Oracle 12c on Cisco UCS and EMC VNX2
Deploying Oracle RAC 12cR1 (12.1.0.1) on Oracle Linux 6 using Cisco Unified Computing System 2.1 and EMC VNX8000
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Oracle 12c on Cisco UCS and EMC VNX2

About this Document

This Cisco Validated Design describes how the Cisco Unified Computing System™ can be used in conjunction with EMC® VNX® storage systems to implement an Oracle Real Application Clusters (RAC) solution that is an Oracle Certified Configuration. The Cisco Unified Computing System provides the compute, network, and storage access components of the cluster, deployed as a single cohesive system. The result is an implementation that addresses many of the challenges that database administrators and their IT departments face today, including needs for a simplified deployment and operation model, high performance for Oracle 12c RAC software, and lower total cost of ownership (TCO). This document introduces the Cisco Unified Computing System and provides instructions for implementing it; it concludes with an analysis of the cluster's performance and reliability characteristics.

Audience

The intended audience of this document includes, but is not limited to, sales engineers, field consultants, professional services, IT managers, partner engineering, and customers who want to take advantage of an infrastructure built to deliver IT efficiency and enable IT innovation.

Introduction

Data powers essentially every operation in a modern enterprise, from keeping the supply chain operating efficiently to managing relationships with customers. Oracle 12c brings an innovative approach to the challenges of rapidly increasing amounts of data and demand for high performance with its containers. Oracle 12c RAC also uses a horizontal scaling (or scale-out) model that allows organizations to take advantage of the fact that the price of one-to-four-socket x86-architecture servers continues to drop while their processing power increases unabated. The clustered approach allows each server to contribute its processing power to the overall cluster's capacity, enabling a new approach to managing the cluster's performance and capacity.
Leadership from Cisco

Cisco is the undisputed leader in providing network connectivity in enterprise data centers. With the introduction of the Cisco Unified Computing System, Cisco is now equipped to provide the entire clustered infrastructure for Oracle RAC deployments. The Cisco Unified Computing System provides compute, network, virtualization, and storage access resources that are centrally controlled and managed as a single cohesive system. With the capability to centrally manage both blade and rack-mount servers, the Cisco Unified Computing System provides an ideal foundation for Oracle RAC deployments.

Historically, enterprise database management systems have run on costly symmetric multiprocessing servers that use a vertical scaling (or scale-up) model. However, as the cost of one-to-four-socket x86-architecture servers continues to drop while their processing power increases, a new model has emerged. Oracle RAC uses a horizontal scaling, or scale-out, model, in which the active-active cluster uses multiple servers, each contributing its processing power to the cluster, increasing performance, scalability, and availability. The cluster balances the workload across the servers in the cluster, and the cluster can provide continuous availability in the event of a failure.

Oracle Certified Configuration

All components in an Oracle RAC implementation must work together flawlessly, and Cisco has worked closely with EMC and Oracle to create, test, and certify a configuration of Oracle RAC on the Cisco Unified Computing System. Cisco's Oracle Certified Configurations provide an implementation of Oracle Database with Real Application Clusters technology consistent with industry best practices. For back-end SAN storage, the certification environment included an EMC VNX storage system with a mix of SAS drives and state-of-the-art Flash drives (FDs) to further speed performance.

Benefits of the Configuration

The Oracle Certified Configuration of Oracle RAC on the Cisco Unified Computing System offers a number of important benefits.

Simplified Deployment and Operation

Because the entire cluster runs on a single cohesive system, database administrators no longer need to painstakingly configure each element in the hardware stack independently. The system's compute, network, and storage-access resources are essentially stateless, provisioned dynamically by Cisco® UCS Manager. This role-based and policy-based embedded management system handles every aspect of system configuration, from a server's firmware and identity settings to the network connections that connect storage traffic to the destination storage system. This capability dramatically simplifies the process of scaling an Oracle RAC configuration or re-hosting an existing node on an upgrade server. Cisco UCS Manager uses the concept of service profiles and service profile templates to consistently and accurately configure resources. The system automatically configures and deploys servers in minutes, rather than the hours or days required by traditional systems composed of discrete, separately managed components. Indeed, Cisco UCS Manager can simplify server deployment to the point where it can automatically discover, provision, and deploy a new blade server when it is inserted into a chassis.

The system is based on a 10-Gbps unified network fabric that radically simplifies cabling at the rack level by consolidating both IP and Fiber Channel traffic onto the same rack-level 10-Gbps converged network. This "wire-once" model allows in-rack network cabling to be configured once, with network
features and configurations all implemented by changes in software rather than by error-prone changes in physical cabling. This Cisco Validated Configuration not only supports physically separate public and private networks; it provides redundancy with automatic failover.

**High-Performance Platform for Oracle RAC**

The Cisco UCS B-Series Blade Servers used in this certified configuration feature Intel Xeon E5-4650 series processors that deliver intelligent performance, automated energy efficiency, and flexible virtualization. Intel Turbo Boost Technology automatically boosts processing power through increased frequency and use of hyper threading to deliver high performance when workloads demand and thermal conditions permit.

The Cisco Unified Computing System's 10-Gbps unified fabric delivers standards-based Ethernet and Fiber Channel over Ethernet (FCoE) capabilities that simplify and secure rack-level cabling while speeding network traffic compared to traditional Gigabit Ethernet networks. The balanced resources of the Cisco Unified Computing System allow the system to easily process an intensive online transaction processing (OLTP) and decision-support system (DSS) workload with no resource saturation.

**Safer Deployments with Certified and Validated Configurations**

Cisco and Oracle are working together to promote interoperability of Oracle's next-generation database and application solutions with the Cisco Unified Computing System, helping make the Cisco Unified Computing System a simple and reliable platform on which to run Oracle software.

**Implementation Instructions**

This Cisco Validated Design introduces the Cisco Unified Computing System and discusses the ways it addresses many of the challenges that database administrators and their IT departments face today. The document provides an overview of the certified Oracle 12c RAC configuration along with instructions for setting up the Cisco Unified Computing System and the EMC VNX2 storage system, including database table setup and the use of flash drives. The document reports on Cisco's performance measurements for the cluster and a reliability analysis that demonstrates how the system continues operation even when commonly encountered hardware faults occur.

**Introducing the Cisco Unified Computing System**

The Cisco Unified Computing System (Cisco UCS) addresses many of the challenges faced by database administrators and their IT departments, making it an ideal platform for Oracle RAC implementations.

**Comprehensive Management**

The system uses an embedded, end-to-end management system that uses a high-availability active-standby configuration. Cisco UCS Manager uses role and policy-based management that allows IT departments to continue to use subject-matter experts to define server, network, and storage access policy. After a server and its identity, firmware, configuration, and connectivity are defined, the server, or a number of servers like it, can be deployed in minutes, rather than the hours or days that it typically
Overview of Cisco Unified Computing System

Radical Simplification

The Cisco Unified Computing System represents a radical simplification compared to the way that servers and networks are deployed today. It reduces network access-layer fragmentation by eliminating switching inside the blade server chassis. It integrates compute resources on a unified I/O fabric that supports standard IP protocols as well as Fiber Channel through FCoE encapsulation. The system eliminates the limitations of fixed I/O configurations with an I/O architecture that can be changed through software on a per-server basis to provide needed connectivity using a just-in-time deployment model. The result of this radical simplification is fewer switches, cables, adapters, and management points, helping reduce cost, complexity, power needs, and cooling overhead.

High Performance

The system's blade servers are based on the Intel Xeon 4650 series processors. These processors adapt performance to application demands, increasing the clock rate on specific processor cores as workload and thermal conditions permit. The system is integrated within a 10 Gigabit Ethernet-based unified fabric that delivers the throughput and low-latency characteristics needed to support the demands of the cluster's public network, storage traffic, and high-volume cluster messaging traffic.

Overview of Cisco Unified Computing System

Cisco Unified Computing System unites computing, networking, storage access, and virtualization resources into a single cohesive system. When used as the foundation for Oracle RAC database and software the system brings lower total cost of ownership (TCO), greater performance, improved scalability, increased business agility, and Cisco's hallmark investment protection.

The system represents a major evolutionary step away from the current traditional platforms in which individual components must be configured, provisioned, and assembled to form a solution. Instead, the system is designed to be stateless. It is installed and wired once, with its entire configuration—from RAID controller settings and firmware revisions to network configurations—determined in software using integrated, embedded management.

The system brings together Intel Xeon processor-powered server resources on a 10-Gbps unified fabric that carries all IP networking and storage traffic, eliminating the need to configure multiple parallel IP and storage networks at the rack level. The solution dramatically reduces the number of components needed compared to other implementations, reducing TCO, simplifying and accelerating deployment, and reducing the complexity that can be a source of errors and cause downtime.

Cisco UCS is designed to be form-factor neutral. The core of the system is a pair of Fabric Interconnects that links all the computing resources together and integrates all system components into a single point of management. Today, blade server chassis are integrated into the system through Fabric Extenders that bring the system's 10-Gbps unified fabric to each chassis.

The Fibre Channel over Ethernet (FCoE) protocol collapses Ethernet-based networks and storage networks into a single common network infrastructure, thus reducing CapEx by eliminating redundant switches, cables, networking cards, and adapters, and reducing OpEx by simplifying administration of these networks (Figure 1). Other benefits include:
I/O and server virtualization
- Transparent scaling of all types of content, either block or file based
- Simpler and more homogeneous infrastructure to manage, enabling data center consolidation

Fabric Interconnects

The Cisco Fabric Interconnect is a core part of Cisco UCS, providing both network connectivity and management capabilities for the system. It offers line-rate, low-latency, lossless 10 Gigabit Ethernet, FCoE, and Fibre Channel functions.

The Fabric Interconnect provides the management and communication backbone for the Cisco UCS B-Series Blade Servers and Cisco UCS 5100 Series Blade Server Chassis. All chassis, and therefore all blades, attached to the Fabric Interconnects become part of a single, highly available management domain. In addition, by supporting unified fabric, Fabric Interconnects support both LAN and SAN connectivity for all blades within their domain. The Fabric Interconnect supports multiple traffic classes over a lossless Ethernet fabric from a blade server through an interconnect. Significant TCO savings come from an FCoE-optimized server design in which network interface cards (NICs), host bus adapters (HBAs), cables, and switches can be consolidated.

The Cisco UCS 6248 Fabric Interconnect is a one-rack-unit (1RU), 10 Gigabit Ethernet, IEEE Data Center Bridging (DCB), and FCoE interconnect built to provide 960 Gbps throughput with very low latency. It has 48 high density ports in 1RU including one expansion module with 16 unified ports. Like its predecessors, it can be seamlessly managed with Cisco UCS Manager.

Fabric Extenders

The Cisco Fabric Extenders multiplex and forward all traffic from blade servers in a chassis to a parent Cisco UCS Fabric Interconnect from 10-Gbps unified fabric links. All traffic, even traffic between blades on the same chassis, is forwarded to the parent interconnect, where network profiles are managed efficiently and effectively by the Fabric Interconnect. At the core of the Cisco UCS Fabric Extender are application-specific integrated circuit (ASIC) processors developed by Cisco that multiplex all traffic.

The Cisco UCS 2208XP Fabric Extender has eight 10 Gigabit Ethernet, FCoE-capable, enhanced small Form-Factor Pluggable (SFP+) ports that connect the blade chassis to the fabric interconnect. Each Cisco UCS 2208XP has thirty-two 10 Gigabit Ethernet ports connected through the midplane to each half-width slot in the chassis. Typically configured in pairs for redundancy, two fabric extenders provide up to 160 Gbps of I/O to the chassis. Each fabric extender on either sides of the chassis are connected through 8 x 10 Gb links to the fabric interconnects and offer:
- Connection of the Cisco UCS blade chassis to the Fabric Interconnect
- Eight 10 Gigabit Ethernet, FCoE-capable SFP+ ports
- Built-in chassis management function to manage the chassis environment (the power supply and fans as well as the blades) along with the Fabric Interconnect, eliminating the need for separate chassis management modules
- Full management by Cisco UCS Manager through the Fabric Interconnect
- Support for up to two Fabric Extenders, enabling increased capacity as well as redundancy
- Up to 160 Gbps of bandwidth per chassis
**Blade Chassis**

The Cisco UCS 5100 Series Blade Server Chassis is a crucial building block of Cisco Unified Computing System, delivering a scalable and flexible blade server chassis.

**Cisco UCS Manager**

Cisco UCS Manager provides unified, embedded management of all software and hardware components of the Cisco Unified Computing System (Cisco UCS) across multiple chassis, rack-mount servers, and thousands of virtual machines. Cisco UCS Manager manages Cisco Unified Computing System as a single entity through an intuitive GUI, a command-line interface (CLI), or an XML API for comprehensive access to all Cisco UCS Manager functions.

**Cisco UCS VIC 1280 Adapters**

Cisco VIC 1280 is the second generation of Mezzanine Adapters from Cisco. VIC 1280 supports up to 256 PCI-e devices and up to 80 Gbps of throughput. Compared with its earlier generation of Palo Adapters it had doubled the capacity in throughput and PCI-e devices and is complaint with many OS and storage Vendors.

**Cisco UCS Virtual Interface Card 1240**

A Cisco innovation, the Cisco UCS VIC 1240 is a four-port 10 Gigabit Ethernet, FCoE-capable modular LAN on motherboard (mLOM) designed exclusively for the M3 generation of Cisco UCS B-Series Blade Servers. When used in combination with an optional port expander, the Cisco UCS VIC 1240 capabilities can be expanded to eight ports of 10 Gigabit Ethernet

**Cisco UCS B420 M3 High-Performance Blade Servers**

The Cisco UCS B420 M3 High-Performance Blade Servers are full-slot, 4-socket, high-performance blade servers offering the performance and reliability of the Intel Xeon processor E5-4650 product family and up to 1 TB of memory. The Cisco UCS B420 M3 supports four Small Form Factor (SFF) SAS and SSD drives and two converged network adapter (CNA) mezzanine slots up to 160 Gbps of I/O throughput. The Cisco UCS B420 M3 blade server extends Cisco UCS by offering increased levels of performance, scalability, and reliability for mission-critical workloads.

The Cisco UCS components used in the certified configuration are shown in Figure 1.
Service Profiles: Cisco Unified Computing System Foundation Technology

Cisco UCS resources are abstract in the sense that their identity, I/O configuration, MAC addresses and worldwide names (WWNs), firmware versions, BIOS boot order, and network attributes (including quality of service (QoS) settings, pin groups, and threshold policies) are all programmable using a just-in-time deployment model. The manager stores this identity, connectivity, and configuration...
information in service profiles that reside on the Cisco UCS 6200 Series Fabric Interconnects. A service profile can be applied to any blade server to provision it with the characteristics required to support a specific software stack. A service profile allows server and network definitions to move within the management domain, enabling flexibility in the use of system resources. Service profile templates allow different classes of resources to be defined and applied to a number of resources, each with its own unique identities assigned from predetermined pools.

**Service Profile - Description, Overview and Elements**

**Service Profile - Description**

Conceptually, a service profile is an extension of the virtual machine abstraction applied to physical servers. The definition has been expanded to include elements of the environment that span the entire data center, encapsulating the server identity (LAN and SAN addressing, I/O configurations, firmware versions, boot order, network VLAN physical port, and quality-of-service [QoS] policies) in logical "service profiles" that can be dynamically created and associated with any physical server in the system within minutes rather than hours or days. The association of service profiles with physical servers is performed as a simple, single operation. It enables migration of identities between servers in the environment without requiring any physical configuration changes and facilitates rapid bare metal provisioning of replacements for failed servers. Service profiles also include operational policy information, such as information about firmware versions.

The highly dynamic environment can be adapted to meet rapidly changing needs in today's data centers with just-in-time deployment of new computing resources and reliable movement of traditional and virtual workloads. Data center administrators can now focus on addressing business policies and data access on the basis of application and service requirements, rather than physical server connectivity and configurations. In addition, using service profiles, Cisco UCS Manager provides logical grouping capabilities for both physical servers and service profiles and their associated templates. This pooling or grouping, combined with fine-grained role-based access, allows businesses to treat a farm of compute blades as a flexible resource pool that can be reallocated in real time to meet their changing needs, while maintaining any organizational overlay on the environment that they want.

**Service Profile - Overview**

A service profile typically includes four types of information:

- **Server definition:** It defines the resources (e.g. a specific server or a blade inserted to a specific chassis) that are required to apply to the profile.
- **Identity information:** Identity information includes the UUID, MAC address for each virtual NIC (vNIC), and WWN specifications for each HBA.
- **Firmware revision specifications:** These are used when a certain tested firmware revision is required to be installed or for some other reason a specific firmware is used.
- **Connectivity definition:** It is used to configure network adapters, fabric extenders, and parent interconnects, however this information is abstract as it does not include the details of how each network component is configured.

A service profile is created by the UCS server administrator. This service profile leverages configuration policies that were created by the server, network, and storage administrators. Server administrators can also create a Service profile template which can be later used to create Service profiles in an easier way. A service template can be derived from a service profile, with server and I/O interface identity information abstracted. Instead of specifying exact UUID, MAC address, and WWN values, a service
template specifies where to get these values. For example, a service profile template might specify the standard network connectivity for a web server and the pool from which its interface's MAC addresses can be obtained. Service profile templates can be used to provision many servers with the same simplicity as creating a single one.

**Service Profile Elements**

In summary, service profiles represent all the attributes of a logical server in Cisco UCS data model. These attributes have been abstracted from the underlying attributes of the physical hardware and physical connectivity. Using logical servers that are disassociated from the physical hardware removes many limiting constraints around how servers are provisioned. Using logical servers also makes it easy to repurpose physical servers for different applications and services.

*Figure 2* below figure represents how Server, Network, and Storage Policies are encapsulated in a service profile.

![Figure 2: Service Profile inclusions](image)

**Understanding the Service Profile Template**

A lot of time can be lost between the point when a physical server is in place and when that server begins hosting applications and meeting business needs. Much of this lost time is due to delays in cabling, connecting, configuring, and preparing the data center infrastructure for a new physical server. In addition, provisioning a physical server requires a large amount of manual work that must be performed individually on each server. In contrast, the Cisco UCS Manager uses service profile templates to significantly simplify logical (virtual) server provisioning and activation. The templates also allow standard configurations to be applied to multiple logical servers automatically, which reduces provisioning time to just a few minutes.

Logical server profiles can be created individually or as a template. Creating a service profile template allows rapid server instantiation and provisioning of multiple servers. The Cisco UCS data model (e.g., pools, policies, and isolation security methods) also creates higher-level abstractions such as virtual network interface cards (VNICS) and virtual host bus adapters (VHBAs). Ultimately, these service
profiles are independent of the underlying physical hardware. One important aspect of the Cisco UCS data model is that it is highly referential. This means you can easily reuse and refer to previously define objects and elements in a profile without having to repeatedly redefine their common attributes and properties.

The Cisco Unified Computing System used for the certified configuration is based on Cisco B-Series Blade Servers; however, the breadth of Cisco's server and network product line suggests that similar product combinations will meet the same requirements.

The system used to create the Oracle Certified Configuration is built from the hierarchy of components illustrated in Figure 1.

- The Cisco UCS 6248 XP 48-Port Fabric Interconnect provides low-latency, lossless, 10-Gbps unified fabric connectivity for the cluster. The fabric interconnect provides connectivity to blade server chassis and the enterprise IP network. Through a 16-port, 8-Gbps Fiber Channel expansion card, the fabric interconnect provides native Fiber Channel access to the EMC VNX storage system. Two fabric interconnects are configured in the cluster, providing physical separation between the public and private networks and also providing the capability to securely host both networks in the event of a failure.

- The Cisco UCS 2208XP Fabric Extender brings the unified fabric into each blade server chassis. The fabric extender is configured and managed by the fabric interconnects, eliminating the complexity of blade-server-resident switches. Two fabric extenders are configured in each of the cluster's two blade server chassis.

- The Cisco UCS 5108 Blade Server Chassis houses the fabric extenders, up to four power supplies, and up to four full width blade servers. As part of the system's radical simplification, the blade server chassis is also managed by the fabric interconnects, eliminating another point of management. Two chassis were configured for the Oracle 12c RAC described in this document.

The blade chassis supports up to eight half-width blades or up to four full-width blades. The certified configuration used four (two in each chassis) Cisco UCS B420 M3 full width Blade Servers, each equipped with four 8-core Intel Xeon E5-4650 series processors. Each blade server was configured with 256 GB of memory.

- The blade server form factor supports a range of mezzanine-format Cisco UCS network adapters, including a 80 Gigabit Ethernet network adapter designed for efficiency and performance, the Cisco UCS VIC 1240 and VIC 1280 Virtual Interface Cards designed to deliver outstanding performance and full compatibility with existing Ethernet and Fiber Channel environments. These adapters present both an Ethernet network interface card (NIC) and a Fiber Channel host bus adapter (HBA) to the host operating system. They make the existence of the unified fabric transparent to the operating system, passing traffic from both the NIC and the HBA onto the unified fabric. This certified configuration used Cisco UCS VIC 1240 and VIC 1280 Virtual Interface Network Adapters (2 adapters per blade) that provide 120 Gbps of performance per blade server.

Cisco Nexus 5548UP Switch

**Figure 3**

Cisco Nexus 5548UP Switch
The Cisco Nexus 5548UP switch delivers innovative architectural flexibility, infrastructure simplicity, and business agility, with support for networking standards. For traditional, virtualized, unified, and high-performance computing (HPC) environments, it offers a long list of IT and business advantages, including:

**Architectural Flexibility**
- Unified ports that support traditional Ethernet, Fiber Channel (FC), and Fiber Channel over Ethernet (FCoE)
- Synchronizes system clocks with accuracy of less than one microsecond, based on IEEE 1588
- Supports secure encryption and authentication between two network devices, based on Cisco TrustSec IEEE 802.1AE
- Offers converged Fabric extensibility, based on emerging standard IEEE 802.1BR, with Fabric Extender (FEX) Technology portfolio, including:
  - Cisco Nexus 2000 FEX
  - Adapter FEX
  - VM-FEX

**Infrastructure Simplicity**
- Common high-density, high-performance, data-center-class, fixed-form-factor platform
- Consolidates LAN and storage
- Supports any transport over an Ethernet-based fabric, including Layer 2 and Layer 3 traffic
- Supports storage traffic, including iSCSI, NAS, FC, RoE, and IBoE
- Reduces management points with FEX Technology

**Business Agility**
- Meets diverse data center deployments on one platform
- Provides rapid migration and transition for traditional and evolving technologies
- Offers performance and scalability to meet growing business needs

**Specifications At-a-Glance**
- A 1-rack-unit, 1/10 Gigabit Ethernet switch
- 32 fixed Unified Ports on base chassis and one expansion slot totaling 48 ports
- The slot can support any of the three modules: Unified Ports, 1/2/4/8 native Fiber Channel, and ethernet or FCoE
- Throughput of up to 960 Gbps

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**EMC VNX Unified Storage System**

EMC VNX series unified storage systems deliver uncompromising scalability and flexibility, while providing market-leading simplicity and efficiency to minimize total cost of ownership.
Based on the powerful family of Intel Xeon Sandy bridge processors, the EMC VNX implements a modular architecture that integrates hardware components for block, file, and object with concurrent support for native NAS, iSCSI, Fiber Channel, and FCoE protocols. The unified configuration includes the following rack mounted enclosures:

- Disk processor enclosure (holds disk drives) or storage processor enclosure (requires disk drive tray) plus stand-by power system to deliver block protocols.
- One or more data mover enclosures to deliver file protocols (required for File and Unified configurations)
- Control station (required for File and Unified configurations)

A robust platform designed to deliver five 9s availability, the VNX series enable organizations to dynamically grow, share, and cost-effectively manage multi-protocol file systems and multi-protocol block storage access. The VNX series has been expressly designed to take advantage of the latest innovation in Flash drive technology, maximizing the storage system's performance and efficiency while minimizing cost per GB.

This VNX generation has active/active storage processors for higher performance when accessing LUNs, compared to the previous generation's active/passive scheme, which meant LUN access through the passive storage processor was slower than through the active one.

The VNX controlling software is now called its Operating Environment (OE) and it can use multi-core CPUs better, with work being spread across the available cores and hence increasing performance.

Finally, Cisco and EMC are collaborating on solutions and services to help build, deploy, and manage IT infrastructures that adapt to changing needs. Industry-leading EMC information infrastructure and intelligent Cisco networking products, including the Cisco Unified Computing System, will reduce the complexity of data centers.

Together, EMC and Cisco provide comprehensive solutions that can benefit customers now and in the future, including:

- High-performance storage and SANs that reduce total cost of ownership
- Disaster recovery to protect data and improve compliance
- Combined computing, storage, networking, and virtualization technologies

Leveraging EMC software creates additional benefits which can be derived when using products such as:

- Fast Cache: Dynamically absorbs unpredicted spikes in system workloads.
- FAST VP: Tiers data from high-performance to high-capacity drives in one-gigabyte increments, with Fully Automated Storage Tiering for Virtual Pools, resulting in overall lower costs, regardless of application type or data age.
- FAST Suite: Automatically optimizes for the highest system performance and the lowest storage cost simultaneously (includes FAST VP and FAST Cache). For additional information refer to: [http://www.emc.com/collateral/hardware/white-papers/h8242-deploying-oracle-vnx-wp.pdf](http://www.emc.com/collateral/hardware/white-papers/h8242-deploying-oracle-vnx-wp.pdf)
- EMC Unisphere®: Delivers simplified management through a single management framework for all NAS, SAN, and replication needs. For additional information refer to: [http://www.emc.com/collateral/software/data-sheet/h7303-unisphere-ds.pdf](http://www.emc.com/collateral/software/data-sheet/h7303-unisphere-ds.pdf)

For additional information about the EMC VNX Series refer to: [http://www.emc.com/storage/vnx/vnx-series.htm](http://www.emc.com/storage/vnx/vnx-series.htm)
For details regarding EMC VNX Series Software Suites and the resulting value in performance, protection, and TCO that can be derived, refer to:

For additional information about the features available in the VNX product line pertaining to your Oracle deployment environment, refer to

**Cisco Certified Configuration Inventory and Solution Overview**

The inventory of the components used in the certification stack is detailed in **Table 1**.
The configuration presented in this Cisco Validated Design is based on the Oracle Database 12c Release 1 with Real Application Clusters technology certification environment specified for an Oracle RAC and EMC VNX storage system is as shown in **Figure 5**.
# Inventory of the Certified Configuration

## Table 1  Inventory of the Certified Configuration

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Cisco Unified Computing System Server Configuration</strong></td>
<td></td>
</tr>
<tr>
<td>Cisco UCS 5108 Blade Server Chassis, with 4 power supply units, 8 fans and 2 fabric extenders</td>
<td>2</td>
</tr>
<tr>
<td>Cisco UCS B420-M3 full width blades</td>
<td>8</td>
</tr>
<tr>
<td>4 Socket - Intel Xeon E5-4650 2.70 GHz processors, 8 cores per socket on 8 blades</td>
<td>256</td>
</tr>
<tr>
<td>16 GB DDR3-1600 MHz DIMM (16 per server, totaling 256 GB per blade server)</td>
<td>128</td>
</tr>
<tr>
<td>Cisco UCS VIC 1240 Virtual Interface Card, 256 PCI devices, Dual 4 x 10G (1 per server)</td>
<td>8</td>
</tr>
<tr>
<td>Cisco UCS VIC 1280 Virtual Interface Card, 256 PCI devices, Dual 4 x 10G (1 per server)</td>
<td>8</td>
</tr>
<tr>
<td>Hard Disk Drives ( SAN Boot Install )</td>
<td>0</td>
</tr>
<tr>
<td>Cisco UCS - 6248XP 48 port Fabric Interconnect</td>
<td>2</td>
</tr>
<tr>
<td>16 port 8 Gbps Fiber Channel expansion module</td>
<td>2</td>
</tr>
<tr>
<td><strong>LAN and SAN Components</strong></td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>Quantity</td>
</tr>
<tr>
<td>LAN and SAN Components</td>
<td></td>
</tr>
<tr>
<td>Cisco Nexus 5548 UP Switch</td>
<td>2</td>
</tr>
<tr>
<td><strong>VLAN Configuration</strong></td>
<td></td>
</tr>
<tr>
<td>Public VLAN</td>
<td>VLAN ID</td>
</tr>
<tr>
<td>Private Network VLAN ( Private traffic VLAN must be configured on the Nexus switches to ensure traffic flow in partial link failure as discussed later</td>
<td>134</td>
</tr>
<tr>
<td>VSAN Configuration</td>
<td>VSAN ID</td>
</tr>
<tr>
<td>Oracle database VSAN</td>
<td>15</td>
</tr>
<tr>
<td><strong>Storage Configuration</strong></td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>Quantity</td>
</tr>
<tr>
<td>EMC VNX 8000 Storage System</td>
<td>1</td>
</tr>
<tr>
<td>600 GB 15k RPM, SAS disk drivers</td>
<td>300</td>
</tr>
<tr>
<td>200 GB flash drives</td>
<td>85</td>
</tr>
<tr>
<td>100 GB flash drives for cache</td>
<td>15</td>
</tr>
<tr>
<td>Bus</td>
<td>8</td>
</tr>
<tr>
<td>Enclosures</td>
<td>16</td>
</tr>
<tr>
<td>Operating System and RPM Components (installed on all Oracle nodes)</td>
<td>OS and RPM's</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Operating System (64 bit)</td>
<td>Oracle Linux 6.3 x86_64(2.6.39-200.24.1.el6uek.x86_64)</td>
</tr>
</tbody>
</table>
| Required RPM's by EMC (to be installed on all Cluster nodes to support EMC Power Path and Host agent) | EMCpower.LINUX-5.7.1.02.00-004.ol6_uek2_r2.x86_64  
HostAgent-Linux-64-x86-en_US-1.0.0.1.0474-1.x86_64 |
In Figure 5, the green lines indicate the public network connecting to Fabric Interconnect A, and the red lines indicate the private interconnects connecting to Fabric Interconnect B. For Oracle RAC environments, it is a best practice to keep all private interconnect (intra-blade) traffic to one Fabric interconnect. The public and private VLANs spanning the fabric interconnects help ensure the connectivity in case of link failure. Note that the FCoE communication takes place between the Cisco
Unified Computing System chassis and fabric interconnects. The Fiber channel traffic leaves the UCS Fabrics through their own N5k Switches to EMC (blue lines). This is a typical configuration that can be deployed in a customer's environment. The best practices and setup recommendations are described in subsequent sections of this document.

**Configuring Cisco Unified Computing System for the 8 node Oracle RAC**


**Configuring Fabric Interconnects**

Two Cisco UCS 6248 UP Fabric Interconnects are configured for redundancy. This provides resiliency in case of a failure.

The first step is to establish connectivity between the blades and fabric interconnects. As shown in Figure 6, sixteen public (eight per chassis) links go to Fabric Interconnect "A" (ports 1 through 16). Similarly, sixteen private links go to Fabric Interconnect B. It is recommended to keep all private interconnects on a single Fabric interconnect. In such case, the private traffic will stay local to that fabric interconnect and will not go to northbound network switch. In other words, all inter blade (or RAC node private) communication will be resolved locally at the fabric interconnect.
Configuring Server Ports

Figure 6 Configuring Server Ports

Configuring SAN and LAN with Cisco UCS Manager

Configuring SAN

On the SAN tab, create and configure the VSANs to be used for database as shown in Figure 7. On the test bed, we used vSAN 15 for the database.
Configuring LAN

On the LAN tab as shown in Figure 8, create VLANs that will be used later for virtual NICs (vNICS) configured for private and public traffic for Oracle RAC. You can also set up MAC address pools for assignment to vNICS. For this setup, we used VLAN 134 for public interfaces and VLAN 10 for Oracle
RAC private interconnect interface. It is also very important that you create both VLANs as global across both fabric interconnects. This way, VLAN identity is maintained across the fabric interconnects in case of failover.

Figure 8  Configuring LAN with Cisco UCS Manager

Even though private VLAN traffic stays local within Cisco UCS domain, it is necessary to configure entries for these private VLANs in northbound network switch. This will allow the switch to route interconnect traffic appropriately in case of partial link or IOM failures.

Configuring Jumbo Frames

Enable Jumbo Frames for Oracle Private Interconnect traffic.

Figure 9  Configuring Jumbo Frames

After these initial setups we can setup UCS service profile templates for the hardware configuration.

Configuring Ethernet Port-Channels

To configure Port-Channels, login to Cisco UCS Manager and from the LAN tab, filter on LAN cloud as shown in Figure 10.
Select Fabric A, right-click on port-channels and create port-channel. In the current Oracle RAC setup ports 17 and 18 on Fabric A were selected to be configured as port channel 10. Similarly ports 17 and 18 on Fabric B were selected as port channel 11.

**Figure 10  Configuring Port Channels**

![Configuring Port Channels](image)

Port Channels on Fabric A

<table>
<thead>
<tr>
<th>Name</th>
<th>Fabric ID</th>
<th>Type</th>
<th>Role</th>
<th>Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port Channel 10</td>
<td>A</td>
<td>Aggregation</td>
<td>Network</td>
<td>Ether</td>
</tr>
<tr>
<td>Eth Interface 1/17</td>
<td>A</td>
<td>Physical</td>
<td>Network</td>
<td>Ether</td>
</tr>
<tr>
<td>Eth Interface 1/18</td>
<td>A</td>
<td>Physical</td>
<td>Network</td>
<td>Ether</td>
</tr>
</tbody>
</table>

Port Channels on Fabric B

<table>
<thead>
<tr>
<th>Name</th>
<th>Fabric ID</th>
<th>Type</th>
<th>Role</th>
<th>Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port Channel 11</td>
<td>B</td>
<td>Aggregation</td>
<td>Network</td>
<td>Ether</td>
</tr>
<tr>
<td>Eth Interface 2/17</td>
<td>B</td>
<td>Physical</td>
<td>Network</td>
<td>Ether</td>
</tr>
<tr>
<td>Eth Interface 2/18</td>
<td>B</td>
<td>Physical</td>
<td>Network</td>
<td>Ether</td>
</tr>
</tbody>
</table>

The next step is to set up VPC in n5k.

**Preparatory Steps to Create Service Templates**

First create the UUID, IP, MAC, WWNN and WWPN pools and keep them handy in case they are not pre-created. If already pre-created make sure that you have enough of them free and unallocated.
Configuring Cisco Unified Computing System for the 8 node Oracle RAC

UUID Pool
Click the servers tab, Filter on pools. Expand UUID suffix pools and create a new pool as shown in Figure 11.

Figure 11 Configuring UUID Pool in Cisco UCS

Create a default pool as shown below:

IP and MAC Pools
Click the LAN tab, filter on pools and create IP and MAC pools as shown below:
The IP pools will be used for console management, while MAC addresses for the vNICs will be addressed later in this document.

**WWNN and WWPN pools**

Click the SAN tab filter on pools and create the pools as shown below:
Configure vNIC Templates

Click the LAN tab, filter on policies and select vNIC templates as shown below. Two templates are created one for Public network and one for Private network. The Private network is for the internal Heart Beat and message transfers between Oracle Nodes while Public network for external clients like middle tiers and ssh sessions to the Oracle database hosts.

The vNIC template for the Oracle Private link is set at 9000 MTU and pinned to Fabric B and the failover is enabled. This allows the vNIC to failover to Fabric A, in case of failures of Fabric B.
Create a Private vNIC Template

Create a Public vNIC Template
Create HBA templates
Click the SAN tab, filter out policies, right-click the vHBA templates and create a template as shown below:
Create another vHBA_FI_B template as shown below:

When the above preparatory steps are complete you can create a service template from which the service profiles can be easily created.

**Create Service Profile Template**

Create a service profile template as shown below before forking service profiles to be allocated to the servers later. Click the Servers tab in the Cisco UCS manager, filter out on Service Profile Templates as below and select Create Service Profile Template.
Configuring Cisco Unified Computing System for the 8 node Oracle RAC
Enter a name, select the default UUID created earlier and move to the next screen.

In the Networking page, create vNICs; one on each fabric and associate them with the VLAN policies created earlier.

Select expert mode, click add in the section that specifies add one or more vNICs that the server should use to connect to the LAN.
From the Create vNIC page, select "Use vNIC template" and adapter policy as Linux. vNIC1 was selected for Oracle private network as shown below:

Create a vNIC2 for public.
From the Storage page, similar to vNICs select expert mode in adapter, choose the WWNN pool created earlier and click Add to create vHBAs. We selected 4xvHBA’s as shown below:

Create vHBA1 using template vHBA_FI_A.
Create vHBA2 using template vHBA_FI_B.
Create vHBA3 using template vHBA_FI_A.
Create vHBA4 using template vHBA_FI_B.
Skip the zoning section and go to vNIC/vHBA placement.
You can retain the system defaults or you can specify them manually as shown below:
Allocate vNIC1, vHBA1 and vHBA3 to the first vic1240, while the rest of vNIC2, vHBA2 and vHBA4 to the second vNIC 1280

**Server Boot Policy:**
Leave this to default as the initiators may vary from one server to the other.

The rest of the maintenance and assignment policies were left to default in the test bed. Other policies may be selected and will vary from site to site, depending on your workloads, best practices and policies.

**Create Service Profiles from Service Profile Templates**

Click the Servers tab, right-click on the root and select Create Service Profile from Template as shown below:
Configuring Cisco Unified Computing System for the 8 node Oracle RAC

This creates 8 service profiles with the following names:
ORA12C_B420M3_1, ORA12C_B420M3_2, ORA12C_B420M3_3, ORA12C_B420M3_4, ORA12C_B420M3_5, ORA12C_B420M3_6, ORA12C_B420M3_7, ORA12C_B420M3_8,

Associating Service Profile to the Servers

Make sure that a few of the entries in the service profile appear as expected and as shown below before associating them to a server.

In order to associate this service profile to a server, perform the following steps.

From the Servers tab, select the desired service profile and select change service profile association.
The service profile is unassociated as of now and can be assigned to a server in the pool. Click Change Service Profile Association under the General tab, from the drop-down of Server Assignment, select an existing server that you would like to assign, and click OK.

### Setting Up EMC VNX Storage

This document provides a general overview of the storage configuration for the database layout. However, it is beyond the scope of this document to provide details about host connectivity and logical unit number (LUNs) in RAID configuration. For more information about Oracle database best practices for deployments with EMC VNX storage, refer to [http://www.emc.com/oracle](http://www.emc.com/oracle).

The following are some generic recommendations for EMC VNX storage configuration with mixed drives.

Turn off the read and write caches for flash drive-based LUNs. In most situations, it is better to turn off both the read and write caches on all the LUNs that reside on flash drives, for the following reasons:

- The flash drives are extremely fast: When the read cache is enabled for the LUNs residing on them, the read cache lookup for each read request adds more overhead compared to SAS drives. This scenario occurs in an application profile that is not expected to get many read cache hits at any rate. It is generally much faster to directly read the block from the flash drives.

- Typically, the storage array is also shared by several other applications along with the database. In some situations, the write cache may become fully saturated, placing the flash drives in a force-flush situation. This adds unnecessary latency. This typically occurs particularly when storage deploys mixed drives and consists of slower Near Line SAS drives. Therefore, it is better in these situations to write the block directly to the flash drives than to the write cache of the storage system.

Distribute database files for flash drives. Refer to Table 2 below for recommendations about distributing database files based on the type of workload.
Four databases were created:
- OLTP - Online Transaction system completely on flash drives.
- DSS - Decision support system on mixed pools.
- CPU - Database to stress the CPU on SAS drives
- CRS - CRS database on SAS drives.

Table 2 illustrates the distribution of LUNs from a VNX8000 for the setup.

### Storage Configuration

#### Table 2: Storage Configuration

<table>
<thead>
<tr>
<th>Purpose</th>
<th>OLTP Database data and temp files</th>
<th>DSS Database data and temp files</th>
<th>CPU and CRS Database data and temp files</th>
<th>Redo Log Files for all the databases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disk Type</td>
<td>Flash</td>
<td>Mixed (SAS and Flash)</td>
<td>SAS</td>
<td>SAS</td>
</tr>
<tr>
<td>RAID Type</td>
<td>RAID 5 Storage Pool</td>
<td>RAID 5 Storage Pool</td>
<td>RAID 5 Storage Pool</td>
<td>RAID 1/0 Storage Pool</td>
</tr>
<tr>
<td>SAS Disks</td>
<td>0</td>
<td>150</td>
<td>20</td>
<td>32</td>
</tr>
<tr>
<td>Flash Disks</td>
<td>50</td>
<td>30</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total LUNs</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>LUN Size</td>
<td>400GB</td>
<td>1000GB</td>
<td>250GB</td>
<td>300GB</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Boot LUNs and Oracle RAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disk Type</td>
<td>SAS</td>
</tr>
<tr>
<td>RAID Type</td>
<td>RAID 5</td>
</tr>
<tr>
<td>SAS Disks</td>
<td>5</td>
</tr>
<tr>
<td>Flash Disks</td>
<td>0</td>
</tr>
<tr>
<td>Total LUNs</td>
<td>8 Boot LUNs</td>
</tr>
<tr>
<td>LUN Size</td>
<td>Boot LUNs - 50GB</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Oracle RAC code Tree and OCR/Voting LUNs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disk Type</td>
<td>SAS</td>
</tr>
<tr>
<td>RAID Type</td>
<td>RAID 5</td>
</tr>
<tr>
<td>SAS Disks</td>
<td>5</td>
</tr>
<tr>
<td>Flash Disks</td>
<td>0</td>
</tr>
<tr>
<td>Total LUNs</td>
<td>8 RAC LUNs and 5 OCR/Voting LUNs</td>
</tr>
<tr>
<td>LUN Size</td>
<td>RAC LUNs - 60GB</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Purpose</th>
<th>ACFS File system for RDBMS Code Tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>LUN Size</td>
<td>ACFS File system for RDBMS Code Tree</td>
</tr>
</tbody>
</table>
A total of 32 ports were used from storage processors and were equally distributed between SPA and SPB as shown in Table 3 and were connected to the respective N5K's.

Table 3      Service Processor Distribution

<table>
<thead>
<tr>
<th>Processor</th>
<th>Slot/Port</th>
<th>WWPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPA</td>
<td>A0P0</td>
<td>50:06:01:60:36:60:05:e7</td>
</tr>
<tr>
<td></td>
<td>A0P1</td>
<td>50:06:01:61:36:60:05:e7</td>
</tr>
<tr>
<td></td>
<td>A0P2</td>
<td>50:06:01:62:36:60:05:e7</td>
</tr>
<tr>
<td></td>
<td>A0P3</td>
<td>50:06:01:63:36:60:05:e7</td>
</tr>
<tr>
<td></td>
<td>A1P0</td>
<td>50:06:01:64:36:60:05:e7</td>
</tr>
<tr>
<td></td>
<td>A1P1</td>
<td>50:06:01:65:36:60:05:e7</td>
</tr>
<tr>
<td></td>
<td>A1P2</td>
<td>50:06:01:66:36:60:05:e7</td>
</tr>
<tr>
<td></td>
<td>A1P3</td>
<td>50:06:01:67:36:60:05:e7</td>
</tr>
<tr>
<td></td>
<td>A7P0</td>
<td>50:06:01:60:36:64:05:e7</td>
</tr>
<tr>
<td></td>
<td>A7P1</td>
<td>50:06:01:61:36:64:05:e7</td>
</tr>
<tr>
<td></td>
<td>A7P2</td>
<td>50:06:01:62:36:64:05:e7</td>
</tr>
<tr>
<td></td>
<td>A7P3</td>
<td>50:06:01:63:36:64:05:e7</td>
</tr>
<tr>
<td></td>
<td>A8P0</td>
<td>50:06:01:64:36:64:05:e7</td>
</tr>
<tr>
<td></td>
<td>A8P1</td>
<td>50:06:01:65:36:64:05:e7</td>
</tr>
<tr>
<td></td>
<td>A8P2</td>
<td>50:06:01:66:36:64:05:e7</td>
</tr>
<tr>
<td></td>
<td>A8P3</td>
<td>50:06:01:67:36:64:05:e7</td>
</tr>
<tr>
<td>SPB</td>
<td>B0P0</td>
<td>50:06:01:68:36:60:05:e7</td>
</tr>
<tr>
<td></td>
<td>B0P1</td>
<td>50:06:01:69:36:60:05:e7</td>
</tr>
<tr>
<td></td>
<td>B0P2</td>
<td>50:06:01:6a:36:60:05:e7</td>
</tr>
<tr>
<td></td>
<td>B0P3</td>
<td>50:06:01:6b:36:60:05:e7</td>
</tr>
<tr>
<td></td>
<td>B1P0</td>
<td>50:06:01:6c:36:60:05:e7</td>
</tr>
<tr>
<td></td>
<td>B1P1</td>
<td>50:06:01:6d:36:60:05:e7</td>
</tr>
<tr>
<td></td>
<td>B1P2</td>
<td>50:06:01:6e:36:60:05:e7</td>
</tr>
<tr>
<td></td>
<td>B1P3</td>
<td>50:06:01:6f:36:60:05:e7</td>
</tr>
<tr>
<td></td>
<td>B7P0</td>
<td>50:06:01:68:36:64:05:e7</td>
</tr>
<tr>
<td></td>
<td>B7P1</td>
<td>50:06:01:69:36:64:05:e7</td>
</tr>
<tr>
<td></td>
<td>B7P2</td>
<td>50:06:01:6a:36:64:05:e7</td>
</tr>
<tr>
<td></td>
<td>B7P3</td>
<td>50:06:01:6b:36:64:05:e7</td>
</tr>
<tr>
<td></td>
<td>B8P0</td>
<td>50:06:01:6c:36:64:05:e7</td>
</tr>
<tr>
<td></td>
<td>B8P1</td>
<td>50:06:01:6d:36:64:05:e7</td>
</tr>
<tr>
<td></td>
<td>B8P2</td>
<td>50:06:01:6e:36:64:05:e7</td>
</tr>
<tr>
<td></td>
<td>B8P3</td>
<td>50:06:01:6f:36:64:05:e7</td>
</tr>
</tbody>
</table>
In the sections of N5K zoning, we will cover how these WWPNs will be used in zoning, boot policies and in achieving high availability in case of failures.

**Configuring SAN Zoning on N5K 5548 UP Switches**

Note: Two numbers of N5K 5548 UP switches were configured.

*Figure 12 N5K Configurations with vPC*

Figure 12 illustrates how the N5K UP switches are connected to North bound switches and storage, while connected to the underlying Cisco UCS Fabrics. The N5K switches form a core group in controlling SAN zoning.

**Fibre Channel Zoning**

Prior to configuring zoning details, decide how many paths are needed for each LUN and extract the WWPN numbers for each of the HBAs.

To access the WWPNs for each of the HBAs, login to the Cisco UCS manager. Click Equipment, chassis, servers and select the desired server. On the right-hand menu, click the Inventory tab and HBAs, as shown below:
The WWPN numbers for all the 4 HBAs for server 1 as an example is illustrated above. In the current setup, it was decided to have a total of 4 paths, 2 paths from each Fabrics and N5K’s to the storage.

The zoning for Server1, HBA1 can be setup as shown below:

```
zone name ora12c_b420_1_hba1 vsan 15
* fcid 0x7413ef [device-alias A0P0] <-SPA
* fcid 0x7405ef [device-alias B0P0] <- SPB
* fcid 0x740001 [pwnn 20:00:00:25:b5:00:00:6e] <- Extracted from the above figure for HBA1.
```

The WWPNs from storage are distributed between both storage processors providing distribution and redundancy in case of a failure.

The following is an example for server 1:

<table>
<thead>
<tr>
<th>N5K-A</th>
<th>Zone Name</th>
<th>WWPN Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ora12c_b420_1_hba1</td>
<td>[pwnn 20:00:00:25:b5:00:00:6e]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[pwnn 50:06:01:60:36:60:05:e7] [A0P0]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[pwnn 50:06:01:68:36:60:05:e7] [B0P0]</td>
</tr>
<tr>
<td></td>
<td>ora12c_b420_1_hba3</td>
<td>[pwnn 20:00:00:25:b5:00:00:3d]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[pwnn 50:06:01:61:36:60:05:e7] [A0P1]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[pwnn 50:06:01:69:36:60:05:e7] [B0P1]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>N5K-B</th>
<th>Zone Name</th>
<th>WWPN Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ora12c_b420_1_hba2</td>
<td>[pwnn 20:00:00:25:b5:00:00:4d]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[pwnn 50:06:01:60:36:64:05:e7] [A7P0]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[pwnn 50:06:01:68:36:64:05:e7] [B7P0]</td>
</tr>
<tr>
<td></td>
<td>ora12c_b420_1_hba4</td>
<td>[pwnn 20:00:00:25:b5:00:00:1d]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[pwnn 50:06:01:61:36:64:05:e7] [A7P1]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[pwnn 50:06:01:69:36:64:05:e7] [B7P1]</td>
</tr>
</tbody>
</table>

Log in to each N5K through ssh and issue the following:
Setup VLAN and VSANs on both N5Ks

```conf
term
vlan 134
    name Oracle_RAC_Public_Traffic
    exit
vlan 10
    name Oracle_RAC_Private_Traffic
    no ip igmp snooping
    exit
vsan database
vsan 15
exit
```

Setting Up Device Aliases for Storage Initiators

**NSK-A**

```conf
device-alias database
device-alias name A0P0 pwnn 50:06:01:60:36:60:05:e7
device-alias name A0P1 pwnn 50:06:01:61:36:60:05:e7
device-alias name A0P2 pwnn 50:06:01:62:36:60:05:e7
device-alias name A0P3 pwnn 50:06:01:63:36:60:05:e7
device-alias name A1P0 pwnn 50:06:01:64:36:60:05:e7
device-alias name A1P1 pwnn 50:06:01:65:36:60:05:e7
device-alias name A1P2 pwnn 50:06:01:66:36:60:05:e7
device-alias name A1P3 pwnn 50:06:01:67:36:60:05:e7
device-alias name B0P0 pwnn 50:06:01:68:36:60:05:e7
device-alias name B0P1 pwnn 50:06:01:69:36:60:05:e7
device-alias name B0P2 pwnn 50:06:01:6a:36:60:05:e7
device-alias name B0P3 pwnn 50:06:01:6b:36:60:05:e7
device-alias name B1P0 pwnn 50:06:01:6c:36:60:05:e7
device-alias name B1P1 pwnn 50:06:01:6d:36:60:05:e7
device-alias name B1P2 pwnn 50:06:01:6e:36:60:05:e7
device-alias name B1P3 pwnn 50:06:01:6f:36:60:05:e7
exit
device-alias commit
exit
```

**NSK-B**

```conf
device-alias database
device-alias name A7P0 pwnn 50:06:01:60:36:64:05:e7
device-alias name A7P1 pwnn 50:06:01:61:36:64:05:e7
device-alias name A7P2 pwnn 50:06:01:62:36:64:05:e7
device-alias name A7P3 pwnn 50:06:01:63:36:64:05:e7
device-alias name A8P0 pwnn 50:06:01:64:36:64:05:e7
device-alias name A8P1 pwnn 50:06:01:65:36:64:05:e7
device-alias name A8P2 pwnn 50:06:01:66:36:64:05:e7
device-alias name A8P3 pwnn 50:06:01:67:36:64:05:e7
device-alias name B7P0 pwnn 50:06:01:68:36:64:05:e7
device-alias name B7P1 pwnn 50:06:01:69:36:64:05:e7
device-alias name B7P2 pwnn 50:06:01:6a:36:64:05:e7
device-alias name B7P3 pwnn 50:06:01:6b:36:64:05:e7
device-alias name B8P0 pwnn 50:06:01:6c:36:64:05:e7
device-alias name B8P1 pwnn 50:06:01:6d:36:64:05:e7
device-alias name B8P2 pwnn 50:06:01:6e:36:64:05:e7
device-alias name B8P3 pwnn 50:06:01:6f:36:64:05:e7
exit
```
device-alias commit
exit

Setting Up Zones
The following is an example for one zone on one N5K:

```bash
conf term
zoneset name ora12c_FI_A vsan 15
zone name orarac1_hba1
member device-alias A2P0
member device-alias A2P2
member device-alias B2P0
member device-alias B2P0
member pwnn 20:00:00:25:b5:00:00:1f ( ora12crac1 hba1 wwpn )
exit
exit
zoneset activate name ora12c_FI_A vsan 15
```

copy running-config startup-config

Optionally, configure the device aliases for simpler maintenance as above, or use WWPN for the storage initiators.

Repeat the above for all the HBAs. A detailed list of zones added in the setup is provided in the Appendix.

Setting Up VPC on N5Ks

As shown in Figure 12, both N5K's port 17 receives traffic from UCS Fabric A, that has port-channel 10 defined. Similarly both N5K's port 18 receives traffic from UCS Fabric B, that has port-channel 11 configured.

Login into N5K-A as admin.

```bash
conf term
feature vpc
vpc domain 1
peer-keepalive destination <IP Address of peer-N5K>
exi

interface port-channel1
switchport mode trunk
switchport trunk allowed vlan 1,10,134
spanning-tree port type network
speed 10000
vpc peer-link

interface port-channel10
description oracle 12c port-channel
switchport mode trunk
switchport trunk allowed vlan 1,10,134
spanning-tree port type edge trunk
vpc 10

interface port-channel11
```
description oracle 12c port-channel
switchport mode trunk
switchport trunk allowed vlan 1,10,134
spanning-tree port type edge trunk
vpc 11

interface Ethernet1/5
  description connected to UCS-Fab-A-Port17
  switchport mode trunk
  switchport trunk allowed vlan 1,10,134
  channel-group 10 mode active

interface Ethernet1/6
  description connected to UCS-Fab-B-Port18
  switchport mode trunk
  switchport trunk allowed vlan 1,10,134
  channel-group 11 mode active

interface Ethernet1/8
  description "Public Traffic to 3750"
  switchport mode trunk
  switchport access vlan 134
  switchport trunk native vlan 134
  switchport trunk allowed vlan 1,134
  speed 1000

copy running-config startup-config

Repeat the above on both N5K’s.

Show vpc status should show the following for a successful configuration:

vPC Peer-link status
---------------------------------------------------------------
<table>
<thead>
<tr>
<th>id</th>
<th>Port</th>
<th>Status</th>
<th>Active vlans</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Po1</td>
<td>up</td>
<td>1,10,134</td>
</tr>
</tbody>
</table>

vPC status
---------------------------------------------------------------
<table>
<thead>
<tr>
<th>id</th>
<th>Port</th>
<th>Status</th>
<th>Consistency</th>
<th>Reason</th>
<th>Active vlans</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Po10</td>
<td>up</td>
<td>success</td>
<td>success</td>
<td>1,10,134</td>
</tr>
<tr>
<td>11</td>
<td>Po11</td>
<td>up</td>
<td>success</td>
<td>success</td>
<td>1,10,134</td>
</tr>
</tbody>
</table>

show interface port-channel 10-11 brief
---------------------------------------------------------------
<table>
<thead>
<tr>
<th>Port-channel VLAN</th>
<th>Type</th>
<th>Mode</th>
<th>Status</th>
<th>Reason</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Po10</td>
<td>1</td>
<td>eth</td>
<td>trunk</td>
<td>up</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>a-10G(D)</td>
</tr>
</tbody>
</table>
Setting Up Jumbo Frames on N5K

Jumbo frames with an mtu=9000 have to be setup on n5k. Oracle Interconnect traffic under normal conditions does not go to the northbound switch like N5K's as all the private vNICs are configured in Fabric B. However if there is a partial link or IOM failure, the private interconnect traffic has to go to the immediate northbound switch (N5K in our case) to reach Fabric B.

The command shown below details how to configure Jumbo frames Nexus 5K Fabric A Switch:

```
ora12c-n5k-a# conf terminal
Enter configuration commands, one per line. End with CNTL/Z.
ora12c-n5k-a (config)# class-map type network-qos class-platinum
ora12c-n5k-a (config-cmap-nq)# exit
ora12c-n5k-a (config)# policy-map type network-qos jumbo
ora12c-n5k-a (config-pmap-nq)# class type network-qos class-default
ora12c-n5k-a (config-pmap-nq-c)# mtu 9216
ora12c-n5k-a (config-pmap-nq-c)# multicast-optimize
ora12c-n5k-a (config-pmap-nq-c)# exit
ora12c-n5k-a (config-pmap-nq-c)# system qos
ora12c-n5k-a (config-sys-qos)# service-policy type network-qos jumbo
ora12c-n5k-a (config-sys-qos)# exit
ora12c-n5k-a (config)# copy running-config startup-config
[########################################] 100%
ora12c-n5k-a (config)#
```

Enable this on both N5K setups.

Installing the Operating System, Additional RPMs and Preparing the System for Oracle 12c RAC, Flex ASM, ACFS and RDBMS Installation

---

*Note*  
Oracle Linux 6.3 was installed.

Preparatory Steps

A few changes may have to be done on the storage and on N5K in order to install Oracle Linux 6.3 with boot LUNs, configured on EMC PowerPath. Detailed steps are provided in EMC PowerPath for Linux version 5.7 Installation and Administration guide.

Cisco UCS Manager allows you to define boot policies for each server that can be configured to present the boot LUN.
Storage Boot LUNs Configuration

Make sure that the boot LUN for the server is presented to the host first from the storage side. Eight storage groups were defined, one for each Cisco UCS B420. For server 1, the boot LUN was added to the first storage group. Also make a note of the host ID (preferably 0 as this is the first LUN presented to the host)

Figure 13 Storage Group Properties

Verify the connectivity status and the host initiators.

SAN Zoning Changes on N5K for Boot

Change the zoning policy on N5K’s so that only one path is available during the boot time. Disable the zones say on N5K-B and enable only on N5K-A. Also make sure that only one path is available before install. The Linux installer should show the paths as sda/sdb etc and not as mpatha/mpathb in order to make boot LUNs with PowerPath. When the installation is complete and PowerPath is completely setup, this may be reverted back to its full paths. As an example for server 1 (ora12crac1) only one zone is made available before install as below.

```
zone name ora12c_b420_1_hba1 vsan 15
  * fcid 0x7413ef [device-alias A0P0]
  * fcid 0x740001 [pwwn 20:00:00:25:b5:00:00:6e]
```

Configure Boot Policies on Cisco UCS Servers

Define boot policy for the server 1

Log in to Cisco UCS Manager, go to the Servers tab, filter on Policies, right-click Boot Policy to create a policy as shown in Figure 14.
Installing the Operating System, Additional RPMs and Preparing the System for Oracle 12c RAC, Flex ASM,

Figure 14  Creating Boot Policy

Click OK to add the SAN Boot Target. Next, add the secondary target for SAN primary
For both SAN Primary and SAN secondary, add the SAN Boot targets as shown below. The Boot Target LUN ID should match the Host ID from VNX as mentioned earlier.

![Boot Target Configuration]

The policy will look like the screenshot above after adding the targets to both Primary and Secondary. These steps have to be repeated for all the Oracle 12c servers.

While the screenshot illustrates how to set up the paths during the runtime operation, changes have to be made to a single path before the OS install.

To make sure that you do not have multiple paths during boot time, temporarily disable all the paths and enable only one as shown below:

![Single Boot Target Configuration]

This completes the preparatory step for the OS installation.

**Installing Oracle Linux 6.3 Image**

Download Oracle Linux 6.3 images from [https://edelivery.oracle.com/linux](https://edelivery.oracle.com/linux) or as appropriate. Mount the image and launch the installer.

Launch the KVM console for the desired server, click Virtual Media, add image and reset the server. When the server comes up, it launches the Oracle Linux Installer.

Only a few of the screen shots for the install are provided below.

Select your language and installation.
Select the hostname and click Configure Network to configure both your private and public networks. Edit each network interface and populate with the appropriate entries.
Installing the Operating System, Additional RPMs and Preparing the System for Oracle 12c RAC, Flex ASM,

Figure 16 Installing Linux 2

Which type of installation would you like?

**Use All Space**
Removes all partitions on the selected device(s). This includes partitions created by other operating systems.

*Tip:* This option will remove data from the selected device(s). Make sure you have backups.

**Replace Existing Linux System(s)**
Removes only Linux partitions (created from a previous Linux installation). This does not remove other partitions you may have on your storage devices(s) such as VFAT or FAT32.

*Tip:* This option will remove data from the selected device(s). Make sure you have backups.

**Shrink Current System**
 Shrinks existing partitions to create free space for the default layout.

**Use Free Space**
Retains your current data and partitions and uses only the unpartitioned space on the selected device(s), assuming you have enough free space available.

**Create Custom Layout**
Manually create your own custom layout on the selected device(s) using our partitioning tool.
Before clicking Next, select Review and modify partitioning layout.

Select the appropriate devices and size.

Click Change device and select First sector of boot partition as shown below:
Installing the Operating System, Additional RPMs and Preparing the System for Oracle 12c RAC, Flex ASM,

Select Customize now to add additional packages to the existing install.

From the Servers menu, select System administration tools and then select oracleasm-support tools.
Select Desktops and then select the X Windows System.
Installing the Operating System, Additional RPMs and Preparing the System for Oracle 12c RAC, Flex ASM,

After few minutes, the system installation completes.

Reboot the server and accept license information, register the system as needed and synchronize the time with NTP. If NTP is not configured, Oracle RAC cluster synchronization daemon kicks in on a Oracle RAC node to sync up the time between the cluster nodes and maintaining the mean cluster time. Both NTP and OCSSD are mutually exclusive.
Installing the Operating System, Additional RPMs and Preparing the System for Oracle 12c RAC, Flex ASM,

This completes the OS Installation.

## Miscellaneous Post-Installation Steps

Please note that not all of these steps may have to be changed on your setup. Validate and change as needed. The following changes were made on the test bed where Oracle RAC install was done.

### Disable selinux

It is recommended to disable selinux.

Edit `/etc/selinux/config` and change to

```
SELINUX=disabled
#SELINUXTYPE=targeted
```

### Modify/Create the DBA Group if Needed

```
groupmod -g 500 oinstall
```

### Change sshd_config File

```
RSAAuthentication yes
PubkeyAuthentication yes
AuthorizedKeysFile .ssh/authorized_keys
AuthorizedKeysCommand none
UsePAM yes
X11Forwarding yes
Subsystem sftp /usr/libexec/openssh/sftp-server
```

### Disable Firewalls

```
service iptables stop
service ip6tables stop
chkconfig iptables off
chkconfig ip6tables off
```

Make sure `/etc/sysconfig/network` has an entry for hostname. Preferably add `NETWORKING_IPV6=no`

### Configure SSH Trust for Oracle User

Configure trust between nodes for Oracle user. This can also be done by the Oracle Installer during run time.

```
ssh-keygen -t rsa
cd $HOME/.ssh.
```
cat id_rsa.pub >> authorized_keys
ssh <server name > should login back to the host.

Setup yum.repository

cd /etc/yum.repos.d
edit the downloaded file public-yum-ol6.repo and change status as enabled=1
Run yum update.
You may have to set up the http_proxy environment variable in case the server accesses the Internet through a proxy.
Please make sure that the following RPM packages are available after the yum update. Alternatively install with yum install.
oracleasm-2.0.4-1.el6.x86_64
oracleasm-support-2.1.5-1.el6.x86_64
oracle-rdbms-server-12cR1-preinstall-1.0-1.el6.x86_64.rpm
The exact version of the packages could be different on the uek kernel being used.

Install the Linux Driver for Cisco 10G FCOE HBA

Go to http://software.cisco.com/download/navigator.html
In the download page, select servers-Unified computing. On the right menu select your class of servers say Cisco UCS B-series Blade server software and then select Unified Computing System (UCS) Drivers in the following page.
Select your firmware version under All Releases, say 2.1 and download the ISO image of UCS-related drivers for your matching firmware, for example ucs-bxxx-drivers.2.1.1a.iso.
Extract the fnic rpm from the iso.
Alternatively you can also mount the iso file. You can use KVM console too and map the iso.
After mapping virtual media - Login to host to copy the rpm

    [root@oral2crac1 ~]# mount -o loop /dev/cdrom /mnt
    [root@oral2crac1 ~]# cd /mnt
    [root@oral2crac1 ~]# cd /mnt/Linux/Storage/Cisco/1280/Oracle/OL6.3
    [root@oral2crac1 ~]# ls
    dd-fnic-1.5.0.18-oracle-uek-6.3.iso
    README-Oracle Linux Driver for Cisco 10G FCoE HBA.docx
Extract the rpm from iso.
Follow the instructions in README-Oracle Linux Driver for Cisco 10G FCoE HBA. In case you are running this on Oracle Linux Redhat compatible kernel, the appropriate driver for your Linux version should be installed.
Below are the steps followed for uek2 kernel:

    [root@oral2crac1 ~]# rpm -ivh kmod-fnic-1.5.0.18-1.el6uko.x86_64.rpm
    Preparing...  ###########################################################
    [100%]
Oracle 12c on Cisco UCS and EMC VNX2

Installing the Operating System, Additional RPMs and Preparing the System for Oracle 12c RAC, Flex ASM,

1: kmod-fnic

[100%]

[root@rac2 fnic]# modprobe fnic
[root@rac2 fnic]# modinfo fnic
filename: /lib/modules/2.6.39-200.24.1.el6uek.x86_64/extra/fnic/fnic.ko
version: 1.5.0.18
license: GPL v2
author: Abhijeet Joglekar <abjoglek@cisco.com>, Joseph R. Bykholt <jeykholt@cisco.com>
description: Cisco FCoE HBA Driver
srcversion: 24F8E443F0EEDBDF4802F20
alias: pci:v00001137d00000045sv*sd*bc*sc*i*
depends: libfc,libfcoe,scsi_transport_fc
vermagic: 2.6.39-200.24.1.el6uek.x86_64 SMP mod_unload modversions
parm: fnic_log_level:bit mask of fnic logging levels (int)
parm: fnic_trace_max_pages:Total allocated memory pages for fnic trace buffer (uint)

For more details on the install, follow the README document found in the iso above.

In general it is good practice to install the latest drivers. In case you are planning to run RHEL compatible kernel, you may have to check for any additional drivers in enic/fnic category to be installed.

Reboot the host after making the changes and verify.

Configure PowerPath

After reboot, configure PowerPath as it is only with single path now. Please contact EMC for the appropriate version of PowerPath for the operating system.

The Oracle Linux 6.3 installs with 2 kernels

Uek2 kernel - 2.6.39-200.24.1.el6uek.x86_64 which is the default.
Red Hat binary compatible kernel - 2.6.32-279.el6.x86_64.

Obtain the following rpm's from EMC directly.

HostAgent-Linux-64-x86-en_US-1.0.0.1.0474-1.x86_64
EMCpower.LINUX-5.7.1.02.00-004.ol6_uek2_r2.x86_64 ( power path rpm for uek2 kernel )

For the actual list of PowerPath and Linux Kernel versions, please check at http://powerlink.emc.com

Make sure that multipath is not running.

[root@ora12crac1 ~]# service --status-all | grep multipath
[root@ora12crac1 ~]# multipath -ll
-bash: multipath: command not found

[root@ora12crac1 ~]# rpm -ivh
HostAgent-Linux-64-x86-en_US-1.0.0.1.0474-1.x86_64
EMCpower.LINUX-5.7.1.02.00-004.ol6_uek2_r2.x86_64

Preparing... #.................................................................
[100%]

[root@ora12crac1 ~]# rpm -ivh
EMCpower.LINUX-5.7.1.02.00-004.ol6_uek2_r2.x86_64
Preparing...  ###################################################################
1:EMCpower.LINUX  ###################################################################
[100%]

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[root@ora12crac1 ~]# service hostagent start
Starting Navisphere agent:                     [  OK  ]

[root@ora12crac1 ~]# service PowerPath start
Starting PowerPath:  done

[root@ora12crac1 ~]# powermt check_registration
There are no license keys now registered.

[root@ora12crac1 ~]# emcpreg -add < power path key here >
1 key(s) successfully added.

[root@ora12crac1 ~]# powermt set policy=co
[root@ora12crac1 ~]# powermt config
[root@ora12crac1 ~]# powermt save

[root@ora12crac1 ~]# powermt display dev=all
Pseudo name=emcpowera
VNX ID=FNM00130600116 [SG_12c_Server1]
Logical device ID=6006016013203300E3AEB4EE32E0E211 [12c_OS_Luns_1]
state=alive; policy=CLAROpt; queued-IOs=0
Owner: default=SP A, current=SP A       Array failover mode: 4
============================================================================
==
--------------- Host ---------------   - Stor - -- I/O Path --   -- Stats
---
###  HW Path               I/O Paths    Interf.  Mode     State   Q-IOs
Errors
============================================================================
==
 3 fnic                   sda         SP A0    active   alive      0
0

Note Only one path is active right now.

Reconfigure Zoning and Boot Policies

When PowerPath is installed, make necessary changes both in boot policies and zoning info as mentioned earlier to revert back to all the paths.

The zoning attributes for each HBA (hba1 as an example below) needs to be reverted back to what was planned earlier

zone name oral2c_b420_1_hba1 vsan 15
device-alias A0P0
device-alias B0P0
pwwn 20:00:00:25:b5:00:00:6e

Similarly, change the boot policy of the server to multiple paths as below
Reboot the server.

After reboot, all the paths should be active as shown below.

After activating, powermt should display text as shown below:

```
[root@ora12crac1 ~]# powermt display dev=all
Pseudo name=emcpowera
VNX ID=FNM00130600116 [SG_12c_Server1]
Logical device ID=6006016013203300E3AEB4EE32E0E211 [12c_OS_Luns_1]
state=alive, policy=CLAROpt, queued-I0s=0
Owner: default=SP A, current=SP A       Array failover mode: 4
============================================================================
==                     Host ---------------   - Stor - -- I/O Path --   -- Stats
---
###  HW Path               I/O Paths    Interf.  Mode     State   Q-I0s
Errors
============================================================================
==
  2 fnic                   sduo        SP B8    active   alive      0
  0
  2 fnic                   sdrm        SP A8    active   alive      0
  0
  4 fnic                   sdok        SP B9    active   alive      0
  0
  4 fnic                   sdkk        SP A9    active   alive      0
  0
  1 fnic                   sdig        SP B0    active   alive      0
  0
  1 fnic                   sdco        SP A0    active   alive      0
  0
  3 fnic                   sdcc        SP A1    active   alive      0
  0
  3 fnic                   sda         SP B1    active   alive      0
  0
```

Configuring Boot LUN

Please follow the instructions from the EMC PowerPath Install and Administration guide. A few of the steps are mentioned below:

The Powermt command shown above details that emcpowera is the pseudo device for 12c_OS_Luns_1 lun.

- Capture the partitions from /proc/partitions
Installing the Operating System, Additional RPMs and Preparing the System for Oracle 12c RAC, Flex ASM,

[root@ora12crac1 -]# cat /proc/partitions | grep emcpowera
120 0 73400320 emcpowera
120 1 512000 emcpowera1 -> Boot partition
120 2 72887296 emcpowera2

- Backup /etc/fstab file and change the entries

```
/dev/mapper/vg_ora12crac1-lv_root / ext4 defaults 1 1
# UUID=e7b411c6-815e-4196-a755-3187529c3554 /boot ext4
defaults 1 2
/dev/emcpowera1 /boot ext4 defaults,_netdev 1 0
# fsck disabled for /boot partition
/dev/mapper/vg_ora12crac1-lv_home /home ext4 defaults
1 0
/dev/mapper/vg_ora12crac1-lv_swap swap swap defaults 0 0
tmpfs /dev/shm tmpfs size=132326088
0 0
devpts /dev/pts devpts gid=5,mode=620 0 0
sysfs /sys sysfs defaults 0 0
proc /proc proc defaults 0 0
```

Change to pseudo devices entries in fstab

- Unmount and mount boot partition

```
[root@ora12crac1 ~]# umount /boot
[root@ora12crac1 ~]# mount /boot
```

- Check emcpower devices for system partitions now

```
[root@ora12crac1 ~]# df -k
Filesystem 1024-blocks Used Available Capacity Mounted on
/dev/mapper/vg_ora12crac1-lv_root 51606140 18937112 30047588 39% /
/tmpfs 115778344 596064 115182280 1% /dev/shm
/dev/mapper/vg_ora12crac1-lv_home 16005540 2317200 12875284 16% /home
/dev/emcpowera1 495844 80353 389891 18% /boot
```

- Make lvm changes

```
Take backup of /etc/lvm.conf and make changes to filter as below.
# filter = [ "a/.*" ] -> Comment out the existing entry
filter = [ "a/emcpower.*", "r/sd.*", "r/disk.*" ] # New values
```

- Run vgscan and lvmdiskscan to flush out cache

```
[root@ora12crac1 ~]# vgscan -v
Wiping cache of LVM-capable devices
Wiping internal VG cache
Reading all physical volumes. This may take a while...
```

```
[root@ora12crac1 ~]# lvmdiskscan
/dev/ram0 [ 16.00 MiB]
/dev/ram1 [ 16.00 MiB]
/dev/emcpowera1 [ 500.00 MiB]
/dev/ram2 [ 16.00 MiB]
/dev/emcpowera2 [ 69.51 GiB]
```

- Create new image file
cd /boot
[root@ora12crac1 boot]# dracut /boot/initramfs-PP-$(uname -r).img $(uname -r)

[root@ora12crac1 boot]# ls -l initramfs*
-rw-r--r--. 1 root root 16155005 Mar 17 09:25 initramfs-2.6.32-279.el6.x86_64.img
-rw-r--r--  1 root root 20732599 Mar 19 12:30 initramfs-2.6.39-200.24.1.el6uek.x86_64.img
-rw-r--r--  1 root root 20666728 Mar 17 10:32 initramfs-PP-2.6.39-200.24.1.el6uek.x86_64.img

• Backup grub.conf and replace the entries pointing to new PowerPath initramfs.
• Reboot the server

This completes the SAN boot installation items.

Note
Repeat these steps (above) on all the hosts.

Configure Oracle ASM

Oracle ASM is installed as part of the installation in OEL 6 but needs to be configured:

[root@ora12crac1 ~]# /etc/init.d/oracleasm configure
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 [oracle]:
Default group to own the driver interface [oinstall]:
Start Oracle ASM library driver on boot (y/n) [y]:
Scan for Oracle ASM disks on boot (y/n) [y]:
Writing Oracle ASM library driver configuration: done
Initializing the Oracle ASMLib driver: [  OK  ]
Scanning the system for Oracle ASMLib disks: [  OK  ]

[root@ora12crac1 ~]# cat /etc/sysconfig/oracleasm | grep -v '^#'
ORACLEASM_ENABLED=true
ORACLEASM_UID=oracle
ORACLEASM_GID=oinstall
ORACLEASM_SCANBOOT=true
ORACLEASM_SCANORDER="emcpower"  • Add this entry
ORACLEASM_SCANEXCLUDE="sd"  • Add this entry

This will create a mount point /dev/oracleasm/disks
Configure ASM LUNs and Create Disks

Mask the LUNs and create partitions

- Configure Storage LUNs
  Add the necessary LUNs to the storage groups and provide connectivity to the hosts. Reboot the hosts so that SCSI is scanned and the LUNs are visible.
  
  `ls /dev/emcpower*` or `powermt display dev=all` should reveal that all devices are now visible on the host.

- Partition LUNs
  Partition the LUNs with an offset of 1MB. While it is necessary to create partitions on disks for Oracle ASM (just to prevent any accidental overwrite), it is equally important to create an aligned partition. Setting this offset aligns host I/O operations with the back end storage I/O operations.
  
  Use host utilities like `fdisk` to create a partition on the disk.
  
  Create a input file, `fdisk.input` as shown below:
  ```
  d
  n
  p
  l

  <- Leave a double space here
  x
  b
  l
  2048 <- 2048 for EMC VNX.
  p
  w
  ```

  Execute as `fdisk /dev/emcpower[name] < fdisk.input`. This makes partition at 2048 cylinders. In fact this can be scripted for all the LUNs too.

  Now all the pseudo partitions should be available in `/dev` as `emcpowera1`, `emcpowerb1`, `emcpowerab1` etc.

Create ASM Disks

when the partitions are created, create ASM disks with oracleasm APIs.

`oracleasm createdisk -v DSS_1 /dev/emc[partition name]`

This will create a disk label as `DSS_1` on the partition. This can be queried with oracle supplied `kfed/kfod` utilities as well.

Repeat the process for all the partitions and create ASM disks for all your database and RAC files.

Scan the disks with oracleasm and these will be visible under `/dev/oracleasm/disks` mount point created by oracleasm earlier as shown below:

```
[root@ora12crac1 ~]# oracleasm scandisks
```
Oracle 12c Install

12c Grid Infrastructure Install

The steps to create the 8 Node Oracle RAC 12c database are not detailed this section. A few of the screenshots are provided for reference. While Oracle 12c has several features, only a few of them have been validated as part of the Oracle Certification effort. The most notable of them are the Oracle flex ASM along with pluggable databases.

Launch the Installer:
Select Install and configure Oracle Grid Infrastructure.

Select Configure Flex Cluster.
After selecting the language, select Grid Plug and play information. To use Flex ASM, configuring GNS is mandatory. The Appendix includes a few of the configuration files for GNS.
Select only HUB nodes in the setup.

Configure the private and public networks as needed for your setup.
Configure OCR/Voting disks with Normal redundancy.
After selecting the software location, confirm the root script execution by providing the root password.
Click Yes.
Oracle 12c Install

Oracle Gold Infrastructure - Setting up Grid Infrastructure - Step 17 of 19

Progress

79%

Completed 'Prepare for configuration steps'

Status

✓ Install Grid Infrastructure for a Cluster
✓ Prepare
✓ Copy files
✓ Link libraries
✓ Setup
✓ Perform remote operations
✓ Update inventory
✓ Execute Restart Scripts
✓ Execute post script on Hub nodes
✓ Configure Oracle Grid Infrastructure for a Cluster

Configuration scripts generated by the installer need to be run as a privileged user (root). Installer will run these scripts using the privileged user credentials provided earlier.

Are you sure you want to continue?

Yes
No
Login to each of the nodes and perform the minimum health checks to make sure that the Cluster is healthy on all the eight nodes.

**12c ACFS Installation**

Create a diskgroup named ACFSOH from the command line followed by launching ASMCA from grid nodes.

ACFS file system will be used as shared oracle home for 12c RDBMS binaries.
Oracle 12c Install

Run the registration scripts for auto-start if prompted.

When configured, reboot the nodes to validate that the ACFS Cluster file system is running automatically along with the other cluster services. Querying the cluster resources will reveal information as shown below:
12c RDBMS Installation

The details of RDBMS install are not covered in this document. Using the shared Oracle Home mount point created above from ACFS, launch Oracle Installer and install the software. The database in the certification test bed was created with OAST tool kit and not through DBCA. DBCA could as well be used for creating the databases.

12c Client Installation

Oracle client for generating the load on the databases was done by installing 12c OAST toolkit. OAST is a load generating tool kit from oracle that is used for certifications. For details on this tool please contact oracle for details. However, any other testing tool openly available in the market and compatible with Oracle 12c could be used to stress the tool.

OAST tool was used to create the database and see data in it. Four databases were created.
Oastcpu -> Stress the CPU of all the nodes.
Oastcrs -> Stress the interconnect.
Oastiop -> OLTP type of database to stress the storage mostly on IOPS
Oastdss -> DSS type of database to stress the bandwidth of the system.

Oracle 12c New Features and Enhancements

Table 4 lists some of the Oracle 12c new features and enhancements.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multitenant Architecture (CDB’s and PDB’s)</td>
<td>Introduced in 12c</td>
</tr>
<tr>
<td>RAC (Real Application Clusters)</td>
<td>Application Continuity</td>
</tr>
<tr>
<td>Advanced Compression</td>
<td>Smart Compression</td>
</tr>
<tr>
<td>Data Guard</td>
<td>Far sync, Global Data Services</td>
</tr>
<tr>
<td>Real Application Testing</td>
<td>Consolidated Replays</td>
</tr>
<tr>
<td>Advanced Security</td>
<td>Data Redaction</td>
</tr>
</tbody>
</table>
### Oracle 12c New Features and Enhancements

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flex Clusters</td>
<td>Several Hub and Spoke nodes</td>
</tr>
<tr>
<td>Flex ASM</td>
<td>No dependency on ASM processes any more</td>
</tr>
<tr>
<td>RMAN enhancements</td>
<td>CDB/PDB backup and Recovery, duplicating Pluggable databases</td>
</tr>
<tr>
<td>Heat Map and Automatic Data</td>
<td>ILM Implementation Strategy</td>
</tr>
<tr>
<td>Optimization</td>
<td>Enhanced Data Masking</td>
</tr>
<tr>
<td>Resource Manager</td>
<td>DBRM for Pluggable databases</td>
</tr>
</tbody>
</table>

Some of the above features either introduced or enhanced with 12c enable rapid provisioning, plug/unplug databases with minimal or no application level changes. The multitenancy with resource isolation reduces CAPEX and OPEX expenses along with faster provisioning. It's beyond the scope to explain all the features of 12c in this document. However few of them that were used in the certification exercise are mentioned below. Please refer Oracle online documentation for further details on all of these. A glimpse of these features provided here to give an overview before jumping into the stress and performance tests done with these features on the test bed.

### Oracle Flex Clusters

**Figure 18  Overview of Flex Clusters**

The traditional Oracle RAC clusters have been extended to flex clusters that could serve several applications including Oracle RAC for databases. By embracing flex clusters policy decisions are centralized to Central Grid Infrastructure. The hub and leaf nodes are connected and a leaf is attached to at least to one Hub. Hub nodes are same as earlier generation of RAC nodes and have access to shared storage while leaf nodes do not require access to shared storage and can run applications that can be controlled with Grid infrastructure.
**Oracle Flex ASM**

Prior to Oracle 12c, if ASM instance on one of the RAC nodes crashes, all the instances running on that node will crash too. This issue has been addressed in Flex ASM; Flex ASM can be used even if all the nodes are hub nodes. However, GNS configuration is mandatory for enabling Flex ASM.

**Figure 19** illustrates ASM running only on nodes 1, 3 and 5 while nodes 2 and 4 are dependent on other nodes.

You can check what instances are connected with a simple query as shown below:

```
[oracle@ora12crac3 ~]$ srvctl status asm -detail
ASM is running on ora12crac1,ora12crac2,ora12crac5
ASM is enabled.
On Node1 - ora12crac1
SQL> @apxinfo
```

<table>
<thead>
<tr>
<th>GROUP_NUMBER</th>
<th>INSTANCE_NAME</th>
<th>DB_NAME</th>
<th>STATUS</th>
<th>CON_ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>+ASM1</td>
<td>+ASM</td>
<td>CONNECTED</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>+ASM1</td>
<td>+ASM</td>
<td>CONNECTED</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>+APX1</td>
<td>+APX</td>
<td>CONNECTED</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>+APX6</td>
<td>+APX</td>
<td>CONNECTED</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>+APX8</td>
<td>+APX</td>
<td>CONNECTED</td>
<td>0</td>
</tr>
</tbody>
</table>

APX1(ora12crac1), APX6(ora12crac3) and APX8(ora12crac4) are connected to ASM1

The above result is from a simple query as below. Change the instance_name per your setup.

```
Select group_number,instance_name,db_name,status,con_id from v$asm_client where instance_name not like '%oast%';
```

The output indicates that the query that was run on node1 having +ASM1 running is connected to node3 and node4. Hence if +ASM1 instance on node dies, the APX connections will migrate to another node in the cluster running ASM processes. This was tested as part of ASM failover tests.
Oracle 12c Multitenant Architecture

Oracle 12c Multitenant architecture encapsulates one or more databases that are contained in a single container. Each database in a container is called as Pluggable database that can be plugged and unplugged into/from a container whenever needed.

The diagram below, from Oracle’s web site, provides an overview of Multitenant architecture in Oracle 12c.

Each container has the following:

- Root - that stores Oracle supplied metadata. The root container is named cdb$root.
- Seed PDB - that is a seed PDB, a system supplied template and can be used to create new PDB's
- PDB's - One or more Pluggable databases which are user created databases
Container and Pluggable databases help consolidation of smaller databases to a single container; ease manageability and consolidation of the databases. While pluggable databases are not exactly like virtualized database, they provide similar functionality. We can have a single container database, with many databases plugged into them. There is a single operating system unlike virtualized mode where we have multiple OS for each VM. If a PDB database grows or shrinks or the server runs out of the resources it can be moved to another container database on another server. The backup and restore policies can be centralized and privilege controlled too and the Dev/QA/Test systems can be consolidated as well. May be using some of the rolling upgrade features, patches can be centralized and applied too. While cpu_count has been there for a while in Oracle RDBMS, Oracle 12c Resource Manager provides fine grain control of resources for PDB's. However, like any other Oracle feature, use cases could be different from one Organization to other and needs to be validated, checking both the functionality and compliance and best practices if any, with internal IT procedures, while implementing pluggable databases.

Creation of CDB

Container database is created first and is very similar to a conventional database of earlier versions. Create database …enable pluggable database instructs Oracle to create a CDB database.

Creation of PDB

Create pluggable database statement creates a PDB. This includes all the metadata and links necessary with cdb$root. Figure 21 illustrates the creation of PDB.

Figure 21  PDB Database Creation Methods

There are several methods you can use to migrate to a PDB database as shown in Figure 21. In the test bed for Oracle 12c certification, the cpu and dss databases were plugged into iops. Originally the database oastcpu, oastdss and oastiops were created as a single container databases with one PDB each. The CRS database was created as a Non-CDB. CPU and DSS were plugged to IOPS container. The following is a snippet of code used to create pluggable databases on the testbed:

```
Shutdown pluggable databases - oastdss_pdb, oastiop_pdb, oastcpu_pdb
oastcpu - 40G sga and 27,264 MB buffer cache at 4096 block size
oastdss - 16G sga and 9,888 MB buffer cache at 16384 block size
oastiop - 24G sga and 14,656 MB buffer cache at 8192 block size

Connect to dss database
```
Using Resource Manager with PDB

When PDB's are plugged into a single container, there is a need to effectively control the resources used by each PDB. Oracle 12c Resource Manager was used to control the resources of each PDB in the iops container.

```
alter system set resource_manager_plan='' scope=both sid='*';
EXEC DBMS_RESOURCE_MANAGER.CREATE_PENDING_AREA();
EXEC DBMS_RESOURCE_MANAGER.DELETE_CDB_PLAN(plan => 'cpu_oltp_dss_plan');
EXEC DBMS_RESOURCE_MANAGER.VALIDATE_PENDING_AREA();
EXEC DBMS_RESOURCE_MANAGER.SUBMIT_PENDING_AREA();
```

BEGIN

```
BEGIN
  DBMS_RESOURCE_MANAGER.CREATE_CDB_PLAN(
    plan => 'cpu_oltp_dss_plan',
    comment => 'CDB Resource plan for OAST stress minus crs');
END;
/
BEGIN
  DBMS_RESOURCE_MANAGER.CREATE_CDB_PLAN_DIRECTIVE(
    plan => 'cpu_oltp_dss_plan',
    pluggable_database => 'oastcpu_pdb',
    shares => 2,
    utilization_limit => 60,
    parallel_server_limit => 0);
END;
/
BEGIN
  DBMS_RESOURCE_MANAGER.CREATE_CDB_PLAN_DIRECTIVE(
    plan => 'cpu_oltp_dss_plan',
    pluggable_database => 'oastiop_pdb',
    shares => 3,
    utilization_limit => 35,
    parallel_server_limit => 0);
END;
/
BEGIN
  DBMS_RESOURCE_MANAGER.CREATE_CDB_PLAN_DIRECTIVE(
    plan => 'cpu_oltp_dss_plan',
    pluggable_database => 'oastdss_pdb',
    shares => 1,
    utilization_limit => 5,
    parallel_server_limit => 8);
END;
/
EXEC DBMS_RESOURCE_MANAGER.VALIDATE_PENDING_AREA();
EXEC DBMS_RESOURCE_MANAGER.SUBMIT_PENDING_AREA();
alter system set resource_manager_plan='cpu_oltp_dss_plan' scope=both sid='*';

The following query can be leverage to check the resource utilization limits in the database.

COLUMN PLAN HEADING 'Plan' FORMAT A26
COLUMN PLUGGABLE_DATABASE HEADING 'Pluggable|Database' FORMAT A25
COLUMN SHARES HEADING 'Shares' FORMAT 999
COLUMN UTILIZATION_LIMIT HEADING 'Utilization|Limit' FORMAT 999
COLUMN PARALLEL_SERVER_LIMIT HEADING 'Parallel|Server|Limit' FORMAT 999

SELECT PLAN,
  PLUGGABLE_DATABASE,
  SHARES,
  UTILIZATION_LIMIT,
  PARALLEL_SERVER_LIMIT
FROM DBA_CDB_RSRC_PLAN_DIRECTIVES
ORDER BY PLAN;
Oracle 12c Performance, Stress and Destructive Scenarios

Performance Tests

<table>
<thead>
<tr>
<th>Separate Databases</th>
<th>Find out Peak Values through iteration</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU</td>
<td>Max CPU</td>
</tr>
<tr>
<td>CRS</td>
<td>Max Interconnect</td>
</tr>
<tr>
<td>IOPS</td>
<td>Max IOPS</td>
</tr>
<tr>
<td>DSS</td>
<td>Max MBPS</td>
</tr>
</tbody>
</table>

Simultaneously load all of the above

<table>
<thead>
<tr>
<th>Container Databases</th>
<th>Combine IOPS, DSS and CPU in a single Container as pluggable databases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control resources through Resource Manager</td>
</tr>
<tr>
<td></td>
<td>CPU Usage%</td>
</tr>
<tr>
<td></td>
<td>Interconnect in MBPS</td>
</tr>
<tr>
<td></td>
<td>IOPS</td>
</tr>
<tr>
<td></td>
<td>MBPS</td>
</tr>
</tbody>
</table>

Stress Tests

48 hours stress test

| Single container with 3 pluggable databases and one CRS database |
| Measure any drop in performance output when stressed at the peak values obtained from Performance tests. |

Destructive Tests

A detailed list of destructive test cases attempted with the system running in full load, at its peak, is documented in the following sections.

Performance Data from the Test Bed

Orion Tests

Before conducting the Oracle Read Write tests using the OAST workload, orion tests were run, to capture the performance data from the test bed. A separate suite of tests were run on OLTP and DSS LUNs to understand the performance characteristics and guesstimate the IO throughput we can get from the test bed.
Figure 22  Orion Tests 100% Reads on OLTP LUNs

Figure 23  Orion Tests IOPS and Latency vs Read% on OLTP LUNs

Figure 24  Orion Tests 30% Writes on OLTP LUNs
Summary

Orion tests revealed that system can go up to 750k IOPS with OLTP LUNs at 100% Reads, while it drops to around 300k with 30% writes. The latency increases considerably with write %. On the other hand DSS LUNs gave a bandwidth of 17GB/s of output. It was expected that there will be 30% writes on OLTP and 10% writes on DSS before starting the tests and hence the percentages chosen. While the above tests were run separately, a combined workload on both OLTP and DSS is expected to bring down the IOPS and MBPS figures further.

OAST Workloads

Each database was stressed to obtain the peak point before reducing them in a combined workload so that system sustains the load. The purpose was to max out the system on IO/CPU/Interconnect resources to the maximum balancing all of them. While this involved quite a number of iterations to achieve, only the final results are presented below. Out of the individual database tests only OLTP databases is presented here.

OLTP Workload

Data from Enterprise Manager 12c Grid Control
### Iostat Data from One Out-of-Eight Nodes

<table>
<thead>
<tr>
<th>Device</th>
<th>r/s</th>
<th>w/s</th>
<th>rMB/s</th>
<th>wMB/s</th>
<th>avgrq-sz</th>
<th>avgqu-sz</th>
<th>await</th>
<th>svctm</th>
<th>%util</th>
</tr>
</thead>
<tbody>
<tr>
<td>emcpoweraa1</td>
<td>3,412</td>
<td>313</td>
<td>26.66</td>
<td>3.00</td>
<td>16.3</td>
<td>4.95</td>
<td>1.33</td>
<td>0.26</td>
<td>96.4</td>
</tr>
<tr>
<td>emcpowerab1</td>
<td>3,379</td>
<td>301</td>
<td>26.40</td>
<td>3.05</td>
<td>16.39</td>
<td>4.56</td>
<td>1.24</td>
<td>0.26</td>
<td>96.07</td>
</tr>
<tr>
<td>emcpowerac1</td>
<td>3,406</td>
<td>327</td>
<td>26.61</td>
<td>3.21</td>
<td>16.36</td>
<td>4.99</td>
<td>1.34</td>
<td>0.26</td>
<td>96.8</td>
</tr>
<tr>
<td>emcpowerad1</td>
<td>3,480</td>
<td>324</td>
<td>27.19</td>
<td>3.29</td>
<td>16.41</td>
<td>4.78</td>
<td>1.26</td>
<td>0.25</td>
<td>96.7</td>
</tr>
<tr>
<td>emcpowerae1</td>
<td>3,503</td>
<td>317</td>
<td>27.36</td>
<td>3.00</td>
<td>16.28</td>
<td>4.99</td>
<td>1.31</td>
<td>0.25</td>
<td>96.7</td>
</tr>
<tr>
<td>emcpoweraf1</td>
<td>3,463</td>
<td>311</td>
<td>27.05</td>
<td>2.90</td>
<td>16.25</td>
<td>4.72</td>
<td>1.25</td>
<td>0.26</td>
<td>97.13</td>
</tr>
<tr>
<td>emcpowerag1</td>
<td>3,416</td>
<td>324</td>
<td>26.69</td>
<td>3.23</td>
<td>16.38</td>
<td>5.04</td>
<td>1.35</td>
<td>0.26</td>
<td>96.27</td>
</tr>
<tr>
<td>emcpowerah1</td>
<td>3,460</td>
<td>287</td>
<td>27.03</td>
<td>2.61</td>
<td>16.2</td>
<td>4.65</td>
<td>1.24</td>
<td>0.26</td>
<td>96.57</td>
</tr>
<tr>
<td>emcpowerai1</td>
<td>3,476</td>
<td>318</td>
<td>27.16</td>
<td>3.16</td>
<td>16.37</td>
<td>5.03</td>
<td>1.33</td>
<td>0.26</td>
<td>96.97</td>
</tr>
<tr>
<td>emcpoweraj1</td>
<td>3,448</td>
<td>311</td>
<td>26.94</td>
<td>3.16</td>
<td>16.4</td>
<td>4.72</td>
<td>1.26</td>
<td>0.26</td>
<td>96.37</td>
</tr>
<tr>
<td>emcpowerak1</td>
<td>3,514</td>
<td>327</td>
<td>27.45</td>
<td>3.48</td>
<td>16.49</td>
<td>5.15</td>
<td>1.34</td>
<td>0.25</td>
<td>96.43</td>
</tr>
<tr>
<td>emcpoweral1</td>
<td>3,489</td>
<td>317</td>
<td>27.26</td>
<td>3.12</td>
<td>16.35</td>
<td>4.79</td>
<td>1.26</td>
<td>0.25</td>
<td>96.17</td>
</tr>
<tr>
<td>emcpoweram1</td>
<td>3,424</td>
<td>320</td>
<td>26.75</td>
<td>3.04</td>
<td>16.29</td>
<td>5</td>
<td>1.34</td>
<td>0.26</td>
<td>96.73</td>
</tr>
<tr>
<td>emcpoweran1</td>
<td>3,508</td>
<td>309</td>
<td>27.41</td>
<td>3.36</td>
<td>16.5</td>
<td>4.75</td>
<td>1.25</td>
<td>0.25</td>
<td>97.17</td>
</tr>
<tr>
<td>emcpowerao1</td>
<td>3,528</td>
<td>329</td>
<td>27.56</td>
<td>3.11</td>
<td>16.29</td>
<td>5.18</td>
<td>1.34</td>
<td>0.25</td>
<td>96.77</td>
</tr>
<tr>
<td>emcpowerap1</td>
<td>3,440</td>
<td>325</td>
<td>26.88</td>
<td>3.09</td>
<td>16.3</td>
<td>4.77</td>
<td>1.27</td>
<td>0.26</td>
<td>96.23</td>
</tr>
<tr>
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## AWR Data

### System Statistics - Per Second

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<th>Logical Reads/s</th>
<th>Physical Reads/s</th>
<th>Physical Writes/s</th>
<th>Redo Size (k)</th>
<th>Block Changes/s</th>
<th>User Calls/s</th>
<th>Execs/s</th>
<th>Parses/s</th>
<th>Logons/s</th>
<th>Txns/s</th>
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<td>6,081.97</td>
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Sum 3,233,544.06 48,561.53 88,533.83 344,148.74 13,744.29 46,843.04 66.75 6.11 6,283.23

Avg 404,193.01 46,967.07 6,070.19 11,066.73 43,018.59 1,718.04 5,855.38 8.34 0.76 785.40

Std 47,408.19 4,435.96 641.38 1,307.56 5,084.63 202.95 689.89 1.70 0.02 93.03

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<th>#</th>
<th>Reads MB/sec</th>
<th>Write MB/sec</th>
<th>DBWR</th>
<th>Direct Writes</th>
<th>LGWR</th>
<th>Reads requests/sec</th>
<th>DBWR</th>
<th>Direct Reads</th>
<th>Writes requests/sec</th>
<th>LGWR</th>
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<td>47,668.13</td>
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Sum 2,922.34 2,885.29 0.07 482.02 374.06 0.01 89.74 399,148.05 368,753.66 8.69 43,673.97 36,939.09 0.95 6,709.08

Avg 365.29 360.66 0.01 60.25 46.76 0.00 11.22 46,143.51 46,094.21 1.09 5,459.25 4,617.39 0.13 838.63

## CPU Utilization Across Nodes

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<th>Logical Reads/s</th>
<th>Physical Reads/s</th>
<th>Physical Writes/s</th>
<th>Redo Size (k)</th>
<th>Block Changes/s</th>
<th>User Calls/s</th>
<th>Execs/s</th>
<th>Parses/s</th>
<th>Logons/s</th>
<th>Txns/s</th>
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<tbody>
<tr>
<td>ora12crac1</td>
<td>Cpu(s):</td>
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<tr>
<td>ora12crac2</td>
<td>Cpu(s):</td>
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</tr>
<tr>
<td>ora12crac3</td>
<td>Cpu(s):</td>
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<tr>
<td>ora12crac4</td>
<td>Cpu(s):</td>
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<tr>
<td>ora12crac5</td>
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<td>ora12crac6</td>
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<tr>
<td>ora12crac7</td>
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<td>ora12crac8</td>
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**Oracle 12c on Cisco UCS and EMC VNX2**
Interconnect Across Nodes

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<th>Time</th>
<th>recv</th>
<th>send</th>
<th>usr</th>
<th>sys</th>
<th>idl</th>
<th>wai</th>
<th>hiq</th>
<th>sq</th>
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<td>55M</td>
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<td>8</td>
<td>51</td>
<td>17</td>
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<td>ora12crac2</td>
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<td>55M</td>
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<td>9</td>
<td>43</td>
<td>19</td>
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<td>57M</td>
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<td>47</td>
<td>18</td>
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Summary

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<th>Enterprise Manager</th>
<th>Iostat</th>
<th>AWR</th>
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<tbody>
<tr>
<td>Txn/s</td>
<td>6283 txn/s</td>
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</tr>
<tr>
<td>Throughput</td>
<td>400,000 iops</td>
<td>483,248 iops</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>3200 MB/s</td>
<td>3,858 MB/s</td>
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</tbody>
</table>

Note: The iostat is a point in time, while AWR is averaged over 10mts interval.

Discrete Databases

There are four databases one for CPU (oastcpu), one for IOPS (oastiop), one for DSS (oastdss) and one for CRS (oastcrs). All the four databases were loaded simultaneously to stress the system in all the fronts and in order to capture the peak performance from the system.

Oastcpu
Performance Data from the Test Bed

Oastiop

AWR Data - oastiop

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<th>Reads MB/sec</th>
<th>Writes MB/sec</th>
<th>Reads requests/sec</th>
<th>Writes requests/sec</th>
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<tbody>
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<td>Buffer Cache</td>
<td>Direct Reads</td>
<td>Total</td>
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<td>91.45</td>
<td>0.01</td>
<td>22.72</td>
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<td>0.01</td>
<td>22.95</td>
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<td>Sum</td>
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<td>910.28</td>
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<td>Avg</td>
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<td>113.79</td>
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Oracle 12c on Cisco UCS and EMC VNX2
### AWR Data - oastdss

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<th>Writes MB/sec</th>
<th>Reads requests/sec</th>
<th>Writes requests/sec</th>
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<tbody>
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<td>Total Buffer Cache Direct Reads Total DBWR Direct Writes LGWR</td>
<td>Total Buffer Cache Direct Reads Total DBWR Direct Writes LGWR</td>
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<td>1.19 0.52 0.01 0.33</td>
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<td>1,563.12 0.01 1,558.72 0.02 0.01 0.00 0.00</td>
<td>12,761.63 0.46 12,484.09 1.22 0.55 0.01 0.32</td>
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<td>1,573.67 0.01 1,569.48 0.02 0.01 0.00 0.00</td>
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<tr>
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<td>570.03 0.01 565.84 0.02 0.01 0.00 0.00</td>
<td>4,795.81 0.45 4,531.68 1.20 0.53 0.01 0.32</td>
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<td>5</td>
<td>1,534.77 0.01 1,530.81 0.02 0.01 0.00 0.00</td>
<td>12,497.76 0.44 12,247.76 1.31 0.62 0.01 0.34</td>
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<td>1,122.61 0.01 1,114.25 0.03 0.01 0.00 0.00</td>
<td>9,447.06 0.46 9,244.49 1.21 0.53 0.01 0.32</td>
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<td>1,200.57 0.02 1,196.18 0.02 0.01 0.00 0.00</td>
<td>9,745.54 0.46 9,574.15 1.39 0.56 0.01 0.43</td>
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<tr>
<td>8</td>
<td>1,171.53 0.02 1,170.89 0.03 0.01 0.00 0.00</td>
<td>9,411.82 0.46 9,377.75 1.30 0.59 0.01 0.32</td>
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<tr>
<td>Sum</td>
<td>8,736.62 0.10 8,706.17 0.19 0.09 0.00 0.04</td>
<td>71,612.33 4.26 69,710.00 10.11 4.47 0.05 2.70</td>
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<tr>
<td>Avg</td>
<td>1,092.08 0.01 1,088.27 0.02 0.01 0.00 0.00</td>
<td>8,951.54 0.53 8,713.75 1.26 0.56 0.01 0.34</td>
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### AWR Data – Interconnect

<table>
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<th>#</th>
<th>Sent (MB/s)</th>
<th>Received (MB/s)</th>
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<td>Total Cache IPQ DLM PNG Misc</td>
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<td>208.63 190.71 0.26</td>
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<tr>
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<td>125.10 110.99 0.06 14.03 0.00 0.01</td>
<td>217.55 194.75 0.03</td>
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<tr>
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<td>328.40 310.89 0.06 17.44 0.00 0.01</td>
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<tr>
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<td>205.76 187.71 0.16 17.87 0.00 0.01</td>
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<td>208.63 190.71 0.26</td>
</tr>
<tr>
<td>7</td>
<td>19.04 0.77 0.06 18.20 0.00 0.01</td>
<td>232.29 224.38 0.03</td>
</tr>
<tr>
<td>8</td>
<td>348.06 330.88 0.10 17.07 0.00 0.01</td>
<td>252.73 231.06 0.11</td>
</tr>
<tr>
<td>Sum</td>
<td>1,263.66 1,145.08 0.61 117.91 0.02 0.05</td>
<td>1,398.28 1,286.44 0.63</td>
</tr>
<tr>
<td>Avg</td>
<td>180.52 163.58 0.09 16.84 0.00 0.01</td>
<td>199.75 183.78 0.09</td>
</tr>
<tr>
<td>Std</td>
<td>133.58 134.09 0.04 2.03 0.00 0.00</td>
<td>41.65 87.43 0.09</td>
</tr>
</tbody>
</table>

### AWR Data – Interconnect 2

The interconnect configuration and interconnect communication will influence the performance of database clusters. The tables below show detailed interconnect communication in and between database instances. It is important that database instances are configured to use a private interconnect for message and bulk transfers.

---

Oracle 12c on Cisco UCS and EMC VNX2
OS Watcher

Summary

Mining the oast files for txn/s:

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Users</th>
<th>TPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>oastops</td>
<td>1/29/2014</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>09:40:03:95935</td>
<td>150</td>
<td>164,551</td>
</tr>
<tr>
<td></td>
<td>09:40:18:78096</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/29/2014</td>
<td>3</td>
<td>165,057</td>
</tr>
<tr>
<td></td>
<td>09:40:10:25975</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/29/2014</td>
<td>1</td>
<td>163,541</td>
</tr>
<tr>
<td></td>
<td>09:40:00:25579</td>
<td></td>
<td></td>
</tr>
<tr>
<td>oastcpu</td>
<td>1/29/2014</td>
<td>0</td>
<td>165,420</td>
</tr>
<tr>
<td></td>
<td>09:40:04:14313</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/29/2014</td>
<td>7</td>
<td>183,463</td>
</tr>
<tr>
<td></td>
<td>09:40:06:42682</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/29/2014</td>
<td>2</td>
<td>183,099</td>
</tr>
<tr>
<td></td>
<td>09:40:18:83919</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/29/2014</td>
<td>0</td>
<td>88,145</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>1,113,276</td>
</tr>
</tbody>
</table>

System performance:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TPM from OAST Tool</td>
<td>1,113,276</td>
</tr>
<tr>
<td>IOPS</td>
<td>208,726</td>
</tr>
<tr>
<td>MBPS</td>
<td>9,887 MB/s</td>
</tr>
<tr>
<td>Interconnect Traffic</td>
<td>2,662 MB/s</td>
</tr>
</tbody>
</table>
Performance of the Pluggable Database

CPU, IOPS and DSS databases were plugged to single container database oastio. The CRS database was left as separate non-CDB database.

For controlling the resources used across the pluggable databases, resource manager was used. It was bit iterative to arrive at the optimal stress of CPU and IO resources.

The performance data was collected with these two databases, as shown below:

**EM Graphs**

The EM graph clearly depicts the fall in IOPS and increase in MBPS when DSS workload kicks in. Data collected from ASM is shown below.
Performance Data from the Test Bed

Bandwidth from VNX ~ 10,908 MB/s

Throughput from VNX ~ 256,067

```
oratop 1: 1414 oast 12:57:57 up 2.0h, 8 ins, 8136 mt, 779 sn, 4 us, 1334 db

 ID  %CU  HLD  MBPS  IOPS  %FR  PGAV  ASC  ASI  ASM  ASO  AAS  USN  TPS  UCPS  SSRT  DEC  DBW

 1  40   12  1633  19k  35  36  16  82  70  26  158.0  175  543  2675  19m  16  84
 5  42   7  1508  22k  37  36  16  74  68  16  154.4  165  574  2710  18m  18  82
 4  43   8  1421  23k  37  36  24  46  94  16  155.9  162  587  2685  19m  18  82
 6  47   6  1062  25k  35  36  31  53  66  10  142.1  153  651  3112  14m  21  79
 2  46   7  186  23k  37  36  20  34  95  1   137.6  144  681  3388  13m  21  79

 EVENT     (Real-Time)  AVG: TOT WAITS  TIME(s)  AVG MS FCT  WAIT CLASS

 DB CPU     798510       91
 wait for EMON to process ntf  7698   36977   4803.4     4 Configuration
 log file parallel write  6779688   21003     3.1    2 System I/O
 db file sequential read  7185876   12856     1.8    1 User I/O
 db file parallel write  2014361   11244     5.6    1 System I/O
```
Interconnect

<table>
<thead>
<tr>
<th>Name</th>
<th>Details</th>
<th>Interface Type</th>
<th>Total Util (%)</th>
<th>Total Eior (%)</th>
<th>Total Eior (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V envisCluster</td>
<td>Cluster</td>
<td>Interface</td>
<td>498,093</td>
<td>498,093</td>
<td>498,093</td>
</tr>
<tr>
<td>V envisCluster</td>
<td>Must</td>
<td>Interface</td>
<td>498,093</td>
<td>498,093</td>
<td>498,093</td>
</tr>
<tr>
<td>V envisCluster</td>
<td>Must</td>
<td>Interface</td>
<td>498,093</td>
<td>498,093</td>
<td>498,093</td>
</tr>
<tr>
<td>V envisCluster</td>
<td>Must</td>
<td>Interface</td>
<td>498,093</td>
<td>498,093</td>
<td>498,093</td>
</tr>
<tr>
<td>V envisCluster</td>
<td>Must</td>
<td>Interface</td>
<td>498,093</td>
<td>498,093</td>
<td>498,093</td>
</tr>
<tr>
<td>V envisCluster</td>
<td>Must</td>
<td>Interface</td>
<td>498,093</td>
<td>498,093</td>
<td>498,093</td>
</tr>
<tr>
<td>V envisCluster</td>
<td>Must</td>
<td>Interface</td>
<td>498,093</td>
<td>498,093</td>
<td>498,093</td>
</tr>
<tr>
<td>V envisCluster</td>
<td>Must</td>
<td>Interface</td>
<td>498,093</td>
<td>498,093</td>
<td>498,093</td>
</tr>
</tbody>
</table>

System Performance

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TPM</td>
<td>975,402</td>
<td></td>
</tr>
<tr>
<td>IOPS</td>
<td>256,067</td>
<td></td>
</tr>
<tr>
<td>MBPS</td>
<td>10,908 MB/s</td>
<td></td>
</tr>
<tr>
<td>Interconnect Traffic</td>
<td>2,114 MB/s</td>
<td></td>
</tr>
</tbody>
</table>

Compare Performance of Discrete and Pluggable Databases

Below is a snippet of the performance characteristics:

<table>
<thead>
<tr>
<th></th>
<th>Discrete</th>
<th>Pluggable</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPM</td>
<td>1,113,276</td>
<td>975,402</td>
</tr>
<tr>
<td>IOPS</td>
<td>208,726</td>
<td>256,067</td>
</tr>
<tr>
<td>MBPS</td>
<td>9,887 MB/s</td>
<td>10,908 MB/s</td>
</tr>
<tr>
<td>Interconnect Traffic</td>
<td>2,662 MB/s</td>
<td>2,114 MB/s</td>
</tr>
</tbody>
</table>

It appears that both Discrete and Pluggable databases performed very close in terms of performance. All the four variables listed above depend on each other. A drop in IOPS may be accompanied by an increase in TPM and vice-versa. It was very difficult to obtain and tune for consistency in the tests. Also, in order to control the resources, resource manager was used for pluggable databases which in turn had its own tuning effort.
Stress Tests

A 36-48 hrs stress tests were run on the system in order to ascertain, that there is no substantial drop in performance and also to check for any errors in the alert log and other Oracle trace files, system message files etc.

Data was collected from Oracle, EMC frame and also from system files and no errors were observed.
Database LUNs throughput during the 48 hrs run:

<table>
<thead>
<tr>
<th>DB</th>
<th>r/s</th>
<th>w/s</th>
<th>rMB/s</th>
<th>wMB/s</th>
<th>Lun util%</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLTP</td>
<td>170,533</td>
<td>15,057</td>
<td>1,332</td>
<td>150</td>
<td>83</td>
</tr>
<tr>
<td>DSS</td>
<td>35,379</td>
<td>0</td>
<td>8,835</td>
<td>0</td>
<td>76</td>
</tr>
<tr>
<td>REDO</td>
<td>56</td>
<td>2,930</td>
<td>3</td>
<td>30</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>205,968</td>
<td>17,987</td>
<td>10,170</td>
<td>180</td>
<td></td>
</tr>
</tbody>
</table>

The performance of the system was consistent throughout without any errors in the log files. Care was of course taken to make sure that system is not running out of space during the 48 hrs stress run. The IOPS remained around 200k while the throughput around 10GB/s. The FCoE traffic captured from Cisco UCS Fabrics above, the iostat data from OS, the AWR data from Oracle and SP[A,B] data from EMC frame showed consistent results throughout the test.
Destructive and Hardware Failover Tests

Some of the destructive and hardware failover tests in this section were conducted on a fully loaded system (with both OLTP and DSS workload running) to check on the high availability and recoverability of the system when faults were injected. The test cases are listed in Figure 27.

Figure 27  Destructive Test Cases

<table>
<thead>
<tr>
<th>Test</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 1 – Multiple Network Connection Failures</td>
<td>Run the system on full work load, stressing all the components to their max. Disconnect the public links from first chassis and private links from second chassis one after other and reconnect each of them after 5 minutes. Run the system on full work load as above. Disconnect connection to N5K-A from Fabric A, wait 5 minutes, connect it back and repeat for N5K-B. Only second chassis servers rebooted. They joined the cluster back with a successful reconfigurations. No disruption to the client or server traffic.</td>
</tr>
<tr>
<td>Test 2 – Network failure between FI and Corporate network</td>
<td>Run the system on full work load as above. Reboot Fabric A, let it join the cluster back and then Reboot Fabric B. Fabric failovers did not cause any disruption to ethernet and/or FC traffic.</td>
</tr>
<tr>
<td>Test 3 – Fabric Failover tests</td>
<td>Run the system on full load and disconnect the storage paths on the fabrics. All nodes went for a reboot because of inaccessibility of voting files. All instances joined the cluster back later.</td>
</tr>
<tr>
<td>Test 4 – Disconnect all FC Storage paths</td>
<td>Run the system on full load and swap out the blades one from each chassis. The blades were configured with boot over SAN. The blades were rediscovered by the chassis and the nodes joined the cluster back.</td>
</tr>
<tr>
<td>Test 5 – Blades Swap Test</td>
<td>Kill the volume driver process vdbg under full load, on couple of nodes, that handles extents locks and other volume management functions. DB instances crash as the underlying acfs files system is not available.</td>
</tr>
<tr>
<td>Test 6 – ACFS Test 1</td>
<td>Run the system on full load and enlarge the ACFS file system. No disruption to Oracle client or BG processes.</td>
</tr>
<tr>
<td>Test 7 – ACFS Test 2</td>
<td>Run the system on full load and kill the ASM CKPT process. Process re-spawned and workload continued.</td>
</tr>
<tr>
<td>Test 8 – ACFS Test 3</td>
<td>Run the system on full load and send sigkill to the ASM pmon process. ASM process migrates to another node and there is no interruption to Oracle Work load.</td>
</tr>
</tbody>
</table>

Figure 28 illustrates some of the destructive tests.
Figure 28  ASM Destructive Test

[Diagram showing ASM Destructive Test process]
Test 2 - Network Connectivity Failures

Figure 29   N5K Failure Tests

Oracle 12c on Cisco UCS and EMC VNX2
Test 3 - Fabric Failover Tests

Figure 30  Fabric Failover Tests

Fabric Failover Test

VLAN 10 for private network fails over to Fabric A. Public and Private Networks uninterrupted. Throughput is reduced to 50%. Oracle continues to operate without any interruption to the database service.
Test 4: Storage Path Failure Tests

Figure 31  Voting Disk Failures

All the FC paths from both the fabrics disconnected. Because of loss of voting disk access, Oracle rebooted the blades.
# Lessons Learned and Best Practices for Running Oracle 12c on VNX 8000

## Appendix A: Cisco UCS Service Profiles

### Linux
- If using `yum update` (latest) on uek kernel please make sure to check Cisco Inter-operability matrix. Cisco Certified matrix should list the uek versions.
- Use huge pages instead of AMM (Automatic Memory Management). Disable transparent huge pages preferably. Refer metalink note 1606759.1 for details.
- Make sure you are using the right/latest Power Path for the kernel.

### Oracle
- May have to increase few parameters in flex ASM depending on the load (sudden bursts).
- Controlling the resources across PDB's through resource manager is iterative.
- Create PDB’s does not do a space check. Being worked on by Oracle. Take due care while plugging and unplugging databases.

### VNX
- Upgrade to the latest firmware.

### Cisco UCS
- Discovery issues observed few times on Cisco UCS B420 M3. The blade gets hung up during the discovery phase; this issue is fixed in Cisco UCS Manager 2.2.

## ORA-12C-FI-B# show fabric-interconnect

<table>
<thead>
<tr>
<th>Fabric Interconnect:</th>
<th>ID</th>
<th>OOB IP Addr</th>
<th>OOB Gateway</th>
<th>OOB Netmask</th>
<th>Operability</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>10.29.134.8</td>
<td>10.29.134.1</td>
<td>255.255.255.0</td>
<td>Operable</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>10.29.134.9</td>
<td>10.29.134.1</td>
<td>255.255.255.0</td>
<td>Operable</td>
</tr>
</tbody>
</table>

## ORA-12C-FI-B# show fabric version

### Fabric Interconnect A:
- Running-Kern-Vers: 5.0(3)N2(2.11f)
- Running-Sys-Vers: 5.0(3)N2(2.11f)
- Package-Vers: 2.1(1f)A
- Startup-Kern-Vers: 5.0(3)N2(2.11f)
- Startup-Sys-Vers: 5.0(3)N2(2.11f)
- Act-Kern-Status: Ready
- Act-Sys-Status: Ready
- Bootloader-Vers: v3.5.0(02/03/2011)

### Fabric Interconnect B:
- Running-Kern-Vers: 5.0(3)N2(2.11f)
- Running-Sys-Vers: 5.0(3)N2(2.11f)
- Package-Vers: 2.1(1f)A
- Startup-Kern-Vers: 5.0(3)N2(2.11f)
- Startup-Sys-Vers: 5.0(3)N2(2.11f)
- Act-Kern-Status: Ready
- Act-Sys-Status: Ready
- Bootloader-Vers: v3.5.0(02/03/2011)

## ORA-12C-FI-B# show server inventory
### Appendix A: Cisco UCS Service Profiles

<table>
<thead>
<tr>
<th>Server</th>
<th>Equipped PID</th>
<th>Equipped VID</th>
<th>Equipped Serial (SN)</th>
<th>Slot</th>
<th>Status</th>
<th>Ackd Cores</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1</td>
<td>UCSB-B420-M3 V01</td>
<td>FCH16447HH2</td>
<td>Equipped</td>
<td></td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>1/2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Equipped Not Pri</td>
<td></td>
</tr>
<tr>
<td>1/3</td>
<td>UCSB-B420-M3 V01</td>
<td>FCH16437BSM</td>
<td>Equipped</td>
<td></td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>1/4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Equipped Not Pri</td>
<td></td>
</tr>
<tr>
<td>1/5</td>
<td>UCSB-B420-M3 V01</td>
<td>FCH161374EC</td>
<td>Equipped</td>
<td></td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Equipped Not Pri</td>
<td></td>
</tr>
<tr>
<td>1/7</td>
<td>UCSB-B420-M3 V01</td>
<td>FCH16437BTK</td>
<td>Equipped</td>
<td></td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>1/8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Equipped Not Pri</td>
<td></td>
</tr>
<tr>
<td>2/1</td>
<td>UCSB-B420-M3 V01</td>
<td>FCH16447HEV</td>
<td>Equipped</td>
<td></td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>2/2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Equipped Not Pri</td>
<td></td>
</tr>
<tr>
<td>2/3</td>
<td>UCSB-B420-M3 V01</td>
<td>FCH16447HF4</td>
<td>Equipped</td>
<td></td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>2/4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Equipped Not Pri</td>
<td></td>
</tr>
<tr>
<td>2/5</td>
<td>UCSB-B420-M3 V01</td>
<td>FCH1623700J</td>
<td>Equipped</td>
<td></td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>2/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Equipped Not Pri</td>
<td></td>
</tr>
<tr>
<td>2/7</td>
<td>UCSB-B420-M3 V01</td>
<td>FCH16437BRS</td>
<td>Equipped</td>
<td></td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>2/8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Equipped Not Pri</td>
<td></td>
</tr>
</tbody>
</table>

```
ORA-12C-FI-B# show service-profile inventory
Service Profile Name| Type | Server | Assignment | Association
--------------------|------|--------|------------|-------------|
Ora12c_b420_1       | Instance | 1/1 | Assigned | Associated
Ora12c_b420_2       | Instance | 1/3 | Assigned | Associated
Ora12c_b420_3       | Instance | 1/5 | Assigned | Associated
Ora12c_b420_4       | Instance | 1/7 | Assigned | Associated
Ora12c_b420_5       | Instance | 2/1 | Assigned | Associated
Ora12c_b420_6       | Instance | 2/3 | Assigned | Associated
Ora12c_b420_7       | Instance | 2/5 | Assigned | Associated
Ora12c_b420_8       | Instance | 2/7 | Assigned | Associated
ORA12C_B420M3_1     | Instance |  | Unassigned | Unassociated
```

```
ORA-12C-FI-B# show service-profile inventory expand
Service Profile Name: Ora12c-b420-template
Type: Updating Template
Server:
Description: Certification of Oracle 12c on b420 and VNX 8000
Assignment: Unassigned
Association: Unassociated

Service Profile Name: Ora12c-b420M3-Template
Type: Instance
Server:
Description: Oracle12c on UCS and EMC VNX 8000
Assignment: Unassigned
Association: Unassociated
```
Service Profile Name: Ora12c_b420_1
Type: Instance
Server: 1/1
Description:
Assignment: Assigned
Association: Associated

Server 1/1:
Name:
Acknowledged Serial (SN): FCH16447HH2
Acknowledged Product Name: Cisco UCS B420 M3
Acknowledged PID: UCSB-B420-M3
Acknowledged VID: V01
Acknowledged Memory (MB): 245760
Acknowledged Effective Memory (MB): 229376
Acknowledged Cores: 32
Acknowledged Adapters: 2

Bios:
Model: UCSB-B420-M3
Revision: 0
Serial:
Vendor: Cisco Systems, Inc.

Motherboard:
Product Name: Cisco UCS B420 M3
PID: UCSB-B420-M3
VID: V01
Vendor: Cisco Systems Inc
Serial (SN): FCH16447HH2
HW Revision: 0

Array 1:
<table>
<thead>
<tr>
<th>DIMM Location</th>
<th>Presence</th>
<th>Overall Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Capacity (MB)</td>
<td>Clock</td>
</tr>
<tr>
<td>1 A0</td>
<td>Equipped</td>
<td>Operable</td>
</tr>
<tr>
<td>DDR3</td>
<td>16384</td>
<td>1600</td>
</tr>
<tr>
<td>2 A1</td>
<td>Missing</td>
<td>Removed</td>
</tr>
<tr>
<td>Undisc</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>3 A2</td>
<td>Missing</td>
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Appendix A: Cisco UCS Service Profiles

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CPUs:

ID: 1
- Presence: Equipped
- Architecture: Xeon
- Socket: CPU1
- Cores: 8
- Speed (GHz): 2.700000
- Stepping: 7
- Product Name: Intel(R) Xeon(R) E5-4650
- PID: UCS-CPU-E5-4650
- VID: 01
- Vendor: Intel(R) Corporation
- HW Revision: 0

ID: 2
- Presence: Equipped
- Architecture: Xeon
- Socket: CPU2
- Cores: 8
- Speed (GHz): 2.700000
- Stepping: 7
- Product Name: Intel(R) Xeon(R) E5-4650
- PID: UCS-CPU-E5-4650
- VID: 01
- Vendor: Intel(R) Corporation
- HW Revision: 0

ID: 3
- Presence: Equipped
- Architecture: Xeon
- Socket: CPU3
- Cores: 8
- Speed (GHz): 2.700000
- Stepping: 7
- Product Name: Intel(R) Xeon(R) E5-4650
- PID: UCS-CPU-E5-4650
- VID: 01
- Vendor: Intel(R) Corporation
- HW Revision: 0
Appendix B: N5K Zone Definitions

N5K-A

oral2c-n5k-a(config)# show zones active
zoneset name oral2c_PI_A vsan 15
zone name oral2c_b420_1_hba1 vsan 15
  * fcid 0x7413ef [device-alias A0P0]
  * fcid 0x7405ef [device-alias B0P0]
  * fcid 0x740001 [pwnn 20:00:00:25:b5:00:00:6e]

zone name oral2c_b420_1_hba3 vsan 15
  * fcid 0x740fef [device-alias A0P1]
  * fcid 0x7407ef [device-alias B0P1]
  * fcid 0x740063 [pwnn 20:00:00:25:b5:00:00:3d]
zone name ora12c_b420_2_hba1 vsan 15
* fcid 0x7413ef [device-alias A0P0]
* fcid 0x7405ef [device-alias B0P0]
* fcid 0x740021 [pwnw 20:00:00:25:b5:00:00:5d]

zone name ora12c_b420_2_hba3 vsan 15
* fcid 0x740041 [pwnw 20:00:00:25:b5:00:00:0d]
* fcid 0x7400ef [device-alias A0P1]
* fcid 0x7407ef [device-alias B0P1]

zone name ora12c_b420_3_hba1 vsan 15
* fcid 0x7411ef [device-alias A0P2]
* fcid 0x7406ef [device-alias B0P2]
* fcid 0x740005 [pwnw 20:00:00:25:b5:00:00:3c]

zone name ora12c_b420_4_hba1 vsan 15
* fcid 0x7406ef [device-alias B0P2]
* fcid 0x7411ef [device-alias A0P2]
* fcid 0x740082 [pwnw 20:00:00:25:b5:00:00:1b]

zone name ora12c_b420_4_hba3 vsan 15
* fcid 0x7404ef [device-alias B0P3]
* fcid 0x7414ef [device-alias A0P3]
* fcid 0x740081 [pwnw 20:00:00:25:b5:00:00:0e]

zone name ora12c_b420_6_hba3 vsan 15
* fcid 0x7410ef [device-alias B1P1]
* fcid 0x7400ef [device-alias A1P1]
* fcid 0x740161 [pwnw 20:00:00:25:b5:00:00:0f]

zone name ora12c_b420_5_hba1 vsan 15
* fcid 0x7401ef [device-alias A1P0]
* fcid 0x7415ef [device-alias B1P0]
* fcid 0x740003 [pwnw 20:00:00:25:b5:00:00:59]

zone name ora12c_b420_3_hba3 vsan 15
* fcid 0x7404ef [device-alias B0P3]
* fcid 0x7414ef [device-alias A0P3]
* fcid 0x7400c1 [pwnw 20:00:00:25:b5:00:00:6d]

zone name ora12c_b420_5_hba3 vsan 15
* fcid 0x7400ef [device-alias A1P1]
* fcid 0x7410ef [device-alias B1P1]
* fcid 0x7400a1 [pwnw 20:00:00:25:b5:00:00:2e]

zone name ora12c_b420_6_hba1 vsan 15
* fcid 0x7415ef [device-alias B1P0]
* fcid 0x7401ef [device-alias A1P0]
* fcid 0x740181 [pwnw 20:00:00:25:b5:00:00:38]

zone name ora12c_b420_7_hba1 vsan 15
* fcid 0x7403ef [device-alias A1P2]
* fcid 0x7412ef [device-alias B1P2]
* fcid 0x740183 [pwnw 20:00:00:25:b5:00:00:27]

zone name ora12c_b420_7_hba3 vsan 15
* fcid 0x7402ef [device-alias A1P3]
Appendix B: N5K Zone Definitions

* fcid 0x7416ef [device-alias B1P3]
* fcid 0x740141 [pwwn 20:00:00:25:b5:00:00:2f]

zone name ora12c_b420_8_hba1 vsan 15
* fcid 0x7412ef [device-alias B1P2]
* fcid 0x7403ef [device-alias A1P2]
* fcid 0x740007 [pwwn 20:00:00:25:b5:00:00:16]

zone name ora12c_b420_8_hba3 vsan 15
* fcid 0x7416ef [device-alias B1P3]
* fcid 0x7402ef [device-alias A1P3]
* fcid 0x740002 [pwwn 20:00:00:25:b5:00:00:4f]

N5K-B

oral2c-n5k-b(config)# show zones active
zoneset name ora12c_FI_B vsan 15
zone name ora12c_b420_1_hba4 vsan 15
* fcid 0x7f0023 [pwwn 20:00:00:25:b5:00:00:1d]
* fcid 0x7f0eef [device-alias A7P1]
* fcid 0x7f0aef [device-alias B7P1]

zone name ora12c_b420_1_hba2 vsan 15
* fcid 0x7f0021 [pwwn 20:00:00:25:b5:00:00:4d]
* fcid 0x7f18ef [device-alias A7P0]
* fcid 0x7f0bef [device-alias B7P0]

zone name ora12c_b420_2_hba2 vsan 15
* fcid 0x7f0001 [pwwn 20:00:00:25:b5:00:00:1f]
* fcid 0x7f18ef [device-alias A7P0]
* fcid 0x7f0bef [device-alias B7P0]

zone name ora12c_b420_4_hba4 vsan 15
* fcid 0x7f09ef [device-alias A7P3]
* fcid 0x7f08ef [device-alias B7P3]
* fcid 0x7f0101 [pwwn 20:00:00:25:b5:00:00:3e]

zone name ora12c_b420_3_hba2 vsan 15
* fcid 0x7f09ef [device-alias A7P2]
* fcid 0x7f11ef [device-alias A7P2]
* fcid 0x7f0004 [pwwn 20:00:00:25:b5:00:00:2c]

zone name ora12c_b420_6_hba4 vsan 15
* fcid 0x7f00ef [device-alias A8P1]
* fcid 0x7f10ef [device-alias B8P1]
* fcid 0x7f0181 [pwwn 20:00:00:25:b5:00:00:3f]

zone name ora12c_b420_4_hba2 vsan 15
* fcid 0x7f11ef [device-alias A7P2]
* fcid 0x7f09ef [device-alias B7P2]
* fcid 0x7f00c2 [pwwn 20:00:00:25:b5:00:00:0b]

zone name ora12c_b420_5_hba2 vsan 15
* fcid 0x7f0002 [pwwn 20:00:00:25:b5:00:00:69]
* fcid 0x7f15ef [device-alias A8P0]
* fcid 0x7f16ef [device-alias B8P0]

zone name ora12c_b420_3_hba4 vsan 15
* fcid 0x7f08ef [device-alias B7P3]
* fcid 0x7f19ef [device-alias A7P3]
* fcid 0x7f00c1 [pwwn 20:00:00:25:b5:00:00:1e]

zone name ora12c_b420_2_hba4 vsan 15
* fcid 0x7f0008 [pwwn 20:00:00:25:b5:00:00:6c]
* fcid 0x7f00ef [device-alias A7P1]
* fcid 0x7f00aef [device-alias B7P1]

zone name ora12c_b420_6_hba2 vsan 15
* fcid 0x7f01a1 [pwwn 20:00:00:25:b5:00:00:48]
* fcid 0x7f01f5ef [device-alias A8P0]
* fcid 0x7f016ef [device-alias B8P0]

zone name ora12c_b420_5_hba4 vsan 15
* fcid 0x7f0008 [pwwn 20:00:00:25:b5:00:00:6c]
* fcid 0x7f00ef [device-alias A8P1]
* fcid 0x7f00aef [device-alias B8P1]
* fcid 0x7f0081 [pwwn 20:00:00:25:b5:00:00:5e]

zone name ora12c_b420_7_hba2 vsan 15
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* fcid 0x7f016ef [device-alias B8P0]

zone name ora12c_b420_7_hba4 vsan 15
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* fcid 0x7f01f5ef [device-alias A8P1]
* fcid 0x7f016ef [device-alias B8P1]

zone name ora12c_b420_8_hba2 vsan 15
* fcid 0x7f01a1 [pwwn 20:00:00:25:b5:00:00:37]
* fcid 0x7f01f5ef [device-alias A8P1]
* fcid 0x7f016ef [device-alias B8P1]
* fcid 0x7f01a3 [pwwn 20:00:00:25:b5:00:00:37]

zone name ora12c_b420_8_hba4 vsan 15
* fcid 0x7f01a1 [pwwn 20:00:00:25:b5:00:00:37]
* fcid 0x7f01f5ef [device-alias A8P1]
* fcid 0x7f016ef [device-alias B8P1]
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Appendix C: Oracle Patches

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Appendix D: Oracle spfile Parameters

Note

Linux Huge Pages were setup on each host

AS

asm_diskgroups='OCRVOTEDG','OLTPDG','DSSDG','CPUCRSDG','ACFSOH','REDODG'
asm_power_limit=1
memory_target=1076M
sessions=600

Container Database
sga_max_size=128G
sga_target=128G
db_name='oltp'
ccluster_database=TRUE
log_buffer= 183623680
processes=3000
db_files=4000
db_4k_cache_size=26G //CPU PDB
db_16_cache_size=10G //DSS PDB
memory_max_target=0
memory_target=0 //use huge pages
pga_aggregate_target=30G
resource_manager_plan=cpu_oltp_dss_plan //Resource Manager

Appendix E: Key Linux Parameters

sysctl.conf
kernel.sem = 8192 48000 8192 8192
net.core.rmem_default = 4194304
net.core.rmem_max = 16777216
net.core.wmem_default = 4194304
net.core.wmem_max = 16777216
vm.nr_hugepages = 72100
limits.conf
/etc/security/limits.d/oracle-rdbms-server-12cR1-preinstall.conf
oracle soft nofile 4096
oracle hard nofile 65536
oracle soft nproc 32767
oracle hard nproc 32767
oracle soft stack 10240
oracle hard stack 32768

DB Patches

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<td>17039360</td>
<td>ORA-600 [OCIKDBLinkConn-8] querying CDB views</td>
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Appendix F: Cluster Information


The Cluster Nodes are: ora12crac1, ora12crac2, ora12crac3, ora12crac4, ora12crac5, ora12crac6, ora12crac7, ora12crac8
The Local Node is: ora12crac1
The Remote Nodes are: ora12crac2, ora12crac3, ora12crac4, ora12crac5, ora12crac6, ora12crac7, ora12crac8

Major Clusterware Software Version is: 12.1.0.1.0
Major Clusterware Active Version is: 12.1.0.1.0
Major Clusterware Release Version is: 12.1.0.1.0

CRS_HOME is installed at: /oracle/product/12cgrid
CRS_BASE is installed at: /oracle/product/grid
CRS_OWNER is: oracle
CRS_GROUP is: oinstall

All databases created: oastcpu, oastcrs, oastdss, oastiop

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<td>administratorRAC</td>
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Cluster Name: oral2ccluster
SCAN Name: oral2c-scan.ucs.cisco.com
SCAN Listeners: LISTENER_SCAN1 (Port: TCP:1521)
LISTENER_SCAN2 (Port: TCP:1521)
LISTENER_SCAN3 (Port: TCP:1521)
GNS Status: configured and enabled
GNS Version: 12.1.0.1.0
GNS Subdomain : ucs.cisco.com
GNS-to-DNS Port : 53
GNS-to-mDNS Port : 5,353

Node VIP Version : 12.1.0.1.0
Local Node VIPs :
    (static) ora.ora12crac1.vipora12crac1-vip.ucs.cisco.com
    (static) ora.ora12crac2.vipora12crac2-vip.ucs.cisco.com
    (static) ora.ora12crac3.vipora12crac3-vip.ucs.cisco.com
    (static) ora.ora12crac4.vipora12crac4-vip.ucs.cisco.com
    (static) ora.ora12crac5.vipora12crac5-vip.ucs.cisco.com
    (static) ora.ora12crac6.vipora12crac6-vip.ucs.cisco.com
    (static) ora.ora12crac7.vipora12crac7-vip.ucs.cisco.com
    (static) ora.ora12crac8.vipora12crac8-vip.ucs.cisco.com

Oracle Interfaces : eth010.29.134.0globalpublic
                    eth1192.168.134.0globalcluster_interconnect,asm

OCR Location : '+OCR VOTEDG'
Voting Disk Location : '+OCR VOTEDG'

Cluster Mode : Flex Cluster

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<td>ora12crac6(8,Active)</td>
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MGMTDB Status : enabled and is running on ora12crac1
MGMTDB HOME : <CRS home>
MGMTDB Spfile : '+OCR VOTEDG/_mgmtdb/spfile-MGMTDB.ora'
MGMTDB Instance : '-MGMTDB'

DISKGROUPREDUNDANCYAU COMPATIBILITYDB_COMPATIBILITYSIZE_MBFREE_MBUSABLE_MB PATH
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### Appendix F: Cluster Information

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<th>VOLUME_NAME</th>
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<td>ACFS_VOL_OH</td>
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<td>ACFSOH</td>
<td>/oracle/product/12.1ACFS</td>
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</table>

ASM Host connects Client

```
ora12crac1.ucs.cisco.com(+ASM1) <---
ora12crac1.ucs.cisco.com(+ASM1) <---
ora12crac1.ucs.cisco.com(+ASM1) <---
ora12crac1.ucs.cisco.com(+ASM1) <---
ora12crac1.ucs.cisco.com(+ASM1) <---
ora12crac1.ucs.cisco.com(+ASM1) <---
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ora12crac1.ucs.cisco.com(+ASM1) <---
ora12crac1.ucs.cisco.com(+ASM1) <---
ora12crac1.ucs.cisco.com(+ASM1) <---
ora12crac1.ucs.cisco.com(+ASM1) <---
ora12crac1.ucs.cisco.com(+ASM1) <---
```

Oracle 12c on Cisco UCS and EMC VNX2
Appendix F: Cluster Information

ora12crac1.ucs.cisco.com(+ASM1)    <---
'oauthcrs3(ora12crac8)'
ora12crac1.ucs.cisco.com(+ASM1)    <---
'oauthcrs4(ora12crac3)'
ora12crac1.ucs.cisco.com(+ASM1)    <---
'oauthcrs7(ora12crac7)'
ora12crac1.ucs.cisco.com(+ASM1)    <---
'oauthcrs8(ora12crac6)'
ora12crac1.ucs.cisco.com(+ASM1)    <---
'oauthcrs9(ora12crac1)'
ora12crac1.ucs.cisco.com(+ASM1)    <---
'oauthcrs10(ora12crac5)'
ora12crac1.ucs.cisco.com(+ASM1)    <---
'oauthcrs11(ora12crac2)'
ora12crac1.ucs.cisco.com(+ASM1)    <---
'oauthcrs12(ora12crac4)'
ora12crac1.ucs.cisco.com(+ASM1)    <---
'oauthcrs13(ora12crac3)'
ora12crac1.ucs.cisco.com(+ASM1)    <---
'oauthcrs14(ora12crac7)'
ora12crac1.ucs.cisco.com(+ASM1)    <---
'oauthcrs15(ora12crac6)'
ora12crac1.ucs.cisco.com(+ASM1)    <---
'oauthcrs16(ora12crac8)'
ora12crac2.ucs.cisco.com(+ASM3)    <---
'+APX3(ora12crac2)'
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'oauthcrs3(ora12crac5)'

OCR/CRSD Master :oral2crac1
CRSD PE Master : oral2crac1
CRSD PE Standby : oral2crac5

<oral2crac1> 05-14 20:01:12.587: My R:3 = Min R:3   R of OCR:1   R of CRS
Standby:0 R of ASM Inst:2 OCR on ASM:1 ASM mode:2
<oral2crac4> 05-14 20:04:03.879: My R:1 < Min R:3   R of OCR:1   R of CRS
Standby:0 R of ASM Inst:0 OCR on ASM:1 ASM mode:2
<oral2crac2> 05-14 20:03:06.693: My R:3 = Min R:3   R of OCR:1   R of CRS
Standby:0 R of ASM Inst:2 OCR on ASM:1 ASM mode:2
<oral2crac8> 05-14 20:02:25.735: My R:1 < Min R:3   R of OCR:1   R of CRS
Standby:0 R of ASM Inst:0 OCR on ASM:1 ASM mode:2
<oral2crac5> 05-14 20:03:14.102: My R:4 > Min R:3   R of OCR:1   R of CRS
Standby:1 R of ASM Inst:2 OCR on ASM:1 ASM mode:2
Appendix G: FCoE Throughput from Fabric Interconnects

The following is a sample script that was used to mine FCoE throughput from fabrics. This is Cisco UCS Manager version dependent and may need some changes.
Write an expect script to access the details from each IOM as shown below:

```bash
#!/usr/bin/expect
set timeout -1
spawn -noecho ssh -o StrictHostKeyChecking=no admin@<ip address of UCSM>
expect {
    "Password:" {
        send "UCSMPassword\r"
    }
}
expect "# "
send "connect local-mgmt a\r"
expect "# "
send "connect iom 1\r"
expect "# "
log_file "a-iom-1.lst"
send "show platform software woodside rate | grep 0-NI\r"
expect "# "
log_file
send "exit 0\r"
```

Repeat the same for each of the other IOM's like Fab A iom 2, Fab B iom 1, Fab B iom 2.

Mine the log files created to sum up the IO throughput at a given time. The output captured could be Kbps or Mbps or Gbps. A little Math may be needed in scripting, to covert all of them to one units and proceed. The script below is provided as a reference only:

```bash
if [ $units == "Kbps" ]; then
test1=`echo $value/1024/1024 | bc -l`....
```