TECHNICAL PAPER

Hitachi Unified Compute Platform 6000 with SAP Business Suite on HANA using Hitachi Virtual Storage Platform (VSP) Gx00 with Unified NAS Modules

Reference Architecture Guide

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Hitachi Data Systems

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Reference Architecture Guide

This reference architecture guide describes an example architecture of how to deploy SAP Business Suite on Hitachi Unified Compute Platform using the following:

- Hitachi Compute Blade 2500 (CB 2500) with 520X B3 server blades
- Hitachi Compute Blade 2500 with 520H B4 server blades
- Hitachi Virtual Storage Platform G800 with unified NAS modules
- SAP HANA 1.0 SPS12 or later
- SAP Business Suite on HANA (SAP ECC6 EHP8)
- SuSE Linux Enterprise Server for SAP Applications 12 or Redhat Enterprise Linux 7.2

This technical paper assumes that you have familiarity with the following:

- Storage area network (SAN)-based storage systems
- General storage concepts
- Common IT storage practices
- SAP HANA
- SAP Business Suite

Solution Overview

This reference solution uses Hitachi Unified Compute Platform for the SAP HANA Platform with the following components for the scale-up configuration and SAP S/4HANA application servers:

- **Hitachi Compute Blade 2500 (CB 2500)** — An enterprise-class blade server platform. This solution uses one CB 2500 chassis with two 520X B3 server blades for the SAP HANA Platform and two 520H B4 server blades for the SAP Business Suite application, as shown in Figure 1.
- **Hitachi Virtual Storage Platform (VSP) Gx00**— Storage virtualization system designed to manage storage assets more efficiently. These models scale for all data types, flexibly adapting for performance, capacity, and multi-vendor storage. This solution uses one VSP G800 with two integrated NAS Modules, in an active/active cluster, for a completely unified storage solution. However, VSP G400 or VSP G600 can also be used instead based on your requirement.
- **Management Server** — This server has an ultra-dense design, the rack optimized server for solutions, 2U four nodes is equipped with four independent nodes. It has the flexibility to set up different workloads independently in one 2U shared infrastructure. Use one server chassis with a single node that acts as a central device for managing SAP HANA.
- **Brocade VDX 6740 switch** — A 48-port switch that provides 10 GbE connectivity to the appliance. This solution uses two Brocade VDX 6740 switches.
- **Brocade ICX 6430-24 switch** — This 24-port 1 GbE switch provides the network for management of all hardware components. Use one Brocade ICX 6430-24 switch.
- **SAP HANA Platform** — A flexible, data source-agnostic, in-memory data platform that allows customers to analyze large volumes of data in real time.

This reference architecture describes an example configuration to deploy SAP Business Suite system (SAP ECC) on SAP HANA with TDI Tailored Datacenter Integration) approach using the hardware components mentioned above. This solution is deployed in a highly available configuration for SAP Business Suite and SAP HANA.

Figure 1 shows the topology of this reference architecture.

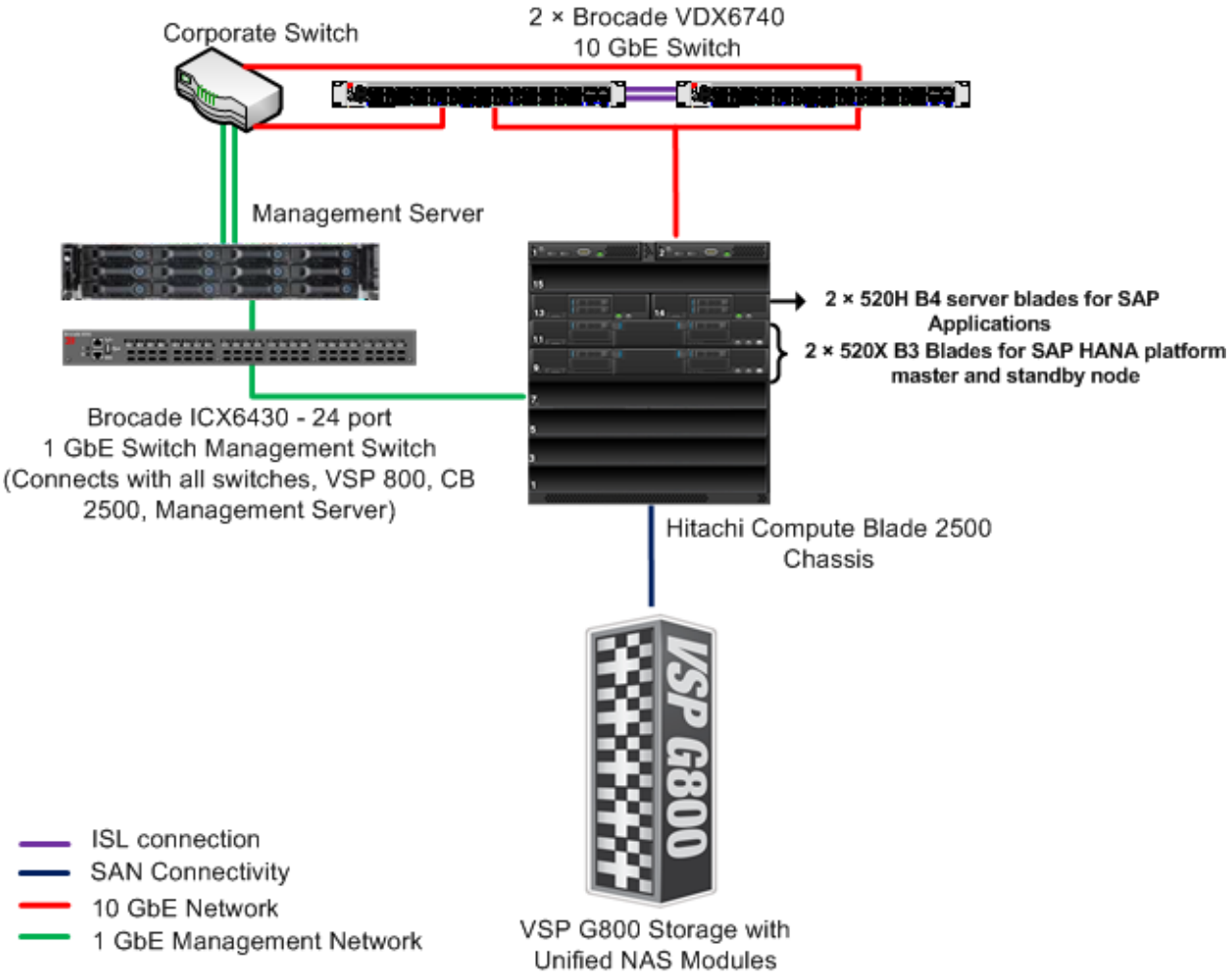

Figure 1

Key Solution Elements

The following are the key hardware and software components used in this reference architecture.

Hardware Elements

Table 1 lists the hardware used to deploy the specific scale-up configuration of Hitachi Unified Compute Platform for the SAP Business Suite and SAP HANA Platform.

Table 1. Hardware Elements

Hardware	Quantity	Configuration (per unit)	Role
Hitachi Compute Blade 2500 (CB 2500) chassis	1	■ 8 full-width blade slots ■ 2 management modules ■ 10 cooling fan modules ■ 5 Power Supply Modules (PSM) ■ 28 I/O board modules ■ 6 × 10 Gb 2-port LAN PCIe adapters ■ 6 × 16 Gb 2-port Hitachi FIVE-FX FC PCIe adapters	Server blade chassis
Hitachi Compute Blade 520X B3 server blade	2	■ 2 × 22-core processors ■ 2 × pass through mezzanine cards. One on mezzanine slot 2 and one on mezzanine slot 4 of the server blade	SAP HANA servers
Hitachi Compute Blade 520H B4 server blade	2	■ 2 × 22-core processors ■ 1 × pass through mezzanine card on mezzanine slot 2	SAP application servers
Hitachi Virtual Storage Platform G800 with NAS modules	Single frame	■ Single frame	Block and shared storage for SAP HANA nodes and SAP application servers

Table 1. Hardware Elements (Continued)

Hardware	Quantity	Configuration (per unit)	Role
Management server	1	■ Intel Xeon E5-2620 v3 processor, 2.4 GHz CPU, 32 GB RAM ■ 2 × 500 GB 7200 RPM SATA drives ■ 1 dual port 10GigE Intel 82599ES SFP+OCP Mezzanine card ■ 1 dual port 1 GigE Base-T Intel i350 Mezzanine Card ■ Emulex Dual Port 8 Gb/sec Fibre Channel HBA	One node of the server serves as the management server running the following: ■ NTP ■ Hitachi Command Suite ■ Hi-Track® Remote Monitoring system ■ SAP HANA Studio
Brocade VDX 6740 switch	2	■ Two switches with dedicated VLANs for client and NFS network	10 GbE network connection for client and NFS network
Brocade ICX6430-24 port switch	1	■ 1 GbE ■ 24 ports	1 GbE management network

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.

Table 2 lists the configurations for the 520H B4 server blades used for the SAP application. The 520X B3 server blade configuration is explained in the Hitachi Unified Compute Platform 6000 for the SAP HANA Platform in Scale-up Configuration with Intel Xeon E7-8800 v4 Processors reference architecture guide.

Table 2. 520H B4 Server Blade Configuration

Feature	Configuration
Processors	2 Intel Xeon E5-2699v4 processors
Processor SKU	Intel Xeon E5-2699v4
Processor frequency	2.2 GHz
Processor cores	22 cores
Number of DIMMs per blade	24 × 32 GB DIMMs (768 GB)

Hitachi Virtual Storage Platform Gx00

Hitachi Virtual Storage Platform (VSP) 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 VSP 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 VSP Gx00 models. This proven, mature software provides common features to consolidate assets, reclaim space, extend life, and reduce migration effort.

This solution uses one VSP G800 with two integrated NAS Modules, in an active/active cluster, for a completely unified storage solution. Automatic and user-transparent deduplication provides storage savings. You can combine the NAS modules with the data-integrator-to-cloud feature to tier the storage of lesser-used files. This solution design only supports VSP G400, VSP G600, and VSP G800 out of the five available Gx00 models because only these three models support unified NAS platforms. The following are some advantages of using unified NAS modules in this solution:

- Shared and block storage required for SAP Business Suite and SAP HANA are provided by the same storage array, and no external NAS platform is required.
- No complex cluster setup is required for highly available NAS platforms when software-based NFS servers are used. This saves additional hardware and maintenance costs.
- Unified NAS modules can also provide NFS file system for backup of master and standby SAP HANA servers if required.
- Unified NAS modules can provide NFS file system to other applications in the customer landscape if required. Connectivity can be established through 10GbE switches used in this solution.

Software Elements

Table 3 describes the software products used to deploy this solution. If using higher versions, please check the corresponding product vendor's compatibility and support matrix. SLES12 operating system is used to deploy this solution, but other supported operating systems can be used for the implementation (for example, supported versions of RHEL can be used for SAP HANA).

Table 3. Software Elements

Software	Version
SUSE Linux Enterprise Server for SAP Applications	SLES12
SAP HANA Platform	1.0 SPS12
Hitachi Storage Navigator	Microcode dependent
SAP Business Suite	ECC 6 EHP 8, NW 7.50

SAP HANA

The SAP HANA platform is flexible, multipurpose in-memory software. It combines SAP software components optimized to specific hardware. These components come from leading hardware partners of SAP, including Hitachi Data Systems.

The SAP HANA platform allows customers to analyze large volumes of data in real time. It is also a development platform, providing an infrastructure and tools for building high-performance applications based on SAP HANA Extended Application Services (SAP HANA XS). It is the foundation of various SAP HANA editions, like the SAP HANA Platform Edition, providing core database technology, and the SAP HANA Enterprise Edition, bundling additional components for data provisioning. The SAP HANA Platform Edition integrates a number of SAP components, including the SAP HANA database, SAP HANA studio and SAP HANA clients. As a SAP customer, you can get more information on the SAP HANA platform at the SAP Service Marketplace and SAP Help Portal.

SUSE Linux Enterprise Server (SLES) for SAP Applications

The following option is available as guest operating system for SAP HANA database and SAP Business Suite Application servers:

- **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.

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 Note for SLES is a good starting point for information on this topic:

- 1944799 - SAP HANA Guidelines for SLES Operating System Installation

SAP Business Suite

The SAP Business Suite, powered by SAP HANA, delivers a unified way of addressing your transactional and analytical needs within a single in-memory platform. Perform real-time planning, execution, reporting, and analysis across your end-to-end business processes to drive your entire business in real-time.

SAP Business Suite i2013 has the following core applications:

- SAP Customer Relationship Management
- SAP Enterprise Resource Planning
- SAP Product Lifecycle Management
- SAP Supply Chain Management
- SAP Supplier Relationship Management

SAP NetWeaver, the underlying technology platform to power SAP Business Suite, is a three-layer application stack:

- Presentation
- Application server
- Database

Solution Design

This solution provides an example configuration of how a single CB 2500 chassis with two 520X B3 server blades, two 520H B4 server blades, and one VSP G800 storage array with unified NAS modules can be used for deploying a highly available SAP Business Suite system on SAP HANA database.

- Two full-width slots in the CB 2500 chassis are used for two 520X B3 blades, one for the SAP HANA master node and one for the SAP HANA standby node.
- Two half-width slots in the CB 2500 chassis are used for two half-width 520H B4 blades for SAP application servers.

Note – The number of server blades used in this reference architecture for application and database are just an example. Your actual requirement depends on the number of users and type of workloads. Perform hardware sizing to find out your hardware requirements. Also, bare-metal installation is used in this solution for application and database, but this can also be performed using virtualization platform such as VMware. Assistance is available from your Hitachi Data Systems pre-sales representative or by contacting Hitachi Data Systems via email: sap@hds.com.

Sizing and Scalibility

Sizing

The unit used to perform SAP system sizing is SAP Application Performance Standard (SAPS). SAPS is a hardware-independent unit of measurement that describes the performance of a system configuration in the SAP environment. It is derived from the Sales and Distribution (SD) benchmark, where 100 SAPS is defined as 2,000 fully business processed order line items per hour. SAP documentation regarding sizing can be found at SAP Service Marketplace (quick link sizing). SAP application sizing can be performed using the SAP Quicksizer. The SAP documentation and the SAP notes regarding sizing referred to in this reference architecture are a good starting point, but per SAP guidelines, SAP system sizing must always be performed by an experienced SAP consultant.

SAP Application Sizing

SAP Quicksizer results provide SAPS required for the application tier and database tier. This can be used as a starting point for sizing the application layer for the SAP Business Suite application. In this reference architecture, 520H B4 server blades are used for the application tier. These blades are certified by SAP on behalf of the SAP Benchmark Council for 104,180 SAPS, certification number: 2016030. This can be used as a reference to perform SAP application server sizing. Each 520H B4 server blade has 2 CPUs and 44 cores. Assuming Hyperthreading is activated (2 threads per physical core), each blade will have 88 threads or 88 vCPUs (virtual CPUs if virtualization is used). This translates to 2367 SAPS per physical core and 1183 SAPS per vCPU. The benchmark score is achieved by generating workload using a benchmarking tool and consuming close to 100% CPU. Perform the sizing by taking into consideration that the CPU utilization should not go beyond 65%. Also, about 10% overhead for virtualization must be considered.

SAP HANA Database Sizing

Refer to the following SAP notes and the SAP QuickSizer to perform SAP HANA Platform sizing for SAP Business Suite database:

1514966 - SAP HANA 1.0: Sizing SAP In-Memory Database

1793345 - Sizing for SAP Suite on HANA

Note - These SAP Notes refer to web links from the SAP website. S-user ID with proper authorization may be required to access some of those links (for example, to access SAP Notes).

Scalability

This reference architecture only describes the configuration with two 520X B3 server blades for SAP HANA database (one master and one standby) and the two 520H B4 server blades for the application tier. However, it is possible to install up to a large size (8-socket) scale-up configuration and use more 520H B4 server blades to add additional application servers based on SAPS requirements and design. Refer to the Hitachi Unified Compute Platform 6000 for the SAP HANA Platform in Scale-up Configuration with Intel Xeon E7-8800 v4 Processors reference architecture guide for all supported scale-up SAP HANA Platform sizes and design. This configuration can be achieved by using one or more CB 2500 chassis and using VSP G400, VSP G600, or VSP G800, Brocade switches, and a management server. It is also possible to install more than one SAP Business Suite system in the same VSP Gx00. Refer to the Hitachi Virtual Storage Platform Family data sheet for the specifications and capabilities of VSP Gx00 family. Please contact your Hitachi Data Systems representative to design a solution based on your requirements.

High Availability for SAP System

SAP runs mission critical applications and it is important that these systems remain available to users at all times. This requires that these systems are able to make faster recovery after a system component failure (high availability) or after a disaster (disaster recovery). Needless to say, this should happen without any data loss (zero RPO) and in a very short recovery time (low RTO). This section explains how to achieve high availability (HA) for production systems using the HA features of Hitachi Data Systems servers and storage for hardware failures and the HA features of SAP Netweaver (along with SUSE HAE) and SAP HANA software for software failures as follows:

- Hardware Failures: Hitachi Data Systems SAP HANA solutions using Hitachi Compute Blade 2500 with 520X B3 and 520H B4 server blades offer redundant hardware components to provide fault tolerance such as redundant power supplies and fans, two hot-swappable management modules, and multiple Ethernet and Fibre Channel HBA interfaces. Similarly, Hitachi Virtual Storage Platform family storage arrays offer redundant hardware components such as dual controllers, redundant front-end and back-end I/O modules, and power supply units and dual NAS modules. Hitachi Data Systems storage design for SAP Application and SAP HANA use striping and double parity to provide redundancy for automatic recovery from disk failures. Redundant network components are used (two Brocade VDX 6740 switches) with two network connections from each physical server, one to each switch. Two Fibre Connection connections per server are used.
- Software Failures: This reference architecture achieves high availability configuration by addressing the possible single point of failures (SPOFs) of SAP software:
  - “Database Instance (SAP HANA)” on page 9
  - “ABAP SAP Central Services (Message Server and Enqueue Server)” on page 10
  - “Central File System ” on page 12

For more details about high availability of SAP systems, refer to High Availability - Frequently Asked Questions.

Database Instance (SAP HANA)

This reference architecture uses SAP HANA host auto-failover to provide high availability for the SAP HANA Platform. Refer to Setting Up Host Auto-Failover for details. SAP HANA is installed with one master and one standby node. In case of failure of master server, the standby node takes over the data and log LUNs and becomes the new master. Shared binaries are already available using the highly available NAS file system provided by VSP G800 NAS modules.

ABAP SAP Central Services (Message Server and Enqueue Server)

SAP separates the message server and the enqueue work process of the Central Instance for High Availability configuration and groups them in ASCS (ABAP SAP Central Services). The enqueue server contains a lock table in the memory of the host (primary node) on which the ASCS instance is running. The enqueue Replication server is installed to replicate the lock table to a different host (secondary node). In case of a ASCS failure on the primary host, services are failed over to the secondary node. In this case, the lock table replicated to this secondary host is used to build the lock table for the enqueue server. Refer to the Enqueue Replication - SAP NetWeaver High Availability on SUSE Linux Enterprise best practice guide for implementation steps. Figure 2 on page 11 shows one such failover scenario in SUSE Cluster Web GUI (HAWK - HA Web Konsole) as described below.

- Initially, ASCS is running on host sapapp2 and ERS is running on sapapp1.
- Shutdown of sapapp2 is triggered.
- The slave instance of the master/slave construct is promoted to be the Master. This results in ASCS11 running on sapapp1.
- The cluster now has no enqueue replicator.
- SAP system is still up and running as the single point of failure ASCS is up.

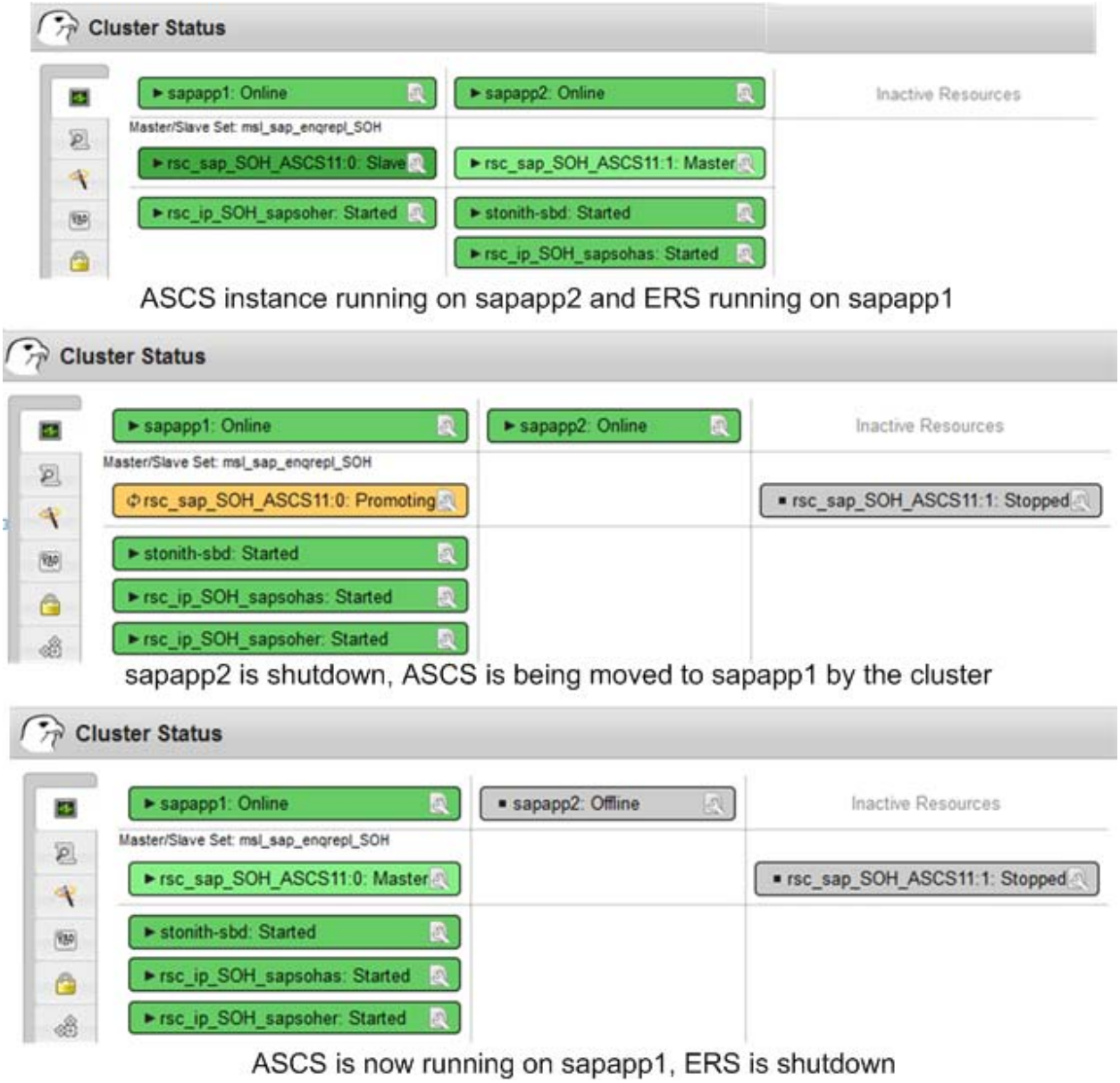
Cluster Status
sapapp1: Online
sapapp2: Online
Inactive Resources
Master/Slave Set: msl_sap_enqrepl_SOH
rsc_sap_SOH_ASCS11:0: Slave
rsc_sap_SOH_ASCS11:1: Master
rsc_ip_SOH_sapsoher: Started
stonith-sbd: Started
rsc_ip_SOH_sapsohas: Started
ASCS instance running on sapapp2 and ERS running on sapapp1
Cluster Status
sapapp1: Online
sapapp2: Online
Inactive Resources
Master/Slave Set: msl_sap_enqrepl_SOH
rsc_sap_SOH_ASCS11:0: Promoting
rsc_sap_SOH_ASCS11:1: Stopped
stonith-sbd: Started
rsc_ip_SOH_sapsohas: Started
rsc_ip_SOH_sapsoher: Started
sapapp2 is shutdown, ASCS is being moved to sapapp1 by the cluster
Cluster Status
sapapp1: Online
sapapp2: Offline
Inactive Resources
Master/Slave Set: msl_sap_enqrepl_SOH
rsc_sap_SOH_ASCS11:0: Master
rsc_sap_SOH_ASCS11:1: Stopped
stonith-sbd: Started
rsc_ip_SOH_sapsohas: Started
rsc_ip_SOH_sapsoher: Started
ASCS is now running on sapapp1, ERS is shutdown

Figure 2

Table 4 shows the information used for the installation of SAP components in this solution.

Table 4. Information used for the Installation of SAP Components

Component	Instance Number	Hostname	IP Address	Virtual Hostname	Virtual IP Address
SAP ASCS	11	sapapp1	192.168.150.161	sapsohas	192.168.150.61
SAP ERS	12	sapapp2	192.168.150.162	sapsoher	192.168.150.62
SAP PAS	01	sapapp1	192.168.150.161	sapsohpas	192.168.150.63
SAP AAS	02	sapapp2	192.168.150.162	sapsohaas	192.168.150.64
SAP HANA node 1	10	hananode1	192.168.150.163	N/A	N/A
SAP HANA node 2	10	hananode2	192.168.150.164	N/A	N/A

Application Connectivity to the Database After Failover

The SAP installation program *SAPInst* configures failover support for application servers by using *hdbuserstore* to specify a list of all host names that the server can connect to as shown below in the output of the `hdbuserstore list` command on each application server:

```
KEY DEFAULT

ENV : hananode1:31015;hananode2:31015

USER: SAPABAP1
```

`Also set` DB Reconnect Parameters according to your database failover time.

Central File System

This solution has the following critical file systems that must be made highly available:

- File system */sapmnt* hosts the kernel and profiles of application servers of an SAP system and therefore it is very critical. This file system must be mounted on all the instances of a SAP system for the system to be up and running.
- File system */usr/sap/trans* (transport directory) is a critical part of Change and Transport System (CTS). This file system is a tool that helps you to organize development projects in ABAP Workbench and in Customizing, and then transport the changes between the SAP systems in your system landscape. This file system is usually shared across multiple systems of a landscape. If this is not available, transports in SAP systems will not work.
- File system */hana/shared* is a central file system for SAP HANA database and is mounted on both master and standby HANA servers. It hosts HANA shared binaries and profiles for the database and must be available at all times for SAP HANA database to function.
- This solution uses unified NAS modules with VSP G800 to provide highly available NFS file systems, and it has been tested in Hitachi Data Systems lab. Every component such as NAS modules, network connections, power supplies, and storage internal paths are redundant so that if one component fails, the other can take over its role without causing any outage of SAP system. Refer to “Network File System Design for Shared Binaries” on page 20 for details.

Management Server

This solution uses one management server. This acts as a central device for managing this high-performance SAP HANA solution. Manage the following from the management server:

- Hitachi Compute Blade 2500 chassis
  - 520X B3 server blades
  - 520H B4 server blades
- Brocade ICX 6430 — 24 port switch
- Brocade VDX 6740 switches
- SAP HANA nodes
- SAP application servers
- Hitachi Virtual Storage Platform G800
- NTP configuration and maintenance
- Hi-Track Remote Monitoring system from Hitachi Data Systems
- Hitachi Command Suite, Hitachi Storage Advisor and management of the server blades
- SAP HANA Studio

Figure 3 shows the management server network ports using one dual port 1 GbE Base-T Intel i350 mezzanine card.

- **Slot 01 Port 2** — Connect this port to the customer network. It provides a 1 GbE network to the management server.
- **Slot 01 Port 1** — Connect this port to the Brocade ICX 6430-24 port switch that provides the 1 GbE network to all other switches, chassis, and Hitachi NAS Platform nodes.

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

Connect the 10 GbE network ports to the two Brocade switches, VDX 6740-A, Port #20 and VDX 6740-B, Port #20 to provide management access to the SAP HANA and SAP application nodes from the management server using the NFS network.

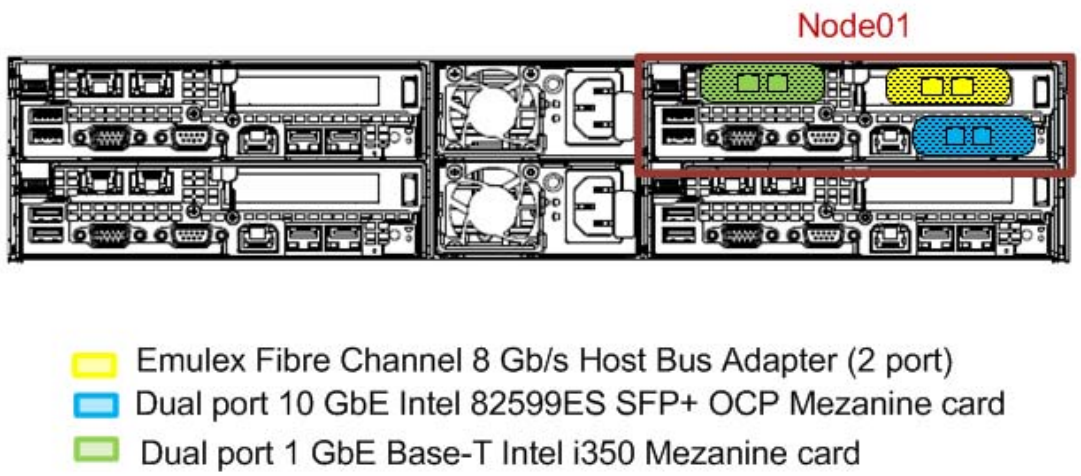

Figure 3

Install the following software on the management server:

- Hitachi Command Suite
- Hitachi Compute Systems Manager software
- NTP server service
- PuTTY
- JRE version jre-7u51-windows-i586 (no 64 bit)
- Adobe Flash Player
- Remote client software
- SAP HANA Studio

Fibre Channel Architecture

The solution uses two 16 Gb/sec 2-port Hitachi FIVE-FX Fibre Channel adapters installed on the PCIe slot of the I/O board modules of the SAP HANA database and application servers. On the VSP G800, this solution uses two 8 Gb/sec Fibre Channel ports directly attached to the Hitachi Compute Blade 2500 server chassis via the Fibre Channel PCI-Ex adapters installed on the SAP HANA server blades and SAP application server blades. This configuration supports high availability by providing multiple paths from the host within Hitachi Compute Blade 2500 to multiple ports on VSP G800.

Network Architecture

The network architecture of this solution can be divided into the following:

- Management Network
- Compute Network

Management Network

Management Network — Used for management of the chassis, server blades, VSP G800, and Brocade VDX 6740 switches. This provides a 1 Gb/sec network for management of these hardware components through the management server.

- This resides on a 1 GbE Brocade ICX 6430-24 port switch.
- The management network does not need to have a VLAN assigned to it.
- The Brocade ICX 6430-24 port switch uses the default switch configuration.
- The Hitachi Compute Blade 2500 chassis has two management modules to secure fault tolerance. Both management modules are connected to the Brocade ICX 6430-24 port switch.
- VSP G800 management server (MiniMapp server) is connected to the Brocade ICX 6430-24 port switch.
- The two Brocade VDX 6740 switches are connected to the Brocade ICX 6430-24 port switch.
- The management server is connected to the Brocade ICX 6430-24 port switch.

Compute Network

There are 10GBASE-SR 2-port LAN adapters installed on the PCIe slots of the I/O board module blades of the Hitachi Compute Blade 2500 chassis. The solution uses the following:

- Two 10 Gb ports on the 10GBASE-SR 2-port LAN adapters installed on each 520H B4 server blade for connectivity with the two Brocade VDX 6740 switches.
- Four 10 Gb ports from two 10GBASE-SR 2-port LAN adapters installed on each 520X B3 blade for connectivity with the two Brocade VDX 6740 switches.

This solution requires the following separate networks.

- **SAP Production Client Network** — Communication between the SAP HANA database and SAP application servers. It is set with an MTU size of 9100 in accordance with Brocade best practices, and isolated using a VLAN of 150.
- **SAP NFS Network —** Access SAP HANA and application shared binaries, transport directory, and profiles using the NFS protocol. It is set with an MTU size of 9100 in accordance with Brocade best practices, and isolated using a VLAN of 100.
- **Cluster Communication Network** - Used for communication between two SUSE HAE cluster nodes on SAP application servers. It is set with an MTU size of 9100 in accordance with Brocade best practices, and isolated using a VLAN of 120.

Make the following network connections for the client network setup of the SAP HANA node as an uplink network setup:

- **520X B3 Server Blades**: Bond the eth9901 and eth9902 ports as bond0, and eth9911 and eth9912 as bond1 at the operating system level using active-active network bond mode with options "mode= 802.3ad miimon=100 xmit_hash_policy=layer3+4 updelay=5000 lacp_rate=fast", which acts as the client and NFS network for the SAP HANA node.
- **520H B4 Server Blades**: SAP Application server blades: Bond the eth9901 and eth9902 ports as bond0 at the operating system level using active-active network bond mode with options " mode= 802.3ad miimon=100 xmit_hash_policy=layer3+4 updelay=5000 lacp_rate=fast ", which acts as the client network and NFS network. Refer to Table 5 for port numbers.
  - Do not assign an IP address to bond0.
  - Create separate VLANs at the operating system level for bond0 with VLAN ID 100, 120, and 150, and assign IP addresses to the VLANs.
  - Configure the Brocade VDX switch ports connected to these application servers to allow access to VLAN 100, 120, and 150.
- Configure the external switch ports with a short LACP timeout value to detect corrupted connections quickly.

Table 5. Network Connection from Server Blades to Brocade VDX Switches

SAP Application / Database	Blade Number	PCI-Ex Slot Number, Port	Bond	VDX 6740 Switch and Port	Accessible VLAN IDs
SAP Application server	Blade 13	IOBD 01B, Port 0 (eth9901)	Bond0	VDX 6740-A, Port #3	100,120,150
		IOBD 01B, Port 1 (eth9902)		VDX 6740-B, Port #3	
SAP Application server	Blade 14	IOBD 02B, Port 0 (eth9901)	Bond0	VDX 6740-A, Port #4	100,120,150
		IOBD 02B, Port 1 (eth9902)		VDX 6740-B, Port #4	
SAP HANA database server	Blade 9	IOBD 09B, Port 0 (eth9901)	Bond0	VDX 6740-A, Port #1	150
		IOBD 10B, Port 0 (eth9902)		VDX 6740-B, Port #1	
		IOBD 9B, Port 1 (eth9911)	Bond1	VDX 6740-A, Port #21	100
		IOBD 10B, Port 1 (eth9912)		VDX 6740-B, Port #21	

Table 5. Network Connection from Server Blades to Brocade VDX Switches (Continued)

SAP Application / Database	Blade Number	PCI-Ex Slot Number, Port	Bond	VDX 6740 Switch and Port	Accessible VLAN IDs
SAP HANA database server	Blade 11	IOBD 13B, Port 0 (eth9901)	Bond0	VDX 6740-A, Port #2	150
		IOBD 14B, Port 0 (eth9902)		VDX 6740-B, Port #2	
		IOBD 13B, Port 1 (eth9911)	Bond1	VDX 6740-A, Port #22	100
		IOBD 14B, Port 1 (eth9912)		VDX 6740-B, Port #22	

Storage Architecture

Hitachi Virtual Storage Platform G800 with unified NAS is used for this solution. Sizing and configuring of storage including storage drive box trays (DBS), spare drives, the operating system volume (OS), SAP HANA shared volume (/hana/shared), SAP HANA log volume (/hana/log), SAP HANA data volume (/hana/data), SAP Application Server, and other SAP Application Server volumes vary for different size solutions by taking into account requirements including I/O, capacity, etc. **This reference architecture distinguishes between two groups of storage based on purpose:**

- **SAP HANA Database Storage**
- **SAP System Application Server Storage**

SAP HANA Database Storage

Refer to the *Storage Architecture* section of the SAP HANA Tailored Data Center Integration on Hitachi Virtual Storage Platform Gx00 using Hitachi Dynamic Provisioning Pools reference architecture guide for storage design of scale-up SAP HANA platforms. A 1 TB sample layout system is used in this solution with the following differences:

- The /hana/shared file system is not local but is provided as an NFS file system by VSP G800 unified NAS modules and is mounted on both master and standby SAP HANA database servers.
- Instead of using a single LUN of 1 TB for the /hana/shared file system, this solution uses four LUNs of 250 GB each. This is required because *Storage Pool* in Unified NAS can only be created by using a minimum of four system drives. Refer to Figure 4 and Figure 6 for details.
- The /hana/shared LUNs are not mapped to any external to Fibre Channel path, but to a NAS Platform (User LU).
- Data and Log LUNs are mapped to both master and standby SAP HANA database servers so that the standby node can mount the data and log file system if the master fails.

SAP Application Server Storage

Figure 4 shows the disk configuration of the storage subsystem for different memory size solutions. Refer to SAP Note 1597355 - Swap-space recommendation for Linux for swap space recommendation for your SAP application server size. Figure 4 also shows the storage design used for SAP application servers.

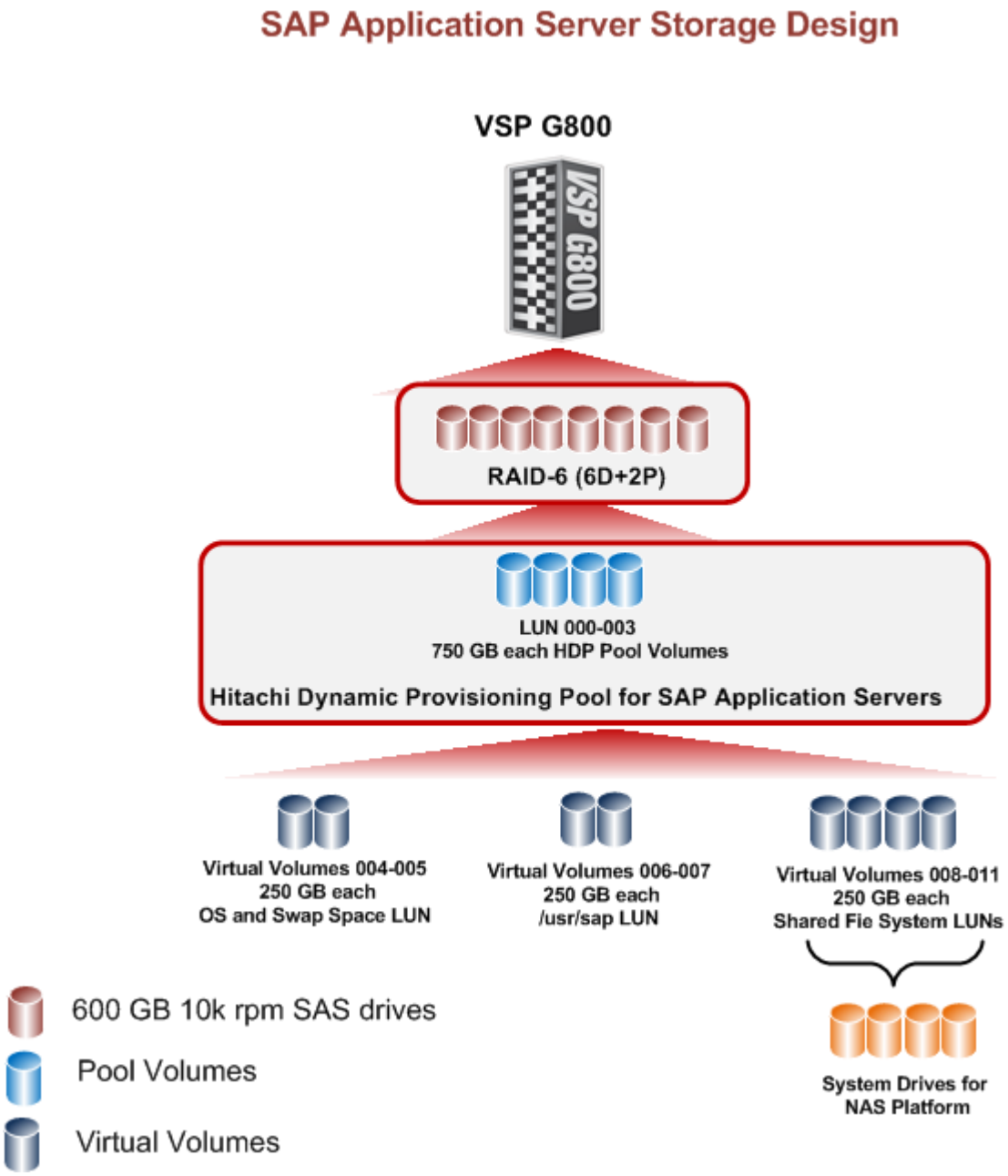

Figure 4

Table 6 lists the storage configuration for different SAP applications.

Table 6. Storage Configuration for SAP Applications

SAP Application	RAID Group and File System
SAP Application	■ 1 RAID6 (6D+2P) ■ 8 × 600 GB HDD ■ OS and Swap: 2 × 250 GB LUNs ■ Shared File System: 4 x 250 GB LUNs ■ /usr/sap Directory LUN: 2 × 250 GB LUNs

Network File System Design for Shared Binaries

This reference architecture uses two Hitachi NAS Platform file system modules. They are part of Hitachi Virtual Storage Platform G800 in the cluster configuration. The two Hitachi NAS Platform (HNAS) servers are cluster interconnected with four 10 Gb/sec network links. Each HNAS server connects internally to the Virtual Storage Platform G800 virtual ports. No additional Fibre Channel connections are required. Ports C1, C2, C3, and C4 are the HNAS cluster ports. To enable clustering, connect ports C1, C2, C3, and C4 of the first NAS Platform server to ports C1,C2, C3 and C4 of the second NAS platform server. Ports tg1, tg2, tg3, tg4, tg5, and tg6 are 10 GbE ports. Link aggregate and connect these ports to the Brocade VDX 6740-48 switches.

Figure 5 shows the back of VSP G800 with unified NAS modules. Slot 1 and Slot 3 are the two NAS modules with Cluster I/F ports and Ethernet ports. Slot 2 and Slot 4 show the front end and back end directors of VSP G800.

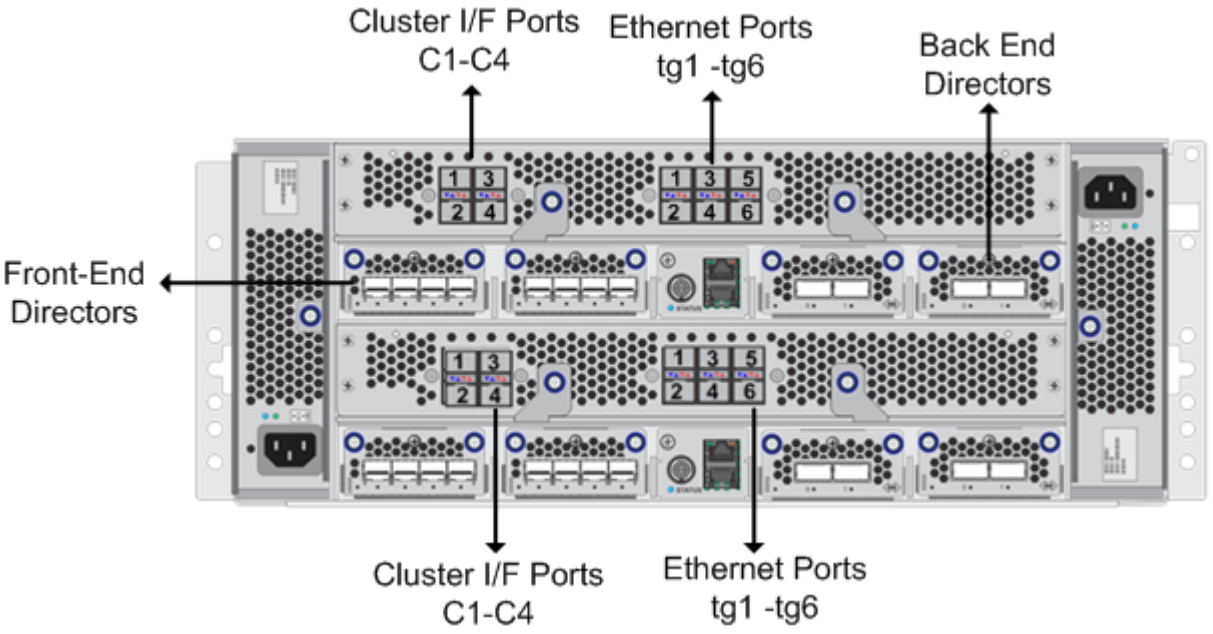

Figure 5

System Management Unit (NAS Manager)

Web Manager, the graphical user interface of the system management unit, provides front-end server administration and monitoring tools. This solution uses a system management unit integrated into the maintenance utility of VSP G800 that manages the two Hitachi NAS modules.

Network File System Design for Shared Binaries

This solution requires a network file system to store SAP HANA and SAP Application binaries and configuration files. A 1 TB SAP HANA node and SAP application servers use four virtual volume LDEVs each for shared storage. Refer to Figure 6 and use the following steps to configure shared storage for SAP HANA and SAP application servers:

- Refer to each LDEV in the storage as *System Drive* in NAS Platform.
- Create two virtual servers (EVS1 and EVS2), one for SAP HANA and one for SAP Application shared binaries, and assign IP addresses to these servers on NFS network 192.168.150.xxx. Assign SAP HANA EVS and SAP Application EVS to a different NAS module so that workload can be balanced when both NAS modules are operational.
- Using four 250 GB system drives, create a storage pool called **HANABIN_<SID>**, and using this pool create a shared file system /**hana_shared_<SID>** and assign EVS1 to the file system.
- Using four 250 GB system drives, create a storage pool called **SAPAPP, and using this pool create** shared file systems /**sapmnt_SID** and /**transport_DIR** and assign EVS2 to the file system.
- Mount the NFS export **/hana_shared_<SID>** on the file system path **/hana/shared/<SID>** on SAP HANA servers.
- Mount the NFS exports on the file system path **/sapmnt** and **/usr/sap/trans** on SAP Application servers.

If one NAS module fails, EVS servers assigned to this NAS module fail over to the other NAS module without any service interruptions. A maximum of 64 EVS servers can be created.

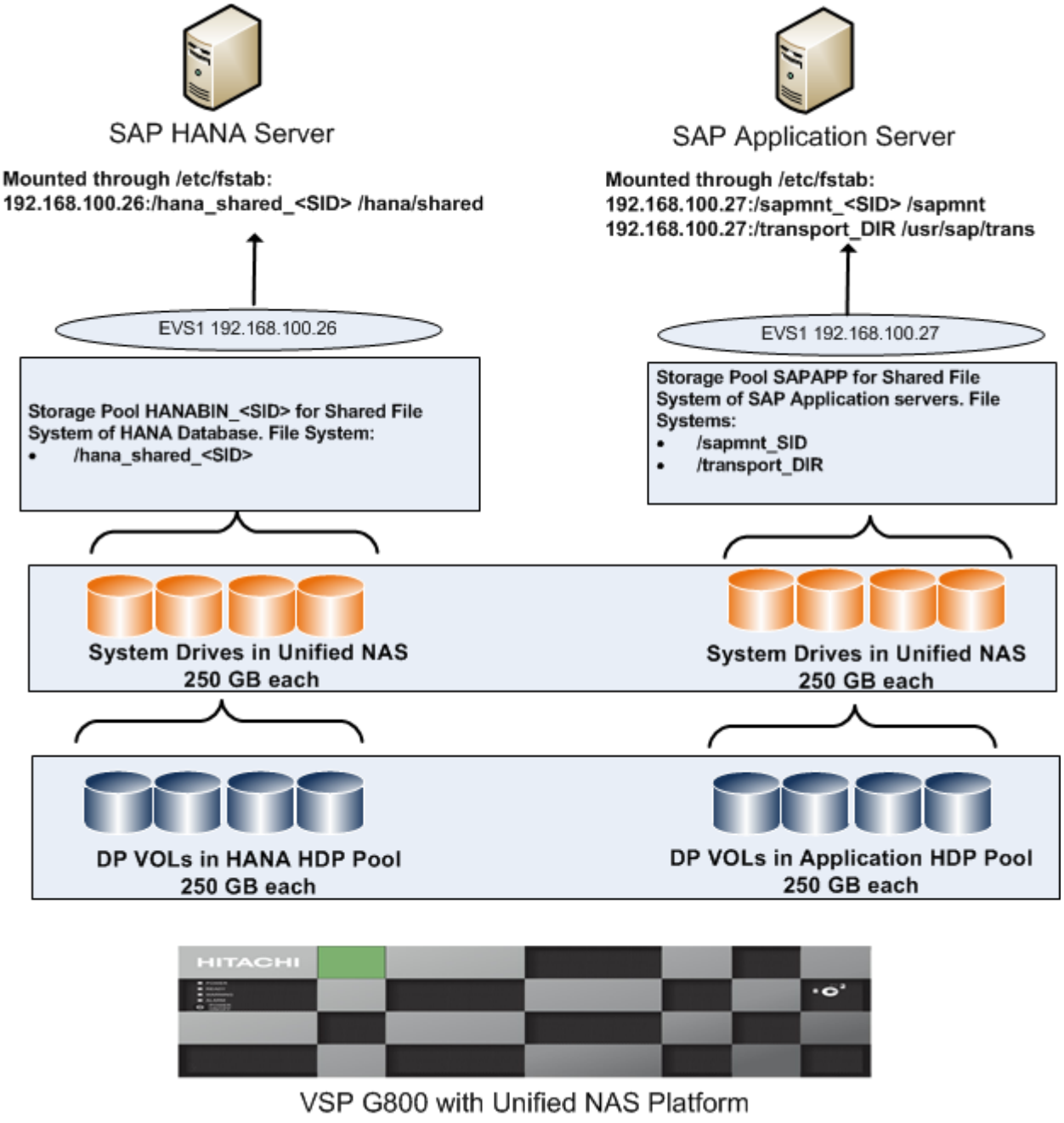

Figure 6

Configuration of Applications and Database

Operating System Configuration

The SAP HANA scale-up configuration and SAP Application servers require an OS volume. SAP HANA uses one 100 GB LUN and SAP Application servers use 250 GB LUNs on Hitachi Virtual Storage Platform G800 for the operating system volume.

The two ports of the 16 Gb Hitachi FIVE-FX Fibre Channel 2-port adapters have the operating system OS LUN configured as the primary boot device. The operating system LUN holds partitions for SUSE Linux for SAP Application version 12 and the Linux swap space. On SAP HANA server, this LUN also has a partition for /usr/sap.

Activate Device-Mapper Multipath

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

Using Device-Mapper Multipath allows the configuration of multiple I/O paths between the server blades, and Hitachi Virtual Storage Platform G800. Multipathing aggregates all physical I/O paths into a single logical path. The LUNs are always available, unless all paths fail.

Device-Mapper Multipath is used for the following I/O paths:

- SAP HANA server OS LUN.
- SAP HANA data volume LUN.
- SAP HANA log volume LUN.
- SAP HANA shared volume LUN.
- SAP Application server OS LUN.
- SAP Instance Directory (/usr/sap) LUN.

SAP HANA Configuration

SAP HANA File System

Table 7. SAP HANA File System

File System	Description	Type	Location
/hana/shared/HIT	SAP HANA Shared Binaries	NFS	Mounted on all SAP HANA servers
/hana/data	SAP HANA Log Files	Local	Mounted on the master HANA server (if failover happens, this file system moves to the new master server)
/hana/log	SAP HANA Log Files	Local	Mounted on master HANA server (if failover happens, this file system moves to the new master server)

SAP HANA Software Installation

- Perform the system sizing. Refer to “Sizing” on page 8 for more information.
- Download SLES for SAP Applications 12 media from the SuSE website.
- Download the SAP HANA installation documentation from http://help.sap.com/hana_platform.
- Download the installation media from https://support.sap.com/swdc.
- Install SLES12 on the 520X B3 server blades.
- Follow recommendations from SAP Note 1944799 - SAP HANA Guidelines for SLES Operating System Installation and other related SAP notes.
- Create file systems as described in the SAP Installation Guide using VVols) mentioned in the “SAP HANA Database Storage” on page 17 section. File systems used in this reference architecture are shown in Table 7 on page 22.
- Perform installation of the SAP HANA master node on the first HANA server. The following SAP HANA software components are installed on the SAP HANA database server:
  - SAP HANA database.
  - SAP HANA database client software.
  - SAP Host agent.
- Add the SAP HANA standby node on the second HANA server.

SAP Business Suite Configuration

SAP Application File System

Table 8 shows the file systems used in this reference architecture for SAP applications.

Table 8. SAP Application File System

File System	Description	Type	Location
/usr/sap/trans	Transport directory	NFS	Mounted on all SAP Application servers
/sapmnt/<SID>	sapmnt	NFS	Mounted on all SAP Application servers.
/usr/sap	Instance directory for instances running on the server	Local	Separate file system mounted on each SAP Application server.

SAP Business Suite (SAP ECC) Installation

Perform the following steps to install SAP Business Suite:

- Perform the system sizing. Refer to “Sizing” on page 8 for more information.
- Download the SAP installation documentation from https://service.sap.com/instguides.
- Download the installation media from https://support.sap.com/swdc.
- Install SLES12 on the 520H B4 server blades.
- Make sure that settings recommended in SAP note 1275776 - Linux: Preparing SLES for SAP environments are implemented.
- Create file systems as described in the SAP Installation Guide using VVols mentioned in “SAP Application Server Storage” on page 18. File systems used in this reference architecture are shown in Table 7 on page 22.
- Create operating system users and groups as described in the SAP Installation Guide. In a distributed installation, the same user IDs and group IDs must be used.
- Perform the installation and post-installation steps as described in the SAP installation guide.

Engineering Validation

Validation of this reference architecture paper has been performed by installing the SAP Business Suite on SAP HANA database in a highly available configuration. The validation testing was executed by Hitachi Data Systems in a lab environment as follows:

- SAP Business Suite (ECC6 EHP8) HA test cases were performed successfully as described in *Section 15 Cluster Tests* of best practice guide Enqueue Replication - SAP NetWeaver High Availability on SUSE Linux Enterprise.
- SAP HANA HA test cases were performed successfully according to scenarios described in SAP HANA Host Auto-Failover. As this solution design only contains a master and a standby SAP HANA node, not all scenarios in this document need to be tested.
- Failover test cases were performed on the unified NAS platform by manually failing single point of failures such as the NAS module, cluster interconnect cables, and Ethernet cables to ensure that there was no impact on SAP Application or SAP HANA database.

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.

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