Cisco UCS X - Series and Hitachi Adaptive Solutions for SAP HANA Tailored Data Center Integration using MDS with Virtual Storage Platform E1090

Reference Architecture Guide

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Feedback

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Revision history

Changes	Date
Initial release	June 30, 2022

Reference Architecture Guide

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

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 UCSX with the following:

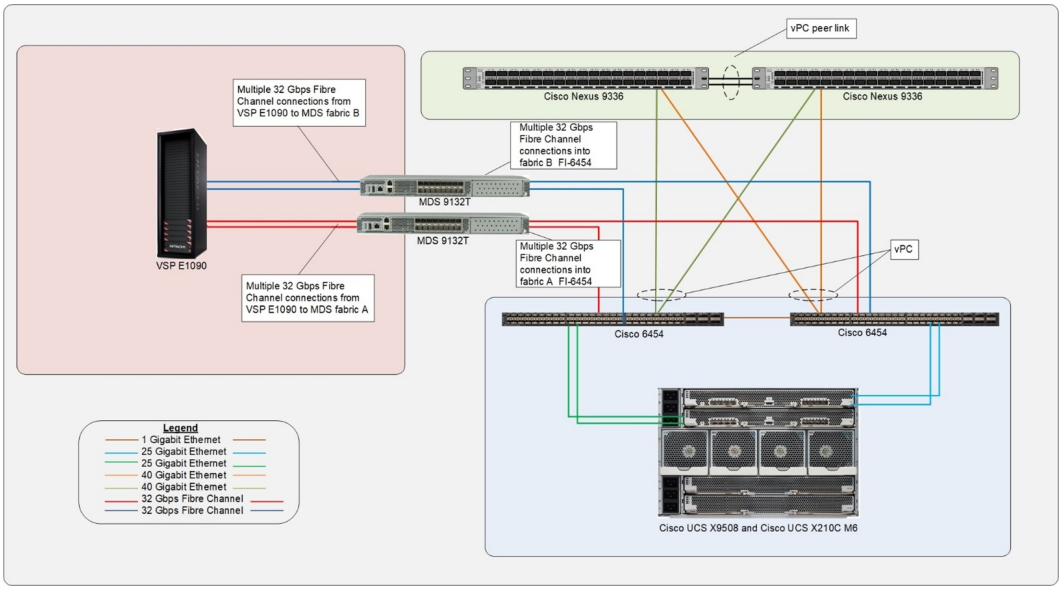
- Cisco UCS X9508 Blade Server Chassis
- Cisco UCS X9416 X Fabric Modules
- Cisco UCS 9108 Intelligent Fabric Modules (IFMs)
- Cisco UCS X210C M6 Blade Servers
- Cisco MDS 9132T
- Cisco UCS 6454 Fabric Interconnects
- Cisco Nexus 9000 series switches
- Cisco Intersight
- Hitachi Virtual Storage Platform E1090 (VSP E1090), using Non-Volatile Memory express (NVMe) solid-state drives (SSDs)

SAP HANA architecture

These components form a powerful and scalable design, built on the best practices of Hitachi Vantara and Cisco to create an excellent environment for a 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 uses Hitachi Virtual Storage Platform E1090 with UCSX.

The following figure shows the topology of this architecture for Cisco UCSX and Hitachi Adaptive Solutions for SAP HANA TDI with a VSP E1090 storage system.



The architecture was validated with 32 Gbps Fibre Channel capability.

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

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

Note: Testing of this configuration was in a lab environment. Many factors 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. See Product descriptions (on page 19)for detailed component information.

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 different components.

Hardware elements

The following table lists the hardware and firmware versions validated to deploy Cisco and Hitachi Adaptive Solutions for SAP HANA TDI using Cisco UCS MDS 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. See References (on page 19) for more information.

Table 1 Key Hardware Components

	Hardware Component	Firmware Version
Network	Cisco Nexus 9336C-FX2 switch	Release 7.0(3) I7 (9)
	Cisco UCS Network Adaptor UCSX-V4-Q25GML	Release 5.2(1b)
	Cisco UCS 6454 Fabric Interconnect	Release 9.3(5)I42(1f)
	Cisco UCS 9108 Intelligent Fabric Modules (IFMs)	Release 4.2(1f)
Compute	Cisco UCS X210C-M6 Servers	Release 5.0(1b)
	Cisco UCS X9508 Blade Server Chassis	N/A
	Cisco UCS VIC (Fibre Channel)	Release 5.0(1b)
	Cisco UCS X9416 X Fabric Modules	N/A
Fibre Channel SAN	Cisco MDS 9132T	Release 9.2(2)
Storage	Hitachi VSP E1090	93-06-21-80

Table 2 VSP E1090 Specifications

Item			Specifications
	Type		VSP E1090
System	SVOS Version		Hitachi Storage Virtualization Operating System RF v9.8
	Maximum Drives	NVMe SSD	96
	Drive Options	NVMe SSD	1.9 TB, 3.8 TB, 7.6 TB, 15.3 TB
	RAID Level		RAID 10, RAID 5, RAID 6
	RAID group configuration	RAID 1	2D+2D, 4D+4D
		RAID 5	3D+1P, 4D+1P, 6D+1P, 7D+1P
		RAID 6	6D+2P, 12D+2P, 14D+2P
	Max. number of LDEVs		65280
	Max. storage capacity		1.3 PB
	Max. external configuration		255 PB

Item			Specifications
	Type		VSP E1090
Memory	Cache memory capacity		1024 GiB
Device I/F	Supported channel type	Fibre Channel	32
		Data transfer rate	8 Gbps, 16 Gbps, 32 Gbps
	Max. 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

Table 3 VSP E1090 Hardware elements

	Storage Components
VSP E1090	§ CTL: 1 pair
(NVMe SSD)	§ 32 Gbps 4-port CHB
	§ MPU: 1 pair
	§ Cache: 1024 GB
	§ NVMe SSDs: 48 × 1.9 TB

Software elements

The following tables describe the software products used to deploy this solution.

Table 4 Key Software Components for VSP E1090

Software		Software or Firmware Version
Operating system choices	SUSE Linux Enterprise Server for SAP Applications	SLES 15 SP3 ▪ ENIC: 4.1.0.5-868.13 ▪ FNIC: 2.0.0.74-198.0
	Red Hat Enterprise Linux for SAP Solutions	RHEL 8.4 ▪ ENIC: 4.1.0.5-868.10 ▪ FNIC: 2.0.0.72-189.0
Database	SAP HANA	2.0 SPS 06
Management	Cisco Intersight	Cloud

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 (SLES) for SAP Applications

  Compete more effectively though improved uptime, better efficiency, and accelerated innovation using SUSE Linux Enterprise Server for SAP Applications. 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 for SAP Applications 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 (RHEL) for SAP Solutions

  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. See the following SAP Notes for SLES and RHEL for more information:

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

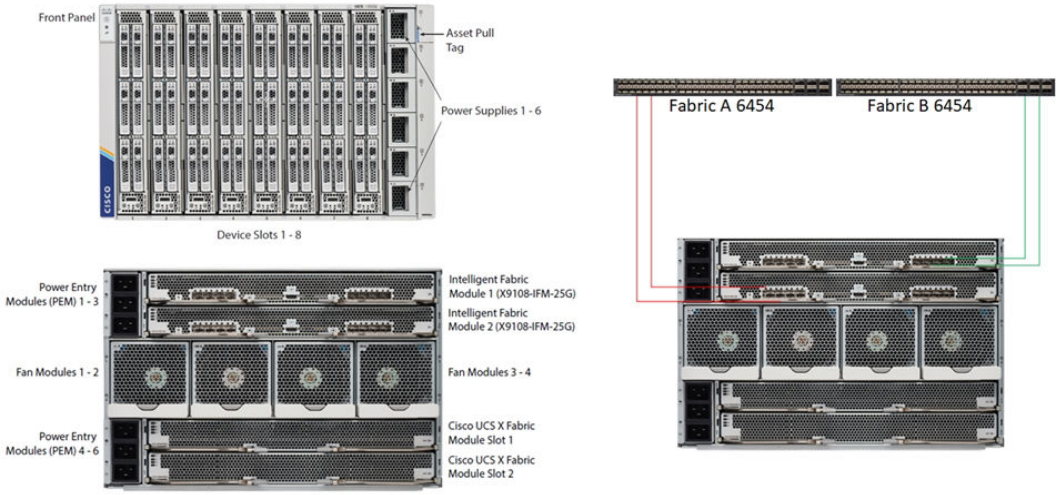
Cisco and Hitachi Adaptive Solutions for SAP HANA TDI on Cisco UCSX with VSP E1090 in an MDS configuration uses the following design components:

- Cisco UCS X9508 Blade Server Chassis
- Cisco UCS X210C M6 Blade Server
- Network architecture
- Storage configuration
- SAP HANA configuration

Cisco UCS X9508 Blade Server Chassis

The 7RU Cisco UCS X9508 Blade Server Chassis has eight flexible slots that can house a combination of compute nodes and a pool of current and future I/O resources that can include GPU accelerators, disk storage, and nonvolatile memory.

The following figure shows the Cisco UCS X9508 Blade Server Chassis:



The Cisco UCS 9108 25G Intelligent Fabric Modules connects the I/O fabric between the Cisco UCS 6454 Fabric Interconnect and the Cisco UCS X9508 Chassis, enabling a lossless and deterministic converged fabric to connect all blades and chassis together.

The Cisco UCS X-Fabric Modules slots provide an alternative path to bridging/switching within the chassis and interconnect compute node CPUs, storage devices, and communication devices so that all these components interoperate directly without translating PCIe to Ethernet.

Cisco UCS X210C M6 Blade Server

The enterprise-class Cisco UCS X210C M6 Blade Server is the first computing device to integrate into the Cisco UCS X-Series Modular System. The Cisco UCS X210c M6 provides these main features:

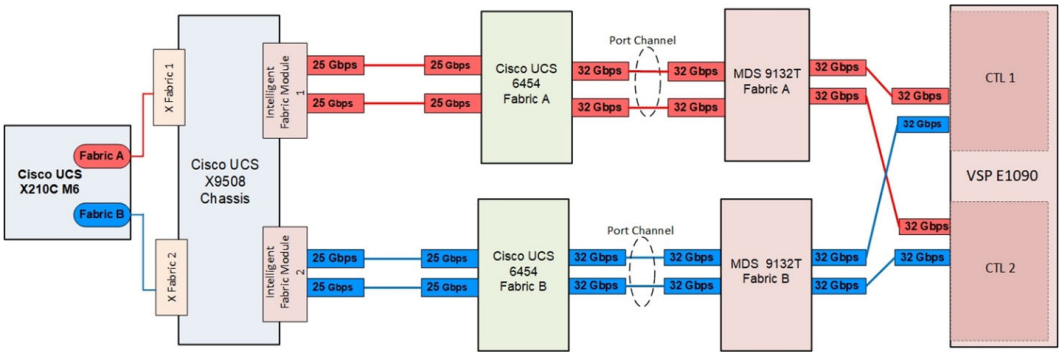
- CPU: Up to 2 × 3rd Gen Intel Xeon Scalable Processors with up to 40 cores per processor.
- Memory: Up to 32 × 256 GB DDR4-3200 DIMMs for up to 8 TB of main memory. Configuring up to 16x 512-GB Intel Optane persistent memory DIMMs can yield up to 12 TB of memory.
- Storage: Up to six hot-pluggable, Solid-State Drives (SSDs), or Non-Volatile Memory express (NVMe) 2.5-inch drives with a choice of enterprise-class RAID or passthrough controllers with four lanes each of PCIe Gen 4 connectivity and up to 2 M.2 SATA drives for flexible boot and local storage capabilities.
- mLOM virtual interface card: The Cisco UCS Virtual Interface Card (VIC) 14425 can occupy the server's modular LAN on motherboard (mLOM) slot, enabling up to 50 Gbps of unified fabric connectivity to each of the chassis Intelligent Fabric Modules (IFMs) for 100 Gbps connectivity per server.

The following figure shows the Cisco UCS X210C M6 Blade Server:

Network architecture configuration

The Cisco UCS X210C M6 Servers used in this topology are hosted within a Cisco UCS X9508 Blade Server Chassis. They connect into the fabric interconnects from the chassis using Cisco UCS 9108 Intelligent Fabric Modules (IFMs). The IFMs support 25 Gbps connections to the 10/25 Gbps ports of the Cisco UCS 6454 Fabric Interconnects, delivering high port availability.

The following figure shows the network topology from the UCS Blade Servers to the VSP E1090



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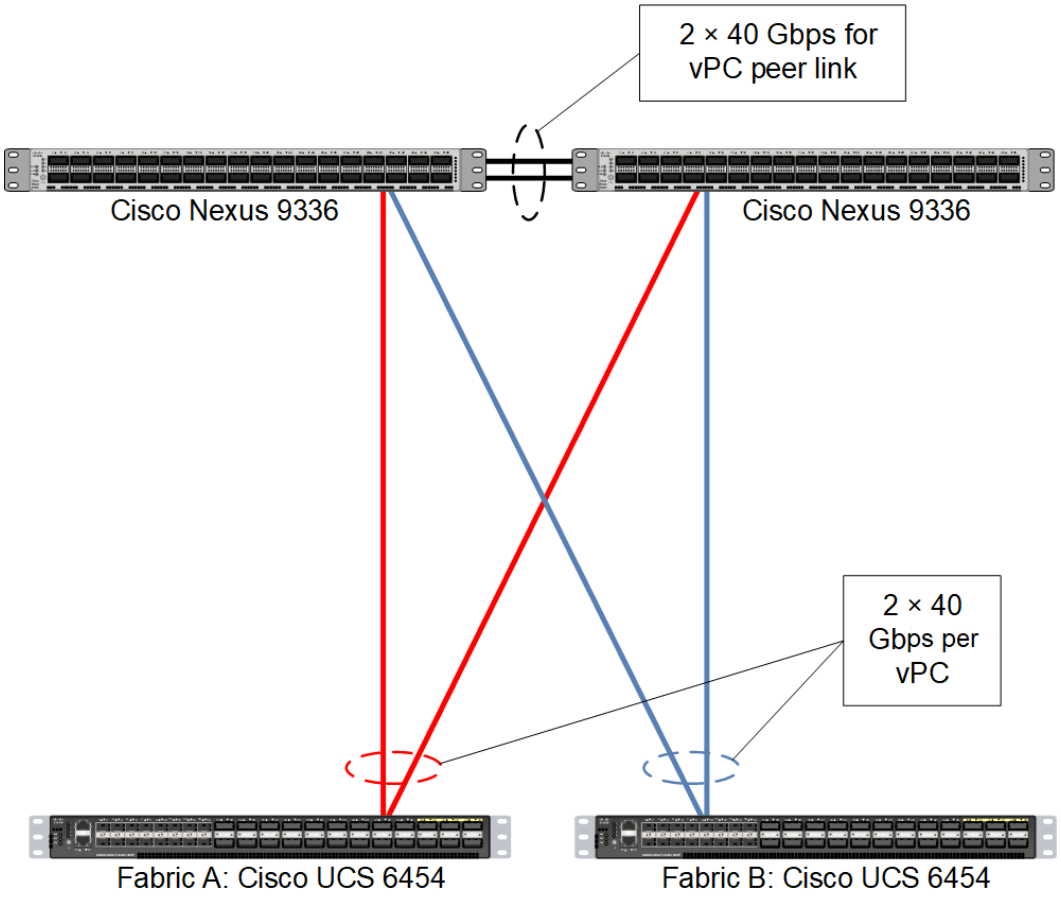
The application gateways are hosted by the pair of Cisco Nexus 9336 switches, but primary routing is passed onto an existing router that is upstream of the converged infrastructure for the SAP HANA environment.

The following figure shows the upstream network for the application gateway.



For the SAP HANA nodes, you must 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

You need the following storage components to implement a scale-up SAP HANA system with Cisco UCS X Series Blade Servers in a Cisco UCS X9508 Blade Server Chassis using VSP E1090 with NVMe SSDs:

- Cisco VIC FCoE host bus adapter (HBA)
- Storage, such as VSP E1090 with NVMe SSDs
- Storage drive box trays (DBS drive boxes)
- Spare drives

Note: Each implementation of this reference architecture can use a different storage architecture. Validation for this environment used VSP E1090 as external storage.

Use the port properties listed in the following table:

Table 5 VSP E1090 Port Properties

For this setting	Use this value
Port Security	Enabled
Port Speed	32 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 the following tables for the storage layout.

Table 6 VSP E1090 Dynamic Provisioning Pools

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

The example layout uses the dynamic provisioning pool layout on the VSP E1090 used for validation for a SAP HANA TDI solution with 512 GB and 1 TB scale-up systems.

Table 7 Dynamic Provisioning Pool for a SAP HANA TDI Solution for VSP E1090

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	1536	MPU -10
			00:00:02	OS_SH_DA_Pool_2	1536	MPU-20
			00:00:03	OS_SH_DA_Pool_3	1536	MPU-10
			00:00:04	OS_SH_DA_Pool_4	1536	MPU-20
Log_Pool	2	RAID 6 (6D+2P), 1.9 TB SSD Drives	00:01:01	Log_Pool_1	878	MPU-10
			00:01:02	Log_Pool_2	878	MPU-20
			00:01:03	Log_Pool_3	878	MPU-10
			00:01:04	Log_Pool_4	878	MPU-20

Provision the virtual volumes for the operating system, SAP HANA shared, data, and log volumes.

While mapping the LUN path assignment for each node, add volumes in the following order:

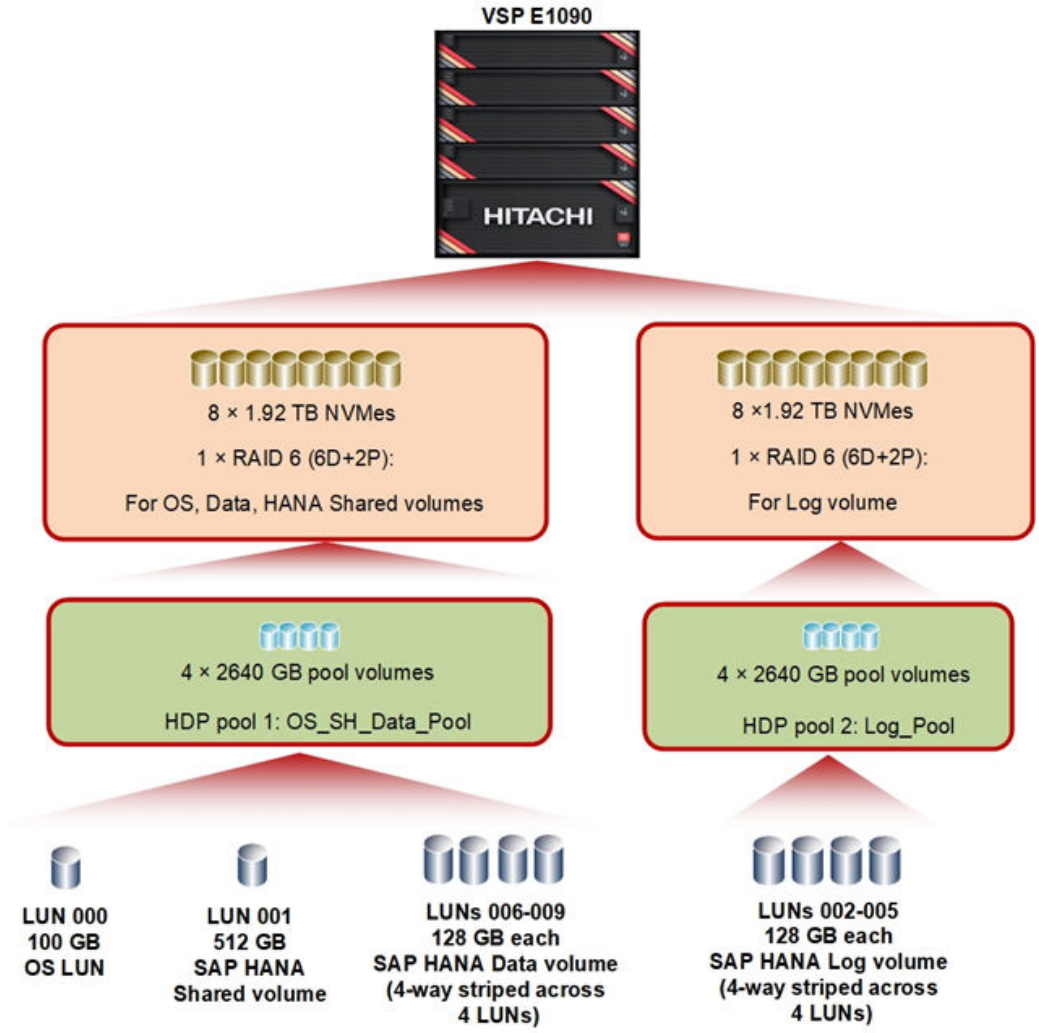
1. The operating system volume
2. The SAP HANA shared volume
3. The log volume
4. The data volume

The following table lists the settings used during validation for a SAP HANA TDI solution with 512 GB and 1 TB scale-up systems.

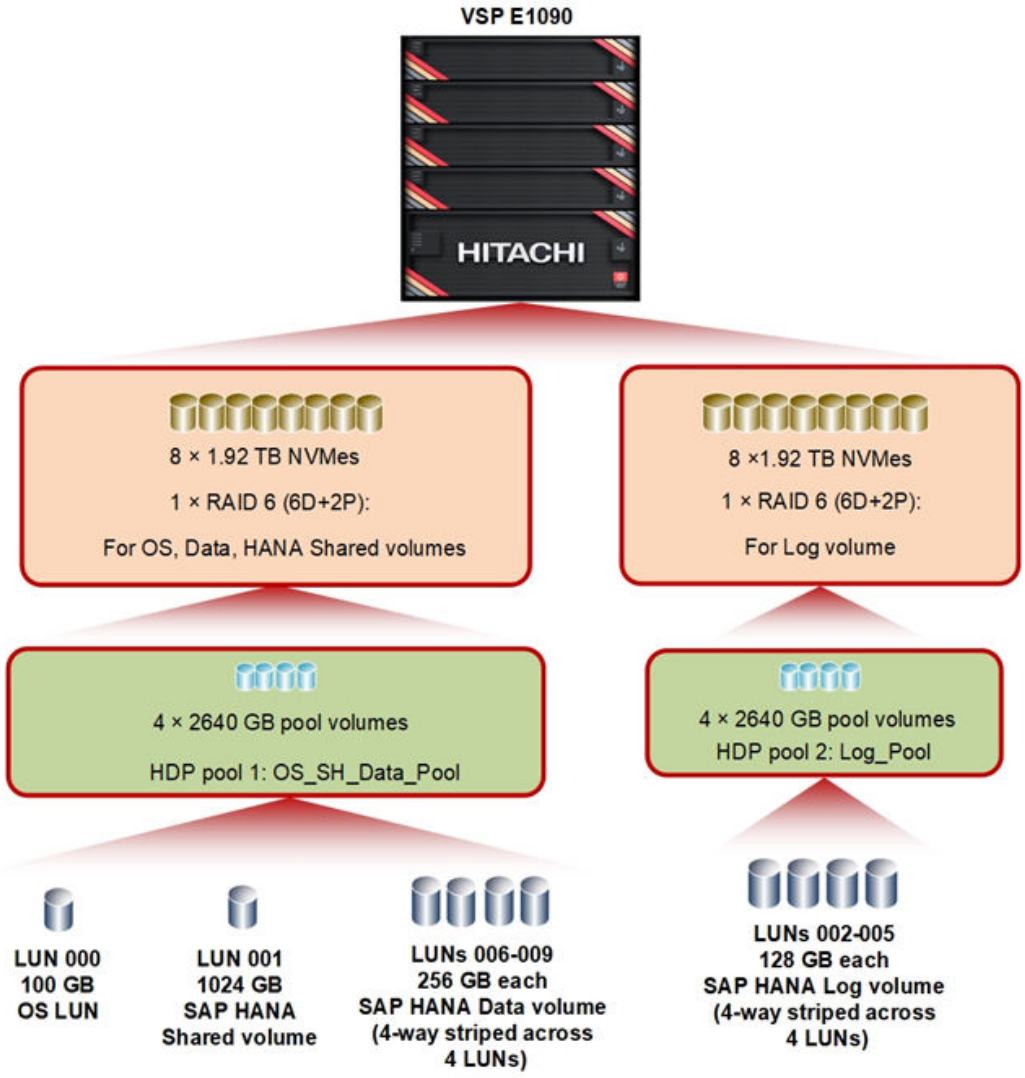
Table 8 Virtual Volumes for the SAP HANA Nodes for 512 GB and 1 TB Memory Sizes

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	512 GB
	00:03:00	HANA_OS	100 GB	MPU-20	1024 GB
	00:02:01	HANA_SH	512 GB	MPU-10	512 GB
	00:03:01	HANA_SH	1024 GB	MPU-20	1024 GB
Log_Pool	00:02:02	HANA_LOG_1	128 GB	MPU-10	512 GB
	00:02:03	HANA_LOG_2	128 GB	MPU-20	
	00:02:04	HANA_LOG_3	128 GB	MPU-10	
	00:02:05	HANA_LOG_4	128 GB	MPU-20	
Log_Pool	00:03:02	HANA_LOG_1	128 GB	MPU-10	1024 GB
	00:03:03	HANA_LOG_2	128 GB	MPU-20	
	00:03:04	HANA_LOG_3	128 GB	MPU-10	
	00:03:05	HANA_LOG_4	128 GB	MPU-20	
OS_SH_Data_Pool	00:02:06	HANA_DATA_1	128 GB	MPU-10	512 GB
	00:02:07	HANA_DATA_2	128 GB	MPU-20	
	00:02:08	HANA_DATA_3	128 GB	MPU-10	
	00:02:09	HANA_DATA_4	128 GB	MPU-20	
OS_SH_Data_Pool	00:03:06	HANA_DATA_1	256 GB	MPU-10	1024 GB
	00:03:07	HANA_DATA_2	256 GB	MPU-20	
	00:03:08	HANA_DATA_3	256 GB	MPU-10	
	00:03:09	HANA_DATA_4	256 GB	MPU-20	

The following figure shows the VSP E1090 storage layout for a SAP HANA system with 512 GB memory size used for validation.



The following figure shows the VSP E1090 storage layout for a SAP HANA system with 1 TB memory size used for validation.



The following table lists the LUN path assignments used when validating this environment.

Table 9 LUN Path Assignments

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
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

See the *SAP HANA Server Installation Guide*, official SAP documentation that describes the installation process. Click here to View all SAP installation and administration documentation.

Install the following SAP HANA software components on the server:

- Database
- Client

Engineering validation

The test methodology for validating this SAP HANA TDI solution using a Cisco UCS X9508 Blade Server Chassis, and Cisco X210C M6 Blade Servers in an enterprise storage configuration with VSP E1090 used the following.

SAP HANA Hardware and Cloud Measurement Tools HCMT-060_0 was tested on these volumes for SLES 15 SP3 and RHEL 8.4:

- 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 SPS 06:

```
[communication]
tcp_backlog = 2048

[fileio]
async_read_submit[log] = on
async_write_submit_active[log] = auto
async_write_submit_blocks[log] = all
min_submit_batch_size[log] = 16
max_submit_batch_size[log] = 64
max_parallel_io_requests[log] = 64
size_kernel_io_queue[log] = 512
async_read_submit[data] = on
async_write_submit_active[data] = auto
async_write_submit_blocks[data] = all
min_submit_batch_size[data] = 16
max_submit_batch_size[data] = 64
max_parallel_io_requests[data] = 64
size_kernel_io_queue[data] = 512

[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 Systems
- Cisco UCS X-Series Modular System
- Recommended Cisco NX-OS Releases for Cisco Nexus 9000 Series Switches
- Hitachi Interoperability Reports
- Hitachi Virtual Storage Platform E series family (VSP E1090)

Product descriptions

The following products are used in this solution.

Cisco Unified Computing System

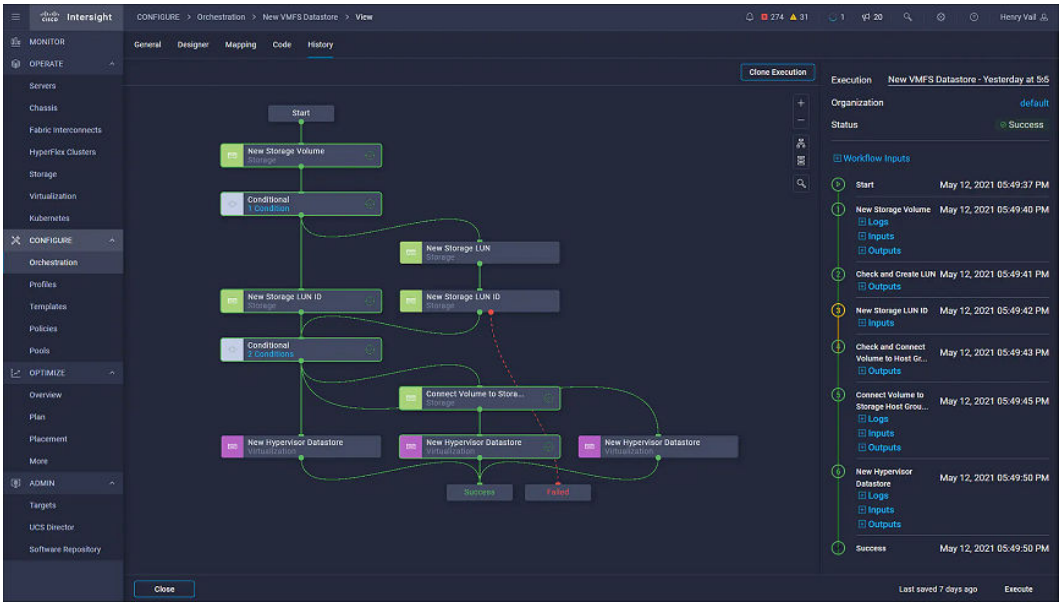
The Cisco Unified Computing System is a next-generation data center platform that unites compute, network, storage access, and virtualization into a cohesive system designed to reduce total cost of ownership (TCO) and increase business agility. Managed as a single system, whether it has one server or 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.

Cisco Intersight Capabilities with Hitachi Virtual Storage Platform

Hitachi has enabled a magnitude of storage management capabilities that will now be able to be done using Cisco Intersight with the goal of saving administrators time and frustration.

Within the Cisco Intersight management platform, administrators can use the concept of tasks and workflows to easily manage their hybrid IT environments.

Tasks are essentially a library of functions that leverage API invoke calls that can be customized, or they can be provided by Cisco out of the box. These tasks can be compiled to create workflows to enable quick and easy automation of infrastructure without requiring code experts. This provides true single pane of glass orchestration through Cisco Intersight, reducing the need for datacenter administrators to host multiple screens to complete functions.



The following tables show the current capabilities of Hitachi Virtual Storage Platform (VSP) in orchestration with tasks and workflows provided by Intersight to end users.

Table 10 List of support tasks for Hitachi VSP

Tasks	Hitachi VSP
Compress Storage Pool	Y
Connect Initiators to Storage Host	Y
Connect Volume to Storage Host	Y
Copy Storage Volume	Y
Disconnect Initiators from Storage Host	Y
Disconnect Volume from Storage Host	Y
Edit Storage Pool	Y
Expand Storage Volume	Y
Expand Storage Pool	Y
Format Storage Volume	Y
New Storage Host	Y
New Storage Pool	Y
New Storage Volume	Y
Remove Storage Host	Y
Remove Storage Pool	Y
Remove Storage Volume	Y

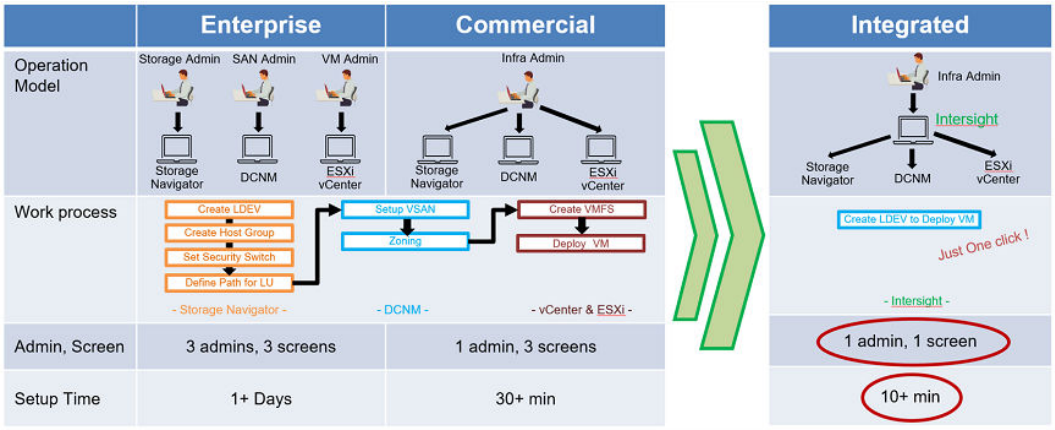
Table 11 List of supported workflows for Hitachi VSP

Storage Workflows	Hitachi VSP
New Storage Host	Y
New VMFS Datastore	Y
Remove Storage Host	Y
Update Storage Host	Y

With these capabilities administrators can complete a majority of day 0 to day N tasks to support their hybrid IT environment with Hitachi VSP storage systems.

A related reference architecture has been published as part of Cisco and Hitachi Adaptive solutions, at Hitachi Virtual Storage Platform with Cisco Intersight Reference Architecture Guide.

This reference architecture explores the benefits of integrated management with Cisco Intersight compared to conventional methods using multiple management interfaces. When creating a virtual environment for enterprise workloads with Cisco Intersight with VSP integration, on average 50 hours of time is saved over the course of a year and 80% fewer screens are required to complete such operations, as shown in the following figure.



Hitachi Virtual Storage Platform E series family

The Hitachi Virtual Storage Platform E series family provides agile and automated storage built upon the innovative technologies found in our high-end enterprise systems. The expansion of the VSP E series portfolio includes 2 new all-NVMe flash models that deliver super charged, ultra-low latency performance for the business-critical applications that small and midsized businesses rely on.

- Improve IT agility: “Faster-to-market” for IT projects with proven high-performance infrastructure. Brings “enterprise-class” features and benefits to customers of all sizes whose business is outpacing their existing infrastructure and supports modern business processes like DevOPs.
- Financial elasticity that aligns costs to business goals, growth, and use: Customers can “have it their way” with purchase, lease, or cloud-like consumption models.
- Improved workforce efficiency: a better digital experience which boosts customer satisfaction (with both internal LOBs and end-users) and increases business productivity and profitability.

Hitachi Storage Virtualization Operating System RF

Hitachi Storage Virtualization Operating System RF powers the Hitachi Virtual Storage Platform (VSP) family. 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.

Flash performance is optimized with a patented flash-aware I/O stack, which accelerates data access. Adaptive inline data reduction increases storage efficiency while enabling a balance of data efficiency and application performance. Industry-leading storage virtualization allows SVOS RF to use third-party all-flash and hybrid arrays as storage capacity, consolidating resources for a higher ROI and providing a high-speed front end to slower, less-predictable arrays.

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. For more information, see https://www.sap.com/products/hana.html.

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 guide for basic concepts and for planning.

- SAP HANA Server Installation and Update Guide

  This guide provides an overview of how to install and update a SAP HANA system with the SAP HANA lifecycle management tools.

- SAP HANA Administration Guide

  This guide explains how to configure, manage, maintain, and optimize your SAP HANA installation using SAP HANA administration tools.

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

Hitachi Vantara

Corporate Headquarters
2535 Augustine Drive
Santa Clara, CA 95054 USA
HitachiVantara.com | community.HitachiVantara.com

Contact Information
USA: 1-800-446-0744
Global: 1-858-547-4526
HitachiVantara.com/contact