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Hitachi Ops Center Analyzer for Cisco and Hitachi Adaptive Solutions for SAP HANA Tailored Data Center Integration

Best Practices Guide

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Revision history

Changes	Date
Initial release	June 30, 2021

Best Practices Guide

Hitachi Ops Center provides a unified solution for the entire infrastructure stack of Cisco and Hitachi Adaptive Solutions for SAP HANA Tailored Datacenter Integration (Adaptive Solutions for SAP HANA TDI) that offers monitoring, capacity planning, and problem analysis capabilities. Hitachi Ops Center provides end-to-end system management for the same environment. This guide helps customers reduce management costs, define service-level agreements (SLAs), and monitor business-critical applications such as the SAP HANA environment in an Adaptive Solutions for SAP HANA TDI environment for resource performance and capacity planning.

This best practices paper describes how to monitor a heterogeneous infrastructure comprising SAP HANA systems consolidated on a Hitachi enterprise storage system under SAP HANA tailored data center integration (TDI). This guide also includes guidelines for using Hitachi Ops Center Analyzer to monitor your SAP HANA TDI environment by setting thresholds and alerts to get the best out of your consolidated SAP HANA environment. It can help identify the bottlenecks, analyze performance trends (be it current or historical) and helps optimize the performance of compute, switches, and storage system devices.

With a SAP HANA appliance deployment, the hardware vendor pre-configures the storage and server hardware components. When you use Hitachi systems for a SAP HANA TDI deployment, you customize each installation by using any supported servers and certified enterprise storage vendor. You can also leverage your existing hardware to reduce your total cost of ownership (TCO) for a high-performance SAP HANA infrastructure.

When implementing Cisco and Hitachi Adaptive Solutions for SAP HANA TDI, an infrastructure developed through collaboration between Hitachi Vantara and Cisco Systems, the recommendation is to follow these directions and guidelines for the setup and configuration of the storage system. See SAP HANA Tailored Data Center Integration - Frequently Asked Questions for more details.

SAP HANA Tailored Datacenter Integration

SAP increases flexibility and provides an alternative to SAP HANA appliances with SAP HANA Tailored Datacenter Integration in five phases. This includes many kinds of virtualization technology. Understanding the possibilities and requirements of an SAP HANA TDI environment is crucial.

All virtualized environments for SAP HANA are considered as SAP HANA TDI by SAP. In these environments, every VM counts as one HANA node when counting the supported number of SAP HANA nodes connected to a single enterprise storage system. SAP provides documentation that explains the phases of SAP HANA TDI, and the hardware and software requirements for the whole stack.

See the following SAP documents for more information:

- Overview Slide Deck
- Frequently Asked Questions
- SAP HANA Storage Requirements Whitepaper
- SAP HANA Network Requirements Whitepaper

Hitachi offers a solution for the entire SAP HANA TDI stack from hardware infrastructure to software deployment.

SAP HANA certified enterprise storage

SAP introduced the certification of enterprise storage systems as SAP HANA certified enterprise storage to enable consolidation of multiple HANA systems on a single enterprise storage system. You can find the certified storage information in the Certified and Supported SAP HANA Hardware Directory. Each entry lists the maximum supported number of production SAP HANA nodes.

SAP HANA nodes can be one of the following:

- Bare metal servers certified as HANA appliance servers
- HANA supported Intel systems
- Virtual machines running on a certified hypervisor

The following table shows the supported maximum number of SAP HANA systems connected in parallel to a single Hitachi Virtual Storage Platform (VSP). While running storage key performance indicator (KPI) testing using Hardware and Cloud Measurement Tool (HCMT), the storage was fully dedicated to the testing.

Note: If you need to have mixed applications running in parallel on the same storage system, SAP HANA and non-SAP HANA, then you must perform testing for the expected workload using the SAP HANA HCMT to meet SAP KPIs.

Storage	Drive Type	Maximum SAP HANA Systems	Minimum Parity Group	
			Data	Log
VSP G350 and VSP G370	SAS HDDs	3	3 RAID-6 (14D +2P)	1 RAID-6 (6D +2P)
VSP G350, VSP F350, VSP G370, and VSP F370	SAS SSDs	16	3 RAID-10 (2D +2D)	3 RAID-10 (2D +2D)
VSP G700	SAS HDDs	13	6 RAID-6 (14D +2P)	3 RAID-6 (6D +2P)

Storage	Drive Type	Maximum SAP HANA Systems	Minimum Parity Group	
			Data	Log
VSP G700 and VSP F700	SAS SSDs	34*	4 RAID-10 (2D +2D)	5 RAID-10 (2D +2D)
VSP G900 and VSP F900	SAS SSDs	40*	4 RAID-10 (2D +2D)	4 RAID10 (2D +2D)
VSP E590	NVMe SSDs	19	1 RAID-5 (6D +1P)	1 RAID-5 (6D +1P)
VSP E790	NVMe SSDs	34*	3 RAID-10 (2D +2D)	2 RAID-10 (2D +2D)
VSP E990	NVMe SSDs	50	7 RAID-10 (2D +2D)	7 RAID-10 (2D +2D)
VSP 5100, VSP 5100H	SAS SSDs	37	7 RAID-10 (2D +2D)	7 RAID-10 (2D +2D)
VSP 5500 or VSP 5500H (1 pair nodes)	SAS SSDs	74	14 RAID-10 (2D +2D)	14 RAID-10 (2D +2D)
VSP 5500, VSP 5500H (2 pair nodes)	SAS SSDs	148	28 RAID-10 (2D +2D)	28 RAID-10 (2D +2D)
VSP 5500, VSP 5500H (3 pair nodes)	SAS SSDs	222	42 RAID-10 (2D +2D)	42 RAID-10 (2D +2D)
* Extrapolated scalability for maximum number of nodes using engineering validation data and information.				

When you implement an SAP HANA TDI infrastructure on Hitachi Virtual Storage Platform using NVMe SSDs, you do not have to use the exact storage design that was used for enterprise storage KPI testing. However, the recommendation is to follow these directions and guidelines for the setup and configuration of the storage system. See SAP HANA Tailored Data Center Integration - Frequently Asked Questions for more details.

Servers for SAP HANA TDI environments

Only compute servers certified for use with SAP HANA and listed in the official SAP HANA Hardware Directory (HWD) are supported for use in an SAP HANA TDI environment. This follows the same bill of materials as the certified SAP HANA appliance server, but without the storage or local disks.

Servers certified as appliance servers with a certificate provided by SAP for a specific operating system can only use that operating system for SAP HANA in that implementation. This is different for supported Intel systems listed in the HWD. For these servers, there is no separate certification for different operating system versions and service pack stacks. The server vendor's operating system certifications indicate the servers supported for these TDI-only servers.

See Certified and Supported SAP HANA Hardware for a description of all certified servers and enterprise storage solutions. See SAP HANA Tailored Data Center Integration - Frequently Asked Questions for more information on SAP HANA TDI.

Note: Since the release of SAP HANA TDI in November 2013, several versions of HCMT have been published. To verify that the hardware configuration of your SAP HANA TDI infrastructure meets the SAP KPIs, you must use the same version of HCMT used during the certification of the hardware, compute servers, and storage system for your tests. SAP Note 2493172 describes how to determine the right version of HCMT for your tests.

Note: Testing of this configuration was performed 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 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. For detailed component information, see Product Descriptions.

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.

Note: The substitution of hardware and software versions other than those listed here is acceptable within this reference architecture, but the substitutions must comply with the hardware and software compatibility matrices from Cisco, Hitachi, and SAP. For more information, see References (on page 33).

Table 1 Key Hardware Components

Hardware Component		Firmware Version
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
	Cisco UCS 6454 Fabric Interconnect	Release 4.1(1b)
Compute	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)
	Cisco UCS VIC (Fibre Channel)	Release 5.1 (1e)
Fibre Channel SAN	MDS 9706	Release 8.4(1a)
Storage	VSP E590 and VSP E790	93-03-20-40/04

Table 2 VSP E590 and VSP E790 Specifications

Item			Specifications
	Type		VSP E590 and VSP E790
System	SVOS Version		Hitachi Storage Virtualization Operating System RF v9.5
	Maximum Drives	NVMe SSD	24
	Drive Options	NVMe SSD	1.9 TB, 3.8 TB, 7.6 TB, 15.3 TB
	RAID Level		RAID-10, RAID-6, RAID-5
	RAID group configuration	RAID-10	2D+2D
		RAID-5	3D+1P, 4D+1P, 6D+1P, 7D+1P
		RAID-6	6D+2P, 12D+2P, 14D+2P
	Max. number of LDEVs		32768 (VSP E590), 49152 (VSP E790)
	Max. storage capacity		0.33 PB
	Max. external configuration		128 PB (VSP E590), 192 PB (VSP E790)

Item			Specifications
	Type		VSP E590 and VSP E790
Memory	Cache memory capacity		768 GB
Device I/F	Supported channel type	Fibre Channel	24
		Data transfer rate	8 Gbps, 16 Gbps, 32 Gbps
	Max. number of CHB		6
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 E590 and VSP E790 Specifications

	Storage Components
VSP E590 (NVMe SSD)	▪ CTL: 1 pair ▪ 32 Gbps 4-port CHB ▪ MPU: 1 pair ▪ Cache: 768 GB ▪ NVMe SSDs: 24 × 1.9 TB
VSP E790 (NVMe SSD)	▪ CTL: 1 pair ▪ 32 Gbps 4-port CHB ▪ MPU: 1 pair ▪ Cache: 768 GB ▪ NVMe SSDs: 24 × 1.9 TB

Software elements

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

Operating system choices

- 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 most SAP HANA customers.

- Red Hat Enterprise Linux (RHEL) 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.

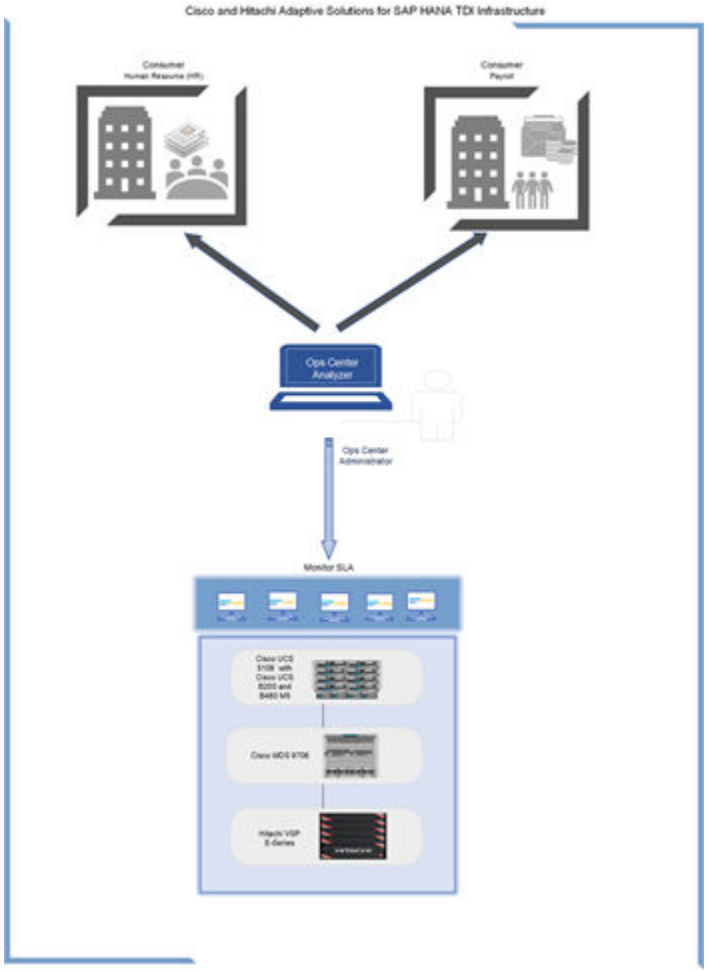
Changing the configuration settings is only supported along the guidelines of SAP and the operating system distributor and may otherwise cause significant performance problems. See the following SAP Notes for SLES and RHEL for more information:

- 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

Hitachi Ops Center implementation

With Hitachi Ops Center Analyzer, you can register all of the Cisco and Hitachi Adaptive Solutions for SAP HANA TDI infrastructure resources, such as the Cisco UCS blade, Cisco MDS switches, and the Hitachi storage systems such as the VSP E series that can be monitored at a granular level along with RAID groups and volumes. You can also, set service-level thresholds for each resource based on your workload.

Ops Center then sends alerts based on threshold violations or performance degradations and lists potential infrastructure bottlenecks. The following figure shows Ops Center Analyzer monitoring the Adaptive Solutions for SAP HANA TDI infrastructure.



Install Ops Center

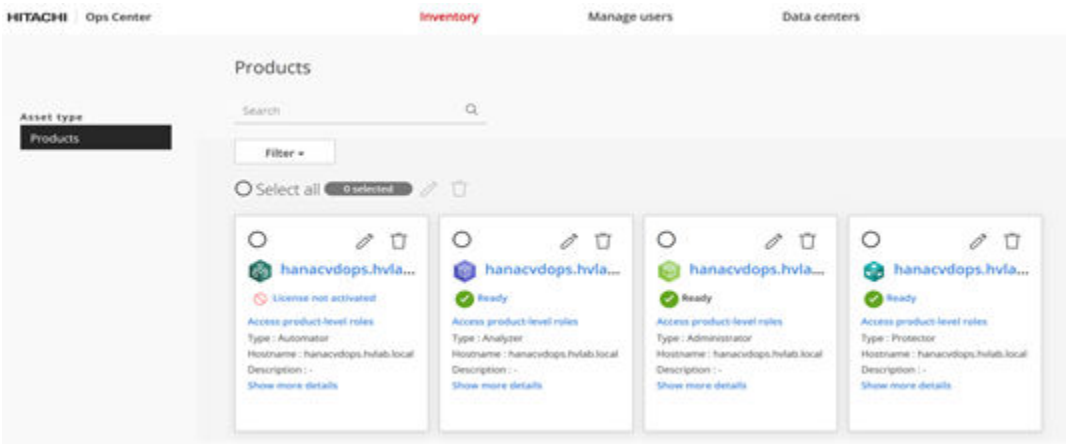
There are multiple options for installing Hitachi Ops Center and its products:

- Install Hitachi Ops Center products by using the OVA file in a VMware ESXi installation.
- Install Hitachi Ops Center products by using the installer on a bare metal management server.
- Installing Ops Center on one VM using the installers on one virtual machine.

Detailed information about the setup procedure can be found in the installation and configuration guide for each product included in the Hitachi Ops Center Product Documentation Library (PDL).

Set up Ops Center

After going through the installation steps and the initial login, the installed Ops Center products are displayed in the inventory screen as shown in the following figure



For details about initial configuration and setup of Ops Center Analyzer, see the Getting started in your Ops Center Analyzer environment documentation.

Add probes to the probe server

You can have multiple virtual machines for different Ops Center probe servers. For example, this might apply to an infrastructure that is only accessible from a management server. You can install a probe server on the management server that can access both - the infrastructure that requires monitoring and the main Ops Center server that delivers the monitoring data.

A Fibre Channel connection is required from the probe server to the Hitachi enterprise storage for the Hitachi command device LUN.

The recommended probes for a HANA TDI environment are:

- Hitachi Enterprise Storage probe
- Fibre Channel Switch Probe
- Linux OS Server Probe

Follow the prerequisites and instructions for adding the different types of probes. When configuring the RAID Agent for storage probes, make sure to configure Access Type 1 or 2, depending on your storage model.

Then, connect to the Ops Center probe server with your web browser, click Add Probe, and complete the Add Probe Wizard.

SAP considers server operating system probes third-party software/external tools on a SAP HANA server. For SAP HANA appliance servers, SAP has specific rules outlined in SAP Notes 1730928 - Using external software in a HANA appliance and 1730929 - Using external tools in an SAP HANA appliance (SAP login required).

Detecting and analyzing performance problems

The following metrics are used to measure an enterprise workload utilization:

- IOPS (I/O per second): the number of operations
- Throughputs (in MBps (MB per second): the amount of data transferred
- Response time (read/write operations): the sum of service and wait time.

These metrics are very important to diagnose performance issues. Hitachi Ops Center Analyzer provides health checks, automated alerts, and detailed performance metrics for the entire infrastructure stack. These include the host and storage side, and the fabric.

A performance bottleneck can occur for various reasons, like page swapping, latency, CPU contention, and inefficient load balancing across ports. To detect and analyze these bottlenecks, Ops Center Analyzer provides the following views:

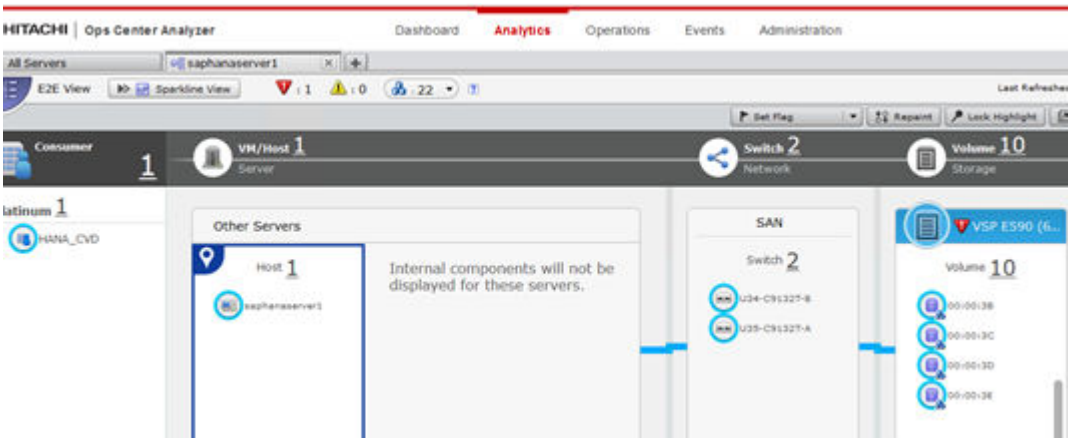
1. Dashboard

   The dashboard displays summary reports for the monitored resources, system and resource events, event trends, and consumer groups. The report widgets display the threshold violations and critical alerts detected on all monitored resources when threshold values are exceeded.

2. End-to-end (E2E) view

   The E2E topology view provides detailed configuration of the infrastructure resources, such as the host, the fabric switch, and the storage system. You can also view the relationship between the infrastructure components. You can manually analyze the dependencies between the components in your environment and identify the resource causing performance problems.

   You can use this view to monitor resources in your data center at a granular level to understand their impact on the rest of the infrastructure resources. The connecting links represent the relationship between the infrastructure components.



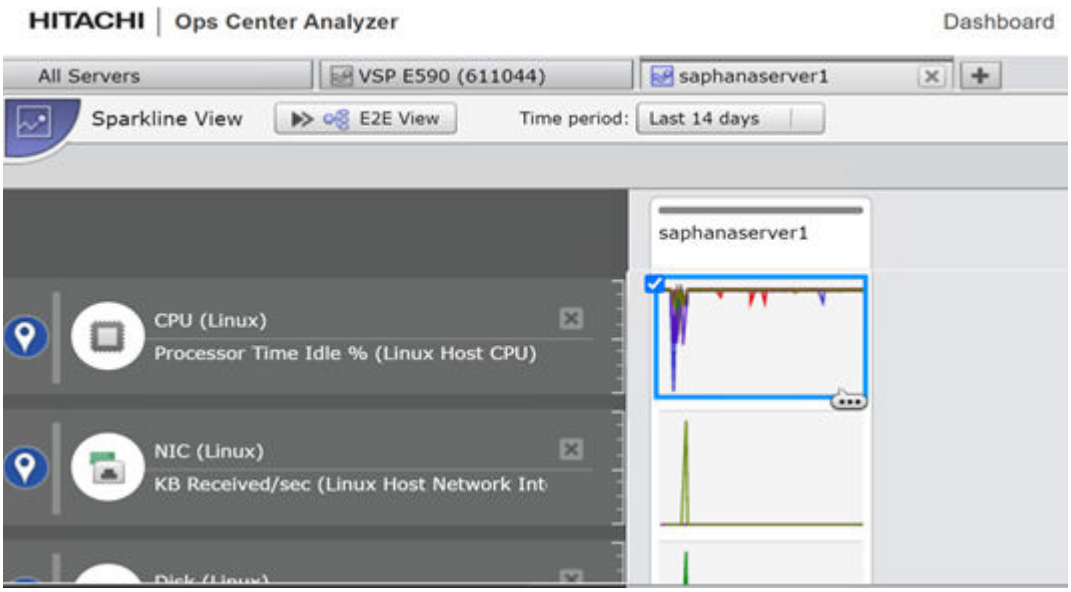
3. Sparkline View

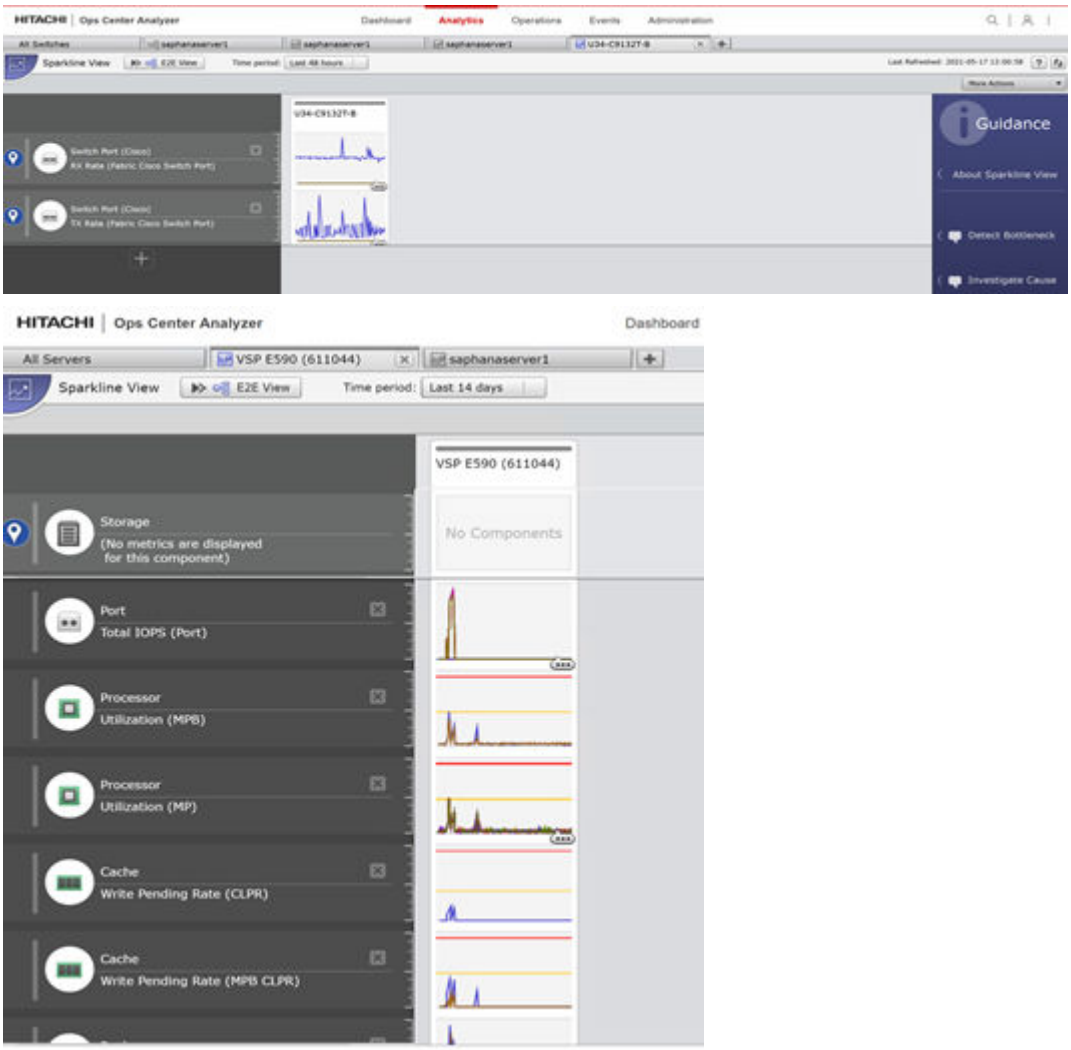
   The Sparkline view presents multiple charts that track performance by each component. Use this view to correlate performance trends between the user and system resources.

   You can analyze the performance of all associated components for example:

   - Cisco UCS Blade Servers (such as CPU, memory, NIC, HBA, and disk)
   - Cisco MDS switches (port and port-channel)
   - Hitachi VSP storage systems (such as, port, processor, cache, pool, and parity group)

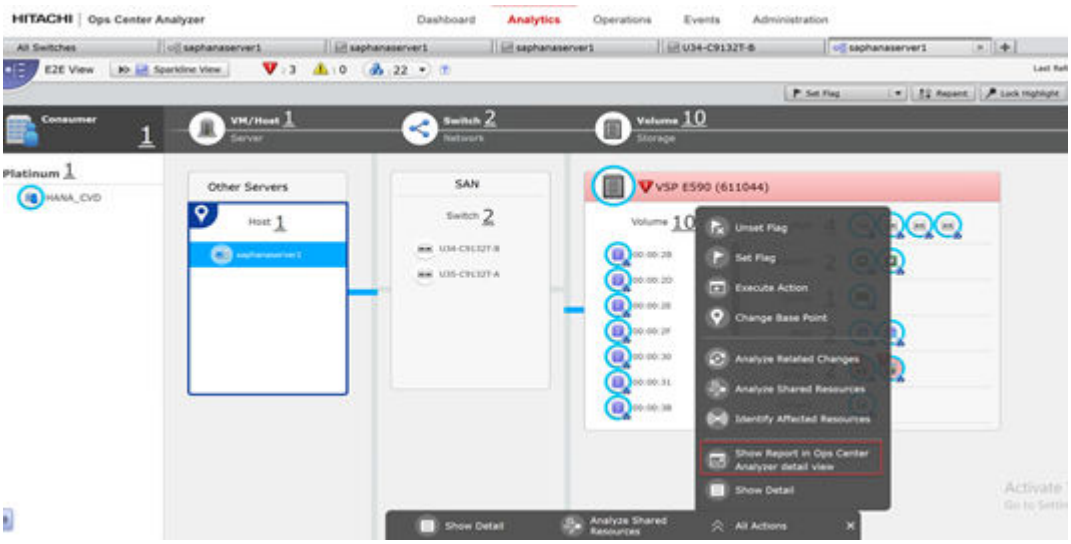
   The following figures show the different options of the Sparkline view.



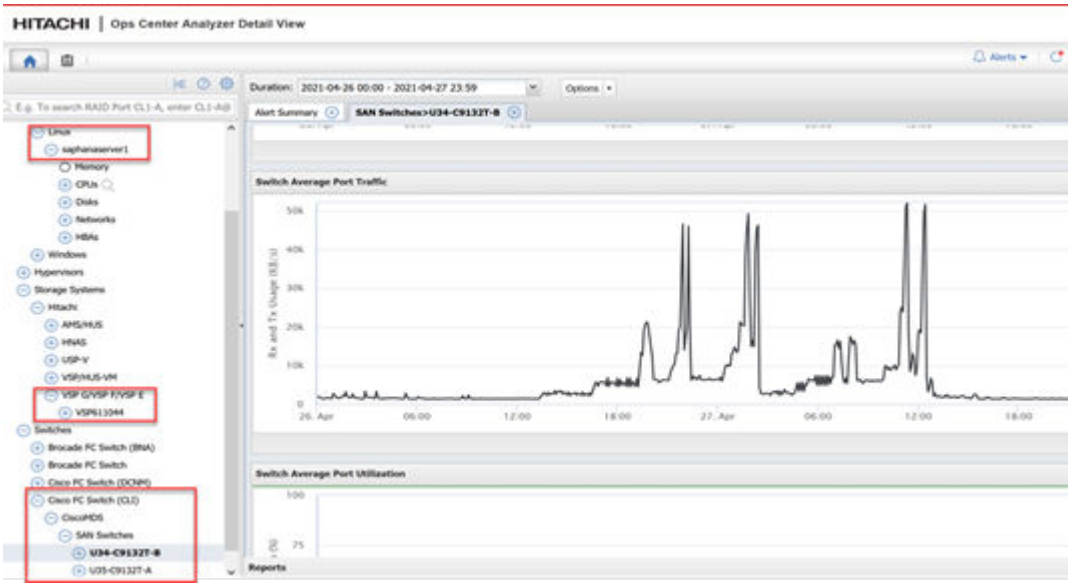


4. Detail View

   Use the detail view to conduct historical trend analysis across a wide set of infrastructure statistics, create advanced monitoring custom reports, and perform additional troubleshooting and diagnostics. You can access detail view reports directly from the E2E view. Click any resource icon and select Show Report in Analyzer detail view as shown in the following figure.



The report shows the performance of the infrastructure resources marked in red. The following figure shows the performance of the host, switch, and the storage system.



Best Practices for performance analysis in Cisco and Hitachi Adaptive Solutions for SAP HANA TDI landscape

As a best practice in a performance methodology, you should always baseline your system infrastructure operating in a normal state. During this normal state, you can determine appropriate threshold values, performance goals, and other criteria while monitoring the application workload that forms a part of your performance management strategy.

Performance problems occur due to various factors in your infrastructure and that's where Hitachi Ops Center Analyzer plays a crucial role by providing a wide set of monitoring statistics and metrics to resolve these performance bottlenecks at each component level in your infrastructure. These include Cisco UCS compute servers, Cisco MDS switches, and Hitachi VSP storage systems..

Ops Center Analyzer offers an out-of-the-box analytics solution that enables identifying and troubleshooting performance problems at the node level.

The following scenarios indicate a performance problem in your SAP HANA environment:

- Significant performance delta from your baselines — The baselines help you compare the current performance trends. Ops Center Analyzer sends you an alert notifying a potential performance problem for you to take remedial actions.
- Threshold or service-level agreement (SLA) violations — Exceeded threshold values could mean a potential threat to the defined SLAs.
- Infrastructure and application performance degradation — Another indicator of performance slowdown.
- Imbalanced load distribution across shared resources — This might cause over and under-utilization of resources resulting in bottlenecks.

Identifying key performance metrics

To identify the performance problems in the SAP HANA environment, identify the key performance metrics that are relevant to the problem and the workload being analyzed. Because Ops Center Analyzer provides a consolidated view for multiple servers/instances in a single dashboard over the whole infrastructure stack, you can verify the stack to ensure that you get maximum results for performance, reliability, and cost-optimization.

SAP HANA alert reference

The following section provides examples of SAP HANA alerts that can be matched in Hitachi Ops Center to provide a single point of reference for the infrastructure administrators who are not focused on application-centric alerts.

ID	Name	Description	Category	Unit	Thresholds/Severity	
1	Physical memory usage	Determines what percentage of total physical memory available on the host is used. All processes consuming memory are considered, including non-SAP HANA processes.	Memory	percent	Default thresholds: 95, 98, 100	Severity levels: 2, 3, 4

ID	Name	Description	Category	Unit	Thresholds/Severity	
2	Disk usage	Determines what percentage of each disk containing data, log, and trace files is used. This includes space used by non-SAP HANA files.	Disk	percent	Default thresholds: 90, 95, 98	Severity levels: 2, 3, 4
5	Host CPU usage	Determines the percentage of CPU idle time on the host and therefore whether or not CPU resources are running low.	CPU	percent	Default thresholds: 25, 15, 10	Severity levels: 2, 3, 4
30	Check internal disk full event	Determines whether or not the disks to which data and log files are written are full. A disk full event causes your database to stop and must be resolved.	Disk	state	Default thresholds: HANDLED, NEW	Severity levels: 2, 4
51	Size of diagnosis files	Identifies large diagnosis files. Unusually large files can indicate a problem with the database.	Diagnosis Files	MB	Default thresholds: 1024, 2048	Severity levels: 2, 3
77	Database disk usage	Determines the total used disk space of the database. All data, logs, traces, and backups are considered.	Disk	GB	Default thresholds: 300, 400, 500	Severity levels: 2, 3, 4

For more details, see the SAP HANA Alert Reference.

An example of matching HANA's disk usage or disk full alerts for the operating system is to use the attributes *usedpercent* and *freepercent* of the Linux probe *lHostFileSystemDevice* resource applied to the following file systems:

- HANA Data Volume
- HANA Log Volume
- HANA Shared Volume

Ops Center performance metrics

The following table provides a list of recommended Ops Center performance metrics to monitor your SAP HANA TDI storage consolidation environment.

Probe	Resource Type	Attribute ID	Description
Linux	lHostDisk	l_avgqu-sz	Average queue length of the requests issued to the device.
Linux	lHostDisk	l_await	monitor redo logging IO response time
Linux	lHostDisk	l_svctm	monitor redo logging IO response time
Linux	lHostProcess	l_cpuUtilization	Monitor CPU Utilization of the process
Linux	lHostProcess	l_memoryutilization	Monitor memory utilization of the process
Hitachi Enterprise Storage	raidClpr	writePendingRate	Of the cache memory allocated for a CLPR, the percentage that is being used by write-pending data
Hitachi Enterprise Storage	raidMPB	Utilization	Usage rate of the processor
Hitachi Enterprise Storage	raidMpbClpr	writePendingRate	Of the cache memory allocated for each MP blade in the CLPR, the percentage that is being used by the write pending data of the LDEV that is owned by the MP Blade of the MP Blade ID field.
Hitachi Enterprise Storage	raidMP	utilization	Usage rate of the processor
Hitachi Enterprise Storage	raidLdev	transferRate	Total data transfer rate
Hitachi Enterprise Storage	raidDkaEsw	accessPathUsage	Usage rate of the access path between the disk adapter and the cache switch
Hitachi Enterprise Storage	raidPG	utilization	Usage rate of the parity group. The total usage rate of the logical devices that associate with the parity groups is stored in this field

Probe	Resource Type	Attribute ID	Description
Hitachi Enterprise Storage	raidPG	transferRate	Total data transfer rate
Hitachi Enterprise Storage	raidPG	totalIOPS	Sum of read IOPS and write IOPS
Hitachi Enterprise Storage	raidPool	transferRate	Total data transfer rate: ▪ Read Xfer Rate: Total read data transfer rate for virtual volumes mapped to the Dynamic Provisioning pool ▪ Write xfer Rate: Total write data transfer rate for virtual volumes mapped to the Dynamic Provisioning pool
Hitachi Enterprise Storage	raidPool	readResponseTime	Average processing time per read request for virtual volumes mapped to the Dynamic Provisioning pool
Hitachi Enterprise Storage	raidPool	writeResponseTime	Average processing time per write request for virtual volumes mapped to the Dynamic Provisioning pool
Hitachi Enterprise Storage	raidPool	responseTime	▪ Read Response Time Rate: Average processing time per read request for virtual volumes mapped to the Dynamic Provisioning pool ▪ Write Response Time Rate: Average processing time per write request for virtual volumes mapped to the Dynamic Provisioning pool
Hitachi Enterprise Storage	raidStorage	writePending	Of the cache memory, the cache memory size used by write pending data
Cisco FC Switch (CLI)	fabCiscoSwitch Port	rxUtil	Total receive rate utilization
Cisco FC Switch (CLI)	fabCiscoSwitch Port	txUtil	Total transmits rate utilization

Probe	Resource Type	Attribute ID	Description
Cisco FC Switch (CLI)	fabCiscoSwitch Port	txKbps	Transmission rate of the fabric switch
Cisco FC Switch (CLI)	fabCiscoSwitch Port	rxKbps	Receive rate if the fabric switch
Cisco FC Switch (CLI)	fabCiscoSwitch	cpuUtil	CPU Utilization of the fabric switch
Cisco FC Switch (CLI)	fabCiscoSwitch	memoryUtil	Memory utilization on the fabric switch.

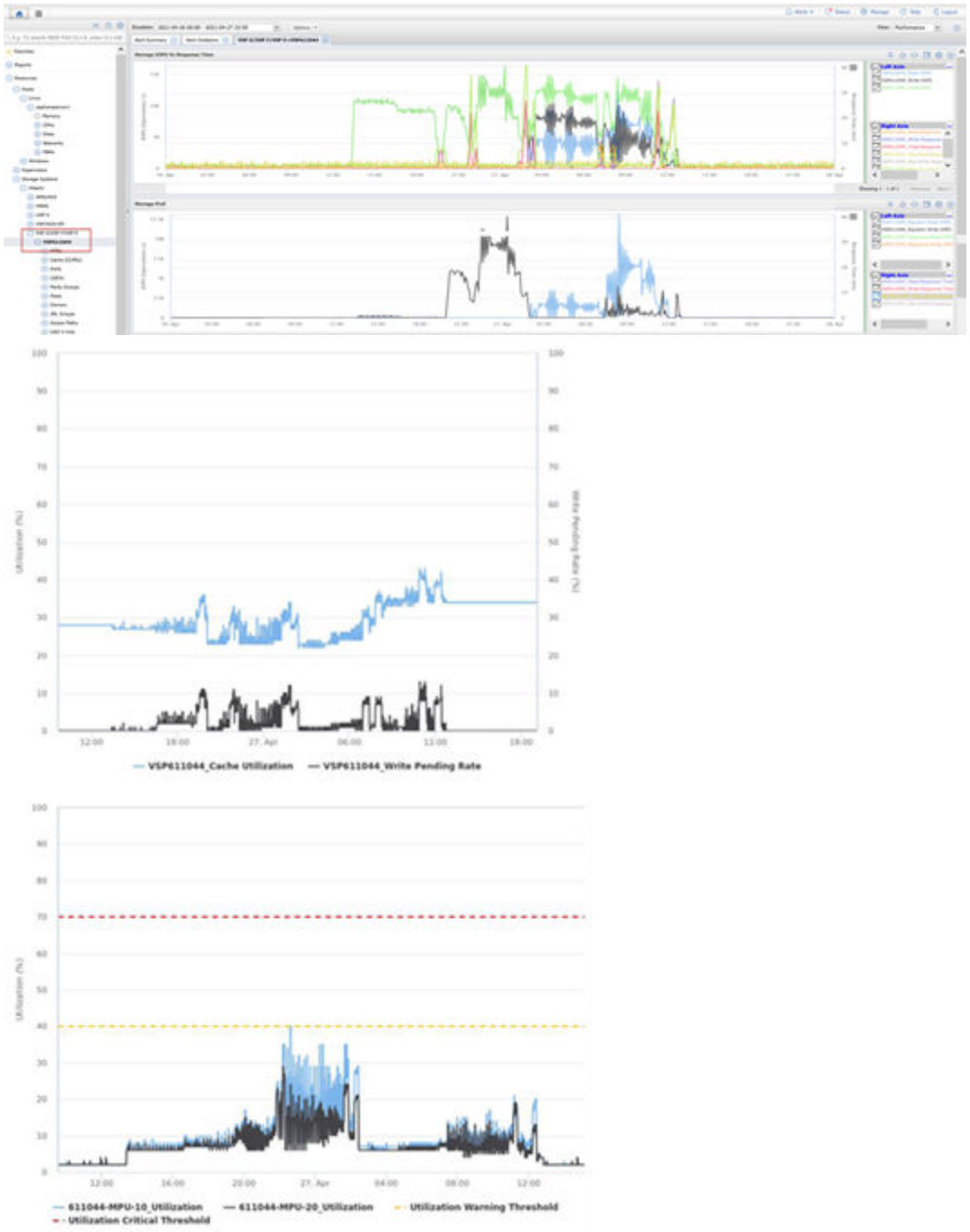
Accessing Ops Center Analyzer detail view

You can access Analyzer Detail View from the E2E View. The Analyzer Detail View interface is launched in a separate browser window. The resource tree opens to the selected resource along with the latest available report in the performance View.

By clicking the node name under the Hosts > Linux tree, a default report opens on the right panel of the window. The following figures show examples of the resources report for the following:

- Cisco UCS SAP HANA server
- Hitachi Virtual Storage Platform E590
- Cisco MDS switch

Click the serial number of the VSP E590 storage system to display the following default report.



Click the Cisco Fibre Channel Switch (CLI) to display the following report.

These reports provide a more detailed view of the performance of each resource. You can customize a report to extend the default figure.

You can download health checks and send them through email on a scheduled basis.

Performance analysis example

This section highlights a lab simulated scenario analyzing a critical event generated by a Hitachi Virtual Storage Platform E590 storage system on the Ops Center analyzer dashboard. Ops Center analyzer effective dashboard reporting, detailed view, and in-depth set of metrics helped identify the problem and resolve the performance issue.

Scenario:

Ops Center Analyzer simplifies management of infrastructure resources and the users of those resources. You can create consumers to associate users with the resources they are using.

Two consumer groups, Platinum representing human resources (HR) and Gold representing payroll, were created with each representing a horizontal functional department in an organization. Each consumer had its own set of hosts and allocated volumes.

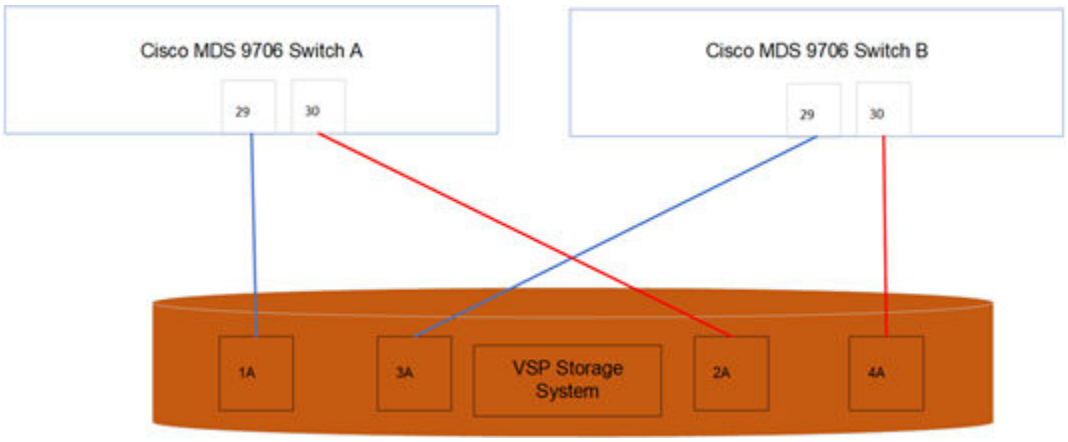
Each SAP HANA node in the example had the following storage layout:

- Operating system (OS) volume
- SAP HANA shared volume
- SAP HANA log volume
- SAP HANA data volume

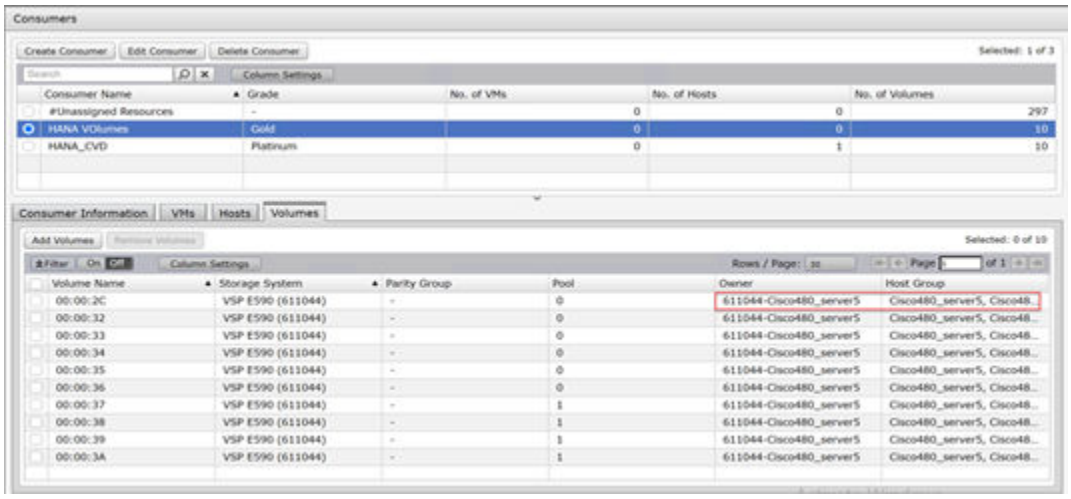
Provision the storage as follows:

- Create two dynamic provisioning pools for the three SAP HANA systems on storage:
- Use OS_SH_DT_Pool to provision the operating system volume, SAP HANA shared volume, and Data volume.
- Use LG_Pool to provision the Log volume.
- VSP E590 ports 1A, 2A, 3A, 4A
- Cisco MDS Switch A ports 29 and 30
- Cisco MDS Switch B ports 29 and 30

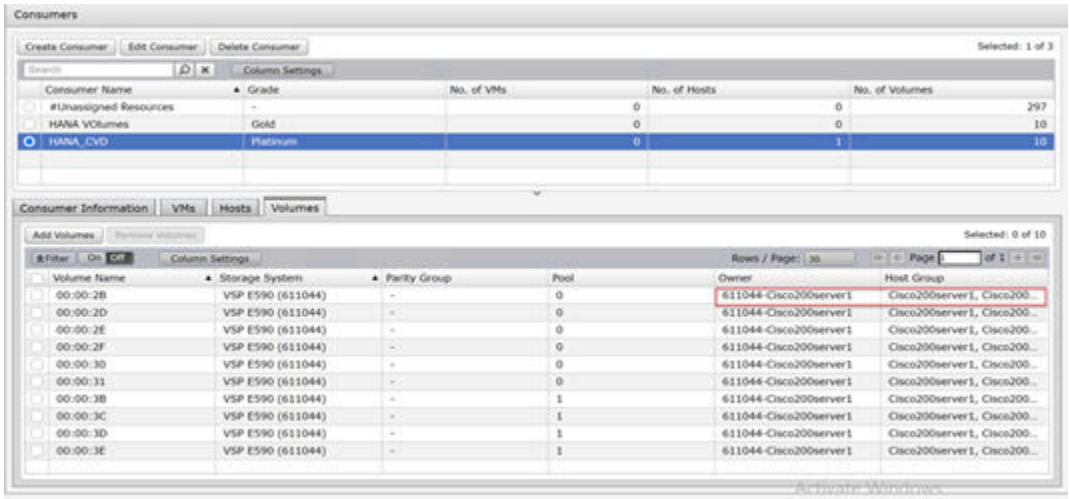
The following figure shows the port connectivity between the Cisco MDS 9706 switch and the VSP E590 storage system.



- The Gold consumer group Cisco UCS B480 is assigned 10 volumes running SAP HANA workloads as shown in the following figure.

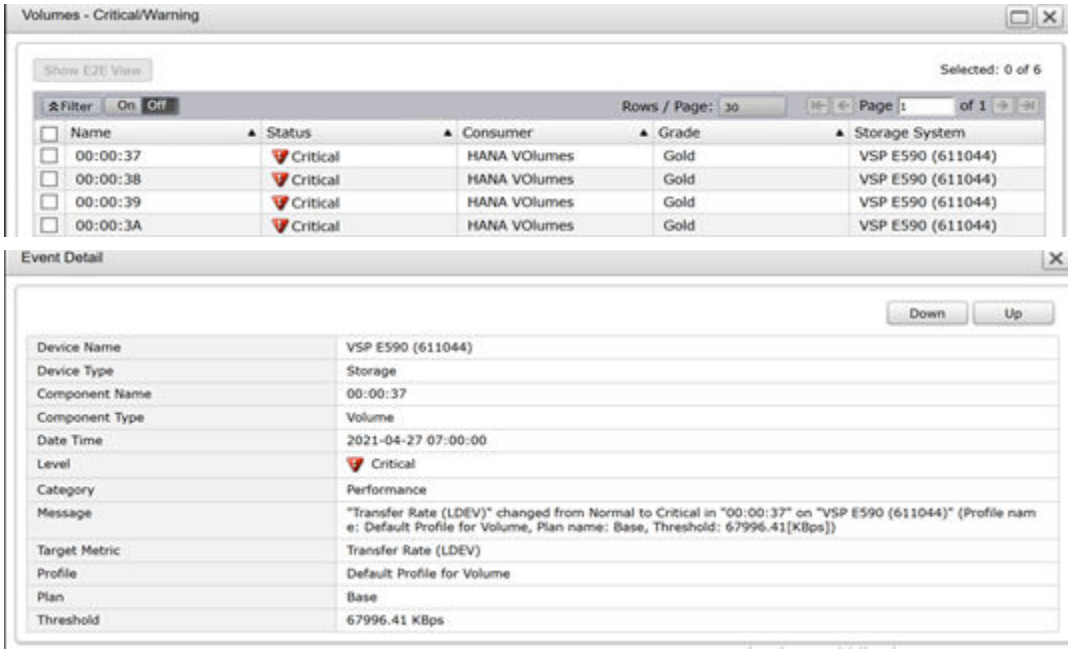


- The Platinum consumer group Cisco UCS B200 is assigned 10 Volumes running SAP HANA workloads as shown in the following figure.

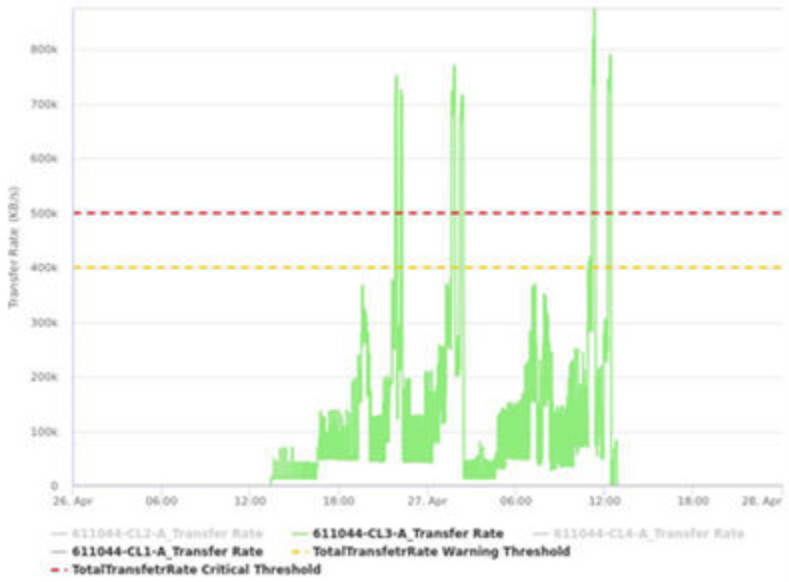


Ops Center Analyzer dashboard reported some critical events that required further investigation. The following figure shows the IO issues for the gold consumer group.

Drilling down further into the critical events showed four log volumes with I/O issues.



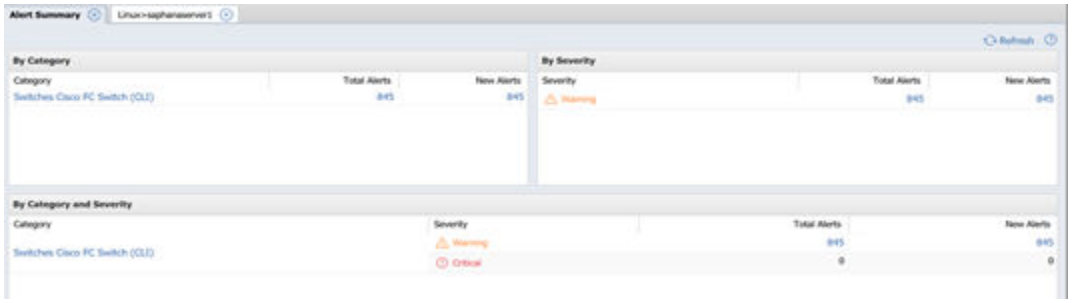
Upon further investigation it was observed that one of the ports, 1A on VSP E590, had no traffic compared to port 3A. This caused an uneven load distribution on VSP E590 controller 1 as shown in the following figure.



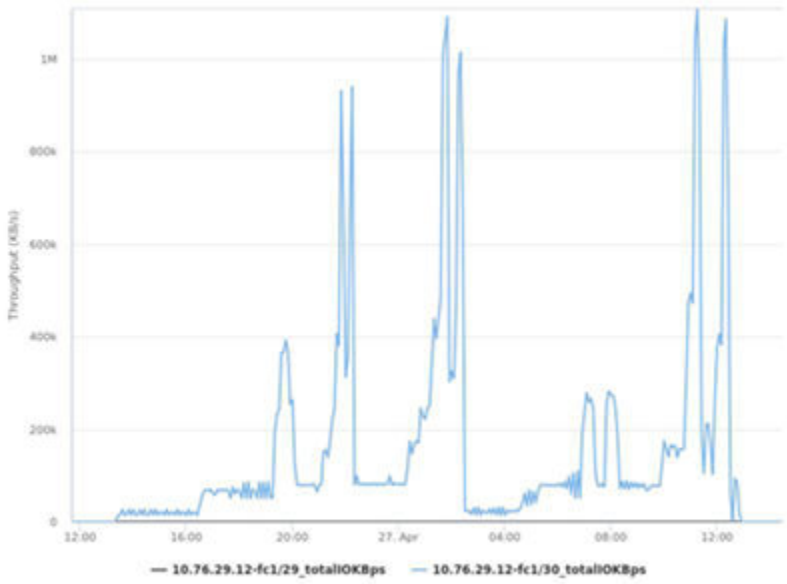
Ops Center E2E topology view provides detailed data flow information about the infrastructure resources from host to fabric switch and to the storage system. This lets you view the relationship between the infrastructure components.

In the performance issue that was simulated in the lab environment, Ops Center Analyzer displayed warning messages at the Cisco MDS switch A layer for ports 29 and 30 that were used for I/O traffic.

With the help of the E2E View, a surge in the I/O transfer rate was also observed on port 30 at the Cisco MDS switch A layer. In the lab environment, the performance implications to the SAP HANA application were minimal, but in the production environment where the SAP HANA environment could be running more than 30 nodes concurrently, the impact could be significant.

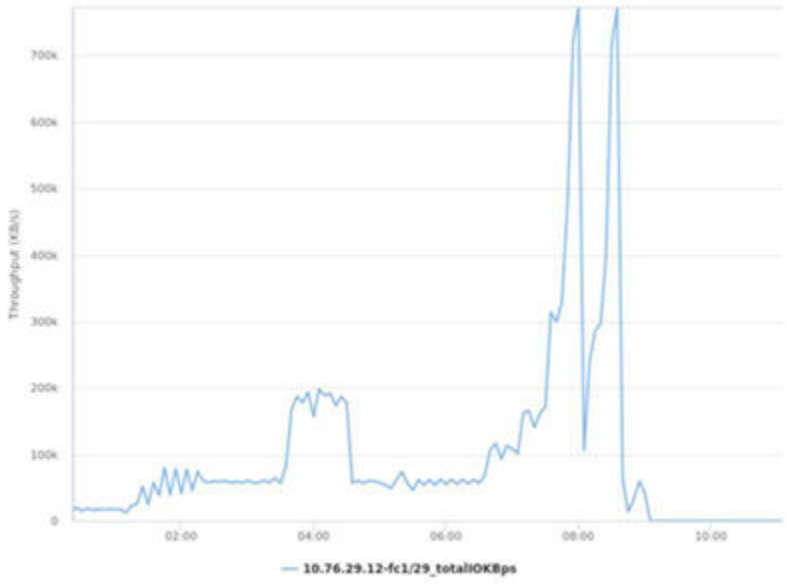


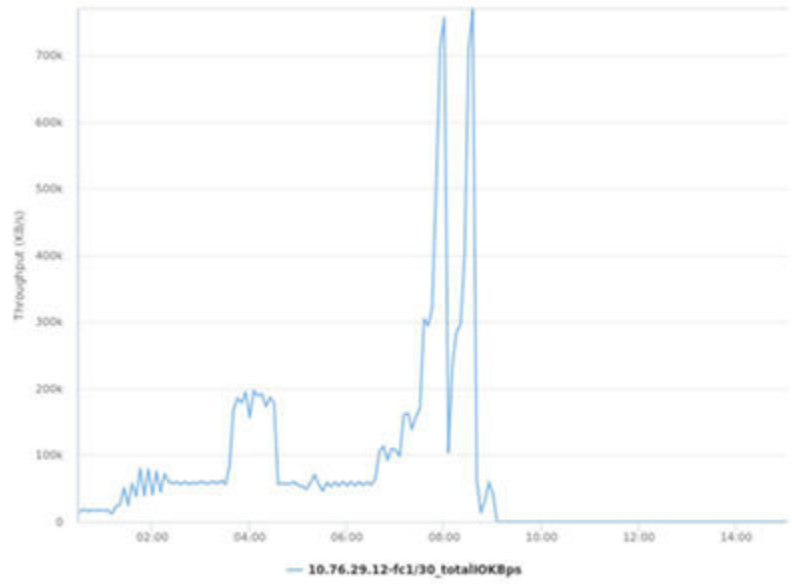
Drilling down on one of the warning messages showed port 30 was passing almost all of the I/O traffic compared to port 29, implying an anomaly.

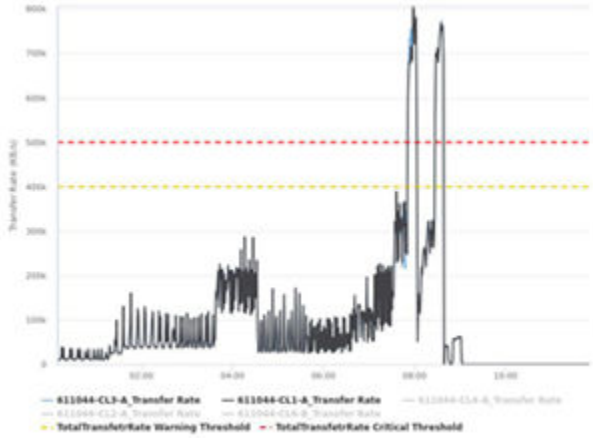


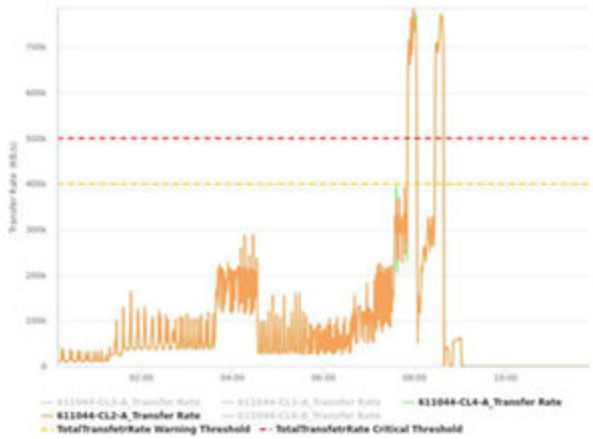
You can use the Ops Center Analyzer E2E view to show the relationship between the infrastructure components such as the port connectivity between the Cisco MDS switches and the VSP E590 storage system. In this view, it was evident that VSP storage port 1A had no traffic due to connectivity issues between Cisco MDS switch A port 29 and VSP E590 port 1A.

After reseating the SFP cables on port 29, the load distribution was even across both port 29 and port 30, and VSP E590 storage system controller 1 showed even I/O traffic across ports 1A and 3A, as shown in the following figures.




700k
600k
500k
400k
300k
200k
100k
0
Throughput (KB/s)
02:00
04:00
06:00
08:00
10:00
12:00
14:00
10.76.29.12-fc1/30_totalIOKBps


611044-CL3-A_Transfer Rate
611044-CL1-A_Transfer Rate
TotalTransfetrRate Warning Threshold
TotalTransfetrRate Critical Threshold


611044-CL4-A_Transfer Rate
611044-CL2-A_Transfer Rate
TotalTransfetrRate Warning Threshold
TotalTransfetrRate Critical Threshold

Performance analysis best practices

The following metrics at each resource level are good indicators for your analysis to guide you in resolving performance issues and ensuring defined SLAs are met when timely remedial measures are put into action. Alerts and threshold violations from Ops Center Analyzer help to further investigate the following potential bottlenecks:

1. Response time/Latency
2. IOPS
3. Utilization

Cisco UCS Compute

- Check performance on the SAP HANA compute nodes if you see any change in the disk throughputs causing high latency.
- Check for any page swapping due to high memory utilization.
- Check the HBA queue depth for any hardware failures (for example, an SFP cable is not connected, the HBA is not seated properly, or the Fibre Channel cable is disconnected).

Cisco MDS Switch

- Check for port traffic and port throughputs.
- Check for data path utilization.
- Check that the port link is not down because that may cause load balancing issues and high latency.

Hitachi Virtual Storage Platform E590

- Look for changes in the performance metrics for pool, parity group, cache write pending rate, storage MP utilization, and port traffic causing high latency.
- Check for data path utilization.
- Check for any hardware failures such as a port that is down, or a cable that is unplugged.

Engineering validation

The engineering validation testing of this SAP HANA storage consolidation project consisted of SAP HANA certified Cisco B200 M5 and B480 M5 servers that were connected to a Hitachi Virtual Storage Platform E590 using a pair of Cisco 9706 SAN switches.

Testbed setup

The storage configuration tested in the Hitachi Vantara lab used NVMe SSDs for the persistent storage of the SAP HANA nodes according to Hitachi Vantara storage consolidation best practices.

The following table lists the Hitachi Virtual Storage Platform E590 and VSP E790 specifications.

Item			Specifications
	Type		VSP E590 and VSP E790
System	SVOS Version		Hitachi Storage Virtualization Operating System RF v9.5
	Maximum Drives	NVMe SSD	24
	Drive Options	NVMe SSD	1.9 TB, 3.8 TB, 7.6 TB, 15.3 TB
	RAID Level		RAID-10, RAID-6, RAID-5
	RAID group configuration	RAID-10	2D+2D
		RAID-5	3D+1P, 4D+1P, 6D+1P, 7D+1P
		RAID-6	6D+2P, 12D+2P, 14D+2P
	Max. number of LDEVs		32768 (VSP E590), 49152 (VSP E790)
	Max. storage capacity		0.33 PB
	Max. external configuration		128 PB (VSP E590), 192 PB (VSP E790)
Memory	Cache memory capacity		768 GB
Device I/F	Supported channel type	Fibre Channel	24
		Data transfer rate	8 Gbps, 16 Gbps, 32 Gbps
	Max. number of CHB		6
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

Validation testing

Storage KPI testing was performed using the SAP HANA Hardware and Cloud Measurement Tool (HCMT).

See SAP Note 2493172 - Hardware and Cloud Measurement Tools (SAP user credentials are required) for HCMT details.

SAP HANA HCMT was used to generate workloads for different numbers of nodes in parallel. To get a long period workload on the VSP E590 storage system, the script was set to run for a longer duration.

Conclusion

Ops Center Analyzer provides analytical diagnostics to quickly identify, isolate, and determine the root cause of performance problems. The traditional approach of troubleshooting problems in the unified infrastructure poses several challenges. Ops Center Analyzer offers an out-of-the-box analytics solution that lets you identify and troubleshoot your environment in an E2E topology with a consolidated view of the entire infrastructure.

Product descriptions

The following information describes the hardware and software components used in this best practices.

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 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.

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.

Hitachi Ops Center

Manage, optimize, orchestrate and protect your data with advanced IT analytics and automation using Hitachi Ops Center. Achieve new insights, accelerate resource delivery, eliminate risks, and speed innovation to modernize your data center operations.

Use the power of AI operations with the following:

- Analyzer: Improve IT operations with machine learning (ML) to drive resource service levels, utilization and automation at lower costs. Obtain operational visibility from virtual machines, servers, SAN switches to shared storage resources to optimize an application's full data path.
- Automator: Deliver resources up to 70% faster than manual processes. Free staff to focus on strategic initiatives.
- Protector: Meet tight service level requirements when protecting critical data and applications. Automatically support secondary business functions with data copies staff need to do their jobs. Make better use of backup data for activities, such as e-discovery and analysis. Simplify administration and replication management. Do it all with no disruption to production application availability and performance.

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 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.

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

References

Use these references when designing your system.

- UCS Hardware and Software Compatibility from Cisco Systems
- Release Notes from Cisco Systems
- Recommended Cisco NX-OS Releases for Cisco Nexus 9000 Series Switches
- Hitachi Interoperability Reports
- Hitachi Virtual Storage Platform E series family (VSP E590, VSP E790, and VSP E990)

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