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This guide provides introductory information about the Hitachi Virtual Storage Platform G1000 hardware and software components.

- Document revision level
- Accessing product documentation
- Getting help
- Comments
Accessing product documentation

Product user documentation is available on the Hitachi Data Systems Portal: https://portal.hds.com. 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 Data Systems Support Portal is the destination for technical support of your current or previously-sold storage systems, midrange and enterprise servers, and combined solution offerings. The Hitachi Data Systems customer support staff is available 24 hours a day, seven days a week. If you need technical support, log on to the Hitachi Data Systems Support Portal for contact information: https://portal.hds.com

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Comments

Please send us your comments on this document to doc.comments@hds.com. Include the document title and number, including the revision level (for example, -07), and refer to specific sections and paragraphs whenever possible. All comments become the property of Hitachi Data Systems Corporation.

Thank you!
Hitachi Virtual Storage Platform G1000 is a unified storage system that provides high performance, high availability, and reliability. VSP G1000 scales to meet the demands of IT organizations’ ever-increasing workloads. When combined with server virtualization, the mission-critical storage virtualization of VSP G1000 supports a new breed of applications at cloud scale while reducing complexity.

The following key features illustrate how VSP G1000 provides a Continuous Cloud Infrastructure for the enterprise:

- **Global storage virtualization** enables an always-on infrastructure with enterprise-wide scalability that provides a complete separation between host and storage. The scalability is independent of connectivity, location, storage system, or vendor. Remote data center replication support allows provisioning and management of virtual storage machines up to 100 meters apart.

- **Integrated active mirroring** enables volume extensibility between systems and across sites through the provisioning and management of active-active volumes up to 100 km apart. Combined with remote data center replication, this mirroring is an ideal solution for critical applications that require zero recovery point and recovery time objectives. Active mirroring is enabled by the Hitachi global-active device feature.

- **Unified storage with enterprise scalability** allows you to centrally manage multivendor storage resources across all virtualized internal and external storage pools, whether deployed for SAN, NAS, or object storage.

- **Unified storage management software** (Hitachi Command Suite) simplifies administrative operations and streamlines basic management tasks.

- **Hitachi Accelerated Flash storage** offers a patented data center-class design and rack-optimized form factor that delivers more than 600 TB per system. It supports a sustained performance of 100,000 8K I/O operations per second per device, with fast and consistent response time.

- **Server virtualization integration with leading virtual server platforms** provides end-to-end visibility, from an individual virtual machine to the storage logical unit, protecting large-scale multivendor environments:
  - **VMware**
    - Storage Manager for VMware vCenter®
hitachi storage replication adapter (sra)

Microsoft® Windows® 2012 (including Microsoft Hyper-V®) and Systems Center

- Microsoft Virtual ShadowCopy Service (VSS) for enhanced data protection
- 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 System Center Orchestrator

User interfaces for VSP G1000

The Hitachi Virtual Storage Platform G1000 storage system features multiple storage management interfaces for ease and flexibility of use:

- **Hitachi Command Suite (HCS)** unifies storage management, streamlines all management tasks, and simplifies administrative operations. Capabilities include:
  - Unified storage management across unstructured and structured data
  - A single management console for managing all Hitachi storage systems and tiers
  - Integrated management console providing consolidated user resource management, consolidated task list, and improved configuration available from launch points in HCS to Hitachi Device Manager - Storage Navigator

- **Command control interface (CCI)** enables you to perform storage system configuration and data management operations by issuing commands to enterprise storage systems. CCI for VSP G1000 provides command-line access to the same provisioning and storage management operations that are available in Hitachi Command Suite and Hitachi Device Manager - Storage Navigator as well as in-system replication, remote replication, and data protection operations. CCI commands can be used interactively or in scripts to automate and standardize storage administration functions, simplifying the job of the storage administrator and reducing administration costs.

ShadowImage In-System Replication, and Hitachi TrueCopy Remote Replication operations.

- **Device Manager - Storage Navigator (HDvM-SN)** is the storage management interface for mainframe-only environments. Device Manager - Storage Navigator communicates directly with the VSP G1000 storage systems using a LAN to obtain storage system configuration and status information and send user-requested commands to the storage systems.
This chapter briefly describes the hardware components used in the Hitachi Virtual Storage Platform G1000 storage system.

- **About the VSP G1000 storage system**
- **Hardware components**
- **Features**
About the VSP G1000 storage system

The VSP G1000 storage system contains new architecture, technology, and several new features. These include an improved, seventh-generation hierarchical star net architecture that is shown in the following illustration of the VSP G1000 hardware architecture.

In this architecture, the virtual storage directors (microprocessors) are shared across the cache, front-end directors (host adapters), and back-end directors (disk adapters), providing processing power where and when it is needed, without wait time or interruption. This significantly increases the I/O throughput.

VSP G1000 provides a highly granular upgrade path, allowing the addition of data drives to the drive chassis, and components such as virtual storage directors to the controller chassis as storage and processing needs increase. A VSP G1000 system configuration may range from a single controller with no drives, to a dual-controller managing up to 2,304 drives with homogeneous logic control, cache, front-end and back-end interfaces, all mounted in standard Hitachi Data Systems 19-inch racks. You can use non-Hitachi standard racks that meet the specifications listed in the Hitachi Virtual Storage Platform G1000 Hardware Guide.
Hardware components

A basic VSP G1000 storage system consists of a controller chassis and one or more drive chassis that contain the drives. The system includes a controller rack that contains a controller chassis, and may be either diskless (no drive chassis) or may contain one or two drive chassis.

Up to two additional racks can contain an intermix of 16U SFF or LFF drive chassis and/or 8U flash drive chassis. They can also contain one or two Hitachi Network Attached Storage (HNAS) file system servers. The VSP G1000 supports three types of drives: SFF HDDs or SSDs, LFF HDDs, and flash module drives. The drives are mounted in a chassis that is specific to each type of drive.

The controller chassis contains the control logic, processors, memory, and interfaces to the drive chassis and the host servers. A drive chassis contains drives, power supplies, and the interface circuitry that connects it to the controller.

The following illustration shows a fully configured VSP G1000 system with two controllers containing 8 virtual storage director pairs (128 CPU cores), 2 TB cache, and 12 16U drive chassis containing 2,304 SFF drives with a storage capacity of 4.5 PB.
Controller chassis

The controller chassis includes the logical components, memory, SAS drive interfaces, and host interfaces. The controller chassis is mounted at the bottom of the rack. If a two-controller system has two service processors, both are mounted in controller chassis #0. A controller chassis includes the following maximum number of components:

- Two service processors or one service processor and one hub
- 1 TB cache memory
- Two cache backup assemblies, each comprising a set of two boxes that back up the cache in case of power failure
- Two cache path control adapters (CPA), each comprising a pair of redundant blades that host cache modules as well as providing the PCI-Express path to distribute data among virtual storage director (VSD) pairs, front-end directors and back-end directors. They mirror the data to prevent data loss if one blade fails.
- Four virtual storage director (microprocessor) pairs
- Four redundant power supplies with cooling fans
- Six front-end directors (FEDs), each comprising a pair of redundant blades
- Two back-end directors (BEDs), each comprising a pair of redundant blades
- Ten cooling fan assemblies

The following illustration shows the front and rear views of the controller chassis. All components are installed symmetrically on the left and right sides of the controller. The rear side of the controller includes 12 configurable I/O slots. Four of the slots support either FEDs or BEDs, and four of the slots support either FEDs or VSD pairs. Components can be added to these slots as needed to increase performance or storage capacity, or to support more host systems. Note that it is not possible to include the maximum number of VSDs, FEDs, and BEDs, all at the same time.
Drive chassis

VSP G1000 supports three types of drives: SFF, LFF, and flash module drives. Each drive type requires its own chassis.

<table>
<thead>
<tr>
<th>Drive chassis</th>
<th>Description</th>
<th>Drive trays / Drives per tray</th>
<th>Maximum number of chassis/drives per system</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFF</td>
<td>A 16U chassis that contains up to 192 SFF HDDs and/or SFF SSDs.</td>
<td>Eight 2U trays, up to 24 drives each</td>
<td>6 / 1,152 drives Up to 192 SSDs 12 / 2,304 drives Up to 384 SSDs</td>
</tr>
<tr>
<td>LFF</td>
<td>A 16U chassis that contains up to 96 LFF HDDs and/or LFF SSDs.</td>
<td>Eight 2U trays, up to 12 drives each</td>
<td>6/ 576 12/1,152</td>
</tr>
<tr>
<td>FMD</td>
<td>An 8U flash drive chassis that contains up to 48 flash modules.</td>
<td>Four 2U trays, up to 12 drives each</td>
<td>2/96 4/192</td>
</tr>
</tbody>
</table>

LFF and SFF chassis

A single VSP G1000 controller supports a mix of up to six 16U SFF chassis or up to six 16U LFF chassis. The actual number of SFF and LFF chassis that can
be installed depends on whether any flash drive chassis are installed, and whether any HNAS servers, Ethernet switches, or Fibre Channel switches are installed.

As shown in the following illustration, a 16U SFF chassis consists of eight 2U drive trays. Each SFF drive tray can contain up to 24 vertically mounted SFF HDD or SSD flash drives, for a total of 192 drives per chassis. Disk and SSD drives can be combined within a tray or within an SFF drive chassis. A single controller system supports up to 192 SFF SSDs.

A 16U LFF chassis consists of eight 2U drive trays. Each LFF drive tray can contain up to 12 horizontally mounted LFF drives, for a total of 96 drives per chassis.

The following illustration shows a fully configured LFF chassis containing 192 SFF drives, and a fully configured LFF chassis containing 96 LFF drives.

See the Hitachi Virtual Storage Platform G1000 Hardware Guide for more information about the supported drives and chassis.
Flash chassis

An FMD (flash module drive) chassis contains a set of four 2U flash drive trays as shown in the following illustration. Each tray can contain up to 12 horizontally mounted flash module drives.

The minimum number of flash module drives in a flash chassis is four, one in each drive tray. Flash module drives can be added to an FMD chassis in increments of four, eight, or 16, depending on the desired RAID configuration.

A single VSP G1000 controller supports a maximum of two FMD chassis, each containing up to 48 flash modules. The number of FMD chassis that can be installed depends on how many SFF or LFF drive chassis are installed, and whether any HNAS servers, Ethernet switches, or Fibre Channel switches are installed. A two-controller system supports a maximum of four FMD chassis.

See the *Hitachi Virtual Storage Platform G1000 Hardware Guide* for more information about the flash module drive and the FMD chassis.
Features

This section describes the main features of Virtual Storage Platform G1000.

The VSP G1000 storage system includes several state-of-the-art advances in hardware technology that improve reliability, serviceability, and access to drives and other components when maintenance is needed. These include:

- **Hitachi Accelerated Flash storage** offers a patented data-center-class design and rack-optimized form factor that delivers more than 600 TB per system. It supports a sustained performance of 100,000 8K I/O per second, per device, with low and consistent response time.

- **The latest 2.5 in. and 3.5 in. 6 Gb/sec SAS drives** support lower power consumption and higher density per rack with up to 2,304 drives in six 19-inch standard racks.

- **Hitachi NAS Platform hardware accelerated network protocols** support up to 2 Gb/sec throughput for sequential workloads and up to 1.2 million NFS operations per second.

- **Primary data deduplication** is supported using Hitachi NAS hardware-based SHA-256 calculation engines. They enable up to 90% capacity savings while maintaining high performance.

- **Efficient caching** makes up to 2 TB global cache dynamically accessible by all connected hosts and Hitachi NAS Platform nodes.

- **The controller racks can be placed up to 100 meters apart**, providing maximum flexibility to optimize data center space usage and to provide ease of access for operation and maintenance. Drive racks connected to the controller racks must be installed next to the controller rack.

- **High-speed 8-core CPUs** in the virtual storage directors, expanded cache memory (up to 2 TB per system), flexible installation, and increased drive types and capacities.

- **Nondisruptive migration** is available as a service from Hitachi Data Systems authorized service representatives.

The new system includes integrated data and storage management using Hitachi Command Suite and Device Manager—Storage Navigator. These provide unified management across all Hitachi storage systems and data types. See [Software overview on page 25](#) for more information.

External SAN storage virtualization extends the useful life of existing assets by allowing legacy devices to transparently inherit new functionality from VSP G1000 and SVOS. This capability eases migration and reduces costs and risk when moving from legacy Hitachi or non-Hitachi storage systems. It supports dynamic tiering of storage capacity (internal or external capacity) and nondisruptive data migration between tiers and between vendors.
Scalability

The VSP G1000 storage system offers an entirely new type of scalable and adaptable integrated active-active architecture that supports unified management. It offers greater performance, reliability, and flexibility. It can be configured in several ways as needed to meet performance and storage requirements.

Scalable system performance

System performance can be optimized according to user needs, and can be easily upgraded (in small or large increments) as storage needs increase. The following table shows the supported configurations.

<table>
<thead>
<tr>
<th>Number of controllers</th>
<th>Number of VSD pairs/CPU cores</th>
<th>Cache size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>min=1 (16 cores) max=4 (64 cores)</td>
<td>min=64 GB max=1 TB</td>
</tr>
<tr>
<td>2</td>
<td>min=2 (32 cores) max=8 (128 cores)</td>
<td>min=128 GB max=2 TB</td>
</tr>
</tbody>
</table>

Notes:
1. A VSD pair consists of two VSD blades. Each VSD contains one 8-core processor.
2. Cache memory modules can be either 16 GB or 32 GB. Only one memory module size can be installed in a system.

For more information, see the Virtual Storage Platform G1000 Hardware Guide.

Scalable storage capacity

- The minimum configuration is a single controller chassis in a diskless configuration, mounted in one rack.
- A small VSP G1000 system can include a single controller chassis and one or two drive chassis or flash drive chassis, mounted in one rack.
- A mid-sized system can include one controller and a maximum of six LFF or SFF drive chassis, mounted in up to three racks.
- For block systems, the maximum configuration is a two-controller version of the mid-sized system with twelve 16U LFF/SFF drive chassis, mounted in six racks.
- For unified file and block storage systems, the maximum configuration varies, depending on how many HNAS servers and switches are installed.
In addition to the number of disk drives, the system can be configured with disk drives of different capacities and speeds, varying numbers of front-end directors (FEDs) and back-end directors (BEDs), as follows:

- A single controller supports a maximum of two BEDs, each comprising a redundant pair of BED blades. In this configuration, the controller supports a maximum of four FEDs, each comprising a redundant pair of FED blades.
- Cache memory capacity: see the table in "Scalable system performance."
- Disk drives with capacities of 300 GB, 600 GB, 900 GB, 1.2 TB, and 4 TB.
- SSD capacities of 400 GB and 800 GB.
- Flash module drive capacities of 1.6 TB and 3.2 TB.
- Channel ports: 80 for one module, 176 for two modules with at least one BED installed.

High performance

The VSP G1000 storage system offers high performance that enables consolidation and real-time applications, a wide range of storage and data services, software, logical partitioning, along with simplified and unified data replication across heterogeneous storage systems. Its large-scale, enterprise-class virtualization layer, combined with Hitachi Dynamic Tiering and thin provisioning software, allows you to consolidate internal and external storage into a single pool.

Virtual Storage Platform G1000 includes several features that improve performance:

- Disk drives with 7,200, 10,000, or 15,000 RPM
- Flash drives with ultra-high-speed response
• High-speed data transfer between the BED and HDDs at a rate of 6 Gb/sec with the SAS interface

System performance is scalable and upgradable, as described in Scalability on page 19.

High capacity

Virtual Storage Platform G1000 controls up to 65,280 logical volumes and up to 2,304 disk drives, providing a maximum physical disk capacity of approximately 4,511 TB per two-controller storage system.

Connectivity

OS support

The Virtual Storage Platform G1000 storage system supports most major IBM® mainframe operating systems and open operating systems, including Microsoft Windows®, Oracle Solaris®, IBM AIX®, UNIX®, Linux®, HP-UX™, OpenVMS™, and VMware®. For more information on supported operating systems, see http://www.hds.com/products/interoperability/index.html.

Host connectivity

VSP G1000 supports mainframe (Fibre Channel (FICON)), open (Fibre Channel) host interfaces, or a combination of the two.

High reliability

The Virtual Storage Platform G1000 storage system includes the following features that enhance reliability:

• Support for RAID6 (6D+2P/14D+2P), RAID5 (3D+1P/7D+1P), and RAID1 (2D+2D/4D+4D).

• All main system components (power supplies, cache memory, data drives, microprocessors, and so on) are configured in redundant pairs. If one of the components in a pair fails, the other component takes over until the failed component is replaced. Meanwhile, the storage system continues normal operation.

• The system preserves all data and configuration information in the event of a power failure.

High flexibility

The VSP G1000 storage system is available in many configurations, from a small, one-rack, diskless system, to a large, six-rack system that includes two controller chassis, up to 2,304 SFF HDD drives or 1,152 LFF drives, up to 384 SSD drives, up to 192 flash module drives, and a total of 2 TB cache, according to the storage needs. It can be easily reconfigured as storage needs change.
The system supports both block-only and unified (block and file) configurations in open and mainframe environments. The unified systems contain Hitachi Network Attached Storage servers and switches in addition to the block controller and storage drives.

VSP G1000 storage systems provide the foundation for matching application requirements to different classes of storage and delivering critical services, including:

- Business continuity services
- Content management services (search, indexing)
- Thin provisioning
- Dynamic Tiering
- High availability
- Security services
- I/O load balancing
- Data classification
- File management services

### Nondisruptive service and upgrades

The Virtual Storage Platform G1000 storage system is designed so that service and upgrades can be performed without interrupting normal operations.

- Main components can be *hot swapped* (added, removed, or replaced without disruption) during normal operation. The main components include every module in the controller chassis and the drive chassis (such as power supplies, cache, VSDs, SVPs, a hub, and drives) and interface modules (such as front-end directors and back-end directors).
- A service processor (SVP) mounted on the controller chassis monitors the running condition of the storage system. Connecting the SVP with a service center allows authorized service personnel to maintain the system remotely.
- The firmware (microcode) can be upgraded without disrupting normal operation. The firmware is stored in shared memory (part of the cache memory module) and transferred in a batch, reducing the number of transfers from the SVP to the controller chassis over the LAN. Replacing the firmware online is faster because the storage system uses two or more processors at the same time.
- Nondisruptive data migration is available as a service from Hitachi Data Systems authorized service representatives. Self-service nondisruptive data migration is planned for a future release.

### Economical and quiet

The three-speed fans in the controller and drive chassis are controlled thermostatically. Sensors in the units measure the temperature of the exhaust air and set the fan speed to the minimum necessary to maintain the
unit temperature in a preset range. When the system is not busy, it generates less heat and fan speed is reduced, saving energy and reducing the noise level.

When the storage system is in standby mode, the disk drives spin down and the controller and drive chassis use significantly less power. For example, a system that consumes 100 amps during normal operation uses only 70 amps in standby mode.
Software overview

This chapter is an overview of the software components, including features and benefits.

- Single point of management
- Advanced SAN multipathing
- Centralized reporting
- Thin provisioning
- Dynamic tiering
- Data replication
- Performance management
- Data mobility
Single point of management

Hitachi Command Suite (HCS) is an application-centric storage management solution that simplifies administration of a common pool of multivendor storage. The software offers comprehensive management, control, and discovery for file, object, and block storage services, reducing complexity, costs, and risk in the storage infrastructure.

The base HCS product consists of Hitachi Device Manager, which provides centralized management of multiple Hitachi storage systems. By providing a single console for managing complex storage environments, Device Manager software unifies and simplifies storage management. Featuring an intuitive GUI, Device Manager supports multiple management views for primary and secondary storage, including physical, logical, host, and NAS and virtual server for provisioning and storage pooling.

Note: Key functions of the previously separate Storage Navigator have been integrated into HCS to enable a unified interface for storage management.

HCS comprises the following optional components, each of which is licensed separately:

- **Hitachi Tiered Storage Manager**: Supports storage tiers of differing performance characteristics so that volume data storage costs and performance can be optimized.
- **Hitachi Replication Manager**: Adds remote replication capabilities and supports backup and disaster recovery.
- **Hitachi Tuning Manager**: Supports optimizing the performance of storage resources.
- **Hitachi Compute Systems Manager**: Supports centralized monitoring and management of hosts, including rebooting and power management.
- **Hitachi Command Director**: Supports sophisticated business centric views of storage environments, such as adherence to service-level agreements and data usage trends to forecast future storage requirements.
- **Hitachi Dynamic Link Manager**: Supports the use of multiple paths between resources such as hosts and storage for path failover and load balancing.
- **Hitachi Global Link Manager**: Supports management of multipath management software between resources, such as hosts and storage.

At minimum, you must license Device Manager. Additional licensing can be added as needed for other storage management products. Related functionality becomes available in the HCS user interface in the form of activated menu choices, and new or updated tabs and related screens and buttons.
The following figure shows the main HCS dashboard.

Hitachi Command Suite offers the following benefits:

**Central inventory management to properly manage growth**
- Common administrative framework consolidates asset management across all virtualized storage resources for operational efficiency to increase storage return on investment
- Common management console to discover, configure, monitor, and report on all tiers and virtualized storage resources
- Dashboard highlights system-wide capacity usage, top consumers, and system alerts
- Logical group constructs to easily align storage resources with business applications
- Integrated management framework enables automation, mobility, service-level management, and data protection

**Simplified storage provisioning for rapid deployment**
The common management framework consolidates storage provisioning for both structured and unstructured data:
- Centrally configure storage pools for block, file, and object consumers
- Centrally manage data security, mobility, performance, and replication
- Simplified provisioning with contextual workflows
- Reduce operational expenses; manage more with less effort

**Maximize business application performance**
- Automatically align with business applications, define tiers, and set policies by application workload for maximum performance
- Automate optimal data placement to increase storage utilization by up to 50%

**Automated lower cost and less management**
- Automatically move inactive data to lower-cost storage
Automatically move active data to highest-performing tier
Define tiers and set policies to optimize cost

Meet business application service levels with Hitachi Command Director
- Define key storage performance and capacity objectives by business application
- Global storage service-level management dashboard to monitor compliance 24/7 and identify applications at risk
- Monitor application service levels and storage system health from virtually anywhere with the mobile Apple® iPad® app
- Investigate service-level violations to quickly identify and resolve potential bottlenecks

Ensure performance is running at peak efficiency with Hitachi Command Suite Analytics, featuring Hitachi Tuning Manager
Comprehensive storage system health monitoring and troubleshooting to deliver the operational efficiencies required to optimize shared Hitachi storage resources

Advanced SAN multipathing
Hitachi Dynamic Link Manager offers robust multipath SAN connections between servers and storage systems. It provides fault-tolerant failover, failback, load balancing, and centralized path management, for improved information access, usability, and availability. Automatic workload balancing helps to maintain outstanding system performance across all available paths. If one path fails, Dynamic Link Manager automatically switches the I/O to an alternate path, ensuring that an active route to data is always available.

Dynamic Link Manager offers the following benefits:

Business continuity
- Improves system performance by spreading I/O request workload across available paths to ensure that no single path is overworked or underutilized
- Provides a high level of data availability through automatic path failover and failback, ensuring continuous access to application data, improved application performance, and reduced risk of financial loss due to failures of critical applications
- Improves availability and data access on storage systems in SAN environments, with path failover and I/O balancing over multiple HBAs
- With its health-check facility, monitors online path status at specified intervals, and places a failed path offline when an error is detected
Productivity and process
- Provides a centralized facility for managing path failover, automatic failback, and selection of I/O balancing techniques through integration with Hitachi Global Link Manager
- Eases installation and use through the auto-discovery function, which automatically detects all available paths for failover and load balancing
- Provides one path-management tool for all your operating systems
- Includes a command line interface (CLI) that allows administrators the most flexibility in managing paths across the network
- Provides manual and automatic failover and failback support

Centralized reporting
Hitachi Command Director centralizes reporting across Hitachi Command Suite. By consolidating reporting of storage configuration, capacity, performance, and tier information, Command Director provides a business-oriented view into the storage environment to easily align Hitachi storage assets with critical business applications and simplify application-to-storage reporting. It also ensures compliance with application-specific storage service levels. The following figure shows the main Command Director dashboard.

Hitachi Command Director offers the following benefits:
**Manage storage assets by business application**
- Gain a business intelligence view of storage resources correlated to the respective business applications and functions
- Customize dashboards of business applications and related storage resources for enterprise-wide monitoring and reporting needs

**Improve utilization of storage assets**
- Receive detailed reporting of allocated and utilized storage capacity without the need for host-based agents, to increase storage utilization and improve return on storage investments
- Ensure optimal file server performance by monitoring key file server performance statistics to help identify the busiest NAS nodes

**Monitor business applications for adherence to storage service levels**
- Proactively monitor compliance of storage service levels for mission-critical business applications
- Establish storage SLOs by application, based on detailed capacity and performance metrics

**Detect problems early to avoid storage performance bottlenecks**
- Monitor overall storage system health based on best practice rules to help detect problems early and reduce the likelihood of any performance issues
- Provide a consolidated service-level view of your infrastructure by aggregating key storage performance, capacity, and tier indicators from across the Hitachi Command Suite of management products
- Incorporates a REST-based API for extraction of performance and capacity data

**Thin provisioning**

Hitachi Dynamic Provisioning (an integral part of HCS) provides the VSP G1000 storage system with thin provisioning services. Thin provisioning gives applications access to virtual storage capacity. Applications that access virtual, thin provisioned volumes are automatically allocated physical disk space by the storage system as they write data. Thin provisioning allows volumes to use only the amount of physical space required and no more.

All thin provisioned volumes share a common pool of physical disk capacity. Unused capacity in the pool is available to any application using thin provisioned volumes. This eliminates the waste of over-allocated and underutilized storage.

Dynamic Provisioning also simplifies storage provisioning and automates data placement on disks for optimal performance. You do not need to micromanage application storage allocations or perform complex, manual
performance tuning. In addition, you can add physical storage resources to
the thin provisioning pool at any time, without application downtime.

Dynamic Provisioning offers the following benefits:

**Nondisruptive addition of physical disks**

Actual storage capacity from the DP pool is assigned to a DP volume when
the data is written. Until then, a DP volume appears as a virtual LVI/LUN
volume with no actual storage capacity. Because the application sees only the
virtual capacity allocated to it, additional physical disk capacity can be
installed transparently when needed without interruption.

**Improved performance**

Dynamic Provisioning improves performance by avoiding contention and
performance bottlenecks. By evenly spreading out hundreds of users' I/O
patterns over all available spindles, Dynamic Provisioning optimizes
aggregate throughput, generally delivering the best performance.

**Reduced storage acquisition costs**

Reduced acquisition costs extend to savings in space, power, and cooling
requirements.

The ability to define a volume as larger than a physical disk allows you to
plan for future storage needs during initial installation. You can purchase only
the physical disk capacity for your current needs, adding physical storage
incrementally over time.

**Simplified replication planning**

Because you can define the desired volume capacity without regard to the
physical disk capacity, for volumes of 4 TB and smaller, you do not need to
use LUSE for volume expansion. This also simplifies creating replication pairs.

**Dynamic tiering**

Hitachi Dynamic Tiering (HDT) is based on Hitachi Dynamic Provisioning. It
further simplifies tiered storage management by automating fine-grained,
page-based movement of data to the most appropriate storage media
according to workload and usage patterns. It automates management,
maximizes service levels, and minimizes storage costs. The following figure
shows the Edit LUN Paths dialog of HCS, which allows you to choose the
remote path for an HDT type volume.
Dynamic Tiering offers the following benefits:

**Reduced storage costs**
- Reduces media costs and drive counts through self-optimized use of storage tiers
- Achieves space efficiency through thin provisioning
- Eliminates manual data classification
- Eliminates manual data movement between tiers
- Reduces operational overhead
- Reduces space, power, and cooling requirements

**Improved performance**
- Optimizes data placement automatically for performance using an I/O rate-based heat index
- Gives SSD-class performance to information stored largely on less expensive tiers by automatically moving the most accessed data to the highest (SSD) tier
- Supports the highest efficiency and throughput through granular page-based data movement
- Uses wide striping across the entire pool

**Efficient administration**
- Simplifies management of up to three storage tiers as a single volume
- Automatically moves the most active data to the highest performing tier
- Automatically adjusts to dynamic workloads and capacity requirements
- Moves pages up and down for optimal placement
- Significantly reduces administration time
Data replication

Hitachi Replication Manager provides management capabilities to configure, manage, and monitor Hitachi replication products for local and remote sites. Replication Manager supports open systems and mainframe environments and provides support for multiple data centers and multiple storage systems at each data center. It simplifies and optimizes configuration, operation, task management, automation, and monitoring of the critical applications and storage components of your replication infrastructure. The following figure shows the Replication Manager interface.

Replication Manager offers the following benefits:

**Centralized management of a replication environment**

Replication Manager can be used to manage storage systems and hosts at different sites. The status of copy pairs, the progress of copy operations, and performance information (such as data transfer delays between copy pairs and buffer usage when copying volumes) can be centrally managed from a single console.
Integrated database backup management

Replication Manager supports creating backups of databases. Called *application replicas*, these backups are managed as a series of secondary volumes that are rotated on a scheduled basis. Replication Manager manages the relationships between backup objects and their associated logical units within storage devices, the relationships between primary and secondary volumes, and the backup history. Replicas can be mounted and dumped to tape using scripts executed through Replication Manager.

Visual representation of replication structures

Replication Manager provides a centralized workspace where you can visually check the structure of copy pairs configured across multiple storage systems. Host and storage system relationships and copy pair definitions can be visualized using functional views. Copy pairs in complex configurations such as multitarget configurations and cascade configurations can be viewed as lists.

Monitoring and immediate notification of error information

Replication Manager provides capabilities to specify monitoring conditions for designated copy pairs and sidefiles. Alerts can be automatically generated when the conditions are satisfied. You can continue monitoring the system even when not logged in to Replication Manager because alerts can be reported in the form of email messages or SNMP traps. The status of application replicas is tracked and reflected in summary form so that you know to what extent the application databases are protected. These monitoring features allow you to work out advance strategies to handle potential problems such as the deterioration of transfer performance due to insufficient network capacity or blocked pairs caused by buffer overflows.

Modification of replication structures

Replication Manager provides capabilities to configure additional copy pairs as business operations expand and improve performance by expanding buffer capacity for copying volumes. You can also change pair states manually after error recovery. Using the wizards provided in the GUI, you can set up pairs while visually keeping track of complex replication structures.

Monitoring and analyzing remote copy performance (write delay time)

When using Universal Replicator, you can check copy performance visually and perform root cause analysis using the Replication tab of the Hitachi Command Suite GUI.

Performance management
Hitachi Tuning Manager is a path-aware storage resource management application that maps, monitors, and analyzes storage network resources from the application to the storage device. It provides the end-to-end visibility required to isolate and diagnose performance bottlenecks with a focus on business applications, such as Oracle, Microsoft SQL Server, Microsoft Exchange, and IBM® DB2®. The following figure shows the Tuning Manager interface.

Tuning Manager offers the following benefits:

- Simplifies performance reporting and management of your storage environment
- Improves service quality with accurate performance reporting
- Increases application availability through rapid problem identification and isolation
- Reduces storage costs with proper forecasting and planning of required storage resources
- Incorporates a REST-based API for extraction of performance and capacity data

**Data mobility**

Hitachi Tiered Storage Manager provides the unique ability to migrate volumes between heterogeneous tiers of storage, without affecting application access to data. The software supports up to 64 simultaneous migrations, using 64 processor threads, and it offers a single interface for all data movement between storage virtualized by the VSP G1000 storage system.

The following figure shows the Mobility tab of HCS, which is used to access Hitachi Tiered Storage Manager.
Tiered Storage Manager offers the following benefits:

- Matches application price, performance, and availability needs to storage attributes
- Controls the automated behavior of Dynamic Tiering through the use of standard and custom policies and profiles. You can also proactively create and pool different classes of storage for maximum efficiency and long-term performance
- Manages storage resources according to the needs of specific business applications, while supporting the ability to migrate data nondisruptively
High availability with global-active device

Global-active device employs volume replication to provide a high-availability environment for hosts across storage systems and sites. The purpose of global-active device is to provide data protection and minimize data access disruptions for host applications due to storage system or site failures.

Establishing a global-active device pair has 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 a global-active device pair due to a host failure.

- Virtual machine integration:
  If a virtual machine is creating a high load at one site, you can simply move it to the other (and data migration is unnecessary).

How global-active device works

A global-active device pair consists of a primary data volume and a synchronous, remote copy on a Hitachi Virtual Storage Platform G1000 (VSP G1000) storage system. A virtual storage machine is set up in a secondary VSP G1000 using the physical information from the primary system. The global-active device primary and secondary volumes are also assigned the same virtual LDEV number in the virtual storage machine. As a result, the paired volumes are treated by the host as a single volume on a single storage system (with both volumes receiving the same data from the host).

The following figure shows an example global-active device configuration.
Global-active device (GAD) pair volumes are monitored by a quorum disk (preferably located at third site). The quorum disk acts as a heartbeat for the GAD pair; the primary and secondary storage systems access the quorum disk periodically to check on the other storage system. In the event of a communication or hardware failure, the quorum disk determines which storage system is still accessible, allowing operations to continue without interruption.

The SAN multipathing software on the host runs in an active-active configuration. If the primary volume (P-VOL) or secondary volume (S-VOL) cannot be accessed, host I/O is automatically redirected to an alternative path. Native multipath software operates at campus distances using cross-site paths (as shown in the previous diagram). At metro distances, Hitachi Dynamic Link Manager (HDLM) offers increased performance using preferred paths (shortest possible route).

**Global-active device storage system configurations**

A global-active device environment can be implemented in one site or across two or three sites.
Global-active device requires three storage systems: primary, secondary, and an external system used for the quorum disk. The configuration can be set up across three, two, or one site.

**Three-site configuration**
- In a three-site configuration (recommended), each storage system is located at a separate site. This configuration provides maximum protection against system or site failures.
- In a two-site configuration, both the primary storage system and the quorum storage system are located at the primary site. This configuration provides a moderate level of protection against system or site failures.
- In a one-site configuration (not shown), all storage systems are located at the same site. This configuration protects against storage system failures but not site-wide failures.

For a complete description of global-active device configurations, requirements, and setup, see:
- *VSP G1000 Global-Active Device User Guide*
- *Hitachi Command Suite User Guide*
- Hitachi Command Suite Dynamic Link Manager documentation
Software management examples

Using a series of examples, this chapter explains how you can manage VSP G1000 using the Hitachi Command Suite management software.

- **Example 1**: Enabling simple and efficient storage provisioning and unified management with Command Suite

- **Example 2**: Ensuring optimal storage performance and business application service levels with data analytics

- **Example 3**: Maximizing business application performance and availability with data mobility
Example 1: Enabling simple and efficient storage provisioning and unified management with Command Suite

Today, financial institutions provide a wide array of services to their customers. These services must support both structured data (online and ATM transactions, such as withdrawing or depositing checks and cash) and unstructured data (such as email messages, SMS text messages, customer feedback, bank statements, and electronic forms). To meet the ever-increasing need for customer access to the services, the institutions must have a solution that meets the following needs:

• Ability to process customer transactions quickly and accurately. At the same time, provide access to online reports (such as account statements) and forms (such as for opening a new bank account or for applying for a mortgage).
• Flexibility to accommodate structured and unstructured data, and ability to access services no matter where the storage system resides.
• Centralized management of all storage repositories to reduce storage management costs and total cost of ownership.

Overall, financial institutions require a platform with the breadth and flexibility to provide services wherever, whenever, and however customers need them.

Solution

Hitachi Command Suite (HCS) software consolidates block and file storage arrays to unify the management of all types of data, and provides a single, integrated view for all customers.

HCS natively discovers Hitachi storage systems, Hitachi NAS systems, and Hitachi Data Ingestor file appliance-based systems, displaying the correlation of VSP G1000 File Module system drives with back-end physical volumes and VSP G1000 File Module storage pools.
HCS discovers and displays related file systems, mount points, and share information for CIFS, and export information for NFS systems. It unifies block, file, and content data across all Hitachi storage and manages all virtualized heterogeneous storage assets.

HCS natively provisions storage to an HNAS cluster the same way as to a physical or hypervisor server, such as the VMware ESX server. It creates and manages file systems, CIFS shares, and NFS exports using the unified, common GUI. Reaching across file, block, content, and application environments, HCS improves business application availability and performance, and expedites access to critical data.

**Example 2: Ensuring optimal storage performance and business application service levels with data analytics**

Banks offer several incentives to its customers. One of them is online banking, which customers have come to prefer. They see the need and growing importance of creating an excellent experience for their online customers. They must provide quick, 24/7 access to online banking services, and must do so across the many devices and platforms used by customers. Customers expect access to these services anytime and from anywhere. If the service is not fast, not available 24/7, and not consistent, customer loyalty can be negatively affected and result in bank account closures.

ATM machines provide yet another critical service to bank customers. ATM transactions have become an essential component of the banking industry. The problem with ATM machines is when they are not functioning.

Banks strive to keep their business-critical services available for customers, but often find the following problems still exist:
• Lack of performance baselines or benchmarks to analyze response time for online banking and ATM applications
• Insufficient root cause analysis (RCA) techniques that look deep into application performance problems, and ineffective existing techniques
• Absence of real-time monitoring capability and analysis of all elements in the customer environment
• No tools to help storage administrators analyze application performance or to determine if the storage is at fault
• Lack of custom reporting capabilities to obtain detailed storage capacity and performance metrics to gain insight into key storage system performance indicators
• Uncertainty whether critical business applications are meeting required storage service levels

Solution

Use Hitachi Command Suite Analytics to monitor performance and meet storage service-level needs.

• To help banks determine how well their online banking service is performing, they must know the current level of performance and benchmark it against an industry best practice. Storage downtime affects system availability for online transactions. One of the best ways to avoid bottlenecks is through regular monitoring, system feedback, and on-demand customizable reporting based on parameters defined by users. The parameters can be based on storage or files, such as EVS, FS, and VVOL utilization, and on capacity reporting, such as on tiers, users, and groups. Instead of reacting to bottlenecks after they occur, administrators can get alerts from HCS Analytics about potential bottlenecks before they occur. Administrators can identify problem performance trends at an earlier stage to avoid system downtime.
HCS Analytics performs end-to-end performance monitoring along the application’s entire data path to quickly determine if storage is the source of application-performance degradation. With this monitoring information, storage administrators can take appropriate measures to remove upcoming bottlenecks and to improve storage (and ultimately application) performance.

- To ensure that critical business applications are meeting required storage service levels and comply with storage service-level requirements, storage administrators can use HCS Analytics to accurately monitor application storage levels and quickly resolve problems. Applications have varying service-level objectives (SLO) based on their business criticality. For important applications, such as online banking and ATM transactions, storage administrators can use HCS Analytics to provide the applications with appropriate storage resources in compliance with defined SLO requirements.

Management software

To ensure business application performance and predictive growth, Hitachi Command Suite Analytics provides all the necessary capabilities to find storage resource trouble spots, identify the actual affected storage resources, and help determine the root cause of problems. It also provides centralized service-level management of mission-critical business applications.

HCS Analytics features Tuning Manager and Command Director:
- *Hitachi Tuning Manager* provides comprehensive storage performance monitoring required to maximize both business application and Hitachi storage system performance. It provides integrated performance analytics that can quickly identify, isolate, and find possible causes of performance bottlenecks. Within the HCS central management console, the integrated
analytics capabilities provide the necessary first step to quickly address performance problems associated with Hitachi storage environments. If additional performance details or diagnosis is required, Tuning Manager includes a web-based interface to provide deeper performance monitoring across a comprehensive range of performance and capacity metrics, with historical trending and custom reporting capabilities.

- **Hitachi Command Director** defines key storage performance and capacity objectives by business application. It features a global storage service-level management dashboard to monitor compliance 24/7 and identify applications at risk. It provides an analysis of application performance and capacity (allocation and utilization) to properly define storage service levels.

Command Director then monitors service levels and storage system health and investigates service-level violations to quickly identify and resolve potential bottlenecks. Command Director also features a new SLO profile recommendation engine. Recommendations are generated automatically based on historical performance data. Users can easily update profile assignments for volumes at application, pool, and volume levels.

### Example 3: Maximizing business application performance and availability with data mobility

Customer service is a top priority for major commercial and retail banks. They strive to maintain good relationships with, and retain current customers as well as attract new ones. They would also like to achieve faster response times for customer transactions involving personal banking or credit cards, and for potential customers inquiring about their services.

In addition to ensuring the timeliness of critical transactions, banks must provide customers with effective processing of mortgage applications from inception to closing.

Banks must optimize the cost of maintaining data gathered from numerous mortgage applications. While users can tolerate slightly slower response times that are required for transactional systems, they are quickly frustrated by consistently slow responses. In a fast-paced business, older and closed mortgage applications lose business relevance quickly, so it does not make sense to store them on fast storage. A lower tier of storage can be used to achieve effective, long-term archiving of inactive data (such as closed or inactive mortgage applications that companies maintain largely in response to legal requirements).

**Solution**

A Hitachi Dynamic Tiering (HDT) pool is added to a VSP G1000 to support mortgage applications. Using Hitachi Command Suite Mobility, a custom
policy is applied to the volumes in the HDT pool that supports the mortgage applications.

The policy is set to ensure that infrequently or never accessed mortgage applications are placed on the lowest cost storage, reducing the total cost of ownership. Conversely, the newest and still-active mortgage applications are promoted to the fastest tier and get the fastest response time.

Management software

To optimize data access and application Quality of Service, Hitachi Command Suite Data Mobility software places data wherever and whenever it is needed. HCS Data Mobility features Dynamic Tiering, Tiered Storage Manager, and the file-tiering capabilities of the Hitachi Virtual Storage Platform G1000 system.

- **Hitachi Dynamic Tiering** automates data lifecycle management at a low cost while delivering top-tier performance to the information most frequently accessed by the business. HDT manages the tiering dynamically. It monitors and manages space utilization at the page level rather than at the file or dataset level. This means that only frequently referenced parts of a file or dataset reside on the highest tier of storage, minimizing the amount of tier 0 storage required for the highly referenced data.

  HDT identifies hot spots of frequent access and moves them to the highest tier of storage to improve storage performance. It also moves less frequently referenced pages to lower tiers of storage. All of this occurs with complete transparency to the application.

- **Hitachi Tiered Storage Manager (HTSM)** proactively matches application performance and availability needs to storage attributes for optimal placement.

- **Intelligent file tiering** improves performance in file-sharing environments by automatically separating metadata from user data, placing metadata on the fastest storage tier for improved response times, while keeping user data on less expensive storage tiers.
The following tables list the manuals available for VSP G1000 and optional Command Suite components (separate license required). For unified configuration with Hitachi NAS Platform, the file-related documentation is also listed.

### Table 6-1 VSP G1000 manuals

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<tr>
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<td>General reference</td>
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<td>VSP G1000 Firmware Release Notes, RN-8001xx-Mxxx</td>
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<td>Hitachi Device Manager Release Notes, RN-00HS266</td>
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<td>Management software setup</td>
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| **Data protection** | VSP G1000 Provisioning Guide for Open Systems, MK-92RD8014  
VSP G1000 Provisioning Guide for Mainframe Systems, MK-92RD8013 |
| **Open** | Hitachi Thin Image User Guide, MK-92RD8011  
Hitachi ShadowImage® User Guide, MK-92RD8021  
Hitachi TrueCopy® User Guide, MK-92RD8019  
Hitachi Universal Replicator User Guide, MK-92RD8023 |
| **Mainframe** | Hitachi ShadowImage® for Mainframe User Guide, MK-92RD8020  
Hitachi TrueCopy® for Mainframe User Guide, MK-92RD8018  
Hitachi Compatible XRC® User Guide, MK-92RD8027  
Hitachi Compatible FlashCopy®/ FlashCopy® SE User Guide, MK-92RD8010 |
| **Analytics** | VSP G1000 Performance Guide, MK-92RD8012  
Hitachi Compatible PAV® User Guide, MK-92RD8026 |
| **Security** | Hitachi Command Suite User Guide, MK-90HC172  
Encryption License Key User Guide, MK-92RD8009  
Hitachi Volume Shredder User Guide, MK-92RD8025 |
| **System maintenance** | Hitachi SNMP Agent User Guide, MK-92RD8015  
| **Troubleshooting** | Hitachi Command Suite Messages, MK-90HC178  
Hitachi SNMP Agent User Guide, MK-92RD8015 |
| **Command line interface** | Hitachi Command Control Interface User and Reference Guide, MK-90RD7010  
Hitachi Command Control Interface Command Reference, MK-90RD7009 |

**Table 6-2 Command Suite optional component manuals**

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<tr>
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| **Software installation** | Hitachi Command Suite Tuning Manager Installation Guide, MK-96HC141  
Hitachi Command Suite Command Director Installation and Configuration Guide, MK-90HCMD002  
Hitachi Command Suite Compute Systems Manager Installation and Configuration Guide, MK-91HC195 |
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| Management software setup | Hitachi Command Suite Replication Manager Configuration Guide, MK-90HC175 |
| Hitachi Command Suite Command Director Installation and Configuration Guide, MK-90HCMD002 |
| Hitachi Command Suite Compute Systems Manager Installation and Configuration Guide, MK-91HC195 |
| Hitachi Command Suite Tuning Manager Agent Administration Guide, MK-92HC013 |

| SAN multipathing | Hitachi Command Suite Compute Systems Manager User Guide, MK-91HC194 |
| Hitachi Command Suite Dynamic Link Manager (for AIX®) User Guide, MK-92DLM111 |
| Hitachi Command Suite Dynamic Link Manager (for Linux®) User Guide, MK-92DLM113 |
| Hitachi Command Suite Dynamic Link Manager (for Solaris) User Guide, MK-92DLM114 |
| Hitachi Command Suite Dynamic Link Manager (for VMware®) User Guide, MK-92DLM130 |
| Hitachi Command Suite Global Link Manager Installation and Configuration Guide, MK-95HC107 |
| Hitachi Command Suite Global Link Manager Messages, MK-95HC108 |

| Provisioning | Hitachi Command Suite Tiered Storage Manager for Mainframe User Guide, MK-92HC207 |

| Data protection | Hitachi Command Suite Replication Manager User Guide, MK-99HC166 |

<p>| Analytics | Hitachi Command Suite Tuning Manager Server Administration Guide, MK-92HC021 |
| Hitachi Command Suite Tuning Manager Agent Administration Guide, MK-92HC013 |
| Hitachi Command Suite Tuning Manager User Guide, MK-92HC022 |
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**Table 6-3  Hitachi NAS Platform manuals**

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<td><em>Hitachi NAS Platform Antivirus Administration Guide, MK-92HNAS004</em></td>
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| System maintenance and repair | *Hitachi NAS Platform 3080 and 3090 G2 Hardware Reference, MK-92HNAS017*  
*Hitachi NAS Platform and Hitachi Unified Storage File Module Series 4000 Hardware Reference, MK-92HNAS030* |
Hitachi Data Systems

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