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Hitachi Unified Compute Platform Select for the SAP HANA Platform in a 2 TB Scale-Up Configuration

Reference Architecture Guide

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Hitachi Data Systems

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Hitachi Unified Compute Platform Select for the SAP HANA Platform in a 2 TB Scale-Up Configuration

Reference Architecture Guide

Hitachi Unified Compute Platform Select for the SAP HANA platform in a 2 TB scale-up configuration is a pre-configured analytical appliance ready to plug into a network to provide real-time access to operational data for use in analytic models. The 2 TB refers to the amount of memory used in this reference architecture.

This reference architecture guide describes the planning, design, and best practices to deploy the 2 TB scale-up configuration of Unified Compute Platform Select for the SAP HANA platform using the following:

- Hitachi Compute Blade 2000 server
- Hitachi Unified Storage 130 storage system
- SAP High-Performance Analytic Appliance (HANA) software
- Fusion-io ioDrive2 storage devices

This technical paper assumes familiarity with the following:

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

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 guide for the 2 TB scale-up configuration of Hitachi Unified Compute Platform Select for the SAP HANA platform uses the following:

- **Hitachi Compute Blade 2000** — An enterprise-class server platform. This solution uses four X57A2 server blades.
- **Hitachi Unified Storage 130** — A midrange storage solution. The persistent storage (data volume) of the SAP HANA server resides on this storage device.
- **SAP High-Performance Analytic Appliance (HANA)** — A multi-purpose, in-memory appliance to analyze transactional and analytical data.
- **Fusion-io ioDrive2** — An enterprise solid-state flash storage device. This solution uses two or four 1.2 TB MLC ioDrive2 storage devices. This acts as the low latency storage for the SAP HANA server log volume.
- **Emulex Fibre Channel Host Bus Adapters** — Provides SAN connectivity to the data center network.

Figure 1 on page 3 shows the topology of this reference architecture.

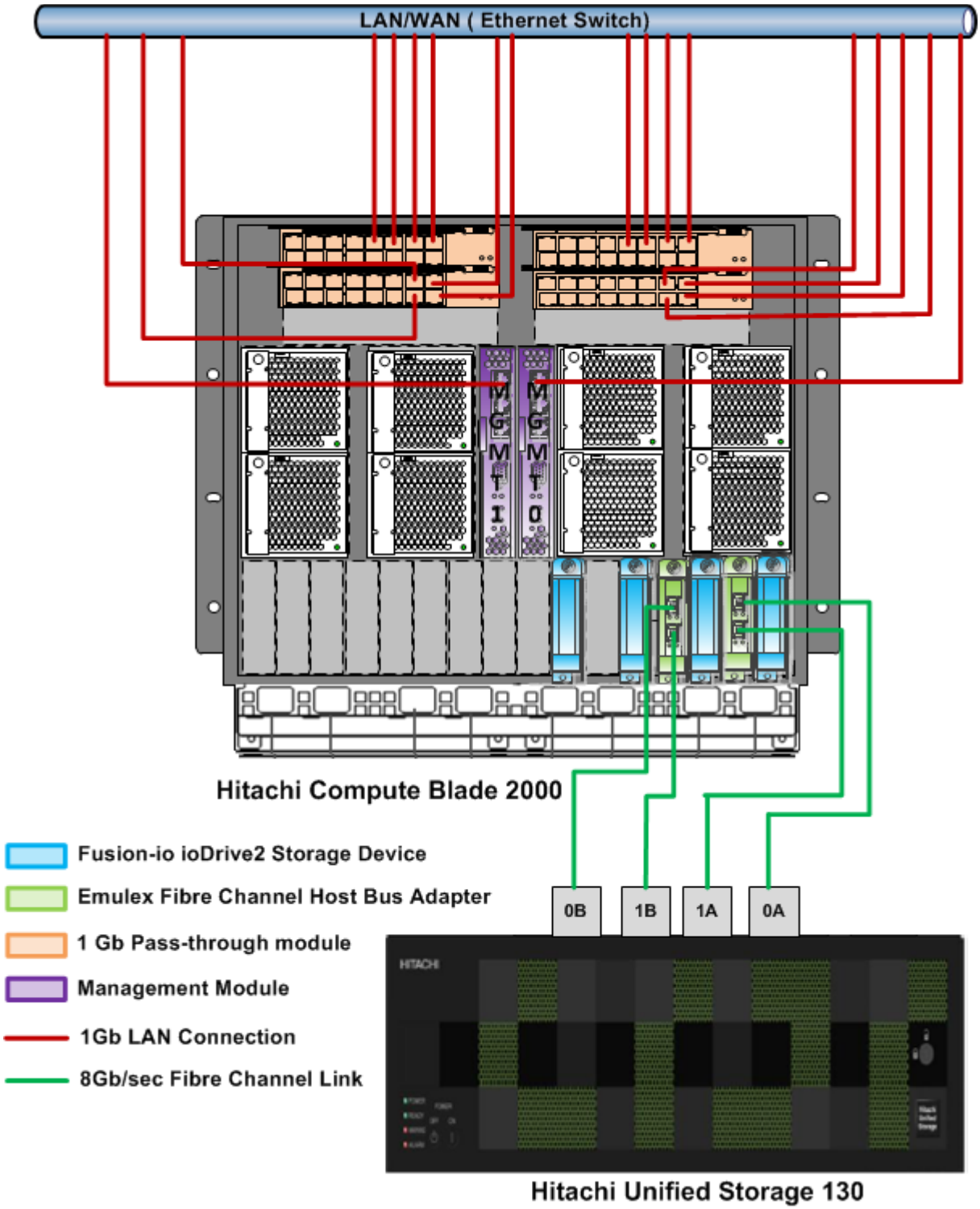
LAN/WAN (Ethernet Switch)
MGMT1
MGMT0
Hitachi Compute Blade 2000
Fusion-io ioDrive2 Storage Device
Emulex Fibre Channel Host Bus Adapter
1 Gb Pass-through module
Management Module
1Gb LAN Connection
8Gb/sec Fibre Channel Link
0B
1B
1A
0A
HITACHI
Hitachi Unified Storage 130

Figure 1

Key Solution Elements

These are the key hardware and software components used the 2 TB scale-up configuration of Hitachi Unified Compute Platform Select for the SAP HANA platform.

Hardware Elements

Table 1 describes the major hardware elements used for this solution.

Table 1. Hardware Elements

Hardware	*Quantity*	*Configuration*	*Role*
Hitachi Compute Blade 2000 chassis	1	■ 8-blade chassis ■ 2 Management modules ■ 8 Cooling fan modules ■ 4 Power supply modules ■ 4 × 1 Gb/sec pass-through modules	Server blade chassis

Hitachi Compute Blade 2000 X57A2 server blade	4	■ 2 × 10 core processors
		■ 512 GB memory
		■ 1 Ethernet mezzanine card in these slots:
		  ■ Slot 0 of Blade 0
		  ■ Slot 0 of Blade 1
			SAP HANA server

SMP connector module	1	■ 4-blade SMP connector board ■ SMP expansion module ■ SMP connector cover	SMP connector
Hitachi Unified Storage 130	1	■ 8 × 8 Gb/sec Fibre Channel ports ■ 16 GB cache memory ■ 43 × 300 GB 10k RPM SAS drives	Primary storage
Fusion-io ioDrive2 storage device	2 or 4	■ 1.2 TB MLC flash memory platform	HANA log volumes
Emulex HBA	2	■ 8 Gb/sec dual-port Fibre Channel HBA	Host bus adapters
NIC	1	■ 10 Gb Ethernet PCIe card	Optional for 10 Gb connectivity

Hitachi Compute Blade 2000

Hitachi Compute Blade 2000 is an enterprise-class blade server platform. It features the following:

- A balanced system architecture that eliminates bottlenecks in performance and throughput
- Configuration flexibility
- Sustainable power-saving capabilities
- Fast server failure recovery using a N+1 cold standby design that allows replacing failed servers within minutes

This solution uses a four-blade SMP connection interface to connect four X57A2 server blades. This combination acts as a single HANA server node for the large size configuration with the following:

- 8 CPUs
- 80 cores
- 2048 GB of RAM

Table 2 has the specifications for each X57A2 server blade.

Table 2. X57A2 Server Blade Configuration

Feature	*Configuration*
Processors	■ Intel Xeon 8800 series processors ■ 2 processors per server blade
Processor SKU	■ Westmere E7-8870
Processor Frequency	■ 2.4 GHz
Processor cores	■ 10 cores
Memory DIMM slots	■ 32
Memory	■ 512 GB with 16 GB DIMMS
Network ports	■ 2 × 1Gb Ethernet (SERDES)
Mezzanine slots I/O expansion slots	■ 2
Other interfaces	■ 2 USB 2.0 port ■ 1 Serial port

Fusion-io ioDrive2 Storage Device

This solution uses 1.2 TB Fusion-io ioDrive2 storage devices for the SAP HANA log volumes. In the basic version, there are two devices aggregated in RAID-0 mode for capacity. The version with four devices offers extra protection by combining the devices using RAID-10.

The ioDrive2 storage devices improve application response times with a persistent, high-performance, high-capacity memory tier.

Software Elements

Table 3 lists the major software elements used for this solution.

Table 3. Software Elements

Software	*Version*
Hitachi Storage Navigator Modular 2	Microcode dependent
SAP HANA	1.0 SP05
SUSE Linux Enterprise Server for SAP Applications	11 SP2

SAP High Performance Analytic Appliance (HANA)

The SAP High Performance Analytic Appliance (HANA) platform is flexible, multipurpose in-memory software. It combines SAP software components optimized to specific hardware. The use of the SAP HANA appliance does not depend on the data source.

The SAP HANA appliance enables the real-time analysis of huge volumes of detailed business information from almost any data source. It captures operational data in memory as it occurs. Flexible views quickly expose analytic information. External data can be added to analytic models from across an entire organization.

This hardware and software combination integrates a number of SAP components, including the following:

- **SAP In-Memory Database** — This hybrid in-memory database combines row-based, column-based, and object-based database technology. It takes advance of parallel processing capabilities of multi-core CPU architectures
- **SAP LT (Landscape Transformation)** — This replicates source system data to the SAP HANA appliance.

SAP customers may download more information on the SAP HANA platform at the SAP Service Marketplace. See **Installation and Upgrade Guides** for SAP In-Memory Computing (SAP In-Memory Appliance — SAP HANA) to download information. The following are available:

- SAP HANA Master Guide — This is the central starting point for the technical implementation of the SAP HANA platform. Use this to for basic concepts and for planning the SAP HANA application system landscape.
- **SAP HANA Installation and Initial Configuration Guides** — Use the various installation guides to install the required SAP In-Memory Database and the other software components for the different replication technologies. Refer to the SAP HANA Overall Installation Guide for an overview on how to install SAP HANA.
- SAP HANA Operational Concept — Attached to SAP Note 1599888, this explains the appliance software concept.
- SAP HANA Technical Operations Manual — This is a picture of the available administration tools with SAP HANA appliance and the key tasks for a system administrator.
- SAP HANA Update Guide — This explains how to update SAP HANA and its components.
- SAP HANA Product Availability Matrix — This provides information about SAP HANA-supported software and hardware platforms. Search for "HANA" on this page.

SUSE Linux Enterprise Server (SLES) for SAP Applications

Hitachi Unified Compute Platform Select for the SAP HANA platform in a scale-up configuration runs on a 64-bit version of SUSE Linux Enterprise Server (SLES) for SAP Applications 11 SP2.

Only use the delivered operating system configuration for your appliance. Changing the configuration settings can cause significant performance problems to occur.

Do not modify the operating system, except as SAP approves. SAP must validate and approve any updates related to the kernel or runtime libraries (**glibc**). Wait for all operating system patches until officially released by SAP HANA.

For more details, see Section 2.5.1, “Updating and Patching the Operating System,” in SAP HANA Technical Operations Manual.

Solution Design

The detailed design for this 2 TB scale up configuration of the large Hitachi Unified Compute Platform Select for the SAP HANA platform reference architecture includes the following:

Hitachi Compute Blade 2000 Chassis Configuration

Figure 2 on page 9 shows the front and back view of Hitachi Compute Blade 2000 used in the 2 TB scale-up configuration of Hitachi Unified Compute Platform Select for the SAP HANA platform.

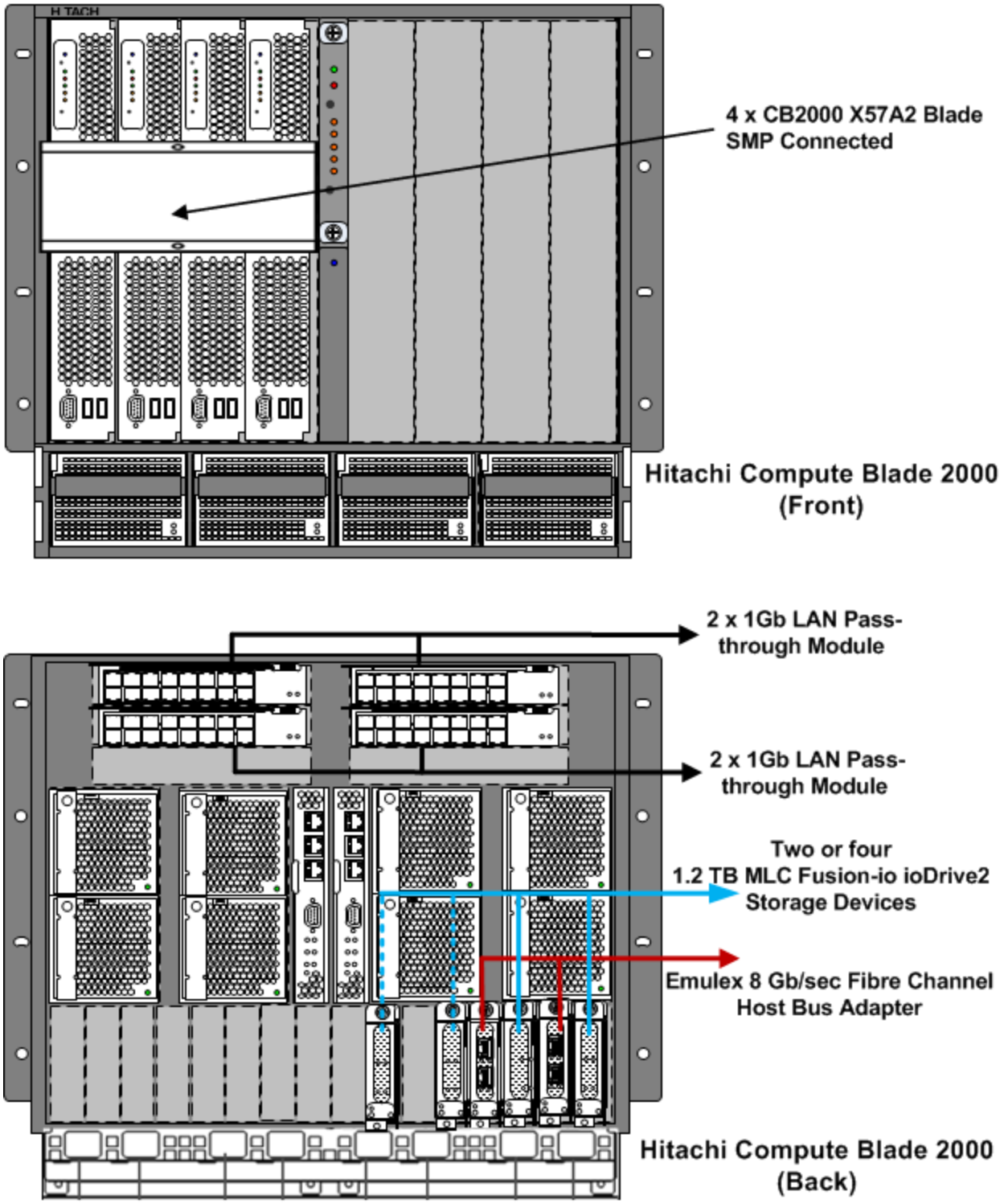
4 x CB2000 X57A2 Blade
SMP Connected
Hitachi Compute Blade 2000
(Front)
2 x 1Gb LAN Pass-
through Module
2 x 1Gb LAN Pass-
through Module
Two or four
1.2 TB MLC Fusion-io ioDrive2
Storage Devices
Emulex 8 Gb/sec Fibre Channel
Host Bus Adapter
Hitachi Compute Blade 2000
(Back)

Figure 2

There are two PCIe slots available on each server blade.

- Use the right PCIe slot of each server blade for a 1.2 TB Fusion-io ioDrive2 storage device.
  - For the basic version, only use the slots of Blade 0 and Blade 1.
  - For the protected version, use the slots of all four server blades.
- Use the left PCIe slot of Blade 0 and Blade 1 for one Emulex 8 Gb/sec 2-port host bus adapter.

Do not change the position of the 1.2 TB Fusion-io ioDrive2 storage device and the Emulex 8 Gb/sec dual-port host bus adapter on the PCIe slot. A position change affects the performance and boot sequence.

Optionally, the left PCIe slot of Blade 2 can have one 10 Gb Ethernet PCIe card.

Hitachi Compute Blade 2000 Server Architecture

The 2 TB scale up configuration of the Hitachi Unified Compute Platform Select for the SAP HANA platform reference architecture uses four Hitachi Compute Blade 2000 X57A2 server blades connected using the four-blade SMP interface connector. This creates a single eight-socket SMP system with 80 cores and 2048 GB of memory. With the SMP configuration, the following is true:

- Blade 0 is the primary server blade.
- Blade 1, Blade 2, and Blade 3 are the non-primary server blades.

Table 4 lists the server blade configuration.

Table 4. Server Blade Configuration

Server Blades	Four Blade SMP ▪ Blade 0 (primary) ▪ Blade 1 (non-primary) ▪ Blade 2 (non-primary) ▪ Blade 3 (non-primary)
Server Name	SAPHANAL
Role	SAP HANA server with 2 TB of memory
Number of CPU Cores	80
Memory (GB)	2048

Direct Connect Fibre Channel Architecture

The direct connect Fibre Channel architecture for the 2 TB scale-up configuration of Hitachi Unified Compute Platform Select for the SAP HANA platform has one Emulex Fibre Channel host bus adapter on each of the following for a direct connection to Hitachi Unified Storage 130.

- Left PCIe slot of Blade 0 (primary server blade)
- Left PCIe slot of Blade 1

This direct-attached storage configuration provides better performance with the direct connection of Hitachi Unified Storage 130 and the server blades, as compared with a Fibre Channel switch connection. Not using a connection through Fibre Channel switches reduces latency.

This solution used Storage Port 0A, Storage Port 1A, Storage Port 0B, and Storage Port 1B on Hitachi Unified Storage 130.

- Port 0A and Port 1A connect to the Emulex Fibre Channel host bus adapter in the left PCIe slot of Server Blade 0 (primary server blade). The Emulex Fibre Channel host bus adapter in the left PCIe slot of the Server Blade 0 connects to the following:
  - Port 0A connects to the top port
  - Port 1A connects to the bottom port
- Port 0B and Port 1B connect to the Emulex Fibre Channel host bus adapter in the left PCIe slot of Server Blade 1. The Emulex Fibre Channel host bus adapter in the left PCIe slot of Server Blade 1 connects to the following:
  - Port 0B connects to the top port
  - Port 1B connects to the bottom port

This configuration supports high availability by providing multiple paths from the hosts within Hitachi Compute Blade 2000 to multiple ports on Hitachi Unified Storage 130. In case of an Emulex HBA card failure, this redundancy gives the SAP HANA server two additional paths to Hitachi Unified Storage 130.

For the direct connection between Hitachi Compute Blade 2000 and Hitachi Unified Storage 130, set the Hitachi Unified Storage 130 Fibre Channel ports to **loop topology**.

Figure 3 on page 12 shows the direct connect Fibre Channel architecture.

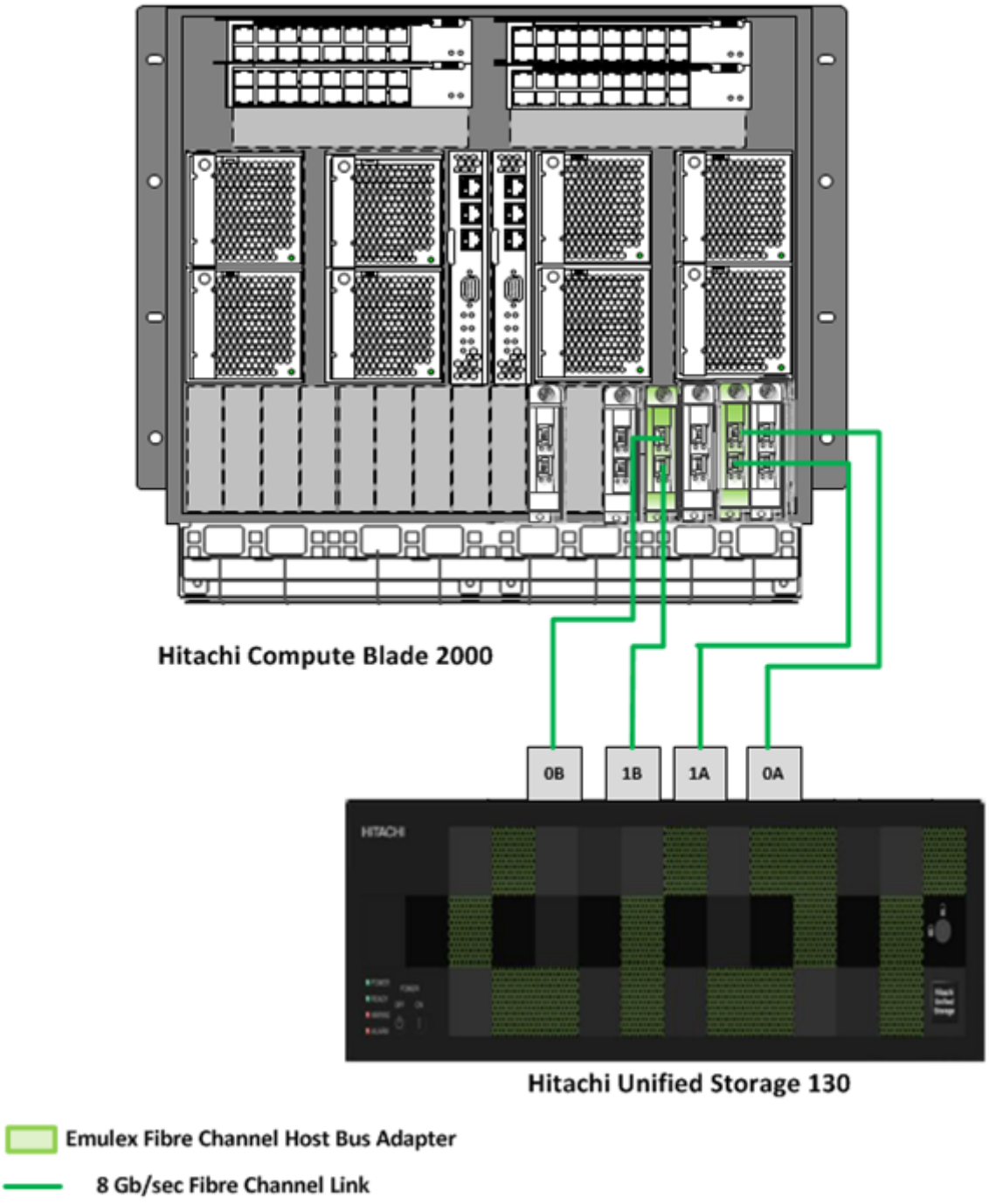
Hitachi Compute Blade 2000
0B
1B
1A
0A
Hitachi Unified Storage 130
Emulex Fibre Channel Host Bus Adapter
8 Gb/sec Fibre Channel Link

Figure 3

Network Architecture

Hitachi Compute Blade 2000 uses the network architecture for the 2 TB scale-up configuration of Hitachi Unified Compute Platform Select for the SAP HANA platform found in Table 5 (standard configuration) and Table 6 (optional configuration).

Table 5. Hitachi Compute Blade 2000 Network Hardware — Standard Configuration

NICs per Server Blade	■ 2 onboard Intel 82576 gigabit Ethernet ports
Mezzanine Slot 0 (Blade 0 and Blade1)	■ 1 Ethernet mezzanine card ■ 4 × 1 Gb/sec ports
Switch Bay 0	■ 1 Gb LAN pass-through module ■ 16 × 1 Gb/sec ports
Switch Bay 1	■ 1 Gb LAN pass-through module ■ 16 × 1 Gb/sec ports
Switch Bay 2	■ 1 Gb LAN pass-through module ■ 16 × 1 Gb/sec ports
Switch Bay 3	■ 1 Gb LAN pass-through module ■ 16 × 1 Gb/sec ports

Table 6. Hitachi Compute Blade 2000 Network Hardware — Optional Configuration

NICs per Server Blade	■ 2 onboard Intel 82576 gigabit Ethernet ports
Mezzanine Slot 0 (Blade 0 and Blade1)	■ 1 Ethernet mezzanine card ■ 4 × 1 Gb/sec ports
Left PCIe Slot (Blade 2)	■ 1 × 10 Gb Ethernet PCIe card
Switch Bay 0	■ 1 Gb LAN pass-through module ■ 16 × 1 Gb/sec ports
Switch Bay 1	■ 1 Gb LAN pass-through module ■ 16 × 1 Gb/sec ports
Switch Bay 2	■ 1 Gb LAN pass-through module ■ 16 × 1 Gb/sec ports
Switch Bay 3	■ 1 Gb LAN pass-through module ■ 16 × 1 Gb/sec ports

This reference architecture uses two on-board NICs. Each NIC connects through the mid-plane of the chassis to the internal ports of the pass-through module in Switch Bay 0 and Switch Bay 1.

There is one four-port 1 Gb LAN mezzanine card on the following:

- Slot 0 of Blade 0
- Slot 0 of Blade 1

Optionally, the left PCIe slot of Blade 2 can have one 10 Gb Ethernet PCIe card.

There are 1 Gb/sec pass-through modules installed in the following on the Hitachi Compute Blade 2000 chassis:

- Switch Bay 0
- Switch Bay 1
- Switch Bay 2
- Switch Bay 3

For redundancy, the Hitachi Compute Blade 2000 chassis has two management modules. Each module supports an independent management LAN interface from the data network for remote and secure management of the chassis and all server blades.

Each module supports a command line interface and a web interface. It also supports SNMP and email alerts. Each module is hot swappable and supports live firmware updates without the need for shutting down the blades.

Figure 4 on page 15 shows the standard network configuration used for the Hitachi Compute Blade 2000 chassis.

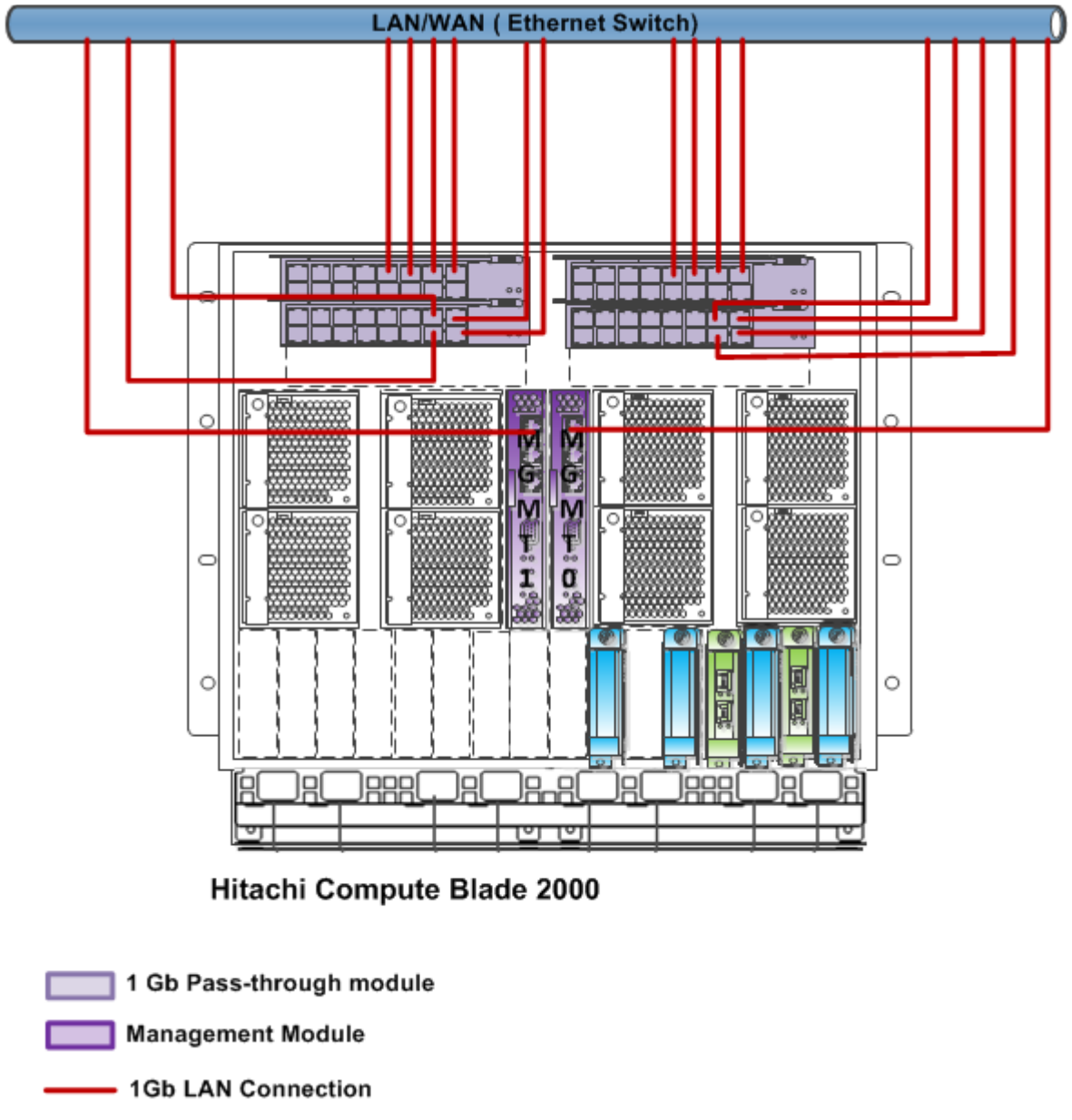

Figure 4

Storage Architecture

Many factors drive the sizing and configuring of storage used in the 2 TB scale-up configuration of Hitachi Unified Compute Platform Select for the SAP HANA platform reference architecture. This includes I/O and capacity requirements. The following describe how the storage sizing for this reference architecture was determined:

- "RAID Configuration" on page 17
- "LUN Configuration," starting on page 17
- "Storage Requirements" on page 18

Figure 5 shows the disk configuration of the storage subsystem.

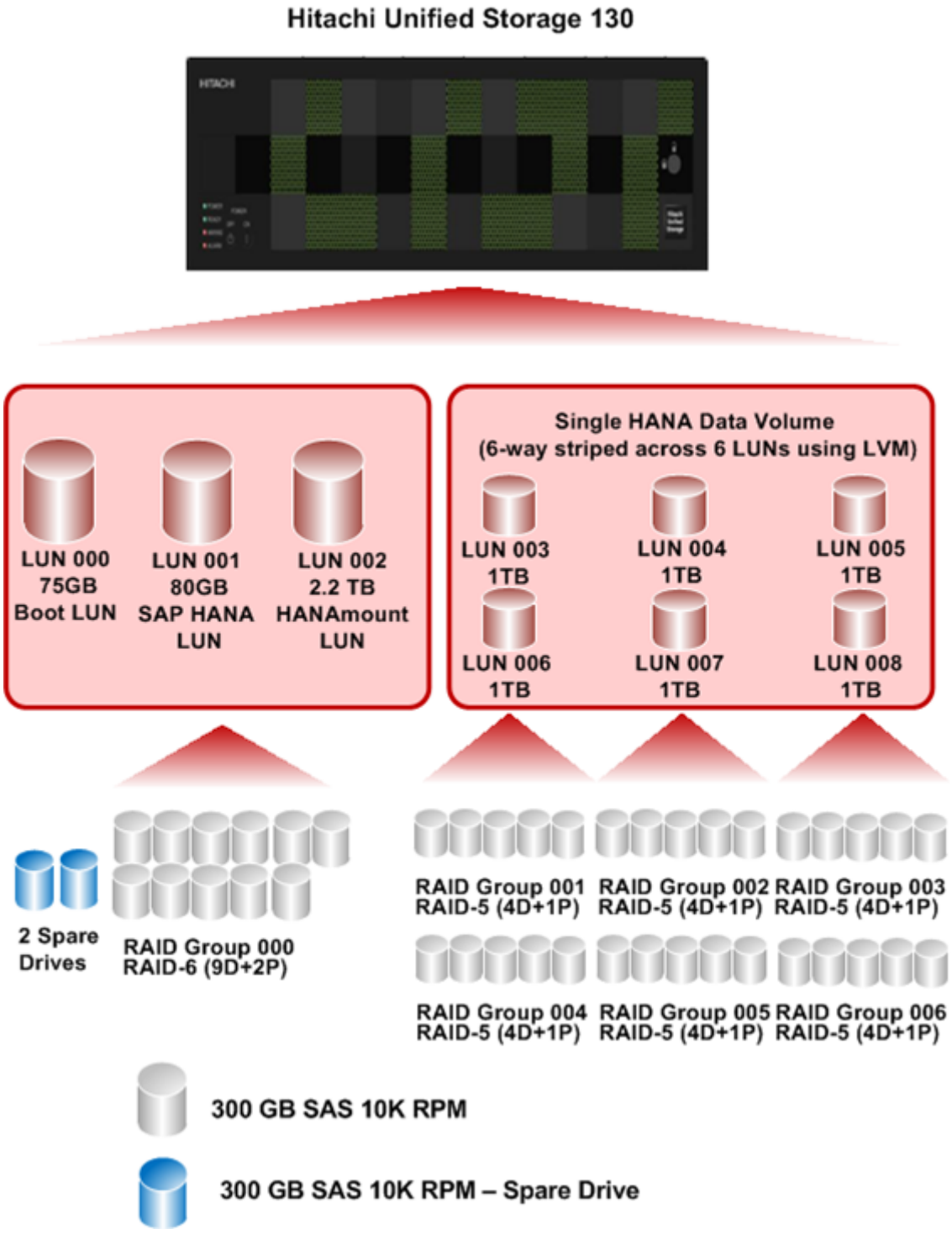

Figure 5

RAID Configuration

This reference architecture uses the following RAID configuration on Hitachi Unified Storage 130.

- One RAID-6 (9D+2P) group created using 11 × 300 GB SAS 10k RPM drives
- Six RAID-5 (4D+1P) groups created using 30 × 300 GB SAS 10k RPM drives
- Two 300 GB SAS drives as spare drives

Table 7 has the configuration for each RAID group.

Table 7. RAID Configuration

RAID Group	RAID Level	Number of Drives	Drive Size	Drive Speed	Usable Total Capacity
000	RAID-6 (9D+2P)	11	300 GB	10k RPM	2.4 TB
001	RAID-5 (4D+1P)	5	300 GB	10k RPM	1 TB
002	RAID-5 (4D+1P)	5	300 GB	10k RPM	1 TB
003	RAID-5 (4D+1P)	5	300 GB	10k RPM	1 TB
004	RAID-5 (4D+1P)	5	300 GB	10k RPM	1 TB
005	RAID-5 (4D+1P)	5	300 GB	10k RPM	1 TB
006	RAID-5 (4D+1P)	5	300 GB	10k RPM	1 TB

LUN Configuration

This reference architecture contains the following:

- One 75 GB boot LUN to host the SAP HANA server operating system
- One 80 GB LUN to host the SAP HANA appliance software
- One 2.2 TB LUN to host the SAP hanamnt directory
- Six LUNs with capacity of 1.1 TB each to host the SAP HANA data volumes to store the SAP HANA application data

Table 8 shows the LUN allocation for each RAID group.

Table 8. LUN Allocation

LUN	LUN Size	RAID Group	LUN Usage
000	75 GB	000	SAP HANA Boot LUN
001	80 GB	000	SAP HANA Installation LUN
002	2.2 TB	000	SAP HANA mount directory
003	1.1 TB	001	SAP HANA Data Volume
004	1.1 TB	002	SAP HANA Data Volume
005	1.1 TB	003	SAP HANA Data Volume

Table 8. LUN Allocation (Continued)

LUN	LUN Size	RAID Group	LUN Usage
006	1.1 TB	004	SAP HANA Data Volume
007	1.1 TB	005	SAP HANA Data Volume
008	1.1 TB	006	SAP HANA Data Volume

To support high availability, each LUN has four paths from the host within Hitachi Compute Blade 2000 connected to multiple ports on Hitachi Unified Storage 130. Assign each LUN to the following on Hitachi Unified Storage 130:

- Storage Port 0A
- Storage Port 1A
- Storage Port 0B
- Storage Port1B

Storage Requirements

The total usable capacity for this appliance is 6.6 TB. The minimum requirement set by SAP is to have 3 times the amount of memory of the data volumes. For this solution, that is 3 times 2048 GB, or 6 TB.

The SAP HANA log volume capacity for this appliance is the two (RAID-0) or four (RAID-10) 1.2 TB Fusion-io ioDrive2 storage devices. The minimum requirement set by SAP is to have capacity equal to the amount of main memory. This is 2048 GB.

SAP HANA Configuration

This is the set-up of SAP HANA in the 2 TB scale-up configuration of Hitachi Unified Compute Platform Select for the SAP HANA platform reference architecture.

SAN OS Boot Configuration

This four server blade configuration requires SAN boot. It uses one 75 GB LUN on Hitachi Unified Storage 130 for the operating system boot volume. Mapping for the boot volume is to the following:

- Storage Port 0A
- Storage Port 1A
- Storage Port 0B
- Storage Port1B

The Emulex BIOS setting for all four ports has the 75 GB SAP HANA boot LUN configured as the primary boot device. The installation of SUSE Linux for SAP Applications 11 SP2 is on the boot LUN.

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 Unified Storage 130. Multipathing aggregates all physical I/O paths into a single logical path. The LUN is always available unless all four paths fail.

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

- SAP HANA server boot LUN
- SAP HANA data volume LUN
- SAP HANA installation LUN
- SAP HANA mount directory LUN

HANA Data Volume Configuration

Logical Volume Manager for the Linux operating system configures the SAP HANA persistent storage volumes. With the six 1 TB SAP HANA data volume LUNs, Logical Volume Manager creates a single 6-way striped volume with a 1 MB stripe size to store the SAP HANA data volume. The striped volume acts as the persistent storage for the SAP HANA server.

HANA Log Volumes Configuration

This reference architecture uses XFS to configure the log volumes using two or four 1.2 TB Fusion-io ioDrive2 storage devices.

After completing the Fusion-io ioDrive2 hardware installation on the PCIe slots of the server blade hosting SAP HANA, install the Fusion-io driver software. This includes the installation of the following:

- Fusion-io ioDrive2 driver RPMs
- Fusion-io ioDrive2 utility RPMs
- Fusion-io ioDrive2 ioMemory VSL facility driver

The driver for the Fusion-io ioDrive2 is built specifically for the installed SUSE operating system kernel version, using the iomemory-vsl source rpm packages.

After the configuration of the Fusion-io drives, use the **mdadm** command to create a single striped RAID array with a chunk size of 64 KB using all Fusion-io ioDrive2 storage devices.

- For the basic model, create a RAID-0 stripe over two cards.
- For the protected model, create a RAID-10 stripe over four cards.

Using RAID-0 or RAID-10 to stripe two or more ioDrive2 storage devices provides added performance during parallel read/writes in Linux.

Format the HANA log volume with the XFS journaling file system. Mount this log volume with the **–o nobarrier** option to provide better performance with XFS.

Tune the Linux I/O scheduler queue size for all Fusion-io ioDrive2 storage devices. The **nr_requests** parameter configuration is set to 256.

SAP HANA Installation and Mount Directory

This reference architecture uses the following:

- One 80 GB LUN for SAP HANA installation
- One 2.2 TB LUN for SAP mount directory

Use the XFS file system on these LUNs.

SAP HANA Appliance Software Installation

After configuring the file system for the SAP HANA data volume and log volume, load the latest version of SAP HANA 1.0 SP05 on the SAP HANA server.

Install the following SAP HANA software components on the SAP HANA server node:

- SAP HANA database
- SAP HANA client
- SAP Host Agent
- LM structure
- SAPCAR
- SAP JVM
- SUM for SAP HANA

For More Information

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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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