TECHNICAL PAPER

Hitachi Unified Compute Platform 6000 for the SAP HANA Platform with Logical Partitioning

Reference Architecture Guide

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Hitachi Data Systems

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Hitachi Unified Compute Platform 6000 for the SAP HANA Platform with Logical Partitioning

Reference Architecture Guide

Use this reference architecture guide to design a scalable converged solution for SAP. Hitachi Unified Compute Platform 6000 (UCP) for the SAP HANA platform with logical partitioning (LPAR) in a scale-up configuration is a pre-configured virtual appliance, ready to plug into your network. It provides real time data processing of operational data for use in analytic models.

This describes how to deploy Hitachi Unified Compute Platform for SAP HANA using the following:

- **Hitachi Compute Blade 2500 (CB 2500)**

  This has enterprise computing power and performance with flexible I/O architecture and logical partitioning. Multiple applications easily and securely co-exist in the same chassis.

  This solution uses a varying number of 520X B2 or 520 B3 server blades to provide the flexibility of multiple LPAR configuration options.

- **Hitachi Virtual Storage Platform G600 (VSP G600)**

  These scale for all data types, flexibly adapting for performance, capacity, and multi-vendor storage.

  In this solution, the persistent storage of SAP HANA resides on Hitachi Virtual Storage Platform G600.

- **Symmetric multiprocessing connector**

  This connects multiple server blades together into one unit.

- **Brocade ICX 6430-24 switch**

  This 24-port 1 GbE switch provides a management network to the appliance.

- **Brocade VDX 6740-48 switch**

  This 48-port switch provides 10 GbE external connectivity to the appliance.

- **Rack optimized server for solutions, 2U four node**

  This an ultra-dense design has the flexibility to set up different workloads independently in one 2U shared infrastructure. This solution uses one node our of four in the server as a management server.

- **10 GbE 2-port LAN PCIe adapters**

- **Hitachi 16 Gb/sec PCI-FX Fibre Channel adapters**

- **Logical partitioning (LPAR)**

  A feature of Hitachi Compute Blade family, this firmware-based hypervisor creates logical partitions on one physical server.

- **SAP HANA**

  This is a multi-purpose, in-memory database to analyze transactional and analytical data.

- **Operating System**

  Use one of the following:

  - SUSE Linux Enterprise Server
  - Red Hat Enterprise Linux

Figure 1 shows the hardware necessary in a converged system for real-time analytics to create a scale-up converged solution with logical partitioning.

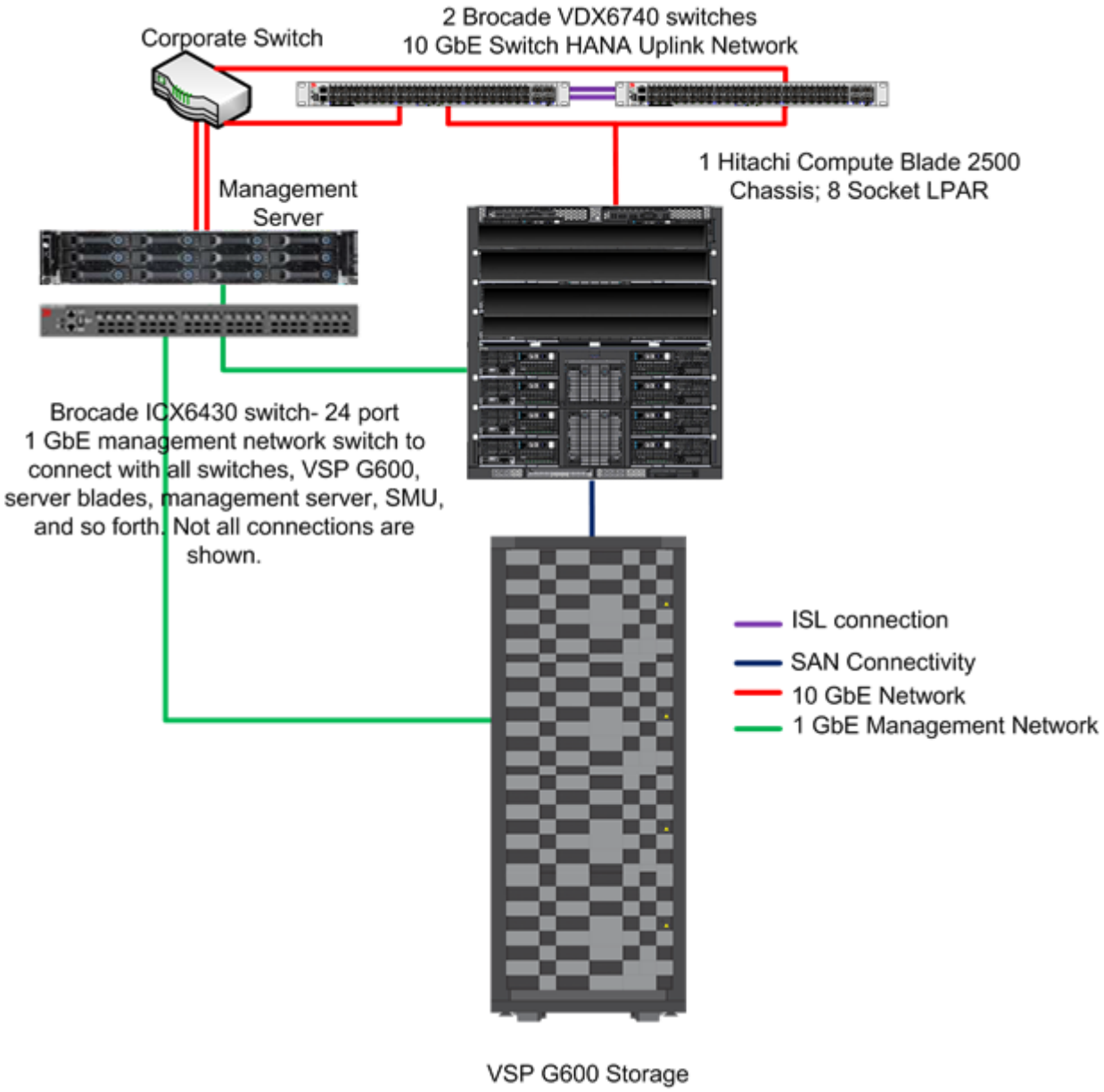

Figure 1

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.

Key Solution Elements

Based on Hitachi Unified Compute Platform for SAP HANA, these are the key hardware and software components used to run mission-critical SAP applications.

Hardware Elements

These are the key hardware elements used in this solution.

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.

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

Different sizes of this solution use a different number of 520X B2 or 520X B3 server blades (one, two, or four) in Hitachi Compute Blade 2500.

Symmetric Multiprocessing Connector

For multiple server blades, the solution uses symmetric multiprocessing (SMP) technology to combine multiple server blade resources into a single server.

The server blades use SMP in one of two ways, depending on the size of the solution:

- Combine two server blades with a 2-blade SMP connection board.
- Combine four server blades with a 4-blade SMP connection board.

Hitachi Virtual Storage Platform Gx00 Models

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

Hitachi Storage Virtualization Operating System provides storage virtualization, high availability, superior performance, and advanced data protection for all Virtual Storage Platform Gx00 models. This proven, mature software provides common features to consolidate assets, reclaim space, extend life, and reduce migration effort. New management software improves ease of use to save time and reduce complexity. The infrastructure of Storage Virtualization Operating System creates a management framework for improved IT response to business demands.

This solution uses a single server with up to eleven LPARs connected to one Virtual Storage Platform G600. Further consolidation of multiple servers is possible using VSP G800 and VSP G1000. All storage models have been certified for Hitachi bare metal scale-up appliances.

Rack Optimized Server for Solutions, 2U Four Node

The rack optimized server for solutions, 2U four node, is an ultra-dense design equipped with four independent nodes. It creates the flexibility to set up different workloads independently in one 2U shared infrastructure, providing optimal data center performance per dollar.

In this environment, the rack optimized server is the management server. This component is optional.

Note — This reference architecture guide assumes that the environment has the optional management server.

Brocade Switches

Brocade and Hitachi Data Systems partners 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.

This solution can include the following Brocade products:

- Brocade VDX 6740-48 port switch
- Brocade ICX 6430-24 port switch

Software Elements

These are the key software elements used in this solution.

Hitachi Storage Virtualization Operating System

Hitachi Storage Virtualization Operating System (SVOS) 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.

Storage Virtualization Operating System includes standards-based management software on a Hitachi Command Suite (HCS) base. This provides storage configuration and control capabilities for you.

Storage Virtualization Operating System uses Hitachi Dynamic Provisioning (HDP) to provide wide striping and thin provisioning. Dynamic Provisioning provides one or more wide-striping pools across many RAID groups. Each pool has one or more dynamic provisioning virtual volumes (DP-VOLs) without initially allocating any physical space. Deploying Dynamic Provisioning avoids the routine issue of hot spots that occur on logical devices (LDEVs).

Logical Partitioning

The logical partitioning feature from Hitachi partitions the physical resources of one single-blade or multi-blade server logically into independent server environments called LPARs (logical partitions). The LPAR manager enables the consolidation of multiple production SAP HANA instances on the same physical server using a single Virtual Storage Platform.

LPARs that use a full socket runs in dedicated mode. CPUs, memory, and I/O devices, and storage ports are assigned dedicated to LPARs to create fully isolated server environments for SAP HANA.

Single node installations within each LPAR run on the same physical host without any noisy neighbor effects between the different server environments.

LPARs that use one-half of a socket run in shared mode. CPU cores and memory are dedicated to each LPAR. To provide redundant I/O paths, the I/O devices are shared across two LPARs. The shared mode LPARs also shares ports on the storage system.

Guest Operating System Choices

The following options are available as guest operating system for the LPARs:

- **SUSE Linux Enterprise Server (SLES) for SAP Applications**

  Compete more effectively though improved uptime, better efficiency, and accelerated innovation using SUSE Linux Enterprise Server. This is a versatile server operating system for efficiently, deploying highly available enterprise-class IT services in mixed IT environments with performance and reduced risk.

  SUSE Linux Enterprise Server was the first Linux operating system to be certified for use with SAP HANA. It remains the operating system of choice for the vast majority of SAP HANA customers.

- **Red Hat Enterprise Linux (RHEL)**

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

Changing the configuration settings is only supported along the guidelines of SAP and the operating system distributor and may otherwise cause significant performance problems. The following SAP Notes for SLES and RHEL are a good starting point for information on this topic:

- 1944799 - SAP HANA Guidelines for SLES Operating System Installation
- 2009879 - SAP HANA Guidelines for Red Hat Enterprise Linux (RHEL) Operating System

For more details, see “Updating and Patching the Operating System,” in the SAP HANA Technical Operations Manual.

SAP HANA

SAP HANA converges database and application platform capabilities in-memory to transform transactions, analytics, text analysis, predictive and spatial processing so businesses can operate in real-time. This combines database, data processing, and application platform capabilities in a single in-memory platform. In addition, the platform provides libraries for predictive, planning, text processing, spatial, and business analytics — all on the same architecture. This architecture comes from leading hardware partners of SAP, including Hitachi.

By eliminating the divide between transactions and analytics, SAP HANA allows you to answer any business question anywhere in real time.

SAP customers can download more information on SAP HANA at the SAP Service Marketplace. See the installation and upgrade guides download section for SAP In-Memory Computing (SAP In-Memory Appliance — SAP HANA). The following are available:

- SAP HANA Platform (Core) Documentation.

  This page is the central starting point to find documentation for SAP HANA.

- SAP Integration and Certification Center (SAP ICC)

  This page provides information about appliances certified by SAP hardware partners.

Find information on production SAP HANA on Hitachi systems with LPAR in SAP Note 2063057.

Solution Design

This is the detailed design for Hitachi Unified Compute Platform 6000 for SAP HANA with logical partitioning (LPAR) in a scale-up configuration reference solution.

Logical Partitioning Supported Solutions

SAP HANA on Hitachi solutions with logical partitioning is based on a number of bare-metal appliance configurations with modifications that are required for running logical partitions (LPARs) in dedicated mode. This document describes the configurations for production LPAR SAP HANA instances.

Table 1 lists the supported basis configurations for SAP HANA with logical partitioning. The memory and I/O devices are co-located with the CPUs assigned to the LAPR.

This document uses the term “CPU socket” to differentiate between the LPAR size and the bare metal system size. CPU socket does not refer to an empty CPU socket, but includes the processor.

Except for half of a CPU socket, a partition on the CPU at core level is not supported for LPARs running production SAP HANA instances.

Table 1. Supported Scale-up Configurations for SAP HANA with Logical Partitioning

Solution Size		Small (S)	Medium (M)	Large (L)
Number of CPU Sockets		2	4	8
Number of Server Blades		1	2 (using a 2-blade SMP)	4 (using a 4-blade SMP)
Total Memory (in GB)		256, 512, 768, 1024, 1536, 2048	512, 1024, 2048, 3072, 4096	1024, 2048, 3072, 4096, 6144, 8192
Number of LPARs for Production Usage		Any combination of LPARs that totals two sockets	Any combination of LPARs that totals four sockets	Any combination of LPARS that totals eight sockets in the maximum of 11 LPARS
Maximum Memory Size per LPAR	1/2-socket	25% of the memory	12.5% of the memory	6.25% of the memory
	1-socket	50% of the memory	25% of the memory	12.5% of the memory
	2-socket	100% of the memory	50% of the memory	25% of the memory
	4-socket	Not applicable	100% of the memory	Not supported

Note — LPAR systems with total memory of 2048 GB for small, 4096 GB for medium, and 8192 GB for large are not supported on 520X B2 blades.

Hitachi Compute Blade 2500 Configuration

This solution uses one Hitachi Compute Blade 2500 with the following components:

The LPAR SAP HANA scale-up configurations can have one, two, or four 520X B2 or 520X B3 server blades. Refer to Table 2 for supported configurations.

There are two management modules on Hitachi Compute Blade 2500 connected to the management network.

Table 2. Chassis Configuration

Feature	Small (2-Socket) Configuration	Medium (4-Socket) Configuration	Large (8-Socket) Configuration
Number and type of server blades	1 × 520X B2 or 520X B3	2 × 520X B2 or 520X B3	4 × 520X B2 or 520X B3
Server Blade Location	Blade 1 (primary)	Blade 3 (non-primary) Blade 1 (primary)	Blade 7 (non-primary) Blade 5 (non-primary) Blade 3 (non-primary) Blade 1 (primary)
SMP	none	1 × 2 blade SMP	1 × 4 blade SMP
Network ports	1 × 2-port 10GBASE-SR LAN PCI-E adapter on two I/O board modules for each server blade		
Fibre Channel Ports	1 Hitachi 16 Gb/sec, 2-port Fibre Channel PCI-E adapters on two I/O board modules for each server blade		
Other interfaces	For all sizes: ■ 1 USB 3.0 port ■ KVM connector (VGA, COM, USB 2.0 port)		

You can install a maximum of 28 I/O board modules (IOBD) on one Hitachi Compute Blade 2500. Depending on the size of the environment, use between 4 and 16 I/O board modules.

Figure 2 on page 9 shows the layout of the I/O board modules from the back of the Hitachi Compute Blade 2500 chassis.

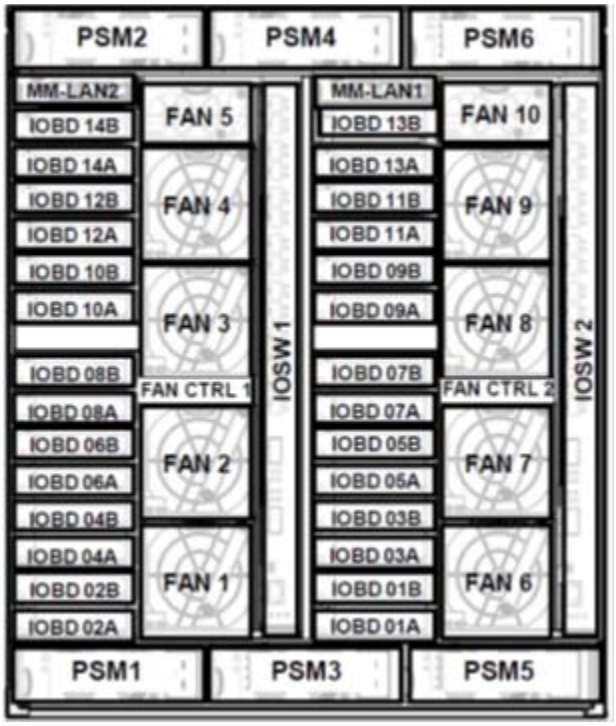

Figure 2

Server Blade Architecture

Each solution size has a different number of server blades, from one up to four full-width server blades. Multiple server blades use a two- or four-server blade SMP connector board to create a single four- or eight-socket SMP node with up to a total of 192 cores and different memory sizes. Table 3 shows the supported server blade configurations. Table 4 shows the supported memory configuration.

Table 3. Server Blade Configuration

	Item		Type or Number
Server blade quantity	Small (2-socket)		1 server blade
	Medium (4-socket)		2 server blades
	Large (8-socket)		4 server blades
Server blade model	520X B3	Processor SKU (choose only one)	Intel Xeon E7-8890 v4
			Intel Xeon E7-8880 v4
		Processor Cores (choose only one)	24 for the Intel Xeon E7-8890 v4 processor
			22 for the Intel Xeon E7-8880 v4 processor
		Processor Frequency	2.5 GHz
	520X B2	Processor SKU	Intel Xeon E7-8880 v3
		Processor Cores	18
		Processor Frequency	2.2 GHz

Table 4. Memory Configuration

DIMMs	Memory Per Server Blade	Total Memory		
		Small (2-Socket)	Medium (4-Socket)	Large (8-Socket)
16 × 16 GB DIMMs	256 GB	256 GB	512 GB	1024 GB
32 × 16 GB DIMMs	512 GB	512 GB	1024 GB	2048 GB
48 × 16 GB DIMMs	768 GB	768 GB	1536 GB	3072 GB
32 × 32 GB DIMMs	1024 GB	1024 GB	2048 GB	4096 GB
48 × 32 GB DIMMs	1536 GB	1536 GB	3072 GB	6144 GB
32 x 64 GB DIMMS	2048 GB	2048 GB	4096 GB	8192 GB

Storage Architecture

Hitachi Virtual Storage Platform G600 is used for this solution. Sizing and configuring of storage including storage drive box trays (DBS), spare drives, the operating system volume (OS), and the SAP HANA shared volume (/hana/shared) varies for different size solutions by taking storage and I/O requirements into account.

Fibre Channel SAN Architecture

This solution uses between 4 and 16 × 16 Gb/sec Fibre Channel ports on Hitachi Virtual Storage Platform G600 directly attached to Hitachi Compute Blade 2500 using the Fibre Channel PCI-E adapters. Table 5 shows the Fibre Channel port mappings between the ports on Hitachi Virtual Storage Platform G600 and the Fibre Channel adapters on the I/O board modules.

Table 5. Fibre Channel Port Mapping

Server Blade Number	PCI-E Slot Number	Port Number	VSP G600 Port
Blade 1	IOBD 01A	0	1A
		1	2A
	IOBD 02A	0	3A
		1	4A
Blade 3	IOBD 03A	0	1B
		1	2B
	IOBD 04A	0	3B
		1	4B
Blade 5	IOBD 05A	0	1C
		1	2C
	IOBD 06A	0	3C
		1	4C
Blade 7	IOBD 07A	0	1D
		1	2D
	IOBD 08A	0	3D
		1	4D

This configuration provides the following from the LPAR within Hitachi Compute Blade 2500 to the ports on Virtual Storage Platform G600:

- Two dedicated paths for each 1-socket LPAR
- Four dedicated paths for 2-socket LPARs
- Four dedicated paths for 4-socket LPARs

In a sub-socket environment, share the I/O path between the LPARs configured on the same socket. Perform the I/O isolation at the HBA level.

Shared Storage Architecture

Shared storage architecture can realize better return on investment and reduce total cost of ownership than having storage dedicated to one LPAR. This architecture increases the number of LPARs that can use the storage subsystem and reduces the number of disks required.

Use the following dynamic provisioning pool configuration:

- One dynamic provisioning pool for the operating system (OS), SAP HANA shared, and SAP HANA data
  - Depending on the LPAR system size, there are two or more parity groups with RAID-6 (14D + 2P) with 16 × 600 GB 10k RPM SAS drives
  - These RAID groups are all assigned to one dynamic provisioning pool
- One dynamic provisioning pool for the SAP HANA log
  - Depending on the LPAR system size, there are one or more parity groups with RAID-6 (6D + 2P) with 8 × 600 GB 10k RPM SAS drives
  - These RAID groups are all assigned to one dynamic provisioning pool

Each LPAR in this solution has the following LUNs:

- One LUN to host the LPAR guest operating system
- One LUN to host the SAP HANA shared volume that matches the LPAR memory size
- Four LUNs to host the SAP HANA log volume
- Four or eight LUNs to host the SAP HANA data volume

Network Architecture

This solution uses two logical networks. Each logical network maps to a separate physical network.

- **Client Network**

  This network provides client access to the LPARs and the SAP HANA database running on the LPARs.

- **Management Network**

  This network provides the network used for the management of hardware and LPARs.

When providing additional features in a solution, you can use more logical networks to isolate network traffic. Figure 3 shows the network connections for a server blade with two 1-socket LPAR configuration.

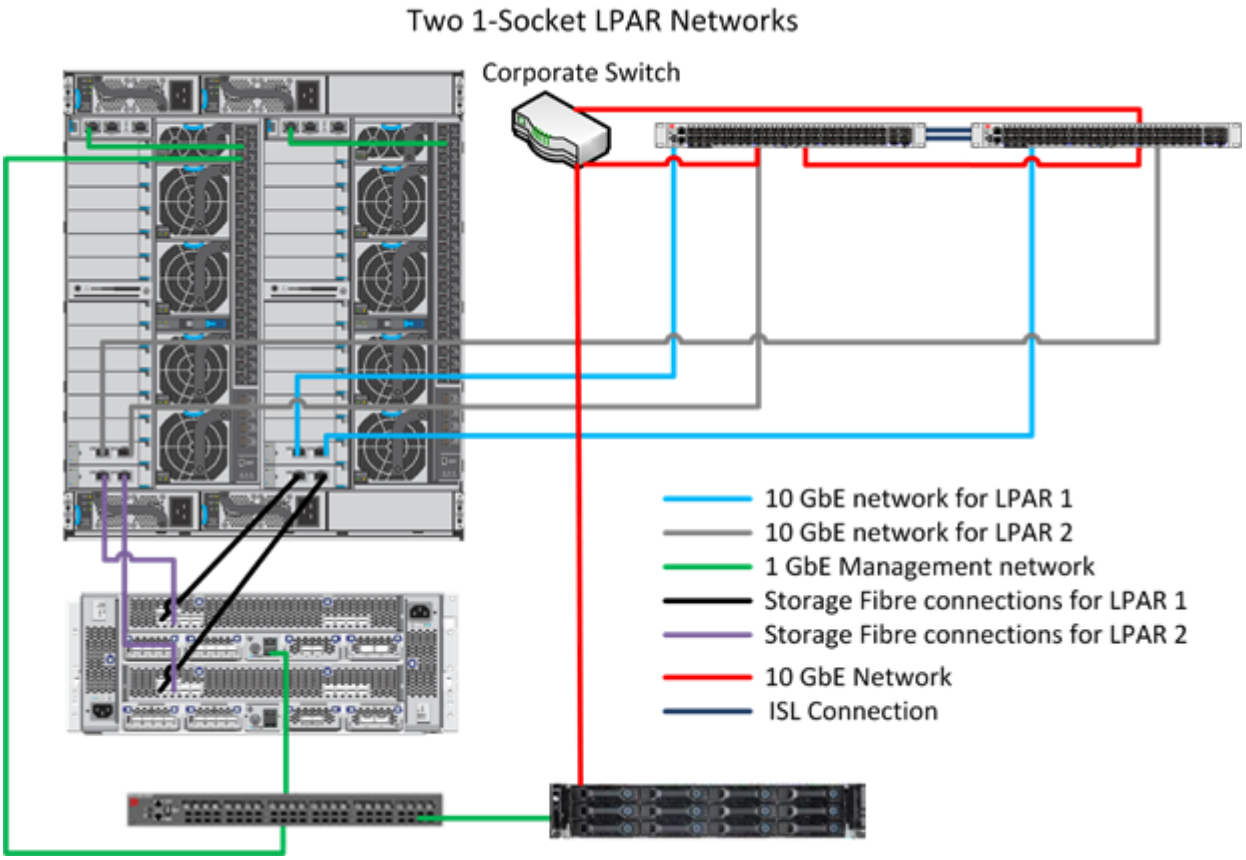

Figure 3

Switches

Two sets of switches are options for this solution.

- **Brocade VDX 6740-48 Top Of the Rack (TOR) Client Switches**

  Use these switches for the client network connections to the SAP HANA node. The switches are uplinked to the client switch.

  Connect two switches together using ISL. This lets both switches act together as a single logical switch. If one switch fails, there still is a path to the hosts.

- **Brocade ICX 6430-24 Management Switch**

  Use this switch to connect the management ports of the hardware to the management server. This provides an isolated network for managing the solution.

Client Network

This solution uses 10GBASE-SR 2-port LAN adapters installed on the PCI-E B-slots of each I/O board module. Between two and four LAN adapters are used for connecting to external 10 GbE switches.

In a full socket environment, dedicate each network controller to an LPAR.

In a sub-socket environment, share each NIC port between the LPAR configured on the same socket. Perform the network isolation at the NIC level through the SR-IOV feature.

- Two 10 GbE network ports for each 0.5-socket LPAR
- Two 10 GbE network ports for each 1-socket LPAR
- Four 10 GbE network ports for each 2-socket LPAR
- Four 10 GbE network ports for each 4-socket LPAR

To provide redundancy, configure two network interfaces at the operating system level to use **active-active** network bonding mode. This acts as the client network for the SAP HANA node. Connect these network interfaces to the TOR switches. To provide redundancy, make one connection to each of the TOR client network switches.

Management Network

Logical partitioning manager requires two additional network ports for the LPAR management network path. These ports are provided by two 1 GbE 4-port LAN mezzanine cards located in slot 1 and slot 3 of server blade 1. The LAN mezzanine cards connect to the management network through two 1GbE or 10GbE LAN switch modules located in the back of the Hitachi Compute Blade 2500 chassis.

Consolidate all 1 GbE management network connections using these 1G/10Gb internal switch modules, especially the LAN connection to the Hitachi Compute Blade 2500 chassis management modules. These connections are then up-linked to the management switch.

LPAR management network links are aggregated using active-backup mode. The IP address of LPAR manager and the chassis management modules (SVP) have to be in the same subnet.

The Hitachi Compute Blade 2500 chassis has two management modules to secure fault tolerance with the following:

- Manage the power supply of each module and monitor the status of the system unit.
- Support the management functionality of the network within the system unit for server blades and various modules.
- Connect between a management module and an external network through a management LAN module

Management Server

This solution uses a rack optimized server for solutions, 2U four node, for the management server. This acts as a central device for managing SAP HANA. This server is optional.

Manage the following from the management server:

- Hitachi Compute Blade 2500 chassis
- 520X B2 or 520X B3 server blades
- Brocade switches
- LPAR
- SAP HANA node or nodes
- Hitachi Virtual Storage Platform
- NTP configuration

Figure 4 shows the management server network ports using one dual port 1 GbE Base-T Intel i350 mezzanine card. These ports provide the 1 GbE network to the management server:

- **Slot 01 Port 2** — Connect this to the Brocade ICX 6430 switch.
- **Slot 01 Port 1** — Connect this to the Brocade ICX 6430 port switch.

The management server has the following additional components:

- One dual port 10 GbE Intel 82599ES SFP+ OCP mezzanine card
- One Emulex 2-port 8 Gb/sec Fibre Channel HBA on the PCIe slot

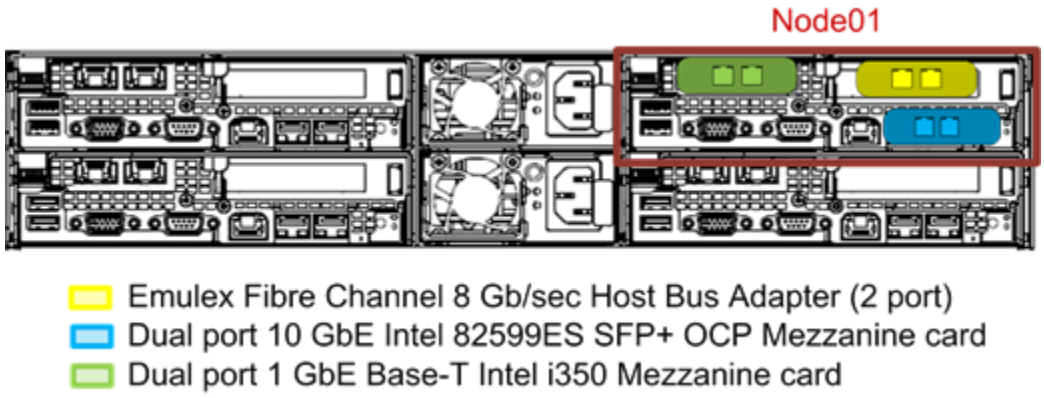

Figure 4

SAP HANA Node

This describes the SAP HANA volume and operating system configuration for the LPAR solution on Hitachi Unified Compute Platform 6000 for SAP HANA.

SAN Operating System Boot Configuration

A scale-up configuration for SAP HANA requires SAN boot.

The operating system LUN is the primary boot device for each LPAR on the 16 Gb/sec 2-port Fibre Channel mezzanine cards. The operating system LUN holds partitions for the following:

- Operating system
- /usr/sap/ directory
- Linux swap space

The following sections that describe configurations and volume assignment hold true for each LPAR.

Activate Device-Mapper Multipath

This reference architecture uses Device-mapper Multipath, a native component of the Linux operating system.

Using Device-mapper Multipath allows the configuration of multiple I/O paths between the server blades and Hitachi Virtual Storage Platform G600. Multipathing aggregates all physical I/O paths into a single logical path. The LUNs are always available unless all paths fail.

Use Device-mapper Multipath for the following I/O paths:

- Operating system volume LUN
- SAP HANA data volume LUN
- SAP HANA log volume LUN
- SAP HANA shared volume LUN

SAP HANA Data Volume Configuration

Logical Volume Manager creates a single striped volume for each LPAR on which the XFS file system is created to store the SAP HANA data volume. The striped volume acts as the persistent layer for the SAP HANA server.

SAP HANA Log Volumes Configuration

Logical Volume Manager creates a single striped volume for each LPAR on which the XFS file system is created to store the SAP HANA log volume.

SAP HANA Shared Volume

Logical Volume Manager is used to create a single volume for SAP HANA. This volume contains SAP HANA binaries, configuration, and traces.

SAP HANA Appliance Software Installation

After configuring the file system for the SAP HANA data and log volumes, SAP HANA 1.0 is installed on the SAP HANA server or servers.

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 Hitachi Data Systems Global 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 Hitachi Data Systems Corporate Resources website. Click the **Product Demos** tab for a list of available recorded demonstrations.

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