Hitachi Integrated Systems Solution with Oracle RAC 19c Virtualized on Oracle Linux KVM Hypervisor with Hitachi Virtual Storage Platform and Hitachi Advanced Server HA820 G3

Reference Architecture Guide

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Thank you!

Revision history

Changes	Date
Initial release.	August 2025

Reference Architecture Guide

The Hitachi Integrated Systems solution with Oracle RAC 19c virtualized on Oracle Linux KVM Hypervisor with Hitachi Virtual Storage Platform and Hitachi Advanced Server HA820 G3 with Intel Xeon 4th generation Scalable Processors provides reliability, high availability, and scalability while processing small to large Oracle workloads. This reference architecture provides a virtualized Oracle RAC Database 19c on Oracle KVM. In this solution Oracle RAC Database nodes are deployed on Oracle KVM hosts with Oracle Linux 9.1 UEK 7 and guest virtual machines (VMs) with Oracle Linux 8.6 UEK 6.

The solution is a fast, agile offering from Hitachi Vantara that makes efficient use of deployed resources. The goal of Oracle RAC virtualization using Oracle Linux KVM hypervisor is IT transformation because you want a fast and flexible journey to reduce costs and quickly scale your environment up or down.

Oracle Linux KVM feature provides built in kernel capabilities to use Oracle Linux kernel as hypervisor. It provides a full virtualization solution containing virtualization extensions (Intel VT or AMD-V) on Linux machines to create a 2 node Oracle RAC environment the following components are used:

- Hitachi Virtual Storage Platform models are used as storage resource.
- Hitachi Advanced Server HA820 G3 with Intel® Xeon® Platinum 8470 Processor 52C CPUs for storage and computing resources.
- Oracle KVM Hypervisor
- Oracle Real Application Clusters (RAC)

Running Oracle RAC on Oracle KVM provides following benefits:

- Oracle Linux KVM is an open source with no licensing cost.
- It conforms to Oracle hard partitioning licensing requirements.
- It supports full hardware assisted virtualization.

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

This document is for the following audiences:

- Database administrators
- Storage administrators
- System administrators
- IT professionals responsible for planning and deploying an Oracle Database solution

To use this document, you need familiarity with the following:

- Hitachi Virtual Storage Platform
- Hitachi Advanced Server HA820 G3 servers
- Storage Area Networks
- Oracle Database administration
- Oracle Database 19c Release 19
- Oracle Linux 9.1 for KVM hosts and Oracle Linux 8.6 for the Guest OS

Note: Testing of this configuration was in a lab environment. Many factors 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 the Hitachi Integrated Systems solution with Oracle RAC 19c virtualized on Oracle Linux KVM Hypervisor with Hitachi Virtual Storage Platform and Hitachi Advanced Server HA820 G3. This solution is engineered, pre-tested, and qualified to provide high performance and high reliability in demanding, dynamic Oracle environments.

Business benefits

Oracle Linux KVM consists of a loadable kernel module *kvm.ko* that provides core virtualization infrastructure and a processor specific module *kvm-intel.ko or kvm-armd.ko*.

Here are some benefits of this reference architecture:

- Hard partitioning support complying with Oracle licensing rules.
- Reduce operation and support costs while increasing IT efficiency and agility — on premises and in the cloud with Oracle Virtualization.
- Add or remove servers in the Oracle KVM Manager pool based on business requirements.
- Virtual Machine snapshot capabilities.
- Online VM migration with VM cloning features

High-level infrastructure

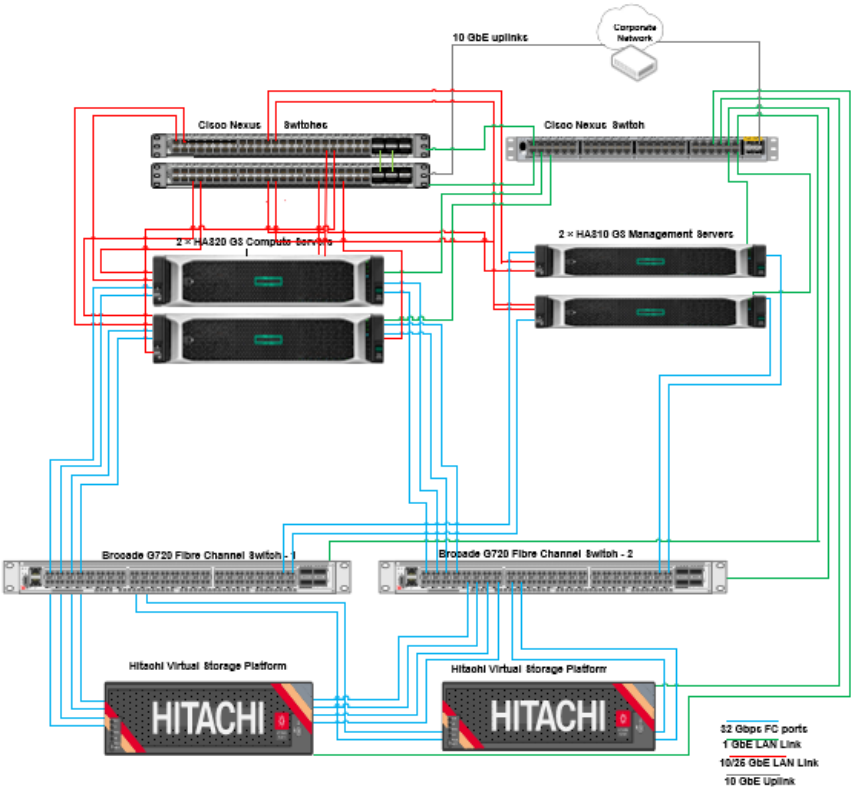
Hitachi Solution for Databases with Oracle RAC includes the following components:

- Hitachi Advanced Server HA820 G3 servers
- Hitachi Advanced Server HA810 G3 servers
- Hitachi Virtual Storage Platform
- Brocade G720 32 Gbps SAN infrastructure
- Cisco 10/25 GbE LAN infrastructure

The configuration has the following characteristics:

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

The following figure shows the high-level infrastructure for this solution.



Note: Management servers are not used in this implementation. They are shown for reference only.

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.

Key solution components

The key solution components for this solution are listed in the following tables. Detailed component information is provided in Product descriptions (on page 18).

The following table lists the hardware components used in this solution.

Vendor	Hardware	Detail Description	Version	Quantity
Hitachi Vantara	Virtual Storage Platform	6 × CHA pairs (8 × 32 Gbps Fibre Channel ports in use) 594 GB cache memory 24 x 1.9 TB NVMe SDDs*	93-07-00-40/83	1
	Hitachi Virtual Storage Platform E1090 – Management node storage system	Two Controllers 8 × 32 Gbps Fibre Channel ports 16 × 12 Gbps backend SAS ports 1024 GB cache memory 48 × 1.9 TB NVMe SSDs*	93-07-01-80/100	1
Hitachi Vantara	Hitachi Advanced Server HA820 G3	2 × Intel Xeon Platinum 8470 52 Cores CPUs @ 2.00GHz 64-bit 1024 GB (32GB × 32) memory	iLO 6: 1.30 Feb 28 2023 System ROM: U54 v1.30 (03/01/2023)	2

Vendor	Hardware	Detail Description	Version	Quantity
		RDIMM DDR5-4800 MHz		
		2 x HPE SN1610E 32Gb 2p FC HBA	Firmware: 14.0.499.29	
		8 SFF 24G x1NVMe/SAS UBM3 BC BP	Driver: lpfc Firmware: 1.24	
Brocade	G720 Fibre Channel switches	64 × 32 Gbps ports Fibre Channel switch 32 Gbps SFPs	Fabric OS: v9.1.1c	2
Cisco	Nexus N9K-C93180YC-FX3	54 × 10/25 GbE ports 6 × 40/100 Gbps Quad SFP (QSFP28) ports	BIOS: version 05.23 NXOS: version 7.0(3)I7(1)	1
	C92348GC-X	48 ×1 GbE ports Ethernet switches	BIOS: version 05.40 NXOS: version 9.3(2)	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.

Note: Customers can choose larger capacity SSDs to fit their business requirements.

The following table lists software components for compute nodes.

Software	Version	Function
Oracle Linux	9.1 with 5.15.0-3.60.5.1.el9uek.x86_64 on KVM hosts 8.6 with 5.4.17-2136.307.3.1.el8uek.x86_64 on RAC VMs(Guest OS)	Operating system
Oracle Database	19c (Version 19.19.0.0.0)	Database software
Oracle Real Application Clusters	19c (Version 19.19.0.0.0)	Cluster software
Oracle Grid Infrastructure	19c (Version 19.19.0.0.0)	Volume management, file system software, and Oracle automatic storage management
Oracle ASM	2.12	Support ASM storage device for Oracle RAC

Solution design

This section describes the reference architecture environment to implement this solution.

The infrastructure configuration includes the following:

- Oracle KVM hosts — There are two hosts configured in an Oracle database environment.
- Storage System — There are Raw Disks 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 G720 switches.

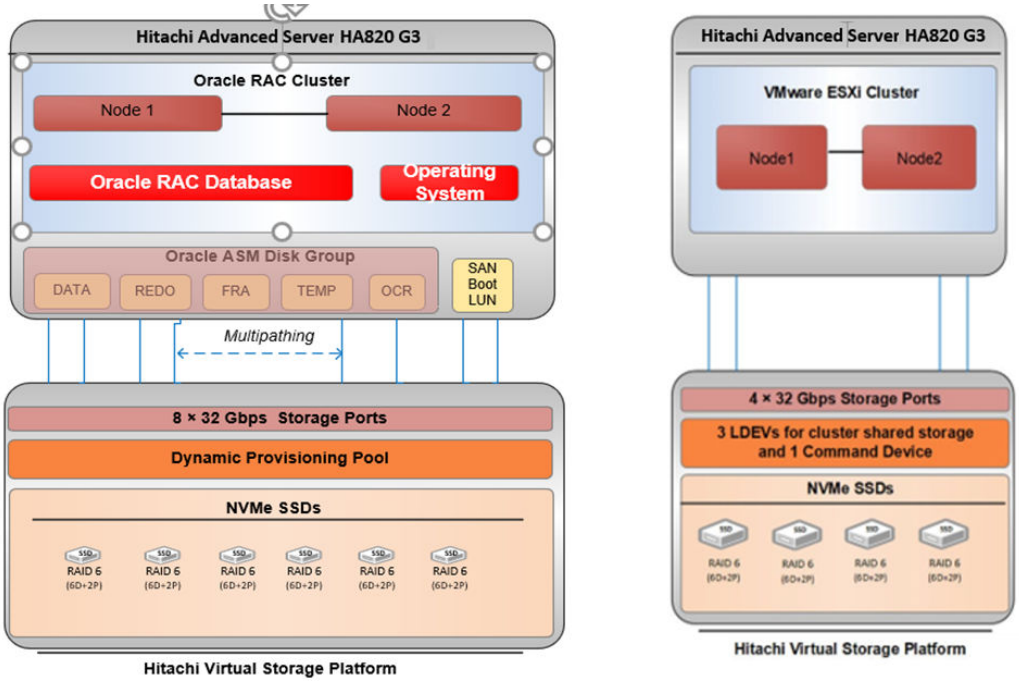
Storage architecture

This section describes the storage architecture for this solution.

Storage configuration

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

The following figure illustrates the high-level storage configuration for this solution.



The following table shows the storage pool configuration used for this solution.

Pool ID	Oracle RAC-Pool
Pool Type	Dynamic Provisioning Pool
RAID Group	1-1 to 1-3
RAID Level	RAID 6 (6D+2P)
Drive Type	1.9 TB SSD
Number of Drives	24
Number of LDEVs	24
LDEV Size(s)	1320 GB
Pool Capacity	45.6 TB

In this solution, servers use SAN boot with RAID 6 protection. The following table shows the logical storage configuration used in this solution.

ASM disk group	Total number of dynamic provisioning volumes	Dynamic provisioning volume sizes (GB)	Purpose	Storage Ports
DATA	10	200 GB	OLTP Application Tablespaces, System Sysaux, Undo	3C,1C,7C,4C,5A,5C,8A,7A
REDO	4	20 GB	Online Redo Logs and Control Files	
TEMP	2	200 GB	Temp Tablespace	
FRA	4	200 GB	Incremental Backups, Archived Redo Logs, Control File and Auto backups	
OCR	3	20 GB	Oracle Cluster Registry and Voting Disk	
N/A	2	350 GB	SAN Boot OS Volumes	

The following table lists configuration details for management servers.

Item	Value/Description
Purpose	VMware Datastores CCI device
RAID level	RAID 6 (6D+2P)
Drive type	1.9TB NVMe SSD
Number of drives	48
Number of Pool DEVs	4
LDEV size	3 × 1000 GB
Number and size of CCI devices	1 × 100 MB
Storage port for management servers	7A, 7B, 8A, 8B

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 for Virtual Storage Platform 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 to be used in various deployment scenarios to provide the right balance between performance and ease of management for a given scenario.

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 this configuration in the OCR ASM diskgroups.

Oracle initial parameters

The following table shows the Oracle Database settings.

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

Oracle ASM disk mappings

The following table shows 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.

ASM Disk Group	ASM Disk	UDEV Rules	LUN Details	Purpose
N/A	N/A	/dev/xvd[a]1	1 × 350 GB	OS and Oracle Database
OCR	OCR1-OCR3	/dev/xvd[b-d]1	3 × 20 GB	Oracle cluster registry and voting disk
DATA1	DATA1-DATA10	/dev/xvd[e-n]1	10 × 200 GB	Application data
REDO	REDO01-REDO04	/dev/xvd[o-r]1	4 × 20 GB	Online REDO log group
FRA	FRA1-FRA4	/dev/xvd[s-v]1	4 × 200 GB	Flash recovery area
TEMP	TEMP1-TEMP2	/dev/xvd[w-x]1	2 × 200 GB	Temporary Tablespace

Server and application architecture

This reference architecture uses two Hitachi Advanced Server HA820 G3 servers with 4th Generation Intel Xeon Scalable Processors for each storage system architecture that was tested.

This provides the compute power for the Oracle database to manage complex database queries and a large volume of transaction processing in parallel.

The following table lists the details of the server configurations for this solution.

Server Make and Model	Server Host Name	Role	CPU Type	CPU Core	RAM
Hitachi Advanced Server HA820 G3 KVM Host	KVM server-01	Oracle Linux KVM Hypervisor Host (Version 7.2.0) (KVM host1)	2 × Intel Xeon Platinum 8470 52C CPUs	208 (2 × 2 52)	1024 GB (32 GB × 32)
	KVM server-02	Oracle Linux KVM Hypervisor Host (Version 7.2.0) (KVM host2)		208 (2 × 2 × 52)	1024 GB (32 GB × 32)
KVM VMs	VM1	Oracle Linux KVM VM for Oracle RAC Node 1	2 × Intel Xeon Platinum 8470	10 × 10	200 GB
KVM VMs	VM2	Oracle Linux KVM VM for Oracle RAC Node 2	2 × Intel Xeon Platinum 8470	10 × 10	200GB

SAN architecture

Map the provisioned LDEVs to multiple ports on the Virtual Storage Platform. These LDEV port assignments provide multiple paths to the storage system from the host for high availability. This reference architecture uses two dual port HBAs per Advanced Server HA820 G3.

Compute servers

- 8 SAN switch connections are used for VSP E790 Fibre Channel ports.
- 8 SAN switch connections are used for server HBA ports.

Management servers

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

Note: In a production environment, it is recommended to use separate storage ports for the management servers to avoid impact on database performance. Shared storage ports can be used; however, port utilization should be monitored 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 Oracle KVM sever node with at least the bonding interfaces for the following:

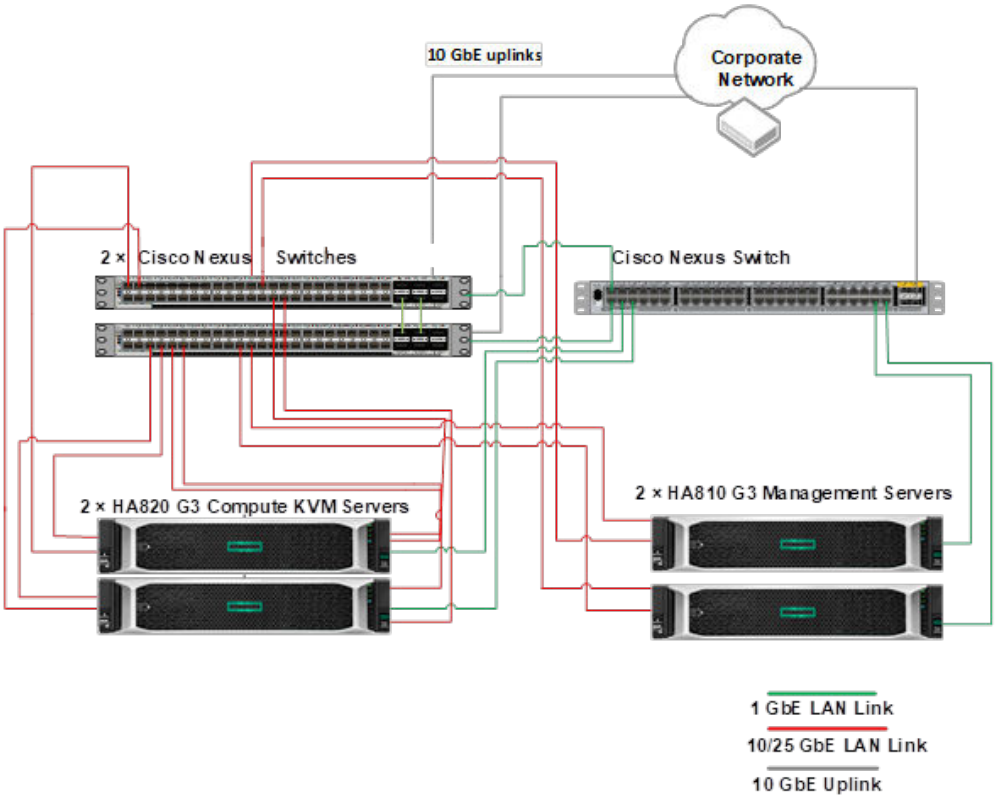
- Management network
- Public network
- Private network

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

- Oracle KVM management network
- Private Oracle database network
- Public network

Physical network configuration

The following figure shows the IP network switch connection.



The following table lists the HA820 G3 and HA810 G3 network configuration for server nodes.

Server	NIC Ports	Subnet	NIC Bond	IP Address	Network	Bandwidth (Gbps)	Cisco Nexus 93180YC-FX3 Switch	
							Switch Number	Port
HA820 G3 Server1	NIC 1-Port 0	33	Bond0	10.76.33.xx	Public	25	1	31 32
	NIC 1-Port 1					25	2	
	NIC 2-Port 0	10	Bond1	192.168.10.xx	Private	25	1	33 34
	NIC 2-Port 1					25	2	
HA820 G3 Server2	NIC 1-Port 0	33	Bond0	10.76.33.xx	Public	25	1	29 47
	NIC 1-Port 1					25	2	
	NIC 2-Port 0	10	Bond1	192.168.10.xx	Private	25	1	37 38
	NIC 2-Port 1					25	2	

The following table lists the HA820 G3 and HA810 G3 network configuration for management servers.

Server	NIC Ports	Subnet	NIC Bond	IP Address	Network	Bandwidth (Gbps)	Cisco Nexus 93180YC-FX3 Switch	
							Switch Number	Port
HA810 G3 Management Server1	NIC 1-Port 0	242	Bond0	10.76.33.xx	Public	25	1	49
	NIC 1-Port 1					25	2	
HA810 G3 Management Server2	NIC 1-Port 0	242	Bond0	10.76.33.xx	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).

Engineering validation

This section summarizes the key lab verification tests performed on the Hitachi Integrated Systems solution with Oracle RAC 19c Virtualized on Oracle Linux KVM Hypervisor with Hitachi Virtual Storage Platform and Hitachi Advanced Server HA820 G3.

Database configuration

The following table lists parameter details for a two-node Oracle ASM database.

Oracle Database Parameter	Value
Compatible	19.19.0.0.0
Oracle Database size	2 TB
Database storage type	ASM
Database fill factor	70%

Test environment

The following table lists configuration details for testing.

Item	Value
Operating System on VMs	OL 8.6
Workload Type	OLTP/OLAP
Database Size	2 TB
Number of vCPUs	100
Virtual Memory	250 Gb per VM
Host Cluster VM Network	2 × 25 Gbps NIC Bonding

Test methodology

Oracle Orion and peakmarks OLTP test cases were used to test this solution.

Peakmarks

Test results are demonstrated using peakmarks OLTP test cases.

Peakmarks is benchmark software for Oracle platforms. It is used in our tests for the purposes of:

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

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

Conclusion

Hitachi Integrated Systems has been tested and validated as an ideal platform for virtualized workloads. This solution was tested on Oracle RAC database as well as with multiple environments running at the same time.

Note: For peakmarks performance results contact your Hitachi sales representative.

Product descriptions

These products are used in this reference architecture.

Hitachi Integrated Systems Platform

The Hitachi Integrated Systems platform is a high-performance, low-latency, integrated, converged solution using Hitachi Virtual Storage Platform One Block storage, Hitachi Advanced Server HA820 G3, as well as HA810 G3 with Sapphire Rapids Scalable Processors.

Hitachi Storage Virtualization Operating System RF

Hitachi Storage Virtualization Operating System RF powers the Hitachi Virtual Storage Platform (VSP) family. 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.

Flash performance is optimized with a patented flash-aware I/O stack, which accelerates data access. Adaptive inline data reduction increases storage efficiency while enabling a balance of data efficiency and application performance. Industry-leading storage virtualization allows SVOS RF to use third-party all-flash and hybrid arrays as storage capacity, consolidating resources for a higher ROI and providing a high-speed front end to slower, less-predictable arrays.

See https://www.hitachivantara.com/en-us/products/storage-platforms/storage-software for more information.

Hitachi Advanced Server HA820 G3

Hitachi Advanced Server HA820 G3 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 environments that require the maximum memory capacity. Hitachi Advanced Server HA820 G3 provides flexible I/O scalability for today's diverse data center application requirements.

Optimized for performance, high density, and power efficiency in a dual-processor server, HA820 G3 delivers a balance of compute and storage capacity. These rack mounted servers have the flexibility to power a wide range of solutions and applications.

The highly scalable memory supports up to 8 TB RAM using 32 slots of 2300 MHz DDR5 RDIMM. HA820 G3 is powered by the Intel Xeon Emerald Rapids scalable processor family for complex and demanding workloads. Flexible OCP and PCIe I/O expansion card options are available.

Oracle Linux KVM (OL-KVM)

Oracle Linux KVM is a feature of Oracle Linux. With the Unbreakable Enterprise Kernel (UEK) Release 6, the Oracle Linux server virtualization solution with KVM has been enhanced. Users can take either a previously deployed version of Oracle Linux and turn the OS into a KVM host, or a KVM configuration can be set up from a base Oracle Linux installation. Oracle Linux KVM is the same hypervisor used in Oracle Cloud Infrastructure, giving users an easy migration path to move workloads into Oracle Cloud.

There are two types of VMs configured for Hitachi solutions for Oracle database namely VMs optimized for *Server class* and VMs optimized for *High Performance VMs*.

With *High Performance VMs* we can configure a virtual machine for high performance, so that it runs with performance metrics as close to bare metal as possible. When you choose high performance optimization, the virtual machine is configured with a set of automatic and recommended manual settings for maximum efficiency.

- The high-performance option is supported by Red Hat Virtualization 4.2 and later
- To change the optimization mode of a new or existing virtual machine to high performance, we may need to make manual changes to the cluster and to the pinned host configuration first.

Oracle Linux

Oracle Linux (OL, formerly known as Oracle Enterprise 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 Real Application Clusters Option

Oracle Database has a multi-tenant architecture used to 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 Real Application Clusters (Oracle RAC) is a clustered version of Oracle Database. It is based on a comprehensive high-availability stack that can be used as the foundation of a database cloud system, as well as a shared infrastructure. This ensures high availability, scalability, and agility for any application.

Oracle Automatic Storage Management (Oracle ASM) is a volume manager and file system for Oracle database files. This supports both 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 a foundation for the virtual infrastructure used for the management applications in this architecture. This allows the environment to operate independently from any general-purpose operating system, offering security, reliability, and simplified management.

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 is 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. These include vCenter SSO (Single Sign-on), Inventory Service, vSphere Web Client, and the vCenter Server itself.

Brocade switches from Broadcom

Brocade and Hitachi Vantara have partnered 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.

Brocade Fibre Channel switches deliver industry-leading performance with seventh generation 64Gb/sec Fibre Channel interfaces, simplifying scale-out network architectures. Get the high-performance, availability, ease of management, and support for the next generation of Hitachi Virtual Storage Platform storage systems on a solid storage network foundation that can grow as your need grows.

See https://www.broadcom.com/products/fibre-channel-networking/switches for more information.

Cisco Nexus switches

The Cisco Nexus switch product line offers a range of solutions that simplify the connection and management of disparate data center resources through 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.

Peakmarks® test descriptions

The following table lists peakmarks® Key Performance Tests/Metrics for platform components in database operations.

Category	Key Performance Metric	peakmarks® Workload
Server System All accessed data is stored entirely in the database buffer cache. No I/O operations.	Query throughput and response time for simple queries	SRV-QUERY1
	Query throughput and response time for more complex queries	SRV-QUERY25
	Throughput logical reads for online reports	SRV-REPORT
	Scan throughput database buffer cache	SRV-SCAN
	Query throughput and response time for mixed queries and scans	SRV-MIXED
Storage System	SQL sequential I/O throughput	STO-READ
	SQL sequential I/O throughput - using smart scan (offload)	STO-OFFLOAD
	SQL random read throughput and service time - 100% read	STO-RANDOM
	SQL random read throughput and service time - 80% read	STO-RANDOM
	SQL random write throughput	STO-SCATTER

The following table lists peakmarks® Key Performance Metrics for critical database background processes.

Category	Key Performance Metric	peakmarks® Workload
Log Writer (LGWR)	Commit throughput and latency for small transactions	LGWR-LAT1
	Commit throughput and latency for medium-sized transactions	LGWR-LAT25
	Commit throughput and latency for large transactions	LGWR-LAT125
	Log Writer throughput	LGWR-THR
Database Writer (DBWR)	Database Writer throughput	DBWR-THR

The following table lists peakmarks® Key Performance Metrics for representative database operations.

Category	Key Performance Metric	peakmarks® Workload
Data Load	Throughput transactional data load - using the buffer cache	DL-BUFFER
	Throughput data warehouse data load - bypassing the buffer cache	DL-DIRECT
	Throughput IoT data load - using memory-optimized tables	DL-STREAM
Data Analytics	Throughput data scan - using the storage system	DA-STORAGE
	Throughput data scan - using smart scan	DA-OFFLOAD
	Throughput data scan - using row store	DA-ROWSTORE
	Throughput data scan - using column store	DA-COLSTORE
Transaction Processing	Transaction throughput and response time of light transactions	TP-LIGHT
	Transaction throughput and response time of medium transactions	TP-MEDIUM
	Transaction throughput and response time of heavy transactions	TP-HEAVY
	Transaction throughput and response time for mixed transactions	TP-MIXED

The following is a list of measurement units:

- [s] seconds
- [ms] milliseconds
- [µs] microseconds
- [qps] queries per second
- [rps] rows per second
- [dbps] database blocks per second
- [tps] transactions per second
- [Mops] million operations per second
- [MBps] megabyte per second
- [IOPS] I/O operations per second

Hitachi Vantara

Corporate Headquarters
2535 Augustine Drive
Santa Clara, CA 95054 USA

HitachiVantara.com/contact