Cisco and Hitachi Adaptive Solutions for SAP HANA Tailored Data Center Integration in a Direct-Attached Configuration with Hitachi Virtual Storage Platform E990

Reference Architecture Guide

By Hitachi Vantara

September 2020

Feedback

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Revision History

Revision	Changes	Date
MK-SL-208-00	Initial release	September 17, 2020

Table of Contents

Key Solution Elements **3**

Hardware Elements 3

Software Elements 5

Solution Design **7**

Cisco UCS 5108 Blade Server Chassis with Cisco UCS 2208XP Fabric Extender 7

Network Architecture Configuration 9

Storage Configuration 11

SAP HANA Configuration 16

Engineering Validation **16**

References **18**

Cisco and Hitachi Adaptive Solutions for SAP HANA Tailored Data Center Integration in a Direct-Attached Configuration with Hitachi Virtual Storage Platform E990

Reference Architecture Guide

Create a best-practices-based enterprise environment with Cisco and Hitachi Adaptive Solutions for SAP HANA Tailored Data Center Integration (TDI). Orchestrate efficiency across the data path with an intelligent system. Developed through collaboration between Hitachi Vantara and Cisco, this solution helps you anticipate and navigate challenges as they grow.

This architecture builds a self-optimizing data center that automatically spreads workloads across devices to help ensure consistent utilization and performance. This solution helps you effectively plan infrastructure growth and eliminate budgeting guesswork with predictive risk profiles that identify historical trends.

This solution architecture implements Adaptive Solutions for SAP HANA TDI to support Cisco Unified Computing System (Cisco UCS) with the following:

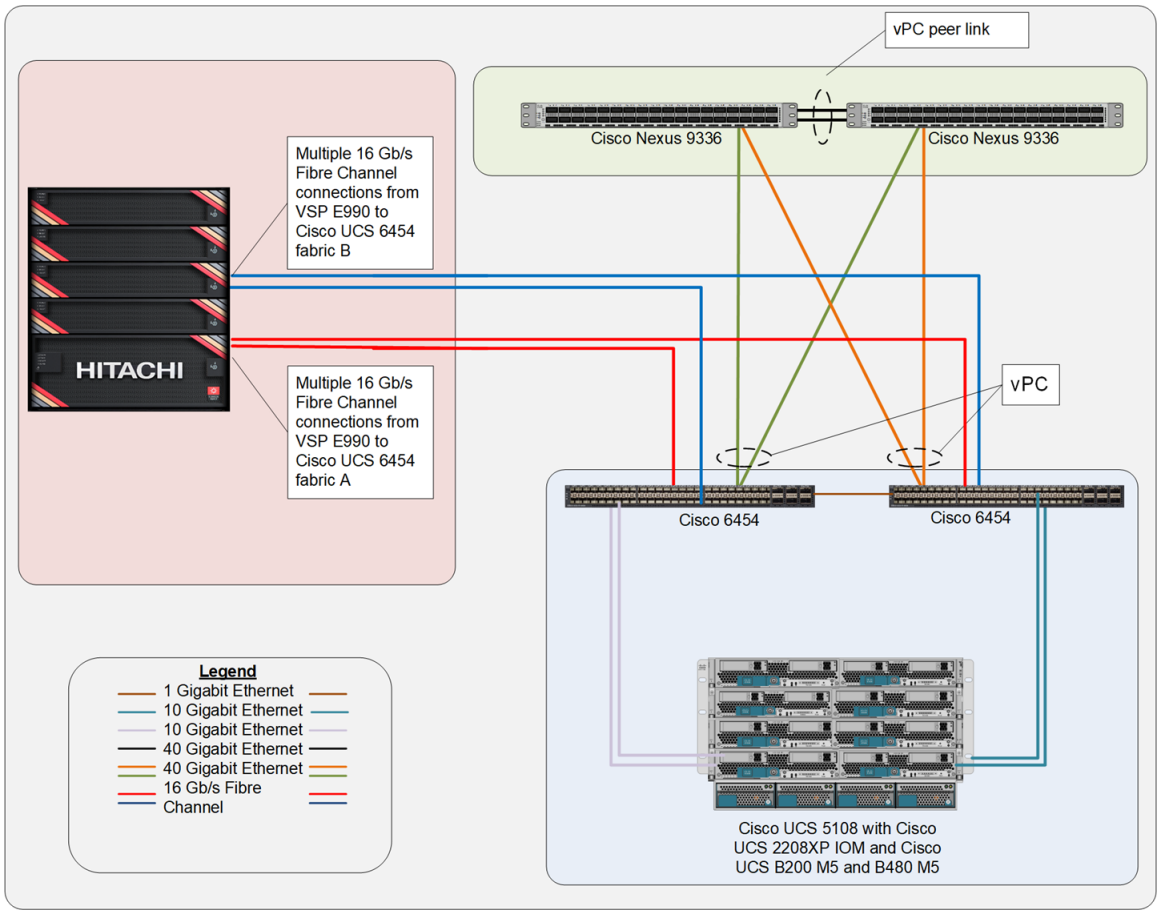
- Cisco UCS 5108 Blade Server Chassis
- Cisco UCS B-Series Blade Servers
- Cisco UCS 6454 Fabric Interconnects
- Cisco Nexus 9000 series switches
- Hitachi Virtual Storage Platform (VSP) 990 using non-volatile memory express (NVMe) solid state drives (SSDs) in a direct-attached storage (DAS) configuration.
- SAP HANA

Within this direct-attached model, these components form a powerful and scalable design, built on the best practices of all companies to create an excellent environment for an SAP HANA deployment. This architecture supports SUSE Linux Enterprise Server (SLES) and Red Hat Enterprise Linux (RHEL) for SAP applications.

The validation of this environment used Hitachi Virtual Storage Platform E990.

Figure 1 on page 2 shows the topology of this architecture for Cisco and Hitachi Adaptive Solutions for SAP HANA Tailored Data Center Integration, featuring Cisco UCS 6454 Fabric interconnects with a Hitachi Virtual Storage Platform E990 subsystem.

Figure 1



The architecture in Figure 1 was validated with 16 Gb/s Fibre Channel capability. However, both Virtual Storage Platform E990 and UCS 6454 have 32 Gb/s Fibre Channel capability.

This document assumes that you have familiarity with the following technologies:

- Cisco UCS
- General storage concepts
- Common IT storage practices
- Hitachi Virtual Storage Platform
- SAP HANA

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

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

Note – Do not change the layout of any of the components in this environment without consulting your Hitachi Vantara account representative. Changing this layout can require manual configuration of the network or using different components.

Hardware Elements

Table 1 lists the hardware and firmware version validated to deploy Cisco and Hitachi Adaptive Solutions for SAP HANA Tailored Data Center Integration using a Cisco UCS direct-attached storage configuration. The substitution of hardware and software versions other than those listed here is acceptable within this reference architecture, but substitutions must comply with the hardware and software compatibility matrices from Cisco, Hitachi, and SAP. For more information, see "References" on page 18.

TABLE 1. KEY HARDWARE COMPONENTS

Hardware Component		Specification
Network	Cisco Nexus 9336C-FX2 switch	Release 7.0(3) I7 (7)
	Cisco UCS Virtual Interface Card (VIC) 1440 (network adapter)	Release UCSB-MLOM-40G-04
Compute	Cisco UCS 6454 Fabric Interconnect	Release 4.1(1b)
	Cisco UCS 2208XP Fabric extender I/O module (IOM)	Release 4.1(1b)
	Cisco UCS B200 and Cisco UCS B480 M5 Blade Servers	4.1(1b)
Interface	Cisco UCS VIC (Fibre Channel)	Release 5.1 (1e)
Storage	Hitachi Virtual Storage Platform E990	See Table 2, "Hitachi Virtual Storage Platform E990 Specifications," on page 4

TABLE 2. HITACHI VIRTUAL STORAGE PLATFORM E990 SPECIFICATIONS

Component	Type		Specification
System	Hitachi Storage Virtualization Operating System		Version 9.2
	NVMe SSD	Maximum drives	96
		Drive options	1.9 TB, 3.8TB, 7.6 TB, 15.3 TB
	DBN (drive box for NVMe)		4
	RAID levels and group configuration	RAID-10	2D+2D, 4D+4D
		RAID-5	3D+1P, 4D+1P, 6D+1P, 7D+1P
		RAID-6	6D+2P, 12D+2P, 14D+2P
	Maximum number of LDEVs		65280
	Maximum storage capacity		1.3 PB
	Maximum external configuration		255 PB
Memory	Cache memory capacity		1024 GB
Storage I/F	DKC to drive interface		PCIe/Dual Port
	Data transfer rate		8 Gb/s
	Maximum number of DKBN		8
Device I/F	Supported channel type	Fibre Channel	32
		Data transfer rate	8 Gb/s, 16 Gb/s, 32 Gb/s
	Maximum number of CHB		8
Non-stop maintenance	Control PCB		Supported
	Cache memory		Supported
	Cache flash memory		Supported
	Power supply, fan		Supported
	Microcode		Supported
	Flash drive		Supported
	Flash module drive		Supported

Cisco Unified Computing System

The Cisco Unified Computing System is a next-generation data center platform that unites compute, network, storage access, and virtualization into a cohesive system designed to reduce total cost of ownership (TCO) and increase business agility. Managed as a single system, whether it has one server or hundreds of servers with thousands of virtual machines, the Cisco Unified Computing System decouples scale from complexity. The Cisco Unified Computing System accelerates the delivery of new services simply, reliably, and securely through end-to-end provisioning and migration support for both virtualized and nonvirtualized systems.

Hitachi Virtual Storage Platform E990

Hitachi Virtual Storage Platform E990 supercharges business application performance with all-NVMe storage. It uses Hitachi Ops Center, so you can improve IT operations with the latest AI and ML capabilities. Advanced data reduction in Virtual Storage Platform E990 enables you to run data reduction with even the most performance hungry applications.

The all-NVMe architecture in Virtual Storage Platform E990 delivers consistent, low-microsecond latency to reduce latency costs for critical applications. This predictable performance optimizes storage resources.

With Virtual Storage Platform E990 and the rest of Hitachi's midrange storage family, you have agile and automated data center technology. These systems allow you to cost-effectively meet your current digital expectations and give you the ability to address future challenges, as your application data needs and service levels evolve. With time-tested, proven availability and scalability, Hitachi Vantara delivers infrastructure solutions that help you maximize your data center advantage.

Software Elements

Table 3 describes the software products used to deploy this solution.

TABLE 3. KEY SOFTWARE COMPONENTS

Software		Software or Firmware Version
Operating system choices	SUSE Linux Enterprise Server for SAP applications	SLES 15 SP1 and SLES 12 SP4 ▪ Enic: 4.0.0.6-802.21 ▪ Fnic: 2.0.0.59-133.0
	Red Hat Enterprise Linux for SAP Solutions	RHEL 8.1 ▪ Enic: 4.0.0.8-802.24 ▪ Fnic: 2.0.0.60-141.0
Database	SAP HANA	

Hitachi Storage Virtualization Operating System RF

Hitachi Storage Virtualization Operating System RF (SVOS RF) 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.

SVOS RF optimizes NVMe and SAS flash to deliver optimized performance in the VSP 5000 series, VSP E990 and VSP F series. It incorporates artificial intelligence and machine learning to reduce costs with intelligent tiering. This automates data placement to assure that your data always resides on the most optimized tier.

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. Also, 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 Vantara.

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

As a SAP customer, you can download more information, including the following:

- **SAP HANA Master Guide**

  This is the central starting point for the technical implementation of SAP HANA. Use this for basic concepts and for planning.

- **SAP HANA Server Installation and Update Guide**

  Use the various installation guides to install the required SAP In-Memory Database and the other software components for the different replication technologies.

- **SAP HANA Administration Guide**

  This provides the central operations documentation for the on-premises deployment of the SAP HANA Platform.

The SAP HANA hardware directory provides information about SAP HANA appliances certified by SAP hardware partners.

Operating System Choices

Cisco and Hitachi Adaptive Solution for SAP HANA TDI in a direct-attached storage configuration can run on the following Linux operating systems:

- **SUSE Linux Enterprise Server 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 most SAP HANA customers.

- **Red Hat Enterprise Linux for SAP HANA**

  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 SUSE Linux Enterprise Server and Red Hat Enterprise Linux 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
- 2235581 – SAP HANA: Supported Operating System

Solution Design

Cisco and Hitachi Adaptive Solutions for SAP HANA Tailored Data Center Integration on Cisco UCS with Hitachi Virtual Storage Platform E990 in a direct-attached storage configuration uses these design components:

- "Cisco UCS 5108 Blade Server Chassis with Cisco UCS 2208XP Fabric Extender" on page 7
  - "Cisco UCS B200 M5 Blade Server" on page 8
  - "Cisco UCS B480 M5 Blade Server" on page 9
- "Network Architecture Configuration" on page 9
- "Storage Configuration" on page 11
- "SAP HANA Configuration" on page 16

Cisco UCS 5108 Blade Server Chassis with Cisco UCS 2208XP Fabric Extender

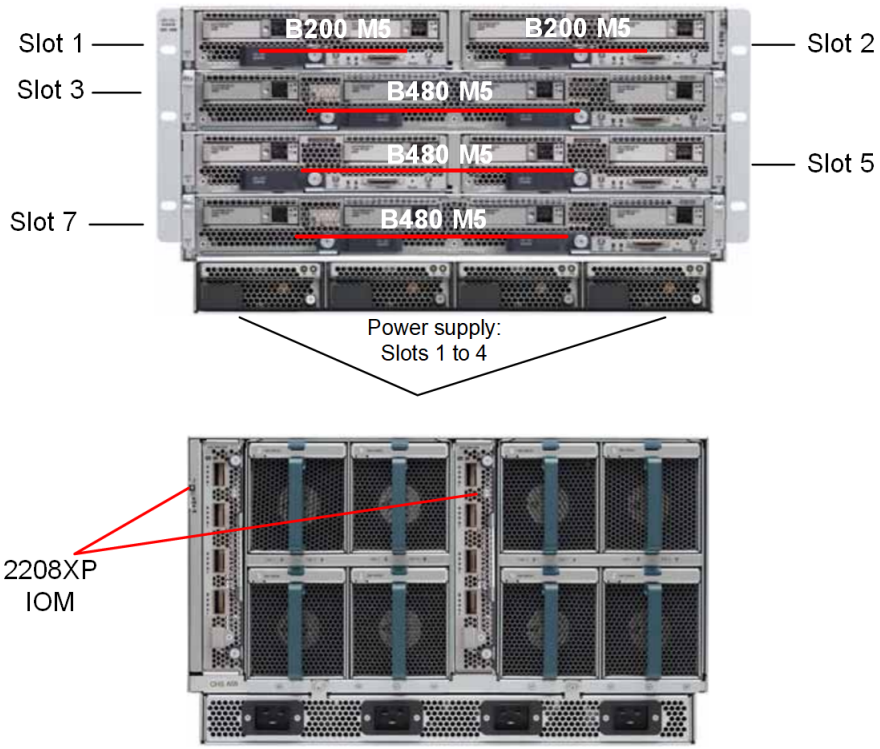
The 6RU Cisco UCS 5108 Blade Server Chassis can accommodate up to eight half-width, four full-width, or any combination of blade form factors (M1 to M5 generation) that fit in the available number of blade slots.

Each Cisco UCS B200 M5 Blade Server in this topology is hosted in a Cisco UCS 5108 Blade Server Chassis, connected to the fabric interconnects from the chassis using Cisco UCS 2208XP Fabric Extender IOMs.

Each Cisco 2208XP Fabric Extender IOM supports 10 Gb/s connections into the 10/25 Gb/s ports of each Cisco UCS 6454 Fabric Interconnect, delivering high port availability.

Figure 2 on page 8 shows the front and rear view of a Cisco UCS 5108 Blade Server Chassis with Cisco B200 M5 Blade Servers and Cisco B480 M5 Blade Servers.

Figure 2



Cisco UCS B200 M5 Blade Server

The enterprise-class Cisco UCS B200 M5 Blade Server extends the capabilities of the Cisco UCS portfolio in a half-width blade form factor. The B200 M5 server harnesses the power of the Intel Xeon Scalable processors, with the following:

- Up to 3072 GB of RAM using 128-GB DIMMs
- Two SSDs or HDDs
- Up to 80 Gb/s throughput connectivity

Figure 3 on page 9 shows Cisco UCS B200 M5 Blade Server.

Figure 3

Cisco UCS B480 M5 Blade Server

The Cisco UCS B480 M5 Blade Server combines a large memory footprint with four-socket scalability, using Intel Xeon Scalable processors. The B480 M5 uses Cisco UCS VIC technology to achieve up to 160 Gb/s of aggregate I/O bandwidth in a dense, full-width blade form factor.

The B480 M5 maintains memory performance, even as capacity grows, and can support up to 6 TB of memory without compromising CPU speed or core count.

Up to four Cisco UCS B480 M5 Blade Servers can be installed in the Cisco UCS 5108 Blade Server Chassis.

Figure 4 shows the Cisco UCS B480 M5 Blade Server.

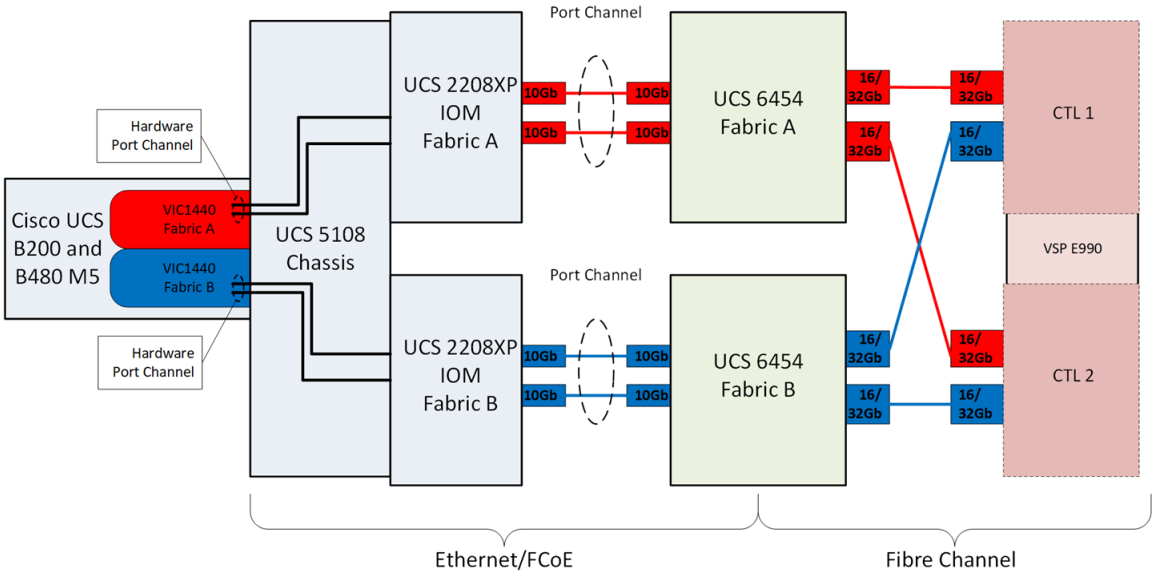
Figure 4

Network Architecture Configuration

The Cisco UCS B200 Blade Server and Cisco B480 M5 Blade Server used in this topology are hosted within a Cisco UCS 5108 Blade Server Chassis. They connect into the fabric interconnects from the chassis using Cisco UCS 2208XP Fabric Extender IOMs. The 2208XP IOM supports 10 Gb/s connections to the 10/25 Gb/s ports of the Cisco UCS 6454 Fabric Interconnects, delivering high port availability.

Figure 5 on page 10 shows the network topology from the UCS Blade Servers to the 6454 Fabric Interconnects through the 2208XP IOMs.

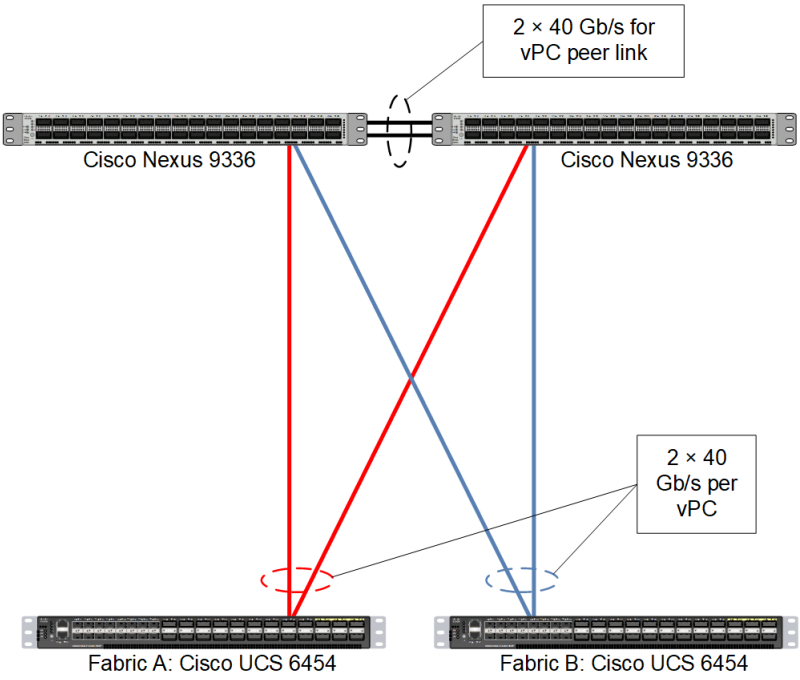
Figure 5



The application gateways are hosted by the pair of Cisco Nexus 9336 switches, but primary routing is passed onto an existing router that is upstream of the converged infrastructure for the SAP HANA environment.

Figure 6 shows the upstream network for the application gateway.

Figure 6



For the SAP HANA nodes, you need to make network connections to the Cisco Nexus 9336 switches or to any other external switches. Bond the corresponding two ports, ethX and ethY, as bond0 at the operating system level using the active-active network bond mode with the following options:

mode=802.3ad miimon=100 xmit_hash_policy=2 lacp_rate=fast mtu=9000

This network acts as the client network for the SAP HANA node.

Storage Configuration

Note – Each implementation of this reference architecture can use a different storage architecture. Validation for this environment used Hitachi Virtual Storage Platform E990 as external storage.

You need the following storage components to implement a scale-up SAP HANA system with Cisco UCS B200 Blade Servers or Cisco B480 M5 Blade Servers in a Cisco UCS 5108 Blade Server Chassis using Hitachi Virtual Storage Platform E990 using NVMe SSD's :

- Cisco VIC FCoE host bus adapter (HBA)
- Storage, such as Hitachi Virtual Storage Platform E990 with NVMe SSD
- Storage drive box trays (DBS drive boxes)
- Spare drives

Use the port properties listed in Table 4.

TABLE 4. PORT PROPERTIES ON HITACHI VIRTUAL STORAGE PLATFORM E990

For this setting	Use this value
Port Security	Enabled
Port Speed	16 Gbps
Fabric	OFF
Connection Type	P-to-P

The SAP HANA node needs the following storage layout:

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

This reference architecture utilizes a dynamic provisioning pool design for the storage layout that ensures maximum utilization and optimization at a lower cost.

Use two dynamic provisioning pools with the specific parity groups listed in Table 5 for the storage layout.

TABLE 5. DYNAMIC PROVISIONING POOLS

Dynamic Provisioning Pool Name	Purpose	Parity Group RAID Level and Disks
OS_SH_Data_Pool	Operating system LUN SAP HANA shared LUN Data LUN	RAID-6 (6D+2P), 1.9 TB SSD drives
Log_Pool	Log LUN	RAID-6 (6D+2P), 1.9 TB SSD drives

The example layout in Table 6 uses the dynamic provisioning pool layout on the Hitachi Virtual Storage Platform E990 used for validation for a SAP HANA TDI solution with 768 GB and a 1.5 TB scale-up system.

TABLE 6. EXAMPLE OF A DYNAMIC PROVISIONING POOL FOR A SAP HANA TDI SOLUTION

Dynamic Provisioning Pool	Parity Group ID	Parity Group RAID Level and Disks	LDEV ID	LDEV Name	LDEV Size (GB)	MPU Assignment
OS_SH_Data_Pool	1	RAID 6 (6D+2P), 1.9 TB SSD Drives	00:00:01	OS_SH_DA_Pool_1	2640	MPU-10
			00:00:02	OS_SH_DA_Pool_2	2640	MPU-20
			00:00:03	OS_SH_DA_Pool_3	2640	MPU-10
			00:00:04	OS_SH_DA_Pool_4	2640	MPU-20
Log_Pool	2	RAID 6 (6D+2P), 1.9 TB SSD Drives	00:01:01	Log_Pool_1	2640	MPU-10
			00:01:02	Log_Pool_2	2640	MPU-20
			00:01:03	Log_Pool_3	2640	MPU-10
			00:01:04	Log_Pool_4	2640	MPU-20

Provision the virtual volumes for the operating system, SAP HANA shared, data, and log volumes. Table 7 were the settings used during validation for an SAP HANA TDI solution with 768 GB and a 1.5 TB scale-up system.

TABLE 7. EXAMPLE OF VIRTUAL VOLUMES FOR THE SAP HANA NODES FOR 768 GB AND 1.5 TB MEMORY SIZES

Dynamic Provisioning Pool	Virtual Volume ID	Virtual Volume Name	Virtual Volume Size	MPU Assignment	System Memory
OS_SH_Data_Pool	00:02:00	HANA_OS	100 GB	MPU-10	768 GB
	00:03:00	HANA_OS	100 GB	MPU-20	1536 GB
	00:02:01	HANA_SH	768 GB	MPU-10	768 GB
	00:03:01	HANA_SH	1536 GB	MPU-20	1536 GB

TABLE 7. EXAMPLE OF VIRTUAL VOLUMES FOR THE SAP HANA NODES FOR 768 GB AND 1.5 TB MEMORY SIZES (CONTINUED)

Dynamic Provisioning Pool	Virtual Volume ID	Virtual Volume Name	Virtual Volume Size	MPU Assignment	System Memory
Log_Pool	00:02:02	HANA_LOG_1	96 GB	MPU-10	768 GB
	00:02:03	HANA_LOG_2	96 GB	MPU-20	
	00:02:04	HANA_LOG_3	96 GB	MPU-10	
	00:02:05	HANA_LOG_4	96 GB	MPU-20	
Log_Pool	00:03:02	HANA_LOG_1	192 GB	MPU-10	1536 GB
	00:03:03	HANA_LOG_2	192 GB	MPU-20	
	00:03:04	HANA_LOG_3	192 GB	MPU-10	
	00:03:05	HANA_LOG_4	192 GB	MPU-20	
OS_SH_Data_Pool	00:02:06	HANA_DATA_1	192 GB	MPU-10	768 GB
	00:02:07	HANA_DATA_2	192 GB	MPU-20	
	00:02:08	HANA_DATA_3	192 GB	MPU-10	
	00:02:09	HANA_DATA_4	192 GB	MPU-20	
OS_SH_Data_Pool	00:03:06	HANA_DATA_1	384 GB	MPU-10	1536 GB
	00:03:07	HANA_DATA_2	384 GB	MPU-20	
	00:03:08	HANA_DATA_3	384 GB	MPU-10	
	00:03:09	HANA_DATA_4	384 GB	MPU-20	

Figure 7 shows the storage layout for an SAP HANA system with 768 GB memory size used for validation.

Figure 7

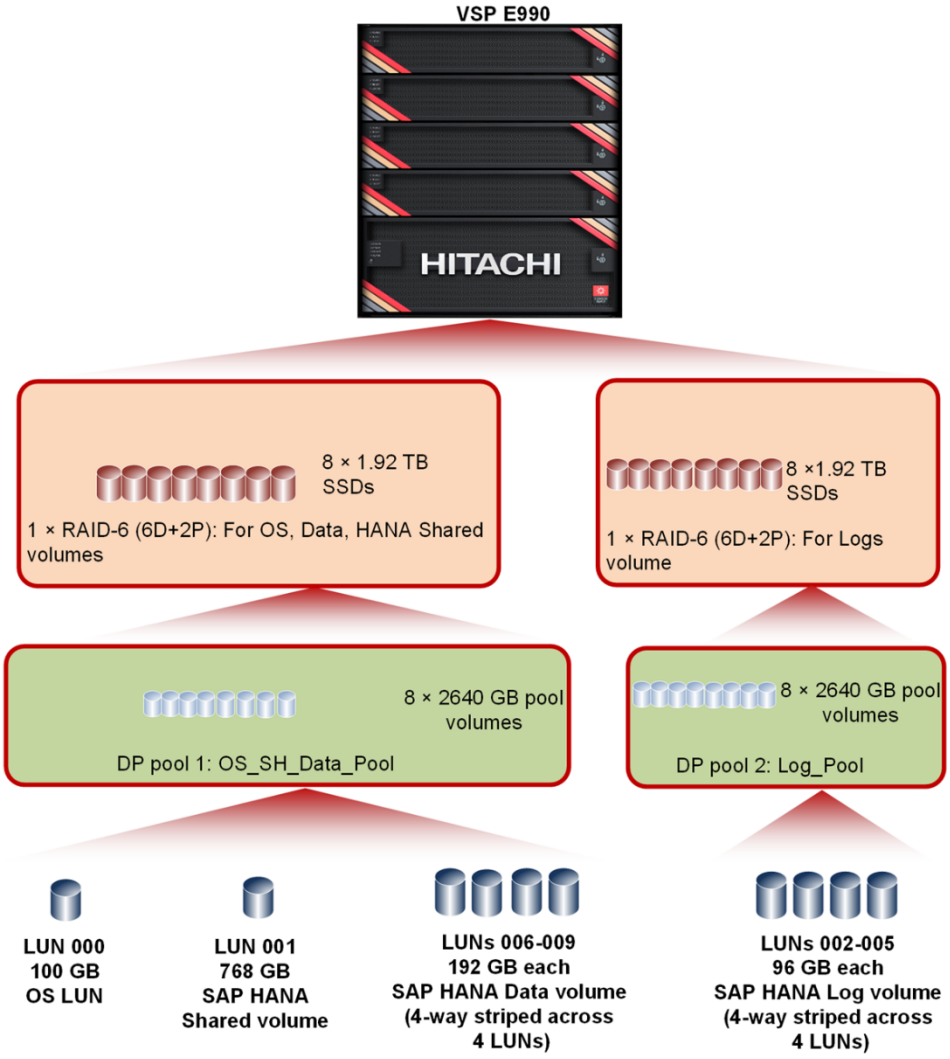


Figure 8 shows the storage layout for an SAP HANA system with 1.5 TB memory size used for validation.

Figure 8

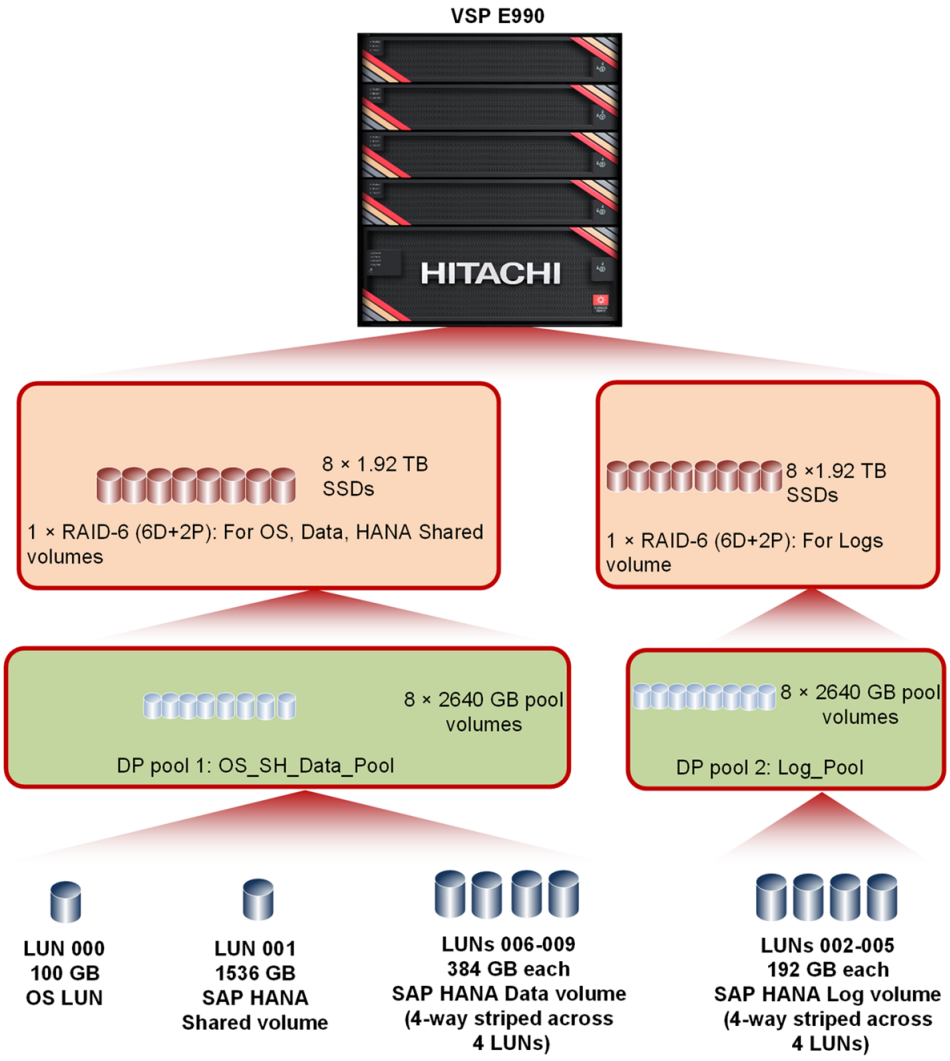


Table 8 has the LUN path assignment used when validating this environment.

TABLE 8. EXAMPLE LUN PATH ASSIGNMENT

LUN ID	LDEV ID	LDEV Name
0000	00:02:00	HANA_OS
0001	00:02:01	HANA_SH
0002	00:02:02	HANA_LOG_1
0003	00:02:03	HANA_LOG_2
0004	00:02:04	HANA_LOG_3

TABLE 8. EXAMPLE LUN PATH ASSIGNMENT (CONTINUED)

LUN ID	LDEV ID	LDEV Name
0005	00:02:05	HANA_LOG_4
0006	00:02:06	HANA_DATA_1
0007	00:02:07	HANA_DATA_2
0008	00:02:08	HANA_DATA_3
0009	00:02:09	HANA_DATA_4

SAP HANA Configuration

Refer to the official SAP documentation which describes the installation process, the SAP HANA Server Installation Guide. View all SAP installation and administration documentation.

Install the following SAP HANA software components on the server:

- Database
- Client

Engineering Validation

The components validated in this integrated architecture are the following:

- **Cisco Nexus 9336C-FX2 Switch** – This switch provides100 Gb/s-capable LAN connectivity to the Cisco UCS computing resources.
- **Cisco UCS 6454 Fabric Interconnect** – This interconnect provides unified management of Cisco UCS resources and their access to storage and networks.
- **Cisco UCS B200 M5 Blade Server** – This is a high-powered, versatile blade server for SAP HANA with two CPUs.
- **Cisco UCS B480 M5 Blade Server** – This is a high-powered, versatile blade server for SAP HANA with four CPUs.
- **Hitachi Virtual Storage Platform E990** – Hitachi Virtual Storage Platform E990 super-charges business application performance with all-NVMe storage.
- **Cisco UCS Manager** – This manages the environment through the Cisco UCS 6454 Fabric Interconnect, providing stateless compute and policy-based implementation of the servers it manages.
- **SAP HANA** – This combines database, data processing, and application platform capabilities in a single in-memory platform.

In your implementation, other Hitachi Virtual Storage Platform models, including from the Virtual Storage Platform 5000 series, and Cisco products may be substituted. Contact your sales representative for more information.

The test methodology for validating this SAP HANA TDI solution using a Cisco UCS 5108 Blade Server Chassis and Cisco B200 M5 Blade Servers and Cisco B480 M5 Blade Servers in an enterprise storage configuration with Hitachi Virtual Storage Platform E990 used the following:

- SAP HANA Hardware and Cloud Measurement Tools HCMT-046_0 was tested on these volumes for SLES 15 SP1, SLES 12 SP4 and RHEL 8.1:
  - Data volume
  - Log volume

For optimal use of SAP HANA database, use the parameters listed in the following global.ini file. Use SAP Note 2399079 to define the parameters in the global.ini file for SAP HANA 2.0:

```
[communication]
tcp_backlog = 2048
[fileio]
max_parallel_io_requests[data] = 128
max_submit_batch_size[data] = 64
size_kernel_io_queue[data] = 512
async_read_submit[data] = on
async_write_submit_blocks[data] = all
min_submit_batch_size[data] = 16
async_write_submit_active[data] = auto
max_parallel_io_requests[log] = 128
max_submit_batch_size[log] = 64
size_kernel_io_queue[log] = 512
async_read_submit[log] = on
async_write_submit_blocks[log] = all
min_submit_batch_size[log] = 16
async_write_submit_active[log] = auto
[multidb]
mode = multidb
database_isolation = low
singletenant = yes
[persistence]
basepath_datavolumes = /hana/data/HIT
basepath_logvolumes = /hana/log/HIT
```

References

Use these references when designing your system.

- UCS Hardware and Software Compatibility from Cisco
- Release Notes from Cisco
- Recommended Cisco NX-OS Releases for Cisco Nexus 9000 Series Switches
- Hitachi Interoperability Reports
- Specifications for Hitachi Virtual Storage Platform E990

For More Information

Hitachi Vantara Global Services offers experienced storage consultants, proven methodologies and a comprehensive services portfolio to assist you in implementing Hitachi products and solutions in your environment. For more information, see the Services website.

Demonstrations and other resources are available for many Hitachi products. To schedule a live demonstration, contact a sales representative or partner. To view on-line informational resources, see the Resources website.

Hitachi Academy is your education destination to acquire valuable knowledge and skills on Hitachi products and solutions. Our Hitachi Certified Professional program establishes your credibility and increases your value in the IT marketplace. For more information, see the Hitachi Vantana Training and Certification website.

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