Hitachi Solution for Databases - Virtualized Oracle Real Application Cluster (RAC) on VMware vSphere using Hitachi Virtual Storage Platform E990 and Hitachi Advanced Server DS220

Reference Architecture Guide

By Hitachi Vantara

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Feedback

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Revision History

Revision	Changes	Date
MK-SL-209-00	Initial release	November 17, 2020

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Hitachi Solution for Databases - Virtualized Oracle Real Application Cluster (RAC) on VMware vSphere using Hitachi Virtual Storage Platform E990 and Hitachi Advanced Server DS220

Reference Architecture Guide

The use of Hitachi Solution for Databases with Oracle Real Application Cluster (RAC) virtualized on VMware vSphere provides significant dynamic scalability, high availability, and reliability benefits while processing small to large Oracle workloads and maintaining predictable performance capabilities for varying deployment types. This reference architecture provides a validated virtualization solution for Oracle Database 19c running on VMware ESXi 6.7 while keeping virtualization overhead to a minimum, with virtual machines using Oracle Linux 7.8 as Oracle RAC instances.

Hitachi Solution for Databases with virtualized Oracle RAC on VMware vSphere is a fast, agile offering from Hitachi Vantara that makes efficient use of deployed resources. Oracle on VMware aims for simplifying IT transformation, as it offers increased efficiency, quality of service, predictable performance, flexible journey to minimize cost, dynamic scalability, disaster recovery with VMware vSphere and-most importantly-it is intuitive to implement.

This solution integrates many innovative technologies from Hitachi Vantara, Oracle, and VMware. To prepare virtualized Oracle RAC on VMware vSphere, this environment includes the following:

- Hitachi Virtual Storage Platform (VSP E990)

- Hitachi Advanced Server DS220 for storage and computing resources

- Hitachi Advanced Server DS120 for management servers

- Oracle Real Application Cluster 19c

- VMware vCenter Server Appliance

- VMware ESXi

- VMware vSphere

- Running Oracle databases on VMware vSphere provides the following benefits:

- Dynamic scalability

- Predictable performance

- High availability

This solution provides the flexibility to select storage and compute resources based on unique requirements. Deploy small databases as well as large databases, depending on resource availability.

This document is for the following audiences:

- Database administrators

- Storage administrators

- System administrators

To use this reference architecture guide, you need familiarity with the following:

- Hitachi Virtual Storage Platform E990

- Hitachi Advanced Server DS220 servers

- Hitachi Advanced Server DS120 servers

- Storage Area Networks

- Oracle Database administration

- Oracle Database 19c Release 3

- Oracle Linux

- VMware vCenter Server Appliance

- VMware ESXi

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.

Solution Overview

Use this reference architecture to implement Hitachi Solution for Databases with virtualized Oracle Real Application Cluster (RAC) on VMware vSphere using DS220 as VMware ESXi hosts and Hitachi Virtual Storage Platform E990 (VSP E990) with VMware vCenter Server Appliance. This solution is engineered, pre-tested, and qualified to provide high performance, high availability, and high reliability in demanding, dynamic Oracle environments. This reference architecture implements Hitachi Solution for Databases for Oracle Real Application Clusters database on two VMware ESXi hosts using VSP E990, which addresses high availability, performance, and scalability requirements for OLTP and OLAP workloads.

Business Benefits

The Oracle RAC solution for VMware vSphere virtualization provides numerous benefits to database administrators because it creates a layer of abstraction between application, operating system, and the underlying hardware. VMware vCenter Server Appliance manages the node resources jointly such that the cluster owns all the CPU and memory of all nodes.

The following are some of the benefits of this reference architecture:

- Achieve high Oracle Real Application Clusters database performance with VSP E990 storage.

- Provide a solution for customers who are looking for converged Oracle products – not covered by physical servers for Oracle RAC.

- Create a VMware ESXi cluster with multiple Hitachi Advanced Server DS220 servers to deploy virtual machines for an Oracle Real Application Clusters database deployment.

- Add or remove ESXi hosts in the VMware ESXi cluster based on business requirements.

- Using the Oracle solution with VMware ESXi reduces space, power consumption, and IT administrative requirements while driving high-speed performance.

High Level Infrastructure

Hitachi Solution for Databases with virtualized Oracle Real Application Cluster (RAC) on VMware vSphere includes the following components:

- Hitachi Advanced Server DS220 servers
- Hitachi Advanced Server DS120 servers
- Hitachi Virtual Storage Platform E990
- Brocade G620 32 Gb/s SAN infrastructure
- Cisco 10/25 GbE LAN infrastructure

The configuration of Virtual Storage Platform E990 and Advanced Server DS220 has the following characteristics:

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

Figure 1shows the high-level infrastructure for this solution.

Figure 1
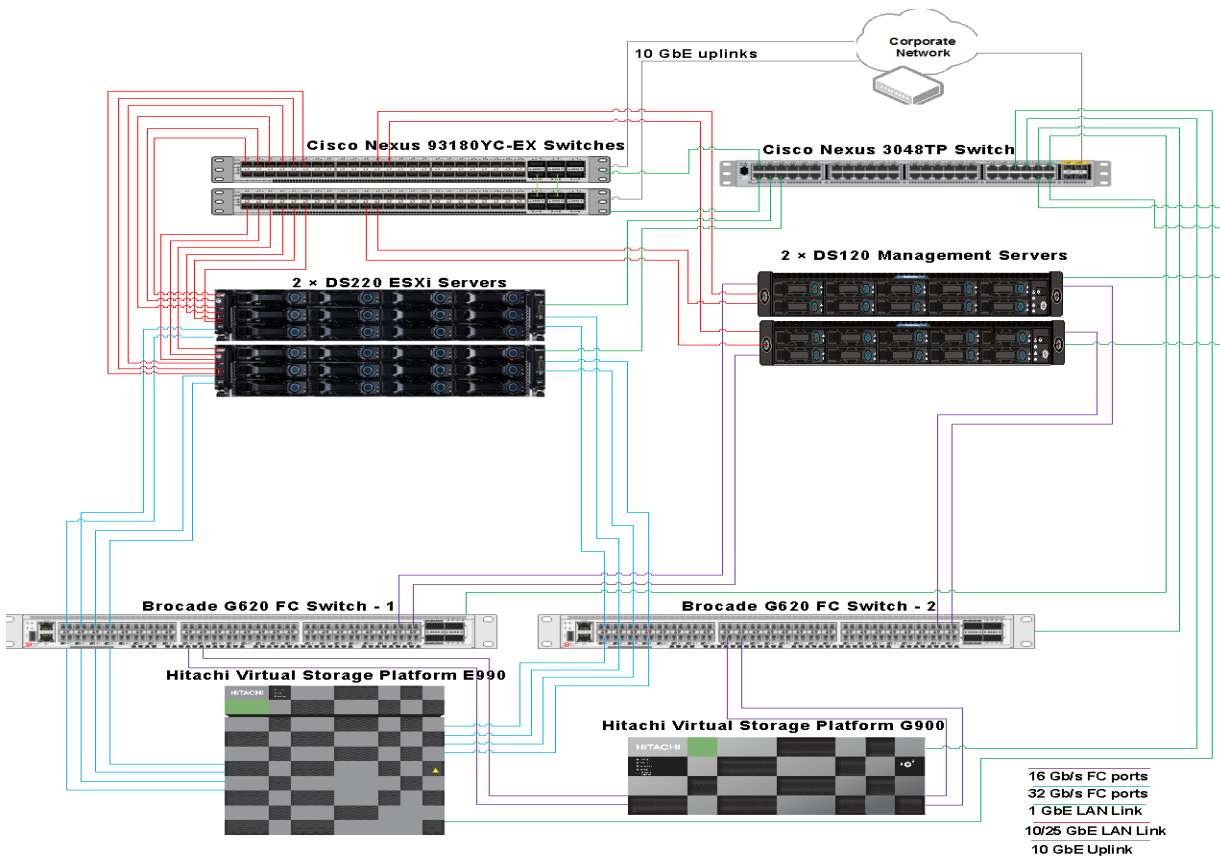
To avoid any performance impact to the production database, Hitachi Vantara recommends using a configuration with the following characteristics:

▪ A dedicated storage system for the production database

▪ A dedicated storage system for storing backup data, if needed

The uplink speed to the corporate network depends on the customer environment and requirements. The Cisco Nexus 93180YC-EX switches used in this reference architecture can support uplink speeds of 40 GbE or 100 GbE if higher bandwidth is required.

Key Solution Components

The key solution components for this solution are listed in Table 1, Table 2, and Table 3. Detailed component information is provided in the Product Descriptions section.

TABLE 1. HARDWARE COMPONENTS

Hardware	Detail Description	Version	Quantity
Hitachi Virtual Storage Platform VSP E990	Two Controllers: 8 × 32Gb/s Fibre Channel ports 1024 GB cache memory 16 × 1.9 TB Backend NVMe SDDs	93-01-01-60/01	1
Hitachi Virtual Storage Platform VSP G900	Two Controllers 4 × 32 Gbps Fibre Channel ports 16 × 12 Gbps backend SAS ports 512 GB cache memory 4 × 6.0 TB 7.2K RPM SAS drives	88-04-02-60/00	1
Hitachi Advanced Server DS220	2 × Intel Xeon Platinum 8276L 28C CPU @ 2.20GHz 768 GB (64GB × 12) DIMM DDR4 Synchronous Registered (Buffered) 2666 MHz	BIOS: S5BH3B16.H00 BMC: 4.64.06 CPLD: 11	2
	2 Intel XXV710 dual port 25 GbE NIC cards	Driver: i40e Driver Version: 1.7.17 Firmware: 6.8	
	Intel X722 Dual Port 10 GbE SFP+	Driver: i40e Driver Version: 1.7.17 Firmware: 4.0	
	2 × Emulex LightPulse LPe31002-M6 2-Port 16Gb Fibre Channel Adapters	Driver: lpfc Driver Version: 12.0.193.14. Firmware: 12.0.193.13	

TABLE 1. HARDWARE COMPONENTS (CONTINUED)

Hardware	Detail Description	Version	Quantity
Hitachi Advanced Server DS120	2 × Intel Xeon Gold Processor 6240, 18-core, 2.60GGHz, 85W 256 GB (32 GB × 8) DIMM DDR4 Synchronous Registered (Buffered) 2666 MHz 1 × 64 GB MLC SATADOM for boot	BIOS: S5BH3B16.H00 BMC: 4.64.06 CPLD:11	2
	1 × Dual Port 25 GbE NIC Intel XXV710 PCIe card	Driver Version: 1.7.17 Firmware: 6.80 (1.2007.0)	
	1 × Emulex LightPulse LPe31002-M6 2-Port 16 Gb Fibre Channel Adapters	Firmware: 12.0.193.13 Driver version: 12.0.193.14	
Brocade G620 Fibre Channel switches	24 × 48 port Fibre Channel switches 32 Gb/s SFPs	Kernel: 2.6.34.6 Fabric OS: v8.2.0b	2
Cisco Nexus 93180YC-EX	48 × 10/25 GbE fiber ports 6 × 40/100 Gbps Quad SFP (QSFP28) ports	BIOS: version 07.61 NXOS: version 7.0(3)I7(6)	2
Cisco Nexus 3048TP	1 GE 48-Port Gb Ethernet Switch	BIOS: version 4.0.0 NXOS: version 7.0(3)I4(7)	1

Note – The solution was tested with PCIe and OCP mezzanine NIC cards. Using all PCIe cards is recommended for consistency and better NIC bonding options. SATADOM, SAN boot, or local boot can be used for the boot option.

TABLE 2. SOFTWARE COMPONENTS FOR COMPUTE NODES

Software	Version	Function
Oracle Linux	7.8 with UEK kernel update 5.4.17-2011.4.6.el7uek.x86_64	Operating system for Oracle VM
Oracle Database	19c (19.3.0.0)	Database software
Oracle Grid Infrastructure	19c (19.3.0.0)	Volume management, file system software, and Oracle automatic storage management

TABLE 3. SOFTWARE COMPONENTS FOR MANAGEMENT NODES

Software	Version	Function
VMware ESXi	6.7.0 U3	Hypervisor for management server
VMware vCenter Server Appliance	6.7.0 U3	VMware cluster management server
Hitachi Device Manager- Storage Navigator	Microcode dependent	Storage management software
Hitachi Ops Center	10.2.0	Hitachi infrastructure management software
Swingbench	2.6.0	Oracle database stress test tool

Solution Design

This describes the reference architecture environment to implement Hitachi Solution for Databases with virtualized Oracle RAC on VMware vSphere. The environment uses Hitachi Virtual Storage Platform E990.

The infrastructure configuration includes the following:

- VMware ESXi server – There are two hosts configured in an Oracle database environment.

- Management Node – One VMware vCenter Server Appliance is used to manage all ESXi hosts.

- Storage System – There are virtual volumes 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 storage configuration takes into consideration Hitachi Virtual Storage Platform, Oracle, and VMware recommended best practices for the design and deployment of database storage.

Figure 2 illustrates the high-level storage configuration for this solution.

Figure 2

Figure 2

```
┌─────────────────────────────────────────────────────────┐      ┌──────────────────────────┐
│              Hitachi Advanced Server DS220                │      │  Hitachi Advanced Server │
│-----------------------------------------------------------│      │           DS120          │
│                    Virtual Machines                       │      │                          │
│   ┌──────────────────┐        ┌──────────────────┐        │      │  ┌────────────────────┐  │
│   │ Virtual Machine 1│        │ Virtual Machine 2│        │      │  │ VMware ESXi Cluster│  │
│   └──────────────────┘        └──────────────────┘        │      │  │                    │  │
│   ┌───────────────────────────────────────────────┐       │      │  │ ┌──────┐  ┌──────┐ │  │
│   │                Database VM                     │       │      │  │ │Node 1│──│Node 2│ │  │
│   └───────────────────────────────────────────────┘       │      │  │ └──────┘  └──────┘ │  │
│   ┌───────────────────────────────────────────────┐       │      │  └────────────────────┘  │
│   │             Oracle Database                    │       │      │                          │
│   └───────────────────────────────────────────────┘       │      └──────────────────────────┘
│   ┌───────────────────────────────────────────────┐       │
│   │           Oracle ASM Disk Group                │       │
│   │ DATADG  REDODG  FRADG  TEMPDG  OCRDG            │       │
│   └───────────────────────────────────────────────┘       │
│   ┌───────────────────────────────────────────────┐       │
│   │             VMware ESXi cluster                │       │
│   │ Hitachi Server 1      Hitachi Server 2         │       │
│   └───────────────────────────────────────────────┘       │
└─────────────────────────────────────────────────────────┘
                        ESXi multipathing
```

Solid State Drives: SSD RAID-10 (2D+2D), SSD RAID-10 (2D+2D), SSD RAID-10 (2D+2D), SSD RAID-10 (2D+2D)

8 Storage Ports

Dynamic Provisioning Pool — 70 VVols

Hitachi Virtual Storage Platform E990

4 Storage Ports

3 LDEVs for cluster shared storage and 1 Command Device
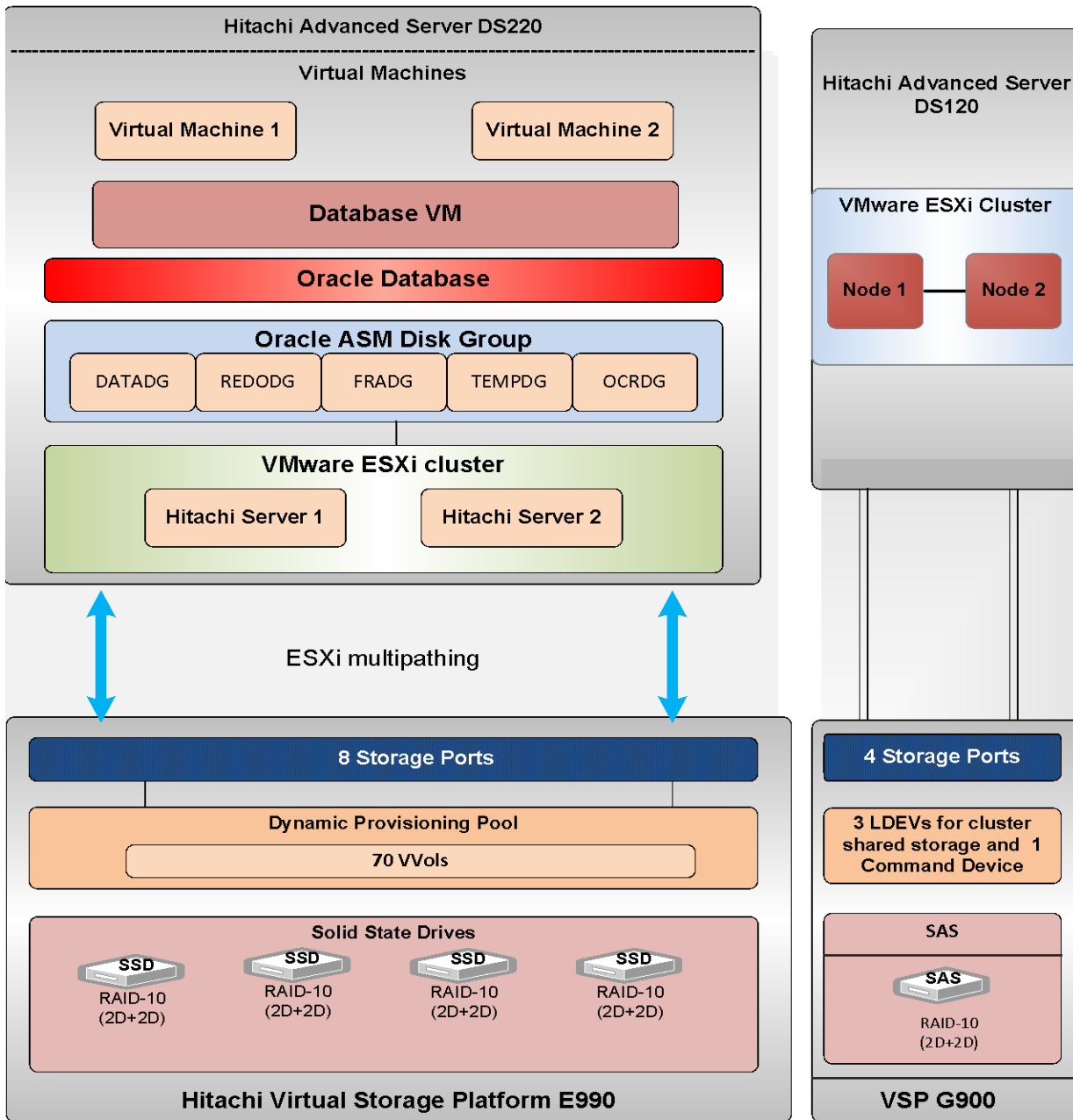
SAS — SAS RAID-10 (2D+2D)

VSP G900

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

TABLE 4. DYNAMIC PROVISIONING POOL FOR HITACHI VIRTUAL STORAGE PLATFORM E990

Pool ID	VMware-ESXi-Cluster
Pool Type	Dynamic Provisioning Pool
RAID Group	1-1 to 1-4
RAID Level	RAID-10 (2D+2D)
Drive Type	1.9 TB SSD
Number of Drives	16
Number of LDEVs	70
LDEV Size(s)	880 GB
Pool Capacity	13.74 TB

In this solution, servers use SAN boot with RAID 10 protection. Table 5 shows the logical storage configuration used in this solution.

TABLE 5. VSP E990 LOGICAL STORAGE CONFIGURATION

ASM disk group	Total number of dynamic provision volumes	Dynamic provisioning volume sizes	Purpose	Storage Port
DATA	16	200 GB	OLTP application tablespaces, system sysaux, undo, temp	1A, 2A, 1B, 2B, 1C, 2C, 1D, 2D
REDO	8	10 GB	Online redo logs and control files	
TEMP	4	40 GB	Temp logs	
FRA	2	200 GB	Incremental backups, archived redo logs, control file and auto backups	
OCR	3	60 GB	Oracle cluster registry and voting disk	
N/A	2	200 GB	SAN Boot host OS volumes	
N/A	2	200 GB	SAN Boot Oracle RAC VM OS volumes	

Table 6 shows the VSP G900 configuration for management servers.

TABLE 6. VSP G900 CONFIGURATION FOR MANAGEMENT SERVERS

Item	Value or Description
Purpose	VMware datastores CCI device
RAID Level	RAID-10 (2D+2D)
Drive Type	6.0 TB 7.2K RPM SAS
Number of Drives	4
Number of Spare Drives	0
Number of LDEVs	3
LDEV Size(s)	3000 GB
Number and Size of CCI device	1 × 100 MB
Storage Port for Management Servers	7A, 7B, 8A, 8B

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.

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 dynamic provisioning pool, and capacity on the dynamic provisioning pool configured for the Oracle environment.

Database Layout

The database layout design uses recommended practices from Hitachi Vantara for Hitachi Virtual Storage Platform E990 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 the specific application implementation. The design can vary greatly from one implementation to another, based on the RAID configuration type and number of drives used in the implementation.

The components in this solution have the flexibility for use in various deployment scenarios to provide the right balance between performance and ease of management for a given scenario.

The database layout has two nodes with Oracle RAC instances. The Oracle Linux 7.8 operating system is installed on two vCenter VMs with Oracle RAC database installed on them.

Shared LUNs from storage are assigned to two VMs as shared virtual machine disks (VMDK) for the Oracle RAC database. The shared LUN is mapped to a datastore cluster, and virtual machine disks (VMDK) are utilized for OS SAN boot of VMs.

Oracle ASM Configurations

- **Data and Indexes Tablespace** - Assign an ASM diskgroup with external redundancy for the data and index tablespaces.

- **TEMP Tablespace** - Place the TEMP tablespace in this configuration in the TEMP ASM diskgroup.

- **Undo Tablespace** - Create an UNDO tablespace in this configuration within the Oracle Data ASM diskgroup.

- **Online Redo Logs** - Create an ASM diskgroup with external redundancy for Oracle online redo logs.

- **Oracle Cluster Registry and Voting Disk** - Create an ASM diskgroup with normal redundancy to contain the OCR and voting disks and to protect against single disk failure to avoid loss of cluster availability. Place each of these files in the OCR ASM diskgroups.

Oracle Initial Parameters

Table 7 lists the Oracle Database settings.

TABLE 7. ORACLE DATABASE SETTINGS

Environment	Value
RAC	Yes
ASM	Yes – to support Oracle RAC Database

Oracle ASM Disk Mappings

Table 8 lists the details of the disk mappings from the LUNs to the ASM disk groups for Oracle Database tablespaces for the 2 TB database size. This is an example with a single instance database virtual machine. Adjust parameters accordingly when multiple virtual machine pairs are used.

TABLE 8. LUN DISK MAPPINGS TO ASM GROUPS

ASM Disk Group	ASM Disk	UDEV Rules	LUN Details	Purpose
N/A	N/A	/dev/xvd[a-b]1	2 × 200 GB	OS and Oracle Database
OCR	N/A	/dev/xvd[c-e]1	3 × 60 GB	Oracle cluster registry and voting disk
DATA	N/A	/dev/xvd[f-u]1	16 × 200 GB	Application data
REDO	N/A	/dev/xvd[v-z]1, /dev/xvda[a-c]1	8 × 10 GB	Online REDO log group
FRA	N/A	/dev/xvda[d-e]1	4 × 200 GB	Flash recovery area
TEMP	N/A	/dev/xvda[f-i]1	4 × 40 GB	Temp

Management Server Configurations

Table 9 lists management server virtual machine (VM) configuration details.

TABLE 9. MANAGEMENT SERVER VIRTUAL MACHINE CONFIGURATION

Virtual Machine	vCPU	Virtual Memory	Disk capacity	IP Address
vCenter Server Appliance	2	10 GB	300 GB	192.168.242.xx
Hitachi Ops Center Administrator	4	16 GB	100 GB	192.168.242.xx
Hitachi Ops Center Analyzer	4	32 GB	800 GB	192.168.242.xx
Hitachi Ops Center Analyzer detail view	4	10 GB	110 GB	192.168.242.xx

Server and Application Architecture

This reference architecture uses two Hitachi Advanced Server DS220 servers for each storage system. This provides the compute power for the VMware infrastructure that is used for the Oracle RAC database deployment.

Two Hitachi Advanced Server DS120 servers are used for VMware ESXi management server configuration as well as additional virtual machines to manage the environment.

Table 10 lists the details of the server configurations for this solution.

TABLE 10. HITACHI ADVANCED SERVER DS220 AND DS120 SPECIFICATIONS

Server Name and Model	Server Host Name	Role	CPU Core	RAM
DS220	VMware ESXi server 1	VMware ESXi server for Oracle RAC database VM	56 (2 × 28C)	768 GB (64 GB × 12)
	VMware ESXi server 2	VMware ESXi server for Oracle RAC database VM	56 (2 × 28C)	768 GB (64 GB × 12)
DS120	VMware ESXi 1	Management server for Hitachi management applications	16	256 GB (32 GB × 8)
	VMware ESXi 2		16	256 GB (32 GB × 8)

SAN Architecture

Map the provisioned LDEVs to multiple ports on Hitachi Virtual Storage Platform E990 (VSP E990). These LDEV port assignments provide multiple paths to the storage system from the host for high availability. This reference architecture uses two dual port Emulex HBAs per Advanced Server DS220.

- Compute Servers

- 8 SAN switch connections are used for VSP E990 Fibre Channel ports.

- 8 SAN switch connections are used for server HBA ports.

- Management Servers

- 4 SAN switch connections are used for VSP G900 Fibre Channel ports.

- 4 SAN switch connections are used for management server HBA ports.

Table 11 lists details of the Fibre Channel switch connect configuration on Hitachi Virtual Storage Platform E990 SAS ports.

TABLE 11. SAN HBA CONNECTION CONFIGURATION TO HITACHI VIRTUAL STORAGE PLATFORM E990

Server	HBA	Host Group Name	Host Name	Switch Zone	Storage System	Storage Port	Brocade G620 Switch
DS220 Server 1	HBA1	CN31	CN31_HBA1_1	CN31_HBA1_1_ ASE44_66_1A	VSP E990	1A	SAN-switch 1
	HBA2	CN31	CN31_HBA1_2	CN31_HBA1_2_ ASE44_66_2A		2A	SAN-switch 2
	HBA3	CN31	CN31_HBA2_1	CN31_HBA2_1_ ASE44_66_1B		1B	SAN-switch 1
	HBA4	CN31	CN31_HBA2_2	CN31_HBA2_2_ ASE44_66_2B		2B	SAN-switch 2
DS220 Server 2	HBA1	CN32	CN32_HBA1_1	CN32_HBA1_1_ ASE44_66_3A		3A	SAN-switch 1
	HBA2	CN32	CN32_HBA1_2	CN32_HBA1_2_ ASE44_66_4A		4A	SAN-switch 2
	HBA3	CN32	CN32_HBA2_1	CN32_HBA2_1_ ASE44_66_3B		3B	SAN-switch 1
	HBA4	CN32	CN32_HBA2_2	CN32_HBA2_2_ASE44_66_4B		4B	SAN-switch 2

TABLE 11. SAN HBA CONNECTION CONFIGURATION TO HITACHI VIRTUAL STORAGE PLATFORM E990 (CONTINUED)

Server	HBA	Host Group Name	Host Name	Switch Zone	Storage System	Storage Port	Brocade G620 Switch
DS120 Server1	HBA1	MN33	MN33_HBA1	MN33_HBA1_ASE42_43_1A	VSP G900	1A	SAN-switch 1
	HBA2	MN33	MN33_HBA2	MN33_HBA2_ASE42_43_3A		3A	SAN-switch 2
DS120 Server2	HBA1	MN34	MN34_HBA1	MN34_HBA1_ASE42_43_2A		2A	SAN-switch 1
	HBA2	MN34	MN34_HBA2	MN34_HBA2_ASE42_43_4A		4A	SAN-switch 2

Note – In a production environment, use separate storage ports for the management servers to avoid impact on database performance. While shared storage ports can be used, monitor port utilization to avoid performance issues in high performance environments.

Network Architecture

Do the following when configuring networks in your environment:

- Use NIC bonding to provide failover and load balancing of interconnections within a server.
- Set all NICs to full duplex mode.

Configure each VMware ESXi server node with at least the bonding interfaces for the following:

- Management network
- Public network
- Private network

Each virtual machine has public, private and management vNICs. Use separate VLANs for the following:

- VMware vCenter server management network
- Private Oracle database network
- Public network

Table 12 describes the network configuration for VMware vCenter virtual machines installed with Oracle RAC database.

TABLE 12. NETWORK CONFIGURATION FOR VMWARE VCENTER VIRTUAL MACHINES

VMs	vSwitch	Network	IP Configuration	Uplinks	Bandwidth
Oracle RAC VM 1 and Oracle RAC VM 2	IDSE-DSwitch	Management Network	10.76.32.xx	Uplink 1	10 GbE
			10.76.32.xx	Uplink 2	
		Public Network	10.76.32.xx	Uplink 4	25 GbE
			10.76.32.xx	Uplink 6	
		Private Network	192.168.100.xx	Uplink 3	25 GbE
			192.168.100.xx	Uplink 5	

Physical Network Configuration

Figure 3 shows the IP network switch connection.

Figure 3
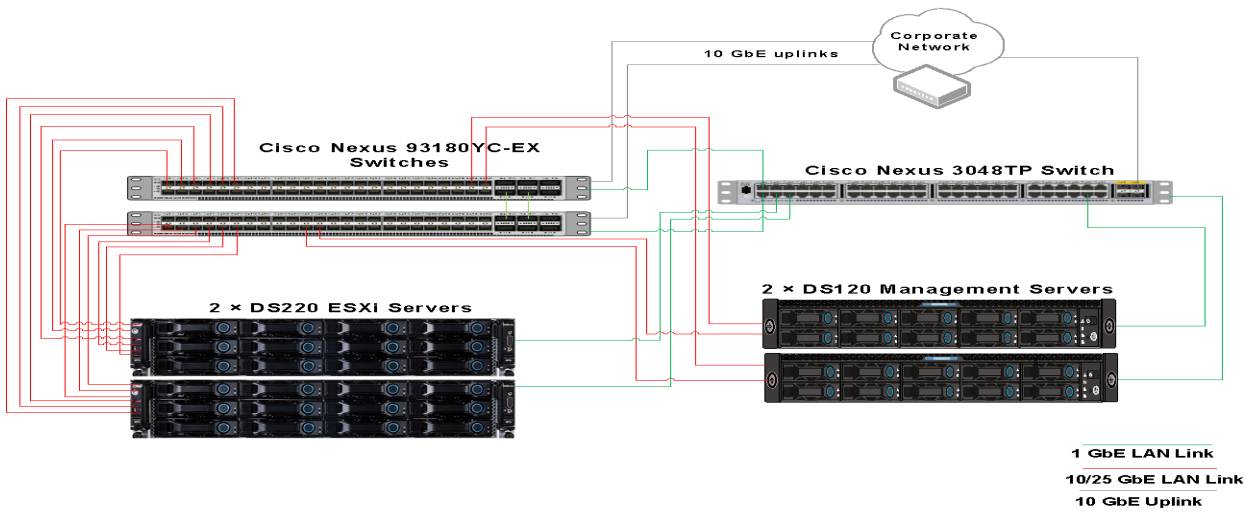
Table 13, Table 14, and Table 15 list the network configurations for this solution.

TABLE 13. HITACHI ADVANCED SERVER DS220 AND DS120 NETWORK CONFIGURATION

Server	NIC Ports	Subnet	NIC Bond	IP Address	Network	Bandwidth (Gb/s)	Cisco Nexus 93180YC-EX Switch	
							Switch Number	Port
DS220 Server1	NIC 1-Port 0	242	Bond0	192.198.242.204	Management/ Public	10	1	41
	NIC 1-Port 1					10	2	
	NIC 2-Port 0	242	Bond1	192.198.242.205	Public	25	1	42
	NIC 3-Port 0					25	2	
	NIC 2-Port 1	100	Bond2	192.168.100.10	Private/Public	25	1	
	NIC 3-Port 1					25	2	
DS220 Server2	NIC 1-Port 0	242	Bond0	192.198.242.206	Management/ Public	10	1	43
	NIC 1-Port 1					10	2	
	NIC 2-Port 0	242	Bond1	192.198.242.207	Public	25	1	44
	NIC 3-Port 0					25	2	
	NIC 2-Port 1	100	Bond2	192.168.100.11	Private/Public	25	1	
	NIC 3-Port 1					25	2	
DS120 Management Server1	NIC 1-Port 0	242	Bond0	192.198.242.101	Management/ Public	25	1	49
	NIC 1-Port 1					25	2	
DS120 Management Server2	NIC 1-Port 0	242	Bond0	192.198.242.102	Management/ Public	25	1	50
	NIC 1-Port 1					25	2	

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

TABLE 14. NETWORK CONFIGURATION FOR SERVERS AND HITACHI VIRTUAL STORAGE PLATFORM E990

Name	IP Address
VMware ESXi Server 1	192.168. 242.xx
VMware ESXi Server 2	192.168. 242.xx
Management Server 1	192.168.242.xx
Management Server 2	192.168.242.xx
VSP E990	192.168.242.xx
VSP E990 CTL1	192.168.242.x
VSP E990 CTL2	192.168.242.x

TABLE 15. NETWORK CONFIGURATION FOR SWITCHES

Switch Type	Model	Switch Name	IP Address for MGMT Port
Cisco 1GbE Management Network Switch	Cisco Nexus 3048TP	Cisco3048TP-1	192.168.242.95
Cisco 10G/25GbE Network Switch	Cisco Nexus N9K-C93180YC-EX	Cisco C93180YC-EX-1	192.168.242.97
Cisco 10G/25GbE Network Switch	Cisco Nexus N9K-C93180YC-EX	Cisco C93180YC-EX-2	192.168.242.98
Brocade Fibre Channel SAN Switch	G620	SAN-switch 1	192.168.242.67
Brocade Fibre Channel SAN Switch	G620	SAN-switch 2	192.168.242.68

Engineering Validation

This summarizes the key lab verification tests performed on Hitachi Solution for Databases - Virtualized Oracle on Hitachi Unified Compute Platform CI using Hitachi Virtual Storage Platform E990 and Hitachi Advanced Server DS220.

Database Configuration

Table 16 lists parameter details for a two node Oracle ASM database.

TABLE 16. ORACLE ASM DATABASE PARAMETERS

Oracle Database Parameter	Value
Compatible	19.3.0.0.0
Oracle Database size	2 TB
Database storage type	ASM
Database fill factor	80%

Table 17 shows the details of Oracle Database environment parameters for peakmarks.

TABLE 17. ORACLE DATABASE ENVIRONMENT PARAMETERS

Category	Item	Value
Oracle Database environment parameters	SGA_TARGET	32 GB
	PGA_AGGREGATE_TARGET	13 GB
	DB_KEEP_CACHE_SIZE	6 GB
	DB_RECYCLE_CACHE_SIZE	2 GB
	INMEMORY_SIZE	800 MB

Testing Environment

Table 18 lists configuration details for Hitachi Virtual Storage Platform E990 with SAS backend with one node for testing.

TABLE 18. TEST ENVIRONMENT

Item	Value
Operating System	OL 7.8
Workload Type	OLTP/OLAP
Database Size	2 TB
Number of vCPUs	16

TABLE 18. TEST ENVIRONMENT (CONTINUED)

Virtual Memory	128 GB
Host Cluster VM Network	2 × 25 Gbps NIC Bonding
	1 × 10 Gbps NIC Bonding

Test Methodology

Oracle Orion and peakmarks were used for performance testing of this solution.

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.

peakmarks

The test results are demonstrated using peakmarks OLTP test cases.

peakmarks is benchmark software for Oracle platforms. It was used in our tests 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 9.4 tool is used to validate this solution.

Failover and Failback tests using VMware vSphere vMotion

VMware vSphere vMotion allows the migration of virtual machines to different hosts and datastores simultaneously with no downtime. The migration process is completely transparent to users. Processed virtual machines continue to run with no service disruption.

Test scenarios performed using vSphere vMotion:

- Virtual machine migration with compute resources. In this case, only the virtual machines and its compute resources are migrated to a specified VMware ESXi host.
- Virtual machine migration with compute and storage resources. In this case, the virtual machine with its compute and storage resources are migrated to a specified ESXi host.
- ESXi host failover. In this case, due to ESXi host failover, the virtual machines connected to a failed ESXi host migrate to any other active ESXi hosts using vSphere vMotion.

Test Results

Table 19 provides Orion test result details.

TABLE 19. ORION TEST RESULTS

Test Category	Test Case	Test Result	
		Throughput	**RT (ms)**
Orion	8 KB Random Read	602,025 IOPS	1.3
	8 KB Random Write	327,078 IOPS	0.8
	1 MB Sequential Read	13.783 GB/s	N/A
	1 MB Sequential Write	4.292 GB/s	N/A

Table 20 provides peakmarks test results.

TABLE 20. PEAKMARKS TEST RESULTS

Test Category	Test Case	Test Results	
		Throughput	**RT (ms)**
peakmarks	STO-READ	13.022 GB/s	N/A
	STO-Random 100% read	455,618 IOPS	1.8
	SRV-SCAN	29,936 GB/s	N/A
	DA-LOW/ ROW	29.779 GB/s	N/A
	DA-LOW/STO	12.510 GB/s	N/A
	TP-LIGHT 1 RPT 0 %update	115,672 TPS	0.4
	TP-LIGHT 1 RPT 20 %update	47,076 TPS	0.6
	TP-LIGHT 1 RPT 30%update	44,817 TPS	0.6
	TP-MEDIUM 25 RPT 0%update	13,535 TPS	0.2
	TP-MEDIUM 25 RPT 20%update	1,238 TPS	0.4
	TP-MEDIUM 25 RPT 30%update	1,437 TPS	0.3

Figure 4 shows swingbench data with all transactions that occurred while the virtual machine was migrated with compute and storage resource information.

Figure 4
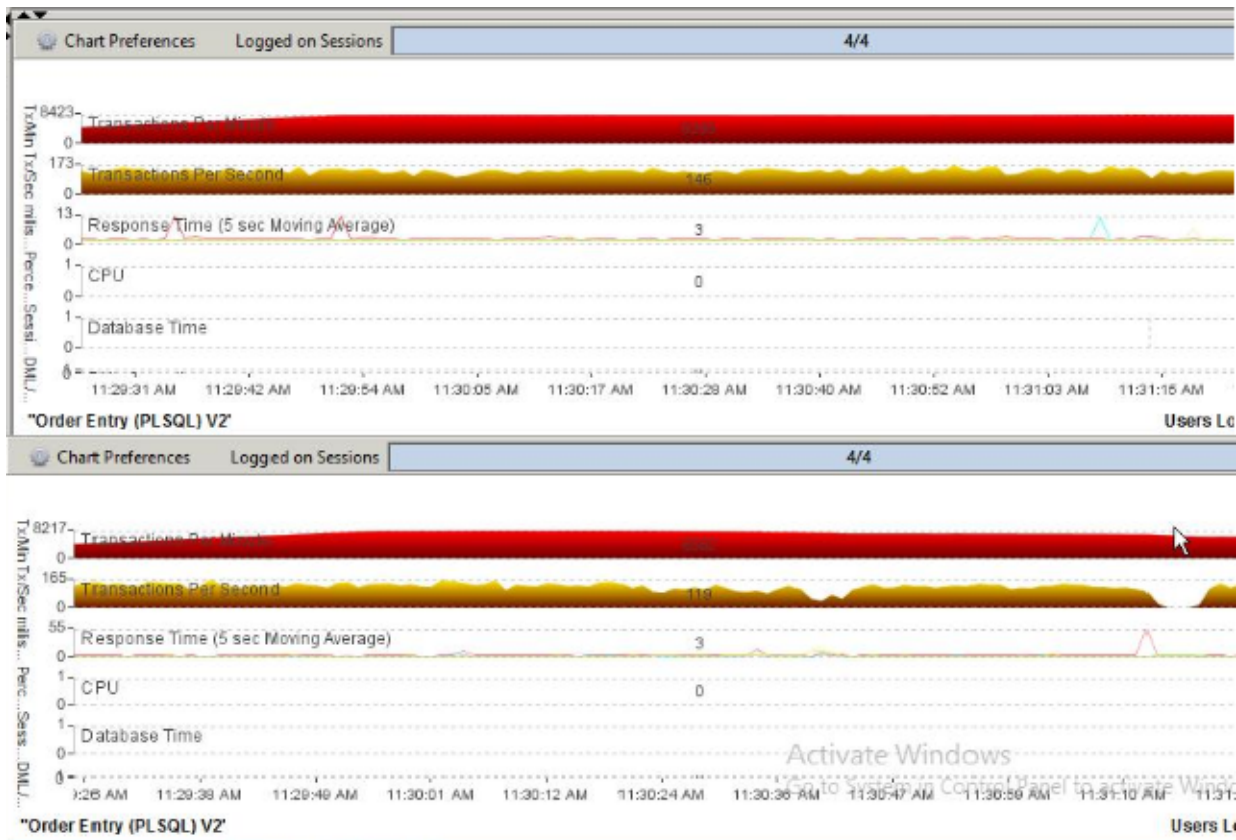
Conclusion

Hitachi Virtual Storage Platform E990 has been tested and validated as an ideal platform for virtualized workloads. It was tested on an Oracle Real Application cluster database as well as with multiple environments running at the same time.

Product Descriptions

Hitachi Virtual Storage Platform E990

Hitachi Virtual Storage Platform E990 supercharges business application performance with all-NVMe storage. It uses Hitachi Ops Center, so you can improve IT operations with the latest AI and ML capabilities. Advanced data reduction in Virtual Storage Platform E990 enables you to run data reduction with even the most performance-hungry applications.

The all-NVMe architecture in Virtual Storage Platform E990 delivers consistent, low-microsecond latency to reduce latency costs for critical applications. This predictable performance optimizes storage resources.

With Virtual Storage Platform E990 and the rest of Hitachi's midrange storage family, you have agile and automated data center technology. These systems allow you to cost-effectively meet your current digital expectations and give you the ability to address future challenges, as your application data needs, and service levels evolve. With time-tested, proven availability and scalability, Hitachi Vantara delivers infrastructure solutions that help you maximize your data center advantage.

Hitachi Virtual Storage Platform E990, used in this reference architecture, supports Oracle Real Application Clusters.

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Hitachi Storage Virtualization Operating System RF

Hitachi Storage Virtualization Operating System RF (SVOS RF) spans and integrates multiple platforms. It integrates storage system software to provide system element management and advanced storage system functions. Used across multiple platforms, Storage Virtualization Operating System includes storage virtualization, thin provisioning, storage service level controls, dynamic provisioning, and performance instrumentation.

SVOS RF integrates with Hitachi's Base and Advanced software packages to deliver superior availability and operational efficiency. You gain active-active clustering, data-at-rest encryption, insights via machine learning, and policy-defined data protection with local and remote replication.

Hitachi Advanced Server DS220

Hitachi Advanced Server DS220 is a high-performance two-socket 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 Advanced Server DS120

Optimized for performance, high density, and power efficiency in a dual-processor server, Hitachi Advanced Server DS120 delivers a balance of compute and storage capacity. This rack mounted server has the flexibility to power a wide range of solutions and applications.

The highly scalable memory supports up to 3 TB RAM using 24 slots of 2666 MHz DDR4 RDIMM. DS120 is powered by the Intel Xeon scalable processor family for complex and demanding workloads. Flexible OCP and PCIe I/O expansion card options are available.

The following applications were installed in individual virtual machines in this architecture and would be used in most cases:

- VMware vCenter Server
- Hitachi Ops Center

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

Hitachi Ops Center

Manage, optimize, orchestrate and protect your data with advanced IT analytics and automation using Hitachi Ops Center. Achieve new insights, accelerate resource delivery, eliminate risks, and speed innovation to modernize your data center operations.

Use the power of AI operations with the following:

- Analyzer. Improve IT operations with machine learning (ML) to drive resource service levels, utilization, and automation at lower costs. Obtain operational visibility from virtual machines, servers, SAN switches to shared storage resources to optimize an application's full data path.

- Automator. Deliver resources up to 70% faster than manual processes. Free staff to focus on strategic initiatives.

- Protector. Meet tight service level requirements when protecting critical data and applications. Automatically support secondary business functions with data copies staff need to do their jobs. Make better use of backup data for activities, such as e-discovery and analysis. Simplify administration and replication management. Do it all with no disruption to production application availability and performance.

Oracle Linux

Oracle Linux is a Linux distribution packaged and freely distributed by Oracle, available partially under the GNU General Public License. It is compiled from Red Hat Enterprise Linux source code, replacing Red Hat branding with Oracle branding.

Oracle Database With the Real Application Clusters Option

Oracle Database has a multi-tenant architecture so you can consolidate many databases quickly and manage them as a cloud service. Oracle Database also includes in-memory data processing capabilities for analytical performance. Additional database innovations deliver efficiency, performance, security, and availability. Oracle Database comes in two editions: Enterprise Edition and Standard Edition 2.

Oracle Automatic Storage Management

Oracle Automatic Storage Management (Oracle ASM) is a volume manager and a file system for Oracle database files. This supports single-instance Oracle Database and Oracle Real Application Clusters configurations. Oracle ASM is the recommended storage management solution that provides an alternative to conventional volume managers, file systems, and raw devices.

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. This reference architecture uses VMware ESXi for the management servers only.

VMware vCenter Server Appliance

The VMware 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.

This reference architecture uses VMware vCenter Server Appliance for the management server cluster only.

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 customers should check the support matrix to ensure support prior to implementation.

The solution uses Brocade G620 Fibre Channel switches.

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

For More Information

Hitachi Vantara Global Services offers experienced storage consultants, proven methodologies and a comprehensive services portfolio to assist you in implementing Hitachi products and solutions in your environment. For more information, see the [Services](#) website.

Demonstrations and other resources are available for many Hitachi products. To schedule a live demonstration, contact a sales representative or partner. To view on-line informational resources, see the [Resources](#) website.

Hitachi Academy is your education destination to acquire valuable knowledge and skills on Hitachi products and solutions. Our Hitachi Certified Professional program establishes your credibility and increases your value in the IT marketplace. For more information, see the Hitachi Vantana [Training and Certification](#) website.

For more information about Hitachi products and services, contact your sales representative, partner, or visit the [Hitachi Vantara](#) website.

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