

WHITE PAPER

# Hitachi Solution for Databases - Oracle Real Application Clusters Database 12c based on Hitachi Advanced Server DS220 and Virtual Storage Platform G350

Reference Architecture Guide

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# Feedback

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## Revision History

Revision	Changes	Date
MK-SL-078-00	Initial release	June 20, 2018

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# Hitachi Solution for Databases - Oracle Real Application Clusters Database 12c based on Hitachi Advanced Server DS220 and Virtual Storage Platform G350

## Reference Architecture Guide

This paper describes how using Hitachi Unified Compute Platform Converged Infrastructure for Oracle Real Application Cluster provides a high performance, converged solution for Oracle databases. The environment uses two Hitachi Advanced Servers DS220, two Hitachi Advanced Server DS120 for management servers and Hitachi Virtual Storage Platform G350 with SSD devices. Use this document to design a converged solution for your Oracle environment to meet your requirements and budget.

This Hitachi Unified Compute Platform CI architecture for Oracle Database is engineered, pre-tested, and qualified to provide predictable performance and the highest reliability in demanding, dynamic Oracle environments. This solution is validated to ensure consistent, predictable results with the integration of servers, storage systems, network, and storage software. The environment provides reliability, high availability, scalability, and performance while processing small-scale to large-scale OLTP workloads. The dedicated servers run Oracle Database 12c R2 with the Oracle Application Cluster (RAC) option. The operating system is Oracle Linux 7.4.

This reference architecture is for people in the following roles:

- Database Administrator
- Storage Administrator
- IT professionals with the responsibility of planning and deploying an Oracle Real Application server

To use this reference architecture guide, familiarity with the following is required:

- Hitachi Virtual Storage Platform G350
- Hitachi Advanced Server DS220
- Hitachi Advanced Server DS120
- VMware ESXi
- VMware vCenter Server Appliance
- Hitachi Adapters for Oracle Database
- Hitachi Storage Adapter for Oracle Enterprise Manager
- Hitachi Server Adapter for Oracle Enterprise Manager
- Storage area networks
- Oracle Database Administration
- Oracle Database 12c Release 2 with Oracle RAC option
- Oracle Automatic Storage Management
- Oracle Linux Operating System

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**Note** — Testing of this configuration was in a lab environment. Many things affect production environments beyond prediction or duplication in a lab environment. Follow the recommended practice of conducting proof-of-concept testing for acceptable results in a non-production, isolated test environment that otherwise matches your production environment before your production implementation of this solution.

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## Solution Overview

This reference architecture describes a Hitachi Unified Compute Platform Converged Infrastructure (UCP CI) with Hitachi Advanced Server DS220, Hitachi Advanced Server DS120, and Hitachi Virtual Storage Platform G350 systems. This environment addresses the high availability, performance, and scalability requirements for Oracle Real Application Cluster. Tailor your implementation of this solution to meet your specific needs.

## Business Benefits

This reference architecture provides the following benefits:

- Predictable, repeatable, reliable results that are tested, pre-validated, and fully supported
- Faster speed to deploy and increased ability to meet changing needs, with a single source for components and prescriptive guides
- Customer proven architecture and reliability of Hitachi Vantara Virtual Storage Platform
- Simplified and centralized storage management

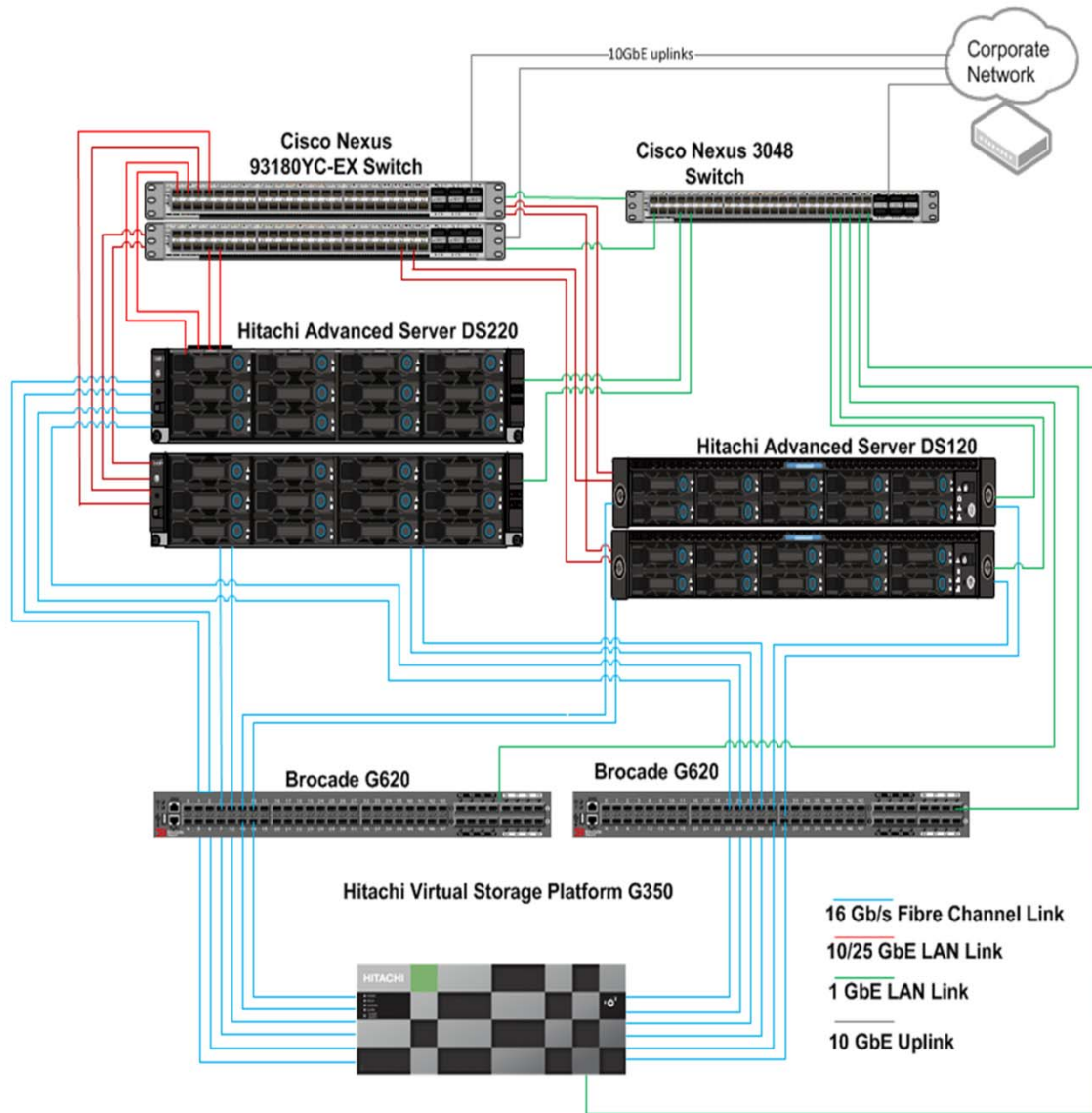
## High Level Infrastructure

This reference architecture includes the following key characteristics:

- Fully redundant hardware
- Dual fabric connectivity between hosts and storage

Figure 1 shows the high-level infrastructure for this Hitachi UCP CI for Oracle RAC solution.

Figure 1



## Key Solution Components

Table 1 lists the key hardware components used in this reference architecture.

TABLE 1. KEY HARDWARE COMPONENTS

Hardware	Detail Description	Version	Quantity
Hitachi Virtual Storage Platform HM850 – G350	<ul style="list-style-type: none"> <li>■ 2 x Controllers</li> <li>■ 12 x 16Gb/sec Fibre Channel Ports</li> <li>■ 128 GB Cache Memory</li> </ul>	88-01-03-20/00	1
	<ul style="list-style-type: none"> <li>■ 24 x 1.9 TB SSDs</li> <li>■ 4 x 3 TB 7.2k rpm SAS drives</li> <li>■ 2 x spare SSDs</li> </ul>		
Hitachi Advanced Server DS220	<ul style="list-style-type: none"> <li>■ 2 x Intel® Xeon® Gold 6140 CPU 2.30GHz</li> <li>■ 12 x 64 GB Memory DIMMs 2666 MHz</li> <li>■ 2 x 1.9 TB SAS HDD (Optional)</li> <li>■ 2 x 64 GB SATADOM</li> </ul>	BMC3.75.06 BIOS: 3A10.H3 CPLD: 10	2
	<ul style="list-style-type: none"> <li>■ 2 x Intel Corporation Ethernet Controller XXV710 for 25 GbE SFP28</li> </ul>	Driver: i40e Version: 2.1.26 Firmware: 5.51 0x80002bca 1.1568.0	
	<ul style="list-style-type: none"> <li>■ 2 x Emulex LightPulse LPe 31002-M6 16 Gb/sec Fibre Channel Adapter</li> </ul>	Boot: 11215621 Firmware: 11.2.156.27	
	<ul style="list-style-type: none"> <li>■ 1 x QS3516 Controller (Required with optional HDD)</li> </ul>	5.020.00-0910	

TABLE 1. KEY HARDWARE COMPONENTS (CONTINUED)

Hardware	Detail Description	Version	Quantity
Hitachi Advanced Server DS120	<ul style="list-style-type: none"> <li>■ 2 x Intel Xeon Silver 4110 CPU @ 2.10 GHz, 85W</li> <li>■ 8 x 32 GB DDR4 R-DIMM 2666 MHz (256GB total)</li> <li>■ 1 x 64 GB SATADOM</li> </ul>	BMC3.75.06 BIOS: 3A10.H3 CPLD: 10	2
	<ul style="list-style-type: none"> <li>■ 1 x Intel Corporation Ethernet Controller XXV710 for 25 GbE SFP28</li> </ul>	Driver: i40e Version: 2.1.26 Firmware: 5.51 0x80002bca 1.1568.0	
	<ul style="list-style-type: none"> <li>■ 1 x Emulex LightPulse LPe31002-M6 2-Port 16 Gb Fibre Channel Adapter</li> </ul>	Boot: 11215621 Firmware: 11.2.156.27	
Brocade G620 Fibre Channel switches	<ul style="list-style-type: none"> <li>■ 48 port Fibre Channel switch</li> <li>■ 16 Gbps SFPs</li> <li>■ Brocade hot-pluggable SFP+, LC connector</li> </ul>	Kernel: 2.6.34.6 Fabric OS: v8.0.1	2
Cisco Nexus – LAN Switches	<ul style="list-style-type: none"> <li>■ Nexus 93180YC-EX</li> <li>■ 48 x 10/25 GbE Fibre Channel ports</li> <li>■ 6 x 40/100 Gbps Quad SFP(QSFP28) ports</li> </ul>	BIOS: 07.61 NXOS: 7.0(3)I4(7)	2
Cisco Nexus - Management Switch	<ul style="list-style-type: none"> <li>■ Nexus 3048 Switch for Management network</li> <li>■ 1 GbE 48-port Ethernet Switch</li> </ul>	BIOS: 4.0.0 NXOS: 7.0(3)I4(7)	2

Certain components may be optional depending on the existing infrastructure and required interconnect topology. This may include the SAN, IP switches, and/or the management servers. However, this documents the environment tested in the lab to support a full deployment of the architecture including supporting components.



Table 2 lists the key software components used in this reference architecture.

TABLE 2. KEY SOFTWARE COMPONENTS FOR COMPUTE NODE

Software	Version	Function
Oracle Linux	OL 7.4	Operating System
Oracle 12c	12.2.0.1	Oracle Database Software
Oracle Real Application Cluster	12c Release 1 (12.1.0.2.0)	Cluster Software
Oracle 12c Grid Infrastructure	12.2.0.1	Oracle Cluster software

Table 3 lists the key software components for management node used in this reference architecture.

TABLE 3. KEY SOFTWARE COMPONENT FOR MANAGEMENT NODE

Software	Version	Function
VMware ESXi	6.5.0.13000 Build 7515524	VMWare Hypervisor server
vCenter Server Appliance	6.5.0	VMWare appliances management server – VM with Red Hat 7.4 Operating System
Hitachi Storage Adapter for Oracle Enterprise Manager	2.2.0	Storage Management Software
Hitachi Server Adapter for Oracle Enterprise Manager	2.2.0	Server Management Software
Manager for Hitachi adapters for Oracle Database	2.2.0	Hitachi adapters management Virtual appliance software
Hitachi Storage Navigator	Microcode dependent	Storage Management Software
Hitachi Infrastructure Analytics Advisor (HIAA)	v4.0.0-00	Storage Performance and Analytics tool – VM with Red Hat 7.4 Operating System
Hitachi Data Center Analytics (HDCA)	v9.0.0-00	Storage Analytics tool – VM with Red Hat 7.4 Operating System
Hitachi Storage Advisor (HSA)	2.3.0	Storage Orchestration Software
Oracle Enterprise Manager Cloud Control 13c	13c Release 2 (13.2.00)	OEM software

TABLE 3. KEY SOFTWARE COMPONENT FOR MANAGEMENT NODE (CONTINUED)

Software	Version	Function
Oracle Enterprise Manager Cloud Control 13c plug-ins	13c Release 2	Hitachi Storage and Server OEM plugins
vSVP*	Microcode dependent	Configuration and management of the storage system and collection of performance data

\* Note that a physical Service Processor (SVP) is used in this solution; however, it is optional and using a vSVP is recommended.

### Hitachi Virtual Storage Platform G350

[Hitachi Virtual Storage Platform Gx00](#) models are based on industry-leading enterprise storage technology. With flash-optimized performance, these systems provide advanced capabilities previously available only in high-end storage arrays. With the Virtual Storage Platform Gx00 models, you can build a high performance, software-defined infrastructure to transform data into valuable information.

Hitachi Storage Virtualization Operating System provides storage virtualization, high availability, superior performance, and advanced data protection for all Virtual Storage Platform Gx00 models. This proven, mature software provides common features to consolidate assets, reclaim space, extend life, and reduce migration effort.

This solution uses Virtual Storage Platform G350, which supports [Oracle Real Application Clusters](#).

### Hitachi Advanced Server DS120 Server

[Hitachi Advanced Server DS120](#) provides flexible and scalable configurations for hyper-converged datacenters, provides computing performance, sophisticated power and thermal design to avoid unnecessary OPEX with quick deployment. For this solution two DS120 servers are used. The two DS120 servers are configured as a VMware vCenter cluster. Virtual machines on the cluster are used to host management applications. The management applications installed will depend on customer needs and requirements. The following applications were installed in individual virtual machines in this architecture and would be installed in most cases.

- vCenter
- Oracle Enterprise Manager (OEM) Cloud Control 13c
- Hitachi Storage Adapter for Oracle Enterprise Manager
- Hitachi Server Adapter for Oracle Enterprise Manager
- Manager for Hitachi Adapter for Oracle Database server
- VMware ESXi
- Virtual Service Processor (vSVP)

Other management applications may be installed on additional virtual machines depending on customer needs and requirements.

## Hitachi Advanced Server DS220

[Hitachi Advanced Server DS220](#) is a general-purpose rackmount server designed for optimal performance and power efficiency. This allows owners to upgrade computing performance without overextending power consumption and offers non-latency support to virtualization environments that require the maximum memory capacity. Hitachi Advanced Server DS220 provides flexible I/O scalability for today's diverse data center application requirements.

## Hitachi Infrastructure Analytics Advisor

With [Hitachi Infrastructure Analytics Advisor](#), you can define and monitor storage service level objectives (SLOs) for resource performance. You can identify and analyze historical performance trends to optimize storage system performance and plan for capacity growth.

Use Hitachi Infrastructure Analytics Advisor to register resources (storage systems, hosts, servers, and volumes), and set service-level thresholds. You are alerted to threshold violations and possible performance problems (bottlenecks). Using analytics tools, you find which resource has a problem and analyze its cause to help solve the problem. The Infrastructure Analytics Advisor ensures the performance of your storage environment based on real-time SLOs.

## Hitachi Storage Adapter for Oracle Enterprise Manager

Hitachi Storage Adapter for Oracle Enterprise Manager presents an integrated, detailed view of the Hitachi storage or converged infrastructure supporting your Oracle databases. By gaining visibility into capacity, performance, and configuration information, administrators can manage service levels more effectively, and ensure service level agreements (SLAs) are met to support business goals.

## Hitachi Server Adapter for Oracle Enterprise Manager

[Hitachi Server Adapter](#) for Oracle Enterprise Manager makes it possible to monitor Hitachi Advanced Server DS220 and DS120 in Oracle Enterprise Manager. This adapter provides visibility of the status, health, and attributes for the servers. The adapter also supplies information about any Oracle database instances running on the servers and supports both RAC and non-RAC databases.

## Hitachi Storage Advisor

[Hitachi Storage Advisor](#) is a systems management application for Hitachi Virtual Storage Platform (VSP) family, reduces complexities and enables a simplified, unified and extensible approach to centralized storage management. Hitachi Storage Advisor simplifies management operations, helping you to rapidly configure storage systems and IT services for new business applications.

## VMware Esxi

[VMware ESXi](#) is the next-generation hypervisor, providing a new foundation for virtual infrastructure. This innovative architecture operates independently from any general-purpose operating system, offering improved security, increased reliability, and simplified management.

## vCenter Appliance

[The vCenter Server Appliance](#) is a preconfigured Linux virtual machine, which is optimized for running VMware vCenter Server and the associated services on Linux.

vCenter Server Appliance comes as an Open Virtualization Format (OVF) template. The appliance is imported to an ESXi host and configured through the web-based interface. It comes pre-installed with all the components needed to run a vCenter Server, including vCenter SSO (Single Sign-on), Inventory Service, vSphere Web Client and the vCenter Server itself.

## Oracle Linux Operating System

Using the stability and flexibility of Oracle Linux, reallocate your resources toward meeting the next challenges instead of maintaining the status quo. Deliver meaningful business results by providing exceptional reliability of military-grade security. Use Oracle Linux to tailor your infrastructure as markets shift and technologies evolve.

## Oracle 12c Database with Oracle Real Application Cluster

[Oracle Database](#) is optimized for use with other Oracle products. It uses Oracle Database Automatic Storage Management (ASM), combining the features of a volume manager and an application-optimized file system for database files. ASM is part of the grid infrastructure component in Oracle Database.

[Real Application Clusters](#) (Oracle RAC) scales the database across multiple servers and protects against server failure.

[Automatic Storage Management](#) (Oracle ASM) combines the features of a volume manager and an application-optimized file system for database files.

[Oracle Clusterware](#) is portable cluster software that allows clustering of independent servers so that they cooperate as a single system. Oracle Clusterware is the required cluster technology for Oracle Real Application Clusters.

## Brocade Switches

Brocade and Hitachi Vantara partner to deliver storage networking and data center solutions. These solutions reduce complexity and cost, as well as enable virtualization and cloud computing to increase business agility.

SAN switches are optional and direct connect is also possible under certain circumstances, but the customers should check the support matrix to ensure it is supported prior to implementation.

The solution uses the following Brocade products:

- Brocade G620, 48 port Fibre Channel

## Cisco Switches

The Cisco Nexus Switch product line provides a series of solutions that attempt to make it easier to connect and manage disparate data center resources with software-defined networking (SDN). Leveraging the Cisco Unified Fabric, which unifies storage, data and networking (Ethernet/IP) services, the Nexus Switches create an open, programmable network foundation built to support a virtualized data center environment.

The solution uses the following Cisco products:

- Nexus 93180YC-EX, 48-port 10/25 GbE switch
- Nexus 3048TP, 48-port 1GbE Switch

## Solution Design

This describes the reference architecture environment to implement Hitachi Unified Compute Platform with Converged Infrastructure for Oracle with the Real Application Clusters option. The environment uses Hitachi Virtual Storage Platform G350.

The infrastructure configuration includes the following:

- **Oracle RAC Servers** - There are two server nodes configured in an Oracle Real Application Cluster.
- **Storage System** - There are V-VOLs mapped to each port that are presented to the server as LUNs.
- **SAN Connection** - There are SAN connections to connect the Fibre Channel HBA ports to the storage through Brocade G620 switches.

## Storage Architecture

This describes the storage architecture for this solution

### *Storage Configuration*

The configuration takes into consideration Hitachi Vantara for Hitachi Virtual Storage Platform and Oracle recommended practices for the design and deployment of database storage.

The high-level storage configuration diagram for this solution is shown in Figure 2.

Figure 2

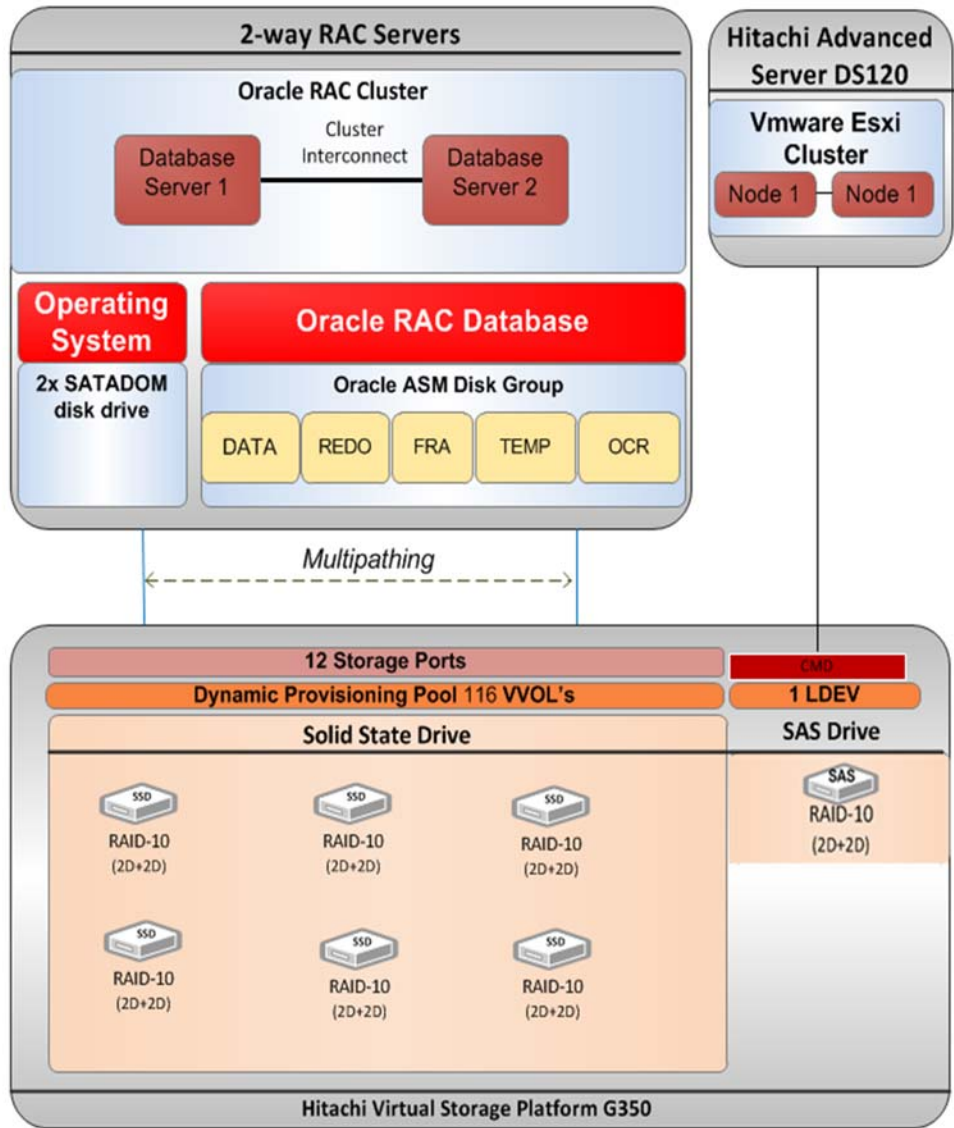


Table 4 shows the storage pool configuration used in this solution.

TABLE 4. STORAGE POOL CONFIGURATION

Pool ID	Composable-ora-pool
RAID Group	1-1 – 1-6
RAID Level	RAID-10 (2D+2D)

TABLE 4. STORAGE POOL CONFIGURATION

Pool ID	Composable-ora-pool
Drive Type	1.92 TB SSD
Number of Drives	24
Number of Spare Drives	2
Number of LDEVs	24
LDEV Size(s)	880 GB
Pool Capacity	20.62 TB

Table 5 shows logical storage configuration used in this solution.

TABLE 5. LOGICAL STORAGE CONFIGURATION

Dynamic Provisioning Pool ID	Composable-ora-pool				
Number of DPVols	64	16	16	16	3
DPVols Sizes (GB)	160	10 GB	40 GB	10 GB	5 GB
ASM Disk Group	DATA	REDO	FRA	TEMP	OCR
Purpose	OLTP Application Tablespaces System Sysaux Undo Temp	Online Redo logs Control Files	Incremental Backups Archive Logs Autobackups	Temporary file for oracle	Oracle Cluster Registry Voting Disk
Storage Port	1A, 2A, 3A, 4A, 5A, 6A, 7A, 8A, 1B, 3B, 2B, 4B				

There is an additional RAID group consisting of four 3 TB 7.2k rpm SAS drives configured as RAID-10 (2D+2D). This is used as shared storage for the management server cluster. A single 3 TB LUN is mapped to four storage ports. Additional LUNs can be mapped if required. While the test environment was configured using a dedicated SAS RAID group for the management server cluster, this can be configured as a dedicated SSD RAID group, a dedicated HDP pool, or it can use capacity on the HDP pool configured for the Oracle environment depending on customer requirements.

## Database Layout

The database layout design uses recommended practices from Hitachi Vantara for Hitachi Virtual Storage Platform G350 for small random I/O traffic, such as OLTP transactions. The layout also considers Oracle ASM best practices when using Hitachi Vantara storage. Base the storage design for database layout needs on the requirements of a specific application implementation. The design can vary greatly from one implementation to another. The components in this solution set have the flexibility for use in various deployment scenarios to provide the right balance between performance and ease of management.

- **Data and Indexes Tablespace** — Assign a Data ASM disk group for the data and index tablespaces. The smallfile tablespace for data consists of 2048 datafiles that are 8 GB each.
- **TEMP Tablespace** — Create a bigfile temporary tablespace from a Data ASM disk group in this configuration.
- **Undo Tablespace** — Create 2 bigfile UNDO tablespaces from the Data ASM disk group. Assign one UNDO tablespace for each database instance in this 2-node SMP Oracle RAC database.
- **Online Redo Logs** — Assign a REDO ASM disk group for online redo logs. Four redo logs are created for each database instance in a two-node Oracle RAC database. Set the size of each redo log file to 8 GB.
- **Oracle Cluster Registry and Voting Disk** — Place each of these files in the OCR ASM disk group in this 2-node Oracle RAC configuration.
- **Database Block Size Settings** — Set the database block size to 8 KB. Set the ASM allocation unit to 4 MB.
- **ASM FILE SYSTEM I/O Settings** — Set the Oracle ASM I/O operations for database files, as follows:

FILESYSTEMIO\_OPTIONS = setall

TABLE 6. ORACLE RAC DATABASE SETTINGS

Environment	Value
RAC configuration	Yes
ASM	Yes – Oracle RAC Database

Table 7 shows the detail of Oracle database environment parameters tested in this solution.

TABLE 7. ORACLE DATABASE ENVIRONEMNT PARAMETERS

Setting	Value
DB_BLOCK_SIZE	8 KB
SGA_TARGET	230 GB
PGA_AGGREGATE_TARGET	77 GB
DB_CACHE_SIZE	125 GB
DB_KEEP_CACHE_SIZE	55 GB



TABLE 7. ORACLE DATABASE ENVIRONEMNT PARAMETERS

Setting	Value
DB_RECYCLE_CACHE_SIZE	14 GB
LOG_BUFFER	512 MB
USE_LARGE_PAGES	TRUE
FILESYSTEMIO_OPTIONS	SETALL
DISK_ASYNC_IO	TRUE

Table 8 shows Oracle ASM disk configuration detail.

TABLE 8. ORACLE ASM DISK CONFIGURATION

ASM Disk Group	ASM Disk	DM-Multipath LUNs	LUN Details	Purpose
OCRDG	OCRDISK1 – OCRDISK3	/dev/mapper/mpatha[g-i]	3 × 30 GB	Oracle Cluster Registry and Voting Disk
DATADG	DATADISK1 – DATADISK64	/dev/mapper/mpath[a-z] /dev/mapper/mpatha[b-w] /dev/mapper/mpathb[a-p]	64 × 160 GB	Application Data
REDODG	REDODISK1 – REDODISK16	/dev/mapper/mpathb[q-z] /dev/mapper/mpatha[o-t]	16 × 10 GB	Online Redo log group
FRADG	FRADISK1 – FRADISK16	/dev/mapper/mpathc[a-o]	16 × 40 GB	Flash Recovery Area
TEMPDG	TEMPDISK1 – TEMPDISK16	/dev/mapper/mpathc[p-z] /dev/mapper/mpathd[a-e]	16 × 10 GB	Temporary Data file

### Server and Application Architecture

This reference architecture uses two Hitachi Advanced Server DS220 servers for a two node Oracle RAC configuration. This provides the compute power for the Oracle RAC database to handle complex database queries and a large volume of transaction processing in parallel. Table 9 describes the details of the server configuration for this solution.

This reference architecture uses two Hitachi Advanced Server DS120 servers running VMware ESXi 6.5 configured as a cluster to host virtual machines for management applications.

TABLE 9. HITACHI ADVANCED SERVER DS220 AND DS120 SPECIFICATIONS

Hitachi Advanced Server	Server Name	Role	CPU Core	Memory
DS220	pg350-srv1	Oracle RAC node 1	36 (18 Core x 2 sockets per server)	768 GB
	pg350-srv2	Oracle RAC node 2	36 (18 Core x 2 sockets per server)	768 GB
DS120	VMware ESXI-Node 1	Management server to host VMs	16	256 GB (8 x 32 GB)
	VMware ESXI-Node 2	Management server to host VMs	16	256 GB (8 x 32 GB)

### SAN Architecture

Map the provisioned LDEVs to multiple ports on Hitachi Virtual Storage Platform G350. These LDEV port assignments provide multiple paths to the storage system from the host for high availability.

- 8 SAN switch connections are being used for VSP G350 host ports.
- 8 SAN switch connections are being used for server HBA ports.

TABLE 10. SAN SWITCH ZONING CONFIGURATION

Server	HBA	Storage Host Group	Switch Zone	Storage Port	Brocade G620 Switch
DS220 – Server 1	HBA1_1	CN1_HBA1_1	CN1_HBA1_1_G350_1A	1A	1
	HBA1_2	CN1_HBA1_2	CN1_HBA1_2_G350_2A	2A	2
	HBA2_1	CN1_HBA2_1	CN1_HBA2_1_G350_1B	5A	1
	HBA2_2	CN1_HBA2_2	CN1_HBA2_2_G350_2B	6A	2
DS220 – Server 2	HBA1_1	CN2_HBA1_1	CN2_HBA1_1_G350_3A	3A	1
	HBA1_2	CN2_HBA1_2	CN2_HBA1_2_G350_4A	4A	2
	HBA2_1	CN2_HBA2_1	CN2_HBA2_1_G350_3B	7A	1
	HBA2_2	CN2_HBA2_2	CN2_HBA2_2_G350_4B	8A	2
DS120 – Mgmt. server 1	HBA1_1	MN1_HBA1_1	MN1_HBA1_1_G350_1B	1B	1
	HBA1_2	MN1_HBA1_2	MN1_HBA1_2_G350_3B	3B	2

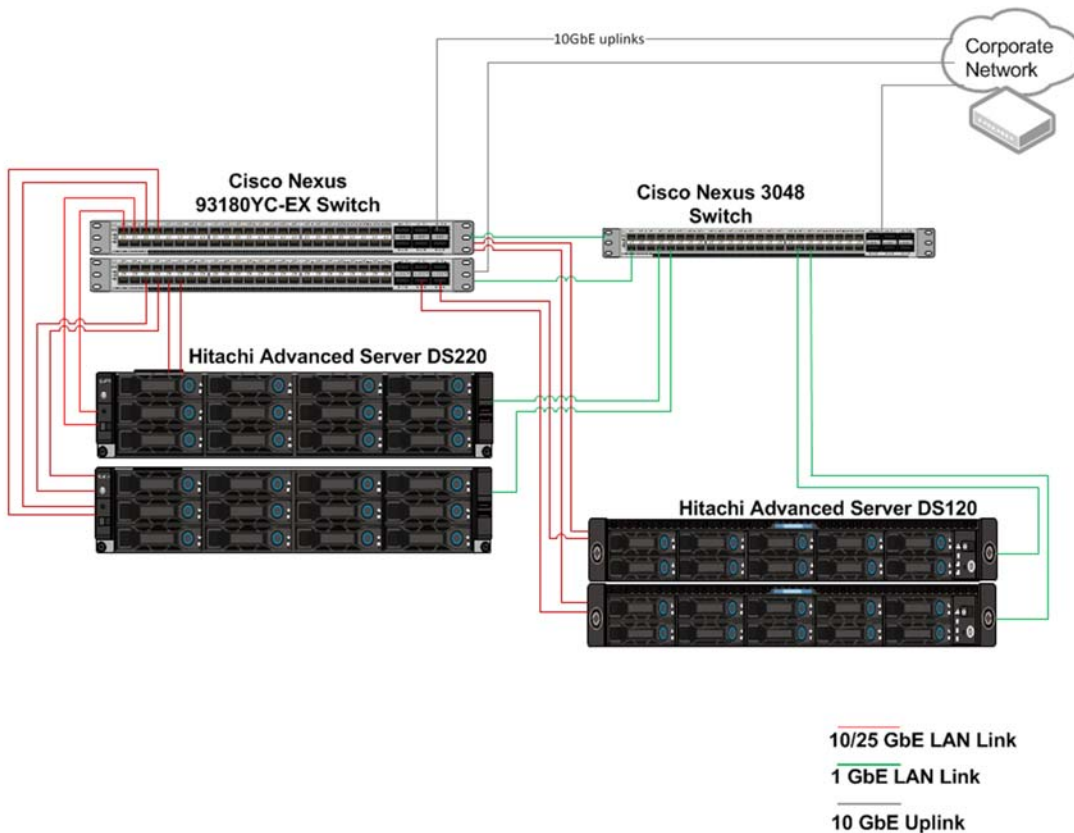
TABLE 10. SAN SWITCH ZONING CONFIGURATION (CONTINUED)

Server	HBA	Storage Host Group	Switch Zone	Storage Port	Brocade G620 Switch
DS120 – Mgmt. server 2	HBA1_1	MN2_HBA1_1	MN2_HBA1_1_G350_2B	2B	1
	HBA1_2	MN2_HBA1_2	MN2_HBA1_2_G350_4B	4B	2

### Network Architecture

Figure 3 shows the physical network connection used in this solution.

Figure 3



Oracle Real Application Cluster Database requires the following separate networks:

- **Private Network (also called cluster interconnect)** — This network must be scalable. In addition, it must meet the low latency needs of the network traffic generated by the cache synchronization of Oracle Real Application Clusters and inter-node communication among the nodes in the cluster.
- **Public Network** — This network provides client connections to the applications and Oracle Real Application Clusters.

Observe these points when configuring private and public networks in your environment:

- Hitachi Vantara recommends using pairs of 25 Gbps NICs for the cluster interconnect network and public network.
- Use NIC bonding to provide failover and load balancing of interconnections within a server.
- Set all NICs to full duplex mode.
- Configure each Oracle RAC server node with three bonding interfaces to provide failover and load balancing of interconnections within a sever:
  - Management network
  - Public network – recommended 2 per server
  - Private network – recommended 2 per server

Table 11 shows the IP network configuration used in this solution. Your values may be different.

When creating NIC Bonding pairs, ports should be used on different cards to avoid single point of failure (SPoF).

TABLE 11. IP NETWORK CONFIGURATION

Server	NIC Ports	NIC Bond	VLAN/ Subnet	IP Address	Network	Bandwidth (Gbps)	Cisco Nexus 93180YC-EX Switch	
							Switch Number	Port
DS220 Server 1	NIC0	Bond 0	242	192.168.242.142	Public Oracle	25	1	31
	NIC2					25	2	31
	NIC1	Bond 1	208	192.168.208.111	Private	25	1	32
	NIC3					25	2	32
	BMC - Dedicate d NIC	-	242	192.168.242.137	Public Managem ent	1	-	
DS220 Server 2	NIC0	Bond 0	242	192.168.242.144	Public Oracle	25	1	33
	NIC2					25	2	33
	NIC1	Bond 1	208	192.168.208.112	Private	25	1	34
	NIC3					25	2	34
	BMC - Dedicate d NIC	-	242	192.168.242.138	Public Managem ent	1	-	
Management Server 1	NIC0	-	242	192.168.242.101	Public	25	1	49

TABLE 11. IP NETWORK CONFIGURATION (CONTINUED)

Server	NIC Ports	NIC Bond	VLAN/ Subnet	IP Address	Network	Bandwidth (Gbps)	Cisco Nexus 93180YC-EX Switch	
							Switch Number	Port
	BMC - Dedicated NIC	-	244	192.168.242.169	Public Management	1	-	-
Management Server 2	NIC0	-	242	192.168.242.103	Public	25	1	50
	BMC - Dedicated NIC	-	244	192.168.242.170	Public Management	1	-	-

Table 12 shows IP addresses for management VMs used in this solution.

TABLE 12. IP ADDRESSES FOR MANAGEMENT VMS

Name	IP Address	Notes
Hitachi Infrastructure Analytics Advisor (HIAA)	192.168.242.194	IP Address for storage management and analytics
Hitachi Data Center Analytics (HDCA)	192.168.242.197	IP Address for storage management and analytics
Hitachi Storage Adapter for Oracle Enterprise Manager	192.168.242.125	Configuration and management of the storage system, and collects performance data
Hitachi Server Adapter for Oracle Enterprise Manager	192.168.242.126	Configuration and management of the storage system, and collects performance data
VMWare vCenter Appliance	192.168.242.102	Storage Management Software
Physical SVP	192.168.242.140	Storage virtual Platform
Oracle Enterprise Manager Cloud Control 13c	192.168.242.16	OEM software
Manager for Hitachi Adapter for Oracle Database	192.168.242.80	Hitachi Adapter management software
Hitachi Storage Advisor (HSA)	192.168.242.81	Storage Management software

Table 13 shows storage configuration for the management node used in this architecture.

TABLE 13. STORAGE AND VOLUME CONFIGURATION FOR MANAGEMENT NODE

Server/Application	Volume/Size	RAID Group	Notes
Mgmt. Node -1/Mgmt. Node - 2	4 x 3 TB SAS drives	Cluster Shared Storage	Cluster shared storage for management VMs
DS120 Server 101 (Local Disk)	Local 1 x 64 GB SATA DOM	N/A	Local Drive - Boot Device
DS120 server 103 (Local Disk)	Local 1 x 64 GB SATA DOM	N/A	Local Drive - Boot Device
vCenter	300 GB	Cluster Shared Storage	
Hitachi Infrastructure Analytics Advisor/Hitachi Data Center Analytics	800 GB	Cluster Shared Storage	
Hitachi Data Center Analytics Probe server	110 GB	Cluster Shared Storage	
Hitachi Adapter for Oracle Database	40-50 GB	Cluster Shared Storage	
Oracle Enterprise Manager Cloud Control	200 GB	Cluster Shared Storage	
Hitachi Storage Advisor	100 GB	Cluster Shared Storage	
vSVP	120 GB	Cluster Shared Storage	

### Hitachi Vantara Applications

The following Hitachi Vantara applications were used for data analytics and performance metrics gathering during execution of this solution.

- Hitachi Infrastructure Analytics Advisor v4.0 (HIAA)
- Hitachi Data Center Analytics Probe v9.0 (HDCA Probe) server

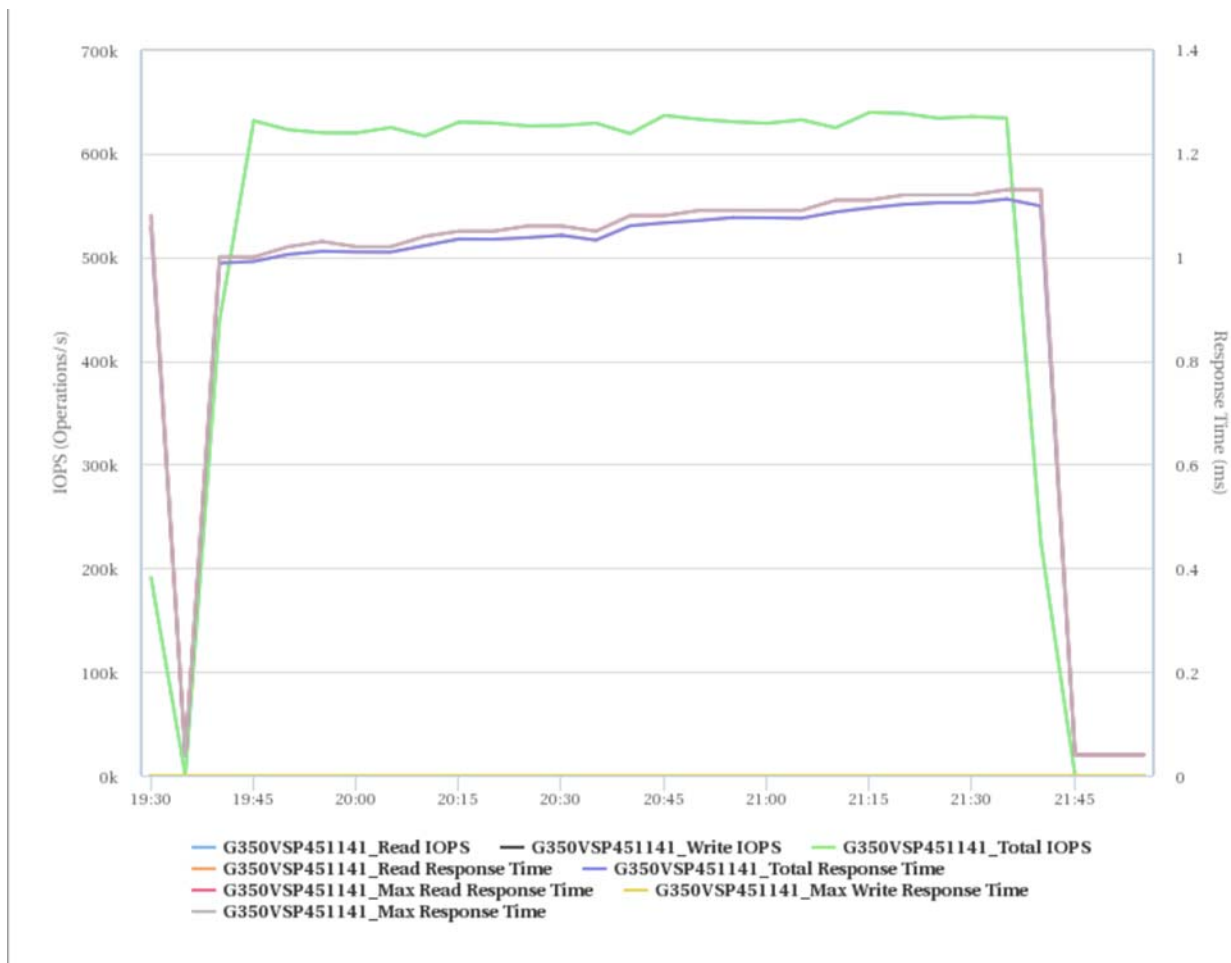
The following are the key features of Hitachi Infrastructure Analytics Advisor:

- Unified infrastructure monitoring dashboard
- Advanced reporting
- Storage I/O controls for SLO management
- System and Resource Events
- Granular Data Collection
- End-to-end monitoring

Please refer to the [Hitachi Infrastructure Analytics Advisor](#) for more details.

Figure 4 shows a performance graph of storage IOPS vs. response time from the HIAA and HDCA applications.

**Figure 4**



## Hitachi Storage Advisor (HSA)

Hitachi Storage Advisor is a unified software management tool that reduces the complexity of managing storage systems by simplifying the setup, management, and maintenance of storage resources.

Some of the key Storage Advisor capabilities include:

- Simplified user experience for managing infrastructure resources.
- Recommended system configurations to speed initial storage system setup and accelerate new infrastructure resource deployments.
- Integrated configuration workflows with Hitachi Vantara recommended practices to streamline storage provisioning and data protection tasks.
- Common, centralized management for supported storage systems.
- A REST-based API to provide full management programmability and control in addition to unified file-based management support.
- Storage Advisor enables automated SAN zoning during volume attaches and detach. Optional auto-zoning eliminates the need for repetitive zoning tasks to be performed on the switch.

Please refer to the [Hitachi Storage Advisor](#) documentation for more details.

Figure 5 shows Hitachi Storage Advisor with VSP G900 storage system.

**Figure 5**



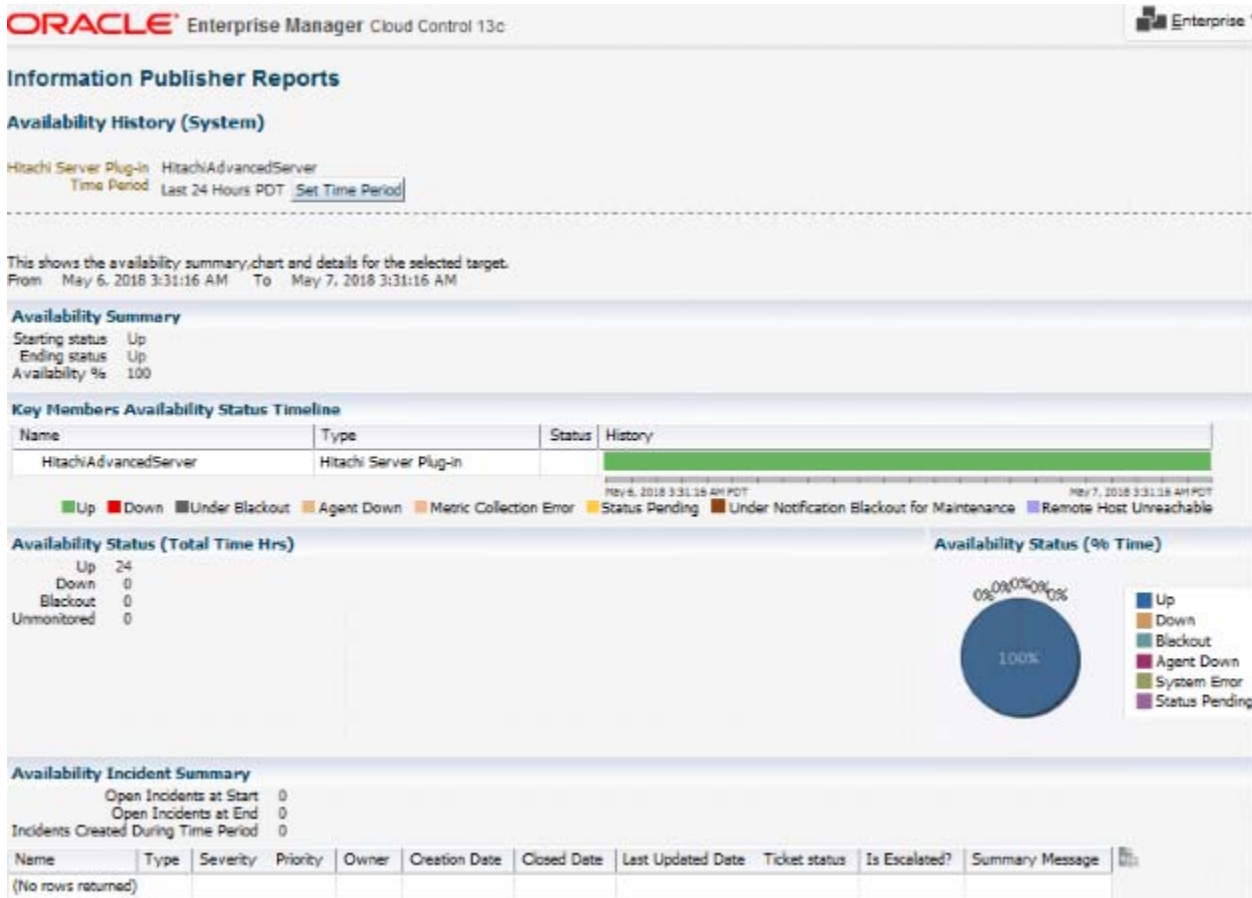


## Hitachi Server Adapter for Oracle Enterprise Manager

Hitachi Server Adapter for Oracle Enterprise Manager shows the availability summary chart and details about the selected target servers when Hitachi Server Adapter software plugin is installed in OEM.

Figure 6 shows system availability history report on Oracle Enterprise cloud control.

Figure 6



## Engineering Validation

This summarizes the key observations from the test results for Hitachi Unified Compute Platform CI for Oracle Real Application Cluster using two Hitachi Advanced Server DS220 and Hitachi Virtual Storage Platform G350 with Oracle Orion and peakmarks.

## Test Methodology

The test results are demonstrated using Oracle Orion and Peakmarks tools.

### Oracle Orion

Oracle Orion is a tool for predicting the performance of an Oracle database without having to install Oracle or create a database. Unlike other I/O calibration tools, Oracle Orion is expressly designed for simulating Oracle database I/O workloads using the same I/O software stack as Oracle. Orion can also simulate the effect of striping performed by Oracle Automatic Storage Management.

For more information about Orion, see "I/O Configuration and Design" in the Oracle [Database Performance Tuning Guide](#).

The Oracle Orion 12.2.0.1 tool is used to validate this solution.

### Peakmarks

[peakmarks](#) is the leading benchmark software for Oracle platforms that is used for the following:

- Performance verification (quality assurance)
- Evaluation of different infrastructure products, technologies, and solutions (price/performance comparison)
- Performance optimization (improvement in efficiency)

This provides transparency and comparability in price versus performance considerations for Oracle infrastructures.

The Peakmarks 9.2 tool is used to validate this solution.

### Database Configuration

Table 14 shows Oracle database parameters used in this solution.

TABLE 14. DATABASE PARAMETERS

Oracle Database Parameter	Value
Compatible	12.2.0.1
Cluster_database	TRUE
Cluster_database_instances	2
Oracle Database Size	8 TB
Database Storage Type	ASM
Database fill factor	80%

### Test Results

Table 15 shows Oracle Orion test cases, metrics, and results to validate this solution on two Oracle RAC nodes.

TABLE 15. ORACLE ORION TEST RESULTS

Test Case	Test/Workload Type	Metrics	Value
1	Storage performance - 100% OLTP Random Read (8k)	Max. IO/s	632,830
		Avg. RT	1.06 ms
2	Storage performance - 100% OLTP Random Writes (8k)	Max. IO/s	98,972
		Avg. RT	1.2 ms

TABLE 15. ORACLE ORION TEST RESULTS (CONTINUED)

Test Case	Test/Workload Type	Metrics	Value
3	Storage performance - 100% OLAP Sequential Reads (1024K)	Max. Throughput	12.1 GBps
4	Storage performance - 100% OLAP Sequential Writes (1024K)	Max. Throughput	4.7 GBps

Table 16 shows peakmarks baseline test cases, metrics, and results to validate this solution on two Oracle RAC nodes.

TABLE 16. PEAMKARKS TEST RESULTS - PEAKMARKS BASELINE

Test Case	Test/Workload Type	Test/Workload Type	Results
1	Storage performance - 100% OLTP Random Read (8k)	Max. IO/s	490,500
		Avg. RT	1.04 ms
2	Storage performance - 100% OLTP Random Writes (8k)	Max. IO/s	151,062
		Avg. RT	0.9 ms
3	Storage performance -100% OLAP Sequential Reads (1024K)	Max. Throughput	10.03 GBps
4	Storage mixed random read write (STO MIX 20% update ratio)	Max. IO/s	220,921
		Avg. RT	0.9 ms
5	Database medium OLTP select performance - 25 rows per transaction (DBX-S25)	Throughput in transaction per second	17,053
		Throughput in rows per second	426,331
		Avg. RT for SQL statement	7.36 ms

TABLE 16. PEAMKARKS TEST RESULTS - PEAKMARKS BASELINE (CONTINUED)

Test Case	Test/Workload Type	Test/Workload Type	Results
6	Server performance test - (SRV-S25)	Throughput in transaction per second	14,860
		Throughput in rows per second	1,069,953
		Throughput in logical buffer reads per second	28,183,253
		Avg. RT for SQL statement	0.10 ms
7	CPU processor performance test -Arithmetic ADD operation (CP2-SA)	Throughput in operations per second	98,018,673,985

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