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Hitachi Virtual Storage Platform 5000 Series

90-02-0*x* or later

Product Overview

This guide provides an overview of the Hitachi Virtual Storage Platform 5000 series storage systems, including general specifications, hardware components, software features, and management software.

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Preface

This guide provides an overview of the Hitachi Virtual Storage Platform 5000 series (VSP 5000 series) storage systems, including hardware components, general system specifications, software features, and management interfaces.

Product version

This document revision applies to the following product versions:

- VSP 5000 series: firmware 90-02-0*x* or later
- SVOS RF 9.2 or later
- Hitachi Ops Center: v10.0.1-00 or later

Accessing product documentation

Product user documentation is available on Hitachi Vantara Support Connect: https://knowledge.hitachivantara.com/Documents. Check this site for the most current documentation, including important updates that may have been made after the release of the product.

Getting help

Hitachi Vantara Support Connect is the destination for technical support of products and solutions sold by Hitachi Vantara. To contact technical support, log on to Hitachi Vantara Support Connect for contact information: https://support.hitachivantara.com/en_us/contact-us.html.

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Comments

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Thank you!

Chapter 1: Virtual Storage Platform 5000 series

Hitachi Virtual Storage Platform 5000 series (VSP 5000 series) represents the industry's highest performing and most scalable storage solution. Built on 57 years of Hitachi engineering experience and innovation in the IT sector, VSP 5000 series offers superior performance, resiliency, and agility, featuring response times as low as 70 microseconds, and all backed up with the industry's first and most comprehensive 100% data availability guarantee.

Introducing VSP 5000 series

VSP 5000 series reliably delivers more data faster than ever for open-systems and mainframe applications. These enterprise-level storage systems are available in configurations from 3.8 TB to 69 PB of raw capacity, with scalability to handle up to 21 million IOPS. Hitachi Remote Ops monitoring system and Hitachi Ops Center Analyzer software enable industry-leading uptime. To ensure that operations are always up and running, VSP 5000 series models can optionally be backed by a 100% data availability guarantee.

VSP 5000 series provides high performance, high availability, and reliability for always-on, enterprise-class data centers and features the industry's most comprehensive suite of local and remote data protection capabilities, including true active-active metro-clustering. When combined with server virtualization, storage virtualization supports applications at cloud scale while reducing complexity.

Key features

- **Agility and scalability**

  There are four VSP 5000 series models: VSP 5100, VSP 5500, VSP 5100H, and VSP 5500H. The VSP 5100 all-flash array (AFA) is a scale-up enterprise storage platform with one pair of controller nodes supporting open and mainframe workloads. The VSP 5500 AFA starts with a single node pair and scales out to three node pairs to provide up to 69 PB of raw capacity and 21 million IOPS of performance. Both models are also available as hybrid arrays, VSP 5100H and VSP 5500H, that support a mixed environment of NVMe solid-state devices (SSDs) (VSP 5500 models only), serial-attached SCSI (SAS) SSDs, Hitachi flash module drives (FMDs), and SAS hard disk drives (HDDs).

- **All-flash performance accelerated by NVMe technology**

  NVMe drives provide high throughput and low latency to achieve high response performance, enabling large volumes of data to be processed rapidly with response times as low as 70 microseconds.

- **Capacity efficiency**

  VSP 5000 series supports advanced adaptive data reduction (ADR) technologies with total efficiency rates of up to 7:1 to improve storage utilization and reduce storage footprint. Compression and also deduplication, if desired, can be enabled for all internal and external storage media at the volume level for enhanced tunability.

- **Reliability and resiliency**

  Leveraging hot-swappable components, nondisruptive maintenance and upgrades, and outstanding data protection, VSP 5000 series offers complete system redundancy and is backed by a 100% data availability guarantee. VSP 5000 series's active-active controller architecture protects against local faults and performance issues, and hardware redundancy eliminates all active single points of failure, no matter how unlikely, to provide the highest level of reliability and data availability.

- **Artificial-intelligence based solutions**

  All VSP 5000 series models are packaged with Hitachi Ops Center Analytics, which analyzes telemetry to optimize application performance and prevent extended outages. Manual administrative tasks are streamlined and implemented with fewer errors, facilitating the addition of new applications and the expansion of existing applications. In addition, Hitachi Ops Center Analytics works with Hitachi Ops Center Automator to maintain best practices and quality of service (QoS).

- **Simple, easy-to-use management**

  VSP 5000 series can be set up quickly and managed with ease using Hitachi Ops Center Administrator. Hitachi Ops Center Administrator reduces the complexity of steps needed to deploy, monitor, and reconfigure storage resources. In addition, REST APIs allow integration with existing toolsets and automation templates to further consolidate management tasks.

- **Protection from unauthorized access**

  All VSP 5000 series models are hardened to prevent any leaks of physical data and unauthorized system access, enabling you to protect sensitive data from unauthorized access, meet stringent data privacy requirements, and adhere to strict regulatory compliance policies. Additional measures are available to ensure quick recovery from ransomware attacks.

Specifications at a glance

The following table lists general specifications for VSP 5000 series.

Feature	VSP 5100	VSP 5100H	VSP 5500	VSP 5500H
Performance	Up to 4,200,000 IOPS		Up to 21,000,000 IOPS	
Maximum number of drives	96 NVMe 192 FMD 768 SFF SSD	96 NVMe 192 FMD 768 SFF SSD/HDD	288 NVMe 576 FMD 2,304 SFF SSD	288 NVMe 576 FMD 2,304 SFF SSD/HDD

Feature	VSP 5100	VSP 5100H	VSP 5500	VSP 5500H
		384 LFF HDD		1,152 LFF HDD
Maximum (internal) raw capacity	23 PB	23 PB	69 PB	69 PB
Maximum cache capacity	1 TiB	1 TiB	6 TiB	6 TiB
Host interfaces (ports on front-end modules)	32 x FC (16 or 32 Gbps) 32 x FICON® (16 Gbps) 16 x iSCSI (10 Gbps)		192 x FC (16 Gbps, 32 Gbps) 192 x FICON® (16 Gbps) 96 x iSCSI (10 Gbps)	
RAID levels	RAID-1+0 (2D+2D, 4D+4D) RAID-6 (6D+2P, 14D+2P) RAID-5 (3D+1P, 7D+1P)			

Application solutions

Hitachi's portfolio of storage solutions for converged, cloud, storage, server, database, and other applications enables you to solve your application infrastructure challenges and achieve the highest application service levels.

VMware® support

VSP 5000 series all-flash arrays are designed to complement vSphere virtualization to deliver the full benefits of software-defined data center infrastructure. Deep integration with VMware enables you to optimize performance, utilization, virtual machine (VM) provisioning, management, and data protection.

- **Hitachi Storage Provider for VMware vCenter (VASA)**

  Use Hitachi Storage Provider for VMware vCenter to enable storage-aware tagging services for VMFS and to enable VMware vSphere Virtual Volumes (vVols) for a software-defined, hardware-enabled Hitachi Storage infrastructure. Hitachi Storage Provider enables efficient provisioning and usage of storage and VMDK resources based on application-specific data services, such as snapshot, encryption, and replication.

- **Hitachi Infrastructure Management Pack for VMware vRealize Operations (vROPS)**

  Hitachi Infrastructure Management Pack for VMware vROPS integrates metrics and alerts from physical and virtual layers to help you manage the capacity and performance of Hitachi storage and converged infrastructure deployments in VMware environments. By providing dashboards, metrics, and correlated alerts, Hitachi vROPS significantly enables efficient resource utilization and proactive troubleshooting to reduce operational costs.

- **Hitachi Storage Connector for VMware vRealize Orchestrator (vRO)**

  Hitachi Storage Connector for VMware vRO enables you to automate and orchestrate workflow tasks on VSP 5000 series and other Hitachi storage, extending the capabilities of VMware vRO by providing access to over 130 foundational Hitachi storage-specific workflows.

- **Hitachi Infrastructure Content Pack for VMware vRealize Log Insight (vRLI)**

  Hitachi Infrastructure Content Pack for VMware vRLI delivers real-time log analysis and advanced troubleshooting across physical and virtual infrastructures. It simplifies searching for errors by collecting and grouping information to show important, relevant, and useful events, and it provides a comprehensive view into Hitachi storage systems, enabling you to identify potential issues and keeping track of components that show departure from normal operations.

- **Hitachi Storage Plug-in for VMware vCenter**

  Using Hitachi Storage Plug-in for VMware vCenter integrates management of VSP 5000 series and other Hitachi storage systems within the VMware vCenter console, enabling your VMware vCenter administrator to provision and manage datastores with essential configuration options from Hitachi storage systems.

- **Hitachi Storage Replication Adapter for VMware Site Recovery Manager (SRA)**

  VMware vCenter Site Recovery Manager (SRM) automates the disaster recovery and testing process using either host or storage-based replication. Hitachi Storage Replication Adapter (SRA) is the software interface that integrates VSP 5000 series and other Hitachi storage systems and its replication software with VMware vCenter SRM processes. Used together, VMware vCenter SRM and Hitachi storage and software provide an automated and seamless disaster recovery solution within the VMware vCenter infrastructure.

- **Hitachi Data Instance Director Adapter for VMware Site Recovery Manager (HDID SRA)**

  The Hitachi Data Instance Director (HDID) software provides a higher level of automation for configuration of local and remote replication relationships between primary and secondary systems. The HDID SRA is compatible with HDID replication-managed environments that manage all the pausing, swapping, and resuming of the associated replication pairs that vCenter SRM may require. The HDID SRA is deployed independently from the SRA for VMware SRM.

- **Hitachi Data Instance Director Connector for VMware vRealize Orchestrator (vRO)**

  This connector enables admins to include HDID storage hardware-offload based services such as VM-level backup, restore, and copy data management functionality in their vRO Workflows. Currently supported workflows include backup and restore of VMs, clone VMs from prior snapshots, and mount VMDKs from snapshots to any VM. These vRO operations can be performed from the vCenter UI via the packaged XML imported into vCenter.

- **VMware vSphere Storage APIs for Array Integration**

  VMware vSphere Storage APIs for Array Integration (VAAI) allow VMware vSphere environments to use advanced features and capabilities of VSP 5000 series and other Hitachi VSP storage systems from within the VMware interface. Processing is performed directly on the storage infrastructure to move the I/O load from the VMware vCenter host platform onto the storage controller. Offloading storage-related operations to the storage system speeds up the datastore and VMDK provisioning operations and frees virtualization management for more critical tasks.

Microsoft Windows® support

Server virtualization integration with leading virtual server platforms gives you end-to-end visibility from an individual virtual machine to the storage logical unit and protects large-scale multivendor environments. Support for Microsoft Windows® (including Microsoft Hyper-V) and Microsoft System Center includes:

- Microsoft Virtual ShadowCopy Service (VSS)
- Microsoft Windows Offloaded Data Transfer (ODX)
- Hitachi Infrastructure Adapter for Microsoft Systems Center Operations Manager
- Hitachi Storage Adapter for Microsoft Storage Management Provider
- Hitachi Storage Adapter for Microsoft Systems Center Orchestrator

Oracle® support

Hitachi Vantara has developed and supported IT solutions for many of the world's largest companies with the most demanding Oracle® database environments, solutions that maximize business value, enhance progress toward greater business outcomes, and ensure performance from Oracle® systems.

- Hitachi storage and server adapters for Oracle® databases provide integrated tools for converged infrastructure management and data protection. Hitachi Storage Adapters for Oracle Enterprise Manager, Oracle VM, Oracle Web Center, Oracle Automated Storage Reclamation Utility, and Oracle Database Cloning help you manage your database with less effort and better results. Hitachi Storage Adapter for Oracle Recovery Manager integrates multiple protection services to maximize database availability.
- Hitachi drivers for Oracle® environments enhance consolidation, performance, and efficiency.
- The Database Infrastructure Evaluation Tool (DIET), available to Oracle® database administrators at no cost, analyzes your entire Oracle® database environment, and provides best practices and expert recommendations on areas for improvement to ensure your storage, compute, and converged infrastructure operates at peak utilization.
- Hitachi Dynamic Provisioning gives your Oracle® applications the right amount and right type of storage to maximize performance and efficiency.
- Hitachi Dynamic Tiering offers finely tuned performance for Oracle®, automatically keeping the most crucial data on the fastest storage.

Chapter 2: Storage system hardware

Hitachi Virtual Storage Platform 5000 series (VSP 5000 series) storage systems are high-performance, large-capacity, enterprise RAID storage systems that accommodate scalability to meet a wide range of capacity and performance requirements. VSP 5000 series features all-flash and hybrid models that can scale up in capacity and also scale out for performance, allowing for massive consolidation of workloads and providing exceptional performance and efficiency.

Hardware overview

Combining all-flash storage accelerated by NVMe technology and a new multi-node architecture with the proven performance and resiliency of Hitachi VSP technology, VSP 5000 series offers state-of-the-art advances that provide the highest performance and reliability to meet the most demanding requirements.

VSP 5000 series is available in 2-node, 4-node, and 6-node models that support a variety of drives, including NVMe solid-state devices (SSDs), SAS hard disk drives (HDDs), SAS SSDs, and Hitachi flash module drives (FMDs).

- **All-flash arrays**

  The VSP 5100 and VSP 5500 AFAs offer industry-leading NVMe flash performance in addition to the proven performance of Hitachi FMDs. VSP 5100 and VSP 5500 provide an all-flash solution that works seamlessly with other Hitachi infrastructure products through common management software and rich automation tools.

- **Hybrid arrays**

  The VSP 5100H and VSP 5500H hybrid arrays combine high-speed Hitachi flash drives with data reduction and Hitachi Dynamic Tiering active flash, making it simple to move to all-flash gradually over time.

Storage system architecture

The new multi-node architecture of VSP 5000 series allows scale out and linear performance expansion as storage needs increase. All VSP 5000 series models share the same hardware architecture, differing only in number of nodes, number and types of features (front-end modules, back-end modules), and number and types of drives.

VSP 5000 series is available in the following configurations:

- VSP 5100: 2-node all-flash array
- VSP 5100H: 2-node hybrid array
- VSP 5500: 2-node, 4-node, or 6-node scalable all-flash array
- VSP 5500H: 2-node, 4-node, or 6-node scalable hybrid array

The redundancy and backup features of VSP 5000 series eliminate all active single points of failure, no matter how unlikely, enabling the storage system to provide the highest level of reliability and data availability. Each node pair features an advanced, multiple-redundancy architecture. All physical and logical elements needed to sustain processing are duplicated within each node pair (front-end modules, back-end modules, and separate, duplicate copies of cache and shared memory contents). In addition, the hosts are connected to each node pair using an alternate path scheme, and the front-end and back-end modules are also split across the nodes within each node pair to provide full backup.

In addition to the high-level of redundancy that this architecture delivers, many of the individual hardware components contain redundant circuits, paths, or processors, enabling the storage system to remain operational in the unlikely event of multiple component failures. Each node in a node pair is powered by its own set of power supplies that can provide power for the entire node pair in the event of power supply failure. Because of this redundancy, a single node pair can sustain even the loss of multiple power supplies and still continue operation.

Hardware components

The VSP 5000 series models are rack-mounted, enterprise-level storage systems supporting all-open, all-mainframe, and multiplatform configurations. The main hardware components are the controller boards, cache memory, cache flash memory, front-end modules, back-end modules, drives, service processor (SVP), and power supplies and batteries.

Controller boards

VSP 5000 series features two 10-core Intel processors on each controller board, providing 25% more core processors than VSP G1x00 and VSP F1500 models. The fabric-acceleration module (also called Hitachi Interconnect Edge or HIE) controls data transfer between the controllers.

Cache memory

VSP 5000 series places all read and write data in cache. The amount of fast-write data in cache is dynamically managed by the cache control algorithms to provide the optimum amount of read and write cache, depending on the workload read and write I/O characteristics. In addition, write data is mirrored until destaged, while read data is not mirrored to use cache more efficiently. All cache memory in VSP 5000 series is nonvolatile and protected by battery backup.

Cache flash memory

The nonvolatile cache flash memory (CFM) contains the cache directory and configuration information for the storage system, and it also backs up the data in

cache in the event of an input power failure. Cache flash memory is also duplexed across controllers and is protected by (redundant) battery backup.

Front-end modules

The front-end modules (FEMs) process the commands from the hosts and manage host access to cache. Each FEM feature (pair of boards) contains one type of host channel interface: Fibre Channel, iSCSI (optical), or FICON®. The channel interfaces on each board can transfer data simultaneously and independently. Fibre Channel and FICON® features are available in shortwave (multi-mode) and longwave (single-mode) versions.

Back-end modules

The back-end module (BEM) features, also installed in pairs for redundancy and performance, control the transfer of data between the data drives and cache. VSP 5000 series supports four types of BEM features: standard SAS BEMs, standard NVMe BEMs, mixed SAS/NVMe BEMs, and encrypting BEMs. The encrypting BEMs (EBEMs) provide data encryption for both open and mainframe systems. RAID-level intermix (all supported RAID types) is allowed within an array domain (under a BEM pair).

Drives

VSP 5000 series supports a variety of drives, featuring ultra-high-speed-response nonvolatile memory express (NVMe) solid-state devices (SSDs) in addition to serial-attached SCSI (SAS) hard disk drives (HDDs), SAS SSDs, and Hitachi flash module drives (FMDs). Dynamic sparing is performed automatically if needed: spare drives, which can be hot swapped without interrupting data availability, can be configured to replace failed drives automatically, securing the fault-tolerant integrity of the logical drives.

The drive chassis types for internal drives are:

- Small-form-factor (SFF) chassis for 2.5-inch (SAS) drives
- SFF chassis for 2.5-inch NVMe drives
- Large-form-factor (LFF) chassis for 3.5-inch (SAS) drives
- FMD chassis for Hitachi FMDs (also SAS)

Each drive chassis contains enclosure boards and AC-DC power supplies with built-in cooling fans that are implemented in a duplex configuration for redundancy. All drive chassis components can be replaced and added while the storage system is in operation.

VSP 5000 series also supports a diskless configuration that has external storage only and no internal drives. External storage systems benefit from the data services that VSP 5000 series delivers, including data reduction, metroclustering, and automation.

Service processor

VSP 5000 series includes a service processor (SVP). The SVP, which is integrated into the storage system, is used by authorized Hitachi Vantara personnel to maintain, service, and upgrade the storage system. The SVP collects performance data for hardware components to enable diagnostic testing and analysis and is

connected with a service center for remote monitoring and maintenance of the storage system.

Power supplies and batteries

Each controller node is powered by redundant power supplies, with each power supply able to provide power for the entire node, if necessary. The AC power supplied to each node is converted by the AC-DC power supplies to supply DC power to other storage system components. The backup batteries for user data are installed on cache backup modules (BKMF: backup module with fan) attached to the controller boards. If input power is interrupted for more than 20 milliseconds, the controllers use power from the batteries to back up the data in cache as well as the storage system configuration data onto the cache flash memory.

Chapter 3: Software components and features

Virtual Storage Platform 5000 series (VSP 5000 series) is powered by Hitachi's Storage Virtualization Operating System RF (SVOS RF) and supported by Hitachi storage management software, enabling you to effectively manage, centralize, and control your software-defined infrastructure while at the same time reducing complexity, costs, and risk.

Storage Virtualization Operating System RF

SVOS RF delivers best-in-class business continuity and data availability and simplifies storage management. Flash performance is optimized with a patented flash-aware I/O stack to further accelerate 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 and extending the life of storage investments.

SVOS RF works with the virtualization capabilities of the Hitachi VSP storage systems to provide the foundation for global storage virtualization. SVOS RF delivers software-defined storage by abstracting and managing heterogeneous storage to provide a unified virtual storage layer, resource pooling, and automation. SVOS RF also offers self-optimization, automation, centralized management, and increased operational efficiency for improved performance and storage utilization. Optimized for flash storage, SVOS RF provides adaptive inline data reduction to keep response times low as data levels grow, and selectable services enable data-reduction technologies to be activated based on workload benefit.

SVOS RF integrates with Hitachi's Base and Advanced software packages to deliver superior availability and operational efficiency. You gain active-active clustering, data-at-rest encryption, insights via machine learning, and policy-defined data protection with local and remote replication.

Base software package

The Base software package, which comes standard on all VSP 5000 series, delivers software to simplify management and protection of your data and includes best-class analytics software to improve uptime and ROI of IT operations.

The Base software package includes:

- SVOS RF core functionality, including Universal Volume Manager for storage virtualization
- Hitachi Ops Center Administrator for simple, GUI system management
- Local replication for cloning and snapshots
- Hitachi Data Instance Director for copy management and data protection
- Hitachi Ops Center Analyzer for data-center-wide, AI-powered insights
- Data Mobility for tiering between storage arrays and media types

Advanced software package

When business continuity is critical, or when you need to automate and accelerate delivery of IT resources, you can upgrade to the Advanced software package. Remote replication and metroclustering software enables delivery of continuous, scalable data access. Intelligent automation software simplifies and enhances provisioning of resources to reduce operational overhead and avoid misconfigurations.

The Advanced software package includes:

- All Base package products and features
- Remote replication (Universal Replicator and TrueCopy) for disaster recovery
- Global-active device (GAD) for business continuity and metro clustering
- Hitachi Ops Center Automator for data-center-wide workflow automation and orchestration

In-System Replication software

Hitachi's In-System Replication software for VSP 5000 series ensures rapid restart-and-recovery times by combining local mirroring of full volumes with fast, space-efficient snapshots.

- High-speed, nondisruptive in-system mirroring technology of Hitachi ShadowImage® rapidly creates multiple copies of mission-critical information within the storage system in mainframe and open-systems environments. ShadowImage keeps data RAID-protected and fully recoverable, without affecting service or performance levels. Replicated data volumes can then be split from the host applications and used for system backups, application testing, and data mining applications, while business continues to run at full capacity.
- The high-speed, nondisruptive snapshot technology of Hitachi Thin Image snapshot software rapidly creates copies of mission-critical information within the storage system or virtualized storage pool without impacting host service or performance levels. Because snapshots store only the changed data, the storage capacity required for each snapshot copy is substantially less than the capacity of the source volume. As a result, Thin Image can provide significant savings over full-volume cloning methods. Thin Image snapshot copies are fully read/write compatible with other hosts and can be used for system backups, application testing, and data mining applications.

Application-consistent ShadowImage clones and Thin Image snapshots can be orchestrated using Hitachi Data Instance Director (HDID) software. HDID supports Microsoft® Exchange and SQL Server® as well as Oracle databases on Linux operating systems. These clones and snapshots can be easily created as part of a complete data protection workflow. HDID can also trigger a ShadowImage clone or Thin Image snapshot on the remote side of a distance replication pair.

Hitachi Vantara Global Services Solutions provides Implementation Services for in-system replication software. These services improve testing and application deployment operations with high-speed, problem-free data duplication. Hitachi Vantara consultants tailor the configuration and integration of the in-system replication software to meet your backup and recovery application requirements.

Remote Replication software

Hitachi's Remote Replication software for VSP 5000 series combines Hitachi TrueCopy® and Universal Replicator solutions to enable remote data protection at up to four data centers. Providing continuous, nondisruptive, host-independent data replication, Hitachi Remote Replication software ensures the highest levels of data integrity for local or metropolitan areas. Copies generated by Hitachi Remote Replication software products can be used for the rapid recovery or restart of production systems on primary or secondary (disaster recovery) systems following an outage. They can also be used for nondisruptive test and development, data warehousing, data mining, data backup, and data migration applications.

SVOS RF business continuity solutions are designed for maximum flexibility, enabling organizations to build a recovery strategy that spans multiple data centers and delivers to their specific SLAs.

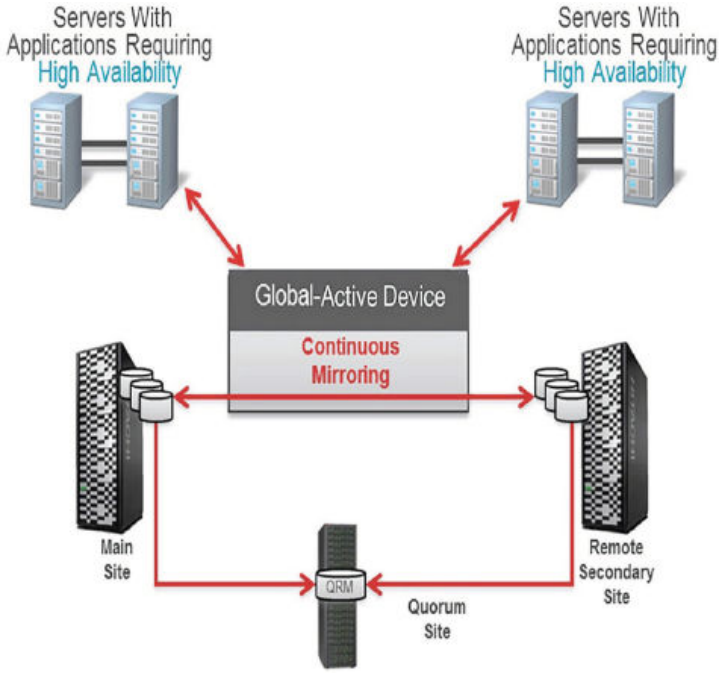
- Hitachi TrueCopy® enables synchronous remote replication of mission-critical data from a primary data center to a secondary data center. TrueCopy delivers immediate zero-RPO and automated failover capabilities and is compatible with open-systems and mainframe environments.
- Universal Replicator features journal disk caching for achieving tight RPO time capabilities, even in the event of a network outage. Universal Replicator provides asynchronous remote copy, over any distance and is compatible with open-systems and mainframe environments. Deployed implementations can be configured with or without delta resync, which ensures replication consistency for the highest level of remote copy data integrity at any distance.

TrueCopy and Universal Replicator can also be automated as part of an end-to-end, unified data protection, retention, and recovery management solution within Hitachi Data Instance Director (HDID) software. HDID can also automatically trigger Thin Image snapshots and ShadowImage clones from the remote copy of the data.

From remote copy planning to advanced implementation services, Hitachi Vantara Global Services Solutions can support the successful and timely deployment of the most resilient data protection infrastructures. Services to support TrueCopy and Universal Replicator software and other business continuity and disaster recovery solutions from Hitachi Vantara are available.

High availability with global-active device

Global-active device (GAD) simplifies and automates high availability to ensure continuous operations for mission-critical data and applications. GAD provides full metroclustering between data centers that can be up to 500 km apart. Supporting read/write copies of the same data in two places at the same time, GAD's active-active design implements cross-mirrored storage volumes between matched VSP storage systems to protect data and minimize data-access disruptions for host applications due to site or storage system failures. GAD ensures that up-to-date data is always available and enables production workloads on both systems, while maintaining full data consistency and protection.



Global-active device volume pairs have the following benefits:

- **Continuous I/O:** If a primary volume becomes unavailable, the host continues to transparently access the secondary volume.
- **Clustered failover:** You do not need to perform storage system tasks such as suspension or resynchronization of GAD pairs due to a host failure.
- **Virtual machine integration:** If a virtual machine is creating a high load at one site, you can move the load to the other site.
- **High performance:** Multipath software allows application access to mirrored data from the shortest path for highest performance.
- **Workload mobility:** The concurrent data mirroring capability of global-active device makes data immediately available to servers at a second site (over metro distances).
- **Nondisruptive data migration:** Data volumes can be migrated between storage systems without disruption to normal operations.

Data Mobility software

By simplifying tiered storage management, Hitachi's Data Mobility software delivers the highest storage performance for the most frequently accessed data while at the same time lowering costs by automatically optimizing data placement.

Hitachi Data Mobility software automatically and transparently moves data across tiers of storage, maximizing business application service levels while minimizing costs. Support for a broad range of storage media, configurations, and virtualized third-party arrays facilitates seamless data migration from older to newer Hitachi storage.

- Dynamic Tiering automates data placement and access in a tiered storage environment, dynamically moving the most active data to the highest-performing storage tiers while moving less frequently accessed data to lower tiers. An additional active-flash mode moves suddenly active data to higher-performing tiers in real time. In seconds to subseconds, active flash responds to workload demands based on current I/O activity and proactively preserves flash endurance by monitoring and demoting pages that exceed thresholds for heavy write I/O.
- Nondisruptive data migration is accomplished using the global storage virtualization technology of the Hitachi VSP storage systems. Resources on the migration source storage system are virtualized on the target storage system. From the perspective of the host, I/O requests continue to be serviced by the source storage system during the migration process.

Data-at-rest encryption

The Encryption License Key feature of VSP 5000 series protects your sensitive data against breaches associated with storage media (for example, loss or theft). Encryption License Key includes a controller-based encryption implementation as well as integrated key management functionality that can leverage third-party key management solutions via the OASIS Key Management Interoperability Protocol (KMIP).

The data at-rest encryption (DARE) functionality is implemented using cryptographic chips included as part of the encryption hardware. The encryption hardware encrypts and decrypts data as it is being written to and read from the physical drives. The key management functionality controls the full key life cycle, including the generation, distribution, storage, backup/recovery, rekeying, and destruction of keys. In addition, the design of this key management functionality includes protections against key corruption (for example, integrity checks on keys) as well as key backups (both primary and secondary).

The Encryption License Key feature provides the following benefits:

- Hardware-based Advanced Encryption Standard (AES) encryption, using 256-bit keys in the XTS mode of operation, is provided for open and mainframe systems.
- Encryption can be applied to some or all supported internal drives.
- Each encrypted internal drive is protected with a unique data encryption key.
- Encryption has negligible effects on I/O throughput and latency.
- Encryption requires little to no disruption of existing applications and infrastructure.
- Cryptographic erasure (media sanitization) of data is performed when an internal encrypted drive is removed from the storage system.

CLI and API integration

Advanced management tools, including CLIs and REST APIs, are available for more advanced management of your VSP 5000 series storage environment.

The Command Control Interface (CCI) software provides powerful command-line control for VSP 5000 series. CCI enables you to configure your storage system and perform data management operations by issuing commands directly to the storage system. CCI commands can be used interactively or in scripts to automate and standardize storage administration functions, thereby simplifying storage administration tasks and reducing administration costs. CCI also provides enhanced control and functionality for SVOS RF in-system and remote replication operations, including ShadowImage, Thin Image, TrueCopy, Universal Replicator, and global-active device. For remote replication operations, CCI interfaces with the system software and high-availability (HA) software on the hosts as well as the software on the storage systems to provide failover operation commands that support mutual hot standby in conjunction with industry-standard failover products.

REST-based APIs for VSP 5000 series extend operations, enabling integration with existing toolsets and automation templates to further simplify and consolidate management tasks. For details about API integration solutions for VSP 5000 series, contact your Hitachi Vantara representative.

Storage management software

The Hitachi approach to software-defined solutions enables you to effectively manage your IT infrastructure to align storage resources to rapidly changing business demands, achieve superior returns on infrastructure investments, and minimize operational costs. Hitachi Ops Center, Hitachi's suite of management software for VSP 5000 series, delivers higher storage availability, mobility, and optimization for key business applications and automates storage management operations with integrated best practices to accelerate new resource deployments. Hitachi storage management software enables you to manage more storage capacity with less effort and ensure that service levels for business-critical applications are met while increasing utilization and performance of virtualized storage assets.

The Hitachi Ops Center storage management software for VSP 5000 series includes:

- Hitachi Ops Center Administrator
- Hitachi Ops Center Analyzer
- Hitachi Ops Center Automator
- Hitachi Data Instance Director

Overview of Ops Center Administrator

Hitachi Ops Center Administrator is a unified software management tool that reduces the complexity of managing storage systems by simplifying the setup, management, and maintenance of storage resources.

Ops Center Administrator reduces infrastructure management complexities and enables a new simplified approach to managing storage infrastructures. It provides intuitive graphical user interfaces and recommended configuration practices to streamline system configurations and storage management operations. You can leverage Ops Center Administrator to easily provision new storage capacity for business applications without requiring in-depth knowledge of the underlying infrastructure resource details. It provides centralized management while reducing the number of steps to configure, optimize, and deploy new infrastructure resources.

Some of the key Ops Center Administrator capabilities include:

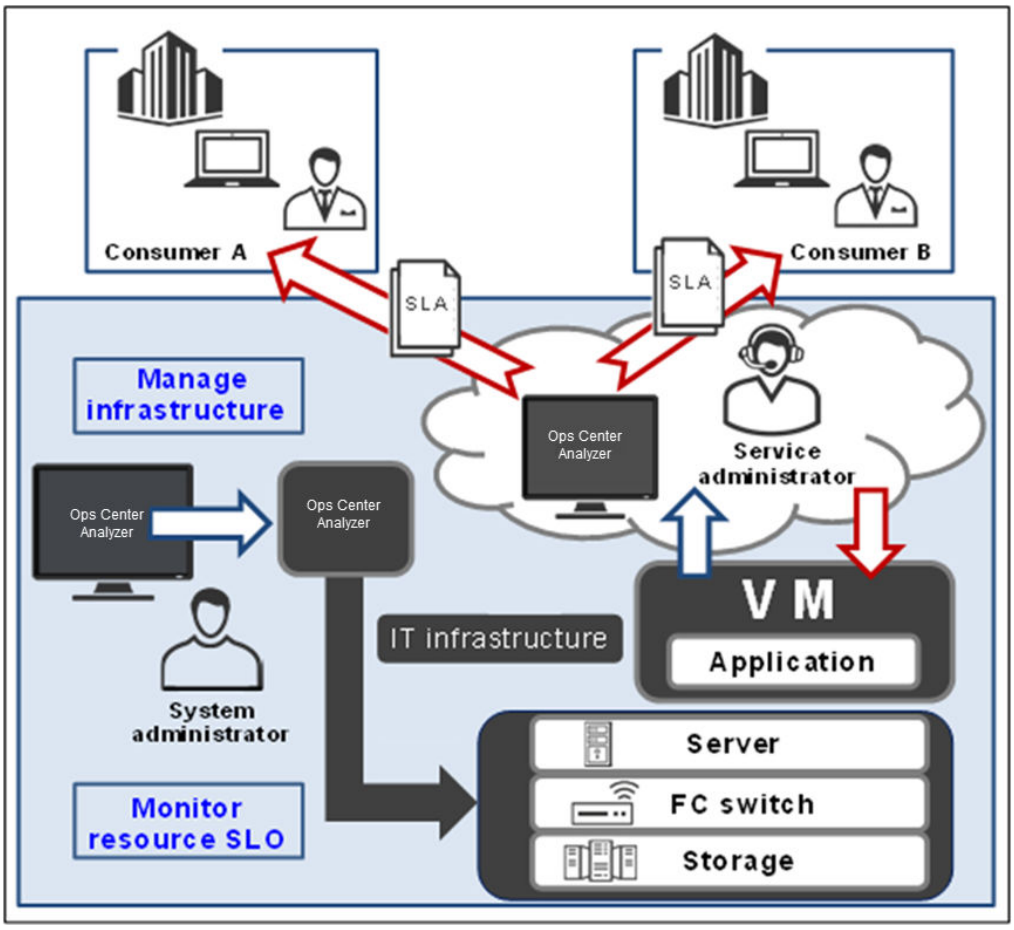
- Simplified user experience for managing infrastructure resources. Visual aids enable easy viewing and interpretation of key management information, such as used and available capacity, and guide features to help quickly determine appropriate next steps for a given management task.
- Recommended system configurations to speed initial storage system setup and accelerate new infrastructure resource deployments.
- Integrated configuration workflows with Hitachi recommended practices to streamline storage provisioning and data protection tasks.
- Common, centralized management for supported storage systems.
- A REST-based API to provide full management programmability and control.
- Ops Center Administrator enables automated SAN zoning during volume attach and detach. Optional auto-zoning eliminates the need for repetitive zoning tasks to be performed on the switch.

Hitachi Ops Center Analyzer

Hitachi Ops Center Analyzer is data center management software that monitors, reports, and correlates end-to-end performance from server to storage. With Hitachi Ops Center Analyzer, you can define and monitor storage service-level objectives (SLOs) for resource performance. You can identify and analyze historical performance trends to optimize storage system performance and plan for capacity growth. When a performance hot spot is identified or a service-level threshold is exceeded, the integrated diagnostic engine aids in diagnosing, troubleshooting, and finding the root cause of performance bottlenecks.

Using Ops Center Analyzer, you register resources (storage systems, hosts, servers, and volumes) and set service-level thresholds. You are alerted to threshold violations and possible performance problems (bottlenecks). Using analytics tools, you find which resource has a problem and analyze its cause to help solve the problem.

The following figure shows how Ops Center Analyzer ensures the performance of your storage environment based on real-time SLOs.



The system administrator uses Ops Center Analyzer to manage and monitor the IT infrastructure based on SLOs, which match the service-implementation guidelines that are negotiated under a service-level agreement (SLA) with consumers.

Ops Center Analyzer monitors the health of the IT infrastructure using performance indicators and generates alerts when SLOs are at risk.

Having data center expertise, the service administrator uses Ops Center Analyzer to assign resources, such as VMs and storage capacity from registered storage systems, to consumer applications. This manages critical SLO violations and ensures that service performance meets the SLAs.

Analyzer detail view

Analyzer detail view is the storage performance analytics module for Hitachi Ops Center Analyzer that includes a highly scalable data repository and analytics engine for historical performance and capacity trending across the data center. Analyzer detail view provides deep and granular performance monitoring and reporting to help users in identifying infrastructure bottlenecks and trends order optimize both application and storage system performance. This software enables a common, centralized storage analytics solution for Hitachi and multi-vendor storage environments that reduces the need for vendor-specific performance analytic tools.

Analyzer viewpoint

Analyzer viewpoint is a new add-on module for central enterprise visibility that complements Hitachi Ops Center Analyzer. Analyzer viewpoint periodically collects information about all resources from Ops Center Analyzer servers running at multiple data centers. Using Analyzer viewpoint, you can then easily display and check the comprehensive operational status of data centers around the world in a single window.

Analyzer viewpoint enables you to:

- **Check the overall status of multiple data centers:** Analyzer viewpoint enables you to collectively display and view information about supported resources in the data centers, including large-scale systems consisting of multiple data centers.
- **Analyze problems related to resources:** The Analyzer viewpoint UI displays information about resources in a specific data center in a drill-down view that allows you to easily identify errors. You can then launch the Ops Center Analyzer UI from Analyzer viewpoint, enabling you to quickly perform the tasks needed to resolve the error condition.

Hitachi Ops Center Automator

Hitachi Ops Center Automator provides tools to automate and simplify end-to-end processes, such as storage provisioning, for storage and data center administrators. The building blocks of Ops Center Automator are prepackaged automation templates that you can customize to your specific environment and processes to create services that automate complex tasks such as resource provisioning. Ops Center Automator integrates with other existing Hitachi Ops Center applications, including Hitachi Ops Center API Configuration Manager and Hitachi Ops Center Analyzer, to automate common infrastructure management tasks by using your existing infrastructure services.

The key features of Ops Center Automator include:

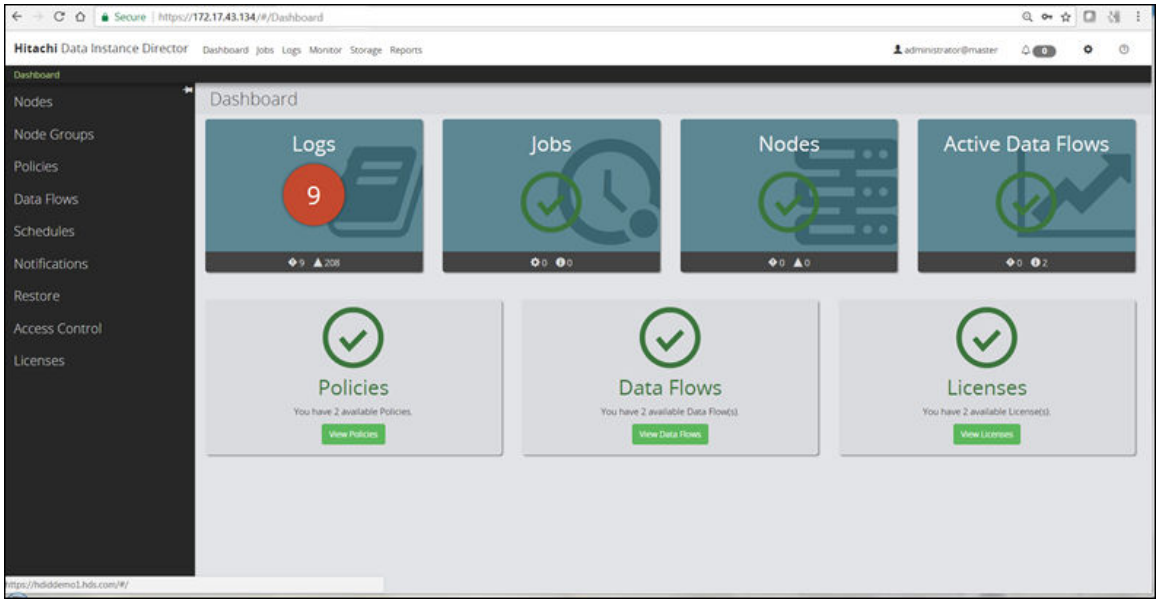
- Automation services for intelligent provisioning of volumes from different storage classes
- Preconfigured service templates that help you create customized automation services
- Role-based access to defined services
- Intelligent pool selection based on an algorithm that chooses the best pools in terms of performance and capacity
- Assignment of common service management attributes that can be assigned and shared across all automation services
- Application integration by using a REST API*
- Infrastructure group creation based on customer needs and environment

* To increase operational simplicity, Hitachi Ops Center deploys a REST API that applications can call to have Ops Center Automator execute tasks for them. The REST API enables third-party tools to integrate with Automator, reducing both effort and risk of errors. Automator is fully integrated with Hitachi Ops Center Analyzer to simplify the monitoring of telemetric data and the required corrections. Automation is accomplished by Analyzer using the REST API to call services created in Automator to address specific issues.

Hitachi Data Instance Director

The enterprise copy data management platform enabled by Hitachi Data Instance Director (HDID) provides business-defined data protection to simplify the creation and management of complex policies to meet service-level objectives for data availability, recoverability, and retention.

HDID provides an orchestration layer for remote replication supporting global-active device, TrueCopy, and Universal Replicator, local and remote snapshots and clones with Thin Image and ShadowImage, continuous data protection, and incremental-forever backup.



HDID provides the following benefits:

Operational recovery

HDID offers multiple approaches to meeting operational recovery requirements, allowing business service-level objectives for recovery to be met at optimal cost for differing criticality of data.

- *Storage replication-based operational recovery* This integration provides the ability to create fast, frequent copies of production data, with no impact on the performance of the production system. Very aggressive recovery point objectives (RPO) can be easily achieved for Microsoft Windows platforms for Microsoft Exchange and Microsoft SQL Server, for Oracle database environments on Linux, IBM® AIX®, and Solaris, and for SAP HANA environments on Linux. HDID also provides storage-based protection of VMware vSphere environments natively for Hitachi block storage systems and via Hitachi Virtual Infrastructure Integrator for Hitachi NAS Platform. Both types of vSphere integration allow vSphere administrators to apply protection policies without leaving the vSphere management interfaces. Other applications can also be integrated using the simple scripting interface.

  HDID configures, automates, and orchestrates local application-consistent snapshot and clone copies using the local replication capabilities of the Hitachi Virtual Storage Platform family storage systems. This integration provides the ability to create fast, frequent copies of production data, with no impact on the performance of the production system. Very aggressive recovery point objectives (RPO) can be easily achieved for Microsoft Windows platforms for Microsoft Exchange and Microsoft SQL Server, for Oracle database environments on Linux, IBM® AIX®, and Solaris, and for SAP HANA environments on Linux. HDID

  Storage data snapshots and clones can be mounted and unmounted automatically as part of an HDID policy workflow. They can facilitate access to a current copy of production data for testing and development purposes, or back up to a target device such as a purpose-built backup appliance (PBBA) or tape.

- *Host-based operational recovery*

  HDID includes several storage-agnostic technologies for protection of application and file system data. Continuous data protection (CDP) and live backup support Windows environments, with application-specific support for Microsoft Exchange and SQL Server. Batch mode backup is supported on Windows, Linux, IBM® AIX®, and Oracle Solaris systems.

Disaster recovery

HDID provides choices for restoring operations at, or from, another location following a site level outage.

- *Storage-based disaster recovery*

  HDID configures and automates global-active device active-active storage cluster, Hitachi TrueCopy® synchronous remote replication and Universal Replicator on block-based systems, and file replication on HNAS, to provide a copy of data in another location. HDID can also orchestrate application-aware snapshots of these remote replicas.

Long-term retention

The governance copy services allow you to back up file data to Hitachi Content Platform (HCP) for Windows, Linux, IBM® AIX®, and Oracle Solaris systems. Unlike other data protection products, HDID places data in its original format; meaning that it can be read without HDID, which allows you to support corporate and regulatory data retention requirements. Because the data is readable, it is indexable with tools such as Hitachi Content Intelligence and can be used for analytics with tools such as Pentaho Data Integration.

Unified management

One of the many benefits of HDID is its single-footprint platform. It enables you to layer, combine, and orchestrate backup, CDP, snapshots, and replication, along with access control and retention policies, to achieve the specific workflows and service levels each application requires.

The simple and easy-to-use graphical user interface (UI) incorporates a powerful policy builder that resembles laying out business processes on a whiteboard. Using the UI, you can easily create and change policies as needed, visualize data copy and movement processes, and align them with business management processes.

Additional features of HDID include:

- Block-level, incremental-forever data capture dramatically reduces the storage capacity needed for copy data, as compared to traditional full and incremental methods.
- Supports a range of storage repositories, including block, file, and object.
- Scales seamlessly to manage petabytes of data.

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