card	Serial Port	
▶	Host USB Device	
VMCI device	USB Controller	
 Other Devices 		
	CSI Device PCI Device	
	Shared PCI Device	
	SCSI Controller	
	SATA Controller	
New device:	Select Add	
Compatibility: ESXi 6.0 an	d later (VM version 11) OK	Cancel

Figure 7-52 Add a new hard disk

5. Click the arrow in front of **New Hard Disk** to expand the settings, input the size of new disk, and select the location of the disk, as shown in Figure 7-53.

ITSO_VM1 - Edit Settings		(?) ₩
Virtual Hardware VM Options	SDRS Rules vApp Options	
Floppy drive 1	Client Device	•
▶ 🛄 Video card	Specify custom settings	
▹ <i>left SATA controller 0</i>		
► A VMCI device		
 Other Devices 		
👻 🛄 New Hard disk	5 GB 👻	
Maximum Size	222.79 GB	
VM storage policy	Datastore Default	
Location	Store with the virtual machine	
Disk Provisioning	Store with the virtual machine	
	Browse	
	O Thin provision	
Sharing	Unspecified	
Shares	Normal 🚽 1000	
Limit - IOPs	Unlimited	
Virtual flash read cache	0 GB - Advanced	
Virtual Device Node	SCSI controller 0 SCSI(0:1)	
Disk Mode	Dependent 🛛 🔹	*
New device:	Add	
Compatibility: ESXi 6.0 and later	(VM version 11) OK Ca	ancel

Figure 7-53 Select new disk location

6. Select the datastore where to store this virtual disk as shown in Figure 7-54, and click **OK** to continue.

Select a datastore cluster or datas	tore			×
VM Storage Policy: Datastore Defau	ult	• 0		
The following datastores are accessit destination datastore for the virtual m	le from the destination achine configuration	on resource that you se files and all of the virtu	elected. Select the al disks.	
Name	Capacity	Provisioned	Free	Туре
DATABASE	6 TB	1,006 MB	6 TB	VMFS (
VM_OS	1,023.75 GB	1.76 TB	222.79 GB	VMFS (
ISO_repository	199.75 GB	5.07 GB	194.68 GB	VMFS (
OCR_REDO	99.75 GB	976 MB	98.8 GB	VMFS (
ESXi1	32.5 GB	976 MB	31.55 GB	VMFS (
4				•
			OK	Cancel

Figure 7-54 Select datastore

- 7. Go back to disk settings, and set the following options, as shown in Figure 7-55 on page 89:
 - a. Disk Provisioning: Thick provision eager zeroed
 - b. Sharing: Multi-writer
 - c. Virtual Device Node: SCSI controller 1, refer to the plan for SCSI ID
 - d. Disk Mode: Independent Persistent

ITSO_VM1 - Edit Settings		
Virtual Hardware VM Options	SDRS Rules vApp Options	
Floppy drive 1	Client Device	*
▶ 🛄 Video card	Specify custom settings	
▶		
VMCI device		
 Other Devices 		
✓ *New Hard disk	5 GB 🔻	
Maximum Size	98.8 GB	
VM storage policy	Datastore Default	
Location	OCR_REDO 💌	
Disk Provisioning	 Thick provision lazy zeroed Thick provision eager zeroed Thin provision 	
Sharing (*)	Multi-writer	
Shares	Normal 💌 1000	
Limit - IOPs	Unlimited	
Virtual flash read cache	0 GB - Advanced	
Virtual Device Node	SCSI controller 1 SCSI(1:0)	
Disk Mode	Dependent 🔹 🛈	•
New device:	Dependent Independent - Persistent	
Compatibility: ESXi 6.0 and later	(Independent - Nonpersiste	ancel

Figure 7-55 Hard disk settings

- 8. Repeat these steps to create all eight shared disks for virtual machine ITSO_VM1.
- 9. From the vSphere Web Client, select **ITSO_VM2** in the inventory, right-click **ITSO_VM2**, and select **Edit Settings** from pop-up menu.
- 10.Click the Virtual Hardware tab, click **New Device** to expand the drop list, select **SCSI Controller** in the list, and click **Add** to add one additional SCSI controller.

11.Click **New Device** to expand the drop list, click **Existing Hard Disk** in the list, as shown in Figure 7-56, and click **Add** to continue.

ITSO_VM2 - Edit Sett	ngs	(? ••
Virtual Hardware VM C	ptions SDRS Rules vApp Op	ptions	
F 🔲 CPU	56 🗣 🕤		
Memory	245760 💌 MB	3 🗸	
▶ 🛄 Hard disk 1	B New Hard Disk GB	• •	
▶ SCSI controller 0	Existing Hard Disk		
▶ G SCSI controller 1	🖧 RDM Disk		
▶ Metwork adapter 1	Metwork	▼ Connect	
Network adapter 2		▼ Connect	
▶ ▶ CD/DVD drive 1 	CD/DVD Drive	Connect	
Floppy drive 1		Connect	
▶ I Video card	Serial Port	T	
Image: Image	Host USB Device		
VMCI device	USB Controller		
 Other Devices 			
	SCSI Device		
	PCI Device		
	Shared PCI Device		
	SCSI Controller		
	SATA Controller		
New device:	Select	Add	
Compatibility: ESXi 6.0 an	d later (VM version 11)	OK Can	zel

Figure 7-56 Add an existing hard disk

12. Select the datastore, and find the file of the shared virtual disk (usually it is a vmdk file), as shown in Figure 7-57. Click **OK** to continue.

Select File					×
Datastores		Contents	11	Information	I
ESXi2		A ITSO_VM1_2.vmdk		Name:	ITSO_VM1.vmdk
ISO_repository		A ITSO_VM1_1.vmdk		Size:	5 GB
▶		A ITSO_VM1.vmdk		Modified:	5/28/16, 7:12 AM
DCR_REDO					
▶ 🗐 DATABASE					
File Type: Compatible Virtual Diak	./*	malk * dok * row)) 1 1		
Compatible virtual Disks	s(".	muk, .usk, ".raw)	J		
				0	K Cancel

Figure 7-57 Select disk location

- 13. Click the arrow in front of **New Hard Disk** to expand the settings, and set the following options, as shown in Figure 7-58 on page 92:
 - a. Sharing: Multi-writer
 - b. Virtual Device Node: SCSI controller 1, refer to the plan for SCSI ID
 - c. Disk Mode: Independent Persistent

Note: The Thick provision eager zeroed virtual disk is shown as lazy zeroed type. Ignore the incorrect disk type that is shown in this example.

ITSO_VM2 - Edit Settings		· ? >>		
Virtual Hardware VM Options	SDRS Rules vApp Options			
▶	Client Device			
Floppy drive 1	Client Device			
▶ Wideo card	Specify custom settings			
SATA controller 0				
VMCI device				
 Other Devices 				
✓ → *New Hard disk	5 GB v			
Maximum Size	222.79 GB			
VM storage policy	Datastore Default			
Туре	Thick provision lazy zeroed			
Sharing (*)	Multi-writer			
Disk File	[OCR_REDO] ITSO_VM1/ITSO_VM1.vmdk	::		
Shares	Normal 🚽 1000			
Limit - IOPs	Unlimited •			
Virtual flash read cache	0 GB - Advanced			
Virtual Device Node	SCSI controller 1 SCSI(1:0)			
Disk Mode (*)	Independent - Per 🔻 🛈	•		
New device:	Existing Hard Disk			
Compatibility: ESXi 6.0 and later (VM version 11) OK Cancel				

Figure 7-58 Hard disk settings

7.2.4 Install VMware Tools

VMware Tools is a suite of utilities provided by VMware. The utilities run on a virtual machine's guest operating system, and improve management of the virtual machine. It is suggested to install VMware Tools on virtual machines in a VersaStack environment.

To check whether VMware Tools is installed, log in to the vSphere Web Client and click the virtual machine's name in the inventory, Figure 7-59 shows a virtual machine with VMware Tools installed and running.



Figure 7-59 VMware Tools running

Figure 7-60 shows a virtual machine that does not have VMware Tools installed yet.



Figure 7-60 VMware Tools not running

To install VMware Tools for a virtual machine running Red Hat Linux, complete these steps:

- 1. Ensure that the virtual machine is powered on.
- From the vSphere Web Client, select virtual machine name in the inventory, right-click virtual machine name, and select Guest OS → Install VMware Tools from pop-up menu, as shown in Figure 7-61.

6	Actions - test	
	Power	>
	Guest OS	Answer Question
	Snapshots	Install VMware Tools
Ę	Open Console	Upgrade VMware Tools
	Migrate	Install/Upgrade VMware Tools
	Clone	Unmount VMware Tools Installer
	Template	Customize Guest OS
	Fault Tolerance	View Guest User Mappings
	VM Policies	IP Addresses:
	Compatibility	Host: Vm-host-oracle-04
	Export System Logs	e 🛈 🍛 🧝 🐄
₽.	Edit Resource Settings	B stalled on this virtual machine.
b	Edit Settings	
	Move To	CPU(s), 0 MHz used
	Rename	2048 MB, 0 MB memory active
	Edit Notes	
	Tags & Custom Attributes	, , , , , , , , , , , , , , , , , , , ,
	Add Permission	GB
	Alarms	ublic (connected)
	Remove from Inventory	isconnected
	Delete from Disk	isconnected
	All vRealize Orchestrator plugin Actions	

Figure 7-61 Install VMware Tools

3. Click **Mount** in the window that opens to mount the VMware Tools disk image to the virtual machine, as shown in Figure 7-62.

Install VMware Tools
VMware Tools includes drivers to improve graphics, mouse, networking, and storage for VMware virtual devices.
Click Mount to mount the disk image with VMware Tools on the virtual CD/DVD drive of the virtual machine. Then, go to the console to run the VMware Tools Install wizard from the virtual CD/DVD.
Click Cancel if the guest OS is not running. The guest OS of the virtual machine must be running to install VMware Tools.
Mount Cancel

Figure 7-62 Mount disk image of VMware Tools

4. Log in to Linux running on the virtual machine as the root user.
5. Create a mount point and mount cdrom in Linux, as shown in Example 7-1.

```
Example 7-1 Create mount point and mount cdrom
```

```
# mkdir /mnt/dvd
# mount /dev/sr0 /mnt/dvd
mount: /dev/sr0 is write-protected, mounting read-only
```

6. Copy the VMware Tools package file to a temporary local directory, and extract the package, as shown in Example 7-2.

```
Example 7-2 Copy and extract VMware tools package
```

```
# cp /mnt/dvd/VMwareTools-9.10.5-2981885.tar.gz /tmp
# cd /tmp/
# tar -zxf VMwareTools-9.10.5-2981885.tar.gz
```

7. Change to the new directory called vmware-tools-distrib, then start the VMware Tools installation, as shown in Example 7-3.

Example 7-3 Install VMware tools

```
# cd /tmp/vmware-tools-distrib/
# ./vmware-install.pl
```

7.2.5 Disable VMware Tools Time Synchronization

Oracle RAC Database uses Cluster Time Synchronization Service (CTSS) service to synchronize time between Oracle RAC nodes, so it is suggested to disable VMware Tools time synchronization on virtual machines.

From the vSphere Web Client, select **ITSO_VM1** in the inventory, right-click **ITSO_VM1** and select **Edit Settings** from pop-up menu. Click VM Options tab, click the arrow in front of VM Tools to expand settings, as shown in Figure 7-63. Make sure that **Synchronize guest time with host** is cleared.

1 ITSO_VM1 - Edit Settings		(?) ►
Virtual Hardware VM Options	SDRS Rules vApp Options	
▶ General Options	VM Name: ITSO_VM1	
VMware Remote Console ▶ Options	Lock the guest operating system when the last remote user disconnects	
Power Operations	Shut Down Guest	-
	Suspend	•
	Power On / Resume VM	
	G Restart Guest	-
Run VMware Tools Scripts	After powering on	
	After resuming	
	✓ Before suspending	
	Before shutting down guest	
Tools Upgrades	Check and upgrade VMware Tools before each power on	
Time	Synchronize guest time with host	
 Power management 	Expand for power management settings	
 Boot Options 	Expand for boot options	
 Advanced 	Expand for advanced settings	
Fibre Channel NPIV	Expand for Fibre Channel NPIV settings	
Compatibility: ESXi 6.0 and later (VM version 11) OK Cancel		

Figure 7-63 VMware Tools settings

7.2.6 Enable disk UUID

The disk Universally Unique Identifier (UUID) is the unique identifier of one disk. By enabling disk UUID on virtual machines, VMware will always present a consistent UUID to the virtual machines. It is useful to identify the name of shared disks on each virtual machine in the cluster.

Complete these steps to enable disk UUID in virtual machines:

- 1. Shut down ITSO_VM1 either from the host or from the vSphere Client.
- 2. From the vSphere Web Client, select **ITSO_VM1** in the inventory, right-click **ITSO_VM1**, and select **Edit Settings** from the pop-up menu.

3. Click the VM Options tab, click the arrow in front of **Advanced** to expand settings, as shown in Figure 7-64, and click **Edit Configuration**.

🗗 ITSO_VM4 - Edit Settings			(?) ▶
Virtual Hardware VM Options S	SDRS Rules	vApp Options	
VMware Remote Console Options	LOCK THE	guest operating system when the last remo ects	te user
VMware Tools	Ex	cpand for VMware Tools settings	
 Power management 	Ex	cpand for power management settings	
 Boot Options 	Ex	cpand for boot options	
- Advanced			
Settings	Disable a	acceleration	
	Enable le	ogging	
Debugging and statistics	Run norma	ally	•
Swap file location	 Default Use the machine 	settings of the cluster or host containing the e.	virtual ::
	 Virtual m Store the machine 	nachine directory e swap files in the same directory as the virtu e.	ual
	 Datastor Store the used for same dir not visib performation 	re specified by host e swap files in the datastore specified by the swap files. If not possible, store the swap fil rectory as the virtual machine. Using a datas le to both hosts during vMotion might affect ance for the affected virtual machines.	host to be les in the store that is the vMotion
Configuration Parameters		Edit Configuration	
Latency Sensitivity	Normal	• 0	-
Compatibility: ESXi 6.0 and later (VN	1 version 11)	ОК	Cancel

Figure 7-64 Virtual machine options

4. The current virtual machine configuration parameters are listed. Click **Add Row** to start adding one more parameter, as shown in Figure 7-65.

Configuration Parameters		
Modify or add configuration parameters as needed for experimental features or as instructed by technical support. Entries cannot be removed.		
Name	Value	
nvram	ITSO_VM4.nvram	
pciBridge0.present	TRUE ::	
svga.present	TRUE	
pciBridge4.present	TRUE	
pciBridge4.virtualDev	pcieRootPort	
pciBridge4.functions	8	
pciBridge5.present	TRUE	
pciBridge5.virtualDev	pcieRootPort	
pciBridge5.functions	8	
pciBridge6.present	TRUE	
pciBridge6.virtualDev	pcieRootPort	
nciBridge6 functions	8	
	Add Row	
	OK Cancel	

Figure 7-65 List virtual machine configuration parameters

5. Input the parameter name as disk.EnableUUID, and value is set to true, as shown in Figure 7-66. Click **OK** to continue.

Configuration Parameters		
Modify or add configuration parameters as needed for experimental features or as instructed by technical support. Entries cannot be removed.		
Name	Value	
replay.filename	<u>۸</u>	
scsi0:0.redo		
scsi1:0.redo		
scsi1:1.redo		
scsi1:2.redo		
scsi1:3.redo		
scsi1:4.redo		
scsi1:5.redo		
scsi1:6.redo		
scsi1:8.redo		
disk.EnableUUID	true	
	T	
	Add Row	
	OK Cancel	

Figure 7-66 Add a configuration parameter

6. Power on the virtual machine.

Repeat the above steps to enable disk UUID on the rest of virtual machines.

To get the UUID of a virtual disk, first locate the file of the virtual disk on ESXi host. It is usually under the directory /vmfs/volumes/datastore_name/virtual_machine_name. Issue the command as shown in Example 7-4 with the root user.

Example 7-4 Inquiry virtual disk UUID

[root@VM-Host-Oracle-01:~] vmkfstools -J getuuid /vmfs/volumes/OCR_REDO/ITSO_VM1/ITSO_VM1.vmdk UUID is 60 00 C2 9d 36 01 a6 44-2f 61 2e f6 39 16 e9 cb

To list the UUIDs of all disks in Red Hat Linux running on virtual machine, go to /dev/disks/by-id/ directory to list the link files whose names start with wwn, as shown in Example 7-5.

Example 7-5 List all disks UUIDs in Red Hat Linux

```
# cd /dev/disk/by-id/
# ls -1 wwn*
lrwxrwxrwx. 1 root root 9 May 27 21:16 wwn-0x6000c29042e2c8f9c2c477aa529cdd43 ->
../../sdf
lrwxrwxrwx. 1 root root 9 May 27 23:16 wwn-0x6000c293cde59615ca88fcd00b3c974f ->
../../sda
lrwxrwxrwx. 1 root root 10 May 27 23:16
wwn-0x6000c293cde59615ca88fcd00b3c974f-part1 -> ../../sda1
lrwxrwxrwx. 1 root root 10 May 27 23:16
wwn-0x6000c293cde59615ca88fcd00b3c974f-part2 -> ../../sda2
lrwxrwxrwx. 1 root root 9 May 27 21:16 wwn-0x6000c2944d3a235c5c249145baebe634 ->
../../sdc
lrwxrwxrwx. 1 root root 9 May 27 21:16 wwn-0x6000c2968068b713c270ca0941fc70aa ->
../../sda
lrwxrwxrwx. 1 root root 9 May 27 21:16 wwn-0x6000c29be3eec07dad92dc236dee7adf ->
../../sdd
lrwxrwxrwx. 1 root root 9 May 27 21:16 wwn-0x6000c29c0f2bb25dc26c365f6ca822e6 ->
../../sdh
lrwxrwxrwx. 1 root root 9 May 27 21:16 wwn-0x6000c29d3601a6442f612ef63916e9cb ->
../../sdb
lrwxrwxrwx. 1 root root 9 May 27 21:16 wwn-0x6000c29d55112026025f75304fd1ad12 ->
../../sdi
lrwxrwxrwx. 1 root root 9 May 27 21:16 wwn-0x6000c29d6ee47e293b0924813b485552 ->
../../sde
```

Use the following command to list UUID for a single disk, as shown in Example 7-6.

Example 7-6 Inquiry UUID for one disk

```
# sg_inq --id /dev/sda
VPD INQUIRY: Device Identification page
Designation descriptor number 1, descriptor length: 20
designator_type: NAA, code_set: Binary
associated with the addressed logical unit
NAA 6, IEEE Company id: 0xc29
```

Note: The **sg_inq** command requires sg3_utils RPM package.

7.3 Considerations of installing Red Hat Enterprise Linux

The installation of Red Hat Enterprise Linux on virtual machines is beyond the intended scope of this book. However, there are two suggestations for the users who install Linux in this environment:

- Base Environment Selection during installation
- Swap size

7.3.1 Base Environment Selection during installation

Oracle Grid Infrastructure and RAC database installation requires a graphic interface. It is suggested to install Red Hat Enterprise Linux Server 7.2 x86_64 version, with **Server with GUI** base environment group selected, as shown in Figure 7-67. The Oracle installation described later is based on this OS version.

ase Environment	Add-Ons for Selected Environment
 Minimal Install Basic functionality. Infrastructure Server Server for operating network infrastructure services. File and Print Server File, print, and storage server for enterprises. Basic Web Server Server for serving static and dynamic internet content. Virtualization Host Minimal virtualization host. 	 Backup Server Software to centralize your infrastructure's backups. DNS Name Server This package group allows you to run a DNS name server (BIND) on the system. E-mail Server Allows the system to act as a SMTP and/or IMAP e- mail server. FTP Server Allows the system to act as an FTP server.
Server with GUI Server for operating network infrastructure services, with a GUI.	 File and Storage Server CIFS, SMB, NFS, iSCSI, iSER, and iSNS network storage server. Hardware Monitoring Utilities

Figure 7-67 Red Hat Environment Groups

7.3.2 Swap size

Red Hat Linux will configure swap automatically during installation. However, it is suggest that you configure the swap size following the rules in Table 7-6, according to the Oracle Database installation guide.

Table 7-6 Swap size suggestation

Memory Size	Swap Size
Between 2 GB and 16 GB	Equal to the size of the RAM
More than 16 GB	16 GB

8

Oracle RAC installation

This chapter describes detailed instructions about how to install Oracle RAC 12c Release 1 (12.1.0.2.0) Enterprise Edition on virtual machines running on the VersaStack environment. It covers following tasks:

- ► Preparing for installing Oracle Grid Infrastructure
- ► Installing Oracle Grid Infrastructure
- ► Installing Oracle RAC database
- Creating ASM Disk Groups
- Creating Oracle RAC database

For more information, see *Oracle Grid Infrastructure Installation Guide 12c Release 1 (12.1) for Linux*, which is found at the following website:

https://docs.oracle.com/database/121/CWLIN/E48914-18.pdf

Also, see Oracle Database Installation Guide 12c Release 1 (12.1) for Linux, which is found at the following website:

https://docs.oracle.com/database/121/LADBI/title.htm

8.1 Oracle Cluster network and storage planning

This section shows the Ethernet network and storage planning of a sample 4-node Oracle RAC cluster.

8.1.1 Network planning

Oracle RAC has the following IP addresses requirements. All these IP addresses should be registered with relevant names in the DNS server before Oracle RAC installation.

- ► A public IP address for each node
- ► A virtual IP address for each node
- ► A private IP address for each node
- Three Single Client Access Name (SCAN) addresses for Oracle RAC cluster

The node IP addresses and names in this environment are detailed in Table 8-1.

	Node1	Node2	Node3	Node4
Public name	itsovm1	itsovm2	itsovm3	itsovm4
Public IP address	192.168.161.71	192.168.161.72	192.168.161.73	192.168.161.74
Virtual name	itsovm1-vip	itsovm2-vip	itsovm3-vip	itsovm4-vip
Virtual IP address	192.168.161.81	192.168.161.82	192.168.161.83	192.168.161.84
Private name	itsovm1-priv	itsovm2-priv	itsovm3-priv	itsovm4-priv
Private IP address	10.0.0.1	10.0.0.2	10.0.0.3	10.0.0.4

Table 8-1 Node IP addresses

The SCAN IP addresses and name in this environment are detailed in Table 8-2.

Table 8-2	SCAN IP	addresses
-----------	---------	-----------

SCAN name	SCAN IP
itso-cluster-scan	192.168.161.75
	192.168.161.76
	192.168.161.77

8.1.2 Storage planning

According to disk planning for virtual machines in Table 7-5 on page 83, eight shared disks are mapped to each node. The ASM disk groups are detailed in Table 8-3.

ASM Disk Group	Disk Size(GB)	Disk UUID
OCR	5	6000c29d3601a6442f612ef63916e9cb
	5	6000c2944d3a235c5c249145baebe634
	5	6000c29be3eec07dad92dc236dee7adf

 Table 8-3
 Storage planning

ASM Disk Group	Disk Size(GB)	Disk UUID
REDO	80	6000c29042e2c8f9c2c477aa529cdd43
DATA	1024	6000c29d6ee47e293b0924813b485552
	1024	6000c2968068b713c270ca0941fc70aa
	1024	6000c29c0f2bb25dc26c365f6ca822e6
	1024	6000c29d55112026025f75304fd1ad12

8.2 Oracle RAC installation preparation

This section describes the necessary preparation tasks on the Linux operating system before Oracle RAC installation, and includes the following areas:

- Hardware configuration check
- Kernel and Linux operating system check
- Linux operating system configuration
- Oracle ASMLib installation and configuration

Note:

- 1. Unless specified, run all the actions described in this section on each node of the Oracle RAC cluster.
- 2. Unless specified, run all the commands in this section using the root user.

8.2.1 Check hardware configuration

To install Oracle RAC 12c on Linux x86_64 platform, the following hardware requirements should be met:

- At least 4 GB of RAM for Oracle Grid Infrastructure and Oracle Database.
- At least one 1 GbE Ethernet interface card for public network communication (suggest having two cards bonded as one for redundancy), 10 GbE is preferred.
- At least one 1 GbE Ethernet interface card for private network communication (suggest having two cards bonded as one for redundancy), 10 GbE is preferred.
- Server should be started in runlevel 3 or runlevel 5.
- ► Server display cards provide at least 1024 x 768 display resolution.
- Server is connected to the network, contains a display monitor and DVD drive.
- ► At least 6.1 GB of disk space for an Oracle Database.
- ► At least 6.9 GB of disk space for an Oracle Grid Infrastructure.
- At least 1 GB allocated to /tmp.

To check hardware configuration on each node, complete these steps:

1. Use grep MemTotal /proc/meminfo command to check the system memory size, Example 8-1 shows that the total memory size of this virtual machine is 247458036 kB.

Example 8-1 Check memory size # grep MemTotal /proc/meminfo MemTotal: 247458036 kB

2. Use **ip link** or **ifconfig -a** command to check existing Ethernet interfaces, Example 8-2 shows that there are two Ethernet interfaces installed in this virtual machine.

Example 8-2 Check Ethernet interfaces

```
# ip link
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN mode
DEFAULT
    link/loopback 00:00:00:00:00 brd 00:00:00:00:00
2: eno16782080: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP
mode DEFAULT qlen 1000
    link/ether 00:50:56:b7:8b:75 brd ff:ff:ff:ff:ff
3: eno33561344: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP
mode DEFAULT qlen 1000
    link/ether 00:50:56:b7:de:f0 brd ff:ff:ff:ff:ff:ff
```

 To check the current running speed of an Ethernet interface, use the ethtool command followed by the interface name, Example 8-3 shows this Ethernet is running at 10 Gbps (10000 Mb/s).

Example 8-3 Show Ethernet speed

```
# ethtool eno16782080
Settings for eno16782080:
  Supported ports: [ TP ]
  Supported link modes:
                           1000baseT/Full
                           10000baseT/Full
  Supported pause frame use: No
  Supports auto-negotiation: No
  Advertised link modes: Not reported
  Advertised pause frame use: No
  Advertised auto-negotiation: No
  Speed: 10000Mb/s
  Duplex: Full
  Port: Twisted Pair
  PHYAD: 0
  Transceiver: internal
  Auto-negotiation: off
  MDI-X: Unknown
  Supports Wake-on: uag
  Wake-on: d
  Link detected: yes
```

4. Use **run1eve1** command to check the current run level of operating system, Example 8-4 shows operating system is running at runlevel 5.

```
Example 8-4 Check Linux run level
```

runlevel
N 5

Note: Runlevel 5 means Linux host boots into a graphical environment.

5. To check usable file system size, use df -h command in Linux.

8.2.2 Check Linux kernel and OS version

For Oracle running on Red Hat Enterprise Linux 7.x x86_64 platform, it requires Linux Kernel version 3.10.0-54.0.1.el7.x86_64 or later. Use the **uname** -a command to check current kernel version on Linux, as shown in Example 8-5.

Example 8-5 Check Linux kernel version

uname -a
Linux localhost.localdomain 3.10.0-327.el7.x86_64 #1 SMP Thu Oct 29 17:29:29 EDT
2015 x86_64 x86_64 x86_64 GNU/Linux

Another alternative is to check Red Hat OS version. The kernel version of each Red Hat Linux release is published on the following Red Hat website:

https://access.redhat.com/articles/3078

To check the current OS version, use either of the following commands that are shown in Example 8-6. The OS version that was used in this environment is Red Hat Enterprise Linux Server 7.2.

Example 8-6 Check OS version

```
# cat /etc/redhat-release
Red Hat Enterprise Linux Server release 7.2 (Maipo)
# lsb_release -a
LSB Version::core-4.1-amd64:core-4.1-noarch
Distributor ID:RedHatEnterpriseServer
```

```
Description:Red Hat Enterprise Linux Server release 7.2 (Maipo)
Release:7.2
Codename:Maipo
```

Note: The **1sb_release** command requires the redhat-lsb-core RPM package to be installed.

8.2.3 Setup hostname

A host uses the default hostname localhost if it is not set during OS installation. A host deployed from VMware virtual machine template always has the same hostname with its template. Oracle RAC database requires that each node in the cluster has a unique name.

To set a hostname for a host, use the **hostnamect1** set-hostname command followed by the wanted hostname as shown in Example 8-7.

Example 8-7 Setup hostname

```
# hostnamectl set-hostname itsovm1
```

To verify the configured hostname, use the hostnamect1 command as shown in Example 8-8.

Example 8-8 Listing hostname information

```
# hostnamectl
Static hostname: itsovm1
Icon name: computer-vm
Chassis: vm
Machine ID: d930cf0ba73c4d15b74d71f7d66ab66d
Boot ID: 20bef504e6d242c08141d073aed3445a
Virtualization: vmware
Operating System: Red Hat Enterprise Linux Server 7.2 (Maipo)
CPE OS Name: cpe:/o:redhat:enterprise_linux:7.2:GA:server
Kernel: Linux 3.10.0-327.el7.x86_64
Architecture: x86-64
```

After the hostname is set up, the next action is to update /etc/hosts file with a line containing the current IP address and hostname. A sample of the /etc/hosts file is shown in Example 8-9.

Example 8-9 A /etc/hosts sample

```
# more /etc/hosts
127.0.0.1 localhost localhost.localdomain localhost4 localhost4.localdomain4
::1 localhost localhost.localdomain localhost6 localhost6.localdomain6
192.168.161.71 itsovm1
```

Note: Do not append hostname to the loopback address in the /etc/hosts file.

8.2.4 Configure IP address

IP address on the Ethernet interface cannot be configured during Red Hat OS installation, and to verify whether it is configured or not, use **ifconfig** -a command as shown in Example 8-10.

Example 8-10 Check IP addresses on Ethernet interfaces

```
# ifconfig -a
eno16782080: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
inet 192.168.161.71 netmask 255.255.252.0 broadcast 192.168.163.255
inet6 fe80::250:56ff:feb7:8b75 prefixlen 64 scopeid 0x20<link>
ether 00:50:56:b7:8b:75 txqueuelen 1000 (Ethernet)
RX packets 3618801 bytes 5332420791 (4.9 GiB)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 171808 bytes 13282007 (12.6 MiB)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
eno33561344: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
ether 00:50:56:b7:de:f0 txqueuelen 1000 (Ethernet)
```

```
RX packets 3 bytes 180 (180.0 B)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 0 bytes 0 (0.0 B)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
```

Example 8-10 shows Ethernet interface eno16782080 is configured with IP address 192.168.161.71, while Ethernet interface eno33561344 is not. Because the two Ethernet interfaces in this node are connected to a public and private network respectively, it is important to confirm that the correct IP address is configured on the correct Ethernet interface so that network communication is operational. To do so, complete the following steps:

1. Retrieve MAC addresses of public and private interfaces from VMware vSphere.

From the vSphere Web Client, select **ITSO_VM1** in the inventory, navigate to **VM Hardware** in **Summary** in right pane, and click **Network Adapter 1** and **Network Adapter 2** to show more information, as shown in Figure 8-1.

TISO_VM1 Actions -		
Getting Started Summary M	onitor Manage Related Objects	
▼ VM Hardware		
▶ CPU	56 CPU(s), 518 MHz used	
Memory	245760 MB, 0 MB memory active	
Hard disk 1	200 GB	
Hard disk 2	5 GB	
Other hard disks	9 hard disks (view disks)	
 Network adapter 1 		
MAC Address	00:50:56:b7:8b:75	
DirectPath I/O	Inactive 👔	
Network	Public (connected)	
MAC Address	00:50:56:b7:de:f0	
DirectPath I/O	Inactive 👔	
Network	InterConnect (connected)	

Figure 8-1 Check MAC Addresses of Ethernet interfaces

2. Determine the device names of public and private interfaces by comparing to MAC addresses from VMware and Linux.

By comparing the MAC addresses from vSphere Web Client with the output of command **ifconfig** -a, you can tell the device name of public Ethernet interface is eno16782080, and private Ethernet interface is eno33561344.

3. Verify or configure IP addresses for public and private interfaces.

According to 8.1.1, "Network planning" on page 104, the IP addresses of Ethernet adapters for this node is shown in Table 8-4.

Network	Device name	IP address	
Public	eno16782080	192.168.161.71	
Private	eno33561344	10.0.0.1	

Table 8-4 IP addresses for interfaces

To verify whether IP address is configured on Ethernet interface or not, use the command **ifconfig** -a. If it is not configured, use a tool to modify the configuration file that is located in the /etc/sysconfig/network-scripts directory. The configuration file name should start with **ifcfg**-, and be followed by the device name of Ethernet interface. For example, **ifcfg-eno33561344** is the configuration file for Ethernet interface eno33561344.

Usually you must change the following parameters in the Ethernet interface configuration file.

BOOTPROTO	Change from dhcp to none
ONBOOT	Change from no to yes
NETMASK or PREFIX	Specify network mask
IPADDR	Specify IP address of interface

Example 8-11 shows a completed Ethernet interface configuration file.

Example 8-11 Ethernet interface configuration file

cat /etc/sysconfig/network-scripts/ifcfg-eno33561344 **TYPE=Ethernet** BOOTPROTO=none DEFROUTE=yes IPV4 FAILURE FATAL=no IPV6INIT=yes IPV6 AUTOCONF=yes IPV6 DEFROUTE=yes IPV6 FAILURE FATAL=no NAME=eno33561344 UUID=493bbcbe-5c6d-4257-b627-cb817ff9bc13 DEVICE=eno33561344 ONBOOT=yes IPADDR=10.0.0.1 PREFIX=24 IPV6 PEERDNS=yes IPV6 PEERROUTES=yes

To activate network configuration with latest configuration file, run the **systemct1** restart **network.service** command.

Note: Clients can also use Red Hat graphic tool to configure IP address for Ethernet interface. To start this tool, run the **gnome-control-center** command in the Linux GUI, and click the **Network** icon.

8.2.5 Check swap size

Usually the swap size in Linux is related to the system memory size. Table 8-5 describes the suggested relationship between the system memory size and swap size.

Table 8-5 Swap size requirement

Memory Size	Swap Size
Between 2 GB and 16 GB	Equal to the size of the RAM
More than 16 GB	16 GB

The system memory size of the node in this environment is 240 GB. According to the above rule, a 16 GB swap size is required, Example 8-12 shows how to check swap size in Linux.

Example 8-12 Check swap size in Linux

grep SwapTotal /proc/meminfo
SwapTotal: 16883708 kB

8.2.6 Enable jumbo frames support on private Ethernet interface

Jumbo frames are Ethernet frames with more than 1,500 bytes of payload (MTU). Typical jumbo frames can carry up to 9,000 bytes of payload. Usually enabling jumbo frames can improve network performance as well as reduce server usage and CPU cycles while transferring large files.

Jumbo Frames have these requirements on hardware and configuration:

- 1. Ethernet interfaces and switches are running in 10 Gb mode.
- 2. All network components from end to end support jumbo frames configuration.

Generally, enable jumbo frames support on the private Ethernet interface for Oracle RAC node. However, enabling jumbo frames support on the public Ethernet interface is optional, depending on customer network environment and server configuration.

Ethernet interfaces and switches in the VersaStack environment are all capable of running at 10 Gb mode, and it is possible to configure jumbo frames support on Ethernet switches.

Form information about configuring jumbo frames support on Ethernet interfaces in VMware ESXi, see 7.1.6, "Enable Jumbo Frames" on page 69.

To configure jumbo frames support on private Ethernet interface on Oracle RAC node, navigate to the /etc/sysconfig/network-scripts directory, open the private interface configuration file, and append one row that describes MTU, as shown in Example 8-13.

Example 8-13 Enable jumbo frames

echo 'MTU=9000' >> /etc/sysconfig/network-scripts/ifcfg-eno33561344

After you restart the Linux network service, the private Ethernet interface should be able to support jumbo frames. Example 8-14 shows how to use the **ping** command to test jumbo frames in Linux.

Example 8-14 Jumbo Frames testing

```
# ping -s 8192 10.0.0.2
PING 10.0.0.2 (10.0.0.2) 8192(8220) bytes of data.
8200 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=0.609 ms
8200 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.326 ms
8200 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.346 ms
8200 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.348 ms
8200 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=0.308 ms
```

8.2.7 Configure DNS Server

Use DNS to resolve names that are used in Oracle RAC environment, especially SCAN. To configure DNS Servers for a node, modify the /etc/resolve.conf file to add the correct search and nameserver parameters. Example 8-15 shows a typical DNS configuration file on the Linux host.

Example 8-15 DNS configuration file

cat /etc/resolv.conf
search versastack.local
nameserver 192.168.161.50
nameserver 192.168.161.51

According to our network planning, Oracle SCAN in DNS is required to be configured as one single name entry with three A records. After DNS is set up, make sure that all three A records are returned in **nslookup**. Example 8-16 shows how to test whether Oracle SCAN name resolution is correctly configured in DNS server.

Example 8-16 DNS lookup test

```
# nslookup
> itso-cluster-scan
Server: 192.168.161.50
Address: 192.168.161.50#53
Name: itso-cluster-scan.versastack.local
Address: 192.168.161.77
Name: itso-cluster-scan.versastack.local
Address: 192.168.161.76
Name: itso-cluster-scan.versastack.local
Address: 192.168.161.75
```

8.2.8 Synchronize Time with Time Server

Oracle RAC Cluster requires that the echo node in the cluster is configured with the same time zone, and the clock on each node is synced. There are two supported options for time synchronization:

- An operating system configured Network Time Protocol (NTP)
- Oracle Cluster Time Synchronization Service (CTSS)

To check current time and time zone information, run the **timedatect1** command as shown in Example 8-17.

Example 8-17 Check time and time zone

```
# timedatectl
Local time: Mon 2016-05-30 13:18:58 EDT
Universal time: Mon 2016-05-30 17:18:58 UTC
RTC time: Mon 2016-05-30 19:19:02
Time zone: America/New_York (EDT, -0400)
NTP enabled: yes
NTP synchronized: no
RTC in local TZ: no
DST active: yes
Last DST change: DST began at
Sun 2016-03-13 01:59:59 EST
Sun 2016-03-13 03:00:00 EDT
Next DST change: DST ends (the clock jumps one hour backwards) at
Sun 2016-11-06 01:59:59 EDT
Sun 2016-11-06 01:00:00 EST
```

If the time zone is not correctly configured, run the **timedatect1 set-timezone** command followed by the wanted time zone city, which can be gotten from the **timedatect1 list-timezones** command as shown in Example 8-18.

Example 8-18 List timezones

timedatectl list-timezones
Africa/Abidjan
Africa/Accra
Africa/Addis_Ababa
Africa/Algiers
...<truncated output>...

Before starting Oracle RAC installation, ensure that the clocks on all nodes are set to the same time. Therefore, a manual time sychronization with the time server is required. To start the synchronization process, run the **ntpdate** command followed by a legal time server provided by system administrator, as shown in Example 8-19.

Example 8-19 Synchronize time by using ntpdate

```
# ntpdate -v 192.168.160.254
26 May 11:34:37 ntpdate[26430]: ntpdate 4.2.6p5@1.2349-o Fri Oct 16 08:51:51 UTC
2015 (1)
26 May 11:34:56 ntpdate[26430]: step time server 192.168.160.254 offset 12.412580
sec
```

This environment uses the Oracle CTSS service to synchronize time between Oracle RAC nodes. In this case, disable the NTP service. First, check whether the ntp package is installed, as shown in Example 8-20.

Example 8-20 Query ntp package

```
# rpm -qa|grep ntp
ntpdate-4.2.6p5-22.el7.x86_64
fontpackages-filesystem-1.44-8.el7.noarch
```

python-ntplib-0.3.2-1.el7.noarch ntp-4.2.6p5-22.el7.x86_64

If ntp package is not listed in the above output, no action is required. Otherwise, it is suggested to stop and disable ntp service, and remove the ntpd.pid file, as shown in Example 8-21.

Example 8-21 Stop and disable ntpd service

```
# systemctl status ntpd.service
# systemctl stop ntpd.service
# systemctl disable ntpd.service
# rm /var/run/ntpd.pid
```

8.2.9 Install required RPM packages

To install Oracle RAC Database 12c on Red Hat Enterprise Linux 7 (x86_64), the following RPM packages are required:

- compat-libcap1
- compat-libstdc++-33
- ► gcc
- ▶ gcc-c++
- ► glibc
- ▶ glibc-devel
- ► ksh
- ► libaio
- libaio-devel
- ► libgcc
- libstdc++
- ► libstdc++-devel
- ► libXi
- ► libXtst
- ▶ make
- sysstat

Tips:

- It is suggested to configure yum to install these required RPM packages because some of the packages that are listed have dependent packages.
- compat-libstdc++-33 package is in rhel-7-server-optional-rpms repository, which is not enabled by default.

To check whether these packages are installed, save this package list to a file named pkg.lst in Linux, and run the command shown in Example 8-22. A prompt of xxx is not installed is shown in the output if a required package is missing.

Example 8-22 Check required rpm packages

```
# for i in `cat pkg.lst`;do rpm -q $i;done
compat-libcap1-1.10-7.el7.x86_64
compat-libstdc++-33-3.2.3-72.el7.x86_64
gcc-4.8.5-4.el7.x86_64
gcc-c++-4.8.5-4.el7.x86_64
glibc-2.17-105.el7.x86_64
```

```
glibc-devel-2.17-105.el7.x86_64
ksh-20120801-22.el7_1.2.x86_64
libaio-0.3.109-13.el7.x86_64
libaio-devel-0.3.109-13.el7.x86_64
libgcc-4.8.5-4.el7.x86_64
libstdc++-4.8.5-4.el7.x86_64
libstdc++-devel-4.8.5-4.el7.x86_64
libXtst-1.2.2-2.1.el7.x86_64
make-3.82-21.el7.x86_64
sysstat-10.1.5-7.el7.x86_64
```

8.2.10 Create users and groups

For installing and administering Oracle Grid Infrastructure and Oracle RAC Database software, it is suggested to create different users and groups in Linux. The Oracle Grid Infrastructure software owner is the user grid and the Oracle Database software owner is the user oracle in this environment.

Example 8-23 shows the commands to create users, groups, and directories required for Oracle installation.

Example 8-23 Commands to create users, groups, and directories for Oracle installation

```
# /usr/sbin/groupadd -g 54321 oinstall
# /usr/sbin/groupadd -g 54322 dba
# /usr/sbin/groupadd -g 54323 oper
# /usr/sbin/groupadd -g 54324 backupdba
# /usr/sbin/groupadd -g 54325 dgdba
# /usr/sbin/groupadd -g 54326 kmdba
# /usr/sbin/groupadd -g 54327 asmdba
# /usr/sbin/groupadd -g 54328 asmoper
# /usr/sbin/groupadd -g 54329 asmadmin
# useradd -u 54421 -g oinstall -G dba,oper,backupdba,dgdba,kmdba,asmdba,asmoper
oracle
# useradd -u 54422 -g oinstall -G dba,asmadmin,asmdba,asmoper grid
# mkdir -p /u01/app/grid
# mkdir -p /u01/app/oracle
# mkdir -p /u01/app/12.1.0/grid
# mkdir -p /u01/app/oraInventory
# chown -R oracle:oinstall /u01
# chown oracle:oinstall /u01/app/oracle
# chown grid:oinstall /u01/app/grid
# chown grid:oinstall /u01/app/oraInventory
# chmod -R 775 /u01/
```

After the oracle user and grid user are created, use the **id** command to verify the group information of each user, as shown in Example 8-24.

Example 8-24 Verify user group information

```
# id grid
uid=54422(grid) gid=54321(oinstall)
groups=54321(oinstall),54322(dba),54327(asmdba),54328(asmoper),54329(asmadmin)
```

```
# id oracle
uid=54421(oracle) gid=54321(oinstall)
groups=54321(oinstall),54322(dba),54323(oper),54324(backupdba),54325(dgdba),54326(
kmdba),54327(asmdba),54328(asmoper)
```

To allow a successful login of the oracle and grid user later, the password of each user has to be set, as shown in Example 8-25.

Example 8-25 Set up password for oracle and grid user

```
# passwd oracle
Changing password for user oracle.
New password:
Retype new password:
passwd: all authentication tokens updated successfully.
# passwd grid
Changing password for user grid.
New password:
Retype new password:
passwd: all authentication tokens updated successfully.
```

8.2.11 Configure firewall

Starting from Red Hat Enterprise Linux 7, a new dynamic firewall daemon firewalld is introduced. This daemon provides a dynamically managed firewall with support for network "zones" to assign a level of trust to a network and its associated connections and interfaces. For more information about firewalld, see Section 4.5 in the *Red Hat Enterprise Linux 7 Security Guide*, which is available at:

https://access.redhat.com/documentation/en-US/Red_Hat_Enterprise_Linux/7/html/Secu
rity_Guide/sec-Using_Firewalls.html

A zone in firewalld defines the level of trust for network connections. There are nine zones predefined in firewalld in total. Only these zones are going to be modified in this environment:

- public zone: Default zone, for use in public areas. All connections from other computers are denied except for selected incoming connections.
- trusted zone: All network connections are accepted.

Example 8-26 shows how to list the current public and trusted zone configuration.

Example 8-26 List runtime public and trusted zone configuration

```
# firewall-cmd --zone=public --list-all
public (default, active)
    interfaces: eno16782080 eno33561344
    sources:
    services: dhcpv6-client ssh
    ports:
    masquerade: no
    forward-ports:
    icmp-blocks:
    rich rules:
```

```
# firewall-cmd --zone=trusted --list-all
trusted
interfaces:
sources:
services:
ports:
masquerade: no
forward-ports:
icmp-blocks:
rich rules:
```

To make sure that Oracle RAC Database Cluster is able to provide services for external clients, network connections from the following TCP ports should be accepted:

- ► Port 1521 Oracle Transparent Network Substrate (TNS) Listener port
- Port 5500 Oracle Enterprise Manager port

Example 8-27 shows how to add the port to the public zone.

Example 8-27 Add port to public zone

```
# firewall-cmd --zone=public --add-port=1521/tcp
success
# firewall-cmd --zone=public --add-port=5500/tcp
success
```

It is suggested to allow all network traffic on the private interconnect Ethernet interface. For Oracle RAC installation, it is better to trust service IP addresses of Oracle RAC nodes. Example 8-28 shows how to configure the trusted zone.

Example 8-28 Configure trusted zone

```
# firewall-cmd --zone=trusted --change-interface=eno33561344
success
# firewall-cmd --zone=trusted --add-source=192.168.160.0/22
success
```

After an Ethernet interface is added to the trusted zone in firewall, the interface configuration file also needs to be updated to make sure that the configuration is persistent, as shown in Example 8-29.

Example 8-29 Modify interface configuration file

echo 'ZONE=trusted' >> /etc/sysconfig/network-scripts/ifcfg-eno33561344

Any changes that are made to firewalld need to be saved by using the command shown in Example 8-30 in case the configuration is lost after the firewall daemon reload.

Example 8-30 Save firewall configuration

```
# firewall-cmd --runtime-to-permanent
success
```

The final permanent firewall configuration is shown in Example 8-31.

Example 8-31 Show permanent firewall configuration

```
# firewall-cmd --permanent --zone=public --list-all
public (default, active)
  interfaces: eno16782080
  sources:
  services: dhcpv6-client ssh
  ports: 1521/tcp 5500/tcp
 masquerade: no
  forward-ports:
  icmp-blocks:
  rich rules:
# firewall-cmd --permanent --zone=trusted --list-all
trusted (active)
  interfaces: eno33561344
  sources: 192.168.160.0/22
  services:
  ports:
  masquerade: no
  forward-ports:
  icmp-blocks:
  rich rules:
```

Note: Linux Firewall can be also configured by using the graphical user interface tool **firewall-config**.

8.2.12 Configure SELinux

Security-Enhanced Linux (SELinux) is an implementation of a flexible mandatory access control architecture in the Linux operating system. It is suggested to run SELinux in enforcing mode. To check the status of SELinux, run the **sestatus** command as shown in Example 8-32.

Example 8-32 Check SELinux status

# sestatus	
SELinux status:	enabled
SELinuxfs mount:	/sys/fs/selinux
SELinux root directory:	/etc/selinux
Loaded policy name:	targeted
Current mode:	enforcing
Mode from config file:	enforcing
Policy MLS status:	enabled
Policy deny_unknown status:	allowed
Max kernel policy version:	28

There is a known issue that the oracleasm script might fail if SELinux is in enforcing mode. For more detailed information and instructions on how to work around the issue, see the following guide:

https://docs.oracle.com/cd/E52668 01/E53499/E53499.pdf

It is suggested to disable the SELinux policy module for oracleasm as shown in Example 8-33.

Example 8-33 Disable SELinux policy module for oracleasm

```
# semodule -d oracleasm
# semodule -1|grep oracleasm
oracleasm 1.0.0 Disabled
```

8.2.13 Set Kernel parameters

Many kernel parameters are required to be configured for Oracle installation. The descriptions of each kernel parameter and its suggested value are shown in Table 8-6.

Table 8-6 Kernel parameters

Kernel Parameter	Description	Suggested Value
kernel.sem	The kernel parameter sem is composed of four parameters: SEMMSL, SEMMNI, SEMMNS, SEMOPM.	250 32000 100 128
kernel.shmmax	This kernel parameter defines the maximum size in bytes of a single shared memory segment that a Linux process can allocate in its virtual address space.	Half of memory in bytes
kernel.shmmni	SHMMNI is the maximum number of shared memory segments.	4096
kernel.shmall	This parameter sets the total number of shared memory pages that can be used.	Memory size * 0.4 / Page size
fs.file-max	This parameter defines the maximum number of open file handles.	6815744
net.ipv4.ip_local_port_r ange	This parameter defines the range that local ports are allowed in for TCP and UDP traffic.	9000 65535
net.core.rmem_default	This parameter defines the default setting in bytes of the socket receive buffer.	262144
net.core.rmem_max	This parameter defines the maximum socket receive buffer size in bytes.	4194304
net.core.wmem_default	This parameter defines the default setting in bytes of the socket send buffer.	262144
net.core.wmem_max	This parameter defines the maximum socket send buffer size in bytes.	1048576
fs.aio-max-nr	This parameter sets the maximum number of concurrent asynchronous I/O requests.	1048576

To modify these kernel parameters, edit /etc/sysctl.conf to add the lines that are shown in Example 8-34.

Example 8-34 /etc/sysctl.conf

kernel.sem = 250 32000 100 128 kernel.shmmax = 126698514432

```
kernel.shmmni = 4096
kernel.shmall = 24745803
fs.file-max = 6815744
net.ipv4.ip_local_port_range = 9000 65535
net.core.rmem_default = 262144
net.core.rmem_max = 4194304
net.core.wmem_default = 262144
net.core.wmem_max = 1048576
fs.aio-max-nr = 1048576
```

In order for the changes to take effect immediately, run the command shown in Example 8-35.

```
Example 8-35 Refresh with the new configuration
```

sysctl -p /etc/sysctl.conf

8.2.14 Set user limits

For grid owner user and database owner user, Oracle requires that you set appropriate system resource limits, and the suggested ranges are shown in Table 8-7.

Resource	Description	Soft Limit	Hard Limit
nofile	Maximum number of open file descriptors	>= 1024	>= 65536
nproc	DC Maximum number of processes		>= 16384
stack	Maximum stack size (KB)	> 10240KB	<= 32768KB
memlock	Maximum locked-in-memory address space (KB)	> = 90% Memory with HugePages	> = 90% Memory with HugePages

Table 8-7 Resource limit

To check the current user soft and hard limits, log in to Linux with the username that you want, and run the command ulimit -Sa and ulimit -Ha.

To update the limits of oracle and grid user in this environment, open the /etc/security/limits.conf file and add content as shown in Example 8-36. The maximum number of processes limit (npoc) is not added to this file because the default limits setting meets the requirement.

Example 8-36	Oracle and grid user limit
Example o-30	Oracle and grid user minit

oracle	soft	nofile	4096
oracle	hard	nofile	65536
oracle	soft	stack	10240
oracle	hard	stack	32768
oracle	soft	memlock	222712233
oracle	hard	memlock	222712233
grid	soft	nofile	4096
grid	hard	nofile	65536
grid	soft	stack	10240
grid	hard	stack	32768
grid	soft	memlock	222712233
grid	hard	memlock	222712233

The limits setting should be effective immediately after the user logs in again. Double-check the limits before Oracle installation. Example 8-37 shows the updated limits of the oracle user.

Example 8-37 Oracle user limits

<pre>[oracle@itsovm1 ~]\$ </pre>	ulimit -Sa	
core file size	(blocks, -c)	0
data seg size	(kbytes, -d)	unlimited
scheduling priority	(-e)	0
file size	(blocks, -f)	unlimited
pending signals	(-i)	966511
max locked memory	(kbytes, -1)	222712233
max memory size	(kbytes, -m)	unlimited
open files	(-n)	4096
pipe size	(512 bytes, -p)	8
POSIX message queues	(bytes, -q)	819200
real-time priority	(-r)	0
stack size	(kbytes, -s)	10240
cpu time	(seconds, -t)	unlimited
max user processes	(-u)	4096
virtual memory	(kbytes, -v)	unlimited
file locks	(-x)	unlimited
[oracle@itsovm4 ~]\$ u	ulimit -Ha	
core file size	(blocks, -c)	unlimited
data seg size	(kbytes, -d)	unlimited
scheduling priority	(-e)	0
file size	(blocks, -f)	unlimited
pending signals	(-i)	966511
max locked memory	(kbytes, -1)	222712233
max memory size	(kbytes, -m)	unlimited
open files	(-n)	65536
pipe size	(512 bytes, -p)	8
POSIX message queues	(bytes, -q)	819200
real-time priority	(-r)	0
stack size	(kbytes, -s)	32768
cpu time	(seconds, -t)	unlimited
max user processes	(-u)	966511
virtual memory	(kbytes, -v)	unlimited
file locks	(-x)	unlimited

8.2.15 Disable avahi-daemon service and Zero Configuration Networking

Avahi is a daemon that runs on Linux by default. It implements Apple's Zeroconf architecture (also known as "Rendezvous" or "Bonjour"). It might cause ora.cssd fails to join the cluster in certain situations. Therefore, Oracle suggests that you disable the avahi-daemon service. For more information, see the following Oracle document:

https://support.oracle.com/epmos/faces/DocumentDisplay?parent=DOCUMENT&id=1501093.1

To check current avahi-daemon status, run the **systemctl status avahi-daemon** command as shown in Example 8-38.

Example 8-38 Check avahi-daemon status

<pre># systemctl</pre>	status avahi-daemon
avahi-daemo	on.service – Avahi mDNS/DNS-SD Stack
Loaded:	<pre>loaded (/usr/lib/systemd/system/avahi-daemon.service; enabled; vendor</pre>
preset: ena	abled)
Active:	active (running) since Fri 2016-05-27 11:33:38 EDT; 1h 2min ago
Main PID:	1513 (avahi-daemon)
Status:	"avahi-daemon 0.6.31 starting up."
CGroup:	/system.slice/avahi-daemon.service
	<pre>・・1513 avahi-daemon: running [linux.local]</pre>
	••1521 avahi-daemon: chroot helper

Example 8-39 shows how to disable the avahi-daemon persistently.

Example 8-39 Disable avahi-daemon service

```
# systemctl stop avahi-daemon
Warning: Stopping avahi-daemon.service, but it can still be activated by:
    avahi-daemon.socket
# systemctl disable avahi-daemon
Removed symlink /etc/systemd/system/multi-user.target.wants/avahi-daemon.service.
Removed symlink /etc/systemd/system/sockets.target.wants/avahi-daemon.socket.
Removed symlink /etc/systemd/system/dbus-org.freedesktop.Avahi.service.
```

The Zero Configuration Networking feature need to be disabled also, as it can cause communication issues between cluster member nodes. Update the /etc/sysconfig/network file with one line as shown in Example 8-40.

Example 8-40 Disable Zero Configuration Networking

```
# Created by anaconda
NOZEROCONF=yes
```

8.2.16 Disable RemovelPC feature

By default in Red Hat Enterprise Linux 7.2, systemd-logind service removes all IPC objects owned by a user if this user fully logs out. This feature removes shared memory segments and semaphores for oracle and grid users if they are not connected any more, which crashes the Oracle ASM and database instances.

To disable this feature, update the /etc/systemd/logind.conf file as shown in Example 8-41.

Example 8-41 RemoveIPC configuration

#	This file is part of systemd.
#	
#	systemd is free software; you can redistribute it and/or modify it
#	under the terms of the GNU Lesser General Public License as published by
#	the Free Software Foundation; either version 2.1 of the License, or
#	(at your option) any later version.
#	

```
# Entries in this file show the compile time defaults.
# You can change settings by editing this file.
# Defaults can be restored by simply deleting this file.
# See logind.conf(5) for details.
[Login]
#NAutoVTs=6
#ReserveVT=6
#KillUserProcesses=no
#KillOnlvUsers=
#KillExcludeUsers=root
#InhibitDelavMaxSec=5
#HandlePowerKey=poweroff
#HandleSuspendKey=suspend
#HandleHibernateKey=hibernate
#HandleLidSwitch=suspend
#HandleLidSwitchDocked=ignore
#PowerKeyIgnoreInhibited=no
#SuspendKeyIgnoreInhibited=no
#HibernateKeyIgnoreInhibited=no
#LidSwitchIgnoreInhibited=yes
#IdleAction=ignore
#IdleActionSec=30min
#RuntimeDirectorySize=10%
#RemoveIPC=yes
RemoveIPC=no
```

For more information about RemoveIPC, see the Oracle support website at:

https://support.oracle.com/epmos/faces/DocumentDisplay?id=2081410.1

It is also mentioned on Red Hat website at:

https://bugzilla.redhat.com/show bug.cgi?id=1264533

8.2.17 Shared memory file system /dev/shm

Mounting tmpfs at shared memory file system /dev/shm is handled automatically by Red Hat Linux. This temporary file system size is always set to be half of the installed memory, so manual configuration in /etc/fstab is no longer necessary. However, Oracle installation program checks /etc/fstab for entry of mounting /dev/shm. It is suggested to add one entry in /etc/fstab as shown in Example 8-42.

Example 8-42	tmpfs in /etc/fstab			
<pre># for tmpfs</pre>				
tmpfs	/dev/shm	tmpfs	rw,exec	0 0

8.2.18 Disable Transparent HugePages

Transparent HugePages (THP) allocates memory dynamically during run time. According to Oracle, it can cause memory allocation delays. To avoid performance issues of Oracle Database, Oracle suggests disabling THP on all Oracle Database servers.

To check whether THP is enabled, run the command shown in Example 8-43.

Example 8-43 Check Transparent HugePages status

```
# cat /sys/kernel/mm/transparent_hugepage/enabled
[always] madvise never
```

From the output in Example 8-43, [always] means that THP is enabled. To disable THP, update the /etc/default/grub file, and insert transparent_hugepage=never to the end of line starting with GRUB_CMDLINE_LINUX, as shown in Example 8-44.

Example 8-44 The /etc/default/grub file

```
# cat /etc/default/grub
GRUB_TIMEOUT=5
GRUB_DISTRIBUTOR="$(sed 's, release .*$,,g' /etc/system-release)"
GRUB_DEFAULT=saved
GRUB_DISABLE_SUBMENU=true
GRUB_TERMINAL_OUTPUT="console"
GRUB_CMDLINE_LINUX="crashkernel=auto rd.lvm.lv=rhel/root rd.lvm.lv=rhel/swap rhgb
quiet transparent_hugepage=never"
GRUB_DISABLE_RECOVERY="true"
```

After the /etc/default/grub file is updated, run the following command to generate a new configuration file, and reboot the server to activate the new configuration, as shown in Example 8-45.

Example 8-45 Generate new grub configuration file

```
# grub2-mkconfig -o /boot/grub2/grub.cfg
Generating grub configuration file ...
Found linux image: /boot/vmlinuz-3.10.0-327.el7.x86_64
Found initrd image: /boot/initramfs-3.10.0-327.el7.x86_64.img
Found linux image: /boot/vmlinuz-0-rescue-de0320fd093243d8955006cc0e7efecb
Found initrd image: /boot/initramfs-0-rescue-de0320fd093243d8955006cc0e7efecb.img
done
```

```
# shutdown -r now
```

8.2.19 Setting disk I/O scheduler on Linux

Many disk I/O schedulers are available in Linux. The deadline I/O scheduler caps maximum latency per request and maintains a good disk throughput, which is best for disk-intensive database applications. Oracle suggests using Deadline scheduler for disks that are used in Oracle Database.

To check the current disk I/O scheduler on Linux, run the command shown in Example 8-46.

Example 8-46 Show Disk I/O Scheduler

```
# cat /sys/block/sd*/queue/scheduler
noop [deadline] cfq
```

```
noop [deadline] cfq
noop [deadline] cfq
noop [deadline] cfq
noop [deadline] cfg
```

Red Hat Enterprise Linux 7.x uses deadline as the default I/O scheduler for all SCSI devices. No additional steps that are required to select deadline IO scheduler for SAN devices in RHEL 7.x.

8.2.20 Create disk partitions

Because ASMLib supports disk partitions only, you must create partitions on disks to be managed by Oracle ASM.

It is important to identify the disk and align with storage planning mentioned in 8.1.2, "Storage planning" on page 104 before creating disk partitions. Example 8-47 shows how to list the size of disks.

Example 8-47 List size of disks

```
# fdisk -1|grep 'Disk /dev'
Disk /dev/sda: 214.7 GB, 214748364800 bytes, 419430400 sectors
Disk /dev/sdb: 5368 MB, 5368709120 bytes, 10485760 sectors
Disk /dev/sdc: 5368 MB, 5368709120 bytes, 10485760 sectors
Disk /dev/sdd: 5368 MB, 5368709120 bytes, 10485760 sectors
Disk /dev/sdc: 85.9 GB, 85899345920 bytes, 167772160 sectors
Disk /dev/sdf: 1099.5 GB, 1099511627776 bytes, 2147483648 sectors
Disk /dev/sdg: 1099.5 GB, 1099511627776 bytes, 2147483648 sectors
Disk /dev/sdh: 1099.5 GB, 1099511627776 bytes, 2147483648 sectors
Disk /dev/sdi: 1099.5 GB, 1099511627776 bytes, 2147483648 sectors
Disk /dev/mapper/rhel-root: 196.5 GB, 196457005056 bytes, 383705088 sectors
Disk /dev/mapper/rhel-swap: 17.3 GB, 17288921088 bytes, 33767424 sectors
```

The most accurate way is to identify it through the disk UUID, which mentioned in 7.2.6, "Enable disk UUID" on page 96, and also the UUID of each shared disk in this environment is listed in Table 8-3 on page 104.

Complete these steps to create a partition that consumes all the available space:

- 1. Run fdisk followed by disk device name to start creating partition.
- 2. Enter n to create a partition.
- 3. Enter p to select the default primary partition type.
- 4. Enter 1 to create the first primary partition.
- 5. Press Enter to select the default starting sector.
- 6. Press Enter to select the default ending sector.
- 7. Enter w to write the partition table.

Example 8-48 shows the whole process of creating a partition on disk /dev/sdb.

Example 8-48 Create a disk partition

```
# fdisk /dev/sdb
Welcome to fdisk (util-linux 2.23.2).
Changes will remain in memory only, until you decide to write them.
Be careful before using the write command.
Device does not contain a recognized partition table
Building a new DOS disklabel with disk identifier 0xc0949480.
Command (m for help): n
Partition type:
       primary (0 primary, 0 extended, 4 free)
   р
   е
       extended
Select (default p): p
Partition number (1-4, default 1): 1
First sector (2048-10485759, default 2048):
Using default value 2048
Last sector, +sectors or +size{K,M,G} (2048-10485759, default 10485759):
Using default value 10485759
Partition 1 of type Linux and of size 5 GiB is set
Command (m for help): w
The partition table has been altered!
Calling ioctl() to re-read partition table.
Syncing disks.
```

Example 8-49 shows how to list the partitions that are configured on one disk.

Example 8-49 List disk partitions

```
# fdisk -1 /dev/sdb
```

/dev/sdb1

```
Disk /dev/sdb: 5368 MB, 5368709120 bytes, 10485760 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk label type: dos
Disk identifier: 0xc0949480
Device Boot Start End Blocks Id System
```

10485759

2048

Repeat these steps to create partitions on all disks to be managed by Oracle ASM. Be aware that it is only required to create disk partitions on one node only as all these disks are shared disks.

5241856

83 Linux

8.2.21 Install and Configure Oracle ASMLib

Oracle ASMLib consists of three RPM packages as shown in Table 8-8.

Table 8-8	Oracle ASMI ib	nackages
10010 0 0		paunages

Package Description	RPM Package Name	Source
ASMLib Kernel Driver	kmod-oracleasm	Red Hat CD
Userspace Library	oracleasmlib	Oracle website
Driver Support Files	oracleasm-support	Oracle website

The later two packages are available from the Oracle website. The link below is for the Red Hat Enterprise Linux 7.x version:

http://www.oracle.com/technetwork/server-storage/linux/asmlib/rhel7-2773795.html

Use the commands shown in Example 8-50 to install Oracle ASMLib on each Linux node.

Example 8-50 Install Oracle ASMLib

```
# rpm -ivh kmod-oracleasm-2.0.8-15.el7.x86_64.rpm
# rpm -ivh oracleasmlib-2.0.12-1.el7.x86_64.rpm
# rpm -ivh oracleasm-support-2.1.8-3.el7.x86_64.rpm
```

Start initial configuration as shown in Example 8-51. Set the user to own ASMLib driver interface to grid and group to own to asmadmin.

Example 8-51 Oracle ASMLib initial configuration

/usr/sbin/oracleasm configure -i
Configuring the Oracle ASM library driver.

This will configure the on-boot properties of the Oracle ASM library driver. The following questions will determine whether the driver is loaded on boot and what permissions it will have. The current values will be shown in brackets ('[]'). Hitting <ENTER> without typing an answer will keep that current value. Ctrl-C will abort.

Default user to own the driver interface []: grid Default group to own the driver interface []: asmadmin Scan for Oracle ASM disks on boot (y/n) [y]: y Writing Oracle ASM library driver configuration: done

Load the oracleasm driver module and mount the ASM driver file system manually, as shown in Example 8-52.

Example 8-52 Load ASMLib driver

```
# /usr/sbin/oracleasm init
Creating /dev/oracleasm mount point: /dev/oracleasm
Loading module "oracleasm": oracleasm
Configuring "oracleasm" to use device physical block size
Mounting ASMlib driver filesystem: /dev/oracleasm
```

To double check whether the *oracleasm* service is running and enabled, run the commands as shown in Example 8-53.

Example 8-53 Check oracleasm service

```
# systemctl status oracleasm.service
? oracleasm.service - Load oracleasm Modules
Loaded: loaded (/usr/lib/systemd/system/oracleasm.service; enabled; vendor
preset: disabled)
Active: active (exited) since Fri 2016-05-27 12:27:16 EDT; 7s ago
Process: 3087 ExecStart=/usr/sbin/service oracleasm start_sysctl (code=exited,
status=0/SUCCESS)
Main PID: 3087 (code=exited, status=0/SUCCESS)
# systemctl is-enabled oracleasm.service
enabled
```

To create an ASM disk, run the command **oracleasm createdisk** followed by the label of ASM disk, and then followed by the device name of the disk. Example 8-54 shows the process to create all ASM disks to be used in this Oracle RAC environment.

Example 8-54 Create ASM disks

```
# oracleasm createdisk OCR1 /dev/sdb1
Writing disk header: done
Instantiating disk: done
# oracleasm createdisk OCR2 /dev/sdc1
Writing disk header: done
Instantiating disk: done
# oracleasm createdisk OCR3 /dev/sdd1
Writing disk header: done
Instantiating disk: done
# oracleasm createdisk REDO /dev/sde1
Writing disk header: done
Instantiating disk: done
# oracleasm createdisk DATA1 /dev/sdf1
Writing disk header: done
Instantiating disk: done
# oracleasm createdisk DATA2 /dev/sdg1
Writing disk header: done
Instantiating disk: done
# oracleasm createdisk DATA3 /dev/sdh1
Writing disk header: done
Instantiating disk: done
# oracleasm createdisk DATA4 /dev/sdi1
Writing disk header: done
Instantiating disk: done
```

Note: It is only necessary to run ASM disks creation commands from one node, the other nodes are able to discover these ASM disks later.

To discover ASM disks on other nodes, run the following commands that are shown in Example 8-55.

Example 8-55 Discover and list ASM disks

```
# oracleasm scandisks
Reloading disk partitions: done
Cleaning any stale ASM disks...
Scanning system for ASM disks...
Instantiating disk "OCR1"
Instantiating disk "OCR2"
Instantiating disk "REDO"
Instantiating disk "OCR3"
Instantiating disk "DATA2"
Instantiating disk "DATA1"
Instantiating disk "DATA4"
Instantiating disk "DATA3"
# oracleasm listdisks
DATA1
DATA2
DATA3
DATA4
OCR1
OCR2
OCR3
REDO
```

8.3 Oracle Grid Infrastructure installation

This section shows how to install Oracle Grid Infrastructure, a prerequisite of installing Oracle RAC Database, which consists of Oracle Clusterware and ASM.

8.3.1 Get installation packages

Oracle Grid Infrastructure and Oracle Database 12c for Linux installation packages can be downloaded from Oracle website below, or they are available on Oracle Database 12c DVDs:

http://www.oracle.com/technetwork/database/enterprise-edition/downloads/database12 c-linux-download-2240591.html Copy the Oracle Grid Infrastructure installation packages to one node of the cluster, calculate the checksum of the files, and compare the values to those published on the Oracle website (Figure 8-2) to ensure file integrity as shown in Example 8-56.

Oracle Database 12c Release 1 (12.1.0.2.0) for Linux x86-64

 Iinuxamd64_12c_database_1of2.zip (1,673,544,724 bytes) (cksum - 839029806)
 Iinuxamd64_12c_database_2of2.zip (1,014,530,602 bytes) (cksum - 1187131466)

 Directions

 All files are in the .zip format. There is an unzip utility here if you need one.
 Download and unzip both files to the same directory.
 Installation guides and general Oracle Database 12c documentation are here.

 Oracle Database 12c Release 1 Grid Infrastructure (12.1.0.2.0) for Linux x86-64

 Inuxamd64_12c_grid_1of2.zip (1,747,043,545 bytes) (cksum - 1194876808)
 Inuxamd64_12c_grid_2of2.zip (646,972,897 bytes) (cksum - 2519919927)

 Contains the Grid Infrastructure Software including Oracle Clusterware, Automated Storage Management (ASM), and ASM Cluster File System. Download and install prior to installing Oracle Real Application Clusters, Oracle Real Application Clusters One Node, or other application software in a Grid Environment

Figure 8-2 Checksums of Oracle Database packages

Example 8-56 Verify checksum of Oracle grid infrastructure packages

```
# cksum linuxamd64_12102_grid_1of2.zip
1194876808 1747043545 linuxamd64_12102_grid_1of2.zip
# cksum linuxamd64_12102_grid_2of2.zip
2519919927 646972897 linuxamd64_12102_grid_2of2.zip
# cksum linuxamd64_12102_database_1of2.zip
839029806 1673544724 linuxamd64_12102_database_1of2.zip
# cksum linuxamd64_12102_database_2of2.zip
1187131466 1014530602 linuxamd64_12102_database_2of2.zip
```

Extract the packages for installation as shown in Example 8-57.

Example 8-57 Extract Oracle installation packages

unzip linuxamd64_12102_grid_1of2.zip
unzip linuxamd64_12102_grid_2of2.zip
unzip linuxamd64_12102_database_1of2.zip
unzip linuxamd64_12102_database_2of2.zip

8.3.2 Install Oracle Cluster Verification Utility

Oracle provides a tool called Oracle Cluster Verification Utility (CVU) to perform cluster environment tests for Oracle RAC installation. It is bundled with the Oracle Grid Infrastructure software, and needs to be installed on each node before running Grid Infrastructure installation.
Example 8-58 shows the location of this package and how to install it.

Example 8-58 Install Oracle Cluster Verification Utility

8.3.3 Oracle Grid Infrastructure installation

Oracle Grid Infrastructure and Oracle Database installation requires GUI access. It can be done either using Linux console or redirecting to X11 software on client machine. The installation steps in this section are from a virtual machine console provided by VMware vSphere. To launch a console for virtual machine ITSO_VM1, from the vSphere Web Client, select ITSO_VM1 in the inventory, right-click ITSO_VM1, and select Open Console from pop-up menu, as shown in Figure 8-3.



Figure 8-3 Open virtual machine console

To install Oracle Grid Infrastructure from Linux console, complete these steps:

1. It is required to use grid owner user (grid in this environment) to start Grid Infrastructure installation. Log in with grid from the console, open a terminal, and start the installer by running **runInstaller** in the grid directory, as shown in Figure 8-4.

```
grid@itsovm1:/software/grid
                                                                         ×
File Edit View Search Terminal Help
[grid@itsovm1 Desktop]$ cd /software/grid
[grid@itsovm1 grid]$ ls
install rpm
                       runInstaller stage
response runcluvfy.sh sshsetup
                                   welcome.html
[grid@itsovm1 grid]$ ./runInstaller
Starting Oracle Universal Installer...
Checking Temp space: must be greater than 415 MB. Actual 174075 MB
                                                                      Passed
Checking swap space: must be greater than 150 MB. Actual 16487 MB
                                                                     Passed
Checking monitor: must be configured to display at least 256 colors. Actual 1
6777216 Passed
Preparing to launch Oracle Universal Installer from /tmp/OraInstall2016-05-26_02
-33-29PM. Please wait ...[grid@itsovm1 grid]$
```

Figure 8-4 Run Oracle Grid Infrastructure installer

2. From the Oracle Grid Infrastructure installation options window, select **Install and Configure Oracle Grid Infrastructure for a Cluster** because it will be an Oracle RAC Database environment, as shown in Figure 8-5. Click **Next** to continue.

Oracle Grid Infrastructure 12c Release 1 Installer - Step 1 of 16 - 🛛 🗙				
Select Installation Option	GRID INFRASTRUCTURE 12 ^C			
Reference installation Option	 Install and Configure Oracle Crid Infrastructure for a <u>Cluster</u> 			
Installation Type Cluster Configuration Network Interface Usage Storage Option OCR Storage Voting Disk Storage	○ <u>U</u> pgrade Oracle Grid Infrastructure or Oracle Automatic Storage Management ○ Install Oracle <u>G</u> rid Infrastructure Software Only			
Management Options Operating System Groups Installation Location Root script execution Prerequisite Checks Summary Install Product Finish				
Help	< <u>Back</u> Next > Install Cancel			

Figure 8-5 Grid Infrastructure installation options

3. From Oracle Grid Infrastructure Cluster Type option window, select **Configure a Standard Cluster**, as shown in Figure 8-6, and click **Next** to continue.

Oracle Grid Infrastructure 12 c Release 1 Installer - Step 2 of 16 - 🛛 🗙				
Select Cluster Type	GRID INFRASTRUCTURE 12 ^C			
💻 Installation Option	Choose the type of cluster required.			
👷 Cluster Type	Onfigure a Standard cluster			
Installation Type	Choose this option to configure a group of servers into a single cluster.			
Cluster Configuration	○ Configure a <u>F</u> lex cluster			
Network Interface Usage	Flex clusters are highly scalable clusters in which servers can be assigned specific roles to satisfy			
Storage Option	database or application functions.			
OCR Storage				
Voting Disk Storage				
Management Options				
Operating System Groups				
Installation Location				
Root script execution				
Prerequisite Checks				
y Summary				
🍦 Install Product				
5 Finish				
Help	< <u>Back</u> <u>Next</u> > <u>Install</u> Cancel			

Figure 8-6 Grid cluster type options

4. For Oracle Grid Infrastructure Installation Type option, select **Advanced Installation**, as shown in Figure 8-7, and click **Next** to continue.

Oracle Grid Infrastructure 12c Release 1 Installer - Step 3 of 16 - 🛛 🗙				
Select Installation Type	GRID INFRASTRUCTURE 12 ^C			
Cluster Type	Typical Installation Perform a full grid infrastructure installation with basic configuration. • Advanced Installation			
Cluster Configuration Network Interface Usage Storage Option OCR Storage Voting Disk Storage Management Options Operating System Groups Installation Location Root script execution Prerequisite Checks Summary Install Product Finish	Allows advanced configuration options such as alternative storage choices, additional networking flexibility, integration with IPMI.			
Help	< <u>Back</u> Install Cancel			

Figure 8-7 Grid installation type options

5. Oracle Grid Infrastructure supports multiple languages choices. **English** is selected by default. If additional language support is needed, select the language name from the left box, and click the **Arrow** button to add it to the list, as shown in Figure 8-8. Click **Next** to continue.

			-
Ora	cle Grid Infrastructure 12c F	Release 1 Installer - Step 4 of 11 _ D	×
Select Product Languages			2 °
Installation Option Cluster Type Installation Type Product Languages Operating System Groups Installation Location Root script execution Prerequisite Checks Summary Install Product Finish	Select the languages in which you Available languages: Arabic Bengali Brazilian Portuguese Bulgarian Canadian French Catalan Croatian Czech Danish Dutch Egyptian English (United Kingdom) Estonian Finnish French Germ an Greek Hebrew Hungarian Icelandic Indonesian	ur product will run. Selected languages: English ((((((((((((((((((
Help		< <u>B</u> ack <u>N</u> ext > <u>Install</u> Ca	ncel

Figure 8-8 Grid language options

6. From cluster name and SCAN setting window, enter the cluster name and SCAN name. Remember that the SCAN name here should be the one registered in DNS server. Click to clear **Configure GNS** because GNS is not used in this environment, as shown in Figure 8-9. Click **Next** to continue.

01	racle Grid Infrast	tructure 12c Release 1 Installer - Step 5 of 18 _ 🛛 🗙
Grid Plug and Play Inform	ation	
Installation Option Cluster Type Installation Type Product Languages	Single Client Ac the cluster as a <u>C</u> luster Name: <u>S</u> CAN Name:	cess Name (SCAN) allows clients to use one name in connection strings to connect to whole. Client connect requests to the SCAN name can be handled by any cluster node. itso-cluster
Cluster Node Information Network Interface Usage Storage Option OCR Storage Voting Disk Storage Management Options Operating System Groups Installation Location Root script execution Prerequisite Checks Summary Install Product Finish	SC <u>A</u> N Port: Configure CI Configure Create a CNS VIF <u>C</u> NS Su <u>U</u> SE Shar CNS Cli	1521 NS re nodes Virtual IPs as assigned by the Dynamic Networks ingw GNS P Address: ib Domain: itsovm.null red GNS ient Data: Browse
Help		< <u>Back</u> Next > Install Cancel

Figure 8-9 Cluster name and SCAN name

7. The cluster node information window now shows node in this cluster including public node name and private node name, as shown in Figure 8-10. To add a node to the cluster, click the **Add** button.

Oracle Grid Infrastructure 12c Release 1 Installer - Step 6 of 18 _ U X				
Cluster Node Information	0			
Cluster Type	Provide the list of nodes to be managed by Ora Virtual Hostname.	cle Grid Infrastructure with their Public Hostname and		
Installation Type	Public Hostname	Virtual Hostname		
Product Languages	itsovm1	jitsovm1-vip		
Grid Plug and Play				
© Cluster Node Information				
<u>Network Interface Usage</u>				
🔍 Storage Option				
OCR Storage				
Voting Disk Storage				
Management Options				
Operating System Groups				
Installation Location				
Root script execution				
Prerequisite Checks				
ý Summary	SSH <u>c</u> onnectivity	Cluster Configuration File <u>A</u> dd <u>E</u> dit <u>R</u> emove		
 Install Product 				
Ö Finish				
Help		< <u>Back Next > Install</u> Cancel		

Figure 8-10 Cluster node information

 Enter both the public hostname and private hostname of one node, as shown in Figure 8-11. Remember that these hostnames should be registered in the DNS server as planned. Click OK to add one node to the cluster.

A.	d cluster Note information
pecify the name for the	public host name. If you want to configure virtual host
Dublic Hostnomo:	iteoum?
Public <u>H</u> ostname.	Itsovm2
	it cours 7 - win

Figure 8-11 Add one node to cluster

 After all the nodes are added to the cluster, click SSH Connectivity. Input the password of grid user, as shown in Figure 8-12, then click Setup to set up passwordless SSH connectivity between all cluster member nodes.

Oracle Grid Infrastructure 12c Release 1 Installer - Step 6 of 18 - 🛛 🗙				
Cluster Node Information				
Cluster Type	Provide the list of nodes to be managed by Virtual Hostname.	Oracle Grid Infrastructure with their Public Hostname and		
Installation Tune	Public Hostname	Virtual Hostname		
	itsovm1	itsovm1-vip		
 Product Languages 	itsovm2	itsovm 2-vip		
Grid Plug and Play	itsovm3	itsovm 4-vip		
Cluster Node Information				
Network Interface Lisage				
V Network Interface Osage				
Storage Option				
OCR Storage				
Voting Disk Storage	SSH <u>c</u> onnectivity	Jse Cluster Configuration File		
 Management Options 				
Operating System Groups	<u>O</u> S Username: grid	OS Pass <u>w</u> ord:		
Installation Location	User home is shared by the selected n	odes		
Root script execution	Reuse private and public keys existing	in the user home		
Prerequisite Checks				
Summan.		<u>T</u> est Setu <u>p</u>		
y summary	1 <u></u>			
Install Product				
o Finish				
Help		< <u>Back</u> Next > Install Cancel		

Figure 8-12 Setup passwordless SSH connectivity for grid user

10. It takes a few seconds to set up SSH connectivity. After the process is complete, a prompt is displayed as shown in Figure 8-13. Click **OK** to continue.



Figure 8-13 SSH setup completion

11.Network interface usage configuration dialog lists all network interfaces found on cluster node. Make sure to select the correct usage for each interface as shown in Figure 8-14. Sometimes the interface is not shown due to the device name being not consistent on each node in the cluster. Make your decision based on subnet information because it will be consistent on all nodes. Click **Next** to continue if the choices are made.

Ora	acle Grid Infrastructure 12	c Release 1 Installer – Ste	p7of18 _ 🗆 🗙
Specify Network Interface	Usage		
Cluster Type	Private interfaces are used by	Oracle Grid Infrastructure for in	iternode traffic.
\uparrow	Interface Name	Subnet	Use for
	eno16782080	192.168.160.0	Public
Product Languages	eno33561344	10.0.0	Private 🗾
🖕 Grid Plug and Play	virbr0	192.168.122.0	Do Not Use
Cluster Node Information			
Network Interface Usage			
Storage Option OCR Storage Voting Disk Storage Management Options Operating System Groups Installation Location Root script execution Prerequisite Checks Summary Install Product Einich	Automatic Storage Managem interface subnets either as "A	acte cluster registry (OCR) and Ent (Oracle Fiex ASM) then you n SM" or as "ASM & Private".	oung disk files dang of alle Fiex
Help		< <u>B</u> ac	ik Next > Install Cancel

Figure 8-14 Network interface usage

Note: Set the usage of any interface that is not used in Oracle environment to **Do Not Use**.

12.Oracle supports several ways to place Oracle Cluster Registry (OCR) and vote disk files, select **Use Standard ASM for storage**, as shown in Figure 8-15, and click **Next** to continue.

Oracle Grid Infrastructure 12c Release 1 Installer - Step 8 of 18 - 🛛 🗙			
Storage Option Information			
Installation Option Cluster Type Installation Type Product Languages Grid Plug and Play Cluster Node Information Network Interface Usage Storage Option OCR Storage Voting Disk Storage Management Options Operating System Groups Installation Location Root script execution Prerequisite Checks Summary Install Product Finish	 You can place Oracle Cluster Registry (OCR) files and voting disk files on Oracle ASM storage, or on a file system. Oracle ASM can be configured on this cluster or can be an existing ASM on a storage server cluster. Use Standard ASM for storage Choose this option to configure Local Oracle ASM in this cluster and store OCR and voting disk files on it. ASM instance will be configured on all nodes of the cluster. Use Oracle Flex ASM for storage Choose this option to configure OCR and voting disks on ASM storage. ASM instance will be configured or aduced number of cluster nodes. Configure as ASM Client Cluster Choose this option to store OCR and Voting disk files on Oracle ASM Storage configured on a storage server cluster. ASM Client Data: Browse 		
<u>H</u> elp	< <u>Back</u> <u>N</u> ext> <u>Install</u> Cancel		

Figure 8-15 Storage options for OCR and voting disk files

13.Complete these steps to create an ASM disk group to store OCR and vote disks, as shown in Figure 8-16 on page 142:

Disk group name	Specify the name of the ASM disk group here, such as OCR in this example.	
Redundancy	The number of vote disks depends on the Redundancy level chosen here: EXTERNAL creates one voting disk, NORMAL creates three voting disks, HIGH creates five voting disks. Selec NORMAL because three voting disks are planned.	
Allocation Unit Size	An allocation unit is the fundamental unit of allocation within a disk group, considering CPU utilization and memory consumption. It is suggested to set allocation unit size to 4 MB.	
Add Disk	Select the names of the disks to be planned for creating the OCR disk group, usually the name of disk would be "ORCL:" followed by the label of the ASM disk. If the candidate list is empty, click Change Discovery Path button and change it to /dev/oracleasm/disks/* and retry.	

For more information about ASM disk group, see the *Automatic Storage Management Administrator's Guide 12c Release 1* at:

https://docs.oracle.com/database/121/0STMG/E41058-11.pdf

Ora	cle Grid Infrastructure 12c Release 1 Installer - Step	9 of 18 _ 🗆 🗙
Create ASM Disk Group		
Installation Option Cluster Type Installation Type Product Languages Grid Plug and Play Cluster Node Information Network Interface Usage Storage Option	Select Disk Group characteristics and select disks Disk group name OCR Redundancy High Normal External Allocation Unit Size Image: MB Add Disks Image: All Disks	
Create ASM Disk Group	Disk Path	Size (in MB) Status
ASM Password Management Options Operating System Groups Installation Location Root script execution Prerequisite Checks Summary Install Product Finish	 ORCL:DATA1 ORCL:DATA2 ORCL:DATA3 ORCL:DATA4 ✓ ORCL:OCR1 ✓ ORCL:OCR2 ✓ ORCL:OCR3 	1048575 Candidate 1048575 Candidate 1048575 Candidate 1048575 Candidate 5119 Candidate 5119 Candidate 5119 Candidate 5119 Candidate Change Discovery Path
Help	< <u>B</u> ack	Next > Install Cancel

After the setting is finished, click **Next** to continue as shown in Figure 8-16.

Figure 8-16 Create ASM disk group for OCR and voting disk files

14.Oracle supports setting either the same or different passwords for SYS and ASMSNMP users. Select **Use same passwords for these accounts** and input the passwords, as shown in Figure 8-17. The SYS user is an ASM administration user with SYSASM privileges, and it is suggested to use a strong password. After the setting is finished, click **Next** to continue.

Ora	acle Grid Infrastructure 12c Release	1 Installer - Step 10 of 18 _ 🛛 🗙
Specify ASM Password	-	
Cluster Type	The new Oracle Automatic Storage Manag SYSASM privileges for administration. Ora user with SYSDBA privileges to monitor th Specify the password for these user accor	ement (Oracle ASM) instance requires its own SYS user with Icle recommends that you create a less privileged ASMSNMP e ASM instance. unts.
	Use <u>d</u> ifferent passwords for these accord	Confirm Password
 <u>Network Interface Usage</u> <u>Storage Option</u> 	SZS	
Create ASM DIsk Group ASM Pass word Management Options	Our of the second se	ts
Operating System Groups	Specify <u>P</u> assword:	Confirm Password:
Prerequisite Checks Summary		
Finish		
Help		< <u>Back N</u> ext > Install Cancel

Figure 8-17 Set password for ASM users

15. Failure Isolation is a feature to isolate a failed node from the rest of the cluster to prevent data corruption. It can be done through Intelligent Management Platform Interface (IPMI) specification interface if it is available. Select **Do not use Intelligent Management Platform Interface specification (IPMI)** as shown in Figure 8-18, and click **Next** to continue if IPMI is not available.

Ora	cle Grid Infrastructure 12c Release 1 Installer - Step 11 of 19 _ 🛛 🗙
Failure Isolation Support	
Installation Option Cluster Type Installation Type Product Languages Grid Plug and Play Cluster Node Information Network Interface Usage Storage Option Create ASM Disk Group ASM Password Failure Isolation Management Options Operating System Groups Installation Location Root script execution Prerequisite Checks Summary Install Product Finish	Choose one of the following Failure Isolation Support options. Use Intelligent Platform Management Interface (IPMI) To ensure successful installation with IPMI enabled, ensure your IPMI drivers are properly installed and enabled. Uger Name : Password : @ Do not use Intelligent Platform Management Interface (IPMI)
Help	< <u>Back</u> <u>Next></u> <u>Install</u> Cancel

Figure 8-18 Failure isolation options

16. Enterprise Manager Cloud Control is a tool that allows the database administrator to monitor and manage databases from a single console. Click to clear **Register with Enterprise Manager Cloud Control** as shown in Figure 8-19, because there is no OMS host in this environment. Click **Next** to continue.

Ora	cle Grid Infrastructure 12c Rel	lease 1 Installer - Step 1	2 of 19 -	• ×
Specify Management Optio	ns		GRID INFRASTRUCTURE	12 [°]
Cluster Type	You can configure to have this inst Management to be managed by Ent Control configuration to perform t Register with Enterprise Manage	ance of Oracle Grid Infrastruct erprise Manager Cloud Contro he registration. er (EM) Cloud Con <u>t</u> rol	ure and Oracle Automatic Sto I. Specify the details of the Clu	rage oud
	O <u>M</u> S host: OM <u>S</u> port: EM A <u>d</u> min User Name: EM Admin Pass <u>w</u> ord:			
Management Options Operating System Groups Installation Location Root script execution Prerequisite Checks Summary Install Product Finish				
Help		< <u>B</u> ack	<u>N</u> ext > <u>I</u> nstall	Cancel

Figure 8-19 Management options

17. To assign OS groups for Oracle ASM Management, select them according to Table 8-9, as shown in Figure 8-20 on page 146. Click **Next** to continue.

Table 8-9 ASM groups

Oracle ASM role	OS Group
Oracle ASM Administrator (OSASM) Group	asmadmin
Oracle ASM DBA (OSDBA for ASM) Group	asmdba
Oracle ASM Operator (OSOPER for ASM) Group	asmoper

Oracle Grid Infrastructure 12c Release 1 Installer - Step 13 of 19 _ 0				o x
Privileged Operating Syste	m Groups			12 ^c
Installation Option Cluster Type Installation Type Product Languages Grid Plug and Play Cluster Node Information Network Interface Usage Storage Option Create ASM Disk Group ASM Password Failure Isolation Management Options Operating System Groups Installation Location Root script execution Prerequisite Checks Summary Install Product	Select the name of the operating authentication to Oracle Autom: Oracle <u>A</u> SM Administrator (OSA Oracle ASM <u>D</u> BA (OSDBA for ASM Oracle ASM <u>Operator (OSOPER f</u>	system group, that you wa atic Storage Management. SM) Group () Group or ASM) Group (Optional)	ant to use for operating system asmadmin asmdba asmoper	
			< <u>B</u> ack Next > Install	Cancel

Figure 8-20 Assign OS groups for ASM

18.Specify the locations for ORACLE_BASE and Grid Infrastructure software, as shown in Figure 8-21, and click **Next** to continue.

Oracle	e Grid Infrastructure 12c Release 1 Installer - Step 14 of 19 _	o x
Specify Installation Location		12 ^c
 Installation Option Cluster Type Installation Type Product Languages Grid Plug and Play Cluster Node Information Network Interface Usage Storage Option Create ASM Disk Group ASM Password Failure Isolation Management Options Operating System Groups Installation Location Root script execution Prerequisite Checks Summary Install Product Einich 	Specify the Oracle Grid Infrastructure for a Cluster Oracle base. By default, Oracle Grid Infra is installed in a path indicating the Oracle Grid Infrastructure release and grid infrastructure owner. Qracle base: /u01/app/grid Specify a location for storing Oracle software files separate from configuration files in the O directory. This software directory is the Oracle Grid Infrastructure home directory. Software location (u01/app/12.1.0/grid) (u01/app/12.1.0/grid) Software location (u01/app/12.1.0/grid) Software location (u01/app/12.1.0/grid) Specify a location (u01/ap	structure software B <u>r</u> owse racle base Bro <u>w</u> se
Help	< <u>Back</u> Next>	Cancel

Figure 8-21 Specify installation location

19. Specify the location for installation metadata files, as shown in Figure 8-22, and click **Next** to continue.

	Dracle Grid Infrastructure 12c Release 1 Installer - Step 15 of 20 _ C X
Create Inventory	
Installation Option Cluster Type Installation Type Product Languages Grid Plug and Play Cluster Node Information Network Interface Usage Storage Option Create ASM Disk Group ASM Password Failure Isolation Management Options Operating System Groups Installation Location Prerequisite Checks Summary Install Product	 You are starting your first installation on this host. Specify a directory for installation metadata files (for example, install log files). This directory is called the "inventory directory". The installer automatically sets up subdirectories for each product to contain inventory data. The subdirectory for each product typically requires 150 kilobytes of disk space. Inventory Directory: /u01/app/oralnventory Browse Members of the following operating system group (the primary group) will have write permission to the inventory directory (oralnventory). oralnventory Croup Name: oinstall
Help	< <u>Back</u> <u>Next></u> <u>Install</u> Cancel

Figure 8-22 Specify inventory directory

20. Two scripts are required to be run with root user on each node during Grid Infrastructure installation. The installation program offers options to run these scripts automatically, as shown in Figure 8-23. It is suggested to run these scripts manually. To do so, click to clear the **Automatically run configuration scripts**, and click **Next** to continue.

Oracle Grid Infrastructure 12 c Release 1 Installer - Step 16 of 20 _ u ×			
Root script execution conf			
Installation Option	While configuring the software, certain operations have to be performed as "root" user. You can choose to have the Installer perform these operations automatically by specifying inputs for one of the options below.		
Installation Type Product Languages Grid Plug and Play	Automatically run configuration scripts Use "root" user <u>c</u> redential Pass <u>w</u> ord :		
Cluster Node Information Network Interface Usage Storage Option Create ASM Disk Group	O Use <u>s</u> udo Program path : //usr/local/bin/sudo User name :		
ASM Password Failure Isolation Management Options	Password :		
Operating System Groups Installation Location Create Inventory			
Root script execution Prerequisite Checks Summary			
Install Product	<u>Back</u> <u>Next > Install</u> Cancel		

Figure 8-23 Root script execution configuration

21. The installation program performs prerequisite checks as shown in Figure 8-24. This process usually takes several minutes.

0	racle G	Grid Infrastructure 12c Release 1 Installer - Step 17 of 20 -
Perform Prerequisite Ch	ecks	
 Installation Option Cluster Type Installation Type Product Languages Grid Plug and Play Cluster Node Information Network Interface Usage Storage Option Create ASM Disk Group ASM Password Failure Isolation Management Options Operating System Groups Installation Location Create Inventory Root script execution Summary Install Product 	Ver pro Che	erifying that the target environment meets minimum installation and configuration requirements for roducts you have selected. This can take time. Please wait. 4% hecking Multicast check
Help		<pre>< Back Next > Install Cancel</pre>

Figure 8-24 Perform prerequisite checks

22. The verification result shows as soon as the prerequisite checks are finished. Figure 8-25 shows that there is one warning on /dev/shm. This is a known issue and can be ignored, so select **Ignore All** and click **Next** to continue.

Note: The detailed warning information about /dev/shm, described as The size of in-memory file system mounted at /dev/shm is "24576" megabytes which does not match the size in /etc/fstab as "0" megabytes, is a known issue documented on the Oracle website at:

https://support.oracle.com/epmos/faces/DocumentDisplay?id=1918620.1

0	racle	Grid Infrastructure 12c Release 1 Installer - Step 17 of 20		×
Perform Prerequisite Che	ecks			12 °
 Installation Option Cluster Type Installation Type Product Languages Grid Plug and Play Cluster Node Information Network Interface Usage Storage Option Create ASM Disk Group ASM Password Failure Isolation Management Options. Operating System Groups Installation Location Create Inventory Root script execution Prerequisite Checks Summary Install Product 		Verification Result Some of the minimum requirements for installation are not completed. Revier in the following table, and recheck the system. Check Again Eix & Check Again Show Failed Image: All Nodes Checks Checks Image: All Nodes Image: All Nodes Checks Image: All Nodes Image: All Nodes Checks Image: All Nodes Image: All Nodes Image: All Nodes Checks Image: All Nodes Image: All Nodes Image: All Nodes Iman	ew and fix the s value of the second se	e issues listed Ignore All Fixable No
<u>H</u> elp		< <u>B</u> ack Next >	- <u>I</u> nstal	Cancel

Figure 8-25 Prerequisite check result

23.A warning prompt is displayed as shown in Figure 8-26 to confirm the ignoring action. Click **Yes** to continue.



Figure 8-26 Confirm ignoring prerequisites



24. Figure 8-27 shows a summary of the installation settings. Click Install to continue.

Figure 8-27 Grid infrastructure installation summary

25. Grid Infrastructure installation begins. Check the progress bar for installation process as shown in Figure 8-28.

Or	acle Grid Infrastructure 12c Release 1 Installer - Step 19 of 20 -	o x
Install Product		12 ^C
Cluster Type Installation Type Product Languages Grid Plug and Play Cluster Node Information	Progress 6% Loading products. Please wait. Status Install Grid Infrastructure for a Cluster Install Grid Infrastructure for a Cluster	Progress
Astronometry interface Usage Storage Option Create ASM Disk Group ASM Password Failure Isolation Management Options Operating System Groups	Copy files Copy files Copy files Link binaries Setup Perform remote operations Pe Setup Oracle Base Pe Update Inventory Execute Root Scripts Configure Oracle Grid Infrastructure for a Cluster	nding nding nding nding nding nding nding nding
 Installation Location Create Inventory Root script execution Prerequisite Checks Summary Install Product 	Details R CRACLE 12 ^c Policy Management GRID INFRASTRUCTURE 12 ^c Critical Resources On Demand	etry <u>Skip</u>
Help	< <u>B</u> ack <u>N</u> ext > <u>I</u> nstall	Cancel

Figure 8-28 Installation in progress

26. During the installation, a window prompts you to run two scripts as root user, as shown in Figure 8-29.

Execute Configuration scripts				
The following configuration scripts need to be executed as the "root" user in each new cluster node. Each script in the list below is followed by a list of nodes.				
Number	Script Location	Nodes		
1	/u01/app/oralnventory/orainstRoot.sh	itsovm1,itsovm2,itsovm3,itsovm4		
2	/u01/app/12.1.0/grid/root.sh	itsovm1,itsovm2,itsovm3,itsovm4		
 To execute the configuration scripts: 1. Open a terminal window 2. Log in as "root" 3. Run the scripts in each cluster node 4. Return to this window and click "OK" to continue Run the script on the local node first. After successful completion, you can start the script in parallel on all other nodes.				
<u>Н</u> еlp ОК				

Figure 8-29 Prompt to execute root scripts

27.Open a terminal window and login as root user on the first node in cluster, known as itsovm1 in this environment. Run the script /u01/app/oraInventory/orainstRoot.sh as shown in Example 8-59.

Example 8-59 Running /u01/app/oraInventory/orainstRoot.sh

```
# /u01/app/oraInventory/orainstRoot.sh
Changing permissions of /u01/app/oraInventory.
Adding read,write permissions for group.
Removing read,write,execute permissions for world.
```

Changing groupname of /u01/app/oraInventory to oinstall. The execution of the script is complete.

- 28. Repeat the above step on the other three hosts in sequence.
- 29.Go back to the terminal on the first node in cluster, known as itsovm1 in the environment, and run the script /u01/app/12.1.0/grid/root.sh using the root user, as shown in Example 8-60.

```
Example 8-60 Run /u01/app/12.1.0/grid/root.sh
```

```
# /u01/app/12.1.0/grid/root.sh
Performing root user operation.
The following environment variables are set as:
    ORACLE_OWNER= grid
    ORACLE_HOME= /u01/app/12.1.0/grid
```

Enter the full pathname of the local bin directory: [/usr/local/bin]:

```
Copying dbhome to /usr/local/bin ...
Copying oraenv to /usr/local/bin ...
Copying coraenv to /usr/local/bin ...
```

Creating /etc/oratab file... Entries will be added to the /etc/oratab file as needed by Database Configuration Assistant when a database is created Finished running generic part of root script. Now product-specific root actions will be performed. Using configuration parameter file: /u01/app/12.1.0/grid/crs/install/crsconfig_params 2016/05/27 14:43:53 CLSRSC-4001: Installing Oracle Trace File Analyzer (TFA) Collector.

2016/05/27 14:44:16 CLSRSC-4002: Successfully installed Oracle Trace File Analyzer (TFA) Collector.

2016/05/27 14:44:17 CLSRSC-363: User ignored prerequisites during installation

OLR initialization - successful root wallet root wallet cert root cert export peer wallet profile reader wallet pa wallet peer wallet keys pa wallet keys peer cert request pa cert request peer cert pa cert peer root cert TP profile reader root cert TP pa root cert TP peer pa cert TP pa peer cert TP profile reader pa cert TP profile reader peer cert TP peer user cert pa user cert 2016/05/27 14:44:56 CLSRSC-330: Adding Clusterware entries to file 'oracle-ohasd.service' CRS-4133: Oracle High Availability Services has been stopped. CRS-4123: Oracle High Availability Services has been started. CRS-4133: Oracle High Availability Services has been stopped. CRS-4123: Oracle High Availability Services has been started. CRS-2672: Attempting to start 'ora.evmd' on 'itsovm1' CRS-2672: Attempting to start 'ora.mdnsd' on 'itsovm1' CRS-2676: Start of 'ora.mdnsd' on 'itsovm1' succeeded CRS-2676: Start of 'ora.evmd' on 'itsovm1' succeeded CRS-2672: Attempting to start 'ora.gpnpd' on 'itsovm1' CRS-2676: Start of 'ora.gpnpd' on 'itsovm1' succeeded

CRS-2672: Attempting to start 'ora.cssdmonitor' on 'itsovm1' CRS-2672: Attempting to start 'ora.gipcd' on 'itsovm1' CRS-2676: Start of 'ora.cssdmonitor' on 'itsovm1' succeeded CRS-2676: Start of 'ora.gipcd' on 'itsovm1' succeeded CRS-2672: Attempting to start 'ora.cssd' on 'itsovm1' CRS-2672: Attempting to start 'ora.diskmon' on 'itsovm1' CRS-2676: Start of 'ora.diskmon' on 'itsovm1' succeeded CRS-2676: Start of 'ora.cssd' on 'itsovm1' succeeded ASM created and started successfully. Disk Group OCR created successfully. CRS-2672: Attempting to start 'ora.crf' on 'itsovm1' CRS-2672: Attempting to start 'ora.storage' on 'itsovm1' CRS-2676: Start of 'ora.storage' on 'itsovm1' succeeded CRS-2676: Start of 'ora.crf' on 'itsovm1' succeeded CRS-2672: Attempting to start 'ora.crsd' on 'itsovm1' CRS-2676: Start of 'ora.crsd' on 'itsovm1' succeeded CRS-4256: Updating the profile Successful addition of voting disk 7cd47f01f1e84f82bfef846752f4bab2. Successful addition of voting disk ab468b2ebcca4ffbbf793400a8301cec. Successful addition of voting disk 7316d6b073a44f6dbf03323dcbb983ef. Successfully replaced voting disk group with +OCR. CRS-4256: Updating the profile CRS-4266: Voting file(s) successfully replaced ## STATE File Universal Id File Name Disk group -- ----------1. ONLINE 7cd47f01f1e84f82bfef846752f4bab2 (ORCL:OCR1) [OCR] 2. ONLINE ab468b2ebcca4ffbbf793400a8301cec (ORCL:OCR2) [OCR] 3. ONLINE 7316d6b073a44f6dbf03323dcbb983ef (ORCL:OCR3) [OCR] Located 3 voting disk(s). CRS-2791: Starting shutdown of Oracle High Availability Services-managed resources on 'itsovm1' CRS-2673: Attempting to stop 'ora.crsd' on 'itsovm1' CRS-2677: Stop of 'ora.crsd' on 'itsovm1' succeeded CRS-2673: Attempting to stop 'ora.storage' on 'itsovm1' CRS-2673: Attempting to stop 'ora.mdnsd' on 'itsovm1' CRS-2673: Attempting to stop 'ora.gpnpd' on 'itsovm1' CRS-2677: Stop of 'ora.storage' on 'itsovm1' succeeded CRS-2673: Attempting to stop 'ora.crf' on 'itsovm1' CRS-2673: Attempting to stop 'ora.ctssd' on 'itsovm1' CRS-2673: Attempting to stop 'ora.evmd' on 'itsovm1' CRS-2673: Attempting to stop 'ora.asm' on 'itsovm1' CRS-2677: Stop of 'ora.mdnsd' on 'itsovm1' succeeded CRS-2677: Stop of 'ora.gpnpd' on 'itsovm1' succeeded CRS-2677: Stop of 'ora.crf' on 'itsovml' succeeded CRS-2677: Stop of 'ora.evmd' on 'itsovm1' succeeded CRS-2677: Stop of 'ora.ctssd' on 'itsovm1' succeeded CRS-2677: Stop of 'ora.asm' on 'itsovm1' succeeded CRS-2673: Attempting to stop 'ora.cluster interconnect.haip' on 'itsovm1' CRS-2677: Stop of 'ora.cluster interconnect.haip' on 'itsovm1' succeeded CRS-2673: Attempting to stop 'ora.cssd' on 'itsovm1' CRS-2677: Stop of 'ora.cssd' on 'itsovm1' succeeded CRS-2673: Attempting to stop 'ora.gipcd' on 'itsovm1'

```
CRS-2677: Stop of 'ora.gipcd' on 'itsovm1' succeeded
CRS-2793: Shutdown of Oracle High Availability Services-managed resources on
'itsovm1' has completed
CRS-4133: Oracle High Availability Services has been stopped.
CRS-4123: Starting Oracle High Availability Services-managed resources
CRS-2672: Attempting to start 'ora.mdnsd' on 'itsovm1'
CRS-2672: Attempting to start 'ora.evmd' on 'itsovm1'
CRS-2676: Start of 'ora.mdnsd' on 'itsovm1' succeeded
CRS-2676: Start of 'ora.evmd' on 'itsovm1' succeeded
CRS-2672: Attempting to start 'ora.gpnpd' on 'itsovm1'
CRS-2676: Start of 'ora.gpnpd' on 'itsovm1' succeeded
CRS-2672: Attempting to start 'ora.gipcd' on 'itsovm1'
CRS-2676: Start of 'ora.gipcd' on 'itsovm1' succeeded
CRS-2672: Attempting to start 'ora.cssdmonitor' on 'itsovm1'
CRS-2676: Start of 'ora.cssdmonitor' on 'itsovm1' succeeded
CRS-2672: Attempting to start 'ora.cssd' on 'itsovm1'
CRS-2672: Attempting to start 'ora.diskmon' on 'itsovm1'
CRS-2676: Start of 'ora.diskmon' on 'itsovm1' succeeded
CRS-2676: Start of 'ora.cssd' on 'itsovm1' succeeded
CRS-2672: Attempting to start 'ora.cluster interconnect.haip' on 'itsovm1'
CRS-2672: Attempting to start 'ora.ctssd' on 'itsovm1'
CRS-2676: Start of 'ora.ctssd' on 'itsovm1' succeeded
CRS-2676: Start of 'ora.cluster interconnect.haip' on 'itsovm1' succeeded
CRS-2672: Attempting to start 'ora.asm' on 'itsovm1'
CRS-2676: Start of 'ora.asm' on 'itsovm1' succeeded
CRS-2672: Attempting to start 'ora.storage' on 'itsovm1'
CRS-2676: Start of 'ora.storage' on 'itsovm1' succeeded
CRS-2672: Attempting to start 'ora.crf' on 'itsovm1'
CRS-2676: Start of 'ora.crf' on 'itsovm1' succeeded
CRS-2672: Attempting to start 'ora.crsd' on 'itsovm1'
CRS-2676: Start of 'ora.crsd' on 'itsovm1' succeeded
CRS-6023: Starting Oracle Cluster Ready Services-managed resources
CRS-6017: Processing resource auto-start for servers: itsovml
CRS-6016: Resource auto-start has completed for server itsovm1
CRS-6024: Completed start of Oracle Cluster Ready Services-managed resources
CRS-4123: Oracle High Availability Services has been started.
2016/05/27 14:50:28 CLSRSC-343: Successfully started Oracle Clusterware stack
CRS-2672: Attempting to start 'ora.asm' on 'itsovm1'
CRS-2676: Start of 'ora.asm' on 'itsovm1' succeeded
CRS-2672: Attempting to start 'ora.OCR.dg' on 'itsovm1'
CRS-2676: Start of 'ora.OCR.dg' on 'itsovm1' succeeded
2016/05/27 14:51:44 CLSRSC-325: Configure Oracle Grid Infrastructure for a
Cluster ... succeeded
```

30. Repeat the above step on the other three hosts in sequence.

31. After the scripts complete, click **OK** to continue. The installation program finishes the rest of procedures and then shows a successful installation window as shown in Figure 8-30.



Figure 8-30 Completion of Grid infrastructure installation

8.4 Oracle RAC Database installation

This section introduces how to install Oracle RAC Database software on four nodes. Complete these steps to start Oracle RAC Database installation:

 It is required to use Oracle database owner user (also known as. oracle in this environment) to start the Oracle Database installation. Log in with oracle from console, open a terminal, and start the installer by running **runInstaller** in database directory, as shown in Figure 8-31.

```
oracle@itsovm1:/software/database
                                                                               ×
File Edit View Search Terminal Help
[oracle@itsovm1 Desktop]$ cd /software/database/
[oracle@itsovm1 database]$ ls
install response rpm runInstaller sshsetup stage welcome.html
[oracle@itsovm1 database]$ ./runInstaller
Starting Oracle Universal Installer...
Checking Temp space: must be greater than 500 MB. Actual 167145 MB
                                                                        Passed
Checking swap space: must be greater than 150 MB. Actual 16487 MB
                                                                       Passed
                                                                       Actual 1
Checking monitor: must be configured to display at least 256 colors.
6777216
          Passed
Preparing to launch Oracle Universal Installer from /tmp/OraInstall2016-05-26 05
-29-34PM. Please wait ...
```

Figure 8-31 Run Oracle database installer

2. Oracle supports sending security updates if an Oracle Support email and password is provided. Click to clear **I wish to receive security updates via My Oracle Support** if it is not necessary, as shown in Figure 8-32. Click **Next** to continue.

	Oracle Database 12c Release 1 Installer - Step 1 of 9 -	•	×
Configure Security Update		12	c
Configure Security Updates	Provide your email address to be informed of security issues, install the product and initiate configuration manager. <u>View details</u> .		
Installation Option Grid Installation Options Install Type Typical Installation Prerequisite Checks Summary Install Product Finish	Email: Easier for you if you use your My Oracle Support email address/username. I wish to receive security updates via My Oracle Support. My Oracle Support Password: My Oracle Support Password:		
Help	< <u>B</u> ack <u>N</u> ext > <u>I</u> nstall	Can	cel

Figure 8-32 Configure security updates

3. A window is displayed appears to confirm the action, as shown in Figure 8-33. Click **Yes** to continue.



Figure 8-33 Confirm not to provide email

4. Select **Install database software only** and click **Next** to continue, as shown in Figure 8-34.

	Oracle Database 12c Release 1 Installer - Step 2 of 9	-		×
Select Installation Option		ORACLE DATABASE	12	С
Configure Security Updates Installation Option Grid Installation Options Install Type Typical Installation Prerequisite Checks Summary Install Product Finish	Select any of the following install options. Create and configure a database for install database software only Upgrade an existing database			
Help		<u>N</u> ext >	Can	cel

Figure 8-34 Oracle database installation options

5. Select **Create Real Application Clusters database installation** and click **Next** to continue, as shown in Figure 8-35.

	Oracle Database 12c Release 1 Installer - Step 3 of 9	- • ×
Grid Installation Options		
<u>Configure Security Updates</u>	Select the type of database installation you want to perform.	
Installation Option	○ <u>S</u> ingle instance database installation	
Grid Installation Options	Oracle <u>Real</u> Application Clusters database installation	
histall Type	Oracle RAC On <u>e</u> Node database installation	
Y Typical Installation		
Prerequisite Checks		
y Summary		
unstall Product		
5 Finish		
Help	< <u>B</u> ack	Next > Install Cancel

Figure 8-35 Oracle database type options

6. Select the four nodes in the list, click the **SSH Connectivity** button, and input the password of the Oracle user. Then click the **Setup** button to set up passwordless SSH connectivity between all cluster member nodes, as shown in Figure 8-36.

	Oracle Database 12c Release 1 Installer - Step 4 of 10 _ C X
Select List of Nodes	
Configure Security Updates Installation Option Crid Installation Options Nodes Selection Install Type Typical Installation Prerequisite Checks Summary Install Product Finish	Select nodes (in addition to the local node) in the cluster where the installer should install Oracle RAC or Oracle RAC One. Node name I itsovm1 I itsovm1 I itsovm2 I itsovm3 I itsovm3 I itsovm4 Itsovm4 SSH gonnectivity Select all Deselect all QS Username: oracle OS Password: Itsove Its shared by the selected nodes Its shared by the selected nodes Reuse private and public keys existing in the user home Test Setup
Help	< <u>Back</u> <u>Next</u> > <u>Install</u> Cancel

Figure 8-36 Config nodes and passwordless SSH connectivity for oracle user

7. A dialog will be prompted after the passwordless SSH connectivity setup is completed, as shown in Figure 8-37.

	Oracle Database 12c Release 1 Installer - Step 4 of 10 - 🛛 🗙
Select List of Nodes	
Configure Security Updates Installation Option Grid Installation Options Nodes Selection Install Type Typical Installation Prerequisite Checks Summary Install Product Finish	Select nodes (in addition to the local node) in the cluster where the installer should install Oracle RAC or Oracle RAC One. Node name 1 itsovm1 2 itsovm2 3 itsovm3 Coracle Database 12c Release 1 Installer Oracle Database 12c Release 1 Installer Successfully established passwordless SSH connectivity between the selected nodes. t all @eselect all @K User Home is shared by the selected nodes t all @eselect all [Installe] [
<u>H</u> elp	< <u>Back</u> Next > Install Cancel

Figure 8-37 Passwordless SSH connectivity setup completion

8. Oracle database supports multiple languages, **English** is selected by default. If additional language support is needed, select the language name from the left box, and click the **Arrow** button to add it to the list, as shown in Figure 8-38, then click **Next** to continue.

	Oracle Database 12c Release 1 Installer - Step 5 of 12 - 🛛 🗙
Select Product Languages	
Configure Security Updates Installation Option Grid Installation Options Nodes Selection Product Languages Database Edition Installation Location Operating System Groups Prerequisite Checks Summary Install Product Finish	Select the languages in which your product will run. Available languages: Arabic Bengali Brazilian Portuguese Bulgarian Canadian French Catalan Croatian Czech Danish Dutch Egyptian English (United Kingdom) Estonian Finnish French Greek Hebrew Hungarian Icelandic Indonesian
Help	< <u>Back</u> <u>Next></u> Install Cancel

Figure 8-38 Oracle database language options

9. There are two Oracle database editions. Make sure that **Enterprise Edition** is selected, as shown in Figure 8-39, and click **Next** to continue.

	Oracle Database 12c Release 1 Installer - Step 6 of 12 - 🛛 🗙
Select Database Edition	
Configure Security Updates Installation Option Grid Installation Options Nodes Selection Product Languages Database Edition Installation Location Operating System Groups Prerequisite Checks Summary Install Product Finish	Which database edition do you want to install? Enterprise Edition (6.4CB) Oracle Database 12c Enterprise Edition is a self-managing database that has the scalability, performance, high availability, and security features required to run the most demanding, mission-critical applications. Standard Edition (6.1CB) Oracle Database 12c Standard Edition is a full-featured data management solution ideally suited to the needs of medium-sized businesses. It includes Oracle Real Application Clusters for enterprise-Class availability and comes complete with its own Oracle Clusterware and storage management capabilities.
<u>H</u> elp	< <u>Back</u>

Figure 8-39 Oracle database edition options
10.Specify the locations for ORACLE_BASE and Oracle Database software (Oracle Home), as shown in Figure 8-40, and click **Next** to continue.

	Oracle Database 12c Release 1 Installer - Step 7 of 12 - 🛛 🗙
Specify Installation Location	
Configure Security Updates Installation Option Grid Installation Options Nodes Selection Product Languages Database Edition Installation Location Operating System Groups Prerequisite Checks Summary Install Product Finish	Specify a path to place all Oracle software and configuration-related files installed by this installation owner. This location is the Oracle base directory for the installation owner. Oracle base: /u01/app/oracle Specify a location for storing Oracle database software files separate from database configuration files in the Oracle base directory. This software directory is the Oracle database home directory. Software location? /u01/app/oracle/product/12:1.0/dbhome Srowse
Help	< <u>Back</u> <u>N</u> ext > <u>Install</u> Cancel

Figure 8-40 Oracle database installation location

11.Assign OS groups for Oracle Database Management according to the criteria in Table 8-10, as shown in Figure 8-41 on page 168, and click **Next** to continue.

Table 8-10 Oracle Database groups

Oracle Database Role	OS Group
Database Administrator (OSDBA) group	dba
Database Operator (OSOPER) group	oper
Database Backup and Recovery (OSBACKUPDBA) group	backupdba
Data Guard administrative (OSDGDBA) group	dgdba
Encryption Key Management administrative (OSKMDBA) group	kmdba

	Oracle Database 12c Release 1 Installer - Step 8 of 12	- • ×
Privileged Operating System	n groups	
Configure Security Updates Installation Option Grid Installation Options Nodes Selection Product Languages Database Edition Installation Location	SYS privileges are required to create a database using operating system Membership in OS Groups grants the corresponding SYS privilege, eg SYSDBA privilege. Database Administrator (OSDBA) group: dba Database Operator (OSOPER) group (Optional): Database Backup and Recovery (OSBACKUPDBA) group: Data Guard administrative (OSDGDBA) group:	em (OS) authentication. g. membership in OSDBA grants the r kupdba v ba v
Operating System Groups	Encryption Key Management administrative (OSKMDBA) group: kmd	lba 🔻
Summary Install Product Finish		
Help	< <u>B</u> ack	Next > Install Cancel

Figure 8-41 Oracle database OS groups

12. The installation program performs prerequisite checks as shown in Figure 8-42. This process usually takes several minutes.

	Oracle Database 12c Release 1 Installer - Step 9 of 12	-		×
Perform Prerequisite Chec	s and the second se	DATABASE	12	c
Configure Security Updates Installation Option Grid Installation Options Nodes Selection Product Languages Database Edition Installation Location Operating System Groups Prerequisite Checks Summary Install Product Finish	Verifying that the target environment meets minimum installation and products you have selected. This can take time. Please wait. 2% Checking Oracle base: /u01/app/oracle	configuration require	ements fo	r
Help	< <u>B</u> ack	<u>N</u> ext > <u>I</u> nstall	Can	cel

Figure 8-42 Perform prerequisite checks

13. The verification result shows as soon as the prerequisite checks are finished, Figure 8-43 shows that there is one warning on /dev/shm. This is a known issue, and can be ignored. Select **Ignore All** and click **Next** to continue.

6		
erification Result me of the minimum requirements for inst the following table, and recheck the syste heck Again Eix & Check Again Shu Checks Checks Mode / dev/shm mounted as temporar ecks whether / dev/shm is mounted correct	erification Result me of the minimum requirements for installation are not completed. Rev the following table, and recheck the system. heck Again Eix & Check Again Show Failed I All Node Checks Checks Checks Method (Checks) Checks (dev/shm mounted as temporary file system) ecks whether /dev/shm is mounted correctly as temporary file system (erification Result me of the minimum requirements for installation are not completed. Review and fix the the following table, and recheck the system. heck Again Eix & Check Again Show Failed Table All Nodes Checks Checks Checks Status Checks (Aev/shm mounted as temporary file system Warning) ecks whether /dev/shm is mounted correctly as temporary file system (more details)
	allation are not completed. Rev m. ow Failed All Node y file system	DATABASE callation are not completed. Review and fix the cm. cow Failed Call Nodes Call

Figure 8-43 Prerequisite check result



14. Figure 8-44 shows a summary of the installation settings. Click Install to continue.

Figure 8-44 Oracle database installation summary

15.Oracle Database installation begins. Check the progress bar for installation process as shown in Figure 8-45.

	Oracle Database 12c Release 1 Installer - Step 11 of 12 - 🛛	×
Install Product		20
Configure Security Updates Installation Option Grid Installation Options Nodes Selection Product Languages Database Edition Installation Location Operating System Groups Prerequisite Checks Summary Install Product Install Product	Frogress 65% Copying Oracle home '/u01/app/oracle/product/12.1.0/dbhome' to remote nodes 'itsovm2, itsovm3,itsovm4'. Status Image: Status of the installation of the progress of th	5
Help	Details Retry . ORACLE: 12 ^c ATABASE Ca	Skip

Figure 8-45 Oracle database installation in progress

16.During the installation, a window will open prompting you to run a script as root user, as shown in Figure 8-46.

	Execute Configuration scripts	
The follow cluster no <u>S</u> cripts to	ving configuration scripts need to be executed as the "r de. Each script in the list below is followed by a list of i be executed:	oot" user in each new nodes.
Number	Script Location	Nodes
1	/u01/app/oracle/product/12.1.0/dbhome/root.sh	itsovm1,itsovm2,itsovm3,i
To execut 1. Ope 2. Log 3. Run 4. Retu	e the configuration scripts: n a terminal window in as "root" the scripts in each cluster node irn to this window and click "OK" to continue	
<u>H</u>	elp	ОК

Figure 8-46 Prompt to execute root script

17.Open a terminal window and login as root user on the first node in cluster, known as itsovm1 in this environment. Run the /u01/app/oracle/product/12.1.0/dbhome/root.sh script as shown in Example 8-61.

Example 8-61 Execute /u01/app/oracle/product/12.1.0/dbhome/root.sh

```
# /u01/app/oracle/product/12.1.0/dbhome/root.sh
Performing root user operation.
The following environment variables are set as:
    ORACLE_OWNER= oracle
    ORACLE_HOME= /u01/app/oracle/product/12.1.0/dbhome
Enter the full pathname of the local bin directory: [/usr/local/bin]:
The contents of "dbhome" have not changed. No need to overwrite.
The contents of "oraenv" have not changed. No need to overwrite.
The contents of "coraenv" have not changed. No need to overwrite.
Entries will be added to the /etc/oratab file as needed by
Database Configuration Assistant when a database is created
Finished running generic part of root script.
Now product-specific root actions will be performed.
```

18. Repeat the above step on the other three hosts in sequence.

19. After you finish running the script, click **OK** to continue. The installation program finishes the rest of procedures and shows a successful installation window as shown in Figure 8-47.

	Oracle Database 12c Release 1 Installer - Step 12 of 12	-	• ×
Finish		ORACLE DATABASE	12 ^c
Configure Security Updates Installation Option Grid Installation Options Nodes Selection Product Languages Database Edition Installation Location Operating System Groups Prerequisite Checks Summary Install Product Simmary	The installation of Oracle Database was successful.		
<u>H</u> elp	< <u>Back</u>	<u>l</u> ext >Install	Close

Figure 8-47 Oracle RAC database installation completion

8.5 Create Oracle ASM disk groups

This section describes how to create Oracle ASM disk groups using a graphic tool called ASM Configuration Assistant. ASM disk groups are used to store Oracle Database files. To create ASM disk groups, complete these steps:

- 1. To launch ASM Configuration Assistant, log in with grid from the console, open a terminal, and issue the command /u01/app/12.1.0/grid/bin/asmca.
- 2. ASM Configuration Assistant lists existing ASM disk groups information, as shown in Figure 8-48. Click **Create** button to create an ASM disk group.

	ASM Cor	figuration As	sistant: Config	gure ASM: Disk	Groups	>
	ASM Instances Disk C You can choose to create groups with 11.2 ASM co	Groups Volum a new disk grou mpatibility or hig	es ASM Cluste p or add disks to her.	r File Systems an existing disk gro	oup. To create dynam	ic volumes, you need disk
	Disk Groups	ns on a disk grou	ip, right mouse ci	ick on the row.		
	Disk Group Name	Size (GB)	Free (GB)	Usable (GB)	Redundancy	State
	OCR	14.99	5.56	0.28	NORMAL	MOUNTED(4 of 4)
Hole	Create Mount All	Dismount All				Fvi

Figure 8-48 ASM configuration assistant

- 3. Click Show Advanced Options, as shown in Figure 8-49, and complete these steps:
 - a. Input new ASM disk group name, such as REDO in this environment.
 - b. Select the redundancy level as **External (None)** because it is not necessary to keep multiple data copies.
 - c. Check the disks to be used to create REDO disk group from the list, for example ORCL:REDO in this environment.
 - d. Select Allocation Unit size as 4 MB.
 - e. Click **OK** to create the ASM disk group.

	Cr	eate Disk Gr	oup		
sk Group Name REDO					
sk droup Name Rebo					
Redundancy					
Redundancy is achieved by two different failure groups () High () Normal () Ext	storing multiple copies of the da , and high redundancy from at le ernal (None)	ta on different f ast three differe	ailure groups nt failure gro	. Normal redu ups.	undancy needs disks from at leas
Select Member Disks					
Show Eligible O Show A	п				
	n				
Quorum failure groups are	used to store voting files in exte	nded clusters ar	nd do not con	tain any user	data. They require ASM
compatibility of 11.2 or higi	ner.				
Disk Path	Header Status	Disk Name	Size (MB)	Ouorum	0
ORCL:DATA1	PROVISIONED	D.D.C.F.C.F.C.F.C.	1048575		-
ORCL:DATA2	PROVISIONED		1048575		-
ORCL:DATA3	PROVISIONED		1048575		
ORCL:DATA4	PROVISIONED		1048575		
ORCL:REDO	PROVISIONED		81919		
			01919		-
Note: If you do not see the c The Disk Discovery Path lim Disk Discovery Path: <defau< td=""><td>lisks which you believe are availa its set of disks considered for di Itt></td><td>ble, check the D scovery.</td><td>isk Discovery</td><td>Path and rea</td><td>d/write permissions on the disks Change Disk Discovery Path</td></defau<>	lisks which you believe are availa its set of disks considered for di Itt>	ble, check the D scovery.	isk Discovery	Path and rea	d/write permissions on the disks Change Disk Discovery Path
Note: If you do not see the c The Disk Discovery Path lim Disk Discovery Path: <defau Disk Group Attributes</defau 	lisks which you believe are availa its set of disks considered for di Ilt>	ble, check the D scovery.	isk Discovery	Path and rea	d/write permissions on the disks Change Disk Discovery Path
Note: If you do not see the c The Disk Discovery Path lim Disk Discovery Path: <defau Disk Group Attributes An allocation unit (AU) is th</defau 	lisks which you believe are availa its set of disks considered for di It> e fundamental unit in which cont	ble, check the D scovery. iguous disk spa	isk Discovery	Path and rea	d/write permissions on the disks Change Disk Discovery Path ASM file extent size is a multiple
Note: If you do not see the c The Disk Discovery Path lim Disk Discovery Path: <defau Disk Group Attributes An allocation unit (AU) is th of AUs. The AU size cannot</defau 	lisks which you believe are availa its set of disks considered for di ilt> e fundamental unit in which cont be modified later.	ble, check the D scovery. iguous disk spa	isk Discovery	Path and rea	d/write permissions on the disks Change Disk Discovery Path . ASM file extent size is a multiple
Note: If you do not see the c The Disk Discovery Path lim Disk Discovery Path: <defau Disk Group Attributes An allocation unit (AU) is th of AUs. The AU size cannot Allocation Unit Size (MB)</defau 	lisks which you believe are availa its set of disks considered for di llt> e fundamental unit in which cont be modified later.	ble, check the D scovery. iguous disk spa	isk Discovery .ce is allocated	Path and rea	d/write permissions on the disks Change Disk Discovery Path ASM file extent size is a multiple
Note: If you do not see the c The Disk Discovery Path lim Disk Discovery Path: <defau Disk Group Attributes An allocation unit (AU) is th of AUs. The AU size cannot Allocation Unit Size (MB) Specify minimum software y</defau 	lisks which you believe are availa its set of disks considered for di lit> e fundamental unit in which cont be modified later. 4	ble, check the D scovery. iguous disk spa	isk Discovery ce is allocated	Path and rea d to ASM files	d/write permissions on the disks Change Disk Discovery Path ASM file extent size is a multiple be compatible with.
Note: If you do not see the c The Disk Discovery Path lim Disk Discovery Path: <defau Disk Group Attributes An allocation unit (AU) is th of AUs. The AU size cannot Allocation Unit Size (MB) Specify minimum software v</defau 	lisks which you believe are availa its set of disks considered for di lit> e fundamental unit in which cont be modified later. 4 ersions for ASM, Database and A	ble, check the D scovery. iguous disk spa	isk Discovery ce is allocated	Path and rea d to ASM files	d/write permissions on the disks Change Disk Discovery Path . ASM file extent size is a multiple be compatible with.
Note: If you do not see the c The Disk Discovery Path lim Disk Discovery Path: <defau Disk Group Attributes An allocation unit (AU) is th of AUs. The AU size cannot Allocation Unit Size (MB) Specify minimum software v ASM Compatibility</defau 	lisks which you believe are availa its set of disks considered for di lit> e fundamental unit in which cont be modified later. 4 ersions for ASM, Database and A 12.1.0.0.0	ble, check the D scovery. iguous disk spa SM volumes tha	isk Discovery ce is allocated	Path and rea d to ASM files oup need to b	d/write permissions on the disks Change Disk Discovery Path . ASM file extent size is a multiple be compatible with.
Note: If you do not see the c The Disk Discovery Path lim Disk Discovery Path: <defau Disk Group Attributes An allocation unit (AU) is th of AUs. The AU size cannot Allocation Unit Size (MB) Specify minimum software v ASM Compatibility Database Compatibility</defau 	lisks which you believe are availa its set of disks considered for di lit> e fundamental unit in which cont be modified later. 4 ersions for ASM, Database and A 12.1.0.0.0	ble, check the D scovery. iguous disk spa SM volumes tha	isk Discovery ce is allocated	Path and rea d to ASM files	d/write permissions on the disks Change Disk Discovery Path . ASM file extent size is a multiple be compatible with.
Note: If you do not see the c The Disk Discovery Path lim Disk Discovery Path: <defau Disk Group Attributes An allocation unit (AU) is th of AUs. The AU size cannot Allocation Unit Size (MB) Specify minimum software v ASM Compatibility Database Compatibility ADVM Compatibility</defau 	lisks which you believe are availa its set of disks considered for di llt> e fundamental unit in which cont be modified later. 4 • ersions for ASM, Database and A 12:1.0.0.0	ble, check the D scovery. iguous disk spa	isk Discovery ce is allocated	Path and rea	d/write permissions on the disks Change Disk Discovery Path . ASM file extent size is a multiple be compatible with.
Note: If you do not see the c The Disk Discovery Path lim Disk Discovery Path: <defau Disk Group Attributes An allocation unit (AU) is th of AUs. The AU size cannot Allocation Unit Size (MB) Specify minimum software v ASM Compatibility Database Compatibility ADVM Compatibility Refer Oracle Automatic Stor</defau 	lisks which you believe are availa its set of disks considered for di ilt> e fundamental unit in which cont be modified later. 4 ersions for ASM, Database and A 12:1.0.0.0 1 2:1.0.0.0 1 2:1.0.0.0 1 2:1.0.0.0 1 2:1.0.0.0	ble, check the D scovery. iguous disk spa SM volumes tha s Guide for mor	isk Discovery ce is allocated at this disk gro e details on th	Path and rea d to ASM files oup need to b	d/write permissions on the disks Change Disk Discovery Path . ASM file extent size is a multiple be compatible with.
Note: If you do not see the c The Disk Discovery Path lim Disk Discovery Path: <defau Disk Group Attributes An allocation unit (AU) is th of AUs. The AU size cannot Allocation Unit Size (MB) Specify minimum software v ASM Compatibility Database Compatibility Refer Oracle Automatic Stor</defau 	lisks which you believe are availa its set of disks considered for di ilt> e fundamental unit in which cont be modified later. 4	ble, check the D scovery. iguous disk spa SM volumes tha s Guide for mor	isk Discovery ce is allocated at this disk group e details on th	Path and rea d to ASM files bup need to b	d/write permissions on the disks Change Disk Discovery Path . ASM file extent size is a multiple be compatible with.

Figure 8-49 Create ASM disk group

4. Repeat the above steps to create more ASM disk groups. After you are finished, all the ASM disk groups are listed in ASM Configuration Assistant, as shown in Figure 8-50.

Disk Group Name Size (GB) Free (GB) Usable (GB) Redundancy State DATA 4095.98 4095.74 4095.74 EXTERN MOUNTED(4 of 4) REDO 80.00 79.79 EXTERN MOUNTED(4 of 4) OCR 14.99 5.54 0.27 NORMAL MOUNTED(4 of 4)		ASM Con ASM Instances Disk of You can choose to creat groups with 11.2 ASM co Tip: To perform operatio Disk Groups	Groups Volum e a new disk grou ompatibility or hig ons on a disk grou	sistant: Config cs ASM Cluster p or add disks to her. up, right mouse c	gure ASM: Disk r File Systems an existing disk gru lick on the row.	Groups	_ C X
Data 4095.98 4095.74 4095.74 Received and and and and and and and and and an		Disk Group Name	Size (GB)	Free (GB)	Usable (GB)	Redundancy	State
REDO 80.00 79.79 79.79 EXTERN MOUNTED(4 of 4) OCR 14.99 5.54 0.27 NORMAL MOUNTED(4 of 4)		DATA	4095.98	4095 74	4095 74	EXTERN	MOUNTED(4 of 4)
OCR 14.99 5.54 0.27 NORMAL MOUNTED(4 of 4)		REDO	80.00	79.79	79.79	EXTERN	MOUNTED(4 of 4)
		OCR	14.99	5.54	0.27	NORMAL	MOUNTED(4 of 4)
	Help						Exit

Figure 8-50 List ASM disk groups

8.6 Oracle RAC Database creation

This section describes how to create a sample Oracle RAC database using a tool called Database Configuration Assistant.

8.6.1 Oracle RAC Database creation

To create an Oracle RAC Database, complete these steps:

- 1. To launch Database Configuration Assistant, log in with oracle from console, open a terminal, and issue the command /u01/app/oracle/product/12.1.0/dbhome/bin/dbca.
- 2. In the Database Operation window, select **Create Database**, as shown in Figure 8-51, and click **Next** to continue.

	Database Configuration Assistant - Welcome - Step 1 of 6 - 🛛 🗙
Database Operation	
Database Operation Creation Mode Prerequisite Checks Summary Progress Page Finish	Select the operation that you want to perform.
Help	< <u>Back</u> <u>Mext</u> <u>Finish</u> Cancel

Figure 8-51 Create Oracle database

3. Select **Advanced Mode** to allow more flexible configuration, as shown in Figure 8-52, and click **Next** to continue.

Da	atabase Configuration Assistant -	Create Database - Step 2 of 14	4 <u> </u>
Creation Mode		-	
 Database Operation Creation Mode Database Template Database Identification Management Options Database Credentials Storage Locations Database Options Initialization Parameters Creation Options Prerequisite Checks Summary Progress Page Finish 	Create a database with default co Global Database Nam e: Storage Type: Database Files Location: Fast Recovery Area: Database Character Set: Administrative Password : Confirm Password: Crgate As Container Database Pluggable Database Name:	nfiguration Automatic Storage Management (ASM) +DATA +REDO WE8MSWIN1252 - MS Windows Code P C Asse C	Browse Browse Browse Page 1252 8-bit Wes V
<u>H</u> elp		< <u>B</u> ack <u>N</u> ext	> Einish Cancel

Figure 8-52 Creation mode options

4. Select Database Type as Oracle Real Application Clusters (RAC) database, Configuration Type as Admin-Managed, select General Purpose for Transaction Processing template, as shown in Figure 8-53, and click Next to continue.

	Dat	abase Configuration	Assistant - Create Database - Step 3 of	f14 _ 🗆 🗙
Da	tabase Template			
0-9-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0	Database Operation Creation Mode Database Template Database Identification Management Options Database Credentials Storage Locations Database Options Initialization Parameters Creation Options Prerequisite Checks Summary Progress Page Finish	Select the type of da Database Type: Configuration Type: Templates that inclu in minutes, as oppor as when you need to Select a template for Select Temp O Cust Data	tabase you want to configure. Oracle Real Application Clusters (RAC) database Admin-Managed de datafiles contain pre-created databases. They a sed to an hour or more. Use templates without data ochange attributes like block size, which cannot be ryour database. plate ral Purpose or Transaction Processing om Database Warehouse	Ilowyou to create a new database files only when necessary, such altered after database creation.
	Help		< <u>B</u> ack	lext > Einish Cancel

Figure 8-53 Database templates

5. Enter the **Global Database Name** and **SID Prefix**, and clear **Create as Container Database**, as shown in Figure 8-54, and click **Next** to continue.

	Database Configuration Assistant - Create Database - Step 4 of 15 _ Z ×				
Dat	abase Identification				
3-3-3	Database Operation Creation Mode <u>Database Template</u>	Provide the identifier info uniquely identified by a 0 referenced by an Oracle cluster database instanc	rmation required to access the database unic ilobal Database Name, typically of the form "n instance on each cluster database node. Spec is.	quely. An Oracle database is ame.domain". A database is ify a prefix to be used to name the	
	Database Identification	<u>G</u> lobal Database Name	sample		
ý	Database Placement	<u>S</u> ID Prefix:	sample		
Ý	Management Options				
Ý	Database Credentials				
Ý	Storage Locations	<u>Create As Container I</u>	atabase		
Ý	Database Options	Creates a database c	ontainer for consolidating multiple databases	into a single database and	
Ý	Initialization Parameters	databases (PDB).	ualization. A container database (CDB) can na	we zero or more pluggable	
Ý	Creation Options	Create an Empty C	ontainer Database		
Ý	Prerequisite Checks	Create a Containe	r Database with one or more PDBs		
Ý	Summary	Number of PDBs			
Ý	Progress Page				
0	Finish	<u>P</u> DB Name:			
	Help]	< <u>B</u> ack	Next > Einish Cancel	

Figure 8-54 Database identification

 Only the node where DBCA is run from is chosen to join Oracle RAC Cluster by default. Select the other three nodes in the left pane, and click the **Right Arrow** to add them to Oracle RAC Cluster, as shown in Figure 8-55.

Dat	abase Configuration Assistar	at – Create Database – Step 5 of 1	5 <u> </u>
Database Placement			
Database Operation Creation Mode Database Template Database Identification Database Identification Database Placement Management Options Database Credentials Storage Locations Database Options Initialization Parameters Creation Options Prerequisite Checks Summary Progress Page Finish	Select Nodes Select the nodes on which you v always be selected. Available: itsovm2 itsovm3 itsovm4	vant to create the cluster database. The loc Selected: itsovm1	al node "itsovm 1" should
<u>H</u> elp		< <u>B</u> ack <u>N</u> ext	t > Einish Cancel

Figure 8-55 Select Oracle RAC nodes

7. Verify whether the list of nodes is correct, as shown in Figure 8-56, and click **Next** to continue.



Figure 8-56 Select all 4 nodes in cluster

8. Clear Run Cluster Verification Utility (CVU) Checks Periodically, Configure Enterprise Manager (EM) Database Express, and Register with Enterprise Manager (EM) Cloud Control, as shown in Figure 8-57, and click Next to continue.

Da	abase Configuration Assistant - Create Database - Step 6 of 15 - 🛛 🗙	
Management Options		
Database Operation Creation Mode Database Template	Specify the management options for the database. Run Cluster Verification Utility (CVU) Checks Periodically Configure Enterprise Manager (EN) Database Express	
Database Identification	EM Database Express Port: 5500	
Management Options Database Credentials Storage Locations Database Options Initialization Parameters Creation Options Prerequisite Checks Summary Progress Page	QMS Host:	
Leip	< Back Next > Einish Cancel	

Figure 8-57 Oracle database management options

9. Set password for SYS and SYSTEM users. Select Use the same administrative Password for All accounts, and input the password, as shown in Figure 8-58. The SYS user is a database administration user with SYSDBA privileges. It is suggested to use a strong password. After the setting is finished, click Next to continue.

Dat	abase Configuration Assistant - C	Treate Database – Step 7	of 15 _ 🗆 🗙
Database Credentials			
Database Operation Creation Mode	For security reasons, you must speci	fy passwords for the following u vords	iser accounts in the new database.
🍦 Database Template	User Name	Password	Confirm Password
Database Identification	SYS		
Database Placement	SYSTEM		
Management Options			
Database Credentials			
Storage Locations			
Database Options	Use the Same Administrative Pass	word for All Accounts	
 Initialization Parameters 	Password:		
Creation Options	Confirm Password		
Prerequisite Checks			
Summary			
Progress Page			
- Finish			
Help		< <u>B</u> ack	<u>N</u> ext > <u>Einish</u> Cancel

Figure 8-58 Set password for Oracle database

10. In the storage locations window, as shown in Figure 8-59, complete these steps:

- a. Select Automatic Storage Management (ASM) for Database files Storage Type.
- b. Select Use Common Location for All Database Files.
- c. Input the name of the ASM disk group storing database files, such as +DATA in this environment.

Da	tabase Configuration Assistant - Create Database - Step 8 of 15 - 🛛 🗙
Storage Locations	
Database Operation Creation Mode Database Template Database Identification Database Placement Management Options Database Credentials Storage Locations Database Options Initialization Parameters	Database files Storage Type: Automatic Storage Management (ASM) Use Database File Locations from Template Uge Common Location for All Database Files File Location: +DATA Use Oracle-Managed Files Multiplex Redo Logs and Control Files Choose the recovery options for the database. Regovery files Storage Type: Automatic Storage Management (ASM)
Creation Options Prerequisite Checks Summary Progress Page Finish	Fast Recovery Area: +DATA Browse Fast Recovery Area Size: 5535 \$ MB * Enable Archiving Edit Archive Mode Parameters File Location Variables
Help	<pre></pre>

d. Select Use Oracle-Managed Files.

Figure 8-59 Oracle database storage locations

e. Click **Multiplex Redo Logs and Control Files** to open the window shown in Figure 8-60.

	Multiplex Redo Logs and Control Files	
lt is spr	s recommended that online redo logs and control files be written to multiple locations read across different disks to provide greater fault tolerance.	
	Location	
1	+REDO	1.
2		33
3		100
4		
-		-
	<u>Q</u> K <u>C</u> ancel	se

Figure 8-60 Specify redo log files location

- f. Input the name of ASM disk group storage redo logs and control files, such as +REDO in this environment. Click **OK** to continue.
- g. Clear Specify Fast Recovery Area.
- h. Clear Enable Archiving.
- i. Click Next to continue.
- 11. Figure 8-61 shows the database options. Keep the default settings, and click **Next** to continue.

Data	abase Configuration Assistant - Create Database - Step 9 of 15 _ Z ×
Database Options	
 Database Operation Creation Mode Database Template Database Identification Database Placement Management Options Database Credentials Storage Locations Matabase Options Prerequisite Checks Summary Progress Page Finish 	Sample Schemas Database Vault & Label Security Sample Schemas illustrate the use of a layered approach to complexity, and are used by some demonstration programs. Installing this will give you the following schemas in your database: Human Resources, Order Entry, Online Catalog, Product Media, Information Exchange, Sales History. It will also create a tablespace called EXAMPLE. The tablespace will be about 150 MB. Specify whether or not to add the Sample Schemas to your database. Samgle Schemas Samgle Schemas Specify the SQL scripts you want to run after the database is created. The scripts are run in the order they are listed below. Sglect a script: Browse
Help	< <u>Back</u> Next > Einish Cancel

Figure 8-61 Oracle database options

12. From the initialization parameters window, select **Typical Settings** for memory and clear **Use Automatic Memory Management** because AMM is not compatible with HugePages, as shown in Figure 8-62. Click **Next** to continue.

Datab	ase Configuration Assistant - C	reate Databa	se - Step 10 of 15	_ = ×
Initialization Parameters		Č.		
 Database Operation Creation Mode Database Template Database Identification Database Placement Management Options Database Credentials Storage Locations Database Options Initialization Parameters Creation Options Prerequisite Checks Summary Progress Page Finish 	Mgmory Sizing Character Image: Im	Sets Connection 96640 MB % sigement Automatic St 96640 MB	250 MB 250 MB Show Memory I ared Memory Management 72,480 \Rightarrow M Bytes \checkmark 24,160 \Rightarrow M Bytes \checkmark	241656 MB Distribution
Help	All Initialization Parameters		< Back Next >	Finish Cancel

Figure 8-62 Oracle database initialization parameters

13. Select Create Database, and clear Generate Database Create Scripts, as shown in Figure 8-63, then click Customize Storage Locations button to modify redo log size.

Data	ase Configuration Assistant - Create Database - Step 11 of 15 - 🛛	×
Creation Options		20
Database Operation Creation Mode Database Template Database Identification Database Placement Management Options Database Credentials Storage Locations	Select the database creation options.	rse
Database Options Database Options Initialization Parameters Creation Options Prerequisite Checks Summary Progress Page Finish		
Help	< Back Next > Einish Ca	ncel

Figure 8-63 Oracle database creation options

14. In the Customize Storage window, it lists control files, datafiles, and Redo Log groups, as shown in Figure 8-64.

	Customize Storage	
Storage Control Files Datafiles Carbon Log Groups 	Customize Storage Database Storage Database Storage Prom the Database Storage page, you can specify storage parameters for database creation. This page displays a tree listing and summary view (multi-column lists) to enable you to change and view the following objects: Control files Tablespaces Datafiles Redo Log Groups From any object type folder, click Create to create a new object. To delete an object, select the specific object from within the object type folder and click Delete. Important: If you select a database template including data files, then you will not be able to add or remove data files or tablespaces. Selecting this type of template enables you to change the following:	
	 Destination of the datafiles Control files or log groups 	
Add <u>R</u> emove	<u>O</u> K <u>C</u> lose	

Figure 8-64 Customize storage

15.Click **Redo Logs Group 1** to show the current Redo log file size in the right pane, as shown in Figure 8-65. Change it to **1024 MB** and click the **Apply** button.

	Customize Storage
E-Storage	Edit Redo Log Group - 1 Group #: 1 Eile Size: S1200 K Bytes Thread: 1 Redo Log Members File Name <omf_1_redolog_member_0></omf_1_redolog_member_0>
<u>A</u> dd <u>R</u> emove	Apply Revert

Figure 8-65 Customize redo log files

16.Repeat the above steps to change the file size for all eight Redo Log files, as shown in Figure 8-66, and click **OK** to continue.

□-Storage	Customize Sto	og Groups	
		Change All :	Update All
Redo Log Groups	Name	Size(MB)	
	3	1024	
	2	1024	
	1	1024	
···••መ 4	7	1024	
	6	1024	
	5	1024	
	4	1024	
	8	1024	
Add Remove			Apply Revert
			<u>OK</u> <u>C</u> lose

Figure 8-66 List redo log files size

17. The Database Configuration Assistant program performs prerequisite checks as shown in Figure 8-67. This process usually takes several minutes.

Database Configuration Assistant - Create Database - Step 12 of 15 -					
Prerequisite Checks			= 12	2 ^c	
 Database Operation Creation Mode Database Template Database Identification Database Placement Management Options Database Credentials Storage Locations Database Options Initialization Parameters Creation Options Prerequisite Checks Summary Progress Page Finish 	Prerequisite Checks 15% Cluster Validation Checks				
Help	< <u>B</u> ack	Next >Einish	Ca	ncel	

Figure 8-67 Perform prerequisite checks

Databa	ase Configuration Assistant – Create Database –	Step 13 of 15 _ 🗆 🗙
Summary	ă c	
Database Operation Creation Mode Database Template Database Identification Database Placement Management Options Database Credentials Storage Locations Database Options Initialization Parameters Creation Options Prerequisite Checks	Database Configuration Assistant: Summary Create Database — S Database Configuration Summary Global Database Name: sample Database Configuration Type: Admin-Mana Node List: itsovml,itsov SID List: sample1,sam Create As Container Database No Storage Type: Automatic Str Memory Configuration Type: Automatic Str Template Name: General Purp Database Configuration Details	summary ged Cluster Database m2,itsovm3,itsovm4 ple2,sample3,sample4 orage Management (ASM) ared Memory Management ose or Transaction Processing
Summary Progress Page	Database Components	
U Finish	Component	Selected
	Oracle JVM	true
	Oracle Text	true
	Oracle Multimedia	true
	Oracle OLAP	true
Help	<	<u>Back</u> <u>Next</u> > <u>Einish</u> Cancel

18. Figure 8-68 shows a summary of creating database settings. Click **Finish** to continue.

Figure 8-68 Oracle database creation summary

19. Figure 8-69 shows the progress of database creation. The process usually takes about 10 minutes.

Data	base Configuration Assistant - Create Database - Step 14 of 15	_ 0 ×
Progress Page		
 Database Operation Creation Mode Database Template Database Identification 	Progress Clone database "sample" creation in progress 0%	
Database Placement Management Options Database Credentials Storage Locations Database Options Initialization Parameters Creation Options Prerequisite Checks Summary Progress Page Finish	Steps Copying database files Creating and starting Oracle instance Creating cluster database views Completing Database Creation	Status In Progress
Help	< <u>B</u> ack <u>N</u> ext >	Einish Cancel

Figure 8-69 Oracle database creation in progress

20. After the database creation is completed, a window like that shown in Figure 8-70 is shown. Only SYS and SYSTEM users are unlocked by default, and to unlock other users or change password for other users, click **Password Management**.

Data	abase Configuration Assistant - Create Database - Step 15 of 15 _ Z X
Finish	
 Database Operation Creation Mode Database Template Database Identification Database Placement Management Options Database Credentials Storage Locations Database Options Initialization Parameters Creation Options Prerequisite Checks Summary Progress Page Finish 	Database creation complete. For details check the logfiles at: /u01/app/oracle/cfgtoollogs/dbca/sample. Database Information: Global Database Name: sample System Identifier(SID) Prefix: sample Server Parameter File name: +DATA/sample/spfilesample.ora Note: All database accounts except SYS and SYSTEM are locked. Select the Password Management button to view a complete list of locked accounts or to manage the database accounts. From the Password Management window, unlock only the accounts you will use. Oracle strongly recommends changing the default passwords immediately after unlocking the account.
Help	< <u>B</u> ack <u>N</u> ext > <u>F</u> inish <u>Close</u>

Figure 8-70 Oracle database creation completion

21.Lock/unlock database users, or change the password for users in the Password Management window, as shown in Figure 8-71. Click **OK** to finish database creation.

Lock / uniock database	user accounts and	/ or change the deta	uit passwords:	
User Name	Lock Account? 🔺	New Password	Confirm Password	
SYS				-
SYSTEM				
OUTLN	×			
LBACSYS	×			3
OLAPSYS	×			100
SI_INFORMTN_SCHEMA	×			
DVSYS	×			
ORDPLUGINS	×			
XDB	× .			
ANONYMOUS	×			
CTXSYS	×			
ORDDATA	×			
GSMADMIN_INTERNAL	×			
APPQOSSYS	×			
APEX_040200	×			
WMCVC				

Figure 8-71 Oracle database password management

8.6.2 Update grid and oracle user profile

Oracle RAC Database is a database with multiple instances from different nodes, which means the Oracle instance ID on each node is different. It is suggested to configure Oracle instance ID for the grid and oracle user in its profile on each node.

The grid user's Oracle instance ID in this environment is shown in Table 8-11.

Node	Instance ID
itsovm1	+ASM1
itsovm2	+ASM2
itsovm3	+ASM3
itsovm4	+ASM4

Table 8-11 grid user Oracle instance ID

The oracle user's Oracle instance ID in this environment is shown in Table 8-12.

Table 8-12 oracle user Oracle instance ID

Node	Instance ID
itsovm1	sample1
itsovm2	sample2
itsovm3	sample3
itsovm4	sample4

To configure grid user profile on itsovm1, log in to the node with the grid user, use a text editor to open the .bash_profile file, and append the lines shown in Example 8-62.

Example 8-62 The grid user profile

```
export ORACLE_BASE=/u01/app/grid
export ORACLE_HOME=/u01/app/12.1.0/grid
export ORACLE_SID=+ASM1
export PATH=$ORACLE_HOME/bin:$PATH
umask 022
```

Repeat the above step on the other three nodes. Remember to change the Oracle instance ID.

To configure oracle user profile on itsovm1, log in to the node with the oracle user, use a text editor to open the .bash_profile file, and append the lines shown in Example 8-63.

Example 8-63 The oracle user profile

```
export ORACLE_BASE=/u01/app/oracle
export ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome
export ORACLE_SID=sample1
export PATH=$ORACLE_HOME/bin:$PATH
umask 022
```

Repeat the above step on the other three nodes. Remember to change the Oracle instance ID.

8.6.3 HugePages Configuration

Usually the default memory page size is 4 KB in Linux. HugePages has been available since Linux Kernel 2.6. You can improve system performance by reducing the amount of system resources that are required to access page table entries by using HugePages in Linux.

To check whether HugePages is configured in Linux, run the command shown in Example 8-64.

Example 8-64 Show HugePages number

grep -i HugePages /proc/meminfo AnonHugePages: 0 kB HugePages_Total: 0 HugePages_Free: 0 HugePages_Rsvd: 0 HugePages_Surp: 0 Hugepagesize: 2048 kB HugePages_Total is the number of HugePages that are configured on the host. It is not configured by default. To configure HugePages on Oracle RAC node, complete these steps:

1. Make sure that the Oracle database is up and running. Check whether oracle and grid user are shown in the output of the **ipcs** -**m** command, as shown in Example 8-65.

Example 8-65 Show shared memory segments

# 1pcs -m						
Shar	ed Memory S	Segments -				
key	shmid	owner	perms	bytes	nattch	status
0x0000000	221380608	grid	640	4096	0	
0x00000000	221413377	grid	640	4096	0	
0xf675ea7c	221446146	grid	640	24576	33	
0x00000000	275349507	oracle	640	8388608	295	
0x00000000	275382276	oracle	640	7596723404	8 295	
0x00000000	275415045	oracle	640	262144000	295	
0xc1c7c898	275447814	oracle	640	24576	295	
0x00000000	278560775	grid	640	4194304	39	
0x00000000	278593544	grid	640	780140544	39	
0x00000000	278626313	grid	640	6291456	39	
0x381a5a60	278659082	grid	640	16384	39	
0x00000000	1368817675	root	600	524288	2	dest
0x00000000	1368850444	root	600	4194304	2	dest
0x00000000	1369014285	root	600	4194304	2	dest
0x00000000	1370161167	root	600	2097152	2	dest

2. Log in to one node with root user, create a script named hugepages.sh with the content shown in Example 8-66.

Example 8-66 Script to calculate Hugepages number

```
#!/bin/bash
HPG_SZ=`grep Hugepagesize /proc/meminfo | awk {'print $2'}`
NUM_PG=1
for SEG_BYTES in `ipcs -m | awk {'print $5'} | grep "[0-9][0-9]*"`
do
    MIN_PG=`echo "$SEG_BYTES/($HPG_SZ*1024)" | bc -q`
    if [ $MIN_PG -gt 0 ]; then
        NUM_PG=`echo "$NUM_PG+$MIN_PG+1" | bc -q`
    fi
done
echo $NUM_PG
```

- 3. Run the script hugepages.sh and document the number shown, for example 36745 in this environment.
- Append a line with content vm.nr_hugepages = 36745 to /etc/sysctl.conf file, as shown in Example 8-67.

```
Example 8-67 Modify /etc/sysctl.conf file
echo "vm.nr_hugepages = 36745" >> /etc/sysctl.conf
```

- 5. Repeat the above step on each node in the Oracle RAC cluster.
- 6. Stop all the database instances and reboot the system.

8.7 Oracle RAC Database Management

This section introduces some Oracle RAC Database management operations, including the following topics:

- Enable archive log mode
- Add redo log group
- Multiplex Oracle control files
- Update processes and sessions parameters
- Startup and shutdown of Oracle CRS and Database
- OCR and voting disk management

8.7.1 Enable archive log mode

Oracle database can run in two log modes: No Archive Mode or Archive Mode. The major difference is that the Oracle archiver background processes (ARCn) archive redo logs in Archive mode. By default, the database is created in No Archive Mode. However, it is suggested to enable database in Archive Mode if it is in production.

For more information about No Archive Mode and Archive Mode, see the *Oracle Database Administrator's Guide*.

To enable Oracle RAC database in Archive Mode, complete these steps:

1. Connect to database with SYS user, and check the current database log mode, Example 8-68 shows database is in No Archive Mode.

Example 8-68 Inquiry database archive log mode [oracle@itsovm1 ~]\$ sqlplus /nolog SQL*Plus: Release 12.1.0.2.0 Production on Sat May 28 16:11:14 2016 Copyright (c) 1982, 2014, Oracle. All rights reserved. SQL> connect / as sysdba; Connected. SQL> archive log list; Database log mode No Archive Mode Automatic archival Disabled Archive destination /u01/app/oracle/product/12.1.0/dbhome/dbs/arch Oldest online log sequence 397 Current log sequence 398 SQL> select inst id, instance name, version, archiver, status from gv\$instance;

 INS	ST_ID INSTAN	NCE_NAME	VERSION	ARCHIVE STATUS	
 1 4 3 2	sample1 sample4 sample3 sample2	12.1.0.2.0 12.1.0.2.0 12.1.0.2.0 12.1.0.2.0 12.1.0.2.0	STOPPED STOPPED STOPPED STOPPED	OPEN OPEN OPEN OPEN	

 Check the current log archive destination, log archive destination state, and log archive format, as shown in Example 8-69.

SQL> show parameter log archive dest 1 NAME TYPE VALUE _____ log_archive_dest_1 string log archive dest 10 string log archive dest 11 string SQL> show parameter log archive dest state 1 NAME TYPE VALUE -----log archive dest state 1 string enable log_archive_dest_state_10 string enable log archive dest state 11 string enable SQL> show parameter log archive format; TYPE VALUE NAME _____ log archive format string %t %s %r.dbf

Example 8-69 Show archive log destination parameter

3. Modify the log archive destination to the +DATA ASM disk group, as shown in Example 8-70.

Example 8-70 Modify archive log destination

SQL> alter system set log_archive_dest_1='LOCATION=+DATA/sample/archivelog';

System altered.

4. Stop the database using oracle user, as shown in Example 8-71.

Example 8-71 Stop Oracle database

[oracle@itsovm1 ~]\$ srvctl stop listener [oracle@itsovm1 ~]\$ srvctl stop database -d sample

Start the Oracle database to mount state with single instance, as shown in Example 8-72.

Example 8-72 Start one Oracle database instance to mount mode

[oracle@itsovm1 ~]\$ srvctl start instance -d sample -i sample1 -o mount

Connect to the database with SYS user, and run the command to enable archive mode for the database, as shown in Example 8-73.

Example 8-73 Enable archivelog mode

[oracle@itsovm1 ~]\$ sqlplus /nolog

SQL*Plus: Release 12.1.0.2.0 Production on Sat May 28 16:29:58 2016

Copyright (c) 1982, 2014, Oracle. All rights reserved.

SQL> conn / as sysdba; Connected. SQL> alter database archivelog; Database altered.

 Start the Oracle database to open stage, and check the current archive log status, as shown in Example 8-74.

```
Example 8-74 Inquiry archivelog mode
```

```
SQL> alter database open;
Database altered.
SQL> archive log list;
Database log mode Archive Mode
Automatic archival Enabled
Archive destination +DATA/sample/archivelog
Oldest online log sequence 397
Next log sequence to archive 398
Current log sequence 398
```

8. Issue a manual switch logfile command, as shown in Example 8-75.

```
Example 8-75 Trigger manual log file switch
SQL> alter system switch logfile;
```

System altered.

9. Shut down the database manually and startup all instances, as shown in Example 8-76.

```
Example 8-76 Restart Oracle database
```

```
SQL> shutdown immediate;
Database closed.
Database dismounted.
ORACLE instance shut down.
SQL> exit
```

[oracle@itsovm1 ~]\$ srvctl start database -d sample

10. Switch to grid user and run **asmcmd** to check whether Redo log is archived during manual switching logfile, as shown in Example 8-77.

```
Example 8-77 List archived login ASM
```

```
[grid@itsovm1 ~]$ asmcmd -p
ASMCMD [+] > ls +DATA/sample/archivelog
1_398_912970625.dbf
2016_05_28/
```
8.7.2 Add redo log group

This Oracle RAC environment has four database instances. Each database instance has its own redo thread. By default each thread has 2 online redo log groups. It is suggested to add one more redo log group to each thread. To do so, complete these steps:

1. Log in as SYS user, run the following SQL to get current redo log information, as shown in Example 8-78.

Example 8-78 Inquiry redo log files

```
SQL> select a.group#, b.thread#, b.bytes, b.status, a.member from v$logfile a,
v$log b where a.group# = b.group#;
   GROUP# THREAD# BYTES STATUS MEMBER
-----
       1 1073741824 CURRENT +REDO/SAMPLE/ONLINELOG/group 2.258.912970627
      1 1073741824 INACTIVE +REDO/SAMPLE/ONLINELOG/group 1.257.912970625
   1
       3 1073741824 INACTIVE +REDO/SAMPLE/ONLINELOG/group 5.259.912970667
   5
   6
       3 1073741824 CURRENT +REDO/SAMPLE/ONLINELOG/group 6.260.912970667
       2 1073741824 INACTIVE +REDO/SAMPLE/ONLINELOG/group 3.261.912970669
   3
       2 1073741824 CURRENT +REDO/SAMPLE/ONLINELOG/group 4.262.912970669
   4
       4 1073741824 CURRENT +REDO/SAMPLE/ONLINELOG/group 7.263.912970671
   7
   8
       4 1073741824 INACTIVE +REDO/SAMPLE/ONLINELOG/group 8.264.912970671
```

8 rows selected.

Database altered.

2. Add one more redo log file for each thread, as shown in Example 8-79.

Example 8-79 Add redo log files

SQL> alter database add logfile thread 1 group 9 size 1024M; Database altered. SQL> alter database add logfile thread 2 group 10 size 1024M; Database altered. SQL> alter database add logfile thread 3 group 11 size 1024M; Database altered. SQL> alter database add logfile thread 4 group 12 size 1024M;

3. Make an inquiry of the latest redo log file information. The newly added redo log groups are in an unused state, as shown in Example 8-80.

Example 8-80 Inquiry redo log files

SQL> select a.group#, b.thread#, b.bytes, b.status, a.member from v\$logfile a, v\$log b where a.group# = b.group#; GROUP# THREAD# BYTES STATUS MEMBER 2 1 1073741824 CURRENT +REDO/SAMPLE/ONLINELOG/group_2.258.912970627 1 1073741824 INACTIVE +REDO/SAMPLE/ONLINELOG/group_1.257.912970625 5 3 1073741824 INACTIVE +REDO/SAMPLE/ONLINELOG/group_5.259.912970667

	6	3	1073741824	CURRENT	+REDO/SAMPLE/ONLINELOG/group_6.260.912970667
	3	2	1073741824	INACTIVE	+REDO/SAMPLE/ONLINELOG/group_3.261.912970669
	4	2	1073741824	CURRENT	+REDO/SAMPLE/ONLINELOG/group_4.262.912970669
	7	4	1073741824	CURRENT	+REDO/SAMPLE/ONLINELOG/group_7.263.912970671
	8	4	1073741824	INACTIVE	+REDO/SAMPLE/ONLINELOG/group_8.264.912970671
	9	1	1073741824	UNUSED	+REDO/SAMPLE/ONLINELOG/group_9.265.913751035
	10	2	1073741824	UNUSED	+REDO/SAMPLE/ONLINELOG/group_10.266.913751057
	11	3	1073741824	UNUSED	+REDO/SAMPLE/ONLINELOG/group_11.267.913751089
	12	4	1073741824	UNUSED	+REDO/SAMPLE/ONLINELOG/group_12.268.913751107
12	rows	sel	ected.		

8.7.3 Multiplex Oracle control files

Control file is an important file in the Oracle database. The default Oracle installation has only one control file. If the only control file is damaged due to a disk failure, the database is shut down. For this reason, each Oracle Database should have at least two control files, each stored on a different disk. The following steps show how to multiplex Oracle control files on different ASM disk groups:

1. Log in as SYS user to query current control file information, as shown in Example 8-81.

```
Example 8-81 Inquiry control files
SQL> select name from v$controlfile;
NAME
+RED0/SAMPLE/CONTROLFILE/current.256.912970623
```

2. Shut down the Oracle database to multiplex control files, as shown in Example 8-82.

Example 8-82 Stop Oracle database

```
[oracle@itsovm1 ~]$ srvctl stop listener
[oracle@itsovm1 ~]$ srvctl stop database -d sample
```

 Use RMAN to copy the current control file to other ASM disk groups, as shown in Example 8-83.

Example 8-83 Copy control files

[oracle@itsovm1 ~]\$ rman target / nocatalog

Recovery Manager: Release 12.1.0.2.0 - Production on Sun May 29 12:32:51 2016

Copyright (c) 1982, 2014, Oracle and/or its affiliates. All rights reserved.

connected to target database (not started)

RMAN> startup nomount;

Oracle instance started

Total System Global Area 76235669504 bytes

Fixed Size 7652568 bytes

```
Variable Size
                          14227082024 bytes
Database Buffers
                         61740154880 bytes
Redo Buffers
                            260780032 bytes
RMAN> restore controlfile to '+OCR' from
'+REDO/SAMPLE/CONTROLFILE/current.256.912970623';
Starting restore at 29-MAY-16
allocated channel: ORA DISK 1
channel ORA DISK 1: SID=197 instance=sample1 device type=DISK
channel ORA DISK 1: copied control file copy
Finished restore at 29-MAY-16
RMAN> restore controlfile to '+DATA' from
'+REDO/SAMPLE/CONTROLFILE/current.256.912970623';
Starting restore at 29-MAY-16
using channel ORA_DISK_1
channel ORA DISK 1: copied control file copy
Finished restore at 29-MAY-16
```

 Log in to the host using the grid user, and run asmcmd to check the file names copied by RMAN, as shown in Example 8-84.

Example 8-84 List names of new control files

```
[grid@itsovm1 ~]$ asmcmd
ASMCMD> 1s -1 +DATA/sample/controlfile/
Type
          Redund Striped Time
                                          Sys Name
CONTROLFILE UNPROT FINE
                          MAY 29 12:00:00 Y
                                               current.308.913120473
ASMCMD> 1s -1 +OCR/sample/controlfile/
                                          Sys Name
          Redund Striped Time
Туре
CONTROLFILE HIGH
                          MAY 29 12:00:00 Y
                  FINE
                                               current.276.913120449
```

 Log in to the Oracle database as the SYS user to modify the control_files parameter, as shown in Example 8-85.

Example 8-85 Modify control_files parameter

System altered.

6. Shut down the Oracle database and start it up to normal state, as shown in Example 8-86.

Example 8-86 Restart Oracle database

```
SQL> shutdown immediate;
ORA-01507: database not mounted
ORACLE instance shut down.
SQL> exit
Disconnected from Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
64bit Production
With the Partitioning, Real Application Clusters, Automatic Storage Management,
OLAP,
Advanced Analytics and Real Application Testing options
```

```
[oracle@itsovm1 ~]$ srvctl start database -d sample
```

 Log in to the Oracle database as the SYS user to see the latest control files information, as shown in Example 8-87.

Example 8-87 Inquiry control files

SQL> select name from v\$controlfile;

NAME

```
+REDO/SAMPLE/CONTROLFILE/current.256.912970623
+DATA/sample/controlfile/current.308.913120473
+OCR/sample/controlfile/current.276.913120449
```

8.7.4 Update processes and sessions parameters

Oracle parameter processes specify the maximum number of operating system user processes that can simultaneously connect to Oracle. Parameter sessions specifies the maximum number of sessions that can be created in the system. For a heavy load Oracle database, update these two parameters to a large number to avoid ORA-12516 or ORA-12520 errors.

To check the current settings of processes and sessions parameter, use the SYS user to log in and run the command shown in Example 8-88.

Example 8-88 Show processes and sessions parameters

SQL> show parameter sessions;

NAME TYPE VALUE

```
java_max_sessionspace_size integer 0
java_soft_sessionspace_limit integer 0
license_max_sessions integer 0
license_sessions_warning integer 0
sessions integer 300
shared server sessions integer
```

Usually the value of sessions is approximately (1.5 * processes) + 22. Example 8-89 shows adjusting processes to 1000 and sessions to 1522.

Example 8-89 Modify processes and sessions parameters

```
SQL> alter system set processes=1000 scope=spfile;
System altered.
SQL> alter system set sessions=1522 scope=spfile;
System altered.
```

The new values will be effective until the Oracle Database's next startup. Reboot the Oracle Database to apply the changes as shown in Example 8-90.

```
Example 8-90 Restart Oracle database
```

[oracle@itsovm1 ~]\$ srvctl stop database -d sample [oracle@itsovm1 ~]\$ srvctl start database -d sample

8.7.5 Startup and shutdown of Oracle CRS and Database

To shut down Oracle CRS and Database, run the command shown in Example 8-91 with the root user.

Example 8-91 Stop Oracle CRS and database

```
# /u01/app/12.1.0/grid/bin/crsctl stop crs
CRS-2791: Starting shutdown of Oracle High Availability Services-managed resources
on 'itsovm1'
CRS-2673: Attempting to stop 'ora.crsd' on 'itsovm1'
CRS-2790: Starting shutdown of Cluster Ready Services-managed resources on
'itsovm1'
CRS-2673: Attempting to stop 'ora.oc4j' on 'itsovm1'
CRS-2673: Attempting to stop 'ora.mgmtdb' on 'itsovm1'
CRS-2673: Attempting to stop 'ora.sample.db' on 'itsovm1'
CRS-2673: Attempting to stop 'ora.LISTENER.lsnr' on 'itsovm1'
CRS-2673: Attempting to stop 'ora.cvu' on 'itsovm1'
CRS-2677: Stop of 'ora.cvu' on 'itsovm1' succeeded
CRS-2672: Attempting to start 'ora.cvu' on 'itsovm3'
CRS-2676: Start of 'ora.cvu' on 'itsovm3' succeeded
CRS-2677: Stop of 'ora.LISTENER.lsnr' on 'itsovml' succeeded
CRS-2673: Attempting to stop 'ora.itsovm1.vip' on 'itsovm1'
CRS-2677: Stop of 'ora.itsovm1.vip' on 'itsovm1' succeeded
CRS-2672: Attempting to start 'ora.itsovm1.vip' on 'itsovm2'
```

```
CRS-2677: Stop of 'ora.sample.db' on 'itsovm1' succeeded
CRS-2673: Attempting to stop 'ora.DATA.dg' on 'itsovm1'
CRS-2677: Stop of 'ora.DATA.dg' on 'itsovm1' succeeded
CRS-2677: Stop of 'ora.mgmtdb' on 'itsovm1' succeeded
CRS-2673: Attempting to stop 'ora.MGMTLSNR' on 'itsovm1'
CRS-2677: Stop of 'ora.MGMTLSNR' on 'itsovm1' succeeded
CRS-2672: Attempting to start 'ora.MGMTLSNR' on 'itsovm2'
CRS-2676: Start of 'ora.itsovm1.vip' on 'itsovm2' succeeded
CRS-2677: Stop of 'ora.oc4j' on 'itsovm1' succeeded
CRS-2672: Attempting to start 'ora.oc4j' on 'itsovm4'
CRS-2676: Start of 'ora.MGMTLSNR' on 'itsovm2' succeeded
CRS-2672: Attempting to start 'ora.mgmtdb' on 'itsovm2'
CRS-2676: Start of 'ora.oc4j' on 'itsovm4' succeeded
CRS-2676: Start of 'ora.mgmtdb' on 'itsovm2' succeeded
CRS-2673: Attempting to stop 'ora.OCR.dg' on 'itsovm1'
CRS-2673: Attempting to stop 'ora.REDO.dg' on 'itsovm1'
CRS-2677: Stop of 'ora.OCR.dg' on 'itsovm1' succeeded
CRS-2677: Stop of 'ora.REDO.dg' on 'itsovm1' succeeded
CRS-2673: Attempting to stop 'ora.asm' on 'itsovm1'
CRS-2677: Stop of 'ora.asm' on 'itsovm1' succeeded
CRS-2673: Attempting to stop 'ora.ons' on 'itsovm1'
CRS-2677: Stop of 'ora.ons' on 'itsovm1' succeeded
CRS-2673: Attempting to stop 'ora.net1.network' on 'itsovm1'
CRS-2677: Stop of 'ora.net1.network' on 'itsovm1' succeeded
CRS-2792: Shutdown of Cluster Ready Services-managed resources on 'itsovm1' has
completed
CRS-2677: Stop of 'ora.crsd' on 'itsovm1' succeeded
CRS-2673: Attempting to stop 'ora.storage' on 'itsovm1'
CRS-2673: Attempting to stop 'ora.mdnsd' on 'itsovm1'
CRS-2673: Attempting to stop 'ora.gpnpd' on 'itsovm1'
CRS-2677: Stop of 'ora.storage' on 'itsovm1' succeeded
CRS-2673: Attempting to stop 'ora.crf' on 'itsovm1'
CRS-2673: Attempting to stop 'ora.ctssd' on 'itsovm1'
CRS-2673: Attempting to stop 'ora.evmd' on 'itsovm1'
CRS-2673: Attempting to stop 'ora.asm' on 'itsovm1'
CRS-2677: Stop of 'ora.gpnpd' on 'itsovm1' succeeded
CRS-2677: Stop of 'ora.mdnsd' on 'itsovm1' succeeded
CRS-2677: Stop of 'ora.crf' on 'itsovm1' succeeded
CRS-2677: Stop of 'ora.ctssd' on 'itsovml' succeeded
CRS-2677: Stop of 'ora.evmd' on 'itsovm1' succeeded
CRS-2677: Stop of 'ora.asm' on 'itsovm1' succeeded
CRS-2673: Attempting to stop 'ora.cluster interconnect.haip' on 'itsovm1'
CRS-2677: Stop of 'ora.cluster interconnect.haip' on 'itsovml' succeeded
CRS-2673: Attempting to stop 'ora.cssd' on 'itsovm1'
CRS-2677: Stop of 'ora.cssd' on 'itsovm1' succeeded
CRS-2673: Attempting to stop 'ora.gipcd' on 'itsovm1'
CRS-2677: Stop of 'ora.gipcd' on 'itsovm1' succeeded
CRS-2793: Shutdown of Oracle High Availability Services-managed resources on
'itsovm1' has completed
CRS-4133: Oracle High Availability Services has been stopped.
```

To start Oracle CRS and Database, run the command shown in Example 8-92 with the root user.

Example 8-92 Start Oracle CRS and database

```
# /u01/app/12.1.0/grid/bin/crsctl start crs
```

To list Oracle CRS resource status, or check CRS startup progress, run the command shown in Example 8-93 with the grid user.

Example 8-93 Show CRS resources states

Name	Target	State	Server	State details
Local Resour	ces			
ora.DATA.dg				
	ONLINE	ONLINE	itsovm1	STABLE
	ONLINE	ONLINE	itsovm2	STABLE
	ONLINE	ONLINE	itsovm3	STABLE
	ONLINE	ONLINE	itsovm4	STABLE
ora.LISTENER	R.lsnr			
	ONLINE	ONLINE	itsovm1	STABLE
	ONLINE	ONLINE	itsovm2	STABLE
	ONLINE	ONLINE	itsovm3	STABLE
	ONLINE	ONLINE	itsovm4	STABLE
ora.OCR.dg				
	ONLINE	ONLINE	itsovm1	STABLE
	ONLINE	ONLINE	itsovm2	STABLE
	ONLINE	ONLINE	itsovm3	STABLE
	ONLINE	ONLINE	itsovm4	STABLE
ora.RED0.dg				
	ONLINE	ONLINE	itsovm1	STABLE
	ONLINE	ONLINE	itsovm2	STABLE
	ONLINE	ONLINE	itsovm3	STABLE
	ONLINE	ONLINE	itsovm4	STABLE
ora.asm				
	ONLINE	ONLINE	itsovm1	Started,STABLE
	ONLINE	ONLINE	itsovm2	Started,STABLE
	ONLINE	ONLINE	itsovm3	Started,STABLE
	ONLINE	ONLINE	itsovm4	Started,STABLE
ora.net1.net	work			
	ONLINE	ONLINE	itsovm1	STABLE
	ONLINE	ONLINE	itsovm2	STABLE
	ONLINE	ONLINE	itsovm3	STABLE
	ONLINE	ONLINE	itsovm4	STABLE
ora.ons				
	ONLINE	ONLINE	itsovm1	STABLE
	ONLINE	ONLINE	itsovm2	STABLE
	ONLINE	ONLINE	itsovm3	STABLE
	ONLINE	ONLINE	itsovm4	STABLE
Cluster Reso	ources			

ora.LISTENER_S	CAN1.lsn	r		
1	ONLINE	ONLINE	itsovm1	STABLE
ora.LISTENER_S	CAN2.lsn	r		
1	ONLINE	ONLINE	itsovm2	STABLE
ora.LISTENER_S	CAN3.lsn	r		
1	ONLINE	ONLINE	itsovm4	STABLE
ora.MGMTLSNR				
1	ONLINE	ONLINE	itsovm2	169.254.142.90 10.0. 0.2,STABLE
ora.cvu				
1	ONLINE	ONLINE	itsovm2	STABLE
ora.itsovm1.vi	р			
1	ONLINE	ONLINE	itsovm1	STABLE
ora.itsovm2.vi	р			
1	ONLINE	ONLINE	itsovm2	STABLE
ora.itsovm3.vi	р			
1	ONLINE	ONLINE	itsovm3	STABLE
ora.itsovm4.vi	р			
1	ONLINE	ONLINE	itsovm4	STABLE
ora.mgmtdb				
1	ONLINE	ONLINE	itsovm2	Open,STABLE
ora.oc4j				
1	ONLINE	ONLINE	itsovm2	STABLE
ora.sample.db				
1	ONLINE	ONLINE	itsovm1	Open,STABLE
2	ONLINE	ONLINE	itsovm2	Open,STABLE
3	ONLINE	ONLINE	itsovm3	Open,STABLE
4	ONLINE	ONLINE	itsovm4	Open,STABLE
ora.scan1.vip				
1	ONLINE	ONLINE	itsovm1	STABLE
ora.scan2.vip				
1	ONLINE	ONLINE	itsovm2	STABLE
ora.scan3.vip				
1	ONLINE	ONLINE	itsovm4	STABLE

It is also possible to start or stop Oracle database only, and leave CRS running. First log in using the oracle user to get the database name, as shown in Example 8-94.

Example 8-94 Get database name

[oracle@itsovm1 ~]\$ srvctl config database
sample

To stop a specific Oracle database, run the following command using the oracle user, as shown in Example 8-95.

Example 8-95 Stop Oracle database

```
[oracle@itsovm1 ~]$ srvctl stop database -d sample
```

To start a specific Oracle database, run the command shown in Example 8-96 using the oracle user.

Example 8-96 Start Oracle database

[oracle@itsovm1 ~]\$ srvctl start database -d sample

And it is also possible to start or stop one Oracle database instance, and leave the rest of instances running. First log in using the oracle user to get the instance names as shown in Example 8-97.

Example 8-97 Show database configuration

```
[oracle@itsovm1 ~]$ srvctl config database -d sample -a
Database unique name: sample
Database name: sample
Oracle home: /u01/app/oracle/product/12.1.0/dbhome
Oracle user: oracle
Spfile: +DATA/SAMPLE/PARAMETERFILE/spfile.265.912970673
Password file: +DATA/SAMPLE/PASSWORD/pwdsample.256.912970459
Domain:
Start options: open
Stop options: immediate
Database role: PRIMARY
Management policy: AUTOMATIC
Server pools:
Disk Groups: DATA, REDO, OCR
Mount point paths:
Services:
Type: RAC
Start concurrency:
Stop concurrency:
Database is enabled
Database is individually enabled on nodes:
Database is individually disabled on nodes:
OSDBA group: dba
OSOPER group: oper
Database instances: sample1, sample2, sample3, sample4
Configured nodes: itsovm1, itsovm2, itsovm3, itsovm4
Database is administrator managed
```

To stop a specific Oracle database instance, run the command shown in Example 8-98 using the oracle user.

Example 8-98 Stop a database instance
[oracle@itsovm1 ~]\$ srvctl stop instance -d sample -i sample1

To start a specific Oracle database instance, run the command shown in Example 8-99 using the oracle user.

Example 8-99 Start a database instance

```
[oracle@itsovm1 ~]$ srvctl start instance -d sample -i sample1
```

8.7.6 OCR and voting disk management

To verify the integrity of OCR, run the command shown in Example 8-100 using the grid user.

```
Example 8-100 Perform OCR check
```

```
[grid@itsovm1 ~]$ ocrcheck
Status of Oracle Cluster Registry is as follows :
   Version
                                       4
                            :
   Total space (kbytes)
                                  409568
                           :
   Used space (kbytes)
                                   1768
                           :
   Available space (kbytes) :
                                  407800
                           : 2057472910
   ΙD
   Device/File Name
                           :
                                   +0CR
                                   Device/File integrity check succeeded
                                   Device/File not configured
                                   Device/File not configured
                                   Device/File not configured
                                   Device/File not configured
```

Cluster registry integrity check succeeded

Logical corruption check bypassed due to non-privileged user

To list current voting disks, run the command shown in Example 8-101 using the grid user.

Example 8-101 List voting disks

[gri	d@itsovm1	. ~]\$ crsctl query css votedisk	
##	STATE	File Universal Id	File Name Disk group
1.	ONLINE	aa4865c2ae924f4cbf95862ad4985605	(/dev/oracleasm/disks/OCR1) [OCR]
2.	ONLINE	95b6d848bb6f4f4fbff7471f0d803159	(/dev/oracleasm/disks/OCR2) [OCR]
3.	ONLINE	a0527f228c404f9fbfb5ef3642fa67e4	(/dev/oracleasm/disks/OCR3) [OCR]
Loca	ited 3 vot	ing disk(s).	

9

Using IBM Spectrum Protect

This chapter covers the steps necessary to use IBM Spectrum Protect to ensure that you have a current backup of the Oracle RAC database.

It is beyond the scope of this book to show how to install IBM Spectrum Protect. This chapter provide information, where applicable, that shows where to obtain the code, documentation, and scripts necessary to install IBM Spectrum Protect. Contact your IBM representative if you need any assistance in preparing for, installing, or configuring IBM Spectrum Protect.

This chapter includes the following sections:

- Environment overview
- IBM Spectrum Protect server deployment
- DP for Oracle: Install and configure IBM Spectrum Protect on Oracle server node

9.1 Environment overview

This section details the IBM Spectrum Protect server components that were deployed on the example Oracle DB server on VersaStack environment.

IBM Spectrum Protect includes these core components:

- IBM Spectrum Protect backup server
- Spectrum Operations Center
- IBM Spectrum Protect Data Protection for Databases: Oracle

9.1.1 IBM Spectrum Protect Backup Server

IBM Spectrum Protect is a highly scalable backup solution that can be deployed on multiple hardware and software platforms. For a list of Tivoli Storage Manager Supported Operating Systems, refer to the following website:

http://www.ibm.com/support/docview.wss?uid=swg21243309#Server%20Table

Within the Oracle on VersaStack setup, we deployed IBM Spectrum Protect V7.1.6 on Red Hat Enterprise Linux Server (RHEL) V7.2. This example uses a host name of TSM716.

Linux x86_64 Server Requirements and Support for running IBM Spectrum Protect on Linux x86_64 can be found at the following website:

http://www.ibm.com/support/docview.wss?rs=663&context=SSGSG7&q1=ServerRequirements
&uid=swg21204361&loc=en US&cs=utf-8&lang=en

9.1.2 IBM Spectrum Protect Blueprints

The blueprint consists of a document, or "cookbook", that describes the three reference architectures in detail, including IBM hardware model numbers and configuration requirements. It also includes scripts to speed up the installation and configuration, increasing time-to-value. The storage preparation script automates preparation of the file systems that are used by the Tivoli Storage Manager server. The blueprint configuration script verifies that the hardware configuration meets the blueprint specifications, validates kernel settings on Linux systems, and verifies the configuration of required file systems before running the standard Tivoli Storage Manager server installation. The script also configures the Tivoli Storage Manager server using best practices and performs these tasks:

- Creates a DB2 instance
- Defines data deduplication storage pools with optimal performance settings
- Defines administrative maintenance tasks that are optimized for data deduplication scalability
- Defines Tivoli Storage Manager database backup to disk
- Creates a dsmserv.opt file with best practice option overrides
- Creates policy domains for database, mail and file servers with management classes for 30, 60, and 120-day retention
- Defines backup schedules for all client types that can be easily selected when deploying the wanted client workloads

The workload simulation script runs simulated Tivoli Storage Manager database and storage pool workloads. It provides performance measurements that can be used to compare as a reference against those measured on the blueprint configuration.

More information can be found at the following website:

https://www.ibm.com/developerworks/community/wikis/home?lang=en#!/wiki/Tivoli%20St orage%20Manager/page/IBM%20Spectrum%20Protect%20Blueprints

9.1.3 IBM Spectrum Protect Operations Center

The IBM Spectrum Protect Operations Center is a light-weight management application that offers the daily dashboard and management interface for the IBM Spectrum Protect servers. It can be deployed on the same system hosting the primary IBM Spectrum Protect server or on, for example, the VM that also hosts the IBM Tivoli Monitoring for IBM Spectrum Protect server.

Tivoli Storage Manager Operations Center Software and Hardware Requirements can be found at the following website:

http://www.ibm.com/support/docview.wss?uid=swg21653418

The example deployment installed the Operations Center on the IBM Spectrum Protect server.

9.1.4 IBM Spectrum Protect Data Protection for Databases: Oracle

IBM Spectrum Protect for Databases (formerly IBM Tivoli Storage Manager for Databases) helps protect Oracle and Microsoft SQL data no matter where it is stored. You can continue running primary applications on your database servers while they back up, and restore data to and from auxiliary storage by using automated tasks, utilities, and interfaces. This software performs online, consistent, and centralized backups to help you avoid downtime, protect vital enterprise data, and minimize operational costs.

IBM Spectrum Protect Data Protection for Databases: Oracle on UNIX, IBM AIX®, and Linux hardware and software requirements and installation prerequisites can be found at the following website:

http://www.ibm.com/support/knowledgecenter/SSTFZR_7.1.3/db.orc/r_dporc_inst_prereq
.html

9.2 IBM Spectrum Protect server deployment

The IBM Spectrum Protect server deployment was performed in two major steps. First, the code was installed, and then the ISP server was configured.

Download the relevant software through IBM Passport Advantage® and Passport Advantage Express available here:

https://www.ibm.com/software/passportadvantage/

If you have problems accessing this, contact your IBM sales representative.

9.2.1 Code installation: Step 1

Two packages were installed on the example Red Hat system. The first package was the Client code, referred to as Backup/Archive Client (BAC). The package installed by using rpm was:

7.1.6.0-TIV-TSMBAC-LinuxX86.tar

For detailed installation instructions, see *Installing the Tivoli Storage Manager backup-archive clients* in IBM Knowledge Center available at:

http://www.ibm.com/support/knowledgecenter/SSGSG7 7.1.6/client/c inst.html

The second package was the Server code. The package installed using the installation script (install.sh) was:

7.1.6.000-TIV-TSMSRV-Linuxx86_64.bin

For detailed installation instructions, see *Installing and upgrading the server* in IBM Knowledge Center available at:

http://www.ibm.com/support/knowledgecenter/en/SSGSG7_7.1.6/srv.common/t_installing srv.html?view=kc

Both packages were installed by using the instructions in that documentation.

These links are updated as changes are made to the code, and contain any relevant information.

9.2.2 Server configuration using automated Blueprint script: Step 2

This step contains two substeps: Linux disk mapping and configuring the ISP server using the IBM Blueprint automation script.

The example disk was configured to support the TSM server, DB2 space – database, log, and archive and database backup disk space and disk space for the backup data (tsmstg01-07). Our disk configuration is shown in Figure 9-1.

[root@TSM716 ~]# df -h					
Filesystem	Size	Used	Avail	Use %	Mounted on
/dev/mapper/rhel-root	50G	8.1G	42G	17%	1
devtmpfs	126G	0	126G	0%	/dev
tmpfs	126G	160K	126G	18	/dev/shm
tmpfs	126G	51M	126G	18	/run
tmpfs	126G	0	126G	0%	/sys/fs/cgroup
/dev/sdbe1	494M	158M	337M	32 %	/boot
/dev/mapper/rhel-home	58G	11G	47G	19 %	/home
tmpfs	26G	0	26G	0%	/run/user/0
tmpfs	26G	40K	26G	18	/run/user/1000
/dev/mapper/tsmdb512-tsmdb512a	512G	785M	501G	18	/tsmdb512a
/dev/mapper/tsmdb512-tsmdb512b	512G	785M	501G	18	/tsmdb512b
/dev/mapper/tsmdb512-tsmdb512c	512G	785M	501G	18	/tsmdb512c
/dev/mapper/tsmdb512-tsmdb512d	512G	785M	501G	18	/tsmdb512d
/dev/mapper/tsmarch-tsmarch01	512G	6.4G	496G	2%	/tsmarch01
/dev/mapper/tsmdbbk-tsmdbbk01	504G	1.5G	477G	18	/tsmdbbk01
/dev/mapper/tsmdbbk-tsmdbbk02	504G	1.7G	477G	18	/tsmdbbk02
/dev/mapper/tsmdbbk-tsmdbbk03	504G	2.1G	477G	18	/tsmdbbk03
/dev/mapper/tsmdbbk-tsmdbbk04	504G	1.3G	477G	18	/tsmdbbk04
/dev/mapper/tsmstg-tsmstg01	З.4Т	221G	З.ОТ	7 %	/tsmstg01
/dev/mapper/tsmstg-tsmstg02	1.5T	197G	1.2т	14%	/tsmstg02
/dev/mapper/tsmstg-tsmstg03	2.5T	212G	2.2T	9 %	/tsmstg03
/dev/mapper/tsmstg-tsmstg04	З.4Т	211G	3.1T	7 %	/tsmstg04
/dev/mapper/tsmstg-tsmstg05	З.9Т	202G	3.6T	6 %	/tsmstg05
/dev/mapper/tsmstg-tsmstg06	504G	201G	278G	42 %	/tsmstg06
/dev/mapper/tsmstg-tsmstg07	504G	183G	296G	39 %	/tsmstg07
/dev/mapper/tsmdb512-tsmlog00	256G	129G	123G	52%	/tsmact01
[root@TSM716 ~]#					

Figure 9-1 Mappings of the disk configuration

ISP server configuration

To download the documentation and the scripts, navigate to *Links to the version 2.3 blueprint downloads*, available at:

https://www.ibm.com/developerworks/community/wikis/home?lang=en#!/wiki/Tivoli%20St
orage%20Manager/page/IBM%20Spectrum%20Protect%20Blueprints

The server was configured by using the Blueprint Perl script (TSMserverconfig.pl) using the response file for a small server as defined in the IBM Blueprint documentation (*Blueprint for Linux x86*) srv_blueprint_xlinux_v23.pdf.

Table 19 on page 45 of that document details the parameters and values in the response file.

Figure 9-2 contains the contents of the response file that is used for this deployment. We followed the directions contained in the Blueprint documentation to achieve this configuration.

```
[root@TSM716 tsmconfig]# cat responsefilesmall.txt
serverscale S
db2user tsminst1
db2userpw Object00
db2group tsmsrvrs
db2userhomedir /home/tsminst1
instdirmountpoint /home/tsminst1/tsminst1
dbdirpaths /tsmdb512a,/tsmdb512b,/tsmdb512c,/tsmdb512d
tsmstgpaths /tsmstg01,/tsmstg02,/tsmstg03,/tsmstg04,/tsmstg05,/tsmstg06,/tsmstg07
actloqpath /tsmact01
archlogpath /tsmarch01
dbbackdirpaths /tsmdbbk01,/tsmdbbk02,/tsmdbbk03,/tsmdbbk04
backupstarttime 22:00
tsmsysadminid admin1
tsmsysadminpw Object00
tcpport
              1500
              TSM716
servername
serverpassword Object00
[root@TSM716 tsmconfig]#
```

Figure 9-2 Response file

The configuration was started with the following command, which was entered on the Linux CLI:

Perl TSMserverconfig.pl responsefilesmall.txt

Disk full error: During the TSM server configuration, an issue was encountered between IBM DB2, the TSM implementation, and the 4096 allocation unit size (segment size) disks in the environment. During initial formatting of the DB2 database used by TSM to track backup data, the formatting process failed due to the use of 4096 block size disks for the IBM DB2 database files (data volumes and log volume).

The following message was found in the IBM DB2 logs:

FUNCTION: DB2 UDB, oper system services, sqloseekwrite64, probe:20
MESSAGE : ZRC=0x850F000C=-2062614516=SQL0_DISK "Disk full."

This problem is called *Database creation is failing with "Disk full" error during DMS tablespace creation on a storage subsystem with a sector size other than 512 bytes.* It is documented here:

http://www.ibm.com/support/docview.wss?uid=swg21449214

Our solution was to acquire four disks that use a 512 segment size and allocated the DB2 mounts to these four disks.

The five DB2 database mount points were mapped to the four disks with a 512 segment size as follows:

/dev/mapper/tsmdb512-tsmdb512a /tsmdb512a	ext4	defaults	0 0
/dev/mapper/tsmdb512-tsmdb512b /tsmdb512b	ext4	defaults	0 0
/dev/mapper/tsmdb512-tsmdb512c /tsmdb512c	ext4	defaults	0 0
/dev/mapper/tsmdb512-tsmdb512d /tsmdb512d	ext4	defaults	0 0
/dev/mapper/tsmdb512-tsmlog00 /tsmact01	ext4	defaults	0 0

ISP server initial testing

As a quick test after the successful completion of the TSM server configuration Perl script, start a CLI session by using the **dsmadmc** command found in /opt/tivoli/tsm/client/ba/bin as shown in Figure 9-3.

```
[root@TSM716 bin]# pwd
/opt/tivoli/tsm/client/ba/bin
[root@TSM716 bin]# dsmadmc
IBM Tivoli Storage Manager
Command Line Administrative Interface - Version 7, Release 1, Level 6.0
(c) Copyright by IBM Corporation and other(s) 1990, 2016. All Rights Reserved.
Enter your user id: admin1
Enter your password:
Session established with server TSM716: Linux/x86_64
Server Version 7, Release 1, Level 6.0
Server date/time: 07/14/2016 08:25:37 Last access: 07/14/2016 08:16:20
```

tsm: TSM716>

Figure 9-3 The dsmadmc command

9.3 DP for Oracle: Install and configure IBM Spectrum Protect on Oracle server node

This section covers the installation and configuration of IBM Spectrum Protect on the Oracle server node.

9.3.1 BAC Installation

Install the same BAC code package on the Oracle server as you did on the TSM server because the platforms are the same. This package is 7.1.6.0-TIV-TSMBAC-LinuxX86.tar, per the product documentation.

For detailed installation instructions, see *Installing the Tivoli Storage Manager backup-archive clients* in IBM Knowledge Center available at:

http://www.ibm.com/support/knowledgecenter/SSGSG7_7.1.6/client/c_inst.html

BAC Configuration

After installing the Client code, create a dsm.sys and dsm.opt file to reflect your TSM implementation.

Figure 9-4 shows the example BAC dsm.sys file.

```
/opt/tivoli/tsm/client/ba/bin
[root@itsovml bin]# cat dsm.sys
* Tivoli Storage Manager
*
                                                     *
* Sample Client System Options file for UNIX (dsm.sys.smp)
                                                     *
* This file contains the minimum options required to get started
* using TSM. Copy dsm.sys.smp to dsm.sys. In the dsm.sys file,
* enter the appropriate values for each option listed below and
* remove the leading asterisk (*) for each one.
* If your client node communicates with multiple TSM servers, be
 sure to add a stanza, beginning with the SERVERNAME option, for
÷
 each additional server.
SErvername TSM716
 COMMMethod
                TCPip
  TCPPort
               1500
  TCPServeraddress 192.168.161.45
               ITSOVM1
  nodename
  passwordaccess
               generate
```

Figure 9-4 Example BAC dsm.sys file

BAC dsm.opt is shown in Figure 9-5.

```
[root@itsovml bin64]# cat dsm.opt
SErvername tdpo
[root@itsovml bin64]# cd ../../ba/bin
[root@itsovml bin]# cat dsm.opt
****
* Tivoli Storage Manager
                                                     *
                                                     *
* Sample Client User Options file for UNIX (dsm.opt.smp)
                                                     *
* This file contains an option you can use to specify the TSM
 server to contact if more than one is defined in your client
* system options file (dsm.sys). Copy dsm.opt.smp to dsm.opt.
* If you enter a server name for the option below, remove the
* leading asterisk (*).
* SErvername
              A server name defined in the dsm.sys file
              TSM716
SErvername
```

```
Figure 9-5 Example BAC dsm.opt file
```

BAC initial test

To test the installation and configuration of the base client code, perform a simple file level test backup as shown in Figure 9-6.

```
[root@itsovml bin]# pwd
/opt/tivoli/tsm/client/ba/bin
 [root@itsovml bin]# dsmc incr /opt/tivoli/tsm/client/ba/bin*.*
IBM Tivoli Storage Manager
Command Line Backup-Archive Client Interface
   Client Version 7, Release 1, Level 6.0
  Client date/time: 07/14/2016 08:17:15
 (c) Copyright by IBM Corporation and other(s) 1990, 2016. All Rights Reserved.
Node Name: ITSOVM1
Session established with server TSM716: Linux/x86 64
  Server Version 7, Release 1, Level 6.0
   Server date/time: 07/14/2016 08:16:50 Last access: 07/14/2016 07:25:10
Incremental backup of volume '/opt/tivoli/tsm/client/ba/bin*.*'
Successful incremental backup of '/opt/tivoli/tsm/client/ba/bin*.*'
Total number of objects inspected:
                                                      15
Total number of objects backed up:
                                                         0
Total number of objects updated:
                                                         0
Total number of objects rebound:
                                                        0
Total number of objects deleted:
                                                        0
                                                       0
Total number of objects expired:
Total number of objects failed:0Total number of objects encrypted:0Total number of objects grew:0Total number of retries:0
Total number of retries:0Total number of bytes inspected:70.43 KBTotal number of bytes transferred:0 BData transfer time:0.00 secNetwork data transfer rate:0.00 KB/secAggregate data transfer rate:0.00 KB/secObjects compressed by:0%Total data reduction ratio:100.00%
                                              00:00:01
Elapsed processing time:
```

Figure 9-6 Initial test

9.3.2 Install and configure Data Protection (DP) for Databases (TDPO)

Now that you have a functioning TSM environment, you need to include the existing Oracle server into the environment.

The goal is to use TDPO to send a backup to the TSM server. After you install TDPO and configure your environment, an RMAN backup will, with the addition of just one parameter, automatically forward the backup to TSM for safe-keeping.

The example Oracle server environment has these characteristics:

Oracle server information

Hostname:	itsovm1
Ipaddr:	192.168.161.71
Oracle version:	12c - 12.1.0

Oracle database information:

```
ORACLE_SID=sample1
ORACLE_BASE=/u01/app/oracle
ORACLE HOME=/u01/app/oracle/product/12.1.0/dbhome
```

DP for Oracle Install package

Use the DP for Oracle product documentation available at:

http://www.ibm.com/support/knowledgecenter/SSTFZR_7.1.3/db.orc/t_protect_dpdborc.h
tml?view=embed

Specifically use this file that clients and Business Partners can obtain by using Passport Advantage:

ISP_DB_716_DP_ORACLE_LINUX_MP_ML.tar.gz

Note: DP for Oracle was not changed in v7.1.6 and at the time of writing the most current version information is v7.1.3.

Install this package by following the product documentation referenced previously.

DP for Oracle configuration

The installation creates a new directory (oracle) under /opt/tivoli/tsm/client/

To configure the TDPO, make changes to files in the TSM client API and Oracle directories as shown in Example 9-1.

Example 9-1 Directories (api and oracle)

```
[root@itsovm1 client]# pwd
/opt/tivoli/tsm/client
[root@itsovm1 client]# ls -l
total 12
drwxr-xr-x. 4 root bin 4096 Jul 12 09:29 api
drwxr-xr-x. 4 root bin 4096 Jul 12 09:30 ba
drwxrwxr-x. 6 root root 4096 Jul 12 14:07 oracle
```

9.3.3 TDPO.opt

There is a bin64 subdirectroy under oracle that contains a sample tdpo.opt (tdpo.opt.smp). Modify this file for your environment as shown Figure 9-7.

```
[root@itsovml bin64]# pwd
/opt/tivoli/tsm/client/oracle/bin64
[root@itsovml bin64]# cat tdpo.opt
* IBM Tivoli Storage Manager for Databases
*
    Data Protection for Oracle
* Sample tdpo.opt for the LinuxAMD64 Data Protection for Oracle
DSMI_ORC_CONFIG /opt/tivoli/tsm/client/oracle/bin64/dsm.opt
*DSMI_LOG /opt/tivoli/tsm/client/oracle/bin64
DSMI_LOG /home/oracle
*TDP0_FS /adsmorc
*TDP0_NODE <hostname>
*TDP0_OWNER <username>
*TDP0_PSWDPATH /opt/tivoli/tsm/client/oracle/bin64
*TDP0_PSWDPATH /home/oracle
                 1
*TDPO DATE FMT
*TDPO NUM FMT
                  1
*TDPO_TIME_FMT
                   1
*TDPO MGMT CLASS 2
                     mgmtclass2
*TDPO MGMT CLASS 3
                     mgmtclass3
*TDPO MGMT CLASS 4
                    mqmtclass4
```

Figure 9-7 Example TDPO.opt file

9.3.4 TDPO dsm.opt

Create a dsm.opt following the product documentation in the same directory as shown in Figure 9-8.

```
[root@itsovml bin64]# pwd
/opt/tivoli/tsm/client/oracle/bin64
[root@itsovml bin64]# cat dsm.opt
SErvername tdpo
```

Figure 9-8 Example TPDO dsm.opt file

9.3.5 BAC API dsm.sys

The final configuration step is to update the client API dsm.sys file to conform to your TSM implementation.

Placing the SErvername tdpo stanza before SErvername TSM716 stanza resolves issues with the **tdpofconf password** command later in the configuration. The completed api/bin64/dsm.sys file is shown in Figure 9-9.

```
[root@itsovm1 bin64]# pwd
/opt/tivoli/tsm/client/api/bin64
[root@itsovml bin64]# cat dsm.sys
*
* Tivoli Storage Manager
                                                         *
                                                         *
* Sample Client System Options file for UNIX (dsm.sys.smp)
*
 This file contains the minimum options required to get started
*
 using TSM. Copy dsm.sys.smp to dsm.sys. In the dsm.sys file,
 enter the appropriate values for each option listed below and
* remove the leading asterisk (*) for each one.
 If your client node communicates with multiple TSM servers, be
 sure to add a stanza, beginning with the SERVERNAME option, for
*
 each additional server.
SErvername tdpo
             TCPip
  COMMMethod
                 1500
  TCPPort
  TCPServeraddress 192.168.161.45
  passwordaccess generate
  nodename
                 itsovml ora
               /home/oracle
  passworddir
SErvername TSM716
                 TCPip
  COMMMethod
  TCPPort
                 1500
  TCPServeraddress 192.168.161.45
  passwordaccess
                 generate
  nodename
                 itsovml
```

Figure 9-9 Completed BAC API dsm.sys file

Set the TSM node password for TDPO by running the **tdpoconf** command with /opt/tivoli/tsm/client/oracle/bin64/tdpoconf as the oracle user.

Set the TSM node password for TDPO to enable authenticated communications between TDPO process on the Oracle server and the TSM server.

Create a node on the TSM server named itsovm1_ora with the password Object00 before you issue the **tdpoconf** command.

The command **tdpoconf password** creates an encrypted TSM.PWD password file that allows this authentication as shown in Example 9-2.

Example 9-2 Password file

```
[oracle@itsovm1 ~]$ whoami
Oracle
[oracle@itsovm1 ~]$ env | grep ORA
```

```
ORACLE SID=sample1
ORACLE BASE=/u01/app/oracle
ORACLE HOME=/u01/app/oracle/product/12.1.0/dbhome
[oracle@itsovm1 bin64]$ pwd
/opt/tivoli/tsm/client/oracle/bin64
[oracle@itsovm1 ~]$ ./tdpoconf password
IBM Tivoli Storage Manager for Databases:
Data Protection for Oracle
Version 7, Release 1, Level 3.0
(C) Copyright IBM Corporation 1997, 2015. All rights reserved.
IBM Tivoli Storage Manager for Databases Utility
*
   Password file initialization/update program
Please enter current password:
Please enter new password:
Please reenter new password for verification:
ANU0260I Password successfully changed.
```

The TSM.PWD file is now updated/created in the directory indicated in the configuration and the command 1s - 1 shown in Example 9-3 shows where this file was created.

Example 9-3 Created pwd file

```
[oracle@itsovm1 bin64]$ ls -l /home/oracle/TSM.PWD
-rw-----. 1 oracle oinstall 132 Jul 14 09:11 /home/oracle/TSM.PWD
```

The TSM server has two nodes defined. The first (ITSOVM1) is used for standard file backup and restore, and the second (ITSOVM1_ORA) is used for Oracle backup and restore operations. Figure 9-10 shows the **q node** command listing these two nodes.

```
tsm: TSM716>q node
Session established with server TSM716: Linux/x86 64
 Server Version 7, Release 1, Level 6.0
 Server date/time: 07/14/2016 08:59:39 Last access: 07/14/2016 08:46:22
                         Platform Policy Domain Days Sinc- Days Sinc-
Name e Last e Passwor-
Node Name
                                                                              Locked?
                                                       Access
                                                                 d Set
 ------
                         _____
                                    _____
                                                    -----
                                                                 -----
                                                                              _____
                                  STANDARD
ITSOVM1
                        Linux
                                                          <1
                                                                        1
                                                                              No
                         x86-64
ITSOVM1 ORA
                         TDPO
                                    STANDARD
                                                           1
                                                                         2
                                                                                No
                         Linux8-
                          6-64
tsm: TSM716>
```

```
Figure 9-10 Query node command
```

9.3.6 Use RMAN to back up the Oracle Database using TDPO

The use of TDPO requires minor changes to the processes, procedures, and scripts developed by the Oracle DBAs to protect their systems. Just one parameter is added to direct the backup or restore to use TSM. TDPO is fully supported with or without the use to an RMAN catalog database.

This is the only operational change that is needed to use TDPO.

An example RMAN backup of the sample database is shown in Example 9-4 using the **rman** command. This command is usually used in a script. Note the addition of the TDPO parameter pointer to TDPO configuration that was established earlier.

Example 9-4 RMAN backup

```
[oracle@itsovm1 ~]$ rman target /
RMAN> run
2> {
3> allocate channel t1 type 'sbt tape' parms
4> 'ENV=(TDPO OPTFILE=/opt/tivoli/tsm/client/oracle/bin64/tdpo.opt)';
5> backup filesperset 5
6> format 'df %t %s %p'
7> (database);
8> }
using target database control file instead of recovery catalog
allocated channel: t1
channel t1: SID=2812 instance=sample1 device type=SBT TAPE
channel t1: Data Protection for Oracle: version 7.1.3.0
Starting backup at 13-JUL-16
channel t1: starting full datafile backup set
channel t1: specifying datafile(s) in backup set
input datafile file number=00008 name=+DATA/sample/soe.dbf
input datafile file number=00001 name=+DATA/SAMPLE/DATAFILE/system.258.912970523
input datafile file number=00006 name=+DATA/SAMPLE/DATAFILE/users.259.912970569
channel t1: starting piece 1 at 13-JUL-16
channel t1: finished piece 1 at 13-JUL-16
piece handle=df 917091597 4 1tag=TAG20160713T113957 comment=API Version 2.0, MMS
Version 7.1.3.0
channel t1: backup set complete, elapsed time: 07:49:07
channel t1: starting full datafile backup set
channel t1: specifying datafile(s) in backup set
input datafile file number=00004 name=+DATA/SAMPLE/DATAFILE/undotbs1.260.9129705
69
input datafile file number=00003 name=+DATA/SAMPLE/DATAFILE/sysaux.257.912970481
input datafile file number=00002 name=+DATA/SAMPLE/DATAFILE/undotbs3.263.9129706
43
input datafile file number=00005 name=+DATA/SAMPLE/DATAFILE/undotbs2.262.9129706
43
input datafile file number=00007 name=+DATA/SAMPLE/DATAFILE/undotbs4.264.9129706
43
channel t1: starting piece 1 at 13-JUL-16
channel t1: finished piece 1 at 13-JUL-16
piece handle=df 917119744 5 1tag=TAG20160713T113957 comment=API Version 2.0, MMS
Version 7.1.3.0
channel t1: backup set complete, elapsed time: 00:01:55
channel t1: starting full datafile backup set
channel t1: specifying datafile(s) in backup set
including current control file in backup set
including current SPFILE in backup set
channel t1: starting piece 1 at 13-JUL-16
channel t1: finished piece 1 at 13-JUL-16
```

```
piece handle=df_917119859_6_1 tag=TAG20160713T113957 comment=API Version 2.0,MMS
Version 7.1.3.0
channel t1: backup set complete, elapsed time: 00:00:01
Finished backup at 13-JUL-16
released channel: t1
```

9.3.7 IBM Spectrum Protect activity log for Oracle database backup

Example 9-5 TSM activity log

Example 9-5 shows the TSM activity log from the third full backup (see Example 9-4 on page 226) of the SAMPLE database. Note that the total database size is nearly 1.6 TB.

	-0
07/13/2016 19:28:32	ANR0951I Session 242 for node ITSOVM1_ORA processed 1 files by using inline data deduplication or compression, or both. The number of original bytes was 1,580,024,201,216. Inline data deduplication reduced the data by 636,189,798 bytes and inline compression reduced the data by 828,340,493,675 bytes. (SESSION: 242)

9.3.8 View of backup data from IBM Spectrum Protect Operations Center

Using TSM as the backup repository (Container pool) that has inline data deduplication and compression causes a 54% reduction in the amount to data stored. Figure 9-11 shows the deduppool.

Ô	Overviews Clients Services Servers Storage	Reports 😵	🖪 🖨 🎍 admin1 🗸
B	DEDUPPOOL Normal Scontainer		🥳 TSM716 🛛
Summary			
Properties	Usage and Configuration	Capacity Used over 2 Weeks	
Directories	DEDUPPOOL 1.3 TB Savings 54% Directories 7 Coverflow pool	2 TB	Container
		u Thurs Fri Sat Sun Mon Tues Wed Thurs Fri Sat Sun	Mon Tues Wed Today

Figure 9-11 The deduppool

9.3.9 View of Oracle server node from IBM Spectrum Protect Operations Center

Figure 9-12 shows the TSM file space for the example ITSOVM1_ORA Oracle server node. It shows the amount of data and files that are currently held for this node.

Ô	Overviews Clients Serv	rices Serv	ers Storage	Reports			\$	Ľ	Ф	₄ admin1 🗸	
	ITSOVM1_ORA									🦸 TSM716 🛛	
Summary							Q 🗸 Filter			IR	
Properties	Name	^	Files		Occupancy	Copy Pools					
	Archive				_						
File Spaces	🔹 🔯 Backup			306	2.891 TB						
Remote Access	/adsmorc			306	2.9 TB						
Diagnosis	🖼 Space Management			-	-						

Figure 9-12 Oracle server node

9.3.10 TSM CLI query occ command after backups

Example 9-6 shows the TSM CLI **query occ** command after backups. This is another way of displaying the information that is shown in Figure 9-12.

Example 9-6 Output of query occ command

tsm: TSM716>q	000							
Node Name	Туре	Filespace Name	FSID	Storage Pool Name	Number of Files	Physical Space Occupied (MB)	Logical Space Occupied (MB)	
ITSOVM1	Bkup	/	1	DEDUPPOOL	49	-	3.93	
ITSOVM1	Bkup	/run	2	DEDUPPOOL	784	-	152.37	
ITSOVM1_0- RA	Bkup	/adsmorc	1	DEDUPPOOL	459	-	4,546,479.0 0	

Figure 9-13 displays the summary information for the Oracle server TSM node, ITSOVM1_ORA, using the IBM Spectrum Protect Operations Center. This summary shows the recent backup activity for the Oracle database.

Ô	Overviews Clients Services Servers Storage	Reports 🔅	🛚 🖨 🎍 admin1 🗸
	ITSOVM1_ORA		🥳 TSM716 🛛
Summary			
Properties	Client Files	Activity over 2 Weeks	
File Spaces	5	2 ТВ	 Backed up
Remote Access			
Diagnosis	0 24 Now		
	Platform		
	LNX:Red Hat Enterprise Linux Server		
	Current Sessions	1	
	There are no active sessions for the client.		
	Contact		
	Name		
	Email	0	
	IP address 192.168.161.71	inurs ⊢n Sat Sun Mon iues vved Thurs Fri Sat Su Backedup	n mun lues Wed loday

Figure 9-13 Summary information for ITSOVM1_ORA

The following examples show configuration details for the IBM Spectrum Protect server, including this information:

- General OS and processor details
- File system table (fstab)

Example 9-7 shows the example TSM716 server OS information.

Example 9-7 TSM716 server OS information

Linux: Linux version 3.10.0-327.el7.x86 64 (mockbuild@x86-034.build.eng.bos.redhat.com) х Х Build: (gcc version 4.8.3 20140911 (Red Hat 4.8.3-9) (GCC)) х х Release : 3.10.0-327.el7.x86_64 х х Version : #1 SMP Thu Oct 29 17:29:29 EDT 2015 х х cpuinfo: model name : Intel(R) Xeon(R) CPU E5-2660 v4 @ 2.00GHz х х х cpuinfo: vendor id : GenuineIntel х cpuinfo: microcode : 0xb000014 х х cpuinfo: cpuid level : 13 Х х # of CPUs: 56 х х Machine : x86 64 х х х Nodename : itsovm1 х /etc/*ease[1]: NAME="Red Hat Enterprise Linux Server" х х /etc/*ease[2]: VERSION="7.2 (Maipo)" х Х

x /etc/*ease[3]: ID="rhel"

Figure 9-14 shows the file system table.

```
[root@TSM716 ~]# cat /etc/fstab
# /etc/fstab
# Created by anaconda on Thu Jun 30 08:17:22 2016
#
# Accessible filesystems, by reference, are maintained under '/dev/disk'
# See man pages fstab(5), findfs(8), mount(8) and/or blkid(8) for more info
#
/dev/mapper/rhel-root
                                                ext4
                                                         defaults
                                                                        0 0
UUID=6edaf44e-7c08-44ee-a23e-27375f0c6368 /boot
                                                                  ext4
                                                                          defaults
                                                                                          0 0
                                                                        0 0
/dev/mapper/rhel-home
                                                        defaults
                      /home
                                                ext4
/dev/mapper/rhel-swap
                       swap
                                                swap
                                                        defaults
                                                                       0 0
/dev/mapper/tsmdb512-tsmdb512a /tsmdb512a
                                                  ext4
                                                           defaults
                                                                           0 0
/dev/mapper/tsmdb512-tsmdb512b /tsmdb512b
                                                  ext4
                                                           defaults
                                                                           0 0
                                                                           0 0
/dev/mapper/tsmdb512-tsmdb512c /tsmdb512c
                                                  ext4
                                                           defaults
/dev/mapper/tsmdb512-tsmdb512d /tsmdb512d
                                                  ext4
                                                           defaults
                                                                           0 0
/dev/mapper/tsmdb512-tsmlog00 /tsmact01
                                                 ext4
                                                           defaults
                                                                          0 0
                                                         defaults
                                                                        0 0
/dev/mapper/tsmarch-tsmarch01 /tsmarch01
                                                ext4
/dev/mapper/tsmdbbk-tsmdbbk01 /tsmdbbk01
                                                ext4
                                                         defaults
                                                                        0 0
                                                                        0 0
/dev/mapper/tsmdbbk-tsmdbbk02 /tsmdbbk02
                                                ext4
                                                         defaults
                                                                        0 0
/dev/mapper/tsmdbbk-tsmdbbk03 /tsmdbbk03
                                                        defaults
                                                ext4
/dev/mapper/tsmdbbk-tsmdbbk04 /tsmdbbk04
                                                ext4
                                                        defaults
                                                                        0 0
/dev/mapper/tsmstg-tsmstg01 /tsmstg01
                                                ext4
                                                        defaults
                                                                        0 0
/dev/mapper/tsmstg-tsmstg02 /tsmstg02
                                                ext4
                                                         defaults
                                                                        00
/dev/mapper/tsmstg-tsmstg03 /tsmstg03
                                                ext4
                                                        defaults
                                                                       00
/dev/mapper/tsmstg-tsmstg04 /tsmstg04
                                                        defaults
                                                                       0 0
                                                ext4
/dev/mapper/tsmstg-tsmstg05 /tsmstg05
                                                         defaults
                                                                       00
                                                ext4
/dev/mapper/tsmstg-tsmstg06 /tsmstg06
                                                ext4
                                                         defaults
                                                                        0 0
/dev/mapper/tsmstq-tsmstq07 /tsmstq07
                                                         defaults
                                                                        0 0
                                                ext4
[root@TSM716 ~]#
```

Figure 9-14 File system table

Figure 9-15 shows the RMAN output of the list backup command (truncated for brevity).

RMAN> list backup; using target database control file instead of recovery catalog List of Backup Sets _____ BS Key Type LV Size Device Type Elapsed Time Completion Time - ---Full 1.44T SBT TAPE 07:42:03 12-JUL-16 1 BP Key: 1 Status: AVAILABLE Compressed: NO Tag: TAG20160712T155101 Handle: df_917020262_1_1 Media: 0 List of Datafiles in backup set 1 File LV Type Ckp SCN Ckp Time Name ---- -- ---- -----Full 60336183 12-JUL-16 +DATA/SAMPLE/DATAFILE/system.258.912970523 Full 60336183 12-JUL-16 +DATA/SAMPLE/DATAFILE/users.259.912970569 1 6 Full 60336183 12-JUL-16 +DATA/sample/soe.dbf 8 BS Key Type LV Size Device Type Elapsed Time Completion Time _____ Full 8.44G SBT TAPE 00:02:52 12-JUL-16 2 BP Key: 2 Status: AVAILABLE Compressed: NO Tag: TAG20160712T155101 Handle: df 917047989 2 1 Media: 0 List of Datafiles in backup set 2 File LV Type Ckp SCN Ckp Time Name ---- ---- ------ ------ -----Full 60414385 12-JUL-16 +DATA/SAMPLE/DATAFILE/undotbs3.263.912970643 2 Full 60414385 12-JUL-16 +DATA/SAMPLE/DATAFILE/sysaux.257.912970481 3 Full 60414385 12-JUL-16 +DATA/SAMPLE/DATAFILE/undotbs1.260.912970569 4 Full 60414385 12-JUL-16 +DATA/SAMPLE/DATAFILE/undotbs2.262.912970643 5 Full 60414385 12-JUL-16 +DATA/SAMPLE/DATAFILE/undotbs4.264.912970643 7 BS Key Type LV Size Device Type Elapsed Time Completion Time ••• _____ 3 Full 18.75M SBT TAPE 00:00:02 12-JUL-16 BP Key: 3 Status: AVAILABLE Compressed: NO Tag: TAG20160712T155101 Handle: df 917048184 3 1 Media: 0 SPFILE Included: Modification time: 07-JUN-16 SPFILE db_unique_name: SAMPLE Control File Included: Ckp SCN: 60414703 Ckp time: 12-JUL-16

Figure 9-15 RMAN list backup

Related publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this book.

IBM Redbooks

The following IBM Redbooks publications provide additional information about the topic in this document. Some publications that are referenced in this list might be available in softcopy only.

- ▶ IBM FlashSystem V9000 in a VersaStack Environment, REDP-5264
- Implementing the IBM System Storage SAN Volume Controller with IBM Spectrum Virtualize V7.6, SG24-7933
- Implementing the IBM Storwize V7000 and IBM Spectrum Virtualize V7.6, SG24-7938
- ► Introducing and Implementing IBM FlashSystem V9000, SG24-8273
- VersaStack Solution by Cisco and IBM with IBM DB2, IBM Spectrum Control, and IBM Spectrum Protect, SG24-8302
- VersaStack Solution by Cisco and IBM with SQL, Spectrum Control, and Spectrum Protect, SG24-8301

You can search for, view, download, or order these documents and other Redbooks, Redpapers, Web Docs, draft and additional materials, at the following website:

ibm.com/redbooks

Other resources

These publications are also relevant as further information sources:

- IBM System Storage Open Software Family SAN Volume Controller: CIM Agent Developers Reference, SC26-7545
- IBM System Storage Open Software Family SAN Volume Controller: Command-Line Interface User's Guide, SC26-7544
- IBM System Storage Open Software Family SAN Volume Controller: Configuration Guide, SC26-7543
- IBM System Storage Open Software Family SAN Volume Controller: Host Attachment Guide, SC26-7563
- IBM System Storage Open Software Family SAN Volume Controller: Installation Guide, SC26-7541
- IBM System Storage Open Software Family SAN Volume Controller: Planning Guide, GA22-1052
- IBM System Storage Open Software Family SAN Volume Controller: Service Guide, SC26-7542

- IBM System Storage SAN Volume Controller Software Installation and Configuration Guide, SC23-6628
- IBM System Storage SAN Volume Controller V6.2.0 Software Installation and Configuration Guide, GC27-2286

Online resources

These websites are also relevant as further information sources:

VersaStack Designs (links to PDF download page)

http://www.cisco.com/c/en/us/solutions/enterprise/data-center-designs-cloud-com
puting/versastack-designs.html

VersaStack Solution - Cisco

http://www.cisco.com/c/en/us/solutions/data-center-virtualization/versastack-so lution-cisco-ibm/index.html

VersaStack Solution by Cisco and IBM

http://www.ibm.com/common/ssi/cgi-bin/ssialias?infotype=PM&subtype=SP&htmlfid=T SS03159USEN&appname=TAB_2_1_Appname

- Video: Client value of VersaStack https://www.youtube.com/watch?v=dvDG6UHMEuQ
- Video: Growth Opportunities with VersaStack Solution https://www.youtube.com/watch?v=h32TsA2smLk
- Video: High-Level Business Value of VersaStack from IBM and CISCO https://www.youtube.com/watch?v=E0W4ggyN99o
- Video: IBM and Cisco VersaStack Compression https://www.youtube.com/watch?v=xDbk4ddXzL0
- Video: IBM and Cisco VersaStack Data Virtualization https://www.youtube.com/watch?v=N-rNcokXzf0
- Video: IBM and Cisco VersaStack Flash Optimization and IBM Easy Tier https://www.youtube.com/watch?v=J7Rr13fEv0U
- Video: IBM and Cisco VersaStack Introduction https://www.youtube.com/watch?v=mkg1fkpAKII
- Video: IBM and Cisco VersaStack Turbo Compression https://www.youtube.com/watch?v=PR Uir1mxXE
- Video: New VersaStack Solution by Cisco and IBM https://www.youtube.com/watch?v=HHtgEABDYts
- Video: Take 5 VersaStack by Cisco and IBM https://www.youtube.com/watch?v=18mKR0sKQ30
- Video: Talking VersaStack with Your Customers https://www.youtube.com/watch?v=UHANwo51ie0

- Oracle Real Application Clusters Overview
 https://www.oracle.com/database/real-application-clusters/index.html
- Oracle Real Application Clusters Resources
 https://www.oracle.com/database/real-application-clusters/resources.html
- Oracle Database 12c http://www.oracle.com/technetwork/database/enterprise-edition/overview/index.html

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