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# Hitachi Unified Compute Platform 6000 for Oracle Real Application Clusters with SMP Server Blades and Hitachi Virtual Storage Platform G1500

## Reference Architecture Guide

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September 2017

# Feedback

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# Revision History

| Revision | Changes | Date |
|---|---|---|
| AS-618-00 | Initial release | September 6, 2017 |

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# Hitachi Unified Compute Platform 6000 for Oracle Real Application Clusters with SMP Server Blades and Hitachi Virtual Storage Platform G1500

Reference Architecture Guide

See how using Hitachi Unified Compute Platform (UCP) 6000 for Oracle Real Application Cluster provides a high performance, converged solution for Oracle databases. The environment uses two powerful two-way symmetrical multi-processing (SMP) nodes and Hitachi Virtual Storage Platform G1500 with Hitachi Accelerated Flash. Use this document to design a converged solution for your Oracle environment to meet your requirements and budget.

This validated solution integrates 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 R1 with the Oracle Real Application Cluster (RAC) option. The operating system is Oracle Linux 7.3.

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:

- Storage area networks
- Oracle Database administration
- Oracle Database 12c Release 1 with Oracle RAC option
- Oracle Automatic Storage Management
- Oracle Linux
- Two-way symmetrical multi-processing (SMP) system

**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

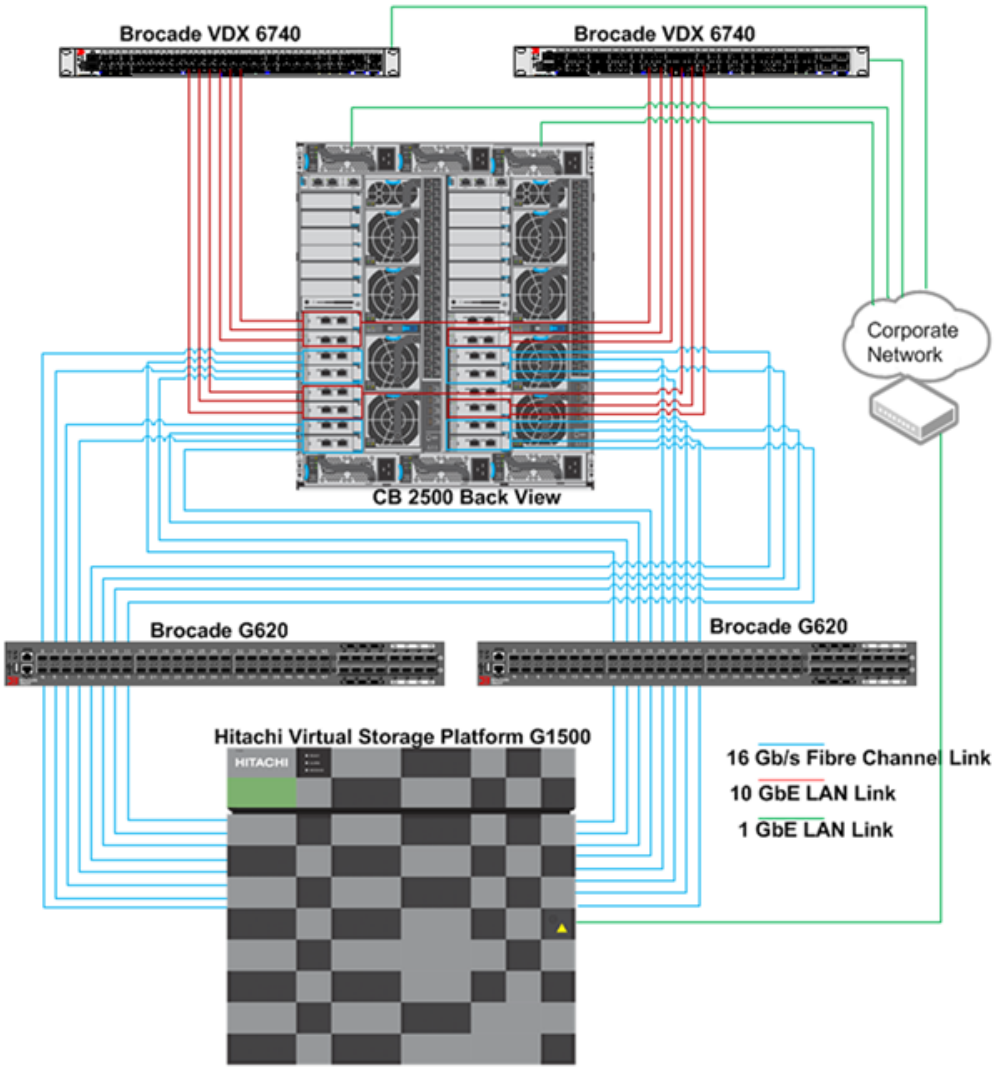
This reference architecture describes a Hitachi Unified Compute Platform 6000 for Oracle RAC system with two 2-way SMP nodes using Hitachi Virtual Storage Platform G1500 with 1.6 TB DC2 flash module drive (FMD) using Hitachi Accelerated Flash. This environment addresses the high availability, performance, and scalability requirements for Oracle Real Application Cluster. Tailor your implementation of this solution to meet your specific needs.

This reference architecture includes the following:

- Hitachi Compute Blade 2500 with four 520X B3 server blades configured as two two-way SMP servers
  - **Oracle RAC Node 1** — 2 × 520X B3 SMP server blade
  - **Oracle RAC Node 2** — 2 × 520X B3 SMP server blade
- Hitachi Virtual Storage Platform G1500 with Hitachi Accelerated Flash
- 16 Gb/s Fibre Channel SAN infrastructure
- 10 GbE LAN infrastructure

Figure 1 shows the high-level infrastructure for this Hitachi UCP 6000 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 G1500 (VSP G1500) | ■ Single Controller<br>■ 16 × 16 Gb/s Fibre Channel Ports<br>■ 4 pairs of virtual storage directors<br>■ 2 pairs of front-end directors<br>■ 2 pairs of back-end directors<br>■ 1024 GB cache memory | 80-05-42-00/00 | 1 |
| | ■ 1.6 TB FMDs<br>■ 2 + spare FMDs | | 48 |
| Hitachi Compute Blade 2500 (CB 2500) | ■ 10 fan modules<br>■ 2 management modules<br>■ 6 power supply modules | A0185-B-1476 | 1 |
| 520X B3 full server blade | ■ 2 Intel Xeon E7-8880v4 processor CPUs<br>■ 4 × 768 GB (16 GB × 48) DDR4 per server blade | 10-04/10-04 | 4 |
| | ■ Emulex LPe16002B-M6_HI 2 port 16 Gb/s Fibre Channel adapter | 11.1.215.0 | 8 |
| | ■ 10 GbE dual port local area network (LAN) adapter | 4.4.31 | 6 |
| | ■ SMP connector kit | | 2 |
| Brocade VDX 6740 switch | ■ 10 GbE IP switches | 4.1.3a | 2 |
| Brocade G620 switch | ■ Brocade G620 48 port Fibre Channel switch | v8.0.1 | 2 |

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

**TABLE 2. KEY SOFTWARE COMPONENTS**

| Software | Version | Function |
|---|---|---|
| Oracle Linux | 7.3 | Operating System |
| Oracle 12c | 12c Release 1(12.1.0.2.0) | Database Software |
| Oracle Real Application Cluster | 12c Release 1(12.1.0.2.0) | Cluster Software |
| Oracle Automatic Storage Management | 12c Release 1(12.1.0.2.0) | Volume Management and File System Software |
| Hitachi Dynamic Link Manager | 8.5.0-01 | Multipath Software |
| Hitachi Storage Navigator | Microcode dependent | Storage management Software |
| Hitachi Infrastructure Analytics Advisor | 3.1 | Host and Storage Monitoring |

## Hitachi Compute Blade 2500

Hitachi Compute Blade 2500 delivers enterprise computing power and performance with unprecedented scalability and configuration flexibility. Lower your costs and protect your investment.

Flexible I/O architecture and logical partitioning allow configurations to match application needs exactly with Hitachi Compute Blade 2500. Multiple applications easily and securely co-exist in the same chassis.

Hitachi Compute Blade 2500 with 520X B3 Full Width Blade and Symmetric Multi-Processing (SMP) system provides the scalability and flexibility for an Oracle RAC configuration.

Each SMP server consists of two 520X B3 blades, each blade with 2 x Intel Xeon processors, connected via SMP connector to form a single server where main memory is shared, has full access to all I/O subsystems, and is controlled by a single operating system which provides high data processing and computing capabilities.

Add server management and system monitoring at no cost with Hitachi Compute Systems Manager. Seamlessly integrate with Hitachi Command Suite in Hitachi storage environments.

## Hitachi Virtual Storage Platform G1500

Hitachi Virtual Storage Platform G1500 is flash-optimized virtual storage platforms that deliver up to 4M IOPS of performance and offer the industry's only 100% data-availability guarantee. Hitachi Virtual Storage Platform G1500 uses virtual storage directors (VSDs) that are shared across the cache, front-end directors (FEDs), and back-end directors (BEDs), providing immediate processing power without wait time of interruption to maximize I/O throughput.

The storage systems provide a highly granular upgrade path, allowing the addition of drives to the drive chassis and components such as FEDs to the controller chassis as storage and processing needs increase.

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

Oracle Real Application (RAC) with Automatic Storage Management (ASM) option has been deployed and tested with Hitachi Virtual Storage (VSP) G1500 storage system.

## Hitachi Infrastructure Analytics Advisor

Hitachi Infrastructure Analytics Advisor provides the comprehensive storage performance management and diagnostics required to optimize business application servers with storage system performance. Infrastructure Analytics Advisor includes the tools to properly monitor and analyze performance statistics from the application through its entire data path to the shared storage resources.

Infrastructure Analytics Advisor allows you to define custom storage service level objectives (SLOs) for performance and capacity by virtual machine or application server. Continuously monitor these SLOs to ensure compliance to service level agreements. Alerts provide early notification when exceeding service-level thresholds so for quick analysis with built-in diagnostic aids to efficiently determine the root cause of a service level problem.

## Hitachi Dynamic Link Manager Advanced

Hitachi Dynamic Link Manager Advanced combines all the capabilities of Hitachi Dynamic Link Manager and Hitachi Global Link Manager into a comprehensive multipathing solution. It includes capabilities such as the following:

- Path failover and failback
- Automatic load balancing to provide higher data availability and accessibility

Used for SAN multipathing, the Hitachi Dynamic Link Manager Advanced configuration in this solution uses its extended round-robin load balancing policy. This policy selects a path by rotating through all available paths. Balancing the load across all available paths optimizes IOPS and response time.

## 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 Switch

Brocade and Hitachi Data Systems 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. The solution using the following Brocade products:

- Brocade VDX 6740 10 GbE switch module
- Brocade G620 48 port Fibre Channel switch

# Solution Design

This describes the reference architecture environment, implementing a half-rack environment for Hitachi Unified Compute Platform 6000 for Oracle Real Application Cluster with SMP servers using Hitachi Virtual Storage Platform G1500 with Hitachi Accelerated Flash.

Specific infrastructure configuration details include the following:

- **Server** — Configure two 2-way SMP server nodes in an Oracle Real Application Cluster.
- **Storage System** — Map LDEVs to each port that are presented to the server as LUNs.
- **SAN Connection** — Connect each Fibre Channel HBA port to the storage front-end port using the switched SAN environment.

## Storage Architecture

This describes how to configure the storage architecture of this reference architecture. It takes into consideration Hitachi Data Systems and Oracle recommended practices for the deployment of database storage design.

Figure 2 on page 7 is the high-level storage configuration diagram used for this solution with Hitachi Virtual Storage Platform G1500.

**Figure 2**

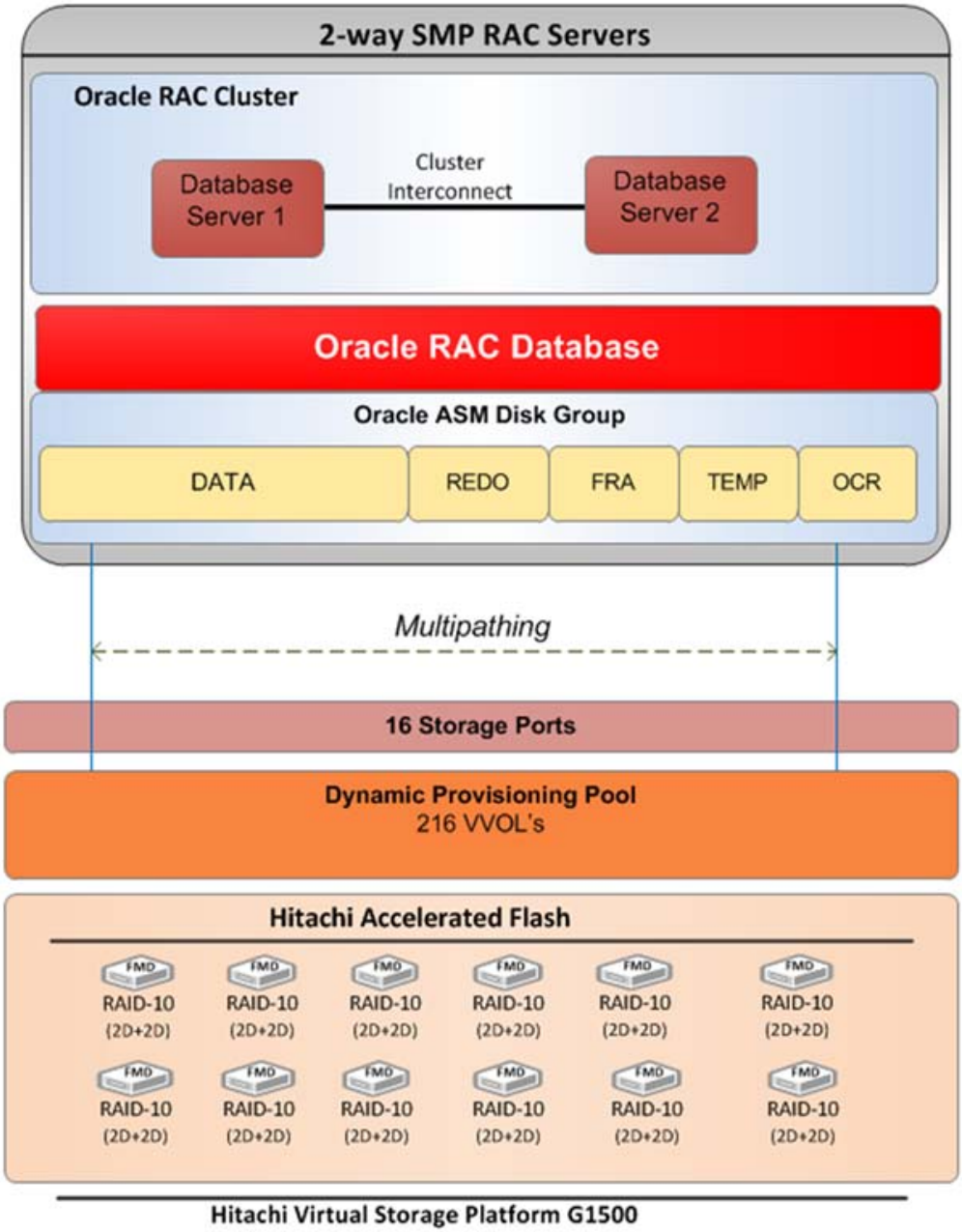

2-way SMP RAC Servers
Oracle RAC Cluster
Database Server 1
Cluster Interconnect
Database Server 2
Oracle RAC Database
Oracle ASM Disk Group
DATA
REDO
FRA
TEMP
OCR
Multipathing
16 Storage Ports
Dynamic Provisioning Pool
216 VVOL's
Hitachi Accelerated Flash
FMD
RAID-10
(2D+2D)
Hitachi Virtual Storage Platform G1500

Table 3 shows dynamic provisioning pool for Oracle Database.

TABLE 3. STORAGE POOL CONFIGURATION

| | |
|---|---|
| **Dynamic Provisioning Pool ID** | oracle |
| **RAID Group** | 1-1 - 1-12 |
| **RAID Level** | RAID-10 (2D+2D) |
| **Drive Type** | 1.6 TB flash module drive (FMD) |
| **Number of Drives** | 48 |
| **Number of Spare Drives** | 2 |
| **Number of LDEVs** | 384 |
| **Number of LDEVs per RAID Group** | 32 |
| **LDEV Size** | 102.3 GB |

Table 4 shows the logical storage configuration used for Virtual Storage Platform G1500

**TABLE 4. LOGICAL STORAGE CONFIGURATION**

| | | | | | |
|---|---|---|---|---|---|
| **Dvnamic Provisioning Pool ID** | oracle | | | | |
| **Boot Device** | SAN boot LUNs of 200 GB, one per SMP server | | | | |
| **Number of Virtual Volumes** | 128 | 32 | 32 | 3 | 16 |
| **Virtual Volume Size** | 150 GB | 20 GB | 1,600 GB | 5 GB | 100 GB |
| **ASM Diskgroup** | DATA | REDO | FRA | OCR | TEMP |
| **Purpose** | OLTP application tablespace<br>System<br>Sysaux<br>Undo | Redo logs<br>Control files | Oracle fast recovery area<br>Incremental backups<br>Archived redo logs<br>Control file autobackups | Oracle cluster registry<br>Voting disk | Temp |
| **Storage Port** | 1A, 1B, 1C, 1D, 2A, 2B, 2C, 2D, 3A, 3B, 3C, 3D, 4A, 4B, 4C, 4D | | | | |

## Database Layout

The database layout design uses recommended practices from Hitachi Data Systems for Hitachi Virtual Storage Platform G1500 using Hitachi Accelerated Flash for small random I/O traffic, such as OLTP transactions. The layout also considers Oracle ASM best practices when using Hitachi 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 SMP 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 SMP Oracle RAC configuration.
- **Size Settings** — Set the database block size to 8 KB. Set the ASM allocation unit to 1 MB.
- **ASM FILE SYSTEM I/O Settings** — Set the Oracle ASM I/O operations for database files, as follows:

  FILESYSTEMIO_OPTIONS = setall

Table 5 has the Oracle RAC database configuration.

**TABLE 5. ORACLE RAC DATABASE SETTING**

| For This Environment | Use This Value |
|---|---|
| RAC configuration | YES |
| ASM | Yes - Oracle RAC Database |

Table 6 lists the Oracle environment parameters for the SMP and Hitachi Virtual Storage Platform G1500 architecture.

**TABLE 6. ORACLE ENVIRONMENT PARAMETERS**

| For This Setting | Use This Value |
|---|---|
| SGA_TARGET | 768 GB |
| PGA_AGGREGATE_TARGET | 384 GB |
| DB_CACHE_SIZE | 360 GB |
| DB_KEEP_CACHE_SIZE | 192 GB |
| DB_RECYCLE_CACHE_SIZE | 192 GB |

TABLE 6. ORACLE ENVIRONMENT PARAMETERS (CONTINUED)

| For This Setting | Use This Value |
|---|---|
| LOG_BUFFER | 512 MB |
| USE_LARGE_PAGES | TRUE |
| FILESYSTEMIO_OPTIONS | SETALL |
| DISK_ASYNCH_IO | TRUE |

Table 7 shows the details of the disks mappings from LUNs to the operating system devices and to the ASM disk groups for Oracle RAC database tablespaces.

TABLE 7. ORACLE ASM DISK CONFIGURATION

| VVOLs | LUN | LUN Size | ASM Disk | ASMDG | Purpose |
|---|---|---|---|---|---|
| 00:00:00-00:00:01 | 0-1 | 200 GB | N/A | N/A | SAN Boot LUNS, one per SMP server |
| 00:00:02-00:00:04 | 2-4 | 5 GB | OCR00-OCR02 | OCR | Oracle Cluster Registry<br>Voting Disk |
| 00:00:05-00:00:36 | 5-36 | 20 GB | REDO00-REDO31 | REDO | Online REDO log group |
| 00:00:37-00:00:52 | 37-52 | 100 GB | TEMP00-TEMP15 | TEMP | Temporary Files |
| 00:00:53-00:01:79 | 53-179 | 150 GB | DATA00-DATA127 | DATA | OLTP Application data<br>System<br>Sysaux<br>Undo |
| 00:01:80-00:02:12 | 180-212 | 1600 GB | FRA00-FRA31 | FRA | Archive logs<br>Incremental backups<br>Control file autobackups |

## Server and Application Architecture

This reference architecture uses a single Hitachi Compute Blade 2500 chassis with two 2-way SMP server blades. Four 520X B3 server blades are used for a two 2-node SMP Oracle RAC servers.

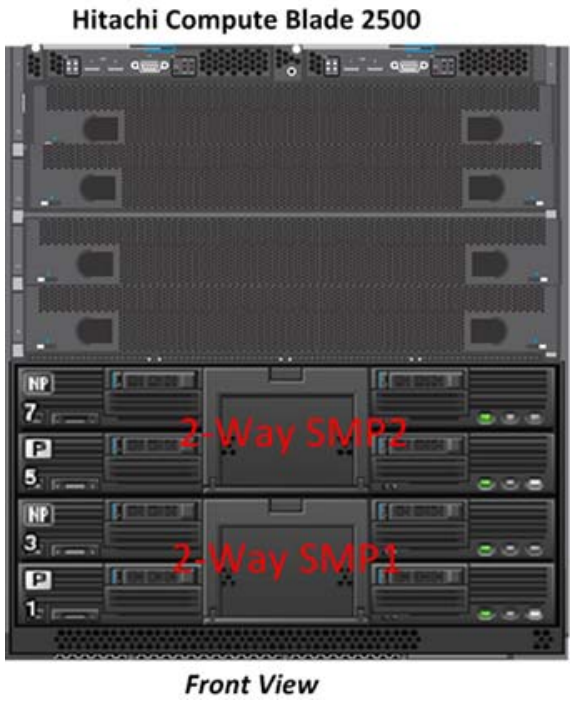
This provides the compute power for the Oracle RAC database to handle complex database queries and a large volume of transaction processing in parallel. Table 8 describes the details of the SMP server configuration for this solution.

**TABLE 8. SERVER DETAILS**

| Server | Form Size | Server Name | Role | CPU Core | RAM | Server Blade |
|---|---|---|---|---|---|---|
| Node1 | 2 × Full-Width | Smp-srv01 | RAC Node | 4 × 22 | 2 × 768 GB | 1 |
| Node2 | 2 × Full-Width | Smp-srv02 | RAC Node | 4 × 22 | 2 × 768 GB | 2 |

Figure 3 shows the server infrastructure for the reference architecture.

**Figure 3**



*Server BIOS Setting*

Table 9 shows those server BIOS setting parameters that were changed from the default parameters when validating this solution. These changes resulted in better performance with Oracle Orion and Peakmarks testing.

Verify that, in your environment, these BIOS settings are selected to achieve better performance.

**TABLE 9. CHANGED SERVER BIOS SETTINGS**

| BIOS Setting | Parameter | Value or Selection |
|---|---|---|
| BIOS Setting for Processor<br>(From **System Setting**, select **Processors**.) | Processor Performance States | Disable |
| | C-States | Disable |
| | Package ACPI C-State Limit | N/A |
| | C1 Enhanced Mode | Disable |
| BIOS Setting for Power<br>(From **System Setting**, select **Power**.) | Active Energy Manager | Capping Disabled |
| | Power/Performance Bias | Platform Controlled |
| | Platform Controlled Type | Maximum Performance |
| BIOS Setting for Memory<br>(From **System Setting**, select **Memory**.) | Memory Power Management | Disable |

## SAN Architecture

Map the provisioned LDEVs to multiple ports on Hitachi Virtual Storage Platform G1500. These LDEV port assignments provide multiple paths to the storage system from the host for high availability.

Each of the 2-way SMP database servers use eight Fibre Channel ports, with two ports from each of the PCIe HBA cards listed in Table 10. This provides eight pathway connections for all LUNs mapped to each of the database servers in the Oracle RAC database.

Table 10 shows the SAN connection from the HBA of the server blade to the Virtual Storage Platform G1500 ports.

**TABLE 10. FIBRE CHANNEL SAN CONNECT CONFIGURATION ON HITACHI VIRTUAL STORAGE PLATFORM G1500**

| Host | HBA | Storage Port | Storage Host Group | Zone Name |
|---|---|---|---|---|
| SMP1 | HBA1-1 | 1A | CB2500_SMP1_HBA1_1 | CB2500_SMP1_HBA1_1_G1500_1A |
| | HBA1-2 | 2A | CB2500_SMP1_HBA1_2 | CB2500_SMP1_HBA1_2_ G1500_2A |
| | HBA2-1 | 1C | CB2500_SMP1_HBA2_1 | CB2500_SMP1_HBA2_1_ G1500_1C |
| | HBA2-2 | 2C | CB2500_SMP1_HBA2_2 | CB2500_SMP1_HBA2_2_ G1500_2C |
| | HBA3-1 | 3A | CB2500_SMP1_HBA3_1 | CB2500_SMP1_HBA3_1_ G1500_3A |
| | HBA3-2 | 4A | CB2500_SMP1_HBA3_2 | CB2500_SMP1_HBA3_2_ G1500_4A |
| | HBA4-1 | 3C | CB2500_SMP1_HBA4_1 | CB2500_SMP1_HBA4_1_ G1500_3C |
| | HBA4-2 | 4C | CB2500_SMP1_HBA4_2 | CB2500_SMP1_HBA4_2_ G1500_4C |

**TABLE 10. FIBRE CHANNEL SAN CONNECT CONFIGURATION ON HITACHI VIRTUAL STORAGE PLATFORM G1500 (CONTINUED)**

| Host | HBA | Storage Port | Storage Host Group | Zone Name |
|---|---|---|---|---|
| SMP2 | HBA1-1 | 1B | CB2500_SMP2_HBA1_1 | CB2500_SMP2_HBA1_1_ G1500_1B |
| | HBA1-2 | 2B | CB2500_SMP2_HBA1_2 | CB2500_SMP2_HBA1_2_ G1500_2B |
| | HBA2-1 | 1D | CB2500_SMP2_HBA2_1 | CB2500_SMP2_HBA2_1_ G1500_1D |
| | HBA2-2 | 2D | CB2500_SMP2_HBA2_2 | CB2500_SMP2_HBA2_2_ G1500_2D |
| | HBA3-1 | 3B | CB2500_SMP2_HBA3_1 | CB2500_SMP2_HBA3_1_ G1500_3B |
| | HBA3-2 | 4B | CB2500_SMP2_HBA3_2 | CB2500_SMP2_HBA3_2_ G1500_4B |
| | HBA4-1 | 3D | CB2500_SMP2_HBA4_1 | CB2500_SMP2_HBA4_1_ G1500_3D |
| | HBA4-2 | 4D | CB2500_SMP2_HBA4_2 | CB2500_SMP2_HBA4_2_ G1500_4D |

### *Emulex 16 Gb/s PCIe HBA Card Configuration*

This describes the configuration for the Emulex 16 Gb/s PCIe HBA cards that are used on the SMP server blades.

Figure 4 shows the Emulex 16 Gb/s HBA PCIe cards that are installed in Hitachi Compute Blade 2500 with 520X B3 server blades. For details on allocating the I/O slots for the HBAs, see Table 11, “I/O Board Slots,” on page 15.

**Figure 4**

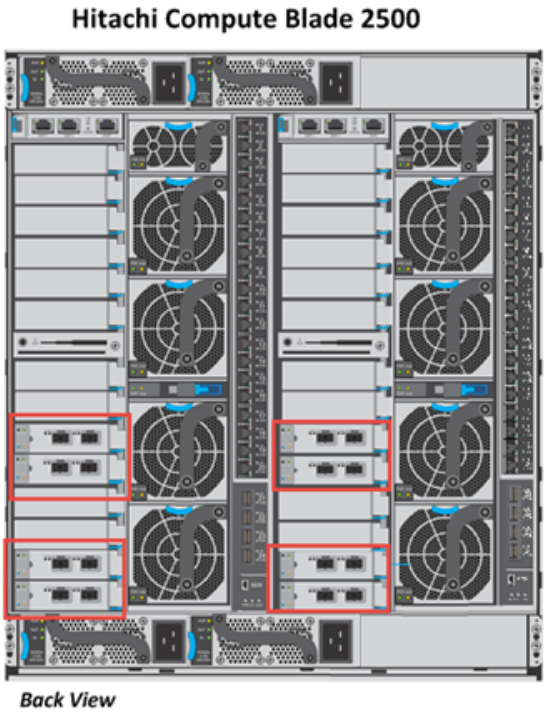


Table 11 shows the PCIe I/O board slots allocation on Hitachi Compute Blade 2500 for the HBAs and local area network (LAN) adapters used when testing this environment. Although the HBA cards could be used between the two server blades within the two-way symmetrical multi-processing (SMP) node, there was significant performance benefit by installing them in the primary node only of each SMP node.

**TABLE 11. I/O BOARD SLOTS**

| SMP Node | I/O Slots (Left) | I/O Cards | I/O Slots (Right) | I/O Cards |
|---|---|---|---|---|
| 2-way SMP-Node 2 | 08B | NIC3 | 07B | N/A |
| | 08A | NIC2 | 07A | NIC1 |
| | 06B | HBA4 | 05B | HBA3 |
| | 06A | HBA2 | 05A | HBA1 |
| 2-way SMP-Node 1 | 04B | NIC3 | 03B | N/A |
| | 04A | NIC2 | 03A | NIC1 |
| | 02B | HBA4 | 01B | HBA3 |
| | 02A | HBA2 | 01A | HBA1 |

Set these parameters in Table 12 for each of the Hitachi HBA PCIe cards.

**TABLE 12. EMULEX HBA PCIE CARD PARAMETERS**

| For This | Set This |
|---|---|
| Boot Function | Enable |
| Link Speed | 16Gbps |
| Connection Type | Point-to-Pont |
| Multiple Port ID | Disable |
| Select Boot Device | Enable |
| Multipath Function | Enable |

## Network Architecture

This reference architecture 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 cache synchronization of Oracle RAC and inter-node communication among the nodes in the cluster.
- **Public Network** — This network provides client connections to the applications and Oracle RAC.

Hitachi Data Systems recommends using a pair of 10 Gb/s NICs for the cluster interconnect and public network.

Each SMP server blade in this reference architecture uses 3 × 10 Gb/s 2-port LAN adapter cards connected to 2 Brocade VDX 6740 network switches. Create NIC bonding from a pair of 10 Gb/s NIC cards for private, public, and management networks to achieve failover and load balance. See Table 13, “Network Configuration,” on page 17 for more detail information about NIC bonding.

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

- For each server in the Oracle RAC clusterware configuration, use at least two identical, high bandwidth, low-latency NICs for the interconnection.
- Use NIC bonding to provide fail over and load balancing of interconnections within a server.
- Set all NICs to full duplex mode.
- Use at least two public NICs for client connections to the application and database.
- Use at least two private NICs for the cluster interconnection.

Figure 5 shows the network configuration for the reference architecture environment.

**Figure 5**

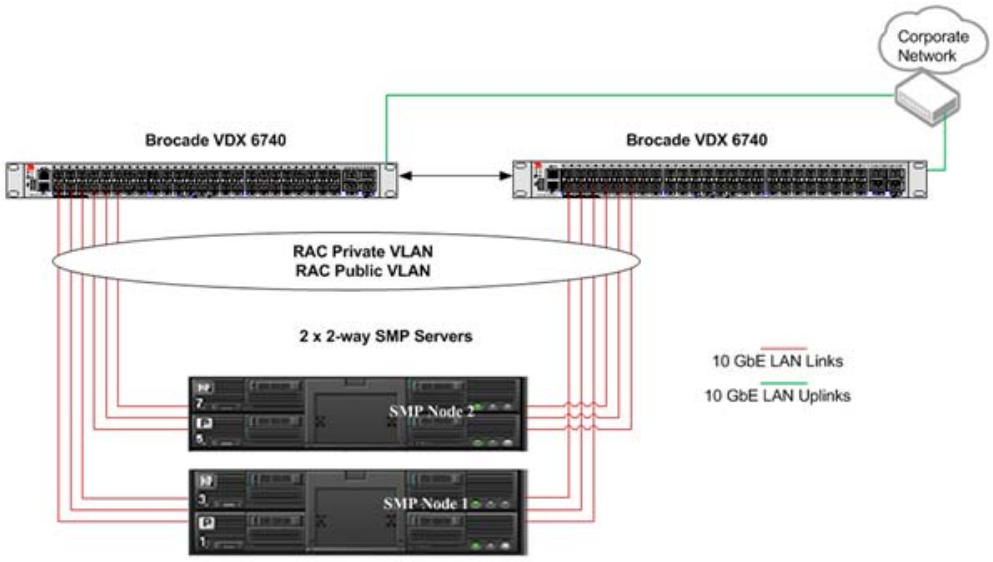



Table 13 lists the network configuration for this solution. Configure the VLAN accordingly to fit your network environment.

**TABLE 13. NETWORK CONFIGURATION**

| Server | NIC Ports | VLAN/ Subnet | NIC BOND | IP Address | Network | Bandwidth (Gb/s) |
|---|---|---|---|---|---|---|
| SMP Server 1 | NIC1-1 | 208 | Bond100 | 192.208.103.11 | Private | 10 |
| | NIC2-2 | | | | | 10 |
| | NIC1-2 | 242 | Bond300 | 172.17.167.69 | MGM | 10 |
| | NIC3-1 | | | | | 10 |
| | NIC2-1 | 242 | Bond200 | 172.17.167.75 | Public | 10 |
| | NIC3-2 | | | | | 10 |

TABLE 13. NETWORK CONFIGURATION (CONTINUED)

| Server | NIC Ports | VLAN/ Subnet | NIC BOND | IP Address | Network | Bandwidth (Gb/s) |
|---|---|---|---|---|---|---|
| SMP Server 2 | NIC1-1 | 208 | Bond100 | 192.208.103.12 | Private | 10 |
| | NIC2-2 | | | | | 10 |
| | NIC1-2 | 242 | Bond300 | 172.17.167.70 | MGM | 10 |
| | NIC3-1 | | | | | 10 |
| | NIC2-1 | 242 | Bond200 | 172.17.167.76 | Public | 10 |
| | NIC3-2 | | | | | 10 |

## Hitachi Infrastructure Analytics Advisor

Leverage Hitachi Infrastructure Analytics Advisor (HIAA) to monitor storage systems, hosts, servers, networks, and VMware hosts and appliances. Infrastructure Analytics Advisor can diagnose performance problems (bottlenecks) and provide alert periodically based on the threshold set to the systems.

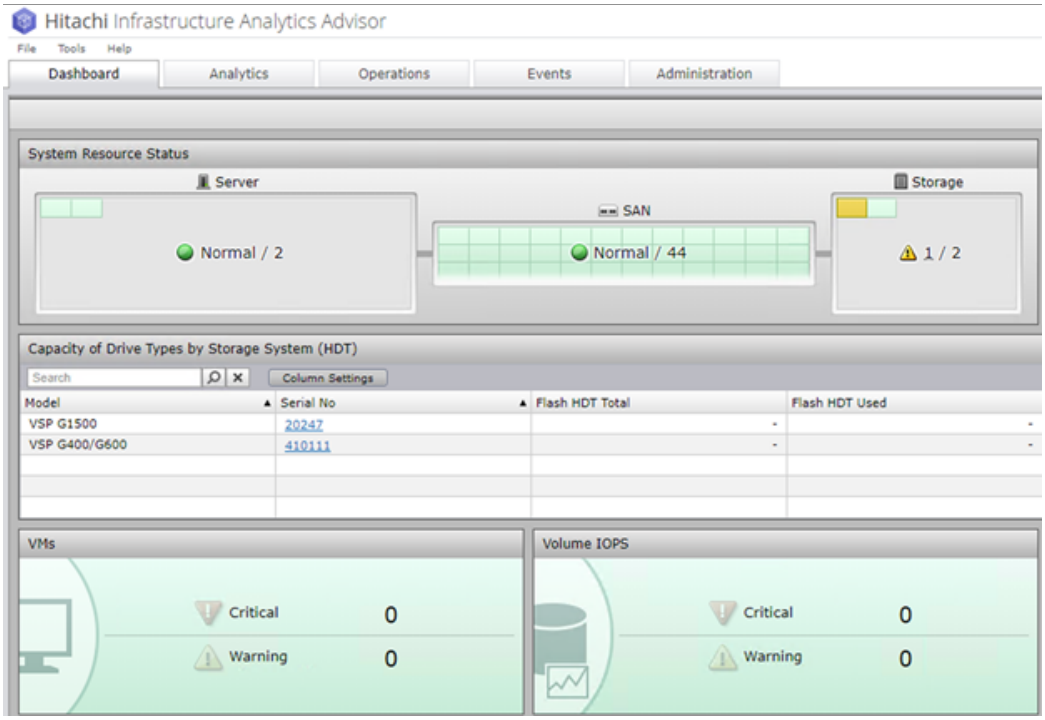
These are the key features for Infrastructure Analytics Advisor.

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

Refer to Hitachi Infrastructure Analytics Advisor User Guide (PDF) for more details.

Figure 6 on page 18 shows the dashboard view for Hitachi Infrastructure Analytics Advisor v3.1.

**Figure 6**




# Engineering Validation

This summarizes the key observations from the test results for Hitachi Unified Compute Platform 6000 for Oracle Real Application Cluster using Hitachi Virtual Storage Platform G1500 with Hitachi Accelerated Flash and Oracle Orion and Peakmarks.

## Test Methodology

Oracle Orion and Peakmarks were used to generate a workload for the Oracle Real Application Cluster database with symmetrical multi-processing (SMP) servers and Hitachi Virtual Storage Platform G1500.

### *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 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 ASM.

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

Oracle Orion 12.1.0.2.0 was used to validate this solution.

### *Peakmarks*

With more than 50 Oracle workloads for components (processor, server, storage) and representative database operations (data bulk load, data analytics, OLTP), peakmarks is a comprehensive benchmark suite for Oracle platforms that can be adapted to the infrastructure and scales from a notebook to the largest SMP and cluster configurations.

Peakmarks is the leading benchmark software for Oracle platforms for the following:

- Performance verification (quality assurance)
- Evaluation of different infrastructure products, technologies, and solutions (price or performance comparison)
- Performance optimization (improvement in efficiency)
- This provides transparency and comparability in price versus performance considerations for Oracle infrastructures

Peakmarks 9.2 was used to validate this solution.

### *Test Environment*

Table 14, "Test Environment," and Table 15, "Test Applications," describe the test environment and applications used to validate this environment.

**TABLE 14. TEST ENVIRONMENT**

| Item | Description | Value |
|---|---|---|
| Operating System | Operating system being used for this environment | Oracle Linux 7.3 |
| Workload Type | I/O workload type used to test the database and storage | OLTP and OLAP |
| Database Size | Total size of the data used for the testing | 16 TB |
| Number of Cores | CPU cores | 88 per node |
| Memory | Server memory | 1,536 GB per node |
| Network | Cluster interconnect | 10 Gb/s |

**TABLE 15. TEST APPLICATIONS**

| Software | Version | Function |
|---|---|---|
| Oracle | 12.1.0.2.0 | Oracle GI and Database |
| Orion | 12.1.0.2.0 | I/O workload generation |
| Peakmarks | 9.2 | Oracle Database workload generation |

## Test Results

Table 16 lists the Oracle Orion I/O test case results generated when validating this solution.

**TABLE 16. ORACLE ORION I/O TEST CASE RESULTS**

| Test Case | Test or Workload Type | Metric | Value |
|---|---|---|---|
| 1 | Storage performance — 100% OLTP random read (8K) | Maximum I/Os | 2,058,051 |
| | | Average RT | 0.9 ms |
| 2 | Storage performance — 100% OLTP random writes (8K) | Maximum I/Os | 777,137 |
| | | Average RT | 1.03 |
| 3 | Storage performance — 100% OLAP sequential reads (1024K) | Maximum throughput | 25,257 MB/s |
| 4 | Storage performance — 100% OLAP sequential writes (1024K) | Maximum throughput | 13,092 MB/s |

Table 17 lists the Peakmarks test case results generated when validating this solution.

**TABLE 17. PEAKMARKS TEST CASE RESULTS**

| Test Case | Test/Workload Type | Metric | Value |
|---|---|---|---|
| 1 | Storage performance random read (STO-RR) | Maximum I/Os | 922,478 |
| | | Average RT | 0.8 ms |
| 2 | Storage performance random write (STO-RWF) | Maximum I/Os | 557,905 |
| | | Average RT | 0.3 ms |
| 3 | Storage performance sequential read (STO-SR) | Maximum throughput | 19,904 MB/s |
| 4 | Storage mixed random read write (STO-MIX 30% update ratio) | Maximum I/Os | 396,638 |
| | | Average RT | 0.8 |
| 5 | Database medium OLTP select performance — 25 rows per transaction (DBX-S25) | Throughput in transactions per second | 17,838 |
| | | Throughput in rows per second | 445,889 |
| | | Average RT for SQL statement | 3.5 ms |
| 6 | Server performance test — OLTP 25 rows per transaction (SRV-S25) | Throughput in transactions per second | 7,152 |
| | | Throughput in rows per second | 686,560 |
| | | Throughput in logical buffer reads per second | 18,407,046 |
| | | Average RT for SQL statement | 0.1 |
| 7 | CPU processor performance test — Arithmetic ADD operation (CP2-SA) | Throughput in operations per second | 16,764,392,766 |

# For More Information

Hitachi Data Systems 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.

Live and recorded product demonstrations are available for many Hitachi products. To schedule a live demonstration, contact a sales representative. To view a recorded demonstration, see the Resources website.

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